PM 5138A
FUNCTION GENERATOR 0.1 mHz – 10 MHz

Service Manual

940403

4822 872 15115

PHILIPS

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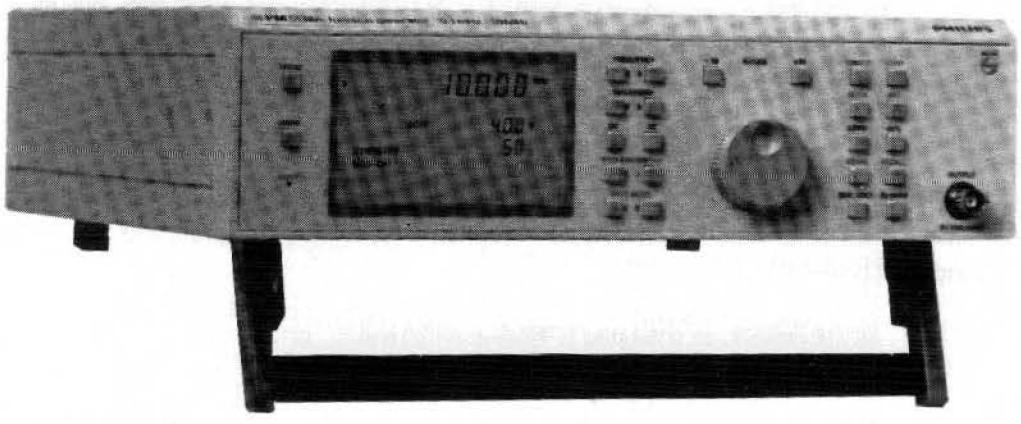

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Please note

In correspondence concerning this instrument, please quote the type number and serial number as given on the type plate.

Bitte beachten

Bei Schriftwechsel über dieses Gerät wird gebeten, die Typennummer und die Gerätenummer anzugeben. Diese befinden sich auf dem Typenschild an der Rückseite des Gerätes.

Noter s.v.p.

Dans votre correspondance et dans vos réclamations se rapportant à cet appareil, veuillez toujours indiquer le numéro de type et le numéro de série qui sont marqués sur la plaquette de caractéristiques.

Important

As the instrument is an electrical apparatus, it may be operated only by trained personnel. Maintenance and repairs may also be carried out only by qualified personnel.

Wichtig

Da das Gerät ein elektrisches Betriebsmittel ist, darf die Bedienung nur durch eingewiesenes Personal erfolgen. Wartung und Reparatur dürfen nur von geschultem, fach- und sachkundigem Personal durchgeführt werden.

Important

Comme l'instrument est un équipement électrique, le service doit être assuré par du personnel qualifié. De même, l'entretien et les réparations sont à confier aux personnes suffisamment qualifiées.

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SALES & SERVICE CENTRES

2 LINE VOLTAGE SETTING AND FUSES

The safety instructions in previous chapters must be followed.

Before plugging in the power cord make sure that the instrument is set to the local line voltage.

WARNING

If the power cord has to be adapted to the local situation, such adaption should be done by a qualified person only.

On delivery from the factory the instrument is set to one of the following line voltages:

Instrument Version	Instrument Code No.	Line Voltage Setting	Delivered Power Cord
PM 5138A/1x1	9445 051 381x1	220 V	Universal Europe
PM 5138A/1x3	9445 051 381x3	120 V	North America
PM 5138A/1x4	9445 051 381x4	240 V	England (U.K.)
PM 5138A/1x5	9445 051 381x5	220 V	Switzerland
PM 5138A/1x8	9445 051 381x8	240 V	Australia

The set line voltage and the corresponding fuse rating are indicated on the rear panel.

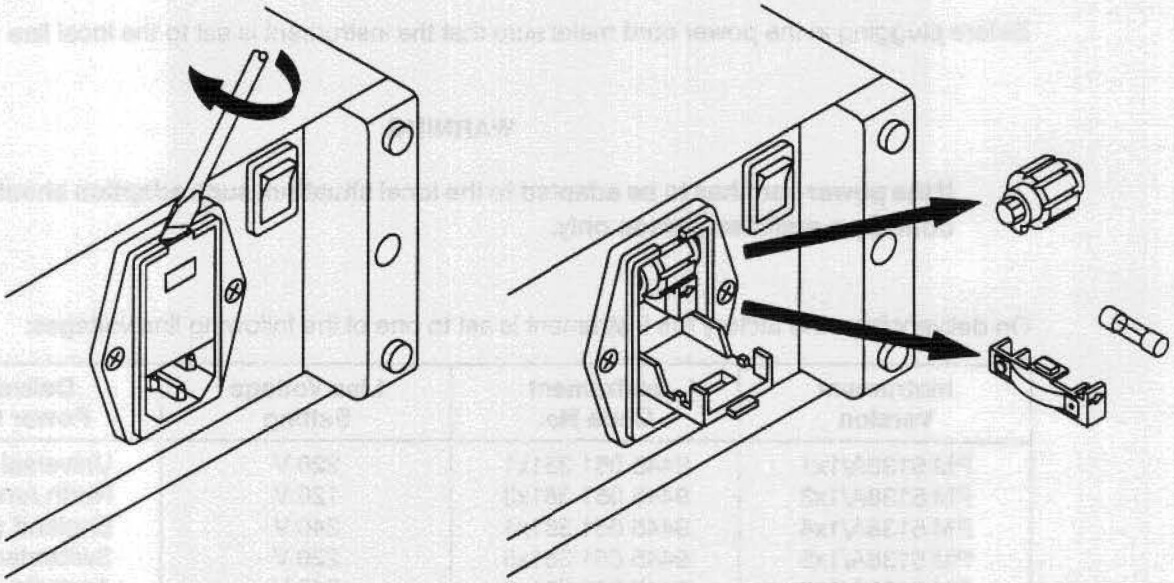
Make sure that only fuses of the required current rating, and of the specified type, are used for replacement. The use of repaired fuses and/or the short circuiting of fuse holders are prohibited. The fuse should be replaced only by a qualified person who is aware of the hazard involved.

WARNING

To prevent electric shock, the instrument must be disconnected from all voltage sources when a fuse is to be replaced or when the instrument is to be adapted to a different line voltage.

The instrument can be set to the following line voltages: 100 V, 120 V, 220 V and 240 V ac. These nominal voltages can be selected via the voltage selector, located at the rear panel, adjacent to the power socket. The fuse is located in a holder at the same place. For line power voltage selection or replacement of the fuse, remove the power cord and pry open the compartment with a small screwdriver (see drawing next page).

Select one of the voltage ranges, as appropriate, by turning the selector. If necessary, insert the correct fuse (T0.4A or T0.8A) into the fuse holder instead of the original one.



3 DESCRIPTION OF THE BLOCK DIAGRAM, Figure 100

The CLOCK GENERATOR produces the clock frequency 10 x 2^{21} Hz = 20.97 MHz for the Triangle Wave Synthesizer (TWS) and the 2 MHz clock frequency for the Modulation Oscillator. The Voltage Controlled Oscillator (VCO) for the 20.97 MHz in the Phase-Locked Loop (PLL) is an LC oscillator with a varicap tuning diode. The PLL is either coupled to the internal 10 MHz Crystal OSCILLATOR or to an external reference signal via the 10 MHz Bandpass Filter (BPF). Switching over to the external reference is automatically done, when 10 MHz or one of its subharmonics, e.g., 1 MHz, is applied to the REFERENCE INPUT connector. The clock frequency of 20.97 MHz can be modulated with the M1 signal from the Modulation Oscillator.

For internal modulation the MODULATION OSCILLATOR generates the programmable TTL signal M1 or B2 for the modulation modes Phase-Shift-Key PSK, GATE, BURST, or the programmable sine wave signal M1 for AM and FM. The amplitude determines the modulation depth m or the FM deviation.

The TWS generates the read addresses 0 to 1023 for the subsequent RAM. Up to the characteristic frequency f_{char} = 20.48 kHz, all 1024 amplitude samples are generated per output signal period. Above f_{char} the number of elements decreases linearly with increasing frequency, whereby the rate by which the elements are generated is still the clock frequency 20.97 MHz.

During signal generation, the distinct signal amplitude samples are read out from the RAM. If the basic signal waveform is altered or the duty cycle in the frequency range ≤ 20 kHz is altered, the corresponding amplitude samples are loaded into the RAM by the CPU, then the CPU switches the RAM to read mode again.

The Digital-to-Analog Converter (DAC) converts the digital amplitude samples into analog voltages between −0.5 and +0.5 V. The 5 MHz Lowpass Filter (LPF) smooths the staircase sine wave signal of the DAC. For square wave, pulses, sawtooth signals, and arbitrary waveforms, the output signal of the DAC bypasses the filter.

The FREQUENCY MULTIPLIER doubles the frequency above 5 MHz by analog squaring.

The PULSE GENERATOR generates rectangular signals and the TTL output signal from the most significant bit B4 of the TWS. The Pulse Generator also generates signals for frequencies above 20 kHz by zero crossing detection of the sine wave signal. For frequencies above 20 kHz, the Pulse Generator sets the duty cycle for the rectangular signals.

The MODULATOR for the modulation modes AM, PSK, GATE, and BURST is based on a multiplier circuit .

The MODULATION OSCILLATOR generates the programmable sine modulation signal or the keying signal for the internal AM, FM, PSK, GATE, or for triggering the BURST LOGIC. For external modulation the Modulation Oscillator passes the signal from the MOD/TRIG input connector to the Modulator, to the PLL of the Clock Generator, or to the BURST LOGIC.

The BURST LOGIC generates the control signal $\overline{BT}$ for the Modulator and $\overline{BK}$ for the CPU by counting the programmed carrier periods N = 1 ... 2000.

3 DESCRIPTION DU SCHÉMA DE FONCTIONNEMENT, Figure 100

Le GÉNÉRATEUR D'HORLOGE produit la fréquence d'horloge 10 x 2^{21} Hz = 20,97 MHz pour le Triangle Wave Synthesizer (TWS) et la fréquence d'horloge de 2 MHz pour l'oscillateur de modulation. L'oscillateur contrôlé en tension (VCO) pour le 20,97 MHz dans la boucle à verrouillage de phase (PLL) est un oscillateur LC avec une diode d'accord varicap. La PLL est soit couplée à l'OSCILLATEUR interne à quartz de 10 MHz, soit à un signal de référence externe via le filtre passe-bande 10 MHz (BPF). Le passage en référence externe se fait automatiquement lorsque le 10 MHz ou l'une de ses sous-harmoniques, par exemple 1 MHz, est appliqué au connecteur REFERENCE INPUT. La fréquence d'horloge de 20,97 MHz peut être modulée avec le signal M1 de l'oscillateur de modulation.

Pour la modulation interne, l'OSCILLATEUR DE MODULATION génère le signal TTL programmable M 1 ou B2 pour les modes de modulation Phase-Shift-Key PSK, GATE, BURST, ou la sinusoïdale programmable signal M1 pour AM et FM. L'amplitude détermine la profondeur de modulation m ou la déviation FM.

Le TWS génère les adresses de lecture 0 à 1023 pour la RAM suivante. Jusqu'à la fréquence caractéristique f_{char} = 20,48 kHz, les 1024 échantillons d'amplitude sont générés par période de signal de sortie. Au-dessus de f_{char}, le nombre d'éléments diminue linéairement avec l'augmentation de la fréquence, le taux par lequel les éléments sont générés est toujours la fréquence d'horloge 20,97 MHz.

Lors de la génération du signal, les échantillons d'amplitude de signal distincts sont lus à partir de la RAM. Si la base la forme d'onde du signal est modifiée ou le rapport cyclique dans la plage de fréquences ≤20kHz est modifié, le correspondant les échantillons d'amplitude sont chargés dans la RAM par le CPU, puis le CPU commute la RAM pour repasser en mode lecture.

Le convertisseur numérique-analogique (DAC) convertit les échantillons d'amplitude numérique en tensions analogiques entre -0,5 et +0,5 V. Le filtre passe-bas 5 MHz (LPF) lisse le signal sinusoïdal en escalier du DAC. Pour les ondes carrées, les impulsions, les signaux en dents de scie et les formes d'onde arbitraires, le signal de sortie du DAC contourne le filtre.

Le MULTIPLICATEUR DE FRÉQUENCE double la fréquence au-dessus de 5 MHz par quadrature analogique.

Le GÉNÉRATEUR D'IMPULSIONS génère des signaux rectangulaires et le signal de sortie TTL à partir du bit le plus significatif B4 du TWS. Le générateur d'impulsions génère également des signaux pour des fréquences supérieures à 20 kHz par détection de passage par zéro du signal sinusoïdal. Pour les fréquences supérieures à 20 kHz, le générateur d'impulsions définit le rapport cyclique pour les signaux rectangulaires.

Le MODULATEUR pour les modes de modulation AM, PSK, GATE et BURST est basé sur un multiplicateur circuit.

L'OSCILLATEUR DE MODULATION génère le signal de modulation sinusoïdal programmable ou le keying signal pour l'AM, FM, PSK, GATE interne, ou pour déclencher la BURST LOGIC. Pour modulation externe l'oscillateur de modulation transmet le signal du connecteur d'entrée MOD/TRIG au modulateur, à la PLL du générateur d'horloge ou à la BURST LOGIC.

La BURST LOGIC génère le signal de commande $\overline{B1}$ pour le Modulateur et $\overline{BK}$ pour le CPU en comptant les périodes de porteuse programmées N = 1 ... 2000.

The AMPLITUDE CONTROLLER acts as fine control for the output amplitude.
The subsequent AMPLIFIER has constant gain; it amplifies the ±2 mA (4 mA_{pp}) maximum output of the Amplitude Controller to 40 V_{pp}. The Amplifier is protected against short-circuits and external voltages by current limiting.
The ATTENUATOR can be set to 0, 20, and 40 dB; its output impedance can be set to 50 Ω or 600 Ω.

The DC GENERATOR is a programmable DC source for the output offset voltage. It can be set independently of the ac amplitude within a ±20 V output voltage window.

The multifunction DISPLAY on Unit 5 is a backlit liquid crystal display (LCD) with 160 segments controlled in duplex mode by two segment encoders. Unit 5 also has the KEYBOARD with its assigned decoder and keyboard interface.

The Central Processing Unit (CPU) contains the following:
- microprocessor, clocked with 12 MHz
- EPROM for the operating software
- RAM for storing settings
- EEPROM for the arbitrary wave

The instrument can be remotely controlled via the IEEE-488 Interface or the RS-232 Interface. Only one of the two interfaces can be built in. The interface processor transfers the parallel IEEE-488 bus data, or the serial RS-232 bus data to the internal serial I2C bus. To ensure reliable operation, the I2C bus is decoupled by optocouplers.

Le CONTRÔLEUR D'AMPLITUDE agit comme un contrôle fin de l'amplitude de sortie.

L'AMPLIFICATEUR suivant a un gain constant ; il amplifie la sortie maximale de ± 2 mA (4 mA_{pp}) du contrôleur d'amplitude à 40 V_{pp}. L'amplificateur est protégé contre les courts-circuits et les tensions externes par limitation de courant.

L'ATTÉNUATEUR peut être réglé sur 0, 20 et 40 dB ; son impédance de sortie peut être réglée sur 50 Ω ou 600 Ω.

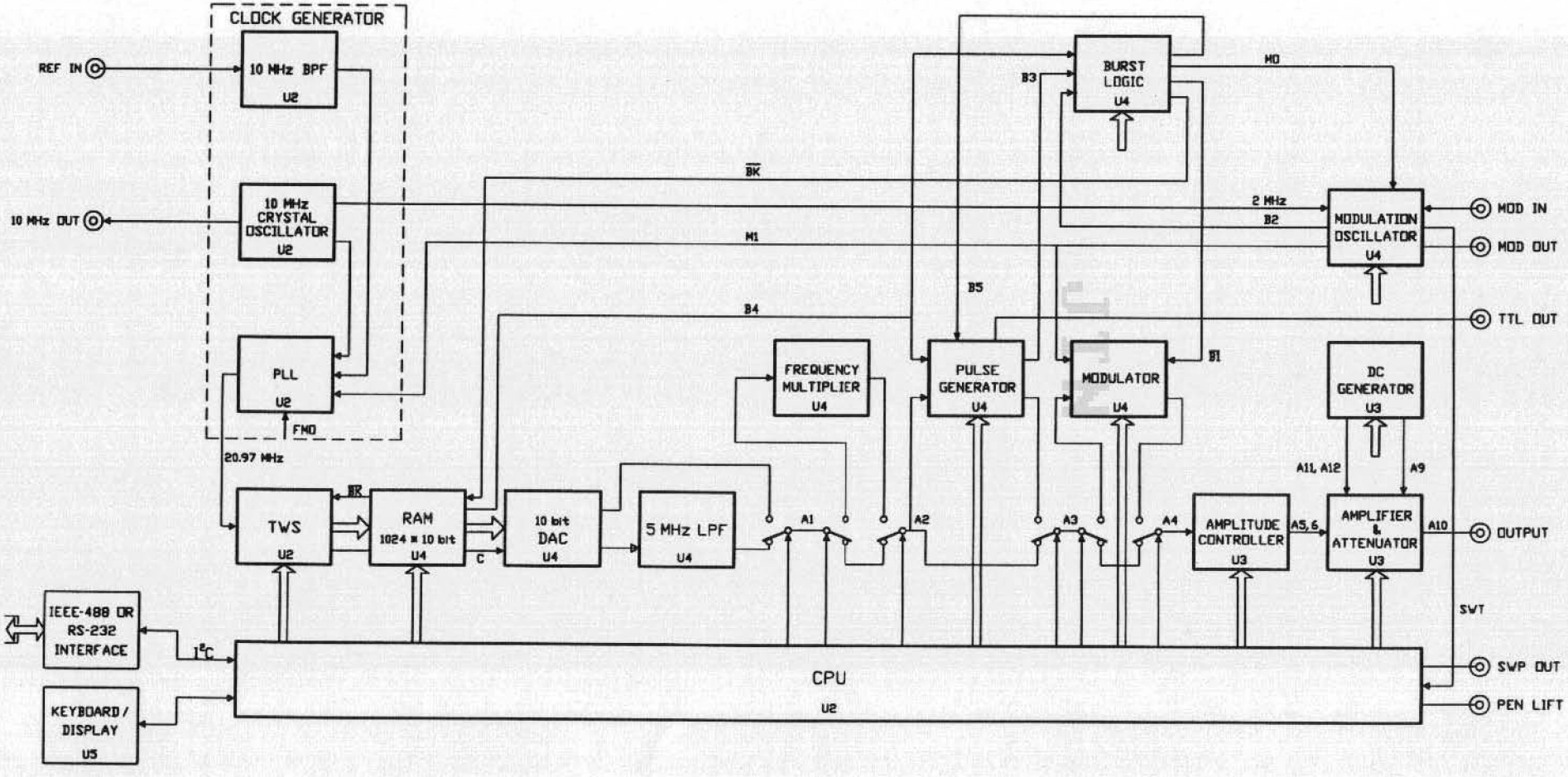
Le GÉNÉRATEUR DC est une source programmable DC pour la tension de décalage de sortie. Il peut être réglé indépendamment de l'amplitude du courant alternatif dans une fenêtre de tension de sortie de ± 20 V.

L'ÉCRAN multifonction de l'unité 5 est un écran à cristaux liquides (LCD) rétroéclairé avec 160 segments contrôlés en mode duplex par des codeurs à deux segments. L'unité 5 a également le CLAVIER avec son décodeur et interface clavier assigné.

L'unité centrale de traitement (CPU) contient les éléments suivants :

- microprocesseur, cadencé à 12 MHz
- EPROM pour le logiciel d'exploitation
- RAM pour stocker les paramètres
- EEPROM pour l'onde arbitraire

L'instrument peut être contrôlé à distance via l'interface IEEE-488 ou l'interface RS-232. Seulement l'une des deux interfaces peut être intégrée. Le processeur d'interface transfère le bus parallèle IEEE-488 ou les données du bus série RS-232 vers le bus série interne I_2C. Pour assurer un fonctionnement fiable, le bus I_2C est découplé par des optocoupleurs.


CLOCK GENERATOR
REF IN
10 MHz BPF
U2
10 MHz OUT
10 MHz CRYSTAL OSCILLATOR
U2
PLL
U2
FM0
20.97 MHz
BURST LOGIC
U4
B3
M0
BK
2 MHz
B2
M1
MODULATION OSCILLATOR
U4
MOD IN
MOD OUT
B5
B4
TTL OUT
B1
FREQUENCY MULTIPLIER
U4
PULSE GENERATOR
U4
MODULATOR
U4
DC GENERATOR
U3
A11, A12
A9
BR
TWS
U2
RAM
1024 x 10 bit
U4
C
10 bit DAC
U4
5 MHz LPF
U4
A1
A2
A3
A4
AMPLITUDE CONTROLLER
U3
A5, 6
AMPLIFIER & ATTENUATOR
U3
A10
OUTPUT
SWT
IEEE-488 OR RS-232 INTERFACE
I²C
CPU
U2
SWP OUT
PEN LIFT
KEYBOARD / DISPLAY
U5

4 CIRCUIT DESCRIPTION, TROUBLESHOOTING

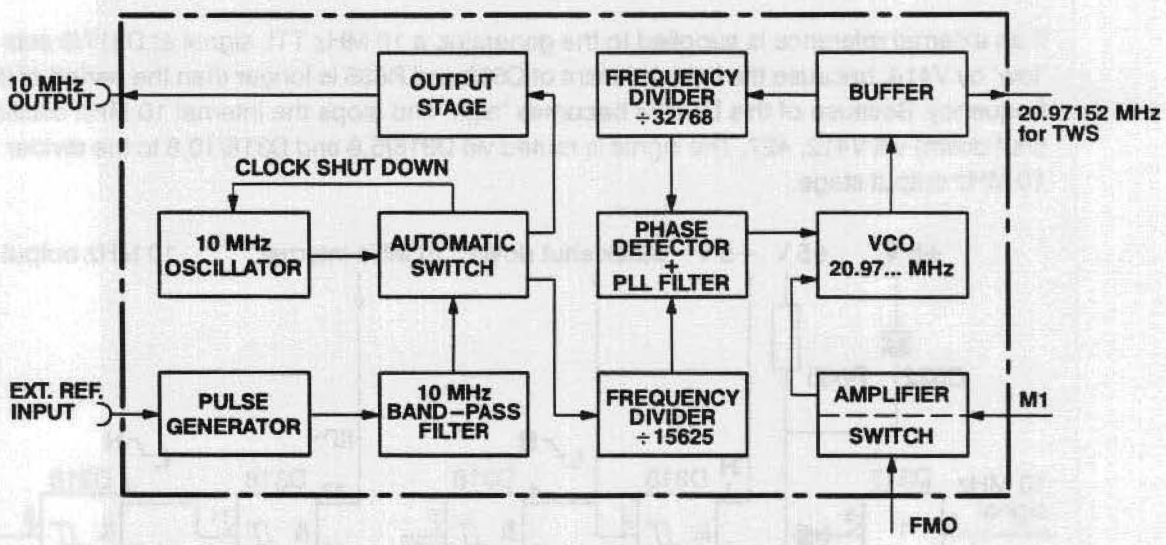
4.1 POWER SUPPLY, Figure 103

The Power Supply on Unit 1 generates five stabilized dc voltages: +5 V, +10 V, −10 V, +26 V, and −26 V. V302 generates +5 V. The four-terminal voltage regulators V305/V306 generate ±26 V. The latter are used in the amplifier circuitry on Unit 3, for the backlight display on Unit 5, and for the Clock Generator on Unit 2.
A power on and power down reset for the microprocessor (CPU) is achieved by transistor stage V351 via line $\overline{\text{PDR}}$.
An additional dc voltage of +7.7 V is generated by V357 to supply the fan.
Switching transistor V356 generates the control voltage of 0 V/+5 V for the pen lift output. The stage is controlled by line PL from the CPU.

The sweep output voltage of 0 V to 10 V at the rear panel is generated by the shift register D307, digital-to-analog converter N308, and amplifier N309 in the lower part of the circuit diagram. The voltage ramp has 10 to 200 steps depending on the sweep time. This circuitry is controlled by C-bus lines SC, SD, and strobe line STR8 from the CPU. The sweep function itself is directly controlled by the processor; it is digitally generated.

4.2 CLOCK GENERATOR, Figure 105

Simplified Block Diagram:



The Voltage Controlled Oscillator (VCO) generates a clock frequency of 20.97152 MHz (10×2^{21} Hz) for the subsequent Triangle Wave Synthesizer (TWS), routed via amplifier/buffer V364 ... 366, V370, 371. This frequency is divided by 32768 (D322, 321/15,13) and routed to the phase detector D323/3. The detector compares the signal with the reference frequency of 10 MHz divided by 15625 (D319, 320, 321), fed to pin 14. The PLL filter N325 performs the DC control voltage for the VCO, applied to varicap V415. The operating point of the diode is adjusted by R663; see Adjustment Procedure, Section 8.3.2.

4 DESCRIPTION DU CIRCUIT, DEPANNAGE

4.1 ALIMENTATION ÉLECTRIQUE, Figure 103

L'alimentation de l'unité 1 génère cinq tensions stabilisées : +5 V, + 10 V, -10 V, +26 V et -26 V. V302 génère le +5 V. Les régulateurs de tension à quatre bornes V305/V306 génèrent les ± 26 V. Ces derniers sont utilisés dans le circuit de l'amplificateur sur l'unité 3, pour l'affichage rétroéclairé sur l'unité 5 et pour l'horloge Générateur sur l'unité 2.

Une remise sous tension et hors tension du microprocesseur (CPU) est réalisée par l'étage transistor V351 via la ligne $\overline{PDR}$.

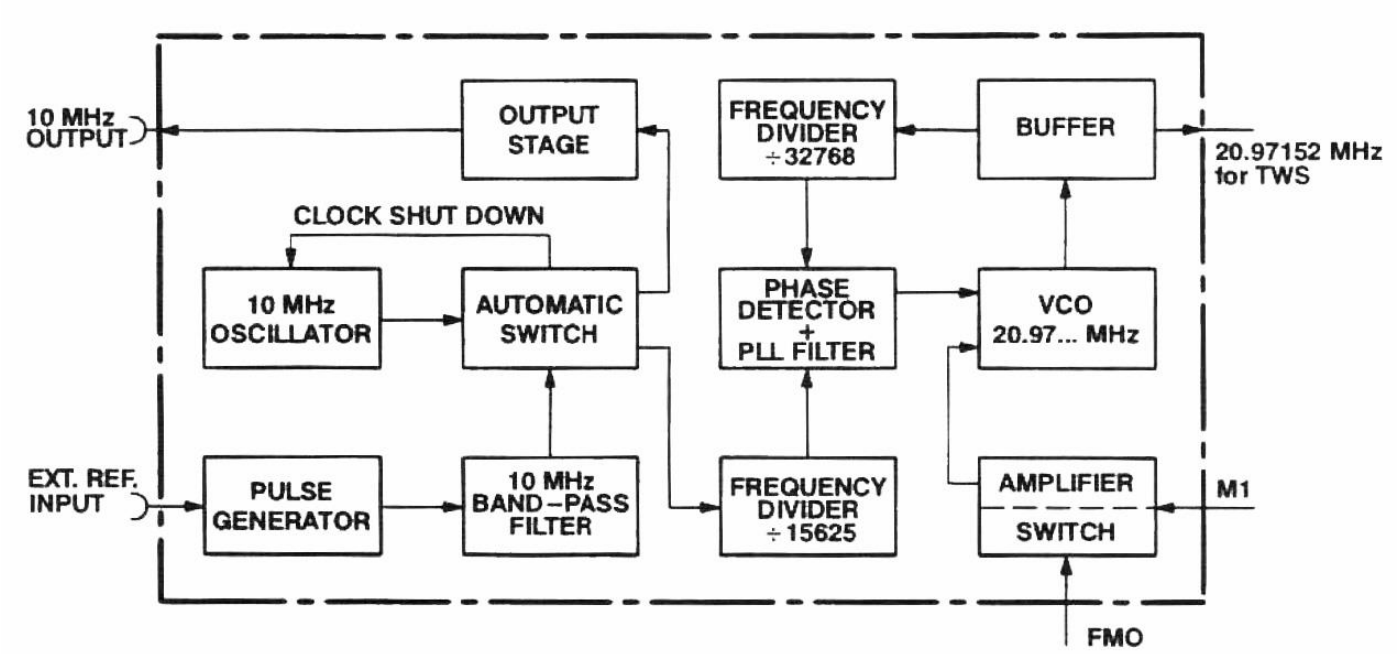
Une tension supplémentaire de + 7,7 V est générée par V357 pour alimenter le ventilateur.

Le transistor de commutation V356 génère la tension de commande de 0 V / +5 V pour la sortie de levage du stylet. L'étage est commandé par la ligne PL du CPU.

La tension de sortie de balayage de 0 V à 10 V sur le panneau arrière est générée par le registre à décalage D307, le convertisseur numérique analogique N308 et l'amplificateur N309 dans la partie inférieure du schéma de circuit. La tension la rampe comporte de 10 à 200 pas selon le temps de balayage. Ce circuit est contrôlé par des lignes C-bus SC, SD et ligne strobe STR8 du CPU. La fonction de balayage elle-même est directement contrôlée par le processeur; il est généré numériquement.

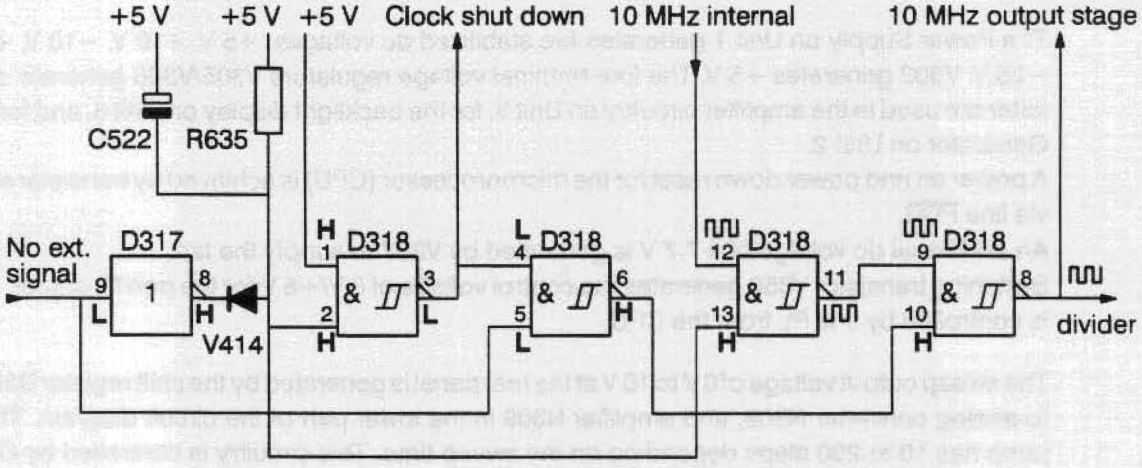
4.2 GÉNÉRATEUR D'HORLOGE, Figure 105

Schéma fonctionnel simplifié :



L'oscillateur commandé en tension (VCO) génère une fréquence d'horloge de 20.97152MHz($10x2^{21}$ Hz) pour le synthétiseur d'ondes triangulaires (TWS) qui suit, acheminé via l'amplificateur/buffer V364 ... 366, V370, 371. Cette fréquence est divisée par 32768 (D322, 321/15, 13) et acheminée vers le détecteur de phase D323/3. Le détecteur compare le signal avec la fréquence de référence de 10 MHz divisée par 15625 (D319, 320, 321), envoyé à la broche 14. Le filtre PLL N325 réalise la tension continue de contrôle pour le VCO, appliqué à varicap V415. Le point de fonctionnement de la diode est ajusté par R663 ; voir Procédure d'ajustement, Section 8.3.2.

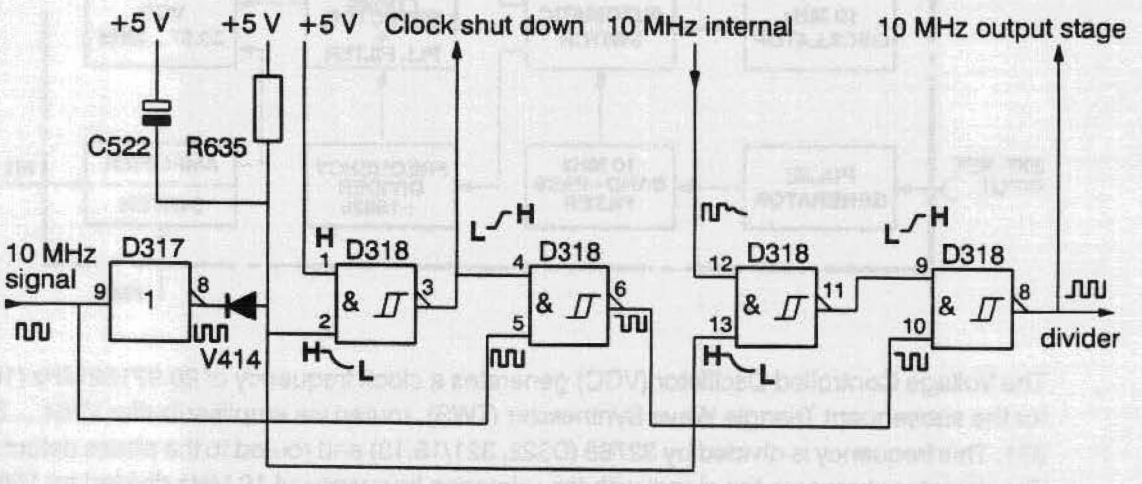
The 10 MHz reference frequency is generated by an internal oscillator circuit, Z800, C524, 526, 528, R625, D317/1,2, R 637 routed via the automatic switch (gates D318) to the divider D319 and to the output stage V358, 360 if no external reference signal is applied.



The automatic switch routes the internal 10 MHz reference frequency if no external reference issupplied.

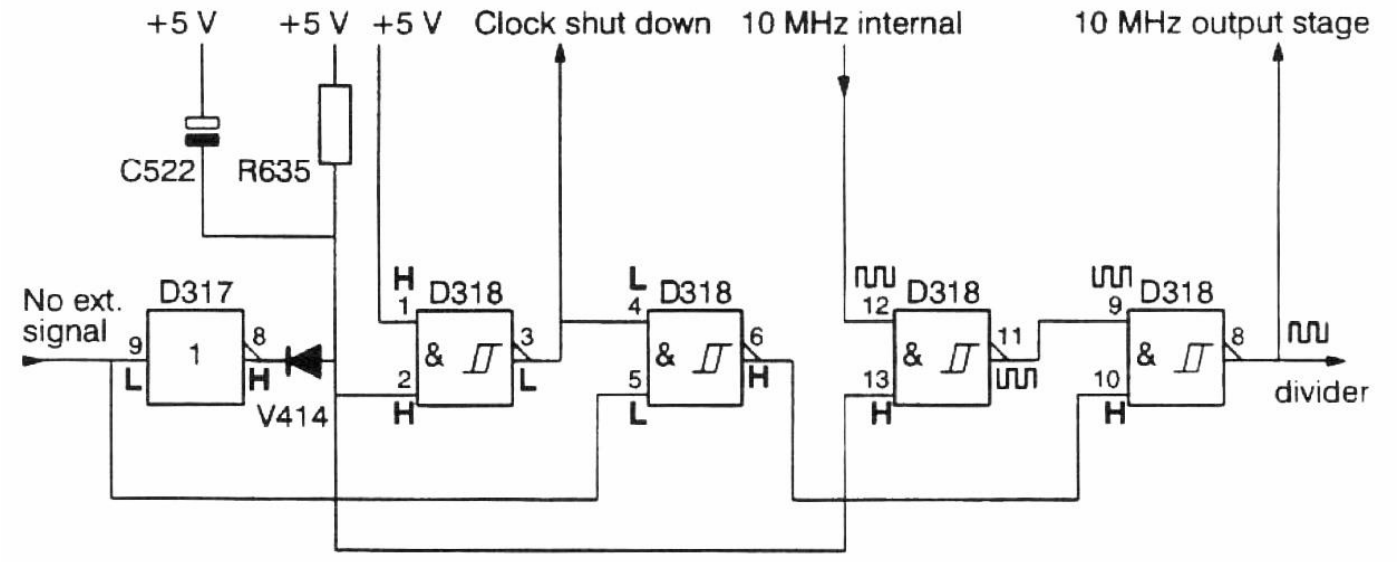
When an external reference signal (10 MHz/N, N = 1, 2, to 10) is fed to the REFERENCE INPUT, D315 with the timing element R615, C510 generates pulses of approximately 50 ns duration. A 10 MHz Bandpass Filter (BPF), C515, 516, 517, 523, 511, and L813, and a negative impedance converter V355 to 357 generate a 10 MHz signal via D317. The circuit is adjusted by R624 and C517.

If an external reference is supplied to the generator, a 10 MHz TTL signal at D317/8 sets D318/2 to 'low' by V414, because the time constant of C522 and R635 is longer than the period of the 10 MHz frequency. Because of this D318/3 becomes 'high' and stops the internal 10 MHz oscillator (clock shut down) via V412, 427. The signal is routed via D318/5,6 and D318/10,8 to the divider and to the 10 MHz output stage.



The automatic switch routes 10 MHz from an external reference signal and stops the internal oscillator.

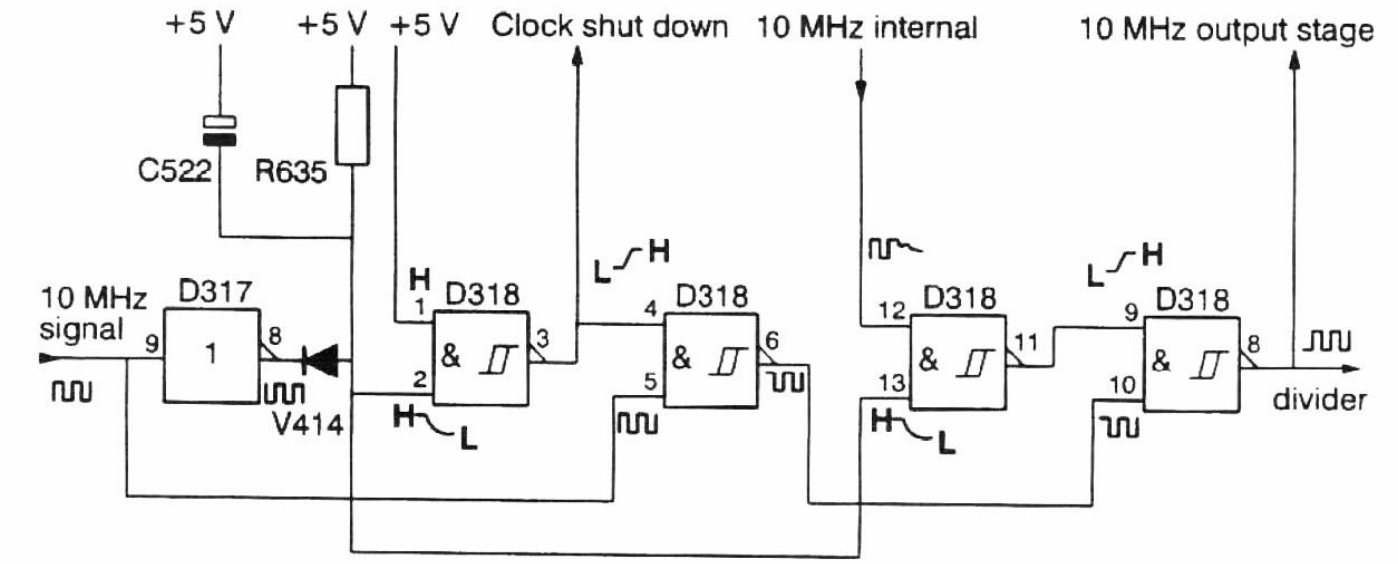
La fréquence de référence de 10 MHz est générée par un circuit oscillateur interne, Z800, C524, 526, 528, R625, D317/1,2, R 637 acheminés via l'interrupteur automatique (portes D318) vers le diviseur D319 et vers l'étage de sortie V358, 360 si aucun signal de référence externe n'est appliqué.



Le commutateur automatique achemine la fréquence de référence interne de 10 MHz si aucune référence externe n'est fournie.

Lorsqu'un signal de référence externe (10 MHz / N, N = 1, 2, te 10) est envoyé à l'ENTRÉE DE RÉFÉRENCE, D315 avec l'élément de temporisation R615, C510 génère des impulsions d'une durée d'environ 50 ns. Un filtre passe-bande (BPF) de 10 MHz, C515, 516, 517, 523, 511 et L813, et un convertisseur d'impédance négative V355 à 357 génèrent un signal de 10 MHz via D317. Le circuit est réglé par R624 et C517.

Si une référence externe est fournie au générateur, un signal TTL de 10 MHz à D317/8 définit D318/2 sur "bas" par V414, car la constante de temps de C522 et R635 est plus longue que la période de la fréquence de 10 MHz. De ce fait D318/3 devient 'high' et arrête l'oscillateur interne 10 MHz (clock shutdown) via V412, 427. Le signal est acheminé via D318/5,6 et D318/10, B vers le diviseur et vers l'étage de sortie 10MHz.



Le commutateur automatique achemine 10 MHz à partir d'un signal de référence externe et arrête l'oscillateur interne.

4.12 IEEE-488 INTERFACE, Figure 124; RS-232 INTERFACE, Figure 126

PM 9548 UNIT #6 ON P. 10-37

The instrument can be remotely controlled via the IEEE-488 Interface or the RS-232 Interface. Only one of the two interfaces can be built in.

The interface controls the communication between the internal I²C-bus and the external bus or data. For this an independent **interface processor** is built in. The processor transfers the parallel IEEE-488 bus data, or the serial RS-232 data to the internal serial I²C-bus. The instrument is in general IEEE-488.2 compatible. The IEEE-488 Interface has a mask-programmed PROM within the processor, while the RS-232 Interface has a separate EPROM.

To ensure reliable operation, and to avoid electromagnetic interference and hum pickup, the I²C-bus is electrically insulated by **optocouplers.** The insulated circuit has a separate power supply, +5 VA. 8 V ac, directly derived from the transformer, are routed via the Power Supply, Unit 1, Figure 103, and the CPU, Unit 2, Figure 106. The fuse for the supply is located on Unit 1, F852. On the interfaces the voltage is rectified, stabilized, and smoothed to 5 V DC.
For troubleshooting on the two interfaces please note the different positions of the optocouplers with relation to the processors and so also the different area for the two 5 V supplies.

When a device-specific message is present, the processor sends an interrupt to the CPU, line INT, 8-pole socket, pin 3, and the message is transferred via the I²C-bus to the instrument processor. During running sweep, this interrupt is disabled by an internal software command. In this case only commands to stop the sweep are accepted.

The RESET line, 8-pole socket, pin 8, sets the instrument processor to its initials state when the power is turned on or when the RESET key is pressed.

The **IEEE-488 bus** and the interface processor communicate via the input/output buffer/driver D317 for the control lines, and via D316 for the data lines.
The I²C-bus lines are routed via the bidirectional buffer/drivers D301, D311.

The **RS-232 signal lines** and the interface processor communicate via the drivers/receiver D105, D106. Crystal G101 with the dividers D102 define the Baud rate for the transmission speed.

5 PERFORMANCE TEST

5.1 INTRODUCTION

The information in the following paragraphs describes the performance tests for the key parameters of the PM 5138A Function Generator using the instrument specifications (Operating manual, Chapter 4) as the performance standard.

These performance tests may be used as an acceptance test upon receipt of the instrument, as an indication that repair and/or adjustment is required, or as a performance verification after repairs or adjustment of the instrument. The PM 5138A must be warmed up with all covers in place for at least 30 minutes before starting the performance tests. For reference conditions see Sections 4.14 and 4.15, Operating manual. The test result requirements in the tables of the following sections do not take into account the tolerances of the measuring equipment.
If not stated otherwise the output impedance of the generator must be set to Zo 50 Ω.

5.2 RECOMMENDED TEST EQUIPMENT

- 50 Ω feedthrough termination
- 600 Ω feedthrough termination
- Wideband oscilloscope (tr <3.5 ns); PM 3295
- DC voltmeter, resolution <100 µV; PM 2535
- Counter/timer; PM 6654
- Spectrum analyzer; HP 8590 A
- RMS voltmeter; Fluke 8920 A
- Distortion meter, resolution 0.01 %; PM 6309
- Power meter; HP 436A with power sensor HP 8482A
- Modulation analyzer; Rohde & Schwarz FAM
- Reference synthesizer, accuracy $\pm 10^{-6}$; PM 5192

5.3 SELF-TEST ROUTINE

When turned on, the instrument performs a self-test that checks the PROMs, RAMs, and EEPROMs. After this the software version is indicated in the upper line of the display for about 1 second. All segments of the display field are shown for about 2 seconds and the instrument is set to that operating mode to which it was set before POWER OFF.

The output signal with the corresponding parameters is now available at the OUTPUT socket.

A possible fault is indicated by "Err" followed by a digit.
For detailed information see Section 3.5.9, Operating manual.

5.4 PERFORMANCE VERIFICATION

5.4.1 Frequency

5.4.1.1 Frequency Accuracy Test

Test Equipment:

– Frequency counter

Procedure:

– Connect the PM 5138A OUTPUT to the frequency counter.
– Set the counter to 10 seconds gate time.

Generator Settings:

Waveform	Frequency	Modulation Mode	Output Voltage ACpp	Output Voltage DC	Test Result Requirement
∿	1 MHz	OFF	10 V	0	0.999998 MHz to 1.000002 MHz
∿	10 MHz	OFF	10 V	0	9.99998 MHz to 10.00002 MHz

5.4.1.2 Unwanted FM Deviation Test

Test Equipment:

– Modulation analyzer

Procedure:

– Connect the PM 5138A OUTPUT to the modulation analyzer.
– Set the modulation analyzer to the RMS measuring mode and LF-measuring bandwidth to 10 Hz to 20 kHz.

Generator Settings:

Waveform (for all)	Frequency	Modulation Mode	Output Voltage ACpp	Output Voltage DC	Test Result Requirement
∿	5.000 MHz 10.000 MHz	OFF OFF	10 V 10 V	0 0	<35 Hz <71 Hz

5.4.2 10 MHz Synchronization

5.4.2.1 Synchronization Capture Range

Test Equipment:

- Reference synthesizer
- Counter

Procedure:

- Connect the TTL-output of the reference synthesizer to REF INPUT of PM 5138A.
- Connect the PM 5138A OUTPUT to the counter.
- Set the counter to 1 second gate time.
- Set the reference synthesizer to the frequencies in the following table.

Waveform	Frequency	Modulation Mode	Output Voltage ACpp	Output Voltage DC	Reference Frequency	Test Result Requirement
∿	1 MHz	OFF	10 V	0	0.998 MHz	0.998 MHz
∿	1 MHz	OFF	10 V	0	1.002 MHz	1.002 MHz

5.4.2.2 10 MHz OUTPUT Level

Test Equipment:

- RMS voltmeter

Procedure:

- Connect RMS voltmeter to the 10 MHz OUTPUT of PM 5138A.
- Set RMS voltmeter to dBm and 50 Ω reference.

Test Result Requirement: 0 to 5 dBm

5.4.3 Waveform Asymmetry

Test Equipment:

– Counter/timer

Procedure:

– Connect the PM 5138A OUTPUT to the counter input.
– Set the counter to 1 second gate time and time interval measurement ( ).

Waveform (for all)	Frequency	Modulation Mode	Output Voltage ACpp	Output Voltage DC	Asymmetrie	Test Result Requirement
⊓	1 kHz	OFF	10 V	0	10 %	99 to 101 µs
	1 kHz	OFF	10 V	0	50 %	499 to 501 µs
	1 kHz	OFF	10 V	0	90 %	899 to 901 µs
⊓	1 MHz	OFF	10 V	0	20 %	190 to 210 ns
	1 MHz	OFF	10 V	0	50 %	490 to 510 ns
	1 MHz	OFF	10 V	0	80 %	790 to 810 ns
⊓	2 MHz	OFF	10 V	0	20 %	90 to 110 ns
	2 MHz	OFF	10 V	0	50 %	240 to 260 ns
	2 MHz	OFF	10 V	0	80 %	390 to 410 ns
⊓	5 MHz	OFF	10 V	0	20 %	30 to 50 ns
	5 MHz	OFF	10 V	0	50 %	90 to 110 ns
	5 MHz	OFF	10 V	0	80 %	150 to 170 ns

5.4.4 Sine Wave

5.4.4.1 Total Harmonic Distortion Test at 1 kHz

Test Equipment:

– Distortion meter

Procedure:

– Connect the PM 5138A OUTPUT to 50 Ω feedthrough termination at the distortion meter input.

Generator Settings:

Waveform	Frequency	Modulation Mode	Output Voltage ACpp	Output Voltage DC	Test Result Requirement
∿	1 kHz	OFF	28 V	0	<0.4 %

5.4.4.2 Harmonic Components

Test Equipment:

– Spectrum analyzer

Procedure:

– Connect the PM 5138A OUTPUT to the 50 Ω input of the spectrum analyzer; be careful not to overload the analyzer input. Overloading the analyzer causes it to generate harmonics, thus invalidating the test.

Generator Settings:

Waveform (for all)	Frequency	Modulation Mode	Output Voltage ACpp	Output Voltage DC	Test Result Requirement
∿	0.5 MHz	OFF	28 V★	0	< −48 dBc
	0.5 MHz	OFF	40 V★	0	< −42 dBc
∿	5 MHz	OFF	28 V★	0	<−40 dBc
	5 MHz	OFF	40 V★	0	<−34 dBc
∿	10 MHz	OFF	28 V★	0	<−36 dBc
	10 MHz	OFF	40 V★	0	<−30 dBc

5.4.4.3 Subharmonic Components (level at ½ of carrier frequency)

Test Equipment:

– Spectrum analyzer

Procedure:

– Connect the PM 5138A OUTPUT to the 50 Ω input of the spectrum analyzer.

Waveform (for all)	Frequency	Modulation Mode	Output Voltage ACpp	Output Voltage DC	Test Result Requirement
∿	5 MHz	OFF	20 V★	0	< −60 dBc
	10 MHz	OFF	20 V★	0	< −38 dBc

★ Note: To avoid demage to the spectrum analyzer, insert a 20-dB attenuator if necessary.

5.4.4.4 Non Harmonic Components

Test Equipment:

– Spectrum analyzer

Procedure:

– Connect the PM 5138A OUTPUT to the 50 Ω input of the spectrum analyzer.
– Measure the relative level of the non-harmonic components, >15 kHz distanced from the carrier.
– Measuring frequency range 0 to 100 MHz.

Generator settings:

Waveform (for all)	Frequency	Modulation Mode	Output Voltage ACpp	Output Voltage DC	Test Result Requirement
∿	500 kHz	OFF	20 V	0	< –37 dBc
	500 kHz	OFF	40 mV	0	< –37 dBc
∿	5 MHz	OFF	20 V	0	<–37 dBc
	5 MHz	OFF	40 mV	0	<–37 dBc
∿	10 MHz	OFF	20 V	0	<–37 dBc
	10 MHz	OFF	40 mV	0	<–37 dBc

5.4.5 Square Wave and Rectangular Pulses

5.4.5.1 Rise and Fall Times

Test Equipment:

– Wideband scope; tr <3.5 ns

Procedure:

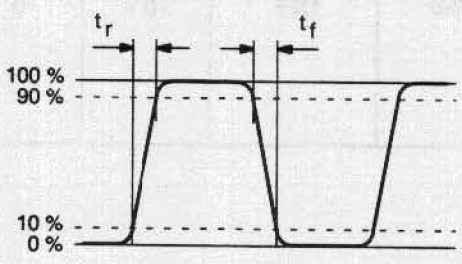
– Connect the PM 5138A OUTPUT to the 50 Ω feedthrough termination at the scope.

Generator Settings:

Waveform (for all)	Frequency	Modulation Mode	Output Voltage ACpp	Output Voltage DC	Test Result Requirement	
⊓	20 kHz	OFF	40 V	0	tr,tf ★	< 30 ns
	20 kHz	OFF	200 mV	0		< 30 ns
⊓	20.01 kHz	OFF	40 V	0		< 30 ns
	20.01 kHz	OFF	200 mV	0		< 30 ns
⊓	50 kHz	OFF	40 V	0		< 30 ns
	50 kHz	OFF	200 mV	0		< 30 ns
⊓	100 kHz	OFF	40 V	0		< 30 ns
	100 kHz	OFF	200 mV	0		< 30 ns
⊓	200 kHz	OFF	40 V	0		< 30 ns
	200 kHz	OFF	200 mV	0		< 30 ns
⊓	500 kHz	OFF	40 V	0		< 30 ns
	500 kHz	OFF	200 mV	0		< 30 ns
⊓	501 kHz	OFF	40 V	0		< 25 ns
	501 kHz	OFF	200 mV	0		< 25 ns

Repeat these steps with positive and negative pulses, ⊓ ⊔, AC pp 20 V and 100 mV.

★ tr = rise time
tf = fall time
for 50 % symmetry setting



5.4.5.2 Overshoot, Ringing, Tilt

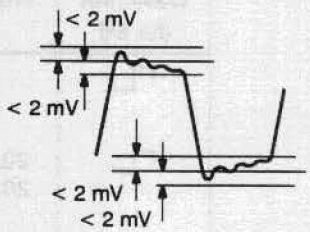
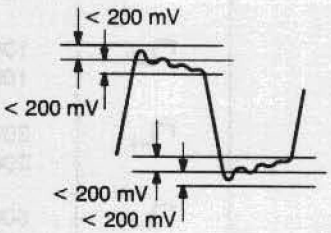
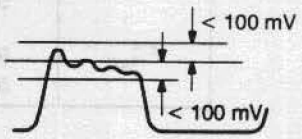
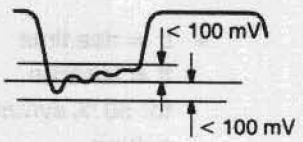
Test Equipment:

– Wideband scope

Procedure:

– Connect the PM 5138A OUTPUT to the 50 Ω feedthrough termination at the scope.

Generator Settings:

Waveform	Frequency	Modulation Mode	Output Voltage ACpp	Output Voltage DC	Test Result Requirement
⎍	2 MHz	OFF	0.200 V	0	
⎍	2 MHz	OFF	20 V	0	
⎍	2 MHz	OFF	10 V	0	
⎍	2 MHz	OFF	10 V	0	

5.4.6 AC Output Amplitude

5.4.6.1 AC Voltage Accuracy Test in the Frequency Range ≤200 kHz

Test Equipment:

– RMS voltmeter

Procedure:

– Connect the PM 5138A OUTPUT to the 50 Ω feedthrough termination at the RMS voltmeter input.

Generator Settings:

Waveform (for all)	Frequency	Modulation Mode	Output Voltage ACpp	Output Voltage DC	Test Result Requirement
∿	10 kHz	OFF	150 mV	0	25.9 to 27.0 mV
	10 kHz	OFF	0.41 V	0	71.0 to 73.9 mV
	10 kHz	OFF	4.00 V	0	0.693 to 0.721 V
	10 kHz	OFF	4.1 V	0	0.710 to 0.739 V
	10 kHz	OFF	40 V	0	7.215 to 7.212 V
∿	200 kHz	OFF	150 mV	0	25.9 to 27.0 mV
	200 kHz	OFF	0.41 V	0	70.7 to 74.3 mV
	200 kHz	OFF	4.00 V	0	0.689 to 0.724 V
	200 kHz	OFF	4.1 V	0	0.707 to 0.743 V
	200 kHz	OFF	40 V	0	6.894 to 7.248 V
⊓	10 kHz	OFF	150 mV	0	36.8 to 38.2 mV
	10 kHz	OFF	0.41 V	0	100.5 to 104.5 mV
	10 kHz	OFF	4.00 V	0	0.980 to 1.020 V
	10 kHz	OFF	4.1 V	0	1.005 to 1.045 V
	10 kHz	OFF	40 V	0	9.80 to 10.20 V
⊓	10 kHz	OFF	150 mV	0	36.8 to 38.2 mV
	10 kHz	OFF	0.21 V	0	51.4 to 53.5 mV
	10 kHz	OFF	2.00 V	0	0.490 to 0.510 V
	10 kHz	OFF	2.1 V	0	0.514 to 0.535 V
	10 kHz	OFF	20 V	0	4.90 to 5.10 V

5.4.6.2 AC Voltage Accuracy Test In the Frequency Range >200 kHz

Test Equipment:

- Power meter with power sensor
- 20-dB attenuator

Procedure:

- Calibrate and zero the power meter.
- Connect the probe to the PM 5138A OUTPUT.

Generator Settings:

Waveform (for all)	Frequency	Modulation Mode	Output Voltage ACpp	Output Voltage DC	Test Result Requirement
∿	5 MHz	OFF	1.50 V	0	1.34 to 1.48 mW
	5 MHz	OFF	4.00 V	0	9.51 to 10.50 mW
	5 MHz	OFF	4.1 V	0	9.99 to 11.03 mW
	5 MHz	OFF	20 V★	0	237.7 to 262.6 mW
	5 MHz	OFF	40 V★	0	950.7 to 1050.6 mW
∿	10 MHz	OFF	1.00 V	0	0.56 to 0.69 mW
	10 MHz	OFF	3.00 V	0	5.03 to 6.26 mW
	10 MHz	OFF	4.00 V	0	8.93 to 11.13 mW
	10 MHz	OFF	4.1 V	0	9.39 to 11.69 mW
	10 MHz	OFF	20 V★	0	223.3 to 278.2 mW
	10 MHz	OFF	40 V★	0	893.0 to 1113.0 mW

★ **Note:** To avoid damage to the power meter, insert a 20-dB attenuator and take into account a power factor of 0.01.

5.4.7 DC Voltage

5.4.7.1 DC Voltage Accuracy Test at AC OFF

Test Equipment:

– DC voltmeter

Procedure:

– Connect the PM 5138A OUTPUT to the 50 Ω feedthrough termination at the DC voltmeter input.

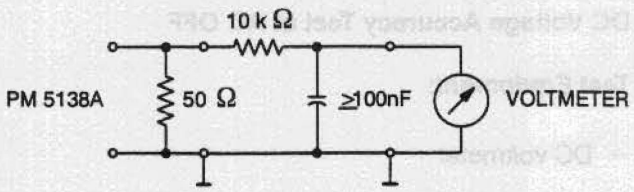
Generator Settings:

Waveform (for all)	Frequency	Modulation Mode	Output Voltage ACpp	Output Voltage DC	Test Result Requirement
	1 kHz	OFF	2 V	−10 V	−4.800 to −5.200 V
	1 kHz	OFF	2 V	−9 V	−4.310 to −4.690 V
	1 kHz	OFF	2 V	−8 V	−3.820 to −4.180 V
	1 kHz	OFF	2 V	−7 V	−3.330 to −3.670 V
	1 kHz	OFF	2 V	−6 V	−2.840 to −3.160 V
⎓	1 kHz	OFF	2 V	−5 V	−2.350 to −2.650 V
	1 kHz	OFF	2 V	−4 V	−1.860 to −2.140 V
	1 kHz	OFF	2 V	−3 V	−1.370 to −1.630 V
	1 kHz	OFF	2 V	−2 V	−0.880 to −1.120 V
	1 kHz	OFF	2 V	−1 V	−0.390 to −0.610 V
	1 kHz	OFF	2 V	−0.1 V	+0.051 to −0.151 V
⎓	1 kHz	OFF	2 V	0 V	−100 to +100 mV
	1 kHz	OFF	2 V	+0.1 V	−0.051 to +0.151 V
	1 kHz	OFF	2 V	+1 V	+0.390 to +0.610 V
	1 kHz	OFF	2 V	+2 V	+0.880 to +1.120 V
	1 kHz	OFF	2 V	+3 V	+1.370 to +1.630 V
	1 kHz	OFF	2 V	+4 V	+1.860 to +2.140 V
⎓	1 kHz	OFF	2 V	+5 V	+2.350 to +2.650 V
	1 kHz	OFF	2 V	+6 V	+2.840 to +3.160 V
	1 kHz	OFF	2 V	+7 V	+3.330 to +3.670 V
	1 kHz	OFF	2 V	+8 V	+3.820 to +4.180 V
	1 kHz	OFF	2 V	+9 V	+4.310 to +4.690 V
	1 kHz	OFF	2 V	+10 V	+4.800 to +5.200 V

5.4.7.2 DC Voltage Offset Error Test

Test Equipment:

- DC voltmeter
- Low-pass filter



Procedure:

- Connect the PM 5138A OUTPUT to the 50 Ω feedthrough termination at the DC voltmeter input.

Note: Take care that the DC voltmeter does not respond on the AC portion of the tested voltage. If necessary, insert a low-pass filter.

Generator Settings:

Waveform (for all)	Frequency	Modulation Mode	Output Voltage ACpp	Output Voltage DC	Test Result Requirement
∿	1 MHz	OFF	20 V	0	−100 to +100 mV
	2 MHz	OFF	20 V	0	−100 to +100 mV
	·	·	·	·	·
	1 MHz steps	·	·	·	·
	·	·	·	·	·
∿	9 MHz	OFF	20 V	0	−100 to +100 mV
	10 MHz	OFF	20 V	0	−100 to +100 mV

Repeat with ACpp = 40 V, test result requirement as above

5.4.8 Modulation

5.4.8.1 Modulation Frequency Accuracy Test

Test Equipment:

- Frequency counter

Procedure:

- Connect the PM 5138A MODULATION OUTPUT (at the rear of the instrument) to the frequency counter.
- Set the counter to >1 second gate time.

Generator Settings:

Waveform	Frequency	Modulation Mode	Output Voltage f_{MOD}	Output Voltage m %	Test Result Requirement
∿	1 kHz	AM INT	11 Hz	50	10.989 to 11.011 Hz
∿	1 kHz	AM INT	1 kHz	50	999 to 1001 Hz

5.4.8.2 AM Envelope Distortion Test

Test Equipment:

– Modulation analyzer

Procedure:

– Connect the PM 5138A OUTPUT to the modulation analyzer RF input.
– Set the analyzer to AM, DIST, and the filter to 30 Hz to 20 kHz.

Note: The modulation depth m of 90 % must be checked with the modulation analyzer. If necessary, change the generator setting.

Generator Settings:

Waveform (for all)	Frequency	Modulation Mode	Modulation Parameter		Output Voltage		Test Result Requirement
			f_{MOD}	m %	ACpp	DC	
∿	5 MHz	AM INT	1 kHz	90	5 V	0	<0.5 %
	10 MHz	AM INT	1 kHz	90	5 V	0	<0.5 %

5.4.8.3 Internal AM Modulation Depth (m) Accuracy Test

Test Equipment:

– Modulation analyzer

Procedure:

– Connect the PM 5138A OUTPUT to the modulation analyzer.
– Set the analyzer to $\frac{P+P}{2}$ and the filter to 30 Hz to 200 kHz.

Generator Settings:

Waveform (for all)	Frequency	Modulation Mode	Modulation Parameter		Output Voltage		Test Result Requirement
			f_{MOD}	m %	ACpp	DC	
∿	2 MHz	AM INT	20 kHz	10	5 V	0	9 to 11 %
	2 MHz	AM INT	·	50	5 V	0	49 to 51 %
	2 MHz	AM INT	·	90	5 V	0	89 to 91 %
∿	5 MHz	AM INT	·	10	5 V	0	8 to 12 %
	5 MHz	AM INT	·	50	5 V	0	48 to 52 %
	5 MHz	AM INT	·	90	5 V	0	88 to 92 %
∿	10 MHz	AM INT	·	10	5 V	0	7 to 13 %
	10 MHz	AM INT	·	50	5 V	0	47 to 53 %
	10 MHz	AM INT	20 kHz	90	5 V	0	87 to 93 %

Note: Take into account the tolerances of the used modulation analyzer.

5.4.8.4 FM Distortion Test

Test Equipment:

– Modulation analyzer

Procedure:

– Connect the PM 5138A OUTPUT to the modulation analyzer RF input.

– Set the modulation analyzer to FM, DIST, $\frac{P+P}{2}$, and the filter to 30 Hz to 20 kHz.

Generator Settings:

Waveform	Frequency	Modulation Mode	Modulation Parameter		Output Voltage		Test Result Requirement
			f_{MOD}	DEV	ACpp	DC	
∿	10 MHz	FM INT	1 kHz	1.00 %	5 V	0	<0.4 %

5.4.8.5 FM Deviation Accuracy Test

Test Equipment:

– Modulation analyzer

Procedure:

– Connect the PM 5138A OUTPUT to the modulation analyzer.

– Set analyzer to FM, $\frac{P+P}{2}$, and the filter to 30 Hz to 20 kHz.

Generator Settings:

Waveform (for all)	Frequency	Modulation Mode	Modulation Parameter		Output Voltage		Test Result Requirement
			f_{MOD}	DEV	ACpp	DC	
	10 MHz	FM INT	1 kHz	2 %	5 V	0	197 to 203 kHz
	10 MHz	FM INT	·	1.8 %	5 V	0	177 to 183 kHz
	10 MHz	FM INT	·	1.6 %	5 V	0	157 to 163 kHz
	10 MHz	FM INT	·	1.4 %	5 V	0	137 to 143 kHz
∿	10 MHz	FM INT	·	1.2 %	5 V	0	117 to 123 kHz
	10 MHz	FM INT	·	1.0 %	5 V	0	97 to 103 kHz
	10 MHz	FM INT	·	0.8 %	5 V	0	77 to 83 kHz
	10 MHz	FM INT	·	0.6 %	5 V	0	57 to 63 kHz
	10 MHz	FM INT	·	0.4 %	5 V	0	37 to 43 kHz
	10 MHz	FM INT	1 kHz	0.2 %	5 V	0	17 to 23 kHz
	10 MHz	FM INT	100 kHz	2 %	5 V	0	180 to 220 kHz
	10 MHz	FM INT	·	1.8 %	5 V	0	160 to 200 kHz
	10 MHz	FM INT	·	1.6 %	5 V	0	140 to 180 kHz
	10 MHz	FM INT	·	1.4 %	5 V	0	120 to 160 kHz
∿	10 MHz	FM INT	·	1.2 %	5 V	0	100 to 140 kHz
	10 MHz	FM INT	·	1.0 %	5 V	0	80 to 120 kHz
	10 MHz	FM INT	·	0.8 %	5 V	0	60 to 100 kHz
	10 MHz	FM INT	·	0.6 %	5 V	0	40 to 80 kHz
	10 MHz	FM INT	·	0.4 %	5 V	0	20 to 60 kHz
	10 MHz	FM INT	100 kHz	0.2 %	5 V	0	0 to 40 kHz

5.4.8.6 Phase Shift Keying (PSK) Functional Test

Test Equipment:

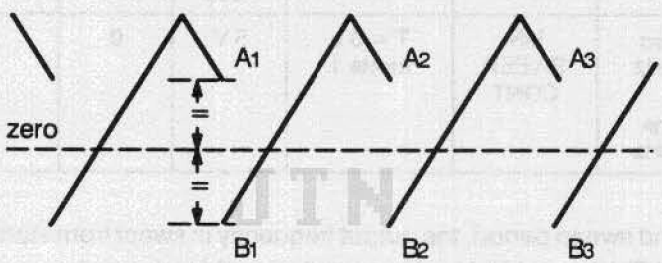
– Scope

Procedure:

– Connect the PM 5138A OUTPUT to the 50 Ω feedthrough termination at the scope.
– Connect the PM 5138A MODULATION OUTPUT to the external trigger input of the scope.
– Set the scope to external trigger and set the trace to the zero voltage line.

Generator Settings:

Waveform	Frequency	Modulation Mode	Modulation Parameter	Output Voltage ACpp	Output Voltage DC	Test Result Requirement
∿	1 kHz	PSK INT	f_{MOD} 1 kHz	5 V	0	See drawing



The pairs A,B of the transition points (showing varying distances A – B) must be symmetrical to the zero voltage line.

5.4.8.7 Gate Functional Test

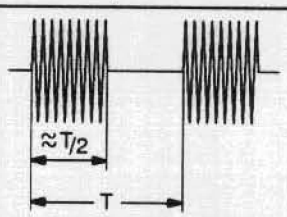
Test Equipment:

– Scope

Procedure:

– Connect the PM 5138A OUTPUT to the 50 Ω feedthrough termination at the scope.

Generator Settings:

Waveform	Frequency	Modulation Mode	Modulation Parameter	Output Voltage ACpp	Output Voltage DC	Test Result Requirement
∿	100 kHz	GATE INT	f_{MOD} 1 kHz	5 V	0	

Note: Check the duty cycle of the gated output signal: approximately 50 % and voltage pp 2.5 V.

5.4.8.8 Sweep Functional Test

Test Equipment:

– Dual channel scope

Procedure:

– Connect the PM 5138A OUTPUT to the 50 Ω feedthrough termination at the scope input channel A.
– Connect the PM 5138A SWEEP OUT (at the rear of the instrument) to channel B of the scope.
– Set channel B to DC-coupling.
– Set the trigger to channel A.
– Set the scope to chopped mode.

Generator Settings:

Waveform	Frequency	Modulation Mode	Modulation Parameter	Output Voltage ACpp	Output Voltage DC	Test Result Requirement
∿	f_{START} 1 kHz f_{STOP} 10 kHz	LIN SWEEP CONT	T = 5 s mode 1	5 V	0	See following text

During the 5-second sweep period, the output frequency is swept from start to stop (channel A), and the SWEEP OUTPUT (channel B) is rising from 0 to +10 V open loop.

– Connect channel B to the PM 5138A PEN LIFT OUTPUT (rear).
– Start single sweep by pressing the SINGLE key.

When sweep is running the PEN LIFT voltage (channel B) must be approximately 0 V; at the end of the sweep the PEN LIFT voltage is switched to approximately +5 V.

5.4.8.9 Burst Functional Test

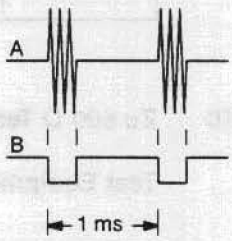
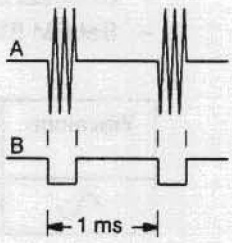
Test Equipment:

- Dual channel scope
- External TTL source of 1 kHz

Procedure:

- Connect the PM 5138A OUTPUT to the 50 Ω feedthrough termination at scope channel A.
- Connect the PM 5138A MODULATION OUTPUT (at the rear of the instrument) to channel B of the scope.
- Connect the external 1 kHz-TTL source to the PM 5138A MODULATION INPUT (rear).

Generator Settings:

Waveform	Frequency	Modulation Mode	Modulation Parameter	Output Voltage ACpp	Output Voltage DC	Test Result Requirement
∿	10 kHz	BURST INT CONT Repetition frequency (f_{MOD}) 1 kHz $\phi = 0°$	3 ON cycles	5 V	0	
∿	10 kHz	BURST EXT	3 ON cycles	5 V	0	Must be the same display
∿	10 kHz	BURST INT CONT Repetition frequency (f_{MOD}) 1 kHz $\phi = -180°$ $\phi = +180°$	3 ON cycles	5 V	0	
∿	10 kHz	BURST EXT	3 ON cycles	5 V	0	Must be the same display

5.4.9 TTL OUTPUT Level Test

Test Equipment:

– Scope

Procedure:

– Connect the PM 5138A TTL OUT to the scope (without 50 Ω termination).

Generator Settings:

Waveform	Frequency	Modulation Mode	Output Voltage ACpp	Output Voltage DC	Test Result Requirement
–	1 kHz	OFF	–	–	low level: −0.3 to +0.3 V high level: +4.7 to +5.3 V

5.4.10 Zo 600 Ω Test

Test Equipment:

– RMS voltmeter

Procedure:

– Connect the PM 5138A OUTPUT directly to the RMS voltmeter.
– Set PM 5138A to Zo 600 Ω.

Waveform	Frequency	Modulation Mode	Output Voltage ACpp	Output Voltage DC	Test Result Requirement
∿	1 kHz	OFF	20 V	0	6.894 to 7.248 V

– Connect the PM 5138A OUTPUT to the 600 Ω termination at the RMS voltmeter.

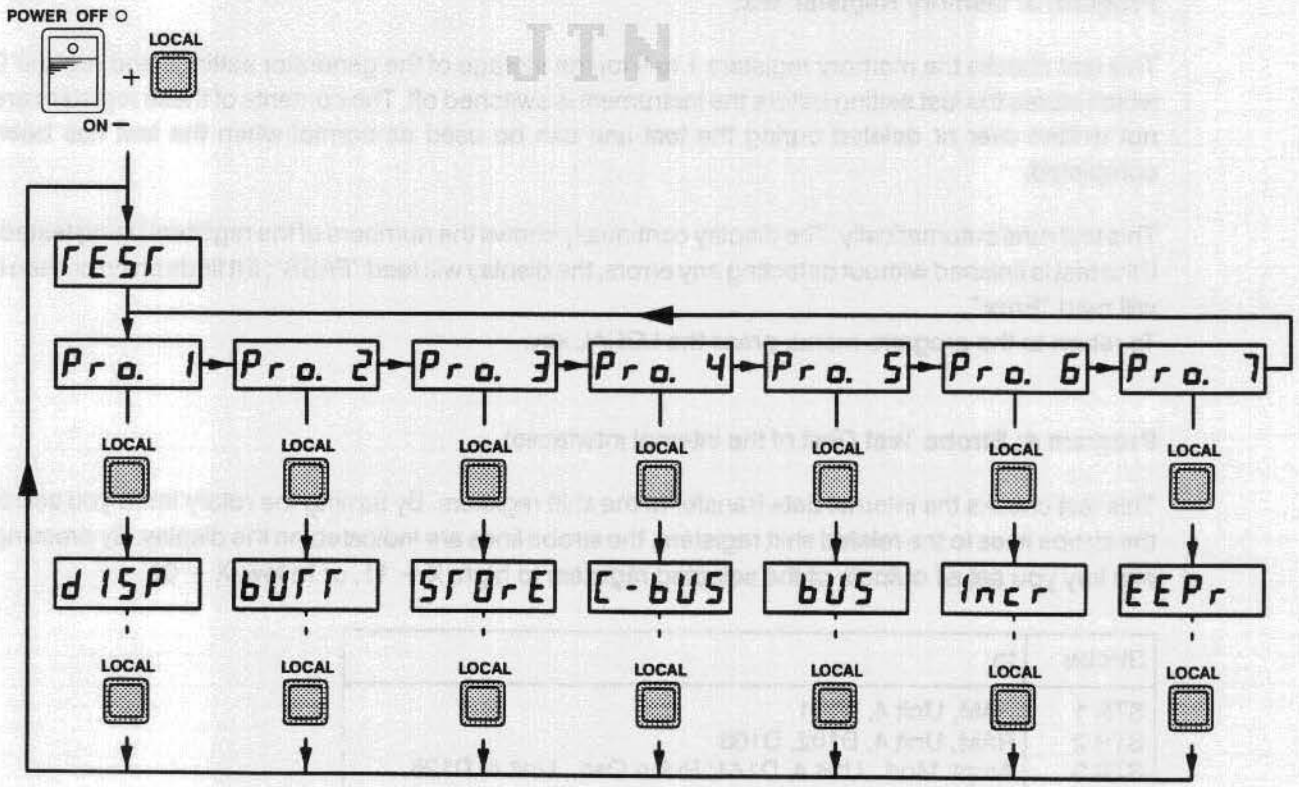
Waveform	Frequency	Modulation Mode	Output Voltage ACpp	Output Voltage DC	Test Result Requirement
∿	1 kHz	OFF	20 V	0	3.447 to 3.624 V

6 TEST PROGRAM

The test program of the PM 5138A contains the following seven subprograms:

1. Display test
2. Keyboard test
3. Memory register test
4. Strobe test (test of the internal interfaces)
5. Interface test (RS-232 or IEEE-488)
6. Rotary knob test
7. EEPROM test (PM 5138A/12 and PM 5138A/13 only)

The test program is activated by pressing the LOCAL key for about 3 seconds, while the instrument is being switched on, or by pressing the LOCAL key and pressing the concealed RESET key. The self-test routine is followed by the word "TEST" in the display followed by the menu of subprograms 1 to 7. Press the LOCAL key briefly to select and carry out the test required. Press LOCAL again for about 1 second to return to the subprogram menu. To leave the test program, either press RESET or turn off the instrument.



Program 1: Display Test

This test checks the operation of the liquid crystal display and the respective decoders/drivers.

When the text "Pro. 1" appears in the subprogram menu, press the LOCAL key to select the display test. The letters "dISP" appear in the display, whereupon each segment of the display is switched on one after the other. The generator waits with its total display lit up until either you press LOCAL to take it back to the program menu or until you leave the test program.

Program 2: Keyboard Test

This test checks the function of each key as well as those of the keyboard decoder.

Select this test and the letters "bUTT" (button) appear in the display. Press any key at random, except LOCAL, and the current number of this key will appear in the display together with a control number, e.g., 12–2 when key DC is pressed. This control number is generated by the keyboard decoder and can be changed to 0, 1, 2, or 3 by pressing this key again. The keys are numbered row by row from left to right. Thus, for example, the key SINGLE has the number 5 and the key ADDR the number 11.
To return to the program menu, press LOCAL.

Program 3: Memory Register Test

This test checks the memory registers 1 to 9 for the storage of the generator settings and register 0 which stores the last setting before the instrument is switched off. The contents of these registers are not written over or deleted during the test and can be used as normal when the test has been completed.

This test runs automatically. The display continually shows the numbers of the registers being tested. If the test is finished without detecting any errors, the display will read "PASS"; if it finds an error, then it will read "Error".
To return to the program menu, press the LOCAL key.

Program 4: Strobe Test (Test of the internal interfaces)

This test checks the internal data transfer to the shift registers. By turning the rotary knob you select the strobe lines to the related shift registers; the strobe lines are indicated on the display. By pressing any key you set all outputs of the selected registers to high, X – 11, or to low, X – 00.

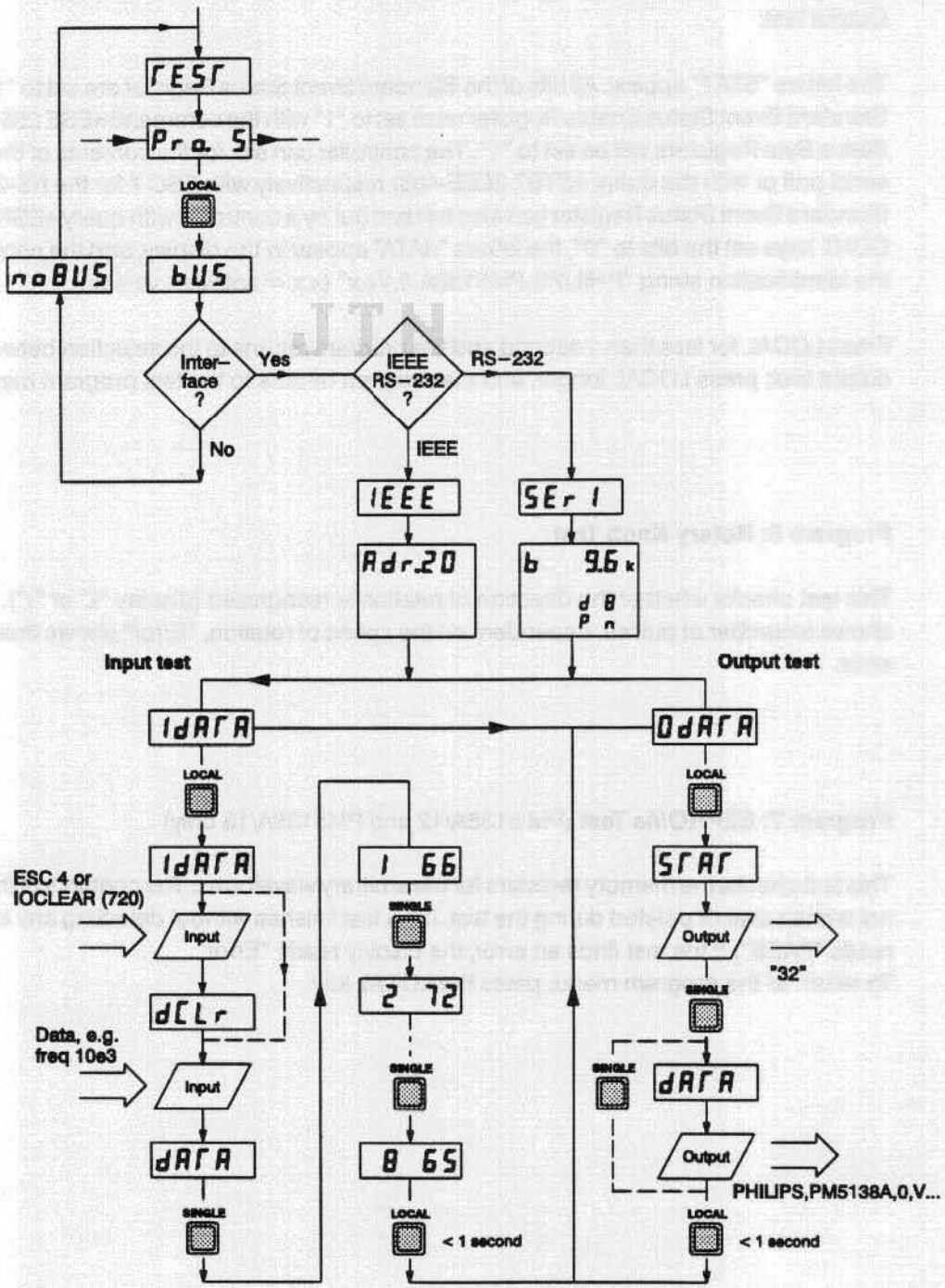
Strobe	to
STR 1	RAM, Unit 4, D101
STR 2	RAM, Unit 4, D102, D103
STR 3	Ampl. Mod., Unit 4, D144; Pulse Gen., Unit 4, D126
STR 4	Burst Logic, Unit 4, D121, D122
STR 5	Modulation Oscillator, Unit 4, D130, D138, D139
STR 6	TWS, Unit 2, D331
STR 7	DC Generator, Unit 3, D301
STR 8	Sweep out voltage, Unit 1, D307
STR 9	Amplitude Controller, Unit 3, D101, D102

To return to the program menu, press the LOCAL key.

Program 5: Interface Test (RS-232 or IEEE-488)

This test checks the built-in interface, its input and output buffers, and the correct coding and decoding of the data transferred.

The test automatically checks which interface is actually available; if none, "noBUS" will appear in the display and the instrument returns to the program menu. In instruments with an interface, there is a choice between an input test ("IdATA") and an output test ("OdATA"). Selection is done by pressing the LOCAL key. For the IEEE-488 interface the device address is set to 20. The configuration for the RS-232 interface is: Baud rate 9600, data bits 8, parity no. Using the RS-232 Interface the instrument must be set with ESC 2 to remote.



Input test:

The display shows "dCLr" when the interface command "IOCLEAR(720)" or "ESC 4" has been received. When data to set the instrument are received, the display will show "dATA", and the first eight figures of the string can be shown individually in hexadecimal form by pressing the SINGLE or CONT keys. The data input can be repeated as often as desired.

Press LOCAL for less than 1 second and the program will return to the selection between input and output test.

Output test:

The letters "STAT" appear. All bits of the Standard Event Status Register are set to "1". If the bits of the Standard Event Status Enable Register were set to "1" with the command ★ESE 255 the MAV bit of the Status Byte Registers will be set to "1". The controller can ask for the contents of the Status Byte with serial poll or with the query ★STB? (IEEE-488) respectively with ESC 7 for the RS-232 interface. The Standard Event Status Register can also be read out by a controller with query ★ESR?. The SINGLE or CONT keys set the bits to "0", the letters "dATA" appear in the display, and the controller can read in the identification string "PHILIPS,PM5138A,0,Vx.x" (x.x = software version).

Press LOCAL for less than 1 second and the program returns to the selection between the input and output test; press LOCAL longer, and the program returns to the test program menu.

Program 6: Rotary Knob Test

This test checks whether the direction of rotation is recognized (display "L" or "r"). The display also shows a number of pulses, dependent on the speed of rotation. "Error" shows that there may be an error.

Program 7: EEPROMs Test (PM 5138A/12 and PM5138A/13 only)

This test checks the memory registers for the arbitrary waveforms. The contents of these registers are not written over or deleted during the test. If the test finishes without detecting any errors, the display reads "PASS"; if the test finds an error, the display reads "Error".
To return to the program menu, press the LOCAL key.

7 DISASSEMBLING THE INSTRUMENT

7.1 GENERAL INFORMATION

This section provides the disassembling procedures required for the removal of components during repair operations.
All 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 disassembling make a careful note of all disconnected leads so that they can be reconnected to their correct terminals when the instrument is reassembled.

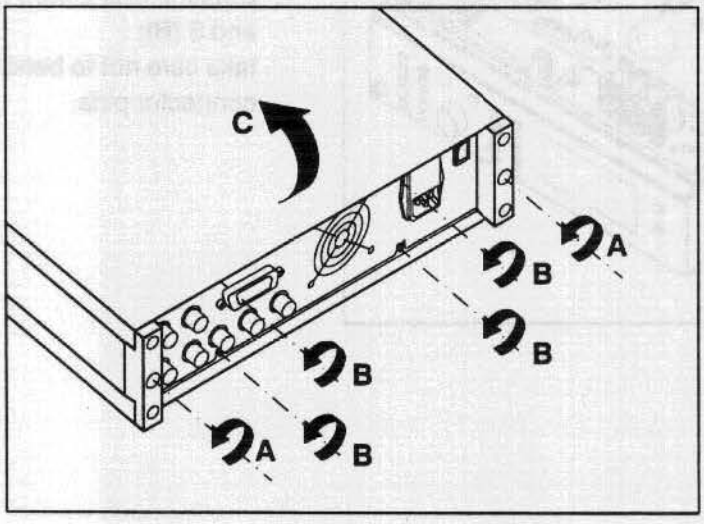
CAUTION:

Damage may result if:
- The instrument is turned on when a circuit board has been removed.
- A circuit board is removed within one minute after turning off the instrument.

7.2 REMOVING THE COVERS

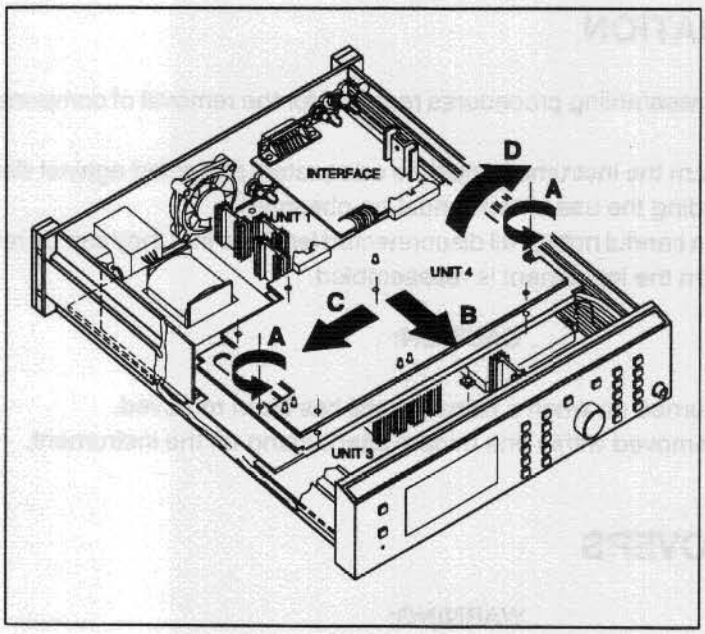
WARNING:

Removing the instrument covers or removing parts, except those to which access can be gained by hand, is likely to expose live parts, and also accessible terminals may be live.
To avoid electric shock, turn off line power and remove the power cord before disassembling the instrument.
If adjustment, maintenance or repair of the disassembled instrument under voltage is inevitable, it shall be carried out only by qualified personnel using customary precautions against electric shock.
Capacitors inside the instrument may still be charged even after the instrument has been turned off or disconnected from the power supply.



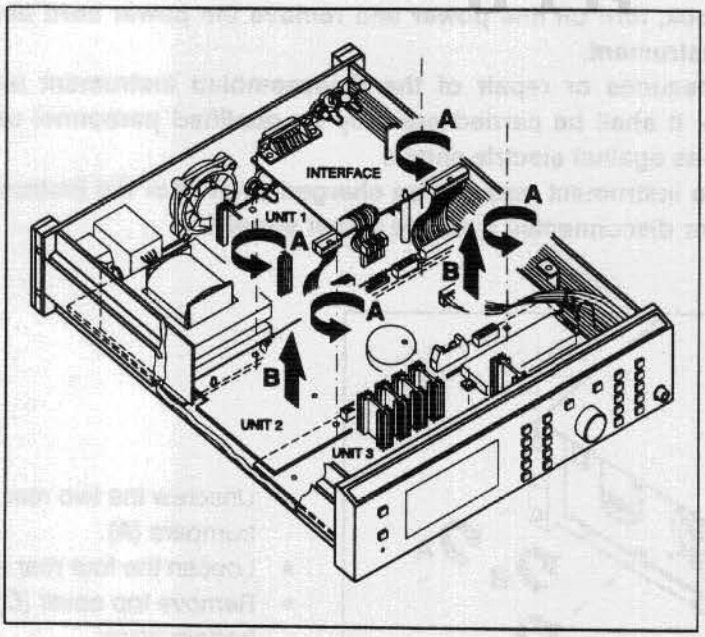
- Unscrew the two rear bumpers (**A**).
- Loosen the four rear screws (**B**).
- Remove top cover (**C**) and bottom cover.

7.3 UNIT 4



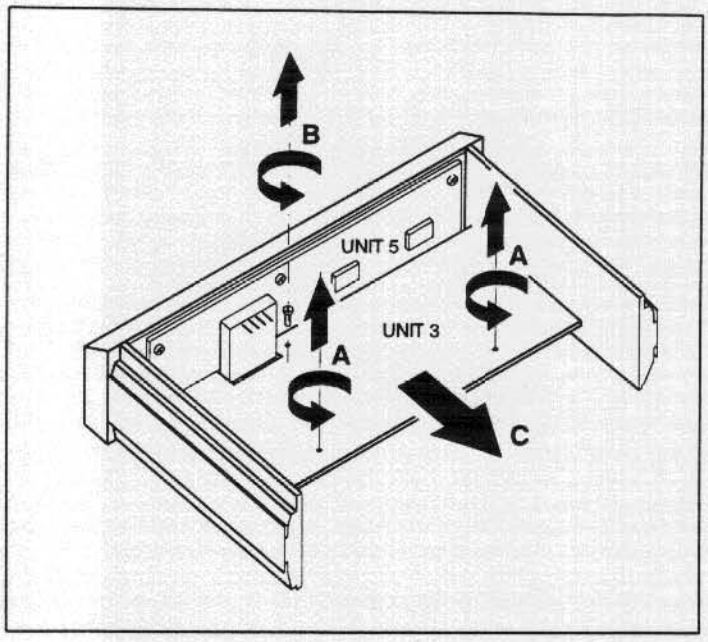
- Remove all cables from Unit 4.
- Unscrew two screws (**A**).
- Move Unit 4 slightly to the front (**B**).
- Move Unit 4 to the left-hand side (**C**) and lift it off (**D**).
- In order to detache the unit from the holder unscrew the five corner and one central nut.

7.4 UNIT 2



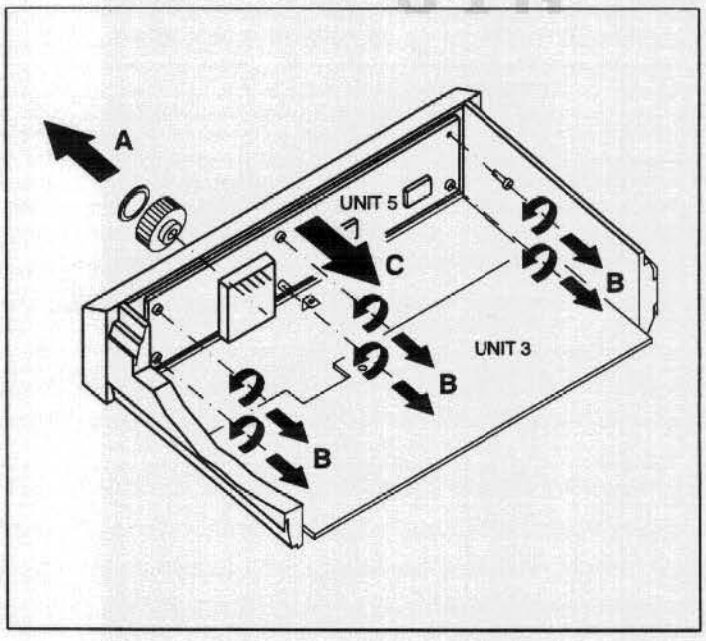
- Remove Unit 4, see Section 7.3.
- Remove all cables from Unit 2.
- Unscrew the four nuts (**A**).
- Detache Unit 2 from Units 1 and 3 (**B**):
  take care not to bend the connector pins.

7.5 UNIT 3



- Remove Units 4 and 2, see Sections 7.3 and 7.4.
- Remove coax cable to output socket.
- Unscrew the two distance pieces from the rear (**A**) and one screw from the central front (**B**) of Unit 3.
- Move the unit with its holder slightly to the back (**C**), shift the unit to the front in order to detache it from its holder.
- Move the unit to the left-hand side and lift it off (similar to Unit 4, steps C, D).

7.6 UNIT 5



- Remove Units 4 and 2, move Unit 3 to the back, see Sections 7.3, 7.4, 7.5.
- Remove cap from the rotary knob.
- Unscrew central nuts; remove the knob (**A**).
- Unscrew six screws and one distance piece (**B**).
- Remove Unit 5 (**C**).

7.7 TEXT PLATE

The text plate is an adhesive foil strip which cannot be reattached after you have remove it. Place a small screwdriver behind the foil strip and remove it carefully.

8 CHECKING AND ADJUSTING

8.1 GENERAL INFORMATION

This chapter provides the complete adjustment procedure for the instrument. Because various control functions are interdependent, a certain order of adjustment is necessary. The procedure is, therefore, presented in a sequence best suited to particular adjustment.

- Warm-up time under average conditions is 30 minutes
- Adjustment should be done after 1 hour
- Ambient temperature (23 ±1) °C
- Line voltage, nominal value ±2 %
- The cabinet must be closed with a special cover (part of the Service Kit)
- Instrument performance should be checked before any adjustment is done

- All limits and tolerances given in this section are calibration guides, and should not be interpreted as instrument specifications
- Tolerances given are for instrument under test and do not include test equipment errors

WARNING

High voltages exist at several points inside the instrument. To avoid injury, do not touch exposed connections and components while power is on. Disconnect line power before removing protective panels, soldering, or replacing components.

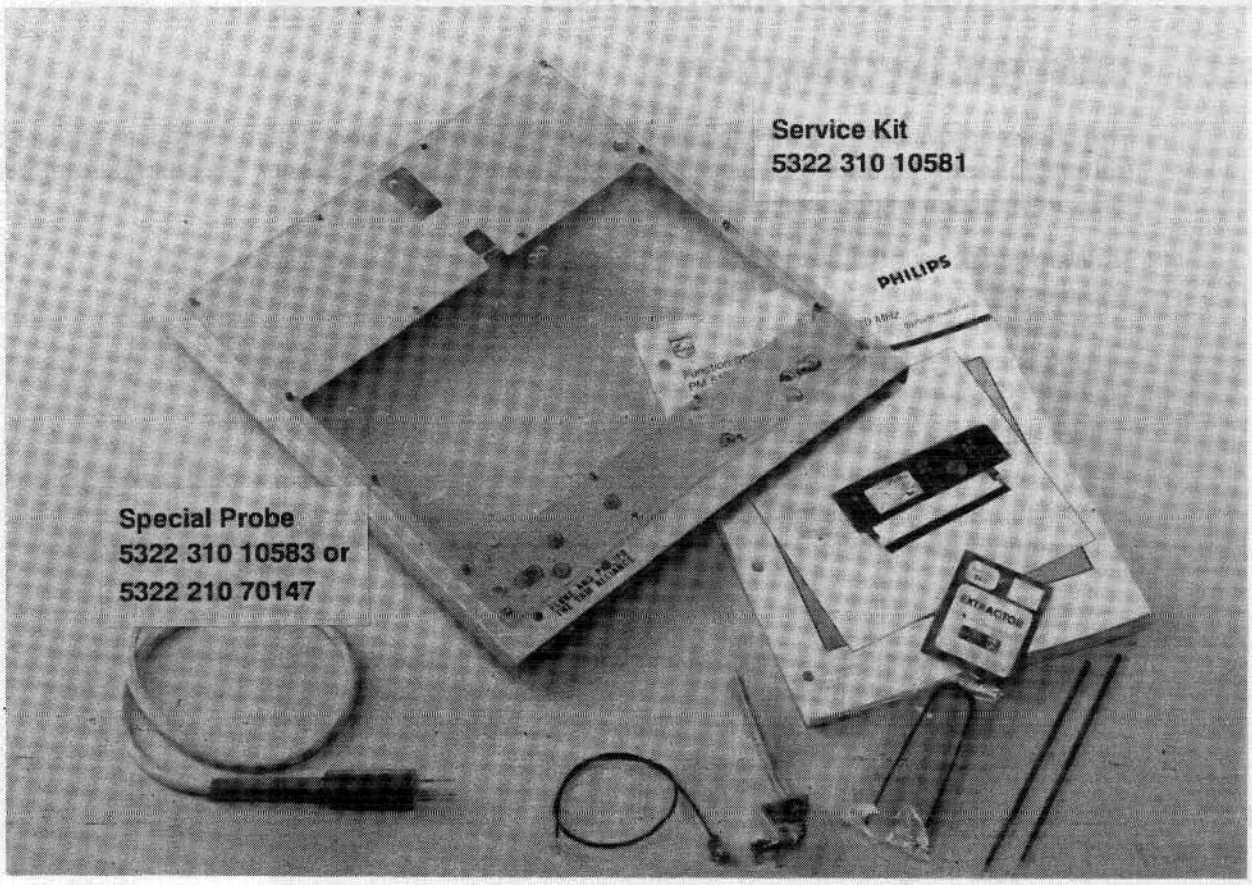
8.1.1 Recommended Test Equipment

- 50 Ω feedthrough termination, tolerance ±0.05 Ω (±0.1 %)
- 600 Ω feedthrough termination, tolerance ±0.6 Ω (±0.1 %)
- BNC cables, mini-coax to BNC adapter, 20 dB attenuator
- Wideband oscilloscope (tr <3.5 ns); PM 3295
- AC/DC voltmeter, resolution <100 µV; PM 2535
- RMS voltmeter; Fluke 8920 A
- Counter/timer; PM 6654
- Modulation analyzer; Rohde & Schwarz FAM
- Spectrum analyzer; HP 8590 A
- Reference synthesizer, accuracy $\pm 10^{-6}$; PM 5192
- RCL meter; PM 6303A with probe ★

- **Service Kit, 5322 310 10581, see page 8 – 2; consisting of:**
  - Special cover with holes for adjustment
  - Adapter mini-coax to BNC
  - Extension cable mini-coax
  - Extraction tool for ICs
  - Trimming tool
  - Service Manual PM 5138A, 4822 872 15115, Service Manual PM 5136, 4822 872 15014.

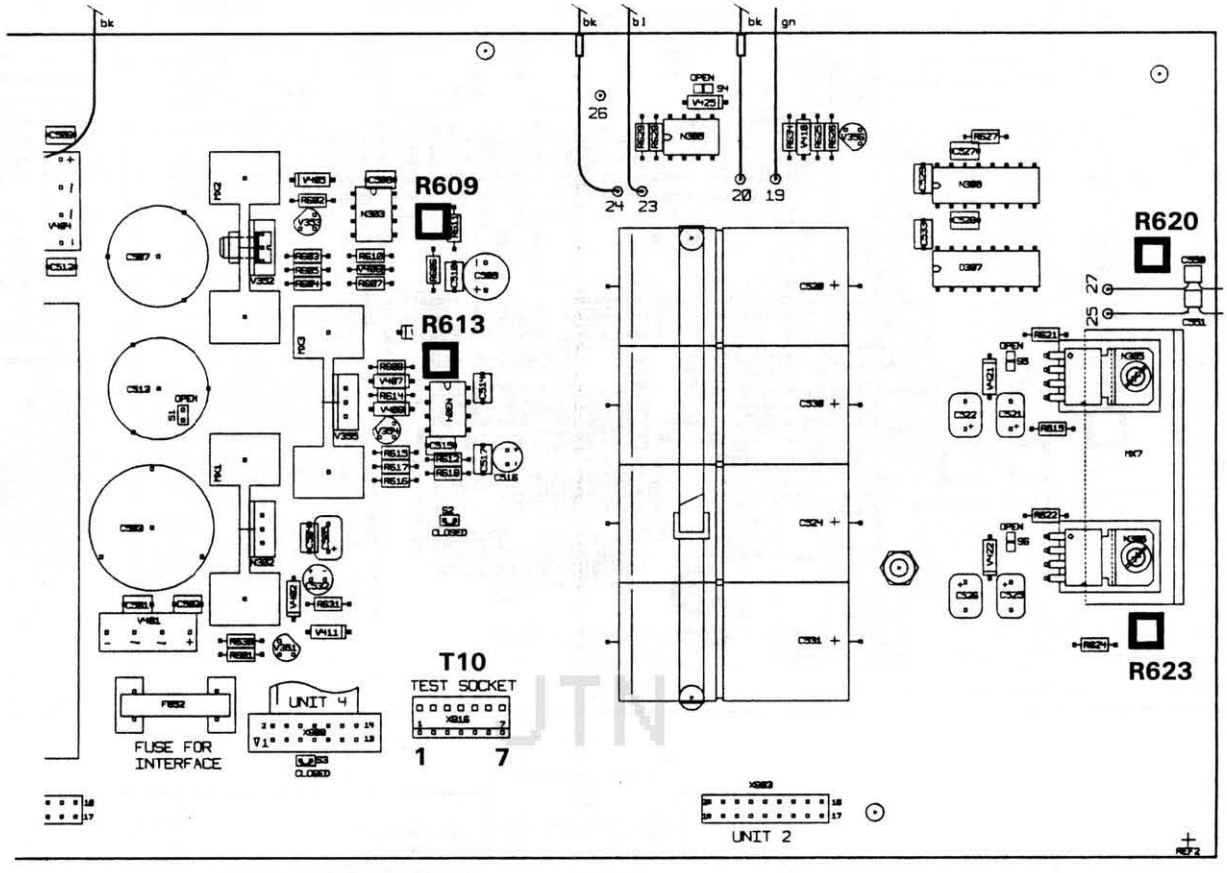
The Service Kit is the same as for PM 5138 and PM 5136. If you already have a complete Service Kit for PM 5139, you only need the special adjustment cover which you can order alone, code no. 5322 310 18084.

★ After coil replacement in the lowpass filter it is recommended to use a special probe, 5322 310 10583 if you use the PM 6303 RCL Meter, or 5322 210 70147 if you use the PM 6303A or PM 6304 RCL Meter. For adjusting the filter, see Section 8.3.7.

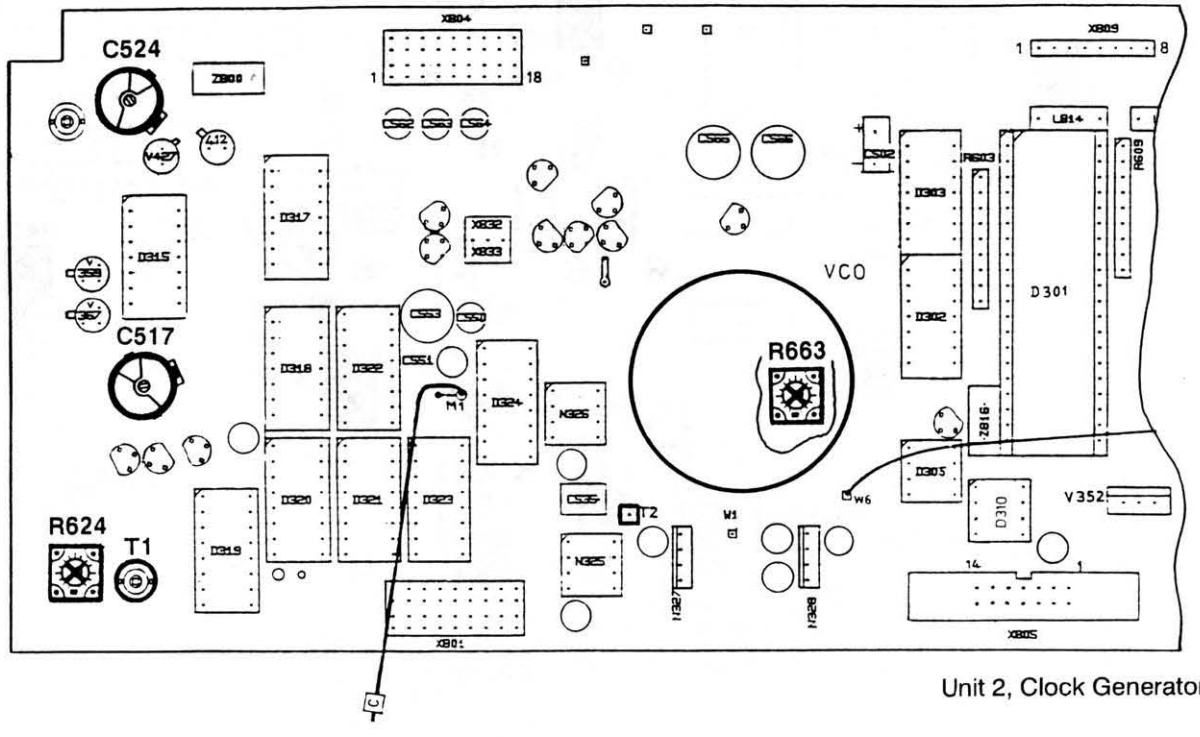


Parts of the Service Kit and Special Probe (left)

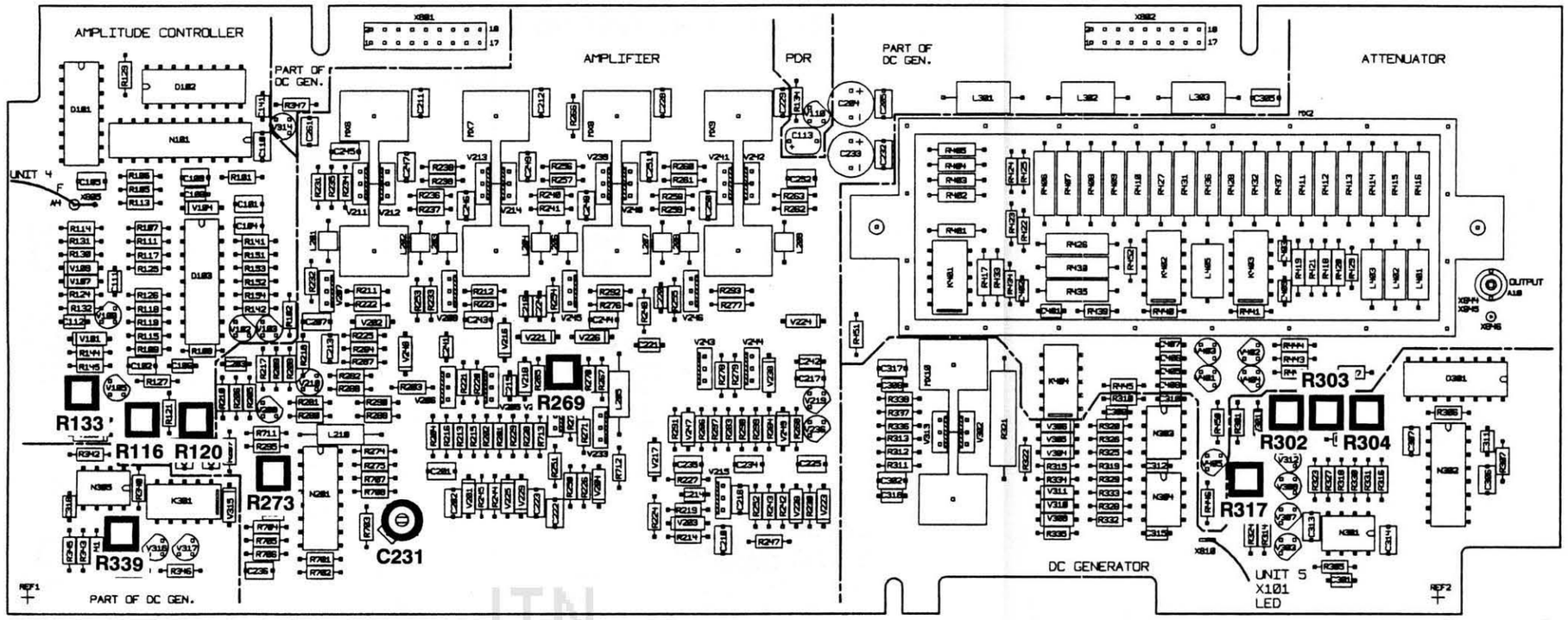
8.2 SURVEY OF ADJUSTING ELEMENTS



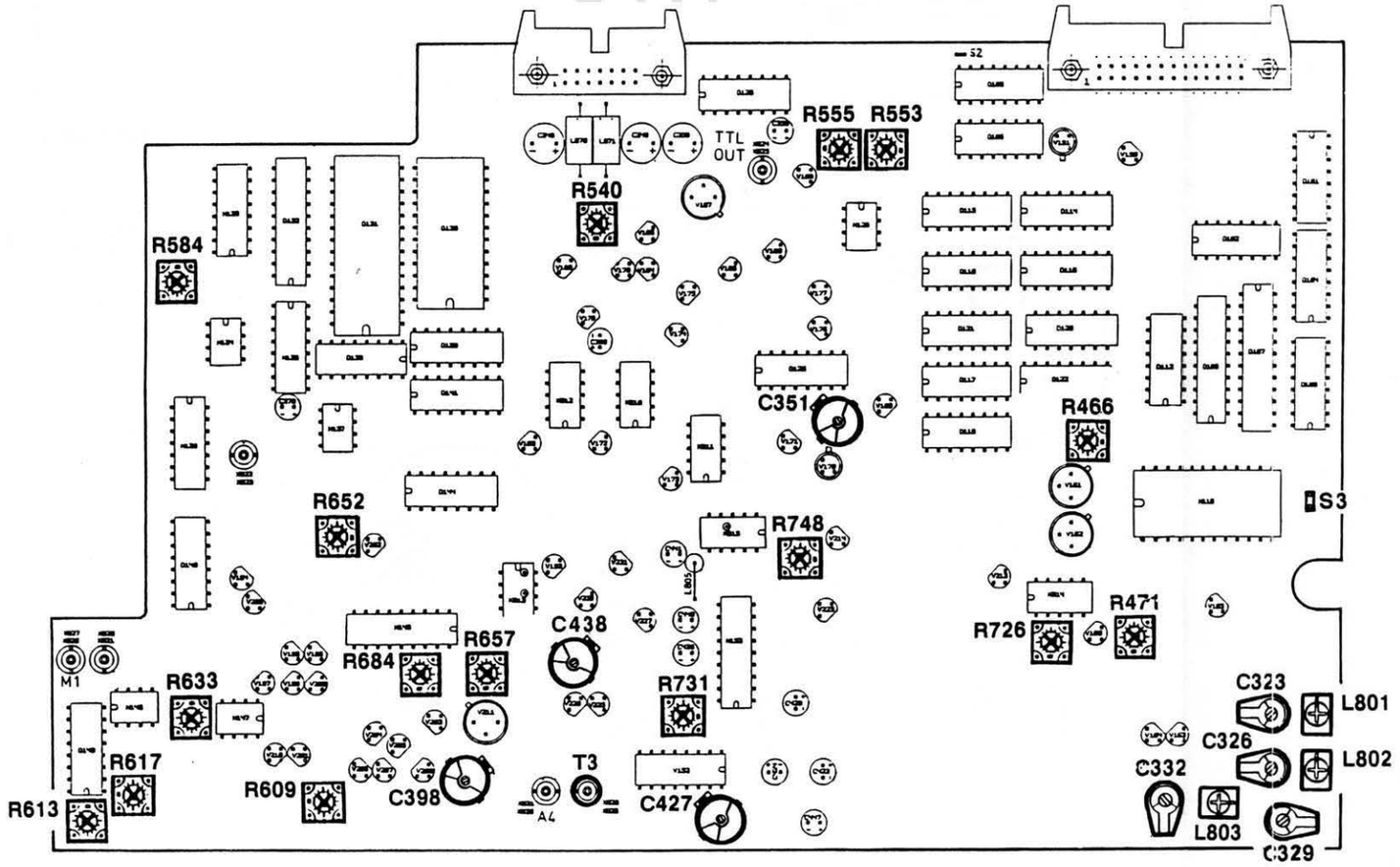
Unit 1, Power Supply



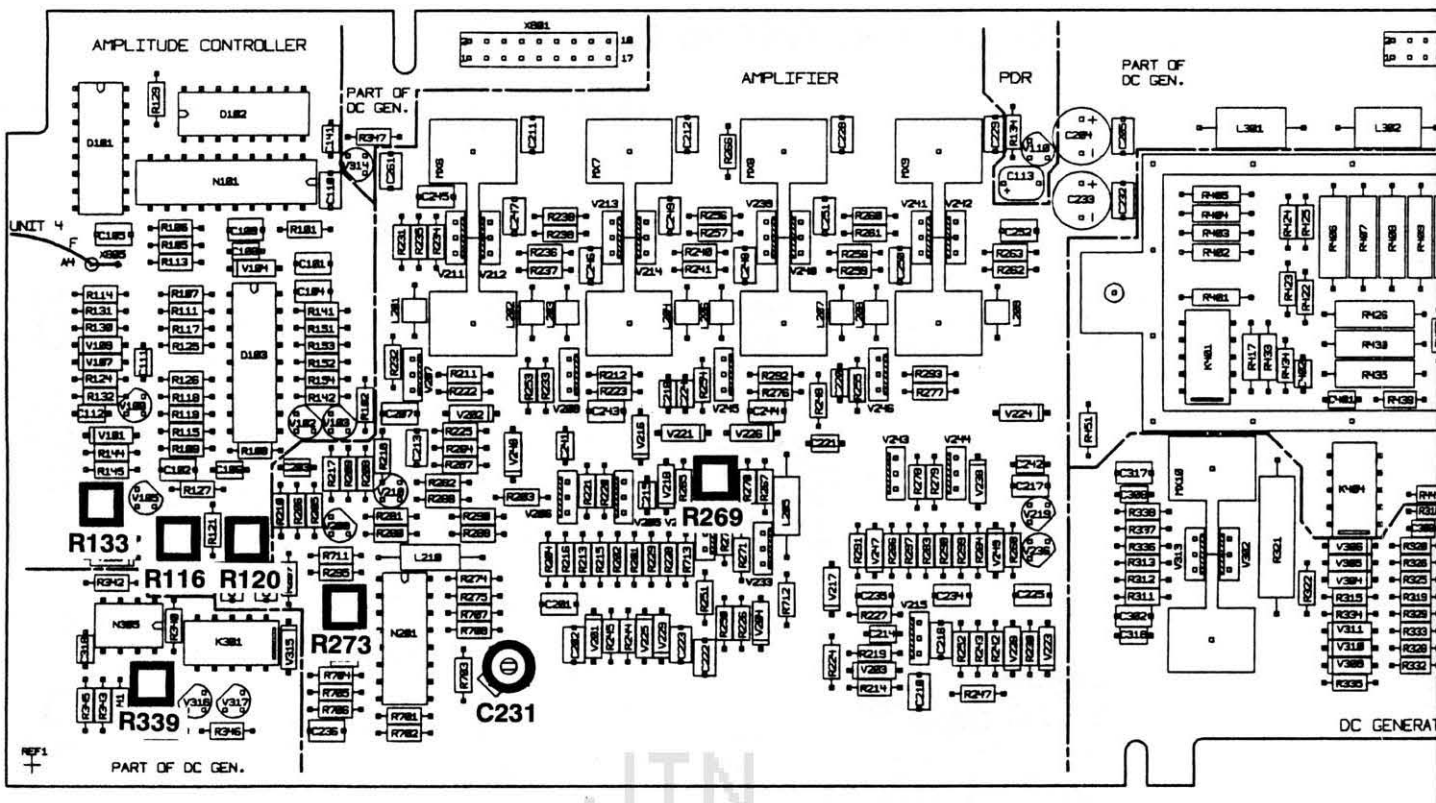
Unit 2, Clock Generator

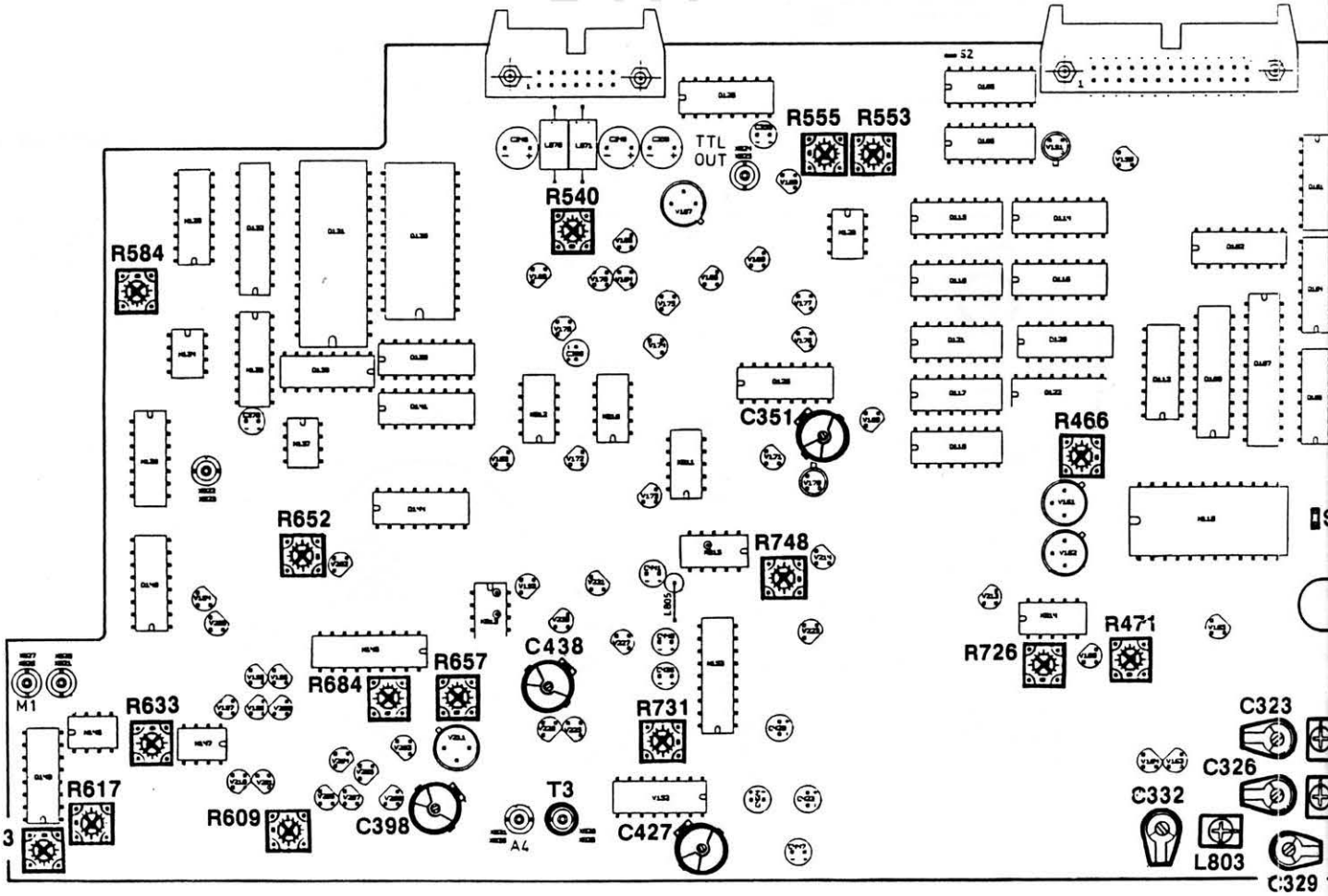


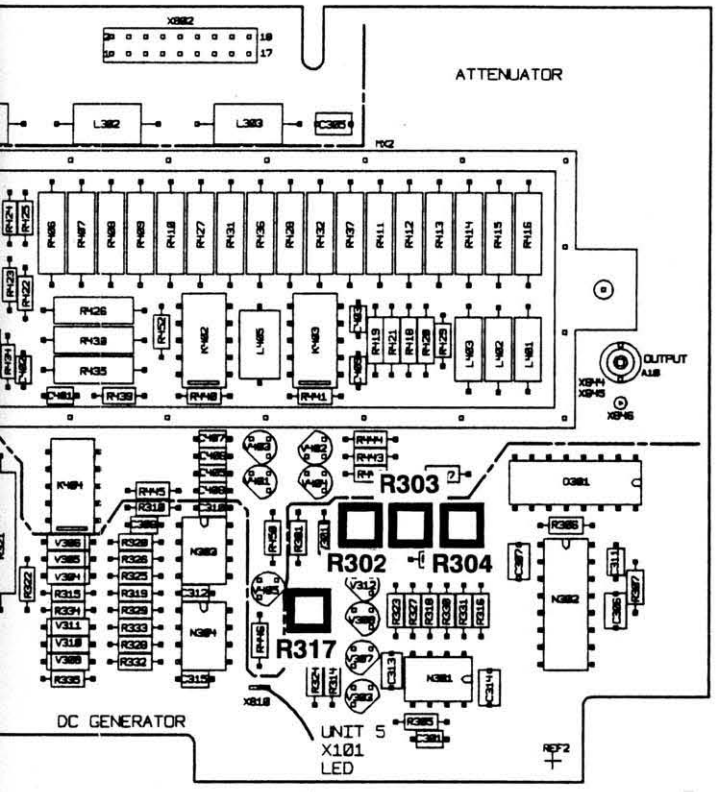
Unit 3, Amplitude Controller
Amplifier
Attenuator
DC Generator



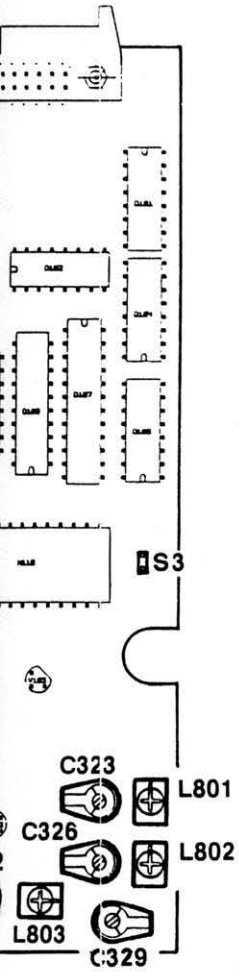
Unit 4, RAM
DAC and Lowpass Filter
Frequency Multiplier
Amplitude Modulator
Pulse Generator
Modulation Oscillator
Burst Logic


AMPLITUDE CONTROLLER
PART OF DC GEN.
AMPLIFIER
PDR
PART OF DC GEN.
UNIT 4
R133
R116
R120
R273
R339
R269
C231
PART OF DC GEN.
DC GENERAT


TTL OUT
R555
R553
R540
R584
C351
R466
R652
R748
R726
R471
C438
R657
R684
R731
R633
M1
R617
R609
C398
T3
C427
R613
C323
C326
C332
L803
C329



Unit 3, Amplitude Controller
Amplifier
Attenuator
DC Generator



Unit 4, RAM
DAC and Lowpass Filter
Frequency Multiplier
Amplitude Modulator
Pulse Generator
Modulation Oscillator
Burst Logic

8.3 ADJUSTMENT PROCEDURE

Remove the top cover of the instrument and unscrew Unit 4, because it is necessary to move this unit slightly to make some adjustments. Attach the special adjustment cover (part of the Service Kit) instead of the normal cover.

8.3.1 Supply Voltages / Power Supply, Unit 1

Test equipment: DC voltmeter

Procedure: Move Unit 4 a little to the front.
Connect the DC voltmeter to ground and test point 10, pin 1 to 6, Unit 1.

Generator settings: Sine wave, frequency 2 kHz, MOD OFF,
AC = 20 V, DC = 0 V

Step	Generator Setting	Adjusting Element	Test Point	Value to set	Value min. to max.
1	unchanged	– – –	T10, pin 1	DC, 5 V	4.80 to 5.20 V
2	"	U1/R609	T10, pin 3	DC, +10 V	+9.998 to +10.002 V
3	"	U1/R613	T10, pin 4	DC, −10 V	−9.998 to −10.002 V
4	"	U1/R620	T10, pin 5	DC, +26 V	+25.98 to +26.02 V
5	"	U1/R623	T10, pin 6	DC, − 26 V	−25.98 to −26.02 V

8.3.2 Reference Frequency / Clock Generator, Unit 2

Test equipment: DC voltmeter, RMS voltmeter, counter, scope, adapter

Procedure: Remove the adjustment cover.
Remove Unit 4.
Connect the DC voltmeter to ground and test point T2 on Unit 2.
Turn potentiometer R624 on Unit 2 to right stop.
Check the DC value;
it must be between +0.1 V and +0.5 V.
If not, adjust with potentiometer R663 to +0.3 ±0.2 V.
Reinstall Unit 4 and the adjustment cover.
Connect the counter to the generator TTL OUT.

Remark: Do not connect a cable to the 10 MHz OUT connector.

Generator settings: Sine wave, frequency 1 MHz, MOD OFF,
AC = 10 V, DC = 0 V

Step	Generator Setting	Adjusting Element	Test Point	Value to set	Value min. to max.
6	unchanged	U2/C524	TTL OUT	1 MHz	1 000 000.3 Hz .. 999 999.7 Hz

Feed reference frequency 1 MHz ±10 Hz, sine wave, 0 dBm to REF IN.
Connect the scope with 50 Ω termination to T1 on Unit 2; use the BNC adapter.
Set the scope to AC coupling.
Set C517/U2 to maximum capacity.
Turn R624/U2 until the signal appears on the scope.
Turn R624 slightly reverse until the signal just disappears.

Step	Generator Setting	Adjusting Element	Test Point	Value to set	Value min. to max.
7	unchanged	U2/C517	U2/T1	AC_{pp} maximum	
8	"	U2/R624	U2/T1	AC_{pp} 30 mV	25 to 35 mV

Repeat step 7 and 8 until the maximum is 30 ±5 mV.

Connect the counter to the generator 10 MHz OUTPUT.
Set the reference frequency to 1.003 MHz ±10 Hz.

Step	Generator Setting	Adjusting Element	Test Point	Value to set	Value min. to max.
9	unchanged	– – –	10 MHz out	10 030 000 Hz	10 030 100 Hz 10 029 900 Hz

Set the reference frequency to 0.997 MHz ±10 Hz.

Step	Generator Setting	Adjusting Element	Test Point	Value to set	Value min. to max.
10	unchanged	– – –	10 MHz out	9 970 000 Hz	9 970 100 Hz 9 969 900 Hz

Disconnect the counter.
Connect the RMS voltmeter with 50 Ω termination to the generator 10 MHz OUTPUT.

Step	Generator Setting	Adjusting Element	Test Point	Value to set	Value min. to max.
11	unchanged	– – –	10 MHz out	level typ. 2 dBm	min. 1 dBm

8.3.3 Amplitude and Offset / DAC Output, Unit 4

Test equipment: DC voltmeter, RMS voltmeter, adapter

Procedure: Connect the RMS voltmeter to test point T3 on Unit 4, use the adapter.

Generator settings: Sine wave, frequency 2 kHz, MOD OFF, AC = 20 V, DC = 0 V

Step	Generator Setting	Adjusting Element	Test Point	Value to set	Value min. to max.
12	unchanged	U4/R466	U4/T3	353.6 mV RMS	353.2 to 354.0 mV

Connect the DC voltmeter instead of the RMS voltmeter.

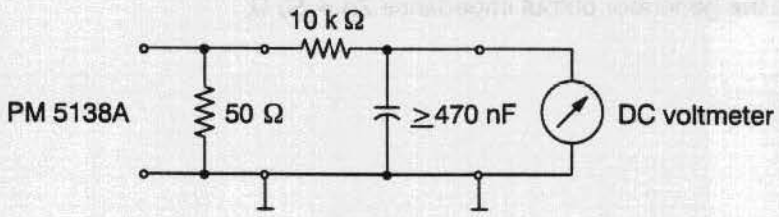
Step	Generator Setting	Adjusting Element	Test Point	Value to set	Value min. to max.
13	unchanged	U4/R471	U4/T3	DC 0 V	−0.5 to +0.5 mV

8.3.4 Amplitude and Offset for Amplitude Controller and Amplifier, Unit 3; Output Impedance for Attenuator, Unit 3

Test equipment: DC voltmeter, RMS voltmeter, scope

Procedure: Connect the DC voltmeter with 50 Ω termination to the generator OUTPUT.

Note: Take care that the DC voltmeter does not respond to the AC portion of the tested voltage. If necessary insert a lowpass filter.



Generator settings: Sine wave, frequency 2 kHz, MOD OFF,
AC = 32 V, DC = 0 V

Step	Generator Setting	Adjusting Element	Test Point	Value to set	Value min. to max.
14	AC OFF	U3/R273	OUTPUT	DC 0 V	−2 to +2 mV
15	AC ON	U3/R116	OUTPUT	DC 0 V	−5 to +5 mV

Steps 14 and 15 are iterative.

Connect the scope with 50 Ω termination to the generator OUTPUT for step 16.
Connect the RMS voltmeter with 50 Ω termination instead of the scope for step 17.
Set the generator to sine wave, frequency 2 kHz,
AC = 0 (display must show .000 V), DC = 0, MOD OFF.

Step	Generator Setting	Adjusting Element	Test Point	Value to set	Value min. to max.
16	AC = 0 DC = 0	U3/R133	OUTPUT	AC to minimum	– – –
17	AC = 3.20 V DC = 0	U3/R120	OUTPUT	AC RMS 0.5657 V	0.5647 to 0.5667 V

Connect the RMS voltmeter with 600 Ω termination to the generator OUTPUT for step 18.
Set the generator to Zo = 600 Ω output impedance: The LED next to the key must be lit.

Step	Generator Setting	Adjusting Element	Test Point	Value to set	Value min. to max.
18	AC = 3.20 V DC = 0	– – –	OUTPUT	AC RMS 0.5657 V	0.5627 to 0.5687 V

Return to the generator output impedance Zo = 50 Ω.

8.3.5 Square Wave / Amplifier, Unit 3

Test equipment: Scope

Procedure: Connect the scope with 50 Ω termination to the generator OUTPUT.

Generator settings: Square wave, symmetry 50 %, frequency 5 MHz, DC = 0, Zo = 50 Ω

Step	Generator Setting	Adjusting Element	Test Point	Value to set	Value min. to max.
19	4.1 V	U3/R269	OUTPUT	best rise/fall time	see Fig. 1
	4.1 V	U3/C231	OUTPUT	without overshoot;	see Fig. 2
20	40.0 V	– – –	OUTPUT	optimal signal performance	tr/tf <17 ns

Steps 19 and 20 are iterative.

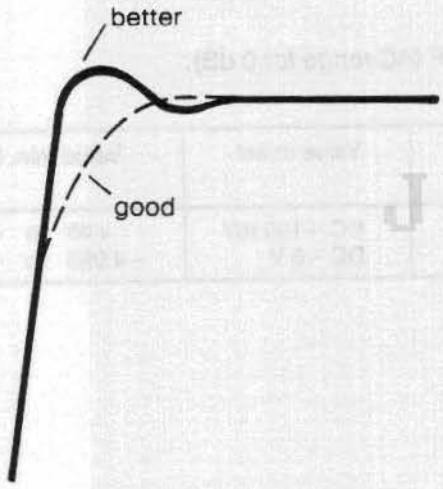


Fig. 1: Adjustment with R670

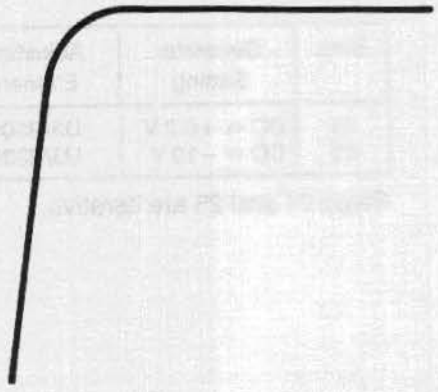


Fig. 2: Adjustment with C530

8.3.6 DC at 40 dB and 0 dB Attenuation / DC Generator, Unit 3

Test equipment: DC voltmeter

Procedure: Connect the DC voltmeter with 50 Ω termination to the generator OUTPUT.

Generator settings: Sine wave, frequency 2 kHz,
AC = 0 V (display must show .000 V in lowest AC range, 40 dB).

Step	Generator Setting	Adjusting Element	Test Point	Value to set	Value min. to max.
21	DC = +0.2 V	U3/R302	OUTPUT	DC +100 mV	+95 to +105 mV
22	DC = −10 V	U3/R304	OUTPUT	DC −5 V	−4.995 to −5.005 V
23	DC = +10 V	U3/R317	OUTPUT	DC +5 V	+4.995 to +5.005 V

Check steps 21 and 22; if necessary repeat adjustments.

Set the generator first to AC >4 V, then to AC OFF (AC range for 0 dB).

Step	Generator Setting	Adjusting Element	Test Point	Value to set	Value min. to max.
24	DC = +0.2 V	U3/R303	OUTPUT	DC +100 mV	+95 to +105 mV
25	DC = −10 V	U3/R339	OUTPUT	DC −5 V	−4.995 to −5.005 V

Steps 24 and 25 are iterative.

8.3.7 Amplitude Flatness / Low-Pass Filter (LPF), Unit 4

Steps 26, 27, 28, 29 are only necessary if components in the lowpass filter circuit (C321-C332, L801-L803) have been replaced. If not, skip this part and continue with step 30.

Test equipment: RCL meter, probe, see Section 8.1.1

Procedure: Remove Unit 4.
Open soldering switches S3, AS1, AS2, AS3, AS4, AS5 on Unit 4.
Prepare the test lead of the RCL meter for measurements at test points AT1 – AT4.
The test lead must be free of capacitance: perform open-circuit trimming and short-circuit trimming with the probe connected to the RCL meter, see PM 6303A Operating Manual. For short-circuit trimming carefully push the pins of the probe on to a conductive surface.

Note: The measurement accounts for capacitances of the multilayer PCB. Make sure that the PCB is free of potential; do not touch the LPF area during measurement.

Step	Generator Setting	Adjusting Element	Test Point	Value to set	Value min. to max.
26	none	U4/C323	AT1	43 pF	42.9 to 43.1 pF
27	none	U4/C326	AT2	55.5 pF	55.4 to 55.6 pF
28	none	U4/C329	AT3	150 pF	149.9 to 150.1 pF
29	none	U4/C332	AT4	85.5 pF	85.4 to 85.6 pF

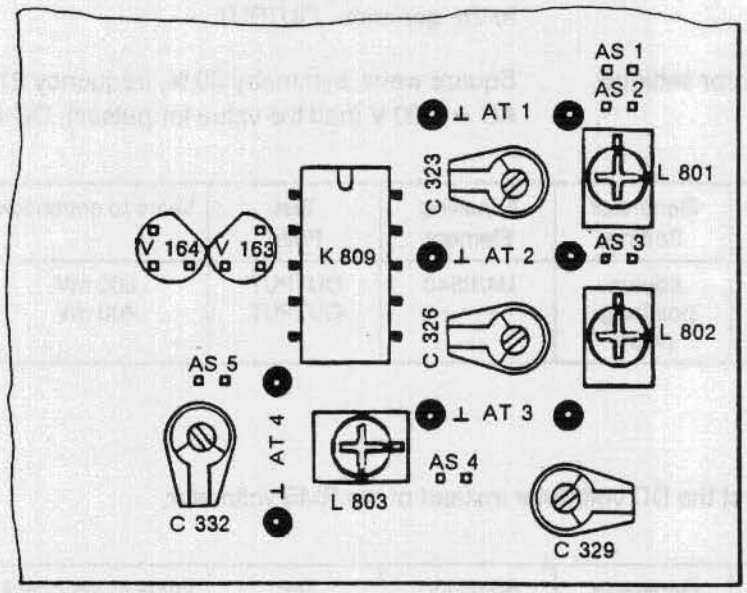


Fig. 3 Part of Unit 4, LPF

Close the solder switches.
Reinstall the Unit 4 into the instrument.
Reinstall the adjustment cover.

Test equipment: RMS voltmeter

Procedure: Connect the RMS voltmeter with 50 Ω termination to the generator OUTPUT.
Prepare the voltmeter for relative dBm measurements.

Generator settings: Sine wave, frequency 5 kHz,
AC = 8 V, DC = 0, MOD OFF

Step	Generator Setting	Adjusting Element	Test Point	Value to set	Value min. to max.
30	5 kHz	– – –	OUTPUT	store measured dBm value P	
31	5 MHz	U4/C332	OUTPUT	P ±0.05 dBm ★	
32	4 MHz	U4/C329	OUTPUT	P ±0.05 dBm	P ±0.05 dBm

★ Adjust L803 slightly only if you cannot set this value with C332.

Check the level in the frequency range 5 kHz to 5 MHz. If the level in the lower frequency range 1 to 3 MHz deviates more than −0.1 dBm, turn L802 approximately 90 degrees clockwise; if it deviates more than +0.1 dBm, turn L802 counterclockwise. Repeat steps 30 to 32.

8.3.8 Duty Cycle / Pulse Generator, Unit 4

Test equipment: RMS voltmeter, DC voltmeter, counter for interval measurement.

Procedure: Connect the RMS voltmeter with 50 Ω termination to the generator OUTPUT.

Generator settings: Square wave, symmetry 50 %, frequency 21 kHz,
AC = 3.20 V (half the value for pulses), DC = 0, MOD OFF

Step	Generator Setting	Adjusting Element	Test Point	Value to set/check	Value min. to max.
33	square	U4/R540	OUTPUT	800 mV	798 to 802 mV
34	pos./neg. pulse	– – –	OUTPUT	400 mV	396 to 404 mV

Connect the DC voltmeter instead of the RMS voltmeter.

Step	Generator Setting	Adjusting Element	Test Point	Value to set/check	Value min. to max.
35	square	– – –	OUTPUT	– – –	−32 to +32 mV

Connect the counter instead of the voltmeter. Set the counter to interval measurement ( )

Step	Generator Setting	Adjusting Element	Test Point	Value to set	Value min. to max.
36	square 80 % 100 kHz AC = 10 V	U4/R553	OUTPUT	8 µs	7.99 to 8.01 µs
37	square 20 % 100 kHz AC = 10 V	U4/R555	OUTPUT	2 µs	1.99 to 2.01 µs
38	square 20 % 5 MHz AC = 10 V	U4/C351	OUTPUT	40 ns	39 to 41 ns

8.3.9 Output Signal Spectrum / Frequency Multiplier, Unit 4

Test equipment: RMS voltmeter, spectrum analyzer

Procedure: Connect the analyzer with 50 Ω termination to the generator OUTPUT.
Set the analyzer to f_{CENTER} = 200 kHz, f_{SPAN} = 400 kHz.
Set C427, C438 on Unit 4 to minimum.
Set R731, R726 on Unit 4 to mid-position

Generator settings: Sine wave, SWEEP LIN, f_{START} = 200 kHz, f_{STOP} = 10 MHz, not triggered, symmetry 50 %, AC = 0.8 V, DC = 0

Step	Generator Setting	Adjusting Element	Test Point	Value to set	Value min. to max.
39	unchanged	U4/R748	OUTPUT	100 kHz subharm. to minimum	< −50 dBc

Set the analyzer to f_{CENTER} = 6 MHz, f_{SPAN} = 12 MHz.
Set the generator to SWEEP LIN, f_{START} = 6 MHz, f_{STOP} = 10 MHz, not triggered.

Step	Generator Setting	Adjusting Element	Test Point	Value to set	Value min. to max.
40	unchanged	U4/C427	OUTPUT	9 MHz component to minimum	< −47 dBc
41	unchanged	U4/R731	OUTPUT	3 MHz subharm. to minimum	< −47 dBc

Connect the RMS voltmeter with 50 Ω termination instead of the analyzer.
Set the generator to sine wave, 5 MHz, AC = 3.20 V, DC = 0, MOD OFF.

Step	Generator Setting	Adjusting Element	Test Point	Value to set	Value min. to max.
42	5 MHz	– – –	OUTPUT	store measured dBm value P	
43	5.001 MHz	U4/R726	OUTPUT	P ± minimum	P ±0.02 dBm
44	10 MHz	U4/C438	OUTPUT	P ± minimum	P ±0.02 dBm
45	67,to10MHz	– – –	OUTPUT	– – –	P ±0.12 dBm ★

★ Take into account the frequency response of the voltmeter.
If the values +0.12 dBm or −0.12 dBm are exceeded, repeat steps 42 to 44 to correct the total level within the ±0.12 dBm window. Check step 45 again.

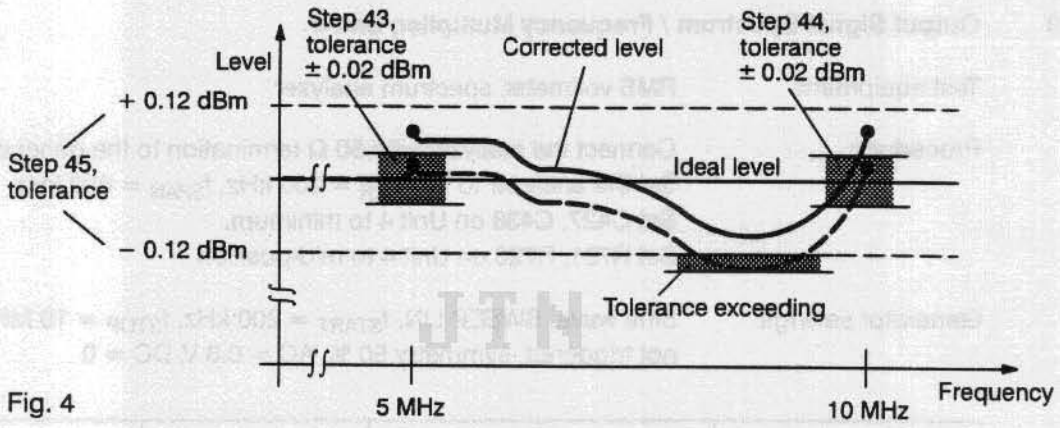


Fig. 4

Set the generator to AC = 0.040 V.
Connect the analyzer instead of the RMS voltmeter.

Step	Generator Setting	Adjusting Element	Test Point	Value to set	Value min. to max.
46	6 MHz	– – –	OUTPUT	2nd and 3rd harm.	< −40 dBc
				spurious, ★	< −42 dBc
47	8 MHz	– – –	OUTPUT	2nd and 3rd harm.	< −40 dBc
				spurious, ★	< −42 dBc
48	10 MHz	– – –	OUTPUT	2nd and 3rd harm.	< −40 dBc
				spurious, ★	< −42 dBc
				★ f < 100 MHz	

8.3.10 FM Deviation / Modulation Oscillator, Unit 4

Test equipment: Modulation analyzer

Procedure: Connect the modulation analyzer with 20 dB attenuation to the generator OUTPUT.
Set the analyzer to FM, AF-Frequency.
Set R584 on Unit 4 to the left stop.

Generator settings: Sine wave, frequency = 5 MHz, FM INT, DEV = 1 %, AC = 8 V, DC = 0

Step	Generator Setting	Adjusting Element	Test Point	Value to set	Value min. to max.
49	unchanged	– – –	OUTPUT	– – –	>52 kHz
50	unchanged	U4/R584	OUTPUT	50 kHz	49.9 to 50.1 kHz

8.3.11 Gate Function / Amplitude Modulator, Unit 4

Test equipment: Scope, RMS voltmeter

Procedure: Connect channel A of the scope with 50 Ω termination to the generator OUTPUT.
Connect channel B of the scope to the MODULATION OUTPUT of the generator.
Set the scope trigger to channel B.

Generator settings: Sine wave, frequency = 1 MHz, GATE INT, AC = 8 V, DC = 0

Step	Generator Setting	Adjusting Element	Test Point	Value to set	Value min. to max.
51	unchanged	U4/R609	OUTPUT	carrier during OFF period to minimum	

Connect the RMS voltmeter with 50 Ω termination instead of the scope.

Step	Generator Setting	Adjusting Element	Test Point	Value to set	Value min. to max.
52	GATE EXT	– – –	OUTPUT	store measured dBm value P	
53	Feed +5 V to MOD INPUT	– – –	OUTPUT		P > –43 dBm

8.3.12 AM Modulation Depth and Amplitude / Amplitude Modulator, Unit 4

Test equipment: RMS voltmeter, modulation analyzer, 20 dB attenuator

Procedure: Connect the RMS voltmeter with 50 Ω termination to the generator OUTPUT.

Generator settings: Sine wave, frequency = 1 kHz, GATE EXT (no signal at MOD INPUT), AC = 8 V, DC = 0

Step	Generator Setting	Adjusting Element	Test Point	Value to set	Value min. to max.
54	GATE EXT	– – –	OUTPUT	store measured dBm value P	
55	AM INT, depth = 0	U4/R633	OUTPUT	P –6 dBm	P –6.01 dBm P –5.99 dBm

Steps 54 and 55 must be done iteratively.

Connect the modulation analyzer instead of the RMS voltmeter; use the 20 dB attenuator.

Step	Generator Setting	Adjusting Element	Test Point	Value to set	Value min. to max.
56	5 MHz, AM INT, depth = 50 %	U4/R613	OUTPUT	50 %	49.9 to 50.1 %

8.3.13 PSK Envelope / Amplitude Modulator, Unit 4

Test equipment: Scope

Procedure: Connect the scope with 50 Ω termination to the generator OUTPUT.

Generator settings: Sine wave, frequency = 200 kHz, PSK INT, AC = 8 V, DC = 0

Steps 57 and 58 must be done iteratively. It is best if both steps are done at the same time.

Step	Generator Setting	Adjusting Element	Test Point	Value to set	Value min. to max.
57	200 kHz, PSK	U4/R617	OUTPUT	min. amplitude difference ★	
58	"	U4/R652	OUTPUT	min. envelope displacement ★	

★ See Figures 5 and 6.

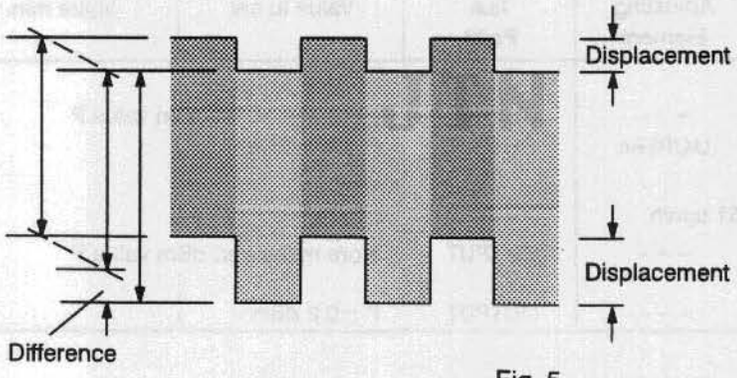


Fig. 5

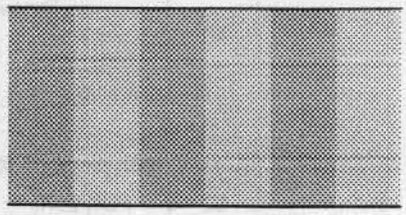


Fig. 6

8.3.14 Modulator AC and DC / Amplitude Modulator, Unit 4

Test equipment: DC voltmeter, RMS voltmeter

Procedure: Connect the DC voltmeter with 50 Ω termination to the generator OUTPUT.

Generator settings: Sine wave, frequency = 1 kHz, AM INT, depth = 0
AC = 8 V, DC = 0, (no connection to MOD/TRIG INPUT)

Step	Generator Setting	Adjusting Element	Test Point	Value to set	Value min. to max.
59	1 kHz, AM depth = 0	U4/R657	OUTPUT	DC 0 V	– 5 to +5 mV

Connect the RMS voltmeter instead of the DC voltmeter.

Step	Generator Setting	Adjusting Element	Test Point	Value to set	Value min. to max.
60	20 kHz, MOD OFF	– – –	OUTPUT	store measured dBm value P	
61	GATE EXT	U4/R684	OUTPUT	P ±0.1 dBm	
	Check steps 57 to 61 again				
62	PSK EXT, 200 kHz	– – –	OUTPUT	store measured dBm value P	
63	PSK INT	– – –	OUTPUT	P ±0.2 dBm	

8.3.15 Square Wave / Amplitude Modulator, Unit 4

Test equipment: Scope

Procedure: Connect the scope with 50 Ω termination to the generator OUTPUT.

Generator settings: Square wave, frequency = 5 MHz, AM INT, depth = 0,
AC = 1 V, DC = 0

Step	Generator Setting	Adjusting Element	Test Point	Value to set	Value min. to max.
64	unchanged	U4/C398	OUTPUT	tr/tf min. without overshoots	tr/tf <23 ns

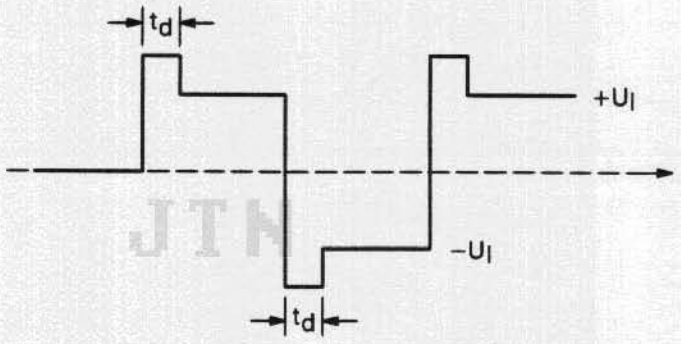
8.3.16 Overload Protection (Current Limiting)

Test equipment: Scope, resistor 10 Ω, 1 %, 1 W

Procedure: Connect the resistor to the generator OUTPUT and to ground.
Connect the scope without termination to the generator OUTPUT.

Generator settings: Square wave, frequency 1 kHz,
AC = 40.0 V, DC = 0

Step	Generator Setting	Adjusting Element	Test Point	Value to set	Value min. to max.
65	unchanged	– – –	OUTPUT	Current Limiting: voltage at resistor	after delay of approx. t_d = 100 µs the voltage must be limited to U_I = ±2.65 ±0.35 V



8.3.17 Bit Generator (Rotary Knob), see also Section 4.11

(only necessary after rotary knob replacement).
For this test, Unit 5 must be removed, see Section 7.6.

Test equipment: Scope

Step	Generator Setting	Adjusting Element	Test Point	Value to set	Value min. to max.
66	not important	R602	A1 (blue wire)		high>2.4 V low 0.2 ... 0.4 V
67	not important	R603	A2 (green wire)	 during continuous turning	high>2.4 V low <0.4 V

10 SPARE PARTS, FIGURES

SERVICE KIT # 5322 310 10581 ---- P. 8-1 + 8-2

10.1 GENERAL

The instrument is repaired preferably to component level.
If the fault cannot be found at the component level, the single units can be ordered; or preferably the complete instrument can be sent to Hamburg.
Spare Parts must be ordered via Consumer Service PCS Eindhoven.

10.2 STANDARD PARTS

Electrical and mechanical parts replacements can be obtained through your local Fluke/Philips organization or representative. However, many of the standard electronic components can be obtained from other local suppliers. 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 instrument performance.

10.3 SPECIAL PARTS

In addition to the standard electronic components, the following special components are used:
- Components, manufactured or selected by Fluke/Philips to meet specific performance requirements.
- Components that are important for the safety of the instrument are marked with 'S' in the parts list.

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

10.4 TRANSISTORS AND INTEGRATED CIRCUITS

- If removed during routine maintenance, return transistors and IC's to their original positions.
- Do not replace or switch semiconductor devices unnecessarily, because this may affect the calibration of the instrument.
- Any replacement component should be of the original type or a direct replacement. Bend the leads to fit the socket or pcb holes and cut the leads to the same lenght as on the component being replaced.
- When a part has been replaced, check the operation of the part of the instrument that may be affected.
- When reinstalling power-supply transistors, use heat-sink compound to increase the heat-transfer capabilities.

WARNING

To avoid skin irritation or injury, handle heat-sink compound with care. Avoid contact with the eyes. Wash hands thoroughly after use.

10.5 STATIC-SENSITIVE COMPONENTS

This instrument contains electrical components that are susceptible to damage from static discharge. Servicing static-sensitive assemblies or components should be performed only at a static-free work station by qualified service personnel.

10.6 HANDLING MOS DEVICES

Though all our MOS integrated circuits incorporate protection against electrostatic discharges, they can nevertheless be damaged by accidental overvoltages. In storing and handling them, the following precautions are recommended.

CAUTION

To avoid electric shock testing or handling and mounting call for special attention to personal safety. Personnel handling MOS devices should wear a ground strap.

10.6.1 Storage and Transport

Store and transport the circuits in their original packing. Alternatively, you can use a conductive material or a special IC carrier that either short-circuits all leads or insulates them from external contact.

10.6.2 Testing or Handling

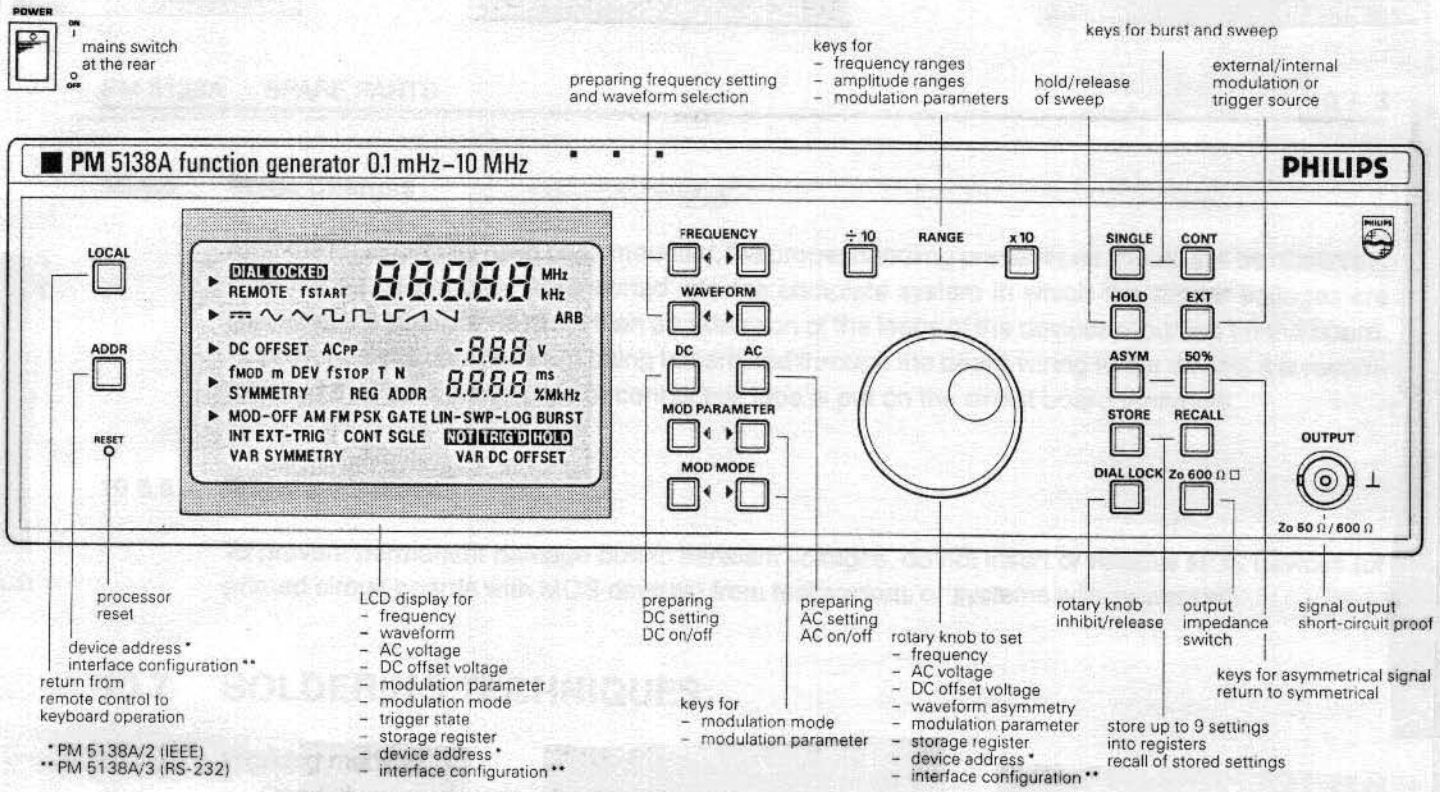
Personnel must wear a ground strap and work on a conductive surface (e.g., metal table top) when testing the circuits or transferring them from one carrier to another. Connect all testing and handling equipment to the same surface.
Signals should not be applied to the inputs while the device power supply is off. All unused input leads should be connected either to the supply voltage or to ground.

10.6.3 Mounting

Mount MOS integrated circuits on printed circuit boards after all other components have been mounted. Take care that the circuits themselves, metal parts of the board, mounting tools, and the person doing the mounting are kept at the same electric (ground) potential. If it is impossible to ground the printed circuit board, the person mounting the circuits should touch the board before bringing the MOS circuits into contact with it.

10.6.4 Soldering

Soldering iron tips, including those of low voltage irons, or soldering baths should also be kept at the same potential as the MOS circuits and the board.

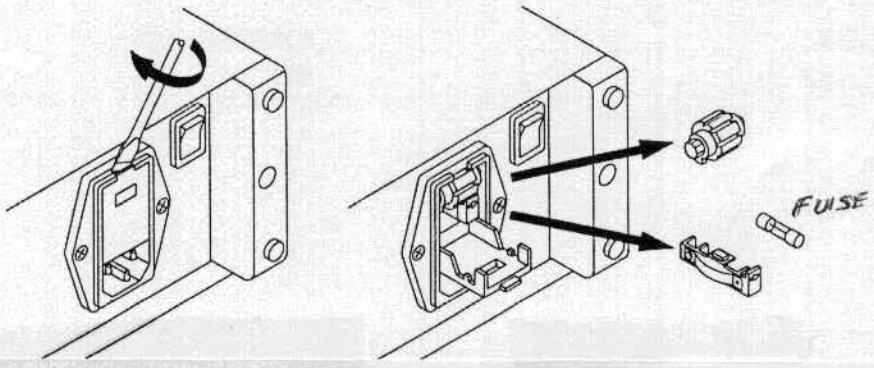


OPERATING INSTRUCTIONS PM 5138A

Rear Panel

Description	Function
INPUTS REFERENCE ⊥	External reference frequency input.
INPUTS MOD/TRIG ⊥	External modulation or trigger signal input.
IEEE 488 / RS232 oder IEEE 488 / RS232	IEEE-488 or RS-232 connector for remote control.
220VAC	Line voltage connector with fuse and voltage selector.
POWER OFF O ON —	Power switch
OUTPUTS 10 MHz ⊥	10 MHz internal reference frequency output for synchronization purposes
OUTPUTS MOD ⊥	Internal modulation or keying signal output.
OUTPUTS PEN LIFT ⊥	Signal output, e.g., to control a plotter pen during sweep.
OUTPUTS SWEEP ⊥	Sweep voltage output (0 – 10 V, proportional to sweep frequency).
OUTPUTS TTL ⊥	TTL signal output (frequency as output signal)

Select one of the voltage ranges, as appropriate, by turning the selector. If necessary, insert the specified fuse (T0.4A or T0.8A) that matches the line voltage setting into the fuse holder.



10.7.1 Surface Mounted Devices (SMD) Handling and Replacement

Tools and Materials:

The removal and attachment method of SMD components mainly employs convection heating. This involves the application of hot air to the solder joints. For removing, nozzles are available for different size and shaped components. This permits the heat to be placed directly on the leads.
There are always two settings on the hot-air tool, one for temperature (50 ... 500 °C) and the other for the air flow.
Next, a mini soldering iron can be used to prepare the solder pads before attachment and to do any touchup work.

To ensure proper repair of the surface mounted devices, the following tools have been carefully selected and are therefore recommended:
- A hot-air solder tool: Leister Hot-Jet
- Nozzles for the different packages
- Micro Electronic Systems (MES) repair kit, containing dispenser, vacuum pipette and different caplettes
- Mini soldering iron station: WEPC-COD3 (regulated transformer) and Weller MLR-20 (mini soldering iron)

The following materials are recommended:
- Soldering tin, dia 0.8 mm, SnPb 60/40 with a Resin Midly Activated (RMA) flux.
  Ordering code: 4822 390 80133
- Solder past 026
- Non-corrosive and Resin Midly Activated (RMA) Flux-Colophony.
  Ordering code: 4822 390 50025
- Desolder braided wire; ordering code: 4822 321 40042
- Magnifying glass 3x ... 10x

NOTE: The recommended Leister tools and Weller mini soldering iron can be ordered via your local dealer.

Handling SMD

Electrostatic Discharge (ESD):
All integrated circuits and many semi-conductors are susceptible to ESD. Careless handling during repair can reduce life drastically. To prevent any failure which is caused by static damage, some precautions must be taken for
- transportation: use static shielding bags and containers
- working area: use anti-static mat and wristband, connected to earth potential.

Replacement of SMD:

CAUTION

Components once removed must NOT be used again.

Fluxing and Cleaning:

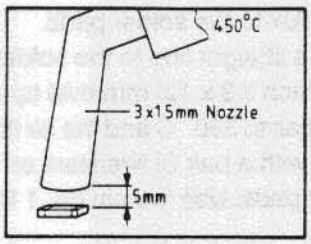
For optimal soldering result, solder flux must be used to chemically clean the metals and the solder. The flux removes oxide from the metals and acts as a wetting agent. Because the use of flux can cause electrical leakage problems in high-ohmic circuits, it is important to use non-corrosive and Resin Midly Activated (RMA) flux, such as Colophony.
The flux residue left over after attachment the SMD components must be removed. To ensure proper cleaning of the board, this must be done IMMEDIATELY after repair. The longer the flux remains on the board, the harder it is to clean.

Replacement of SMDs with up to four connections

NOTE: Before removing the component, observe very carefully its position to avoid that the new component is installed upside-down. This is especially important for capacitors and four-leads SOTs.

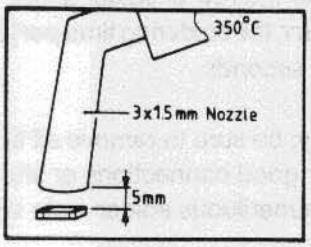
REMOVING:

ATTENTION: Be careful that the adjacent components are not damaged by the hot-air flow.



- Prepare the hot-air tool; attach a 3 x 1.5 mm oval tip nozzle, set the temperature of the hot gas to 450 °C and the air flow to 'high'.
- Hold the nozzle 5 mm above the component to be removed.
- Heat the component up equally for about 5 seconds.
- When the solder becomes molten, remove the component from the board using the vacuum pipette.
- Remove the hot-air tool.
- Clean all pads with the braided wire.

ATTACHING:

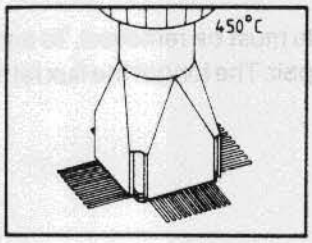


- Apply new solder paste in small dots to all soldering pads.
- Prepare the hot-air tool; use a 3 x 1.5 mm oval tip nozzle, set the hot gas to 350 °C and the air flow to 'low'.
- Place the new component with a pair of tweezers on the sticky solder paste of the contact pads.
- Position the component well.
- Apply the heat from a distance of 5 mm in the direction of the solder paste.
- Allow even reflow of the solder, the soldering time per joint should be not more than about 10 seconds.
- Remove the hot-air tool.
- Clean the pcb very carefully; be sure to remove all flux residue.
- Inspect the solder joints and, if necessary, remove superfluous solder rests with the use of braided wire.

Replacement of SMDs with more connections

REMOVING:

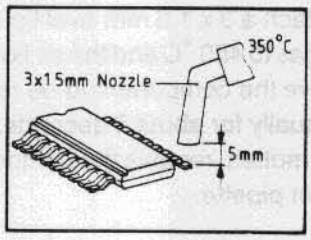
ATTENTION: Be careful that the adjacent components are not damaged by the hot-air flow.



- Prepare the hot-air tool; attach the correct nozzle, set the temperature of the hot gas to 450 °C and the air flow to 'high'.
- Hold the nozzle on the component to be removed.
- Heat all connections of the component equally up for about 10 seconds.
- When the solder becomes molten, remove the component from the board using the vacuum pipette. Use a small screwdriver to break the glue bond when necessary.
- Remove the hot-air tool.
- Clean all pads with the braided wire.

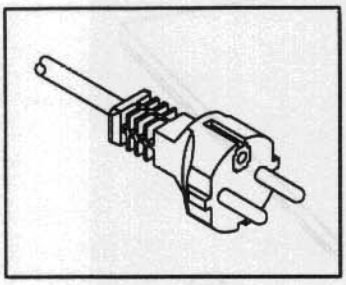
ATTACHING:

NOTE: It is very helpful to use a magnifying glass having a magnification of 3 to 10 to check the correct position of all leads.

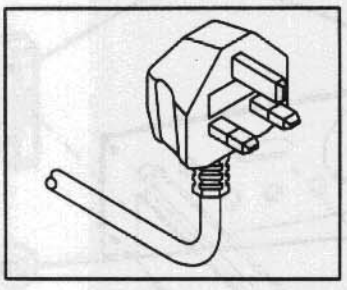


- Apply a certain amount of flux to the solder pads.
- Apply new solder paste in a straight line to the soldering pads.
- Prepare the hot-air tool; attach a 3 x 1.5 mm oval tip nozzle, set the temperature of the hot gas to 350 °C and the air flow to 'low'.
- Place the new component with a pair of tweezers on the sticky solder paste of the contact pads. Use the pin no. 1 location for reference.
- Fix the component with a small soldering tip by briefly heating soldering pads in two diagonally opposite corners.
- Apply the heat from a distance of 5 mm in the direction of the solder paste.
- Slowly move the nozzle over the row of solder joints.
- Allow even reflow of the solder, the soldering time per joint should be not more than about 10 seconds.
- Remove the hot-air tool.
- Clean the pcb very carefully; be sure to remove all flux residue.
- Inspect the solder joints for good connections or short-circuits and, if necessary, remove superfluous solder rests with the use of braided wire.

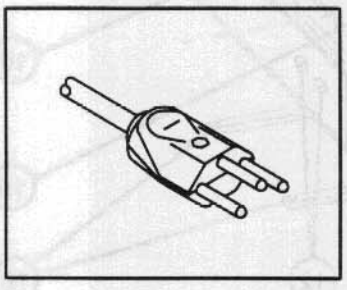
10.8 MAINS CABLES



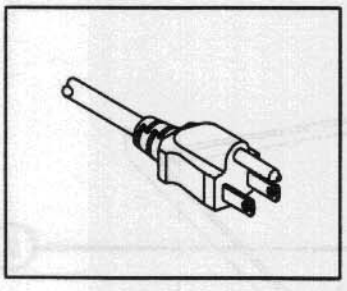
Universal Europe
5322 321 10755



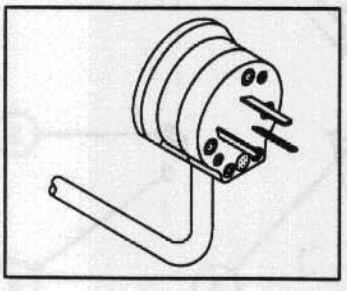
England, U.K.
5322 321 10756



Switzerland
5322 321 10753



North America
5322 321 10752



Australia
5322 321 10754

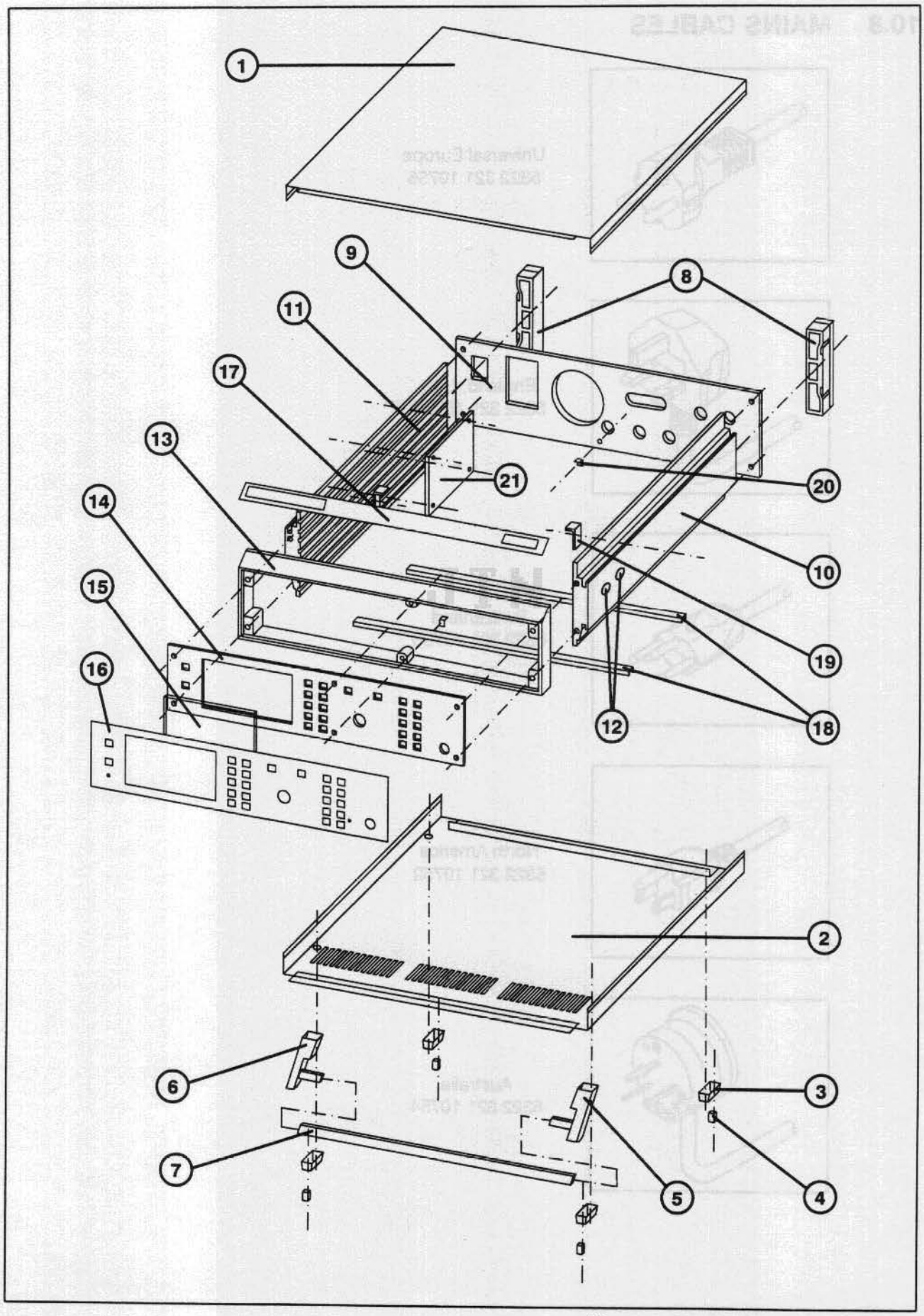


Fig. 30 Mechanical Parts, Housing

10.9 MECHANICAL PARTS, HOUSING (Figure 30)

Item	Quantity	Description	Ordering Code
1	1	TOP COVER	5322 447 91915
2	1	BOTTOM COVER	5322 447 91818
3	4	PLASTIC FOOT	5322 462 41712
4	4	RUBBER FOOT	5322 462 44148
5	1	HOLDER FOR HANDLE (RIGHT)	5322 256 91648
6	1	HOLDER FOR HANDLE (LEFT)	5322 256 91647
7	1	HANDLE	5322 498 50311
8	2	REAR BUMPER	5322 462 41711
9	1	REAR PANEL	5322 447 91822
10	1	SIDE PANEL (RIGHT)	5322 447 92164
11	1	SIDE PANEL (LEFT)	5322 447 92163
12	4	COVER PAD FOR SIDE PANEL	5322 466 62439
13	1	FRAME FOR FRONT PLATE	5322 464 90663
14	1	FRONT PLATE	5322 447 91821
15	1	WINDOW FOR DISPLAY	5322 450 62173
16	1	TEXT FOIL PM 5138A	5322 456 90458
17	1	LOGO STRIP PM 5138A	5322 466 93368
18	2	UNIT HOLDER	5322 535 93098
19	2	HOLDER FOR UNIT 4	5322 466 30377
20	2	HOLDER FOR UNITS 1 AND 3	5322 462 41707
21	1	MONTING PLATE FOR TRANSFORMER	5322 466 30378

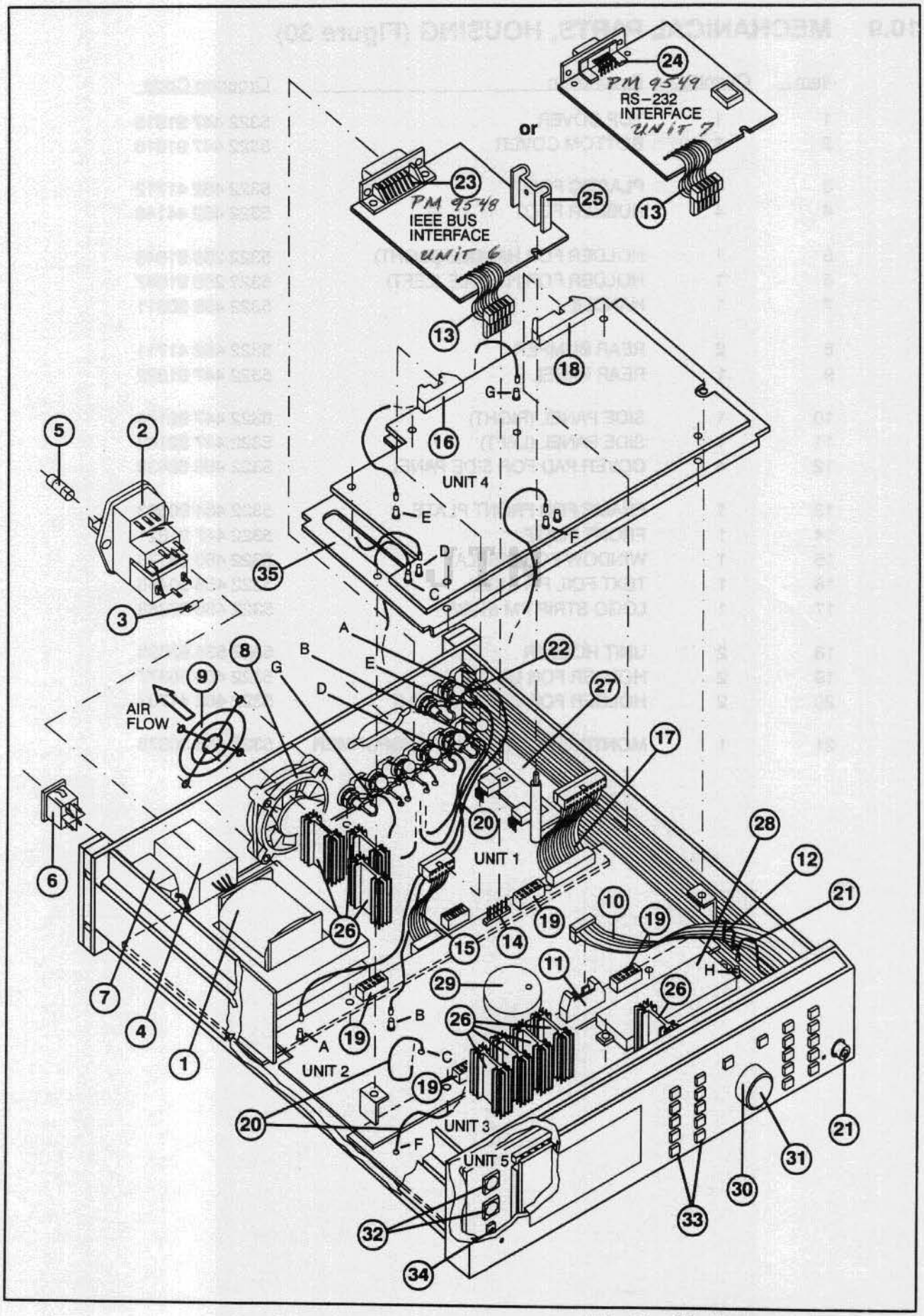


Fig. 31 Mechanical Parts on Units, Cables, Miscellaneous

10.10 MECHANICAL PARTS ON UNITS, CABLES, PARTS NOT ON UNITS, MISCELLANEOUS (Figure 31)

Item		Quantity	Description		Ordering Code
1	L751	1	TRANSFORMER	S	5322 148 20039
2	L870	1	MAINS SOCKET WITH VOLTAGE	S	5322 121 43938
		1	SELECTOR AND FILTER		
3	R608	1	HIGH VOLTAGE RES. VR25 4.7 MOHM	S	4822 053 20475
4		1	PROTECTION COVER MAINS SOCKET	S	5322 462 41709
5	800	1	FUSE 800 MAT/250 V	S	4822 070 38001
		1	FUSE 400 MAT/250 V	S	4822 070 34001
6	871	1	POWER SWITCH	S	5322 276 12029
7		1	PROTECTION COVER FOR POWER SWITCH	S	5322 462 41708
8	860	1	FAN		5322 361 10715
9		1	PROTECTION GRID FOR FAN		5322 458 10413
10	X805	1	CONNECTION CABLE U2 - U5		5322 321 60743
11		1	PLUG FOR ITEM 10		5322 265 41007
12		1	CABLE CLIP		5322 401 11521
13	W801	1	CONNECTION CABLE IEEE-488 INERFACE - U2		5322 321 60757
	W101	1	CONNECTION CABLE RS-232 INERFACE - U2		5322 321 60757
14	X809	1	PLUG FOR ITEM 13		5322 267 41136
15	X808	1	CONNECTION CABLE U1 - U4		5322 321 60745
16		1	PLUG FOR ITEM 15		5322 265 41045
17	X807	1	CONNECTINON CABLE U2 - U4		5322 321 60743
18		1	PLUG FOR ITEM 17		5322 265 51294
19	X801-804	4	CONNECTOR U1 - U2 AND U2 - U3 (SOCKET)		5322 267 70284
		4	CONNECTOR U1 - U2 AND U2 - U3 (PLUG)		5322 264 71048
20		1 set	MINI-COAX CABLES (7 PIECES WITH PLUG)		5322 310 10411
21		1	MINI-COAX WITH BNC (WIRED)		5322 321 60742
		1	EMC UNIT AT THE OUTPUT		5322 214 91391
	R650	1	VDR RESISTOR		5322 116 21137
22	X820-834	7	BNC CONNECTOR REAR		5322 267 10173
		14	DISTANCE PIECE FOR BNC		5322 532 51309
		7	SOLDER TAG FOR BNC		5322 290 30318
		7	SOLDER TAG, CRENATED		5322 290 30319
	C511-517	7	CAPACITORS 100 NF		5322 122 20041
	R601-607	7	VDR RESISTOR		5322 116 21137

S = Safety component

Item		Quantity	Description	Ordering Code
23	X802	1	IEEE-488 CONNECTOR	5322 267 60162
24	X101	1	RS-232 CONNECTOR	5322 267 41137
25		1	HEATSINK ON UNIT 1	5322 255 41324
26		8	HEATSINK ON UNIT 3 AND UNIT 1	5322 255 41307
27		1	HEATSINK ON UNIT 6	5322 255 40439
28		2	SCREEN ATTENUATOR (TOP SAME AS BUTTOM)	5322 380 41011
29		1	SCREEN VCO, TOP	5322 380 41013
		1	SCREEN VCO, BOTTOM	5322 380 41014
30		1	KNOB	5322 414 60708
31		1	CAP FOR KNOB	5322 414 70125
32	S820-844	24	SWITCH (PUSHBUTTON)	4822 276 11076
33		24	CAP FOR PUSHBUTTON	5322 414 60707
34	S822	1	RESET PUSHBUTTON	5322 276 12919
35		1	HOLDER AND SCREENING FOR UNIT 4	5322 466 30376

UNITS COMPLETE

UNIT 1, POWER SUPPLY	5322 214 91392
UNIT 2, CPU/TWS/CLOCK GENERATOR, see page 10 – 15	5322 214 91398
UNIT 3, AMPL. CONTROLLER/DC GENER./AMPLIFIER/ATTENUATOR	5322 214 91404
UNIT 4, RAM/DAC/MODULATION OSCILLATOR/BURST/MULTIPLIER	5322 214 91399
UNIT 5, KEYBOARD AND DISPLAY	5322 214 91389
UNIT 6, IEEE-488 INTERFACE	PM 9548
UNIT 7, RS-232 INTERFACE	PM 9549

10.11 ELECTRICAL PARTS ON UNITS AND COMPLETE UNITS

Pos. No.	Description				Ordering Code
UNIT 1, POWER SUPPLY					
UNIT 1, COMPLETE					5322 214 91392
INTEGRATED CIRCUITS / UNIT 1					
D307	INTEGR.CIRCUIT	74HCT4094N			4822 209 61522
N302	INTEGR.CIRCUIT	LM7805CT			5322 209 86445
N303,304	INTEGR.CIRCUIT	TL071ACP			5322 209 32989
N305	INTEGR.CIRCUIT	LM78GCP			4822 209 30093
N306	INTEGR.CIRCUIT	LM79GCP			4822 209 30094
N308	INTEGR.CIRCUIT	DAC08EN			5322 209 11254
N309	INTEGR.CIRCUIT	TL071ACP			5322 209 32989
TRANSISTORS AND DIODES / UNIT 1					
V351,354	TRANSISTOR	BC557B			4822 130 44568
V352	TRANSISTOR	BD645			5322 130 42701
V353	TRANSISTOR	BC547B			4822 130 40959
V355	TRANSISTOR	BD646			4822 130 41212
V356	TRANSISTOR	BC337–25			4822 130 40981
V357	TRANSISTOR	BD139			4822 130 40823
V401	BRIDGE RECT.	GBPC35–08 5322 130 32031			~~4822 130 81278~~ SEE PCN 4920
V402,403	DIODE	BZX79–B4V7			4822 130 34174
V404	BRIDGE RECT.	GBPC35–08			4822 130 81278
V405	DIODE	BZX79–B7V5			4822 130 30861
V406	DIODE	BZV12			5322 130 34269
V407	DIODE	BZX79–B13			4822 130 34195
V408	DIODE	BZX79–B4V7			4822 130 34174
V409	BRIDGE RECT.	GBPC35–08 5322 130 32031			~~4822 130 81278~~ PCN 4920
V410,411	DIODE	BAW62			4822 130 30613
V412	DIODE	BZX79–B8V2			4822 130 34382
V421,422	DIODE	BZX79–B5V1			4822 130 34233
V425	DIODE	BZX79–B6V2			4822 130 34167
CAPACITORS / UNIT 1					
C501,502	CAP.CERAMIC	100NF	10%	100V	5322 126 11584
C503	CAP.ELECTROLYT.	10000µF	20%	16V	5322 124 21343
C504	CAP.CERAMIC	100NF	10%	100V	5322 126 11584
C505	CAP.ELECTROLYT.	1µF	10%	25V	5322 124 80871
C506,508	CAP.CERAMIC	100NF	10%	100V	5322 126 11584
C507	CAP.ELECTROLYT.	4700µF	20%	25V	4822 124 22259
C509	CAP.ELECTROLYT.	220µF	20%	25V	4822 124 41393

Pos. No.	Description				Ordering Code
C510–512	CAP.CERAMIC	100NF	10%	100V	5322 126 11584
C513	CAP.ELECTROLYT.	4700µF	20%	25V	4822 124 22259
C514,515	CAP.CERAMIC	100NF	10%	100V	5322 126 11584
C516	CAP.ELECTROLYT.	47µF	20%	35V	4822 124 40846
C517,519	CAP.CERAMIC	100NF	10%	100V	5322 126 11584
C518	CAP.FOIL	100NF	5%	250V	5322 121 42578
C520	CAP.ELECTROLYT.	4700µF	20%	50V	5322 124 80868
C521,525	CAP.ELECTROLYT.	1µF	10%	25V	5322 124 80871
C522	CAP.ELECTROLYT.	2,2µF	10%	35V	4822 124 80009
C523	CAP.CERAMIC	100NF	10%	100V	5322 126 11584
C524	CAP.ELECTROLYT.	4700µF	20%	50V	5322 124 80868
C526	CAP.ELECTROLYT.	2.2µF	10%	35V	4822 124 80009
C527,528	CAP.CERAMIC	100NF	10%	100V	5322 126 11584
C529	CAP.CERAMIC	10NF	10%	100V	4822 122 31414
C530,531	CAP.ELECTROLYT.	4700µF	20%	50V	5322 124 80868
C532	CAP.ELECTROLYT.	100µF	20%	16V	4822 124 21912
C533	CAP.CERAMIC	100NF	10%	100V	5322 126 11584
C550,551	CAP.CERAMIC	100NF	10%	100V	5322 126 11584

RESISTORS / UNIT 1

R601	RES.METAL FILM	1K	1%	0.4W	4822 050 11002
R602	RES.METAL FILM	2K49	1%	0.4W	4822 050 12492
R603	RES.METAL FILM	100R	1%	0.4W	4822 050 11001
R604,605	RES.NETWORK	1R44	1%	0.33W	5322 116 82498
R606	RES.METAL FILM	1K54	1%	0.4W	4822 050 11542
R607	RES.METAL FILM	1K69	1%	0.4W	4822 050 11692
R608	RES.METAL FILM	5K11	MBA0204	0.25W	5322 117 11196
R609	POTM.TRIMMER	500R	20% LIN	0.5W	5322 101 11076
R610	RES.METAL FILM	1K	1%	0.4W	4822 050 11002
R611	RES.METAL FILM	3K01	1%	0.4W	4822 050 13012
R612	RES.METAL FILM	2K61	1%	0.4W	5322 117 10992
R613	POTM.TRIMMER	50R	20% LIN	0.5W	5322 101 11113
R614	RES.METAL FILM	2K49	1%	0.4W	4822 050 12492
R615	RES.METAL FILM	100R	1%	0.4W	4822 050 11001
R616,616	RES.NETWORK	1R44	1%	0.33W	5322 116 82498
R618	RES.METAL FILM	5K11	MBA0204	0.25W	5322 117 11196
R619	RES.METAL FILM	14K70	1%	0.4W	4822 050 11473
R620	POTM.TRIMMER	500R	20% LIN	0.5W	5322 101 11076
R621	RES.METAL FILM	4K42	1%	0.4W	5322 117 11182
R622	RES.METAL FILM	1K78	1%	0.4W	5322 117 10983
R623	POTM.TRIMMER	500R	20% LIN	0.5W	5322 101 11076
R624	RES.METAL FILM	14K70	1%	0.4W	4822 050 11473
R625	RES.METAL FILM	20K50	1%	0.4W	4822 050 12053

Pos. No.	Description				Ordering Code
R626	RES.METAL FILM	2K61	1%	0.4W	5322 117 10992
R627,628	RES.METAL FILM	10K	1%	0.4W	4822 050 11003
R629	RES.METAL FILM	10K	1%	0.4W	4822 050 11003
R630	RES.METAL FILM	5K11	1%	0.4W	4822 050 15112
R631	RES.METAL FILM	51K10	1%	0.4W	4822 050 15113
R633	RES.METAL FILM	511R	1%	0.4W	5322 117 10785
R634	RES.METAL FILM	205R	1%	0.4W	4822 050 12051

MISCELLANEOUS / UNIT 1

F852	FUSE 400 MAT	4822 070 34001
X816	TEST SOCKET	5322 265 54006
X803,804	CONNECTOR MALE 2X50–P	5322 264 71048

UNIT 2, CPU / TWS / CLOCK GENERATOR

UNIT 2, COMPLETE 5322 214 91398

delivered without EPROM D306, EEPROM D310, battery G812.
Please insert the EPROM D306 and eventually the EEPROM D310 from the old unit into the new unit. Insert a new battery G812.

INTEGRATED CIRCUITS / UNIT 2

D301	PROCESSOR	PCB80C652	5322 209 73417
D302	INTEGR.CIRCUIT	PC74HCT04P	4822 209 82341
D303	INTEGR.CIRCUIT	74HCT132N	4822 209 83044
D304	INTEGR.CIRCUIT	PC74HCT573P	5322 209 11488
D305	INTEGR.CIRCUIT	PCF8570P	5322 209 11065
D306	EPROM LOADED	HN27512G–25 –Ref PCN474B	5322 130 83675
D307	INTEGR.CIRCUIT	74HCT4514P	5322 209 72809
D308	INTEGR.CIRCUIT	PC74HC367P	5322 209 11417
D310	EEPROM	HN58C256P–20	5322 209 52566
D311	INTEGR.CIRCUIT	74HCT32	5322 209 11266
D315	INTEGR.CIRCUIT	N74F132N	5322 209 83342
D317	INTEGR.CIRCUIT	PC74HCU04P	5322 209 11323
D318	INTEGR.CIRCUIT	74HCT132N	4822 209 83044
D319–321	INTEGR.CIRCUIT	PC74HCT390P	5322 209 11483
D322	INTEGR.CIRCUIT	47HCT4020	5322 209 31534
D323	INTEGR.CIRCUIT	PC74HCT4046AP	5322 209 73332
D330	INTEGR.CIRCUIT	N74F08N	4822 209 72675
D331	INTEGR.CIRCUIT	PCF1842P - SEE PCN456L	5322 209 62544
D332	INTEGR.CIRCUIT	N74F821N	4822 209 30097
N325	INTEGR.CIRCUIT	ADOP27GN	5322 209 73739
N326	INTEGR.CIRCUIT	OP37GN	5322 209 73741
N327	INTEGR.CIRCUIT	LM78GCP	4822 209 30093
N328	INTEGR.CIRCUIT	LM79GCP	4822 209 30094

Pos. No.	Description				Ordering Code
TRANSISTORS AND DIODES / UNIT 2					
V351	TRANSISTOR	BC548B			4822 130 40937
V352	TRANSISTOR	BD203			5322 130 44325
V353–354	TRANSISTOR	BC548C			4822 130 44196
V355–358	TRANSISTOR	BC548B			4822 130 40937
V359	TRANSISTOR	2N4035			5322 130 44201
V360	TRANSISTOR	BC558B			4822 130 44197
V361	TRANSISTOR	BF450			4822 130 44237
V362	TRANSISTOR	BC548B			4822 130 40937
V363	TRANSISTOR	BC548B			4822 130 40937
V364,365	TRANSISTOR	BF450			4822 130 44237
V366	TRANSISTOR	BC558C			5322 130 60068
V367	TRANSISTOR	2N4035			5322 130 44201
V369,370	TRANSISTOR	BF240			4822 130 40902
V371	TRANSISTOR	BF450			4822 130 44237
V401–404	DIODE	BAW62			4822 130 30613
V405,406	DIODE	BAT85			4822 130 31983
V409–411	DIODE	BAW62			4822 130 30613
V412	DIODE	BAV45			5322 130 34037
V413	DIODE	BAW62			4822 130 30613
V414	DIODE	BA481			5322 130 32239
V415	DIODE	BB112			4822 130 32227
V417,422	DIODE	BAW62			4822 130 30613
V418	DIODE	BZX79–B7V5			4822 130 30861
V419	DIODE	BZX79–B3V9			4822 130 31981
V420	DIODE	BZX79–B3V0			4822 130 31881
V421	DIODE	BZV86–2V0			4822 130 81424
V423	DIODE	BZX79–B9V1			4822 130 30862
V427	DIODE	BAV45			5322 130 34037
CAPACITORS / UNIT 2					
C501,503	CAP.CERAMIC	100NF	10%	100V	5322 126 11584
C502	CAP.SOLID ALU.	2.2µF	20%	25V	4822 124 21255
C504	CAP.CERAMIC	10NF	–20/+50%	100V	4822 122 31414
C505,506	CAP.CERAMIC	27PF	2%	100V	4822 122 30045
C507,508	CAP.ELECTROLYT.	100µF	20%	16V	4822 124 21912
C509	CAP.CERAMIC	100NF	10%	100V	5322 126 11584
C510	CAP.CERAMIC	56PF	2%	100V	4822 122 32027
C511	CAP.FOIL	1NF	1%	250V	4822 121 50566
C512,514	CAP.CERAMIC	100NF	10%	100V	5322 126 11584
C513	CAP.CERAMIC	10NF	–20/+50%	100V	4822 122 31414
C515	CAP.CERAMIC	100PF	2%	100V	4822 122 31316

Pos. No.	Description				Ordering Code
C516	CAP.CERAMIC	82PF	2%	100V	4822 122 31237
C517	CAP.TRIMMER	3P–50P		250V	5322 125 50243
C518	CAP.CERAMIC	100NF	10%	100V	5322 126 11584
C519–522	CAP.CERAMIC	1NF	10%	100V	5322 122 32331
C522	CAP.ELECTROLYT.	1µF	20%	63V	4822 124 21913
C523	CAP.CERAMIC	100PF	2%	100V	4822 122 31316
C524	CAP.TRIMMER	2.5–27P		100V	5322 125 54083
C525	CAP.CERAMIC	100NF	10%	100V	5322 126 11584
C526	CAP.CERAMIC	27PF	2%	100V	4822 122 30045
C527	CAP.CERAMIC	1NF	10%	100V	5322 122 32331
C528	CAP.CERAMIC	47PF	2%	100V	4822 122 31072
C529	CAP.CERAMIC	22PF	2%	100V	5322 122 32143
C530–532	CAP.CERAMIC	10NF	−20/+50%	100V	4822 122 31414
C533	CAP.CERAMIC	100NF	10%	100V	5322 126 11584
C534	CAP.CERAMIC	100NF	10%	50V	5322 122 30108
C535	CAP.CERAMIC	10µF	5%	5V	5322 121 42398
C536	CAP.CERAMIC	100NF	10%	50V	5322 122 30108
C537,538	CAP.ELECTROLYT.	100µF	20%	16V	4822 124 21912
C539	CAP.ELECTROLYT.	100µF	20%	16V	4822 124 21912
C540	CAP.CERAMIC	1.5NF	10%	500V	4822 122 31169
C541	CAP.CERAMIC	100NF	10%	100V	5322 126 11584
C542	CAP.CERAMIC	22PF	2%	100V	5322 122 32143
C543	CAP.CERAMIC	470NF	20%	50V	5322 122 33078
C544	CAP.CERAMIC	100NF	10%	100V	5322 126 11584
C545	CAP.CERAMIC	10PF	2%	100V	4822 122 32185
C546	CAP.ELECTROLYT.	2.2µF	20%	63V	4822 124 40244
C547	CAP.ELECTROLYT.	1µF	20%	63V	4822 124 21913
C548	CAP.ELECTROLYT.	100µF	20%	16V	4822 124 21912
C549	CAP.CERAMIC	33PF	2%	100V	5322 122 32072
C550,551	CAP.ELECTROLYT.	22µF	20%	63V	5322 124 41301
C552	CAP.CERAMIC	1NF	10%	100V	5322 122 32331
C553	CAP.ELECTROLYT.	220µF	20%	25V	4822 124 41393
C554	CAP.CERAMIC	10NF	−20/+50%	100V	4822 122 31414
C555	CAP.CERAMIC	100NF	10%	100V	5322 126 11584
C556	CAP.CERAMIC	27PF	2%	100V	4822 122 30045
C557–559	CAP.CERAMIC	10NF	−20/+50%	100V	4822 122 31414
C560,561	CAP.CERAMIC	100NF	10%	100V	5322 126 11584
C562–564	CAP.ELECTROLYT.	100µF	20%	16V	4822 124 21912
C565,566	CAP.ELECTROLYT.	150µF	50%	35V	5322 124 41613
C567	CAP.ELECTROLYT.	100µF	20%	16V	4822 124 21912
C568–575	CAP.CERAMIC	100NF	10%	100V	5322 126 11584
C577,578	CAP.ELECTROLYT.	47µF	20%	35V	4822 124 40846
C579,580	CAP.ELECTROLYT.	100µF	20%	16V	4822 124 21912
C581	CAP.CERAMIC	100NF	10%	100V	5322 126 11584
C582	CAP.CERAMIC	10NF	−20/+50%	100V	4822 122 31414
C583,585	CAP.CERAMIC	470NF	20%	50V	5322 122 33078
C584	CAP.CERAMIC	10PF	2%	100V	4822 122 32185
C586	CAP.CERAMIC	22PF	2%	100V	5322 122 32143

Pos. No.	Description				Ordering Code
RESISTORS / UNIT 2					
R602	RES.METAL FILM	100K	1%	0.4W	4822 050 11004
R603	RES.NETWORK	8X4K7	5%	0.125W	5322 116 90132
R604	RES.NETWORK	4X47K	2%		5322 111 91102
R605	RES.METAL FILM	18K7	1%	0.4W	5322 117 10984
R606–608	RES.METAL FILM	48K70	1%	0.4W	4822 050 14873
R609	RES.NETWORK	8X4K7	5%	0.125W	5322 116 90132
R610	RES.METAL FILM	1K33	1%	0.4W	4822 050 11332
R611	RES.METAL FILM	147R	1%	0.4W	5322 117 11173
R612	RES.METAL FILM	24R9	1%	0.4W	5322 117 10778
R613	POTM.TRIMMER	100R	20%	LIN	5322 101 10873
R614	RES.METAL FILM	953R	1%	0.4W	5322 117 10794
R615	RES.METAL FILM	422R	1%	0.4W	5322 117 10952
R616	RES.METAL FILM	2K05	1%	0.4W	4822 050 12052
R618	RES.METAL FILM	2K74	1%	0.4W	4822 050 12742
R619	RES.METAL FILM	619R	1%	0.4W	5322 117 11005
R620	RES.METAL FILM	953R	1%	0.4W	5322 117 10794
R622	RES.METAL FILM	3K32	1%	0.4W	4822 050 13322
R623	RES.METAL FILM	205R	1%	0.4W	4822 050 12051
R624	POTM.TRIMMER	1K	20%	LIN	4822 101 10792
R625	RES.METAL FILM	3K32	1%	0.4W	4822 050 13322
R626	RES.METAL FILM	2K05	1%	0.4W	4822 050 12052
R627	RES.METAL FILM	5K11	1%	0.4W	4822 050 15112
R628	RES.METAL FILM	51R10	1%	0.4W	4822 050 15119
R629	RES.METAL FILM	51R10	1%	0.4W	4822 050 15119
R630	RES.METAL FILM	8K25	1%	0.4W	4822 050 18252
R631	RES.METAL FILM	2K05	1%	0.4W	4822 050 12052
R634	RES.METAL FILM	5K11	1%	0.4W	4822 050 15112
R635	RES.METAL FILM	51K10	1%	0.4W	4822 050 15113
R636	RES.METAL FILM	100K	1%	0.4W	4822 050 11004
R637–639	RES.METAL FILM	1M	1%	0.4W	4822 050 11005
R640	RES.METAL FILM	787R	1%	0.4W	5322 117 11186
R641	RES.METAL FILM	3K01	1%	0.4W	4822 050 13012
R642	RES.METAL FILM	750R	1%	0.4W	4822 050 17501
R643	RES.METAL FILM	48R7	1%	0.4W	5322 117 11184
R644	RES.METAL FILM	100R	1%	0.4W	4822 050 11001
R645	RES.METAL FILM	9K09	1%	0.4W	5322 117 11011
R646	RES.METAL FILM	5K11	1%	0.4W	4822 050 15112
R647	RES.METAL FILM	100R	1%	0.4W	4822 050 11001
R649	RES.METAL FILM	1K	1%	0.4W	4822 050 11002
R650	RES.METAL FILM	10K	1%	0.4W	4822 050 11003
R652	RES.METAL FILM	100K	1%	0.4W	4822 050 11004
R653	RES.METAL FILM	2K15	1%	0.4W	4822 050 12152
R654	RES.METAL FILM	100R	1%	0.4W	4822 050 11001
R655	RES.METAL FILM	1K	1%	0.4W	4822 050 11002
R656	RES.METAL FILM	78K70	1%	0.4W	4822 050 17873
R657	RES.METAL FILM	1K27	1%	0.4W	5322 117 10974
R658,659	RES.METAL FILM	5K11	1%	0.4W	4822 050 15112

Pos. No.	Description				Ordering Code
R660	RES.METAL FILM	2K26	1%	0.4W	5322 117 10987
R661	RES.METAL FILM	6K49	1%	0.4W	5322 117 10796
R662	RES.METAL FILM	1K47	1%	0.4W	5322 117 10976
R664	RES.METAL FILM	301R	1%	0.4W	5322 117 10779
R665	RES.METAL FILM	24K9	1%	0.4W	5322 117 10991
R666	RES.METAL FILM	1M	1%	0.4W	4822 050 11005
R667	RES.METAL FILM	226R	1%	0.4W	4822 050 12261
R668	RES.METAL FILM	536R	1%	0.4W	5322 117 10787
R669	RES.METAL FILM	1K	1%	0.4W	4822 050 11002
R670	RES.METAL FILM	4K64	1%	0.4W	4822 050 14642
R671	RES.METAL FILM	1K47	1%	0.4W	5322 117 10976
R672	RES.METAL FILM	1K15	1%	0.4W	5322 117 10773
R673	RES.METAL FILM	4K02	1%	0.4W	5322 117 10783
R674	RES.METAL FILM	511R	1%	0.4W	5322 117 10785
R675	RES.METAL FILM	402R	1%	0.4W	5322 117 10998
R676	RES.METAL FILM	15R4	1%	0.4W	5322 117 11174
R677	RES.METAL FILM	2K49	1%	0.4W	4822 050 12492
R678	RES.METAL FILM	316R	1%	0.4W	5322 117 10948
R679	RES.METAL FILM	17R8	1%	0.4W	5322 117 10944
R680	RES.METAL FILM	301R	1%	0.4W	5322 117 10779
R681	RES.METAL FILM	10R	1%	0.4W	4822 050 11009
R682	RES.METAL FILM	3K01	1%	0.4W	4822 050 13012
R683	RES.METAL FILM	261R	1%	0.4W	4822 050 12611
R684	RES.METAL FILM	536R	1%	0.4W	5322 117 10787
R685	RES.METAL FILM	2K05	1%	0.4W	4822 050 12052
R686	RES.METAL FILM	301R	1%	0.4W	5322 117 10779
R688	RES.METAL FILM	487K	1%	0.4W	5322 117 11183
R689	RES.METAL FILM	1K69	1%	0.4W	4822 050 11692
R690	RES.METAL FILM	348R	1%	0.4W	4822 050 13481
R691,692	RES.METAL FILM	2K05	1%	0.4W	4822 050 12052
R693	RES.METAL FILM	1K47	1%	0.4W	5322 117 10976
R694	RES.METAL FILM	1K87	1%	0.4W	5322 117 11176
R696	RES.METAL FILM	3K01	1%	0.4W	4822 050 13012
R697	RES.METAL FILM	2K37	1%	0.4W	5322 117 10988
R698	RES.METAL FILM	10K	1%	0.4W	4822 050 11003
R699	RES.METAL FILM	20K50	1%	0.4W	4822 050 12053

CRYSTALS / UNIT 2

G800	CRYSTAL	10.000 000 MHZ	5322 242 72235
G816	CRYSTAL	12.000 000 MHZ	4822 242 71663

COILS / UNIT 2

L810	COIL	470 NH	5322 157 62404
L811,814	COIL	220 µH	5322 157 53012
L812	COIL	15 µH	5322 158 10629
L813	COIL	1.0 µH	5322 152 20693

Pos. No.	Description		Ordering Code
RELAYS / UNIT 2			
K840	RELAY		5322 280 80716
MISCELLANEOUS / UNIT 2			
G812	LITHIUM BATTERY	3 V	5322 138 10088
	IC SOCKET 24–P		5322 255 40881
	IC SOCKET 40–P		5322 255 44235
	IC SOCKET 28–P		5322 255 44234
	IC SOCKET 8–P		5322 267 50729
X801–804	CONNECTOR FEMALE		5322 267 70284
X809	CONNECTOR 50–P MALE		5322 267 41136
X817	PIN FOR MINI COAX CONNECTOR		5322 268 14141
X818	MINI COAX CONNECTOR		5322 265 10266
X832	PIN FOR MINI COAX CONNECTOR		5322 268 14141
X833	MINI COAX CONNECTOR		5322 265 10266
X834	PIN FOR MINI COAX CONNECTOR		5322 268 14141
X835	MINI COAX CONNECTOR		5322 265 10266

UNIT 3, AMPLITUDE CONTROLLER / AMPLIFIER / DC GENERATOR / ATTENUATOR

UNIT 3, COMPLETE			5322 214 91404
INTEGRATED CIRCUITS / UNIT 3			
D101,102	INTEGR.CIRCUIT	74HCT4094N	4822 209 61522
D103	INTEGR.CIRCUIT	OQ0146	5322 209 72904
D301	INTEGR.CIRCUIT	74HCT4094N	4822 209 61522
N101	INTEGR.CIRCUIT	AM6012F	5322 209 12592
N201	INTEGR.CIRCUIT	CA3127E	5322 130 42627
N301	INTEGR.CIRCUIT	TL072ACP	5322 209 83579
N302	INTEGR.CIRCUIT	DAC08EN	5322 209 11254
N303,304	INTEGR.CIRCUIT	LF356N	5322 209 86451
N305	INTEGR.CIRCUIT	TL072ACP	5322 209 83579

Pos. No.	Description				Ordering Code
TRANSISTORS AND DIODES / UNIT 3					
V101	DIODE	BZX79–B4V7			4822 130 34174
V102,103	TRANSISTOR	PH2369			4822 130 41594
V104	DIODE	BZV86–2V0			4822 130 81424
V105	TRANSISTOR	BC548C			4822 130 44196
V106,107	DIODE	BAW62			4822 130 30613
V108	TRANSISTOR	PH2369			4822 130 41594
V109	DIODE	BAW62			4822 130 30613
V110	TRANSISTOR	BC557B			4822 130 44568
V201,203	DIODE	BAW62			4822 130 30613
V202	DIODE	BZX79–B13			4822 130 34195
V204	DIODE	BZX79–B7V5			4822 130 30861
V205–208	TRANSISTOR	BFQ252			4822 130 62708
V209,210	TRANSISTOR	BF450			4822 130 44237
V211–215	TRANSISTOR	BFQ232			4822 130 62437
V216–218	DIODE	BAW62			4822 130 30613
V219	TRANSISTOR	BC548C			4822 130 44196
V221	DIODE	BZV86–2V0			4822 130 81424
V223–229	DIODE	BAW62			4822 130 30613
V233	TRANSISTOR	BFQ162			4822 130 62436
V234	TRANSISTOR	BFQ162			4822 130 62436
V236	TRANSISTOR	BC558C			5322 130 60068
V238	DIODE	BAW62			4822 130 30613
V239–246	TRANSISTOR	BFQ252			4822 130 62708
V247–249	DIODE	BAW62			4822 130 30613
V301	DIODE	BZV11			5322 130 34294
V302	TRANSISTOR	BD140			4822 130 40824
V303	TRANSISTOR	BC548C			4822 130 44196
V304–306	DIODE	BZV86–2V0			4822 130 81424
V307	TRANSISTOR	BC547B			4822 130 40959
V308	TRANSISTOR	BC557B			4822 130 44568
V309–311	DIODE	BZV86–2V0			4822 130 81424
V312	TRANSISTOR	BC558C			5322 130 60068
V313	TRANSISTOR	BD139			4822 130 40823
V314	TRANSISTOR	BC547B			4822 130 40959
V315	DIODE	BAW62			4822 130 30613
V316,317	TRANSISTOR	BC548C			4822 130 44196
V401–405	TRANSISTOR	BC547B			4822 130 40959
CAPACITORS / UNIT 3					
C101–105	CAP.CERAMIC	100NF	10%	100V	5322 126 11584
C106,108	CAP.CERAMIC	10NF	–20/+50%	100V	4822 122 31414
C109,110	CAP.CERAMIC	100NF	10%	100V	5322 126 11584
C111	CAP.CERAMIC	5.6PF	0.25PF	100V	5322 122 32163
C112	CAP.CERAMIC	10NF	–20/+50%	100V	4822 122 31414
C113	CAP.ELECTROLYT.	22µF	10%	10V	5322 124 80869
C141	CAP.CERAMIC	10NF	–20/+50%	100V	4822 122 31414

Pos. No.	Description				Ordering Code
C201,202	CAP.CERAMIC	100NF	10%	100V	5322 126 11584
C203	CAP.CERAMIC	1.8PF	0.25PF	100V	5322 122 32313
C204	CAP.ELECTROLYT.	100µF	20%	50V	5322 124 42408
C205–213	CAP.CERAMIC	100NF	10%	100V	5322 126 11584
C214	CAP.CERAMIC	4.7NF	80%	63V	4822 122 31125
C215–217	CAP.CERAMIC	100NF	10%	100V	5322 126 11584
C218	CAP.CERAMIC	100PF	2%	100V	4822 122 31316
C220	CAP.CERAMIC	0.47PF	0.25PF	500V	4822 122 31212
C221	CAP.CERAMIC	4.7NF	80%	63V	4822 122 31125
C222,223	CAP.CERAMIC	100NF	10%	100V	5322 126 11584
C224	CAP.CERAMIC	0.47PF	0.25PF	500V	4822 122 31212
C225,228	CAP.CERAMIC	100NF	10%	100V	5322 126 11584
C229	CAP.CERAMIC				5322 122 33078
C231	CAP.TRIMMER	1P8–22P		250V	4822 125 50045
C232	CAP.CERAMIC	100NF	10%	100V	5322 126 11584
C233	CAP.ELECTROLYT.	100µF	20%	50V	5322 124 42408
C234,236	CAP.CERAMIC	100NF	10%	100V	5322 126 11584
C237	CAP.CERAMIC	10NF	–20/+50%	100V	4822 122 31414
C241	CAP.CERAMIC	10PF	2%	100V	4822 122 32185
C242	CAP.CERAMIC	5.6PF	0.25PF	100V	5322 122 32163
C243–261	CAP.CERAMIC	100NF	10%	100V	5322 126 11584
C301	CAP.CERAMIC	1NF	10%	100V	5322 122 32331
C302–307	CAP.CERAMIC	100NF	10%	100V	5322 126 11584
C308	CAP.CERAMIC	10NF	–20/+50%	100V	4822 122 31414
C309	CAP.CERAMIC	3.3NF	10%	100V	4822 122 30099
C310	CAP.CERAMIC	100PF	2%	100V	4822 122 31316
C311	CAP.CERAMIC	10NF	–20/+50%	100V	4822 122 31414
C312	CAP.CERAMIC	100PF	2%	100V	4822 122 31316
C313,314	CAP.CERAMIC	100NF	10%	100V	5322 126 11584
C315	CAP.CERAMIC	3.3NF	10%	100V	4822 122 30099
C316,318	CAP.CERAMIC	10NF	–20/+50%	100V	4822 122 31414
C317	CAP.CERAMIC	100NF	10%	100V	5322 126 11584
C401	CAP.CERAMIC	10NF	–20/+50%	100V	4822 122 31414
C402,403	CAP.CERAMIC	6.8PF	0.25PF	100V	4822 122 31049
C405–408	CAP.CERAMIC	10NF	100V	100V	4822 122 31414
C409	CAP.CERAMIC	18PF	2%	100V	4822 122 31061

RESISTORS / UNIT 3

R101	RES.METAL FILM	825K	1%	0.4W	5322 117 10792
R102	RES.METAL FILM	51R10	1%	0.4W	4822 050 15119
R105,106	RES.METAL FILM	5K11	MBA0204	0.25W	5322 117 11196
R107,108	RES.METAL FILM	28R7	1%	0.4W	5322 117 10995
R109,113	RES.METAL FILM	10K	1%	0.4W	4822 050 11003
R111,114	RES.METAL FILM	51R10	1%	0.4W	4822 050 15119
R115	RES.METAL FILM	100K	1%	0.4W	4822 050 11004

Pos. No.	Description				Ordering Code
R116	POTM.TRIMMER	50K	20% LIN	0.5W	5322 101 11115
R117,118	RES.METAL FILM	6K19	1%	0.4W	5322 117 11006
R119	RES.METAL FILM	100R	1%	0.4W	4822 050 11001
R120	POTM.TRIMMER	2K0	20% LIN	0.5W	5322 101 11114
R121	RES.METAL FILM	909R	1%	0.4W	4822 050 19091
R123	RES.METAL FILM	4K64	1%	0.4W	4822 050 14642
R124	RES.METAL FILM	4K42	1%	0.4W	5322 117 11182
R125,126	RES.METAL FILM	110R	1%	0.4W	4822 050 11101
R127	RES.METAL FILM	46K40	1%	0.4W	4822 050 14643
R129	RES.METAL FILM	2K49	1%	0.4W	4822 050 12492
R130	RES.METAL FILM	4K02	1%	0.4W	5322 117 10783
R131	RES.METAL FILM	825K	1%	0.4W	5322 117 10792
R132	RES.METAL FILM	86R60	1%	0.4W	4822 050 18669
R133	POTM.TRIMMER	100K	±20%	0.5W	5322 100 20885
R134	RES.METAL FILM	2K15	1%	0.4W	4822 050 12152
R141,142	RES.METAL FILM	28R7	1%	0.4W	5322 117 10995
R143	RES.METAL FILM	1K	1%	0.4W	4822 050 11002
R144,145	RES.METAL FILM	5K11	MBA0204	0.25W	5322 117 11196
R151–154	RES.METAL FILM	61R9	1%	0.4W	5322 117 11185
R201–204	RES.METAL FILM	28R7	1%	0.4W	5322 117 10995
R205	RES.METAL FILM	825K	1%	0.4W	5322 117 10792
R206	RES.METAL FILM	287R	1%	0.4W	4822 050 12871
R207	RES.METAL FILM	4K02	1%	0.4W	5322 117 10783
R208	RES.METAL FILM	825K	1%	0.4W	5322 117 10792
R209	RES.METAL FILM	287R	1%	0.4W	4822 050 12871
R210	RES.METAL FILM	4K02	1%	0.4W	5322 117 10783
R211,212	RES.METAL FILM	10R	1%	0.4W	4822 050 11009
R213–216	RES.METAL FILM	28R7	1%	0.4W	5322 117 10995
R217,218	RES.METAL FILM	51R10	1%	0.4W	4822 050 15119
R219	RES.METAL FILM	28R7	1%	0.4W	5322 117 10995
R220,221	RES.METAL FILM	10R	1%	0.4W	4822 050 11009
R222,23	RES.METAL FILM	100R	1%	0.4W	4822 050 11001
R224	RES.METAL FILM	464R	1%	0.4W	4822 050 14641
R225	RES.METAL FILM	7K50	1%	0.4W	4822 050 17502
R226	RES.METAL FILM	10K	1%	0.4W	4822 050 11003
R227	RES.METAL FILM	110R	1%	0.4W	4822 050 11101
R228	RES.METAL FILM	205R	1%	0.4W	4822 050 12051
R229	RES.METAL FILM	422R	1%	0.4W	5322 117 10952
R230	RES.METAL FILM	10K	1%	0.4W	4822 050 11003
R231	RES.METAL FILM	464R	1%	0.4W	4822 050 14641
R232,233	RES.METAL FILM	61R9	1%	0.4W	5322 117 11185
R234,236	RES.METAL FILM	12R1	1%	0.4W	5322 117 11172
R235,237	RES.METAL FILM	3R16	MBA0204	0.25W	5322 117 11195
R238,240	RES.METAL FILM	12R1	1%	0.4W	5322 117 11172

Pos. No.	Description				Ordering Code
R239,241	RES.METAL FILM	3R16	MBA0204	0.25W	5322 117 11195
R242	RES.METAL FILM	147R	1%	0.4W	5322 117 11173
R243	RES.METAL FILM	1K	1%	0.4W	4822 050 11002
R244,245	RES.METAL FILM	1K47	1%	0.4W	5322 117 10976
R247	RES.METAL FILM	1K	1%	0.4W	4822 050 11002
R248	RES.METAL FILM	26R1	1%	0.4W	5322 117 10993
R250,251	RES.METAL FILM	75R	1%	0.4W	4822 050 17509
R252	RES.METAL FILM	750R	1%	0.4W	4822 050 17501
R253	RES.METAL FILM	2K37	1%	0.4W	5322 117 10988
R254,255	RES.METAL FILM	61R9	1%	0.4W	5322 117 11185
R256,258	RES.METAL FILM	12R1	1%	0.4W	5322 117 11172
R257,259	RES.METAL FILM	3R16	MBA0204	0.25W	5322 117 11195
R260,262	RES.METAL FILM	12R1	1%	0.4W	5322 117 11172
R261,263	RES.METAL FILM	3R16	MBA0204	0.25W	5322 117 11195
R264	RES.METAL FILM	2K37	1%	0.4W	5322 117 10988
R265,266	RES.METAL FILM	464R	1%	0.4W	4822 050 14641
R267	RES.METAL FILM	61R9	1%	0.4W	5322 117 11185
R268	RES.METAL FILM	10K	1%	0.4W	4822 050 11003
R269	POTM.TRIMMER	50R	20% LIN	0.5W	5322 101 11113
R270	RES.METAL FILM	51R10	1%	0.4W	4822 050 15119
R271,272	RES.METAL FILM	196R	1%	0.4W	5322 117 11177
R273	POTM.TRIMMER	100K	±20%	0.5W	5322 100 20885
R274,275	RES.METAL FILM	61R9	1%	0.4W	5322 117 11185
R276,277	RES.METAL FILM	51R10	1%	0.4W	4822 050 15119
R278,279	RES.METAL FILM	10R	1%	0.4W	4822 050 11009
R280,282	RES.METAL FILM	316R	1%	0.4W	5322 117 10948
R281	RES.METAL FILM	46K40	1%	0.4W	4822 050 14643
R283,284	RES.METAL FILM	28R7	1%	0.4W	5322 117 10995
R287,290	RES.METAL FILM	1K47	1%	0.4W	5322 117 10976
R288,289	RES.METAL FILM	133R	1%	0.4W	4822 050 11331
R291	RES.METAL FILM	28R7	1%	0.4W	5322 117 10995
R292,293	RES.METAL FILM	10R	1%	0.4W	4822 050 11009
R294,295	RES.METAL FILM	1K62	1%	0.4W	5322 117 10979
R296–299	RES.METAL FILM	28R7	1%	0.4W	5322 117 10995
R301	RES.METAL FILM	619R	1%	0.4W	5322 117 11005
R302,303	POTM.TRIMMER	1K	20%	LIN	4822 101 10792
R304	POTM.TRIMMER	500R	20% LIN	0.5W	5322 101 11076
R306,307	RES.METAL FILM	3K32	1%	0.4W	4822 050 13322
R308,309	RES.METAL FILM	6K19	1%	0.4W	5322 117 11006
R310	RES.METAL FILM	316R	1%	0.4W	5322 117 10948
R311–313	RES.METAL FILM	46R40	1%	0.4W	4822 050 14649
R314	RES.METAL FILM	1K	1%	0.4W	4822 050 11002
R315	RES.METAL FILM	3K01	1%	0.4W	4822 050 13012
R316	RES.METAL FILM	4K64	1%	0.4W	4822 050 14642
R317	POTM.TRIMMER	500R	20% LIN	0.5W	5322 101 11076
R318	RES.METAL FILM	3K16	1%	0.4W	4822 050 13162
R319,320	RES.METAL FILM	100K	1%	0.4W	4822 050 11004

Pos. No.	Description				Ordering Code
R321	RES.METAL FILM	47R	5%	3W	4822 053 12479
R322	RES.METAL FILM	1M	1%	0.4W	4822 050 11005
R323	RES.METAL FILM	274R	1%	0.4W	4822 050 12741
R324	RES.METAL FILM	205K	1%	0.4W	5322 117 11045
R325,326	RES.METAL FILM	100K	1%	0.4W	4822 050 11004
R327	RES.METAL FILM	274R	1%	0.4W	4822 050 12741
R328,329	RES.METAL FILM	100K	1%	0.4W	4822 050 11004
R330	RES.METAL FILM	3K16	1%	0.4W	4822 050 13162
R331	RES.METAL FILM	4K64	1%	0.4W	4822 050 14642
R332,333	RES.METAL FILM	100K	1%	0.4W	4822 050 11004
R334	RES.METAL FILM	3K01	1%	0.4W	4822 050 13012
R335	RES.METAL FILM	316R	1%	0.4W	5322 117 10948
R336–338	RES.METAL FILM	46R40	1%	0.4W	4822 050 14649
R339	POTM.TRIMMER	500R	20% LIN	0.5W	5322 101 11076
R340	RES.METAL FILM	1K15	1%	0.4W	5322 117 10773
R341	RES.METAL FILM	9K09	1%	0.4W	5322 117 11011
R342	RES.METAL FILM	100R	1%	0.4W	4822 050 11001
R343	RES.METAL FILM	9K09	1%	0.4W	5322 117 11011
R344,346	RES.METAL FILM	7K87	1%	0.4W	5322 117 10791
R345	RES.METAL FILM	1K21	1%	0.4W	5322 117 10973
R347	RES.METAL FILM	4K64	1%	0.4W	4822 050 14642
R401–405	RES.METAL FILM	100E	0,1%	0.25W	5322 116 51701
R406–416	RES.METAL FILM	100R	MBE0414	0.65W	5322 117 11197
R417–421	RES.METAL FILM	100E	0,1%	0.25W	5322 116 51701
R422,423	RES.METAL FILM	178R	1%	0.4W	4822 050 11781
R424,425	RES.METAL FILM	196R	1%	0.4W	5322 117 11177
R426–428	RES.METAL FILM	100R	MBE0414	0.65W	5322 117 11197
R429	RES.METAL FILM	4K02	1%	0.4W	5322 117 10783
R430–432	RES.METAL FILM	100R	MBE0414	0.65W	5322 117 11197
R433	RES.METAL FILM	56R2	0,1%	0.125W	5322 116 82504
R434	RES.METAL FILM	4K42	1%	0.4W	5322 117 11182
R435–437	RES.METAL FILM	100R	MBE0414	0.65W	5322 117 11197
R439–441	RES.METAL FILM	10R	1%	0.4W	4822 050 11009
R442–444	RES.METAL FILM	4K64	1%	0.4W	4822 050 14642
R445	RES.METAL FILM	10R	1%	0.4W	4822 050 11009
R446	RES.METAL FILM	422R	1%	0.4W	5322 117 10952
R447	RES.METAL FILM	4K64	1%	0.4W	4822 050 14642
R450	RES.METAL FILM	10K	1%	0.4W	4822 050 11003
R451	RES.METAL FILM	3R16	MBA0204	0.25W	5322 117 11195
R452	RES.METAL FILM	5K62	1%	0.4W	4822 050 15622
R701	RES.METAL FILM	287R	1%	0.4W	4822 050 12871
R702,702	RES.METAL FILM	10R	1%	0.4W	4822 050 11009
R704	RES.METAL FILM	46K40	1%	0.4W	4822 050 14643
R705,706	RES.METAL FILM	1K62	1%	0.4W	5322 117 10979
R707,708	RES.METAL FILM	61R9	1%	0.4W	5322 117 11185
R711	RES.METAL FILM	215R	1%	0.4W	5322 117 10986
R712,713	RES.METAL FILM	28R7	1%	0.4W	5322 117 10995

Pos. No.	Description		Ordering Code
COILS / UNIT 3			
L201–204	DAMPING BEAD		5322 526 10605
L205,210	COIL	68 µH	5322 157 62402
L206–209	DAMPING BEAD		5322 526 10605
L301–303	COIL	4 µH	5322 158 10271
L401–403	COIL	220 µH	5322 157 53012
L405	COIL	4 µH	5322 158 10271
RELAYS / UNIT 3			
K301	RELAY		5322 280 80716
K401–404	RELAY		5322 280 80716
MISCELLANEOUS / UNIT 3			
X801,802	CONNECTOR MALE 2X50–P		5322 264 71048
X844	PIN FOR MINI COAX CONNECTOR		5322 268 14141
X845	MINI COAX CONNECTOR		5322 265 10266

UNIT 4, RAM / DAC / MODULATION OSCILLATOR / BURST / MULTIPLIER

UNIT 4, COMPLETE			5322 214 91399
INTEGRATED CIRCUITS, UNIT 4			
D101–103	INTEGR.CIRCUIT	74HCT4094N	4822 209 61522
D104	INTEGR.CIRCUIT	PC74HC367P	5322 209 11417
D105,106	INTEGR.CIRCUIT	74HC4050N	5322 209 33188
D107,108	INTEGR.CIRCUIT	CY7C128A–20PC	5322 130 83672
D112	INTEGR.CIRCUIT	74HCT4094N	4822 209 61522
D114	INTEGR.CIRCUIT	PC74HCT123P	5322 209 11379
D115	INTEGR.CIRCUIT	PC74HCT4053P	4822 209 71584
D116	INTEGR.CIRCUIT	N74F112N	5322 209 70942
D117–119	INTEGR.CIRCUIT	PC74HCT191P	5322 209 11481
D120	INTEGR.CIRCUIT	PC74HCT11P	4822 209 11427
D121,122	INTEGR.CIRCUIT	74HCT4094N	4822 209 61522
D125	INTEGR.CIRCUIT	PC74HCT4053P	4822 209 71584
D126	INTEGR.CIRCUIT	74HCT4094N	4822 209 61522

Pos. No.	Description		Ordering Code
D130	INTEGR.CIRCUIT	PCF1842P – SEE PCN 4562	5322 209 62544
D131	SINE PROM	HN27C64G–25 PROG	5322 209 51856
D132	INTEGR.CIRCUIT	PC74HCT574P	5322 209 11489
D138,139	INTEGR.CIRCUIT	74HCT4094N	4822 209 61522
D140–143	INTEGR.CIRCUIT	PC74HCT4052P	4822 209 71583
D144	INTEGR.CIRCUIT	74HCT4094N	4822 209 61522
D146	INTEGR.CIRCUIT	OQ0146	5322 209 72904
D153	INTEGR.CIRCUIT	OQ0146	5322 209 72904
N110	INTEGR.CIRCUIT	TDC1012N7	5322 209 62546
N111	INTEGR.CIRCUIT	LF356N	5322 209 86451
N127	INTEGR.CIRCUIT	DAC08EN	5322 209 11254
N128	INTEGR.CIRCUIT	LF356N	5322 209 86451
N133	INTEGR.CIRCUIT	DAC08EN	5322 209 11254
N134	INTEGR.CIRCUIT	TL072ACP	5322 209 83579
N135	INTEGR.CIRCUIT	AD7523JN	5322 209 70195
N136	INTEGR.CIRCUIT	NE521N	5322 209 14441
N137,145	INTEGR.CIRCUIT	LF356N	5322 209 86451
N147	INTEGR.CIRCUIT	TL072ACP	5322 209 83579
N152	INTEGR.CIRCUIT	CA3183E	5322 209 85461

TRANSISTORS AND DIODES / UNIT 4

V160	TRANSISTOR	BC548C	4822 130 44196
V161	TRANSISTOR	BSS61	5322 130 44714
V163	TRANSISTOR	BC558C	5322 130 60068
V164,165	TRANSISTOR	BC548C	4822 130 44196
V169	TRANSISTOR	PH2369	4822 130 41594
V170	TRANSISTOR	2N4035	5322 130 44201
V171	TRANSISTOR	PH2369	4822 130 41594
V172,173	TRANSISTOR	BC548C	4822 130 44196
V174,175	TRANSISTOR	BF450	4822 130 44237
V176–179	TRANSISTOR	PH2369	4822 130 41594
V180,186	TRANSISTOR	BF240	4822 130 40902
V183	TRANSISTOR	BC548C	4822 130 44196
V184,185	TRANSISTOR	BF450	4822 130 44237
V187	TRANSISTOR	2N5583	5322 130 44033
V189,190	TRANSISTOR	PH2369	4822 130 41594
V191	TRANSISTOR	2N4035	5322 130 44201
V193	TRANSISTOR	BC548C	4822 130 44196
V194	TRANSISTOR	BC558C	5322 130 60068
V195,196	TRANSISTOR	PH2369	4822 130 41594
V197	TRANSISTOR	BF240	4822 130 40902
V198,199	TRANSISTOR	BC548C	4822 130 44196

Pos. No.	Description				Ordering Code
V200,201	TRANSISTOR	BC548C			4822 130 44196
V202	TRANSISTOR	BF240			4822 130 40902
V203–205	TRANSISTOR	BF450			4822 130 44237
V206,207	TRANSISTOR	BF240			4822 130 40902
V208	TRANSISTOR	BF450			4822 130 44237
V209	TRANSISTOR	BC558C			5322 130 60068
V210	TRANSISTOR	BC548C			4822 130 44196
V211	TRANSISTOR	BFW16A			5322 130 44015
V213,214	TRANSISTOR	BC548C			4822 130 44196
V223	TRANSISTOR	BF240			4822 130 40902
V224–227	TRANSISTOR	BF450			4822 130 44237
V228,229	TRANSISTOR	BF240			4822 130 40902
V230,231	TRANSISTOR	BF450			4822 130 44237
V241	DIODE	BAT85			4822 130 31983
V243	DIODE	BAW62			4822 130 30613
V244	DIODE	BZV11			5322 130 34294
V245	DIODE	BZV13			5322 130 34301
V246	DIODE	BZX79–B4V7			4822 130 34174
V249,250	DIODE	BZX79–B5V1			4822 130 34233
V251	DIODE	BZV86–2V0			4822 130 81424
V252,253	DIODE	BAW62			4822 130 30613
V254	DIODE	BZX79–B7V5			4822 130 30861
V257,258	DIODE	BZX79–B5V6			4822 130 34173
PCN 4111 V259,260	DIODE	BA481 BA482 *			5322 130 32239 34955
V261	DIODE	BZV86–1V4			4822 130 81423
V262	DIODE	BAW62			4822 130 30613
V263,264	DIODE	BA481			5322 130 32239
V268–271	DIODE	BZX79–B4V7			4822 130 34174
V272	DIODE	BAW62			4822 130 30613
V273	DIODE	BZV86–1V4			4822 130 81423
V274–282	DIODE	BAW62			4822 130 30613
V283	DIODE	BZX79–B4V7			4822 130 34174
V284,286	DIODE	BZV86–1V4			4822 130 81423
V285	DIODE	BZX79–B6V8			4822 130 34278
V287	DIODE	BZX79–B5V1			4822 130 34233
V288,289	DIODE	BAW62			4822 130 30613
V293	DIODE	BZV86–1V4			4822 130 81423
V294	DIODE	BZX79–B4V3			4822 130 31554
V295	DIODE	BAW62			4822 130 30613
CAPACITORS / UNIT 4					
C301,302	CAP.CERAMIC	470PF	2%	100V	4822 122 32062
C303,304	CAP.CERAMIC	100NF	10%	100V	5322 126 11584
C305	CAP.CERAMIC	10PF	2%	100V	4822 122 32185
C306,307	CAP.CERAMIC	100NF	10%	100V	5322 126 11584
C308	CAP.CERAMIC	4.7NF	80%	63V	4822 122 31125
C309,312	CAP.CERAMIC	1NF	10%	100V	5322 122 32331
C310	CAP.CERAMIC	100NF	10%	100V	5322 126 11584

* V259 & V260 ------ OLDER INSTRUMENTS WITH TYPE BAT14 ARE OK. ------ PCN 4111

Pos. No.	Description				Ordering Code
C311,316	CAP.CERAMIC	10NF	−20/+50%	100V	4822 122 31414
C313,315	CAP.CERAMIC	100NF	10%	100V	5322 126 11584
C317	CAP.CERAMIC	100NF	10%	100V	5322 126 11584
C319,320	CAP.CERAMIC	10NF	−20/+50%	100V	4822 122 31414
C321	CAP.CERAMIC	33PF	2%	100V	5322 122 32072
C322	CAP.CERAMIC	100NF	10%	100V	5322 126 11584
C323,326	CAP.TRIMMER	1.5−5PF		12V	5322 125 11053
C324	CAP.CERAMIC	39PF	2%	100V	4822 122 31069
C325	CAP.CHIP	4.7PF	0.25PF	100V	4822 122 31822
C327	CAP.CERAMIC	120PF	2%	100V	4822 122 31348
C328	CAP.CHIP	15PF	2%	100V	4822 122 31823
C329	CAP.TRIMMER	1.5−5PF		12V	5322 125 11053
C330	CAP.CERAMIC	68PF	2%	100V	4822 122 31349
C332	CAP.TRIMMER	2−14PF		12V	5322 125 11052
C333−340	CAP.CERAMIC	10NF	−20/+50%	100V	4822 122 31414
C341	CAP.CERAMIC	100PF	2%	100V	4822 122 31316
C342	CAP.CERAMIC	33PF	2%	100V	5322 122 32072
C343	CAP.CERAMIC	100PF	2%	100V	4822 122 31316
C344,345	CAP.CERAMIC	100NF	10%	100V	5322 126 11584
C346,348	CAP.ELECTROLYT.	220µF	20%	25V	4822 124 41393
C347,349	CAP.CERAMIC	10NF	−20/+50%	100V	4822 122 31414
C350	CAP.ELECTROLYT.	220µF	20%	25V	4822 124 41393
C351	CAP.TRIMMER	3P−50P		250V	5322 125 50243
C352	CAP.CERAMIC	120PF	2%	100V	4822 122 31348
C353	CAP.CERAMIC	100NF	10%	100V	5322 126 11584
C354,357	CAP.CERAMIC	10NF	−20/+50%	100V	4822 122 31414
C355,356	CAP.CERAMIC	100NF	10%	100V	5322 126 11584
C358	CAP.ELECTROLYT.	100µF	20%	16V	4822 124 21912
C359	CAP.CERAMIC	27PF	2%	100V	4822 122 30045
C361−368	CAP.CERAMIC	100NF	10%	100V	5322 126 11584
C369	CAP.CERAMIC	10NF	−20/+50%	100V	4822 122 31414
C370	CAP.CERAMIC	680PF	10%	100V	5322 122 32052
C371	CAP.CERAMIC	1NF	10%	100V	5322 122 32331
C372,373	CAP.CERAMIC	100NF	10%	100V	5322 126 11584
C374	CAP.CERAMIC	1NF	10%	100V	5322 122 32331
C375,376	CAP.CERAMIC	100NF	10%	100V	5322 126 11584
C377	CAP.CERAMIC	33PF	2%	100V	5322 122 32072
C378	CAP.ELECTROLYT.	100µF	20%	16V	4822 124 21912
C380	CAP.ELECTROLYT.	22µF	20%	63V	5322 124 41301
C385−387	CAP.CERAMIC	10NF	−20/+50%	100V	4822 122 31414
C388	CAP.CERAMIC	10PF	2%	100V	4822 122 32185
C389,391	CAP.CERAMIC	10NF	−20/+50%	100V	4822 122 31414
C392,393	CAP.CERAMIC	100NF	10%	100V	5322 126 11584
C394,395	CAP.CERAMIC	10NF	−20/+50%	100V	4822 122 31414
C396	CAP.CERAMIC	100NF	10%	100V	5322 126 11584
C397	CAP.CERAMIC	0.47PF	0.25PF	500V	4822 122 31212
C398	CAP.TRIMMER	1P8−22P		250V	4822 125 50045
C399	CAP.CERAMIC	100PF	2%	100V	4822 122 31316

Pos. No.	Description				Ordering Code
C405	CAP.CERAMIC	10NF	−20/+50%	100V	4822 122 31414
C419	CAP.CERAMIC	100NF	10%	100V	5322 126 11584
C423,424	CAP.ELECTROLYT.	22µF	20%	63V	5322 124 41301
C425,426	CAP.CERAMIC	10NF	−20/+50%	100V	4822 122 31414
C427	CAP.TRIMMER	2P−40P		250V	4822 125 50092
C428	CAP.CERAMIC	10NF	−20/+50%	100V	4822 122 31414
C429	CAP.ELECTROLYT.	100µF	20%	16V	4822 124 21912
C430	CAP.CERAMIC	10NF	−20/+50%	100V	4822 122 31414
C431	CAP.CERAMIC	1.8PF	0.25PF	100V	5322 122 32313
C432−434	CAP.CERAMIC	10NF	−20/+50%	100V	4822 122 31414
C436	CAP.ELECTROLYT.	22µF	20%	63V	5322 124 41301
C437	CAP.CERAMIC	100NF	10%	100V	5322 126 11584
C438	CAP.TRIMMER	2P−40P		250V	4822 125 50092
C440,441	CAP.ELECTROLYT.	22µF	20%	63V	5322 124 41301
C446	CAP.CERAMIC	22PF	2%	100V	5322 122 32143
C447	CAP.ELECTROLYT.	22µF	20%	63V	5322 124 41301
C448	CAP.CERAMIC	4.7NF	80%	63V	4822 122 31125

RESISTORS / UNIT 4

R451	RES.METAL FILM	48K70	1%	0.4W	4822 050 14873
R459	RES.METAL FILM	5K11	1%	0.4W	4822 050 15112
R460	RES.METAL FILM	3K01	1%	0.4W	4822 050 13012
R462	RES.METAL FILM	1K33	1%	0.4W	4822 050 11332
R463	RES.METAL FILM	9K53	1%	0.4W	5322 117 10795
R464	RES.METAL FILM	1K78	1%	0.4W	5322 117 10983
R465	RES.METAL FILM	1K33	1%	0.4W	4822 050 11332
R466	POTM.TRIMMER	500R	20% LIN	0.5W	5322 101 11076
R467,468	RES.METAL FILM	24R9	0.1%	0.25W	5322 117 10763
R469	RES.METAL FILM	100K	1%	0.4W	4822 050 11004
R470	RES.METAL FILM	4K87	1%	0.4W	5322 117 11165
R471	POTM.TRIMMER	1K	20%	LIN	4822 101 10792
R472	RES.METAL FILM	7K50	1%	0.4W	4822 050 17502
R477	RES.METAL FILM	221R	0.1%	0.25W	5322 117 11164
R478	RES.NETWORK	4R87	1%	0.33W	5322 116 82501
R479	RES.METAL FILM	2K37	1%	0.4W	5322 117 10988
R480	RES.METAL FILM	51R10	1%	0.4W	4822 050 15119
R481	RES.METAL FILM	909R	1%	0.4W	4822 050 19091
R482	RES.METAL FILM	12R1	1%	0.4W	5322 117 11172
R483	RES.METAL FILM	226R	1%	0.4W	4822 050 12261
R490,493	RES.METAL FILM	2K05	1%	0.4W	4822 050 12052
R491	RES.METAL FILM	10K	1%	0.4W	4822 050 11003
R492	RES.METAL FILM	1K	1%	0.4W	4822 050 11002
R494	RES.METAL FILM	1K78	1%	0.4W	5322 117 10983

Pos. No.	Description				Ordering Code
R500	RES.METAL FILM	10K	1%	0.4W	4822 050 11003
R501	RES.METAL FILM	825K	1%	0.4W	5322 117 10792
R502	RES.METAL FILM	3K01	1%	0.4W	4822 050 13012
R503	RES.METAL FILM	205R	1%	0.4W	4822 050 12051
R504	RES.METAL FILM	5K11	1%	0.4W	4822 050 15112
R505,506	RES.METAL FILM	100R	1%	0.4W	4822 050 11001
R507	RES.METAL FILM	5K11	1%	0.4W	4822 050 15112
R508	RES.METAL FILM	226R	1%	0.4W	4822 050 12261
R509	RES.METAL FILM	1K	1%	0.4W	4822 050 11002
R510,511	RES.METAL FILM	5K11	1%	0.4W	4822 050 15112
R512	RES.METAL FILM	12R1	1%	0.4W	5322 117 11172
R514	RES.METAL FILM	53R6	0.1%	0.125W	5322 116 82503
R515	RES.METAL FILM	422R	1%	0.4W	5322 117 10952
R516	RES.METAL FILM	590R	1%	0.4W	5322 117 10954
R517	RES.NETWORK	3R48	1%	0.33W	5322 116 82499
R518,519	RES.METAL FILM	237R	1%	0.4W	4822 050 12371
R520	RES.NETWORK	3R48	1%	0.33W	5322 116 82499
R521,522	RES.METAL FILM	105R	1%	0.4W	5322 117 11171
R523	RES.METAL FILM	8K25	1%	0.4W	4822 050 18252
R524	RES.METAL FILM	2K61	1%	0.4W	5322 117 10992
R525	RES.METAL FILM	100K	1%	0.4W	4822 050 11004
R526	RES.NETWORK	4R87	1%	0.33W	5322 116 82501
R527,530	RES.METAL FILM	10K	1%	0.4W	4822 050 11003
R528	RES.METAL FILM	1K87	1%	0.4W	5322 117 11176
R529	RES.METAL FILM	10K	1%	0.4W	4822 050 11003
R531	RES.METAL FILM	215R	1%	0.4W	5322 117 10986
R532	RES.METAL FILM	19R6	1%	0.4W	5322 117 11179
R533	RES.METAL FILM	3K83	1%	0.4W	4822 050 13832
R534	RES.METAL FILM	48R7	1%	0.4W	5322 117 11184
R535,536	RES.METAL FILM	205R	1%	0.4W	4822 050 12051
R537	RES.METAL FILM	249R	1%	0.4W	4822 050 12491
R538	RES.METAL FILM	953R	1%	0.4W	5322 117 10794
R539	RES.METAL FILM	649R	1%	0.4W	5322 117 10956
R540	POTM.TRIMMER	50R	20% LIN	0.5W	5322 101 11113
R541	RES.METAL FILM	750R	1%	0.4W	4822 050 17501
R543	RES.METAL FILM	12R1	1%	0.4W	5322 117 11172
R544	RES.METAL FILM	53R6	0.1%	0.125W	5322 116 82503
R551	RES.METAL FILM	402R	1%	0.4W	5322 117 10998
R552	RES.METAL FILM	5K11	1%	0.4W	4822 050 15112
R553	POTM.TRIMMER	2K0	20% LIN	0.5W	5322 101 11114
R554	RES.METAL FILM	18K7	1%	0.4W	5322 117 10984
R555	POTM.TRIMMER	1K	20%	LIN	4822 101 10792
R556	RES.METAL FILM	5K36	1%	0.4W	5322 117 10788
R557	RES.METAL FILM	4K64	1%	0.4W	4822 050 14642
R558	RES.METAL FILM	205R	1%	0.4W	4822 050 12051
R559	RES.METAL FILM	365R	1%	0.4W	4822 050 13651
R560	RES.METAL FILM	5K11	1%	0.4W	4822 050 15112

Pos. No.	Description				Ordering Code
R561	RES.METAL FILM	511R	1%	0.4W	5322 117 10785
R562,563	RES.METAL FILM	24R9	1%	0.4W	5322 117 10778
R564	RES.METAL FILM	100R	1%	0.4W	4822 050 11001
R565	RES.METAL FILM	2K05	1%	0.4W	4822 050 12052
R566	RES.METAL FILM	205R	1%	0.4W	4822 050 12051
R567,569	RES.METAL FILM	301R	1%	0.4W	5322 117 10779
R568	RES.METAL FILM	51R10	1%	0.4W	4822 050 15119
R570	RES.METAL FILM	1K	1%	0.4W	4822 050 11002
R571	RES.METAL FILM	249R	1%	0.4W	4822 050 12491
R580,581	RES.METAL FILM	5K11	1%	0.4W	4822 050 15112
R582	RES.METAL FILM	10K5	1%	0.4W	5322 117 10809
R583	RES.METAL FILM	619R	1%	0.4W	5322 117 11005
R584	POTM.TRIMMER	2K0	20% LIN	0.5W	5322 101 11114
R585	RES.METAL FILM	6K49	1%	0.4W	5322 117 10796
R586	RES.METAL FILM	511R	1%	0.4W	5322 117 10785
R587	RES.METAL FILM	1K96	1%	0.4W	4822 050 11962
R588	RES.METAL FILM	196K	1%	0.4W	5322 117 11178
R589	RES.METAL FILM	4K02	1%	0.4W	5322 117 10783
R590	RES.METAL FILM	715K	1%	0.4W	5322 117 10959
R591	RES.METAL FILM	4K02	1%	0.4W	5322 117 10783
R592	RES.METAL FILM	2K05	1%	0.4W	4822 050 12052
R593	RES.METAL FILM	100K	1%	0.4W	4822 050 11004
R594	RES.METAL FILM	2K26	1%	0.4W	5322 117 10987
R595	RES.METAL FILM	10K	1%	0.4W	4822 050 11003
R596	RES.METAL FILM	20K50	1%	0.4W	4822 050 12053
R597	RES.METAL FILM	100K	1%	0.4W	4822 050 11004
R598	RES.METAL FILM	1K	1%	0.4W	4822 050 11002
R600	RES.METAL FILM	100K	1%	0.4W	4822 050 11004
R601,602	RES.METAL FILM	51R10	1%	0.4W	4822 050 15119
R603	RES.METAL FILM	536R	1%	0.4W	5322 117 10787
R608	RES.METAL FILM	51K10	1%	0.4W	4822 050 15113
R609	POTM.TRIMMER	20K	20% LIN	0.5W	5322 101 11074
R610	RES.METAL FILM	5K11	1%	0.4W	4822 050 15112
R611	RES.METAL FILM	205R	1%	0.4W	4822 050 12051
R612	RES.METAL FILM	8K25	1%	0.4W	4822 050 18252
R613	POTM.TRIMMER	2K0	20% LIN	0.5W	5322 101 11114
R614	RES.METAL FILM	16K2	1%	0.4W	5322 117 10981
R616	RES.METAL FILM	619R	1%	0.4W	5322 117 11005
R617	POTM.TRIMMER	100R	20% LIN	0.5W	5322 101 11075
R618	RES.METAL FILM	51R10	1%	0.4W	4822 050 15119
R619	RES.METAL FILM	909R	1%	0.4W	4822 050 19091
R620	RES.METAL FILM	10K	1%	0.4W	4822 050 11003
R621	RES.METAL FILM	100K	1%	0.4W	4822 050 11004
R622	RES.METAL FILM	205R	1%	0.4W	4822 050 12051
R623	RES.METAL FILM	1K27	1%	0.4W	5322 117 10974
R624	RES.METAL FILM	11K	1%	0.4W	4822 050 11103
R625	RES.METAL FILM	5K11	1%	0.4W	4822 050 15112

Pos. No.	Description				Ordering Code
R626	RES.METAL FILM	10K	1%	0.4W	4822 050 11003
R627	RES.METAL FILM	2K26	1%	0.4W	5322 117 10987
R628	RES.METAL FILM	5K62	0.1%	0.25W	5322 116 80372
R629	RES.METAL FILM	205R	1%	0.4W	4822 050 12051
R630	RES.METAL FILM	10K	0.1%	0.25W	5322 116 53102
R631	RES.METAL FILM	10R	1%	0.4W	4822 050 11009
R632	RES.METAL FILM	46K40	1%	0.4W	4822 050 14643
R633	POTM.TRIMMER	10K	20% LIN	0.5W	5322 100 20692
R634	RES.METAL FILM	100K	1%	0.4W	4822 050 11004
R635	RES.METAL FILM	1K	1%	0.4W	4822 050 11002
R636,637	RES.METAL FILM	10K	0.1%	0.25W	5322 116 53102
R638	RES.METAL FILM	681R	1%	0.4W	5322 117 11198
R639	RES.METAL FILM	681R	1%	0.4W	5322 117 11198
R640	RES.METAL FILM	562K	1%	0.4W	4822 050 15624
R641	RES.METAL FILM	205R	1%	0.4W	4822 050 12051
R642	RES.METAL FILM	10K	1%	0.4W	4822 050 11003
R643	RES.METAL FILM	5K62	1%	0.4W	4822 050 15622
R644,645	RES.METAL FILM	2K87	1%	0.4W	5322 117 10947
R646,647	RES.METAL FILM	100R	1%	0.4W	4822 050 11001
R648	RES.METAL FILM	649R	1%	0.4W	5322 117 10956
R649	RES.METAL FILM	5K62	1%	0.4W	4822 050 15622
R650	RES.METAL FILM	205R	1%	0.4W	4822 050 12051
R651	RES.METAL FILM	100K	1%	0.4W	4822 050 11004
R652	POTM.TRIMMER	20K	20% LIN	0.5W	5322 101 11074
R653,654	RES.METAL FILM	10K	1%	0.4W	4822 050 11003
R655	RES.METAL FILM	536R	1%	0.4W	5322 117 10787
R656	RES.METAL FILM	34K80	1%	0.4W	4822 050 13483
R657	POTM.TRIMMER	200K	20% LIN	0.5W	5322 101 11116
R658	RES.METAL FILM	536R	1%	0.4W	5322 117 10787
R659,660	RES.METAL FILM	301R	1%	0.4W	5322 117 10779
R661	RES.METAL FILM	464R	1%	0.4W	4822 050 14641
R662	RES.METAL FILM	249R	1%	0.4W	4822 050 12491
R663,664	RES.METAL FILM	75R	1%	0.4W	4822 050 17509
R665,666	RES.METAL FILM	205R	1%	0.4W	4822 050 12051
R667	RES.METAL FILM	1K96	1%	0.4W	4822 050 11962
R668	RES.METAL FILM	3K16	1%	0.4W	4822 050 13162
R669	RES.METAL FILM	464R	1%	0.4W	4822 050 14641
R670	RES.METAL FILM	249R	1%	0.4W	4822 050 12491
R671	RES.METAL FILM	2K26	1%	0.4W	5322 117 10987
R672	RES.METAL FILM	51R10	1%	0.4W	4822 050 15119
R673	RES.METAL FILM	205R	1%	0.4W	4822 050 12051
R674	RES.METAL FILM	322R	1%	0.4W	4822 050 13321
R675	RES.METAL FILM	4K32	0.1%	0.125W	5322 116 82505
R676	RES.METAL FILM	2K26	1%	0.4W	5322 117 10987
R677	RES.METAL FILM	100R	1%	0.4W	4822 050 11001
R678	RES.METAL FILM	5K9	0.1%	0.125W	5322 116 80323
R679,681	RES.METAL FILM	10K	1%	0.4W	4822 050 11003
R680	RES.METAL FILM	5K11	1%	0.4W	4822 050 15112
R682	RES.METAL FILM	40R2	1%	0.4W	5322 117 11181
R683	RES.METAL FILM	2K15	1%	0.4W	4822 050 12152
R684	POTM.TRIMMER	10K	20% LIN	0.5W	5322 100 20692
R685,686	RES.METAL FILM	5K11	1%	0.4W	4822 050 15112

Pos. No.	Description				Ordering Code
R726	POTM.TRIMMER	50R	20% LIN	0.5W	5322 101 11113
R728	RES.METAL FILM	1K	1%	0.4W	4822 050 11002
R729,730	RES.METAL FILM	511R	1%	0.4W	5322 117 10785
R731	POTM.TRIMMER	100R	20% LIN	0.5W	5322 101 11075
R732	RES.METAL FILM	511R	1%	0.4W	5322 117 10785
R733	RES.METAL FILM	825K	1%	0.4W	5322 117 10792
R734,735	RES.METAL FILM	511R	1%	0.4W	5322 117 10785
R736	RES.METAL FILM	825K	1%	0.4W	5322 117 10792
R737	RES.METAL FILM	4K87	1%	0.4W	5322 117 11165
R738	RES.METAL FILM	511R	1%	0.4W	5322 117 10785
R739	RES.METAL FILM	249R	1%	0.4W	4822 050 12491
R740	RES.METAL FILM	1K47	1%	0.4W	5322 117 10976
R741	RES.METAL FILM	825K	1%	0.4W	5322 117 10792
R742	RES.METAL FILM	2K87	1%	0.4W	5322 117 10947
R743,744	RES.METAL FILM	205R	1%	0.4W	4822 050 12051
R745	RES.METAL FILM	2K87	1%	0.4W	5322 117 10947
R746	RES.METAL FILM	825K	1%	0.4W	5322 117 10792
R747	RES.METAL FILM	121K	1%	0.4W	5322 117 10775
R748	POTM.TRIMMER	50K	20% LIN	0.5W	5322 101 11115
R749	RES.METAL FILM	71R50	1%	0.4W	4822 050 17159
R750	RES.METAL FILM	261R	1%	0.4W	4822 050 12611
R751	RES.METAL FILM	2K37	1%	0.4W	5322 117 10988
R752	RES.METAL FILM	22K6	1%	0.4W	5322 117 10777
R753	RES.METAL FILM	562R	1%	0.4W	5322 117 10789
R754	RES.METAL FILM	4K64	1%	0.4W	4822 050 14642
R755,756	RES.METAL FILM	51R10	1%	0.4W	4822 050 15119
R757	RES.METAL FILM	22R6	1%	0.4W	5322 117 10945
R758	RES.METAL FILM	51R10	1%	0.4W	4822 050 15119
R759	RES.METAL FILM	909R	1%	0.4W	4822 050 19091
R760	RES.METAL FILM	51R10	1%	0.4W	4822 050 15119
R761	RES.METAL FILM	4K64	1%	0.4W	4822 050 14642
R762	RES.METAL FILM	562R	1%	0.4W	5322 117 10789
R763,764	RES.METAL FILM	205R	1%	0.4W	4822 050 12051
R765,766	RES.METAL FILM	909R	1%	0.4W	4822 050 19091
R767	RES.METAL FILM	100K	1%	0.4W	4822 050 11004
R768	RES.METAL FILM	40R2	1%	0.4W	5322 117 11181
R769	RES.METAL FILM	68R1	1%	0.4W	5322 117 10958
R770	RES.METAL FILM	51R10	1%	0.4W	4822 050 15119
R771	RES.METAL FILM	5K11	1%	0.4W	4822 050 15112
R772	RES.METAL FILM	1K33	1%	0.4W	4822 050 11332
R774	RES.METAL FILM	100K	1%	0.4W	4822 050 11004
R775	RES.METAL FILM	4K87	1%	0.4W	5322 117 11165

Pos. No.	Description		Ordering Code
COILS / UNIT 4			
L801–803	SET OF COILS, ADJUSTED		5322 157 71179
L804	COIL	680 µH	5322 157 62399
L805	COIL	4.7 MH	5322 157 62403
L816	DAMPING BEAD		5322 526 10605
L870,871	DAMPING BEAD		5322 158 10271
L872	DAMPING BEAD		5322 526 10605
L880,881	DAMPING BEAD		5322 526 10605
L885	DAMPING BEAD		5322 526 10015
RELAYS / UNIT 4			
K809–815	RELAY		5322 280 80716
MISCELLANEOUS / UINT 4			
X807	CONNECTOR MALE 26–P		5322 265 51294
X808	CONNECTOR MALE 14–P		5322 265 41045
X820	PIN FOR MINI COAX CONNECTOR		5322 268 14141
X821	MINI COAX CONNECTOR		5322 265 10266
X822	PIN FOR MINI COAX CONNECTOR		5322 268 14141
X823	MINI COAX CONNECTOR		5322 265 10266
X824	PIN FOR MINI COAX CONNECTOR		5322 268 14141
X825	MINI COAX CONNECTOR		5322 265 10266
X826	PIN FOR MINI COAX CONNECTOR		5322 268 14141
X827	MINI COAX CONNECTOR		5322 265 10266
X828	PIN FOR MINI COAX CONNECTOR		5322 268 14141
X829	MINI COAX CONNECTOR		5322 265 10266
X830	PIN FOR MINI COAX CONNECTOR		5322 268 14141
X831	MINI COAX CONNECTOR		5322 265 10266

Pos. No.	Description				Ordering Code
UNIT 5, KEYBOARD AND DISPLAY					
UNIT 5, COMPLETE					5322 214 91389
INTEGRATED CIRCUITS / UNIT 5					
D302	INTEGR.CIRCUIT	SAA3007P			5322 209 72061
D303	INTEGR.CIRCUIT	74HCT132N			4822 209 83044
D304,305	INTEGR.CIRCUIT	PCF8576T			5322 209 11129
DISPLAY / UNIT 5					
H401	PRINTED CIRCUIT	DL300			5322 130 82157
H402	DISPLAY	LPH1535–2 SEE PCN 4217 FOR OTHER REQ'D CHANGES +SN EFF.			4822 130 91005
DIODES / UNIT 5					
V403	DIODE	BZV86–2V0			4822 130 81424
V404	DIODE	BZV86–1V4			4822 130 81423
H403	LED	TLHY4405			4822 130 83412
CAPACITORS / UNIT 5					
C501,502	CAP.CERAMIC	100PF	2%	100V	4822 122 31316
C503,504	CAP.CERAMIC	100NF	10%	100V	5322 126 11584
C513	CAP.CERAMIC	100NF	10%	100V	5322 122 20041
RESISTORS / UNIT 5					
R602,603	POTM.TRIMMER	5K	20%	LIN	4822 101 10793
R604	RES.METAL FILM	178K	1%	0.4W	5322 117 11175
R605	RES.METAL FILM	301R	1%	0.4W	5322 117 10779
CRYSTALS / UNIT 5					
G850	RESONATOR	CSB455A			5322 242 71606
SWITCHES / UNIT 5					
S820–844	SWITCH (PUSHBUTTON)				4822 276 11076
S822	RESET PUSHBUTTON				5322 276 12919
BITGENERATOR / UNIT 5					
S405	BITGENERATOR BG40				5322 693 11084

Pos. No.	Description				Ordering Code
UNIT 6, IEEE-488 INTERFACE					
UNIT 6, COMPLETE					PM 9548
OPTOCOUPLERS / UNIT 6					
H303–308	TRANSISTOR,PHOTO	CNX36			5322 130 90097
INTEGRATED CIRCUITS / UNIT 6					
D301,311	INTEGR.CIRCUIT	OQ0300A			5322 209 11126
D313	PROCESSOR	PCF84C41CP/066			5322 209 30099
D314	INTEGR.CIRCUIT	PC74HCT04P			4822 209 82341
D315	INTEGR.CIRCUIT	PC74HCT08P			5322 209 11265
D316	INTEGR.CIRCUIT	SN75160BN			5322 209 73557
D317	INTEGR.CIRCUIT	SN75161BN			5322 209 73556
N318	INTEGR.CIRCUIT	MC7815CT			5322 209 71759
TRANSISTORS AND DIODES / UNIT 6					
V312,319	TRANSISTOR	PH2369			4822 130 41594
V401,402	DIODE	BAT85			4822 130 31983
V403	TRANSISTOR	PC40			5322 130 83608
V404,405	DIODE	BAT85			4822 130 31983
CAPACITORS / UNIT 6					
C501	CAP.ELECTROLYT.	100µF	20%	16V	4822 124 21912
C502–513	CAP.CERAMIC	10NF	−20/+50%	100V	4822 122 31414
C514,515	CAP.CERAMIC	5.6PF	0.25PF	100V	5322 122 32163
C516	CAP.ELECTROLYT.	47µF	20%	10V	5322 124 21391
C517,519	CAP.CERAMIC	10NF	−20/+50%	100V	4822 122 31414
C520	CAP.CERAMIC	2200µF	20%	16V	4822 124 21382
C521,522	CAP.CERAMIC	100NF	10%	100V	5322 126 11584
C523	CAP.ELECTROLYT.	47µF	20%	10V	5322 124 21391
RESISTORS / UNIT 6					
R601,602	RES.METAL FILM	100R	1%	0.4W	4822 050 11001
R603	RES.METAL FILM	8K25	1%	0.4W	4822 050 18252
R606,609	RES.METAL FILM	10K	1%	0.4W	4822 050 11003
R607,608	RES.METAL FILM	261R	1%	0.4W	4822 050 12611
R610	RES.METAL FILM	1K	1%	0.4W	4822 050 11002
R611	RES.METAL FILM	205K	1%	0.4W	5322 117 11045
R612	RES.METAL FILM	10K	1%	0.4W	4822 050 11003

Pos. No.	Description				Ordering Code
R621	RES.METAL FILM	261R	1%	0.4W	4822 050 12611
R622,623	RES.METAL FILM	10K	1%	0.4W	4822 050 11003
R624	RES.METAL FILM	261R	1%	0.4W	4822 050 12611
R625	RES.METAL FILM	46K40	1%	0.4W	4822 050 14643
R626	RES.METAL FILM	205K	1%	0.4W	5322 117 11045
R627	RES.METAL FILM	825K	1%	0.4W	5322 117 10792
R628	RES.METAL FILM	10K	1%	0.4W	4822 050 11003
R629	RES.METAL FILM	8K25	1%	0.4W	4822 050 18252
R630,631	RES.METAL FILM	10K	1%	0.4W	4822 050 11003
R632,633	RES.METAL FILM	100R	1%	0.4W	4822 050 11001
R634–637	RES.METAL FILM	4K64	1%	0.4W	4822 050 14642
R604,605	RES.METAL FILM	1K78	1%	0.4W	5322 117 10983
R638,639	RES.METAL FILM	1K78	1%	0.4W	5322 117 10983

CRYSTALS / UNIT 6

G781	CRYSTAL	9.216 000 MHZ	5322 242 72349

MISCELLANEOUS / UNIT 6

W801	CONNECTION CABLE TO UNIT 2	5322 321 60757
X802	IEEE–488 CONNECTOR	5322 267 60162
	IC SOCKET 28–P	5322 255 44047

UNIT 7, RS-232 INTERFACE

UNIT 7, COMPLETE PM 9549

OPTOCOUPLERS / UNIT 7

H101–107	TRANSISTOR,PHOTO	CNX36	5322 130 90097

INTEGRATED CIRCUITS / UNIT 7

D101	PROCESSOR	PCB80C652	5322 209 33173
D102	INTEGR.CIRCUIT	PC74HC393T	5322 209 60427
D103,104	INTEGR.CIRCUIT	PC74HC14T	5322 209 11548
D105,106	INTEGR.CIRCUIT	L232	5322 209 61886
D107	INTEGR.CIRCUIT	PC74HCT573T	5322 209 31276
D109	EPROM LOADED	N27C010	5322 209 52543
N101	INTEGR.CIRCUIT	LM7805CT	5322 209 86445

Pos. No.	Description				Ordering Code
TRANSISTORS AND DIODES / UNIT 7					
V101	TRANSISTOR	PC40			5322 130 83608
V102	TRANSISTOR,CHIP	BSR57			5322 130 60646
V103–108	DIODE,CHIP	BAS32L			4822 130 80446
CAPACITORS / UNIT 7					
C101	CAP.ELECTROLYT.	100µF	20%	16V	4822 124 21912
C102,103	CAP.CHIP	27PF	2%	63V	4822 122 31825
C104	CAP.ELECTROLYT.	1000µF	20%	40V	5322 124 21551
C105,106	CAP.CHIP	100NF	10%	63V	4822 122 33496
C107	CAP.ELECTROLYT.	100µF	20%	16V	4822 124 21912
C108,113	CAP.CHIP	10NF	10%	50V	4822 122 32442
C115,116	CAP.ELECTROLYT.	22µF	20%	63V	5322 124 41301
C117,118	CAP.ELECTROLYT.	47µF	20%	35V	4822 124 40846
C119,120	CAP.ELECTROLYT.	22µF	20%	63V	5322 124 41301
C123	CAP.ELECTROLYT.	100µF	20%	16V	4822 124 21912
C124,125	CAP.CHIP	100NF	10%	63V	4822 122 33496
C137	CAP.CHIP	10NF	10%	50V	4822 122 32442
RESISTORS / UNIT 7					
R102,103	RES.METAL FILM	10K	0.1%	0.25W	5322 116 81249
R104,105	RES.METAL FILM	82R	1%	0.25W	5322 116 81305
R109–111	RES.METAL FILM	464R	1%	0.25W	5322 116 83697
R112	RES.METAL FILM	4K64	1%	0.25W	5322 116 83698
R113	RES.METAL FILM	464K	1%	0.25W	5322 117 11036
R114,116	RES.METAL FILM	4K64	1%	0.25W	5322 116 83698
R115,117	RES.METAL FILM	464K	1%	0.25W	5322 117 11036
R118,122	RES.METAL FILM	4K64	1%	0.25W	5322 116 83698
R119,121	RES.METAL FILM	464K	1%	0.25W	5322 117 11036
R123,125	RES.METAL FILM	464K	1%	0.25W	5322 117 11036
R124	RES.METAL FILM	4K64	1%	0.25W	5322 116 83698
R126–129	RES.METAL FILM	464R	1%	0.25W	5322 116 83697
R131	RES.METAL FILM	100K	1%	0.25W	5322 116 81258
R133	RES.METAL FILM	1M	1%	0.25W	5322 116 81259
R141	RES.METAL FILM	4K64	1%	0.25W	5322 116 83698
R142	RES.METAL FILM	19K6	1%	0.25W	5322 117 11029
CRYSTALS / UNIT 7					
G101	CRYSTAL	11.059 200 MHZ			5322 242 72245
MISCELLANEOUS / UNIT 7					
W101	CONNECTION CABLE TO UNIT 2				5322 321 60757
X101	RS–232 CONNECTOR				5322 267 41137
	IC SOCKET 32–P PLCC				5322 255 41318

FIGURES

Fig. 100 Basic Block Diagram
Fig. 101 Overall Circuit Diagram

Fig. 102 Unit 1, Component Layout
Fig. 103 Unit 1, Power Supply

Fig. 104 Unit 2, Component Layout
Fig. 105 Unit 2, Clock Generator
Fig. 106 Unit 2, CPU
Fig. 107 Unit 2, Triangle Wave Synthesizer (TWS)

Fig. 108 Unit 3, Component Layout
Fig. 109 Unit 3, Amplitude Controller
Fig. 110 Unit 3, Amplifier
Fig. 111 Unit 3, Attenuator
Fig. 112 Unit 3, DC Generator

Fig. 113 Unit 4, Component Layout
Fig. 114 Unit 4, RAM
Fig. 115 Unit 4, DAC and Lowpass Filter
Fig. 116 Unit 4, Frequency Multiplier
Fig. 117 Unit 4, Amplitude Modulator
Fig. 118 Unit 4, Pulse Generator
Fig. 119 Unit 4, Modulation Oscillator
Fig. 120 Unit 4, Burst Logic

Fig. 121 Unit 5, Component Layout
Fig. 122 Unit 5, Keyboard and Display

Fig. 123 Unit 6, Component Layout
Fig. 124 Unit 6, IEEE-488 Interface

Fig. 125 Unit 7, Component Layout
Fig. 126 Unit 7, RS-232 Interface

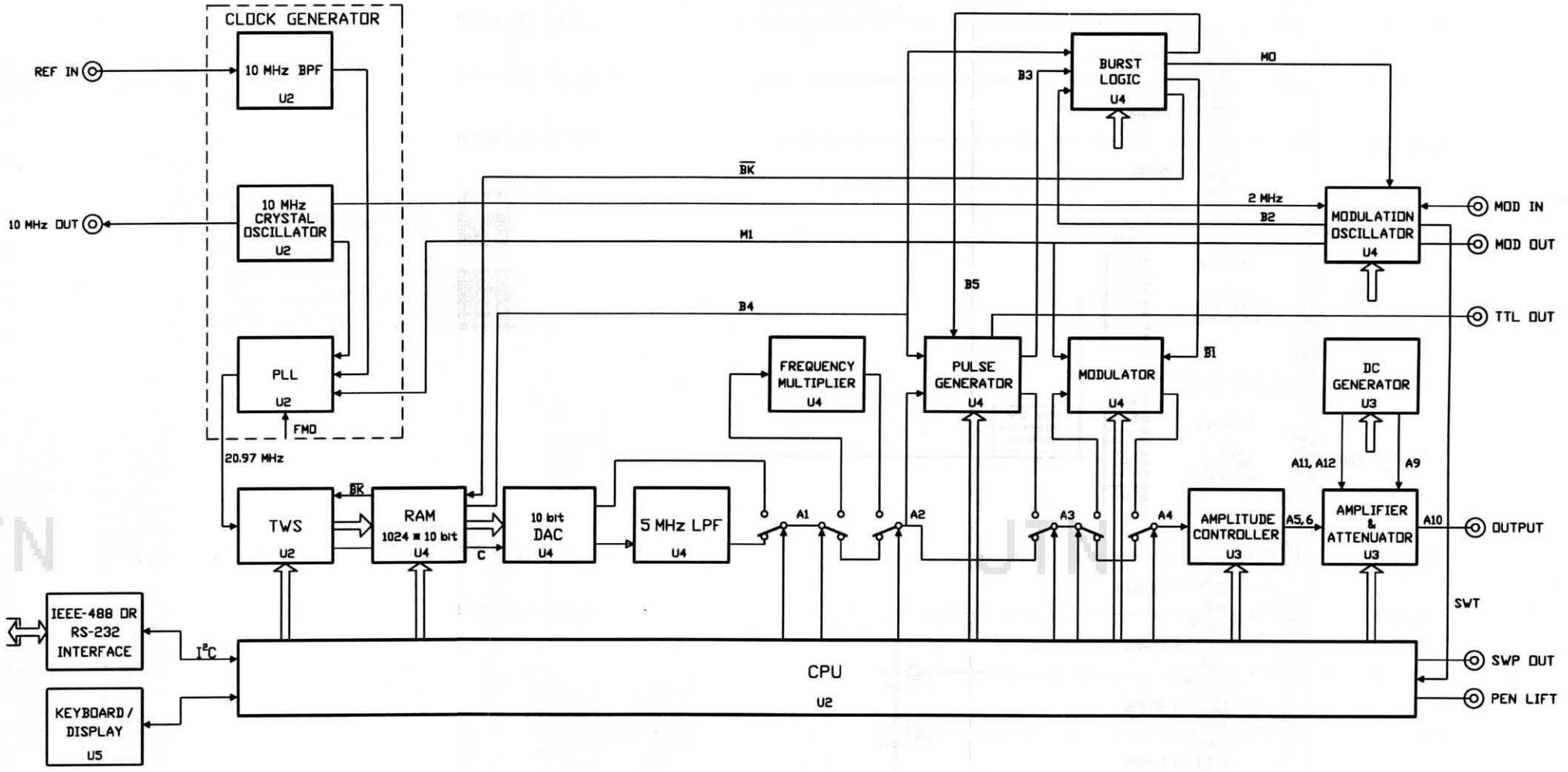
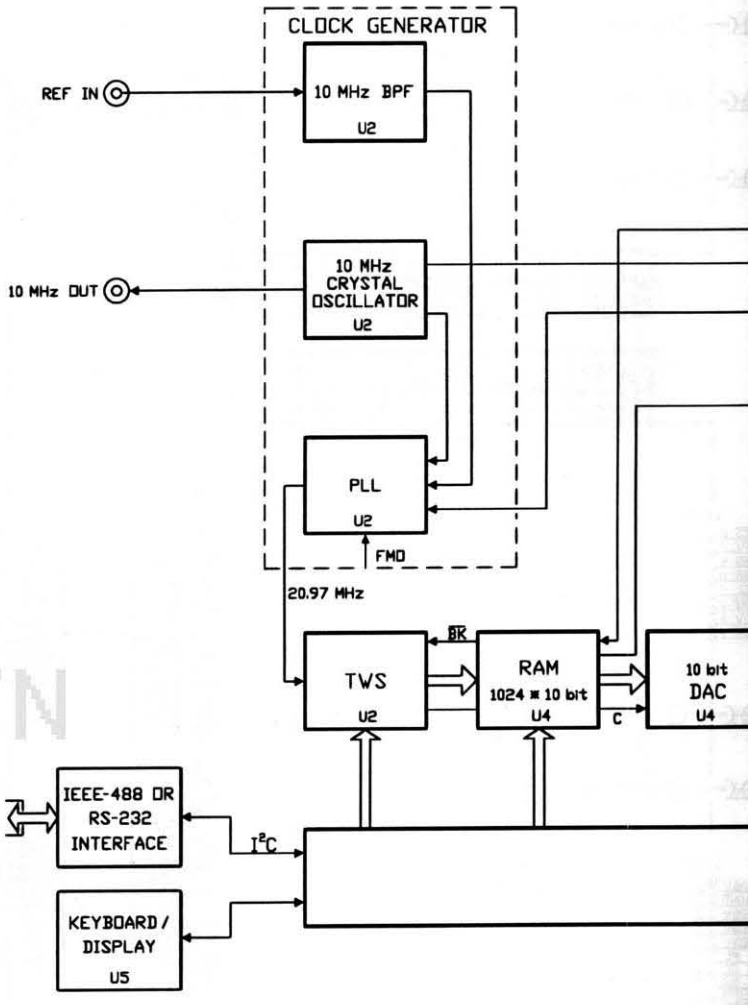


Fig. 100 Basic Block Diagram


CLOCK GENERATOR
REF IN
10 MHz BPF
U2
10 MHz OUT
10 MHz
CRYSTAL
OSCILLATOR
U2
PLL
U2
FMO
20.97 MHz
TWS
U2
BR
RAM
1024 x 10 bit
U4
C
10 bit
DAC
U4
IEEE-488 OR
RS-232
INTERFACE
I²C
KEYBOARD /
DISPLAY
U5

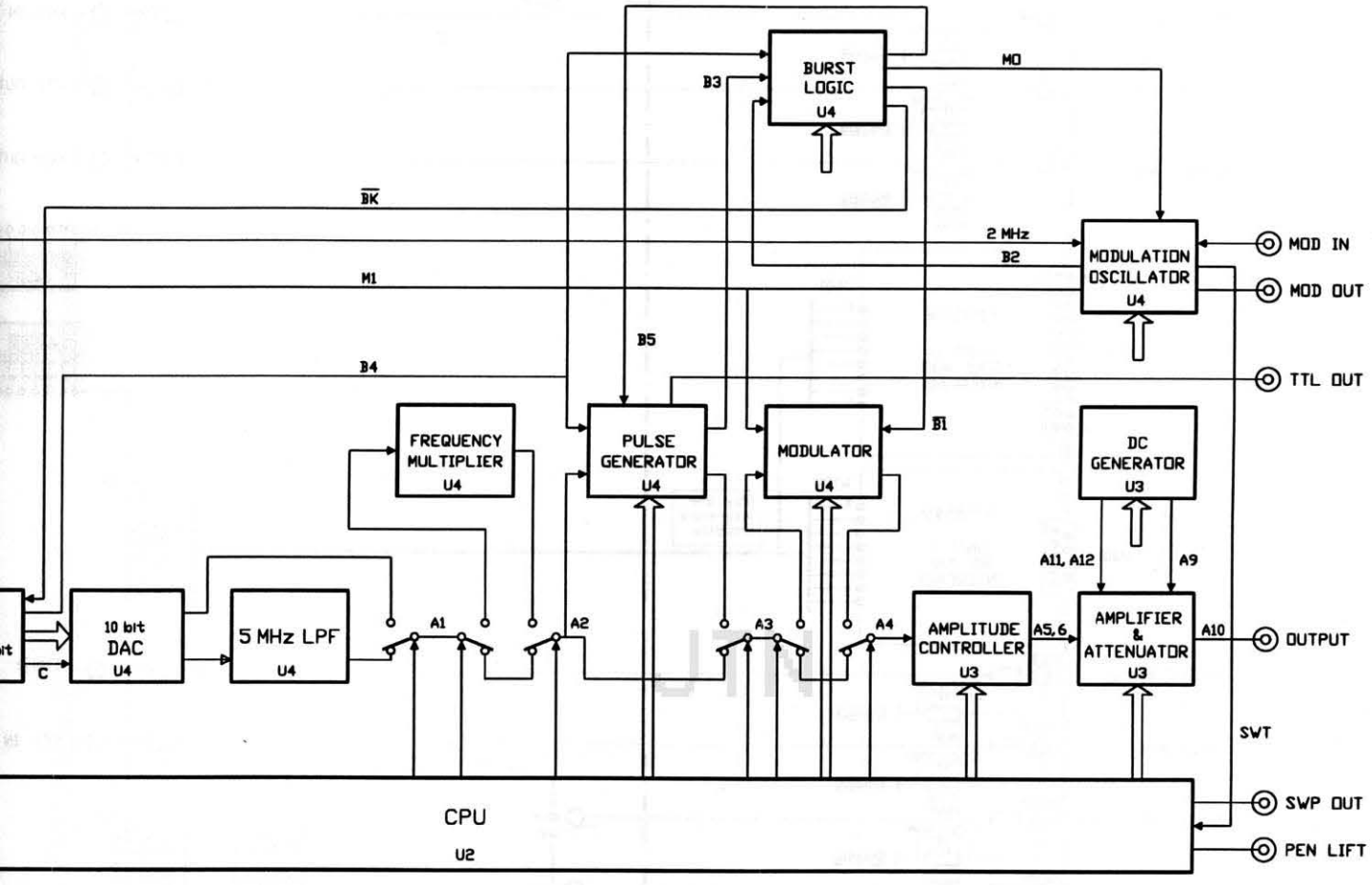
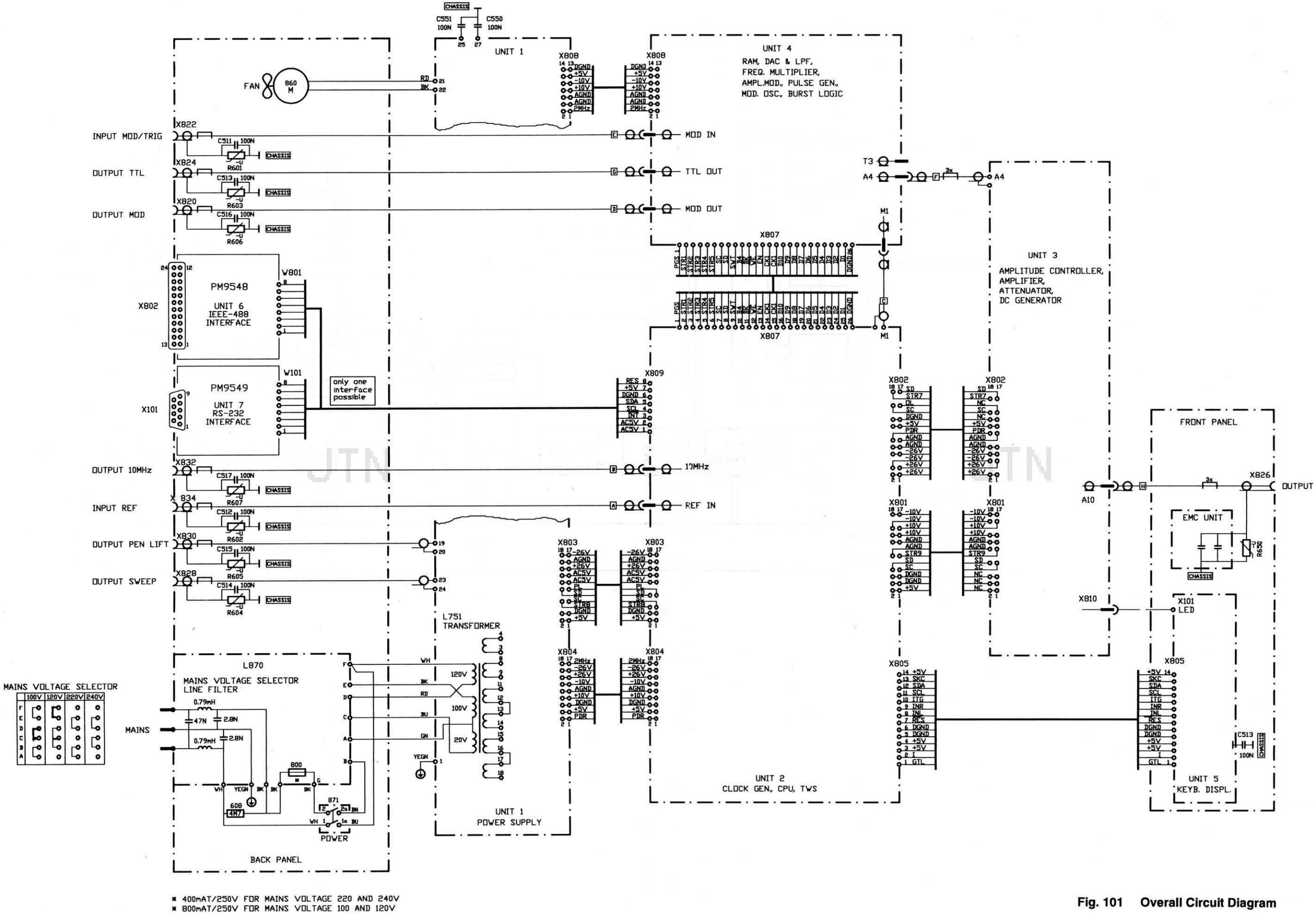
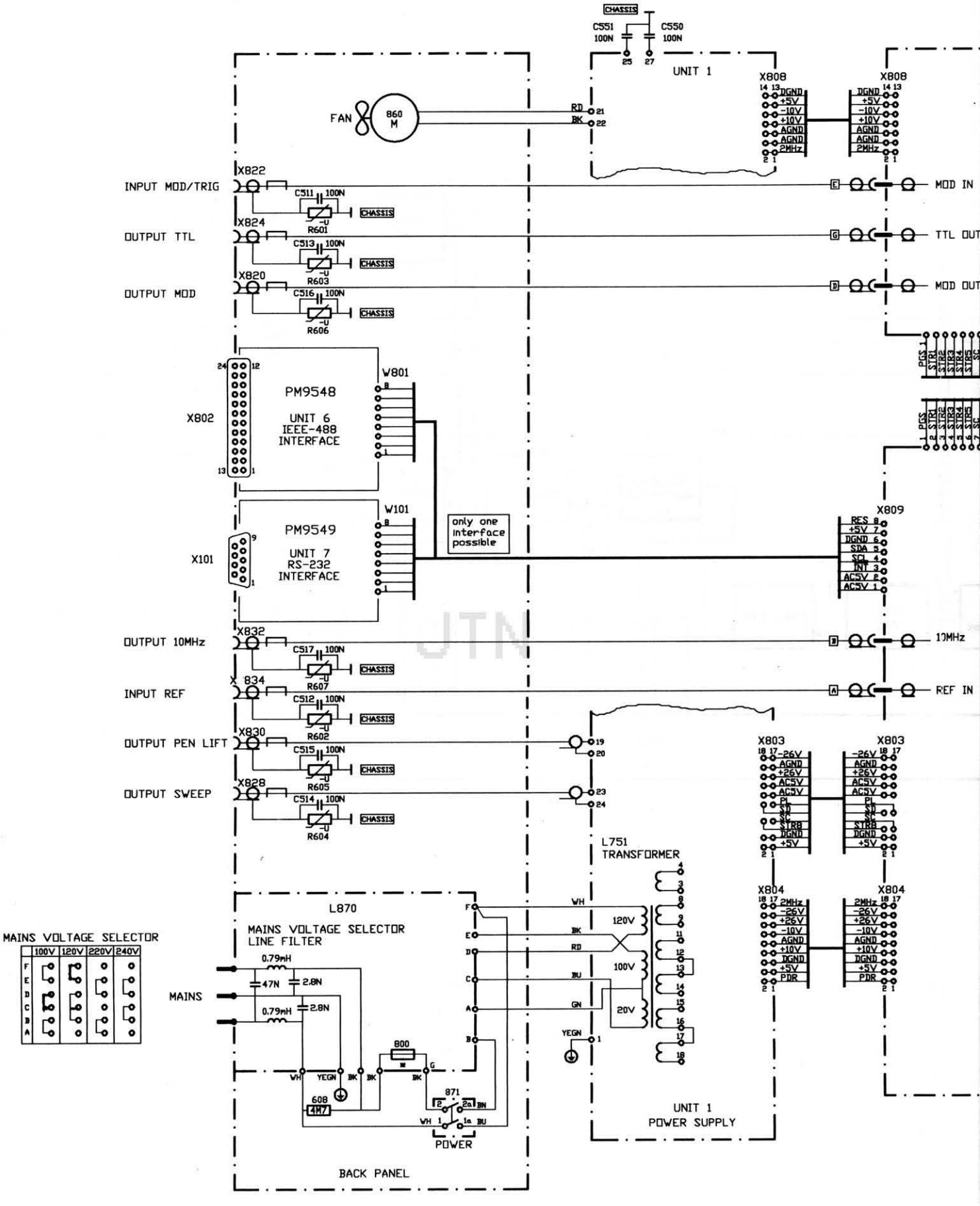


Fig. 100 Basic Block Diagram



* 400mAT/250V FOR MAINS VOLTAGE 220 AND 240V
* 800mAT/250V FOR MAINS VOLTAGE 100 AND 120V

Fig. 101 Overall Circuit Diagram



* 400mAT/250V FOR MAINS VOLTAGE 220 AND 240V
* 800mAT/250V FOR MAINS VOLTAGE 100 AND 120V

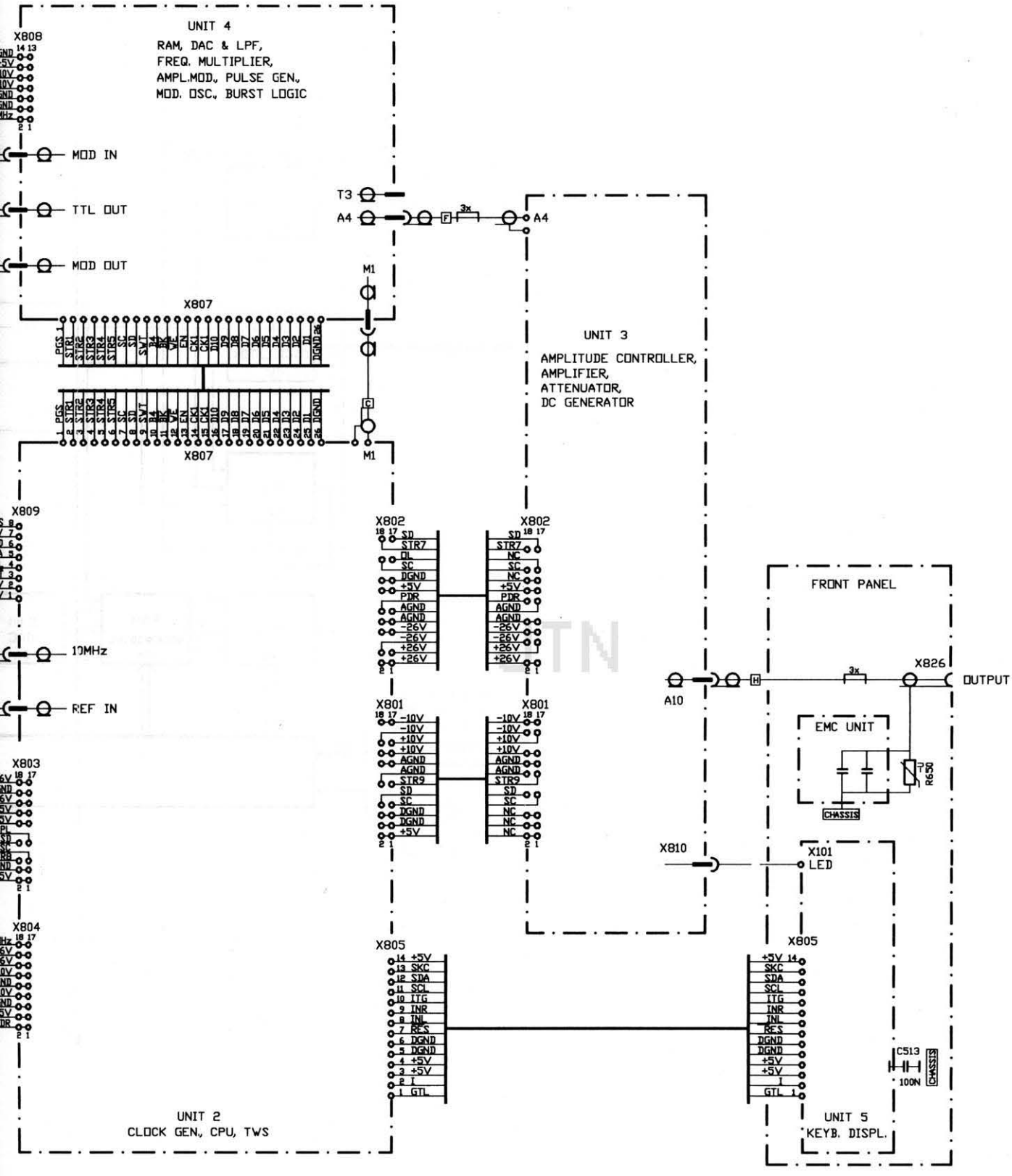
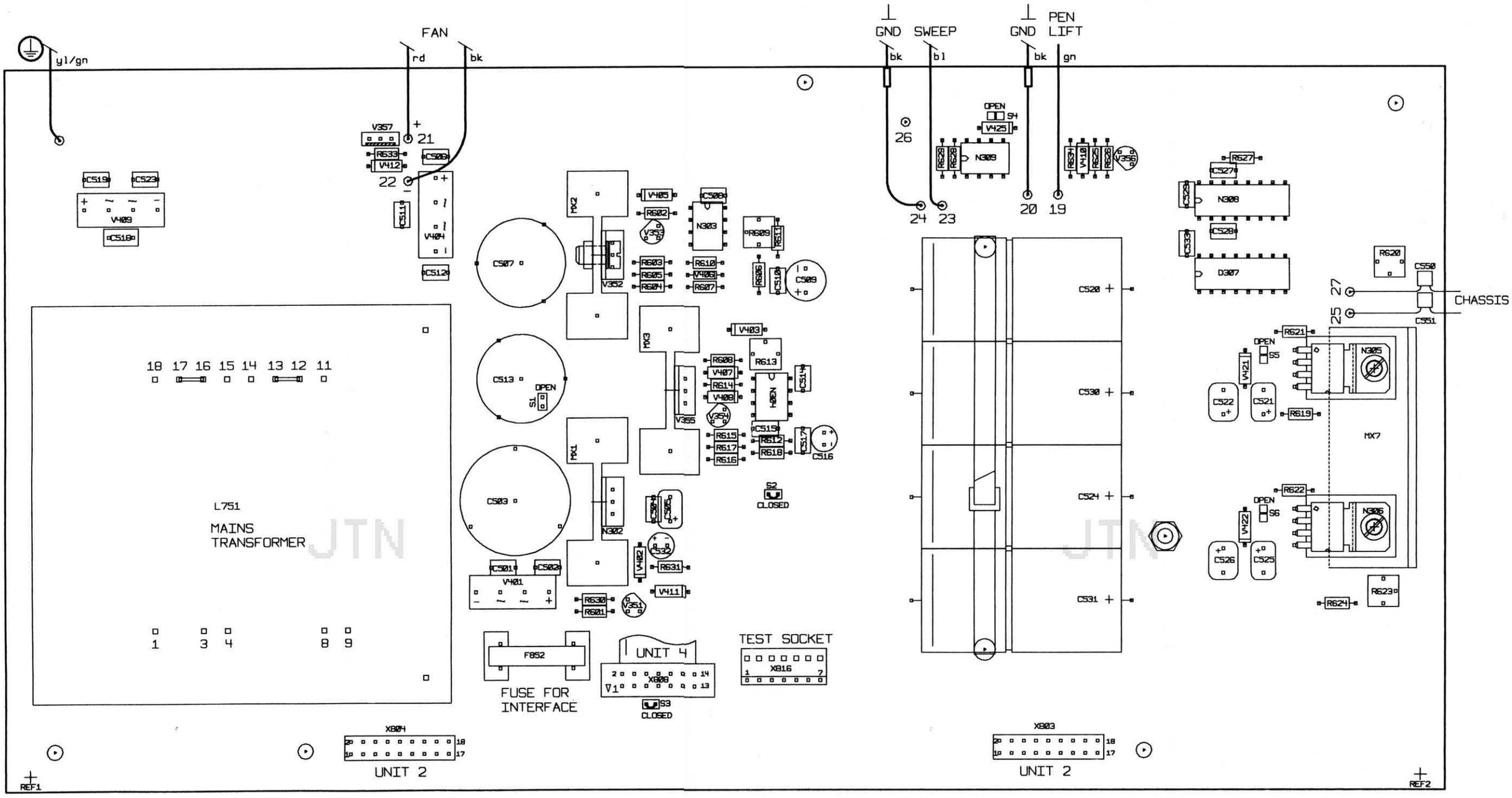


Fig. 101 Overall Circuit Diagram



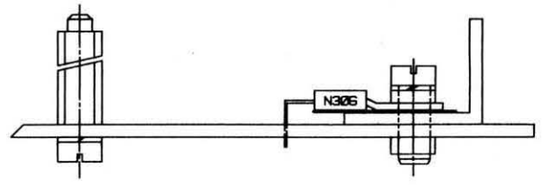
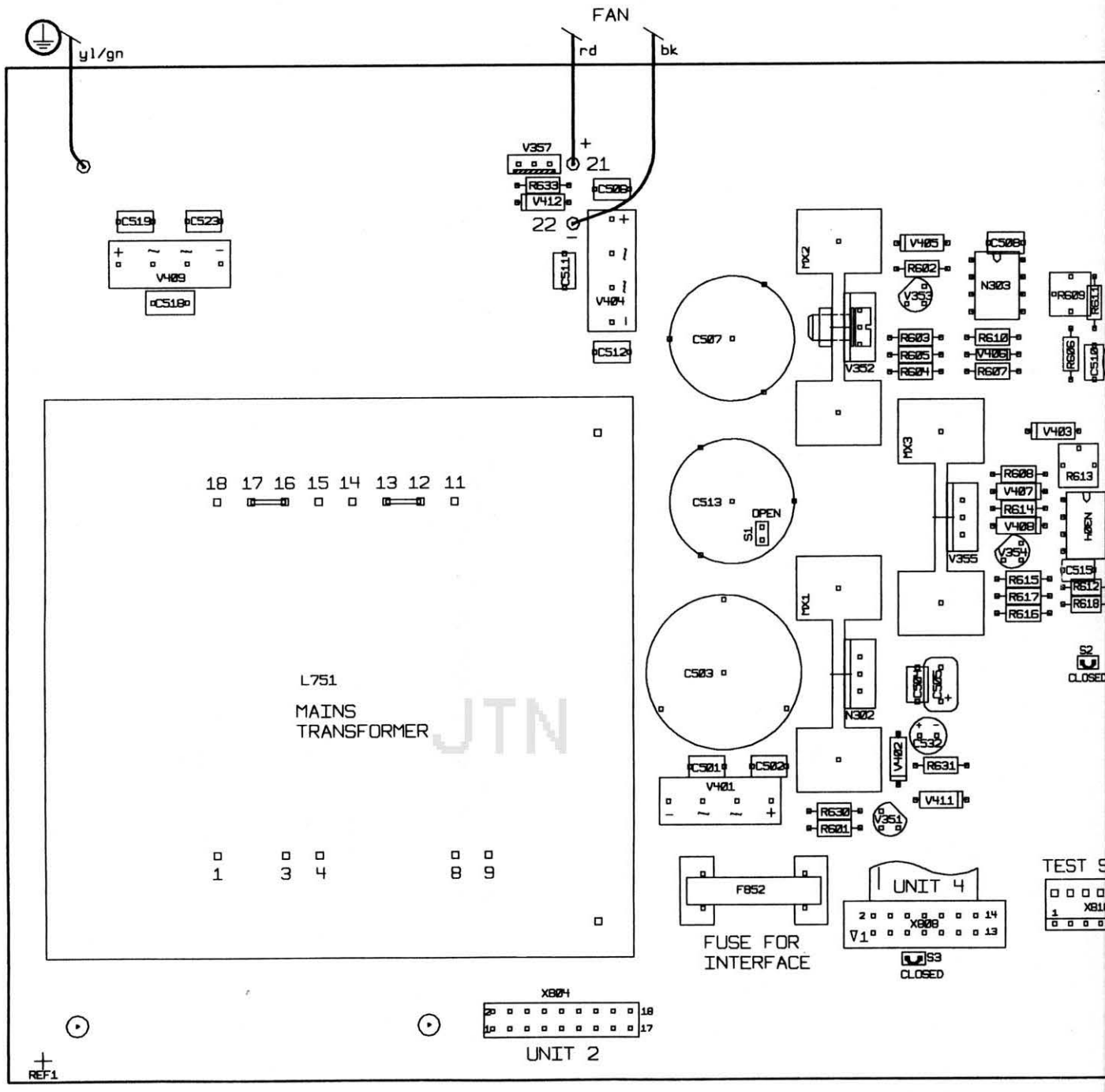
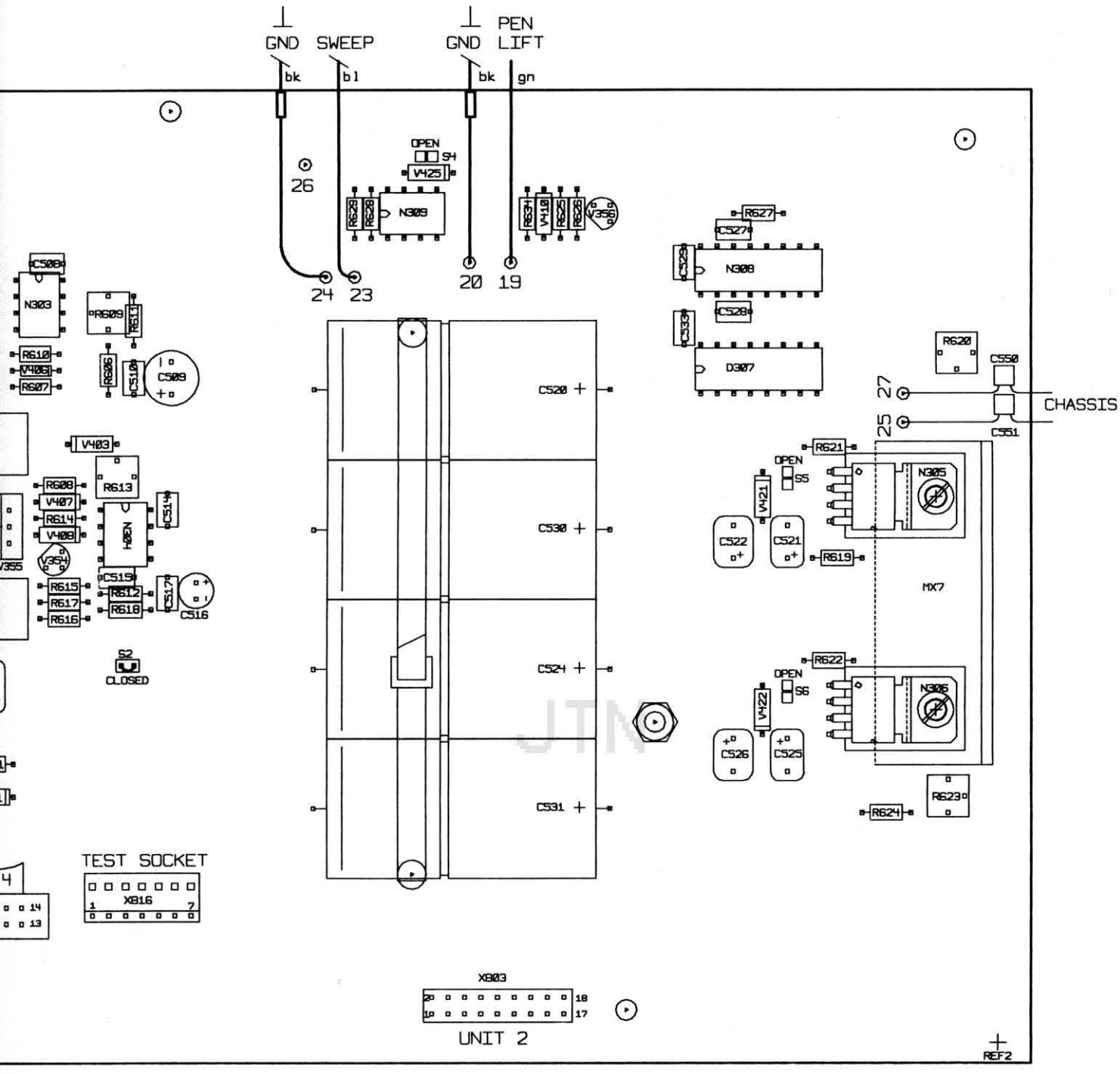


Fig. 102 Unit 1, Component Layout


FAN
yl/gn
rd
bk
V357
21
22
R633
V412
C508
C519
C523
V409
C518
C511
V404
C512
C507
MX2
V405
R602
C500
N303
R609
R611
V353
R603
R605
R604
V352
R610
V406
R607
C506
R606
C510
V403
MX3
R608
V407
R614
V408
R613
H8EN
V354
V355
C513
OPEN
S1
C515
R615
R617
R616
R612
R618
S2
CLOSED
MX1
C503
C505
C504
C532
N302
V402
R631
V411
C501
C502
V401
R630
R601
V351
18 17 16 15 14 13 12 11
L751
MAINS
TRANSFORMER
JTN
1 3 4 8 9
F852
FUSE FOR
INTERFACE
UNIT 4
X800
V1
2
14
13
S3
CLOSED
TEST S
X81
1
XB04
20
18
19
17
UNIT 2
REF1



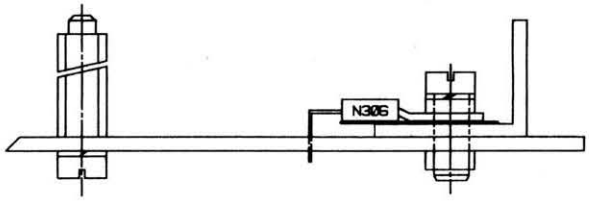


Fig. 102 Unit 1, Component Layout

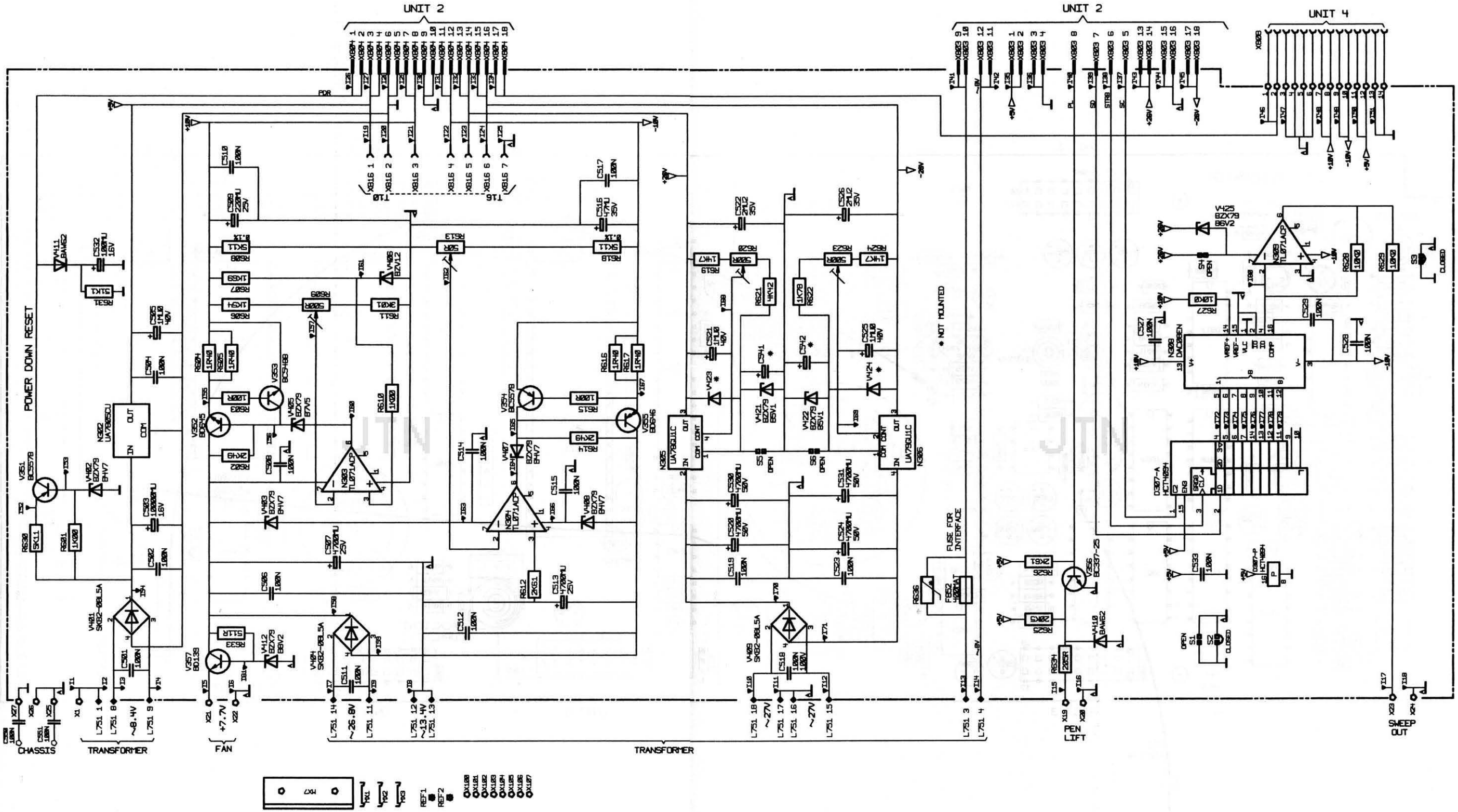
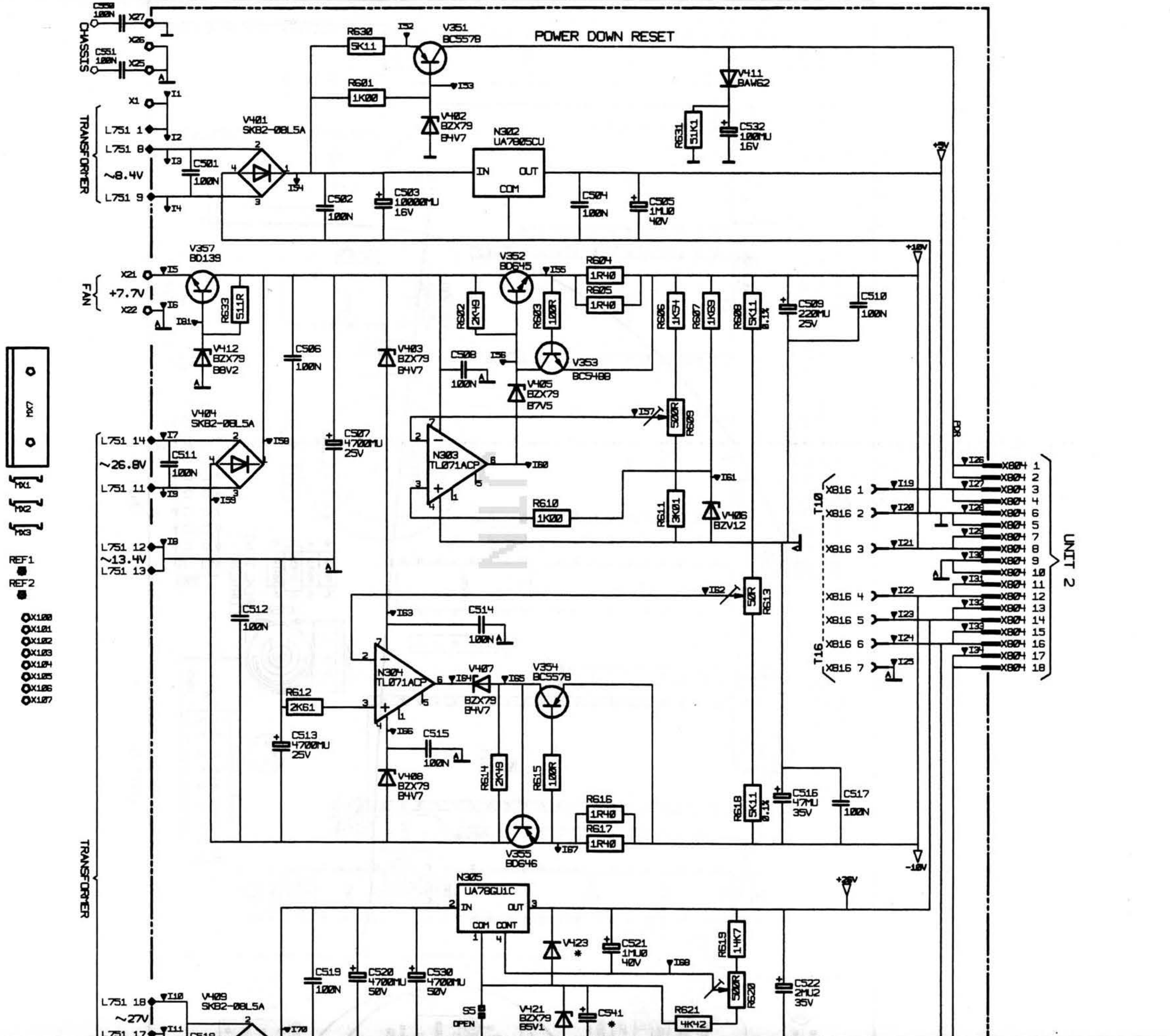


Fig. 103 Unit 1, Power Supply



POWER DOWN RESET
CHASSIS
TRANSFORMER
FAN
+7.7V
~8.4V
~26.8V
~13.4V
~27V
R630 5K11
V351 BC557B
R601 1K00
V402 BZX79 B4V7
V411 BAW62
R631 51K1
C532 100MU 16V
V401 SKB2-08L5A
N302 UA7805CU
IN OUT COM
C501 100N
C502 100N
C503 10000MU 16V
C504 100N
C505 1MU0 40V
+5V
+10V
V357 BD139
R633 511R
V412 BZX79 B8V2
V352 BD645
R602 2K49
R603 100R
R604 1R40
R605 1R40
V353 BC548B
C508 100N
V405 BZX79 B7V5
R606 1K54
R607 1K69
R608 5K11 0.1%
C509 220MU 25V
C510 100N
C506 100N
V403 BZX79 B4V7
V404 SKB2-08L5A
C507 4700MU 25V
C511 100N
N303 TL071ACP
R609 500R
R610 1K00
R611 3K01
V406 BZV12
C512 100N
R613 50R
C514 100N
N304 TL071ACP
V407 BZX79 B4V7
V354 BC557B
R612 2K61
C513 4700MU 25V
C515 100N
V408 BZX79 B4V7
R614 2K49
R615 100R
R616 1R40
R617 1R40
R618 5K11 0.1%
C516 47MU 35V
C517 100N
V355 BD646
-10V
+20V
N305 UA78GU1C
IN OUT COM CONT
V423 *
C521 1MU0 40V
R619 14K7
R620 500R
C522 2MU2 35V
C519 100N
C520 4700MU 50V
C530 4700MU 50V
S5 OPEN
V421 BZX79 B5V1
C541 *
R621 4K42
V409 SKB2-08L5A
C518
L751 1
L751 8
L751 9
L751 14
L751 11
L751 12
L751 13
L751 18
L751 17
X21
X22
X1
X25
X26
X27
C550 100N
C551 100N
MX7
MX1
MX2
MX3
REF1
REF2
X100
X101
X102
X103
X104
X105
X106
X107
X816 1
X816 2
X816 3
X816 4
X816 5
X816 6
X816 7
T10
T16
X804 1
X804 2
X804 3
X804 4
X804 5
X804 6
X804 7
X804 8
X804 9
X804 10
X804 11
X804 12
X804 13
X804 14
X804 15
X804 16
X804 17
X804 18
UNIT 2

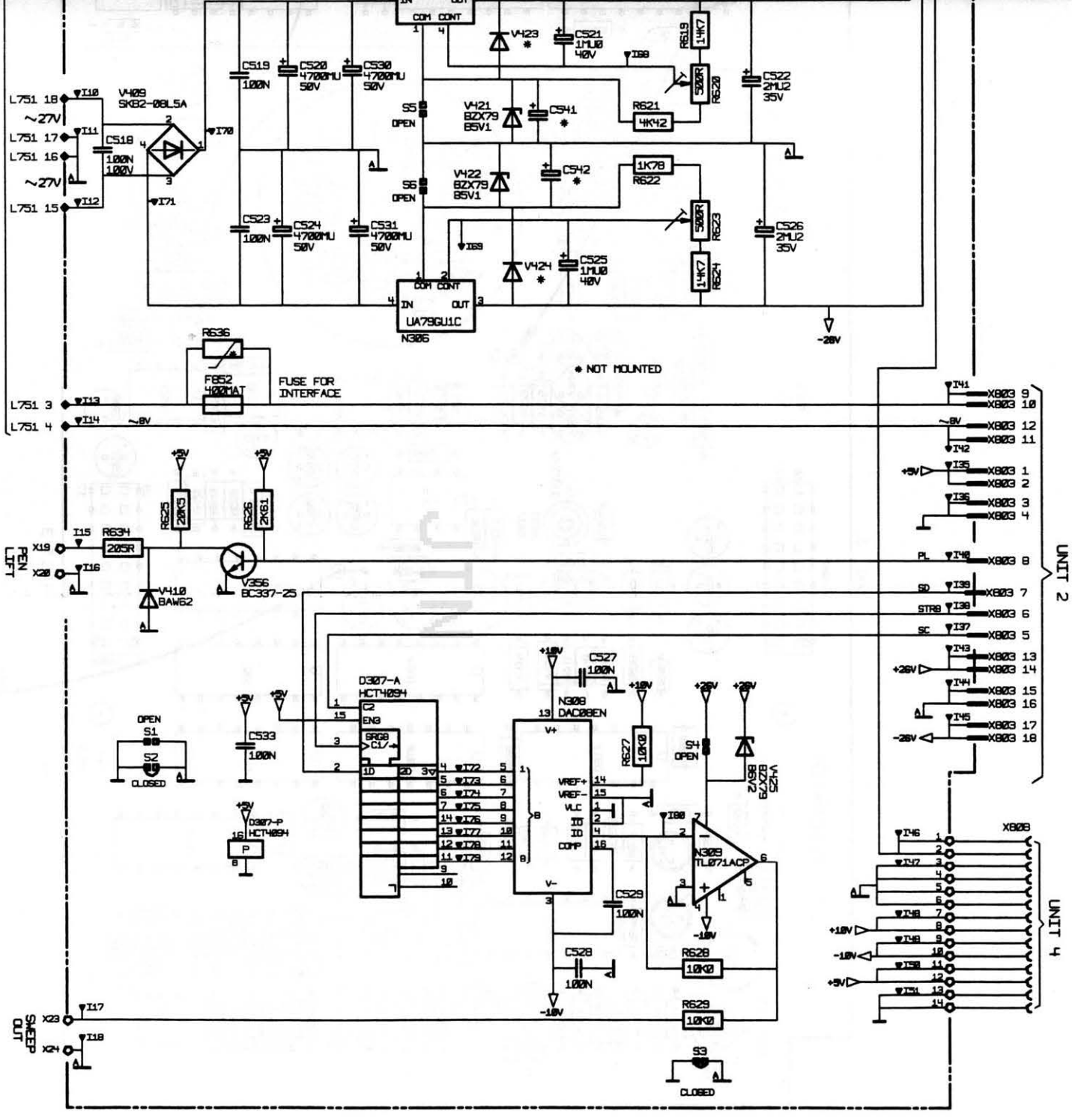


Fig. 103 Unit 1, Power Supply

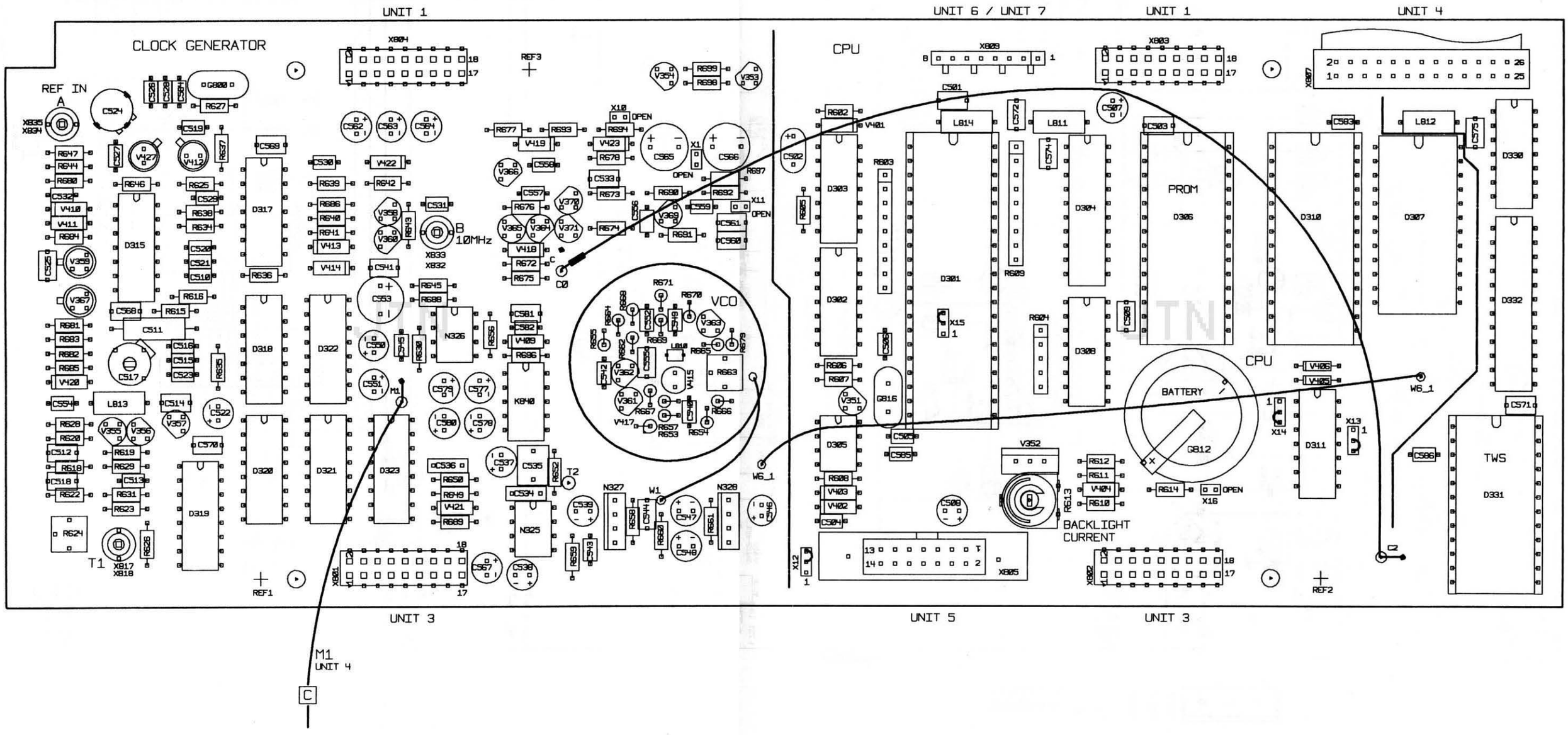
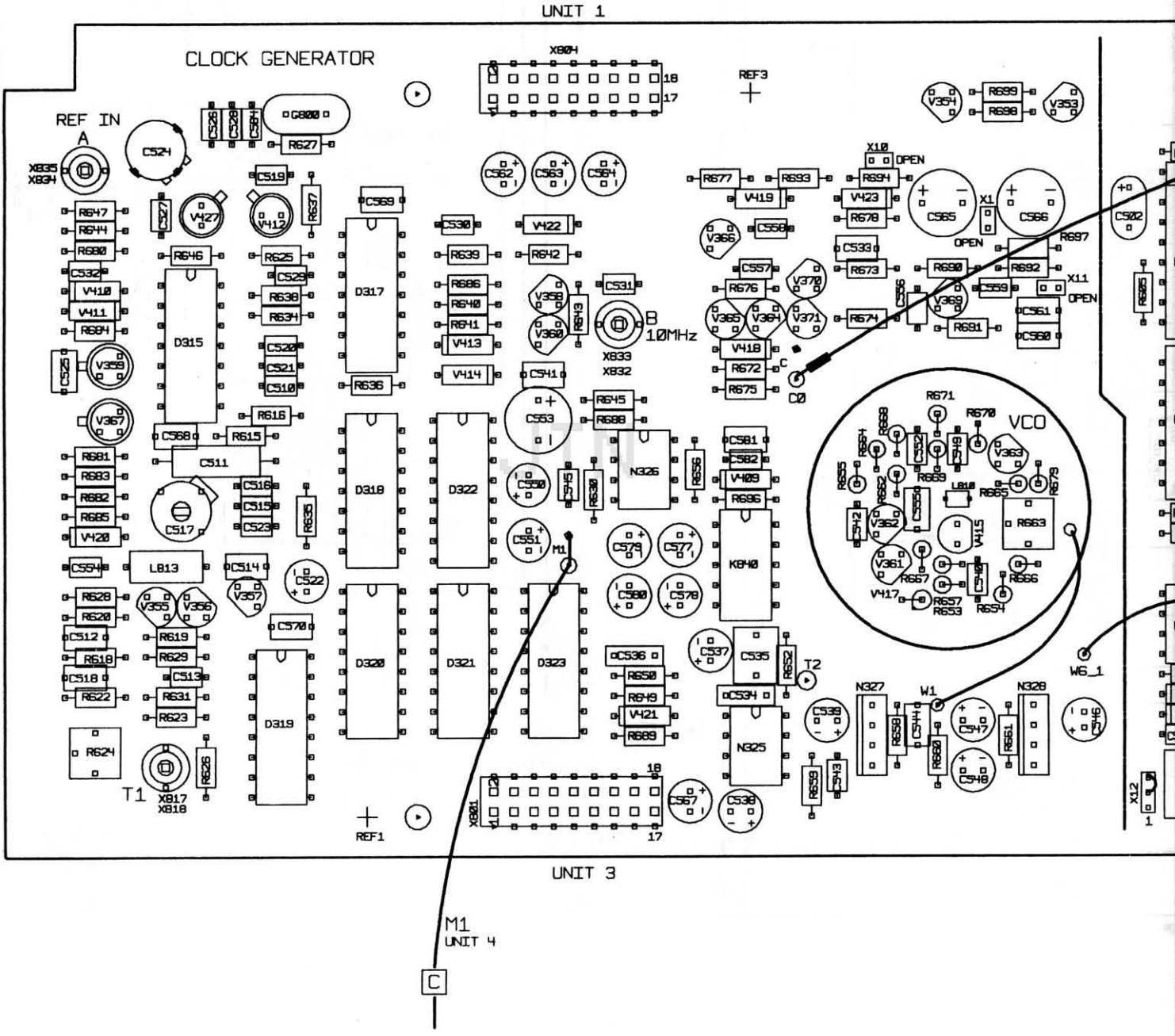


Fig. 104 Unit 2, Component Layout


UNIT 1
CLOCK GENERATOR
REF IN
A
X835
X834
C524
C528
C529
C534
G800
R627
C519
R637
V427
V412
R647
R644
R680
C532
V410
V411
R684
C525
V358
V367
R681
R683
R682
R685
V420
C554
R628
R620
C512
R618
C518
R622
R624
T1
X817
X818
R626
LB13
V355
V356
R619
R629
C513
R631
R623
C517
R646
C568
R615
C511
C516
C515
C523
R635
V357
C514
C522
C570
D319
R625
C529
R638
R634
C520
C521
C510
R616
D315
C569
D317
R636
D318
D320
D322
D321
D323
C530
R639
R686
R640
R641
V413
V414
V422
R642
V358
V360
R643
C531
B
10MHz
X833
X832
C541
C553
R645
R688
C550
C545
R630
N326
R656
C551
M1
C579
C577
C580
C578
C581
C582
V409
R696
K840
C536
R650
R649
V421
R689
C537
C535
R652
T2
C534
N325
C539
R639
C543
C567
C538
X801
18
17
REF1
REF3
X804
18
17
C562
C563
C564
R677
R693
V419
V366
C558
C557
R676
V365
V364
V371
V370
R675
R672
R674
R673
C533
C556
V369
R691
R690
R692
C559
C561
C560
C565
C566
X10
OPEN
R694
V423
R678
X1
OPEN
R697
X11
OPEN
V354
R699
R698
V353
C502
R685
R671
R670
VCO
R668
R684
C552
C549
V363
R669
R679
R635
R682
LB18
R665
C542
C553
V362
R663
V361
V415
R667
R666
V417
R657
R653
R654
C544
C540
W6_1
W1
N327
R658
C544
C547
C548
R660
R661
N328
C546
X12
1
M1
UNIT 4
C
UNIT 3

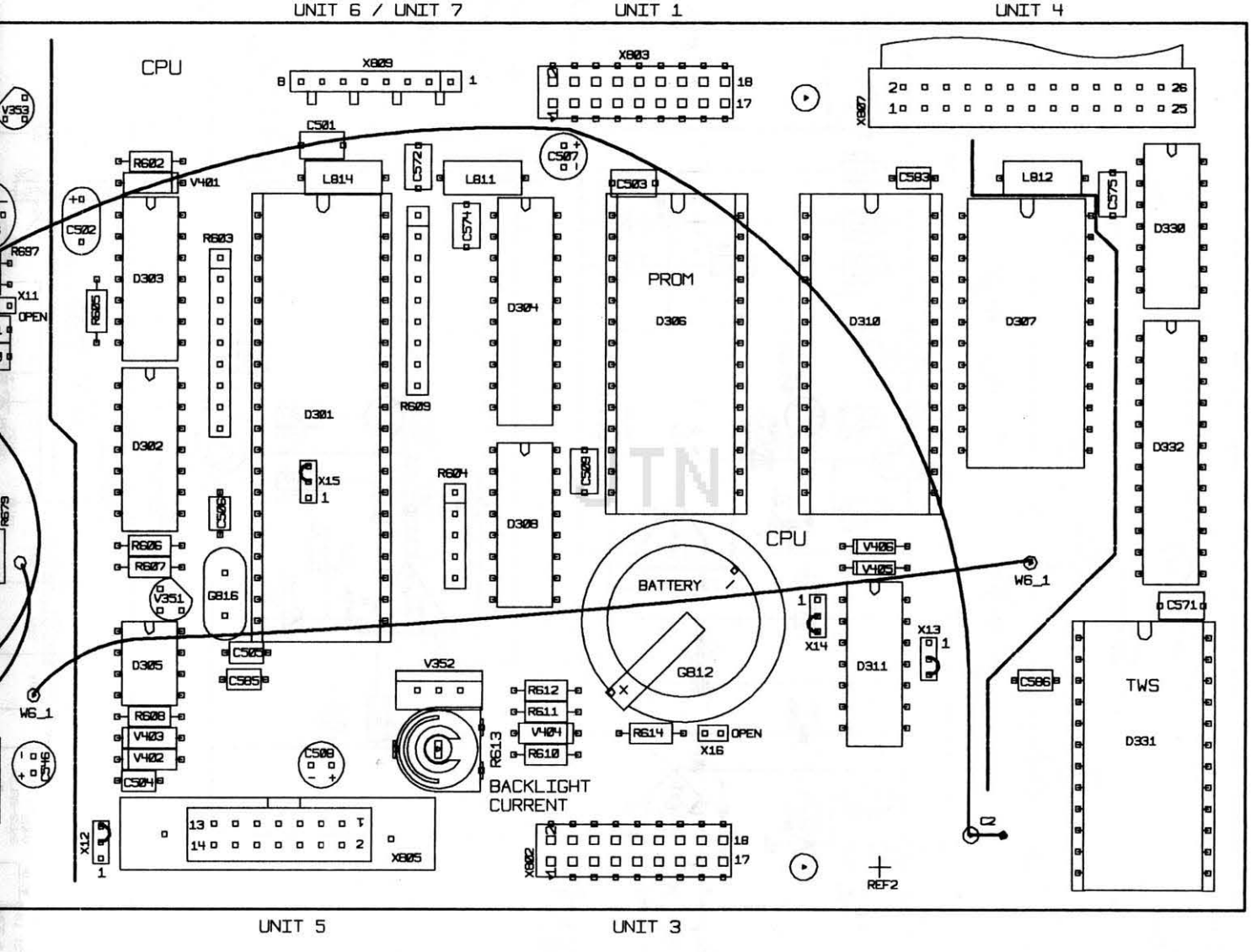


Fig. 104 Unit 2, Component Layout

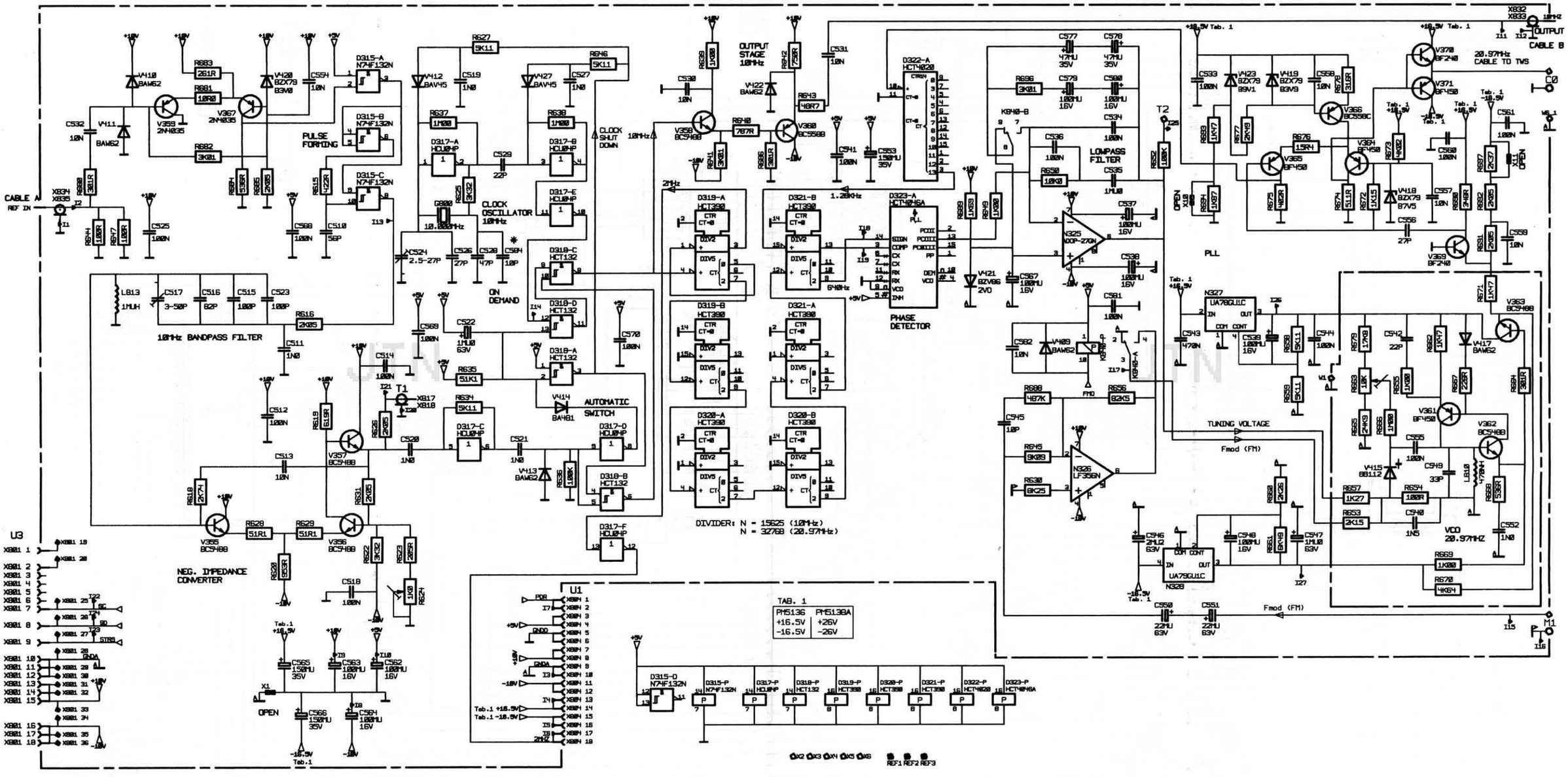
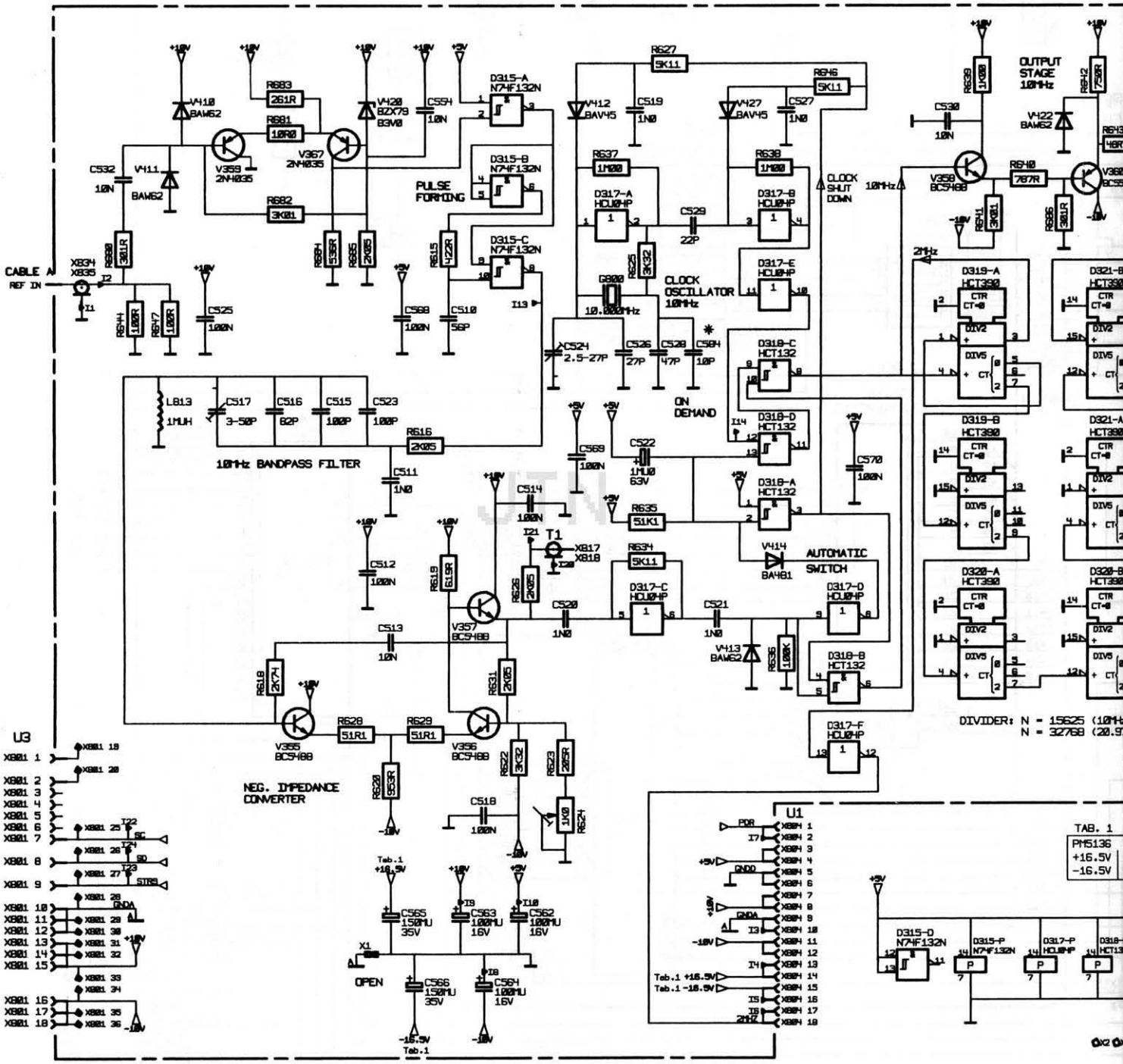


Fig. 105 Unit 2, Clock Generator


CABLE A
REF IN
PULSE FORMING
CLOCK OSCILLATOR 10MHz
10.000MHz
CLOCK SHUT DOWN
ON DEMAND
AUTOMATIC SWITCH
10MHz BANDPASS FILTER
NEG. IMPEDANCE CONVERTER
OUTPUT STAGE 10MHz
OPEN
DIVIDER: N = 15625 (10MH
N = 32768 (20.9
TAB. 1
PM5136
+16.5V
-16.5V

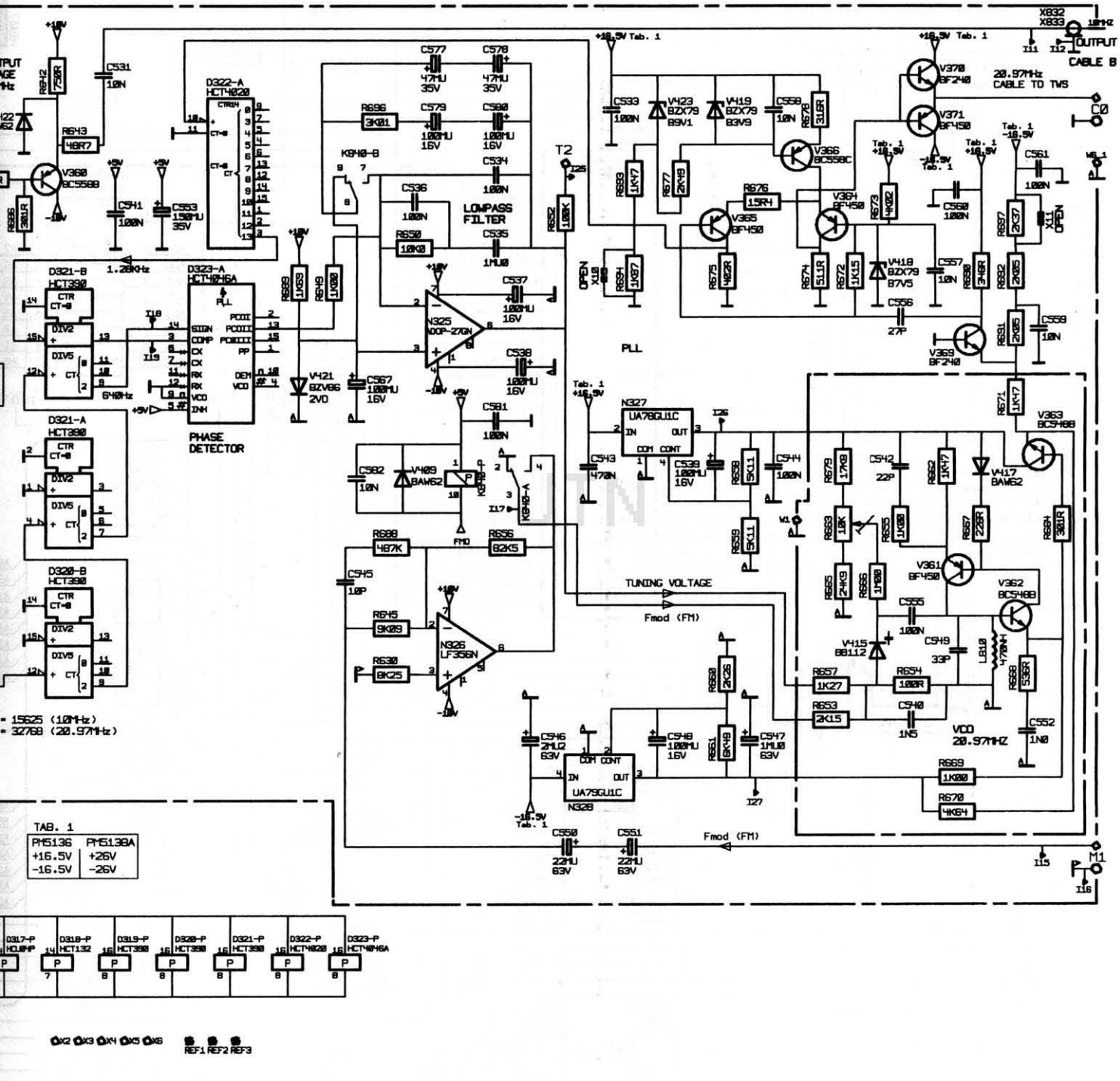
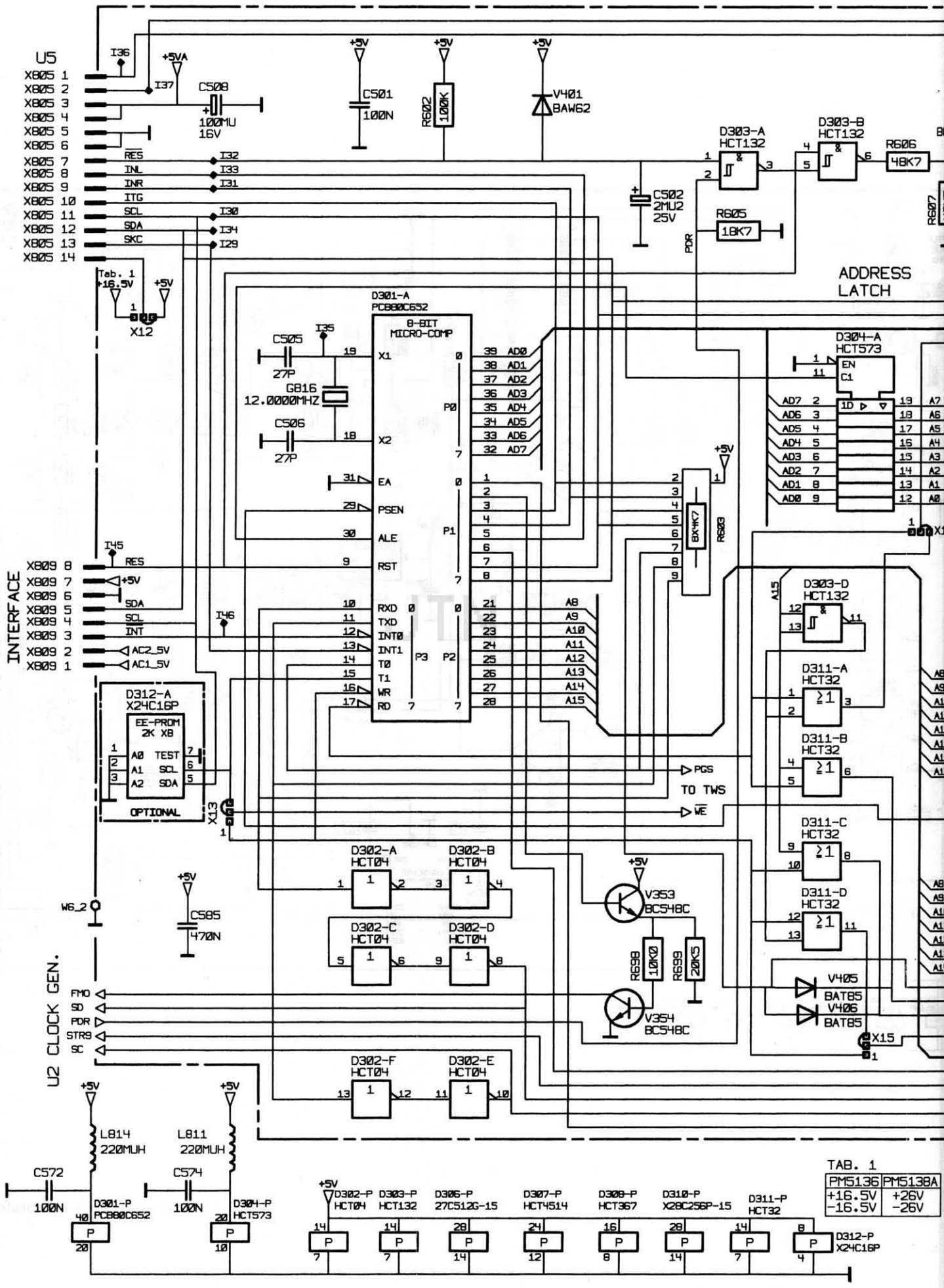


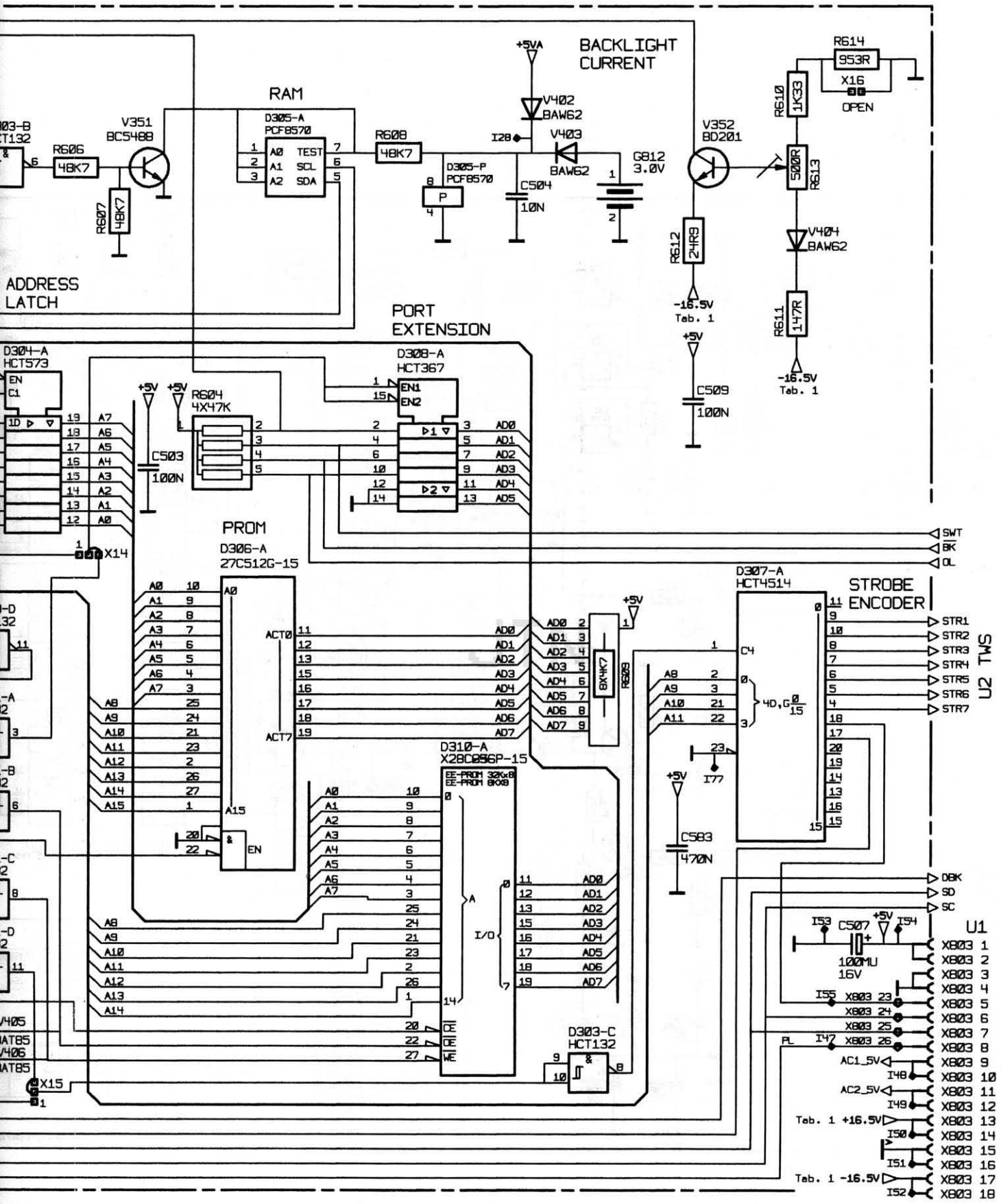
Fig. 105 Unit 2, Clock Generator

U5
X805 1
X805 2
X805 3
X805 4
X805 5
X805 6
X805 7 RES
X805 8 INL
X805 9 INR
X805 10 ITG
X805 11 SCL
X805 12 SDA
X805 13 SKC
X805 14
I36
I37
+5VA
C508 100MU 16V
+5V
C501 100N
R602 100K
V401 BAW62
I32
I33
I31
I30
I34
I29
Tab. 1 +16.5V
X12
D303-A HCT132
D303-B HCT132
R606 48K7
V351 BC548B
R607 48K7
C502 2MU2 25V
R605 18K7
PDR
ADDRESS LATCH
RAM
D305-A PCF8570
A0 TEST
A1 SCL
A2 SDA
R608 48K7
D305-P PCF8570
P
C504 10N
V402 BAW62
I28
V403 BAW62
G812 3.0V
BACKLIGHT CURRENT
V352 BD201
R614 953R
X16
OPEN
R610 1K33
R613 500R
V404 BAW62
R612 24R9
R611 147R
-16.5V Tab. 1
C509 100N
D301-A PCB80C652
8-BIT MICRO-COMP
C505 27P
G816 12.0000MHZ
C506 27P
I35
X1
X2
EA
PSEN
ALE
RST
RXD
TXD
INT0
INT1
T0
T1
WR
RD
P0
P1
P2
P3
AD0
AD1
AD2
AD3
AD4
AD5
AD6
AD7
A8
A9
A10
A11
A12
A13
A14
A15
D304-A HCT573
EN
C1
1D
R604 4X47K
C503 100N
X14
PORT EXTENSION
D308-A HCT367
EN1
EN2
1G1
2G2
PROM
D306-A 27C512G-15
A0
A1
A2
A3
A4
A5
A6
A7
A8
A9
A10
A11
A12
A13
A14
A15
ACT0
ACT7
D303-D HCT132
D311-A HCT32
D311-B HCT32
D311-C HCT32
D311-D HCT32
≥1
8X4K7
R603
D307-A HCT4514
STROBE ENCODER
STR1
STR2
STR3
STR4
STR5
STR6
STR7
U2 TWS
C4
4D,G
A8
A9
A10
A11
I77
C583 470N
D310-A X28C256P-15
EE-PROM 32Kx8
EE-PROM 8Kx8
I/O
WE
D303-C HCT132
SWT
BK
DL
DBK
SD
SC
U1
I53
C507 100MU 16V
I54
I55
I47
PL
I48
I49
I50
I51
I52
X803 1
X803 2
X803 3
X803 4
X803 5
X803 6
X803 7
X803 8
X803 9
X803 10
X803 11
X803 12
X803 13
X803 14
X803 15
X803 16
X803 17
X803 18
Tab. 1 +16.5V
Tab. 1 -16.5V
INTERFACE
X809 8 RES
X809 7 +5V
X809 6 SDA
X809 5 SCL
X809 4 INT
X809 3
X809 2 AC2_5V
X809 1 AC1_5V
I45
I46
D312-A X24C16P
EE-PROM 2K X8
OPTIONAL
X13
W6_2
C585 470N
U2 CLOCK GEN.
FMO
SD
PDR
STR9
SC
D302-A HCT04
D302-B HCT04
D302-C HCT04
D302-D HCT04
D302-F HCT04
D302-E HCT04
V353 BC548C
V354 BC548C
R698 10K0
R699 20K5
V405 BAT85
V406 BAT85
X15
PGS
TO TWS
WE
L814 220MUH
L811 220MUH
C572 100N
C574 100N
D301-P PCB80C652
D304-P HCT573
D302-P HCT04
D303-P HCT132
D306-P 27C512G-15
D307-P HCT4514
D308-P HCT367
D310-P X28C256P-15
D311-P HCT32
D312-P X24C16P
TAB. 1

PM5136	PM5138A
+16.5V	+26V
-16.5V	-26V

Fig. 106 Unit 2, CPU


U5
X805 1
X805 2
X805 3
X805 4
X805 5
X805 6
X805 7
X805 8
X805 9
X805 10
X805 11
X805 12
X805 13
X805 14
I36
I37
+5VA
C508
100MU
16V
C501
100N
R602
100K
+5V
V401
BAW62
D303-A
HCT132
D303-B
HCT132
R606
48K7
C502
2MU2
25V
R605
18K7
PDR
RES
INL
INR
ITG
SCL
SDA
SKC
I32
I33
I31
I30
I34
I29
ADDRESS
LATCH
Tab. 1
+16.5V
X12
D301-A
PCB80C652
8-BIT
MICRO-COMP
C505
27P
G816
12.0000MHZ
C506
27P
I35
X1
X2
EA
PSEN
ALE
RST
RXD
TXD
INT0
INT1
T0
T1
WR
RD
P0
P1
P2
P3
AD0
AD1
AD2
AD3
AD4
AD5
AD6
AD7
D304-A
HCT573
EN
C1
1D
A7
A6
A5
A4
A3
A2
A1
A0
8K*K7
R603
A8
A9
A10
A11
A12
A13
A14
A15
D303-D
HCT132
D311-A
HCT32
D311-B
HCT32
D311-C
HCT32
D311-D
HCT32
INTERFACE
X809 8
X809 7
X809 6
X809 5
X809 4
X809 3
X809 2
X809 1
I45
I46
RES
+5V
SDA
SCL
INT
AC2_5V
AC1_5V
D312-A
X24C16P
EE-PROM
2K X8
A0
A1
A2
TEST
SCL
SDA
OPTIONAL
X13
PGS
TO TWS
WE
D302-A
HCT04
D302-B
HCT04
D302-C
HCT04
D302-D
HCT04
D302-E
HCT04
D302-F
HCT04
W6_2
C585
470N
V353
BC548C
V354
BC548C
R698
10K0
R699
20K5
V405
BAT85
V406
BAT85
X15
U2 CLOCK GEN.
FMO
SD
PDR
STR9
SC
L814
220MUH
L811
220MUH
C572
100N
C574
100N
D301-P
PCB80C652
D304-P
HCT573
TAB. 1
PM5136
PM5138A
+16.5V
-16.5V
+26V
-26V
D302-P
HCT04
D303-P
HCT132
D306-P
27C512G-15
D307-P
HCT4514
D308-P
HCT367
D310-P
X28C256P-15
D311-P
HCT32
D312-P
X24C16P



TAB. 1

PM5136	PM5138A
+16.5V	+26V
-16.5V	-26V

D312-P
X24C16P

Fig. 106 Unit 2, CPU

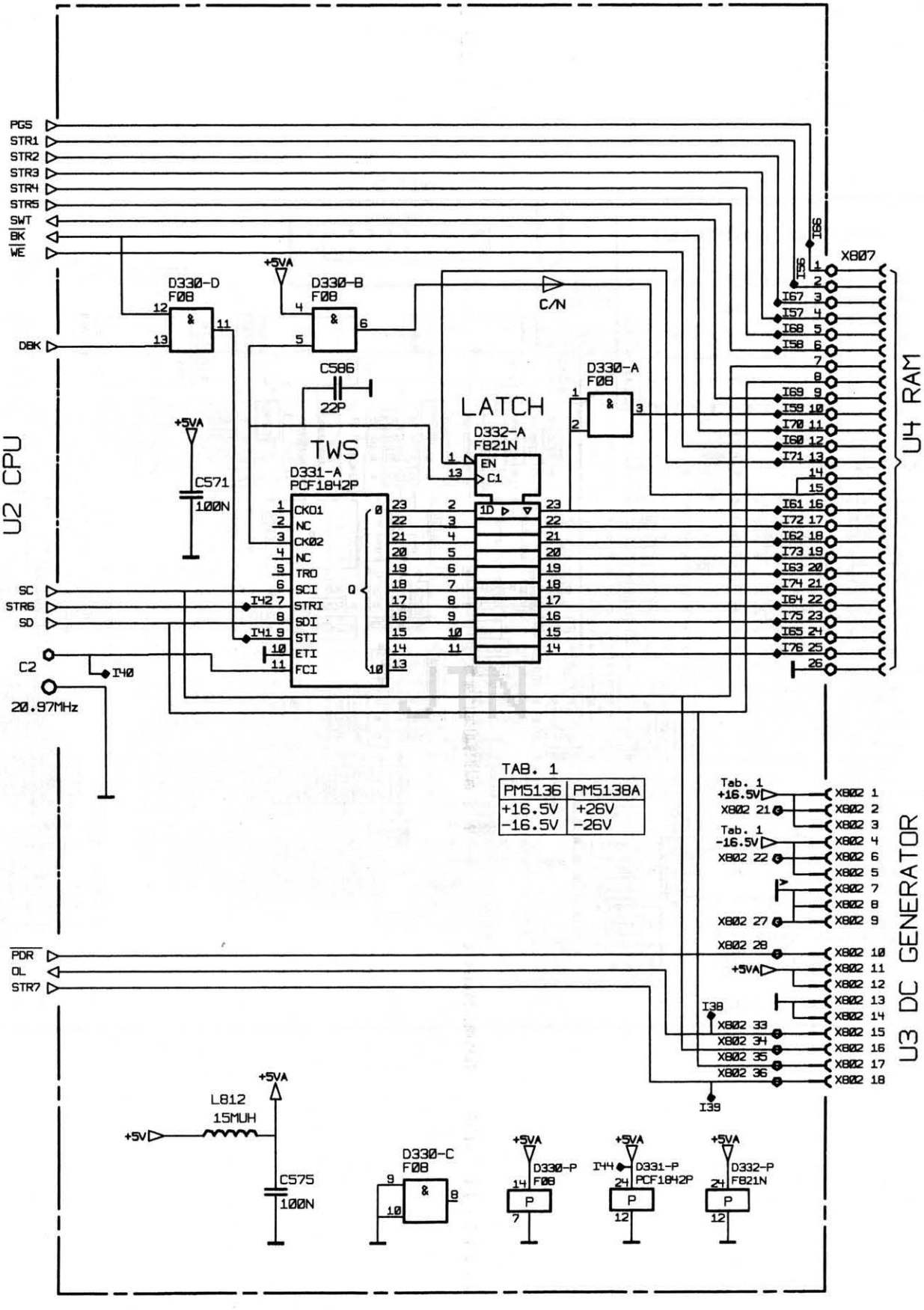


Fig. 107 Unit 2, Triangle Wave Synthesizer (TWS)

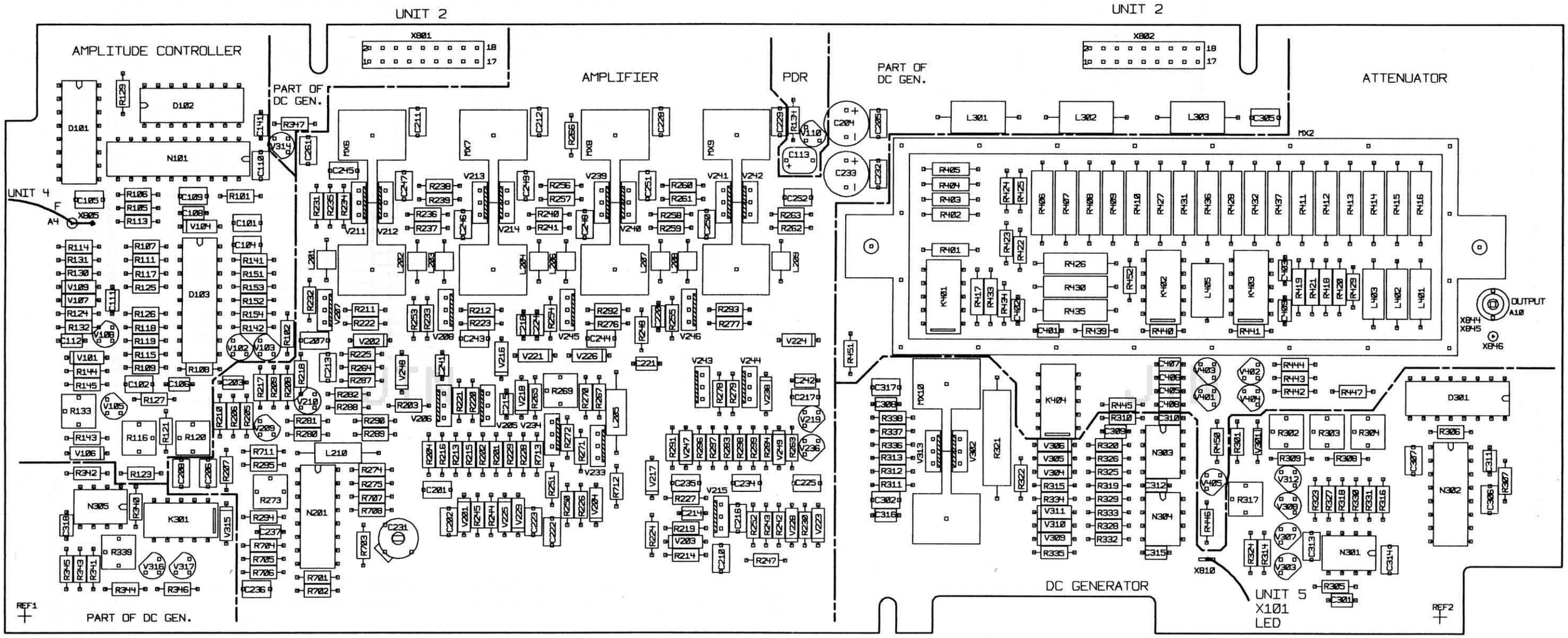
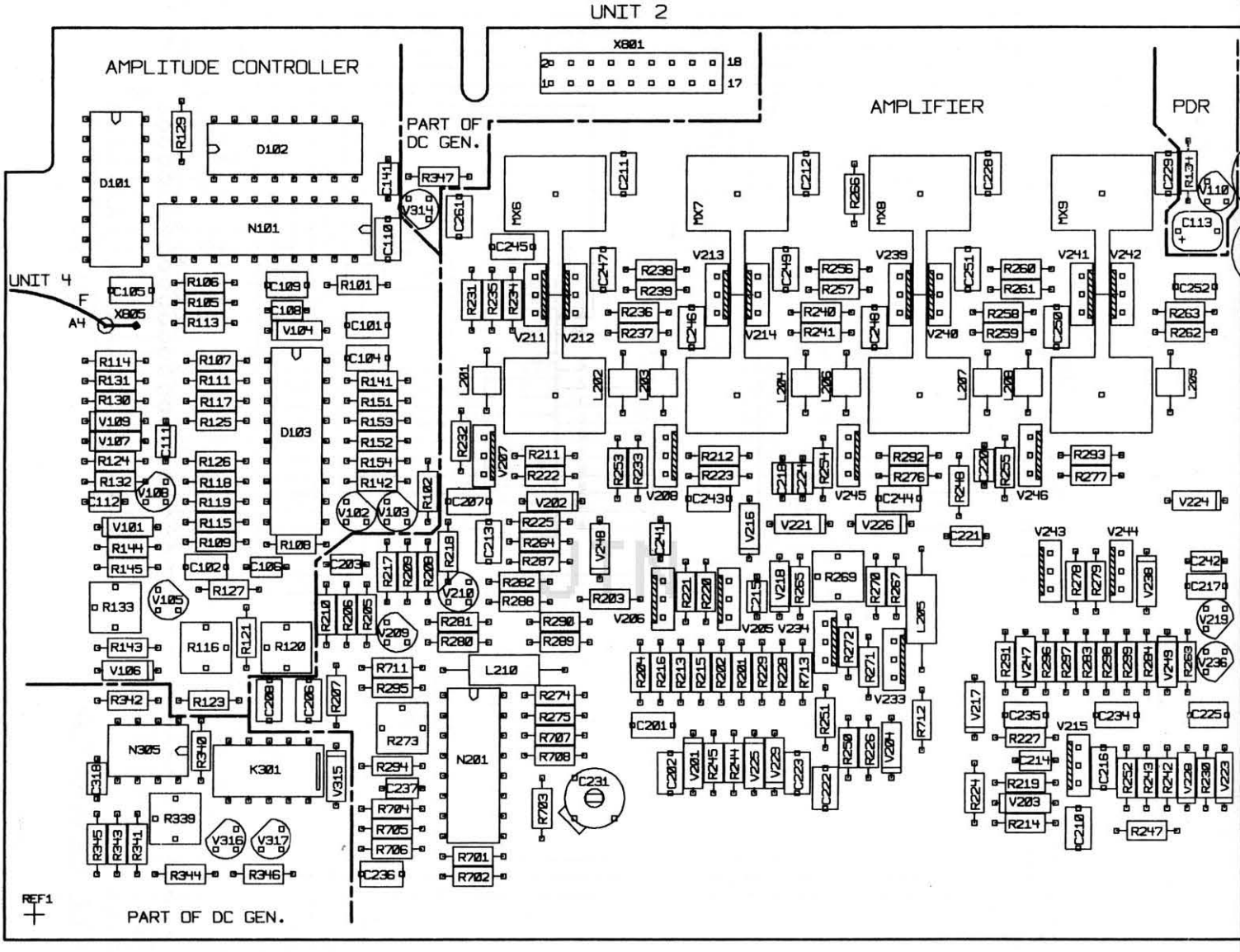


Fig. 108 Unit 3, Component Layout


UNIT 2
AMPLITUDE CONTROLLER
PART OF DC GEN.
AMPLIFIER
PDR
X801
18
17
UNIT 4
F
A4
X805
D101
D102
N101
D103
K301
N305
N201
L210
MX6
MX7
MX8
MX9
REF1
PART OF DC GEN.

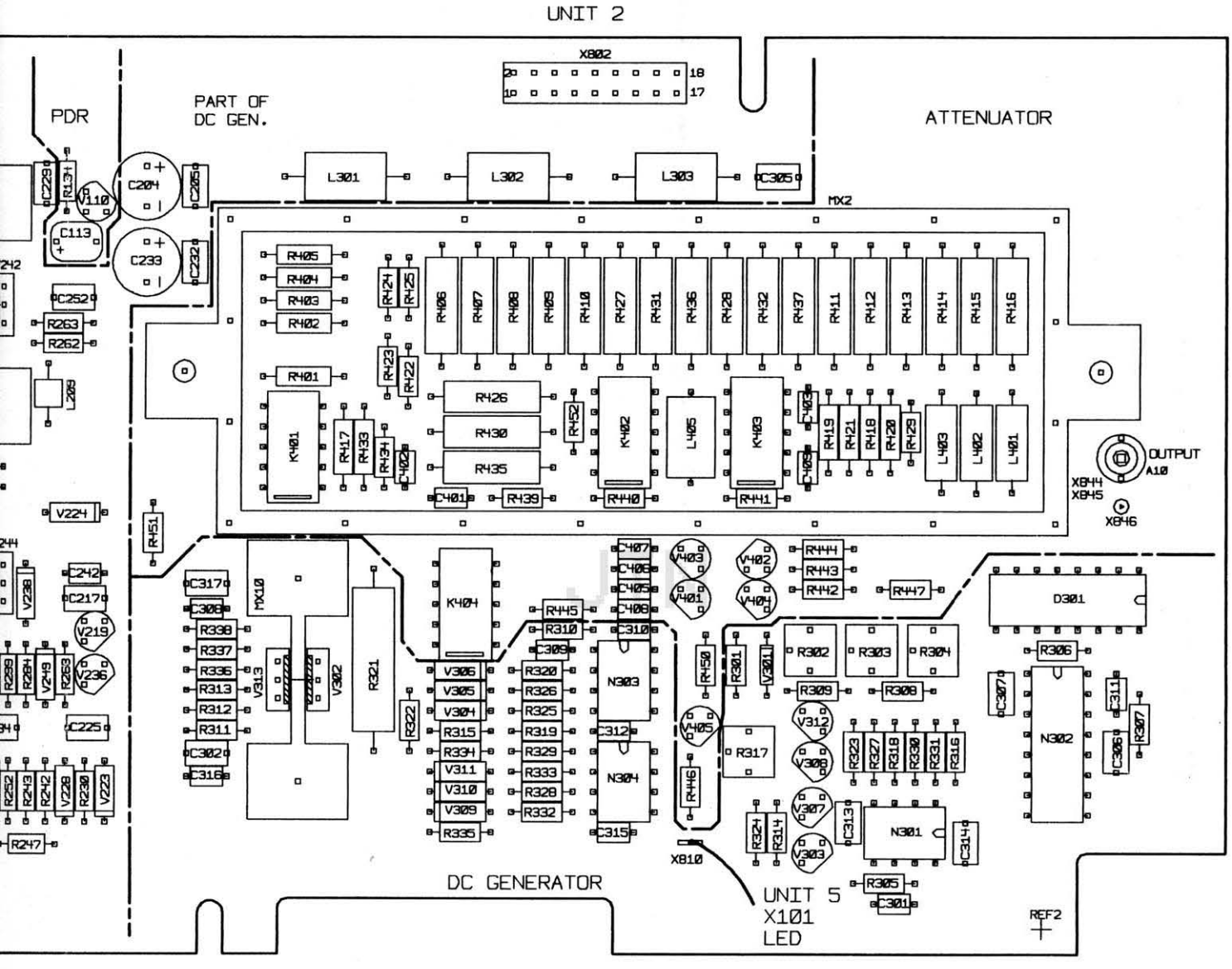
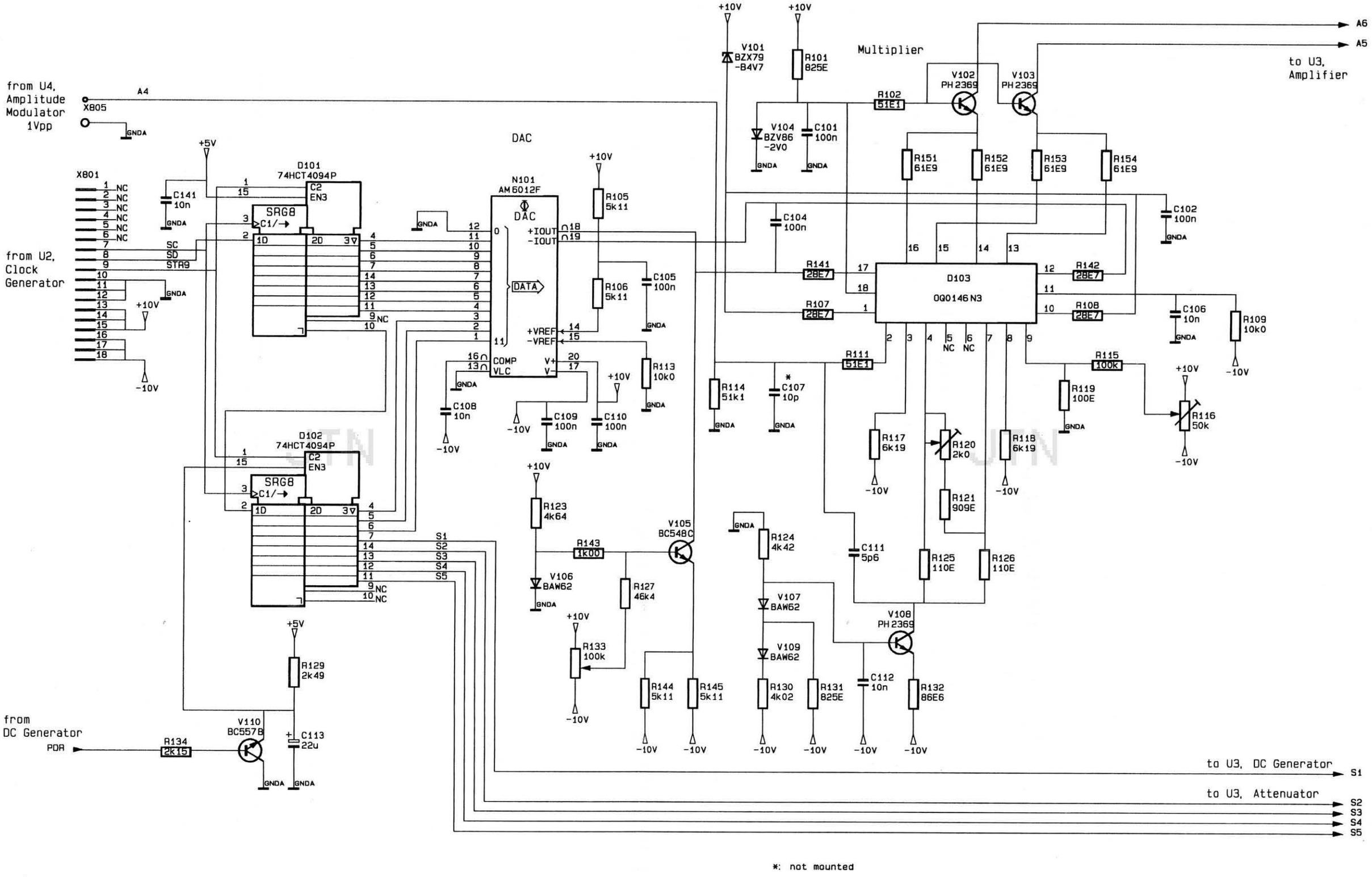
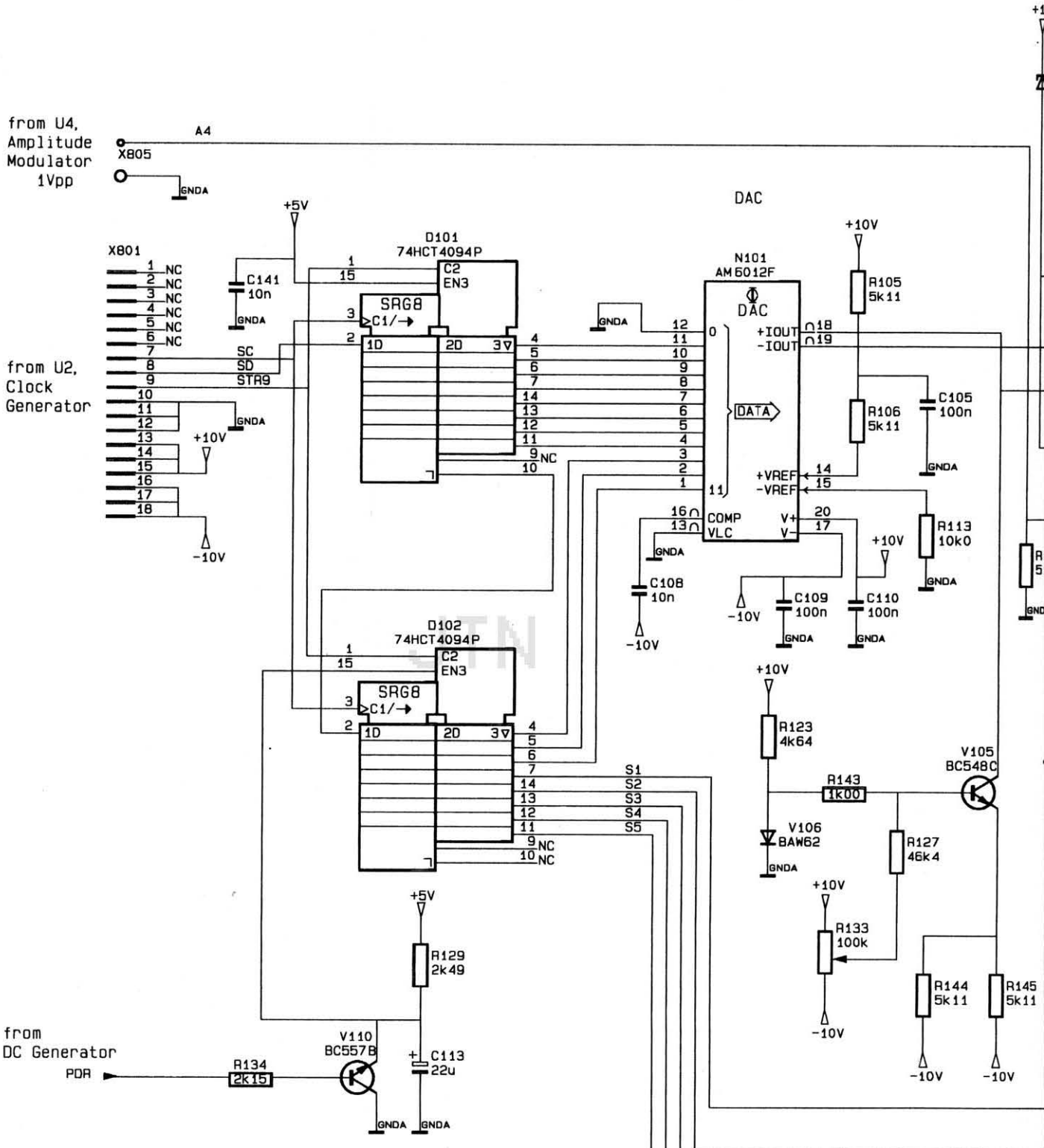


Fig. 108 Unit 3, Component Layout



*: not mounted

Fig. 109 Unit 3, Amplitude Controller


from U4,
Amplitude
Modulator
1Vpp
A4
X805
GNDA
DAC
+5V
+10V
X801
D101
74HCT4094P
N101
AM6012F
C141
10n
SRG8
C2
EN3
C1/→
1D
2D
3▽
DAC
R105
5k11
R106
5k11
C105
100n
from U2,
Clock
Generator
SC
SD
STR9
NC
DATA
+IOUT
-IOUT
+VREF
-VREF
COMP
VLC
V+
V-
R113
10k0
C108
10n
C109
100n
C110
100n
-10V
D102
74HCT4094P
R123
4k64
V105
BC548C
R143
1k00
V106
BAW62
R127
46k4
R133
100k
R144
5k11
R145
5k11
S1
S2
S3
S4
S5
R129
2k49
from
DC Generator
PDR
R134
2k15
V110
BC557B
C113
22u

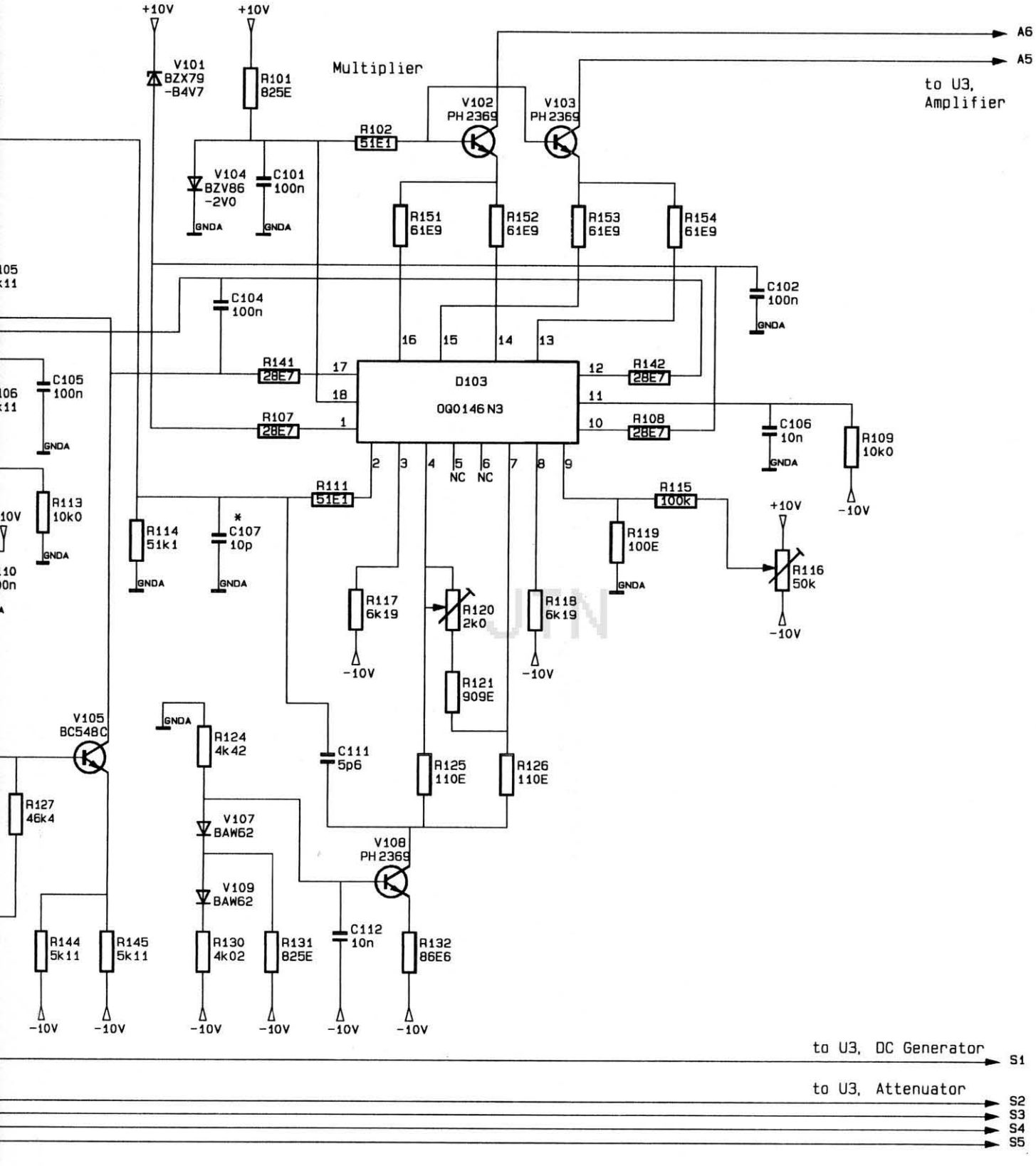


Fig. 109 Unit 3, Amplitude Controller

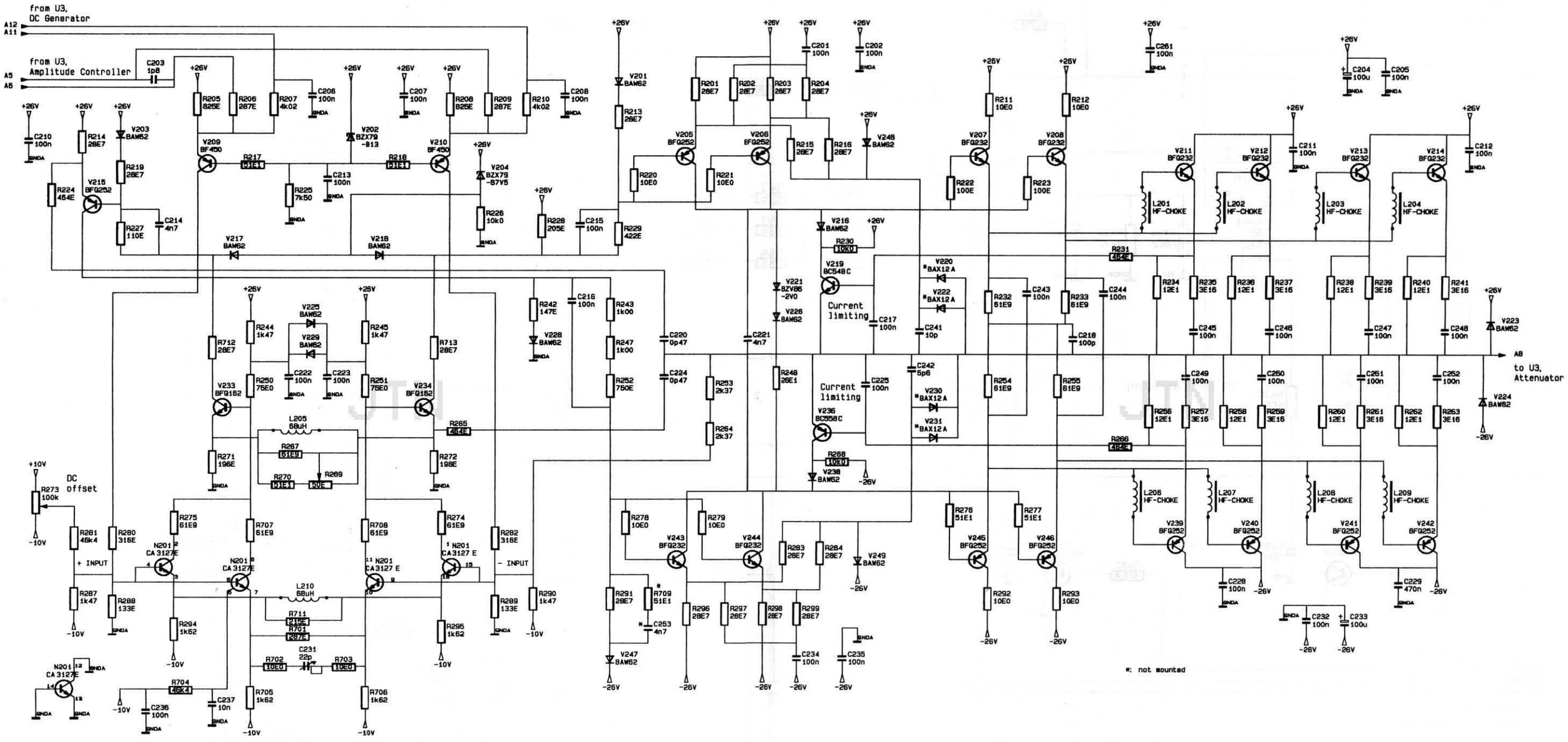
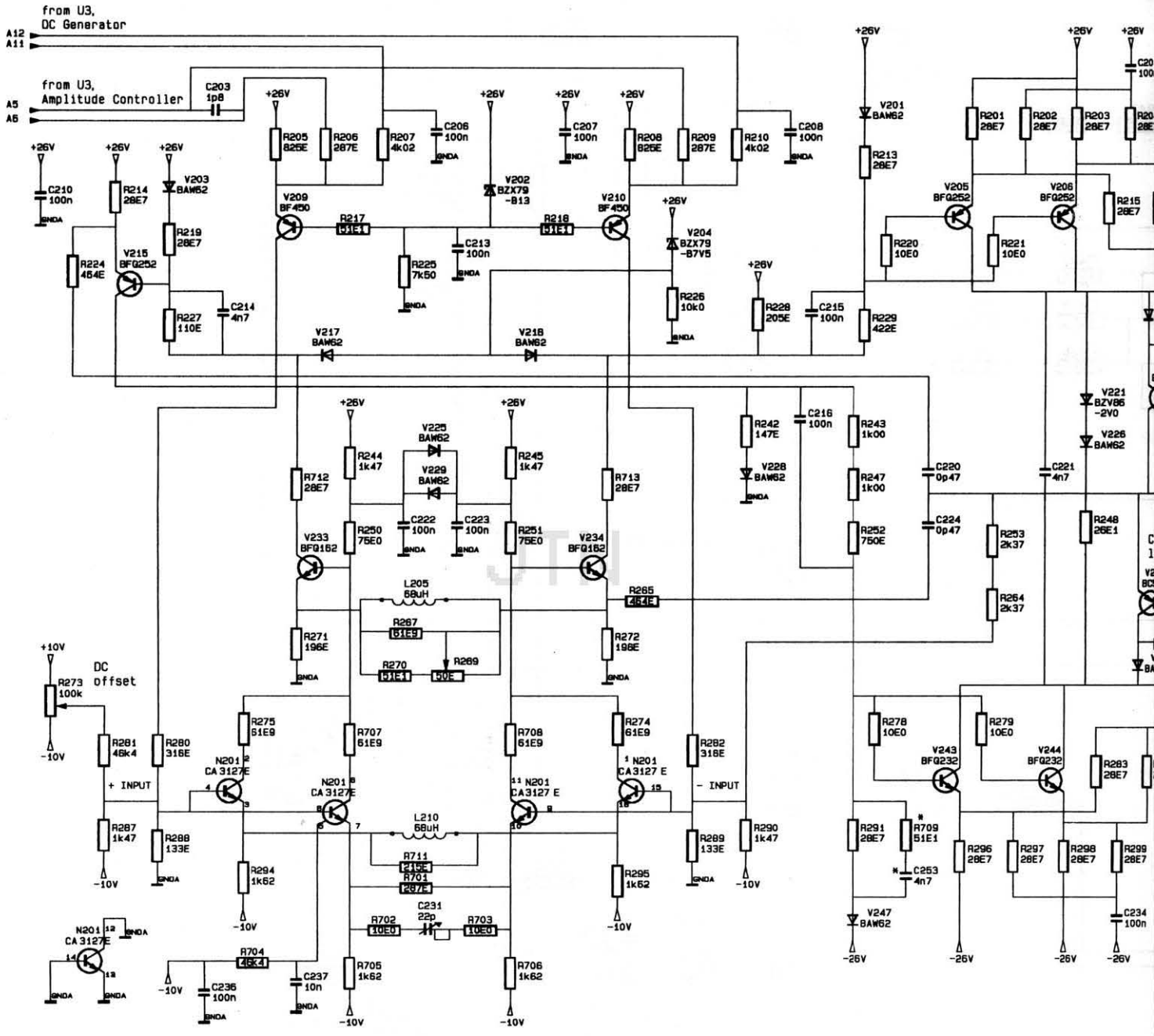


Fig. 110 Unit 3, Amplifier


from U3,
DC Generator
A12
A11
from U3,
Amplitude Controller
A5
A6
C203 1p8
+26V
R205 825E
R206 287E
R207 4k02
C206 100n
GNDA
V202 BZX79 -B13
C207 100n
R208 825E
R209 287E
R210 4k02
C208 100n
V201 BAW62
R213 28E7
R201 28E7
R202 28E7
R203 28E7
C210 100n
R214 28E7
V203 BAW62
R219 28E7
V209 BF450
R217 51E1
R218 51E1
V210 BF450
V204 BZX79 -B7V5
R226 10k0
R228 205E
C215 100n
R229 422E
V205 BFQ252
V206 BFQ252
R215 28E7
R220 10E0
R221 10E0
R224 464E
V215 BFQ252
R225 7k50
C213 100n
R227 110E
C214 4n7
V217 BAW62
V218 BAW62
V221 BZV85 -2V0
V226 BAW62
V225 BAW62
V229 BAW62
R244 1k47
R245 1k47
R712 28E7
R713 28E7
R242 147E
C216 100n
R243 1k00
R247 1k00
R252 750E
V228 BAW62
C220 0p47
C224 0p47
C221 4n7
R248 26E1
R253 2k37
R264 2k37
R250 75E0
R251 75E0
C222 100n
C223 100n
V233 BFQ152
V234 BFQ152
L205 68uH
R265 464E
R267 61E9
R269 50E
R270 51E1
R271 196E
R272 198E
+10V
R273 100k
DC Offset
-10V
R281 46k4
+ INPUT
R280 316E
R287 1k47
R288 133E
R275 61E9
R707 61E9
R708 61E9
R274 61E9
N201 CA3127E
R282 316E
- INPUT
R289 133E
R290 1k47
R294 1k62
R295 1k62
L210 68uH
R711 215E
R701 287E
C231 22p
R702 10E0
R703 10E0
R704 46K4
C236 100n
C237 10n
R705 1k62
R706 1k62
R278 10E0
R279 10E0
V243 BFQ232
V244 BFQ232
R283 28E7
R291 28E7
R709 51E1
C253 4n7
R296 28E7
R297 28E7
R298 28E7
R299 28E7
V247 BAW62
C234 100n
-26V

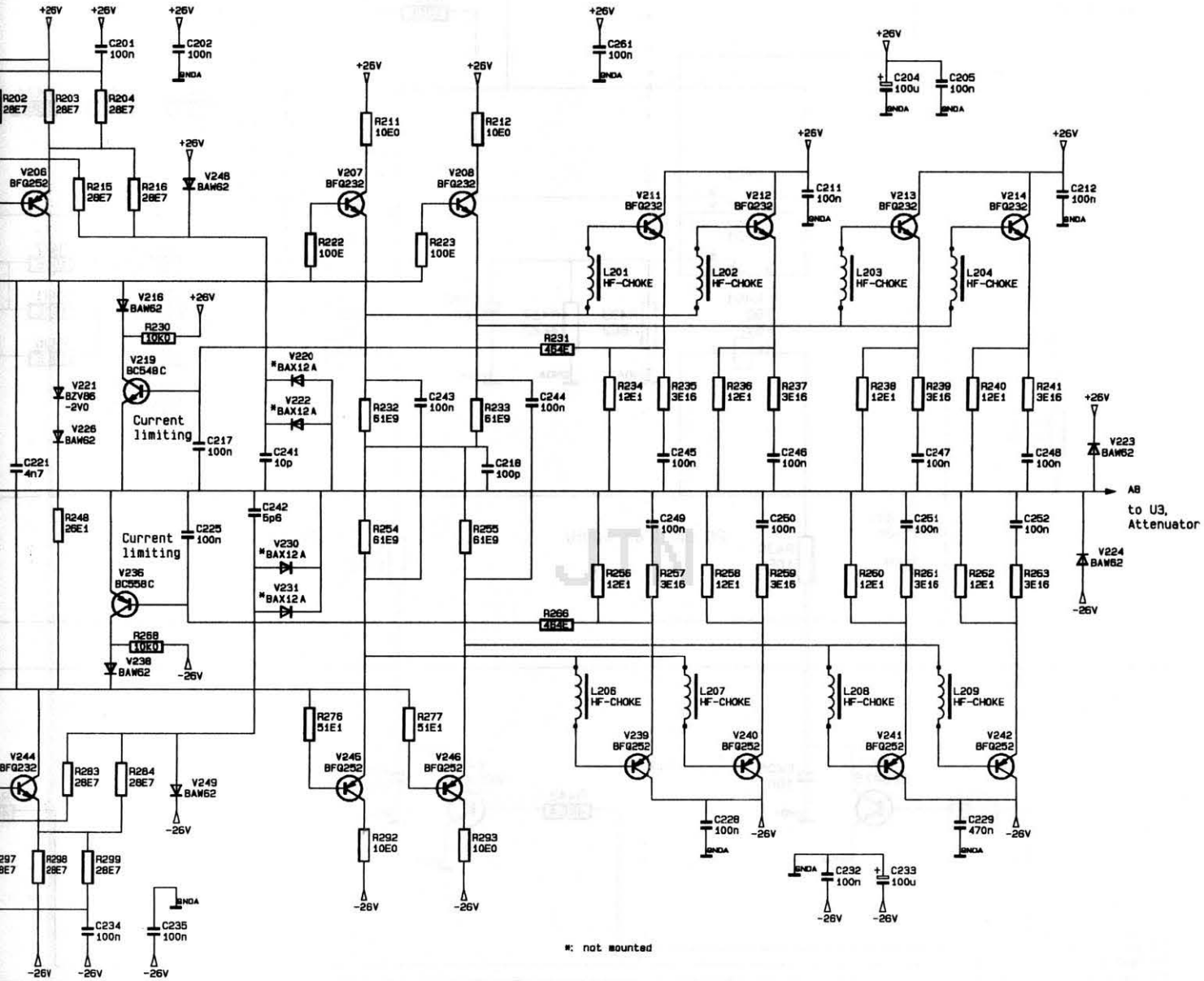
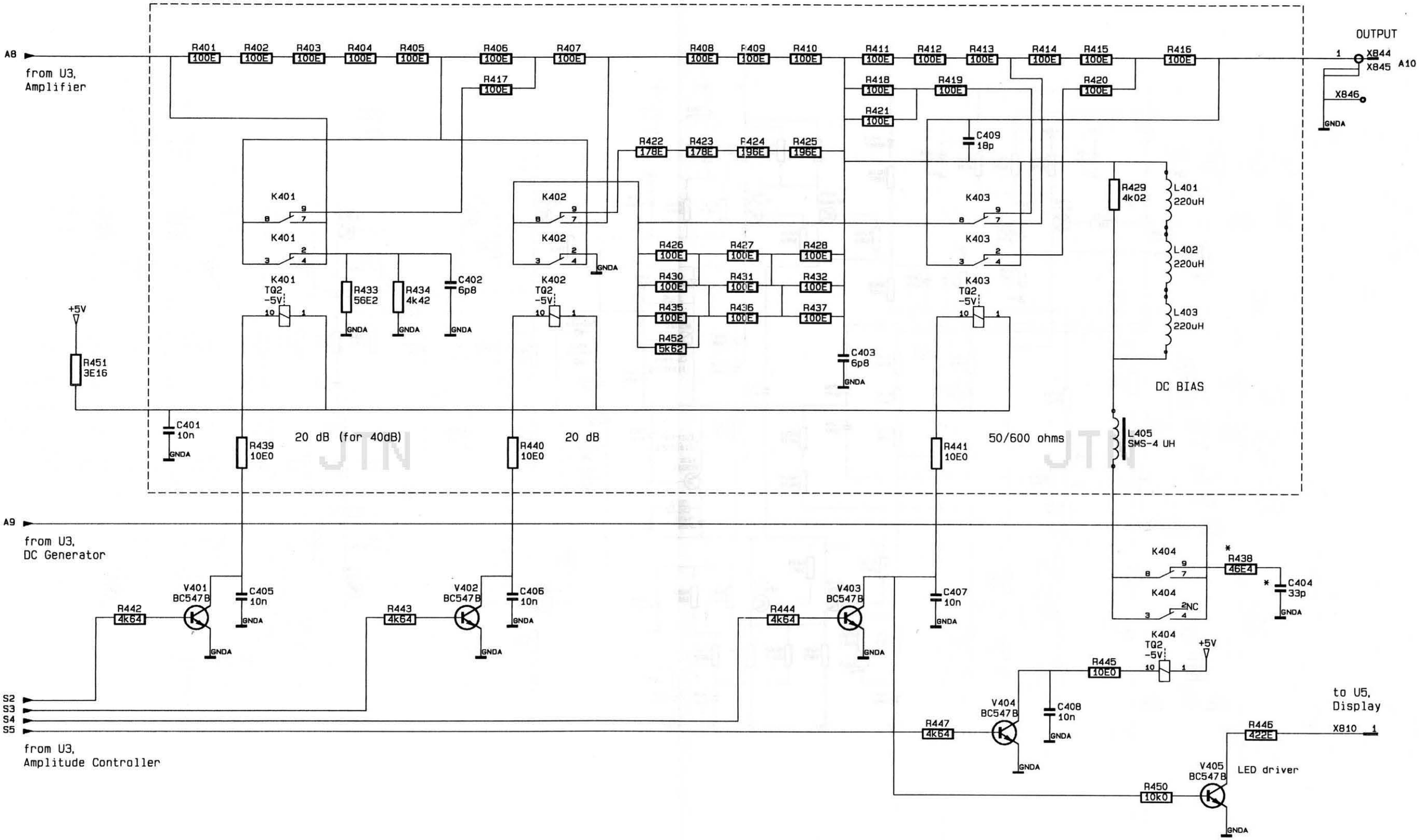
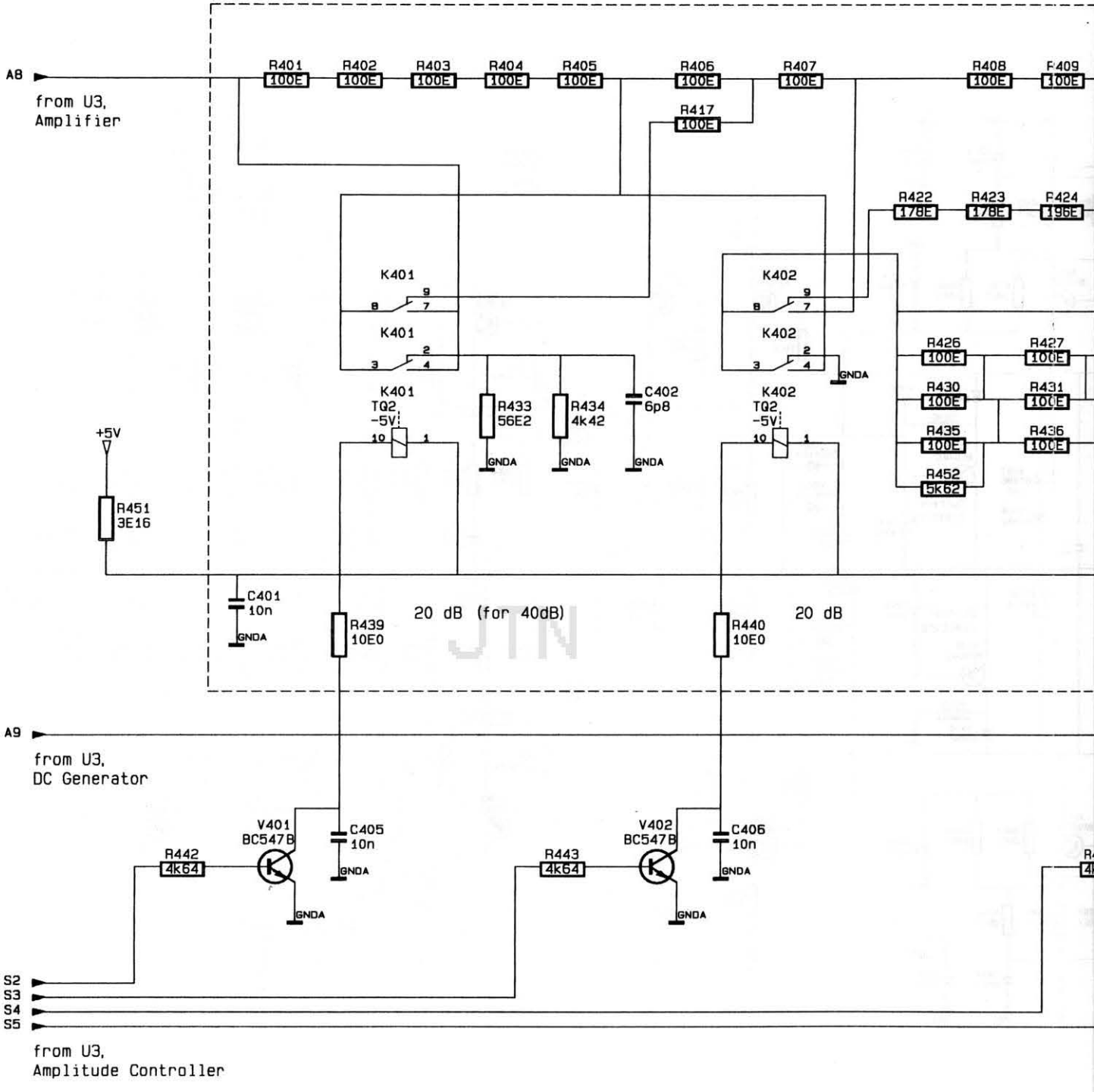


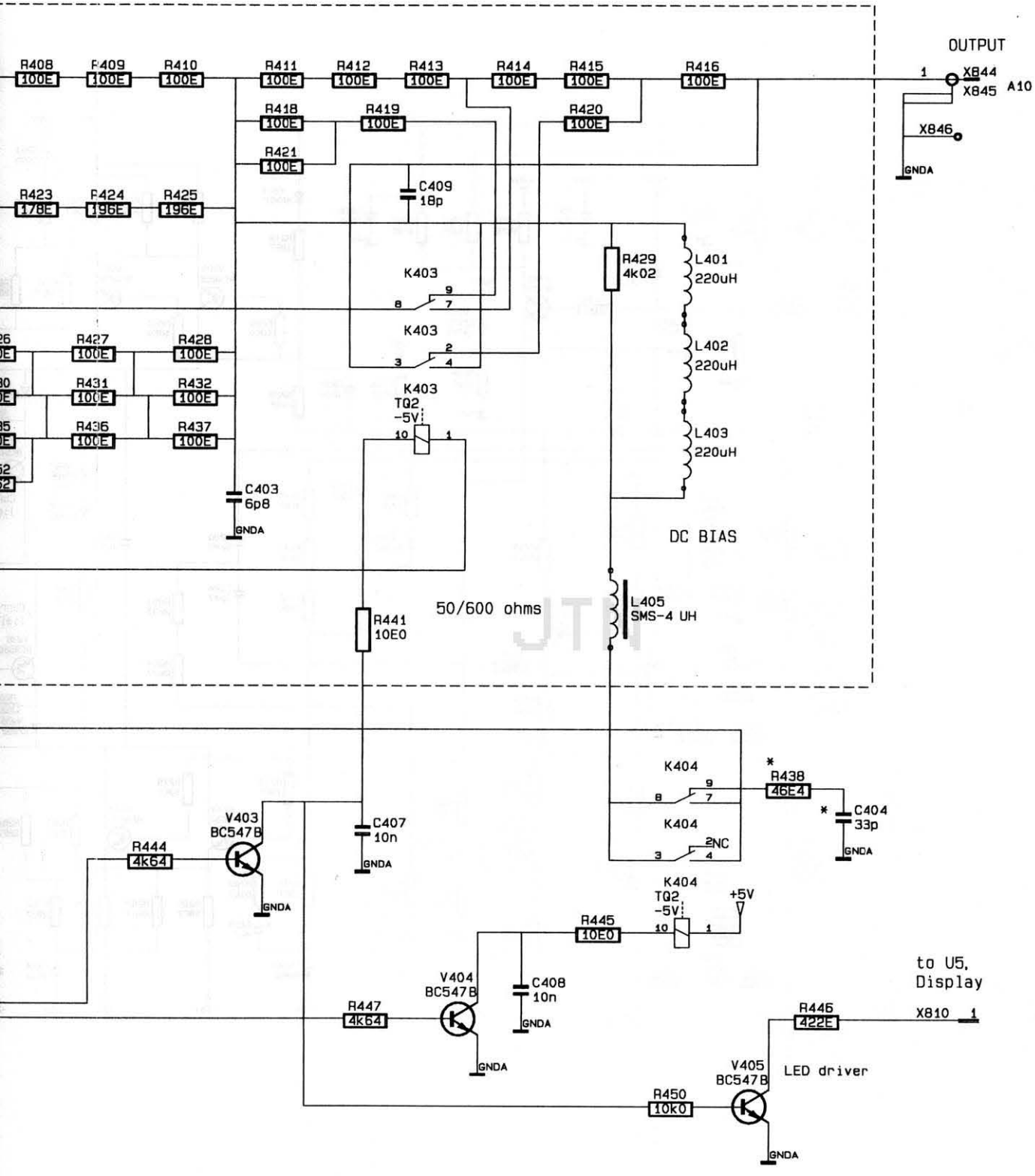
Fig. 110 Unit 3, Amplifier



* not mounted

Fig. 111 Unit 3, Attenuator


A8
from U3,
Amplifier
R401 100E
R402 100E
R403 100E
R404 100E
R405 100E
R406 100E
R407 100E
R408 100E
R409 100E
R417 100E
R422 178E
R423 178E
R424 196E
K401
K402
R426 100E
R427 100E
R430 100E
R431 100E
R435 100E
R436 100E
R452 5k62
+5V
R451 3E16
C401 10n
GNDA
R439 10E0
20 dB (for 40dB)
R440 10E0
20 dB
R433 56E2
R434 4k42
C402 6p8
TQ2 -5V
A9
from U3,
DC Generator
V401 BC547B
V402 BC547B
C405 10n
C406 10n
R442 4k64
R443 4k64
S2
S3
S4
S5
from U3,
Amplitude Controller
* not



* not mounted

Fig. 111 Unit 3, Attenuator

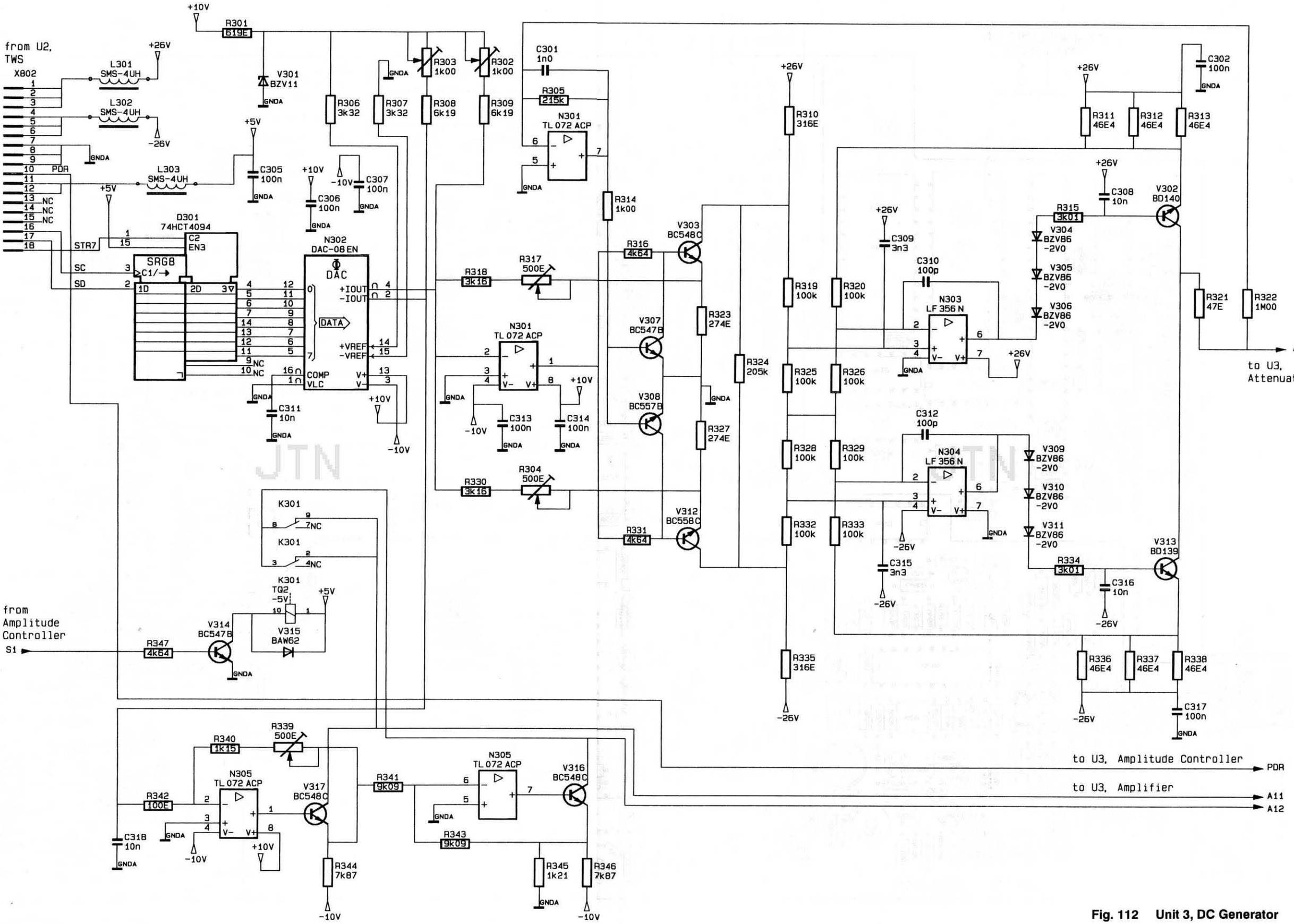
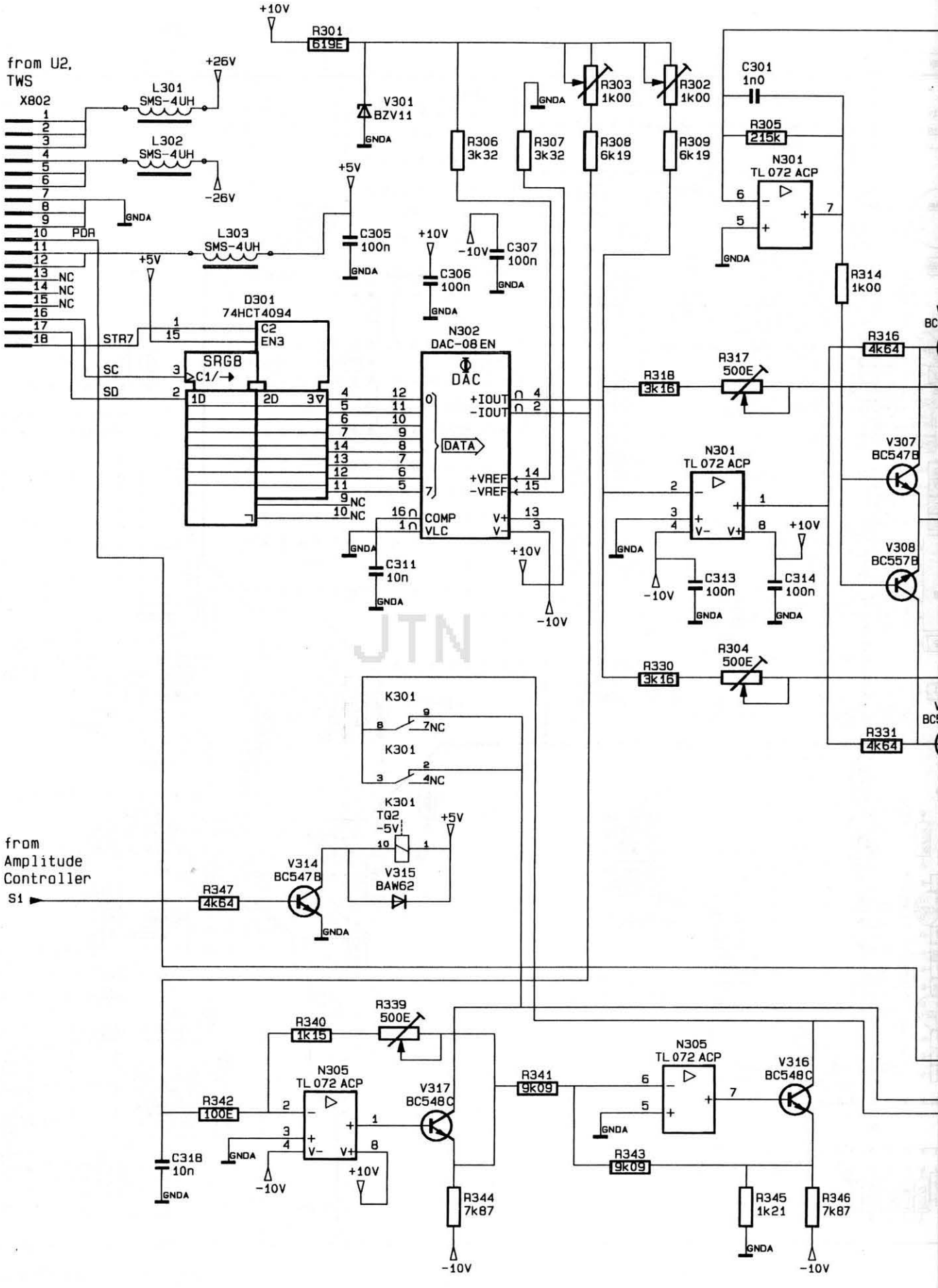


Fig. 112 Unit 3, DC Generator


from U2,
TWS
X802
L301
SMS-4UH
+26V
L302
SMS-4UH
-26V
GNDA
PDR
L303
SMS-4UH
NC
NC
NC
+5V
R301
619E
V301
BZV11
R306
3k32
R307
3k32
R303
1k00
R308
6k19
R302
1k00
R309
6k19
C305
100n
C306
100n
C307
100n
+10V
-10V
D301
74HCT4094
STR7
SC
SD
SRGB
C2
EN3
C1/→
1D
2D
3D
N302
DAC-08 EN
DAC
DATA
+IOUT
-IOUT
+VREF
-VREF
COMP
VLC
V+
V-
NC
C311
10n
C301
1n0
R305
215k
N301
TL 072 ACP
R314
1k00
R316
4k64
R317
500E
R318
3k16
V307
BC547B
V308
BC557B
N301
TL 072 ACP
C313
100n
C314
100n
R304
500E
R330
3k16
R331
4k64
K301
NC
K301
NC
K301
TQ2
-5V
+5V
V314
BC547B
V315
BAW62
from
Amplitude
Controller
S1
R347
4k64
R339
500E
R340
1k15
N305
TL 072 ACP
R342
100E
C318
10n
V317
BC548C
R341
9k09
N305
TL 072 ACP
V316
BC548C
R343
9k09
R344
7k87
R345
1k21
R346
7k87

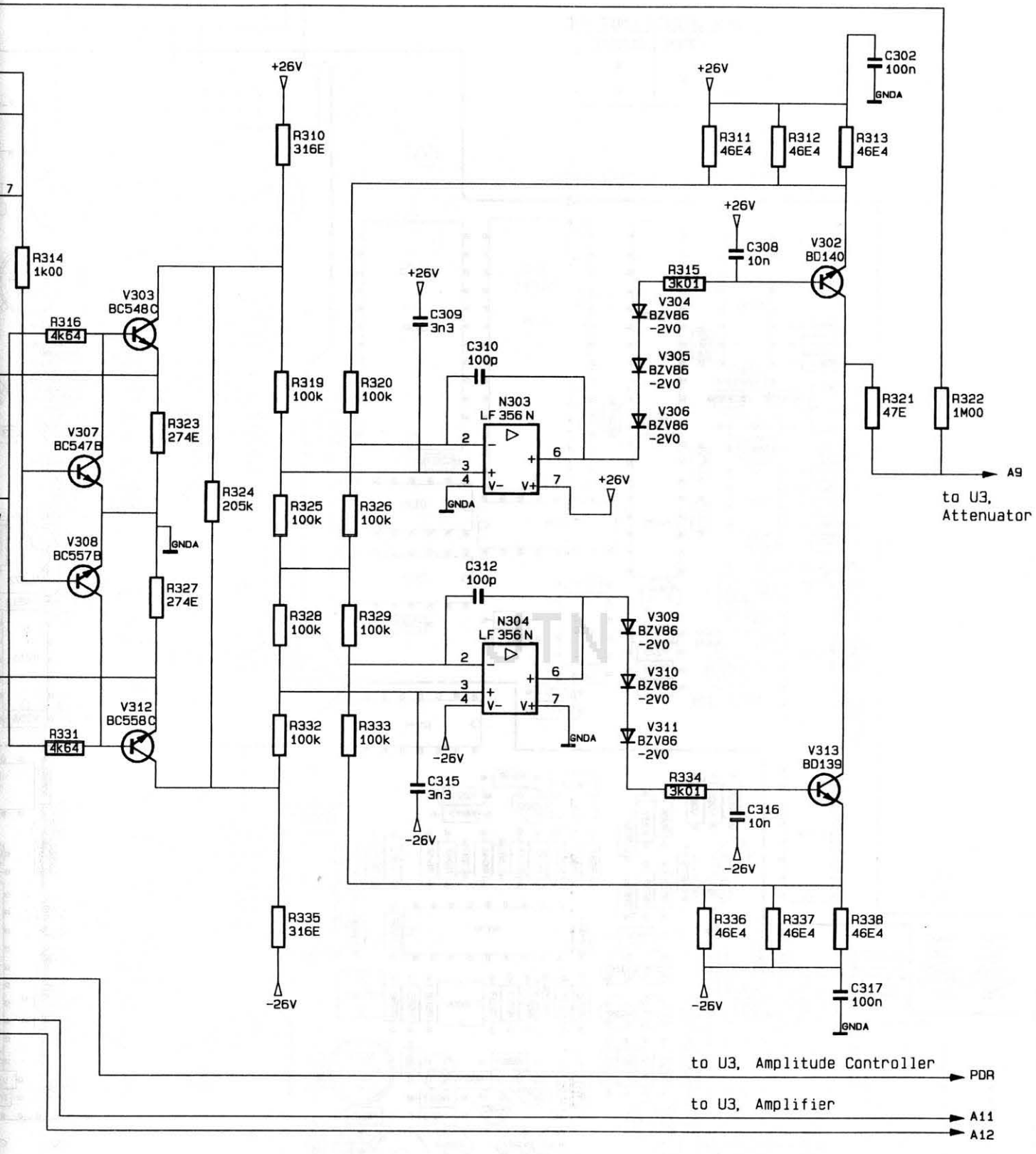


Fig. 112 Unit 3, DC Generator

SOLDER JOINTS UNIT 4		
	OPEN	CLOSED
S1-S4		X
S5	X	
S6-S8		X

UNIT 1

UNIT 2

MODULATION OSCILLATOR

PULSE GENERATOR

TTL OUT

BURST

LOGIC

RAM

DAC

LOWPASS FILTER

FREQUENCY MULTIPLIER

AMPLITUDE MODULATOR

MOD IN

MOD OUT

M1

A4

T3

S1

S2

S3

S4

S5

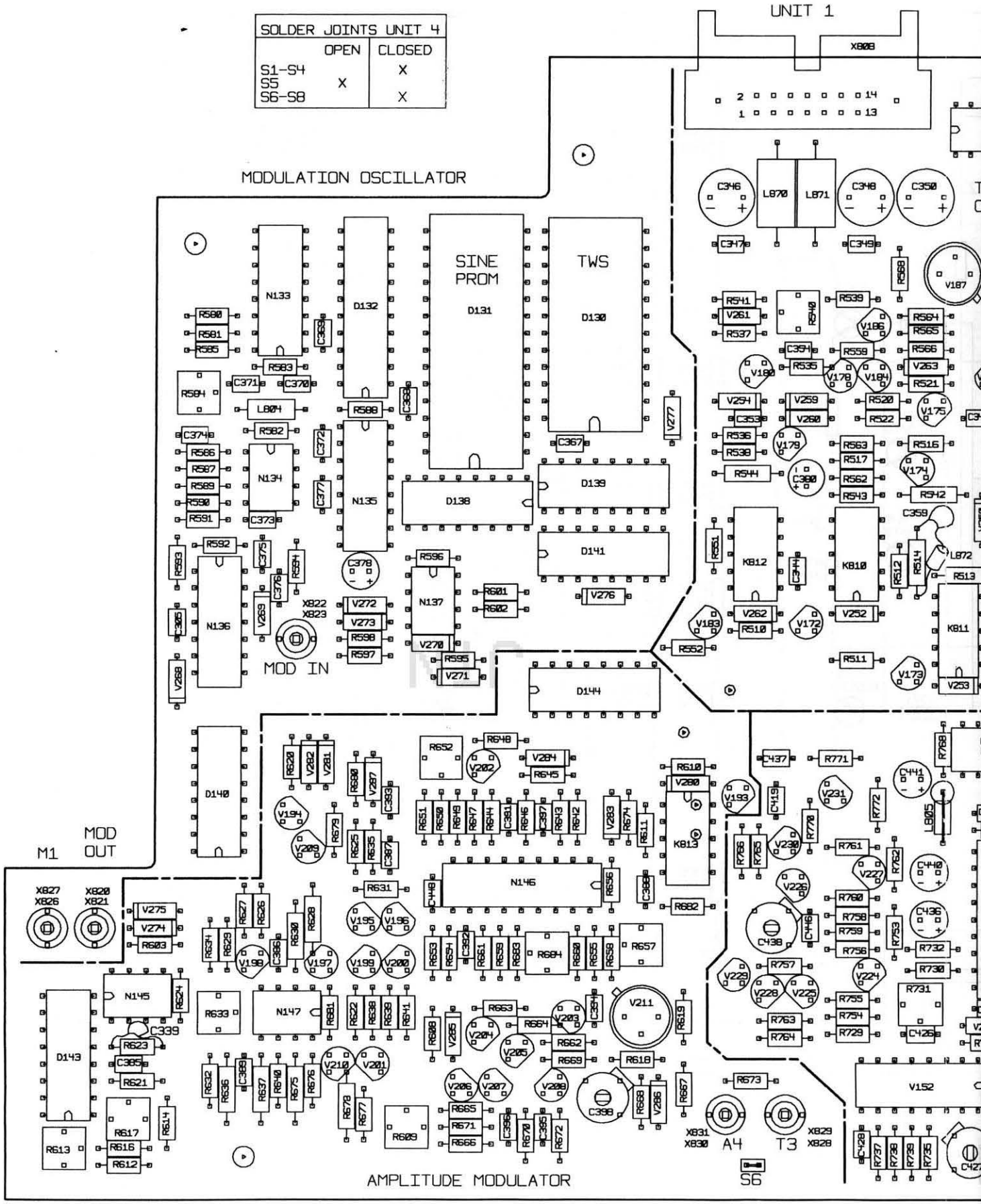
S6

S7

S8

Fig. 113 Unit 4, Component Layout

SOLDER JOINTS UNIT 4		
	OPEN	CLOSED
S1-S4		X
S5	X	
S6-S8		X



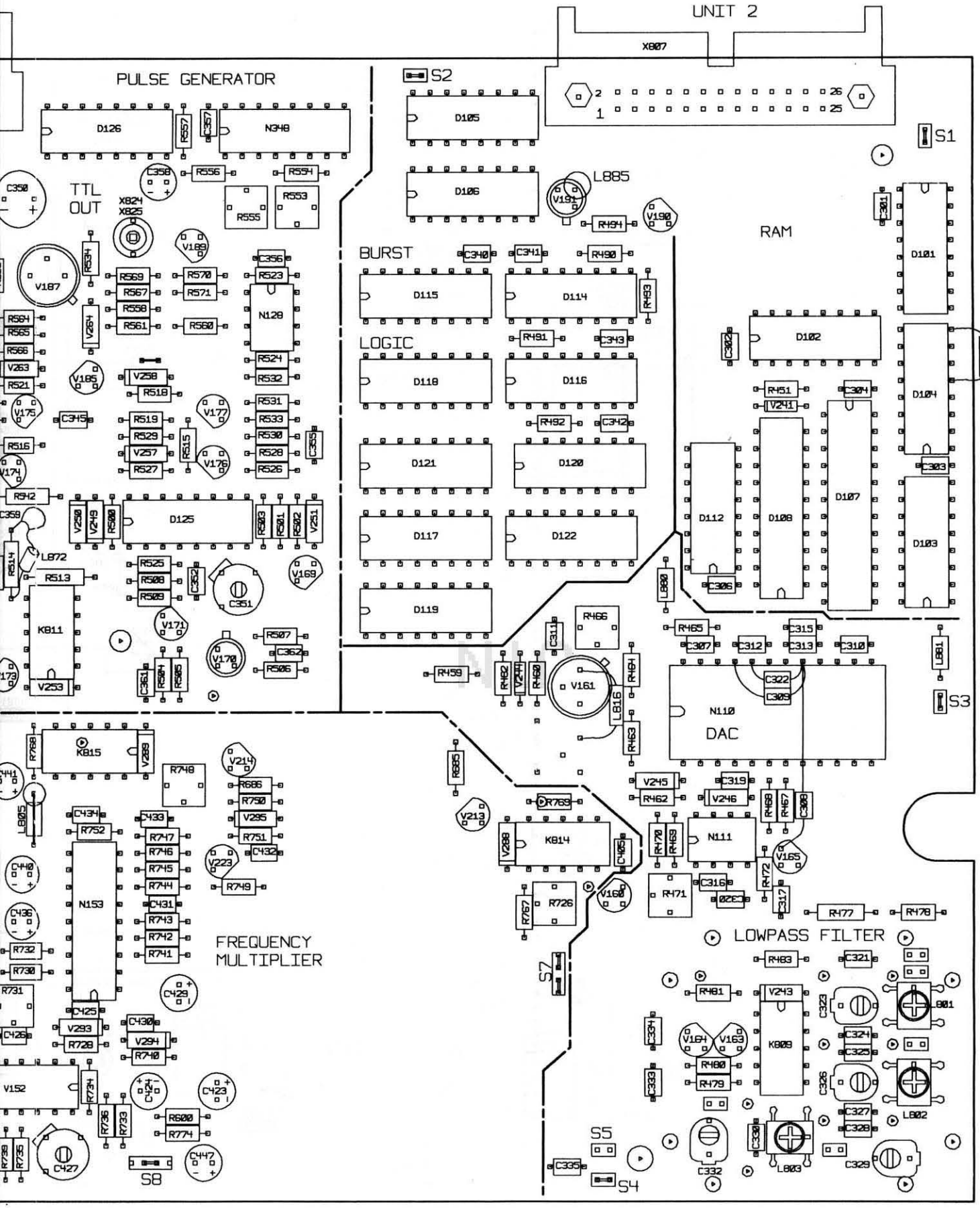


Fig. 113 Unit 4, Component Layout

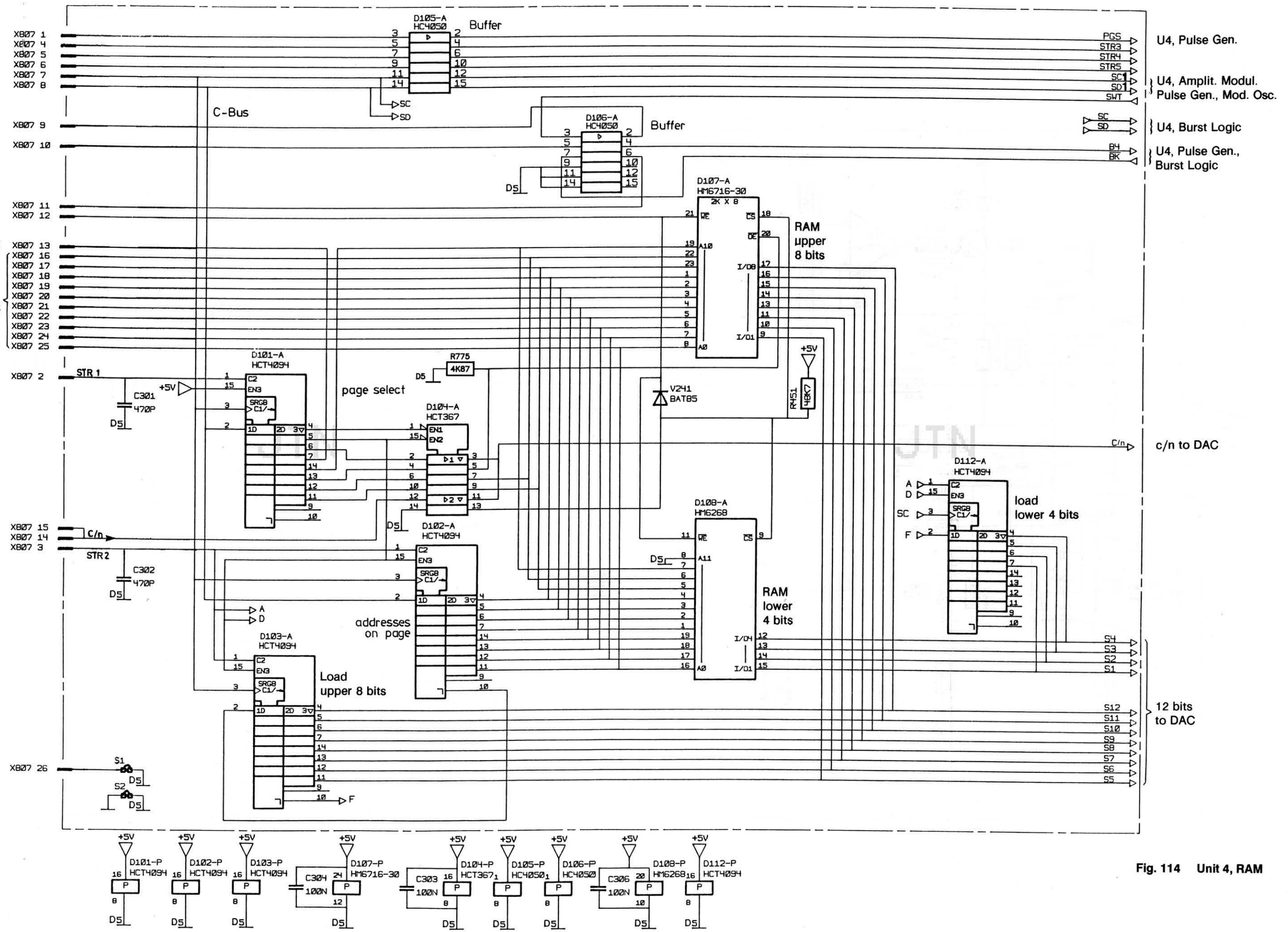
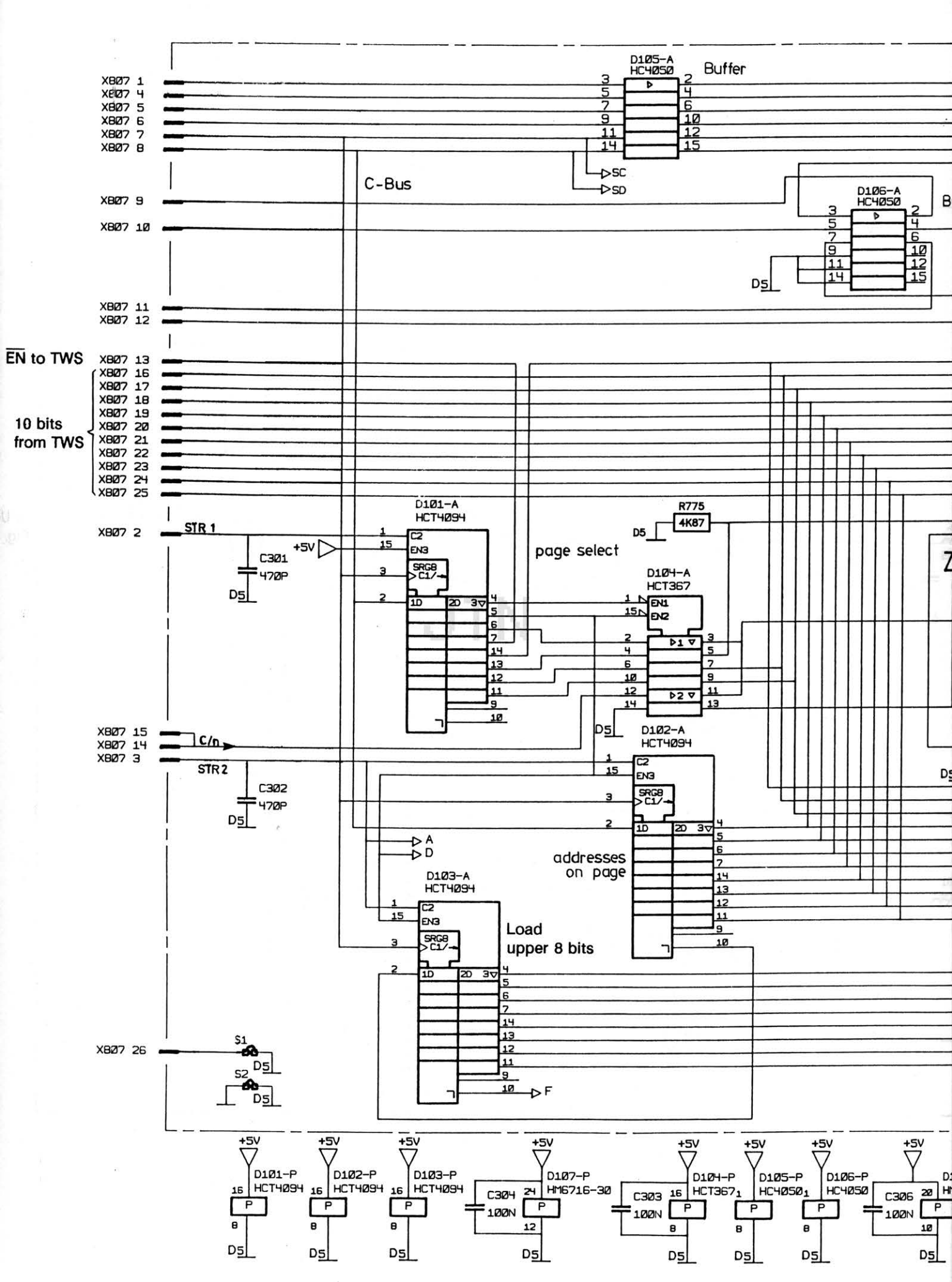


Fig. 114 Unit 4, RAM


X807 1
X807 4
X807 5
X807 6
X807 7
X807 8
X807 9
X807 10
X807 11
X807 12
X807 13
X807 16
X807 17
X807 18
X807 19
X807 20
X807 21
X807 22
X807 23
X807 24
X807 25
X807 2
X807 15
X807 14
X807 3
X807 26
EN to TWS
10 bits from TWS
STR 1
STR2
C/n
C-Bus
Buffer
D105-A HC4050
D106-A HC4050
D101-A HCT4094
D102-A HCT4094
D103-A HCT4094
D104-A HCT367
R775 4K87
C301 470P
C302 470P
page select
addresses on page
Load upper 8 bits
S1
S2
+5V
D5
SC
SD
A
D
F
D101-P HCT4094
D102-P HCT4094
D103-P HCT4094
C304 100N
D107-P HM6716-30
C303 100N
D104-P HCT367
D105-P HC4050
D106-P HC4050
C306 100N

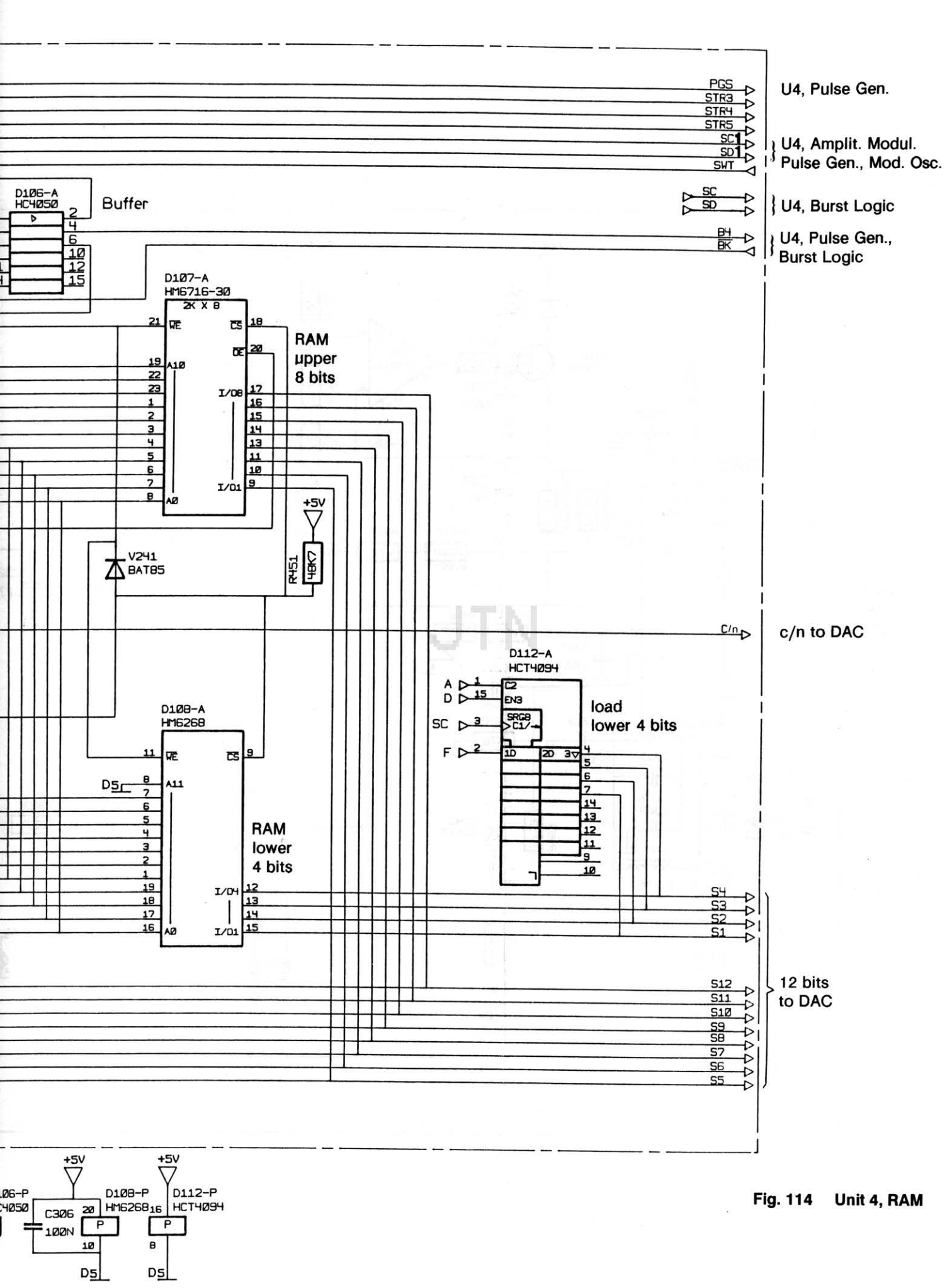


Fig. 114 Unit 4, RAM

DAC

Low-pass filter 5MHz

Buffer

fc < 5 MHz:
fc > 20kHz:
ref. sine for

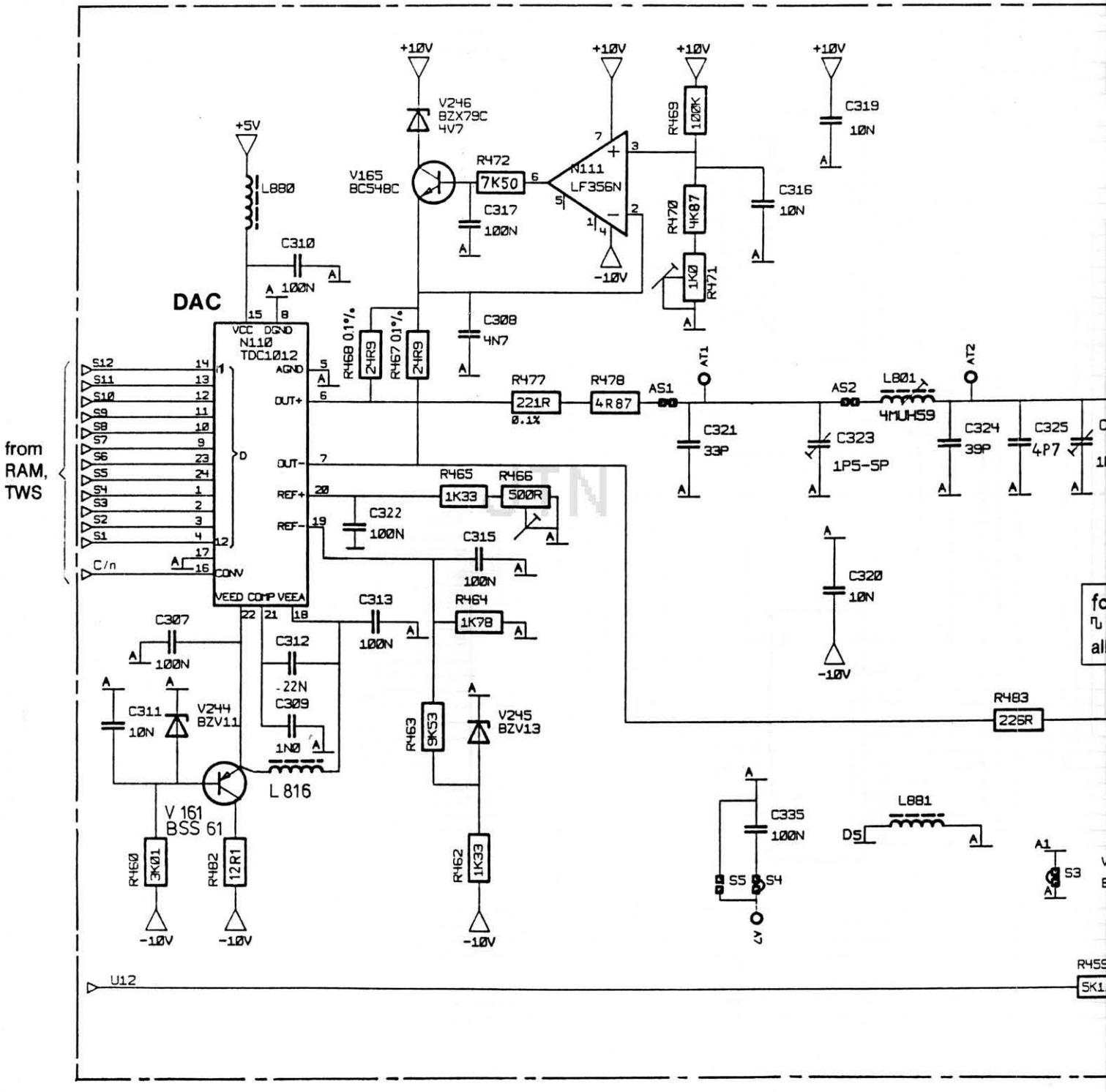
fc < 20kHz:
ARB,
all asym. signals

from RAM, TWS

to U4, Fig. 116

U12

Fig. 115 Unit 4, DAC and Lowpass Filter


DAC
from RAM, TWS
+10V
+5V
-10V
V246 BZX79C 4V7
V165 BC548C
R472 7K50
N111 LF356N
R469 100K
R470 4K87
R471 1K0
C319 10N
C316 10N
C317 100N
C310 100N
C308 4N7
L880
N110 TDC1012
VCC DGND
AGND
OUT+
OUT-
REF+
REF-
CONV
VEED COMP VEEA
S12
S11
S10
S9
S8
S7
S6
S5
S4
S3
S2
S1
C/n
R468 01% 24R9
R467 01% 24R9
R477 221R 0.1%
R478 4R87
AS1
AS2
AT1
AT2
L801 4MUH59
C321 33P
C323 1P5-5P
C324 39P
C325 4P7
C320 10N
R465 1K33
R466 500R
C322 100N
C315 100N
C313 100N
R464 1K78
C307 100N
C312 22N
C309 1N0
C311 10N
V244 BZV11
V 161 BSS 61
L 816
R463 9K53
V245 BZV13
R460 3K01
R482 12R1
R462 1K33
R483 226R
C335 100N
L881
D5
S5
S4
A7
A1
U12

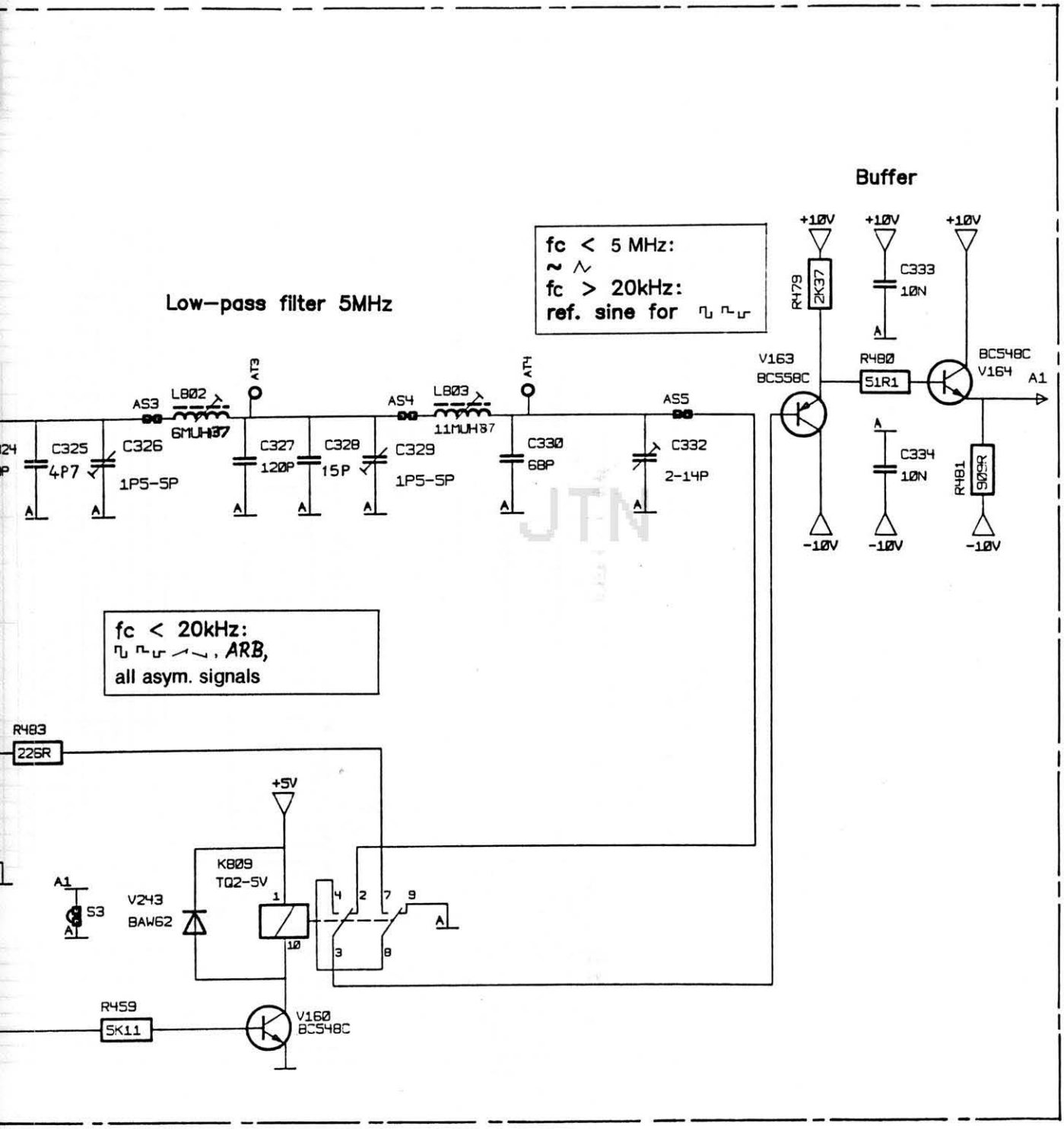


Fig. 115 Unit 4, DAC and Lowpass Filter

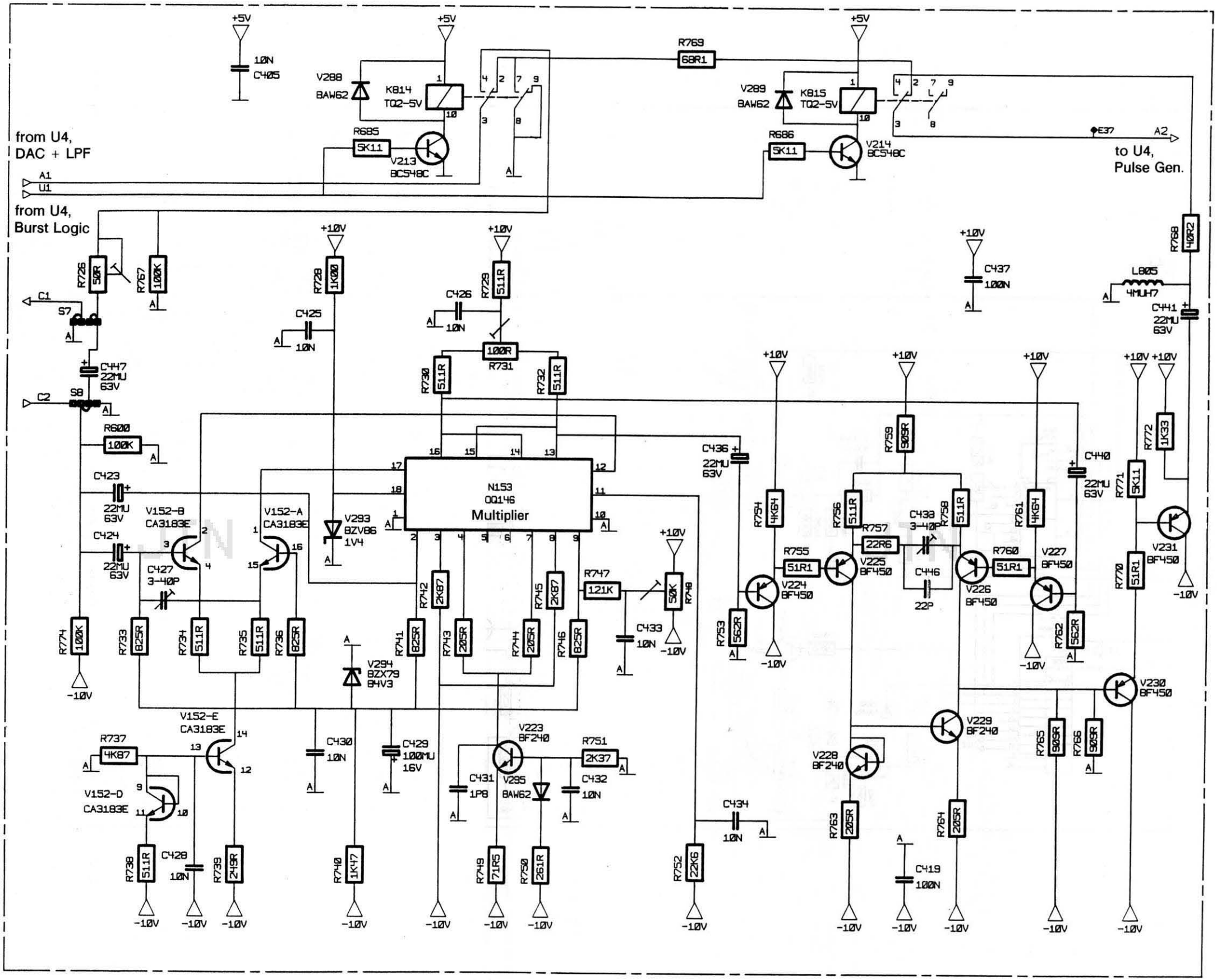
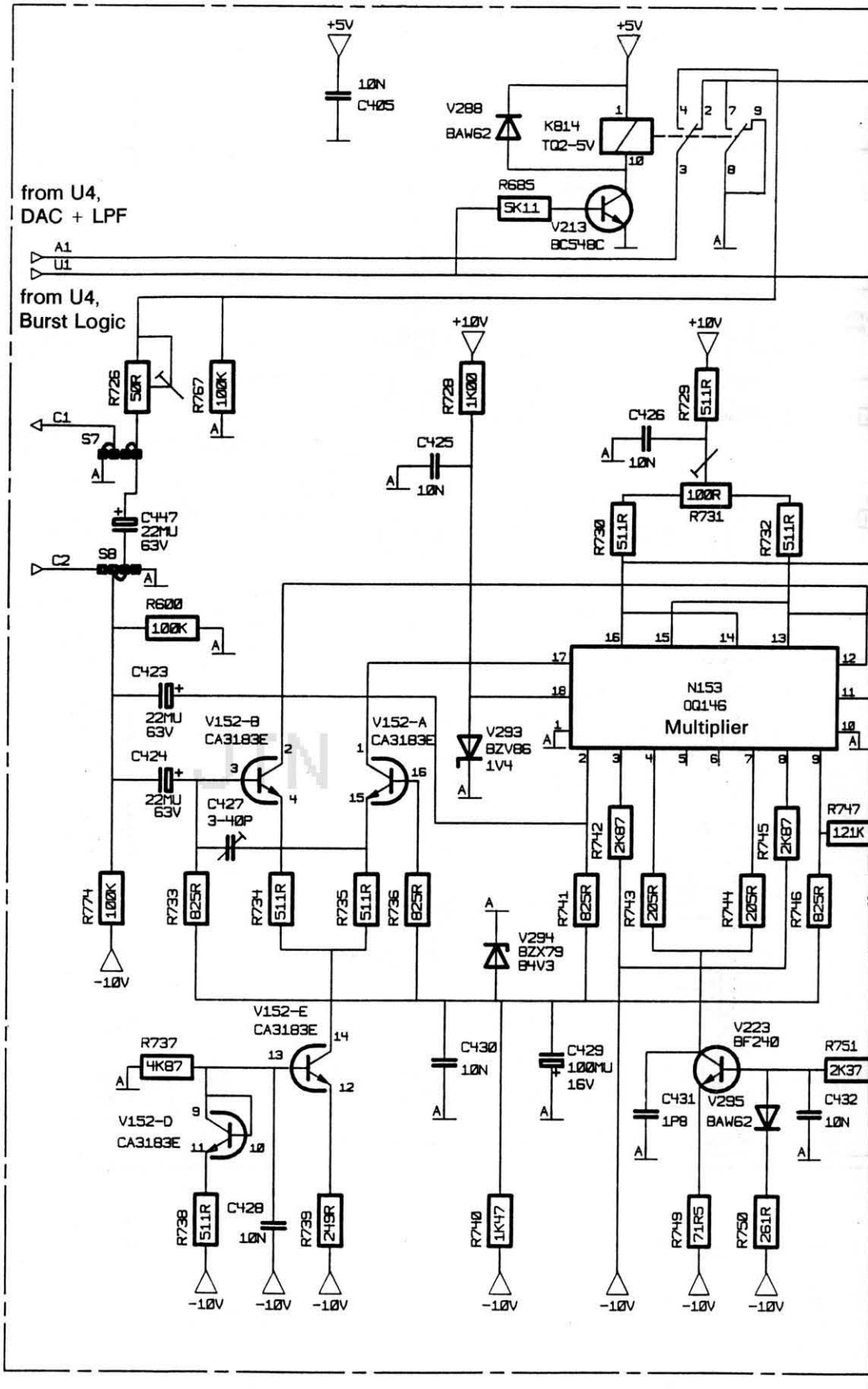


Fig. 116 Unit 4, Frequency Multiplier


from U4,
DAC + LPF
from U4,
Burst Logic
A1
U1
+5V
10N
C405
V288
BAW62
K814
TQ2-5V
R685
5K11
V213
BC548C
+10V
R726
50R
R767
100K
C1
S7
C447
22MU
63V
S8
C2
R600
100K
C423
22MU
63V
C424
22MU
63V
C427
3-40P
R774
100K
-10V
R728
1K00
C425
10N
R729
511R
C426
10N
100R
R731
R730
511R
R732
511R
N153
00146
Multiplier
V293
BZV86
1V4
V152-B
CA3183E
V152-A
CA3183E
R733
825R
R734
511R
R735
511R
R736
825R
V294
BZX79
B4V3
R741
825R
R742
2K87
R743
205R
R744
205R
R745
2K87
R746
825R
R747
121K
V152-E
CA3183E
R737
4K87
V152-D
CA3183E
R738
511R
C428
10N
R739
249R
C430
10N
C429
100MU
16V
R740
1K47
V223
BF240
C431
1P8
V295
BAW62
C432
10N
R751
2K37
R749
71R5
R750
261R
V152-P
CA3183E
P
S
V152-C
CA3183E

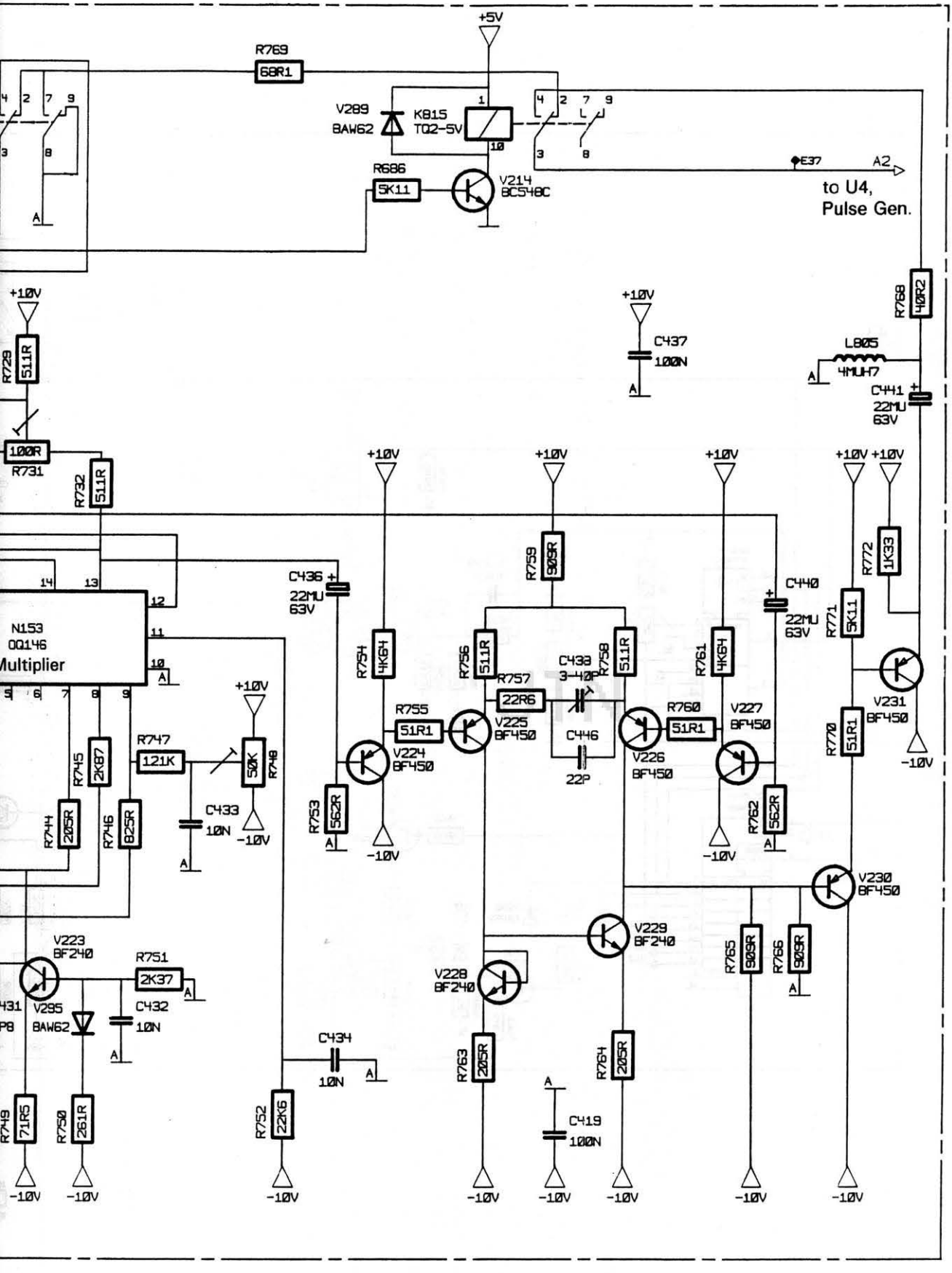


Fig. 116 Unit 4, Frequency Multiplier

from U4, Pulse Gen.

from U4, Burst Logic

from U4, Ampl. Mod.

from U4, Pulse Gen.

to U3, Ampli Contr.

to U4, Pulse Gen.

to U4, DAC + LPF

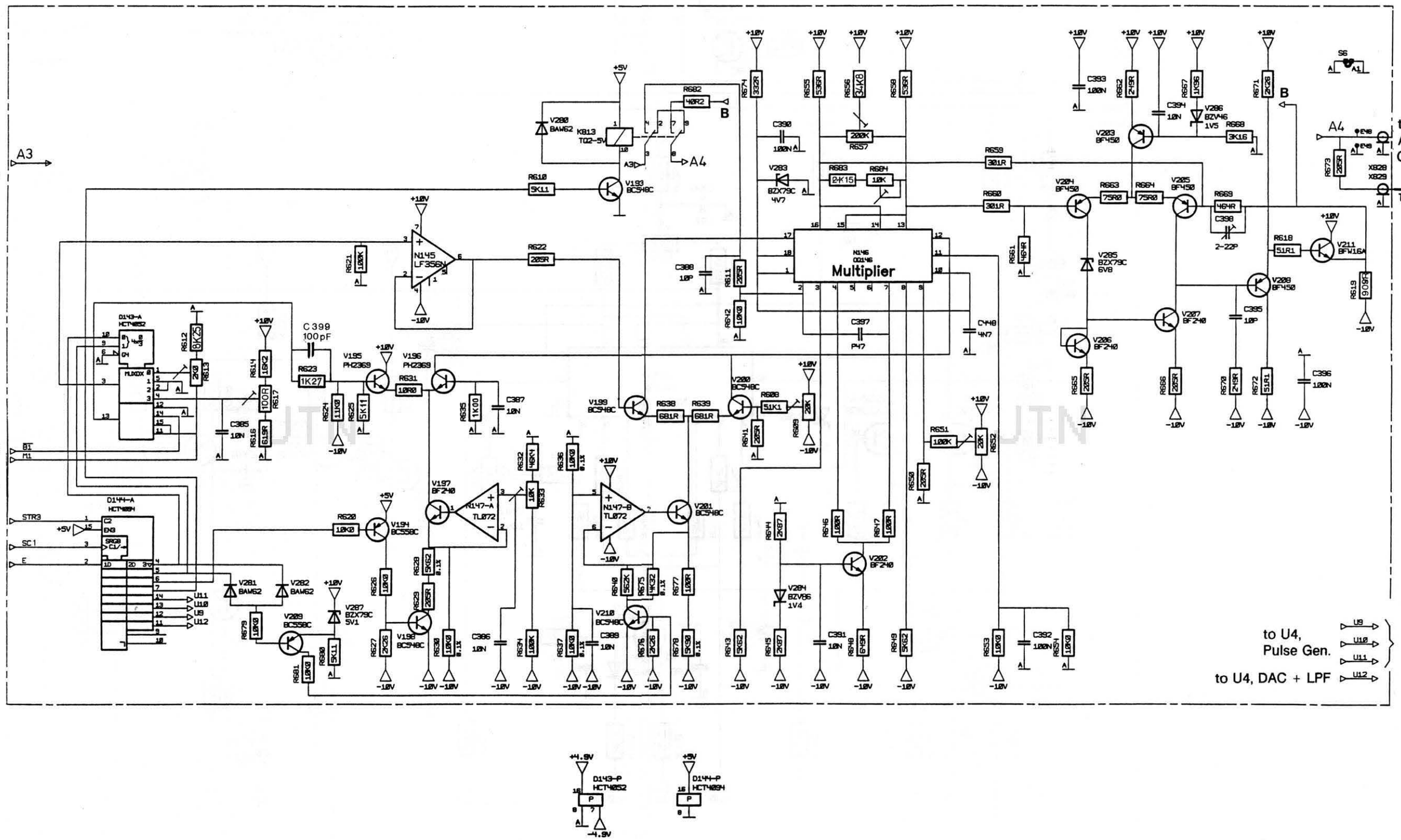
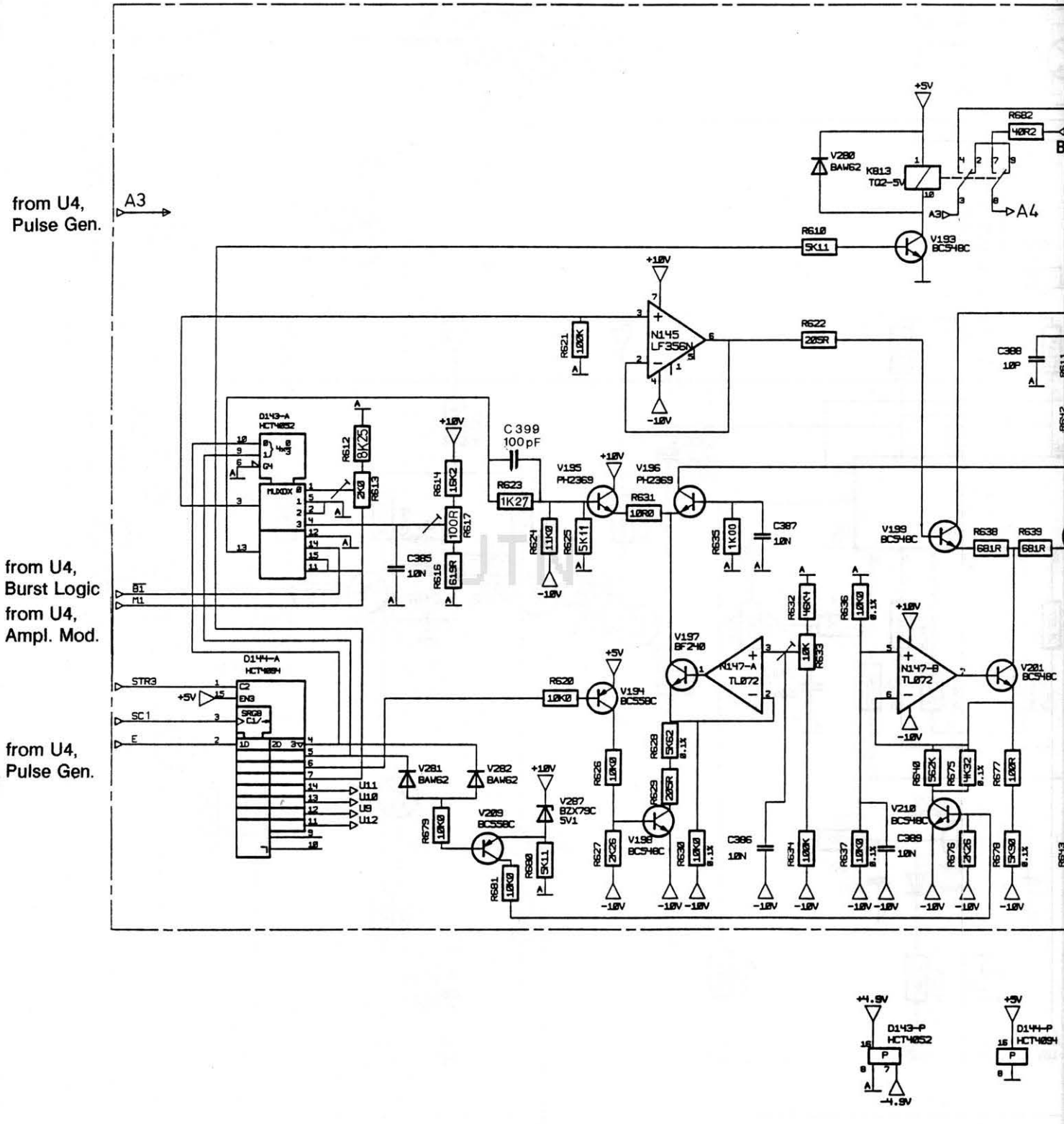


Fig. 117 Unit 4, Amplitude Modulator


from U4, Pulse Gen.
from U4, Burst Logic
from U4, Ampl. Mod.
from U4, Pulse Gen.
A3
A4
+5V
R682
40R2
V280 BAW62
K813 TQ2-5V
R610 5K11
V193 BC548C
+10V
N145 LF356N
R621 100K
R622 205R
C388 10P
D143-A HCT4052
R612 8K25
R613 2K0
R614 18K2
R617 100R
R616 619R
C385 10N
C399 100pF
R623 1K27
V195 PH2369
V196 PH2369
R631 10K0
R624 11K0
R625 5K11
R635 1K00
C387 10N
V199 BC548C
R638 681R
R639 681R
BI
M1
D144-A HCT109H
STR3
SC1
E
+5V
R620 10K0
V194 BC558C
V197 BF240
N147-A TL072
R632 45K4
R633 10K
R636 10K0 0.1%
N147-B TL072
V201 BC548C
R628 5K62 0.1%
R626 10K0
R629 205R
V198 BC548C
R627 2K26
R630 10K0 0.1%
C386 10N
R634 100K
R637 10K0 0.1%
C389 10N
V210 BC548C
R676 2K26
R678 5K90 0.1%
R640 562K
R675 1K32 0.1%
R677 100R
V281 BAW62
V282 BAW62
V209 BC558C
V287 BZX79C 5V1
R679 10K0
R681 10K0
R680 5K11
U11
U10
U9
U12
-10V
D143-P HCT4052
+4.9V
-4.9V
D144-P HCT109H

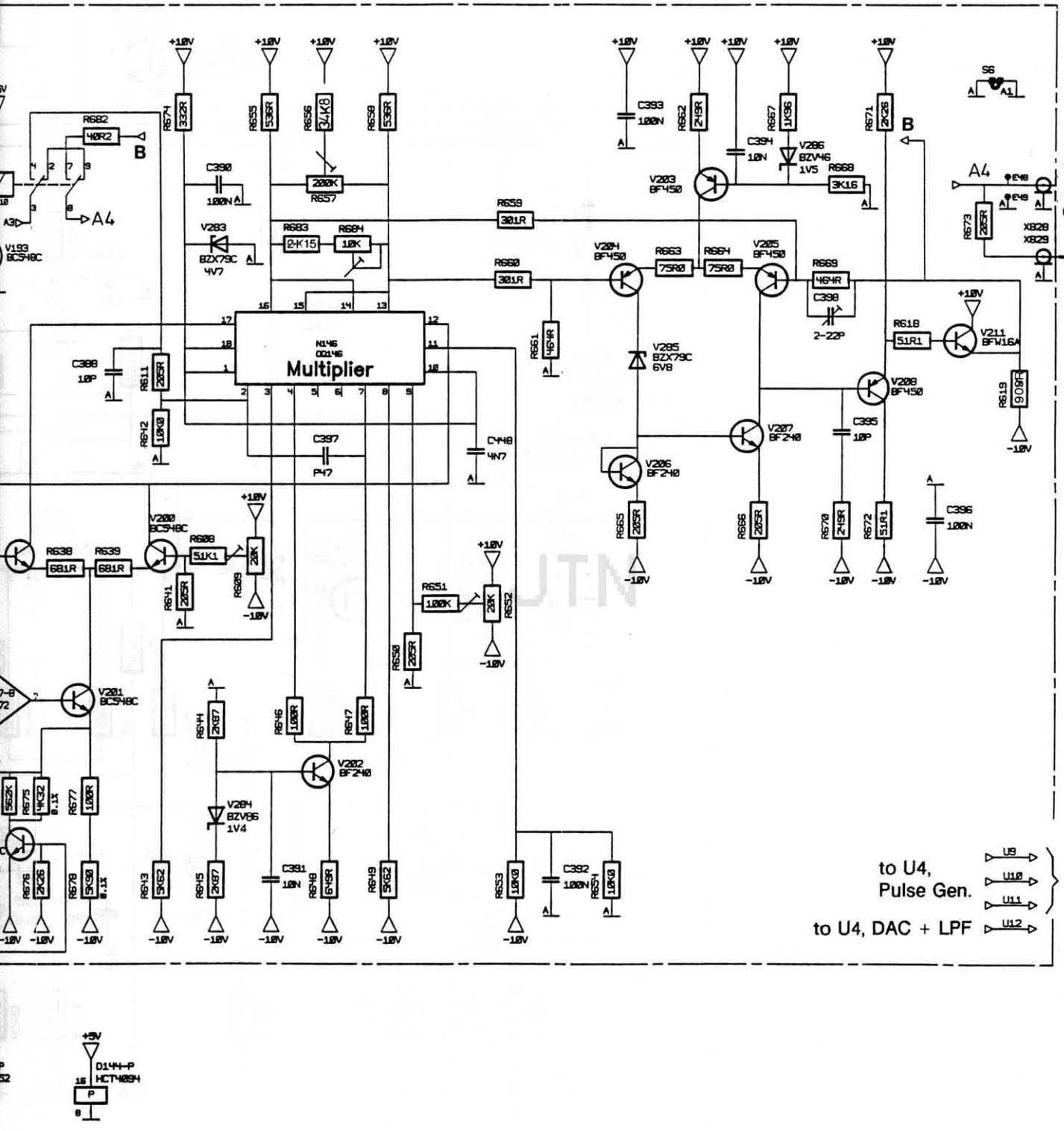


Fig. 117 Unit 4, Amplitude Modulator

from U1, Power Supply

from U2, TWS (MSB)

from U4, RAM

from U4, Fig. 116

from U2, CPU

from U4, Burst Logic

from U4 Ampl. Mod.

Asymmetry

Duty Cycle for fc > 20 kHz

DAC

TTL OUT

to U4, Burst Logic

fc > 20 kHz

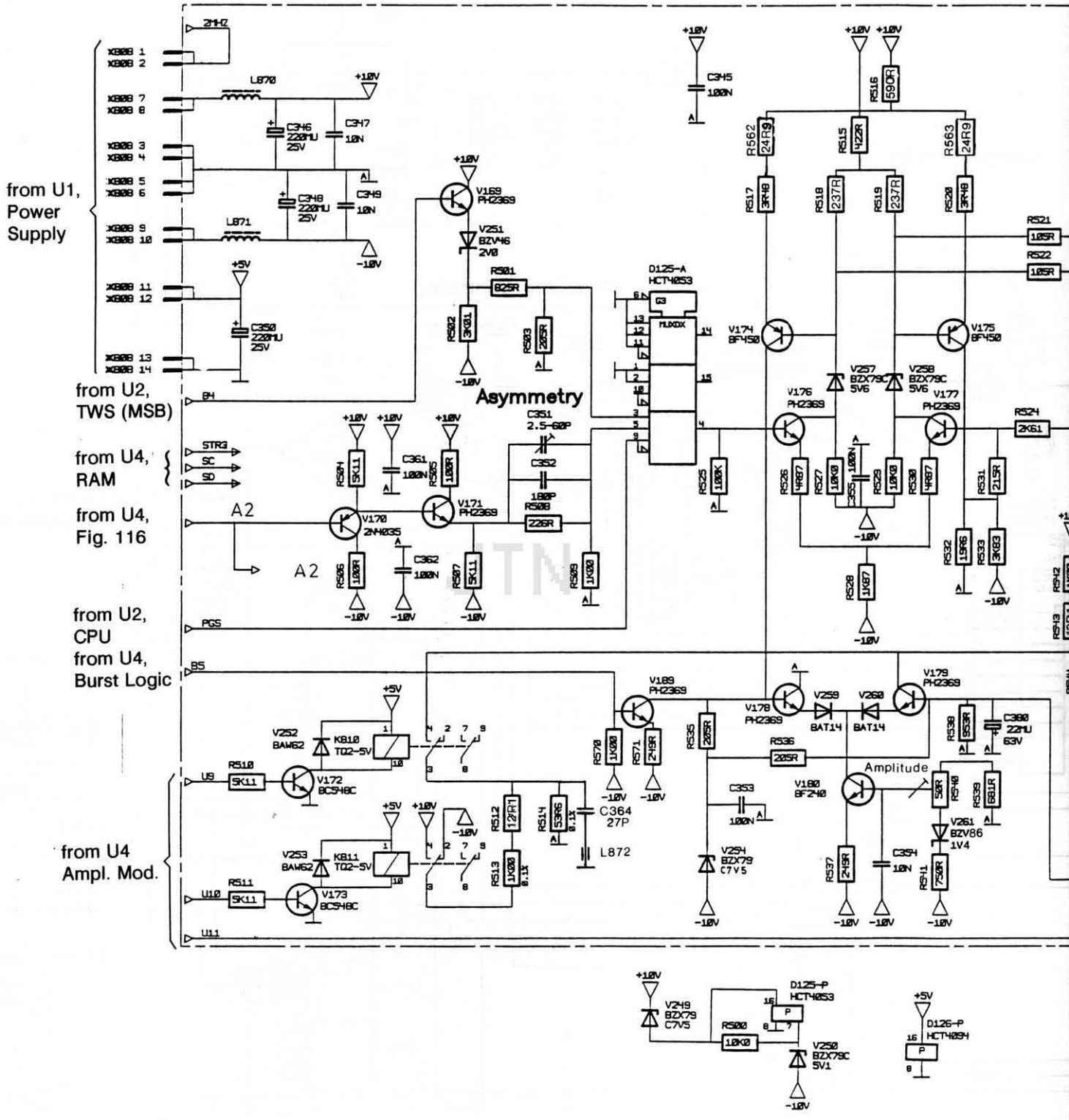
to U4, Amplitude Modulator

Amplitude

A2

A3

Fig. 118 Unit 4, Pulse Generator


from U1, Power Supply
from U2, TWS (MSB)
from U4, RAM
from U4, Fig. 116
from U2, CPU
from U4, Burst Logic
from U4 Ampl. Mod.
Asymmetry
Amplitude
A2
A2
+10V
+5V
-10V
V169 PH2369
V251 BZV46 2V0
V170 2N4035
V171 PH2369
V172 BC548C
V173 BC548C
V174 BF450
V175 BF450
V176 PH2369
V177 PH2369
V178 PH2369
V179 PH2369
V180 BF240
V189 PH2369
V252 BAW62
V253 BAW62
V254 BZX79 C7V5
V257 BZX79C 5V6
V258 BZX79C 5V6
V259 BAT14
V260 BAT14
V261 BZV86 1V4
V249 BZX79 C7V5
V250 BZX79C 5V1
D125-A HCT4053
D125-P HCT4053
D126-P HCT4094
L870
L871
L872
C345 100N
C346 220MU 25V
C347 10N
C348 220MU 25V
C349 10N
C350 220MU 25V
C351 2.5-60P
C352
C353 100N
C354 10N
C355 100N
C361 100N
C362 100N
C364 27P
C380 22MU 63V
R501 825R
R502 3K01
R503 205R
R505 100R
R506 100R
R507 5K11
R508 226R
R509 1K00
R510 5K11
R511 5K11
R512 12R1
R513 1K00
R514 33R6
R516 590R
R517 3R48
R518 237R
R519 237R
R520 3R48
R521 105R
R522 105R
R524 2K61
R525 100K
R526 4K87
R527 10K0
R528 1K87
R529 10K0
R530 4K87
R531 215R
R532 19R6
R533 3K63
R535 205R
R536 205R
R537 249R
R538 953R
R539 681R
R540 5R6
R541 750R
R562 24R9
R563 24R9
R570 1K00
R571 2K49
R572 1K00
R500 10K0
U9
U10
U11
PH
PGS
BS
STR3
SC
SD

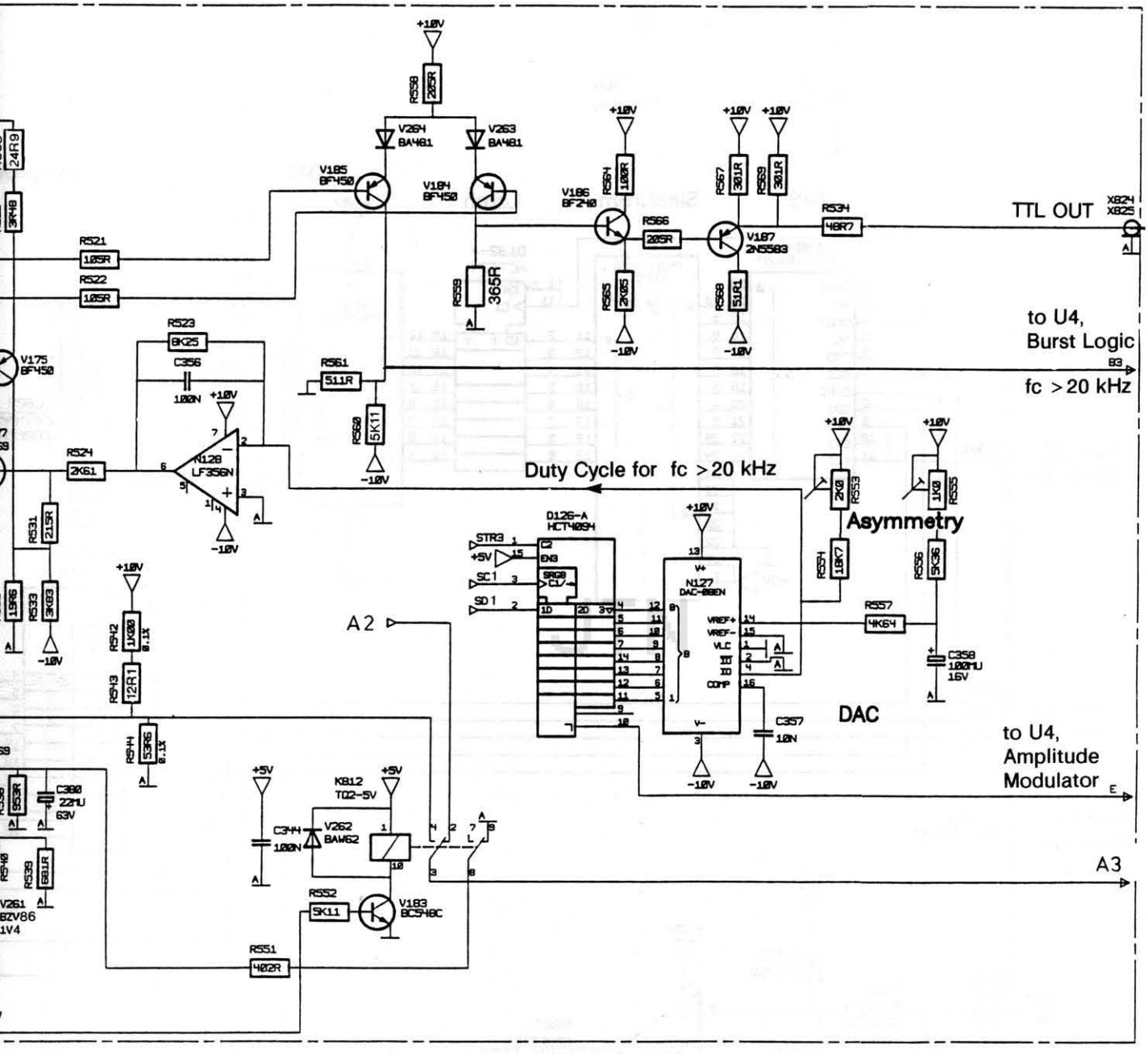


Fig. 118 Unit 4, Pulse Generator

TWS

SineProm

Latch

DAC

Low-pass filter

Comparator

Amplitude Controller

Mod.freq. amplitude

from U2, Clock Gen.

from U4, RAM

from U4, Burst Logic

~ for AM/FM

TTL for Burst/Gate/PSK

to U4, Ampl. Mod.

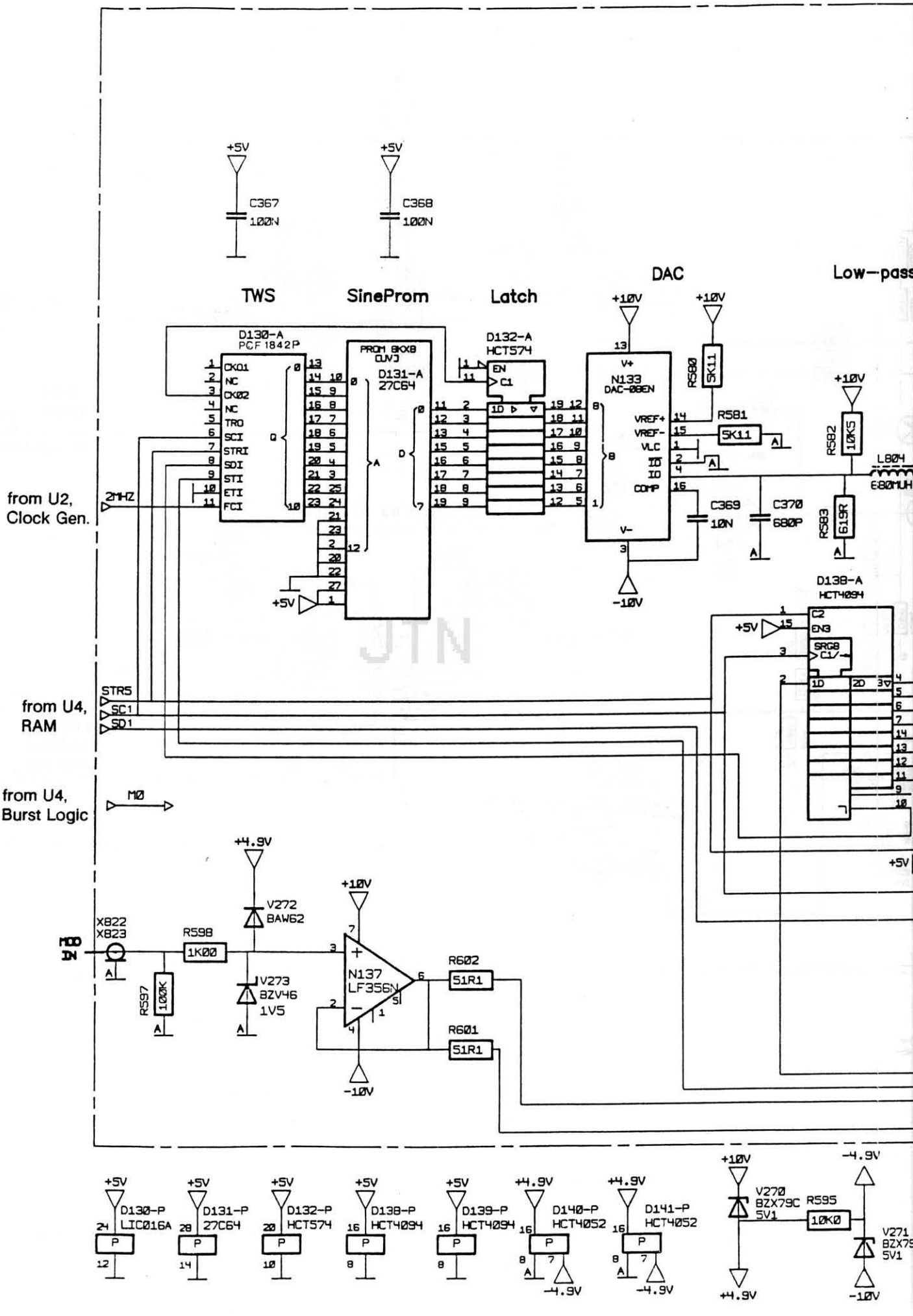
to U2, Clock Gen.

to U4, Burst Logic

to U2, CPU

MOD OUT

Fig. 119 Unit 4, Modulation Oscillator


TWS
SineProm
Latch
DAC
Low-pass
from U2, Clock Gen.
from U4, RAM
from U4, Burst Logic
2MHZ
STR5
SC1
SD1
M0
D130-A PCF1842P
D131-A 27C64
D132-A HCT574
N133 DAC-08EN
D138-A HCT4094
N137 LF356N
V272 BAW62
V273 BZV46 1V5
R598 1K00
R597 100K
R602 51R1
R601 51R1
R580 5K11
R581 5K11
R582 10K5
R583 619R
C367 100N
C368 100N
C369 10N
C370 680P
L804 680MUH
+5V
+10V
-10V
+4.9V
D130-P LIC016A
D131-P 27C64
D132-P HCT574
D138-P HCT4094
D139-P HCT4094
D140-P HCT4052
D141-P HCT4052
V270 BZX79C 5V1
R595 10K0
V271 BZX79 5V1

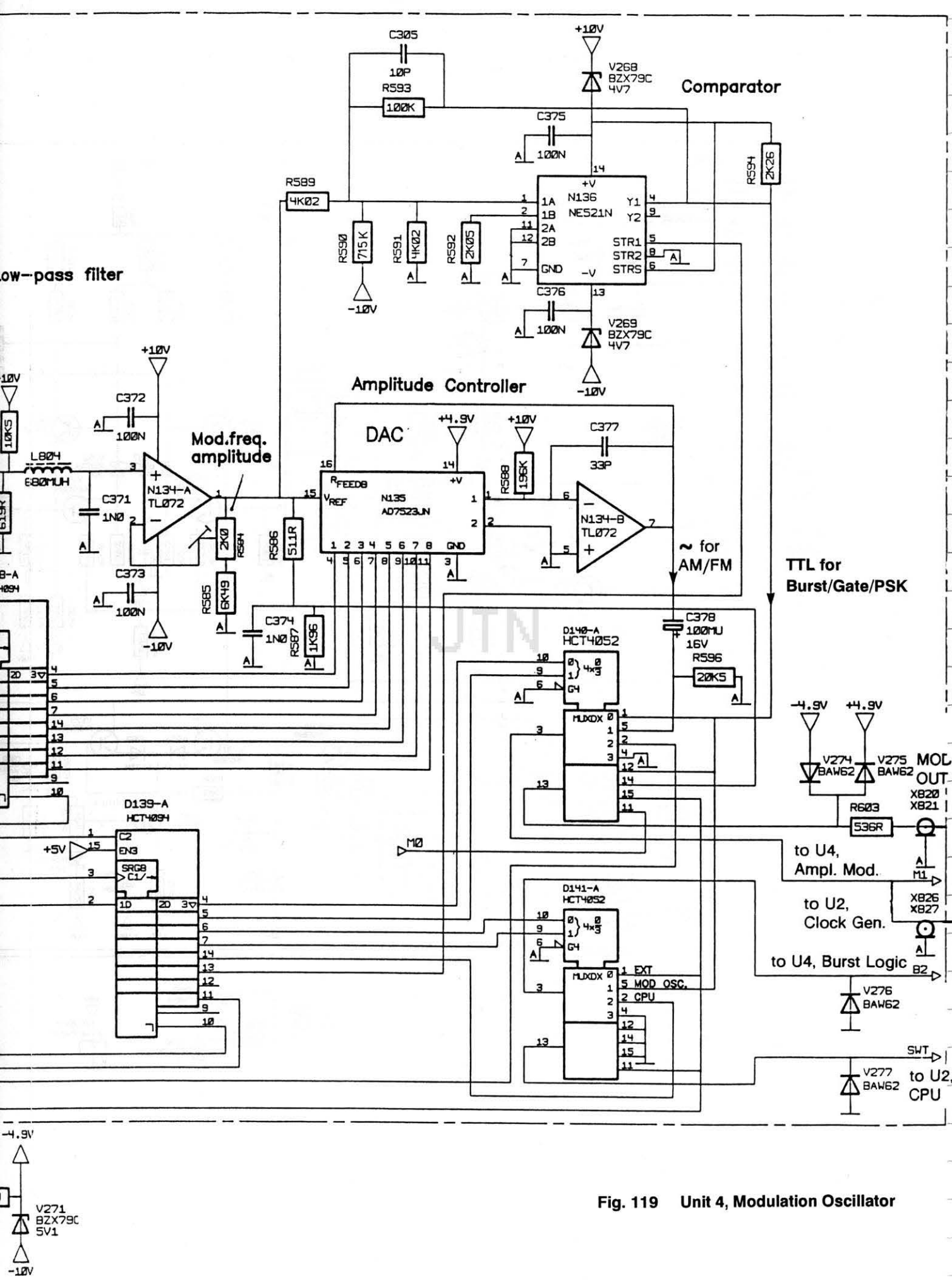


Fig. 119 Unit 4, Modulation Oscillator

from U4, Modulation Oscillator

from U4, Pulse Gen. from U4 RAM (MSB)

from U4, RAM

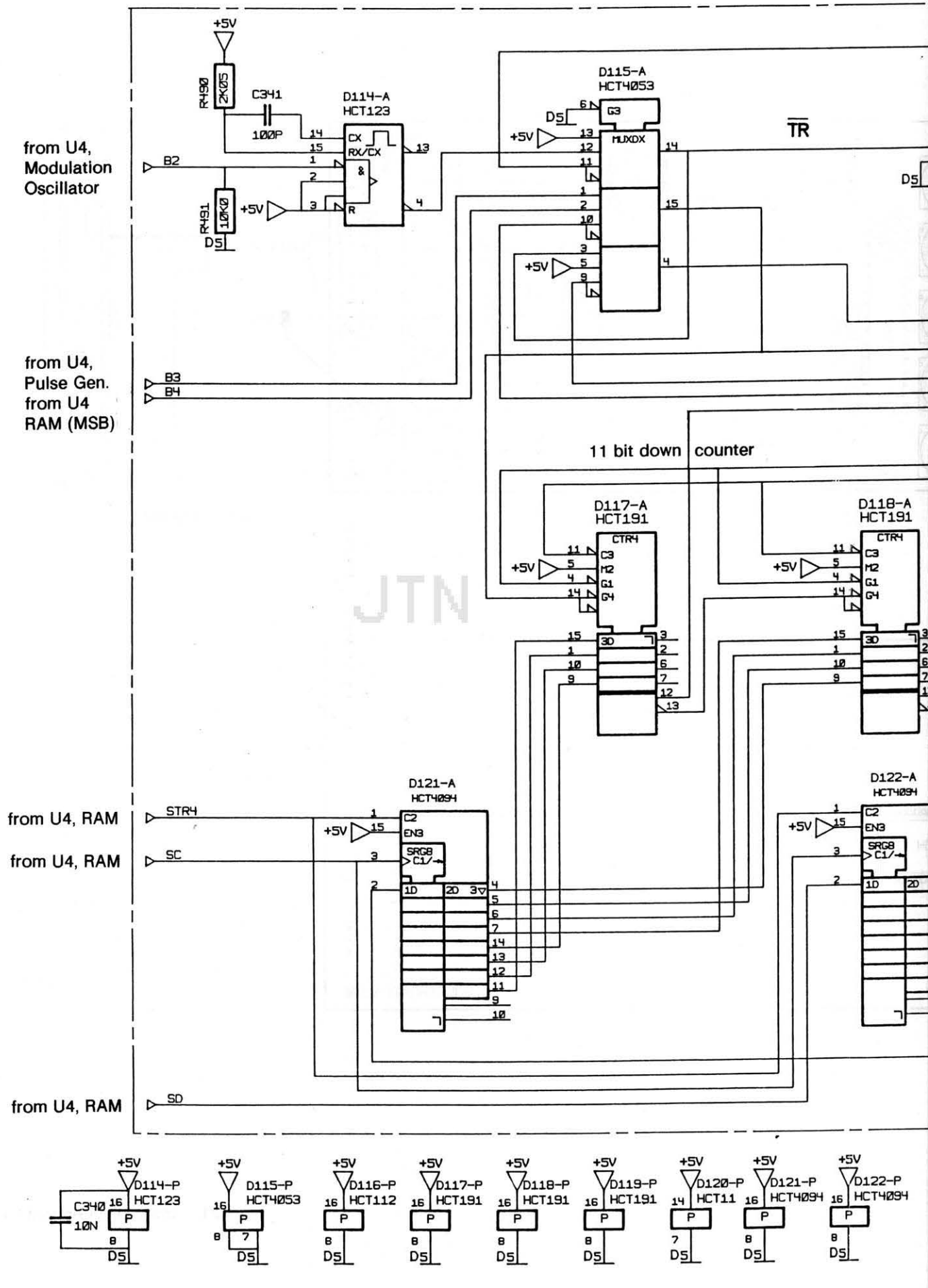
from U4, RAM

from U4, RAM

R490 2K05
C341 100P
D114-A HCT123
R491 10K0
D115-A HCT4053
MUXDX
C342 33P
R492 1K00
D116-A HCT112
TR
BK
to U2, CPU; active for fc <20 kHz
D116-B HCT112
to U4, Mod. Oscillator; active for fc >20 kHz
B1
D120-A HCT11
11 bit down counter
D117-A HCT191
D118-A HCT191
D119-A HCT191
CTR4
D120-C HCT11
M0
to U4, Modulation Oscillator
V190 PH2369
R494 1K78
L885
V191 2N4035
B5
to U4, Pulse Gen.
R493 2K05
C343 100P
D114-B HCT123
D120-B HCT11
LO
D121-A HCT4094
D122-A HCT4094
SRG8
U1
to U4, Fig. 116
B2
B3
B4
STR4
SC
SD
+5V
D5

C340 10N D114-P HCT123
D115-P HCT4053
D116-P HCT112
D117-P HCT191
D118-P HCT191
D119-P HCT191
D120-P HCT11
D121-P HCT4094
D122-P HCT4094

Fig. 120 Unit 4, Burst Logic


from U4, Modulation Oscillator
from U4, Pulse Gen. from U4 RAM (MSB)
from U4, RAM
from U4, RAM
from U4, RAM
11 bit down counter
D114-A HCT123
D115-A HCT4053
D117-A HCT191
D118-A HCT191
D121-A HCT4094
D122-A HCT4094
R490 2K05
C341 100P
R491 10K0
C340 10N
B2
B3
B4
STR4
SC
SD
TR
+5V
D5
D114-P HCT123
D115-P HCT4053
D116-P HCT112
D117-P HCT191
D118-P HCT191
D119-P HCT191
D120-P HCT11
D121-P HCT4094
D122-P HCT4094

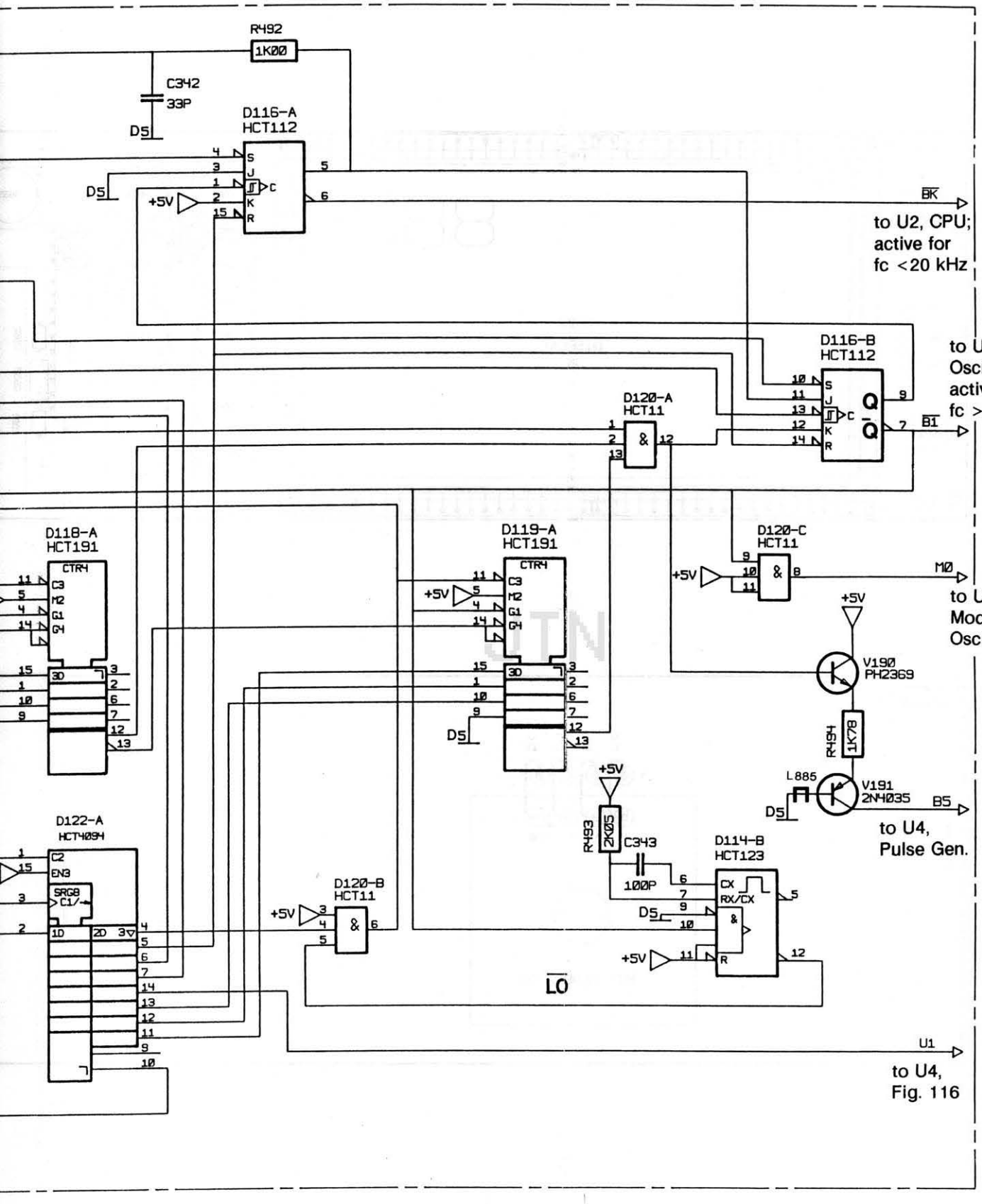
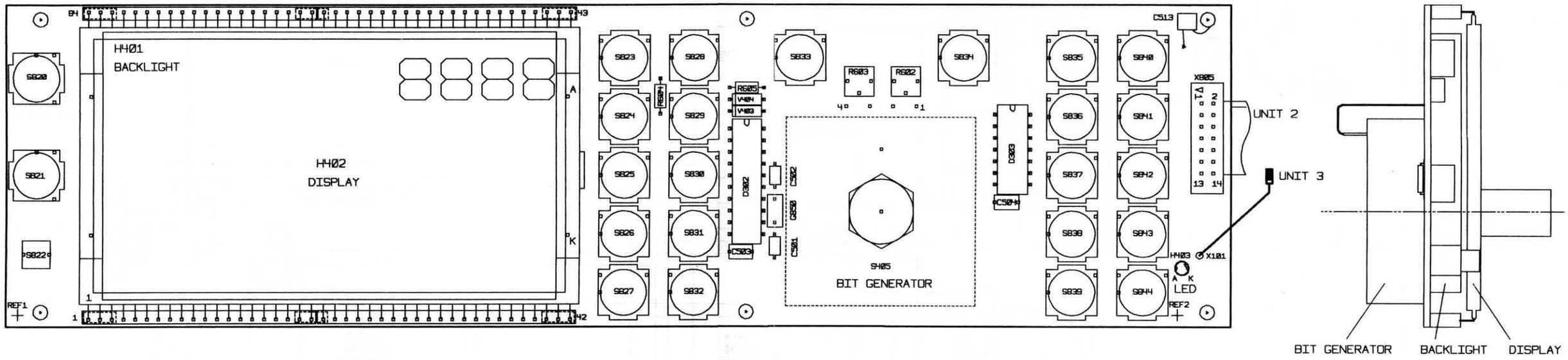


Fig. 120 Unit 4, Burst Logic



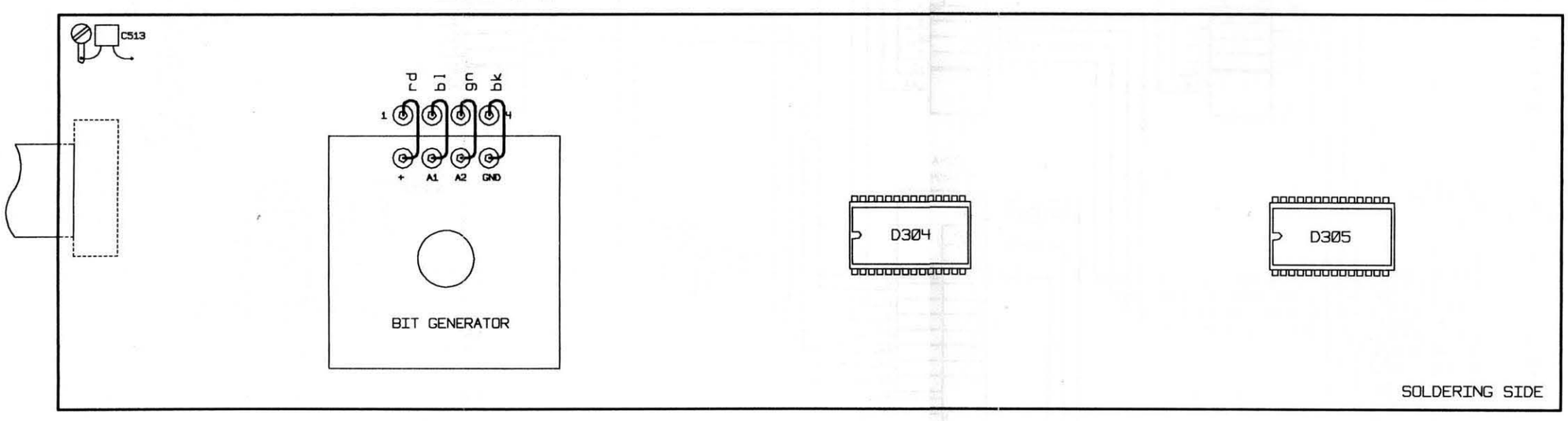
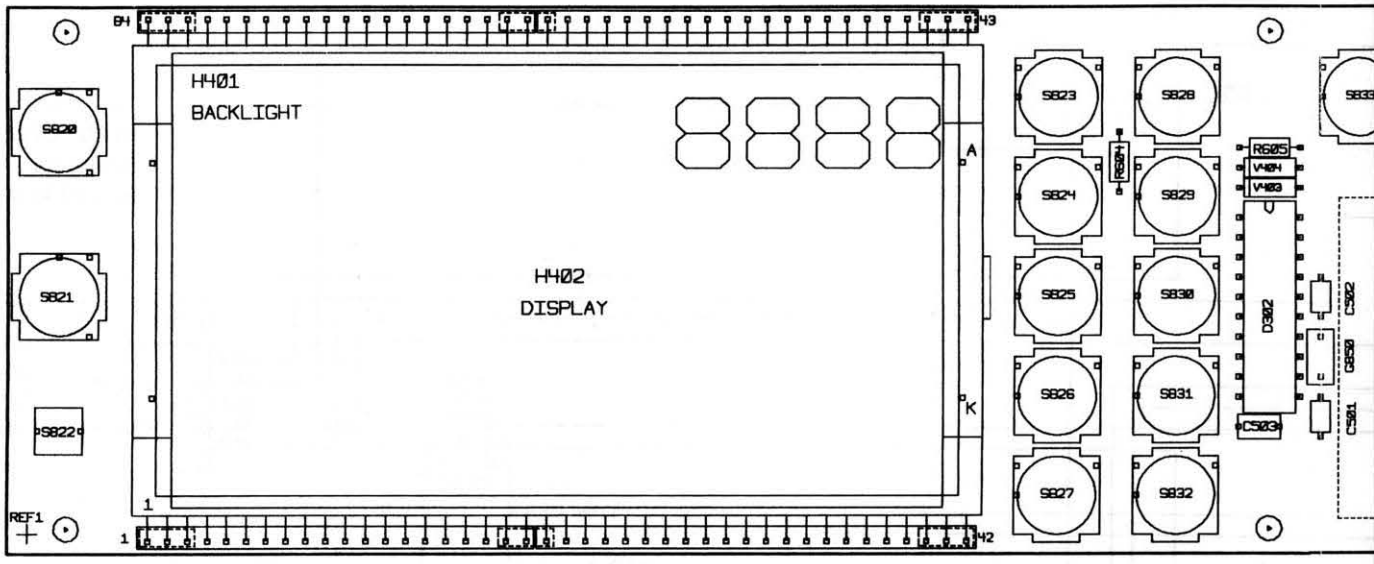
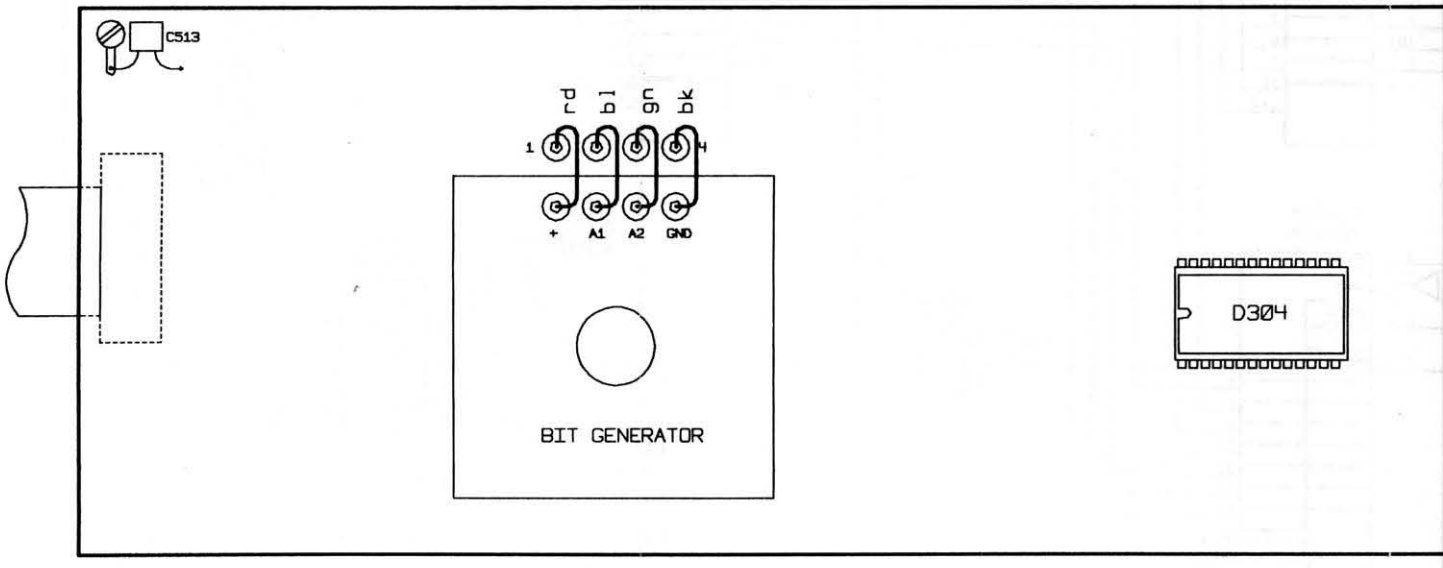
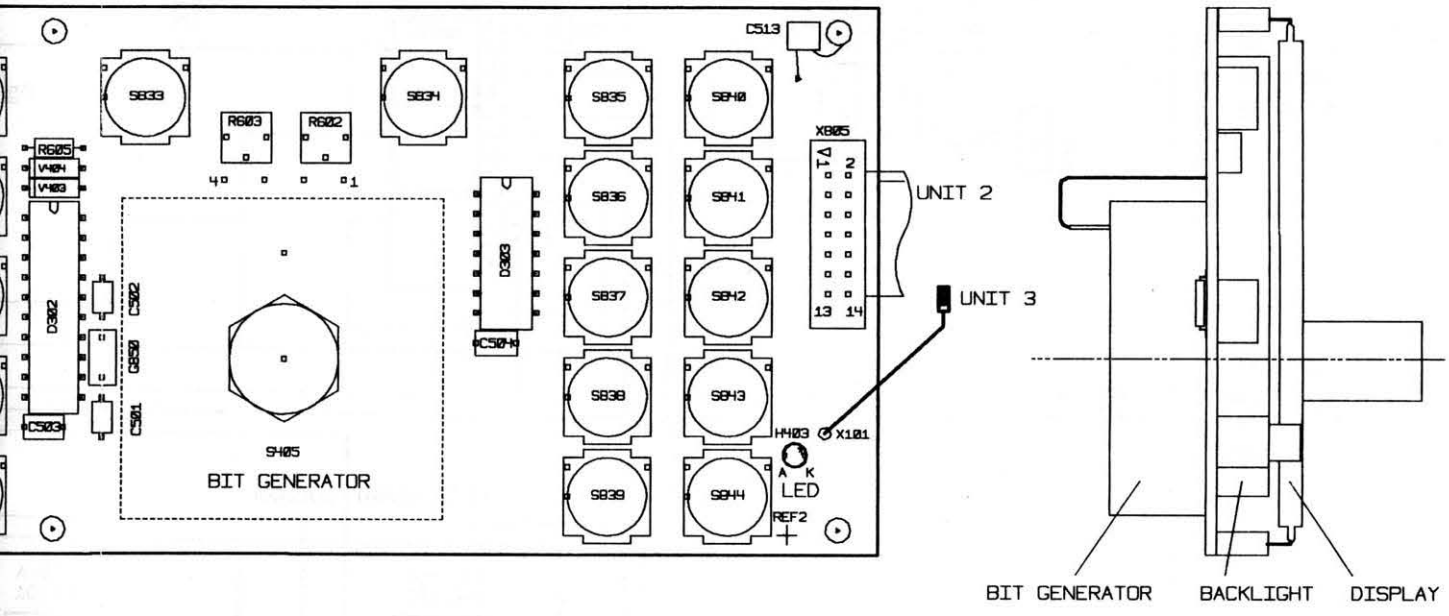


Fig. 121 Unit 5, Component Layout


H401
BACKLIGHT
H402
DISPLAY
S820
S821
S822
S823
S824
S825
S826
S827
S828
S829
S830
S831
S832
R605
V404
V403
D302
C502
C503
C501
REF1
A
K
1
42
43


C513
rd
bl
gn
bk
1
4
+
A1
A2
GND
BIT GENERATOR
D304



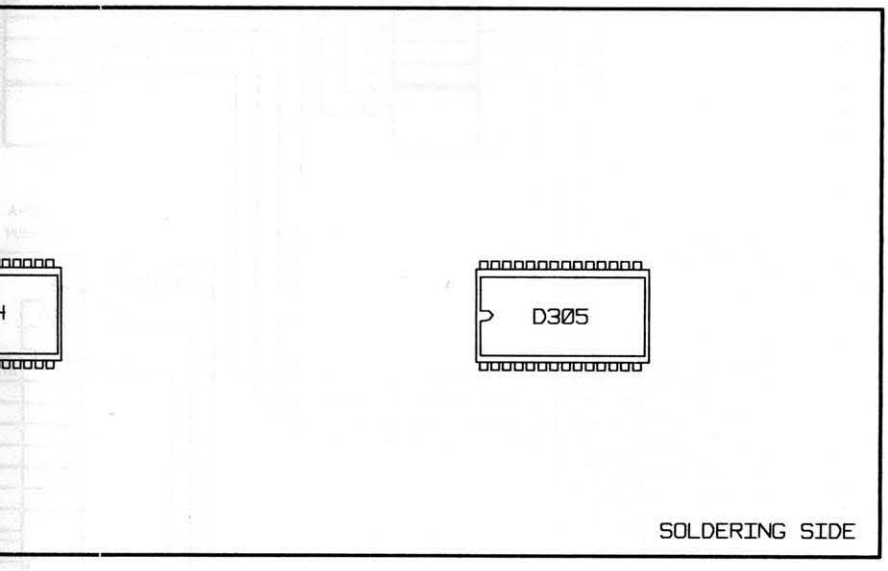


Fig. 121 Unit 5, Component Layout

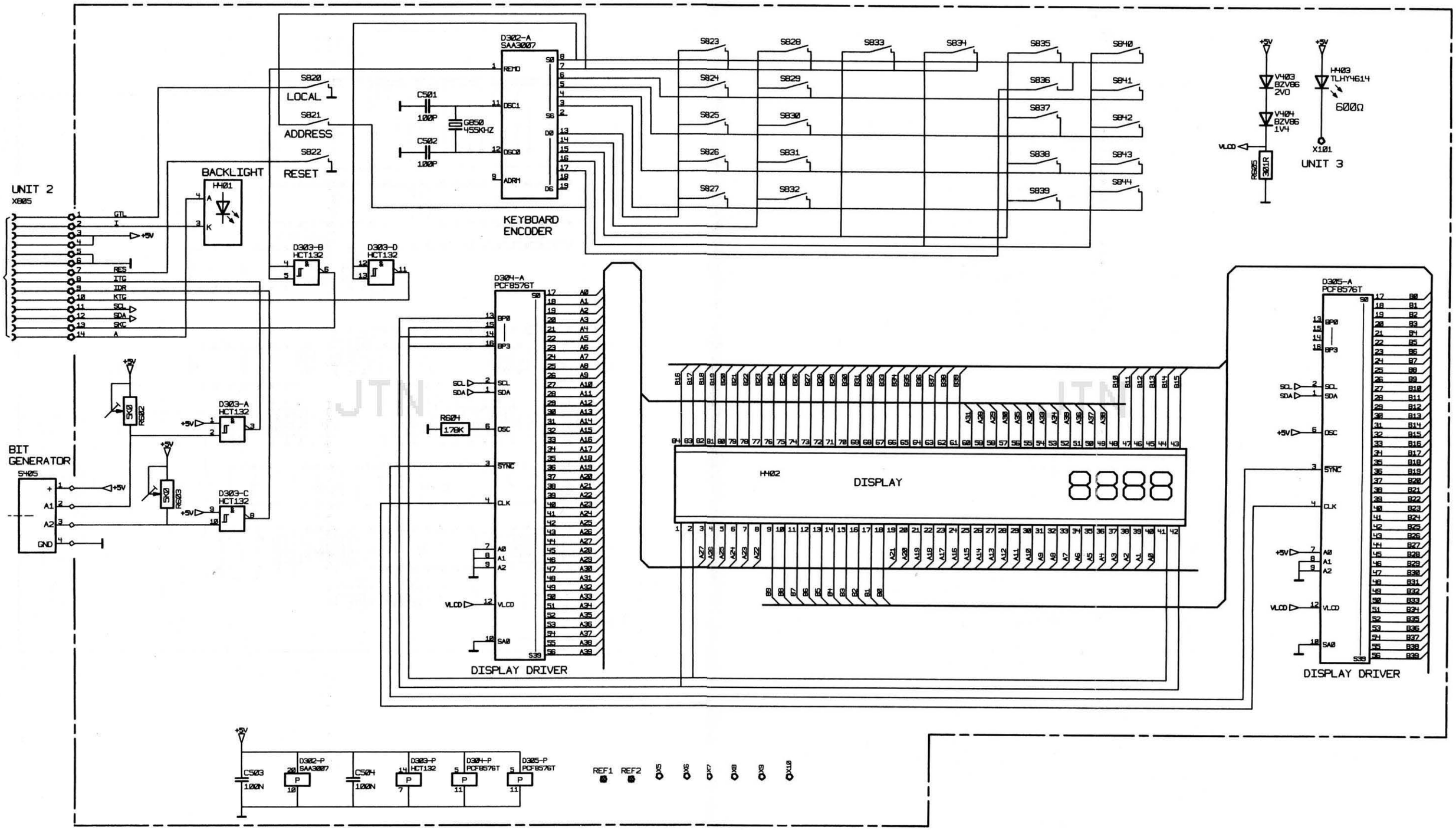
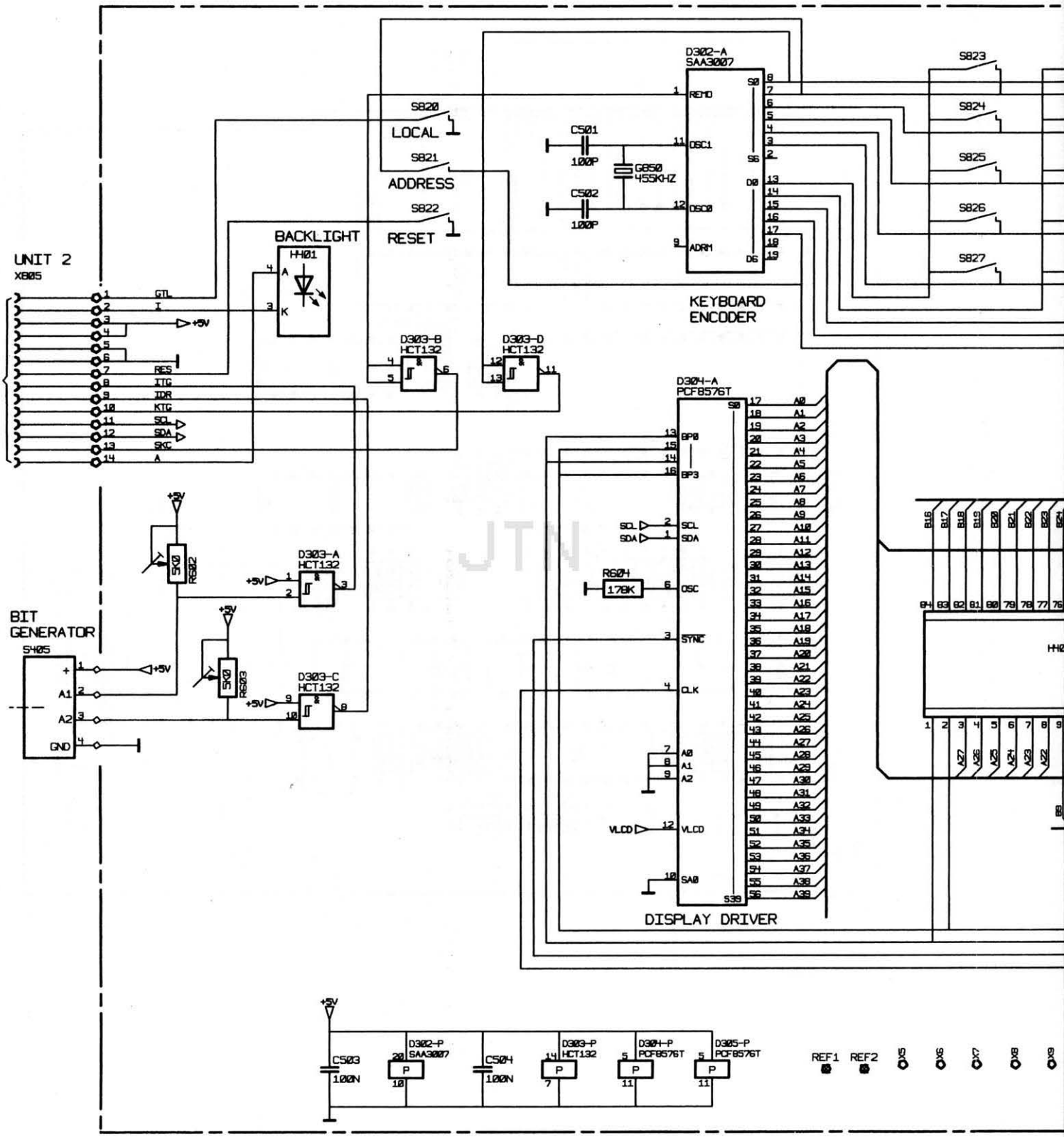


Fig. 122 Unit 5, Keyboard and Display


UNIT 2
X805
GTL
I
+5V
RES
ITG
IDR
KTG
SCL
SDA
SKC
A
BACKLIGHT
HH01
S820
LOCAL
S821
ADDRESS
S822
RESET
D302-A
SAA3007
REMO
OSC1
OSC0
ADRM
S0
S6
D0
D6
C501
100P
G850
455KHZ
C502
100P
S823
S824
S825
S826
S827
KEYBOARD
ENCODER
D303-B
HCT132
D303-D
HCT132
D304-A
PCF8576T
BP0
BP3
SCL
SDA
OSC
SYNC
CLK
A0
A1
A2
VLCD
SA0
S39
A0
A1
A2
A3
A4
A5
A6
A7
A8
A9
A10
A11
A12
A13
A14
A15
A16
A17
A18
A19
A20
A21
A22
A23
A24
A25
A26
A27
A28
A29
A30
A31
A32
A33
A34
A35
A36
A37
A38
A39
DISPLAY DRIVER
RS04
178K
D303-A
HCT132
D303-C
HCT132
RS02
5K0
RS03
5K0
BIT
GENERATOR
S405
+
A1
A2
GND
C503
100N
C504
100N
D302-P
SAA3007
D303-P
HCT132
D304-P
PCF8576T
D305-P
PCF8576T
REF1
REF2

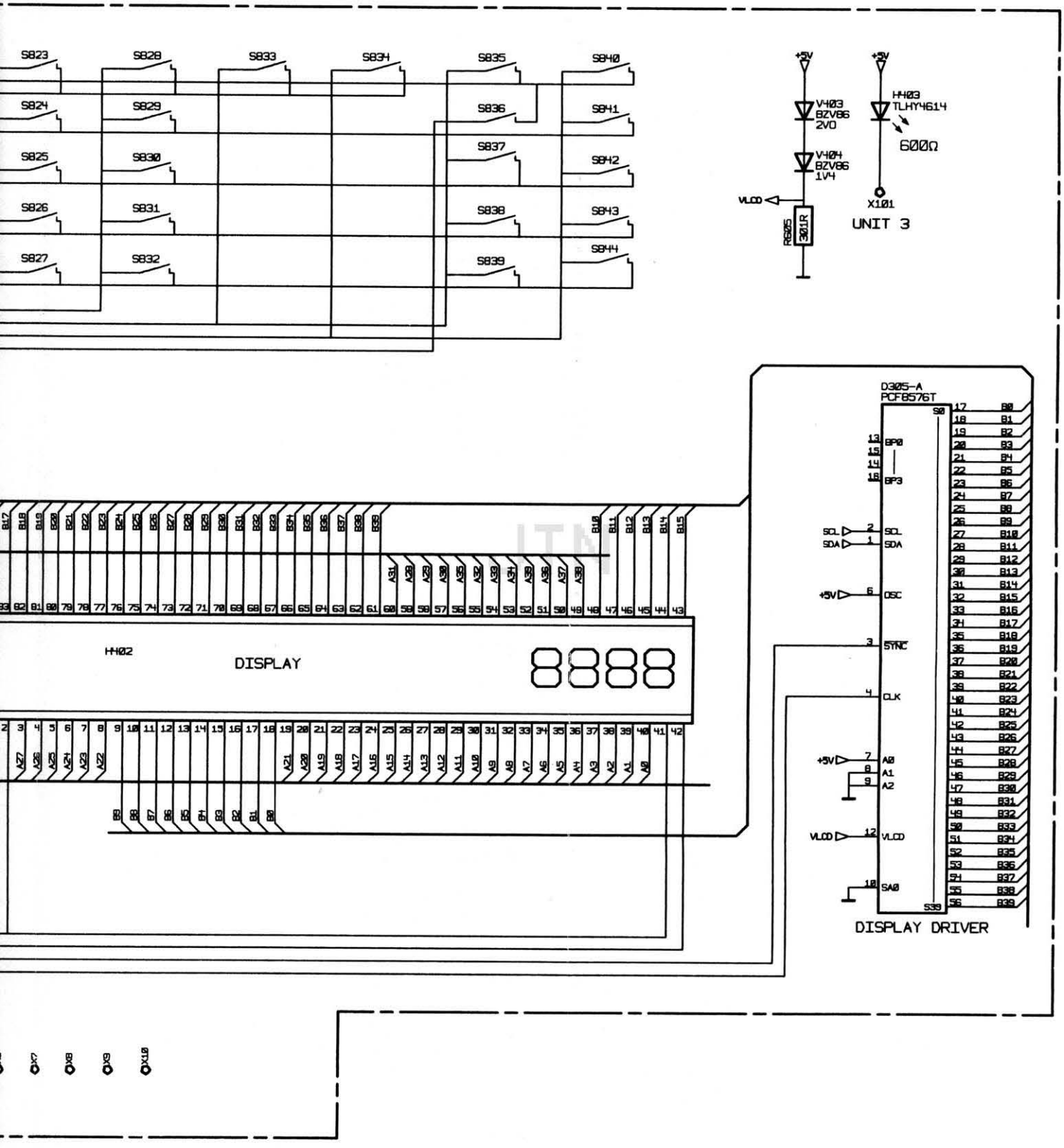


Fig. 122 Unit 5, Keyboard and Display

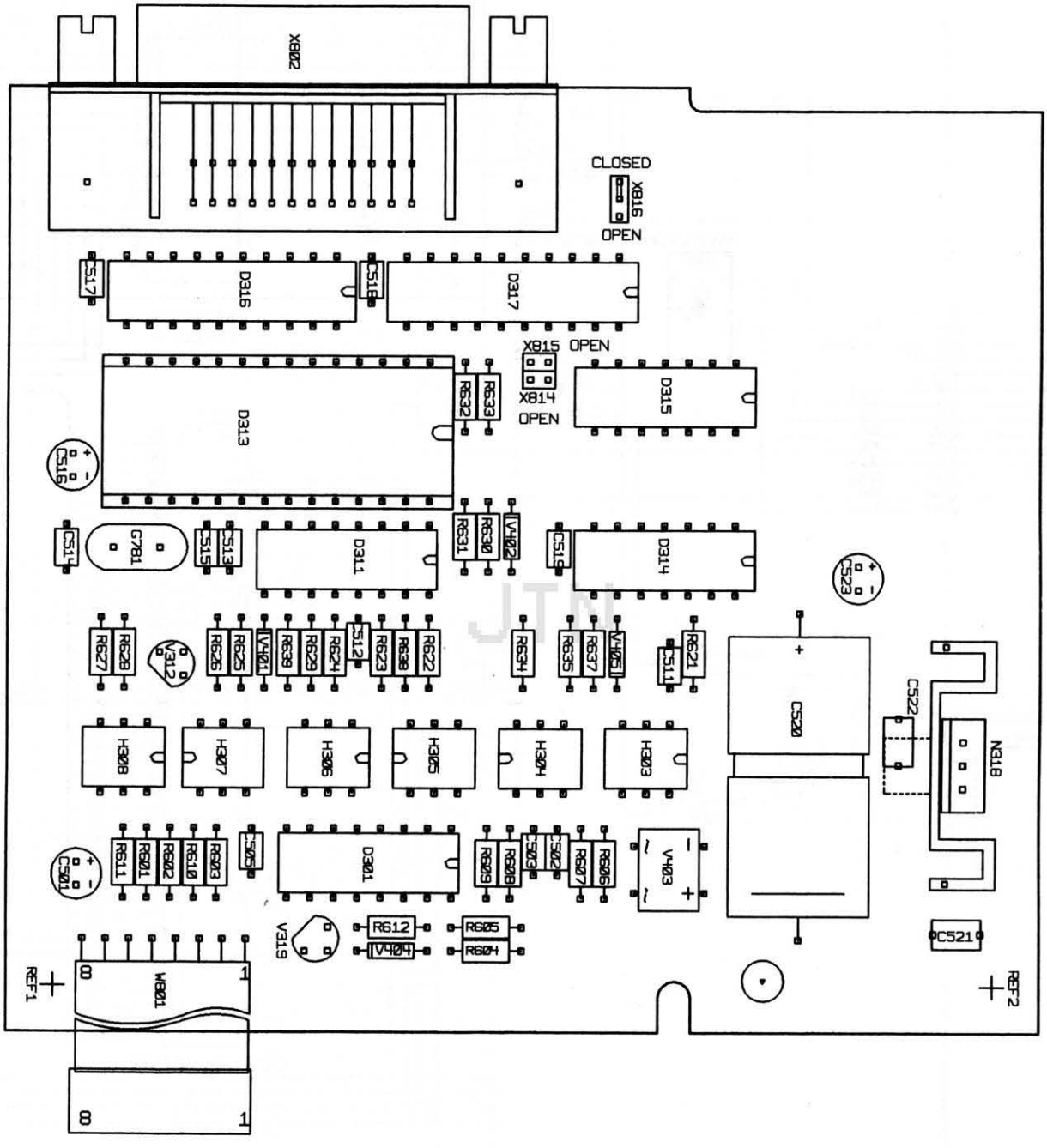


Fig. 123 Unit 6, Component Layout

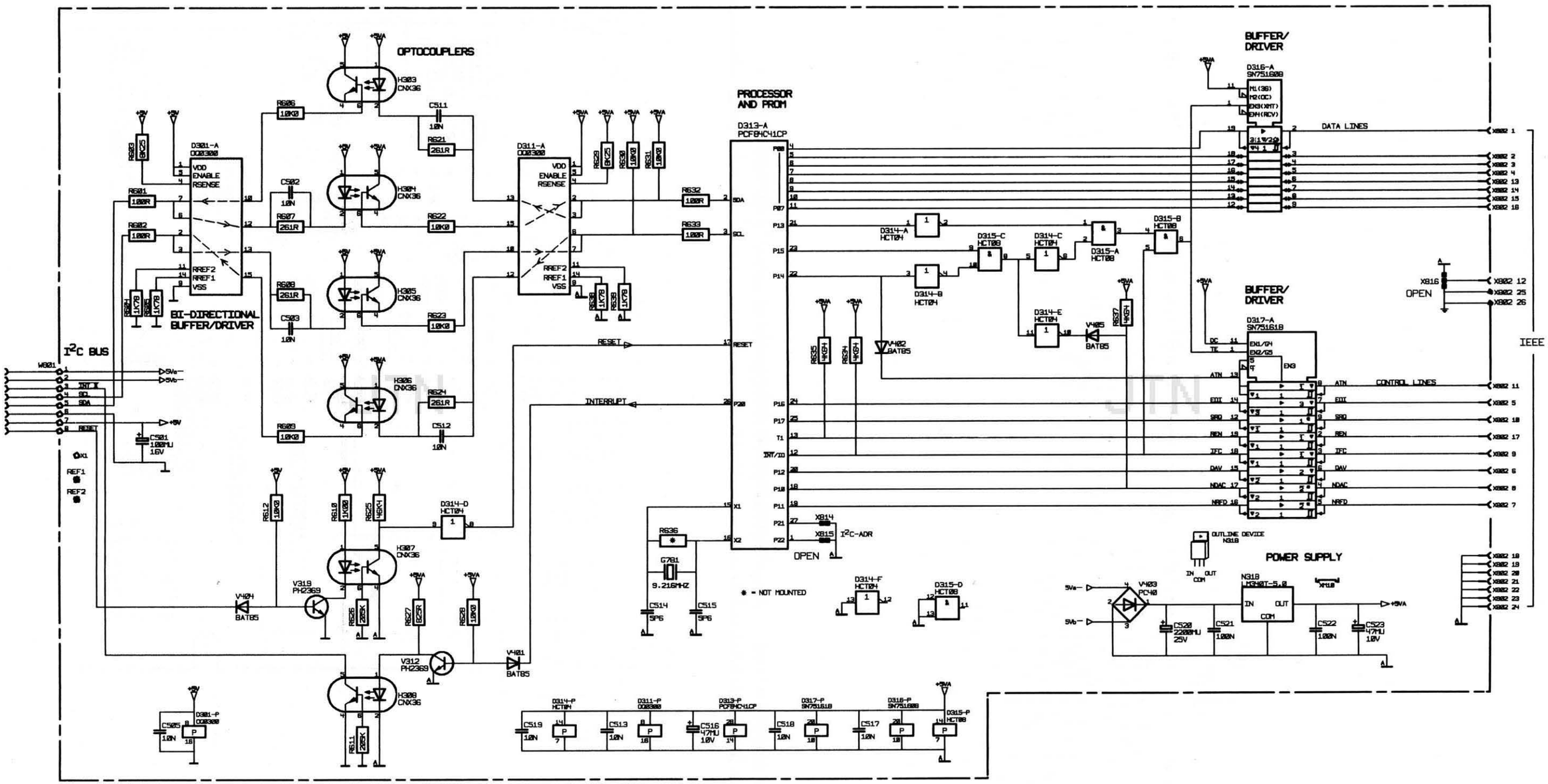
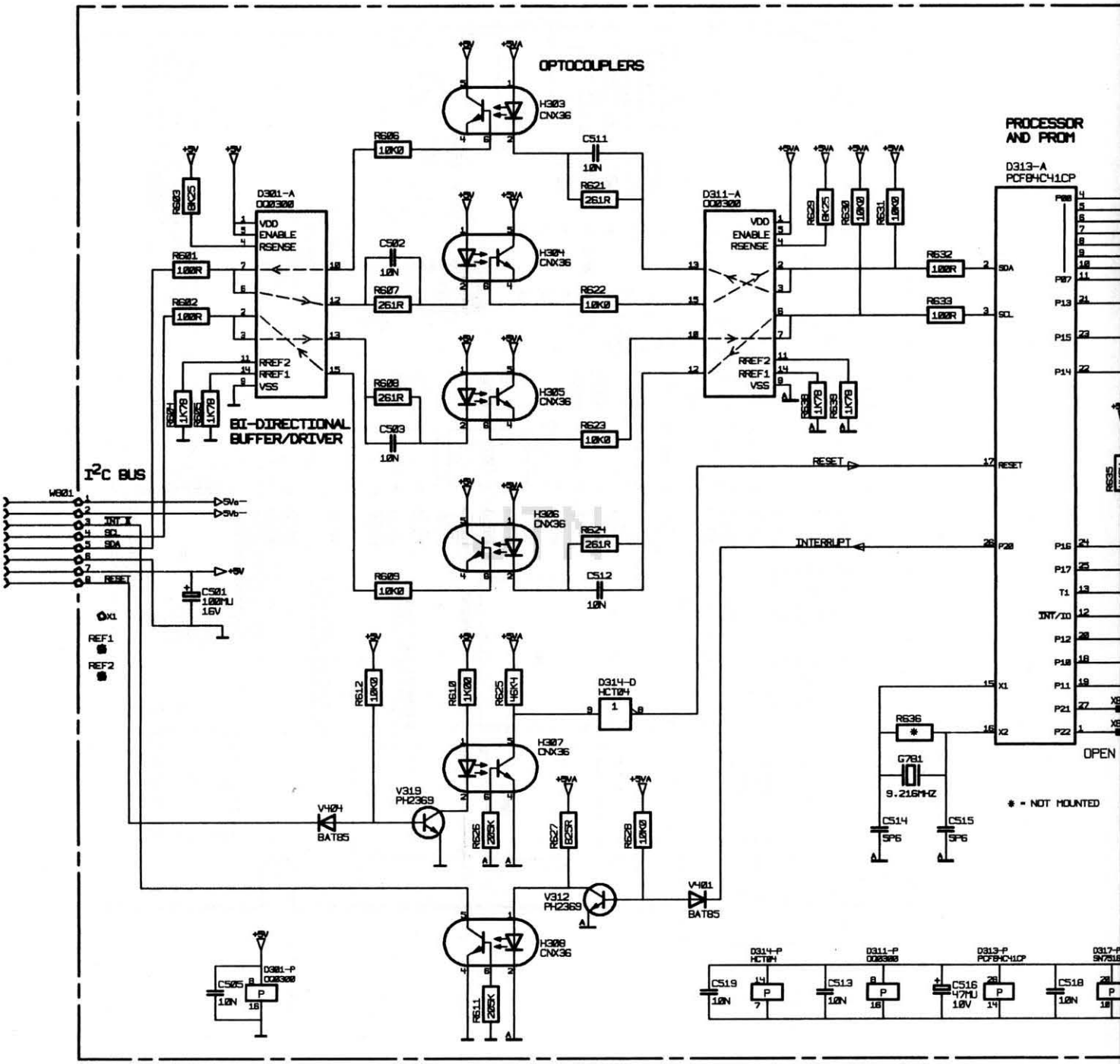


Fig. 124 Unit 6, IEEE-488 Interface


OPTOCOUPLERS
PROCESSOR AND PROM
D313-A PCF8HC41CP
D311-A 002300
D301-A 002300
VDD
ENABLE
RSENSE
RREF2
RREF1
VSS
BI-DIRECTIONAL BUFFER/DRIVER
I²C BUS
W801
INT_N
SCL
SDA
RESET
INTERRUPT
SDA
SCL
P87
P13
P15
P14
P16
P17
T1
INT/IO
P12
P10
P11
P21
P22
P20
X1
X2
OPEN
* = NOT MOUNTED
9.216MHZ
D314-D HCT04
V319 PH2369
V312 PH2369
V401 BAT85
V404 BAT85
H303 CNX36
H304 CNX36
H305 CNX36
H306 CNX36
H307 CNX36
H308 CNX36
D314-P HCT04
D311-P 002300
D313-P PCF8HC41CP
D317-P SN7518
D301-P 002300

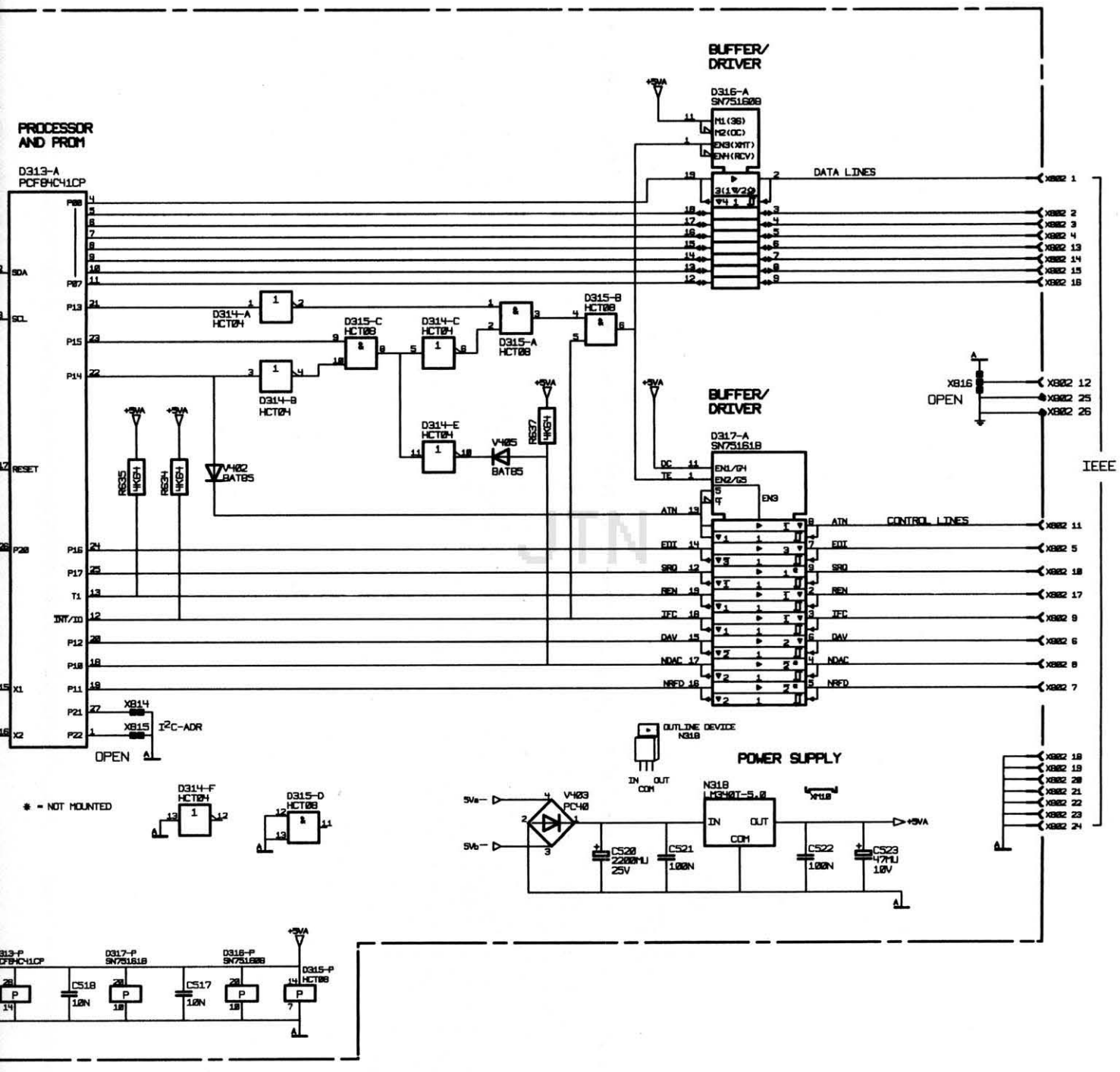


Fig. 124 Unit 6, IEEE-488 Interface

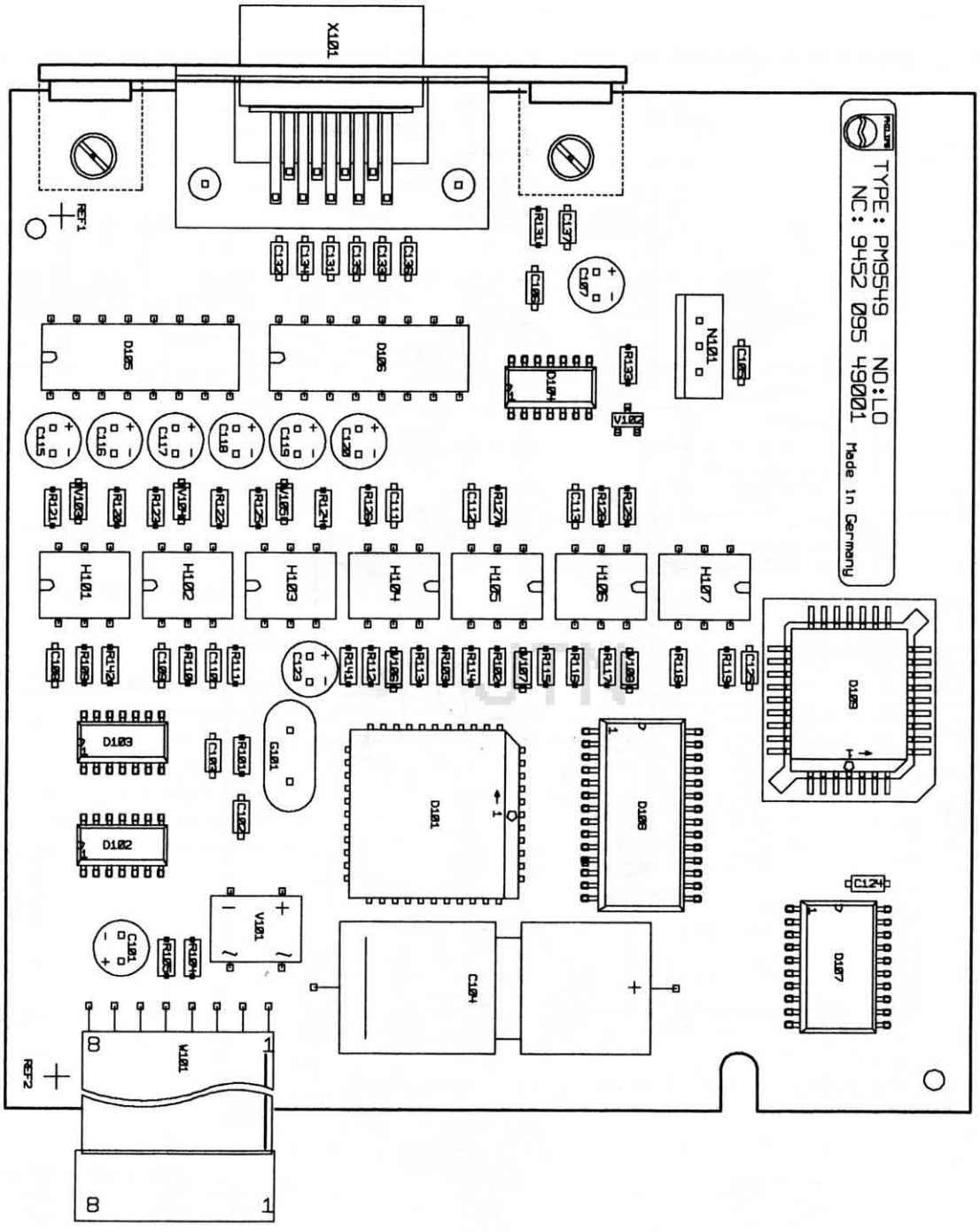


Fig. 125 Unit 7, Component Layout

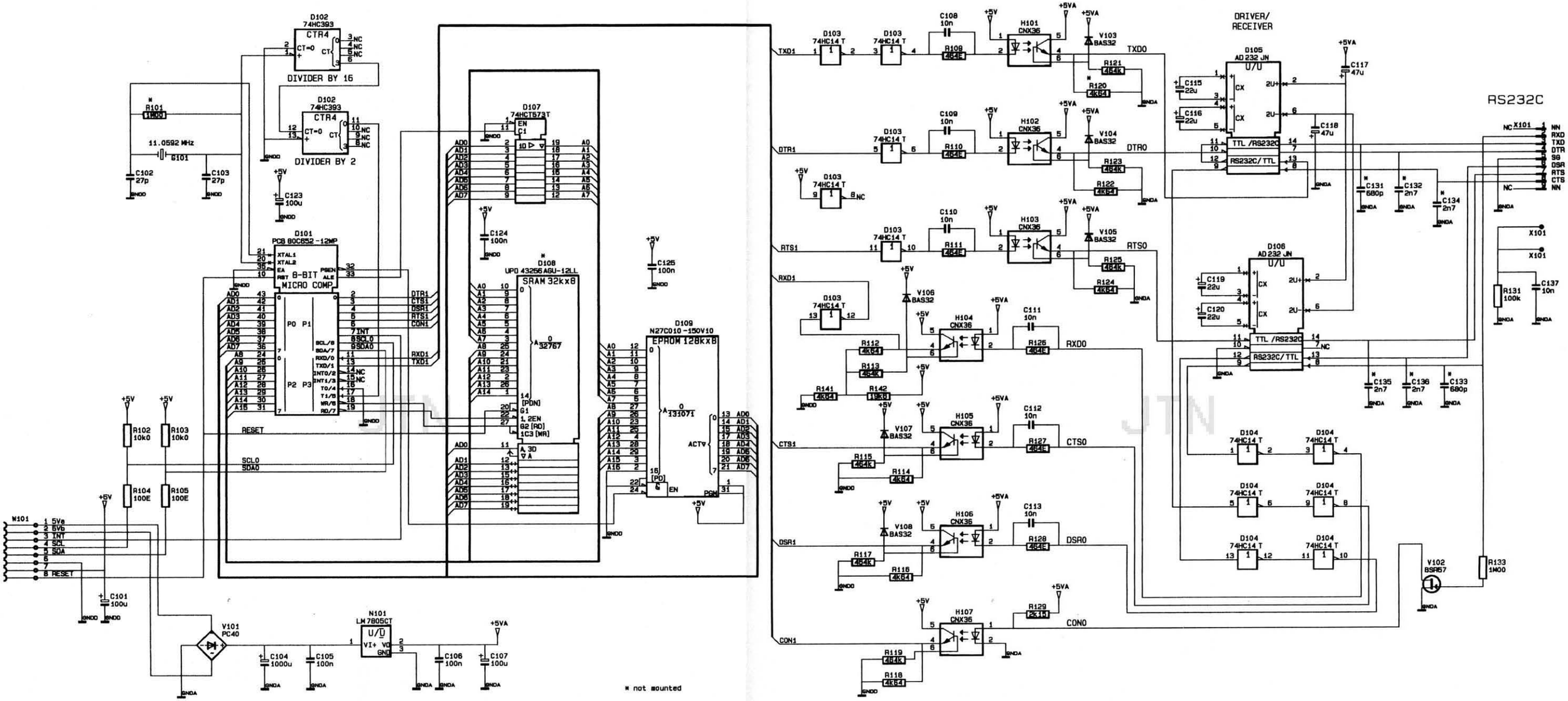
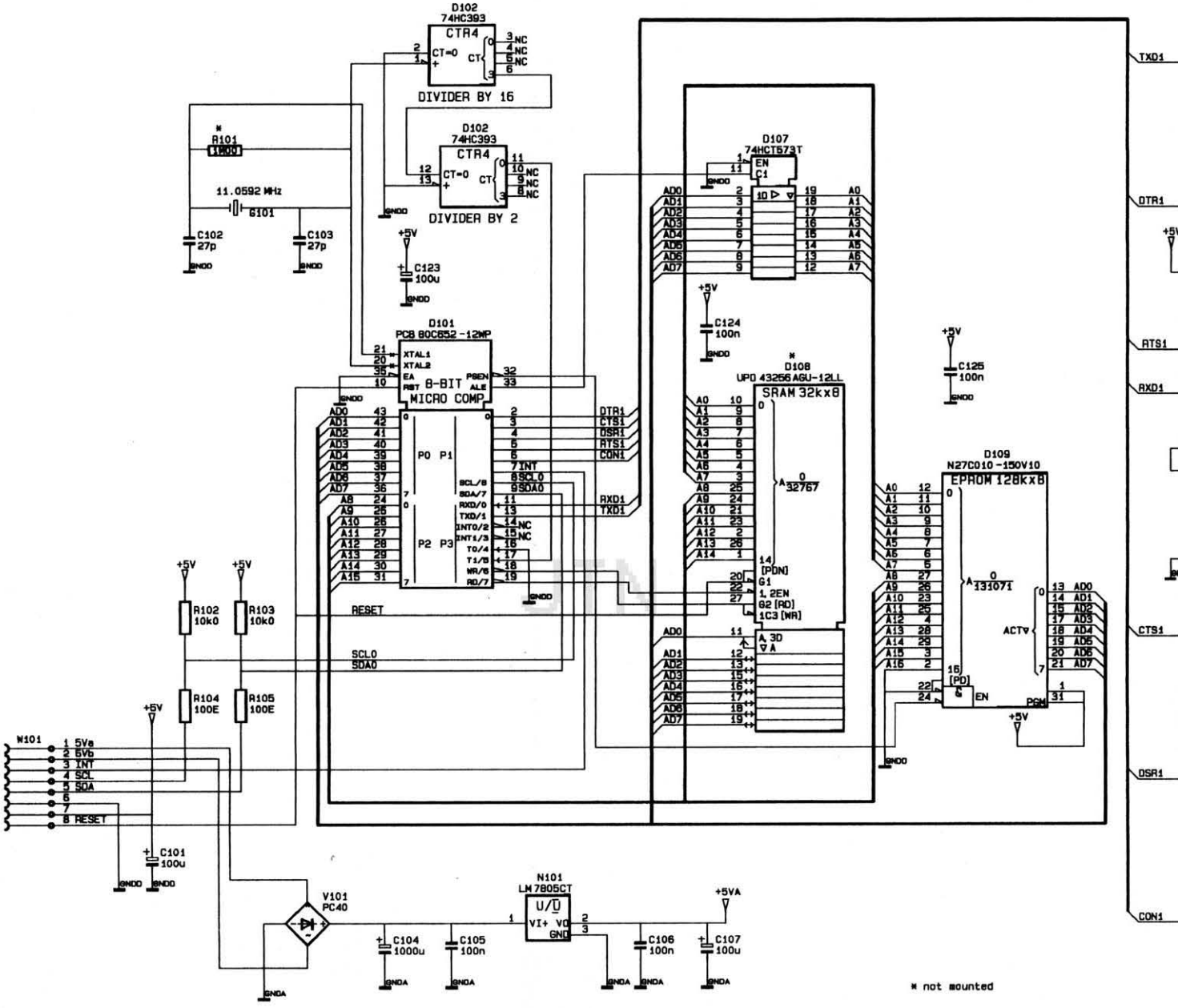


Fig. 126 Unit 7, RS-232 Interface


D102
74HC393
CTR4
CT=0
DIVIDER BY 16
D102
74HC393
CTR4
CT=0
DIVIDER BY 2
R101
1M00
11.0592 MHz
G101
C102
27p
C103
27p
C123
100u
D101
PCB 80C652-12MP
8-BIT
MICRO COMP
XTAL1
XTAL2
EA
RST
PSEN
ALE
P0 P1
P2 P3
SCL/8
SDA/7
RXD/0
TXD/1
INT0/2
INT1/3
T0/4
T1/5
WR/6
RD/7
INT
SCL0
SDA0
DTR1
CTS1
DSR1
RTS1
CON1
RXD1
TXD1
NC
D107
74HCT573T
EN
C1
1D
C124
100n
D108
UPD 43256AGU-12LL
SRAM 32kx8
32767
[PDN]
G1
1, 2EN
G2 [RD]
1C3 [WR]
3D
C125
100n
D109
N27C010-150V10
EPROM 128kx8
131071
ACT
[PD]
EN
PGM
R102
10k0
R103
10k0
R104
100E
R105
100E
RESET
SCL0
SDA0
N101
1 5Va
2 5Vb
3 INT
4 SCL
5 SDA
6
7
8 RESET
C101
100u
V101
PC40
N101
LM7805CT
U/U
VI+ VO
GND
C104
1000u
C105
100n
C106
100n
C107
100u
+5VA
GNDD
GNDA
TXD1
DTR1
RTS1
RXD1
CTS1
DSR1
CON1
* not mounted

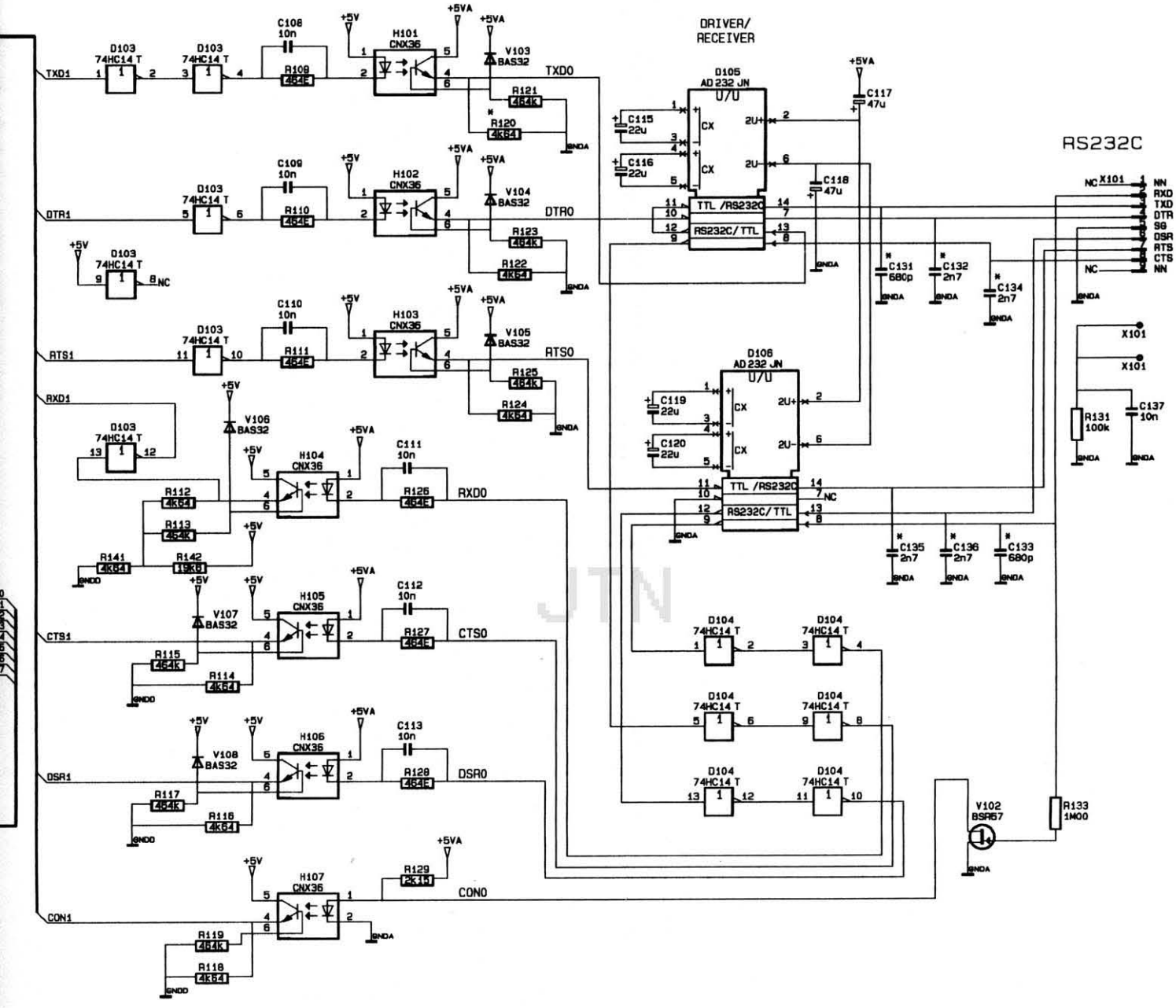


Fig. 126 Unit 7, RS-232 Interface