



## TROUBLE SHOOTING

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## 11.0 TROUBLE SHOOTING

### 11.1 INTRODUCTION

The following information is provided to facilitate trouble shooting. Information contained in other sections of the manual should also be used to locate the defect. An understanding of the circuit is helpful in locating troubles, particularly where integrated circuits are used. Refer to circuit descriptions for this information.

### 11.2 TROUBLE SHOOTING TECHNIQUES

If a fault appears, the following test sequence can be used to find the defective part:

- Check if the settings of the controls of the oscilloscope are correct. Consult the Operating Instructions.
- Check the equipment to which the oscilloscope is connected and the interconnection cables.
- Check if the oscilloscope is well-calibrated. If not, refer to chapter 9 "ADJUSTING PROCEDURE".
- Visually check the part of the oscilloscope in which the fault is expected. In this way, it is possible to find faults such as bad soldering connections, bad interconnection plugs and wires, damaged components or transistors and IC's that are not correctly plugged into their sockets.
- Check the circuit part in which the fault is expected: the symptom often indicates this part of the circuit. If the power supply is defective the symptom will appear in several circuit parts.

After having carried out the previous steps, individual components in the suspected circuit parts must be examined:

- Transistors and diodes. Check the voltage between base and emitter (0,7 V approx. in conductive state) and the voltage between collector and emitter (0,2 V approx. in saturation) with a voltmeter or an oscilloscope. When removed from the p.c.b. it is possible to test the transistor with an ohmmeter since the base/emitter and base/collector junctions can be regarded as diodes. Like a normal diode, the resistance is very high in one direction and low in the other direction. When measuring take care that the current from the ohmmeter does not damage the component under test. Replace the suspected component by a new one if you are sure that the circuit is not in such condition that the new component will be damaged.
- Integrated circuits. In circuit testing can be done with an oscilloscope or voltmeter. A good knowledge of the circuit part under test is essential. Therefore first read the circuit description in chapter 8 "CIRCUIT DESCRIPTIONS".

- Capacitors. Leakage can be traced with an ohmmeter adjusted to its highest resistance range. When testing take care of polarity and maximum allowed voltage. An open capacitor can be checked if the response for AC signals is observed. Also a capacitance meter can be used: compare the measured value with the value and tolerance indicated in the parts list.
- Resistors. Can be checked with an ohmmeter after having unsoldered one side of the resistor from the p.c.b. Compare the measured value with the value and tolerance indicated in the parts list.
- Coils and transformers. An ohmmeter can be used for tracing an open circuit. Shorted or partially shorted windings can be found by checking the waveform response when HF signals are passed through the circuit. Also an inductance meter can be used.
- Data latches. To measure on inputs and outputs of data latches a measuring oscilloscope can be triggered by the clock signal which is connected to the clock input of the data latch.  
Check the input data lines one by one during the active edge of the clock signal.  
This measurement can only be done in this way when there is an acceptable repetition time of the clock signal. A too low clock pulse repetition time results in a too low intensity of the trace on the measuring oscilloscope screen.  
The outputs can easily be checked by a voltmeter or oscilloscope.

### 11.3 TROUBLE SHOOTING HINTS

- If the oscilloscope does not operate at all then check the mains fuse and all power supply voltages.
- Try to find the unit where the failure is by accurately checking every malfunction of the oscilloscope. The block diagram (figures 6.1 and 6.2) may be of great use.
- Finding errors in certain parts can be done by using the service diagnostic software (see section 11.4).
- If there is no signal or text visible on the C.R.T. screen then check:
  - Intensity controls
  - Power supply to C.R.T.
  - Z-control
- If there are only traces visible, something will be broken in the hardware that controls the displaying of text:
  - Text intensity control
  - Z-control
  - Units A3 + A4
- If text is visible but no traces, please check the trace intensity control.
- If the DPU operates properly, the signal IL02--LT gives regularly negative pulses.

- If the acquisition operates properly, HDOF at X3054 on unit A52 changes regularly. The falling edge of the signal is the start of the capture of one sample.

#### 11.4 DESCRIPTION OF THE DIAGNOSTIC SOFTWARE

##### 11.4.1 Introduction

The diagnostic software consists of three parts:

- the power up routine
- softkey selectable diagnostic software
- hardware selectable diagnostic software

It is recommended to read the concerning hardware description first (chapter 8), before using the diagnostic software.

Each part will be described in the following subsections.

##### 11.4.2 The power up routine

The power up routine is initiated every time the oscilloscope is turned on or when the microprocessor is restarted by the watchdog circuit (unit A6). It performs the following actions:

- First all leds on the front panel are turned on during 3 seconds.
- The leds SYNCHRONIZE and COUNT DOWN are extinguished.  
Now the part of the microprocessor RAM (unit A5) which does not contain data that should be retained, is tested. If the test fails, the leds stay off and the address where the failure is, is continuously read and written by the microprocessor. This makes tracing of the failure easier.
- The led SYNCHRONIZE is turned on, so only led COUNT DOWN is off. Now the TEXT MEMORY is tested. The TRACE MEMORY can not be tested, because these data should be retained.  
If the test fails, the led COUNT DOWN stays off and the address where the failure is, is continuously read and written by the microprocessor, as with the previous test.
- The led COUNT DOWN is also turned on, so all leds are on.  
Now the part of the microprocessor ram (unit A5) that contains settings, is tested by means of a checksum test.  
If a fault is found in a setting belonging to a stored trace, this setting is cleared.

If a fault is found in a programmed front setting, the concerning front setting and all front setting which are stored at higher addresses are cleared. Because all settings are stored in time order of entrance, an "arbitrary" part of the settings is cleared. Next the actual front setting is checked. If it has a checksum fault an AUTO SET is initiated, else the oscilloscope is set according to the values found in the ram.

It is this last routine that initiates AUTO SET after power up, if no backup batteries are installed.

- Finally the battery voltage is tested, and if it is too low, a message appears on the CRT screen.

The battery check is only done in this stage of the power up routine; nowhere else during operation.

The oscilloscope is now ready for operation.

- Resumed:
- If the power up routine hangs up with both leds SYNCHRONIZE and COUNT DOWN off, the microprocessor ram is defective.
  - If it hangs up with only led COUNT DOWN off, the display ram is defective.
  - If stored traces or programmed front settings are cleared or an AUTO SET is initiated, while the backup batteries are OK, the contents of the microprocessor ram is destroyed. This may be caused by the oscilloscope being turned off at the moment the microprocessor was writing in the ram, but if it happens every time the oscilloscope is turned on the ram itself is broken.

NOTE: If the power up routine hangs up, the watchdog circuit on unit A6 is triggered regularly by the microprocessor, to prevent a new initiation of the power up routine again.

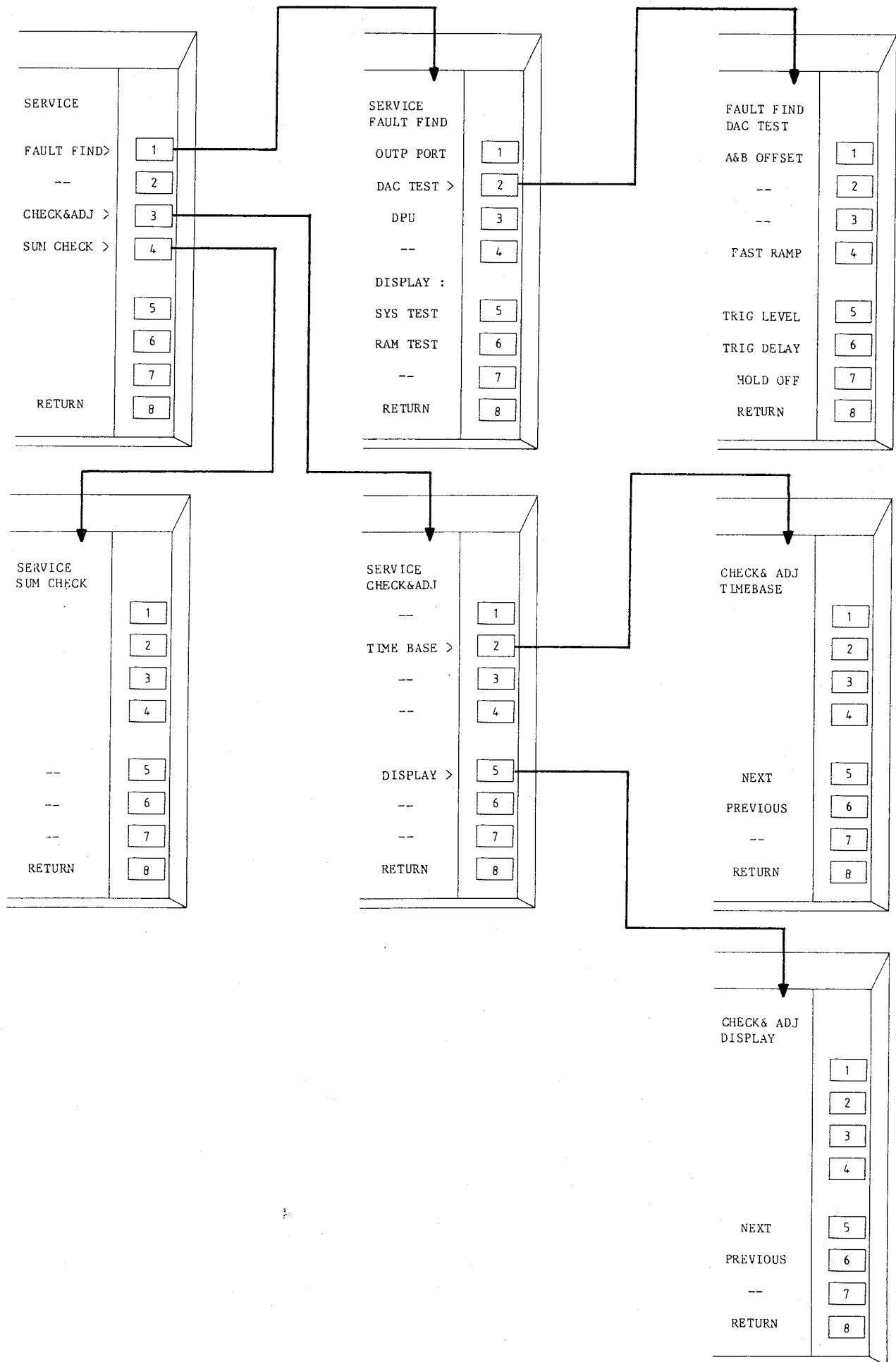


Figure 11.1 Service select menu structure.

### 11.4.3 Softkey selectable diagnostic software

If some functions of the oscilloscope do not operate properly, the softkey selectable diagnostic software can be used to detect the defective hardware circuits.

This diagnostic software also contains a number of check and adjust routines (see chapter 9).

The routines destroy the actual front setting. Therefore returning to normal operation via the softkeys generates an AUTO SET.

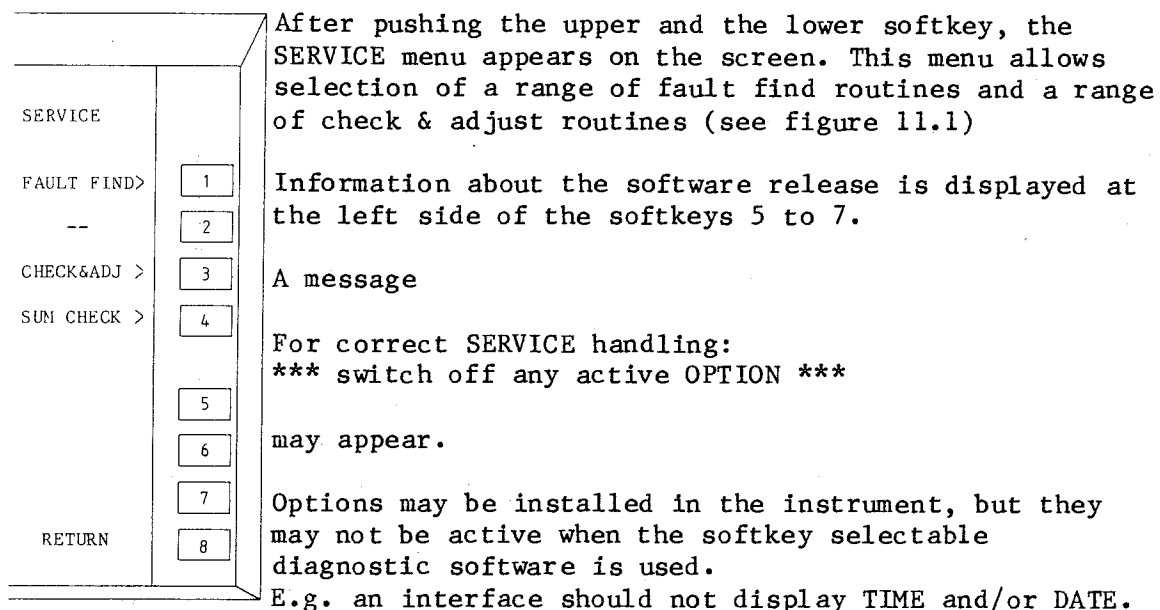
It is always possible to return to normal operation by pressing the green pushbutton AUTO SET.

When a routine is operative and a setting is done on the front panel, the following message is given:

Instrument in SERVICE mode.

Changes are executed, but not always correct.

This is done because settings can not be executed if the concerning hardware is controlled by the selected diagnostic routine.



## 1 FAULT FIND&gt;

SERVICE FAULT FIND	
OUTP PORT	1
DAC TEST >	2
DPU	3
--	4
DISPLAY :	
SYS TEST	5
RAM TEST	6
--	7
RETURN	8

If FAULT FIND is selected the SERVICE FAULT FIND menu is displayed and a number of fault finding routines can be selected.

Each test can be stopped by pressing the same softkey again or by selecting another test.

In this part of the diagnostic software the traces are suppressed.

## 1 1 OUTP PORT

If OUTP PORT is selected an alternating pattern of zeroes and ones with a frequency of 1.6 Hz is generated at the following output ports:

Name	IC nrs	Unit
Variable feedback latches	D3124 + D3144	A25
Trigger latch	D2222	A34
Time-base latch	D3304	A51
Vertical latches	D5001 + D6001	A55
Variable latches	D5002 + D6002	A55

This test can be used to test the proper operation of these latches and their controlling hardware by checking all the outputs with an oscilloscope.

The output signals are at TTL level, except the signals from unit A55. These latches have output signals of 12 Volt.

1 2 DACTEST&gt;

FAULT FIND DAC TEST	
A&B OFFSET	1
--	2
--	3
FAST RAMP	4
TRIG LEVEL	5
TRIG DELAY	6
HOLD OFF	7
RETURN	8

If DACTEST is selected, the FAULT FIND DAC TEST menu is displayed.

With this menu a number of DACs in the acquisition section of the oscilloscope can be tested, by checking their output voltage with another oscilloscope.

Because the softkeys are only checked after a cycle of a test and the cycle can take some time (up to a few seconds), it may be necessary to keep a softkey pressed down a while to get the desired action.

1 2 1 A&amp;B OFFSET

If A&B OFFSET is selected, a sawtooth signal is generated at the outputs of the OFFSET DACs of channels A and B (N3136, N3137, N3138 and N3139 on unit A25). During the slope of the sawtooth the digital values at the inputs of these 14 bit DACs is incremented by 16 every time. So the 4 less significant bits are not tested.

The period is 0.4 s.

The output voltages are measured on the vertical signal unit A55.

Measuring points and voltages:

Name	ICs	Voltage range
OSCRA	N5007 pin 7	0-10 V
OSFIA	N5007 pin 14	0-4 V
OSCRB	N6007 pin 7	0-10 V
OSFIB	N6007 pin 14	0-4 V

1 2 2 --

1 2 3 --

## 1 2 4 FAST RAMP

If FAST RAMP is selected, a sawtooth signal is generated at the output of the FAST RAMP DAC (N3313 on unit A51).

During the slope of the sawtooth the digital value at the input of this 14 bit DAC is incremented by 16 every time. So the 4 less significant bits are not tested. The output voltage amplitude is 9 V. The period is 0.7 s.

Measuring point:

Time-base unit A51, N3314 pin 6.

## 1 2 5 TRIG LEVEL

If TRIG LEVEL is selected, a sawtooth signal is generated at the output of the TRIGGER LEVEL DAC (N3141 on unit A25).

During the slope of the sawtooth the digital value at the input of this 14 bit DAC is incremented by 16 every time. So the 4 less significant bits are not tested. The output voltage amplitude is 3.9 V. The period is 0.7 s.

Measuring point:

Trigger control unit A34, node R2229-Emitter V2206.

## 1 2 6 TRIG DELAY

If TRIG DELAY is selected, a sawtooth signal is generated at the output of the TRIGGER DELAY DAC (N3306 on unit A51).

During the slope of the sawtooth the digital value at the input of this 14 bit DAC is incremented by 16 every time. So the 4 less significant bits are not tested. The output voltage amplitude is 8 V. The period is 0.7 s.

Measuring point:

Time-base unit A51, N3307 pin 6.

## 1 2 7 HOLD OFF

If HOLD OFF is selected, a sawtooth signal is generated at the output of the HOLD OFF DAC (N3309 on unit A51).

During the slope of the sawtooth the digital value at the input of this 14 bit DAC is incremented by 16 every time. So the 4 less significant bits are not tested. The output voltage amplitude is 19 V. The period is 0.7 s.

Measuring point:

Time-base unit A51, N3311 pin 6.

## 1 2 8 RETURN

Return to SERVICE FAULT FIND menu.

## 1 3 DPU

If DPU is selected, the control memory of the DPU CONTROL unit A8 is loaded with a program that is run afterwards. This brings the DPU in a steady cycle, which enables testing of the system.

On a number of output signals of the DPU CONTROL a pulse is generated (see table below). These are all the output signals to the DPU (unit A9) and the trigger address comparator on unit A4, except TRRY and RSDU--LT.

The signals can be found on connector X1402.

The pulse width is 125 ns; the repetition time is 4,5 us.

All signals are at TTL level.

Signal name	Pinnr.	Signal name	Pinnr.
DUAB00	C20	RDDURM	C26
DUAB01	C21	SFSR00	C12
DUAB02	A21	SFSR01	C11
DUAB03	C22	STRLF	C15
DUAB04	A22	ENOFD	A18
DUAB05	C23	CKF	C25
DUAB06	A23	CO	C13
DUAB07	C24	SLAM	A28
DUAB08	C16	RSDUR-LT	C19
DUAB09	A17	OTDIAD	C29
DUAB10	C18	OEDU00	A29
DUAB11	C17	OEDU01	A31
CSDURM	A27	LEDP	C31
CKDUR1	C3	SLOFAD	C27
CKDUR2-LT	A25	CNCPCN	A15
CKDUR3	A26	FBRY	C32

The state of the signals at the testpoints of unit A8 is:

Signal name	State
TRRY	0
EC	0
DAVA	0
IL02--LT	1
CKPL	Symmetrical square wave, cycle time = 125 ns.

1 4 --

## 1 5 DISPLAY SYS TEST

If DISPLAY SYS TEST is selected, the display system continuously displays the softkey text area, which can be seen as an intensified display. Traces, other text areas and miscellaneous text are not displayed. So the display system (units A1, A2, A3 and A4) is brought in a steady cycle, which enables testing of the system. See section 8.1 to 8.4 for the concerning hardware.

NOTE: if there is a failure in the display system, which causes the softkey text area not to be displayed, this test can not be selected in a visible way. Nevertheless pushing the softkeys in the right sequence selects this test.

## 1 6 DISPLAY RAM TEST

If DISPLAY RAM TEST is selected, the display ram on unit A4 is tested. This ram consists of the text memory (D2014 and D2016) and the trace memory (D2008, D2009, D2011 and D2012). In the text memory the softkey text and the miscellaneous text is not tested.

If the test is completed successfully, a message:

DISPLAY RAM test completed successfully.

is displayed.

If the test fails, all leds on the front panel start blinking and the address where the failure is, is continuously read and written by the microprocessor.

NOTES: - this test destroys the contents of the trace memory, so after the test all traces are lost.

- as with the DISPLAY SYS TEST (see above), this test can be selected by pushing the softkeys in the right sequence, in case of a display failure.

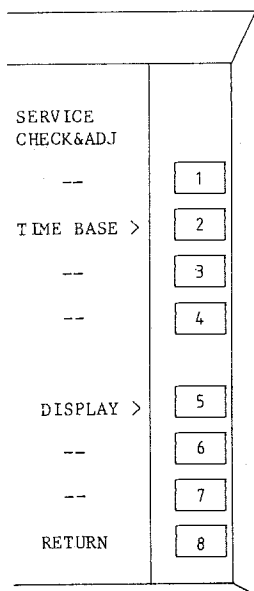
1 7 --

1 8 RETURN

Returns to SERVICE SELECT menu.

2 --

3 CHECK &amp; ADJ&gt;



If CHECK & ADJ is selected, the CHECK & ADJ menu is displayed and a number of adjust routines can be selected.

Each routine is only operative if it is displayed.

See chapter 9 for detailed information about the use of the adjust routines.

3 1 --

3 2 TIME BASE&gt;

CHECK & ADJ TIMEBASE		1
		2
		3
		4
NEXT		5
PREVIOUS		6
--		7
RETURN		8

If TIME BASE is selected, the CHECK & ADJ TIMEBASE menu is displayed.

Information about the activated adjust routine for the vertical section of the oscilloscope is given at the left side of the softkeys 1 to 4.

The sequence number of the routine is displayed in the top of the menu behind "TIMEBASE".

3 2 5 NEXT

Activates and displays the time-base adjust routine with the next higher sequence number.

3 2 6 PREVIOUS

Activates and displays the time-base adjust routine with the next lower sequence number.

3 2 7 --

3 2 8 RETURN

Return to SERVICE CHECK & ADJ menu.

3 3 --

3 4 --

3 5 DISPLAY&gt;

CHECK & ADJ DISPLAY		1
		2
		3
		4
NEXT		5
PREVIOUS		6
--		7
RETURN		8

If DISPLAY is selected, the CHECK & ADJ DISPLAY menu is displayed.

Information about the activated adjust routine for the display section of the oscilloscope is given at the left side of the softkeys 1 to 4.

The sequence number of the routine is displayed in the top of the menu behind "DISPLAY".

3 5 5 NEXT

Activates and displays the display adjust routine with the next higher sequence number.

3 5 6 PREVIOUS

Activates and displays the display adjust routine with the next lower sequence number.

3 5 7 --

3 5 8 RETURN

Return to SERVICE CHECK & ADJ menu.

3 6 --

3 7 --

3 8 RETURN

Return to SERVICE CHECK & ADJ menu.

## 4 SUM CHECK&gt;

SERVICE	
SUM CHECK	
	1
	2
	3
	4
--	5
--	6
--	7
RETURN	8

If SUM CHECK is selected, the SUM CHECK menu is displayed.

At the left side of the softkeys 1 to 4 the sum check data are displayed.

4 5 --  
 4 6 --  
 4 7 --  
 4 8 RETURN

Return to SERVICE menu.

5 --  
 6 --  
 7 --  
 8 RETURN

Return to normal operation.

When a routine is still operative the following message is given:

Changes are executed, but not always correct.

This is done because settings can not be executed if the concerning hardware is controlled by the selected diagnostic.

Therefore this way of returning to normal operation is not recommended.

#### 11.4.4 Hardware selectable diagnostic software

By changing over the service switches on unit A6, a number of service routines can be selected, which are suitable to test the hardware. For some routines not all hardware is needed. So these tests can be used by starting with the minimum required hardware and as long as the routines operate correctly more hardware can be connected until the routines do not operate anymore. The last connected hardware will be broken then.

The table below gives an overview of the tests.

Test	Service switches				Minimum required hardware
	X1716	X1704	X1706	X1707	
Normal operation	fitted	down	down	down	all cards
RAM test	removed	down	up	down	A5 + A6
Front + output ports	removed	up	down	down	A5 + A6 + A8 + frontpanel
Address range	removed	up	up	up	A6

- NOTES:
- Figure 11.2 shows the service switches in normal operation position.
  - If X1716 is not fitted in normal operation, the oscilloscope may operate normally, but it is possible that it does not start up under certain conditions, because the watchdog circuit is disabled.
  - Any options (A7 or A10) should be removed.

The RAM TEST enables testing of the microprocessor ram on unit A5. The test is a cyclic sequence that consists of the following parts:

- All leds on the frontpanel are turned on during 3 seconds.
- All leds are turned off, except the led TRIGGER.
- The microprocessor ram is written with a certain pattern in a certain sequence.
- The led SYNCHRONIZE is turned on.
- The contents of the microprocessor ram is read back and checked. If the contents is OK, all leds are turned on during 3 seconds, etc. If the contents is wrong, the 3 leds TRIGGER, SYNCHRONIZE and COUNT DOWN start blinking with a frequency of about 2 Hz and the address where the failure is, is continuously read and written by the microprocessor.

The FRONTPANEL AND OUTPUT PORTS TEST enables the testing of the frontpanel and the output ports, which can not be tested by the softkey selectable output port test (see section 11.4.3).

When the test is started all leds on the frontpanel start blinking with a frequency of about 2 Hz.

After pushing a pushbutton, the softkeys included, or turning a rotary switch all leds are turned off.

Now the three leds TRIGGER, SYNCHRONIZE and COUNT DOWN form the display of a three byte binary counter. The counter counts the opening or closing of every pushbutton switch on the frontpanel as well as the level changes of the outputs of the rotary switches as they are turned. The counter counts always up, independent of the turning direction of the rotary switches.

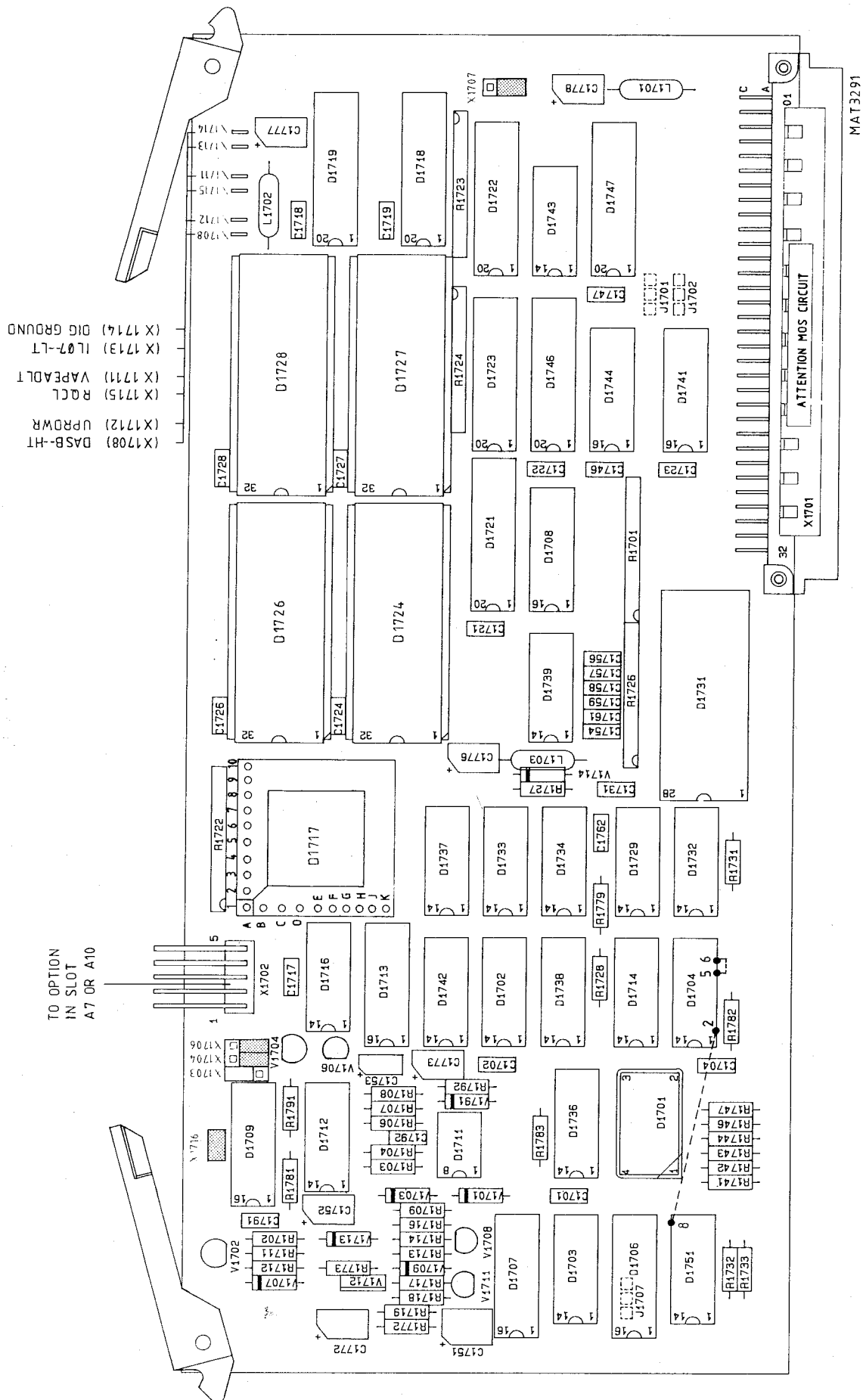


Figure 11.2 Location of service switches.

While the front test is started by pushing a button or turning a rotary switch, the output port test is also started. This test writes an alternating pattern to hardware that is selected by signals with the following names:

Unit	Signal name	IC numbers
A2	WRVEPOLT	D2314 + D2316
A2	WRHOPOLT	D2317 + D2318 + D2332
A3	WRDPSTLT	D2119
A3	WRPSDPLT	D2103 + D2104
A3	WRDPPALT	D2106 + D2107
A3	WRHOVRLT	D2108
A5	LEACL	D1814
A8	SLOT2	D1419
A8	SLOT4	D1421 + D1422

At the outputs of mentioned latches a symmetrical square wave appears with a repetition time of 270 us, except D1814 which gives signals with a repetition time of 1 ms.

Furtheron the alternating pattern is written to the following hardware:

Unit	Signal name	IC numbers
A3	Z + Interrupt timer	D2126
A8	Control memory	D1426 + D1427 + D1428 + D1429

NOTE: - This test can be done without unit A8 fitted, if a diode link is made between MYSL03LT (pin B6) and DATRAKLT (pin C8) on connector X1701. The anode of the diode should be connected to pin C8.

The ADDRESS RANGE TEST writes and reads in sequence the hexadecimal code 5555 to all addresses, followed by the same sequence with hexadecimal code AAAA.

The complete test takes about 74 seconds and is repeated automatically. Each address is read immediately after it is written. The read data are not checked.

During this test all levels of the lines of the microprocessor busses should change regularly.

NOTES: - Data and address bus lines to other units via the motherboard (unit A12) only change if the address range outside unit A6 is addressed.  
- This test can also be run with unit A6 removed from the oscilloscope and supplied by an external 5 Volt power supply.

## 11.5 RECALIBRATION AFTER REPAIR

After an electrical component has been renewed the calibration of that particular circuit should be checked, as well as the calibration of other closely-related circuits.

Since the power supply affects all circuits, calibration of the entire instrument should be checked if work has been done in the power supply or if the transformer has been renewed.