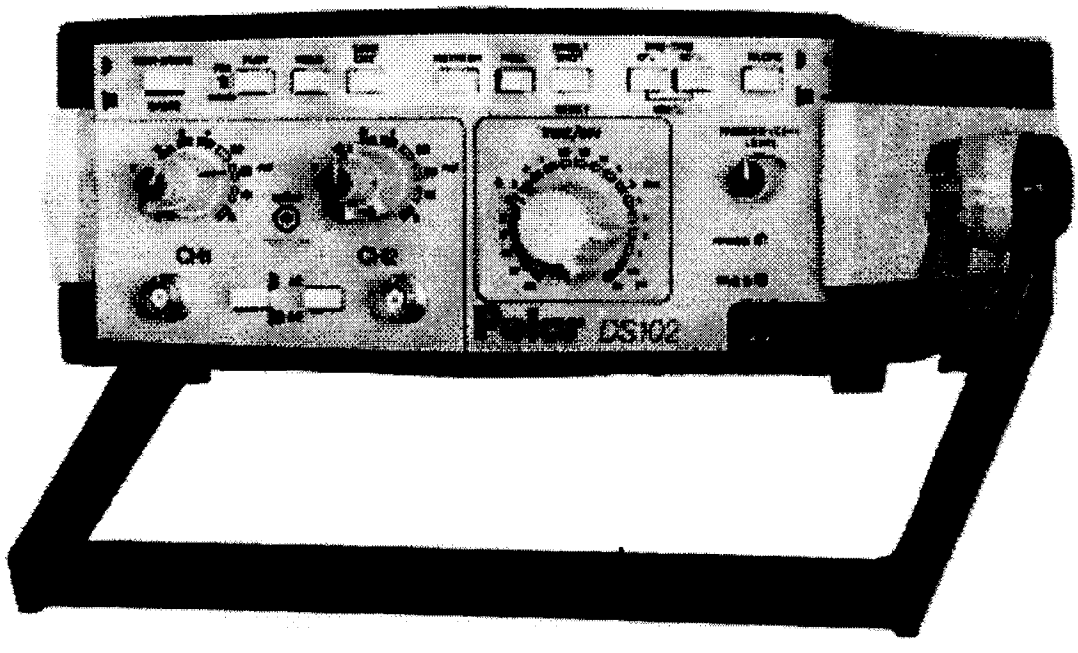

Polar

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DS102 OPERATOR MANUAL

1987

WARRANTY

For a period of one year from the date of its purchase new and undamaged from Polar Instruments Ltd., POLAR INSTRUMENTS LTD. or its authorized distributors will, without charge, repair or replace at its option, this product if found to be defective in materials or workmanship, and if returned to POLAR INSTRUMENTS LTD. or its authorized distributors transportation prepaid. This warranty is expressly conditioned upon the product having been used only in normal usage and service in accordance with instructions of POLAR INSTRUMENTS LTD. and not having been altered in any way or subject to misuse, negligence or damage, and not having been repaired or attempted to be repaired by any other than POLAR INSTRUMENTS LTD. or its authorized distributors. EXCEPT FOR THE FOREGOING EXPRESS WARRANTY OF REPAIR OR REPLACEMENT POLAR INSTRUMENTS LTD. MAKES NO WARRANTY OF ANY KIND, INCLUDING BUT NOT LIMITED TO, ANY EXPRESS OR IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE, AND POLAR INSTRUMENTS LTD. SHALL NOT BE LIABLE FOR ANY DAMAGES, WHETHER DIRECT OR NOT OR OTHERWISE, BEYOND REPAIR OR REPLACING THIS PRODUCT.

OPERATOR SAFETY

WARNING!

Failure to comply with the following instructions could cause the instrument to become unsafe under certain conditions.

POWER SUPPLY

This unit is designed to operate from either 100–128 volts or 200–250 volts, 50/60 hz a.c. source, complete with safety ground. Before switch-on, make sure that it is set to the correct range (see rear panel).

GROUNDING

This unit is grounded (earthed) through the protective grounding conductor of the power cord. This is the green/yellow wire on instruments supplied without a moulded plug, and it must be connected to the protective ground (earth) contact of the plug used.

The mains plug shall only be inserted in a socket outlet provided with a protective ground (earth) contact.

WARNING!

Any interruption of the protective conductor inside or outside the apparatus or disconnection of the protective ground (earth) is likely to make the apparatus dangerous. Intentional interruption is prohibited.

FUSE

To avoid a fire hazard, use only a fuse of the correct type and rating as specified on the rear panel adjacent to the fuse holder.

SERVICEABLE PARTS

This unit contains no user serviceable parts. When it is connected to its supply, the opening of covers or removal of panels is likely to expose live (dangerous) voltages.

To maintain operator safety, do not operate the unit unless the enclosure is complete and securely assembled.

DS102 DESCRIPTION

This instrument is designed to give digital storage features on any standard analogue conventional oscilloscope. It contains two high speed analogue to digital converters (sampling up to 10Mhz) and two 2048 byte memories to store the sampled data.

The output may be taken to an oscilloscope or analogue plotter. In addition an optional RS232 adaptor is available.

CONTENTS

SPECIFICATIONS

VERTICAL:

2 channels
AC or DC coupled
5 mV/div to 5 V/div in 1–2–5 sequence
Accuracy 5% in store, 30% in non-store. (+15°C to 30°C)
Input impedance 1 Megohm/25pF
Maximum input voltage ± 300V (DC or DC plus peak AC)

HORIZONTAL:

Time/div 80 s/div to 20 μs/div

TRIGGER:

Internal – CH1 only
External – rear panel via BNC input (TTL compatible – LEVEL to be set fully anticlockwise)

DIGITAL STORAGE:

Memory – Each channel 2048 x 8
Vertical resolution – 8 bit
Sampling – 10 Megasamples/sec to 5 samples/sec
Save – halts acquisition of CH2 in Refresh Hold – halts acquisition of CH1 and CH2 in all modes

MODES:

Refresh – 80 s/div to 20 μs/div
Roll – 80 s/div to 5 ms/div
Single Shot – 80 s/div to 20 μs/div

PRETRIGGER:

0%, 50%, 100% in Single Shot

REAR PANEL CONNECTORS:

(i) Ch 1 output to 'scope (0.2 V/div, 0 to +2 V)
(ii) Ch 2 output to 'scope (0.2 V/div, 0 to +2 V)
(iii) Trigger output to 'scope – TTL negative edge to trigger external 'scope.
Also functions as a Plotter pen lift – TTL low for pen down.
(iv) External trigger input (TTL compatible). Slope set by SLOPE switch.
LEVEL must be fully anticlockwise. Maximum input voltage ± 5 V.
(v) Expansion port for use with RS232 interface.

EXTERNAL 'SCOPE REQUIREMENTS:

Dual (or single) channel at 0.2 V/div
Timebase at 0.1 ms/div
External trigger input, negative slope

PLOT OUTPUT:

(i) Ch 1 or Ch 2 outputs used for signal at 0.2 V/div (Output from 0 to +2 V)
(ii) Plot times selected by 10 x TIME/DIV switch setting.
(iii) Pen lift – TTL high, pen up;
– TTL low, pen down
(front panel LED on)

ENVIRONMENT:

Operating: 0°C to +40°C
Storage: –25°C to +55°C

PHYSICAL:

Weight – 1.8kg
Dimensions – 260 x 260 x 97 mm (including handle)

ACCESSORIES:

Supplied with OPERATOR MANUAL
Optional Accessories:–1 metre BNC to BNC lead
RS232 Interface Adaptor
Service Manual

SECTION 1

CONNECTING THE DS102 TO AN OSCILLOSCOPE

1 With your 'scope switched on and powered, set it up as follows:–

(a) VERTICAL
- Dual Channel
- ALT (if selectable)
- 0.2 V/div (both channels)
- Variables (if present) in CAL
- DC coupling (both channels)

(b) HORIZONTAL
- A (or main) sweep
- 0.1 ms/div
- Variable (if present) in CAL
- MAG (if present) OFF

(c) TRIGGER
- EXTERNAL source
- DC coupling
- –ve slope
- AUTO mode
- LEVEL in mid position

Ensure the controls are for A (or main) sweep

(d) OTHER
- INTENSITY well up
- BANDWIDTH LIMIT (if present) use lower setting

Check that the CH1 and CH2 'scope vertical position controls will move the traces and position both traces just below the bottom graticule line, (not the centre line). Note the DS102 is NOT connected for this adjustment.

Now switch the 'scope to NORMAL trigger (if present). Note this is likely to cause both traces to disappear from the screen.

Scope settings should not be altered, apart from minor adjustments to INTENSITY, FOCUS etc as required.

2 With the DS102 powered and switched on, set it as follows:–

(a) ROLL button IN
ALL other buttons OUT

(b) All three variable potentiometers at mid position.

(c) TIME/DIV at 0.1 s (about 11 o'clock)

3 (a) Connect CH1 and CH2 outputs on the DS102 rear panel to CH1 and CH2 inputs of the 'scope.

(b) Connect the SCOPE TRIG on the DS102 rear panel to the EXT TRIG input of the scope.

(c) Adjust the 'scope TRIGGER LEVEL for a triggered display.

4 The 'scope should be displaying two traces (Channel 1 and Channel 2). Check that using the DS102 position controls, the traces can be moved off the top and bottom of the screen.

Possible problems/solutions

i. Whole trace moves up and down with DS102 position:–

(a) Check DS102 is not in NON STORE and TIME/DIV is .1 s.
(b) Check 'scope triggering (especially slope and level).

ii. Discontinuities in display:–

(a) Check 'scope timebase setting – .1 ms/div; MAGNIFIER x 1.
(b) Check EXTERNAL trigger selected on 'scope.

iii. Insufficient position range:–

(a) Check 'scope I/P setting – 0.2 V/div CALIBRATED.
(b) Ground 'scope I/P and check traces are just below bottom graticule line.
(c) Check 'scope CALIBRATION!

CHANGE OF POWER RANGE

(a) DISCONNECT UNIT FROM POWER SOURCE

(b) Remove the base by unscrewing the 4 screws through the feet on the enclosure base.

(c) The pcb mounted transformer has two 0-120 V primary windings. Primary voltage selection is made by pcb links which are marked adjacent to the transformer.

(d) Change the primary connections as required.

For 115/120 V - windings in parallel (2 links on pcb)
For 220/240 V - windings in series (1 link on pcb)

(e) Change the rear panel fuse to the rating as stated on the rear panel.

(g) Replace the base carefully ensuring that the rear panel is slotted in the case and that the flexible screen over the VOLTS/DIV switches is tucked into the enclosure side.

SECTION 2

FRONT PANEL CONTROLS AND FEATURES.

1 Vertical (Y) Amplifier (CH1 and CH2).

(a) V/DIV – Two 10 way rotary switches that control the vertical gain of the amplifiers – arranged in a 1 – 2 – 5 sequence 5 mV to 5 V/div.

(b) POSITION – Two potentiometers, concentric with the V/DIV switches which vary the DC level of the signal PRIOR to digitisation. ie they behave as vertical position controls on the INPUT to the analogue to digital converter.

(c) AC – DC – Two push–push switches which either couple the input signal via a blocking capacitor in AC, or directly couple it in DC to the input amplifier.

(d) BNC sockets – Two sockets for the input signals.
Input resistance 1 Megohm (+/– 3%), input capacitance 25 pF (approximately).
Maximum input voltage +/– 300V. (DC or DC plus peak AC)

2 TIME/DIV – A continous rotary switch with 20 marked calibrated positions. It adjusts the rate at which the input signals are sampled and digitised. This effectively varies the time/division of the 'scope display between 80 s to 20 μs/div.

See section 4.3 for further details, including its use for setting the Plot time when PLOT is selected.

The anticlockwise position adjacent to 40 s will cause an effective display of 80 s/div.

The clockwise position adjacent to 20μs is selected when the expansion port is used with the RS232 adaptor.

3 Trigger

(a) TRIGGER (CH1) LEVEL – A potentiometer that controls the particular voltage level on Channel 1 signal at which the internal trigger signal is generated. It must be fully anticlockwise if EXTERNAL trigger is being used.

(b) SLOPE – A push–push switch that selects the slope of the signal (+ or –) on which the LEVEL control generates the trigger signal.

(c) ARMED – A yellow LED for use in SINGLE SHOT mode. It is lit when the unit is ready to accept a trigger pulse (depression of the RESET button) and is extinguished when the single frame has been acquired.

(d) TRIG'D – A green LED for use in SINGLE SHOT and REFRESH modes.

It is lit once a trigger signal has occurred and is extinguished at the end of each frame acquisition.

4 NON–STORE/STORE – A push–push switch. In the STORE position (button out) the CH1 and CH2 signals are directed to the analogue to digital converter (ie normal digital storage).

In the NON–STORE position (button in) the vertical signals are picked off after the vertical amplifier and directly connected to the oscilloscope. There is no storage in this position and accuracy is +/– 20%.

5 MODES (also see section 4)

(a) REFRESH – A push switch to select REFRESH which is cancelled by ROLL or SINGLE SHOT.

Following a trigger pulse the input signals are digitised and written into the memory. The memory is continuously displayed. Each time a trigger pulse occurs the process is repeated, ie for a continuous input the memory is constantly being refreshed.

(b) ROLL – A push switch to select ROLL which is cancelled by REFRESH or SINGLE SHOT.

For use at slow speeds (0.1 s and slower) this simulates a chart recorder mode. The input is continuously sampled, digitised and displayed on the scope with the current sample on the right of the CRT, ie the most recent information appears on the right of the CRT and then moves to the left as newer information (samples) appear on the right.

SCHEMATIC DESCRIPTION

VERTICAL AMPLIFIER AND TRIGGER GENERATOR

The following refers to schematic 1. A full description is given for Channel 1 (component references begin with a 1 eg R107). Channel 2 operation is exactly the same except it has no trigger pick off.

The input signal is coupled via the AC/DC switch to the rotary VOLTS/DIV switch. Input attenuators are mounted on this switch.

In 5mV to 50mV, there is no attenuation. In 100mV to 500mV, R102 and R103 form a X10 attenator with associated compensating capacitors C103 and C109. In 1V to 5V, R104 and R105 form a X 100 attenuator with compensation from C105 and C106. C102 and C104 provide input normalisation to allow the input capacitance to be matched between ranges.

The output of the attenuators is coupled via R107 and R108 (protection components) to IC145 connected as a unity gain amplifier.

The next stage comprises of IC146, its gain being set by R109 - R112 which are selected by the VOLTS/DIV switch.

R114 supplies a position current set by R113 which is added to the signal current. R124 balances IC146.

The output stage IC145 contains the overall gain adjustment (R140) and is configured as an inverting amplifier with an adjustable gain of approximately 1.

The overall gain from BNC input to IC145 pin 7 is approximately 40 to 50.

The trigger pick off (Channel 1 only) is applied to IC147. The signal is coupled via R173. R172 provides a position dc offset to minimise trigger change with position. IC144 is a comparator producing an output squarewave whose edges occur when the signal voltage equals the TRIGGER LEVEL voltage.

IC143 speeds the squarewave edges and also provides an EXTERNAL TRIGGER TTL input facility via R131. The SLOPE switch determines which phase of trigger signal is applied to the trigger flip flop IC32 shown on schematic 2.

TIMING SIGNALS

Schematic 3 shows details of the TIME/DIV switch and other signals required for timing.

IC1 is configured as a basic 20MHz clock controlled by the crystal. This frequency is divided down as shown and provides the basic sample rate selected by the TIME/DIV switch.

A separate 2MHz output is taken to provide a clock for the digital to analogue converter.

Two other outputs, 10MHz and IC1 pin 11 are taken for timing control on schematic 2.

MAIN LOGIC AND CONVERSION

The following description pertains to schematic 2.

1. Overview

Channel 1 analogue signal is applied to the analogue to digital converter (A to D) IC11. This samples the input at a rate set by the TIME/DIV switch and the output digital word is stored in memory IC14.

The data is read back from the memory IC14 and converted into analogue information by a digital to analogue converter (also in IC11). The output via R11 is taken to the display oscilloscope.

Channel 2 has its own A to D and D to A converter (IC15) and memory IC17 and operates as Channel 1.

Control logic is common to both channels.

IC21, IC22 and IC23 are a synchronous counter used to set the memory address for data acquisition (A to D into memory), ie the write counter.

IC29 is a counter used to control the memory address when reading the data out of memory into the D to A (ie display address), ie a read counter.

IC27 and IC28 are connected as a comparator to compare the data acquisition address with the display address. This is used in SINGLE SHOT to provide pretrigger facilities and also in ROLL.

IC32 controls the trigger and arm functions. The outputs, as well as driving the relevant LED's also control the acquisition of signals, depending on the selected mode.

IC36 pin 5 provides the output negative going trigger pulse for the display 'scope. Data is output whilst IC36 pin 5 is low.

IC24, 25 and 26 control whether the write counter or read counter has access to the address bus.

2. Refresh

Whilst data is being output to the 'scope IC36 pin 5 is low. When the read counter, IC29 has finished addressing the last memory address, its pin 15 goes low and this clocks IC36 taking its pin 5 high. This action clocks IC32, lighting the ARMED LED and removing the clear from IC32 pin 13. IC32 pin 11 is now free to respond to the next positive going trigger pulse edge.

On receipt of this edge, IC32 is clocked, the TRIG'D LED is lit and both memories are filled at a rate set by the TIME/DIV switch.

Counter IC29 runs continuously but the write counters take priority when they need access to the memories. The write counters only run when data is being acquired ie 2048 counts after a trigger pulse. They are then held cleared until the next trigger pulse clocks IC32 pin 11.

3. Single Shot

Blocks are organised differently in Single Shot by IC31 under control of IC34 pin 8. Writing and reading of the memories does not overlap.

Once the system is ARMED (by pressing the SINGLE SHOT button) IC31 switches to the position as shown on schematic 2.

Once arming has occurred, data begins to be written into the memories at a rate determined by the TIME/DIV switch.

The trigger pulse clocks IC32 removing the reset on counter IC29 which is clocked from pin 14 of IC21.

IC29 and the write counter continue to run, loading the memories, until the selected pretrigger value is reached which clears the armed flip flop IC32 via IC13 pin 10. This freezes the write counter (IC21, 22, 23) and reverses the switch positions of IC31 putting the display counter clock to 2MHz.

Comparators IC27 and 28 compare the write and read counter values and generate an edge to clock IC36 at comparison. This produces the SCOPE TRIG signal.

The display mode is maintained until SINGLE SHOT is pressed or another mode selected.

4. Roll

The read and write counters operate continuously in this mode and trigger signals to IC32 have no effect. Power is removed from the ARMED and TRIG'D LED's.

The display counter is permanently clocked at 2MHz and is continuously sending memory data to the D to A. This is only interrupted when the A to D needs access when writing in a new data byte.

The SCOPE TRIG signal is generated from comparators IC27 and IC28 which produce a pulse when the read and write counters have the same count.

This mode only operates at TIME/DIV rates below 5ms/div.

POWER SUPPLY

There are three voltage supplies all derived from 3 terminal regulators.

This is a continous process and no triggers are necessary.

(c) SINGLE SHOT/RESET – A momentary switch to select SINGLE SHOT or RESET which cancels REFRESH and ROLL.
A full description of this appears in section 4.6.

6 PRE TRIG – Two push–push switches which allow selection of 0% 50% or 100% pre trigger in the single shot mode. This enables the user to view either 50% or 100% of the signal occuring before the trigger pulse. 0% causes the display to start coincident with the trigger pulse.

7 SAVE CH2 – A push–push switch. When pressed in REFRESH it stops the channel 2 memory being updated, ie Channel-2 memory becomes frozen or saved.

8 HOLD – A push push switch. When depressed in REFRESH, it stops both memories (Channel 1 and Channel 2) being updated, ie both memories hold the current waveforms until the HOLD is released.

9 PLOT

(a) PLOT – A push push switch. When HOLD has been selected and PLOT is depressed, the output signals from the DS102 appear after a delay at a rate determined by the TIME/DIV setting. This allows the CH1 or CH2 BNC outputs to be connected to a plotter.

(b) PEN DOWN – A yellow LED which only operates if PLOT is selected. It is illuminated when the DS102 is outputting CH1 and CH2 signals on its BNC sockets. This is coincident with a TTL low level on the SCOPE TRIG BNC which may be used to drive the pen on the plotter. Note that there will be a delay between depressing PLOT and this LED illuminating. (See section 7.2).

SECTION 3

REAR PANEL CONNECTORS

1 CH1 – Channel 1 output at 0.2 V/div. (Output between 0 V and +2 V)

2 CH2 – Channel 2 output at 0.2 V/div. (Output between 0 V and +2 V)

3 SCOPE TRIGGER – A negative going TTL output pulse designed to provide an external trigger for the scope.

This can also be used for pen lift on a plotter, the output level being logic low for the duration of one output frame from the CH1 and CH2 outputs.

4 EXT TRIG I/P – An external trigger input, TTL level compatible. The TRIGGER level control must be set fully anti–clockwise and the slope is selected by the SLOPE switch. Maximum input voltage +5 V.

5 EXPANSION PORT – A 26 way connector for use with Polar accesories only. Currently an RS232 adaptor is available.

CALIBRATION PROCEDURE

Equipment required:-

(i) Oscilloscope.

(ii) Amplitude Calibrator (1kHz squarewave, output 50mV and 1V, ± 0.5%).

(iii) Squarewave Generator (1kHz and 10kHz squarewave, output 0.5V, 1V and 5V, Risetime <100ns).

(iv) Dummy Probe (1MΩ 1% in parallel with variable capacitor 15 - 35 pF).

(v) Insulated trimming tool.

Note, the following procedure is not a performance check but covers adjustment of the 12 trimmers in the DS102. The unit should be allowed to warm up for 20 minutes before commencing step 4 and subsequent steps.

1. Connect the Amplitude Calibrator directly to the oscilloscope.

   (i) Set the 'scope to 0.2V/div and the Amplitude Calibrator to 1V.

   (ii) Adjust the 'scope for a stable display and check for 5 divisions of deflection on both channels. Adjust the 'scope calibration if necessary or take note of any error since this must be subtracted or added when setting the DS102 gain trimmers.

   (iii) Apply 1V, 10kHz to both 'scope channels and check for a flat compensated response. Adjust if necessary.

   (iv) Repeat (iii) with a 1kHz squarewave.
   The above checks are necessary to ensure that the 'scope is calibrated and its attenuators compensated. FAILURE TO DO THIS COULD RESULT IN THE DS102 BEING INCORRECTLY CALIBRATED.

2. Remove the DS102 base by unscrewing the four screws through its feet and lifting them and the base from the assembly.

   This exposes the printed circuit boards mounted in the enclosure lid.

3. Connect the unit to the 'scope as described in Section 2. Set up the 'scope as described and do not alter its controls for the rest of this procedure.

4. Set the DS102 as follows:-
   ROLL - in
   All other buttons - out
   TIME/DIV - 20ms

   (a) Switch CH1 VOLTS/DIV between 5mV and 50mV and adjust R124 for no vertical trace shift.

   (b) Switch CH2 VOLTS/DIV between 5mV and 50mV and adjust R224 for no vertical trace shift.

   NOTE: Take care not to rotate the POSITION controls when turning the VOLTS/DIV switches for this step. If vertical hum or pick up causes a problem, terminate the input BNC with a 50 ohm terminator.

5. Set the DS102 as follows:-
   ROLL - in
   All other buttons - out
   TIME/DIV - 5ms
   CH1 and CH2 VOLTS/DIV - 10mV
   Set the Amplitude Calibrator to 50mV and connect it to CH1.

   (a) Adjust R140 for exactly 5 divisions of signal amplitude.

   (b) Connect the Amplitude Calibrator to CH2 and adjust R240 for exactly 5 divisions of signal amplitude.

6. Set the DS102 as follows:-
   REFRESH - in
   All other buttons - out
   TIME/DIV - 20µs
   CH1 VOLTS/DIV - 0.1V
   CH2 VOLTS/DIV - 1V
   Set the Squarewave Generator to 10kHz (approximately) and connect it to CH1.

   (a) Adjust the Squarewave Generator for 5 to 6 divisions of amplitude and adjust the DS102 TRIGGER LEVEL for a stable display. A squarewave should be present on the CRT.
   Refer to figure 1 for locations of the trimmer capacitors.

   (b) Adjust C103 for a flat, clean response.

   (c) Set CH1 VOLTS/DIV to 1V and increase squarewave output so that 5 to 6 divisions are displayed.
   Adjust C105 for a flat, clean response.

   (d) Connect the squarewave to CH2 and observe 5 to 6 divisions of untriggered display.

   The DS102 can be triggered as follows:-
   (i) If the Squarewave Generator has a TTL output synchronised to the squarewave output, it can be applied to the rear panel "EXT TRIG I/P" and the LEVEL control turned fully counter clockwise.
   (ii) Otherwise a twin BNC coupler can be used to apply the squarewave to CH1 and CH2 simultaneously.
   A triggered display should result from (i) or (ii) above.

   (e) Adjust C205 for a flat, clean display.

   (f) Set CH2 VOLTS/DIV to 0.1V and reduce the squarewave to 5 divisions. Note that if using CH1 signal (d(ii) above) for a trigger, CH1 must also be reduced to 0.1V/DIV.

   (g) Adjust C203 for a flat, clean display.

7. Set DS102 as follows:-
   REFRESH - in
   All other buttons - out
   TIME/DIV - 0.2ms
   CH1 VOLTS/DIV - 50mV
   CH2 VOLTS/DIV - 1V
   Set the Squarewave Generator to 1kHz and connect it to CH1 via a dummy probe (see Equipment Required)

(a) Set the Generator to 5 divisions amplitude and adjust the TRIGGER LEVEL for a stable display. Adjust the variable capacitor in the dummy probe for a clean, flat display.

(b) Change CH1 VOLTS/DIV to 0.1V and increase the signal to 5 divisions. Adjust C102 for a flat, clean display. Refer to figure for location of the trimmer capacitors.

(c) Increase CH1 to 1V/DIV, increase the signal to 5 divisions and adjust C104 for a flat, clean display.

(d) Swap the signal and dummy probe to CH2. Produce a triggered display as described in 6(d) but take care if using (ii) to pick the signal off before the dummy probe ie the dummy probe output should only go to CH2 to avoid capacitive loading.

(e) Adjust C204 for a flat, clean display.

(f) Change CH2 VOLTS/DIV to 0.1V and reduce the squarewave output to 5 divisions. (Reduce CH1 VOLTS/DIV if necessary to maintain a triggered display).
Adjust C202 for a flat, clean display.

This completes adjustment of the DS102 preset trimmers.

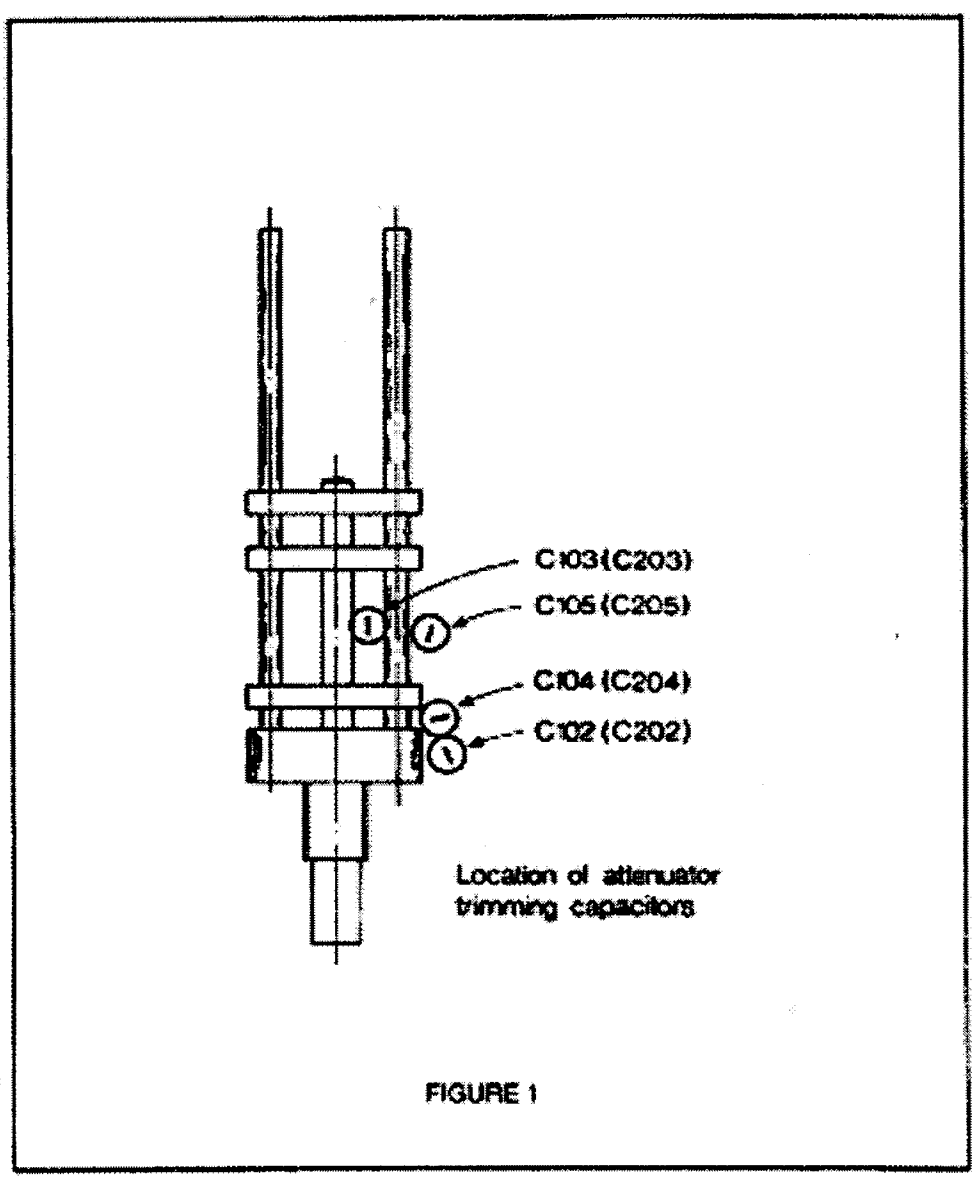


FIGURE 1

CHANGE INFORMATION

1. IC11, IC15 (29.10.86)

   A specification change concerning the above IC's caused a change from part number UVC3100, UVC3101 and UVC3102 to UVC3120. These numbers are printed on the IC.

   If it becomes necessary to replace one of the former part numbers, then the replacement should be with UVC3120. Certain other changes will also be necessary to accommodate internal IC differences:—

   1. Add Z1/Z2 (2V5 zener) across C12/C7.
   2. Add R31/R32 (270R carbon film 5% resistor) from pin 25 to Pin 36 (+5VA).

   These changes are shown on schematic 2B.

2. C18, R10 (15.12.86)

   C18 and R10 changed to 0.01µF and 10K respectively to reduce transients when pressing the RESET button.

SECTION 4

UNDERSTANDING THE DS102

To obtain maximum benefit from the DS102, we strongly recommend that you spend some time reading this section.

Digital storage can give some apparently strange displays if the conversion method is not considered. As with all instruments, time invested in understanding the product will be amply rewarded when using it.

4.1 Basic Concepts of Digital Storage Oscilloscopes

This subsection covers the principles employed by the DS102, it is not intended as a primer on general digital storage oscilloscopes.

Each channel of the DS102 has three basic sections:-

(a) Analogue to digital converter (ADC)
(b) Digital Memory
(c) Digital to analogue converter (DAC)

The input signal is sampled at a specific rate (set by the TIME/DIV switch) and each sample is digitised, ie given an 8 bit number representing its amplitude.

The digitised values are stored in sequential locations of a memory. 2048 samples are required to fill each memory.

The DAC receives the stored digitised values and converts them back into an analogue value, suitable for ultimately applying to the vertical deflection plates of cathode ray tube (CRT).

Each sample of the input signal is stored as an 8 bit word. This gives a maximum of 256 different values.

ie	Minimum value	00000000
	Maximum value	11111111

The 256 different values cover a nominal 10 vertical divisions of CRT deflection, giving 25 dots per division.

The 2048 words of memory define the horizontal resolution. The unit is calibrated to produce a horizontal resolution of 200 dots per division (10 divisions will require 2000 words of memory giving an overall trace length of 10.24 divisions with the 2048 words available).

Although the display on the CRT is made up of dots, they are sufficiently close that they are unlikely to be noticeable except when magnifying the display. The DS102 contains a dot joiner (linear interpolation) to improve the display quality if it is magnified.

It is worth mentioning here that the DS102 TIME/DIV controls the sampling rate and hence the rate at which the memory is filled. A fixed internal clock determines the rate at which the samples are read out of the memory and applied to the DAC and then to the 'scope.

This latter display rate is set to ensure that the samples are applied to the 'scope sufficiently fast to avoid flicker. The DS102 TIME/DIV does not alter the rate at which the signals are applied to the 'scope.* Hence the 'scope will always show a bright, flicker free display if it is set to the correct (and fixed) time/div of 0.1 ms/div.

When using the DS102 and viewing the 'scope display, it may be useful to imagine that you are viewing the contents of the memory NOT necessarily viewing the signal being applied to the DS102. Conceptually this is important because it helps to avoid some of the confusion that can occur when interpreting the display.

* The only exception occurs in PLOT when a plotter is used to display the signals.

4.2 Block Diagram Description

Figure 1 shows a simplified block diagram with only one vertical channel shown.

The input signal is applied to a standard vertical amplifier whose output goes to the ADC input and also the STORE/NON STORE switch. In NON STORE the user can view directly in real time, the internal vertical amplifier output. This can be useful if interpretation of the stored waveforms is causing a problem, (eg if aliasing is suspected).

The ADC samples the input signal at a rate set by the TIME/DIV switch. It produces an 8 bit word representing the analogue signal value and applies this to the data bus feeding the memory. The address at which the memory stores the 8 bit word is determined by the STORE ADDRESS COUNTER which is also clocked by the output of the TIME/DIV switch.

PARTS LIST

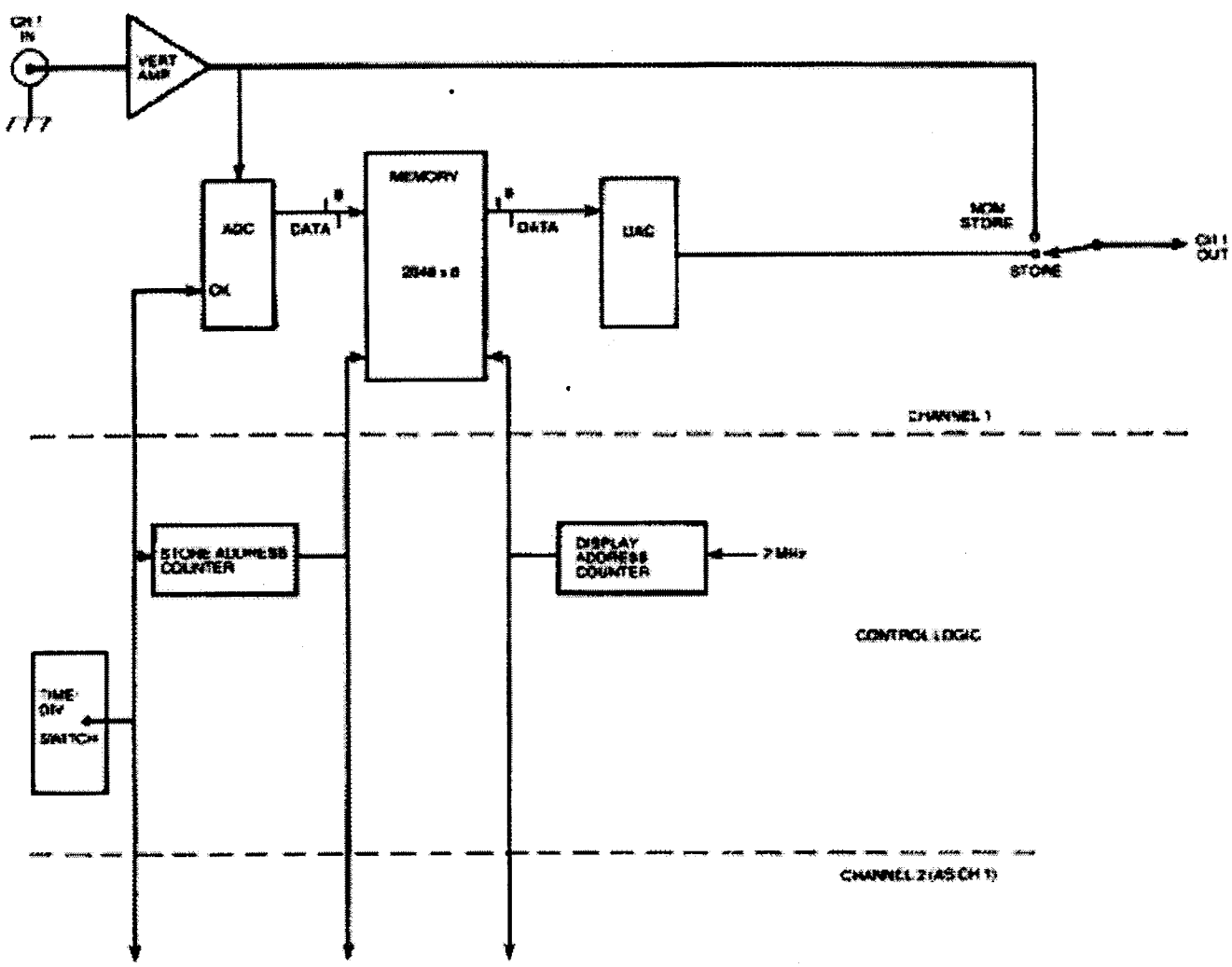
Order replacement parts by part number, description and state instrument type and serial number. The list below only covers parts that are likely to be difficult or impossible to obtain from local suppliers.

Polar part number	Deacription
CVD125	10pF (brown) variable
CVD126	5.5pF (blue) variable
DZA311	ZN404, 2.5V reference
ICA176	TMM2016 - 90 (RAM)
ICA185	UVC3120 - 08 (A to D converter)
LDD104	20MHz Crystal
MMP139	Shaft extender and coupling
SWB127	VOLTS/DIV switch
TXM113	Power transformer

Hence each clock pulse from the TIME/DIV switch causes the ADC to produce an 8 bit word and the STORE ADDRESS COUNTER to place it in the correct address. On the next clock pulse, the ADC will produce a new 8 bit word (dependent on the signal value at that time) and the counter will place it in the next memory address. After 2048 clock pulses, the memory will be full.

To retrieve the data for display, the memory data is applied to a DAC which converts the digital signal into an analogue value between zero and +2 volts. The DISPLAY ADDRESS COUNTER determines which address is read by the DAC and the 2 MHz clock (as shown) controls the rate of the readout to the DAC.

FIGURE 1 – BLOCK DIAGRAM



A 2 MHz clock has 0.5 μs period hence:–

Time to display Memory = 2048 x 0.5 μs
= 1.024 ms

ie One trace length of display (10 divisions) = 1.024 ms.

Thus with the 'scope set to 0.1 ms/div the trace is 10.24 divisions long.

The above calculation is presented to reinforce that fact that the DS102 TIME/DIV does not affect the rate at which signals are applied to the 'scope. The DS102 TIME/DIV controls the rate at which signals are entered into its memory. The system is only calibrated if the external 'scope is left at 0.1 ms/div.

It must be stated that figure 1 is drawn to give a conceptual understanding of how the digitisation occurs – the actual electronic circuitry is not necessarily constructed exactly as the diagram.

4.3 TIME/DIV switch.

Reference to figure 1 shows how this switch controls the clock frequency applied to both the ADC and the STORE ADDRESS COUNTER. In this way it determines the rate at which the input signal is sampled and hence the effective time required to fill the memory.

Since the 'scope is displaying the memory contents over 10 horizontal divisions, the time to fill one tenth of the memory (200 words) is, in effect, the time per division of the display.

Table 1 relates the switch setting to sampling frequency, period between samples, time to fill 2000 addresses of the memory and time to fill 200 addresses of the memory.

The memory, in practice, has 2048 addresses rather than 2000. The last 48 give an extra 2.4% locations and allow the memory to produce 10.24 divisions on the CRT display.

Table 1

DS102 TIME/DIV	SAMPLE RATE	TIME BETWEEN SAMPLES	TIME FOR 2000 SAMPLES (10 DIVS)	TIME FOR 200 SAMPLES (1 DIV)
20 μs	10 MHz	.1 μs	.2 ms	20 μs
50 μs	4 MHz	.25 μs	.5 ms	50 μs
100 μs/.1 ms	2 MHz	.5 μs	1 ms	0.1 ms
200 μs/.2 ms	1 MHz	1 μs	2 ms	0.2 ms
500 μs/.5 ms	400 KHz	2.5 μs	5 ms	0.5 ms
1 ms	200 KHz	5 μs	10 ms	1 ms
2 ms	100 KHz	10 μs	20 ms	2 ms
5 ms	40 KHz	25 μs	50 ms	5 ms
10 ms	20 KHz	50 μs	100 ms	10 ms
20 ms	10 KHz	100 μs	200 ms	20 ms
50 ms	4 KHz	250 μs	500 ms	50 ms
100 ms/.1 s	2 KHz	500 μs	1 s	.1 s
200 ms/.2 s	1 KHz	1 ms	2 s	.2 s
500 ms/.5 s	400 Hz	2.5 ms	5 s	.5 s
1 s	200 Hz	5 ms	10 s	1 s
2 s	100 Hz	10 ms	20 s	2 s
5 s	40 Hz	25 ms	50 s	5 s
10 s	20 Hz	50 ms	100 s	10 s
20 s	10 Hz	100 ms	200 s	20 s
40 s	5 Hz	200 ms	400 s	40 s
80 s	2.5 Hz	400 ms	800 s	80 s

4.4 Refresh Mode

The waveform (or random signal at first switch on) stored in the memory is continuously displayed on the 'scope in this mode.

After a trigger signal is produced from the CH1 signal or EXT TRIG, the ADCs (Channel 1 and Channel 2) begin to write new data into their memories, overwriting any existing data stored in them. This occurs at a rate set by the TIME/DIV.

If the rate is slow enough and there is a different signal being applied to the memory from that previously stored, then the user will observe on the 'scope the gradual disappearance of the old signal and it being replaced by the new one.

Once both memories are full the process will stop until a new trigger pulse is generated and the cycle repeats.

If the input signal is continuous then subsequent rewriting (REFRESHING) of the memory will not be observed since the new signal being written is exactly the same as was previously stored! Section 7 describes how a bright up pulse may be available to show the point being written.

This mode operates in all TIME/DIV settings and also has a SAVE CH2 facility. If the SAVE CH2 button is depressed, then the Ch 2 memory contents are frozen (but still displayed) whereas Ch1 memory is still refreshed in the normal way.

4.5 Roll Mode

This is a free run mode – ie the memories are continuously updated by the ADCs and trigger signals are ignored. Again, as in Refresh, the 'scope is always displaying the memories' contents.

The mode simulates a chart recorder display where a pen continuously plots the amplitude of the signal on a moving strip of paper. In this case the "pen" is on the right hand side of the CRT display and the "paper" moves from right to left! (Try to forget anything you know about 'scope timebases and how the sweep moves at this point!)

The effect on the display is that the signal moves from right to left the right hand side being real time (t = 0) the far left hand side showing you what occurred 10 divisions (10 x TIME/DIV setting) ago.

This mode is useful for observing real time slow events, as they happen. The HOLD button, when depressed will cause the memories' contents to be frozen and continuously displayed.

ROLL should not be used at TIME/DIV settings above 5 ms – in fact it is really only of use at slower settings where you have time to observe how the signal is behaving.

4.6 Single Shot and Pretrigger

In the Single Shot mode, the display is blanked until the signal has been acquired. It then switches to display only and the memories' contents are held frozen. The sequence of events is as follows:–

(i) When SINGLE SHOT is selected (or RESET pressed) the ARMED LED is lit. The display is blanked (nothing visible on the 'scope) and the memories begin to be filled with Ch1 and Ch2 signals at a rate set by the TIME/DIV switch.

(ii) A trigger pulse occurs some time later (either from Ch1 signal or EXT TRIG) causing the TRIG'D LED to light. Three PRE TRIGGER settings give the following options:–

In 0% PRE TRIGGER, the memories would then store a further 2048 samples of signal (ie 10.24 divisions) and freeze their contents, which would be displayed on the 'scope.

In 100% PRE TRIGGER the memories would immediately stop accepting data, freeze their contents and the display would hence show what had been stored in the memories prior to the trigger pulse.

In 50% PRE TRIGGER, the memories would accept a further 1024 samples of signal before freezing their contents. This effectively has the trigger point in the middle of the CRT display.

PRE TRIGGER is a major feature of digital storage since it allows the user to view events that occured
before the trigger signal. Conventional analogue scopes only offer 0% pretrigger.

The frozen memories' contents are displayed until either another mode is selected or the RESET is pressed which causes the single shot action to repeat.

SECTION 5

POSSIBLE PROBLEMS

5.1 Aliasing/Display errors.

Symptoms:
(a) The displayed waveform appears to be much lower in frequency than expected.

(b) The display amplitude at low sweep speeds varies with the TIME/DIV setting.

(c) The display has envelope modulation.

Cure:
Increase the TIME/DIV to a faster sampling rate.

Explanation:
The input waveform is being periodically sampled at a rate determined by the TIME/DIV switch. If the sampling rate is lower than the frequency of the input waveform, then successive samples taken from different cycles of the input can give displays that are not representative of the input.
Figure 2 illustrates this.

Note – If aliasing is suspected, the NON STORE feature can be used to make a real time measurement of the input period.

FIGURE 2a - ALIASING

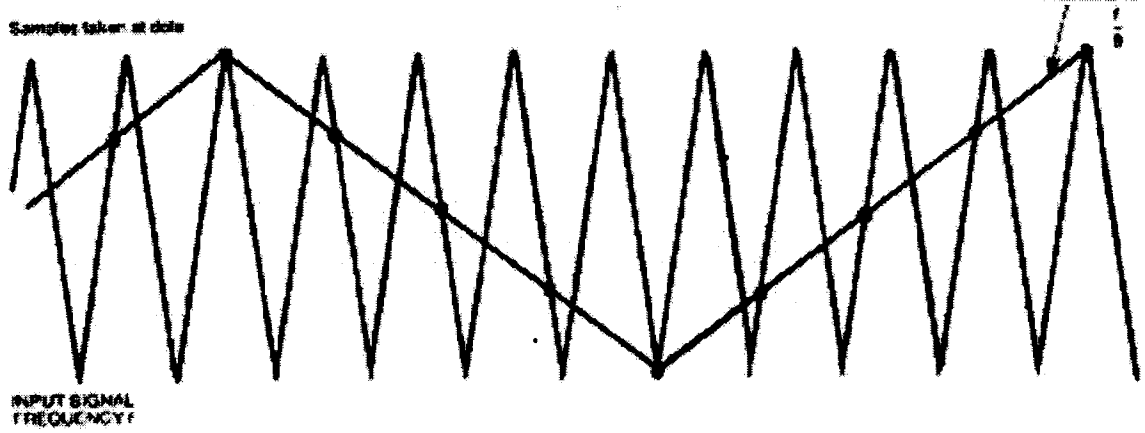
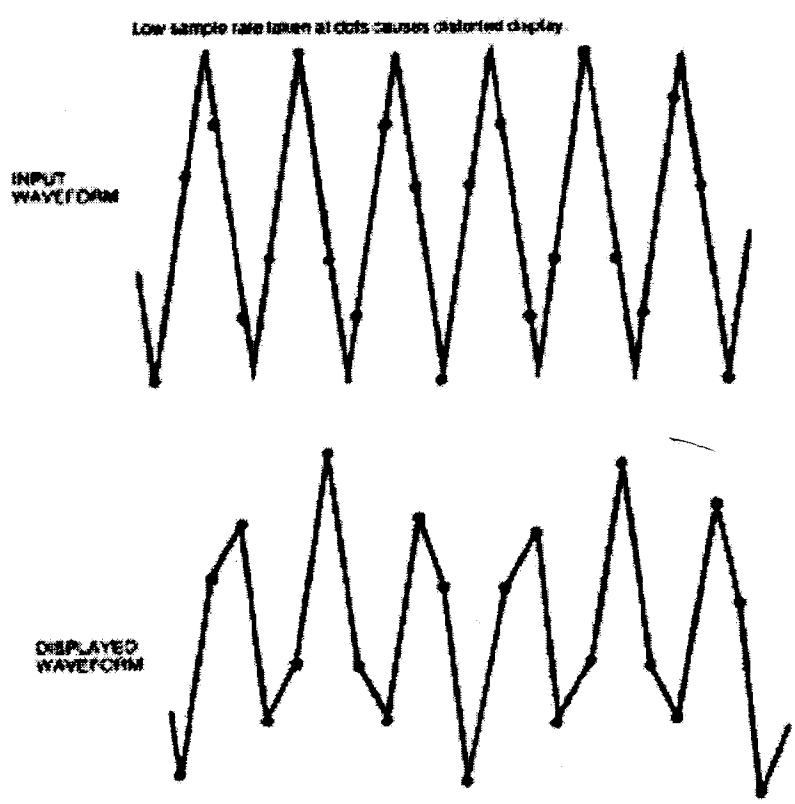


FIGURE 2b – ENVELOPE MODULATION



5.2 Single Shot Displays

Symptoms:
In either 50% or 100% Pre trigger, the display has garbage or random results over part of the screen.

Cure:
(i) Reduce the amount of pre trigger and repeat measurement.

(ii) Repeat the measurement until sufficient time elapses between pressing RESET and trigger pulse generation (see explanation below).

Explanation:
The following sequence of events occurs after pressing SINGLE SHOT or RESET.

(i) The display blanks, the memories begin to fill with data and the ARMED LED is illuminated.
The system continues to do this until a trigger pulse is generated.

(ii) A trigger pulse occurs, the TRIG'D LED is illuminated.

(iii) Each memory continues to fill for a time depending on the amount of pretrigger selected. ie
0% – the memory continues for 2048 counts
50% – the memory continues for 1024 counts
100% – the memory stops immediately

The 'scope then displays the memories' contents.

With 0% (ie no pretrigger) no problems should occur.

In 50% or 100% there can be a problem if the trigger pulse occurs too soon after the ARMED condition. This is the cause of random results appearing at the start of the display. A numerical example may help in understanding this:–

Assume the TIME/DIV is set at 0.1 s (ie it will take 1.024 seconds to fill the memory) and 100% pre trigger is selected.

The RESET is depressed and the memory begins to fill but after 0.6 second a trigger pulse occurs. Because of 100% pre trigger, the memory stops filling and its contents are displayed.

Unfortunately only 0.6 seconds worth of display is valid (the time between RESET and a trigger pulse) – the remaining 42.4% is left over from previous use.

Hence for a valid display, the following criteria must exist:–

The DS102 must be ARMED for a time equal to or greater than the pre trigger time selected.

Pre trigger time is calculated by:–

$$\text{Pre trigger time} = \frac{\text{Pre trig \%}}{100} \times \text{TIME/DIV setting} \times 10.24$$

example: Pre trig at 50%, TIME/DIV at 1 ms

$$\text{therefore: Pre trig time} = \frac{50}{100} \times 1\text{ ms} \times 10.24$$

$$= 5.12\text{ ms}$$

5.3 Insufficient bandwidth

A common misconception is that 10 MHz sampling implies that you can observe 10 MHz sinewaves. This is not the case!

A minimum number of samples are needed for each cycle before a sensible display can be obtained. 10 MHz sampling of a 10 MHz wave would give 1 sample per cycle!

The DS102 has sufficient bandwidth and sampling speed to store and display a 1 MHz sinewave without much distortion – however the 'scope will need to expand the displayed trace either using its MAGNIFIER and/or increasing the 'scope's time per division from 0.1 ms. Remember to return the 'scope's controls to the 0.1 ms condition after using them for this purpose.

SECTION 6

GENERATING X–Y DISPLAYS

A common requirement, particularly for transducer measurements, is to produce an X–Y display on the 'scope. Provided that the 'scope has X–Y facilities then this is quite easily achieved as follows:–

(1) Put the 'scope in XY, both 'scope channels at 0.2 V/div.

(2) Ground both Ch 1 and Ch 2 'scope inputs and use its position controls to place the dot in the lower left corner of the display. Switch back to DC coupling.

(3) Set the DS102 TIME/DIV to 1 s, ROLL mode, all other buttons out.

The DS102 will now produce XY displays on the screen. This can be observed by turning the DS102 position controls and noting that one channel moves the dot vertically, the other horizontally.

The display erases after 10 times the TIME/DIV setting. You can vary the TIME/DIV to alter the erasure rate.

Notes:–

(a) HOLD will freeze the display and stop erasure.
(b) Take care to avoid excessive 'scope INTENSITY levels.
(c) ROLL mode gives a continous display with no triggering.
(d) If REFRESH is selected, then a trigger pulse (CH 1 or external) is required before the memories can be filled.

SECTION 7

PLOTTER OUTPUT

The rear panel CH1 or CH2 outputs can be connected to an analogue plotter plotter bearing in mind that the output signals are from 0 V to +2 V.

The time taken for the DS102 to output its memories' contents is 10.24 times the TIME/DIV setting.

The rear panel SCOPE TRIG can be used for pen lift. It outputs a TTL low for pen down and the front panel LED adjacent to the PLOT switch comes on when the unit is outputting the memory contents.

Note that PLOT will only function if HOLD has been selected.

Figure 3 shows the sequence.

When PLOT is selected, the memories' contents are clocked out and appear on the BNC sockets at a rate determined by the TIME/DIV setting. It will take 10.24 times the TIME/DIV setting to clock out the whole memories' contents.

When PLOT is first selected, there is no way of determining the exact entry point into the memory eg the unit may begin to output at the slow rate, commencing near the end of the stored waveforms. The PEN DOWN LED will be lit when memory contents are being outputted. After the "waiting period" (see Figure 3, equal to 10.24 times TIME/DIV setting) the unit will start to output the stored waveforms from the beginning of memory – ie a true, full output will occur over the following 10.24 times TIME/DIV setting.

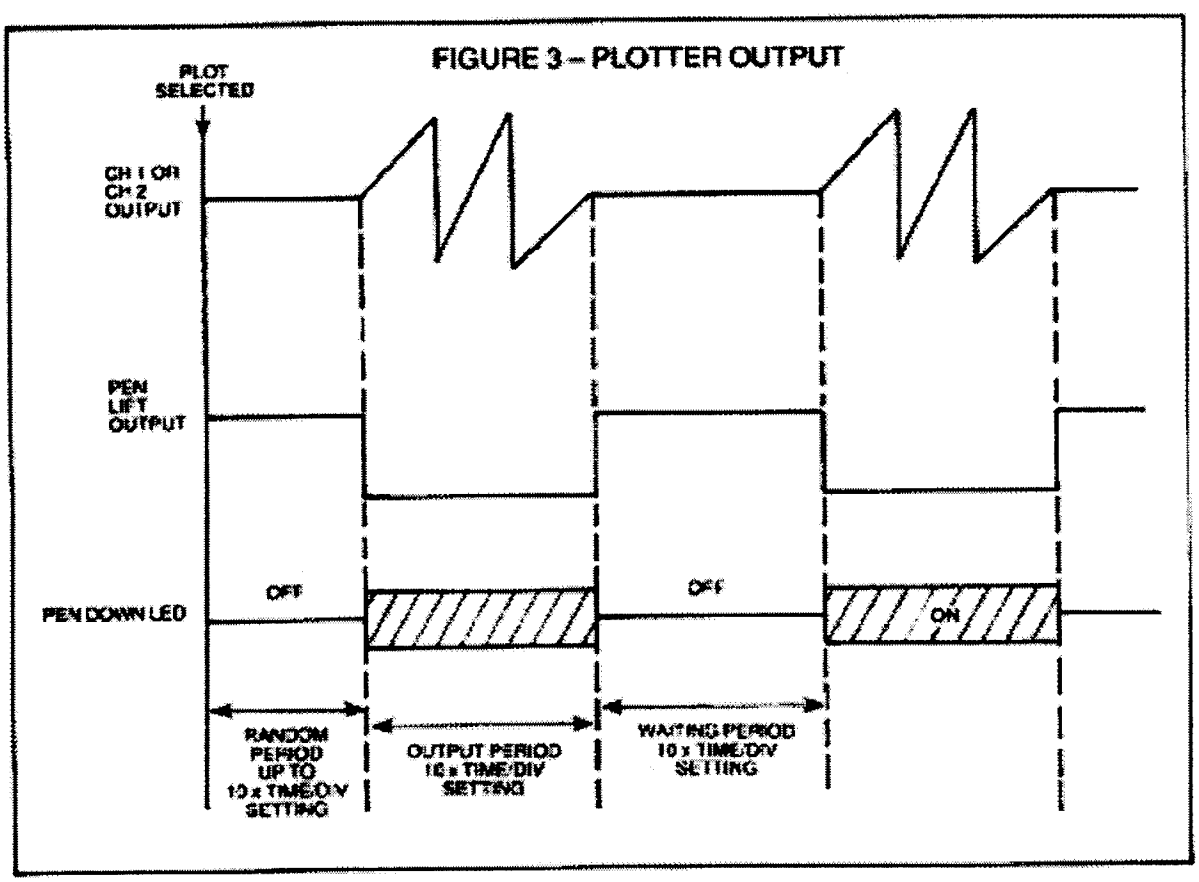
The "waiting period" is the same duration as the "output period" eg 102.4 seconds at 10s/div – to minimise this, the TIME/DIV can be turned to a faster speed until the "PEN DOWN" LED comes on and then immediately turned back to the desired rate.

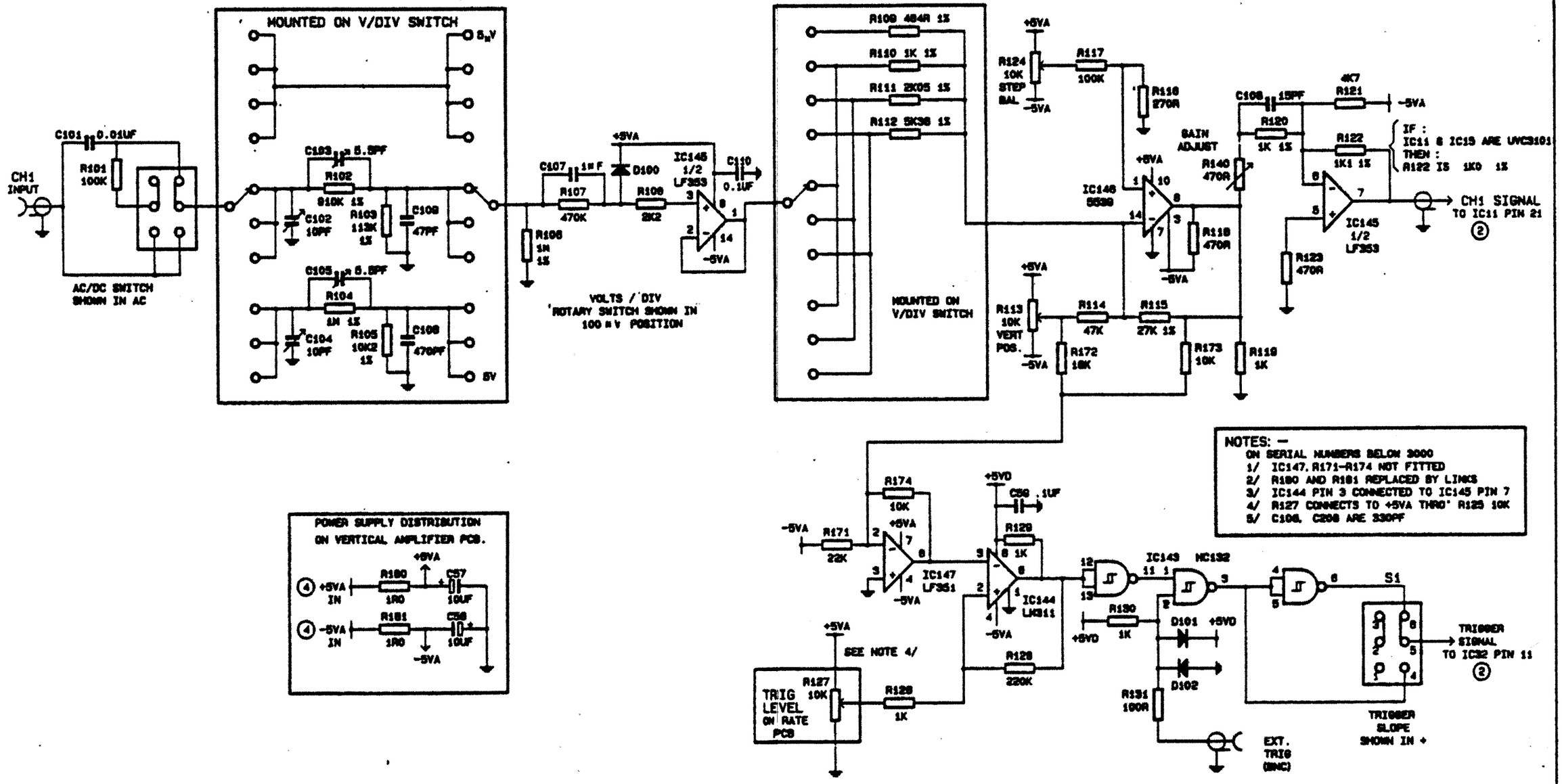
EXPANSION PORT

A 26 way connector is present on the rear panel for use by the Polar RS232 interface connector. This allows data from the DS102 to be downloaded into a microcomputer using this external interface.

The customer should not attempt to make any connections to this port except via Polar authorised products.

FIGURE 3 – PLOTTER OUTPUT





ISSUE	CHANGE	DATE
4		24.10.88
3	REDRAWN	20. 8.88

POLAR INSTRUMENTS LTD
P.O. BOX 97
GUERNSEY.
CHANNEL ISLANDS

DS102
CH1 VERTICAL AMPLIFIER (DETAILED)
TRIGGER GENERATOR
CH2 VERTICAL AMPLIFIER

DRG NO: 1 OF 4

NOTES:

= NOT ON PCB

1. ABBREVIATIONS AS FOLLOWS:-
   E.P. - EXPANSION PORT
   RL - ROLL
   RF - REFRESH
   SS - SINGLE SHOT
   PT1 - PRETRIG 100%
   PT2 - PRETRIG 50%

2. PUSH BUTTON SWITCH CONTACT NUMBERS ARE AS SHOWN VIEWED FROM PCB COMPONENT SIDE

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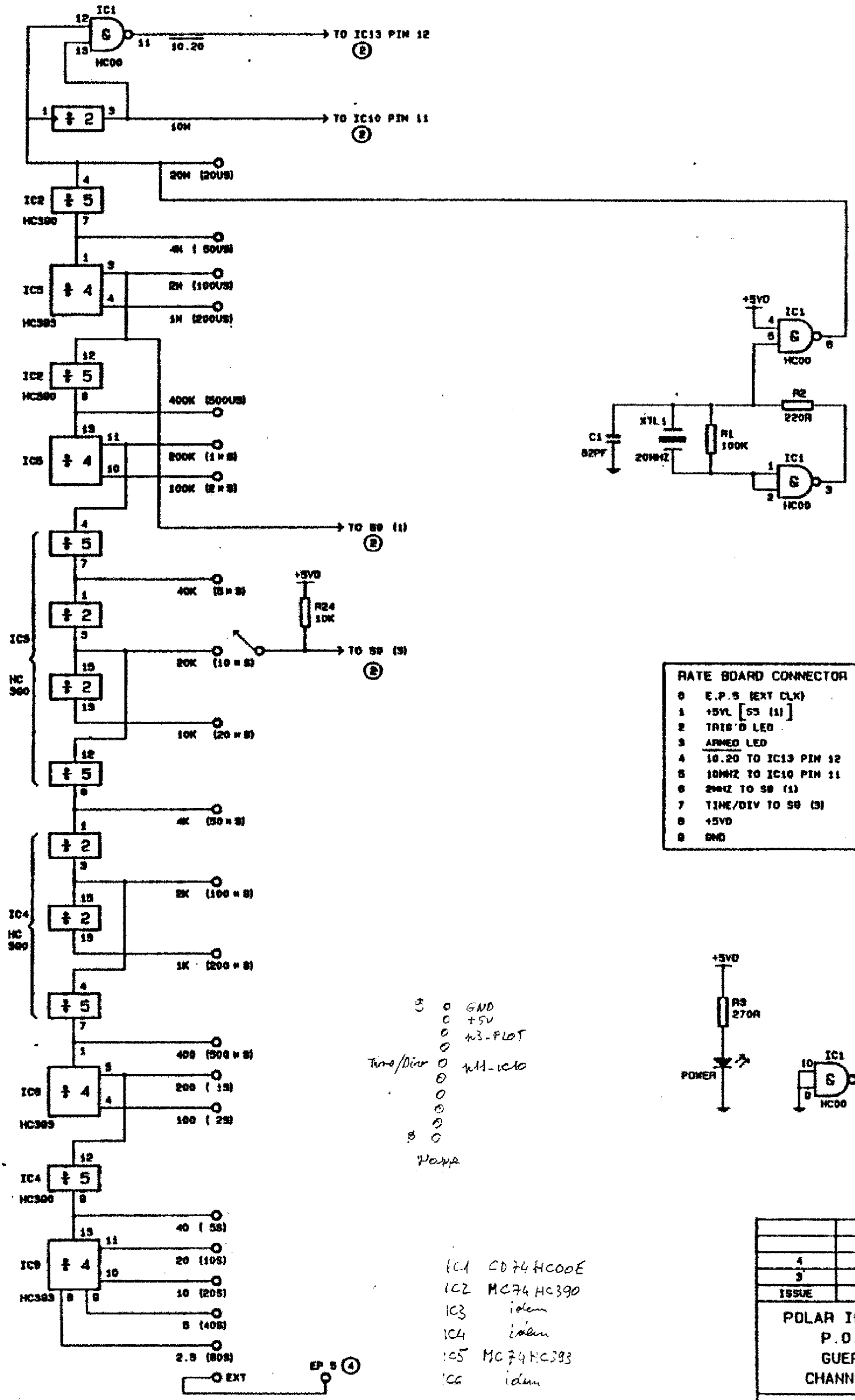
GUERNSEY.
CHANNEL ISLANDS

DS102
MAIN SCHEMATIC
(EFFECTIVE SET N° 30001)

DRG 2B OF 4



RATE BOARD CONNECTOR	
0	E.P.S (EXT CLK)
1	+5VL [S5 (1)]
2	TRIG'D LED
3	ARMED LED
4	10.20 TO IC13 PIN 12
5	10MHZ TO IC10 PIN 11
6	2MHZ TO S9 (1)
7	TIME/DIV TO S9 (3)
8	+5VD
9	GND

3 ○ GND
○ +5V
○ M3-PLOT
Time/Div ○ M11-IC10
○
8 ○

Nappe

IC1 CD74HC00E
IC2 MC74HC390
IC3 idem
IC4 idem
IC5 MC74HC393
IC6 idem

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4		24.10.88
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POLAR INSTRUMENTS LTD
P.O. BOX 97
GUERNSEY.
CHANNEL ISLANDS

OS102
TIME/DIV
(RATE PCB)

ORG 3 OF 4

EXPANSION PORT

(EFFECTIVE SET N° 3000)

(1) (6) (4)

T1

PWR

L

SEE REAR PANEL FOR DETAILS

120 LINK

240 LINK

120 LINK

G

N

U41 78M05 — +5VD

C45 0.1UF

C46 10UF

U40 78M05 — +5VA

C43 0.1UF

C41 2200UF 16V

C44 10UF

GND

M005 BRIDGE

C42 1000UF 16V

C47 0.1UF

C48 10UF

U42 79M05 — -5VA

EXPANSION PORT (EP)

VIEWED FROM REAR PANEL

(ONLY PRESENT AFTER SERIAL N° 3000)

CH2

SCOPE TRIG — D0 — D2 — D4 — D6 — EXT CLOCK — 0V

N/C — D1 — D3 — D5 — D7 — N/C

25 O O O O O O O O O O O O O 1

26 O O O O O O O O O O O O O 2

PLOT — Z AXIS — D1 — D3 — D5 — D7 — N/C

D0 — D2 — D4 — D6 — 0V

CH1

+5VD

IC10 HC74 — IC35 HC04 — IC36 HC10 — IC13 HC02 — IC24 HC157 — IC25 HC157 — IC26 HC157 — IC27 HC688 — IC28 HC688 — IC29 HC4040 — IC12 HC244 — IC16 HC244 — IC37 HC00 — IC38 HC74 — IC34 HC00 — IC32 HC74 — IC31 HC157 — IC21 HC161 — IC22 HC161 — IC23 HC161 — C25 .1 UF — IC14 — C26 .1 UF — IC17

ISSUE	CHANGE	DATE
4	EP.3 WAS 'RST'	24.10.86
3	REDRAWN	20. 6.86

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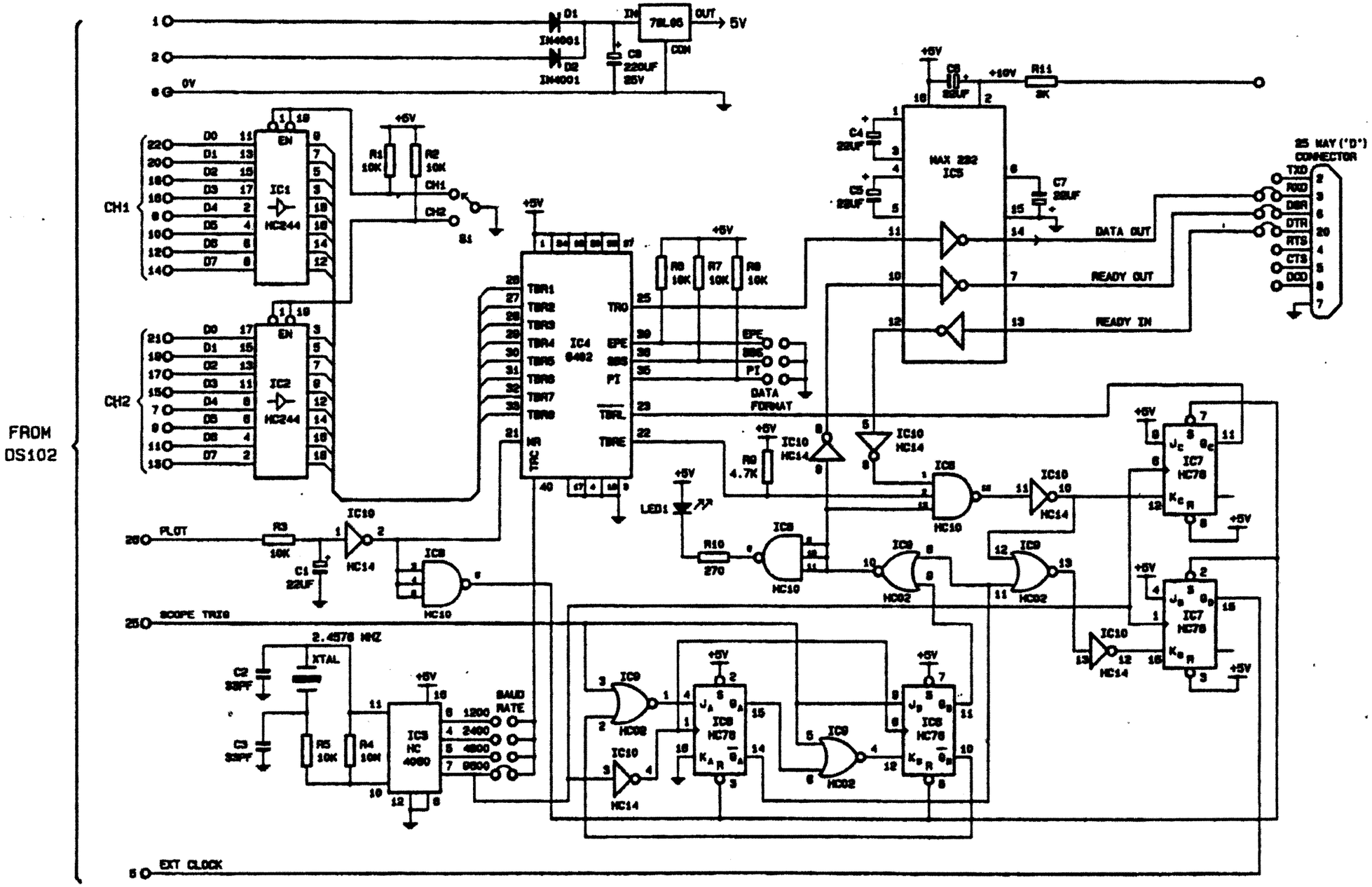
CHANNEL ISLANDS

DS102
1. POWER SUPPLY & DISTRIBUTION
2. EXPANSION PORT

DRG 4 OF 4



			POLAR INSTRUMENTS LTD P.O. BOX 97 GUERNSEY. CHANNEL ISLANDS	DS102/RS232 SERIAL ADAPTOR SCHEMATIC
3	REDRAWN	01.07.88		DRG NO: DS102/RS232
ISSUE	CHANGE	DATE		