FLUKE 105

SCOPEMETER® Series II

Service Manual

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FLUKE®

IMPORTANT

In correspondence concerning the ScopeMeter® test tool please give the model number and serial number as located on the type number plate on the instrument.

For your reference:

Model number:	Flukexx
Code number:	9444 yyy yyyyy
Serial number:	DM nn mmmm(m)

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 contained in this manual.

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

TABLE OF CONTENTS

1 SAFETY INSTRUCTIONS

Read this chapter carefully before installation and use of the instrument.

1.1 INTRODUCTION

The following sections contain information, cautions and warnings which must be followed to ensure safe operation and to keep the instrument in a safe condition.

WARNING: **Servicing described in this manual is to be done only by qualified service personnel. To avoid electrical shock, do not service the instrument unless you are qualified to do so.**

1.2 SAFETY PRECAUTIONS

For the correct and safe use of this instrument it is essential that both operating and service personnel follow generally accepted safety procedures in addition to the safety precautions specified in this manual. Specific warning and caution statements, where they apply, will be found throughout the manual. Where necessary, the warning and caution statements and/or symbols are marked on the instrument.

1.3 CAUTION AND WARNING STATEMENTS

CAUTION: **Is used to indicate correct operating or maintenance procedures in order to prevent damage to or destruction of the equipment or other property.**

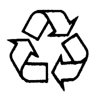
WARNING: **Calls attention to a potential danger that requires correct procedures or practices in order to prevent personal injury.**

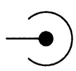
1.4 SYMBOLS


Caution (refer to accompanying documents)

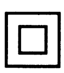

Ground symbol


Common input symbol, equipotentiality


Recycling symbol


High BNC input symbol


Static sensitive components (black/yellow)


Equipment protected throughout by
DOUBLE INSULATION or REINFORCED INSULATION

1.5 IMPAIRED SAFETY

Whenever it is likely that safety has been impaired, the instrument must be turned off and disconnected from all external voltage sources, and the batteries must be removed. The matter should then be referred to qualified technicians. Safety is likely to be impaired if, for example, the instrument fails to perform the intended measurements or shows visible damage.

1.6 GENERAL SAFETY INFORMATION

WARNING: Removing the instrument covers or removing parts, except those to which access can be gained by hand, is likely to expose live parts and accessible terminals which can be dangerous to life.

The instrument must be disconnected from all voltage sources and batteries must be removed before it is opened.

Capacitors inside the instrument can hold their charge even if the instrument has been separated from all voltage sources and batteries are removed. Components which are important for the safety of the instrument may only be replaced by components obtained through your local FLUKE organization. These components are indicated by an asterisk (*) in the parts list section (chapter 8).

2 CHARACTERISTICS

2.1 INTRODUCTION TO THE FLUKE 105 SPECIFICATION

2.1.1 Contents:

2.1.2 General

This instrument has been designed and tested in accordance with IEC publication 1010 for Category III instruments. Properties expressed in numerical values are guaranteed by Fluke within the tolerances stated. Numerical values without tolerances are typical and represent the characteristics of an average instrument. The accuracy of all measurements are within ± [%(of reading) ± (one least significant digit)] from 18 °C to 28 °C. Add 0.1 x (Specified accuracy) /°C for < 18 °C or > 28 °C Ambient.

* Manufacturer	Fluke Corporation	
* Type	Fluke 105 ScopeMeter®	Series II family
* Purpose	Dual Trace Oscilloscope with EXTernal trigger & Multimeter with: Direct Voltage Alternating Voltage EXTernal mV (AC &/or DC) Diode Test Resistance Continuity Test/Beeper	

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION

2.2 DISPLAY

* Type	LCD	
* Useful Screen Area	84 mm x 84 mm	1 div equals 25 pixels. 1 div equals 8.75 mm.
Resolution	240 x 240 pixels	
* Contrast ratio		Adjustable via USER OPTIONS or UP/DOWN menus.
* Backlight	Electro Luminescence	

2.3 SCOPE MODE SIGNAL ACQUISITION

* Sampling Type @ 1 µs/div...60 s/div @ 5 ns/div...500 ns/div	 Real Time Quasi Random	
* Maximum Sample Rate	25 MS/s	Sampling Rate depends on time/div setting and is 25 MS/s @ 1 µsec/div (and with GLITCH CAPTURE ON).
* Maximum Vertical (voltage) Resolution	8 bits	Over 10 divisions.
* Maximum Horizontal (time) Resolution	25 Samples/div	
* Record Length With capture 20 div With capture 10 div	 512 Samples 256 Samples	
* Acquisition Time (for 20.48 div)		
60 s/div...1 µs/div	20.48 x time/div	Excluding selected trigger delay time.
500 ns/div...5 ns/div	20.48 x time /div	Excluding selected trigger delay time. In Quasi Random Mode the acquisition time depends on signal triggers.
* Hold-off Time	< 100 ms or 4 div	Excluding selected trigger delay time.
* Sources	Input A External mV Input Input B	 2 Channel Acquisition is in: chopping mode from 60s/div...50µs/div alternating mode from 20µs/div...5 ns/div
* MIN MAX Envelope mode	MIN MAX button	Input A only. Grey-Scale envelope record of all changes in the displayed portion of the waveform. The most recent trace is black.

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION

2.4 Inputs A & B

* Signal Input	Insulated BNC	Signal Input BNC common and black banana jack (COM) are connected together.
Common Input	Black Safety Banana Jack	Part of External Trigger/External mV Input.
* Input Impedance		Frequency dependent, see Fig. 2.1.
R parallel	1 MΩ ± 1%	For DC coupled input. For AC coupled input or GND, add 22 nF in series with R & C parallel.
C parallel	25 pF	

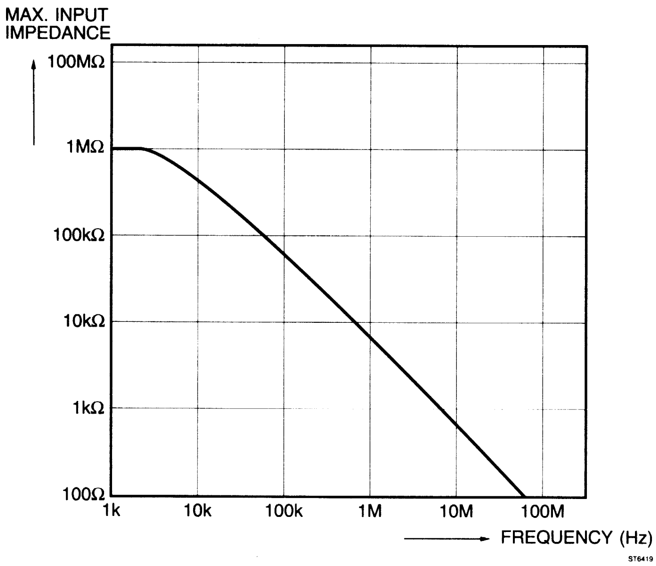


Figure 2.1 Max. Input Impedance Versus Frequency

* Input Coupling	AC DC GND	Sequence: ac, dc, GND (pre-charge ac); and then back to ac.

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION
* Maximum Input Voltage (rms)	300V	Frequency dependent, see fig. 2.2. Between BNC inner and outer contact. Outer BNC contacts and Ground (Black) Banana Jack are internally connected together.

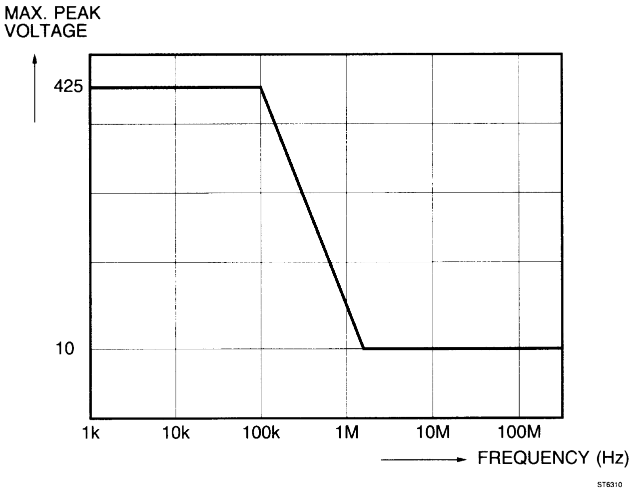


Figure 2.2 Max Input Voltage Versus Frequency

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION
* Deflection Coefficient		
Steps	1 mV/div...100 V/div	In a 1-2-5 sequence of 14 positions. 1 mV and 2 mV/div only for repetitive signals and timebase 60s...1µs/div. If one of the input channels is in 1mV or 2mV/div, both input channels will be switched to average=4.
Error Limit		
Gain	± (2% ± 1 pixel)	Add 3% for 1mV/div and 2mV/div.
Nonlinearity	±(2% ± 1 pixel)	per IEC 351 for frequencies < 1 MHz.
* Dynamic Range	9.5 div 4 div	for frequencies < 10 MHz. for frequencies upto 100 MHz.
* Position Range (move control)	- 4 div...+ 4 div	
* Frequency Response.		Z source = 50Ω.
Lower Bandwidth Transition Point		
DC Input Coupling	DC	
AC Input Coupling -3 dB	≤ 10 Hz	< 1 Hz with 10:1 probe.
Upper Bandwidth Transition Point	≥ 100 MHz (-3 dB)	Subtract 5 MHz for < 18°C and > 28°C Ambient.

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION
* Pulse Response		Z Source = 50Ω; measured over central 6 div.
Rise time	3.5 ns	
* Max. Base Line Instability Jump	0.2 div or 1 mV	The base-line is automatically readjusted after switching the attenuator or AC/DC/GND.
* AVERAGE		Running Average
Maximum Constant	256 x	
Constant in Roll	10 x	
* GLITCH detection		Channel A only.
Time-base setting	≥1µs/div	
Pulse-width for 100% probability	40 ns	
Pulse-width for 25% probability	10 ns	
* ZOOM		Expansion or compression in 1,2,5 sequence around the 4th division.
Range for delay	< 640 div	

2.5 SCOPE MODE TIME BASE

* Modes	Recurrent Single Shot Roll	 Automatic selected
* Ranges		
Recurrent	1 s/div...50 µs/div	Single channel or dual channel chopped.
	20µs/div...5 ns/div	Single channel or dual channel alternate. For alternating every sweep needs a trigger; A sweep first; B sweep arms automatically.
Single Shot	1 s/div...100 ns/div	For 500 ns, 200 ns, and 100 ns an automatic interpolation takes place.
Roll Mode	60 s/div...2 s/div	Single channel or dual channel chopped.
Maximum Time Base Error	± 0.1% ± 1 LSB	

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION

2.6 SCOPE MODE TRIGGER

* Sources		Selected independently.
Input A Signal	INPUT A	
Input B Signal	INPUT B	
External Trigger Input	EXT mV/Trigger	
Generator Signal	Generator	
* External Trigger Input Connector	Dual Safety Banana Jack	External Trigger Input common (low) jack is electrically connected to the Input A and Input B commons (outer contacts of BNC's).
* External Trigger Input Impedance		
R parallel	1 MΩ ± 1%	If used for mV DC/AC > 1MΩ.
C parallel	25 pF	Including Banana to BNC adapter
* Trigger Error		for frequencies < 1 MHz.
Voltage Level	± 1 LSB ± 0.5 div	5 s/div...50 µs/div 20 µs/div...5 ns/div
Time Delay	± 1 LSB ± 5 ns	
* Maximum External Trigger Input (rms)	300V	Frequency dependent, see fig. 2.2.
* Trigger Sensitivity		Values must be multiplied with 2.5 resp. 5 in 2mV/div and 1mV/div ranges
Input A or B		
≤ 10 MHz	≤ 0.8 div	
≤ 100 MHz	≤ 1 div	
≤ 150 MHz	≤ 2 div	
External Trigger Input	selectable level 0.2 and 2V	TTL logic compatible using 10:1 resp 1:1 attenuation Probe.
* Trigger Slope Selection	positive going negative going	

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION
* Trigger Level Control Range		
Input A or B	± 4 div	
Trigger at 50%	0.5 x peak/peak value	Measured during 20 ms, max freq 10MHz/1.5 div.
External Trigger Input	Fixed	
N-Cycle Mode		
5s/div..1µs/div	N=2...255	For time-base settings from 20µs...1µs/div acquisition and trigger on Channel A only.
* Trigger Delay		
Range	-20...640 div	
Events (5s/div..1µs/div)	1...1023	Start via Ext; Count with Channel A.

2.7 SCOPE MODE TRACE DISPLAY

* Sources		A Maximum of 4 traces (3 live) can be selected.
	Input A Input B Input A + or - B Input A versus B Memory #1 up to 20	
* Position range		
Horizontal	+ 4 div...-16.5 div	
Vertical	- 4 div...+4 div	From screen center, select per trace.
	-3 div to +3 div	With CURSORS on.

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION

2.8 SCOPE MODE WAVEFORM MATH

* Functions		
	Multiply Add Subtract Filter Invert Integrate	Uses entire Memory or Input waveform. For timebase settings from 20 µs to 5 ns, live (Input) waveforms can be used only when displayed on the LCD.

2.9 SCOPE MODE CURSORS

* Functions		
	dV dt 1/dt Trig to left Trig to right V at left V at right Vrms V DC (mean) V peak/peak V max peak V min peak Frequency Rise Time Phase	maximum of 5 simultaneous measurement functions. Display as: - absolute values - absolute difference (δ) - relative difference (%)
* Horizontal		
Display Resolution	25 parts per div	
Digital Readout Resolution	3 digits	
Error Limit	± 0.1% ± 1 LSB	
Cursor Range	Visible part of signal	Cursors cannot pass each other.
* Vertical		
Display Resolution	25 parts per div	
Digital Readout Resolution	3 digits	
Error Limit	± 2%	Referred to input at BNC or Probe tip, after Probe re-calibration.

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION

2.10 SCOPE CONTINUOUS AUTOSET

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION
* General	At initialization of AUTO SET a selection is made for:	
	Trigger source	EXT, A, B
	Trigger slope	+ or -, whichever is most stable.
	Trigger Level	15 or 85%, whichever is most stable. 50% in 10 ns/div range.
	Voltage range	see Vertical Acquisition
	Timebase range	see Horizontal Acquisition
	Defaults are chosen for:	
	Trigger source control	automatic
	Trigger slope control	automatic
	Trigger delay	-2 div
	Input coupling	DC
	Average	off
	X-move	zero
	Y-move	zero if one channel is on; +1 and -1 div if channels A and B are on.
	A versus B	off
	Cursors	unchanged
	Generator	unchanged
	Dot Join	unchanged
	The defaults can be changed under USER OPTIONS.	
	After initialization continuous tracking of Trigger Level, Trigger Slope, Voltage Range and Timebase Range.	
	Switching to manual: Manually changing Trigger Slope, Voltage Range or Timebase range leaves the other settings automatic. Manually changing Trigger Level results in complete manual setting.	
* Settling time	3 seconds typical	Depending on the complexity of the signal. Not specified when glitch on.
* Vertical Acquisition		
Input voltage > 20 mV	approx. 5 div	Due to trigger uncertainty at freq.> 2 MHz or at duty cycle <> 50% sensitivity can deviate from above, but signal will remain on the screen.
Input voltage < 20 mV	Input at 50 mV/div	

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION
* Horizontal Acquisition	Free Run Recurrent	
Frequency Range	10 Hz...100 MHz	
TB Deflection coefficient Signal 40 Hz...5 MHz	min. 2, max 6 signal periods over 8 div	
Signal 5 MHz...100 MHz	min. 2, max 20 signal periods over 8 div	TB setting max. 10 ns/div
When no trigger found		10 µs/div

2.11 MULTIMETER MODES

The Multimeter uses Input A for V DC & V AC measurements and the Safety Banana Jack Inputs for Resistance, Diode Test, Continuity, DC mV and AC mV measurements. An internal reference is used to optimize the accuracy of Input A and any probes used. The accuracy of all Multimeter measurements are within ± [(% of reading) + (number of least significant digits)] from 18°C to 28°C with relative humidity up to 90% for a period of one year after calibration. Add 0.1 x (specified accuracy)/°C for < 18°C or > 28°C Ambient.

- Displayed range include used probe, if calibrated.
- Values listed are without attenuating probe.
- Displays with no trigger are optimized for power line (mains) related measurements.

* DC Voltage Input A Ranges	100 mV, 300 mV, 1V, 3V, 10V, 30V, 100V, 300V	Manual or automatic ranging on peak Voltage. High Voltage 10:1 Probe extends measurement to 600V. Peak voltage is 2.5x Range, except 375V in 300V range.
Resolution	0.1 mV, 0.1 mV, 1 mV, 1 mV, 0.01V, 0.01V, 0.1V, 0.1V	Multiply x10 with 10:1 Probe.
Accuracy	± (0.5% + 5)	
Full Scale Reading	1000 / 3000 Counts	
Display update	< 250 ms	
Response Time		
Normal	< 3.5 s	
SMOOTH	< 10 s	
FAST	< 1 s	
Zeroing	automatic	
Normal (Series) Mode Rejection Ratio	> 50 dB @ 50 Hz or 60 Hz	

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION
* AC Voltage Input A		
Ranges	100 mV, 300 mV, 1V, 3V, 10V, 30V, 100V, 250V	Manual or automatic ranging on peak voltage. High Voltage x10 Probe extends measurement to 600V. Peak voltage is 2.5x Range and 375V in 250V range.
Resolution	0.1 mV, 0.1 mV, 1 mV, 1 mV, 0.01V, 0.01V, 0.1V, 0.1V	Multiply x10 with High Voltage Probe.
Accuracy (AC Coupled)		Valid from 5%..100% of range.
50 Hz...60 Hz	± (1% + 10)	
20 Hz...20 kHz	± (2% + 15)	Add 1% above 1 kHz using 10:1 Probe.
5 Hz...1 MHz	± (3% + 20)	For frequencies < 10 Hz with Probe, or < 100Hz direct, use function ac+dc.
5 Hz...5 MHz	± (10% + 25)	
Accuracy (DC Coupled)		
50 Hz...60 Hz	± (1% + 10)	
1 Hz...20 kHz	± (2% + 15)	
Crest Factor	not applicable	Meter prevents crest factor errors by autoranging on input waveform peaks.
Full Scale Reading	1000 / 3000 Counts	
Display update	< 250 ms	
Response Time		
Normal	< 3.5 s	Input frequency ≥ 50 Hz.
SMOOTH	< 10 s	
FAST	< 1 s	
dc Common Mode Rejection Ratio	> 100 dB @ dc > 100 dB @ 50, 60, or 400 Hz	
ac Common Mode Rejection Ratio	> 60 dB @ dc..60Hz	
* Resistance		
Open Circuit Voltage	< 4V	
Full Scale Voltage		
30Ω	< 25 mV	
300Ω... 3 MΩ	< 250 mV	
30 MΩ	< 2V	
Ranges	30 Ω	Manual range only.
	300Ω, 3 kΩ, 30 kΩ, 300 kΩ, 3 MΩ, 30 MΩ	Manual or automatic ranging.

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION
Resolution	0.01Ω, 0.1Ω, 0.001 kΩ, 0.01 kΩ, 0.1 kΩ, 0.001 MΩ, 0.01 MΩ	
Accuracy	± (2.5% + 25) ± (0.5% + 5)	30Ω range All other ranges
Full Scale Reading	3000 Counts	Up to 9999 counts in 30Ω range, Up to 3000 counts in 30 MΩ range, Up to 4500 counts in other ranges.
Measurement current	0.5 mA...70 nA	Decreases as range increases.
Display update	< 250 ms	
Response Time		
Normal	< 3.5 s	
SMOOTH	< 10 s	
FAST	< 1 s	
Protection	600 V RMS	
Continuity		
Beeps if resistance is < :	5% of selected Range +/- 50 Counts	
* Diode Test		OL is indicated if measured Voltage is >2.8V.
Maximum Voltage	4V	
Range	2.800V	
Resolution	0.001V	
Voltage Accuracy	± (0.5% + 5)	Applies for voltage measurement
Digital Display	3000 Counts	If value > 2800 read out gives OL.
Measurement Current	0.5 mA typically	
Display update	< 250 ms	
Response Time		
Normal	< 3.5 s	
SMOOTH	< 10 s	
FAST	< 1 s	
Protection	600V RMS	
Polarity	+ on RED Banana Jack - on BLACK Banana Jack	

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION
* External mV mode	Displays multiple numeric readings and scope waveform picture of the signal at the Banana Jack inputs. Use for Accessory (including Temperature) input.	
DC Voltage		
Ranges	300mV, 3V	
Resolution	0.1mV, 1mV	
Accuracy	± (0.5% + 5)	
Full Scale Reading	3000 Counts	
Display update	< 250 ms	
Response Time		
Normal	< 3.5 s	
SMOOTH	< 10 s	
FAST	< 1 s	
Input	+ on RED Banana Jack - on BLACK Banana Jack	mV input. COM input.
Normal (series) Mode Rejection	>50dB at 50Hz or 60Hz	
Common Mode Rejection	>100dB	at DC, 50, 60, or 400Hz
Probe Scaling		1mV/°C, 1mV/°F, 1mV/A, 10mV/A, 100mV/A, 1V/A (1mV/mA)
AC or AC+DC True RMS Voltage		
Ranges	300mV, 3V	
Resolution	0.1mV, 1mV	
Accuracy	± (2% + 15)	>5% of range, DC and 1Hz to 400Hz, 50 and 60Hz
Full Scale Reading	3000 Counts	OL at 2500 counts in range 3V
Display update	< 250 ms	
Response Time		
Normal	< 3.5 s	
SMOOTH	< 10 s	
FAST	< 1 s	
Input	+ on RED Banana Jack - on BLACK Banana Jack	mV input. COM input.
Common Mode Rejection	>60dB, DC to 60Hz	
Probe Scaling		1mV/A, 10mV/A, 100mV/A, 1V/A (1mV/mA)

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION
* Multimeter Math (Display) Functions		
Relative	ZERO Δ	Displayed Value = Reading - Reference Reading
% Change (% Relative)	ZERO %Δ	Displayed Value = [(Reading/Reference Reading) -1] x 100
% Scale		Displayed Value = [(Reading - Set 0% Reading)/(Set 100% Reading - Set 0% Reading)] x 100
Set 0% Reference	SET 0%	Present, Maximum, Minimum, Max - Min, Average, or User selected Reading.
Set 100% Reference	SET 100%	Present, Maximum, Minimum, Max - Min, Average, or User selected Reading.
Power with respect to 1 mW in selected load resistance	dBm	
Select load resistance	1200, 1000, 900, 800, 600, 500, 300, 250, 150, 135, 125, 110, 93, 75, 60 & 50	
Voltage Ratio in dB with respect to 1V	dBV	
Audio power Select load resistance	WATTS or dBW 50, 16, 8, 4, 2, & 1 Ω	
* Touch Hold	HOLD Causes the meter to capture the next measured reading (and beep) when a new stable measurement has been detected. When first enabled, the numeric display is frozen (held) until a stable measurement is detected. Stable measurements are defined as within ± 100 display counts for 1 s; and above a floor of 200 display counts in volts (300 counts in ac, 0 counts in Ω and diode test). Overload is a valid stable condition except in Ω and diode test.	
MIN MAX TRENDPLOT™	Logs MIN, MAX, and AVERAGE readings to memory at full accuracy and displays all three as graphs. Uses automatic vertical scaling and horizontal time compression for hands-off from 15 sec/div. to 8 days/div. MIN MAX button.	
* AUTO RANGE Voltage		Voltage and Time are coupled. RANGE key selects manual Voltage Range. The AUTOSET key restarts automatic voltage ranging.

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION
Time		
range_up		
5 ms..50 µs	> 8 periods in display	TIME key selects manual timebase.
20 µs...1 µs	> 4 periods in display	The AUTOSET key restarts automatic timebase ranging.
range down		
5 ms..50 µs	< 1.5 periods in display	
20 µs...1 µs	< 0.75 periods in display	
* Frequency		
Range	1 Hz...2 kHz	Ext mV input. Manual for freq. < 20 Hz.
	1 Hz..5 MHz	Input A. Manual for freq. < 20 Hz.
accuracy	± (.5 % + 2 counts)	
Timebase accuracy	± 0.01%	
Resolution	4 digits	
Measuring time	3.5 s	gradually slower from 100 Hz and down
SMOOTH	< 10 s	Running average over 32 measurements
FAST	< 1 s	
Ranging	Automatic	
* Duty Cycle		Selectable Positive or Negative pulse inputs.
Range	2.0% to 98%	
Resolution	0.1%	
Accuracy	± (0.5% + 2 counts)	For logic or pulse signal inputs.
* RPM, Revolutions per Minute		Selectable: 1 pulse/rev. or 1 pulse/2rev.
Range	60RPM to 99.99kRPM	1 pulse/revolution. Manual for <1200 RPM.
	120RPM to 99.99kRPM	1 pulse/2 revolutions. Manual for <2400 RPM.
Resolution	1 RPM	10 RPM for RPM> 10,000
Accuracy	± (0.5% + 2 counts)	
* Pulse Width		Selectable Positive or Negative pulse inputs.
Range	250 µs to 50ms	Input signal at 50% duty cycle.
Resolution	3 digits	
Accuracy	± (0.5% + 2 counts)	For logic or pulse signal inputs from 2% to 98% duty cycle.

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION

2.12 GENERATOR

* Probe Adjust		A squarewave voltage is available via the generator output for adjusting probe compensation.
Voltage	5V	
Frequency	976 Hz	
Source resistance	400Ω	
* DC Calibration		Including 10:1 attenuation Probe.
Voltage	3V	Inaccuracy is optimized internally.
Source resistance	400Ω	
* Sinewave		
Amplitude	1V	
Frequency	976 Hz	
Maximum Individual Harmonic	3%	
Source Resistance	400Ω	
* Squarewave		
Amplitude	5V ±10%	5V
Frequency	1.95 kHz 976 Hz 488 Hz	Selectable
Source Resistance	400Ω	
* Current Ramp		
Amplitude	0 to +3 mA	in 128 steps, time for each step can vary.
Maximum Compliance Voltage	2V	
* Voltage Ramp		
Amplitude	-2V to +2V	in 128 steps, time between steps can vary.
Maximum Current	±1 mA	

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION

2.13 SET-UP, WAVEFORM, & SCREEN MEMORIES

* SET-UP MEMORY		
Memory size	40 maximum	Front Panel Set-ups
Functions	Save	Actual front panel settings are stored in memory, replacing contents of memory location indicated on the LCD.
	Delete	Contents of memory location indicated on the LCD are deleted.
	Recall	Actual front panel settings are replaced by contents of memory location indicated on the LCD.
* WAVEFORM MEMORY		
Memory size	20 maximum	Waveforms
Functions	Save	Waveform indicated on the LCD is stored in memory, replacing contents of memory location indicated on the LCD.
	Delete	Contents of memory location indicated on the LCD are deleted.
	Recall	Waveform in memory location indicated on the LCD is placed on the display.
* SCREEN MEMORY		
Memory size	10 maximum	Screens
Functions	Save	The entire display screen and actual front panel settings are stored in memory, replacing contents of memory location indicated on the LCD.
	Delete	Contents of memory location indicated on the LCD are deleted.
	Recall	The entire display screen is replaced by the contents of the memory location indicated on the LCD.

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION

2.14 POWER ADAPTOR / BATTERY CHARGER

* Input Connector	5 mm Power Jack	Per DIN 45323
* Source Voltage dc		
Nominal	15 V dc	
Limits of Operation	8V...20 V dc	
* Charging Current		
Instrument ON	60 mA	
Instrument OFF	170 mA	
* Allowable Temperature During Charging	0°C...45°C	
* Power Consumption		
Instrument ON	5W	
Instrument OFF	3W	

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION

2.15 POWER SUPPLY

* Battery Voltage Range 4V...6V

The batteries are not charged at delivery. A Warning is given if the battery voltage becomes lower than 4.4V. The instrument is switched off if the battery voltage becomes lower than 4V.

If the instrument is Battery Powered, it will switch off automatically after 10 minutes of no operator actions, except in MIN MAX or ROLL modes.

* Recommended Batteries

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION
NiCd Battery Pack	PM 9086/011	Only this Battery Pack is internally re-chargeable.
Recharging time	21 hours	
Life time		After 500 cycles the capacity will be > 1100 mAh. The nominal capacity is 2200 mAh.
Operating time	> 5 hours	After Charging for > 15 hours.
Stand Alone Batteries (4x)		
Model	KR27/50 K70 C-CELL	Per IEC Per ANSI
Operating time	> 4 hours	
Temperature Rise of Batteries	20° C	After instrument has reached a stable operating temperature.
Temperature Range of Batteries.		
Working	-20°...65°C	
Storage	-30°...65°C	It is recommended to remove the batteries from the instrument when it is stored longer than 24 hours below -30 °C or above 65 °C.

CAUTION! UNDER NO CIRCUMSTANCES SHOULD BATTERIES BE LEFT IN THE INSTRUMENT AT TEMPERATURES BEYOND THE RATED SPECIFICATIONS OF THE BATTERIES BEING USED!

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION

2.16 MECHANICAL

* Height	262 mm	With holster 281 mm
* Width	129 mm	With holster 140 mm
* Depth	60 mm	With holster 62 mm
* Weight	1.5 kg	With holster, 1.8 kg

2.17 ENVIRONMENTAL

* The characteristics are valid only if instrument is checked in accordance with the official checking procedure.

* Meets Environmental Requirements of:	MIL-T-28800D Type III Class 3, Style C	
* Temperature		Batteries removed from instrument unless batteries meet the required temperature specifications. Maximum Operating Temperature derated 3 °C for each km. (each 3000 feet) above sea level.
Operating	0°C...50°C	
Non Operating (Storage)	-20°C...70°C	
* Maximum Humidity		
Non Operating (Storage)	95% Relative Humidity	
Operating		
20°C...30°C	90%	
30°C...50°C	70%	
* Maximum Altitude		Batteries removed from instrument unless batteries meet maximum altitude specifications.
Operating	3 km (10 000 feet)	
Non Operating (Storage)	12 km (40 000 feet)	

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION
* Vibration (Operating)		
Frequency 5...15 Hz	Sweep Time 7 min.	
Excursion (pk to pk)	1.5 mm	
Max Acceleration	7 m/s^2 (0.7 x g)	@ 15 Hz
Frequency 15...25 Hz	Sweep Time 3 min.	
Excursion (pk to pk)	1.0 mm	
Max Acceleration	13 m/s^2 (1.3 x g)	@ 25 Hz
Freq. 25...55 Hz	Sweep Time 5 min.	
Excursion (pk to pk)	0.5 mm	
Max Acceleration	30 m/s^2 (3.0 x g)	@ 55 Hz
Resonance Dwell	10 min.	@ each resonance frequency (or @ 33 Hz if no resonance is found).
* Shock (Operating)		
Number of shocks	18 Total 6 Each Axis	 (3 in each direction)
Shock Wave Form	Half Sine	
Duration	6..9 ms	
Peak Acceleration	400 m/s^2 (40 x g)	
* Bench Handling		
Meets requirements of:	MIL-STD-810, Method 516, Procedure VI	
* Salt Atmosphere		
Structural parts meet	MIL-STD-810, Method 509, Procedure I with 5 % salt solution	
* EMI (Electro Magnetic Interference)		
Meets requirements of:	MIL-STD-461 Class B	Applicable requirements of Part 7: CE03, CE07, CS01, CS02, CS06, RE02, RS03. (RS02: max 2 div distortion in 20 mV/div).
	VDE 0871 Grenzwertklasse B	
* Packing meets requirements of:	UND 1400	

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION
* Transportation meets requirements of:	AN-D628	
Packaged Transportation Drop Meets requirements of:	Nat. Safe Transp. Assoc. Procedure 1A-B-2	
Packaged Transportation Vibration Meets requirements of:	Nat. Safe Transp. Assoc. Procedure 1A-B-1	
ESD (ElectroStatic Discharge) Meets requirements of:	IEC 801-2	Test severity level 15 kV.
Water and Dust protection	IP 51	IP 51According to IEC 529

2.18 OPTICAL-TO-RS232 INTERFACE

* Type of interface	RS232	Uses PM9080/001 Optically Isolated RS232 Adapter/Cable.
	9 pole D-plug male	
* Spacing		
"0"	Light	
"1"	No light	
* Functions for printers:		
Baud Rate	1200,9600	Input and Output are the same
Number of STOP-bits	1	
Parity	No	
Character length	8	
Transmission mode	Asynchronous, full duplex	
Handshake	XON/XOF	Software handshake only
* Interfacing function Repertory for interface:		Default 1200 Baud
Baud Rate	75...19k2	Input and Output are the same. Selectable by Controller.
Number of STOP-bits	1 or 2	
Parity	No, odd or even	
Character length	7 or 8	
Transmission mode	Asynchronous, full duplex	
Handshake	XON/XOF or no Handshake	Software handshake only; default: no Handshake

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION
* Print facilities		
Protocol HP ThinkJet compatible	EPSON FX, LQ compatible HP ThinkJet compatible	
print out	Screen log of readings:s: single every 2, 5, 10 or 60s	
	selectable waveform	
* Front Panel Control		
Modes	Local	Front panel exclusively under manual control.
	Remote-locked	Front panel exclusively under RS-232-C control.
	Remote-unlocked	Return To Local by User ReQuest.

2.19 SAFETY

* Meets requirements of:	IEC 1010-1	For 600V, Installation Category III, Pollution Degree 2.
	ANSI/ISA S82 UL 1244 CSA C22.2 No.1010.1	4 kV, 6 kV with PM8918 probe.
* Approvals	UL 1244 CSA C22.2 No.1010.1	

2.20 ACCESSORIES

* Accessories furnished with instrument:		
2 x 10 MΩ 10:1 Passive Safety Probes.	PM 8918	
Scope Probe Accessory set:	PM9094/001	
2 x HF adapter black		
2 x High Voltage testpin		
2 x mini test hook		
2 x Trim screw driver		
4 mm adapter		
Banana to BNC adapter	PM 9081/001	Shrouded
Alligator Clip red (for 10:1 probe)		
Alligator Clip grey (for 10:1 probe)		
Set Testleads and Testpins:		
2 x testleads	1.5 m	
2 x testpins		
2 x banana adapter		
1 x Indust. Alligator Clip black		
Product Software		
SW90D FlukeView™ for DOS		
SW90W FlukeView™ for Windows		
RS232 interface cable	PM9080/001	
Learn Your ScopeMeter (Demo Board)		
Holster	PM 9083/011	
Accessory case	C 75	
Operating Manual		
Quick operating guide		
Power Adaptor / Battery Charger:		Depending on model one of:
	PM 8907/001	Universal Europe.
	PM 8907/003	North American.
	PM 8907/004	United Kingdom.
	PM 8907/008	Universal 115V/ 230V.

2.21 SERVICE AND MAINTENANCE

* Mean Time Between Failures	40 000 hours	Predicted value, calculated through Parts Counting Method, according to MIL HDBK- 217E.
* Mean Time to Repair	1.5 hours	
* Calibration Interval	1 Year	
* Mean Time To Calibrate	0.5 hours	

3 CIRCUIT DESCRIPTIONS

3.1 INTRODUCTION TO CIRCUIT DESCRIPTION

3.1.1 General

This chapter presents a layered description of the ScopeMeter test tool circuitry. First the overall theory of operation is described, referring to the overall block diagram (section 3.2).
The next section gives some information concerning the data acquisition.
Then the circuits on both digital (A1) and analog (A2) printed circuit boards (PCB) are described. After a short introduction, a detailed circuit description is given for each circuit part.

The various circuit descriptions refer to the circuit diagrams in chapter 9.

NOTE: The large digital (A1) and analog (A2) printed circuit board diagrams are provided as separate drawings. Whenever a signal line continues on another drawing, it is indicated by the following comment:

"FROM A1" ----> *coming from the digital (A1) circuit (figure 9.8)*

"TO A2a" ----> *the signal continues on the first circuit diagram of the analog A2 PCB (figure 9.5)*

3.1.2 Location of electrical parts

The item numbers of C..., R..., V..., N..., D... and K... have been divided into groups. These groups relate to the functional parts on the PCBs:

Table 3.1 Location of electrical parts

Item number	Functional part	PCB	diagram
1200-1299	µP, Digital ASIC, M-ASIC, ROM, RAM and related circuitry	A1	A1a/b
1300-1399	battery sense, RAM power, receiver, transmitter	A1	A1a
1400-1499	LCD and related circuitry, backlight	A1	A1b
1500-1599	ON/OFF circuit, RESET circuit	A1	A1a
2100-2199	attenuator channel B	A2	A2a
2200-2299	attenuator channel A	A2	A2a
2300-2399	Analog ASIC and ADC	A2	A2a/b
2500-2599	battery charger and power supply	A2	A2c
2700-2799	EXTernal input-/output circuitry	A2	A2b
2800-2899	generator	A2	A2b
2900-2999	analog control circuitry	A2	A2a

3.2 FUNCTIONAL BLOCK DESCRIPTION

3.2.1 Introduction

This section contains an overall block diagram of the ScopeMeter test tool. Refer to figure 3.1.

The block diagram can be divided in two parts. The upper part of the diagram shows the components that are situated on the Printed Circuit Board (in the following text: PCB), that is connected to the ScopeMeter's test tool bottom cover. Because this PCB contains mainly analog circuits, it is called the **analog A2 PCB**.

The lower part of the diagram contains the digital circuitry. This circuitry is located on the **digital A1 PCB**, the PCB connected to the top cover.

The general layout of the block diagram is the same as the layout of the circuit diagrams in chapter 9. The circuits that can be found on the same circuit diagram (chapter 9) are placed in a dashed box in the *block diagram.*

Analog A2 PCB
The signals at the red and grey BNC are attenuated by the **CHANNEL A ATTENUATOR** and the **CHANNEL B ATTENUATOR.** These attenuators are set by the Microprocessor (on the digital A1 PCB) via the **ANALOG CONTROL CIRCUIT**. Also input protection circuits are provided here.

The output signals of the attenuator blocks are fed to the **ANALOG ASIC** (ASIC = Application Specific Integrated Circuit). This component is controlled by the microprocessor on the digital A1 PCB. The Analog ASIC incorporates signal amplification and channel selection. It also prepares the signal for sampling by the **Analog to Digital Converter (ADC)**.

The red and black banana jack inputs are connected to the **EXTERNAL (BANANA) INPUT/OUTPUT CIRCUIT**. When the ScopeMeter test tool is set to EXT mV, DIODE TEST or OHM mode, the External (banana) input/output circuit outputs its signal into the Channel A Attenuator section. In SCOPE mode, the circuit can act as a trigger input. The trigger signal is fed to the Analog ASIC. In the Analog ASIC "channel A", "channel B" or "External trigger" can be selected as trigger source. The trigger signal is used to generate the DELTA- T voltage (time relation between trigger moment and sampling moment).

The built-in **GENERATOR** uses the External (banana) input/output circuitry as output. It is possible to generate a DC voltage and a square wave voltage. Model 99 also can generate sine wave voltages, a ramp voltage, and a ramp current.

The power supply circuitry is also located on the analog A2 PCB. The separate Power adapter/battery charger **PM8907/...** converts the line voltage into 15V DC. This voltage is used by the **BATTERY CHARGER** to charge a **NiCad BATTERY PACK (PM9086/001)**, if present.

The **POWER SUPPLY** section transforms the input voltage (line operated) or the battery voltage (battery operated) into the supply voltages for the various circuits on A1 and A2.

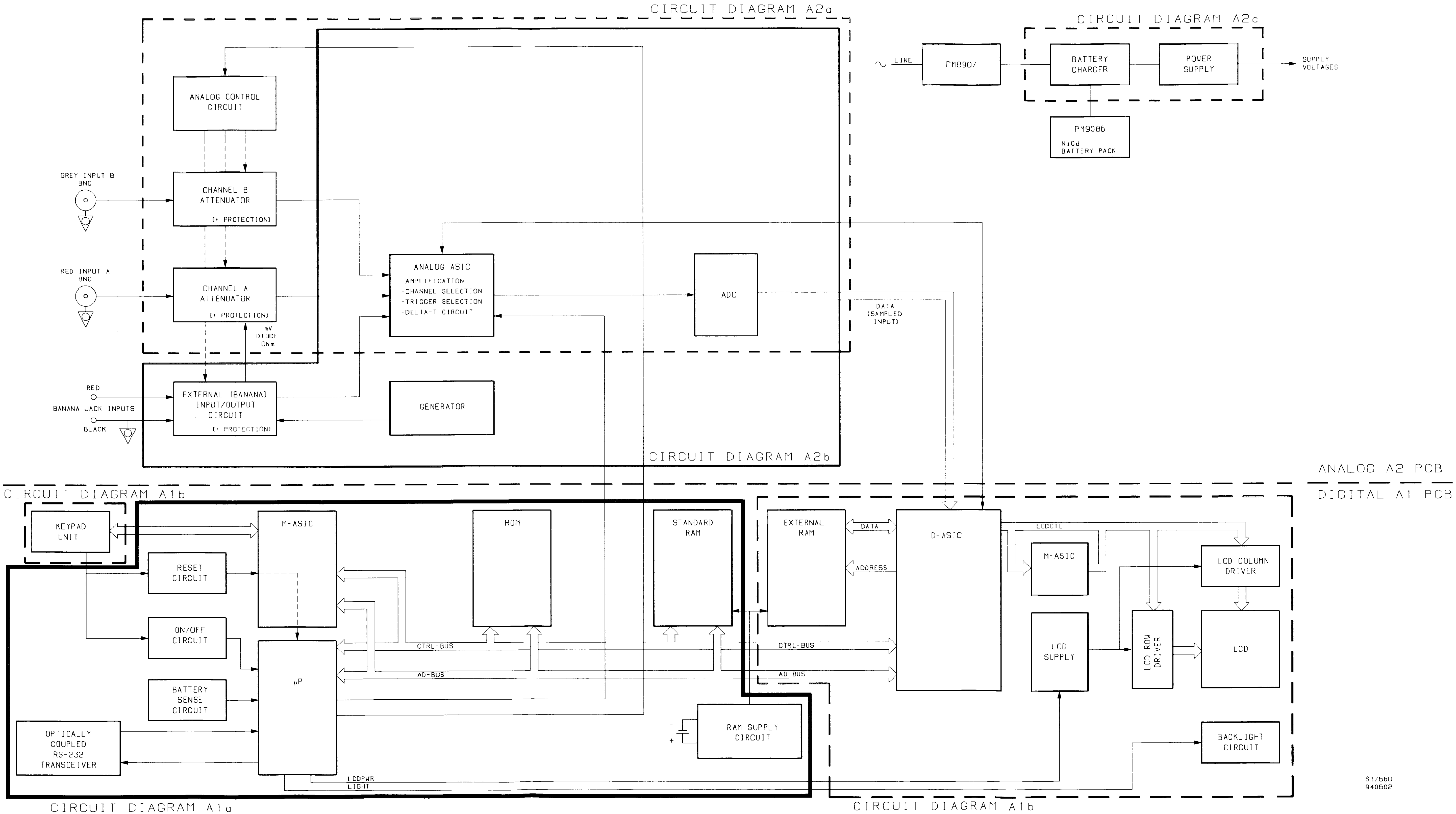


Figure 3.1 Overall Functional Block Diagram

Digital A1 PCB
The ScopeMeter test tool is controlled by the **MICROPROCESSOR**, located on the digital A1 PCB. This microprocessor performs several control tasks, for example:

- Scanning the **KEYPAD** for user commands. The keypad is connected to the microprocessor via the **M-ASIC**.
- Communication with the outside world via the **OPTICALLY COUPLED RS-232-C TRANSCEIVER**. This section contains an Infrared LED (transmitter) and a phototransistor (receiver).
- Monitoring the battery voltage (**BATTERY SENSE CIRCUIT**).
- Controlling the Analog ASIC on the analog A2 PCB.
- Switching the power on or off (**POWER ON/OFF CIRCUIT**).
- Performing a proper RESET at power on (**RESET CIRCUIT**).
- Controlling the analog A2 circuits (via the **ANALOG CONTROL CIRCUIT**).
- Signal processing of acquired data. The microprocessor reads, calibrates and stores the acquired data.

The **DIGITAL ASIC** is the core of the digital circuitry. It provides:

- Timebase functions. For example: the ADC sampling signal is generated by the Digital ASIC.
- Trigger functions (in real-time sampling mode).
- Acquisition Control Logic (ACL). This function controls the acquisition according to trigger and acquisition modes. The Digital ASIC contains acquisition RAM for quick data storage.
- Min/Max mode.
- Decoding of the internal ASIC addresses and synchronization of Digital ASIC and microprocessor access to the acquisition RAM.
- Display control. The Digital ASIC generates the picture to be displayed on the LCD.

The picture, generated by the Digital ASIC is displayed on the **Liquid Crystal Display (LCD)**. The LCD is controlled by the **LCD ROW DRIVERS** and the **LCD COLUMN DRIVERS**. The **LCD SUPPLY** section provides for the voltages needed. ScopeMeter test tool has a **BACKLIGHT CIRCUIT**, which can illuminate the LCD.

In the **MEMORY ASIC** (M_ASIC) a number of circuits are integrated:

- ADDRESS LATCH circuit
- MEMORY MANAGER, to control ROM and RAM
- KEYBOARD SCANNER
- BOOT CIRCUIT, to perform a correct startup
- LCD control circuits ODD/EVEN SELECTION and AB-MIX (RANDOMIZE)

3.2.2 Data acquisition

- Data acquisition path

The analog input signals are first attenuated and/or amplified and then converted into digital values by the ADC. The samples of the input signals are stored in the Acquisition RAM of the Digital ASIC. If 512 samples are stored in memory, the second trigger pulse will signal the microprocessor that the acquisition is ready. (We assume that the test tool is using random repetitive sampling, see next section.) Then the acquired data is ready for processing. The microprocessor reads the data from the Acquisition RAM and processes the data according to the actual calibration values. These calibration values (constants) are copied from Flash ROM to RAM during startup. The calibration values have been stored in Flash ROM during the calibration process. After processing, the data is stored in the External RAMs. These RAMs also contain the more static picture elements, for example the grid-, cursor- and text data.

- A multitasking kernel for hardware and software scheduling

Processing the acquired data is only one of the tasks of the microprocessor. The test tool uses a multitasking kernel for hardware and software scheduling, based on internal and external interrupts. The microprocessor contains internal timers, which can be programmed by the software. One of these timers is used to generate interrupts, e.g. to scan the keypad for depressed or released keys.

Except processing (calibrating) the acquired data, the microprocessor also does mathematical computations and controls the hardware. The multitasking kernel takes care that every 20 ms of processing time, a task is interrupted. This task will then be held and rescheduled, unless it requires execution without interruption. In this way a variety of user-requested tasks can be handled quasi-simultaneously, without the user being aware of the heavy loads on the microprocessor. The display of the data on the LCD is done by the Digital ASIC, also taking part in the multitasking scheme.

- Sampling and Triggering

The test tool uses two types of sampling, commonly used in many Digital Storage Oscilloscopes: **REAL-TIME SAMPLING** and **RANDOM REPETITIVE SAMPLING**.

In the real-time sampling mode (timebase settings: 60s/div...1 μs/div) the test tool takes a series of samples from a single period of the input signal. These samples are later used to reconstruct the signal. During the real-time sampling mode, the Digital ASIC calculates the trigger pulses out of the acquired data (for timebase settings between 60s/div...50 μs/div). For timebase settings between 20 μs/div and 5 ns/div, and for external triggering, the triggering is done by the Analog ASIC, using analog comparators.

In random repetitive sampling mode (time base 500 ns/div ... 5 ns/div), the test tool takes a sample from successive cycles in a repetitive signal. These samples are stored in memory and combined to reconstruct the original signal.

In this sampling mode, samples are taken from the input signal at intervals determined by the internal clock. Since there is no time-correlation between the system's clock and the incoming signal, all samples are taken at random points of the signal. The time between the trigger moment and the sampling moment must be tracked to enable reconstruction of the signal from the samples. This time, DELTA T, is generated by the Analog ASIC. See section 3.4.5 and figure 3.12.
During random repetitive sampling mode, the test tool always uses analog triggering (Analog ASIC).

3.3 DIGITAL CIRCUITS (A1)

3.3.1 Introduction

The following paragraphs describe the circuits on the digital A1 PCB in detail. Refer to circuit diagrams figure 9.2a and 9.2b in chapter 9.

3.3.2 Overview digital circuits

The digital circuitry of the ScopeMeter test tool can be separated into three main parts:

- Microprocessor circuitry
- Digital ASIC (in the following text: D-ASIC) circuitry
- LCD circuitry

A block diagram, which clearly shows the connections between these main parts, is shown in figure 3.1.

3.3.3 MICROPROCESSOR circuitry (μP)

- Introduction

The ScopeMeter test tool is controlled by a single chip microcomputer with on-board ROM (called Mask ROM in the following text). This microprocessor controls the total system operation and communication between the test tool and the outside world (key pad, RS-232-C interface). It also controls the communication between the internal system components.

- Detailed circuit description

See figure 3.1 and circuit diagram A1 (figure 9.2a).

Microprocessor

The ScopeMeter test tool uses an Intel 83C196 microprocessor (D1201), with on-board Mask-programmed ROM (Mask ROM). This microprocessor has a 16-bit multiplexed Address/Data-bus (called AD-bus in the following text). The address bits are latched in the M-ASIC D1210. The M-ASIC also buffers the microprocessor AD- bus.

The microprocessor's Mask ROM contains the startup software and a diagnostic kernel test (see chapter 7). It also contains the software to drive the serial RS-232-C interface. This enables the microprocessor to load software into the STANDARD ROM (Flash ROM).

STANDARD ROM D1242, 4M Flash EPROM, containts the system software.

The STANDARD RAM contains, amongst others, the actual ScopeMeter test tool settings, saved waveforms, saved setups, saved screens, and results of calculations on acquisition data. One of the following RAMs can be mounted: D1232 (M5M5256BRV, 32K*8), or D1230 (HM628128AR, 128K*8). The RAMs are powered by the RAM POWER circuit, which is battery backed up.

STANDARD ROM and STANDARD RAM are connected to the microprocessor via the AD- bus. The addresses are latched in the M-ASIC first.

The microprocessor contains five 8-bit I/O ports. Port 3 and 4 share their bits with the Address/Data bus. The other I/O ports 0, 1 and 2 are used for various purposes. For example: operating the RS-232-C interface, battery sense, switching the power on/off, switching the backlight on/off, etc.

Keypad circuitry.
The keypad switches are arranged in a matrix. The microprocessor controls the rows and reads the columns of the keypad matrix via the M-ASIC. If no key has been pressed, all ROW lines are set low. As the column lines are connected to the +5V supply via pull-up resistors located in the M-ASIC, the microprocessor reads high levels on all column lines.

Suppose that key F1 is pressed. Then column line COL0 goes low and the microprocessor detects that a switch in column 0 is pressed. Now the row lines are sequentially made high, and the microprocessor watches column line COL0 to see for which row line the COL0 line goes high. As key F1 is pressed, a high level on row line 0 will cause column line COL0 to go high.

Optically isolated RS-232-C interface
The serial communications circuitry, which is built into the microprocessor, is used to operate the infrared (IR) RECEIVER and TRANSMITTER of the ScopeMeter test tool. For this purpose a stripped version of the RS-232-C protocol is used.

Only the TXD (transmit data) and RXD (receive data) lines from the RS-232-C standard are used. The IR transmitter LED H1201 is driven directly from the TXD-not pin of the microprocessor. If a "0" is transmitted, the LED lights.

The IR receiver uses operational amplifier N1301 to power the collector of phototransistor H1202. If any IR light is received, the phototransistor will drive V1207 in saturation. This results in a "low" RXD line, interpreted by the microprocessor as a "1".

Battery sense circuitry
The battery voltage -VBAT generated on the analog unit is amplified by -2/3 at operational amplifier N1301. The resulting signal BAT_LEVEL is connected to an A/D converter input of the microprocessor. In this way the microprocessor can monitor the battery voltage level. If the battery voltage level drops below 4.3V, the microprocessor generates the BATTERY LOW indication on the LCD. If the level drops below 3.9V, the ScopeMeter test tool switches off.

Analog ASIC bus
The Analog ASIC (A-ASIC D2301, see circuit diagram A2a/A2b, figure 9.5/9.6) or A-ASIC, as used in the following text, is controlled by the microprocessor. The microprocessor uses the signals CDAT, CCLK and DTAEa,b,c to set the A-ASIC and the attenuator sections on the analog A2 PCB. These signals together form the CONTROL bus on the analog A2 PCB.

ON/OFF circuit.
To switch the test tool on/off, transistor V2542 in the power supply part on the Analog Board A2 must be made conductive/non-conductive (refer to section 3.4.9). If transistor V1503 is non-conductive, the POWER ON line (X1201:1) is open (high impedance). As a result V2542 is non-conductive as its gate-source voltage is zero (N-channel enhancement FET).

Switching ON:
The ON/OFF circuit operates almost like a thyristor. When the ON/OFF key is pressed, a current flows from +VRAM via R1502, R1503 V1502a, V1504, V1505, V1506 and R1507 to -VBAT. Transistor V1501 will become conductive. The POWER ON line goes high (+VRAM), and FET V2542 conducts as its Vgs becomes 8V (+VRAM -VBATT). Now the supply has been turned on. The microprocessor will set the ON/OFF line low. The Vbe of V1503 increases by the current drawn via V1501, R1504, R1505, V1502b and R1506. V1503 becomes conductive, and keeps V1501 conductive (thyristor function "on").

Note: *If the µP does not set the ON-OFF line low, the supply will not stay on when the ON/OFF key is released. To keep the supply on, independent of the µP, solder pad J1501 must be closed. This can be helpful at troubleshooting.*

Switching OFF:
When the ON/OFF key is pressed during power-on, the ON-RESET line goes low. The microprocessor receives a reset signal UPRESETN via V1513, D1215, and the M-ASIC (in: RESETN, out: uPRESETN). It will make the ON/OFF line high, and as a result V1503 and V1501 become non-conductive. The POWER ON line is now open (high impedance) and FET V2542 becomes non-conductive.

RESET circuit
The RESET circuit consists of V1510, V1512, V1513, D1215 and related components. When the ScopeMeter test tool power is switched on, the +5V supply voltage starts to rise. This causes the zener diode V1511 to conduct. After some time transistor V1510 also starts to conduct.
R1514 and C1510 form a time delay.

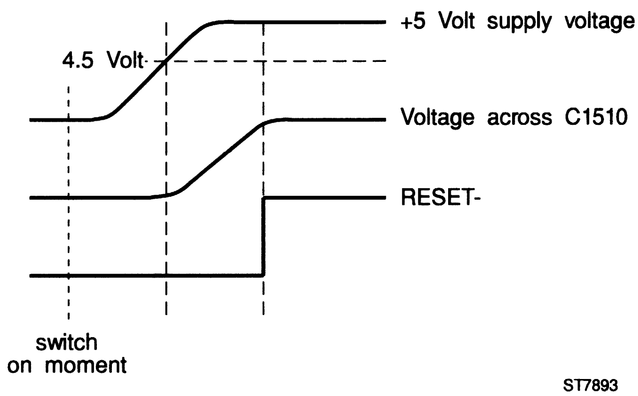


Figure 3.2 RESET signal timing

The RESET signal now is buffered by D1215 and connected with the RESET inputs of the M-ASIC (BOOT CIRCUIT) and the D-ASIC circuitry. The RESETN signal controls the EAN output of the M -ASIC.
After a reset, the voltage on the EA (External ACCESS) input of the microprocessor (pin 14) is "high" (EAN signal). The microprocessor starts up using the internal Mask ROM software. First the Flash ROMs are checked to see if they contain valid software. If this is true, the EAN line is set "low". Now the microprocessor invokes a software reset. Because of the "low" voltage on the EA input of the microprocessor, the microprocessor will "start up" again, using the external Flash ROM software. At the software reset, the microprocessor also enables the LCD by means of the signal LCDPWR.

3.3.4 DIGITAL ASIC (D-ASIC) circuitry

- Introduction

The Digital Application Specific Integrated Circuit (or D-ASIC) D1203 forms the core of the digital circuitry of the ScopeMeter test tool, all located on the digital A1 PCB.
Many functions are incorporated in this complex CMOS integrated circuit (see figure 3.4 on the next page):

- Timebase
- Trigger
- Acquisition Control Logic
- Acquisition RAM
- Min/max
- Display control
- Decoding and synchronization
- Digital-to-analog converters (DACs)

- Detailed circuit description:

See figure 3.3 and circuit diagram A1 (figure 9.2b).

The following gives a short description of the separate parts of the D-ASIC, which perform the functions mentioned above:

Timebase

The D-ASIC contains a crystal oscillator, which uses the 25 MHz crystal G1201. An internal programmable divider generates timebase signal TRACK with a frequency from 0.8333 Hz up to 25 MHz (see section 3.4.5). This TRACK signal is used to sample the input signals.

Trigger

The trigger module in the D-ASIC takes care of all trigger related functions:

- pre triggering
- post triggering
- event counting: the time interval corresponding to the trigger delay is increased by a programmed number of "events" (trigger level crossings of the external trigger signal), which must occur before triggering.
- n-cycle mode: trigger level crossings of the input signal are counted, and triggering occurs every n^{th} crossing ($2 < n < 255$). The n-cycle mode can be used as a digital trigger hold-off.

In the real-time sampling mode (time base 60s/div ... 1 µs/div), the D-ASIC determines the trigger moment with digital comparators. In the quasi-random sampling mode, the A-ASIC determines the trigger moment with analog comparators.

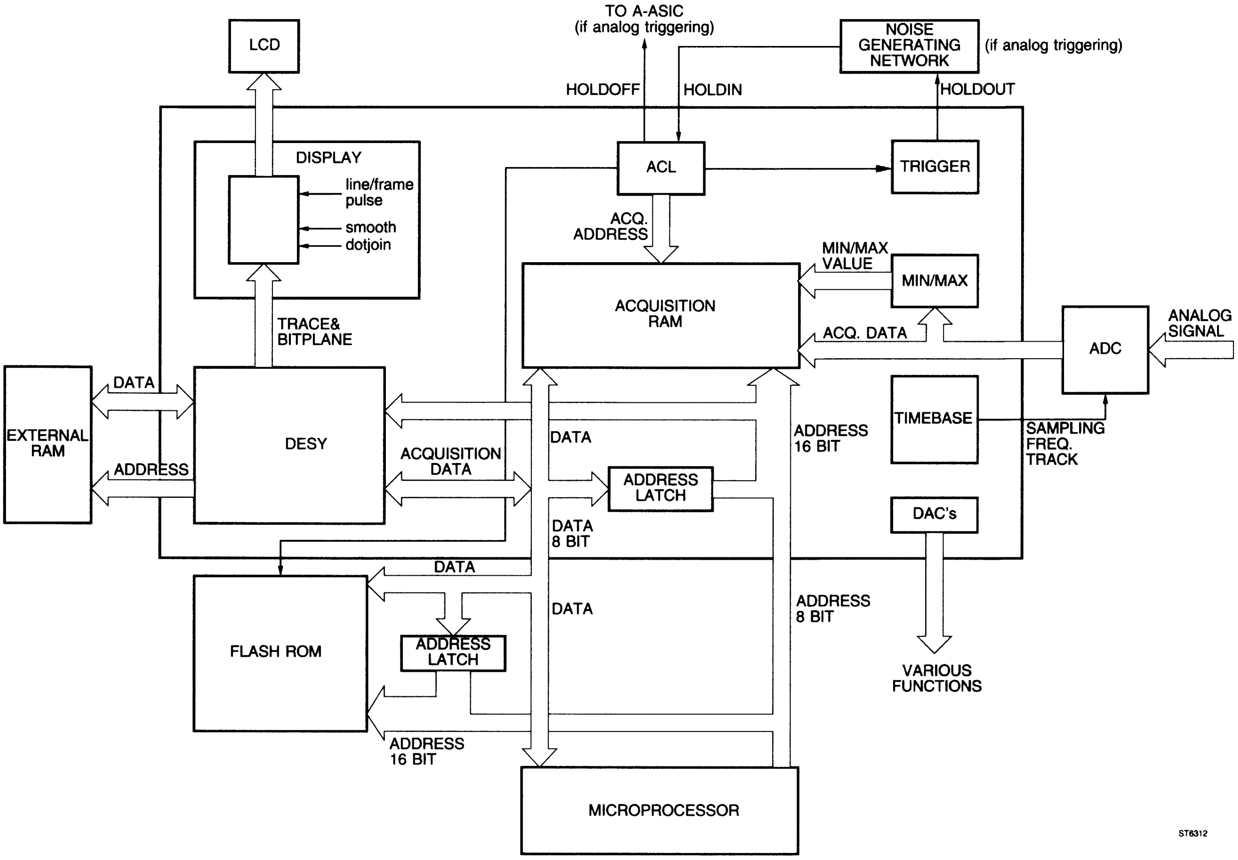


Figure 3.3 Schematic Diagram D-ASIC D1203

Acquisition Control Logic (ACL)

The ACL controls the analog input circuitry and the ADC (N2302, see circuit diagram A2a/A2b, figure 9.5/9.6). The ACL also writes the digital representations of the input signals to the Acquisition RAM in the D-ASIC, according to the selected trigger and acquisition modes. Before the acquired trace data is displayed, it is first processed by the microprocessor. The microprocessor corrects for offset- and amplification errors, using the calibration values that are stored in Flash ROM.

In fast timebase positions the ACL acquires 1024 values. Then the acquisition is stopped and the microprocessor can read the data out of the Acquisition RAM. In slow timebase positions the ACL uses the Acquisition RAM as a FIFO (First In First Out) memory. The microprocessor can start reading the acquired data immediately after triggering. Now there is synchronization between the ACL and the microprocessor.

If the system uses analog triggering (time base 20 µs/div ... 5 ns/div), the trigger hold-off signal (HLDOFFN) to the A-ASIC is generated. The D-ASIC generates the HLDOUTN signal. This signal is fed to the HLDIN input of the D-ASIC, via R1259 and C1257. These components generate jitter on the HOLDOFF signal, which is needed as a random factor in the Delta- T circuit.

Glitch detect

The Min/max module finds the minimum and maximum value of the input signals between two time base pulses, and writes them into the Acquisition RAM. To detect narrow glitches, the TRACK signal (ADC sample frequency) is always 25 MHz when GLITCH DETECT is selected.

Display control
This module reads screen data from the External RAMs (D1208, D1209 or D1218) and sends it to the LCD. It also sends line pulses LINECL (17 kHz) and frame pulses FRAME (70 Hz). This screen data, consisting of for example cursor and grid information, is stored in External RAMs as bitplane information. The trace data is stored as a value for every vertical line on the LCD. This data is converted to bitplane data and added to the cursor and grid information. The display control module also makes it possible to change the dotsize of the signal displayed and to use dot joining.

Decoding and synchronization (DESY)
The DESY section is the decoder for the D-ASIC's internal addresses. This module also synchronises the microprocessor with the D-ASIC's Display control module, as both access the same Acquisition RAM.

Digital to analog converters (DACs)
The DACs module contains 10 one-bit pulse width modulated monotonous DACs, whose resolution ranges from five to ten bits. The DACs are used to control level shifting, analog trigger level, LCD contrast and the generator function (see section 3.4.7).

External RAMs

One of the following RAMs can be mounted: D1208 (HM62256AR, 32K*8), D1218 (M5M5256BRV, 32K*8), or D1209 (HM628128AR, 128K*8). The RAM contains:

- bitplane data for the LCD picture
- text, to be used on the display
- data in RECORD mode
- data in A versus B mode (A= ↑ B= →)
- bitplane data used while making a printout of the screen

Ram Power circuit
The External RAM and the Standard RAM are powered by the RAM Power circuit. The RAM Power circuit is fed directly by the batteries, independently of the main power supply. Backup battery G1300 powers the RAMs if the batteries are removed. So no saved data (setups, waveforms, screens) will be lost then.
The RAM Power circuit is a simple oscillator, used to generate a stabilised voltage +VRAM out of the battery voltage -VBAT. The basic oscillator circuit is shown in figure 3.4.

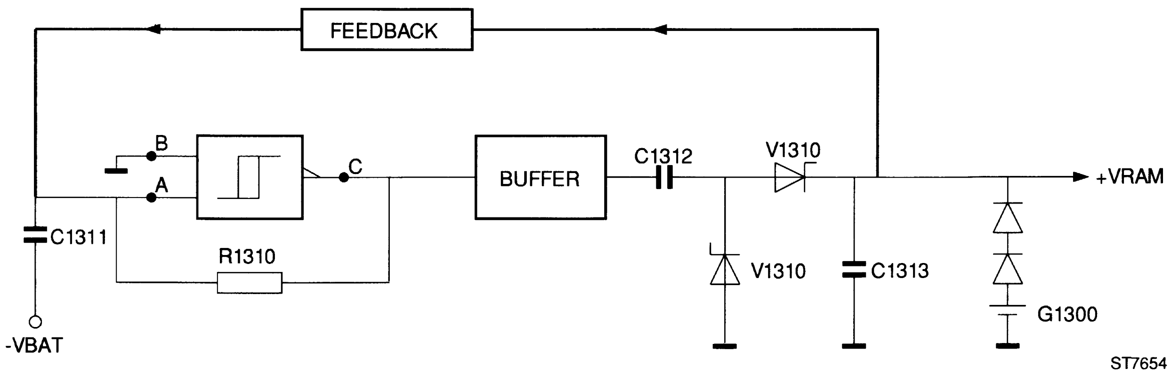


Figure 3.4 RAM Power circuit

Input B of Schmitt input NAND D1310 is connected to ground "high". When the voltage on input A is "low", the output C will be "high". Capacitor C1311 will charge via R1310. After some time input A will become "high", resulting in a "low" output C.

Capacitor C1311 will then discharge via resistor R1310. The generated output pulses are buffered and converted into a DC voltage by C1312, V1310 and C1313. The output voltage +VRAM is fed back to the NAND input A, via several transistors (voltage gap). If the output voltage +VRAM has reached the correct value, the pulse train at NAND output C is stopped via this feedback (see figure 3.6).

In this way capacitor C1313 is charged just enough to keep the output voltage +VRAM at a stable value (3V DC).

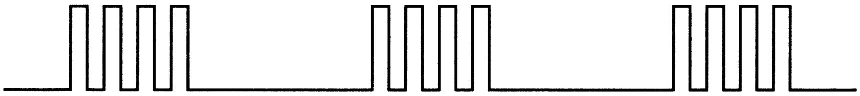


Figure 3.5 Pulse train signal on input A of Schmitt input NAND (Test Point 310)

3.3.5 LCD circuitry

- Introduction

The LCD used in the ScopeMeter test tool is controlled by six LCD driver integrated circuits. These drivers get their information (data- and control signals) from the D-ASIC. The microprocessor enables the display when valid data is present.

The test tool is provided with a transflective LCD with a backlight, which can be switched on or off by the user.

- Detailed circuit description

See figure circuit diagram A1 (figure 9.2).

LCD

The test tool uses a Super Twisted Nematic Liquid Crystal Display (LCD H1401, see circuit diagram A1, figure 9.2), with a resolution of 240 * 240 pixels.

The picture on the LCD screen is written column (vertical line) after column, rather than row (horizontal line) after row.

LCD drivers

The LCD display is controlled by the D-ASIC, via six LCD drivers:

- three LCD row drivers: D1404, D1405, D1406, each controlling 80 rows.
- three LCD column drivers: D1401, D1402, D1403, each controlling 80 columns.

Description of the LCD drivers input-/output signals:

LCD driver outputs Y1...Y80 and X1...X80

These outputs are connected to the LCD matrix. Every column driver serves 80 pixel columns of the LCD. Every row driver serves 80 pixel rows. The output signals are staircase signals, with levels equal to the V1...V6 voltages.

Data inputs D0... D3 (row drivers only!)
The actual display data coming from the D-ASIC is sent via the LCDCTL (LCD ConTroL) bus to the LCD drivers D0...D3 inputs. Data are provided via the lines:
- LCD1, LCD3, LCD1A, and LCD3A to D1404; D1404 controls the even numbered rows Y2...Y160.
- LCD0, LCD2, LCD0A, and LCD2A to D1405; D1405 controls the odd numbered rows Y1...Y159.
- LCD0, LCD1, LCD2, and LCD3 to D1406; D1406 controls the odd and even rows Y161...Y240.

The signals LCD0A...LCD3A are derived from LCD0...LCD3 by the odd/even circuit in the M-ASIC.

Terminal input voltages V1...V6
Out of the voltages V1...V6 the LCD drivers generate the staircase signals. The voltages are generated by the LCD SUPPLY circuit.

Display control signals LINECL, DATACL, DTCLA, M1, FRAME
These signals are used to control the LCD. The LCD picture is constructed from these display control signals and the data signals and sent to the LCD via the LCD driver outputs.
DATACL clocks the data into the driver buffer of D1406, DTCLA clocks the data into the driver buffers of D1404 and D1405.
The FRAME signal is the data signal for the column drivers D1401, D1402 and D1403.
LINECL clocks one complete line (column) into the LCD.
The M1 signal is described furtheron (see "M-randomize section" below).

LCD supply section
The pulse modulated signal, CONTR (contrast), comes from the D-ASIC. CONTR is filtered by R1430 and C1430 to get a DC voltage. The value of this voltage depends on the duty cycle of the CONTR signal. Via V1435, divider resistors R1420...R1424 and buffer opamps N1420, the CONTR signal controls the value of the voltages V1, V3, V4, V5 and V6. The LCD contrast depends on the value of these voltages.
As long as the signal LCDPWR, coming from the microprocessor, is "low" (0V), transistor V1435 does not conduct, and voltage V2 is approximately zero. As a result the LCD is blanked. After the microprocessor invokes a software reset, the LCDPWR line is made "high". Then V2 becomes approximately -20V.
The voltages V1...V6 are temperature corrected to compensate for the temperature dependency of the LCD (80 mV/°C). These voltages have to be corrected by the same amount to get a constant (over a temperature range) brightness and contrast of the LCD. This temperature compensation done by Positive Temperature Coefficient (PTC) resistor R1433. If the value of this resistor changes, also V2 changes. Voltage V2 is made out of the -30V voltage, coming from the Analog A2 PCB. Transistor V1432 limits the current through V1433 to approximately 30 mA. If the current exceeds 30 mA, the voltage drop across R1439 causes V1432 to start conducting.

M-Randomize section
The signal M ("LCD backplane modulation signal"), generated by the D-ASIC, has a time relation with the display control signals. The M-Randomize section in the M-ASIC converts M into M1, which is not time related to other display control signals. The M1 signal is used by the LCD drivers to convert all DC voltages into AC voltages without any DC component, able to drive the LCD. A DC component of the LCD drive voltage can cause memory effects on the LCD.

Backlight circuitry
The backlight circuitry is based on the Hartley oscillator principle. Components V1443, T1440, and C1441 form the oscillator. Transistor V1440 supplies the current to the circuit. This transistor is switched on/off by the LIGHT signal (backlight on/off), coming from the microprocessor.
The output voltage is regulated via transistor V1441 and diodes V1340B, V1442, V1444 and V1445. If the backlight voltage becomes more than 200V peak-to-peak, V1441 will draw away current (energy) supplied to the oscillation circuit.

3.3.6 M-ASIC

The M-ASIC D1210 contains a number of more or less independent circuits:

Address latch
The multiplexed Microprocessor AD bus (AD0...AD15) is supplied to the M-ASIC. The M-ASIC latches the address bits, and supplies them to the address outputs A00...A14.

Memory manager
The memory manager is a collection of circuits, mainly intended to control the ROM and RAM memories.

Keyboard scanner
The keyboard scanner consists of a row driver and a column read back circuit.
The row driver controls the keyboard rows after a switch has been pressed.
The column read back circuit reads the columns after the level at a row driver output has been changed.
Refer also to Section 3.3.3. "MICROPROCESSOR circuitry, keyboard circuitry".

Boot circuit
The boot circuit controls the Microprocessor EAN line. Refer to Section 3.3.3 "MICROPROCESSOR circuitry, RESET circuit" for detailed information.

Odd/even selection
This circuit cares that data for the even LCD lines Y2...Y160, and data for the odd LCD lines Y1...Y159, are supplied to respectively D1404 and D1405.

M-Randomize (AB-MIX)
The M-Randomize part generates the LCD backplane modulation signal M1. This signal M1 is de-synchronized from the other display control signals in order to prevent memory effects on the display. See also DISPLAY CONTROL SIGNALS.

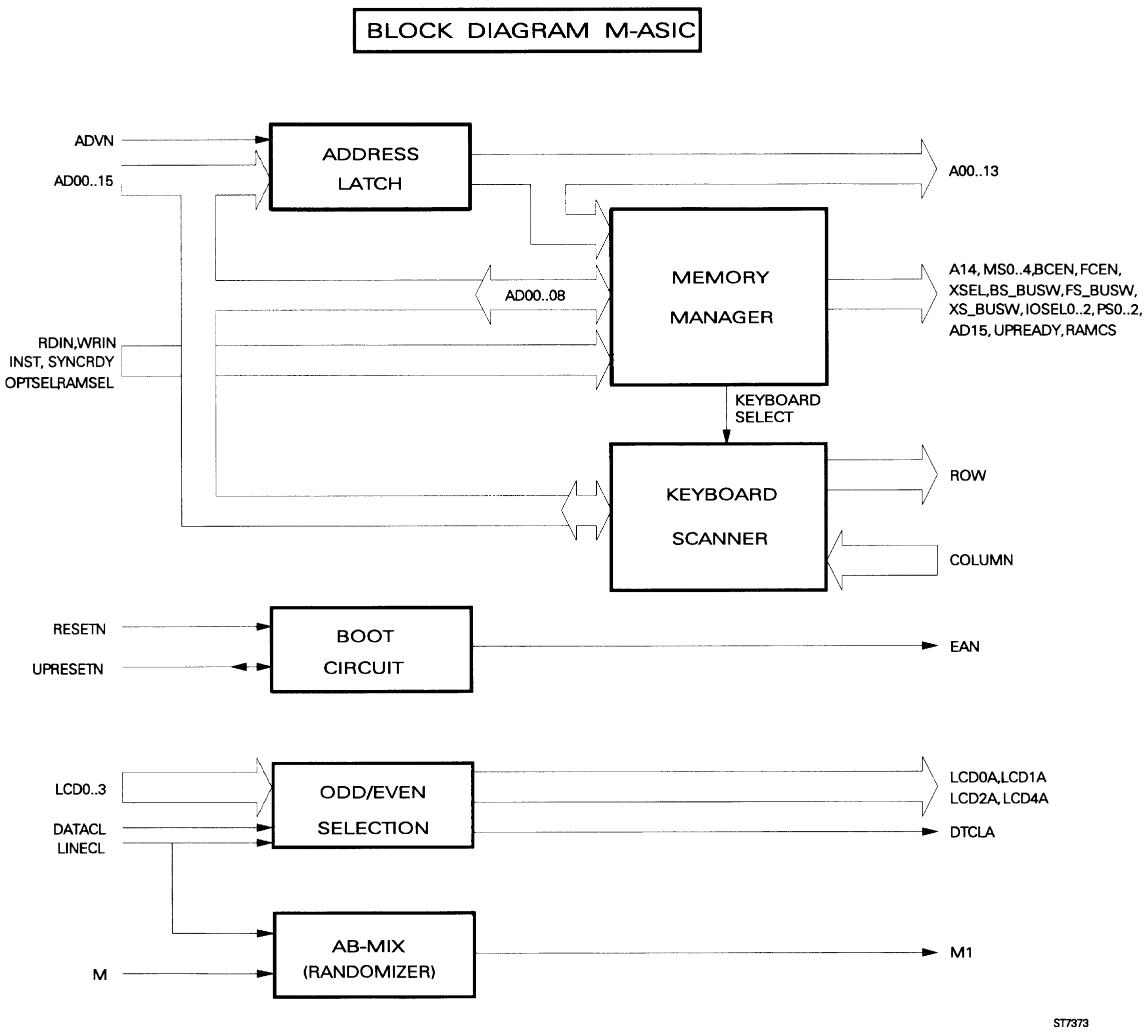


Figure 3.6 M-ASIC block diagram.

3.4 ANALOG CIRCUITS (A2)

3.4.1 Introduction

This paragraph describes the circuits on the analog A2 PCB in detail. Refer to circuit diagrams A2a, A2b, and A2c (figures 9.4a, 9.4b, and 9.4c in chapter 9).

3.4.2 Overview analog circuits

The analog A2 PCB contains several functional parts:

- circuits in the acquisition path
  - attenuator sections
  - EXTernal (banana) input/output circuitry
  - Analog ASIC and ADC circuitry
- control circuitry
- signal generator
- power supply and battery charger

Each of these parts will be described separately. First a short introduction is given, followed by a detailed description.

3.4.3 ATTENUATOR sections, CHANNEL A and B

- Introduction

See figure 3.7.

The attenuator sections of both channels A and B are identical. In the following only channel A is described. The corresponding components for channel B have the same numbering, except the second number, which is '1' instead of '2'. For example: R2202 in channel A corresponds with R2102 in channel B.

The attenuator section consists of a high frequency (here after referred to as H.F.) path and a low frequency (here after referred to as L.F.) path, which are combined again in the impedance converter (see figure 3.7). To get a flat frequency characteristic, both paths must overlap over a wide frequency range. Circuits are provided for automatic offset compensation.
The output of the attenuator sections of channel A and B is processed further by the A-ASIC.

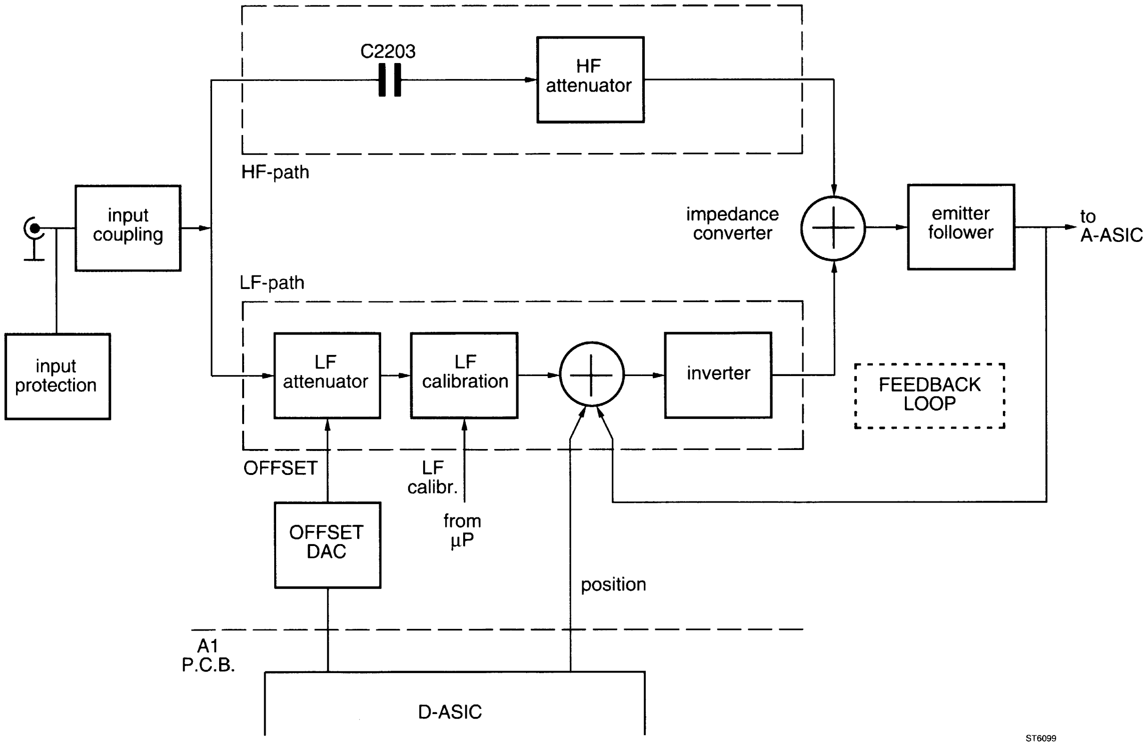


Figure 3.7 Schematic diagram attenuator section

- Detailed circuit description

See figure 3.7 and circuit diagram A2a (figure 9.4a).

Input coupling

The incoming signal first passes the AC/DC coupling section (C2202). When relay K2201 is opened, the signal is AC coupled via C2202.

H.F. (high frequency) path

After the coupling section, the L.F. part of the signal is blocked by capacitor C2203. Only the H.F. part of the input signal enters the H.F. attenuator. This is a triple capacitive divider, consisting of a 1 to 100, a 1 to 10, and a 1 to 1.48 divider.

The 1 to 1.48 divider section is switched on when relay switches K2202 and K2203 are in the "upper" position (as shown on circuit diagram A2a, figure 9.5).
The 1 to 1.48 divider consists of C2203 and C2209 in parallel with some parasitic capacitors. The attenuation of 1.48 times in this straight-on path is compensated for later in the circuitry.

The separate sections are switched in the signal path, depending on the attenuation required:

Table 3.2 Sections used in various attenuator settings

Attenuator Settings	Sections Used	Attenuation
5 mV/div 100 mV/div	1.48x	1.48 times
200 mV/div 1 V/div	1.48x, 10x	14.8 times
2 V/div 10 V/div	1.48x, 100x	148 times
20 V/div 100 V/div	1.48x, 10x, 100x	1480 times

In the ScopeMeter test tool the response of the H.F. attenuator sections is adjusted by means of three variable capacitors C2209, C2207 and C2114. These variable capacitors are used to compensate for parasitic capacitors of the printed circuit board.
The 1 to 1.48 divider (1 to 1.48 section) can be adjusted with variable capacitor C2209.
The 1 to 14.8 divider (1 to 1.48 and 1 to 10 sections) can be adjusted with variable capacitor C2207.
The 1 to 148 divider (1 to 1.48, 1 to 10 and 1 to 100 sections) can be adjusted with capacitor C2214.

NOTE: These capacitors do not have to be readjusted at every calibration. (see chapter 5, section 5.6.1) The capacitors are rough adjustments, used to compensate for hardware differences. The attenuator response is fine adjusted by means of the L.F. calibration section (see next page).

Impedance converter
The output of the H.F. path is connected with the impedance converter, formed by transistors V2207 and V2209 (see circuit diagram A2a, figure 9.4a). The bias voltage of V2207 is determined by R2216. To prevent destruction of the gate of V2207 by high voltages or voltage peaks, two clamps V2206 and V2204 are provided. Summation of the H.F. and the L.F. signal parts is obtained in transistor V2207, which acts as the collector impedance of V2208.

L.F. (Low frequency) path
The L.F. part of the input signal enters the L.F. path, which consists of a L.F. attenuator section, a L.F. calibration section and a regulating feedback loop, which consists of a summator, inverter, another summator, and an emitter follower (see figure 3.7).

L.F. attenuator
Fig 3.8 shows the L.F. attenuator section in detail:

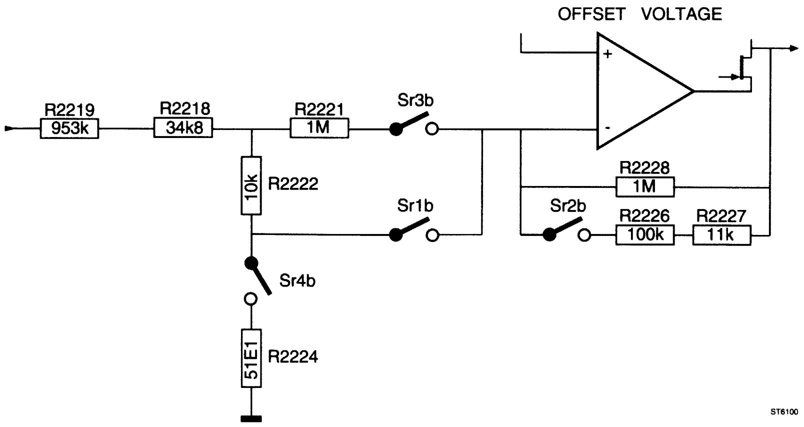


Figure 3.8 Principal diagram L.F. attenuator section

The L.F. attenuator consists of an inverting amplifier, N2201, which attenuates the L.F. signal by a factor, depending on the settings of switches D2201. These switches are controlled by signals named Sr1b...Sr4b. A "high" signal closes the corresponding switch.

Table 3.3 Attenuator drive signals Sr1b...Sr4b

Attenuator settings	Sr1b	Sr2b	Sr3b	Sr4b	Attenuation up to TP207	Attenuation up to TP204
5 mV/div...100 mV/div	high	low	low	low	1.48 times	1 time
200 mV/div...1 V/div	high	high	low	low	14.8 times	10 times
2 V/div...10 V/div	low	low	high	high	148 times	100 times
20 V/div...100 V/div	low	high	high	high	1480 times	1000 times

The attenuation of the LF CALIBRATION and FEEDBACK LOOP is about 1.48 times.

The signal Sr4b operates the switch, which is used to ground the L.F. part of the input signal during offset calibration. This is done automatically to prevent drift.

The offset DAC circuitry (see figure 3.7) provides the offset voltage for operational amplifier N2201. The offset compensation is done automatically by means of the signals So10b...So14b, coming from the D-ASIC.

L.F. Calibration

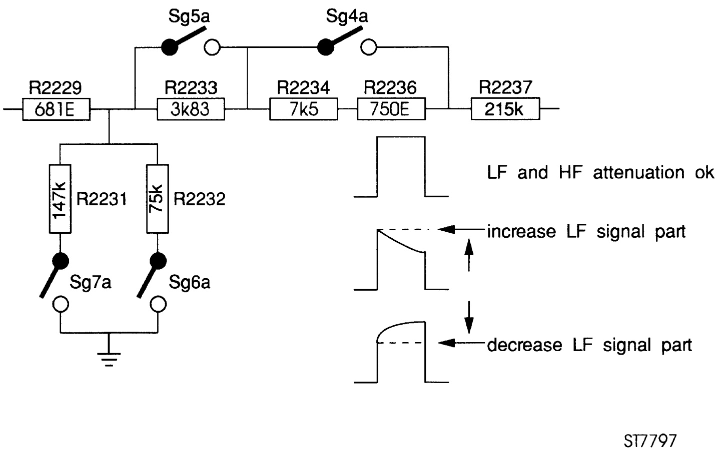


Figure 3.9 Automatic adjustment of the L.F. attenuation

Fine adjustment of the L.F. path attenuation is completed during calibration of the H.F. path attenuation. This is done by means of a simple 4-bits D-to-A converter, consisting of resistors R2229, R2231, R2232, R2233, R2234, R2236, and switches D2202. These switches are operated by signals Sg4a, Sg5a, Sg6a, and Sg7a, see figure 3.6. Resistors R2229, R2231 and R2232 divide the output signal of the attenuator section. Resistors R2233, R2234, and R2236 increase the input resistance of the inverting amplifier of the regulating loop.

Feedback loop

The output signal of the impedance converter is fed back to the input of operational amplifier N2201, with the signal coming from the L.F. calibration section (via R2237) and a DC position voltage (via R2248), proportional with the MOVEment of the trace (via R2248). Transistor V2210 is used to enlarge the dynamic range: when D-POSCHA is active, R2270 is incorporated in the circuitry.

The feedback loop operates as follows. If, for example, the output signal of the L.F. path is too small, the correction amplifier N2201 will drive V2207 via V2208. In this way the amplitude of the L.F. path and the position voltage are increased (compensation).

Input protection

The input protection safeguards the test tool against overvoltage. The input protection circuit consists of C2203 and V2206/V2204 (clamp HF attenuator) and R2219 and V2212/V2213 (clamp LF attenuator).

PTC resistors R2256/R2276 protect the test tool against accidental misuse, which involves applying voltage between the BNC input common and the black banana jack input common.

3.4.4 BANANA JACK INPUT/OUTPUT circuitry

- Introduction

See figure 3.10.

The ScopeMeter test tool is provided with two safety 4 mm banana jack inputs, which are used as inputs in the EXT mV, DIODE TEST, and OHM modes or as EXTernal trigger input in SCOPE mode. These banana jack inputs also serve as outputs for the built-in generator. Protection circuitry is provided to prevent damage by overvoltage.

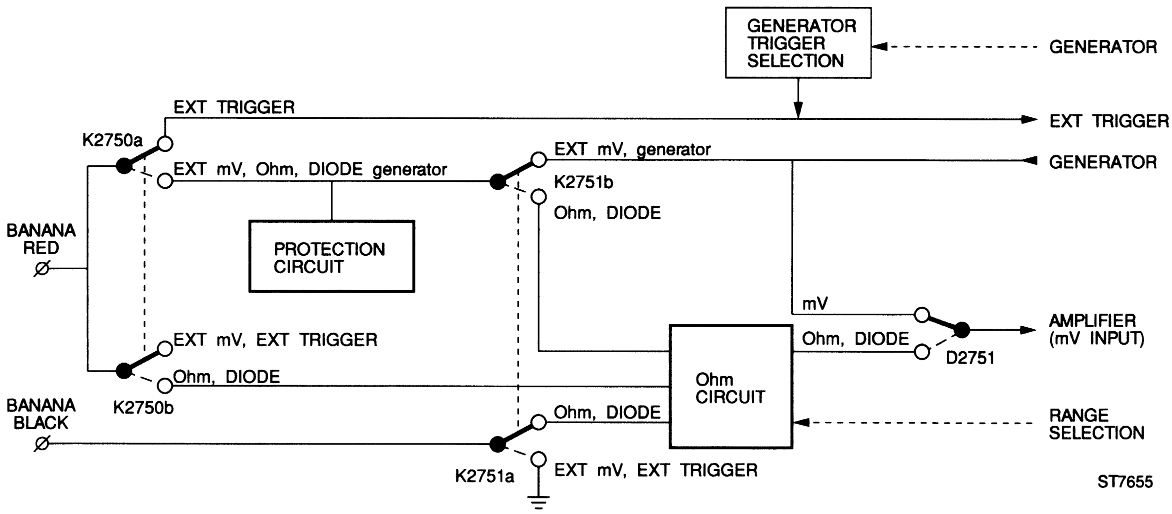


Figure 3.10 Schematic diagram signal flow in Banana jack input/output circuitry

- Detailed circuit description

See figure 3.10 and circuit diagram A2b (figure 9.4b).

EXT mV measurement circuitry

The EXT mV input voltage on the red banana jack input is fed to the L.F. part of the channel A attenuator section, via the following path: R2750, K2750a, K2751b, R2761, D2751 (refer to circuit diagram A2b, figure 9.6). When the test tool is switched to EXT mV measurement the settings are as follows:

Table 3.4 A-ASIC and attenuator settings in EXT mV mode

RANGE	A-ASIC (D2301)	LF-ATTENUATOR (channel A)
300 mV 3 V	100 mV/div 100 mV/div	1* 0.1*

Ohm measurement circuitry

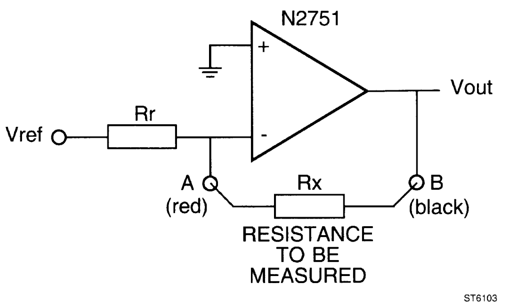


Figure 3.11 Ohm measurement circuitry (principle of operation)

The resistance R_x to be measured is connected as a feedback resistor of an amplifier circuit (opamps N2751). The output voltage of this measuring amplifier is proportional to resistance R_x:

$$V_{out} = (V_{ref}/R_r) \times R_x$$

The different ranges are obtained by selecting different values for resistor R_r. This can be done with the Ohm range selection circuit (D2750 and surrounding resistors), which is controlled by the Analog Control circuitry (circuit diagram A2a, figure 9.5, B-OFFSET lines).

Table 3.5 Ohm range selection circuit control lines

RANGE	Sc15	Sc16	Sc17	Sc18
300Ω	1	0	1	0
3kΩ	1	0	1	0
30kΩ	1	0	0	0
300kΩ	1	1	0	0
3MΩ	0	1	0	0
30MΩ	0	1	0	0

Switches D2751 choose between the EXT mV voltage and the voltage from the Ohm circuit. The outputs of these switches are connected to the L.F. part of the channel A attenuator (circuit diagram figure 9.3b).

Diode measurement circuitry
While in DIODE METER mode, the test tool uses the same circuitry as in the 300Ω range of the OHM mode.

WARNING: The BLACK banana jack input is not connected to the BNC grounds, while in OHM or DIODE METER mode! While in OHM er DIODE METER mode, the ScopeMeter test tool can not be grounded via the BLACK banana jack input.

EXTernal triggering
The trigger signal is fed to the A-ASIC on A2a figure 9.4a via resistor R2750 and voltage divider R2753/R2754 (see circuit diagram A2b, figure 9.4b). It is also possible to trigger on the signal made by the generator. Then the trigger signal is made out of the signals STIMUL and G-OUTP by D2850, V2758, and related components.

Generator signal
The output of the generator (see paragraph 3.4.7) is sent to the EXT banana jack inputs via K2751b, K2750a and R2750.

Protection circuit (generator mode)
If a high voltage is applied to the banana jack inputs A and B, a current will flow from input A, through PTC (Positive Temperature Coefficient) R2750, zener diodes V2750 or V2751 and via V2752 and V2753 back to input B (see circuit diagram A2b, figure 9.4b). The voltage across the zener diodes is limited to 7.5V for each diode. The rest of the input voltage is dropped across R2750. The resistance of this PTC will rise and limit the current in the circuit. Opamp N2750 drives V2752 and V2753, to prevent capacitive load of the generator by these zener diodes.

Protection (Ohm and diode measurement)
If a high voltage is put on the banana jack inputs, this results in an increase of the voltage over PTC R2750. This increases the value of this PTC, limiting the current in the circuit. Zener diode V2764 limits the output voltage of the measuring amplifier circuit N2751. Resistor R2771 and clamp diodes V2759...V2763 protect the input of the measuring amplifier.

3.4.5 ANALOG ASIC (A-ASIC) and ADC circuitry

- Introduction
See figure 3.12.

The signals coming from the channel A and B attenuators are fed to D2301. Various oscilloscope functions are integrated in this Application Specific Integrated Circuit (ASIC).
Analog ASIC D2301 selects the signal source and prepares the signal for further processing by the ADC circuitry. Also a trigger signal is derived from one of the channel A or B inputs or the external trigger input (banana connectors).

- Detailed circuit description
See figure 3.12 and circuit diagram A2a/A2b (figure 9.4a/9.4b).

First a short description is given for the internal circuits of the A-ASIC. The schematic diagram of the A-ASIC D2301 is shown in figure 3.12. The A-ASIC input/output signals are also described in the following sections.

Channel A Amplifier and Channel B Amplifier
The output signals of the channel A and B attenuator sections are amplified in the A-ASIC to obtain the most sensitive ranges.

Table 3.6 A-ASIC relative amplification at various attenuator settings

Attenuator setting:	A-ASICrelative amplification:
100 mV/div	1 time
50 mV/div	2 times
20 mV/div	5 times
10 mV/div	10 times
5 mV/div	20 times
2 mV/div*	10 times
1 mV/div*	20 times

(* both 1mV/div and 2 mV/div settings are made by multiplying times five and averaging the signal in 5 mV/div. and 10 mV/div.)

The standard gain of the A-Asic in 100 mV/div. is 2.6 times.
The A-ASIC itself can handle input signals with a maximum amplitude of 750 mV peak-peak. A vertical offset voltage YPOS is added to the signal in the attenuator sections (section 3.4.3). This means that 0V on an A- ASIC input terminal results in a trace in the vertical middle of the screen.

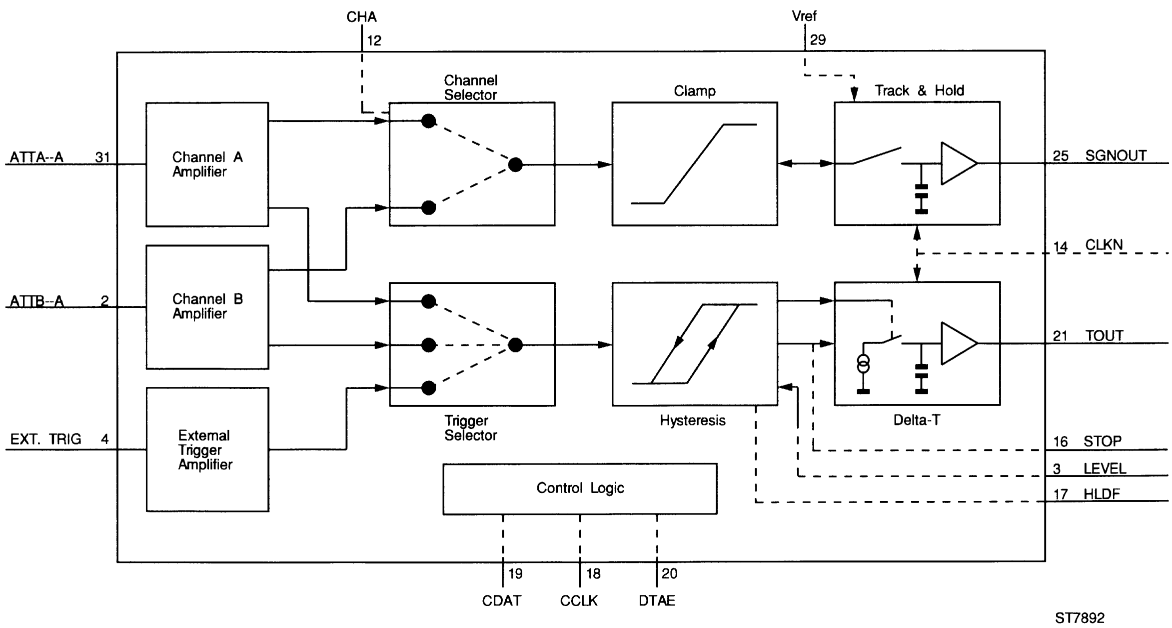


Figure 3.12 Schematic diagram A-ASIC D2301

Channel Selector

The channel selector selects channel A or channel B, depending on the level of the CHANA signal (input 12).

If CHA is "high" (> 3.5 V) channel A is selected.
If CHA is "low" (< 1.5 V) channel B is selected.

If a timebase speed faster than 20 μs is selected, both channels are displayed in alternate mode and CHA is a square wave signal with a timebase-dependent frequency (see table 3.7). If a timebase speed slower than 50 μs is selected, both channels are displayed in chopped mode. The CHA signal is a square wave signal with a trigger-dependent frequency of 500 kHz maximum.

Table 3.7 Frequencies of A-ASIC signals in various modes

Time Base	TRACKN freq 1)	CHA freq 1)	MODE horizontal		MODE vertical		TRIGGER 2)
60 s/div	0.8333 Hz	0.416 Hz	roll		CHOP	REAL TIME	DIGITAL
20 s/div	2.5 Hz	1.25 Hz	roll		CHOP	REAL TIME	DIGITAL
10 s/div	5 Hz	2.5 Hz	roll		CHOP	REAL TIME	DIGITAL
5 s/div	10 Hz	5 Hz	roll		CHOP	REAL TIME	DIGITAL
2 s/div	25 Hz	12.5 Hz	roll		CHOP	REAL TIME	DIGITAL
1 s/div	50 Hz	25 Hz	RECURRENT	SINGLE	CHOP	REAL TIME	DIGITAL
.5 s/div	100 Hz	50 Hz	RECURRENT	SINGLE	CHOP	REAL TIME	DIGITAL
.2 s/div	250 Hz	125 Hz	RECURRENT	SINGLE	CHOP	REAL TIME	DIGITAL
.1 s/div	500 Hz	259 Hz	RECURRENT	SINGLE	CHOP	REAL TIME	DIGITAL
50 ms/div	1 kHz	500 Hz	RECURRENT	SINGLE	CHOP	REAL TIME	DIGITAL
20 ms/div	2.5 kHz	1.25 kHz	RECURRENT	SINGLE	CHOP	REAL TIME	DIGITAL
10 ms/div	5 kHz	2.5 kHz	RECURRENT	SINGLE	CHOP	REAL TIME	DIGITAL
5 ms/div	10 kHz	5 kHz	RECURRENT	SINGLE	CHOP	REAL TIME	DIGITAL
2 ms/div	25 kHz	12.5 kHz	RECURRENT	SINGLE	CHOP	REAL TIME	DIGITAL
1 ms/div	50 kHz	25 kHz	RECURRENT	SINGLE	CHOP	REAL TIME	DIGITAL
.5 ms/div	100 kHz	50 kHz	RECURRENT	SINGLE	CHOP	REAL TIME	DIGITAL
.2 ms/div	250 kHz	125 kHz	RECURRENT	SINGLE	CHOP	REAL TIME	DIGITAL
.1 ms/div	500 kHz	250 kHz	RECURRENT	SINGLE	CHOP	REAL TIME	DIGITAL
50 µs/div	1 MHz	500 kHz	RECURRENT	SINGLE	CHOP	REAL TIME	DIGITAL
20 µs/div	1.25 MHz	Trigger dependent	RECURRENT	SINGLE	ALT	REAL TIME	ANALOG
10 µs/div	2.5 MHz	Trigger dependent	RECURRENT	SINGLE	ALT	REAL TIME	ANALOG
5 µs/div	5 MHz	Trigger dependent	RECURRENT	SINGLE	ALT	REAL TIME	ANALOG
2 µs/div	12.5 MHz	Trigger dependent	RECURRENT	SINGLE	ALT	REAL TIME	ANALOG
1 µs/div	25 MHz	Trigger dependent	RECURRENT	SINGLE	ALT	REAL TIME	ANALOG
.5 µs/div	25 MHz	Trigger dependent	RECURRENT	SINGLE	ALT	RANDOM	ANALOG
.2 µs/div	25 MHz	Trigger dependent	RECURRENT	SINGLE	ALT	RANDOM	ANALOG
.1 µs/div	25 MHz	Trigger dependent	RECURRENT	SINGLE	ALT	RANDOM	ANALOG
50 ns/div	25 MHz	Trigger dependent	RECURRENT	SINGLE	ALT	RANDOM	ANALOG
20 ns/div	25 MHz	Trigger dependent	RECURRENT	SINGLE	ALT	RANDOM	ANALOG
10 ns/div	25 MHz	Trigger dependent	RECURRENT	SINGLE	ALT	RANDOM	ANALOG
5 ns/div	25 MHz	Trigger dependent	RECURRENT	SINGLE	ALT	RANDOM	ANALOG

1) In MIN/MAX mode the frequency of CHA is zero and the sample frequency TRACK is always 25 MHz.
2) External triggering is always analog.

Output buffer
The DC bias level of the output signal is controlled by the Vref input. Vref assures, the signal is centered within the dynamic range of the ADC.

Track & Hold
The maximum sampling frequency of the ADC used in the ScopeMeter test tool is 25 MHz. Because of this a Track & Hold circuit is incorporated in the A-ASIC. The Track & Hold circuit determines the frequency range of the whole system.

The timing in this part of the A-ASIC is determined by clock signal TRACK (input 13). The frequency of the TRACKN signal depends on the selected timebase speed (see table 3.7).

The output signal, SGNOUT, (output 25) is fed to the ADC. The voltage range of SGNOUT is 1.5V...3.5V. The intermediate level of SGNOUT is derived from the VREF voltage level, which is made by the ADC.

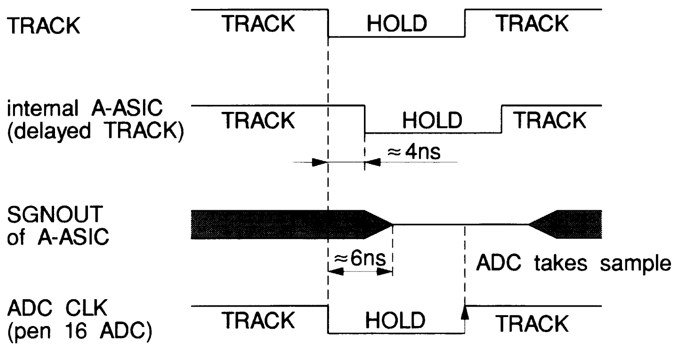


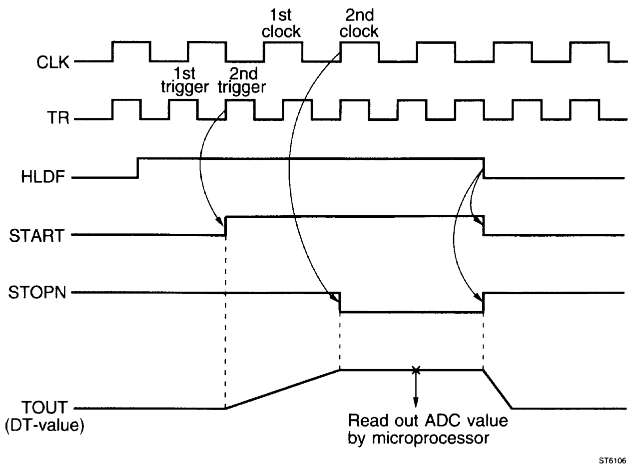
Figure 3.13 Track & Hold timing

External Trigger Amplifier
This amplifier section processes the incoming external trigger signal so that it can be used in the trigger section. The input of this section is TTL compatible in mode 1/10.

Trigger Selector
In this section the channel A, channel B or external trigger input signal is selected to act as trigger source. The trigger slope is also selected in this block.

Hysteresis
The hysteresis section converts the trigger signal into a pulse shaped signal. Because of the hysteresis, the circuit prevents false triggers on noisy signals. The LEVEL signal (input 3) that determines the trigger level, is a DC voltage approximately between +0.5V and +2.0V. The LEVEL signal is a DC voltage, generated in the Digital ASIC. Resistor R2309 and capacitors C2312 and C2313 form a lowpass filter, to convert a pulse width modulated signal into the DC voltage.

Delta-T circuit
The Delta-T circuit measures the time between a trigger pulse and the moment the input signal is sampled. Figure 3.14 shows the timing diagram with relation to the signal HLDF (input 17), START (internal), STOPN (output 16), and TOUT (output 21).



START: internal (in the A-ASIC) start signal for the Delta-T measurement.
TOUT: a voltage proportional to the measured value (time) of Delta T.

Figure 3.14 Timing diagram Delta-T circuit

Control logic
The control logic section contains a serial-in parallel-out shift register. This section gets its data from the microprocessor (D1201, circuit diagram A1, figure 9.2) via the CDAT (serial data), CCLK (serial clock), and DTAE (data-latch) lines. The control logic section controls all functional blocks within the A-ASIC.

ADC
The output signal SNGOUT (pin 25) of the A-ASIC is fed to the
8-bit Analog Digital Converter TDA 8703. This component operates on a 25 MHz clock signal.

The ADC provides for the reference voltage needed by the A-ASIC. This reference voltage is derived from the ADC. VREF is made of the voltages on pin 4 (VRB = Reference Bottom Voltage: +1.5V) and pen 9 (VRT = Reference Top Voltage: +3.5V) of the ADC. During normal operating conditions this reference voltage, VREF, is +2.5V (+/- 3.6%, ref. to ground). VREF is adjusted with potentiometer R2346, marked "OFFSET" and can be measured between TP331 and ground. The sensitivity of the ADC is adjusted with R2347, marked "GAIN". These calibrations are described in chapter 5, section 5.6.1: "Hardware SCOPE Calibration Adjustments".

The 8-bit output of the ADC: ADCO...ADC7 is connected to the Digital ASIC on the digital A1 PCB.

3.4.6 ANALOG CONTROL CIRCUIT

- Introduction
See figure 3.13.

The various sections of the ScopeMeter test tool, situated on the analog A2 PCB, are controlled by the microprocessor on the digital A1 PCB. This is done by means of the CCLK (serial clock), CDAT (serial data) and DTAE (data-latch) lines. This bus system creates several control signals, which for example drive the relays switches in the attenuator sections.

- Detailed circuit description
See figure 3.13 and circuit diagram A2a (figure 9.4a).

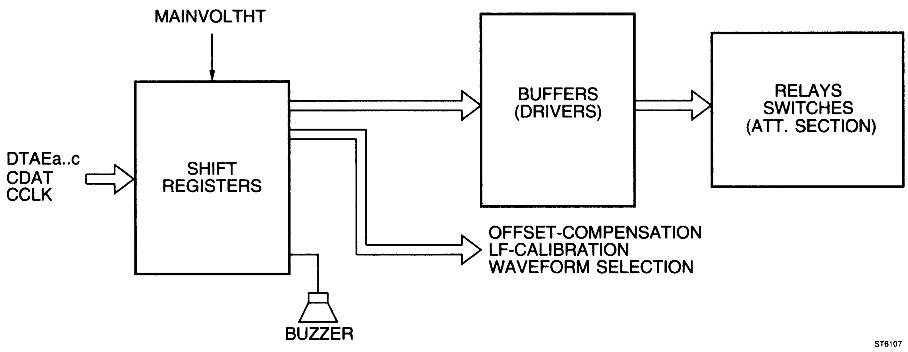


Figure 3.15 Schematic diagram analog control circuitry

Each shift register transforms the serial signal CDAT into 8 parallel control signals. This is done by means of the serial clock signal CCLK and the data-latch signals DTAEa, DTAEb and DTAEc. The control circuitry comprises two series of cascaded shift registers: D2907-D2908-D2909 (24 signals) and D2904- D2906(16 signals).

The signals, that are made by the shift registers, are used:

- to control the buffers (D2901 / D2902 / D2903), which drive the relays in the attenuator section.
- for offset compensation (A-RANGE and B-RANGE) in the attenuator sections.
- for L.F.-calibration (A-OFFSET and B-OFFSET) in the attenuator sections.
- to select the waveform in the signal generator section (sinewave/squarewave/DC).
- to drive the buzzer (beeper).

- Relay tables

In the following tables the number "1" means "high" (active) signal. "0" means "low" signal and "X" means "can be high or low (don't care)".

SCOPE mode INPUT B BNC, DC coupled

	K2101	K2102	K2103	K2201	K2202	K2203	K2750	K2751
1) 100 mV/div	1	0	0	x	x	x	x	0
2) 1V/div	1	1	0	x	x	x	x	0
10V/div	1	0	1	x	x	x	x	0
100V/div	1	1	1	x	x	x	x	0
GROUND	0	1	1	x	x	x	x	0

SCOPE mode INPUT B BNC, AC coupled

	K2101	K2102	K2103	K2201	K2202	K2203	K2750	K2751
100 mV/div	0	0	0	x	x	x	x	0
1V/div	0	1	0	x	x	x	x	0
10V/div	0	0	1	x	x	x	x	0
100V/div	0	1	1	x	x	x	x	0
GROUND	0	1	1	x	x	x	x	0

SCOPE mode INPUT A BNC, DC coupled

	K2101	K2102	K2103	K2201	K2203	K2203	K2750	K2751
100 mV/div	x	x	x	1	0	0	x	0
1V/div	x	x	x	1	1	0	x	0
10V/div	x	x	x	1	0	1	x	0
100V/div	x	x	x	1	1	1	x	0
GROUND	x	x	x	x	0	1	1	0

SCOPE mode INPUT A BNC, AC coupled

	K2101	K2102	K2103	K2201	K2202	K2203	K2750	K2751
100 mV/div	x	x	x	0	0	0	x	0
1V/div	x	x	x	0	1	0	x	0
10V/div	x	x	x	0	0	1	x	0
100V/div	x	x	x	0	1	1	x	0
GROUND	x	x	x	x	0	1	1	0

1) Relay information valid for SCOPE attenuator settings up to 100 mV/div.

2) Relay information valid for SCOPE attenuator settings between 100 mV/div and 1V/div, etc.

SIGNAL GENERATOR, EXTERNAL TRIGGER (banana jack inputs)

	K2101	K2102	K2103	K2201	K2202	K2203	K2750	K2751
Ext. Trig	x	x	x	x	x	x	0	0
Generator	x	x	x	x	x	x	1	0

METER mode, V DC (INPUT A BNC)

	K2101	K2102	K2103	K2201	K2202	K2203	K2750	K2751
300 mV	0	1	1	1	1	0	x	0
3V	0	1	1	1	0	1	x	0
30V	0	1	1	1	1	1	x	0
300V	0	1	1	1	1	1	x	0

METER mode, V AC (INPUT A BNC)

	K2101	K2102	K2103	K2201	K2202	K2203	K2750	K2751
300 mV	0	1	1	0	1	0	x	0
3V	0	1	1	0	0	1	x	0
30V	0	1	1	0	1	1	x	0
300V	0	1	1	0	1	1	x	0

METER mode, V DC + AC (INPUT A BNC)

	K2101	K2102	K2103	K2201	K2202	K2203	K2750	K2751
300 mV	0	1	1	1	1	0	x	0
3V	0	1	1	1	0	1	x	0
30V	0	1	1	1	1	1	x	0
300V	0	1	1	1	1	1	x	0

EXT mV mode (banana jacks inputs)

	K2101	K2102	K2103	K2201	K2202	K2203	K2750	K2751
300 mV	0	1	1	0	0	1	1	0
3V	0	1	1	0	0	1	1	0

OHM mode (banana jack inputs)

	K2101	K2102	K2103	K2201	K2202	K2203	K2750	K2751
30, 300 Ohm	0	1	1	0	0	1	1	1
3 KOhm	0	1	1	0	0	1	1	1
30 KOhm	0	1	1	0	0	1	1	1
300 KOhm	0	1	1	0	0	1	1	1
3 MOhm	0	1	1	0	0	1	1	1
30 MOhm	0	1	1	0	0	1	1	1

- Control lines tables

SCOPE mode INPUT B BNC, DC coupled

	Sr1a	Sr2a	Sr3a	Sr4a	Sgnd8b	Sr1b	Sr2b	Sr3b	Sr4b	Sgnd8a	mV	OHM
100 mV/div	1	0	0	0	0	x	x	x	x	x	x	x
1V/div	1	1	0	0	0	x	x	x	x	x	x	x
10V/div	0	0	1	1	0	x	x	x	x	x	x	x
100V/div	0	1	1	1	0	x	x	x	x	x	x	x
GROUND	0	0	0	1	1	x	x	x	x	x	x	x

SCOPE mode INPUT B BNC, AC coupled

	Sr1a	Sr2a	Sr3a	Sr4a	Sgnd8b	Sr1b	Sr2b	Sr3b	Sr4b	Sgnd8a	mV	OHM
100 mV/div	1	0	0	0	0	x	x	x	x	x	0	0
1V/div	1	1	0	0	0	x	x	x	x	x	0	0
10V/div	0	0	1	1	0	x	x	x	x	x	0	0
100V/div	0	1	1	1	0	x	x	x	x	x	0	0
GROUND	0	0	0	1	1	x	x	x	x	x	0	0

SCOPE mode INPUT A BNC

	Sr1a	Sr2a	Sr3a	Sr4a	Sgnd8b	Sr1b	Sr2b	Sr3b	Sr4b	Sgnd8a	mV	OHM
100 mV/div	x	x	x	x	x	1	0	0	0	0	0	0
1V/div	x	x	x	x	x	1	1	0	0	0	0	0
10V/div	x	x	x	x	x	0	0	1	1	0	0	0
100V/div	x	x	x	x	x	0	1	1	1	0	0	0
GROUND	x	x	x	x	x	0	0	0	1	1	0	0

SCOPE mode INPUT A BNC, AC coupled

	Sr1a	Sr2a	Sr3a	Sr4a	Sgnd8b	Sr1b	Sr2b	Sr3b	Sr4b	Sgnd8a	mV	OHM
100 mV/div	x	x	x	x	x	1	0	0	0	0	0	0
1V/div	x	x	x	x	x	1	1	0	0	0	0	0
10V/div	x	x	x	x	x	0	0	1	1	0	0	0
100V/div	x	x	x	x	x	0	1	1	1	0	0	0
GROUND	x	x	x	x	x	0	0	0	1	1	0	0

METER mode, V DC (INPUT A BNC)

	Sr1a	Sr2a	Sr3a	Sr4a	Sgnd8b	Sr1b	Sr2b	Sr3b	Sr4b	Sgnd8a	mV	OHM
300 mV	0	0	0	1	1	1	1	0	0	0	0	0
3V	0	0	0	1	1	0	0	1	1	0	0	0
30V	0	0	0	1	1	0	1	1	1	0	0	0
300V	0	0	0	1	1	0	1	1	1	0	0	0

METER mode, V AC (INPUT A BNC)

	Sr1a	Sr2a	Sr3a	Sr4a	Sgnd8b	Sr1b	Sr2b	Sr3b	Sr4b	Sgnd8a	mV	OHM
300 mV	0	0	0	1	1	1	1	0	0	0	0	0
3V	0	0	0	1	1	0	0	1	1	0	0	0
30V	0	0	0	1	1	0	1	1	1	0	0	0
300V	0	0	0	1	1	0	1	1	1	0	0	0

METER mode, V DC + AC (INPUT A BNC)

	Sr1a	Sr2a	Sr3a	Sr4a	Sgnd8b	Sr1b	Sr2b	Sr3b	Sr4b	Sgnd8a	mV	OHM
300 mV	0	0	0	1	1	1	1	0	0	0	0	0
3V	0	0	0	1	1	0	0	1	1	0	0	0
30V	0	0	0	1	1	0	1	1	1	0	0	0
300V	0	0	0	1	1	0	1	1	1	0	0	0

EXT mV mode (banana jack inputs)

	Sr1a	Sr2a	Sr3a	Sr4a	Sgnd8b	Sr1b	Sr2b	Sr3b	Sr4b	Sgnd8a	mV	OHM
300 mV	0	0	0	1	1	0	0	0	1	1	1	0
300V	0	0	0	1	1	0	1	0	1	1	1	0

OHM - DIODE TEST mode (banana jack inputs)

	Sr1a	Sr2a	Sr3a	Sr4a	Sgnd8b	Sr1b	Sr2b	Sr3b	Sr4b	Sgnd8a	mV	OHM
30, 300 Ohm	0	0	0	1	1	0	0	0	1	1	0	1
3 KOhm	0	0	0	1	1	0	0	0	1	1	0	1
30 KOhm	0	0	0	1	1	0	0	0	1	1	0	1
300 KOhm	0	0	0	1	1	0	0	0	1	1	0	1
3 MOhm	0	0	0	1	1	0	0	0	1	1	0	1
30 MOhm	0	0	0	1	1	0	1	0	1	1	0	1
Diode	0	0	0	1	1	0	1	0	1	1	0	1

	Sc15	Sc16	Sc17	Sc18
30, 300 Ohm	1	0	1	1
3 KOhm	1	0	1	0
30 KOhm	1	0	0	0
300 KOhm	1	1	0	0
3 MOhm	0	1	0	0
30 MOhm	0	1	0	0
Diode	1	0	1	1

	G_OUTP
Ext. Trig.	0
Generator	1

	BUZ
Buzzer off	1
Buzzer on	0

	SCOPE mode Attenuator settings		METER mode
	≥ 20 mV/div	≤ 10 mV/div	
D-POSCHA	0	1	1
D-POSCHB	1	1	x

While the ScopeMeter test tool is operating in METER mode or when the instrument is calibrated, the signals Si, mV, OHM, Sr1b, Sr2b, Sr3b, Sr4b, and D_POSCHB can change ("high/low"). Signals Ex and Ey are used to switch the relays. Both signals are "high" when the relays are not operated.

Signals Sg4a, Sg5a, Sg6a, and Sg7a set the L.F. gain for channel A. Sg4b, Sg5b, Sg6b, and Sg7b set the L.F. gain for channel B. Sg4a (Sg4b) is the most significant bit (MSB), Sg7a (Sg7b) is the least significant bit (LSB).

Signals So10b, So11b, S012b, So13b, and So14b are used to set the offset compensation in the preamplifier circuits of channel A. Signals Sc15, Sc16, Sc17, Sc18, and S014a are used to set the offset compensation in the preamplifier circuits of channel B. S010b (Sc15) is the most significant bit (MSB), So14b (So14a) is the least significant bit (LSB).

3.4.7 SIGNAL GENERATOR circuit, COMPONENT TESTER circuit

- Introduction

The ScopeMeter test tool has a built-in signal generator, which can produce the following signals, used to adjust the probes:

- square wave voltage,	amplitude: frequency:	5V peak-to-peak 1.95 kHz
- DC voltage		3V

Model 99 can also produce:

- sine wave voltages,	amplitude: frequency:	1V peak-to-peak 976 Hz
- square wave voltages,	amplitude: frequencies:	5V peak-to-peak 488 Hz, 976 Hz, 1.95 kHz

- slow ramp voltage, -2V...+2V
- slow ramp current, 0...+3mA

The signal generator uses a square wave voltage, coming from the D-ASIC to generate the various signals. The circuit consists of an operational amplifier, a fourth order filter, and a current source. The configuration can be changed by means of programmable switches to produce different output signals.

- Detailed circuit description

See figure 3.16 and circuit diagram A2b (figure 9.4b).

Figure 3.16 shows the basic generator circuitry:

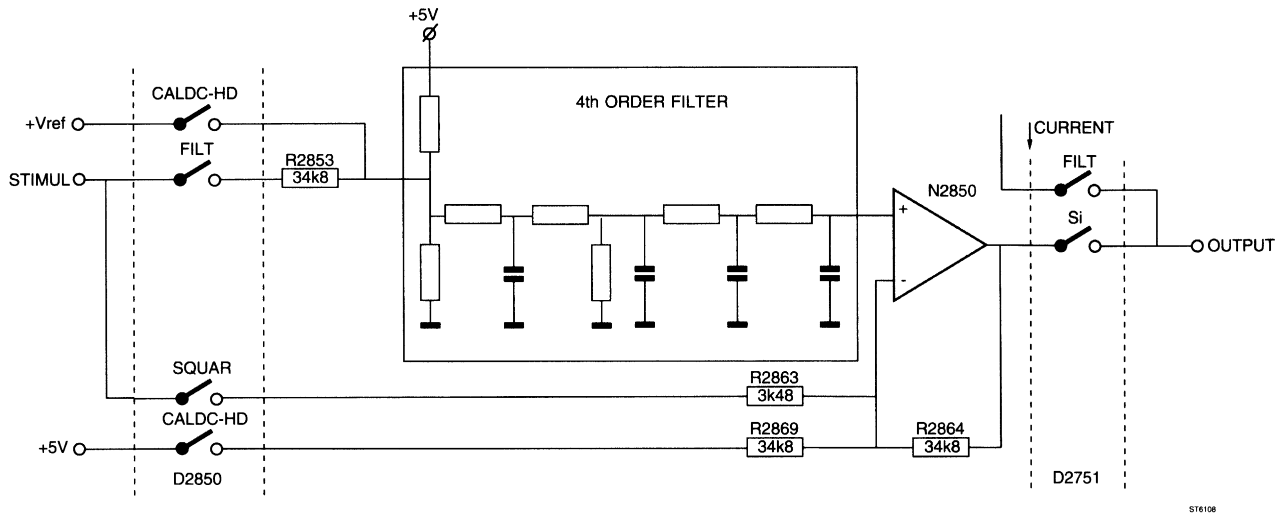


Figure 3.16 Basic generator circuitry

This circuit uses a square wave voltage, STIMUL, coming from the D-ASIC. This signal has an amplitude between 0V and +5V. The duty cycle of the square wave signal is varied depending on the signal to be generated. The reference voltage +Vref is used to generate the DC voltage.

The configuration depends on the settings of switches D2850 and D2751. These switches are controlled by the signals FILT, CALDC- HD, SQUAR and Si. Table 3.8 lists the various settings and resulting generator output signals.

Table 3.8 Generator control signals for various generator output signals

STIMUL		CONTROL SIGNALS				OUTPUT SIGNAL	
frequency	duty cycle	CALDC-HD	FILT	SQUAR	Si	amplitude	waveform
488 Hz	50%	0	0	1	1	5 V p-p	
976 Hz	50%	0	0	1	1	5 V p-p	Square wave voltage
1.95 kHz	50%	0	0	1	1	5 V p-p	
-	-	1	0	0	1	3 V p-p	DC voltage
976 Hz	50%	0	1	0	1	1 V p-p	Sine wave voltage
20 kHz	0-100%	0	1	0	1	-2...+2 V p-p	Slow ramp voltage
20 kHz	0-100%	0	1	0	0	0...+3 mA	Slow ramp current

In this table "1" means: signal "high" (switch closed) and "0" means signal "low" (switch open).

The slow ramp current signal is made with a current source. A simplified schematic diagram is given in figure 3.17:

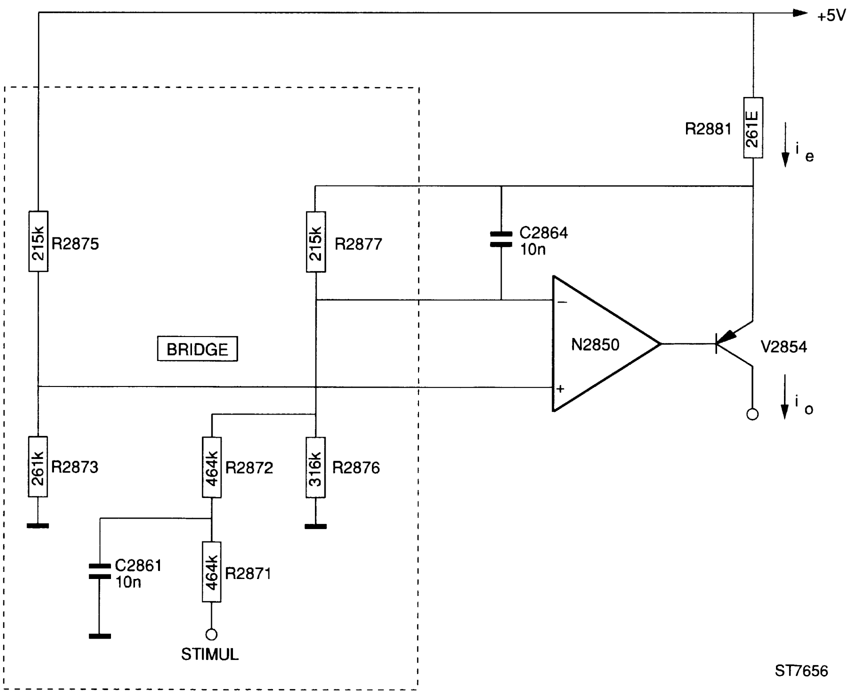


Figure 3.17 Current source section of generator

When the duty cycle of STIMUL is 0%, the bridge will be in balance and current $i_e = 0$. When the duty cycle of STIMUL is increased, a DC component is generated, which has a linear relation to the duty cycle. The operational amplifier tries to keep the voltages on both inputs the same. The operational amplifier will now drive transistor V2854 to increase i_e. Because i_e is almost equal to i_o, the output current will also increase. In this way it is possible to regulate the current i_o by means of the duty cycle of STIMUL.

3.4.8 BATTERY CHARGER

- Introduction
See figure 3.18.

The battery charger consists of a switched mode power supply and some auxiliary circuitry. Whenever the ScopeMeter test tool is connected to the line voltage (via the separate power adapter/battery charger PM8907), the instrument switches over to line voltage operation automatically. If a NiCd battery pack is installed, the test tool will charge this if line voltage is present. Special circuitry prevents discharge of the batteries when the instrument is not being used.

- Detailed circuit description
See figure 3.18 and circuit diagram A2c (figure 9.4c).

HF Filter
The input voltage (between 8V and 20V) first passes HF FILTER Z2501 and is used to drive a flyback converter.

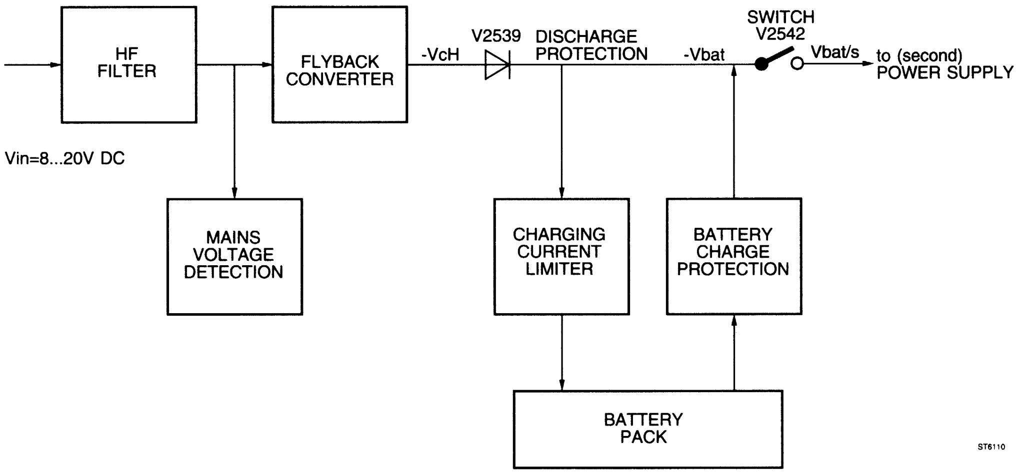


Figure 3.18 Schematic diagram battery charger

Line voltage detection
When the ScopeMeter test tool is operated on line voltage, transistor V2521 will be driven by the (filtered) input voltage. The signal MAINVOLTHT will become "low" to indicate that the test tool is operated from the line voltage. The related signal MAINS-D (connector X1201, pin 5) is connected to the microprocessor analog input 19. When the signal MAINS-D is "high", the microprocessor will not switch off the test tool , as in battery operated mode.

Flyback converter

See figure 3.19 and circuit diagram A2c (figure 9.4c).

The main components of this flyback converter are V2532 (converter-switch), L2504 and L2506 (windings), R2582 (sense resistor), and C2536 and V2533 (secondary circuit). The main regulating element is N2503 (see figure 3.19).

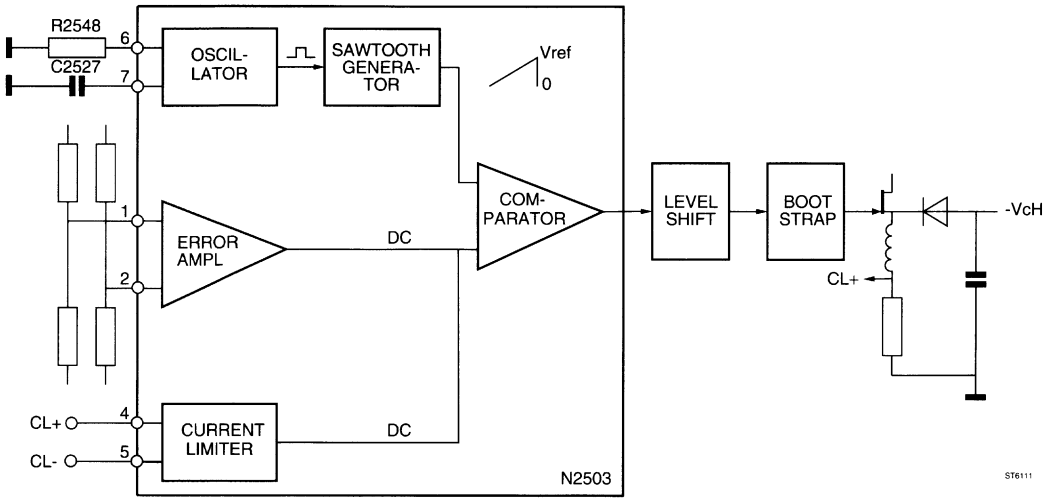


Figure 3.19 Schematic diagram flyback converter

N2503 incorporates an oscillator, the frequency of which is determined by R2548 and C2527 (fixed frequency of 100 kHz). This oscillator drives a sawtooth generator. The produced sawtooth voltage is compared to a DC voltage. This DC voltage is made by an internal error amplifier (voltage regulator), which compares the produced converter voltage -V_CH to a stable 5V reference voltage. This is done with a bridge circuit (R2554, R2555, R2557, R2558).

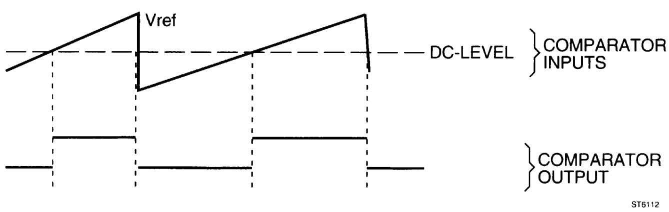


Figure 3.20 Internal N2503 voltage waveforms

When the sawtooth voltage is larger than the DC voltage, the output signal (CA, CB on pins 12,13) is "high". When the sawtooth voltage is less than the DC voltage, the output signal is "low". In this way the duty cycle of N2503's output signal can be changed, thus changing the energy transferred to the secondary converter circuit.

The output signal is level shifted by transistor V2526 and related circuitry. Now this square wave signal is used to drive converter switch V2532, which is bootstrapped via V2528, V2529, R2546, R2562, and C2537.

Charging current limiter

N2503 limits the voltage difference between CL+ (pin 4) and CL- (pin 5) to 200 mV. If the voltage between these two inputs starts to rise, the internal DC voltage will rise, and the duty cycle of the output square wave voltage will decrease (see voltage regulation described earlier).

If the ScopeMeter test tool is connected to the line voltage and is not operational, the flyback converter operates almost without a load (only the NiCd battery pack). This implies that the current floating through windings L2504 and L2505 (averaged in time) is almost zero. Because of this, the voltage on CL+ is about 30 mV and the voltage on CL- is about 170 mV. The battery pack will be charged with 170 mA.

If the flyback converter is operated normally (ScopeMeter test tool "ON"), the voltage on both CL- and CL+ will rise and the charging current will decrease to 100 mA.

Battery charge protection
To prevent charging of non-rechargeable batteries, a special protection circuit is provided. For safety reasons, this circuit consists of two cascaded sections. When the test tool is "ON", the flyback converter will be operative. The produced voltage POWER-ON will drive both Field Effect Transistors V2537 and V2538 open (conductive) via R2568 and R2569. Now the battery plus contact is connected to the test tool circuit ground. If line voltage is present, the voltage -VCH produced by the flyback converter will drive V2534 and V2536, which prevent transistors V2537 and V2538 from conducting. The battery plus contact is disconnected from ground.

Power ON/OFF circuitry
During normal operation the POWER-ON signal is +5V. Transistor V2542 is opened (conductive), so -Vbat/s equals -V_CH. If the test tool is operating and the RESPOWHT ("reset power supply") becomes "high", V2541 will conduct and V4542 will stop conducting. This will disconnect -Vbat/s from -V_CH.

3.4.9 POWER SUPPLY

- Introduction
See figure 3.21.

Different supply voltages are needed for various ScopeMeter test tool sections. A second flyback converter is used to convert -Vbat/s to supply voltages of -30V, -5V and +5V. This voltage, -Vbat/s, is made by the first flyback converter (in the battery charger section) or comes from the batteries. -Vbat/s is 5V if operated with NiCad battery pack, and 8V if operated from line voltage.

- Detailed circuit description
See figure 3.21 and circuit diagram A2c (figure 9.4c).

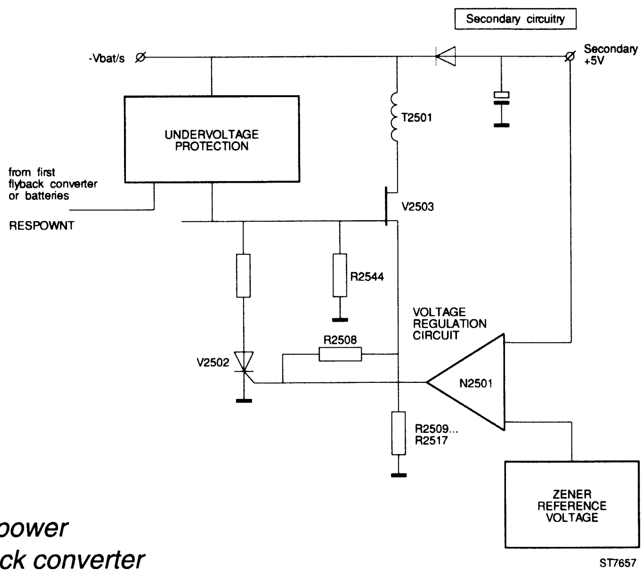


Figure 3.21 Schematic diagram power supply, second flyback converter

This self-oscillating flyback converter consists of:
- V2503 (converter-switch)
- R2509...R2517 (sense-resistors)
- V2502 (thyristor switch)
- R2544 (start-up resistor)
- T2501 (windings)
- 3 separate secondary circuits for -30V, -5V, and +5V

The main regulating component is operational amplifier N2501. This op-amp compares the produced secondary +5V voltage with a reference voltage, produced by zener diode N2502. If the secondary +5V increases, the fault signal generated by the N2501 will produce a current that causes an extra voltage drop over R2508. Because of this, thyristor V2502 will fire earlier. The switching frequency of the flyback converter increases and the secondary +5 V voltage decreases.

When the ScopeMeter test tool is switched on (RSSLSTN is "active low"), V2544 (see circuit diagram A2c, figure 9.6) connects the inverting input of N2501 to ground. When the ScopeMeter test tool starts up, capacitor C2509 causes the reference voltage and therefore the output voltage, to rise slowly, limiting the inrush ("starting") current drawn from the batteries or line voltage.

Undervoltage detection and protection circuit
When the flyback converter is oscillating, capacitor C2532 is charged every period via R2543 and V2516. During normal operation C2532 is discharged by V2517, which is driven via R2541, V2511, R2529, and V2509. If, for example, the secondary +5V voltage becomes too low, C2532 is not discharged by V2517. This will activate the RESPOWHT signal, and the power will be switched off completely, preventing further damage of circuits. (The +5V voltage can become too low because the input voltage -Vbat/s is too low, or the power output to the ScopeMeter test tool circuitry is too high.)

R2542, C2531, and diode V2508 will reset C2532 during the start up of the power supply (the voltage across C2532 will become zero). This is necessary because V2517 cannot be driven via V2541, just after the ScopeMeter test tool is switched on.

Reference source
The reference source provides a stable positive (+Vref) and negative reference voltage (-Vref) used in other parts of the ScopeMeter test tool. It also uses the voltage across zener diode N2502 as an input voltage.

NOTE: The flyback converter, used in the battery charger section (section 3.4.8) has a fixed oscillating frequency of 100 kHz. The amount of energy supplied is regulated by varying the duty cycle. The flyback converter used in this power supply, however, is self-oscillating and operates on a variable oscillating frequency and a fixed duty cycle. For alkaline batteries, for example, the oscillating frequency is about 62 kHz.

4 PERFORMANCE VERIFICATION PROCEDURE

4.1 GENERAL INFORMATION

The ScopeMeter test tool should be calibrated and in operating condition when you receive it.

The following performance tests are provided to ensure that the test tool is in a proper operating condition. If the instrument fails any of the performance tests, calibration adjustments (see chapter 5) and/or repair (see chapter 7) is necessary.

The Performance Verification Procedure described here consists of two parts:

- Standard Performance Verification Procedure
  (separate SCOPE- and METER-section)
- Additional Performance Verification Procedure

The **Standard Performance Verification Procedure** uses built-in front panel settings or frontsettings, that can be accessed via the SERVICE MENU. To enter the SERVICE MENU, press the backlight key, then press AUTOSET, and then release the backlight key. This menu allows you to choose between SCOPE and METER performance testing ("Verify").

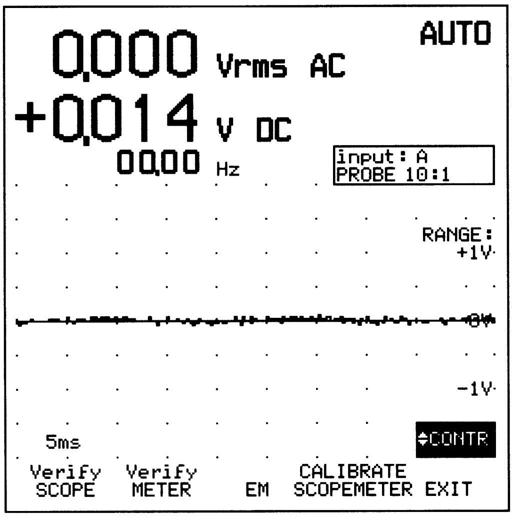


Figure 4.1 Service menu (entered from METER mode)

When the ScopeMeter test tool is in SERVICE mode, only the function keys (F1 .. F5), the UP/DOWN keys (△ ▽) and the ON/OFF key (ON/OFF) can be used.
It is possible to move forward or backward through the frontsettings, that apply to the separate performance test steps. This can be done using the UP/DOWN keys. You can leave the Performance Verification Procedure any time by pressing function key F5. The Performance Verification Procedure steps are explained in the following sections.

The **Additional Performance Verification Procedure** can be used to do some extra checks, depending on the ScopeMeter test tool version. In these tests the ScopeMeter test tool must be set up manually.

NOTE: *This Performance Verification Procedure is a quick way to check most of the instrument's specifications. Because of the highly integrated design of the ScopeMeter test tool, it is not always necessary to check all features separately. The procedure described here often combines many test steps in one procedure step, thereby minimizing total test time.*

The Performance Verification Procedure is based on the specifications, listed in chapter 2 of this Service Manual. The values (requirements) given here are valid for ambient temperatures between 18 °C and 28 °C.

4.2 STANDARD PERFORMANCE VERIFICATION PROCEDURE

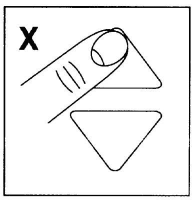
This section explains the required Performance Verification Procedure setup, with the actions that have to be done for each step. Follow the instructions described with each step.
The recommended test equipment, required for this Standard Performance Verification Procedure, is listed in table 4.1.

Table 4.1 Recommended test equipment Standard Performance Verification Procedure

Instrument Type	**Recommended Model**
Multifunction Calibrator	Fluke 5100B
Function Generator	Philips PM 5134
Time Mark Generator	Tektronix TG 501
Constant Amplitude Sine wave Generator	Tektronix SG 503
Square wave Calibration Generator	Tektronix PG 506

- Cables and terminations for the generators (all BNC type)
- Two standard banana test leads (delivered with the ScopeMeter test tool)
- BNC (female)-to-banana (male) (delivered with the ScopeMeter test tool)

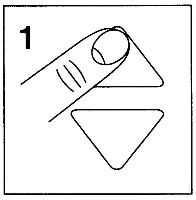
NOTE: *During the following Performance Verification Procedure, the ScopeMeter test tool inputs are connected to the signal generator outputs by means of coaxial cables (INPUT A or B BNC) or two standard banana test leads (banana jack inputs). The oscilloscope probes delivered with the instrument are not used during the Standard Performance Verification Procedure. The calibration of the probes is described in the Users Manual.*



In the following text, this figure is used to indicate that one of the UP key (△) or the DOWN key (▽) must be pressed, to display the indicated step number "x".

1/2. LCD test

While in the SERVICE menu, press the SCOPE function key to enter the **SCOPE section of the Performance Verification Procedure**.



Now a (dark) test pattern is displayed. This pattern consists of a circle placed in a square, and three diagonal lines (see figure 4.2).

Observe the test pattern closely. The lines may not be interrupted; the pattern must be continuous. In this test sets the display to a high contrast, resulting in a dark display. If there are defects in the pixel columns of the Liquid Crystal Display, they must be clearly visible now as intermissions in the pattern.

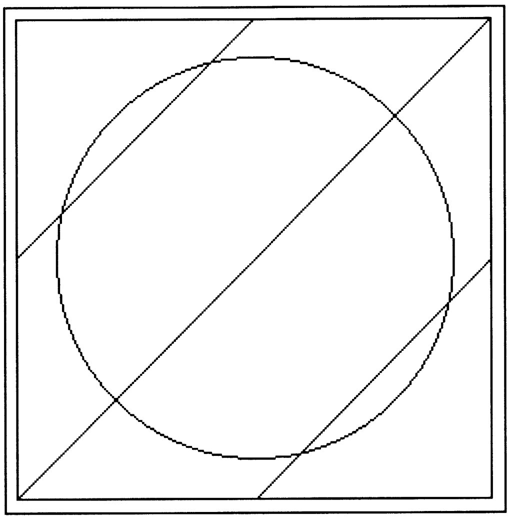
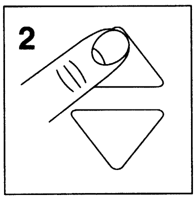
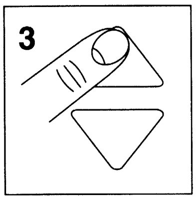


Figure 4.2 Test pattern



Press the UP key again to go to step 2. Now the display shows the same pattern, but with a low contrast (bright display). This will help you to locate any failures in the pixel rows of the LCD.

3. Ground level check



Press the UP key to go to step 3. The purpose of this step is to check the ground level position adjustments (0V) for both traces. The display shows the text " Verif 3", to show that this is the third SCOPE Performance Verification step (see figure 4.3).

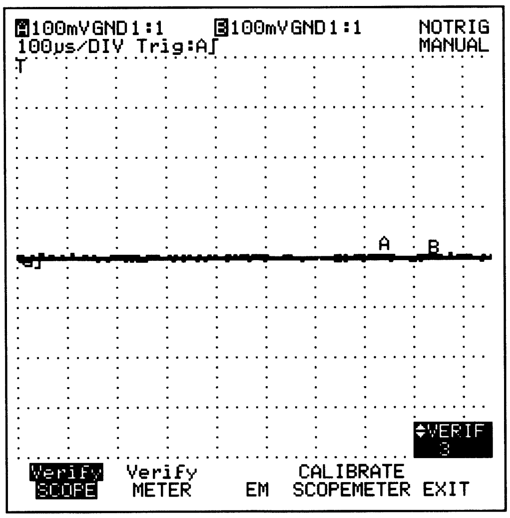
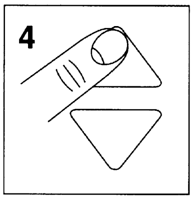


Figure 4.3 Reference set-up

Requirements:
Verify that the traces of both channels A and B are situated on the vertical middle of the screen.

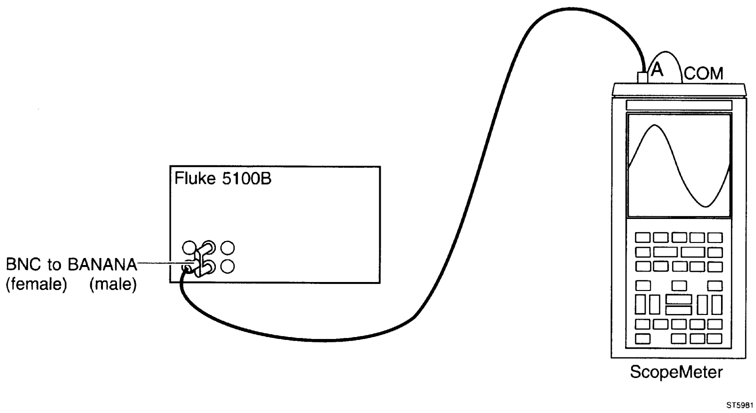
4. Vertical deflection coefficients channel A



These tests check the vertical deflection coefficients for channel A in the 100 mV/div AC range.

Test equipment:
Fluke 5100B Calibrator

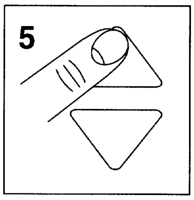
Test setup:
Connect the banana jack COM to the BNC common



Procedure/requirements for AC test:

A Apply a 1 kHz sine wave signal with an amplitude of 600 mV AC peak-to-peak to the INPUT A BNC.
(Set the Fluke 5100B to 212.13 mV RMS, 1 kHz sine wave).
Verify that the amplitude of the sine wave signal displayed is 5.88...6.12 divisions.

5/6/7. Vertical deflection coefficients channel B

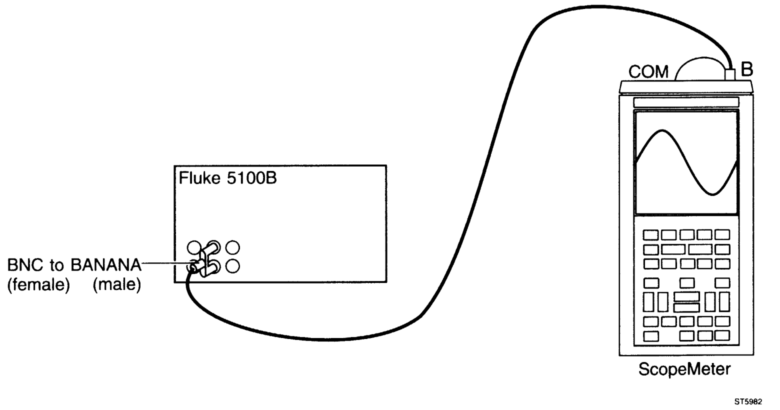


These tests check the vertical deflection coefficients for channel B in the AC ranges.

Test equipment:
Fluke 5100B Calibrator

Test setup:

Connect the banana jack COM to the BNC common



Procedure/requirements for channel B AC tests:

Apply the input voltage and the setting of channel B according to table 4.2 and check that the amplitude of the signal agrees with the value listed. Use the UP/DOWN keys to select each step number.

NOTE: The AC voltages listed in this are peak-to-peak voltages (sine wave). The values listed between brackets () are the RMS values that have to be chosen on the Fluke 5100B calibrator.

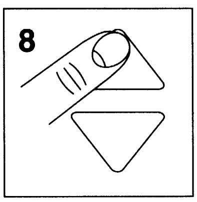
Requirements:

Table 4.2 Requirements vertical deflection coefficients for channel B

Input voltage	Step number on display	Requirements
600 mV AC pp (212.13mV RMS), 1 kHz	"5"	5.88...6.12 div.
6V AC pp (2.1213V RMS), 1 kHz	"6"	5.88...6.12 div.
60V AC (21.213 V RMS), 1 kHz	"7"	5.88...6.12 div.

The ScopeMeter test tool uses the same input circuitry (hardware) for the SCOPE and the METER modes (in the above attenuator settings). When the voltage accuracy is checked (see the description "METER Performance Verification Procedure" step 1), the deflection coefficients for SCOPE channel A are also tested.

8/9. Rise time



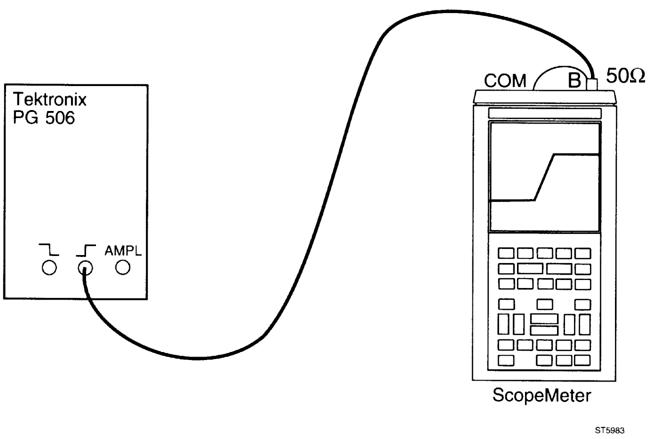
The rise time of the test tool is checked by means of a fast rise time pulse. First channel B is measured.

Test equipment:

Tektronix PG 506 Square Wave Calibration Generator

Test setup channel B rise time measurement:

Connect the banana jack COM to the BNC common



Procedure for channel B rise time measurement:

A Apply a fast rise time pulse, repetition frequency 1 MHz, amplitude 0.5V to the INPUT B BNC. Use a 50Ω termination. Set the generator in position "FAST RISE".

B Adjust the pulse amplitude to exactly 5 divisions. See figure 4.4.

Requirements:

C Check the rise time, measured between 10% and 90% of the pulse amplitude. See figure 4.4. The rise time t_r (measured) must be 3.5 ns (0.7 div) or less.

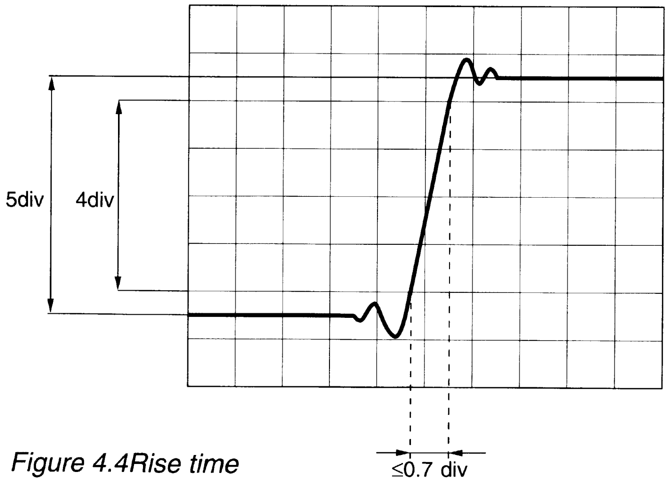
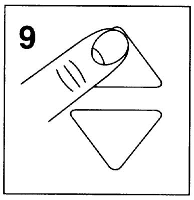


Figure 4.4Rise time

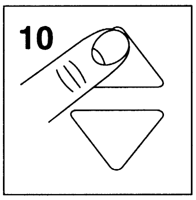


Test setup channel A rise time measurement:
Refer to the test set-up for channel B measurement. Connect the pulse generator to the INPUT A BNC.

Procedure for channel A rise time measurement:
Refer to the settings/procedure for channel B measurement.

Requirements:
Refer to channel B requirements.

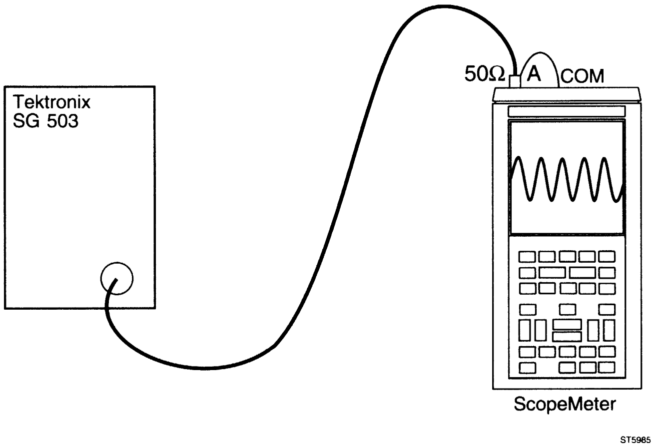
10/11/12/13. Frequency response



These tests check the upper transition point of the bandwidth for channels A and B.

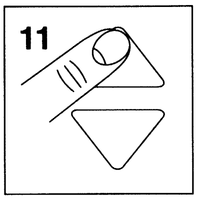
Test equipment:
Tektronix SG 503 Constant Amplitude Sine wave Generator

Test setup:
Connect the banana jack COM to the BNC common



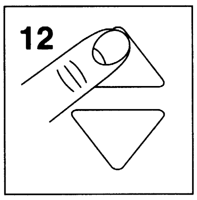
Procedure/requirements for channel A frequency response measurement:

A Apply a 50 kHz sine wave with an amplitude of 120 mV peak-to- peak to the INPUT A BNC. Use a 50Ω termination. Adjust the input signal to a trace height of exactly 6 divisions.

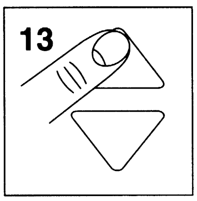


B Without changing the amplitude of the sine wave signal, switch over to step 11 using the UP key. Increase the frequency of the sine wave to 50 MHz and verify that the vertical deflection is 4.2 divisions or more.

Procedure/requirements for channel B frequency response measurement:

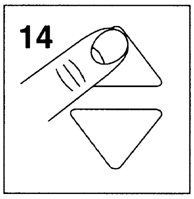


C Apply a 50 kHz sine wave with an amplitude of 120 mV peak-to- peak to the INPUT B BNC. Use a 50Ω termination.
Adjust the input signal to a trace height of exactly 6 divisions.



D Without changing the amplitude of the sine wave signal, switch over to step 13 using the UP key. Increase the frequency of the sine wave to 50 MHz and check that the vertical deflection is 4.2 divisions or more.

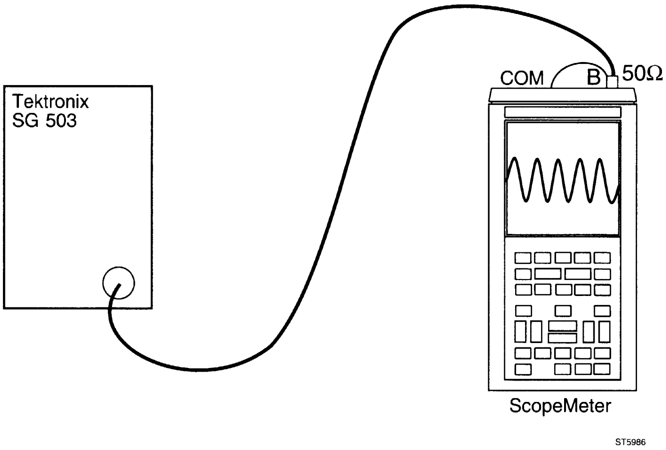
14/15/16/17. Trigger sensitivity channel A and B



The trigger sensitivity depends on the frequency of the trigger signal. This test checks the trigger sensitivity and the +SLOPE/-SLOPE function (triggering on negative slope) for both channels A and B. Channel B is tested first. The verified limits include the trigger sensitivity and the trigger voltage level error.

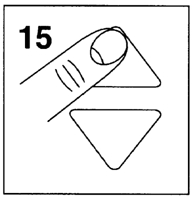
Test equipment:
Tektronix SG 503 Constant Amplitude Sine Wave Generator

Test setup:
Connect the banana jack COM to the BNC common



Procedure/requirements for channel B trigger sensitivity measurement:

A Apply a 150 MHz sine wave, with an amplitude of approximately 1V peak-to-peak to the INPUT B BNC. Use a 50Ω termination.
B Adjust the amplitude of the input signal to exactly 2.5 divisions on the display.
C Verify that the signal is well triggered.
D Apply a 100 MHz sine wave, with an amplitude of approximately 130 mV peak-to-peak to the INPUT B BNC. Use a 50Ω termination.
E Adjust the amplitude of the input signal to exactly 1.5 divisions on the display.
F Verify that the signal is well triggered.



G Apply a 10 MHz sine wave, with an amplitude of 300 mV peak-to-peak to the INPUT B BNC. Use a 50Ω termination.

H Adjust the amplitude of the input signal to exactly 1.3 divisions on the display.

I Verify that the signal is well triggered on the **falling** edge. See figure 4.5.

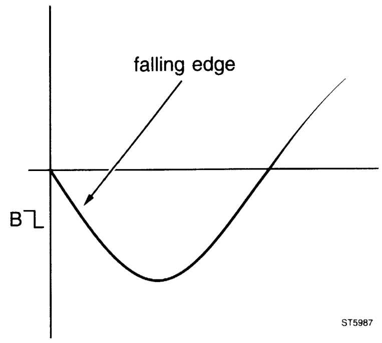
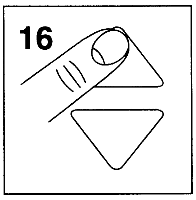
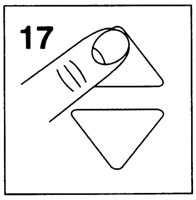


Figure 4.5 Signal triggered on the falling (negative) edge

Procedure/requirements for channel A trigger sensitivity measurement:

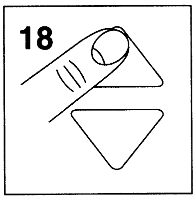


K Repeat steps G...I of step 15 for channel A.



L Repeat steps A...F of step 14 for channel A.

18. Timebase



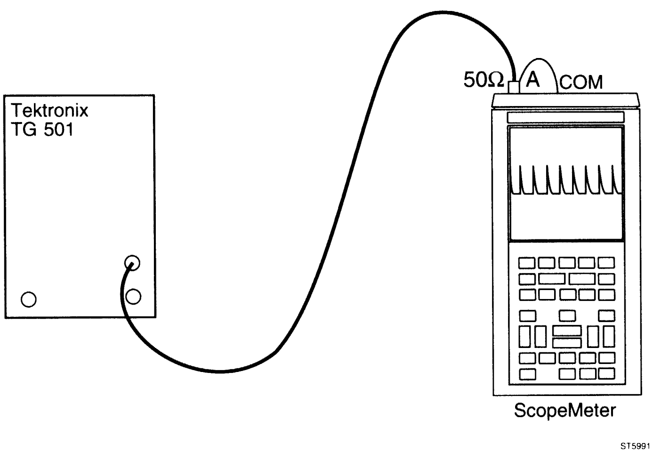
This test uses a marker pulse calibration signal to verify the deflection coefficient of the time base.

Test equipment:

Tektronix TG 501 Time Mark Generator

Test set-up:

Connect the banana jack COM to the BNC common



Procedure/requirements:

A Apply a 1 µs (1V peak-to-peak) time marker signal to the INPUT A BNC. Use a 50Ω termination.

B Verify that the distance between the 10th marker pulse and the 10th vertical grid line is the same as the distance between the 2nd marker pulse and the 2nd vertical grid line. (Tolerance ± 1 pixel = ± 0.04 divisions).

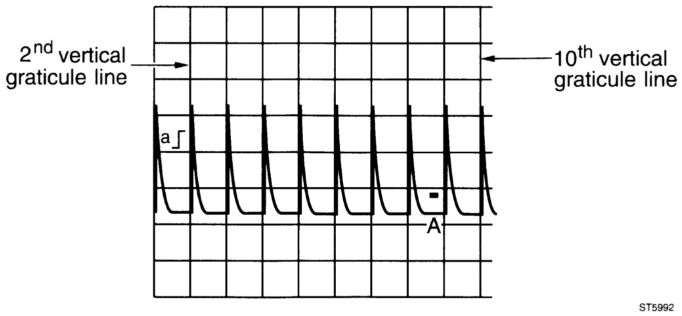
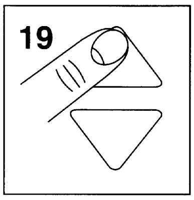


Figure 4.6 The distance between the 10th marker pulse and the 10th vertical grid line must be the same as the distance between the 2nd marker pulse and the 2nd vertical grid line

19. Trigger sensitivity external channel

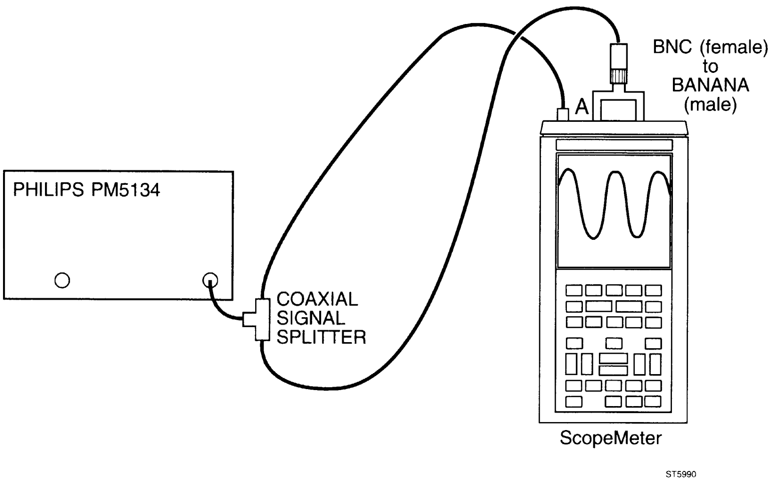


This test checks the trigger sensitivity, using the external banana connectors as the trigger input.

Test equipment:

Philips PM 5134 Function Generator

Test setup:



Procedure/requirements:

A Apply a 1 kHz sine wave signal, that has an amplitude of 1.8V peak-to-peak, superimposed on 1.4V DC to the INPUT A BNC and to the banana jack inputs. Use a coaxial signal splitter and a BNC-to-banana converter (see test setup).

B Verify that the signal is well triggered.

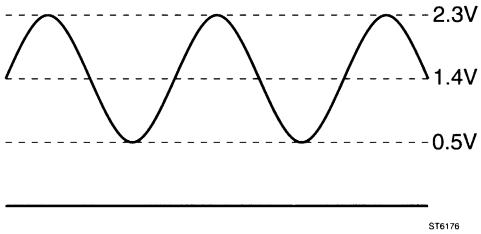
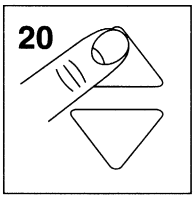


Figure 4.71.8V peak-to-peak sine wave superimposed on 1.4V DC

20. Horizontal deflection: x-deflection

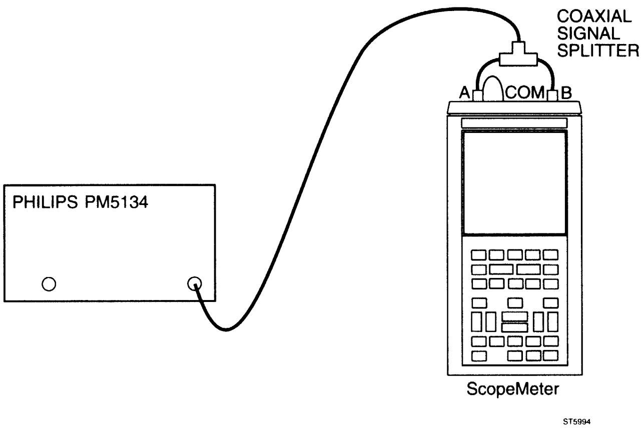


This test checks the correct working of the X-Y (A versus B) mode.

Test equipment:

Philips PM 5134 Function Generator

Test set-up:



Procedure:

A Apply a 2 kHz sine wave signal of 800 mV peak-to-peak to the INPUT A BNC and INPUT B BNC. Adjust the input signal to a trace height of 8 divisions.

Requirements:
Verify that a figure with an angle of 45° is displayed, and that the gap is smaller than 10 pixels. See figure 4.8.

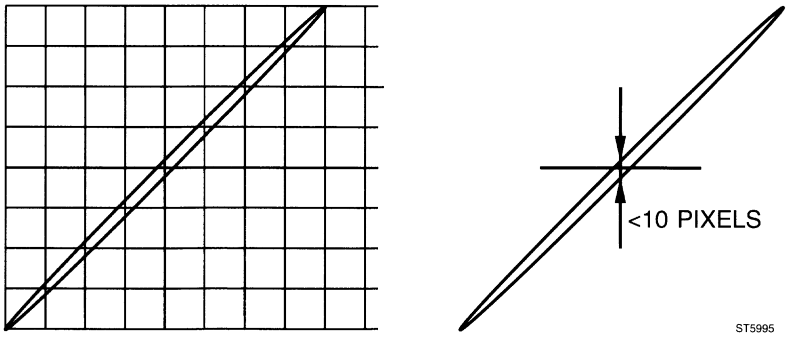
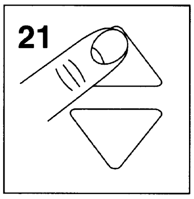


Figure 4.8 A versus B display

21/22. Base line instability

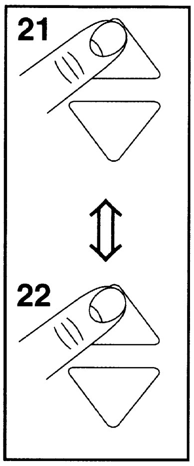


This test checks the maximum base line instability.

Test equipment:
none

Test setup:
no special setup required (open input).

Procedure/requirements:

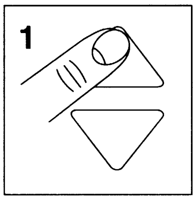


A Turn off the signal sources connected to the ScopeMeter test tool input or minimize (zero) the signal amplitudes.
B Use the UP/DOWN keys to switch from front setting number 21 to number 22 and back to 21.

C Verify that the trace does not jump more than 0.2 divisions while switching between front settings 21 and 22.

While in the SERVICE menu, press the METER softkey to enter the **METER part of the Performance Verification Procedure.**

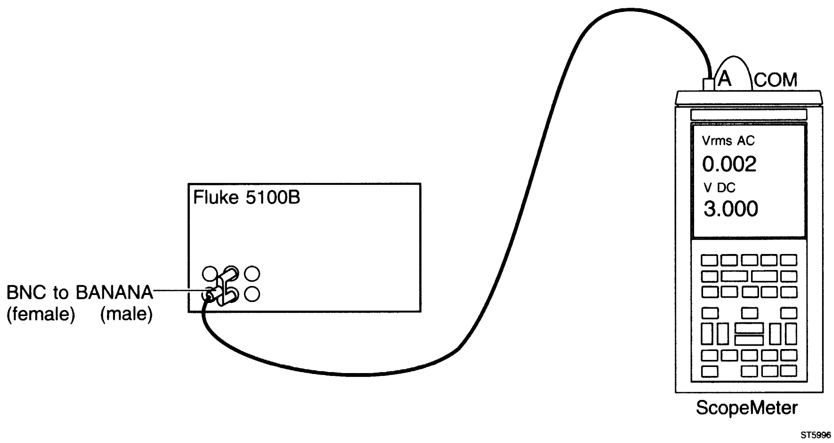
1. Voltage accuracy METER mode



The following section checks the voltage accuracy in METER mode. The ScopeMeter test tool uses the same input circuitry (hardware) for the SCOPE (channel A) and the METER modes (in these attenuator settings). When the voltage accuracy of the METER is checked, the deflection coefficients for SCOPE channel A are also tested.

Test equipment:
Fluke 5100B Calibrator

Test setup:
Connect the banana jack COM to the BNC common



Procedure:

A Apply 300 mV DC to the INPUT A BNC.
B Change the input signal according to table 4.3 and check that the reading meets the requirements.

NOTE: The ScopeMeter test tool is set to METER "AUTORANGE" (step 1) with a dual (AC and DC) readout. This implies that the range is set automatically according to the input signal.

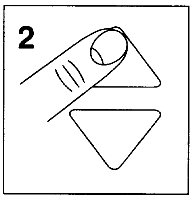
WARNING: After you have performed verification M1, deactivate the Fluke 5100B to remove the 100V. Always set the Fluke 5100B to 300 mV DC before touching the connection cables!

Requirements:

Table 4.3 Requirements for voltage accuracy test METER mode

Input signal	Requirements
300 mV DC	298.0...302.0V DC
300 mV RMS AC, 1 kHz	292.5...307.5V RMS AC
1V DC	0.990...1.010V DC
1V RMS AC, 1kHz	0.965...1.035V RMS AC
3V DC	2.980...3.020V DC
3V RMS AC, 1 kHz	2.925...3.075V RMS AC
30V DC	29.80...30.20V DC
30V RMS AC, 1 kHz	29.25...30.75V RMS AC
100V DC	099.0...101.0V DC
100V RMS AC, 1kHz	096.5...103.5V RMS AC

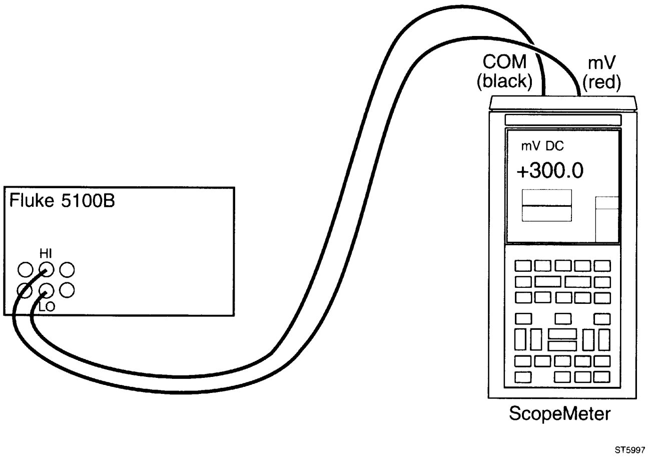
2. VOLTAGE accuracy EXT mV mode



These tests check the accuracy of the EXT mV mode. The signal must be supplied to the banana jack inputs.

Test equipment:
Fluke 5100B Calibrator

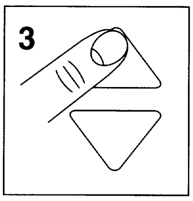
Test setup:



Procedure/requirements:

A Apply 300 mV DC to the banana jack inputs.
B Verify that the readout is between 298...302 mV DC.
C Apply 3V DC to the banana jack inputs.
D Verify that the readout is between 2.980...3.020V DC.
E Apply 250 mV RMS AC, 60 Hz to the banana jack inputs.
F Verify that the reading is between 243.5...256.5 mV AC.
G Apply 2V RMS AC, 60 Hz to the banana jack inputs.
H Verify that the reading is between 1.945...2.055V AC.

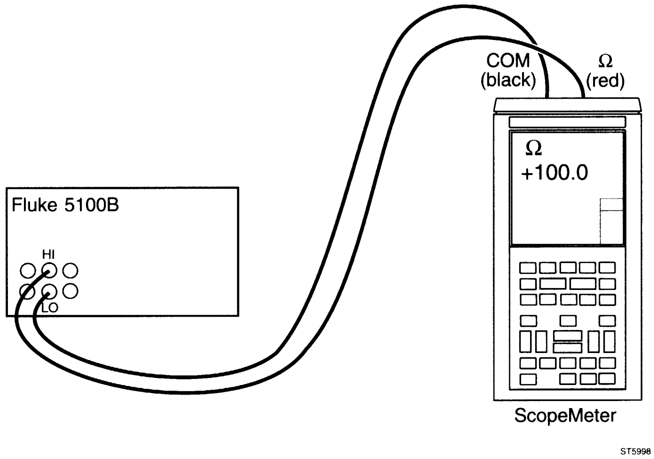
3. Resistance accuracy OHM mode



These tests check the accuracy of the OHM mode. The signal has to be supplied to the banana jack inputs.

Test equipment:
Fluke 5100B Calibrator

Test setup:



Procedure/requirements:

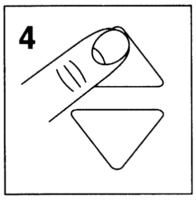
A Set the output of the Fluke 5100B to the values in table 4.4.

B Verify that the readings meet the requirements of listed in table 4.4.

Table 4.4 Requirements for Ohms accuracy test

Input signal	Requirements
0.0Ω (short)	000.0Ω...000.5Ω
100.0Ω	099.0Ω...101.0Ω
1.0 kΩ	0.990 kΩ...1.010 kΩ
10 kΩ	09.99 kΩ...10.10 kΩ
100 kΩ	099.0 kΩ...101.0 kΩ
1 MΩ	0.990 MΩ...1.010 MΩ
10 MΩ	09.90 MΩ...10.10 MΩ

4. Diode test mode accuracy

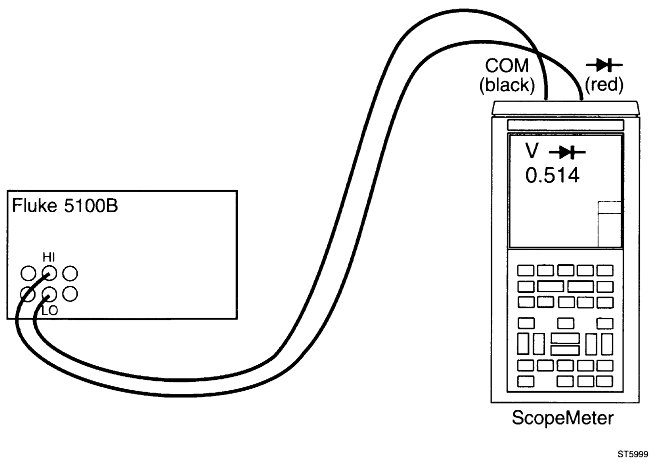


This test checks the accuracy of the Diode test mode.

Test equipment:

Fluke 5100B Calibrator

Test setup:

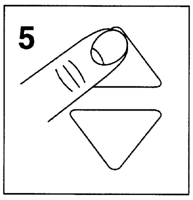


Procedure/requirements:

A Set the Fluke 5100B to 1V DC.

B Check that the readout is between 0.990...1.010 DC.

5. Signal display and frequency measurement



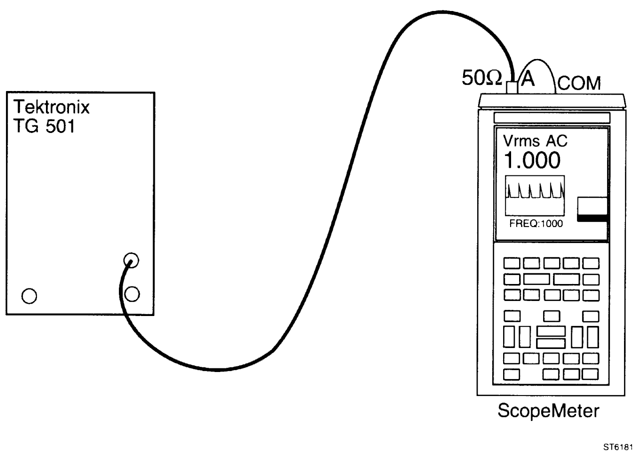
This test checks the waveform display and the frequency measurement function in METER MODE.

Test equipment:

Tektronix TG 501 Time Mark Generator

Test setup:

Connect the banana jack COM to the BNC common



Procedure/requirements:

A Apply a 1 ms (1V peak-to-peak) time marker signal to the INPUT A BNC. Use a 50Ω termination.

B Check that a stable (triggered) signal is displayed.

C Check that the frequency displayed is between 993...1007 Hz.

4.3 STANDARD PERFORMANCE VERIFICATION PROCEDURE SUMMARY

This table provides an overview of all steps in the Standard Performance Verification Procedure. It is intended to be used as a reference for frequent users. For details on how to perform each Standard Performance Verification Procedure step, refer to section 4.2.

SCOPE PART

STEP	SIGNAL SOURCE	SIGNAL AMPL/FREQ	TEST TOOL INPUTS	REQUIRED
1	-	-	-	No interrupted lines
2	-	-	-	No interrupted lines
3	-	-	-	Traces on mid screen
4	Fluke 5100B	212.1 mV(RMS)/1 kH (sine)	A	Amplitude: 5.88...6.12 div.
		300 mV/DC	A	Dist. mid screen and trace: 2.94...3.06 div.
5	Fluke 5100B	300 mV/DC	B	Dist. mid screen and trace: 2.94...3.06 div.
		212.1 mV(RMS)/1 kH (sine)	B	Amplitude: 5.88...6.12 div.
6	Fluke 5100B	3V/DC	B	Dist. mid screen and trace: 2.94...3.06 div.
		6V(pp)/1 kHz (sine)	B	Amplitude: 5.88...6.12 div.
7	Fluke 5100B	30V/DC	B	Dist. mid screen and trace: 2.94...3.06 div.
		60V(pp)/1 kHz (sine)	B	Amplitude: 5.88...6.12 div.
8	Tek PG 506	0.5V/1 MHz (fast rise/square wave)	B (50Ω term)	Rise time: < 0.7 div.
9	Tek PG 506	0.5V/1 MHz (fast rise/square wave)	A (50Ω term)	Rise time: < 0.7 div.
10	Tek SG 503	120 mV(pp)/50 kHz (sine)	A (50Ω term)	Adjust amplitude to 6 div.
11	Tek SG 503	120 mV(pp)/50 MHz (sine)	A (50Ω term)	Amplitude: > 4.2 div.
12	Tek SG 503	120 mV(pp)/50 kHz (sine)	B (50Ω term)	Adjust amplitude to 6 div.
13	Tek SG 503	120 mV(pp)/50 MHz (sine)	B (50Ω term)	Amplitude: > 4.2 div.
14	Tek SG 503	≈1V(pp)/150 MHz (sine)	B (50Ω term)	Well triggered signal at 2.5 div.
		≈130 mV(pp)/100 MHz (sine)		Well triggered signal at 1.5 div.
15	Tek SG 503	300 mV(pp)/10 MHz (sine)	B (50Ω term)	Triggered on falling edge at 1.3 div.
16	Tek SG 503	300 mV(pp)/10 MHz (sine)	A (50Ω term)	Triggered on falling edge at 1.3 div.
17	Tek SG 503	≈1V(pp)/100 MHz (sine)	A (50Ω term)	Well triggered signal at 4 div.
		≈130 mV(pp)/60 MHz (sine)		Well triggered signal at 2 div.
18	Tek TG 501	1V(pp)/1 μs (marker)	A (50Ω term)	Markers on lines (tolerance ± 1 pixel = ± 0.04 div.)
19	PM5134	1.8V/1 kHz (sine) (pp) on 1.4V/DC	A & EXT	Well triggered signal
20	PM5134	800 mV(pp)/2 kHz (sine)	A & B	Figure with angle 45° displayed on screen; gap < 10 pixels.
21	-	-	-	Trace jumps < 0.2 div. when switching
22	-	-	-	between setting 21 and 22.

METER PART (continued)

STEP	SIGNAL SOURCE	SIGNAL AMPL/FREQ	TEST TOOL INPUTS	REQUIRED
1	Fluke 5100B	300 mV/DC	A	298.0...302.0 mV
		300 mV(RMS)/1 kHz		292.5...307.5 mV
		1V/DC		0.990...1.010V
		1V(RMS)/1kHz		0.965...1.035V
		3V/DC		2.980...3.020V
		3V(RMS)/1 kHz		2.925...3.075V
		30V/DC		29.80...30.20V
		30V(RMS)/1 kHz		29.25...30.75V
		100V/DC		099.0...101.0V
		100V(RMS)/1kHz		096.5...103.5V

METER PART (continued)

STEP	SIGNAL SOURCE	SIGNAL AMPL/FREQ	TEST TOOL INPUTS	REQUIRED
2	Fluke 5100B	300 mV/DC 3V/DC 250 mV RMS 60 Hz 2.0V/60 Hz	banana	298.0...302.0 mV 2.980...3.020V 243.5...256.5 mV RMS AC 1.945...2.055v RMS AC
3	Shorted Input Fluke 5100B	0.0Ω 100.0Ω 1.0 kΩ 10 kΩ 100 kΩ 1 MΩ 10 MΩ	banana	000.0Ω...000.5Ω 099.0Ω...101.0Ω 0.990 kΩ...1.010 kΩ 09.99 kΩ...10.10 kΩ 099.0 kΩ...101.0 kΩ 0.990 MΩ...1.010 MΩ 09.90 MΩ...10.10 MΩ
4	Fluke 5100B	1.0 VDC	banana	0.990...1.010V
5	Tek TG 501	1 ms (marker)	A (50Ω term)	Stable oscilloscope picture Frequency: 993...1007.

4.4 ADDITIONAL PERFORMANCE VERIFICATION PROCEDURE

This paragraph describes the Additional Performance Verification Procedure.
This procedure can be used to do some extra performance tests, depending on the ScopeMeter test tool model. Follow the instructions described with each step.

The recommended test equipment required for this Additional Performance Verification Procedure is listed in table 4.4.

Table 4.4 Recommended test equipment for Additional Performance Verification Procedure

Instrument Type	Recommended Model
Function Generator	Philips PM 5134
Multimeter	Philips PM 2525
Power Supply	Philips PE 1537
Time Mark Generator	Tektronix TG 501
Constant Amplitude Sine wave Generator	Tektronix SG 503
Square wave Calibration Generator	Tektronix PG 506

- Cables and terminators for the generators (all BNC type)
- Two standard banana test leads (delivered with the ScopeMeter test tool)
- BNC (female)-to-banana (male) (delivered with the ScopeMeter test tool)
- 5 mm Power Jack connector plug with attached cable (e.g.: 4822 321 20125)

NOTE: During the following Performance Verification Procedure, you must connect the ScopeMeter test tool inputs to the signal generator outputs. This connection must be made by coaxial cables (INPUT A or B BNC) or two standard banana test leads (banana jack inputs). The Additional Performance Verification Procedure does not use the oscilloscope probes delivered with the instrument. The calibration of the probes is described in the Operating Manual.

RESET

Before each additional verification procedure step the ScopeMeter test tool must be reset in the following way:

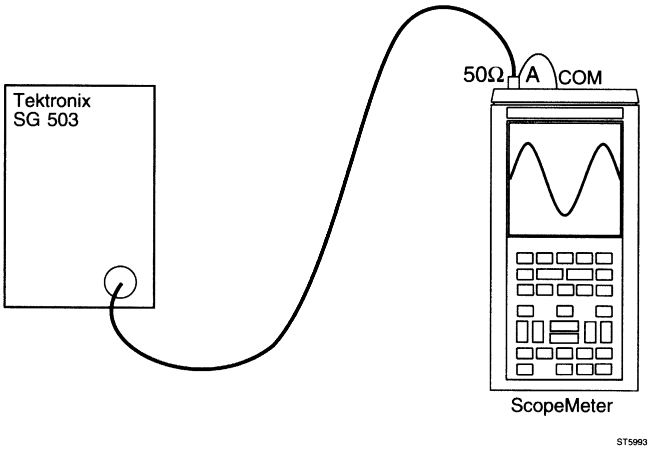
1 Turn the test tool off.
2 Press and hold the F1 key.
3 Pres and release the ON-OFF key.
The test tool turns on, and you should hear a single beep.
input: A PROBE 1:1 appears on the display.
4 Release the F1 key.

1. Autoset

This test checks the correct operation of the AUTO SET function.

Test equipment:
Tektronix SG 503 Constant Amplitude Sine wave Generator

Test setup:
Connect the banana jack COM to the BNC common



Settings/procedure/requirements:
A Reset the ScopeMeter test tool.
B Press the F1 key to select SCOPE mode.
C Apply a 50 MHz sine wave signal of 100 mV peak-to-peak to the INPUT A BNC. Use a 50Ω termination.
D Press the AUTO SET key. Check that the display is stable and well triggered. Minimal 2 and maximal 20 signal periods must be displayed, over 8 divisions. The signal amplitude must be approximately 5 divisions. The NOTRIG indication on the display must not flash.
E Repeat settings/procedure for the INPUT B BNC.

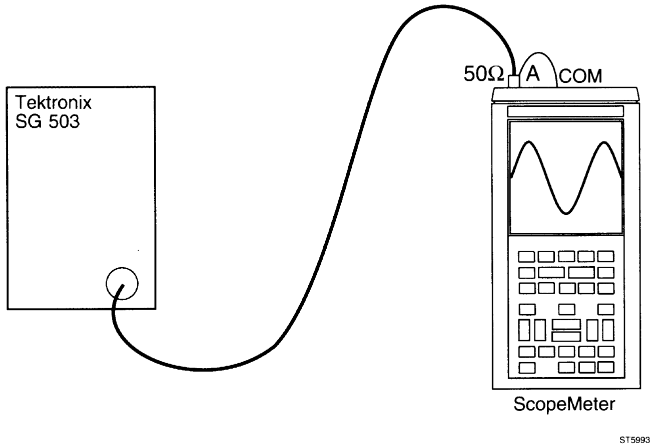
2. Vertical dynamic range and position range (move control)

This test checks the vertical dynamic range, together with the position range (move control). A certain overdrive of the ScopeMeter test tool must be allowed.

Test equipment:
Tektronix SG 503 Constant Amplitude Sine wave Generator

Test setup:

Connect the banana jack COM to the BNC common



Settings/procedure/requirements for input A:

A Reset the ScopeMeter test tool.

Vertical dynamic range check:

B Press the F1 key to select SCOPE mode.

C Apply a 50 kHz sine wave signal of 950 mV peak-to-peak to the INPUT A BNC. Use a 50Ω termination.

D Press the AUTO SET key. Set INPUT A to 100 mV/div. and set the timebase speed to 10μs/div.

E Use the vertical MOVE key to shift the bottom of the sine wave vertically over the screen in the lower division. Shift the top of the sine wave in the upper division. Verify that the top and bottom of the sine wave signal of 9.5 divisions can be displayed distortion free.

F Apply a 100 MHz sine wave signal of approximately 500 mV peak- to-peak (4 divisions on the screen) to the INPUT A BNC. Use a 50Ω termination.

G Set the timebase speed to 5 ns/div.

H Now a sine wave with an amplitude of 4 divisions must be displayed distortion free.

Move control check:

A Adjust the signal amplitude to 8 divisions on the screen.

B Check that the trace can be moved over 4 divisions up (+ 4 div.) and over 4 divisions down (- 4 div.).

Settings/procedure/requirements for input B:

Repeat the total procedure for input B (not for model 91).

3. Trigger level control range

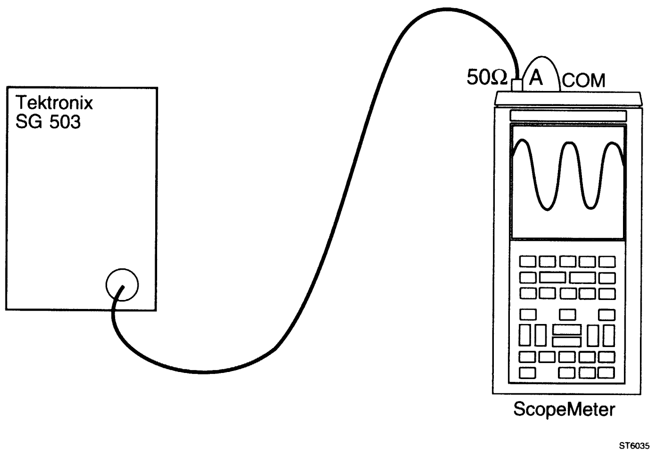
This test checks the trigger level control range.

Test equipment:

Tektronix SG 503 Constant Amplitude Sine wave Generator

Test setup:

Connect the banana jack COM to the BNC common



Settings/procedure/requirements

A Reset the test tool.

B Press the F1 key to select SCOPE mode.

C Apply a 500 kHz sine wave with an amplitude of 950 mV peak-to-peak to the INPUT A BNC. Use a 50Ω termination.

D Press the AUTOSET key and verify that the signal is well triggered.

E Set the INPUT attenuation to 100 mV/div., and the time base to 500 ns/div.

F Press the TRIGGER key and then the F4 key (ADJUST LEVEL). Adjust the trigger level with the ▲ and the ▼ keys.
Verify that the signal is well triggered over a trigger level range of 8 divisions (4 divisions up, and 4 divisions down).
The trigger level value is displayed. The trigger level marker (AI) will shift while adjusting the trigger level. See figure 4.9

G Repeat the same procedure for INPUT B (not for model 91).

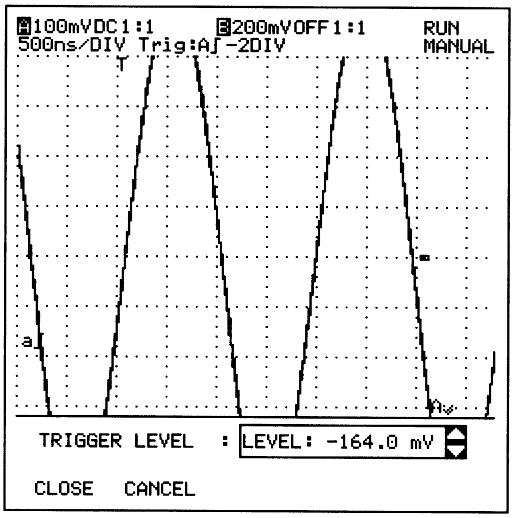


Figure 4.9 Trigger level control

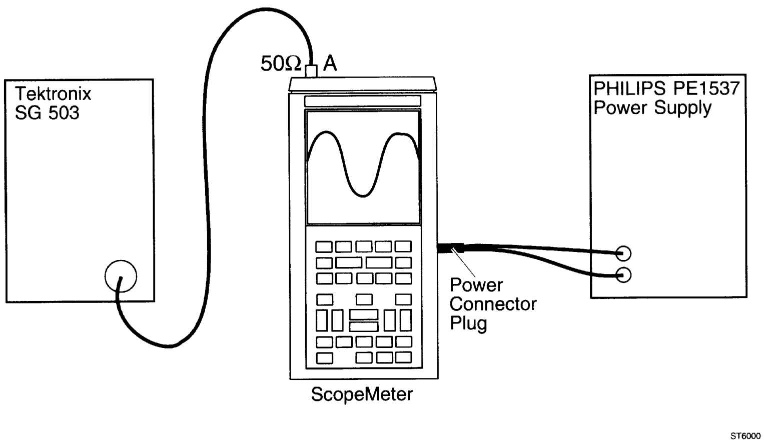
4. Power supply voltage range

This test checks the correct operation of the ScopeMeter test tool within the boundaries of the DC supply voltage.

Test equipment:

Philips PE 1537 Power Supply 0-40V/0-1A
Tektronix SG 503 Constant Amplitude Sine Wave Generator
5 mm Power Jack connector plug with attached cable (for example order 4822 321 20125)

Test set-up:



Settings/procedure:

A Insert the power plug into the power adapter contact on the right side of the ScopeMeter test tool.
B Turn on the PE1537 power supply and set the voltage to a value between 8 and 20V DC.
C Apply a 50 kHz sine wave with an amplitude of 100 mV peak-to- peak to the INPUT A BNC. Use a 50Ω termination.
D Turn on the ScopeMeter test tool. At power on, a beep tone must be audible.
E Press the SCOPE/METER key to select SCOPE mode.
F Press AUTO SET and verify that a well triggered signal with an amplitude of approximately 5 divisions is displayed over the whole supply voltage range.

Requirements:

A The ScopeMeter test tool must start at any DC voltage between 8 and 20V, applied at its power adapter contact.
B The test tool must remain operative over the indicated voltage range.
C The amplitude of the trace displayed must be approximately 5 divisions, independent of the supply voltage.

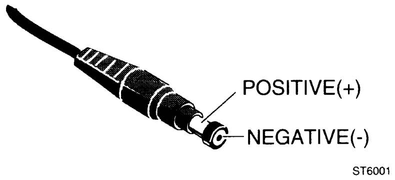


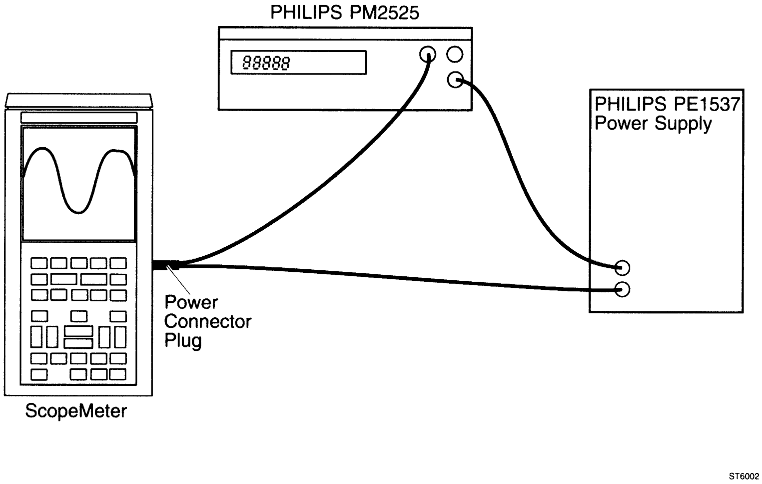
Figure 4.10 Power Jack connector

5. Supply current

This test checks the total supply current (supply current and the built-in battery charger current).

Test equipment:
Philips PE 1537 Power Supply 0-40V/0-1A
Digital Multimeter (Philips PM 2525 or equivalent)
5 mm Power Jack connector plug with attached cable (for example order 4822 321 20125).

Test set-up:



Settings/procedure/requirements:

NOTE: A PM 9086 battery pack (included in the shipment) has to be installed for this test. Only NiCad batteries can be charged by the ScopeMeter test tool!

A Set the PE1537 power supply to 15V DC.
B Check that the charging current is 200 mA (typical reading on multimeter).
C Turn on the ScopeMeter test tool.
D Check that the total supply current is 330 mA (typical reading on multimeter).

6. Battery backup functional test

This test verifies that the ScopeMeter test tool settings will be kept in memory if power is switched off while the batteries are removed.

Test equipment:
none

Test setup:
no specific test setup required

Settings/procedure:
A Remove the battery pack (see section 6.2.1) and power the test tool via the PM8907 power adapter.
B Turn on the ScopeMeter test tool and press the F1 (SCOPE) key to get into scope mode.
C Press the AUTO SET key and set input A to 500 mV/div. Set the timebase to 1 ms/div.
D Turn off the ScopeMeter test tool and keep it switched off for one hour to enable all capacitors to discharge.
E Turn on the ScopeMeter test tool again, and verify that the settings for the timebase and attenuator have not changed.

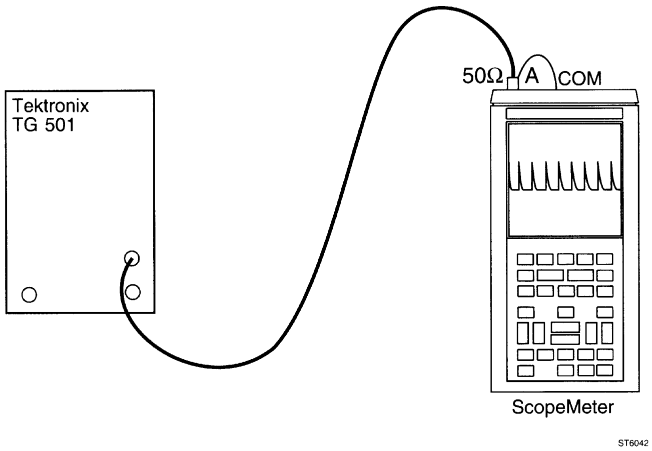
Requirements:
ScopeMeter test tool settings at power off must be recalled each time power is turned on.

7. Cursor measurements: time accuracy

This test checks the accuracy of the cursors while measuring time.

Test equipment:
Tektronix TG 501 Time Mark Generator

Test setup:
Connect the banana jack COM to the BNC common



Setting/procedure:

A Reset the test tool.
B Press the F1 key to select SCOPE mode.
C Apply a 1 ms time marker signal to the input A BNC and then press the AUTOSET key.
D Set the time base to 1 ms/div.
E Press the HOLD-RUN key to freeze the display.
F Select dt cursor measurements by pressing the following keys:

SUBMENU >> **F1** (more scope) >> **F4** (next page) >> ▲ or ▼ to highlight **CURSOR READINGS** >> **F5** (select item) to select **CURSOR READINGS** >> ▲ or ▼ to highlight **ADD MAIN READING** >> **F5** to select the cursor functions menu >> ▲ or ▼ to highlight **dt** >> **F5** to select dt >> **F1** (close) to leave the menu.

G Position the cursor lines with the LEFT CURSOR and the RIGHT CURSOR key, so that the vertical cursor lines cover a distance of six time marker intervals. See figure 4.11.

Requirements:
The measured time distance between the cursors (dt) must be **6.00** ms.

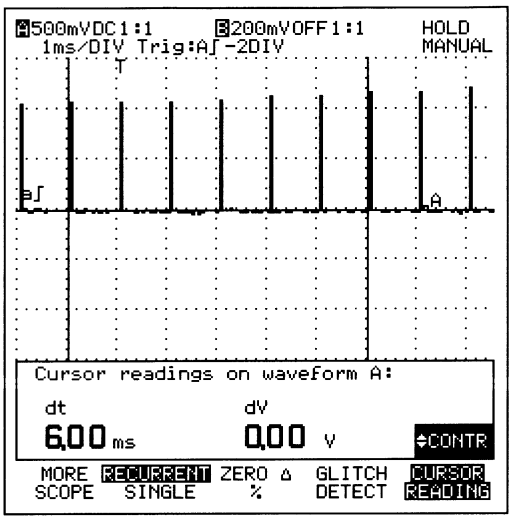


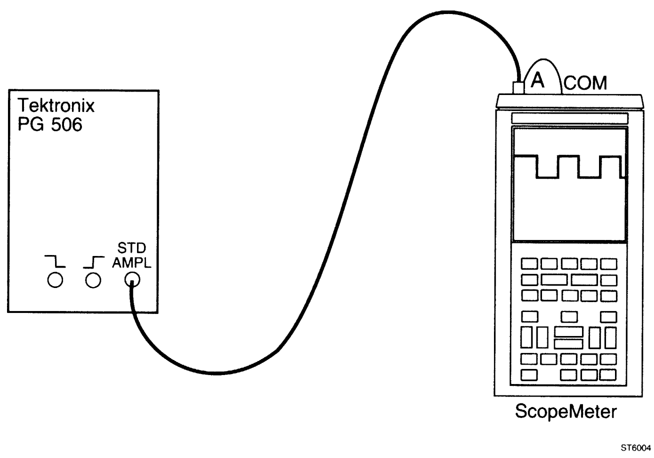
Figure 4.11 Cursor lines on marker pulses

8. Cursor measurements: voltage accuracy

This test checks the accuracy of the cursors while measuring voltage.

Test equipment:
Tektronix PG 506 Square Wave Calibration Generator

Test setup:
Connect the banana jack COM to the BNC common



Setting/procedure:

A Reset the test tool.
B Press the F1 key to select SCOPE mode.
C Apply a 1 kHz square wave of 1V peak-to-peak to the input A BNC and then press the AUTOSET key.
D Press the INPUT A key and then press the F3 key two times to select AC input coupling. Set input A to 0.2 V/div. The displayed signal amplitude is 5 divisions.
E Press the HOLD-RUN key to freeze the display.
F Select dV cursor measurements by pressing the SUB MENU key and then the F5 key. If cursor measurements are already on, the F5 key will switch off cursor measurements. Press F5 again to switch on.
G Position the left cursor lines with the LEFT CURSOR key to the horizontal middle of the top of the waveform.
H Position the right cursor lines with the RIGHT CURSOR key to the horizontal middle of the bottom of the waveform.

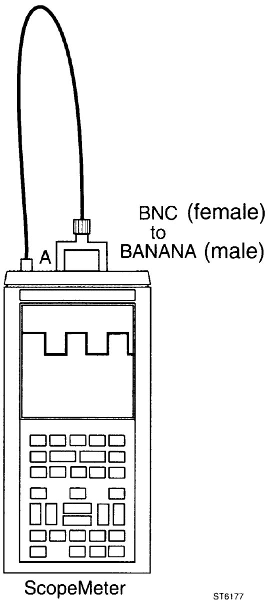
Requirements:
The measured voltage dV must be **0.97V** ... **1.03V**.

9. Generator

This test checks the built-in generator.

Test equipment:
none

Test setup:



Setting/procedure/requirements:

Square wave

A Reset the test tool.
B Press the F1 key to select SCOPE mode.
C Press the SPECIAL FUNCT key. Now press the F2 key (generate menu) to reveal the generator menu.
D Press the F5 key (select item) to turn the generator on if it is off.
E Press the ▼ key to highlight GENERATOR WAVEFORM, and press the F5 key to open the generator function menu.
Highlight SQUARE 1.95 kHz (or SINE if you continued at J) with the ▲ or ▼ key and press the F5 key to select this item. Pres the F1 key (close) to leave the generator menu.
F Press the AUTOSET key.
G Select frequency cursor measurements by pressing the following keys (if you continued from J you can skip this step, and go to H):

SUBMENU >> **F1** (more scope) >> **F4** (next page) >> ▲ or ▼ to highlight **CURSOR READINGS** >> **F5** (select item) to select **CURSOR READINGS** >> ▲ or ▼ to highlight **ADD MAIN READING** >> **F5** to select the cursor functions menu >> ▲ or ▼ to highlight **FREQUENCY** >> **F5** to select **FREQUENCY** >> **F1** (close) to leave the menu.

H Position the left vertical cursor line with the LEFT CURSOR key to the left screen margin. Position the right vertical cursor line with the RIGHT CURSOR key to the right screen margin.

I The display will look like figure 4.12. The generator must produce a square wave signal with an amplitude of 5V and a frequency of 1.95 kHz (typical values).

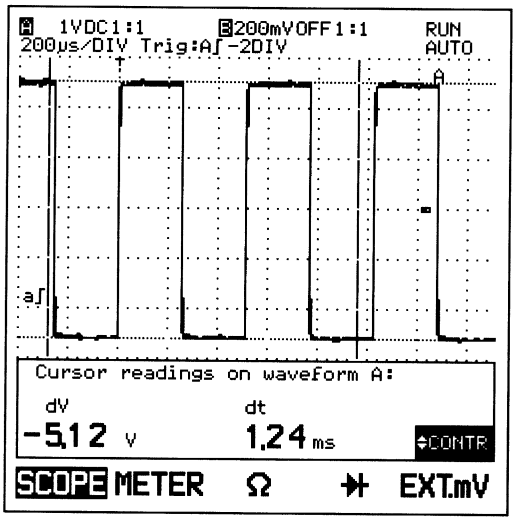


Figure 4.12 Generator square wave signal.

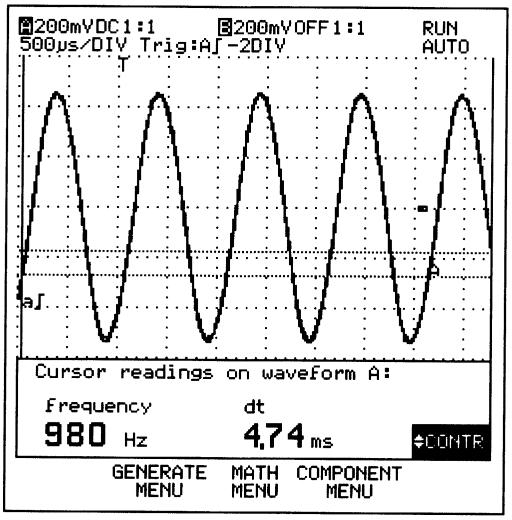


Figure 4.13 Generator sine wave signal.

Sine wave

J Start at C again and select SINE WAVE at E.

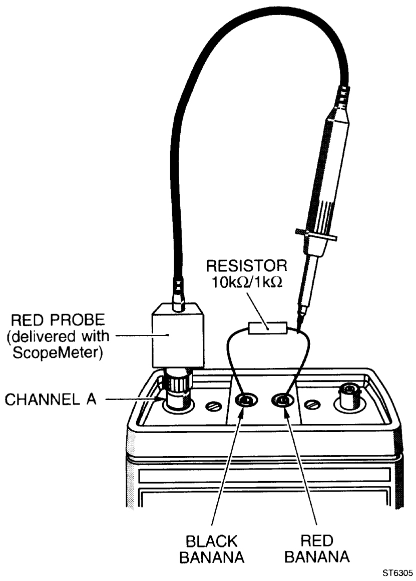
K The display will look like figure 4.13. The generator must produce a sine wave signal with an amplitude of 1V and a frequency of 976 Hz (typical values).

10. Component test function

This test checks the component test function (slow ramp voltage and slow ramp current).

Test equipment:
Red scope probe (delivered with the ScopeMeter test tool)

Test setup:



Settings/procedure/requirements

A Turn the test tool off. Press and hold the F5 key, and turn the test tool on. Release the F5 key after you hear two beeps. The 10:1 probe is selected now.

Voltage sweep

B Connect a 10 kΩ resistor to the banana input sockets. Connect the red 10:1 probe as indicated in the test setup figure above.

C Press the SPECIAL FUNCT key, and then press the F4 key to open the Component Test menu. Press F5 to turn the component test on.

D Press the ▼ key to highlight the TEST Waveform SOURCE. Press the F5 key to open the voltage/current window. Press the ▲ or ▼ key to highlight voltage sweep, and press the F5 key to select voltage sweep. Press the F1 key to close the menu.

E Adjust the INPUT A attenuator with the mV-RANGE-V key to 0.5V/div.
The display must show a 45° line. See figure 4.14

Current sweep

F Connect a 1 kΩ resistor to the banana input sockets. Connect the red 10:1 probe as indicated in the test setup figure above.

G Press the SPECIAL FUNCT key, and then press the F4 key to open the Component Test menu. Press F5 to turn the component test on.

H Press the ▼ key to highlight the TEST Waveform SOURCE. Press the F5 key to open the voltage/current window. Press the ▲ or ▼ key to highlight current sweep, and press the F5 key to select current sweep. Press the F1 key to close the menu.

I Adjust the INPUT A attenuator with the mV-RANGE-V key to 20 mV/div.
The display must show a line as indicated in figure 4.15.

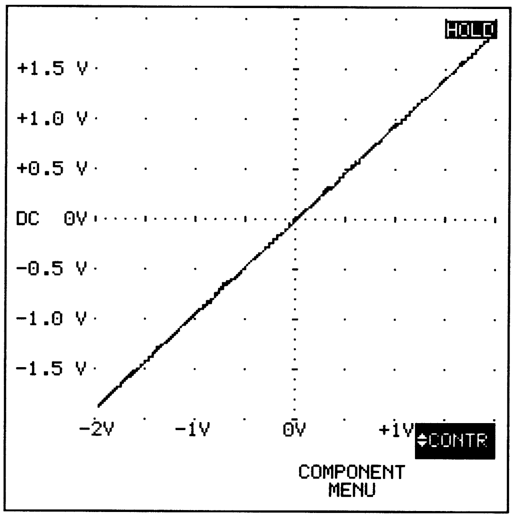


Figure 4.14 Component test voltage sweep

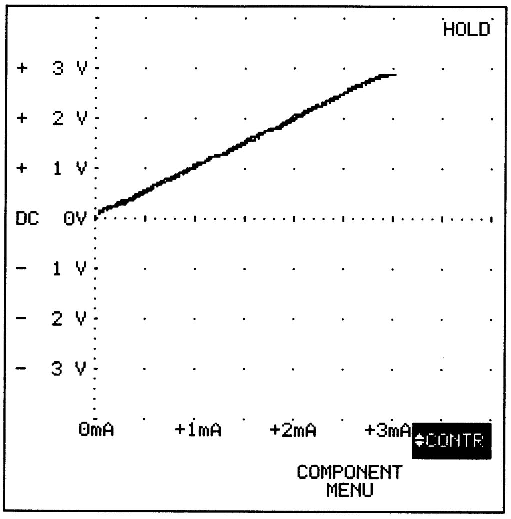


Figure 4.15 Component test current sweep

5 CALIBRATION ADJUSTMENT PROCEDURE

5.1 GENERAL INFORMATION

The following information provides the complete Calibration Adjustment Procedure for the ScopeMeter test tool. Because various control functions are interdependent, a certain order of adjustment is necessary. The procedure is therefore presented in a sequence that is best suited to this order. Before you make calibration adjustments, always use the Performance Verification Procedure in chapter 4 to check the ScopeMeter test tool performance.

The Fluke 91 ScopeMeter test tool has an input A and an External mV input. All references to input B or channel B do not apply.

The Calibration Adjustment Procedure, described here, consists of the following three parts:

- CONTRAST Calibration Adjustment Procedure
- SCOPE Calibration Adjustment Procedure
- METER Calibration Adjustment Procedure

Almost all Calibration Adjustments can be done without opening the instrument. Only the first four steps of the SCOPE Calibration Adjustment Procedure require disassembling of the ScopeMeter test tool (see section 5.6.1).

NOTE: Every year use the Performance Verification Procedure in chapter 4 to check the test tool. If it fails the Performance Verification Procedure, Calibration Adjustments must be made. If it also fails the Calibration Adjustment Procedure, repair is necessary (see chapter 7). (After repair, it is sometimes also necessary to do also a Hardware Calibration Adjustment, see section 5.6.1)

Sections 5.5, 5.6 and 5.7 describe the calibration process in detail. Section 5.8 contains a summary of all calibration adjustments as a reference for more frequent users.

5.2 RECOMMENDED CALIBRATION ADJUSTMENT EQUIPMENT

The equipment recommended for the Calibration Adjustment Procedure is listed in table 5.1.

All calibration adjustments must be done in ambient temperatures between 18 °C and 28 °C. Allow the ScopeMeter test tool to warm up for at least 20 minutes.

Table 5.1 Recommended calibration adjustment equipment survey

Instrument Type	**Recommended Model**
Multifunction Calibrator	Fluke 5100B
Square Wave Calibration Generator	Tektronix PG 506
Function Generator	Philips PM 5134
*) Personal Computer	Any IBM compatible PC, running MS-DOS
*) Optical to RS-232 Interface Cable	PM9080/001
*) Flash ROM Refresh software	Contact your Service Center
*) +12V (± 2.5%) Programming voltage	

*) These items are required after two or three calibrations, see note paragraph 5.3, page 5.3 for details.

- Cables and terminators for the generators (all BNC type)
- Standard banana test leads
  (two banana test leads are delivered with the ScopeMeter test tool)
- BNC (female)-to-banana (male) (delivered with the ScopeMeter test tool)
- The red and grey probes, delivered with the ScopeMeter test tool.

5.3 ENTERING THE CALIBRATION PROCEDURE

The Calibration Adjustment Procedure is operated via built-in sequences. Before you can activate a calibration sequence, you must first connect a 12V DC programming voltage to the ScopeMeter test tool. To do this, first remove the battery pack. See section 6.2.1.

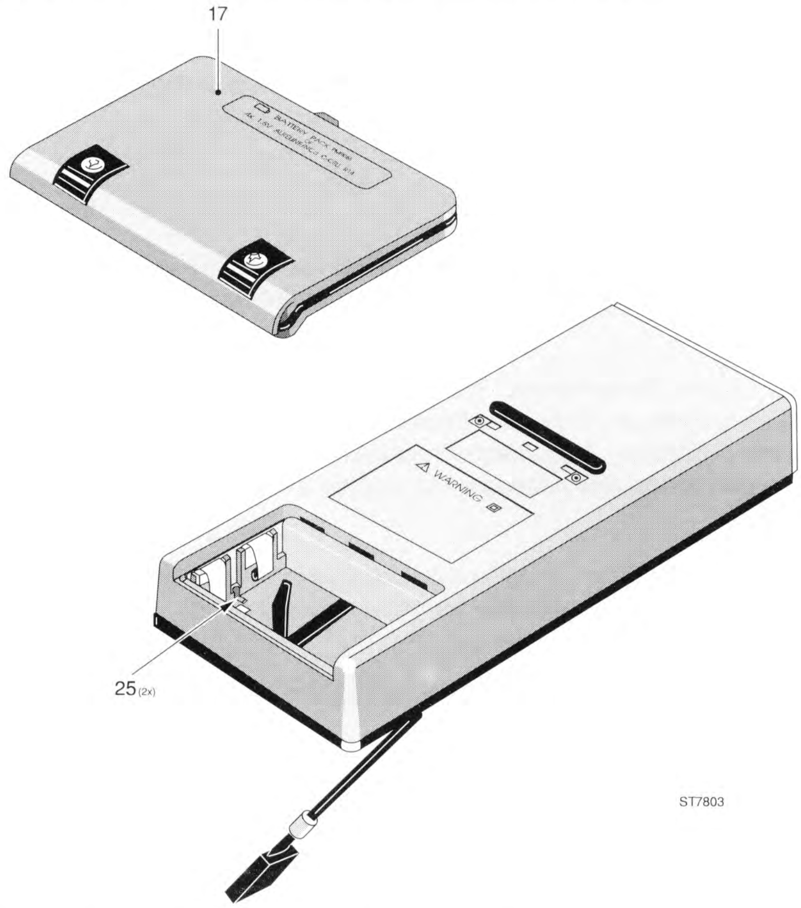


Figure 5.1 Position of the +12V and 0 contacts for calibration (items 25)

If you have removed the battery pack and the battery cover (figure 5.1, item 17), you will have access to the +12V/0 contacts (figure 5.1, item 25). These contacts are placed in the left middle (+12V) and the right middle (0) of the battery compartment. Connect +12V DC to the contact marked "+12V" and 0V to the contact marked "0".

CAUTION: To avoid damaging the Flash ROM circuitry be sure to apply the polarity of 12V programming voltage correctly.

NOTE: After you have performed the Calibration Procedure, remove the 12V programming voltage. Do not perform measurements with the ScopeMeter test tool, while the programming voltage is still present.

Connect the test tool to the Power Adapter/Battery Charger PM 8907 and turn on the power. Now press the BACKLIGHT key, then press AUTOSET, and then release the BACKLIGHT key. This will start the SERVICE menu (see figure 4.1, chapter 4). This menu allows you to start the calibration sequence. Press the corresponding function key marked "CALIBRATE ScopeMeter test tool". This will start the CALIBRATE menu.

NOTE: If there is not enough space in the FLASH memory you get a message on the display.

After two or three electronic calibrations (see NOTE above), the ScopeMeter test tool will display a message that the internal Flash ROMs are full. To enable another calibration, you must first empty the Flash ROMs and reinstall the operating software. To do this, send the ScopeMeter test tool to your nearest Service Center. It is also possible to "refresh" the FlashROMs by yourself, using a PC. For more information: contact your nearest Service Center.

5.4 OPERATING THE CALIBRATION PROCEDURE

Function keys in the CALIBRATE menu
In the CALIBRATE menu, it is possible to choose the calibration mode (sequence) to be performed.

Press the function key marked:
- CONTRAST for the CONTRAST Calibration Adjustment Procedure (see section 5.5).
- SCOPE for the SCOPE Calibration Adjustment Procedure (see section 5.6).
- METER for the METER Calibration Adjustment Procedure (see section 5.7).

When one of these three calibration sequences is chosen, the corresponding text on the screen will be shown in reverse. This shows that this calibration mode is active.

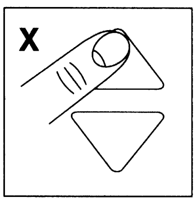
If you press the ESCAPE softkey, the ScopeMeter test tool will leave the CALIBRATE menu and return to the SERVICE menu.

NOTE: If you use the ESCAPE softkey to leave the SERVICE menu before storing the new calibration values with the CAL STORE softkey, you will lose all new calibration values. The instrument will continue using the calibration values that were used before entering the CALIBRATE menu.

The CAL STORE function key saves the new calibration values that are obtained in the CONTRAST, SCOPE or METER sequences, to the Flash ROM. From the moment you press the CAL STORE function key, the ScopeMeter test tool uses the new calibration data. The old calibration data is no longer valid. This will also fill one calibration field in the Flash ROM. See section 5.3.

NOTE: After calibrating the ScopeMeter test tool, reset the instrument (use a MASTER RESET), before performing measurements. A MASTER RESET is done when the test tool is turned on while the F5 function key is depressed. Two beeps are audible.

Keys in CONTRAST, SCOPE, or METER Calibration mode
The calibration is presented as a sequence. You can advance through this sequence by pressing the UP/DOWN keys. Pressing the UP △ key advances one step; pressing the DOWN ▽ key brings you back one step.



In sections 5.5, 5.6 and 5.7 this figure is used to indicate that the UP or DOWN key must be pressed to choose the indicated step number "x".

When the ScopeMeter test tool LCD displays the indication " CAL", you must first apply the appropriate input (calibration) signal. When the correct signal is present at the correct terminal, you start the built-in calibration by pressing the most right READY function key. The text "READY" will be in reverse video, to show that the internal calibration is active. When the process is ready, the "READY" text will change again, from inverted to normal. Now you can use the UP key to advance to the next calibration step or the DOWN key to return to a previous calibration step.

After you have completed a calibration sequence, press either the CONTRAST, SCOPE, METER or ESCAPE function key again to return to the CALIBRATE menu. The new calibration data will stay in memory to enable you to store it permanently with the CAL STORE function key.

Press the ESCAPE function key twice to leave the active calibration mode without storing the new calibration data. This will also return you to the SERVICE menu.

5.5 CONTRAST CALIBRATION ADJUSTMENT PROCEDURE

You activate the CONTRAST Calibration Adjustment Procedure from the CALIBRATE menu, by pressing the left most CONTRAST function key. When this function key is depressed, the text "CONTRAST" is shown in reverse video, to show that this calibration mode is active.

Now use the UP/DOWN keys to adjust the contrast of the LCD to your own (personal) setting. When you have found the correct setting, you can make this setting ready for calibration storage, by pressing the READY softkey once.

NOTE: When you press the READY function key, this does not mean that the new value of the LCD contrast is actually stored in the Flash ROMs of the ScopeMeter test tool. This only happens when you press the CAL STORE function key.

Press the CONTRAST function key again to leave the CONTRAST Calibration Adjustment Procedure. The text "CONTRAST" will change from reverse video into normal again.

5.6 SCOPE CALIBRATION ADJUSTMENT PROCEDURE

You can start the SCOPE Calibration Adjustment Procedure from the CALIBRATE menu by pressing the SCOPE function key. When this function key is pressed, the text "SCOPE" is shown in reverse video, to show that this calibration mode is active.

The SCOPE Calibration Adjustment Procedure is divided into two parts:

- Hardware SCOPE Calibration Adjustments: steps H1 to H4
- Closed Case SCOPE Calibration Adjustments: steps S5 to S29

NOTE: During the following Calibration Adjustment Procedure,you must connect the ScopeMeter test tool inputs to the signal generator outputs by means of coaxial cables (input A or B) or two standard banana test leads (banana jack inputs).

5.6.1 Hardware SCOPE Calibration Adjustments

The first four steps of the SCOPE Calibration Adjustment Procedure are called **Hardware SCOPE Calibration Adjustments**. To perform the Hardware SCOPE Calibration Adjustments, you must open the ScopeMeter test tool. The disassembly procedure for these calibration adjustments is described in chapter 6 (section 6.1 and 6.2.3).

WARNING: To prevent personal injury, do not perform any disassembly procedures before reading chapter 6.

When the ScopeMeter test tool is disassembled, it is not possible to apply the +12V programming voltage in the normal way. It is possible to apply the +12V programming voltage by means of two test clips (see figure 5.2).

Remove all voltage sources from the ScopeMeter test tool. Turn the digital A1 PCB, mounted in the top cover so that the display and the keyboard are facing down. Connect the +12V programming voltage to the appropriate places on the PCB. It can be helpful to first install two metal screws again. See figure 5.2.
Turn the top cover and the mounted PCB. Connect the ScopeMeter test tool to the power supply and turn the instrument on. Go to the SERVICE menu and press the CALIBRATE function key. You can make the adjustments necessary with six trim capacitors (three for the attenuator of each channel) and two adjustment potentiometers (for the Analog ASIC).

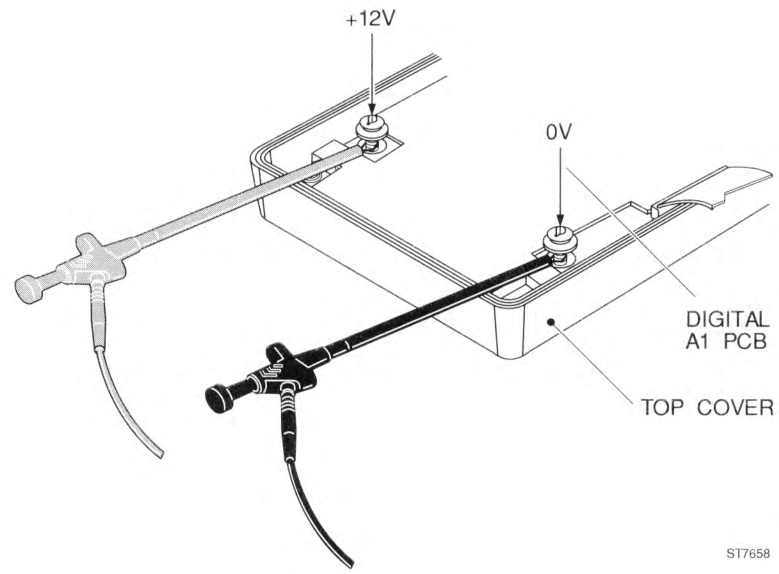
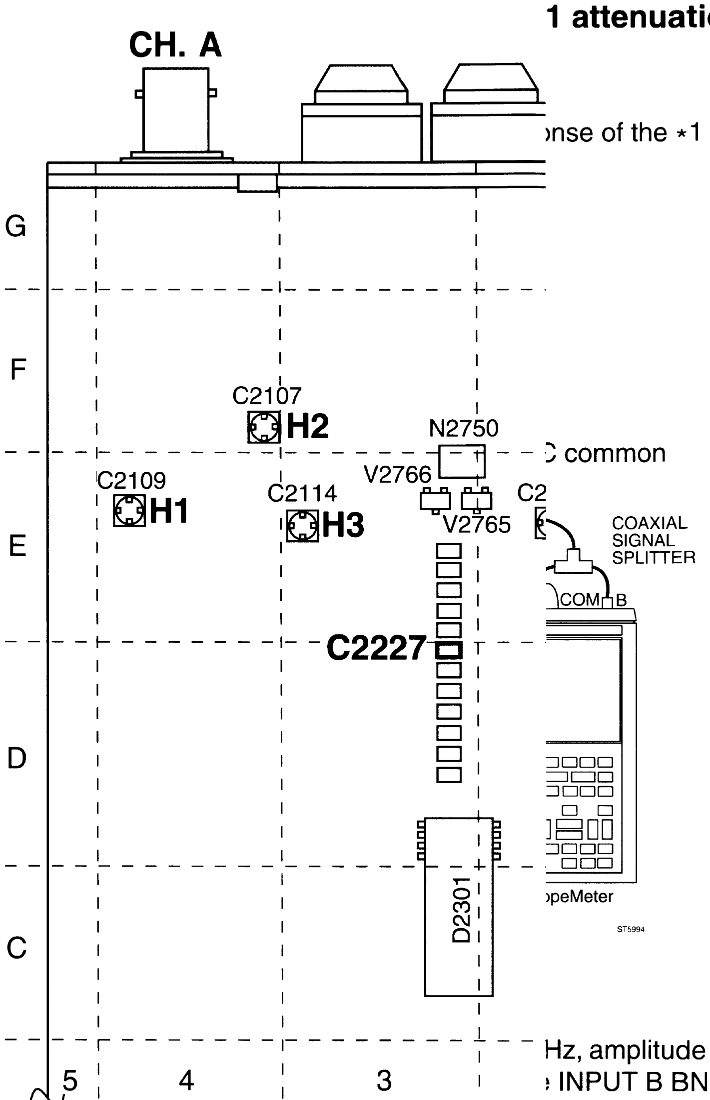


Figure 5.2 Connecting the +12V programming voltage for Hardware SCOPE Calibration Adjustments

*NOTE: You only have to do Hardware SCOPE Calibration Adjustments, if you have repaired the ScopeMeter test tool in the Attenuator sections or in the Analog ASIC circuitry. After you have done a Hardware SCOPE Calibration Adjustment or you have adjusted one of the potentiometers, you always need to do a full (software) SCOPE and METER calibration.
If you decide not to do the Hardware Calibration Adjustment now, you can advance to calibration S5 by pressing the UP key 4 times.*

1 attenuation



›nse of the *1 attenuation circuit.

C common

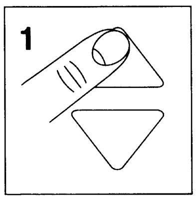
Hz, amplitude 300 mV peak-to-peak (between 0 mV
INPUT B BNC.
o get the best channel A pulse response on the LCD
rimmer C2209 can be found in figure 5.3.
to get the best channel B pulse response on the
found in figure 5.3.

Figure 5.3 Analog A2 PCB; position of hardw

10 attenuation

›nse of the *10 attenuation circuit.

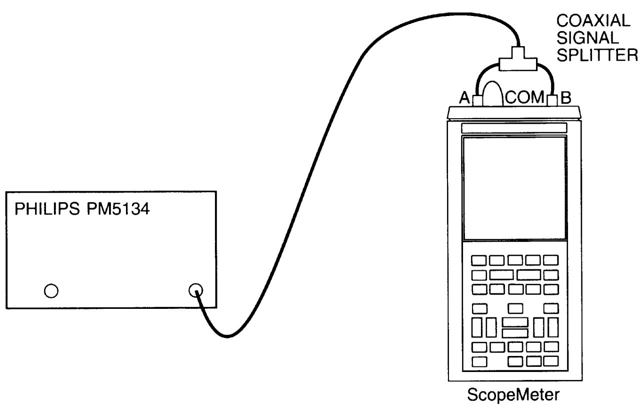
H1. Hardware pulse response of the *1 attenuation



Purpose: optimal pulse response of the *1 attenuation circuit.

Calibration equipment:
Philips PM 5134 Function Generator

Calibration setup:
Connect the banana jack COM to the BNC common



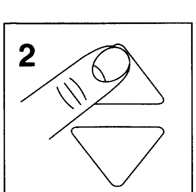
Procedure:

A - Apply a square wave with a frequency of 1 kHz, amplitude 300 mV peak-to-peak (between 0 mV and +300 mV) to the INPUT A BNC and the INPUT B BNC.

B - Turn trimmer C2209 on the analog A2 PCB to get the best channel A pulse response on the LCD (least distorted waveform). The position of trimmer C2209 can be found in figure 5.3.

C - Turn trimmer C2109 on the analog A2 PCB to get the best channel B pulse response on the LCD. The position of trimmer C2109 can be found in figure 5.3.

H2. Hardware pulse response of the *10 attenuation



Purpose: optimal pulse response of the *10 attenuation circuit.

Calibration equipment:
Philips PM 5134 Function Generator

Calibration setup:
See calibration setup H1.

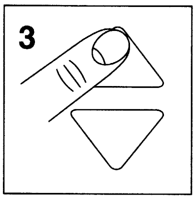
Procedure:

A - Apply a square wave with a frequency of 1 kHz, amplitude 3V peak-to-peak (between 0V and +3V) to the INPUT A BNC and the INPUT B BNC.

B - Turn trimmer C2207 on the analog A2 PCB to get the best channel A pulse response on the LCD (least distorted waveform). The position of trimmer C2207 can be found in figure 5.3.

C - Turn trimmer C2107 on the analog A2 PCB to get the best channel B pulse response on the LCD. The position of trimmer C2107 can be found in figure 5.3.

H3. Hardware pulse response of the *100 attenuation



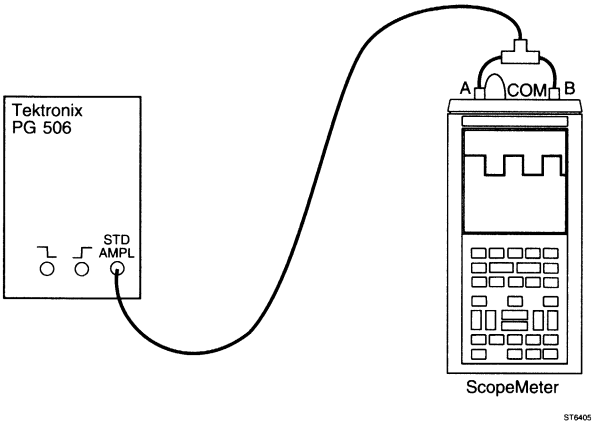
Purpose: optimal pulse response of the *100 attenuation circuit.

Calibration equipment:

Tektronix PG 506 Square Wave Calibration Generator

Calibration setup:

Connect the banana jack COM to the BNC common



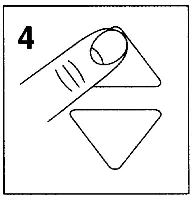
Procedure:

A - Apply a square wave with a frequency of 1 kHz, amplitude 20V peak-to-peak (between 0V and +20V) the INPUT A BNC and the INPUT B BNC. Set the generator to the position "STD AMPL".

B - Turn trimmer C2214 on the analog A2 PCB to get the best channel A pulse response on the LCD (least distorted waveform). The position of trimmer C2214 can be found in figure 5.3.

C - Turn trimmer C2114 on the analog A2 PCB to get the best channel B pulse response on the LCD. The position of trimmer C2114 can be found in figure 5.3.

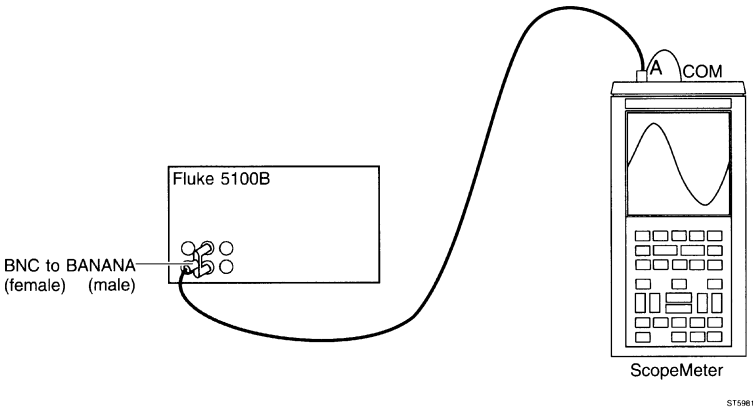
H4. Hardware offset and gain



Purpose: optimal response of complete analog A2 circuitry.

Calibration equipment:
Fluke 5100B Calibrator

Calibration setup:
Connect the banana jack COM to the BNC common



Procedure:

A - Connect Test Point TP209 on the analog A2 PCB to GROUND. The position of Test Point TP209 can be found in section 9: figure 9.4 (A2 PCB layout wired components side). Instead of connecting TP209 to GROUND you can shortcircuit C2227 (e.g. with a pair of tweezers). The position of C2227 can be found in figure 5.3.

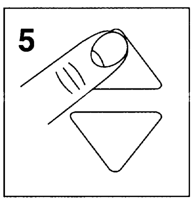
B - Apply a 1 kHz sine wave signal with an amplitude of 720 mV AC peak-to-peak to the INPUT A BNC. (Set the Fluke 5100B to 254.56 mV RMS, 1 kHz sine wave.)

C - Turn the potentiometers R2346 and R2347 so that the sine wave on the LCD is exactly 6 divisions: maximum (peak) on +3 divisions, minimum (peak) on -3 divisions (tolerance $\pm$ 1 dot).

5.6.2 Closed Case SCOPE Calibration Adjustments

NOTE: The following calibration adjustments are done electronically. For these calibrations, the ScopeMeter test tool must be in a fully assembled state!

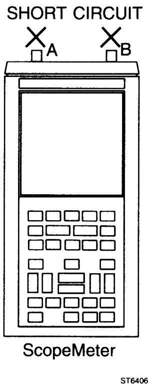
S5. Offset correction



Purpose: remove offset of channel A and B input operational amplifiers.

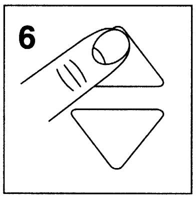
Calibration equipment:
none.

Calibration setup:



Procedure:
A - Short circuit the INPUT A BNC and the INPUT B BNC.
B - Press the READY function key.

S6/7. Pulse response of the *1/*10 attenuation (fine adjustments)

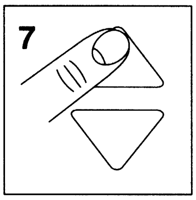


Purpose: optimal pulse response of the *1, *10 attenuation circuit.

Calibration equipment:
Philips PM 5134 Function Generator

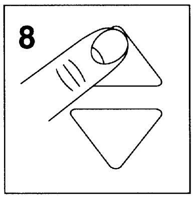
Calibration setup:
See calibration setup H1.

Procedure:
A - Apply a square wave with a frequency of 1 kHz, amplitude 300 mV peak-to-peak (between 0 mV and +300 mV) to the INPUT A BNC and the INPUT B BNC.
B - Press the READY function key.



C - Apply a square wave with a frequency of 1 kHz, amplitude 3V peak-to-peak (between 0V and +3V) to the INPUT A BNC and the INPUT B BNC.
D - Press the READY function key.

S8/9. Pulse response of the *100/*1000 attenuation (fine adjustments)

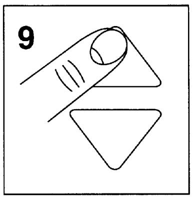


Purpose: optimal pulse response of the *100, *1000 attenuation circuit.

Calibration equipment:
Tektronix PG 506 Square Wave Calibration Generator

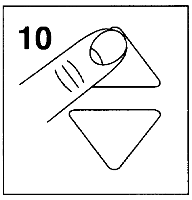
Calibration setup:
See calibration setup H3.

Procedure:
A - Apply a square wave with a frequency of 1 kHz, amplitude 20V peak-to-peak (between 0V and +20V) to the INPUT A BNC and the INPUT B BNC. Set the generator to the position "STD AMPL".
B - Press the READY function key.



C - Apply a square wave with a frequency of 1 kHz, amplitude 50V peak-to-peak (between 0V and +50V) to the INPUT A BNC and the INPUT B BNC. Set the generator to the position "STD AMPL".
D - Press the READY function key.

S10/11/12/13/14/15/16/17
Gain for 5 mV, 10 mV, 20 mV, 50 mV, 100 mV, 200 mV, 2V, 20V



Purpose: correction of the system gain (from BNC to microprocessor) in attenuator settings: 5 mV, 10 mV, 20 mV, 50 mV, 100 mV, 200 mV, 2V, 20V.

Calibration equipment:
Tektronix PG 506 Square Wave Calibration Generator

Calibration setup:
See calibration setup H3.

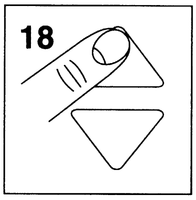
Procedure:
A - Apply a square wave with a frequency of 1 kHz, amplitude 20 mV peak-to-peak to the INPUT A BNC and the INPUT B BNC. Set the generator to the position "STD AMPL".
B - Press the READY function key.
C - Change the input voltage according to table 5.2.
After each calibration press the READY function key. Use the UP/DOWN keys to advance/go back in the list.

NOTE: These steps calibrate both channel A and B at the same time.

Table 5.2 Calibration signals for step S10...S17

Calibration step number	Calibration voltage
S10	square wave, 1 kHz, 20 mV peak-to-peak
S11	square wave, 1 kHz, 50 mV peak-to-peak
S12	square wave, 1 kHz, 100 mV peak-to-peak
S13	square wave, 1 kHz, 200 mV peak-to-peak
S14	square wave, 1 kHz, 500 mV peak-to-peak
S15	square wave, 1 kHz, 1V peak-to-peak
S16	square wave, 1 kHz, 10V peak-to-peak
S17	square wave, 1 kHz, 100V peak-to-peak

S18/19. Shift gain *1 mode and /8 mode

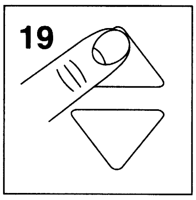


Purpose: correct for the shift gain in "times 1 mode" and in "divided by 8 mode".

Calibration equipment:
Tektronix PG 506 Square Wave Calibration Generator

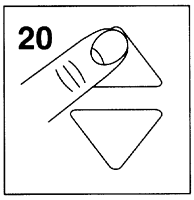
Calibration setup:
See calibration setup H3.

Procedure:
A - Apply a square wave with a frequency of 1 kHz, amplitude 200 mV peak-to-peak (between 0 mV and +200 mV) to the INPUT A BNC and the INPUT B BNC. Set the generator to the position "STD AMPL".
B - Press the READY function key.



C - Apply a square wave with a frequency of 1 kHz, amplitude 20 mV peak-to-peak (between 0 mV and +20 mV) to the INPUT A BNC and the INPUT B BNC. Set the generator to the position "STD AMPL".
D - Press the READY function key.

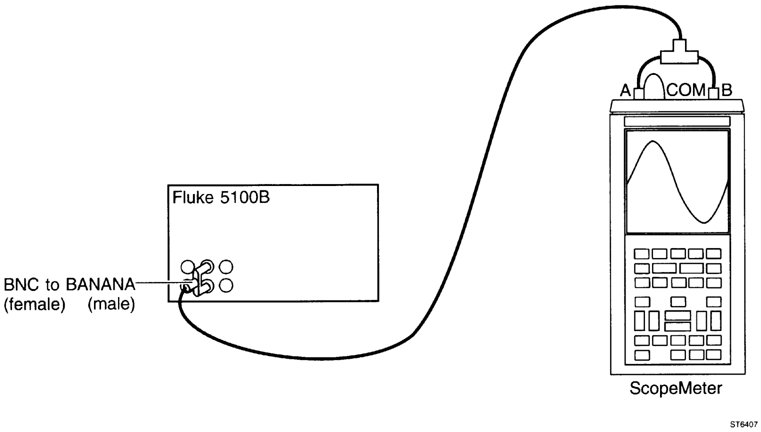
S20/21/22/23. Channel A and channel B 50% and 90% trigger level



Purpose: calibrate the 50% and 90% analog trigger level of channel A and channel B.

Calibration equipment:
Fluke 5100B Calibrator

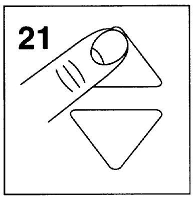
Calibration setup:
Connect the banana jack COM to the BNC common



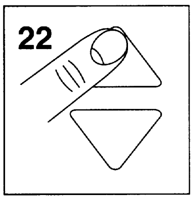
Procedure:

A - Apply a sine wave with a frequency of 10 kHz, amplitude 2V peak-to-peak to the INPUT A BNC and INPUT B BNC. (Set the Fluke 5100B to 0.707V RMS,10 kHz sine wave).

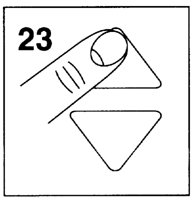
B - Press the READY function key.



C - Press the READY function key.

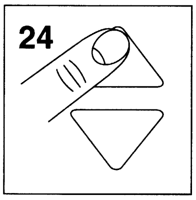


D - Press the READY function key.
(Skipped in model 91)



E - Press the READY function key
(Skipped in model 91)

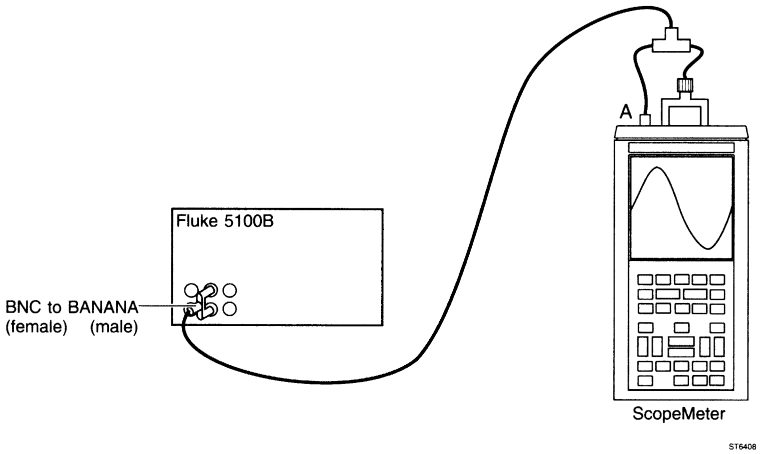
S24. External triggering



Purpose: calibrate the 0.2V external trigger level.

Calibration equipment:
Fluke 5100B Calibrator

Calibration setup:

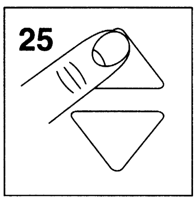


Procedure:

A - Apply a 10 kHz sine wave signal with an amplitude of 2V peak-to-peak to the INPUT A BNC and also to the banana jack inputs. Use a coaxial signal splitter and a BNC(female)-to-banana(male) converter (see calibration setup). (Set the Fluke 5100B to 0.707V RMS, 10 kHz sine wave).

B - Press the READY function key.

S25. Random sampling

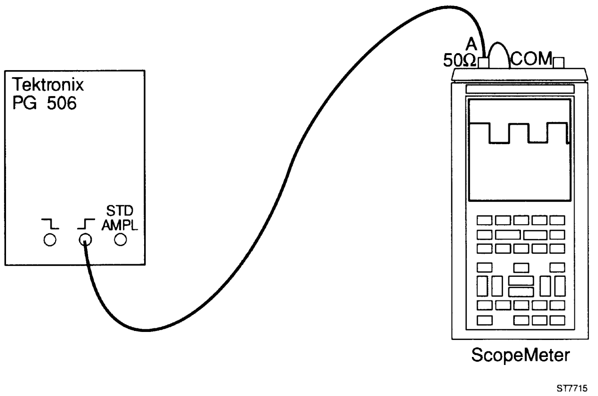


Purpose: calibration of the random sampling levels.

Calibration equipment:
Tektronix PG 506 Square Wave Calibration Generator

Calibration setup:

Connect the banana jack COM to the BNC common



Procedure:

A - Apply a 1 MHz square wave signal with an amplitude of approximately 600 mV peak-to-peak to channel A. Set the generator to the FAST RISE position. Use a 50Ω termination.

B - Press the READY function key.

C - Now press the SCOPE function key to go back to the CALIBRATE menu.

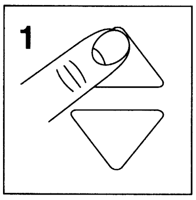
Continue with the meter calibration adjustment procedure, section 5.7

5.7 METER CALIBRATION ADJUSTMENT PROCEDURE

Press the METER function key to activate the METER Calibration Adjustment Procedure from the CALIBRATE menu. When you press this function key, the text "METER" will be shown in reverse video to show that this calibration mode is active.

NOTE: During the METER calibration, the values displayed on the LCD do not represent the values of the input voltages!

M1. Linearity calibration and M2. Zeroing the ranges

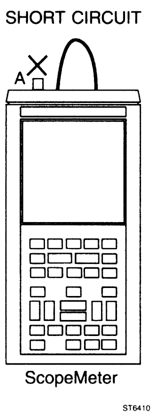


Purpose M1: calibration of the linearization table, used by the ScopeMeter test tool.

Purpose M2: this calibration zeros all ranges of the ScopeMeter test tool in METER mode: 300 mV, 3V, 30V and 300V on the INPUT A BNC and 300 mV and 3V of the banana input jacks.

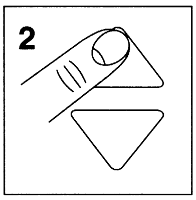
Calibration equipment:
none

Calibration set-up:



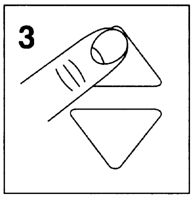
Procedure:
A - Short circuit the INPUT A BNC and the banana jacks inputs.
B - Press the READY function key.

NOTE: During this calibration step many internal calibration constants are being set. This process can last up to 3 minutes.



C - Short circuit the INPUT A BNC and the banana jack inputs.
D - Press the READY function key.

M3. Channel A, 300 mV range: zero for open input



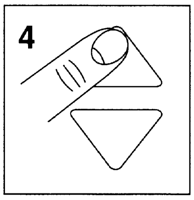
Purpose: zero channel A in the 300 mV range with open input.

Calibration equipment:
none

Calibration setup:
INPUT A BNC open.

Procedure:
A - Remove any connection from the INPUT A BNC.
B - Press the READY function key.

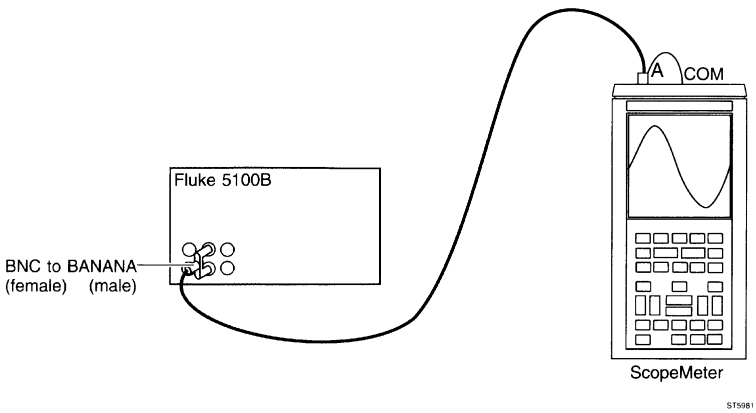
M4/5/6/7. Channel A, 300 mV/3V/30V/300V range: gain calibration



Purpose: calibration of the channel A gain in the 300 mV, 3V, 30V and 300V ranges.

Calibration equipment:
Fluke 5100B Calibrator

Calibration setup:
Connect the banana jack COM to the BNC common



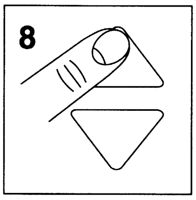
Procedure:
A - Apply 300 mV DC to the INPUT A BNC.
B - Press the READY function key.
C - Change the input voltage according to table 5.3. After each calibration press the READY function key.
Use the UP/DOWN keys to advance/go back in the list.

WARNING: After you have performed calibration M7, deactivate the Fluke 5100B to remove the 300V DC. Always set the Fluke 5100B to 300 mV DC before touching the connection cables!

Table 5.3 Calibration signals for step M4...M7

Calibration Step Number	Calibration Voltage
M4	300 mV DC
M5	3V DC
M6	30V DC
M7	300V DC

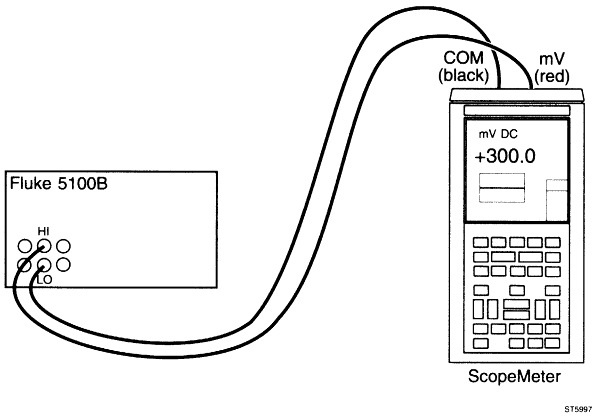
M8/9. EXT mV mode, 300 mV/3V range: gain calibration



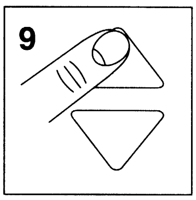
Purpose: calibration of the EXT mV mode gain in the 300 mV and 3V ranges.

Calibration equipment:
Fluke 5100B Calibrator

Calibration setup:

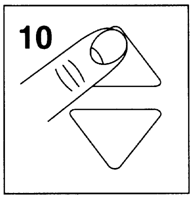


Procedure:
A - Apply 300 mV DC to the banana connectors.
B - Press the READY softkey.



C - Apply 3V DC to the banana jack inputs.
D - Press the READY function key.

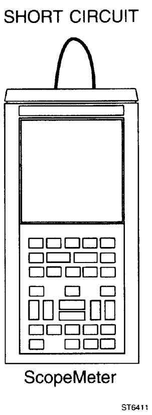
M10. All ranges 0Ω calibration



Purpose: calibration of the 0Ω points in all ranges.

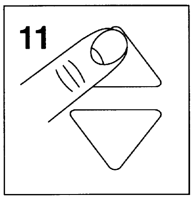
Calibration equipment:
none

Calibration setup:



Procedure:
A - Short circuit the banana jack inputs.
B - Press the READY function key.

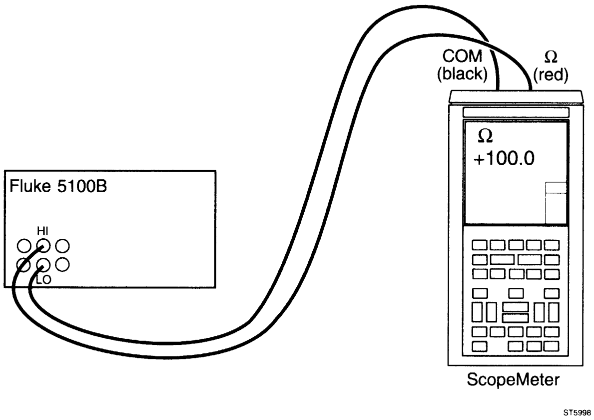
M11/12/13/14/15/16. Calibration of the Ohm ranges



Purpose: calibration of the 30Ω, 300Ω, 3 kΩ, 30 kΩ, 300 kΩ, 3 MΩ, and 30 MΩ ranges.

Calibration equipment:
Fluke 5100B Calibrator

Calibration setup:



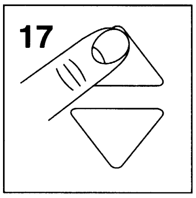
Procedure:

A - Connect 100Ω to the banana jack inputs.
B - Press the READY function key.
C - Change the resistance according to table 5.4. After each calibration press the READY fyunction key. Use the UP/DOWN keys to advance/go back in the list.

Table 5.4 Calibration signals for step M11...M16

Calibration Step Number	Calibration Resistance
M11	100Ω
M12	1 kΩ
M13	10 kΩ
M14	100 kΩ
M15	1 MΩ
M16	10 MΩ

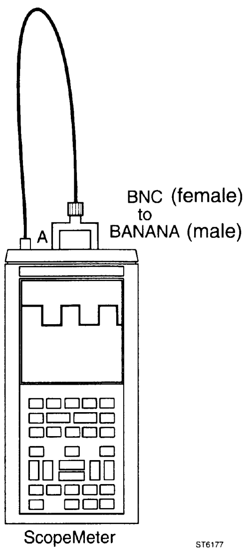
M17. Voltage ramp calibration



Purpose: calibration of the voltage ramp of the component tester.

Calibration equipment:
none

Calibration setup:

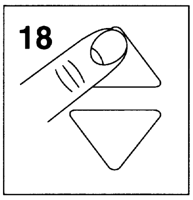


Procedure:

A - Connect the INPUT A BNC to the red GENERATOR OUT banana jack, by means of a BNC cable and a BNC (female)-to- banana(male) connector.

B - Press the READY function key.

M18. Current ramp calibration

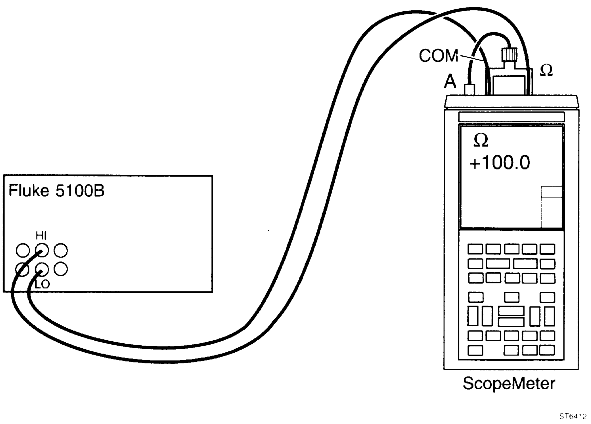


Purpose: calibrate the current ramp of the component tester.

Calibration equipment:

Fluke 5100B Calibrator

Calibration setup:

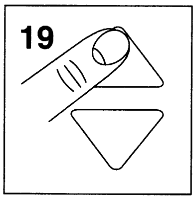


Procedure:

A - Connect a resistance of 100Ω between the banana jack inputs. Connect the INPUT A BNC signal input to the red banana jack input. Do not use a probe! Refer to the calibration setup.

B - Press the READY function key.

M19/20. 10:1 calibration for INPUT A (red) and INPUT B (grey) probes

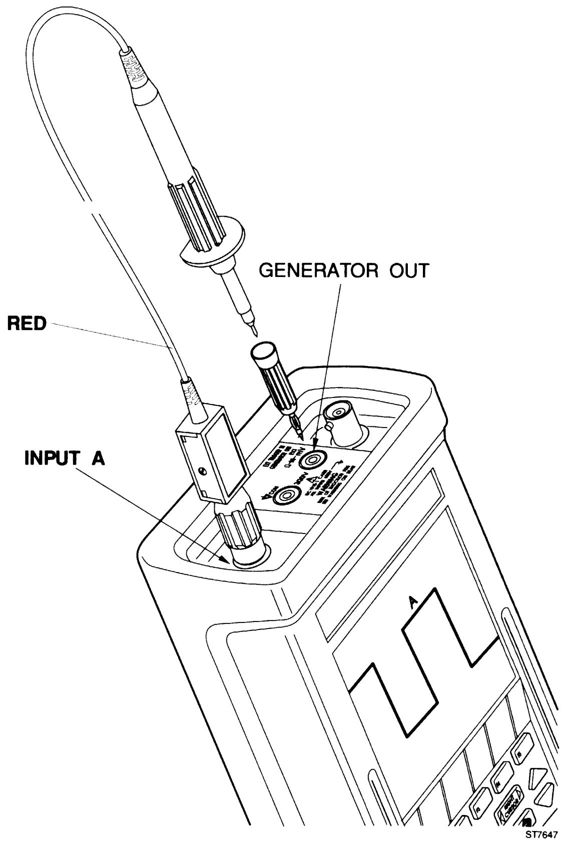


Purpose: determine the gain, using a 10:1 probe.
M20 is skipped in model 91.

Calibration equipment:

Red scope probe (delivered with the ScopeMeter test tool)
Grey scope probe (delivered with the ScopeMeter test tool)
4 mm banana adapter (delivered with the ScopeMeter test tool)

Calibration setup:



IMPORTANT: Calibration steps M19 and M20 determine the internal calibration constants that compensate for probe characteristics. To achieve full accuracy (as listed in the specifications in chapter 2), calibrations M19 and M20 must be performed, using the probes that are normally to be used with the instrument.

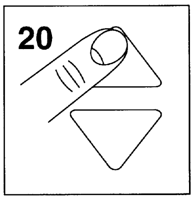
If the probes delivered with the ScopeMeter test tool are not available at the time of calibration, use other probes specifically designed for the ScopeMeter test tool. In this case you must notify the user that these calibrations have been performed, using different probes. To achieve full accuracy, the user must do a User Probe Calibration, using his own probes. This procedure is described in the Users Manual. You will loose the results of the User Probe Calibration when you do a MASTER RESET. (A MASTER RESET is done when the ScopeMeter test tool is turned on while the F5 function key is depressed. Two beeps are audible.)

Procedure:

A - Connect the red scope probe to the INPUT A BNC.

B - Connect the probe tip to the GENERATOR OUT red banana jack using the 4 mm banana adapter. Refer to the Calibration setup.

C - Press the READY function key.
After a few seconds the ScopeMeter test tool will display:
"Calibration has been completed successfully"
and will also beep once. Press F1 to clear the message. Now you can go to the next calibration step.

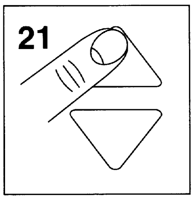


D - Connect the grey scope probe to the INPUT B BNC.

E - Connect the probe tip to the GENERATOR OUT red banana jack using the 4 mm banana adapter. Refer to the Calibration set-up.

F - Press the READY function key.
After a few seconds the ScopeMeter test tool will display:
"Calibration has been completed successfully"
and it will also beep once. Now you can go to the next calibration step.

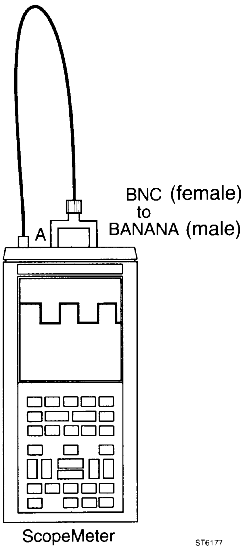
M21/22. 1:1 probe calibration for INPUT A and INPUT B



Purpose: determine the gain, using a 1:1 probe.
M22 is skipped in model 91.

Calibration equipment:
none

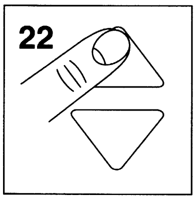
Calibration set-up:



Procedure:

A - Connect the INPUT A BNC to the GENERATOR OUT red banana jack, by means of a BNC cable and a BNC (female)-to- banana(male) connector.

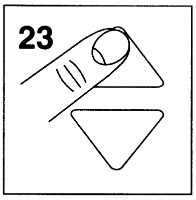
B - Press the READY function key.
After a few seconds the ScopeMeter test tool will display:
"Calibration has been completed successfully"
and will also beep once. Now you can go to the next calibration step.



C - Connect the INPUT B BNC to the GENERATOR OUT red banana jack, by means of a BNC cable and a BNC(female)-to-banana(male) connector.

D - Press the READY function key.
After a few seconds the ScopeMeter test tool will display:
"Calibration has been completed successfully"
and it will also beep once.

M23. Channel A, 1V range: gain calibration.



Purpose: calibration of the channel A gain in the 1V range.

Calibration equipment:
Fluke 5100B calibration

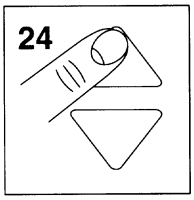
Calibration setup:
As for M4/5/6/7

Procedure:

A - Apply 1V DC to the INPUT A BNC.

B - Press the READY function key.

M24. Channel A, 100V range: gain calibration.



Purpose: calibration of the channel A gain in the 100V range.

Calibration equipment:
Fluke 5100B calibration

Calibration setup:
As for M4/5/6/7

Procedure:
A - Apply 100V DC to the INPUT A BNC.
B - Press the READY function key.

WARNING: **After you have performed M24, deactivate the Fluke 5100B to remove the 100V DC. Set the Fluke 5100B to 0V DC before touching the cables!**

Calibration is now complete. You must store the calibration values now: see CAL STORE.

CAL STORE

To save the new calibration values, you must proceed as follows:
- press the METER softkey to leave the active CALIBRATION mode.
- press the CAL STORE softkey to store the new calibration values in flash ROM.

5.8 CALIBRATION ADJUSTMENT PROCEDURE SUMMARY

This table provides an overview of all steps in the Calibration Adjustment Procedure. It is intended to be used as a reference for frequent users. For details on how to perform each Calibration Adjustment step, refer to sections 5.5, 5.6 and 5.7.

Table 5.5 Calibration Adjustment Procedure Summary

STEP	SIGNAL SOURCE	SIGNAL AMPL/FREQ	TEST TOOL INPUTS	ACTIONS
CONTRAST Calibration Adjustment Procedure				
-	-	- -		Adjust for clear picture.
SCOPE Calibration Adjustment Procedure				
Hardware SCOPE Calibration Adjustments: only to be done when ScopeMeter test tool is repaired!				
H1	PM5134	300 mV(pp)/1 kHz (square)	A & B	Adjust C2109/C2209.
H2	PM5134	3V(pp)/1 kHz (square)	A & B	Adjust C2107/C2207.
H3	Tek PG 506	20V(pp)/1 kHz (square)	A & B	Adjust C2114/C2214.
H4	Fluke 5100B	254.5 mV (RMS)/1 kHz (sine)	A	Adjust R2346/R2347, Ground testpoint 209.
Closed case SCOPE Calibration Adjustments				
S5	-	-	-	Short circuit BNCs.
S6	PM5134	300 mV(pp)/1 kHz (square)	A & B	-
S7	PM5134	3V(pp)/1 kHz (square)	A & B	-
S8	Tek PG 506	20V(pp)/1 kHz (square)	A & B	-
S9	Tek PG 506	50V(pp)/1 kHz (square)	A & B	-
S10	Tek PG 506	20 mV(pp)/1 kHz (square)	A & B	-
S11	Tek PG 506	50 mV(pp)/1 kHz (square)	A & B	-
S12	Tek PG 506	100 mV(pp)/1 kHz (square)	A & B	-
S13	Tek PG 506	200 mV(pp)/1 kHz (square)	A & B	-
S14	Tek PG 506	500 mV(pp)/1 kHz (square)	A & B	-
S15	Tek PG 506	1V(pp)/1 kHz (square)	A & B	-
S16	Tek PG 506	10V(pp)/1 kHz (square)	A & B	-
S17	Tek PG 506	100V(pp)/1 kHz (square)	A & B	-
S18	Tek PG 506	200 mV(pp)/1 kHz (square)	A & B	-
S19	Tek PG 506	20 mV(pp)/1 kHz (square)	A & B	-
S20	Fluke 5100B	707 mV (RMS)/10 kHz (sine)	A & B	-
S21	Fluke 5100B	707 mV (RMS)/10 kHz (sine)	A & B	-
S22	Fluke 5100B	707 mV (RMS)/10 kHz (sine)	A & B	-
S23	Fluke 5100B	707 mV (RMS)/10 kHz (sine)	A & B	-
S24	Fluke 5100B	707 mV (RMS)/10 kHz (sine)	A & banana	-
S25	Tek PG 506	600 mV(pp)/1 MHz	A (50Ω termin.)	-

STEP	SIGNAL SOURCE	SIGNAL AMPL/FREQ	TEST TOOL INPUTS	ACTIONS

METER Calibration Adjustments

STEP	SIGNAL SOURCE	SIGNAL AMPL/FREQ	TEST TOOL INPUTS	ACTIONS
M1	-	-	-	Short circuit BNCs & banana
M2	-	-	-	Short circuit A BNC & banana
M3	-	-	-	A BNC open
M4	Fluke 5100B	300 mV DC	A	-
M5	Fluke 5100B	3V DC	A	-
M6	Fluke 5100B	30V DC	A	-
M7	Fluke 5100B	300V DC	A	-
M8	Fluke 5100B	300 mV DC	bananas	-
M9	Fluke 5100B	3V DC	bananas	-
M10	-	-	-	Short circuit banana input
M11	Fluke 5100B	100 Ω	bananas	-
M12	Fluke 5100B	1 kΩ	bananas	-
M13	Fluke 5100B	10 kΩ	bananas	-
M14	Fluke 5100B	100 kΩ	bananas	-
M15	Fluke 5100B	1 MΩ	bananas	-
M16	Fluke 5100B	10 MΩ	bananas	-
M17	-	-	A BNC to bananas	-
M18	Fluke 5100B	100 Ω	resistor between bananas, connect A BNC to banana	
M19	red probe	-	probe tip to bananas	-
M20	grey probe	-	probe tip to bananas	-
M21	-	-	A BNC to bananas	-
M22	-	-	B BNC to bananas	-
M23	Fluke 5100B	1V DC	A	-
M24	Fluke 5100B	100V DC	A	-

6 DISASSEMBLING THE SCOPEMETER TEST TOOL

6.1 GENERAL INFORMATION

Whenever the ScopeMeter test tool needs repair and/or Hardware SCOPE Calibration Adjustments, the instrument must be disassembled.

NOTE: For replacement of components refer to section 7.2; for Hardware SCOPE Calibration Adjustments refer to section 5.6.1.

This section provides the required disassembling procedures. Both printed 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 disassembly process, make a careful note of all disconnected leads so that they can be reconnected to their correct terminals when you reassemble the instrument.

WARNING: **Removing the instrument covers or removing parts, except those to which access can be gained by hand, is likely to expose live parts and accessible terminals may be live. To avoid electric shock, disconnect the instrument from all voltage sources and remove batteries before disassembling the instrument. If any adjustment, maintenance, or repair of the disassembled instrument under voltage is required, it shall be carried out only by qualified personnel using customary precautions against electric shock. Capacitors inside the instrument can hold their charge even if the instrument has been separated from all voltage sources and batteries have been removed.**

6.2 DISASSEMBLY PROCEDURES

The following sections describe the disassembly process of the ScopeMeter test tool in sequence (from fully assembled instrument to separate printed circuit boards and chassis parts). Start and end disassembly at the appropriate heading levels.

WARNING: **To avoid electric shock, disconnect test leads, probes and power supply from any live source and from the ScopeMeter test tool itself.**

6.2.1 Removing the battery pack

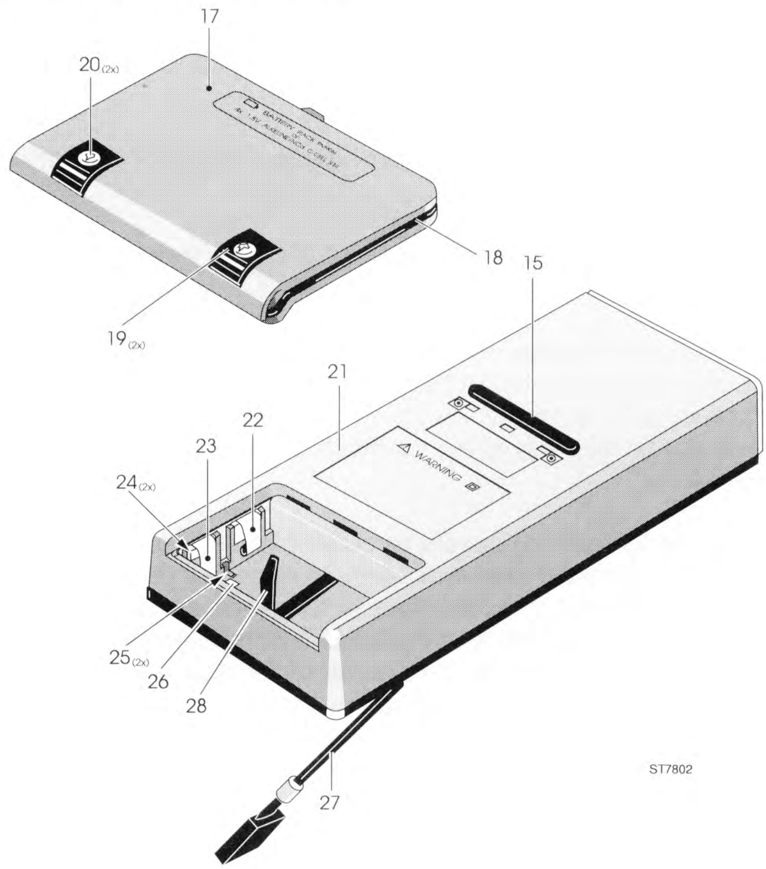


Figure 6.1 Removing the battery pack

1. The battery cover (item 17) is secured to the ScopeMeter test tool with two black M3 Torx screws (item 20). Use a Torx screwdriver to loosen the two screws (do not remove them) from the battery cover.
2. Lift the battery cover from the ScopeMeter test tool.
3. Pull the black battery pull strip (item 28) carefully to lift the battery pack.
4. Remove the battery pack.

6.2.2 Opening the ScopeMeter test tool

Referring to figure 6.2, use the following procedure to open the ScopeMeter test tool.

1. Loosen the two black M3 Torx screws (item 4) (do not remove them) from the front cover.
2. Lift the front cover assembly (item 3) from the ScopeMeter test tool.

NOTE: The gasket, between the front cover and the two case halves, is sealed to, and must remain with, the front cover. The front cover assembly lifts away from the top and bottom case halves easily. Do not damage the gasket or separate it from the front cover.
A correctly fitted gasket assures the sealing of the ScopeMeter test tool.

3. Remove the battery pack (see Section 6.2.1).

4. The bottom cover assembly is secured to the top cover with two M3 Torx screws (item 29) that are accessible in the battery compartment. Use a Torx screwdriver to remove the two screws.

5. Lift the bottom cover a little from the top cover and unfold the ScopeMeter test tool.

NOTE: Do not damage the black gaskets and keep them with the front cover and the lower case half. A correctly fitted gasket assures proper sealing of the ScopeMeter test tool.

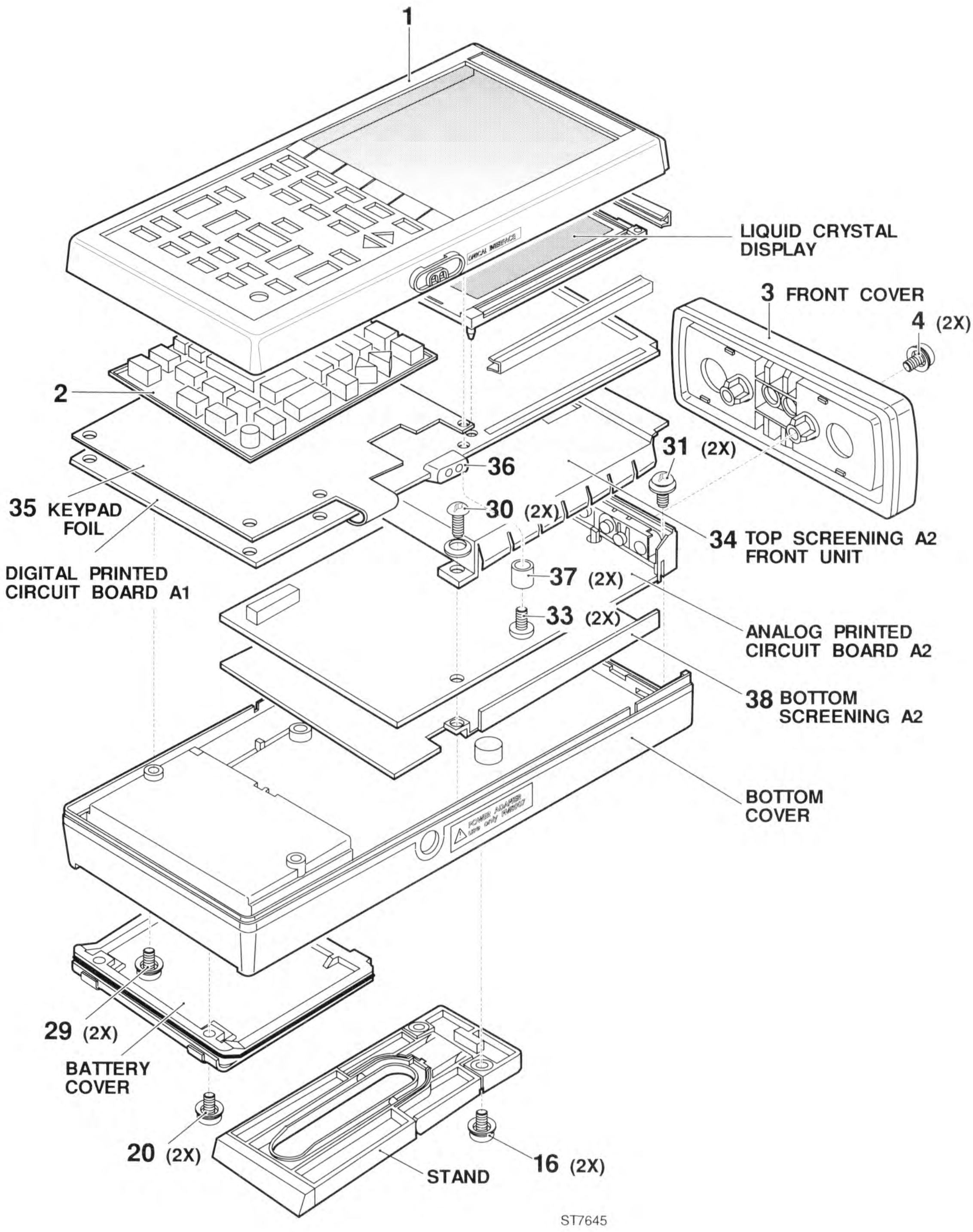


Figure 6.2 Opening the ScopeMeter test tool

6.2.3 Removing the analog A2 PCB, to enable Hardware SCOPE Calibration Adjustments

Referring to figure 6.2, use the following procedure to remove the analog A2 PCB.

1. First open the ScopeMeter test tool (see Section 6.2.2).
2. The analog A2 PCB and top screening are secured to the bottom cover with two M3 Torx screws (item 30). Use a Torx screwdriver to remove the screws.
3. Carefully lift the metal top screening, while pulling it backwards.
4. Pull the battery wiring plug (item 27, figure 6.1) out of the connector on the analog A2 PCB.
5. Use a Torx screwdriver to loosen the two black screws (item 13) (do not remove them) from the input unit assembly. Now the analog A2 PCB can be lifted out of the bottom cover assembly.
6. The bottom of the analog A2 PCB shows the components (potentiometers) used for hardware calibration adjustments. The Hardware SCOPE Calibration Adjustments are described in section 5.6.1.

NOTE: The digital A1 PCB is fixed to the top cover and must be connected to the analog A2 PCB by the 30-pole flat cable.

CAUTION: Damage may occur if you disconnect the flat cable between the two printed circuit boards within ten seconds after turning off the instrument. Damage may also occur when the Analog unit (A2) is powered when not connected to the Digital unit (A1).

6.2.4 Removing the digital A1 PCB

1. First open the ScopeMeter test tool (see Section 6.2.2).

NOTE: Note how the 30-pole flat cable is positioned in the connector: it must be replaced in exactly the same way

When the ScopeMeter test tool is opened, the blue marks on the flat cable must be visible. Carefully lift the upper part of the flat cable connector on the digital A1 PCB. This plastic clamp must be lifted at both sides simultaneously to unlock the flat cable. Now pull the flat cable out of the connector on the digital A1 PCB. Do not touch the flat cable ends!

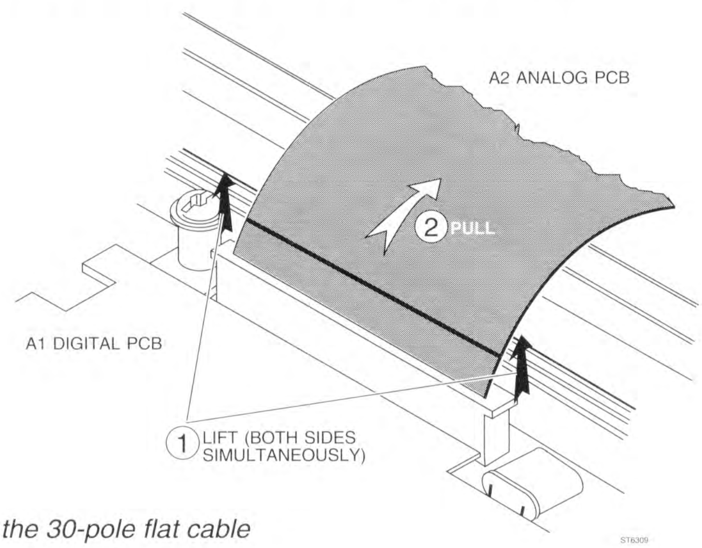


Figure 6.3 Removing the 30-pole flat cable

2. The digital A1 PCB is secured to the top cover with two M3 Torx screws (item 33). These screws contain small standoffs. Be sure to reinstall them when the ScopeMeter test tool is reassembled. Use a Torx screwdriver to remove the screws.

3. Remove the digital A1 PCB from of the top cover. Be careful not to damage the infrared LED and phototransistor of the optical interface.

NOTE: When reassembling the digital A1 PCB, make sure that the infrared LED and phototransistor are exactly aligned with the holes in the top cover.

7 CORRECTIVE MAINTENANCE

7.1 DIAGNOSTIC TESTING AND TROUBLESHOOTING

7.1.1 Introduction

The ScopeMeter test tool provides semimodular design to aid in troubleshooting. This section describes procedures needed to isolate a problem in a specific functional area. Finally, troubleshooting hints for each functional area are presented.

If the ScopeMeter test tool fails, first verify that you are operating it correctly by reviewing the operating instructions in the Users Manual.

WARNING: Opening the case may expose hazardous voltages. Always disconnect the instrument from all voltage sources and remove the batteries before opening the case. Remember that repairs or servicing should be performed by qualified personnel only.

7.1.2 Troubleshooting techniques

If a fault appears, the following test sequence can be used to help you to locate the defective component:

- Check to verify that the control settings of the test tool are correct. Consult the operating instructions in the Users Manual.
- Check the equipment to which the test tool is connected and check the interconnection cables.
- Verify that the test tool is properly calibrated (see section 4 Performance Verification Procedure). If it is not, refer to Chapter 5: "Calibration Adjustment Procedure".
- Locate the circuit(s) in which you suspect the fault: the symptom often suggests the faulty circuit. If the power supply is defective, the symptom may appear to be caused by several circuits.
- Check the circuit(s) in which you suspect the fault. Often it is possible to find faults such as cold or defective solder joints, intermittent or open interconnection plugs and wires or damaged components.

7.1.3 Performance Verification

The Performance Verification Procedure described in chapter 4 is a very quick way to check most of the test tool's specifications. It is based on the specifications listed in Chapter 2 of this Service Manual. If the test tool fails of any of the tests, Calibration Adjustments (see chapter 5) and/or repair (see chapter 7) is necessary.

7.1.4 Troubleshooting

7.1.4.1 Trouble shooting hints

OPENING THE SCOPEMETER TEST TOOL:
To troubleshoot the test tool, open it as described in subsection 6.2.2 "Opening the ScopeMeter test tool" of chapter 6 "DISASSEMBLING THE SCOPEMETER TEST TOOL".

TEST POINT AND COMPONENTS LOCATION:
Added with the A1 PCB layout figure 9.1 and the circuit diagrams figure 9.2a and 9.2b are location reference lists for fast location of the test points and the components.

CONNECTING THE GROUND (ZERO) LOGIC 0 REFERENCE:
While performing measurements, it is possible to use the metal shielding as zero reference. It is also possible to install the metal screws, as is described in section 5.6.1 "Hardware SCOPE Calibration Adjustments". You can use one of the screws as a zero reference: refer to figure 5.2. The A1 also provides a ground alligator clip connection in the lower left corner (∞).

LOGIC 1 LEVEL:
The logic one level is +5V.

7.1.5 Digital A1 PCB Troubleshooting

7.1.5.1 Powering the ScopeMeter test tool.

Power the test tool with the Power Adapter/Battery Charger PM8907.

7.1.5.2 Kernel Test

Start with the Kernel Test if the test tool does not function at all (no display, no beep at power on). With the Kernel Test the microprocessor and the transmitter/receiver circuit of the optical interface can be tested.

NOTE: If loading the FlashROM fails, it is possible to get a ScopeMeter test tool which is not functioning. For example: if the operating system is corrupted, it is not possible to operate the test tool normally. In this case you can reload the operating software as follows:

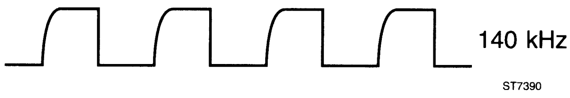
- *ground test point TP202, and turn on the test tool*
- *load the operating software into the FlashROMs. For this action you need special software: contact your nearest Fluke Service Center.*
- *release the ground from TP202 and perform a MASTER RESET (hold down the F5 key and turn the test tool on).*

Proceed as follows to start the kernel test:

1. Ground TP202 on the digital A1 PCB.
2. Power the test tool with the Power Adapter/Battery Charger PM8907.
3. Turn on the ScopeMeter test tool.

As TP202 (MASKN) is grounded, the test tool does not access the FlashROM software. Only the program in the microprocessor ROM (MASK program) is running.

4. Measure the signal on TP115 (AD15) with an oscilloscope. The oscilloscope must show a 140 kHz signal, see the figure below.



5. Connect the optical interface via the PM9080 cable to a PC (DOS), and send 10 characters X (capital) from the PC to ScopeMeter test tool. Check that the test tool receives the characters (TP340), and that it responds (TP350).

   Proceed as follows:

   - make a file X.X containing 10 characters X (capitals):

     type **COPY CON X.X**
     XXXXXXXXXX
     press **Ctrl Z**

   - set the parameters of used the PC communication port, e.g. COM1:

     type **MODE COM1: 1200 N 8 1**

   - send file X.X (= 10 times a X) to the ScopeMeter test tool:

     type **COPY X.X COM1**

     NOTE: you can make a batch file X.BAT to repeat the command COPY X.X COM1 continuously proceed as follows:

     Type **COPY CON X.BAT**
     COPY X.X COM1
     X.BAT
     Press **Ctrl Z**

     Type **X.BAT** to start
     Press **Ctrl Break** to stop.

   - measure on TP340 (RXD) and TP350 (TXD) with an oscilloscope to see that the test tool receives the characters X (TP340), and that it responds (TP350).
     On TP340 and TP350 +5V pulses must be measured.

Proceed as follows to stop the kernel test:

1. Switch off the test tool.

2. Remove the connection between TP202 and ground.

3. Perform a MASTER RESET when switching on again.

7.1.5.3 Test Point signals

The digital A1 PCB is provided with test points. In the A1 PCB diagrams, the test points are marked "TP...". On the A1 PCB the test points are located in a white square, provided with the test points number and name. The test points can be used to check the correct functioning of the digital A1 PCB.

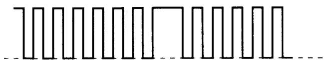
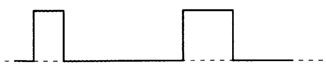
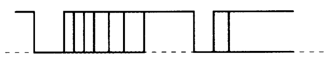
All measurements are made in the default MASTER RESET condition (start the measurements in the ScopeMeter test tool after a MASTER RESET).

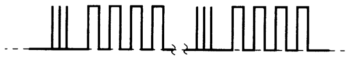
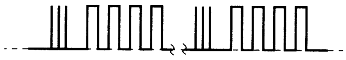
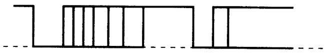
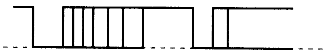
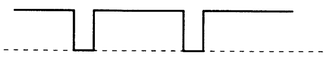
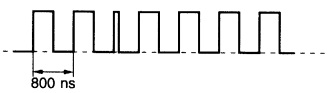
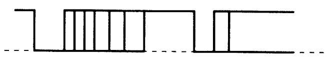
A MASTER RESET is performed as follows:
1. Remove all signals from the ScopeMeter test tool.
2. Turn off the ScopeMeter test tool.
3. Hold down the F5 key and press the ON/OFF key simultaneously. Two beeps are audible, and all volatile memories (RAM with battery backup) are reset. The test tool is automatically set to the METER mode.

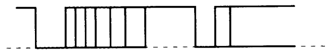
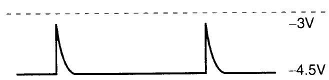
Use another oscilloscope with high input impedance and 10:1 probe to measure the signals on the test points. See table 7.1. Use the alligator-clip point (two joined metallized holes in the digital A1 PCB, sector D4).

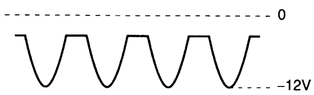
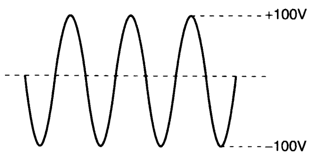
Table 7.1. Overview on Test Points on the digital A1 PCB

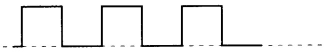
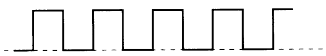
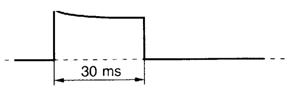
Logic 0 = 0V ; Logic 1 = +5V

TP	Name	Signal	Freq/Per	Description
005	+5V	+5.1V ... +5.3V	DC	+5V supply. If too low, check A2 revision level. Upgrade to level 17 if it is 16 or lower
050	ADVN		100 ns	Adress valid signal
052	WRIN		varying	Write signal, 80 ns pulses
053	RDIN		varying	Read signal, 80 ns pulses
100	AD0		varying	Address/data lines AD0
. . .	. . .			up to
115	AD15			AD15
150	PS0		varying	Page select 0; 0.5 ... 1.5 µs pulses
151	PS1	0V	DC	Page select 1
152	PS2		varying	Page select 2; 0.5 ... 1.5 µs pulses
170	MS0		varying	Address line for standard RAM and ROM; minimum pulse width 0.15 µs

TP	Name	Signal	Freq/Per	Description
171	MS1		varying	Address line for standard RAM and ROM
172	MS2		varying	Address line for standard ROM
173	MS3	0V	DC	Address line for standard ROM D1220; shows pulses if D1220 (FROM type 28F200 or 28F400) is installed
174	SCEN		varying	Chip enable signal for external RAM
175	FCEN		varying	Chip enable signal for standard ROM
176	BCEN	-	-	not used
177	XCEN		varying	Chip enable signal for standard RAM
180 . . . 194	A00 . . . A14		varying	Address lines A00 up to A14
201	µPCLK		12.5 MHz	Microprocessor clock
202	MASKN	+5V	DC	Mask not input. If made low, only µP-ROM program runs (FlashROM software does not run)
203	WEN		varying	Write signal for D-ASIC and EXTERNAL RAM
204	REN		12.5 MHz	Read signal for D-ASIC and EXTERNAL RAM
208	+5VUP	+5V	DC	µP supply
210	RESETN	+5V	DC	Reset line, is kept low after power on until +5V supply is at 4.7V
215	+5VMA	+5V	DC	M-ASIC supply
225	+5VFL	+5V	DC	FlashROM supply
230	READY		varying	µP ready input to lengthen external memory cycles; low pulses ≥ 0.15 µs

TP	Name	Signal	Freq/Per	Description
231	µRESETN	+5V	DC	Microprocessor reset; low during reset
232	INST		varying	ROM instruction fetch; low pulses ≥ 0.15 µs
235	+5VDA	+5V	DC	Display control circuit supply
300	-VBAT	-4.8V	DC	Nominal battery voltage (without mains adapter)
		-4.3V ± 0.15V		"battery low" warning
		-3.9V ± 0.15V		ScopeMeter test tool switches off
301	BAT-LEVEL	+3.2V	DC	At nominal battery voltage (without mains adapter)
		+2.9V ± 0.1V		"battery low" warning
		+2.65V 0.1V		ScopeMeter test tool switches off
310	-		4 ms	RAM POWER oscillator signal at power off; +0.8V DC at power on
311	+VRAM	+4V	DC	RAM POWER output at power off
		+5V	DC	RAM POWER output at power on
330	VPP	+12V	DC	FlashROM programming voltage, to be supplied in battery compartment
340	RXD	+5V or 0V	DC	Optical interface receiver H1340 dark: +5V, light: 0V
350	TXD	+5V or pulses	-	Optical interface transmitter Not sending: +5V, sending: pulses
401	FRAME		15 ms	Display column-scan pulse, X1-X80 (display refresh)
402	FR1		15 ms	Display column-scan pulse, X81-X160
403	FR2		15 ms	Display column-scan pulse, X161-X240
405	+5VDP	+5V	DC	Display control supply

TP	Name	Signal	Freq/Per	Description
406	CAR		60 µs	Enables row drivers D1404 and D1405 if data in D1406 is complete
420	V1	-0.3V ... +4.6V	DC	Contrast light ... dark
421	V6	-2V ... +2.7V	DC	Contrast light ... dark
422	V3	-3.7V ... +0.8V	DC	Contrast light ... dark
423	V4	-22V	DC	At room temperature; changes with temperature
424	V5	-24V	DC	See 423
425	V2	-26V	DC	See 423
430	-	+0.3V ... +5V	DC	Contrast control signal, light ... dark
431	LCDPWR	+5V	DC	LCD ON/OFF (+5V/0V), low during reset
432	-30V	-30V	DC	LCD-SUPPLY supply voltage
440	BLGND	0V	DC	Backlight ground (backlight ON); ≈ 200 mV ripple
441	L-BIAS		1 kHz	Backlight ON
442	BACKLIGHT		1 kHz	Backlight supply voltage (backlight ON)
446	DTCLA		500 kHz	Data clock for LCD row drivers
450	LCD0		varying	LCD row driver data input
451	LCD1		varying	LCD row driver data input
452	LCD2		varying	LCD row driver data input

TP	Name	Signal	Freq/Per	Description
453	LCD3		varying	LCD row driver data input
454	M		35Hz	LCD backplane modulation signal
455	LINECL		16 kHz	LCD column clock; pulse length 2 µs
456	DATACL		0.8 ... 1.2 µs	LCD row driver data clock
460	LCD0A		varying	LCD row driver data input
461	LCD1A		varying	LCD row driver data input
462	LCD2A		varying	LCD row driver data input
463	LCD3A		varying	LCD row driver data input
464	M1		600Hz	Randomized backplane modulation signal
501	ON	+5V -5.5V -5V -8V	DC DC DC DC	At power on; At power off, if mains adapter voltage is present and battery installed At power off, battery supply only At power off, if mains adapter voltage is present, and battery removed
502	NOT-ON	0V +3V ... 4V +3V ... 4V	DC DC DC	At power on At power off, if mains adapter voltage is present At power off, battery supply only
503	ON-OFF		30 ms	Power off pulse from µP at switching off
504	ON-RESET	+5V +3V ... 4V 0V	DC DC DC	At power on At power off During pressing the ON/OFF key
505	ON-KEY	0 -5 ... -5.5	DC DC	At power off and power on During pressing the ON/OFF key

7.2 MAINTENANCE OF THE PRIMARY CIRCUIT (PM8907/...)

The ScopeMeter test tool itself has no primary (mains) power supply.
The instrument is powered with a separate **Power adapter/battery charger PM8907/...**, in which the primary power supply is located. The PM8907/... is non-repairable. It can be ordered at your nearest Fluke Service Center.

Table 7.1 Power adapter/battery charger survey.

Typenumber	Description
PM8907/001	Universal Europe 220V, 50 Hz
PM8907/003	North American UL, CSA, 110V, 60 Hz
PM8907/004	United Kingdom 240V, 50 Hz
PM8907/008	Universal 115V / 230V

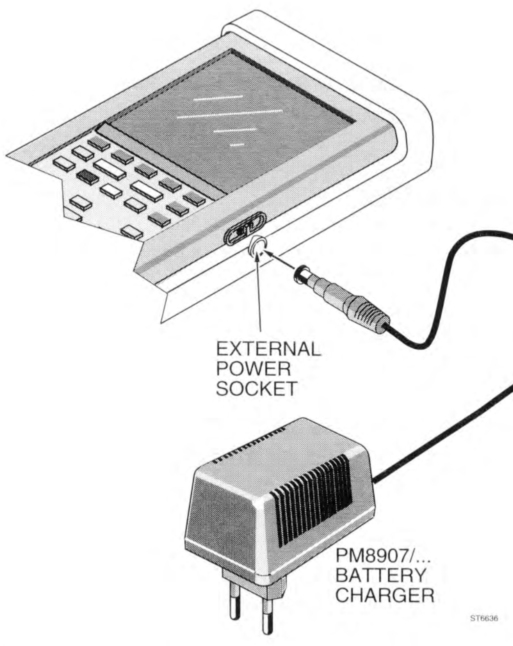


Figure 7.1 ScopeMeter test tool Power Adapter/battery Charger PM8907/....

7.3 REPLACEMENTS

7.3.1 Standard parts

Electrical and mechanical parts replacements can be obtained through your local FLUKE organization or representative. However, many generic electronic components can be obtained from other sources. Before purchasing or ordering replacement parts, check the parts list for value, tolerance, rating, and description.

NOTE: *Physical size and shape of a component may affect instrument performance, particularly at high frequencies. Always use direct-replacement components, unless it is known that a substitute will not degrade the instrument's performance.*

7.3.2 Special parts

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

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

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

7.3.3 Transistors and integrated circuits

Some notes on handling these components:

- Do not replace or swap semiconductor devices unnecessarily, because the change may affect the calibration of the instrument.
- When a device has been replaced, check the circuit that may be affected for proper operation. See also the Performance Verification Procedure in chapter 4.

7.3.4 Static-sensitive components

In the ScopeMeter test tool the black/yellow "static-sensitive components" symbol is present (see also figure 7.2). 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 overvoltages.

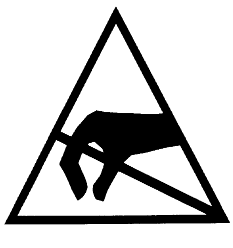


Figure 7.2 Static-sensitive symbol (black/yellow)

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

When storing and handling static-sensitive components, the normal precautions for these devices are recommended. Handling and servicing static-sensitive assemblies and components should be done 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.

7.3.5 Replacement of parts

7.3.5.1 Replacing parts in the battery compartment

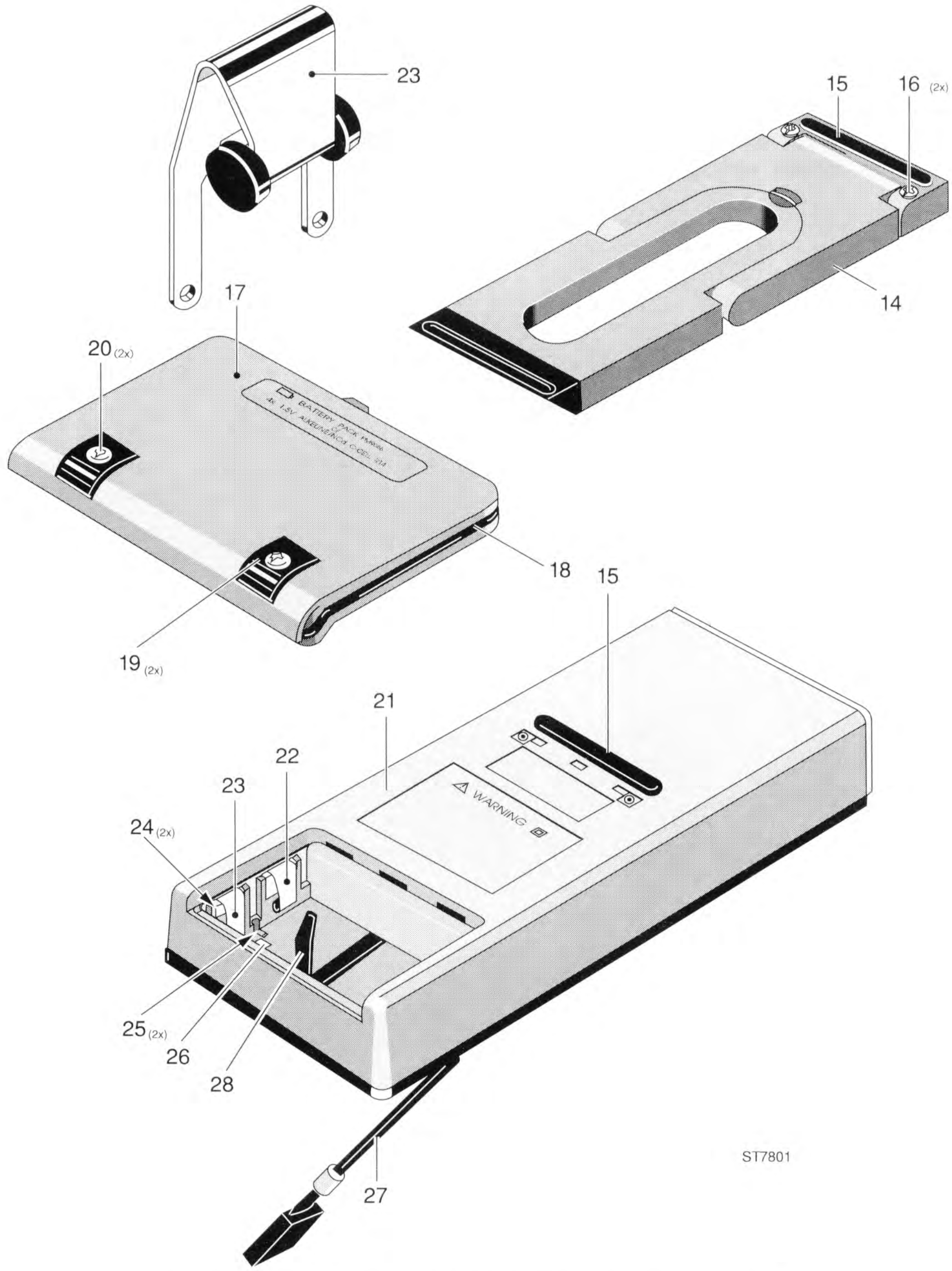


Figure 7.3 Replacing parts in battery compartment

Referring to figure 7.3, use the following procedure for replacements in the battery compartment.

Battery cover assembly replacement

1. The battery cover (item 17) is secured to the ScopeMeter test tool with two black M3 Torx screws (item 20). Use a Torx screwdriver to loosen the two screws (do not remove them) from the battery cover.

2. Lift the battery cover from the ScopeMeter test tool.

3. Reinstall the new battery cover.

Battery-cover Gasket replacement

1. Remove the battery cover (item 17).

2. Use a pair of tweezers to pull the elastic gasket (item 18) from the battery cover.

3. Mount the new elastic gasket on the battery cover.

NOTE: Take care that the gasket is not damaged. A correctly fitted gasket assures the sealing of the ScopeMeter test tool.

Battery cover Torx screws and Feet replacement

1. Remove the battery cover.

2. The black M3 Torx screws are of a captured type (item 20). Remove screws by unscrewing them with a Torx screwdriver. Add a little pressure with another small screwdriver at the back of the screw.

NOTE: Do not force the screws by pressing them in or out. The screw action is vital for the captured screws.

3. Pull the two rubber feet (item 19) from the battery cover.

4. Push the new rubber feet onto the battery cover.

5. Reinstall the (new) black M3 Torx screws into the battery cover.

7.3.5.2 Replacing parts on front cover

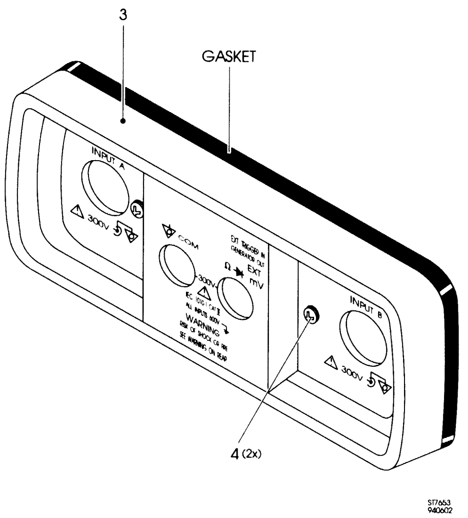


Figure 7.4 Replacing parts on front cover

Referring to figure 7.4, use the following procedure for replacements on the front cover.

Front cover assembly replacement

1. The front cover is secured to the ScopeMeter test tool with two black M3 Torx screws (item 4). Use a Torx screwdriver to loosen the two screws (do not remove them) from the front cover.

2. Lift the front cover assembly (item 3) from the ScopeMeter test tool.

NOTE: The gasket between the front cover and the two case halves is sealed to, and must remain with, the front cover. The front cover lifts away easily. Do not damage the gasket and do not separate the front cover from the gasket. A correctly fitted gasket assures the sealing of the ScopeMeter test tool .

3. Reinstall the new front cover.

Front cover Torx screw replacement

1. Remove the front cover.

2. The two black M3 Torx screws (item 4) are captured type screws. Remove screws by unscrewing them with a Torx screwdriver. Add a little pressure with another small screwdriver at the back of the screw.

NOTE: Do not force the screws by pressing them in or out. The screw action is vital for the captured screws.

3. Reinstall the new Torx screws into the front cover.

7.3.5.3 Replacing parts on bottom cover

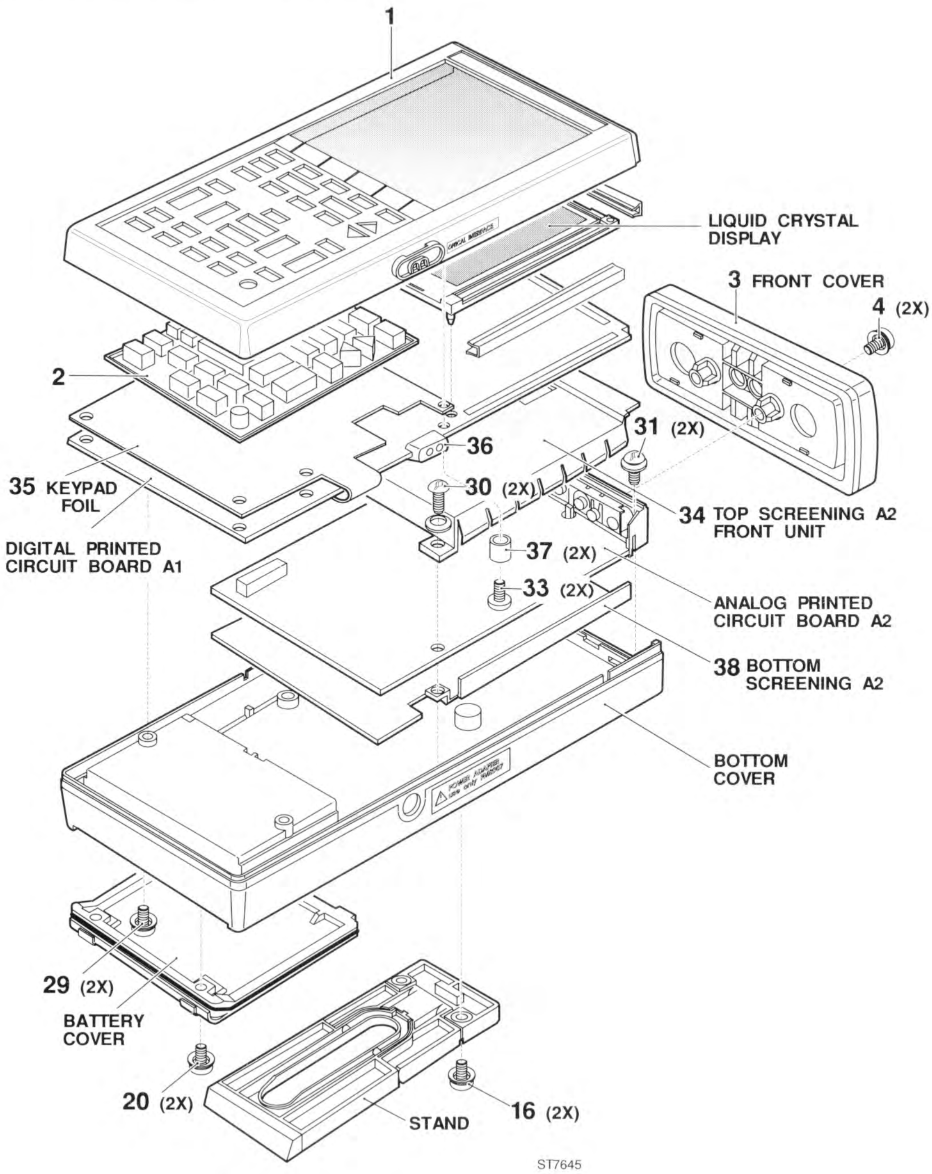


Figure 7.5 Bottom cover replacements

Referring to figure 7.5, use the following procedure for replacements in the bottom cover.

Bottom cover assembly replacements

1. First remove the battery cover assembly (see Section 7.3.5.1.)

2. The bottom cover is secured to the top cover by two M3 Torx screws (item 29) that are accessible in the battery compartment. Use a Torx screwdriver to remove the two screws.

3. Lift the bottom cover a little from the top cover and unfold the ScopeMeter test tool.

NOTE: A flat cable is used for interconnection between the bottom cover with the analog A2 PCB and the digital A1 PCB. To remove the flat cable, refer to Section 6.2.4. The gasket between the two case halves is sealed to, and must remain with, the lower case half. The upper case half lifts away easily. Do not damage the gasket and do not separate the lower case half from the gasket. A correctly fitted gasket assures the sealing of the ScopeMeter test tool.

4. The analog A2 PCB and top screening are secured to the bottom cover by two M3 Torx screws (item 30). Use a Torx screwdriver to remove the two screws.

5. Carefully lift the metal top screening, while pulling it backwards.

6. Pull the battery wiring plug (item 27) out of the connector on the analog A2 PCB.

7. Use a Torx screwdriver to loosen the two black screws (item 13). Do not remove them from the input unit assembly. Now the analog A2 PCB can be lifted out of the bottom cover assembly.

8. Fold the analog A2 PCB back on the digital A1 PCB in the top cover.

9. Lift the bottom cover screening out of the bottom cover assembly.

10. Reinstall the new bottom cover assembly.

Battery wiring assembly replacement

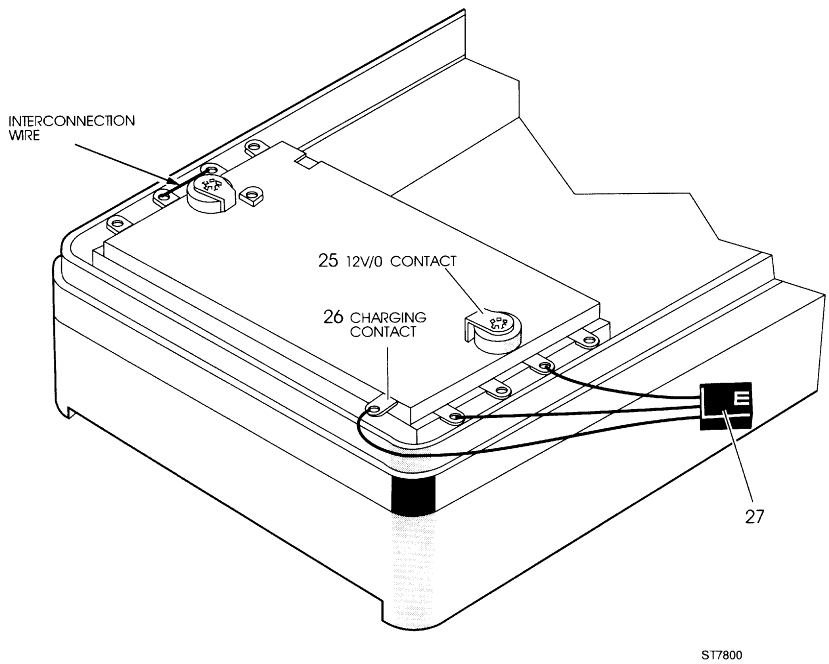


Figure 7.6 Wiring assembly replacement

Referring to figures 7.3 and 7.6, use the following procedure for replacing the battery wiring and battery contacts.

1. First remove the bottom cover assembly.

2. Unsolder the battery wiring assembly (item 27) from the battery compartment.

3. Reinstall the new battery wiring assembly.

Battery contacts replacement

1. First remove the bottom cover assembly.

2. Remove the battery wiring assembly.

3. Unsolder the small battery contact interconnection wire (see figure 7.6).

4. Bend the solder tags of the battery contacts (figure 7.3, item 23) in the bottom cover in such way that the contacts can be pulled out of the battery compartment.

5. Pull the battery contacts (figure 7.3, items 22 and 23) and the black buffers (figure 7.3, item 24) out of the battery compartment with a pair of tweezers.

NOTE: The extra black plastic buffers in two battery contacts (see figure 7.3, item 23) prevent erroneous charging of the battery. Mount these battery contacts in the correct position!

6. Reinstall the new battery contacts.

Battery charging contact and +12V/0 contact replacement

1. First remove the bottom cover assembly.

2. Remove the battery wiring assembly.

3. Bend the solder lugs of the contacts (figure 7.3, items 25 and 26) in the bottom cover so that the contacts can be pulled from the battery compartment.

4. Pull the contacts from the battery compartment.

5. Reinstall the new charging contact and/or the new +12V/0 contacts.

7.3.5.4 Stand replacement

Referring to figure 7.3, use the following procedure for stand replacement.

Stand assembly replacement

1. The stand is secured to the ScopeMeter test tool with two black M3 Torx screws (figure 7.3, item 16). Use a Torx screwdriver to loosen the two screws.

2. Lift the stand from the ScopeMeter test tool.

3. Reinstall the new stand.

Stand Torx screw replacement

1. Remove the stand assembly (figure 7.3, item 14).

2. The black M3 Torx screws are of a captured type (item 16).Remove screws by unscrewing them with a Torx screwdriver. Add a little pressure with another small screwdriver at the back of the screw.

NOTE: Do not force the screws by pressing them in or out. The screw action is vital for the captured screws.

3. Reinstall the new Torx screws.

7.3.5.5 30-pole flat cable replacement

Refer to Section 6.2.4. of this Service Manual for instructions on how to replace the 30-pole flat cable.

7.3.5.6 Input unit assembly replacement

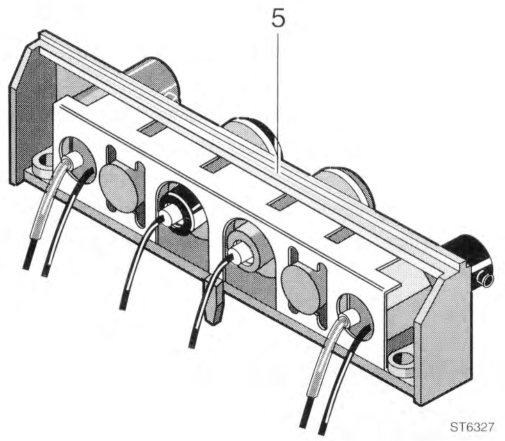


Figure 7.7 Input unit assembly

Referring to figure 7.7, use the following procedure for input unit assembly replacement.

1. Remove the front cover assembly.
2. Disassemble the bottom cover assembly.
3. Remove the 30-pole flat cable.
4. Unsolder the wiring (6x) of the input terminals from the analog A2 PCB.
5. The input unit assembly is clamped onto the analog A2 PCB. Loosen these clamps and pull the input unit assembly from the analog A2 PCB.

NOTE: The white gaskets on the input terminals (4x) are sealed to, and must remain with the input unit assembly. Do not damage the gaskets and do not separate them from the input unit assembly. Correctly fitted gaskets assure the sealing of the ScopeMeter test tool.

6. Reinstall the front unit assembly.

7.3.5.7 Top cover assembly replacement

Referring to figure 7.5, use the following procedure for top cover assembly replacement.

1. Remove the bottom cover assembly.
2. Remove the 30-pole flat cable.
3. The digital A1 PCB is secured to the top cover with two M3 Torx screws (item 33). These screws contain standoffs. Be sure to put them on the right place again. Use a Torx screwdriver to remove the screws.
4. Lift the digital A1 PCB out of the top cover. Be careful not to damage the infrared LED and phototransistor of the optical interface.

NOTE: The gasket between the two Optical RS-232-C Interface LEDs on the digital A1 PCB and front cover must remain with the LEDs. The top cover lifts away easily. Do not damage the gasket. A correctly fitted gasket assures the sealing of the ScopeMeter test tool.

5. Lift the keypad from the top cover (item 2).
6. Reinstall the new top cover (item 1).

7.3.5.8 Keypad replacement

1. Remove the bottom cover assembly.
2. Remove the 30-pole flat cable.
3. Disassemble the top cover assembly.
4. Lift the keypad from the top cover (item 2, fig. 7.5).
5. Reinstall the new keypad.

7.3.5.9 Liquid crystal display (LCD), contact strips and backlight foil replacement

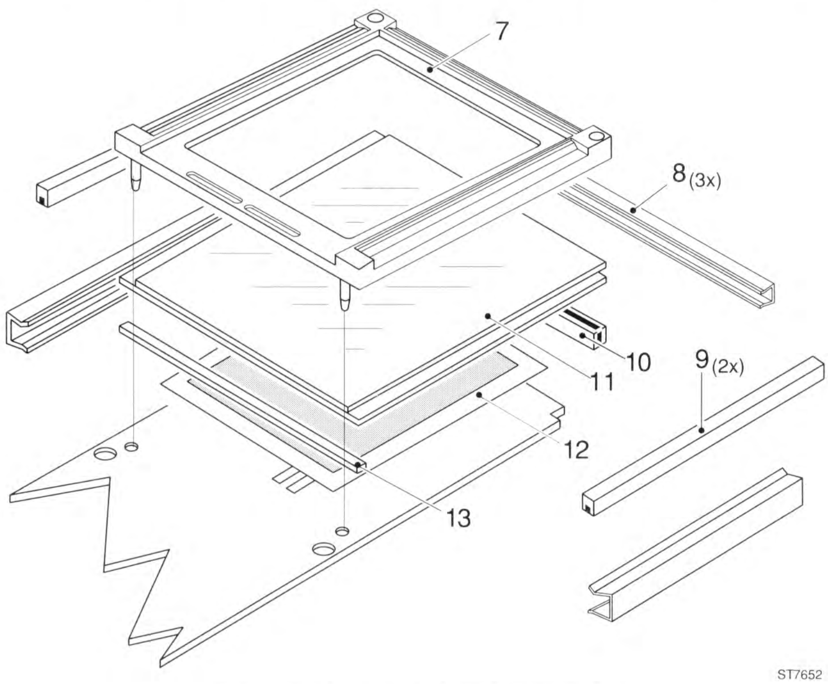


Figure 7.8 LCD replacement

Referring to figure 7.8, use the following procedure for LCD replacement.

1. Remove the bottom cover assembly.
2. Remove the 30-pole flat cable.
3. Disassemble the top cover assembly.

NOTE: *Oils or dirt from the hands are ennemies of the LCD contact strips used in the LCD assembly. Whenever handling these strips, it is advised that tweezers be used so as not to contaminate them. Care should also be taken when handling the front panel lens or LCD glass. Dirt or finger prints on these parts will be visible to the user and may impair the readability of the display.*

4. Pull the three metal clamps from the display (item 8).
5. Lift the LCD complete in its frame from the digital A1 PCB.
6. Push the LCD including the LCD contact strips out of the display frame.

7. Lift the top "I" LCD contact strip (item 10) from the display.

8. Pull the left and right "L" LCD contact strips (item 9) from the display.

9. The backlight foil (item 12) is glued to the reflective LCD. The backlight foil has two contact legs that make contact with two large rectangle spots on the digital A1 PCB.

10. Pull the backlight foil from the display.

11. Reinstall the LCD rubber filling part (item 13) and the back light foil.

12. Reinstall the two "L" LCD contact strips.

13. Reinstall the display with "L" LCD contact strips in the display frame.

14. Reinstall the "I" LCD contact strips on the display.

15. Reinstall the frame with the display assembly on the digital A1 PCB.

16. Reinstall the three metal clamps.

17. Reinstall the digital A1 PCB and top cover.

7.4 SOLDERING TECHNIQUES

7.4.1 General soldering techniques

Method:

- Carefully unsolder the soldering leads of the semiconductor one after the other.
- Remove all superfluous soldering material. Use desoldering wick, ordering code: 4822 321 40042.
- Verify that the leads of the replacement part are clean and have pre-tinned leads.
- Place the replacement semiconductor exactly in the same position, and solder each lead to the relevant printed circuit padon the PCB.

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).

CAUTION: When you are soldering inside the instrument it is essential to use a low voltage soldering iron, the tip of which must be connected to the ground of the ScopeMeter test tool.

A suitable soldering iron is:

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

Ordinary 60/40 tin/lead solder with flux core and a 35W to 40W pencil- type soldering iron can be used to do most of the soldering. If a higher wattage soldering iron is used on the circuit PCB, excessive heat may cause the circuit wiring to separate from the PCB base material.

7.4.2 Soldering micro-miniature semiconductors

Because of the small dimensions of these SOT semiconductors and the lack of space between the components on the PCB, it is necessary to use a miniature soldering iron with a pinpoint tip (max. diameter 1 mm.) to solder a SOT onto a PCB.

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 OSC 296 (ordering code 4822 872 08407)** for a complete discussion of the soldering techniques for SMD's.

7.5 SPECIAL TOOLS

7.5.1 Extender flat cable

For diagnostic testing and troubleshooting, a 30-pole 50 cm extender flat cable can be used. Using this extender flat cable makes it easier to separate the two units A1 and A2 without breaking the interconnection.

The ordering code for the extender flat cable is: 5322 321 61369.

7.6 RECALIBRATION AFTER REPAIR

After any electrical component has been replaced the performance of that particular circuit should be checked, as well as the performance of other closely-related circuits. If necessary a recalibration must be performed. Since the power supply influences all circuits, the performance of the entire instrument should be verified if work has been done in the power supply or if the transformer has been replaced. If necessary a recalibration must be done. If parts of the attenuator circuits and/or the Analog ASIC have been replaced, it might be necessary to do Hardware SCOPE Calibration Adjustments. Refer to section 5.6.1 of this Service Manual.

7.7 INSTRUMENT REPACKING

If the ScopeMeter test tool is to be reshipped 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 ScopeMeter test tool, **including the RED and the GREY scope probe**, its serial number, and a complete description of the problem and the work that is to be done. If the original container is not available, repack the instrument so that no damage occurs during transport.

8 LIST OF REPLACEABLE PARTS

8.1 INTRODUCTION

The replaceable parts section provides illustrated parts lists for all ScopeMeter test tool Series II models.

The mechanical parts are listed numerically by assembly. The electrical parts on the printed circuit boards A1 and A2 are listed alphanumerically by assembly. Each part is shown in an accompanying illustration.

The parts lists provide the following information for each part:

- Item number
- Figure number
- Description
- Ordering code
- Total quantity of components per assembly

8.2 HOW TO OBTAIN PARTS

Contact your local Fluke authorized representative. The addresses and telephone numbers are listed in this manual at the end of section 11: "Sales & Service all over the world".
In the U.S. order directly from the Fluke Parts Dept. by calling 1- 800-526-4731.

To ensure prompt and efficient handling of your order, include the following information:

1. Model number (Fluke xx), Code number (9444 ... .) and Serial number (DM......). The items are printed on the type plate on the bottom cover.
2. Ordering code
3. Item number
4. Description
5. Quantity

Table 8.1 ScopeMeter test tool final assembly. (See figure 8.1)

When servicing the ScopeMeter test tool, use only the replacement parts specified.

Item	Figure	Description	Ordering code	Qty
1	8.1	Top cover assembly 105	5322 447 92346	1
2	8.1	Keypad 99/105	5322 414 20487	1
29	8.1	Bottom cover torx-screw blank M3x10	5322 502 21507	2
30	8.1	Board A2 torx-screw blank M3x8	5322 502 13772	2
31	8.1	Input unit torx-screw blank M3x10	5322 502 13771	2
32	8.1	30-pole flat cable	5322 321 61238	1
-	-	30-pole extender flat cable for repair purposes	5322 321 61369	1
33	8.1	Top cover torx-screw blank M3x12	5322 502 21213	2
34	8.1	Top screening A2 front unit	5322 447 70129	1
35	8.1	Key pad foil	5322 218 41052	1
36	8.1	Gasket for optical interface I/O	5322 255 41213	1
37	8.1	3 mm spacer	4822 532 20577	2
38	8.1	Bottom screening A2	5322 466 83171	1

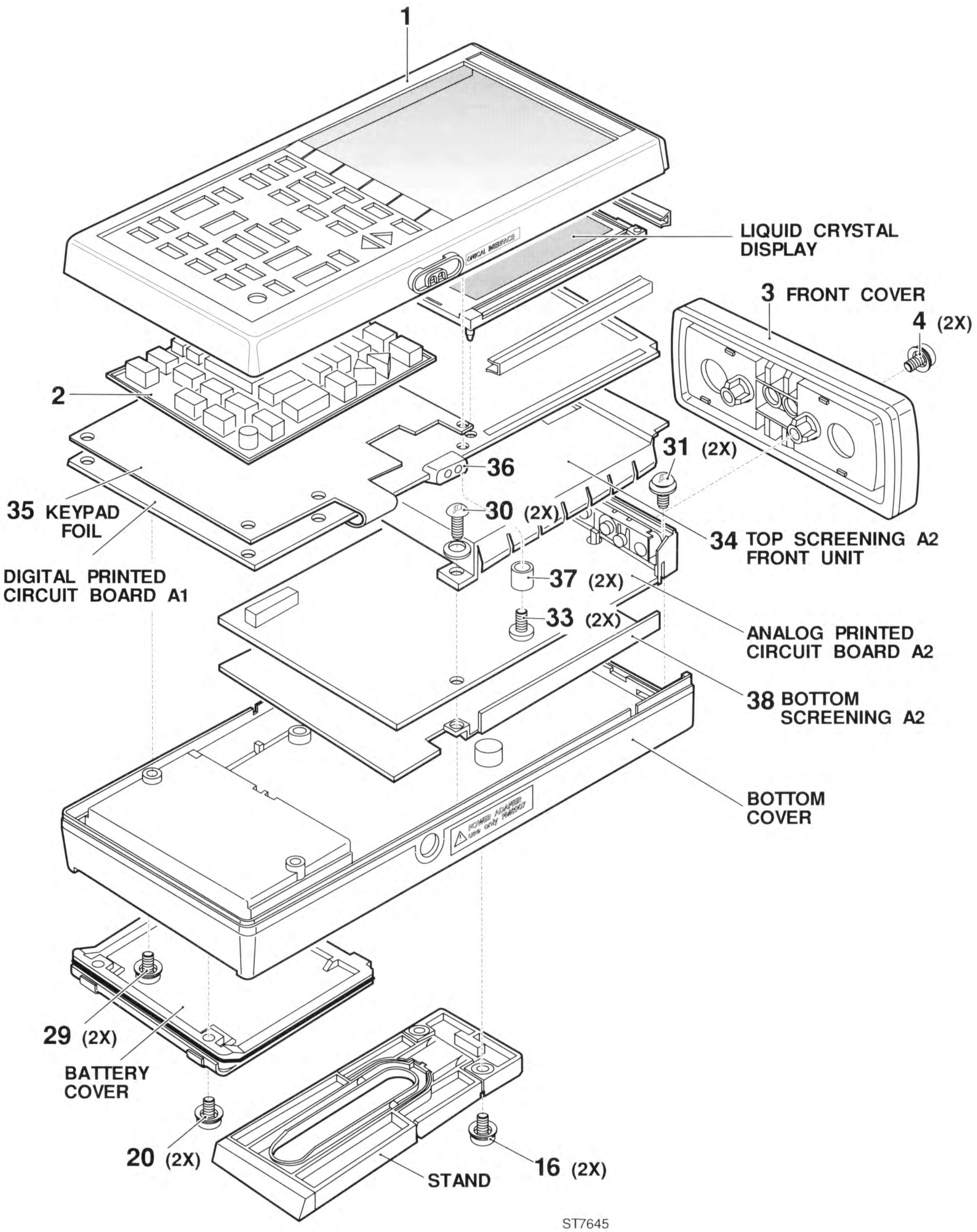
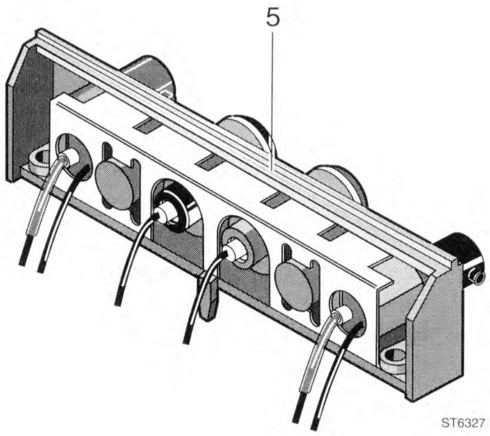


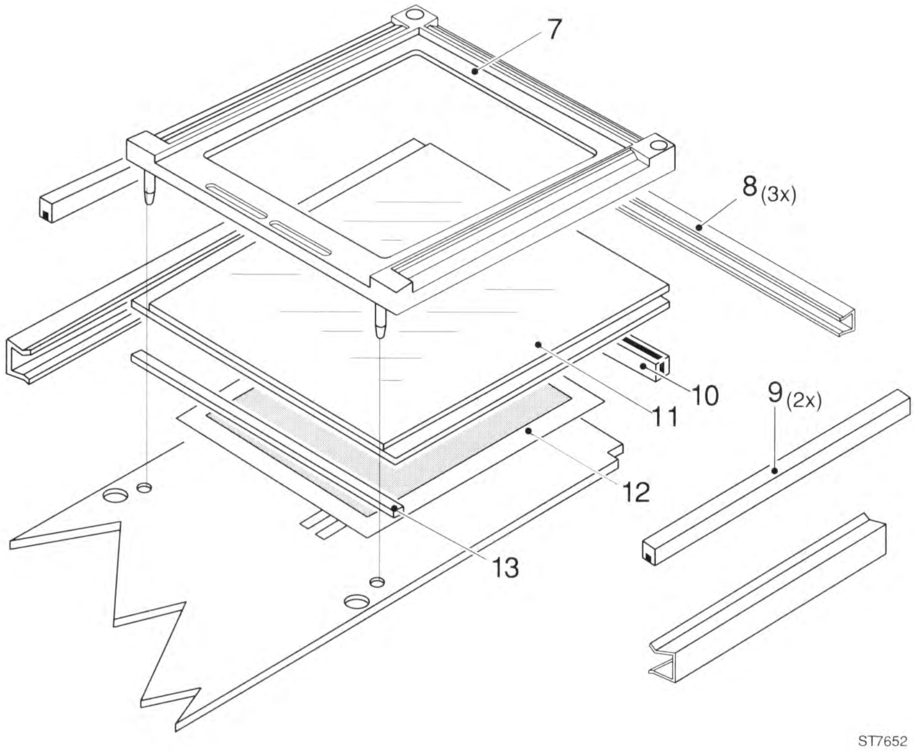
Figure 8.1 ScopeMeter test tool final assembly

Table 8.2 Front cover assembly (See figure 8.2)
Input unit assembly
Display asssembly

When servicing the ScopeMeter test tool, use only the replacement parts specified.

Item	Figure	Description	Ordering code	Qty
3	8.2	Front cover assembly 92, 96, 99, 105	5322 447 92298	1
4	8.2	Torx screw black M3x10	5322 502 13771	2
5	8.2	Input unit assembly 92, 96, 99, 105	5322 218 61462	1
7	8.2	LCD frame	5322 255 41246	1
8	8.2	LCD clamps	5322 401 11411	3
9	8.2	LCD contact strip L-shape	5322 466 62048	2
10	8.2	LCD contact strip I-shape	5322 268 90443	1
11	8.2	Display transflective (all models)	5322 130 91054	1
12	8.2	Backlight foil	5322 466 62052	1
13	8.2	LCD rubber filling part	5322 466 62049	1





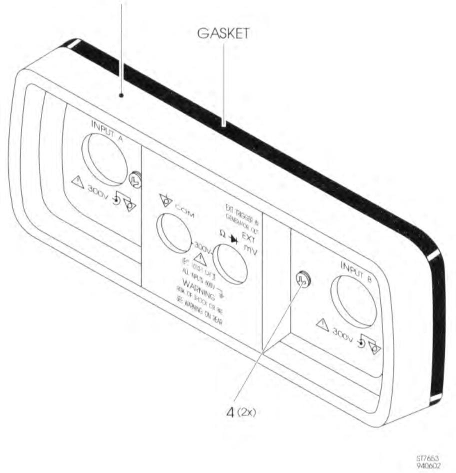


Figure 8.2 Front cover assembly
Display assembly
Input assembly

Table 8.3 Battery contact assembly. (See figure 8.3)
Stand assembly
Battery cover assembly
Bottom cover assembly

When servicing the ScopeMeter test tool, use only the replacement parts specified.

Item	Figure	Description	Ordering code	Qty
14	8.3	Stand assembly (item 15+16 included)	5322 456 90416	1
15	8.3	Anti slip strip	5322 466 62045	1
16	8.3	Torx screw black M3x10	5322 502 13771	1
17	8.3	Battery cover assembly	5322 447 70116	1
18	8.3	Gasket	5322 530 51238	1
19	8.3	Rubber foot	5322 462 41825	2
20	8.3	Torx screw black M3x10	5322 502 13771	2
21	8.3	Bottom cover assembly	5322 447 70113	1
22	8.3	Battery contact spring	5322 492 70908	3
23	8.3	Battery contact spring assembly	5322 492 70909	1
24	8.3	Buffer	5322 466 62047	4
25	8.3	12V/0 contact	5322 466 82843	2
26	8.3	Charging contact	5322 466 82842	1
27	8.3	Battery wiring assembly	5322 321 61997	1
28	8.3	Battery pull strip	5322 466 62046	1

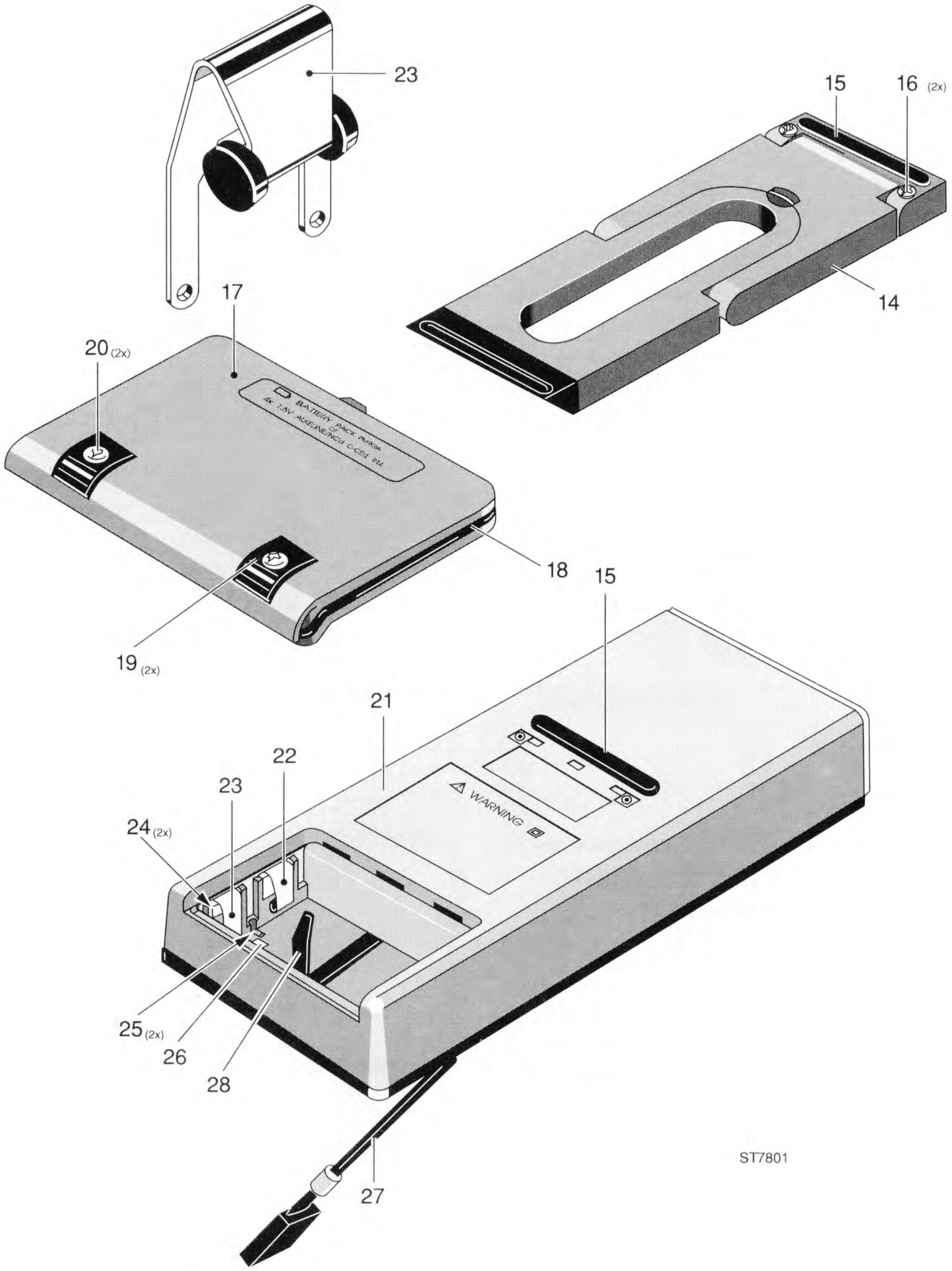


Figure 8.3 Battery contact assembly
Stand assembly
Battery cover assembly
Bottom assembly

Table 8.4 Digital A1 PCB assembly (figure 8.4)

When servicing the ScopeMeter test tool, use only the replacement parts specified.

Item	Figure	Description	Ordering code	Qty
A1	8.4	Digital A1 PCB assembly 105	5322 216 51291	1

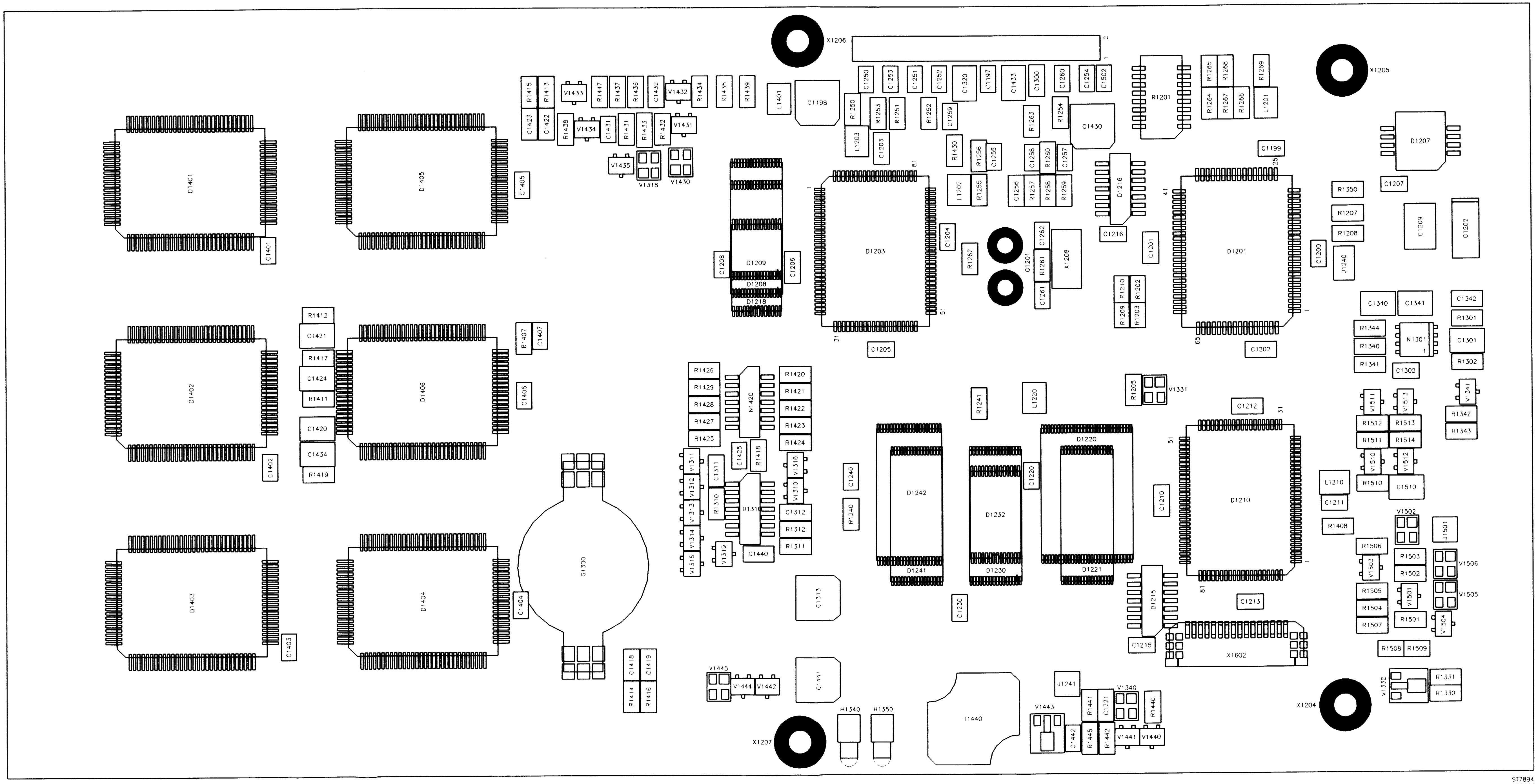


Figure 8.4 Digital A1 PCB assembly

Item	Description		Ordering code

CAPACITORS

C1197	CAP.CHIP	63V 10% 22NF	5322 122 32654
C1198	CAP.ELECTROLYT.	50V 20% 10UF	5322 124 42332
C1199	CAP.CHIP	63V 10% 22NF	5322 122 32654
C1200	CAP.CHIP	63V 10% 22NF	5322 122 32654
C1201	CAP.CHIP	63V 10% 100NF	4822 122 33496
C1202	CAP.CHIP	63V 10% 100NF	4822 122 33496
C1203	CAP.CHIP	63V 10% 100NF	4822 122 33496
C1204	CAP.CHIP	63V 10% 22NF	5322 122 32654
C1205	CAP.CHIP	63V 10% 22NF	5322 122 32654
C1206	CAP.CHIP	63V 10% 100NF	4822 122 33496
C1208	CAP.CHIP	63V 10% 22NF	5322 122 32654
C1210	CAP.CHIP	63V 10% 100NF	4822 122 33496
C1211	CAP.CHIP	63V 10% 22NF	5322 122 32654
C1212	CAP.CHIP	63V 10% 100NF	4822 122 33496
C1213	CAP.CHIP	63V 10% 22NF	5322 122 32654
C1215	CAP.CHIP	63V 10% 10NF	5322 122 34098
C1216	CAP.CHIP	63V 10% 22NF	5322 122 32654
C1221	CAP.CHIP	63V 10% 100NF	4822 122 33496
C1230	CAP.CHIP	63V 10% 22NF	5322 122 32654
C1240	CAP.CHIP	63V 10% 22NF	5322 122 32654
C1250	CAP.CHIP	63V 10% 10NF	5322 122 34098
C1251	CAP.CHIP	63V 10% 10NF	5322 122 34098
C1252	CAP.CHIP	63V 10% 10NF	5322 122 34098
C1253	CAP.CHIP	63V 10% 10NF	5322 122 34098
C1254	CAP.CHIP	63V 5% 15PF	5322 122 33869
C1256	CAP.CHIP	63V 10% 100NF	4822 122 33496
C1257	CAP.CERAMIC	63V 5% 10PF	5322 122 32448
C1258	CAP.CERAMIC	63V 5% 120PF	5322 122 33861
C1259	CAP.CHIP	63V 5% 680PF	5322 126 10733
C1260	CAP.CHIP	63V 10% 22NF	5322 122 32654
C1261	CAP.CHIP	63V 5% 15PF	5322 122 33869
C1262	CAP.CHIP	63V 5% 15PF	5322 122 33869
C1300	CAP.CHIP	63V 10% 100NF	4822 122 33496
C1301	CAP.CHIP	63V 10% 220NF	4822 122 32916
C1302	CAP.CHIP	63V 10% 22NF	5322 122 32654
C1311	CAP.CHIP	63V 10% 2.7NF	4822 122 33498
C1312	CAP.CHIP	63V 10% 100NF	4822 122 33496
C1313	CAP.ELECTROLYT.	6.3V 20% 100UF	5322 124 42331
C1320	CAP.CHIP	63V 10% 220NF	4822 122 32916
C1340	CAP.CHIP	63V 10% 220NF	4822 122 32916
C1341	CAP.CHIP	63V 10% 220NF	4822 122 32916
C1342	CAP.CHIP	63V 10% 2.7NF	4822 122 33498
C1401	CAP.CHIP	63V 10% 22NF	5322 122 32654
C1402	CAP.CHIP	63V 10% 22NF	5322 122 32654
C1403	CAP.CHIP	63V 10% 22NF	5322 122 32654
C1404	CAP.CHIP	63V 10% 22NF	5322 122 32654
C1405	CAP.CHIP	63V 10% 22NF	5322 122 32654

Item	Description		Ordering code
C1406	CAP.CHIP	63V 10% 22NF	5322 122 32654
C1407	CAP.CERAMIC	63V 5% 120PF	5322 122 33861
C1418	CAP.CHIP	63V 10% 100NF	4822 122 33496
C1419	CAP.CHIP	63V 10% 100NF	4822 122 33496
C1420	CAP.CHIP	63V 10% 220NF	4822 122 32916
C1421	CAP.CHIP	63V 10% 220NF	4822 122 32916
C1422	CAP.CHIP	63V 10% 100NF	4822 122 33496
C1423	CAP.CHIP	63V 10% 100NF	4822 122 33496
C1424	CAP.CHIP	63V 10% 220NF	4822 122 32916
C1425	CAP.CHIP	63V 10% 22NF	5322 122 32654
C1430	CAP.ELECTROLYT.	50V 20% 10UF	5322 124 42332
C1431	CAP.CHIP	63V 5% 680PF	5322 126 10733
C1432	CAP.CHIP	63V 10% 100NF	4822 122 33496
C1433	CAP.CHIP	63V 10% 220NF	4822 122 32916
C1434	CAP.CHIP	63V 10% 220NF	4822 122 32916
C1440	CAP.CHIP	63V 10% 100NF	4822 122 33496
C1441	CAP.ELECTROLYT.	50V 20% 10UF	5322 124 42332
C1442	CAP.CHIP	63V 10% 10NF	5322 122 34098
C1502	CAP.CHIP	63V 10% 10NF	5322 122 34098
C1510	CAP.CHIP	63V 10% 220NF	4822 122 32916

DIGITAL INTEGRATED CIRCUITS

D1201	MICROPROCESSOR	µP 83C196 UHM V1.0	5322 209 12591
D1203	I.C. DIGITAL	DASIC	5322 209 30819
D1210	I.C. DIGITAL	MEM MANAGER MASIC	5322 209 32946
D1215	INTEGR.CIRCUIT	74HC132	5322 209 60428
D1216	INTEGR.CIRCUIT	74HC132	5322 209 60428
D1218	I.C. RAM	32KX8SRAM M5M5256BRV-70LL	5322 209 52729
D1230	I.C. RAM	128KSRAM M5M51008ARV-70LL	5322 209 52707
D1242	I.C. E-PROM	4MB FEPROM E28F00	5322 209 52714
D1310	INTEGR.CIRCUIT	HEF4093BT	5322 209 11147
D1401	INTEGR.CIRCUIT	LCD DRIVER HD66205	5322 209 52458
D1402	INTEGR.CIRCUIT	LCD DRIVER HD66205	5322 209 52458
D1403	INTEGR.CIRCUIT	LCD DRIVER HD66205	5322 209 52458
D1404	INTEGR.CIRCUIT	LCD DRIVER HD66204	5322 209 52457
D1405	INTEGR.CIRCUIT	LCD DRIVER HD66204	5322 209 52457
D1406	INTEGR.CIRCUIT	LCD DRIVER HD66204	5322 209 52457

BATTERY/CRYSTAL

G1	BATTERY	LITH BATT 3V/190MAH	4822 138 10464
G1201	CRYSTAL	CRISTAL 25MHZ	5322 242 81633
G1300	HOLDER,BATTERY	BATTERY HOLDER	5322 256 60343

OPTO DEVICES

H1340	PHOTO TRANSISTOR	SFH 309F-4	4822 130 62297
H1350	IRLED	SFH 409-2	5322 130 61296
H1401	DISPLAY	LCD	5322 130 91054

Item	Description		Ordering code

COILS

L1201	COIL	1UH 5%	5322 157 63648
L1202	COIL	HF30ACB-322513T	5322 157 63651
L1203	COIL	1UH 5%	5322 157 63648
L1210	COIL	1UH 5%	5322 157 63648
L1220	COIL	1UH 5%	5322 157 63648
L1401	COIL	1UH 5%	5322 157 63648

ANALOG INEGRATED CIRCUITS

N1301	INTEGR.CIRCUIT	LM358M	4822 209 60175
N1420	INTEGR.CIRCUIT	LM324D	5322 209 83125

RESISTORS

R1201	RES.NETWORK	RES NETWORK 56K	5322 111 91993
R1202	RES.CHIP	RC-01 0E	4822 051 10008
R1209	RES.CHIP	RC-01 0E	4822 051 10008
R1241	RES.CHIP	RC-01 0E	4822 051 10008
R1250	RES.CHIP	RC-02 11K 1%	4822 051 10113
R1251	RES.CHIP	RC-02 11K 1%	4822 051 10113
R1252	RES.CHIP	RC-02 11K 1%	4822 051 10113
R1253	RES.METAL FILM	RC-02H 5K62 1%	5322 117 10573
R1254	RES.CHIP	RC-02H 1K 1%	4822 051 10102
R1255	RES.CHIP	RC-02H 1K 1%	4822 051 10102
R1257	RES.CHIP	RC-02H 11K 1%	4822 051 10113
R1258	RES.CHIP	RC-02H 51K1 1%	4822 051 55113
R1259	RES.CHIP	RC-02H 11K0 1%	4822 051 10113
R1260	RES.CHIP	RC-02H 1K0 1%	4822 051 10103
R1261	RES.CHIP	RC-02H 1M0 1%	4822 051 10105
R1262	RES.CHIP	RC-02H 121E 1%	4822 051 51211
R1263	RES.CHIP	RC-02H 261E 1%	4822 051 52611
R1264	RES.CHIP	RC-02H 1K0 1%	4822 051 10102
R1265	RES.CHIP	RC-02H 1K0 1%	4822 051 10102
R1266	RES.CHIP	RC-02H 1K0 1%	4822 051 10102
R1267	RES.CHIP	RC-02H 1K0 1%	4822 051 10102
R1268	RES.CHIP	RC-02H 1K0 1%	4822 051 10102
R1269	RES.CHIP	RC-02H 121E 1%	4822 051 51211
R1301	RES.CHIP	RC-02H 121K 1%	4822 051 51214
R1302	RES.METAL FILM	RC-02H 90K9 1%	5322 117 11754
R1310	RES.METAL FILM	RC-02H 34K8 1%	5322 117 10558
R1311	RES.CHIP	RC-02H 121E 1%	4822 051 51211
R1312	RES.CHIP	RC-02H 2K15 1%	5322 117 10485
R1330	RES.CHIP	RC-02H 1K0 1%	4822 051 10102
R1331	RES.METAL FILM	RC-02H 681E 1%	5322 117 10579
R1340	RES.METAL FILM	RC-02H 464K 1%	5322 117 10568
R1341	RES.CHIP	RC-02H 1K0 1%	4822 051 10102
R1342	RES.CHIP	RC-02H 1K0 1%	4822 051 10102
R1344	RES.CHIP	RC-02H 11K 1%	4822 051 10113
R1350	RES.METAL FILM	RC-02H 383E 1%	5322 117 10559

Item	Description		Ordering code
R1407	RES.CHIP	RC-02H 1K0 1%	4822 051 10102
R1408	RES.CHIP	RC-02H 1K0 1%	4822 051 10102
R1411	RES.CHIP	RC-02H 100E 1%	4822 051 10101
R1412	RES.CHIP	RC-02H 100E 1%	4822 051 10101
R1413	RES.CHIP	RC-02H 215E 1%	5322 117 10484
R1414	RES.CHIP	RC-02H 215E 1%	5322 117 10484
R1415	RES.CHIP	RC-02H 215E 1%	5322 117 10484
R1416	RES.CHIP	RC-02H 215E 1%	5322 117 10484
R1417	RES.CHIP	RC-02H 100E 1%	4822 051 10101
R1418	RES.METAL FILM	D2542R2FCS 42E2	5322 117 11753
R1419	RES.CHIP	RC-02H 100E 1%	4822 051 10101
R1420	RES.METAL FILM	RC-02H 5K62 1%	5322 117 10573
R1421	RES.METAL FILM	RC-02H 5K62 1%	5322 117 10573
R1422	RES.CHIP	RC-02H 68K1 1%	4822 051 56813
R1423	RES.METAL FILM	RC-02H 5K62 1%	5322 117 10573
R1424	RES.METAL FILM	RC-02H 5K62 1%	5322 117 10573
R1425	RES.METAL FILM	D2542R2FCS 42E2	5322 117 11753
R1426	RES.METAL FILM	D2551R1FCS 51E1	5322 117 11737
R1427	RES.METAL FILM	D2551R1FCS 51E1	5322 117 11737
R1428	RES.METAL FILM	D2551R1FCS 51E1	5322 117 11737
R1429	RES.METAL FILM	D2551R1FCS 51E1	5322 117 11737
R1430	RES.CHIP	RC-02H 11K0 1%	4822 051 10113
R1431	RES.CHIP	RC-02H 2K15 1%	5322 117 10485
R1432	RES.METAL FILM	RC-02H 3K48 1%	5322 117 10557
R1433	SENSOR	TEMP. SENSOR	5322 130 91332
R1434	RES.CHIP	RC-02H 11K0 1%	4822 051 10113
R1435	RES.CHIP	RC-02H 121K 1%	4822 051 51214
R1436	RES.CHIP	RC-02H 1K0 1%	4822 051 10102
R1437	RES.METAL FILM	RC-02H 19K6 1%	5322 117 10541
R1438	RES.CHIP	RC-02H 11K0 1%	4822 051 10113
R1439	RES.METAL FILM	D2551R1FCS 51E1	5322 117 11737
R1440	RES.METAL FILM	RC-02H 3K48 1%	5322 117 10557
R1441	RES.CHIP	RC-02H 10K0 1%	4822 051 10103
R1442	RES.CHIP	RC-02H 215E 1%	5322 117 10484
R1445	RES.CHIP	RC-02H 215E 1%	5322 117 10484
R1501	RES.CHIP	RC-02H 100K 1%	4822 051 10104
R1502	RES.CHIP	RC-02H 100K 1%	4822 051 10104
R1503	RES.CHIP	RC-02H 100K 1%	4822 051 10104
R1504	RES.CHIP	RC-02H 1K0 1%	4822 051 10102
R1505	RES.CHIP	RC-02H 100K 1%	4822 051 10104
R1506	RES.CHIP	RC-02H 100K 1%	4822 051 10104
R1507	RES.CHIP	RC-02H 11K0 1%	4822 051 10113
R1509	RES.CHIP	RC-01 0E 1%	4822 051 10008
R1510	RES.CHIP	RC-02H 215E 1%	5322 117 10484
R1511	RES.CHIP	RC-02H 11K0 1%	4822 051 10113
R1512	RES.CHIP	RC-02H 121E 1%	4822 051 51211
R1513	RES.CHIP	RC-02H 11K0 1%	4822 051 10113
R1514	RES.CHIP	RC-02H 1M0 1%	4822 051 10105

Item	Description		Ordering code

TRANSFORMER

Item	Description		Ordering code
T1440	TRANSFORMER	TRAFO BACKLIGHT	5322 146 21627

DIODES/TRANSISTORS

Item	Description		Ordering code
V1310	DIODE,CHIP	BAT54S	4822 130 82262
V1311	TRANSISTOR,CHIP	BC858C	4822 130 42513
V1312	TRANSISTOR,CHIP	BC848C	5322 130 42136
V1313	TRANSISTOR,CHIP	BC848C	5322 130 42136
V1314	TRANSISTOR,CHIP	BC848C	5322 130 42136
V1315	TRANSISTOR,CHIP	BC848C	5322 130 42136
V1316	TRANSISTOR,CHIP	BC807	4822 130 42132
V1318	DIODE,CHIP	BAS28	5322 130 80214
V1319	TRANSISTOR,CHIP	BC848C	5322 130 42136
V1331	DIODE,CHIP	BAS28	5322 130 80214
V1332	DIODE,REFERENCE	BZV49-C13	5322 130 82043
V1340	DIODE,CHIP	BAS28	5322 130 80214
V1341	TRANSISTOR,CHIP	BC848C	5322 130 42136
V1430	DIODE,CHIP	BAS28	5322 130 80214
V1431	TRANSISTOR,CHIP	BC858C	4822 130 42513
V1432	TRANSISTOR,CHIP	BC848C	5322 130 42136
V1433	TRANSISTOR,CHIP	BC858C	4822 130 42513
V1434	DIODE,CHIP	BAT54S	4822 130 82262
V1435	TRANSISTOR,CHIP	BC848C	5322 130 42136
V1440	TRANSISTOR,CHIP	BC858C	4822 130 42513
V1441	TRANSISTOR,CHIP	BC858C	4822 130 42513
V1442	DIODE,REFERENCE	BZX84-B47	4822 130 82521
V1443	TRANSISTOR,CHIP	BCX54-16	5322 130 62237
V1444	DIODE,REFERENCE	BZX84-B47	4822 130 82521
V1445	DIODE,CHIP	BAS28	5322 130 80214
V1501	TRANSISTOR,CHIP	BC858C	4822 130 42513
V1502	DIODE,CHIP	BAS28	5322 130 80214
V1503	TRANSISTOR,CHIP	BC848C	5322 130 42136
V1504	TRANSISTOR,CHIP	BC848C	5322 130 42136
V1505	DIODE,CHIP	BAS28	5322 130 80214
V1506	DIODE,CHIP	BAS28	5322 130 80214
V1510	TRANSISTOR,CHIP	BC858C	4822 130 42513
V1511	DIODE,REFERENCE	BZX84-C3V6	5322 130 32731
V1512	TRANSISTOR,CHIP	BC858C	4822 130 42513
V1513	TRANSISTOR,CHIP	BC858C	4822 130 42513

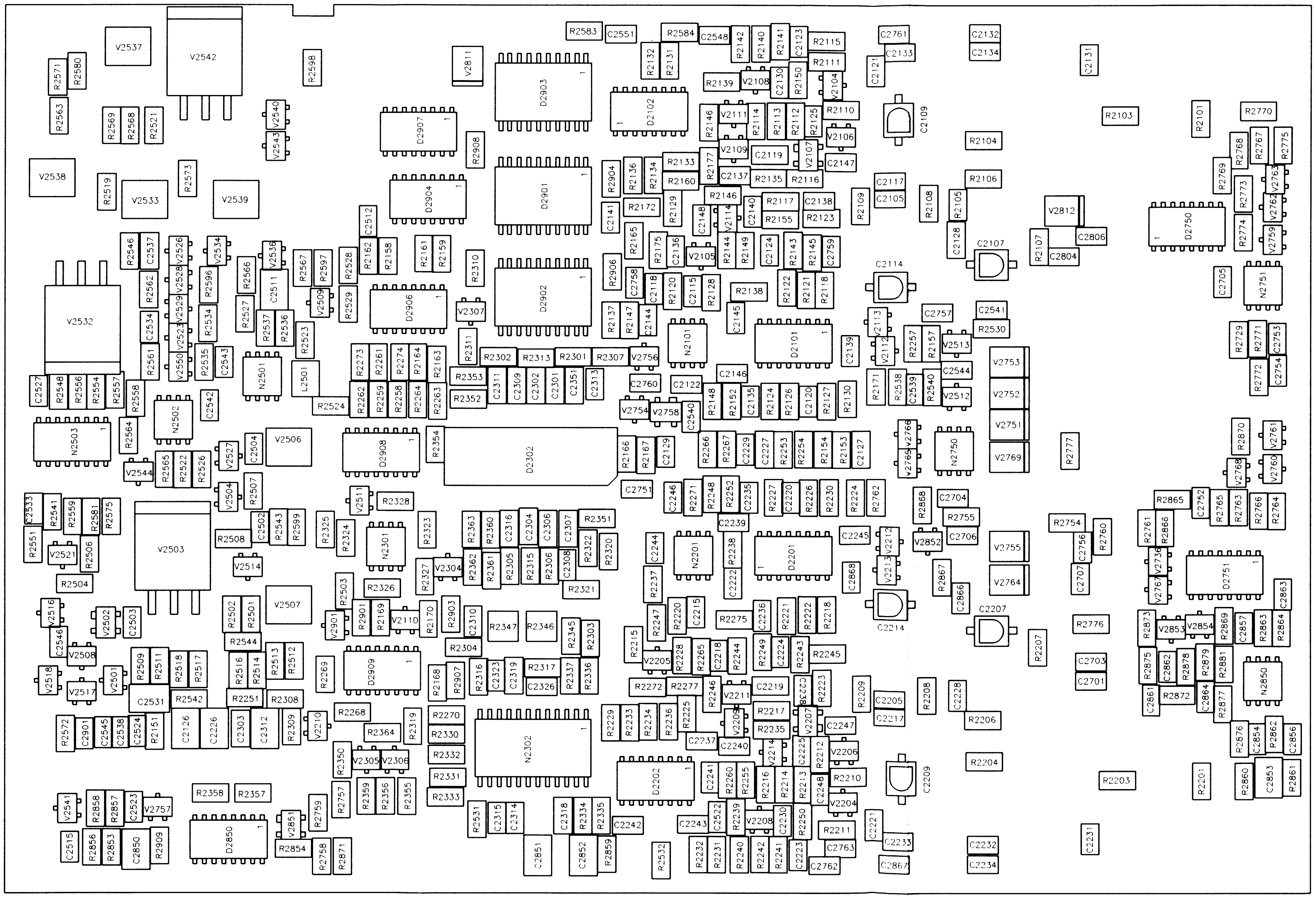
CONNECTORS

Item	Description		Ordering code
X1602	CONNECTOR	CONNECTOR 16P	5322 267 51318

Table 8.5 Analog A2 PCB assembly (Figure 8.5)

When servicing the ScopeMeter test tool, use only the replacement parts specified.

Item	Figure	Description	Ordering code	Qty
A2	8.5/8.6	Analog A2 PCB assembly 105	5322 216 51292	1



ST7895
950508

Figure 8.5 Analog A2 PCB assembly (SMD components side is idental for all models)

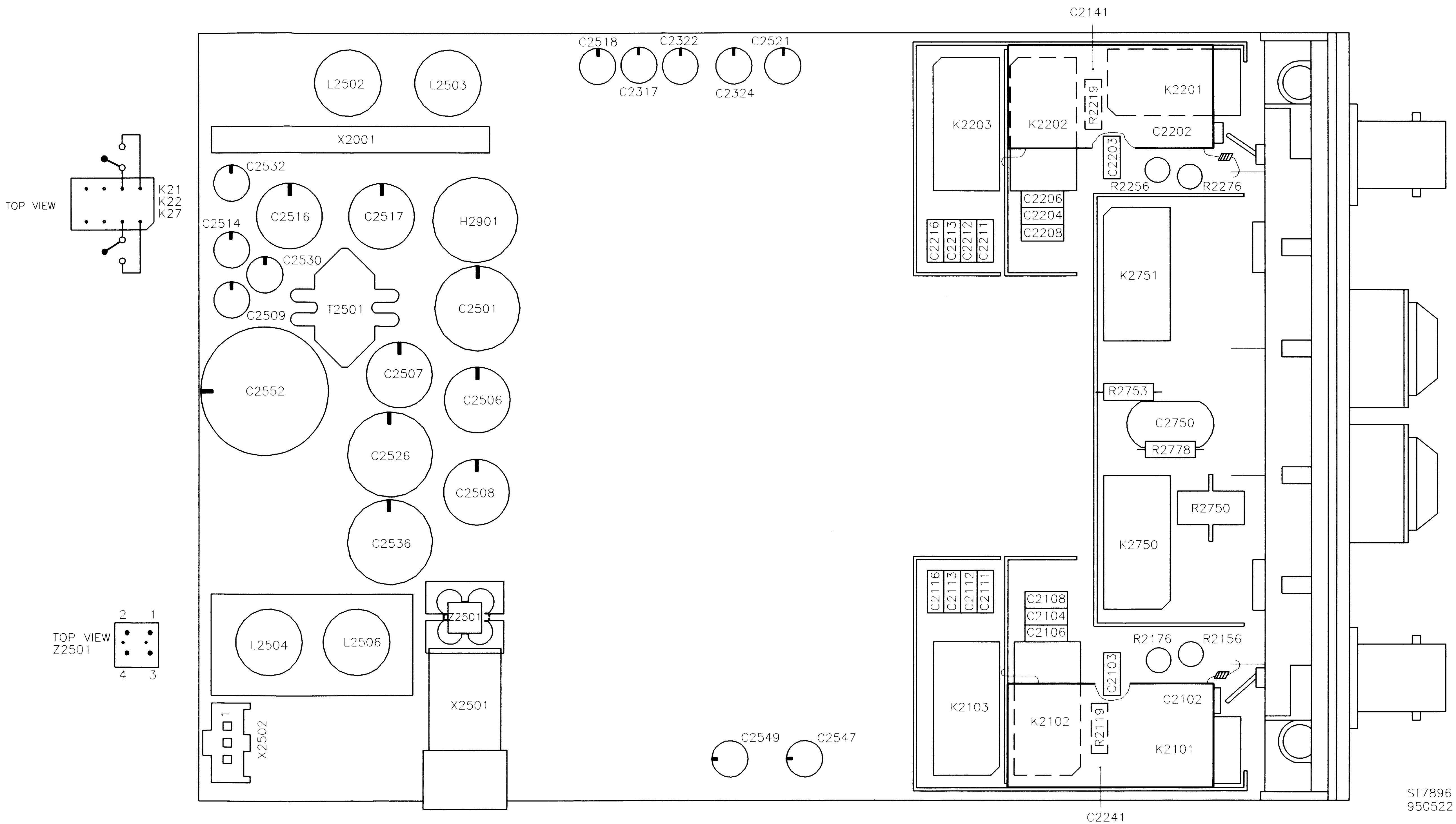


Figure 8.6 Analog A2 PCB assembly (Wired components side)

Item	Description				Ordering code

CAPACITORS

C2102	CAP.FOIL	400V	10%	22NF	5322 121 70399
C2103	CAP.	500V	2%	56PF	5322 122 32982
C2104	CAP.CERAMIC	500V	0.25PF	8.2PF	4822 122 31194
C2105	CAP.CHIP	63V	5%	12PF	4822 122 33926
C2106	CAP.CERAMIC	500V	2%	10PF	5322 126 13328
C2107	CAP.TRIMMER		3-10 PF	MUR	5322 125 50306
C2108	CAP.CERAMIC	100V	2%	47PF	4822 122 31072
C2109	CAP.TRIMMER		3-10 PF	MUR	5322 125 50306
C2111	CAP.CERAMIC	500V	0.25PF	6.8PF	5322 126 13327
C2112	CAP.CERAMIC	500V	0.25PF	6.8PF	5322 126 13327
C2113	CAP.CERAMIC	100V	2%	56PF	5322 126 13329
C2114	CAP.TRIMMER		3-10 PF	MUR	5322 125 50306
C2115	CAP.CHIP		5%	12PF	4822 122 33926
C2116	CAP.CERAMIC	500V	0.25PF	8.2PF	4822 122 31194
C2117	CAP.CHIP	C2115	2%	56PF	5322 126 12506
C2118	CAP.CHIP	63V	5%	330PF	5322 122 31863
C2119	CAP.CHIP	63	10%	100NF	4822 122 33496
C2120	CAP.CERAMIC	63V	0.5PF	5.6PF	5322 122 32967
C2121	CAP.CHIP	63V	10%	10NF	5322 122 34098
C2122	CAP.CHIP	63V	10%	3.3NF	4822 122 33891
C2123	CAP.CHIP	63V	5%	1NF	5322 126 10511
C2124	CAP.CHIP	63V	10%	3.3NF	4822 122 33891
C2125	CAP.CERAMIC	63V	5%	120PF	5322 122 33861
C2126	CAP.CHIP	63V	10%	220NF	4822 122 32916
C2127	CAP.CERAMIC	63V	10%	68NF	4822 122 32891
C2128	CAP.CERAMIC	63V	5%	10PF	5322 122 32448
C2129	CAP.CHIP	63V	10%	3.3NF	4822 122 33891
C2130	CAP.CHIP	63V	10%	10NF	5322 122 34098
C2131	CAP.CHIP	63V	10%	10NF	5322 122 34098
C2132	CAP.CHIP	63V	10%	10NF	5322 122 34098
C2133	CAP.CHIP	63V	10%	10NF	5322 122 34098
C2134	CAP.CHIP	63V	10%	10NF	5322 122 34098
C2135	CAP.CHIP	63V	10%	22NF	5322 122 32654
C2136	CAP.CHIP	63V	5%	680PF	5322 126 10733
C2137	CAP.CHIP	63V	5%	82PF	4822 122 33515
C2138	CAP.CHIP	63V	10%	22NF	5322 122 32654
C2139	CAP.CHIP	63V	10%	2.2NF	4822 122 33127
C2140	CAP.CHIP	63V	10%	22NF	5322 122 32654
C2141	CAP.CHIP	63V	10%	2.2NF	4822 122 33127
C2144	CAP.CHIP	63V	10%	2.2NF	4822 122 33127
C2145	CAP.CHIP	63V	10%	2.2NF	4822 122 33127
C2146	CAP.CHIP	63V	10%	2.2NF	4822 122 33127
C2147	CAP.CHIP	63V	10%	2.2NF	4822 122 33127
C2148	CAP.CHIP	63V	10%	2.2NF	4822 122 33127
C2202	CAP.FOIL	400V	10%	22NF	5322 121 70399

Item	Description				Ordering code
C2203	CAP.	500V	2%	56PF	5322 122 32982
C2204	CAP.CERAMIC	500V	0.25PF	8.2PF	4822 122 31194
C2205	CAP.CHIP	63V	5%	12PF	4822 122 33926
C2206	CAP.CERAMIC	500V	2%	10PF	5322 126 13328
C2207	CAP.TRIMMER		3-10 PF	MUR	5322 125 50306
C2208	CAP.CERAMIC	100V	2%	47PF	4822 122 31072
C2209	CAP.TRIMMER		3-10 PF	MUR	5322 125 50306
C2211	CAP.CERAMIC	500V	0.25PF	6.8PF	5322 126 13327
C2212	CAP.CERAMIC	500V	0.25PF	6.8PF	5322 126 13327
C2213	CAP.CERAMIC	100V	2%	56PF	5322 126 13329
C2214	CAP.TRIMMER		3-10 PF	MUR	5322 125 50306
C2215	CAP.CHIP	63V	5%	12PF	4822 122 33926
C2216	CAP.CERAMIC	500V	0.25PF	8.2PF	4822 122 31194
C2217	CAP.CHIP	63V	2%	56PF	5322 126 12506
C2218	CAP.CHIP	63V	5%	270PF	4822 122 33216
C2219	CAP.CHIP	63V	10%	100NF	4822 122 33496
C2220	CAP.CERAMIC	63V	0.5PF	5.6PF	5322 122 32967
C2221	CAP.CHIP	63V	10%	10NF	5322 122 34098
C2222	CAP.CHIP	63V	10%	3.3NF	4822 122 33891
C2223	CAP.CHIP	63V	5%	1NF	5322 126 10511
C2224	CAP.CHIP	63V	10%	3.3NF	4822 122 33891
C2225	CAP.CERAMIC	63V	5%	120PF	5322 122 33861
C2226	CAP.CHIP	63V	10%	220NF	4822 122 32916
C2227	CAP.CERAMIC	63V	10%	68NF	4822 122 32891
C2228	CAP.CERAMIC	63V	5%	10PF	5322 122 32448
C2229	CAP.CHIP	63V	10%	3.3NF	4822 122 33891
C2230	CAP.CHIP	63V	10%	10NF	5322 122 34098
C2231	CAP.CHIP	63V	10%	10NF	5322 122 34098
C2232	CAP.CHIP	63V	10%	10NF	5322 122 34098
C2233	CAP.CHIP	63V	10%	10NF	5322 122 34098
C2234	CAP.CHIP	63V	10%	10NF	5322 122 34098
C2235	CAP.CHIP	63V	10%	22NF	5322 122 32654
C2236	CAP.CHIP	63V	5%	680PF	5322 126 10733
C2237	CAP.CHIP	63V	5%	82PF	4822 122 33515
C2238	CAP.CHIP	63V	10%	22NF	5322 122 32654
C2239	CAP.CHIP	63V	10%	2.2NF	4822 122 33127
C2240	CAP.CHIP	63V	10%	22NF	5322 122 32654
C2241	CAP.CHIP	63V	10%	2.2NF	4822 122 33127
C2242	CAP.CHIP	63V	10%	2.2NF	4822 122 33127
C2243	CAP.CHIP	63V	10%	2.2NF	4822 122 33127
C2244	CAP.CHIP	63V	10%	2.2NF	4822 122 33127
C2245	CAP.CHIP	63V	10%	2.2NF	4822 122 33127
C2246	CAP.CHIP	63V	10%	2.2NF	4822 122 33127
C2247	CAP.CHIP	63V	10%	2.2NF	4822 122 33127
C2248	CAP.CHIP	63V	10%	2.2NF	4822 122 33127
C2301	CAP.CHIP	63V	10%	100NF	4822 122 33496
C2302	CAP.CHIP	63V	10%	100NF	4822 122 33496

Item	Description				Ordering code
C2303	CAP.CHIP	63V	10%	100NF	4822 122 33496
C2304	CAP.CHIP	63V	10%	100NF	4822 122 33496
C2306	CAP.CHIP	63V	10%	100NF	4822 122 33496
C2307	CAP.CHIP	63V	10%	100NF	4822 122 33496
C2308	CAP.CHIP	63V	10%	10NF	5322 122 34098
C2309	CAP.CHIP	63V	10%	100NF	4822 122 33496
C2310	CAP.CHIP	63V	10%	10NF	5322 122 34098
C2311	CAP.CHIP	63V	10%	100NF	4822 122 33496
C2312	CAP.CHIP	63V	10%	220NF	4822 122 32916
C2313	CAP.CHIP	63V	10%	22NF	5322 122 32654
C2314	CAP.CHIP	63V	10%	22NF	5322 122 32654
C2315	CAP.CERAMIC	63V	0.25PF	1PF	5322 122 32447
C2316	CAP.CHIP	63V	10%	100NF	4822 122 33496
C2317	CAP.ELECTROLYT.	16V	20%	68UF	4822 124 11162
C2318	CAP.CHIP	63V	10%	100NF	4822 122 33496
C2319	CAP.CHIP	63V	10%	100NF	4822 122 33496
C2321	CAP.CHIP	63V	10%	2.2NF	4822 122 33127
C2322	CAP.ELECTROLYT.	50V	20%	4.7UF	4822 124 23627
C2323	CAP.CHIP	63V	10%	2.2NF	4822 122 33127
C2324	CAP.ELECTROLYT.	50V	20%	4.7UF	4822 124 23627
C2326	CAP.CERAMIC	63V	5%	47PF	5322 122 32452
C2351	CAP.CHIP	63V	10%	100NF	4822 122 33496
C2359	CAP.CHIP	63V	0.25PF	3.3PF	5322 122 32286
C2501	CAP.FOIL		20%	470UF	5322 121 43885
C2502	CAP.CERAMIC	63V	10%	68NF	4822 122 32891
C2503	CAP.CHIP	63V	10%	2.2NF	4822 122 33127
C2504	CAP.CHIP	63V	10%	2.2NF	4822 122 33127
C2506	CAP.FOIL		20%	1200UF	5322 121 43884
C2507	CAP.FOIL		20%	180UF	5322 121 43886
C2508	CAP.FOIL		20%	1200UF	5322 121 43884
C2509	CAP.ELECTROLYT.	16V	20%	68UF	4822 124 11162
C2511	CAP.CHIP	63V	10%	220NF	4822 122 32916
C2512	CAP.CHIP	63V	10%	22NF	5322 122 32654
C2514	CAP.ELECTROLYT.	16V	20%	68UF	4822 124 11162
C2515	CAP.CHIP	63V	10%	22NF	5322 122 32654
C2516	CAP.FOIL		20%	470UF	5322 121 43887
C2517	CAP.FOIL		20%	470UF	5322 121 43887
C2518	CAP.ELECTROLYT.	16V	20%	68UF	4822 124 11162
C2521	CAP.ELECTROLYT.	16V	20%	68UF	4822 124 11162
C2522	CAP.CHIP	63V	10%	22NF	5322 122 32654
C2523	CAP.CHIP	63V	10%	22NF	5322 122 32654
C2524	CAP.CHIP	63V	10%	22NF	5322 122 32654
C2526	CAP.FOIL		20%	470UF	5322 121 43885
C2527	CAP.CHIP	63V	5%	680PF	5322 126 10733
C2530	CAP.ELECTROLYT.	16V	20%	68UF	4822 124 11162
C2531	CAP.CHIP	63V	10%	220NF	4822 122 32916
C2532	CAP.ELECTROLYT.	16V	20%	68UF	4822 124 11162

Item	Description				Ordering code
C2533	CAP.CHIP	63V	10%	2.2NF	4822 122 33127
C2534	CAP.CHIP	63V	10%	22NF	5322 122 32654
C2536	CAP.FOIL		20%	470UF	5322 121 43885
C2537	CAP.CERAMIC	63V	10%	68NF	4822 122 32891
C2538	CAP.CHIP	63V	10%	22NF	5322 122 32654
C2539	CAP.CHIP	63V	10%	22NF	5322 122 32654
C2540	CAP.CHIP	63V	10%	22NF	5322 122 32654
C2541	CAP.CHIP	63V	10%	22NF	5322 122 32654
C2542	CAP.CHIP	63V	10%	10NF	5322 122 34098
C2543	CAP.CHIP	63V	10%	10NF	5322 122 34098
C2544	CAP.CERAMIC	63V	5%	120PF	5322 122 33861
C2545	CAP.CHIP	63V	10%	22NF	5322 122 32654
C2546	CAP.CHIP	63V	10%	22NF	5322 122 32654
C2547	CAP.ELECTROLYT.	16V	20%	68UF	4822 124 11162
C2548	CAP.CHIP	63V	10%	22NF	5322 122 32654
C2549	CAP.ELECTROLYT.	16V	20%	68UF	4822 124 11162
C2551	CAP.CHIP	63V	10%	22NF	5322 122 32654
C2552	CAP.ELECTROLYT.		20%	3900UF	5322 124 42329
C2701	CAP.CHIP	63V	10%	10NF	5322 122 34098
C2703	CAP.CHIP	63V	10%	10NF	5322 122 34098
C2706	CAP.CERAMIC	63V	5%	10PF	5322 122 32448
C2707	CAP.CHIP	63V	10%	22NF	5322 122 32654
C2750	CAP.CERAMIC	3KV	10%	22PF	5322 126 13331
C2752	CAP.CHIP	63V	10%	22NF	5322 122 32654
C2753	CAP.CHIP	63V	10%	2.2NF	4822 122 33127
C2754	CAP.CHIP	63V	10%	2.2NF	4822 122 33127
C2756	CAP.CHIP	63V	10%	22NF	5322 122 32654
C2757	CAP.CHIP	63V	10%	2.2NF	4822 122 33127
C2758	CAP.CHIP	63V	10%	2.2NF	4822 122 33127
C2759	CAP.CHIP	63V	10%	2.2NF	4822 122 33127
C2760	CAP.CHIP	63V	10%	2.2NF	4822 122 33127
C2761	CAP.CHIP	63V	10%	2.2NF	4822 122 33127
C2762	CAP.CHIP	63V	10%	2.2NF	4822 122 33127
C2763	CAP.CHIP	63V	10%	2.2NF	4822 122 33127
C2804	CAP.CHIP	63V	10%	10NF	5322 122 34098
C2806	CAP.CHIP	63V	10%	10NF	5322 122 34098
C2850	CAP.CERAMIC	63V	5%	3.3NF	5322 122 33897
C2851	CAP.CERAMIC	63V	5%	3.3NF	5322 122 33897
C2852	CAP.CERAMIC	63V	5%	3.3NF	5322 122 33897
C2853	CAP.CHIP	63V	5%	2.2NF	5322 126 13457
C2854	CAP.CHIP	63V	5%	680PF	5322 126 10733
C2856	CAP.CHIP	63V	5%	270PF	4822 122 33216
C2857	CAP.CERAMIC	63V	5%	47PF	5322 122 32452
C2861	CAP.CHIP	63V	10%	10NF	5322 122 34098
C2862	CAP.CHIP	63V	10%	10NF	5322 122 34098
C2863	CAP.CERAMIC	63V	5%	47PF	5322 122 32452
C2864	CAP.CHIP	63V	10%	10NF	5322 122 34098

Item	Description				Ordering code
C2866	CAP.CHIP	63V	10%	2.2NF	4822 122 33127
C2867	CAP.CHIP	63V	10%	2.2NF	4822 122 33127
C2868	CAP.CHIP	63V	10%	2.2NF	4822 122 33127
C2901	CAP.CHIP	63V	10%	10NF	5322 122 34098

DIGITAL INTEGRATED CIRCUITS

D2101	I.C. INTERFACE	74HC4316D		PEL	4822 209 63764
D2102	I.C. INTERFACE	74HC4316D		PEL	4822 209 63764
D2201	I.C. INTERFACE	74HC4316D		PEL	4822 209 63764
D2202	I.C. INTERFACE	74HC4316D		PEL	4822 209 63764
D2302	INTEGR.CIRCUIT	A.ASIC OQ0259			5322 209 90317
D2750	I.C. INTERFACE	74HC4316D		PEL	4822 209 63764
D2751	I.C. INTERFACE	74HC4316D		PEL	4822 209 63764
D2850	I.C. INTERFACE	74HC4316D		PEL	4822 209 63764
D2901	I.C. INTERFACE	74HC541D		PEL	4822 209 63763
D2902	I.C. INTERFACE	74HC541D		PEL	4822 209 63763
D2903	I.C. INTERFACE	74HC541D		PEL	4822 209 63763
D2904	INTEGR.CIRCUIT	74HC4094D		PEL	5322 209 12171
D2906	INTEGR.CIRCUIT	74HC4094D		PEL	5322 209 12171
D2907	INTEGR.CIRCUIT	74HC4094D		PEL	5322 209 12171
D2908	INTEGR.CIRCUIT	74HC4094D		PEL	5322 209 12171
D2909	INTEGR.CIRCUIT	74HC4094D		PEL	5322 209 12171

BUZZER

H2901	BUZZER	-12B-12			5322 280 10245

RELAYS

K2101	RELAY	RAL3W-K			5322 280 80745
K2102	RELAY	RAL3W-K			5322 280 80745
K2103	RELAY	RAL3W-K			5322 280 80745
K2201	RELAY	RAL3W-K			5322 280 80745
K2202	RELAY	RAL3W-K			5322 280 80745
K2203	RELAY	RAL3W-K			5322 280 80745
K2750	RELAY	RAL3W-K			5322 280 80745
K2751	RELAY	RAL3W-K			5322 280 80745

COILS

L2501	COIL	1UH	5%	TDK	5322 157 63648
L2502	COIL	68UH		TDK	5322 157 63092
L2503	COIL	68UH		TDK	5322 157 63092
L2504	COIL	22UH		TDK	5322 157 52707
L2506	COIL	22UH		TDK	5322 157 52707

ANALOG INTEGRATED CIRCUITS

Item	Description				Ordering code
N2101	INTEGR.CIRCUIT	LF453CM		NSC	4822 209 63757
N2201	INTEGR.CIRCUIT	LF453CM		NSC	4822 209 63757
N2302	INTEGR.CIRCUIT	TDA8703T/C4		PEL	5322 209 30676
N2501	INTEGR.CIRCUIT	LM358M		NSC	4822 209 60175
N2502	INTEGR.CIRCUIT	LM285M-1.2		NSC	4822 209 63765
N2503	INTEGR.CIRCUIT	SG3524D		PEL	5322 209 71807
N2750	INTEGR.CIRCUIT	C27M2ACDR			5322 209 31309
N2751	INTEGR.CIRCUIT	C27M2ACDR			5322 209 31309
N2850	INTEGR.CIRCUIT	LF453CM		NSC	4822 209 63757

RESISTORS

Item	Description				Ordering code
R2101	RES.METAL FILM	D25	1%	51E1	5322 117 11737
R2103	RES.CHIP	RRC-02H	1%	100K	4822 051 10104
R2104	RES.METAL FILM	D25	1%	10E	5322 117 11733
R2105	RES.METAL FILM	D25	1%	21E5	5322 117 11734
R2106	RES.CHIP	RC-02H	1%	121E	4822 051 51211
R2107	RES.METAL FILM	D25	1%	51E1	5322 117 11737
R2108	RES.CHIP	RC-02H	1%	100E	4822 051 10101
R2109	RES.METAL FILM	D25	1%	46E4	5322 117 11736
R2110	RES.METAL FILM	D25	1%	21E5	5322 117 11734
R2111	RES.METAL FILM	RC-02H	1%	3K83	5322 117 10561
R2112	RES.CHIP	RC-01	5%	10M	4822 051 10106
R2113	RES.CHIP	RC-01	5%	10M	4822 051 10106
R2114	RES.CHIP	RC-01	5%	10M	4822 051 10106
R2115	RES.CHIP	RC-02H	1%	1K33	4822 051 51332
R2116	RES.METAL FILM	D25	1%	75E	5322 117 11741
R2117	RES.METAL FILM	D25	1%	51E1	5322 117 11737
R2118	RES.METAL FILM	RC-02H	1%	34K8	5322 117 10558
R2119	RES.METAL FILM	ST MRS25	1%	953K	4822 050 29534
R2120	RES.CHIP	RC-01	5%	10M	4822 051 10106
R2121	RES.CHIP	RC-02H	1%	1M	4822 051 10105
R2122	RES.CHIP	RC-02H	1%	10K	4822 051 10103
R2123	RES.CHIP	RC-02H	1%	1M	4822 051 10105
R2124	RES.METAL FILM	D25	1%	51E1	5322 117 11737
R2125	RES.METAL FILM	RC-02H	1%	19K6	5322 117 10541
R2126	RES.CHIP	RC-02H	1%	100K	4822 051 10104
R2127	RES.CHIP	RC-02H	1%	11K	4822 051 10113
R2128	RES.CHIP	RC-02H	1%	1M	4822 051 10105
R2129	RES.METAL FILM	RC-02H	1%	681E	5322 117 10579
R2130	RES.CHIP	RC-02H	1%	100K	4822 051 10104
R2131	RES.CHIP	RC-02H	1%	147K	4822 051 51474
R2132	RES.METAL FILM	RC-02H	1%	75K	5322 117 10584
R2133	RES.METAL FILM	RC-02H	1%	3K83	5322 117 10561
R2134	RES.METAL FILM	RC-02H	1%	7K5	5322 117 10583
R2135	RES.METAL FILM	D25	1%	51E1	5322 117 11737
R2136	RES.METAL FILM	RC-02H	1%	750E	5322 117 10582

Item	Description				Ordering code
R2137	RES.METAL FILM	RC-02H	1%	215K	5322 117 10543
R2138	RES.CHIP	RC-02H	1%	1K	4822 051 10102
R2139	RES.CHIP	RC-02H	1%	10K	4822 051 10103
R2140	RES.METAL FILM	D25	1%	51E1	5322 117 11737
R2141	RES.CHIP	RC-02H	1%	10K	4822 051 10103
R2142	RES.CHIP	RC-02H	1%	178E	4822 051 51781
R2143	RES.METAL FILM	RC-02H	1%	3K48	5322 117 10557
R2144	RES.CHIP	RC-02H	1%	121E	4822 051 51211
R2145	RES.METAL FILM	RC-02H	1%	3K83	5322 117 10561
R2146	RES.METAL FILM	RC-02H	1%	3K83	5322 117 10561
R2147	RES.CHIP	RC-02H	1%	147K	4822 051 51474
R2148	RES.METAL FILM	RC-02H	1%	464K	5322 117 10568
R2149	RES.METAL FILM	D25	1%	51E1	5322 117 11737
R2150	RES.METAL FILM	D25	1%	10E	5322 117 11733
R2151	RES.METAL FILM	RC-02H	1%	61K9	5322 117 10578
R2152	RES.METAL FILM	RC-02H	1%	75K	5322 117 10584
R2153	RES.METAL FILM	RC-02H	1%	75K	5322 117 10584
R2154	RES.CHIP	RC-02H	1%	10K	4822 051 10103
R2155	RES.CHIP	RC-02H	1%	1M	4822 051 10105
R2156	RES.P.T.C.	DISK	600V	1K1	5322 116 40232
R2157	RES.METAL FILM	RC-02H	1%	31K6	5322 117 10554
R2158	RES.CHIP	RC-02H	1%	51K1	4822 051 55113
R2159	RES.CHIP	RC-02H	1%	100K	4822 051 10104
R2160	RES.METAL FILM	RC-02H	1%	511E	5322 117 10569
R2161	RES.CHIP	RC-02H	1%	2K15	5322 117 10485
R2162	RES.METAL FILM	RC-02H	1%	215K	5322 117 10543
R2163	RES.METAL FILM	RC-02H	1%	464K	5322 117 10568
R2164	RES.METAL FILM	RC-02H	1%	825K	5322 117 10587
R2165	RES.CHIP	RC-01	5%	1E	4822 051 10108
R2166	RES.METAL FILM	D25	1%	68E1	5322 117 11739
R2167	RES.CHIP	RC-02H	1%	1M	4822 051 10105
R2168	RES.CHIP	RC-02H	1%	11K	4822 051 10113
R2169	RES.METAL FILM	RC-02H	1%	31K6	5322 117 10554
R2170	RES.METAL FILM	RC-02H	1%	3K83	5322 117 10561
R2171	RES.CHIP	RC-02H	1%	100E	4822 051 10101
R2172	RES.CHIP	RC-02H	1%	2K15	5322 117 10485
R2175	RES.METAL FILM	RC-02H	1%	383K	5322 117 10563
R2176	RES.P.T.C.	DISK	600V	1K1	5322 116 40232
R2177	RES.METAL FILM	D25	1%	21E5	5322 117 11734
R2201	RES.METAL FILM	D25	1%	51E1	5322 117 11737
R2203	RES.CHIP	RC-02H	1%	100K	4822 051 10104
R2204	RES.METAL FILM	D25	1%	10E	5322 117 11733
R2205	RES.METAL FILM	D25	1%	21E5	5322 117 11734
R2206	RES.CHIP	RC-02H	1%	121E	4822 051 51211
R2207	RES.METAL FILM	D25	1%	51E1	5322 117 11737
R2208	RES.CHIP	RC-02H	1%	100E	4822 051 10101
R2209	RES.METAL FILM	D25	1%	46E4	5322 117 11736

Item	Description				Ordering code
R2210	RES.METAL FILM	D25	1%	21E5	5322 117 11734
R2211	RES.METAL FILM	RC-02H	1%	3K83	5322 117 10561
R2212	RES.CHIP	RC-01	5%	10M	4822 051 10106
R2213	RES.CHIP	RC-01	5%	10M	4822 051 10106
R2214	RES.CHIP	RC-01	5%	10M	4822 051 10106
R2215	RES.CHIP	RC-02H	1%	1K33	4822 051 51332
R2216	RES.METAL FILM	D25	1%	75E	5322 117 11741
R2217	RES.METAL FILM	D25	1%	51E1	5322 117 11737
R2218	RES.METAL FILM	RC-02H	1%	34K8	5322 117 10558
R2219	RES.METAL FILM	ST MRS25	1%	953K	4822 050 29534
R2220	RES.CHIP	RC-01	5%	10M	4822 051 10106
R2221	RES.CHIP	RC-02H	1%	1M	4822 051 10105
R2222	RES.CHIP	RC-02H	1%	10K	4822 051 10103
R2223	RES.CHIP	RC-02H	1%	1M	4822 051 10105
R2224	RES.METAL FILM	D25	1%	51E1	5322 117 11737
R2225	RES.METAL FILM	RC-02H	1%	19K6	5322 117 10541
R2226	RES.CHIP	RC-02H	1%	100K	4822 051 10104
R2227	RES.CHIP	RC-02H	1%	11K	4822 051 10113
R2228	RES.CHIP	RC-02H	1%	1M	4822 051 10105
R2229	RES.METAL FILM	RC-02H	1%	681E	5322 117 10579
R2230	RES.CHIP	RC-02H	1%	100K	4822 051 10104
R2231	RES.CHIP	RC-02H	1%	147K	4822 051 51474
R2232	RES.METAL FILM	RC-02H	1%	75K	5322 117 10584
R2233	RES.METAL FILM	RC-02H	1%	3K83	5322 117 10561
R2234	RES.METAL FILM	RC-02H	1%	7K5	5322 117 10583
R2235	RES.METAL FILM	D25	1%	51E1	5322 117 11737
R2236	RES.METAL FILM	RC-02H	1%	750E	5322 117 10582
R2237	RES.METAL FILM	RC-02H	1%	215K	5322 117 10543
R2238	RES.CHIP	RC-02H	1%	1K	4822 051 10102
R2239	RES.CHIP	RC-02H	1%	10K	4822 051 10103
R2304	RES.METAL FILM	RC-02H	1%	511K	5322 117 10571
R2305	RES.CHIP	RC-01	5%	1E	4822 051 10108
R2306	RES.CHIP	RC-01	5%	1E	4822 051 10108
R2307	RES.CHIP	RC-01	5%	1E	4822 051 10108
R2308	RES.METAL FILM	RC-02H	1%	75K	5322 117 10584
R2309	RES.METAL FILM	RC-02H	1%	75K	5322 117 10584
R2310	RES.METAL FILM	RC-02H	1%	2K87	5322 117 10549
R2313	RES.CHIP	RC-01	5%	1E	4822 051 10108
R2315	RES.CHIP	RC-02H	1%	100E	4822 051 10101
R2316	RES.CHIP	RC-02H	1%	100K	4822 051 10104
R2317	RES.CHIP	RC-02H	1%	100K	4822 051 10104
R2319	RES.METAL FILM	RC-02H	1%	750E	5322 117 10582
R2320	RES.CHIP	RC-02H	1%	51K1	4822 051 55113
R2321	RES.METAL FILM	RC-02H	1%	316K	5322 117 10555
R2322	RES.METAL FILM	RC-02H	1%	31K6	5322 117 10554
R2330	RES.METAL FILM	D25	1%	56E2	5322 117 11738
R2331	RES.METAL FILM	D25	1%	56E2	5322 117 11738

Item	Description				Ordering code
R2332	RES.METAL FILM	D25	1%	56E2	5322 117 11738
R2333	RES.METAL FILM	D25	1%	56E2	5322 117 11738
R2334	RES.METAL FILM	D25	1%	56E2	5322 117 11738
R2335	RES.METAL FILM	D25	1%	56E2	5322 117 11738
R2336	RES.METAL FILM	D25	1%	56E2	5322 117 11738
R2337	RES.METAL FILM	D25	1%	56E2	5322 117 11738
R2345	RES.CHIP	RC-02H	1%	100K	4822 051 10104
R2346	POTM.TRIMMER	POTM RVG4	25%	10K	5322 100 12194
R2347	POTM.TRIMMER	POTM RVG4	25%	10K	5322 100 12194
R2351	RES.CHIP	RC-02H	1%	121K	4822 051 51214
R2352	RES.CHIP	RC-02H	1%	1K	4822 051 10102
R2353	RES.CHIP	RC-02H	1%	2K15	5322 117 10485
R2354	RES.METAL FILM	RC-02H	1%	3K16	5322 117 10553
R2355	RES.METAL FILM	D25	1%	75E	5322 117 11741
R2356	RES.CHIP	RC-02H	1%	1K	4822 051 10102
R2357	RES.METAL FILM	D25	1%	56E2	5322 117 11738
R2358	RES.CHIP	RC-02H	1%	1K	4822 051 10102
R2359	RES.METAL FILM	D25	1%	31E6	5322 117 11732
R2360	RES.METAL FILM	RC-02H	1%	4K22	5322 117 10565
R2361	RES.METAL FILM	RC-02H	1%	511E	5322 117 10569
R2362	RES.METAL FILM	RC-02H	1%	4K22	5322 117 10565
R2363	RES.METAL FILM	RC-02H	1%	511E	5322 117 10569
R2364	RES.METAL FILM	D25	1%	31E6	5322 117 11732
R2501	RES.METAL FILM	RC-02H	1%	511E	5322 117 10569
R2502	RES.METAL FILM	RC-02H	1%	511E	5322 117 10569
R2503	RES.CHIP	RC-01	5%	1E	4822 051 10108
R2504	RES.CHIP	RC-02H	1%	11K	4822 051 10113
R2506	RES.METAL FILM	D25	1%	10E	5322 117 11733
R2507	RES.METAL FILM	D25	1%	34E8	5322 117 11735
R2508	RES.METAL FILM	D25	1%	51E1	5322 117 11737
R2509	RES.CHIP	RC-01	5%	1E	4822 051 10108
R2511	RES.CHIP	RC-01	5%	1E	4822 051 10108
R2512	RES.CHIP	RC-01	5%	1E	4822 051 10108
R2513	RES.CHIP	RC-01	5%	1E	4822 051 10108
R2514	RES.CHIP	RC-01	5%	1E	4822 051 10108
R2516	RES.CHIP	RC-01	5%	1E	4822 051 10108
R2517	RES.CHIP	RC-01	5%	1E	4822 051 10108
R2518	RES.CHIP	RC-01	5%	1E	4822 051 10108
R2519	RES.CHIP	RC-01	5%	10M	4822 051 10106
R2521	RES.CHIP	RC-01	5%	10M	4822 051 10106
R2522	RES.CHIP	RC-02H	1%	11K	4822 051 10113
R2523	RES.METAL FILM	RC-02H	1%	3K16	5322 117 10553
R2524	RES.CHIP	RC-02H	1%	178E	4822 051 51781
R2526	RES.METAL FILM	RC-02H	1%	34K8	5322 117 10558
R2527	RES.CHIP	RC-02H	1%	2K15	5322 117 10485
R2528	RES.CHIP	RC-02H	1%	11K	4822 051 10113
R2529	RES.CHIP	RC-02H	1%	121E	4822 051 51211

Item	Description				Ordering code
R2530	RES.CHIP	RC-02H	1%	5K11	5322 117 10487
R2531	RES.CHIP	RC-01	5%	1E	4822 051 10108
R2532	RES.METAL FILM	D25	1%	10E	5322 117 11733
R2534	RES.METAL FILM	RC-02H	1%	19K6	5322 117 10541
R2535	RES.CHIP	RC-02H	1%	51K1	4822 051 55113
R2536	RES.CHIP	RC-02H	1%	1K	4822 051 10102
R2537	RES.METAL FILM	RC-02H	1%	34K8	5322 117 10558
R2538	RES.METAL FILM	RC-02H	1%	3K16	5322 117 10553
R2540	RES.METAL FILM	RC-02H	1%	3K16	5322 117 10553
R2541	RES.CHIP	RC-02H	1%	11K	4822 051 10113
R2542	RES.METAL FILM	D25	1%	10E	5322 117 11733
R2543	RES.CHIP	RC-02H	1%	5K11	5322 117 10487
R2544	RES.METAL FILM	RC-02H	1%	34K8	5322 117 10558
R2546	RES.CHIP	RC-02H	1%	121E	4822 051 51211
R2548	RES.CHIP	RC-02H	1%	14K7	4822 051 51473
R2551	RES.CHIP	RC-02H	1%	11K	4822 051 10113
R2554	RES.CHIP	RC-02H	1%	1K33	4822 051 51332
R2556	RES.METAL FILM	RC-02H	1%	5K62	5322 117 10573
R2557	RES.CHIP	RC-02H	1%	2K15	5322 117 10485
R2558	RES.CHIP	RC-02H	1%	2K15	5322 117 10485
R2559	RES.CHIP	RC-02H	1%	2K15	5322 117 10485
R2561	RES.METAL FILM	RC-02H	1%	215K	5322 117 10543
R2562	RES.CHIP	RC-02H	1%	11K	4822 051 10113
R2563	RES.METAL FILM	D25	1%	10E	5322 117 11733
R2564	RES.METAL FILM	RC-02H	1%	7K5	5322 117 10583
R2565	RES.METAL FILM	D25	1%	51E1	5322 117 11737
R2566	RES.METAL FILM	RC-02H	1%	34K8	5322 117 10558
R2567	RES.METAL FILM	RC-02H	1%	34K8	5322 117 10558
R2568	RES.METAL FILM	RC-02H	1%	215K	5322 117 10543
R2569	RES.METAL FILM	RC-02H	1%	215K	5322 117 10543
R2571	RES.CHIP	RC-01	5%	1E	4822 051 10108
R2572	RES.CHIP	RC-02H	1%	100K	4822 051 10104
R2573	RES.METAL FILM	RC-02H	1%	215K	5322 117 10543
R2575	RES.CHIP	RC-02H	1%	51K1	4822 051 55113
R2581	RES.CHIP	RC-02H	1%	100K	4822 051 10104
R2582	RES.	2W SMW02	5%	0E1	5322 113 41318
R2583	RES.CHIP	RC-01	5%	1E	4822 051 10108
R2584	RES.METAL FILM	D25	1%	10E	5322 117 11733
R2596	RES.METAL FILM	RC-02H	1%	19K6	5322 117 10541
R2597	RES.METAL FILM	RC-02H	1%	19K6	5322 117 10541
R2598	RES.CHIP	RC-02H	1%	100K	4822 051 10104
R2599	RES.METAL FILM	RC-02H	1%	19K6	5322 117 10541
R2729	RES.METAL FILM	RC-02H	1%	61K9	5322 117 10578
R2750	RES.N.T.C.	DISC SPEC			5322 116 40214
R2753	RES.METAL FILM	VR25	487K	1%	5322 116 82905
R2754	RES.METAL FILM	RC-02H	1%	511K	5322 117 10571
R2755	RES.CHIP	RC-02H	1%	1K	4822 051 10102

Item	Description				Ordering code
R2757	RES.METAL FILM	RC-02H	1%	34K8	5322 117 10558
R2758	RES.CHIP	RC-02H	1%	10K	4822 051 10103
R2759	RES.CHIP	RC-02H	1%	261E	4822 051 52611
R2760	RES.METAL FILM	D25	1%	68E1	5322 117 11739
R2761	RES.METAL FILM	RC-02H	1%	215K	5322 117 10543
R2762	RES.CHIP	RC-02H	1%	1M	4822 051 10105
R2763	RES.CHIP	RC-01	5%	10M	4822 051 10106
R2764	RES.CHIP	RC-02H	1%	68K1	4822 051 56813
R2765	RES.CHIP	RC-02H	1%	10K	4822 051 10103
R2766	RES.METAL FILM	RC-02H	1%	19K6	5322 117 10541
R2767	RES.CHIP	RC-02H	1%	5K11	5322 117 10487
R2768	RES.METAL FILM	RC-02H	1%	237K	5322 117 11742
R2769	RES.CHIP	RC-02H	1%	147K	4822 051 51474
R2770	RES.METAL FILM	RC-02H	1%	34K8	5322 117 10558
R2771	RES.CHIP	RC-02H	1%	100K	4822 051 10104
R2772	RES.CHIP	RC-02H	1%	100K	4822 051 10104
R2773	RES.CHIP	RC-02H	1%	1K	4822 051 10102
R2774	RES.CHIP	RC-02H	1%	1K	4822 051 10102
R2775	RES.METAL FILM	RC-02H	1%	3K48	5322 117 10557
R2776	RES.METAL FILM	RC-02H	1%	34K8	5322 117 10558
R2777	RES.METAL FILM	D25	1%	51E1	5322 117 11737
R2778	RES.METAL FILM	RST VR25	487K	1%	5322 116 82905
R2853	RES.METAL FILM	RC-02H	1%	31K6	5322 117 10554
R2854	RES.METAL FILM	RC-02H	1%	31K6	5322 117 10554
R2856	RES.CHIP	RC-02H	1%	68K1	4822 051 56813
R2857	RES.CHIP	RC-02H	1%	68K1	4822 051 56813
R2858	RES.CHIP	RC-02H	1%	2K15	5322 117 10485
R2859	RES.METAL FILM	RC-02H	1%	75K	5322 117 10584
R2860	RES.CHIP	RC-01	5%	10M	4822 051 10106
R2861	RES.METAL FILM	RC-02H	1%	237K	5322 117 11742
R2862	RES.METAL FILM	RC-02H	1%	562K	5322 117 10575
R2863	RES.METAL FILM	RC-02H	1%	3K48	5322 117 10557
R2864	RES.METAL FILM	RC-02H	1%	34K8	5322 117 10558
R2865	RES.METAL FILM	RC-02H	1%	34K8	5322 117 10558
R2866	RES.CHIP	RC-02H	1%	121E	4822 051 51211
R2867	RES.METAL FILM	RC-02H	1%	34K8	5322 117 10558
R2868	RES.METAL FILM	RC-02H	1%	34K8	5322 117 10558
R2869	RES.METAL FILM	RC-02H	1%	34K8	5322 117 10558
R2870	RES.MET.GLAZED	RC-02H	1%	261K	5322 117 10853
R2871	RES.METAL FILM	RC-02H	1%	464K	5322 117 10568
R2872	RES.METAL FILM	RC-02H	1%	464K	5322 117 10568
R2873	RES.MET.GLAZED	RC-02H	1%	261K	5322 117 10853
R2875	RES.METAL FILM	RC-02H	1%	215K	5322 117 10543
R2876	RES.METAL FILM	RC-02H	1%	316K	5322 117 10555
R2877	RES.METAL FILM	RC-02H	1%	215K	5322 117 10543
R2878	RES.CHIP	RC-02H	1%	51K1	4822 051 55113
R2879	RES.METAL FILM	RC-02H	1%	19K6	5322 117 10541

Item	Description				Ordering code
R2881	RES.CHIP	RC-02H	1%	261E	4822 051 52611
R2901	RES.METAL FILM	RC-02H	1%	19K6	5322 117 10541
R2903	RES.CHIP	RC-02H	1%	147K	4822 051 51474
R2904	RES.METAL FILM	RC-02H	1%	31K6	5322 117 10554
R2906	RES.METAL FILM	RC-02H	1%	31K6	5322 117 10554
R2907	RES.METAL FILM	RC-02H	1%	34K8	5322 117 10558
R2908	RES.METAL FILM	RC-02H	1%	31K6	5322 117 10554
R2909	RES.METAL FILM	RC-02H	1%	31K6	5322 117 10554

TRANSFORMER

T2501	TRANSF,MAINS	TRAFO			5322 146 21674

DIODES/TRANSISTORS

V2104	TRANSISTOR,CHIP	BFR92	PEL		5322 130 42145
V2105	TRANSISTOR,CHIP	BFR31	PEL		5322 130 44787
V2106	TRANSISTOR,CHIP	BFR92	PEL		5322 130 42145
V2107	TRANSISTOR	BF991	PEL		5322 130 61707
V2108	TRANSISTOR,CHIP	BFS20	PEL		5322 130 42718
V2109	TRANSISTOR,CHIP	BFR92	PEL		5322 130 42145
V2110	TRANSISTOR,CHIP	BC848C	PEL		5322 130 42136
V2111	TRANSISTOR,CHIP	BFR92	PEL		5322 130 42145
V2112	TRANSISTOR,CHIP	BC848C	PEL		5322 130 42136
V2113	TRANSISTOR,CHIP	BC848C	PEL		5322 130 42136
V2114	TRANSISTOR,CHIP	BFR92	PEL		5322 130 42145
V2204	TRANSISTOR,CHIP	BFR92	PEL		5322 130 42145
V2205	TRANSISTOR,CHIP	BFR31	PEL		5322 130 44787
V2206	TRANSISTOR,CHIP	BFR92	PEL		5322 130 42145
V2207	TRANSISTOR	BF991	PEL		5322 130 61707
V2208	TRANSISTOR,CHIP	BFS20	PEL		5322 130 42718
V2209	TRANSISTOR,CHIP	BFR92	PEL		5322 130 42145
V2210	TRANSISTOR,CHIP	BC848C	PEL		5322 130 42136
V2211	TRANSISTOR,CHIP	BFR92	PEL		5322 130 42145
V2212	TRANSISTOR,CHIP	BC848C	PEL		5322 130 42136
V2213	TRANSISTOR,CHIP	BC848C	PEL		5322 130 42136
V2214	TRANSISTOR,CHIP	BFR92	PEL		5322 130 42145
V2304	TRANSISTOR,CHIP	BC848C	PEL		5322 130 42136
V2305	TRANSISTOR,CHIP	BFR92	PEL		5322 130 42145
V2306	TRANSISTOR,CHIP	BFR92	PEL		5322 130 42145
V2501	DIODE,CHIP	BAV99	PEL		5322 130 34337
V2502	TRANSISTOR,CHIP	BRY62	PEL		5322 130 62661
V2503	TRANSISTOR,FET	BUZ11A	SIE		5322 130 62659
V2504	DIODE,CHIP	BAV99	PEL		5322 130 34337
V2506	RECTIFIER	MBRD630CTT4	MOT		5322 130 62922
V2507	RECTIFIER	MBRD630CTT4	MOT		5322 130 62922
V2508	DIODE,CHIP	BAV99	PEL		5322 130 34337
V2509	TRANSISTOR,CHIP	BC848C	PEL		5322 130 42136

Item	Description			Ordering code
V2511	TRANSISTOR,CHIP	BC858C	PEL	4822 130 42513
V2512	DIODE,CHIP	BAV99	PEL	5322 130 34337
V2513	TRANSISTOR,CHIP	BC858C	PEL	4822 130 42513
V2514	DIODE,CHIP	BAV99	PEL	5322 130 34337
V2516	TRANSISTOR,CHIP	BC858C	PEL	4822 130 42513
V2517	TRANSISTOR,CHIP	BC848C	PEL	5322 130 42136
V2518	TRANSISTOR,CHIP	BF821	PEL	4822 130 61923
V2521	TRANSISTOR,CHIP	BC848C	PEL	5322 130 42136
V2523	DIODE,CHIP	BAV99	PEL	5322 130 34337
V2526	TRANSISTOR,CHIP	BC817	PEL	4822 130 42133
V2527	DIODE,CHIP	BAV99	PEL	5322 130 34337
V2528	TRANSISTOR,CHIP	BC848C	PEL	5322 130 42136
V2529	DIODE,CHIP	BAV99	PEL	5322 130 34337
V2532	TRANSISTOR,FET	FET BUZ11A	SIE	5322 130 62659
V2533	RECTIFIER	MBRD630CTT4	MOT	5322 130 62922
V2534	TRANSISTOR,CHIP	BC848C	PEL	5322 130 42136
V2536	TRANSISTOR,CHIP	BC848C	PEL	5322 130 42136
V2537	TRANSISTOR	2SK974STR	HIT	5322 130 62921
V2538	TRANSISTOR	2SK974STR	HIT	5322 130 62921
V2539	RECTIFIER	MBRD630CTT4	MOT	5322 130 62922
V2540	TRANSISTOR,CHIP	BC848C	PEL	5322 130 42136
V2541	TRANSISTOR,CHIP	BC848C	PEL	5322 130 42136
V2542	TRANSISTOR,FET	FET BUZ11A	SIE	5322 130 62659
V2543	TRANSISTOR,CHIP	BC848C	PEL	5322 130 42136
V2544	TRANSISTOR,CHIP	BC858C	PEL	4822 130 42513
V2550	DIODE,CHIP	BAV99	PEL	5322 130 34337
V2736	TRANSISTOR,CHIP	BC858C	PEL	4822 130 42513
V2751	DIODE,CHIP	1SMB7.5AT3	MOT	5322 130 83912
V2752	DIODE,CHIP	1SMB7.5AT3	MOT	5322 130 83912
V2753	DIODE,CHIP	1SMB7.5AT3	MOT	5322 130 83912
V2754	TRANSISTOR,CHIP	BFR31	PEL	5322 130 44787
V2755	DIODE,CHIP	1SMB7.5AT3	MOT	5322 130 83912
V2756	TRANSISTOR,CHIP	BFR31	PEL	5322 130 44787
V2757	DIODE,CHIP	BAV99	PEL	5322 130 34337
V2758	TRANSISTOR,CHIP	SFET BSS83	PEL	5322 130 60502
V2759	DIODE,CHIP	BAV99	PEL	5322 130 34337
V2760	TRANSISTOR,CHIP	BC848C	PEL	5322 130 42136
V2761	TRANSISTOR,CHIP	BC848C	PEL	5322 130 42136
V2762	DIODE,CHIP	BAV99	PEL	5322 130 34337
V2763	DIODE,CHIP	BAV99	PEL	5322 130 34337
V2764	DIODE,CHIP	1SMB7.5AT3	MOT	5322 130 83912
V2765	TRANSISTOR,CHIP	BC848C	PEL	5322 130 42136
V2766	TRANSISTOR,CHIP	BC848C	PEL	5322 130 42136
V2767	TRANSISTOR,CHIP	BC848C	PEL	5322 130 42136
V2768	TRANSISTOR,CHIP	BC848C	PEL	5322 130 42136
V2769	DIODE,CHIP	1SMB7.5AT3	MOT	5322 130 83912
V2811	DIODE,CHIP	1SMB7.5AT3	MOT	5322 130 83912

Item	Description			Ordering code
V2812	DIODE,CHIP	1SMB7.5AT3	MOT	5322 130 83912
V2851	TRANSISTOR,CHIP	SFET BSS83	PEL	5322 130 60502
V2852	TRANSISTOR,CHIP	BC858C	PEL	4822 130 42513
V2853	TRANSISTOR,CHIP	BC858C	PEL	4822 130 42513
V2854	TRANSISTOR,CHIP	BC858C	PEL	4822 130 42513
V2901	TRANSISTOR,CHIP	BC858C	PEL	4822 130 42513

CONNECTORS

X2001	CONNECTOR	30-P 1.25MM RECHT		5322 267 70302
X2501	SOCKET	CK HEC0739-01-010		4822 267 30431

EMI-FILTER

Z2501	COIL	50V 10A	MUR	5322 156 11139

8.3 STANDARD KIT ACCESSORY REPLACEMENTS

DESCRIPTION	MODEL - ORDERING CODE	FIGURE	ITEM
Grey Holster	PM9083/011		
NiCad Battery Pack	PM9086/011		
Power Adapter/Battery Charger (four models available:)			
• Universal Europe 220V, 50 Hz	PM8907/001		
• North America 110V, 60 Hz	PM8907/003		
• United Kingdom 240V, 50 Hz	PM8907/004		
• Universal 115V/230V	PM8907/008		
Accessory Case, Soft	C 75		
Probe Set 10:1 probes	PM8918/002	Fig. 8.7	
• 10:1 Probe (Red)	5322 210 70139		Item 1
• 10:1 Probe (Grey)	5322 210 70138		Item 2
• HF Adapter (2 x Black)	5322 263 50193		Item 3
• Adapter Probe Tip to Banana (Red)	5322 264 20096		Item 4
• Adapter Probe Tip to Banana (Grey)	5322 264 20097		Item 5
• High Voltage Testpin (Red)	5322 264 20087		Item 6
• High Voltage Testpin (Grey)	5322 264 20088		Item 7
• Mini Test Hook (Red)	5322 210 70131		Item 8
• Mini Test Hook (Grey)	5322 210 70129		Item 9
• Trim Screwdriver (Red)	5322 395 50417		Item 10
• Trim Screwdriver (Grey)	5322 395 50416		Item 11
Industrial Alligator Clips (1 Red, 1 Grey)	PM9084/001	Fig. 8.9	
Multimeter Test Lead Set	5322 310 32086	Fig. 8.8	
• Test Leads (1 Red, 1 Black)	TL24		Item 1
• Test Pins (1 Red, 1 Black)	TP20		Item 2
• Industrial Alligator Clip (Black)	AC20		Item 3
• Banana Adapter (Red)	5322 264 20051		Item 4
• Banana Adapter (Black)	5322 264 20052		Item 5
Adapter Dual Banana Plug to BNC	PM9081/001	Fig. 8.10	
Product Software			
• SW90D FlukeView™ for DOS			
• SW90W FlukeView™ for Windows			
Probe Accessory set models 92, 96, 99 and 105	PM9094/001		
• Adapter Dual Banana Plug to BNC	PM9081/001	Fig. 8.10	
• HF Adapter (2 x Black)	5322 263 50193	Fig. 8.7	Item 3
• Adapter Probe Tip to Banana (Red)	5322 264 20096	Fig. 8.7	Item 4
• Adapter Probe Tip to Banana (Grey)	5322 264 20097	Fig. 8.7	Item 5
• High Voltage Testpin (Red)	5322 264 20087	Fig. 8.7	Item 6
• High Voltage Testpin (Grey)	5322 264 20088	Fig. 8.7	Item 7
• Mini Test Hook (Red)	5322 210 70131	Fig. 8.7	Item 8
• Mini Test Hook (Grey)	5322 210 70129	Fig. 8.7	Item 9
• Trim Screwdriver (Red)	5322 395 50417	Fig. 8.7	Item 10
• Trim Screwdriver (Grey)	5322 395 50416	Fig. 8.7	Item 11

Demo Board	5322 216 51279
Users Manual (English)	4822 872 00642
Users Manual (German)	4822 872 00643
Users Manual (French)	4822 872 00644
Users Manual (Dutch)	4822 872 00652
Users Manual (Spanish)	4822 872 00645
Users Manual (Italian)	4822 872 00653
Users Manual (Danish)	4822 872 00654
Users Manual (Norwegian)	4822 872 00655
Users Manual (Swedish)	4822 872 00656
Users Manual (Finnish)	4822 872 00657
Users Manual (Chinese)	4822 872 00658
Users Manual (Japanese)	4822 872 00661
Users Manual (Korean)	4822 872 00659
Quick Operating Guide	4822 872 00646

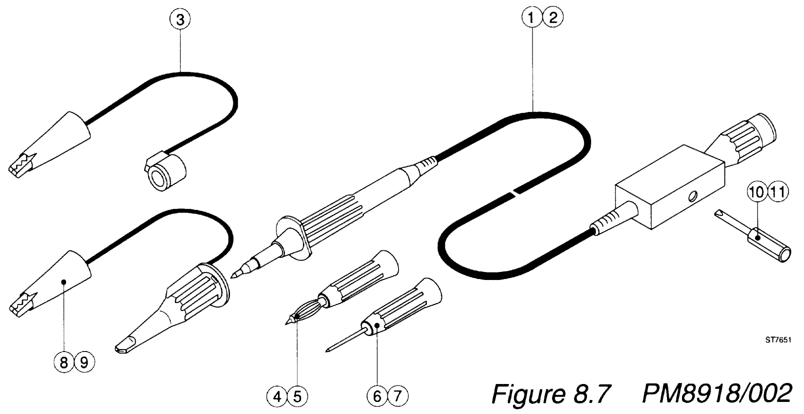


Figure 8.7 PM8918/002

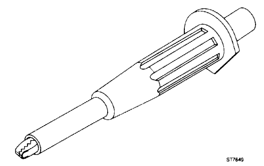


Figure 8.9 PM9084/001

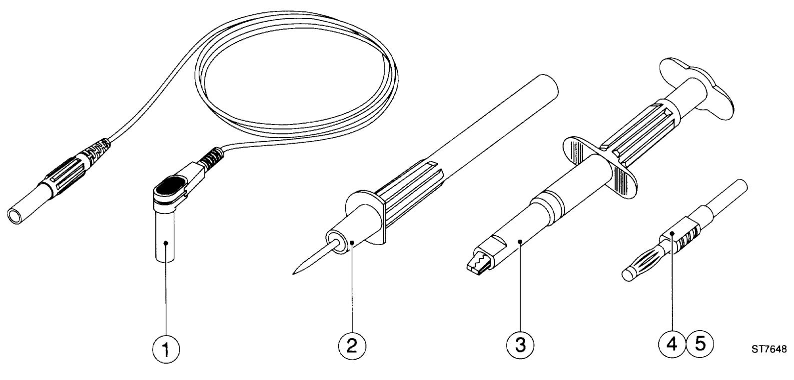


Figure 8.8 Multimeter Test Lead Set

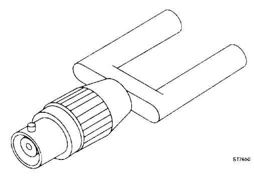


Figure 8.10 PM9081/001

9 CIRCUIT DIAGRAMS

This chapter contains all circuit diagrams and PCB layouts of both the ScopeMeter test tool analog and digital PCBs.

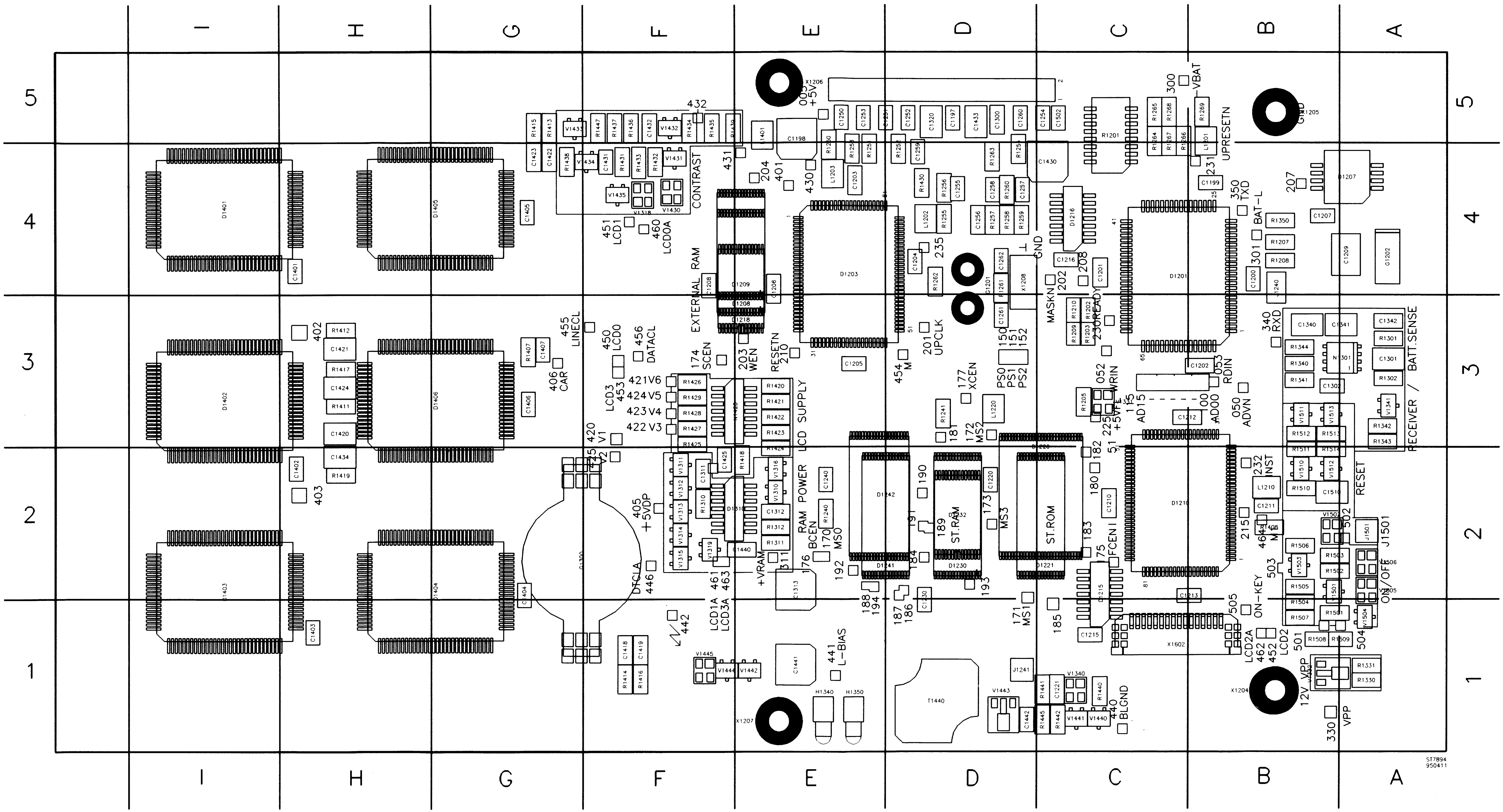


Figure 9.1 Digital A1 PCB

PARTS LOCATION A1 PCB

C1197	D5	C1441	E1	R1310	F2	TP111	C3	TP432	F5
C1198	E5	C1442	D1	R1311	E2	TP112	C3	TP440	C1
C1199	B4	C1502	C5	R1312	E2	TP113	C3	TP441	E1
C1200	B4	C1510	B2	R1330	A1	TP114	C3	TP442	F1
C1201	C4	D1201	C4	R1331	A1	TP115	C3	TP446	F2
C1202	B3	D1203	E4	R1340	B3	TP150	D3	TP450	F3
C1203	E4	D1208	E3	R1341	B3	TP151	D3	TP451	F4
C1204	D4	D1209	E4	R1342	A3	TP152	D3	TP452	B1
C1205	E3	D1210	C2	R1343	A3	TP170	E2	TP453	F3
C1206	E4	D1215	C2	R1344	B3	TP171	D2	TP454	D3
C1208	F4	D1216	C4	R1350	B4	TP172	D3	TP455	F3
C1210	C2	D1218	E4	R1407	G3	TP173	D2	TP456	F3
C1211	B2	D1220	C2	R1420	E3	TP174	F3	TP460	F4
C1212	C3	D1221	D2	R1421	E3	TP175	C2	TP461	F2
C1213	C2	D1230	D2	R1422	E3	TP176	E2	TP462	B1
C1215	C1	D1232	D2	R1423	E3	TP177	D3	TP463	F2
C1216	C4	D1241	E2	R1424	E2	TP180	C2	TP464	B2
C1221	C1	D1242	E2	R1425	F3	TP181	D3	TP501	B1
C1230	D2	D1310	F2	R1426	F3	TP182	C2	TP502	A2
C1240	E2	D1401	I4	R1427	F3	TP183	C2	TP503	B2
C1250	E5	D1402	I3	R1428	F3	TP184	D2	TP504	A1
C1251	E5	D1403	I2	R1429	F3	TP185	C1	TP505	B1
C1252	D5	D1404	H2	R1430	D4	TP186	D2	V1310	E2
C1253	E5	D1405	H4	R1431	F4	TP187	D2	V1311	F2
C1254	C5	D1406	H3	R1432	F4	TP188	E2	V1312	F2
C1256	D4	G1	G2	R1433	F4	TP189	D2	V1313	F2
C1257	D4	G1201	D4	R1434	F5	TP190	D2	V1314	F2
C1258	D4	G1300	G2	R1435	F5	TP191	D2	V1315	F2
C1259	D4	H1340	E1	R1436	F5	TP192	E2	V1316	E2
C1260	D5	H1350	E1	R1437	F5	TP193	D2	V1318	F4
C1261	D3	L1201	B4	R1438	G4	TP194	E2	V1319	F2
C1262	D4	L1202	D4	R1439	F5	TP201	D3	V1331	C3
C1300	D5	L1203	E4	R1440	C1	TP202	C4	V1332	B1
C1301	A3	L1210	B2	R1441	C1	TP203	E3	V1340	C1
C1302	B3	L1220	D3	R1442	C1	TP204	E4	V1341	A3
C1311	F2	L1401	E5	R1445	C1	TP208	C4	V1430	F4
C1312	E2	N1301	B3	R1501	B1	TP210	E3	V1431	F4
C1313	E2	N1420	F3	R1502	B2	TP215	B2	V1432	F5
C1320	D5	R1201	C5	R1503	B2	TP225	C3	V1433	G5
C1340	B3	R1202	C3	R1504	B1	TP230	C3	V1434	G4
C1341	B3	R1209	C3	R1505	B2	TP231	B4	V1435	F4
C1342	A3	R1241	D3	R1506	B2	TP232	B2	V1440	C1
C1401	H4	R1250	E4	R1507	B1	TP235	D4	V1441	C1
C1402	H2	R1251	E4	R1510	B2	TP300	C5	V1442	E1
C1403	H1	R1252	D4	R1511	B3	TP301	B4	V1443	D1
C1404	G2	R1253	E4	R1512	B3	TP310	F2	V1444	F1
C1405	G4	R1254	D4	R1513	B3	TP311	E2	V1445	F1
C1406	G3	R1255	D4	R1514	B2	TP330	B1	V1501	B2
C1407	G3	R1257	D4	T1440	D1	TP340	B3	V1502	B2
C1418	F1	R1258	D4	TP005	E5	TP350	B4	V1503	B2
C1419	F1	R1259	D4	TP050	B3	TP401	E4	V1504	A1
C1420	H3	R1260	D4	TP052	C3	TP402	H3	V1505	A2
C1421	H3	R1261	D4	TP053	B3	TP403	H2	V1506	A2
C1422	G4	R1262	D4	TP100	B3	TP405	F2	V1510	B2
C1423	G4	R1263	D4	TP101	B3	TP406	G3	V1511	B3
C1424	H3	R1264	C5	TP102	B3	TP420	F3	V1512	B2
C1425	F2	R1265	C5	TP103	B3	TP421	F3	V1513	B3
C1430	C4	R1266	C5	TP104	C3	TP422	F3	X1201	D5
C1431	F4	R1267	C5	TP105	C3	TP423	F3	X1602	C1
C1432	F5	R1268	C5	TP106	C3	TP424	F3		
C1433	D5	R1269	B5	TP107	C3	TP425	F2		
C1434	H2	R1301	A3	TP108	C3	TP430	E4		
C1440	E2	R1302	A3	TP109	C3	TP431	E4		

Figure 9.2a Digital A1 circuit diagram (part a)

D1230 - D1218
POSSIBLE RAM TYPES AND PINNING

PIN	HM62256	M5M5256BRV	M5M51008 HM628128
A0	20	10	20
A1	18	9	19
A2	17	8	18
A3	16	7	17
A4	15	6	16
A5	13	5	15
A6	12	4	14
A7	11	3	13
A8	5	25	3
A9	4	24	2
A10	32	21	31
A11	2	23	1
A12	10	2	12
A13	6	26	4
A14	9	1	11
A15	-	-	7
A16	-	-	10
$\overline{WE}$	7	27	5
$\overline{RE}$	1	22	32
$\overline{CE}$	31	20	30
CS	-	-	6
VCC	8	28	8
VSS	24	14	24
D0	21	11	21
D1	22	12	22
D2	23	13	23
D3	25	15	25
D4	26	16	26
D5	27	17	27
D6	28	18	28
D7	29	19	29

Figure 9.2b Digital A1 circuit diagram (part b)

PARTS LOCATION ANALOG BOARD A2

C2105	E4	C2237	D1	C2703	F2	N2850	G1	R2163	C3
C2107	E4	C2239	D2	C2704	E2	R2101	G4	R2164	B3
C2109	E4	C2240	D1	C2705	G4	R2103	F4	R2165	D4
C2114	E3	C2241	D1	C2706	E2	R2104	E4	R2166	D3
C2115	D3	C2242	D1	C2707	F2	R2105	E4	R2167	D3
C2117	E4	C2243	D1	C2751	D2	R2106	E4	R2168	C1
C2118	D3	C2244	D2	C2752	G2	R2107	F4	R2169	B2
C2119	D4	C2245	E2	C2753	G3	R2108	E4	R2170	C2
C2120	D3	C2246	D2	C2754	G3	R2109	E4	R2171	E3
C2121	E5	C2247	E1	C2756	F2	R2110	E4	R2172	D4
C2122	D3	C2248	E1	C2757	E3	R2111	E5	R2175	D4
C2123	D5	C2301	C3	C2758	C4	R2112	D4	R2177	D4
C2124	D4	C2302	C3	C2758	D3	R2113	D4	R2201	G1
C2126	A1	C2303	B1	C2759	E4	R2114	D4	R2203	F1
C2127	E3	C2304	C2	C2760	D3	R2115	E5	R2204	E1
C2128	E4	C2306	C2	C2761	E5	R2116	D4	R2206	E1
C2129	D3	C2307	C2	C2762	E1	R2117	D4	R2207	F2
C2130	D5	C2308	C2	C2763	E1	R2118	E3	R2208	E1
C2131	F5	C2309	C3	C2804	F4	R2120	D3	R2209	E1
C2132	E5	C2310	C2	C2806	F4	R2121	D3	R221	E1
C2133	E5	C2311	C3	C2850	A1	R2122	D3	R2210	E1
C2134	E5	C2311	C3	C2851	C1	R2123	E4	R2212	E1
C2135	D3	C2312	B1	C2852	C1	R2124	D3	R2213	D1
C2136	D4	C2313	C3	C2853	G1	R2125	D4	R2214	D1
C2137	D4	C2314	C1	C2854	G1	R2126	D3	R2215	D2
C2138	E4	C2315	C1	C2856	G1	R2127	E3	R2216	D1
C2139	E3	C2316	C2	C2857	G2	R2128	D3	R2217	D1
C2140	D4	C2317	C1	C2861	F1	R2129	D4	R2218	E2
C2141	C4	C2318	C1	C2862	F1	R2130	E3	R2220	D2
C2144	D3	C2319	C1	C2864	G1	R2131	D5	R2221	D2
C2145	D3	C2323	C1	C2866	E2	R2132	D5	R2222	D2
C2146	D3	C2326	C1	C2867	E1	R2133	D4	R2223	E1
C2147	E4	C2351	C3	C2868	E2	R2134	D4	R2224	E2
C2148	D4	C2502	B2	C2901	A1	R2135	D4	R2225	D1
C2159	C4	C2503	A2	D2101	D3	R2136	D4	R2227	D2
C2205	E1	C2504	B3	D2102	D4	R2137	C3	R2228	D2
C2207	E2	C2511	B3	D2201	D2	R2138	D3	R2229	C1
C2209	E1	C2512	B4	D2202	D1	R2139	D5	R2230	E2
C2214	E2	C2515	A1	D2302	C3	R2140	D5	R2231	D1
C2215	D2	C2522	D1	D2750	F4	R2141	D5	R2232	D1
C2217	E1	C2523	A1	D2751	G2	R2142	D5	R2233	D1
C2218	D2	C2524	A1	D2850	B1	R2143	D4	R2234	D1
C2219	D1	C2527	A3	D2901	C4	R2144	D4	R2235	D1
C2220	D2	C2531	A1	D2902	C3	R2145	D4	R2236	D1
C2221	E1	C2533	A2	D2903	C5	R2146	D4	R2237	D2
C2222	D2	C2534	A3	D2904	B4	R2146	D4	R2238	D2
C2223	D1	C2537	A4	D2906	B3	R2147	D3	R2239	D1
C2224	D2	C2538	A1	D2907	B4	R2148	D3	R2240	D1
C2226	A1	C2539	E3	D2908	B3	R2149	D4	R2241	D1
C2227	D3	C2540	D3	D2909	B1	R2150	D5	R2242	D1
C2228	E1	C2541	E3	L2501	B3	R2151	A1	R2243	D2
C2229	D3	C2542	A1	N2101	D3	R2152	D3	R2244	D2
C2230	D1	C2542	A3	N2201	D2	R2153	E3	R2245	E2
C2231	F1	C2543	A3	N2301	B2	R2154	E3	R2246	D1
C2231	F1	C2544	E3	N2302	C1	R2155	D4	R2247	D2
C2232	E1	C2545	A1	N2501	B3	R2157	E3	R2248	D2
C2233	E1	C2546	A2	N2502	A3	R2158	B4	R2249	D2
C2234	E1	C2548	D5	N2503	A3	R2160	D4	R2250	D1
C2235	D2	C2551	C5	N2750	E3	R2161	B4	R2251	B1
C2236	D2	C2701	F1	N2751	G4	R2162	B4	R2252	D2

R2253	D3	R2354	C3	R2567	B4	R2872	F1	V2528	A4
R2254	D3	R2355	B1	R2568	A4	R2873	F2	V2529	A3
R2255	D1	R2356	B1	R2569	A4	R2875	F1	V2532	A3
R2257	E3	R2357	B1	R2571	A5	R2876	G1	V2533	A4
R2258	B3	R2358	A1	R2572	A1	R2877	G1	V2534	A4
R2259	B3	R2359	B1	R2573	A4	R2878	F1	V2536	B4
R2260	D1	R2360	C2	R2575	A2	R2879	G2	V2537	A5
R2261	B3	R2361	C2	R2580	A5	R2881	G2	V2538	A4
R2262	B3	R2362	C2	R2581	A2	R2901	B2	V2539	A4
R2263	C3	R2363	C2	R2583	C5	R2903	C2	V2540	B4
R2264	B3	R2364	B1	R2584	D5	R2904	C4	V2541	A1
R2265	D2	R2501	B2	R2596	A4	R2906	C4	V2542	A5
R2266	D3	R2503	B2	R2597	B4	R2907	C1	V2543	B4
R2267	D3	R2504	A2	R2598	B5	R2908	C4	V2544	A3
R2268	B1	R2506	A2	R2599	B2	R2909	A1	V2550	A3
R2269	B1	R2507	B2	R2729	G3	V2104	E5	V2736	F2
R2269	B1	R2508	A2	R2754	F2	V2105	D4	V2751	F3
R2270	C1	R2509	A2	R2755	E2	V2106	E4	V2752	F3
R2271	D2	R2511	A2	R2757	B1	V2107	D4	V2753	F3
R2272	D1	R2512	B2	R2758	B1	V2108	D5	V2754	D3
R2273	B3	R2513	B2	R2759	B1	V2109	D4	V2755	F2
R2274	B3	R2514	B2	R2760	F2	V2110	B2	V2756	D3
R2275	D2	R2516	B2	R2760	G3	V2111	D4	V2757	A1
R2277	D1	R2517	A2	R2761	F2	V2112	E3	V2758	D3
R2301	C3	R2518	A2	R2762	E2	V2113	E3	V2759	G4
R2302	C3	R2519	A4	R2763	G2	V2114	D4	V2761	G3
R2303	C2	R2521	A4	R2764	G2	V2204	E1	V2762	G4
R2304	C2	R2522	A3	R2765	G2	V2205	D2	V2763	G4
R2305	C2	R2523	B3	R2766	G2	V2206	E1	V2764	F2
R2306	C2	R2524	B3	R2767	G4	V2207	D1	V2767	F2
R2307	C3	R2526	A3	R2768	G4	V2208	D1	V2768	G3
R2308	B1	R2526	B3	R2769	G4	V2209	D1	V2769	F3
R2309	B1	R2528	B4	R2770	G4	V2210	B1	V2811	C5
R2310	C4	R2529	B3	R2771	G3	V2211	D1	V2812	F4
R2313	C3	R2530	E3	R2772	G3	V2212	E2	V2851	B1
R2315	C2	R2531	C1	R2773	G4	V2213	E2	V2852	E2
R2316	C1	R2532	D1	R2774	G4	V2214	D1	V2853	F2
R2319	B1	R2534	A3	R2775	G4	V2304	C2	V2854	G2
R2320	C2	R2535	A3	R2776	F2	V2305	B1	V2901	B2
R2321	C2	R2536	B3	R2777	F3	V2306	B1		
R2322	C2	R2537	B3	R2853	A1	V2307	C3		
R2324	B2	R2538	E3	R2854	B1	V2501	A1		
R2325	B2	R2540	E3	R2856	A1	V2502	A2		
R2326	B2	R2541	A2	R2857	A1	V2503	A2		
R2328	B2	R2543	B2	R2858	A1	V2504	A2		
R2330	C1	R2544	B2	R2859	C1	V2506	B3		
R2331	C1	R2546	A4	R2860	G1	V2507	B2		
R2332	C1	R2548	A3	R2861	G1	V2508	A2		
R2333	C1	R2551	A2	R2862	G1	V2509	B3		
R2334	C1	R2554	A3	R2863	G2	V2511	B2		
R2335	C1	R2556	A3	R2863	G2	V2512	E3		
R2336	C1	R2557	A3	R2864	G2	V2513	E3		
R2337	C1	R2558	A3	R2865	F2	V2514	B2		
R2345	C2	R2559	A2	R2866	F2	V2516	A2		
R2346	C2	R2561	A3	R2867	E2	V2517	A1		
R2347	C2	R2562	A3	R2868	E2	V2518	A1		
R2350	B1	R2563	A4	R2869	G2	V2521	A2		
R2351	C2	R2564	A3	R2870	G3	V2523	A3		
R2352	C3	R2565	A3	R2870	G3	V2526	A4		
R2353	C3	R2566	B4	R2871	B1	V2527	A3		

PARTS LOCATION A1 CIRCUIT DIAGRAM PART A

C1197	G2
C1198	G2
C1199	H4
C1200	H4
C1201	H5
C1202	H5
C1203	H4
C1204	H4
C1205	H5
C1206	H5
C1208	E7
C1210	I4
C1211	I4
C1212	I5
C1213	I5
C1215	E7
C1216	G3
C1220	H4
C1221	H9
C1230	E8
C1240	H4
C1259	E2
C1260	E2
C1300	D2
C1301	C9
C1302	G3
C1311	F4
C1312	F6
C1313	E6
C1340	A11
C1341	B11
C1342	B10
C1401	I4
C1402	I4
C1403	I5
C1404	I5
C1405	I5
C1406	I6
C1502	B2
C1510	B6
D1201	A16
D1215	B7
D1216	E22
D1220	D25
D1221	B28
D1230	G25
D1232	G2
D1241	B25
D1242	E25
D1310	E5
G1300	F7
H1340	B11
H1350	A12
J1240	G20
J1501	C3
L1201	H4
L1203	H4
L1210	I4
L1220	H4
L1401	I4
N1301	A10
R1201	B14
R1202	D13
R1203	D12
R1204	E22
R1205	F22
R1207	A14
R1208	A14
R1209	E21
R1210	D21
R1240	E22
R1241	F22
R1301	D8
R1302	C9
R1310	F4
R1311	E5
R1312	E5
R1330	H8
R1331	H8
R1340	A9
R1341	A11
R1342	C11
R1343	B10
R1344	B10
R1350	B12
R1501	A3
R1502	A3
R1503	B3
R1504	B2
R1505	B2
R1506	C2
R1507	C4
R1510	A5
R1511	A5
R1512	B5
R1513	B6
R1514	B6
TP005	G6
TP050	A21
TP052	A21
TP053	A21
TP100	A22
TP101	A22
TP102	A22
TP103	B22
TP104	B22
TP105	B22
TP106	B22
TP107	C22
TP108	C22
TP109	C22
TP110	C22
TP111	D22
TP112	D22
TP113	D22
TP114	D22
TP115	E22
TP150	B21
TP151	B21
TP152	B21
TP170	E23
TP171	E23
TP172	E23
TP173	E23
TP174	I23
TP175	F23
TP176	E21
TP177	H23
TP180	A23
TP181	A23
TP182	A23
TP183	B23
TP184	B23
TP185	B23
TP186	B23
TP187	C23
TP188	C23
TP189	C23
TP190	C23
TP191	D23
TP192	D23
TP193	D23
TP194	D23
TP201	A16
TP202	A15
TP207	A14
TP208	H6
TP210	B8
TP215	I6
TP225	H6
TP230	D22
TP231	G19
TP232	D19
TP235	H6
TP300	C2
TP301	D9
TP310	F3
TP311	E7
TP330	H9
TP340	B12
TP350	A13
TP405	I6
TP501	B2
TP502	B4
TP503	C4
TP504	B4
V1310	F6
V1311	E4
V1312	E4
V1313	E4
V1314	E5
V1315	E5
V1316	E6
V1318B	E7
V1319	D5
V1331A	H9
V1331B	H9
V1332	H8
V1340A	B9
V1341	B11
V1430A	E7
V1430B	E17
V1501	A2
V1502A	B3
V1502B	B2
V1503	B3
V1504	B4
V1505	B4
V1506	B4
V1510	A6
V1511	B5
V1512	B6
V1513	B7
X1201	B1
X1204	H8
X1205	H8
X1602	H18

PARTS LOCATION A1 PCB CIRCUIT DIAGRAM PART B

C1250	E7
C1251	E7
C1252	E7
C1253	F7
C1254	F7
C1255	F7
C1256	F5
C1257	F5
C1258	F7
C1261	H3
C1262	H3
C1300	H8
C1320	G14
C1407	F17
C1418	C16
C1419	D16
C1420	B16
C1421	B16
C1422	C16
C1423	D16
C1424	D16
C1425	D15
C1430	B13
C1431	D13
C1432	D12
C1433	E12
C1434	E13
C1440	H12
C1441	H14
C1442	G14
D1203	D3
D1208	A6
D1209	A6
D1210	A11
D1216	H6
D1218	A7
D1401	A19
D1402	A21
D1403	A23
D1404	C19
D1405	E19
D1406	G19
G1201	G3
L1202	F6
N1420	B15
R1250	E7
R1251	E7
R1252	E7
R1253	F7
R1254	F7
R1255	F7
R1256	F7
R1257	F5
R1258	F5
R1259	F6
R1260	G7
R1261	H3
R1262	H4
R1263	H7
R1407	G17
R1411	B16
R1412	B16
R1413	C16
R1414	C16
R1415	D16
R1419	D16
R1417	D16
R1420	B14
R1421	C14
R1422	C14
R1423	D14
R1424	D14
R1425	B15
R1426	B15
R1427	C15
R1428	C15
R1429	D15
R1430	B13
R1431	C13
R1432	D13
R1433	D13
R1434	D12
R1435	D13
R1436	D13
R1437	E13
R1438	E12
R1439	E12
R1440	G13
R1441	G12
R1442	H13
R1445	G14
T1440	H15
	G14
TP203	A5
TP204	A5
TP300	H11
TP401	B17
TP402	B20
TP403	B22
TP406	D17
TP420	B16
TP421	B16
TP422	C16
TP423	C16
TP424	D16
TP425	E16
TP430	A13
TP431	C13
TP432	E12
TP440	F16
TP441	G13
TP442	H16
TP446	B12
TP450	B11
TP451	B11
TP452	B11
TP453	B11
TP454	B11
TP455	B11
TP456	B11
TP460	B12
TP461	B12
TP462	B12
TP463	B12
TP464	B12
V1318A	B13
V1340B	H14
V1431	D13
V1432	D12
V1433	E13
V1434	E15
V1435	B14
V1440	G13
V1441	G12
V1442	H13
V1443	G15
V1444	H14
V1445	H14

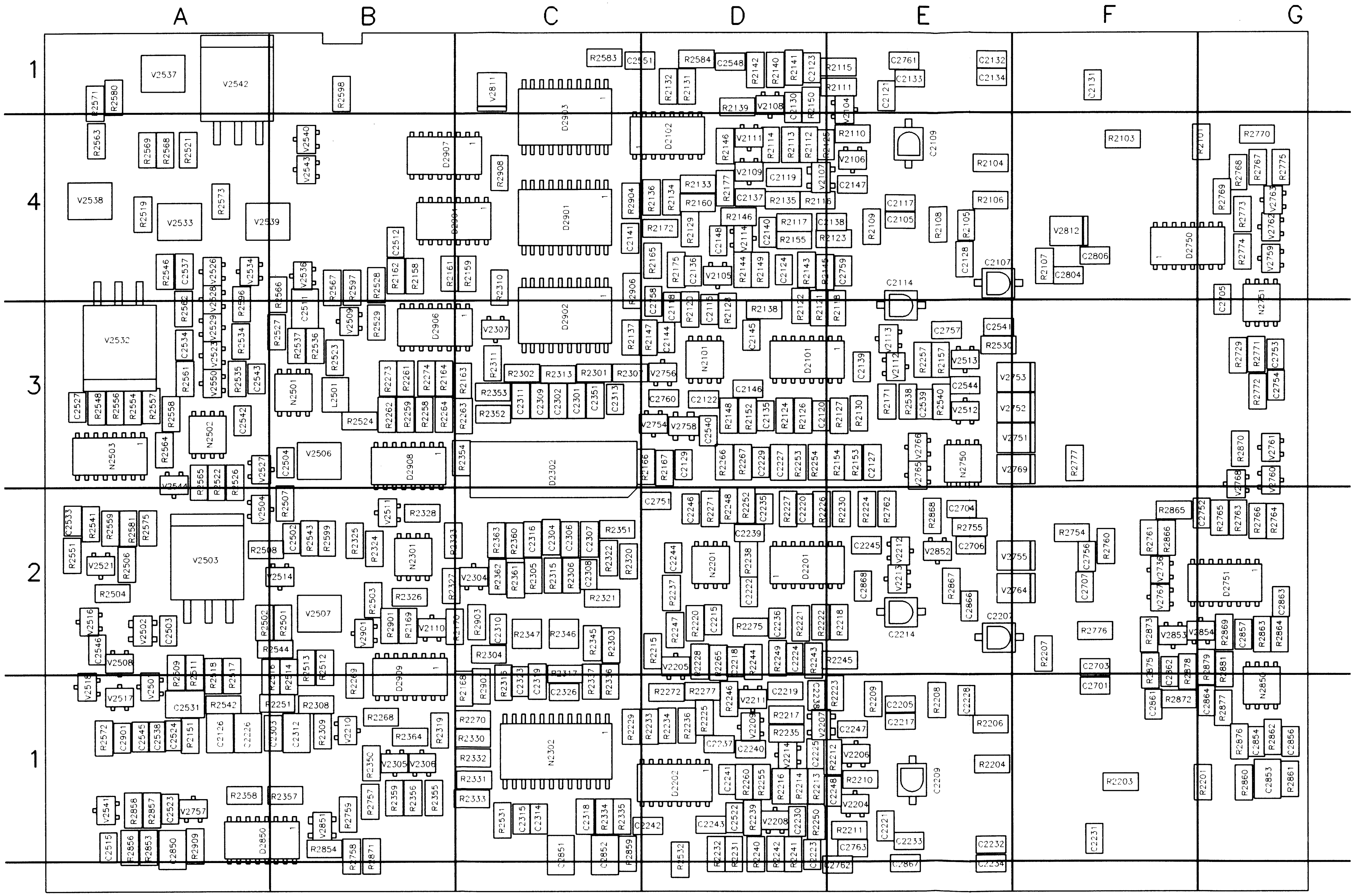


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Figure 9.3a ANALOG BOARD A2 assembly (SMD components side)

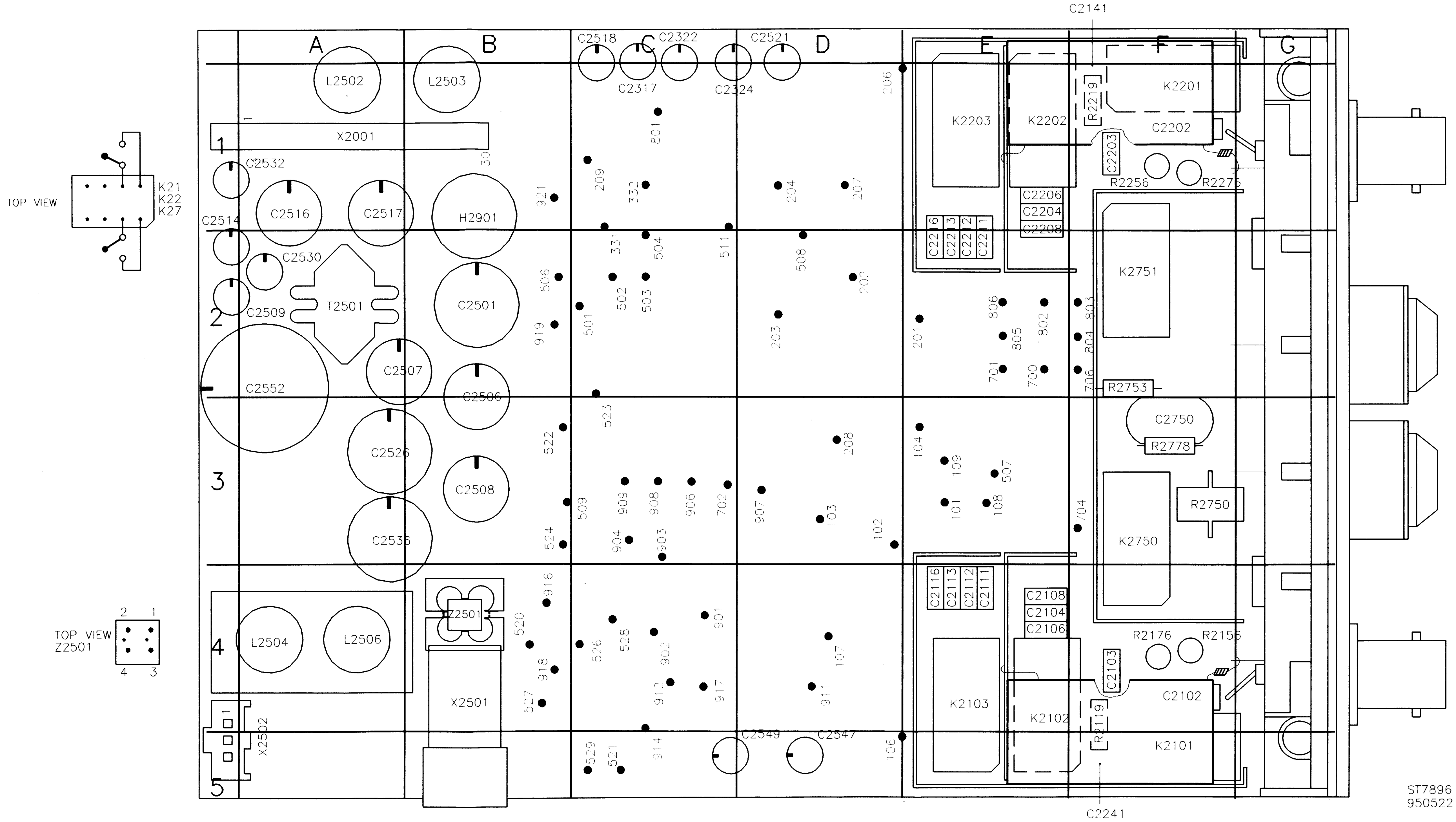

Figure 9.3b   Analog A2 PCB (wired component side)

PARTS LOCATION A2 (PCB WIRED COMPONENTS SIDE)

C2102	F4	C2507	A2	L2504	A4	TP206	D1	TP702	C3
C2103	F4	C2508	B3	L2506	A4	TP207	D1	TP704	F3
C2104	E4	C2509	A2	R2119	F4	TP208	D3	TP706	F2
C2106	E4	C2514	A2	R2156	F4	TP209	C1	TP801	C1
C2108	E4	C2516	A1	R2176	F4	TP331	C1	TP802	E2
C2111	E4	C2517	A1	R2219	F1	TP332	C1	TP803	F2
C2112	E4	C2518	C1	R2256	F1	TP501	C2	TP804	F2
C2113	E4	C2521	D1	R2276	F1	TP502	C2	TP805	E2
C2116	E4	C2530	A2	R2582	A5	TP503	C2	TP806	E2
C2141	F5	C2532	A1	R2750	F3	TP504	C2	TP901	C4
C2202	F1	C2547	D5	R2753	F2	TP506	B2	TP902	C4
C2203	F1	C2549	C5	R2778	F3	TP508	D2	TP903	C3
C2204	E1	C2552	A2	T2501	A2	TP509	B3	TP904	C3
C2206	E1	C2750	F3	X2001	A1	TP511	C1	TP906	C3
C2208	E1	H2901	B1	X2501	B4	TP520	B4	TP907	D3
C2211	E1	K2101	F5	X2502	A4	TP521	C5	TP908	C3
C2212	E1	K2102	E4	Z2501	B4	TP522	B3	TP909	C3
C2213	E1	K2103	E4	TP102	D3	TP523	C2	TP911	D4
C2216	E1	K2201	F1	TP103	D3	TP524	B3	TP912	C4
C2241	F1	K2202	E1	TP106	D5	TP526	C4	TP914	C4
C2317	C1	K2203	E1	TP107	D4	TP527	B4	TP916	B4
C2322	C1	K2750	F3	TP201	E2	TP528	C4	TP917	C4
C2324	C1	K2751	F2	TP202	D2	TP529	C5	TP918	B4
C2501	B2	L2502	A1	TP203	D2	TP700	E2	TP919	B2
C2506	B3	L2503	B1	TP204	D1	TP701	E2	TP921	B1

PARTS LOCATION A2 (CIRCUIT DIAGRAM A2a)

C2102	A14
C2103	A15
C2104	A16
C2105	B19
C2107	A16
C2108	A17
C2109	A18
C2111	A18
C2112	A18
C2113	A18
C2114	A19
C2115	C15
C2116	A19
C2117	B19
C2118	D22
C2119	A21
C2120	D15
C2122	C19
C2123	D20
C2124	C22
C2125	A20
C2126	A2
C2127	A2
C2128	A17
C2129	A7
C2130	D20
C2131	A11
C2132	B11
C2133	B11
C2134	C11
C2135	A4
C2136	E23
C2137	A23
C2138	A21
C2139	D14
C2140	B22
C2141	B16
C2144	D19
C2145	D14
C2146	D19
C2147	A21
C2202	E14
C2203	E15
C2205	F19
C2206	E16
C2207	E16
C2208	E17
C2209	F17
C2210	G13
C2211	F18
C2212	E18
C2213	F18
C2214	F18
C2215	G15
C2216	E19
C2217	F19
C2218	H22
C2219	F21
C2220	H15
C2222	G19
C2223	H20
C2225	E20
C2226	G2
C2227	G3
C2228	E17
C2229	G8
C2230	H20
C2232	D11
C2233	D11
C2234	D11
C2235	G4
C2236	I23
C2237	E23
C2238	E21
C2240	F22
C2241	G16
C2242	J17
C2243	J17
C2244	H19
C2245	H14
C2246	H19
C2247	E21
C2248	F22
C2301	C20
C2302	C21
C2302	D26
C2303	D29
C2304	F21
C2304	G26
C2306	C21
C2306	D27
C2307	C22
C2307	D27
C2307	F11
C2308	C28
C2309	E20
C2309	F25
C2310	D29
C2311	E20
C2311	F25
C2312	G29
C2313	G28
C2314	D31
C2315	D32
C2316	F21
C2316	G27
C2317	B32
C2318	B32
C2319	B32
C2322	D31
C2323	D30
C2324	D30
C2326	C31
C2340	C19
C2351	D26
C2705	H3
C2707	E4
C2750	B3
C2752	D10
C2753	H3
C2754	H3
C2756	E4
C2757	D6
C2758	B3
C2758	D6
C2759	E6
C2760	B3
C2761	C6
C2762	D9
C2763	D8
C2801	C1
C2804	F11
C2806	F11
C2850	E13
C2851	E14
C2852	E14
C2853	E14
C2854	E15
C2856	E15
C2857	E13
C2861	A15
C2862	B15
C2863	E16
C2864	A16
C2866	F14
C2867	E17
C2868	E17
C2901	B3
CH A	E12
D2101	C14
D2102	C17
D2201	G14
D2202	F17
D2301	D21
D2302	E26
D2750	D7
D2751	D17
D2751	D9
D2850	A2
D2850	D12
D2901	A10
D2902	C10
D2903	E10
D2904	E3
D2906	E5
D2907	C2
D2908	C3
D2909	C7
H2901	C8
K2101	A11
K2101	A14
K2101	A15
K2102	A17
K2102	B11
K2103	A17
K2103	A19
K2103	B11
K2201	C11
K2201	E14
K2202	C11
K2202	E15
K2202	E16
K2203	D11
K2203	E17
K2203	E19
K2750	C3
K2750	D2
K2750	F11
K2751	D4
K2751	E11
K2751	F2
N2101	C15
N2101	C19
N2201	G15
N2201	G19
N2301	F30
N2301	H30
N2302	C31
N2750	C3
N2751	G3
N2751	G4
N2850	B16
N2850	D16
R2101	A14
R2103	A14
R2104	A16
R2106	A16
R2108	A18
R2109	A19
R2110	A20
R2111	B20
R2112	A20
R2114	B21
R2115	B19
R2116	B21
R2117	A22
R2118	B13
R2119	B13
R2120	B15
R2121	C13
R2122	C13
R2123	A21
R2125	B16
R2126	D15
R2127	D15
R2128	C15
R2129	C16
R2130	D15
R2131	D16
R2132	D16
R2133	C16
R2134	C17
R2135	A22
R2136	C17
R2137	C18
R2138	C19
R2139	C20
R2140	C20
R2141	C20
R2142	C21
R2143	C22
R2144	C23
R2145	C22
R2146	C23
R2147	D22
R2148	A4
R2149	C22
R2151	A2
R2152	A4
R2153	A3
R2154	A3
R2155	B22
R2157	A6
R2158	A6
R2159	A6
R2160	A23
R2161	A6
R2162	B6
R2163	B6
R2164	B6
R2165	D22
R2166	A6
R2167	A7
R2168	B6
R2169	B6
R2170	B7
R2171	D14
R2172	B22
R2175	D23
R2177	B23
R2201	E13
R2203	E14
R2204	E15
R2206	E15
R2207	G16
R2208	E17
R2209	E19
R2210	E19
R2211	F20
R2212	F20
R2213	E21
R2214	F21
R2215	F19
R2215	G15
R2216	F21
R2217	E22
R2218	F13
R2219	F13
R2220	G15
R2221	G13
R2222	H13
R2223	E21
R2224	H14
R2226	H15
R2227	H15
R2228	H15
R2229	G16
R2230	H15
R2231	H16
R2232	H16

R2234	G17
R2235	E22
R2236	G17
R2237	G18
R2238	G19
R2239	G20
R2240	G20
R2241	H20
R2242	H21
R2243	H22
R2244	H22
R2244	H23
R2245	G22
R2246	G23
R2247	H22
R2248	G4
R2249	G22
R2250	H19
R2251	G2
R2251	H7
R2252	G4
R2252	H7
R2253	G3
R2253	H7
R2254	H4
R2254	H7
R2255	F22
R2257	G7
R2258	G7
R2258	H7
R2259	G7
R2259	H8
R2260	E23
R2265	H22
R2266	G8
R2267	G8
R2270	H8
R2271	H14
R2272	F22
R2275	H23
R2277	E23
R2301	C20
R2302	C21
R2302	D26
R2303	C30
R2304	D29
R2305	F21
R2305	G26
R2306	C21
R2306	D27
R2307	C22
R2307	D25
R2308	D29
R2309	F29
R2310	H32
R2311	G32
R2312	F22
R2313	E20
R2313	F25
R2314	E20
R2315	C28
R2316	D29
R2317	C29
R2319	E31
R2320	G28
R2322	G28
R2323	F30
R2324	F30
R2325	G30
R2326	G30
R2327	C20
R2327	F31
R2328	C20
R2328	E28
R2330	C33
R2331	C32
R2332	C33
R2333	C32
R2334	C33
R2335	C32
R2336	C33
R2337	C32
R2340	D19
R2341	D19
R2342	C19
R2343	C20
R2345	C29
R2346	C29
R2347	D29
R2350	F31
R2351	F25
R2352	H31
R2353	H31
R2354	H27
R2355	E32
R2356	E30
R2357	F32
R2358	F32
R2359	E31
R2360	F28
R2361	F28
R2362	F28
R2363	F28
R2364	E31
R2729	G3
R2750	C3
R2753	C4
R2754	C5
R2755	D3
R2757	A4
R2759	B3
R2760	D5
R2761	D7
R2762	D10
R2763	D5
R2764	D5
R2765	D10
R2766	E5
R2767	D6
R2768	D6
R2769	D7
R2770	E5
R2771	H3
R2772	H4
R2773	G4
R2774	G4
R2775	E5
R2776	E9
R2777	C4
R2778	C1
R2838	B22
R2853	E13
R2854	E13
R2856	D13
R2857	E13
R2858	E13
R2859	E14
R2860	E14
R2861	E15
R2862	E15
R2864	E16
R2865	B14
R2866	E17
R2867	F14
R2868	F14
R2869	F15
R2870	C14
R2871	A15
R2872	A15
R2873	B15
R2875	B15
R2876	A15
R2877	A16
R2878	B16
R2879	B16
R2881	A17
R2901	C8
R2903	B2
R2904	A9
R2906	C10
R2907	B3
R2908	E2
R2909	C2
TP101	D12
TP103	C16
TP104	C14
TP104	C16
TP106	B20
TP107	B22
TP107	B24
TP108	A6
TP109	A3
TP202	G13
TP206	F20
TP207	F24
TP208	G8
TP209	G3
TP331	C29
TP332	C29
TP700	D4
TP701	D4
TP702	B3
TP704	G3
TP706	G4
TP717	F5
TP801	D12
TP802	F14
TP803	D15
TP804	E16
TP805	B15
TP806	A16
TP901	A11
TP902	B11
TP903	B11
TP904	B11
TP906	C11
TP907	C11
TP908	D11
TP909	D11
TP911	E11
TP912	E11
TP914	F11
TP916	F3
TP918	D3
TP919	D5
TP921	D7
V2104	B20
V2105	B15
V2106	A20
V2107	A21
V2108	C21
V2109	A23
V2110	B7
V2111	C23
V2112	D12
V2113	D13
V2114	B22
V2204	F20
V2205	G15
V2206	E20
V2207	E21
V2208	G21
V2209	E23
V2210	H8
V2211	G23
V2212	H13
V2213	H13
V2214	F22
V2304	G27
V2305	E31
V2305	F30
V2307	H31
V2736	D8
V2751	C4
V2752	D4
V2753	D4
V2754	C6
V2755	H5
V2756	C6
V2757	A4
V2758	B3
V2759	F5
V2760	F4
V2761	G4
V2762	F5
V2763	F6
V2764	H5
V2765	D2
V2766	D2
V2767	D8
V2768	E10
V2769	C4
V2811	F11
V2812	F11
V2851	E13
V2852	F15
V2853	B14
V2854	B17
V2901	C8
X2001	A1
X2001	B4
X2001	C1
X2001	E33
X2001	F1
X2001	G1
X2108	A13
X2109	A13
X2201	F1
X2208	E13
X2209	E13

Figure 9.4a   Analog A2 circuit diagram A2a

PARTS LOCATION A2 (CIRCUIT DIAGRAM A2b)

C2302	C21	D2850	D12	R2364	D26	TP706	G4
C2303	C24	K2750	C3	R2729	G3	TP801	D12
C2304	F21	K2750	D2	R2750	C3	TP802	F14
C2306	C22	K2751	D4	R2753	C4	TP803	D15
C2307	C22	K2751	F2	R2754	C5	TP804	E16
C2308	B23	N2301	E25	R2755	D3	TP805	B15
C2309	E20	N2301	G25	R2757	A4	TP806	A16
C2310	C24	N2302	B26	R2759	B3	V2304	E22
C2311	E20	N2750	C3	R2760	D5	V2305	D26
C2312	E24	N2751	G3	R2761	D7	V2305	E25
C2313	E23	N2751	G4	R2762	D10	V2307	G26
C2314	C26	N2850	B16	R2763	D5	V2307	G26
C2315	C26	N2850	D16	R2764	D5	V2736	D8
C2316	F21	R2302	C21	R2765	D10	V2751	C4
C2317	A27	R2303	B25	R2766	E5	V2752	D4
C2318	A26	R2304	C24	R2767	D6	V2753	D4
C2319	A27	R2305	F21	R2768	D6	V2754	C6
C2322	C26	R2306	C21	R2769	D7	V2755	H5
C2323	C25	R2307	C20	R2770	E5	V2756	C6
C2324	C25	R2308	C24	R2771	H3	V2757	A4
C2324	C25	R2309	E23	R2772	H4	V2758	B3
C2326	B26	R2310	G27	R2773	G4	V2759	F5
C2351	C20	R2311	E26	R2774	G4	V2760	F4
C2705	H3	R2313	E20	R2775	E5	V2761	G4
C2707	E4	R2315	B23	R2776	E9	V2762	F5
C2750	B3	R2316	C24	R2777	C4	V2763	F6
C2752	D10	R2317	B24	R2778	C1	V2764	H5
C2753	H3	R2320	E23	R2853	E13	V2765	D2
C2754	H3	R2321	E23	R2854	E13	V2766	D2
C2756	E4	R2322	E23	R2856	D13	V2767	D8
C2757	D6	R2323	E24	R2857	E13	V2768	E10
C2758	B3	R2324	E24	R2858	E13	V2769	C4
C2758	D6	R2325	E25	R2859	E14	V2851	E13
C2759	E6	R2326	E25	R2860	E14	V2852	F15
C2760	B3	R2328	D23	R2861	E15	V2853	B14
C2761	C6	R2330	B28	R2862	E15	V2854	B17
C2762	D9	R2331	B27	R2864	E16	X2001	D28
C2763	D8	R2332	B28	R2865	B14	X2001	F1
C2801	C1	R2333	B27	R2866	D18	X2201	F1
C2850	E13	R2334	B28	R2866	E17		
C2851	E14	R2335	B27	R2867	F14		
C2852	E14	R2336	B28	R2868	F14		
C2853	E14	R2337	B27	R2869	F15		
C2854	E15	R2346	B24	R2870	C14		
C2856	E15	R2347	C24	R2871	A15		
C2857	E13	R2350	E25	R2872	A15		
C2861	A15	R2351	D20	R2873	B15		
C2862	B15	R2352	G26	R2875	B15		
C2863	E16	R2353	G27	R2876	A15		
C2864	A16	R2354	G22	R2877	A16		
C2866	F14	R2355	D26	R2878	B16		
C2867	E17	R2356	D25	R2879	B16		
C2868	E17	R2357	E27	R2881	A17		
D2302	D21	R2358	E27	TP331	B24		
D2319	D26	R2359	D26	TP332	B24		
D2750	D7	R2360	E23	TP700	D4		
D2751	D17	R2361	E23	TP701	D4		
D2751	D9	R2362	E23	TP702	B3		
D2850	A2	R2363	E23	TP704	G3		

Figure 9.4b Analog A2 circuit diagram A2b

PARTS LOCATION A2 (CIRCUIT DIAGRAM A2c)

C2431	G13	R2512	G17	TP501	F13
C2434	A5	R2513	G17	TP502	F13
C2501	G14	R2514	G17	TP503	E15
C2502	E14	R2516	G18	TP504	F18
C2503	G15	R2517	G18	TP506	G18
C2504	E15	R2518	G18	TP507	A15
C2506	C17	R2519	F8	TP508	A15
C2507	F17	R2521	F8	TP509	D19
C2508	E17	R2522	C18	TP511	E18
C2509	D17	R2523	D18	TP520	B1
C2511	D19	R2524	D18	TP521	C2
C2512	D19	R2526	C17	TP522	B4
C2514	C19	R2527	D18	TP523	B5
C2515	E18	R2528	D19	TP524	C5
C2516	E18	R2529	D20	TP526	B8
C2517	C21	R2530	B15	TP527	F9
C2518	B21	R2531	B21	TP528	F9
C2521	E19	R2532	E18	TP529	D9
C2522	E19	R2534	B13	V2501	E14
C2523	F17	R2535	A13	V2502	F15
C2524	C21	R2536	B12	V2503	E16
C2526	A3	R2537	B12	V2504	F17
C2527	C3	R2538	B13	V2506	C17
C2530	B3	R2540	A14	V2507	E16
C2532	G13	R2541	G15	V2508	F13
C2533	C4	R2542	G13	V2509	D20
C2536	G6	R2543	A13	V2511	E20
C2537	B6	R2544	F15	V2512	B14
C2538	G10	R2546	A8	V2513	A15
C2539	A14	R2548	B3	V2514	G15
C2540	E17	R2551	C4	V2516	E13
C2541	E17	R2554	BA5	V2517	F13
C2543	A13	R2556	C5	V2518	E13
C2544	A14	R2557	B5	V2521	A10
C2545	H10	R2558	C5	V2523	F5
C2546	C19	R2559	A4	V2526	F5
C2547	E19	R2561	A5	V2527	B6
C2548	E19	R2562	B6	V2528	B6
C2549	B21	R2563	D8	V2532	A8
C2551	B21	R2564	C8	V2533	F7
C2552	C21	R2565	C8	V2534	F7
L2501	C18	R2566	F7	V2536	F8
L2502	E17	R2567	F8	V2537	E9
L2503	C20	R2568	E8	V2538	F9
L2504	B8	R2569	E8	V2539	G9
L2506	B8	R2571	D8	V2540	E10
N2501	A13	R2572	G10	V2541	E10
N2501	D19	R2573	G10	V2542	G11
N2502	D17	R2575	A9	V2543	E10
N2503	B4	R2580	A9	V2544	D17
N2750	A14	R2581	A8	V2546	E10
R2501	E14	R2582	D8	V2550	G5
R2502	F14	R2583	B21	X2001	C22
R2503	E16	R2584	E18	X2001	G11
R2504	F15	R2596	G7	X2001	E11
R2506	F15	R2597	G8	X2001	C22
R2507	E15	R2598	D17	X2501	B1
R2508	G15	R2599	E14	X2502	H11
R2509	G16	T2501	F16	Z2501	A2
R2511	G16	T2501	E16		

Figure 9.4c Analog A2 circuit diagram A2c

10 MODIFICATIONS

10.1 HARDWARE MODIFICATIONS, PCB REVISION LEVELS

On PCN's (Product Change Notices), revision levels are used to indicate the PCB status.
The ANALOG BOARD A1 and the DIGITAL BOARD A2 have two stickers on them which identify their revision level. However, one of these stickers is used only in the factory to identify the revision level of a lower assembly. This number on this revision level sticker begins with an "S".
The revision level stickers for complete DIGITAL BOARD A1 and ANALOG BOARD A2 assemblies are located as indicated below. All revision level descriptions refer to the complete DIGITAL BOARD A2 and ANALOG BOARD A1 assembly.

The revision level number is printed on the left hand side of the sticker.

04	XX	YY	ZZZZZZZ
	XX	YY	

Revision Level Number

The ANALOG BOARD A1 revision level sticker for the complete assembly is located near input A on the shield that is permanently attached to the board. You must remove the top shield to access it.

The DIGITAL BOARD A2 revision level sticker is located between the two display driver chips D1406 and D1407.

10.2 FIRMWARE VERSIONS

Press function keys F1 and F5 at the same time to display the installed software release. Contact your nearest Service Center for information about upgrading the software.

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