8 CORRECTIVE MAINTENANCE PROCEDURES

8.1 DISMANTLING THE INSTRUMENT

8.1.1 General information

This section contains the dismantling procedures required for the removal and testing of components during repair.
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 the dismantling a careful note must be made of all disconnected leads so that they can be reconnected to their correct terminals during assembly.

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

8.1.2 Removing the cabinet and carrying handle

Note: The cabinet does not need to be removed to do the calibration adjustment procedure.

To remove the cabinet proceed as follows:
- Fit the front cover on to the instrument.
- Hinge the carrying handle clear of the front cover.
- Place the instrument with the front cover on a flat surface.
- Pull off both plastic parts that are around the instrument's rear feet.
- Remove the screws (6) that secure the cabinet to the instrument's rear panel.
- Gently slide the cabinet (and carrying handle) off the instrument.

ATTENTION:
- *When installing the cabinet again, special care must be taken that cables are not damaged between the cabinet and the chassis. This is especially important for the flat cable above the Cathode Ray Tube (CRT) that connects Front unit A4 and CRT controls unit A5.*
- *Also take care that the cabinet fits well into the plastic front frame and that grounding fingers are not damaged during installation.*

The rotation points of the carrying handle are secured by means of metal 'omega' clips. After removal of these clips the handle can be removed by pulling both handle ends outwards away from the instrument.

8.2 REPLACEMENTS

WARNING: The Extremely High Tension (EHT) cable is directly connected to the EHT-multiplier unit. When the EHT cable to the post-acceleration anode is disconnected, the cable must be discharged by shorting the terminal to the instrument's earth.

8.2.1 Standard parts

Electrical and mechanical replacement parts can be obtained through your local PHILIPS/FLUKE 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 componenent may affect the instrument's performance, particularly at high frequencies. Always use direct-replacement components, unless it is known that a substitute will not degrade the instrument's performance.

8.2.2 Special parts

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

- Components, manufactured or selected by FLUKE to meet specific performance requirements.
- Components which are important for the safety of the instrument.

ATTENTION: Both type of components may only be replaced by components obtained through your local FLUKE organization of representative.

8.2.3 Transistors and Integrated Circuits

- Return transistors and IC's to their original positions, if removed during routine maintenance.
- Do not replace or switch semi-conductor devices unnecessarily, as it 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 p.c.b. holes and cut the leads to the same length as on the component being replaced. See also the Performance Test in this manual.
- When a device has been replaced, check the operation of the part of the instrument that may be affected.

8.3 STATIC SENSITIVE COMPONENTS

In the oscilloscope the black/yellow 'static sensitive components' symbol is present (see also figure 8.1). This means that this instrument contains electrical components that can be damaged by electrostatical discharge. Although all MOS integrated circuits incorporate protection against electrostatic discharge, they nevertheless can be damaged by accidental over-voltages.

Figure 8.1 Static sensitive symbol (black/yellow)

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

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

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

Extensive information on how to deal with static sensitive components is contained in Support Bulletin OSC296 (ordering number 4822 872 08407).

8.4 SOLDERING TECHNIQUES

8.4.1 General soldering techniques

Working method:

- Carefully unsolder the soldering tags of a semi-conductor one after the other.
- Remove all superfluous soldering material. Use desolder braided wire; ordering code: 4822 321 40042.
- Check that the leads of the replacement part are clean and pre-tinned on the soldering places.
- Place the replacement semiconductor exactly in the same position, and solder each lead to the relevant printed conductor on the printed circuit board.

NOTE: The maximum permissible soldering time is 10 seconds during which the temperature of the leads must not exceed 250 °C. The use of solder with a low melting point is recommended. Take care not to damage the plastic encapsulation of the semiconductor (softening point of the plastic is 150 °C).

ATTENTION: When you are soldering inside the instrument it is essential to use a low voltage soldering iron, the tip of which must be grounded to the chassis of the oscilloscope.

A suitable soldering iron is:
Mini soldering iron station, WECP-COD3 (regulated transformer) and Weller LR-20 (soldering iron).

Ordinary 60/40 solder with core and 35 ... 40 W pencil-type soldering iron can be used to do the majority of the soldering. If a higher wattage-rating soldering iron is used on the printed circuit board, excessive heat can cause the circuit wiring to separate from the base material.

8.4.2 Soldering micro-miniature semi-conductors

Because of the small dimensions of these SOT semi-conductors and the lack of space between the components on the printed circuit board, it is necessary to use a miniature soldering iron with a pin-point tip (max. diameter 1mm) to solder a SOT on to a printed circuit board.

Suitable soldering tools are:
- Mini soldering iron station, WECP-COD3 (regulated transformer) and Weller MLR-20 (mini soldering iron).
- A hot-air solder tool: Leister Hot-Jet.

Next, the following materials are recommended:
- Soldering tin, diameter 0.8 mm, SnPb 60/40 with a Resin Mildly Activated (RMA) flux. Ordering code: 4822 390 80133.
- Desolder braided wire; ordering code 4822 321 40042.
- Solder paste 26.
- Non-corrosive and Resin Mildly Activated (RMA) flux-Colophony. Ordering code: 4822 390 50025.

Refer to the Support Bulletin OSC296 (ordering code 4822 872 08407) for a complete discussion of the soldering techniques for SMD’s.

8.5 REMOVING THE UNITS, MECHANICAL PARTS AND CRT

NOTE: For installation, reverse the sequence.

8.5.1 Removing the rotary knobs

Rotary knobs can be removed by simply pulling them off. The knobs have an integrated shaft and fixing device. Most of the knobs (11) have a light grey colour. The knobs for cursor positioning are dark grey. The knobs DELAY and LEVEL DTB are almost white (’dark mushroom’).

For installation push the rotary into its hole, rotate it gently until it clicks into place.

8.5.2 Detachment of ribbon cables

The white ribbon cables are used together white connectors with integrated locking device. Proceed as follows to take the cable out of the connector:

- Lift the outside part of the connector: this unlocks the cable.
- Pull the ribbon cable out of the connector.

Proceed as follows to connect the the ribbon cable again:

- Push the ribbon cable fully into the connector. The blue line on the cable must be on the connector side where the contacts are visible (in unlocked position). Figure 8.2 explains this.
- Push down the outside part of the connector in order to lock the cable.

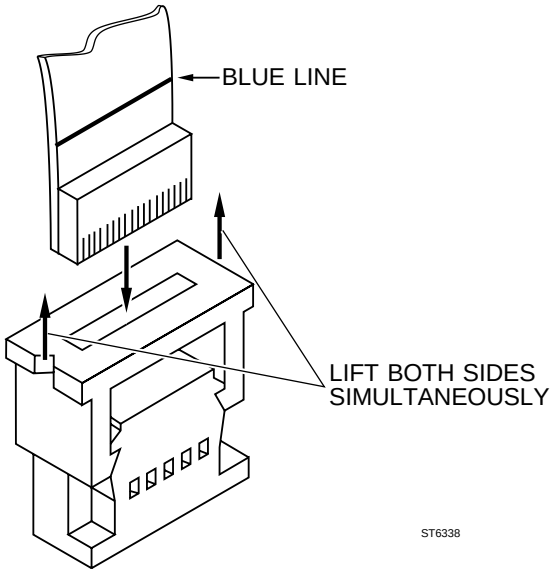

Figure 8.2 Mounting position of white ribbon cables in connector

8.5.3 Removal of signal unit A1

- Remove 3 screws with washers that fix the printed circuit board to the chassis plate.
- Remove 1 long screw that fixes (and grounds) the screen of the input attenuators to the chassis plate.
- Unplug the blue ribbon cable.
- Lift the rear side of the unit over the plastic stud and slide the unit backwards: the unit becomes loose from the chassis now.

NOTE: The unit can be toppled over. The SMD component side is accessible now and can be measured in working condition after reinstallation of the blue ribbon cable. Figure 8.4 shows this.

- Unplug the white ribbon cable and the coaxial delayline connector.
- Unplug the connectors for the output options (MTB gate, DTB gate, MTB sweep) if they are present in the instrument.
- Remove the unit from the instrument.

For removal of the screen of the attenuators proceed as follows:
Pull off the plactic bracket between the BNC inputs.
Remove the two screws between the BNC's.
Remove the two screws in the sides of the screening plate.

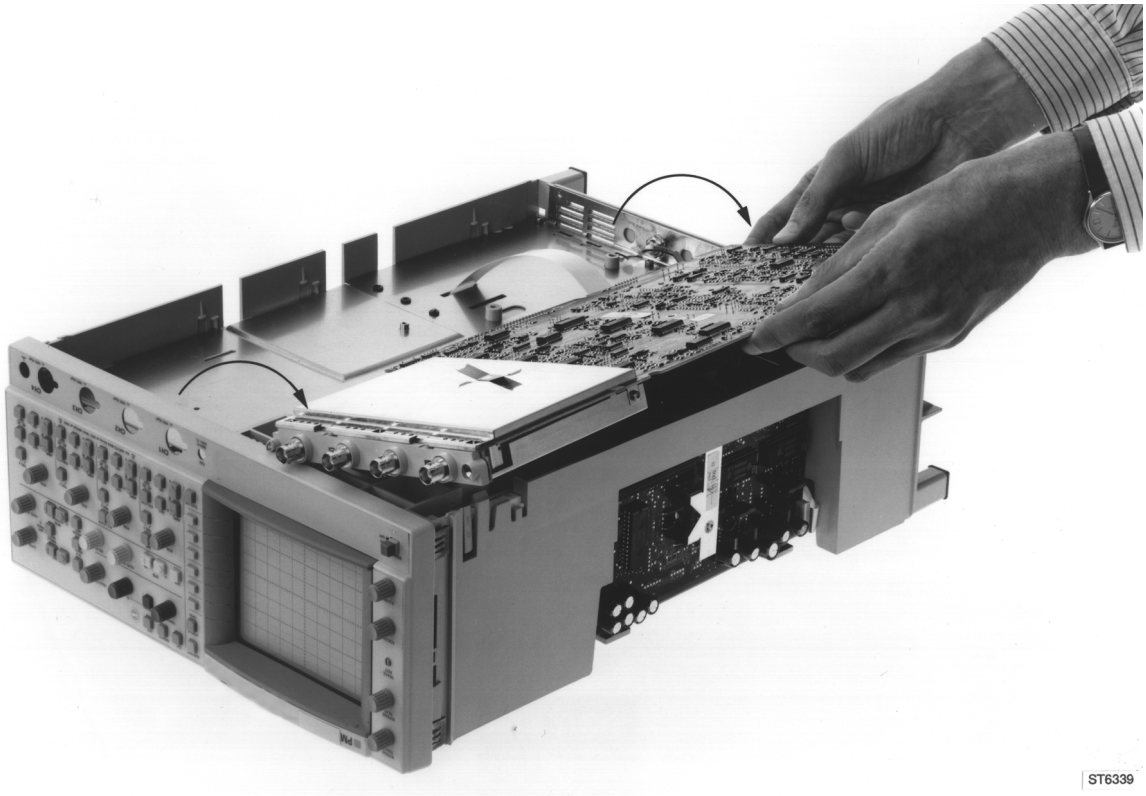

Figure 8.3 Signal unit in position to measure SMD component side

8.5.4 Removal of Final XYZ amplifier unit A2

ATTENTION: On the XYZ unit there are parts that carry high voltages. If working on the unit under live condition cannot be avoided, it must be done by a qualified technician who is aware of the dangers involved.

- Remove the screw that secures (and grounds) the unit to the bottom chassis plate.
- Disconnect the 4 wires that lead to the CRT (The X- and Y-deflection plates): this action must be done carefully to avoid damage to the side connections of the CRT. For correct reinstallation refer to the wiring diagram in chapter 4.2.
- Bend out the two clamping lips that secure the unit at the top side. The unit is loosened now.

NOTE: The unit can be put now in an inclined position as shown in figure 8.3. Measuring on the SMD-component side in working condition is possible then. Measuring the output wires that lead to the X- and Y-deflection plates is possible with a 10 kΩ damping resistor between measuring point and probe tip. This avoids oscillations.

- Unplug two ribbon cables and take the unit out of the chassis.
- Unplug the delayline connector.

Figure 8.4 Final XYZ amplifier in inclined position

8.5.5 Removal of unit at socket of CRT

WARNING: On this unit there are parts that carry dangerous high voltages (-2.2 kV). Some of these voltages remain some time after disconnecting the instrument from the mains. Therefore it is recommended to wait at least five minutes after having disconnected the instrument from the mains, before removing the printed circuit board. If working on the unit under live condition cannot be avoided, it must be done by a qualified technician who is aware of the dangers involved.

Now proceed as follows:
- Unplug the ribbon cable at the Final XYZ amplifier or at the CRT socket unit.
- Pull the unit gently off the CRT socket.
- Unplug the -2.2 kV cathode/filament (3 wires).

8.5.6 Removal of Cathode Ray Tube (CRT)

IMPORTANT:
- *Handle the CRT and its side connections carefully. Rough handling or scratching can cause the CRT to implode.*
- *When installing the CRT, first remove its protective cover. Then take care that its screen is pressed tight to the front side of the chassis.*

- Remove the unit from the socket of the CRT (refer to 8.5.5).
- Disconnect the 4 wires that lead to the CRT (The X- and Y-deflection plates): this action must be done carefully to avoid damage to the side connections of the CRT. For correct reinstallation refer to the wiring diagram in chapter 4.2.
- Pull the graticule lamp holder out of the front rubber.
- Remove the bezel and contrast filter.
- Unplug the trace rotation cable (3 wires) at the connector board.

WARNING: The E.H.T. cable is directly connected to the E.H.T. multiplier that is present on the power supply. When the E.H.T. cable is disconnected from the CRT, the cable must be discharged by shorting it to the instrument's ground (e.g. the CRT screen).

- Unlock the EHT cable and discharge it to ground potential.
- Push the two plastic clamping lips that secure the CRT support to the chassis and gently lift the CRT including its shield out of the oscilloscope.

8.5.7 Removal of microprocessor unit A3

- To preserve the memory contents, move the battery back-up plug X1006 on unit A6 to X1901 on unit A3 when the instrument is turned ON.
- Remove the screw that secures the unit to the rear panel.
- Remove the screw that secures (and grounds) the unit to the bottom chassis plate.
- Unplug the ribbon cable that leads to signal unit A1.
- If the IEEE option is installed, unplug the ribbon cable that leads to the IEEE-connector.
- Slide the unit upwards out of the instrument.

NOTE: The microprocessor unit can be measured under working conditions, by using the extension board with ordering code 5322 218 61479. On this board there is a jumper that can be removed to switch off the EHT- converter. This feature is not used when testing the microprocessor.

8.5.8 Removal of the units in the front frame (A4, A5)

The plastic front frame incorporates the Front unit A4 and the CRT controls unit A5. The frame can be removed from the chassis by bending out four clamping lips. Before doing so unlock the ribbon cable at the connector board.

Removal of Front unit A4:
- Pull the self-locking white plastic clamps.
- Remove the rotary knobs.
- Bend out the four clamping lips that secure unit A4 to the front frame and take the unit out.
- If required separate the rubber key mat from the printed circuit board.

NOTE: - Do not allow dirt to reach the contact areas of the printed circuit board and the key mat. If dirty, contact areas may be cleaned with cleansing alcohol.
- Small studs on the key mat position it on the printed circuit board. During installation the studs must be pressed gently into the matching holes of the circuit board. This can be done by using a small screwdriver.
- The key mat as delivered as a spare part is universal. It may be that the number of keys are too much for your instrument. If so, the unnessary keys must be cut off with a sharp knife.

Removal of CRT controls unit A5:
- Remove the rotary knobs.
- Pull the two self-locking white plastic clamps.
- Take the unit out of the front frame.

8.5.9 Removal of the Power supply unit A6

- Turn ON the instrument.
- Move the back-up voltage plug (X1006) to the microprocessor unit A3 (X1901) to back-up the memory.
- Turn OFF the instrument.

WARNING: On the power supply unit there are many parts that carry dangerous high voltages. Some of these voltages remain some time after disconnecting the instrument from the mains. Therefore it is recommended to wait at least five minutes after having disconnected the instrument from the mains, before removing the printed circuit board. If working on the power supply under live condition cannot be avoided, it must be done by a qualified technician who is aware of the dangers involved.

- Disconnect the oscilloscope from the mains.
- Remove the screw that secures the unit to the chassis.
- Unplug the cables from the -2.2 kV cathode/filament (3 wires) and the fan (2 wires).

WARNING: The E.H.T. cable is directly connected to the E.H.T. multiplier that is present on the power supply. When the E.H.T. cable is disconnected from the CRT, the cable must be discharged by shorting it to the instrument's ground (e.g. the CRT shielding).

- Unplug the +14.3 kV connector from the CRT.
- Unlock the plastic clamps (are part of the chassis) that secure the lower edges of the unit.
- Slide the unit upwards out of the instrument and unplug the mains input connector (3 thick wires).

NOTE: The power supply unit can be measured under working conditions, by using the extension board with ordering code 5322 218 61479. On this board there is a jumper that can be removed to switch off the EHT- converter. For safety reasons it is strongly recommended to use this feature. Refer to chapter 8.8 for more faultfinding hints.

NOTE: Return the Battery Back-Up voltage to original position (X1006) on unit A6 when the instrument is turned ON.

8.5.10 Removal of digitizer unit A8.

- Remove the screw that secures (and grounds) the unit to the bottom chassis plate.
- Slide the unit upwards out of the instrument.
- Unplug the coaxial cables from the unit (the cables and connectors have colour coded rings to facilitate correct reinstallation).

NOTE: The IC's DARLIC (D8027) and DSP (D8069) are placed on sockets. Since these IC's have numerous pins, special tools are recommended to pull them out of their sockets. For DSP the type 821566-1 (for PLCC68) manufactured by AMP is a suitable tool. For DARLIC the type TW2068 (for pin grid array) manufactured by Terminal is suitable. Reinstallation of DARLIC requires considerable pressure; however take care that pins are not bent and that components of the other side of the printed circuit board are not damaged.

The unit can be measured under working conditions, by using the extension board with ordering code 5322 218 61479. On this board there is a jumper that can be removed to switch off the EHT-converter on the power supply A8. This feature needs not to be used when testing the digitizer.

8.6 INSTRUMENT REPACKING

If the instrument is to be shipped to a Service Centre for service or repair, attach a tag showing the full address and the name of the individual at the users firm that can be contacted. The Service Centre needs the complete instrument, its serial number and a fault description. If the original packing is not available, repack the instrument in such a way that no damage occurs during transport.

8.7 TROUBLESHOOTING TECHNIQUES

If a fault appears, the following test sequence can be used to assist in locating the defective component:

- Check to verify that the control settings of the instrument are correct. Consult the operating instructions in the Operating guide.
- Check the equipment to which the instrument is connected, and check the interconnection cables.
- Verify that the instrument is properly calibrated. If it is not, start the autocalibration procedure by pressing the CAL key for 2 seconds. If this does not solve the problem refer to Chapter 7 'Calibration Adjustment Procedure'.
- Locate the circuit(s) in which the fault is suspected: the symptom often indicates the faulty circuit. If the power supply is defective, the symptom may appear in several circuits.
- Visually check the circuit(s) in which the fault is suspected. Often it is possible to find faults such as 'cold' or defective solder joints, intermittent or open interconnection plugs and wires or damaged components.

8.8 TROUBLESHOOTING THE POWER SUPPLY

WARNING: On the power supply there are many parts that carry dangerous high voltages. Some of these voltages remain some time after disconnecting the unit from the mains. Therefore, it is recommended to wait at least five minutes after having disconnected the unit from the mains, before removing the unit. If working on the power supply unit under live condition cannot be avoided, it must be done by a qualified technician who is aware of the dangers involved. The use of an mains isolation transformer is strongly recommended.

The table below indicates the output voltages, currents and power figures delivered by the power supply. To determine whether a certain fault condition is initiated by the power supply itself or by the connected oscilloscope circuits, a dummy load is listed in the table. The table gives also an example of the resistor types that can be used to compose the dummy load. The resistors and connector (ordering number 5322 267 70308) that fits on connector X1002 can be ordered at Consumer Service.

Supply voltage	Current drain	Substitution resistance	Dissipated power	Dummy load resistors
+5 V	3000 mA	1.7 Ω	15 W	5x 10Ω/4W (4822 112 21054) in parallel
-5.2 V	1750 mA	2.9 Ω	8.7 W	3x 10Ω/4W (4822 112 21054) in parallel
+12 V	1750 mA	6.8 Ω	21 W	3x 22Ω/7W (4822 112 41063) in parallel
-12 V	1450 mA	8.3 Ω	17.4 W	3x 27Ω/7W (4822 112 41065) in parallel
+18 V	550 mA	32.8 Ω	10 W	3x 10Ω/4W (4822 112 21054) in series
-18 V	195 mA	92.5 Ω	3.5 W	2x 47Ω/4W (4822 112 21072) in series
+58 V	60 mA	966 Ω	12.1 W	2x 470Ω/7W (4822 112 41098) in series
-58 V	80 mA	725 Ω	4.7 W	330Ω/4W (4822 112 21094) and 390Ω/4W (4822 112 21096) in series
+10 Vref	9 mA	1100 Ω	0.1 W	--
6.3 Vac	240 mA	26.3 Ω	1.5 W	--
-2.2 kV	700 uA	3.1 MΩ	1.55 W	--
+14.5 kV	50 uA	290 MΩ	0.7 W	--

Another way of fault location is the use of the extension board with ordering code 5322 218 61479. On this board there is a jumper that can be removed to switch off the EHT-converter. For safety reasons it is strongly recommended to use this feature.

The current drawn from a certain supply voltage can be measured after having removed the series choke and connecting a current meter instead of it. The chokes are L1273 (+5 V), L1201 (-5.2 V), L1202 (+12 V), L1203 (-12 V), L1204 (+18 V), L1206 (-18 V), L1208 (+58 V) and L1209 (- 58 V).

8.9 SPECIAL TOOLS

8.9.1 Extension board

For test and repair purposes the units A3 and A6 can be plugged in their connectors via an extension board. This board is available under ordering number 5322 218 61479. On this board there is a jumper that can be removed to switch off the EHT-converter. For safety reasons it is strongly recommended to use this feature.

8.9.2 Flash-ROM loader program

After calibration of the oscilloscope, the softkey ’save calibr data’ must be pressed. This saves the calibration data in the oscilloscope’s internal Flash-ROM’s. When the oscilloscope is turned off now, calibration data does not disappear with no back-up batteries installed. The save action can be done 10 times.

The Flash-ROM’s contain blocks of calibration data (of which the most recent block is valid) and the operating software. After operation of softkey ’save calibr data’, the text ’XX CALIBRATION FIELDS FREE’ is displayed. XX can be a figure between 10 ... 1 or ’NO’. In case of ’NO’, the Flash ROM must be emptied and redundant blocks of calibration data must be removed. To have this done, send your oscilloscope to the nearest Service Center.

The data exchange takes place via the oscilloscope’s RS232 interface. It occurs via a program running on a Personal Computer with RS232 interface.

The Flash-ROM’s D1013 and D1015 as listed in the parts lists is empty. After echange it must be filled with operating software and calibration data. Also for this the oscilloscope must be sent to the nearest Service Center.

8.10 RECALIBRATION AFTER REPAIR

After any electrical component has been renewed the calibration of its associated 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 it work has been done in the power supply or if the transformer has been renewed.

8.11 TESTS BUILT INTO THE INSTRUMENT.

8.11.1 Power-up test.

After turning the oscilloscope on, power-up tests start automatically. The tests take less than a second. A message appears on the screen when errors are found. With no message displayed, the oscilloscope is ready for use. The tests that are sequentially done and the associated error messages are:

- The oscilloscope's internal control bus is checked. This is done by addressing N9001, N9002, N9003, N8005, N6014, D9009 (unit A1), N1001, N2002 (unit A2), N1141 (unit A6) and N8009, N8070 (unit A8). Error message: 'NO ACKNOWLEDGE ON I2C BUS'.
- The oscilloscope's hardware configuration is tested on the units A1, A3 and A8. On unit A1 is tested for 60, 100 or 200 MHz and 4, 2+2 or 2 channels. On A3 the presence of an IEEE interface and on A8 the amount of memories. Also is tested if the the software version corresponds with the hardware modification level. Error messages: 'WRONG A1 HARDWARE VERSION', 'WRONG A3 HARDWARE VERSION' or 'WRONG A8 HARDWARE VERSION'.
- The communication between the front unit A4 (named 'ufo') and microprocessor A3 is checked. Message: 'CANNOT COMMUNICATE WITH UFO'.
- The contents of the settings memory is checked if back-up batteries are installed. Message: 'NO BATTERY BACKUP'.
- Many IC's and belonging bus structures on unit A8 such as BATGE, DARLIC, CURCON, MAM and PRAM are tested. In case of an error, a message such as DARLIC ERROR, CURCON ERROR or similar is displayed.

8.11.2 Introduction to diagnostic tests.

The tests are accessible via the softkey menu's. A good knowledge of the circuitry of the oscilloscope is necessary to take advantage of these tests. Refer to chapter 5 'Unit descriptions' for additional information and circuit diagrams.

Tests can be performed on:

- The microprocessor system.
- The inputs for the microprocessor (rotaries and keys via the processor in the front unit).
- The outputs from the microprocessor (digital to analog converters and output buffers).
- The IC's and bus structures of digitizer unit A8.

The configuration of the control part under direct microprocessor influence is given in the figure. The lines SDA (Serial DAta) and SCL (Serial CLock) are fed to the many circuits, where the serial information is converted into the different control signals.

NOTE: For servicing, solder joints are added in the p.c.b. tracks. These can be used to localize a fault in the bus by means of isolating a suspected IC from SCL or SDA lines.

Proceed as follows to reach the tests:

- Press menukey 'UTIL'.
- Press softkey 'MAINTENANCE'.
- Now softkey selection is possible between 'SELFTEST' and 'REPAIR TOOLS'.

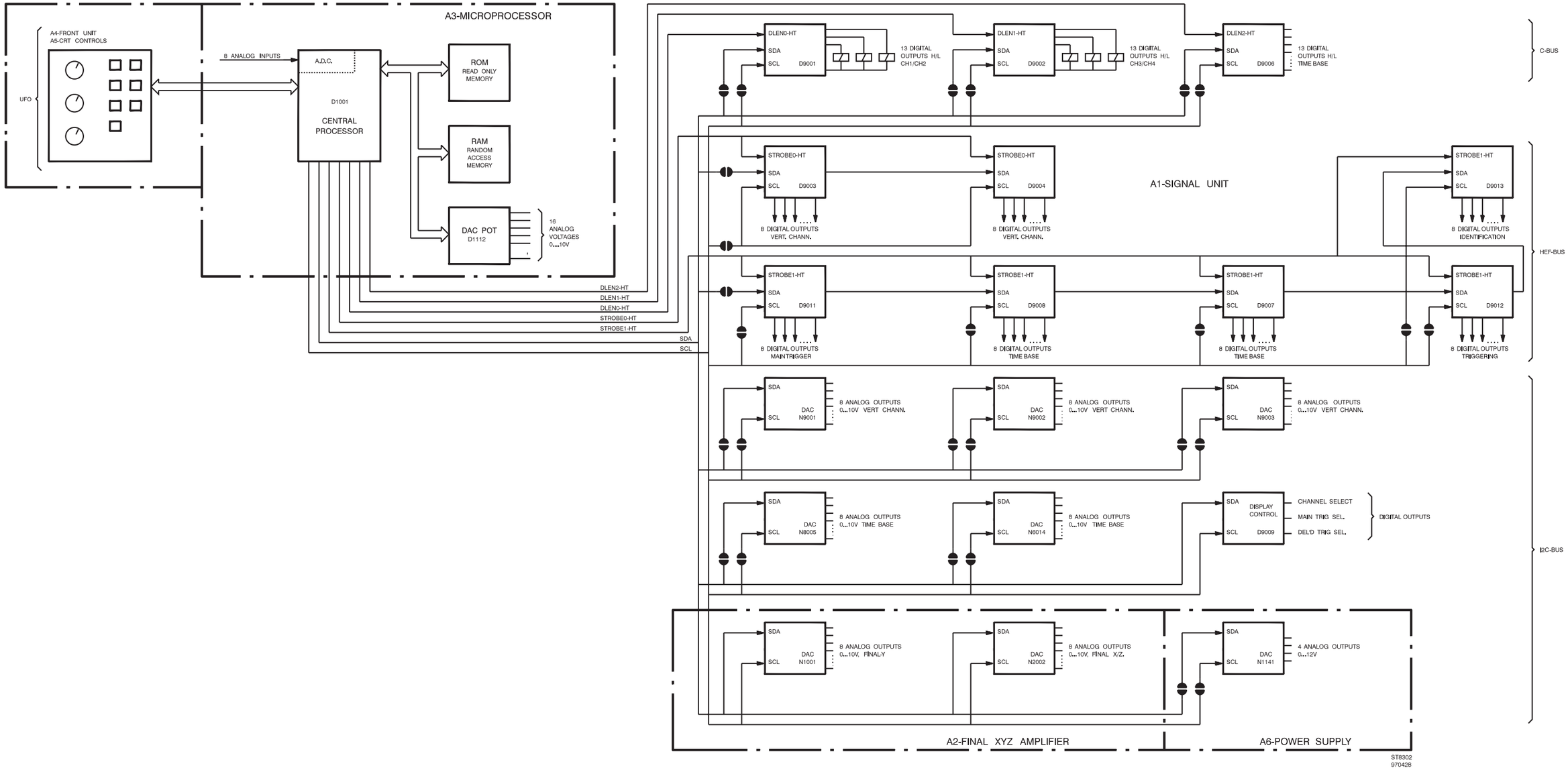

Figure 8.3. Configuration of control part under direct control of microprocessor

8.11.3 SELFTESTS

Under the softkey ’SELFTEST’ it is possible to run tests for the microprocessor and digitizer units. With a toggle softkey, selection is possible between ’test-all’ and ’specific’.

A test is started with softkey ’start’. A test that is being executed can be interrupted with softkey ’abort’. A test completed succesfully gives the screen message ’TEST PASSED’.
The selection ’test all’ starts a sequence of all tests. If a fault is found, ’specific’ must be selected: this gives the possibility to determine what part is defective. By means of the ’TRACK’ rotary, one of the specific tests can be selected. Softkey ’RETURN’ is used to move upwards in the menu structure.

The selftests mainly check the bus structures that interconnect the IC’s on digitizer unit A8 and microprocessor unit A3. The tests are done with bitpatterns such as 1111 ... (FF hex), 0000 ... (00 hex), 1010 ... (AA hex) and 0101 ... (55 hex) that are 16 or 8 bits wide. It is tested for bit(s) stuck at one (+5 V), bit(s) is stuck at zero (0 V), bits interconnected or bit(s) interrupted. The message ’TEST PASSED’ is displayed on the screen if a test is terminated succesfully; if not ’TEST FAILED’ or an error code is displayed. The error code gives information about the kind of fault that has occurred. The tests of the random access memories (e.g. MAM, FAM, PRAM) are done for many memory locations: the message ’TEST PASSED’ gives a good certainty that the chip is error free. Tests for other devices (e.g. BATGE, DARLIC, CURCON) do not test each and every aspect of the chip. The tests write bitpatterns into a certain buffer. Then the pattern is read from the buffer and checked. It must also be borne in mind that tests cannot be run if certain parts (e.g. the microprocessor on unit A3, text generator) are not functioning. The tests are initiated from the microprocessor and routed to digitizer A8 via bus lines and connector board A10.

CPURAM

This test checks the RAM (D1012) on unit A3. D1012 belongs to microprocessor D1001 on unit A3.

If completed succesfully the message ’TEST PASSED’ is displayed.

In case of an error the message ’TEST FAILED’ is displayed.

BATGE (Bus Arbiter and Trace GEnerator)

Main function(s) of BATGE (D8048) are arbitration between multiple processors and memories at high speed (40 MHz clock). D8048 has a connection with MAM (D8054, D8056).

During the BATGE test 4 bitpatterns are send to a testregister inside D8048. Then they are read and verified. This test does not cover every aspect of the functioning of D8048. Moreover the fact that the microprocessor address and databits 00 ... 07 are combined can give incorrect error messages.

In case of an error, the message ’TEST FAILED’ is displayed. The second line of this message has five positions that give information about the kind of fault that is detected. This information is intended for factory use.

DSP (Digital Signal Processor)

Main function(s) of DSP (D8069) are Average, Envelope, Mathematical, Interpollation, Filters, Display memory refresh, X position control, Delta T processing. D8069 has a connection with the PRAM (D8049, D8052).

The DSP test checks the communication between DSP and microprocessor on unit A3. A message is sent to the DSP and this device should answer with an acknowledge. In case of an error, the message ’TEST FAILED’ is displayed.

DARLIC (Data Acquisition and tRigger Logic IC)

Main function(s) of DARLIC (D8027) are data path (speed conversion, transfer from FAM to MAM) and trigger engine (start/stop acquisition, pre/posttriggering, delta-t counter, timed pattern mode).

During the DARLIC test 2 bitpatterns (FF hex and 00 hex) are send to a register inside D8027. Then they are read and verified. The test does not cover each and every aspect of the functioning of DARLIC.

In case of an error, the message 'TEST FAILED' is displayed without any further specification.

CURCON (CURsor and text CONtrol IC)

Main functions of CURCON (D8047) are generation of text and cursors. CURCON has a connection with RAM D8051.

During the CURCON test the databus is checked for stuck at 0, stuck at 1, opens and interconnections. Also the databus connection between Curcon and belonging RAM (D8051) is tested. This test does not cover each and every aspect of the functioning of D8047.

In case of an error, the message 'TEST FAILED' is displayed. The second line of this message has five positions that gives information about the kind of fault that is detected. This information is intended for factory use.

MAM (Main Acquisition Memory)

In this memory (D8054, D8056) the register contents, display information and other data are stored.

During the MAM test the global databus from BATGE to MAM is checked for stuck at 0, stuck at 1, opens and interconnections. This test does not cover each and every aspect of the functioning of D8054/56.

In case of an error, the message 'TEST FAILED' is displayed. The second line of this message has five positions that give information about the kind of fault that is detected. This information is intended for factory use.

FAM (Fast Acquisition Memory)

In this memory the signal samples from the ADC are stored. The memory consists of 8 RAM's D8037 ... D8046.

The FAM test is a databus test. In case of an error, the message 'TEST FAILED' is displayed. The second line of this message has five positions that give information about the kind of fault that is detected. This information is intended for factory use.

PRAM (PRogrAm Memory)

Serves as program memory (D8049, D8052) for the DSP (Digital Signal Processor). Has a connection with DSP.

In case of an error during the PRAM test, the message 'TEST FAILED' is displayed. The second line of this message has five positions that give information about the kind of fault that is detected. This information is intended for factory use.

ROM0, ROM1,

Flash-ROM 0 (D1013) and Flash-ROM 1 (D1015) on unit A3 belong to microprocessor D1001.
If completed succesfully the message 'TEST PASSED' and the belonging checksum are displayed.
In case of a ROM0 or ROM1 error, the oscilloscope will not function normally.

8.11.4 Repair tools

8.11.4.1 General

Under the softkey 'REPAIR TOOLS', tests can be selected concerning the exchange of information in the area around the microprocessor and digitizer unit A8:
- Data exchange between keys/rotaries and microprocessor.
- Data exchange between microprocessor and the devices that control the oscilloscope circuits.
- Data exchange between microprocessor unit A3 and digitizer A8.

Tests can be selected with a softkey pair. A test can be activated with toggle softkey 'on off'. Data in connection with the tests is displayed in the viewing area as two lines of information. The last setting is present in the utmost right position of the lowest of the two lines.

8.11.4.2 Repair tools / ufo

With this test the proper functioning of the keys and rotaries at the front panel (ufo) can be tested. Each control has its own number. There is also information given concerning the position occupied by the controls. The tables below indicate the information from controls towards microprocessor. This is separately listed for rotaries and keys.

Rotaries (L is rotation left to right, R is rotation right to left, X indicates the rotation speed):

ILLUM	L/R0X	INTENS TEXT	L/R1X	INTENS TRACE	L/R2X
POS CH2	L/R3X	DELAY	L/R4X	HOLD OFF	L/R5X
POS CH4	L/R6X	TRIGGER LEVEL	L/R7X	FOCUS	L/R8X
FOCUS	L/R8X	TRACE ROT	L/R9X	TRACK	L/RAX
POS CH1	L/RBX	Δ	L/RCX	TRIGGER POS	L/RDX
POS CH3	L/REX	X POS	L/RFX		

Keys (A = autorepeat, M = more than 1 key pressed, X=P is function off, X=U is function on):

CAL	X00	AUTOSET	X01	ANALOG	X20
STATUS/LOCAL	X02	Softkey 5	X03	Softkey 6	X04
TEXT OFF	X05	CH1 + CH2	X06	AC DC GND CH1	X07
UTIL	X10	SETUPS	X11	Softkey 1	X12
Softkey 4	X13	AMPL mV CH1	X14	AMPL V CH1	X15
AMPL mV CH2	X16	AMPL V CH2	X17	pin hole	X21
Softkey 2	X22	Softkey 3	X23	AUTO RANGE CH1	X24
ON CH1	X25	AUTO RANGE CH2	X26	ON CH2	X27
DTB s	X32	DTB	X33	VERT MENU	X34
TRIG1	X35	INV CH2	X36	AC DC GND CH2	X37
TRIGGER	X41	CURSORS	X42	DTB ns	X43
AVERAGE	X44	TRIG2	X45	AMPL mV CH3	X46
AMPL V CH3	X47	MAGNIFY down	X51	RUN/STOP	X52
TB MODE	X53	TRIG4	X54	TRIG3	X55
AUTO RANGE CH3	X56	ON CH3	X57	MAGNIFY up	X61
MTB s	X63	INV CH4	X64	AUTO RANGE CH4	X65
CH3 + CH4	X66	AC DC GND CH3	X67	SINGLE	X72
MTB ns	X73	AC DC GND CH4	X74	ON CH4	X75
AMPL mV CH4	X76	AMPL V CH4	X77	ACQUIRE	X31
AUTO RANGE TB	X62				
SAVE	X30	RECALL	X40	MEASURE	X50
MATH	X60	DISPLAY	X70	PLOT	X71

Note: the table with keys is based upon PM3394A. In other oscilloscope versions some of the keys are not present or have a different function.

8.11.4.3 Repair tools / I²C bus

This test displays the data (SDA) that is send by the microprocessor to a number of addressable devices. Synchronization is achieved via SCL. Each data block sent by the microprocessor is preceeded by an address on which the device can respond. The characters 'A, B, C, D, E and F' represent one hexadecimal character. The devices are the ADC's mentioned under 'REPAIR TOOLS / DAC ' and DAC N1141 on power supply unit A1.

Device	Unit	Name of circuit diagram	Address	Data format		
D9009	A1	Display and trigger control	36	AB	CD	EF
N9001	A1	Control circuits	40	AB	CD	
N9002	A1	Control circuits	4C	AB	CD	
N9003	A1	Control circuits	44	AB	CD	
N8005	A1	Time base logic	48	AB	CD	
N1001	A2	Final Y preampl. + control	46	AB	CD	
N2002	A2	Final X amplifier + control	4E	AB	CD	
N1141	A6	EHT converter + auxiliary	88	AB	CD	
N8070	A8	Curcon, DAC's, Z-control	42 *	AB	CD	
N8009	A8	Display interface	44 *	AB	CD	

*) The DAC's on digitizer unit A8 are directly controlled by DARLIC (D8027).

8.11.4.4 Repair tools / adc

This test displays the decimal representation of the input voltage applied to the analog inputs ACH0 ... ACH7 of the microprocessor D1001. The readout consists of two lines of information.

The first line displays in sequence the analog inputs:
- ACH7: the NTC-resistor R1009 (on unit A3) that measures the temperature inside the oscilloscope is connected to this input.
- ACH6 (PROBE 4): the voltage value applied to this input represents the type of the probe applied to CH4.
- ACH5 (TBSMART): the voltage value representing the state of a number of time base circuits is applied here. TBSMART originates from unit A1 and is applied to unit A3.
- ACH4 (PROBE 3): the voltage value applied to this input represents the type of the probe applied to CH3.

The second line displays in sequence:
- ACH3 (PROBE 2): the voltage value applied to this input represents the type of the probe applied to CH2.
- ACH2 (XCAL): the applied voltage originates from the measuring circuit of the horizontal output on unit A2. This is used for automatic calibration of he horizontal section.
- ACH1 (YCAL): the applied voltage originates from the measuring circuit of the vertical output on unit A2. This is used for automatic calibration of he vertical section.
- ACH0 (PROBE 1): the voltage value applied to this input represents the type of the probe applied to CH1.

8.11.4.5 Repair tools / hef

To control simple on/off functions there are 7 buffers (of the type HEF4094) on unit A1: this structure is called the 'HEF-bus'. Each buffer has 8 outputs as shown in the figure. The buffers are divided into 2 groups: group 0 consists of 2 buffers and group 1 consists of 5 buffers. A group can be regarded as a shift register of 16 or 40 bits. Each group of buffers has its common enable signal: STROBE0-HT or STROBE1-HT.

The test makes the data (SDA) visible that is shifted by the microprocessor into the shift register. Data is displayed in the viewing area as two lines of information. The last data block is present in the utmost right position of the lowest of the two lines. Synchronization is achieved via SCL.

The configuration of group 0 and 1 is shown in the table:

Group	Enable signal	Buffers	Name of circuit diagram
0 D9004 1 D9008 D9007 D9012 D9013	STROBE0-HT Control circuits STROBE1-HT Time base logic Delayed time base DTB trigger DTB trigger	D9003 D9011	Control circuits MTB trigger

The data representation for group 0 is '0:ABCD'. Each character represents the hexadecimal (16 possible states) information for 4 outputs (total 16 outputs):
- Character 'A' represents the information for D9004 outputs 14, 13, 12, 11.
- Character 'B' represents the information for D9004 outputs 4, 5, 6, 7.
- Character 'C' represents the information for D9003 outputs 14, 13, 12, 11.
- Character 'D' represents the information for D9003 outputs 4, 5, 6, 7.

The data representation for group 1 is '1:ABCD 1:EFGH'. Each character represents the hexadecimal (16 possible states) information for 4 outputs (total 32 outputs):
- Character 'A' represents the information for D9012 outputs 14, 13, 12, 11.
- Character 'B' represents the information for D9012 outputs 4, 5, 6, 7.
- Character 'C' represents the information for D9007 outputs 14, 13, 12, 11.
- Character 'D' represents the information for D9007 outputs 4, 5, 6, 7.
- Character 'E represents the information for D9008 outputs 14, 13, 12, 11.
- Character 'F' represents the information for D9008 outputs 4, 5, 6, 7.
- Character 'G' represents the information for D9011 outputs 14, 13, 12, 11.
- Character 'H' represents the information for D9011 outputs 4, 5, 6, 7.

Note: The data for D9013 is not displayed. This buffer is only used when turning-on the oscilloscope: it tests if hardware and software belong to each other.

There also exists a HEF-bus on digitizer unit A8. This bus consists of D8034, D8036, D8033 and D8032 and is directly controlled by DARLIC (D8027). The data applied to this bus cannot be displayed on the CRT screen.

8.11.4.6 Repair tools / cbus

To control on/off functions in the CH1 ... CH4 attenuators and in the main and delayed time base, there are 3 buffers on unit A1 of the instrument. This configuration is called the 'c-bus'. Each buffer has 13 outputs and can be regarded as a shift register of 13 bits. Each buffer has its own enable signal. The test makes the data (SDA) visible that is shifted by the microprocessor into the buffer. Synchronization is achieved via SCL.

The configuration is shown in the table:

Enable signal	Buffer	Name of circuit diagram
DLEN0-HT DLEN1-HT DLEN2-HT	D9001 D9002 D9006	Control circuits Control circuits Main time base

The data representation for D9006 is ’0:ABCD’. Each character represents the hexadecimal (16 possible states) information for 4 outputs. The data representation for D9001 and D9002 is more complex: these buffers drive the pulse relays in the CH1 ... CH4 attenuators. Changing an attenuator setting can cause the generation of several ’0:ABCD’ blocks of data. Refer to chapter 5.1.1 for information on how the pulse relays are controlled. D9001 controls CH1 and CH2: data blocks have the configuration ’0:ABCD’. D9002 controls CH3 and CH4: data blocks have the configuration ’1:ABCD’.

8.11.4.7 Repair tools / DAC

Thoughout the oscilloscope there are several digital-to-analog converters (DAC’s) that are controlled by the microprocessor. The ’REPAIR TOOLS’ menu enables to select a certain DAC output (via TRACK) and to determine the output voltage (via $\underline{\Lambda}$) at this output. After having opened the instrument, the voltage can be measured with a voltmeter or oscilloscope. The DAC output voltage range is between 0 ... 10V (1 ... 4V for D1112 and D8006). This test is not influenced by softkey ’on off’. A DAC VALUE once changed returns to the old value if the menu is left.
The selections with the TRACK rotary have the configuration X.Y. The character X points to a certain DAC IC. The table shows the relation:

X-value	IC reference number	Unit number	Name of circuit diagram
0.Y	N9001	A1	Control circuits
2.Y	N9003	A1	Control circuits
3.Y	N1001	A2	Final Y preampl. + control
4.Y	N8005	A1	Time base logic
6.Y	N9002	A1	Control circuits
7.Y	N2002	A2	Final X amplifier + control
8.Y	D1112	A3	Potentiometer DAC + IEEE
d1.Y	N8070	A8	Curcon, DAC’s, Z-control
d2.Y	N8009	A8	Display interface
d8.Y	D8006	A8	Reference + adjustment

The character Y points to a certain output within the selected DAC IC. The table shows this for N9001, N9002, N9003 and N8005 on unit A1:

Y-value	Pin number	Name of generated signal: N9001	N9002	N9003	N8005
X.0	11	PA1OFFSTRG	AT3LFCAL	DLDOFFSET	TBINTTRAT-XA
X.1	13	PA1OFFSET	AT3OFFSET	PA4OFFSTRG	DTBVAR
X.2	14	AT1LFCAL	AT3LOOPCAL	PA4OFFSET	DSOCALD
X.3	15	AT1OFFSET	PA2OFFSTRG	AT4LFCAL	DSOCALM
X.4	16	AT1LOOPCAL	PA2OFFSET	AT4OFFSET	DTRSEN
X.5	17	ATCAL0	AT2LFCAL	AT4LOOPCAL	MTRTVMODE
X.6	18	ATCAL1	AT2OFFSET	PA3OFFSTRG	MTRBAL
X.7	20	ATCAL2	AT2LOOPCAL	PA3OFFSET	MTRSEN

Note: for explanation of signal names, refer to chapter 5.1.2

For N1001 and N2002 (unit A2) refer to the table below:

Y-value	Pin number	Name/function of generated signal: N1001	N2002
X.0	11	LF sq. wave	ASTDR
X.1	13	LF sq. wave	DARK
X.2	14	Gain	XHFADJ
X.3	15	HF sq. wave	XTRAGC
X.4	16	Offset	XCRTGCL
X.5	17	Offset	XCRTGCH
X.6	18	MF sq. wave	XCRTOFL
X.7	20	MF sq. wave	XCRTOFH

Note: for explanation of signal names, refer to chapter 5.2.2

For N8070 and N8009 on unit A8 a separate table is not given. The relation between pin number and Y-value is indentical to those given in the tables for the units A1 and A2. The main function of N8070 is intensity control on the digitizer. N8009 controls the gain and offset of the output stage of the digitizer.

For D1112 (unit A3) and D8006 (unit A8) refer to the table below:

Y-value	Pin number	Pin name D1112	D8006
X.7	16	POS CH1	OFFSET ADC A
X.4	19	POS CH2	HF SQ WAVE ADJ CH2
X.2	21	POS CH3	HF SQ WAVE ADJ CH4
X.8	13	POS CH4	OFFSET COMPASS CH1
X.1	22	VAR CH1	NOT USED
X.3	20	VAR CH2	HF SQ WAVE ADJ CH3
X.5	18	VAR CH3	HF SQ WAVE ADJ CH1
X.6	17	VAR CH4	OFFSET COMPASS CH3
X.12	9	VAR MTB	GAIN MASPU A
X.11	10	LEVEL MTB	OFFSET CH 1 AND 3
X.10	11	LEVEL DTB	OFFSET COMPASS CH2
X.15	6	INTENS TEXT	OFFSET ADC B
X.9	12	TRACE SEP	OFFSET COMPASS CH4
X.0	23	FOCUS-DA	NOT USED
X.14	7	HOLD OFF	GAIN MASPU B
X.13	8	INTENS TRACE	OFFSET CH 2 AND 4

IMPORTANT: After having completed these tests, it is recommended to reset the oscilloscope. Therefore press the keys 'STATUS' and 'TEXT OFF' simultaneously.