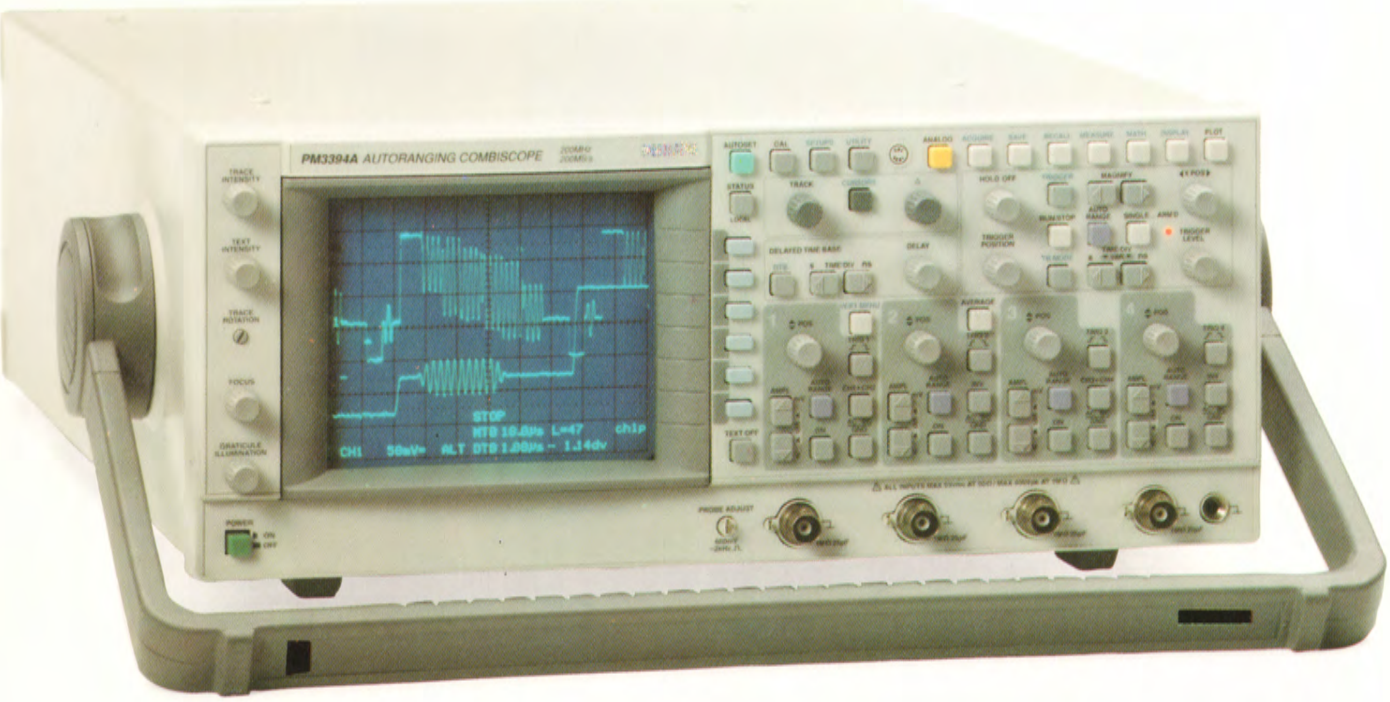
# PM3370A - PM3380A - PM3390A
# PM3382A - PM3384A - PM3392A - PM3394A
# AUTORANGING COMBISCOPE™ INSTRUMENT

## Service Manual

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# PM3370A - PM3380A - PM3390A
# PM3382A - PM3384A - PM3392A - PM3394A
## Autoranging CombiScope™ Instrument

## Service Manual

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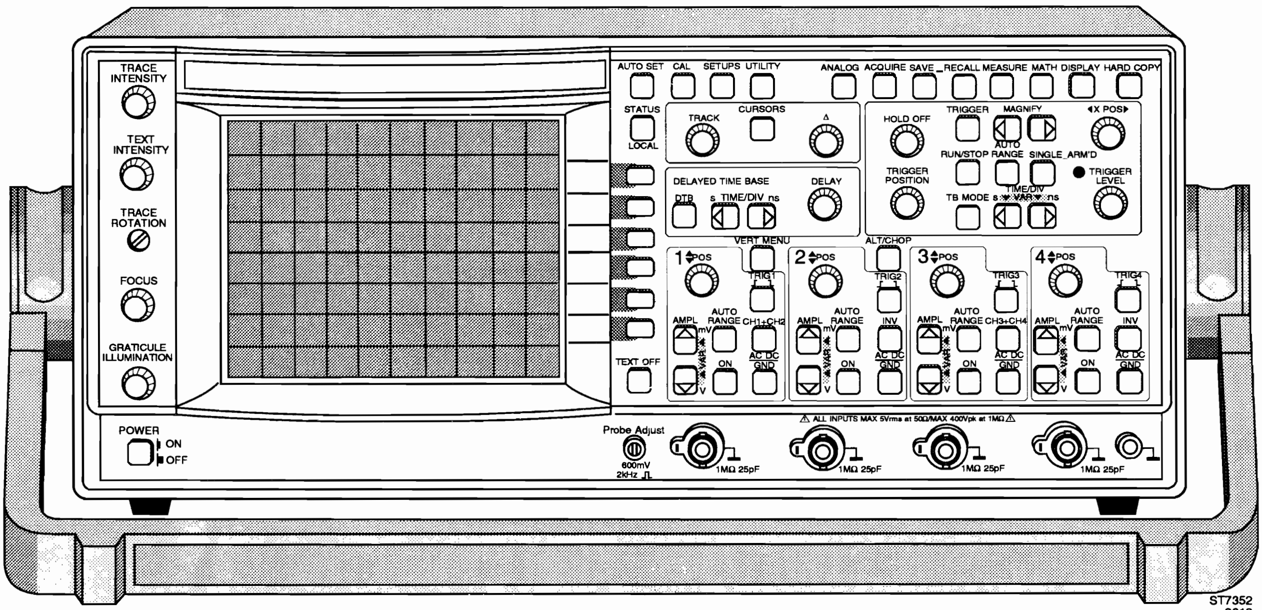


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**Warning:** **These servicing instructions are for use by qualified personnel only. To reduce the risc of electric shock do not perform any servicing other than that contained in the operating instructions unless you are fully qualified to do so.**

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## IMPORTANT

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

For your reference:

Model number: PM 33XXA/YY
Serial number: DM .

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



Printed in The Netherlands

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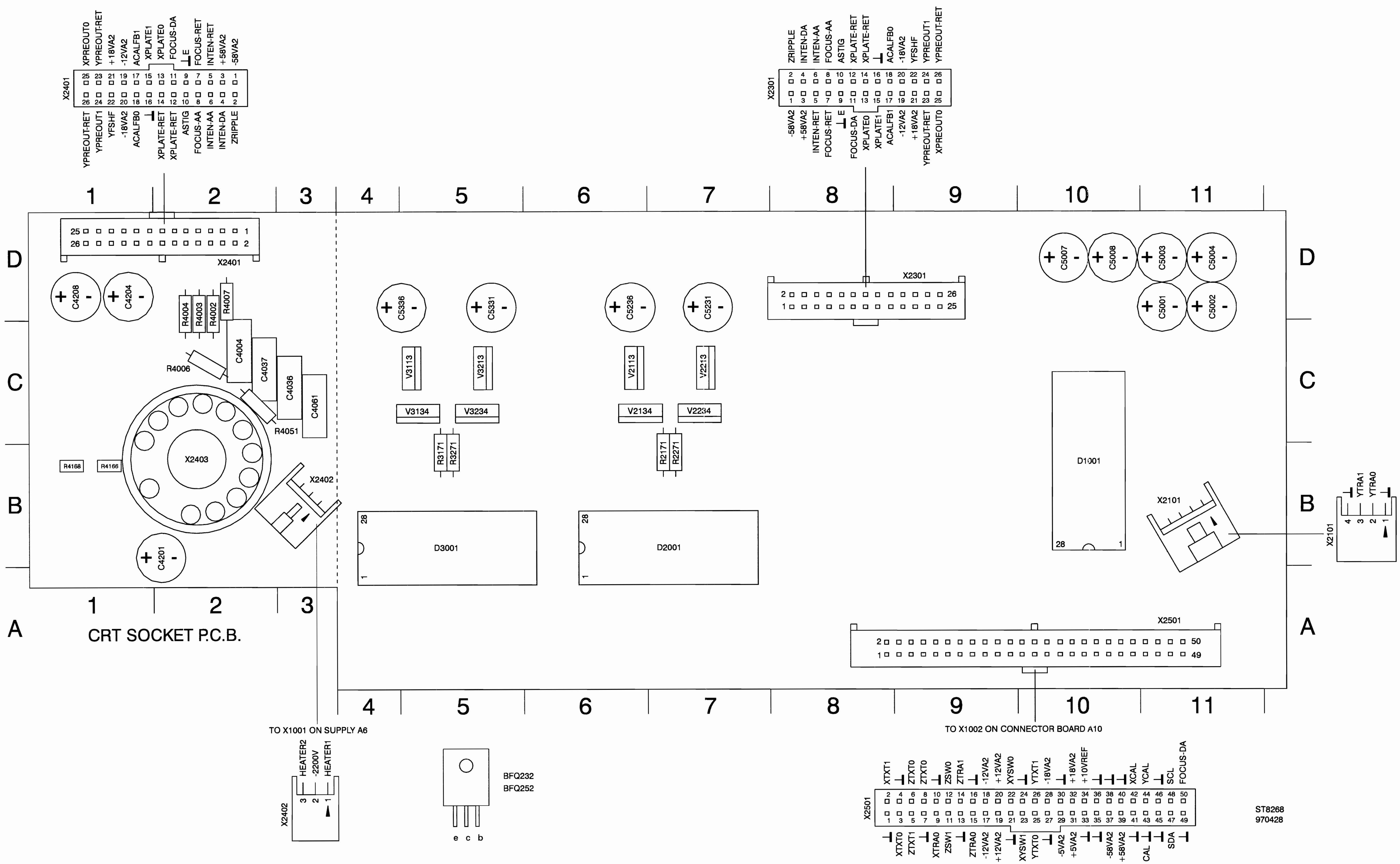
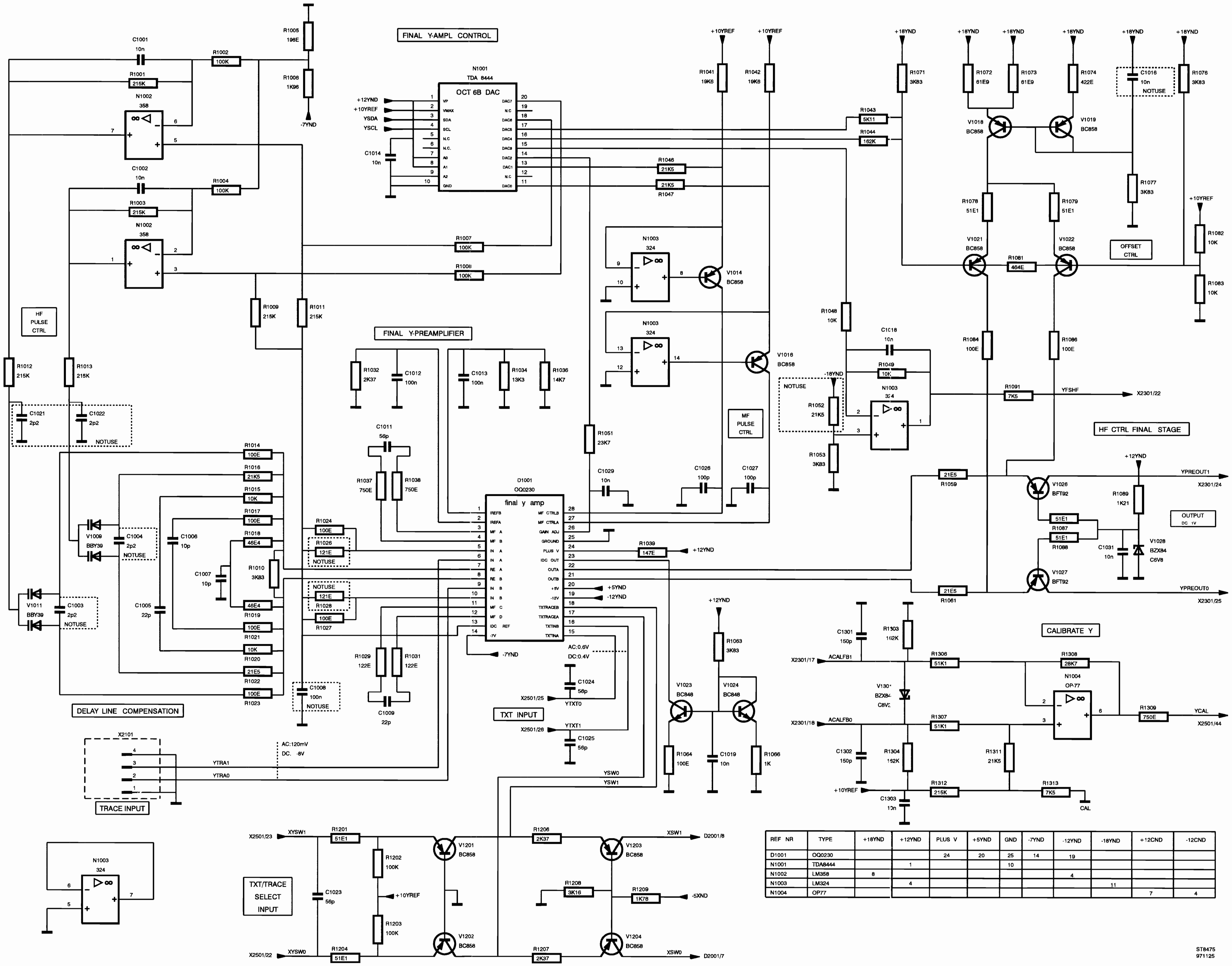
## 5.2.9 Unit lay-outs A2-100 MHz version




Lay-out 1 - Large component side of XYZ amplifier unit A2-100 MHz

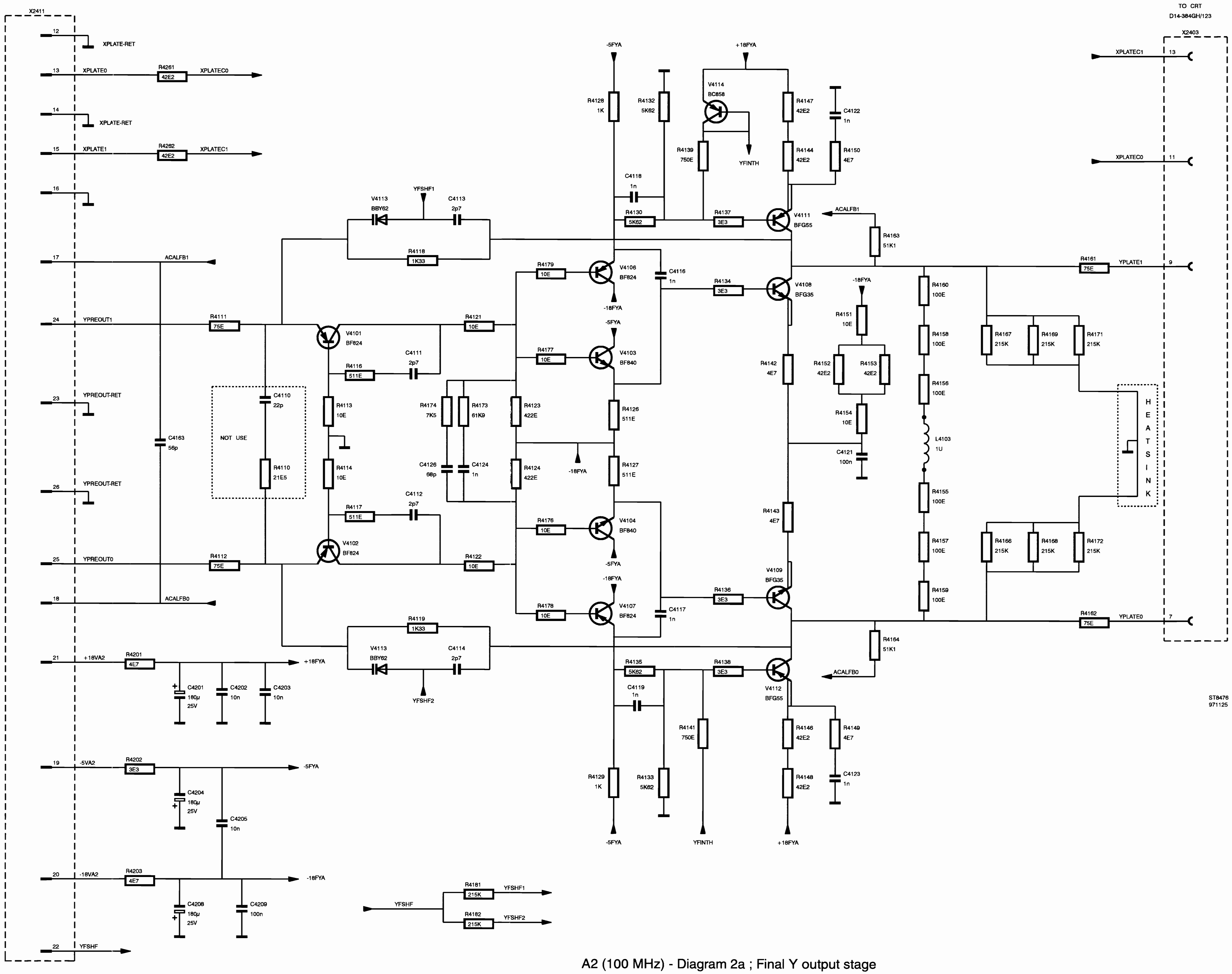

Lay-out 2 - Small component side of XYZ amplifier unit A2-100 MHz

## 5.2.11 Circuit diagrams A2-100 MHz version




| REF NR | TYPE | +18YND | +12YND | PLUS V | +5YND | GND | -7YND | -12YND | -18YND | +12CND | -12CND |
|---|---|---|---|---|---|---|---|---|---|---|---|
| D1001 | OQ0230 | | | 24 | 20 | 25 | 14 | 19 | | | |
| N1001 | TDA8444 | | 1 | | | 10 | | | | | |
| N1002 | LM358 | 8 | | | | | | 4 | | | |
| N1003 | LM324 | | 4 | | | | | | 11 | | |
| N1004 | OP77 | | | | | | | | | 7 | 4 |

A2 (100 MHz) - Diagram 1a ; Final Y preamplifier and control



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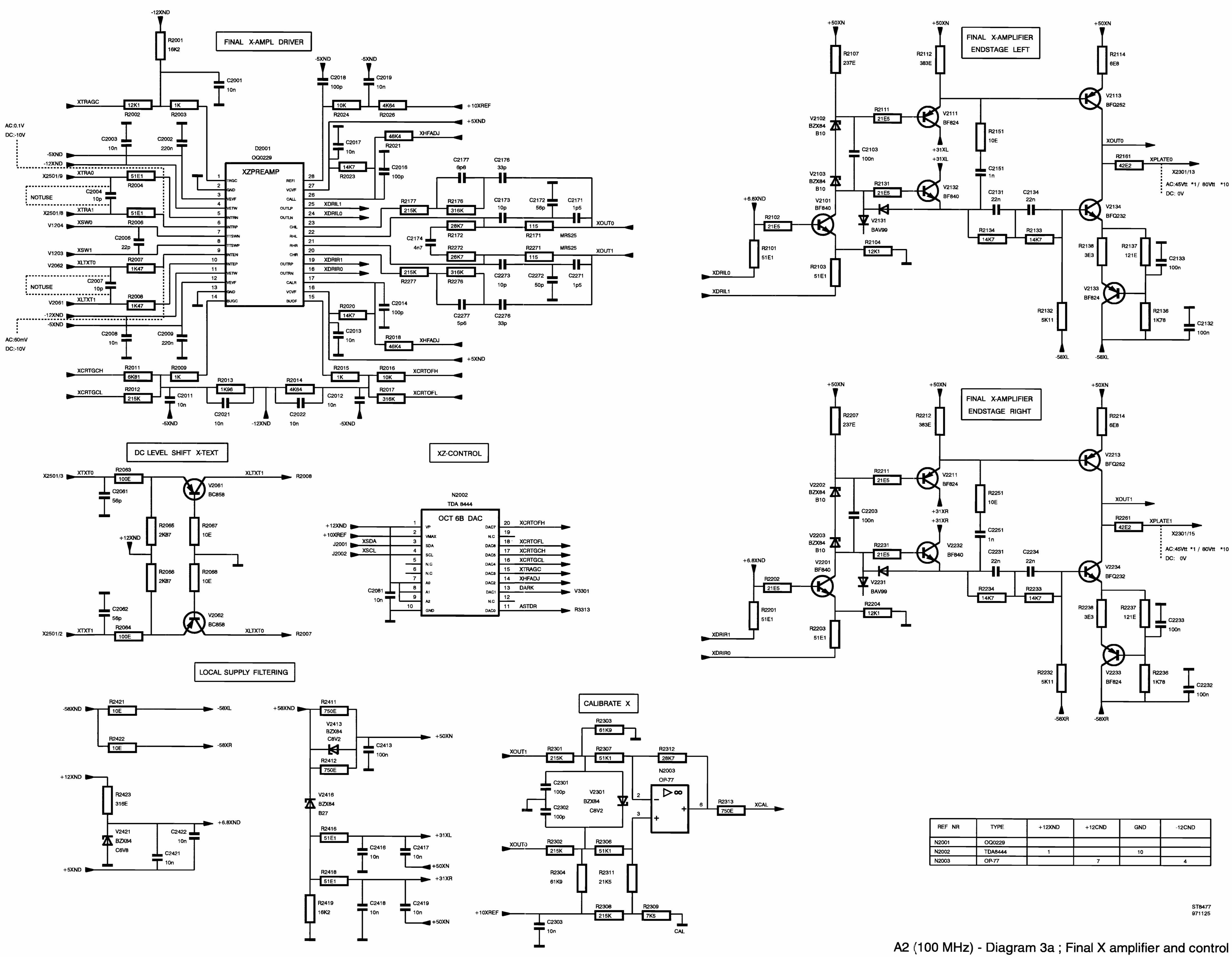
A2 (100 MHz) - Diagram 2a ; Final Y output stage




| REF NR | TYPE | +12XND | +12CND | GND | -12CND |
|---|---|---|---|---|---|
| N2001 | OQ0229 | | | | |
| N2002 | TDA8444 | 1 | | 10 | |
| N2003 | OP-77 | | 7 | | 4 |

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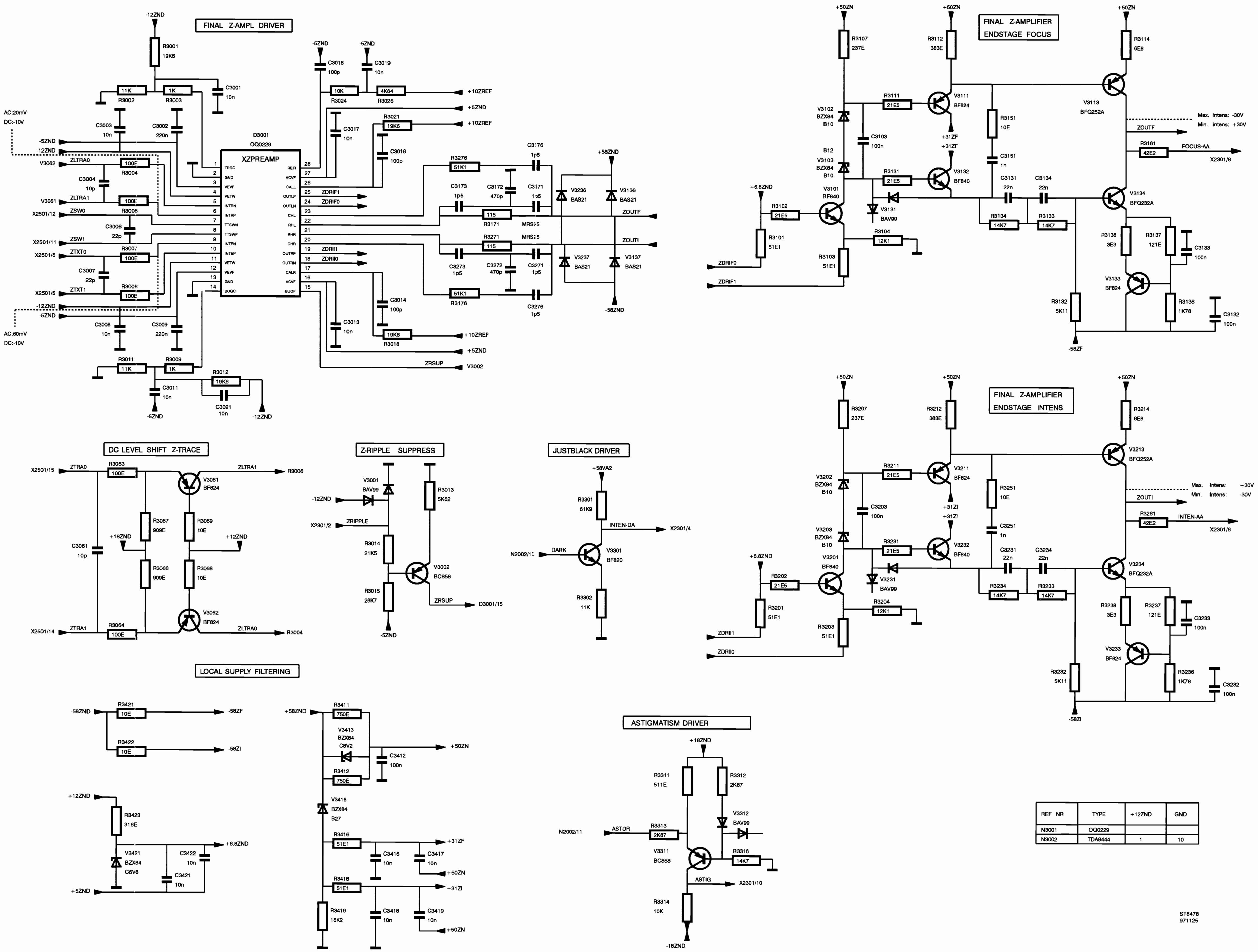
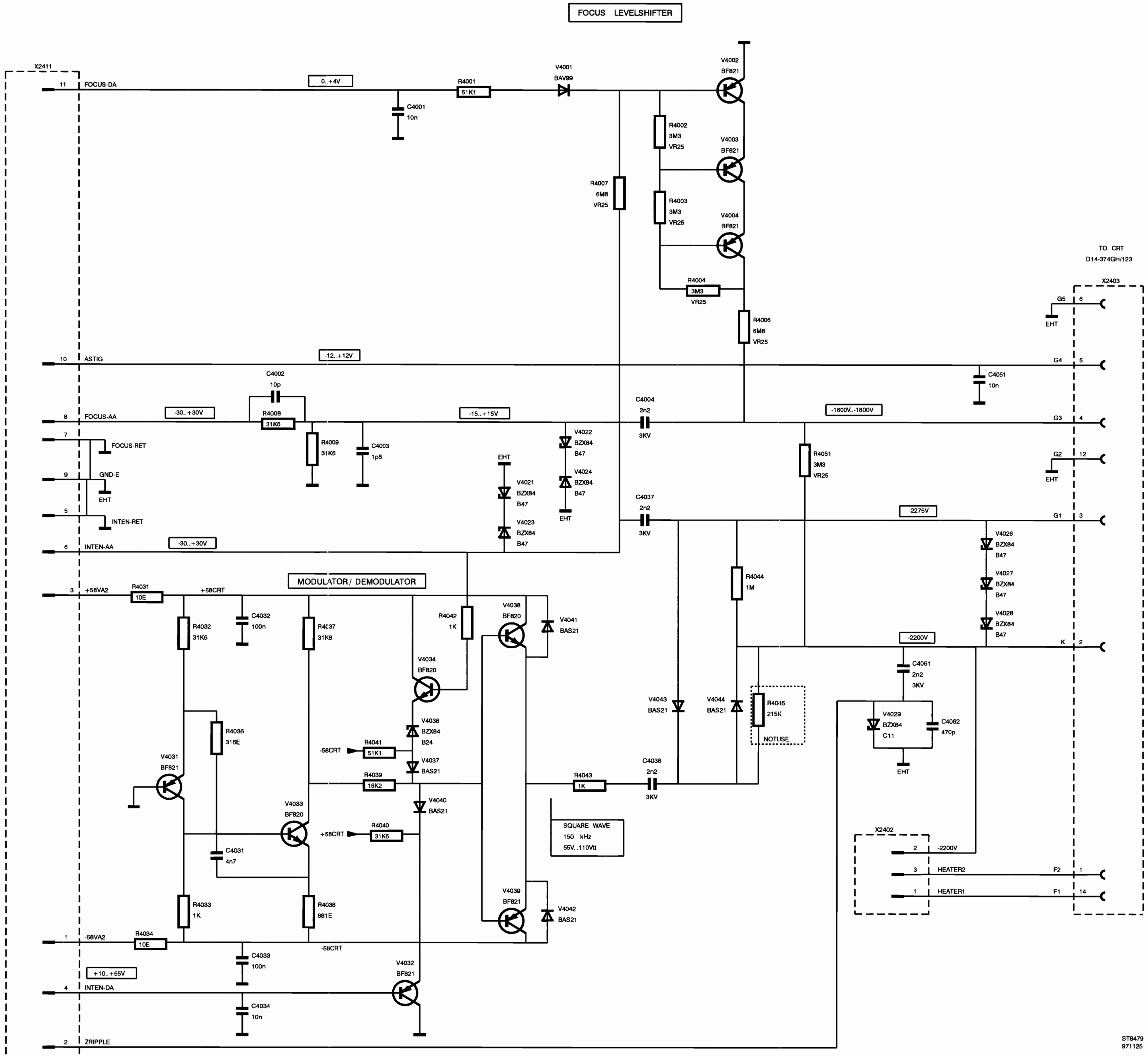
A2 (100 MHz) - Diagram 3a ; Final X amplifier and control

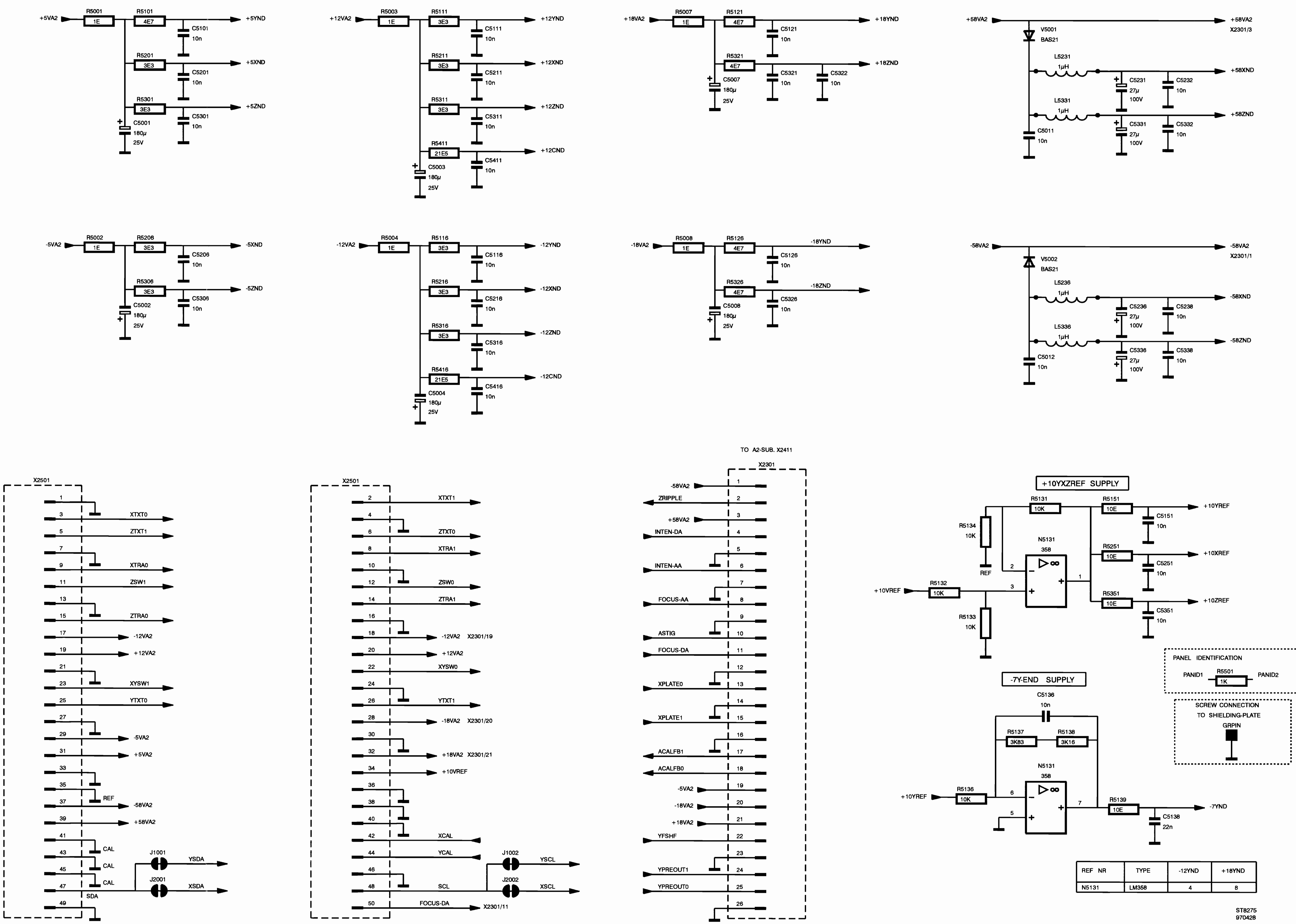



| REF NR | TYPE | +12ZND | GND |
|---|---|---|---|
| N3001 | OQ0229 | | |
| N3002 | TDA8444 | 1 | 10 |

A2 (100 MHz) - Diagram 4a ; Final Z amplifier




A2 (100 MHz) - Diagram 5a ; Modulator/demodulator and focus control



| REF NR | TYPE | -12YND | +18YND |
|---|---|---|---|
| N5131 | LM358 | 4 | 8 |

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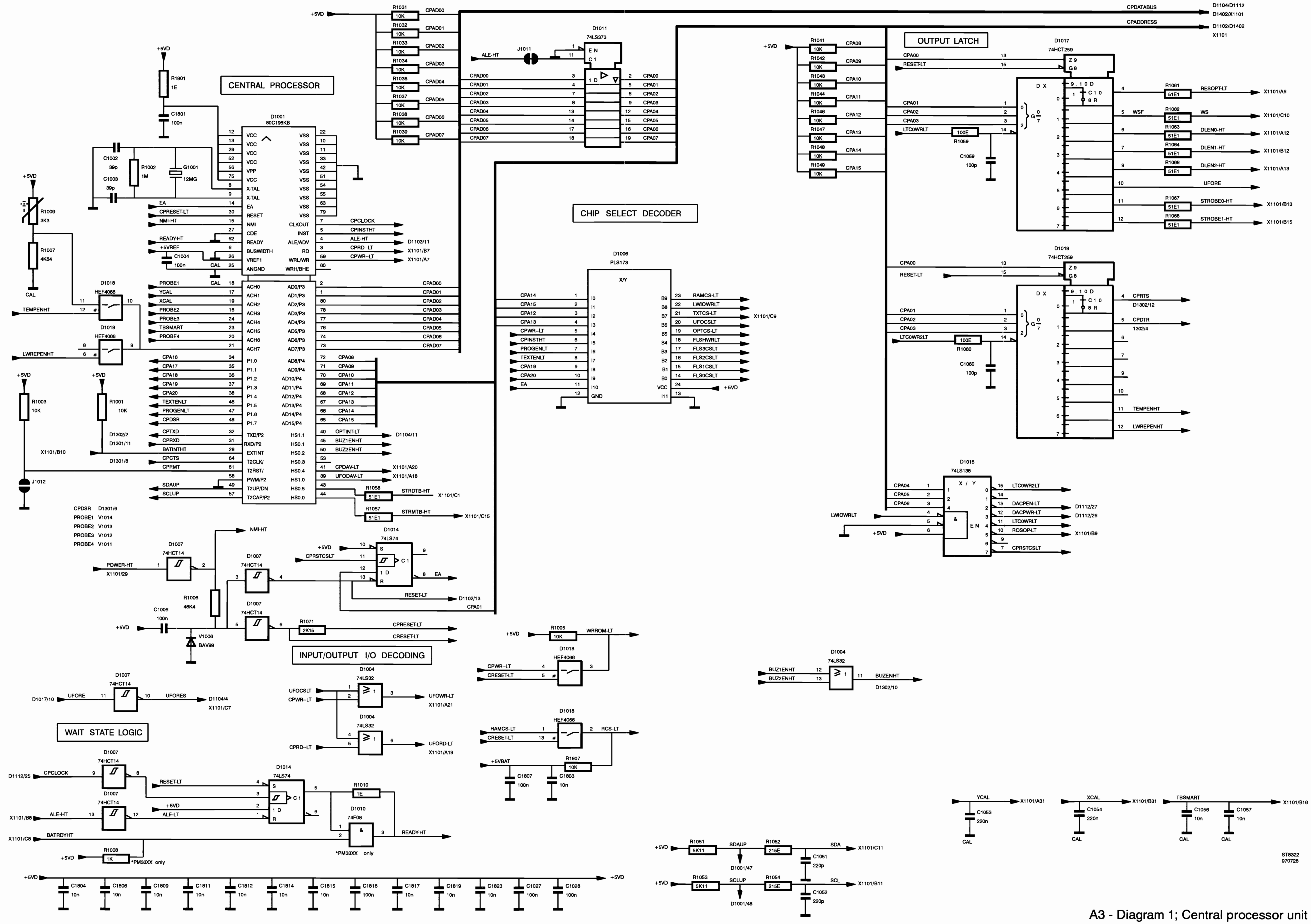
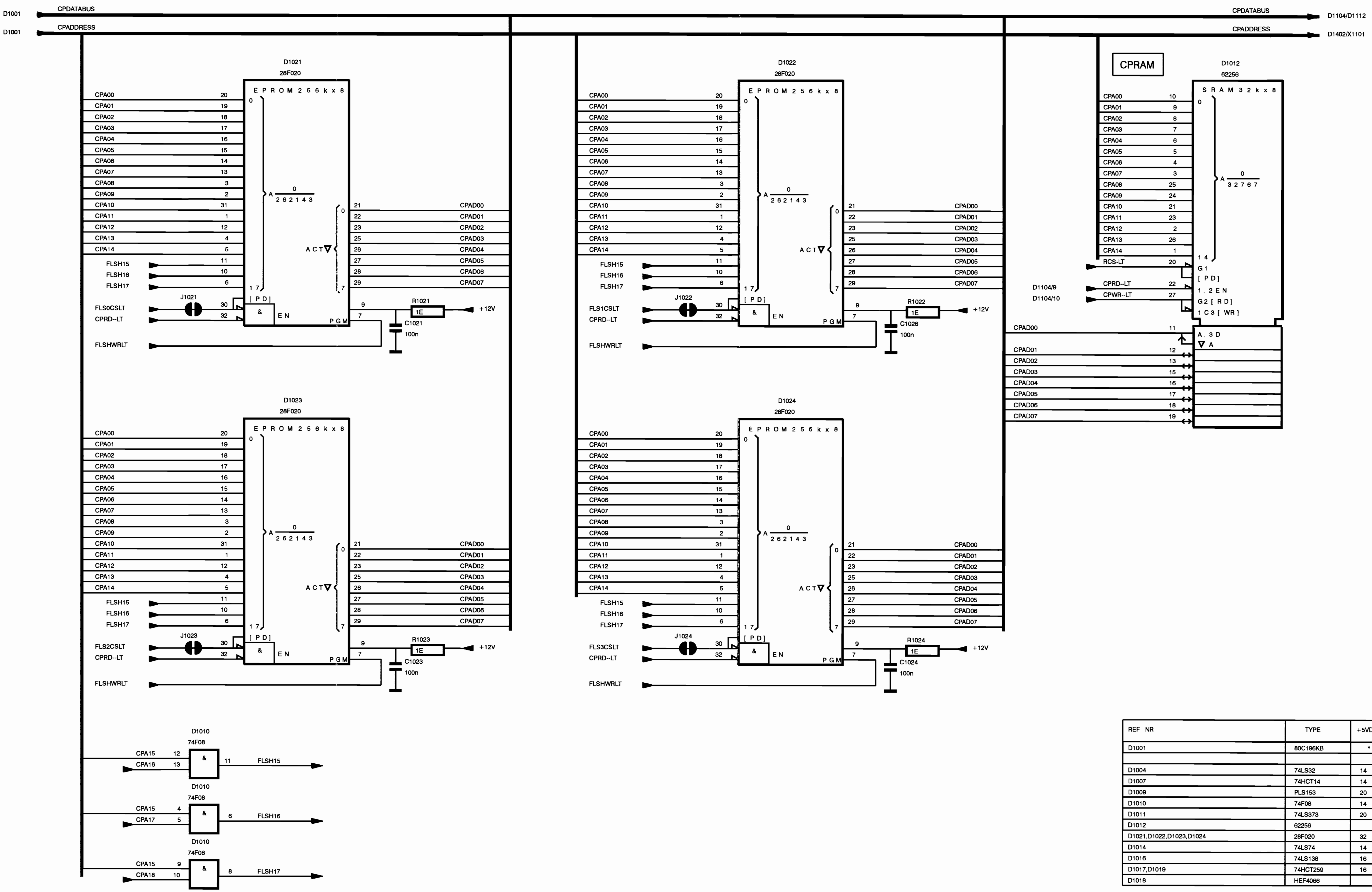
A2 (100 MHZ) - Diagram 6a ; Supply circuits




A3 - Diagram 1; Central processor unit




| REF NR | TYPE | +5VD | +5V BAT | ⊥ |
|---|---|---|---|---|
| D1001 | 80C196KB | * | | * |
| | | | | |
| D1004 | 74LS32 | 14 | | 7 |
| D1007 | 74HCT14 | 14 | | 7 |
| D1009 | PLS153 | 20 | | 10 |
| D1010 | 74F08 | 14 | | 7 |
| D1011 | 74LS373 | 20 | | 10 |
| D1012 | 62256 | | 28 | 14 |
| D1021,D1022,D1023,D1024 | 28F020 | 32 | | 16 |
| D1014 | 74LS74 | 14 | | 7 |
| D1016 | 74LS138 | 16 | | 8 |
| D1017,D1019 | 74HCT259 | 16 | | 8 |
| D1018 | HEF4066 | | 14 | 7 |

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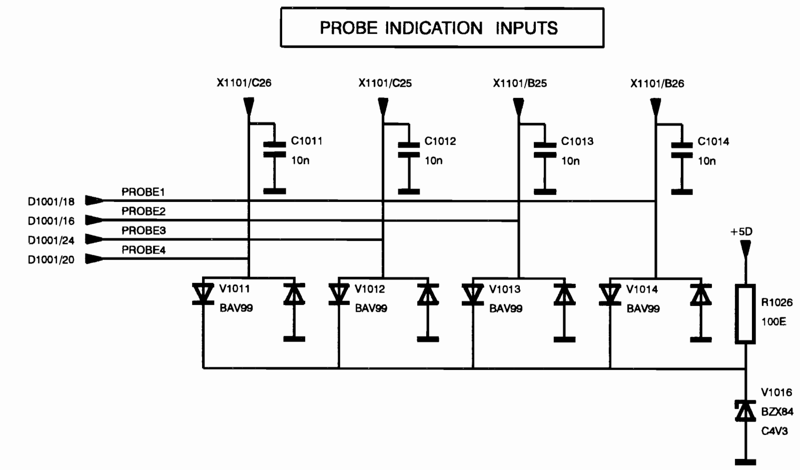
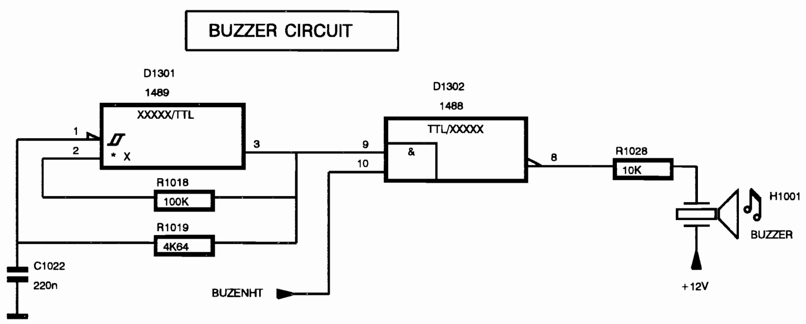
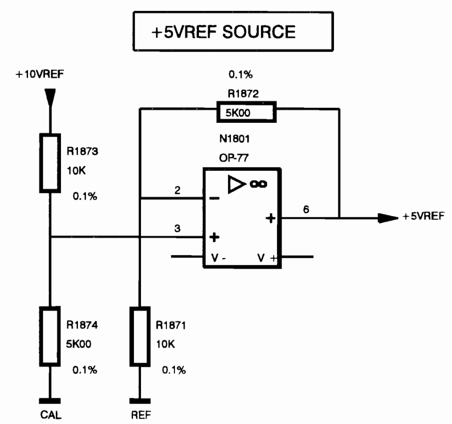
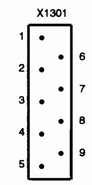
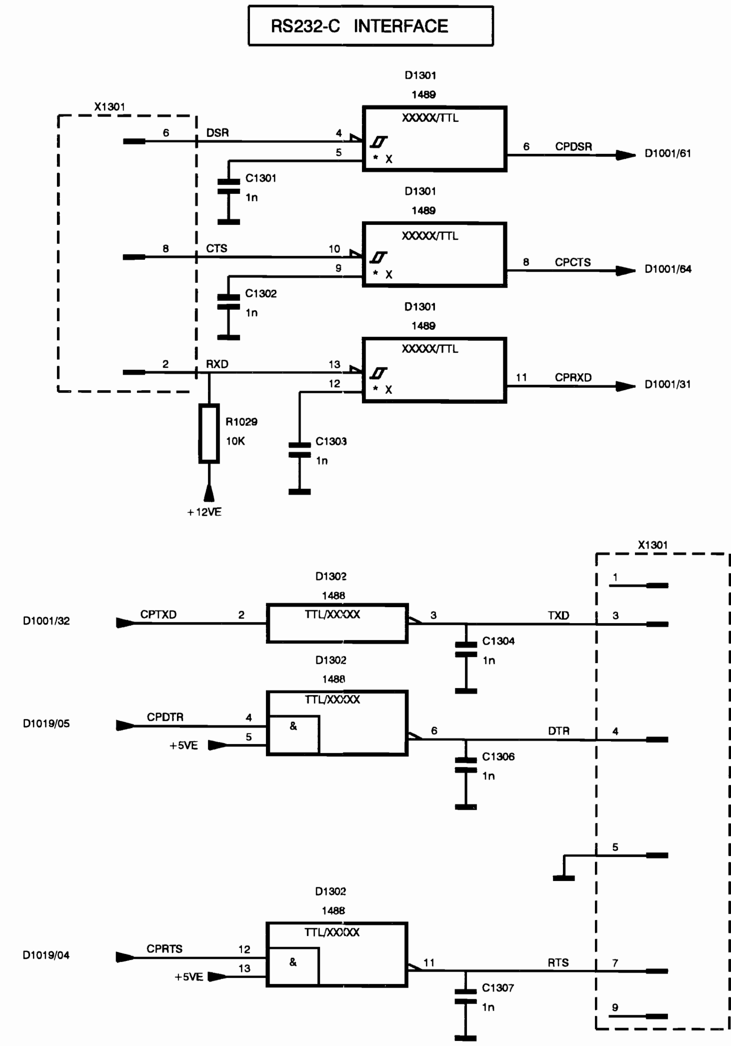
A3 - Diagram 2 ; Processor memory

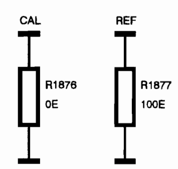


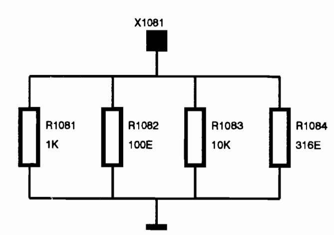



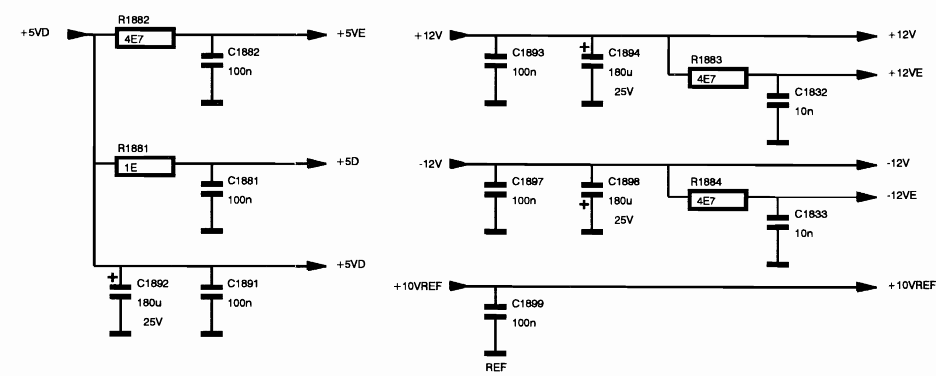







| IDENTIFICATION RESISTOR | | |
|---|---|---|
| REF.NR | VALUE | |
| R1081 | 1K | STANDARD PM33XX |
| R1082 | 100E | IEEE PM33XX |
| R1083 | 10K | STANDARD PM30XX |
| R1084 | 316E | IEEE PM30XX |



| REF NR | TYPE | +5D | +5VE | +12V | -12V | +12VE | -12VE | ⊥ | C |
|---|---|---|---|---|---|---|---|---|---|
| D1008 | HEF4051 | 16 | | | | | | 7,8 | |
| D1301 | 1489 | | 14 | | | | | 7 | C1831 |
| D1302 | 1488 | | | | | 14 | 1 | 7 | C1832, C1833 |
| N1801 | OP-77 | | | 7 | 4 | | | | |

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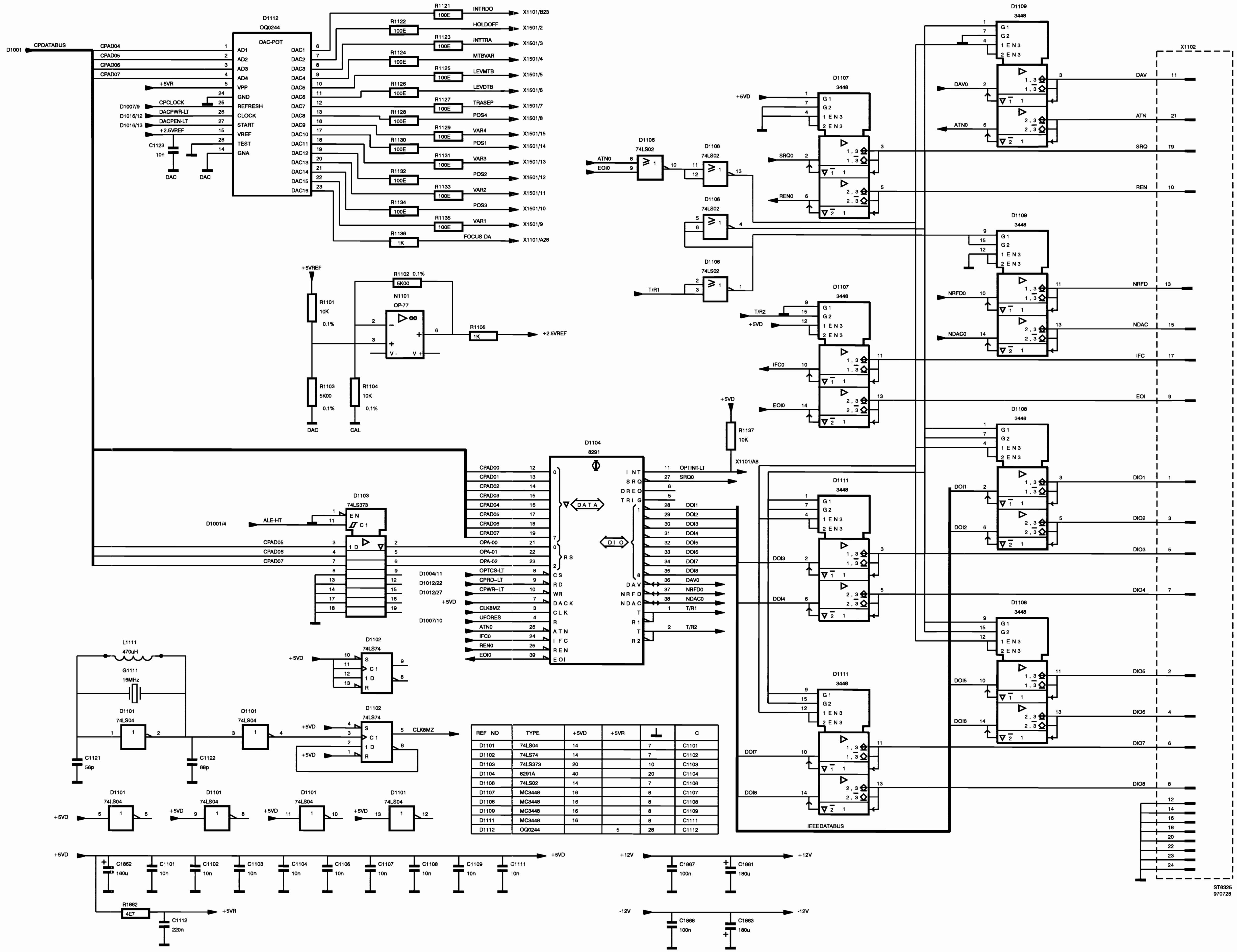


| REF NO | TYPE | +5VD | +5VR | ⊥ | C |
|---|---|---|---|---|---|
| D1101 | 74LS04 | 14 | | 7 | C1101 |
| D1102 | 74LS74 | 14 | | 7 | C1102 |
| D1103 | 74LS373 | 20 | | 10 | C1103 |
| D1104 | 8291A | 40 | | 20 | C1104 |
| D1106 | 74LS02 | 14 | | 7 | C1106 |
| D1107 | MC3448 | 16 | | 8 | C1107 |
| D1108 | MC3448 | 16 | | 8 | C1108 |
| D1109 | MC3448 | 16 | | 8 | C1109 |
| D1111 | MC3448 | 16 | | 8 | C1111 |
| D1112 | OQ0244 | | 5 | 28 | C1112 |

A3 - Diagram 4; Potentiometer DAC and IEEE-option

# 5.6 POWER SUPPLY A6

## 5.6.1 Description A6

### Diagram 1

Diagram 1 comprises the following circuit parts:
- input circuit
- converter circuit
- line trigger circuit

***Input circuit***

Input to the circuit is the mains voltage. The following voltages are allowed:
- AC voltage between 90 and 250 V
- Theoretically a DC voltage between 100 and 380 V can be applied.

The mains input is primarily protected by a slow acting 1.6 A fuse (1.6 AT), which is located on the rear of the instrument.
Inrush current limiting is provided by NTC resistor R1001.
By means of the capacitors C1002, C1003, C1004 and C1006, an input signal for the line trigger generator is made. The capacitors form a voltage divider. This functions only if the mains voltage is AC.

C1001, 1002, 1006, 1007 and L1001 are for interference suppression.
The mains voltage is rectified by V1001 through 1004 and smoothed by C1008 and C1009.
The output voltage from the rectifier at C1009 can between 100 and 380 V.

**WARNING: For measurements in the primary circuit, the use of an isolating transformer is strongly recommended. If no isolating transformer is used, all measurements in the primary circuit must be carried out with floating measuring instruments.**

***Converter circuit***

The power supply is a multiple output flyback converter of the SOPS (Self Oscillating Power Supply) principle. Basically, the converter consists of a switch with control circuitry (transistor V1019) and a transformer (T1001).
The first switching-on of V1019 is initiated by a small current via R1007/R1008. When V1019 is ON, the control voltage of T1001 pin 18 to C1011 is positive and this keeps V1016 and V1019 ON. During the ON or FORWARD cycle, the current through the primary winding of T1001 increases linearly, and energy (0.5 $LI^2$) is stored into this transformer. At about 2.5 A, this value is determined by the control circuit, thyristor V1014 is switched ON and due to this, V1019 is switched OFF. This is the beginning of the OFF or FLYBACK cycle. Now, the transformer voltages are reversed and the stored energy is transformed to the secondary windings. As long as the transformer is not fully demagnetized, the voltage from pin 18 to C1011 is negative and this will keep V1007, V1016 and V1019 switched OFF. As soon as the transformer demagnetizing has ended, this voltage becomes zero and so, a positive going voltage appears at C1011. Due to this, V1007, V1016 and V1019 are switched ON and the FORWARD cycle starts again.

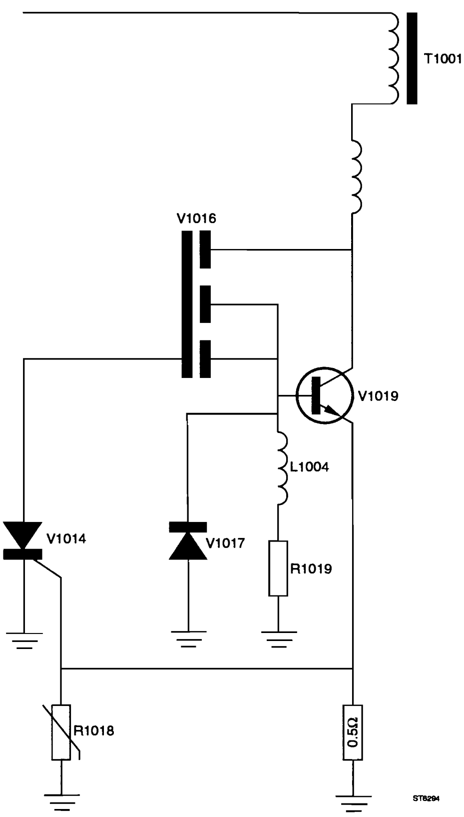



*Figure 5.5 Converter circuit*

To reduce the switching losses in V1019, a dV/dt limiter, often called "snubber", is used. C1021 decreases the dV/dt of the collector voltage of V1019 during switching off, as the current to the transistor can pass during a certain time through C1021. This slowing down of the collector voltage will reduce the switching losses during switching off. During the ON cycle, the energy in C1021 is transferred to L1006 and the capacitor is discharged. During the OFF cycle, the energy in L1006 is transferred to C1018 and during the next ON cycle, the energy in C1018 is delivered to the transformer. In that way, no energy is wasted. As a consequence of this system, the voltage at the transformer is slightly increased during the first part of the ON cycle, but this has no disadvantages.

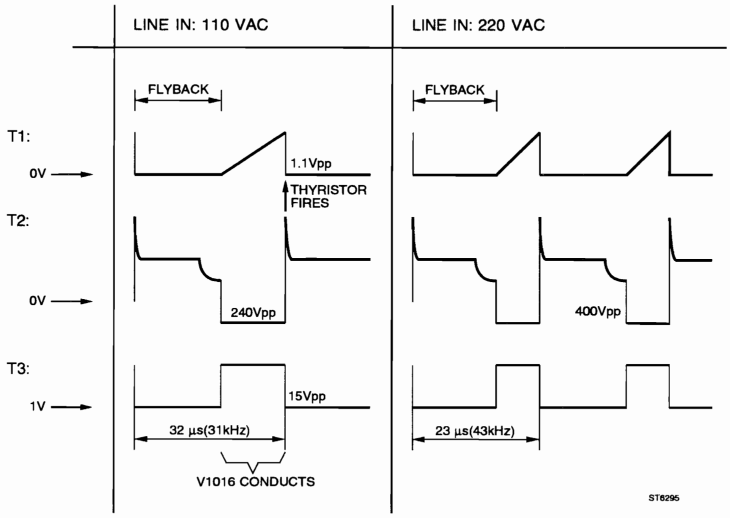



*Figure 5.6 Timing diagram converter circuit*

Voltage regulation takes place by varying the control voltage from R1046 to the gate of V1014. A more positive voltage will cause a smaller peak current through the transformer and this results in smaller output voltages. The converter frequency can be 20 to 50 kHz. This depends on the mains voltage and the load of the power supply. The lower the mains voltage, the lower the frequency. A lower load means a higher frequency. R1018 compensates for gate-cathode voltage variations of V1014 due to the temperature.

***Line trigger circuit***

For triggering purposes, a sinusoidal signal at the mains frequency is available. Of course there will be no LINE signal if the mains voltage is DC.
A small signal is picked up with capacitors C1002, C1003, C1004 and C1006 and amplified in N1046. This results in output signal at pin 1. This circuit provides a sine-wave with low distortion and with an amplitude of 3 to 8 V, depending on the mains voltage.

## Diagram 2

Diagram 2 comprises the following circuit parts:
- trace rotation control
- fan control
- illumination control
- EHT converter

***Trace rotation control***

To supply the trace rotation coil, of which the resistance is about 200 Ω, a voltage of -10 V to +10 V is created in amplifier V1146-1147. Control takes place via a part of N1101 by means of the signal DAC3 which can be 1 to 10 V, together with the signal DAC0 with a level between 1 and 3V. The signals DAC3 and DAC0 originate from the microprocessor unit A3.

***Fan control***

The speed the cooling fan depends on the temperature in the oscilloscope. This temperature is measured at the microprocessor unit A3 by a NTC resistor. The microprocessor generates the signal DAC1 with a level of about 1.7 to 4 V. The fan is supplied by amplifier V1148 which is controlled by this signal. The output from the amplifier is a DC voltage of -10 to +10 V.

***Illumination control***
The illumination of the graticule must be variable. For this reason the illumination voltage can be varied between about 2 and 28 V. Control of the illumination amplifier V1148 takes place by means of the signal DAC2, level about 1.7 to 4 V. The output voltage from the amplifier is -16 to +10 V.

***EHT converter***
The EHT converter supplies three voltages.
- An AC voltage of 6,3 V (F1, F2), to supply the filament of the CRT.
- The cathode voltage to the CRT, a DC voltage of -2200 V.
- The post acceleration voltage to the CRT, a DC voltage of +14 kV.

These voltages are made in a separate converter, equipped with a separate transformer. The EHT converter is a resonant flyback converter, the output voltages of the transformer are sinusoidal.

Basically, the converter consists of a resonant LC circuit formed by the transformer with its parasitic capacitances. This resonance circuit defines the converter frequency which is about 80 kHz. Energy is supplied to this LC circuit by injecting current to it from the supply voltage, the +58 V, by switching ON V1109. Most of the time, V1109 is OFF. The primary peak to peak amplitude is about 200 V, the negative peak about -40 V. During the positive half of the sine-wave, capacitor C1111 is discharged very little via R1114.

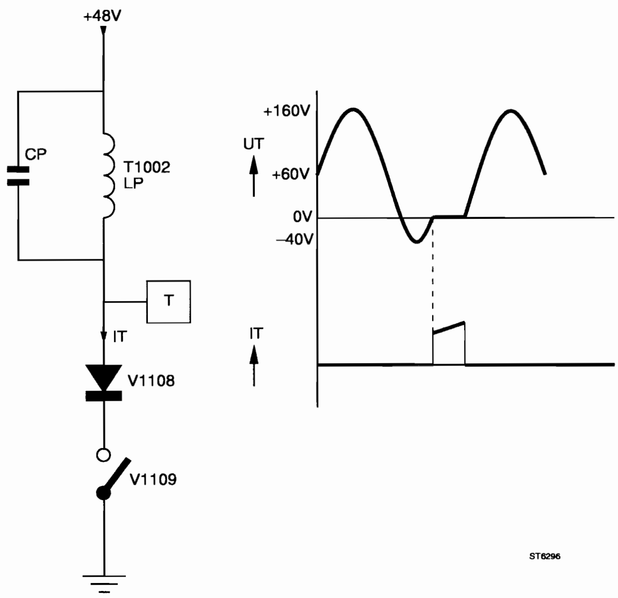



*Figure 5.7 High tension generator*

When the sine-wave reaches its most negative value, a small current will pass through C1111 and V1106 and this acts as base current for V1102. Due to this, the thyristor configuration V1102-1109 will be switched ON and energy is supplied to the resonant circuit. The ON time of V1109 can be controlled by the operational amplifier N1101 pin 7.

To protect against too high voltages, e.g. caused by a defective N1101, the circuit is provided with an over-voltage protection. This circuit consists of V1103 and V1104. The maximum output voltage is defined by this circuit as it will overrule the control circuit at too high voltage.

The AC voltage at T1002 pins 4 and 5 is used to supply the CRT filament voltage of 6.3 V.
The voltage at pins 11 and 3 is rectified and this -2200 V is used as CRT cathode voltage. The voltage at pins 11 and 2 is rectified and multiplied in a cascade circuit. The output, +14 kV, is used as post acceleration voltage to the CRT.

## Diagram 3

Diagram 3 comprises the following circuit parts:
- secondary output circuitry
- over- and under-voltage protection
- power fail circuit
- temperature protection
- 10 V reference circuit
- +5V postregulator circuit

***Secondary output circuitry***
The secondary output circuits consist of rectifier diodes and buffer capacitors, followed by chokes and capacitors for ripple suppression. The output circuits are protected against overload by the under voltage protection.

***Over and under-voltage protection***
To protect the oscilloscope circuitry against over-voltage and the supply circuits against overload, the power supply is provided with a protection circuit. As, due to the multiple output principle, the output voltages are interdependent, it is sufficient to check only one voltage. In case of overload, the output voltages will decrease and this will be detected by the under-voltage detection, V1241, which monitors the -12 V. This will cause the collector of V1241 to be LOW. In case of over-voltage, the over-voltage detection detects a too high +12 V or +5 V and this will cause pin 13 of N1236 to be LOW. Due to this LOW signal, the intervention circuit V1241-1242-1243 will cause a current, the TPDOWN signal, to V1213. This will switch ON this thyristor and this causes switching off the converter by decreasing all output voltages to a very low, safe value.

***Powerfail circuit***
In normal cases, about 250 ms after switching on, the signal POWER HT will become HIGH and stay HIGH. In case of an over- or under-voltage failure, the signal will become LOW due to V1242. In case of a too low mains voltage, i.e. less than 80 V (AC) or 100 V (DC), the signal will become LOW due to N1236 pin 2. The signal POWER HT is a logic signal, it will not switch off the main convertor circuit, but it will shut down the EHT-convertor. POWER HT signals to the microprocessor unit A3 that power is going down. This gives the processor the opportunity to save important data.

***Temperature protection.***
To protect the circuits against too high temperatures, the oscilloscope is provided with an overheat shutdown circuit. The temperature of the power supply printed circuit board is monitored by NTC resistor R1231, which is located on the PCB. At temperatures higher than about +80 °C, pin 8 of N1236 will become HIGH and this will cause pin 14 to be LOW. Due to this, the TPDOWN signal becomes active and the converter is switched off by triggering V1213. This temperature protection is only meant for the power supply.

***+10 V reference circuit***
For application in the power supply and at other places in the oscilloscope, a stable +10 V reference voltage is needed. This voltage is made by N1226/V1226 in the power supply. The voltage is not adjustable. The accuracy is ±5 mV. Temperature coefficient is ±0,001°K. The load of the +10 V is about 10 mA.

***+5 V postregulator circuit***
The +5 V supply voltage originates from the T1001/16,15 transformer winding that supplies current during the forward stroke of the power supply: thus during the time that V1019 conducts. The current runs via transductor coil L1271, diode V1271 and the coils L1272/L1273. During the flyback stroke (power transistor V1019 off) the current runs via diode V1271 (anode connected to earth) and L1272/L1273.

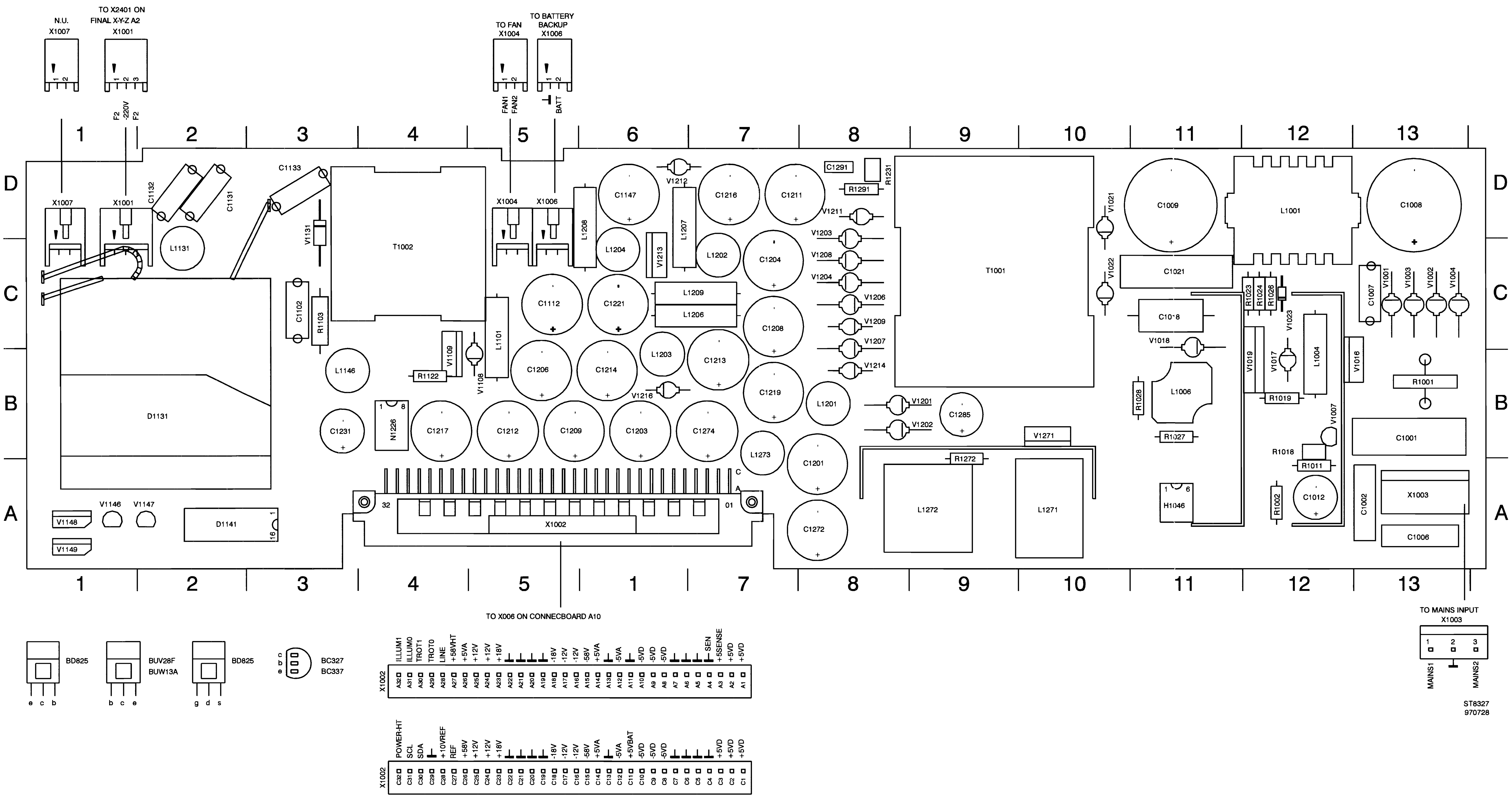
Output voltage regulation occurs via the operational amplifier N1251/1,2,2 and the paralelled transistors V1251/V1252. N1252 compares the actual +5 V output voltage with the +10 VREF reference voltage. Output N1251/1 becomes lower in case that the +5 V output voltage tends to become too high. The result is an increase of the collector current of V1252/V1252. This gives a current in L1271 opposite to the +5 V supply current. This delays the moment that L1271 comes into saturation. Thus L1271 behaves like a coil during a longer period of time with the result that a certain loss of voltage across it stays. As a result the output voltage becomes lower. If saturated the voltage loss across L1271 is 0 volt.

## 5.6.2 Signal name list A6

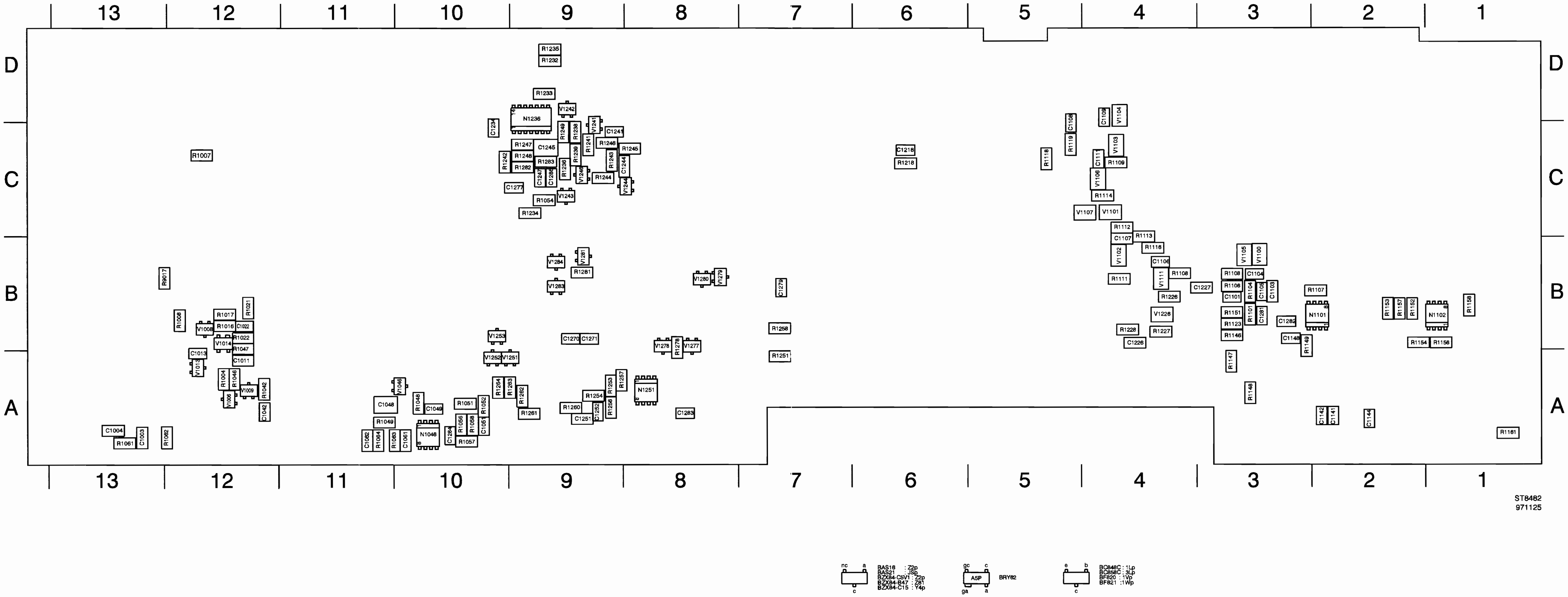
*Note: In the signal name list you find the itemnumber of the component that is source or destination. Behind this itemnumber (separated by ":") you find the number of the diagram where the source/destination can be found.*

| NAME | MEANING | SOURCE | DESTINATION |
|---|---|---|---|
| +5 SENS | +5 V OUTPUT SENSE SIGNAL | X1002:02 | R1253:03 |
| FAN0 | FAN SUPPLY 0 | S-12V:02 | X1004:02 |
| FAN1 | FAN SUPPLY 1 | L1146:02 | X1004:02 |
| GNSENS | GROUND FOR +5 V SENSE SIGNAL | X1002:02 | R1257:03 |
| ILLUM0 | GRATICULE ILLUMINATION 0 | S-18V:02 | X1002:02 |
| ILLUM1 | GRATICULE ILLUMINATION 1 | V1149:02 | X1002:02 |
| LINE | LINE/MAINS TRIGGER SIGNAL | N1046:01 | X1002:01 |
| POWER-HT | POWER UP INDICATION SIGNAL | N1236:03 | X1002:03 |
| | | | V1111:02 |
| SCL | SERIAL CLOCK | X1002:02 | N1141:02 |
| SDA | SERIAL DATA | X1002:02 | N1141:02 |
| TROT0 | TRACE ROTATION 0 | EARTH:02 | X1002:02 |
| TROT1 | TRACE ROTATION 1 | V1146:02 | X1002:02 |

### 5.6.3 Unit lay-outs

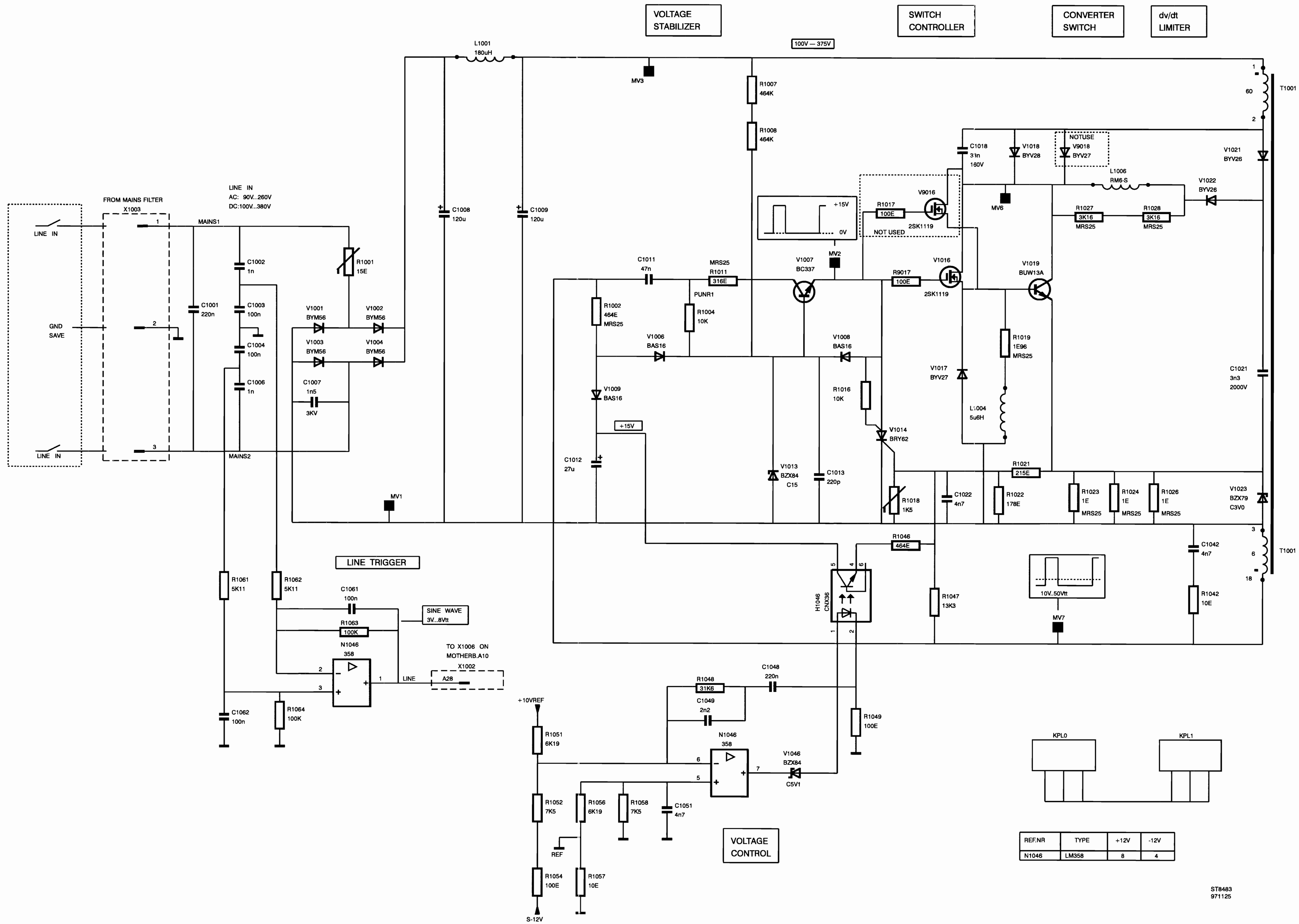


Lay-out 1 - Large component side of Power Supply unit A6

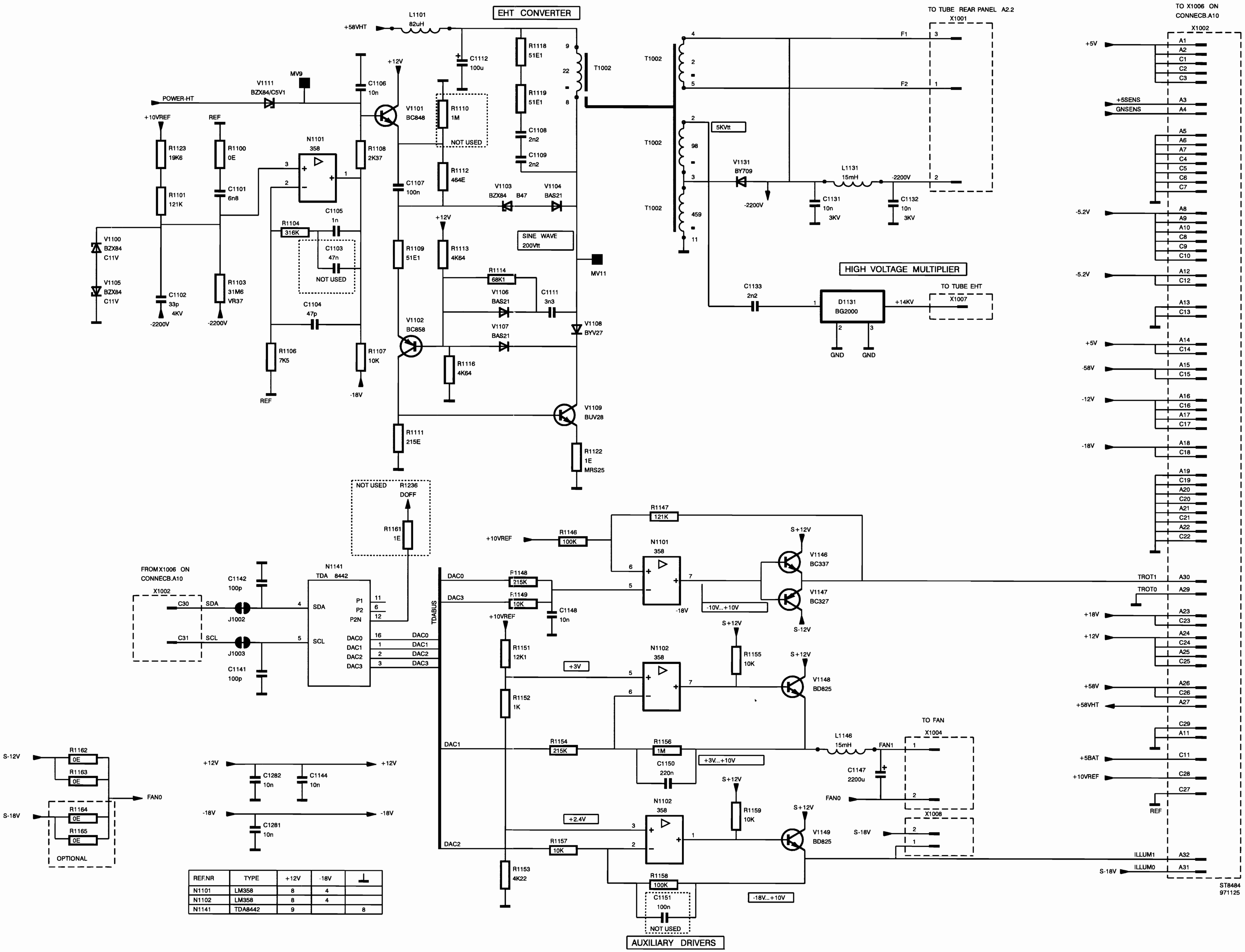



Lay-out 2 - Small component side of Power Supply unit A6

## 5.6.4 Circuit diagram

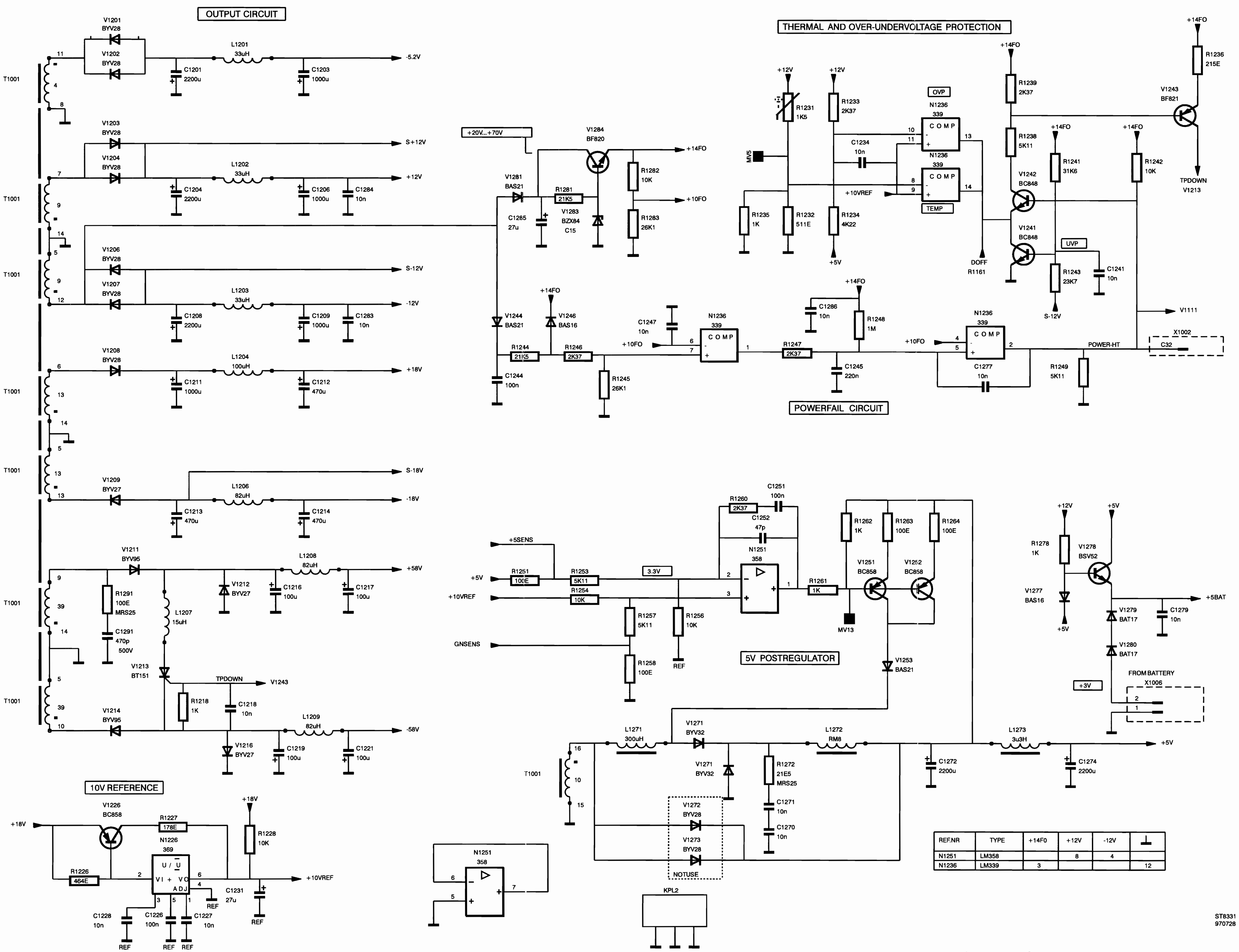



A6 - Diagram 1; Converter circuit




| REF.NR | TYPE | +12V | -18V | ⊥ |
| --- | --- | --- | --- | --- |
| N1101 | LM358 | 8 | 4 | |
| N1102 | LM358 | 8 | 4 | |
| N1141 | TDA8442 | 9 | | 8 |

A6 - Diagram 2; EHT converter and auxiliary circuits




| REF.NR | TYPE | +14F0 | +12V | -12V | ⊥ |
|---|---|---|---|---|---|
| N1251 | LM358 | | 8 | 4 | |
| N1236 | LM339 | 3 | | | 12 |

A6 - Diagram 3; Output circuit and protection circuits

# 7 CALIBRATION ADJUSTMENT PROCEDURE

## 7.1 INTRODUCTION

The calibration adjustment procedure can be split up in two:
- Manual adjustment
- Automatic calibration (AUTOCAL).

All calibration is done with the oscilloscope's cabinet closed. This eliminates calibration inaccuracies due to temperature changes.

Manual calibration data are protected by a keyword and a seal and must be changed by qualified personnel only. Some of the adjustments require external calibration equipment. A list of necessary equipment is given in chapter 6 (performance test). Manual calibration should be done after 2000 service hours or once a year.

Operation of the front panel CAL key activates the automatic calibration. AUTOCAL can only function usefully if the manual adjustments (especially the 'screen calibrations') are correct. The AUTOCAL function should in general be activated once a week. AUTOCAL should be used always after warming-up if the oscilloscope is used in extreme environmental conditions such as very high or low temperatures while maximum accuracy is needed. AUTOCAL requires no external calibration equipment.

The calibration adjustment should be started after a warming-up time of 30 minutes.

The most accurate adjustments are done with a well-focused low intensity display.

The calibration parameters are saved after power-down if the memory back-up batteries are installed. Additionally these parameters can be saved into the instrument's non-volatile memory. This is done by pressing softkey 'save calibr data' and then activation of the pin hole key. The number of times that this save action can be done is limited. The memory is full after a number (10x) of actions and needs to be cleared. Refer to chapter 8 (corrective maintenance) for how to proceed then.

## 7.2 DARK LEVEL OF CRT.

- Press the STATUS and TEXT OFF keys simultaneously: this gives a defined position of the instrument settings.
- Adjust MTB/VAR to 1.00 ms/div.
- Select the key sequence 'UTILITY > MAINTENANCE > ENTER KEYWORD'.
- Enter the five digit keyword '3 2 4 1 5'. If correct, an automatic return to the UTIL MAINTENANCE menu is done.
- Press softkey MANUAL CALIBR.
- Select 'dark' with the TRACK rotary.
- Press softkey 'analog': the Δ sign is displayed behind 'analog'.
- Put the TRACE INTENSITY rotary in minimal intensity position.
- Adjust the Δ rotary so that the dot at the beginning of the CH1 trace is just invisible. Use X POS to move the start of the trace away from the ground level indicator.
- Press softkey 'digital': the Δ sign is displayed behind 'digital'.
- Press the front panel key 'ANALOG' (message DIGITAL MODE appears briefly) and the oscilloscope switches to digital mode.
- Put the TRACE INTENSITY rotary in minimal intensity position.
- Adjust the Δ rotary so that the CH1 trace is just invisible.
- Put TRACE INTENSITY rotary in normal intensity position again.
- Press softkey RETURN to go to the UTIL MAINTENANCE MENU.

## 7.3 TRACE ROTATION.

* Press the ANALOG key (message ANALOG MODE appears briefly) and the oscilloscope switches to analog mode.
- Adjust the INTENS TRACE rotary for a well-visible horizontal on the screen.
- Align the CH1 trace exactly in parallel with the horizontal graticule lines using screw-driver operated TRACE ROT rotary.

## 7.4 HORIZONTAL (X) GAIN AND OFFSET (CRT).

- Press softkey SCREEN CALIBR. This activates the UTIL SCREEN CALIBR CRT menu.
- Select 'x-gain' with the softkeys.
- Adjust the TRACK (gain) and Δ (offset) rotary so that the two vertical lines coincide exactly with the 3rd and 9th graticule line.

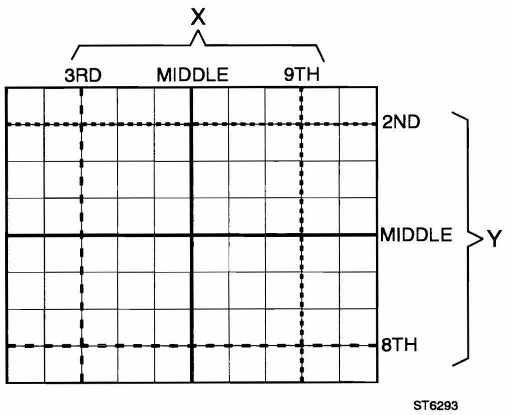



*Figure 7.1 Position of lines for horizontal (X) and vertical (Y) gain and offset calibration.*

## 7.5 TEXT STABILITY AND X-OFFSET (CRT).

- Select 'x-text' with the softkeys (menu header is UTIL SCREEN CALIBR CRT).
- Adjust the TRACK rotary to maximal stability of the text
- Adjust the Δ rotary so that the vertical line is exactly in the middle of the graticule.

## 7.6 VERTICAL (Y) GAIN AND OFFSET (CRT).

- Select 'y-gain' with the softkeys (menu header is UTIL SCREEN CALIBR CRT).
- Adjust the TRACK (gain) and Δ (offset) rotary so that the two horizontal lines coincide exactly with the 2nd and 8th graticule line.
- Select 'y-offs' with the softkeys.
- Adjust the TRACK rotary so that the horizontal line is exactly in the middle of the graticule.

## 7.7 HORIZONTAL GAIN AND OFFSET (VECTOR).

- Push the second softkey again to obtain 'x-gain' (menu header is changed into UTIL SCREEN CALIBR VECTOR).
- Adjust the TRACK rotary to minimal over- or undershoot in horizontal direction.
- Select 'x-offs' with the softkeys.
- Adjust the TRACK rotary so that the lines of the test pattern coincide exactly with the graticule in horizontal direction.

## 7.8 VERTICAL GAIN AND OFFSET (VECTOR)

- Select 'y-gain' with the softkeys (menu header is UTIL SCREEN CALIBR VECTOR).
- Adjust the TRACK rotary to minimal over- or undershoot in vertical direction.
- Select 'y-offs' with the softkeys.
- Adjust the TRACK rotary so that the lines of the test pattern coincide exactly with the graticule in vertical direction.
- Press softkey 'accept' if the screen calibrations are correct.
- Press softkey RETURN to go to the UTIL MAINTENANCE MENU.

## 7.9 ASTIGMATISM.

- Press softkey MANUAL CALIBR.
- Select 'astig' with the TRACK rotary.
- Position the CH1 trace in the centre of the graticule.
- Adjust the Δ rotary for the best possible sharpness of text across the screen: the small dots from which the text is composed must be well visible. Adjustment of the FOCUS rotary is necessary during the adjustment.

## 7.10 AUTOCAL PROCEDURE.

- Press the CAL key during 2 seconds.
- Within 4 minutes the instrument automatically does its main calibrations.
- Watch the CRT and check that no errors are reported. If errors are mentioned, the oscilloscope will need corrective maintenance. The error number indicates in what part of the oscilloscope the fault may be expected.

## 7.11 LF SQUARE-WAVE RESPONSE CH1.

- Press the STATUS and TEXT OFF keys simultaneously: this gives a defined position of the instrument settings.
- Select the key sequence UTILITY > MAINTENANCE > MANUAL CALIBR.
- Select 'lf ch1' with the TRACK rotary.
- Select 'lfx100' with the softkeys: the Δ sign is displayed behind 'lfx100'.
- Put CH1 in 1 V/div with DC coupled input.
- Apply a 100 kHz square-wave signal of 2.75V (pp into 50Ω) from a calibrator (mode 'edge') to CH1. As an alternative you may use a 100 kHz / 5 Vpp square-wave from a function generator.
- Select 50Ω input impedance; if not available use a 50Ω termination resistor between cable and oscilloscope input.
- Adjust MTB/VAR to 2.00 µs/div.
- Adjust the Δ rotary for a flat pulse top (the initial overshoot should not be adjusted).

- Select 'lfx10' with the softkeys: the Δ sign is displayed behind 'lfx10'.
- Put CH1 in 0.1 V/div.
- Change the square-wave signal into 10 kHz/500 mV peak-peak.
- Adjust MTB/VAR to 20.0 µs/div.
- Adjust the Δ rotary for a flat pulse top (the initial overshoot should not be adjusted).
- Remove the input signal.

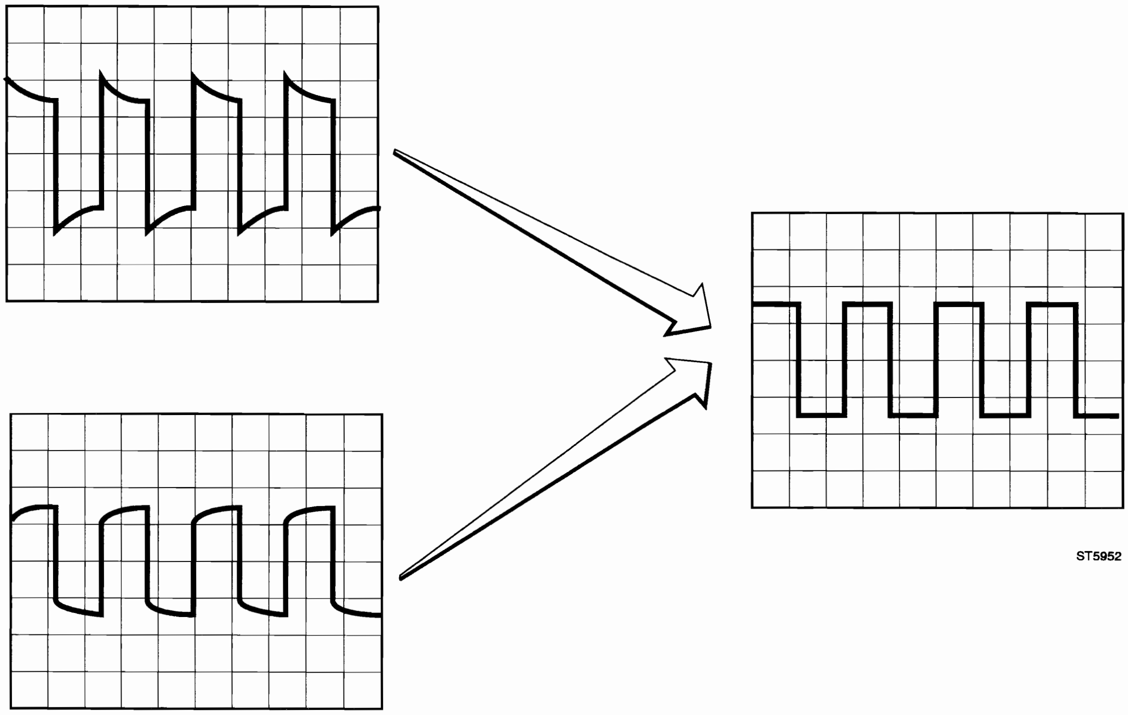



*Figure 7.2 Adjustment of LF square wave response CH1, CH2, CH3 and CH4.*

## 7.12 LF SQUARE-WAVE RESPONSE CH2

- Select 'lf ch2' with the TRACK rotary.
- Select 'lfx100' with the softkeys: the Δ sign is displayed behind 'lfx100'.
- Switch CH2 to ON and CH1 off.
- Press the TRIG 2 key.
- Put CH2 in 1 V/div with DC coupled input.
- Apply a square-wave signal of 100 kHz and 2.75V (pp into 50Ω) from a calibrator (mode 'edge') to CH2. As an alternative you may use a 100 kHz / 5 Vpp square-wave from a function generator.
- Select 50Ω input impedance; if not available use a 50Ω termination resistor between cable and oscilloscope input.
- Adjust MTB/VAR to 2.00 µs/div.
- Adjust the Δ rotary for a flat pulse top (the initial overshoot should not be adjusted).

- Select 'lfx10' with the softkeys: the Δ sign is displayed behind 'lfx10'.
- Put CH2 in 0.1 V/div.
- Change the square-wave signal into 10 kHz/500 mV peak-peak.
- Adjust MTB/VAR to 20.0 µs/div.
- Adjust the Δ rotary for a flat pulse top (the initial overshoot should not be adjusted).
- Remove the input signal.

## 7.13 LF SQUARE-WAVE RESPONSE CH3

This section can be skipped for PM3370A, PM3380A and PM3390A.
For PM3382A and PM3392A only the step 'lfx10' has to be adjusted.

- Select 'lf ch3' with the TRACK rotary.
- Select 'lfx100' with the softkeys: the Δsign is displayed behind 'lfx100'.
- Switch CH3 to ON and CH2 off.
- Press the TRIG 3 key.
- Put CH3 in 1 V/div with DC coupled input.
- Apply a square-wave signal of 100 kHz and 2.75V (pp into 50Ω) from a calibrator (mode 'edge') to CH2. As an alternative you may use a 100 kHz / 5 Vpp square-wave from a function generator.
- Select 50Ω input impedance; if not available use a 50Ω termination resistor between cable and oscilloscope input.
- Adjust MTB/VAR to 2.00 µs/div.
- Adjust the Δ rotary for a flat pulse top (the initial overshoot should not be adjusted).

- Select 'lfx10' with the softkeys: the Δ sign is displayed behind 'lfx10'.
- Put CH3 in 0.1 V/div.
- Change the square-wave signal into 10kHz/500 mV peak-peak.
- Adjust MTB/VAR to 20.0 µs/div.
- Adjust the Δ rotary for a flat pulse top (the initial overshoot should not be adjusted).
- Remove the input signal.

## 7.14 LF SQUARE-WAVE RESPONSE CH4 and EXT TRIG

For PM3370A, PM3380A, PM3382A, PM3390A and PM3392A only the step 'lfx10' has to be adjusted.

- Select 'lf ch4' with the TRACK rotary.
- Select 'lfx100' with the softkeys: the Δ sign is displayed behind 'lfx100'.
- Switch CH4 to ON and CH3 off.
- Press the TRIG 4 key.
- Put CH4 in 1 V/div with DC coupled input.
- Apply a square-wave signal of 100 kHz and 2.75V (pp into 50Ω) from a calibrator (mode 'edge') to CH2. As an alternative you may use a 100 kHz / 5 Vpp square-wave from a function generator.
- Select 50Ω input impedance; if not available use a 50Ω termination resistor between cable and oscilloscope input.
- Adjust MTB/VAR to 2.00 µs/div.
- Adjust the Δ rotary for a flat pulse top (the initial overshoot should not be adjusted).
- Select 'lfx10' with the softkeys: the Δ sign is displayed behind 'lfx10'.
- Put CH4 in 0.1 V/div.
- Change the square-wave signal into 10 kHz/500 mV peak-peak.
- Adjust MTB/VAR to 20.0 µs/div.
- Adjust the Δ rotary for a flat pulse top (the initial overshoot should not be adjusted).
- Remove the input signal.

## 7.15 HF SQUARE-WAVE RESPONSE FINAL Y AMPLIFIER.

- Apply a 1V/1 MHz square-wave signal with a rise-time faster than 1 nsec to CH1. This signal is delivered in the 'edge' mode of the calibrator. As an alternative you may use the fast-rise output of the square-wave calibration generator. Use a 10x attenuator at the end of the cable from the generator. For reduced channels (0.1 and 0.5 V/div) and EXT TRIG (0.1 and 1 V/div) use a 2:1 (6dB) attenuator.
- Press AUTOSET.
- Put CH1 in 20 mV/div with DC coupled input.
- Select 50Ω input impedance; if not available use a 50Ω termination resistor directly at the oscilloscope input.
- Adjust MTB/VAR to its fastest position (20.0 or 50.0 ns/div). Small adjustments of MTB/VAR may be necessary to have a good view of signal details of interest.
- Select the key sequence 'UTILITY > MAINTENANCE > MANUAL CALIBR' and then select 'hf y' with the TRACK rotary .
- Select in succession 'pulse t4', 'pulse t3', 'pulse t2', 'pulse t1' and 'pulse t0' with the softkeys. Adjust the pulse top to maximum flatness and the risetime to the required value with the Δ rotary. The adjustments are a compromise between fast risetime and minimal pulse distortion (aberrations). The influence of these adjustments ranges from mid-frequency (pulse t4) to high-frequency (pulse t0). The requirement is a rise-time of ≤ 6ns for 60 MHz, ≤ 3,6 ns for 100 MHz and ≤ 2 ns for 200 MHz instruments. This value includes the generator rise-time. The pulse aberrations must not exceed + or - 10%.

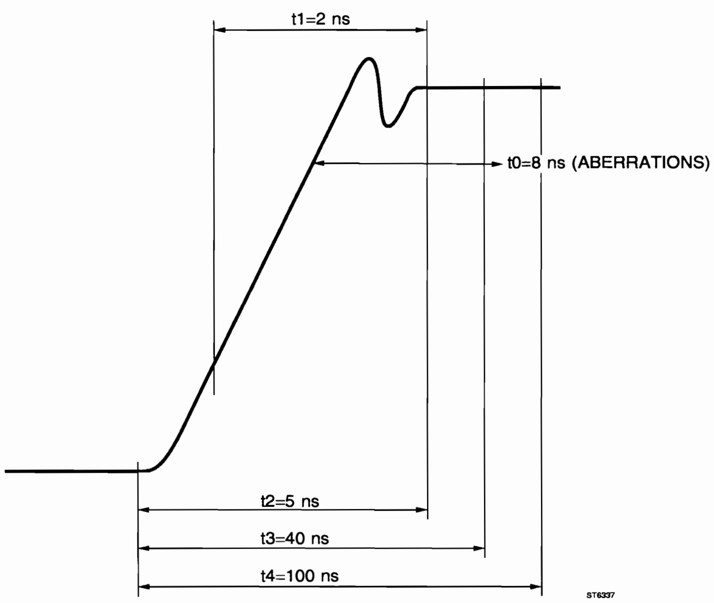



*Figure 7.3 Influence of t4, t3, t2, t1 and t0 on HF square wave response.*

- Remove the input signal.
- Pulse response and bandwidth are interdependent: the higher the pulse aberrations, the higher the bandwidth and vice versa. To check the bandwidth apply a 120 mV/50 kHz sinewave from a constant amplitude sinewave generator (5500A in mode 'levsine') to CH1.
  For reduced channels and EXT TRIG input apply 600 mV / 50 kHz.
- Press AUTOSET.
- Select 50Ω input impedance; if not available use a 50Ω termination resistor directly at the oscilloscope input.
- Adjust the amplitude of the sine-wave to 6 div exactly.
- Increase the frequency of the sinewave up to 60 MHz (for 60 MHz instruments), 100 MHz (for 100 MHz instruments) or 200 MHz (for 200 MHz instruments) and check that the amplitude on the screen does not become smaller then 4,2 div.
- Remove the input signal.
- Repeat the bandwidth check for CH2, CH3, CH4 and EXT TRIG input (the bandwidth check for CH3 and CH4 of PM3392A and EXT TRIG input of PM3390A must be checked via the 10:1 probe that is delivered with the oscilloscope).
- Remove the input signal.

## 7.16 HF RESPONSE DSO MODE

- Press the ANALOG key (message DIGITAL MODE appears briefly) and the oscilloscope switches to digital mode.
- Apply a 1V/1 MHz square-wave signal with a rise-time faster than 1 nsec to CH1. This signal is delivered in the 'edge'mode of the calibrator. As an alternative you may use the fast- rise output of the square-wave calibration generator. Use a 10x attenuator at the end of the cable from the generator. For reduced channels (0.1 and 0.5 V/div) and EXT TRIG (0.1 and 1V/div) use a 2:1 (6 dB) attenuator.
- Press AUTOSET.
- Put CH1 in 20 mV/div with DC coupled input. Reduced channels and EXT TRIG must be put in 0.1 V/div.
- Put MTB/VAR in 5.00 ns/div position.
- Select 50Ω input impedance; if not available use a 50Ω termination resistor directly at the oscilloscope input.
- Use POS CH1 to position the signal in the vertical mid of screen.
- Adjust the TRIGGER LEVEL to -100%.
- Select key sequence UTILITY > MAINTENANCE > MANUAL CALIBR and then 'hfdso' with the TRACK rotary.
- Select 'hf CH1' with the softkeys: the Δ sign appears behind 'hf CH1'. Adjust the pulse top to maximum flatness and the risetime to the required value with the Δ rotary. The adjustments are a compromise between fast risetime and minimal pulse distortion (aberrations). The requirement is a rise-time of ≤ 6 ns for 60 MHz, ≤ 3,6 ns for 100 MHz and ≤ 2 ns for 200 MHz instruments. This value includes the generator rise-time. The pulse aberrations must not exceed + or – 12%.
- Remove the input signal from CH1.
- Check for an equal pulse response (rise-time and aberrations) of all input channels in 20 mV/div. For reduced channels and EXT TRIG input use 0.1 V/div. In case of major differences, repeat the adjustment for a pulse response as equal as possible.
- Remove the input signal.

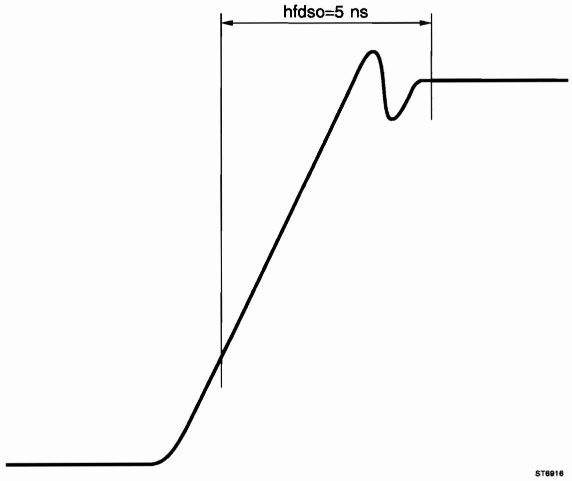



*Figure 7.4 Influence of 'hfdso' on HF square wave response.*

- Pulse response and bandwidth are interdependent: the higher the pulse aberrations, the higher the bandwidth and vice versa. To check the bandwidth apply a 120 mV/50 kHz sinewave from a constant amplitude sinewave generator (5500A in mode 'levsine') to CH1. For reduced channels and EXT TRIG input apply 600 mV/50 kHz
- Press AUTOSET.
- Select 50Ω input impedance; if not available use a 50Ω termination resistor directly at the oscilloscope input.
- Adjust the amplitude of the sine-wave to 6 div exactly.
- Increase the frequency of the sinewave up to 60 MHz (for 60 MHz instruments), 100 MHz (for 100 MHz instruments) or 200 MHz (for 200 MHz instruments) and check that the amplitude on the screen does not become smaller then 4,2 div.
- Remove the input signal.

- Repeat the bandwidth check in sequence for CH2, CH3, CH4 and EXT TRIG input (the bandwidth check for CH3 and CH4 of PM3392A and EXT TRIG input of PM3390A must be checked via the 10:1 probe that is delivered with the oscilloscope).
- Remove the input signal.

## 7.17 TRIGGER DELAY ADJUSTMENT

For PM3390A, PM3380A and PM3370A the 'logic' and 'state' adjustment can be skipped.

- Apply a 1V/1 MHz square-wave signal with a rise-time faster than 1 nsec to CH1. This signal is delivered in the 'edge'mode of the calibrator. as an alternative you may use the fast-rise output of the square-wave calibration generator.
- Press AUTOSET.
- Put CH1 in 0.2 V/div with DC coupled input.
- Select 50Ω input impedance; if not available use a 50Ω termination resistor directly at the oscilloscope input.
- Position the signal exactly in the vertical mid of screen.
- Put MTB/VAR TIME/DIV in 2.00 ns/div (200 MHz instruments) or in 5.00 ns/div position.
- Press menu key TRIGGER and select 'edge', level-pp 'off' and 'dc' trigger coupling.
- Turn the TRIGGER LEVEL rotary and adjust the level indicator (-T) 0.2 div under the vertical mid of screen.
- Adjust the TRIGGER POSITION rotary to a Delay read out of -5 div.
- Select the key sequence UTIL > MAINTENANCE > MANUAL and then select 'tr com' with the TRACK rotary .
- Select 'edge' with the softkey: the Δ sign appears behind 'edge'.
- Adjust the Δ rotary so that the leading edge crosses the center of the screen.

- Press menu key TRIGGER and select 'logic' and 'state' (not present in PM3370A/80A/90A).
- Use the front panel keys TRIG1 ... TRIG4 to obtain the trigger pattern '↑xxx' in the TRIGGER MAIN TB menu.
- Turn the TRIGGER LEVEL rotary and adjust the level indicator (-T) 0.2 div under the vertical mid of screen.
- Select the key sequence UTIL > MAINTENANCE > MANUAL and then select 'tr com' with the TRACK rotary .
- Select 'logic' with the softkey: the Δ sign appears behind 'logic'.
- Adjust the Δ rotary so that the leading edge crosses the center of the screen.

- Select key sequence TB MODE > EVENT DELAY > 'on' and 'CHANNEL 1'.
- Turn the TRIGGER LEVEL rotary and adjust the level indicator (-T) 0.2 div under the vertical mid of screen.
- Turn the Δ rotary to adjust the event level indicator (-E) 0.2 div under the vertical mid of screen.
- Select the key sequence UTIL > MAINTENANCE > MANUAL and then select 'tr com' with the TRACK rotary .
- Select 'events' with the softkey: the Δ sign appears behind 'events'.
- Adjust the Δ rotary so that the leading edge crosses the center of the screen.

- Select the key sequence TB MODE > EVENT DELAY > off.
- Press menu key TRIGGER and select 'edge'.
- Press menu key DTB and select DEL'D TB on, trig'd, dc and MAIN TB off.
- Put MAIN TB TIME/DIV to 100 ns/div and DEL'D TB TIME/DIV to 20.0 ns/div.
- Adjust MAGNIFY to 4x.
- Turn the Δ rotary (DTB TRIGGER LEVEL) and adjust the level indicator (-D) 0.2 div under the vertical mid of screen.
- Select the key sequence UTIL > MAINTENANCE > MANUAL and then select 'tr com' with the TRACK rotary .
- Select 'dtb' with the softkey: the Δ sign appears behind 'dtb'.
- Adjust the Δ rotary so that the leading edge crosses the center of the screen.

## 7.18 SAVING THE CALIBRATION DATA.

If you are sure that the instrument is well calibrated, the calibration data must be saved. For this proceed as follows:

- Press softkey RETURN.
- If present, remove the calibration sticker from the pin hole.
- Press softkey 'save calibr data'.
- Press the pin hole key (e.g. with a paperclip). When doing this, it is indicated in the viewing area how many 'calibration fields' are free to save calibration data.

*Note: The number of times that this 'save' action can be done is limited to 10. Refer to chapter 8.9.2 for how to proceed if the memory is full.*

- Close the pin hole key with a new calibration sticker, part number 5322 455 81144.

## 7.19 TESTING THE INSTRUMENT'S PERFORMANCE

If you want, you can check the instrument's performance by means of chapter 6 'PERFORMANCE TEST'. In general a quick check of the instrument's main characteristics will be sufficient. For this use the following paragraphs in chapter 6 of this manual:

- Vertical deflection; deflection coefficients (6.3.6).
- Horizontal deflection; MAIN TB deflection coefficients (6.3.24).
- Horizontal deflection; delayed time-base deflection coefficients (6.3.27).

# 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.

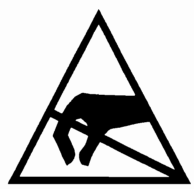


*Figure 8.11 Static sensitive symbol (black/yellow)*

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.

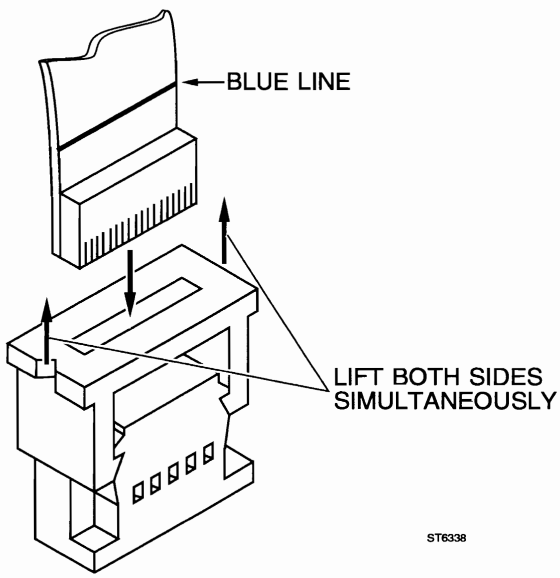



*Figure 8.12 Mounting position of white ribbon cables in connector*

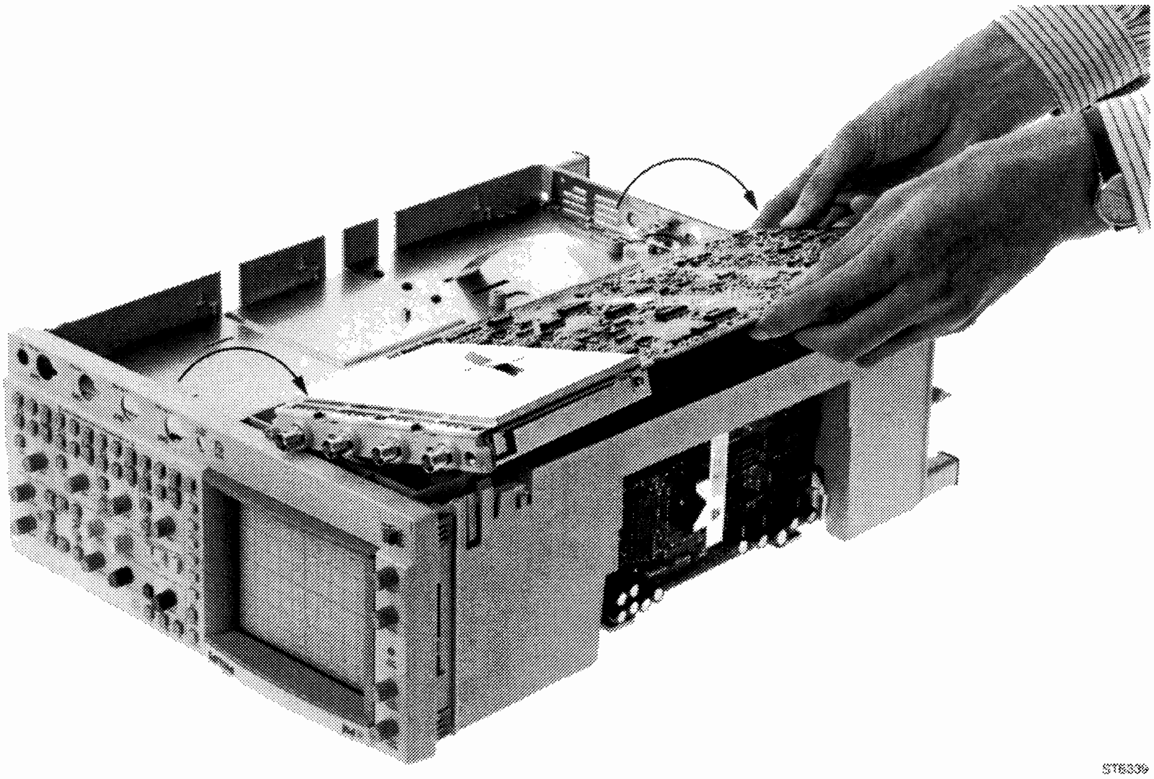
### 8.5.3 Removal of signal unit A1

- 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.



ST8339

*Figure 8.13 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.

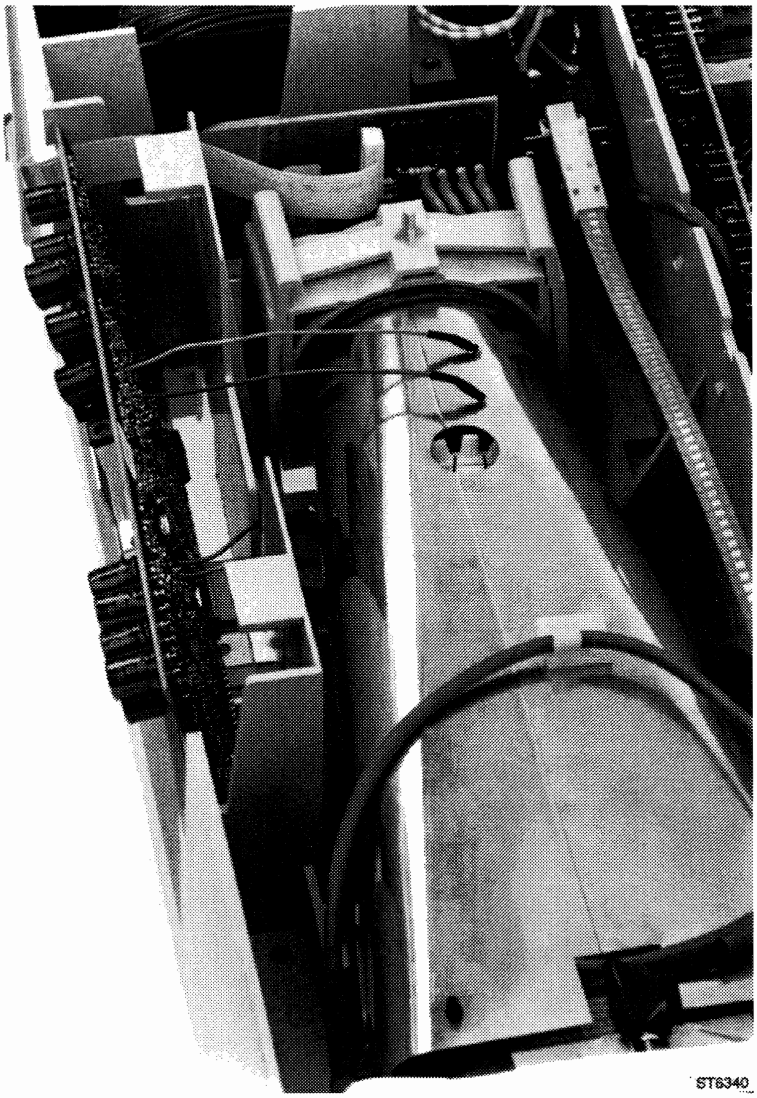



*Figure 8.14 Final XYZ amplifier in inclined position*

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

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'.

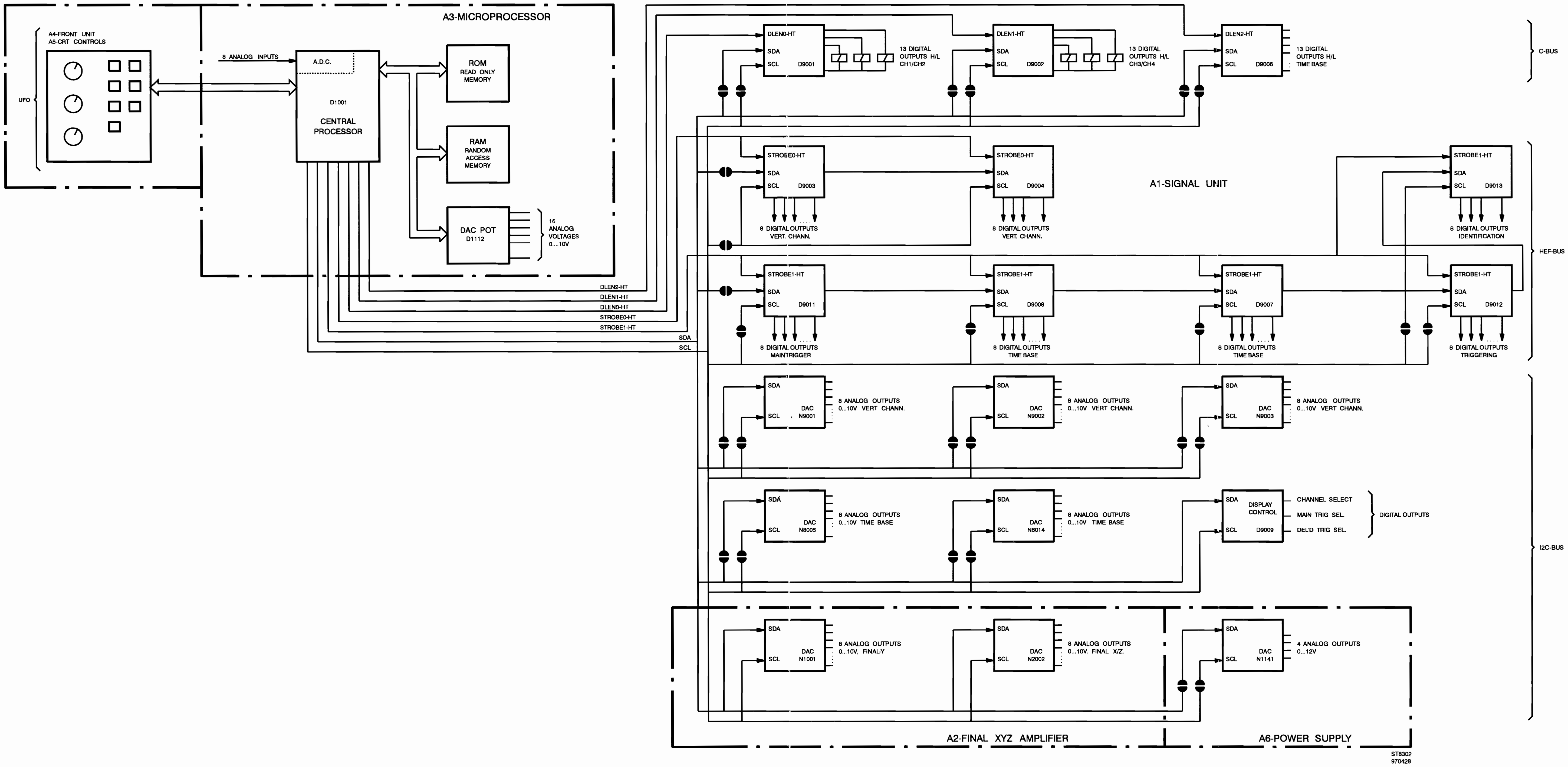



*Figure 8.5 Configuration of control part under direct control of microprocessor.*

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## 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 / $I^2C$ 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 | STROBE0-HT | D9003 | Control circuits |
| D9004 | Control circuits | | |
| 1 | STROBE1-HT | D9011 | MTB trigger |
| D9008 | Time base logic | | |
| D9007 | Delayed time base | | |
| D9012 | DTB trigger | | |
| D9013 | DTB 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 | D9001 | Control circuits |
| DLEN1-HT | D9002 | Control circuits |
| DLEN2-HT | D9006 | 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 $\Delta$) 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- | Pin | Name of generated signal: | | | |
|---|---|---|---|---|---|
| value | number | 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.*

# 9 SAFETY INSPECTION AND TESTS AFTER REPAIR AND MAINTENANCE IN THE PRIMARY CIRCUIT

## 9.1 GENERAL DIRECTIONS

- Take care that the creepage distances and clearances have not been reduced.
- Before soldering, bend the wires through the holes of the solder leads, or wrap the wires around the leads in the form of an open U, or, maintain wiring ridigity by cable clamps or cable lacing.
- Replace all insulating guards and plates after performing all repairs.

## 9.2 SAFETY COMPONENTS

For safety reasons, components in the primary circuit may only be replaced by components indicated in the replaceable parts list.

## 9.3 CHECKING PROTECTIVE GROUND

The correct connection and condition is checked by visual control and by measuring the resistance between the protective ground connection at the plug and the cabinet/frame. The resistance shall not be more than 0.5 Ω, test current 25A. During measurement the line cable should be removed from line power. Resistance variations indicate a defect.

## 9.4 CHECKING INSULATION RESISTANCE

Measure the insulation resistance at U = 500 V dc between the line connections and the protective ground connections. For this purpose, set the mains switch to ON. The insulation resistance shall not be less than 2 MΩ.

*NOTE: The insulation resistance of 2 MΩ is a minimum requirement at 40 °C and 95% relative humidity. Under normal conditions the insulation resistance should be much higher (10 ... 20 MΩ).*

## 9.5 CHECKING LEAKAGE CURRENT

The leakage current shall be measured between each pole of the line power supply in turn, and all accessible conductive parts connected together (including the measuring ground terminal).
The leakage current is not excessive if the measured currents from the mentioned parts is ≤ 0.5 mA rms (without filter capacitor) or ≤ 3.5 mA rms (with filter capacitor).

## 9.6 VOLTAGE TEST

The instrument shall withstand, without electrical breakdown, the application of a test voltage between the supply circuit and accessible conductive parts that are likely to become energized. The test potential shall be 1500 V rms or dc equivalent at supply-circuit frequency, applied for one second. The test shall be conducted when the instrument is fully assembled, and with the primary switch in the ON position.
During the test, both sides of the primary circuit of the instrument are connected together and to one terminal of the voltage test equipment; the other voltage test equipment terminal is connected to the accessible conductive parts.