Fluke 93/95/97
Philips PM93/95/97
SCOPEMETER®

Service Manual

Fluke: 931605
Philips: 4822 872 05352
921201

Warning **These servicing instructions are for use by qualified personnel only. To reduce the risk of electric shock, do not perform any servicing other than that specified in the operating instructions unless you are fully qualified to do so.**

PHILIPS

IMPORTANT

In correspondence concerning this instrument please give the model number and serial number as located on the type number plate on the instrument.

All modifications up to production date 1 December 1992 are incorporated in this manual.

For your reference:

Model number:	PMxx	Flukexx
Code number:	9444 yyy yyyyy	9444 yyy yyyyy
Serial number:	DM nn mmmm(m)	DM nn mmmm(m)

Note: The design of this instrument is subject to continuous development and improvement. Consequently, this instrument may incorporate minor changes in detail from the information contained in this manual.

Printed in The Netherlands

TABLE OF CONTENTS

Page

1 SAFETY INSTRUCTIONS

Read this chapter carefully before installation and use of the instrument.

1.1 INTRODUCTION

The following sections contain information, cautions and warnings which must be followed to ensure safe operation and to keep the instrument in a safe condition.

WARNING: Servicing described in this manual is to be done only by qualified service personnel. To avoid electrical shock, do not service the instrument unless you are qualified to do so.

1.2 SAFETY PRECAUTIONS

For the correct and safe use of this instrument it is essential that both operating and service personnel follow generally accepted safety procedures in addition to the safety precautions specified in this manual. Specific warning and caution statements, where they apply, will be found throughout the manual. Where necessary, the warning and caution statements and/or symbols are marked on the instrument.

1.3 CAUTION AND WARNING STATEMENTS

CAUTION: Is used to indicate correct operating or maintenance procedures in order to prevent damage to or destruction of the equipment or other property.

WARNING: Calls attention to a potential danger that requires correct procedures or practices in order to prevent personal injury.

1.4 SYMBOLS

Caution (refer to accompanying documents)

Common input symbol, equipotentiality.

High BNC input symbol.

Equipment protected throughout by DOUBLE INSULATION or REINFORCED INSULATION

Ground symbol

Recycling symbol

Static sensitive components (black/yellow)

1.5 IMPAIRED SAFETY

Whenever it is likely that safety has been impaired, the instrument must be turned off and disconnected from all external voltage sources, and the batteries must be removed. The matter should then be referred to qualified technicians. Safety is likely to be impaired if, for example, the instrument fails to perform the intended measurements or shows visible damage.

1.6 GENERAL SAFETY INFORMATION

WARNING: Removing the instrument covers or removing parts, except those to which access can be gained by hand, is likely to expose live parts and accessible terminals which can be dangerous to life.

The instrument must be disconnected from all voltage sources and batteries must be removed before it is opened.

Capacitors inside the instrument can hold their charge even if the instrument has been separated from all voltage sources and batteries are removed. Components which are important for the safety of the instrument may only be replaced by components obtained through your local FLUKE/PHILIPS organization. These components are indicated by an asterisk (*) in the parts list section (chapter 9).

2 CHARACTERISTICS

A. Performance Characteristics

- PHILIPS and FLUKE guarantee the properties expressed in numerical values with stated tolerance. Specified non-tolerance numerical values indicate those that could be nominally expected from the mean of a range of identical instruments.

- For definitions of terms, reference is made to IEC Publication 351-1.

- The accuracy of all measurements is within ± {(% of reading) ±(one least-significant digit)} from 18C to 28C.
  Add 0.1 x (specified accuracy)/C for < 18C or > 28C ambient.

B. Safety Characteristics

The instrument has been designed and tested in accordance with IEC Publication 348, Safety Requirements for Electronic Measuring Apparatus, and has been supplied in a safe condition. This manual contains information and warnings that must be followed by the user to ensure safe operation and to keep the instrument in a safe condition.

2.1 DISPLAY

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION
* Type	LCD	
* Useful Screen Area	84 mm x 84 mm	1 div equals 25 pixels. 1 div equals 8.75 mm.
Resolution	240 x 240 pixels	
* Contrast Ratio		Adjustable via LCD Menu.
* Backlight (Model 97 only)	Electro Luminescence	

2.2 SIGNAL ACQUISITION

* Sampling Type		
@ 1 µs/div...60s/div	Real Time	
@ 10 ns/div...500 ns/div	Quasi Random	
* Maximum Sample Rate	25 MS/s	Sampling Rate depends on time/div setting.
* Maximum Vertical (voltage) Resolution	8 bits	Over 10 divisions.
* Maximum Horizontal (time) Resolution	25 Samples/div	Per Channel.
* Record Length		
With capture 20 div	512 Samples	Per Channel.
With capture 10 div	256 Samples	Per Channel.

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION
* Acquisition Time (for 20.4 div)		
60s/div...1 µs/div	20.5 x time/div + 140 ms	Excluding delay time. Delay time is the selected trigger delay.
500 ns/div...10 ns/div	20.5 x time/div + 120 ms	Excluding delay time. In Quasi-Random Mode, the acquisition time depends on triggers.
* Sources	Channel ± A Channel ± B mV Input	Inverted Channel A only for software V4.01 and higher versions.
* Acquisition Modes	1 Channel Only 2 Channels	CHAN A, CHAN B Chopped Mode from 60s/div...50 µs/div. Alternating Mode from 20 µs/div...10 ns/div.

2.3 CHANNELS A & B

* Signal Inputs	Isolated BNC	**Signal input BNC commons are connected together.**
Common Input	Black Safety Banana Jack	Part of External Trigger Input.
* Input Impedance		Frequency dependent, see Figure 2.1.
R parallel	1 MΩ ± 1%	For DC coupled input. For AC coupled input or GND, add 22 nF in series with R and C parallel.
C parallel	25 pF	

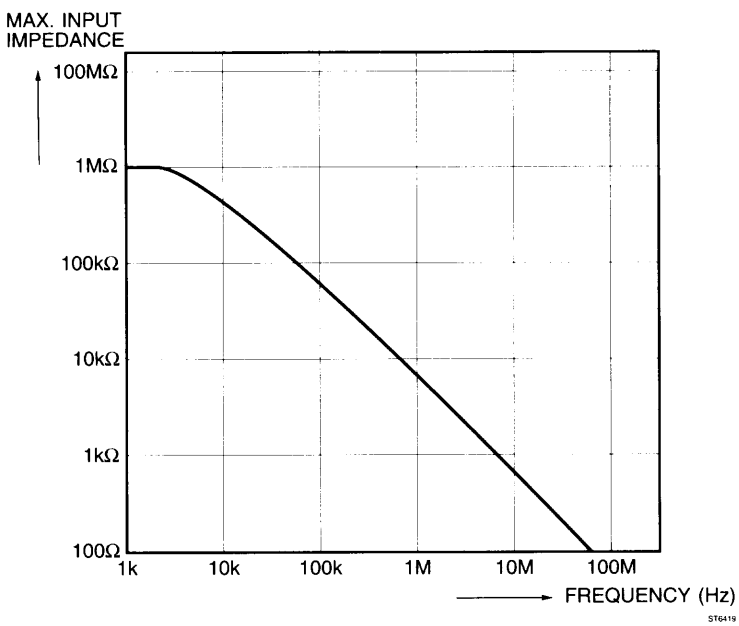


Figure 2.1 Max. Input Impedance Versus Frequency

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION
* Input Coupling	AC DC GND	Sequence: ac-dc-GND (pre-charge ac), and back to ac.
* Maximum Input Voltage (rms)	300 V	Frequency dependent see fig. 2.2 **Between BNC inner and outer contact. Outer BNC contacts and Ground (Black) Banana Jack are internally connected together.**

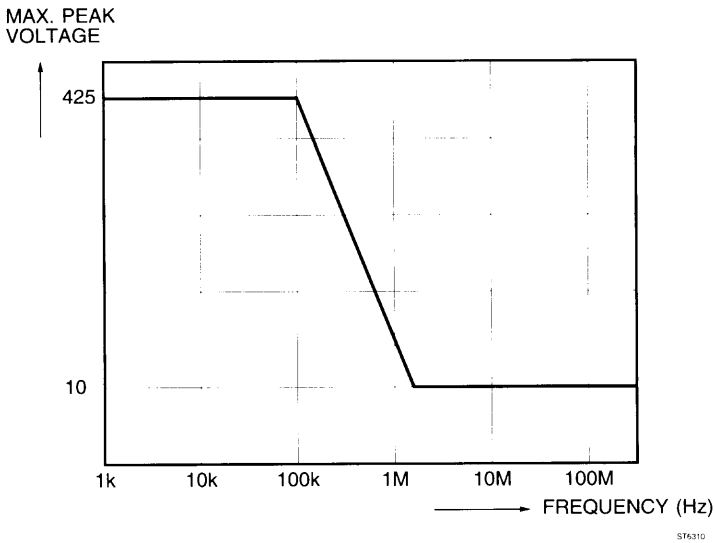


Figure 2.2 Max Input Voltage Versus Frequency

* Deflection Coefficient		
Steps	1 mV/div...2 mV/div (Models 95 and 97 only)	Only for repetitive signals and timebase 60s...1µs. If one of the channels is in this sensitivity, both channels will be switched to Average = 4.
Steps	5 mV/div...100V/div	In a 1-2-5 sequence of 14 positions.
Error Limit Overall Nonlinearity	 ± (2% ± 1 digit) ± (2% ± 1 digit)	 Add 3% for 1 mV and 2 mV per IEC 351 for frequencies < 1 MHz.
* Dynamic Range	9.5 div 4 div	for frequencies < 10 MHz. for frequencies up to 50 MHz.
* Position Range (move control)	- 4 div...+ 4 div	
* Frequency Response		Z source = 50Ω.
Lower Transition Point of Bandwidth		
DC Input Coupling AC Input Coupling - 3dB	DC ≤ 10 Hz	 < 1 Hz including 10 MΩ probe.
Upper Transition Point of Bandwidth	≥ 50 MHz (-3 dB)	Subtract 5 MHz for < 18 °C and > 28 °C Ambient. Rise time 7 ns.

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION
* Max. Baseline Instability		
Jump	0.1 div or 1 mV	The baseline is automatically readjusted after switching the attenuator or AC/DC/GND.
* Average (Models 95 and 97 only)		Running Average.
Maximum Constant	256x	
Constant in Roll	10x	
* MIN MAX (Models 95 and 97 only)		Channel A only.
Timebase setting	≥ 1 µs/div	
Pulse-width for 100% Probability	40 ns	
Pulse-width for 25% Probability	10 ns	
* ZOOM (Models 95 and 97 only)		Expansion or compression in 1,2,5 sequence around the 4th division.
Range for Delay	< 640 div	

2.4 TIMEBASE

* Modes	Recurrent Single Shot Roll	Automatic selected.
* Ranges		
Recurrent	5s/div...10 ns/div	
Dual Channel Chopped	5s/div...50 µs/div	
Dual Channel Alternate	20 µs/div...10 ns/div	
Single Shot	5s/div...10 ns/div	Every sweep needs a trigger. A sweep first; B sweep arms automatically. For 500 ns, 200 ns, and 100 ns; an automatic interpolation takes place. Chopped.
Roll Mode	60s/div...10s/div	
Maximum Timebase Error	± 0.1% ± 1 LSB	

2.5 TRIGGER

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION
* Sources		Selected independently.
Channel A Signal	CHAN A	
Channel B Signal	CHAN B	
External Trigger Input	EXT	
* External Trigger Input **Connector**	Dual Safety Banana Jack	**External Trigger Input common (low) jack is electrically connected to the Channel A and Channel B commons (outer contact of BNC's).**
* External Trigger Input Impedance		
R parallel	1 MΩ ± 1%	If used for mV DC > 1 MΩ.
C parallel	25 pF	Including Banana to BNC adapter.
* Trigger Error		For frequencies < 1 MHz.
Voltage Level	± 1 LSB ± 0.5 div	5s/div...50 µs/div. 20 µs/div...10 ns/div.
Time Delay	± 1 LSB ± 5 ns	
* Maximum External Trigger Input (rms)	300 V	Frequency dependent, see fig. 2.2.
* Trigger Sensitivity		For Models 95 and 97, values must be multiplied by 5 in 2 mV/div. and 1 mV/div.
Channel A or B		
@ 100 MHz	≤ 4 div	
@ 60 MHz	≤ 1.5 div	
@ 10 MHz	≤ 0.8 div	
External Trigger Input		TTL logic compatible using 10:1 attenuation Probe.
* Trigger Slope Selection	positive going negative going	
* Trigger Level Control Range		
Channel A or B	± 4 div	
Trigger at 50%	0.5 x peak/peak value	Measured during 20 ms.
External Trigger Input	Fixed @ TTL:10	Switchable to TTL via set-up menu.

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION
N-cycle mode (Models 95 and 97 only) 5s/div...1 µs/div, N=	2...255	For timebase settings from 20 µs/div...1 µs/div acquisition and trigger on Channel A only.
Events (5s/div...1 µs/div)	1...1023	Start via Ext; count with channel A.
* Trigger Delay		
Range	- 20...640 div	

2.6 SIGNAL MEMORY (MODELS 95 AND 97 ONLY)

* Signal Memory Size		
Memories	8	Memory #1 up to #8.
Memory Depth	512 words	
Wordlength	8 Bit	
Functions	Store	Storage of signals.
	Save	Contents of Channel A and Channel B are saved in temp memory #1 and #2, and (A ± B) in temp memory #3.

2.7 TRACE DISPLAY

* Sources	Channel A Channel B A ± B A vs B	A Maximum of 4 traces plus A vs B can be selected.
	Memory #1 up to #8	(Models 95 and 97 only).
* Position range		
Horizontal	+ 4 div...- 16.5 div	
Vertical	- 4 div...+ 4 div	From screen center, select per trace.

2.8 SETUP MEMORY (MODEL 95 ONLY)

* Memory Size	8 maximum	Combined with waveform.

2.9 SETUP MEMORY (MODEL 97 ONLY)

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION
* Memory Size	10 maximum	Front Panel setups.
* Functions	Save	Actual front panel settings are stored in memory, replacing contents of memory location indicated on LCD.
	Delete	Contents of memory location indicated on LCD are deleted.
	Recall	Actual front panel settings are replaced by contents of memory location indicated on LCD.
With soft up/down keys	Next	Actual settings are replaced by contents of the next (+1) memory location indicated on LCD.
	Previous	Actual settings are replaced by contents of the previous (-1) memory location indicated on LCD.
* Initial setup selection of AUTO SET	only Amplitude only Time Time and Amplitude	
trace identification	on/off	
trigger identification	on/off	
trigger sensitivity external	0.2V/2V	
Clear after Hold/Run	on/off	
refresh time @ RECORD in scope mode	infinite 2 seconds 5 seconds 10 seconds 60 seconds	

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION

2.10 CALCULATION FACILITIES (MODEL 95 ONLY)

* Measurement Functions		Maximum of 5 simultaneous measurement functions.
	delta V delta t RMS value Mean (Average) value Peak to Peak value Rise or Fall time Frequency 1 ÷ delta t Maximum value Minimum value Phase Trigger time to cursor	of portion between portion.
	Ratio	Expression of value in % or absolute on any one of the above values.

2.11 CALCULATION FACILITIES (MODEL 97 ONLY)

* Measurement Functions		Maximum of 5 simultaneous measurement functions.
	delta V delta t RMS value Mean (Average) value Peak to Peak value Rise or Fall time Frequency 1 ÷ delta t Maximum value Minimum value Phase Trigger time to cursor	of portion between portion.
	Ratio	Expression of value in % or absolute on any one of the above values.
* Mathematics	Multiplication Add Subtract Filter Invert Integrate	of whole memory or Channel. For timebase settings 20 µs...10 ns, only displayed Channels can be used.

2.12 CURSORS (MODELS 95 AND 97 ONLY)

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION
* Horizontal		
Display Resolution	25 parts per div	
Digital Readout Resolution	3 digits	
Error Limit	± 0.1% ± 1 LSB	
Cursor Range	Visible part of signal	Cursors cannot pass each other.
* Vertical		
Display Resolution	25 parts per div	
Digital Readout Resolution	3 digits	
Error Limit	± 2%	Referred to input at BNC or Probe tip, after Probe recalibration.

2.13 MULTIMETER

The Multimeter uses the Channel A input for VDC & VAC measurements and the Safety Banana Jack Inputs for Resistance, Diode Test, Continuity, and DC mV measurements. An internal reference is used to optimize the accuracy of the Channel A Input and any probes used. The accuracy of all Multimeter measurements is within ± {(% of reading) + (number of least-significant digits)} from 18 °C to 28 °C with relative humidity up to 90% for a period of one year after calibration. Add 0.1 x (specified accuracy)/C for 18 °C or 28 °C Ambient.

- Displayed range include used probe, if calibrated.
- Values listed are without attenuating probe.
- A Vrms AC and V DC dual display mode is optimized for power line (mains) related measurements.

* DC Voltage		
Ranges	300 mV, 3V, 30V & 300V	Manual or automatic ranging on peak voltage. High Voltage x10 Probe extends measurement to 600V. Peak voltage is 2.5x range, except 375V in 300V range.
Resolution	0.1 mV, 1 mV, 0.01V, & 0.1V	Multiply x10 with High Voltage Probe.
Accuracy	± (0.5% + 5)	
Digital Display	3000 counts	Up to 4500 counts, 3500 counts in 300V range.
Display update	< 300 ms	
Response Time	< 3.5s	
Zeroing	automatic	
Series Mode Rejection Ratio	> 50 dB @ 50 Hz or 60 Hz	

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION
* AC Voltage		
Ranges	300 mV, 3V, 30V, 250V	Manual or automatic ranging on peak voltage. High Voltage x10 Probe extends measurement to 600V. Peak voltage is 2.5x range and 375V in 250V range.
Resolution	0.1 mV, 1 mV, 0.01V, 0.1V	Multiply x10 with High Voltage Probe.
Accuracy (AC Coupled) Using High Voltage 10:1 Probe		Valid from 5%..100% of range. For < 10 Hz with 10:1 probe or < 100 Hz direct (1:1 probe), use function VAC + DC Additinal error ± 1% > 1 kHz
50 Hz...60 Hz 20 Hz...20 kHz 5 Hz...1 MHz	± (1% + 10) ± (2% + 15) ± (3% + 20)	
Accuracy (DC Coupled) Using High Voltage 10:1 Probe		
50 Hz...60 Hz	± (1% + 10)	
1 Hz...20 kHz	± (2% + 15)	
Crest Factor		Meter prevents crest factor errors by autoranging on input waveform peaks.
Digital Display	3000 counts	Up to 4500 counts, at 250V range: 2500.
Display Update	< 300 ms	
Response Time @ Input freq >50 Hz SMOOTH FAST	 < 3.5s < 10s < 1s	
DC Common Mode Rejection Ratio	> 100 dB @ dc	
	> 100 dB @ 50, 60, or 400 Hz	
AC Common Mode Rejection Ratio	> 60 dB @ dc..60 Hz	

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION
* Resistance		
Open Circuit Voltage	< 4V	
Full Scale Voltage 30Ω 300Ω...3 MΩ 30 MΩ	 < 25mV < 250 mV < 2V	
Ranges	30Ω 300Ω, 3 kΩ, 30 kΩ, 300 kΩ, 3 MΩ, 30 MΩ	Manual ranging only [1] Manual or automatic ranging. [1] 30Ω only in software version 4.01 and higher.
Resolution	0.01Ω 0.1W, 0.001 kW, 0.01 kW, 0.1 kΩ, 0.001 MΩ, 0.01 MΩ	
Accuracy	(25% + 25) ± (0.5% + 5)	30Ω range. all other ranges.
Digital Display	3000 counts	Up to 9999 counts in 30Ω range. Up to 3000 counts in 30 MΩ range. Up to 4500 counts in all other ranges.
Measurement Current	0.5 mA...70 nA	Decreases as range increases.
Display Update	< 300 ms	
Response Time SMOOTH FAST	< 3.5s < 10s < 1s	
Protection	600V RMS	
Continuity Beeps if resistance is <:	 5% of selected	
* Diode Test		OL is indicated if measured voltage is > 2.8V.
Maximum Voltage	4V	
Range	2.800V	
Resolution	0.001V	
Accuracy	± (2% + 5)	
Digital Display	3000 counts	If value > 2800 readout gives OL.
Measurement Current	0.5 mA	
Display update	< 300 ms	
Response Time SMOOTH FAST	< 3.5s < 10s < 1s	
Protection	600 V RMS	
Polarity	+ on RED Banana Jack - on BLACK Banana Jack	
Continuity (Alert)	Beeps if reading is below 1V	

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION
* DC mV	Banana Jack Inputs	Used for Accessory (including Temperature) input.
Ranges	300 mV & 3V	Manual or Automatic ranging.
Resolution	0.1 mV & 1 mV	
Accuracy	± (0.5% + 5)	
Digital Display	3000 Counts	Up to 3500 Counts.
Display update	< 300 ms	
Response Time SMOOTH FAST	< 3.5s < 10s < 1s	
Input	+ on RED Banana Jack on BLACK Banana Jack	
* Multimeter Math (Display) Functions (Models 95 and 97 only)		
Relative	ZERO delta	Displayed Value = Reading Reference Reading.
% Change (% Relative)	ZERO % delta	Displayed Value = {(Reading/Reference Reading) -1} x 100.
% Scale		Displayed Value = {(Reading-Set 0% Reading)/(Set 100% Reading-Set 0% Reading)} x 100%.
Set 0% Reference	Set 0%	Present, Maximum, Minimum, Average.
Set 100% Reference	Set 100%	Present, Maximum, Minimum, Average.
Power with respect to 1 mW in selected load resistance	dBm	
Select load resistance	1200, 1000, 900, 800, 600, 500, 300, 250, 150, 135, 125, 110, 93, 75, 60 & 50	
Voltage Ratio in dB with respect to 1V	dBV	
Audio power	WATTS or dBW	
Select load resistance	50, 16, 8, 4, 2 & 1Ω	

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION
* Other Multimeter Operating Modes		
Touch Hold	HOLD	Causes the meter to capture the next measured reading (and beep) when a new stable measurement has been detected. When first enabled, the numeric display is frozen (held) until a stable measurement is detected. Stable measurements are defined as within ± 100 display counts for 4 measurements (~1s.); and above a floor of 200 display counts in volts (300 counts in ac, below 4000 counts in Ω and below 2800 counts in diode). Overload is a valid stable condition except in Ω and diode test.
MIN MAX recording (Models 95 and 97 only)	RECORD	Simultaneous displays of Maximum, Minimum, Peak to Peak, Average, and Present reading.
* Frequency		
Ranging	Automatic	Manual for frequencies < 20 Hz.
Range	1 Hz...5 MHz	
Accuracy	+/- (0.5% + 2 counts)	
Timebase Accuracy	+/- 0.01%	
Resolution	4 digits	
Measuring Time SMOOTH FAST	3.5s < 10s < 1s	gradually degradation from 100 Hz and down. Running average over 32 measurements.
* Duty cycle		For software version V4.01 or higher only.
Range	From <2% to >98%	For signal amplitudes >10% of the input voltage range.
Resolution	0.1%	
Accuracy	± 0.5%	For logic or pulse waveforms.
	$\pm 1\% + \left(\frac{\text{VOLTAGE RANGE}}{\text{RMS INPUT VOLTAGE}} \times 1\%\right)$	For sine or triangle waveforms

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION
* AUTO RANGE		Voltage and Time are coupled.
Voltage Range_Up	3500	Maximum reading in manual range @ 300 mV, 3V, 30V : 4500.
Voltage Range_Down	0300	@external input: 3500.
Time Range_Up 5 ms...50 µs	> 8 periods in display	TIME switch selects manual timebase.
20 µs...1 µs	> 4 periods in display	AUTOSET starts timebase ranging.
Time Range_Down 5 ms...50 µs 20 µs...1 µs	< 1.5 periods in display < 0.75 periods in display	

2.14 AUTO SETTING

* Settling time	3s	The default values are indicated (Model 97 only). If this can be changed with the aid of the SETUP (auto-set) menu, this is shown.
Selectable mode of operation (Model 97 only)	Selected @ initial setup, Complete	
* Display functions		
Channel Baseline	mid screen	One channel display.
Separate	A = + 1 div B = - 1 div	} Dual Channel display.
X-position	zero	SETUP: not affected (Model 97 only).
Y-posit[ion	zero	SETUP: not affected or separation (Model 97 only).
X-expand	x 1	
A vs B	off	SETUP: not affected (Model 97 only).
* Cursors	not affected	if cursors are on a not the selected channel, Channel A. SETUP: not affected (Model 97 only).
Mathematics	off	SETUP: not affected (Model 97 only).

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION
* Text	Not affected	Except for actual setting, that is adapted (Model 97 only).
Trace identification	on	SETUP: OFF (Model 97 only).
* Vertical Acquisition		
Y deflection source	Every source having a triggerable signal at its input	Channel A if no trigger is found.
Input coupling	ac	SETUP: not affected (Model 97 only).
Y deflection		Each channel is independently set.
Input voltage > 20 mV	approx. 5 div	Due to trigger uncertainty at freq. > 2 MHz or at duty cycle <> 50% sensitivity can deviate from above, but signal will remain on the screen.
Input voltage < 20 mV	Channel at 200 mV/div	
Average	off	SET-UP: not affected (Model 97 only).
* Horizontal Acquisition	Free Run Recurrent	
TB Deflection coefficient		
Signal 40 Hz...5 MHz	min. 2, max 6 signal periods over 8 div	
Signal 5 MHz...50 MHz	min. 2, max 20 signal periods over 8 div	
When no trigger found	5 ms/div	
* Triggering		
Delay ≥ 0	Off	SETUP: not affected (Model 97 only).
Negative delay	Not affected	
Triggerable signal @ ext. input	Ext	SETUP: select A or B (Model 97 only).
No signal @ ext input, but trig. signal @ channel A or B	channel A or channel B	Channel with lowest input frequency is selected (Channel A when frequencies are equal).
No triggerable signal. @ any input	Channel A	

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION
Level	40...60% of peak-to-peak value	After Autoset. SETUP: not affected (Model 97 only).
Slope	Positive	SETUP: not affected (Model 97 only).
Events (Models 95 and 97 only)	OFF	SET-UP: not affected (Model 97 only).
N-Cycle (Models 95 and 97 only)	OFF	SET-UP: not affected (Model 97 only).
* Various		
Generator (Model 97 only)	OFF	SETUP: not affected.
Record restart timing (Model 97 only)	OFF	SETUP: 2, 5, 10 or 60s or acquisitions, whichever is the shortest.

2.15 GENERATOR (MODEL 93 AND 95)

* Probe Adjust		A square wave voltage is available via the external trigger input for adjusting probe compensation.
Voltage (p-p)	5V	
Frequency	976 Hz	
Source resistance	400Ω	
* DC Calibration		Including 10:1 attenuation Probe.
Voltage	3V	Inaccuracy is optimized internally.
Source resistance	400Ω	

2.16 GENERATOR (MODEL 97 ONLY)

* Probe Adjust		A square wave voltage is available via the external trigger input for adjusting probe compensation.
Voltage (p-p)	5V	
Frequency	976 Hz	
Source resistance	400Ω	
* DC Calibration		Including 10:1 attenuation Probe.
Voltage (p-p)	3V	Inaccuracy is optimized internally.
Source resistance	400Ω	

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION
* Text	Not affected	Except for actual setting, that is adapted (Model 97 only).
Trace identification	on	SETUP: OFF (Model 97 only).
* Vertical Acquisition		
Y deflection source	Every source having a triggerable signal at its input	Channel A if no trigger is found.
Input coupling	ac	SETUP: not affected (Model 97 only).
Y deflection		Each channel is independently set.
Input voltage > 20 mV	approx. 5 div	Due to trigger uncertainty at freq. > 2 MHz or at duty cycle <> 50% sensitivity can deviate from above, but signal will remain on the screen.
Input voltage < 20 mV	Channel at 200 mV/div	
Average	off	SET-UP: not affected (Model 97 only).
* Horizontal Acquisition	Free Run Recurrent	
TB Deflection coefficient		
Signal 40 Hz...5 MHz	min. 2, max 6 signal periods over 8 div	
Signal 5 MHz...50 MHz	min. 2, max 20 signal periods over 8 div	
When no trigger found	5 ms/div	
* Triggering		
Delay ≥ 0	Off	SETUP: not affected (Model 97 only).
Negative delay	Not affected	
Triggerable signal @ ext. input	Ext	SETUP: select A or B (Model 97 only).
No signal @ ext input, but trig. signal @ channel A or B	channel A or channel B	Channel with lowest input frequency is selected (Channel A when frequencies are equal).
No triggerable signal. @ any input	Channel A	

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION
Level	40...60% of peak-to-peak value	After Autoset. SETUP: not affected (Model 97 only).
Slope	Positive	SETUP: not affected (Model 97 only).
Events (Models 95 and 97 only)	OFF	SET-UP: not affected (Model 97 only).
N-Cycle (Models 95 and 97 only)	OFF	SET-UP: not affected (Model 97 only).
* Various		
Generator (Model 97 only)	OFF	SETUP: not affected.
Record restart timing (Model 97 only)	OFF	SETUP: 2, 5, 10 or 60s or acquisitions, whichever is the shortest.

2.15 GENERATOR (MODEL 93 AND 95)

* Probe Adjust		A square wave voltage is available via the external trigger input for adjusting probe compensation.
Voltage (p-p)	5V	
Frequency	976 Hz	
Source resistance	400Ω	
* DC Calibration		Including 10:1 attenuation Probe.
Voltage	3V	Inaccuracy is optimized internally.
Source resistance	400Ω	

2.16 GENERATOR (MODEL 97 ONLY)

* Probe Adjust		A square wave voltage is available via the external trigger input for adjusting probe compensation.
Voltage (p-p)	5V	
Frequency	976 Hz	
Source resistance	400Ω	
* DC Calibration		Including 10:1 attenuation Probe.
Voltage (p-p)	3V	Inaccuracy is optimized internally.
Source resistance	400Ω	

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION
* LF Sine wave		
Amplitude (p-p)	1V	
Frequency	976 Hz	
Max. Individual Harmonic	3%	
Source resistance	400Ω	
* Square wave		
Amplitude (p-p)	5V	
Frequency	1.95 kHz 976 Hz 488 Hz	} selectable
Source Resistance	400Ω	
* DAC Output Current		Can be used for a component tester.
Amplitude	0 mA...+ 3 mA	In max. 128 amplitude steps. The time for every step can differ.
Max. voltage	2V	
* DAC output voltage		In max. 128 amplitude steps. The time for every step can differ.
Amplitude	- 2V...+ 2V	
Max. Current	± 1 mA	

2.17 POWER ADAPTOR /BATTERY CHARGER

* Input Connector	5 mm Power Jack	Per DIN 45323
* Source Voltage dc		
Nominal	15V dc	
Limits of Operation	8V...20V dc	
* Charging Current		
Instrument ON	60 mA	
Instrument OFF	170 mA	
* Allowable Temperature During Charging	0 °C...45 °C	
* Power Consumption		
Instrument ON	5W	
Instrument OFF	3W	

2.18 POWER SUPPLY

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION
* Battery Voltage Range	4V...6V	The batteries are not charged at delivery. A warning is given if the battery voltage becomes lower than 4.4V. The instrument is switched off if the battery voltage becomes lower than 4 V. If the instrument is Battery Powered, it will switch off automatically after 10 minutes of no operator actions, except in RECORD or ROLL mode.
* Recommended Batteries		
NiCad Battery Pack	PM 9086/001	Only this Battery Pack is internally re-chargeable.
Recharging time	16 hours	
Life time		After 500 cycles the capacity will be > 1100 mAh. The nominal capacity is 2200 mAh.
Operating time	> 4 hours	After Charging for > 15 hours.
Stand Alone Batteries (4x)		
Model	KR27/50 K70 C-CELL	per IEC. per ANSI.
Operating time	> 4 hours	
Temperature Rise of Batteries	20 °C	After instrument has reached a stable operating temperature.
Temperature Range of Alkaline Batteries.		
Working	- 20...65 °C	
Storage	- 30...65 °C	It is recommended to remove the batteries from the instrument when it is stored longer than 24 hours below - 30 °C or above 60 °C. CAUTION! UNDER NO CIRCUMSTANCES SHOULD BATTERIES BE LEFT IN THE INSTRUMENT @ TEMPERATURES BEYOND THE RATED SPECIFICATIONS OF THE BATTERIES BEING USED!

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION

2.19 MECHANICAL

* Height	262 mm	With holster 281 mm.
* Width	129 mm	With holster 140 mm.
* Depth	60 mm	With holster 62 mm.
* Weight	1.5 kg	With holster ca 1.8 kg.

2.20 ENVIRONMENTAL

The characteristics are valid only if the instrument is checked in accordance with the official checking procedure.

* Meets Environmental Requirements of:	MIL-T-28800D Type III Class 3, Style C	
* Temperature		Batteries removed from instrument unless batteries meet the required temperature specifications. Maximum Operating Temperature derated 3 °C for each km. (each 3000 feet) above sea level.
Operating	0 °C...50 °C	
Non Operating (Storage)	- 20 °C...70 °C	
* Maximum Humidity		
Non Operating (Storage)	95% Relative Humidity	
Operating 20 °C...30 °C 30 °C...50 °C	 90% 70%	
* Maximum Altitude		Memory backup batteries removed from instrument unless batteries meet maximum altitude specifications.
Operating	3 km (10 000 feet)	
Non Operating (Storage)	12 km (40 000 feet)	
* Vibration (Operating)		
Frequency 5...15 Hz	Sweep Time 7 min.	
Excursion (pk to pk)	1.5 mm	
Max Acceleration	7 m/s^2 (0.7 x g)	@ 15 Hz.
Frequency 15...25 Hz	Sweep Time 3 min.	

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION
Excursion (pk to pk)	1.0 mm	
Max Acceleration	13 m/s^2 (1.3 x g)	@ 25 Hz.
Frequency 25...55 Hz	Sweep Time 5 min.	
Excursion (pk to pk)	0.5 mm	
Max Acceleration	30 m/s^2 (3.0 x g)	@ 55 Hz.
Resonance Dwell	10 min.	@ each resonance frequency (or @ 33 Hz if no resonance is found).
* Shock (Operating)		
Number of shocks	18 Total 6 Each Axis	(3 in each direction).
Shock Wave Form	Half Sine	
Duration	6...9 ms	
Peak Acceleration	400 m/s^2 (40 x g)	
* Bench Handling Meets requirements of:	MIL-STD-810, Method 516, Procedure V	
* Salt Atmosphere Structural parts meet	MIL-STD-810, Method 509, Procedure I with 5 % salt solution	
* EMI (Electro Magnetic Interference) Meets requirements of:	MIL-STD-461 Class B	Applicable requirements of Part 7: CE03, CE07, CS01, CS02, CS06, RE02, RS03.(RS02: max 2 div distorsion in 20 mV/div).
	VDE 0871 and VDE 0875 Grenzwertklasse B	
Packing meets requirements of:	UND 1400	
Transportation meets requirements of:	AN-D628	
Packaged Transportation Drop meets requirements of:	Nat. Safe Transp. Assoc. Procedure 1A-B-2	

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION
Packaged Transportation Vibration meets requirements of:	Nat. Safe Transp. Assoc. Procedure 1A-B-1	
* ESD (ElectroStatic Discharge) meets requirements of:	IEC 801-2	Test severity level 15 kV.

2.21 INTERFACE (MODEL 97 ONLY)

* Type of interface	RS-232-C	Optical.
Plug	9 pole D-plug male	
* Spacing "0" "1"	 Light No light	
* Interface function repertoiry for printers		
Baud Rate	1200, 9600	Input and Output are the same.
Number of STOP bits Parity Character length	1 No 8	
Tranmission mode	Asynchronous, full duplex	
Handshake	XON/XOFF	Software handshake only.
* Interface function repertoiry for interface		
Baud Rate	75...19K2	Input and Output are the same. Selectable by controller.
Number od STOP bits Parity Character length	1 No, Odd or Even 8	
Tranmission mode	Asynchronous, full duplex	
Handshake	XON/XOFF or no Handshake	Software handshake only; default: no Handshake.
* Print facilities		
Protocol	EPSON FX, LQ compatible HP ThinkJet compatible	
Print out	Screen log of readings: single every 2, 5, 10 or 60s selectable waveform	

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION
* Front Panel Control		
Modes	Local	Front panel exclusively under manual control.
	Remote-locked	Front panel exclusively under RS-232-C control.
	Remote-unlocked	Return To Local by User ReQuest
* CPL Protocol implemented:		
Go to Remote	GR	
Go to Local	GL	
Local Lockout	LL	
Reset Instrument (Master Reset)	RI	
Status Query	SQ	
IDentification query	ID	Restricted; only 0= 1= 2= . Gives Type number and software version.
Auto Setup	AS	
Default Setup	DS	Default Scope setting.
Program Setup	PS	Has to be done with the string that comes out with QS.
Query Setup	QS	
Recall Setup	RS	
Save Setup	SS	
Program Communication parameter	PC	
Arm Trigger	AT	
Trigger acquisition	TA	
Query Waveform	QW	
Program Waveform	PW	
Query for Measurement data	QM	

2.22 SAFETY

* Meets requirements of:	IEC 348 Class II VDE 0411 Class II ANSI/ISA S82 UL 1244 CSA C22.2 No. 231	With or without battery charger.
* Approvals	UL 1244 (applied for) CSA C22.2 No. 231	With or without battery charger.

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION

2.23 ACCESSORIES

* Accessories furnished with instrument:	Users Manual Quick Operating Guide	
	PM 8918/002	2 x 10 MΩ 10:1 Passive Probe, 1.5m.
ScopeMeter Accessory set: 2 x HF adapter 2 x High voltage testpin 2 x Earth lead 2 x Trim screwdriver 4 mm adapter Banana to BNC adapter	PM9081/001	shrouded.
Set Testleads and Testpins: 2 x testleads 2 x testpins 2 x banana adapter		1.5m.
Holster	PM 9083/001	
Accessory case	C 75	
Power Adaptor/Battery Charger:		Depends on model:
	PM 8907/001	Universal Europe.
	PM 8907/003	North American.
	PM 8907/004	United Kingdom.
	PM 8907/008	Universal 115V/ 230V.
PM9080/001 (Model 97 only)		RS-232-C Interface

2.24 SERVICE AND MAINTENANCE

* Main Time Between Failures (MTBF)	40 000 hours	Predicted value, calculated through parts counting method, according to MIL HDBK- 217E.
* Calibration Interval	1 year	
* Mean Time To Calibrate (MTTC)	30 minutes	

3 CIRCUIT DESCRIPTIONS

3.1 INTRODUCTION TO CIRCUIT DESCRIPTION

3.1.1 General

This chapter presents a layered description of the ScopeMeter circuitry. First the ScopeMeter's overall theory of operation is described, referring to the overall block diagram (section 3.2).
The next section gives some information concerning the ScopeMeter's data acquisition.
Then the circuits on both digital (A1) and analog (A2) printed circuit boards (PCB) are described. After a short introduction, a detailed circuit description is given for each circuit part.

The various circuit descriptions refer to the circuit diagrams in chapter 10.

NOTE: The large digital (A1) and analog (A2) printed circuit board diagrams are provided as separate drawings. Whenever a signal line continues on another drawing, it is indicated by the following comment:

"FROM A1" ----> coming from the digital (A1) circuit (figure 10.2)

"TO A2a" ----> the signal continues on the first circuit diagram of the analog A2 PCB (figure 10.5)

3.1.2 Location of electrical parts

The item numbers of C..., R..., V..., N..., D... and K... have been divided into groups. These groups relate to the functional parts on the PCBs:

Table 3.1 Location of electrical parts

Item number	Functional part	PCB diagram	
1200-1299	µP, Digital ASIC and related circuitry	A1	A1
1300-1399	battery sense, RAM power, backlight	A1	A1
1400-1499	LCD and related circuitry	A1	A1
1500-1599	ON/OFF circuit	A1	A1
1600-1699	keypad	A1	A1
2100-2199	attenuator channel B	A2	A2a
2200-2299	attenuator channel A	A2	A2a
2300-2399	Analog ASIC and ADC	A2	A2a/b
2500-2599	battery charger and power supply	A2	A2c
2700-2799	EXTernal input-/output circuitry	A2	A2b
2800-2899	generator	A2	A2b
2900-2999	analog control circuitry	A2	A2a

3.2 FUNCTIONAL BLOCK DESCRIPTION

3.2.1 Introduction

This section contains an overall block diagram of the ScopeMeter. Refer to figure 3.1.

The block diagram can be divided in two parts. The upper part of the diagram shows the components that are situated on the Printed Circuit Board (in the following text: PCB), that is connected to the ScopeMeter's bottom cover. Because this PCB contains mainly analog circuits, it is called the **analog A2 PCB**.

The lower part of the diagram contains the digital circuitry of the ScopeMeter. This circuitry is located on the **digital A1 PCB**, the PCB connected to the ScopeMeter's top cover.

The general layout of the block diagram is the same as the layout of the circuit diagrams in chapter 10. The circuits that can be found on the same circuit diagram (chapter 10) are placed in a dashed box in the *block diagram.*

Analog A2 PCB
The signals at the red and gray BNC input connectors are attenuated by the **CHANNEL A ATTENUATOR** section and the **CHANNEL B ATTENUATOR**. These attenuators are set by the Microprocessor (on the digital A1 PCB) via the **ANALOG CONTROL CIRCUIT**. Also input protection circuits are provided here.

The output signals of the attenuator blocks are fed to the **ANALOG ASIC** (ASIC = Application Specific Integrated Circuit). This component is controlled by the ScopeMeter's microprocessor (on the digital A1 PCB). The Analog ASIC incorporates signal amplification and channel selection. It also prepares the signal for sampling by the **Analog to Digital Converter (ADC)**.

The red and black banana connectors are connected to the **EXTERNAL (BANANA) INPUT/OUTPUT CIRCUIT**. When the ScopeMeter is set to mV, DIODE or OHM METER mode, the External (banana) input/output circuit outputs its signal into the Channel A Attenuator section. In SCOPE mode, the circuit can act as a trigger input. The trigger signal is fed to the Analog ASIC. In the Analog ASIC "channel A", "channel B" or "External trigger" can be selected as trigger source. The trigger signal is used to generate the DELTA- T voltage (time relation between trigger moment and sampling moment).

The built-in **GENERATOR** uses the External (banana) input/output circuitry as output. It is possible to generate a DC voltage and a square wave voltage. ScopeMeter model 97 also can generate sine wave voltages, a ramp voltage, and a ramp current.

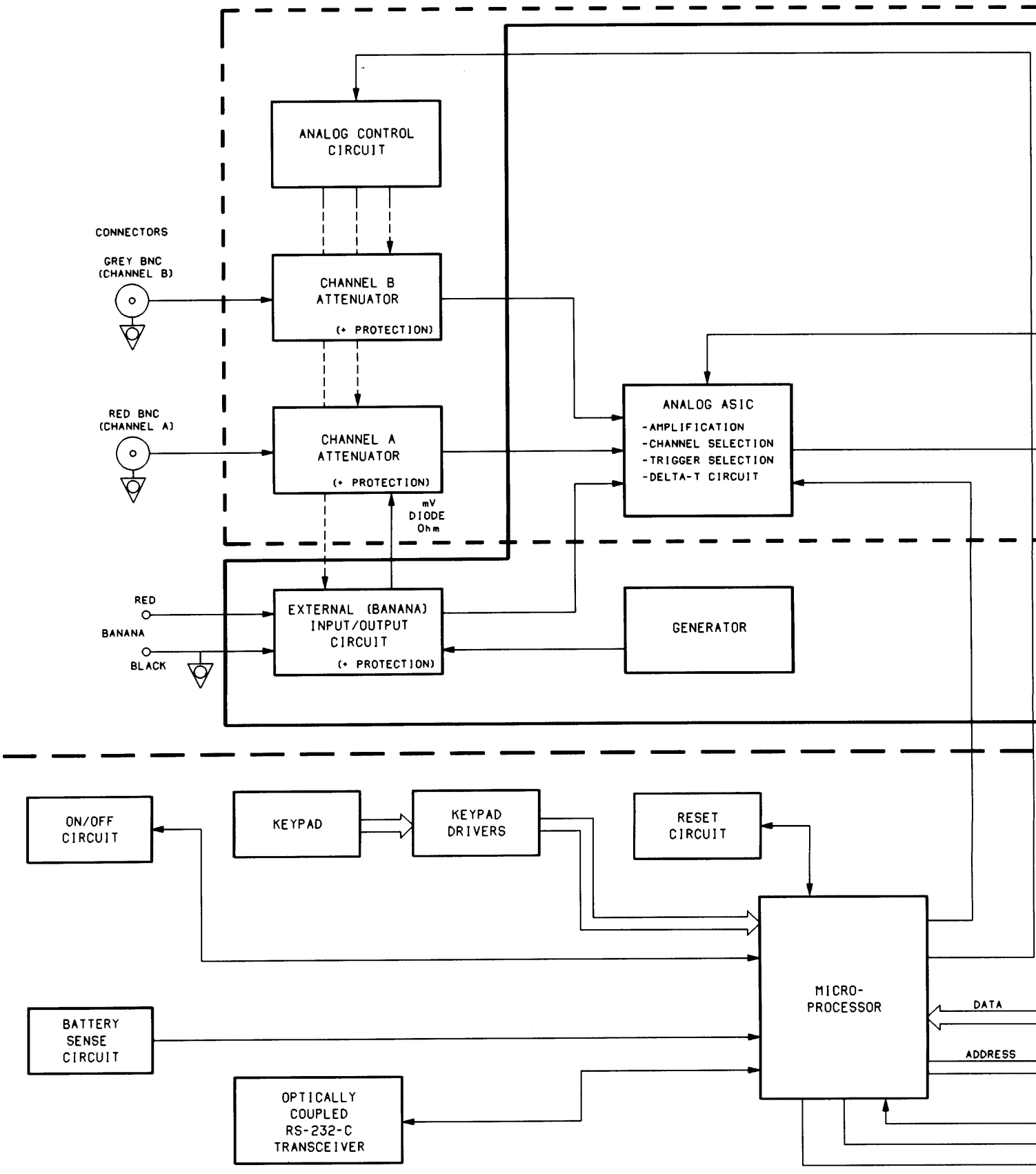
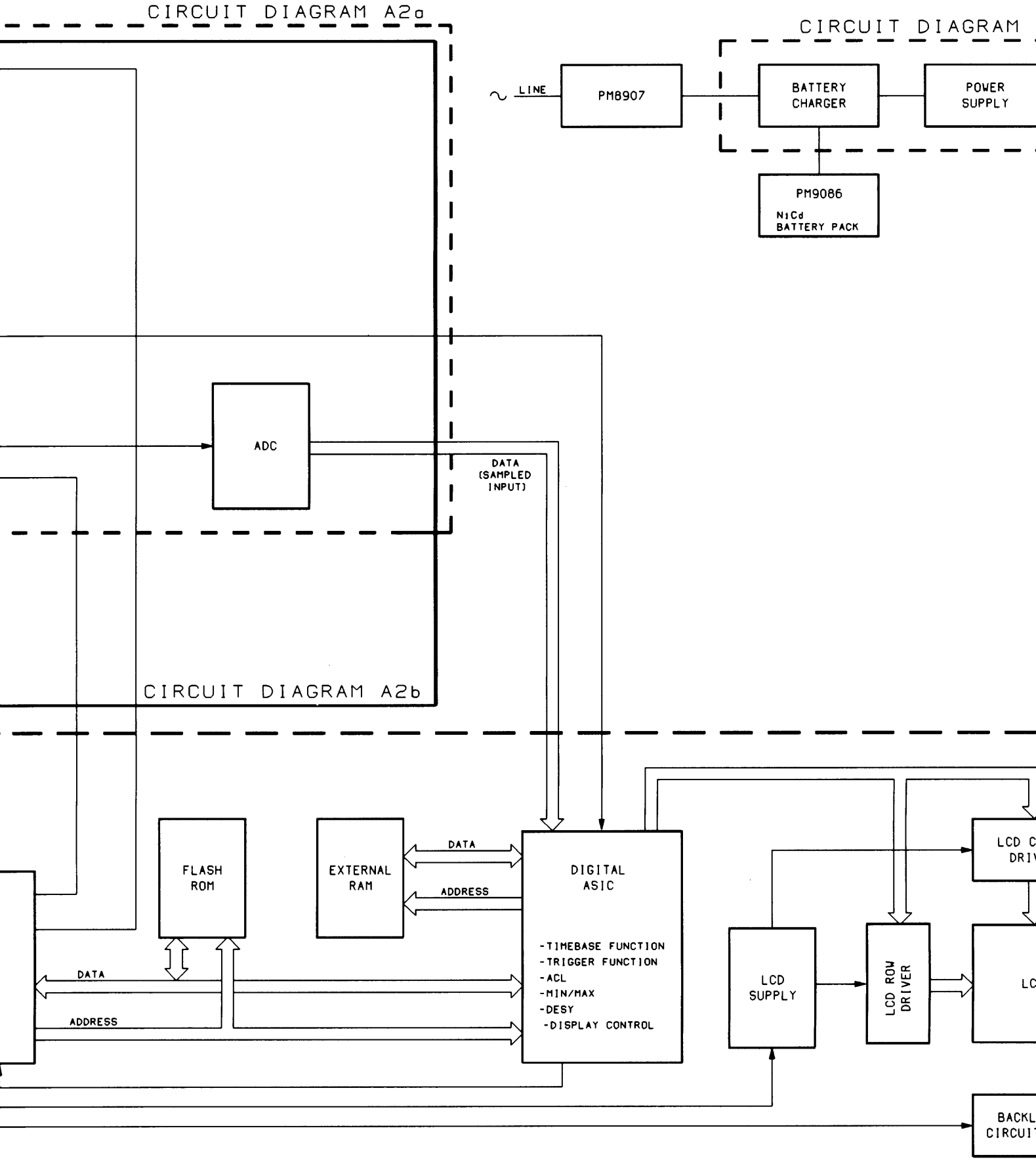
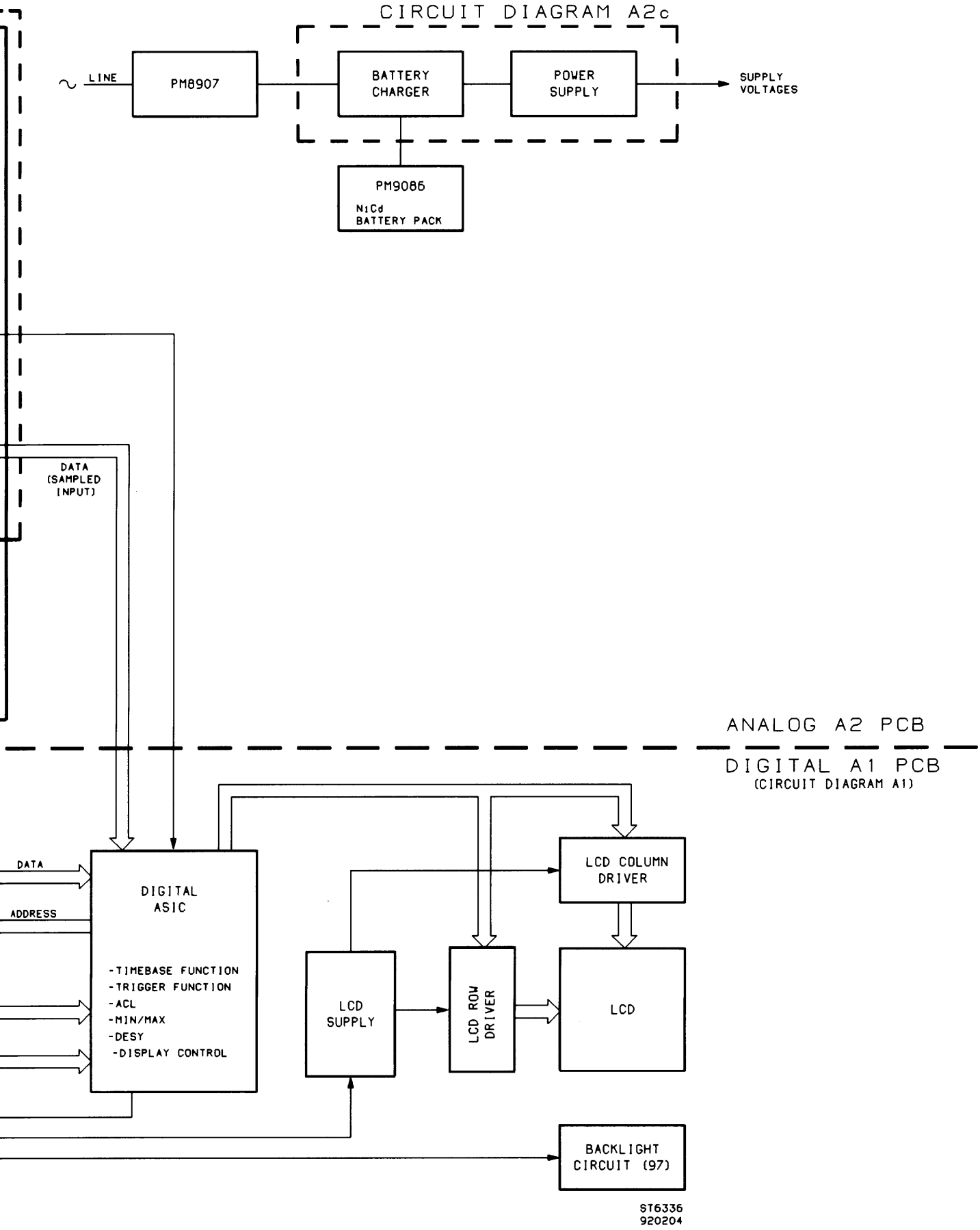


Figure 3.1 Overall Functional Block Diagram ScopeMeter


CIRCUIT DIAGRAM A2a
CIRCUIT DIAGRAM
LINE
PM8907
BATTERY CHARGER
POWER SUPPLY
PM9086
NiCd BATTERY PACK
ADC
DATA (SAMPLED INPUT)
CIRCUIT DIAGRAM A2b
FLASH ROM
EXTERNAL RAM
DATA
ADDRESS
DIGITAL ASIC
-TIMEBASE FUNCTION
-TRIGGER FUNCTION
-ACL
-MIN/MAX
-DESY
-DISPLAY CONTROL
LCD SUPPLY
LCD ROW DRIVER
DATA
ADDRESS


CIRCUIT DIAGRAM A2c
LINE
PM8907
BATTERY CHARGER
POWER SUPPLY
SUPPLY VOLTAGES
PM9086
NiCd BATTERY PACK
DATA (SAMPLED INPUT)
ANALOG A2 PCB
DIGITAL A1 PCB
(CIRCUIT DIAGRAM A1)
DATA
ADDRESS
DIGITAL ASIC
-TIMEBASE FUNCTION
-TRIGGER FUNCTION
-ACL
-MIN/MAX
-DESY
-DISPLAY CONTROL
LCD COLUMN DRIVER
LCD SUPPLY
LCD ROW DRIVER
LCD
BACKLIGHT CIRCUIT (97)
ST6336
920204

The power supply circuitry is also located on the analog A2 PCB. The separate Power adapter/battery charger **PM8907/...** converts the line voltage into 15V DC. This voltage is used by the **BATTERY CHARGER** to charge a **NiCad BATTERY PACK (PM9086/001)**, if present.

The **POWER SUPPLY** section transforms the input voltage (line operated) or the battery voltage (battery operated) into the supply voltages for the various ScopeMeter circuits on A1 and A2.

Digital A1 PCB
The ScopeMeter is controlled by the **MICROPROCESSOR**, located on the digital A1 PCB. This microprocessor performs several control tasks, for example:

- Scanning the **KEYPAD** for user commands. The keypad is connected to the microprocessor via the **KEYPAD DRIVERS**.
- Communication with the outside world via the **OPTICALLY COUPLED RS-232-C TRANSCEIVER**. This section contains an Infrared LED (transmitter) and a phototransistor (receiver).
- Monitoring the battery voltage (**BATTERY SENSE CIRCUIT**).
- Controlling the Analog ASIC on the analog A2 PCB.
- Switching the power on or off (**POWER ON/OFF CIRCUIT**).
- Performing a proper RESET at power on (**RESET CIRCUIT**).
- Controlling the analog A2 circuits (via the **ANALOG CONTROL CIRCUIT**).
- Signal processing of acquired data. The microprocessor reads, calibrates and stores the acquired data.

The **DIGITAL ASIC** is the core of the ScopeMeter's digital circuitry. It provides:

- Timebase functions. For example: the ScopeMeter's ADC sampling signal is generated by the Digital ASIC.
- Trigger functions (in real-time sampling mode).
- Acquisition Control Logic (ACL). This function controls the acquisition according to trigger and acquisition modes. The Digital ASIC contains acquisition RAM for quick data storage.
- Min/Max mode.
- Decoding of the internal ASIC addresses and synchronization of Digital ASIC and microprocessor access to the acquisition RAM.
- Display control. The Digital ASIC generates the picture to be displayed on the LCD.

The picture, generated by the Digital ASIC is displayed on the **Liquid Crystal Display (LCD)**. The LCD is controlled by the **LCD ROW DRIVERS** and the **LCD COLUMN DRIVERS**. The **LCD SUPPLY** section provides for the voltages needed. ScopeMeter model 97 has a **BACKLIGHT CIRCUIT**, which can illuminate the LCD.

3.2.2 Data acquisition

- Data acquisition path in the ScopeMeter

The analog input signals are first attenuated and/or amplified and then converted into digital values by the ADC. The samples of the input signals are stored in the Acquisition RAM of the Digital ASIC. If 512 samples are stored in memory, the second trigger pulse will signal the microprocessor that the acquisition is ready. (We assume that the ScopeMeter is using random repetitive sampling, see next section.) Then the acquired data is ready for processing. The microprocessor reads the data from the Acquisition RAM and processes the data according to the actual calibration values. These calibration values (constants) are copied from Flash ROM to RAM during startup. The calibration values have been stored in Flash ROM during the calibration process. After processing, the data is stored in the External RAMs. These RAMs also contain the more static picture elements, for example the grid-, cursor- and text data.

- A multitasking kernel for hardware and software scheduling

Processing the acquired data is only one of the tasks of the microprocessor. The ScopeMeter uses a multitasking kernel for hardware and software scheduling, based on internal and external interrupts. The microprocessor contains internal timers, which can be programmed by the software. One of these timers is used to generate interrupts, e.g. to scan the keypad for depressed or released keys.

Except processing (calibrating) the acquired data, the microprocessor also does mathematical computations and controls the hardware. The multitasking kernel takes care that every 20 ms of processing time, a task is interrupted. This task will then be held and rescheduled, unless it requires execution without interruption. In this way a variety of user-requested tasks can be handled quasi-simultaneously, without the user being aware of the heavy loads on the microprocessor. The display of the data on the LCD is done by the Digital ASIC, also taking part in the multitasking scheme.

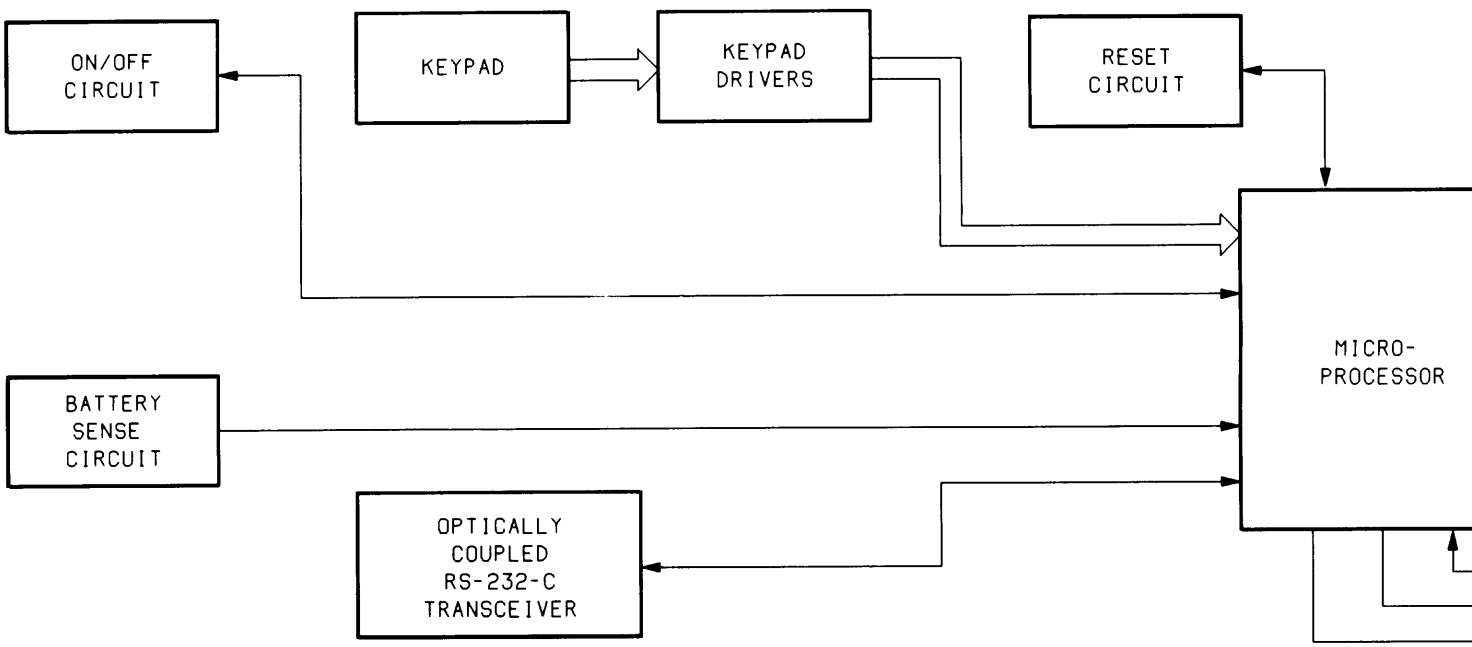
- Sampling and Triggering

The ScopeMeter uses two types of sampling, commonly used in many Digital Storage Oscilloscopes: **REAL-TIME SAMPLING** and **RANDOM REPETITIVE SAMPLING**.

In the real-time sampling mode (timebase settings: 60s/div...1 µs/div) the ScopeMeter takes a series of samples from a single period of the input signal. These samples are later used to reconstruct the signal. During the real-time sampling mode, the Digital ASIC calculates the trigger pulses out of the acquired data (for timebase settings between 60s/div...50 µs/div). For timebase settings between 20 µs/div and 1 µs/div, the triggering is done by the Analog ASIC, using analog comparators.

In random repetitive sampling mode, the ScopeMeter takes a sample from successive cycles in a repetitive signal. These samples are stored in memory and combined to reconstruct the original signal.

In this sampling mode, samples are taken from the input signal at intervals determined by the internal ScopeMeter clock. Since there is no time-correlation between the system's clock and the incoming signal, all samples are taken at random points of the signal. The time between the trigger moment and the sampling moment must be tracked to enable reconstruction of the signal from the samples. This time, DELTA T, is generated by the Analog ASIC. See section 3.4.5 and figure 3.12.
During random repetitive sampling mode, the ScopeMeter always uses analog triggering (Analog ASIC).


ON/OFF
CIRCUIT
KEYPAD
KEYPAD
DRIVERS
RESET
CIRCUIT
MICRO-
PROCESSOR
BATTERY
SENSE
CIRCUIT
OPTICALLY
COUPLED
RS-232-C
TRANSCEIVER

3.3 DIGITAL CIRCUITS

3.3.1 Introduction

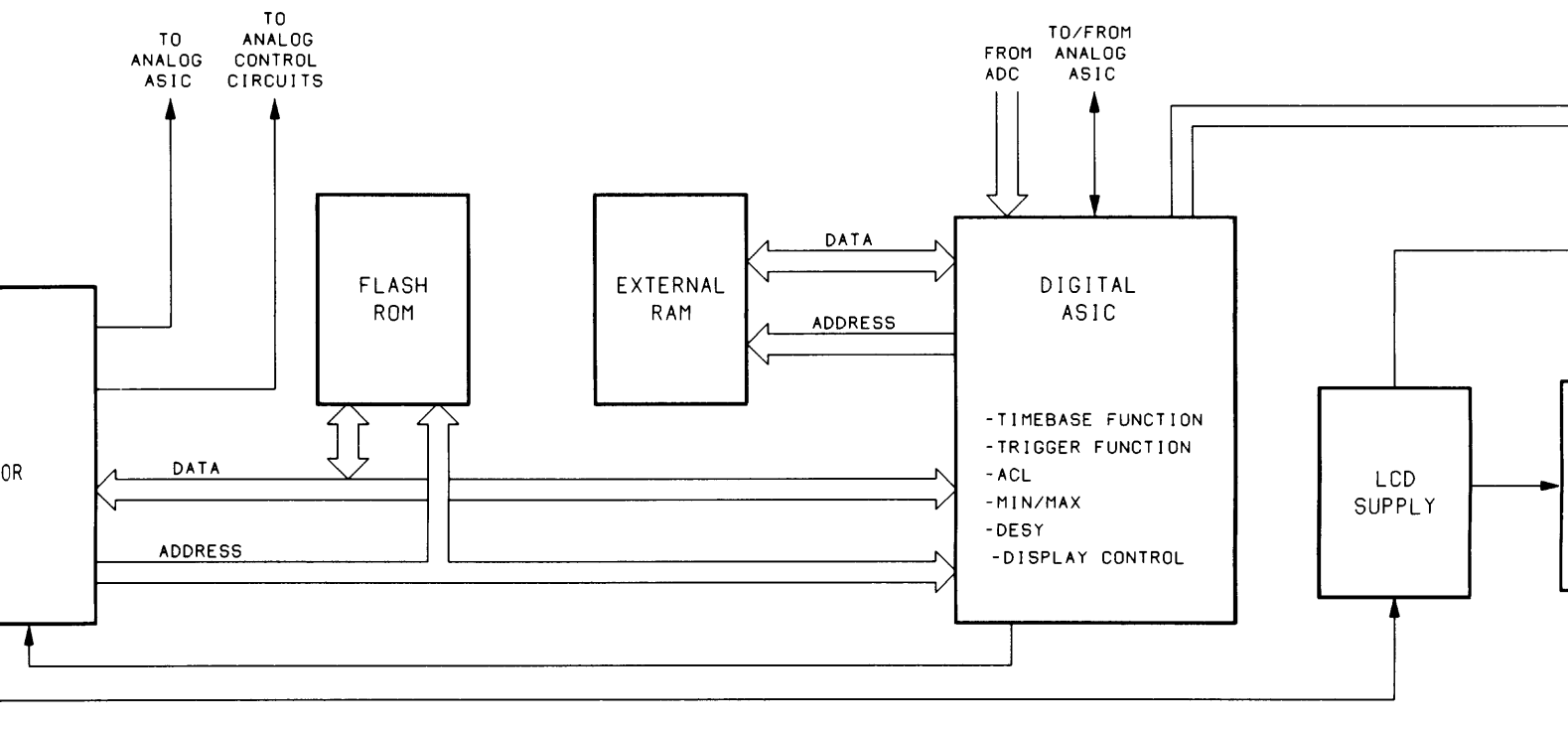
The following paragraphs des
A1 (figure 10.2 in chapter 10)

3.3.2 Overview digital circuit

The digital circuitry of the Sco

- Microprocessor circuitry
- Digital ASIC (in the followi
- LCD circuitry

A block diagram, which clearl
figure 3.2



3.3 DIGITAL CIRCUITS (A1)

3.3.1 Introduction

The following paragraphs describe the circuits on the digital A1 PCB in detail. Refer to circuit diagram A1 (figure 10.2 in chapter 10).

3.3.2 Overview digital circuits

The digital circuitry of the ScopeMeter can be separated into three main parts:

- Microprocessor circuitry
- Digital ASIC (in the following text: D-ASIC) circuitry
- LCD circuitry

A block diagram, which clearly shows the connections between these main parts, is shown in figure 3.2

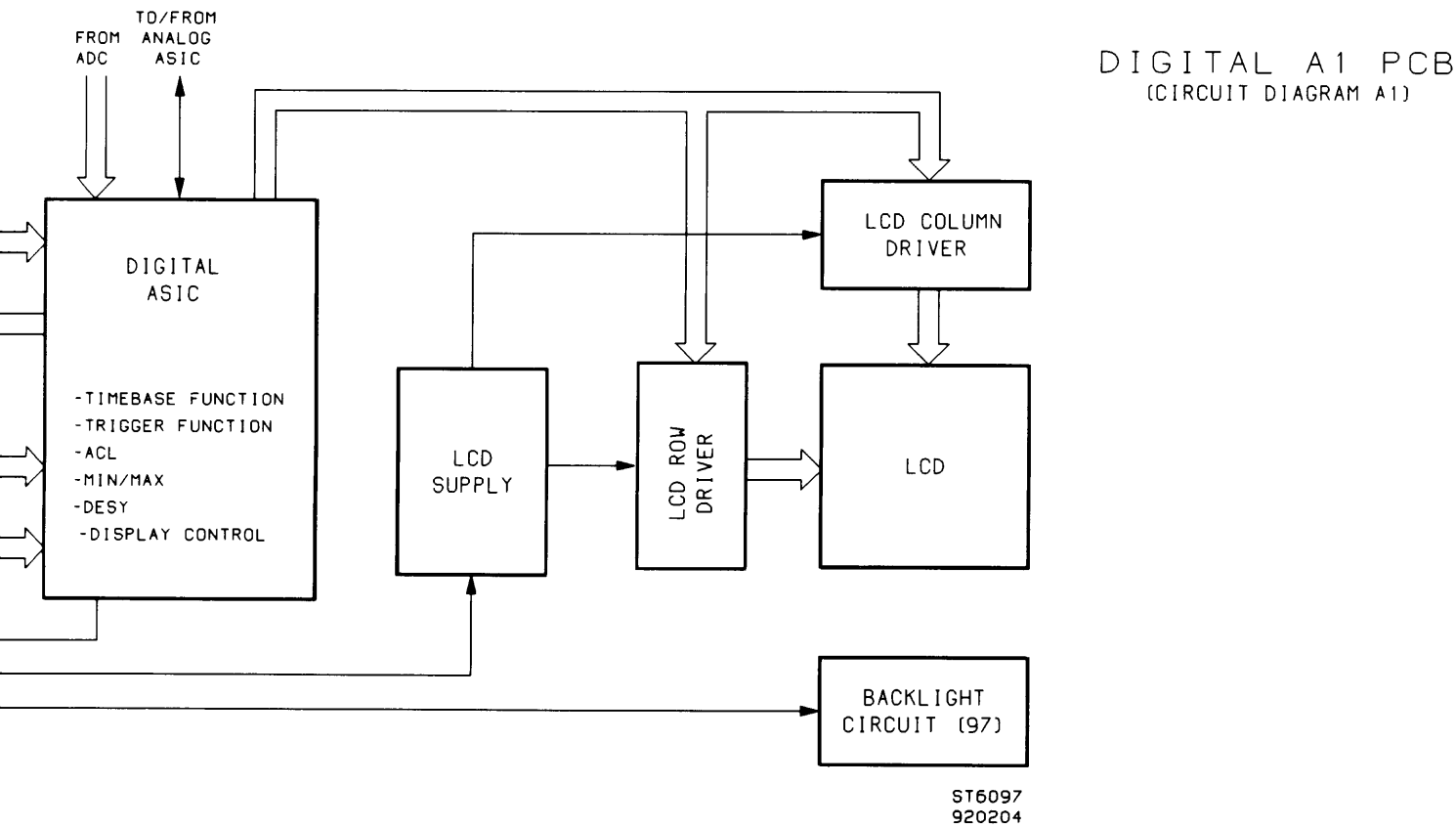


Figure 3.2 Block diagram main parts digital circuitry

- A multitasking kernel for hardware and software scheduling

Processing the acquired data is only one of the tasks of the microprocessor. The ScopeMeter uses a multitasking kernel for hardware and software scheduling, based on internal and external interrupts. The microprocessor contains internal timers, which can be programmed by the software. One of these timers is used to generate interrupts, e.g. to scan the keypad for depressed or released keys.

Except processing (calibrating) the acquired data, the microprocessor also does mathematical computations and controls the hardware. The multitasking kernel takes care that every 20 ms of processing time, a task is interrupted. This task will then be held and rescheduled, unless it requires execution without interruption. In this way a variety of user-requested tasks can be handled quasi-simultaneously, without the user being aware of the heavy loads on the microprocessor. The display of the data on the LCD is done by the Digital ASIC, also taking part in the multitasking scheme.

- Sampling and Triggering

The ScopeMeter uses two types of sampling, commonly used in many Digital Storage Oscilloscopes: **REAL-TIME SAMPLING** and **RANDOM REPETITIVE SAMPLING**.

In the real-time sampling mode (timebase settings: 60s/div...1 µs/div) the ScopeMeter takes a series of samples from a single period of the input signal. These samples are later used to reconstruct the signal. During the real-time sampling mode, the Digital ASIC calculates the trigger pulses out of the acquired data (for timebase settings between 60s/div...50 µs/div). For timebase settings between 20 µs/div and 1 µs/div, the triggering is done by the Analog ASIC, using analog comparators.

In random repetitive sampling mode, the ScopeMeter takes a sample from successive cycles in a repetitive signal. These samples are stored in memory and combined to reconstruct the original signal.

In this sampling mode, samples are taken from the input signal at intervals determined by the internal ScopeMeter clock. Since there is no time-correlation between the system's clock and the incoming signal, all samples are taken at random points of the signal. The time between the trigger moment and the sampling moment must be tracked to enable reconstruction of the signal from the samples. This time, DELTA T, is generated by the Analog ASIC. See section 3.4.5 and figure 3.12.
During random repetitive sampling mode, the ScopeMeter always uses analog triggering (Analog ASIC).

3.3.3 MICROPROCESSOR circuitry (µP)

- Introduction

The ScopeMeter is controlled by a single chip microcomputer with on-board ROM (called Mask ROM in the following text). This microprocessor controls the total system operation and communication between the ScopeMeter and the outside world (key pad, RS-232-C interface). It also controls the communication between the internal system components.

- Detailed circuit description

See figure 3.2 and circuit diagram A1 (figure 10.2).

The ScopeMeter uses an Intel 83C196 microprocessor D1201, with on-board Mask-programmed ROM (Mask ROM). This microprocessor has an 8-bit data bus and a 16-bit address bus. The lower 8 address bits A0...A7 are combined with the data bits (multiplexed data bus). ADDRESS LATCH D1210 is used to separate data bits and address bits.

The microprocessor's Mask ROM contains the startup software and a diagnostic kernel test (see chapter 7). It also contains the software necessary to drive the serial interface and to clear and program the Flash ROMs.

The two Flash ROMs (FROMs) D1207 and D1208 contain the system software. The FROMs are directly connected to the microprocessor via the dat and address busses. The microprocessor addresses the RAMs via the D-ASIC (D1203).

The microprocessor contains five 8-bit I/O ports. Port 3 and 4 share their bits with the data and address busses. The other I/O ports 0, 1, 2 are used for various purposes. For example: reading the keypad, operating the RS-232-C interface, battery voltage sense, switching the power on/off, etc.

Keypad circuitry

The keypad circuitry consists of five shift registers, D1601...D1606, each of which has eight inputs. These inputs are normally kept "high" by 56 KΩ resistor arrays connected to the +5V supply voltage. Whenever a key on the keypad is pressed, the corresponding line is connected to ground, resulting in a "low" signal. All signals are clocked into the shift registers (with the FRONT_CLOCK and FRONT_LATCH signals). Then they are converted into two signals FRONT_DATA1 (shift registers D1603, D1604, D1606) and FRONT_DATA2 (D1601 and D1602).

Optically isolated RS-232-C interface

The serial communications circuitry, which is built into the microprocessor, is used to operate the infrared (IR) RECEIVER and TRANSMITTER of the ScopeMeter. For this purpose a stripped version of the RS-232-C protocol is used.

Only the TXD (transmit data) and RXD (receive data) lines from the RS-232-C standard are used. The IR transmitter LED H1201 is driven directly from the TXD-not pin of the microprocessor. If a "0" is transmitted, the LED lights.

The IR receiver uses operational amplifier N1301 to power the collector of phototransistor H1202. If any IR light is received, the phototransistor will drive V1207 in saturation. This results in a "low" RXD line, interpreted by the microprocessor as a "1".

Battery sense circuitry

The battery voltage -VBAT generated on the analog unit is amplified by -2/3 at operational amplifier N1301. The resulting signal BAT_LEVEL is connected to an A/D converter input of the microprocessor. In this way the microprocessor can monitor the battery voltage level. If the battery voltage level drops below 4.4V, the microprocessor generates the BATTERY LOW indication on the LCD.

Analog ASIC bus

The Analog ASIC (A-ASIC D2301, see circuit diagram A2a/A2b, figure 10.5/10.6) or A-ASIC, as used in the following text, is controlled by the microprocessor. The microprocessor uses the signals CDAT, CCLK and DTAEa,b,c to set the A-ASIC and the attenuator sections on the analog A2 PCB. These signals together form the CONTROL bus.

Flash ROM type selection

The ScopeMeter hardware allows the usage of different types of Flash ROMs. The actual Flash ROM configuration is indicated by resistors R1222 and R1224.

FLASH ROM CONFIGURATION

Resistor(s)	F512 + F256	F010 (1x)
R1222	*	*
R1224		*

The resulting voltage levels (0 volt, 2.5 volt or 5 volt) are read directly by the microprocessor A/D converter inputs.

ON/OFF circuit

The ON/OFF circuit operates almost like a thyristor. When the ON/OFF key is pressed, a current is drawn from the base of V1503, via R1503 and V1501. Transistor V1503 will now start to conduct. This results in a current through R1507, R1504, V1502 and R1506. The signal POWER_ON will now become "high". Also transistor V1506 will conduct, supplying base current to V1503 after the ON/OFF key is released. The POWER-ON signal will latch "high". The ON/OFF signal will go high, turning off V1506 and V1503, the next time the ON/OFF key is depressed. The POWER_ON signal will become "low" and the ScopeMeter power turns off.

RESET circuit

The RESET circuit consists of V1203, V1205, V1215, V1201, D1205 and related components. When the ScopeMeter power is switched on, the +5V supply voltage starts to rise. This causes the zener diode V1202 to conduct. After some time transistor V1203 also starts to conduct.
R1204 and C1203 form a time delay (see figure 3.3).

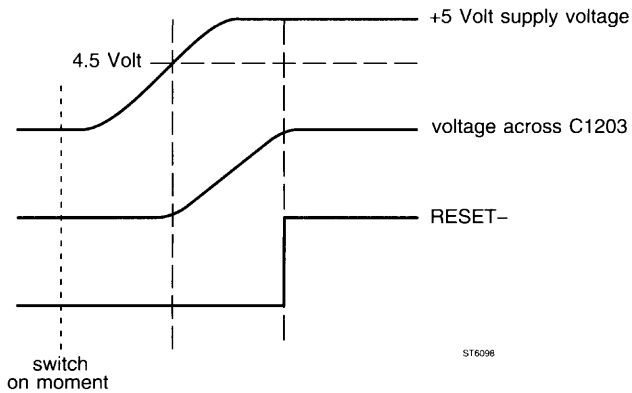


Figure 3.5 RESET signal timing

The RESET signal now is buffered by D1205 and connected with the RESET inputs of the microprocessor and the D-ASIC circuitry.
After a reset, the voltage on the EA (External Address) input of the microprocessor (pin 14) is "high". The Microprocessor starts up using the internal Mask ROM software. First the Flash ROMs are checked to see if they contain valid software. If this is true, output pin 6 of flip-flop D1202 is set "low". Now the microprocessor invokes a software reset. Because of the "low" voltage on the EA input of the microprocessor, the microprocessor will "start up" again, using the external Flash ROM software. The reset pulse is blocked by transistor V1201 to prevent the RESET signal from performing a "hard-reset" on the microprocessor again. At this software reset, the microprocessor enables the LCD by means of the signal LCDPWR. Then the buffers that control the LCD contain valid data.

3.3.3 MICROPROCESSOR circuitry (µP)

- Introduction

The ScopeMeter is controlled by a single chip microcomputer with on-board ROM (called Mask ROM in the following text). This microprocessor controls the total system operation and communication between the ScopeMeter and the outside world (key pad, RS-232-C interface). It also controls the communication between the internal system components.

- Detailed circuit description

See figure 3.2 and circuit diagram A1 (figure 10.2).

The ScopeMeter uses an Intel 83C196 microprocessor D1201, with on-board Mask-programmed ROM (Mask ROM). This microprocessor has an 8-bit data bus and a 16-bit address bus. The lower 8 address bits A0...A7 are combined with the data bits (multiplexed data bus). ADDRESS LATCH D1210 is used to separate data bits and address bits.

The microprocessor's Mask ROM contains the startup software and a diagnostic kernel test (see chapter 7). It also contains the software necessary to drive the serial interface and to clear and program the Flash ROMs.

The two Flash ROMs (FROMs) D1207 and D1208 contain the system software. The FROMs are directly connected to the microprocessor via the dat and address busses. The microprocessor addresses the RAMs via the D-ASIC (D1203).

The microprocessor contains five 8-bit I/O ports. Port 3 and 4 share their bits with the data and address busses. The other I/O ports 0, 1, 2 are used for various purposes. For example: reading the keypad, operating the RS-232-C interface, battery voltage sense, switching the power on/off, etc.

Keypad circuitry

The keypad circuitry consists of five shift registers, D1601...D1606, each of which has eight inputs. These inputs are normally kept "high" by 56 KΩ resistor arrays connected to the +5V supply voltage. Whenever a key on the keypad is pressed, the corresponding line is connected to ground, resulting in a "low" signal. All signals are clocked into the shift registers (with the FRONT_CLOCK and FRONT_LATCH signals). Then they are converted into two signals FRONT_DATA1 (shift registers D1603, D1604, D1606) and FRONT_DATA2 (D1601 and D1602).

Optically isolated RS-232-C interface

The serial communications circuitry, which is built into the microprocessor, is used to operate the infrared (IR) RECEIVER and TRANSMITTER of the ScopeMeter. For this purpose a stripped version of the RS-232-C protocol is used.

Only the TXD (transmit data) and RXD (receive data) lines from the RS-232-C standard are used. The IR transmitter LED H1201 is driven directly from the TXD-not pin of the microprocessor. If a "0" is transmitted, the LED lights.

The IR receiver uses operational amplifier N1301 to power the collector of phototransistor H1202. If any IR light is received, the phototransistor will drive V1207 in saturation. This results in a "low" RXD line, interpreted by the microprocessor as a "1".

Battery sense circuitry

The battery voltage -VBAT generated on the analog unit is amplified by -2/3 at operational amplifier N1301. The resulting signal BAT_LEVEL is connected to an A/D converter input of the microprocessor. In this way the microprocessor can monitor the battery voltage level. If the battery voltage level drops below 4.4V, the microprocessor generates the BATTERY LOW indication on the LCD.

Analog ASIC bus

The Analog ASIC (A-ASIC D2301, see circuit diagram A2a/A2b, figure 10.5/10.6) or A-ASIC, as used in the following text, is controlled by the microprocessor. The microprocessor uses the signals CDAT, CCLK and DTAEa,b,c to set the A-ASIC and the attenuator sections on the analog A2 PCB. These signals together form the CONTROL bus.

Flash ROM type selection

The ScopeMeter hardware allows the usage of different types of Flash ROMs. The actual Flash ROM configuration is indicated by resistors R1222 and R1224.

FLASH ROM CONFIGURATION

Resistor(s)	F512 + F256	F010 (1x)
R1222	*	*
R1224		*

The resulting voltage levels (0 volt, 2.5 volt or 5 volt) are read directly by the microprocessor A/D converter inputs.

ON/OFF circuit

The ON/OFF circuit operates almost like a thyristor. When the ON/OFF key is pressed, a current is drawn from the base of V1503, via R1503 and V1501. Transistor V1503 will now start to conduct. This results in a current through R1507, R1504, V1502 and R1506. The signal POWER_ON will now become "high". Also transistor V1506 will conduct, supplying base current to V1503 after the ON/OFF key is released. The POWER-ON signal will latch "high". The ON/OFF signal will go high, turning off V1506 and V1503, the next time the ON/OFF key is depressed. The POWER_ON signal will become "low" and the ScopeMeter power turns off.

RESET circuit

The RESET circuit consists of V1203, V1205, V1215, V1201, D1205 and related components. When the ScopeMeter power is switched on, the +5V supply voltage starts to rise. This causes the zener diode V1202 to conduct. After some time transistor V1203 also starts to conduct.
R1204 and C1203 form a time delay (see figure 3.3).

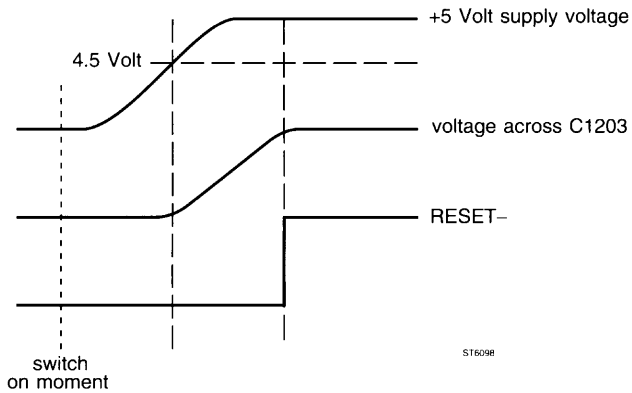


Figure 3.5 RESET signal timing

The RESET signal now is buffered by D1205 and connected with the RESET inputs of the microprocessor and the D-ASIC circuitry.
After a reset, the voltage on the EA (External Address) input of the microprocessor (pin 14) is "high". The Microprocessor starts up using the internal Mask ROM software. First the Flash ROMs are checked to see if they contain valid software. If this is true, output pin 6 of flip-flop D1202 is set "low". Now the microprocessor invokes a software reset. Because of the "low" voltage on the EA input of the microprocessor, the microprocessor will "start up" again, using the external Flash ROM software. The reset pulse is blocked by transistor V1201 to prevent the RESET signal from performing a "hard-reset" on the microprocessor again. At this software reset, the microprocessor enables the LCD by means of the signal LCDPWR. Then the buffers that control the LCD contain valid data.

3.3.4 DIGITAL ASIC (D-ASIC) circuitry

- Introduction

The Digital Application Specific Integrated Circuit (or D-ASIC) D1203 forms the core of the digital circuitry of the ScopeMeter, all located on the digital A1 PCB.
Many functions are incorporated in this complex CMOS integrated circuit (see figure 3.4 on the next page):

- Timebase
- Trigger
- Acquisition Control Logic
- Acquisition RAM
- Min/max
- Display control
- Decoding and synchronization
- Digital-to-analog converters (DACs)

- Detailed circuit description:

See figure 3.4 and circuit diagram A1 (figure 10.2).

The following gives a short description of the separate parts of the D-ASIC, which perform the functions mentioned above:

Timebase
The D-ASIC contains a crystal oscillator, which uses the 25 MHz crystal G1201. An internal programmable divider generates timebase signal TRACK with a frequency from 0.8333 Hz up to 25 MHz (see section 3.4.5). This TRACK signal is used to sample the ScopeMeter input signals.

Trigger
The trigger module in the D-ASIC takes care of all trigger related functions:

- pre triggering
- post triggering
- event counting: the time interval corresponding to the trigger delay is increased by a programmed number of "events" (trigger level crossings of the external trigger signal), which must occur before triggering.
- n-cycle mode: trigger level crossings of the input signal are counted, and triggering occurs every n^{th} crossing ($2 < n < 255$). The n-cycle mode can be used as a digital trigger hold-off.

In the real-time sampling mode (< 1 µs/div), the D-ASIC determines the trigger moment with digital comparators. In the quasi-random sampling mode, the A-ASIC determines the trigger moment with analog comparators.

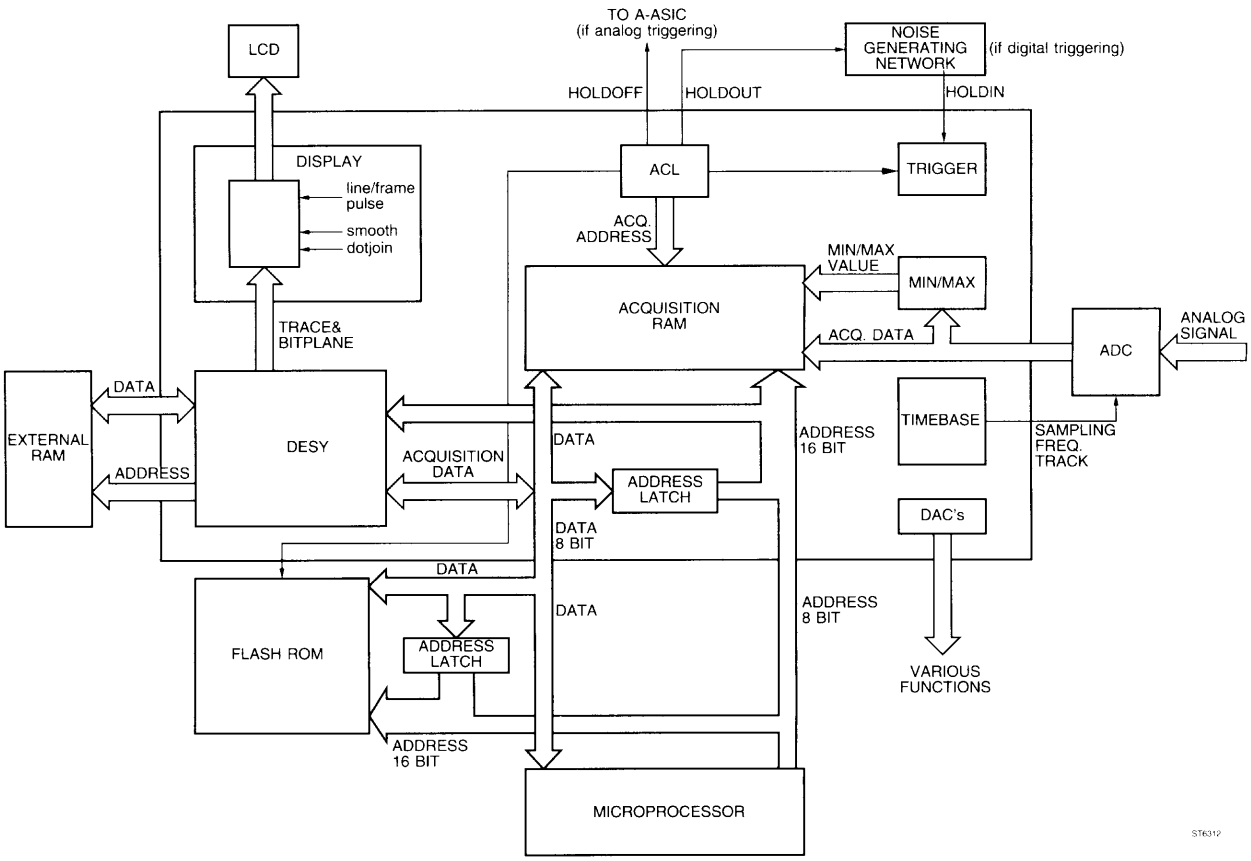


Figure 3.4 Schematic Diagram D-ASIC D1203

Acquisition Control Logic (ACL)

The ACL controls the analog input circuitry and the ADC (N2302, see circuit diagram A2a/A2b, figure 10.5/10.6). The ACL also writes the digital representations of the input signals to the Acquisition RAM in the D-ASIC, according to the selected trigger and acquisition modes. Before the acquired trace data is displayed, it is first processed by the microprocessor. The microprocessor corrects for offset- and amplification errors, using the calibration values that are stored in Flash ROM.

In fast timebase positions the ACL acquires 1024 values. Then the acquisition is stopped and the microprocessor can read the data out of the Acquisition RAM. In slow timebase positions the ACL uses the Acquisition RAM as a FIFO (First In First Out) memory. The microprocessor can start reading the acquired data immediately after triggering. Now there is synchronization between the ACL and the microprocessor.

If the system uses analog triggering (time base ≥ 1µs), the trigger hold-off signal (HLDOFFN) to the A-ASIC is generated. In digital triggering mode, the D-ASIC generates the HLDOUTN signal. This signal is fed to the HLDIN input of the D-ASIC, via R1211, C1221, R1214 and C1211. These components generate noise on the HOLDOUTN signal, which is needed as a random factor in the Delta- T circuit.

Min/max

The Min/max module finds the minimum and maximum value of the input signals between two time base pulses, and writes them into the Acquisition RAM. To detect narrow glitches, the TRACK signal (ADC sample frequency) is always 25 MHz in Min/max mode.

Display control
This module reads screen data from the External RAMs (D1204 and D1205) and sends it to the LCD. It also sends line pulses LINECL (17 kHz) and frame pulses FRAME (70 Hz). This screen data, consisting of for example cursor and grid information, is stored in External RAMs as bitplane information. The trace data is stored as a value for every vertical line on the LCD. This data is converted to bitplane data and added to the cursor and grid information. The display control module also makes it possible to change the dotsize of the signal displayed and to use dot joining.

Decoding and synchronization (DESY)
The DESY section is the decoder for the D-ASIC's internal addresses. This module also synchronises the microprocessor with the D-ASIC's Display control module, as both access the same Acquisition RAM.

Digital to analog converters (DACs)
The DACs module contains 10 one-bit pulse width modulated monotonous DACs, whose resolution ranges from five to ten bits. The DACs are used to control level shifting, analog trigger level, LCD contrast and the generator function (see section 3.4.7).

External RAMs

The External RAM section consists of two 32K * 8 SRAMs (D1204 and D1206). These RAMs contain:

- waveforms (stored with the WAVEFORM key)
- frontsettings (stored with the SETUP key)
- bitplane data for the LCD picture
- text, to be used on the display
- data in RECORD mode
- data in A versus B mode (A= ↑ B= →)
- bitplane data used while making a printout of the screen

Ram Power circuit
The External RAMs are powered by the RAM Power circuit. The RAM Power circuit is fed directly by the batteries, independently of the main power supply.
The RAM Power circuit is a simple oscillator, used to generate a stabilised voltage +VRAM out of the battery voltage -VBAT. The basic oscillator circuit is shown in figure 3.5.

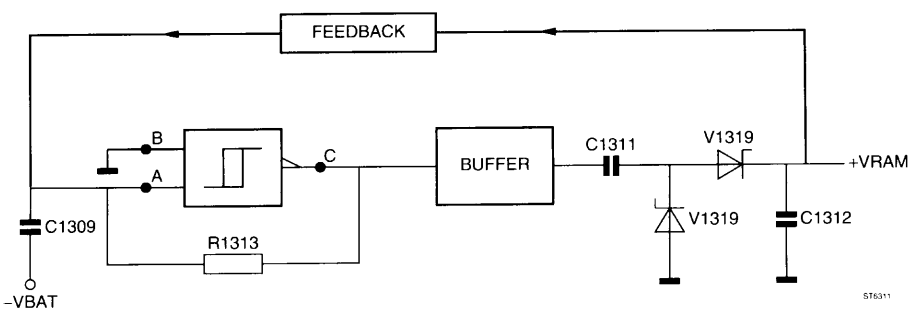


Figure 3.5 Oscillator RAM Power circuit

Input B of Schmitt input NAND D1301 is connected to ground. When the voltage on input A is also "low", the output C will become "high". Capacitor C1309 will charge via R1313. After some time input A will become "high", resulting in a "low" output C.

Capacitor C1309 will then discharge via resistor R1313. The generated output pulses are buffered and converted into a DC voltage by C1311, C1312 and V1319. The output voltage +VRAM is fed back to the NAND input A, via several transistors (voltage gap). If the output voltage +VRAM has reached the correct value, the pulse train at NAND output C is stopped via this feedback (see figure 3.6). In

this way capacitor C1312 is charged just enough to keep the output voltage +VRAM at a stable value (3V DC).

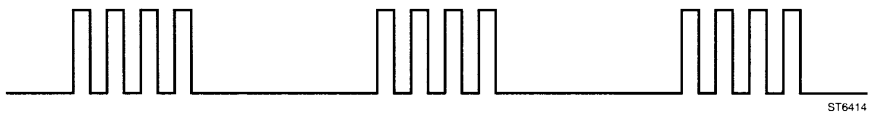


Figure 3.8 Pulse train signal on input A of Schmitt input NAND (Test Point 223)

3.3.5 LCD circuitry

- Introduction

The LCD used in the ScopeMeter is controlled by six LCD driver integrated circuits. These drivers get their information (data- and control signals) directly from the D-ASIC. The microprocessor enables the display when valid data is present.

ScopeMeter models 93 and 95 use a reflective LCD. Model 97 is provided with a transflective LCD with a backlight, which can be switched on or off by the user.

- Detailed circuit description

See figure circuit diagram A1 (figure 10.2).

LCD

The ScopeMeter uses a Super Twisted Nematic Liquid Crystal Display (LCD H1401, see circuit diagram A1, figure 10.2), with a resolution of 240 * 240 pixels.

The picture on the LCD screen is written column (vertical line) after column, rather than row (horizontal line) after row. The LCD screen is divided horizontally in 3 row-sections, each 80 pixels wide and vertically into 3 column-sections, each 80 pixels wide.

LCD drivers

The LCD display is controlled by the D-ASIC, via six LCD drivers:

- three LCD row drivers: D1404, D1406, D1407
- three LCD column drivers: D1401, D1402, D1403

Description of the LCD drivers input-/output signals:

LCD outputs Y1...Y80 and X1...X80

These outputs are connected to the LCD matrix. Every column driver serves 80 pixel columns of the LCD. Every row driver serves 80 pixel rows. The output signals are staircase signals, with levels equal to the V1...V6 voltages.

NOTE: On the output of every LCD driver, a Test Point is provided (TP207...TP212). When the driver is working properly, a staircase voltage can be measured on these test points.

- Data inputs D0...D3 (row drivers only!)

The actual display data coming from the D-ASIC is sent via the DRIVERBUS to the LCD drivers D0...D3 inputs.

- Terminal input voltages V1...V6

Out of these DC signals, with V_{EE} = -20 V, the LCD drivers generate the staircase signals. The input voltages V1...V6 are generated by the LCD supply section.

- Display control signals LINECL, DATACL, M, FRAME

These signals are used to control the LCD. The LCD picture is constructed from these display control signals and the data signals and sent to the LCD via the LCD outputs.
DATACL is the clock signal, used to clock the data D0...D3 into the driver buffer.
LINECL is a clock signal, used to clock one complete line (column) into the LCD.
The M signal is described furtheron (see M-randomize section).

LCD supply section

The pulse modulated signal, CONTRAST, comes from the D-ASIC. CONTRAST is filtered by R1401 and C1401 to get a DC voltage. The value of this DC voltage depends on the duty cycle of the CONTRAST signal. Opamps N1401 convert the DC signal into stabilized DC voltages V1...V6. If the signal, LCDPWR, coming from the D-ASIC, is "high" (+5V), the -20V voltage is generated and the system is active. The -20V supply voltage is temperature corrected to compensate for the temperature dependency of the LCD (-80 mV/C). The LCD supply voltages have to be corrected by the same amount to get a constant (over a temperature range) brightness and contrast of the LCD. This temperature compensation is made by Positive Temperature Coefficient (PTC) R1418. The -20V voltage is made out of the -30V voltage, coming from the analog A2 PCB. Transistors V1404 and V1402 form a protection circuit, that limits the current in case the -20V voltage is short circuited.

M-randomize section

The signal M ("LCD backplane modulation") has a time relation with the display control signals LINECL and DATACL. The M-randomize section converts M into M1, which is no longer time related to the other display control signals. The M1 signal is used by the LCD drivers to convert all DC voltages into AC voltages, able to drive the LCD.
Depending on the type (brand) of LCD mounted, integrated circuits D1408, D1409 and D1410 or D1411 are used.

Backlight circuitry

The backlight circuitry is based on the Hartley oscillator principle. Components V1307, T1301, and C1302 form the oscillator. Transistor V1304 supplies current to the circuit. This transistor is switched on/off by the ON OFF signal, coming from the microprocessor. When the output voltage across the backlight becomes higher than 100V, transistor V1305 will be driven open via V1308, V1309, and V1311. This will draw away current (energy) supplied to the oscillating circuit (feedback regulation).

3.4 ANALOG CIRCUITS (A2)

3.4.1 Introduction

This paragraph describes the circuits on the analog A2 PCB in detail. Refer to circuit diagrams A2a, A2b, and A2c (figures 10.5, 10.6, and 10.7 in chapter 10).

3.4.2 Overview analog circuits

The analog A2 PCB contains several functional parts:

- circuits in the acquisition path
  - attenuator sections
  - EXTernal (banana) input/output circuitry
  - Analog ASIC and ADC circuitry
- control circuitry
- signal generator
- power supply and battery charger

Each of these parts will be described separately. First a short introduction is given, followed by a detailed description.

3.4.3 ATTENUATOR sections, CHANNEL A and B

- Introduction

See figure 3.7.

The attenuator sections of both channels A and B are identical. In the following only channel A is described. The corresponding components for channel B have the same numbering, except the second number, which is '1' instead of '2'. For example: R2202 in channel A corresponds with R2102 in channel B.

The attenuator section consists of a high frequency (here after referred to as H.F.) path and a low frequency (here after referred to as L.F.) path, which are combined again in the impedance converter (see figure 3.7). To get a flat frequency characteristic, both paths must overlap over a wide frequency range. Circuits are provided for automatic offset compensation.
The output of the attenuator sections of channel A and B is processed further by the A-ASIC.

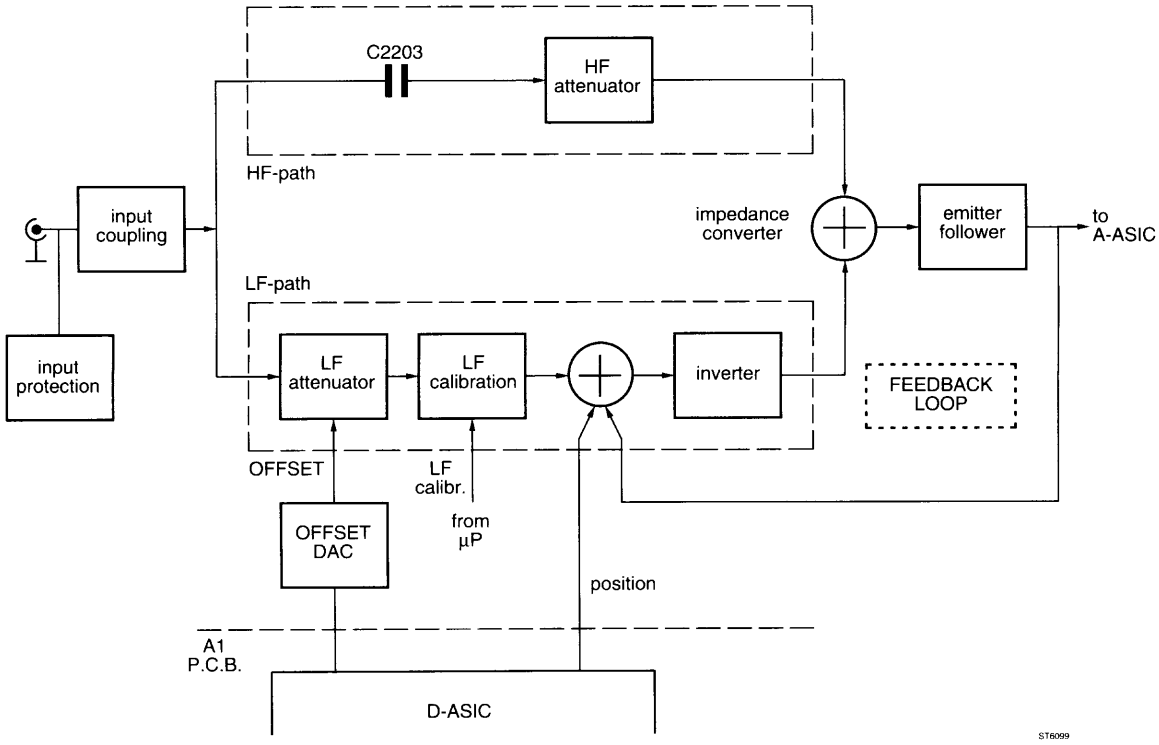


Figure 3.9 Schematic diagram attenuator section

- Detailed circuit description

See figure 3.7 and circuit diagram A2a (figure 10.4).

Input coupling

The incoming signal first passes the AC/DC coupling section (C2202). When relay K2201 is opened, the signal is AC coupled via C2202.

H.F. (high frequency) path

After the coupling section, the L.F. part of the signal is blocked by capacitor C2203. Only the H.F. part of the input signal enters the H.F. attenuator. This is a triple capacitive divider, consisting of a 1 to 100, a 1 to 10, and a 1 to 1.48 divider.

The 1 to 1.48 divider section is switched on when relay switches K2202 and K2203 are in the "upper" position (as shown on circuit diagram A2a, figure 10.5).
The 1 to 1.48 divider consists of C2203 and C2209 in parallel with some parasitic capacitors. The attenuation of 1.48 times in this straight-on path is compensated for later in the circuitry.

The separate sections are switched in the signal path, depending on the attenuation required:

Table 3.2 Sections used in various attenuator settings

Attenuator Settings	Sections Used	Attenuation
5 mV/div 100 mV/div	1.48x	1.48 times
200 mV/div 1 V/div	1.48x, 10x	14.8 times
2 V/div 10 V/div	1.48x, 100x	148 times
20 V/div 100 V/div	1.48x, 10x, 100x	1480 times

In the ScopeMeter the response of the H.F. attenuator sections is adjusted by means of three variable capacitors C2209, C2207 and C2114. These variable capacitors are used to compensate for parasitic capacitors of the printed circuit board.
The 1 to 1.48 divider (1 to 1.48 section) can be adjusted with variable capacitor C2209.
The 1 to 14.8 divider (1 to 1.48 and 1 to 10 sections) can be adjusted with variable capacitor C2207.
The 1 to 148 divider (1 to 1.48, 1 to 10 and 1 to 100 sections) can be adjusted with capacitor C2214.

NOTE: These capacitors do not have to be readjusted at every calibration. (see chapter 5, section 5.6.1) The capacitors are rough adjustments, used to compensate for hardware differences. The attenuator response is fine adjusted by means of the L.F. calibration section (see next page).

Impedance converter
The output of the H.F. path is connected with the impedance converter, formed by transistors V2207 and V2209 (see circuit diagram A2a, figure 10.5). The bias voltage of V2207 is determined by R2216. To prevent destruction of the gate of V2207 by high voltages or voltage peaks, two clamps V2206 and V2204 are provided. Summation of the H.F. and the L.F. signal parts is obtained in transistor V2207, which acts as the collector impedance of V2208.

L.F. (Low frequency) path
The L.F. part of the input signal enters the L.F. path, which consists of a L.F. attenuator section, a L.F. calibration section and a regulating feedback loop, which consists of a summator, inverter, another summator, and an emitter follower (see figure 3.7).

L.F. attenuator
Fig 3.8 shows the L.F. attenuator section in detail:

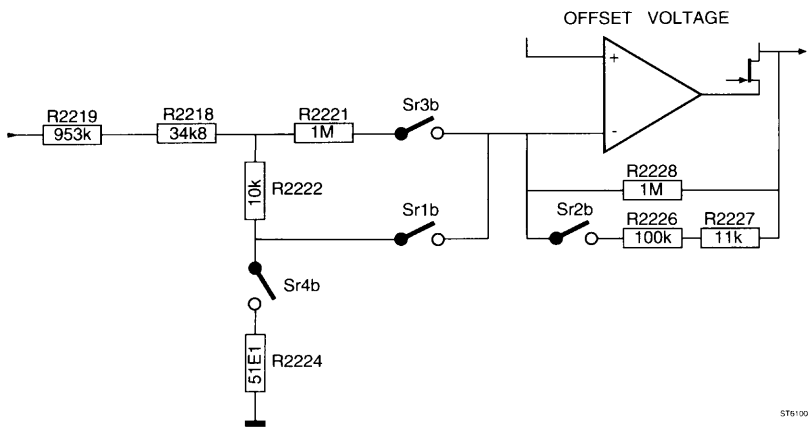


Figure 3.10 Principal diagram L.F. attenuator section

The L.F. attenuator consists of an inverting amplifier, N2201, which attenuates the L.F. signal by a factor, depending on the settings of switches D2201. These switches are controlled by signals named Sr1b...Sr4b. A "high" signal closes the corresponding switch.

Table 3.3 Attenuator drive signals Sr1b...Sr4b

Attenuator settings	Sr1b	Sr2b	Sr3b	Sr4b	Attenuation up to TP207	Attenuation up to TP204
5 mV/div...100 mV/div	high	low	low	low	1.48 times	1 time
200 mV/div...1 V/div	high	high	low	low	14.8 times	10 times
2 V/div...10 V/div	low	low	high	high	148 times	100 times
20 V/div...100 V/div	low	high	high	high	1480 times	1000 times

The attenuation of the LF CALIBRATION and FEEDBACK LOOP is about 1.48 times.

The signal Sr4b operates the switch, which is used to ground the L.F. part of the input signal during offset calibration. This is done automatically to prevent drift.

The offset DAC circuitry (see figure 3.7) provides the offset voltage for operational amplifier N2201. The offset compensation is done automatically by means of the signals So10b...So14b, coming from the D-ASIC.

L.F. Calibration

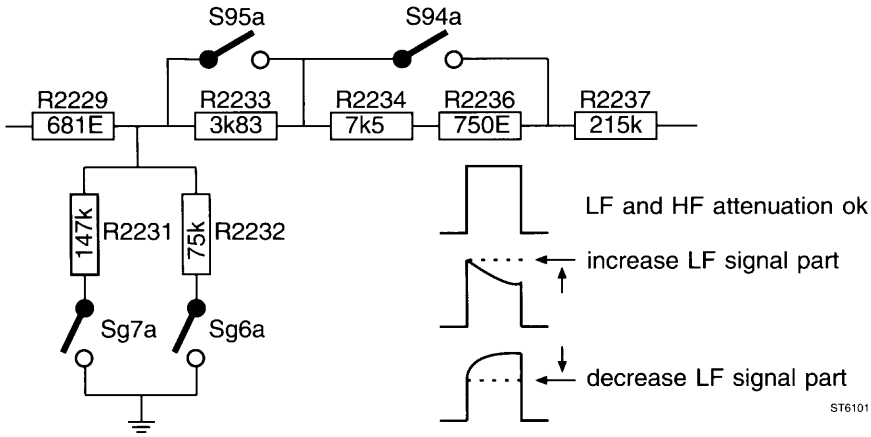


Figure 3.11 Automatic adjustment of the L.F. attenuation

Fine adjustment of the L.F. path attenuation is completed during calibration of the H.F. path attenuation. This is done by means of a simple 4-bits D-to-A converter, consisting of resistors R2229, R2231, R2232, R2233, R2234, R2236, and switches D2202. These switches are operated by signals Sg4a, Sg5a, Sg6a, and Sg7a, see figure 3.6. Resistors R2229, R2231 and R2232 divide the output signal of the attenuator section. Resistors R2233, R2234, and R2236 increase the input resistance of the inverting amplifier of the regulating loop.

Feedback loop

The output signal of the impedance converter is fed back to the input of operational amplifier N2201, with the signal coming from the L.F. calibration section (via R2237) and a DC position voltage (via R2248), proportional with the MOVEment of the trace (via R2248). Transistor V2210 is used to enlarge the dynamic range: when D-POSCHA is active, R2270 is incorporated in the circuitry.

The feedback loop operates as follows. If, for example, the output signal of the L.F. path is too small, the correction amplifier N2201 will drive V2207 via V2208. In this way the amplitude of the L.F. path and the position voltage are increased (compensation).

Input protection

The input protection safeguards the ScopeMeter against overvoltage. The input protection circuit consists of C2203 and V2206/V2204 (clamp HF attenuator) and R2219 and V2212/V2213 (clamp LF attenuator).

3.4.4 EXTERNAL (BANANA) INPUT/OUTPUT circuitry

- Introduction

See figure 3.10.

The ScopeMeter is provided with two banana connectors, which are used as inputs in the mV, DIODE, and OHM METER modes or as EXTernal trigger input in SCOPE mode. These connectors also serve as outputs for the built-in generator. Protection circuitry is provided to prevent damage by overvoltage.

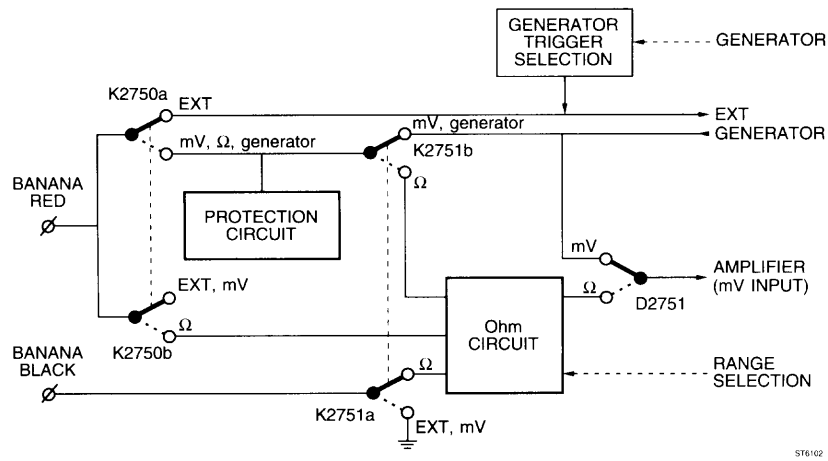


Figure 3.12 Schematic diagram signal flow in EXTernal (banana) input/output circuitry

- Detailed circuit description

See figure 3.10 and circuit diagram A2b (figure 10.6).

mV DC measurement circuitry

The mV DC input voltage on the red banana terminal is fed to the L.F. part of the channel A attenuator section, via the following path: R2750, K2750a, K2751b, R2761, D2751 (refer to circuit diagram A2b, figure 10.6). When the ScopeMeter is switched to mV DC measurement using the EXT banana terminals, the settings are as follows:

Table 3.4 A-ASIC and attenuator settings in mV DC mode

mV DC RANGE	A-ASIC (D2301)	LF-ATTENUATOR (channel A)
300 mV 3 V	100 mV/div 100 mV/div	1* 0.1*

Ohm measurement circuitry

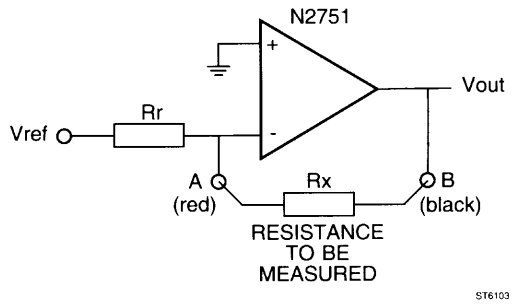


Figure 3.13 Ohm measurement circuitry (principle of operation)

The resistance R_x to be measured is connected as a feedback resistor of an amplifier circuit (opamps N2751). The output voltage of this measuring amplifier is proportional to resistance R_x:

$$V_{out} = (V_{ref}/R_r) \times R_x$$

The different ranges are obtained by selecting different values for resistor R_r . This can be done with the Ohm range selection circuit (D2750 and surrounding resistors), which is controlled by the Analog Control circuitry (circuit diagram A2a, figure 10.5, B-OFFSET lines).

Table 3.5 Ohm range selection circuit control lines

RANGE	Sc15	Sc16	Sc17	Sc18
300Ω	1	0	1	0
3kΩ	1	0	1	0
30kΩ	1	0	0	0
300kΩ	1	1	0	0
3MΩ	0	1	0	0
30MΩ	0	1	0	0

Switches D2751 choose between the mV DC voltage and the voltage from the Ohm circuit. The outputs of these switches are connected to the L.F. part of the channel A attenuator (circuit diagram A2a, figure 10.5).

Diode measurement circuitry

While in DIODE METER mode, the ScopeMeter uses the same circuitry as in OHM mode.

WARNING: The BLACK terminal is not connected to the BNC grounds, while in OHM or DIODE METER mode! While in OHM er DIODE METER mode, the ScopeMeter can not be grounded via the BLACK banana terminal.

EXTernal triggering

The trigger signal is fed to the A-ASIC on A2a (figure 10.5) via resistor R2750 and voltage divider R2753/R2754 (see circuit diagram A2b, figure 10.6). It is also possible to trigger on the signal made by the generator. Then the trigger signal is made out of the signals STIMUL and G-OUTP by D2850, V2758, and related components.

Generator signal

The output of the generator (see paragraph 3.4.7) is sent to the EXT banana terminals via K2751b, K2750a and R2750.

Protection circuit (generator mode)
If a high voltage is applied to the banana terminals A and B, a current will flow from terminal A, through PTC (Positive Temperature Coefficient) R2750, zener diodes V2750 or V2751 and via V2752 and V2753 back to terminal B (see circuit diagram A2b, figure 10.5). The voltage across the zener diodes is limited to 7.5V for each diode. The rest of the input voltage is dropped across R2750. The resistance of this PTC will rise and limit the current in the circuit. Opamp N2750 drives V2752 and V2753, to prevent capacitive load of the generator by these zener diodes.

Protection (Ohm and diode measurement)
If a high voltage is put on the EXT banana terminals, this results in an increase of the voltage over PTC R2750. This increases the value of this PTC, limiting the current in the circuit. Zener diode V2764 limits the output voltage of the measuring amplifier circuit N2751. Resistor R2771 and clamp diodes V2759...V2763 protect the input of the measuring amplifier.

3.4.5 ANALOG ASIC (A-ASIC) and ADC circuitry

- Introduction
See figure 3.12.

The signals coming from the channel A and B attenuators are fed to D2301. Various oscilloscope functions are integrated in this Application Specific Integrated Circuit (ASIC).
Analog ASIC D2301 selects the signal source and prepares the signal for further processing by the ADC circuitry. Also a trigger signal is derived from one of the channel A or B inputs or the external trigger input (banana connectors).

- Detailed circuit description
See figure 3.12 and circuit diagram A2a/A2b (figure 10.5/10.6).

First a short description is given for the internal circuits of the A-ASIC. The schematic diagram of the A-ASIC D2301 is shown in figure 3.12. The A-ASIC input/output signals are also described in the following sections.

Channel A Amplifier and Channel B Amplifier
The output signals of the channel A and B attenuator sections are amplified in the A-ASIC to obtain the most sensitive ranges.

Table 3.6 A-ASIC relative amplification at various attenuator settings

Attenuator setting:	A-ASICrelative amplification:
100 mV/div	1 time
50 mV/div	2 times
20 mV/div	5 times
10 mV/div	10 times
5 mV/div	20 times
2 mV/div*	10 times
1 mV/div*	20 times

(* both 1mV/div and 2 mV/div settings are made by multiplying times five and averaging the signal in 5 mV/div. and 10 mV/div.)

The A-ASIC itself can handle input signals with a maximum amplitude of 750 mV peak-peak. A vertical offset voltage YPOS is added to the signal in the attenuator sections (section 3.4.3). This means that 0V on an A- ASIC input terminal results in a trace in the vertical middle of the screen.

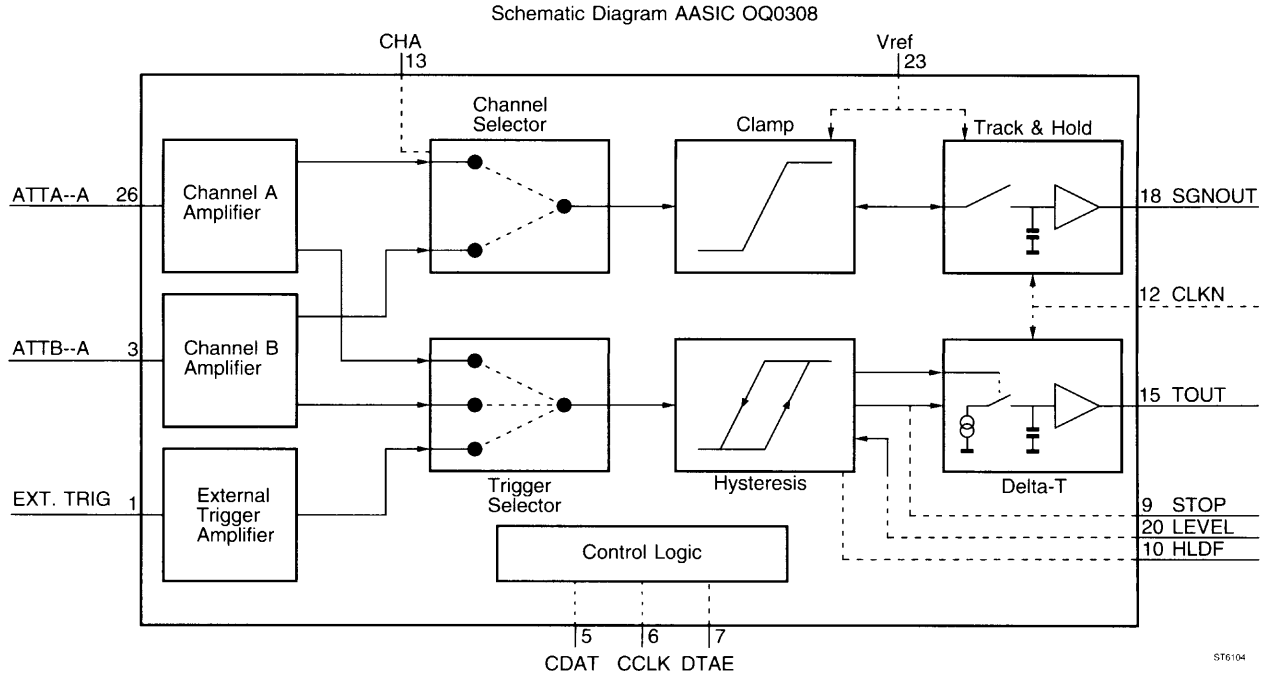


Figure 3.12 Schematic diagram A-ASIC D2301

Channel Selector

The channel selector selects channel A or channel B, depending on the level of the CHANA signal (input 13).

If CHA is "high" (> 3.5 V) channel A is selected.
If CHA is "low" (< 1.5 V) channel B is selected.

If a timebase speed faster than 20 µs is selected, both channels are displayed in alternate mode and CHA is a square wave signal with a timebase-dependent frequency (see table 3.7). If a timebase speed slower than 50 µs is selected, both channels are displayed in chopped mode. The CHA signal is a square wave signal with a trigger-dependent frequency of 500 kHz maximum.

Table 3.7 Frequencies of A-ASIC signals in various modes

Time Base	TRACKN freq 1)	CHA freq 1)	MODE horizontal	MODE vertical
60 s/div	0.8333 Hz	0.416 Hz	roll / RECURRENT	CHOP
20 s/div	2.5 Hz	1.25 Hz		
10 s/div	5 Hz	2.5 Hz		
5 s/div	10 Hz	5 Hz		
2 s/div	25 Hz	12.5 Hz		
1 s/div	50 Hz	25 Hz		
.5 s/div	100 Hz	50 Hz		
.2 s/div	250 Hz	125 Hz		
.1 s/div	500 Hz	259 Hz	SINGLE	
50 ms/div	1 kHz	500 Hz		
20 ms/div	2.5 kHz	1.25 kHz		REAL TIME
10 ms/div	5 kHz	2.5 kHz		
5 ms/div	10 kHz	5 kHz		
2 ms/div	25 kHz	12.5 kHz		
1 ms/div	50 kHz	25 kHz		
.5 ms/div	100 kHz	50 kHz		
.2 ms/div	250 kHz	125 kHz		
.1 ms/div	500 kHz	250 kHz		
50 µs/div	1 MHz	500 kHz		
20 µs/div	1.25 MHz	Trigger dependent		ALT
10 µs/div	2.5 MHz			
5 µs/div	5 MHz			
2 µs/div	12.5 MHz			
1 µs/div	25 MHz			
.5 µs/div	25 MHz			
.2 µs/div	25 MHz			
.1 µs/div	25 MHz			
50 ns/div	25 MHz			
20 ns/div	25 MHz			
10 ns/div	25 MHz			

1) In MIN/MAX mode (only possible for one channel), the frequency of CHA is zero and the sample frequency TRACK is always 25 MHz.

Clamp

To prevent the Track & Hold circuit from overdrive, the signal is clamped. The level of the output signal can be adjusted by means of VREF (input 23). VREF is the reference voltage, made by the circuit consisting of V2301, V2302 and R2323, R2324, and R2325 (see ADC section).

Track & Hold

The maximum sampling frequency of the ADC used in the ScopeMeter is 25 MHz. This means that the ADC can only handle signals with frequencies up to 12.5 MHz (half the sample frequency). Because of this a Track & Hold circuit is incorporated in the A-ASIC. The Track & Hold circuit determines the frequency range of the whole system.

The timing in this part of the A-ASIC is determined by clock signal TRACKN (input 12). The frequency of the TRACKN signal depends on the selected timebase speed (see table 3.7).

The output signal, SGNOUT, (output 18) is fed to the ADC. The voltage range of SGNOUT is 1.5V...3.5V. The intermediate level of SGNOUT is derived from the VREF voltage level, which is made by the ADC.

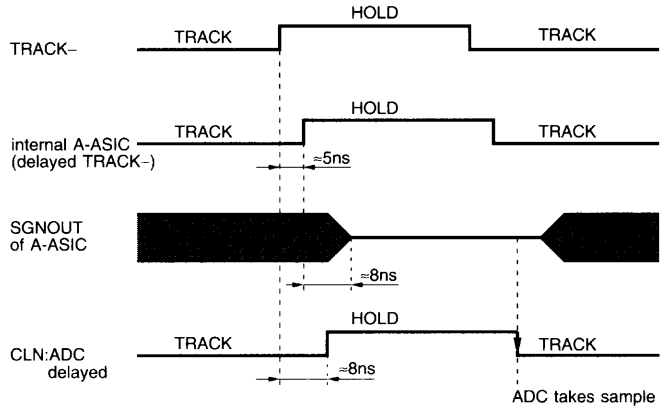


Figure 3.13 Track & Hold timing

External Trigger Amplifier

This amplifier section processes the incoming external trigger signal so that it can be used in the trigger section. The input of this section is TTL compatible.

Trigger Selector

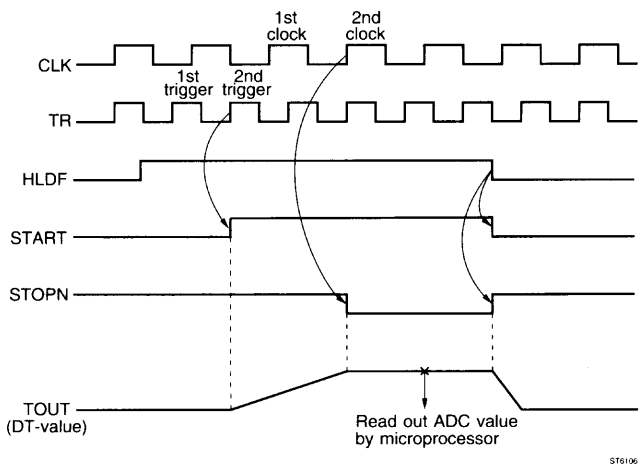
In this section the channel A, channel B or external trigger input signal is selected to act as trigger source. The trigger slope is also selected in this block.

Hysteresis

The hysteresis section converts the trigger signal into a pulse shaped signal. Because of the hysteresis, the circuit will not trigger on noisy signals. The LEVEL signal (input 20) that determines the trigger level, is a DC voltage between +0.5V and +2.0V. The LEVEL signal is a DC voltage, generated in the Digital ASIC. Resistor R2309 and capacitors C2312 and C2313 form a lowpass filter, to convert a pulse width modulated signal into the DC voltage.

Delta-T circuit

The Delta-T circuit measures the time between a trigger pulse and the moment the input signal is sampled. Figure 3.14 shows the timing diagram with relation to the signal HLDF (input 10), START (internal), STOPN (output 9), and TOUT (output 15).



START: internal (in the A-ASIC) start signal for the Delta-T measurement.

TOUT: a voltage proportional to the measured value (time) of Delta T.

Figure 3.14 Timing diagram Delta-T circuit

Control logic

The control logic section contains a serial-in parallel-out shift register. This section gets its data from the microprocessor (D1201, circuit diagram A1, figure 10.2) via the CDAT (serial data), CCLK (serial clock), and DTAE (data-latch) lines. The control logic section controls all functional blocks within the A-ASIC.

ADC

The output signal SNGOUT (pin 18) of the A-ASIC is fed to the 8-bit Analog Digital Converter TDA 8703. This component operates on a 25 MHz clock signal. The signal TRACKN is delayed to compensate for the internal signal delay in the A-ASIC (behind the Track & Hold section) and is fed to ADC pin 17.

The ADC provides for the reference voltage needed by the A-ASIC. This reference voltage is derived from the ADC. VREF is made of the voltages on pin 4 (VRB = Reference Bottom Voltage: +1.5V) and pen 9 (VRT = Reference Top Voltage: +3.5V) of the ADC. During normal operating conditions this reference voltage, VREF, is +2.5V (+/- 3.6%, ref. to ground). VREF is adjusted with potentiometer R2346, marked "OFFSET" and can be measured between TP331 and ground. The sensitivity of the ADC is adjusted with R2347, marked "GAIN". These calibrations are described in chapter 5, section 5.6.1: "Hardware SCOPE Calibration Adjustments".

The 8-bit output of the ADC: ADC0...ADC7 is connected to the Digital ASIC on the digital A1 PCB.

3.4.6 ANALOG CONTROL CIRCUIT

- Introduction

See figure 3.13.

The various sections of the ScopeMeter, situated on the analog A2 PCB, are controlled by the microprocessor on the digital A1 PCB. This is done by means of the CCLK (serial clock), CDAT (serial data) and DTAE (data-latch) lines. This bus system creates several control signals, which for example drive the relays switches in the attenuator sections.

- Detailed circuit description

See figure 3.13 and circuit diagram A2a (figure 10.5).

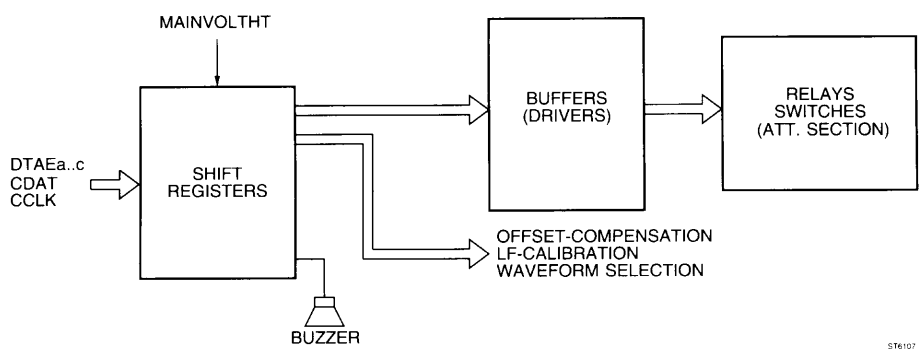


Figure 3.15 Schematic diagram analog control circuitry

Each shift register transforms the serial signal CDAT into 8 parallel control signals. This is done by means of the serial clock signal CCLK and the data-latch signals DTAEa, DTAEb and DTAEc. The control circuitry comprises two series of cascaded shift registers: D2907-D2908-D2909 (24 signals) and D2904- D2906(16 signals).

The signals, that are made by the shift registers, are used:

- to control the buffers (D2901 / D2902 / D2903), which drive the relays in the attenuator section.
- for offset compensation (A-RANGE and B-RANGE) in the attenuator sections.
- for L.F.-calibration (A-OFFSET and B-OFFSET) in the attenuator sections.
- to select the waveform in the signal generator section (sinewave/squarewave/DC).
- to drive the buzzer (beeper).

- Relay tables

In the following tables the number "1" means "high" (active) signal. "0" means "low" signal and "X" means "can be high or low (don't care)".

Channel B DC coupled

	K2101	K2102	K2103	K2201	K2202	K2203	K2750	K2751
[1]) 100 mV/div	1	0	0	x	x	x	x	0
[2]) 1V/div	1	1	0	x	x	x	x	0
10V/div	1	0	1	x	x	x	x	0
100V/div	1	1	1	x	x	x	x	0
GROUND	0	1	1	x	x	x	x	0

Channel B AC coupled

	K2101	K2102	K2103	K2201	K2202	K2203	K2750	K2751
100 mV/div	0	0	0	x	x	x	x	0
1V/div	0	1	0	x	x	x	x	0
10V/div	0	0	1	x	x	x	x	0
100V/div	0	1	1	x	x	x	x	0
GROUND	0	1	1	x	x	x	x	0

Channel A DC coupled

	K2101	K2102	K2103	K2201	K2202	K2203	K2750	K2751
100 mV/div	x	x	x	1	0	0	x	0
1V/div	x	x	x	1	1	0	x	0
10V/div	x	x	x	1	0	1	x	0
100V/div	x	x	x	1	1	1	x	0
GROUND	x	x	x	0	1	1	x	0

Channel A AC coupled

	K2101	K2102	K2103	K2201	K2202	K2203	K2750	K2751
100 mV/div	x	x	x	0	0	0	x	0
1V/div	x	x	x	0	1	0	x	0
10V/div	x	x	x	0	0	1	x	0
100V/div	x	x	x	0	1	1	x	0
GROUND	x	x	x	0	1	1	x	0

[1]) Relay information valid for SCOPE attenuator settings up to 100 mV/div.

[2]) Relay information valid for SCOPE attenuator settings between 100 mV/div and 1V/div, etc.

EXTernal input

	K2101	K2102	K2103	K2201	K2202	K2203	K2750	K2751
Ext. Trig	x	x	x	x	x	x	0	0
Generator	x	x	x	x	x	x	1	0

METER V DC mode

	K2101	K2102	K2103	K2201	K2202	K2203	K2750	K2751
300 mV	0	1	1	1	1	0	x	0
3V	0	1	1	1	0	1	x	0
30V	0	1	1	1	1	1	x	0
300V	0	1	1	1	1	1	x	0

METER V AC mode

	K2101	K2102	K2103	K2201	K2202	K2203	K2750	K2751
300 mV	0	1	1	0	1	0	x	0
3V	0	1	1	0	0	1	x	0
30V	0	1	1	0	1	1	x	0
300V	0	1	1	0	1	1	x	0

METER V DC + AC mode

	K2101	K2102	K2103	K2201	K2202	K2203	K2750	K2751
300 mV	0	1	1	1	1	0	x	0
3V	0	1	1	1	0	1	x	0
30V	0	1	1	1	1	1	x	0
300V	0	1	1	1	1	1	x	0

METER mV mode (EXTernal inputs)

	K2101	K2102	K2103	K2201	K2202	K2203	K2750	K2751
300 mV	0	1	1	0	0	1	1	0
3V	0	1	1	0	0	1	1	0

METER Ω mode

	K2101	K2102	K2103	K2201	K2202	K2203	K2750	K2751
300 Ohm	0	1	1	0	0	1	1	1
3 KOhm	0	1	1	0	0	1	1	1
30 KOhm	0	1	1	0	0	1	1	1
300 KOhm	0	1	1	0	0	1	1	1
3 MOhm	0	1	1	0	0	1	1	1
30 MOhm	0	1	1	0	0	1	1	1

- Control lines tables

Channel B DC coupled

	Sr1a	Sr2a	Sr3a	Sr4a	Sgnd8b	Sr1b	Sr2b	Sr3b	Sr4b	Sgnd8a	mV	OHM
100 mV/div	1	0	0	0	0	x	x	x	x	x	x	x
1V/div	1	1	0	0	0	x	x	x	x	x	x	x
10V/div	0	0	1	1	0	x	x	x	x	x	x	x
100V/div	0	1	1	1	0	x	x	x	x	x	x	x
GROUND	0	0	0	1	1	x	x	x	x	x	x	x

Channel B AC coupled

	Sr1a	Sr2a	Sr3a	Sr4a	Sgnd8b	Sr1b	Sr2b	Sr3b	Sr4b	Sgnd8a	mV	OHM
100 mV/div	1	0	0	0	0	x	x	x	x	x	0	0
1V/div	1	1	0	0	0	x	x	x	x	x	0	0
10V/div	0	0	1	1	0	x	x	x	x	x	0	0
100V/div	0	1	1	1	0	x	x	x	x	x	0	0
GROUND	0	0	0	1	1	x	x	x	x	x	0	0

Channel A DC coupled

	Sr1a	Sr2a	Sr3a	Sr4a	Sgnd8b	Sr1b	Sr2b	Sr3b	Sr4b	Sgnd8a	mV	OHM
100 mV/div	x	x	x	x	x	1	0	0	0	0	0	0
1V/div	x	x	x	x	x	1	1	0	0	0	0	0
10V/div	x	x	x	x	x	0	0	1	1	0	0	0
100V/div	x	x	x	x	x	0	1	1	1	0	0	0
GROUND	x	x	x	x	x	0	0	0	1	1	0	0

Channel A AC coupled

	Sr1a	Sr2a	Sr3a	Sr4a	Sgnd8b	Sr1b	Sr2b	Sr3b	Sr4b	Sgnd8a	mV	OHM
100 mV/div	x	x	x	x	x	1	0	0	0	0	0	0
1V/div	x	x	x	x	x	1	1	0	0	0	0	0
10V/div	x	x	x	x	x	0	0	1	1	0	0	0
100V/div	x	x	x	x	x	0	1	1	1	0	0	0
GROUND	x	x	x	x	x	0	0	0	1	1	0	0

METER V DC mode

	Sr1a	Sr2a	Sr3a	Sr4a	Sgnd8b	Sr1b	Sr2b	Sr3b	Sr4b	Sgnd8a	mV	OHM
300 mV	0	0	0	1	1	1	1	0	0	0	0	0
3V	0	0	0	1	1	0	0	1	1	0	0	0
30V	0	0	0	1	1	0	1	1	1	0	0	0
300V	0	0	0	1	1	0	1	1	1	0	0	0

METER V AC mode

	Sr1a	Sr2a	Sr3a	Sr4a	Sgnd8b	Sr1b	Sr2b	Sr3b	Sr4b	Sgnd8a	mV	OHM
300 mV	0	0	0	1	1	1	1	0	0	0	0	0
3V	0	0	0	1	1	0	0	1	1	0	0	0
30V	0	0	0	1	1	0	1	1	1	0	0	0
300V	0	0	0	1	1	0	1	1	1	0	0	0

METER V DC + AC mode

	Sr1a	Sr2a	Sr3a	Sr4a	Sgnd8b	Sr1b	Sr2b	Sr3b	Sr4b	Sgnd8a	mV	OHM
300 mV	0	0	0	1	1	1	1	0	0	0	0	0
3V	0	0	0	1	1	0	0	1	1	0	0	0
30V	0	0	0	1	1	0	1	1	1	0	0	0
300V	0	0	0	1	1	0	1	1	1	0	0	0

METER mV mode (EXTernal inputs)

	Sr1a	Sr2a	Sr3a	Sr4a	Sgnd8b	Sr1b	Sr2b	Sr3b	Sr4b	Sgnd8a	mV	OHM
300 mV	0	0	0	1	1	0	0	0	1	1	1	0
300V	0	0	0	1	1	0	1	0	1	1	1	0

METER Ω/ ⊣⊢ modes

	Sr1a	Sr2a	Sr3a	Sr4a	Sgnd8b	Sr1b	Sr2b	Sr3b	Sr4b	Sgnd8a	mV	OHM
300 Ohm	0	0	0	1	1	0	0	0	1	1	0	1
3 KOhm	0	0	0	1	1	0	0	0	1	1	0	1
30 KOhm	0	0	0	1	1	0	0	0	1	1	0	1
300 KOhm	0	0	0	1	1	0	0	0	1	1	0	1
3 MOhm	0	0	0	1	1	0	0	0	1	1	0	1
30 MOhm	0	0	0	1	1	0	1	0	1	1	0	1
Diode	0	0	0	1	1	0	1	0	1	1	0	1

	Sc15	Sc16	Sc17	Sc18
300 Ohm	1	0	1	1
3 KOhm	1	0	1	0
30 KOhm	1	0	0	0
300 KOhm	1	1	0	0
3 MOhm	0	1	0	0
30 MOhm	0	1	0	0
Diode	1	0	1	1

	G_OUTP
Ext. Trig.	0
Generator	1

	BUZ
Buzzer off	1
Buzzer on	0

	SCOPE mode Attenuator settings		METER mode
	≥ 20 mV/div	≤ 10 mV/div	
D-POSCHA	0	1	1
D-POSCHB	1	1	x

While the ScopeMeter is operating in METER mode or when the instrument is calibrated, the signals Si, mV, OHM, Sr1b, Sr2b, Sr3b, Sr4b, and D_POSCHB can change ("high/low"). Signals Ex and Ey are used to switch the relays. Both signals are "high" when the relays are not operated.

Signals Sg4a, Sg5a, Sg6a, and Sg7a set the L.F. gain for channel A. Sg4b, Sg5b, Sg6b, and Sg7b set the L.F. gain for channel B. Sg4a (Sg4b) is the most significant bit (MSB), Sg7a (Sg7b) is the least significant bit (LSB).

Signals So10b, So11b, S012b, So13b, and So14b are used to set the offset compensation in the preamplifier circuits of channel A. Signals Sc15, Sc16, Sc17, Sc18, and S014a are used to set the offset compensation in the preamplifier circuits of channel B. S010b (Sc15) is the most significant bit (MSB), So14b (So14a) is the least significant bit (LSB).

3.4.7 GENERATOR circuit

- Introduction

See figure 3.14.

The ScopeMeter has a built-in signal generator, which can produce the following signals, used to adjust the probes:

- square wave voltage, amplitude: 5V peak-to-peak
  frequency: 976 Hz
- DC voltage: 3V

ScopeMeter model 97 can also produce:

- sine wave voltages, amplitude: 5V peak-to-peak
  frequency: 976 Hz
- square wave voltages, amplitude: 5V peak-to-peak
  frequencies: 488 Hz
  1.95 kHz
- slow ramp voltage, -2V...+2V
- slow ramp current, -3 mA...+3mA

The signal generator uses a square wave voltage, coming from the D-ASIC to generate the various signals. The circuit consists of an operational amplifier, a fourth order filter, and a current source. The configuration can be changed by means of programmable switches to produce different output signals.

- Detailed circuit description

See figure 3.16 and circuit diagram A2b (figure 10.6).

Figure 3.16 shows the basic generator circuitry:

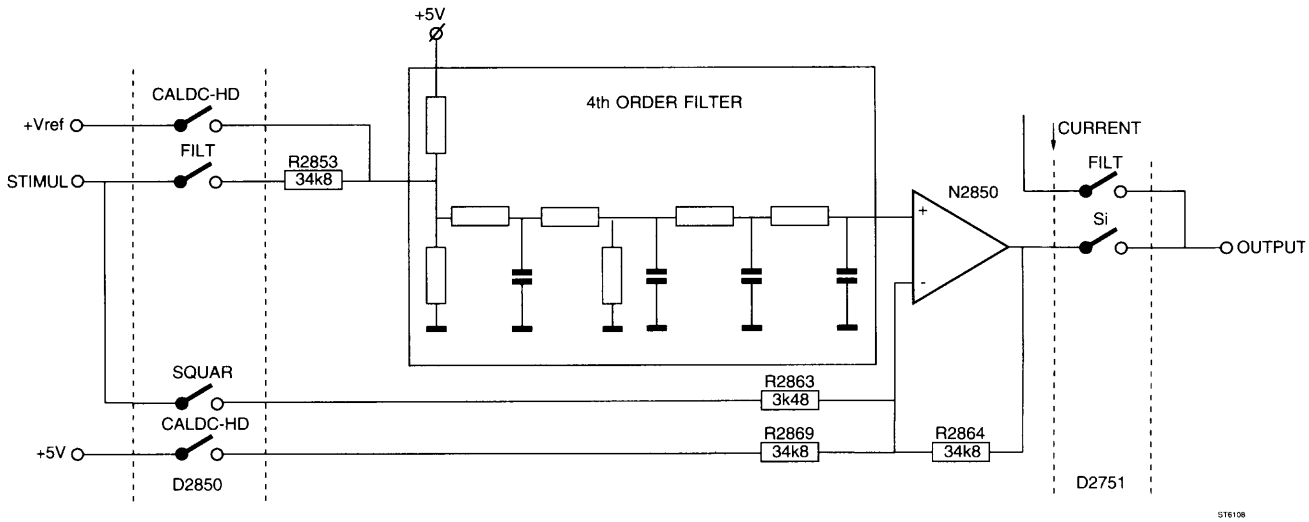


Figure 3.16 Basic generator circuitry

This circuit uses a square wave voltage, STIMUL, coming from the D-ASIC. This signal has an amplitude between 0V and +5V. The duty cycle of the square wave signal is varied depending on the signal to be generated. The reference voltage +Vref is used to generate the DC voltage.

The configuration depends on the settings of switches D2850 and D2751. These switches are controlled by the signals FILT, CALDC- HD, SQUAR and Si. Table 3.8 lists the various settings and resulting generator output signals.

Table 3.8 Generator control signals for various generator output signals

STIMUL		CONTROL SIGNALS				OUTPUT SIGNAL	
frequency	duty cycle	CALDC-HD	FILT	SQUAR	Si	amplitude	waveform
488 Hz 976 Hz 1.95 kHz	50% 50% 50%	0 0 0	0 0 0	1 1 1	1 1 1	5 V p-p 5 V p-p 5 V p-p	Square wave voltage
-	-	1	0	0	1	3 V p-p	DC voltage
976 Hz	50%	0	1	0	1	1 V p-p	Sine wave voltage
20 kHz	0-100%	0	1	0	1	-2...+2 V p-p	Slow ramp voltage
20 kHz	0-100%	0	1	0	0	0...+3 mA	Slow ramp current

In this table "1" means: signal "high" (switch closed) and "0" means signal "low" (switch open).

The slow ramp current signal is made with a current source. A simplified schematic diagram is given in figure 3.17:

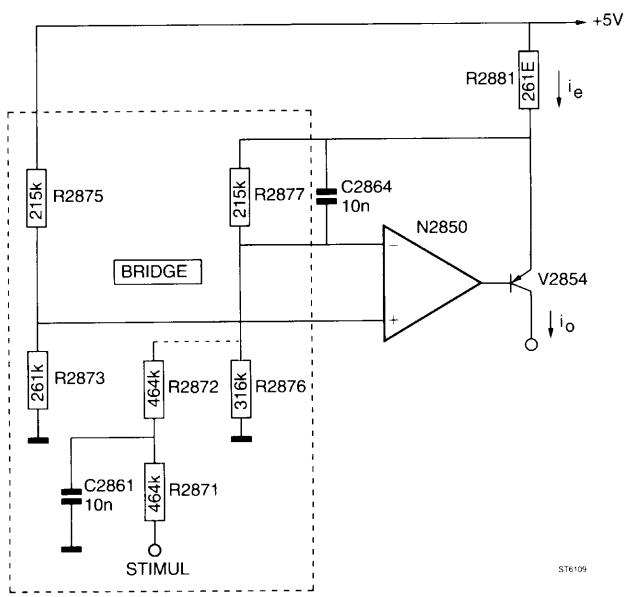


Figure 3.19 Current source section of generator

When the duty cycle of STIMUL is 0%, the bridge will be in balance and current $i_e = 0$. When the duty cycle of STIMUL is increased, a DC component is generated, which has a linear relation to the duty cycle. The operational amplifier tries to keep the voltages on both inputs the same. The operational amplifier will now drive transistor V2854 to increase i_e. Because i_e is almost equal to i_o, the output current will also increase. In this way it is possible to regulate the current i_o by means of the duty cycle of STIMUL.

3.4.8 BATTERY CHARGER

- Introduction

See figure 3.18.

The battery charger consists of a switched mode power supply and some auxiliary circuitry. Whenever the ScopeMeter is connected to the line voltage (via the separate power adapter/battery charger PM8907), the instrument switches over to line voltage operation automatically. If a NiCd battery pack is installed, the ScopeMeter will charge this if line voltage is present. Special circuitry prevents discharge of the batteries when the instrument is not being used.

- Detailed circuit description

See figure 3.18 and circuit diagram A2c (figure 10.7).

HF Filter

The input voltage (between 8V and 20V) first passes HF FILTER Z2501 and is used to drive a flyback converter.

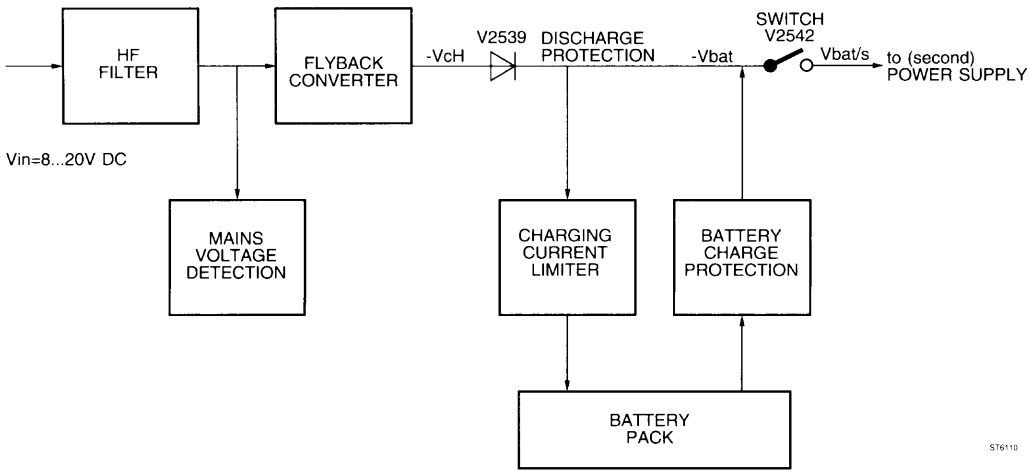


Figure 3.18 Schematic diagram battery charger

Line voltage detection

When the ScopeMeter is operated on line voltage, transistor V2521 will be driven by the (filtered) input voltage. The signal MAINVOLTHT will become "low" to indicate that the instrument is operated from the line voltage. The related signal MAINS-D (connector X1201, pin 5) is connected to the microprocessor analog input 19. When the signal MAINS-D is "high", the microprocessor will not switch off the ScopeMeter, as in battery operated mode.

Flyback converter

See figure 3.19 and circuit diagram A2c (figure 10.7).
The main components of this flyback converter are V2532 (converter-switch), L2504 and L2505 (windings), R2582 (sense resistor), and C2536 and V2533 (secondary circuit). The main regulating element is N2503 (see figure 3.19).

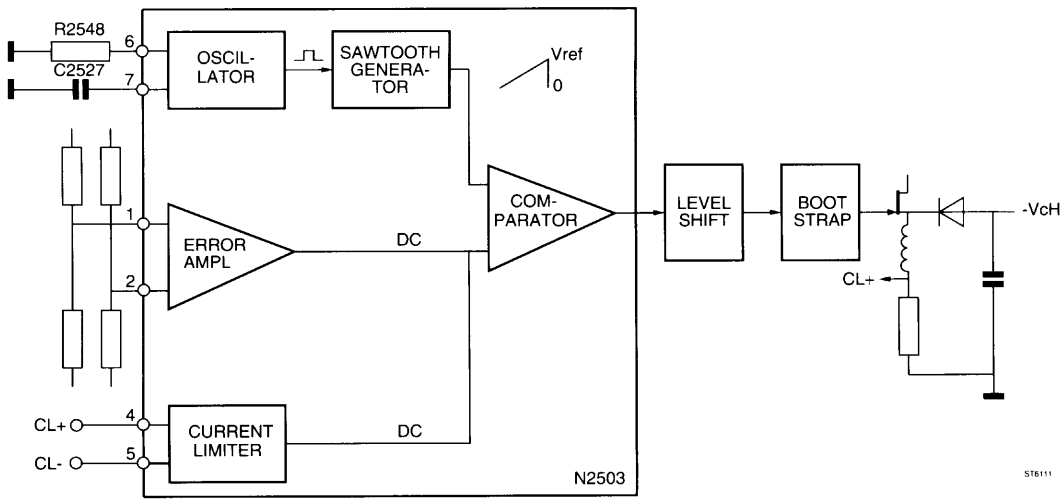


Figure 3.19 Schematic diagram flyback converter

N2503 incorporates an oscillator, the frequency of which is determined by R2548 and C2527 (fixed frequency of 100 kHz). This oscillator drives a sawtooth generator. The produced sawtooth voltage is compared to a DC voltage. This DC voltage is made by an internal error amplifier (voltage regulator), which compares the produced converter voltage -V_CH to a stable 5V reference voltage. This is done with a bridge circuit (R2554, R2555, R2557, R2558).

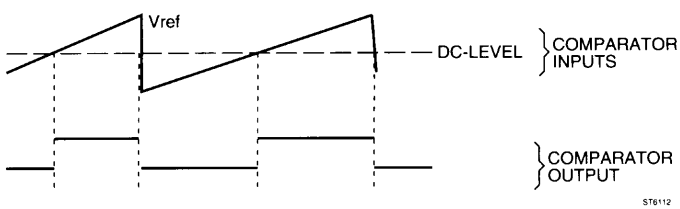


Figure 3.20 Internal N2503 voltage waveforms

When the sawtooth voltage is larger than the DC voltage, the output signal (CA, CB on pins 12,13) is "high". When the sawtooth voltage is less than the DC voltage, the output signal is "low". In this way the duty cycle of N2503's output signal can be changed, thus changing the energy transferred to the secondary converter circuit.

The output signal is level shifted by transistor V2526 and related circuitry. Now this square wave signal is used to drive converter switch V2532, which is bootstrapped via V2528, V2529, R2546, R2562, and C2537.

Charging current limiter

N2503 limits the voltage difference between CL+ (pin 4) and CL- (pin 5) to 200 mV. If the voltage between these two inputs starts to rise, the internal DC voltage will rise, and the duty cycle of the output square wave voltage will decrease (see voltage regulation described earlier).

If the ScopeMeter is connected to the line voltage and is not operational, the flyback converter operates almost without a load (only the NiCd battery pack). This implies that the current floating through windings L2504 and L2505 (averaged in time) is almost zero. Because of this, the voltage on CL+ is about 30 mV and the voltage on CL- is about 170 mV. The battery pack will be charged with 170 mA.

If the flyback converter is operated normally (ScopeMeter "ON"), the voltage on both CL- and CL+ will rise and the charging current will decrease to 100 mA.

Battery charge protection
To prevent charging of non-rechargeable batteries, a special protection circuit is provided. For safety reasons, this circuit consists of two cascaded sections. When the ScopeMeter is "ON", the flyback converter will be operative. The produced voltage POWER-ON will drive both Field Effect Transistors V2537 and V2538 open (conductive) via R2568 and R2569. Now the battery plus contact is connected to the ScopeMeter circuit ground. If line voltage is present, the voltage -VCH produced by the flyback converter will drive V2534 and V2536, which prevent transistors V2537 and V2538 from conducting. The battery plus contact is disconnected from ground.

Power ON/OFF circuitry
During normal operation the POWER-ON signal is +5V. Transistor V2542 is opened (conductive), so -Vbat/s equals -V_CH. If the ScopeMeter is operating and the RESPOWHT ("reset power supply") becomes "high", V2541 will conduct and V4542 will stop conducting. This will disconnect -Vbat/s from -V_CH.

3.4.9 POWER SUPPLY

- Introduction
See figure 3.19.

Different supply voltages are needed for various ScopeMeter sections. A second flyback converter is used to convert -Vbat/s to supply voltages of -30V, -5V and +5V. This voltage, -Vbat/s, is made by the first flyback converter (in the battery charger section) or comes from the batteries. -Vbat/s is 5V if operated with NiCad battery pack, and 8V if operated from line voltage.

- Detailed circuit description
See figure 3.19 and circuit diagram A2c (figure 10.7).

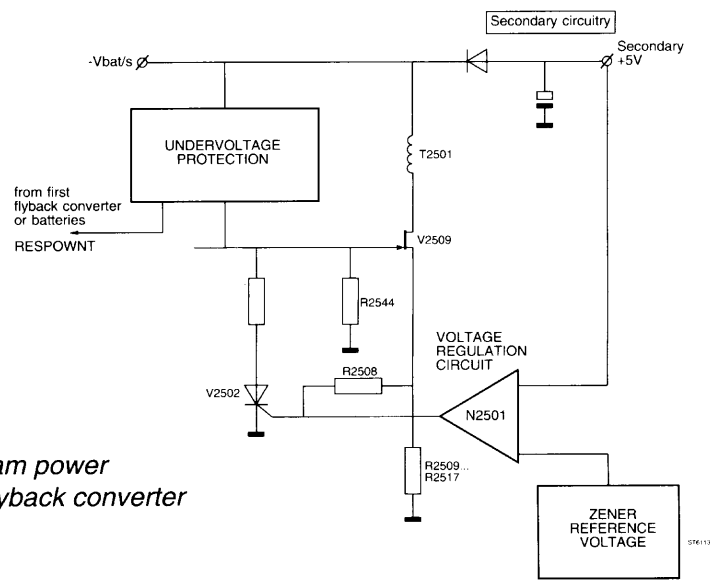


Figure 3.23 Schematic diagram power supply, second flyback converter

This self-oscillating flyback converter consists of:
- V2509 (converter-switch)
- R2509...R2517 (sense-resistors)
- V2502 (thyristor switch)
- R2544 (start-up resistor)
- T2501 (windings)
- 3 separate secondary circuits for -30V, -5V, and +5V

The main regulating component is operational amplifier N2501. This op-amp compares the produced secondary +5V voltage with a reference voltage, produced by zener diode N2502. If the secondary +5V increases, the fault signal generated by the N2501 will produce a current that causes an extra voltage drop over R2508. Because of this, thyristor V2502 will fire earlier. The switching frequency of the flyback converter increases and the secondary +5 V voltage decreases.

When the ScopeMeter is switched on (RSSLSTN is "active low"), V2544 (see circuit diagram A2c, figure 10.6) connects the inverting input of N2501 to ground. When the ScopeMeter starts up, capacitor C2509 causes the reference voltage and therefore the output voltage, to rise slowly, limiting the inrush ("starting") current drawn from the batteries or line voltage.

Undervoltage detection and protection circuit
When the flyback converter is oscillating, capacitor C2532 is charged every period via R2543 and V2516. During normal operation C2532 is discharged by V2517, which is driven via R2541, V2511, R2529, and V2509. If, for example, the secondary +5V voltage becomes too low, C2532 is not discharged by V2517. This will activate the RESPOWHT signal, and the power will be switched off completely, preventing further damage of circuits. (The +5V voltage can become too low because the input voltage -Vbat/s is too low, or the power output to the ScopeMeter circuitry is too high.)

R2542, C2531, and diode V2508 will reset C2532 during the start up of the power supply (the voltage across C2532 will become zero). This is necessary because V2517 cannot be driven via V2541, just after the ScopeMeter is switched on.

Reference source
The reference source provides a stable positive (+Vref) and negative reference voltage (-Vref) used in other parts of the ScopeMeter. It also uses the voltage across zener diode N2502 as an input voltage.

NOTE: The flyback converter, used in the battery charger section (section 3.4.8) has a fixed oscillating frequency of 100 kHz. The amount of energy supplied is regulated by varying the duty cycle. The flyback converter used in this power supply, however, is self-oscillating and operates on a variable oscillating frequency and a fixed duty cycle. For alkaline batteries, for example, the oscillating frequency is about 62 kHz.

4 PERFORMANCE VERIFICATION PROCEDURE

4.1 GENERAL INFORMATION

The ScopeMeter should be calibrated and in operating condition when you receive it.

The following performance tests are provided to ensure that the ScopeMeter is in a proper operating condition. If the instrument fails any of the performance tests, calibration adjustments (see chapter 5) and/or repair (see chapter 7) is necessary.

The Performance Verification Procedure described here consists of two parts:

- Standard Performance Verification Procedure (separate SCOPE- and METER-section)
- Additional Performance Verification Procedure

The **Standard Performance Verification Procedure** uses built-in ScopeMeter front panel settings or frontsettings, that can be accessed via the SERVICE MENU. To enter the SERVICE MENU, press both AC/DC/GROUND keys simultaneously. This menu allows you to choose between SCOPE and METER performance testing ("Verify").

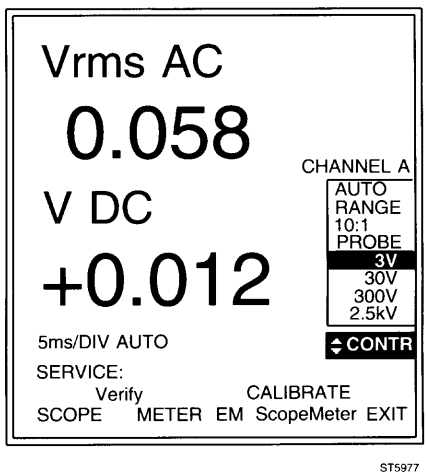


Figure 4.1 Service menu (entered from METER mode)

When the ScopeMeter is in SERVICE mode, only the softkeys, the select/adjust keys and the ON/OFF key can be operated.
It is possible to move forward or backward through the frontsettings, that apply to the separate performance test steps. This can be done using the adjust/select keys. You can leave the Performance Verification Procedure any time by pressing the EXIT softkey. The Performance Verification Procedure steps are explained in the following sections.

The **Additional Performance Verification Procedure** can be used to do some extra checks, depending on the ScopeMeter version (93, 95 or 97). In these tests the ScopeMeter must be set up manually.

NOTE: This Performance Verification Procedure is a quick way to check most of the instrument's specifications. Because of the highly integrated design of the ScopeMeter, it is not always necessary to check all features separately. The procedure described here often combines many test steps in one procedure step, thereby minimizing total test time.

The Performance Verification Procedure is based on the specifications, listed in chapter 2 of this Service Manual. The values (requirements) given here are valid for ambient temperatures between 18 °C and 28 °C.

4.2 STANDARD PERFORMANCE VERIFICATION PROCEDURE

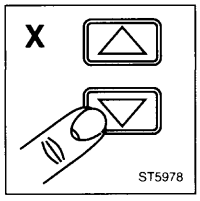
This section explains the required Performance Verification Procedure setup, with the actions that have to be done for each step. Follow the instructions described with each step.
The recommended test equipment, required for this Standard Performance Verification Procedure, is listed in table 4.1.

Table 4.1 Recommended test equipment Standard Performance Verification Procedure

Instrument Type	Recommended Model
Multifunction Calibrator	Fluke 5100B
Function Generator	Philips PM 5134
Time Mark Generator	Tektronix TG 501
Constant Amplitude Sine wave Generator	Tektronix SG 503
Square wave Calibration Generator	Tektronix PG 506

- Cables and terminations for the generators (all BNC type)
- Two standard banana test leads (delivered with the ScopeMeter)
- BNC (female)-to-banana (male) (delivered with the ScopeMeter)

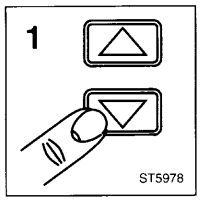
NOTE: During the following Performance Verification Procedure, the ScopeMeter input sockets are connected to the signal generator outputs by means of cables (BNC connector channel A or B) or two standard banana test leads (COM and mV/Ohm/Diode banana connectors). The oscilloscope probes delivered with the instrument are <u>not</u> used during the Standard Performance Verification Procedure. The calibration of the probes is described in the Users Manual.



In the following text, this figure is used to indicate that one of the select/adjust keys (up/down) must be pressed, to display the indicated step number "x" on the ScopeMeter screen.

1/2. LCD test

While in the SERVICE menu, press the SCOPE softkey to enter the **SCOPE section of the Performance Verification Procedure**.



Now a (dark) test pattern is displayed. This pattern consists of a circle placed in a square, and three diagonal lines (see figure 4.2).

NOTE: Firmware versions below V3.20 provide only one diagonal line.

Observe the test pattern closely. The lines may not be interrupted; the pattern must be continuous. In this test sets the display to a high contrast, resulting in a dark display. If there are defects in the pixel columns of the Liquid Crystal Display, they must be clearly visible now as intermissions in the pattern.

After you have checked the display, press the upper select/adjust key once. Now an oscilloscope screen is displayed.

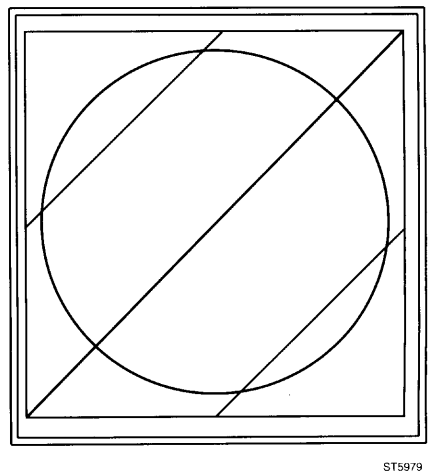
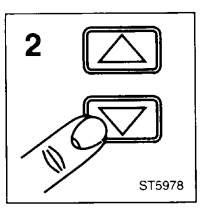
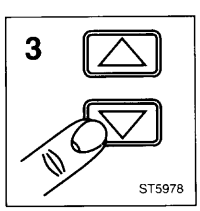


Figure 4.2 Test pattern



Press the upper select/adjust key again to go to step 2. Now the display shows the same pattern, but with a low contrast (bright screen). This will help you to locate any failures in the pixel rows of the LCD.

3. Ground level check



Press the upper select/adjust key to go to step 3. The purpose of this step is to check the ground level position adjustments (0V) for both traces. The ScopeMeter display shows the text " Verif 3", to show that this is the third SCOPE Performance Verification step (see figure 4.3).

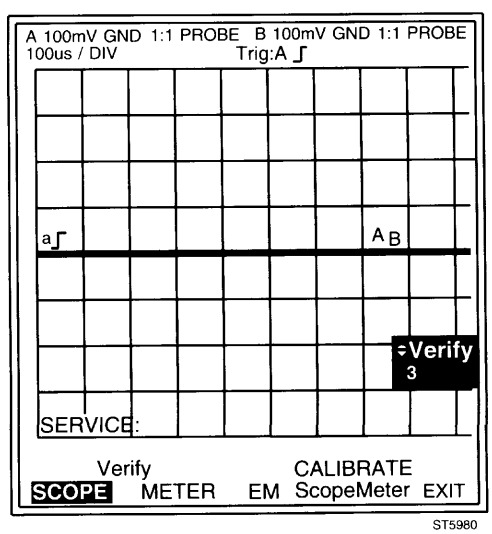
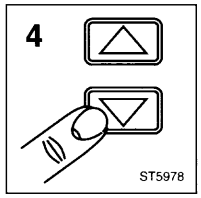


Figure 4.3 Reference set-up

Requirements:

Verify that the traces of both channels A and B are situated on the vertical middle of the screen.

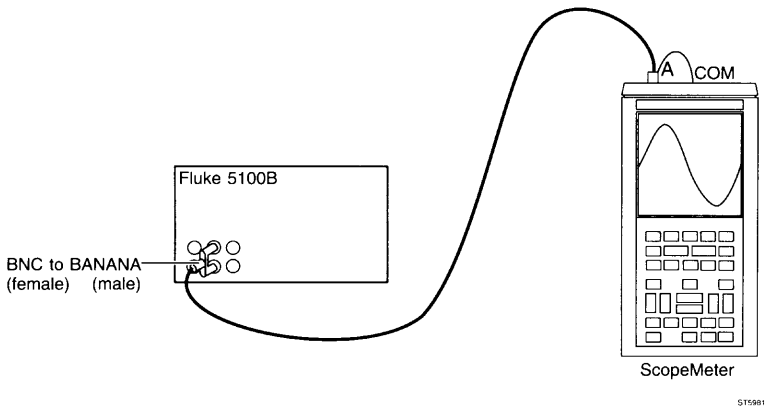
4. Vertical deflection coefficients channel A



These tests check the vertical deflection coefficients for channel A in the 100 mV/div DC and AC ranges.

Test equipment:
Fluke 5100B Calibrator

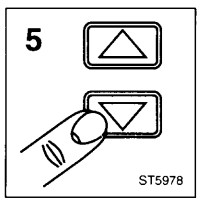
Test setup:
Connect the banana jack COM to the BNC common



Procedure/requirements for AC test:
A Apply a 1 kHz sine wave signal with an amplitude of 600 mV AC peak-to-peak to the channel A BNC connector.
(Set the Fluke 5100B to 212.13 mV RMS, 1 kHz sine wave).
Verify that the amplitude of the sine wave signal displayed is 5.88...6.12 divisions.

Procedure/requirements DC test:
B Apply 300 mV DC to channel A.
Verify that the distance between the trace for channel A and the vertical middle of the screen (ground level) is 2.94...3.06 divisions.

5/6/7. Vertical deflection coefficients channel B

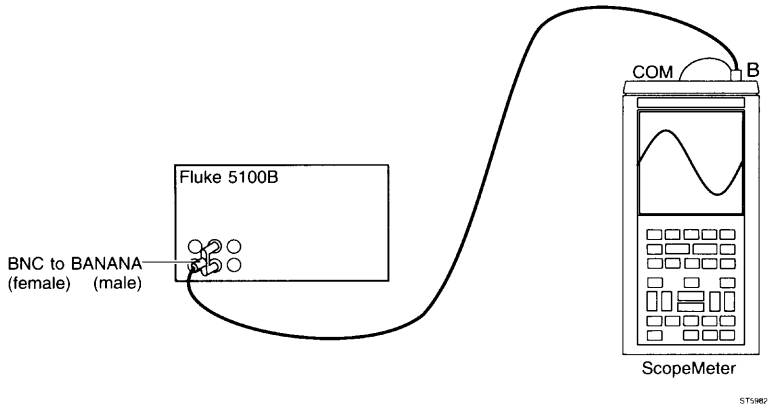


These tests check the vertical deflection coefficients for channel B in the DC and AC ranges.

Test equipment:
Fluke 5100B Calibrator

Test setup:

Connect the banana jack COM to the BNC common



Procedure/requirements for channel B AC and DC tests:

A Apply 300 mV DC to channel B.

B Change the input voltage and the setting of channel B according to table 4.2 and check that the amplitude of the signal agrees with the value listed. Use the select/adjust keys to select each step number.

NOTE: The AC voltages listed in this are peak-to-peak voltages (sine wave). The values listed between brackets () are the RMS values that have to be chosen on the Fluke 5100B calibrator.

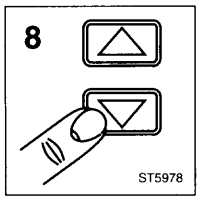
Requirements:

Table 4.2 Requirements vertical deflection coefficients for channel B

Input voltage	Step number on display	Requirements
300 mV DC	"5"	2.94...3.06 div.
600 mV AC pp (212.13mV RMS), 1 kHz	"5"	5.88...6.12 div.
3V DC	"6"	2.94...3.06 div.
6V AC pp (2.1213V RMS), 1 kHz	"6"	5.88...6.12 div.
30V DC	"7"	2.94...3.06 div.
60V AC (21.213 V RMS), 1 kHz	"7"	5.88...6.12 div.

The ScopeMeter uses the same input circuitry (hardware) for the SCOPE and the METER modes (in the above attenuator settings). When the voltage accuracy is checked (see the description "METER Performance Verification Procedure" step 1), the deflection coefficients for SCOPE channel A are also tested.

8/9. Rise time

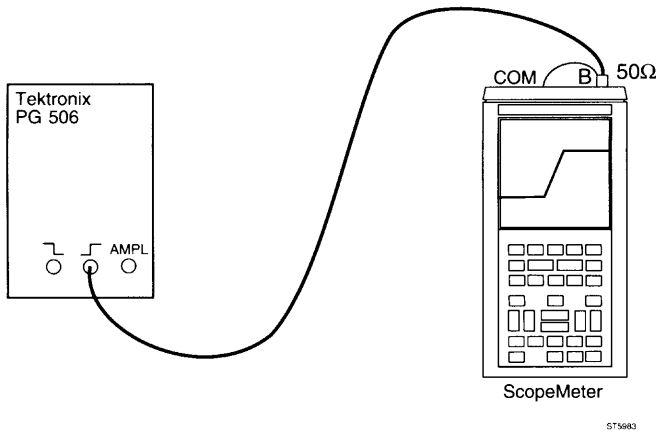


The rise time of the ScopeMeter is checked by means of a fast rise time pulse. First channel B is measured.

Test equipment:

Tektronix PG 506 Square Wave Calibration Generator

Test setup channel B rise time measurement:
Connect the banana jack COM to the BNC common



Procedure for channel B rise time measurement:

A Apply a fast rise time pulse, repetition frequency 1 MHz, amplitude 0.5V to channel B. Use a 50Ω termination. Set the generator in position "FAST RISE".

B Adjust the pulse amplitude to exactly 5 divisions. See figure 4.4.

Requirements:

NOTE:

$$t_r(measured) = \sqrt{(t_r(inputsignal)^2 + t_r(ScopeMeter)^2)}$$

C Check the rise time, measured between 10% and 90% of the pulse amplitude. See figure 4.4. The rise time t_r (measured) must be 7 ns (0.7 div) or less.

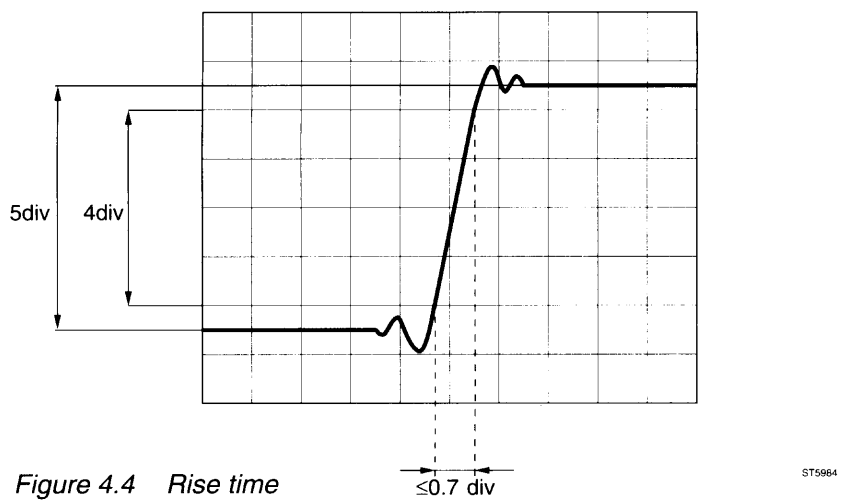
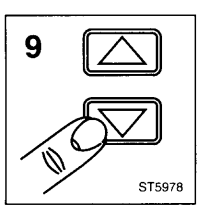


Figure 4.4 Rise time

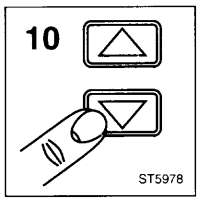


Test setup channel A rise time measurement:
Refer to the test set-up for channel B measurement. Connect the pulse generator to the channel A BNC input connector.

Procedure for channel A rise time measurement:
Refer to the settings/procedure for channel B measurement.

Requirements:
Refer to channel B requirements.

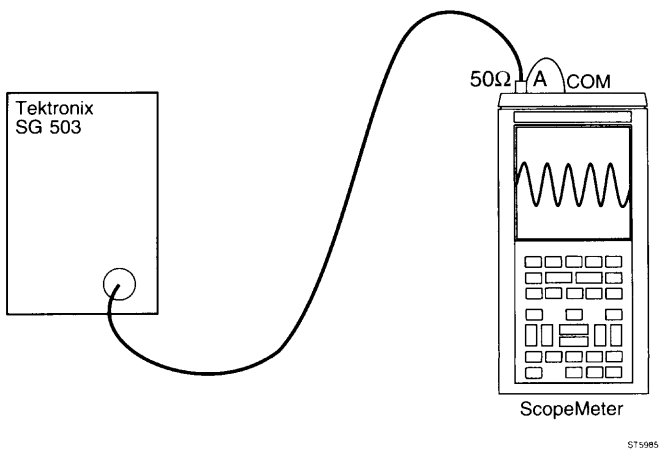
10/11/12/13. Frequency response



These tests check the upper transition point of the bandwidth for ScopeMeter vertical channels A and B.

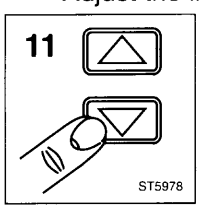
Test equipment:
Tektronix SG 503 Constant Amplitude Sine wave Generator

Test setup:
Connect the banana jack COM to the BNC common

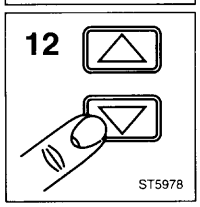


Procedure/requirements for channel A frequency response measurement:

A Apply a 50 kHz sine wave with an amplitude of 120 mV peak-to- peak to channel A. Use a 50Ω termination.
Adjust the input signal to a trace height of exactly 6 divisions.

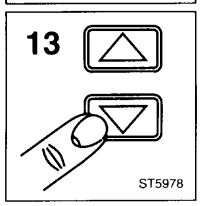


B Without changing the amplitude of the sine wave signal, switch over to step 11 using the upper select/adjust key. Increase the frequency of the sine wave to 50 MHz and verify that the vertical deflection is 4.2 divisions or more.



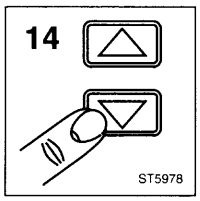
Procedure/requirements for channel B frequency response measurement:

C Apply a 50 kHz sine wave with an amplitude of 120 mV peak-to- peak to channel B. Use a 50Ω termination.
Adjust the input signal to a trace height of exactly 6 divisions.



D Without changing the amplitude of the sine wave signal, switch over to step 13 using the upper select/adjust key. Increase the frequency of the sine wave to 50 MHz and check that the vertical deflection is 4.2 divisions or more.

14/15/16/17. Trigger sensitivity channel A and B



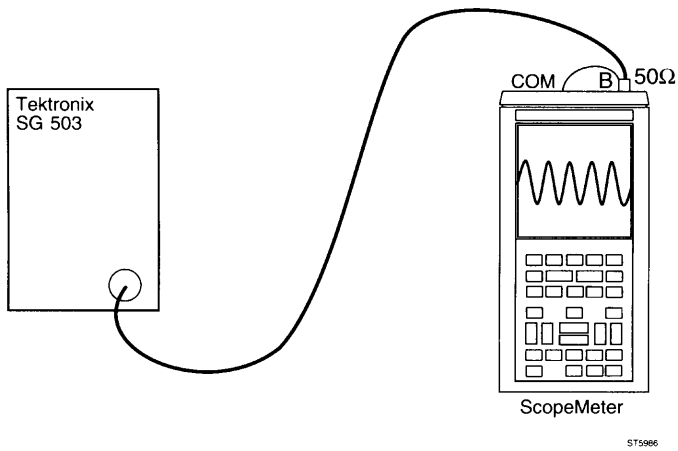
The trigger sensitivity depends on the amplitude and frequency of the trigger signal. This test checks the trigger sensitivity of the ScopeMeter. Also the +SLOPE/-SLOPE function (triggering on negative slope) is tested for both channels A and B. Channel B is tested first.

Test equipment:

Tektronix SG 503 Constant Amplitude Sine Wave Generator

Test setup:

Connect the banana jack COM to the BNC common



Procedure/requirements for channel B trigger sensitivity measurement:

A Apply a 100 MHz sine wave, with an amplitude of approximately 200 mV peak-to-peak to channel B. Use a 50Ω termination.[1)]

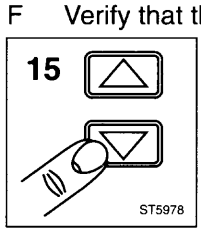
B Adjust the amplitude of the input signal to exactly 4 divisions on the display.

C Verify that the signal is well triggered.

D Apply a 60 MHz sine wave, with an amplitude of approximately 100 mV peak-to-peak to channel B. Use a 50Ω termination.[1)]

E Adjust the amplitude of the input signal to exactly 2 divisions on the display.

F Verify that the signal is well triggered.



G Apply a 10 MHz sine wave, with an amplitude of 300 mV peak-to-peak to channel B. Use a 50Ω termination.[1)]

H Adjust the amplitude of the input signal to exactly 1.5 divisions on the display.

I Verify that the signal is well triggered on the **falling** edge. See figure 4.5.

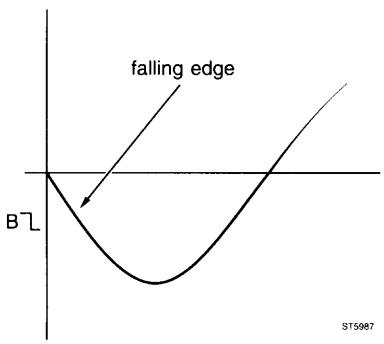
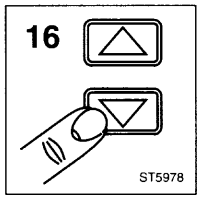


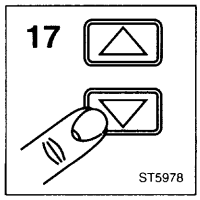
Figure 4.5 Signal triggered on the falling (negative) edge

[1)] The SG 503 setting will be higher than the required ScopeMeter input value!

Procedure/requirements for channel A trigger sensitivity measurement:

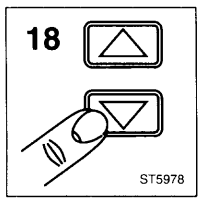


K Repeat steps G...I for channel A.



L Repeat steps A...F for channel A.

18. Timebase



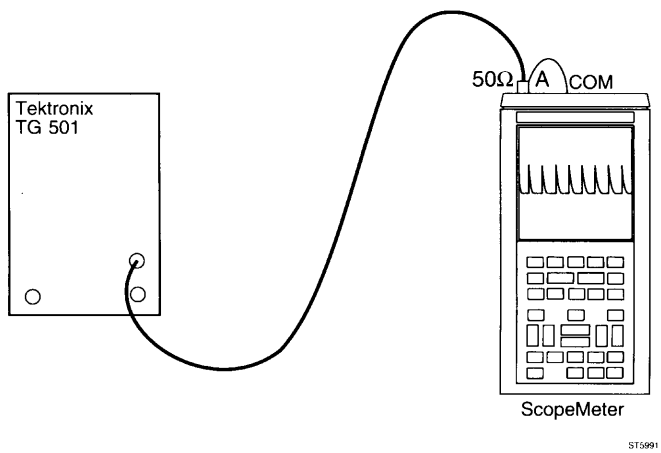
This test uses a marker pulse calibration signal to verify the deflection coefficient of the time base.

Test equipment:

Tektronix TG 501 Time Mark Generator

Test set-up:

Connect the banana jack COM to the BNC common



Procedure/requirements:

A Apply a 1 µs (1V peak-to-peak) time marker signal to channel A. Use a 50Ω termination.

B Verify that the distance between the 10th marker pulse and the 10th vertical grid line is the same as the distance between the 2nd marker pulse and the 2nd vertical grid line. (Tolerance ± 1 pixel = ± 0.04 divisions).

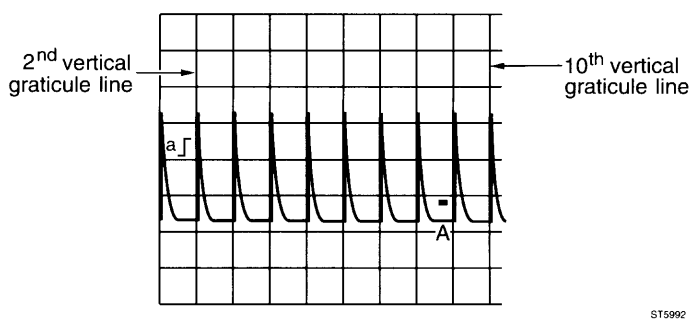
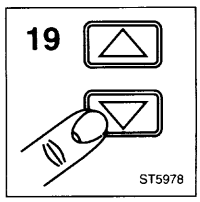


Figure 4.6 The distance between the 10th marker pulse and the 10th vertical grid line must be the same as the distance between the 2nd marker pulse and the 2nd vertical grid line

19. Trigger sensitivity external channel

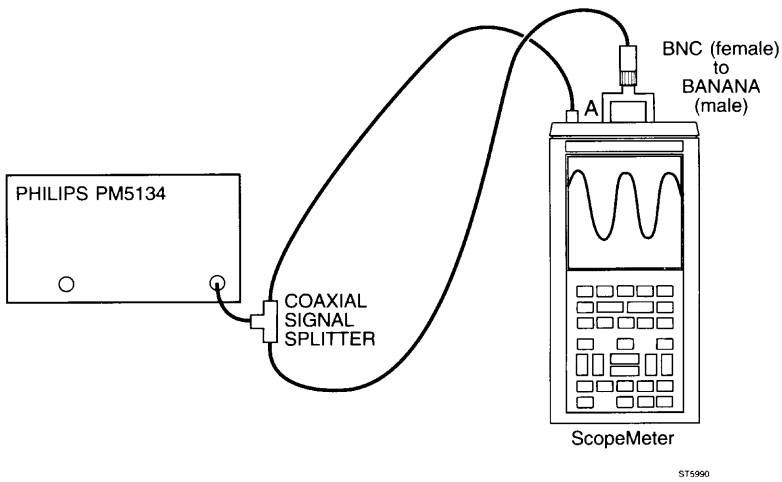


This test checks the trigger sensitivity, using the external banana connectors as the trigger input.

Test equipment:

Philips PM 5134 Function Generator

Test setup:



Procedure/requirements:

A Apply a 1 kHz sine wave signal, that has an amplitude of 1.8V peak-to-peak, superimposed on 1.4V DC to channel A and to the banana input sockets. Use a coaxial signal splitter and a BNC-to-banana converter (see test setup).

B Verify that the signal is well triggered.

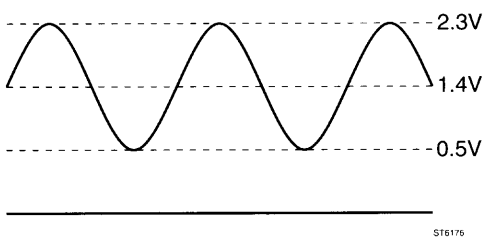
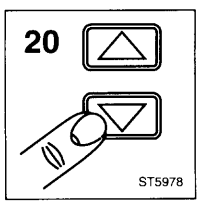


Figure 4.7 1.8V peak-to-peak sine wave superimposed on 1.4V DC

20. Horizontal deflection: x-deflection

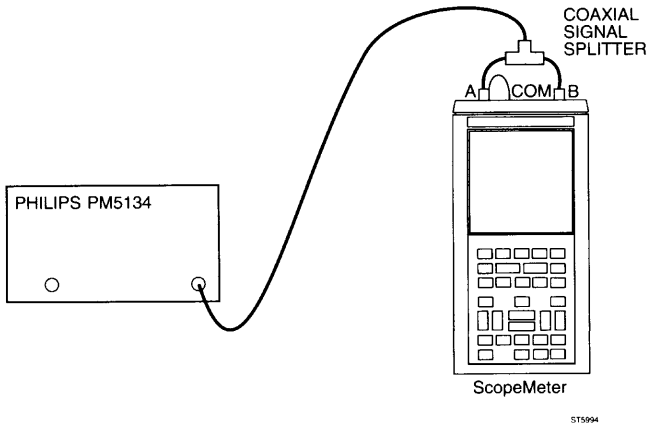


This test checks the correct working of the X-Y (A versus B) mode.

Test equipment:

Philips PM 5134 Function Generator

Test set-up:



Procedure:

A Apply a 2 kHz sine wave signal of 800 mV peak-to-peak to channel A and channel B. Adjust the input signal to a trace height of 8 divisions.

Requirements:

Verify that a figure with an angle of 45° is displayed, and that the gap is smaller than 10 pixels. See figure 4.8.

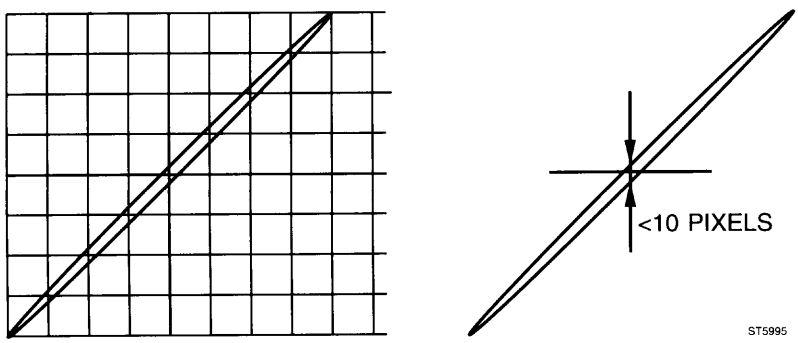
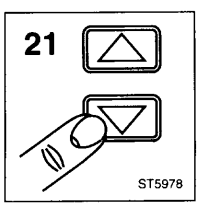


Figure 4.8 A versus B display

21/22. Base line instability



This test checks the maximum base line instability.

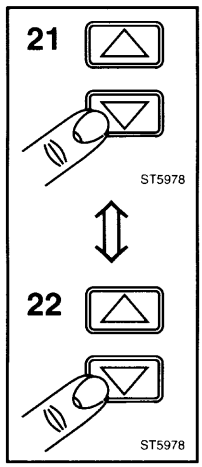
Test equipment:

none

Test setup:

no special setup required

Procedure/requirements:



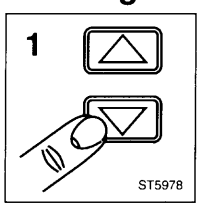
A Turn off the signal sources connected to the ScopeMeter input or minimize (zero) the signal amplitudes.

B Use the select/adjust keys to switch from front setting number 21 to number 22 and back to 21.

C Verify that the trace does not jump more than 0.1 divisions while switching between front settings 21 and 22.

While in the SERVICE menu, press the METER softkey to enter the **METER part of the Performance Verification Procedure.**

1. Voltage accuracy METER mode



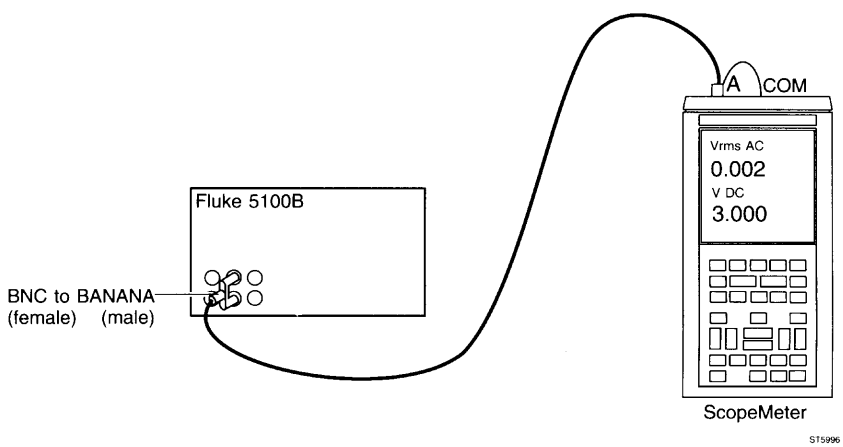
The following section checks the voltage accuracy in METER mode. The ScopeMeter uses the same input circuitry (hardware) for the SCOPE (channel A) and the METER modes (in these attenuator settings). When the voltage accuracy of the METER is checked, the deflection coefficients for SCOPE channel A are also tested.

Test equipment:

Fluke 5100B Calibrator

Test setup:

Connect the banana jack COM to the BNC common



Procedure:

A Apply 300 mV DC to channel A.

B Change the input voltage and the setting of channel A according to table 4.3 and check that the amplitude of the signal agrees with the value listed.

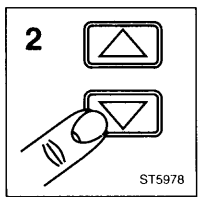
NOTE: The ScopeMeter is set to METER "AUTORANGE" (step 1) with a dual (AC and DC) readout. This implies that the ScopeMeter range is set automatically according to the input signal.

Requirements:

Table 4.3 Requirements for voltage accuracy test channel A, METER mode

Input signal	Requirements
300 mV DC	298.0...302.0V DC
300 mV RMS AC, 1 kHz	292.5...307.5V RMS AC
3V DC	2.980...3.020V DC
3V RMS AC, 1 kHz	2.925...3.075V RMS AC
30V DC	29.80...30.20V DC
30V RMS AC, 1 kHz	29.25...30.75V RMS AC

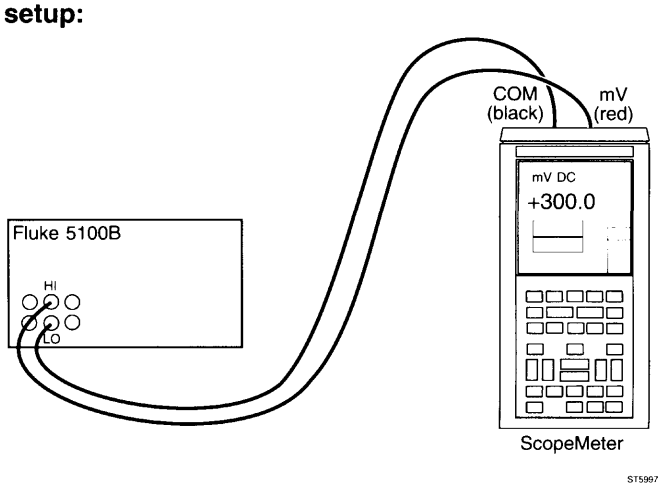
2. DC mV accuracy METER mode



These tests check the accuracy of the DC mV function. The signal must be supplied to the banana input connectors of the ScopeMeter.

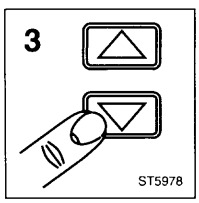
Test equipment:
Fluke 5100B Calibrator

Test setup:



Procedure/requirements:
A Apply 300 mV DC to the banana connectors of the ScopeMeter.
B Verify that the readout is between 298.2...301.8 mV DC.
C Apply 3V DC to the banana connectors of the ScopeMeter.
D Verify that the readout is between 2.982...3.018V DC.

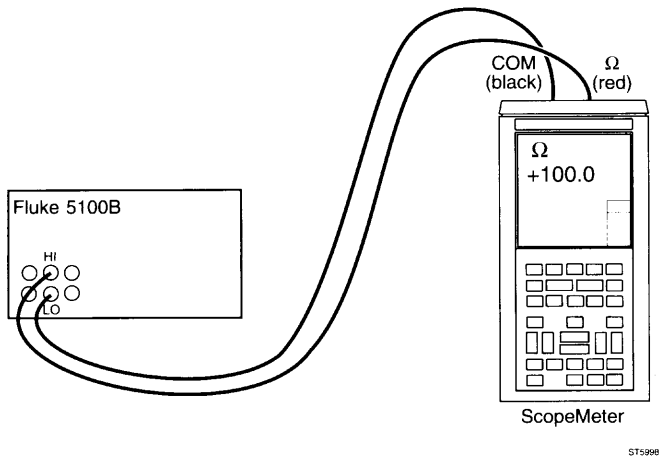
3. Resistance accuracy



These tests check the accuracy of the resistance measurement function. The signal has to be supplied to the banana input connectors of the ScopeMeter.

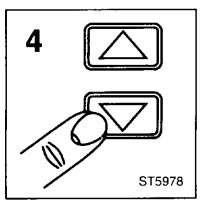
Test equipment:
Fluke 5100B Calibrator

Test setup:



Procedure/requirements for resistance function accuracy test:
A Set the Fluke 5100B to 100Ω.
B Check that the readout is between 99.00...101.0Ω.
C Set the Fluke 5100B to 10 MΩ.
D Check that the readout is between 9.900...10.10 MΩ.

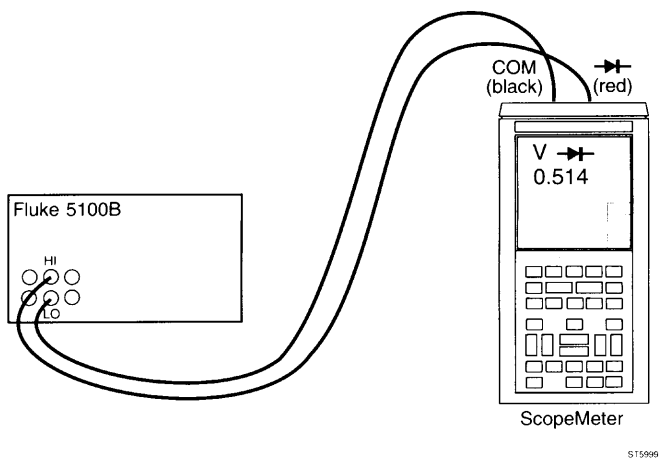
4. Diode test accuracy



This test checks the accuracy of the Diode test function.

Test equipment:
Fluke 5100B Calibrator

Test setup:

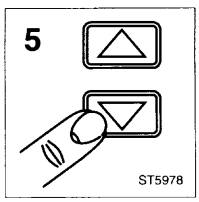


Procedure/requirements for diode accuracy test:

A Set the Fluke 5100B to 1 kΩ.

B Check that the readout is between 0.420...0.580V DC.

5. Signal display and frequency measurement



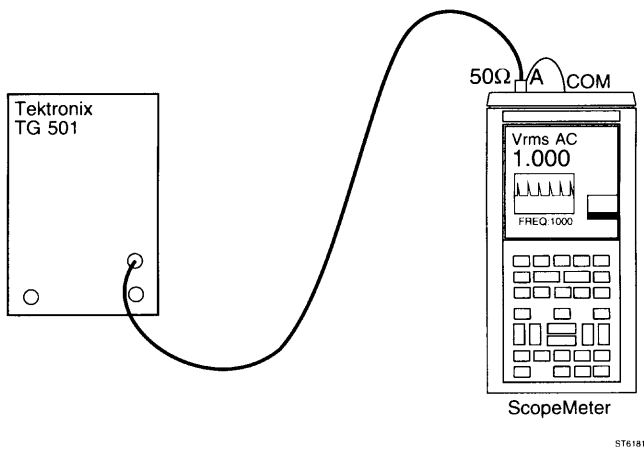
This test checks the waveform display and the frequency measurement function in METER MODE.

Test equipment:

Tektronix TG 501 Time Mark Generator

Test setup:

Connect the banana jack COM to the BNC common



Procedure/requirements for testing waveform display and frequency function:

A Apply a 1 ms (1V peak-to-peak) time marker signal to channel A. Use a 50Ω termination.

B Check that a stable (triggered) signal is displayed.

C Check that the frequency displayed is between 993...1007 Hz.

4.3 STANDARD PERFORMANCE VERIFICATION PROCEDURE SUMMARY

This table provides an overview of all steps in the Standard Performance Verification Procedure. It is intended to be used as a reference for frequent users. For details on how to perform each Standard Performance Verification Procedure step, refer to section 4.2.

SCOPE PART

STEP	SIGNAL SOURCE	SIGNAL AMPL/FREQ	SCOPEMETER INPUTS	REQUIRED
1	-	-	-	No interrupted lines
2	-	-	-	No interrupted lines
3	-	-	-	Traces on mid screen
4	Fluke 5100B	212.1 mV(RMS)/1 kH (sine)	A	Amplitude: 5.88...6.12 div.
		300 mV/DC	A	Dist. mid screen and trace: 2.94...3.06 div.
5	Fluke 5100B	300 mV/DC	B	Dist. mid screen and trace: 2.94...3.06 div.
		212.1 mV(RMS)/1 kH (sine)	B	Amplitude: 5.88...6.12 div.
6	Fluke 5100B	3V/DC	B	Dist. mid screen and trace: 2.94...3.06 div.
		6V(pp)/1 kHz (sine)	B	Amplitude: 5.88...6.12 div.
7	Fluke 5100B	30V/DC	B	Dist. mid screen and trace: 2.94...3.06 div.
		60V(pp)/1 kHz (sine)	B	Amplitude: 5.88...6.12 div.
8	Tek PG 506	0.5V/1 MHz (fast rise/square wave)	B (50Ω term)	Rise time: < 0.7 div.
9	Tek PG 506	0.5V/1 MHz (fast rise/square wave)	A (50Ω term)	Rise time: < 0.7 div.
10	Tek SG 503	120 mV(pp)/50 kHz (sine)	A (50Ω term)	Adjust amplitude to 6 div.
11	Tek SG 503	120 mV(pp)/50 MHz (sine)	A (50Ω term)	Amplitude: > 4.2 div.
12	Tek SG 503	120 mV(pp)/50 kHz (sine)	B (50Ω term)	Adjust amplitude to 6 div.
13	Tek SG 503	120 mV(pp)/50 MHz (sine)	B (50Ω term)	Amplitude: > 4.2 div.
14	Tek SG 503	≈200 mV(pp)/100 MHz (sine)	B (50Ω term)	Well triggered signal at 4 div.
		≈100 mV(pp)/60 MHz (sine)		Well triggered signal at 2 div.
15	Tek SG 503	300 mV(pp)/10 MHz (sine)	B (50Ω term)	Triggered on falling edge at 1.5 div.
16	Tek SG 503	300 mV(pp)/10 MHz (sine)	A (50Ω term)	Triggered on falling edge at 1.5 div.
17	Tek SG 503	≈200 mV(pp)/100 MHz (sine)	A (50Ω term)	Well triggered signal at 4 div.
		≈100 mV(pp)/60 MHz (sine)		Well triggered signal at 2 div.
18	Tek TG 501	1V(pp)/1 µs (marker)	A (50Ω term)	Markers on lines (tolerance ± 1 pixel = ± 0.04 div.)
19	PM5134	1.8V/1 kHz (sine) (pp) on 1.4V/DC	A & EXT	Well triggered signal
20	PM5134	800 mV(pp)/2 kHz (sine)	A & B	Figure with angle 45° displayed on screen; gap < 10 pixels.
21	-	-	-	Trace jumps < 0.1 div. when switching
22	-	-	-	between setting 21 and 22.

METER PART

STEP	SIGNAL SOURCE	SIGNAL AMPL/FREQ	SCOPEMETER INPUTS	REQUIRED
1	Fluke 5100B	300 mV/DC	A	298.0...302.0 mV
		300 mV(RMS)/1 kHz		292.5...307.5 mV
		3V/DC		2.980...3.020V
		3V(RMS)/1 kHz		2.925...3.075V
		30V/DC		29.80...30.20V
		30V(RMS)/1 kHz		29.25...30.75V
2	Fluke 5100B	300 mV/DC	banana	298.2...301.8 mV
		3V/DC		2.982...3.018V
3	Fluke 5100B	100Ω	banana	99.00...101.0Ω
		10 MΩ		9.900...10.10 MΩ
4	Fluke 5100B	1 kΩ	banana	0.420...0.580V
5	Tek TG 501	1V(pp)/1 ms (marker)	A (50W term)	Stable oscilloscope picture Frequency displayed: 993...1007 Hz.

4.4 ADDITIONAL PERFORMANCE VERIFICATION PROCEDURE

This paragraph describes the Additional Performance Verification Procedure.
This procedure can be used to do some extra performance tests, depending on the ScopeMeter version (93, 95, or 97). Follow the instructions described with each step.

The recommended test equipment required for this Additional Performance Verification Procedure is listed in table 4.4.

Table 4.4 Recommended test equipment for Additional Performance Verification Procedure

Instrument Type	Recommended Model
Function Generator	Philips PM 5134
Multimeter	Philips PM 2525
Power Supply	Philips PE 1537
Time Mark Generator	Tektronix TG 501
Constant Amplitude Sine wave Generator	Tektronix SG 503
Square wave Calibration Generator	Tektronix PG 506

- Cables and terminators for the generators (all BNC type)
- Two standard banana test leads (delivered with the ScopeMeter)
- BNC (female)-to-banana (male) (delivered with the ScopeMeter)
- 5 mm. Power Jack connector plug with attached cable (e.g.: 4822 321 20125)

NOTE: During the following Performance Verification Procedure, you must connect the ScopeMeter input connectors to the signal generator outputs. This connection must be made by cables (BNC connector channel A or B) or two standard banana test leads (COM and mV/Ohm/Diode banana connectors). The Additional Performance Verification Procedure does not use the oscilloscope probes delivered with the instrument. The calibration of the probes is described in the Operating Manual.

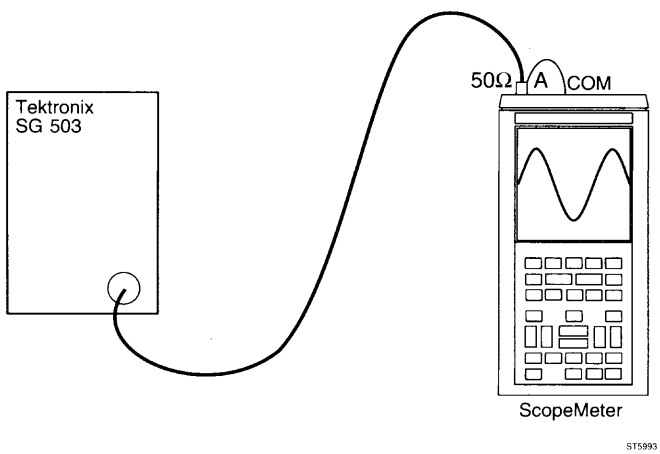
1. Autoset

*** All models ***

This test checks the correct operation of the AUTO SET function.

Test equipment:
Tektronix SG 503 Constant Amplitude Sine wave Generator

Test setup:
Connect the banana jack COM to the BNC common



Settings/procedure/requirements:

A Apply a 50 MHz sine wave signal of 100 mV peak-to-peak to channel A. Use a 50Ω termination.

B Switch on the ScopeMeter and press the SCOPE key to get into SCOPE mode. Now press the AUTO SET key. Check that the display is stable and well triggered. Minimal 2 and maximal 20 signal periods must be displayed, over 8 divisions. The signal amplitude must be approximately 5 divisions. The NOTRIG indication on the display must not flash.

C Repeat settings/procedure for channel B.

2. Vertical dynamic range and position range (move control)

*** All models ***

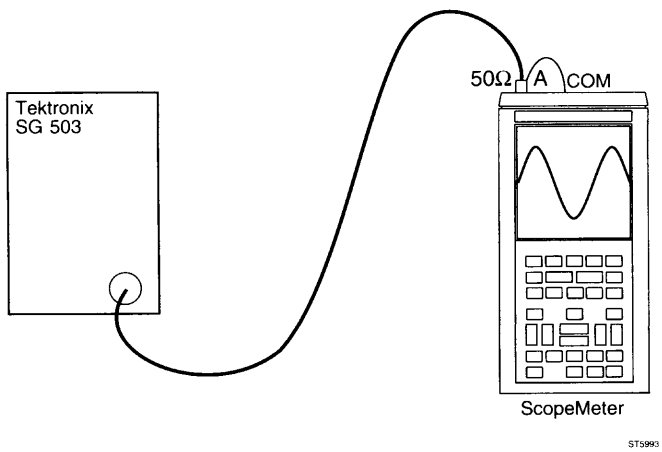
This test checks the vertical dynamic range, together with the position range (move control). A certain overdrive of the ScopeMeter must be allowed.

Test equipment:

Tektronix SG 503 Constant Amplitude Sine wave Generator

Test setup:

Connect the banana jack COM to the BNC common



Settings/procedure/requirements for channel A:

Vertical dynamic range check:

A Switch on the ScopeMeter and press the SCOPE key to get into SCOPE mode.

B Apply a 50 kHz sine wave signal of 950 mV peak-to-peak to channel A. Use a 50Ω termination.

C Press the AUTO SET key. Set channel A to 100 mV/div. and set the timebase speed to 10µs/div.

D Use the vertical MOVE key to shift the bottom of the sine wave vertically over the screen in the lower division. Shift the top of the sine wave in the upper division. Verify that the top and bottom of the sine wave signal of 9.5 divisions can be displayed distortion free.

E Apply a 50 MHz sine wave signal of approximately 500 mV peak- to-peak (4 divisions on the screen) to channel A. Use a 50Ω termination.

F Set the timebase speed to 10 ns/div.

G Now a sine wave with an amplitude of 4 divisions must be displayed distortion free.

Move control check:

A Adjust the signal amplitude to 8 divisions on the screen.

B Check that the trace can be moved over 4 divisions up (+ 4 div.) and over 4 divisions down (- 4 div.).

Settings/procedure/requirements for channel B:

Repeat the total procedure for channel A.

3. Trigger level control range channel A and B

*** All models ***

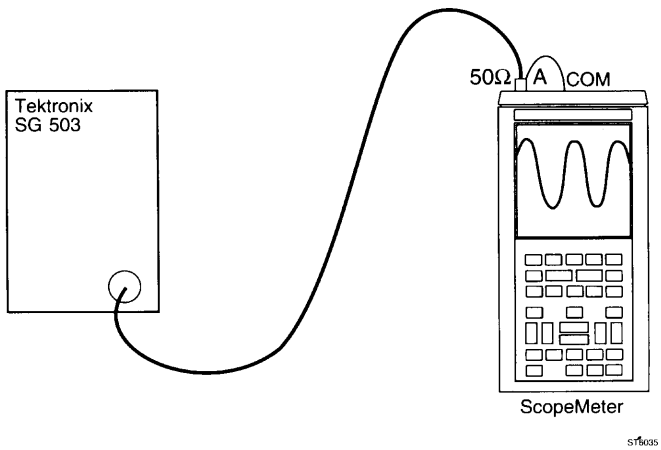
This test checks the trigger level control range.

Test equipment:

Tektronix SG 503 Constant Amplitude Sine wave Generator

Test setup:

Connect the banana jack COM to the BNC common



Settings/procedure/requirements:

A Apply a 500 kHz sine wave with an amplitude of 950 mV peak-to-peak to channel A. Use a 50Ω termination.

B Switch on the ScopeMeter and press the SCOPE key to get into SCOPE mode. Now press the AUTO SET key.

C Verify that the signal is well triggered.

D Set channel A to 100 mV/div.

E Press the TRIGGER key. Use the select/adjust keys to verify that the trigger level range is more than 8 divisions (4 divisions up and 4 divisions down). The selected trigger level is shown on the display (reversed indication "⇳ LEVEL"). Also the trigger level indication, marked with an A⌠ will shift, while shifting the trigger level. See figure 4.9.

F Repeat the same procedure for channel B.

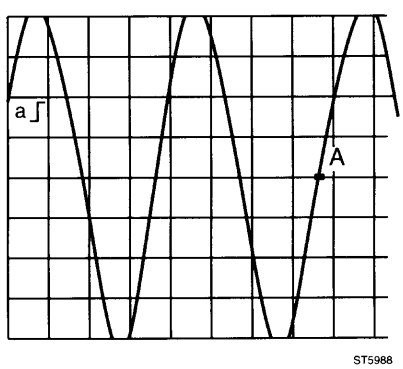


Figure 4.9 Trigger level indication on screen

4. Power supply voltage range

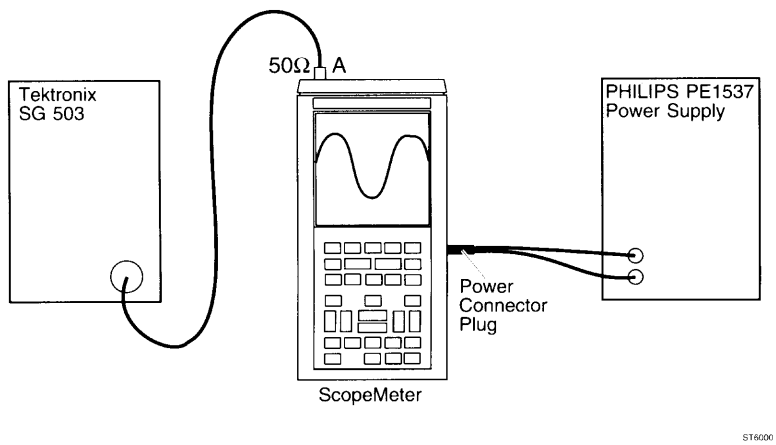
*** All models ***

This test checks the correct operation of the ScopeMeter within the boundaries of the DC supply voltage.

Test equipment:

Philips PE 1537 Power Supply 0-40V/0-1A
Tektronix SG 503 Constant Amplitude Sine Wave Generator
5 mm Power Jack connector plug with attached cable (for example order 4822 321 20125)

Test set-up:



Settings/procedure:

A Insert the power plug into the power adapter contact on the side of the ScopeMeter.
B Switch on the power supply and set the voltage to a wanted value between 8 and 20V DC.
C Apply a 50 kHz sine wave with an amplitude of 100 mV peak-to- peak to channel A. Use a 50Ω termination.
D Switch on the ScopeMeter. At power on, a beep tone must be audible.
E Press AUTO SET and verify that a well triggered signal with an amplitude of approximately 5 divisions is displayed over the whole supply voltage range.

Requirements:

A The ScopeMeter must start at any DC voltage between 8 and 20V, applied at its power adapter contact.
B The ScopeMeter must remain operative over the indicated voltage range.
C The amplitude of the trace displayed must be approximately 5 divisions, independent of the supply voltage.

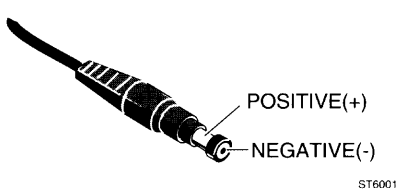


Figure 4.10 Power Jack connector

5. Supply current

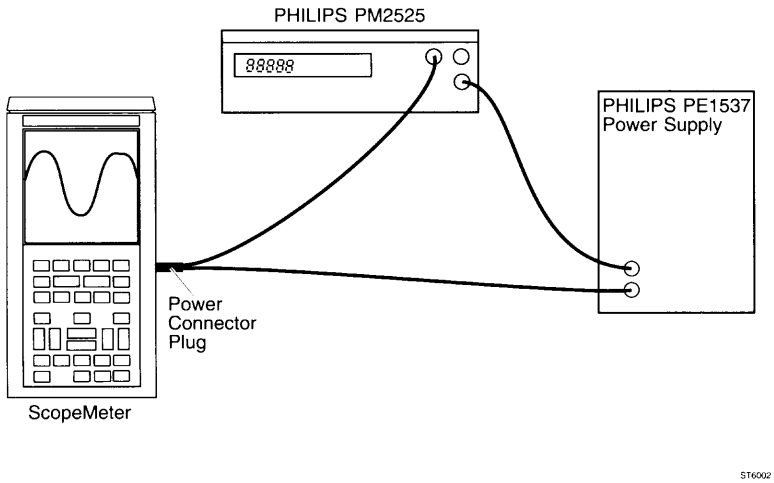
*** All models ***

This test checks the total supply current (ScopeMeter supply current and the built-in battery charger current).

Test equipment:

Philips PE 1537 Power Supply 0-40V/0-1A
Digital Multimeter (Philips PM 2525 or equivalent)
5 mm Power Jack connector plug with attached cable (for example order 4822 321 20125).

Test set-up:



Settings/procedure/requirements:

NOTE: A PM 9086 battery pack (included in the shipment) has to be installed for this test. Only NiCad batteries can be charged by the ScopeMeter!

A Set the power supply to 15V DC.
B Check that the charging current is 200 mA (typical reading on multimeter).
C Switch on the ScopeMeter.
D Check that the total supply current is 330 mA (typical reading on multimeter).

6. Battery backup functional test

*** All models ***

This test verifies that the ScopeMeter settings will be kept in memory if power is switched off while the batteries are installed.

Test equipment:

none

Test setup:

no specific test setup required

Settings/procedure:

A Switch on the ScopeMeter and press the SCOPE key to get into scope mode.
B Press the AUTO SET key and set channel A and B to 500 mV/div. Set the timebase to 1 ms/div.
C Switch off the ScopeMeter with the ON/OFF key and keep it switched off for one hour to enable all capacitors to discharge.
D Press the ON/OFF key to switch on the ScopeMeter again, and verify that the settings for the timebase and attenuator have not changed.

Requirements:

ScopeMeter settings at power off must be restored the next time power is switched on.

7. Cursor measurements: time accuracy

*** Models 95/97 only! ***

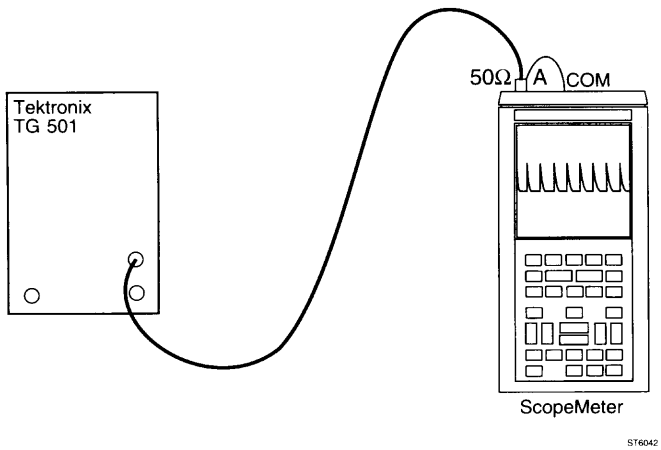
This test checks the accuracy of the cursors while measuring time.

Test equipment:

Tektronix TG 501 Time Mark Generator

Test setup:

Connect the banana jack COM to the BNC common



Setting/procedure:

A Apply a 1 ms time marker signal to channel A. Use a 50Ω termination.
B Switch on the ScopeMeter and press the SCOPE key to get into SCOPE mode. Now press the AUTO SET key.
C Set the timebase to 1 ms/div.
D Press the HOLD/RUN key to freeze the display.
E Press the CURSOR DATA key to get into the cursor menu.
F Press the CURSOR softkey to turn on the cursor lines.
G Position the cursor lines with the <CURSOR -1-> and <CURSOR 2-> keys, so that they cover a distance of 6 time marker intervals. Position the markers exactly to the top of the marker pulses. See figure 4.11.

Requirements:

The measured time distance between the cursors is displayed at the right side next to the traces. This value must be 5.99...6.01 ms.

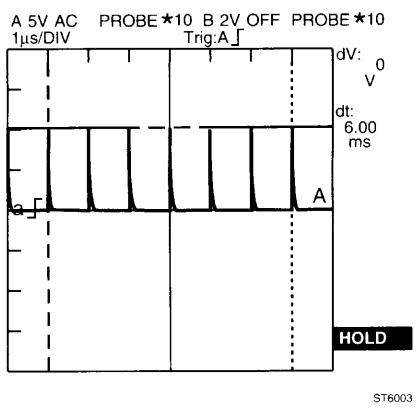


Figure 4.11 Cursor lines on marker pulses

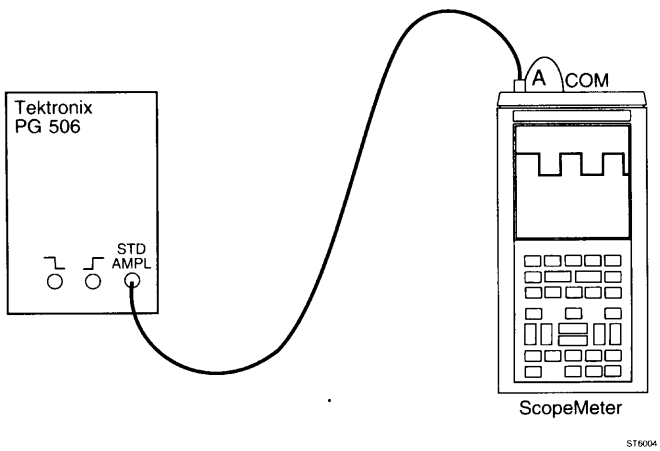
8. Cursor measurements: voltage accuracy

*** Models 95/97 only! ***

This test checks the accuracy of the cursors while measuring voltage.

Test equipment:
Tektronix PG 506 Square Wave Calibration Generator

Test setup:
Connect the banana jack COM to the BNC common



Settings/procedure:

A Apply a 1 kHz square wave voltage of 1V peak-to-peak to channel A. Use the "STD AMPL" output of the PG 506.
B Switch on the ScopeMeter and press the SCOPE key to get into SCOPE mode. Now press the AUTO SET key.
C Set channel A to 200 mV/div and to AC coupling.
D Press the HOLD/RUN key to freeze the display
E Press the CURSOR DATA key to get into the cursor menu.
F Press the CURSOR softkey to activate the cursor lines.
G Position the first cursor in the horizontal middle of the top of the waveform. Use the <CURSOR -1-> key to position cursor 1.
H Position the second cursor in the horizontal mid of the bottom of the waveform. Use the <CURSOR -2-> key to position cursor 2.
I Use the most right softkey to select NORMAL readout.

Requirements:

The measured voltage between the cursors is displayed at the right side next to the traces. This value must be 0.98V...1.02V.

9. SETUP memory functions

*** Model 97 only! ***

ScopeMeter model 97 enables storing up to 10 front settings that will be kept in a memory with a battery backup.
This test checks this function.

Test equipment:
none

Test setup:
no specific set-up required

Setting/procedure:
A Switch on the ScopeMeter and switch to SCOPE mode.
Operate the keys to get a front setting that differs from the default settings:
Set channel A and B to 500 mV/div.
Set the timebase to 1 ms/div.
B Press the SETUP key to get into the SETUP menu
C Press the SAVE softkey, select SETUP 3 from the pop-up menu, and press ENTER. This will save the current front setting as SETUP 3.
D Set channel A and B to 2V/div. Set the timebase to 1 µs/div.
E Switch off the ScopeMeter.
F Switch on the ScopeMeter again (do not use MASTER RESET!). Press the SETUP key to get into the SETUP menu.
G Press the RECALL softkey and choose SETUP 3 from the pop-up menu. (Use the select/adjust keys and the ENTER softkey.) This entry is marked in the pop-up menu. The front setting must be restored to the setting previously selected in step A.
H Now press the DELETE softkey. Use the select/adjust key and the ENTER softkey to choose SETUP 3 from the pop-up menu. The RECALL marker will disappear now as a sign that the front setting is no longer stored in memory.
I Press the SAVE button to display the SETUP pop-up menu.
Verify that the marker before SETUP 3 has disappeared.

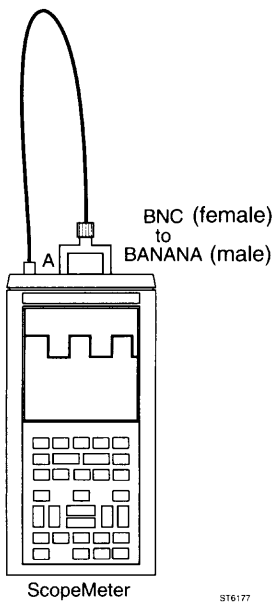
10. Generator

*** Model 97 only! ***

This test checks the built-in generator.

Test equipment:
none

Test setup:



Settings/procedure/requirements:

Square wave

A Switch on the ScopeMeter and press the SCOPE key to get into scope mode.

B Press the SPECIAL FUNCT key. Now press the left most softkey, marked GENERATE. This will reveal the GENERATE pop- up menu.

C Use the select/adjust keys to select "Square: 976 Hz" and press the right most ENTER softkey to activate the generator.

D Press the LCD key, and then press the softkey PROBE CAL. This will reveal the CAL&ADJUST pop-up menu. Use the select/adjust keys to select "Channel A 1:1" and press the ENTER softkey to activate 1:1 coupling.

E Now press AUTO SET.

F Press the CURSOR DATA key. This will get you to the CURSOR DATA menu.

G Press the CURSOR softkey. Use the <-CURSOR 1-> key to position the left cursor line on the most negative part of the square wave signal. Use the <-CURSOR 2-> key to position the right cursor line on the top of the square wave signal.

H Now press the FUNCTION softkey. This will reveal the FUNCTION pop-up menu. Use the select/adjust keys to select "FREQUENCY" and press the ENTER softkey to activate the frequency measurement. Press the FUNCTION softkey again. This will remove the FUNCTION pop-up menu.

I The ScopeMeter display will look like figure 4.12. The generator must produce a square wave signal with an amplitude of 5V and a frequency of 976 Hz (typical values).

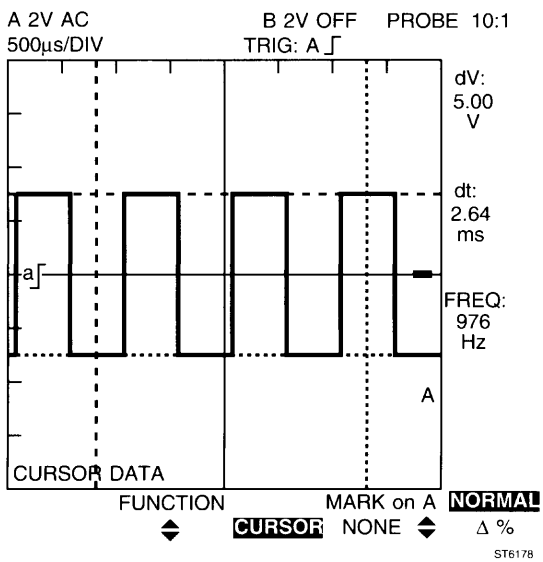


Figure 4.12 Generator produces square wave signal

Sine wave

J Now press the SPECIAL FUNCT key. Press the GENERATE softkey to reveal the GENERATE pop-up menu. Use the select/adjust keys to select "SINEWAVE" and press the ENTER softkey to activate the generator.

K Use the mV/V keys to adjust the attenuator.

L The ScopeMeter display will look like figure 4.13. The generator must produce a sine wave signal with an amplitude of 1V and a frequency of 976 Hz (typical values).

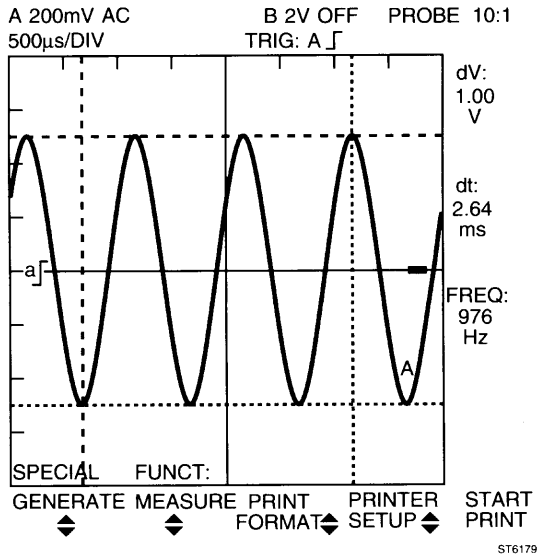


Figure 4.13 Generator produces sine wave signal

11. Component test function

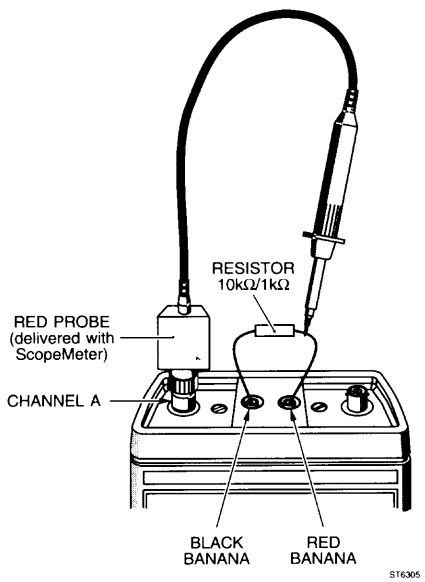
*** Model 97 only! ***

This test checks the component test function (slow ramp voltage and slow ramp current).

Test equipment:

Red scope probe (delivered with the ScopeMeter)

Test setup:



Settings/procedure/requirements:

A Switch on the ScopeMeter and press the SPECIAL FUNCT key to enter the SPECIAL FUNCT menu.

B Now press the MEASURE softkey. This will reveal the MEASURE pop-up menu.

C Use the select/adjust keys to select "Components: VOLTAGE", and press the ENTER softkey (most right) to start the component test function.

D Adjust the channel A attenuator (press the mV/V key once in the direction "mV") to set the vertical axis to 500 mV/div.

E The ScopeMeter display will now look like figure 4.14.
If you use a 10 kΩ resistor, a 45° line will be shown.

F Press the MEASURE softkey and use the select/adjust keys to select "Components: CURRENT" from the MEASURE pop-up menu. Activate the selection by pressing the ENTER softkey.

G Exchange the 10 kΩ resistor for a 1 kΩ resistor.

H Now the ScopeMeter display will show a line under 45°, in the upper left quadrant.

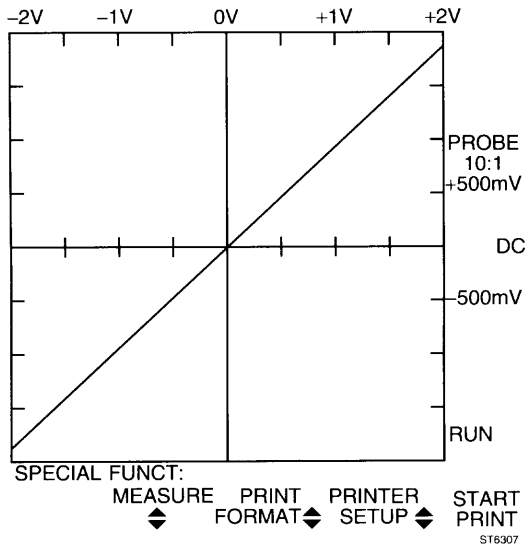


Figure 4.14 Component test "VOLTAGE" mode

5 CALIBRATION ADJUSTMENT PROCEDURE

5.1 GENERAL INFORMATION

The following information provides the complete Calibration Adjustment Procedure for the ScopeMeter. Because various control functions are interdependent, a certain order of adjustment is necessary. The procedure is therefore presented in a sequence that is best suited to this order. Before you make calibration adjustments, always use the Performance Verification Procedure in chapter 4 to check the ScopeMeter performance.

The Calibration Adjustment Procedure, described here, consists of the following three parts:

- CONTRAST Calibration Adjustment Procedure
- SCOPE Calibration Adjustment Procedure
- METER Calibration Adjustment Procedure

Almost all Calibration Adjustments can be done without opening the instrument. Only the first four steps of the SCOPE Calibration Adjustment Procedure require disassembling of the ScopeMeter (see section 5.6.1).

NOTE: Every year use the Performance Verification Procedure in chapter 4 to check the ScopeMeter. If the ScopeMeter fails the Performance Verification Procedure, Calibration Adjustments must be made. If the ScopeMeter also fails the Calibration Adjustment Procedure, repair is necessary (see chapter 7). (After repair, it is sometimes also necessary to do also a Hardware Calibration Adjustment, see section 5.6.1)

Sections 5.5, 5.6 and 5.7 describe the calibration process in detail. Section 5.8 contains a summary of all calibration adjustments as a reference for more frequent users.

5.2 RECOMMENDED CALIBRATION ADJUSTMENT EQUIPMENT

The equipment recommended for the Calibration Adjustment Procedure is listed in table 5.1.

All calibration adjustments must be done in ambient temperatures between 18 °C and 28 °C. The ScopeMeter can be used immediately: there is no warm-up time specified.

Table 5.1 Recommended calibration adjustment equipment survey

Instrument Type	**Recommended Model**
Multifunction Calibrator	Fluke 5100B
Square Wave Calibration Generator	Tektronix PG 506
Function Generator	Philips PM 5134
*) Personal Computer	Any IBM compatible PC, running MS-DOS
*) Optical to RS-232 Interface Cable	PM9080/001
*) Flash ROM Refresh software	Contact your Service Center
*) +12V (± 2.5%) Programming voltage	

*) These items are required after two or three calibrations, see note paragraph 5.3, page 5.3 for details.

- Cables and terminators for the generators (all BNC type)
- Standard banana test leads
  (two banana test leads are delivered with the ScopeMeter)
- BNC (female)-to-banana (male) (delivered with the ScopeMeter)
- The red and grey probes, delivered with the ScopeMeter.

5.3 ENTERING THE CALIBRATION PROCEDURE

The Calibration Adjustment Procedure is operated via built-in sequences. Before you can activate a calibration sequence, you must first connect a 12V DC programming voltage to the ScopeMeter. To do this, first remove the battery pack. See section 6.2.1.

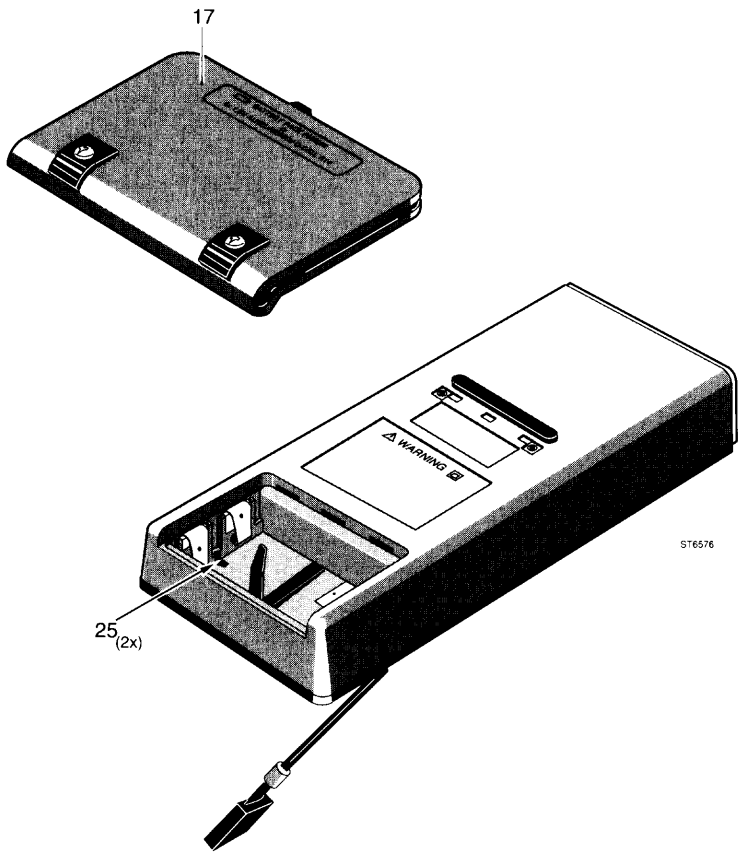


Figure 5.1 Position of the +12V and 0 contacts for calibration (items 25)

If you have removed the ScopeMeter battery pack and the battery cover (figure 5.1, item 17), you will have access to the +12V/0 contacts (figure 5.1, item 25). These contacts are placed in the left middle (+12V) and the right middle (0) of the battery compartment. Connect +12V DC to the contact marked "+12V" and 0V to the contact marked "0".

CAUTION: To avoid damaging the Flash ROM circuitry be sure to apply the polarity of 12V programming voltage correctly.

NOTE: After you have performed the Calibration Procedure, remove the 12V programming voltage. Do not perform measurements with the ScopeMeter, while the programming voltage is still present.

Connect the ScopeMeter to the Power Adapter/Battery Charger PM 8907. Use MASTER RESET to switch the ScopeMeter on. (To do this press the LCD key and keep it pressed. Then also press the ON/OFF key. When the ScopeMeter switches on, you will hear two beeps.) Now press both AC/DC/GROUND keys simultaneously. This will start the SERVICE menu (see figure 4.1, chapter 4). This menu allows you to start the calibration sequence. Press the corresponding softkey marked "CALIBRATE ScopeMeter". This will start the CALIBRATE menu.

NOTE: The ScopeMeter will show the message:
"Space for X calibration sessions."*(X is: 2, 1, or 0); X is 2 for software versions below V4.00 only.*

After two or three electronic calibrations (see NOTE above), the ScopeMeter will display: "Space for 0 calibration sessions". This means that the internal Flash ROMs of the ScopeMeter are full. To enable another calibration, you must first empty the Flash ROMs and reinstall the ScopeMeter operating software. To do this, send the ScopeMeter to your nearest Service Center. It is also possible to "refresh" the FlashROMs by yourself, using a PC. For more information: contact your nearest Service Center.

5.4 OPERATING THE CALIBRATION PROCEDURE

Softkeys in the CALIBRATE menu
In the CALIBRATE menu, it is possible to choose the calibration mode (sequence) to be performed.

Press the softkey marked:
- CONTRAST for the CONTRAST Calibration Adjustment Procedure (see section 5.5).
- SCOPE for the SCOPE Calibration Adjustment Procedure (see section 5.6).
- METER for the METER Calibration Adjustment Procedure (see section 5.7).

When one of these three calibration sequences is chosen, the corresponding text on the screen will be shown in reverse. This shows that this calibration mode is active.

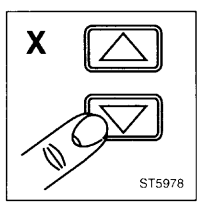
If you press the ESCAPE softkey, the ScopeMeter will leave the CALIBRATE menu and return to the SERVICE menu.

NOTE: If you use the ESCAPE softkey to leave the SERVICE menu before storing the calibrations with the CAL STORE softkey, you will lose all new calibration values. The instrument will continue using the calibration values that were used before entering the CALIBRATE menu.

The CAL STORE softkey saves the new calibration values that are obtained in the CONTRAST, SCOPE or METER sequences, to the Flash ROM. From the moment you press the CAL STORE softkey, the ScopeMeter uses the new calibration data. The old calibration data is no longer valid. This will also fill one calibration field in the Flash ROM. See section 5.3.

NOTE: After calibrating the ScopeMeter, reset the instrument (use a MASTER RESET), before performing measurements.

Keys in CONTRAST, SCOPE, or METER Calibration mode
The calibration is presented as a sequence. You can advance through this sequence by pressing the select/adjust keys. Pressing the upper select/adjust key advances one step; pressing the lower adjust/select key brings you back one step.



In sections 5.5, 5.6 and 5.7 this figure is used to indicate that one of the select/adjust keys (up/down) must be pressed to display the indicated step number "x" displayed on the ScopeMeter screen.

When the ScopeMeter LCD displays the indication " CAL", you must first apply the appropriate input (calibration) signal. When the correct signal is present at the correct terminal, you start the built-in calibration by pressing the most right READY softkey. The text "READY" will be in reverse video, to show that the ScopeMeter's internal calibration is active. When the process is ready, the "READY" text will change again, from inverted to normal. Now you can use the select/adjust keys to advance to the next calibration step or return to a previous calibration step.

After you have completed a calibration sequence, press either CONTRAST, SCOPE or METER softkey again to return to the CALIBRATE menu. The new calibration data will stay in memory to enable you to store it permanently with the CAL STORE key.

Press the ESCAPE softkey twice to leave the active calibration mode without storing the new calibration data. This will also return you to the SERVICE menu.

5.5 CONTRAST CALIBRATION ADJUSTMENT PROCEDURE

You activate the CONTRAST Calibration Adjustment Procedure from the CALIBRATE menu, by pressing the left most CONTRAST softkey. When this softkey is depressed, the text "CONTRAST" is shown in reverse video, to show that this calibration mode is active.

Now use the adjust/select keys to adjust the contrast of the LCD to your own (personal) setting. When you have found the correct setting, you can make this setting ready for calibration storage, by pressing the READY softkey once.

NOTE: When you press the READY softkey, this does not mean that the new value of the LCD contrast is actually stored in the Flash ROMs of the ScopeMeter. This only happens when you press the CAL STORE softkey.

Press the CONTRAST softkey again to leave the CONTRAST Calibration Adjustment Procedure. The text "CONTRAST" will change from reverse video into normal again.

5.6 SCOPE CALIBRATION ADJUSTMENT PROCEDURE

You can start the SCOPE Calibration Adjustment Procedure from the CALIBRATE menu by pressing the SCOPE softkey. When this softkey is pressed, the text "SCOPE" is shown in reverse video, to show that this calibration mode is active.

The SCOPE Calibration Adjustment Procedure is divided into two parts:

- Hardware SCOPE Calibration Adjustments: steps H1 to H4
- Closed Case SCOPE Calibration Adjustments: steps S5 to S29

NOTE: During the following Calibration Adjustment Procedure,you must connect the ScopeMeter input connectors to the signal generator outputs by means of cables (BNC connector channel A or B) or two standard banana test leads (COM and mV/Ohm/Diode banana connectors).

5.6.1 Hardware SCOPE Calibration Adjustments

The first four steps of the SCOPE Calibration Adjustment Procedure are called **Hardware SCOPE Calibration Adjustments**. To perform the Hardware SCOPE Calibration Adjustments, you must open the ScopeMeter. The disassembly procedure for these calibration adjustments is described in chapter 6 (section 6.1 and 6.2.3).

WARNING: To prevent personal injury, do not perform any disassembly procedures before reading chapter 6.

When the ScopeMeter is disassembled, it is not possible to apply the +12V programming voltage in the normal way. It is possible to apply the +12V programming voltage by means of two test clips (see figure 5.2).

Remove all voltage sources from the ScopeMeter. Turn the digital A1 PCB, mounted in the top cover so that the display and the keyboard are facing down. Connect the +12V programming voltage to the appropriate places on the PCB. It can be helpful to first install two metal screws again. See figure 5.2. Be sure not to short circuit with the metal shielding, mounted on the analog A1 PCB. Turn the top cover and the mounted PCB. Connect the ScopeMeter to the power supply and switch the instrument on. Go to the SERVICE menu and press the CALIBRATE ScopeMeter softkey. You can make the adjustments necessary with six trim capacitors (three for the attenuator of each channel) and two adjustment potentiometers (for the Analog ASIC).

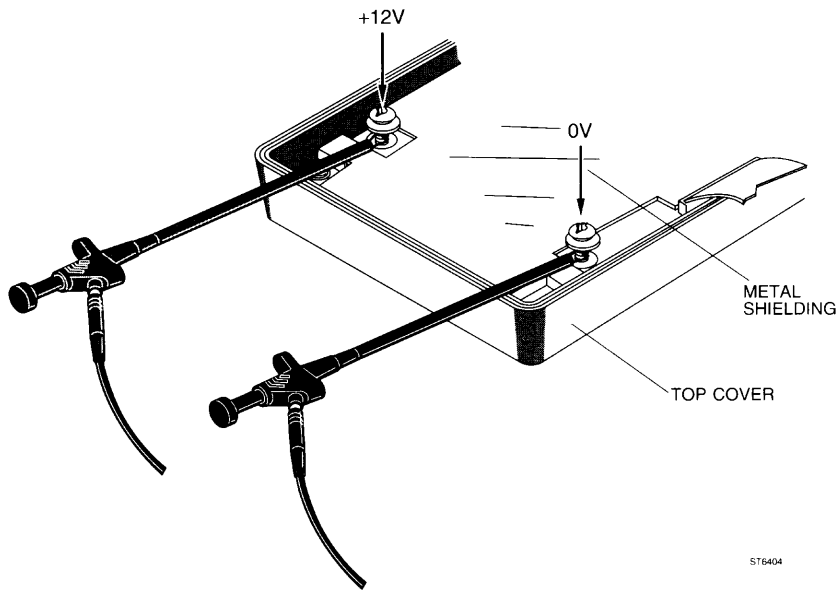


Figure 5.2 Connecting the +12V programming voltage for Hardware SCOPE Calibration Adjustments

NOTE: You only have to do Hardware SCOPE Calibration Adjustments, if you have repaired the ScopeMeter in the Attenuator sections or in the Analog ASIC circuitry. After you have done a Hardware SCOPE Calibration Adjustment or you have adjusted one of the potentiometers, you always need to do a full (software) SCOPE and METER calibration.
If you decide not to do the Hardware Calibration Adjustment now, you can advance to calibration S5 by pressing the upper select/adjust key 4 times.

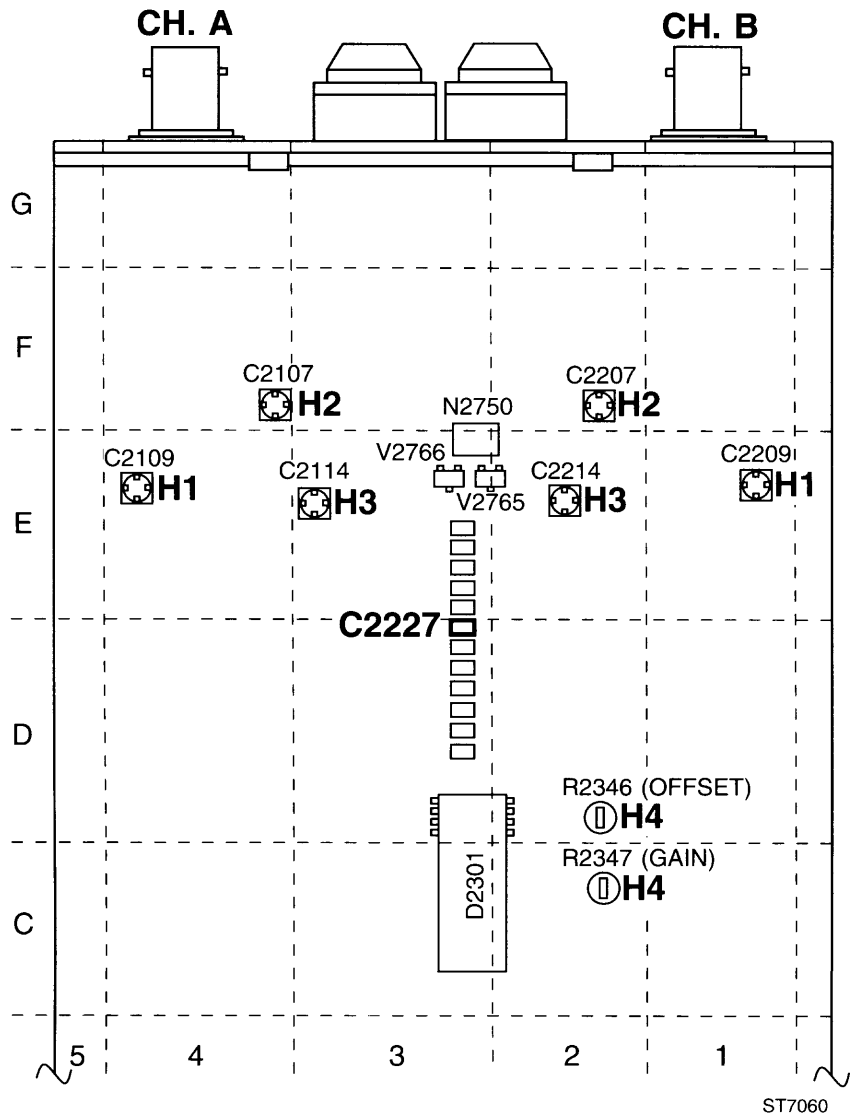
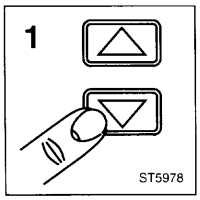


Figure 5.3 Analog A2 PCB; position of hardware adjustment trimmers and potentiometers

H1. Hardware pulse response of the *1 attenuation



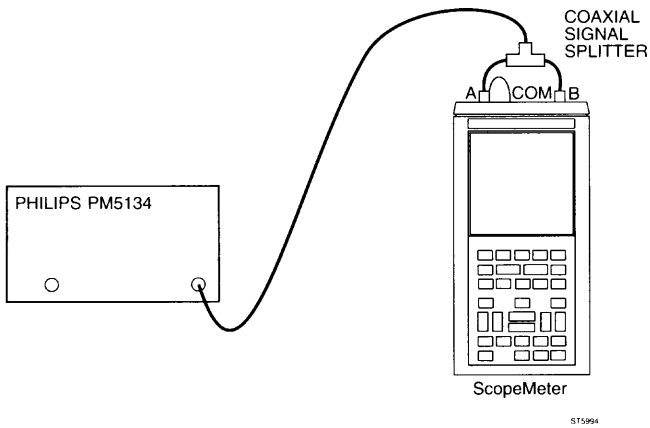
Purpose: optimal pulse response of the *1 attenuation circuit.

Calibration equipment:

Philips PM 5134 Function Generator

Calibration setup:

Connect the banana jack COM to the BNC common



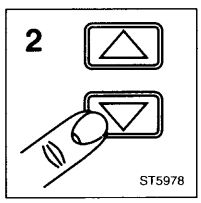
Procedure:

A - Apply a square wave with a frequency of 1 kHz, amplitude 300 mV peak-to-peak (between 0 mV and +300 mV) to both channels A and B.

B - Turn trimmer C2209 on the analog A2 PCB to get the best channel A pulse response on the LCD (least distorted waveform). The position of trimmer C2209 can be found in figure 5.3.

C - Turn trimmer C2109 on the analog A2 PCB to get the best channel B pulse response on the LCD. The position of trimmer C2109 can be found in figure 5.3.

H2. Hardware pulse response of the *10 attenuation



Purpose: optimal pulse response of the *10 attenuation circuit.

Calibration equipment:

Philips PM 5134 Function Generator

Calibration setup:

See calibration setup H1.

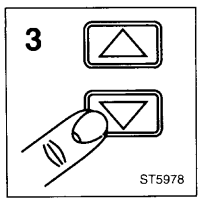
Procedure:

A - Apply a square wave with a frequency of 1 kHz, amplitude 3V peak-to-peak (between 0V and +3V) to both channels A and B.

B - Turn trimmer C2207 on the analog A2 PCB to get the best channel A pulse response on the LCD (least distorted waveform). The position of trimmer C2207 can be found in figure 5.3.

C - Turn trimmer C2107 on the analog A2 PCB to get the best channel B pulse response on the LCD. The position of trimmer C2107 can be found in figure 5.3.

H3. Hardware pulse response of the *100 attenuation



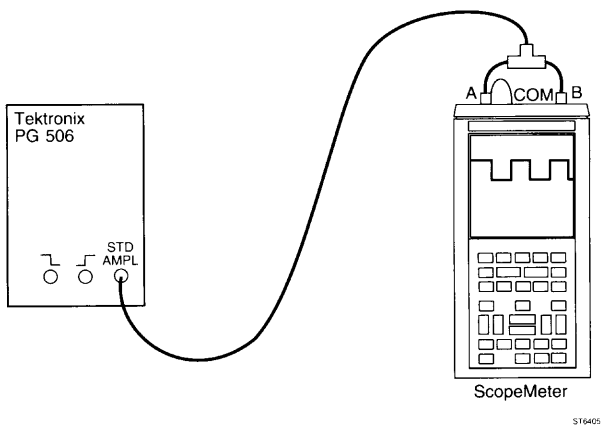
Purpose: optimal pulse response of the *100 attenuation circuit.

Calibration equipment:

Tektronix PG 506 Square Wave Calibration Generator

Calibration setup:

Connect the banana jack COM to the BNC common



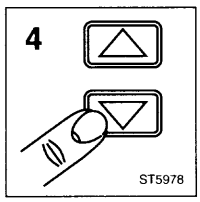
Procedure:

A - Apply a square wave with a frequency of 1 kHz, amplitude 20V peak-to-peak (between 0V and +20V) to both channels A and B. Set the generator to the position "STD AMPL".

B - Turn trimmer C2214 on the analog A2 PCB to get the best channel A pulse response on the LCD (least distorted waveform). The position of trimmer C2214 can be found in figure 5.3.

C - Turn trimmer C2114 on the analog A2 PCB to get the best channel B pulse response on the LCD. The position of trimmer C2114 can be found in figure 5.3.

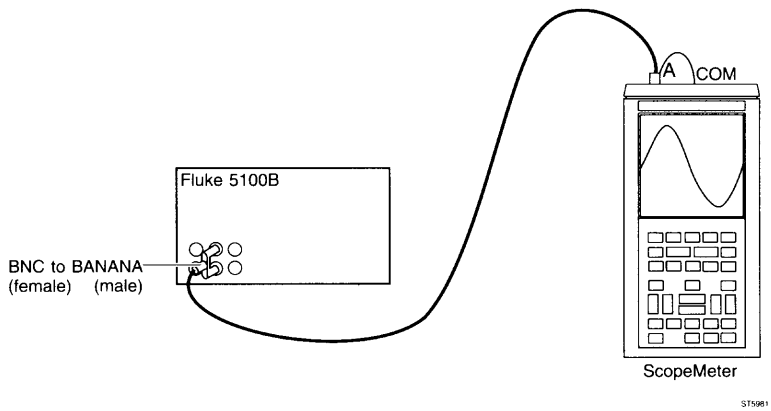
H4. Hardware offset and gain



Purpose: optimal response of complete analog A2 circuitry.

Calibration equipment:
Fluke 5100B Calibrator

Calibration setup:
Connect the banana jack COM to the BNC common



Procedure:

A - Connect Test Point TP209 on the analog A2 PCB to GROUND. The position of Test Point TP209 can be found in section 10: figure 10.4 (A2 PCB layout wired components side). Instead of connecting TP209 to GROUND you can shortcircuit C2227 (e.g. with a pair of tweezers). The position of C2227 can be found in figure 5.3.

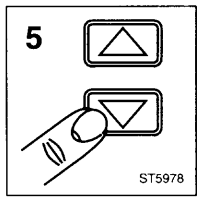
B - Apply a 1 kHz sine wave signal with an amplitude of 720 mV AC peak-to-peak to the channel A BNC connector. (Set the Fluke 5100B to 254.56 mV RMS, 1 kHz sine wave.)

C - Turn the potentiometers R2346 and R2347 so that the sine wave on the LCD is exactly 6 divisions: maximum (peak) on +3 divisions, minimum (peak) on -3 divisions (tolerance ± 1 dot).

5.6.2 Closed Case SCOPE Calibration Adjustments

NOTE: The following calibration adjustments are done electronically. For these calibrations, the ScopeMeter must be in a fully assembled state!

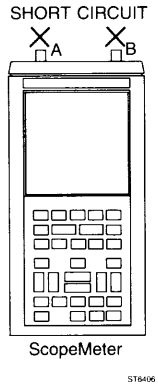
S5. Offset correction



Purpose: remove offset of channel A and B input operational amplifiers.

Calibration equipment:
none.

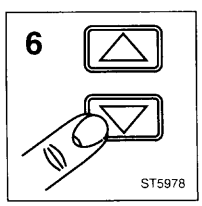
Calibration setup:



Procedure:

A - Short circuit both channel A and channel B inputs.
B - Press the READY softkey.

S6/7. Pulse response of the *1/*10 attenuation (fine adjustments)



Purpose: optimal pulse response of the *1, *10 attenuation circuit.

Calibration equipment:

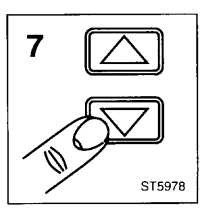
Philips PM 5134 Function Generator

Calibration setup:

See calibration setup H1.

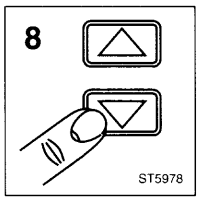
Procedure:

A - Apply a square wave with a frequency of 1 kHz, amplitude 300 mV peak-to-peak (between 0 mV and +300 mV) to both channels A and B.
B - Press the READY softkey.



C - Apply a square wave with a frequency of 1 kHz, amplitude 3V peak-to-peak (between 0V and +3V) to both channels A and B.
D - Press the READY softkey.

S8/9. Pulse response of the *100/*1000 attenuation (fine adjustments)

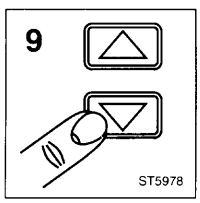


Purpose: optimal pulse response of the *100, *1000 attenuation circuit.

Calibration equipment:
Tektronix PG 506 Square Wave Calibration Generator

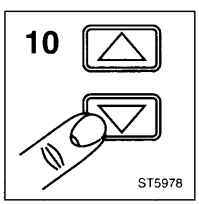
Calibration setup:
See calibration setup H3.

Procedure:
A - Apply a square wave with a frequency of 1 kHz, amplitude 20V peak-to-peak (between 0V and +20V) to both channels A and B. Set the generator to the position "STD AMPL".
B - Press the READY softkey.



C - Apply a square wave with a frequency of 1 kHz, amplitude 50V peak-to-peak (between 0V and +50V) to both channels A and B. Set the generator to the position "STD AMPL".
D - Press the READY softkey.

S10/11/12/13/14/15/16/17
Gain for 5 mV, 10 mV, 20 mV, 50 mV, 100 mV, 200 mV, 2V, 20V



Purpose: correction of the system gain (from BNC to microprocessor) in attenuator settings: 5 mV, 10 mV, 20 mV, 50 mV, 100 mV, 200 mV, 2V, 20V.

Calibration equipment:
Tektronix PG 506 Square Wave Calibration Generator

Calibration setup:
See calibration setup H3.

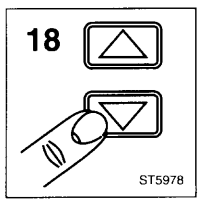
Procedure:
A - Apply a square wave with a frequency of 1 kHz, amplitude 20 mV peak-to-peak to both channels A and B. Set the generator to the position "STD AMPL".
B - Press the READY softkey.
C - Change the input voltage according to table 5.2.
After each calibration press the READY softkey. Use the adjust/select keys to advance/go back in the list.

NOTE: These steps calibrate both channel A and B at the same time.

Table 5.2 Calibration signals for step S10...S17

Calibration step number	Calibration voltage
S10	square wave, 1 kHz, 20 mV peak-to-peak
S11	square wave, 1 kHz, 50 mV peak-to-peak
S12	square wave, 1 kHz, 100 mV peak-to-peak
S13	square wave, 1 kHz, 200 mV peak-to-peak
S14	square wave, 1 kHz, 500 mV peak-to-peak
S15	square wave, 1 kHz, 1V peak-to-peak
S16	square wave, 1 kHz, 10V peak-to-peak
S17	square wave, 1 kHz, 100V peak-to-peak

S18/19. Shift gain *1 mode and /8 mode

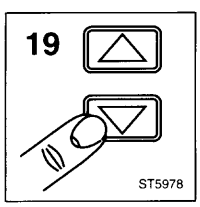


Purpose: correct for the shift gain in "times 1 mode" and in "divided by 8 mode".

Calibration equipment:
Tektronix PG 506 Square Wave Calibration Generator

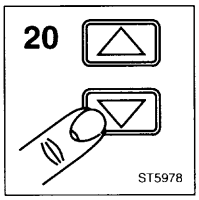
Calibration setup:
See calibration setup H3.

Procedure:
A - Apply a square wave with a frequency of 1 kHz, amplitude 200 mV peak-to-peak (between 0 mV and +200 mV) to both channels A and B. Set the generator to the position "STD AMPL".
B - Press the READY softkey.



C - Apply a square wave with a frequency of 1 kHz, amplitude 20 mV peak-to-peak (between 0 mV and +20 mV) to both channels A and B.
Set the generator to the position "STD AMPL".
D - Press the READY softkey.

S20/21/22/23. Channel A and channel B 50% and 90% trigger level



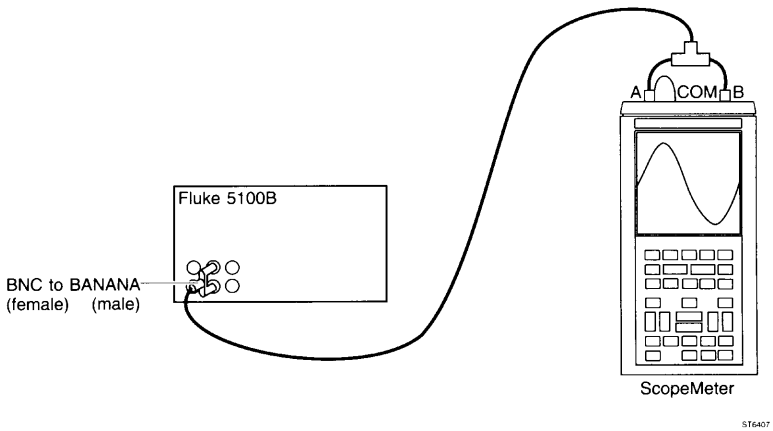
Purpose: calibrate the 50% and 90% analog trigger level of channel A and channel B.

Calibration equipment:

Fluke 5100B Calibrator

Calibration setup:

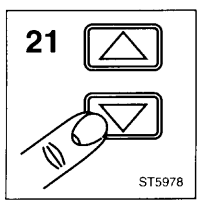
Connect the banana jack COM to the BNC common



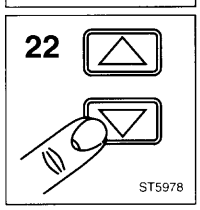
Procedure:

A - Apply a sine wave with a frequency of 10 kHz, amplitude 2V peak-to-peak to both channels A and B. (Set the Fluke 5100B to 0.707 mV RMS,10 kHz sine wave).

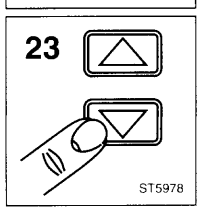
B - Press the READY softkey.



C - Press the READY softkey.

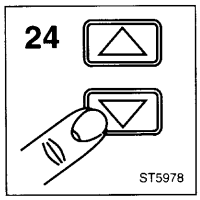


D - Press the READY softkey.



E - Press the READY softkey

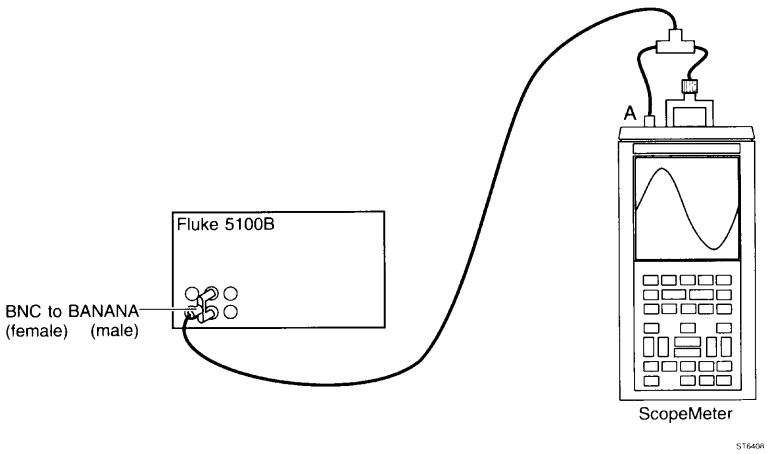
S24. External triggering



Purpose: calibrate the 0.2V external trigger level.

Calibration equipment:
Fluke 5100B Calibrator

Calibration setup:

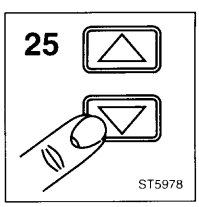


Procedure:

A - Apply a 10 kHz sine wave signal with an amplitude of 2V peak-to-peak to channel A and also to the banana connectors. Use a coaxial signal splitter and a BNC(female)-to-banana(male) converter (see calibration setup). (Set the Fluke 5100B to 0.707V RMS, 10 kHz sine wave).

B - Press the READY softkey.

S25. Random sampling

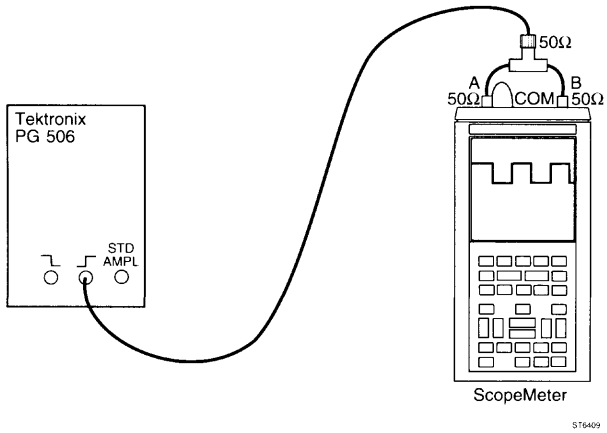


Purpose: calibration of the random sampling levels.

Calibration equipment:
Tektronix PG 506 Square Wave Calibration Generator

Calibration setup:

Connect the banana jack COM to the BNC common



Procedure:

A - Apply a 1 MHz square wave signal with an amplitude of approximately 600 mV peak-to-peak to both channel A and B. Set the generator to the FAST RISE position. Use 50Ω terminations.

B - Press the READY softkey.

C - Now press the SCOPE softkey to go back to the CALIBRATE menu.

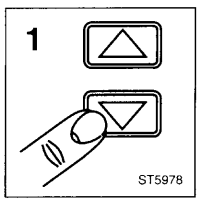
Continue with the meter calibration adjustment procedure, section 5.7

5.7 METER CALIBRATION ADJUSTMENT PROCEDURE

Press the METER softkey to activate the METER Calibration Adjustment Procedure from the CALIBRATE menu. When you press this softkey, the text "METER" will be shown in reverse video to show that this calibration mode is active.

NOTE: During the METER calibration, the values displayed on the LCD do not represent the values of the input voltages!

M1. Linearity calibration and M2. Zeroing the ranges

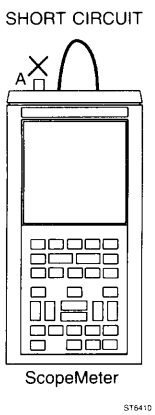


Purpose M1: calibration of the linearization table, used by the ScopeMeter.

Purpose M2: this calibration zeros all ranges of the ScopeMeter in METER mode: 300 mV, 3V, 30V and 300V on channel A and 300 mV and 3V of the banana connectors.

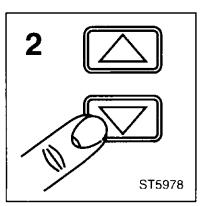
Calibration equipment:
none

Calibration set-up:



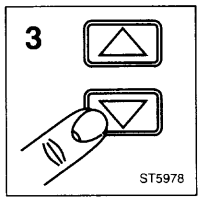
Procedure:
A - Short circuit the channel A BNC and the banana connectors.
B - Press the READY softkey.

NOTE: During this calibration step many internal calibration constants are being set. This process can last up to 3 minutes.



(C - Short circuit the channel A BNC and the banana connectors.)
D - Press the READY softkey.

M3. Channel A, 300 mV range: zero for open input



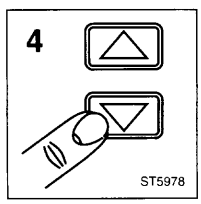
Purpose: zero channel A in the 300 mV range with open input.

Calibration equipment:
none

Calibration setup:
Channel A BNC open.

Procedure:
A - Remove any connection from the channel A BNC.
B - Press the READY softkey.

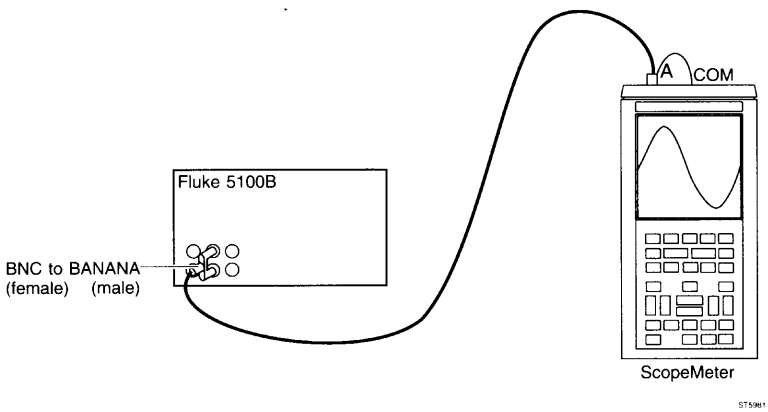
M4/5/6/7. Channel A, 300 mV/3V/30V/300V range: gain calibration



Purpose: calibration of the channel A gain in the 300 mV, 3V, 30V and 300V ranges.

Calibration equipment:
Fluke 5100B Calibrator

Calibration setup:
Connect the banana jack COM to the BNC common



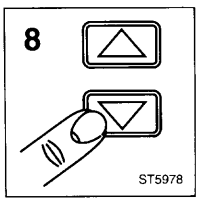
Procedure:
A - Apply 300 mV DC to channel A.
B - Press the READY softkey.
C - Change the input voltage according to table 5.3. After each calibration press the READY softkey. Use the adjust/select keys to advance/go back in the list.

Table 5.3 Calibration signals for step M4...M7

Calibration Step Number	Calibration Voltage
M4	300 mV DC
M5	3V DC
M6	30V DC
M7	300V DC

WARNING: After you have performed calibration M7, deactivate the Fluke 5100B to remove the 300V DC. Always set the Fluke 5100B to 300 mV DC before touching the connection cables!

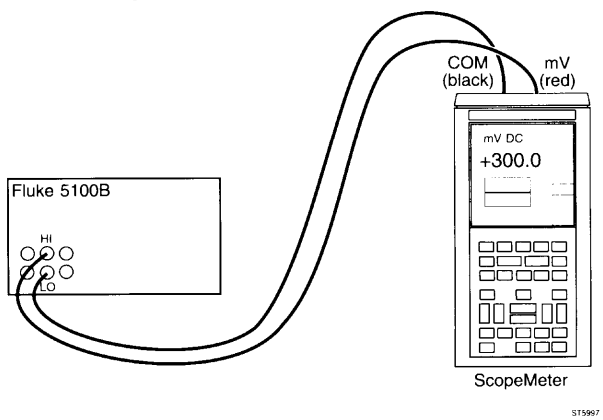
M8/9. External input, 300 mV/3V range: gain calibration



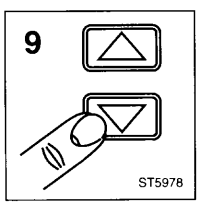
Purpose: calibration of the external input gain in the 300 mV and 3V ranges.

Calibration equipment:
Fluke 5100B Calibrator

Calibration setup:

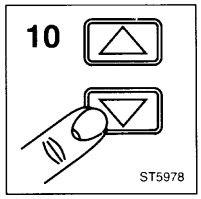


Procedure:
A - Apply 300 mV DC to the banana connectors.
B - Press the READY softkey.



C - Apply 3V DC to the banana connectors.
D - Press the READY softkey.

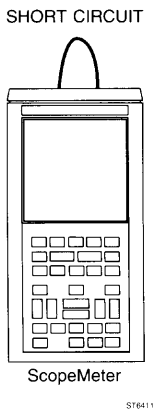
M10. All ranges 0Ω calibration



Purpose: calibration of the 0Ω points in all ranges.

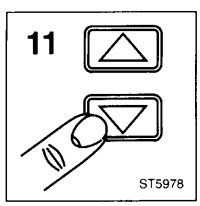
Calibration equipment:
none

Calibration setup:



Procedure:
A - Short circuit the banana connectors.
B - Press the READY softkey.

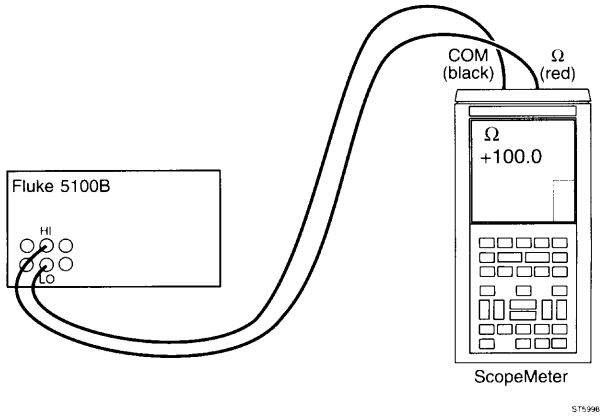
M11/12/13/14/15/16. Calibration of the Ohm ranges



Purpose: calibration of the 300Ω, 3 kΩ, 30 kΩ, 300 kΩ, 3 MΩ, and 30 MΩ ranges.

Calibration equipment:
Fluke 5100B Calibrator

Calibration setup:



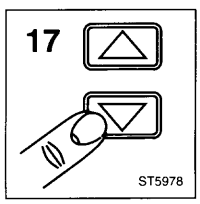
Procedure:

A - Connect 100Ω to the banana connectors.
B - Press the READY softkey.
C - Change the resistance according to table 5.4. After each calibration press the READY softkey. Use the adjust/select keys to advance/go back in the list.

Table 5.4 Calibration signals for step M11...M16

Calibration Step Number	Calibration Resistance
M11	100Ω
M12	1 kΩ
M13	10 kΩ
M14	100 kΩ
M15	1 MΩ
M16	10 MΩ

M17. Voltage ramp calibration

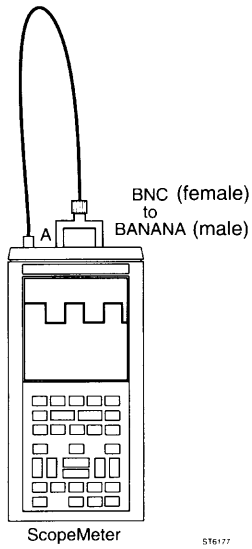


Purpose: calibration of the voltage ramp of the circuit tester.

Calibration equipment:

none

Calibration setup:

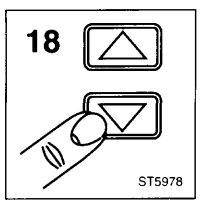


Procedure:

A - Connect the channel A BNC to the red GENERATOR OUT banana connector, by means of a BNC cable and a BNC (female)-to- banana(male) connector.

B - Press the READY softkey.

M18. Current ramp calibration

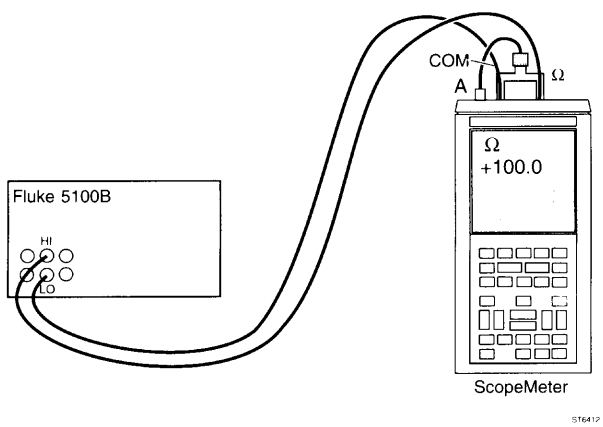


Purpose: calibrate the current ramp of the circuit tester.

Calibration equipment:

Fluke 5100B Calibrator

Calibration setup:

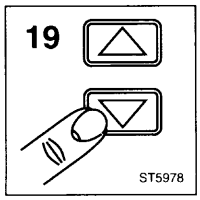


Procedure:

A - Connect a resistance of 100Ω between both banana connectors. Connect channel A to the red banana connector. Do not use a probe! Refer to the calibration setup.

B - Press the READY softkey.

M19/20
10:1 calibration for channel A (red) and channel B (grey) probes

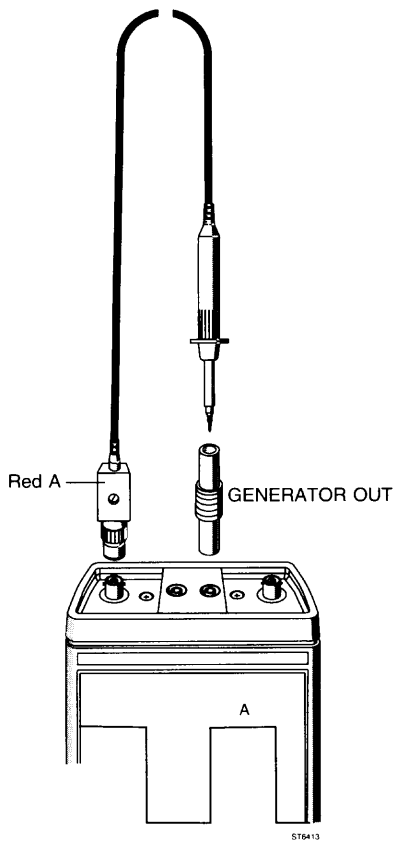


Purpose: determine the gain, using a 10:1 probe.

Calibration equipment:

Red scope probe (delivered with the ScopeMeter)
Grey scope probe (delivered with the ScopeMeter)
Red adjust adapter (delivered with the ScopeMeter)

Calibration setup:



IMPORTANT: Calibration steps M19 and M20 determine the internal calibration constants that compensate for probe characteristics. To achieve full accuracy (as listed in the specifications in chapter 2), calibrations M19 and M20 must be performed, using the probes that are normally to be used with the instrument.

If the probes delivered with the ScopeMeter are not available at the time of calibration, use other probes specifically designed for the ScopeMeter. In this case you must notify the user that these calibrations have been performed, using different probes. To achieve full accuracy, the user must do a User Probe Calibration, using his own probes. This procedure is described in the ScopeMeter Users Manual. Because the results of these User Probe Calibrations

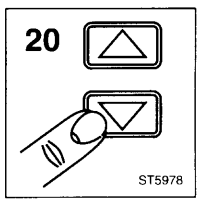
are stored in battery backed up RAM, they must be repeated if the batteries are removed for a longer period. You will also loose the results of the User Probe Calibration when you do a MASTER RESET. (A MASTER RESET is done when the ScopeMeter is switched on while the LCD key is depressed. Two beeps are audible.)

Procedure:

A - Connect the red scope probe to the channel A BNC.

B - Connect the probe tip to the red GENERATOR OUT banana connector using the red adjust adapter. Refer to the Calibration setup.

C - Press the READY softkey. If you have made all connections correctly and you have connected the correct probe, the ScopeMeter will display the text: **"DC PROBE calibration in progress"**.
After a few seconds the ScopeMeter will display:
"PROBE successfully calibrated"
and will also beep once. Now you can go to the next calibration step.

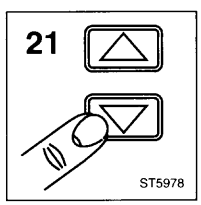


D - Connect the grey scope probe to the channel B BNC.

E - Connect the probe tip to the red GENERATOR OUT banana connector using the red adjust adapter. Refer to the Calibration set-up.

F - Press the READY softkey. If you have made all connections correctly and you have connected the correct probe, the ScopeMeter will display the text: **"DC PROBE calibration in progress"**.
After a few seconds the ScopeMeter will display:
"PROBE successfully calibrated"
and it will also beep once. Now you can go to the next calibration step.

M21/22. 1:1 probe calibration for channel A and channel B

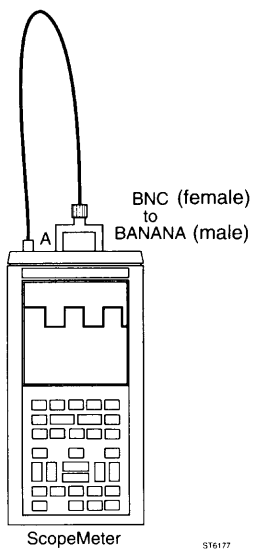


Purpose: determine the gain, using a 1:1 probe.

Calibration equipment:

none

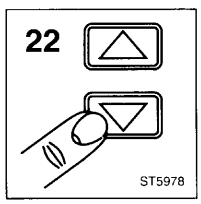
Calibration set-up:



Procedure:

A - Connect the channel A BNC to the red GENERATOR OUT banana connector, by means of a BNC cable and a BNC (female)-to- banana(male) connector.

B - Press the READY softkey.
If all connections are good, the ScopeMeter will display the text:
"DC PROBE calibration in progress".
After a few seconds the ScopeMeter will display:
"PROBE successfully calibrated"
and will also beep once. Now you can go to the next calibration step.



C - Connect the channel B BNC to the red GENERATOR OUT banana connector, by means of a BNC cable and a BNC(female)-to-banana(male) connector.

D - Press the READY softkey. If all connections are good, the ScopeMeter will display the text:
"DC PROBE calibration in progress".
After a few seconds the ScopeMeter will display:
"PROBE successfully calibrated"
and it will also beep once.
Calibration is now complete. You must store the calibration values now: see CAL STORE.

CAL STORE

To save the new calibration values, you must proceed as follows:

- press the METER softkey to leave the active CALIBRATION mode.
- press the CAL STORE softkey to store the new calibration values in flash ROM.

5.8 CALIBRATION ADJUSTMENT PROCEDURE SUMMARY

This table provides an overview of all steps in the Calibration Adjustment Procedure. It is intended to be used as a reference for frequent users. For details on how to perform each Calibration Adjustment step, refer to sections 5.5, 5.6 and 5.7.

Table 5.5 Calibration Adjustment Procedure Summary

STEP	SIGNAL SOURCE	SIGNAL AMPL/FREQ	SCOPEMETER INPUTS	ACTIONS
CONTRAST Calibration Adjustment Procedure				
-	-	- -		Adjust for clear picture.
SCOPE Calibration Adjustment Procedure **Hardware SCOPE Calibration Adjustments: only to be done when ScopeMeter is repaired!**				
H1	PM5134	300 mV(pp)/1 kHz (square)	A & B	Adjust C2109/C2209.
H2	PM5134	3V(pp)/1 kHz (square)	A & B	Adjust C2107/C2207.
H3	Tek PG 506	20V(pp)/1 kHz (square)	A & B	Adjust C2114/C2214.
H4	Fluke 5100B	254.5 mV (RMS)/1 kHz (sine)	A	Adjust R2346/R2347, Ground testpoint 209.
Closed case SCOPE Calibration Adjustments				
S5	-	-	-	Short circuit BNCs.
S6	PM5134	300 mV(pp)/1 kHz (square)	A & B	-
S7	PM5134	3V(pp)/1 kHz (square)	A & B	-
S8	Tek PG 506	20V(pp)/1 kHz (square)	A & B	-
S9	Tek PG 506	50V(pp)/1 kHz (square)	A & B	-
S10	Tek PG 506	20 mV(pp)/1 kHz (square)	A & B	-
S11	Tek PG 506	50 mV(pp)/1 kHz (square)	A & B	-
S12	Tek PG 506	100 mV(pp)/1 kHz (square)	A & B	-
S13	Tek PG 506	200 mV(pp)/1 kHz (square)	A & B	-
S14	Tek PG 506	500 mV(pp)/1 kHz (square)	A & B	-
S15	Tek PG 506	1V(pp)/1 kHz (square)	A & B	-
S16	Tek PG 506	10V(pp)/1 kHz (square)	A & B	-
S17	Tek PG 506	100V(pp)/1 kHz (square)	A & B	-
S18	Tek PG 506	200 mV(pp)/1 kHz (square)	A & B	-
S19	Tek PG 506	20 mV(pp)/1 kHz (square)	A & B	-
S20	Fluke 5100B	707 mV (RMS)/10 kHz (sine)	A & B	-
S21	Fluke 5100B	707 mV (RMS)/10 kHz (sine)	A & B	-
S22	Fluke 5100B	707 mV (RMS)/10 kHz (sine)	A & B	-
S23	Fluke 5100B	707 mV (RMS)/10 kHz (sine)	A & B	-
S24	Fluke 5100B	707 mV (RMS)/10 kHz (sine)	A & banana	-
S25	Tek PG 506	600 mV(pp)/1 MHz	A & B (50Ω termin.)	-

STEP	SIGNAL SOURCE	SIGNAL AMPL/FREQ	SCOPEMETER INPUTS	ACTIONS
METER Calibration Adjustments				
M1	-	-	-	Short circuit BNCs & banana
M2	-	-	-	Short circuit A BNC & banana
M3	-	-	-	A BNC open
M4	Fluke 5100B	300 mV DC	A	-
M5	Fluke 5100B	3V DC	A	-
M6	Fluke 5100B	30V DC	A	-
M7	Fluke 5100B	300V DC	A	-
M8	Fluke 5100B	300 mV DC	bananas	-
M9	Fluke 5100B	3V DC	bananas	-
M10	-	-	-	Short circuit banana input
M11	Fluke 5100B	100 Ω	bananas	-
M12	Fluke 5100B	1 kΩ	bananas	-
M13	Fluke 5100B	10 kΩ	bananas	-
M14	Fluke 5100B	100 kΩ	bananas	-
M15	Fluke 5100B	1 MΩ	bananas	-
M16	Fluke 5100B	10 MΩ	bananas	-
M17	-	-	A BNC to bananas	-
M18	Fluke 5100B	100 Ω	resistor between bananas, connect A BNC to banana	
M19	red probe	-	probe tip to bananas	-
M20	grey probe	-	probe tip to bananas	-
M21	-	-	A BNC to bananas	-
M22	-	-	B BNC to bananas	-

6 DISASSEMBLING THE SCOPEMETER

6.1 GENERAL INFORMATION

Whenever the ScopeMeter needs repair and/or Hardware SCOPE Calibration Adjustments, the instrument must be disassembled.

NOTE: For replacement of components refer to section 7.2; for Hardware SCOPE Calibration Adjustments refer to section 5.6.1.

This section provides the required disassembling procedures. Both printed circuit boards removed from the instrument must be adequately protected against damage, and all normal precautions regarding the use of tools must be observed. During the disassembly process, make a careful note of all disconnected leads so that they can be reconnected to their correct terminals when you reassemble the instrument.

WARNING: Removing the instrument covers or removing parts, except those to which access can be gained by hand, is likely to expose live parts and accessible terminals may be live. To avoid electric shock, disconnect the instrument from all voltage sources and remove batteries before disassembling the instrument. If any adjustment, maintenance, or repair of the disassembled instrument under voltage is required, it shall be carried out only by qualified personnel using customary precautions against electric shock. Capacitors inside the instrument can hold their charge even if the instrument has been separated from all voltage sources and batteries have been removed.

6.2 DISASSEMBLY PROCEDURES

The following sections describe the disassembly process of the ScopeMeter in sequence (from fully assembled instrument to separate printed circuit boards and chassis parts). Start and end disassembly at the appropriate heading levels.

WARNING: To avoid electric shock, disconnect test leads, probes and power supply from any live source and from the ScopeMeter itself.

6.2.1 Removing the battery pack

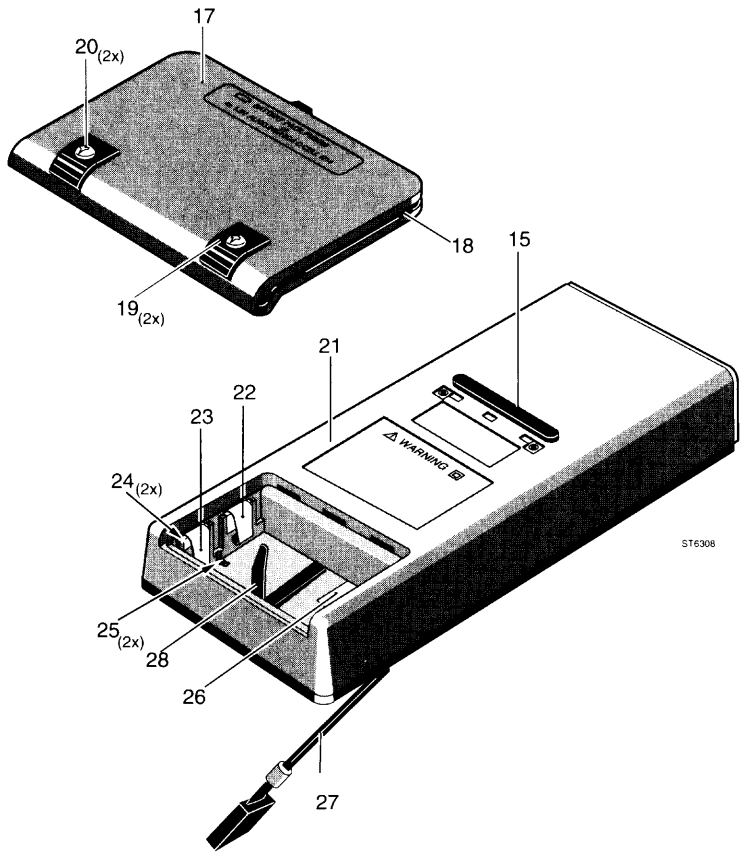


Figure 6.1 Removing the battery pack

1. The battery cover (item 17) is secured to the ScopeMeter with two black M3 Torx screws (item 20). Use a Torx screwdriver to loosen the two screws (do not remove them) from the battery cover.

2. Lift the battery cover from the ScopeMeter.

3. Pull the black battery pull strip (item 28) carefully to lift the battery pack.

4. Remove the battery pack.

6.2.2 Opening the ScopeMeter

Referring to figure 6.2, use the following procedure to open the ScopeMeter.

1. Loosen the two black M3 Torx screws (item 4) (do not remove them) from the front cover.

2. Lift the front cover assembly (item 3) from the ScopeMeter.

NOTE: The gasket, between the front cover and the two case halves, is sealed to, and must remain with, the front cover. The front cover assembly lifts away from the top and bottom case halves easily. Do not damage the gasket or separate it from the front cover.
A correctly fitted gasket assures the sealing of the ScopeMeter.

3. Remove the battery pack (see Section 6.2.1).

4. The bottom cover assembly is secured to the top cover with two M3 Torx screws (item 29) that are accessible in the battery compartment. Use a Torx screwdriver to remove the two screws.

5. Lift the bottom cover a little from the top cover and unfold the ScopeMeter.

NOTE: Do not damage the black gaskets and keep them with the front cover and the lower case half. A correctly fitted gasket assures proper sealing of the ScopeMeter.

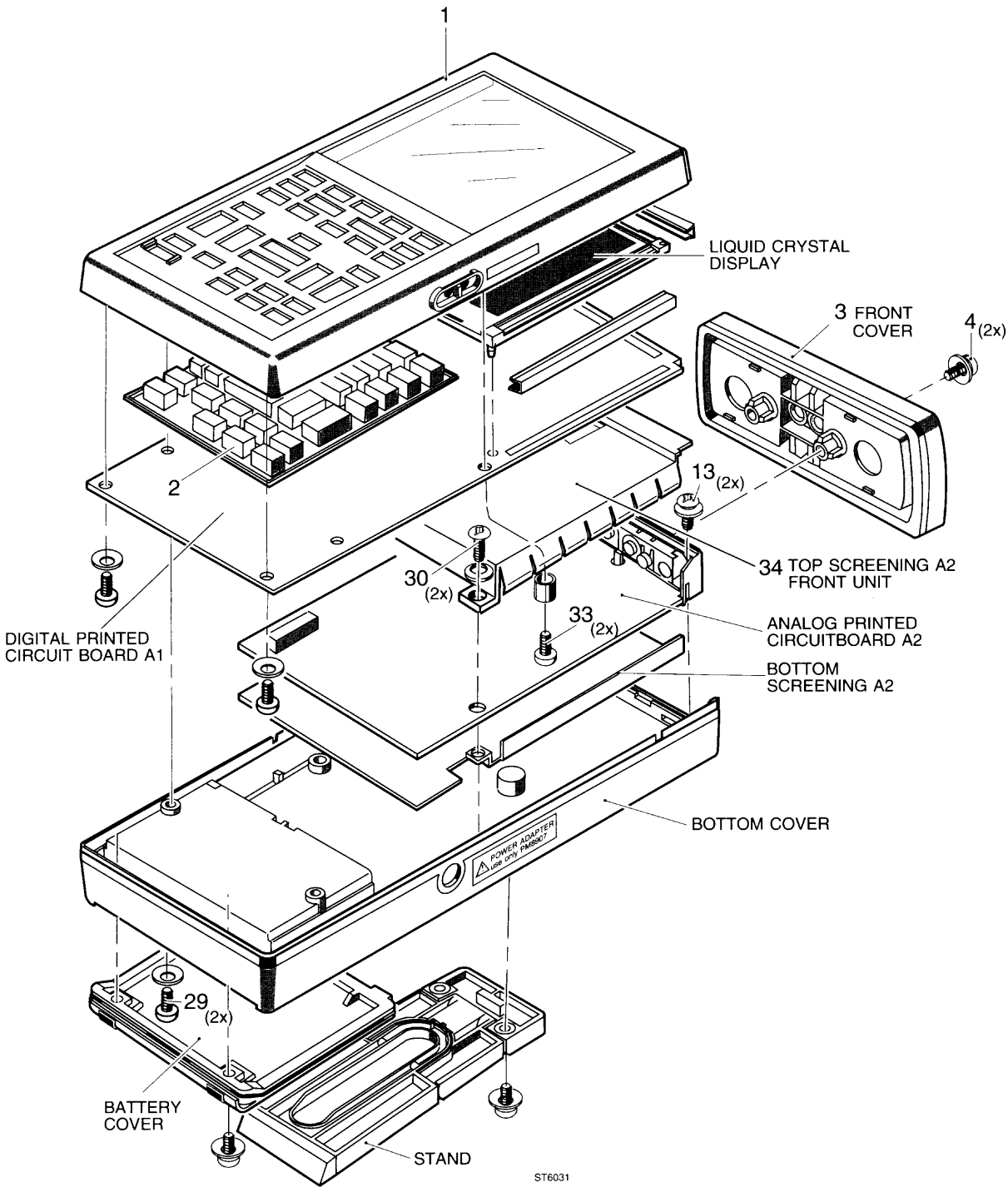


Figure 6.2 Opening the ScopeMeter

6.2.3 Removing the analog A2 PCB, to enable Hardware SCOPE Calibration Adjustments

Referring to figure 6.2, use the following procedure to remove the analog A2 PCB.

1. First open the ScopeMeter (see Section 6.2.2).
2. The analog A2 PCB and top screening are secured to the bottom cover with two M3 Torx screws (item 30). Use a Torx screwdriver to remove the screws.
3. Carefully lift the metal top screening, while pulling it backwards.
4. Pull the battery wiring plug (item 27, figure 6.1) out of the connector on the analog A2 PCB.
5. Use a Torx screwdriver to loosen the two black screws (item 13) (do not remove them) from the input unit assembly. Now the analog A2 PCB can be lifted out of the bottom cover assembly.
6. The bottom of the analog A2 PCB shows the components (potentiometers) used for hardware calibration adjustments. The Hardware SCOPE Calibration Adjustments are described in section 5.6.1.

NOTE: The digital A1 PCB and the metal shielding are still fixed to the top cover and must be connected to the analog A2 PCB by the 30-pole flat cable.

CAUTION: Damage may occur if you disconnect the flat cable between the two printed circuit boards within ten seconds after turning off the instrument. Damage may also occur when the Analog unit (A2) is powered when not connected to the Digital unit (A1).

6.2.4 Removing the digital A1 PCB

1. First open the ScopeMeter (see Section 6.2.2).

NOTE: Note how the 30-pole flat cable is positioned in the connector: it must be replaced in exactly the same way

When the ScopeMeter is opened, the blue marks on the flat cable must be visible.
Carefully lift the upper part of the flat cable connector on the digital A1 PCB. This plastic clamp must be lifted at both sides simultaneously to unlock the flat cable. Now pull the flat cable out of the connector on the digital A1 PCB. Do not touch the flat cable ends!

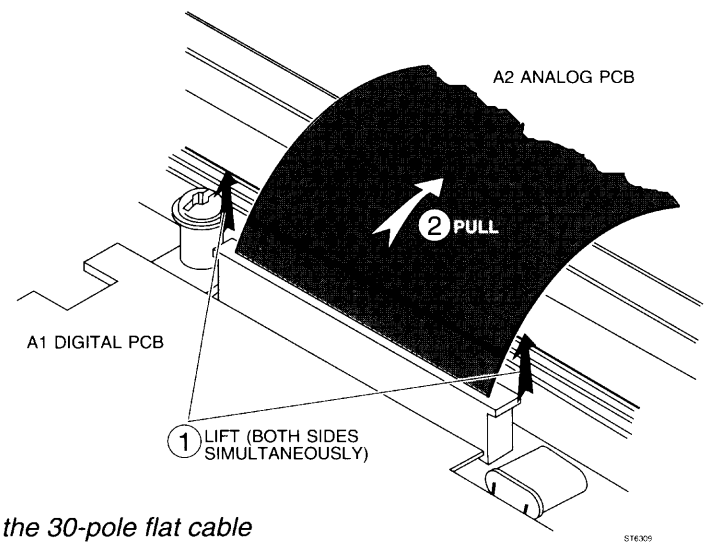


Figure 6.3 Removing the 30-pole flat cable

2. The digital A1 PCB is secured to the top cover with four M3 Torx screws (item 33). Two of these screws contain small standoffs. Be sure to reinstall them in the correct place when the ScopeMeter is reassembled. Use a Torx screwdriver to remove the screws.

3. Remove the digital A1 PCB from of the top cover. Be careful not to damage the infrared LED and phototransistor of the optical interface.

NOTE: When reassembling the digital A1 PCB, make sure that the infrared LED and phototransistor are exactly aligned with the holes in the top cover.

7 CORRECTIVE MAINTENANCE

7.1 DIAGNOSTIC TESTING AND TROUBLESHOOTING

7.1.1 Introduction

The ScopeMeter provides semimodular design to aid in troubleshooting. This section describes procedures needed to isolate a problem in a specific functional area. Finally, troubleshooting hints for each functional area are presented.

If the ScopeMeter fails, first verify that you are operating the ScopeMeter correctly by reviewing the Operation Verification Procedure found in the Users Manual.

WARNING: Opening the case may expose hazardous voltages. Always disconnect the instrument from all voltage sources and remove the batteries before opening the case. Remember that repairs or servicing should be performed by qualified personnel only.

7.1.2 Troubleshooting techniques

If a fault appears, the following test sequence can be used to help you to locate the defective component:

- Check to verify that the control settings of the instrument are correct. Consult the operating instructions in the Users Manual.
- Check the equipment to which the instrument is connected and check the interconnection cables.
- Verify that the instrument is properly calibrated. If it is not, refer to Chapter 5: "Calibration Adjustment Procedure".
- Locate the circuit(s) in which you suspect the fault: the symptom often suggests the faulty circuit. If the power supply is defective, the symptom may appear to be caused by several circuits.
- Check the circuit(s) in which you suspect the fault. Often it is possible to find faults such as cold or defective solder joints, intermittent or open interconnection plugs and wires or damaged components.
- Firmware releases V3.15 or lower are not compatible with units having analog boards A2 with modification sticker 22 or higher. The software must be updated to a higher version.
  See Section 11 " MODIFICATIONS", Digital A1 PCB STICKER 22.

7.1.3 Display and error messages

To ease the ScopeMeter operation display messages are generated. If you operate the ScopeMeter incorrectly, it will display error messages. Each error message is displayed for 5 seconds.

The following table describes the display messages and error messages and the possible solutions. If no specific model number is stated, the message and solution apply to all ScopeMeter models.

MESSAGE	CAUSE
Key not possible in this ScopeMeter mode. (SCOPE/METER mode)	You have pressed an incorrect key. For example: you have pressed the trigger key, while in meter mode.
Solution: Press a correct key.	
Not executed: at least one trace on LCD (SCOPE mode)	You have attempted to switch off the only displayed trace in the CHAN AB menu or WAVEFORM menu (Model 97).
Solution: Turn on another channel.	
Not executed: already max. traces on LCD (SCOPE mode)	(Model 97) You have attempted to turn on more than four traces simultaneously in the CHAN AB menu and the WAVEFORM menu.
Solution: Turn off another trace.	
Chosen function changed other settings. (SCOPE mode)	Sometimes some functions, for example events and n-cycle, can adapt (change) other ScopeMeter settings automatically.
Solution: Switch off the chosen function and check the settings.	
Time base limit reached for present mode (SCOPE mode)	The s TIME ns key has been pressed, forcing the timebase to exceed the limit. For example, if the limit of 100 ns in single trigger mode is exceeded.
Solution: Select RECURRENT trigger mode.	
ScopeMeter auto shut down in 5 minutes! (SCOPE/METER mode)	No new key has been activated in the last 10 minutes. To save battery power, the ScopeMeter shuts down.
Solution: Press a key.	
ScopeMeter model 9x ; Vx.xx ; yy-yy-yy (SCOPE/METER mode)	ScopeMeter "model number; software version; software date". Both softkeys 1 (left) and 5 (right) have been pressed at the same time.
Solution: -	

Scope mode: not more than 5 measurements
(SCOPE mode)

You have attempted to switch on more than five cursor measurements simultaneously in the cursor function pop-up menu.

Solution: Turn off another cursor function.

Unknown probe or wrong connection.
(SCOPE/METER mode)

No probe or a defective probe has been connected during probe DC calibration.

Solution: Connect a correct probe and do another DC calibration. If the warning is still displayed, refer to the troubleshooting information of the Analog A2 PCB later in this section.

No valid memory setup that can be used.
(SCOPE mode)

You have tried to recall a waveform and the corresponding setup (Setup recall active), while a setup has not been saved for the stored waveform.

Solution: Choose a waveform for which there is a valid setup stored, or switch off the "Setup recall" function.

Not executed: no 12V programming voltage
(SCOPE/METER mode)

1. The CALIBRATE ScopeMeter softkey has been pressed in the SERVICE menu without the 12V programming voltage being connected to the programming contacts in the battery compartment.

2. An Analog ASIC D1203 version 6 or higher is installed, but not all required modifications have been made.

Solution: 1. Connect the 12V programming voltage, before pressing the CALIBRATE softkey.

2. See Section 11 "MODIFICATIONS", Digital Board A1, REVISION LEVEL 07.

NOTE: Calibration is to be done by qualified service personnel. Incorrect calibration data is stored if 12V programming voltage is connected, while the CALIBRATE ScopeMeter mode is turned on. For calibration of the Scopemeter refer to chapter 5: "Calibration Adjustment Procedure".

CAL STORE error: no 12V or no space left
(SCOPE/METER mode)

1. **No 12V**. The 12V programming voltage that is connected to the programming contacts in the battery compartment has disappeared during the calibration adjustments.

2. **No space left**. The internal Flash ROMs with the calibration constants are full.

Solution: 1. Check the 12V programming voltage connection in the battery compartment.

2. The calibration constants part in the Flash Roms must be emptied before other calibrations can be made. For refreshing the Flash ROMs, contact your nearest Fluke/Philips Service Center.

PRINTER error: please reset printer.
(SCOPE/METER mode, model 97 only)

No printing or the printing has stopped via the optically isolated RS- 232-C interface PM9080.

Solution: Check the settings on the printer (ON LINE and BAUD RATE). Reset the printer. Verify that if the optically isolated RS-232-C interface is still connected to the ScopeMeter.

CALIBRATION error: wrong input signal(s)
(SCOPE/METER mode)

The ScopeMeter has rejected the connected calibration adjustment signal during calibration.

Solution: Check the calibration signal and repeat the calibration step. If the signal is correct and the error message remains, refer to the troubleshooting information of the Analog A2 PCB later in this section.

PROBE successfully calibrated.
(SCOPE/METER mode)

The probe calibration has been successful.

**** ERROR *** PLEASE RESET INSTRUMENT *****
(SCOPE/METER mode)

General error message: something has gone wrong, which cannot be undone easily.

Solution: Switch off the ScopeMeter and switch it on again, using MASTER RESET: Press the LCD key and keep it pressed. Now press the ON/OFF key. The ScopeMeter will give two beeps and will start up in a default condition.

No AUTOSET on time or att: no channels
(SCOPE mode)

You have tried to do an AUTOSET, while both channels A and B were switched off (only waveforms in memory displayed!).

Solution: Switch on channel A and/or channel B before you activate AUTOSET.

REF differs from present meter mode.
(METER mode)

The settings of the ScopeMeter have been changed, so that previously determined references are not valid.

Solution: Set new references.

PROBE CAL. Use AUTO SET to exit.
(SCOPE/METER mode)

The ScopeMeter has been set into the AC ADJUST mode for channel A or B in the PROBE CAL popup menu.

Solution: AC adjust the probe and/or press the AUTO SET key.

AUTO SET .. AUTO SET .. AUTO SET
(SCOPE/METER mode)

The ScopeMeter performs an auto set after the AUTO SET key has been pressed.

Solution: Wait until the warning disappears (about 1 second). If the warning stays, refer to the troubleshooting information later in this section.

Connect PROBE to GENERATOR OUT.
(SCOPE/METER mode)

The AC ADJUST or the DC CAL item in the PROBE CAL pop up menu has been selected.

Solution: Connect a probe to the generator output and select AC ADJUST or DC CAL or wait for five seconds.

DC PROBE calibration in progress
(SCOPE/METER mode)

The DC CAL item in the PROBE CAL pop-up menu has been selected.

Solution: Wait until the warning disappears. A beep signals the end of the DC PROBE calibration. If the calibration has been successful, the message "PROBE successfully calibrated" will appear.

7.1.4 Main tests

7.1.4.1 Operation Verification Procedure

This test verifies the ScopeMeter with a minimum of test steps and actions. It does not check every facet of the ScopeMeter's characteristics, but it gives you an indication of correct operation.

For operation verification purposes, the ScopeMeter generates a 975 Hz/ 5V peak-to-peak square wave signal that can be measured and verified. This signal is measured in the SCOPE and METER mode.

NOTE: To use the ScopeMeter to its fullest capability it is essential to use only calibrated probes with your instrument. These calibrated probes are delivered with the ScopeMeter.

Operation Verification Procedure:

1. Turn ON the ScopeMeter.
2. Connect the red 10:1 scope probe to channel A (red BNC) input.
3. Connect the red adjust adapter to the red banana GENERATOR OUTput connector.
4. Connect the red probe to the red banana/scope tip adapter.
5. Press the **SCOPE** key.
6. Press the **LCD/CAL** key.
7. Press the **PROBE CAL** softkey to select the CALibration & ADJUST pop-up menu.
8. Press the △ ▽ select/adjust keys to select AC ADJUST of channel A.
9. Press the **ENTER** softkey to enter the AC ADJUST mode.

- Check the **SCOPE** display on the following settings and results:

Channel Configuration	Channel A
Vertical Amplitude	1V/div
Channel Input Coupling	AC
Probe Selected	PROBE x10
Time Base	100 µs/div
Trigger Mode (Press **SCOPE** key)	Recurrent
Trigger Source (Press **TRIGGER** key)	Channel A
Trigger Slope (Press **TRIGGER** key)	+ Slope

Result (see Figure 7.1): Square wave,
Ampl 5V peak-to=peak ± 10%
Freq 976 Hz ± 1%

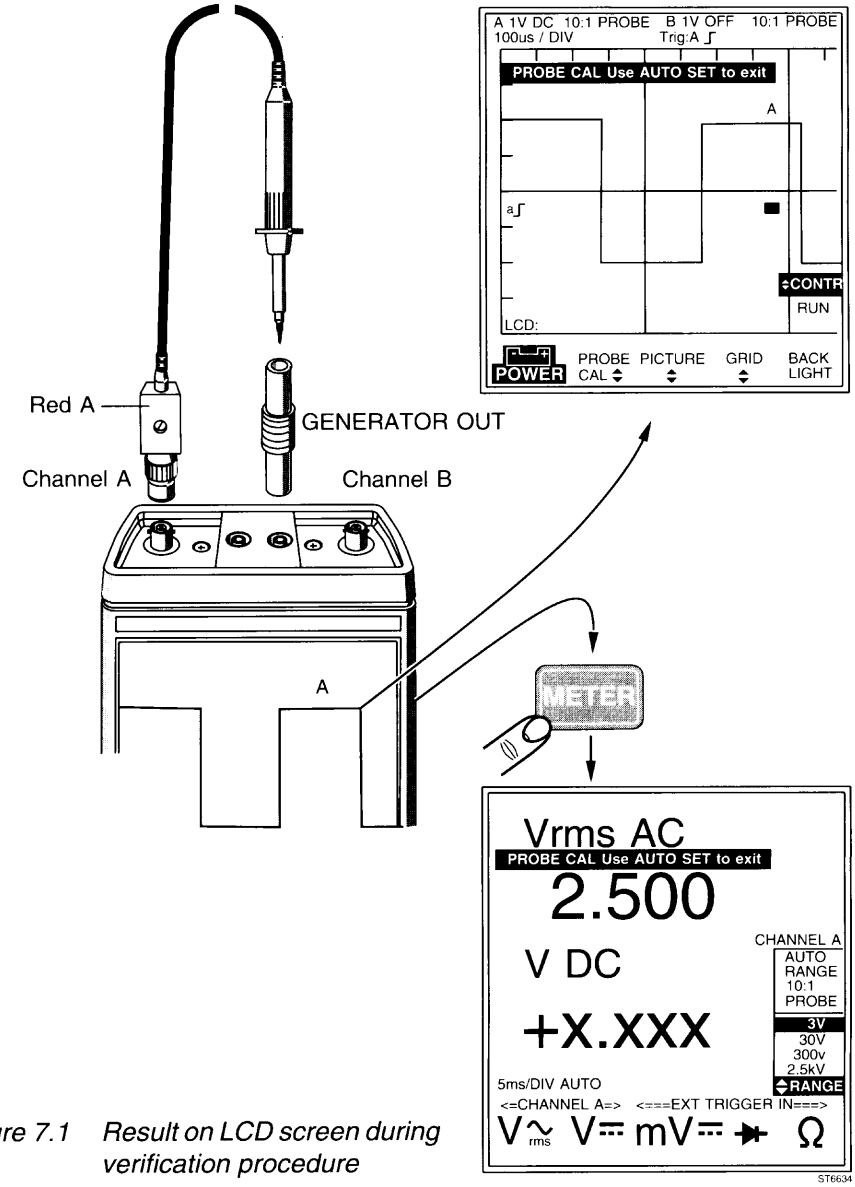


Figure 7.1 Result on LCD screen during verification procedure

10. Press the **METER** key.
The ScopeMeter sets itself to the initial METER measurement function.

- Check the **METER** display on the following settings and results:
Result (see Figure 7.1): Vrms AC 2.500 ±10%
Ranging (see Figure 7.1): AUTO, 3V

11. Press the **AUTO SET** key to end the operation verification procedure for channel A.

NOTE: To verify the SCOPE operation of Channel B, proceed in the same order as Channel A, use the grey channel B BNC socket and the grey 10:1 scope probe.

7.1.4.2 Performance Verification Procedure

The Performance Verification Procedure is a very quick way to check most of the ScopeMeter's specifications. It is based on the specifications listed in Chapter 2 of this Service Manual. If the instrument fails of any of these tests, Calibration Adjustments (see chapter 5) and/or repair (see chapter 7) is necessary. The complete Performance Verification Procedure is described in chapter 4.

7.1.5 Troubleshooting

7.1.5.1 Trouble shooting hints

OPENING THE SCOPEMETER:
To troubleshoot the ScopeMeter, open the instrument as described in subsection 6.2.2 "Opening the ScopeMeter" of chapter 6 "DISASSEMBLING THE SCOPEMETER".

TEST POINT AND COMPONENTS LOCATION:
Added with the PCB layouts figures 10.1, 10.4, and 10.5 and the circuit diagrams figures 10.2, 10.3, 10,6, 10.7, and 10.8 are location reference lists for fast location of the test points and the components.

CONNECTING THE GROUND (ZERO) LOGIC 0 REFERENCE:
While performing measurements, it is possible to use the metal shielding as zero reference. It is also possible to install the metal screws, as is described in section 5.6.1 "Hardware SCOPE Calibration Adjustments". You can use one of the screws as a zero reference: refer to figure 5.2.

LOGIC 1 LEVEL:
The logic one level is +5V.

7.1.6 Digital A1 PCB Troubleshooting

First remove the digital A1 PCB as described in section 6.2.4 "Removing the digital PCB".

7.1.6.1 Powering the ScopeMeter

Power the ScopeMeter with the powerAdapter/Battery Charger PM8907.

7.1.6.2 Kernel Test

The Kernel tests the Address/Data outputs from the microprocessor (D1201), the interface transmitter and receiver circuits of the optical interface, and the Random Access Memories (RAM). The test results are measured with an oscilloscope.

NOTE: If loading the ScopeMeters FlashROMs fails, it is possible to get a ScopeMeter which is not functioning. For example: if the operating system of the ScopeMeter is corrupted, it is not possible to operate the instrument normally. In this case you should also use the following procedure to establish communication with the ScopeMeter. When communication is established, you can reload the operating software into the FlashROMs. (For this action you need special software: contact your nearest Fluke/Philips Service Center.)

1. Power the ScopeMeter with the Power Adapter/Battery Charger PM8907.

2. Ground testpoint TP216, turn on the ScopeMeter and release the ground (from testpoint TP216).

MICROPROCESSOR D1201

3. Measure on connector contact X1201/6 to test the microprocessor D1201.
   Correct = 0.5 Hz.
   Incorrect (defect microprocessor D1201) = not 0.5 Hz.

OPTICAL INTERFACE

4. Shine with a lamp in the "Optical Interface" holes to test the optical interface receiver.

5. Measure on the transceiver line D1201/31.
   Apply light and verify that the signal level changes from +5V DC (dark) to 0V DC (light). Some spikes are allowed.

ADDRESS/DATA LINES

6. Measure on address/data bus 00 (AD00, D1201/2).
   Correct = Logic 0.
   All other address data lines (AD01 to AD15) are logic 1 (+5V).

7. Ground and release testpoint TP217 (first time) and the next address/data AD01 line will go low (to logic 0).
   Continue grounding and releasing testpoint TP217 until address/data line AD15 goes low (fifteenth time).
   With steps 6 and 7 the buffered addresses throughout the whole instrument are active and can be traced.

RAMS D1204 AND D1206

8. The next grounding of testpoint TP217 (sixteenth time) starts the RAM test of the RAMs D1204 and D1206. Measure on connector contact X1201/6.
   During the RAM test connector contact starts at logic 0.
   RAM D1204 and D1206 correct = 0.5 Hz.
   RAM D 1204 or D1206 incorrect = logic 1. Continue at step 9.

9. Ground and release testpoint TP217 (seventeenth time) to start the RAM test of RAM D1206. Measure on connector contact X1201/6.
   During the RAM test connector contact X1201/6 starts at logic 0.
   RAM D1206 correct = 0.5 Hz.
   RAM D1206 incorrect = logic 1.

ESTABLISHING COMMUNICATION

10. After the seventeenth time of grounding TP217, the ScopeMeter sends an <XON> via the RS-232 interface. Now communication is established, it is possible to reprogram the FlashROMs. For special software contact your nearest Fluke/Philips Service Center.

11. Ground testpoint TP216 one more time to abort the Kernel Test.

7.1.6.3 Test point signals

The digital A1 PCB is provided with test points, marked: "TP" See figure 10.1: A1 PCB layout (component side). These can be used to check correct functioning of the PCB.

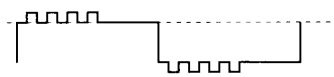
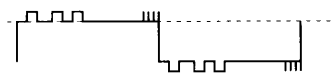
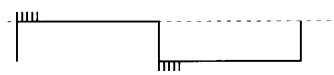
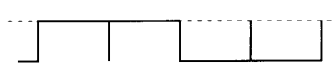
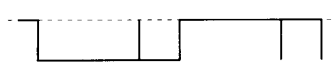
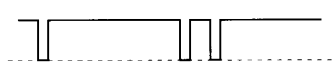
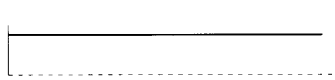
All measurements are made in the default MASTER RESET condition (start the measurements in the ScopeMeter using **MASTER RESET**).

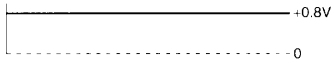
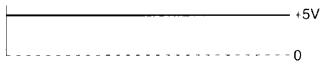
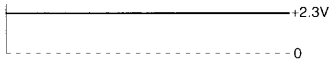
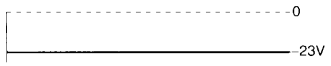
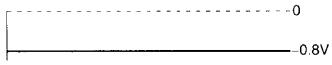
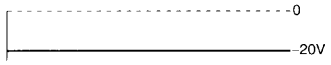
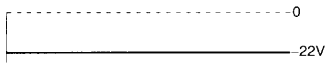
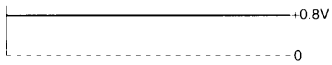
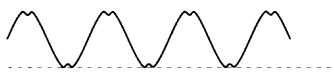
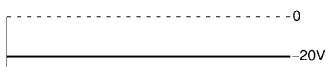
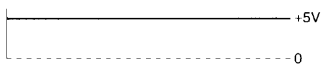
A MASTER RESET is performed as follows:
1. Remove all signals from the ScopeMeter.
2. Turn off the ScopeMeter.
3. Hold down the LCD key and press the ON/OFF key simultaneously. Two beeps are audible, and all volatile memories (RAM with battery backup) are reset. The ScopeMeter is automatically set to the METER mode.

Use another oscilloscope with high input impedance and 10:1 probe to measure the signals on the test points. See table 7.1:

Table 7.1. Overview on Test Points on the digital A1 PCB

Logic 0=0V, Logic 1=+5V

TP	Name	Scope	Freq. Per.	Data H/L/A	Description
207	Y40		595 Hz	A	Output 40, D1404
208	Y120		595 Hz	A	Output 120, D1406
209	Y200		595 Hz	A	Output 200, D1407
210	X40		595 Hz	A	Output 40, D1401
211	X120		595 Hz	A	Output 120, D1402
212	X200		595 Hz	A	Output 200, D1403
213	WEN		≈0.2 µs	A	Write Enable Not, point 10 of D1203
214	REN		≈2 µs	A	Read Enable Not, point 11 of D1203
216	TEST1		0	H	TEST 1/analog channel 3, point 16 of D1201
217	TEST2		12.1 kHz	A	TEST 2/timer 2 clock, point 64 of D1201
219	ON_OFF		0	L	ON OFF/high speed input 0.2, point 53 of D1201
221	POWER_ON		0	H	POWER ON

TP	Name	Scope	Freq. Per.	Data H/L/A	Description
222	NOT_ON		0	L	NOT ON
223	RAM_POWER		0	H	RAM POWER
224	+VRAM		0	H	+Supply Voltage for the RAM/...
233	V1		0	H	Power supply for LCD drive (+2.3V)
234	V2		0	L	Power supply for LCD drive (-23V)
235	V3		0	L	Power supply for LCD drive (-0.8V)
236	V4		0	L	Power supply for LCD drive (-20V)
237	V5		0	L	Power supply for LCD drive (-22V)
238	V6			H	Power supply for LCD drive (+0.8V)
239	µPCLK		12.5 MHz	A	µProcessor clock, point 9 of D1201
240	GROUND				
241	BAT_LEVEL		0	H	BATtery LEVEL/analog channel 6, point 20 of D1201
244	RAMSELN			A	RAM SELect Not, point 20 of D1204
246	OPTSELN		500 kHz	A	Option Select Not
247	A15		2 MHz	A	.../ROM 1 select not
248	-20V		0	H	-20V supply
249	+5V		0	H	+5V supply

7.1.6.4 Default signals measured in the digital circuits.

The Digital A1 PCB is provided with large integrated circuits. For testing the board, the input signals and output signals of the large integrated circuits are given in tables 7.2 up to 7.5. and the corresponding figures. These signals can be used to check correct functioning of the large Integrated Circuits on the digital A1 PCB.

All measurements are made in the default MASTER RESET condition (start the measurements in the ScopeMeter using **MASTER RESET**).

A MASTER RESET is performed as follows:
1. Remove all signals from the ScopeMeter.
2. Turn off the ScopeMeter.
3. Hold down the LCD key and press the ON/OFF key simultaneously. Two beeps are audible, and all volatile memories (RAM with battery backup) are reset. The ScopeMeter is automatically set to the Meter mode.

Use another oscilloscope with high input impedance and 10:1 probe to measure the signals on the integrated circuits.

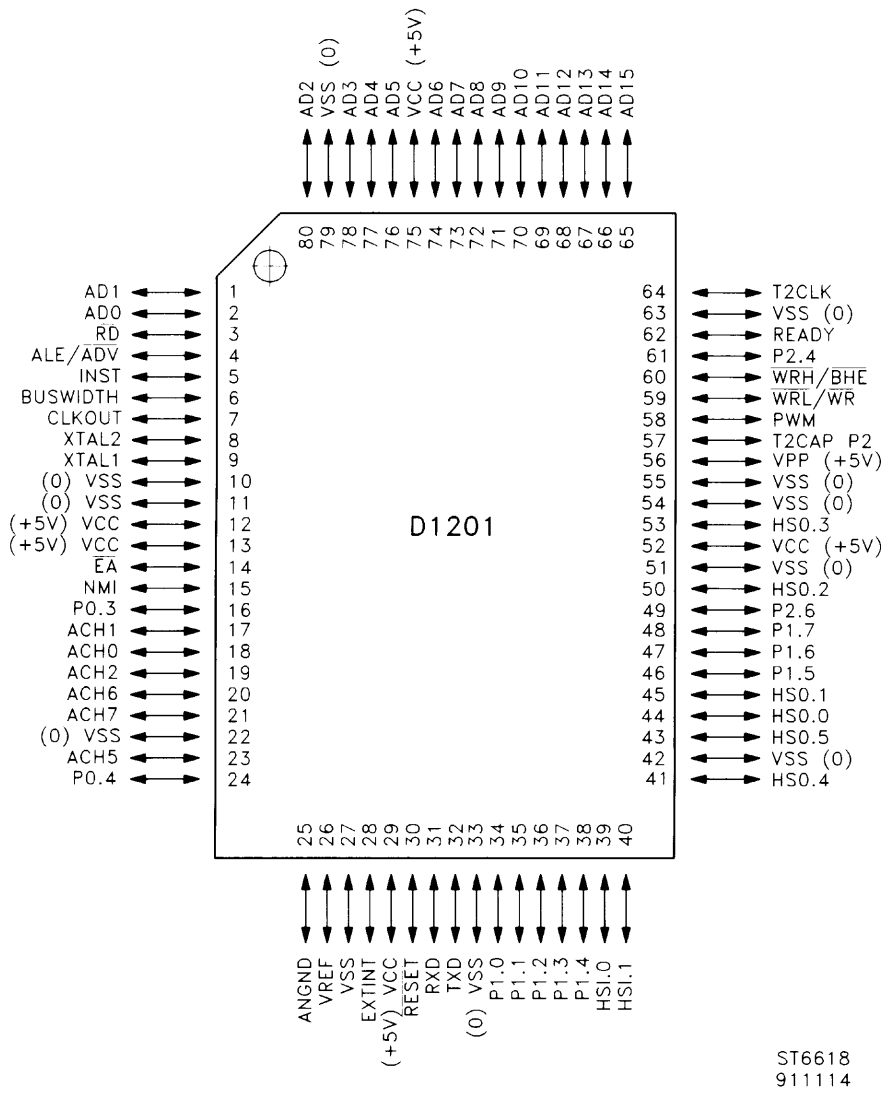
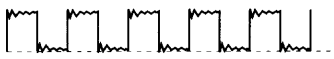
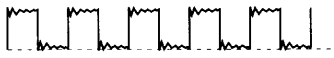
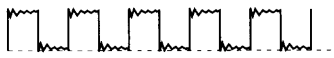
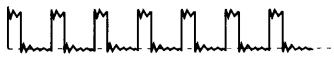
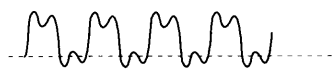
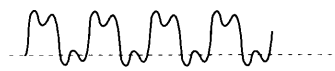
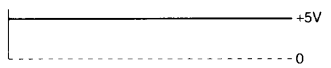
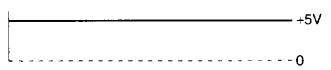
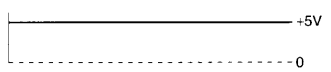
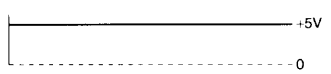
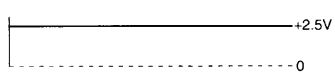
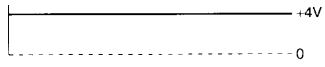
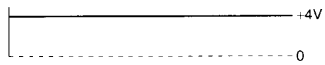
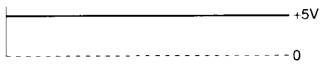
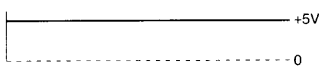
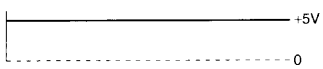
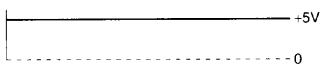
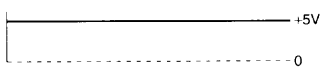
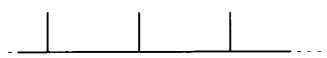
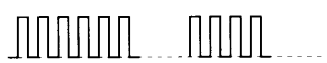
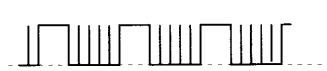
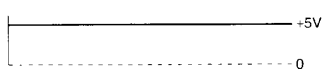


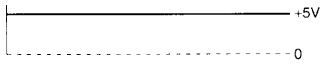
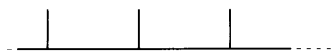
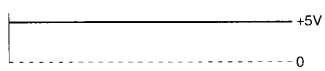
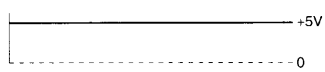
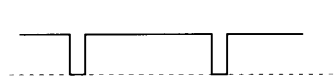
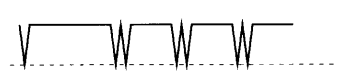
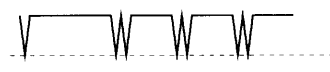
Figure 7.2 Microprocessor D1201

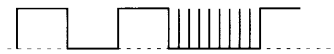
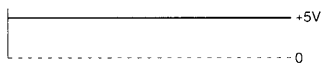
Table 7.2 Signals measured on microprocessor D1201

Logic 0=0V, Logic 1=+5V

Comp	Name (pin) Circ /IC	Scope	Freq. Per.	Data H/L/A	Description
D1201					
1	AD01 /AD1/P3		1.5 MHz	A	Address Data1/Address Data1 port3
2	AD00 /AD0/P3		2 MHz	A	Address Data0/Address Data0 port3
3	RDIN /$\overline{RD}$		2 MHz	A	Read not/Read
4	ADVN /ALE/$\overline{ADV}$		2 MHz	A	Address valid not/Address latch enable/Address valid output
5	/INST		200 kHz	A	/Instruction fetch for external memory
6	/BUSWIDTH		0	L	/Buswidth selection, 8 or 16 bit
7	µPCLKOUT/CLKOUT		6.25 MHz	A	µP clock out/clock out 1/2 oscillation frequency 50% duty cycle
8	/X-TAL2		12.5 MHz	A	/Crystal
9	/X-TAL1		12.5 MHz	A	/Crystal
10	/VSS		0	L	/Voltage supply ground (0)
11	/VSS		0	L	/Voltage supply ground (0)
12	/VCC		0	H	/Main supply (+5V)
13	/VCC		0	H	/Main supply (+5V)
14	/$\overline{EA}$		0	H	/External access
15	/NMI			A	/NonMaskable Interrupt
16	/PO.3		0	H	/port 0.3
17	/ACH1		0	H	/Analog channel 1
18	/ACH0		0	H	/Analog channel 0

Comp	Name (pin) Circ /IC	Scope	Freq. Per.	Data H/L/A	Description
19	/ACH2		0	H	/Analog channel 2
20	/ACH6		0	H	/Analog channel 6
21	/ACH7		0	A	/Analog channel 7
22	/VSS		0	L	/Voltage supply ground (0)
23	/ACH5		0	L	/Analog channel 5
24	HLDOFN/ACH4			H	/A Hold off not /Analog channel 4
25	/ANGND		0	L	/Analog ground (A/D convertor)
26	/VREF		0	H	/Vreference (A/D convertor)
27	/VSS		0	L	/Clock Detect Enable
28	ACQRDY/EXTINT		≈50 Hz	A	Acquisition ready/External interrupt
29	/VCC		0	H	/Main supply (+5V)
30	µPRESET/$\overline{\text{RESET}}$		0	H	µP reset /reset
31	/RXD		0	H	/Receive data/port 2
32	/TXD		0	H	/Transmit data/port 2
33	/VSS		0	L	/Voltage supply ground (0)
34	CDAT /P1.0		≈20 µs	A	Cbus DATA /Port 1.0; repeated each 30-60 ms
35	DTAEb/P1.1		30-60 ms	L	DATA enable /Port 1.1
36	FRONTCLOCK/P1.2		60 kHz	A	Front clock /Port 1.2; repeated each 30-60 ms
37	CCLK /P1.3		100 kHz	A	Cbus clock /Port 1.3; repeated each 30-60 ms
38	PS0 /P1.4		40 Hz	A	page select 0 /Port 1.4
39	FRONTDATA1/HS1.0		0	H	Frontdata1 /High speed input 1.0

Comp	Name (pin) Circ /IC	Scope	Freq. Per.	Data H/L/A	Description
40	FRONTDATA2/HS1.1		0	H	Frontdata2 /High speed input 1.1
41	/HS0.4		400 Hz	A	/High Speed input 0.4
42	/VSS		0	L	/Voltage supply ground (0)
43	AD15 /HS0.5		30-60 ms	L/A	Address data 15/High Speed input 0.5
44	LIGHT/HS0.0		0	L	Light /High Speed input 0.0
45	/HS0.1		0	L	/High Speed input 0.1
46	PS1 /P1.5		0	L	page select 1 /port 1.5
47	PS2 /P1.6		45-1.5 kHz	A	page select 2 /port 1.6
48	PS3 /P1.7		45-1.5 kHz	A	page select 3 /port 1.7
49	DTAEC/P2.6		0	L	Data enable C /port 2.6
50	/HS0.2		0	L	/High Speed input 0.2
51	/VSS		0	L	/Voltage supply ground (0)
52	/VCC		0	H	/Main supply (+5V)
53	ON OFF/HS0.3		0	L	on off /High Speed input 0.2
54	/VSS		0	L	/Voltage supply ground (0)
55	/VSS		0	L	/Voltage supply ground (0)
56	/VPP		0	H	/ (+5V)
57	FRONT LATCH /T2CAP/P2		≈30 ms	H/A	Front latch /
58	TEST2/PWM		12 kHz	A	Test 2 /Pulse width modulator
59	WRIN /$\overline{WRL}$/$\overline{WR}$		2.08 MHz	A	Write not /Write low/Write
60	/$\overline{WRH}$/$\overline{BHE}$		2.08 MHz	A	/Write high, Bus High Enable

Comp	Name (pin) Circ /IC	Scope	Freq.	Data H/L/A	Description
61	ADC7 /P2.4			A	Analog digital convertor/ port 2.4
62	SYNCRDY/READY		2 MHz	A	Synchronisation ready/Ready
63	/VSS		0	L	/Voltage supply ground (0)
64	TEST2/T2CLK		12 kHz	A	Test 2 /Timer 2 clock
65	AD15 /AD15		100 kHz	A	Address data 15/Address data 15
66	AD14 /AD14		100 kHz	A	Address data 14/Address data 14
67	AD13 /AD13		100 kHz	A	Address data 13/Address data 13
68	AD12 /AD12		100 kHz	A	Address data 12/Address data 12
69	AD11 /AD11		100 kHz	A	Address data 11/Address data 11
70	AD10 /AD10		100 kHz	A	Address data 10/Address data 10
71	AD09 /AD		100 kHz	A	Address data 09/Address data 09
72	AD08 /AD		100 kHz	A	Address data 08/Address data 08
73	AD07 /AD		1-2 MHz	A	Address data 07/Address data 07
74	AD06 /AD		1-2 MHz	A	Address data 06/Address data 06
75	/VCC		0	H	/Main supply (+5V)
76	AD05 /AD		1.5 MHz	A	Address data 05/Address data 05
77	AD04 /AD		1.5 MHz	A	Address data 04/Address data 04
78	AD03 /AD		1.5 MHz	A	Address data 03/Address data 03
79	/VSS		0	L	/Voltage supply ground (0)
80	AD02 /AD2		1.5 MHz	A	Address data 02/Address data 02

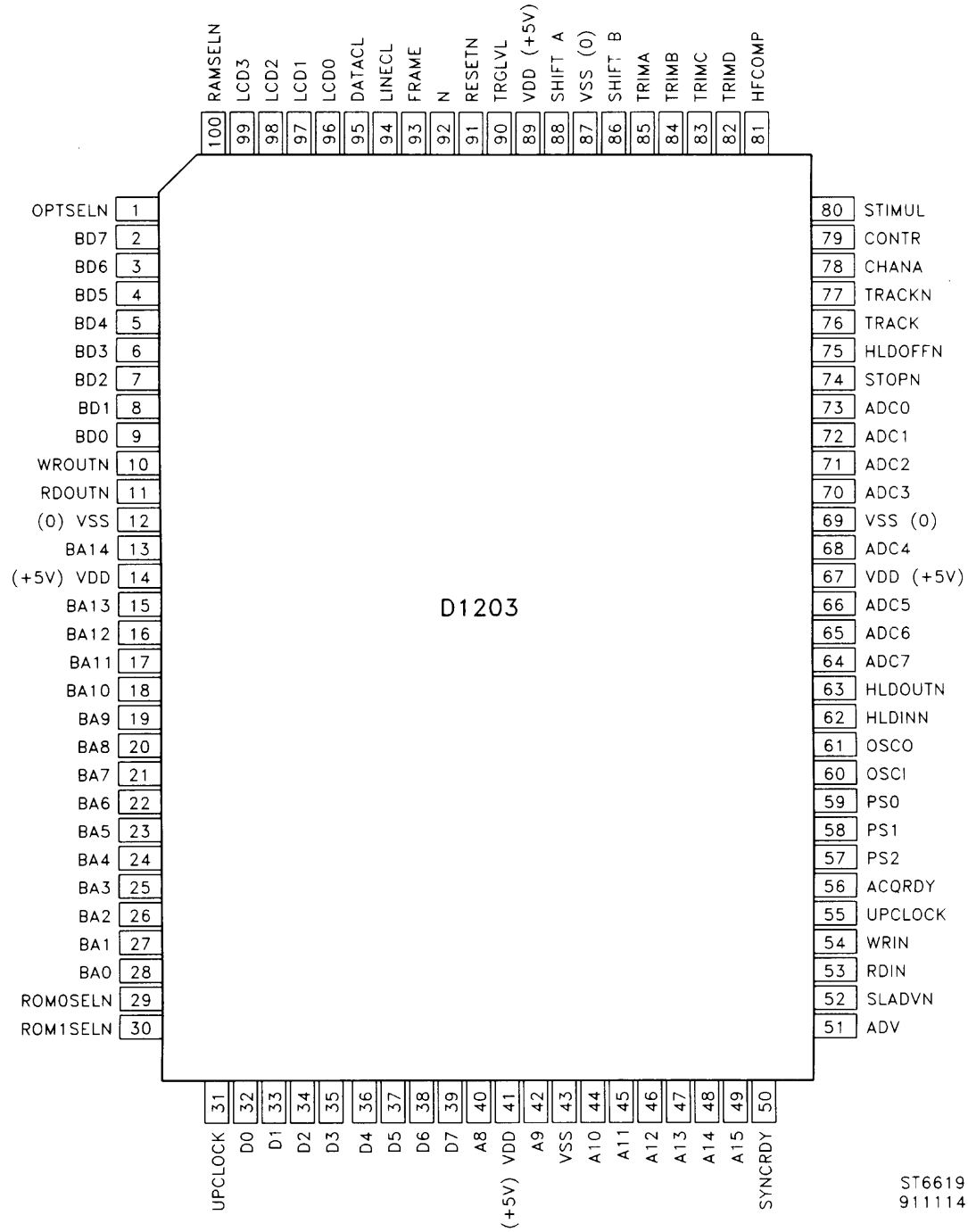
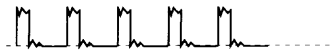
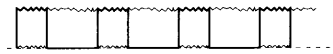
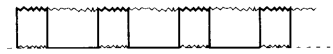
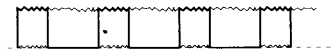
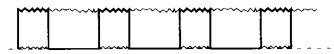
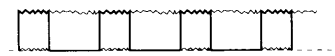
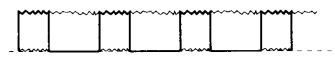
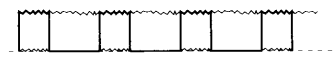
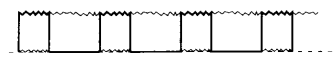
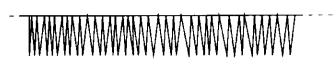
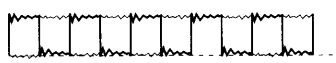
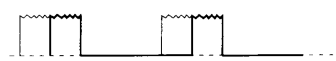
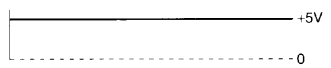
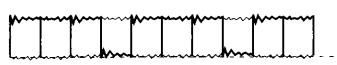
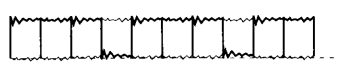
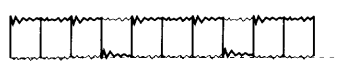


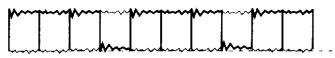
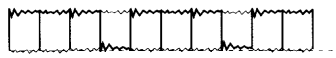
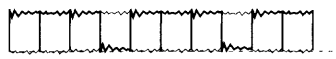
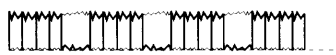
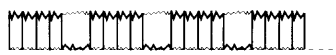
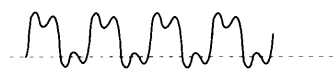
Figure 7.3 Digital ASIC D1203

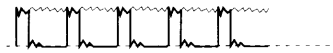
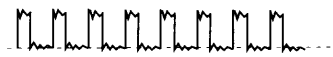
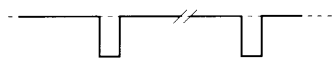
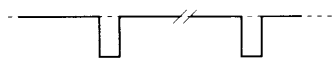
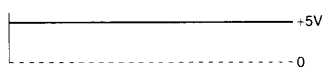
Table 7.3 Signals measured on digital ASIC D1203

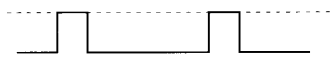
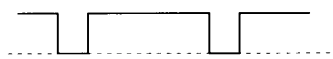
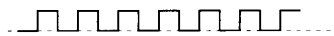
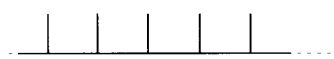
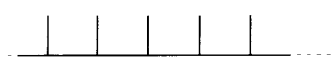
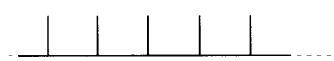
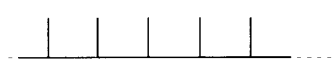
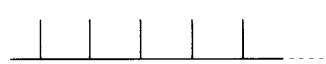
Logic 0=0V Logic 1=+5V

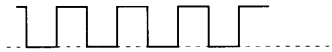
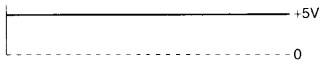
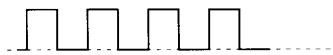
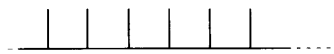
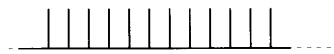
Comp	Name (pin) Circ /IC	Scope	Freq.	Data H/L/A	Description
D1203					
1	/OPTSELN		499.8 kHz	A	Optional RAM Select Not

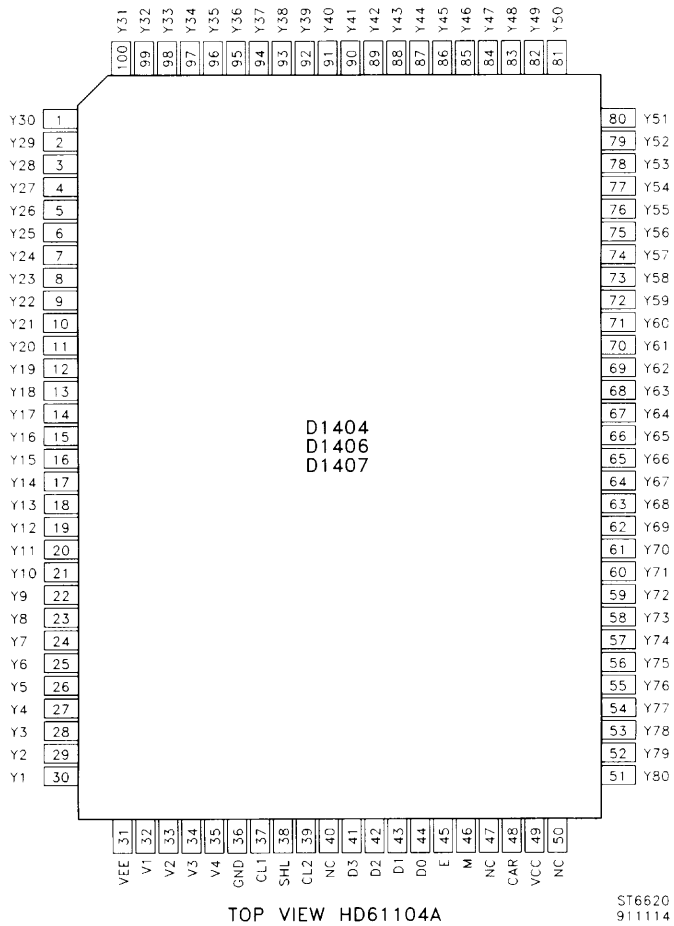
Comp	Name (pin) Circ /IC	Scope	Freq.	Data H/L/A	Description
2	BD07/BD7	Unstable 	100 kHz	A	Buffered Data
3	BD06/BD6	Unstable 	100 kHz	A	Buffered Data
4	BD05/BD5	Unstable 	100 kHz	A	Buffered Data
5	BD04/BD4	Unstable 	100 kHz	A	Buffered Data
6	BD03/BD3	Unstable 	100 kHz	A	Buffered Data
7	BD02/BD2	Unstable 	100 kHz	A	Buffered Data
8	BD01/BD1	Unstable 	100 kHz	A	Buffered Data
9	BD00/BD0	Unstable 	100 kHz	A	Buffered Data
10	WEN/WROUTN	Unstable 	32 kHz	A	Write Enable Not/Write Out Not
11	REN/RDOUTN	Unstable 	1.4995 MHz	A	Read Enable Not/Read Out Not
12	VSS		0	L	Volt Supply ground
13	BA14/BA14	Unstable 	200 kHz	A	Buffered Address
14	+5VD/VDD		0	H	Volt Supply
15	BA13/BA13	Unstable 	635 kHz	A	Buffered Address
16	BA12/BA12	Unstable 	635 kHz	A	Buffered Address
17	BA11/BA11	Unstable 	635 kHz	A	Buffered Address

Comp	Name (pin) Circ /IC	Scope	Freq.	Data H/L/A	Description
18	BA10/BA10	Unstable 	635 kHz	A	Buffered Address
19	BA09/BA9	Unstable 	635 kHz	A	Buffered Address
20	BA08/BA8	Unstable 	635 kHz	A	Buffered Address
21	BA07/BA7	Unstable 	616 kHz	A	Buffered Address
22	BA06/BA6	Unstable 	616 kHz	A	Buffered Address
23	BA05/BA5	Unstable 	616 kHz	A	Buffered Address
24	BA04/BA4	Unstable	590 kHz	A	Buffered Address
25	BA03/BA3	Unstable	599 kHz	A	Buffered Address
26	BA02/BA2	Unstable	599 kHz	A	Buffered Address
27	BA01/BA1	Unstable	599 kHz	A	Buffered Address
28	BA00/BA0	Unstable 	624 kHz	A	Buffered Address
29	CEN/ROM0SELN	1	0	H	...../Rom 0 Select Not
30	A15/ROM1SELN	1	0	H	Address 15/Rom 1 Select Not
31	UPCLOCK		12.5 MHz	A	Micro-processor Clock (1201/9)
32	AD00/D0	0	0	O	Address Data/Data Bus I/O 0
33	AD01/D1	0	0	O	Address Data/Data Bus I/O 1
34	AD02/D2	0	0	O	Address Data/Data Bus I/O 2
35	AD03/D3	0	0	O	Address Data/Data Bus I/O 3
36	AD04/D4	0	0	O	Address Data/Data Bus I/O 4
37	AD05/D5	0	0	O	Address Data/Data Bus I/O 5
38	AD06/D6	0	0	O	Address Data/Data Bus I/O 6
39	AD07/D7	0	0	O	Address Data/Data Bus I/O 7
40	AD08/D8	0	0	O	Address Data/Data Bus I/O 8
41	+5VD/VDD	1	0	H	Volt Supply
42	AD09/D9	0	0	O	Address Data/Data Bus I/O 9
43	..../VSS	0	0	L	Volt Supply Ground
44	AD10/A10	0	0	O	Address Data/Data Bus I/O 10
45	AD11/A11	0	0	O	Address Data/Data Bus I/O 11
46	AD12/A12	0	0	O	Address Data/Data Bus I/O 12
47	AD13/13	0	0	O	Address Data/Data Bus I/O 14
48	AD14/A14	0	0	O	Address Data/Data Bus I/O
49	AD15/A15	0	0	O	Address Data/Data Bus I/O 15
50	SYNCRDY /SYNCRDY	0	0	O	Synchronisation ready

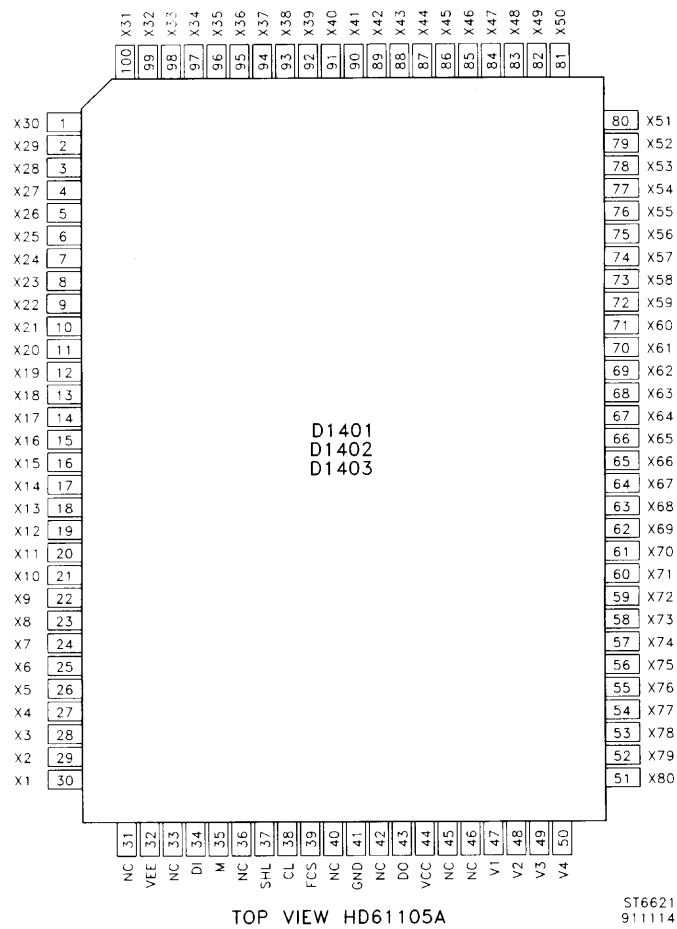
Comp	Name (pin) Circ /IC	Scope	Freq.	Data H/L/A	Description
51	ADVN/ADVN	Unstable 	1.200 MHz	A	Address Valid Not
52	SLADVN	1	0	H	Slow Address Valid Not (not used)
53	RDIN/RDIN	Unstable 	1.200 MHz	A	Read In
54	WRIN/WRIN	Unstable 	33 kHz	A	Write In
55	UPCLOCK/UPCLOCK		6.248 MHz	A	Micro Processor Clock
56	ACQRDY/ACQRDY		5Hz	A	Acquisition Ready
57	PS2/PS2	Unstable 	130 Hz	A	Page Select 2
58	PS1/PS1		0	O	Page Select 1
59	PS0/PS0	Unstable 	125 Hz	A	Page Select 0
60	.../OSCI		25 MHz	X	Oscillator In
61	.../OSCO		25 MHz	X	Oscillator Out
62	/HLDINN	Unstable 	5 Hz	A	Hold In Not
63	/HLDOUTN	Unstable 	5 Hz	A	Hold Out Not
64	ADC7/ADC7	Unstable 	100 Hz	A	ADC data output 7
65	ADC6/ADC6	Unstable 	100 Hz	A	ADC data output 6
66	ADC5/ADC5	Unstable 	100 Hz	A	ADC data output 5
67	+5VD/VDD		0	H	Volt Supply

Comp	Name (pin) Circ /IC	Scope	Freq.	Data H/L/A	Description
68	ADC4/ADC4	Unstable 	100 Hz	A	ADC data output 4
69	.../VSS	0	0	L	Volt Supply Ground
70	ADC3/ADC3	Unstable 	500 Hz	A	ADC data output 3
71	ADC2/ADC2	Unstable 	1 kHz	A	ADC data output 2
72	ADC1/ADC1	Unstable 	2.5 kHz	A	ADC data output 1
73	ADC0/ADC0	Unstable 	2.7 kHz	A	ADC data output 0
74	STOPN/STOPN	Unstable 	5 Hz	A	Acquisition Stop Not
75	HLDOFFN /HLDOFFN	Unstable 	5 Hz	A	Trigger Hold Off Not
76	TRACK/TRACK	Unstable 	11 kHz	A	Track (acquisition clock ADC)
77	.../TRACKN	not used			Track
78	CHANA/CHANA	1	0	H	Channel A
79	CONTR/CONTR		4.88 kHz	A	Contrast
80	STIMUL/STIMUL		976 Hz	A	Stimulus output
81	HF-COMP/HFCOMP	Unstable 	4.882 kHz	A	High Frequency Compensation (32 digit zero meter correction)
82	TRIMD/TRIMD		4.882 kHz	A	Trimming output D
83	.../TRIMC		0	L	Trimming output C
84	.../TRIMB		4.882 kHz	A	Trimming output B (not used)
85	.../TRIMA		4.882 kHz	A	Trimming output A (not used)
86	POS-CHB/SHIFTB		4.882 kHz	A	Position-Channel B/Shift channel B

Comp	Name (pin) Circ /IC	Scope	Freq.	Data H/L/A	Description
87	.../VSS	Logic 0=0V	0	L	Voltage Supply Ground
88	POS-CHA/SHIFTA		4.882 kHz	A	Position Channel A/Shift channel A
89	+5VD/VDD		0	H	Volt Supply
90	LEVEL/TRGLVL		4.882 kHz	A	Level/Trigger Level
91	RESETN/RESETN		0	H	Reset Not
92	M/M		35 Hz	A	Multiplex LCD
93	FRAME/FRAME		70 Hz	A	Frame clock
94	LINECL/LINECL		16.66 kHz	A	Line Clock
95	DATACL/DATACL		999.6 kHz	A	Data Clock
96	D0/LCD0	Unstable 	60 kHz	A	Data 0/Liquid Crystal Display D0
97	D1/LCD1	Unstable 	60 kHz	A	Data 1/Liquid Crystal Display D1
98	D2/LCD2	Unstable 	58 kHz	A	Data 2/Liquid Crystal Display D2
99	D3/LCD3	Unstable 	58 kHz	A	Data 3/Liquid Crystal Display D3
100	.../RAMSELN		999.6 kHz	A	Ram Select Not



TOP VIEW HD61104A



TOP VIEW HD61105A

Figure 7.4 D1401/02/03/04/06/07 Display drivers

Table 7.4 Signals measured on display drivers D1401/02/03

Logic 0=0V Logic 1=+5V

Comp	Name Circ/IC	Scope	Freq.	Data H/L/A	Description
D1401/D1402/D1403					
31	NC		0	L	Not Connected
32	-20V /VEE	0 -20V	0	H	Power supply
33	NC		0	L	Not Connected
34	FRAME/DI		70 Hz	A	.../shift register Data Input
35	M /M		34.7 Hz	A	Signal to convert LCD driver signalinto AC
36	NC		0	L	Not Connected
37	/SHL		0	L	Select shift direction
38	/CL		16.7 kHz	A	shift CLock
39	/FCS		0	L	shift clock phase
40	NC		0	L	Not Connected
41	GND		0	L	GROUND (0V)
42	NC		0	L	Not Connected
43	/DO		70 Hz	A	shift register Data Output
44	VCC	+5V 0	0	H	Volt supply (+5V)
45	NC		0	L	Not Connected
46	NC		0	L	Not Connected
47	V1 /V1		0	H	Power supply for LCD drive
48	V2 /V2		0	H	Power supply for LCD drive
49	V5 /V5		0	H	Power supply for LCD drive

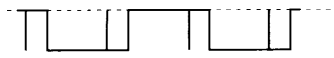
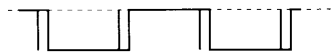
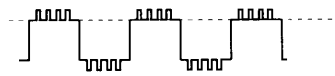
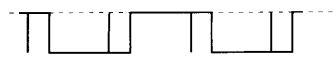
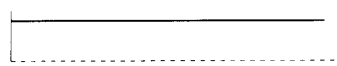
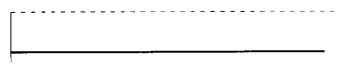
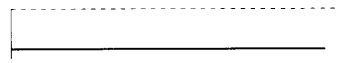
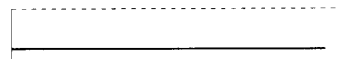
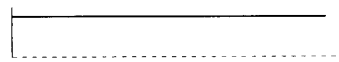
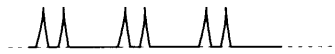
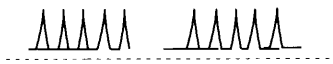
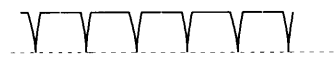
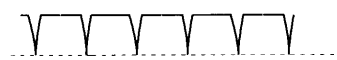
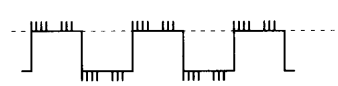
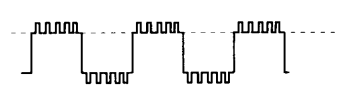
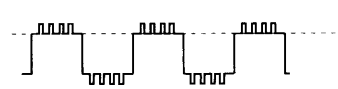
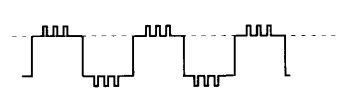
Comp	Name Circ/IC	Scope	Freq.	Data H/L/A	Description
50	V6 /V6		0	H	Power supply for LCD drive
5	X26 /X26 X106 /X26 X186 /X26		34.7 Hz	A	Liquid crystal driver output 5
21	X10 /X10 X90 /X10 X170 /X10		34.7 Hz	A	Liquid crystal driver output 21
55	X76 /X76 X156 /X76 X236 /X76		34.7 Hz	A	Liquid crystal driver output 55
79	X52 /X52 X132 /X52 X212 /X52		34.7 Hz	A	Liquid crystal driver output 79
96	X35 /X35 X115 /X35 X195 /X35		34.7 Hz	A	Liquid crystal driver output 96

Table 7.5 Signals measured on display drivers D1404/06/07

Logic 0=0V Logic 1=+5V

Comp	Name Circ/IC	Scope	Freq.	Data H/L/A	Description
D1404/D1406/D1407					
31	-20V /VEE		0	H	Power supply (-20V)
32	V1 /V1		0	H	Power supply for LCD drive
33	V2 /V2		0	H	Power supply for LCD drive
34	V3 /V3		0	H	Power supply for LCD drive
35	V4 /V4		0	H	Power supply for LCD drive
36	/GND		0	L	GROUND (0V)
37	LINECL/CL1		16.7 kHz	L/A	LINE CLock/Latch Clock 1
38	/SHL		0	H	.../SHift direction
39	DATACL/CL2		833 kHz	A	.../shift CLock 2
40	NC		0	L	Not Connected
41	D0 /D3		16.7 kHz	A	

Comp	Name Circ/IC	Scope	Freq.	Data H/L/A	Description
42	D1 /D2		41.6 kHz	A	
43	D2 /D1		112 kHz	A	
44	D3 /D0		100 kHz	A	
45	/E_N D1404		16.7 kHz	A	.../Enable input
	/E_N D1406		16.7 kHz	A	.../Enable input
	/E_N D1607		0	L	.../Enable input
46	M /M		34.7 Hz	A	switch signal to convert LCD drive waveform in AC
47	NC		0	L	Not Connected
48	/CAR_N D1404		16.7 kHz	H/A	Enable output for cascade connection
	/CAR_N D1406		16.7 kHz	H/A	Enable output for cascade connection
	/CAR_N D1407		16.7 kHz	H/A	Enable output for cascade connection
49	/VCC		0	H	Power supply (+5V)
50	NC		0	L	Not Connected
5	Y26 /Y26 Y106 /Y26 Y186 /Y26		35 Hz	A	Liquid crystal driver output 5
21	Y10 /Y10 Y90 /Y10 Y170 /Y10		35 Hz	A	Liquid crystal driver output 21
55	Y76 /Y76 Y156 /Y76 Y236 /Y76		35 Hz	A	Liquid crystal driver output 55
79	Y52 /Y52 Y132 /Y52 Y212 /Y52		35 Hz	A	Liquid crystal driver output 79
96	Y35 /Y35 Y115 /Y35 Y195 /Y35		35 Hz	A	Liquid crystal driver output 96

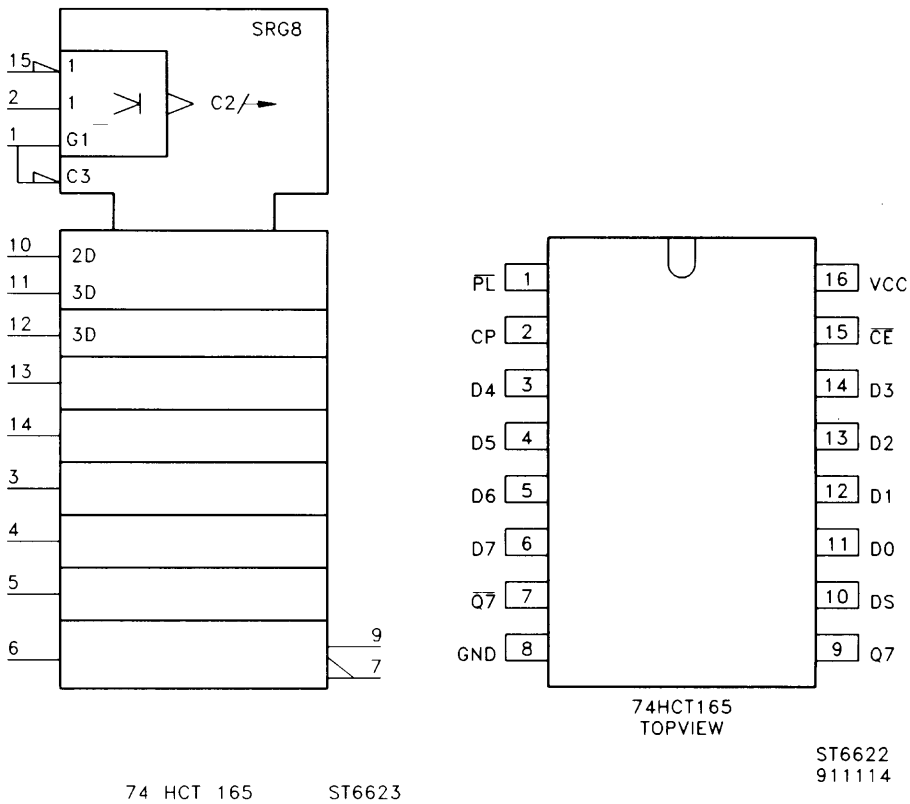
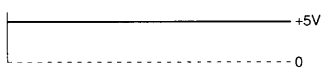


Figure 7.5 Keyboard decoders D1601/02/03/04/06

Table 7.6 Signals measured on keyboard decoders D1601/02/03/04/06

Logic 0=0V Logic 1=+5V

Comp	Name Circ/IC	Scope	Freq.	Data H/L/A	Description
D1601/D1602/D1603/D1604/D1606					
1	FRONT-LATCH/G1	Unstable	34 Hz	A	FRONT LATCH signal
2	FRONT-CLOCK/>1	Unstable	775 Hz	A	FRONT CLOCK signal
3	CURSOR2-L/...	D1601	0	H	CURSOR2-Left key
	B-MOVE-UP/...	D1602	0	H	Channel B-MOVE-UP key
	CURSOR1-R/...	D1603	0	H	CURSOR1-Right key
	TIME-ns/...	D1604	0	H	TIME-ns key
	LCD/...	D1606	0	H	Liquid Crystal Display key
4	CURSOR1-L/...		0	H	CURSOR1-Left key
	TIME-s/...		0	H	TIME-s key
	SOFT-5/...		0	H	Soft key -5
	A-MOVE-UP/...		0	H	Channel A-MOVE-UP key
	SPECIAL/....		0	H	SPECIAL FUNCTion key
5	SOFT-4/...		0	H	Soft key -4
	A-mV/...		0	H	Channel A-mV key
	SOFT-3/...		0	H	Soft key -3
	B-AC/DC/...		0	H	Channel B-AC/DC/GROUND key
	HOLD/RUN/...		0	H	HOLD/RUN

Comp	Name Circ/IC	Scope	Freq.	Data H/L/A	Description
6	SOFT-2/...		0	H	Soft key -2
	CHAN-A/B/...		0	H	CHANnel A/B key
	SOFT-1/...		0	H	Soft key -1
	TRIGGER/...		0	H	TRIGGER key
	SETUP/...		0	H	SETUP key
7	not used		0	L	not used
8	VSS	Logic 0=0V	0	L	Volt Supply ground
9	FRONT-DATA2/...		0	H	FRONT-DATA block 2
	D1602/9 connected to D1601/10		0	H	
	FRONT-DATA1/...		0	H	FRONT-DATA block 1
	D1604/9 connected to D1603/10		0	H	
	D1606/9 connected to D1604/10		0	H	
10	D1601/10 connected tp D1602/9		0	H	
	WAVEFORM/...		0	H	WAVEFORM key
	D1603/10 connected tp D1604/9		0	H	
	D1604/10 connected tp D1606/9		0	H	
	E/...		0	H	not used
11	AUTOSET/...		0	H	AUTOSET key
	RECORD/...		0	H	RECORD key
	A AC/DC/...		0	H	Channel A-AC/DC/GROUND key
	B V/...		0	H	Channel B-V key
	D/...		0	H	not used
12	METER/...		0	H	METER key
	B MOVE DOWN/...		0	H	Channel B-MOVE DOWN key
	CURSOR DATA/...		0	H	CURSOR DATA key
	A MOVE DOWN/...		0	H	Channel A-MOVE DOWN key
	UNDO/...		0	H	UNDO key
13	SCOPE/...		0	H	SCOPE key
	MOVE L/...		0	H	MOVE Left key
	DOWN/...		0	H	DOWN key
	A MOVE DOWN/...		0	H	Channel A MOVE DOWN key
	MATH/...		0	H	MATH key
14	UP/...		0	H	UP key
	A V/...		0	H	Channel A-V key
	CURSOR 2 R/...		0	H	CURSOR 2-Right key
	B mV/...		0	H	Channel B-mV key
	A/...		0	H	not used
15	FRONTCLOCK/...		60kHz	A	
16	VCC/...		0	H	Main supply

7.1.7 Analog A2 PCB Troubleshooting

7.1.7.1 Test point signals

The analog A2 PCB is provided with test points, marked: "TP" See figure 10.4: A2 PCB layout (wired components side). These can be used to check correct functioning of the PCB.

All measurements are made in the default MASTER RESET condition (start the measurements in the ScopeMeter using **MASTER RESET**).

A MASTER RESET is performed as follows:
1. Remove all signals from the ScopeMeter.
2. Power the ScopeMeter with the Power Adapter/Battery charger PM8907.
3. Turn off the ScopeMeter
4. Hold down the LCD key and press the ON/OFF key simultaneously. Two beeps are audible, and all volatile memories (RAM with battery backup) are reset. The ScopeMeter is automatically set to the meter mode.

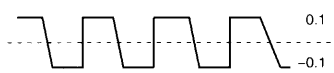
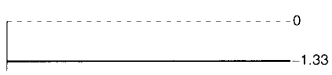
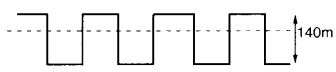
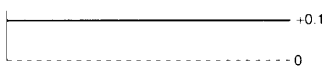
NOTE: For the measurements on Test Points 101...529 and 901...921 apply a 1 Volt, 10 kHz square wave signal to the channel A and channel B BNC. Press the SCOPE button to go to SCOPE mode and press AUTOSET to get a stable picture on the LCD.

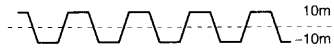
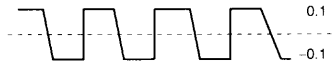
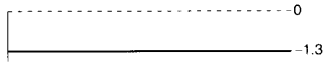
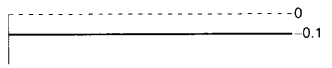
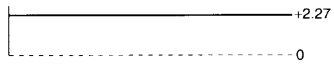
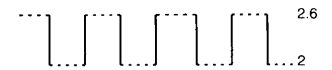
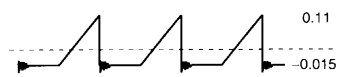
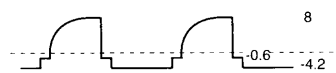
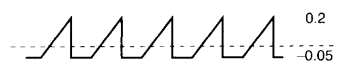
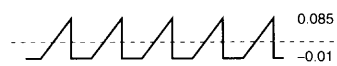
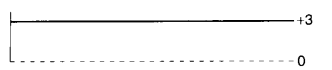
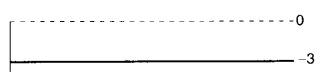
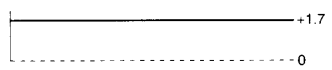
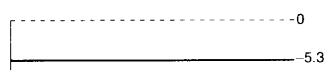
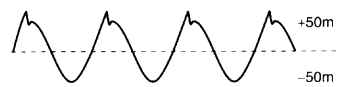
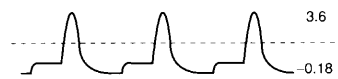
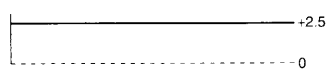
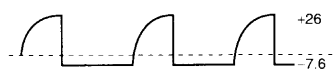
NOTE: For the measurements on Test Points 700...806 first switch on the ScopeMeter using a MASTER RESET. Then press the SPECIAL FUNCTion key and the GENERATE softkey. Use the select/adjust keys to select "square 1.95 kHz", and press the right most ENTER softkey to activate the generator.

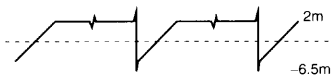
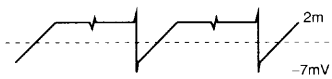
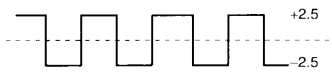
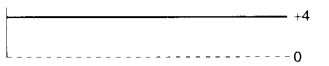
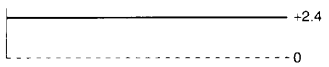
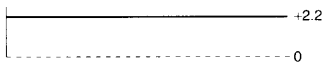
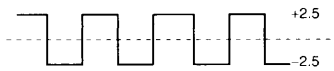
Use another oscilloscope with high input impedance and 10:1 probe to measure the signals on the test points. See table 7.7:

Table 7.7 Overview signals on Test Points (TP) on analog A2 PCB

Logic 0=0V, Logic 1=+5V

TP	Name	Scope	Freq.	Data	Description
101			0		Base V2112
102			0		Output D2101
103			0		Output N2101
104			0		Collector V2105
106			0		Base V2104
107	ATTB--A		10 kHz		Collector V2111
108			0		TP for OFFSET DAC
109	POS-CHB		0		POS-CHB, moves at MOVE ⇳
201			0		Base V2212

202	mV-in from A2d		0	Output D2201
203			10 kHz	Output N2201, V_{DC} = -2V
204			10 kHz	Collector V2205
206			0	Base V2204
207	ATTA--A		10 kHz	Collector V2211
208			0	TP for offset DAC, ≈0V
209	POS-CHA		0	POS-CHA moves at MOVE ⇳
331			0	VREF D2301
332			LF: sq. 10 KHz HF: sq. 500 KHz	SGN-in N2301
501			77 kHz	Collector V2517, V_{DC} = -7.7V
502			77 kHz	Base V2517, V_{DC} = -7V
503			73 kHz	Base V2503
504			73 kHz	Sense Resistors, Pos. side V_{DC} = -7.7V
506			73 kHz	Sense Resistors, Neg. side V_{DC} = -7.75V
507	+Vref		0	+Vref
508	-Vref		0	-Vref
509			0	Output N2501
511			0	TP for FEEDBACK AMPLIFIER
521			100 kHz	PSG-Input Z2501
522			100 kHz	Oscillator N2503
523			0	INV N2503
524			100 kHz	Collector V2526

526		100 kHz Source	V2532
527		100 kHz Source	V2537, V_{DC} = -1.05V
528		100 kHz Source	V2538, V_{DC} = -1.7V
529		0	CLN N2503
700 *		1.95 kHz	Relay contact K2750a/K2751b
701 *		1.95 kHz	Anode Zener V2752
702 *		0	Output D2850
704 *			Collector V2761, V_{DC} = 0.27V
706 *		0	Kathode zener V2763, ripple 0.6V
801 *			Output D2850
802 *		0	Emitter V2852
803 *		0	Non-inverting input N2850a
804 *		1.95 kHz	Output N2850
805 *		0	Non-inverting input N2850b
806 *		0	TP for CURRENT SOURCE
901		0	Output 1&2 D2901
902		0	Output 3&4 D2901
903		0	Output 5&6 D2901
904		0	Output 7&8 D2901
906		0	Output 1&2 D2902
907		0	Output 3&4 D2902
908		0	Output 5&6 D2902
909		0	Output 7&8 D2902

* GENERATE ON, SEE NOTE AT PAGE 7-28!

911		———	0	Output 1&2 D2903
912		———	0	Output 3&4 D2903
914		———	0	Output 7&8 D2903
916	Sgnd8a	———	0	Sgnd8a D2904
917	Ex/Ey	+5 / 0	0	Ex/Ey D2906
918	Sgnd8b	———	0	Sgnd8b D2907
919	Sr4b	———	0	Sr4b D2908
921	D-POSCHB	———	0	D-POSCHB D2909

7.1.7.2 Default signals measured on the Analog A2 pcb

All measurements are made in the defaults MASTER RESET condition (start the mesurements in the ScopeMeter using **MASTER RESET**)

A MASTER RESET is performed as follows:
1. Remove all signals from the ScopeMeter.
2. Power the ScopeMeter with the Power Adapter/Battery charger PM8907.
3. Turn off the ScopeMeter.
4. Hold down the LCD key and press the ON/OFF key simultaneously. Two beeps are audible, and all volatile memories (RAM with battery backup) are reset. The ScopeMeter is automatically set to the meter mode.

Apply a 1 Volt, 10 kHz square wave signal to the channel A and B BNC.
Press the SCOPE key to go to the Scope mode, and press AUTOSET to get a stable picture on the LCD.

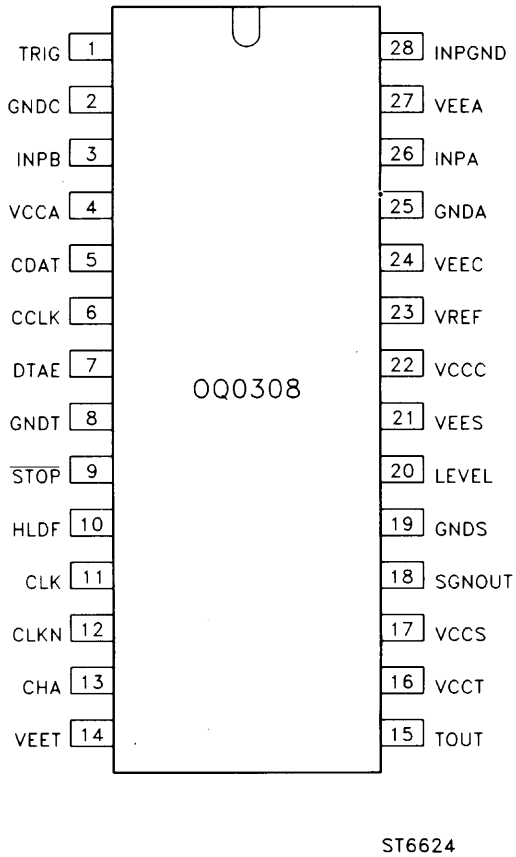
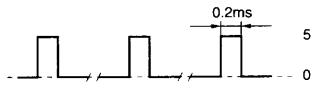
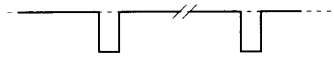
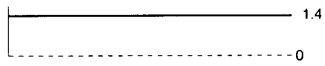
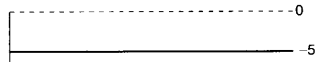
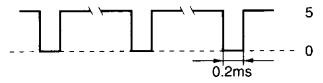
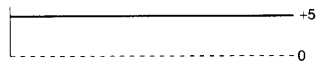
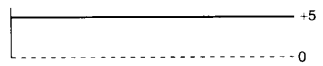
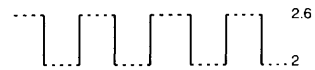
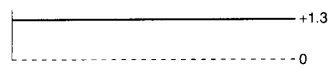
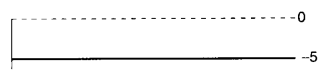
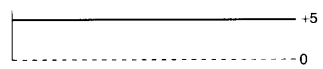
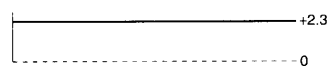
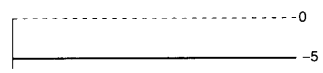
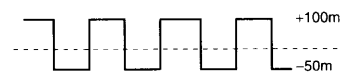
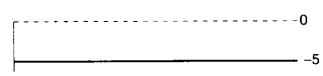


Figure 7.6 Analog ASIC D2301

Table 7.8 Signals measured on analog ASIC D2301

Logic 0=0V Logic 1=+5V

Comp	Name Circ/IC	Scope	Freq.	Data H/L/A	Description
1	TRIG		0		EXT. Trigger input
2	GNDa		0		Ground Analog-input-circuit
3	INPB	+50m -100m	10 kHz		Input signal B
4	VCCa	+4.7 0	0		Positiv power supply Analog-input-circuit
5	CDAT				Serial Data line; HIGH pulses at AUTOSET
6	CCLK	+5 0			Clock line; LOW pulses at AUTOSET
7	DTAE				Latch enable line; HIGH pulses at AUTOSET
8	GNDt		0		Ground Trigger-output-circuit

Comp	Name Circ/IC	Scope	Freq. Per.	Data H/L/A	Description
9	STOP				Trigger output at ≤ 20 µs/div At > 20 µs/div: +5V
10	HLDF VDC = 5				Hold off
11	CLK		0		Clock
12	CLKN		1.25 MHz		CLOCK; 1.25 MHz at 20 µs/div
13	CHA				Channel switch; ≤ 20 µs/div: 5-10 Hz (ALT) 50 µs/div: 500 kHz (CHOP) 100 µs/div: 250 kHz CHOP), etc.
14	VEEt		0		Negativ power supply Trigger-output-circuit
15	TOUT		20 Hz		DC-Trigger output, at ≤ 20 ms/div At > 20 µs/div: 0V
16	VCCt		0		Positiv power supply Trigger-output-circuit
17	VCCs		0		Positiv power supply Signal-output-circuit
18	SNGOUT		LF: sq. 10 kHz HF: sq. 500 kHz		Output signal
19	GNDs		0		Ground Signal-output-curcuit
20	LEVEL		0		Trigger level input
21	VEEs		0		Negativ power supply Signal-output-circuit
22	VCCc		0		Positiv power supply Control-logic circuit
23	VREF		0		Reference potential
24	VEEc		0		Negativ power supply Control-logic circuit
25	GNDc		0		Ground control-logic circuit
26	INPa		10 kHz		Input signal A
27	VEEa		0		Negativ power supply Analog-input-circuit
28	INPGND		0		Ground input

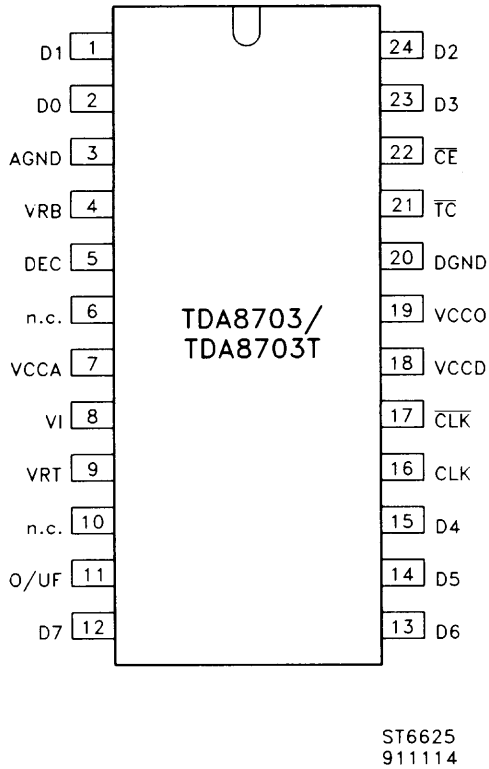
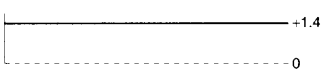
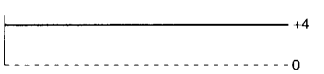
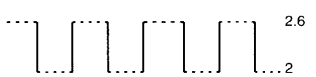
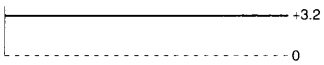
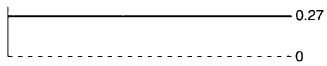
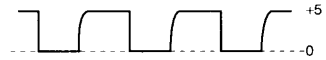
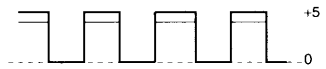
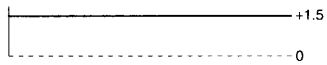
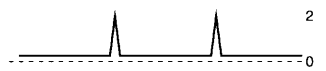
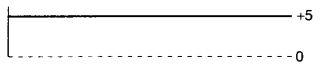
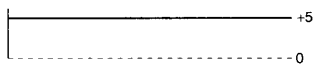


Figure 7.7 ADC N2302

Table 7.9 Signals measured on ADC N2302

Logic 0=0V Logic 1=+5V

Comp	Name Circ/IC	Scope	Freq.	Data H/L/A	Description
1	D1		500 kHz		Data output bit no.1
2	D0		500 kHz		Data output bit no.0
3	AGND		0		
4	VRB		0		
5	DEC		0		
6	NC		0		Not Connected
7	VCCa		0		
8	IN		LF: sq. 10 kHz HF: sq. 500 kHz		
9	VRT		0		

Comp	Name Circ/IC	Scope	Freq.	Data H/L/A	Description
10	NC		0		Not Connected
11	O/UFL		0		Not Connected
12	D7		10 kHz		Data output bit no.7
13	D6		HF: 500 kHz LF: instable		Data output bit no.6
14	D5		10 kHz		Data output bit no.5,
15	D4		10 kHz		Data output bit no.4,
16	CL		0		
17	CLN		1 MHz		
18	VCCD		0		
19	VCCO		0		
20	DGND		0		
21	OCTN		0		
22	CEN		0		
23	D3		500 kHz		Data output bit no.3
24	D2		500 kHz		Data output bit no.2

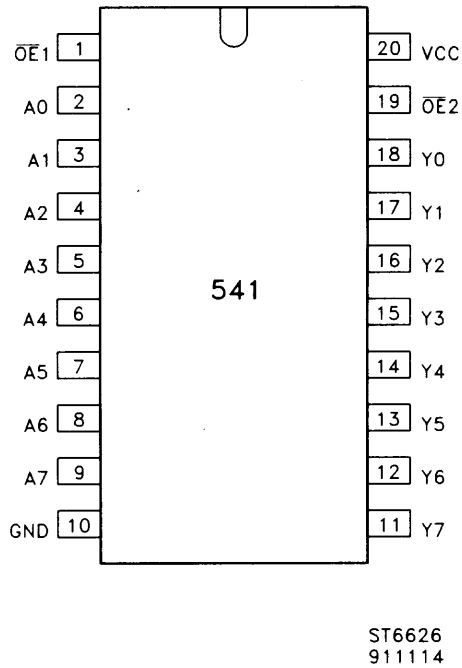


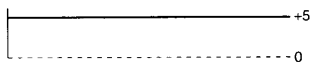
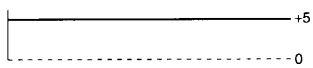
Figure 7.8 Buffer/drivers D2901/D2902/D2903

Table 7.10 Signals measured on buffer/driver D2901

Logic 0=0V Logic 1=+5V

Comp	Name Circ/IC	Scope	Freq.	Data H/L/A	Description
1	Ex	+5V / 0	*		Control signal
2	Sg4b	+5 / 0	*		Input no.1
3	Sg4b	+5 / 0	*		Input no.2
4	Sg5b		*		Input no.3
5	Sg5b		*		Input no.4
6	Sg6b	+5 / 0	*		Input no.5
7	Sg6b	+5 / 0	*		Input no.6
8	So10b		*		Input no.7
9	So10b		*		Input no.8
10	GND		0		Ground

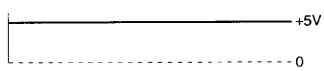
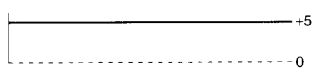
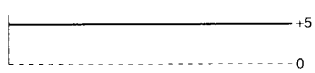
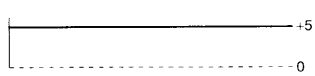
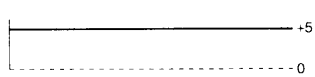
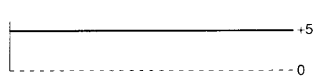
* PULSES DURING AUTOSET

Comp	Name Circ/IC	Scope	Freq.	Data H/L/A	Description
11	TP904		*		Output no.8
12	TP904		*		Output no.7
13	TP903		*		Output no.6
14	TP903		*		Output no.5
15	TP902		*		Output no.4
16	TP902		*		Output no.3
17	TP901		*		Output no.2
18	TP901		*		Output no.1
19	Ex		*		Control signal
20	Vcc		0		Power supply

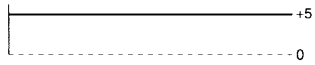
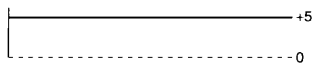
* PULSES DURING AUTOSET

Table 7.11 Signals measured on buffer/driver D2902

Logic 0=0V Logic 1=+5V

Comp	Name Circc/IC	Scope	Freq.	Data H/L/A	Description
1	Ey		*		Control signal
2	Sg4b		*		Input no.1
3	Sg4b		*		Input no.2
4	Sg5b		*		Input no.3
5	Sg5b		*		Input no.4
6	Sg6b		*		Input no.5
7	Sg6b		*		Input no.6
8	So11b		*		Input no.7

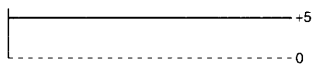
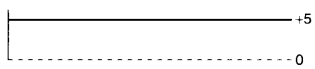
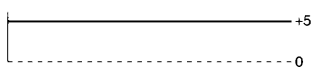
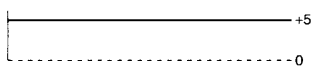
* PULSES DURING AUTOSET

Comp	Name Circ/IC	Scope	Freq.	Data H/L/A	Description
9	So11b		*		Input no.8
10	Gnd		0		Ground
11	TP909		*		Output no.8
12	TP909		*		Output no.7
13	TP908		*		Output no.6
14	TP908		*		Output no.5
15	TP907		*		Output no.4
16	TP907		*		Output no.3
17	TP906		*		Output no.2
18	TP906		*		Output no.1
19	Ey		*		Control signal
20	Vcc		0		Power supply

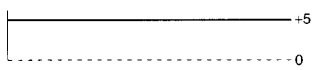
* PULSES DURING AUTOSET

Table 7.12 Signals measured on buffer/driver D2903

Logic 0=0V Logic 1=+5V

Comp	Name Circ/IC	Scope	Freq.	Data H/L/A	Description
1	Ey		*		Control signal
2	Sg4a		*		Input no.1
3	Sg4a		*		Input no.2
4	Sg5a		*		Input no.3
5	Sg5a		*		Input no.4
6	Sg6a		*		Input no.5

* PULSES DURING AUTOSET

Comp	Name Circ/IC	Scope	Freq.	Data H/L/A	Description
7	Sg6a		*		Input no.6
8	Sc16		*		Input no.7
9	Sc16		0		Input no.8
10	Gnd		*		Ground
11	TP914		*		Output no.8
12	TP914		*		Output no.7
13			*		Not connected
14			*		Not connnected
15	TP912		*		Output no.4
16	TP912		*		Output no.3
17	TP911		**		Output no.2
18	TP911		**		Output no.1
19	Ey		0		Control signal
20	Vcc		0		Power supply

* PULSES DURING AUTOSET
** SPIKES DURING AUTOSET

7.2 REPLACEMENTS

7.2.1 Standard parts

Electrical and mechanical parts replacements can be obtained through your local FLUKE/PHILIPS organization or representative. However, many generic electronic components can be obtained from other sources. Before purchasing or ordering replacement parts, check the parts list for value, tolerance, rating, and description.

NOTE: Physical size and shape of a component may affect instrument performance, particularly at high frequencies. Always use direct-replacement components, unless it is known that a substitute will not degrade the instrument's performance.

7.2.2 Special parts

In addition to the standard electronic components, some special components are used:

- Components, custom manufactured or selected by FLUKE/PHILIPS to meet specific performance requirements.
- Components that are important for the safety of personnel.

NOTE: Both type of components may only be replaced by components obtained through your local FLUKE/PHILIPS organization or representative.

7.2.3 Transistors and integrated circuits

Some notes on handling these components:

- Do not replace or swap semiconductor devices unnecessarily, because the change may affect the calibration of the instrument.
- When a device has been replaced, check the circuit that may be affected for proper operation. See also the Performance Verification Procedure in chapter 4.

7.2.4 Static-sensitive components

In the ScopeMeter the black/yellow "static-sensitive components" symbol is present (see also figure 7.4). This means that this instrument contains electrical components that can be damaged by electrostatical discharge. Although all MOS integrated circuits incorporate protection against electrostatic discharge, they nevertheless can be damaged by accidental overvoltages.

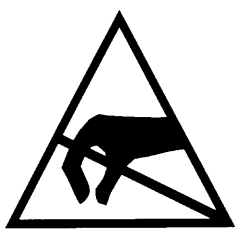


Figure 7.9 Static-sensitive symbol (black/yellow)

It is also possible that a delayed failure or "winding" effect may occur. When this happens, the component will fail anywhere between two hours to six months later.

When storing and handling static-sensitive components, the normal precautions for these devices are recommended. Handling and servicing static-sensitive assemblies and components should be done only at a static free workstation by qualified personnel.

CAUTION: Testing, handling, and mounting call for special attention. Personnel handling static-sensitive devices should normally be connected to ground via a high-ohmic resistor.

7.2.5 Replacement of parts

7.2.5.1 Replacing parts in the battery compartment

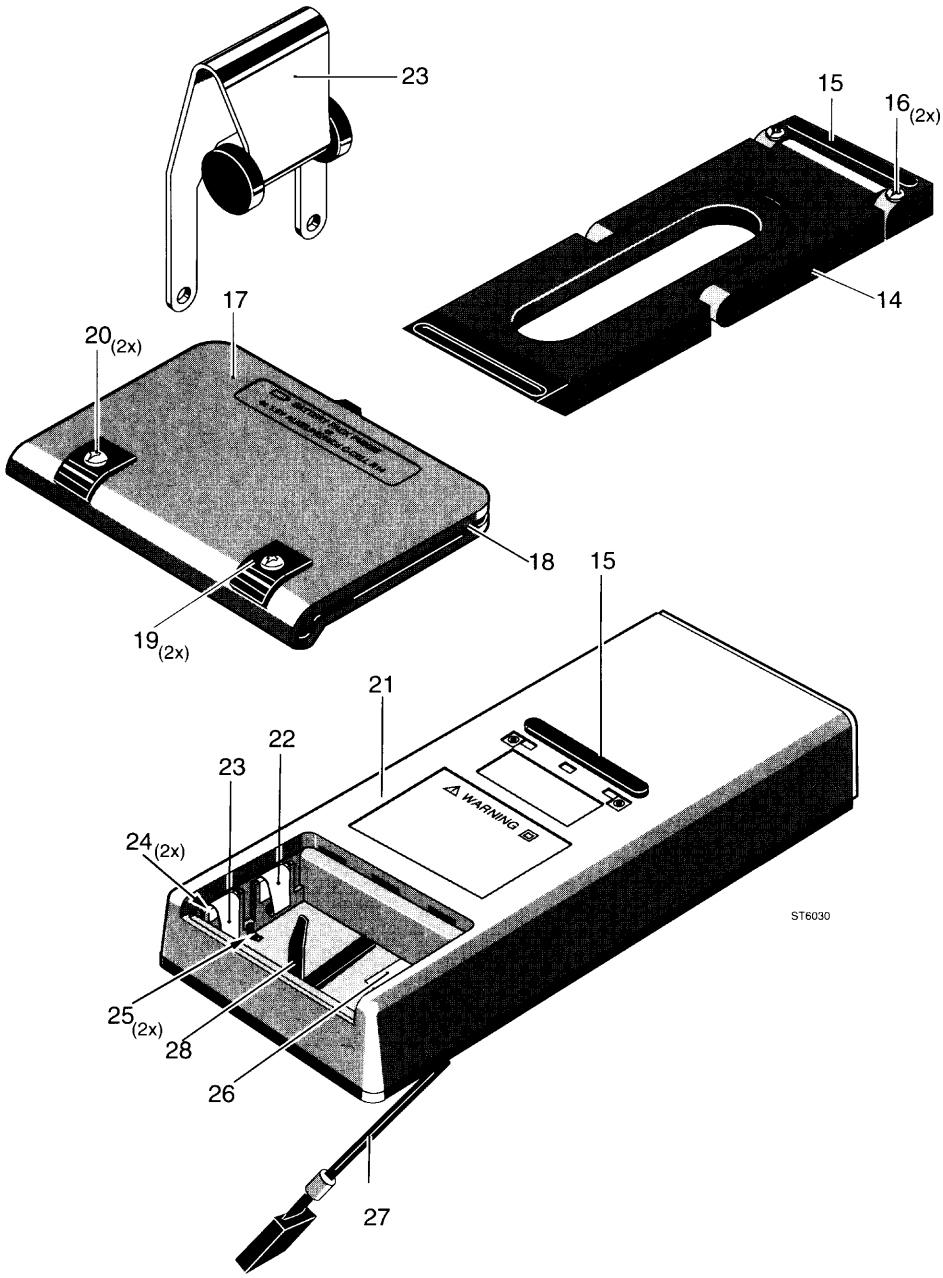


Figure 7.10 Replacing parts in battery compartment

Referring to figure 7.10, use the following procedure for replacements in the battery compartment.

Battery cover assembly replacement

1. The battery cover (item 17) is secured to the ScopeMeter with two black M3 Torx screws (item 20). Use a Torx screwdriver to loosen the two screws (do not remove them) from the battery cover.

2. Lift the battery cover from the ScopeMeter.

3. Reinstall the new battery cover.

Battery-cover Gasket replacement

1. Remove the battery cover (item 17).
2. Use a pair of tweezers to pull the elastic gasket (item 18) from the battery cover.
3. Mount the new elastic gasket on the battery cover.

NOTE: Take care that the gasket is not damaged. A correctly fitted gasket assures the sealing of the ScopeMeter.

Battery cover Torx screws and Feet replacement

1. Remove the battery cover.
2. The black M3 Torx screws are of a captured type (item 20). Remove screws by unscrewing them with a Torx screwdriver. Add a little pressure with another small screwdriver at the back of the screw.

NOTE: Do not force the screws by pressing them in or out. The screw action is vital for the captured screws.

3. Pull the two rubber feet (item 19) from the battery cover.
4. Push the new rubber feet onto the battery cover.
5. Reinstall the (new) black M3 Torx screws into the battery cover.

7.2.5.2 Replacing parts on front cover

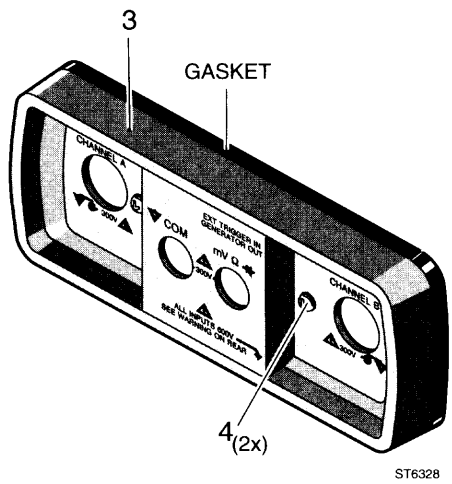


Figure 7.11 Replacing parts on front cover

Referring to figure 7.11, use the following procedure for replacements on the front cover.

Front cover assembly replacement

1. The front cover is secured to the ScopeMeter with two black M3 Torx screws (item 4). Use a Torx screwdriver to loosen the two screws (do not remove them) from the front cover.

2. Lift the front cover assembly (item 3) from the ScopeMeter.

NOTE: The gasket between the front cover and the two case halves is sealed to, and must remain with, the front cover. The front cover lifts away easily. Do not damage the gasket and do not separate the front cover from the gasket. A correctly fitted gasket assures the sealing of the ScopeMeter.

3. Reinstall the new front cover.

Front cover Torx screw replacement

1. Remove the front cover.

2. The two black M3 Torx screws (item 4) are captured type screws. Remove screws by unscrewing them with a Torx screwdriver. Add a little pressure with another small screwdriver at the back of the screw.

NOTE: Do not force the screws by pressing them in or out. The screw action is vital for the captured screws.

3. Reinstall the new Torx screws into the front cover.

7.2.5.3 Replacing parts on bottom cover

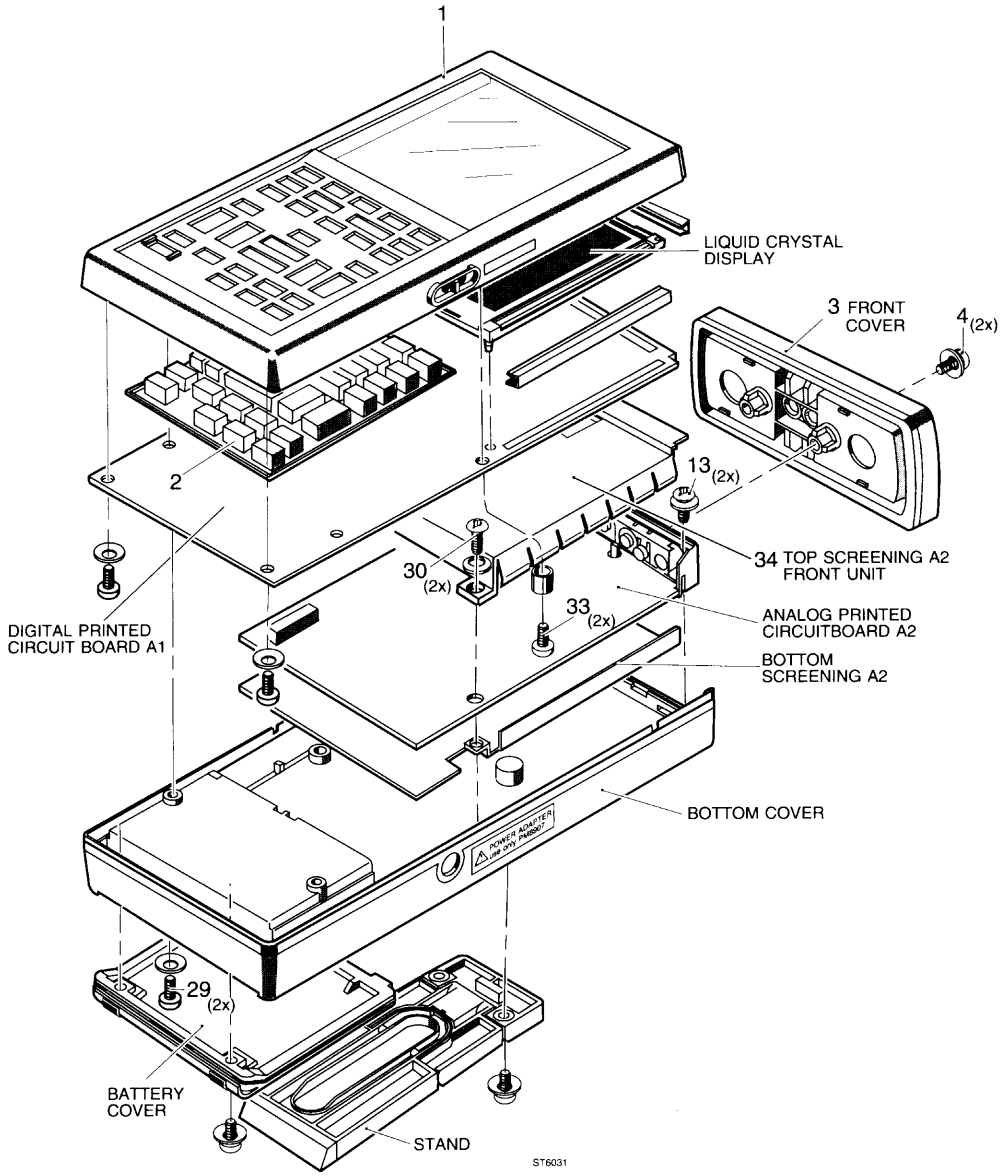


Figure 7.12 Bottom cover replacements

Referring to figure 7.12, use the following procedure for replacements in the bottom cover.

Bottom cover assembly replacements

1. First remove the battery cover assembly (see Section 7.2.5.1.)

2. The bottom cover is secured to the top cover by two M3 Torx screws (item 29) that are accessible in the battery compartment. Use a Torx screwdriver to remove the two screws.

3. Lift the bottom cover a little from the top cover and unfold the ScopeMeter.

NOTE: A flat cable is used for interconnection between the bottom cover with the analog A1 PCB and the digital A2 PCB. To remove the flat cable, refer to Section 6.2.4. The gasket between the two case halves is sealed to, and must remain with, the lower case half. The upper case half lifts away easily. Do not damage the gasket and do not separate the lower case half from the gasket. A correctly fitted gasket assures the sealing of the ScopeMeter.

4. The analog A2 PCB and top screening are secured to the bottom cover by two M3 Torx screws (item 30). Use a Torx screwdriver to remove the two screws.

5. Carefully lift the metal top screening, while pulling it backwards.

6. Pull the battery wiring plug (item 27) out of the connector on the analog A2 PCB.

7. Use a Torx screwdriver to loosen the two black screws (item 13). Do not remove them from the input unit assembly. Now the analog A2 PCB can be lifted out of the bottom cover assembly.

8. Fold the analog A2 PCB back on the digital A1 PCB in the top cover.

9. Lift the bottom cover screening out of the bottom cover assembly.

10. Reinstall the new bottom cover assembly.

Battery wiring assembly replacement

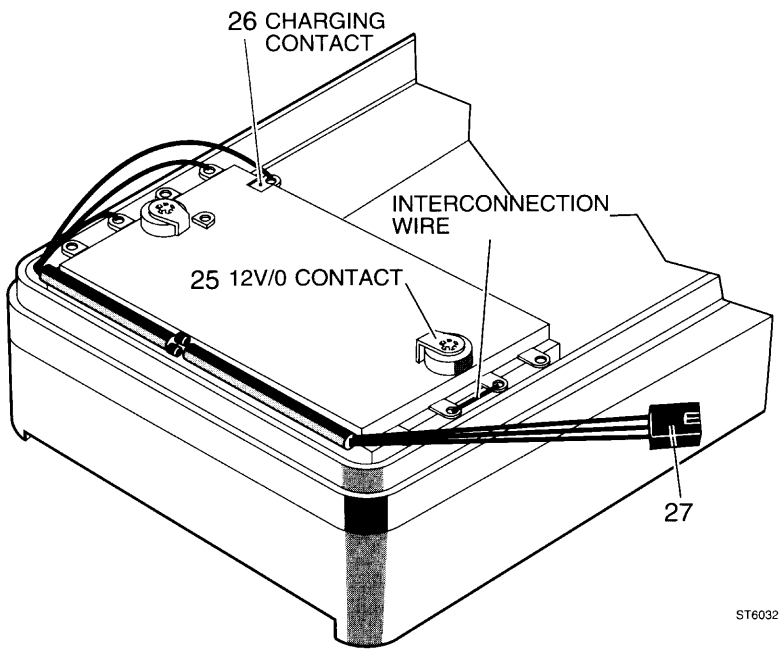


Figure 7.13 Wiring assembly replacement

Referring to figures 7.10 and 7.13, use the following procedure for replacing the battery wiring and battery contacts.

1. First remove the bottom cover assembly.

2. Unsolder the battery wiring assembly (item 27) from the battery compartment.

3. Reinstall the new battery wiring assembly.

Battery contacts replacement

1. First remove the bottom cover assembly.

2. Remove the battery wiring assembly.

3. Unsolder the small battery contact interconnection wire (see figure 7.13).

4. Bend the solder tags of the battery contacts (figure 7.10, item 23) in the bottom cover in such way that the contacts can be pulled out of the battery compartment.

5. Pull the battery contacts (figure 7.5, items 22 and 23) and the black buffers (figure 7.10, item 24) out of the battery compartment with a pair of tweezers.

NOTE: The extra black plastic buffers in two battery contacts (see figure 7.10, item 23) prevent erroneous charging of the battery. Mount these battery contacts in the correct position!

6. Reinstall the new battery contacts.

Battery charging contact and +12V/0 contact replacement

1. First remove the bottom cover assembly.

2. Remove the battery wiring assembly.

3. Bend the solder lugs of the contacts (figure 7.10, items 25 and 26) in the bottom cover so that the contacts can be pulled from the battery compartment.

4. Pull the contacts from the battery compartment.

5. Reinstall the new charging contact and/or the new +12V/0 contacts.

7.2.5.4 Stand replacement

Referring to figure 7.10, use the following procedure for stand replacement.

Stand assembly replacement

1. The stand is secured to the ScopeMeter with two black M3 Torx screws (figure 7.10, item 16). Use a Torx screwdriver to loosen the two screws.

2. Lift the stand from the ScopeMeter.

3. Reinstall the new stand.

Stand Torx screw replacement

1. Remove the stand assembly (figure 7.10, item 15).

2. The black M3 Torx screws are of a captured type (item 16).Remove screws by unscrewing them with a Torx screwdriver. Add a little pressure with another small screwdriver at the back of the screw.

NOTE: Do not force the screws by pressing them in or out. The screw action is vital for the captured screws.

3. Reinstall the new Torx screws.

7.2.5.5 30-pole flat cable replacement

Refer to Section 6.2.4. of this Service Manual for instructions on how to replace the 30-pole flat cable.

7.2.5.6 Input unit assembly replacement

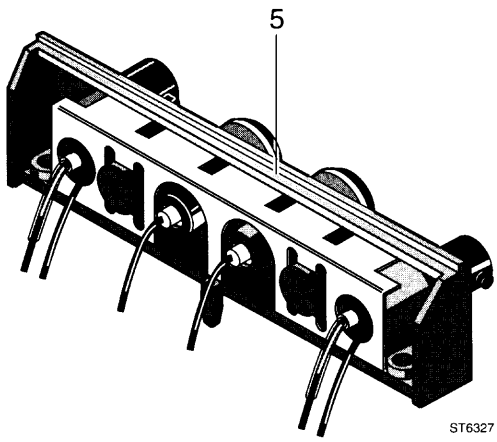


Figure 7.14 Input unit assembly

Referring to figure 7.14, use the following procedure for input unit assembly replacement.

1. Remove the front cover assembly.
2. Disassemble the bottom cover assembly.
3. Remove the 30-pole flat cable.
4. Unsolder the wiring (6x) of the input terminals from the analog A2 PCB.
5. The input unit assembly is clamped onto the analog A2 PCB. Loosen these clamps and pull the input unit assembly from the analog A2 PCB.

NOTE: The white gaskets on the input terminals (4x) are sealed to, and must remain with the input unit assembly. Do not damage the gaskets and do not separate them from the input unit assembly. Correctly fitted gaskets assure the sealing of the ScopeMeter.

6. Reinstall the front unit assembly.

7.2.5.7 Top cover assembly replacement

Referring to figure 7.12, use the following procedure for top cover assembly replacement.

1. Remove the bottom cover assembly.
2. Remove the 30-pole flat cable.
3. The digital A1 PCB and metal screening are secured to the top cover with four M3 Torx screws (item 33). Two of these screws contain standoffs. be sure to put them on the right place again. Use a Torx screwdriver to remove the screws.
4. Remove the metal A1 screening from the digital A1 PCB.
5. Lift the digital A1 PCB out of the top cover. Be careful not to damage the infrared LED and phototransistor of the optical interface.

NOTE: The gasket between the two Optical RS-232-C Interface LEDs on the digital A1 PCB and front cover must remain with the LEDs. The top cover lifts away easily. Do not damage the gasket. A correctly fitted gasket assures the sealing of the ScopeMeter.

6. Lift the keypad from the top cover (item 2).

7. Reinstall the new top cover (item 1).

7.2.5.8 Keypad replacement

1. Remove the bottom cover assembly.

2. Remove the 30-pole flat cable.

3. Disassemble the top cover assembly.

4. Lift the keypad from the top cover (item 2).

5. Reinstall the new keypad.

7.2.5.9 Liquid crystal display (LCD), contact strips and backlight foil (Model 97 only) replacement

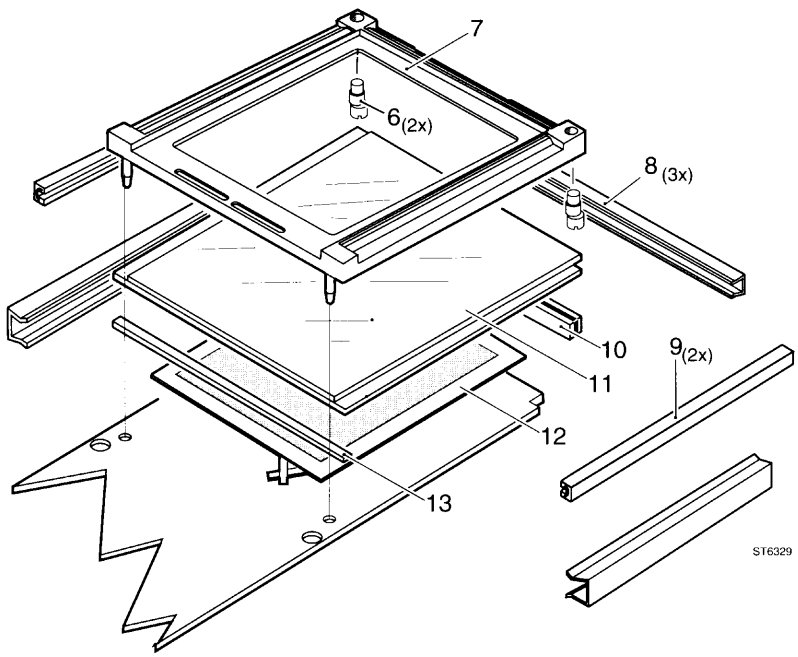


Figure 7.15 LCD replacement

Referring to figure 7.15, use the following procedure for LCD replacement.

1. Remove the bottom cover assembly.

2. Remove the 30-pole flat cable.

3. Disassemble the top cover assembly.

NOTE: Oils or dirt from the hands are ennemies of the LCD contact strips used in the LCD assembly. Whenever handling these strips, it is advised that tweezers be used so as not to contaminate them. Care should also be taken when handling the front panel lens or LCD glass. Dirt or finger prints on these parts will be visible to the user and may impair the readability of the display.

4. Pull the three metal clamps from the display (item 8).
5. Lift the LCD complete in its frame from the digital A1 PCB.
6. Push the LCD including the LCD contact strips out of the display frame.
7. Take the two display adjustment screws (item 6) out of the display frame.
8. Lift the top "I" LCD contact strip (item 10) from the display.
9. Pull the left and right "L" LCD contact strips (item 9) from the display.
10. (MODEL 97 ONLY)
    The backlight foil (item 12) is glued to the reflective LCD (Model 97 only). The backlight foil has two contact legs that make contact with two large rectangle spots on the digital A1 PCB. Refer to the NOTE below.
11. Pull the backlight foil from the display.
12. Reinstall the LCD rubber filling part (item 13) and the back light foil.
13. Reinstall the two "L" LCD contact strips.
14. Reinstall the display with "L" LCD contact strips in the display frame.
15. Reinstall the "I" LCD contact strips on the display.
16. Reinstall the two display adjustment screws.
17. Reinstall the frame with the display assembly on the digital A1 PCB.
18. Reinstall the three metal clamps.
19. Reinstall the digital A1 PCB and top cover.

NOTE: BACKLIGHT CONTACT LEGS

If a backlight foil is installed on a digital A1 PCB revision level 9 or lower, the backlight contact legs must cross each other, as shown in Figure 7.16. Bend the ends of the contact legs slightly to ensure a good connection with the spots on the printed circuit board.

If the digital A1 PCB revision level is 10 or higher, the contact legs need not to cross each other.

Refer to Section 11 for revision level information.

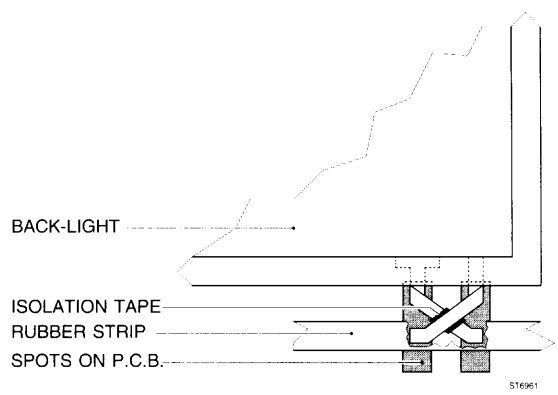


Figure 7.16 Crossed backlight contact legs

7.3 SOLDERING TECHNIQUES

7.3.1 General soldering techniques

Method:

- Carefully unsolder the soldering leads of the semiconductor one after the other.
- Remove all superfluous soldering material. Use desoldering wick, ordering code: 4822 321 40042.
- Verify that the leads of the replacement part are clean and have pre-tinned leads.
- Place the replacement semiconductor exactly in the same position, and solder each lead to the relevant printed circuit padon the PCB.

NOTE: The maximum permissible soldering time is 10 seconds during which the temperature of the leads must not exceed 250C. The use of solder with a low melting point is recommended. Take care not to damage the plastic encapsulation of the semiconductor (softening point of the plastic is 150C).

CAUTION: When you are soldering inside the instrument it is essential to use a low voltage soldering iron, the tip of which must be connected to the ground of the ScopeMeter.

A suitable soldering iron is:

- Mini soldering iron station, WECP-COD3 (regulated transformer) and Weller LR-20 (soldering iron).

Ordinary 60/40 tin/lead solder with flux core and a 35W to 40W pencil- type soldering iron can be used to do most of the soldering. If a higher wattage soldering iron is used on the circuit PCB, excessive heat may cause the circuit wiring to separate from the PCB base material.

7.3.2 Soldering micro-miniature semiconductors

Because of the small dimensions of these SOT semiconductors and the lack of space between the components on the PCB, it is necessary to use a miniature soldering iron with a pinpoint tip (max. diameter 1 mm.) to solder a SOT onto a PCB.

Suitable soldering tools are:

- Mini soldering iron station, WECP-COD3 (regulated transformer) and Weller MLR-20 (mini soldering iron).
- A hot-air solder tool: Leister Hot-Jet

Next, the following materials are recommended:

- Soldering tin, diameter 0.8 mm., SnPb 60/40 with a Resin Mildly Activated (RMA) flux. Ordering code: 4822 390 80133.
- Desolder braided wire. Ordering code 4822 321 40042.
- Solder paste 26.
- Non-corrosive and Resin Mildly Activated (RMA) flux-Colophony. Ordering code: 4822 390 50025.

Refer to the **Support Bulletin OSC 296 (ordering code 4822 872 08407)** for a complete discussion of the soldering techniques for SMD's.

7.4 SPECIAL TOOLS

7.4.1 Extender flat cable.

For diagnostic testing and troubleshooting, a 30-pole 50 cm extender flat cable can be used. Using this extender flat cable makes it easier to separate the two units A1 and A2 without breaking the interconnection.

The ordering code for the extender flat cable is: 5322 321 61369.

7.5 RECALIBRATION AFTER REPAIR

After any electrical component has been replaced the performance of that particular circuit should be checked, as well as the performance of other closely-related circuits. If necessary a recalibration must be performed. Since the power supply influences all circuits, the performance of the entire instrument should be verified if work has been done in the power supply or if the transformer has been replaced. If necessary a recalibration must be done. If parts of the attenuator circuits and/or the Analog ASIC have been replaced, it might be necessary to do Hardware SCOPE Calibration Adjustments. Refer to section 5.6.1 of this Service Manual.

7.6 INSTRUMENT REPACKING

If the ScopeMeter is to be reshipped to a Service Centre for service or repair, attach a tag showing the full address and the name of the individual at the users firm that can be contacted.

The Service Centre needs the complete ScopeMeter, **including the RED and the GREY scope probe**, its serial number, and a complete description of the problem and the work that is to be done. If the original container is not available, repack the instrument so that no damage occurs during transport.

8 MAINTENANCE OF THE PRIMARY CIRCUIT (PM8907/...)

The ScopeMeter itself has no primary (mains) power supply.
The instrument is powered with a separate **Power adapter/battery charger PM8907/...**, in which the primary power supply is located. The PM8907/... is non-repairable. It can be ordered at your nearest Fluke/Philips Service Center.

Table 8.1 Power adapter/battery charger survey.

Typenumber	Description
PM8907/001	Universal Europe 220V, 50 Hz
PM8907/003	North American UL, CSA, 110V, 60 Hz
PM8907/004	United Kingdom 240V, 50 Hz
PM8907/008	Universal 115V / 230V

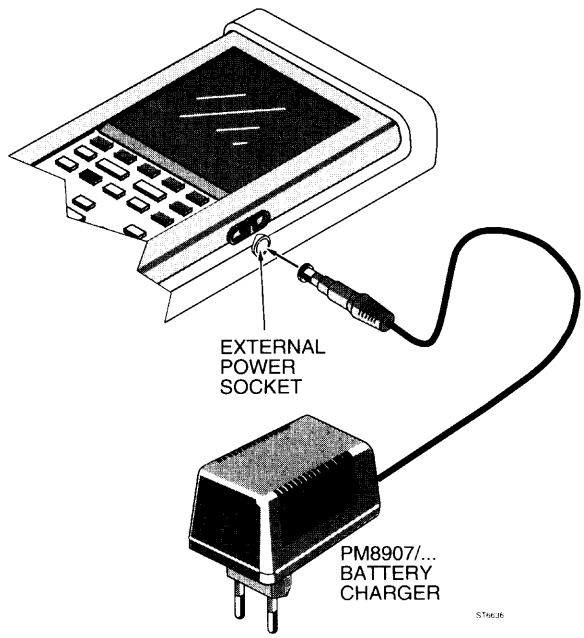


Figure 8.1 ScopeMeter Power Adapter/battery Charger PM8907/....

9 REPLACEABLE PARTS LIST

9.1 INTRODUCTION

The replaceable parts section provides illustrated parts lists for the ScopeMeter models Philips PM93/PM95/PM97 and Fluke 93/95/97.

The mechanical parts are listed numerically by assembly. The electrical parts on the printed circuit boards A1 and A2 are listed alphanumerically by assembly. Each part is shown in an accompanying illustration.

The parts lists provide the following information for each part:

- Item number
- Figure number
- Description
- Ordering code
- Total quantity of components per assembly
- A revision level nn, indicating that a part has been changed. Refer to the revision level overview of the involved PCB in Section 11.

9.2 HOW TO OBTAIN PARTS

For Philips Export B.V.:

Contact your local Philips Sales and Service representative. The addresses and telephone numbers are listed in this manual at the end of section 11: "Sales & Service all over the world".

For the John Fluke Mfg. Co., Inc.:

Contact your local Fluke authorized representative. In the U.S. order directly from the Fluke Parts Dept. by calling 1- 800-526-4731.

To ensure prompt and efficient handling of your order, include the following information:

1. Model number (PM xx), (Fluke xx), Code number (9444 ... .) and Serial number (DM.....). The items are printed on the type plate on the bottom cover.
2. Ordering code
3. Item number
4. Description
5. Quantity

Table 9.1 ScopeMeter final assembly. (See figure 9.1)

When servicing the ScopeMeter, use only the replacement parts specified.

Item	Figure	Description	Ordering code	Qty
1	9.1	Top cover assembly PM93	5322 447 70108	1
1	9.1	Top cover assembly PM95	5322 447 70109	1
1	9.1	Top cover assembly PM97	5322 447 70104	1
1	9.1	Top cover assembly 93	5322 447 70105	1
1	9.1	Top cover assembly 95	5322 447 70111	1
1	9.1	Top cover assembly 97	5322 447 70115	1
2	9.1	Keypad PM93/93	5322 218 61461	1
2	9.1	Keypad PM95/95	5322 218 61459	1
2	9.1	Keypad PM97/97	5322 218 61457	1
29	9.1	Bottom cover torx-screw blank M3	5322 502 13772	2
30	9.1	Board A2 torx-screw blank M3	5322 502 13772	2
31	9.1	Input unit torx-screw blank M3	5322 502 13772	2
32	9.1	30-pole flat cable	5322 321 61238	1
-	-	30-pole extender flat cable for repair purposes	5322 321 61369	1
33	9.1	Top cover torx-screw blank M3	5322 502 13772	2
34	9.1	Top screening A2 front unit	5322 447 70129	1

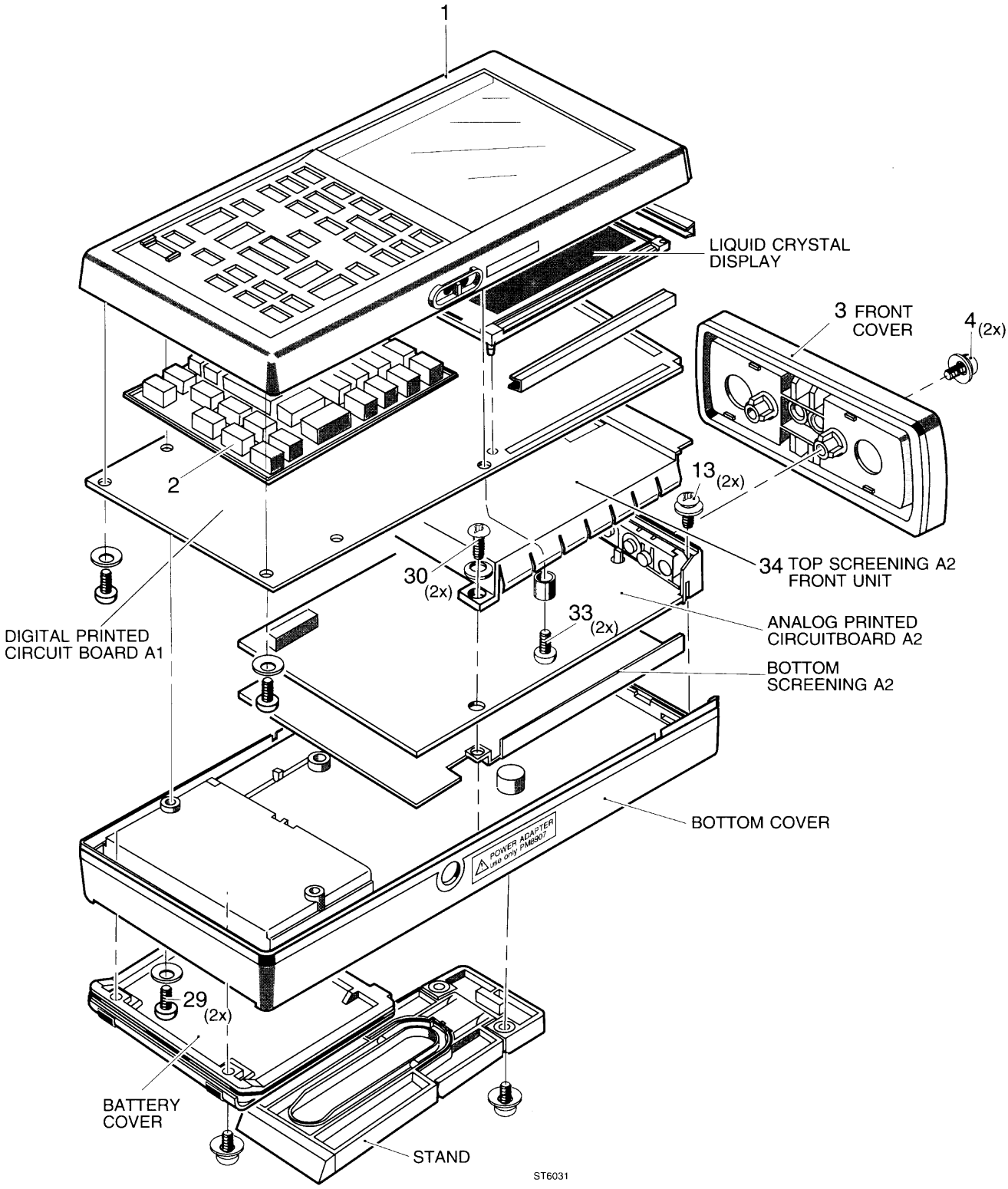
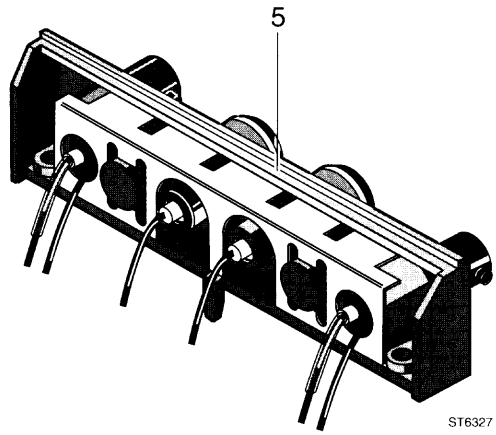


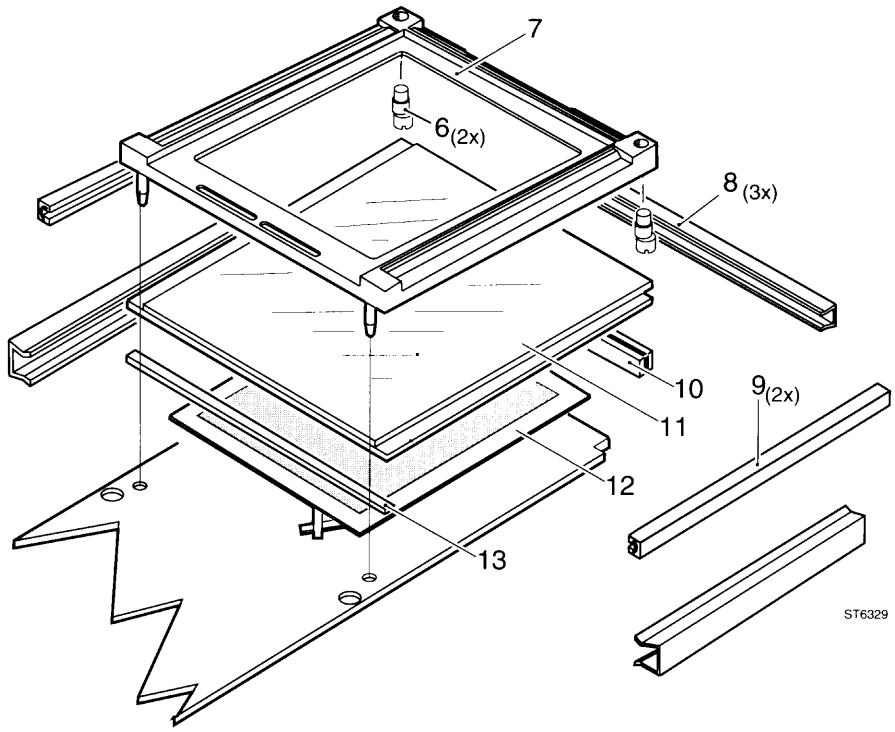
Figure 9.1 ScopeMeter final assembly

Table 9.2 Front cover assembly (See figure 9.2)
Input unit assembly
Display asssembly

When servicing the ScopeMeter, use only the replacement parts specified.

Item	Figure	Description	Ordering code	Qty
3	9.2	Front cover assembly	5322 447 70112	1
4	9.2	Torx screw black M3	5322 502 13771	2
5	9.2	Input unit assembly	5322 218 61462	1
6	9.2	LCD adjust screw	5322 535 93237	2
7	9.2	LCD frame	5322 255 41246	1
8	9.2	LCD clamps	5322 401 11411	3
9	9.2	LCD contact strip L-shape	5322 466 62048	2
10	9.2	LCD contact strip I-shape	5322 268 90443	1
11	9.2	Display reflective PM93/93 PM95/95	5322 130 90991	1
11	9.2	Display transflective PM97/97	5322 130 91054	1
12	9.2	Backlight foil	5322 466 62052	1
13	9.2	LCD rubber filling part	5322 466 62049	1





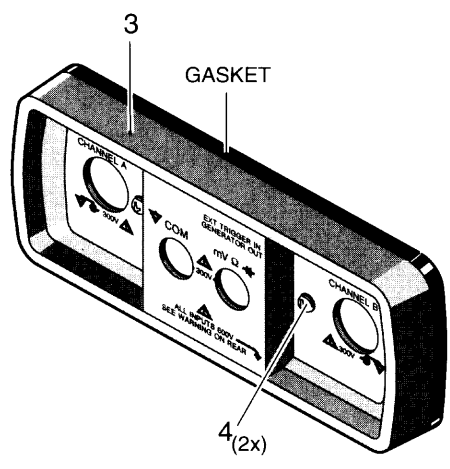


Figure 9.2 Front cover assembly
Display assembly
Input assembly

Table 9.3 Battery contact assembly. (See figure 9.3)
Stand assembly
Battery cover assembly
Bottom cover assembly

When servicing the ScopeMeter, use only the replacement parts specified.

Item	Figure	Description	Ordering code	Qty
14	9.3	Stand assembly (item 15+16 included)	5322 456 90416	1
15	9.3	Anti slip strip	5322 466 62045	1
16	9.3	Torx screw black M3	5322 502 13771	1
17	9.3	Battery cover assembly	5322 447 70116	1
18	9.3	Gasket	5322 530 51238	1
19	9.3	Rubber foot	5322 462 41825	2
20	9.3	Torx screw black M3	5322 502 13771	2
21	9.3	Bottom cover assembly	5322 447 70113	1
22	9.3	Battery contact spring	5322 492 70908	3
23	9.3	Battery contact spring assembly	5322 492 70909	1
24	9.3	Buffer	5322 466 62047	4
25	9.3	12V/0 contact	5322 466 82843	2
26	9.3	Charging contact	5322 466 82842	1
27	9.3	Battery wiring assembly	5322 321 61237	1
28	9.3	Battery pull strip	5322 466 62046	1

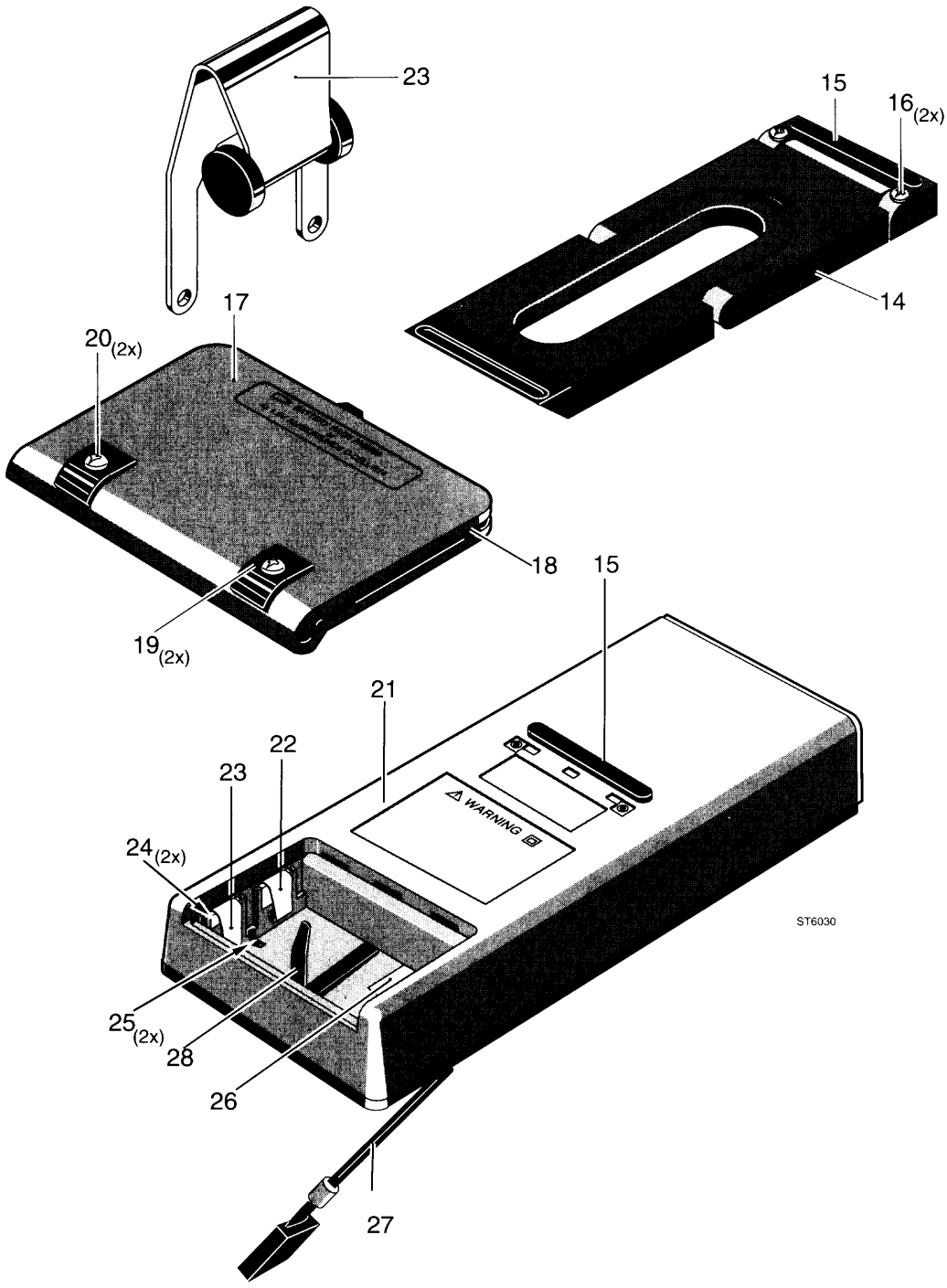


Figure 9.3 *Battery contact assembly*
Stand assembly
Battery cover assembly
Bottom assembly

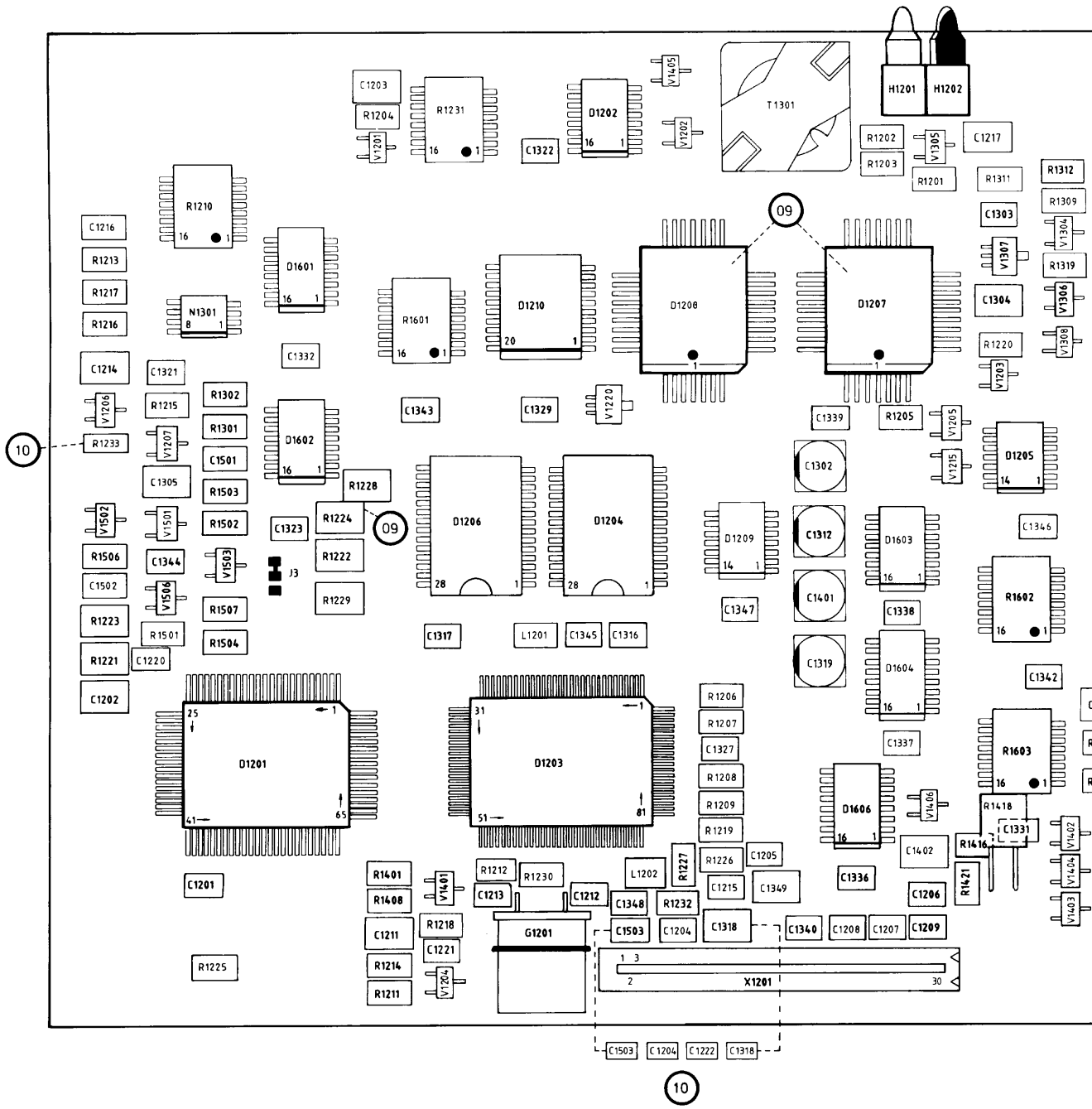
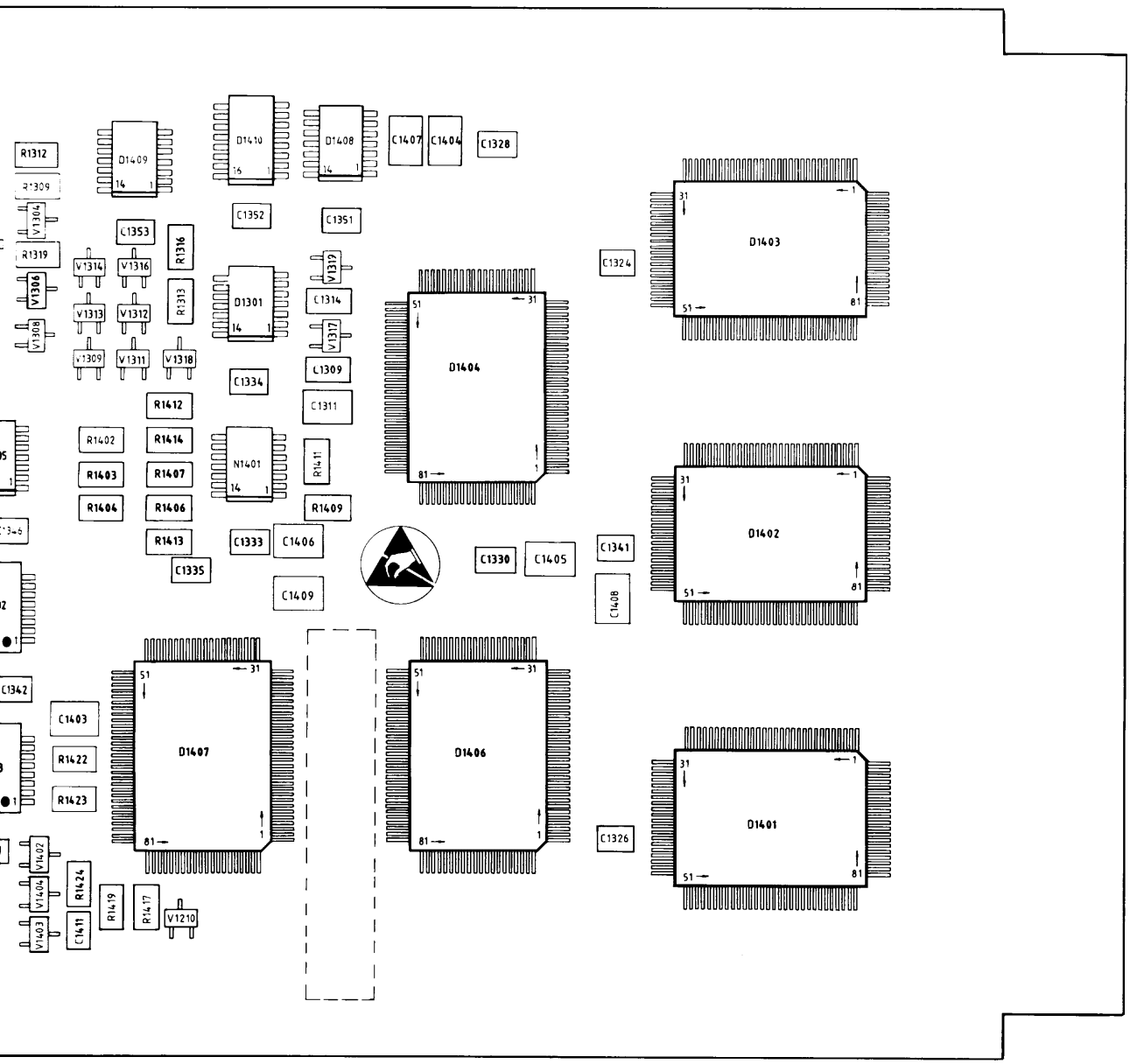

H1201
H1202
T1301
D1202
R1231
C1203
R1204
V1201
C1322
V1405
V1202
R1202
R1203
V1305
C1217
R1201
R1311
R1312
R1309
C1303
V1304
V1307
R1319
C1304
V1306
R1220
V1308
V1203
09
R1210
D1601
N1301
R1601
D1210
D1208
D1207
C1216
R1213
R1217
R1216
C1332
C1343
C1329
V1220
C1339
R1205
V1205
V1215
D1205
C1214
C1321
V1206
R1215
R1302
R1301
C1501
R1503
R1502
V1207
C1305
10
R1233
D1602
R1228
R1224
R1222
R1229
C1323
J3
D1206
D1204
C1302
C1312
C1401
C1319
D1209
C1347
D1603
C1338
C1346
R1602
V1502
R1506
C1502
R1223
R1221
C1202
V1501
C1344
V1506
R1501
C1220
V1503
R1507
R1504
C1317
L1201
C1345
C1316
D1604
C1342
C1337
R1603
D1606
V1406
R1418
C1331
V1402
R1416
C1402
V1404
R1421
C1336
C1206
V1403
D1201
D1203
R1206
R1207
C1327
R1208
R1209
R1219
R1226
C1205
C1215
C1349
R1227
C1201
R1401
R1408
C1211
R1214
R1211
V1401
R1218
C1221
V1204
R1212
R1230
C1213
C1212
L1202
C1348
R1232
G1201
C1503
C1204
C1318
C1340
C1208
C1207
C1209
X1201
R1225
C1222

Table 9.4 Digital A1 PCB assembly (figure 9.4)

When servicing the ScopeMeter, use only the replacement parts specified.

Item	Figure	Description	Ordering code	Qty
A1	9.4	Digital A1 PCB assembly PM93/93 Digital A1 PCB assembly PM95/95 Digital A1 PCB assembly PM97/97	5322 218 61463 5322 218 61464 5322 216 51275	1 1 1



ST6615
921016

Figure 9.4a Digital A1 PCB assembly

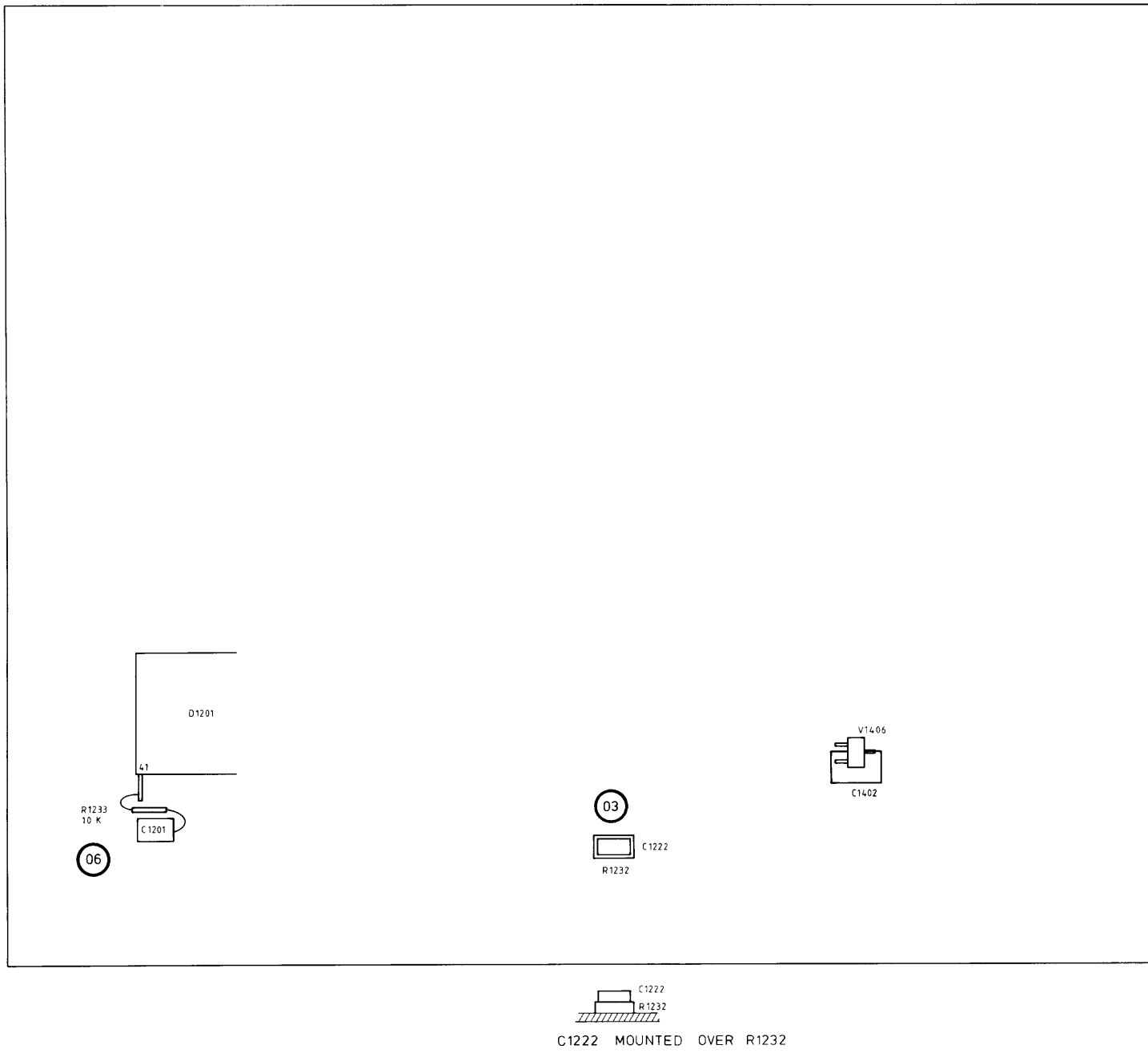
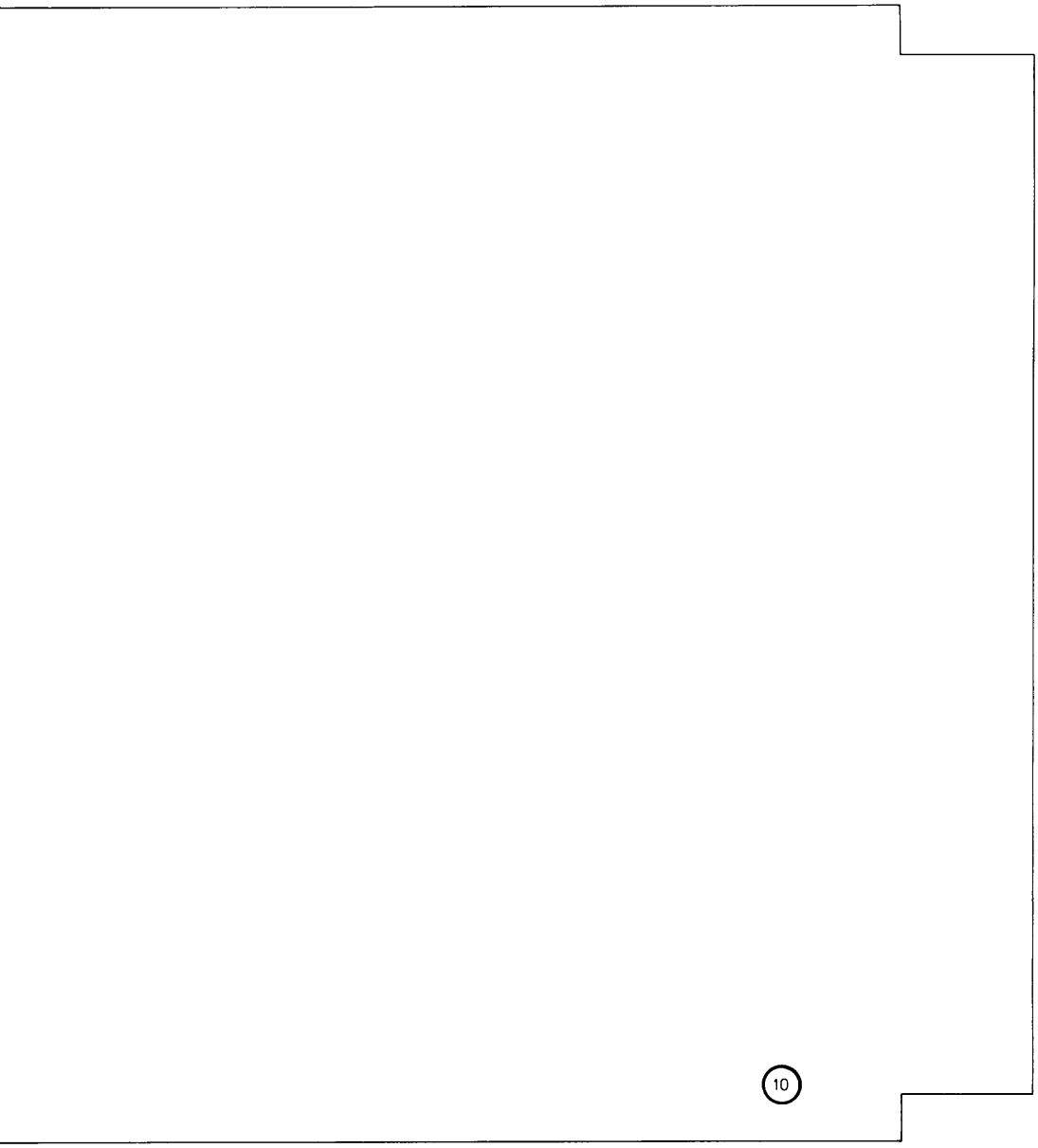


Figure 9.4b Modifications Digital A1 PCB assembly up to revision level 10



ST6849
921016

Ordering code	Description				Item	Revision level
CAPACITORS						
5322 122 34098	CAP.CHIP	63V	10%	10NF	C 1201	
5322 126 10785	CAP.CHIP	63V	10%	100NF	C 1202	
4822 122 32916	CAP.CHIP	63V	10%	220NF	C 1203	
5322 122 32654	CAP.CHIP	63V	10%	22NF	C 1204	
5322 122 33869	CAP.CHIP	63V	5%	15PF	C 1205	
5322 122 34098	CAP.CHIP	63V	10%	10NF	C 1206	
5322 122 34098	CAP.CHIP	63V	10%	10NF	C 1207	
5322 122 34098	CAP.CHIP	63V	10%	10NF	C 1208	
5322 122 34098	CAP.CHIP	63V	10%	10NF	C 1209	
4822 122 32916	CAP.CHIP	63V	10%	220NF	C 1211	
5322 122 33869	CAP.CHIP	63V	5%	15PF	C 1212	
5322 122 33869	CAP.CHIP	63V	5%	15PF	C 1213	
4822 122 32916	CAP.CHIP	63V	10%	220NF	C 1214	
5322 122 33869	CAP.CHIP	63V	5%	15PF	C 1215	
4822 122 33498	CAP.CHIP	63V	10%	2.7NF	C 1216	
4822 122 32916	CAP.CHIP	63V	10%	220NF	C 1217	
5322 126 10733	CAP.CHIP	63V	5%	680PF	C 1220	
5322 122 32448	CAP.CERAMIC	63V	5%	10PF	C 1221	
4822 126 10004	CAP.CHIP	63V	5%	120PF	C 1222	03
5322 124 42332	CAP.ELECTROLYT.	50V	20%	10UF	C 1302	
5322 122 34098	CAP.CHIP	63V	10%	10NF	C 1303	
5322 126 10785	CAP.CHIP	63V	10%	100NF	C 1304	
4822 122 32916	CAP.CHIP	63V	10%	220NF	C 1305	
4822 122 33498	CAP.CHIP	63V	10%	2.7NF	C 1309	
5322 126 10785	CAP.CHIP	63V	10%	100NF	C 1311	
5322 124 42331	CAP.ELECTROLYT.	6.3V	20%	100UF	C 1312	
5322 122 34098	CAP.CHIP	63V	10%	10NF	C 1316	
5322 122 34098	CAP.CHIP	63V	10%	10NF	C 1317	
4822 122 32916	CAP.CHIP	63V	10%	220NF	C 1318	
5322 124 42332	CAP.ELECTROLYT.	50V	20%	10UF	C 1319	
5322 122 34098	CAP.CHIP	63V	10%	10NF	C 1321	
5322 122 34098	CAP.CHIP	63V	10%	10NF	C 1322	
5322 122 34098	CAP.CHIP	63V	10%	10NF	C 1323	
5322 122 34098	CAP.CHIP	63V	10%	10NF	C 1324	
5322 122 34098	CAP.CHIP	63V	10%	10NF	C 1326	
5322 122 34098	CAP.CHIP	63V	10%	10NF	C 1327	
5322 122 34098	CAP.CHIP	63V	10%	10NF	C 1328	
5322 122 34098	CAP.CHIP	63V	10%	10NF	C 1329	
5322 122 34098	CAP.CHIP	63V	10%	10NF	C 1330	
5322 122 34098	CAP.CHIP	63V	10%	10NF	C 1332	
5322 122 34098	CAP.CHIP	63V	10%	10NF	C 1333	
5322 122 34098	CAP.CHIP	63V	10%	10NF	C 1334	
5322 122 34098	CAP.CHIP	63V	10%	10NF	C 1335	
5322 122 34098	CAP.CHIP	63V	10%	10NF	C 1336	
5322 122 34098	CAP.CHIP	63V	10%	10NF	C 1337	

Ordering code	Description				Item	Revision level
5322 122 34098	CAP.CHIP	63V	10%	10NF	C 1338	
5322 122 34098	CAP.CHIP	63V	10%	10NF	C 1339	
5322 122 34098	CAP.CHIP	63V	10%	10NF	C 1340	
5322 122 34098	CAP.CHIP	63V	10%	10NF	C 1341	
5322 122 34098	CAP.CHIP	63V	10%	10NF	C 1344	
5322 122 34098	CAP.CHIP	63V	10%	10NF	C 1345	
5322 122 34098	CAP.CHIP	63V	10%	10NF	C 1346	
5322 122 34098	CAP.CHIP	63V	10%	10NF	C 1347	
5322 122 34098	CAP.CHIP	63V	10%	10NF	C 1348	
4822 122 32916	CAP.CHIP	63V	10%	220NF	C 1349	
5322 122 34098	CAP.CHIP	63V	10%	10NF	C 1351	
5322 122 34098	CAP.CHIP	63V	10%	10NF	C 1352	
5322 122 34098	CAP.CHIP	63V	10%	10NF	C 1353	
5322 124 42332	CAP.ELECTROLYT.	50V	20%	10UF	C 1401	
4822 122 32916	CAP.CHIP	63V	10%	220NF	C 1402	
5322 126 10785	CAP.CHIP	63V	10%	100NF	C 1403	
4822 122 32916	CAP.CHIP	63V	10%	220NF	C 1404	
4822 122 32916	CAP.CHIP	63V	10%	220NF	C 1405	
4822 122 32916	CAP.CHIP	63V	10%	220NF	C 1406	
4822 122 32916	CAP.CHIP	63V	10%	220NF	C 1407	
4822 122 32916	CAP.CHIP	63V	10%	220NF	C 1408	
4822 122 32916	CAP.CHIP	63V	10%	220NF	C 1409	
5322 126 10733	CAP.CHIP	63V	5%	680PF	C 1411	
5322 122 34098	CAP.CHIP	63V	10%	10NF	C 1503	

RESISTORS

5322 111 91899	RES.CHIP	RMC1/8	1%	261E	R 1201	
5322 116 81226	RES.CHIP	RC-02H	1%	215E	R 1202	
4822 111 91814	RES.CHIP	RC-02H	1%	121E	R 1203	
4822 116 81165	RES.CHIP	RC-02H	1%	1M	R 1204	
4822 116 82532	RES.CHIP	RC-02H	1%	11K	R 1205	
4822 116 82532	RES.CHIP	RC-02H	1%	11K	R 1206	
4822 116 82532	RES.CHIP	RC-02H	1%	11K	R 1207	
4822 116 82532	RES.CHIP	RC-02H	1%	11K	R 1208	
5322 111 91811	RES.CHIP	RC-02H	1%	5K62	R 1209	
5322 111 91993	RES.NETWORK	002-563		56K	R 1210	
4822 116 82532	RES.CHIP	RC-02H	1%	11K	R 1211	
4822 116 81165	RES.CHIP	RC-02H	1%	1M	R 1212	
4822 116 82532	RES.CHIP	RC-02H	1%	11K	R 1213	
4822 116 82885	RES.METAL FILM	RC-02H	1%	51K1	R 1214	
5322 116 80427	RES.CHIP	RC-02H	1%	1K	R 1215	
5322 116 82904	RES.MET.GLAZED	RMC1/8	1%	464K	R 1216	
5322 116 80427	RES.CHIP	RC-02H	1%	1K	R 1217	
4822 116 82532	RES.CHIP	RC-02H	1%	11K	R 1218	
5322 116 80427	RES.CHIP	RC-02H	1%	1K	R 1219	
4822 116 82532	RES.CHIP	RC-02H	1%	11K	R 1220	
4822 116 82532	RES.CHIP	RC-02H	1%	11K	R 1221	
4822 116 82532	RES.CHIP	RC-02H	1%	11K	R 1222	

Ordering code	Description				Item	Revision level
4822 116 82532	RES.CHIP	RC-02H	1%	11K	R 1223	
4822 116 82532	RES.CHIP	RC-02H	1%	11K	R 1224	09
5322 116 80427	RES.CHIP	RC-02H	1%	1K	R 1225	
4822 116 81789	RES.CHIP	RMC1/8	1%	316E	R 1226	
5322 111 91899	RES.CHIP	RMC1/8	1%	261E	R 1227	
5322 116 80427	RES.CHIP	RC-02H	1%	1K	R 1228	
4822 111 91826	RES.CHIP	RC-02H	1%	511E	R 1229	
4822 051 56811	RES.CHIP	RC-02H	1%	681E	R 1229	07
4822 111 91814	RES.CHIP	RC-02H	1%	121E	R 1230	
5322 111 91993	RES.NETWORK	002-563		56K	R 1231	
5322 116 80427	RES.CHIP	RC-02H	1%	1K	R 1232	
4822 050 11003	RES.METAL FILM	MRS16T	1%	10K	R 1233	06, 10
5322 116 80428	RES.CHIP	RC-02H	1%	10K	R 1233	10
5322 116 82011	RES.METAL FILM	RC-02H	1%	147K	R 1301	
5322 116 80429	RES.CHIP	RC-02H	1%	100K	R 1302	
5322 116 81795	RES.CHIP	RC-02H	1%	3K48	R 1309	
5322 116 81226	RES.CHIP	RC-02H	1%	215E	R 1311	
5322 116 80428	RES.CHIP	RC-02H	1%	10K	R 1312	
4822 111 91891	RES.METAL FILM	RC-02H	1%	34K8	R 1313	
4822 111 91814	RES.CHIP	RC-02H	1%	121E	R 1314	
5322 116 81794	RES.CHIP	RC-02H	1%	2K15	R 1316	
5322 116 81226	RES.CHIP	RC-02H	1%	215E	R 1319	
4822 116 82532	RES.CHIP	RC-02H	1%	11K	R 1401	
5322 111 91811	RES.CHIP	RC-02H	1%	5K62	R 1402	
5322 111 91811	RES.CHIP	RC-02H	1%	5K62	R 1403	
4822 111 91828	RES.CHIP	RC-02H	1%	68K1	R 1404	
5322 111 91811	RES.CHIP	RC-02H	1%	5K62	R 1406	
5322 111 91811	RES.CHIP	RC-02H	1%	5K62	R 1407	
4822 111 91885	RES.CHIP	RMC1/8	1%	10E	R 1408	02
5322 111 91963	RES.CHIP	RMC1/8	1%	34E8	R 1409	
5322 111 91963	RES.CHIP	RMC1/8	1%	34E8	R 1411	
5322 111 91963	RES.CHIP	RMC1/8	1%	34E8	R 1412	
5322 111 91963	RES.CHIP	RMC1/8	1%	34E8	R 1413	
4822 111 91885	RES.CHIP	RMC1/8	1%	10E	R 1414	02
4822 116 82532	RES.CHIP	RC-02H	1%	11K	R 1416	
5322 116 82902	RES.MET.GLAZED	RMC1/8	1%	23K7	R 1417	
4822 130 90972	TEMP.SENSOR	KTY81-220			R 1418	
5322 116 81794	RES.CHIP	RC-02H	1%	2K15	R 1419	11
4822 111 91821	RES.CHIP	RC-02H	1%	2K61	R 1419	11
5322 111 91893	RES.CHIP	RMC1/8	1%	51E1	R 1421	02
4822 116 82532	RES.CHIP	RC-02H	1%	11K	R 1422	
4822 116 82889	RES.METAL FILM	RC-02H	1%	90K9	R 1423	07
4822 051 57503	RES.CHIP	RC-02H	1%	75K	R 1423	07, 08
4822 051 58253	RES.CHIP	RC-02H	1%	82K5	R 1423	08, 11
4822 051 51214	RES.CHIP	RC-02H	1%	121K	R 1423	11
5322 116 80427	RES.CHIP	RC-02H	1%	1K	R 1424	
5322 116 80429	RES.CHIP	RC-02H	1%	100K	R 1501	
5322 116 80429	RES.CHIP	RC-02H	1%	100K	R 1502	

Ordering code	Description				Item	Revision level
5322 116 80429	RES.CHIP	RC-02H	1%	100K	R 1503	
5322 116 80429	RES.CHIP	RC-02H	1%	100K	R 1504	
5322 116 80429	RES.CHIP	RC-02H	1%	100K	R 1506	
5322 116 80427	RES.CHIP	RC-02H	1%	1K	R 1507	
5322 111 91993	RES.NETWORK	002-563		56K	R 1601	
5322 111 91993	RES.NETWORK	002-563		56K	R 1602	
5322 111 91993	RES.NETWORK	002-563		56K	R 1603	

SEMI-CONDUCTORS

4822 130 42513	TRANSISTOR,CHIP	BC858C	V 1201
5322 130 32731	DIODE,CHIP	BZX84-C3V6	V 1202
4822 130 42513	TRANSISTOR,CHIP	BC858C	V 1203
4822 130 42513	TRANSISTOR,CHIP	BC858C	V 1205
5322 130 34337	DIODE,CHIP	BAV99	V 1206
5322 130 42136	TRANSISTOR,CHIP	BC848C	V 1207
5322 130 34337	DIODE,CHIP	BAV99	V 1210
4822 130 42513	TRANSISTOR,CHIP	BC858C	V 1215
5322 130 82043	DIODE,CHIP	BZV49-C13	V 1220
4822 130 42513	TRANSISTOR,CHIP	BC858C	V 1304
5322 130 34337	DIODE,CHIP	BAV99	V 1305
4822 130 42513	TRANSISTOR,CHIP	BC858C	V 1306
5322 130 62237	TRANSISTOR,CHIP	BCX54-16	V 1307
5322 130 34337	DIODE,CHIP	BAV99	V 1308
4822 130 82521	DIODE,CHIP	BZX84-B47	V 1309
4822 130 82521	DIODE,CHIP	BZX84-B47	V 1311
5322 130 42136	TRANSISTOR,CHIP	BC848C	V 1312
5322 130 42136	TRANSISTOR,CHIP	BC848C	V 1313
5322 130 42136	TRANSISTOR,CHIP	BC848C	V 1314
5322 130 42136	TRANSISTOR,CHIP	BC848C	V 1316
4822 130 42132	TRANSISTOR,CHIP	BC807	V 1317
4822 130 42513	TRANSISTOR,CHIP	BC858C	V 1318
4822 130 82262	DIODE,CHIP	BAT54S	V 1319
5322 130 42136	TRANSISTOR,CHIP	BC848C	V 1401
4822 130 42513	TRANSISTOR,CHIP	BC858C	V 1402
4822 130 42513	TRANSISTOR,CHIP	BC858C	V 1403
5322 130 42136	TRANSISTOR,CHIP	BC848C	V 1404
5322 130 34337	DIODE,CHIP	BAV99	V 1405
4822 130 82262	DIODE,CHIP	BAT54S	V 1406
5322 130 34337	DIODE,CHIP	BAV99	V 1501
5322 130 34337	DIODE,CHIP	BAV99	V 1502
4822 130 42513	TRANSISTOR,CHIP	BC858C	V 1503
5322 130 42136	TRANSISTOR,CHIP	BC848C	V 1506

INTEGRATED CIRCUITS

5322 209 30822	U-PROCESSOR	S83C196	D 1201
5322 209 73179	INTEGR.CIRCUIT	PC74HCT74T	D 1202
5322 209 30819	DIGITAL ASIC	SCOPEMETER	D 1203

Ordering code	Description		Item	Revision level
5322 209 30228	S-RAM 32Kx8	HM62256	D 1204	
5322 209 60428	INTEGR.CIRCUIT	PC74HC132T	D 1205	
5322 209 30228	S-RAM 32Kx8	HM62256	D 1206	
4822 209 63758	FROM 256K	N28F256-A200	D 1207	09
5322 209 52321	FROM-1M	N28F010-200P1C4	D 1207	09
5322 209 30674	FROM 512K	N28F512-200P1C4	D 1208	09
5322 209 60428	INTEGR.CIRCUIT	PC74HC132T	D 1209	
5322 209 73181	INTEGR.CIRCUIT	PC74HCT373T	D 1210	
5322 209 11147	INTEGR.CIRCUIT	HEF4093BT	D 1301	
4822 209 63761	LCD DRIVER	HD61105A	D 1401	
4822 209 63761	LCD DRIVER	HD61105A	D 1402	
4822 209 63761	LCD DRIVER	HD61105A	D 1403	
4822 209 63759	LCD DRIVER	HD61104A	D 1404	
4822 209 63759	LCD DRIVER	HD61104A	D 1406	
4822 209 63759	LCD DRIVER	HD61104A	D 1407	
4822 209 30208	INTEGR.CIRCUIT	PC74HCT86T	D 1408	
5322 209 11996	INTEGR.CIRCUIT	PC74HCT393T	D 1409	
5322 209 30675	INTEGR.CIRCUIT	PC74HCT163T	D 1410	
4822 209 63762	I.C. INTERFACE	PC74HCT165T	D 1601	
4822 209 63762	I.C. INTERFACE	PC74HCT165T	D 1602	
4822 209 63762	I.C. INTERFACE	PC74HCT165T	D 1603	
4822 209 63762	I.C. INTERFACE	PC74HCT165T	D 1604	
4822 209 63762	I.C. INTERFACE	PC74HCT165T	D 1606	
4822 209 60175	INTEGR.CIRCUIT	LM358M	N 1301	
5322 209 61473	INTEGR.CIRCUIT	LM324M	N 1401	

COILS

5322 157 63648	COIL	1UH 5%	L 1201	
5322 157 63651	COIL	CB-322513T	L 1202	04

MISCELLANEOUS

5322 242 80215	CRYSTAL	25MHZ HC-49/U	G 1201	
5322 130 61296	INFRARED ELEMENT	SFH409-2	H 1201	
5322 130 62923	PHOTO TRANSISTOR	SFH309F-4	H 1202	06

CONNECTORS

5322 267 70302	CONNECTOR	30-PIN STRAIGHT	X 1201	

TRANSFORMERS

5322 146 21627	TRANSFORMER		T 1301	

IMPORTANT

Analog A2 PCB assembly 5322 218 61465 can be used in all ScopeMeter versions. Take the following restrictions into account:

1. Firmware V3.15 and lower is not compatible with A2 PCB revision level 22 or higher. Update the firmware if you replace A2.

2. If an A2 PCB revision level 16 or lower is replaced by an A2 revision level 17 or higher, resistors R1423 and R1229 on the Digital A1 PCB must be modified:
   - R1423 into 82k5 (4822 051 58253)
   - R1229 into 681Ω (4822 051 56811)

   See section 11, Digital A1 PCB hardware modifications, revision level 07 and 08.

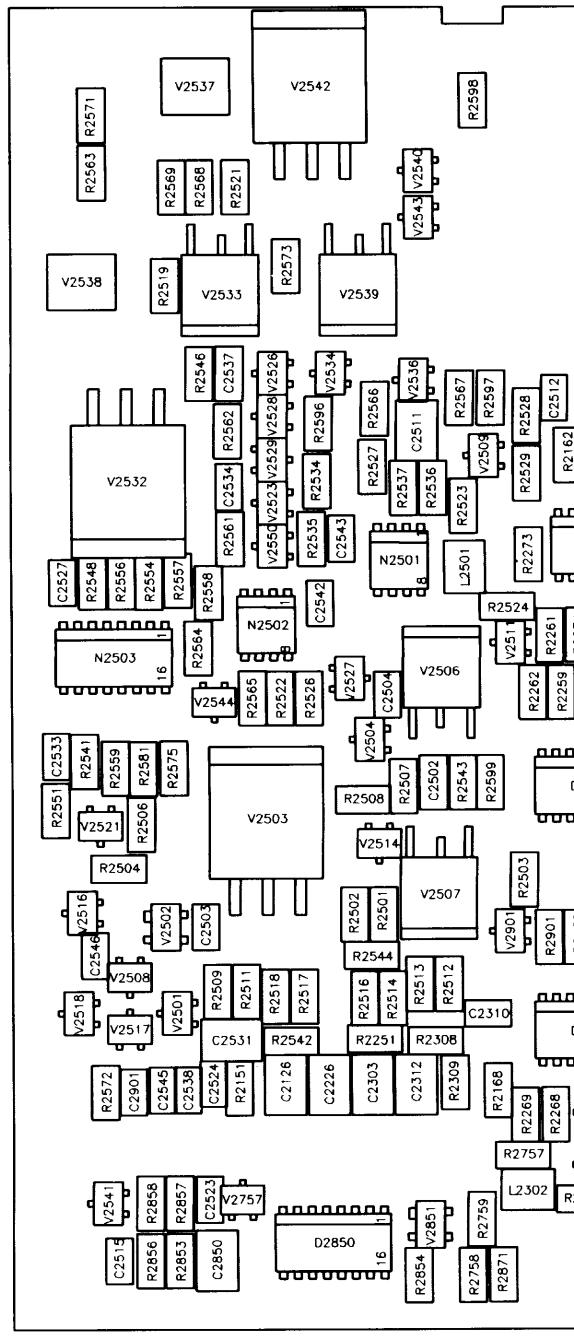
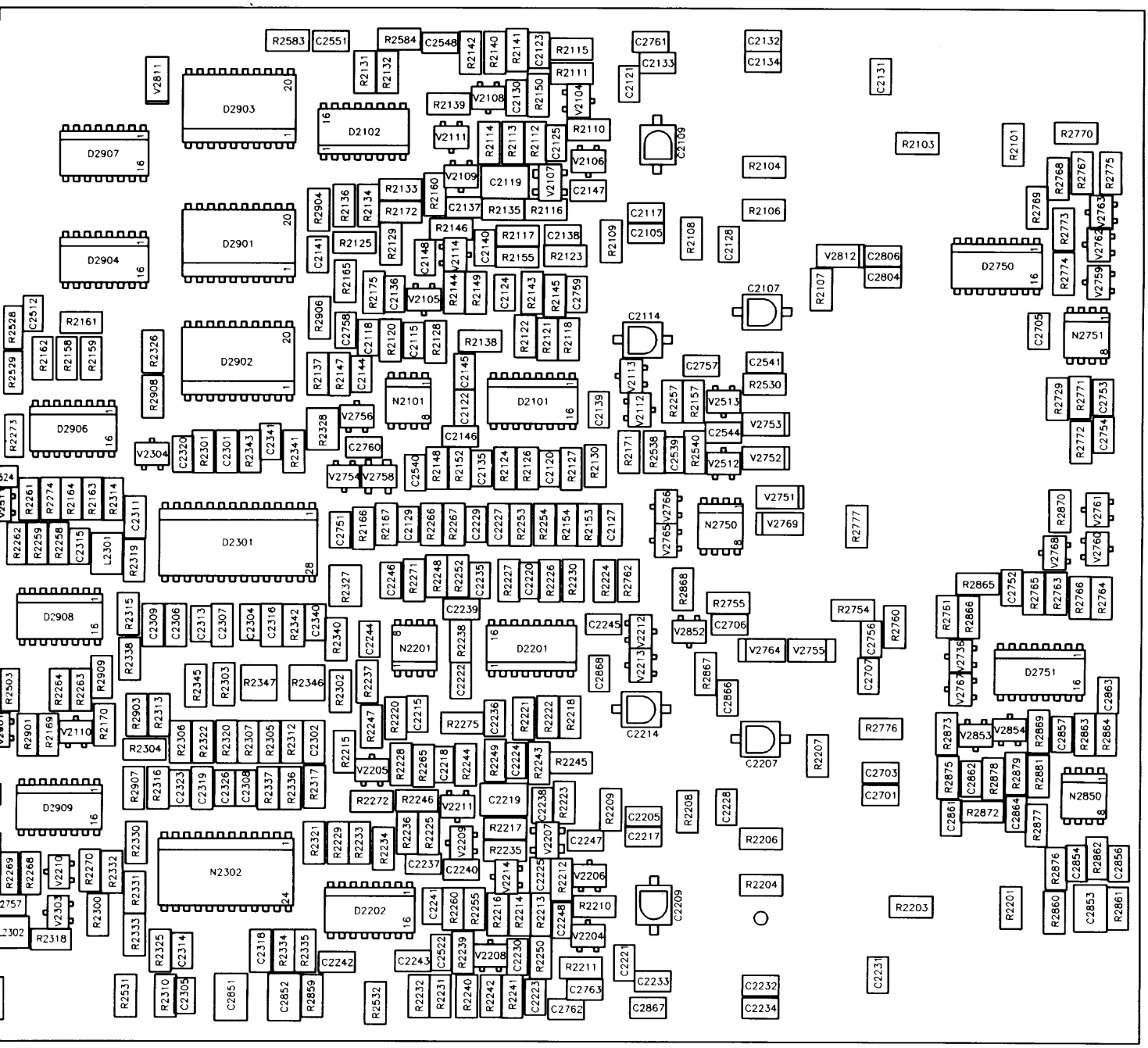


Figure 9.5 Analog A2 PCB assembly (SMD components side) revision level 22 and higher. For assembly drawings of older versions see Figures 10.3 a and 10.3b

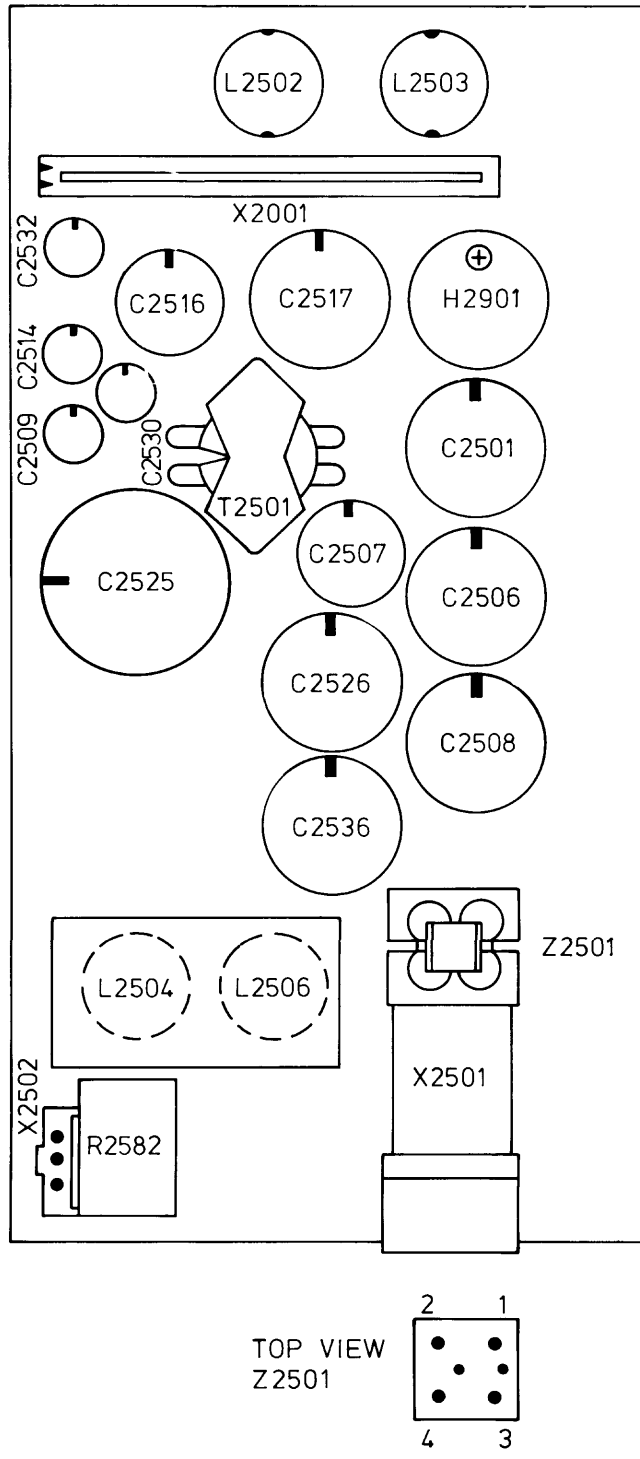
Table 9.5 Analog A2 PCB assembly (Figure 9.5)

When servicing the ScopeMeter, use only the replacement parts specified.

Item	Figure	Description	Ordering code	Qty
A2	9.5/9.6	Analog A2 PCB assembly	5322 218 61465	1



ST6977
920925


L2502
L2503
X2001
C2532
C2516
C2517
H2901
C2514
C2509
C2530
T2501
C2501
C2525
C2507
C2506
C2526
C2508
C2536
L2504
L2506
Z2501
X2501
X2502
R2582

2
1
TOP VIEW
Z2501
4
3

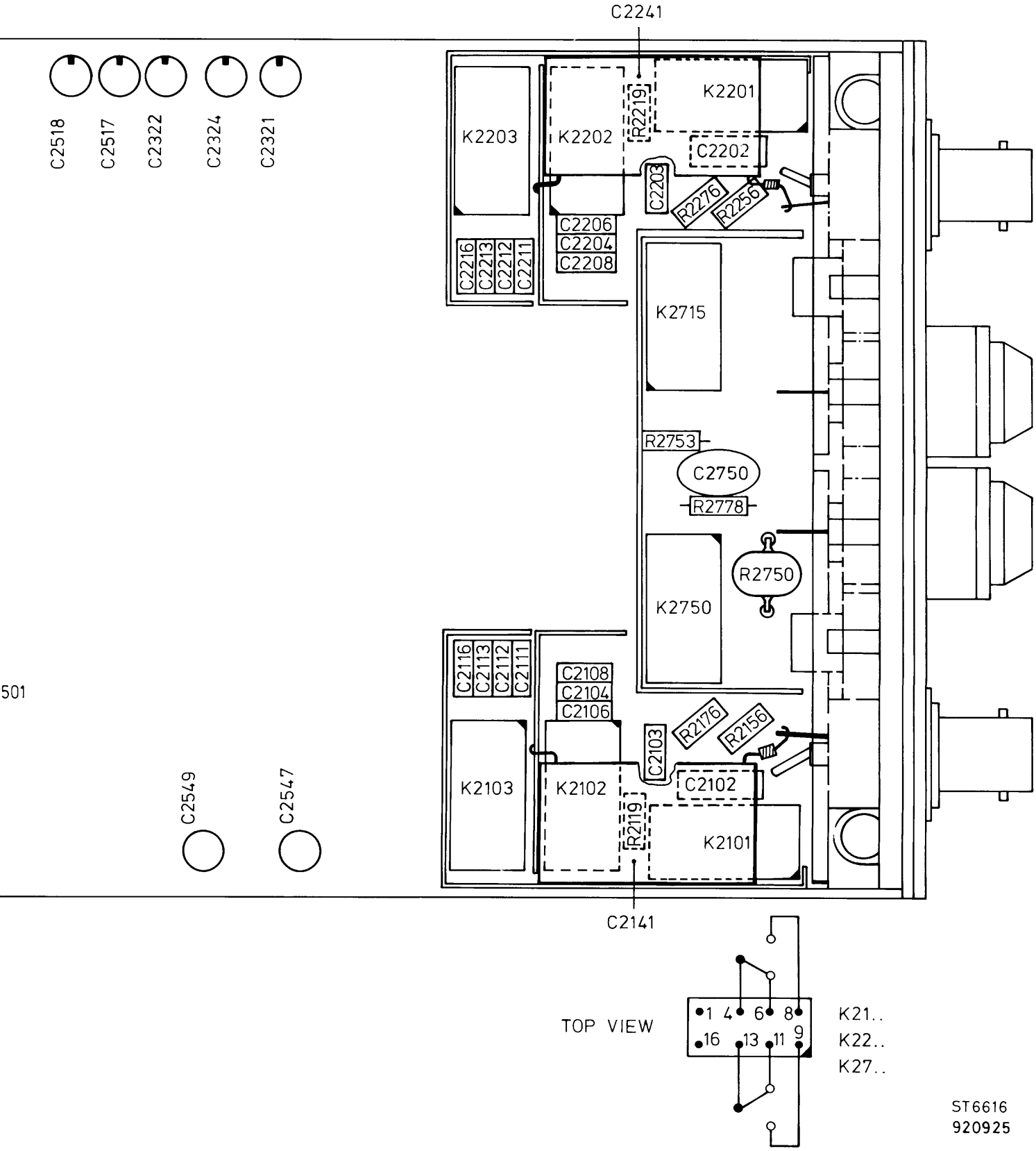


Figure 9.6 Analog A2 PCB assembly (Wired components side) for revision levels 22 and higher. See Figure 10.4b for revision level 21 and lower

CAPACITORS

Ordering code	Description				Item	Revision level
5322 121 40308	CAP.FOIL	400V	10%	22NF	C 2102	
5322 122 32982	CAP.CERAMIC		2%	56PF	C 2103	
4822 122 31194	CAP.CERAMIC		0.25PF	8.2PF	C 2104	
5322 122 33869	CAP.CERAMIC	63V	5%	15PF	C 2105	05, 11, 19
4822 122 31195	CAP.CERAMIC		2%	10PF	C 2106	
5322 125 11029	CAP.VARIABLE		10 PF	MUR	C 2107	
4822 122 31072	CAP.CERAMIC		2%	47PF	C 2108	16
5322 125 11029	CAP.VARIABLE		10 PF	MUR	C 2109	
4822 122 32139	CAP		10%	12PF	C 2110	12
4822 122 30149	CAP.CERAMIC		0.25PF	6.8PF	C 2111	02, 11
4822 122 31049	CAP.CERAMIC		0.25PF	6.8PF	C 2112	
4822 122 32027	CAP.CERAMIC		2%	56PF	C 2113	16
5322 125 11029	CAP.VARIABLE		10 PF	MUR	C 2114	29
5322 861 12331	CAP.CHIP	63V	5%	330PF	C 2115	11
4822 122 31194	CAP.CERAMIC		0.25PF	8.2PF	C 2116	
5322 122 32661	CAP.CHIP	63V	5%	56PF	C 2117	02, 29
5322 861 12331	CAP.CHIP	63V	5%	330PF	C 2118	11
4822 122 32916	CAP.CHIP	63V	10%	220NF	C 2119	20
5322 122 32967	CAP.CERAMIC	63V	5%	5.6PF	C 2120	11
5322 122 34098	CAP.CHIP	63V	10%	10NF	C 2121	
4822 122 33339	CAP.CHIP	63V	10%	4.7NF	C 2122	02, 11
4822 122 33891	CAP.CHIP	63V	10%	3.3NF	C 2123	11, 12
4822 122 33891	CAP.CHIP	63V	10%	3.3NF	C 2124	
4822 126 10004	CAP.CHIP	63V	5%	120PF	C 2125	
4822 122 32916	CAP.CHIP	63V	10%	220NF	C 2126	
4822 122 32891	CAP.CERAMIC	63V	10%	68NF	C 2127	
4822 122 32448	CAP.CERAMIC	63V	0.5PF	10PF	C 2128	02, 11
4822 122 33891	CAP.CHIP	63V	10%	3.3NF	C 2129	
4822 122 33496	CAP.CHIP	63V	10%	100NF	C 2130	11, 22
5322 122 34098	CAP.CHIP	63V	10%	10NF	C 2131	
5322 122 34098	CAP.CHIP	63V	10%	10NF	C 2132	
5322 122 34098	CAP.CHIP	63V	10%	10NF	C 2133	
5322 122 34098	CAP.CHIP	63V	10%	10NF	C 2134	
5322 122 32654	CAP.CHIP	63V	10%	22NF	C 2135	
5322 126 10733	CAP.CHIP	63V	10%	680PF	C 2136	11, 22
4822 122 33515	CAP.CHIP	63V	5%	82PF	C 2137	18, 20
5322 122 32654	CAP.CHIP	63V	10%	22NF	C 2138	15, 22
4822 122 33127	CAP.CHIP	63V	10%	2.2NF	C 2139	02
4822 122 33127	CAP.CHIP	63V	10%	2.2NF	C 2140	
4822 122 33127	CAP.CHIP	63V	10%	2.2NF	C 2141	02
5322 121 44372	CAP.FOIL	250V		220NF	C 2141	23
4822 122 33127	CAP.CHIP	63V	10%	2.2NF	C 2144	02
4822 122 33127	CAP.CHIP	63V	10%	2.2NF	C 2145	02
4822 122 33127	CAP.CHIP	63V	10%	2.2NF	C 2146	02
4822 122 33127	CAP.CHIP	63V	10%	2.2NF	C 2147	02
4822 122 33127	CAP.CHIP	63V	10%	2.2NF	C 2148	
5322 121 40308	CAP.FOIL	400V	10%	22NF	C 2202	

Ordering code	Description				Item	Revision level
5322 122 32982	CAP.		2%	56P	C 2203	
4822 122 31194	CAP.CERAMIC		0.25PF	8.2PF	C 2204	
5322 122 33869	CAP.CERAMIC	63V	5%	15PF	C 2205	02, 11, 19
4822 122 31195	CAP.CERAMIC		2%	10PF	C 2206	
5322 125 11029	CAP.VARIABLE		10 PF	MUR	C 2207	
4822 122 31072	CAP.CERAMIC		2%	47PF	C 2208	16
5322 125 11029	CAP.VARIABLE		10 PF	MUR	C 2209	
4822 122 32139	CAP		10%	12PF	C 2210	12
4822 122 30149	CAP.CERAMIC		0.25PF	6.8PF	C 2211	02, 11
4822 122 31049	CAP.CERAMIC		0.25PF	6.8PF	C 2212	
4822 122 32027	CAP.CERAMIC		2%	56PF	C 2213	16
5322 125 11029	CAP.VARIABLE		10 PF	MUR	C 2214	
5322 861 12331	CAP.CHIP	63V	5%	330PF	C 2215	11
4822 122 31194	CAP.CERAMIC		0.25PF	8.2PF	C 2216	
5322 122 32661	CAP.CHIP	63V	5%	56PF	C 2217	02, 29
4822 122 33216	CAP.CHIP	63V	5%	270PF	C 2218	11
4822 122 32916	CAP.CHIP	63V	10%	220NF	C 2219	20
5322 122 32967	CAP.CERAMIC	63V	5%	5.6PF	C 2220	11
5322 122 34098	CAP.CHIP	63V	10%	10NF	C 2221	
4822 122 33339	CAP.CHIP	63V	10%	4.7NF	C 2222	02, 11
4822 122 33891	CAP.CHIP	63V	10%	3.3NF	C 2223	11, 12
4822 122 33891	CAP.CHIP	63V	10%	3.3NF	C 2224	
4822 126 10004	CAP.CHIP	63V	5%	120PF	C 2225	
4822 122 32916	CAP.CHIP	63V	10%	220NF	C 2226	
4822 122 32891	CAP.CERAMIC	63V	10%	68NF	C 2227	
4822 122 32448	CAP.CERAMIC	63V	0.5PF	10PF	C 2228	02, 11
4822 122 33891	CAP.CHIP	63V	10%	3.3NF	C 2229	
4822 122 33496	CAP.CHIP	63V	10%	100NF	C 2230	11, 22
5322 122 34098	CAP.CHIP	63V	10%	10NF	C 2231	
5322 122 34098	CAP.CHIP	63V	10%	10NF	C 2232	
5322 122 34098	CAP.CHIP	63V	10%	10NF	C 2233	
5322 122 34098	CAP.CHIP	63V	10%	10NF	C 2234	
5322 122 32654	CAP.CHIP	63V	10%	22NF	C 2235	
5322 126 10733	CAP.CHIP	63V	10%	680PF	C 2236	11, 22
4822 122 33515	CAP.CHIP	63V	5%	82PF	C 2237	18, 20
5322 122 32654	CAP.CHIP	63V	10%	22NF	C 2238	15, 22
4822 122 33127	CAP.CHIP	63V	10%	2.2NF	C 2239	
4822 122 33127	CAP.CHIP	63V	10%	2.2NF	C 2240	
4822 122 33127	CAP.CHIP	63V	10%	2.2NF	C 2241	02
5322 121 44372	CAP.FOIL	250V		220NF	C 2241	23
4822 122 33127	CAP.CHIP	63V	10%	2.2NF	C 2242	
4822 122 33127	CAP.CHIP	63V	10%	2.2NF	C 2243	
4822 122 33127	CAP.CHIP	63V	10%	2.2NF	C 2244	
4822 122 33127	CAP.CHIP	63V	10%	2.2NF	C 2245	
4822 122 33127	CAP.CHIP	63V	10%	2.2NF	C 2246	
4822 122 33127	CAP.CHIP	63V	10%	2.2NF	C 2247	
4822 122 33127	CAP.CHIP	63V	10%	2.2NF	C 2248	
4822 122 33496	CAP.CHIP	63V	10%	100NF	C 2301	

Ordering code	Description				Item	Revision level
4822 122 33496	CAP.CHIP	63V	10%	100NF	C 2302	
4822 122 33496	CAP.CHIP	63V	10%	100NF	C 2303	
5322 122 32654	CAP.CHIP	63V	10%	22NF	C 2304	
5322 122 33869	CAP.CHIP	63V	5%	15PF	C 2305	
4822 122 33496	CAP.CHIP	63V	10%	100NF	C 2306	
4822 122 33496	CAP.CHIP	63V	10%	100NF	C 2307	
5322 122 34098	CAP.CHIP	63V	10%	10NF	C 2308	
4822 122 33496	CAP.CHIP	63V	10%	100NF	C 2309	
5322 122 34098	CAP.CHIP	63V	10%	10NF	C 2310	
4822 122 33496	CAP.CHIP	63V	10%	100NF	C 2311	
4822 122 32916	CAP.CHIP	63V	10%	220NF	C 2312	
5322 122 32654	CAP.CHIP	63V	10%	22NF	C 2313	
5322 122 32654	CAP.CHIP	63V	10%	22NF	C 2314	
4822 122 32139	CAP.CHIP	63V	5%	12PF	C 2315	05
4822 122 33496	CAP.CHIP	63V	10%	100NF	C 2316	
4822 124 11162	CAP.ELECTROLYT.		20%	68UF	C 2317	
4822 122 33496	CAP.CHIP	63V	10%	100NF	C 2318	
4822 122 33496	CAP.CHIP	63V	10%	100NF	C 2319	
5322 122 32654	CAP.CHIP	63V	10%	22NF	C 2320	
5322 122 34098	CAP.CHIP	63V	10%	10NF	C 2321	
4822 124 23627	CAP.ELECTROLYT.		20%	4.7UF	C 2322	
4822 122 33127	CAP.CHIP	63V	10%	2.2NF	C 2323	
4822 124 23627	CAP.ELECTROLYT.		20%	4.7UF	C 2324	
5322 122 32452	CAP.CERAMIC	63V	5%	47PF	C 2326	
5322 122 33869	CAP.CHIP	63V	5%	15PF	C 2340	18
5322 122 33869	CAP.CHIP	63V	5%	15PF	C 2341	18
5322 121 43885	CAP.FOIL		20%	470UF	C 2501	
4822 122 32891	CAP.CERAMIC	63V	10%	68NF	C 2502	
4822 122 33127	CAP.CHIP	63V	10%	2.2NF	C 2503	
4822 122 33127	CAP.CHIP	63V	10%	2.2NF	C 2504	
5322 121 43884	CAP.FOIL		20%	1200UF	C 2506	
5322 121 43886	CAP.FOIL		20%	180UF	C 2507	
5322 121 43884	CAP.FOIL		20%	1200UF	C 2508	
4822 124 11162	CAP.ELECTROLYT.		20%	68UF	C 2509	
4822 122 32916	CAP.CHIP	63V	10%	220NF	C 2511	
5322 122 32654	CAP.CHIP	63V	10%	22NF	C 2512	
4822 124 11162	CAP.ELECTROLYT.		20%	68UF	C 2514	
5322 122 32654	CAP.CHIP	63V	10%	22NF	C 2515	
5322 121 43887	CAP.FOIL		20%	470UF	C 2516	
5322 121 43887	CAP.FOIL		20%	470UF	C 2517	
4822 124 11162	CAP.ELECTROLYT.		20%	68UF	C 2518	
5322 122 32654	CAP.CHIP	63V	10%	22NF	C 2519	22
4822 124 11162	CAP.ELECTROLYT.		20%	68UF	C 2521	
5322 122 32654	CAP.CHIP	63V	10%	22NF	C 2522	
5322 122 32654	CAP.CHIP	63V	10%	22NF	C 2523	
5322 122 32654	CAP.CHIP	63V	10%	22NF	C 2524	
5322 121 43885	CAP.FOIL		20%	470UF	C 2526	
5322 126 10733	CAP.CHIP	63V	5%	680PF	C 2527	

Ordering code	Description				Item	Revision level
4822 124 11162	CAP.ELECTROLYT.		20%	68UF	C 2530	
4822 122 32916	CAP.CHIP	63V	10%	220NF	C 2531	
4822 124 11162	CAP.ELECTROLYT.		20%	68UF	C 2532	
4822 122 33127	CAP.CHIP	63V	10%	2.2NF	C 2533	
5322 122 32654	CAP.CHIP	63V	10%	22NF	C 2534	
5322 121 43885	CAP.FOIL		20%	470UF	C 2536	
4822 122 32891	CAP.CERAMIC	63V	10%	68NF	C 2537	02
5322 122 32654	CAP.CHIP	63V	10%	22NF	C 2538	
5322 122 32654	CAP.CHIP	63V	10%	22NF	C 2539	22
5322 122 32654	CAP.CHIP	63V	10%	22NF	C 2540	22
5322 122 32654	CAP.CHIP	63V	10%	22NF	C 2541	22
5322 122 34098	CAP.CHIP	63V	10%	10NF	C 2542	
5322 122 34098	CAP.CHIP	63V	10%	10NF	C 2543	
4822 126 10004	CAP.CHIP	63V	5%	120PF	C 2544	
5322 122 32654	CAP.CHIP	63V	10%	22NF	C 2545	22
5322 122 32654	CAP.CHIP	63V	10%	22NF	C 2546	
4822 124 11162	CAP.ELECTROLYT.		20%	68UF	C 2547	
5322 122 32654	CAP.CHIP	63V	10%	22NF	C 2548	
4822 124 11162	CAP.ELECTROLYT.		20%	68UF	C 2549	
5322 122 32654	CAP.CHIP	63V	10%	22NF	C 2551	
5322 124 42329	CAP.ELECTROLYT.		20%	3900UF	C 2552	
5322 122 34098	CAP.CHIP	63V	10%	10NF	C 2701	
5322 122 34098	CAP.CHIP	63V	10%	10NF	C 2703	
5322 122 32654	CAP.CHIP	63V	10%	22NF	C 2704	13, 22
5322 122 34098	CAP.CHIP	63V	10%	10NF	C 2705	
5322 122 32654	CAP.CHIP	63V	10%	22NF	C 2707	22
5322 126 11389	CAP.CERAMIC		10%	22PF	C 2750	
5322 122 32654	CAP.CHIP	63V	10%	22NF	C 2752	
4822 122 33127	CAP.CHIP	63V	10%	2.2NF	C 2753	
4822 122 33127	CAP.CHIP	63V	10%	2.2NF	C 2754	
5322 122 32654	CAP.CHIP	63V	10%	22NF	C 2756	13, 22
4822 122 33127	CAP.CHIP	63V	10%	2.2NF	C 2757	
4822 122 33127	CAP.CHIP	63V	10%	2.2NF	C 2758	
4822 122 33127	CAP.CHIP	63V	10%	2.2NF	C 2759	
4822 122 33127	CAP.CHIP	63V	10%	2.2NF	C 2760	02
4822 122 33127	CAP.CHIP	63V	10%	2.2NF	C 2761	
4822 122 33127	CAP.CHIP	63V	10%	2.2NF	C 2762	
4822 122 33127	CAP.CHIP	63V	10%	2.2NF	C 2763	
5322 122 34098	CAP.CHIP	63V	10%	10NF	C 2804	
5322 122 34098	CAP.CHIP	63V	10%	10NF	C 2806	
5322 122 33897	CAP.CERAMIC	63V	5%	3.3NF	C 2850	
5322 122 33897	CAP.CERAMIC	63V	5%	3.3NF	C 2851	
5322 122 33897	CAP.CERAMIC	63V	5%	3.3NF	C 2852	
5322 122 33816	CAP.CERAMIC	63V	5%	2.2NF	C 2853	
5322 126 10733	CAP.CHIP	63V	5%	680PF	C 2854	
4822 122 33216	CAP.CHIP	63V	5%	270PF	C 2856	
5322 122 32452	CAP.CERAMIC	63V	5%	47PF	C 2857	
5322 122 34098	CAP.CHIP	63V	10%	10NF	C 2861	

Ordering code	Description				Item	Revision level
5322 122 34098	CAP.CHIP	63V	10%	10NF	C 2862	
5322 122 32452	CAP.CERAMIC	63V	5%	47PF	C 2863	
5322 122 34098	CAP.CHIP	63V	10%	10NF	C 2864	
4822 122 33127	CAP.CHIP	63V	10%	2.2NF	C 2866	
4822 122 33127	CAP.CHIP	63V	10%	2.2NF	C 2867	
4822 122 33127	CAP.CHIP	63V	10%	2.2NF	C 2868	
5322 122 34098	CAP.CHIP	63V	10%	10NF	C 2901	

RESISTORS

5322 116 82895	RES.CHIP	RMC1/8	1%	31E6	R 2101	06, 20
5322 116 80429	RES.CHIP	RC-02H	1%	100K	R 2103	
4822 051 10108	RES.CHIP	RC-01	5%	1E	R 2104	
4822 111 91885	RES.CHIP	RMC1/8	1%	10E	R 2106	
4822 111 91885	RES.CHIP	RMC1/8	1%	10E	R 2107	
5322 111 91893	RES.CHIP	RMC1/8	1%	51E1	R 2108	02
5322 111 91963	RES.CHIP	RMC1/8	1%	34E8	R 2109	
4822 116 81789	RES.CHIP	RMC1/8	1%	316E	R 2110	02
5322 116 82899	RES.MET.GLAZED	RMC1/8	1%	3K83	R 2111	
4822 051 10106	RES.CHIP	RC-01	5%	10M	R 2112	
4822 051 10106	RES.CHIP	RC-01	5%	10M	R 2113	
4822 051 10106	RES.CHIP	RC-01	5%	10M	R 2114	
4822 116 82408	RES.CHIP	RC-02H	1%	1K33	R 2115	
4822 051 51331	RES.CHIP	RMC1/8	1%	133E	R 2116	02, 27
5322 111 91899	RES.CHIP	RMC1/8	1%	261E	R 2117	02, 27
4822 111 91891	RES.METAL FILM	RC-02H	1%	34K8	R 2118	
4822 050 29534	RES.METAL FILM	MRS25	1%	953K	R 2119	
4822 051 10106	RES.CHIP	RC-01	5%	10M	R 2120	
4822 116 81165	RES.CHIP	RC-02H	1%	1M	R 2121	
5322 116 80428	RES.CHIP	RC-02H	1%	10K	R 2122	
4822 051 51005	RES.CHIP	RC-02H	1%	1M	R 2123	15, 22
5322 111 91893	RES.CHIP	RMC1/8	1%	51E1	R 2124	
4822 051 57502	RES.MET.GLAZED	RMC1/8	1%	7K5	R 2125	12
5322 116 80429	RES.CHIP	RC-02H	1%	100K	R 2126	
4822 116 82532	RES.CHIP	RC-02H	1%	11K	R 2127	
4822 116 81165	RES.CHIP	RC-02H	1%	1M	R 2128	
5322 116 82112	RES.CHIP	RMC1/8	1%	681E	R 2129	04
5322 116 80429	RES.CHIP	RC-02H	1%	100K	R 2130	
5322 116 82011	RES.METAL FILM	RC-02H	1%	147K	R 2131	04
4822 116 82887	RES.CHIP	RC-02H	1%	75K	R 2132	04
5322 116 82899	RES.MET.GLAZED	RMC1/8	1%	3K83	R 2133	04
5322 116 80609	RES.MET.GLAZED	RC-02H	1%	7K5	R 2134	04
5322 111 91893	RES.CHIP	RMC1/8	1%	51E1	R 2135	
4822 116 82384	RES.CHIP	RC-02H	1%	750E	R 2136	04
5322 111 91809	RES.METAL FILM	RC-02H	1%	215K	R 2137	
5322 116 80427	RES.CHIP	RC-02H	1%	1K	R 2138	
5322 116 80428	RES.CHIP	RC-02H	1%	10K	R 2139	
5322 111 91893	RES.CHIP	RMC1/8	1%	51E1	R 2140	

Ordering code	Description				Item	Revision level
5322 116 80428	RES.CHIP	RC-02H	1%	10K	R 2141	
4822 051 51781	RES.NETWORK	RMC1/8	1%	178E	R 2142	12
5322 116 81795	RES.CHIP	RC-02H	1%	3K48	R 2143	
4822 111 91814	RES.CHIP	RC-02H	1%	121E	R 2144	
5322 116 82899	RES.MET.GLAZED	RMC1/8	1%	3K83	R 2145	
5322 116 82899	RES.MET.GLAZED	RMC1/8	1%	3K83	R 2146	
5322 116 82011	RES.METAL FILM	RC-02H	1%	147K	R 2147	
5322 116 82904	RES.MET.GLAZED	RMC1/8	1%	464K	R 2148	
5322 111 91893	RES.CHIP	RMC1/8	1%	51E1	R 2149	
4822 111 91885	RES.CHIP	RMC1/8	1%	10E	R 2150	
4822 116 82886	RES.CHIP	RC-02H	1%	61K9	R 2151	
4822 116 82887	RES.CHIP	RC-02H	1%	75K	R 2152	
4822 116 82887	RES.CHIP	RC-02H	1%	75K	R 2153	
5322 116 80428	RES.CHIP	RC-02H	1%	10K	R 2154	
4822 116 81165	RES.CHIP	RC-02H	1%	1M	R 2155	
5322 116 40232	RES.PTC		600V	1K1	R 2156	23
5322 116 82903	RES.MET.GLAZED	RMC1/8	1%	31K6	R 2157	
4822 116 82885	RES.METAL FILM	RC-02H	1%	51K1	R 2158	
5322 116 80429	RES.CHIP	RC-02H	1%	100K	R 2159	
4822 111 91826	RES.CHIP	RC-02H	1%	511E	R 2160	
5322 116 81794	RES.CHIP	RC-02H	1%	2K15	R 2161	
5322 111 91809	RES.METAL FILM	RC-02H	1%	215K	R 2162	
5322 116 82904	RES.MET.GLAZED	RMC1/8	1%	464K	R 2163	
4822 116 82888	RES.METAL FILM	RC-02H	1%	825K	R 2164	
4822 051 10108	RES.CHIP	RC-01	5%	1E	R 2165	
4822 116 90788	RES.CHIP	RMC1/8	1%	68E1	R 2166	14
4822 116 81165	RES.CHIP	RC-02H	1%	1M	R 2167	
4822 116 82532	RES.CHIP	RC-02H	1%	11K	R 2168	
5322 116 82903	RES.MET.GLAZED	RMC1/8	1%	31K6	R 2169	
5322 116 82899	RES.MET.GLAZED	RMC1/8	1%	3K83	R 2170	
5322 116 80428	RES.CHIP	RC-02H	1%	10K	R 2171	20
5322 116 81794	RES.CHIP	RC-02H	1%	2K15	R 2172	
4822 051 55114	RES.CHIP	RC-01	5%	511K	R 2175	22
5322 116 40232	RES.PTC		600V	1K1	R 2176	23
5322 116 82895	RES.CHIP	RMC1/8	1%	31E6	R 2201	06, 20
5322 116 80429	RES.CHIP	RC-02H	1%	100K	R 2203	
4822 051 10108	RES.CHIP	RC-01	5%	1E	R 2204	
4822 111 91885	RES.CHIP	RMC1/8	1%	10E	R 2206	
4822 111 91885	RES.CHIP	RMC1/8	1%	10E	R 2207	
5322 111 91893	RES.CHIP	RMC1/8	1%	51E1	R 2208	02
4822 111 91887	RES.CHIP	RMC1/8	1%	42E2	R 2209	06, 11, 22
4822 116 81789	RES.CHIP	RMC1/8	1%	316E	R 2210	02
5322 116 82899	RES.MET.GLAZED	RMC1/8	1%	3K83	R 2211	
4822 051 10106	RES.CHIP	RC-01	5%	10M	R 2212	
4822 051 10106	RES.CHIP	RC-01	5%	10M	R 2213	
4822 051 10106	RES.CHIP	RC-01	5%	10M	R 2214	
4822 116 82408	RES.CHIP	RC-02H	1%	1K33	R 2215	
4822 051 51331	RES.CHIP	RMC1/8	1%	133E	R 2216	02, 27

Ordering code	Description				Item	Revision level
5322 111 91899	RES.CHIP	RMC1/8	1%	261E	R 2217	02, 27
4822 111 91891	RES.METAL FILM	RC-02H	1%	34K8	R 2218	
4822 050 29534	RES.METAL FILM	MRS25	1%	953K	R 2219	
4822 051 10106	RES.CHIP	RC-01	5%	10M	R 2220	
4822 116 81165	RES.CHIP	RC-02H	1%	1M	R 2221	
5322 116 80428	RES.CHIP	RC-02H	1%	10K	R 2222	
4822 051 51005	RES.CHIP	RC-02	1%	1M	R 2223	15, 22
5322 111 91893	RES.CHIP	RMC1/8	1%	51E1	R 2224	
5322 116 82901	RES.MET.GLAZED	RMC1/8	1%	19K6	R 2225	12
5322 116 80429	RES.CHIP	RC-02H	1%	100K	R 2226	
4822 116 82532	RES.CHIP	RC-02H	1%	11K	R 2227	
4822 116 81165	RES.CHIP	RC-02H	1%	1M	R 2228	
5322 116 82112	RES.CHIP	RMC1/8	1%	681E	R 2229	04
5322 116 80429	RES.CHIP	RC-02H	1%	100K	R 2230	
5322 116 82011	RES.METAL FILM	RC-02H	1%	147K	R 2231	04
4822 116 82887	RES.CHIP	RC-02H	1%	75K	R 2232	04
5322 116 82899	RES.MET.GLAZED	RMC1/8	1%	3K83	R 2233	04
5322 116 80609	RES.MET.GLAZED	RC-02H	1%	7K5	R 2234	04
5322 111 91893	RES.CHIP	RMC1/8	1%	51E1	R 2235	
4822 116 82384	RES.CHIP	RC-02H	1%	750E	R 2236	04
5322 111 91809	RES.METAL FILM	RC-02H	1%	215K	R 2237	
5322 116 80427	RES.CHIP	RC-02H	1%	1K	R 2238	
5322 116 80428	RES.CHIP	RC-02H	1%	10K	R 2239	
5322 111 91893	RES.CHIP	RMC1/8	1%	51E1	R 2240	
5322 116 80428	RES.CHIP	RC-02H	1%	10K	R 2241	
4822 051 51781	RES.NETWORK	RMC1/8	1%	178E	R 2242	12
5322 116 81795	RES.CHIP	RC-02H	1%	3K48	R 2243	
4822 111 91814	RES.CHIP	RC-02H	1%	121E	R 2244	
5322 116 82899	RES.MET.GLAZED	RMC1/8	1%	3K83	R 2245	
5322 116 82899	RES.MET.GLAZED	RMC1/8	1%	3K83	R 2246	
5322 116 82011	RES.METAL FILM	RC-02H	1%	147K	R 2247	
5322 116 82904	RES.MET.GLAZED	RMC1/8	1%	464K	R 2248	
5322 111 91893	RES.CHIP	RMC1/8	1%	51E1	R 2249	
4822 111 91885	RES.CHIP	RMC1/8	1%	10E	R 2250	
4822 116 82886	RES.CHIP	RC-02H	1%	61K9	R 2251	
4822 116 82887	RES.CHIP	RC-02H	1%	75K	R 2252	
4822 116 82887	RES.CHIP	RC-02H	1%	75K	R 2253	
5322 116 80428	RES.CHIP	RC-02H	1%	10K	R 2254	
4822 116 81165	RES.CHIP	RC-02H	1%	1M	R 2255	
5322 116 40232	RES.PTC		600V	1K1	R 2256	23
5322 116 82903	RES.MET.GLAZED	RMC1/8	1%	31K6	R 2257	
4822 116 82885	RES.METAL FILM	RC-02H	1%	51K1	R 2258	
5322 116 80429	RES.CHIP	RC-02H	1%	100K	R 2259	
4822 111 91826	RES.CHIP	RC-02H	1%	511E	R 2260	
5322 116 81794	RES.CHIP	RC-02H	1%	2K15	R 2261	
5322 111 91809	RES.METAL FILM	RC-02H	1%	215K	R 2262	
5322 116 82904	RES.MET.GLAZED	RMC1/8	1%	464K	R 2263	
4822 116 82888	RES.METAL FILM	RC-02H	1%	825K	R 2264	

Ordering code	Description				Item	Revision level
4822 051 10108	RES.CHIP	RC-01	5%	1E	R 2265	
4822 116 90788	RES.CHIP	RMC1/8	1%	68E1	R 2266	14
4822 116 81165	RES.CHIP	RC-02H	1%	1M	R 2267	
4822 116 82532	RES.CHIP	RC-02H	1%	11K	R 2268	
5322 116 82903	RES.MET.GLAZED	RMC1/8	1%	31K6	R 2269	
5322 116 82899	RES.MET.GLAZED	RMC1/8	1%	3K83	R 2270	
5322 116 80428	RES.CHIP	RC-02H	1%	10K	R 2271	20
5322 116 81794	RES.CHIP	RC-02H	1%	2K15	R 2272	
4822 051 55114	RES.CHIP	RC-01	5%	511K	R 2275	22
5322 116 40232	RES.PTC		600V	1K1	R 2276	23
4822 051 51003	RES.CHIP	RC-01	5%	10K	R 2300	22, 25
4822 051 10108	RES.CHIP	RC-01	5%	1E	R 2301	
4822 051 10108	RES.CHIP	RC-01	5%	1E	R 2302	
4822 116 82408	RES.CHIP	RC-02H	1%	1K33	R 2303	
4822 111 91892	RES.METAL FILM	RC-02H	1%	511K	R 2304	
4822 051 10108	RES.CHIP	RC-01	5%	1E	R 2305	
4822 051 10108	RES.CHIP	RC-01	5%	1E	R 2306	
4822 051 10108	RES.CHIP	RC-01	5%	1E	R 2307	
4822 116 82887	RES.CHIP	RC-02H	1%	75K	R 2308	
4822 116 82887	RES.CHIP	RC-02H	1%	75K	R 2309	
5322 111 91899	RES.CHIP	RMC1/8	1%	261E	R 2310	
4822 051 10108	RES.CHIP	RC-01	5%	1E	R 2312	
4822 051 10108	RES.CHIP	RC-01	5%	1E	R 2313	
4822 051 10108	RES.CHIP	RC-01	5%	1E	R 2314	
5322 111 91901	RES.CHIP	RMC1/8	1%	348E	R 2315	20, 27
5322 116 80429	RES.CHIP	RC-02H	1%	100K	R 2316	
4822 111 91828	RES.CHIP	RC-02H	1%	68K1	R 2317	18
5322 116 82897	RES.MET.GLAZED	RMC1/8	1%	383E	R 2318	
4822 111 91888	RES.CHIP	RMC1/8	1%	56E2	R 2319	05
4822 116 82885	RES.METAL FILM	RC-02H	1%	51K1	R 2320	
4822 116 82884	RES.CHIP	RC-02H	1%	316K	R 2321	
5322 116 82903	RES.MET.GLAZED	RMC1/8	1%	31K6	R 2322	
5322 116 82898	RES.MET.GLAZED	RMC1/8	1%	464E	R 2323	20
4822 116 81789	RES.CHIP	RMC1/8	1%	316E	R 2324	20
4822 111 91821	CAP.CHIP	RC-02H	1%	2K61	R 2325	20
4822 051 51003	RES.CHIP	RC-01	5%	10K	R 2326	22
5322 111 91893	RES.CHIP	RMC1/8	1%	51E1	R 2327	18, 20
5322 111 91893	RES.CHIP	RMC1/8	1%	51E1	R 2328	18, 20
4822 111 91888	RES.CHIP	RMC1/8	1%	56E2	R 2330	
4822 111 91888	RES.CHIP	RMC1/8	1%	56E2	R 2331	
4822 111 91888	RES.CHIP	RMC1/8	1%	56E2	R 2332	
4822 111 91888	RES.CHIP	RMC1/8	1%	56E2	R 2333	
4822 111 91888	RES.CHIP	RMC1/8	1%	56E2	R 2334	
4822 111 91888	RES.CHIP	RMC1/8	1%	56E2	R 2335	
4822 111 91888	RES.CHIP	RMC1/8	1%	56E2	R 2336	
4822 111 91888	RES.CHIP	RMC1/8	1%	56E2	R 2337	
5322 116 81794	RES.CHIP	RC-02H	1%	2K15	R 2338	18, 20
5322 116 82895	RES.NETWORK	RMC1/8	1%	31E6	R 2340	06, 11, 20, 22

Ordering code	Description				Item	Revision level
5322 116 82895	RES.NETWORK	RMC1/8	1%	31E6	R 2341	06. 11, 20, 22
5322 116 82896	RES.MET.GLAZED	RMC1/8	1%	46E4	R 2342	06, 18, 20, 22
5322 116 82896	RES.MET.GLAZED	RMC1/8	1%	46E4	R 2343	06, 18, 20, 22
5322 116 80429	RES.CHIP	RC-02H	1%	100K	R 2345	
5322 101 60082	POTM.TRIMMER	VG4	25%	10K	R 2346	
5322 101 60082	POTM.TRIMMER	VG4	25%	10K	R 2347	
4822 111 91826	RES.CHIP	RC-02H	1%	511E	R 2501	
4822 111 91826	RES.CHIP	RC-02H	1%	511E	R 2502	
4822 051 10108	RES.CHIP	RC-01	5%	1E	R 2503	
4822 116 82532	RES.CHIP	RC-02H	1%	11K	R 2504	
4822 111 91885	RES.CHIP	RMC1/8	1%	10E	R 2506	
5322 111 91963	RES.CHIP	RMC1/8	1%	34E8	R 2507	
5322 111 91893	RES.CHIP	RMC1/8	1%	51E1	R 2508	16
4822 051 10108	RES.CHIP	RC-01	5%	1E	R 2509	
4822 051 10108	RES.CHIP	RC-01	5%	1E	R 2511	
4822 051 10108	RES.CHIP	RC-01	5%	1E	R 2512	
4822 051 10108	RES.CHIP	RC-01	5%	1E	R 2513	
4822 051 10108	RES.CHIP	RC-01	5%	1E	R 2514	
4822 051 10108	RES.CHIP	RC-01	5%	1E	R 2516	
4822 051 10108	RES.CHIP	RC-01	5%	1E	R 2517	
4822 051 10108	RES.CHIP	RC-01	5%	1E	R 2518	
4822 051 10106	RES.CHIP	RC-01	5%	10M	R 2519	
4822 051 10106	RES.CHIP	RC-01	5%	10M	R 2521	
4822 116 82532	RES.CHIP	RC-02H	1%	11K	R 2522	
5322 116 81795	RES.CHIP	RC-02H	1%	3K48	R 2523	17
4822 111 91814	RES.CHIP	RC-02H	1%	121E	R 2524	17
4822 111 91891	RES.METAL FILM	RC-02H	1%	34K8	R 2526	
5322 116 81794	RES.CHIP	RC-02H	1%	2K15	R 2527	
4822 116 82532	RES.CHIP	RC-02H	1%	11K	R 2528	
4822 111 91814	RES.CHIP	RC-02H	1%	121E	R 2529	
5322 116 81228	RES.CHIP	RC-02H	1%	5K11	R 2530	
4822 111 91885	RES.CHIP	RMC1/8	1%	10E	R 2531	24
4822 111 91885	RES.CHIP	RMC1/8	1%	10E	R 2532	
5322 116 82901	RES.MET.GLAZED	RMC1/8	1%	19K6	R 2534	
4822 116 82885	RES.METAL FILM	RC-02H	1%	51K1	R 2535	
5322 116 80427	RES.CHIP	RC-02H	1%	1K	R 2536	
4822 111 91891	RES.METAL FILM	RC-02H	1%	34K8	R 2537	
5322 116 82367	RES.METAL FILM	RC-02H	1%	3K16	R 2538	02
5322 116 82367	RES.METAL FILM	RC-02H	1%	3K16	R 2540	02
4822 116 82532	RES.CHIP	RC-02H	1%	11K	R 2541	
4822 111 91885	RES.CHIP	RMC1/8	1%	10E	R 2542	
5322 116 81228	RES.CHIP	RC-02H	1%	5K11	R 2543	
4822 111 91891	RES.METAL FILM	RC-02H	1%	34K8	R 2544	
4822 111 91814	RES.CHIP	RC-02H	1%	121E	R 2546	
4822 111 91816	RES.CHIP	RC-02H	1%	14K7	R 2548	
4822 116 82532	RES.CHIP	RC-02H	1%	11K	R 2551	
4822 116 82408	RES.CHIP	RC-02H	1%	1K33	R 2554	
5322 111 91811	RES.CHIP	RC-02H	1%	5K62	R 2556	
5322 116 81794	RES.CHIP	RC-02H	1%	2K15	R 2557	

Ordering code	Description				Item	Revision level
5322 116 81794	RES.CHIP	RC-02H	1%	2K15	R 2558	
5322 116 81794	RES.CHIP	RC-02H	1%	2K15	R 2559	
5322 111 91809	RES.METAL FILM	RC-02H	1%	215K	R 2561	
4822 116 82532	RES.CHIP	RC-02H	1%	11K	R 2562	
4822 111 91885	RES.CHIP	RMC1/8	1%	10E	R 2563	
5322 111 91811	RES.CHIP	RC-02H	1%	5K62	R 2564	
5322 111 91893	RES.CHIP	RMC1/8	1%	51E1	R 2565	
4822 111 91891	RES.METAL FILM	RC-02H	1%	34K8	R 2566	
4822 111 91891	RES.METAL FILM	RC-02H	1%	34K8	R 2567	
5322 111 91809	RES.METAL FILM	RC-02H	1%	215K	R 2568	
5322 111 91809	RES.METAL FILM	RC-02H	1%	215K	R 2569	
4822 051 10108	RES.CHIP	RC-01	5%	1E	R 2571	
5322 116 80429	RES.CHIP	RC-02H	1%	100K	R 2572	
5322 111 91809	RES.METAL FILM	RC-02H	1%	215K	R 2573	
4822 116 82885	RES.METAL FILM	RC-02H	1%	51K1	R 2575	
5322 116 80429	RES.CHIP	RC-02H	1%	100K	R 2581	
5322 113 41318	RES.	SMW02	5%	0E1	R 2582	
4822 051 10108	RES.CHIP	RC-01	5%	1E	R 2583	03
4822 111 91885	RES.CHIP	RMC1/8	1%	10E	R 2584	
5322 116 82901	RES.MET.GLAZED	RMC1/8	1%	19K6	R 2596	
5322 116 82901	RES.MET.GLAZED	RMC1/8	1%	19K6	R 2597	
5322 116 80429	RES.CHIP	RC-02H	1%	100K	R 2598	
5322 116 82901	RES.MET.GLAZED	RMC1/8	1%	19K6	R 2599	
4822 116 82886	RES.CHIP	RC-02H	1%	61K9	R 2729	
5322 116 40214	RES.N.T.C.	SPEC			R 2750	
5322 116 82905	RES.METAL FILM	R25 487K	1%		R 2753	02
4822 111 91892	RES.METAL FILM	RC-02H	1%	511K	R 2754	
5322 116 80427	RES.CHIP	RC-02H	1%	1K	R 2755	02
4822 111 91891	RES.METAL FILM	RC-02H	1%	34K8	R 2757	
5322 116 80428	RES.CHIP	RC-02H	1%	10K	R 2758	
5322 111 91899	RES.CHIP	RMC1/8	1%	261E	R 2759	
4822 116 90788	RES.NETWORK	RMC1/8	1%	68E1	R 2760	02
5322 111 91809	RES.METAL FILM	RC-02H	1%	215K	R 2761	
4822 116 81165	RES.CHIP	RC-02H	1%	1M	R 2762	
4822 051 10106	RES.CHIP	RC-01	5%	10M	R 2763	
4822 111 91828	RES.CHIP	RC-02H	1%	68K1	R 2764	
4822 051 51003	RES.CHIP	RC-01	5%	10K	R 2765	22
5322 116 82901	RES.MET.GLAZED	RMC1/8	1%	19K6	R 2766	
5322 116 81228	RES.CHIP	RC-02H	1%	5K11	R 2767	02
4822 116 82883	RES.CHIP	RC-02H	1%	237K	R 2768	
5322 116 82011	RES.METAL FILM	RC-02H	1%	147K	R 2769	
4822 111 91891	RES.METAL FILM	RC-02H	1%	34K8	R 2770	
5322 116 80429	RES.CHIP	RC-02H	1%	100K	R 2771	
5322 116 80429	RES.CHIP	RC-02H	1%	100K	R 2772	
4822 051 51002	RES.CHIP	RC-02H	1%	1K	R 2773	07
4822 111 91814	RES.CHIP	RC-02H	1%	121E	R 2774	07
5322 116 81795	RES.CHIP	RC-02H	1%	3K48	R 2775	
4822 111 91891	RES.METAL FILM	RC-02H	1%	34K8	R 2776	

Ordering code	Description				Item	Revision level
5322 111 91893	RES.CHIP	RMC1/8	1%	51E1	R 2777	
5322 116 82905	RES.METAL FILM	R25	1%	487K	R 2778	
4822 051 53483	RES.MET.GLAZED	RMC1/8	1%	34K8	R 2853	03
5322 116 82903	RES.MET.GLAZED	RMC1/8	1%	31K6	R 2854	
4822 111 91828	RES.CHIP	RC-02H	1%	68K1	R 2856	
4822 111 91828	RES.CHIP	RC-02H	1%	68K1	R 2857	
4822 051 10108	RES.CHIP	RC-01	5%	1E	R 2858	02, 17
4822 116 82887	RES.CHIP	RC-02H	1%	75K	R 2859	
4822 051 10106	RES.CHIP	RC-01	5%	10M	R 2860	05, 22
4822 116 82883	RES.CHIP	RC-02H	1%	237K	R 2861	
5322 111 91812	RES.METAL FILM	RC-02H	1%	562K	R 2862	
5322 116 81795	RES.CHIP	RC-02H	1%	3K48	R 2863	
4822 111 91891	RES.METAL FILM	RC-02H	1%	34K8	R 2864	
4822 111 91891	RES.METAL FILM	RC-02H	1%	34K8	R 2865	
4822 111 91814	RES.CHIP	RC-02H	1%	121E	R 2866	
4822 111 91891	RES.METAL FILM	RC-02H	1%	34K8	R 2867	
4822 111 91891	RES.METAL FILM	RC-02H	1%	34K8	R 2868	
4822 051 53483	RES.METAL FILM	RC-02H	1%	34K8	R 2869	02, 03
5322 116 82111	RES.CHIP	RC-02H	1%	261K	R 2870	
5322 116 82904	RES.MET.GLAZED	RMC1/8	1%	464K	R 2871	
5322 116 82904	RES.MET.GLAZED	RMC1/8	1%	464K	R 2872	
5322 116 82111	RES.CHIP	RC-02H	1%	261K	R 2873	
5322 111 91809	RES.METAL FILM	RC-02H	1%	215K	R 2875	
4822 116 82884	RES.CHIP	RC-02H	1%	316K	R 2876	
5322 111 91809	RES.METAL FILM	RC-02H	1%	215K	R 2877	
4822 116 82885	RES.METAL FILM	RC-02H	1%	51K1	R 2878	
5322 116 82901	RES.MET.GLAZED	RMC1/8	1%	19K6	R 2879	
5322 111 91899	RES.CHIP	RMC1/8	1%	261E	R 2881	
5322 116 82901	RES.MET.GLAZED	RMC1/8	1%	19K6	R 2901	
5322 116 82011	RES.METAL FILM	RC-02H	1%	147K	R 2903	
5322 116 82903	RES.MET.GLAZED	RMC1/8	1%	31K6	R 2904	
5322 116 82903	RES.MET.GLAZED	RMC1/8	1%	31K6	R 2906	
4822 111 91891	RES.METAL FILM	RC-02H	1%	34K8	R 2907	
5322 116 82903	RES.MET.GLAZED	RMC1/8	1%	31K6	R 2908	
5322 116 82903	RES.MET.GLAZED	RMC1/8	1%	31K6	R 2909	

SEMI-CONDUCTORS

4822 130 42513	TRANSISTOR,CHIP	BC858C		V 2101	12
4822 123 42513	TRANSISTOR,CHIP	BC858C		V 2102	12
5322 130 42145	TRANSISTOR,CHIP	BFR92		V 2104	
5322 130 44787	TRANSISTOR,CHIP	BFR31		V 2105	
5322 130 42145	TRANSISTOR,CHIP	BFR92		V 2106	
5322 130 61707	TRANSISTOR	BF991		V 2107	
5322 130 42718	TRANSISTOR,CHIP	BFS20		V 2108	
5322 130 42145	TRANSISTOR,CHIP	BFR92		V 2109	
5322 130 42136	TRANSISTOR,CHIP	BC848C		V 2110	
5322 130 42145	TRANSISTOR,CHIP	BFR92		V 2111	

Ordering code	Description		Item	Revision level
4822 130 42513	TRANSISTOR,CHIP	BC858C	V 2112	22
4822 130 42513	TRANSISTOR,CHIP	BC858C	V 2113	22
5322 130 42145	TRANSISTOR,CHIP	BFR92	V 2114	
4822 130 42513	TRANSISTOR,CHIP	BC858C	V 2201	12
4822 130 42513	TRANSISTOR,CHIP	BC858C	V 2202	12
5322 130 42145	TRANSISTOR,CHIP	BFR92	V 2204	
5322 130 44787	TRANSISTOR,CHIP	BFR31	V 2205	
5322 130 42145	TRANSISTOR,CHIP	BFR92	V 2206	
5322 130 61707	TRANSISTOR	BF991	V 2207	
5322 130 42718	TRANSISTOR,CHIP	BFS20	V 2208	
5322 130 42145	TRANSISTOR,CHIP	BFR92	V 2209	
5322 130 42136	TRANSISTOR,CHIP	BC848C	V 2210	
5322 130 42145	TRANSISTOR,CHIP	BFR92	V 2211	
4822 130 42513	TRANSISTOR,CHIP	BC858C	V 2212	22
4822 130 42513	TRANSISTOR,CHIP	BC858C	V 2213	22
5322 130 42145	TRANSISTOR,CHIP	BFR92	V 2214	
5322 130 42136	TRANSISTOR,CHIP	BC848C	V 2301	20
5322 130 44711	TRANSISTOR,CHIP	BFT92	V 2302	20
5322 130 34337	DIODE,CHIP	BAV99	V 2303	
5322 130 42136	TRANSISTOR,CHIP	BC848C	V 2304	22
5322 130 34337	DIODE,CHIP	BAV99	V 2501	
5322 130 62661	TRANSISTOR,CHIP	BRY62	V 2502	
5322 130 62659	TRANSISTOR,CHIP	BUZ11A	V 2503	
5322 130 34337	DIODE,CHIP	BAV99	V 2504	
5322 130 62922	DIODE	MBRD630CTT4	V 2506	
5322 130 62922	DIODE	MBRD630CTT4	V 2507	
5322 130 34337	DIODE,CHIP	BAV99	V 2508	
5322 130 42136	TRANSISTOR,CHIP	BC848C	V 2509	
4822 130 42513	TRANSISTOR,CHIP	BC858C	V 2511	
5322 130 34337	DIODE,CHIP	BAV99	V 2512	
4822 130 42513	TRANSISTOR,CHIP	BC858C	V 2513	
5322 130 34337	DIODE,CHIP	BAV99	V 2514	
4822 130 42513	TRANSISTOR,CHIP	BC858C	V 2516	
5322 130 42136	TRANSISTOR,CHIP	BC848C	V 2517	
4822 130 42513	TRANSISTOR,CHIP	BC858C	V 2518	22
5322 130 42136	TRANSISTOR,CHIP	BC848C	V 2521	
5322 130 34337	DIODE,CHIP	BAV99	V 2523	
4822 130 42133	TRANSISTOR,CHIP	BC817	V 2526	
5322 130 34337	DIODE,CHIP	BAV99	V 2527	
5322 130 42136	TRANSISTOR,CHIP	BC848C	V 2528	
5322 130 34337	DIODE,CHIP	BAV99	V 2529	
5322 130 62922	DIODE	MBRD630CTT4	V 2533	
5322 130 42136	TRANSISTOR,CHIP	BC848C	V 2534	
5322 130 42136	TRANSISTOR,CHIP	BC848C	V 2536	
5322 130 62921	TRANSISTOR	2SK974STR	V 2537	
5322 130 62921	TRANSISTOR	2SK974STR	V 2538	
5322 130 62922	DIODE	MBRD630CTT4	V 2539	
5322 130 48135	TRANSISTOR,CHIP	BC848C	V2540	22

Ordering code	Description		Item	Revision level
5322 130 42136	TRANSISTOR,CHIP	BC848C	V 2541	
4822 130 82262	DIODE,CHIP	BAT54S	V 2543	22
4822 130 42513	TRANSISTOR,CHIP	BC858C	V 2544	
4822 130 42513	TRANSISTOR,CHIP	BC858C	V 2736	
4822 130 82522	DIODE,CHIP	BZD27-C7V5	V 2751	13
4822 130 82522	DIODE,CHIP	BZD27-C7V5	V 2752	
4822 130 82522	DIODE,CHIP	BZD27-C7V5	V 2753	
4822 130 82522	DIODE,CHIP	BZD27-C7V5	V 2755	
5322 130 44787	TRANSISTOR,CHIP	BFR31	V 2754	
4822 130 82522	DIODE,CHIP	BZD27-C7V5	V 2755	08
5322 130 44787	TRANSISTOR,CHIP	BFR31	V 2756	
5322 130 34337	DIODE,CHIP	BAV99	V 2757	
5322 130 60502	TRANSISTOR,CHIP	BSS83	V 2758	
5322 130 34337	DIODE,CHIP	BAV99	V 2759	07
5322 130 42136	TRANSISTOR,CHIP	BC848C	V 2760	
5322 130 42136	TRANSISTOR,CHIP	BC848C	V 2761	
5322 130 34337	DIODE,CHIP	BAV99	V 2762	
5322 130 34337	DIODE,CHIP	BAV99	V 2763	
4822 130 82522	DIODE,CHIP	BZD27-C7V5	V 2764	
5322 130 42136	TRANSISTOR,CHIP	BC848C	V 2765	11, 13
5322 130 42136	TRANSISTOR,CHIP	BC848C	V 2766	11, 13
5322 130 42136	TRANSISTOR,CHIP	BC848C	V 2767	
5322 130 42136	TRANSISTOR,CHIP	BC848C	V 2768	
4822 130 82522	DIODE,CHIP	BZD27-C7V5	V 2769	13
4822 130 82522	DIODE,CHIP	BZD27-C7V5	V 2811	
4822 130 82522	DIODE,CHIP	BZD27-C7V5	V 2769	
4822 130 82522	DIODE,CHIP	BZD27-C7V5	V 2812	
5322 130 60502	TRANSISTOR,CHIP	BSS83	V 2851	
4822 130 42513	TRANSISTOR,CHIP	BC858C	V 2852	
4822 130 42513	TRANSISTOR,CHIP	BC858C	V 2853	
4822 130 42513	TRANSISTOR,CHIP	BC858C	V 2854	
4822 130 42513	TRANSISTOR,CHIP	BC858C	V 2901	

INTEGRATED CIRCUITS

4822 209 63764	I.C. INTERFACE	PC74HC4316T	D 2101	
4822 209 63764	I.C. INTERFACE	PC74HC4316T	D 2102	
4822 209 63764	I.C. INTERFACE	PC74HC4316T	D 2201	
4822 209 63764	I.C. INTERFACE	PC74HC4316T	D 2202	
5322 209 30821	ANALOG ASIC	OQ00308	D 2301	18
4822 209 63764	I.C. INTERFACE	PC74HC4316T	D 2750	
4822 209 63764	I.C. INTERFACE	PC74HC4316T	D 2751	
4822 209 63764	I.C. INTERFACE	PC74HC4316T	D 2850	
4822 209 63763	I.C. INTERFACE	PC74HC541T	D 2901	
4822 209 63763	I.C. INTERFACE	PC74HC541T	D 2902	
4822 209 63763	I.C. INTERFACE	PC74HC541T	D 2903	
5322 209 12171	INTEGR.CIRCUIT	PC74HC4094T	D 2904	
5322 209 12171	INTEGR.CIRCUIT	PC74HC4094T	D 2906	
5322 209 12171	INTEGR.CIRCUIT	PC74HC4094T	D 2907	
5322 209 12171	INTEGR.CIRCUIT	PC74HC4094T	D 2908	

Ordering code	Description		Item	Revision level
5322 209 12171	INTEGR.CIRCUIT	PC74HC4094T	D 2909	
4822 209 63757	INTEGR.CIRCUIT	LF453CM	N 2101	
4822 209 63757	INTEGR.CIRCUIT	LF453CM	N 2201	
5322 209 30676	INTEGR.CIRCUIT	TDA8703T/C4	N 2302	
4822 209 60175	INTEGR.CIRCUIT	LM358M	N 2501	
4822 209 63765	INTEGR.CIRCUIT	LM285M-1.2	N 2502	
5322 209 71807	INTEGR.CIRCUIT	SG3524D	N 2503	
5322 209 31309	INTEGR.CIRCUIT	TLC27M2ACDR	N 2750	13
5322 209 31309	INTEGR.CIRCUIT	TLC27M2ACDR	N 2751	13
4822 209 63757	INTEGR.CIRCUIT	LF453CM	N 2850	

COILS

5322 157 63649	COIL	39NH 20%	L 2301	05
5322 157 63648	COIL	1UH 5%	L 2302	
5322 157 63647	COIL	0.1UH 5%	L 2303	18
5322 157 63647	COIL	0.1UH 5%	L 2304	18
5322 157 63648	COIL	1UH 5%	L 2501	
5322 157 63092	COIL	68UH	L 2502	
5322 157 63092	COIL	68UH	L 2503	
5322 157 52707	COIL	22UH	L 2504	
5322 157 52707	COIL	22UH	L 2506	
5322 156 11139	COIL	FILTER 50V-10A	Z 2501	

MISCELLANEOUS

5322 280 10245	BUZZER	MEB-12B-12	H 2901	
5322 280 80745	RELAY	RAL3W-K	K 2101	
5322 280 80745	RELAY	RAL3W-K	K 2102	
5322 280 80745	RELAY	RAL3W-K	K 2103	
5322 280 80745	RELAY	RAL3W-K	K 2201	
5322 280 80745	RELAY	RAL3W-K	K 2202	
5322 280 80745	RELAY	RAL3W-K	K 2203	
5322 280 80745	RELAY	RAL3W-K	K 2750	
5322 280 80745	RELAY	RAL3W-K	K 2751	

CONNECTORS

5322 267 70302	CONNECTOR	30-PIN STRAIGHT	X 2001	
4822 267 30431	SOCKET	HEC0739-01-010	X 2501	
5322 265 30434	CONNECTOR	3-PIN STRAIGHT	X 2502	

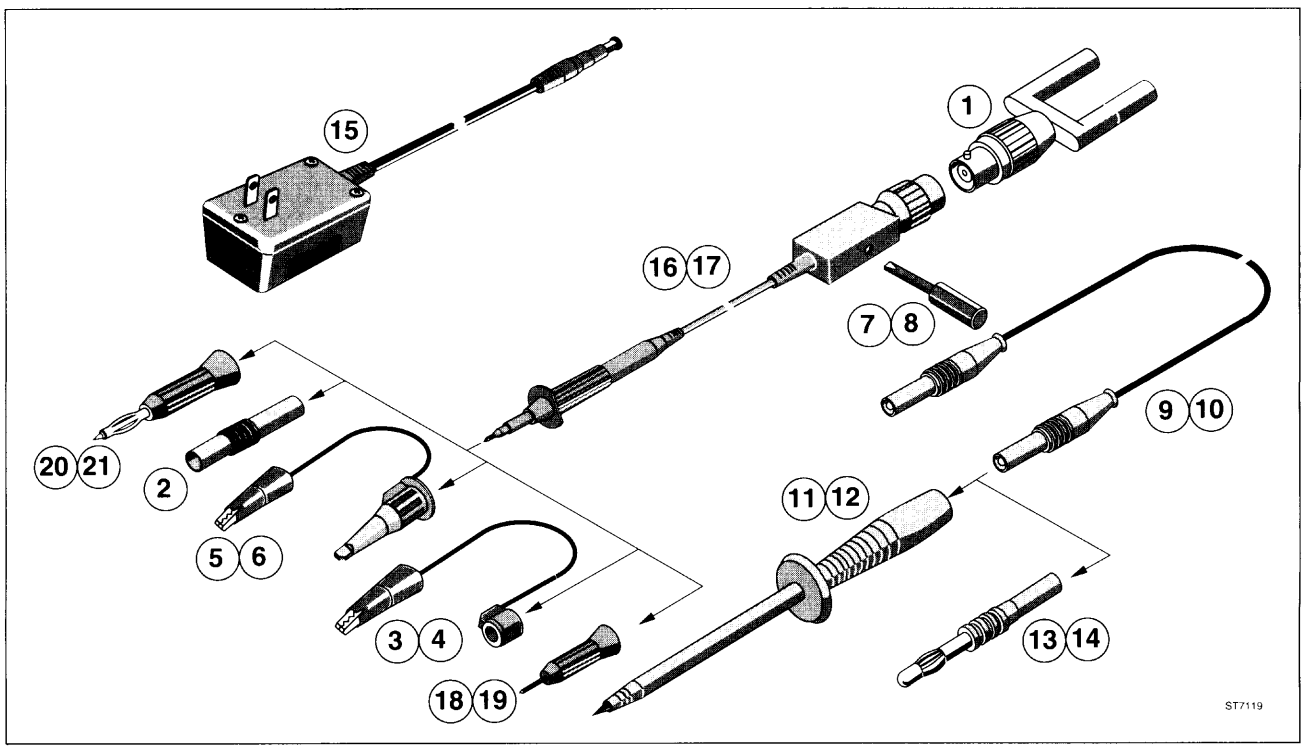
TRANSFORMERS

5322 146 21674	TRANSFORMER		T2501	

Table 9.7 Accessories replacements Fluke

ORDER NUMBER /MODEL NUMBER	DESCRIPTION	ITEM
PM9086/001	NiCad Battery Pack	-
PM8907/003	Line Voltage Adapter/Battery Charger (North America)	15
PM8918/002	Safety-Designed ScopeMeter Probe Set	16, 17, 18, 19, 3, 4, 7, 8, 2 [1])
PM9081/001	Safety-Designed Dual Banana Plug to Female BNC Adapter	1
PM9083/001	ScopeMeter Yellow Protective Holster	-
C75	Accessory Case	-
Fluke 916015	Multimeter Test Lead Set	9, 10, 11, 12, 13, 14
Fluke 916010	ProbeTip to Banana Plug Adapter/Adjust adapter	2 [1])
Fluke 916127	Quick Operating Guide	-
Fluke 916119	ScopeMeter English Users Manual	-
Fluke 916122	ScopeMeter French, Spanish, Italian Users Manual	-
Fluke 931605	Service Manual	-
Fluke 931642	Probe Tip to Banana Plug Adapter RED	20
Fluke 931647	Probe Tip to Banana Plug Adapter GREY	21

Figure 9.6 Accessories replacements Fluke



[1]) Item 2 will be replaced by Item 20 + Item 21

Table 9.8 Accessories replacements Philips

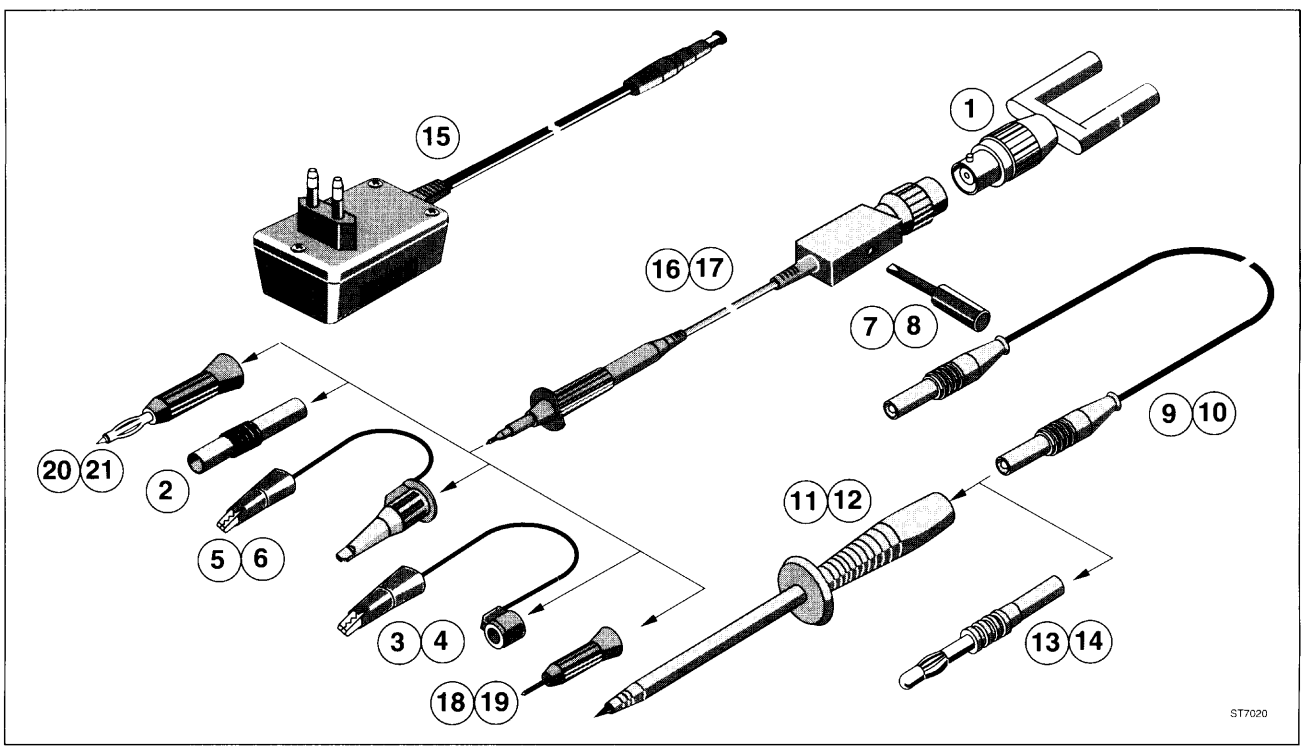
ITEM	DESCRIPTION	ORDER NUMBER /MODEL NUMBER	
1	Adapter Banana/BNC	PM9081/001	
2	Adjust adapter RED	5322 263 50192 [1]	
3	HF adapter BLACK	5322 263 50193	
4	HF adapter BLACK	5322 263 50193	
5	Mini test hook RED	5322 210 70131	
6	Mini test hook GREY	5322 210 70129	
7	Trim screwdriver RED	5322 395 50417	
8	Trim screwdriver GREY	5322 395 50416	
9	Test lead RED	5322 397 60157	PM9266/041
10	Test lead BLACK	5322 397 60156	
11	Test pin RED	5322 264 20046	
12	Test pin BLACK	5322 264 20045	
13	Banana adapter RED	5322 264 20051	
14	Banana adapter BLACK	5322 264 20052	
15	Power adapters/Battery chargers		
	Universal Europe 220V, 50 Hz	PM8907/001	
	North America UL, CSA, 110V, 60 Hz	PM8907/003	
	United Kingdom 240V, 50 Hz	PM8907/004	
	Universal 115V/230V	PM8907/008	
20	Probe tip to banana adapter RED	5322 264 20096	
21	Probe tip to banana adapter GREY	5322 264 20097	

ITEM	DESCRIPTION	ORDER NUMBER /MODEL NUMBER	
16	Scope probe RED		PM8918/002
17	Scope probe GREY		
18	High voltage testpin RED	5322 264 20087	
19	High voltage test pin GREY	5322 264 20088	
2	Adjust adapter RED	5322 263 50192 [1]	
3	HF adapter BLACK	5322 263 50193	
4	HF adapter BLACK	5322 263 50193	
7	Trim screwdriver RED	5322 395 50417	
8	Trim screwdriver GREY	5322 395 50416	
-	NiCad Battery Pack	PM9086/001	
-	Holster	PM9083/001	
-	Accessory case	C 75	

Users Manuals

English	4822 872 00492
Dutch, German, French	4822 872 00494
Swedish, Danish, Finnish, Norwegian	4822 872 00495
French, Spanish, Italian	4822 872 00493
Quick Operating Guide	4822 872 00491
Service Manual	4822 872 05352 (optional)

Figure 9.6 Accessories replacements Philips



[1] Item 2 will be replaced by Item 20 + Item 21

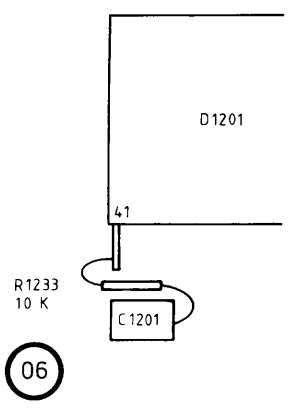
10 CIRCUIT DIAGRAMS

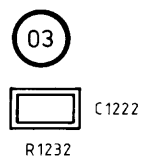
This chapter contains all circuit diagrams and PCB layouts of both the ScopeMeter analog and digital PCBs.

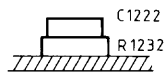
MODIFICATIONS

Changes that have been made are indicated in the diagrams by a Revision Level number, placed in a circle: (nn). Refer to Section 11 for an description of the modifications.

Refer to the replaceable partslist (Section 9) for the correct value and type of a part. Refer to the Revision Level overviews in Section 11 when a revision level number is indicated behind a partnumber.







C1222 MOUNTED OVER R1232

Figure 10.1a Modifications Digital A1 PCB

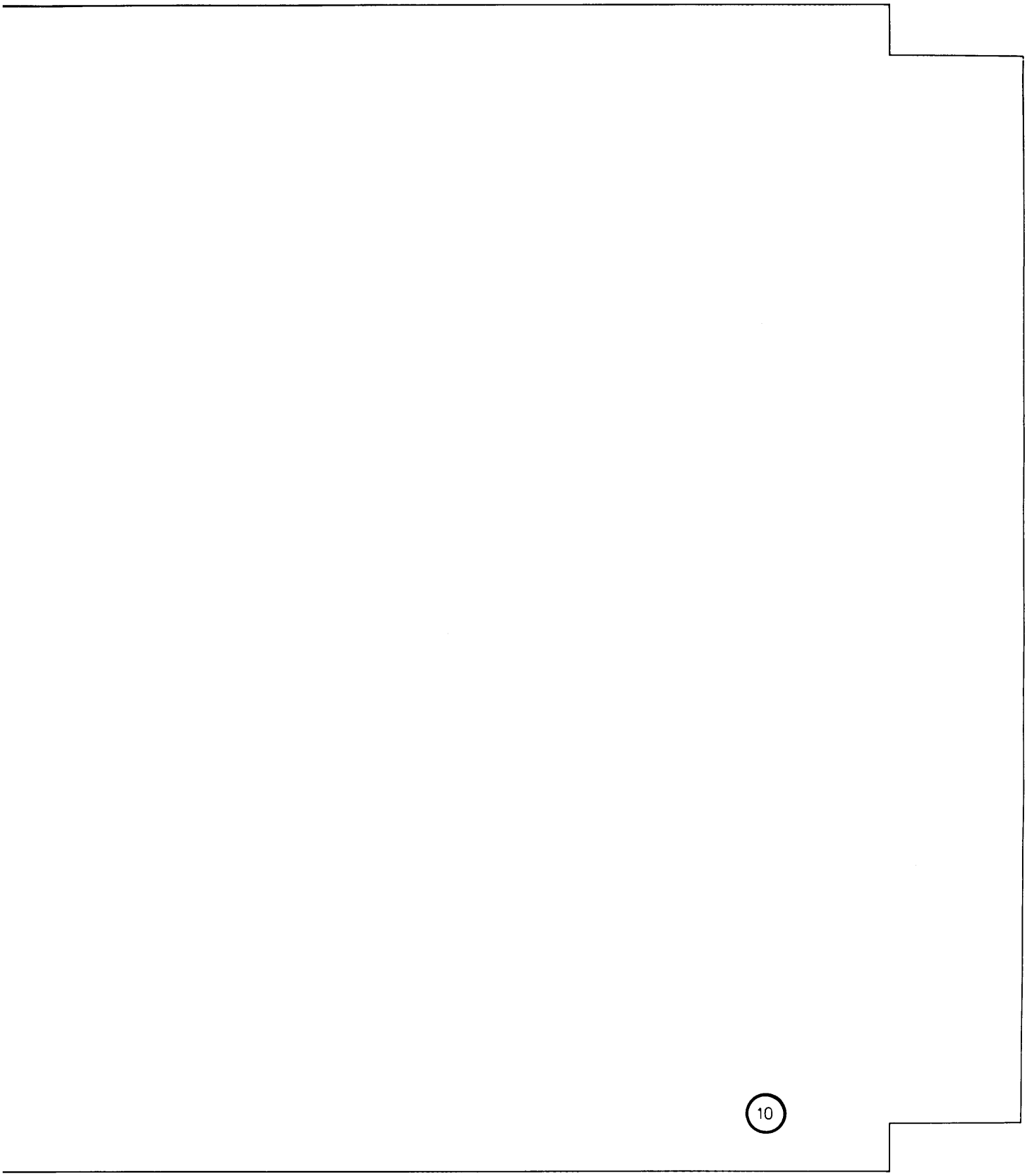
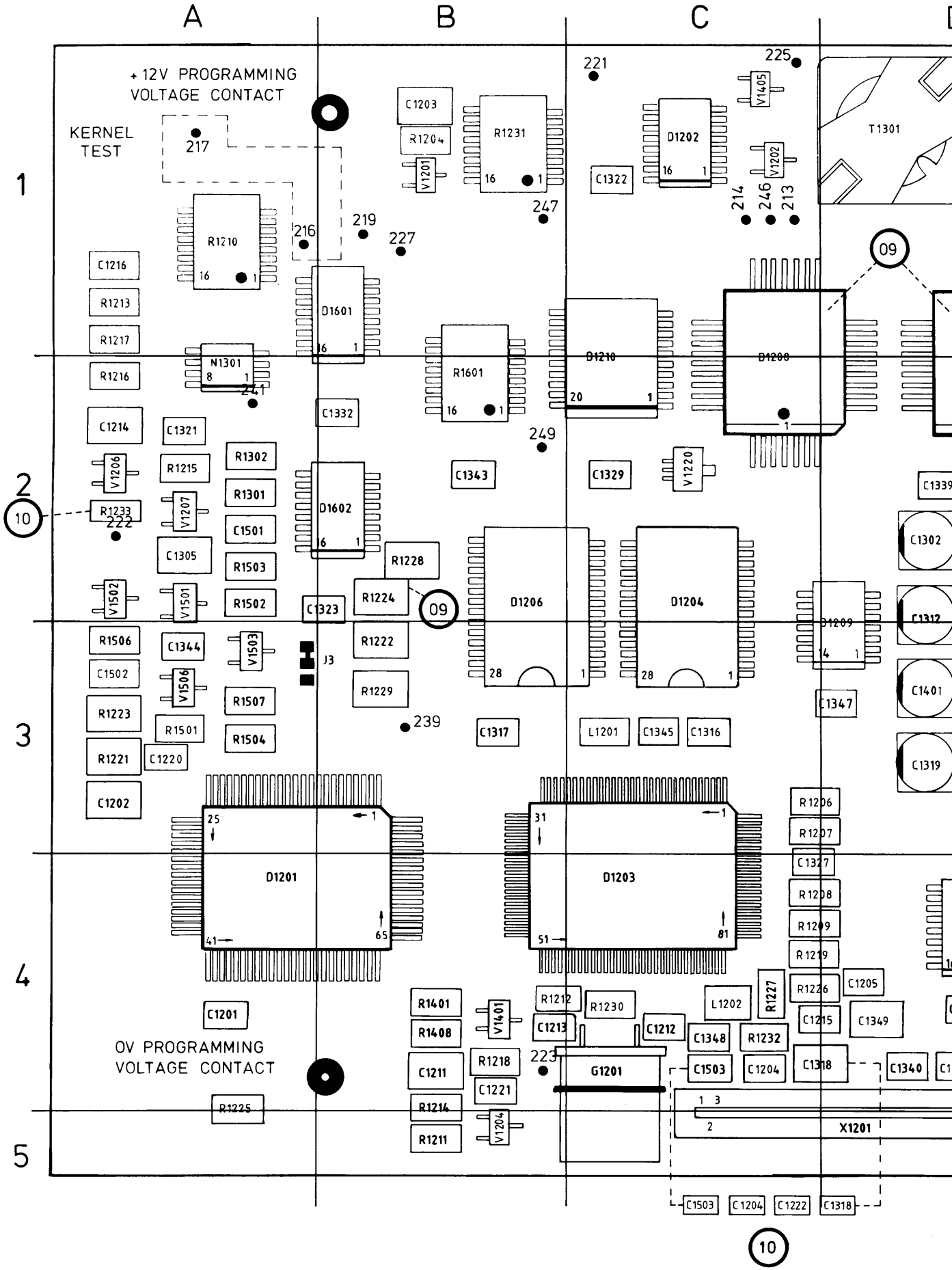
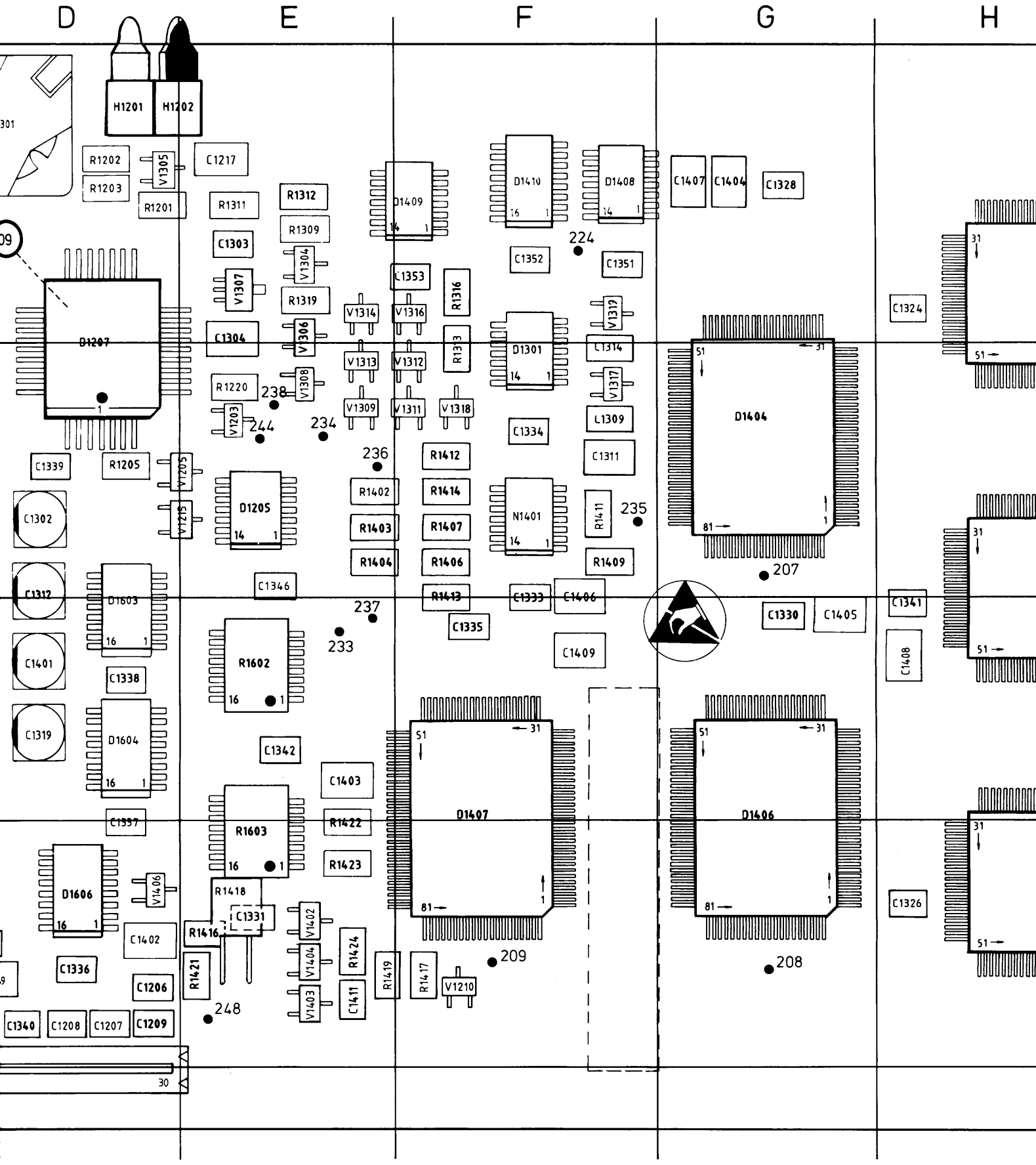


Figure 10.1a Modifications Digital A1 PCB up to Revision Level 10

PARTS LOCATION A1 (PCB)

C1201	A4	C1339	D2	D1604	D3	R1316	F1	V1312	F2
C1202	A3	C1340	D4	D1606	D4	R1319	E1	V1313	E2
C1203	B1	C1341	H3	G1201	C4	R1401	B4	V1316	F1
C1204	C4	C1342	E3	H1201	D1	R1402	E2	V1317	F2
C1205	D4	C1343	B2	H1202	D1	R1403	E2	V1318	F2
C1206	D4	C1344	A3	L1201	C3	R1404	E2	V1319	F1
C1207	D4	C1345	C3	L1202	C4	R1406	F2	V1401	B4
C1208	D4	C1346	E2	N1301	A2	R1407	F2	V1402	E4
C1209	D4	C1347	D3	N1401	F2	R1408	B4	V1403	E4
C1211	B4	C1348	C4	R1201	D1	R1409	F2	V1404	E4
C1212	C4	C1349	D4	R1202	D1	R1411	F2	V1405	C1
C1213	B4	C1351	F1	R1203	D1	R1412	F2	V1406	D4
C1214	A2	C1352	F1	R1204	B1	R1413	F2	V1407	C1
C1215	C4	C1353	F1	R1205	D2	R1414	F2	V1501	A2
C1216	A1	C1401	D3	R1206	C3	R1416	E4	V1502	A2
C1217	E1	C1402	D4	R1207	C3	R1417	F4	V1503	A3
C1220	A3	C1403	E3	R1208	C4	R1418	E4	V1506	A3
C1221	B4	C1404	G1	R1209	C4	R1419	E4	TP207	G2
C1222	C4	C1405	G3	R1210	A1	R1421	E4	TP208	G4
C1302	D2	C1406	F2	R1211	B5	R1422	E4	TP209	F4
C1303	E1	C1407	G1	R1212	B4	R1423	E4	TP210	I4
C1304	E1	C1408	H3	R1213	A1	R1424	E4	TP211	I2
C1305	A2	C1409	F3	R1214	B4	R1501	A3	TP212	I1
C1309	F2	C1411	E4	R1215	A2	R1502	A2	TP213	C1
C1311	F2	C1501	A2	R1216	A2	R1503	A2	TP214	C1
C1312	D2	C1502	A3	R1217	A1	R1504	A3	TP216	A1
C1314	F2	D1201	A4	R1218	B4	R1506	A3	TP217	A1
C1316	C3	D1202	C1	R1219	C4	R1507	A3	TP219	B1
C1317	B3	D1203	C4	R1220	E2	R1601	B2	TP221	C1
C1318	C4	D1204	C2	R1221	A3	R1602	E3	TP222	A2
C1319	D3	D1205	E2	R1222	B3	R1603	E4	TP223	B4
C1321	A2	D1206	B2	R1223	A3	T1301	D1	TP224	F1
C1322	C1	D1207	D1	R1224	B2	V1201	B1	TP225	C1
C1323	B2	D1208	C1	R1225	A4	V1203	E2	TP227	B1
C1324	H1	D1209	D2	R1226	C4	V1204	B5	TP233	E3
C1326	H4	D1210	C1	R1227	C4	V1205	E2	TP234	E2
C1327	C4	D1301	F2	R1228	B2	V1206	A2	TP235	F2
C1328	G1	D1401	H4	R1229	B3	V1207	A2	TP236	E2
C1329	C2	D1402	H2	R1230	C4	V1210	F4	TP237	E3
C1330	G3	D1403	H1	R1231	B1	V1215	E2	TP239	B3
C1331	E4	D1404	G2	R1232	C4	V1220	C2	TP241	A2
C1332	B2	D1406	G3	R1233	A2	V1304	E1	TP244	E2
C1333	F2	D1407	F3	R1301	A2	V1305	D1	TP246	C1
C1334	F2	D1408	F1	R1302	A2	V1306	E1	TP247	B1
C1335	F3	D1409	F1	R1309	E1	V1307	E1	TP248	E4
C1336	D4	D1410	F1	R1311	E1	V1308	E2	TP249	B2
C1337	D4	D1601	B1	R1312	E1	V1309	E2		
C1338	D3	D1603	D3	R1313	F2	V1311	F2		


A
B
C
1
2
3
4
5
+12V PROGRAMMING VOLTAGE CONTACT
KERNEL TEST
0V PROGRAMMING VOLTAGE CONTACT
T1301
D1201
D1202
D1203
D1204
D1206
D1208
D1209
D1210
D1601
D1602
N1301
R1210
R1231
R1601
C1203
R1204
V1201
C1322
V1405
V1202
C1216
R1213
R1217
R1216
C1214
C1321
R1215
V1206
V1207
R1233
C1305
V1502
V1501
R1506
C1502
R1223
R1221
C1202
R1501
C1220
R1302
R1301
C1501
R1503
R1502
V1503
V1506
R1507
R1504
C1332
C1323
R1228
R1224
R1222
R1229
J3
C1343
C1329
V1220
C1317
L1201
C1345
C1316
C1347
C1302
C1312
C1401
C1319
C1339
R1206
R1207
C1327
R1208
R1209
R1219
R1226
C1205
C1215
C1349
R1227
L1202
C1348
R1232
C1503
C1204
C1318
C1340
X1201
G1201
R1401
R1408
C1211
R1214
R1211
V1401
V1204
R1218
C1221
R1212
R1230
C1213
C1212
R1225
C1201
09
10
216
217
219
221
223
225
227
239
241
246
247
249
213
214
222
C1503
C1204
C1222
C1318


D
E
F
G
H
H1201
H1202
R1202
R1203
R1201
V1305
C1217
R1311
R1312
R1309
C1303
V1304
V1307
R1319
C1304
V1306
R1220
V1308
V1203
238
244
234
D1207
C1339
R1205
V1205
V1215
C1302
D1205
C1312
D1603
C1346
C1401
C1338
C1319
D1604
C1342
C1337
R1602
R1603
C1403
R1422
R1423
D1606
V1406
R1418
C1331
R1416
C1402
C1336
C1206
R1421
248
C1340
C1208
C1207
C1209
30
D1409
V1314
V1316
C1353
R1316
V1313
V1312
R1313
V1309
V1311
V1318
236
R1412
R1402
R1414
R1403
R1407
R1404
R1406
R1413
C1335
237
233
V1402
V1404
V1403
R1424
C1411
R1419
R1417
V1210
209
D1410
D1408
C1407
C1404
C1328
224
C1352
C1351
D1301
V1319
C1314
V1317
C1309
C1334
C1311
N1401
R1411
235
R1409
C1333
C1406
C1409
D1407
D1404
207
C1330
C1405
D1406
208
C1324
C1341
C1408
C1326
51
31
81
1
14
16

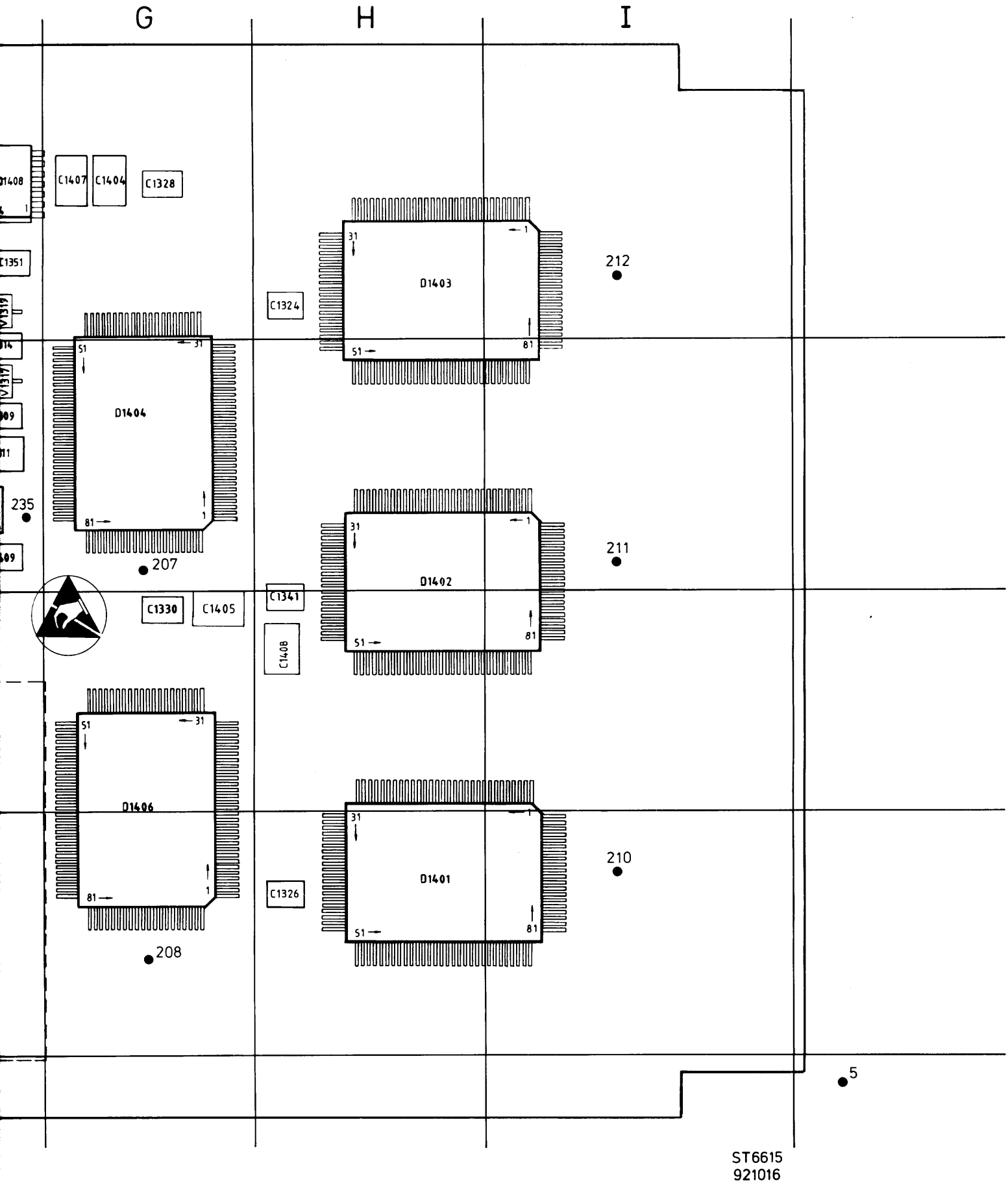
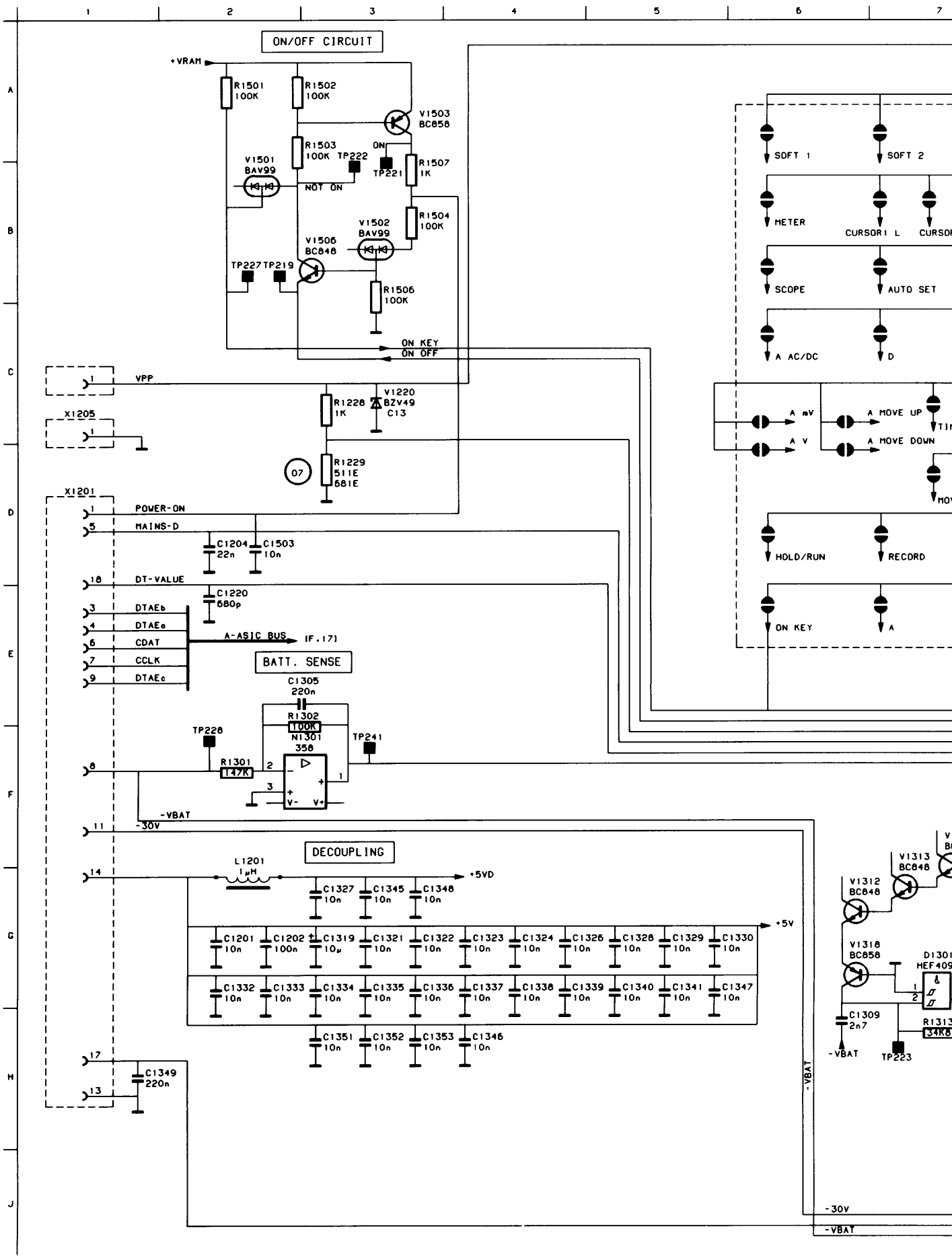
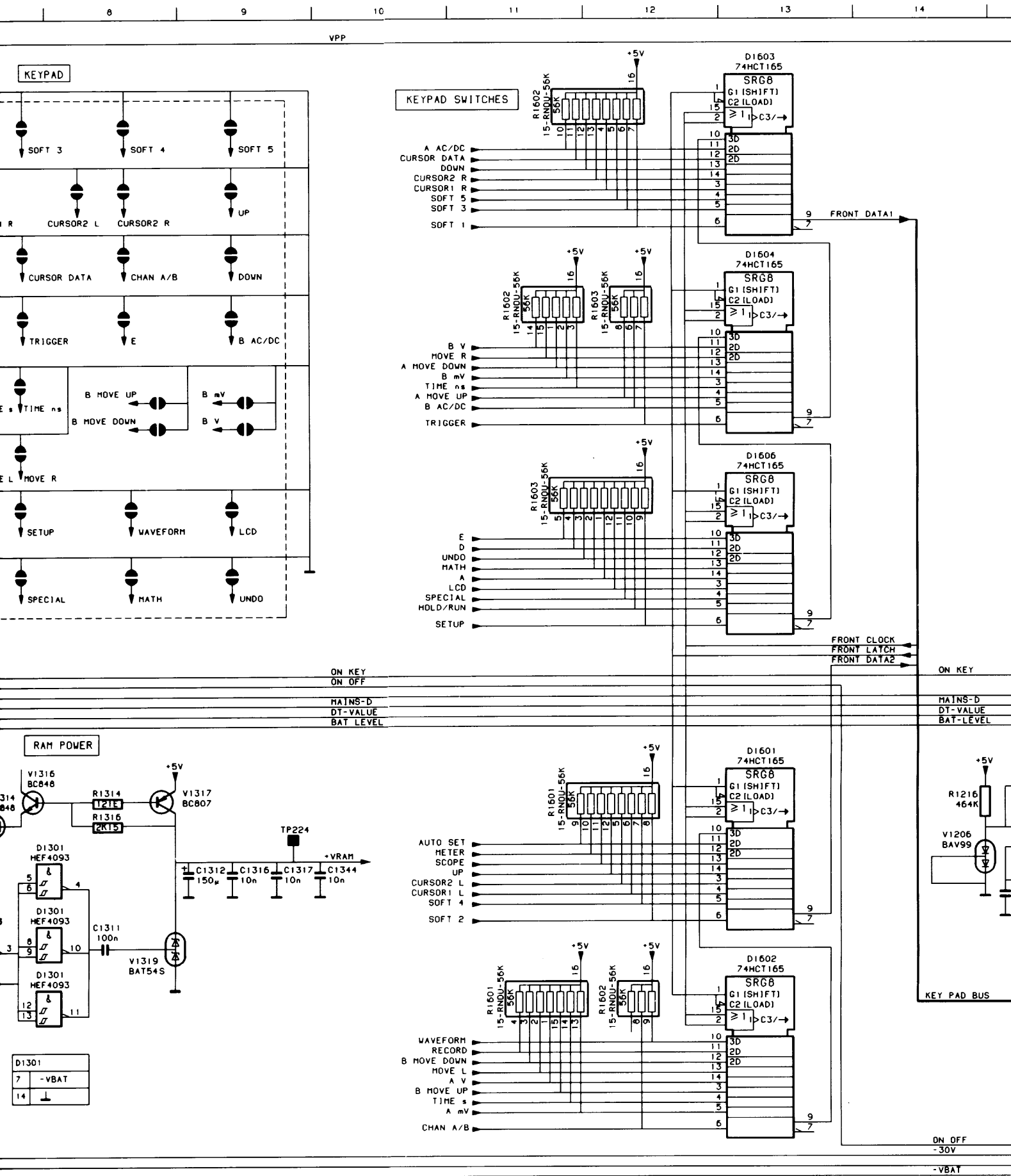
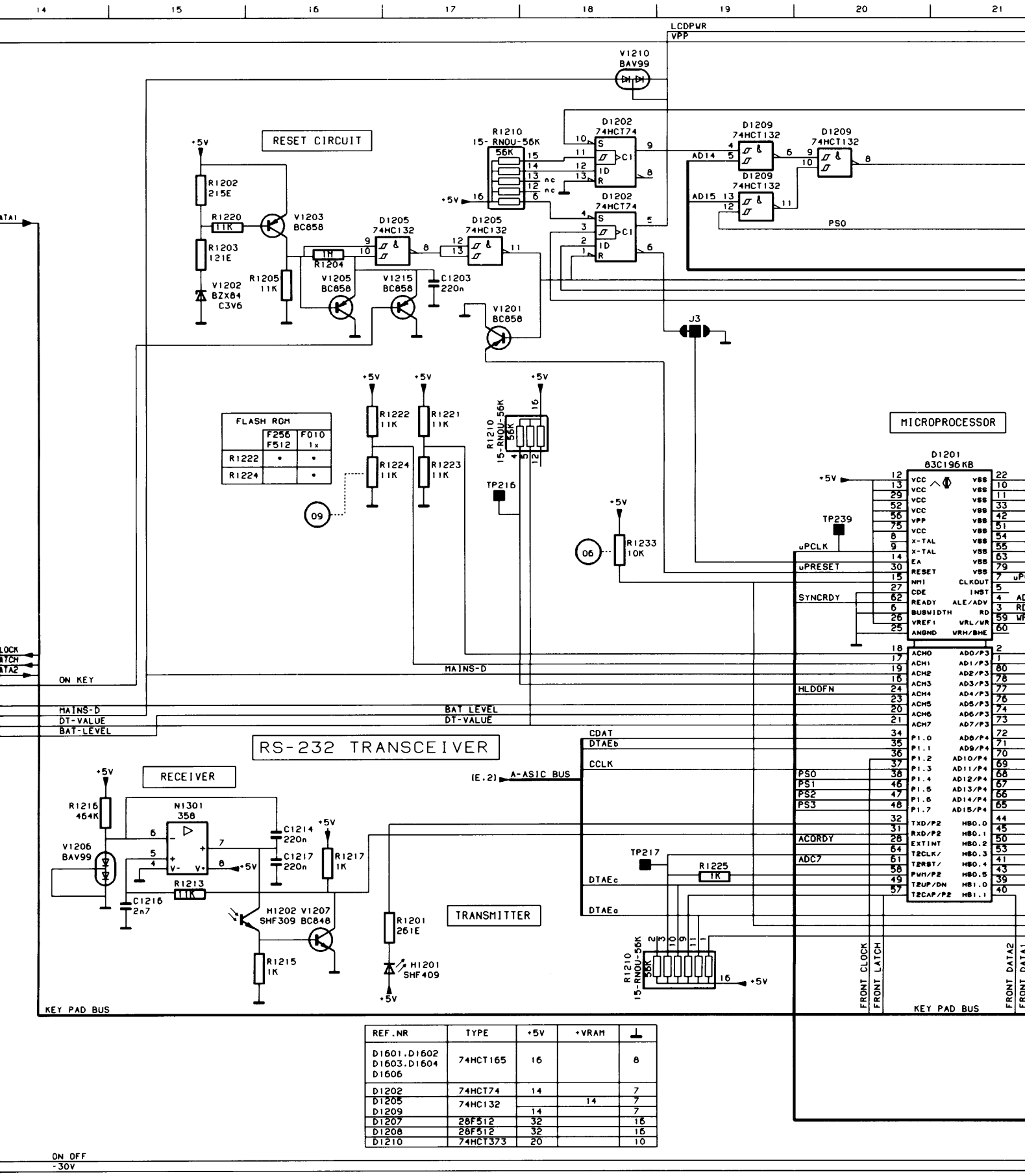


Figure 10.1b Digital A1 PCB


ON/OFF CIRCUIT
+VRAM
R1501 100K
R1502 100K
V1503 BC858
R1503 100K
TP222
ON
TP221
R1507 1K
V1501 BAV99
NOT ON
R1504 100K
V1502 BAV99
V1506 BC848
TP227
TP219
R1506 100K
ON KEY
ON OFF
SOFT 1
SOFT 2
METER
CURSOR1 L
SCOPE
AUTO SET
A AC/DC
D
A mV
A V
A MOVE UP
A MOVE DOWN
HOLD/RUN
RECORD
ON KEY
A
X1205
VPP
R1228 1K
V1220 BZV49 C13
07
R1229 511E 681E
X1201
POWER-ON
MAINS-D
C1204 22n
C1503 10n
DT-VALUE
C1220 680p
DTAEb
DTAEa
CDAT
CCLK
DTAEc
A-ASIC BUS (F.17)
BATT. SENSE
C1305 220n
R1302 100K
N1301 358
TP228
TP241
R1301 147K
-VBAT
-30V
DECOUPLING
L1201 1µH
+5VD
+5V
C1327 10n
C1345 10n
C1348 10n
C1201 10n
C1202 100n
C1319 10µ
C1321 10n
C1322 10n
C1323 10n
C1324 10n
C1326 10n
C1328 10n
C1329 10n
C1330 10n
C1332 10n
C1333 10n
C1334 10n
C1335 10n
C1336 10n
C1337 10n
C1338 10n
C1339 10n
C1340 10n
C1341 10n
C1347 10n
C1351 10n
C1352 10n
C1353 10n
C1346 10n
C1349 220n
V1313 BC848
V1312 BC848
V1318 BC858
D1301 HEF409
C1309 2n7
R1313 34K8
TP223
-VBAT
-30V
-VBAT


8
9
10
11
12
13
14
VPP
KEYPAD
SOFT 3
SOFT 4
SOFT 5
CURSOR2 L
CURSOR2 R
UP
CURSOR DATA
CHAN A/B
DOWN
TRIGGER
E
B AC/DC
TIME ns
B MOVE UP
B MOVE DOWN
B mV
B V
MOVE R
SETUP
WAVEFORM
LCD
SPECIAL
MATH
UNDO
KEYPAD SWITCHES
R1602
15-RNDU-56K
+5V
D1603
74HCT165
SRG8
G1 (SHIFT)
C2 (LOAD)
A AC/DC
CURSOR DATA
DOWN
CURSOR2 R
CURSOR1 R
SOFT 5
SOFT 3
SOFT 1
FRONT DATA1
D1604
74HCT165
R1602
R1603
B V
MOVE R
A MOVE DOWN
B mV
TIME ns
A MOVE UP
B AC/DC
TRIGGER
D1606
74HCT165
R1603
E
D
UNDO
MATH
A
LCD
SPECIAL
HOLD/RUN
SETUP
FRONT CLOCK
FRONT LATCH
FRONT DATA2
ON KEY
ON OFF
MAINS-D
DT-VALUE
BAT LEVEL
RAM POWER
V1316
BC848
R1314
121E
R1316
2K15
V1317
BC807
TP224
+VRAM
C1312
150µ
C1316
10n
C1317
10n
C1344
10n
D1301
HEF4093
C1311
100n
V1319
BAT54S
D1601
74HCT165
R1601
AUTO SET
METER
SCOPE
UP
CURSOR2 L
CURSOR1 L
SOFT 4
SOFT 2
D1602
74HCT165
R1601
R1602
WAVEFORM
RECORD
B MOVE DOWN
MOVE L
A V
B MOVE UP
TIME s
A mV
CHAN A/B
KEY PAD BUS
R1216
464K
V1206
BAV99
ON KEY
MAINS-D
DT-VALUE
BAT-LEVEL
ON OFF
-30V
-VBAT
D1301
7 -VBAT
14 ⊥



REF.NR	TYPE	+5V	+VRAM	⊥
D1601.D1602 D1603.D1604 D1606	74HCT165	16		8
D1202	74HCT74	14		7
D1205	74HC132		14	7
D1209		14		7
D1207	28F512	32		16
D1208	28F512	32		16
D1210	74HCT373	20		10

Figure 10.2a Digital A1 circu

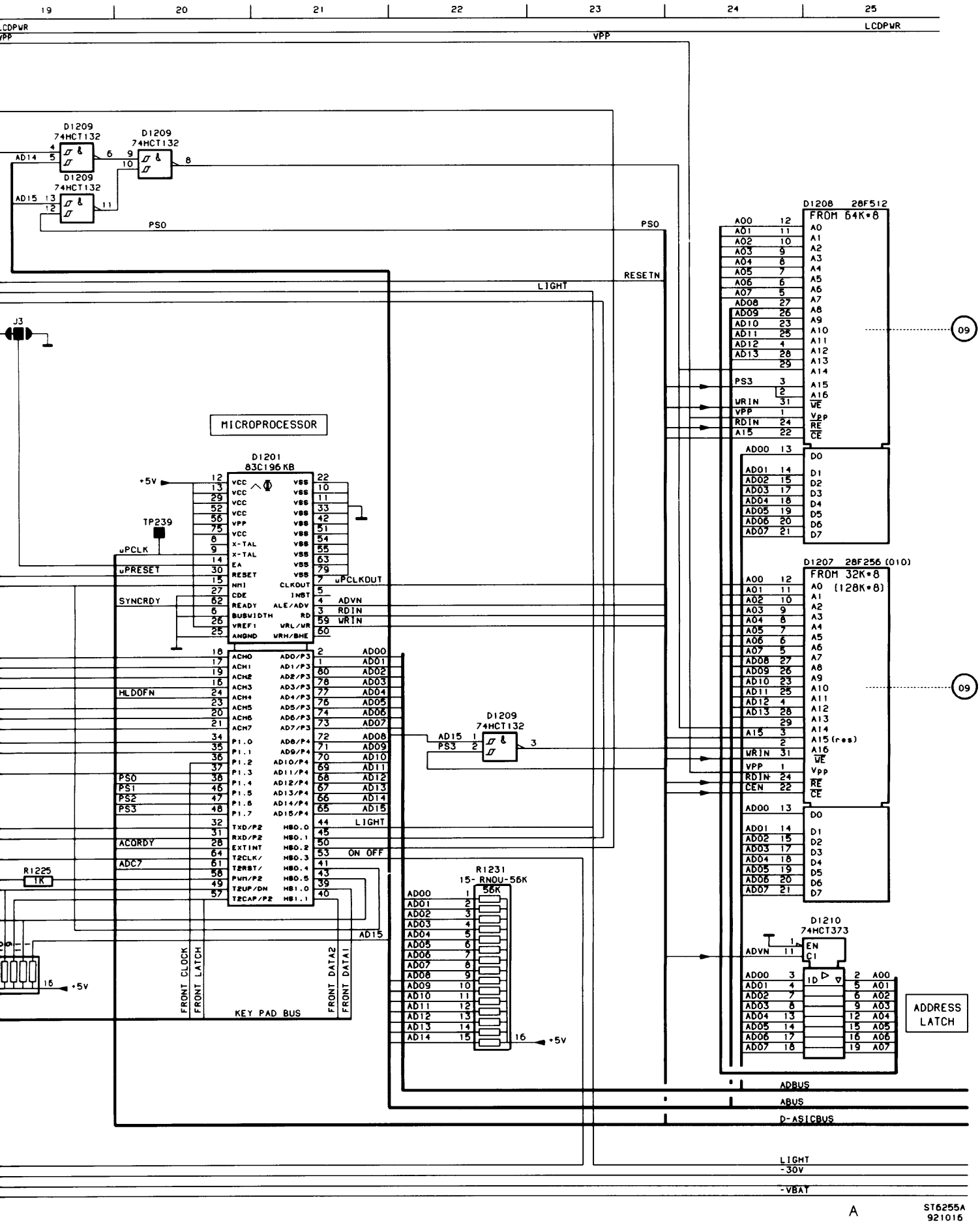


Figure 10.2a Digital A1 circuit diagram (part a)

PARTS LOCATION A1 (CIRCUIT DIAGRAM)

A	E7	C1335	G3	D1604	B13	R1231	G22	TP221	A3
A MOVE UP	C7	C1336	G3	D1606	D13	R1233	E18	TP222	A3
A MOVE DN	C7	C1338	G4	DOWN	B9	R1301	F2	TP223	H7
A AC/DC	C6	C1339	G4	E	C8	R1302	E2	TP224	G9
A mV	C6	C1340	G5	G1337	G4	R1313	H7	TP228	F2
AUTOSET	B7	C1341	G5	H1201	G17	R1314	F8	TP239	D20
B MOVE DN	C8	C1346	G3	H1202	G16	R1316	F8	TP241	F3
B MOVE UP	C8	C1347	G5	HOLD/RUN	D6	R1501	A2	TRIGGER	C6
B V	C9	C1348	G3	J3	C19	R1502	A3	UNDO	E8
B mV	C9	C1349	H1	L1201	G2	R1503	A3	UP	B9
B AC/DC	C9	C1350	H2	LCD	D8	R1504	B3	V1201	C17
B1209	B19	C1351	H3	MATH	E8	R1506	B3	V1202	B15
C1201	G2	C1352	H3	METER	B6	R1507	A3	V1203	B16
C1202	G2	C1353	H3	MOVE L	D7	R1601	H11	V1205	B16
C1203	B17	C1503	D2	MOVE R	D7	R1601	F11	V1206	G14
C1204	D2	CHAN A/B	B8	N1301	F2	R1602	C11	V1207	G16
C1214	F16	CURSOR DA	B7	N1301	F15	R1602	A11	V1210	A18
C1217	G16	CURSOR1 L	B7	ON KEY	E6	R1602	H12	V1215	B17
C1305	E2	CURSOR1 R	B7	R1201	G17	R1602	C12	V1220	C3
C1309	H6	CURSOR2 L	B8	R1202	B15	R1603	D11	V1301	G7
C1311	G8	CURSOR2 R	B8	R1203	B15	R210	G18	V1312	G6
C1312	G9	D	C6	R1204	B16	RECORD	D7	V1313	G7
C1316	G9	D1201	D21	R1205	B16	SCOPE	B6	V1314	F7
C1317	G9	D1202	A18	R1210	A17	SETUP	D7	V1316	F7
C1319	G3	D1202	B18	R1210	D17	SOFT1	A6	V1317	F8
C1321	G3	D1205	B17	R1213	G15	SOFT2	A7	V1318	G6
C1322	G3	D1207	E25	R1215	G16	SOFT3	A7	V1319	G8
C1323	G4	D1208	B25	R1216	F14	SOFT4	A8	V1501	B2
C1324	G4	D1209	F16	R1217	G16	SOFT5	A9	V1502	B3
C1326	G4	D1209	A20	R1221	C17	SPECIAL	E7	V1503	A3
C1327	G3	D1209	A19	R1222	C17	TEST1	D17	V1506	B3
C1328	G5	D1210	G25	R1223	D17	TEST12	G18	WAVEFORM	D8
C1329	G5	D1301	G7	R1224	D17	TIME ns	C7	X1201	D1
C1330	G5	D1301	H7	R1225	G19	TIME s	C7	X1205	C1
C1332	G2	D1601	F13	R1226	C9	TP216	D17		
C1333	G2	D1602	H13	R1228	C3	TP217	G18		
C1334	G3	D1603	A13	R1229	D3	TP219	B2		

PARTS LOCATION A1 (CIRCUIT DIAGRAM)

C1205	C9	D1204	E2	N1404	G12	R1408	D14	TP233	D14
C1207	A7	D1205	A3	R1206	A6	R1409	E14	TP234	H14
C1207	B7	D1205	B3	R1207	B6	R1411	F14	TP237	G14
C1208	B7	D1206	A2	R1211	E9	R1412	F14	TP244	B4
C1209	B7	D1230	D5	R1212	E9	R1413	G14	TP246	A2
C1211	R9	D1401	C12	R1214	E9	R1414	H14	TP247	F4
C1212	E9	D1401	A17	R1218	E9	R1416	G11	TP248	H14
C1213	E9	D1402	A18	R1219	C9	R1417	H13	TP249	D14
C1215	C9	D1403	A20	R1220	E8	R1418	G13	V1304	G19
C1221	E10	D1404	C16	R1220	E7	R1419	F14	V1305	H18
C1222	C9	D1406	D16	R1226	C9	R1421	H11	V1306	H19
C1302	H19	D1407	F16	R1227	C9	R1422	H12	V1307	G20
C1303	G20	D1408	A13	R1230	E9	R1423	G12	V1308	J20
C1304	J19	D1408	B13	R1232	C9	R1424	G12	V1309	J20
C1318	H11	D1409	A12	R1309	G19	T1301	H20	V1311	J19
C1401	E12	D1409	B12	R1311	H20	T1301	H19	V1401	D13
C1402	H13	D1410	B14	R1312	H18	TP207	C17	V1402	H12
C1403	G11	G1201	E9	R1319	H19	TP208	D17	V1403	G12
C1404	E14	H1401	D19	R1401	D12	TP209	F17	V1405	E12
C1405	E14	J1401	C11	R1402	E13	TP210	B18	V1406	H14
C1406	F14	L1202	C8	R1403	E13	TP211	B18	X1201	A22
C1407	F14	N1401	G13	R1404	F14	TP212	B18	X1202	H22
C1409	H14	N1401	E14	R1406	G13	TP213	D2		
C1411	G12	N1401	F14	R1407	G13	TP214	D2		

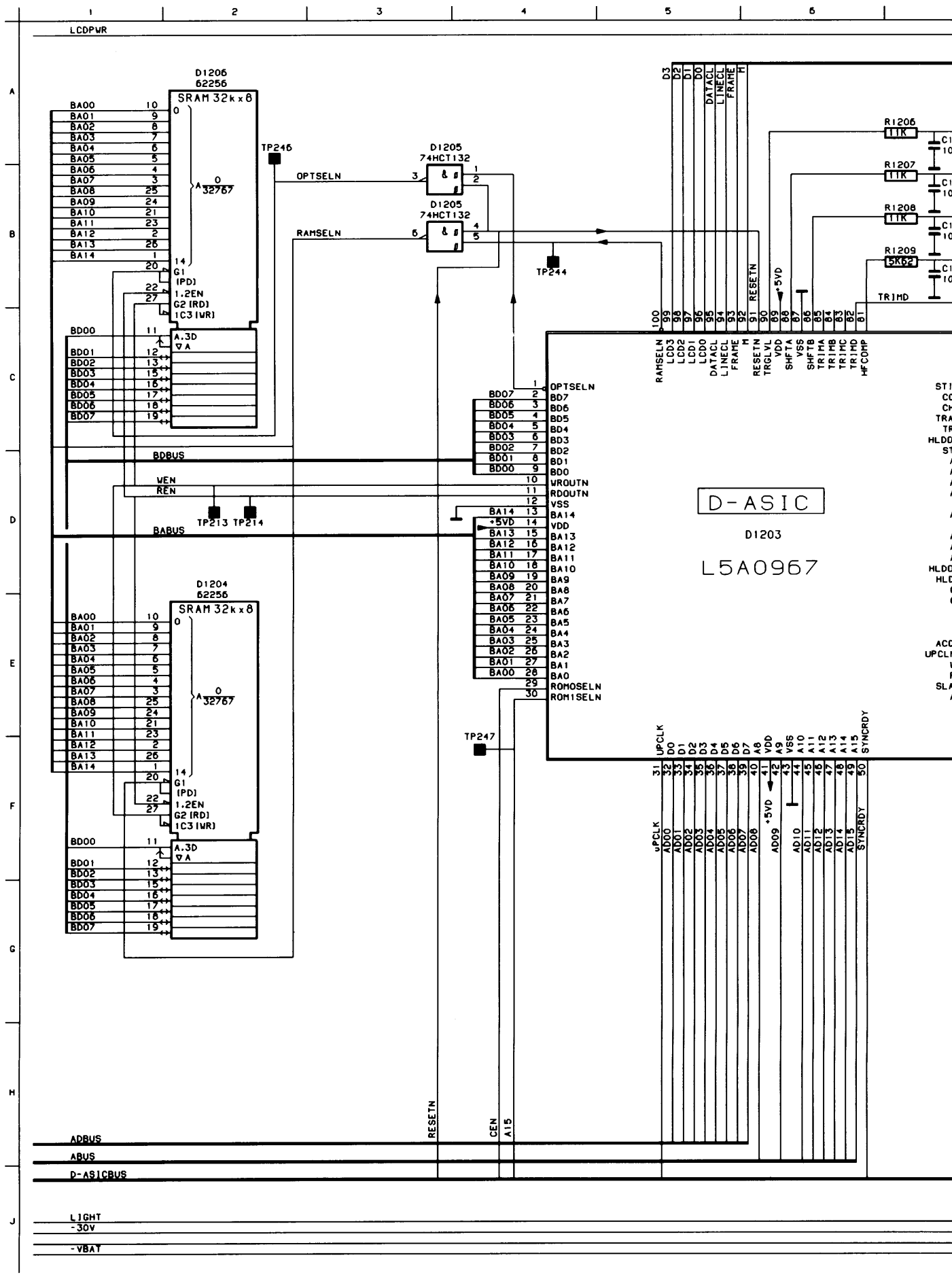
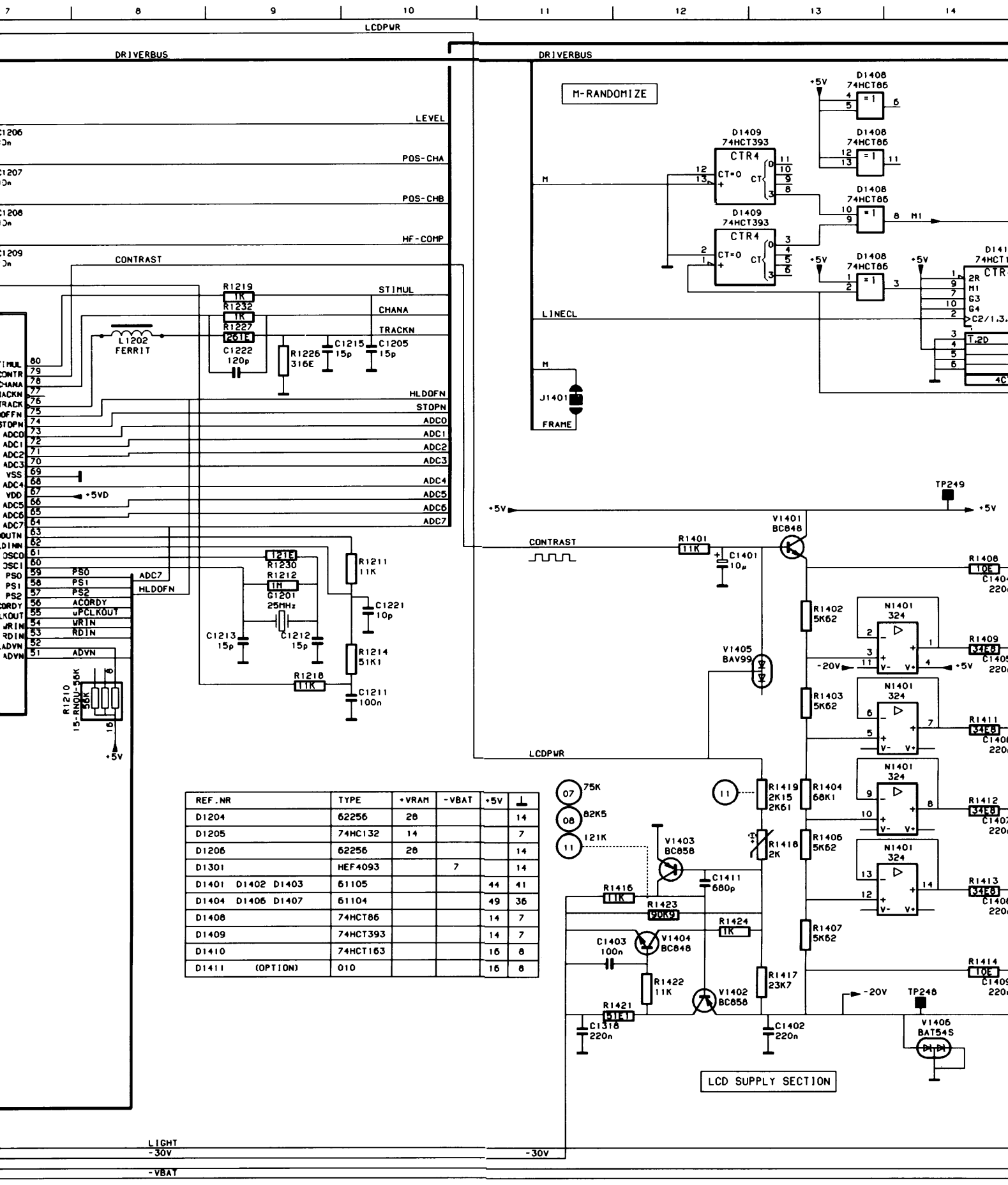
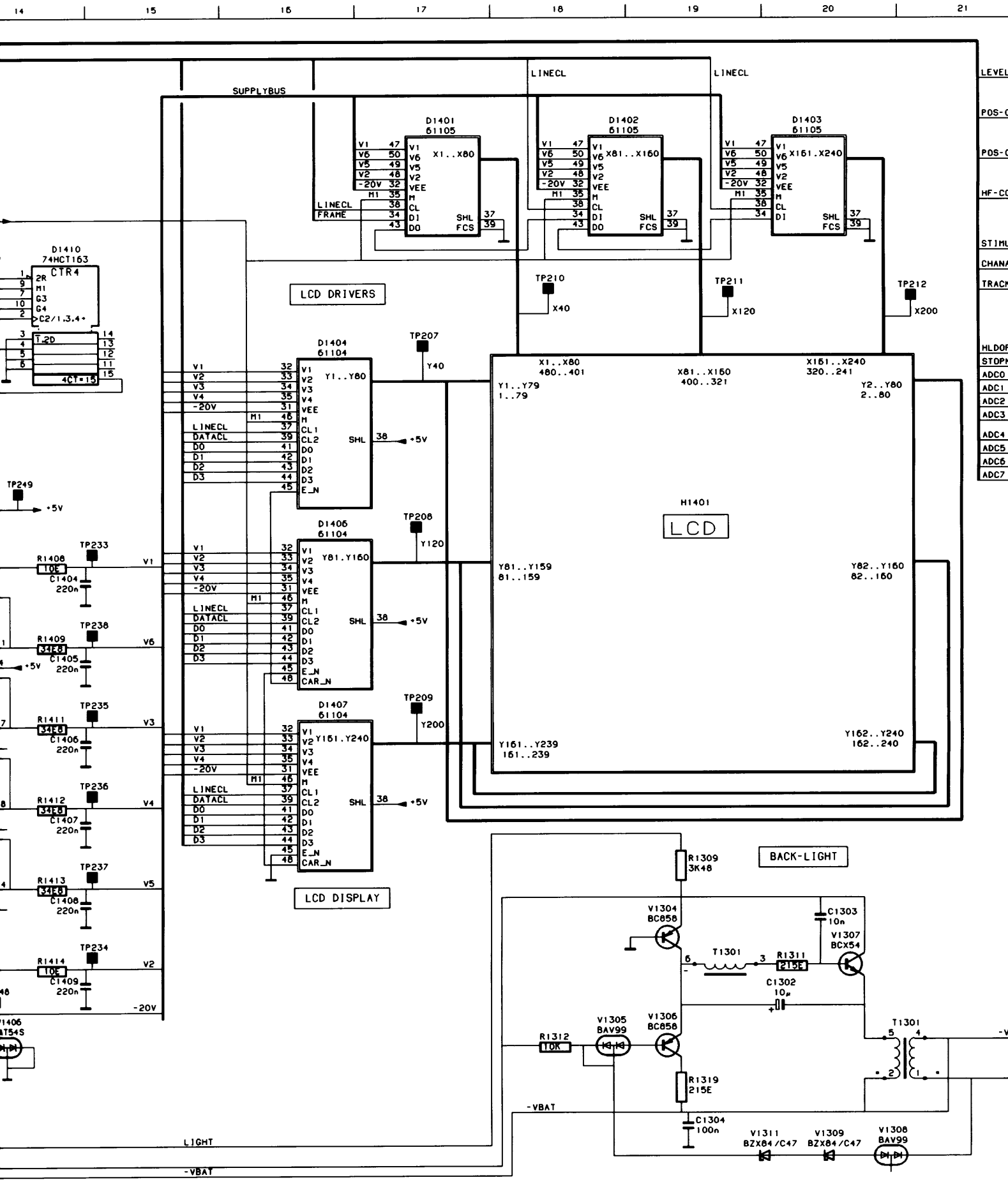
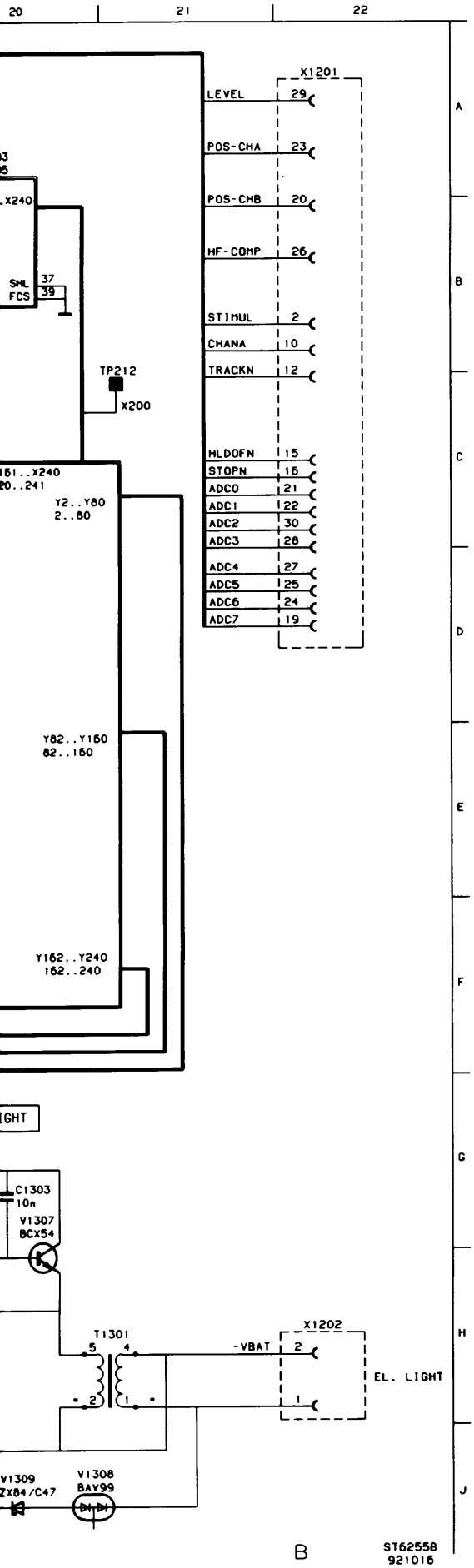


Figure 10.2b Digital A1 circuit diagram (part b)



REF.NR	TYPE	+VRAM	-VBAT	+5V	⊥
D1204	62256	28			14
D1205	74HC132	14			7
D1206	62256	28			14
D1301	HEF4093		7		14
D1401 D1402 D1403	61105			44	41
D1404 D1406 D1407	61104			49	36
D1408	74HCT86			14	7
D1409	74HCT393			14	7
D1410	74HCT163			16	8
D1411 (OPTION)	010			16	8


SUPPLYBUS
LINECL
LINECL
D1401
61105
X1..X80
D1402
61105
X81..X160
D1403
61105
X161..X240
LINECL
FRAME
D1410
74HCT163
CTR4
LCD DRIVERS
TP210
X40
TP211
X120
TP212
X200
D1404
61104
Y1..Y80
TP207
Y40
D1405
61104
Y81..Y160
TP208
Y120
D1406
61104
Y161..Y240
TP209
Y200
D1407
61104
LCD DISPLAY
H1401
LCD
X1..X80
480..401
X81..X160
400..321
X161..X240
320..241
Y1..Y79
1..79
Y2..Y80
2..80
Y81..Y159
81..159
Y82..Y160
82..160
Y161..Y239
161..239
Y162..Y240
162..240
TP249
+5V
TP233
R1408
10E
C1404
220n
V1
TP238
R1409
34E8
C1405
220n
V6
TP235
R1411
34E8
C1406
220n
V3
TP236
R1412
34E8
C1407
220n
V4
TP237
R1413
34E8
C1408
220n
V5
TP234
R1414
10E
C1409
220n
V2
-20V
R1309
3K48
BACK-LIGHT
V1304
BC858
C1303
10n
V1307
BCX54
T1301
R1311
215E
C1302
10µ
V1305
BAV99
V1306
BC858
R1312
10K
R1319
215E
-VBAT
C1304
100n
V1311
BZX84/C47
V1309
BZX84/C47
V1308
BAV99
LIGHT
-VBAT



B

ST62558
921016

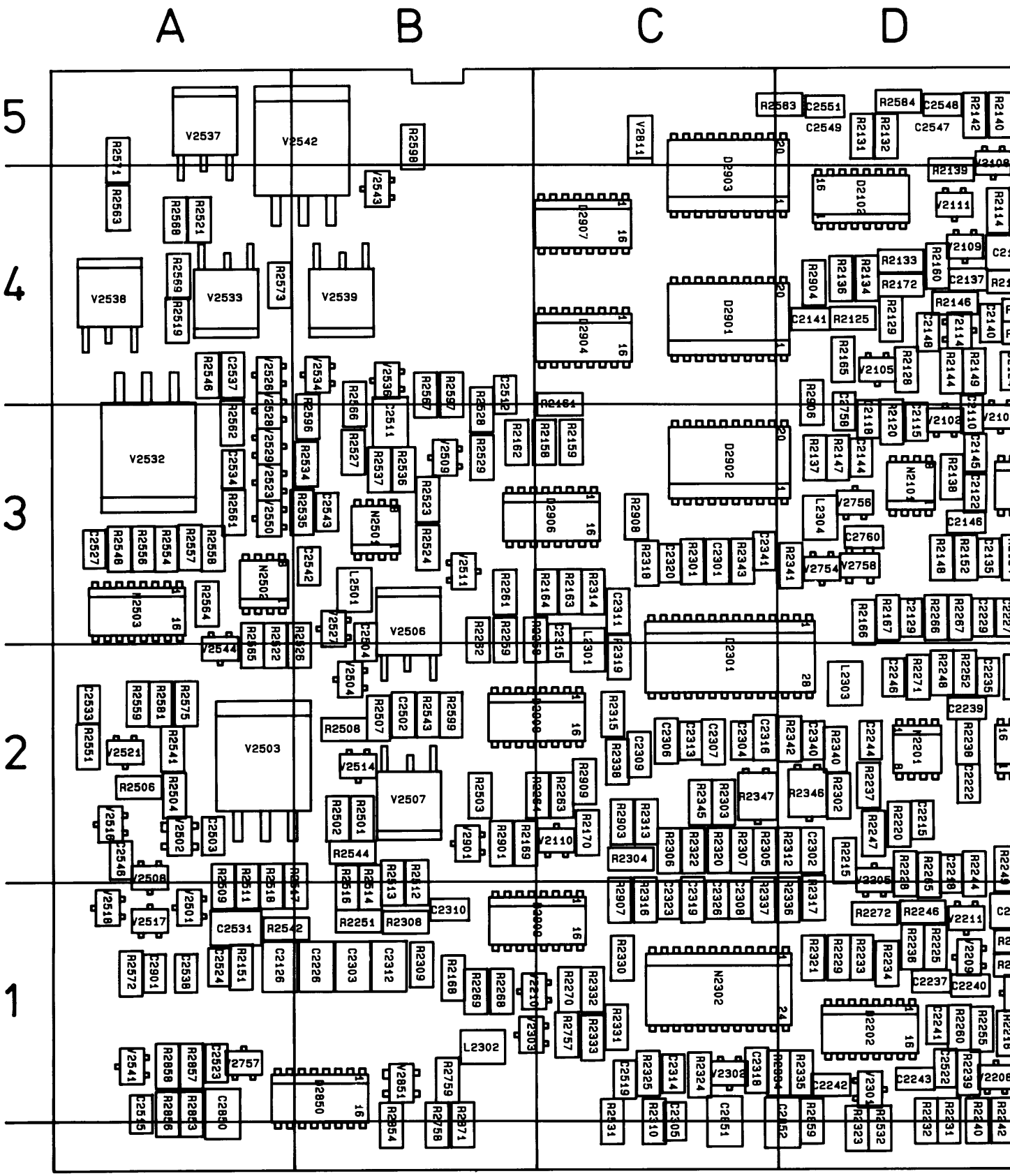
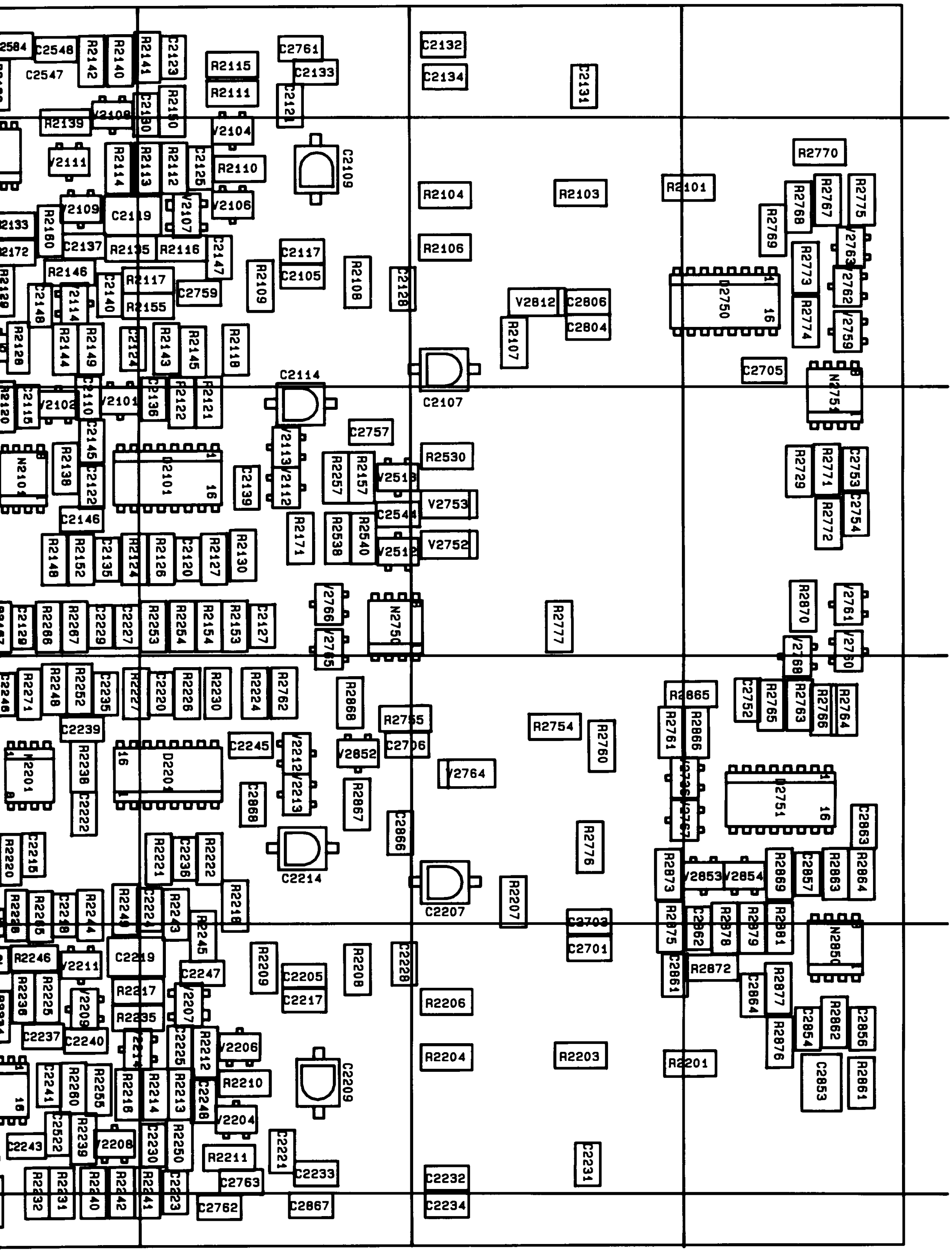


Figure 10.3a Analog A2 PCB (SMD components side) for Revision Level 21 and lower

D E F G



ST6617
920203

PARTS LOCATION A2 (PCB SMD COMPONENTS SIDE)

C2105	E2	C2232	E1	C2541	A5	D2909	B1	R2145	D4
C2107	E2	C2234	E1	C2542	A3	H2561	A3	R2146	D4
C2109	E2	C2235	D2	C2543	A3	L2301	B1	R2147	D3
C2110	D3	C2236	E2	C2544	E3	L2303	D2	R2148	D3
C2114	E3	C2237	D1	C2546	A2	L2304	C3	R2149	D4
C2115	D3	C2239	D2	C2547	D5	L2501	B3	R2150	D5
C2117	E2	C2240	D1	C2549	D5	N2101	D3	R2151	A1
C2118	D3	C2241	D1	C2551	D5	N2201	D2	R2152	D3
C2119	D4	C2242	D1	C2701	F1	N2302	C1	R2153	E3
C2120	D3	C2243	D1	C2703	F2	N2501	B3	R2154	E3
C2121	E1	C2244	D2	C2705	G4	N2502	A3	R2155	D4
C2122	D3	C2245	E2	C2706	E2	N2503	A3	R2157	E3
C2123	D5	C2246	D2	C2752	G2	N2750	E3	R2158	B3
C2124	D4	C2247	D1	C2753	G3	N2751	G4	R2159	B3
C2125	D4	C2248	E1	C2754	G3	N2850	G2	R2160	D4
C2126	A1	C2301	C3	C2757	E3	R2101	F4	R2161	B4
C2127	E3	C2302	C2	C2758	D3	R2103	F4	R2162	B3
C2128	E2	C2303	B1	C2759	D4	R2104	E2	R2163	B3
C2129	D3	C2304	C2	C2760	D3	R2106	E2	R2164	B3
C2130	D5	C2305	C1	C2761	E1	R2107	F3	R2165	D4
C2131	F5	C2306	C2	C2762	E2	R2107	B2	R2166	D3
C2132	E1	C2307	C2	C2763	E1	R2108	E2	R2167	D3
C2133	E1	C2308	C1	C2804	F4	R2109	E2	R2168	B1
C2134	E1	C2309	C2	C2806	F4	R2110	E2	R2169	B2
C2135	D3	C2310	B1	C2850	A1	R2111	E1	R2171	E3
C2136	F3	C2311	C3	C2851	C1	R2112	D4	R2172	D4
C2139	E3	C2312	B1	C2852	C1	R2113	D4	R2201	F1
C2140	D4	C2313	C2	C2853	G1	R2114	D4	R2204	E1
C2141	C4	C2314	C1	C2854	G1	R2115	E1	R2204	E1
C2144	D3	C2315	B3	C2856	G1	R2116	D4	R2206	E1
C2145	D3	C2316	C2	C2857	G2	R2117	D4	R2207	F2
C2146	D3	C2318	C1	C2861	F1	R2118	E2	R2208	E1
C2147	E2	C2319	C1	C2862	F2	R2122	D3	R2209	E1
C2148	D4	C2320	C3	C2863	G2	R2124	D3	R2210	E1
C2203	F1	C2323	C1	C2864	G1	R2125	D4	R2211	E1
C2205	E1	C2326	C1	C2866	E2	R2126	D3	R2212	E1
C2209	E1	C2340	C2	C2867	E1	R2127	E3	R2213	D1
C2214	E2	C2341	C3	C2868	E2	R2128	D4	R2214	D1
C2215	D2	C2423	A1	C2901	A1	R2129	D4	R2215	D2
C2217	E1	C2458	D5	D2101	D3	R2129	D3	R2216	D1
C2218	D2	C2484	D5	D2102	D4	R2130	E3	R2217	D1
C2219	D1	C2502	B2	D2201	D2	R2131	D5	R2217	D1
C2220	D2	C2503	A2	D2202	D1	R2132	D5	R2218	E2
C2207	E2	C2504	B3	D2301	C3	R2133	D4	R2220	D2
C2221	E1	C2511	B3	D2750	F4	R2134	D4	R2221	D2
C2222	D2	C2512	B4	D2751	G2	R2135	D4	R2222	E2
C2223	E1	C2515	A1	D2850	A1	R2136	D4	R2224	E2
C2223	D1	C2519	C1	D2901	C4	R2137	C3	R2225	D1
C2224	D2	C2522	D1	D2902	C3	R2137	D4	R2226	D2
C2225	D1	C2524	A1	D2903	C4	R2138	D3	R2227	D2
C2226	B1	C2527	A3	D2904	C4	R2139	D4	R2228	D2
C2227	D3	C2531	A1	D2906	B3	R2140	D5	R2229	D1
C2228	E1	C2533	A2	D2907	B4	R2141	D5	R2230	E2
C2229	D3	C2534	A3	D2907	C4	R2141	D5	R2231	D1
C2230	D1	C2537	A4	D2907	B4	R2143	D4	R2232	D1
C2231	F1	C2538	A1	D2908	B2	R2144	D4	R2233	D1

R2234	D1	R2322	C2	R2544	B2	R2861	G1	V2503	A2
R2235	D1	R2322	C2	R2546	A4	R2862	G1	V2504	B2
R2236	D1	R2323	D1	R2548	A3	R2863	G2	V2506	B3
R2237	D2	R2324	C1	R2551	A2	R2864	G2	V2507	B2
R2238	D2	R2325	C1	R2554	A3	R2865	F2	V2508	A2
R2239	D1	R2330	C1	R2556	A3	R2866	F2	V2509	B3
R2240	D1	R2331	C1	R2557	A3	R2867	E2	V2511	B3
R2241	D1	R2332	C1	R2558	A3	R2868	E2	V2512	E3
R2242	D1	R2334	C1	R2559	A2	R2869	G2	V2513	E3
R2243	D2	R2335	C1	R2562	A3	R2870	G3	V2514	B2
R2244	D2	R2336	C1	R2563	A4	R2871	B1	V2516	A2
R2246	D1	R2337	C1	R2564	A3	R2872	F1	V2518	A1
R2247	D2	R2338	C2	R2565	A3	R2873	F2	V2521	A2
R2248	D2	R2340	D2	R2566	B4	R2875	F2	V2523	A3
R2249	D2	R2341	C3	R2567	B4	R2876	G1	V2526	A4
R2250	D1	R2342	C2	R2568	A4	R2877	G1	V2527	A3
R2251	B1	R2343	C3	R2571	A5	R2878	F2	V2528	A3
R2252	D2	R2345	C2	R2572	A1	R2879	G2	V2529	A3
R2253	D3	R2346	C2	R2573	A4	R2881	G2	V2532	A3
R2254	D3	R2347	C2	R2575	A2	R2901	B2	V2533	A4
R2255	D1	R2501	B2	R2581	A2	R2903	C2	V2534	A4
R2257	E3	R2502	A2	R2583	C5	R2904	C4	V2536	B4
R2258	B3	R2503	B2	R2597	B4	R2906	C4	V2537	A5
R2259	B3	R2504	A2	R2598	B5	R2907	C1	V2538	A4
R2260	D1	R2506	A2	R2599	B2	R2909	B2	V2539	A4
R2261	B3	R2507	B2	R2729	G3	R2980	C3	V2541	A1
R2262	B3	R2508	A2	R2754	F2	R3333	C1	V2542	A5
R2263	B2	R2509	A2	R2755	E2	V2101	D3	V2543	B4
R2264	B2	R2511	A2	R2757	B1	V2102	D3	V2544	A2
R2265	D2	R2512	B2	R2758	B1	V2104	E2	V2550	A3
R2267	D3	R2513	B2	R2759	B1	V2105	D4	V2596	A3
R2268	B1	R2514	B2	R2760	F2	V2106	E2	V2736	F2
R2268	D3	R2516	B2	R2761	F2	V2107	D4	V2750	E3
R2269	B1	R2517	A2	R2762	E2	V2108	D4	V2752	E3
R2270	B1	R2518	A2	R2763	G2	V2109	D4	V2753	E3
R2271	D2	R2519	A4	R2764	G2	V2110	B2	V2754	C3
R2272	D1	R2521	A4	R2766	G2	V2111	D4	V2756	D3
R2301	C3	R2522	A3	R2767	F2	V2112	E3	V2757	A1
R2302	D2	R2523	B3	R2767	G4	V2114	D4	V2758	D3
R2303	C2	R2524	B3	R2768	G4	V2204	E1	V2759	G4
R2304	C2	R2526	A3	R2769	G4	V2205	D2	V2760	G3
R2305	C2	R2527	B3	R2770	G4	V2206	E1	V2761	G3
R2306	C2	R2528	B4	R2771	G3	V2207	D1	V2762	G4
R2307	C2	R2529	B3	R2772	G3	V2208	D1	V2763	G4
R2308	B1	R2530	E3	R2773	G4	V2209	D1	V2765	E3
R2309	B1	R2531	C1	R2774	G4	V2210	B1	V2766	E3
R2311	C3	R2532	D1	R2775	G4	V2212	E2	V2768	G3
R2312	C2	R2534	A3	R2776	F2	V2213	E2	V2811	C5
R2313	C2	R2535	A3	R2777	F3	V2214	D1	V2812	F4
R2315	C2	R2536	B3	R2810	C1	V2221	D1	V2851	B1
R2316	C1	R2537	B3	R2853	A1	V2301	D1	V2852	E2
R2317	C1	R2538	E3	R2854	B1	V2302	C1	V2853	F2
R2318	C3	R2540	E3	R2856	A1	V2303	B1	V2854	G2
R2319	C2	R2541	A2	R2857	A1	V2417	A1	V2901	B2
R2320	C2	R2542	A1	R2858	A1	V2501	A1	V3113	E3
R2321	C1	R2543	B2	R2859	C1	V2502	A2		

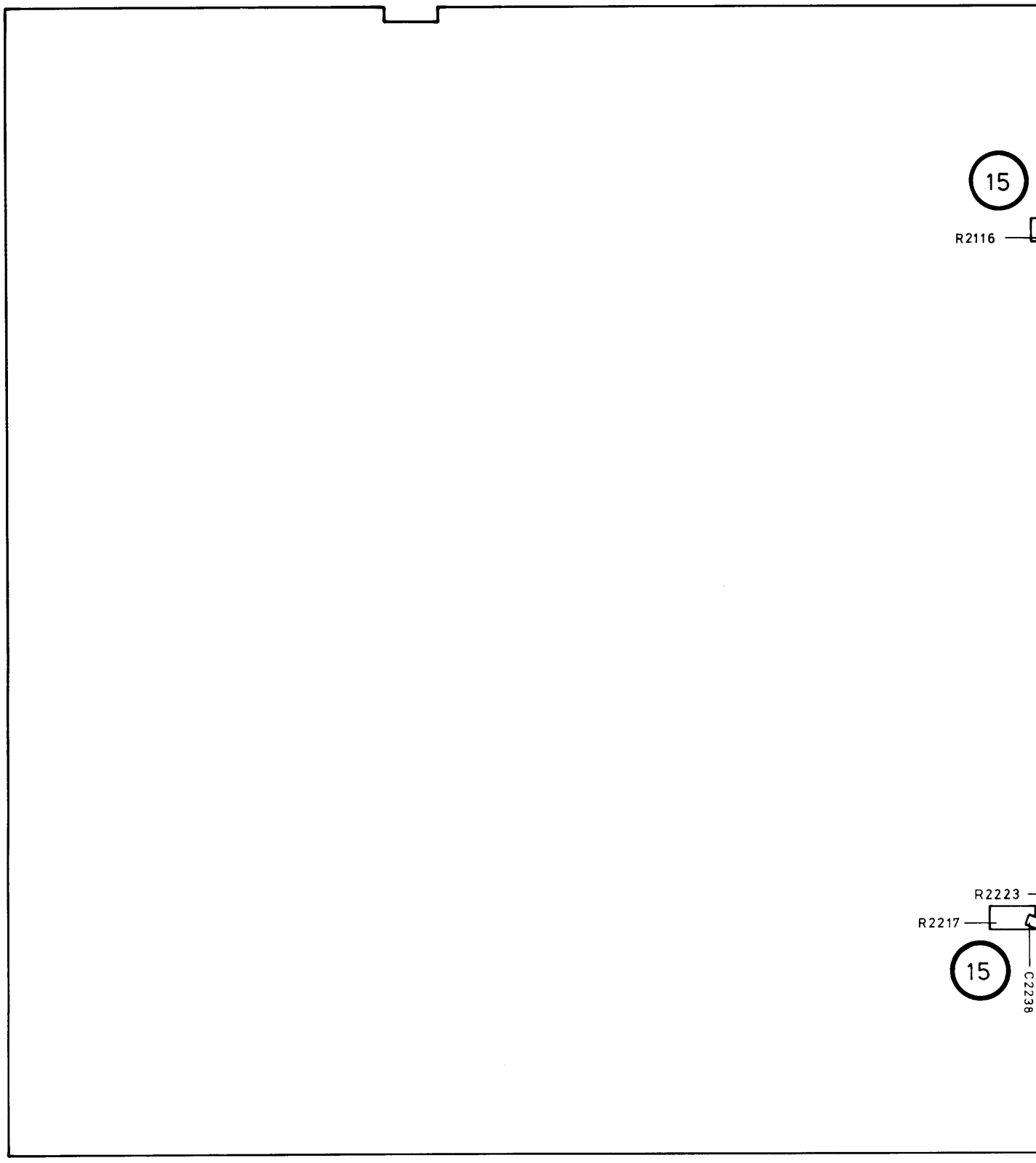
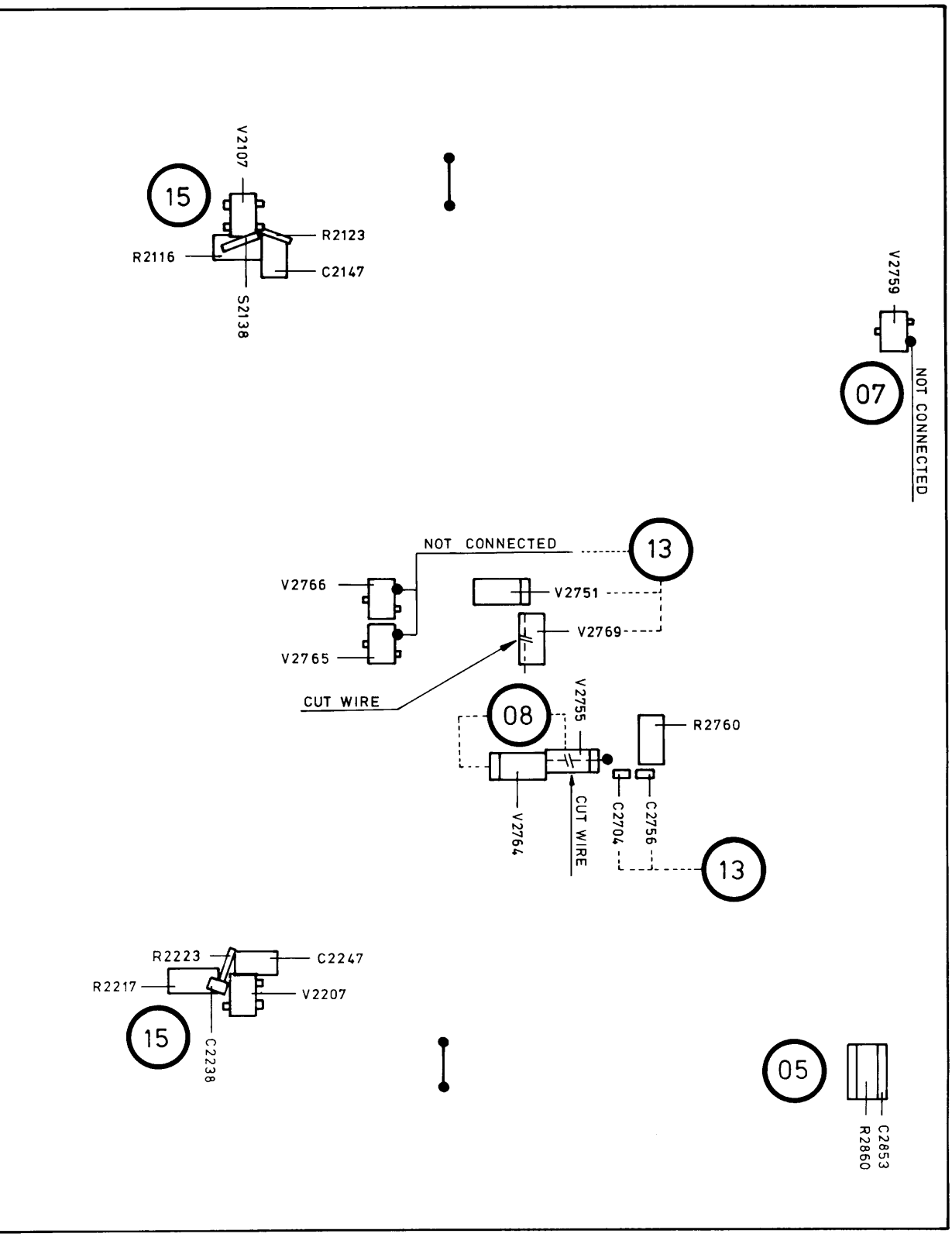


Figure 10.3b Modifications Analog A2 PCB (SMD component side) for Revision Level 21 and lower



ST6850
921016

PARTS LOCATION ANALOG BOARD A2, REVISION LEVEL 22 AND HIGHER

C2105	E4	C2235	D2	C2546	A2	N2101	D3	R2151	A1
C2107	F3	C2237	D1	C2547	D5	N2201	D2	R2152	D3
C2109	E4	C2238	E1	C2548	D5	N2302	C1	R2153	E3
C2114	E3	C2239	D2	C2551	D5	N2501	B3	R2154	E3
C2115	D3	C2240	DI	C2701	F1	N2502	A3	R2155	D4
C2117	E4	C2241	D1	C2703	F2	N2503	A3	R2157	E3
C2118	D3	C2242	D1	C2705	G4	N2750	E3	R2158	C3
C2119	D4	C2243	D1	C2706	E2	N2751	G4	R2159	C3
C2120	E3	C2244	D2	C2707	F2	N2850	G1	R2160	D4
C2121	E5	C2245	E2	C2751	D3	R2101	G4	R2161	C4
C2122	D3	C2246	D2	C2752	G2	R2103	F4	R2162	B3
C2123	E5	C2247	E1	C2753	G3	R2104	F4	R2163	C3
C2124	D4	C2248	E1	C2754	G3	R2106	F4	R2164	C3
C2125	E4	C2301	C3	C2756	F2	R2107	F4	R2165	D4
C2126	A1	C2302	D2	C2757	E3	R2108	E4	R2166	D3
C2127	E3	C2303	B1	C2758	D3	R2109	E4	R2167	D3
C2128	E4	C2304	C2	C2759	E4	R2110	E4	R2168	B1
C2129	D3	C2305	C1	C2760	D3	R2111	E5	R2169	B2
C2130	D5	C2306	C2	C2761	E5	R2112	E4	R2170	C2
C2131	F5	C2307	C2	C2762	E1	R2113	D4	R2171	E3
C2132	F4	C2308	C1	C2763	E1	R2114	D4	R2172	D4
C2133	E5	C2309	C2	C2804	F4	R2115	E5	R2175	D4
C2134	F4	C2310	B1	C2806	F4	R2116	E4	R2201	G1
C2135	D3	C2311	C3	C2850	A1	R2117	D4	R2203	F1
C2137	D4	C2312	B1	C2851	C1	R2118	E2	R2204	F1
C2138	E4	C2313	C2	C2852	C1	R2120	D3	R2206	F1
C2139	E3	C2314	C1	C2853	G1	R2121	E3	R2207	F2
C2140	D4	C2315	C3	C2854	G1	R2122	E3	R2208	E1
C2141	D4	C2316	C2	C2856	G1	R2123	E4	R2209	E1
C2144	D3	C2318	C1	C2857	G2	R2124	D3	R2210	E1
C2145	D3	C2319	C1	C2861	F1	R2125	D4	R2211	E1
C2146	D3	C2320	C3	C2862	G2	R2126	E3	R2212	E1
C2147	E4	C2323	C1	C2863	G2	R2127	E3	R2213	F1
C2148	D4	C2326	C1	C2864	G1	R2128	D3	R2214	F1
C2205	E1	C2340	D2	C2866	E2	R2129	D4	R2215	D2
C2207	F2	C2341	C3	C2867	E1	R2130	E3	R2216	D1
C2209	EI	C2502	B2	C2868	E2	R2131	D5	R2217	D1
C2214	E2	C2503	A2	C2901	A1	R2132	D5	R2218	E2
C2215	D2	C2504	B3	D2101	D3	R2133	D4	R2220	D2
C2217	E1	C2511	B3	D2102	D4	R2134	D4	R2221	E2
C2218	D2	C2512	B4	D2201	D2	R2135	D4	R2222	E2
C2219	D1	C2515	A1	D2202	D1	R2136	D4	R2224	E2
C2220	E2	C2522	D1	D2301	C3	R2137	D3	R2225	D1
C2221	E1	C2523	A1	D2750	F4	R2138	D3	R2226	E2
C2222	D2	C2524	A1	D2751	G2	R2139	D4	R2227	D2
C2223	E1	C2527	A3	D2850	A1	R2140	D5	R2228	D2
C2224	E2	C2531	A1	D2901	C4	R2141	D5	R2229	D1
C2225	E1	C2533	A2	D2902	C3	R2142	D5	R2230	E2
C2226	B1	C2534	A3	D2903	C4	R2143	E4	R2231	D1
C2227	D3	C2537	A4	D2904	C4	R2144	D4	R2232	D1
C2228	E1	C2540	D3	D2906	B3	R2145	E4	R2233	D1
C2229	D3	C2541	F3	D2907	C4	R2146	D4	R2234	D1
C2230	E1	C2542	A3	D2909	B1	R2147	D3	R2235	D1
C2232	F1	C2543	B3	L2301	C3	R2148	D3	R2236	D1
C2233	E1	C2544	E3	L2302	B1	R2149	D4	R2237	D2
C2234	F1	C2545	A1	L2501	B3	R2150	E5	R2238	D2

R2239	D1	R2328	D3	R2558	A3	R2866	G2	V2517	A1
R2240	D1	R2330	C1	R2559	A2	R2867	E2	V2518	A1
R2241	E1	R2331	C1	R2561	A3	R2868	E2	V2521	A2
R2242	D1	R2332	C1	R2562	A3	R2869	G2	V2523	A3
R2243	E2	R2333	C1	R2563	A4	R2870	G3	V2526	A4
R2244	D2	R2334	C1	R2564	A3	R2871	B1	V2527	B3
R2245	E2	R2335	D1	R2565	A3	R2872	G1	V2528	A3
R2246	D1	R2336	D1	R2566	B4	R2873	F2	V2529	A3
R2247	D2	R2337	C1	R2567	B4	R2875	F2	V2530	F3
R2248	D2	R2340	D2	R2568	A4	R2876	G1	V2532	A3
R2249	D2	R2341	D3	R2569	A4	R2877	G1	V2533	A4
R2250	E1	R2342	D2	R2571	A5	R2878	G2	V2534	B4
R2251	B1	R2343	C3	R2572	A1	R2879	G2	V2536	B4
R2252	D2	R2345	C2	R2573	A4	R2881	G2	V2537	A5
R2253	E3	R2346	D2	R2575	A2	R2901	B2	V2538	A4
R2254	E3	R2347	C2	R2581	A2	R2903	C2	V2539	B4
R2255	D1	R2501	B2	R2583	C5	R2904	D4	V2540	B4
R2257	E3	R2502	B2	R2584	D5	R2906	D4	V2541	A1
R2259	B3	R2503	B2	R2596	B3	R2907	C1	V2542	A5
R2260	D1	R2504	A2	R2597	B4	R2908	C3	V2543	B4
R2261	B3	R2506	A2	R2598	B5	R2909	C3	V2544	A2
R2262	B3	R2507	B2	R2599	B2	V2104	E4	V2550	A3
R2263	C2	R2508	B2	R2729	G3	V2105	D4	V2736	F2
R2264	B2	R2509	A2	R2754	F2	V2106	E4	V2750	E3
R2265	D2	R2511	A2	R2755	E2	V2107	E4	V2751	F3
R2266	D3	R2512	B2	R2757	B1	V2108	D4	V2752	F3
R2267	D3	R2513	B2	R2758	B1	V2109	D4	V2753	F3
R2268	B1	R2514	B2	R2759	B1	V2110	C2	V2754	D3
R2269	B1	R2516	B2	R2760	F2	V2111	D4	V2755	F2
R2270	C1	R2517	A2	R2761	F2	V2112	E3	V2756	D3
R2271	D2	R2518	A2	R2762	E2	R2113	E3	V2757	A1
R2272	D1	R2519	A4	R2763	G2	V2114	D4	V2758	D3
R2273	B3	R2521	A4	R2764	G2	V2204	E1	V2759	G4
R2274	B3	R2522	A3	R2765	G2	V2205	D2	V2760	G2
R2275	D2	R2523	B3	R2766	G2	V2206	E1	V2761	G3
R2300	C1	R2524	B3	R2767	G4	V2207	E1	V2762	G4
R2301	C3	R2526	B3	R2768	G4	V2208	D1	V2763	G4
R2302	D2	R2527	B3	R2769	G4	V2209	D1	V2764	F2
R2304	C2	R2528	B4	R2770	G4	V2210	B1	V2765	E3
R2305	C2	R2529	B3	R2771	G3	V2211	D1	V2766	E3
R2306	C2	R2530	F3	R2772	G3	V2212	E2	V2767	F2
R2307	C2	R2531	C1	R2773	G4	V2213	E2	V2768	G3
R2308	B1	R2532	D1	R2774	G4	V2214	D1	V2769	F3
R2309	B1	R2534	B3	R2775	G4	V2303	B1	V2811	C5
R2310	C1	R2535	B3	R2776	F2	V2304	C3	V2812	F4
R2312	C2	R2536	B3	R2777	F3	V2501	A1	V2851	B1
R2313	C2	R2537	B3	R2853	A1	V25O2	A2	V2852	E2
R2314	C3	R2538	E3	R2854	B1	V25O3	A2	V2853	G2
R2315	C2	R2540	E3	R2856	A1	V25O4	B2	V2854	G2
R2316	C1	R2541	A2	R2857	A1	V25O6	B3	V2901	B2
R2317	D1	R2542	A1	R2858	A1	V2507	B2		
R2319	C2	R2543	B2	R2859	D1	V2508	A2		
R2320	C2	R2544	B2	R2860	G1	V2509	B3		
R2321	D1	R2546	A4	R2861	G1	V2511	B3		
R2322	C2	R2548	A3	R2862	G1	V2512	E3		
R2325	C1	R2551	A2	R2863	G2	V2513	E3		
R2326	C3	R2554	A3	R2864	G2	V2514	B2		
R2327	D2	R2557	A3	R2865	G2	V2516	A2		

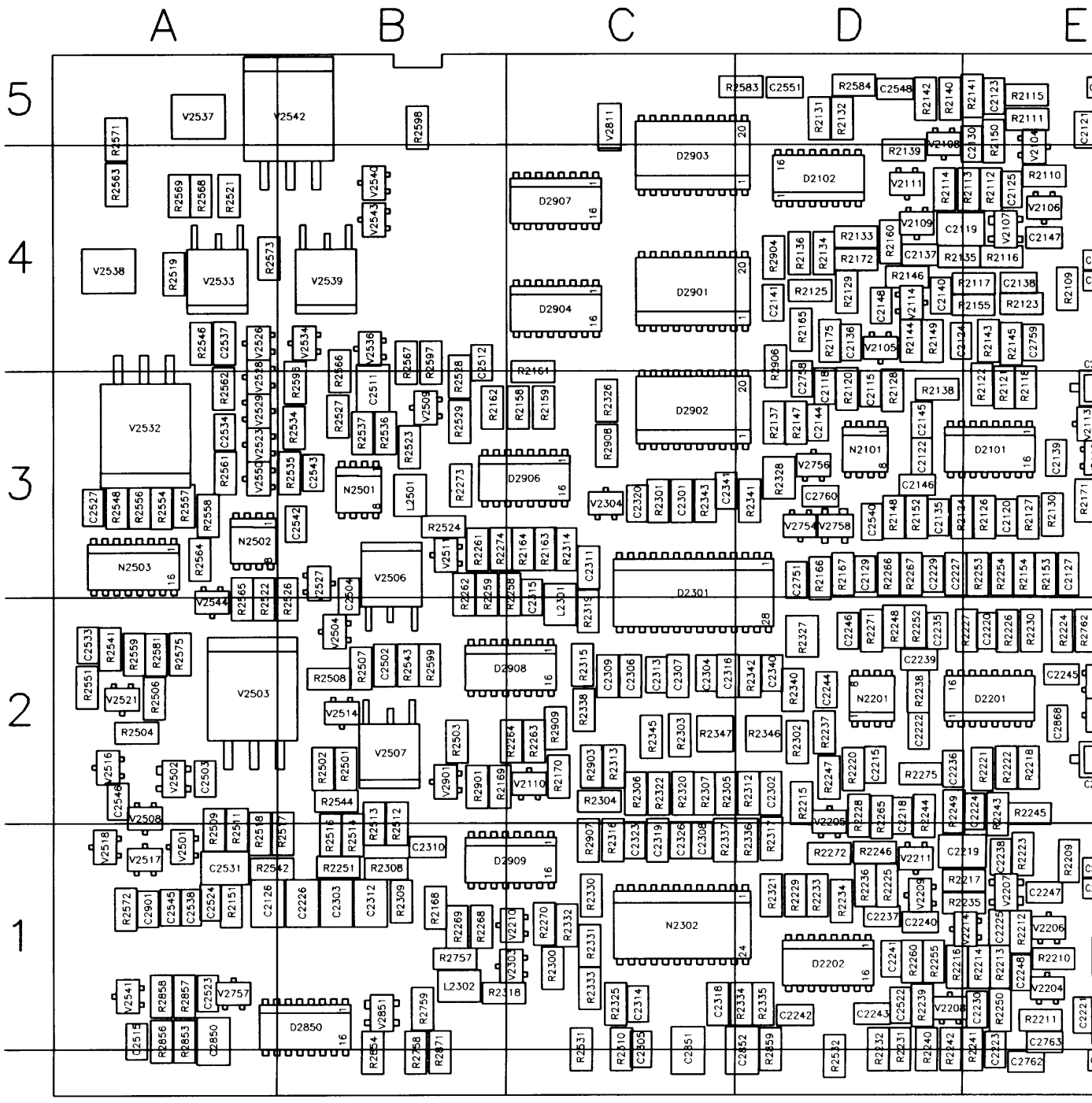
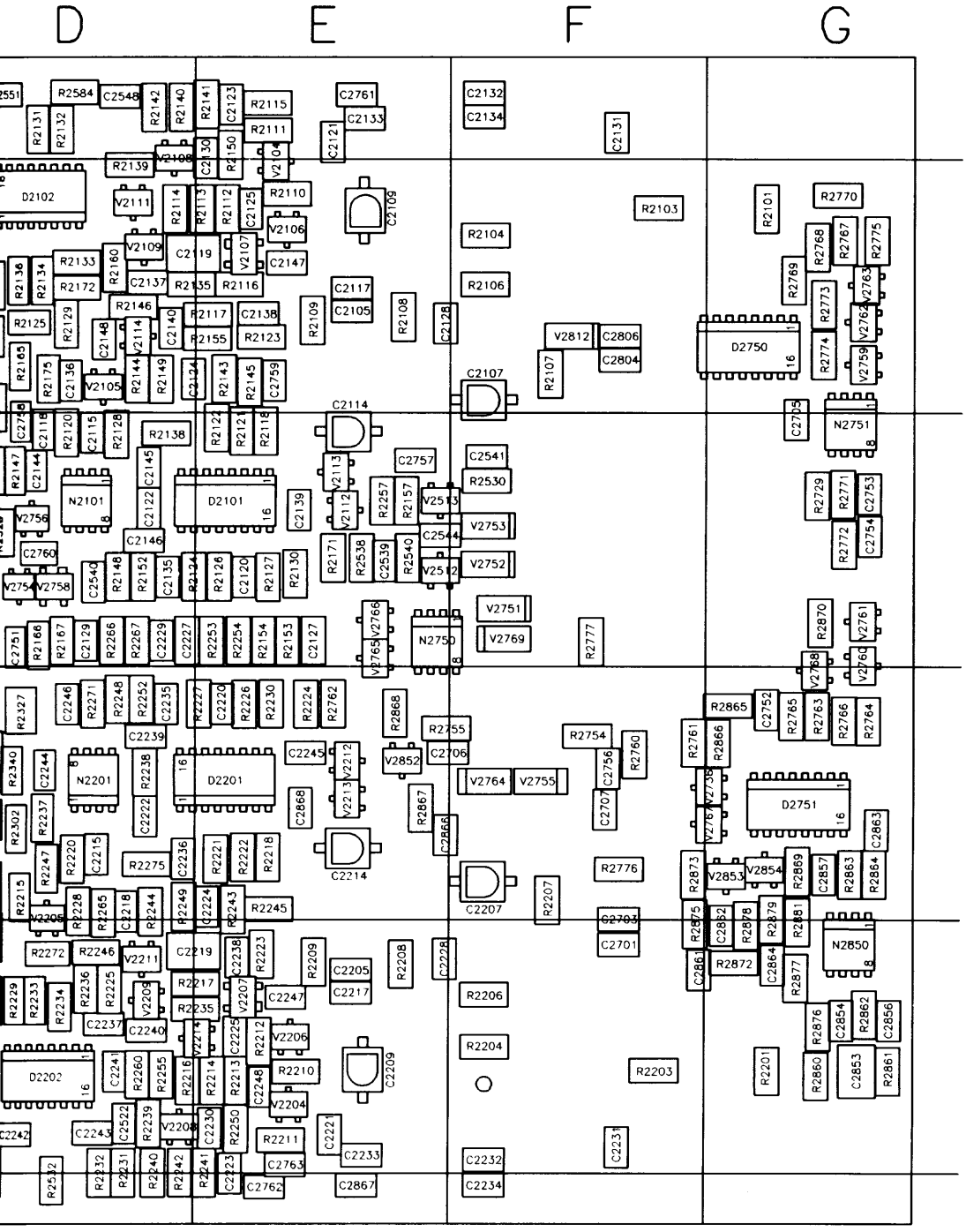


Figure 10.4a ANALOG BOARD A2 assembly for Revision Level 22 and higher (SMD components side)



ST6977
920925

D components side)

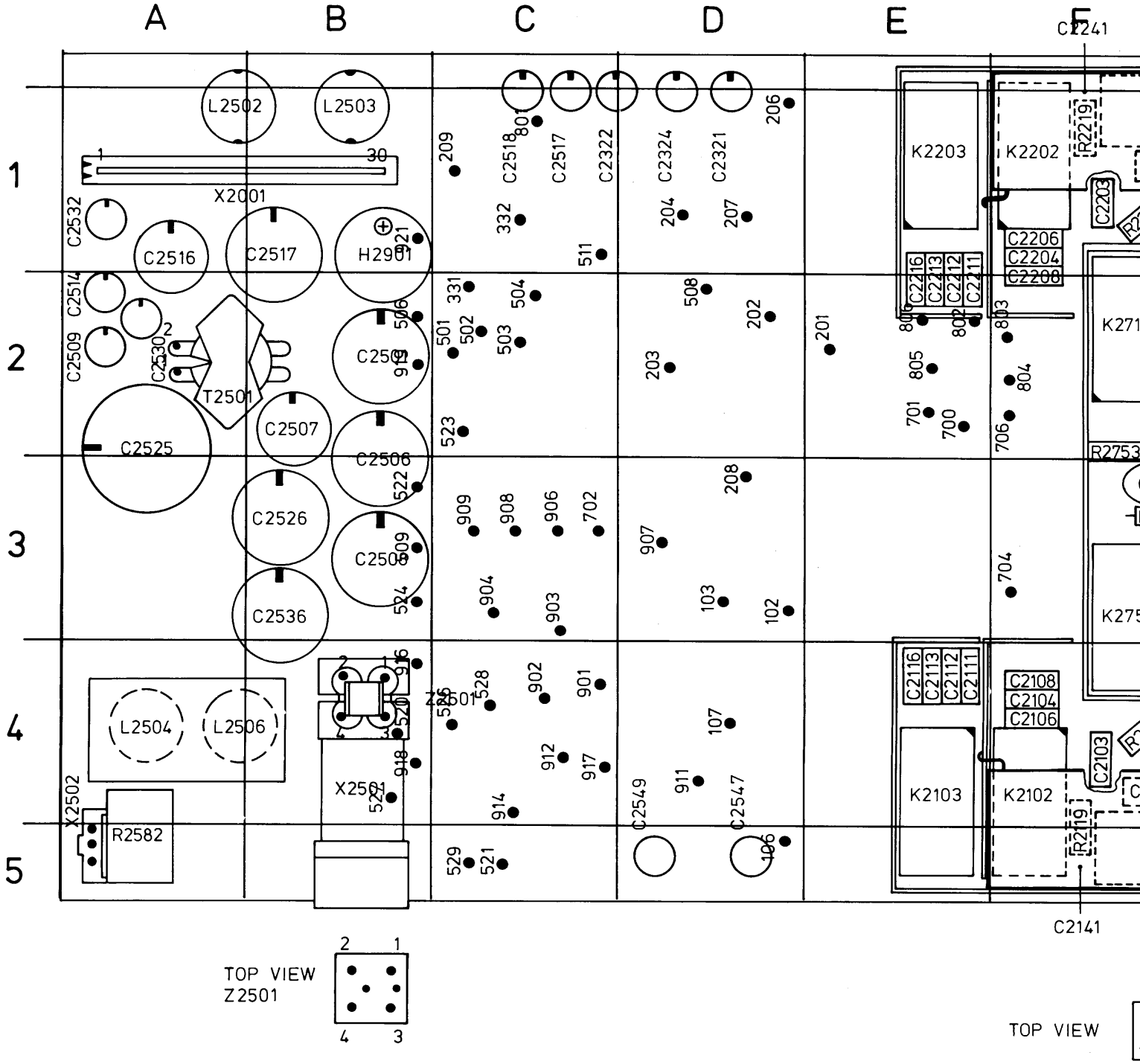


Figure 10.4b Analog A2 PCB (wired component side), for Revision Level 22 and higher

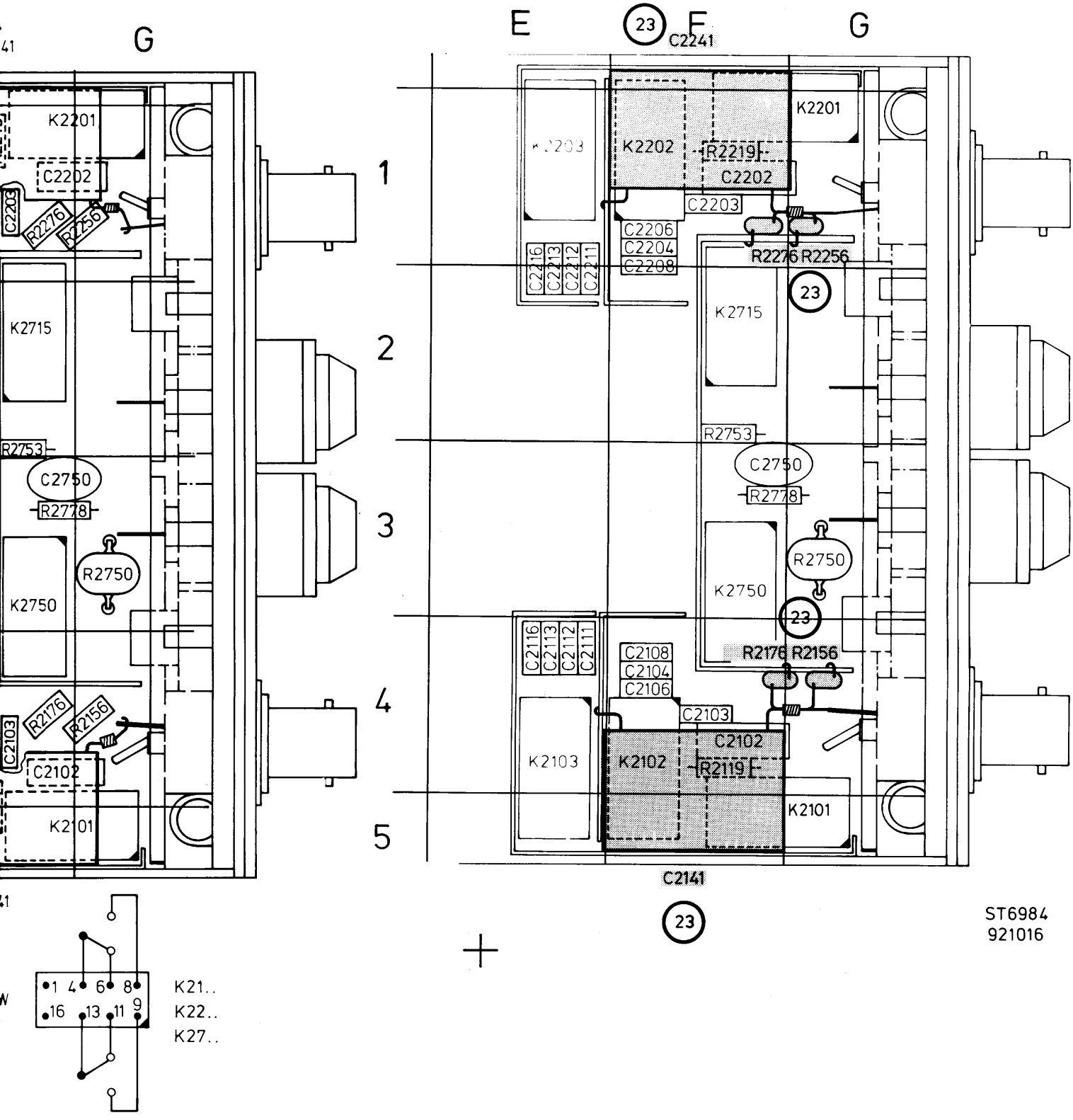


Figure 10.4c Analog A2 PCB for Revision Level 21 and lower with C2141, C2241, R2156, R2256, R2176 and R2276 installed (PTC protection, see Revision Level 23)

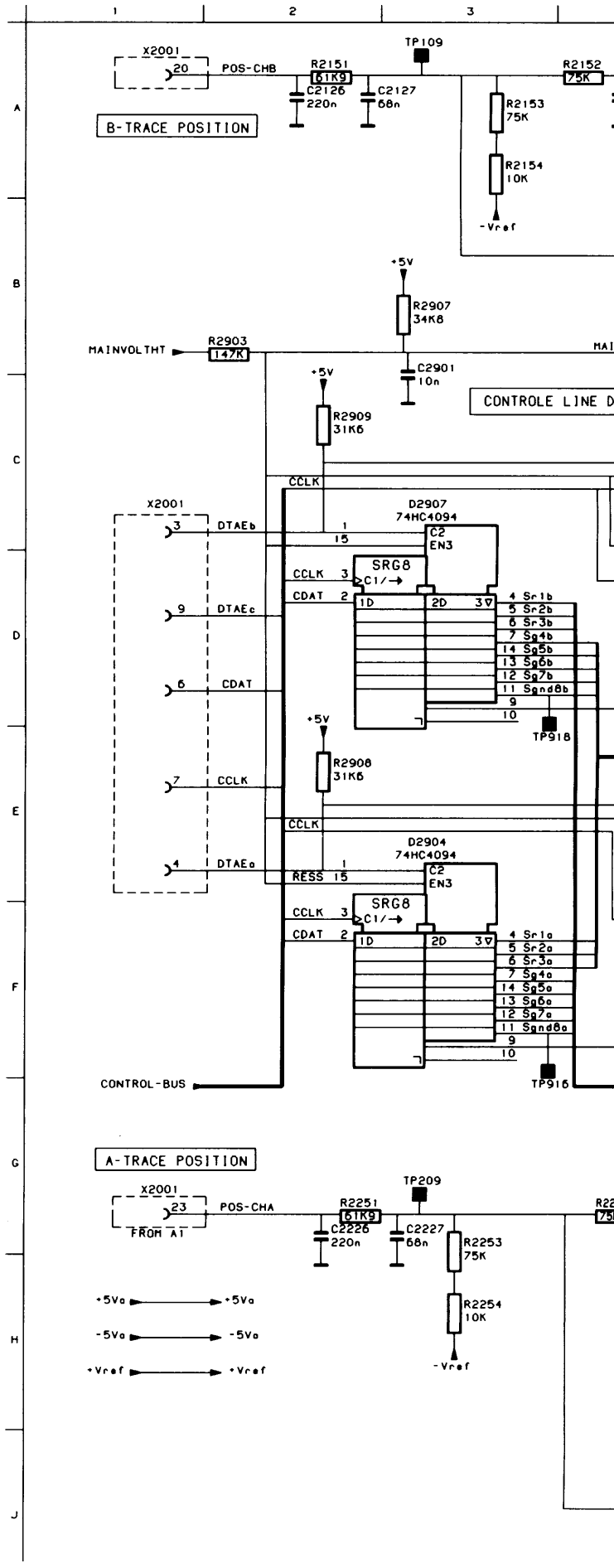
PARTS LOCATION A2 (PCB WIRED COMPONENTS SIDE)

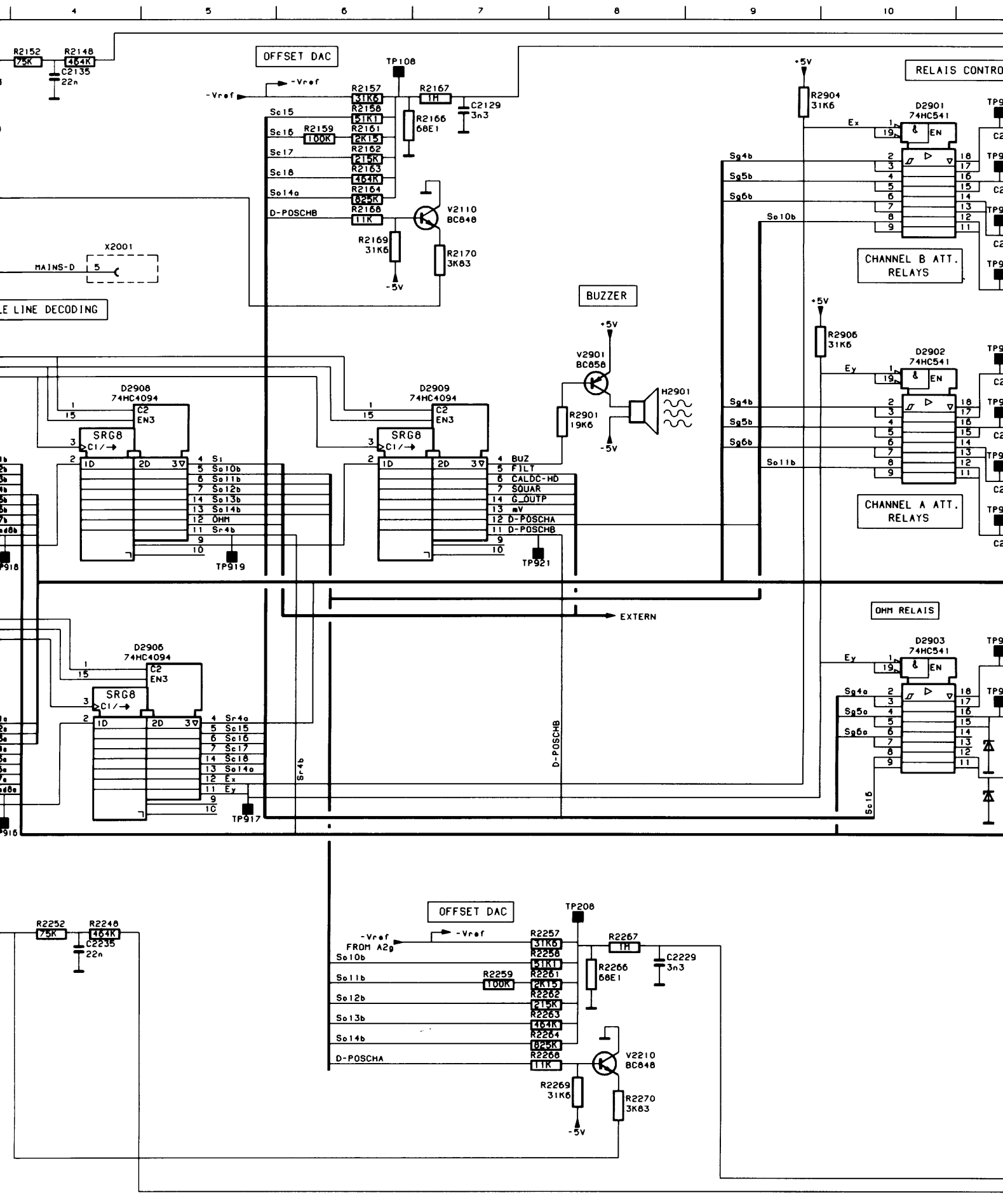
C2102	F4	C2508	B3	L2504	A4	TP206	D1	TP702	C3
C2103	F4	C2509	A2	L2506	A4	TP207	D1	TP704	F3
C2104	E4	C2514	A2	R2119	F4	TP208	D3	TP706	F2
C2106	E4	C2516	A1	R2156	G4	TP209	C1	TP801	C1
C2108	E4	C2517	A1	R2176	F4	TP331	C2	TP802	E2
C2111	E4	C2518	C1	R2219	F1	TP332	C1	TP803	F2
C2112	E4	C2521	D1	R2256	F1	TP501	C2	TP804	F2
C2113	E4	C2524	D1	R2276	F1	TP502	C2	TP805	E2
C2116	E4	C2525	A3	R2582	A5	TP503	C2	TP806	E2
C2141	F5	C2530	A2	R2750	F3	TP504	C2	TP901	C4
C2202	F1	C2532	A1	R2753	F3	TP506	B2	TP902	C4
C2203	F1	C2547	D5	R2778	F3	TP508	D2	TP903	C3
C2204	E1	C2549	C5	T2501	A2	TP509	B3	TP904	C3
C2206	E1	C2750	F3	X2001	A1	TP511	C1	TP906	C3
C2208	E1	H2901	B1	X2501	B4	TP520	B4	TP907	D3
C2211	E1	K1201	F5	X2502	A4	TP521	C5	TP908	C3
C2212	E1	K1202	E4	Z2501	B4	TP522	B3	TP909	C3
C2213	E1	K1203	E4	TP102	D3	TP523	C2	TP911	D4
C2216	E1	K2201	F1	TP103	D3	TP524	B3	TP912	C4
C2241	F1	K2202	E1	TP106	D5	TP526	C4	TP914	C4
C2317	C1	K2203	E1	TP107	D4	TP527	B4	TP916	B4
C2322	C1	K2750	F3	TP201	E2	TP528	C4	TP917	C4
C2501	B2	K2751	F2	TP202	D2	TP529	C5	TP918	B4
C2506	B3	L2502	A1	TP203	D2	TP700	E2	TP919	B2
C2507	A2	L2503	B1	TP204	D1	TP701	E2	TP927	B1

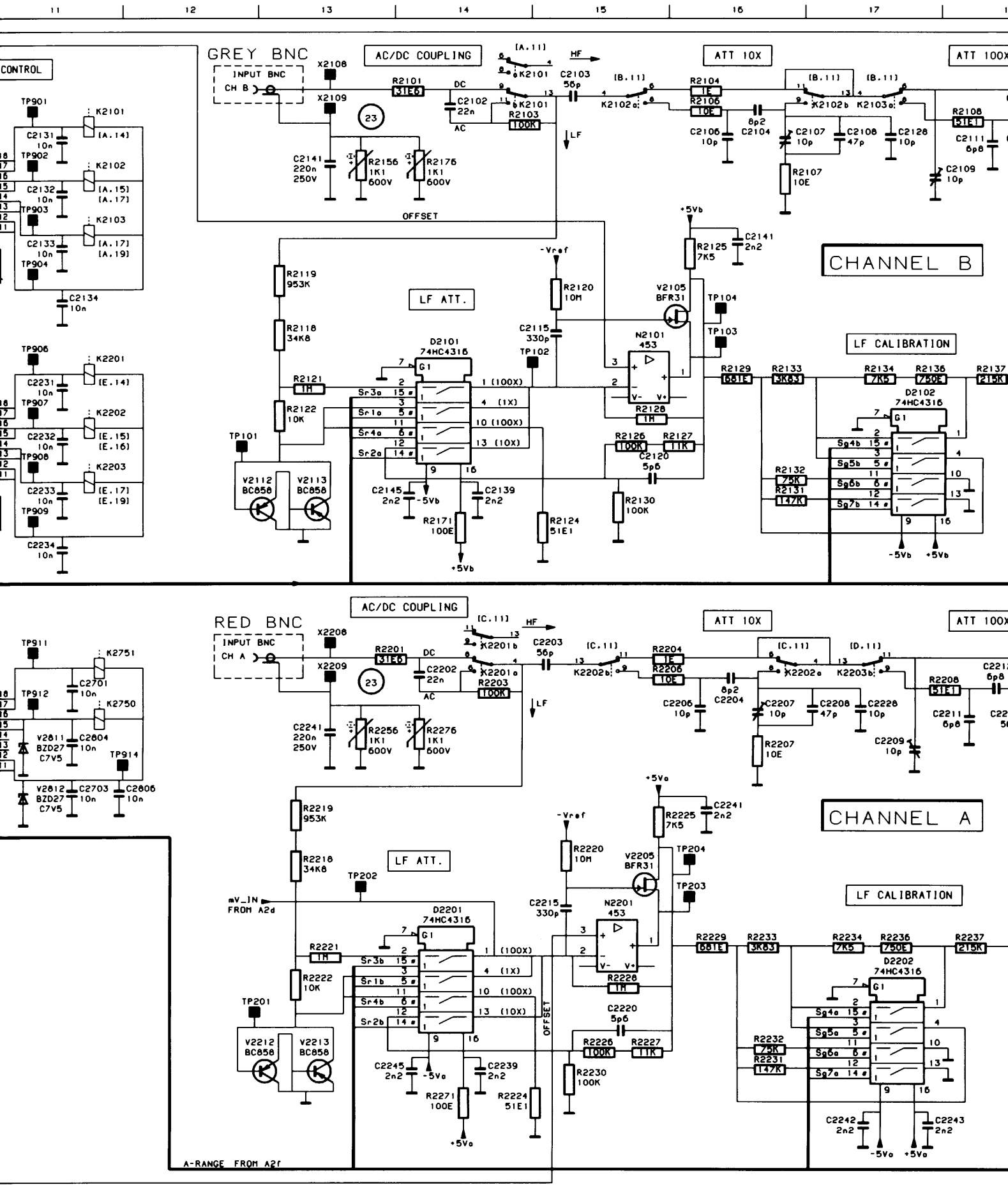
PARTS LOCATION A2 (CIRCUIT DIAGRAM A2a)

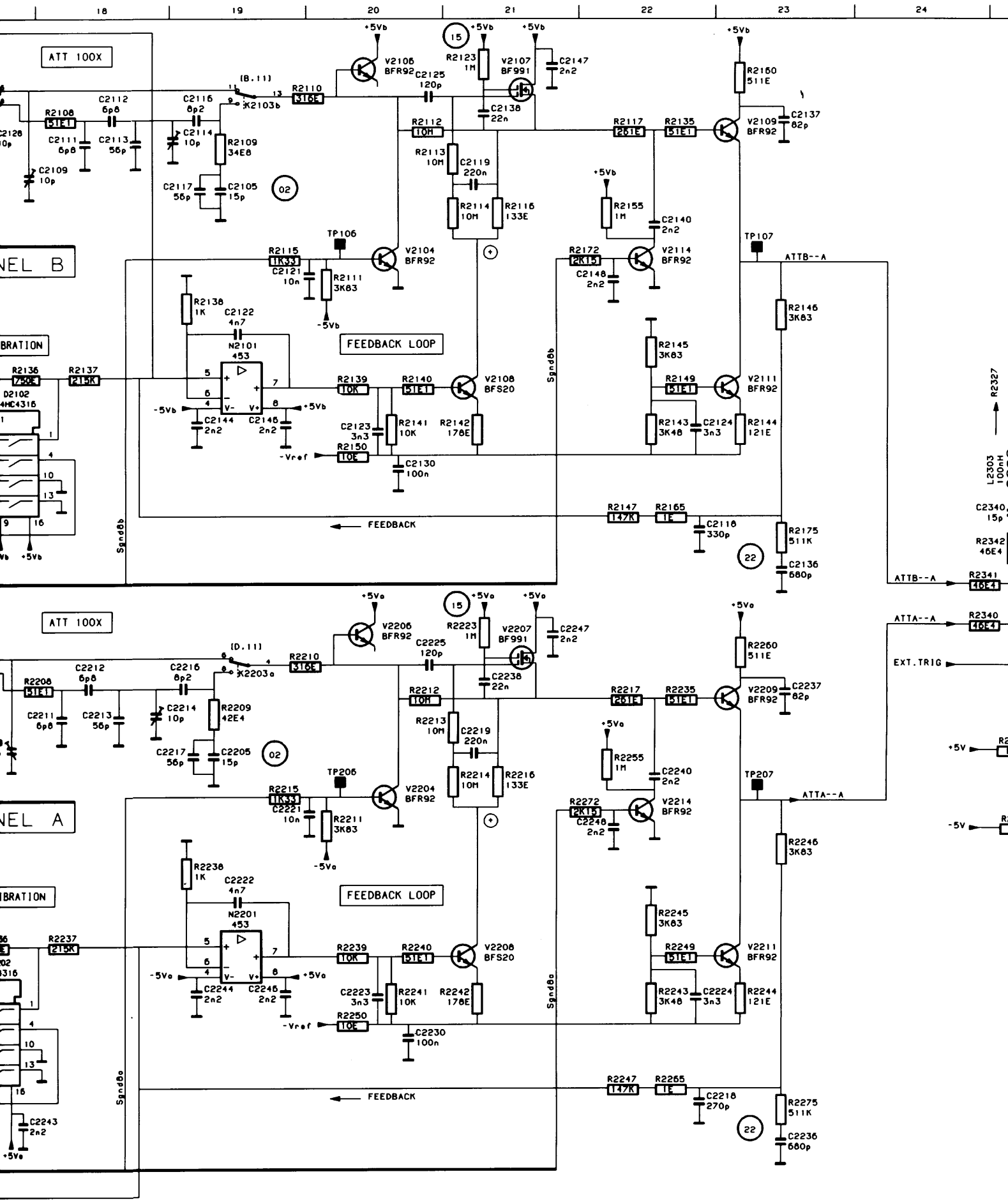
C2102	A14	C2218	H22	D2903	E10	R2128	C15	R2215	F19
C2103	A15	C2219	F21	D2904	E3	R2129	C16	R2215	G15
C2104	A16	C2220	H15	D2906	E5	R2130	D15	R2216	F21
C2105	B19	C2222	G19	D2907	C2	R2131	D16	R2217	E22
C2107	A16	C2223	H20	D2908	C3	R2132	D16	R2218	F13
C2108	A17	C2225	E20	D2909	C7	R2133	C16	R2219	F13
C2109	A18	C2226	G2	H2901	C8	R2134	C17	R2220	G15
C2111	A18	C2227	G3	K2101	A11	R2135	A22	R2221	G13
C2112	A18	C2228	E17	K2101	A15	R2136	C17	R2222	H13
C2113	A18	C2229	G8	K2101	A14	R2137	C18	R2223	E21
C2114	A19	C2230	H20	K2102	B11	R2138	C19	R2224	H14
C2115	C15	C2232	D11	K2102	A17	R2139	C20	R2226	H15
C2116	A19	C2233	D11	K2103	A19	R2140	C20	R2227	H15
C2117	B19	C2234	D11	K2103	A17	R2141	C20	R2228	H15
C2118	D22	C2235	G4	K2103	B11	R2142	C21	R2229	G16
C2119	A21	C2236	J23	K2201	C11	R2143	C22	R2230	H15
C2120	D15	C2238	E21	K2201	E14	R2144	C23	R2231	H16
C2122	C19	C2237	E23	K2202	E16	R2145	C22	R2232	H16
C2123	D20	C2240	F22	K2202	E15	R2146	C23	R2234	G17
C2124	C22	C2241	G16	K2202	C11	R2147	D22	R2235	E22
C2125	A20	C2242	J17	K2203	D11	R2148	A4	R2236	G17
C2126	A2	C2243	J17	K2203	E19	R2149	C22	R2237	G18
C2127	A2	C2244	H19	K2203	E17	R2151	A2	R2238	G19
C2128	A17	C2245	H14	K2750	F11	R2152	A4	R2239	G20
C2129	A7	C2246	H19	K2751	E11	R2153	A3	R2240	G20
C2130	C20	C2247	E21	L2301	F28	R2154	A3	R2241	H20
C2131	A11	C2248	F22	L2302	E32	R2155	B22	R2242	H21
C2132	B11	C2304	F26	L2303	D25	R2157	A6	R2243	H22
C2133	B11	C2307	F11	L2304	D25	R2158	A6	R2244	H22
C2134	C11	C2309	F25	N2101	C19	R2159	A6	R2245	G22
C2135	A4	C2309	F28	N2101	C15	R2160	A23	R2246	F23
C2136	D23	C2311	F25	N2201	G19	R2161	A6	R2247	H22
C2137	A23	C2312	F29	N2201	G15	R2162	B6	R2248	G4
C2138	A21	C2313	F28	N2302	C31	R2163	B6	R2249	G22
C2139	D14	C2314	E31	R2101	A14	R2164	B6	R2250	H19
C2140	B22	C2315	F29	R2103	A14	R2165	D22	R2251	G2
C2141	B16	C2316	F27	R2104	A16	R2166	A6	R2251	H7
C2144	D19	C2317	B32	R2106	A16	R2167	A7	R2252	H7
C2145	D14	C2318	B32	R2108	A18	R2168	B6	R2252	G4
C2146	D19	C2319	B32	R2109	A19	R2169	B6	R2253	H7
C2147	A21	C2320	E30	R2110	A20	R2170	B7	R2253	G3
C2202	E14	C2326	C31	R2111	B20	R2171	D14	R2254	H4
C2203	E15	C2340	D25	R2112	A20	R2172	B22	R2254	H7
C2205	F19	C2341	D25	R2114	B21	R2175	D23	R2255	F22
C2206	E16	C2342	D25	R2115	B19	R2201	E13	R2257	G7
C2207	E16	C2804	F11	R2116	B21	R2203	E14	R2258	H7
C2208	E17	C2806	F11	R2117	A22	R2204	E15	R2258	G7
C2209	F17	C2901	B3	R2118	B13	R2206	E15	R2259	H8
C2210	G13	CH A	E12	R2119	B13	R2207	G16	R2259	G7
C2211	F18	D2101	C14	R2120	B15	R2208	E17	R2260	E23
C2212	E18	D2102	C17	R2121	C13	R2209	E19	R2265	H22
C2213	F18	D2201	G14	R2122	C13	R2210	E19	R2266	G8
C2214	F18	D2202	F17	R2123	A21	R2211	F20	R2267	G8
C2215	G15	D2301	E26	R2125	B16	R2212	F20	R2270	H8
C2216	E19	D2901	A10	R2126	D15	R2213	E21	R2271	H14
C2217	F19	D2902	C10	R2127	D15	R2214	F21	R2272	F22

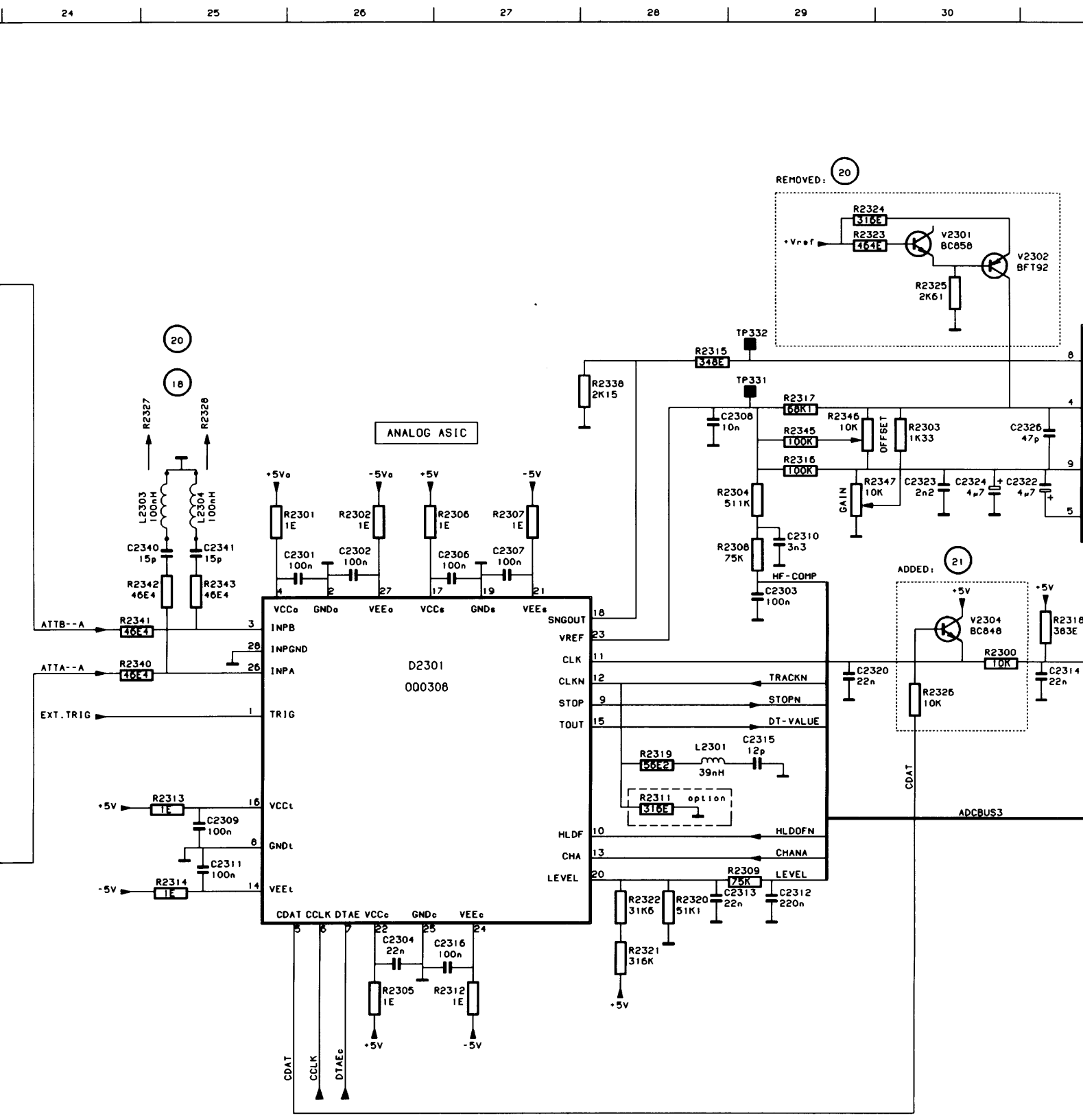
R2275	J23	TP332	C29
R2300	E30	TP717	F5
R2301	D25	TP901	A11
R2303	C30	TP902	B11
R2305	F26	TP903	B11
R2312	F27	TP904	B11
R2313	F25	TP906	C11
R2314	F25	TP907	C11
R2315	C28	TP908	D11
R2316	C29	TP909	D11
R2317	C29	TP911	E11
R2318	E31	TP912	E11
R2319	F28	TP914	F11
R2320	F28	TP916	F3
R2321	F28	TP918	D3
R2322	F28	TP919	D5
R2323	B29	TP921	D7
R2324	B29	V2104	B20
R2325	B30	V2105	B15
R2326	F30	V2106	A20
R2327	D25	V2107	A21
R2328	D25	V2108	C21
R2330	C33	V2109	A23
R2331	C32	V2110	B7
R2332	C33	V2111	C23
R2333	C32	V2112	D12
R2334	C33	V2113	D13
R2335	C32	V2114	B22
R2336	C33	V2204	F20
R2337	C32	V2205	G15
R2338	C28	V2206	E20
R2340	E24	V2207	E21
R2341	E24	V2208	G21
R2343	D25	V2209	E23
R2345	C29	V2210	H8
R2346	C29	V2211	G23
R2347	D29	V2212	H13
R2901	C8	V2213	H13
R2903	B2	V2214	F22
R2904	A9	V2301	B30
R2906	C10	V2302	B30
R2907	B3	V2303	E31
R2908	E2	V2304	E30
R2909	C2	V2811	F11
TP101	D12	V2812	F11
TP103	C16	V2901	C8
TP104	C14	X2001	G1
TP104	C16	X2001	A1
TP106	B20	X2001	B4
TP107	B22	X2001	B33
TP108	A6	X2001	C1
TP109	A3	X2108	A13
TP202	G13	X2109	A13
TP206	F20	X2208	E13
TP207	F23	X2209	E13
TP208	G8		
TP209	G3		
TP331	C29		




OFFSET DAC
RELAIS CONTRO
BUZZER
CHANNEL B ATT. RELAYS
CHANNEL A ATT. RELAYS
OHM RELAIS
LE LINE DECODING
MAINS-D
X2001
-Vref
TP108
R2157 31K6
R2158 51K1
R2159 100K
R2161 2K15
R2162 215K
R2163 464K
R2164 825K
R2166 11K
R2167 1M
R2166 68E1
C2129 3n3
V2110 BC848
R2169 31K6
R2170 3K83
-5V
+5V
R2904 31K6
D2901 74HC541
R2906 31K6
D2902 74HC541
V2901 BC858
R2901 19K6
H2901
D2908 74HC4094
D2909 74HC4094
D2905 74HC4094
D2903 74HC541
SRG8
EN3
TP919
TP921
TP917
EXTERN
D-POSCHB
Sr4b
Sc15
R2252 75K
R2248 464K
C2235 22n
OFFSET DAC
TP208
-Vref FROM A2g
R2257 31K6
R2258 51K1
R2259 100K
R2261 2K15
R2262 215K
R2263 464K
R2264 825K
R2266 11K
R2267 1M
R2266 68E1
C2229 3n3
V2210 BC848
R2269 31K6
R2270 3K83
-5V


GREY BNC
INPUT BNC
CH B
AC/DC COUPLING
ATT 10X
ATT 100X
CHANNEL B
LF ATT.
LF CALIBRATION
OFFSET
RED BNC
INPUT BNC
CH A
AC/DC COUPLING
ATT 10X
ATT 100X
CHANNEL A
LF ATT.
LF CALIBRATION
mV_IN FROM A2d
A-RANGE FROM A2f
CONTROL
D2101 74HC4316
D2102 74HC4316
D2201 74HC4316
D2202 74HC4316
N2101 453
N2201 453
V2105 BFR31
V2205 BFR31
V2112 BC858
V2113 BC858
V2212 BC858
V2213 BC858
V2811 BZD27 C7V5
V2812 BZD27 C7V5
-Vref
+5Vb
-5Vb
+5Va
-5Va
HF
LF
AC
DC


18
19
20
21
22
23
24
ATT 100X
(B.11)
K2103b
R2110 316E
C2125 120p
V2106 BFR92
R2123 1M
V2107 BF991
C2147 2n2
C2138 22n
R2160 511E
V2109 BFR92
C2137 82p
R2108 51E1
C2112 6p8
C2116 8p2
C2111 6p8
C2113 56p
C2114 10p
R2109 34E8
C2109 10p
C2117 56p
C2105 15p
R2112 10M
R2113 10M
C2119 220n
R2114 10M
R2116 133E
R2117 261E
R2135 51E1
R2155 1M
C2140 2n2
V2114 BFR92
R2172 2K15
C2148 2n2
TP106
TP107
ATTB--A
R2115 1K33
C2121 10n
R2111 3K83
V2104 BFR92
R2138 1K
C2122 4n7
N2101 453
FEEDBACK LOOP
R2136 750E
R2137 215K
R2139 10K
R2140 51E1
V2108 BFS20
C2144 2n2
C2145 2n2
C2123 3n3
R2141 10K
R2142 178E
R2150 10E
C2130 100n
R2145 3K83
R2149 51E1
V2111 BFR92
R2143 3K48
C2124 3n3
R2144 121E
R2146 3K83
R2147 147K
R2165 1E
C2116 330p
R2175 511K
C2136 680p
FEEDBACK
Sgnd6b
D2102
4HC4316
-5Vb
+5Vb
-Vref
02
22
ATT 100X
(D.11)
K2203a
R2210 316E
C2225 120p
V2206 BFR92
R2223 1M
V2207 BF991
C2247 2n2
C2238 22n
R2260 511E
V2209 BFR92
C2237 82p
R2208 51E1
C2212 6p8
C2216 8p2
C2211 6p8
C2213 56p
C2214 10p
R2209 42E4
C2217 56p
C2205 15p
R2212 10M
R2213 10M
C2219 220n
R2214 10M
R2216 133E
R2217 261E
R2235 51E1
R2255 1M
C2240 2n2
V2214 BFR92
R2272 2K15
C2248 2n2
TP206
TP207
ATTA--A
R2215 1K33
C2221 10n
R2211 3K83
V2204 BFR92
R2238 1K
C2222 4n7
N2201 453
FEEDBACK LOOP
R2237 215K
R2239 10K
R2240 51E1
V2208 BFS20
C2244 2n2
C2245 2n2
C2223 3n3
R2241 10K
R2242 178E
R2250 10E
C2230 100n
R2245 3K83
R2249 51E1
V2211 BFR92
R2243 3K48
C2224 3n3
R2244 121E
R2246 3K83
R2247 147K
R2265 1E
C2218 270p
R2275 511K
C2236 680p
FEEDBACK
Sgnd6a
-5Va
+5Va
-Vref
02
22
C2243 2n2
R2327
L2303 100nH
C2340 15p
R2342 46E4
R2341 46E4
R2340 46E4
EXT.TRIG
+5V
-5V


24
25
26
27
28
29
30
REMOVED: 20
R2324 316E
R2323 464E
+Vref
V2301 BC858
V2302 BFT92
R2325 2K61
TP332
R2315 348E
TP331
R2338 2K15
R2317 68K1
R2346 10K
OFFSET
R2303 1K33
C2326 47p
R2345 100K
R2316 100K
R2304 511K
GAIN
R2347 10K
C2323 2n2
C2324 4µ7
C2322 4µ7
R2308 75K
C2310 3n3
HF-COMP
C2303 100n
C2308 10n
20
18
R2327
R2328
L2303 100nH
L2304 100nH
C2340 15p
C2341 15p
R2342 46E4
R2343 46E4
ANALOG ASIC
+5Va
-5Va
+5V
-5V
R2301 1E
R2302 1E
R2306 1E
R2307 1E
C2301 100n
C2302 100n
C2306 100n
C2307 100n
D2301
000308
VCCa GNDa VEEa VCCs GNDs VEEs
INPB
INPGND
INPA
TRIG
VCCt
GNDt
VEEt
SNGOUT
VREF
CLK
CLKN
STOP
TOUT
HLDF
CHA
LEVEL
CDAT CCLK DTAE VCCc GNDc VEEc
ATTB--A
ATTA--A
EXT.TRIG
R2341 46E4
R2340 46E4
+5V
-5V
R2313 1E
R2314 1E
C2309 100n
C2311 100n
C2304 22n
C2316 100n
R2305 1E
R2312 1E
TRACKN
STOPN
DT-VALUE
R2319 56E2
L2301 39nH
C2315 12p
R2311 option 316E
HLDOFN
CHANA
LEVEL
R2309 75K
R2322 31K6
R2320 51K1
C2313 22n
C2312 220n
R2321 316K
C2320 22n
ADDED: 21
V2304 BC848
R2326 10K
R2300 10K
R2318 383E
C2314 22n
CDAT
ADCBUS3

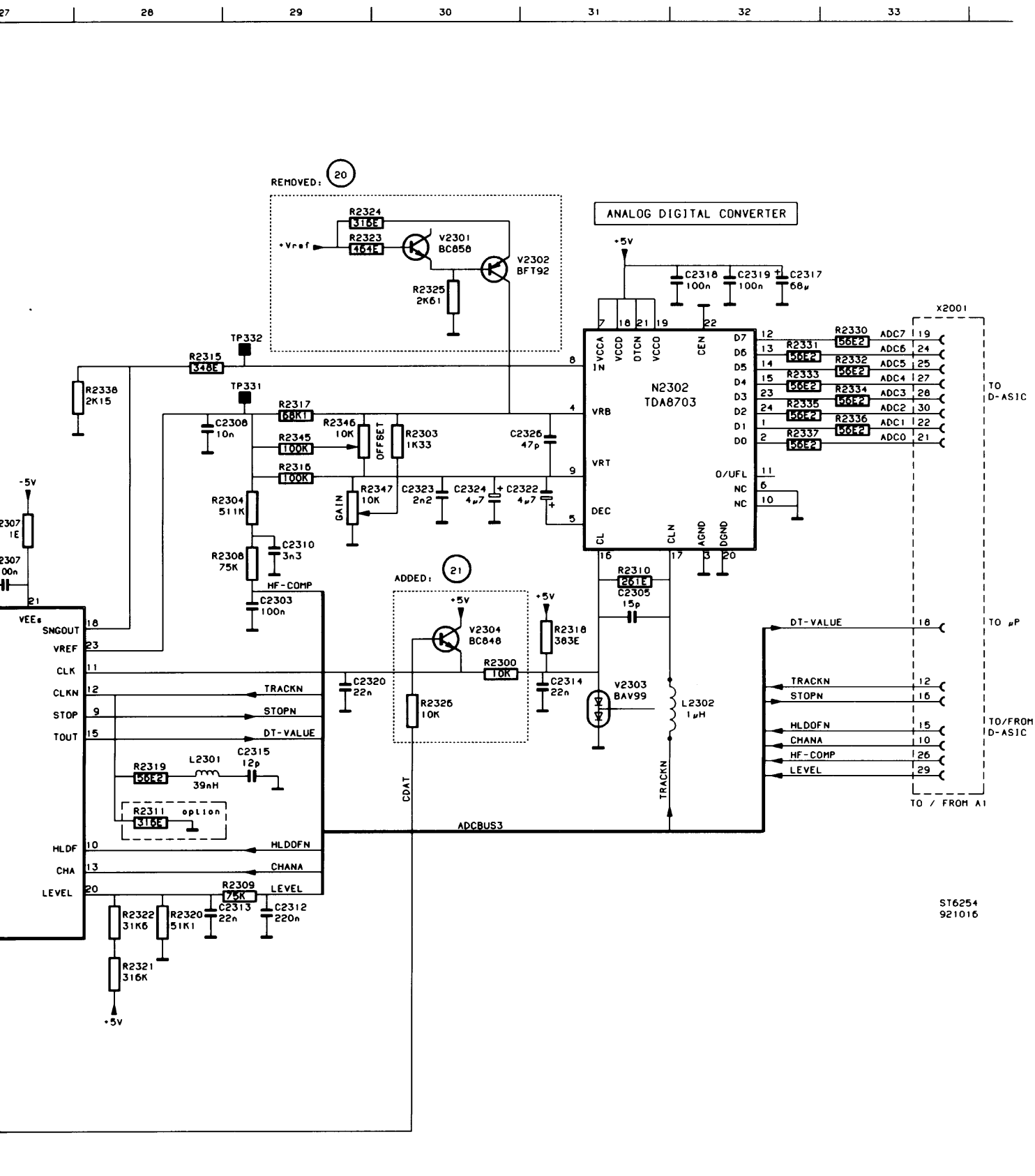


Figure 10.5 Analog A2 circuit diagram A2a

PARTS LOCATION A2 (CIRCUIT DIAGRAM A2b)

C2301	C20	C2868	E17	R2343	C20	R2879	B16
C2302	C21	D2301	D21	R2345	B24	R2881	A17
C2303	C24	D2750	D7	R2346	B24	TP331	B23
C2304	F21	D2751	D17	R2347	C24	TP332	B23
C2305	C26	D2751	D9	R2535	A25	TP700	D4
C2306	C21	D2850	D12	R2729	G3	TP701	D4
C2307	C22	D2850	A2	R2750	C3	TP702	B3
C2308	B23	K2750	D2	R2753	C4	TP704	G3
C2309	E20	K2750	C3	R2754	C5	TP706	G4
C2310	C24	K2751	D4	R2755	D3	TP801	D12
C2311	E24	K2751	F2	R2757	A4	TP802	F14
C2311	E20	L2301	E23	R2759	B3	TP803	D15
C2313	E23	L2302	D26	R2760	D5	TP804	E16
C2314	D25	L2303	C20	R2761	D7	TP805	B15
C2315	E23	L2304	C20	R2762	D10	TP806	A16
C2316	F21	N2302	B26	R2763	D5	V2301	A25
C2317	A27	N2750	C3	R2764	D5	V2302	A25
C2318	A26	N2751	G4	R2766	C5	V2303	D26
C2319	A27	N2751	G3	R2766	E5	V2736	D8
C2320	D24	N2850	B16	R2767	D6	V2751	C4
C2322	C25	N2850	D16	R2768	D6	V2752	D4
C2323	C25	R2301	C20	R2769	D7	V2753	D4
C2324	C25	R2302	C21	R2770	E5	V2754	C6
C2326	B25	R2303	B25	R2771	H3	V2755	H5
C2340	C19	R2304	C23	R2772	H4	V2756	C6
C2704	E4	R2305	F21	R2773	G4	V2757	A4
C2705	H3	R2306	C21	R2774	G4	V2758	B3
C2750	B3	R2307	C22	R2775	E5	V2759	F5
C2751	C5	R2308	C23	R2776	E9	V2760	F4
C2752	D10	R2309	E23	R2777	C4	V2761	G4
C2753	H3	R2310	C26	R2778	C1	V2762	F5
C2754	H3	R2312	F22	R2838	B22	V2763	F6
C2756	E4	R2313	E20	R2853	E13	V2764	H5
C2757	D6	R2314	E20	R2854	E13	V2765	D2
C2758	B3	R2315	B23	R2856	D13	V2766	D2
C2758	D6	R2316	C24	R2857	E13	V2767	D8
C2759	E6	R2317	B24	R2858	E13	V2768	E10
C2760	B3	R2318	D25	R2859	E14	V2769	C4
C2761	C6	R2319	E23	R2860	E14	V2851	E13
C2762	D9	R2320	E23	R2861	E15	V2852	F15
C2763	D8	R2321	F23	R2862	E15	V2853	B14
C2801	C1	R2322	E23	R2864	E16	V2854	B17
C2850	E13	R2323	A24	R2865	B14	X2001	F1
C2851	E14	R2324	A24	R2866	E17	X2001	B28
C2852	E14	R2330	B28	R2867	F14	X2201	F1
C2853	E14	R2331	B27	R2868	F14		
C2854	E15	R2332	B28	R2869	F15		
C2856	E15	R2333	B27	R2870	C14		
C2857	E13	R2334	B28	R2871	A15		
C2861	A15	R2335	B27	R2872	A15		
C2862	B15	R2336	B28	R2873	B15		
C2863	E16	R2337	B27	R2875	B15		
C2864	A16	R2340	D19	R2876	A15		
C2866	F14	R2341	D19	R2877	A16		
C2867	E17	R2342	C19	R2878	B16		

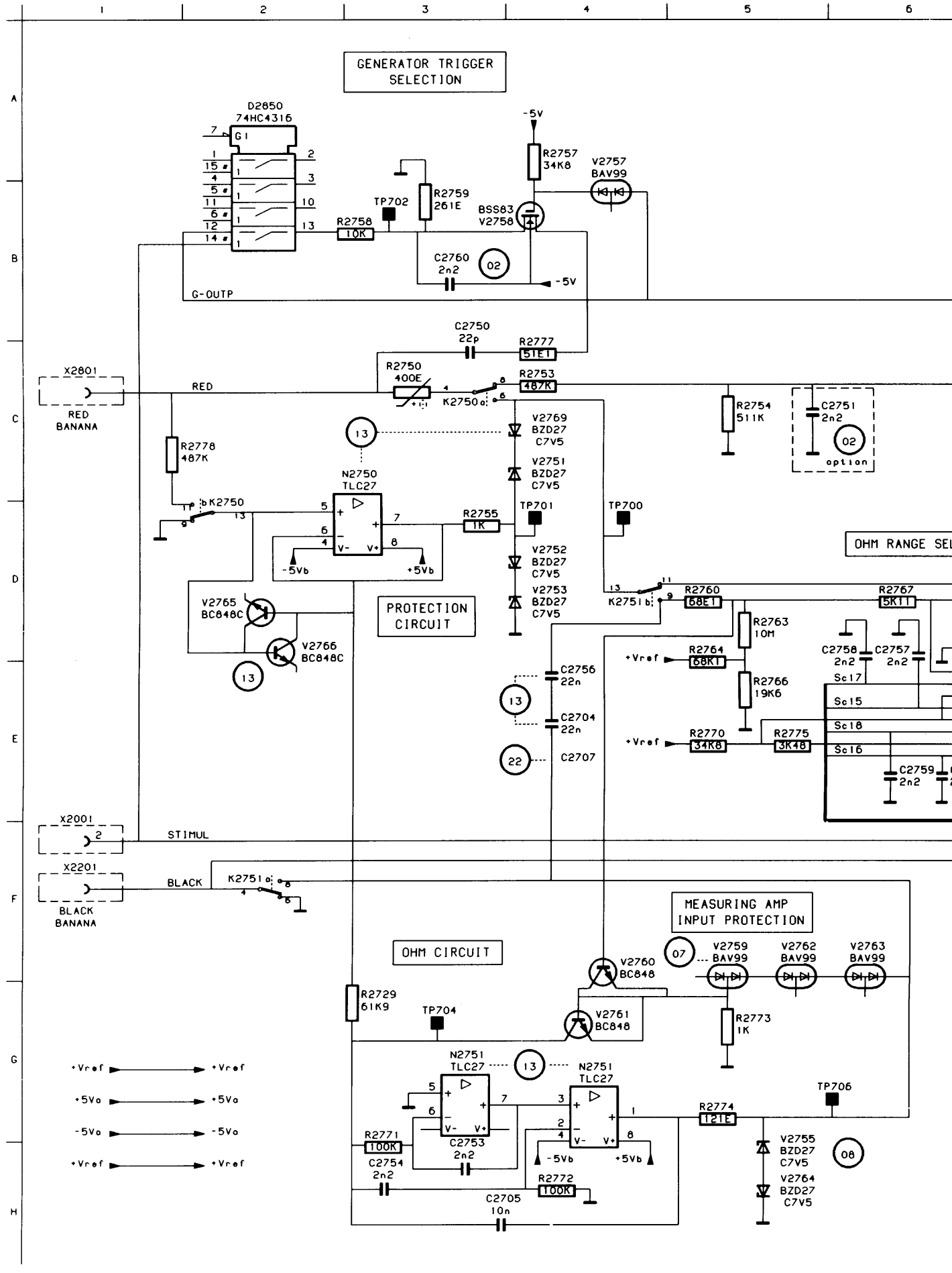
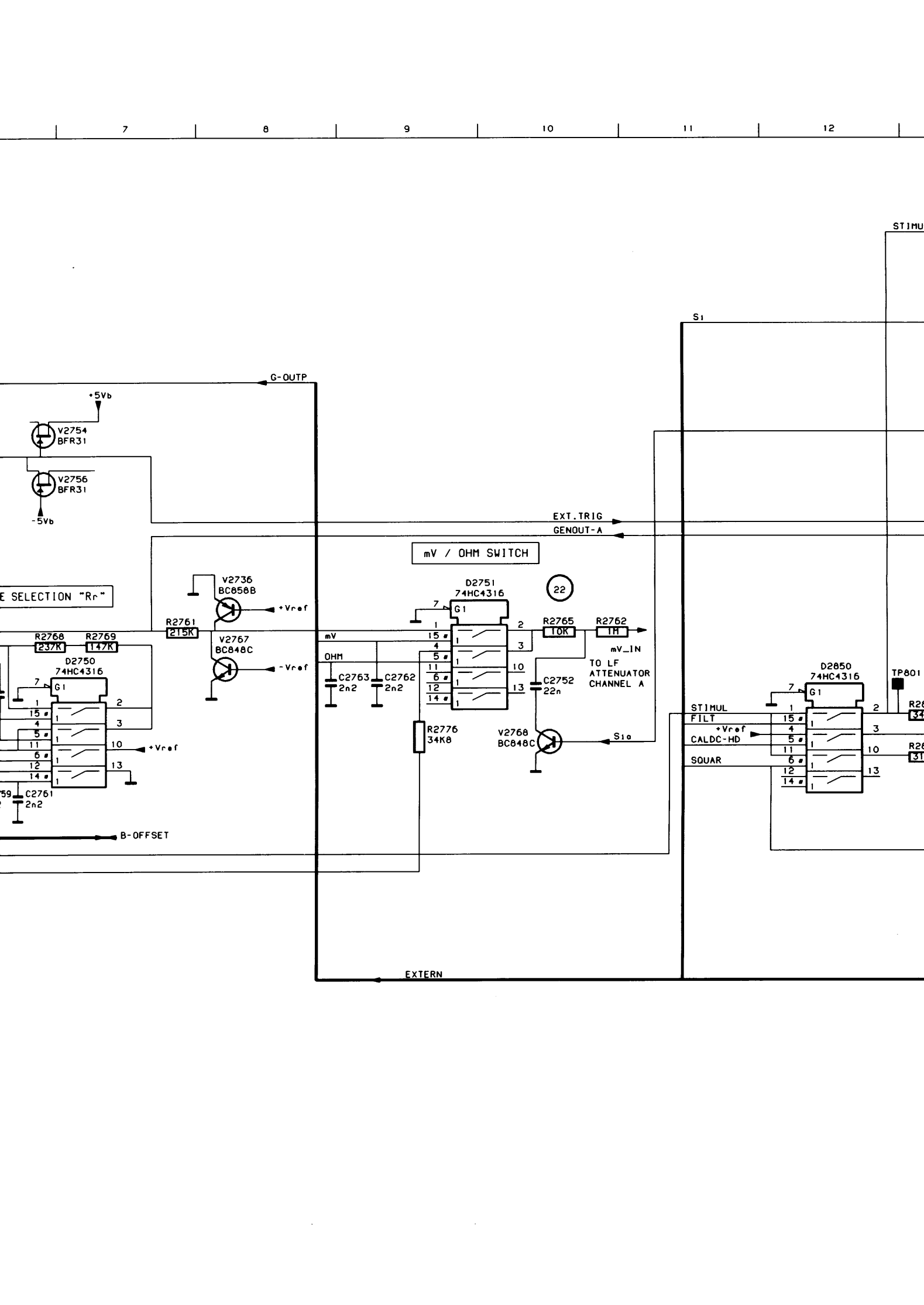
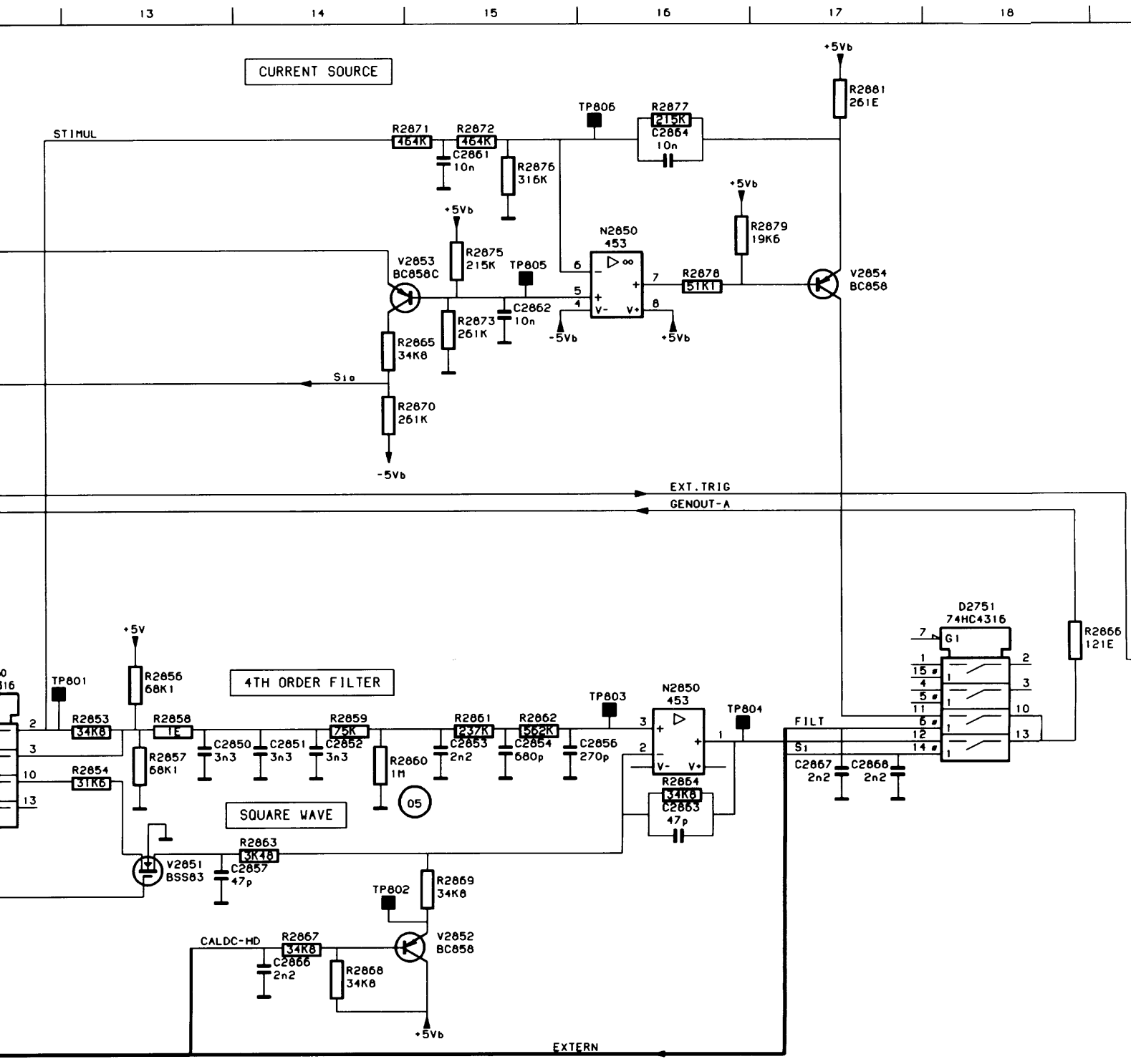
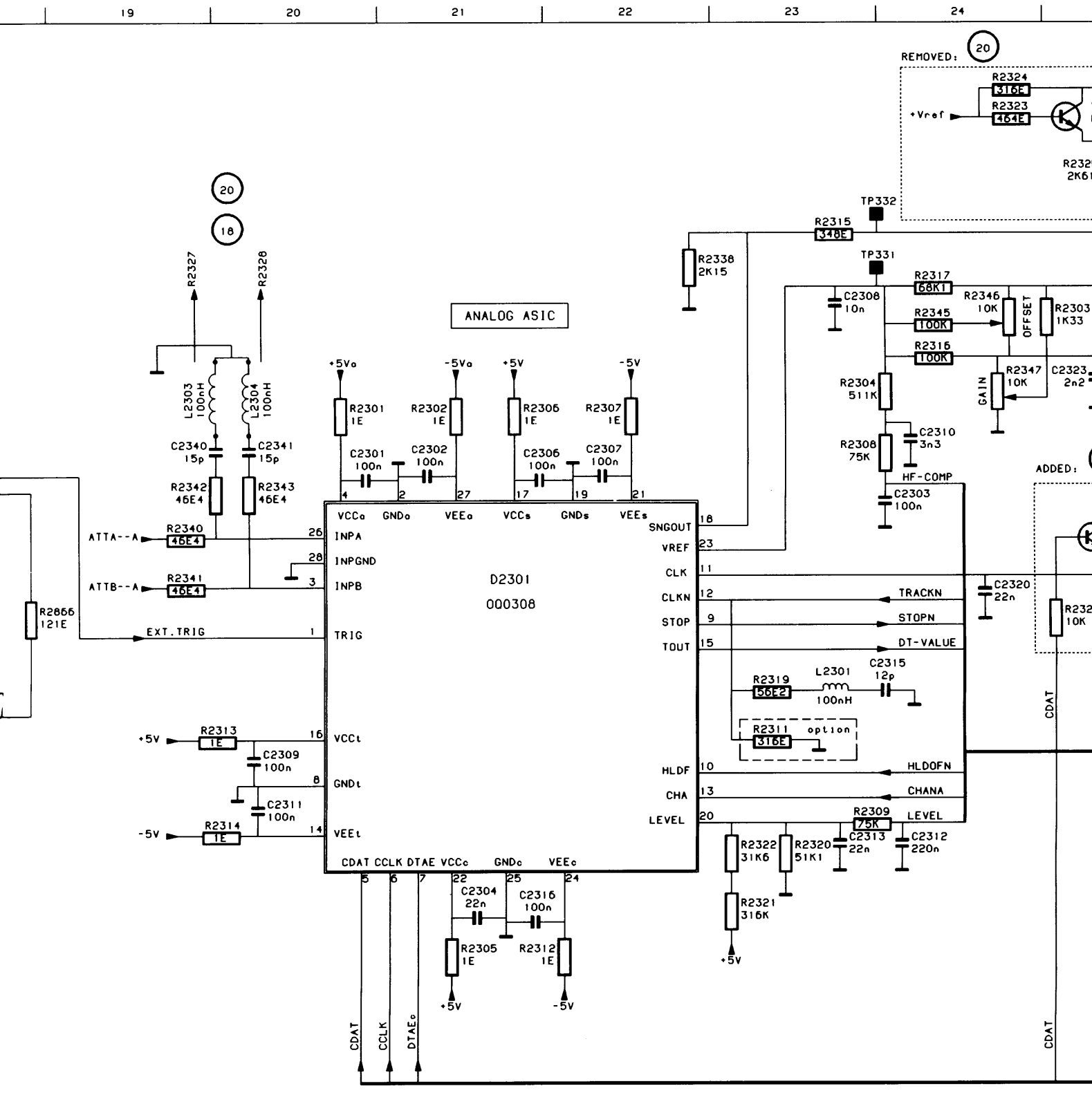
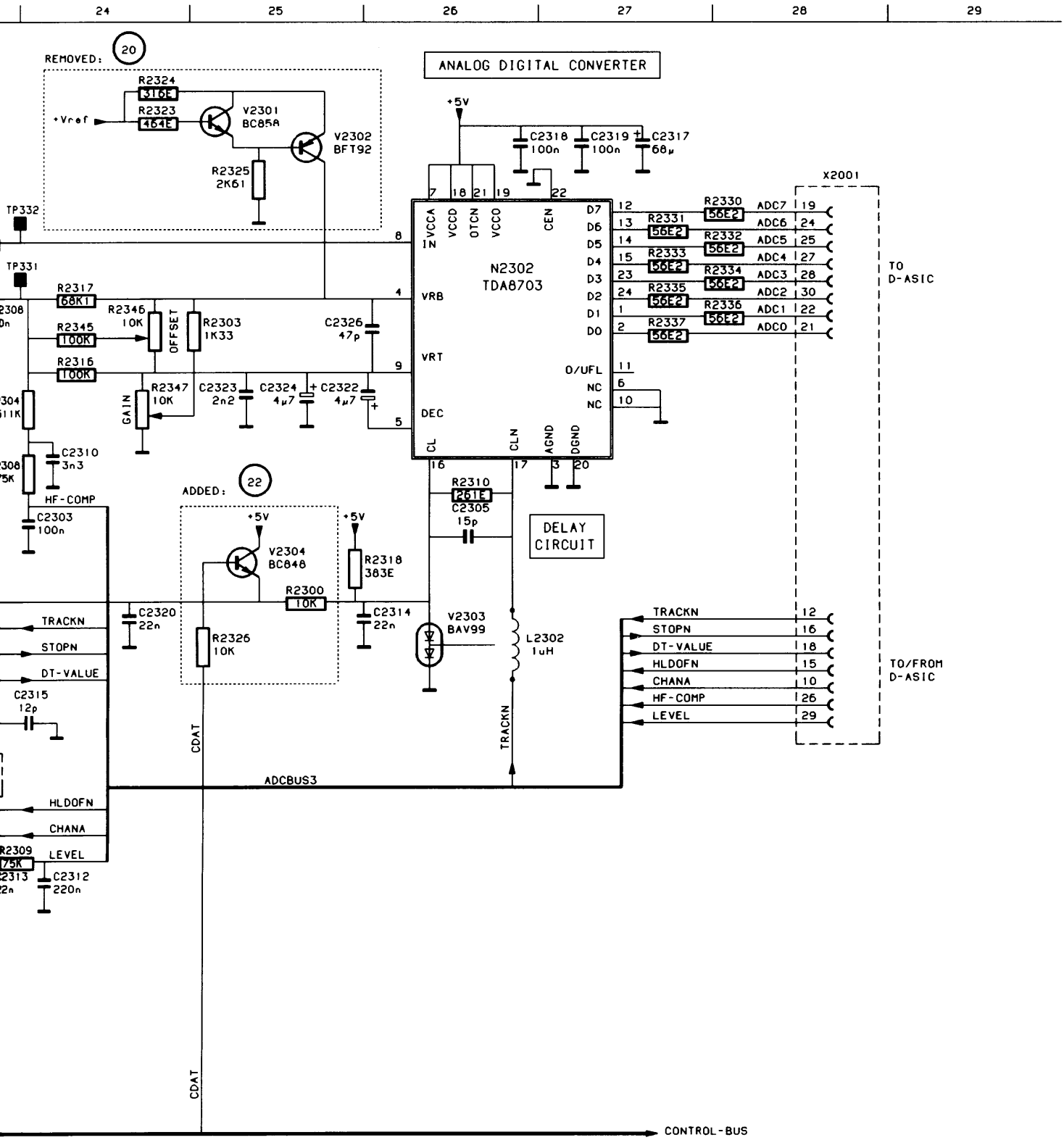


Figure 10.6 Analog A2 circuit diagram A2b


7
8
9
10
11
12
G-OUTP
+5Vb
V2754
BFR31
V2756
BFR31
-5Vb
EXT.TRIG
GENOUT-A
mV / OHM SWITCH
E SELECTION "Rr"
V2736
BC858B
+Vref
R2761
215K
V2767
BC848C
-Vref
R2768
237K
R2769
147K
D2750
74HC4316
+Vref
C2761
2n2
B-OFFSET
D2751
74HC4316
22
R2765
10K
R2762
1M
mV_IN
TO LF
ATTENUATOR
CHANNEL A
mV
OHM
C2763
2n2
C2762
2n2
C2752
22n
R2776
34K8
V2768
BC848C
Sio
S1
STIMU
D2850
74HC4316
STIMUL
FILT
+Vref
CALDC-HD
SQUAR
TP801
EXTERN


13
14
15
16
17
18
CURRENT SOURCE
STIMUL
R2871 464K
R2872 464K
C2861 10n
R2876 316K
TP806
R2877 215K
C2864 10n
+5Vb
R2881 261E
+5Vb
R2879 19K6
+5Vb
R2875 215K
N2850 453
V2853 BC858C
TP805
C2862 10n
R2873 261K
R2865 34K8
R2878 51K1
V2854 BC858
-5Vb
+5Vb
S1a
R2870 261K
-5Vb
EXT.TRIG
GENOUT-A
D2751 74HC4316
R2866 121E
+5V
TP801
R2856 68K1
4TH ORDER FILTER
R2853 34K8
R2858 TE
R2859 75K
R2861 237K
R2862 562K
TP803
N2850 453
TP804
FILT
S1
R2857 68K1
C2850 3n3
C2851 3n3
C2852 3n3
R2860 1M
C2853 2n2
C2854 680p
C2856 270p
R2854 31K6
R2864 34K8
C2863 47p
C2867 2n2
C2868 2n2
SQUARE WAVE
R2863 3K48
V2851 BSS83
C2857 47p
TP802
R2869 34K8
CALDC-HD
R2867 34K8
V2852 BC858
C2866 2n2
R2868 34K8
+5Vb
EXTERN


19
20
21
22
23
24
REMOVED:
20
R2324
316E
R2323
464E
+Vref
R2328
2K61
20
18
R2327
R2328
TP332
R2315
348E
R2338
2K15
TP331
R2317
68K1
C2308
10n
R2346
10K
R2345
100K
OFFSET
R2303
1K33
R2316
100K
GAIN
R2347
10K
C2323
2n2
R2304
511K
C2310
3n3
R2308
75K
HF-COMP
C2303
100n
ADDED:
ANALOG ASIC
+5Va
-5Va
+5V
-5V
R2301
1E
R2302
1E
R2306
1E
R2307
1E
C2301
100n
C2302
100n
C2306
100n
C2307
100n
L2303
100nH
L2304
100nH
C2340
15p
C2341
15p
R2342
46E4
R2343
46E4
VCCa GNDa VEEa VCCs GNDs VEEs
INPA
INPGND
INPB
TRIG
SNGOUT
VREF
CLK
CLKN
STOP
TOUT
HLDF
CHA
LEVEL
D2301
000308
ATTA--A
R2340
46E4
ATTB--A
R2341
46E4
EXT.TRIG
R2866
121E
TRACKN
STOPN
DT-VALUE
HLDOFN
CHANA
LEVEL
C2320
22n
R2319
56E2
L2301
100nH
C2315
12p
R2311
316E
option
R2309
75K
C2313
22n
C2312
220n
R2322
31K6
R2320
51K1
R2321
316K
+5V
R2313
1E
C2309
100n
C2311
100n
R2314
1E
-5V
VCCt
GNDt
VEEt
CDAT CCLK DTAE VCCe GNDe VEEe
C2304
22n
C2316
100n
R2305
1E
R2312
1E
CDAT
CCLK
DTAEe
CDAT



ST6253
921016

PARTS LOCATION A2 (CIRCUIT DIAGRAM A2c)

C2431	G13	R2503	E16	R2575	A9	V2539	G9
C2434	A5	R2504	F15	R2581	A9	V2541	E10
C2501	G14	R2506	F15	R2582	D8	V2542	G11
C2502	E14	R2507	E15	R2583	B21	V2543	E10
C2503	G15	R2508	G15	R2584	E18	V2544	D17
C2504	E15	R2509	G16	R2596	G7	V2550	G5
C2506	C17	R2511	G16	R2597	G8	X2001	C22
C2507	F17	R2512	G17	R2598	D17	X2001	G11
C2508	E17	R2513	G17	R2599	E14	X2001	E11
C2509	D17	R2514	G17	T2501	F16	X2001	C22
C2511	D19	R2516	G18	T2501	E16	X2501	B1
C2512	D19	R2517	G18	TP501	F13	X2502	H11
C2514	C19	R2518	G18	TP502	F13	Z2501	A2
C2515	E18	R2519	F8	TP503	E15		
C2516	E18	R2521	F8	TP504	F18		
C2517	C21	R2522	C18	TP506	G18		
C2518	B21	R2523	D18	TP507	A15		
C2519	B21	R2524	D18	TP508	A15		
C2521	E19	R2526	C17	TP509	D19		
C2522	E19	R2527	D18	TP511	E18		
C2523	F17	R2528	D19	TP520	B1		
C2524	C21	R2529	D20	TP521	C2		
C2526	A3	R2530	B15	TP522	B4		
C2527	C3	R2531	B21	TP523	B5		
C2529	C4	R2532	E18	TP524	C5		
C2530	B3	R2534	B13	TP526	B8		
C2532	G13	R2535	A13	TP527	F9		
C2533	C4	R2536	B12	TP528	F9		
C2536	G6	R2537	B12	TP529	D9		
C2537	B6	R2538	B13	V2501	E14		
C2538	G10	R2540	A14	V2502	F15		
C2539	A14	R2541	G15	V2503	E16		
C2540	E17	R2542	G13	V2504	F17		
C2541	E17	R2543	A13	V2506	C17		
C2543	A13	R2544	F15	V2507	E16		
C2544	A14	R2546	A8	V2508	F13		
C2545	H10	R2548	B3	V2509	D20		
C2546	C19	R2551	C4	V2511	E20		
C2547	E19	R2554	BA5	V2512	B14		
C2548	E19	R2556	C5	V2513	A15		
C2549	B21	R2557	B5	V2514	G15		
C2551	B21	R2558	C5	V2516	E13		
C2552	C21	R2559	A4	V2517	F13		
L2501	C18	R2561	A5	V2518	E13		
L2502	E17	R2562	B6	V2521	A10		
L2503	C20	R2563	D8	V2523	F5		
L2504	B8	R2564	C8	V2526	F5		
L2506	B8	R2565	C8	V2527	B6		
N2501	A13	R2566	F7	V2528	B6		
N2501	D19	R2567	F8	V2532	A8		
N2502	D17	R2568	E8	V2533	F7		
N2503	B4	R2569	E8	V2534	F7		
N2750	A14	R2571	D8	V2536	F8		
R2501	E14	R2572	G10	V2537	E9		
R2502	F14	R2573	G10	V2538	F9		

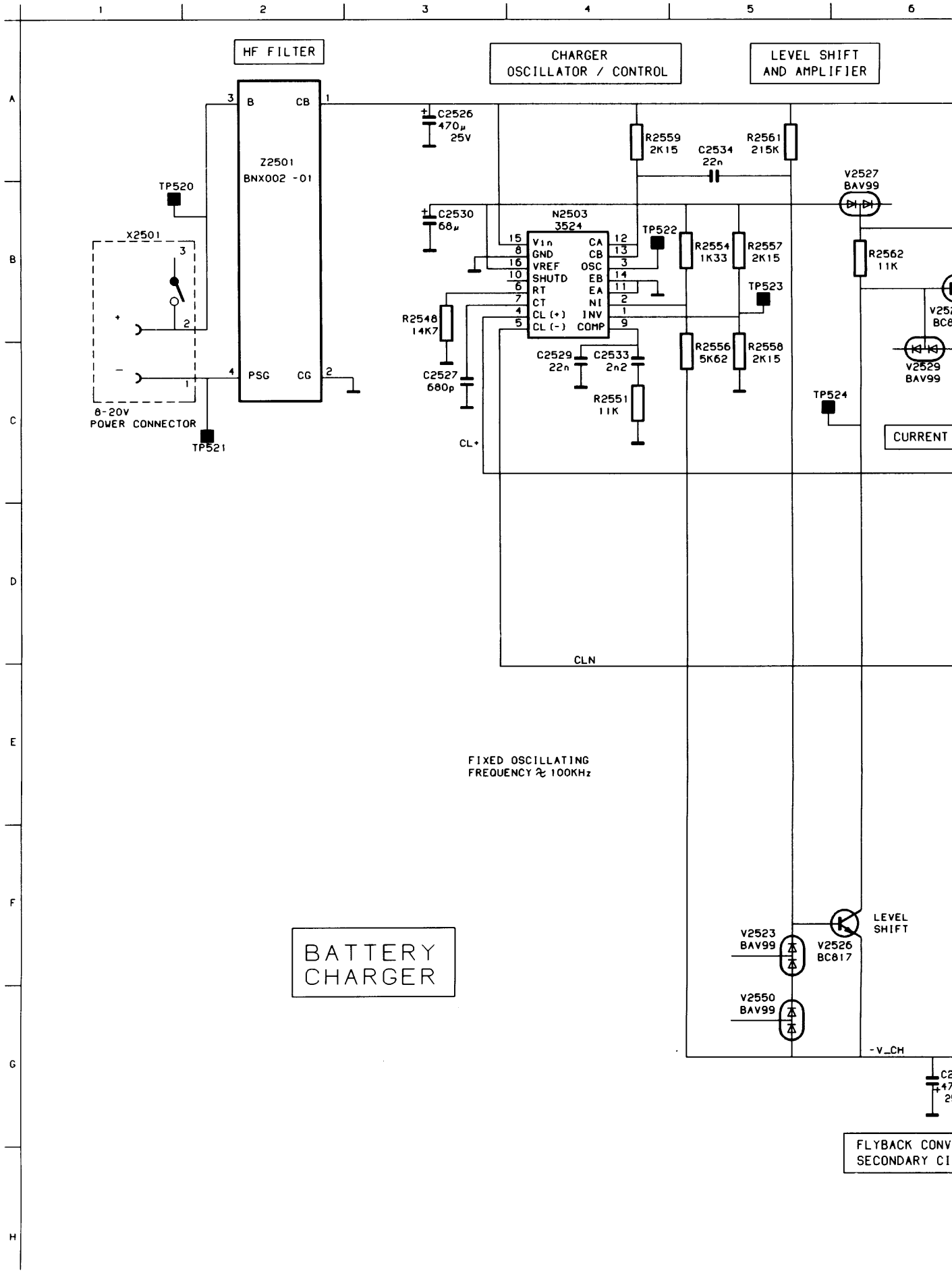
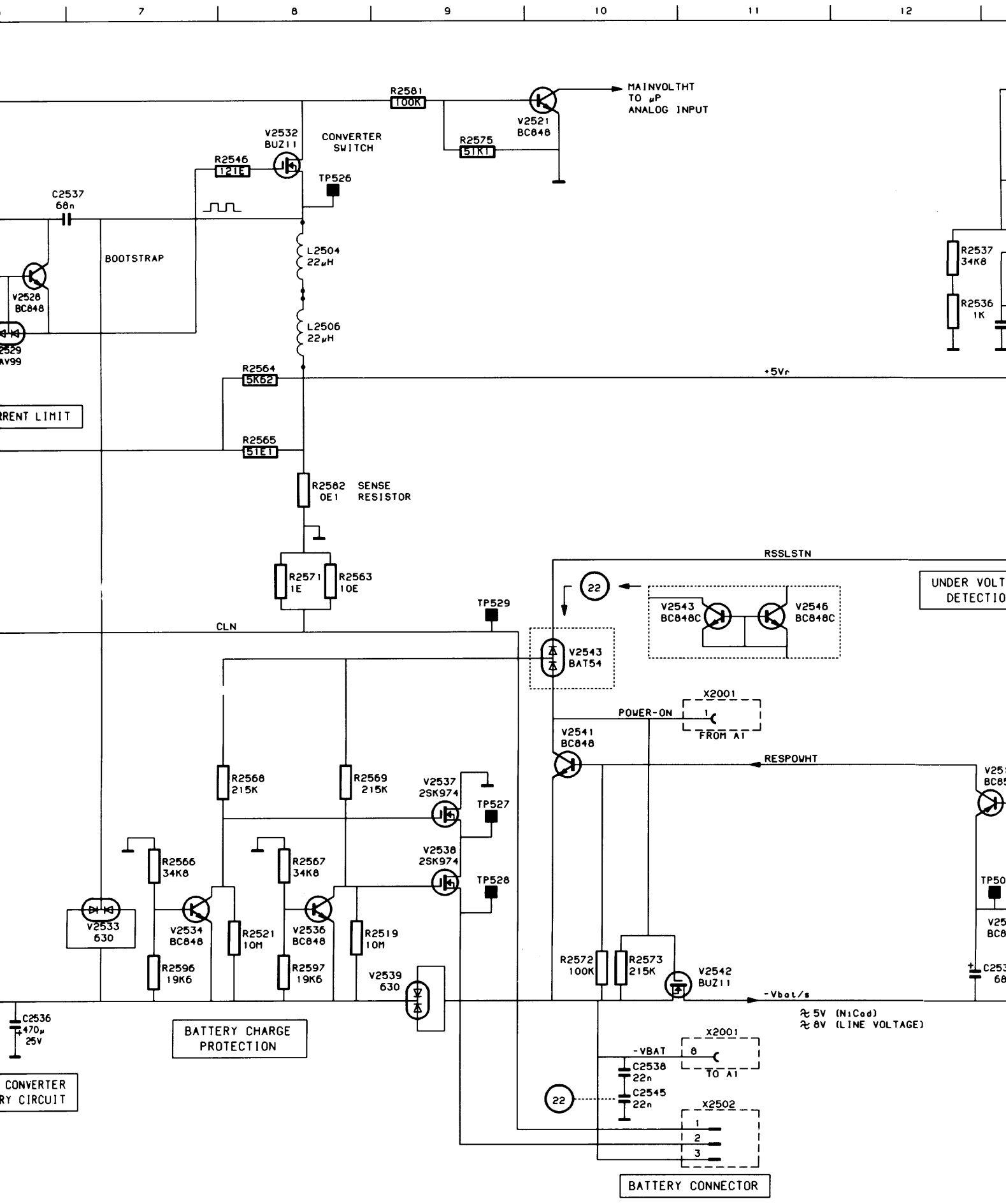
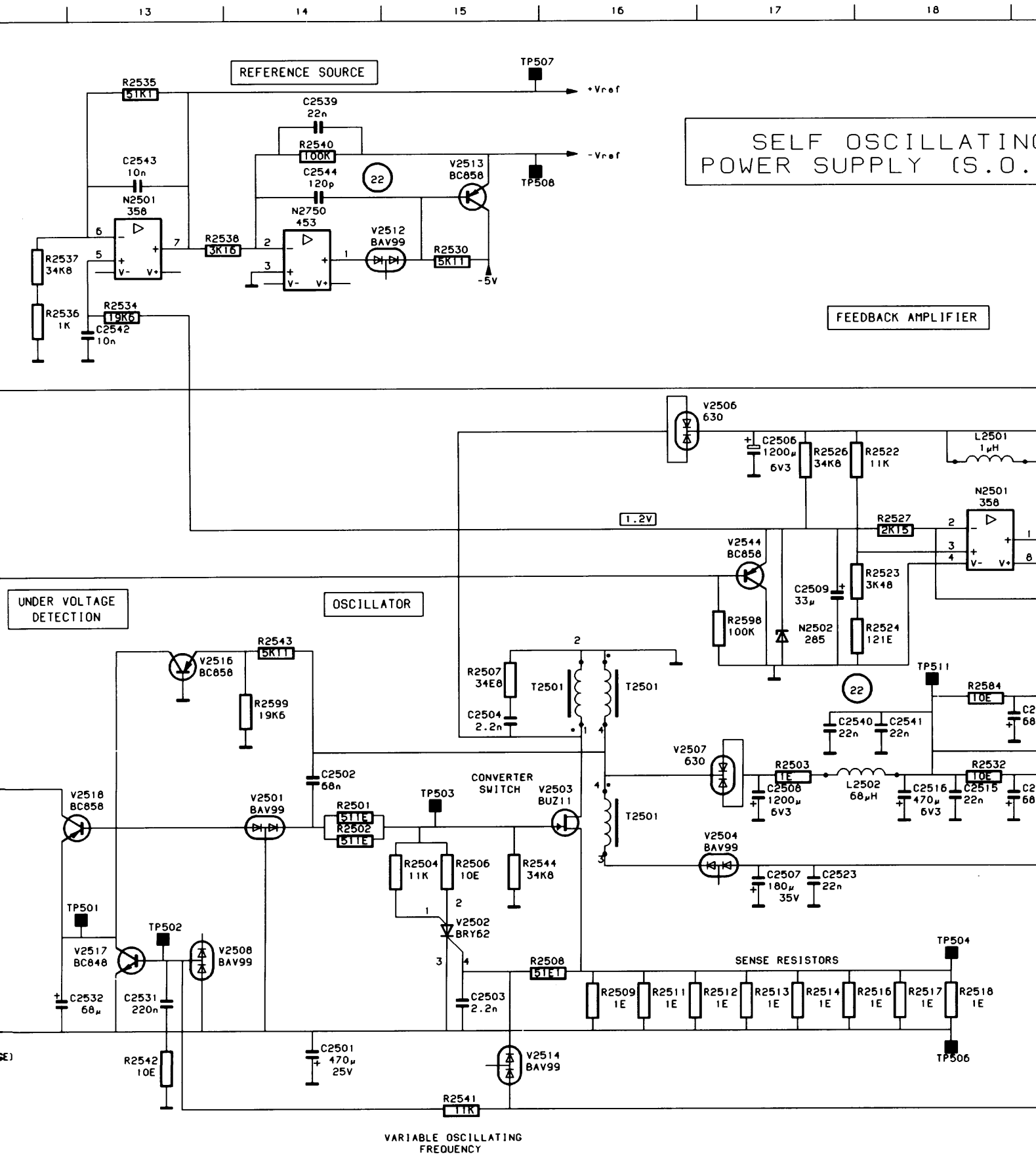


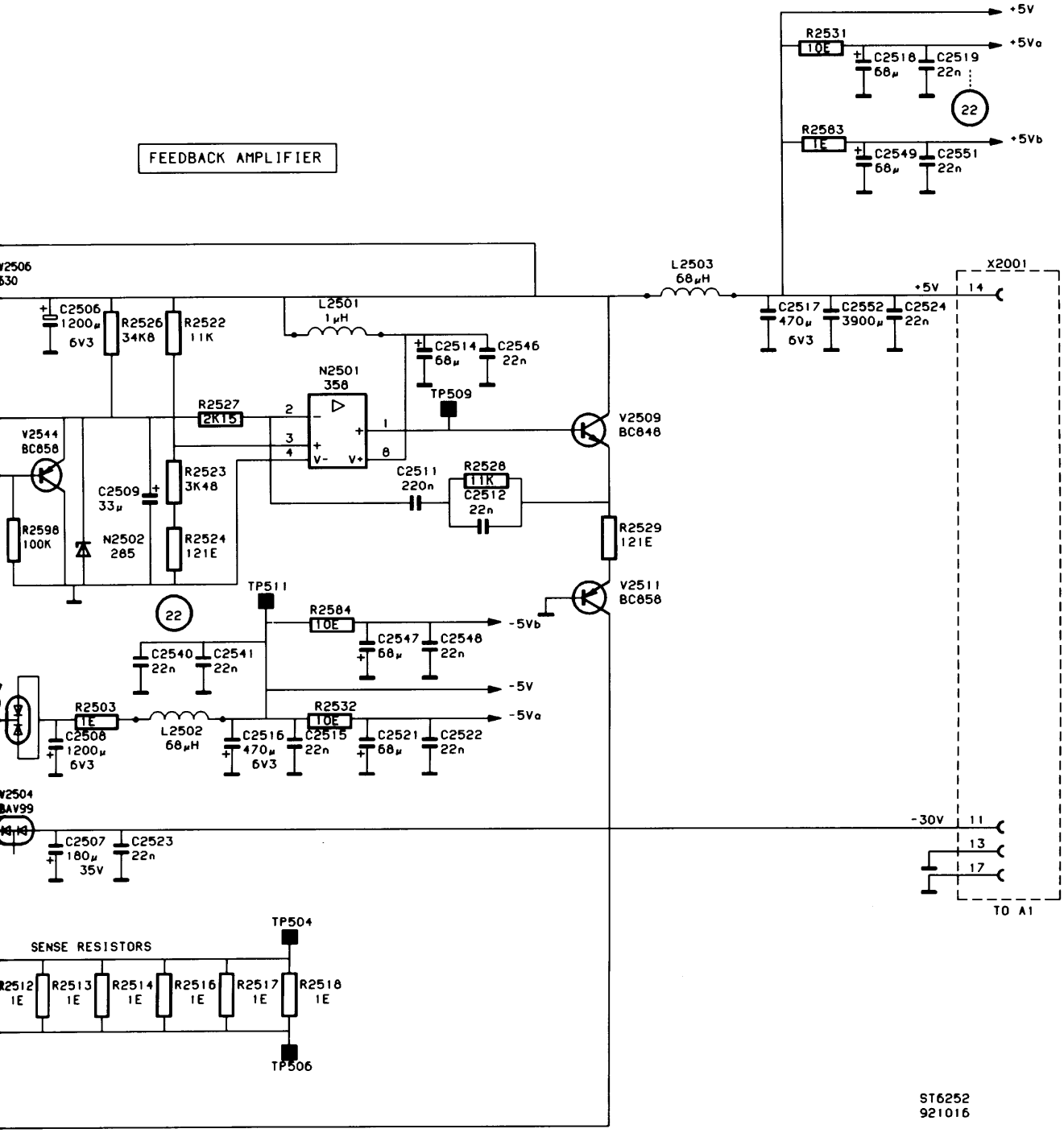
Figure 10.7 Analog A2 circuit diagram A2c


7
8
9
10
11
12
R2581
100K
MAINVOLTHT
TO µP
ANALOG INPUT
V2521
BC848
V2532
BUZ11
CONVERTER
SWITCH
R2575
5IK1
R2546
12IE
TP526
C2537
68n
BOOTSTRAP
L2504
22µH
L2506
22µH
V2528
BC848
R2537
34K8
R2536
1K
+5Vr
R2564
5K62
RRENT LIMIT
R2565
5IE1
R2582 SENSE
0E1 RESISTOR
R2571
1E
R2563
10E
RSSLSTN
UNDER VOLT
DETECTIO
22
V2543
BC848C
V2546
BC848C
TP529
CLN
V2543
BAT54
X2001
POWER-ON
1
FROM A1
V2541
BC848
RESPOWHT
R2568
215K
R2569
215K
V2537
2SK974
TP527
V2538
2SK974
TP528
R2566
34K8
R2567
34K8
V2533
630
V2534
BC848
R2521
10M
V2536
BC848
R2519
10M
R2596
19K6
R2597
19K6
V2539
630
R2572
100K
R2573
215K
V2542
BUZ11
-Vbat/s
≈ 5V (NiCad)
≈ 8V (LINE VOLTAGE)
C2536
470µ
25V
BATTERY CHARGE
PROTECTION
X2001
-VBAT
8
TO A1
C2538
22n
C2545
22n
22
X2502
1
2
3
CONVERTER
RY CIRCUIT
BATTERY CONNECTOR


13
14
15
16
17
18
REFERENCE SOURCE
TP507
+Vref
-Vref
TP508
R2535
5K11
C2539
22n
R2540
100K
C2543
10n
C2544
120p
22
V2513
BC858
N2501
358
N2750
453
V2512
BAV99
R2538
3K16
R2530
5K11
-5V
R2537
34K8
R2536
1K
R2534
19K6
C2542
10n
SELF OSCILLATING
POWER SUPPLY (S.O.
FEEDBACK AMPLIFIER
V2506
630
C2506
1200µ
6V3
R2526
34K8
R2522
11K
L2501
1µH
1.2V
R2527
2K15
V2544
BC858
R2523
3K48
C2509
33µ
R2598
100K
N2502
285
R2524
121E
UNDER VOLTAGE
DETECTION
OSCILLATOR
R2543
5K11
V2516
BC858
R2599
19K6
R2507
34E8
T2501
C2504
2.2n
TP511
R2584
10E
C2540
22n
C2541
22n
V2507
630
R2503
1E
C2508
1200µ
6V3
L2502
68µH
C2516
470µ
6V3
C2515
22n
R2532
10E
C2502
68n
CONVERTER
SWITCH
V2503
BUZ11
TP503
V2518
BC858
V2501
BAV99
R2501
511E
R2502
511E
R2504
11K
R2506
10E
R2544
34K8
V2504
BAV99
C2507
180µ
35V
C2523
22n
TP501
TP502
V2517
BC848
V2508
BAV99
V2502
BRY62
R2508
51E1
SENSE RESISTORS
TP504
R2509
1E
R2511
1E
R2512
1E
R2513
1E
R2514
1E
R2516
1E
R2517
1E
R2518
1E
TP506
C2532
68µ
C2531
220n
C2503
2.2n
C2501
470µ
25V
V2514
BAV99
R2542
10E
R2541
11K
VARIABLE OSCILLATING
FREQUENCY

17 | 18 | 19 | 20 | 21 | 22

SELF OSCILLATING POWER SUPPLY (S.O.P.S.)



11 MODIFICATIONS

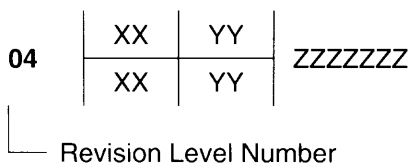
This section lists the modifications made up to production date 1 December 1992.

11.1 HARDWARE MODIFICATIONS, PCB REVISION LEVELS

The ANALOG BOARD A1 and the DIGITAL BOARD A2 have two stickers on them which identify their revision level. However, one of these stickers is used only in the factory to identify the revision level of a lower assembly. This number on this revision level sticker begins with an "S".
The revision level stickers for complete DIGITAL BOARD A1 and ANALOG BOARD A2 assemblies will be located as indicated below. All revision level descriptions refer to the complete DIGITAL BOARD A2 and ANALOG BOARD A1 assembly. Revision levels "nn" are indicated in:

- The replaceable parts lists, Section 9; the revision level is placed in the column "revision level", indicating that a part has been modified. The modification is described below in the revision level overview.
- In the schematics; the revision level "nn" is placed in a circle near the modified part(s). The modification is described below in the revision level overview.

The revision level number is printed on the left hand side of the sticker.



The ANALOG BOARD A1 revision level sticker for the complete assembly is located near the A channel input on the shield that is permanently attached to the board. You must remove the top shield to access it.

The DIGITAL BOARD A2 revision level sticker is located between the two display driver chips D1406 and D1407.

11.2 DIGITAL BOARD A1 REVISION LEVEL OVERVIEW

REVISION LEVEL 01 DATE: 91-05-30

First release.

REVISION LEVEL 02 DATE: 91-06-06

Reason: Contrast variation LCD

ITEM	FROM		TO	
R1421	number not listed	100E	5322 111 91893	51E1
R1408, R1414	number not listed	34E8	4822 111 91885	10E

REVISION LEVEL 03 DATE: 91-07-09

Reason: **Offset at time base ≤ 20 µs/div.**

ITEM	FROM	TO	
C1222	-	4822 126 10004	120PF, C1222 added, parallel to R1232.

REVISION LEVEL 04 DATE: 91-07-12

Reason: **Other type number for L1202 used, same ordering code.**

ITEM	FROM	TO	
L1202	5322 157 63651	5322 157 63651	HF30ACB- 322513

REVISION LEVEL 05 DATE: 91-11-04

Reason: **New printed circuit board version. The board number is located next to display driver D1403.**

ITEM	FROM	TO
BOARD	4022 245 03645	4022 245 03646

REVISION LEVEL 06 DATE: 91-12-16

Reason 1: **Hang up at loading software version V3.15**

ITEM	FROM	TO	
R1233	-	4822 050 11003	10K, added; See fig.10.1a

Reason 2: **New ordering code for H1202**

ITEM	FROM	TO	
H1202	5322 130 62923	4822 130 62297	SFH309F-04

REVISION LEVEL 07 DATE: 92-02-17

Reason: **ANALOG BOARD A2 REVISION LEVEL 17 and higher supplies +5.3V to the DIGITAL BOARD A1. Older ANALOG BOARD A2 versions supply +5V.**
If the +5.3V is supplied and the modifications described below are not implemented, the display contrast will be bad, and the +12V programming voltage will not be accepted.

You must carry out modifications **REVISION LEVEL 07** and **08** if you combine a DIGITAL BOARD A1 with an ANALOG BOARD A2 provided with a new analog ASIC D2301 (OQ0308N6). See also "Hardware modification overview ANALOG BOARD A2" **REVISION LEVEL 17**.

ITEM	FROM		TO	
R1423 [1)]	4822 116 82889	90K9	4822 051 57503	75K
R1229	4822 111 91826	511E	4822 051 56811	681E

*1) to be modified to 82K5, see **REVISION LEVEL 08** below.*

*Note: if a DIGITAL BOARD A1 **REVISION LEVEL 07** or higher is installed in an instrument with ANALOG BOARD A2 **REVISION LEVEL 01/16**, R1423 and R1229 must be replaced with the old values (90K9 and 511E respectively).*

REVISION LEVEL 08 DATE: 92-02-19

Reason: Bad contrast.

ITEM	FROM		TO	
R1423	4822 051 57503	75K	4822 051 58253	82K5

REVISION LEVEL 09 DATE: 92-03-20

Reason: FLASH-EPROM D1207 (256k) and D1208 (512k) are replaced by one 1M FLASH-EPROM D1207 (N28F010-200P1C4). R1224 is added to indicate that the FLASH-EPROM type is 1M (read by the micro processor). The old version FLASH-EPROMs remain available. The procedure for saving and dumping firmware is not affected.

ITEM	FROM		TO	
D1207	4822 209 63758	N28F256	5322 209 52321	N28F010- 200P1C4
D1208	5322 209 30674	N28F512	removed	
R1224	-	-	4822 116 82532	11K, added

REVISION LEVEL 10 DATE: 92-03-20

Reasons: A new printed circuit board version is used, the board number is located next to display driver D1403. Manually mounted parts are included in the pcb lay-out; the display backlight connections (tracks) are reversed, so the backlight leads need no longer to be crossed.

ITEM	FROM	TO
Board	4022 245 03646	4022 245 03647
R1233	4822 050 11003 wired 10K, 1% between C1201 and D1201:41	5322 116 80428 10K, 1% (CHIP) located between V1206 and test spot 222
C1222	located on R1232	located between C1204 and C1318; C1503 and C1404 are moved to the left.

REVISION LEVEL 11 DATE: 92-07-01

Reason: The display contrast changed too much due to ambient temperature variations.

ITEM	FROM		TO	
R1419	5322 116 81794	2K15	4822 111 91821	2K61
R1423	4822 051 58253	82K5	4822 051 51214	121K

11.3 ANALOG BOARD A2 REVISION LEVEL OVERVIEW

REVISION LEVEL 01 DATE: 91-05-30

First release

REVISION LEVEL 02 DATE: 91-06-06

Reason 1: Tune up of the board

ITEM	FROM		TO	
C2139, C2141	number not listed	22NF	4822 122 33127	2.2NF
C2144, C2145	number not listed	22NF	4822 122 33127	2.2NF
C2146, C2147	number not listed	22NF	4822 122 33127	2.2NF
C2537	number not listed	22NF	4822 122 32891	68NF

Interconnection between V2543 pin 1 and base of V2544 added.

Reason 2: Noise on 20V/div. range

ITEM	FROM		TO	
C2751	number not listed	removed		
C2111, C2211	number not listed	6.8PF	4822 122 31194	8.2PF

Reason 3: Lowered temperature coefficient on the 300 Ohm range

ITEM	FROM		TO	
R2760	number not listed	261E	4822 116 90788	68E1
R2767	number not listed	3K48	4822 051 55112	5K11
R2755	number not listed	10K	4822 051 55002	1K
V2750	4822 130 82522	BZD27 C7V5	Removed	

Reason 4: DC shift of the internal generator

ITEM	FROM		TO	
R2869	4822 111 91891	34K8	4822 051 52163	31K6
R2853	5322 116 82903	31K6	4822 051 53833	38K3
R2858	number not listed	825E	4822 051 10108	1E

Reason 5: Tune up of the attenuator

ITEM	FROM		TO	
R2110, R2117	number not listed	464E	4822 051 53161	316E
R2210, R2217	number not listed	464E	4822 051 53161	316E
R2116, R2216	number not listed	215E	4822 051 51331	133E
R2108, R2208	number not listed	100E	5322 111 91893	51E1
C2128, C2228	number not listed	8.2PF	5322 122 32967	5.6PF
C2117, C2217	number not listed	68PF	5322 122 32661	56PF, 5%
C2105, C2205	-		5322 122 32448	10PF, added
C2760	-		4822 122 33127	2.2NF, added

Reason 6: Generator interference on -3V reference voltage and channels A,B due to crosstalk between N2750/2 and V2766.

ITEM	FROM		TO	
R2538, R2540	number not listed	100K	4822 051 53162	3K16

Reason 7: Step response abberation too large

ITEM	FROM		TO	
C2122, C2222	number not listed	3.3NF	5322 122 31866	6.8NF

Reason 8: Bandwidth improved

ITEM	FROM		TO	
R2117, R2217	number not listed	316E	4822 051 52611	261E

REVISION LEVEL 03 DATE: 91-07-01

Reason: Current/voltage ramp for component test improved

ITEM	FROM		TO	
R2583	number not listed	10E	4822 051 10108	1E
R2853	4822 051 53833	38K3	4822 051 53163	31K6
R2869	4822 051 52163	31K6	4822 051 53483	34K8

REVISION LEVEL 04 DATE: 91-07-04

Reason: AC adjustment of LF gain improved

ITEM	FROM		TO	
R2129, R2229	number not listed	2K61	4822 051 56811	681E
R2133, R2233	number not listed	2K61	5322 116 82899	3K83
R2134, R2234	number not listed	5K11	4822 051 57502	7K5
R2136, R2236	number not listed	261E	4822 051 57501	750E
R2132, R2232	number not listed	464K	4822 051 57503	75K
R2131, R2231	number not listed	825K	4822 051 51474	147K

REVISION LEVEL 05 DATE: 91-07-12

Reason: Availability of components

ITEM	FROM		TO	
L2301	number not listed	0.1uH	5322 157 63649	39nH
R2319	number not listed	121E	4822 111 91888	56E2
C2315	number not listed	4.7PF	4822 111 32139	12PF
R2860	-		4822 051 10106	10M, added parallel to C2853

REVISION LEVEL 06 DATE: 91-09-27

Reason: Improved bandwidth (60 MHz).

ITEM	FROM		TO	
R2101, R2201	4822 111 91885	10E	5322 116 82895	31E6
R2209	5322 111 91963	34E8	5322 116 82896	46E4
R2340, R2341	4822 116 90788	68E1	5322 116 82895	31E6
R2342, R2343	5322 116 82895	31E6	5322 116 82895	46E4

REVISION LEVEL 07 DATE: 91-10-07

Reason: Ohm circuit improved

ITEM	FROM		TO	
R2773, R2774	4822 111 91814	121E	4822 051 51002	1K
V2759	-		Remove pin 1 of V2759	

REVISION LEVEL 08 DATE: 91-10-17

Reason: Ohm circuit improved

ITEM	FROM	TO
V2755	-	4822 130 82522 BZD27-C7V5 added. Cut track from anode V2764 to relay K2751 and mount V2755 over it (anode to V2767).

REVISION LEVEL 09, 10 NOT RELEASED

REVISION LEVEL 11 DATE: 91-10-30

Reason 1: Improved Volts AC frequency characteristic

ITEM	FROM		TO	
C2105, C2205	5322 122 32448	10PF	5322 122 33869	15PF
C2111, C2211	4822 122 31194	8.2PF	4822 122 31049	6.8PF
C2115, C2215	4822 122 32139	12PF	5322 861 12331	330PF
C2118	4822 122 33172	390PF	5322 861 12331	330PF
C2120, C2220	5322 122 32448	10PF	5322 122 32967	5.6PF
C2122, C2222	5322 122 31866	6.8NF	4822 122 33339	4.7NF
C2123, C2223	4822 122 33891	3.3NF	4822 122 33174	1.5NF
C2128, C2228	5322 122 32967	5.6PF	5322 122 32448	10PF
C2136, C2236	5322 122 32452	47PF	Removed	
C2218	5322 122 31863	330PF	4822 122 33216	270PF

Connection between K2202 pin 4 and 6 added; connection between K2102 pin 11 and 13 added.

Reason 2: Oscillation N2750

ITEM	FROM		TO	
R2209	5322 116 82896	46E4	4822 111 91887	42E2
R2340, R2341	5322 116 82859	31E6	5322 116 82896	46E4

Reason 3: HF ringing

ITEM	FROM		TO	
V2765, V2766	5322 130 42136	BC848C	5322 130 34337	BAV99
C2130, C2230	5322 122 34098	10NF	4822 122 33496	100NF

REVISION LEVEL 12 DATE: 91-11-29

Reason: Improved AC performance

ITEM	FROM		TO	
V2101, V2102	4822 130 42513	BC858C	Removed	
V2201, V2202	4822 130 42513	BC858C	Removed	
C2110, C2210	4822 122 32139	12PF	Removed	
C2123, C2223	4822 122 33174	1.5NF	4822 122 33892	3.3NF
R2142, R2242	4822 116 90788	68E1	4822 051 51781	178E
R2125, R2225	4822 116 82901	19K6	4822 051 57502	7K5

REVISION LEVEL 13 DATE: 91-12-02

Reason: Temperature drift in the Ohm ranges decreased

ITEM	FROM		TO	
C2704	5322 122 32452	47PF	5322 122 32654	22NF
C2756	5322 122 34098	10NF	5322 122 32654	22NF
C2704, C2756	moved		Mounted in series, between K2751b pin 9 and K2751a pin 8.	
V2751	moved		see V2769	
V2769			4822 130 82522	BZD27-C7V5 added. Mounted in series with V2751 (cut trace, cathode to cathode).
V2765, V2766	5322 130 42136	BAV99	5322 130 42136	BC848C Cut emitter of BC 848C.
N2750, N2751	4822 209 63757	LF453CM	5322 209 31309	TLC27M2ACDR

REVISION LEVEL 14 DATE: 91-12-03

Reason 1: Offset adjustment range improved

ITEM	FROM		TO	
R2166, R2266	4822 111 91888	56E2	4822 116 90788	68E1

Reason 2: New ordering number R2346, R2347

ITEM	FROM		TO	
R2346, R2347	5322 101 11094	10K	5322 101 60082	10K

REVISION LEVEL 15 DATE: 91-12-03

Reason: Improved frequency response at 1 MHz

ITEM	FROM	TO	
R2123	-	4822 051 51005	1M, added between +5Vb and V2107 G2.
R2223	-	4822 051 51005	1M, added between +5Va V2207 G2.
C2138	-	5322 122 32654	22NF, added between V2107 G2 and source.
C2238	-	5322 122 32654	22NF, added between V2207 G2 and source.

REVISION LEVEL 16 DATE: 91-12-23

Reason 1: Noise in random sampling mode

ITEM	FROM		TO	
R2508	4822 111 91814	121E	5322 111 91893	51E1

Reason 2: Decreased temperature coefficient in the 20 VAC range

ITEM	FROM		TO	
C2108, C2208	4822 122 31072	47PF 500V	4822 122 31072	47PF 100V
C2113, C2213	4822 122 32791	56PF 500V	4822 122 32027	56PF 100V

REVISION LEVEL 17 DATE: 92-02-12

Reason: 5V supply increased to 5.3V for future version 6 of D2301 (OQ308)

You must carry out this modification if you replace an analog ASIC OQ308 version 5 by a version 6. In this case you must also carry out the modifications described at REVISION LEVEL 18 and 20 (19 is optional). If the revision level of the DIGITAL BOARD A1 is below 7, you must also carry out the modifications described at REVISION LEVEL 07 of the DIGITAL BOARD A1.

ITEM	FROM		TO	
R2523	5322 116 81795	3K48	4822 051 53162	3K16
R2524	4822 111 91814	121E	4822 051 51781	178E
R2858	4822 051 10108	1E	4822 051 52152	2K15

REVISION LEVEL 18 DATE:92-02-17

Reason: A new version of the OQ308 (D2301), version 6, is used.

You must carry out these modifications if you replace an analog ASIC D2301 (OQ308) version 5 by a version 6. In this case you must also carry out the modifications described at **REVISION LEVEL 20** (**19** is optional). If the revision level of the DIGITAL BOARD A1 is below 7, you must also carry out the modifications described at **REVISION LEVEL 07** of the DIGITAL BOARD A1.

ITEM	FROM		TO	
C2137, C2237 [1]	4822 122 33515	82 PF	5322 122 32967	5.6 PF
C2340, C2341	5322 122 33896	15 PF	5322 122 31946	27 PF
L2303, L2304	5322 157 63647	100 nH	removed	
R2327, R2328 [2]	added on location of L2303, L2304		5322 111 91893	51E1
R2342, R2343 [2]	5322 116 82896	46E4	5322 111 91963	34E8
R2317	4822 111 91828	68K1	4822 051 51004	100K
R2338 [2]	5322 116 81794	2K15	4822 051 51332	1K33
D2301	5322 209 30821	OQ0308N5	5322 209 30821	OQ0308N6

1 not to be modified, changed to 82 PF again at REVISION LEVEL 20, see below.
2) changed for REVISION LEVEL 20 again; to be modified directly to the value indicated at REVISION LEVEL 20 below.

REVISION LEVEL 19 DATE: 92-02-25

Reason: Improvement of the *100 attenuation adjustment range.

ITEM	FROM		TO	
C2105, C2205	5322 122 33869	15 PF	4822 122 32139	12 PF

REVISION LEVEL 20 DATE: 92-02-25

Reason 1: Improvement of pulse response when the OQ0308 (D2301) version 6 is installed. The overshoot for fast rising slope at 10ns/div was too large.

ITEM	FROM		TO	
R2323	5322 116 82898	464E	removed	
R2324	4822 116 81789	316E	removed	
R2325	4822 111 91821	2K61	removed	
R2338	4822 051 51332	1K33	removed	
V2301	5322 130 42136	BC848C	removed	
V2302	5322 130 44711	BFT92	removed	
R2340, R2341	5322 116 82896	46E1	4822 051 51001	100E
R2342, R2343	5322 111 91963	34E8	4822 111 91885	10E
R2327, R2328	5322 111 91893	51E1	4822 051 10108	1E
R2101, R2201	5322 11682895	31E6	4822 111 91885	10E
R2315	5322 111 91901	348E	4822 051 52611	261E
C2137, C2237	5322 122 32967	5.6 PF	4822 122 33515	82 PF

Reason 2: Trace(s) not at zero position after power on; the Volts RMS value gets slowly to final value during first minute after power on.

ITEM	FROM		TO	
C2119, C2219	4822 122 32916	220 NF	4822 122 33496	100 NF
R2171, R2271	5322 116 80428	10K	4822 051 51001	100E

REVISION LEVEL 21, no deliveries

REVISION LEVEL 22 DATE: 92-04-06

Reason: **Tune-up of the board. New printed circuit board version, also prepared for REVISION LEVEL 23 modifications. The board number is located on the wired components side, next to C2525. REVISION LEVEL 23 modifications can be carried out on the REVISION LEVEL 22 version, see below "REVISION LEVEL 23".**

Remarks: ANALOG BOARD A2 revision level 22 and higher requires software version 3.20 or newer.

ITEM	FROM		TO	
board	4022 245 03656		4022 245 03657	
C2130, C2230	4822 122 33496	100NF	5322 122 34098	10NF
C2136, C2236	-		5322 126 10733	680PF ; added.
C2138, C2238	moved			
C2519	5322 122 32654		removed	
C2539	-		5322 122 32654	22NF ; added over R2540
C2540, C2541	-		5322 122 32654	22NF ; added, from TP511 to common.
C2545	-		5322 122 32654	22NF ; added in series with C2538.
C2704	cancelled, renamed C2707			
C2707	-		5322 122 32654	22NF ; added in series with C2756.
C2756	moved			
R2123, R2223	moved			
R2175, R2275	-		4822 051 55114	511K; added parallel to C2118
R2209	4822 111 91887	42E1	5322 111 91063	34E8
R2300, R2326	-		4822 051 51003	10K ; added between C2320 and C2314
R2340, R2341	4822 051 51001	100E	4822 111 91937	75E
R2342, R2343	4822 111 91885	10E	5322 111 91963	34E8
R2765	-		4822 051 51003	10K; added between R2762 and D2751:2-3.
R2860	moved			
V2112, V2212	4822 130 42513	BC858C	5322 130 42136	BC848C
V2113, V2213	4822 130 42513	BC858C	5322 130 42136	BC848C
V2304	-		5322 130 42136	BC848C; added
V2518	4822 130 42513	BC858C	4822 130 61923	BF821
V2540	-		5322 130 42136	BC848C; added
V2543	4822 130 82262	BAT54S	5322 130 42136	BC848C

REVISION LEVEL 23 DATE: 92-04-09

Reason: **PTC protection between the CHANNEL A/B common and the common of the mV Ω input (black COM banana jack) installed.**

ITEM	FROM	TO	
C2141, C2241	-	5322 121 44372	220 NF, 250V; added.
R2156, R2256	-	5322 116 40232	1K1, 600V; added.
R2176, R2276	-	5322 116 40232	1K1, 600V; added.

REVISION LEVEL 24 DATE: 92-04-23

Reason: **Sometimes the overload indication (OL) is not given when the METER input is out of range.**

ITEM	FROM		TO	
R2531	4822 111 91885	10E	4822 051 10108	1E

REVISION LEVEL 25 DATE: 92-04-23

Reason: **Instable display during trigger calibration (the calibration is done correctly).**

ITEM	FROM		TO	
R2300	4822 051 51003	10K	4822 051 52152	2K15

REVISION LEVEL 26 DATE: 92-05-06

Reason: **Modifications for production process only; no consequences for Servicing.**

REVISION LEVEL 27 DATE: 92-05-08

Reason: **The rise time exceeds the factory-specification. It meets the customer-specification.**

ITEM	FROM		TO	
R2116, R2216	4822 051 51331	133E	4822 111 91937	75E
R2117, R2217	5322 111 91899 [1)]	261E	4822 051 51781	178E
R2315	4822 051 52611	261E	4822 051 52611	383E

1) 5322 111 91899 is identical to 4822 051 62611.

REVISION LEVEL 28 DATE: 92-05-22

Reason: **Modifications for production process only; no consequences for Servicing.**

REVISION LEVEL 29 DATE: 92-07-10

Reason: **The adjustment range of C2114 and C2214 was not sufficient due to the tolerance of C2117 and C2217.**

ITEM	FROM		TO	
C2117, C2217	5322 122 32661	56PF, 5%	4822	56PF, 2%

11.4 FIRMWARE MODIFICATIONS

This section describes the improvements made between the various successive software releases. Press softkeys 1 (left) and 5 (right) at the same time to display the installed software release. Contact your nearest Service Center for information about upgrading the software.

Release V3.01

First release.
To run the MetCal verification/calibration procedures Release V3.15 or newer must be installed.

Release V3.06

To run the MetCal verification/calibration procedures Release V3.15 or newer must be installed.

The main improvements made in release V3.06 are:

* When the trace is turned off in METER mode, and ScopeMeter® is in VAC, VDC, or FREQUENCY mode, an extra reading will be visible showing the frequency when in VAC or VDC, or the voltage when in FREQUENCY mode.

* When a pop-up is active, and ScopeMeter® is in METER mode, the readings will still be updated. However, only the three (3) most significant digits will be displayed.

* Probe information will always be displayed (including the 1:1 probe).

* Trigger @ 50% is made more reliable.

* A battery / power-adapter indicator is added in the LCD menu.

* If the rise time cannot be measured because there are no samples enough between the markers, the rise time reading will be preceded by the "<" sign, to indicate that the result is erroneous.

Release V3.10

There are no major changes between release V3.06 and release V3.10.

To run the MetCal verification/calibration procedures Release V3.15 or newer must be installed.

Release V3.15

The main improvements made in release V3.15 are:

* When in AC ADJUST mode, and the selected probe is not 1:1, the LCD will show some help marks near the top of the first edge on the display. The adjustment is complete when the top edge of the signal is between two "=" marks.

* QW and PW commands for the serial interface can be sent with an optional extension. With this extension, the setup memory that belongs to the selected waveform can be read (QW) or sent back (PW).

* The MetCal automatic (IEEE488 controlled) calibration and verification procedures can be run.

Release V3.20

* The following problems are solved:

- At FREE RUN triggering and low speed time base, the acquisition can lock up after some time. The trigger indication is "RUN", but the acquisition is halted.
- The PS command for the serial interface is not always executed correctly.
- Diode measurements results are sometimes erroneous.
- If channel A versus channel B is on, and MIN MAX is turned on, the A versus B picture is not removed.
- Sometimes the 20V LF calibration is not correct. This results in a bad METER AC performance.
- Sometimes the linearization of the METER is erroneous. Also the user interface for the METER linearization calibration is not correct.

Release V3.25

* The following problems are solved:

- When cursor measurement (relative reference) or % is active, wrong readings are given after auto set and after recalling an instrument setup from setup memory.
- If only the shift gains of the scope (calibration adjustment steps S8/9) are calibrated and stored, the stored shift gain calibration data is wrong (zero).

  NOTE: to calibrate ScopeMeter®, all steps of the calibration adjustment procedure must be done in the defined order.

- Sometimes data acquisition stops when switching from METER to SCOPE mode. A known resulting error is that the auto trigger mode is not automatically selected when the trigger level is set outside the signal limits.
- If the time base setting is lowered a number of steps, e.g. from 5s -> 10 ns, the trigger delay setting can change from 640 to -20.
- When pressing both the channel A and B move keys, B will move much faster than A.

Release V4.02

The following functions are added:

- Improved User Interface, the accessibility of the alert function is improved .
- % Duty Cycle Measurements
- 30Ω Range, 0.01Ω resolution
- Invert Waveform in Both Channels
- More Frequency Counter Resolution (ex. 60.00Hz, 400.0Hz, 9.999kHz)
- Record Mode Min Max Time Stamp
- Voltage Measurement at Cursor 1 (95 & 97 only)
- QM commands for the serial interface (97 only):

SCOPE mode	15	VOLT AT -1-
METER mode	7	maximum time
	8	average time
	9	minimum time
	10	duty cycle

- Release V4.02 has two calibration arrays. Older releases have 3 calibration arrays. Refer also to Section 5.3.3 "ENTERING THE CALIBRATION PROCEDURE".

SALES & SERVICE ALL OVER THE WORLD

Bureau de Liaison Philips
El Mauradia, Alger
Tel: 60 14 05

Angola
LUANDA
Tel: 244-2-372250

Philips Antillana N.V.
Willemstad, Curacao
Tel: 599-9-615277

Philips Argentina S.A.
1430 Buenos Aires
Tel: 54-1-5414106/5417141
Tel: 54-1-5422411/5422451*

Coasin S.A.
Buenos Aires, Argentina
Tel: (54) (1) 552-5248

Philips Scientific &Industrial PTY Ltd.
Auckland 3
New Zealand
Tel: 09-894160

Philips Scientific & Industrial PTY Ltd.
North Ryde
Sydney New South Wales 2113
Tel: 02-888 0416
Tel: 02-888 8222*

Philips Scientific & Industrial PTY Ltd.
Melbourne Victoria 3151
Tel: 03-235 3666

Philips Scientific & Industrial PTY Ltd.
Adelaide South Australia 5008
Tel: 08-3482888

Philips Scientific & Industrial PTY Ltd.
Brisbane Queensland 4101
Tel: 07-8440191

Philips Scientific & Industrial PTY Ltd.
Perth West Australia 6104
Tel: 09-277-4199

Philips Professionelle Elektronik GmbH
A 1102 Wien
Tel: 0222/60101-0

Philips Professionelle Elektronik GmbH
1101 Wien
Tel: 0222-60101 ext. 818

Messrs. Mohamed Fakhroo & Bros
Bahrain
Tel: 973-253529

Philips Bangladesh Ltd.
DHAKA
Tel: 325081-5

Motherland Corporation
Dacca-3, Bangladesh
Tel: 880257249

Manning Wilkinson & Challenor
Bridgetown
Tel: 436-6185

Philips Professional Systems S.A.
1070 Brussel
Tel: 02-525 6692
Tel: 02-525 6694*

Holmes, Williams and Purvey
Hamilton
Tel: 809-2955000

E.P.T.A. INGENIERA S.R.L.
LA PAZ
Tel: 3-25952

Coasin Bolivia S.R.L.
La Paz, Bolivia
Tel: (591) (2) 40962

Philips Medical Systems Ltda.
04661 Sao Paulo S.P.
Tel: 55-11-5234811

ATP Hi-Tek Electronica Ltda.
Sao Paulo, Brazil
Tel: (55) (11) 4215477

Brunei (via Singapore) Philips Project Development (S) PTY Ltd.
Singapore 1231
Tel: 65-3502000

Rank O'Connor's, 5nd Bhd
Bandar Seri Begawan
Negara Brunei Darussalam
Tel: (673) (2) 23109 or 23557

Interconsult (Philips Service)*
1309 SOFIA
Tel: 359-2-200785

Fluke Electronics Canada Inc.
Burnaby, British Columbia
Tel: (604) 439-9004

Fluke Electronics Canada Inc.
Mississauga, Ontario
L4Z 1X9 Canada
Tel: (416) 890-7600

Fluke Electronics Canada Inc.
Ottawa, Ontario
Tel: (613) 723-9453

Fluke Electronica Canada Inc.
Dorval, Quebec
Tel: (514) 685-0022

Fluke Electronics Canada Inc.
Calgary, Alberta
Tel: (403) 291-5215

Philips Chilena S.A. de Product Electr.
Casilla 2678
Santiago de Chile
Tel: 56-2-770038

Itronsa
Santiago, Chile
Tel: (56) (2) 232-4308

Philips HongKong Ltd.
Tel: 7735588

Fluke International Corp.
Beijing 100004
People's Republic of China
Tel: (86) 1 512-3435

Industrias Philips de Columbia S.A.
Apartado Aereo 4282
Bogota
Tel: 57 1-2600600

Sistemas E Instrumentation, Ltda.
Bogota, Colombia
Tel: (57) 232-4532

Electrocom
San Jose
Costa Rica
Tel: 53-0083/57

Branch Office Brno*
61300 BRNO
Tel: 42-2-377426

Obnova Pamatek n.p.*
16041 PRAHA 6
Tel: 42-2-594426/60351

D. Ouzounian M. Soultanian & Co. Ltd.
Nicosia
Tel: 357-2-442220

Philips A/S Test &Measurement
DK 2300 Kobenhavn S
Tel: +45-32-882100

Philips Ecuador S.A.
1188Y Cordero
Tel: 593-2-565835

Proteco Coasin Cia., Ltda.
Quito, Ecuador
Tel: (59) 32 529684

Proteco Coasin Cia., Ltda.
Guayaquil, Ecuador
Tel: (593) (4) 387519

Philips Egypt Branch
Middle East B.V.
Dokki, Cairo
Tel: 20-2-3490922

Philips Ethiopia (Priv. Ltd. Co.)
Addis Ababa
Tel: 010-231-1-518300

Awa Southwest Pacific
Suva, Fiji
Tel: (679) 312079

OY Philips AB
SF-02631 Espoo
Tel: +358 0 50261

S.A. Philips Industrielle et Commerciale
93002 Bobigny Cedex
Tel: (1) 49428080
Tel: (1) 49428073*

Philips GmbH - EWI
D-3500 Kassel
Tel: 0561-501466

Philips GmbH - EWI
D 1000 Berlin 30
Tel: 030-21006364

Philips GmbH - EWI
D 4300 Essen 11
Tel: 0201-3610-245

Philips GmbH - EWI
D 6000 Frankfurt 90
Tel: 069-794093-31

Philips GmbH - EWI
D 2000 Hamburg 73
Tel: 040-6797-278
Tel: 040-6797471*

Philips GmbH - EWI
D 8045 Ismaning
Tel: 089-9605-121

Philips GmbH - EWI
D 7012 Fellbach
Tel: 0711-5204-121
Tel: 0711-5204150*

Malawi Engineering Co. Ltd.
ACCRA
Fax: 233-667-131

Philips Scientific Test & Measurement
Watford Herts WD2 4TT
Tel: 0923-240511

Philips Scientific Test & Measurement
Cambridge CB1 2PX
Tel: 0223-358866

Philips S.A. Hellénique
15 GR 17778 Tavros/Athens
Tel: 30-1-4894911

Guyana Stores Ltd.
GEORGETOWN
TLX: 2212 GUYSTORE GY

Philips Hong Kong Ltd.
Hung Hom, Kowloon, HongKong
Tel: 7735588

Schmidt & Co (H.K.), Ltd.
Wanchai, Hong Kong
Tel: (852) (5) 8330-222

MTA-MMSZ Philips Service*
1502 BUDAPEST
Tel: 36-1-1869760

Heimelistaeki S.F.
125 Reykjavik
Tel: 354-1-691500

Sameind H.F.
125 Reykjavik
Tel: 354-1-25833

Peico Electronics & Electricals Ltd. I&E Division
Bombay 400 025
Tel: 022 4930311/4930590

Peico Electronics & Electricals Ltd. I&E Division
Calcutta 700 020
Tel: 473621

Peico Electronics & Electricals Ltd. I&E Division
New Delhi 110 015
Tel: 530153
Tel: 533956/57*

Peico Electronics & Electricals Ltd. I&E Division
Madras 600 006
Tel: 472341

Peico Electronics & Electricals Ltd. I&E Division
Bangalore 560 001
Tel: 579119/579164

Hinditron Services Pvt., Ltd.
Andherl (E) Bombay
400 093, India
Tel: (91) (22) 636-4560
(91) (22) 634-8268

Hinditron Services Pvt., Ltd.
Bangalore 560 080, India
Tel: (91) (812) 363-139

Hinditron Services Pvt., Ltd.
Calcutta 700 017, India
Tel: (91) (33) 432-628

Hinditron Services Pvt., Ltd.
New Delhi, 110 019, India
Tel: (91) (11)-641-0380

Hinditron Services Pvt., Ltd.
Secunderabad 500 003, India
Tel: (91) (842) 821-1117

P.T Daeng Brothers
Jakarta 12950
Tel: 021 5201122

Fluke International Corp.
Everett, WA 98206-9090
Tel: (206) 356-5500

Philips Iran Ltd.
Private Joint Stock Comp.
TEHRAN
Tel: 98-21-674138/675158

Al-Tel Co. Ltd.
Baghdad
Tel: 964-1-7191982

Circuit Specialists Ltd.
Castleroy, Limerick
Tel: 061 330333

Philips S.p.A.
20052 Monza
Tel: (039) 3635240/8/9

NF Circuit Design Block Co., Ltd.
Kokokuku, Yokohama 223
Tel: (045) 452-0411

Nihon Philips Corporation*
Minatu-ku Tohyo 108
Tel: 4485511

John Fluke Mfg. Co., Inc.
Minato-ku, Tokyo 105, Japan
Tel: (81) (3) 434-0181

John Fluke Mfg. Co. Inc.
Chuo-ku, Osaka 541
Japan
Tel: (81) (6) 229-0871

Jordan Medical Supplies & Services
Amman Jordan
Tel: 962-6-819929

Philips Kenya Ltd.
Nairobi
Tel: 254-2-557999

Korea, Republic of Myoung Corporation
Seoul, Korea
Tel: (82) (2) 784-9942

IL Myoung, Inc.
Seoul, Korea
Tel: 82 2 552-8582-4

Myoung Corporation
Taegu, Korea
Tel: 82 53 753-8163/4

Yusaf A. Alghanim & Sons
KUWAIT
Tel: 965-4843988

Philips Industries (Korea) Ltd.
Seoul
Tel: 82-2-7970378

Hanmac Electronics Co. Ltd.
Seoul
Tel: 82-2-5537441

Electronic Supplies S.A.R.L.
Beirut
Tel: 01-894243

Philips Luxembourg
L-1818 Howald
Tel: 496111

Electronic Systems (Malaysia)
Sdn. Bhd.
Petaling Jaya - Selangor 46200
Tel: 60-3-7560112

Mecomb Malaysia Sdn. Bhd.
Selangor, Malaysia
Tel: (60) (3) 774-3422

Charles A. Micallef & Co. Ltd.
Valletta
Tel: 356-221168

Mexicana de Electronica Industrial S.A. (Mexel)
C.P. 03100, Mexico
Tel: (90) (5) 680-4323

Mexel Servicios en Computacion*
Mexico D.F.
Tel: 90-5-563-5411

Samtel*
Casablanca
Tel: 243050

Somaciel
Casablanca 05
Tel: 308051/52

Interelectra E.E.
MAPUTO
TLX: 6203 NEGONHO

Bhajuratna Engineering & Sales (P) Ltd.
Kathmandu
Tel: 2-25134

Associated Enterprises
Kathmandu, Nepal
Tel: 13868

Philips Nederland B.V.
Test en Meetapparaten
5000 AC Tilburg
Tel: 013-390112

Philips Nederland
Technische Service Prof. Akt.*
5652 AJ Eindhoven
Tel: 040-723293

Philips Scientific & Industrial PTY Ltd. Test & Measurement Dept.
Auckland 3
Tel: 09-084-160

Associated Electronic Products (Nigeria) Ltd.
Lagos
Tel: 234-1-900160/69

Norsk A/S Philips
0612 Oslo 6
Tel: 47-2-741010
Tel: 47-2-290942

Messrs. Mustafa Jawad Trading Co.
RUWI - MUSKAT
Tel: 968-709955

Philips Electrical Co. of Pakistan (Private) Ltd.
Karachi - 74400
Tel: 92-21-725772-8

Fluke International Corp.
Everett, WA 98206-9090
Tel: (206) 356-5500
TLX: 185103 FLUKE UT
FAX: (206) 356-5116

Philips del Paraguay S.A.
Asuncion
Tel: 595-21-291924/291934

Philips Peruana S.A.
Lima 100
Tel: 51-14-350059

Importaciones y Representaciones Electronicas S.A.
Lima 1, Peru
Tel: (51) (14) 28-8650

Philips Industrial Development Inc.
Makati, Metro Manila
Philippines
Tel: 810-0161

Spark Radio & Electronics, Corp.
Philippines
Tel: (63) (2) 775192

Electronic Instrument Service*
60-188 PODZNAN
Tel: 48-61-481998

Philips Portuguesa, S.A.R.L. Division of I & E
1009 Lisboa Codex
Tel: 1-657181

Philips Portuguesa* Division I & E
4100 Porto
Tel: (2) 678278

Darwish Trading Company
Doha, Qatar
Tel: 974-434308

Polytechnic Inst. Bucarest* L.C.M.S. Philips Service
BUCAREST 70100
Tel: 40-0-505935

Messrs. A. Rajab & A. Silsilah
Jeddah 21411
Tel: 966-2-6610006

Messrs. A. Rajab & A. Silsilah
Riyadh 11411
Tel: 966-1-4122425

Messrs. A. Rajab & A. Silsilah
Damman
Tel: 966-3-8322596/8331870

Philips Project Development (S) PTY Ltd.
Singapore 9131
Tel: 65-3502000

Rank O'Connor's Pte Ltd.
Singapore 0511
Tel: (65) 473-7944

South African Philips PTY Ltd.
Johannesburg 2000
Tel: 27-11-889-3911

South African Philips PTY Ltd.*
Martindale, New Ville 2092
Tel: 27-11-470-5937

Philips Iberica SAE
08004 Barcelona
Tel: 34-3-3361061

Philips Iberica*
28027 Madrid
Tel: 34-1-4042200

Philips Iberica SAE*
48012 Bilbao
Tel: 34-4-4313800

Hayleys Electronics & Engineering Ltd.
COLOMBO 10
Tel: 94-1-699087

SALES & SERVICE ALL OVER THE WORLD

Computerlink Data Systems, Ltd.
Colombo, 5, Sri Lanka
Tel: (94) (1) 502202/3

C. Kersten & Co. N.V.
P.O. Box 1808
PARIMARIBO

Surtel
PARIMARIBO
Tel: 597-72118/77880

Philips Kistaindustrier AB
16493 Kista
Tel: 46-8-7031370

Philips AG Test und Messtechnik
8027 Zurich
Tel: 01 4882390

Philips SA Test et Mesure
1196 Gland
Tel: 022/647171

Al-Shahed Electronics and Trading Co.
Damascus
Tel: 228003/218605

Philips Taiwan Ltd.
10446 Taipei
Tel: 886-2-5097666

Schmidt Scientific
Taipei
Taiwan
Tel: 02-5005779

Philips (Tanzania) Ltd.
Dar es Salaam
Tel: 2555129571

Philips Electrical Co. of Thailand Ltd.
Bangkok 10500
Tel: 66-2-233-6330/9

Measuretronix Ltd.
Bangkok 10240
Thailand
Tel: (66) (2) 375-2733

Compression & Power Services (1988) Ltd.
SAN FERNANDO By Pass
Tel: 653-5445/6/7

S.T.I.E.T.
32 bis rue Ben Ghedahem
Tunis
Tel: 348666

Turk Philips Ticaret A.S.
80640 Levent-Istanbul
Tel: 90-1-1792770

Al Sanani Trading Est.
Abu Dhabi, U.A.E.
Tel: 971-2-771370

Haris Al-Afaq Ltd.
Dubai, U.A.E.
Tel: 971-4-283625

Industrias Philips del Uruguay S.A.
Montevideo, Uruguay
Tel: (598) (2) 921111

N.V. Philips Gloeilampenfabrieken
MOSCOW
Tel: 7095-2302485

Infomedia Sotrudnichiestvo
121111 MOSCOW
Tel: 240 52 52

Inds. Venezolanas Philips S.A.
Caracas 1010-A
Tel: 58-2-905.7061

Cossin C.A.
Caracas 1070-A, Venezuela
Tel: (58) (2) 241-03-09

Rashed Trading & Travel Agency
Sana'a, Yemen
Tel: 967-2-273231

N.V. Philips Gloeilampenfabrieken
BEOGRAD
Tel: 38-11-625344

Jugoelectro*
11070 BEOGRAD
Tel: 38-11-178134

Technicar Servis*
41000 ZAGREB
Tel: 041-276333

Philips Electronics S.A.R.L.
Kinshasa
Tel: 31693

Philips Electrical Zambia Ltd.
Lusaka
Tel: 218511/218701

Philips Electrical (Pvt.) Ltd.
Harare
Tel: 263-4-47211

For Countries not listed above:

Philips Export B.V.I & E Export Test & Measurement
Building HVW-3
PO Box 218
5600 MD Eindhoven
The Netherlands
Tel: +31 40 766546
Fax: +31 40 766612
TLX 35000 phtc nl

Fluke Int'l Corp.
PO Box 9090
Mail Stop 206A
Everett, WA 98206-9090
Tel: 206-356-5500
Fax: (206) 356-5116
TLX: 185103 FLUKE UT

USA

Huntsville
Huntsville, AL 35805-6202
(205) 837-0581

Phoenix
Tempe, AZ 85282
(602) 438-8314

Irvine*
Irvine, CA 92714
(714) 863-9031

Nothern*
Fremont, CA 94538
(415) 651-5112

Denver*
Aurora, CO 80014
(303) 695-1000

Hartford
Glastonbury, CT 06033
(203) 659-3541

Altamonte Springs*
Altamonte Springs, FL 32803
(407) 331-4881

Atlanta
Marietta, GA 30067
(404) 953-4747

Chicago*
Palatine, IL 60067
(708) 705-0500

Indianapolis
Indianapolis, IN 46268
(317) 875-7870

Boston
Billercia, MA 01821
(508) 663-2400

Rockville*
Rockville, MD 20852
(301) 770-1570

Detroit
Plymouth, MI 48170
(313) 522-9140

Minneapolis
Eagan, MN 55121
(612) 854-5526

St. Louis
St. Louis, MO 63146
(314) 993-3805

Paramus*
Paramus, NJ 07652
(201) 262-9550

Rochester
Rochester, NY 14622
(716) 323-1400

Greensboro
Greensboro, NC 27408
(919) 273-1918

Cleveland
Middleburg Heights, OH 44130
(216) 234-4540

Philadelphia
Malvern, PA 19355
(215) 647-9550

Dallas*
Dallas, TX 75229
(214) 869-0311

San Antonio
San Antonio, TX 78216
(512) 340-0498

Seattle*
Bellevue, WA 98005
(206) 881-6966

Northern California
Fremont, California
(1) (415) 651-5112

Southern California
Irvine, California
(1) (714) 863-9031

Denver
Aurora, Colorado
(1) (303) 695-1171

Orlando
Altamonte Springs, Florida
(1) (407) 331-2929

Chicago
Palatine, Illinois
(1) (708) 705-0500

Washington D.C.
Rockville, Maryland
(1) (301) 770-1576

Paramus
Paramus, New Jersey
(1) (201) 599-9500

Dallas
Carrollton, Texas
(1) (214) 406-1000

Seattle
Everett, Washington
(1) (206) 356-5560

OTHER COUNTRIES:

Buenos Aires, Argentina
Coasin S.A.
(54) (1) 552-5248

La Paz, Bolivia
Coasin Bolivia S.R.L.
(591) (2) 340-962 or 363-365

Sao Paulo, Brazil
ATP/Hi-Tek Electronica Ltda.
(55) (11) 421-5477

Mississauga, Ontario, Canada
Fluke Electronics Canada Inc.
(416) 890-7600

Santiago, Chile
Itronsa
(56) (2) 232-4308

Beijing, People's Republic of China
Fluke International Corp.
(86) (1) 512-3435

Bogota, Colombia
Sistemas E Instrumentation, Ltda.
(57) 287-5424

Quito, Ecuador
Proteco Coasin Cia., Ltda.
(593) (2) 230-283

Wanchai, Hong Kong
Schmidt & Co (H.K.), Ltd.
(852) (5) 833-0222

Tel Aviv, Israel
R.D.T. Electronics Engineering Ltd.
(972) (3) 548-3737

Tokyo, Japan
John Fluke Mfg. Co., Inc.
(81) (3) 3434-0181

Seoul, Korea
IL Myoung, Inc.
(82) (2) 552-8582-4

Selangor, Malaysia
Mecomb Malaysia Sdn. Bhd.
(60) (3) 774-3422

Colonia del Valle, Mexico
Mexicana de Electronica Industrial, S.A. (Mexel)
(52) (5) 682-8040

Lima, Peru
Importaciones y Representaciones Electronicas S.A.
(51) (14) 28-8650

Metro Manila, Philippines
Spark Radio & Electronics, Corp.
(63) (2) 700-621

Singapore, Republic of Singapore
Rank O'Connor's Singapore PTE Ltd.
(65) 473-7944

Taipei, Taiwan, R.O.C.
Schmidt Scientific Taiwan
(886) (2) 501-3468

Bangkok, Thailand
Measuretronix Ltd.
(66) (2) 375-2733-4

Montevideo, Uruguay
Coasin Uruguaya S.A.
(598) (2) 789-015

Caracas, Venezuela
Coasin C.A.
(58) (2) 241-03-09

FOR COUNTRIES NOT LISTED ABOVE:

Fluke International Corp.
PO Box 9090
Mail Stop 206A
Everett, WA 98206-9090
U.S.A.
Tel: (1) (206) 356-5500
Fax: (1) (206) 356-5116
Tlx: 185103 FLUKE UT