Keysight SAS Link Training

User Guide

KEYSIGHT
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Edition

Technology Licenses

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WARNING

A WARNING notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in personal injury or death. Do not proceed beyond a WARNING notice until the indicated conditions are fully understood and met.

Contents

5   SCPI Command Reference

Contents

1 Introduction

This chapter provides an introduction to the SAS Link Training plug-ins. The SAS Link Training plug-ins comprise of the SAS-3 Link Training plug-in and the SAS-4 Link Training plug-in. For simplicity and brevity, this User Guide uses the term "SAS" for information that is relevant to both SAS-3 and SAS-4 standards.

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Overview

Serial Attached SCSI (SAS) protocol relates to data storage interface for computer storage devices, such as SSDs and HDDs, used in high-performance servers.

SAS-3 operates at 12 Gb/s and uses a 8b10b coding scheme. Because of its physical link rate of 12 Gb/s, SAS-3 operates in SAS dword mode. Therefore, unlike SAS-4, which operates in SAS packet mode, there are no SPL packets. Notably, there are 58 data dwords set to 00000000h that are transmitted in a scrambled manner using 8b10b encoding.

SAS-4 operates at 22.5 Gb/s and uses a 128b/150b coding scheme. A standard SAS Protocol Layer (SPL) packet contains 128 bits. 128 bits correspond to sixteen 8 bit symbols. Four symbols form a dword. SAS-4 uses forward error correction (FEC) and 20 FEC parity bits are embedded into the 150-bit segment.

SAS provides an interactive transmitter equalization (TX EQ) optimization process that enables the RX to train the link partner's TX.

The SAS Link Training software is installed as a plug-in to the M8070B software. The plug-in enables bringing the Device Under Test (DUT) directly inside the test setup through the TX EQ Training phase. This enables receiver tolerance testing against impairments, such as jitter and interference, without recabling. For achieving this, link equalization training is performed between the instrument's generator and the receiver of a DUT. After successfully finishing this procedure as defined in the standard, it is possible to transition without signal interruption to a user-defined sequence. This sequence can then be used for testing the impairment tolerance of the user device.

Basic Requirements for SAS-3 Link Training

The SAS-3 Link Training plug-in is supported on the following three hardware configurations:

· M8041A, M8062A. For details, refer to Basic Requirements for SAS-4 Link Training on page 13.

NOTE	For the SAS-3 Link Training plug-in, M8062A works in conjunction with M8041A. Unlike M8041A, which can support the SAS-3 Link Training plug-in on its own (see the last bullet of this list), M8062A requires M8041A to form a valid configuration that supports the SAS-3 Link Training plug-in.

· M8041A, M8051A

NOTE	Similar to M8062A, M8051A works in conjunction with M8041A only.

· M8041A

The current section illustrates the M8041A only configuration and also lists the possible options on how to use the plug-in on an M8051A module.
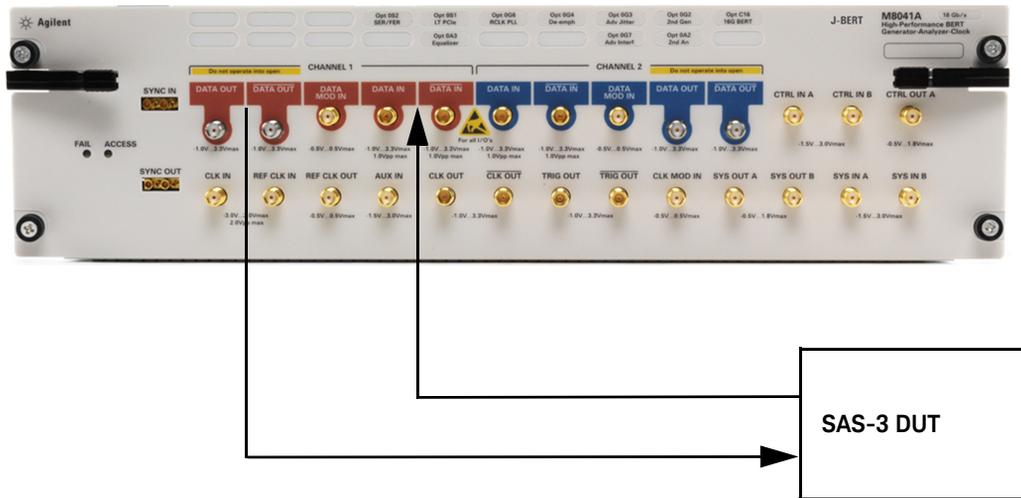
Figure 1   BERT connection setup with SAS-3 DUT

1   Connect the probe/cable from DATA OUT (either from normal DATA
    OUT, complement DATA OUT or both, depending on the DUT type) of
    the M8041A to the DATA IN of the DUT RX.

2   Connect the probe/cable from DATA OUT of the DUT TX to the DATA IN
    (either to normal DATA IN, complement DATA IN or both, depending on
    the DUT type) of the M8041A.

NOTE	You are free to choose the specific DATA IN/DATA OUT connectors on the M8041A module used by the SAS-3 Link Training plug-in.

NOTE	Using the SAS-3 Link Training plug-in requires M8041A or M8051A with a serial number greater than DE55300500. This is always the case for modules with option 0G5 / UG5.

Software Requirements

To install the SAS-3 Link Training plug-in, the M8070B software (version
S6.0 or above) is required.

You can download the software from the following link:

http://www.keysight.com/find/M8070B

> **NOTE** For using the squelch feature with M8062A, M8070B software version 6.0 or above is required.

License/Option Requirements

The SAS-3 Link Training plug-in is a licensed feature. To enable it, the following licenses are required:

> **NOTE** Some of the required licenses can be substituted by an upgrade version or alternative license combination.

Table 1   Required Licenses for M8041A

M8020A Structure	Description	M8020AU / M8062AU Structure	Trial Licenses	Prerequisites	Clock group-wide
M8041A-0G4	Multi-tap De-emphasis, Module-wide License	M8041A-UG4	M8041A-TG4	-	no
M8041A-0S6	SAS-3 Transmitter Equalization Training, Module-wide License	M8041A-US6	M8041A-TS6	ED1(16G)	no
M8041A-C16	BERT one Channel, Data Rate up to 16 Gb/s	-	-	-	no

Table 2   Required Licenses for M8051A

M8020A Structure	Description	M8020AU / M8062AU Structure	Trial Licenses	Prerequisites	Clock group-wide
M8051A-0G4	Multi-tap De-emphasis, Module-wide License	M8051A-UG4	M8051A-TG4	-	no
M8051A-0S6	SAS-3 Transmitter Equalization Training, Module-wide License	M8051A-US6	M8051A-TS6	ED1(16G)	no
M8051A-C16	BERT one Channel, Data Rate up to 16 Gb/s	-	-	-	no

Some licenses are optional that might be necessary for supporting device testing, depending on specific customer needs.

Table 3   Optional Licenses for M8041A

M8020A Structure	Description	M8020AU / M8062AU Structure	Trial Licenses	Prerequisites	Clock group-wide
M8041A-0G3	Advanced Jitter Sources for Receiver Characterization, Module-wide License	M8041A-UG3	M8041A-TG3	-	no
M8041A-0G5	Adjustable Inter-symbol Interference (ISI), Module-wide License	M8041A-UG5	M8041A-TG5	-	no
M8041A-0G7	Advanced Interference Sources for Receiver Characterization, Module-wide License	M8041A-UG7	M8041A-TG7	-	no

Table 4   Optional Licenses for M8051A

M8020A Structure	Description	M8020AU / M8062AU Structure	Trial Licenses	Prerequisites	Clock group-wide
M8051A-0G3	Advanced Jitter Sources for Receiver characterization, Module-wide License	M8051A-UG3	M8051A-TG3	-	no
M8051A-0G5	Adjustable Intersymbol Interference (ISI), Module-wide License	M8051A-UG5	M8051A-TG5	-	no
M8051A-0G7	Advanced Interference Sources for Receiver characterization, Module-wide License	M8051A-UG7	M8051A-TG7	-	no

Basic Requirements for SAS-4 Link Training

Hardware Requirements

Required modules are:
- M8041A
- M8062A

NOTE	For the SAS-4 Link Training plug-in, M8062A can only be operated in conjunction with an M8041A module.

Unlike the SAS-3 Link Training plug-in, the SAS-4 Link Training plug-in cannot be operated on a single M8041A as M8041A does not support the data rate of 22.5 Gbit/s, which is required for SAS-4.
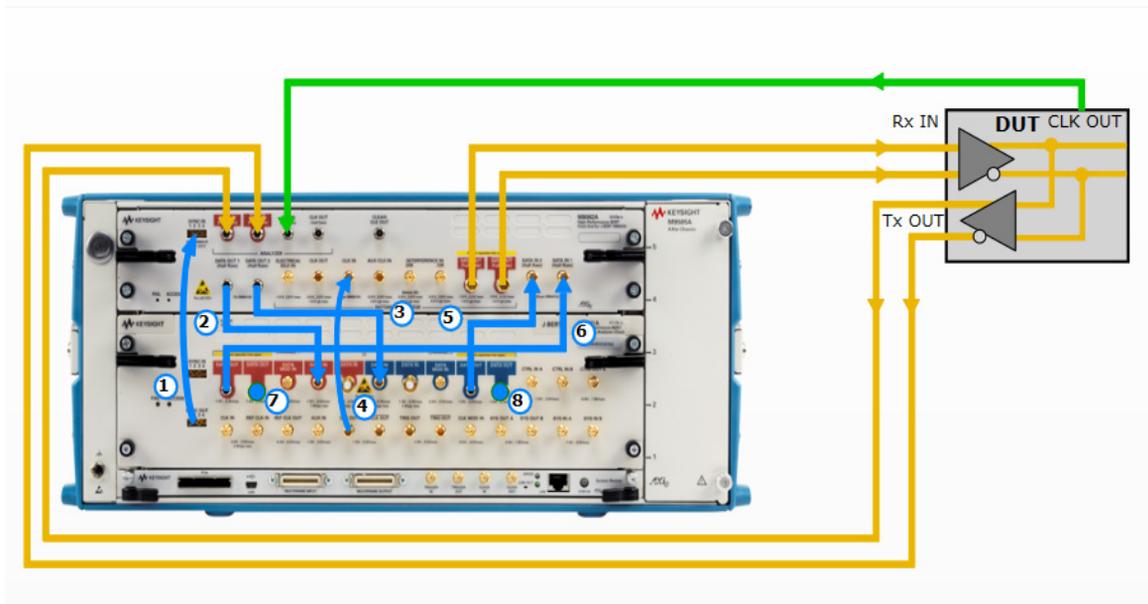
Figure 2   BERT Connection setup with SAS-4 DUT

Perform the following M8041A/M8062A connections:

1   M8041A SYNC OUT1 to M8062A SYNC IN 1
2   M8062A DATA OUT1 to M8041A DATA IN 1
3   M8062A DATA OUT 2 to M8041A DATA IN 2
4   M8041A CLK OUT to M8062A CLK IN
5   M8041A DATA OUT 2 to M8062A DATA IN 2
6   M8041A DATA OUT 1 to M8062A DATA IN 1
7   Terminate M8041A DATA OUT 1 with 50 ohm
8   Terminate M8041A DATA OUT 2 with 50 ohm

Perform the following DUT connections:

·   M8062A DATA OUTs to DUT Rx IN
·   DUT TX OUTs to M8062A DATA IN

> **NOTE**   In this User Guide, normal and complement inputs are considered as a single input or output.

Software Requirements

To install the SAS-4 Link Training plug-in, the M8070B software (version S6.0 or above) is required.

> **NOTE**   For using the squelch feature with M8062A, M8070B software version 6.0 or above is required.

You can download the software from the following link:

http://www.keysight.com/find/M8070B

The M8062A module requires the following options to be used with SAS-4 Link Training:

Table 5   Required Options for M8062A

Options	Module Features
M8062A-C32	32 Gb/s BERT Front End
M8062A-0G4	Multi-tap De-emphasis License
M8062A-0A4	Clock Recovery License
M8062A-OS6	SAS-3/-4 Transmitter Equalization Training, Module-wide License
M8062A-US6	SAS-3/-4 Transmitter Equalization Training, Module-wide License
M8062A-TS6	SAS-3/-4 Transmitter Equalization Training, Module-wide temporary License

NOTE

Only modules supporting the CDR feature can be used with this plug-in. To enable this feature, a hardware upgrade may also be required in modules with serial numbers MY55400300.

The following other options can be useful for device characterization:

Table 6   Additional Options for M8062A

Options	Module Features
M8062A-0G5	Adjustable Intersymbol Interference (ISI) License

Interference Sources

M8062A does not contain interference sources but it is possible to supply differential and common mode interference signals from an external source using the respective inputs INTERFERENCE IN - DM and CM. Differential mode interference is coupled in prior to the internal ISI emulation while common mode interference is coupled in after the internal ISI emulation.

Similarly, the M8041A module requires the following options to drive an M8062A when being used with SAS-4 EQ Training:

Table 7   **Required Options for M8041A**

Options	Module Features
M8041A-C16	BERT one Channel, Data Rate up to 16 Gb/s
M8041A-0G2	Second Channel for Pattern Generator
M8041A-0A2	Second Channel for Analyzer

The following option is not required for Link Training but for performing Jitter Tolerance testing:

Table 8   **Additional Option for M8041A**

Options	Module Features
M8041A-0G3	Advanced Jitter Sources for Receiver Characterization

Installing Plug-in

The SAS Link Training plug-ins must be installed separately on top of the M8070B system software.

To download the installer for the SAS Link Training plug-ins, perform the following steps:

1   Go to the following Keysight web page:
    http://www.keysight.com/find/T10 SAS Link Training Plugin
2   On this page, click **Technical Support**.
3   On the Technical Support page, click **Drivers, Firmware & Software**.
4   Download the installer from the available list of download-able files.

> **NOTE**   The system must have M8070B software (version S6.0 or above) installed on it.

For general instructions on how to install the plug-in, refer to the *Getting Started with Keysight M8070B Plug-ins Guide*.

Starting the SAS Link Training Plug-in

To access the installed SAS Link Training plug-ins:

1   Click **Start** > **All Programs** > **Keysight M8070B**. The user interface for the M8070B system software is displayed.

2   From the M8070B user interface menu, click **Application** to view the list of all installed plug-ins.

3   For SAS-3 Link Training plug-in, select **T10** > **SAS-3 Link Training** plug-in.

The SAS-3 Link Training Editor user interface is displayed as shown in Figure 3:
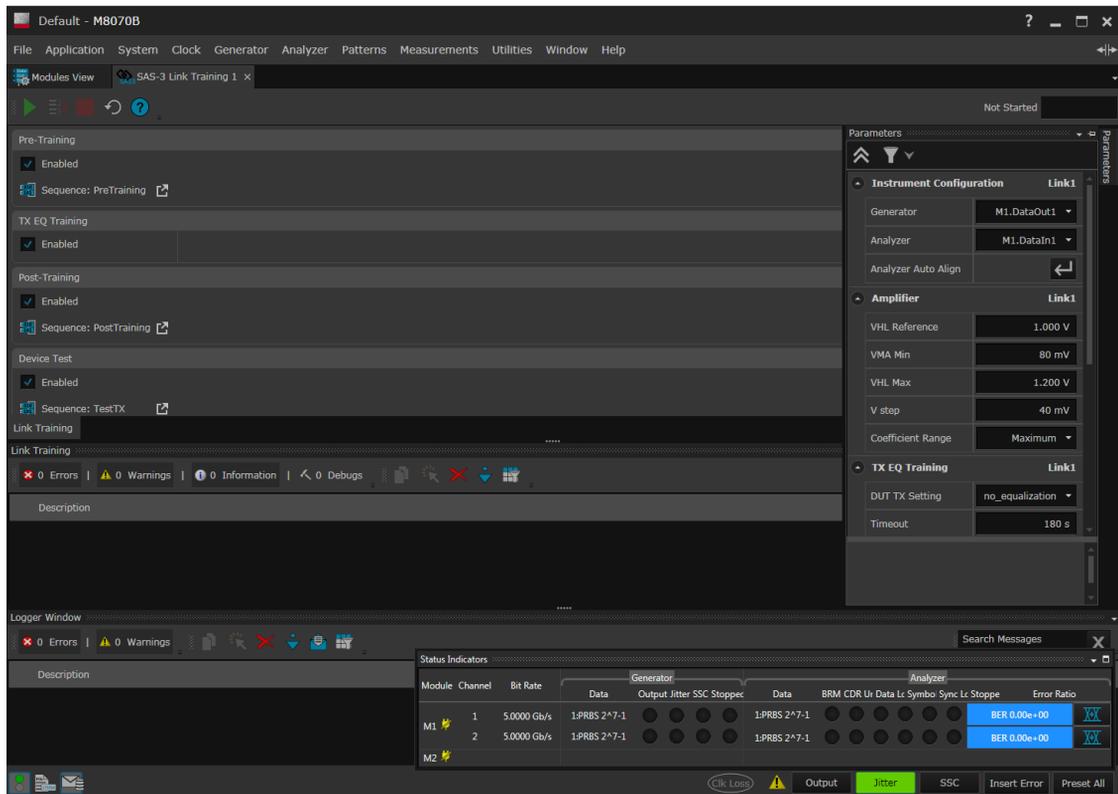
Figure 3   SAS-3 Link Training Plug-in User Interface

4   For SAS-4 Link Training plug-in, select **T10** > **SAS-4 Link Training** plug-in.

The SAS-4 Link Training Editor user interface is displayed as shown in Figure 4:
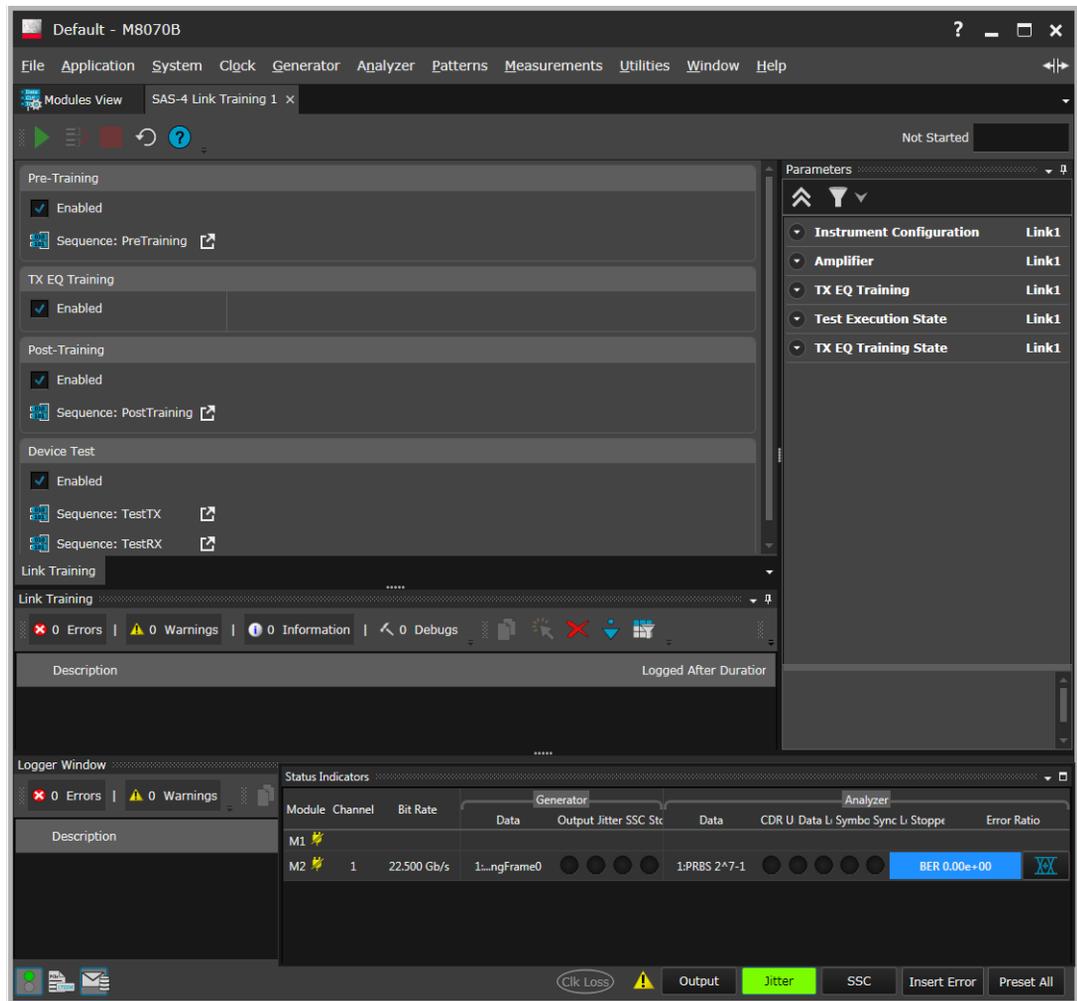
Figure 4   SAS-4 Link Training Plug-in User Interface

Related Documents

For more details about the M8070B system software, refer to the M8070B documentation.

To locate the M8070B documents, click **Start** > **All Programs** > **Keysight M8070B** > **Keysight M8070B Documentation**. Alternatively, you may also visit www.keysight.com/find/M8070B to find the latest versions of the M8070B and related manuals.

For more information about the concepts underlying the procedures discussed in this User Guide, refer to the following specifications:

·   Working Draft of SAS Protocol Layer – 4 (SPL-4), Revision 11.
·   Working Draft of Serial Attached SCSI - 4 (SAS-4), Revision 09.

Contacting Keysight Technologies

For more information on products, applications or services associated with Keysight Technologies, contact your local Keysight office. The complete list is available at: www.keysight.com/find/contactus.

1   Introduction

2 SAS TX EQ Training (Train_Tx-SNW)

This section describes the contents of SAS-3 TX EQ Train_Tx and SAS-4 TX EQ Train_Tx.

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TECHNOLOGIES

Overview

The SAS Link Training plug-ins cover a part of the complete link training process, called "TX Equalization Training".

The SAS Link Training plug-ins have the following four steps of execution:

1   Pre-Training
2   TX EQ Training
3   Post-Training
4   Device Test

Test Execution Steps:

1   Pre-Training: The intent of this step is to allow starting the TX EQ Training phase with a custom-definable sequence. A good practice is to configure this step with a conditionally looped PRBS. This allows turning on of the DUT to happen while seeing predefined data. Breaking out of the conditional loop can then be done by pressing the Break button or using the respective SCPI command. The plug-ins will automatically transition into TX EQ training step after the Pre-Training sequence ends.

> **NOTE**   Default sequence is empty for Pre-Training step.

2   TX EQ Training: In this step, the SAS plug-ins negotiate the optimal equalization setting between the instrument's generator and the DUT's receiver. The SAS Link Training plug-ins support the TX EQ Training through the continuous exchange of fixed-length Train_Tx TTIUs. For more information about SAS-3 Train_Tx, refer to Train_Tx-SNW Structure for SAS-3 on page 26. For more information about SAS-4 Train_Tx, refer to Train_Tx-SNW Structure for SAS-4 on page 29.

3   Post-Training: The Post-Training Sequence includes two sequence blocks, representing the Train_RX SNW parts described in the following sections of the SAS Protocol Layer – 4 (SPL-4) specification:

   • section 5.11.4.2.3.5 (Train_Rx-SNW while in SAS dword mode) for SAS-3.
   • section 5.11.4.2.3.6 (Train_Rx-SNW while in SAS packet mode) for SAS-4.

The first block's pattern is called PACKET_SYNC_LOST and the second block's pattern is called PACKET_SYNC. The effective duration for which these two blocks are sent can be configured coarsely by changing the respective loop count.

The Post-Training block can be modified freely; you can even remove these sequence blocks.
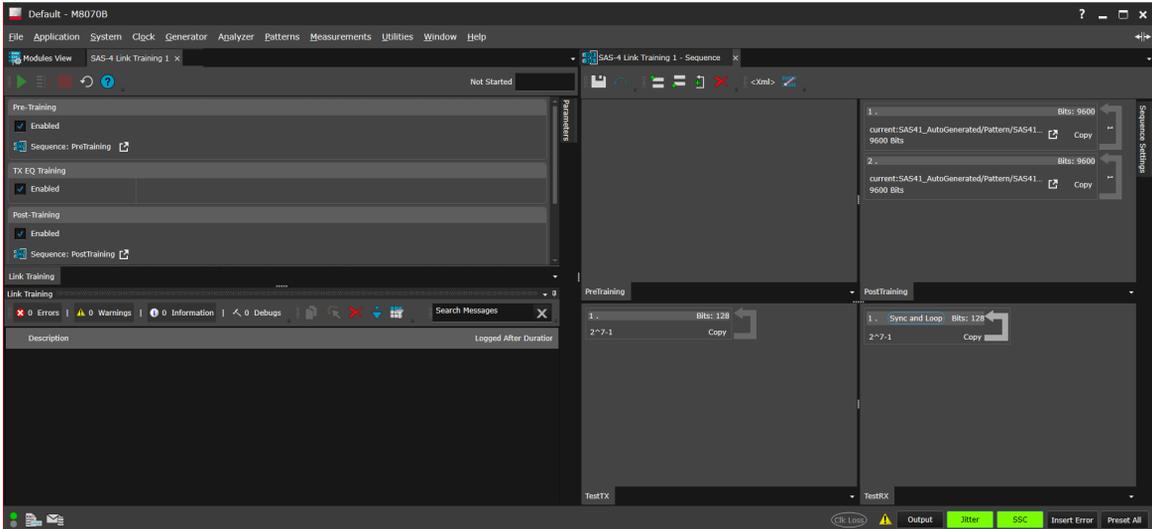
4   Device Test: By default, this step is intended to run a jitter tolerance test by sending out a PRBS from the BERT's generator and capturing and syncing on the same PRBS with the BERT's receiver. While doing this, the DUT needs to be put into loopback mode where it is intended to sample the incoming data from the BERT to just send it back to the BERT. Doing this enables jitter tolerance testing of the DUT.

NOTE

Default sequence for Device-Test is:

- TX: PRBS 7-1, infinitely looping
- RX: PRBS 7-1, sync and loop

Train_Tx-SNW Structure for SAS-3

The SAS-3 Link Training plug-in sends Train_Tx TTIUs continuously during the TX EQ Training phase. The structure of the Train_Tx pattern is as shown in Figure 5. Here, UI means high speed unit intervals at 12 GBd.

```
┌─────────────────────────────────────┐
│                                     │
│       Pattern Marker (40 UI)        │
│                                     │
├─────────────────────────────────────┤
│                                     │
│          TTIU (320 UI)              │
│                                     │
├─────────────────────────────────────┤
│  58 data dwords set to  00000000h   │
│  that are transmitted scrambled and │
│  8b10b encoded                      │
└─────────────────────────────────────┘
```
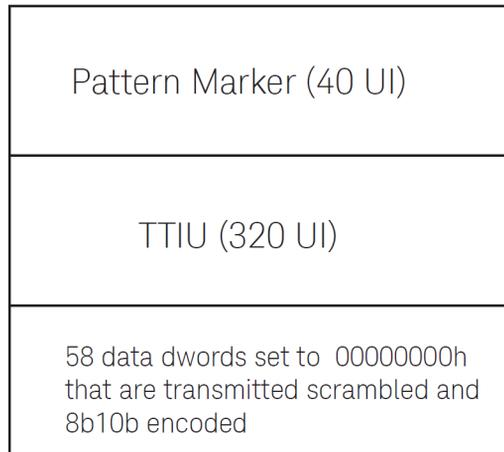
Figure 5   Structure of Train_Tx pattern sent during Train_Tx-SNW

The Train_Tx pattern structure consists of the following components:

Pattern Marker

The pattern marker specifies the start of a Transmitter Training Information Unit ("TTIU"). It consists of 40 UI. A pattern marker is formed by a 20 UI differential high signal level and a 20 UI differential low signal level.

TTIU

Transmitter Training Information Units (TTIU) are the 32-bit cells that follow a pattern marker during transmitter equalization training. A bit cell is a group of ten UIs that encode a single bit of bi-phase mark code (BMC) information. Each TTIU bit cell has either a value of one or zero. The value one specifies BMC encoded one; it means that there is a transition from 0 to 1 or 1 to 0 in the middle of the TTIU bit cell. The value zero specifies BMC encoded zero.

For more details about how TTIU bits are BMC-encoded and transmitted serially bit-by-bit across the physical link, refer to Section 5.9 of the SAS Protocol Layer - 4 (SPL-4) specification.

The following figure illustrates a Train_Tx-SNW TTIU.

Byte/Bit	7	6	5	4	3	2	1	0
0	PATTERN TYPE							
1	PATTERN TYPE SPECIFIC							
2								
3								

Figure 6   TTIU Structure

Byte 0 is transmitted first and byte 3 is transmitted last. Within each byte, bit 7 is transmitted first and bit 0 is transmitted last.

The PATTERN TYPE field defines the format of the PATTERN TYPE SPECIFIC field. The PATTERN TYPE field can take any of the following values:

- 000b - Control/Status TTIU
- 001b to 110b - Reserved
- 111b - Error Response TTIU

For information about the Control/Status TTIU and Error Response TTIU, refer to sections 5.10.2 and 5.10.3, respectively, of the SAS Protocol Layer – 4 (SPL-4) specification.

Data dwords

The Train_Tx pattern sent during Train_Tx-SNW contains 58 data dwords set to 00000000h that are transmitted scrambled and 8b10b encoded.

For information about the scrambling procedure in SAS-3, refer to Annex F, section F.1 in the SAS Protocol Layer - 4 (SPL-4) specification.

For information about 8b10b encoding, refer to section 5.2 in the SAS Protocol Layer - 4 (SPL-4) specification.

Train_Tx-SNW Structure for SAS-4

The SAS-4 Link Training plug-in sends Train_Tx TTIUs continuously during the TX EQ Training phase. The structure of the Train_Tx pattern is as shown in Figure 7. Here, UI means high speed unit intervals at 22.5 GBd.

Pattern Marker (40 UI)
TTIU (320 UI)
59 Scrambled Idle Packets (59*150 UI = 8850 UI)
END_TRAIN (150 UI)

Figure 7   Structure of Train_Tx pattern sent during Train_Tx-SNW

The Train_Tx pattern structure consists of the following components:

Pattern Marker

The pattern marker specifies the start of a Transmitter Training Information Unit ("TTIU"). It consists of 40 UI. A pattern marker is formed by a 20 UI differential high signal level and a 20 UI differential low signal level.

TTIU

Transmitter Training Information Units (TTIU) are the 32-bit cells that follow a pattern marker during transmitter equalization training. A bit cell is a group of ten UIs that encode a single bit of bi-phase mark code (BMC) information. Each TTIU bit cell has either a value of one or zero. The value one specifies BMC encoded one; it means that there is a transition from 0 to 1 or 1 to 0 in the middle of the TTIU bit cell. The value zero specifies BMC encoded zero.

For more details about how TTIU bits are BMC-encoded and transmitted serially bit-by-bit across the physical link, refer to Section 5.9 of the SAS Protocol Layer - 4 (SPL-4) specification.

The following figure illustrates a Train_Tx-SNW TTIU.

Byte/Bit	7	6	5	4	3	2	1	0
0	PATTERN TYPE							
1	PATTERN TYPE SPECIFIC							
2								
3								

Figure 8   TTIU Structure

Byte 0 is transmitted first and byte 3 is transmitted last. Within each byte, bit 7 is transmitted first and bit 0 is transmitted last.

The PATTERN TYPE field defines the format of the PATTERN TYPE SPECIFIC field. The PATTERN TYPE field can take any of the following values:

· 000b - Control/Status TTIU
· 001b to 110b - Reserved
· 111b - Error Response TTIU

For information about the Control/Status TTIU and Error Response TTIU, refer to sections 5.10.2 and 5.10.3, respectively, of the SAS Protocol Layer – 4 (SPL-4) specification.

SPL Packets

Information transmitted in the SAS packet mode is usually encoded into SPL packets that use 128b150b coding. An SPL packet consists of 150 bits, out of which two bits contain header information, 128 bits contains an SPL packet payload, and 20 bits contain forward error correction information.

SPL PACKET HEADER field

These two bits specify the contents of the SPL packet payload. This field can contain any of the following codes:

- 00b – Specifies that the SPL packet payload contains a scrambled idle segment.
- 01b - Specifies that the SPL packet payload descriptor contains a primitive segment containing the following types that are not scrambled:
  - primitives;
  - binary primitives
  - primitive parameters; or
  - extended binary primitive.
- 10b - Specifies that the SPL packet payload contains a scrambled:
  - segment of an SSP frame;
  - segment of an SMP frame;
  - segment of an address frame;
  - segment of an STP frame; or
  - idle dword segment.
- 11b – Specifies that the SPL packet payload contains a scrambled idle segment.

SPL packet payload

The SPL packet payload contains:

- a scrambled idle segment;
- an idle dword segment;
- an SPL frame segment that contains data dwords; or
- a primitive segment that contains:
  - primitives and a primitive parameter, if any;
  - binary primitives and a primitive parameter, if any; or
  - an extended binary primitive;

END_TRAIN

This indicates the end of a Train_Tx pattern during speed negotiation in Train_Tx-SNW.

Transmitter Equalization Training Procedure

Refer to Figure 163 of the SAS-4 specification for a definition of the voltage parameters. It helps with visualizing the maximum and minimum amplitude values that the signal reaches during TX EQ Training and afterwards for a specific coefficient setting. According to the requests sent from the DUT, the plug-in changes its pre-cursor, post-cursor and main tap values within user definable or hardware dependent ranges. When the maximum or minimum voltage level is reached, the plug-in sends a Train_Tx TTIU containing a status report to the DUT, indicating that it has reached its maximum or minimum voltage or coefficient limit. Further changes of the maxed out coefficient value in the same direction for which it reached the limit will therefore not be applied.

| NOTE | Refer to *Figure 161* in the SAS-4 specification to learn about the minimum and maximum coefficient ranges at maximum peak to peak voltage. |

2   SAS TX EQ Training (Train_Tx-SNW)

3   Using SAS Link Training User Interface

This section describes the user interface of the SAS Link Training plug-ins, the plug-ins specific sequence editor, and the M8070B Sequence Editor.

KEYSIGHT
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SAS Link Training User Interface

Figure 9 shows the user interface for the "SAS-3 Link Training" plug-in:
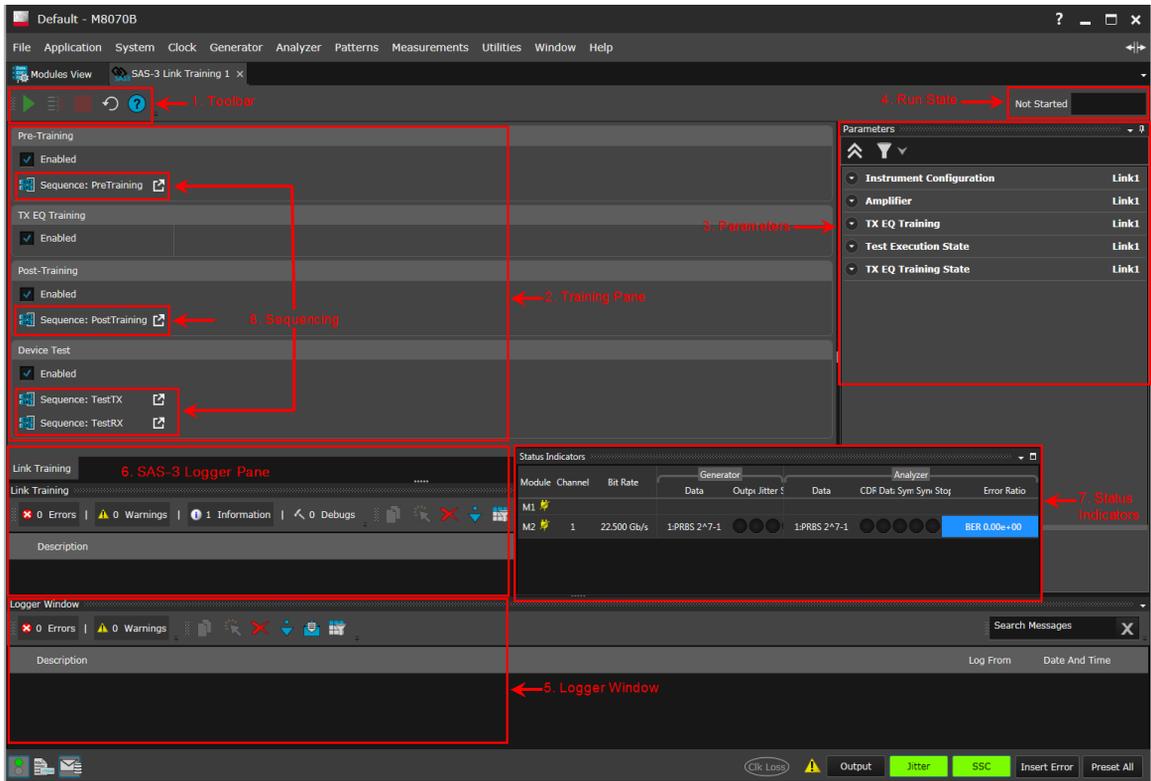
Figure 9   SAS-3 Link Training Plug-in User Interface

The user interface for the SAS-4 Link Training plug-in is similar to the user interface of the SAS-3 Link Training plug-in and is displayed below.
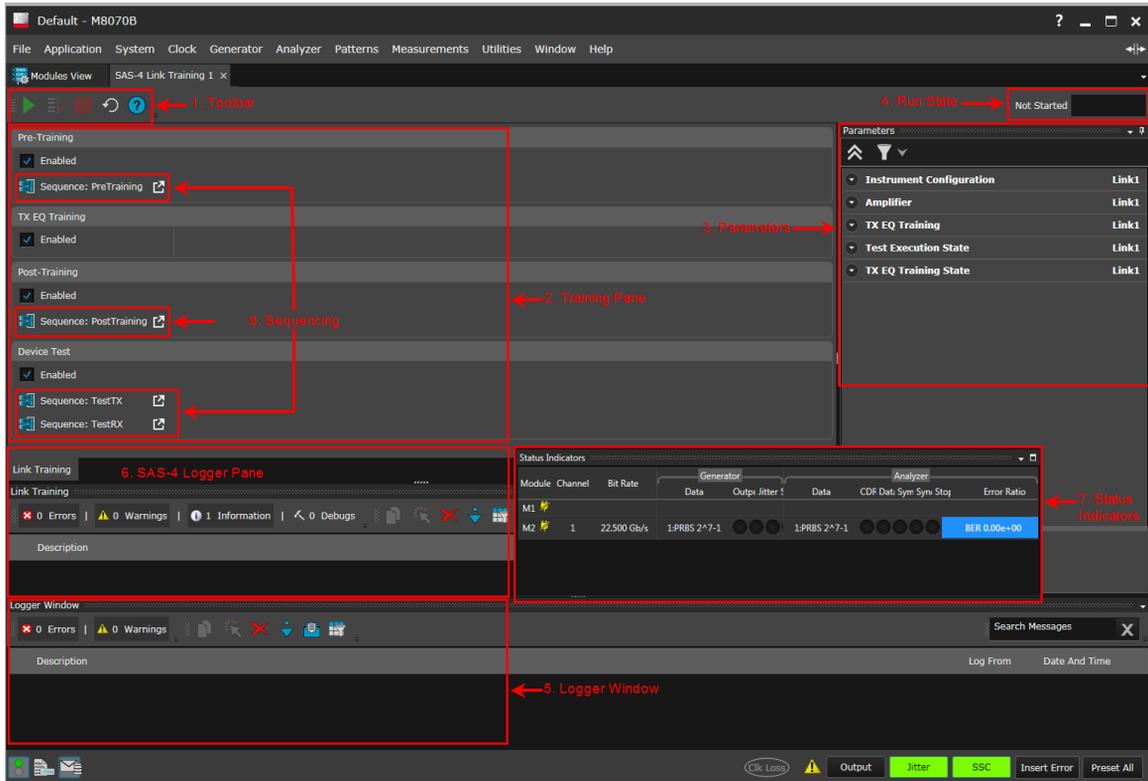
Figure 10   SAS-4 Link Training Plug-in User Interface

Following are the elements of the user interface of SAS Link Training plug-ins:

1 Toolbar
2 Training Pane
3 Parameters
4 Run State
5 The Global Logger Window
6 Logger Pane (SAS)
7 Status Indicators
8 Sequencing (SAS Link Training - Sequence Editor)

Toolbar

The toolbar provides the following shortcuts:

Figure 11   Toolbar

Table 9   Toolbar commands description

	Name	Description
	Start	Sets the SAS Link Training plug-ins into run mode. This command runs the Pre-Training, TX EQ Training, Post Training and Device Test sequentially, if the respective block is enabled.
	Break	Exits an infinite loop that is configured with a "manual" break condition. Sequence execution continues with the next block. Clicking this icon will not influence execution of the TX EQ Training block.
	Stop	Stops plug-in execution.
	Reset	Resets the plug-in to its default values.
	Open Manual	Opens the User Guide.

WARNING

You may use the Break button from the Link Training plug-in or from the M8070B Sequence Editor. Functionality is the same for both options.

Suppose, you are using multiple instances of the plug-in, such that the "SAS-4 Link Training N" corresponds to the 'Nth' Link Training plug-in instance; the Break functionality suspends all breakable loop sequences in the system that may be running simultaneously, thereby affecting all other plug-in instances.

Training Pane

The SAS Link Training plug-ins enable the execution of the following four blocks:

- Pre-Training
- TX EQ Training
- Post-Training
- Device Test

You can edit the sequence parameters in all blocks except in the TX EQ Training block. Refer to section SAS Link Training - Sequence Editor on page 42 to know about how to modify the parameters for sequences.

Performing Link Training

To perform Link Training:

- Click the Run ▶ button from the toolbar. For details, refer to Toolbar on page 38.

In all different states of the Link Training, there is an option **Enabled** available as shown in Figure 12. If you want to skip the respective training state, clear the check box.
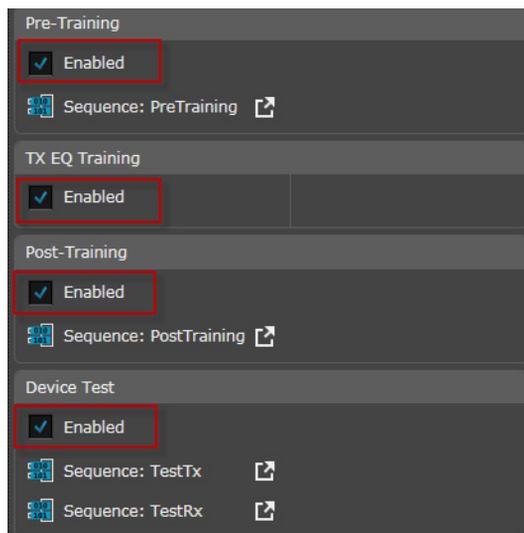
Figure 12   Different states of Link Training

For details on different states of the Link Training, refer to Training Pane on page 72 (chapter 4).

Parameters

The Parameters pane enables you to change the parameters related to the instrument configuration, amplifier settings, and TX Equalization Training parameters.

NOTE	During test execution, parameter changes in other parts of the M8070B software are not recommended but might be necessary. Doing so can interfere with plug-in execution and lead to unexpected behavior.
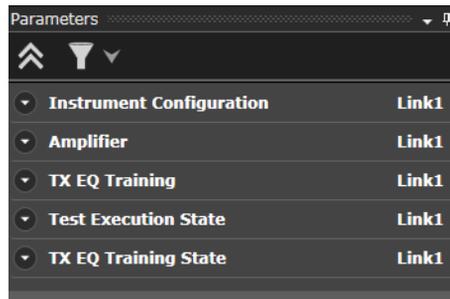
Figure 13   Parameters Pane

For details on plug-in specific parameters, refer to Parameters on page 75 (chapter 4).

Run State

The Run State shows the current state of the plug-in. The plug-in can be in any of the following states:

Not Started

Indicates that the plug-in is in idle mode.
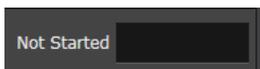
Running

Indicates that the plug-in is currently executing its test sequence.
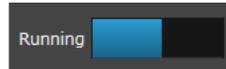
Stopped

Indicates that plug-in execution has been stopped.

Finished

Indicates that plug-in execution is finished.

The Global Logger Window

The global M8070B Logger Window displays the description of Error and Warning messages along with the applications from where they were generated and their time stamps.

For error and status messages dedicated to the Link Training plug-in a separate logger window exists inside the plug-in view.

Figure 14   The Global Logger Window (when SAS Link Training plug-in is running)

Logger Pane (SAS)

Refer to Logger Pane (SAS Link Training plug-in) on page 81 (chapter 4).

Status Indicators

The Status Indicators window displays the current status of the generator and analyzer ports for each channel of the connected modules. For more information on Status Indicators, refer to *Keysight M8070B User Guide*.

SAS Link Training - Sequence Editor

Overview

SAS Link Training - Sequence Editor enables you to create, edit and maintain sequences which are used in the following steps of the Link Training plug-ins execution:

- PreTraining
- PostTraining
- TestTx
- TestRx

Accessing the Sequence Editor

To access the *SAS Link Training - Sequence* window:

- Click any of the sequences in the user interface window of the plug-in as shown (red boxes) in Figure 15:
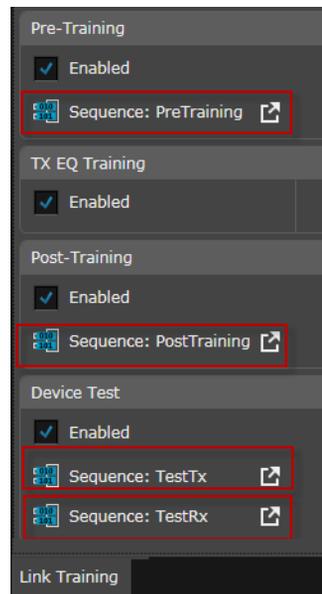
Figure 15   Sequence Editor Window

SAS Link Training - Sequence editor window opens in a new tab as shown in Figure 16.
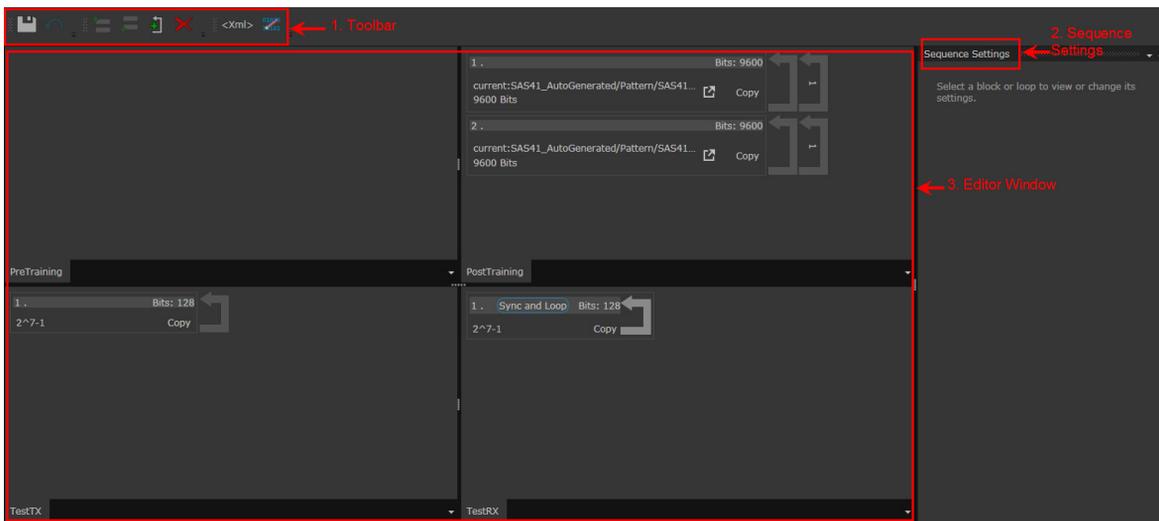
Figure 16   SAS Link Training-Sequence Editor User Interface

The sequence editor user interface includes the following elements showing the sequence which will be played back during execution of the respective step:

- Toolbar
- Sequence Settings
- Editor Window: It is divided into four panes:
  - PreTraining
  - PostTraining
  - TestTX
  - TestRx

Toolbar of SAS Link Training - Sequence Editor

The toolbar of the SAS Link Training - Sequence Editor provides the following sequence editing functions:

Table 10   SAS Link Training - Sequence Editor Toolbar

Icon	Name	Description
	Save	Saves the changes made in the sequence editor. An orange icon indicates that modifications are not yet used during plug-in execution. Once you save the changes, it returns to its default color (grey).
	Discard changes and restore sequences	Discards the changes made in the sequence editor and restores its default values. For more details, refer to Discard changes and restore sequence default.
	Add Block Before Selected Block	Adds a block before the selected sequence block.
	Add Block After Selected Block	Adds a block after the selected sequence block.
	Add New Loop	Creates a loop around a sequence block. For details, refer to Add New Loop.
	Delete Selected block or Loop	Deletes the selected block from the sequence. Deleting a block also removes all the loops that are associated with this block.
<Xml>	XML	Toggles between a graphical and a textual XML sequence representation. The changes made in one representation will reflect into the other representation.
	Show Memory Pattern	In case the selected block uses a memory pattern clicking this icon opens the pattern in a new Pattern Editor View.

Using the SAS Link Training - Sequence Editor Toolbar

To understand how to use the toolbar, click any one of the four panes. For example, you may click **PreTraining**. You can perform the following operations:

- Add block(s)

    i   Click the ▣ **Add Block Before Selected Block** icon to add a

        block before the selected sequence block.

    ii Click the ▣ **Add Block After Selected Block** icon to add a

        block after the selected sequence block.

- Delete block

    i   Select the block you want to delete.

    ii Click the ✕ icon.

- Delete loop

    i   Select the loop indicator you want to delete.

    ii Click the ✕ icon.

- Add New Loop

    i   Click the ▣ **Add new Loop** icon. A **Create Loop** dialog

        is displayed just below the toolbar as shown in the following figure:
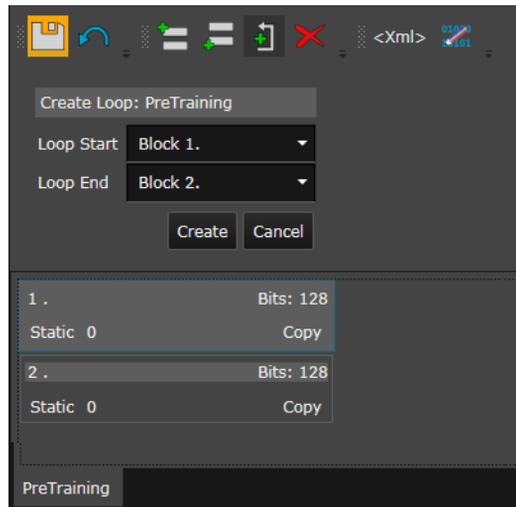
Figure 17   Creating a Loop

    ii   Specify the start and end blocks for the loop in the sequence. For example, select *Loop Start — Block 1* and *Loop End — Block 2.*

    iii Click **Create** to create a loop around the specified blocks.
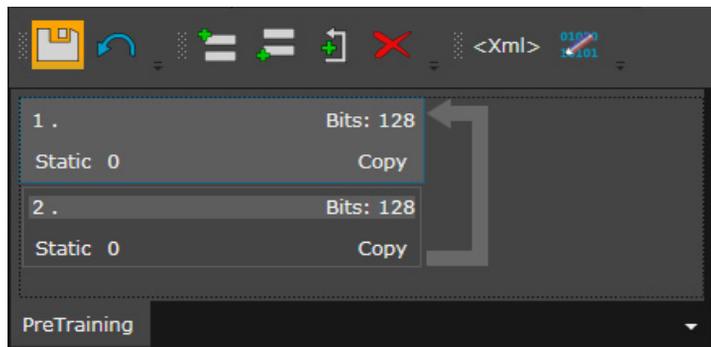
Figure 18   Created Loop

    iv Click the loop indicator. A **Loop Settings** functional block is displayed in the **Sequence Settings** pane, where you can specify the loop count when enabling the Counted Loop option.
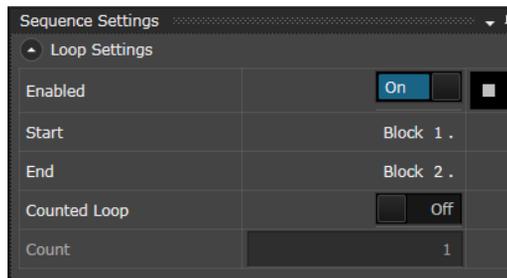
Figure 19   Loop Settings in Sequence Settings

- Discard changes and restore sequence default

    i   Click   Discard changes and restore sequences icon.

         This displays the **Sequence Editor** message box that enables
         you to discard the changes made in the sequence editor and
         restores its default values.
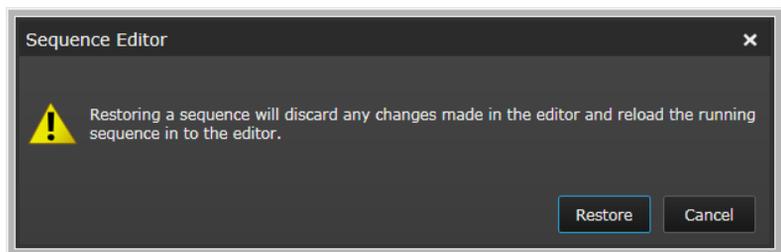
Figure 20   Sequence Editor Dialog

    ii   Click **Restore** if you want to discard the changes and set it to
          the default value. Otherwise click **Cancel**.

NOTE   Click to apply the changes. These changes are applied once the

plug-in is started.

Sequence Settings Sidebar

The Sequence Settings sidebar enables you to set the properties for the selected block and sequence. By using this sidebar, the following settings can be specified:

- Block Data. For details, refer to Block Data on page 49.
- Block Settings. For details, refer to Block Settings on page 50.
- Block Branches. For details, refer to Block Branches on page 51.
- Block Controls. For details, refer to Block Controls on page 53.

NOTE	Some of the Sequence Settings (Serialize and Copy Plus Phase Adjust) might not be compatible with M8062A, although they are available as a selection in the GUI.

Set to Default check box

Most of the options in Block Data and Block Settings in the Sequence Setting sidebar contain a *Set to Default* check box, which gets highlighted when some modifications are made. Select this check box to change the settings to their default values.

The following figure shows how the check box gets highlighted when the **Invert** setting is turned **On**.

Figure 21   Using the Set to Default check box

If you click the **Set to Default** check box, the setting for **Squelch** changes to **Off,** which is its default value.

Figure 22   Example for setting parameter to default value

Block Data

Figure 23   Block Data

The Block Data section allows you to:

· Specify a block *Name*.

· Specify a block *Length*.

· Select *Block Type*. The available options are:

  · Clock: For block type as *Clock*, specify the parameter *Divider* and *Replicate*. The *Replicate* feature shows how the serial patterns are split to multiple locations. It has the following options:

    · Serialize: This setting is not compatible with the plug-in use model.

    · Copy: In this option, each location gets a copy of the pattern.

    · Copy Plus Phase Adjust: This setting is not compatible with the plug-in use model.

  · Pulse: For block type as *Pulse*, specify the *Width*, *Replicate* and *Offset* features.

  · Prbs: For block type as *PRBS*, you need to specify the *Polynomial*, *Replicate*, *Invert* and *Seed (Hex)* features.

  · Static: For block type as *Static*, specify the *Signal Value*, *Replicate* and the *Squelch* features.

  · Memory Pattern: If you select Block Type as *Memory Pattern*, a **Select Pattern** dialog is displayed, which enables you to select a memory pattern.

Compare

The Compare feature enables you to compare the block data for a particular sequence. It provides the flexibility to modify the sequence without deleting the blocks.

· When to use/not use this feature: Suppose you have created a sequence with multiple blocks. Now, if you want to exclude particular block(s) from that sequence while comparing, instead of deleting the whole sequence, just set the compare functionality to *OFF*. It disables these particular block(s) from the sequence for comparison.

NOTE	The Compare feature is used with the TestRx sequence block only. This block is intended for measuring a BER after successfully performing TX EQ Training.

Block Settings
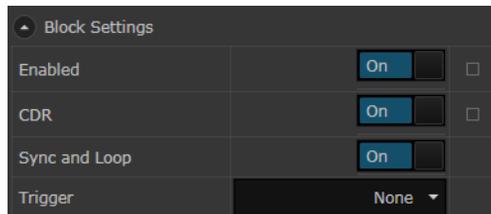
Figure 24   Block Settings

The Block Settings section has the following features:

· Enabled: Click the corresponding **ON/OFF** toggle button to enable the block in the sequence.

· CDR: Click the corresponding **ON/OFF** toggle button to enable/disable the CDR during execution of this block. This parameter only has an effect if the CDR control has been set to sequence driven.

· Sync and Loop: Click the corresponding **ON/OFF** toggle button to turn on Sync and Loop for the corresponding Data In block.

NOTE	Pattern sync is automatically performed when activating the Sync and Loop feature upon every iteration of the corresponding block.

• Trigger: Use the drop down option to specify whether you want to apply trigger on either 'Pulse' or 'Pulse or PRBS Match'.

- If you want to apply trigger on 'Pulse', you have to set the values of Offset and Width.
- If you want to apply trigger on 'Pulse or PRBS Match', you need to set the values of 'Polynomial', 'Invert' and 'Width'.

Block Branches

Block branches are used to vary sequence execution depending on external conditions. You can add up to two branches in a sequence.

To add a branch, click the *Add Branch* button.

i   Go to Block: Specify the block name to jump to.

ii   Click Add Branch if you want to add another branch. Up to two branches can be added within the same block.

iii Click [x] to delete the branch.

iv   Once branching is enabled in a block, the Block Branches icon appears on the sequence block as shown in the following figure:
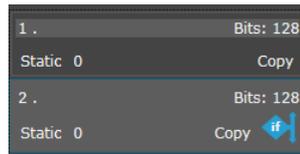
Figure 25   Example of enabling Block Branches

The Block Branches section appears as shown in the following figure:
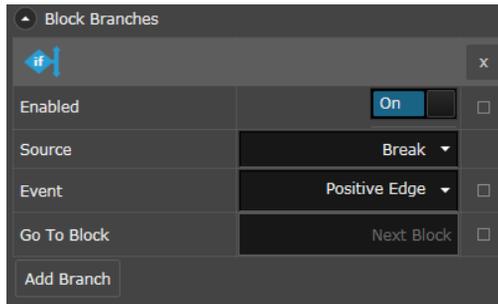
Figure 26   Block Branches

The Block Branches section provides the following settings:

- Enabled: Use the **ON/OFF** toggle button to enable the branching option.
- Source: Use the drop-down list to specify the source for the branch, which has the following options:
    1 Break
    2 Ctrl In A
    3 Error
    4 Ctrl In B
- Event: Specify the event for the branch. It has the following options:
    1 Positive Edge
    2 Negative Edge
    3 High
    4 Low

Block Controls

The Block Controls section enables outputting a specific signal at the target connector (CTRL OUT A, SYS OUT A, SYS OUT B) during playback of the selected sequence block. Possible signal values are Low, High and Pulse. Click **Add Control** to add more block controls. You can add up to four block controls.
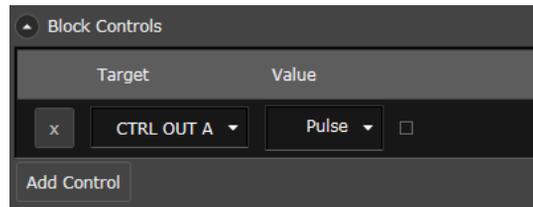
Figure 27   Block Controls

| NOTE | The functionality of the SAS Link Training - Sequence editor is similar to the M8070B Sequence Editor. To know how to access the M8070B Sequence Editor refer to section M8070B Sequence Editor on page 56. For more information, refer to the M8070B User Guide. |

There are also some differences between the M8070B Sequence Editor and the plug-in specific Sequence Editor, such as:

- The plug-in specific sequence editor does not allow to define any locations for the sequences as these are defined by the selected generator and analyzer values of the Link Training plug-in.
- Through the plug-in specific Sequence Editor, it is also not possible to access the functional blocks Instrument Configuration and Sequence Configuration.

Editor Window

The Editor window provides an interactive user interface for creating, editing and exporting the sequences in all four panes. For details, see section Using the SAS Link Training - Sequence Editor Toolbar on page 44.

Tips for Using the SAS Link Training - Sequence Editor

The ideal sequence symbol width for using the SAS Link Training plug-in is 10. Depending on the underlying hardware, this symbol width results in a hardware word width of 80 on an M8041A/M8051A configuration or 160 on an M8041A/M8062A configuration.

Changing sequence-wide configuration properties is currently not supported by the Link Training - Sequence Editor. But it is possible to add these settings manually to the XML file defining the sequence.

NOTE The sequence-specific configuration referred to in the above text will only be effective when specified inside the PreTraining step. The remaining blocks will not consider these configuration settings.

To add these settings, switch to the XML sequence view by clicking the corresponding icon on the toolbar.

Figure 28   XML sequence view

The sequence view switches to the XML representation of the sequence. The <symbolWidth> and <controls> configuration elements are directly relevant to the use of Link Training plug-ins.

Following is a description of these two elements:

- **<symbolWidth>** - This element currently supports the values 1 and 10 for the Link Training plug-ins.

<symbolWidth> Value	Hardware word width on M8041A/M8051A	Hardware word width on M8041A/M8062A
1	64	128
10	80	160

- **<controls>** - This element can generally contain the same settings that are available in the generic Sequence Editor. Especially when using an M8062A with sequence-driven signal squelching, it is necessary to add the specific control configuration into the sequence. This configures the CTRL OUT A connector of the M8041A to be used as the driver of the M8062As Electrical Idle input. For more information on how to use this feature, refer to the M8070B User Guide.

M8070B Sequence Editor

The M8070B Sequence Editor enables you to create and maintain sequences. It also enables you to edit patterns.

To access the M8070B **Sequence Editor**:

From the menu bar, click **Patterns** and select **Sequence Editor**. The **Sequence Editor** window is displayed.
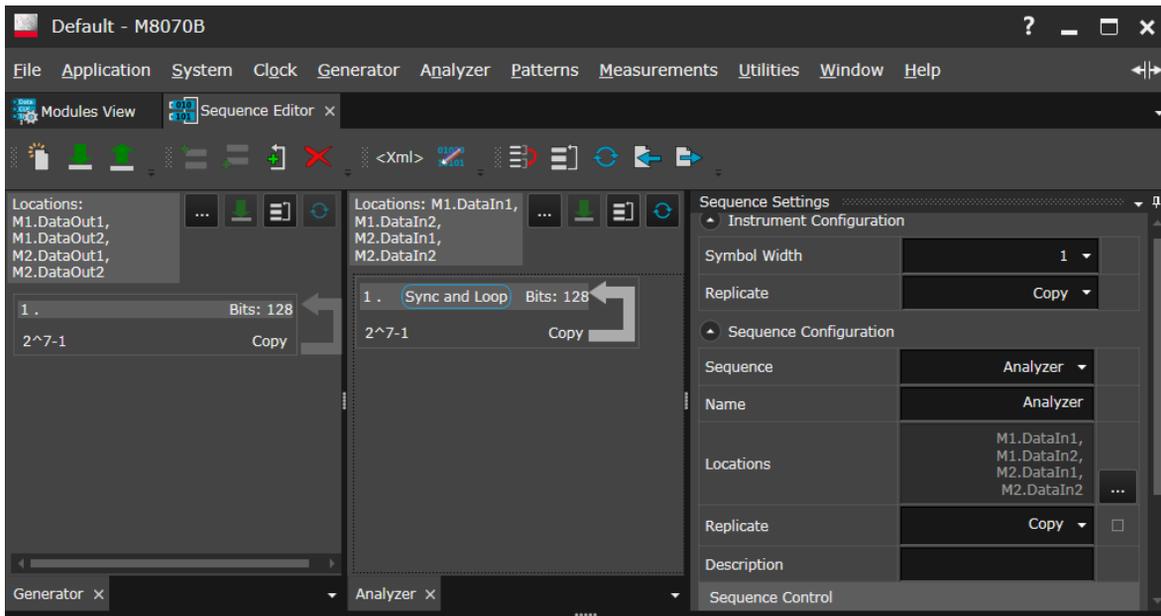
Figure 29   Sequence Editor Window

NOTE   Modifying parameters of M8070B Sequence Editor during plug-in test execution is not recommended, else the plug-in may malfunction.

NOTE   Restarting the automatically generated sequence or skipping a sequence using the M8070B Sequence Editor or using the respective SCPI commands must be done with care while Link Training is running. It might lead to inconsistent/faulty behavior, in the plug-in.

4   Using Plug-in Specific
         Link Training User
         Interface

This chapter familiarizes you with the user interface of the SAS Link
Training plug-ins. Additionally, it also describes some relevant parameters
in the Module View, which are very important for the SAS Link Training
plug-ins.

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Relevant Module Parameters for SAS-3 Link Training Plug-in

The default view of M8070B is the Modules View. However, if it is not available or it is closed, you can still view it.

To view the Modules View:

· Go to the menu bar, click **System** and select **Module View**.

Figure 30 shows an example of Modules View for SAS-3 Link Training plug-in when M8041A (M1) and M8062A (M2) modules are connected:
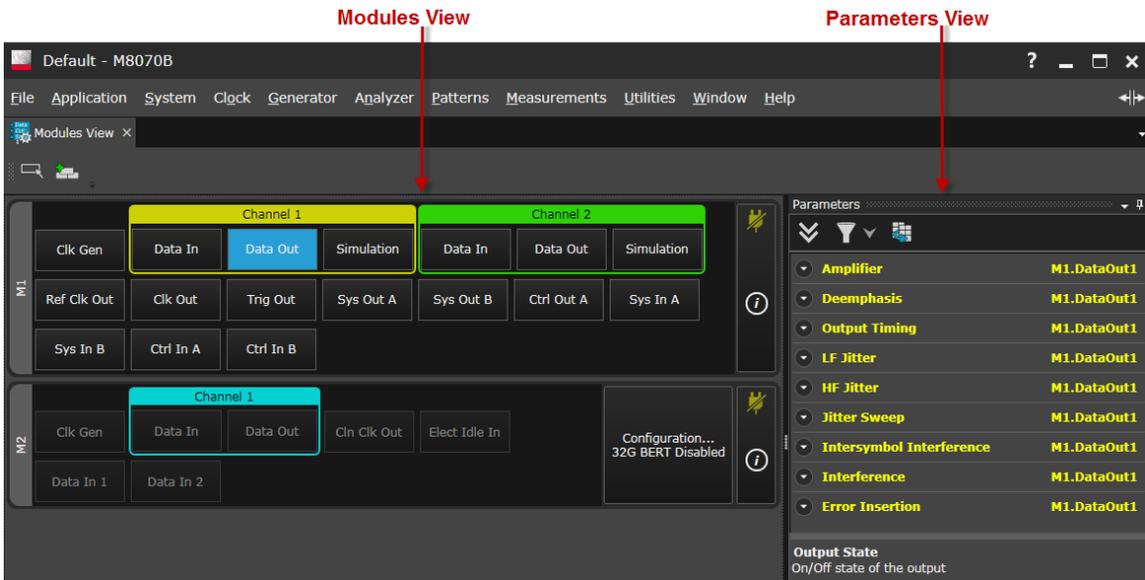
Figure 30   Modules View for SAS-3 Link Training plug-in

In the figure, the left pane shows the connected modules and the right pane shows the Parameters window. Each module has input and output ports, which can be configured through the Parameters window. For more details, refer to the *M8070B User Guide*.

The M8041A (16Gb/s Generator, Analyzer, Clock Module) has two channels and two Data Out ports, while the M8062A (32Gb/s BERT Front End) has only one channel and one Data Out port.

The following section describes the parameters that are either controlled by the plug-in or of importance when performing SAS-3 related tasks. The section does not necessarily list all the relevant parameters.

Plug-in Controlled Parameters

Plug-in controlled parameters consists of values, which are indirectly controlled by the plug-in while it is running.

NOTE	Modifying parameters during plug-in test execution is not recommended and must be handled with care, else the plug-in might malfunction.

The following parameters are modified by the plug-in, while it is running and should normally not be changed manually during runtime.

- Data Out
  - Amplifier
    - Amplitude (Preset: 500 mV)
    - Auto Range (Preset: Off)
    - Amplitude Range (Preset: 0 mV - 300 mV)
  - Deemphasis
    - Preset Register Number
    - Unit
    - Pre-Cursor1
    - Post-Cursor1
  - SAS3NTX and SAS3NRX with N corresponding to a specific Link Training Plug-in Instance.
    These sequences will be automatically created depending on the sequence snippets defined inside the plug-in.

User Controlled Parameters

These parameters are not changed by the Link Training plug-in but are directly relevant to its usage.

- Global
    - Output: The global Output state must be turned on for getting a signal out of the BERT generator.
    - Jitter: For jitter tolerance testing, the global Jitter button must be enabled; otherwise, jitter will be turned off globally.
- Clk Gen
    - Synthesizer
        - Source: Enables you to select the trigger source of the instrument. In general, select the **Internal** option but the module can also be used with another clock source.
        This setting is always made at the M8041A module, when being operated along with M8062A.
        - Reference Frequency: For the Internal clock source, use **Internal 100 MHz**.
        This setting is always made at the M8041A module, when being operated along with M8062A.
        - Frequency: (Preset Setting: 12 GHz)
        Default signaling speed for SAS-3 is 12 Gbit/s +-100 ppm as defined in *Table 42 - General electrical characteristics* of the SAS specification.
        The frequency setting must be performed on the module (M8041A or M8062A) on which the plug-in is operated.
- Data Out: This acts as the output port for the generator, which may be connected to the DUT.
    - Amplifier
        - Output State (Preset: On): Turn it **On**, otherwise the output will be off.
        - Coupling: Select **AC** for Link Training.
        - Transition Time (Preset: Smooth): For behavior similar to SAS-3, the **Smooth** setting should be used to get standard typical transition times.
- Data In: This acts as the input port for the generator, which may be connected to the DUT.
    - Clock (Only relevant when operating the plug-in on M8062A)

- Source (Preset: CDR): In case the instrument and the DUT are not directly clocked off the same source, there will be a slight frequency offset between the two. For more information, refer to Tips on how to use the CDR.
- Comparator (Only relevant when operating the plug-in on M8041A)
    - Coupling (Preset: AC)
      The SAS standard uses AC coupling, by default; therefore, this value must be set accordingly, if required by the DUT.
    - Termination Configuration (Preset: Balanced)
    - Common Mode Voltage (Preset: 0 V)
- CDR (Only relevant when operating the plug-in on M8041A)
    - CDR State (Preset: On): In case the instrument and the DUT are not directly clocked off the same source there will be a slight frequency offset between the two. For more information, refer to Tips on how to use the CDR.
    - Loop Order (Preset: 2nd): Allows Data In to track SSC.
    - Loop Bandwidth (Preset: 10 MHz): Makes CDR more robust against SSC.
- Sequence Editor
    - Break

WARNING   Clicking the Break icon on the Toolbar of the plug-in or of the Sequence Editor executes the same functionality. If there are other sequences in the system, using the sequence break functionality will break out of all the breakable loops in the system that are executing at this time.

You may also apply all the settings mentioned above using the following steps:

| NOTE | Based on the installed version, M8070B contains a default setting for SAS-3 operation. |

1 From the menu bar, click **File** and select **Recall Instrument State**. This opens a **Recall Instrument State** dialog.

2 Select **Factory** › **SAS › SAS3_Link_Training_Preset**, click **Open.**

3 Click **Recall** for applying the predefined settings, otherwise click **Cancel**.

Relevant Module Parameters for SAS-4 Link Training Plug-in

The default view of M8070B is the Modules View. However, if it is not available or it is closed, you can still view it.

To view the Modules View:

· Go to the menu bar, click **System** and select **Module View**.

Figure 31 shows an example of Modules View for SAS-4 Link Training plug-in when M8041A (M1) and M8062A (M2) modules are connected:
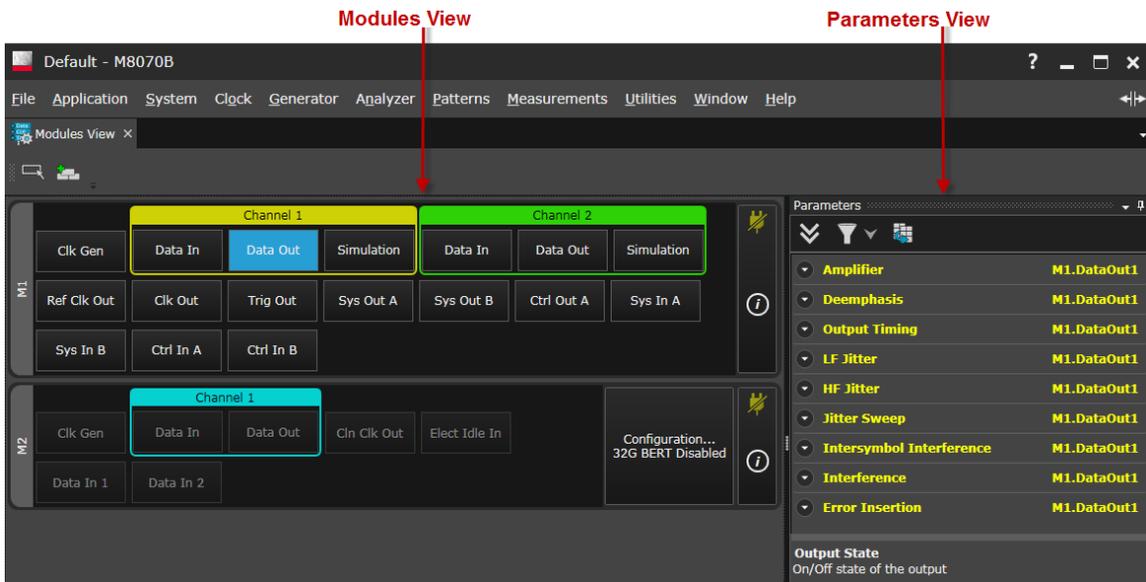
Figure 31   Modules View for SAS-4 Link Training plug-in

In the figure, the left pane shows the connected modules and the right pane shows the Parameters window. Each module has input and output ports, which can be configured through the Parameters window. For more details, refer to the *M8070B User Guide*.

The following section describes the parameters that are relevant for the plug-in.

Plug-in Controlled Parameters

Plug-in controlled parameters are those parameters whose values are indirectly controlled by the plug-in while it is running.

NOTE	Modifying parameters during plug-in test execution is not recommended and must be handled with care, else the plug-in might malfunction.

The following parameters are modified by the plug-in, while it is running and should normally not be changed manually during runtime.

- Amplifier
  - Amplitude
  - Auto Range (Preset: Off)
  - Amplitude Range (Preset: 0 mV - 300 mV)
- Deemphasis
  - Preset Enable
  - Preset Register Number
  - Unit
  - Pre-Cursor1
  - Post-Cursor1

The Sequence Editor must not be changed manually during runtime.

The M8041A (16Gb/s Generator, Analyzer, Clock Module) has two channels and two Data Out ports, while the M8062A (32Gb/s BERT Front End) has only one channel and one Data Out port.

The following parameters of the Data In port are modified by the plug-in. These values are changed only during TX EQ Training to give optimal results. After execution the original values are restored.

The highlighted parameter state indicates the default state for SAS-4 operation.

- CDR
    - Auto Re-Lock: During link training, this parameter is, by default, set to **On**. If it loses synchronization with the received data stream, the CDR is re-acquired.
- Analyzer
    - Re-Sync: During execution of the TX EQ Training block, this parameter is, by default, set to **Automatic**. In case this parameter was previously set to another value, it will be restored after execution of the TX EQ Training block.

User Controlled Parameters

These parameters are not changed by the Link Training plug-in but are directly relevant to its usage.

- Clk Gen
    - Synthesizer
        - Source: Enables you to select the trigger source of the instrument. In general, select the **Internal** option.
        - Reference Frequency: For the Internal clock source, use **Internal 100 MHz**.
        - Frequency: Use **22.5 GHz**.
          Default signaling speed for SAS-4 is 22.5 GBit/s.
- Data Out: This acts as the output port for the generator, which may be connected to the DUT.
    - Amplifier
        - Coupling: Select **AC** for Link Training.
        - Output State: Turn it **On**, otherwise the output will be off.

Tips on how to use the CDR

For the TX EQ Training step, it is not necessarily required to turn on the CDR as the capture algorithm of the plug-in is capable of reconstructing jittered frames. If the data sent by the DUT, before TX EQ Training starts, does not contain a certain minimum amount of transitions, CDR will not be able to lock onto the input signal. In this case, the plug-in can only start capturing training frames from the DUT once the CDR obtained lock. For an M8062A module, it can take multiple seconds from the point of where the DUT starts sending training frames until the CDR locks; the M8041A module is more robust against this problem.

This relock timeout might be too high for a DUT to accept, when waiting for a training frame sent from the BERT. To get around this BERT timeout, it is advantageous to disable the CDR during TX EQ Training and enable it after the TX EQ Training finishes, before starting the jitter tolerance test.

You may also apply all the settings mentioned above using the following steps:

NOTE	Based on the installed version, M8070B contains a default setting for SAS-4 operation.

1 From the menu bar, click **File** and select **Recall Instrument State**. This opens a **Recall Instrument State** dialog.

2 Select **Factory** > **SAS > SAS4_Link_Training_Preset**, click **Open.**

3 Click **Recall** for applying the predefined settings, otherwise click **Cancel**.

Relevant Features of Status Indicators Window

The status bar is located at the bottom of the user interface. The Status Indicators window displays the status for the generator and the analyzer. Some of the global features must be enabled as indicated by green for Link Training.

Figure 32   Status Indicators

· Output: The global *Output* state must be turned on to obtain a signal out of the BERT generator.
· Jitter: For jitter tolerance testing, the global *Jitter* button should be enabled. Else jitter will be switched off globally.

SAS Link Training User Interface

Figure 33 and Figure 34 show the user interfaces of the SAS-3 and SAS-4 Link Training plug-ins, respectively:
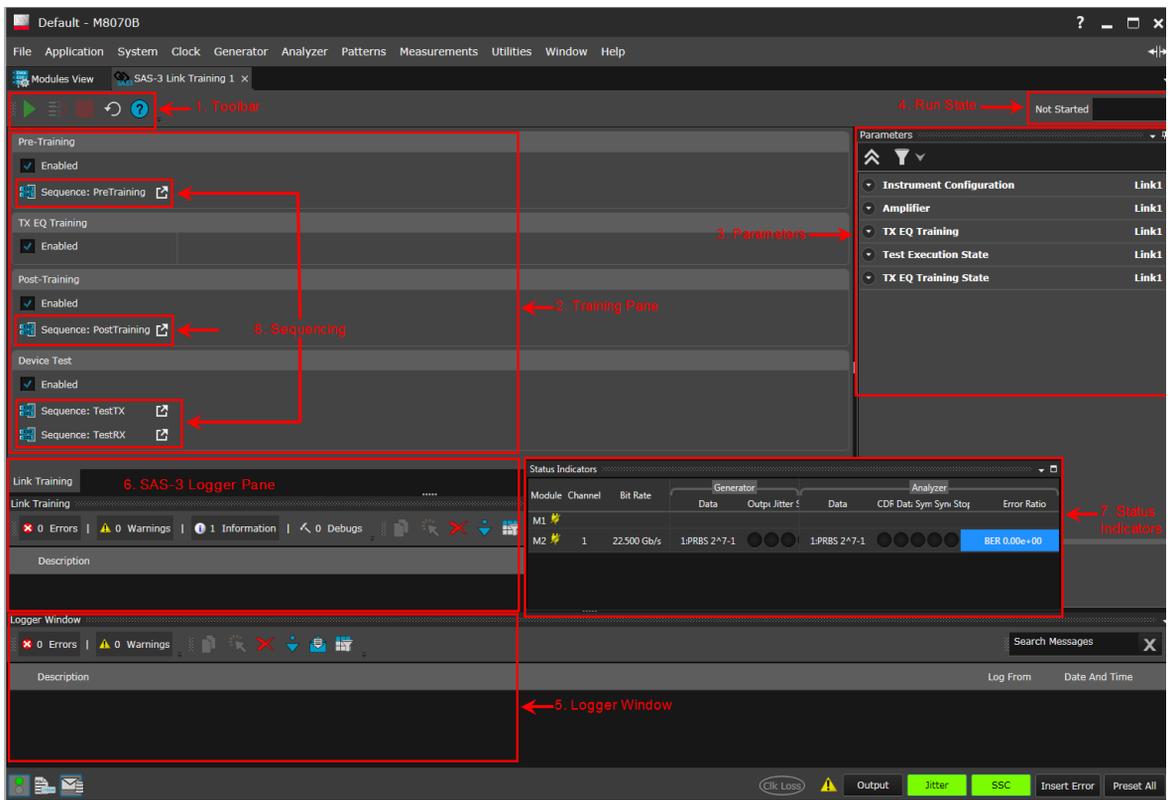
Figure 33   SAS-3 Link Training plug-in User Interface
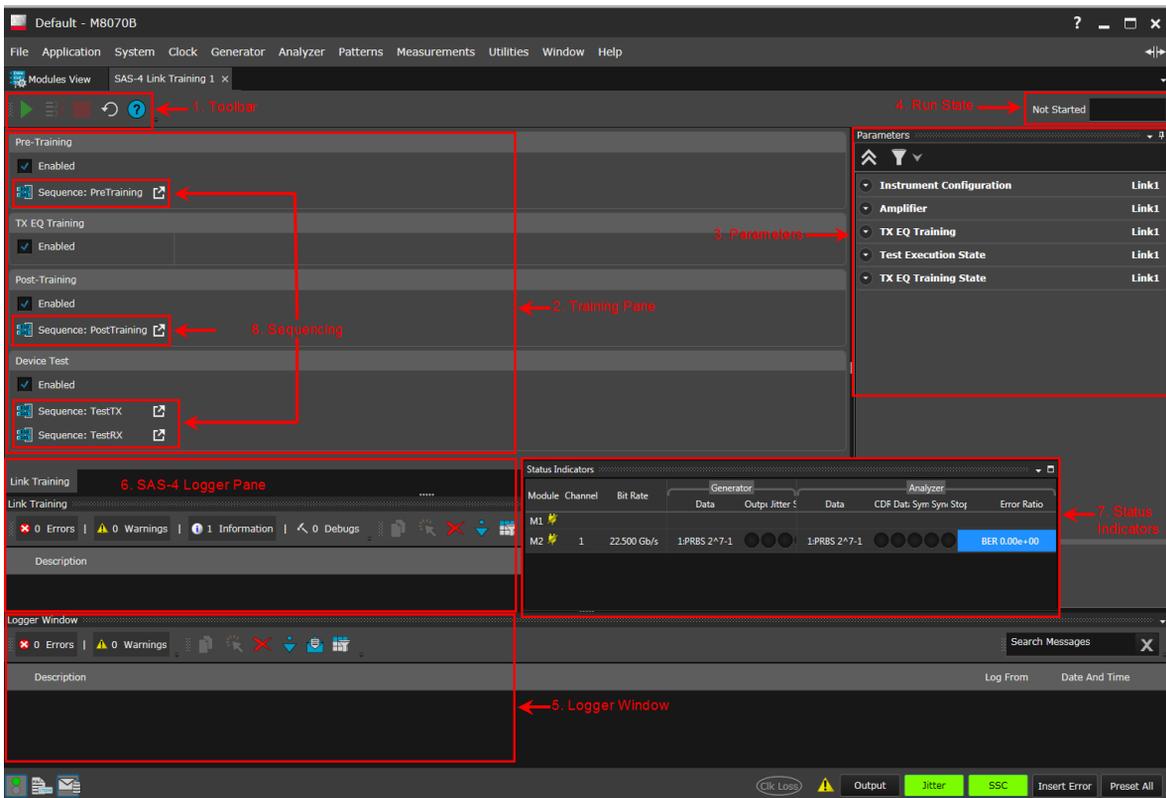
Figure 34   SAS-4 Link Training plug-in User Interface

The user interfaces for the SAS-3 and SAS-4 Link Training plug-ins are very similar. Following are the elements of the user interface:

1 Toolbar

2 Training Pane

3 Parameters

4 Run State

5 Logger Window

6 Logger Pane (SAS Link Training plug-in)

7 Status Indicators

8 Sequencing (SAS Link Training - Sequence Editor on page 42)

Toolbar

Refer to Toolbar on page 38 (chapter 3).

Training Pane

The SAS Link Training plug-ins enable the execution of the following four blocks:

- Pre-Training
- TX EQ Training
- Post-Training
- Device Test

Pre-Training

In this state, the SAS Link Training plug-in prepares the DUT to accept its startup protocol. The Pre-Training state brings the DUT from initialization mode to data exchange (or communication) mode; using either the Pre-Training sequence block or by external means.

NOTE   Default sequence is empty for Pre-Training step.

TX EQ Training
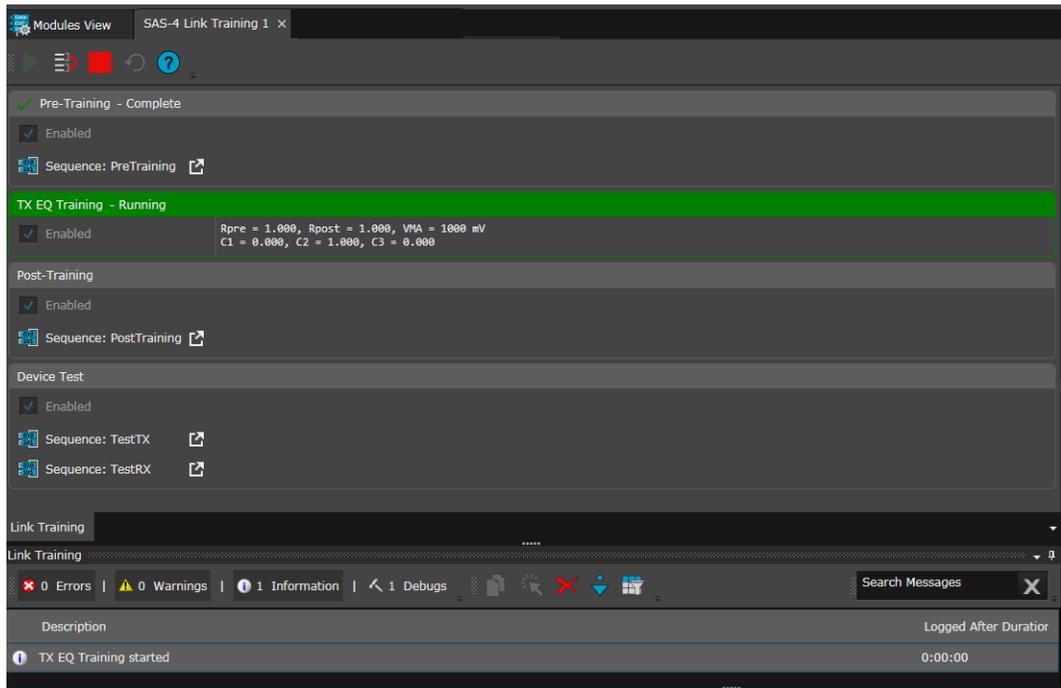
Figure 35   Running TX EQ Training

The purpose of the TX EQ Training block is to configure the ideal de-emphasis setting that fulfills the needs of the DUT. The settings are requested in the Train_Tx TTIUs sent from the DUT to the instrument's generator. The best values are determined by the DUT from the properties of the signal it receives at its RX during TX EQ Training.

You can see the values of the De-emphasis settings displayed in the module view. For details, refer to Plug-in Controlled Parameters on page 66.

TX EQ Training Steps

1 The DUT sends a request to the instrument's generator to specify whether it wants to start TX Equalization Training with the no_equalization, reference_1, or reference_2 coefficient setting. The same is true for the instrument, which also requests from the DUT to use any of these settings for its own transmitter. For more information about these settings, refer to Table 79 of the SAS Protocol Layer – 4 (SPL-4) specification.
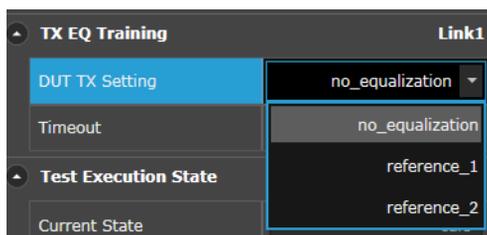
Figure 36   TX EQ Training

2 After the coefficient start condition is defined, the DUT continues to request from the instrument's generator to change its de-emphasis coefficients.

3 This process continues until the DUT is receiving data with an acceptably low error rate.

4 After the DUT is done with its optimizing the received signal, it sends the receiver ready status to the instrument. In turn, the plug-in changes its receiver ready state to True.

5 This concludes the TX EQ Training phase and the instrument's sequencer continues to run the Post-Training or Device Test sequence, if defined; else test execution is completed.

Post-Training

In this step, the SAS Link Training plug-in runs, by default, the Train_Rx sequence containing TRAIN patterns followed by TRAIN_DONE patterns for the SAS-3 Link Training plug-in and PACKET_SYNC_LOST packets followed by PACKET_SYNC packets for the SAS-4 Link Training plug-in. This sequence can be enhanced to contain additional steps. For example, one such step, which may be run by the SAS Link Training plug-in, is to send a custom preparation frame, bringing the DUT into jitter tolerance testing mode also known as loopback mode either by using a special sequence within the Post-Training block or by proprietary means.

Device Test

In this step, the SAS Link Training plug-in can run a custom sequence to perform device testing in loopback mode. For example, this state is intended to perform a jitter tolerance test of the receiver of the DUTs.

> **NOTE**
>
> The default sequences for Device Test are:
>
> - TX: PRBS 7-1, infinitely looping
> - RX: PRBS 7-1, sync and loop

Parameters

The Parameters pane enables you to change the parameters related to test execution, the instruments configuration, amplifier settings and TX EQ training parameters.

> **NOTE**
>
> During test execution, parameter changes are not encouraged and should be done with care to not break TX EQ Training.
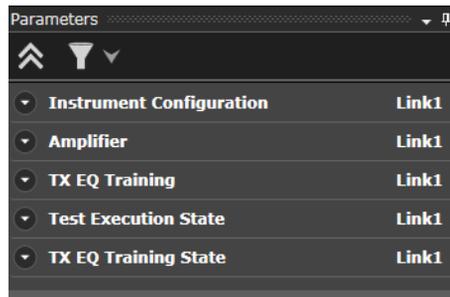
Figure 37   Parameters Pane

Instrument Configuration

Allows you to select a compatible Generator and Analyzer. The SAS-3 Link Training plug-in currently supports three types of modules:

· M8041A 16 Gb/s Generator - Analyzer-Clock
· M8051A 16 Gb/s Generator - Analyzer
· M8062A 32 Gb/s Generator - Analyzer

NOTE   You can use more than one M8051A in a single instrument.

The SAS-4 Link Training plug-in currently supports the following module:

· M8062A 32 Gb/s Generator - Analyzer

It also provides a shortcut to execute the Analyzer Auto Align.

NOTE   Use the functionality of Analyzer Auto Align with care during plug-in execution as it might have a negative effect on the Link Training procedure.

The parameters provided under the Instrument Configuration branch are shown in Figure 38 and described in Table 11.
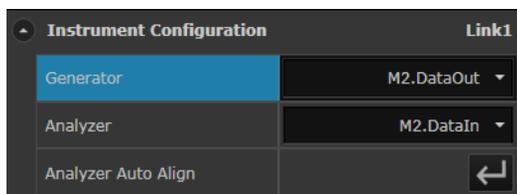
Figure 38   Instrument Configuration Parameters

Table 11   Instrument Configuration Parameters

Name	Description
Generator	Generates an output signal based on a data pattern. It selects the instrument's transmitter, used to send data to the receiver of the DUT.
Analyzer	Examines an incoming bit stream, compares it to the expected pattern and locates inconsistencies. It captures the frames of the DUT's transmitter.
Analyzer Auto Align	Click the ⏎ button to automatically align the selected input to the received signal.

NOTE

The available channel identifiers depend on the module configuration inside the system. Generally, for the SAS-4 Training plug-in, the default channel number will be M2.DataOut and M2.DataIn (Without a number after DataOut or DataIn) because operation of an M8062A module requires a M8041A module as M1. Therefore, the M8041A module resides in slots 1 to 3 and the M8062A module in slots 4 to 5. This is how the channel identifier values mentioned above are attained. However, depending on the available modules and the instruments configuration, the M8062A's module number may be different, such as M3.DataOut and so on.

Amplifier

Defines the different voltage levels of the transmitted output waveform of the SAS Link Training plug-in. It has been designed in a way that the voltage output levels are defined and handled as described in the SAS specification. For more details, refer to Transmitter Equalization Training Procedure on page 33.

The parameters provided under Amplifier are shown in Figure 39 and described in Table 12.
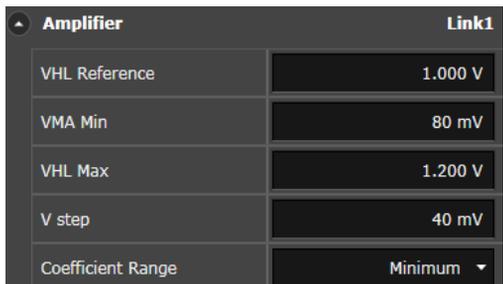
Figure 39   Amplifier Parameters

Table 12   Amplifier Parameters

Name	Description
VHL Reference	Differential voltage value for VHL which is used for no equalization and reference settings as startup value.
VMA min	Minimum differential VMA allowed by the instrument during TX Equalization Training. If VMA reaches the boundaries imposed by this setting, the corresponding coefficient update requests are reported to the DUT as having reached a maximum or minimum value.
VHL max	Maximum differential voltage allowed by the test equipment. This maximum value is intended to limit the amplitude range to protect the DUT's receiver circuit from over voltage. If the output amplitude reaches the boundaries imposed by this setting, the corresponding coefficient update requests are reported to the DUT as having reached a maximum or minimum value.
V step	Differential step size ($Vn(k)-Vn(k-1)$) to be used when changing equalization coefficients during TX Equalization Training.
Coefficient Range	Determine coefficient range allowed by the instrument. Available ranges are either Minimum or Maximum. The exact parameter ranges are as defined in the SAS specification.

TX EQ Training

TX EQ Training defines which TX state (no_equalization, reference_1, or reference_2) will be requested from the DUT and the timeout for the TX Equalization Training procedure.

The timeout is reset whenever there is communication between instrument and DUT. Therefore, a timeout occurs only when no answer is received from the DUT for the specified timeout duration.

The respective parameters are shown in Figure 40 and described in Table 13.
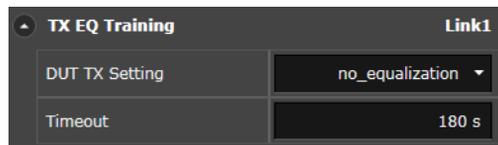
Figure 40   TX EQ Training Parameters

Table 13   TX EQ Training Parameters

Name	Description
DUT TX Setting	Defines which state is requested from the DUT for its TX. It has the following states: • no_equalization • reference_1 • reference_2
Time Out	It occurs when there is no DUT or no answer received in the set time. You can define the timeout from 1 sec to 3600 seconds.

Test Execution State

The parameter provided by Test Execution State is shown in Figure 41 and described in Table 14.
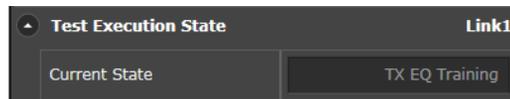
Figure 41   Test Execution State

Table 14   Test Execution State Parameters

Name	Description
Current state	Shows the currently executed test execution state block; the following are the possible states: ▪ Idle ▪ PreTraining ▪ TX EQ Training ▪ PostTraining ▪ DeviceTest ▪ Error ▪ Timeout ▪ Aborted

TX EQ Training State

This functional block shows the parameters of the TX EQ training state. These parameters cannot be controlled directly. They are calculated during the interaction between the instrument and DUT that occurs during the process of TX EQ Training. The parameters are directly related to the setting of the de-emphasis parameters.

The parameters provided by TX EQ Training State are shown in Figure 42 and described in Table 15.

Figure 42   TX EQ Training State Parameters

Table 15   TX EQ Training State Parameters

Name	Description
Rpre	Current pre-cursor equalization ratio used by the instrument.
Rpst	Current post-cursor equalization ratio used by the instrument.
VMA	Current Voltage Modulation Amplitude (VMA) of the equalized output signal.
C1	Current pre-cursor (pre-shoot) coefficient value used by the instrument.
C2	Current main cursor coefficient value used by the instrument.
C3	Current post-cursor (de-emphasis) coefficient value used by the instrument.
INSTR: Response State	Current state of the response blocks inside the Train_Tx phase as seen from the instrument. Following are the possible response states: • Initial Hold State • Requested Update • Acknowledged Update • Idle • Rx Training Finished • Timeout
INSTR: Request State	Current state of the request blocks inside the Train_Tx phase as seen from the instrument. Possible request states are the same as the response state described above.

Run State

The Run State shows the current state of the plug-in. For details, refer to Run State on page 40 (Chapter 3).

Logger Window

Refer to The Global Logger Window on page 41 (Chapter 3).

Logger Pane (SAS Link Training plug-in)

The SAS Link Training Log displays the description of different messages types: Errors, Warnings, Information and Debugs. To activate these messages, click the corresponding button. For details, see Figure 43. By default, during runtime of the plug-in, the debug messages are disabled. However, if more in depth Link Training details are required, activate the

debug messages by clicking the Debugs button. Once the Debugs option is activated, every step of the Link Training procedure is displayed in a separate log message.

NOTE   Depending on the screen and windows size, the Debugs button might be hidden. To activate the additional messages, click the small expander arrow on the right side of the visible message buttons.
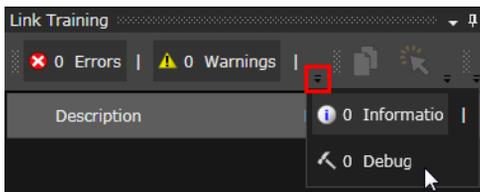
Figure 43   SAS Link Training Expanded View
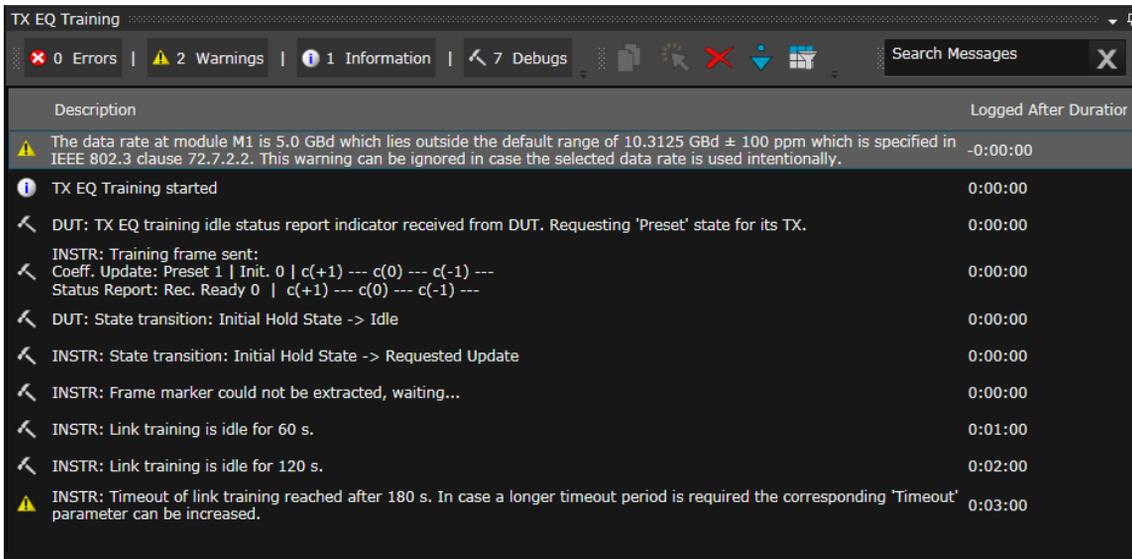
Figure 44   SAS Link Training Log with activated Debugs

Table 16   SAS Log pane description

	Name	Description
❌	Errors	Shows/hides the errors that occur during execution of the Link Training.
⚠️	Warning	Shows/hides the warnings that occur during execution of the Link Training.
ℹ️	Information	Shows/hides information message such as start or stop of the Link Training.
🔨	Debugs	Shows/hides debug messages such as the state description, coefficient description, status of frame markers etc.

Toolbar of SAS Link Training Log pane

It provides the following shortcuts:

Figure 45   Toolbar of SAS Link Training Log

Table 17   Toolbar commands description

	Name	Description
📄	Copy	Copies the desired messages.
🖱️	Select All	Selects all messages.
✖️	Clear Messages	Deletes all messages.
🔽	Enable Auto Scroll To Latest Message	Highlights the most recent message.
📋	Column Option	Selects/clears the check box to show or hide the following options: • Show Log From • Show Time Stamp

Status Indicators

> The Status Indicators window displays the current status of the generator and analyzer ports for each channel of the connected modules. For more information on Status Indicators, refer to *Keysight M8070B User Guide.*

SAS Link Training – Sequence Editor

> Functionality is the same as described for SAS Link Training – Sequence Editor on page 42 (Chapter 3).

Device Tolerance Testing

To perform tolerance testing of a test chip, you must perform some steps that are specific to each chip type. A tolerance test can be executed by sending a signal from the BERT to the DUT which receives and samples this signal and loops it back to the BERT. Activating this functionality depends on the specific DUT.

For this purpose, the BERT expects to receive the same data as it had sent earlier to the DUT. If the looped back signal contains bit errors, it indicates that the receiver of the DUT is unable to tolerate the amount of jitter or interference and therefore, could not interpret the data correctly.

General Procedure

1   Connect the Generator of the BERT to the receiver of the DUT and the Analyzer of the BERT to the transmitter of the DUT.

2   Configure the DUT to attain a state where it expects the Train_Tx-SNW to start. To achieve this, you may be required to use a serial programming interface or to enable a special bit sequence. In the latter case, use the Pre-Training sequence block of the plug-in to setup such a sequence.

3   Edit the test pattern in the Post-Training and the TX EQ Training blocks to allow for loopback testing. The example settings are:

   a   Post-Training block - Train_Rx-SNW, which consists of TRAIN and TRAIN_DONE patterns for SAS-3, and PACKET_SYNC_LOST and PACKET_SYNC packets for SAS-4

   b   TestTX - An infinitely looped PRBS7-1

   c   TestRX - An infinitely looped pattern, e.g., a PRBS7-1 sync and loop to allow the BERT to synchronize to the DUT's loopback signal.

   The default state of the SAS Link Training - Sequence window contains the above mentioned sequence snippets.

4   Start execution of the Link Training plug-in and let it train the DUT's receiver. Once the DUT sends the finished bit inside the Train_Tx pattern to the BERT, the Link Training plug-in also performs the same action and thereby concludes the equalization training.

5   After TX EQ Training succeeds, the BERT transitions to the Post-Training step and sends out a TRAIN and TRAIN_DONE pattern for SAS-3 and PACKET_SYNC_LOST and PACKET_SYNC packet for SAS-4 and then the Device Test block (Default: PRBS7-1 sequence snippet used for both Generator and Analyzer).

6   The DUT must be programmed into loopback mode by custom means.

7   Start with application/device specific tolerance testing.

Jitter Tolerance

To conveniently perform jitter tolerance testing, there is a separate application specific view available.

To launch this interface: Go to **Measurements** > **Jitter Tolerance**

This measurement can be used in conjunction with the SAS Link Training plug-ins, starting at step 7. For more information on how to use this view, refer to the *M8070B User Guide*.
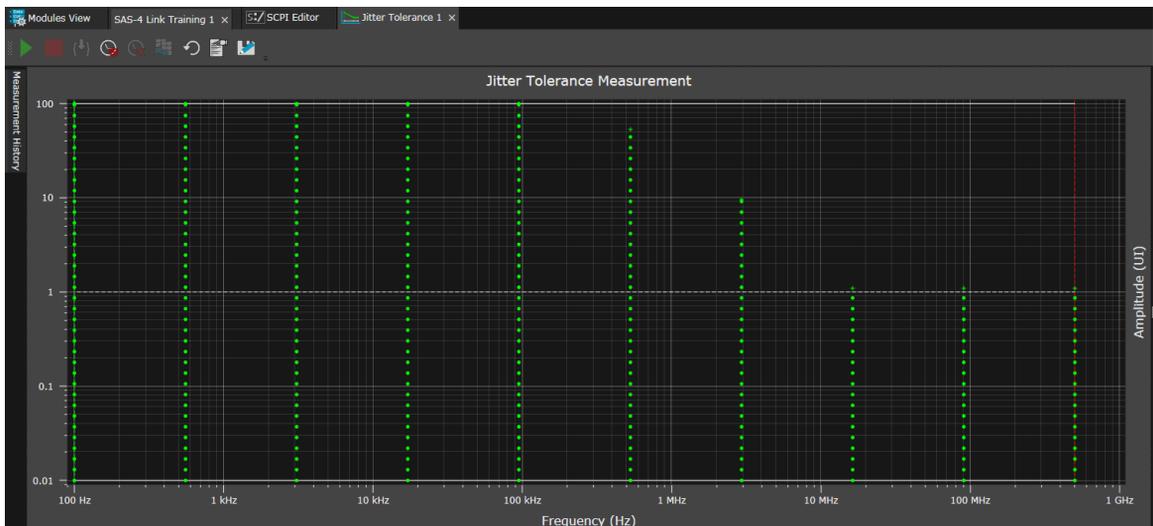
Figure 46   Jitter Tolerance

5 SCPI Command Reference

This chapter describes the SCPI commands supported by the SAS Link Training plug-ins.

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Common SCPI Commands

For each GUI control there is a corresponding SCPI command/query. The SCPI programming reference contains only simple descriptions for each command/query, for full details, refer to the corresponding GUI sections of this User Guide.

The SCPI Commands are common for both plug-ins ('SAS-3 Link Training Plug-in' and 'SAS-4 Link Training plug-in'). But in SCPI syntax you need to perform the following changes for the specific plug-in:

· Plug-in name (represented by [...] in general SCPI syntax)

  · For SAS-3 Link Training Plug-in: "LTSASIII"

  · For SAS-4 Link Training Plug-in: "LTSASIV"

· Identifier example

  · For SAS-3 Link Training Plug-in: 'SAS-3 Link Training 1'

  · For SAS-4 Link Training Plug-in: 'SAS-4 Link Training 1'

Table 18   SCPI Commands

Command	Description	Reference
Plug-in Framework Commands		For details, see Plug-in Framework Commands on page 90
:PLUGin:[...]:AMPlifier:CRANge[?]	Defines the coefficient range allowed by the test equipment.	For details, see page no. 95
:PLUGin:[...]:AMPlifier:VHLMaximum[?]	Defines the maximum differential voltage VHL allowed by the test equipment.	For details, see page no. 95
:PLUGin:[...]:AMPlifier:VHLReference[?]	Defines the differential voltage value for VHL which is used for no equalization and reference settings as startup value.	For details, see page no. 96
:PLUGin:[...]:AMPlifier:VMAMinimum[?]	Defines the minimum differential VMA allowed by the instrument during TX EQ training.	For details, see page no. 96
:PLUGin:[...]:AMPlifier:VSTEPsize[?]	Defines the differential step size (Vn(k) - Vn(k-1)) to be used when changing equalization coefficients during TX EQ Training.	For details, see page no. 97
:PLUGin:[...]:BLOCk:POSTraining:ENABled[?]	Enables or disables the execution of the Post-Training block.	For details, see page no. 97
:PLUGin:[...]:BLOCk:POSTraining:SEQuence:TX:[VALue][?]	Sets the sequence settings for the Post-Training.	For details, see page no. 98
:PLUGin:[...]:BLOCk:POSTraining:STATe?	Returns the execution state of the Post-Training block.	For details, see page no. 99
:PLUGin:[...]:BLOCk:PRETraining:ENABled[?]	Enables or disables the execution of the Pre-Training block.	For details, see page no. 99

Command	Description	Reference
:PLUGin:[...]:BLOCk:PRETraining:SEQuence:TX:[VALue][?]	Sets the sequence settings for the Pre-Training.	For details, see page no. 99
:PLUGin:[...]:BLOCk:PRETraining:STATe?	Returns the execution state of the Pre-Training block.	For details, see page no. 100
:PLUGin:[...]:BLOCk:SEQuence:BREak	Breaks out of all the loops that are defined as breakable and are currently running.	For details, see page no. 101
:PLUGin:[...]:BLOCk:TEST:ENABled[?]	Enables or disables execution of the device test block.	For details, see page no. 101
:PLUGin:[...]:BLOCk:TEST:SEQuence:RX:[VALue][?]	Sets the instruments RX sequence for the test block.	For details, see page no. 102
:PLUGin:[...]:BLOCk:TEST:SEQuence:TX:[VALue][?]	Sets the instruments TX sequence for the test block.	For details, see page no. 103
:PLUGin:[...]:BLOCk:TEST:STATe?	Returns the execution state of the test block.	For details, see page no. 104
:PLUGin:[...]:BLOCk:TXEQ:ENABled[?]	Enables or disables execution of the device test block.	For details, see page no. 104
:PLUGin:[...]:BLOCk:TXEQ:STATe?	Returns the execution state of the TX EQ training block.	For details, see page no. 104
:PLUGin:[...]:INSTrument:DINput[?]	Defines the local receiver which is used to capture frames from the transmitter of the DUT.	For details, see page no. 105
:PLUGin:[...]:INSTrument:DINput:ALIGnment	Aligns the selected input to the received signal.	For details, see page no. 105
:PLUGin:[...]:INSTrument:DOUTput[?]	Defines the local transmitter which is used to communicate with the receiver of the DUT.	For details, see page no. 106
:PLUGin:[...]:LTraining:DUTState[?]	Defines which state is requested from the DUT for its transmitter.	For details, see page no. 106
:PLUGin:[...]:LTraining:RESult?	Returns the result of TX Equalization Training.	For details, see page no. 107
:PLUGin:[...]:LTraining:STATe:CONE?	Returns the current pre-cursor (pre-shoot) coefficient value used by the instrument.	For details, see page no. 107
:PLUGin:[...]:LTraining:STATe:CTWO?	Returns the current main cursor coefficient value used by the instrument.	For details, see page no. 107
:PLUGin:[...]:LTraining:STATe:CTHRee?	Returns the current post-cursor (de-emphasis) coefficient value used by the instrument.	For details, see page no. 108
:PLUGin:[...]:LTraining:STATe:IREQuest?	Returns the current state of the request blocks inside the Train_Tx -SNW as seen from the plug-in.	For details, see page no. 108
:PLUGin:[...]:LTraining:STATe:IRESponse?	Returns the current state of the response blocks inside the Train_Tx -SNW as seen from the plug-in.	For details, see page no. 108
:PLUGin:[...]:LTraining:STATe:RPRE?	Returns the value of the current pre-cursor equalization ratio used by the instrument.	For details, see page no. 109
:PLUGin:[...]:LTraining:STATe:RPST?	Returns the value of the current post-cursor equalization ratio used by the instrument.	For details, see page no. 109

Command	Description	Reference
:PLUGin:[...]:LTraining:STATe:VMAmplitude?	Returns the current Voltage Modulation Amplitude (VMA) of the equalized output signal.	For details, see page no. 109
:PLUGin:[...]:LTraining:TIMEout[?]	Defines the maximum time which may be spent inside any of the TX Equalization Training states, before training is aborted.	For details, see page no. 109
:PLUGin:[...]:TEXEcution:STATe?	Returns current test execution state.	For details, see page no. 110

Plug-in Framework Commands

Plug-in framework commands are a set of "general" SCPI commands for controlling the Link Training plug-ins.

Table 19   Plug-in Framework Commands

Command	Description	Reference
:PLUGin:[...]:CATalog?	Returns the active instance name of the Link Training plug-in. If multiple plug-in instances are open, it returns the name of most recent plug-in instance.	For details, see page no. 91
:PLUGin:[...]:DELete	Closes the active instance of the Link Training plug-in. If multiple plug-in instances are open, it closes the last plug-in instance.	For details, see page no. 91
:PLUGin:[...]:NEW	Opens a new instance of Link Training plug-in.	For details, see page no. 91
:PLUGin:[...]:RESet	Resets the state of Link Training plug-in to its default values.	For details, see page no. 92
:PLUGin:[...]:RUN:LOG?	Returns the logs of the plug-in.	For details, see page no. 92
:PLUGin:[...]:RUN:MESSage?	Returns a value describing the state of the plug-in.	For details, see page no. 92
:PLUGin:[...]:RUN:PROGress?	Returns a number in the range of 0.0 to 1.0 to indicate the progress of the plug-in. A '0.0' indicates that the plug-in is idle or was just started and '1.0' indicates that the plug-in execution has been finished.	For details, see page no. 93
:PLUGin:[...]:RUN:STATus?	Returns the running status of the plug-in. A '0' indicates the plug-in is not running and a '1' indicates that the plug-in execution has been finished.	For details, see page no. 93
:PLUGin:[...]:STARt	Used to start the plug-in execution.	For details, see page no. 94
:PLUGin:[...]:STOP	Used to stop the plug-in execution.	For details, see page no. 94

:PLUGin:[...]:CATalog?

Query	:PLUGin:LTSASIII:CATalog?
	:PLUGin:LTSASIV:CATalog?
Return Value	Name of each active plug-in instance, such as "SAS-3 Link Training 1" or "SAS-4 Link Training 1".
Description	This query returns the respective names of all active plug-in instances of the SAS Link Training plug-in.
	For example, if three plug-in instances of 'SAS-3 Link Training' are active, the query would return "SAS-3 Link Training 1","SAS-3 Link Training 2","SAS-3 Link Training 3".
Example	:PLUGin:LTSASIII:CATalog?
	:PLUGin:LTSASIV:CATalog?

:PLUGin:[...]:DELete

Command	:PLUGin:LTSASIII:DELete
	:PLUGin:LTSASIV:DELete
Description	This command deletes the active plug-in instance of the SAS Link Training plug-in. If multiple plug-in instances are active, for example three plug-in instances are active, the command deletes the active plug-in instance.
	The syntax for this command includes an optional parameter called '<Instance Name>'. If you specify this variable in the command syntax, it deletes the specified plug-in instance instead of the active plug-in instance.
Example	:PLUGin:LTSASIII:DELete
	:PLUGin:LTSASIV:DELete
	:PLUGin:LTSASIV:DELete 'SAS-3 Link Training 1'
	:PLUGin:LTSASIV:DELete 'SAS-4 Link Training 1'

:PLUGin:[...]:NEW

Command	:PLUGin:LTSASIII:NEW '<Instance Name>'
	:PLUGin:LTSASIV:NEW '<Instance Name>'
Input Parameters	'<Instance Name>': Assign any name to the plug-in instance.
Description	This command opens a new instance of the SAS Link Training plug-in by the name specified in the command.
Example	:PLUGin:LTSASIII:NEW 'SAS-3 Link Training 2'

:PLUGin:LTSASIV:NEW 'SAS-4 Link Training 2'

:PLUGin:[...]:RESet

Command	:PLUGin:LTSASIII:RESet
	:PLUGin:LTSASIV:RESet
Description	This command resets the active SAS Link Training plug-in instance to its default values.
	The syntax for this command includes an optional parameter called '<Instance Name>'. If you specify this variable in the command syntax, it resets the specified plug-in instance instead of the active plug-in instance.
Example	:PLUGin:LTSASIII:RESet
	:PLUGin:LTSASIV:RESet
	:PLUGin:LTSASIII:RESet 'SAS-3 Link Training 1'
	:PLUGin:LTSASIV:RESet 'SAS-4 Link Training 1'

:PLUGin:[...]:RUN:LOG?

Command	:PLUGin:LTSASIII:RUN:LOG?
	:PLUGin:LTSASIV:RUN:LOG?
Description	This query returns logs of the active plug-in instance of the SAS Link Training plug-in.
	The syntax for this command includes an optional parameter called '<Instance Name>'. If you specify this variable in the query syntax, it returns the logs for the specified plug-in instance instead of the active instance.
Example	:PLUGin:LTSASIII:RUN:LOG?
	:PLUGin:LTSASIV:RUN:LOG?
	:PLUGin:LTSASIII:RUN:LOG? 'SAS-3 Link Training 2'
	:PLUGin:LTSASIV:RUN:LOG? 'SAS-4 Link Training 2'

:PLUGin:[...]:RUN:MESSage?

Command	:PLUGin:LTSASIII:RUN:MESSage?
	:PLUGin:LTSASIV:RUN:MESSage?
Return Value	NotStarted	Running	Finished	Error	Stopped
Description	This query returns a value describing the state of the active instance of the SAS Link Training plug-in.

The syntax for this command includes an optional parameter called '<Instance Name>'. If you specify this variable in the command syntax, it return a value describing the state of the specified plug-in instance instead of the active plug-in instance.

Example :PLUGin:LTSASIII:RUN:MESSage?

:PLUGin:LTSASIV:RUN:MESSage?

:PLUGin:LTSASIII:RUN:MESSage? 'SAS-3 Link Training 2'

:PLUGin:LTSASIV:RUN:MESSage? 'SAS-4 Link Training 2'

:PLUGin:[...]:RUN:PROGress?

Command :PLUGin:LTSASIII:RUN:PROGress?

:PLUGin:LTSASIV:RUN:PROGress?

Return Value 0.0 | 1.0

Description This query returns a number in the range of 0.0 to 1.0 to indicate the progress of the active plug-in instance of the SAS Link Training plug-in. A '0.0' indicates that the plug-in is idle or was just started and '1.0' indicates that the plug-in execution has been finished.

The syntax for this command includes an optional parameter called '<Instance Name>'. If you specify this variable in the command syntax, it returns the progress for the specified plug-in instance instead of the active plug-in instance.

Example :PLUGin:LTSASIII:RUN:PROGress?

:PLUGin:LTSASIV:RUN:PROGress?

:PLUGin:LTSASIII:RUN:PROGress? 'SAS-3 Link Training 1'

:PLUGin:LTSASIV:RUN:PROGress? 'SAS-4 Link Training 1'

:PLUGin:[...]:RUN:STATus?

Command :PLUGin:LTSASIII:RUN:STATus?

:PLUGin:LTSASIV:RUN:STATus?

Return Value 0 |1

Description This query returns the running status of the active plug-in instance of the SAS Link Training plug-in. A '0' indicates the plug-in is not running and a '1' indicates that the plug-in execution has been finished. The syntax for this command includes an optional parameter called '<Instance Name>'. If

you specify this variable in the command syntax, it would returns the running status of the specified plug-in instance instead of the active plug-in instance.

Example   :PLUGin:LTSASIII:RUN:STATus?

:PLUGin:LTSASIV:RUN:STATus?

:PLUGin:LTSASIII:RUN:STATus? 'SAS-3 Link Training 1'

:PLUGin:LTSASIV:RUN:STATus? 'SAS-4 Link Training 1'

:PLUGin:[...]:STARt

Command   :PLUGin:LTSASIII:STARt

:PLUGin:LTSASIV:STARt

Description   This command starts the plug-in execution of the active plug-in instance of the SAS Link Training plug-in.

The syntax for this command includes an optional parameter called '<Instance Name>'. If you specify this variable in the command syntax, it starts the plug-in execution of the specified plug-in instance instead of the active plug-in instance.

Example   :PLUGin:LTSASIII:STARt

:PLUGin:LTSASIV:STARt

:PLUGin:LTSASIII:STARt 'SAS-3 Link Training 1'

:PLUGin:LTSASIV:STARt 'SAS-4 Link Training 1'

:PLUGin:[...]:STOP

Command   :PLUGin:LTSASIII:STOP

:PLUGin:LTSASIV:STOP

Description   This command stops the plug-in execution of the active plug-in instance of the SAS Link Training plug-in.

The syntax for this command includes an optional parameter called '<Instance Name>'. If you specify this variable in the command syntax, it stops the plug-in execution of the specified plug-in instance instead of the active plug-in instance.

Example   :PLUGin:LTSASIII:STOP

:PLUGin:LTSASIV:STOP

:PLUGin:LTSASIII:STOP 'SAS-3 Link Training 1'

:PLUGin:LTSASIV:STOP 'SAS-4 Link Training 1'

PLUGin:[...]:AMPlifier:CRANge[?]

Command	:PLUGin:LTSASIII:AMPlifier:CRANge 'Identifier', <MINimum|MAXimum>
	:PLUGin:LTSASIV:AMPlifier:CRANge 'Identifier', <MINimum|MAXimum>
Query	:PLUGin:LTSASIII:AMPlifier:CRANge? 'Identifier'
	:PLUGin:LTSASIV:AMPlifier:CRANge? 'Identifier'
Input Parameters	'Identifier': Specify the name of the plug-in instance.
Description	This command defines the coefficient range allowed by the test equipment of the Link Training plug-in. The available parameter ranges are either Minimum or Maximum.
	This query returns the present setting.
Example	:PLUGin:LTSASIII:AMPlifier:CRANge 'SAS-3 Link Training 1', MIN
	:PLUGin:LTSASIV:AMPlifier:CRANge 'SAS-4 Link Training 1', MIN
	:PLUGin:LTSASIII:AMPlifier:CRANge? 'SAS-3 Link Training 1'
	:PLUGin:LTSASIV:AMPlifier:CRANge? 'SAS-4 Link Training 1'

PLUGin:[...]:AMPlifier:VHLMaximum[?]

Command	:PLUGin:LTSASIII:AMPlifier:VHLMaximum 'Identifier', <Nrf>
	:PLUGin:LTSASIV:AMPlifier:VHLMaximum 'Identifier', <Nrf>
Query	:PLUGin:LTSASIII:AMPlifier:VHLMaximum? 'Identifier'
	:PLUGin:LTSASIV:AMPlifier:VHLMaximum? 'Identifier'
Input Parameters	'Identifier': Specify the name of the plug-in instance.
	<Nrf>: See description.
Description	This command defines the maximum differential voltage VHL allowed by the test equipment of the Link Training plug-in.
	This query returns the present setting.
Example	:PLUGin:LTSASIII:AMPlifier:VHLMaximum 'SAS-3 Link Training 1', 2
	:PLUGin:LTSASIV:AMPlifier:VHLMaximum 'SAS-4 Link Training 1', 2
	:PLUGin:LTSASIII:AMPlifier:VHLMaximum? 'SAS-3 Link Training 1'
	:PLUGin:LTSASIV:AMPlifier:VHLMaximum? 'SAS-4 Link Training 1'

:PLUGin:[...]:AMPlifier:VHLReference[?]

Command	:PLUGin:LTSASIII:AMPlifier:VHLReference 'Identifier', ‹Nrf›
	:PLUGin:LTSASIV:AMPlifier:VHLReference 'Identifier', ‹Nrf›
Query	:PLUGin:LTSASIII:AMPlifier:VHLReference? 'Identifier'
	:PLUGin:LTSASIV:AMPlifier:VHLReference? 'Identifier'
Input Parameters	'Identifier': Specify the name of the plug-in instance.
	‹Nrf›: See description.
Return Range	0 to 2.4 V
Description	This command defines the differential voltage value for VHL which is used for no equalization and reference settings as startup value.
	This query returns the present setting.
Example	:PLUGin:LTSASIII:AMPlifier:VHLReference 'SAS-3 Link Training 1', 1.1
	:PLUGin:LTSASIV:AMPlifier:VHLReference 'SAS-4 Link Training 1', 1.1
	:PLUGin:LTSASIII:AMPlifier:VHLReference? 'SAS-3 Link Training 1'
	:PLUGin:LTSASIV:AMPlifier:VHLReference? 'SAS-4 Link Training 1'

:PLUGin:[...]:AMPlifier:VMAMinimum[?]

Command	:PLUGin:LTSASIII:AMPlifier:VMAMinimum 'Identifier', ‹Nrf›
	:PLUGin:LTSASIV:AMPlifier:VMAMinimum 'Identifier', ‹Nrf›
Query	:PLUGin:LTSASIII:AMPlifier:VMAMinimum? 'Identifier'
	:PLUGin:LTSASIV:AMPlifier:VMAMinimum? 'Identifier'
Input Parameters	'Identifier': Specify the name of the plug-in instance.
	‹Nrf›: See description.
Description	This command defines the minimum differential VMA allowed by the instrument during the TX EQ Training.
	This query returns the present setting.
Example	:PLUGin:LTSASIII:AMPlifier:VMAMinimum 'SAS-3 Link Training 1', 60 mV
	:PLUGin:LTSASIV:AMPlifier:VMAMinimum 'SAS-4 Link Training 1', 60 mV
	:PLUGin:LTSASIII:AMPlifier:VMAMinimum? 'SAS-3 Link Training 1'
	:PLUGin:LTSASIV:AMPlifier:VMAMinimum? 'SAS-4 Link Training 1'

:PLUGin:[...]:AMPlifier:VSTEPsize[?]

Command	:PLUGin:LTSASIII:AMPlifier:VSTEPsize 'Identifier', ‹Nrf›
	:PLUGin:LTSASIV:AMPlifier:VSTEPsize 'Identifier', ‹Nrf›
Query	:PLUGin:LTSASIII:AMPlifier:VSTEPsize? 'Identifier'
	:PLUGin:LTSASIV:AMPlifier:VSTEPsize? 'Identifier'
Input Parameters	'Identifier': Specify the name of the plug-in instance.
	‹Nrf›: Enter the value of differential step size voltage.
Return Range	1 mV to 100 mV
Description	This command defines the differential step size (Vn(k) - Vn(k-1)) to be used when changing equalization coefficients during TX Equalization Training.
	This query returns the present setting.
Example	:PLUGin:LTSASIII:AMPlifier:VSTEPsize 'SAS-3 Link Training 1', 25 mV
	:PLUGin:LTSASIV:AMPlifier:VSTEPsize 'SAS-4 Link Training 1', 25 mV
	:PLUGin:LTSASIII:AMPlifier:VSTEPsize? 'SAS-3 Link Training 1'
	:PLUGin:LTSASIV:AMPlifier:VSTEPsize? 'SAS-4 Link Training 1'

:PLUGin:[...]:BLOCk:POSTraining:ENABled[?]

Command	:PLUGin:LTSASIII:BLOCk:POSTraining:ENABled 'Identifier', ‹Bool›
	:PLUGin:LTSASIV:BLOCk:POSTraining:ENABled 'Identifier', ‹Bool›
Query	:PLUGin:LTSASIII:BLOCk:POSTraining:ENABled? 'Identifier'
	:PLUGin:LTSASIV:BLOCk:POSTraining:ENABled? 'Identifier'
Input Parameters	'Identifier': Specify the name of the plug-in instance.
	‹Bool›: Enter 1/ON or 0/OFF to enable or disable the post training state.
Return Value	1 | 0
Description	This command enables or disables the execution of the Post-training block.
	This query returns the present setting.
Example	:PLUGin:LTSASIII:BLOCk:POSTraining:ENABled 'SAS-3 Link Training 1', ON
	:PLUGin:LTSASIV:BLOCk:POSTraining:ENABled 'SAS-4 Link Training 1', ON
	:PLUGin:LTSASIII:BLOCk:POSTraining:ENABled? 'SAS-3 Link Training 1'

:PLUGin:LTSASIV:BLOCk:POSTraining:ENABled? 'SAS-4 Link Training 1'

:PLUGin:[...]:BLOCk:POSTraining:SEQuence:TX:[VALue][?]

Command	:PLUGin:LTSASIII:BLOCk:POSTraining:SEQuence:TX:[VALue] 'Identifier', ‹sequence setting›
	:PLUGin:LTSASIV:BLOCk:POSTraining:SEQuence:TX:[VALue] 'Identifier', ‹sequence setting›
Query	:PLUGin:LTSASIV:BLOCk:POSTraining:SEQuence:TX:[VALue]? 'Identifier'
Input Parameters	'Identifier': Specify the name of the plug-in instance.
	‹sequence setting›: Specify sequence setting.
Return Value	Sequence setting.
Description	This command sets the sequence settings for the Post Training of the Link Training plug-in.
	This query returns the present setting.
Example	:PLUGin:LTSASIII:BLOCk:POSTraining:SEQuence:TX:VALue 'SAS-3 Link Training 1', '<?xml version="1.0" encoding="utf-16"?> <sequenceDefinition xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns:xsd="http://www.w3.org/2001/XMLSchema" xmlns="http://www.keysight.com/schemas/M8000/DataSequence"> <sequence><loop count = "1"><block length = "37760"> <pattern source="current:SAS31_AutoGenerated/Pattern/SAS31_TRAIN_RX"/> </block></loop> </sequence></sequenceDefinition>'
	:PLUGin:LTSASIV:BLOCk:POSTraining:SEQuence:TX:VALue 'SAS-4 Link Training 1', '<?xml version="1.0" encoding="utf-16"?><sequenceDefinition xmlns:xsd="http://www.w3.org/2001/XMLSchema" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns="http://www.keysight.com/schemas/M8000/DataSequence"><sequence><loop><block length="128"><prbs polynomial="2^7-1" /></block></loop></sequence></sequenceDefinition>'
	:PLUGin:LTSASIII:BLOCk:POSTraining:SEQuence:TX:VALue? 'SAS-3 Link Training 1'
	:PLUGin:LTSASIV:BLOCk:POSTraining:SEQuence:TX:VALue? 'SAS-4 Link Training 1'

:PLUGin:[...]:BLOCk:POSTraining:STATe?

Query	:PLUGin:LTSASIII:BLOCk:POSTraining:STATe? 'Identifier'
	:PLUGin:LTSASIV:BLOCk:POSTraining:STATe? 'Identifier'
Input Parameters	'Identifier': Specify the name of the plug-in instance.
Return Value	Not Yet Run | Not Completed | Completed
Description	This query returns the execution state of the Post-Training block of the Link Training plug-in.
Example	:PLUGin:LTSASIII:BLOCk:POSTraining:STATe? 'SAS-3 Link Training 1'
	:PLUGin:LTSASIV:BLOCk:POSTraining:STATe? 'SAS-4 Link Training 1'

:PLUGin:[...]:BLOCk:PRETraining:ENABled[?]

Command	:PLUGin:LTSASIII:BLOCk:PRETraining:ENABled 'Identifier', <Bool>
	:PLUGin:LTSASIV:BLOCk:PRETraining:ENABled 'Identifier', <Bool>
Query	:PLUGin:LTSASIII:BLOCk:PRETraining:ENABled? 'Identifier'
	:PLUGin:LTSASIV:BLOCk:PRETraining:ENABled? 'Identifier'
Input Parameters	'Identifier': Specify the name of the plug-in instance.
	<Bool>: Enter 1/ON or 0/OFF to enable or disable the pre-training state.
Return Value	1 | 0
Description	This command enables or disables the execution of the Pre-Training block of the Link Training plug-in.
	This query returns the present setting.
Example	:PLUGin:LTSASIII:BLOCk:PRETraining:ENABled 'SAS-3 Link Training 1', 1
	:PLUGin:LTSASIV:BLOCk:PRETraining:ENABled 'SAS-4 Link Training 1', 1
	:PLUGin:LTSASIII:BLOCk:PRETraining:ENABled? 'SAS-3 Link Training 1'
	:PLUGin:LTSASIV:BLOCk:PRETraining:ENABled? 'SAS-4 Link Training 1'

:PLUGin:[...]:BLOCk:PRETraining:SEQuence:TX:[VALue][?]

Command	:PLUGin:LTSASIII:BLOCk:PRETraining:SEQuence:TX:[VALue] 'Identifier', <sequence setting>
	:PLUGin:LTSASIV:BLOCk:PRETraining:SEQuence:TX:[VALue] 'Identifier', <sequence setting>
Query	:PLUGin:LTSASIII:BLOCk:PRETraining:SEQuence:TX:[VALue]? 'Identifier'
	:PLUGin:LTSASIV:BLOCk:PRETraining:SEQuence:TX:[VALue]? 'Identifier'

Input Parameters	'Identifier': Specify the name of the plug-in instance.
	<sequence setting>: Specify sequence setting.
Return Value	Sequence settings.
Description	This command sets the sequence settings for the Pre-Training of the Link Training plug-in.
	This query returns the present setting.
Example	:PLUGin:LTSASIII:BLOCk:PRETraining:SEQuence:TX:VALue 'SAS-3 Link Training 1', '<?xml version="1.0" encoding="utf-16"?><sequenceDefinition xmlns:xsd="http://www.w3.org/2001/XMLSchema" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns="http://www.keysight.com/schemas/M8000/DataSequence"><sequence><loop><block length="128"><prbs polynomial="2^7-1" /></block></loop></sequence></sequenceDefinition>'
	:PLUGin:LTSASIV:BLOCk:PRETraining:SEQuence:TX:VALue 'SAS-4 Link Training 1', '<?xml version="1.0" encoding="utf-16"?><sequenceDefinition xmlns:xsd="http://www.w3.org/2001/XMLSchema" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns="http://www.keysight.com/schemas/M8000/DataSequence"><sequence><loop><block length="128"><prbs polynomial="2^7-1" /></block></loop></sequence></sequenceDefinition>'
	:PLUGin:LTSASIII:BLOCk:PRETraining:SEQuence:TX:VALue? 'SAS-3 Link Training 1'
	:PLUGin:LTSASIV:BLOCk:PRETraining:SEQuence:TX:VALue? 'SAS-4 Link Training 1'

:PLUGin:[...]:BLOCk:PRETraining:STATe?

Query	:PLUGin:LTSASIII:BLOCk:PRETraining:STATe? 'Identifier'
	:PLUGin:LTSASIV:BLOCk:PRETraining:STATe? 'Identifier'
Input Parameters	'Identifier': Specify the name of the plug-in instance.
Return Value	Not Yet Run | Not Completed | Completed
Description	This query returns the execution state of the Pre-Training block of the Link Training plug-in.
Example	:PLUGin:LTSASIII:BLOCk:PRETraining:STATe? 'SAS-3 Link Training 1'
	:PLUGin:LTSASIV:BLOCk:PRETraining:STATe? 'SAS-4 Link Training 1'

:PLUGin:[...]:BLOCk:SEQuence:BREak

Command	:PLUGin:LTSASIII:BLOCk:SEQuence:BREak 'Identifier'
	:PLUGin:LTSASIV:BLOCk:SEQuence:BREak 'Identifier'
Input Parameters	'Identifier': Specify the name of the plug-in instance.
Description	This command breaks out of all the loops that are defined as breakable and are currently running in the Link Training plug-in.
Example	:PLUGin:LTSASIII:BLOCk:SEQuence:BREak 'SAS-3 Link Training 1'
	:PLUGin:LTSASIV:BLOCk:SEQuence:BREak 'SAS-4 Link Training 1'

NOTE	Presently, there is no way to limit the break functionality to have its effect only on the selected generator.

:PLUGin:[...]:BLOCk:TEST:ENABled[?]

Command	:PLUGin:LTSASIII:BLOCk:TEST:ENABled 'Identifier', <Bool>
	:PLUGin:LTSASIV:BLOCk:TEST:ENABled 'Identifier', <Bool>
Query	:PLUGin:LTSASIII:BLOCk:TEST:ENABled? 'Identifier'
	:PLUGin:LTSASIV:BLOCk:TEST:ENABled? 'Identifier'
Input Parameters	'Identifier': Specify the name of the plug-in instance.
	<Bool>: Enter 1/ON or 0 /OFF to enable or disable the device test state.
Return Value	1 | 0
Description	This command enables or disables the execution of the device test block of the Link Training plug-in.
	This query returns the present setting.
Example	:PLUGin:LTSASIII:BLOCk:TEST:ENABled 'SAS-3 Link Training 1', ON
	:PLUGin:LTSASIV:BLOCk:TEST:ENABled 'SAS-4 Link Training 1', ON
	:PLUGin:LTSASIII:BLOCk:TEST:ENABled? 'SAS-3 Link Training 1'
	:PLUGin:LTSASIV:BLOCk:TEST:ENABled? 'SAS-4 Link Training 1'

:PLUGin:[...]:BLOCk:TEST:SEQuence:RX:[VALue][?]

Command	:PLUGin:LTSASIII:BLOCk:TEST:SEQuence:RX:[VALue] 'Identifier', <sequence setting>
	:PLUGin:LTSASIV:BLOCk:TEST:SEQuence:RX:[VALue] 'Identifier', <sequence setting>
Query	:PLUGin:LTSASIII:BLOCk:TEST:SEQuence:RX:[VALue]? 'Identifier'
	:PLUGin:LTSASIV:BLOCk:TEST:SEQuence:RX:[VALue]? 'Identifier'
Input Parameters	'Identifier': Specify the name of the plug-in instance.
	<sequence setting>: Specify sequence setting.
Return Value	Sequence settings.
Description	This command sets the instrument's RX sequence for the Test block of the Link Training plug-in.
	This query returns the present setting.
Example	:PLUGin:LTSASIII:BLOCk:TEST:SEQuence:RX:VALue 'SAS-3 Link Training 1', '<?xml version="1.0" encoding="utf-16"?><sequenceDefinition xmlns:xsd="http://www.w3.org/2001/XMLSchema" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns="http://www.keysight.com/schemas/M8000/DataSequence"><sequence><loop><block length="128"><prbs polynomial="2^7-1" /></block></loop></sequence></sequenceDefinition>'
	:PLUGin:LTSASIV:BLOCk:TEST:SEQuence:RX:VALue 'SAS-4 Link Training 1', '<?xml version="1.0" encoding="utf-16"?><sequenceDefinition xmlns:xsd="http://www.w3.org/2001/XMLSchema" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns="http://www.keysight.com/schemas/M8000/DataSequence"><sequence><loop><block length="128"><prbs polynomial="2^7-1" /></block></loop></sequence></sequenceDefinition>'
	:PLUGin:LTSASIII:BLOCk:TEST:SEQuence:RX:VALue? 'SAS-3 Link Training 1'
	:PLUGin:LTSASIV:BLOCk:TEST:SEQuence:RX:VALue? 'SAS-4 Link Training 1'

:PLUGin:[...]:BLOCk:TEST:SEQuence:TX:[VALue][?]

Command	:PLUGin:LTSASIII:BLOCk:TEST:SEQuence:TX:[VALue] 'Identifier', <sequence setting>
	:PLUGin:LTSASIV:BLOCk:TEST:SEQuence:TX:[VALue] 'Identifier', <sequence setting>
Query	:PLUGin:LTSASIII:BLOCk:TEST:SEQuence:TX:[VALue]? 'Identifier'
	:PLUGin:LTSASIV:BLOCk:TEST:SEQuence:TX:[VALue]? 'Identifier'
Input Parameters	'Identifier': Specify the name of the plug-in instance.
	<sequence setting>: Specify sequence setting.
Return Value	Sequence settings.
Description	This command sets the instrument's TX sequence for the Test block of the Link Training plug-in.
	This query returns the present setting.
Example	:PLUGin:LTSASIII:BLOCk:TEST:SEQuence:TX:VALue 'SAS-3 Link Training 1', '<?xml version="1.0" encoding="utf-16"?><sequenceDefinition xmlns:xsd="http://www.w3.org/2001/XMLSchema" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns="http://www.keysight.com/schemas/M8000/DataSequence"><sequence><loop><block length="128"><prbs polynomial="2^7-1" /></block></loop></sequence></sequenceDefinition>'
	:PLUGin:LTSASIV:BLOCk:TEST:SEQuence:TX:VALue 'SAS-4 Link Training 1', '<?xml version="1.0" encoding="utf-16"?><sequenceDefinition xmlns:xsd="http://www.w3.org/2001/XMLSchema" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns="http://www.keysight.com/schemas/M8000/DataSequence"><sequence><loop><block length="128"><prbs polynomial="2^7-1" /></block></loop></sequence></sequenceDefinition>'
	:PLUGin:LTSASIII:BLOCk:TEST:SEQuence:TX:VALue? 'SAS-3 Link Training 1'
	:PLUGin:LTSASIV:BLOCk:TEST:SEQuence:TX:VALue? 'SAS-4 Link Training 1'

:PLUGin:[...]:BLOCk:TEST:STATe?

Query	:PLUGin:LTSASIII:BLOCk:TEST:STATe? 'Identifier'
	:PLUGin:LTSASIV:BLOCk:TEST:STATe? 'Identifier'
Input Parameters	'Identifier': Specify the name of the plug-in instance.
Return Value	Not Yet Run | Not Completed | Completed
Description	This query returns the execution state of the Test block of the Link Training plug-in.
Example	:PLUGin:LTSASIII:BLOCk:TEST:STATe? 'SAS-3 Link Training 1'
	:PLUGin:LTSASIV:BLOCk:TEST:STATe? 'SAS-4 Link Training 1'

:PLUGin:[...]:BLOCk:TXEQ:ENABled[?]

Command	:PLUGin:LTSASIII:BLOCk:TXEQ:ENABled 'Identifier', <Bool>
	:PLUGin:LTSASIV:BLOCk:TXEQ:ENABled 'Identifier', <Bool>
Query	:PLUGin:LTSASIII:BLOCk:TXEQ:ENABled? 'Identifier'
	:PLUGin:LTSASIV:BLOCk:TXEQ:ENABled? 'Identifier'
Input Parameters	'Identifier': Specify the name of the plug-in instance.
	<Bool>: Enter 1/ON or 0/OFF to enable or disable the TX EQ Training state.
Return Value	1 | 0
Description	This command enables or disables the execution of the device test block of the Link Training plug-in.
	This query returns the present setting.
Example	:PLUGin:LTSASIII:BLOCk:TXEQ:ENABled 'SAS-3 Link Training 1', OFF
	:PLUGin:LTSASIV:BLOCk:TXEQ:ENABled 'SAS-4 Link Training 1', OFF
	:PLUGin:LTSASIII:BLOCk:TXEQ:ENABled? 'SAS-3 Link Training 1'
	:PLUGin:LTSASIV:BLOCk:TXEQ:ENABled? 'SAS-4 Link Training 1'

:PLUGin:[...]:BLOCk:TXEQ:STATe?

Query	:PLUGin:LTSASIII:BLOCk:TXEQ:STATe? 'Identifier'
	:PLUGin:LTSASIV:BLOCk:TXEQ:STATe? 'Identifier'
Input Parameters	'Identifier': Specify the name of the plug-in instance.
Return Value	Not Yet Run | Not Completed | Completed

Description	This query returns the execution state of the TX EQ training block of the Link Training plug-in.
Example	:PLUGin:LTSASIII:BLOCk:TXEQ:STATe? 'SAS-3 Link Training 1'
	:PLUGin:LTSASIV:BLOCk:TXEQ:STATe? 'SAS-4 Link Training 1'

:PLUGin:[...]:INSTrument:DINput[?]

Command	:PLUGin:LTSASIII:INSTrument:DINput 'Identifier', ‹Local receiver›
	:PLUGin:LTSASIV:INSTrument:DINput 'Identifier', ‹Local receiver›
Query	:PLUGin:LTSASIII:INSTrument:DINput? 'Identifier'
	:PLUGin:LTSASIV:INSTrument:DINput? 'Identifier'
Input Parameters	'Identifier': Specify the name of the plug-in instance.
	‹Local receiver›: Enter 'M1.DataIn1' | 'M1.DataIn2' | 'M2.DataIn1' | 'M2.DataIn2'.
Return Value	'M1.DataIn1' | 'M1.DataIn2' | 'M2.DataIn1' | 'M2.DataIn2'
Description	This command defines the local receiver which is used to capture frames from the transmitter of the DUT of the Link Training plug-in.
	This query returns the present setting.
Example	:PLUGin:LTSASIII:INSTrument:DINput 'SAS-3 Link Training 1', 'M1.DataIn2'
	:PLUGin:LTSASIV:INSTrument:DINput 'SAS-4 Link Training 1', 'M1.DataIn2'
	:PLUGin:LTSASIII:INSTrument:DINput? 'SAS-3 Link Training 1'
	:PLUGin:LTSASIV:INSTrument:DINput? 'SAS-4 Link Training 1'

:PLUGin:[...]:INSTrument:DINput:ALIGnment

Command	:PLUGin:LTSASIII:INSTrument:DINput:ALIGnment 'Identifier'
	:PLUGin:LTSASIV:INSTrument:DINput:ALIGnment 'Identifier'
Input Parameters	'Identifier': Specify the name of the plug-in instance.
Description	This command aligns the selected input to the received signal of the Link Training plug-in.
Example	:PLUGin:LTSASIII:INSTrument:DINput:ALIGnment 'SAS-3 Link Training 1'
	:PLUGin:LTSASIV:INSTrument:DINput:ALIGnment 'SAS-4 Link Training 1'

:PLUGin:[...]:INSTrument:DOUTput[?]

Command	:PLUGin:LTSASIII:INSTrument:DOUTput 'Identifier', ‹Local transmitter›
	:PLUGin:LTSASIV:INSTrument:DOUTput 'Identifier', ‹Local transmitter›
Query	:PLUGin:LTSASIII:INSTrument:DOUTput? 'Identifier'
	:PLUGin:LTSASIV:INSTrument:DOUTput? 'Identifier'
Input Parameters	'Identifier': Specify the name of the plug-in instance.
	‹Local transmitter›: Enter 'M*.DataOut*'.
Return Value	"M*.DataOut*"
Description	This command defines the local transmitter which is used to communicate with the DUT's receiver of the Link Training plug-in.
	This query returns the present setting.
Example	:PLUGin:LTSASIII:INSTrument:DOUTput 'SAS-3 Link Training 1', 'M1.DataOut1'
	:PLUGin:LTSASIV:INSTrument:DOUTput 'SAS-4 Link Training 1', 'M1.DataOut1'
	:PLUGin:LTSASIII:INSTrument:DOUTput? 'SAS-3 Link Training 1'
	:PLUGin:LTSASIV:INSTrument:DOUTput? 'SAS-4 Link Training 1'

:PLUGin:[...]:LTraining:DUTState[?]

Command	:PLUGin:LTSASIII:LTraining:DUTState 'Identifier', ‹PRESet	INITialize›
	:PLUGin:LTSASIV:LTraining:DUTState 'Identifier', ‹PRESet	INITialize›
Query	:PLUGin:LTSASIII:LTraining:DUTState? 'Identifier'
	:PLUGin:LTSASIV:LTraining:DUTState? 'Identifier'
Input Parameters	'Identifier': Specify the name of the plug-in instance.
Return Value	PRES	INIT
Description	This command defines which state is requested from the DUT for its transmitter of the Link Training plug-in.
	This query returns the present setting.
Example	:PLUGin:LTSASIII:LTraining:DUTState 'SAS-3 Link Training 1', PRES
	:PLUGin:LTSASIV:LTraining:DUTState 'SAS-4 Link Training 1', PRES
	:PLUGin:LTSASIII:LTraining:DUTState? 'SAS-3 Link Training 1'
	:PLUGin:LTSASIV:LTraining:DUTState? 'SAS-4 Link Training 1'

:PLUGin:[...]:LTraining:RESult?

Query	:PLUGin:LTSASIII:LTraining:RESult? 'Identifier'
	:PLUGin:LTSASIV:LTraining:RESult? 'Identifier'
Input Parameters	'Identifier': Specify the name of the plug-in instance.
Return Value	TX EQ Training has two states, so two types of return values are:
	• "N/A": for the state 'Not yet executed'.
	• Rpre = 1.29, Rpst = 2.58, V2 = 252 mV c(+1) = –199 mV, c(0) = 488 mV, c(–1) = –36 mV: for the state 'Executed'
Description	This query returns the result of TX Equalization Training of the Link Training plug-in.
Example	:PLUGin:LTSASIII:LTraining:RESult? 'SAS-3 Link Training 1'
	:PLUGin:LTSASIV:LTraining:RESult? 'SAS-4 Link Training 1'

:PLUGin:[...]:LTraining:STATe:CONE?

Query	:PLUGin:LTSASIII:LTraining:STATe:CONE? 'Identifier'
	:PLUGin:LTSASIV:LTraining:STATe:CONE? 'Identifier'
Input Parameters	'Identifier': Specify the name of the plug-in instance.
Return Value	It returns the value of C1 that is currently assigned for the instrument's DATA OUT as requested from DUT.
Description	This query returns the current pre-cursor (pre-shoot) coefficient value used by the instrument of the Link Training plug-in.
Example	:PLUGin:LTSASIII:LTraining:STATe:CONE? 'SAS-3 Link Training 1'
	:PLUGin:LTSASIV:LTraining:STATe:CONE? 'SAS-4 Link Training 1'

:PLUGin:[...]:LTraining:STATe:CTWO?

Query	:PLUGin:LTSASIII:LTraining:STATe:CTWO? 'Identifier'
	:PLUGin:LTSASIV:LTraining:STATe:CTWO? 'Identifier'
Input Parameters	'Identifier': Specify the name of the plug-in instance.
Return Value	It returns the value of C2 that is currently assigned for the instrument's DATA OUT as requested from DUT.
Description	This command returns the current main cursor coefficient value used by the instrument of the Link Training plug-in.
Example	:PLUGin:LTSASIII:LTraining:STATe:CMinus? 'SAS-3 Link Training 1'
	:PLUGin:LTSASIV:LTraining:STATe:CMinus? 'SAS-4 Link Training 1'

:PLUGin:[...]:LTraining:STATe:CTHRee?

Query	:PLUGin:LTSASIII:LTraining:STATe:CTHRee? 'Identifier'
	:PLUGin:LTSASIV:LTraining:STATe:CTHRee? 'Identifier'
Input Parameters	'Identifier': Specify the name of the plug-in instance.
Return Range	It returns the current post-cursor (de-emphasis) coefficient value used by the instrument.
Description	This query returns the current differential post-cursor (de-emphasis) value used by the instrument of the Link Training plug-in.
Example	:PLUGin:LTSASIII:LTraining:STATe:CTHRee? 'SAS-3 Link Training 1'
	:PLUGin:LTSASIV:LTraining:STATe:CTHRee? 'SAS-4 Link Training 1'

:PLUGin:[...]:LTraining:STATe:IREQuest?

Query	:PLUGin:LTSASIII:LTraining:STATe:IREQuest? 'Identifier'
	:PLUGin:LTSASIV:LTraining:STATe:IREQuest? 'Identifier'
Input Parameters	'Identifier': Specify the name of the plug-in instance.
Return Value	Initial Hold State	Requested Update	Acknowledged Update	Idle	Rx Training Finished	Timeout
Description	This query returns the current state of the request blocks inside the Train_Tx pattern as seen from the plug-in.
Example	:PLUGin:LTSASIII:LTraining:STATe:IREQuest? 'SAS-3 Link Training 1'
	:PLUGin:LTSASIV:LTraining:STATe:IREQuest? 'SAS-4 Link Training 1'

:PLUGin:[...]:LTraining:STATe:IRESponse?

Query	:PLUGin:LTSASIII:LTraining:STATe:IRESponse? 'Identifier'
	:PLUGin:LTSASIV:LTraining:STATe:IRESponse? 'Identifier'
Input Parameters	'Identifier': Specify the name of the plug-in instance.
Return Value	Initial Hold State| Requested Update |Acknowledged Update	Idle	Rx Training Finished	Timeout
Description	This query returns the current state of the response blocks inside the Train_Tx pattern as seen from the plug-in.
Example	:PLUGin:LTSASIII:LTraining:STATe:IRESponse? 'SAS-3 Link Training 1'
	:PLUGin:LTSASIV:LTraining:STATe:IRESponse? 'SAS-4 Link Training 1'

:PLUGin:[...]:LTraining:STATe:RPRE?

Query	:PLUGin:LTSASIII:LTraining:STATe:RPRE? 'Identifier'
	:PLUGin:LTSASIV:LTraining:STATe:RPRE? 'Identifier'
Input Parameters	'Identifier': Specify the name of the plug-in instance.
Description	This query returns the value of current pre-cursor equalization ratio used by the instrument of the Link Training plug-in.
Example	:PLUGin:LTSASIII:LTraining:STATe:RPRE? 'SAS-3 Link Training 1'
	:PLUGin:LTSASIV:LTraining:STATe:RPRE? 'SAS-4 Link Training 1'

:PLUGin:[...]:LTraining:STATe:RPST?

Query	:PLUGin:LTSASIII:LTraining:STATe:RPST? 'Identifier'
	:PLUGin:LTSASIV:LTraining:STATe:RPST? 'Identifier'
Input Parameters	'Identifier': Specify the name of the plug-in instance.
Description	This query returns the value of current post-cursor equalization ratio used by the instrument of the Link Training plug-in.
Example	:PLUGin:LTSASIII:LTraining:STATe:RPST? 'SAS-3 Link Training 1'
	:PLUGin:LTSASIV:LTraining:STATe:RPST? 'SAS-4 Link Training 1'

:PLUGin:[...]:LTraining:STATe:VMAmplitude?

Query	:PLUGin:LTSASIII:LTraining:STATe:VMAmplitude? 'Identifier'
	:PLUGin:LTSASIV:LTraining:STATe:VMAmplitude? 'Identifier'
Input Parameters	'Identifier': Specify the name of the plug-in instance.
Description	This query returns the current Voltage Modulation Amplitude (VMA) of the equalized output signal.
Example	:PLUGin:LTSASIII:LTraining:STATe:VMAmplitude? 'SAS-3 Link Training 1'
	:PLUGin:LTSASIV:LTraining:STATe:VMAmplitude? 'SAS-4 Link Training 1'

:PLUGin:[...]:LTraining:TIMEout[?]

Command	:PLUGin:LTSASIII:LTraining:TIMEout 'Identifier', <NR1>
	:PLUGin:LTSASIV:LTraining:TIMEout 'Identifier', <NR1>
Query	:PLUGin:LTSASIII:LTraining:TIMEout? 'Identifier'
	:PLUGin:LTSASIV:LTraining:TIMEout? 'Identifier'
Input Parameters	'Identifier': Specify the name of the plug-in instance.

<NR1>: Enter the time out in seconds.

Return Range	1 second to 3600 seconds
Description	This command defines the maximum time which may be spent inside any of the TX Equalization Training States, before training is aborted by the Link Training plug-in.
	This query returns the present setting.
Example	:PLUGin:LTSASIII:LTraining:TIMEout 'SAS-3 Link Training 1', 80
	:PLUGin:LTSASIV:LTraining:TIMEout 'SAS-4 Link Training 1', 80
	:PLUGin:LTSASIII:LTraining:TIMEout? 'SAS-3 Link Training 1'
	:PLUGin:LTSASIV:LTraining:TIMEout? 'SAS-4 Link Training 1'

:PLUGin:[...]:TEXEcution:STATe?

Query	:PLUGin:LTSASIII:TEXEcution:STATe? 'Identifier'
	:PLUGin:LTSASIV:TEXEcution:STATe? 'Identifier'
Input Parameters	'Identifier': Specify the name of the plug-in instance.
Return Value	Idle | TX EQ Training
Description	This query returns the current training state of the Link Training plug-in.
Example	:PLUGin:LTSASIII:TEXEcution:STATe? 'SAS-3 Link Training 1'
	:PLUGin:LTSASIV:TEXEcution:STATe? 'SAS-4 Link Training 1'

Executing a SCPI through M8070B SCPI Editor

This section describes how a SCPI command can be executed through M8070B SCPI Editor.

Following are the required steps:

1 From the M8070B user interface menu, click *Utilities* to view the list.

2 Select the SCPI *Editor*.

The *SCPI Editor* user interface appears as shown in the following figure:
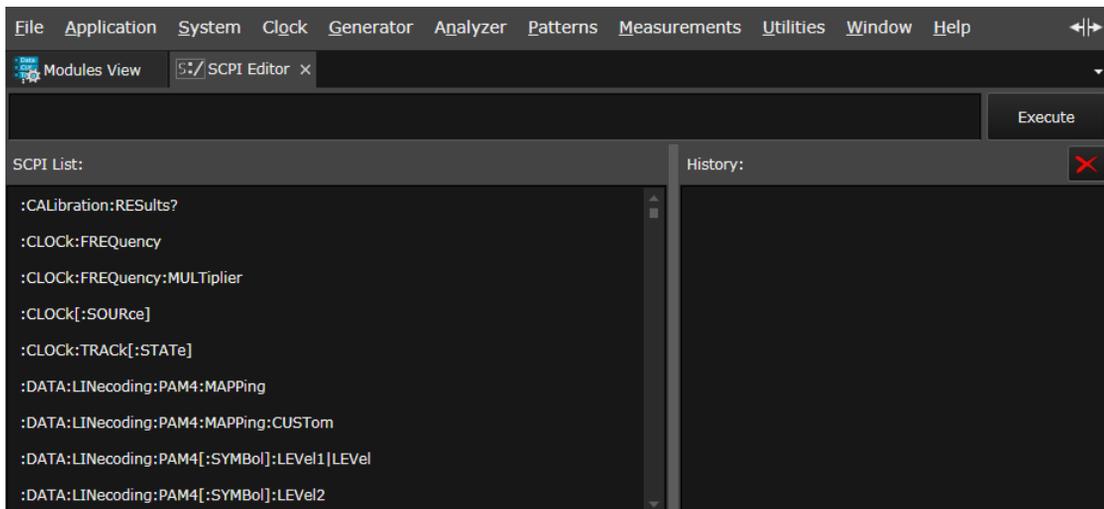
Figure 47   SCPI Editor

3 Select the SCPI from the given list. You may also type the SCPI in the provided text box to expedite the command search. Just above the *SCPI List:,* space is provided to write the SCPI command.

4 Use the proper SCPI command syntax along with the command separators semicolon (";").

5 The following example shows how to execute a SCPI command to enable Pre-Training Block:

- Write the following syntax to open a plug-in instance-
:PLUGin:LTSASIV:NEW 'SAS-4 Link Training 3'.
A new plug-in instance named "SAS-4 Link Training 3" opens in a new tab.

· Write the command you want to run. E.g.
:PLUGin:LTSASIV:BLOCk:PRETraining:ENABled 'SAS-4 Link
Training 3', 1

6   Click Execute. The output of the SCPI command is displayed in the
History pane.

· Click the ❎ Clear History icon to clear the contents of History pane.

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