

Operator's Manual

Mask Tester for LeCroy Digital Oscilloscopes

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MT-OM-E Rev E 1000





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Introduction

The Problem

Oscilloscopes are commonly used in the telecommunications industry to perform "Mask Testing" — a check of whether the signal shape falls within a particular defined tolerance.

However, performing such mask tests can quickly become frustrating, for the following reasons:

- The oscilloscope is a general-purpose instrument that is not optimized for any specific application. Setting it up for mask testing can be particularly tedious.
- Some adjustments, particularly horizontal ones, need to be performed frequently during mask testing. Making these adjustments manually is not only cumbersome, but may even be impossible if the oscilloscope is used in an automated test station.
- Some tests require either amplitude and peak adjustment or special triggering to isolate the correct pattern — also difficult if not impossible to achieve using a standard oscilloscope.

The Solution

LeCroy's innovative Mask Tester application is designed to address these issues and is ideal for Manufacturing Testing, Type Approval and Field Testing applications. The Mask Tester supports the major electrical bit rates in telephony, from both ITU G.703 and ANSI T1.102 standards, and the optical telecommunication standards, ITU-T G.957 and ANSI T1.105. Its leading features include:

- One-step loading of masks and instrument setups
- Mask-to-signal alignment ev en on random bit streams
- Choice of fail actions such as screen printout, "beep", "stop test" and "store failed trace"
- ightharpoonup A complete set of twisted-pair and 75 Ω adapters, providing accurate cable termination and amplitude scaling.

Available Mask Tests

The Mask Tester application supports both ANSI and ITU-T standards. LeCroy's MT01 supports most ITU-T G.703 masks,



MT02 supports most ANSI T1.102 masks, and MT03 supports most ITU-T G.957 standards and their ANSI T1.105 equiv alents. Bundled packages, such as MT01/02, are also available.

MT01 — ITU G.703				
Signal	Bit Rate	Line Impedance	LeCroy Adapter	
E-1	2.048 Mb/s	120 Ω twisted pair	AP120	
E-1	2.048 Mb/s	75 Ω coax	PP090	
E-2	8.448 Mb/s	75 Ω coax	PP090	
E-3	34.368 Mb/s	75 Ω coax	PP090	
E-4	139.264 Mb/s	75 Ω coax	PP090	
STM-1E [†]	155.520 Mb/s	75 Ω coax	PP090	

MT02 — ANSI T1.102-1993				
Signal	Bit Rate Line Impedance		LeCroy Adapter	
DS-1	1.544 Mb/s	100 Ω twisted pair	AP100	
DS-3	44.736 Mb/s	75 Ω coax	PP090	
STS-1	51.840 Mb/s	75 Ω coax	PP090	
STS-3E [†]	155.520 Mb/s	75 Ω coax	PP090	

MT03* — ITU-T G.957 and ANSI T1.105-1996				
Signal Bit Rate		Medium	LeCroy Adapter	
OC3/STM-1	155.520 Mb/s	Singlemode optical fiber	OE325	
OC12/STM-4	622.080 Mb/s	Singlemode optical fiber	OE325	

 ^{*} MT03 is limited to oscilloscope models with a bandwidth = 1 GHz and a sample rate = 4 GS/s
 * STM-1E and STS-3E in the MT01 and MT02 packages, respectively, are limited to oscilloscope models with a bandwidth = 500 MHz and a sample rate of = 1 GS/s

Preparing the Test

Choosing the Right Adapter for the Right Signal

75 W Coax Signals

Plug in the PP090 on the oscilloscope's desired channel connector. The PP090 will provide the correct 75 Ω impedance adaptation.

Then connect your signal using a 75 W cable to the PP090.

Twisted-Pair Signals

Use the appropriate adapter supplied in your package:

For **DS-1 signals**, use the **AP100**.

For 2 Mb/s twisted pairs, use the AP120.

These adapters automatically ensure proper termination, convert the balanced signal into an unbalanced 50 $\,\Omega$ input, and scale the amplitude with the appropriate factor.

Optical Signals

Use the OE325 optical-to-electrical converter supplied in your package. The OE325 can be used on any scope channel for optical signal analysis. By plugging the OE325 into a matched scope channel (see back of OE325 for matching scope serial number and channel), reference receiver processing capability is provided as required for STM-1/OC3 or STM-4/OC12 compliance mask testing.

Test Signal Configuration

All tested signals can be random-bit streams, for optimum convenience and flexibility.

If the signal is not random or PRBS, ensure that it contains valid isolation patterns so that the oscilloscope's pulse isolating mechanism can operate properly. The required isolation patterns are described in Appendix A.



Setting Up the Oscilloscope

- 1. Power up the oscilloscope.
- If you purchased the MT01, MT02, MT01/02 or MT01/02/03 options, plug in the SRAM card containing the masks and instrument setups in the slot located on the lower right-hand side of the front panel. The MT03 option does not require a SRAM card.
- Press the ANALYSIS PACKAGES front panel button on the WavpPro DSO (CURSORS/MEASURE on other scopes). On the DDA, press CURSORS, then select Analysis Packages from the "WAVE PILOT" menu.
- 4. Select the MASK TESTER menu. The oscilloscope is now in "Mask Tester" mode and is dedicated to mask testing. The oscilloscope can now only be controlled by using the seven menu buttons and the two menu knobs associated with the bottom two buttons. Each of these buttons and knobs corresponds to, and controls, the on-screen menu appearing beside it. Beneath them on the scope front panel is the RETURN button, an important navigation control that enables you to return to the next higher menu level and to exit the Mask Tester mode.

Tip: After exiting the Mask Tester mode, the previously selected telecom mask will no longer be displayed. However, for MT01 and MT02, the mask is still assigned to a scope zoom trace and can be displayed by turning the corresponding trace on.

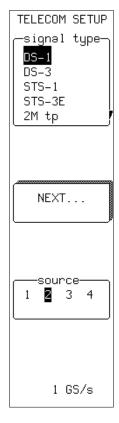
Running the Test

The test proceeds in three steps:

- 1. **Selecting** the signal type
- 2. Adjusting the trace, and the test options
- 3. **Testing**.

The following pages detail these steps.

Selecting



signal type

This is the top menu. Scroll through the list to select the appropriate signal type using the two top-most menu buttons alongside the menu.

When applying the Optical masks, you will have the further choice of applying Reference Receiver filtering or not. The Reference Receiver must be enabled for STM-1/OC3 or STM-4/OC12 compliance testing.

NEXT...

Press the corresponding menu button beside this menu to access the "TRACE ADJUST" trace adjustment and test options menus (*shown next page*).

source

Select the desired channel and connect the signal under test to it using the appropriate adapter (see above and page 13). To enable Reference Receiver processing, the OE325 must be plugged into the matching scope channel as designated on the back of the OE325.



Adjusting the Trace

Case 1

Simple Masks in Volts (ITU 2, 8, 34 Mb/s)

TRACE ADJUST

If test fails, do...

HORIZONTAL ALIGN

-attenuation— (factor) 1.000

> DO TEST NOW

500 MS/s

If test fails, do...

Press the button corresponding to this menu to choose the action the oscilloscope should perform when a trace fails (see page 13).

HORIZONTAL ALIGN

Pressing the button for this menu causes the instrument to recalculate its trigger position to readjust the signal to the mask.

attenuation factor

Use the knob associated with this menu to compensate for any amplitude loss caused by the signal path. Pressing the corresponding menu button resets the value to 1.

DO TEST NOW

Once all adjustments and action setups have been made, start the test using this menu's button.

CMI masks (STM-1E, STS-3E and 139 Mb/s)

If test
fails, do...

offset
0 mV

VERTICAL
ALIGN

HORIZONTAL
ALIGN

attenuation
(factor)
1.000

DO TEST
NOW

1 GS/s

If test fails, do...

Press the button corresponding to this menu to choose the action the oscilloscope should perform when a trace fails (see page 13).

VERTICAL ALIGN

Press this menu's button to adjust the signal offset, possible within a ± 50 mV range. If the required adjustment is outside this range, the warning message "Offset out of range, cannot do test" will be displayed.

HORIZONTAL ALIGN

Pressing the corresponding button causes the instrument to recalculate its trigger position and readjust the signal to the mask.

attenuation factor

Use the knob associated with this menu to compensate for any amplitude loss caused by the signal path. Pressing the menu button resets the value to 1.

DO TEST NOW

Once all adjustments and action setups have been made, start the test using this menu control.



Normalized masks (ANSI DS-1, DS-3, STS-1)

IF test
Fails, do...

AUTO-FIT
TO MASK

averaging
OFF
127

DO TEST
NOW

1 GS/s

If test fails, do...

Press the button corresponding to this menu to choose the action the oscilloscope should perform when a trace fails (see page 13).

AUTO-FIT TO MASK

Pressing the corresponding button will cause the signal to be renormalized to its mask; amplitude and trigger position will be readjusted.

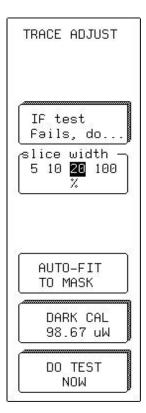
averaging

The signal under test can be averaged using this button. The knob selects the continuous averaging weighting.

DO TEST NOW

Once all adjustments and action setups have been made, start the test using this control (page 14).

Optical signal masks (STM-1/OC3, STM-4/OC12)



If test fails, do...

Press the button corresponding to this menu to choose the action the oscilloscope should perform when a trace fails (see page 13).

AUTO-FIT TO MASK

Pressing the corresponding button will cause the signal to be renormalized to its mask; amplitude and trigger position will be readjusted.

DO TEST NOW

Once all adjustments and action setups have been made, start the test using this control (page 14).

Note: To remove the STM-1 or STM-4 masks prior to leaving the MT mode of operation, return to the Telecom Setup menu set.



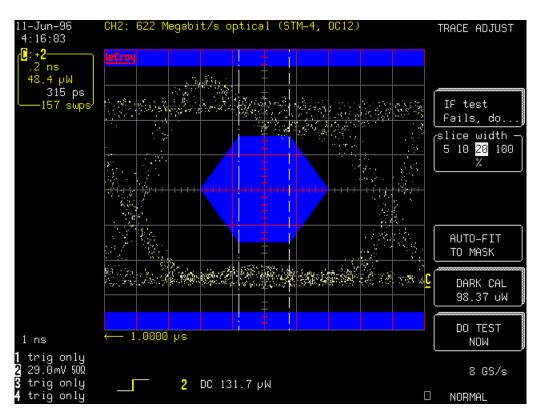
Slice Width

TELECOM SETUP
signal type—
STS-3E
STM-1 (0C3)
STM-4 (0C12)
2M tp
2M coax

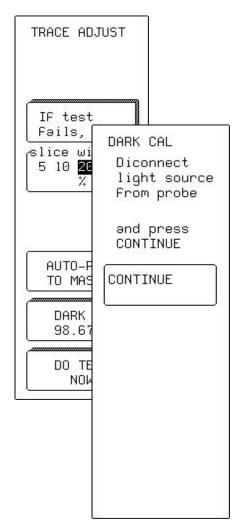
NEXT...

In cases when mask testing is required only over a limited portion of the mask, use the "slice width" function. The area on which the test will be performed is bounded by two cursors. It is possible to select either 5%, 10%, 20%, or 100% of the mask area. When a different value is set, the cursors accordingly move to the new setting. (See the figure below.)

The **slice width** option is only available if one of the MT03 optical packages (OC3 or OC12) is selected in the signal type menu, as shown at left.



Dark Cal



Description:

This function determines the value seen by the scope with no input signal applied. The Dark Cal measurement establishes a reference for accurate top and base measurements.

To perform the Dark Calibration:

- 1. From the "TRACE ADJUST" menu, select **DARK CAL** to access the "DARK CAL" menu.
- Disconnect the light source and cov er the OE325 input connection.
- 3. Select **Continue** to perform the dark calibration.

The scope will acquire the input signal for a few seconds, then return to the TRACE ADJUST menu. The calculated adjustment is displayed inside the Dark Cal menu selection. This value can also be adjusted manually in the range -99 to 99 [μ W] in steps of 0.01 [μ W].

If the scope's internal calibration takes place during a dark calibration, repeat the dark calibration to obtain an accurate measurement.



TBR Parameter

Description:

The TBR (Top to Base Ratio) parameter is used to measure the ratio of top to base for power signals. The measurement can be expressed as

- top to base ratio
- base to top in percent
- top to base in dB.

The offset for top and base can be adjusted in the range -99 to $99 [\mu W]$ in steps of 0.01 $[\mu W]$.

1. Extension to the PARAMETER_CUSTOM command/query

COMMAND SYNTAX

PACU <line>,TBR,<source>,<mesurement_type> <line>:= 1 to 5

<mesurement_type>:={TB,BTP,TBDB}

TB = top/base BTP = base/top in % TBDB = top/base in dB

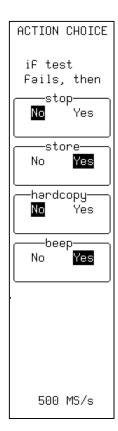
2. PARAMETER_VALUE Query

QUERY SYNTAX

<trace>:PAVA? TBR
<trace>:={TA,TB,TC,TD,C1,C2,C3,C4}

PAVA? CUST<line>

The Test Options



The menus shown on this page are displayed when the "If test fails, do" menu button is pressed. They determine what the instrument does when a trace fails the test.

stop

Select "Yes" with the corresponding button to stop the acquisition.

store

Select "Yes" here to store the failed trace to memory card.

hardcopy

"Yes" to make a hard copy of the screen using the internal printer.

beep

"Yes" to emit a sound.

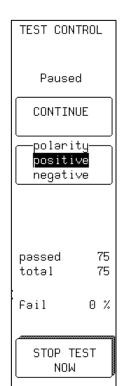


Testing

These menus are displayed when the "DO TEST NOW" menu button is pressed.

Case 1

2, 8 and 34 Mb/s



1 GS/s

PAUSE/CONTINUE

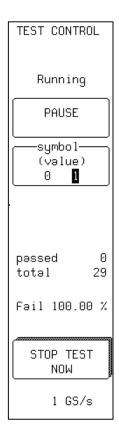
Press this menu's button to pause or continue the test without resetting the pass/fail count.

polarity

Use the corresponding button to toggle between positive and negative pulses. The pass/fail counter will be reset.

STOP TEST NOW

STM-1E, STS-3E and 139 Mb/s



PAUSE/CONTINUE

Press this menu's button to pause or continue the test without resetting the pass/fail count.

symbol

Press the corresponding button to toggle between "1" and "0" patterns. The pass/fail counter will be reset.

STOP TEST NOW



DS-1, DS-3 and STS-1

Paused

CONTINUE

polarity
positive
negative

passed 75
total 75
Fail 0 %

STOP TEST
NOW

1 GS/s

PAUSE/CONTINUE

Press this menu's button to pause or continue the test without resetting the pass/fail count.

polarity

Use the corresponding button to toggle between positive and negative pulses. The pass/fail counter will be reset.

STOP TEST NOW

STM-1, STM-4, OC3 and OC12

TEST CONTROL

Running

PAUSE

Extinction ratio>25.69dB Pwr –12.53dBm X(Fit) 48% Top –9.53dBm Base –35.2dBm

passed 257601 total 257601

Fail 0%

STOP TEST NOW

8 GS/s

PAUSE/CONTINUE

Press this menu's button to pause or continue the test without resetting the pass/fail count.

Automatic Measurements

For optical signal tests five automatic measurements are displayed below the **PAUSE** menu. It is recommended that these measurements be performed with the Reference Receiver turned on to condition the signal prior to measurement. Extinction ratio: 10 Log Top/Base. If the base value is determined to be below 300 nW, which is the lowest power level MT03 can accurately resolve, a ">" is shown indicating that the Extinction ratio is at least the value displayed.

Pwr: (Top + Base)/2. This is equivalent to mean launched power for 1310 nm optical signals. For 1550 nm signals, multiply by the constant value as shown on the OE325 calibration certificate to determine mean launched power.

X(fit): Signal rising and falling edge-crossing point. This measurement is determined during the auto fit to mask.

Top: The average power of light on. Base: The average power of light off.

STOP TEST NOW



Mask Testing Remote Control Commands

IDENTIFICATION CU_OPT?

Query

DESCRIPTION The CU_OPT? query identifies options currently enabled due to the

presence of a PP100. These options can also be enabled by the normal 'option key' mechanism. If so, they are reported by the *OPT? query instead of CU_OPT?. The response to CU_OPT? consists of a series of response fields listing all the options enabled

due to the presence of a PP100.

QUERY SYNTAX CU_OPT?

RESPONSE FORMAT CU_OPT coption_1>, coption_2>,...,coption_n>

<option_n> = MT01: Mask Tester option for ITU

MT02: Mask Tester option for ANSI MT03: Mask Tester for Optical Signals

0: No custom options installed

CUSTOM_APPLICATION, CUAP

Command/Query

DESCRIPTION The CUSTOM_APPLICATION command toggles from Mask

Tester mode to standard oscilloscope mode.

COMMAND SYNTAX CUSTOM_APPLICATION <state>

QUERY SYNTAX CUSTOM APPLICATION?

RESPONSE FORMAT CUSTOM APPLICATION <state>

<state> = OFF for the standard oscilloscope state

MASK_TESTER for the Mask Tester state



SELECTING MT_SELECT_TEST

Command/Query

DESCRIPTION The MT_SELECT_TEST command selects the signal/test type,

and performs "AUTOALIGN" or "HORIZONTAL ALIGN" actions

automatically on the signal.

COMMAND SYNTAX MT_SELECT_TEST <test_name>, <channel> ^๗, <av eraging> ^๗

QUERY SYNTAX MT_SELECT_TEST?

RESPONSE FORMAT MT_SELECT_TEST <test_name>, <channel>, <av eraging>

<test_name> = NO_TEST if no test selected

<test_name> = {2M_TP, 2M_COAX, 8M, 34M, 139M, 156M,

DS1, DS3, STS1, STS3E, OC3, OC12

Note: OC3 and OC12 are equivalent to STM-1 and STM-4

signals, respectively.

d AVAILABILITY

<channel>

On four-channel oscilloscopes:

for 2M_TP, 2M_COAX, 8M, DS1: {C1, C2, C3, C4} for 34M, 139M, 156M, DS3, STS1, STS3E: {C2, C3}

On two-channel oscilloscopes:

for 2M_TP, 2M_COAX, 8M, DS1: {C1, C2}

for 34M, 139M, 156M, DS3, STS1, STS3E: {C2}

<av eraging> av ailable only for DS1, DS3, STS1

Note: Autoalign and Horizontal Align actions are performed automatically using the MT SELECT TEST command.

OPERATION MT_OPC? COMPLETE Query

DESCRIPTION The MT_OPC? (Operation Complete) query checks the

completion of the following commands.

MT_SELECT_TEST MT_VERTICAL_ALIGN

MT_SYMBOL

The query returns a "0" when the command is not completed,

and a "1" otherwise.

QUERY SYNTAX MT_OPC?

RESPONSE FORMAT MT_OPC <state>

<state> = $\{0, 1\}$



ADJUSTING MT_VERTICAL_ALIGN

Command

DESCRIPTION Performs offset alignment for STM-1E, STS-3E and 139M.

COMMAND SYNTAX MT_VERTICAL_ALIGN

MT_OFFSET?

Query

DESCRIPTION Returns the offset value for STM-1E, STS-3E and 139M.

QUERY SYNTAX MT_OFFSET?

RESPONSE FORMAT MT_OFFSET <offset_v alue> mV

MT_ATTENUATION

Command/Query

DESCRIPTION Controls cable attenuation factor for 2M_TP, 2M_COAX, 8M, 34M,

139M, 156M.

COMMAND SYNTAX MT_ATTENUATION<attn_v alue>

QUERY SYNTAX MT_ATTENUATION?

RESPONSE FORMAT MT_ATTENUATION <attn_v alue>

<attn_v alue> = v alue between 0.5 and 1

ADJUSTING MT_FAIL_ACTION
Command/Query

DESCRIPTION Controls the actions the instrument should perform when a test fails.

COMMAND SYNTAX MT_FAIL_ACTION < action > [, < action >]

QUERY SYNTAX MT_FAIL_ACTION?

RESPONSE FORMATMT FAIL ACTION <action>[,<action>]

<action> := {STOP, STORE, DUMP, BEEP}

MT_OPTICAL_PARAMS?

Query

DESCRIPTION Returns optical signal measurement parameter values automatically

displayed for STM1/OC3 and STM4/OC12 tests

QUERY SYNTAX MT_OPTICAL_PARAMS?

RESPONSE FORMAT MT_OPTICAL_PARAMS <extinction ratio dB>, <mean power

dBm>,

Note: reads out the last values computed for display on the OC3 or OC12 test menu. It does not cause computation. If this query is executed before any values have been computed, it returns:

MT_OPTICAL_PARAMS 0.00dB,-99.90dBm,0.0%,-99.90dBm,-99.90dBm

Extinction ratio defaults to 0 dB and mean power to -99.9 dB if top is negative. If top is negative, there is probably no signal. The base value is constrained to be at least 300 nW and not less than 0.0063095 times (22 dB below) the top; that is the calibration specification on the OE325. If the base is clipped, the screen shows a ">" in front of the extinction ratio, a "<" in front of the base, and if the change in power would be greater than 1%, a "<" in front of power. If the base is clipped, the query returns a 1 for < base_clipped>. An example looks like:

MT OPTICAL PARAMS 22.00dB,-8.76dBm, 47.5%,-5.78dBm,-27.78dBm,1

<cross height%>, <topdBm>, <basedBm>, <hbase clipped>



TESTING MT_TEST_STATE
Command/Query

DESCRIPTION Controls the test execution: RUN/STOP or PAUSE/CONTINUE.

COMMAND SYNTAX MT_TEST_STATE < test_state >

<test_state> := {RUN, STOP, CONTINUE, PAUSE}

QUERY SYNTAX MT_TEST_STATE?

RESPONSE FORMAT MT_TEST_STATE dest_state>

<test_state> := {RUN, STOP, PAUSE, ABORTED}

MT_SYMBOL

Command/Query

DESCRIPTION For STM-1E, STS-3E and 139 M selects the "1" or "0" symbol.

For DS1, DS3 and STS1 selects the "POS" or "NEG" pulse.

QUERY SYNTAX MT_SYMBOL?

RESPONSE FORMAT MT_ SYMBOL

dit_v alue>

<bit_v alue> := {0, 1, POS, NEG}

MT_PF_COUNTERS

Query

DESCRIPTION Controls the test execution: RUN/STOP or PAUSE/CONTINUE.

QUERY SYNTAX MT_PF_COUNTERS?

RESPONSE FORMAT MT_PF_COUNTERS PASS,266,OF,286,FAIL_RATE,6.903007



PRINT_SERIAL_NUMBER, PRSN?

Query

For use with an OE325, this command queries the scope for the **DESCRIPTION**

serial number of the OE325, and confirms that it is a correct serial number match for the scope and channel.

QUERY SYNTAX <channel>:PRSN?

C1:PRSN "120200222" **RESPONSE FORMAT**

§§§

Appendix A: Specifications

Name	Bit rate [Mb/s]	Pulse	Impedance	Coding	Isolation Required	Isolation Pattern
	MT01 — ITU-T G.703					
2 M TP	2.048	pos/neg	120 Ω	HDB3	NO	
2 M Coax	2.048	pos/neg	75 Ω	HDB3	NO	
8 M Coax	8.448	pos/neg	75 Ω	HDB3	NO	
34 M	34.368	pos/neg	75 Ω	HDB3	NO	
139 M	139.264	zero/one	75 Ω	CMI	YES	1 01 0/1 00 1
STM-1E [†]	155.520	zero/one	75 Ω	CMI	YES	1 01 0/1 00 1
MT02 — ANSI T1.102						
DS-1	1.544	pos/neg	100 Ω	AMI or B8ZS	YES	0000 1 0 0000 -1 0
DS-3	44.736	pos/neg	75 Ω	B3ZS	YES	0010/00-10
STS-1	51.840	pos/neg	75 Ω	B3ZS	YES	0010/0010
STS-3E [†]	155.520	zero/one	75 Ω	СМІ	YES	1 01 0/1 00 1
MT03* — ITU-T G.957						
STM-4/ OC12	622.080	Light On/Off	-	NRZ	NO	
STM-1/ OC3	155.520	Light On/Off	·	NRZ	NO	

 ^{*} MT03 is limited to oscilloscope models with a bandwidth = 1 GHz and a sample rate = 4 GS/s
 * STM-1E and STS-3E in the MT01 and MT02 packages, respectively, are limited to oscilloscope models with a bandwidth = 500 MHz and a sample rate of = 1 GS/s