Digital Storage/Analog Oscilloscopes

PM3382A-PM3384A 100 MHz 200 MS/s
PM3392A-PM3394A 200 MHz 200 MS/s

CombiScope™ Instrument

Reference Manual

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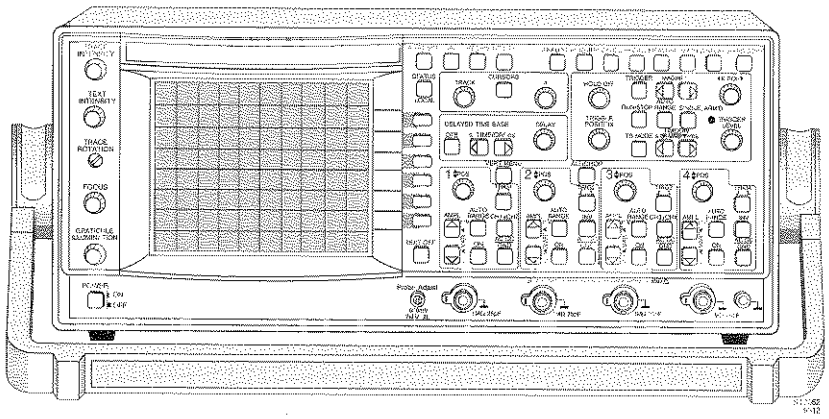

FLUKE

IMPORTANT

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

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

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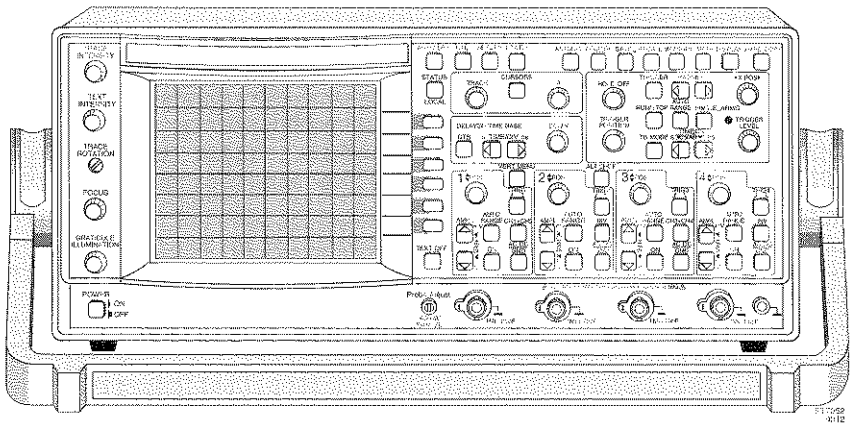

Thank you for purchasing this FLUKE oscilloscope. It has been designed and manufactured to the highest quality standards to give you many years of trouble free and accurate measurements

The powerful measuring functions listed below have been combined with an easy and logical operation to let you use the full power of this instrument each and every day.

If you have any comments on how this product could be improved, please contact your local FLUKE organization. FLUKE addresses are listed in the back of this REFERENCE MANUAL.

There is an OPERATION GUIDE available containing:

- OPERATOR'S SAFETY
- INSTALLATION INSTRUCTIONS
- OPERATING INSTRUCTIONS
- HOW TO USE THE INSTRUMENT
- FUNCTION REFERENCE

PM3382A/PM3384A/PM3392A/PM3394A

There are four models in this family of Fluke oscilloscopes. Each of these models is a combination of an analog real-time oscilloscope and a fully featured digital storage oscilloscope. By pressing a single push button, you can switch the instrument from the analog mode to the digital mode and back. This allows each of the units to be used in an optimum operating mode for all kinds of signal conditions. Complex data streams, modulated waveforms, and video signals can often best be seen in the analog mode of operation. The digital mode of operation is more suited for single events, signals with low repetition frequencies, and when automatic measurements need to be performed.

In this family there is a choice of four models. Two models have a bandwidth of 200 MHz; the two others have a bandwidth of 100 MHz. There is a choice of two models with four fully featured channels or four channels in a '2+2' configuration as shown in the following table:

	PM3382A	PM3384A	PM3392A	PM3394A
Bandwidth	100 MHz	100 MHz	200 MHz	200 MHz
Sample rate	200 Ms/s	200 Ms/s	200 Ms/s	200 Ms/s
Number of Channels	4 (2+2)	4	4 (2+2)	4
Input impedance	1 MΩ	1 MΩ	1 MΩ/50Ω	1 MΩ/50Ω

In the same instrument family, there are two 200-MHz analog oscilloscopes that have specifications similar to the above-mentioned analog/digital combination oscilloscopes operating in analog mode.

All analog/digital combination oscilloscopes listed above have the following features:

- 8K sample acquisition memory, expandable to 32K.
- Up to 40 waveforms stored in memory or 204 waveforms with optional memory extension.
- Autoset function for an instant optimized signal display at the touch of a button.
- Auto-ranging attenuators.
- Auto-ranging timebase.
- Real time clock.
- Cursor measurements with 1% accuracies.
- Extensive set of fully automated voltmeter and time measurement functions.
- Probe operated 'Touch Hold and Measure' function freezes the display and instantly displays the signal frequency, amplitude and dc voltage level.
- Peak detection for the capture of glitches as narrow as 5 ns.
- Pattern, State and Glitch triggering (2 ns)

- Event delay and pretriggering and posttriggering.
- TV triggering including HDTV and TV line selection.
- Serial interface for printing and plotting.
- Averaging to reduce signal noise and to increase the vertical resolution from 8 to 16 bits.
- Advanced mathematics, including digital low-pass filtering. A Math+ option adds integration, differentiation, histogramming, and (as part of a option) FFT.
- Sine interpolation and magnification which enables true to life four channel single shot acquisitions with a timebase up to 625 ns/div (32x magnified)
- A delayed timebase with full trigger features.
- An EIA-232-D interface (standard) and an GPIB/IEEE-488 interface (optional).
- Autocal for automatic fine tuning of all circuitry to achieve maximum accuracy under all user conditions.
- Closed case calibration for efficient maintenance of traceable calibration at minimum cost.

The following options are available:

- A MATH+ option with more automated measurement functions including envelope and measurement pass/fail testing. Also included in this option are Integration, Differentiation, Histogramming, and FFT.
- Memory extension offering 32K acquisition length and the ability to store 204 traces (of 512 samples each) in memory.
- IEEE-488.2 interface using the new SCPI (Standard Commands for Programmable Instruments) industry standard for remote control of test and measurement equipment.

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1 CHARACTERISTICS

A. Performance Characteristics

- Properties expressed in numerical values with tolerances, ranges, or limits stated, are guaranteed by the manufacturer.
- Properties expressed in numerical values without tolerances, ranges, or limits stated, represent the characteristics of an average instrument.
- This specification is valid if the temperature has not changed more than + or - 5 °C since the last AUTO CAL, the probe is of the same type as delivered with the instrument, and if the average factor is 8.
- For definitions of terms, reference is made to IEC Publication 351-1, 359.

B. Safety Characteristics

This instrument has been designed and tested in accordance with IEC Publication 348, Safety Requirements for Electronic Measuring Apparatus, and has been supplied in a safe condition. This manual contains information and warnings which must be followed by the user to ensure safe operation and to keep the instrument in safe condition. The instrument has been designed for indoor use. It may occasionally be subjected to temperatures between +5 °C and 10 °C without degradation of its safety.

C. General Characteristics

- Overall dimensions:
  - Height (without feet) : 139 mm (5.5 in)
  - Width (without handle) : 341 mm (13.5 in)
  - Length (without handle and front cover) : 481 mm (19 in)

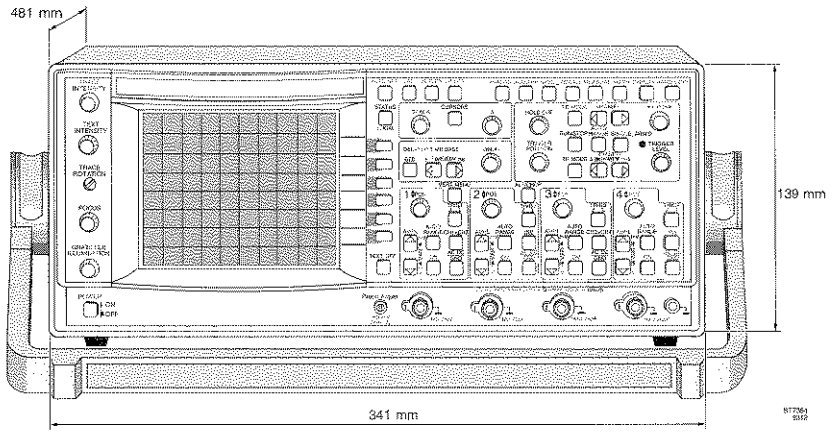


Figure 1.1 Dimensions

Weight	9.5 kg	(19.7 lb)

Operating positions:
a) Horizontally on bottom feet
b) Vertically on rear feet
c) On the carrying handle in three sloping positions

Note: All items that refer specifically to only one mode (analog or digital) are identified in the leftmost column with an 'A' or a 'D'.

1.1 VERTICAL

1.1.1 Channels

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION
CHANNELS	CH1; CH2;	Form a channel set
	CH3; CH4	Form a channel set

1.1.2 Deflection Modes (Analog Only)

MODES	CH1, CH2, CH3, CH4	CH2 and CH4 can be inverted to allow -CH2 or -CH4
	CH1 + CH2	CH2 can be inverted to allow CH1 - CH2
	CH3 + CH4	CH4 can be inverted to allow CH3 - CH4
Automode:		
Auto attenuator	CH1, CH2, CH3, CH4	PM3382A, PM3392A CH1 and CH2 only
Windows ON	CH1, CH2, CH3, CH4	PM3382A, PM3392A CH1 and CH2 only See Note 1.
	Alternate Chopped	
Chopped mode:		
Chopped freq.	1 MHz	

Note 1: If more than one channel ON.

1.1.3 Bandwidth

FREQUENCY RESPONSE		At BNC
Lower transition point of BW input coupling in AC pos	<10 Hz	BW = bandwidth

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION
PM3392A and PM3394A Upper transition point of BW		BW = bandwidth
(Ambient 5 to 40 °C)	>200 MHz	See Note 1
(Ambient 0 to 50 °C)	>175 MHz	See Note 1
PM3382A and PM3384A Upper transition point of BW		BW = bandwidth
(Ambient 5 to 40 °C)	>100 MHz	With external 50Ω
(Ambient 0 to 50 °C)	90 MHz	With externl 50Ω
BANDWIDTH LIMITER Upper transition point of BW	20 MHz	BW = bandwidth

Note 1: PM3394A CH1 through CH4 in 50Ω position at BNC. PM3392A CH1 and CH2 in 50Ω position at BNC and CH3 and CH4 at probe tip.

1.1.4 Attenuator

CH1 and CH2 (PM3382A/PM3392A) steps	2 mV/div to 5V/div	In a 1-2-5 sequence
CH3 and CH4 (PM3382A/PM3392A) steps	0.1V/div 0.5V/div	
CH1 to CH4 (PM3394A/PM3394A) steps	2 mV/div to 5V/div	In a 1-2-5 sequence
Variable gain mode	2 mV/div to 12.5V/div	Continuously variable
Auto Attenuator	2<div<6.4	1-2-5 steps precision (min. 50 mV/div)
Auto Attenuator (Windows ON)	1<div<3.2	1-2-5 steps precision (min. 50 mV/div)

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION
1.1.5 Input Characteristics		
INPUT CONNECTOR	BNC	See Note 1
INPUT IMPEDANCE (in 1 MΩ pos.)		Measured at freq. <1MHz
R parallel-value	1 MΩ	
- tolerance	±1 %	
C parallel-value	25 pF	
- tolerance	±2 pF	
INPUT INPEDANCE (in 50Ω pos.)		PM3392A only CH1 and CH2 PM3394A all channels
R parallel value	50Ω	
- tolerance	±1 %	
VSWR (typical)	1.5:1	See Note 2

Note 1: BNC with Probe Readout pin which causes the instrument to change V/div indication, input impedance, and attenuator setting according to the probe (when equiped with a probe indicator).

Note 2: Measured up to 200 MHz input frequency; in dc and ac coupling of input.

1.1.6 Coupling		
COUPLING	dc, ac, ground	See Note 1

Note 1: In GND position: channel disconnected from input, and connected to ground, BNC open (when not in 50Ω position). The GND coupling is not available for channel CH3 and CH4 in PM3382A and PM 3392A.

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION
1.1.7 Dynamic Range		
DYNAMIC RANGE		
Up to 25 MHz		
PM3382A/PM3384A	±12 div	Symmetrical
Up to 50 MHz		
PM3392A/PM3394A	±12 div	Symmetrical
Up to 100 MHz		
PM3382A/PM3384A	±4 div	Symmetrical
Up to 200 MHz		
PM3392A/PM3394A	±4 div	Symmetrical
1.1.8 Position Range		
POSITION RANGE	±8 div	Symmetrical
1.1.9 Trace Separation		
TRACE SEPARATION		MTB and DTB
Min. range	+ or - ≥ 4 div	MTB fixed, DTB shifts
1.1.10 Input Voltage Limits		
INPUT VOLTAGE LIMITS		See Note 1
In high Z position (dc + ac peak) dc	± 400V	See Note 2
In 50Ω position	± 5V	
ac rms	5V	See Note 3
ac peak	± 50V	See Note 3

Note 1: The instrument should be properly grounded through the protective ground conductor of the power cord.

Note 2: Up to 10 KHz; >10 kHz see figure 1.1

Note 3: Maximum of 50 mJ during any 100 ms interval.

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION

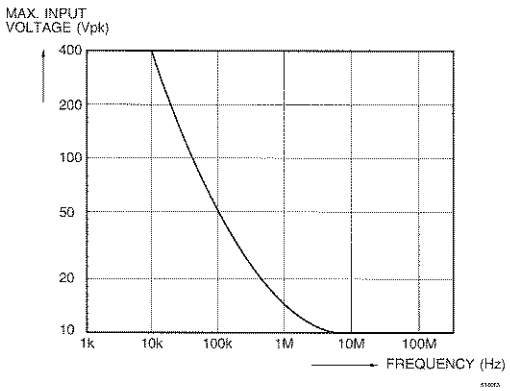


Figure 1.1 Max. input voltage versus frequency

1.1.11 Step Response

5 Divisions Pulse In 50Ω Input Impedance

STEP RESPONSE	See Note 1	

Note 1: Calculated from the formula: Rise time = 0.35 / Bandwidth and is measured over the central 5 divisions (vertical)

1.1.12 Signal Delay

A: VISUAL SIGNAL DELAY	15 ns	
DELAY BETWEEN CHANNELS		
CH1 and CH2	<250 ps	
CH3 and CH4	<250 ps	
CH1.... CH4	<250 ps	4 channel instruments
Any two channels	<500 ps	2+2 channel instruments

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION
1.1.13 Vertical Accuracies		
ACCURACY deflection factor		
A: Gain error (dc)	±1.3 %	Over central 6 divisions See Note 1
D: Additional gain error (dc)	±0.7%	
A: Nonlinearity	≤2 %	See Note 2
D: Digital non linearity	≤3 %	
MAX. BASELINE INSTABILITY		
Jump (all between steps, var, and N/I)	0.2 div or 1 mV	Whichever is greater (after autocal)
Drift	0.1 div/h	
Temperature coefficient	0.03 div/K	
CHANNEL ISOLATION		
Of deselected channels at 10 MHz	100:1	See Note 3
Of deselected channels at upper transition point	50:1	See Note 4
Between selected channels	50:1	See Note 5

Note 1: Add 1.5% for variable gain mode.

Note 2: 2 division center screen signal with a frequency of 50 kHz, shifted within central 6 divisions.

Note 3: At 10 MHz; input to deselected channel equivalent to 8 divisions or less.

Note 4: PM3392A/3394A at 200 MHz; input to deselected channels equivalent to 8 divisions or less (center screen).

Note 5: PM3392A/3394A at 200 MHz; PM3382A/3384A at 100MHz; channels with equal V/division settings; input to either channel.

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION

1.2 TIMEBASE

1.2.1 Timebase (modes)

TIMEBASE MODES	MTB only MTB and DTB DTB only Variable TB Auto TB	MTB= Main Timebase Alternating TB-mode DTB = Delayed Timebase
MTB trigger modes	AUTO TRIGGERED SINGLE SHOT SINGLE SCAN	Free run after 100 ms
DTB trigger modes	DTB starts DTB triggered	Starts after delay time Starts on first trigger after delay time

1.2.2 Timebase Settings (Analog Mode Only)

MTB PM3392A/PM3394A Settings	0.5s/div to 20 ns/div	See Note 1
PM3382A/PM3384A Settings	0.5s/div to 50 ns/div	See Note 1
PM3392A/PM3394A Variable Time/Div range	1.25s/div to 20 ns/div	MTB continuously variable
PM3382A/PM3384A Variable Time/Div range	1.25s/div to 50 ns/div	MTB continously variable
DTB PM3392A/PM3394A Settings	0.5 ms/div to 20 ns/div	See Note 1 See Note 3

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION
PM3382A/PM3384A Settings	0.5 ms/div to 50 ns/div	See Note 1 See Note 3
TIMEBASE MAGNIFICATION	10x	See Note 2

Note 1: In a 1-2-5 sequence. By means of the timebase magnifier (x10) the range is extended to 2 ns/div (PM3392A/94A) or 5ns/div (PM3382A/84A).

Note 2: Expands the normal time/div by 10 times (MTB and DTB)

Note 3: The DTB sweep speed is higher or equal to MTB time/div setting.

1.2.3 DTB Delay (Analog Mode Only)

DELAY TIME	2 ns to 4.9s	
Position range	0.1 div to 9.9 div	
Resolution	1: 40000	

1.2.4 Timebase Settings (Digital Mode Only)

MTB Settings		
REAL TIME SAMPLING	200s/div to 250 ns/div	See Note 1 and 4
ROLL	200s/div to 200 ms/div	See Note 2
RANDOM SAMPLING		
PM3392A/94A	200 ns/div to 2 ns/div	See Note 2
PM3382A/84A	200 ns/div to 5 ns/div	See Note 2
Variable Timebase	100p sec.....1 µsec 1 µsec ..... 100 µsec	1-2-5 sequence. 1 µsec step size.
Auto Timebase	100 µsec..... 200 sec	Equal to analog step size.

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION
DTB Settings		See Note 5
STARTS/TRIGGERED		
REAL TIME SAMPLING	0.5 ms/div to 250 ns/div	Whichever is greater
	0.5 ms/div to 0.001x MTB setting	See Note 1 and 3
RANDOM SAMPLING only for MTB 200 µs/div to 2 ns/div		
PM3392A/94A	200 ns/div to 20 ns/div	Whichever is greater
	200 ns/div to 0.001x MTB setting	See Note 2 and 3
PM3382A/84A	200 ns/div to 50 ns/div	Whichever is greater
	200 ns/div to 0.001x MTB setting	See Note 2 and 3

Note 1: In a 1-2-5 sequence 250 ns.

Note 2: In a 1-2-5 sequence.

Note 3: The DTB sweep speed is higher or equal to MTB time/div. setting.

Note 4: In DTB: 500 ms/div to 250 ns/div.

Note 5: DTB is only possible with normal acquisition length.

Note 6: Triggered DTB is not possible in combination with tv, logic or event delay trigger mode.

1.2.5 Timebase Delay (Digital Mode Only)

TIME DELAY		
TRIGGER POSITION		
Acquisition length normal	-10 to 0 div	pretrigger
Acquisition length max.	-160 to 0 div	pretrigger

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION
DELAY	0 to 1000 div	posttrigger
Resolution	steps of 0.02 div	sample distance
EVENTS DELAY		
Range	1 to 16384	See event counter

1.2.6 DTB Delay (Digital Mode Only)

TRIGGERED		
DELAY TIME	2 ns to 4.9 s	
Position range	0.1 div to 9.9 div	
Resolution	1 : 40000	
STARTS		
DELAY TIME	0 to 10 div of MTB setting	
Position range	0 div to 10 div	
Resolution	1 : 40000	

1.2.7 Analog Timebase Accuracies

Unmagnified:	± (1.3% of reading +0.5% of central 8 div)	See Note 1
Magnified:		See Note 2
Up to 10 ns div	± (1.3% of reading +1.0% of central 8 div)	See Note 1
In 5ns/div and 2ns/div	± (1.8% of reading +1.5% of central 8 div)	See Note 1

Note 1: Add 1% of reading in variable mode.

Note 2: Valid over central unmagnified 8 divisions.

1.2.8 Delaytime Accuracy (Analog Mode)

MTB in 20 µs/div DTB in 2 µs/div	± (0.8% of reading +0.3% of central 8 div + 4 ns)	See Note 1

Note 1: add 1% of reading in variable mode.

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION

1.2.9 DTB Jitter In Starts (Analog Mode)

Jitter	1 part of 25000	

1.2.10 Timebase Accuraries (Digital Mode)

MTB, DTB		
Real time modes	± (0.8% of reading	
DTB in 2 µs/div	+ 0.5% of central 8 div)	
up to memory	± 0.010%	
Equivalent mode	± (1.3% of reading + 0.5% of central 8 div)	
up to memory	± 0.5%	

1.2.11 DTB Jitter In Starts (Digital Mode)

Jitter	120 ps	

1.2.12 External Horizontal Deflection

This paragraph is valid only for the analog mode. In the digital mode X versus Y is defined as a display mode.

DEFLECTION SOURCES	Line and CH1 to CH4	
LINE DEFLECTION		
Deflection amplitude	6 ±1.7 div	Between 49 and 61 Hz at 220 volts
CHANNEL DEFLECTION		Refer to VERTICAL
Error limit	±5%	Over central 6 divisions
Linearity error limit	±2%	See Note 1
Dynamic range up		
to 100 kHz	20 div	
up to 2 MHz	10 div	
POSITION RANGE	±5 div	

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION
FREQUENCY RESPONSE Upper transition point	2 MHz	
MAX. PHASE DIFFERENCE Between horizontal and vertical	3°	Up to 100 kHz

Note 1: 2 div/50kHz center screen signal shifted within central 8 divisions.

1.3 TRIGGERING

1.3.1 Source

SOURCE (S) MTB triggering	CH1 to CH4 Line	
SOURCE(S) DTB triggering	CH1 to CH4	

1.3.2 Modes

MODES MTB triggering	EDGE TV D:PATTERN D:STATE D:GLITCH	 Enter/exit pattern plus timed pattern
MODES DTB triggering	EDGE	

1.3.3 TV Systems

TV systems	TV HDTV	See Note 1 See Note 1

Note 1: Line selection possible in field1and field2.

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION
1.3.4 Coupling		
BANDWIDTH EDGE TRIGGER MTB		Vertical coupling in DC
Lower transition point of BW		BW = Bandwidth
Trigger coupling:		
DC	dc	
AC	10 Hz	
LF-reject	30 kHz	
HF-reject	dc	
Upper transition point of BW		BW = Bandwidth
Trigger coupling:		
DC	)	
AC	)See sensitivity	
LF-reject	)	
HF-reject	30 kHz	
BANDWIDTH EDGE TRIGGER DTB		Vertical coupling in DC
Lower transition point of BW		BW = bandwidth
Trigger coupling:		
DC	dc	
AC	10 Hz	
LF-reject	30 kHz	
HF-reject	dc	
Upper transition point of BW		BW = bandwidth
Trigger coupling:		
DC	)	
AC	)See sensitivity	
LF-reject	)	
HF-reject	30 kHz	

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION
1.3.5 Sensitivity		
EDGE TRIGGER SENSITIVITY MTB and DTB of PM3392A/PM3394A		See Notes 1, 3, 4
dc to 100 MHz	0.6 div	
dc to 200 MHz	1.2 div	
dc to 300 MHz	2.0 div	See Note 2
EDGE TRIGGER SENSITIVITY MTB and DTB of PM3382A/PM3384A		See Notes 1, 3, 4
dc to 50 MHz	0.6 div	
dc to 100 MHz	1.2 div	
dc to 200 MHz	2.0 div	See Note 2
TV TRIGGER SENSITIVITY (ampl. of sync. pulse)	0.7 div	See Note 1
TRIGGER SENSITIVITY D: PATTERN/STATE PM3392A/PM3394A Rectangle pulses		
$t \geq 10$ ns	1.0 div	See Note 5
$t \geq 2$ ns	2.0 div	
PM3382A/PM3384A Rectangle pulses		
$t \geq 20$ ns	1.0 div	See Note 5
$t \geq 4$ ns	2.0 div	

Note 1: All figures are valid for an ambient temperature range of 5 to 40 °C, add 20% for ambient 0 to 50 °C.

Note 2: Measured with a 2 divisions center screen signal.

Note 3: In noise trigger multiply stated value by 2.

Note 4: In 2 ... 5 mV/div multiply stated value by 2.

Note 5: Duty cycle 50%.

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION
1.3.6 Slope		
Slope selection edge	+ or -	MTB and DTB See Note 1
D:Dual slope	Up to full vertical bandwith	See note 2

Note 1: In TV-triggering positive/negative video.
Note 2: Only in single shot, real time mode.

1.3.7 Level		
LEVEL CONTROL RANGE MTB EDGE	±8 div	
Unless: In level p(eak)p(eak)		See Note 1
TV	Fixed	
D: PATTERN, STATE and GLITCH	±5 div	
LEVEL CONTROL RANGE DTB EDGE	±8 div	

Note 1: The control range of the trigger level is related to the peak-peak value and duty cycle of the trigger signal.

1.3.8 Logic Triggering Timing (Digital Mode Only)		
PATTERN/GLITCH DETECTION		
Max. pattern rate	150 MHz	
Min. present time		
PM3394A/92A	2 ns	Pulse amplitude >2 div
PM3384A/82A	4 ns	Pulse amplitude >2 div
range t_1	20 ns, 30 ns, 40 ns, 50 ns to 0.16s	See note 1
range t_2	20 ns, 40 ns, 50 ns, 60 ns to 0.16s	See note 1
accuracy t_1 t_2	±5 ns	

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION
STATE DETECTION		
Max. state rate	150 MHz	
Min. setup time	2.5 ns	Pattern to clock
Min. hold time	2.5 ns	Pattern to clock

Note 1: Timing behavior around t_1 and t_2.

Pattern valid time:

```
------|********|TTTTTTTTTTTTTTTTTTT|********|-------
      t1        t1+10 ns             t2-10 ns   t2
```

- : not triggered
* : undefined
T: triggered

1.3.9 Trigger Accuracies

TRIGGER LEVEL		
Accuracy edge	≤0.2 div	At 1 MHz input signal
D: Accuracy logic	≤0.4 div	At 1 MHz input signal
Trigger gap edge	0.4 div	At 1 MHz input signal in noise trigger multiply by 2
FALSE TRIGGERS	1:100000	See Note 1

Note 1: These values are not tested in production and are based on theoretical estimates and laboratory tests.

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION

1.4 EVENT COUNTER

Event delay		
EDGE	1 to 16384	See Note 1
TV line	1 to n	See Notes 1 and 2
Event enable source	CH1 to CH4 Line Logic	
Event clock	CH1 to CH4	
Event clock mode	Edge	
Event clock slope selection	+ or -	
Event clock coupling	AC, DC	
Event clock sensitivity		
DC to 50 MHz	0.5 div	
Event clock level	8 div	
Max. count frequency	50 MHz	typical value

Note 1: In digital mode, triggered DTB in combination with Event is not possible

Note 2: n is equal to maximum lines of TV system

1.5 HOLD-OFF

HOLD OFF SETTING		
A: Minimum	2 µs or 3 divisions of MTB setting	Whichever is greater
A: Maximum	2s or 20 divisions of MTB setting	Whichever is smaller
D: Minimum	4 ms	See Note 1
D: Maximum	20 divisions of MTB setting	

Note 1: For total hold off time, the process time must be included. See also ACQUISITION TIME.

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION

1.6 PROCESSING

1.6.1 Preprocessing

PREPROCESSING FUNCTIONS		See Note 1
	Invert	CH2; CH4
	Add	CH1+CH2; CH3+CH4; See Note 2
	Subtract	CH1-CH2; CH3-CH4; See Note 2
D:	Peak detection	
D:	Average	See Note 3
D:	Envelope	

Note 1: These functions are performed before the acquisition data is stored in the acquisition registers.

Note 2: Dynamic range in digital mode ±5 div.

Note 3: Average factor 2 to 4096 in power of 2 sequence.

1.6.2 Register Processing (Digital Mode)

REGISTER PROCESSING FUNCTION		See Note 1
	Add	See Note 2
	Sub	See Note 2
	Mul	See Note 2
	Filter	LF filter with adjustable -3dB point

Note 1: There may be run two processes simultaneously. The acquisition registers can also be used as source registers. The result from process one will be stored in memory one. The result from process two will be stored in memory two.

Note 2: The source can be any trace from any register except the result register. The result can be scaled.

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION

1.7 TRACE MEASUREMENTS (DIGITAL MODE)

TRACE MEASUREMENTS FUNCTIONS		See Note 1
Horizontal	Frequency Period Pulse width Rise / fall	
Vertical (with or without offset)	Mean RMS Maximum Minimum Peak/peak Low High Overshoot Preshoot Duty cycle Delay	

Note 1: These measurements can be performed on traces stored in the acquisition and memory registers.

1.8 CURSORS

1.8.1 Cursor Control

NUMBER OF CURSORS	4	
CURSOR RELATION D:	Screen Trace	Free Follows the trace
CURSOR MODES	Time Amplitude Both	 Only screen cursor
Amplitude cursor modes	Absolute Ratio	 See Note 1

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION
Time cursor modes	Absolute Ratio	 See Note 1
Phase cursor Modes	Absolute Ratio	See Note 1

Note 1: The ratio range is 0% to 999% where 100% corresponds to the value in the cursor read out at the moment that the "ΔT=100%" button is pressed.

1.8.2 Cursor Readouts

CURSOR READOUTS	dV	
	dT	See Note 1
	V to GND	
	1/dT	See Note 1
	dQ(Q1, Q2)	See Note 2
	T-trig	See Note 3
READOUT RESOLUTION	3 digits	

Note 1: In the "MTB + DTB timebase" and "DTB", all waveform operations and measurements are performed on the DTB traces.

Note 2: Refer to trigger point (Q1, Q2)
Refer to start of trace (Trace in memory, Q1 and Q2).

Note 3: Gives time differences (delta) between the cursor position and the trigger point (for both cursors).

1.8.3 Cursor Accuracies (Analog Mode)

Voltage measurements		Note 1
Manual	±1% of FULL SCALE	
Time measurements		Note 2
Unmagnified timebase	±1% of FULL SCALE	
Magnified timebase up to 10 ns/div	±1.4% of FULL SCALE	
Magnified timebase in 5 ns/div and 2 ns/div	±2.2% of FULL SCALE	

Note 1: Measured with 1 kHz square wave within central 6 div.
Note 2: within central 8 div.

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION

1.8.4 Cursor Accuracies (Digital Mode)

ERROR LIMIT VERTICAL	See vertical accuracy	
ERROR LIMIT HORIZONTAL	See horizontal accuracy	

1.9 DIGITAL ACQUISITION

1.9.1 Modes

MODES		
Select one:	Recurrent	
	Single shot/scan	
	Roll	Stop on trigger continuous

1.9.2 Sample Rate

Real time	Max. Sample rate 200Ms/s	250 ns/div to 200s/div See Note 1
Equivalent time	Random sampling	2 ns/div to 0.2 µs/div

Note 1: Sampling rate depends on time/division setting.

1.9.3 Multiplexed Channels

This instrument has 4 channels, which are configured as 2 + 2. This implies, that the channels CH1 and CH2 are multiplexed with the channels CH3 and CH4 to share the same dual channel digitizer.

Multiplexed channels (CH1 and CH2) or (CH3 and CH4)	simultaneously	See Note 1
Any other combination for timebase settings		
200s/div to 10 µs/div	CHOPPED	See Note 2
5 µs/div to 2 ns/div	ALTERNATED	

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION
Max. Chop freq.	5 MHz	

Note 1: At 250 ns/div each of the four channels is acquired in alternated mode.

Note 2: When peak detection is activated the multiplexing is in alternated mode.

1.9.4 Trace Memory

This digitizer has a total acquisition memory size of 8K bytes. To apply this memory as efficiently as possible, it is shared by all channels connected to it. The following section summarizes the effects:

Record length normal 1 to 4 channels selected	512 samples/channel	
Record length 'Max' 1 to 4 channels 1 of 4 channels	2K samples/channel 8K samples	See Note 1
Display	501 samples/trace	

Note 1: When peak detection or envelope is activated, all "max" record length figures have to be divided by 2 because samples are stored as peak/ peak combinations.

1.9.5 Acquisition Time

The process time between acquisitions depends from the selected settings and the selected processing. Therefore it is not possible to catch the process time between acquisitions in a formula. The next table gives an indication of the performance of the processing capabilities.

Process time between acquisitions 500 ns/div one channel no trigger delay acquisition length = 512	6 ms	See Note 1 Holdoff is min and no processes or measurements are active
500 ns/div two channel no trigger delay acquisition length = 512 average = 8	16 ms	Holdoff is min and no other processes or measurements are active

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION
Equivalent time		See Note 2
Timebase:		
- at 2 ns/div	2s	
- at 0.2 µs/div	100 ms	

Note 1: Time required to fill the acquisition record at the sampling rate corresponding with the selected timebase setting is not included.

Note 2: After the specified time, there is a 99% probability of all sample positions being updated to the new acquisition. Trigger frequency >2 kHz. These values are not tested in production and are based on theoretical estimates and laboratory tests.

1.9.6 Resolution

ACQUISITION RESOLUTION	8 bits	over 10.24 divisions

1.9.7 Registers

NUMBER OF REGISTERS		Including current acquisition
Acquisition length:		One set contains:
- Normal	9 sets	Four traces
- Max: -4x2k	3 sets	Four traces
-2x4k		Two traces
-1x8k		One trace
WORD LENGTH	16 bits	

1.9.8 Register Manipulations

Clear	The contents of the selected register is set to zero
Save	The contents of the acquisition register is stored in the selected register

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION
Copy		The contents of a selected register is stored in another selected register
Recall		The register can be made visible on the display or can be removed from the display

1.9.9 Digital Acquisition Accuracies

SAMPLING RATE ERROR	±0.01%	X-tal
TIME UNCERTAINTY At double sampling rate	±100ps	

1.10 FRONT PANEL MEMORY

Memory size	10 fronts

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION

1.11 BLANKING OR Z-AXIS (ONLY FOR ANALOG TRACE)

Input connector	BNC	
Input impedance	10 kΩ	
Input coupling	dc	
Max input voltage	±10V	
Input voltage unblank	0.5V or less	See Note 1
Input voltage blanked	+ 2.4 V or more	See Note 1
Response time	80 ns	Rise time 2 ns

Note 1: Half tones are possible at input voltages between +0.8V and +2.4 V. Blanking has only effect on the trace in analog mode.

1.12 DISPLAY

1.12.1 CRT

CRT		
Deflection	Electrostatic	Vector
Dimensions (hxw)	80 mm x 100 mm	8 x 10 divisions
Phospor		
Standard	Green GH (P31)	
GRATICULE	Fixed	
Y-AXIS ORTHOGONALITY	90 ° ±0.5 °	
ACCELERATING VOLTAGE	16.5 kV	
Writing speed	>1.8cm/ns	
TRACE ROTATION		Screwdriver adjustment
Min. range	10 °	External field <0.1 mT
Min. overrange	2 °	
TRACE DISTORTION		
At center of screen	<0.3 mm	Deviation from straight line inside 6 x 8 div
Else	<1.0 mm	

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION

1.12.2 Modes

PRESENTATION MODES	Y versus T Y versus X	

1.12.3 Vertical Display Manipulations (Digital Mode)

Linear		Linear interpolations between measured dots
Sine		Sine like interpolation between measured dots
Vertical magnify	2, 4, 8, 16, 32	
Windows	1, 2, 4	Each trace has his own place on the screen max. 4 traces
Recall trace		Each trace can be made visible on the screen or can be removed from the screen. Note 1
Vertical position	± 8 div	Each trace can be moved over 8 divisions
Max. displayable traces on screen	8	See Note 1

Note 1: At least one trace is visible.

1.12.4 Horizontal Display Manipulations (Digital Mode)

TIMEBASE MAGNIFICATION	2, 4, 8, 16, 32	See Note 1

Note 1: For acquisition depth greater than 512 byte it is possible to make the magnification factor less than one (compress mode) to display the complete trace on the screen.

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION

1.13 EXTERNAL INTERFACES

1.13.1 Calibrator

WAVEFORM		
Shape	square wave	
INTERNAL IMPEDANCE		
Value	1200Ω	
OUTPUT VOLTAGE		
Peak-peak value	600 mV	See Note 1
Tolerance	1%	
OUTPUT CURRENT		
Peak-peak value	0.5 mA	See Note 2
FREQUENCY		
Value	2kHz	
Tolerance	±20%	

Note 1: Positive going with respect to ground; Open voltage (halves when terminated with 1200Ω).
Note 2: When output short circuited (halves when terminated with 1200Ω).

1.13.2 Standard external interface

TYPE OF INTERFACE	RS 232-C		CPL (compact programming language) See operating guide
PINNING			
PIN	I/O	NAME	
1	-	-	Not connected
2	I	RXD	Received data
3	O	TXD	Transmitted data
4	O	DTR	Data terminal ready
5	-	GND	Signal ground
6	I	DSR	Data set ready
7	O	RTS	Request to send
8	I	CTS	Clear to send
9	-	-	Not connected

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION
TRANSMISSION MODES	Asynchronous Full duplex	
HANDSHAKE		
Hardware	RTS/CTS and DSR/DTR	Default: not active See Note 1
Software	XON/XOFF	Default: not active See See Note 1
BAUDRATE	75,110,150,300 600,1200,2000, 2400,4800,9600 19200,38400	Receiving and transmitting Default:1200 See Note 1
NUMBER OF STOP BITS	1	
PARITY	odd,even,or no	Default: no parity See Note 1
CHARACTER LENGTH	7 or 8	Default:8 See Note 1
ERROR RESPONSE	See CPL operating manual	
ELECTRICAL		
TXD and RXD		
Spacing "0"	≥ +3V	
Marking "1"	≤ -3V	
RTS,CTS,DSR and DTR		
ON	≥ +3V	
OFF	≤ -3V	
Current output	≤10mA	
Impedance		
Output	300Ω ±10%	
Input	≥3 kΩ ≤7kΩ	
Voltage		
Output	≥ -12V ≤ +12V	
Input	≥ -25V ≤ +25V	
Connector	Shielded	9 pole RAP male connector according MIL-C-24308

Note 1: Selectabele via UTILITY menu and CPL. When battery installed, same as last power-off value.

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION

1.13.3 Optional external interfaces

IEEE	ANSI/IEEE 488.2	SCPI See section 1.20.5

1.13.4 Printers and plotters support

PRINTERS	HP-thinktjet LQ1500 FX80 HP-LASER
PLOTTERS	HPGL HP7440 HP7550 HP7475A HP7478A PM8277 PM8278

1.13.5 Real Time Clock

(RTC)		
Select:	Time of trigger or Time of pressing hardcopy button	Note 1 Note 2

Note1: These times may be the same when it is not possible to reconstruct the time of trigger.

Note2: - Stamped on any hardcopy via hardcopybutton
- Time is point of data transfer waveform.

1.14 AUTO SET & CALIBRATION

1.14.1 Auto Set

AUTO SET selects the proper channel, sets vertical deflection, timebase speed, intensity, and triggering for an easy-to-read display of input signals, or the user programble AUTO SET items.

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION

1.14.2 Calibration

CALIBRATION FACILITIES	Auto cal	See Note 1

Note 1: Calibrates vertical offset and gain, horizontal offset and gain and sweep time, trigger offset and gain.

1.15 POWER SUPPLY AND BATTERY BACKUP

1.15.1 Power Supply

LINE VOLTAGE		
ac (rms)		
Operation	100V to 240V	
Tolerance	±10%	
LINE FREQUENCY		
Nominal	50 Hz to 400 Hz	
Limits of operation	45 Hz to 440 Hz	
LINE WAVEFORM CHARACTERISTICS		At nominal source voltage
Max. waveform		
Deviation factor	10%	
Crest factor	1.27 to 1.56	
ALLOWABLE POWER INTERTUPTION	20 ms	See Note 1
POWER CONSUMPTION		
Without options	115W	
Max. power consumption	130W	
POWER CORD		
Length	2.1m (82.7 in)	
Power plug	Nat.version	

Note 1: At the lowest allowable source voltage. After this time the oscilloscope data is saved before the instrument goes down, and an automatic power-on sequence starts after restoration of the power source voltage.

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION
1.15.2 Battery Backup		
DATA AND SETTINGS RETENTION		See Note 1
Retention time	2 years	
Batteries:		
Recommended type	LR 6	See Note 2
Quantity	2	
Temperature range	0..+70 °C	See Note 3

Note 1: When instrument is switched off or during power failure.

Note 2: According to IEC 285 (=Alkaline Manganese Penlight Battery).

Note 3: At -40 to 0 °C, settings retention is uncertain. It is advised to remove batteries from instrument when it is stored during longer periods (>24 hours) below -30 °C or above 60 °C. UNDER NO CIRCUMSTANCES SHOULD BATTERIES BE LEFT IN THE INSTRUMENT AT TEMPERATURES BEYOND THE RATED RANGE OF THE BATTERY SPECIFICATION

1.16 MECHANICAL CHARACTERISTICS

PORTABLE VERSION		
Dimensions:		Handles excluded
Length	481 mm (19 in)	Add 5 mm (0.2 in) for cover Add 65 mm (2.5 in) for handle
Width	341 mm (13,5 in)	Add 50 mm (2 in) for handle
Height	139 mm (5,5 in)	Add 8 mm (0.3 in) for feet
Weight:		
Instrument	9.5 kg (19,7 lb)	
COOLING	Regulated Forced air	No air filter

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION

1.17 ENVIRONMENTAL CHARACTERISTICS

1.17.1 General

The characteristics are valid only if instrument is checked in accordance with the official checking procedure. Warm up and recovery time are in accordance with MIL-T 28800D par. 3.7.1.1.

The instrument meets the environmental requirements of MIL-T-28800D Type III Class 3, Style D, Color R (unless specified otherwise).

1.17.2 Environmental

TEMPERATURE		See Note 1
Operating:		
min.low temp.	0 °C	
max.high temp.	+50 °C	
Nonoperating (storage):		
min. low temp.	-40 °C	
max. high temp.	+70 °C	
MAX. HUMIDITY		See Note 1
Operating and Non operating (storage)	95%	Relative humidity noncondensing
MAX. ALTITUDE		See Note 2
Operating	4.6 km (15000 ft)	See Note 3
Nonoperating (storage)	12 km (39000 ft)	
VIBRATION (OPERATING)		See Note 4
Freq. ranges:		g level at max. freq.:
	5 Hz to 15 Hz	0.7 at 15 Hz
	16 Hz to 25 Hz	1.3 at 25 Hz
	26 Hz to 55Hz	3 at 55 Hz

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION
At each freq.range:		
Cycling time	15 min	
Resonance search	5 min	
Resonance dwell	10 min	See Note 5

Note 1: In accordance with MIL-T-28800D par. 3.7.2.1.1. (FIGURE 2).

Note 2: In accordance with MIL-T 28800D par. 3.7.3.

Note 3: Maximum operating temperature derated to 3 °C for each km above sea level

Note 4: In accordance with MIL-T-28800D par. 3.7.4.1.

Note 5: At each resonance frequency (or at 33 Hz if no resonance was found).

SHOCK (OPERATING)		See Note 6
Amount of shocks		
total	18	
each axis	6	3 in each direction
Shock waveform	half sinewave	
Duration	6-9 ms	
Peak acceleration	400 m/s^2	
BENCH HANDLING		See Note 7
Meets requirements of	MIL-ST-810 method 516 procedure V	
TRANSPORTATION	Drop height 0.76m	See Note 9
SALT ATMOSPHERE		
Structural parts		See Note 8

Note 6: In accordance with MIL-T-28800 par. 3.7.5.1.

Note 7: In accordance with MIL-T-28800 par. 3.7.5.3.

Note 8: In accordance with MIL-T-28800 par. 3.7.8.1.

Note 9: Drop in shipping container on 8 corners, 12 edges, 6 surfaces.

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION

1.17.3 EMI

1.17.3.1 Meets MIL-T 28800D Type III Class 3 (Navy requirement, unless specified otherwise).

Meets MIL-STD-461C as follows:

- Conducted Emissions	Part 2	CEO1	(Narrow band)
	Part 4	CEO3	
- Conducted Susceptibility	Part 2	CSO1	
	Part 5	CSO6	(Limited to 300V)
- Radiated Emissions	Part 5,6	REO1	
	Part 2	REO2	(1 GHz max)

1.17.3.2 VDE requirements

The instrument meets the requirements of VDE 0871 Grenzwert-klasse B.

1.17.3.3 Additional EMI requirements

The instrument is tested in accordance with IEC 351-1 par. 5.1.3.1. The maximum deflection factor is 7 mm/mT (0.7 mm/gauss). This value measured with the instrument in a homogeneous field (in any direction with respect to the instrument) with a flux intensity (peak to peak value) of 1.42 mT (14.2 gauss) and of symmetrical sine wave form with a frequency of 45 Hz to 66 Hz.

1.18 SAFETY

MEETS REQUIREMENTS OF	IEC 348 Class I	See Note 1
	UL 1244	See Note 2
	CSA C22.2 No231	See Note 2
	VDE 0411	See Note 1
APPROVALS (applied for)	CSAC22.2 No231	
MAX. X-RADIATION	MIL-T-28800D par. 3.9.3.4.a	

Note 1: Except for power cord, unless shipped with universal European power cord.
Note 2: Except for power cord, unless shipped with North American power cord.

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION

1.19 ACCESSORIES

PACKED WITH INSTRUMENT		
Signal input	2x10 MΩ 10:1 probe	With readout (1.5 m)
	Contrast filter	Blue
	Front cover	Can be locked on instr.
Operating guide		
Reference manual		

1.20 OPTIONS & OPTIONAL VERSIONS

1.20.1 Options Line cord

LINE CORD	Universal	
	European	In accordance with VDE
	North American	In accordance with CSA, UL
	United Kingdom	In accordance with BSI
	Australian	In accordance with SAA
	Swiss	In accordance with SAV

1.20.2 Options digital versions

EXTERNAL INTERFACES	IEEE	Factory installed only
INTERNAL EXTENSIONS	EXTENDED MEMORY	Factory installed only
	MATH+	Factory installed only

1.20.3 Options analog versions

EXTERNAL INTERFACES	Y-out, MTB gate, DTB-gate, ExtTrig.	Factory installed only
	IEEE	Factory installed only

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION

1.20.4 Specification optional outputs

Y SIGNAL OUT	BNC	
Source	CH1	
Coupling	as CH1	
Voltage:		
into 1 MΩ	20mV/div	
with a tolerance of	±10%	
into 50Ω	10mV/div	
with a tolerance of	±10%	
Freq. response	dc to ...	Terminated with 50Ω
Installed in		
PM3392A/94A	200 MHz	
Installed in		
PM3382A/84A	100 MHz	
Dynamic range	±10 div	At 50 MHz
MTB GATE OUT		
Connector	BNC	
Output impedance	1 kΩ	
Voltage:Timebase		
not running	0.2 ± 0.2V	
Timebase running	3.7 ± 1.3V	
DTB GATE OUT		
Connector	BNC	
Output impedance	1 kΩ	
Voltage:Timebase		
not running	0.2 ± 0.2V	
Timebase running	3.7 ± 1.3V	

1.20.5 Specification External trigger option

SOURCE

SOURCE(S) MTB-triggering	CH1 ... CH4	
	External	no line triggering (in analog models)
	Composite	Combi-scopes: line

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION
INPUT CHARACTERISTICS		
INPUT CONNECTOR	BNC	At rear of instrument
INPUT IMPEDANCE		Measured at freg. <1MHz
R parallel - value	1 MΩ	
- tolerance	±1%	
C parallel - value	25 pF	
- tolerance	±5 pF	
DYNAMIC RANGE		
Up to 10 MHz	±2.5V	Symmetrical
⚠ INPUT VOLTAGE LIMITS		See note 1
(d.c. + a.c. peak)	±400V	See note 2

Note 1: Apparaturs should be properly grounded through the protective ground conductor of the power cord.

Note 2: Up to 10 kHz; >10 kHz see figure 1.1.

SENSITIVITY

EDGE TRIGGER SENSITIVITY		See note 3
d.c. to 5 MHz	100 mV	
d.c. to 10 MHz	200 mV	

Note 3: In noise-trigger multiply stated value by 2.

TRIGGER LEVEL

TRIGGERLEVEL		
Range	±1.5V	See note 4
Accuracy	≤0.4V	at 1 kHz input signal triggercoupling DC

Note 4: With Level-pp on the range is restricted to the peak-peak value of the trigger signal.

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION
1.20.6 Specification IEEE-OPTION		
TYPE OF INTERFACE	ANSI/IEEE 488.2	SCPI (see SCPI programming manual) See Note 1
INTERFACE REPERTORY		
Source handshake	SH1	Complete capability
Acceptor handshake	AH1	Complete capability
Talker	T5	Basic talker: yes Serial poll : yes Talk only : yes Unaddress if MLA: yes
Listener	L3	Basic listerner: yes Listener only : yes Unaddress if MTA: yes
Service request	SR1	Complete capability
Remote local	RL1	Complete capability
Parallel poll	PP0	No capability
Device clear	DC1	Complete capability
Device trigger	DT1	Complete capability
Controller	C0	No capability
ELECTRICAL INTERFACE		
Busdrivers	E2	Three state (true=0 to 0.8V;false=2 to 5V)
Connector	Shielded	Amphenol type 57FE-20240-20SD35
Pin 1 ... 4	DIO1...DIO4	
Pin 13 ... 16	DIO5...DIO8	
Pin 18 ... 23	GND	
Pin 24	Logic GND	
Pin 5	EOI	
Pin 6	DAV	
Pin 7	NRFD	
Pin 8	NDAC	
Pin 9	IFC	
Pin 10	SRQ	
Pin 11	ATN	
Pin 12	Shield	
Pin 17	REN	

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION
FUNCTION SELECTION	Via UTILITY-MENU	Busaddress Default: 8 See Note 2
INTERFACE STATUS INDICATOR	On screen	

Note 1: Talker/listener

Note 2: When battery installed, same as last power-off value.

1.20.7 Extended memory

If extended memory option is installed the paragraphs 1.2.5 (Time base delay digital mode), 1.9.4 (Trace memory) and 1.9.7 (Registers) must be replace by the next three paragraphs.

(1.2.5) Time base delay (digital mode)

TIME DELAY TRIGGER POSITION acquisition length normal	-10 to 0 div.	pretrigger
acquisition length max.	-640 to 0 div	pretrigger
DELAY	0 to 1000 div	posttrigger
Resolution	steps of 0.02 div	sample distance
EVENTS DELAY Range	1 to 16384	See event counter

(1.9.4) Trace memory

This digitizer has a total acquisition memory size of 32 kbyte. To apply this memory as efficient as possible it is shared by all channels connected to it. The following section summarizes the effects:

Record length normal 1 to 4 channels selected	512 samples/channel

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION
Record length 'Max'		
1 to 4 channels selected	8k samples/channel	See Note 1
1 of 4 channels	32k samples	
Display	501 samples/trace	

Note 1: When peak detection or envelope is activated, all "max" record length figures have to be divided 2, because samples are stored as peak/peak combinations.

(1.9.7) Registers

NUMBER OF REGISTERS			Including current acq.
one set contains:			
Acquisition length:			
-Normal		51 sets	four traces
-Max:	-4 x 8k	3 sets	four traces
	-2 x 16k		two traces
	-1 x 64k		one trace
WORDLENGTH		16 bits	

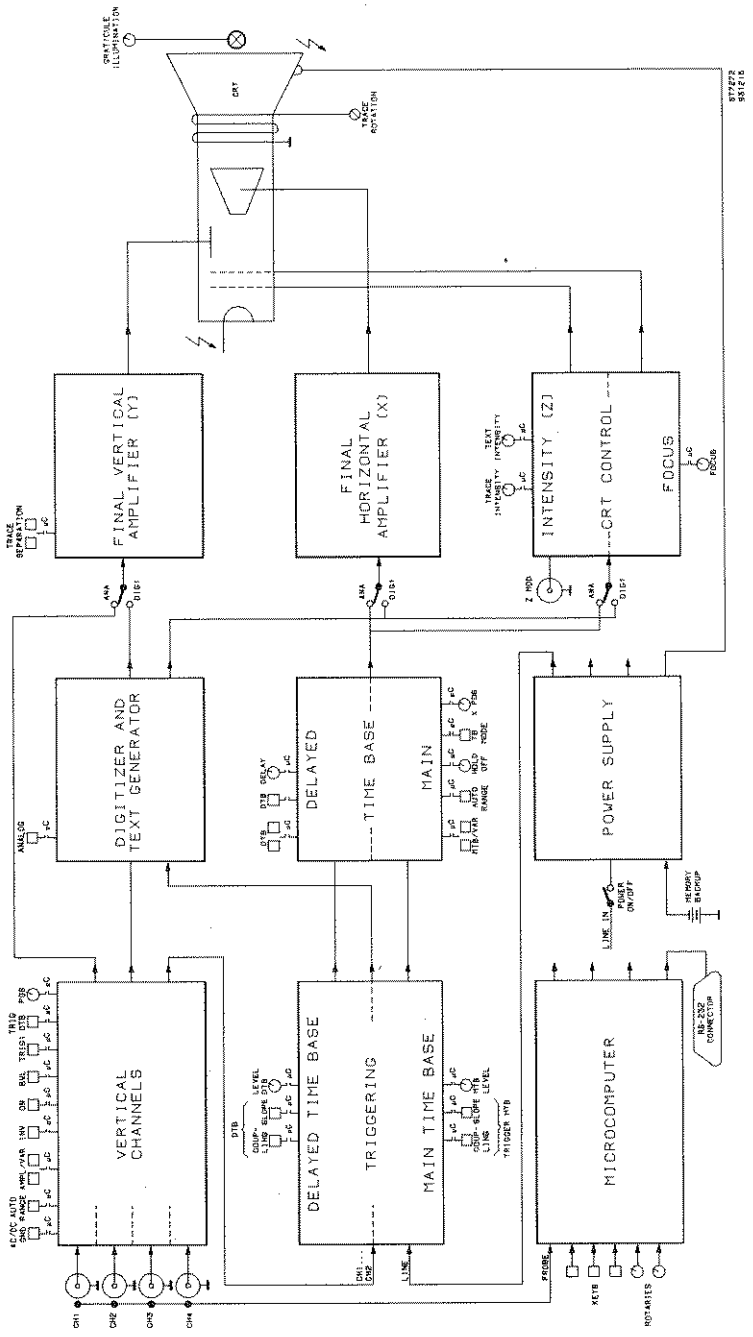


Figure 2.1 Blockdiagram.

2 PRINCIPLE OF OPERATION

2.1 INTRODUCTION

This chapter describes the principle of operation and should be read in combination with the block diagram in figure 2.1.

The block diagram shows the user in which sections of the oscilloscope circuitry the controls and keys are operating, and how signals are routed. For a detailed description of each function, refer to chapter 5 'Function Reference' in the Operating Guide.

Lines between controls/keys and the block they are operating are interrupted. The text 'µC' at the interruption indicates that the control operates the block via the microComputer.

2.2 CONTROL SECTION

The heart of the control section is formed by a MICROCOMPUTER with an incorporated RS-232 interface. The MICROCOMPUTER reads all the keys (except POWER ON/OFF) and rotary controls. It sends control signals to the oscilloscope circuits to put them in the desired mode. Control of the oscilloscope functions can also be done by an external computer connected to the RS-232 CONNECTOR.

2.3 VERTICAL DEFLECTION

This section consists of the blocks VERTICAL CHANNELS and FINAL VERTICAL AMPLIFIER. There are four vertical channels. Small differences between the channels depend on instrument versions. The inputs CH1 ... CH4 are applied to the block VERTICAL CHANNELS. In this block the following functions are made:

- Input coupling can be switched between AC, DC and GND. As an extra 50Ω input impedance can be selected in the 200 MHz models via the VERT MENU key.
- The AMPL/VAR key pair determines the input sensitivity of each channel. The most suitable input sensitivity is selected automatically if AUTO RANGE is active. Some channels may have a switch to toggle between the two most commonly used input sensitivities.

- Each channel can be switched on/off with the ON key and bandwidth can be limited to 20 MHz via BW LIMIT 'on' in the VERT MENU.
- Trigger source selection for MTB and DTB is done via the keys TRIG1 ... TRIG4 and the menu under the DTB key.
- The vertical signal position of each channel can be adjusted with a POS control.

The FINAL VERTICAL AMPLIFIER drives the vertical deflection system of the Cathode Ray Tube (CRT). The TRACE SEPARATION key pair adjusts the vertical distance between MTB and DTB display, when in Alternate Timebase Mode.

2.4 HORIZONTAL DEFLECTION

The horizontal deflection consists of the blocks TRIGGERING, TIMEBASE and FINAL VERTICAL AMPLIFIER. TRIGGERING and TIMEBASE are both split up in sections for MTB and DTB; these sections are almost identical.

Triggering can be done via CH1 ... CH4 or a signal derived from the line voltage. The following controls adjust the triggering:

- COUPLING permits selection between ac, dc, lf-reject, hf-reject and noise suppression.
- SLOPE permits triggering on positive- or negative-going signal edges.
- LEVEL adjusts the signal level where the timebase is started.

The output of the TRIGGERING generates a pulse that starts the TIMEBASE.

The TIMEBASE generates a so-called sawtooth signal that gives a time linear horizontal display on the CRT. The following controls influence the timebase:

- MTB/VAR and DTB adjust the horizontal time scale of MTB and DTB. The best MTB time scale is selected automatically if AUTO RANGE is active.
- The TB MODE key permits selection between auto (free run), trig(gered) and single (shot) mode of MTB. The SINGLE RESET key resets the MTB when in single shot mode.
- The DTB key permits selection of the operating modes of the DTB.
- The HOLD OFF control adjusts the period of time that the MTB does not start upon receipt of a trigger.
- The DELAY control adjusts the time delay between start of MTB and DTB.
- X POS controls the horizontal position of the signal display.

2.5 CRT DISPLAY SECTION

This section determines the intensity and focusing of the signal on the screen. The intensity of trace and text/cursors can be adjusted separately with the controls TRACE INTENSITY and TEXT INTENSITY. The FOCUS control determines the sharpness of text and traces. Moreover focusing is controlled such that changes in intensity do not affect display sharpness.

2.6 POWER SUPPLY

This POWER SUPPLY converts a wide range of line input voltages into stable supply voltages that feed the circuits in the oscilloscope. Also the very high voltages for the CRT are made by the power supply. Another output signal is used to trigger the MTB if 'line' is selected as trigger source. Memories in the oscilloscope are supplied by a MEMORY BACKUP battery if line voltage is switched off.

2.7 DIGITIZER SECTION

In DIGITAL MODE the CH1 ... CH4 input signals are applied to the DIGITIZER AND TEXT GENERATOR where they are digitized and stored in a memory. The signal storage is initiated by pulses from the TRIGGERING.
Also the generation of text/cursors is done in the block DIGITIZER AND TEXT GENERATOR.
For display on the CRT, the digital information is converted into analog and applied to the final amplifiers for VERTICAL and HORIZONTAL deflection. The FOCUS and INTENSITY parts are controlled in a similar way. Switching between ANALOG MODE and DIGITAL MODE is done via the ANA/DIGI switches that are operated by the DIGITIZER AND TEXT GENERATOR. The switches are incorporated in the inputs of the output stages of Final Y, Final X, Intensity and Focusing.

3 BRIEF CHECKING PROCEDURE

3.1 General information

This procedure is intended to verify the instrument's functions with a minimum of test steps and actions required.
It is assumed that the operator doing this test is familiar with this kind of instruments and their characteristics.

WARNING: Before turning on the instrument, ensure that it has been installed in accordance with the instructions mentioned in Chapter 2 of the Operation Guide.

NOTE: The procedure does not verify every facet of the instrument's calibration; rather, it is concerned primarily with those parts of the instrument that are essential to measurement accuracy and correct operation. Removing the instrument covers is not necessary to perform this procedure. All checks are made from the outside of the instrument.

If this test is started a few minutes after turning on the instrument, test steps may be out of specification, due to insufficient warm-up time. Be sure to allow the full warm-up time of 30 minutes (under average conditions).

The check is set up in a logical sequence. For a complete check of every facet of the instrument's calibration, refer to the 'PERFORMANCE TEST' section in Chapter 4 of this Reference Manual (for qualified persons only).

The check can be used for different instrument types. Where differences exist, they are indicated (e.g., in the vertical channels). Those test steps can be skipped.

3.2 Preliminary settings of the controls

For ease of reading the following abbreviations are used:

CW = Clockwise (rotation direction of a control)
CCW = Counter Clockwise (rotation direction of a rotary control)
CRT = Cathode Ray Tube (the oscilloscope's viewing area)
MTB = MAIN TB
DTB = DELAYED TIMEBASE, DEL'D TB

Trace alignment:
- Turn the oscilloscope on with the POWER ON OFF key.
- Press the STATUS and TEXT OFF keys simultaneously. This ensures that the oscilloscope is in the default mode. The default mode is the basis of this brief checking procedure.
- Press the AUTOSET key.
- Turn the TRACE INTENSITY control so that a clearly visible horizontal line appears on the CRT.
- Press the TEXT OFF key when no text is present on the CRT. Turn the TEXT INTENSITY control so that clearly visible text appears on the CRT.
- Turn the FOCUS control to make the line and text look as sharp as possible across the CRT area.
- Turn the GRATICULE ILLUMINATION control so that the desired illumination of the measuring graticule is obtained.
- Verify that the trace on the CRT is exactly parallel to the horizontal lines of the measuring raster; if not, correct this with a small screwdriver on the TRACE ROTATION control.

Instrument calibration.
Press the CAL key for two seconds: this starts the AUTOCALibration procedure. Wait until the normal display appears again. The oscilloscope calibration is now optimized.

Probe adjustment:
- Connect a 10 : 1 probe to the CH1 input.
- Connect the probe tip to the Probe Adjust output socket.
- Press the green AUTOSET key.
- Verify that a square-wave signal is displayed on the CRT.
- Verify that top and bottom of the square wave are straight: if not, this must be corrected by adjusting the probe. The correction is done with a small screwdriver. This adjustment is made in the box at the oscilloscope input side of the probe: refer to figure 3.1 for this.

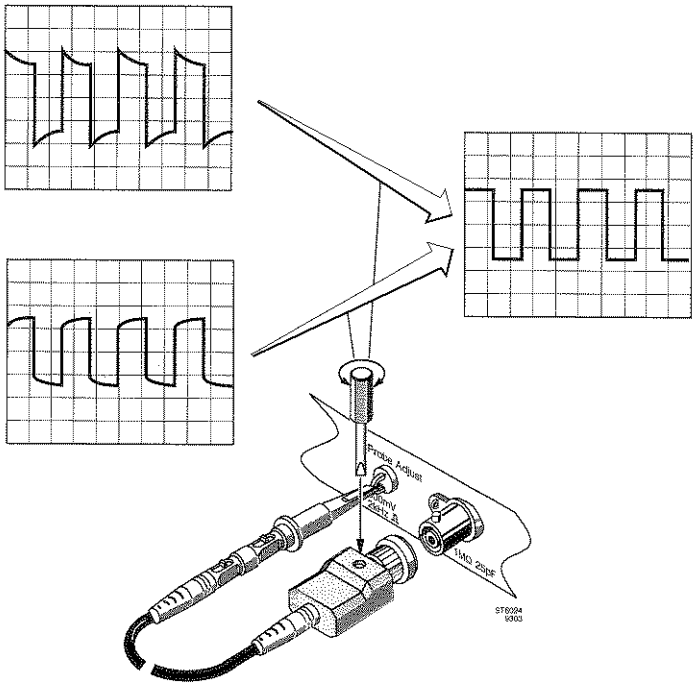


Figure 3.1 Probe adjustment

Note :

- The POS CH1, POS CH2, POS CH3, POS CH4 and X POS controls need occasional readjustment during this procedure to align the waveform with the measuring raster.
- Small readjustments of the TRACE INTENSITY, TEXT INTENSITY and FOCUS controls may also be necessary.
- Information about active instrument settings is indicated on the viewing area as shown in Fig. 3.2.

Repeatedly pressing the TEXT OFF key allows you to select the amount of information on the display.

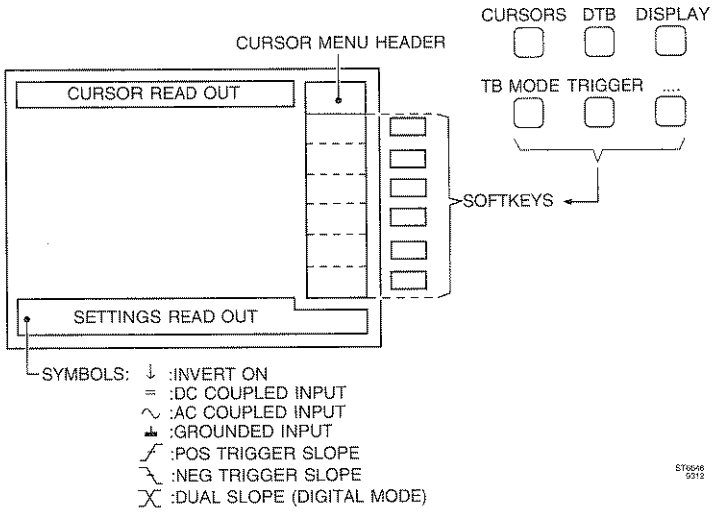


Figure 3.2 CRT viewing area, softkeys, menu keys, and symbols used in this chapter.

3.3 Vertical section

The vertical section consists of four channels CH1, CH2, CH3 and CH4. These are almost identical. The procedure is described for CH1. Steps for CH2, CH3 and CH4 are shown in parenthesies. To check all four channels the procedure must be done four times.

In some instrument versions, CH3 and CH4 have a limited range of input sensitivities. Differences in the keys for AC/DC input coupling, grounded trace (GND) and 50Ω input impedance may exist as well. This is indicated in the text. These test steps may be skipped.

Proceed as follows:

Preparation:
- Connect a probe to the CH1 (CH2, CH3, CH4) input.
- Connect the probe tip to the Probe Adjust output socket.
- Press the AUTOSET key.
- The Probe Adjust output square-wave voltage should be well triggered. The waveform must be easy to read.
- Press the ANALOG key ('DIGITAL MODE' is displayed briefly): the oscilloscope is now in digital mode.

- Press the AUTOSET key again.
- Adjust the AMPL keys to an input sensitivity of 100mV/div; in case of an AMPL toggle key on CH3/CH4 the sensitivity must be 1.00 V.
- Adjust the MAIN TB TIME/DIV keys pair to 100 µs/div.
- Verify that a square wave as indicated in Fig. 3.3 is displayed; in case of an AMPL toggle key on CH3/CH4, the vertical amplitude is 0.6 divisions instead of 6 divisions. The corresponding display is shown in Fig. 3.4.

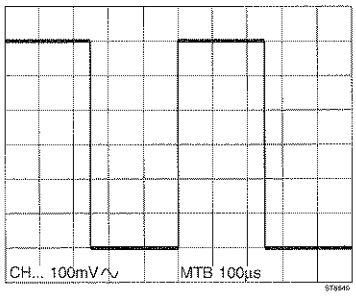


Figure 3.3

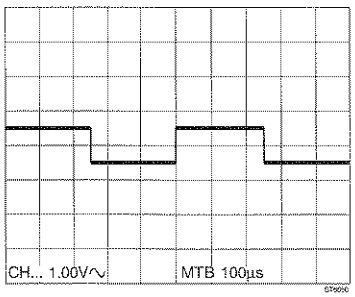


Figure 3.4

Input coupling and POS control:

- Press the AC/DC/GND key so that dc input coupling (=) is obtained.
- Verify that this results in an upward signal shift. Fig. 3.5 shows this for channels with 100mV input sensitivity: the shift is 3 divisions. Fig. 3.6 shows this for channels with 1.00 V input sensitivity: the shift is 0.3 divisions..

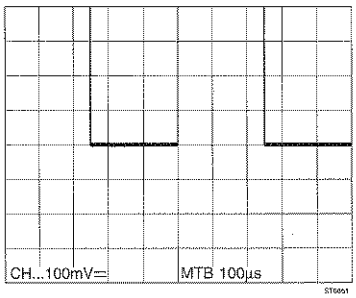


Figure 3.5

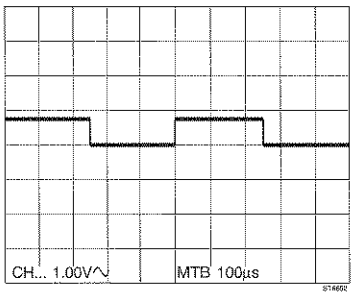


Figure 3.6

- Turn the POS control CCW until the display of Fig. 3.3 or Fig. 3.4 is obtained again.
- Press the AC/DC/GND key so that GND input coupling (⊥) is obtained.
- Verify that this results in a horizontal line in the lower part of the CRT.
- Turn the POS control CW until the line is in the middle of the screen.
- Press the AC/DC/GND key so that ac input coupling (∿) is obtained. The waveform as indicated in Fig. 3.3 or Fig. 3.4 is displayed again.

AMPL and VAR functions (this test is skipped for channels where AMPL is a toggle key):

- Press the lower AMPL key and verify that the signal amplitude is 3 divisions. The input sensitivity is 200mV/div.
- Press the upper AMPL key twice and verify that the amplitude is bigger than the screen height of 8 divisions. Use the POS control to shift the top and bottom of the signal into the screen area.
- Press both AMPL keys; this activates the VAR function. Now input sensitivity can be adjusted in fine steps. The message 'VARIABLE ATTENUATION' is displayed briefly.
- Press the lower AMPL key until a readout of 150 mV is reached.
- Turn the POS control to position the waveform in the middle of the screen.
- Check for a display as indicated in Fig. 3.7.

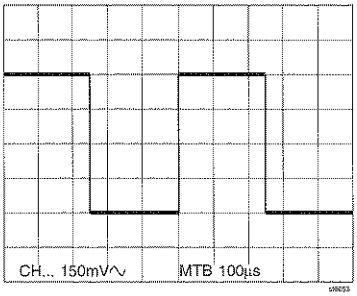


Figure 3.7

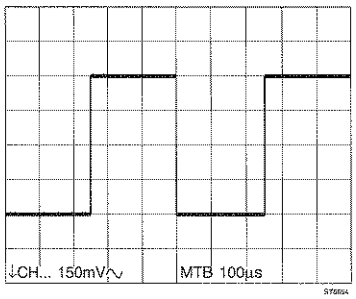


Figure 3.8

INV function:

- The following check is only required for CH2 and CH4.
- Press the INV key and check for a display as shown in Fig. 3.8.

AUTO RANGE function:

- The following check is only required for channels with an AUTO RANGE key. The AUTO RANGE function automatically selects the input sensitivity to the best possible amplitude of an input signal.
- Press the AUTOSET key. Verify that a stable signal is displayed.
- Press the upper AMPL key and select 20.0 mV/div. The signal amplitude is bigger now than the 8 divisions screen height.
- Press the channel's AUTO RANGE key and check that the input signal is again visible with an amplitude between 2 and 6.4 divisions.
- Press the lower AMPL key and select 2.00 V/div. The signal amplitude is very small and it may be that the instrument is not triggered.
- Press the channel's AUTO RANGE key and check that the input signal is again visible with an amplitude between 2 and 6.4 divisions.
- Press the ANALOG key to switch the instrument back to analog mode ("ANALOG MODE' appears briefly).

3.4 Horizontal section, MAIN TB and DELAYED TIME BASE.

Preparation:
- Connect a probe to the CH1 input.
- Connect the probe tip to the Probe Adjust output socket.
- Press the AUTOSET key.
- Adjust the AMPL keys to an input sensitivity of 100mV/div.
- Adjust the MAIN TB TIME/DIV keys to 100 µs/div.
- Verify that a square-wave as shown in Fig. 3.3 is displayed.

MTB trigger slope:
- Press the TRIG 1 key and verify that the displayed square-wave starts with a negative-going signal.
- Press the TRIG 1 key again and verify that the displayed square-wave starts with a positive-going slope as indicated in Fig. 3.3.

Time coeficients MAIN TB and VAR in analog mode:
- Press the left of the MAIN TB TIME/DIV keys and verify that the number of signal periods increases.
- Select 500 µs/division and verify that one signal period is displayed per division.
- Press both MAIN TB TIME/DIV keys: this activates the VAR mode. The message 'VARIABLE TIMEBASE' is displayed briefly.
- Press the right of the MAIN TB TIME/DIV keys until 250 µs is displayed.
- Verify that one signal period occupies 2 divisions.
- Press the left of the MAIN TB TIME/DIV keys until 500 µs is displayed.
- Verify that one signal period occupies 1 divison.
- Press both MAIN TB TIME/DIV keys: the VAR mode is switched off. The message '1-2-5 STEPS' is displayed briefly.
- Press the right of the MAIN TB TIME/DIV keys and verify that the number of signal periods decreases.
- Select 100 µs/division with the MAIN TB TIME/DIV keys and verify that the square wave is displayed as shown in Fig. 3.3.

MAIN TB and DELAYED TIMEBASE functions:
- Press the lower CH1 AMPL key so that an input sensitivity of 200 mV/division is obtained for channel 1.
- Use the CH1 POS control to position the signal in the upper half of the screen.
- Press the DTB menu key: the DELAYED TIMEBASE menu appears at the CRT softkeys.
- Select DEL'D TB 'on' and MAIN TB 'on' from this menu.
- Use the DELAYED TIMEBASE keys, to select 20.0 µs/division.

- Adjust the DELAY control in the DELAYED TIMEBASE section so that the display shown in Fig. 3.9 is obtained. For this the TRACK control must be adjusted so that MAIN TB is above the DEL'D TB display.
- Press the left of the DELAYED TIMEBASE TIME/DIV keys and verify that the number of the displayed signal periods increases. The lowest TIME/DIV range is 100 µs/division.
- Press the right of the DELAYED TIME BASE TIME/DIV keys and verify that the number of displayed periods increases. Proceed until the time scale of 50.0 µs/division is reached.

- Select 'trig'd' from the DELAYED TIME BASE menu.
- Press the front panel key TRIG1 if the DELAYED TIMEBASE is not triggered on CH1. This is indicated in the lower right corner of the display.
- Use the Δ control to adjust the trigger level of DELAYED TIMEBASE for
- a triggered display (signal on DEL'D TB time scale visible).

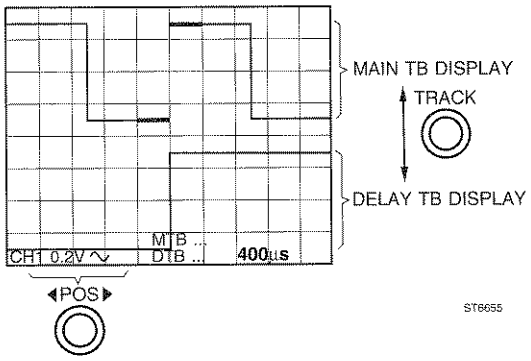


Figure 3.9

MAIN TB trigger slope and time coeficients in digital mode:

- Press the ANALOG key ('DIGITAL MODE' is displayed briefly). The oscilloscope is now in digital mode.
- Press the AUTOSET key.
- Adjust the AMPL keys to an input sensitivity of 100 mV/division.
- Adjust the MAIN TB TIME/DIV keys to 100 µs/DIV.
- Press the TRIG1 key and verify that the displayed square wave starts with a negative going signal.
- Press the TRIG1 key and triggering on the positive slope is obtained again.
- Press the left side of the MAIN TB TIME/DIV keys and verify that the number of signal periods increases.
- Select 500 µs/division and verify that one signal period is displayed per division.

- Press the right side of the MAIN TB TIME/DIV keys and verify that the number of signal periods decreases.
- Use the MAIN TB TIME/DIV to select 20.0 µs/division.

AUTO RANGE function:
- The AUTO RANGE function of the main time base (MAIN TB) adjusts the time base automatically so that 2 to 6 waveform periods are displayed.
- Press the AUTO RANGE key in the time base section.
- Check that the time base is readjusted so that 2 to 6 waveform periods are displayed.
- Press the left of the MAIN TB TIME/DIV keys until MTB 2.00ms is displayed.
- Press the AUTO RANGE key in the time base section.
- Check that the time base is readjusted so that 2 to 6 waveform periods are displayed.
- Press the AUTO RANGE key in the time base section.
- Adjust MAIN TB TIME/DIV to 100µs/div.

MAIN TB and DELAYED TIMEBASE functions:
- Press the lower CH1 AMPL key so that an input sensitivity of 200 mV/division is obtained for channel 1.
- Use the CH1 POS control to position the signal in the upper half of the screen.
- Press the DTB menu key, the DELAYED TIME-BASE menu appears above the CRT softkeys.
- Select DEL'D TB 'on' and MAIN TB 'on' front from the DELAYED TIMEBASE menu.
- Use the DEL'D TB TIME/DIV to select 20.0 µs/division.
- Adjust the DELAY control in the DELAYED TIME BASE section so that the display of Fig. 3.9 is obtained. To do this the TRACK control must be adjusted such that MAIN TB is above the DEL'D TB display.
- Press the left side of the DELAYED TIME BASE TIME/DIV keys and verify that the number of displayed signal periods increases. The lowest TIME/DIV range is 100 µs/division.
- Press the right side of the DELAYED TIME BASE TIME/DIV keys and verify that the number of displayed periods increases. Proceed until the time scale of 50.0 µs/division is reached.

- Select 'trig'd' from the DELAYED TIME BASE menu.
- Press the front panel key TRIG1 if the DELAYED TIMEBASE is not triggered on CH1. This is indicated in the lower right corner of the display.
- Use the Δ control to adjust the trigger level of DELAYED TIMEBASE for a triggered display. The signal on the DEL'D TB time scale is visible.
- Press the ANALOG key to switch the instrument back to analog mode ('ANALOG MODE' is displayed briefly.

3.5 Horizontal section, X-deflection.

Preparation:
- Connect a probe to the CH1 input.
- Connect the probe tip to the Probe Adjust output socket.
- Press the AUTOSET key.
- Press the AMPL keys to adjust to an input sensitivity of 100mV/div.
- Press the MAIN TB TIME/DIV keys to adjust to 100 µs/div.
- Verify that a square wave as shown in fig. 3.3 is displayed.

X-defection check:
- Press the CH2 ON key to turn CH2 on.
- Press the CH1 ON key to turn CH1 off.
- Press the DISPLAY menu key.
- Press the X-DEFL softkey in the DISPLAY menu.
- Select 'on' and 'ch1' as X-SOURCE in the X-DEFL menu.
- Verify that two points with a horizontal distance of approximately 6 divisions are displayed.

3.6 Cursors

Preparation:
- Connect a probe to the CH1 input.
- Connect the probe tip to the Probe Adjust output socket.
- Press the AUTOSET key.
- Adjust the CH1 AMPL key pair to obtain an input sensitivity of 100mV/div.
- Adjust the MAIN TB TIME/DIV keys to100 µs/div.
- Verify that a square wave with an amplitude of 6 divisions is displayed.

VOLT cursors check:
- Press the CURSORS menu key; the CURSORS menu appears at the CRT softkeys.
- Use the softkeys to select 'on' and volt cursors (=).
- Verify that a dashed and a dotted horizontal line (the volt cursors) appear on the screen.
- Press the READOUT softkey and select Δ V from the menu.
- Press softkey RETURN.
- Use the TRACK control to position the dashed line exactly on the bottom level of the waveform.
- Use the Δ control to position the dotted line exactly on the top level of the waveform as shown in figure 3.10.
- Check for a volt cursor readout of approximately 600 mV in the top of the display area.

- Press the ANALOG key ('DIGITAL MODE' is displayed briefly). The oscilloscope is now in digital mode.
- Verify that the cursors are on the top and bottom of the waveform. If necessary, readjust them using the TRACK and Δ controls.
- Check for a volt cursor readout of approximately 600 mV in the top of the display area.

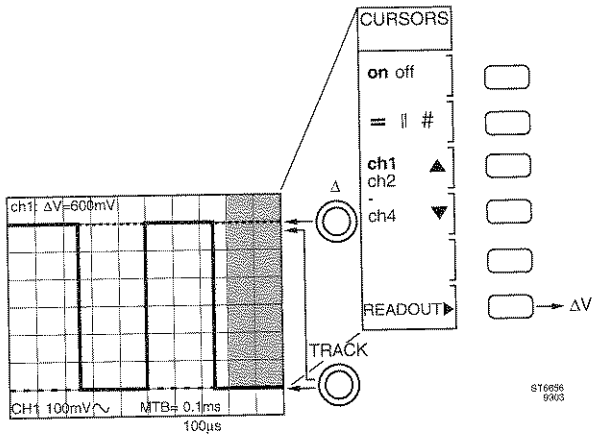


Figure 3.10

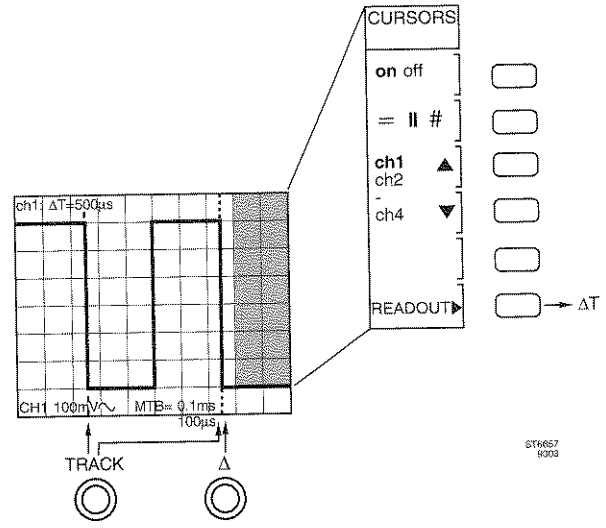


Figure 3.11

- In some tests vertical channels CH2, CH3, CH4 appear in parentheses after CH1, e.g., CH1 (CH2, CH3, CH4). This indicates that the CH1 test should be performed first, followed by the tests for CH2, CH3 and CH4.
- Some of the tests are not necessary for all four oscilloscope types. This is indicated as necessary. The test step may then be skipped.
- Where required, tests are done in either analog or digital mode. Switching between analog and digital mode is done by pressing the ANALOG key. When you enter either analog or digital mode, the display indicates 'ANALOG MODE' or 'DIGITAL MODE' briefly.
- Test steps where the use of a 10:1 probe is mentioned, must be done with the probe type such as delivered with the oscilloscope.

4.2 RECOMMENDED TEST EQUIPMENT

Note: the digital multimeter and oscilloscope are not required for this test.

Type of instrument	Required specification	Example of recommended instrument
Function generator	Freq: 1 Hz...10 MHz Sine wave/square-wave Ampl: 0...20V (pp) DC offset -5...+5V Rise time ≤30 ns Duty cycle 50%	PM5134 or PM5138
Constant amplitude sine wave generator	Freq: 50 kHz...250 MHz Constant pp. amplitude of 120 mV to 3V.	Tektronix SG 503
Constant amplitude sine wave generator	Freq: 50 kHz...300 MHz. Constant pp. amplitude of 120 mV to 3V	Tektronix SG 504 To check the trigger sensitivity in PM3392A/94A
Square-wave calibration generator	For ampl. calibration: Freq: 1 kHz Ampl: 10 mV...50 mV For rise time measurements: Freq: 1 MHz Ampl: 10...900 mV Rise time: ≤1 ns	Tektronix PG 506

Time marker generator	Repetition rate: 0.5s...2 ns	Tektronix TG 501
Digital multimeter	Wide voltage and current ranges.	PM2525 with AC, DC and resistance ranges. High voltage probe. Required: 1% accuracy, PM9246
Variable voltage transformer (VARIAC)	Well insulated output voltage 90...264V (ac)	Order. number 2422 529 00005
TV pattern generator with video output		
Oscilloscope	The bandwidth must be the same or higher than the bandwidth of the instrument under test.	PM3394A
50Ω cables, 75Ω cable, 50Ω terminations, 75Ω termination, 10:1 attenuator, T-piece, power splitter	Tektronix and Fluke BNC types for fast rise time square-wave, high frequency sine wave and other applications.	TEK 012-0482-00 TEK 012-0074-00 TEK 011-0049-01 TEK 011-0055-01 TEK 011-0059-02 PM9067 PM9584/02
BNC/Probe tip adapter	For Bandwidth check in PM3392A	Ord. nr. 5322 263 50022

4.3 TEST PROCEDURE

4.3.1 Preliminary settings

Test equipment:

None

Settings/procedure and requirements:

1 - If not present install 2 penlight (LR6) back up batteries in the holder at the rear panel of the oscilloscope.
2 - Turn on the oscilloscope under test.
3 - Press the STATUS and TEXT OFF keys simultaneously. This assures that the oscilloscope follows the default reaction when the green AUTOSET key is pressed. You can verify that the oscilloscope is in analog mode by pressing the RUN/STOP key. If you are in analog mode, the message 'PLEASE FIRST SWITCH TO DSO' is displayed. The now following steps are applicable for PM3392A and PM3394A.
4 - Press the UTILITY menu key to display the UTILITY menu.
5 - Press softkey AUTOSET to display the UTILITY AUTOSET menu.
6 - Press the relevant softkey to put the oscilloscope in the 'userprog' mode; the text 'userprog' must be intensified.
7 - Press softkey VERT.
8 - Select with softkey '1MΩ / 50Ω / unaffect' the 'unaffect' position.
9 - Check for the instrument settings in the lower part of the viewing area: when not available press TEXT OFF until the maximum amount of information is displayed.

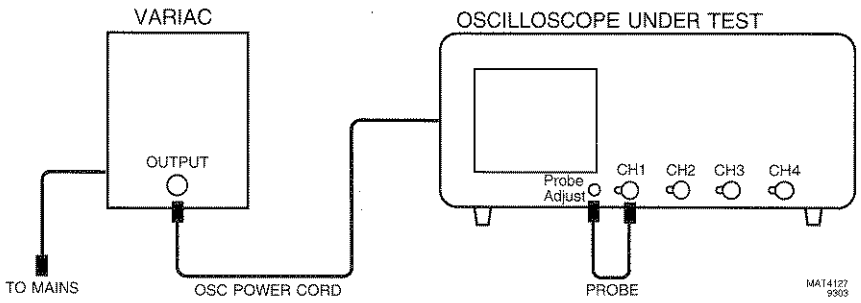
4.3.2 Power supply

This test checks the proper operation of the power supply at all possible line voltages.

Test equipment:

Variable voltage transformer (VARIAC)

Test set-up:



Settings/procedure:

1 - Adjust the input line voltage to the oscilloscope (output from VARIAC) to a desired value between 100 and 240V (rms), frequency 50...400 Hz.
2 - Press POWER ON on the oscilloscope.
3 - Apply the Probe Adjust signal from the front panel of the oscilloscope to input CH1, e.g., by means of a 10:1 probe.
4 - Press the green AUTOSET key.

Requirements:

1 - Verify that the oscilloscope starts at any input voltage between 100 and 240V; in particular the line voltages 100, 120, 220 and 240V must be checked.
2 - Verify that the instrument's performance does not change over the indicated voltage range; and that the displayed Probe Adjust signal is distortion-free and has equal intensity.
3 - Press the ANALOG key ('DIGITAL MODE' is displayed briefly), and verify that the instrument's performance does not change in digital mode at the indicated line voltages (100, 120, 220 and 240V). The displayed Probe Adjust signal must be free from distortion.

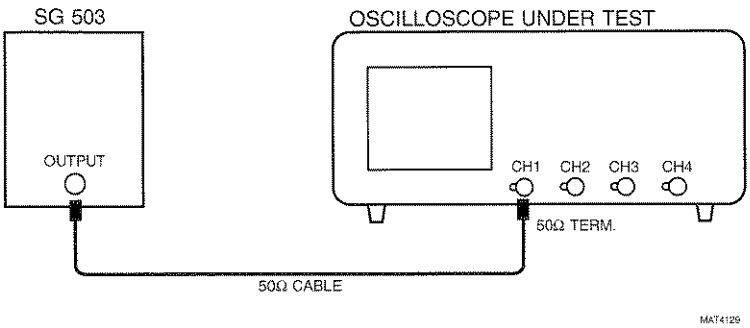
4.3.3 Auto set

This test checks the correct working of the AUTOSET function.

Test equipment:

Constant amplitude sine wave generator (SG 503)

Test set-up:



Settings/procedure:

1 - Apply a 10 MHz sine wave signal of 600 mV (pp into 50Ω) to input CH1;.
2 - Press the green AUTOSET key. Use a 50Ω termination at the end of the coax cable. For instruments with switchable 50Ω input impedance (attainable via VERT MENU key) it is recommended to use the internal termination (when active, the text 'LZ' appears in the lower part of the viewing area). For instruments without internal termination, an external termination should be used.

Requirements:

1 - Verify that the displayed waveform is stable and properly triggered. Amplitude should be within the screen area. Horizontally some signal periods should be displayed.
2 - Repeat the same settings and procedure for CH2, CH3 and CH4.
3 - Press the ANALOG key to return to analog mode. The message 'ANALOG MODE' appears briefly.
4 - Repeat the AUTOSET check in the analog mode for CH2, CH3, and CH4.

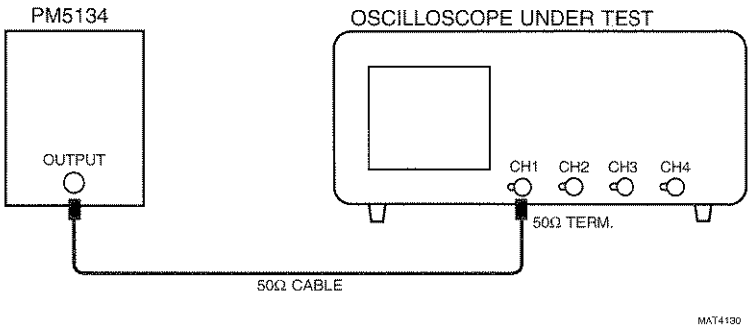
4.3.4 Orthogonality

This test checks the angle between the horizontal and vertical deflection plates (orthogonality).

Test equipment:

LF sine wave generator (function generator PM5134 or PM5138)

Test set up:



Settings/procedure:

1 - Press the CAL key for a few seconds to start the autocal procedure. This takes approximately 4 minutes. When ready, the oscilloscope is fine tuned to optimal accuracy.
2 - Apply a 50 Hz sine wave signal of 8V (pp into 50Ω) to input CH1;
3 - Press the AUTOSET key and adjust the input signal to a trace- height of 8 div (CH1 in 1V/div). Use a 50Ω termination at the end of the cable. For instruments with switchable 50Ω input impedance the use of the internal termination is recommended.
4 - Activate the GND function and verify that the straight line is exactly parallel to the horizontal graticule lines. If not, readjust the TRACE ROTATION.
5 - Switch the GND function off and verify that a signal of 8 divisions is displayed.
6 - Press the DISPLAY menu key.
7 - Press the X-DEFL softkey.
8 - Select 'on' and 'ch2' from the X-DEFL menu.
9 - Use the X POS control to move the vertical line to the center of the screen.

Requirements:

1 - Verify that the vertical line is parallel to the vertical graticule line in the center of the screen.
2 - Verify that the angle with respect to the horizontal graticule lines is 90° ± 0.5° as indicated in the figure.

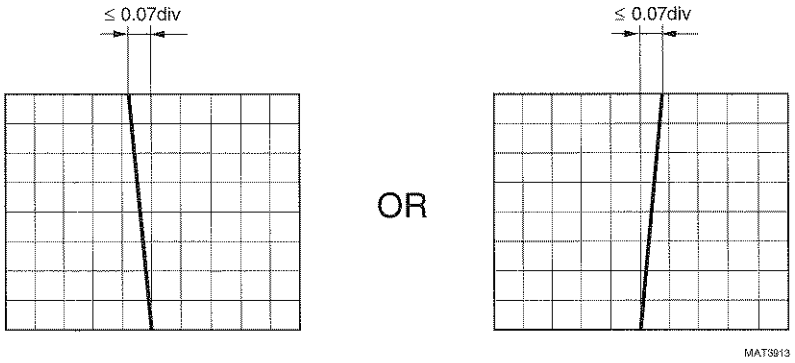


Figure 4.1 Orthogonality

4.3.5 Trace distortion

This test checks the distortion of a horizontal line in the central 6 x 8 divisions of the screen.

Test equipment:

None

Settings/procedure:

1 - Press the AUTOSET key with no input signal applied to the scope.
2 - Use the CH1 POS control to shift the timebase line vertically across the center 6 divisions of the screen.

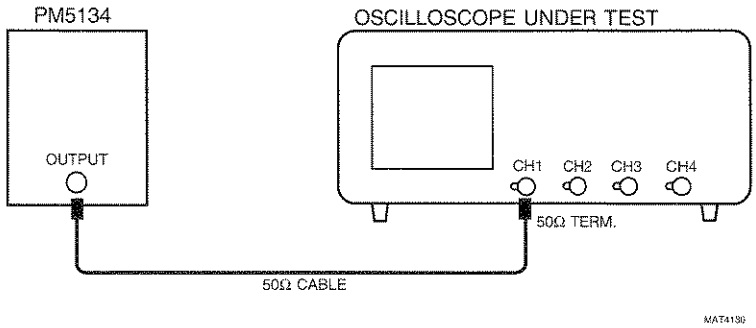
Requirements:

Verify that the deviation from the ideal straight line does not exceed 0.03 divisions in the center of screen and 0.1 divisions elsewhere.

Test equipment:

LF sine wave generator (function generator PM5134 or PM5138)

Test set-up:



Settings/procedure:

1 - Apply a 50 Hz sine wave signal of 8V (pp into 50Ω) to input CH1;
2 - Press the AUTOSET key and adjust the input signal to an amplitude of 8 divisions (CH1 in 1V/div). Use an external 50Ω termination. For instruments with switchable 50Ω input impedance it is recommended to make use of this feature.
3 - Using the CH1 POS control, adjust the display around the center of the screen.
6 - Press the DISPLAY menu key.
7 - Press the X-DEFL softkey.
8 - Select 'on' and 'ch2' from the X-DEFL menu.
9 - Use the X POS control to shift the vertical line across the middle eight divisions of the screen.

Requirements:

Verify that the deviation from the ideal straight line does not exceed 0.03 divisions in the center of screen and 0.1 divisions elsewhere.

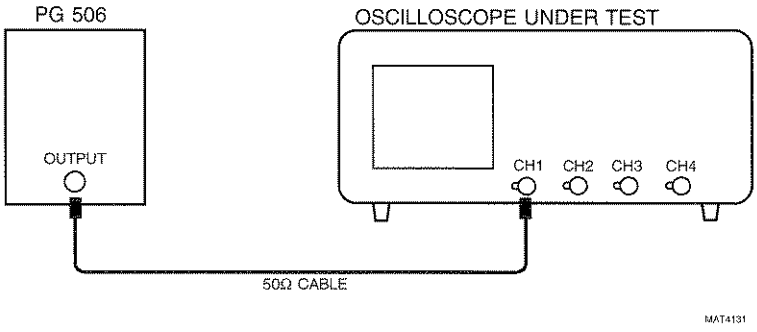
4.3.6 Vertical deflection; deflection coefficients

The vertical deflection coefficients of channels CH1, CH2, CH3, and CH4 are checked by means of a calibrated signal.

Test equipment:

Square-wave calibration generator (PG 506)

Test set up:



Settings/procedure:

1 - Apply a 1 kHz square-wave signal of 20 mV to input CH1. Set the generator in position STD AMPL. The generator must not be terminated with 50Ω (the text 'LZ' must not be visible in the lower part of the viewing area).
2 - Press the green AUTOSET key.
3 - Set CH1 to 5 mV/div and to DC input coupling. The waveform must be in the vertical middle of the screen.
4 - Press the ACQUIRE menu key.
5 - Select BW LIMIT 'on' from the VERT MENU key.
6 - Press the TRIGGER menu key.
7 - Select noise 'on' and 'hf-rej' from the TRIGGER MAIN TB menu.
8 - Change the input voltage and the setting of CH1 according to table I and verify that the amplitude of the signal agrees with this table. The signal should remain positioned in the vertical center of the screen.

Note: Only the input sensitivities essential for input accuracy are checked.

Requirements:

table I.

Input voltage (pp)	Setting	Requirements analog mode	Requirements digital mode
20 mV	5 mV	3.94...4.06 div (±1.3%)	3.92...4.08 div (±2%)
50 mV	10 mV	4.93...5.07 div (±1.3%)	4.9...5.1 div (±2%)
1V	0.2V	4.93...5.07 div (±1.3%)	4.9...5.1 div (±2%)
5V	1V	4.93...5.07 div (±1.3%)	4.9...5.1 div (±2%)

Repeat the settings/procedure in table I for CH2, CH3 and CH4. Use table II for CH3 and CH4 in PM3392A and PM3382A.

table II.

Input voltage (pp)	Setting	Requirements analog mode	Requirements digital mode
0.5V	0.1V	4.93...5.07 div (±1.3%)	4.9...5.1 (±2%)
2V	0.5V	3.94...4.06 div (±1.3%)	3.92...4.08 (±2%)

- Press the ANALOG key ('DIGITAL MODE' is displayed briefly), and repeat the tests in this chapter for the digital mode.
- Press the ANALOG key ('ANALOG MODE' is displayed briefly) to return to analog mode.

4.3.7 Vertical deflection; variable gain control range (continuation of 4.3.6)

This test checks the vertical VARiable gain control.

Settings/procedure:

1 - Apply a square-wave signal of 0.2V to input CH1 and press AUTOSET.
2 - Set CH1 to 50 mV/div and input coupling to DC. Using the CH1 POS control, center the waveform in the screen.
3 - Select the VARiable mode by simultaneously pressing both AMPL keys. The readout changes into 50.0 mV/div.
4 - Press the mV key to adjust an input sensitivity of 40.0 mV/div.

Requirements:

1 - Verify that the displayed amplitude is between 4.86 and 5.14 divisions (+/- 2.8%).
2 - Repeat the settings and procedure for CH2. For the PM3394A and PM3384A repeat the same steps for CH3 and CH4.

4.3.8 Vertical deflection; input coupling (continuation of 4.3.7)

This test verifies the operation of the AC input coupling. Also, the operation of the ground (GND) function is checked.

Settings/procedure:

1 - Switch the CH1 VARiable mode off by simultaneously pressing both AMPL/VAR keys. The readout changes to 50 mV.
2 - CH1 sensitivity is 50 mV/div; the vertical deflection is now 4 divisions.

Requirements:

1 - Activate the CH1 GND function and verify that a horizontal line is displayed.
2 - Select the AC input coupling and verify that a 4 divisions square-wave signal is displayed. Center this signal in the middle of the screen.
3 - Select the DC input coupling and verify that the 4 divisions square-wave signal moves up. This shift is caused by the signal's positive dc component: this component is not blocked in DC coupled mode.

Repeat the settings and procedure for CH2, CH3, and CH4. In the PM3392A and PM3382A, the test of the GND and AC function is skipped for CH3 and CH4.

4.3.9 Vertical cursor accuracy (continuation of 4.3.8.)

This test verifies the accuracy of the voltage cursors

Settings/procedure:

1 - Change the generator output voltage to 0.1V.
2 - Apply this voltage to CH1.
3 - Switch CH1 to ON, and switch the other channels off.
4 - Select DC coupled input and 20 mV/division for CH1.
5 - Select CH1 as trigger source (TRIG 1).
6 - Use the POS control to center the 5 division square wave on the dotted horizontal lines of the graticule.
7 - Press the CURSORS menu key.
8 - Select 'on' and volt cursors (=) from in the CURSORS menu.
9 - Select Δ V from the READOUT menu.

Requirements:

1 - Use the TRACK and Δ controls to position both cursor lines exactly on top and bottom of the signal. Check for a cursor readout between 98.4 and 101.6 mV.
2 - Press the ANALOG key ('DIGITAL MODE' is displayed briefly) and repeat the check in this chapter for the digital mode.
3 - Press the ANALOG key ('ANALOG MODE' is displayed briefly) to return to analog mode.

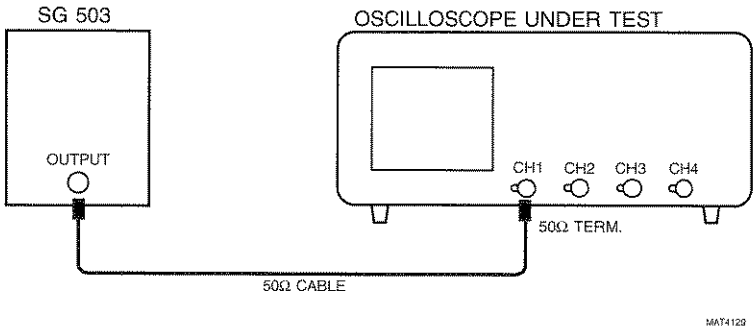
4.3.10 Vertical deflection; high-frequency response

This test verifies the upper transition point of the vertical bandwidth.

Test equipment:

Constant amplitude sine wave generator (SG 503)

Test set-up:



Settings/procedure:

1 - Apply a 50 kHz sine wave signal of 600 mV (pp into 50Ω) to input CH1, and press the AUTOSET key.
2 - Use an external 50Ω termination. Use the internal termination of the oscilloscope, when available (if active, the text 'LZ' is visible in the lower part of the viewing area).
3 - Set CH1 to 0.1V/div.
4 - Adjust the input signal to an amplitude of exactly 6 divisions.
5 - Slowly increase the frequency to 200 MHz (PM3392A, PM3394A) or 100 MHz (PM3382A, PM3384A) and verify that the displayed amplitude does not drop below 4.2 divisions. Internal 50Ω termination is attainable via the VERT MENU key (PM3392A/94A).

6 - Switch the frequency of the sine wave signal back to 50 kHz.
7 - Press the ACQUIRE menu key.
8 - Select BW LIMIT 'on' via the VERT MENU key.
9 - Slowly increase the frequency to 20 MHz and verify that the vertical deflection has decreased to 4.2 div approximately at 20 MHz.
10 - Switch the bandwidth limiter to 'off'.

Requirements:

The vertical deflection must be 4.2 divisions or more. For the bandwidth limiter the requirement is 4.2 div approximately at 20 MHz.

Repeat the above settings and procedure for CH2, CH3 and CH4. The procedure for CH3 and CH4 in PM3392A must be done via the 10:1 probe instead of the 50Ω cable. Oscilloscope in 1V/div and generator voltage 6 Vpp into 50Ω. Termination resistor directly at generator output. Use a BNC / probe tip adapter between termination and 10:1 probe.

- Press the ANALOG key ('DIGITAL MODE' is displayed briefly) and repeat the tests in this chapter for the digital mode. Adjust the MAIN TB TIME/DIV if required.

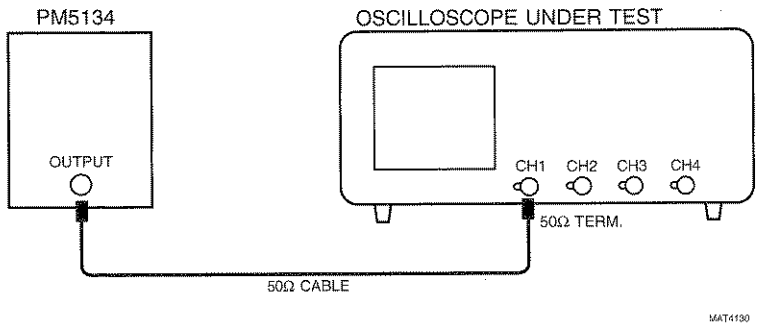
4.3.11 Vertical deflection; low-frequency response

This test verifies the lower transition point of the vertical bandwidth.

Test equipment:

LF sine wave generator (Function generator PM5134 or PM5138)

Test set up:



Settings/procedure:

1 - Apply a 5 kHz sine wave signal of 600 mV (pp into 50Ω) to input CH1, and press the AUTOSET key.
2 - Use an external 50Ω termination. Use the internal termination when available (via the VERT MENU key).
3 - Set CH1 to 0.1V/div.
4 - Adjust the input signal to an amplitude of exactly 6 divisions.
5 - Lower the frequency to 10 Hz and verify that the displayed amplitude does not drop below 4.2 divisions.

Requirements:

The vertical deflection must be 4.2 divisions or more.

Repeat the above settings and procedure for CH2, CH3, and CH4.

Press the ANALOG key ('ANALOG MODE' is displayed briefly) to return to analog mode.

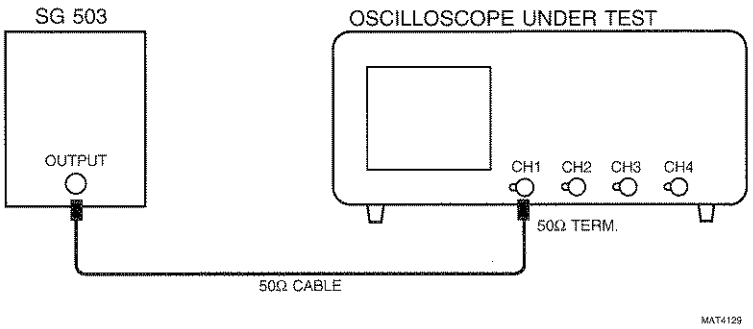
4.3.12 Vertical deflection; dynamic range at 25/50 MHz

The oscilloscope must be capable of displaying signal amplitudes that are larger than the screen. In practice, a low frequency signal with an amplitude equivalent to 24 divisions must be displayed with no distortion.

Test equipment:

Constant amplitude sine wave generator (SG 503)

Test set up:



Settings/procedure:

1 - Apply a 50 MHz (PM3392A/94A) or 25 MHz (PM3382A/84A) sine wave signal of 2.4 V(pp into 50Ω) to input CH1 and press the AUTOSET key.
2 - Use a 50Ω termination. Use the internal termination when avaialble.
3 - Set CH1 to 0.1V/div.
4 - Using the CH1 POS control, shift the sine wave vertically over the screen.

Requirements:

Verify that top and bottom of the sine-wave signal of 24 divisions in amplitude can be displayed with no distortion.

Repeat the above settings and procedure for CH2, CH3, and CH4.

4.3.13 Vertical deflection; dynamic range at 100/200 MHz (continuation of 4.3.12)

In this test, the dynamic range of the amplifier is checked at a high frequency.

Settings/procedure:

1 - Apply a 200 MHz (PM3392A, PM3394A) or 100 MHz (PM3382A, PM3384A) sine-wave signal of 0.8 V(pp into 50Ω) to input CH1.
2 - Press the AUTOSET key, and set CH1 to 0.1V/div.
3 - Use a 50Ω termination. Use the internal termination when available.
4 - Set the amplitude to exactly 8 divisions.

Requirements:

Verify that the sine wave of 8 divisions in amplitude is displayed with no distortion.

Repeat the above settings and procedure for CH2, CH3, and CH4.

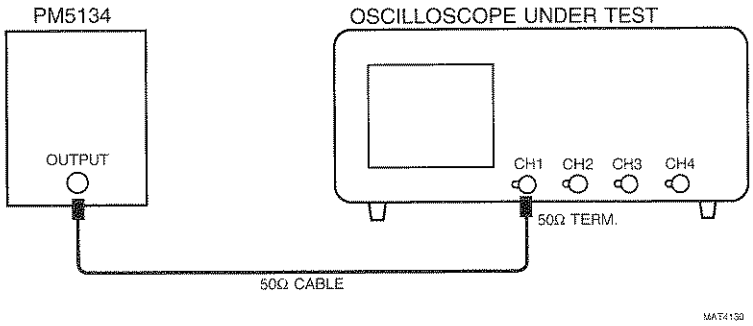
4.3.14 Vertical deflection; position range

The range of the vertical shift is checked with a sine-wave signal of 8 divisions in amplitude.

Test equipment

LF sine wave generator (function generator PM5134 or PM5138)

Test set up:



Settings/procedure:

1 - Apply a 1 kHz sine wave signal with an amplitude of 0.8 V(pp into 50Ω) to input CH1.
2 - Press the AUTOSET key and set CH1 to 0.1V/div.
3 - Use a 50Ω termination. Use the internal termination when available.

Requirements

Turn the CH1 POS control fully clockwise and counterclockwise and verify that top and bottom of the 8 divisions signal can be positioned outside the graticule.

Repeat the above settings and procedure for CH2, CH3, and CH4.

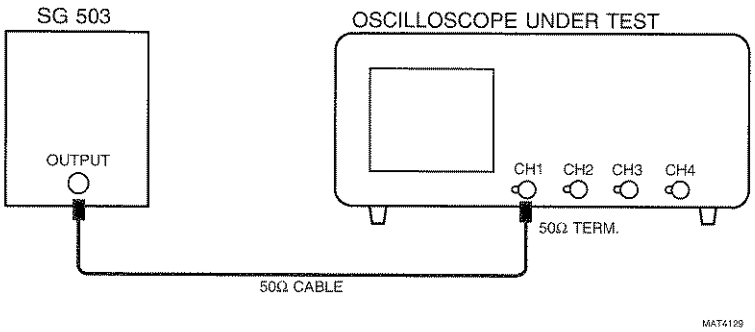
4.3.15 Vertical deflection; crosstalk between channels at 100/200 MHz

At higher frequencies there exists some crosstalk between any two channels. In the following test, crosstalk is verified at a high frequency.

Test equipment:

Constant amplitude sine wave generator (SG 503)

Test set up:



Settings/procedure:

1 - Apply a 200 MHz (PM3392A, PM3394A) or 100 MHz (PM3382A, PM3384A) sine-wave signal of 0.8 V(pp into 50Ω) to input CH1.
2 - Press the AUTOSET key.
3 - Use a 50Ω termination. Use the internal termination when available.
4 - Switch all channels ON.
5 - Set all channels to 0.1 V/div.
6 - Adjust the generator to a signal amplitude of 8 div.
7 - Activate the GND function of CH2, CH3, and CH4.

Requirements:

Verify that the displayed amplitude the channels with no input signal applied is less than 0.16 divisions, (better than 50:1).

Repeat the above settings and procedure:
- Input signal applied to CH2. CH1, CH3, and CH4 input GND.
- Input signal applied to CH3. CH1, CH2, and CH4 input GND.
- Input signal applied to CH4. CH1, CH2, and CH3 input GND.
- Press the ANALOG key ('DIGITAL MODE' is displayed briefly) and repeat the tests in this chapter for the digital mode.

- Press the ANALOG key ('ANALOG MODE' is displayed briefly) to return to analog mode.

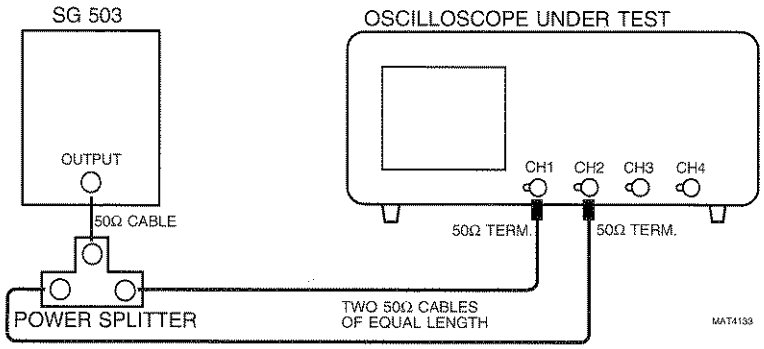
4.3.16 Vertical deflection; common mode rejection ratio at 1 MHz

The common mode rejection ratio (CMRR) is a measure of susceptibility to common mode signals. This susceptibility is verified in this test.

Test equipment:

- HF constant amplitude sine wave generator (SG 503)
- Power splitter

Test set up:



Settings/procedure:

1 - Use a power splitter and two cables of equal length to CH1 and CH2. Apply a 1 MHz sine-wave signal of 0.6 V(pp into 50Ω) to inputs CH1 and CH2.
2 - Press the AUTOSET key.
3 - Use 50Ω terminations. Use the internal terminations when available (via VERT MENU key).
4 - Set CH1 and CH2 to 0.1V/div and adjust the generator voltage for a deflection of 6 divisions.
5 - Set CH1 and CH2 to DC input coupling.
6 - Press the CH1+CH2 key to activate the 'added' mode.
7 - Press the INV key of CH2; the result is the display of CH1-CH2.
8 - Press the ON keys of CH1 and CH2; this switches CH1 and CH2 off and only the differential signal (CH1 CH2) is now visible.
9 - Readjust the VAR function of CH1 or CH2 for minimum amplitude.

Requirements

1 - Verify that the trace-height of the CH1-CH2 differential signal is less than 0.06 divisions.
2 - Repeat the above settings and procedure for CH3 and CH4 (not required for PM3382A-PM3392A).

4.3.17 Vertical deflection; common mode rejection ratio at 50 MHz (continuation of 4.3.16)

The common mode rejection ratio (CMRR) indicates the susceptibility to common mode signals at higher frequencies. The susceptibility is verified in this test.

Settings/procedure:

1 - Use a power splitter and two cables of equal length to CH1 and CH2. Apply a sine-wave signal of 50 MHz with an amplitude of 0.6 V(pp into 50Ω) to inputs CH1 and CH2.
2 - Press the AUTOSET key.
3 - Use a 50Ω termination. Use the internal termination when available.
4 - Set CH1 and CH2 to 0.1 V/div and adjust the generator voltage for a deflection of 6 divisions.
5 - Set CH1 and CH2 to DC input coupling.
6 - Press the CH1+CH2 key; to activate the added mode.
7 - Press the INV key of CH2; the result is the display of the differential signal of CH1-CH2.
8 - Press the ON keys of CH1 and CH2; this switches CH1 and CH2 off and only the differential signal of CH1 CH2 display is now visible.
9 - Readjust the VAR function of CH1 or CH2 for minimum amplitude.

Requirements:

1 - Verify that the amplitude of the CH1-CH2 differential signal is less than 0.24 divisions.
2 - Repeat the above settings and procedure for CH3 and CH4 (not required for PM3382A/PM3392A).

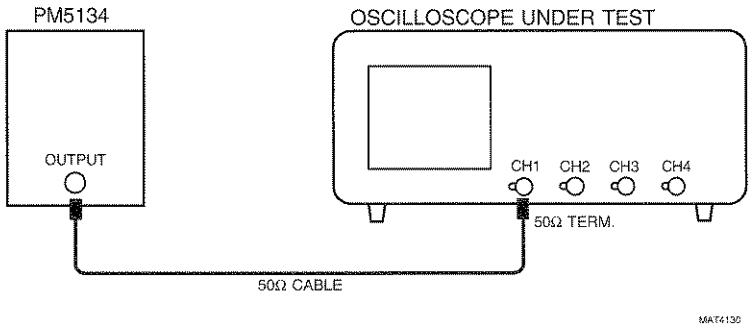
4.3.18 Vertical deflection; LF linearity

The linearity of the vertical amplifier is checked by moving a signal with a fixed amplitude vertically over the entire screen area.

Test equipment

LF square-wave generator (function generator PM5134 or PM5138)

Test set up:



Settings/procedure

1 - Apply a 50 kHz square-wave signal of 200 mV(pp into 50Ω)to input CH1.
2 - Press the AUTOSET key and set CH1 to 0.1V/div.
3 - Use a 50Ω termination. Use the internal termination when available (via VERT MENU key).
4 - Move the square-wave signal to the vertical center of the screen.
5 - Adjust the generator output so that the displayed amplitude is exactly 2 divisions.
6 - Use the CH1 POS control to shift the signal across the central 6 divisions of the screen.

Requirements

1 - Verify that the amplitude in the two upper and lower divisions is between 1.96 ...2.04 divisions (+ or - 2%).
2 - Repeat the above settings and procedure for CH2, CH3 and CH4.
3 - Press the ANALOG key ('DIGITAL MODE' is displayed briefly) and repeat the check in this chapter for the digital mode. The requirement for the digital mode is a vertical amplitude in the upper and lower screen area between1.94 ... 2.06 divisions (+ or 3%).
4 - Press the ANALOG key ('ANALOG MODE' is displayed briefly) to return to analog mode.

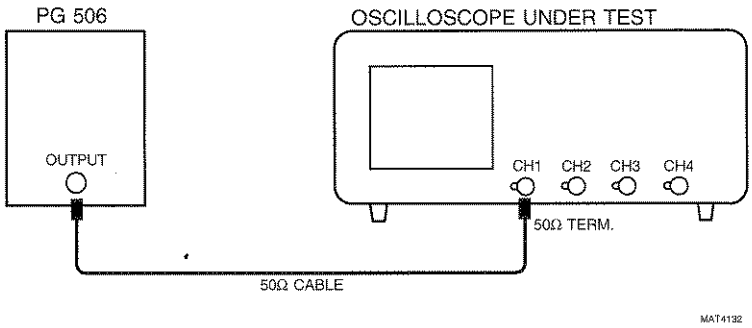
4.3.19 Vertical deflection; visual signal delay

Many applications require that the leading edge of a fast pulse triggering the oscilloscope be made visible. A fixed amount of signal delay is introduced in the vertical channels of this instrument to allow the timebase to start before the triggering leading edge causes vertical deflection to occur.
This delay is verified in the following test.

Test equipment

Square-wave calibration generator (PG 506)

Test set-up:



Settings/procedure:

1 - Apply a signal with a fast rise time of less than 1 ns and an amplitude of 0.5V (into 50Ω), and a frequency of 1 MHz, to input CH1. Set the generator in the FAST RISE position.
2 - Press the AUTOSET button and set CH1 to 0.1V/div.
3 - Use a 50Ω termination. Use the internal termination when provided (via VERT MENU key).
4 - Set the MAIN TB TIME/DIV to 50.0 ns/div.
5 - Press the MAGNIFY key and turn the X POS control to display the leading edge.
6 - Turn the TRACE INTENSITY control clockwise for maximum intensity.
7 - Press the TRIGGER menu key.
8 - Select level pp 'off' and 'dc' trigger coupling from the TRIGGER MAIN TB menu.
9 - Adjust TRIGGER LEVEL for a triggered display and maximum visible signal delay.

Requirements

Verify that the visible signal delay is at least 15 ns (3 divisions).

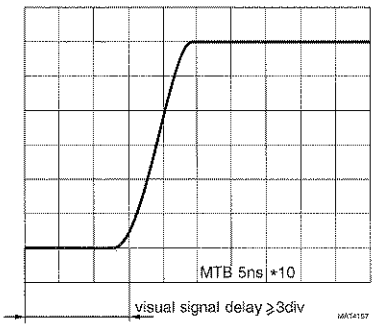


Figure 4.2 Visual signal delay

4.3.20 Vertical deflection; base line instability

In the following test, several adjustments of balance, offset and jump, are checked.

Test equipment

None

Settings/procedure and requirements:

1 - Press the AUTOSET key (no input signal) and set CH1 to 5V/div.
2 - Use the CH1 POS control to position the trace in the vertical middle of the screen.
3 - Press both CH1 AMPL keys simultaneously to select the VARiable mode. The readout changes to 5.00V. The input sensitivity can be adjusted now in very fine steps between 2 mV and 12.5V/div.
4 - Press the 'V' key and verify that the base line jump is not more than 0.2 divisions between 5.00V to 12.5V/div.
5 - Press the 'mV' key and verify that the base line jump is not more than 0.2 divisions between 12.5V/div to 5 mV/div.
6 - Press the ON keys of CH2 and CH1; CH2 is now on and CH1 is off.
7 - Using the CH2 POS control, position the trace in the vertical middle of the screen.

8 - Press both CH2 AMPL keys simultaneously to select the VARiable mode. The readout changes to 5.00V. The input sensitivity can be adjusted now in very fine steps between 2 mV and 12.5V/div.
9 - Press the 'V' key and verify that the base line jump is not more than 0.2 divisions between 5.00V to 12.5V/div.
10 - Press the 'mV' key and verify that the base line jump does not 0.2 divisions between 12.5V/div to 5 mV/div.
11 - Press the INV key repeatedly and verify that the base line jump is not more than 0.2 divisions.

For the PM3394A and PM3384A repeat the above procedure for CH3 and CH4. The CH3 settings are equal to those of CH1; the CH4 settings are equal to CH2.

For the PM3392A and PM3382A the following steps are required to check CH3 and CH4:

1 - Press the ON keys of CH3 and CH2; CH3 is now on and CH2 is off.
2 - Use the CH3 POS control to position the trace in the vertical center of the screen.
3 - Press the CH3 AMPL key repeatedly and verify that the base line jump does not exceed 0.2 divisions.
4 - Press the ON keys of CH4 and CH3; CH4 is now on and CH3 is off.
5 - Using the CH4 POS control, position the trace in the vertical center of the screen.
6 - Press the CH4 AMPL key repeatedly and verify that the base line jump does not exceed 0.2 divisions.
7 - Press the INV key repeatedly and verify that the base line jump does not exceed 0.2 divisions.

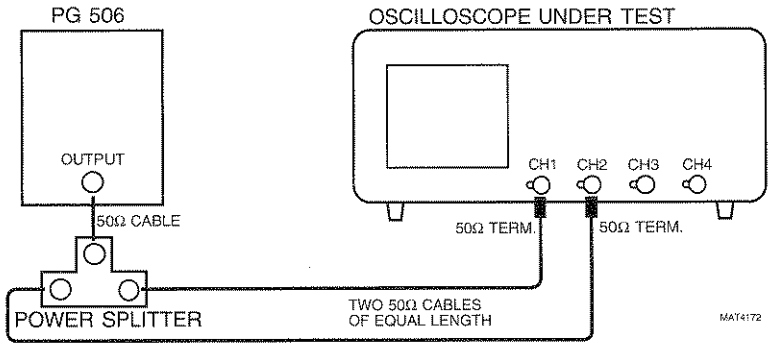
4.3.21 Delay difference between vertical channels

The delay difference between CH1, CH2, CH3, and CH4 is checked here.

Test equipment:

Square wave calibration generator (PG 506)
Power splitter

Test set up:



Settings/procedure PM3392A, PM3394A, PM3382A, PM3384A:

1 - Apply a square-wave signal with a fast rise time of less than 1 ns, and an amplitude of 0.5V (into 50Ω), with a frequency of 1 MHz, to inputs CH1 and CH2. The generator must be set in the FAST RISE position.
Use a power splitter and two cables of equal length to CH1 and CH2.
2 - Press the AUTOSET key.
3 - Use 50Ω terminations. Use the internal terminations when available (via VERT MENU key).
4 - Set CH1 and CH2 to 0.1V/div and input coupling to DC.
5 - Press the MAGNIFY keys and set the MAIN TB TIME/DIV to 2.00 ns/div (PM3392A, PM3394A) or to 5.00 ns/div (PM3382A, PM3384A).
6 - Press the TRIGGER menu key.
7 - Select level-pp 'off' and 'dc' trigger coupling from the related menu.
8 - Press the TB MODE menu key.
9 - Select 'trig' from the related menu.
10 - Adjust TRIGGER LEVEL for a triggered display of the leading edge.
11 - Using the X POS control, position the leading edges of the signals in the horizontal center of the screen.
12 - Using both CH1 and CH2 POS controls, adjust the vertical position of each trace between the dotted 0% and 100% lines. The signals appear to be superimposed.

Requirements

Verify that the delay difference between the two displayed signals is less than 0.25 ns. This equals 0.13 divisions in PM3392A and PM3394A or 0.05 divisions in PM3382A and PM3384A.

Repeat the above settings and procedure for CH3 and CH4.

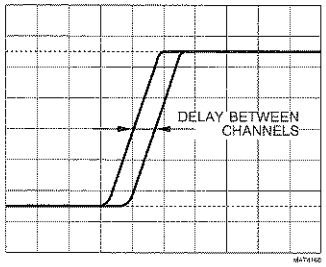


Figure 4.3 Delay difference ≤ 0.13 div in PM3392A/94A or ≤ 0.05 div in PM3382A/84A.

Settings/procedure PM3392A and PM3382A:

1 - Apply a fast rise time (≤1 ns) signal of 0.5V (into 50Ω), frequency 1 MHz, to inputs CH1 and CH3. Generator in position FAST RISE.
Use a power splitter and two cables of equal length to CH1 and CH3.
2 - Press the AUTOSET key.
3 - Use 50Ω terminations.
4 - Set CH1 and CH3 to 0.1V/div and input coupling to DC.
5 - Press MAGNIFY key and set MAIN TB TIME/DIV to 2.00 ns (PM3392A) or to 5.00 ns (PM3382A).
6 - Press the TRIGGER menu key.
7 - Select level-pp 'off' and 'dc' trigger coupling from the related menu.
8 - Press the TB MODE menu key.
9 - Select 'trig' from the related menu.
10 - Adjust TRIGGER LEVEL for a triggered display of the leading edge.
11 - Position the rising edges of the signals in the horizontal center of the screen, by means of the X POS control.
12 - Adjust the two traces between the dotted lines 0% and 100% by means of the CH1 and CH3 POS controls so that both signals cover each other.

Requirements:

Verify that the delay difference between the two displayed signals is less than 0.5 ns: this equals 0.25 divisions in PM3392A or 0.1 divisions in PM3382A.

Repeat settings/procedure for CH1 and CH4.

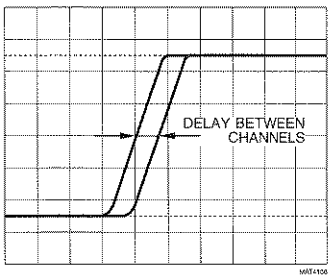


Figure 4.4 Delay difference ≤0.25 div in PM3392A or ≤0.1 div in PM3382A.

- Press the ANALOG key ('DIGITAL MODE' is displayed briefly) and repeat the tests in this chapter for the digital mode. In digital mode, it is not necessary to activate the MAGNIFY function since the timebase ranges up to 2.00 ns/division (PM3392A/3394A) or 5.00 ns/division (PM3382A/3384A).
- Press the ANALOG key ('ANALOG MODE' is displayed briefly) to return to analog mode.

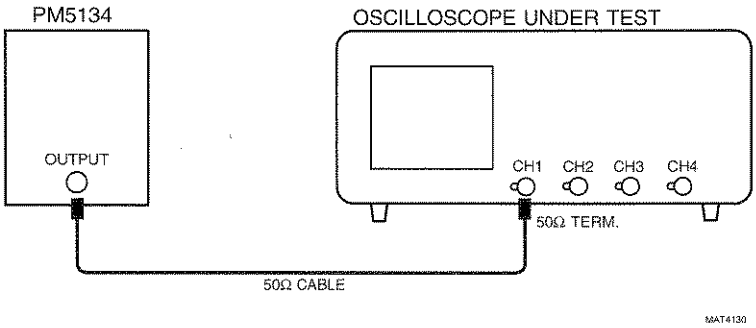
4.3.22 Horizontal deflection; display modes and trace separation

The correct working of main timebase (MAIN TB), delayed timebase (DELAYED TIME BASE) and the trace separation is checked.

Test equipment:

LF sine wave generator (function generator, PM5134 or PM1538)

Test set-up:



Settings/procedure and requirements:

1 - Apply a 2 kHz sine-wave signal of 400 mV(pp into 50Ω) to input CH1.
2 - Press the AUTOSET key and set CH1 to 0.1V/div.
3 - Use a 50Ω termination. For instruments with switchable 50Ω input impedance it is recommended to make use of this feature.
4 - Adjust the generator signal to a trace height of 4 divisions.
5 - Set MAIN TB to 500 µs.
6 - Press the DTB menu key.
7 - Set DEL'D TB to 'on' in the DELAYED TIMEBASE menu.
8 - Set MAIN TB to 'on' in the DELAYED TIMEBASE menu.
9 - Set the DELAYED TIMEBASE to 50.0 µs.
10 - Turn the DELAY control (in the DELAYED TIMEBASE section), and verify that the intensified part can be shifted horizontally along the MAIN TB display.
11 - Operate the TRACK control and check that the DEL'D TB and MAIN TB display can be shifted so that they do not cover each other.

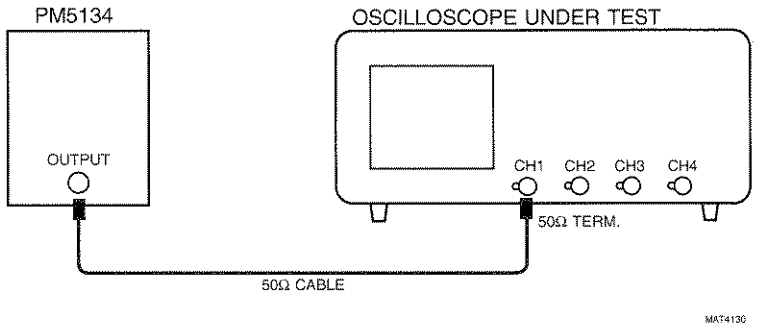
4.3.23 Horizontal deflection; X deflection

The correct working of the X Y mode (X-DEFL 'on') is tested.

Test equipment:

LF sine wave generator (function generator, PM5134 or PM5138)

Test set-up:



Settings/procedure:

1 - Apply a 2 kHz sine-wave signal of 800 mV(pp into 50Ω) to input CH1.
2 - Press the AUTOSET key and set CH1 to 0.1V/div.
3 - Use a 50Ω termination. For instruments with switchable 50Ω input impedance it is recommended to make use of this feature (via VERT MENU key).
4 - Adjust the generator signal to a trace height of 8 divisions.
5 - Press the DISPLAY menu key.
6 - Press the X-DEFL softkey in the DISPLAY menu.
7 - Select 'on' and 'ch1' as X-SOURCE in the X-DEFL menu.
8 - Use the CH1 POS and X POS controls to obtain the display shown in the figure below.

Requirements:

Verify that a line with an angle of 45° is displayed.

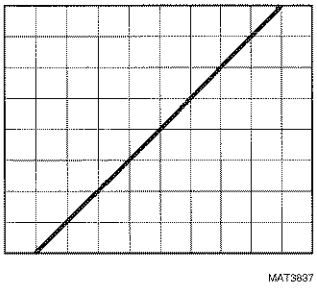


Figure 4.5 X deflection

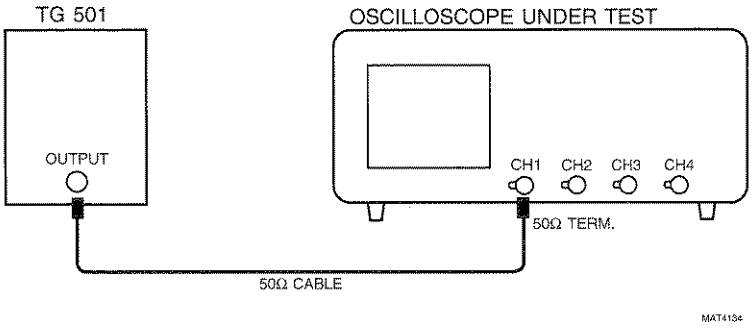
4.3.24 Horizontal deflection; MAIN TB deflection coefficients

The deflection coefficients of the main timebase generator (MAIN TB) are verified by means of a calibration signal.

Test equipment:

Time marker generator (TG 501)

Test set-up:



Settings/procedure:

1 - Apply a 50.0 ns time marker signal to input CH1.
2 - Press the AUTOSET key.
3 - Use a 50Ω termination. For instruments with switchable 50Ω input impedance it is recommended to make use of this feature (via VERT MENU key).
4 - Press the TRIGGER menu key.
5 - Select level-pp 'off' and 'dc' from the TRIGGER MAIN TB menu.
6 - Press the TB MODE menu key.
7 - Select 'trig' from the TB MODE menu.
8 - Adjust the TRIGGER LEVEL control for a correctly triggered display.
9 - Verify the deflection coefficients of MAIN TB with MAGNIFY off (*1) and MAGNIFY on (*10) according to the requirements in the tables. Use the deflection error facility of the time marker generator.

Note:

- *Error limits must be measured between the 2nd and the 10th graticule line (there are 11 graticule lines). These are the central 8 divisions.*
- *With MAGNIFY on (*10), the central 10 divisions of the expanded 100 divisions of MAIN TB are measured.*

- *Only the timebase positions essential for instrument accuracy are checked.*
- *Press the ANALOG key ('DIGITAL MODE' is displayed briefly) to perform the tests for the digital mode. Press the TEXT OFF key for full visibility of the time marker pulses in the central 8 divisions.*
- *Press the ANALOG key ('ANALOG MODE'is displayed briefly) to return to analog mode.*

Requirements for analog mode MAGNIFY off (*1):

MAIN TB setting	Marker pulse	Max. error
20.0 ns (PM3392A/94A)	20 ns	1.8%
100 ns	0.1 µs	1.8%
500 ns	0.5 µs	1.8%
1.00 µs	1 µs	1.8%
5.00 µs	5 µs	1.8%
20.0 µs	20 µs	1.8%
500 µs	0.5 ms	1.8%
1.00 ms	1 ms	1.8%
10.0 ms	10 ms	1.8%

Requirements for analog mode MAGNIFY on (*10):

MAIN TB setting	Marker pulse	Max. error
2.00 ns (PM3392A/94A)	2 ns	3.3%
5.00 ns	5 ns	3.3%
10.0 ns	10 ns	2.3%
100 ns	0.1 µs	2.3%

Requirements for digital mode:

MAIN TB setting	Marker pulse	Max. error
2.00 ns (PM3392A/94A)	2 ns	1.8%
5.00 ns (PM3382A/84A)	5 ns	1.8%
250 ns	0.5 µs	1.3%
500 ns	0.5 µs	1.3%
20.0 ms	20 ms	1.3%
1.00 s	1 s	1.3%

Check for an undistorted display of the time marker pulses. Timing accuracy should not show a noticeable error. In the MAIN TB setting 250 ns/division, the interval between successive time marker pulses should be 2 div.'

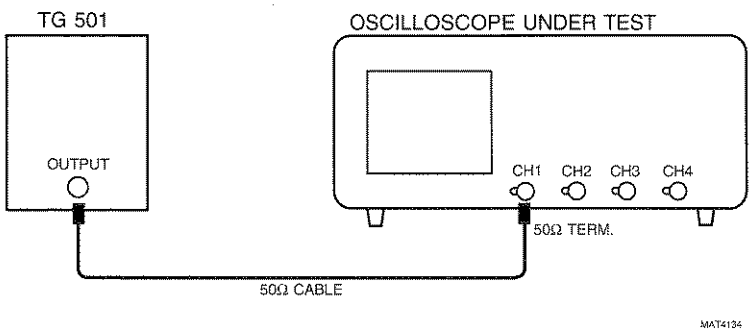
4.3.25 Horizontal deflection; VARiable mode accuracy MAIN TB.

The horizontal MAIN TB deflection coefficients can be varied in steps such as done in 4.3.24. A range of much finer steps can also be selected. Here, the accuracy of this range is checked.

Test equipment:

Time marker generator (TG 501)

Test set-up:



Settings/procedure:

1 - Apply a 5 us time marker signal to input CH1.
2 - Press the AUTOSET key.
3 - Use a 50Ω termination. For instruments with switchable 50Ω input impedance it is recommended to make use of this feature.
4 - Press the TRIGGER menu key.
5 - Select level-pp 'off' and trigger coupling 'dc' from the TRIGGER MAIN TB menu.
6 - Adjust the TRIGGER LEVEL control for a correctly triggered display.
7 - Set the MAIN TB TIME/DIV to 5.00 us.
8 - Select the MTB VARiable mode by pressing both MAIN TB TIME/DIV keys at a time: the message; 'VARIABLE TIMEBASE' is displayed briefly.
9 - Press the 'ns' key and adjust the readout to 2.50 us.

Requirements:

Verify that the horizontal distance between the time markers equals 2 divisions. Use the X POS control to align the marker pulses with the graticule. Now check (across the central 8 divisions) if the timebase accuracy is ±2.8%: make use of the deflection error facility of the time marker generator to check this.

4.3.26 Time cursor accuracy (continuation of 4.3.25)

This test verifies the accuracy of the time cursors.

Settings/procedure:

- Switch the MAIN TB VARiable mode off by pressing both MAIN TB TIME/DIV keys at a time. The message '1-2-5 STEPS'.
- Select 5.00 µs/division for the MAIN TB.
- Switch off the deflection error facility of the time marker generator.
- Press the CURSORS menu key.
- Select 'on' and time cursors (//) from the CURSORS menu.
- Select Δ T in the READOUT menu.

Requirements:

- Position one cursor line exactly on the 2nd time marker on the screen and the other cursor on the 10th time marker. The distance between both cursors is now 8 time marker intervals. Check for a cursor readout between 39.5 and 40.5 µs.
- Press the ANALOG key ('DIGITAL MODE' is displayed briefly) and repeat the check in this chapter for the digital mode. Press the TEXT OFF key to have the full screen width available to display the time markers.
- Press the ANALOG key ('ANALOG MODE' is displayed briefly) to return to analog mode.

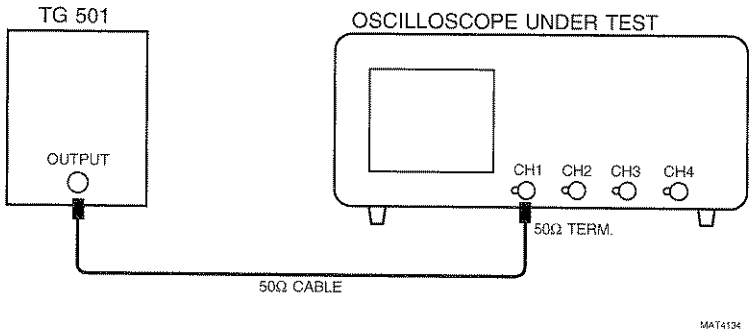
4.3.27 Horizontal deflection; DELAYED TIME BASE deflection coefficients

The deflection coefficients of the delayed timebase generator (DEL'D TB) are verified by means of a calibration signal.

Test equipment:

Time marker generator (TG 501)

Test set-up:



Settings/procedure:

1 - Apply a 0.5 ms time marker signal to input CH1.
2 - Press the AUTOSET key.
3 - Use a 50Ω termination. For instruments with switchable 50Ω input impedance it is recommended to make use of this feature (via VERT MENU key).
4 - Press the TRIGGER menu key.
5 - Select level-pp 'off' and 'dc' trigger coupling from the TRIGGER MAIN TB menu.
6 - Press the TB MODE menu key and select 'trig' from the related menu.
7 - Adjust TRIGGER LEVEL for a correctly triggered display.
8 - Set the trace height to about 4 divisions.
9 - Press the DTB menu key and select DEL'D TB 'on' and MAIN TB 'on' from the related menu .
10 - Set MAIN TB to 1.00 ms and DELAYED TIME BASE to 5.00 µs.
11 - Use the DELAY control (in the DELAYED TIMEBASE SECTION to set the time delay to about 0 seconds.
12 - Adjust the vertical position of the MAIN TB display with the CH1 POS control in the top half of the viewing area.
13 - Adjust the vertical position of the DELAYED TIMEBASE display with the TRACK control.
14 - Verify the DELAYED TIMEBASE deflection coefficients with MAGNIFY off (*1) and MAGNIFY on (*10) according to the requirements in the tables. Use the deflection error facility of the time marker generator.

Note:

- *Error limits must be measured between the 2nd and the 10th graticule line (there are 11 graticule lines). These are the central 8 divisions.*
- *With MAGNIFY on (*10), the central 10 divisions of the expanded 100 divisions of DEL'D TB are measured.*

- *Only the timebase positions that are essential for instrument accuracy are checked.*
- *DEL'D TB TIME/DIV is electrically coupled to MAIN TB TIME/DIV; to check the settings in the table press only the MAIN TB TIME/DIV VAR keys.*

Requirements for analog mode MAGNIFY off (*1):

DEL'D TB setting	MAIN TB setting	Marker pulse	Max. error
5.00 µs	5.00 µs	0.5 ms	1.8%
20.0 µs	20.0 µs	20 µs	1.8%
5.00 µs	5.00 µs	5 µs	1.8%
1.00 µs	1.00 µs	1 µs	1.8%
500 ns	500 ns	0.5 µs	1.8%
100 ns	100 ns	0.1 µs	1.8%
50.0 ns	50.0 ns	50 ns	1.8%
20.0 ns (PM3392A/94A)	20.0 ns	20 ns	1.8%

Requirements for analog mode MAGNIFY on (*10):

DEL'D TB setting	MAIN TB setting	Marker pulse	Max. error
100 ns	100 ns	0.1 µs	2.3%
10.0 ns	10.0 ns	10 ns	2.3%
5.00 ns	5.00 ns	5 ns	3.3%
2.00 ns (PM3392A/94A)	2.00 ns	2 ns	3.3%

4.3.28 Horizontal deflection; delay time multiplier

In this test the minimum and maximum delay time is checked.

Test equipment:

None

Settings/procedure and requirements:

1 - Press the AUTOSET key.
2 - Press the DTB menu key and select DEL'D TB 'on' and MAIN TB 'on' from the appropriate menu .
3 - Set MAIN TB to 500 ns.
4 - Set DEL'D TB to 50.0 ns.
5 - Separate the MAIN TB and DEL'D TB traces with the TRACK control.

6 - Adjust the delay time to 500.0 ns using of the DELAY control (in the DELAYED TIMEBASE section).
7 - Adjust the start of the MAIN TB display exactly on the first graticule line by using the X POS control (at maximum TRACE INTENSITY).
8 - Verify that the difference between the start of MAIN TB and the start of the intensified part is between 0.9 to 1.1 divisions.
9 - Adjust the delay time to 5.00 µs with the DELAY control (in the DELAYED TIMEBASE section).
10 - Verify that the difference between the start of MAIN TB and the start of the intensified part is between 9.9 and 10.1 divisions.

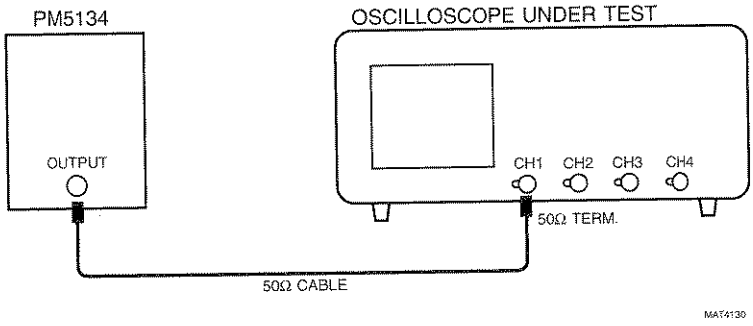
4.3.29 Horizontal deflection; delayed timebase jitter

There is a certain instability in the starting point, the so called jitter, of the DEL'D TB. The maximum allowed jitter is checked in this test.

Test equipment:

LF sine wave generator (function generator PM5134 or PM5138)

Test set-up:



Settings/procedure:

1 - Apply a 1 MHz sine-wave signal of 120 mV(pp into 50Ω) to input CH1.
2 - Press the AUTOSET key and set for a trace-height of 6 divisions.
3 - Use a 50Ω termination. For instruments with switchable 50Ω input impedance it is recommended to make use of this feature (via VERT MENU key).

4 - Press the DTB menu key and select DEL'D TB 'on' and MAIN TB 'on' from the appropriate menu.
5 - Set MAIN TB to 500 µs.
6 - Set DEL'D TB to 500 ns.
7 - Adjust the delay time to 0s using the DELAY control (in the DELAYED TIMEBASE section).
8 - Switch the MAIN TB display to 'off' in the DELAYED TIMEBASE menu; only the DEL'D TB is displayed now.

Requirements:

Verify that the jitter of the DEL'D TB is not more than 0.4 divisions (1 part per 25000).

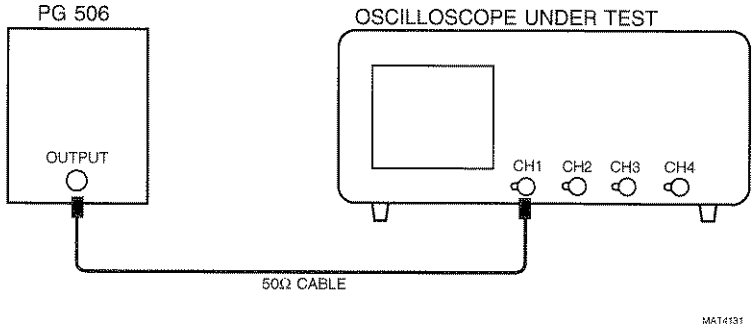
4.3.30 Horizontal deflection; X deflection coefficient via CH1

The amplification of the horizontal amplifier via the vertical input amplifier is checked.

Test equipment:

Square-wave calibration generator (PG 506)

Test set-up:



Settings/procedure:

1 - Apply a 1 kHz square-wave signal of 0.1V to input CH1. Generator in 'STD AMPL' mode and output not terminated into 50Ω ('LZ' must not appear in lower part of viewing area).
2 - Press the AUTOSET key.
3 - Set CH1 to 20 mV and DC coupled input.

4 - Press the DISPLAY menu key.
5 - Press X-DEFL softkey.
6 - Select 'on' and 'ch1' from the X-DEFL menu.
7 - Press the CH2 ON key and then the CH1 ON key; the result is that CH2 is on and CH1 is off.

Requirements:

Verify that two dots with a horizontal distance of 4.7 ... 5.3 divisions are displayed.

4.3.31 Horizontal deflection; X deflection coefficient via 'line'

The amplification of the horizontal amplifier via the line trigger signal is checked. Do this test only when 220V power is available.

Test equipment:

None

Settings/procedure:

1 - Press the AUTOSET key.
2 - Press the DISPLAY menu key.
3 - Press X-DEFL softkey.
4 - Select 'on' and 'line' from the X-DEFL menu.

Requirements:

Verify that a horizontal line of 4.3 to 7.7 divisions is displayed when the line voltage is 220V (rms).

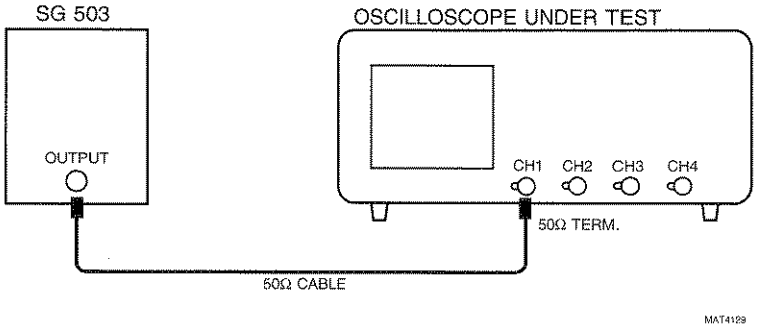
4.3.32 Horizontal deflection; high frequency response

In this test, the bandwidth of the horizontal amplifier is checked.

Test equipment:

Constant amplitude sine wave generator (SG 503).

Test set-up:



Settings/procedure:

1 - Apply a 50 kHz sine-wave signal of 30 mV(pp into 50Ω) to input CH1.
2 - Press the AUTOSET key and set CH1 to 5 mV.
3 - Use a 50Ω termination. For instruments with switchable 50Ω input impedance it is recommended to make use of this feature ('LZ' must be visible in lower part of viewing area).
4 - Press the DISPLAY menu key and then press the X-DEFL softkey.
5 - Select 'on' and 'ch1' from the X-DEFL menu.
6 - Press the CH2 ON key and then the CH1 ON key: the result is that CH2 is on and CH1 off.
7 - Adjust the input voltage for exactly 6 divisions horizontal deflection.
8 - Increase the input frequency up to 2 MHz.

Requirements:

Verify that the trace width is at least 4.2 divisions over the complete bandwidth range.

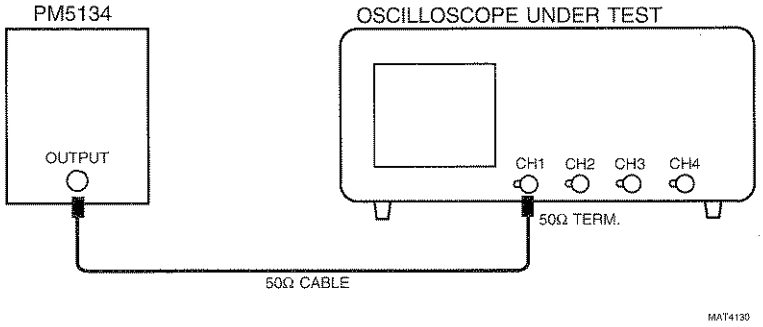
4.3.33 Maximum phase shift between horizontal and vertical deflection

There will be a certain phase shift between the horizontal and vertical amplifier. The value of this shift is measured here.

Test equipment:

LF sine wave generator (function generator, PM 5134 or PM 5138)

Test set-up:



Settings/procedure:

1 - Apply a 2 kHz sine-wave signal of 1.2 V(pp into 50Ω) to CH1.
2 - Press the AUTOSET key and set CH1 to 0.2V/div.
3 - Use a 50Ω termination. For instruments with switchable 50Ω input impedance it is recommended to make use of this feature (via VERT MENU key).
4 - Adjust the generator to a trace height of exactly 6 divisions.
5 - Press the DISPLAY menu key and then press the X-DEFL softkey.
6 - Select 'on' and 'ch1' from the X-DEFL menu.
7 - Increase the input frequency to 100 kHz.

Requirements:

Verify that the phase shift is less than 3°, ≤0.32 div, see figure).

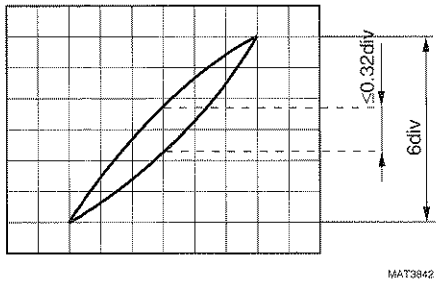


Figure 4.6 Phase shift between horizontal and vertical channel

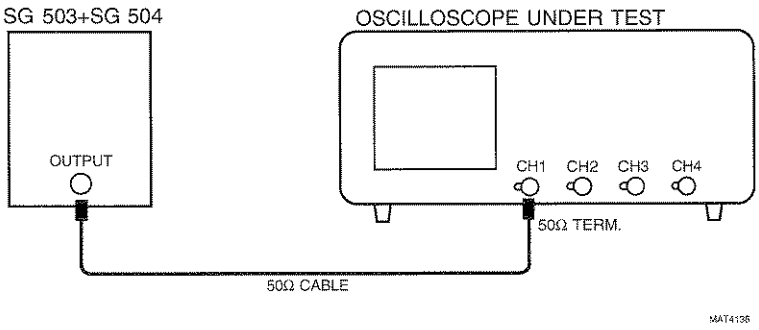
4.3.34 MAIN TB triggering PM3392A/3394A; trigger sensitivity via CH1, CH2, CH3 and CH4

The trigger sensitivity depends on the amplitude and frequency of the trigger signal. In this test the main timebase trigger sensitivity via the CH1, CH2, CH3 and CH4 inputs is checked.

Test equipment:

Constant amplitude sine wave generators (SG 503 + SG 504)

Test set-up:



Settings/procedure and requirements:

1 - Apply a 100 MHz sine-wave signal of 1 V(pp into 50Ω) from the SG 503 to input CH1.
2 - Press the AUTOSET key and set CH1 to 0.5V/div.
3 - Use a 50Ω termination. For instruments with switchable 50Ω input impedance it is recommended to make use of this feature (via VERT MENU key).
4 - Set the input coupling of CH1 to DC and POSition the signal in the vertical center of screen.
5 - Select 'trig' from in the menu under the TB MODE mode key.
6 - Press the TRIGGER menu key and select level-pp 'off' and 'dc' trigger coupling from the TRIGGER MAIN TB menu
7 - Adjust TRIGGER LEVEL for a correctly triggered display.
8 - Decrease the amplitude of the input signal.
9 - Verify that the signal is well-triggered at amplitudes of 0.6 divisions and more.
10 - Decrease the input frequency to 50 kHz.

11 - Verify that the signal stays well-triggered at amplitudes of 0.6 divisions and more.
12 - Increase the input frequency to 200 MHz.
13 - Increase the input voltage to 1.2 division.
14 - Turn TRIGGER LEVEL.
15 - Verify that the signal is well-triggered at amplitudes of 1 division and more.
16 - Apply a 300 MHz sine-wave signal of 2V (pp into 50Ω) from the SG 504 to input CH1.
17 - Adjust the input voltage to 2 divisions. Signal must be in vertical center of screen.
18 - Verify that the signal is well-triggered at amplitudes of 2 divisions and more; adjust TRIGGER LEVEL when necessary.

- Repeat the procedure for CH2, CH3 and CH4 for the frequencies 50 kHz (0.6 division input signal) and 300 MHz (2 division input signal)
- Press the ANALOG key ('DIGITAL MODE' is displayed briefly), then repeat the tests in this chapter for the digital mode.
- Press the ANALOG key ('ANALOG MODE' is displayed briefly) to return to analog mode.

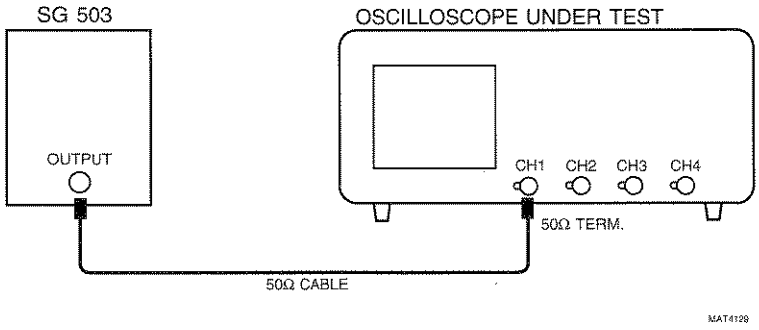
4.3.35 MAIN TB triggering PM3382A/3384A; trigger sensitivity via CH1, CH2, CH3 and CH4

The trigger sensitivity depends on the amplitude and frequency of the trigger signal. In this test the main timebase trigger sensitivity via the CH1, CH2, CH3 and CH4 inputs is checked.

Test equipment:

Constant amplitude sine wave generator (SG 503)

Test set-up:



Settings/procedure and requirements:

1 - Apply a 50 MHz sine-wave signal of 1 V(pp into 50Ω) to input CH1.
2 - Press the AUTOSET key and set CH1 to 0.5V/div.
3 - Use a 50Ω termination.
4 - Set the input coupling of CH1 to DC and POSition the signal in the vertical center of screen.
5 - Select 'trig' from the menu under the TB MODE menu key.
6 - Press the TRIGGER menu key and select level-pp 'off' and 'dc' trigger coupling from the TRIGGER MAIN TB menu
7 - Adjust TRIGGER LEVEL for a correctly triggered display.
8 - Decrease the amplitude of the input signal.
9 - Verify that the signal is well-triggered at amplitudes of 0.6 divisions and more.
10 - Decrease the input frequency to 50 kHz.
11 - Verify that the signal stays well-triggered at amplitudes of 0.6 divisions and more.
12 - Increase the input frequency to 100 MHz.
13 - Increase the input voltage to 1.2 division.
14 - Turn TRIGGER LEVEL.
15 - Verify that the signal is well-triggered at amplitudes of 1.2 division and more.
16 - Increase the input frequency to 200 MHz.
17 - Adjust the input voltage to 2 divisions. Signal must be in vertical center of screen.
18 - Verify that the signal is well-triggered at amplitudes of 2 divisions and more; adjust TRIGGER LEVEL when necessary.

- Repeat the procedure for CH2, CH3 and CH4 for the frequencies 50 kHz (0.6 division input signal) and 200 MHz (2 division input signal)
- Press the ANALOG key ('DIGITAL MODE' is displayed briefly) and repeat the tests in this chapter for the digital mode.
- Press the ANALOG key ('ANALOG MODE is displayed briefly for some seconds) to return to analog mode.

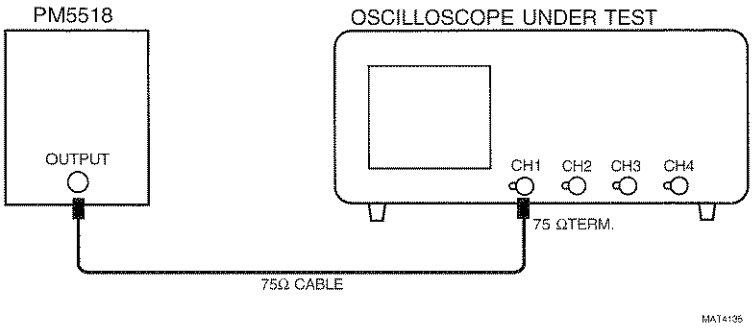
4.3.36 MAIN TB/DEL'D TB triggering; trigger sensitivity TVL-TVF

This test checks the trigger sensitivity for television line- and field synchronization pulses.

Test equipment:

TV pattern generator with video output (PM 5518)

Test set-up:



Note: the number a various tests to be performed is numerous. Therefore it is recommended only to check the tv system(s) as used in your country. The number of tests is also limited by the available TV pattern generator.

1 - Apply a video signal to input CH1 with an amplitude of about 1V synchronization pulse amplitude; use a 75Ω termination instead of internal or external 50Ω.
2 - Press the AUTOSET key.
3 - Press menu key TRIGGER and select 'tv' in the related menu.
4 - Select field 1 or field 2 in the menu.
5 - Select a line number (e.g. 25) by means of the TRACK control.
6 - Select pos or neg (depending on the available TV pattern generator).
7 - Select in the VIDEO SYSTEM submenu hdtv, ntsc, pal or secam (depending on the available TV pattern generator). The maximum number of lines for hdtv can be selected if hdtv is active.

Requirements:

Decrease the amplitude of the input signal and verify that the signal is well-triggered on the tv pulses, at sync pulse amplitudes of 0.7 divisions and more.

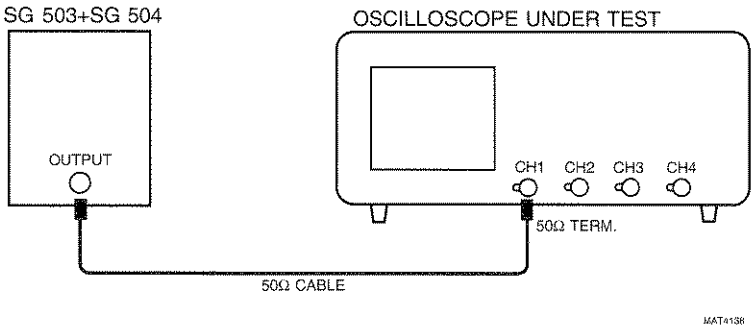
4.3.37 DEL'D TB triggering PM3392A/3394A; trigger sensitivity via CH1, CH2, CH3 and CH4

The trigger sensitivity depends on the amplitude and frequency of the trigger signal. In this test the main timebase trigger sensitivity via the CH1, CH2, CH3 and CH4 inputs is checked.

Test equipment:

Constant amplitude sine wave generators (SG 503 + SG 504)

Test set-up:



Settings/procedure and requirements:

1 - Apply a 100 MHz sine-wave signal of 1 V(pp into 50Ω) from the SG 503 to input CH1.
2 - Press the AUTOSET key and set CH1 to 0.5V/div.
3 - Use a 50Ω termination. For instruments with switchable 50Ω input impedance it is recommended to make use of this feature (via VERT MENU KEY).
4 - Set the input coupling of CH1 to DC and POSition the signal in the vertical center of screen.
5 - Select 'trig' from the menu under the TB MODE menu key.
6 - Press the TRIGGER menu key and select level-pp 'off' and 'dc' trigger coupling from the TRIGGER MAIN TB menu.
7 - Adjust TRIGGER LEVEL for a correctly triggered display.
8 - Press the DTB menu key and select DEL'D TB 'on' and MAIN TB 'on' in the related menu.
9 - Set MAIN TB to 200 ns/division and DELAYED TIMEBASE to 20.0 ns/division.
10 - Adjust the DELAY control in the DELAYED TIMEBASE section to a delay time of 1.000 µs.
11 - Select 'trig'd' and 'dc' coupling from the DELAYED TIME BASE menu, and press the front panel key TRIG1. Or TRIG2 (if CH2 on), TRIG3 (if CH3 on), TRIG4 (if CH4 on).
12 - Adjust the DEL'D TB trigger level via the Δ control for a well- triggered signal (intensified part must be visible).
13 - Operate the TRACK control to separate MAIN TB and DEL'D TB for clearly visible displays.
14 - Decrease the amplitude of the input signal.
15 - Verify that the DEL'D TB is well triggered at signal amplitudes of 0.6 divisions and more.

16 - Decrease the input frequency to 50 kHz. Set the MAIN TB to 50.0 µs/division and DEL'D TB to 20.0 µs/division.
17 - Verify that the DEL'D TB stays well triggered at signal amplitudes of 0.6 divisions and more.
18 - Increase the input frequency to 200 MHz.
19 - Increase the input voltage to 1.2 division.
20 - Operate the Δ control (controls DEL'D TB trigger level).
21 - Verify that the DEL'D TB is well triggered at all amplitudes of 1.2 divisions or more.
22 - Apply a 300 MHz sine-wave signal of 2V (pp into 50 ohm) from the SG504 generator to input CH1.
23 - Adjust the input voltage to 2 divisions. Signal must be in vertical center of screen.
24 - Verify that the DEL'D TB is well triggered at signal amplitudes of 2 divisions and more: adjust the Δ control (DEL'D TB trigger level) if necessary.

- Repeat the procedure for CH2, CH3 and CH4 for the frequencies 50 kHz (0.6 division input signal) and 300 MHz (2 division input signal)
- Press the ANALOG key ('DIGITAL MODE' is displayed briefly) and repeat the tests in this chapter for the digital mode.
- Then press the ANALOG key ('ANALOG MODE' is displayed briefly) to return to analog mode.

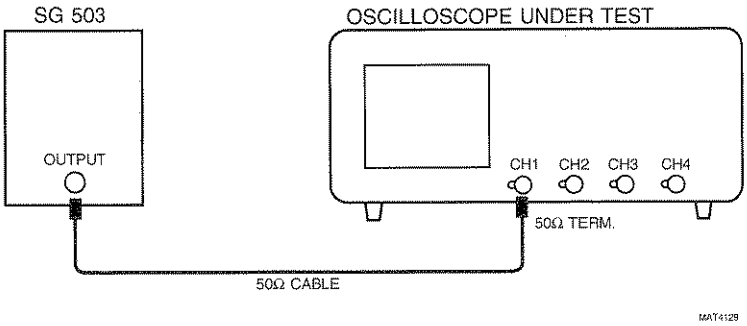
4.3.38 DEL'D TB triggering PM3382A/3384A; trigger sensitivity via CH1, CH2, CH3 and CH4

The trigger sensitivity depends on the amplitude and frequency of the trigger signal. In this test the main timebase trigger sensitivity via the CH1, CH2, CH3 and CH4 inputs is checked.

Test equipment:

Constant amplitude sine wave generator (SG 503)

Test set-up:



Settings/procedure and requirements:

1 - Apply a 50 MHz sine-wave signal of 1 V(pp into 50Ω) from the SG 503 to input CH1.
2 - Press the AUTOSET key and set CH1 to 0.5V/div.
3 - Use a 50Ω termination.
4 - Set the input coupling of CH1 to DC and POSition the signal in the vertical center of screen.
5 - Select 'trig' from the menu under the TB MODE menu key.
6 - Press the TRIGGER menu key and select level-pp 'off' and 'dc' trigger coupling from the TRIGGER MAIN TB menu
7 - Adjust TRIGGER LEVEL for a correctly triggered display.
8 - Press the DTB menu key and select DEL'D TB 'on' and MAIN TB 'on' from the related menu.
9 - Set the MAIN TB to 200 ns/division and DELAYED TIMEBASE to 50.0 ns/division.
10 - Adjust the DELAY control in the DELAYED TIMEBASE section to a delay time of 1.000 µs.
11 - Select 'trig'd' and 'dc' coupling from the DELAYED TIMEBASE menu and press the front panel key TRIG1. Or TRIG2 (if CH2 on), TRIG3 (if CH3 on), TRIG4 (if CH4 on).
12 - Adjust the DEL'D TB trigger level via the Δ control for a well- triggered signal (intensified part must be visible).
13 - Operate the TRACK control to separate the MAIN TB and DEL'D TB for clearly visible displays.
14 - Decrease the amplitude of the input signal.
15 - Verify that the DEL'D TB is well triggered at signal amplitudes of 0.6 divisions and more.

16 - Decrease the input frequency to 50 kHz. Set the MAIN TB to 50.0 µs/division and DEL'D TB to 20.0 µs/division.
17 - Verify that the DEL'D TB stays well triggered at signal amplitudes of 0.6 divisions and more.
18 - Increase the input frequency to 100 MHz.
19 - Increase the input voltage to 1.2 division.
20 - Operate the Δ control (controls the DEL'D TB trigger level).
21 - Verify that the DEL'D TB is well triggered at all amplitudes of 1.2 division or more.
22 - Increase the input frequency to 200 MHz.
23 - Adjust the input voltage to 2 divisions.
24 - Verify that the DEL'D TB is well-triggered at signal amplitudes of 2 divisions and more. Signal must be in vertical center of screen. Adjust the Δ control (DEL'D TB trigger level) if necessary.

- Repeat the procedure for CH2, CH3 and CH4 for the frequencies 50 kHz (0.6 division input signal) and 200 MHz (2 division input signal)
- Press the ANALOG key ('DIGITAL MODE ' is displayed briefly), and repeat the tests in this chapter for the digital mode.
- Then press the ANALOG key (message ANALOG MODE is displayed briefly) to return to analog mode.

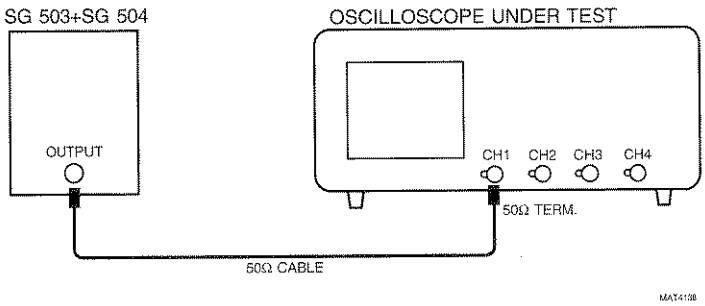
4.3.39 Trigger sensitivity in logic mode PM3392A/3394A

The trigger sensitivity in the logic mode 'pattern' depends on the amplitude and frequency of the trigger signal. In this test, the trigger sensitivity is tested with a sine wave via the CH1, CH2, CH3, and CH4 inputs.

Test equipment:

Constant amplitude sine wave generator (SG 503)

Test setup:



1 - Press the ANALOG key ('DIGITAL MODE' is displayed briefly) to activate the digital mode.
2 - Apply a 100 MHz sine-wave signal of 1 V(pp into 50 ohm) from the constant amplitude sine-wave generator to input CH1.
3 - Press the AUTOSET key, and set CH1 to 0.5V/division.
4 - Use a 50 ohm termination. For instruments with switchable 50 ohm input impedance it is recommended to make use of this feature (via VERT MENU key).
5 - Set the input coupling to DC and POSition the signal in the vertical center of the screen.
6 - Select 5.00 ns/division for MAIN TB.
7 - Press the TRIGGER menu key and select 'logic', 'pattern', and 'enter' from the related menu.
8 - Operate the front panel keys TRIG1, TRIG2, TRIG3 and TRIG4 to obtain the trigger pattern Hxxx (x = don't care) in the menu.
9 - Press the TB MODE menu key and select 'trig' from the related menu.
10 - Decrease the amplitude of the generator voltage to 1 division.
11 - Turn the TRIGGER LEVEL control and check that a well-triggered signal is obtained.
12 - Apply a 300 MHz sine-wave signal of 2 V(pp into 50Ω) from the SG 504 to input CH1.
13 - Adjust the input voltage to 2 divisions.
14 - Verify that the signal is well triggered at amplitudes of 2 divisions and more; adjust TRIGGER LEVEL when necessary.
15 - Press the ANALOG key ('ANALOG MODE' is displayed briefly) to return to analog mode.

Repeat the procedure for CH2 with trigger pattern xHxx
Repeat the procedure for CH3 with trigger pattern xxHx
Repeat the procedure for CH4 with trigger pattern xxxH

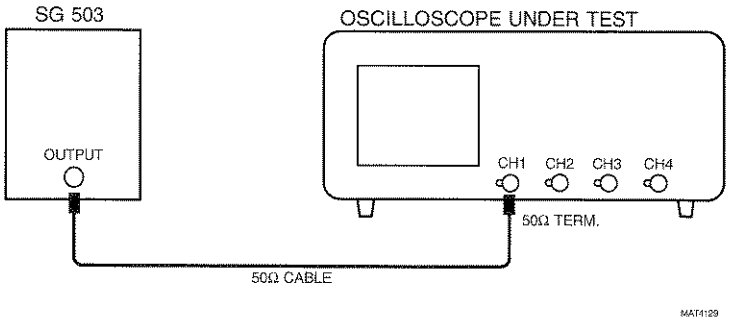
4.3.40 Trigger sensitivity in logic mode PM3382A/3384A

The trigger sensitivity in the logic mode 'pattern' depends on the amplitude and frequency of the trigger signal. In this test, the trigger sensitivity is tested with a sine wave via the CH1, CH2, CH3, and CH4 inputs.

Test equipment:

Constant amplitude sine wave generator (SG 503)

Test setup:



1 - Press the ANALOG key ('DIGITAL MODE' is displayed briefly) to activate the digital mode.
2 - Apply a 50 MHz sine-wave signal of 1 V(pp into 50 ohm) from the constant amplitude sine-wave generator to input CH1.
3 - Press the AUTOSET key, and set CH1 to 0.5V/division.
4 - Use a 50 ohm termination.
5 - Set the input coupling to DC and POSition the signal in the vertical center of the screen.
6 - Select 5.00 ns/division for MAIN TB.
7 - Press the TRIGGER menu key and select 'logic', 'pattern', and 'enter' from the related menu.
8 - Operate the front panel keys TRIG1, TRIG2, TRIG3 and TRIG4 to obtain the trigger pattern Hxxx (x = don't care) in the menu.
9 - Press the TB MODE menu key and select 'trig' from the related menu.
10 - Decrease the amplitude of the generator voltage to 1 division.
11 - Turn the TRIGGER LEVEL control and check that a well-triggered signal is obtained.
12 - Increase the input frequency to 200 MHz.

13 - Increase the input voltage to 2 division.
14 - Turn the TRIGGER LEVEL control, and check that a well-triggered signal is obtained.
15 - Press the ANALOG key ('ANALOG MODE' is displayed briefly) to return to analog mode.

Repeat the procedure for CH2 with trigger pattern xHxx
Repeat the procedure for CH3 with trigger pattern xxHx
Repeat the procedure for CH4 with trigger pattern xxxH

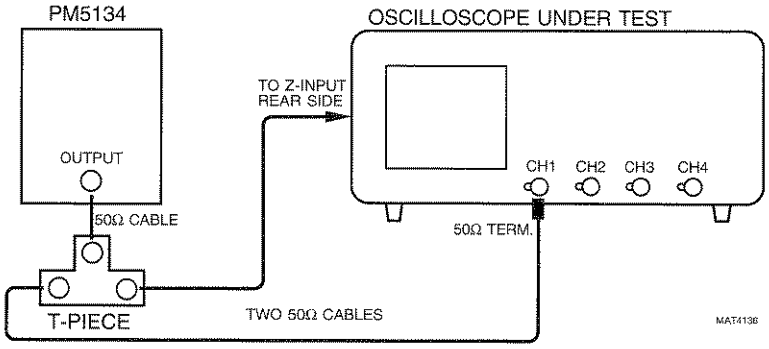
4.3.41 Z-MOD sensitivity

This test checks the sensitivity of the Z modulation facility.

Test equipment:

- Square-wave generator (function generator PM 5134 or PM 5138)
- T-piece

Test set-up:



Settings/procedure and requirements:

1 - Apply a 1 kHz square-wave signal, duty cycle 50%, amplitude between 0 to +2.5V (into 50Ω), to input CH1. Use a 50Ω termination directly at the generator output.
2 - Press the AUTOSET key.
3 - Set MTB to 0.5 ms/div.
4 - Set the trace of CH1 in mid position with the CH1 POS control.
5 - Apply the same signal by means of the T-piece to the Z input (rear side).

6 - Adjust TRACE INTENSITY so that only the bottom half of the squarewave is displayed. The top half must be invivisible (0.5 ms light on; 0.5 ms light off).
7 - Decrease the input signal to 0.5V.
8 - Set CH1 to 0.5V/division.
9 - Verify that the top half of the square wave is visible at full intensity.

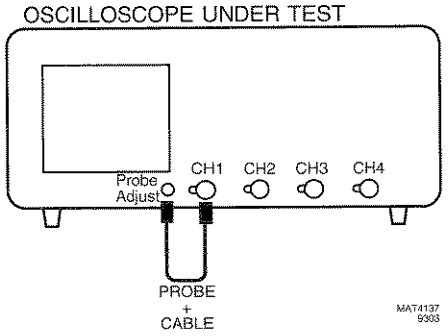
4.3.42 Probe Adjust signal; frequency and output voltage

The Probe Adjust signal is a calibration signal with fixed frequency and voltage. In this test, the values of frequency and voltage are checked.

Test equipment:

None

Test set-up:



Settings/procedure:

1 - Connect the Probe Adjust signal to input CH1 and press the AUTOSET key.
2 - Select GND of CH1.
3 - Set the trace in the center of the screen.
4 - Select DC input coupling for CH1.

Requirements:

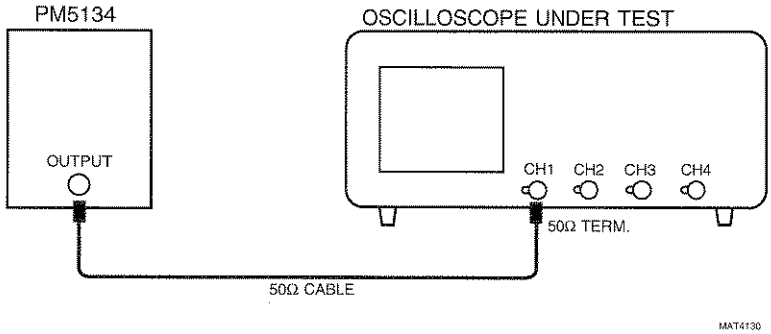
1 - Verify that a positive going square-wave signal of 0.6 V(pp) is displayed, i.e. 3 divisions vertical at 0.2V.
2 - Verify that the frequency of the displayed signal is about 2 kHz, i.e. a period time between 4.0 ... 6.0 divisions horizontal at MTB 100 µs/div.

4.3.43 Auto range functions

The AUTO RANGE function of the vertical channels automatically selects the input sensitivity. The result is that the input signal is displayed with 2 to 6.4 divisions amplitude.
The AUTO RANGE function of the main time base (MAIN TB) adjusts the time base automatically so that approximately 2 to 6 waveform periods are displayed.

Test equipment:

LF sine wave generator (function generator, PM5134 or PM5138)



Settings/procedure:

1 - Apply a 50kHz sine-wave signal of 2 V(pp into 50Ω) to CH1.
2 - Use a 50Ω termination. For instruments with switcheable 50Ω input impedance it is recommended to make use of this feature (via VERT MENU key).
3 - Press the AUTOSET key.
4 - Adjust the generator output voltage to maximum (20 ... 30 V approximately). The signal amplitude now exceeds the 8 div screen height.
5 - Press the ANALOG key ('DIGITAL MODE' is displayed briefly) to switch the digital mode to on.
6 - Press the CH1 AUTO RANGE key. Check that the vertical amplitude is automatically adjusted to between 2 and 6.4 divisions.
7 - Vary the generator output voltage from maximum to 100 mV.

Requirements:

- Check that the signal amplitude stays between 2 and 6.4 divisions.
- Repeat this procedure for the other vertical channels that have an AUTO RANGE key.

Settings/procedure:

1 - Adjust the generator to a 1 kHz sine-wave of 2 V(pp into 50Ω) applied to CH1.
2 - Press the AUTOSET key.
3 - Press the AUTO RANGE key of the main time base MAIN TB.
4 - Vary the generator output frequency between 1kHz and maximum (10 MHz approxinately).

Requirement:

- Check that between 2 and 6 waveform periods are displayed.

5 PREVENTIVE MAINTENANCE

5.1 GENERAL INFORMATION

This instrument normally requires no maintenance, since none of its components is subject to wear.

However, to ensure reliable and trouble-free operation, the instrument should not be exposed to moisture, heat, corrosive elements or excessive dust.

5.2 REMOVING THE BEZEL AND THE CONTRAST FILTER

The bezel can be removed by pulling the upper rim away from the front panel. This makes the contrast filter accessible for e.g. cleaning. The filter has open spaces at the edges that allow to lift it from the screen with a small screwdriver.

When cleaning the filter, ensure that a soft cloth is used. The cloth must be free from dust and abrasive particles in order to prevent scratches.

When installing the filter take care that the side facing the screen is the one that has a small distance from the screen.

When installing the bezel take care that the grooves for text/softkey alignment are on the right hand side.

5.3 RECALIBRATION

From experience, it is expected that the instrument operates within its specifications for a period of at least 2,000 hours, or for one year if used infrequently. Recalibration must be carried out by qualified personnel only.

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