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User Manual

Tektronix

VXOA41
Optical Attenuator

070-8777-01

CE

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Safety Summary

You might be eager to begin using your VXOA41, but please take a moment to review these safety precautions. They are provided for your protection and to prevent damage to the VXOA41 Optical Attenuator. This safety information applies to all operators and service personnel.

Symbols and Terms

These two terms appear in manuals:



CAUTION. Caution statements identify conditions or practices that could result in damage to the equipment or other property.



WARNING. Warning statements identify conditions or practices that could result in personal injury or loss of life.

These two terms appear on equipment:

- *CAUTION* indicates a personal injury hazard not immediately accessible as one reads the marking, or a hazard to property including the equipment itself.
- *DANGER* indicates a personal injury hazard immediately accessible as one reads the marking.

This symbol appears in manuals:



Static-Sensitive Devices

These symbols appear on equipment:



DANGER
High Voltage



Protective ground
(earth) terminal



ATTENTION
Refer to manual

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Specific Precautions

Observe all of these precautions to ensure your personal safety and to prevent damage to either the VXOA41 or equipment connected to it.

Optical Output



WARNING. *To prevent damage to your eyes, avoid looking into the optical output port while there is an optical signal connected to the input port. Even if the VXOA41 is switched off, light can pass through the attenuator. Always attach the output port to a receiver before attaching the source signal to the input port.*

Power Source

The VXOA41 is designed for operation in a C-size or D-size VXI mainframe. To ensure safe operation, follow all precautions listed in the instrument's documentation. Do not attempt to operate the VXOA41 with any other power source.

Grounding the VXOA41

The VXOA41 is grounded through the VXI mainframe. To avoid electric shock, plug the mainframe power cord into a properly wired receptacle where earth ground has been verified by a qualified service person.

Without the protective ground connection, all parts of the VXOA41 are potential shock hazards. This includes knobs and controls that may appear to be insulators.

Use the Proper Power Cord

Use only the power cord and connector specified for your VXI mainframe. Use only a power cord that is in good condition.

User the Proper Fuse

To avoid fire hazard, use only the fuse specified in the parts list for your VXI mainframe and that is identical in type, voltage rating, and current rating.

Do Not Remove Covers or Panels

To avoid personal injury, do not operate the VXOA41 or VXI mainframe without the panels or covers.

Do Not Operate in Explosive Atmospheres

The VXOA41 provides no explosion protection from static discharges or arcing components. Do not operate the VXOA41 in an atmosphere of explosive gasses.

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Getting Started

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Getting Started

Congratulations on your purchase of a VXOA41 Optical Attenuator. The VXOA41 Optical Attenuator is a high-performance instrument used to attenuate optical signals. Some of the outstanding characteristics of the VXOA41 are:

- Attenuation to 60 dB — the VXOA41 can attenuate signals up to 60 dB in steps of 0.01 dB. A shutter provides greater than 100 dB attenuation.
- 600 nm to 1700 nm calibrated spectral response in one unit.
- Linear response within ±0.05 dB.
- Ability to store attenuation levels, which is useful for repeat measurements.
- Versions available for both single and multimode fiber.
- VXI double-wide C-size module with message-based interface.

The VXOA41 is a message-based VXI module. Control communications are provided at two levels: low-level word serial commands and ASCII commands. Low-level word serial commands provide system administration services. Word serial commands are used by the VXI Resource Manager to determine system status, allocate resources, and initiate normal system operation. These commands are not normally accessed by the system user.

The ASCII command set is used for instrument control and communication. The commands use IEEE Std 488.2 style syntax. Word serial protocol transports these communications between the system controller or slot 0 (if the system controller is not included in the VXI mainframe) and the instrument module.

First Time Operation

Before operating the VXOA41 for the first time, you must perform the following steps:

1. Verify that you have met the power and cooling requirements for the VXI mainframe with the VXOA41 installed.

NOTE. *There is a label located on the right-side shield that lists the power and cooling requirements.*

---

2. Verify that the backplane jumpers have been properly set up for the desired slot in the mainframe; if necessary, refer to the installation instructions later in this section.

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3. Ensure that you have the logical address switches on the VXOA41 set to the desired address (see Figure 1-1).
4. Ensure that the VXOA41 is properly installed in the VXI mainframe.
5. Verify that you can communicate with the VXI module as described in the *Checkout Procedure*.

Installation

After unpacking all components, inspect them for any damage that may have occurred due to shipping.

You can install the VXOA41 into any appropriate C- or D-size VXI mainframe in slots 1–12. Verify that the mainframe can provide adequate power and cooling for the module. Table 1–1 lists the VXOA41 power requirements. The power and cooling requirements are also labeled on the VXOA41 side cover as well as in *Specifications* later in this manual.

Table 1–1: VXOA41 Module Power Requirements

Voltage	Average Current	Maximum Current
+24 V	72 mA	320 mA
–24 V	31 mA	40 mA
+12 V	N/A	N/A
–12 V	N/A	N/A
+5 V	2.1 A	2.3 A
–5.2 V	34 mA	50 mA
–2 V	30 mA	680 mA



WARNING. *Shock hazards exist due to high currents within the mainframe compartment. Do not configure the Bus Grant and Interrupt Acknowledge jumpers unless you are technically qualified to do so.*

Before installing the VXOA41 in a VXI mainframe, a technically qualified person should verify that the slot where you intend to install the module has the Bus Grant (BG0–BG3) and Interrupt Acknowledge (IACK) jumpers properly installed for the mainframe slot. The VXI mainframes contain daisy-chain jumpers for these signals. The jumpers must be configured for the VXOA41 so that the slot is not bypassed.

The VXOA41 is a 2-wide VXI slot instrument. The left slot will pass on daisy-chained IACK signals to the right, but the right slot of the VXOA41 will

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not pass IACK signals because it does not connect to the backplane. Thus, the mainframe slot that accepts the right side of the VXOA41 must have jumpers installed to pass on IACK signals.

Installing the VXOA41 in a VXI Mainframe

Use the following procedures to install the VXOA41 into a Tektronix mainframe. If you use the VXOA41 with another mainframe, you may have to modify this procedure.



CAUTION. *Some components on the VXOA41 are susceptible to static-discharge damage. Observe standard handling precautions for static-sensitive devices. Always wear a grounded wrist strap, or equivalent, while installing or removing the VXOA41.*

1. The VXOA41 contains a DIP switch that you use to set the module address within the mainframe. Figure 1-1 shows the switch location. The switch can be accessed through the hole in the side panel. Set the switch to the desired address before installing the VXOA41 in the mainframe.

   If the system resource manager supports Dynamic Auto Configure, you can set the switch to 255 (FF). At power-on, the logical address will automatically be configured. For proper operation, the logical address must be unique in the VXI system. In other words, no two modules in the VXI system can have the same logical address.

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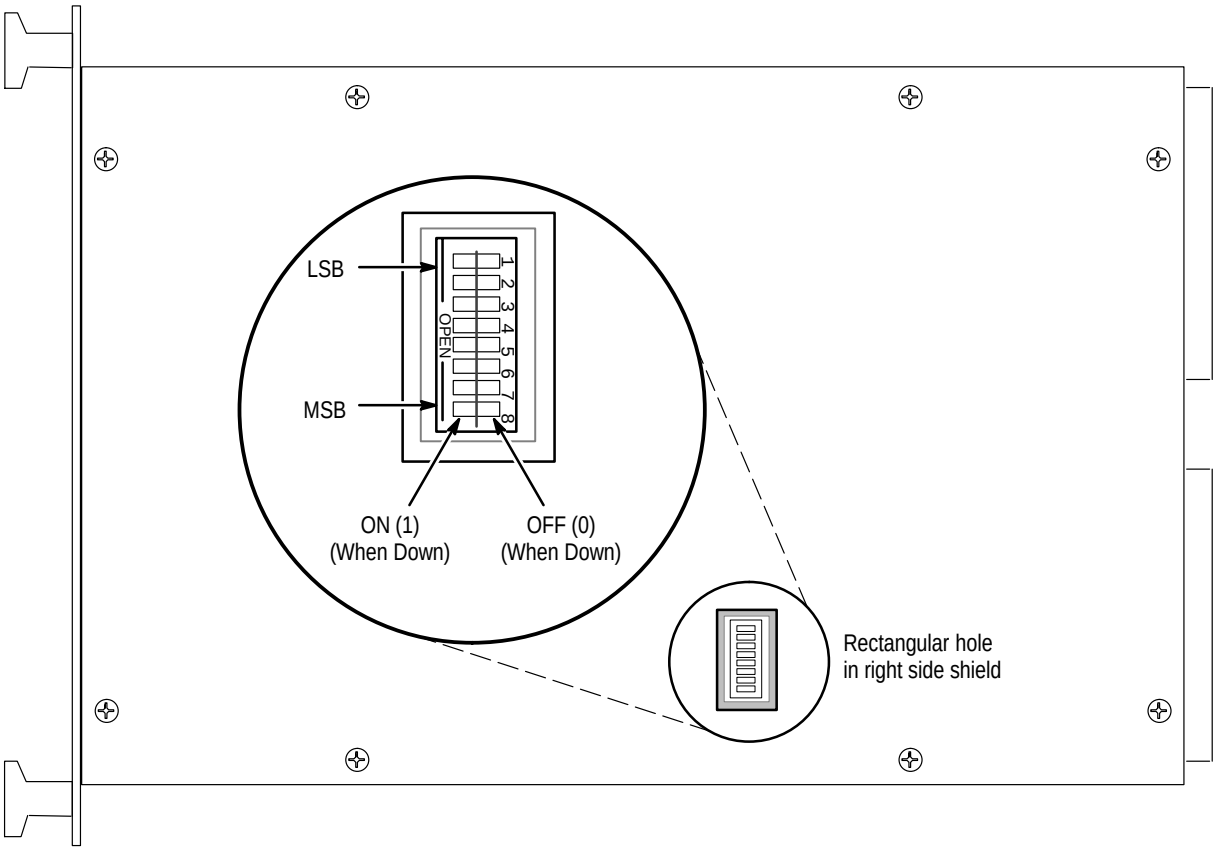


Figure 1-1: Logical Address Switch location on the VXOA41

2. Ensure that the rear-panel power ON/OFF switches and the front-panel ON/STANDBY switch on the mainframe are in the OFF and STANDBY positions, respectively.



CAUTION. *If you install the VXOA41 in a D-size mainframe, make sure that you connect the P1 and P2 connectors of the module to the P1 and P2 connectors of the mainframe. Connecting the P1 and P2 connectors of the module to the P2 and P3 connectors of the mainframe can severely damage the VXOA41 or the mainframe.*

3. Carefully insert the module into the mainframe top and bottom guides in the slots where you plan to install the module, and push the module into the mainframe as far as it will go without forcing it. This should seat the P1 and P2 connectors.

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***NOTE**. If the VXOA41 is installed in a D-size mainframe, ensure that the front-panel gap is properly sealed to maintain adequate internal air flow for cooling.*

4. Ensure the module is fully seated into its VXI connectors and that the front panel of the module is flush with the front of the mainframe chassis. Tighten the module retainer screws at the top and bottom of the front panel to secure the module in the mainframe.

Removing the VXOA41 from a VXI Mainframe

Use the following steps to remove the VXOA41 from a Tektronix mainframe. If you use the VXOA41 with another mainframe, you may have to modify this procedure.

1. Ensure that the rear-panel power ON/OFF switches and the front panel ON/STANDBY switch on the mainframe are in the OFF and STANDBY positions, respectively.
2. Loosen the module retainer screws.
3. Grasp both handles of the module and pull the module straight out of the mainframe as shown in Figure 1-2.

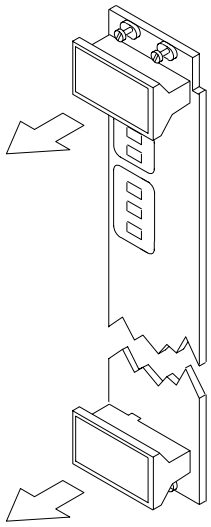


Figure 1-2: Removing the VXOA41 from the Mainframe

4. Once the module has been removed, store it in a static-free environment.

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Checkout Procedure

Once you have installed the VXOA41 in a VXI mainframe, you can communicate with it as with any other VXI module. You do not need any special software installed. However, because you are working in a VXI environment, this procedure assumes that you have the capability to communicate with the VXOA41 using standard talker/listener hardware or software or other program development environments.

There are basically two steps that you should perform to verify that the VXOA41 is correctly installed and operating on the VXI bus.

1. Verify that the READY LED is lighted approximately five seconds after you power on the mainframe; this LED verifies that the power-up diagnostics have passed.

2. After the diagnostics have passed, you can verify that the VXOA41 communicates with a controller or commander by issuing *IDN? to the VXOA41 and reading the results. If the VXOA41 properly responds to ID? or *IDN?, you have verified the communications with the module on the VXI bus. In general, the VXOA41 should respond to an ID? as follows:

```
TEKTRONIX,VXOA41,B010XXX,CF:91.1,CN RM:1.1
```


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Operating Basics

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Operating Basics

This section provides a brief description of the indicators and connectors of the VXOA41 Optical Attenuator.

Front-Panel Indicators and Connectors

The VXOA41 front-panel indicators and connectors consist of five LEDs (light emitting diodes) and two connectors as shown in Figure 2-1.

Two of the front-panel LEDs show the module status. The READY LED is a green LED that lights when the power-on diagnostics have successfully completed. If the diagnostics fail, the READY LED will not light.

The ACCESSED LED is an amber LED that briefly lights each time communications to the VXOA41 occur. It also lights while the MODID is asserted by the VXI Slot 0 module. This feature supports physical identification of modules within the mainframe.

The ATT ADJ LED is a red LED that lights when the attenuation is being changed. When it is dark, the requested attenuation level has been achieved.

The MIN ATT LED is a red LED that lights when the attenuation level has been set to the minimum level.

The DISABLE LED is a red LED that lights when the internal shutter has moved across the optical path. Maximum attenuation is acheived when the internal shutter blocks the optical path.

The two connectors on the front panel are FC-PC style connectors. The top connector is for the signal input; the lower connector is for the attenuated output signal.

NOTE. *See Appendix F for instructions on how to change the optical connectors to another style, such as ST or DIN 47256.*



WARNING. *To prevent damage to your eyes, avoid looking into the optical output port while there is an optical signal connected to the input port. Even if the VXOA41 is switched off, light can pass through the attenuator. Always attach the output port to a receiver before attaching the source signal to the input port.*

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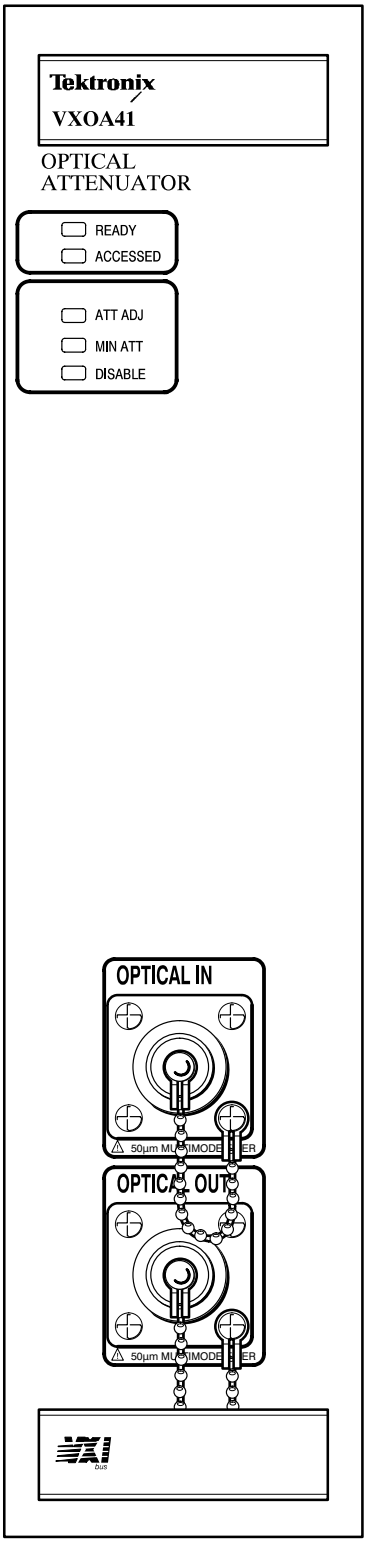


Figure 2-1: VXOA41 Front Panel (Option 1 Shown)

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Reference

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Command Syntax

You can control the VXOA41 using a large group of commands and queries. This section describes the syntax these commands and queries use and the conventions the VXOA41 uses to process them. The commands and queries themselves are listed in the section entitled *Commands*.

You transmit commands to the VXOA41 using the enhanced American Standard Code for Information Interchange (ASCII) character encoding. Appendix C includes a chart of the ASCII character set.

This manual uses Backus-Naur Form (BNF) notation and syntax diagrams to describe commands and queries. The syntax diagrams follow the notations and conventions of the ANSI/IEEE Std 488.2-1987, section 7.2.

This manual uses the BNF symbols listed in Table 3–1.

Table 3–1: BNF Symbols and Meanings

Symbol	Meaning
< >	Defined element
::=	Is Defined As
|	Exclusive OR
{ }	Group; one element is required
[ ]	Optional; can be omitted
. . .	Previous element(s) may be repeated
( )	Comment

Clearing the VXOA41

You can stop any query or process by using the Clear VXI Word Serial command.

Command and Query Structure

Commands consist of set commands and query commands (usually simply called commands and queries). Commands modify instrument settings or tell the VXOA41 to take a specific action. Queries cause the VXOA41 to return information about its status.

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Most commands have both a set form and a query form. The query form of the command is the same as the set form but with a question mark on the end. For example, the set command ATT:DB has a query form ATT:DB?. Not all commands have both a set and query form; some commands are set only and some are query only.

A command message is a command or query name, followed by any information the VXOA41 needs to execute the command or query. Command messages consist of three different element types, defined in Table 3–2 and shown in the example in Figure 3-1.

Table 3–2: Command Message Elements

Symbol	Meaning
<Header>	The basic command name. If the header ends with a question mark, the command is a query. The header may begin with a colon (:) character; if the command is concatenated with other commands the beginning colon is required. The beginning colon can never be used with command headers beginning with star (*).
<Mnemonic>	A header sub-function. Some command headers have only one mnemonic. If a command header has multiple mnemonics, they are always separated from each other by a colon (:) character.
<Argument>	A quantity, quality, restriction, or limit associated with the header. Not all commands have an argument, while other commands have multiple arguments. Arguments are separated from the header by one or more space characters. Arguments are separated from each other by a <Separator>, which is defined below.
<Separator>	A separator between arguments of multiple-argument commands. The separator can be a single comma, or it may optionally have white space characters before and after the comma.

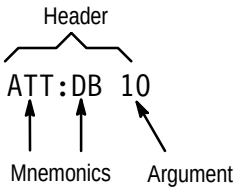


Figure 3-1: Command Message Elements

Commands

Commands cause the VXOA41 to perform a specific function or change one of its settings. Commands have the following structure:

```
[:]<Header>[<Space><Argument>[<Separator><Argument>]...]
```


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Queries

Queries cause the VXOA41 to return information about its status or settings. Queries have the structure:

```
[:]<Header>?

[:]<Header>?[<Space><Argument>[<Separator><Argument>]...]
```

You may use only a part of the header in a query command. When you do this, the instrument returns information about all the possible mnemonics that you have left unspecified. For example, `ATT:DB?` returns the current setting in absolute dB units, while `ATT?` returns the setting in absolute units and units relative to the reference as well as all other `ATT:` parameters.

Headers in Query Responses

You can control whether or not headers are returned by the VXOA41 as part of the query response. Use the `HEADER` command to control this feature. If `HEADER` is on, command headers are returned as part of the query, and the query response is formatted as a valid set command. When `HEADER` is off, only the values are sent back in the response, which may be easier to parse and to extract information from. Table 3–3 shows the difference in responses.

NOTE. *Command queries that begin with an asterisk never return a header in the response (per IEEE 488.2).*

Table 3–3: Comparison of Header On and Off Responses

Query	Header Off Response	Header On Response
`EVENT?`	`128`	`:EVENT 128`
`ATT:DB?`	`32.53`	`:ATT:DB 32.53`

Command Entry

When sending commands to the VXOA41, keep the following in mind:

- You can enter commands in uppercase or lowercase.
- Precede all commands with blank characters. Blank characters include any combination of the ASCII control characters 00 through 09 and 0B through 20 hexadecimal (0 through 9 and 11 through 32 decimal).
- The VXOA41 ignores commands consisting of any combination of blank characters, carriage returns, and line feeds.

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Abbreviating Commands

You can abbreviate many VXOA41 commands. These abbreviations are shown in capitals in the command's listing in the *Commands* section. For example, the command DISPlay can be entered simply as DISP or display.

If you use the HEADER command to have command headers included as part of query responses, you can further control whether the returned headers are abbreviated or are full-length. The Verbose command lets you control this.

Concatenating Commands

You can concatenate any combination of set commands and queries using a semicolon (;). The VXOA41 executes concatenated commands in the order received. Concatenating commands is useful when you want to avoid events generated by conflicting settings — see Conflicts on page 3–40.

When concatenating commands and queries you must follow these rules:

1. Completely different headers must be separated by both a semicolon and by the beginning colon on all commands but the first. For example, the commands `ATT:DB 15` and `DISABLE OFF` would be concatenated into a single command:

   ```
   ATT:DB 15;:DIS OFF
   ```

2. Never precede a star (*) command with a colon:

   ```
   ATT:DB 10;*OPC
   ```

3. When you concatenate queries, the responses to all the queries are concatenated into a single response message. For example, if the disable mode is OFF and the attenuator is 20 dB, the concatenated query:

   ```
   DIS?;:ATT:DB?
   ```

   will return either `DIS 0;:ATT:DB 20` if HEADER is set to ON or `0;20` if HEADER is set to OFF.

4. Set commands and queries may be concatenated in the same message. For example,

   ```
   ATT:DB 15;DIS ON;DIS?;:ADJ?
   ```

   is a valid message that sets the attenuation to 15 dB, the disable mode to ON, and responds with the disable status and the adjusting status. Concatenated commands and queries are executed in the order received.

Here are some invalid concatenations:

- `DISABLE OFF;ATT:DBR 5`
  No colon before `ATT`
- `ATT:MIN;:*OPC`
  Extra colon before a star (*) command

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Message Terminators

This manual uses <EOI> (End of Input) to represent a message terminator.

In VXI byte transfer protocol, the EOI is represented as being bit 8 of the Byte Available and Byte Request word serial commands. If bit 8 is set, then EOI is associated with the current data byte for that word serial command. When using VXI byte transfer protocol, the VXOA41 always accepts the EOI interface symbol as an input message terminator.

The end-of-message terminator may be either the END message (EOI asserted concurrently with the last data byte), the ASCII code for line feed (LF) sent as the last data byte, or both.

The end-of message terminator should not immediately follow a semicolon (;).

The VXOA41 always terminates responses to queries with linefeed and EOI asserted.

Argument Types

The argument of a command can take several forms. The individual descriptions of each command tell which argument types to use with that command.

Block Arguments

One VXOA41 command utilizes a block argument form. The elements of the block arguments described in Table 3–4.

Table 3–4: Block Argument Elements

Symbol	Meaning
<Block>	A block of data bytes, which is defined below
<NZDig>	A non-zero digit character, in the range 1–9
<Dig>	A digit character, in the range 0–9
<DChar>	A character with the binary equivalent of 0 through FF hexadecimal (0 through 255 decimal)

The block argument is in the following format:

```
<Block> ::= #<NZDig><Dig>[<Dig>. . .][<DChar>. . .]
```

<NZDig> specifies the number of <Dig> elements that follow. Taken together, the <Dig> elements form a decimal integer that specifies how many <DChar> elements follow. See Figure 3-2.

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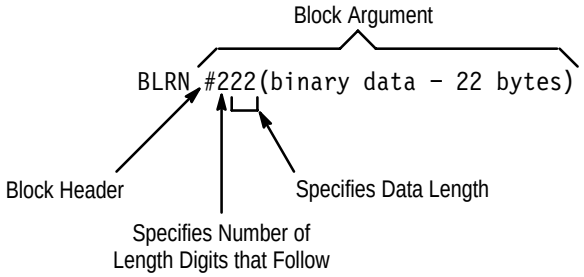


Figure 3-2: Block Argument Example

The block argument can also take the following format:

```
<Block> ::= #0[<DChar>. . .]<EOI>
```

Under IEEE Std 488.2 the above format is also a valid form for block arguments. If this form is used, the last byte of the block must have EOI asserted. Consequently, this must be the last or only command. Although the VXOA41 accepts this format, it will never respond to a query with this format.

Numeric Arguments

Many VXOA41 commands require numeric arguments. Descriptions of these arguments are given in Table 3–5.

Table 3–5: Numeric Argument Descriptions

Symbol	Meaning
<NR1>	Signed integer value
<NR2>	Floating point value without an exponent
<NR3>	Floating point value with an exponent
<NRf>	Flexible numeric argument {NR1|NR2|NR3}. A suffix composed of a multiplier (letter exponent) and units may be used as an alternate to NR3. For example, this numeric type would let you use “10nm” as an alternate to “10E–9m”.

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Syntax Diagrams

The syntax diagrams in this manual use the following symbols and notation:

- Circles and ovals contain literal elements that must be sent exactly as shown. Command and query names are abbreviated to the minimum required spelling.
- Boxes contain the defined elements described earlier in this section, such as <NRf> or <QString>.
- Arrows connect the elements and show the allowed paths through the diagram. Parallel paths show that one and only one of the paths must be taken. A path around a group of elements shows that those elements are optional. Loops show elements that can be repeated.

Figure 3-3 shows the structure of a few typical syntax diagrams.

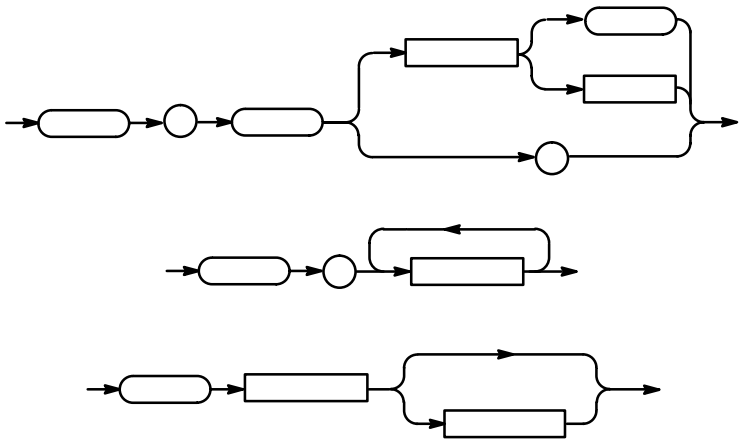


Figure 3-3: Typical Syntax Diagrams

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Commands

VXOA41 commands fall into two main groups: Common Commands and Device Commands. The commands follow Tektronix Standard Codes and Formats 1991.

Most of these commands can be used either as set commands or queries. However, some commands can only be used to set: these have the words “No Query Form” included with the command name. Other commands can only be used to query: these have a question mark appended to the header, and include the words “Query Only” in the command name.

Headers, mnemonics, and arguments are usually spelled out fully in text, with the minimum required spelling shown in upper case. For example, to use the command `RECall` you must enter at least `REC`. The examples in this manual use the abbreviated forms.

Common Commands and Queries

Several commands and queries used with the VXOA41 are common to all devices that support IEEE 488.2. These commands and queries are defined by IEEE Std 488.2-1987.

Table 3–6 lists the Common Commands supported by the VXOA41. Complete descriptions of these commands appear in an alphabetical listing of commands later in this section.

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Table 3–6: Commands Common to All GPIB Devices and Supported by the VXOA41

Header	Full Command Name
ALLev?	All Events
BLRN	Binary Device Setup
*CAL?[1]	Instrument Self Calibration
*CLS	Clear Status
DESE	Device Event Status Enable
*ESE	Standard Event Status Enable
*ESR?	Standard Event Status Register
EVENT?	Event
EVMSG?	Event Message
EVQTy?	Number of Events in Queue
FACTory	Set to Factory Defaults
HEADer	Header
*IDN?	Identification
*LRN?	Learn Device Setup
*OPC	Operation Complete
*OPT?	Option Identification Query
*PSC	Power-On Status Clear
*RST	Reset
*SRE	Service Request Enable
*STB?	Read Status Byte
*TST?	Self-Test
VERBOSE	Verbose
*WAI	Wait To Continue

1 ***CAL? always returns 0.**

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Device Commands and Queries

Table 3–7 lists the device commands, queries, and command parameters that are specific to the VXOA41. Complete descriptions of these commands appear in the alphabetical listing of commands that immediately follows this table.

Table 3–7: VXOA41 Device Commands and Parameters

Header	Full Command Name
ADJusting?	Attenuator Adjusting
ATTenuation	Attenuation
ATTenuation:DB	Attenuation in Absolute Terms
ATTenuation:DBR	Attenuation with Reference Value
ATTenuation:MIN	Minimum Attenuation
ATTenuation:INCRement	Attenuation Increment
ATTenuation:NEXT	Command Trigger
ATTenuation:TRIGger	VXI Trigger Output
ATTenuation:TPOLarity	VXI Trigger Output Polarity
DISable	Light Shutter Status
RECall	Recall Attenuation Setting
REFerence	Reference
STORe1|2	Store Attenuation
WAVelength	Wavelength

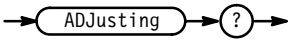
ADJusting? (Query Only)

The ADJusting? query returns the status of the attenuator. A 1 is returned if the attenuator is moving to some attenuation value. A 0 is returned if the attenuator is stationary.

Related Commands *OPC, *WAI

Syntax `ADJusting?`

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Syntax ADJ?

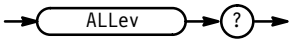
Would return the string ":ADJUSTING 0" or ":ADJUSTING 1".

ALLev? (Query Only)

The ALLev? query causes the VXOA41 to return all events and their messages. This query also removes the returned events from the Event Queue. The messages are separated by commas. Use the *ESR? query to enable the events to be returned. For a complete discussion of the use of these registers, see page 3–35. This command is similar to repeatedly sending EVMsg? queries to the VXOA41.

Related Commands *CLS, DESE, *ESE, *ESR?, EVENT?, EVMsg?, EVQTY, *SRE, *STB?

Syntax ALLev?



Returns The event code and message in the following format:

<Event Code><Comma><QString>[<Event Code><Comma><QString>...]

<QString>::= <Message>;[<Command>]

<Command> is the command that caused the error and it might be returned when a command error is detected by the VXOA41. As much of the command will be returned as possible without exceeding the 60 character limit of the <Message> and <Command> strings combined. The command string is right-justified.

Examples ALLev?

Might return the string:
401,"Power on"

ALLev?

Would return a string similar to the following if an unrecognized command were sent to the VXOA41:
113,"Undefined header; unrecognized command-abc".

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ATTenuation

ATTenuation can be used as both a query and as a command to set device parameters. ATTenuation has three parameters: DB, DBR, and MIN. Use the DB term to query or set attenuation in absolute terms relative to minimum attenuation. To query or set attenuation values relative to the REFerence value, use the DBR term. To set the attenuation to the minimum (0 dB), use the MIN term.

NOTE. *Attenuation can be changed even if the light shutter is closed.*

Related Commands STORe, RECall

Syntax

```
ATTen:DB?

ATTen:DBR?

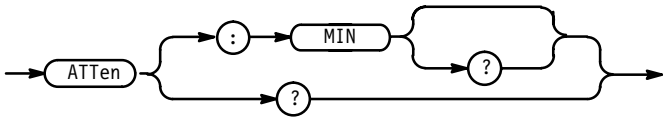
ATTen:DB <NRf>

ATTen:DBR <NRf>

ATTen:MIN

ATTen:MIN?

ATTen?
```



Arguments If you make a query without an argument (for example, ATTen?), the response is the same as that for an ATTen:DB?; DBR? query.

Examples

`ATT:DB?`
Would return the string :
`:ATTEN:DB <present setting, absolute>`

`ATT:DBR?`
Would return the string:
`:ATTEN:DBR <present setting, minus REF>`

`ATT:MIN?`
Would return the string:
`:ATTEN:MIN <1 if at min, 0 otherwise>`

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ATTenuation:INCRement

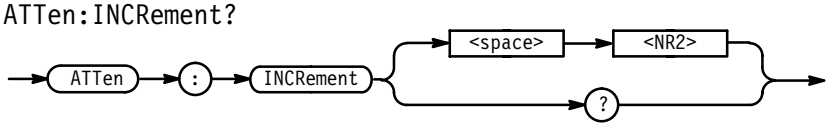
ATTenuation:INCRement sets and queries the increment value used in the triggered auto-increment mode. Each time a trigger occurs (a trigger word serial command or the ATT:NEXT command) the VXOA41 changes the current attenuation setting by the set increment value. The increment value may be either positive or negative.

NOTE. *Attenuation can be changed even if the light shutter is closed.*

Related Commands ATTenuation:NEXT

Syntax

```
ATTen:INCRement <NR2>
ATTen:INCRement?
```



Arguments The argument has a range of –60 to +60. The minimum increment is 0.1. Setting the increment to –0.01 < *value* < 0.01 disables the auto-increment feature.

Examples

```
ATT:INCR?
```

Would return the string:

```
:ATTEN:INCR <present setting, absolute>
```

```
ATT:INCR 5.0
```

Sets the auto-increment value to 5.0 dB.

ATTenuation:NEXT

ATTenuation:NEXT causes the VXOA41 to change the current attenuation setting by the current auto-increment value.

NOTE. *Attenuation can be changed even if the light shutter is closed.*

Related Commands ATTenuation:INCRement

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Syntax `ATTen:NEXT`



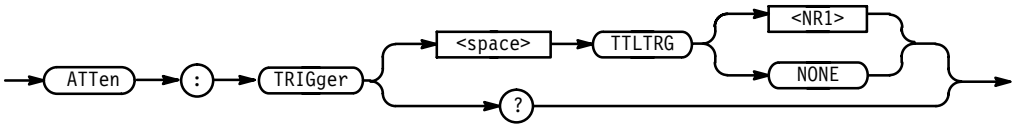
ATTenuation:TRIGger

The ATTenuation:TRIGger command controls the usage of a VXI TTL trigger line in monitoring the attenuator adjusting status. When a trigger line is selected, the associated trigger line will be asserted or unasserted when the attenuator is busy adjusting (attenuation is not stable). The polarity of the trigger signal is determined by the ATTenuation:TPOLarity command. The desired TTL trigger line is specified as TTLTRG0 through TTLTRG7. To disable the TTL trigger line usage, use the command ATTenuation:TRIGger NONE.

Related Commands ATTenuation:TPOLarity

Syntax `ATTen:TRIGger { TTLTRG<NR1> | NONE }`

`ATTen:TRIGger?`



Arguments The numeric argument has a range of 0 to 7. That is, TTLTRG<NR1> can take on the values `TTLTRG0`, `TTLTRG1`, . . . `TTLTRG7`. Note that there is no space between TTLTRG and the numeric argument.

Examples

`ATT:TRIG TTLTRG1`
Specifies that the line TTLTRG1 will be used to monitor attenuator adjusting status.

`ATT:TRIG NONE`
Disables the TTL trigger line usage.

`ATT:TRIG?`
Might return the string:
`ATTENUATION:TRIGGER TTLTRG7`

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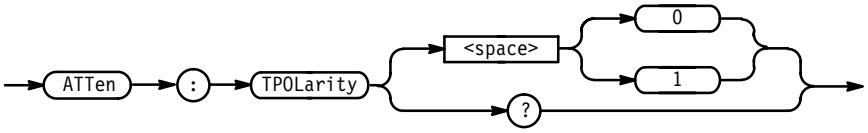
ATTenuation:TPOLarity

The ATTenuation:TPOLarity command sets the polarity of the VXI TTL trigger line used to monitor the attenuator adjusting status.

Related Commands ATTenuation:TRIGger

Syntax

```
ATTen:TPOLarity { 0 | 1 }
ATTen:TPOLarity?
```



Arguments The numeric argument can be either 0 or 1. When the argument is 0, the trigger line specified with the ATT:TRIG command is asserted when the attenuator is busy adjusting and unasserted when the attenuator is stable. If the argument is 1, the trigger line will be unasserted when the attenuator is busy adjusting and asserted when it is stable.

Examples

`ATT:TPOL 0`
Sets the polarity of the TTL trigger line so that the line is asserted when the attenuator is busy.

`ATT:TPOL`
Might return the string:
`ATTENUATION:TPOLARITY 1`

BLRN

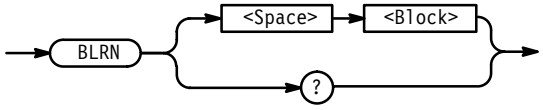
The query version of this command reads the instrument configuration in binary form. The command version configures the instrument binary data format. The configuration is 22 bytes long.

Related Commands *LRN

Syntax

```
BLRN <Block>
BLRN?
```


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Examples BLRN?

Might return the response:

BLRN #222 <22 bytes of binary data>

*CAL? (Query Only)

This command query returns a number that denotes the calibration status of the VXOA41. If the *CAL? query returns 0, then calibration is OK. If a non-zero value is returned, the unit needs to be returned to Tektronix for calibration.

Related Commands *TST?

Syntax *CAL?



Examples *CAL?

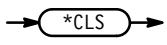
Wil normally return "0".

*CLS (No Query Form)

The *CLS (Clear Status) command clears the VXOA41 status data structures. This command also puts the VXOA41 in the Operation Complete Command Idle State and in the Operation Complete Query Idle State. While in these states, the VXOA41 has nothing in its buffers and does not execute commands or queries.

Related Commands DESE, *ESE, *ESR, EVENT?, EVMSG?,*SRE, *STB

Syntax *CLS



The *CLS command clears

- the Event Queue

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- the Standard Event Status Register (SESR)
- the Status Byte Register (except the MAV bit; see below)

If the *CLS command immediately follows an <EOI>, the output queue and MAV bit (Status Byte Register bit 4) are also cleared. MAV indicates information is in the output queue. DCL will clear the output queue and thus MAV. *CLS does not clear the output queue or MAV. (A complete discussion of these registers and bits and of event handling in general is on page 3–35.)

DESE

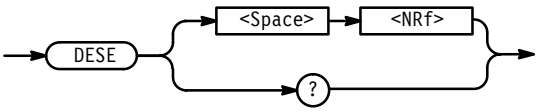
The DESE (Device Event Status Enable) command sets and queries the bits in the Device Event Status Enable Register (DESER). The DESER prevents events from being reported to the Standard Event Status Register (SESR) and from being entered into the Event Queue. For a complete discussion of the use of these registers, see page 3–35.

Related Commands *CLS, *ESE, *ESR, EVENT?, EVMSG?, *SRE, *STB

Syntax

```
DESE <NRf>

DESE?
```



Arguments <NRf> is a value in the range from 0 to 255. The binary bits of the DESER are set according to this value. For example, DESE 209 sets the DESER to the binary value 11010001 (that is, the first bit in the register is set to 1, the second bit to 1, the third bit to 0, etc.).

The power-on default for DESER is all bits set if *PSC is 1. If *PSC is 0, the DESER maintains its value through a power cycle.

NOTE. *Setting the DESER and the ESER to the same value allows only those codes to be entered into the Event Queue and summarized on the ESB bit (bit 5) of the Status Byte Register. Use the* *ESE *command to set the ESER. A complete discussion of event handling is on page 3–35.*

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Examples

`DESE 209`

Sets the DESER to binary 11010001, which enables the PON, URQ, EXE, and OPC bits.

`DESE?`

Might return the string `:DESE 186`, showing that the DESER contains the binary value 10111010.

DISable

To query or set the status of the light shutter, use the DISable term. A DISable argument of 1, or ON, closes the light shutter and blocks all light through the fiber ports. A DISable argument of 0, or OFF, opens the shutter and allows light to pass through the fiber ports (light will be attenuated at the level specified by the ATTEN:DB or ATTEN:DBR terms).

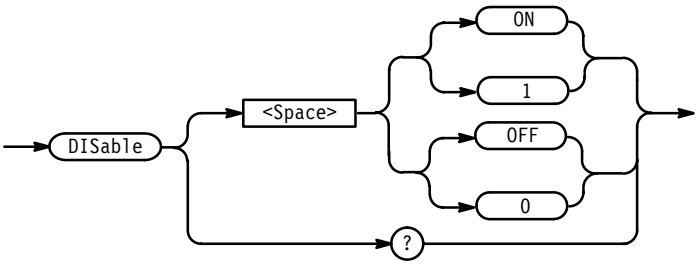
Related Commands N/A

Syntax

`DISable { ON | 1 }`

`DISable { OFF | 0 }`

`Disable?`



Examples

`DIS?`

Returns the string:
`DIS 0`
if the light shutter is not closed.

*ESE

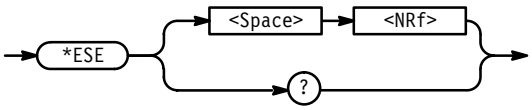
The *ESE (Event Status Enable) command sets and queries the bits in the Event Status Enable Register (ESER). The ESER prevents events from being reported to the Status Byte Register (STB). For a complete discussion of the use of these registers, see page 3–35.

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Related Commands *CLS, DESE, *ESR, EVENT?, EVMSG? *SRE, *STB

Syntax `*ESE <NRf>`

`*ESE?`



Arguments `<NRf>` is a value in the range from 0 through 255. The binary bits of the ESER are set according to this value.

The power-on default for ESER is 0 if `*PSC` is 1. If `*PSC` is 0, the ESER maintains its value through a power cycle.

***NOTE**. Setting the DESER and the ESER to the same value allows only those codes to be entered into the Event Queue and summarized on the ESB bit (bit 5) of the Status Byte Register. Use the* `DESE` *command to set the DESER. A complete discussion of event handling is on page 3–35.*

Examples `*ESE 209`

Sets the ESER to binary 11010001, which enables the PON, URQ, EXE, and OPC bits.

`*ESE?`

Might return the string `*ESE 186`, showing that the ESER contains the binary value 10111010.

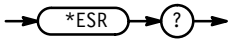
*ESR? (Query Only)

The *ESR? (Event Status Register) query returns the contents of the Standard Event Status Register (SESR). *ESR? also clears the SESR (since reading the SESR clears it). For a complete discussion of the use of these registers, see page 3–35.

Related Commands ALLev?, *CLS, DESE, *ESE, EVENT?, EVMSG?, EVQTy?, *SRE, *STB

Syntax `*ESR?`

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Examples *ESR?

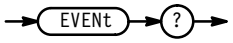
Might return the value 213, showing that the SESR contains binary 11010101.

EVENt? (Query Only)

The EVENt? query returns from the Event Queue an event code that provides information about the results of the last *ESR? read. EVENT? also removes the returned value from the Event Queue. Note that the ALLev? command removes all pending events from the event queue and places them in the output queue. A complete discussion of event handling is on page 3–35.

Related Commands ALLev?, *CLS, DESE, *ESE, *ESR?, EVMSG?, EVQty?, *SRE, *STB

Syntax EVENt?



Examples EVENt?

Might return the response :EVENT 110, showing that there was an error in a command header.

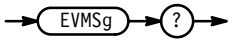
EVMSg? (Query Only)

The EVMSg? query removes from the Event Queue a single event code associated with the results of the last *ESR? read and returns the event code along with an explanatory message. A complete discussion of event handling is on page 3–35.

Related Commands *CLS, DESE, *ESE, *ESR?, EVENT?, *SRE, *STB

Syntax EVMSg?

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Examples `EVMS?`

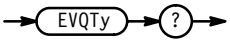
Might return the message:
`:EVMSG 110,"Command header error".`

EVQTy? (Query Only)

The EVQTy? query returns returns the number of events associated with the last Standard Event Status Register read and thus the length of a subsequent response to an ALLev? query. The maximum number of event queue items is 32.

Related Commands *CLS, DESE, *ESE, *ESR?, EVMSG?, *SRE, *STB

Syntax `EVQTy?`



Examples `EVQT?`

Might return the response `:EVQTY 4`, showing that there are four events in the event queue.

FACTory (No Query Form)

The FACTory command resets the VXOA41 to its factory default settings and purges stored settings.

***NOTE**. The FACTory command can take 5 to 10 seconds to complete depending on attenuation settings.*

Related Commands DESE, *ESE, HEADER, *PSC, *RST, *SRE, VERBOSE

Syntax `FACTory`



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The FACTory command does the following:

- Puts the VXOA41 in the Operation Complete Command Idle State.
- Puts the VXOA41 in the Operation Complete Query Idle State.
- Clears the Event Status Enable Register (equivalent to the command `*ESE 0`).
- Clears the Service Request Enable Register (equivalent to the command `*SRE 0`).
- Sets the Device Event Status Enable Register to all-enabled (equivalent to the command `DESE 255`).
- Sets the Power-on status clear flag to TRUE (equivalent to the command `*PSC 1`).
- Sets the Response Header Enable State to TRUE (equivalent to the command `HEADER 1`).
- Sets the Verbose Header State to TRUE (equivalent to the command `VERBOSE 1`).
- Sets the certain parameters as shown in Table 3–8.

Table 3–8: FACTory Default Settings

Parameter	Setting
ATT:DB	0
REF	0
STORE1	0
STORE2	0
DISABLE	OFF
WAVELENGTH	1300

The FACTory command does not alter the following items:

- The state of the VXI interface.
- The selected VXI address.
- Calibration data that affects device specifications.

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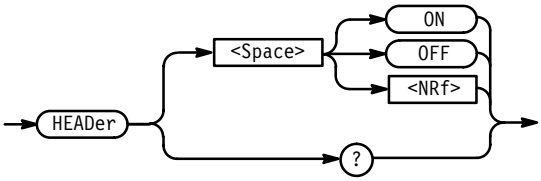
HEADer

The HEADer command sets and queries the Response Header Enable State that causes the VXOA41 to either include or omit headers on query responses. This command does not affect IEEE Std 488.2 Common Commands (those starting with an asterisk) or the *LRN? response.

Related Commands VERBOSE

Syntax

```
HEADer { ON | OFF | <NRf> }
HEADer?
```



Arguments

ON or <NRf> ≠ 0 sets the Response Header Enable State to TRUE. This causes the VXOA41 to include headers on applicable query responses. You can then use the query response as a command.

OFF or <NRf> = 0 sets the Response Header Enable State to FALSE. This causes the VXOA41 to omit headers on query responses, so that only the argument is returned.

Examples

```
HEADER OFF
```
Causes the VXOA41 to omit headers from query responses.

```
HEADER 1
```
Causes the VXOA41 to include headers on applicable query responses.

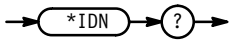
```
HEADER?
```
Might return the value 1, showing that the Response Header Enable State is TRUE.

*IDN? (Query Only)

The *IDN? (Identification) query returns the VXOA41's unique identification code.

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Syntax *IDN?



The query response is an ASCII string separated into four fields by commas:

TEKTRONIX,VXOA41,<serial number>,CF:91.1CN RM:<firmware version number>

Examples *IDN?

Might return the response:

TEKTRONIX,VXOA41,B010101,CF:91.1CN RM:1.5

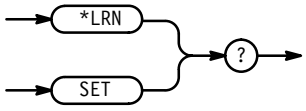
*LRN? or SET?

The *LRN? (Learn Device Setup) or SET? query returns a string listing the VXOA41's settings, except for calibration values. You can use this string to return the VXOA41 to the state it was in when you made the *LRN? query.

Related Commands HEADER, VERBOSE

Syntax *LRN?

SET?



NOTE. *The *LRN? query always returns a string with command headers, regardless of the setting of the HEADER command. This is because the returned string is intended to be able to be sent back to the VXOA41 as a command string. The VERBOSE command can still be used to specify whether the returned headers should be abbreviated or full length.*

Examples *LRN?

Might return the string:

:REFERENCE 0.00;:WAVELENGTH 1300;:ATTENUATION:DB 0.00;:DISPLAY DB;:DISABLE 0;:STORE1 0.00;:STORE2 0.00

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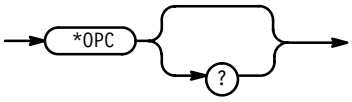
*OPC

The *OPC (Operation Complete) command generates the operation complete message in the Standard Event Status Register (SESR) when all pending operations finish. The *OPC? query places the ASCII character “1” into the Output Queue when all pending operations are finished. The *OPC? response is not available to read until all pending operations finish. For a complete discussion of the use of these registers and the output queue, see page 3–35.

Related Commands *WAI, ADJusting?

Syntax `*OPC`

`*OPC?`



*OPT? (Query Only)

The *OPT (Option Identification Query) command returns a string that identifies what options are installed in the VXOA41.

Related Commands N/A

Syntax `*OPT?`



Returns The command returns a single “0” if the VXOA41 is in standard configuration (no options, single-mode fiber). If options are installed, the command returns a string of three fields, with each field separated by a comma. Each of the fields represents one of the possible options. Since the options are mutually exclusive, two of the fields will always be “0”. One of the fields, which one depends on what option is installed, will indicate the installed option with the syntax: “`OPTION { 1 | 2 | 3 }: <fiber core size in microns> um multimode fiber`”

Examples `*OPT?`

Might return the string:

```
0,0,OPTION 3: 100um multimode fiber
```


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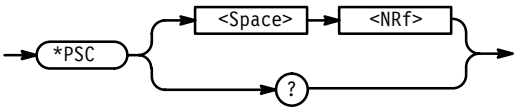
*PSC

The *PSC (Power-On Status Clear) command sets and queries the power-on status flag that controls the automatic power-on handling of the DESER, SRER, and ESER registers. When PSC is TRUE, the DESER register is set to 255 and the SRER and ESER registers are set to 0 at power-on. When PSC is FALSE, the current values in the DESER, SRER, and ESER registers are preserved in non-volatile memory when power is shut off and restored at power-on. For a complete discussion of the use of these registers, see page 3–35.

Related Commands DESE, *ESE, *RST, *SRE

Syntax

```
*PSC <NRf>
*PSC?
```



Arguments <NRf> is a value in the range from –32767 to 32767.

<NRf> = 0 sets the power-on status clear flag to FALSE, disables the power-on clear and allows the VXOA41 to assert SRQ after power-on.

<NRf> ≠ 0 sets the power-on status clear flag TRUE. Sending *PSC 1 therefore enables the power-on clear and prevents any SRQ assertion after power-on. Using an out-of-range value causes an execution error.

Examples

*PSC 0
Sets the power-on status clear flag to FALSE.

*PSC?
Might return the value 1, showing that the power-on status clear flag is set to TRUE.

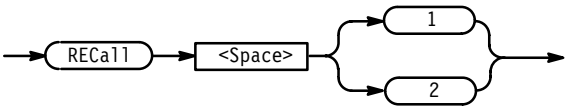
RECall (No Query Form)

The RECall command sets the attenuation of the instrument to either stored value 1 or 2.

Related Commands STORe

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Syntax `RECall { 1 | 2 }`



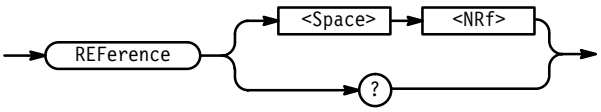
REFerence

This command reads and sets the reference used when returning the attenuation in the ATT–REF mode. The units for command mode and responses is dB. Values smaller than 0.01 dB are rounded to the nearest one-hundredth dB. The REF value may not exceed ±99.99. The combination of the REF value and the ATTen value may not exceed ±99.99. For example, if the ATTen value is set to 30 dB and the REF value is set to –70 dB, the resultant ATT–REF value would be 100 dB, and an execution error event would result. The factory default for REF is 0.00 (dB).

Related Commands N/A

Syntax `REFerence <NRf>`

`REFerence?`



Arguments `<NRf>` is a number that cannot exceed ±99.99.

Examples `REF 45.00`

Sets the REFerence value to 45.00 dB.

`REF?`

Would return the string:
:REF 45.00

*RST (No Query Form)

The *RST (Reset) command returns the VXOA41 to a known set of instrument settings.

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NOTE. *The *RST command can take 5 to 10 seconds to complete depending on attenuation settings.*

Related Commands *PSC, FACTory

Syntax *RST



*RST does the following:

- Puts the VXOA41 into the Operation Complete Command Idle State.
- Puts the VXOA41 into the Operation Complete Query Idle State.
- Returns the instrument settings to those listed on page 3–23.

The *RST command does not alter the following:

- The state of the IEEE Std 488.2 interface.
- The selected IEEE Std 488.2 address of the VXOA41.
- Calibration data that affects device specifications.
- The Output Queue.
- The Standard Status Register Enable setting.
- The Standard Event Status Enable setting.
- The Power-on status clear flag setting.
- HEADer and VERBose settings.

*SRE

The *SRE (Service Request Enable) command sets and queries the bits in the Service Request Enable Register (SRER). For a complete discussion of the use of these registers, see page 3–35.

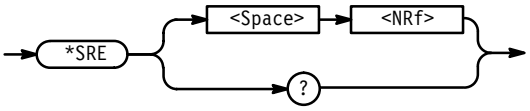
Related Commands ALLev?, *CLS, DESE, *ESE, *ESR, EVENT?, EVMSG?, EVQty?, *PSC, *STB

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Returns

*SRE <NRf>

*SRE?



Arguments

<NRf> is a value in the range from 0 to 255. The binary bits of the SRER are set according to this value. Using an out-of-range value causes an execution error.

The power-on default for SRER is 0 if *PSC is 1. If *PSC is 0, the SRER maintains its value through a power cycle.

Examples

*SRE 48

Sets the bits in the SRER to 00110000 binary.

*SRE?

Might return a value of 32, showing that the bits in the SRER have the binary value 00100000.

*STB? (Query Only)

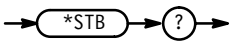
The *STB? (Read Status Byte) query returns the Status Byte Register (SBR) using the Master Summary Status (MSS) bit. For a complete discussion of the use of these registers, see page 3–35.

Related Commands

ALLev?, *CLS, DESE, *ESE, *ESR, EVENT?, EVMSG?, EVQty?, *SRE

Syntax

*STB?



Examples

*STB?

Might return the value 96, showing that the STB contains the binary value 01100000.

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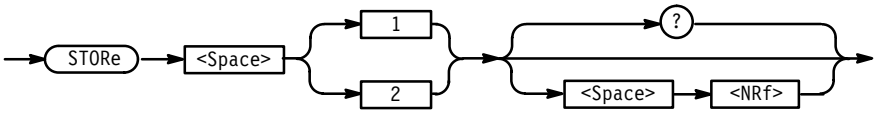
STORe

The STORe command, Store Attenuation, sets or reads the value of stored positions 1 or 2. Using the command form (for example, STOR1) without a value specified stores the current attenuation in the specified location.

Related Commands RECall

Syntax

```
STORe { 1 | 2 }?
STORe { 1 | 2 }
STORe { 1 | 2 } <NRf>
```



Arguments <NRf> specifies the attenuation value to be stored. The range for the attenuation value is 0 ≤ <NRf> ≤ 60.00. All attenuation values associated with the STORe command and query forms are in absolute dB and never include the REFERENCE value, even if the front panel display shows that the VXOA41 is set to ATT-REF mode.

Examples

`STORE1?`
Returns the attenuation value stored in register 1, in the form:
`:STORE1 <NRf>`

`STORE1 20.00`
Sets the attenuation value in stored register 1 to 20.00 dB.

`STORE2`
Stores the current attenuation value in stored register 2.

*TST? (Query Only)

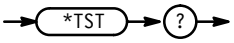
The *TST? (Self-Test) query runs the VXOA41 internal self-test and reports the results. The self-test does not require operator interaction and does not create bus conditions that violate IEEE Std 488.1/488.2 standards. When complete, the VXOA41 returns to the state it was in just prior to the self-test. The test response is a value <NR1> as described in Table 3–9.

Related Commands N/A

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NOTE. *If an error is detected, *TST? stops and returns an error code and does not complete any remaining tests. It also places a device dependent event in the event queue.*

Syntax *TST?



NOTE. *The *TST? query can take 5 seconds or more to respond.*

Table 3–9: Results from *TST?

<NR1>	Meaning
0	Test completed with no errors detected
101, 102	ROM checksum error
104	Non-volatile RAM is bad
115	System timer is bad
401	Calibration EEPROM is bad
410, 411	Calibration needed

Examples *TST?

Might return the value 115, indicating that the system timer is not working correctly.

VERBOSE

The VERBOSE command sets and queries the Verbose Header State that controls the length of headers on query responses. This command does not affect IEEE Std 488.2 Common Commands (those starting with an asterisk).

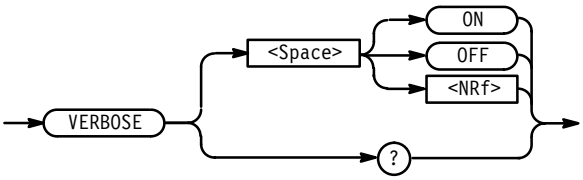
Related Commands HEADER, *LRN?

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Syntax

```
VERBOSE { ON | OFF | <NRf> }

VERBOSE?
```



Arguments

ON or <NRf> ≠ 0 sets the Verbose Header State TRUE, which returns full-length headers for applicable setting queries.

OFF or <NRf> = 0 sets the Verbose Header State FALSE, which returns minimum-length headers for applicable setting queries.

Examples

VERBOSE ON
Sets the Verbose Header State TRUE.

VERBOSE?
Might return the value 1, showing that the Verbose Header State is TRUE.

*WAI (No Query Form)

The *WAI (Wait) command prevents the VXOA41 from executing further commands or queries until all pending operations finish.

Related Commands

*OPC, ADJusting?

Syntax

```
*WAI
```



WAVelength

This commands set or queries the wavelength used by the instrument when determining the equivalent attenuator positioning for a given attenuation.

Related Commands

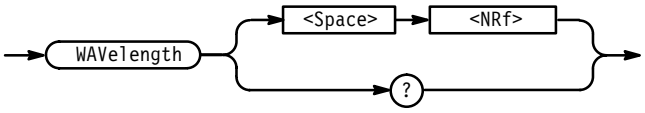
N/A

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Syntax

```
WAVelength <NRf>

WAVelength?
```



Arguments

The valid range for the wavelength argument is 600 nm to 1700 nm. Default units are always in nanometers with N (for nano or 1E–09) and U (for micro or 1E–06) accepted as multipliers; M (for meters) is also an acceptable term (see examples below).

Examples

`WAV?`

Returns the value of wavelength to which the VXOA41 is set. An example response is:
`:WAVELENGTH 1300`

`WAV 1300`

Sets the wavelength to 1300 nm.

`WAV 1300NM`

Sets the wavelength to 1300 nm.

`WAV 1.3UM`

Sets the wavelength to 1300 nm.

`WAV 1300.0E-09M`

Sets the wavelength to 1300 nm.

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Status and Events

The VXOA41 provides a status and event reporting system for the programming interface. This system informs you of certain significant events that occur within the VXOA41.

The VXOA41 status handling system consists of five 8-bit registers and two queues. This section describes these registers and components and explains how the event handling system operates.

Registers

The registers in the event handling system fall into two functional groups:

- The Standard Event Status Register (SESR) and the Status Byte Register (SBR) contain information about the status of the VXOA41. These registers are therefore called the Status Registers.
- The Device Event Status Enable Register (DESER), the Event Status Enable Register (ESER), and the Service Request Enable Register (SRER) determine whether selected types of events are reported to the Status Registers and the Event Queue. These three registers are called the Enable Registers.

Status Registers

The Standard Event Status Register (SESR) and the Status Byte Register (SBR) record certain types of events that may occur while the VXOA41 is in use. These registers are defined by IEEE Std 488.2. Refer also to Figure 3-4 and Table 3–10.

Each bit in a Status Register records a particular type of event, such as an execution error or service request. When an event of a given type occurs, the bit that represents that type of event is set to a value of one. (You can disable bits so that they ignore events and remain at zero; see the Enable Registers section on page 3–37.) Reading the status registers tells you what types of events have occurred.

The Standard Event Status Register (SESR). The SESR, shown in Figure 3-4, records eight types of events that can occur within the VXOA41. Use the *ESR? query to read the SESR register. Reading the register clears the bits of the register so that the register can accumulate information about new events.

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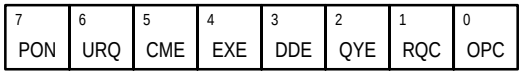


Figure 3-4: The Standard Event Status Register (SESR)

Table 3–10: SESR Bit Functions

Bit	Function
7 (MSB)	**PON** (Power On). Shows that the VXOA41 was powered on.
6	**URQ** (User Request). Not used.
5	**CME** (Command Error). Shows that an error occurred while the VXOA41 was parsing a command or query. Table 3–13, on page 3–41, lists Command error messages.
4	**EXE** (Execution Error). Shows that an error occurred while the VXOA41 was executing a command or query. Table 3–14, on page 3–42, lists Execution error messages.
3	**DDE** (Device Error). Shows that a device error occurred. Table 3–15, on page 3–43, lists Device error messages.
2	**QYE** (Query Error). Shows that either an attempt was made to read the Output Queue when no data was present or pending, or that data in the Output Queue was lost.
1	**RQC** (Request Control). Not used.
0 (LSB)	**OPC** (Operation Complete). Shows that the operation is complete. The *OPC command sets this bit.

The Status Byte Register (SBR). The SBR, shown in Figure 3-5, records whether output is available in the Output Queue, whether the VXOA41 requests service, and whether the SESR has recorded any events.

Use a “Read STB“ word serial command or the *STB? query to read the contents of the SBR. Refer to Table 3–11. The bits in the SBR are set and cleared depending on the contents of the SESR, the Event Status Enable Register (ESER), and the Output Queue. (When you use the Read STB word serial command to obtain the SBR, bit 6 is the RQS bit. When you use the *STB? query to obtain the SBR, bit 6 is the MSS bit.)

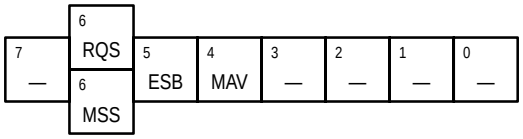


Figure 3-5: The Status Byte Register (SBR)

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Table 3–11: SBR Bit Functions

Bit	Function
7 (MSB)	Not used (always 0).
6*	**RQS** (Request Service), obtained from a “Read STB” word serial command. Shows that the VXOA41 requests service from the controller.
6	**MSS** (Master Status Summary), obtained from *STB? query. Summarizes the ESB and MAV bits in the SBR.
5	**ESB** (Event Status Bit). Shows that status is enabled and present in the SESR.
4	**MAV** (Message Available). Shows that output is available in the Output Queue.
3–0	Not used (always 0).

*** When the user has enabled a VME interrupt for the VXOA41, this bit is the indicator of whether the VME interrupt has been asserted.**

Enable Registers

The DESER, ESER, and SRER allow you to select which events are reported to the Status Registers and the Event Queue. Each Enable Register acts as a filter to a Status Register (the DESER also acts as a filter to the Event Queue) and can prevent information from being recorded in the register or queue.

Each bit in an Enable Register corresponds to a bit in the Status Register it controls. In order for an event to be reported to its bit in the Status Register, the corresponding bit in the Enable Register must be set to 1. If the bit in the Enable Register is set to 0, the event is not recorded.

The next section describes the Enable Registers and the commands used to set them.

The Device Event Status Enable Register (DESER). Figure 3-6 shows the DESER. This DESER controls which types of events are reported to the SESR and the Event Queue. The bits in the DESER correspond to those in the SESR, as described earlier.

Use the DESE command to enable and disable the bits in the DESER. Use the DESE? query to read the DESER.

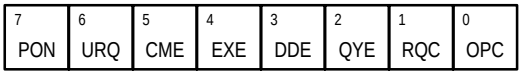


Figure 3-6: The Device Event Status Enable Register (DESER)

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The Event Status Enable Register (ESER). Figure 3-7 shows the ESER. The ESER controls which types of events are summarized by the Event Status Bit (ESB) in the SBR.

Use the *ESE command to set the bits in the ESER, and use the *ESE? query to read it.

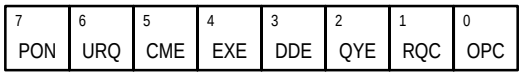


Figure 3-7: The Event Status Enable Register (ESER)

The Service Request Enable Register (SRER). Figure 3-8 shows the SRER. The SRER controls which bits in the SBR generate a Service Request and are summarized by the Master Status Summary (MSS) bit.

Use the *SRE command to set the SRER. Use the SRE? query to read it. The RQS bit remains set to one until either the Status Byte Register is read with a Read STB word serial command or the MSS bit changes back to a zero.

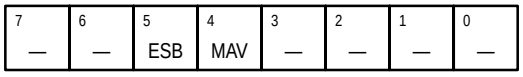


Figure 3-8: The Service Request Enable Register (SRER)

The Enable Registers and the *PSC Command

The *PSC command controls the contents of the Enable Registers at power-on. Sending *PSC 1 sets the Enable Registers at power on as follows:

- DESER 255 (equivalent to a DESe 255 command)
- ESER 0 (equivalent to an *ESE 0 command)
- SRER 0 (equivalent to an *SRE command)

Sending *PSC 0 lets the Enable Registers maintain their values in nonvolatile memory through a power cycle.

***NOTE**. To enable the PON (Power On) event to generate a Service Request, send *PSC 0, use the DESe and *ESE commands to enable PON in the DESER and ESER, and use the *SRE command to enable bit 5 in the SRER. Subsequent power-on cycles will generate a Service Request.*

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Queues

The VXOA41 status and event reporting system contains two queues: the Output Queue and the Event Queue.

The Output Queue

The Output Queue stores up to 8000 bytes of a query response while it is waiting to be output. The Output Queue is emptied each time a new command or query message is received. Because of this, all query responses must be read before the next command or query is sent, otherwise responses to earlier queries will be lost and an error may result.

The Event Queue

The Event Queue stores detailed information on up to 32 events. If more than 32 events fill the Event Queue, the thirty-second event is replaced by event code 350, “Too many events.”

To read the Event Queue, use either the EVENT? query (which returns only the event number) or the EVMSG? query (which returns the event number and a text description of the event). Reading an event removes it from the queue.

Before reading an event from the Event Queue, you must use the *ESR? query to read the summary of that event from the SESR. Sending an *ESR? query makes the events summarized by the *ESR? read available to the EVENT? and EVMSG? queries, and empties the SESR.

Reading the SESR erases any events that were summarized by a previous *ESR? read but not read from the Event Queue. Events that follow an *ESR? read are put in the Event Queue but are not available until *ESR? is used again.

Event Handling Sequence

Figure 3-9, on page 3–40, shows how to use the status and event handling system. In the explanation that follows, numbers in parentheses refer to numbers in Figure 3-9.

When an event occurs, a signal is sent to the DESER (1). If that type of event is enabled in the DESER (that is, if the bit for that event type is set to 1), the appropriate bit in the SESR is set to one and the event is recorded in the Event Queue (2). If the corresponding bit in the ESER is also enabled (3), then the ESB bit in the SBR is set to one (4).

When output is sent to the Output Queue, the MAV bit in the SBR is set to one (5).

When a bit in the SBR is set to one and the corresponding bit in the SRER is enabled (6), the MSS bit in the SBR is set to one and a service request is generated (7).

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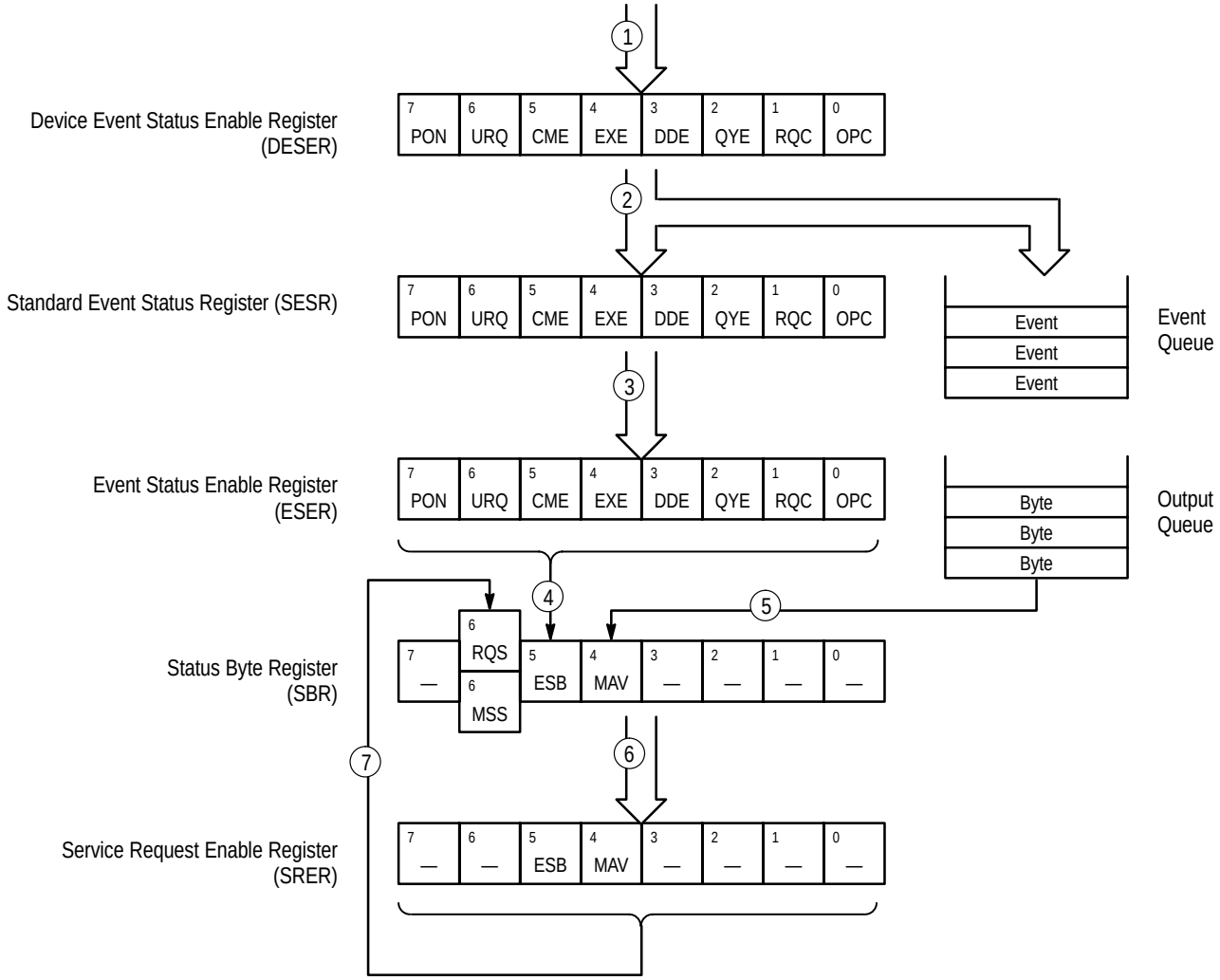


Figure 3-9: Status and Event Handling Process

Conflicts

Whenever a command is issued that results in a conflict, an event is generated on the EXE bit (bit 4).

To avoid generating this event, concatenate commands so that the conflict is resolved when the command is completed. For example, when setting the attenuator in DBR mode, always make sure that the REF command precedes the ATT:DBR command,otherwise an execution warning will result.

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Messages

Tables 3–12 through 3–17 list all the programming interface messages the VXOA41 generates in response to commands and queries.

For most messages, a secondary message from the VXOA41 gives more detail about the cause of the error or the meaning of the message. This message is part of the message string and is separated from the main message by a semicolon.

Each message is the result of an event. Each type of event sets a specific bit in the SESR and is controlled by the equivalent bit in the DESER. Thus, each message is associated with a specific SESR bit. In the message tables that follow, the associated SESR bit is specified in the table title, with exceptions noted with the error message text.

Table 3–12 lists the messages returned when the system has no events or status to report. These have no associated SESR bit.

Table 3–12: No Event Messages

Code	Message
0	No events to report – queue empty
1	No events to report – new events pending *ESR?

Table 3–13 lists the error messages generated by improper command syntax. Check that the command is properly formed and that it follows the rules in the Command Syntax chapter starting on page 3–1.

Table 3–13: Command Error Messages — CME Bit 5

Code	Message
100	Command error
101	Invalid character
102	Syntax error
103	Invalid message or unit separator
104	Data type error
105	GET not allowed
106	Invalid program data separator
108	Parameter not allowed
109	Missing parameter
110	Command header error
111	Header separator error

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Table 3–13: Command Error Messages — CME Bit 5 (Cont.)

Code	Message
112	Program mnemonic too long
113	Undefined header
118	Query not allowed
120	Numeric data error
121	Invalid character in number
123	Numeric overflow
124	Too many digits
128	Numeric data not allowed
130	Suffix error
131	Invalid suffix
134	Suffix too long
138	Suffix not allowed
140	Character data error
141	Invalid character data
144	Character data too long
148	Character data not allowed
150	String data error
151	Invalid string data
158	String data not allowed
160	Block data error
161	Invalid block data
168	Block data not allowed

Table 3–14 lists the execution errors that are detected during execution of a command.

Table 3–14: Execution Error Messages — EXE Bit 4

Code	Message
200	Execution error
220	Parameter Error
221	Settings in conflict

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Table 3–14: Execution Error Messages — EXE Bit 4 (Cont.)

Code	Message
222	Data out of range
223	Too much data

Table 3–15 lists the device errors that can occur during operation of the VXOA41. These errors may indicate that the VXOA41 needs repair.

Table 3–15: Device Error Messages — DDE Bit 3

Code	Message
300	Internal error
310	System error
313	Calibration memory lost
315	Configuration memory lost
350	Too many events (does not set DDE bit)

Table 3–16 lists the system event messages. These messages are generated whenever certain system conditions occur.

Table 3–16: System Event Messages — QYE Bit 2

Code	Message
401	Power on – PON Bit 7
402	Operation complete – OPC Bit 0
403	User request – URQ Bit 6
410	Query interrupted
420	Query unterminated
430	Query deadlocked
440	Query unterminated after indefinite response

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Table 3–17 lists warning messages that do not interrupt the flow of command execution. These notify you that you might get unexpected results.

Table 3–17: Execution Warning Messages — EXE Bit 4

Code	Message
500	Execution warning

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Appendices

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Appendix A: Accessories and Options

The following paragraphs describe the standard and optional accessories for the VXOA41 Optical Attenuator. To purchase optional accessories, or purchase additional standard accessories, see a Tektronix products catalog or contact your local Tektronix field representative.

Standard Accessories

- The *VXOA41 Optical Attenuator User Manual* (Tektronix part number 070-8777-00) is this manual.

Optional Accessories

The optional accessories appropriate for your instrument depend on which option was installed on your VXOA41 at the time of purchase.

Optical Cables, Single Mode, 2 meter, 8/125 micron

- FC/PC to Diamond 2.5, Tektronix part number 174-1497-00.
- FC/PC to Diamond 3.5, Tektronix part number 174-1385-00.
- FC/PC to ST, Tektronix part number 174-1386-00.
- FC/PC to FC/PC, Tektronix part number 174-1387-00.
- FC/PC to Biconic, Tektronix part number 174-1388-00.

Optical Cables, Multimode, 2 meter, 62.5/140 micron

- FC/PC to Biconic, Tektronix part number 174-2323-00.
- FC/PC to SMA906, Tektronix part number 174-2324-00.
- FC/PC to FC/PC, Tektronix part number 174-2322-00.

Optical Cables, Multimode, 2 meter, 100/140 micron

***NOTE**. At the time of publication, the 100 µm cables listed below do not utilize physical contact connectors.*

- FC to SMA, Tektronix part number 174-0878-00.
- ST to SMA, Tektronix part number 174-0876-00.

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- Diamond 2.5 to SMA, Tektronix part number 174-1303-00.

Optical Connector Kit

- Universal optical input and output connector kit, Tektronix part number 020-1885-00.

NOTE. *Each connector kit contains only one connector. To change both optical connectors on the VXOA41 you must purchase two kits.*

Options

The following options are available for the VXOA41.

Option 1: 50 Micron Multimode Fiber

Option 1 changes the optical input and output ports to accept 50 µm multimode fiber, utilizing FC-PC connections.

Option 2: 62.5 Micron Multimode Fiber

Option 2 changes the optical input and output ports to accept 62.5 µm multimode fiber, utilizing FC-PC connections.

Option 3: 100 Micron Multimode Fiber

Option 3 changes the optical input and output ports to accept 100 µm multimode fiber, utilizing FC-PC connections.

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Appendix B: Specifications

The performance characteristics described in this appendix (Tables B–1 through B–3) are valid under the following conditions:

- The instrument must have been calibrated at an ambient temperature between +20° C and +30° C.
- The instrument must have had a warm-up period of at least 20 minutes.
- All optical connections to the instrument are made using physical contact connectors. Tektronix offers a limited selection of fiber optic jumper cables which utilize physical contact on the connector ends (for example, Tektronix part number 174-1387-00; see Appendix A).
- Both input and output connectors have been cleaned as described on page F–1.

Table B–1: Optical Characteristics

Characteristics	Specification
Wavelength Range	600 nm – 1700 nm
Input	
Standard	Singlemode Fiber
Option 1	50 µm Multimode Fiber
Option 2	62.5 µm Multimode Fiber
Option 3	100 µm Multimode Fiber
Insertion Loss	
1100 – 1700 nm	≤ 2.0 dB
700 – 1100 nm	≤ 4.0 dB
Return Loss	≤ 45 dB
Option 1	≤ 25 dB
Option 2	≤ 25 dB
Option 3	≤ 25 dB
Attenuation Range	
600 – 1350 nm	≥ 60 dB (calibrated, 0.01 dB step size)
1350 – 1600 nm	≥ 50 dB (calibrated, 0.01 dB step size)

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Table B–1: Optical Characteristics (Cont.)

Characteristics	Specification
Maximum Attenuation	≥ 100 dB (shutter activated)
Option 1	≥ 100 dB (shutter activated)
Option 2	≥ 100 dB (shutter activated)
Option 3	≥ 90 dB (shutter activated)
Repeatability	± 0.05 dB
Linearity	± 0.05 dB
Accuracy	
850 ± 20 nm	≤ 0.15 dB (typically ≤ 0.05 dB)
1300 ± 20 nm	≤ 0.15 dB (typically ≤ 0.05 dB)
1500 ± 20 nm	≤ 0.15 dB (typically ≤ 0.05 dB)

Table B–2: Physical Characteristics

Characteristics	Specification
Net Weight	2.4 kg (5.25 lb)
External Dimensions	
Height	60.66 mm (2.39 in)
Width	366.70 mm (14.38 in)
Length	345.03 mm (13.58 in)

Table B–3: Environmental Performance

Characteristic	Specification
Temperature	
Operating	0° C to +50° C (32° F to 122° F)
Nonoperating (storage)	–40° C to +70° C (–40° F to 160° F) (Meets MIL-T-28800D, class 5)
Humidity	
Operating and Nonoperating	95% RH: 11° C to 30° C (52° F to 86° F) 75% RH: 11° C to 40° C (52° F to 104° F) 45% RH: 11° C to 50° C (52° F to 122° F) (Exceeds MIL-T-28800D, Class 5, noncondensing)

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Table B–3: Environmental Performance (Cont.)

Characteristic	Specification
Vibration	0.38 mm (0.015 in) p-p, 5 Hz to 55 Hz, 75 minutes. Meets MIL-T-28800D, Class 5, when installed in qualified power modules.
Shock	30 g's, (1/2 sine), 11 ms duration, 3 shocks in each direction along 3 major axes, 18 total shocks. Meets MIL-T-28800D, Class 5, when installed in qualified power modules.
Bench Handling	12 drops from 45°, 4 in or equilibrium, whichever occurs first. Meets MIL-T-28800D, Class 5, when installed in qualified power modules, and IEC 348 (Electronic measuring apparatus).
Packaged Product Vibration and Shock	The packaged product qualifies under the National Safe Transit Association's Preshipment Test Procedures, Project 1A-B-1 and 1A-B-2.

Table B–4: Certifications and compliances

Characteristic	Specification
EC Declaration of Conformity – EMC	Meets intent of Directive 89/336/EEC for Electromagnetic Compatibility. Compliance was demonstrated to the following specifications as listed in the Official Journal of the European Communities:
	EN 50081-1 Emissions: EN 55011 Class A Radiated and Conducted Emissions EN 60555-2 AC Power Line Harmonic Emissions
	EN 50082-1 Immunity: IEC 801-2 Electrostatic Discharge Immunity IEC 801-3 RF Electromagnetic Field Immunity IEC 801-4 Electrical Fast Transient/Burst Immunity IEC 801-5 Power Line Surge Immunity
FCC Compliance	Emissions comply with FCC Code of Federal Regulations 47, Part 15, Subpart B, Class A Limits

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Appendix C: Interface Specifications

Interface Standard

The VXOA41 conforms to the VXIbus Specification Version 1.3 as a message-based I4 device. All instrument commands comply with the IEEE 488.2 standard.

- No commander capability
- No Signal Register
- No VMEbus master capability
- No Fast Handshake
- No Shared Memory
- No Response Generator
- Can generate events
- Has programmable interrupter
- No interrupt handling
- Has Trigger word serial command
- Supports VXIbus 488.2 protocol
- Supports VXIbus instrument protocol
- No extended long word protocol
- No longword protocol

The VXOA41 manufacturer identification number is 4093. The VXOA41 device identification number is 4080. Both of these numbers are printed on the label located on the right-side shield of the VXOA41.

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Character Set (ASCII Chart)

Table C–1 shows the character set used for all messages to and from the VXOA41. This is identical to standard ASCII.

Table C–1: The ASCII Character Set

	0	1	2	3	4	5	6	7
0	NUL 0	DLE 16	space 32	0 48	@ 64	P 80	‘ 96	p 112
1	SOH 1	DC1 17	! 33	1 49	A 65	Q 81	a 97	q 113
2	STX 2	DC2 18	” 34	2 50	B 66	R 82	b 98	r 114
3	ETX 3	DC3 19	# 35	3 51	C 67	S 83	c 99	s 115
4	EOT 4	DC4 20	$ 36	4 52	D 68	T 84	d 100	t 116
5	ENQ 5	NAK 21	% 37	5 53	E 69	U 85	e 101	u 117
6	ACK 6	SYN 22	& 38	6 54	F 70	V 86	f 102	v 118
7	BEL 7	ETB 23	’ 39	7 55	G 71	W 87	g 103	w 119
8	BS 8	CAN 24	(40	8 56	H 72	X 88	h 104	x 120
9	HT 9	EM 25	) 41	9 57	I 73	Y 89	i 105	y 121
A	LF 10	SUB 26	* 42	: 58	J 74	Z 90	j 106	z 122
B	VT 11	ESC 27	+ 43	; 59	K 75	[91	k 107	{ 123
C	FF 12	FS 28	, 44	< 60	L 76	\ 92	l 108	| 124
D	CR 13	GS 29	– 45	= 61	M 77	] 93	m 109	} 125
E	SO 14	RS 30	. 46	> 62	N 78	^ 94	n 110	~ 126
F	SI 15	US 31	/ 47	? 63	O 79	_ 95	o 111	rubout 127

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VXI Word Serial Commands

The VXOA41 recognizes the following VXI word serial commands. These commands are described in the VXIbus Specification Version 1.3. Each word serial command is a 16-bit word that the Slot 0 controller sends to the instrument via its data low register.

Abort Normal Operation Halts any pending or active operations from the bus and goes into the CONFIGURE substate of the PASSED state. While in the CONFIGURE substate, the DIR bit in the response register is 0 and the instrument cannot accept commands via the Byte Available or Byte Request word serial commands. A Begin Normal Operation command is required to put the instrument into the NORMAL OPERATION substate.

Assign Interrupter Line Assigns a VME interrupt line for use. This interrupt line is used the same way as the SRQ line is used in a GPIB system. The instrument can be configured to generate an interrupt on the assigned interrupt line when an event is activated.

Asynchronous Mode Control Enables the generation of events by the instrument. The only valid setting of this command is to enable/disable events that can generate an interrupt. Signals and responses are not supported.

Begin Normal Operation Sent by the resource manager of the system to take the instrument out of the CONFIGURE substate and into the NORMAL OPERATION substate. After receipt of this command, the instrument asserts the DIR bit of its response register and is ready to accept commands via the Byte Available word serial command.

Byte Available Indicates that the commander has put a byte of data into the data register. This command is equivalent to a GPIB controller addressing an instrument to listen and then sending a byte of data to it.

Byte Request The commander is ready to receive a byte of data from the instrument as a result of a previous query.

Clear Causes the instrument to clear the VXIbus of any pending operations. This is analogous to sending DCL or SDC on the GPIB.

Clear Lock Causes the instrument to exit the locked state (sets the Locked* bit of the response register). The equivalent GPIB command is RTL.

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Control Event Enables the generation of events by the instrument. The two event types supported are request true and request false.

End Normal Operation When the instrument finishes any pending operations, it enters the CONFIGURE substate. While in the CONFIGURE substate, the DIR bit in the response register is 0 and the instrument cannot accept commands via the Byte Available or Byte Request word serial commands. A Begin Normal Operation command is required to put the instrument into the NORMAL OPERATION substate.

Read Interrupter Line Returns the currently assigned VME interrupter line.

Read Interrupters Returns the number of interrupters supported. The VXOA41 supports only one interrupter.

Read Protocol Returns the capabilities of the instrument to the Commander. This word always has the value 0xFE23.

Read Protocol Error Reports the most recent word serial protocol error code to the commander.

Read STB Returns the value of the status byte. This command is analogous to a serial poll on the GPIB (refer to the section *Status and Events*).

Set Lock Puts the instrument into the locked state (the Locked* bit of the response register is cleared).

Trigger This command causes the attenuator to change its attenuation setting by the current increment amount, if the increment is nonzero. See ATTenuate:INCRement and ATTenuate:NEXT in the *Commands* section.

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Appendix D: Using the *OPC Query/Command

When you are using the VXOA41 in an automated test environment, it is important that you be aware of the finite times for certain commands to complete. For example, suppose you develop an automated test in which the attenuator is adjusted over the VXI bus via the ATT:DB n command. After each adjustment by the attenuator, you might then take a reading from an optical power meter (such as the Tektronix OCP 5502). In such a sequence, it is important that you not initiate the reading from the optical power meter before the VXOA41 has completed all adjustments and has come to a stable position (that is, the ATT ADJ indicator is no longer illuminated).

Below is an example that illustrates the use of instrument commands and queries utilizing the *OPC? query/command. In this example, queries to other instruments (such as the power meter) are not made until all of the VXOA41's pending operations have completed.

Example: A command is sent to the VXOA41 to change attenuation to 45 dB; the command is immediately followed by an *OPC? query to the same VXOA41.

1. Write to the VXOA41 VXI address: ATT:DB 45.00; *OPC?
2. Read from VXOA41 the VXI address: 1

Depending on the previous attenuation setting of the VXOA41, several seconds may be required before the ATT:DB command is completed and the *OPC? produces a "1" in the VXOA41 output queue. After the *OPC? query is sent to the VXOA41, the programmer should immediately attempt a read instruction from the controller. The programmer's controller should wait until the VXOA41 finishes all adjustments and the *OPC query provides a "1" to be read.

***NOTE**. It is important that you remember to set the time-out of the controller's READ instruction to be greater than the longest time possible for the VXOA41 to make any adjustments (up to five seconds may be required to make large changes to attenuation settings).*

You can also have the OPC bit of the SESR set by using the command form of *OPC instead of the query form. By setting the OPC bit to "1" via an *OPC command, an event will be generated assuming the user has enabled the proper register bits.

- Advanced programmers can develop other methods to accomplish the set-and-wait-until-complete routine utilizing the event queues and status registers provided in the VXOA41.

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Appendix E: Packing for Shipment

If you ship the VXOA41, pack it in the original shipping carton and packing material. If the original packing material is not available, package the instrument as follows:

1. Obtain a corrugated cardboard shipping carton with inside dimensions at least 15 cm (6 in) taller, wider, and deeper than the VXOA41. The shipping carton must be constructed of cardboard with 375 pound test strength.
2. If you are shipping the VXOA41 to a Tektronix field office for repair, attach a tag to the VXOA41 showing the instrument owner and address, the name of the person to contact about the instrument, the instrument type, and the serial number.
3. Wrap the VXOA41 with polyethelene sheeting or equivalent material to protect the finish.
4. Cushion the VXOA41 in the shipping carton by tightly packing dunnage or urethane foam on all sides between the carton and the VXOA41. Allow 7.5 cm (3 in) on all sides, top, and bottom.
5. Seal the shipping carton with shipping tape or an industrial stapler.

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Appendix F: Maintenance

This appendix describes how to perform routine maintenance on the VXOA41 Optical Attenuator. There are no user-serviceable parts in the VXOA41. Should your instrument need service, contact your nearest Tektronix service representative.

The following maintenance procedures are discussed in this chapter.

- Cleaning the Optical Ports
- Changing the Optical Port Connectors

Cleaning the Optical Ports

If the VXOA41 performance appears degraded, the optical fiber and optical port may be dirty. Clean the fiber connector with a clean cloth. To clean an optical port, perform the following steps:

1. Turn the power supply off and then pull the VXOA41 out of the mainframe.
2. Use a Phillips screwdriver to remove the four screws that secure the bulkhead connector to the front panel (see Figure F-1).
3. Gently pull the bulkhead out of the unit and unscrew the fiber connector. Be careful not to pull beyond the fiber slack. If there is insufficient slack or if you accidently push the disconnected fiber back into the instrument, then perform the following three steps:
   a. Remove the screws that secure the side cover and remove the side cover (See Figure F-1).
   b. You will now have access to the optical fiber. Unscrew it from the bulkhead if necessary or push it back through the front panel.
   c. Reinstall the cover when finished.
4. Using a soft, lint-free cloth with a high-quality glass cleaner, clean the tip of the fiber cable.
5. If available, use low-pressure compressed air or canned air to blow any dirt out of the bulkhead connector. If compressed air is not available, then the bulkhead will have to be taken apart and cleaned. Refer to the Changing the Optical Port Connectors procedure, on page F–2, for information about bulkhead disassembly.

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6. After cleaning the bulkhead, reconnect the fiber and install the bulkhead. Be sure to reinstall the dust cover chain.

***NOTE**. To keep cleaning to a minimum, install the dust cover when no fiber is connected to the optical port.*

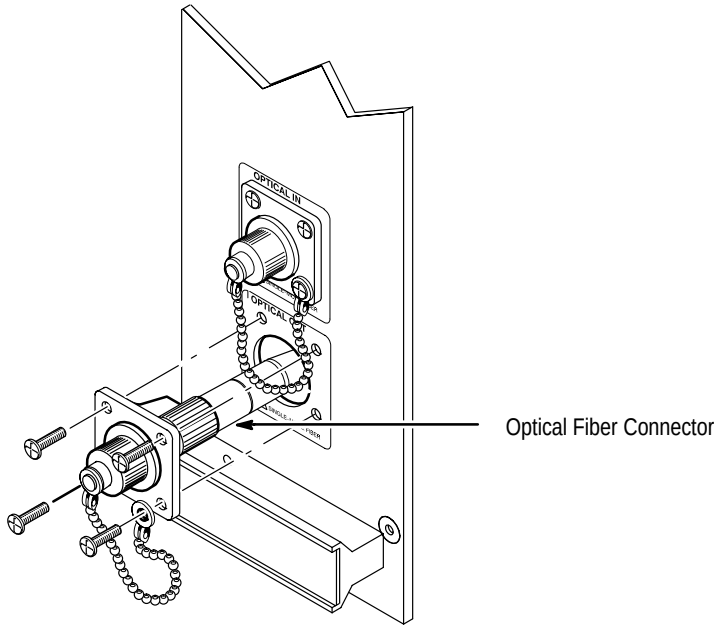


Figure F-1: Removing the Optical Bulkhead Connector

Changing the Optical Port Connectors

The VXOA41 is shipped with the FC connector bulkhead and dust cover installed. If you wish to change to the ST, DIN 47256, or SC connectors perform the following procedure.

1. Turn the power supply off first and then pull the VXOA41 out of the mainframe.

2. Using a Phillips screwdriver, remove the four screws that secure the bulkhead connector to the front panel (see Figure F-1).

3. Gently pull the bulkhead out of the unit and unscrew the fiber connector. Be careful not to pull beyond the fiber slack. If there is insufficient slack or if you accidently push the disconnected fiber back into the instrument, then perform the following three steps:

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a. Using a Phillips screwdriver, remove the screws that secure the side cover and then remove the side cover (See Figure F-1).

b. You will now have access to the optical fiber. Unscrew it from the bulkhead if necessary or push it back through the front panel.

c. Reinstall the side cover when finished.

4. Disassemble the bulkhead as shown in Figures F-2 through F-5.

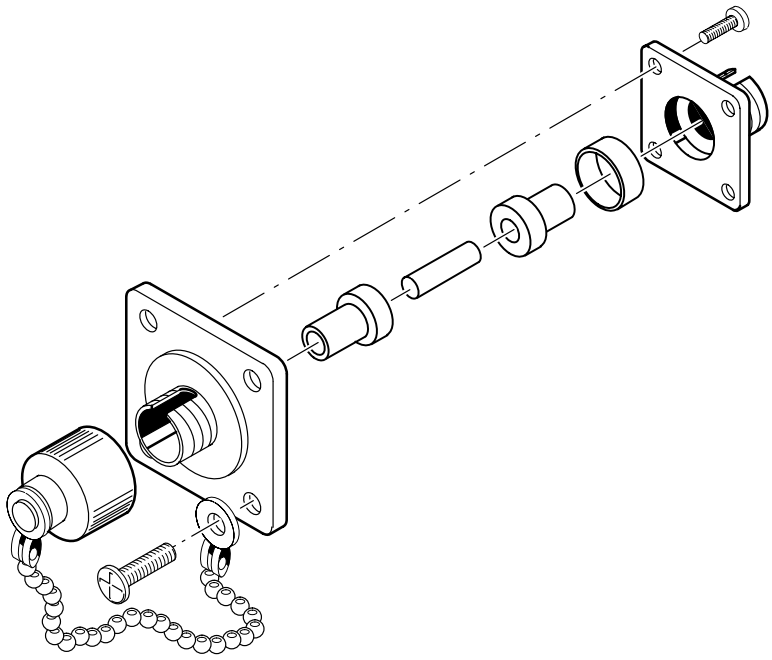


Figure F-2: FC Optical Bulkhead Assembly

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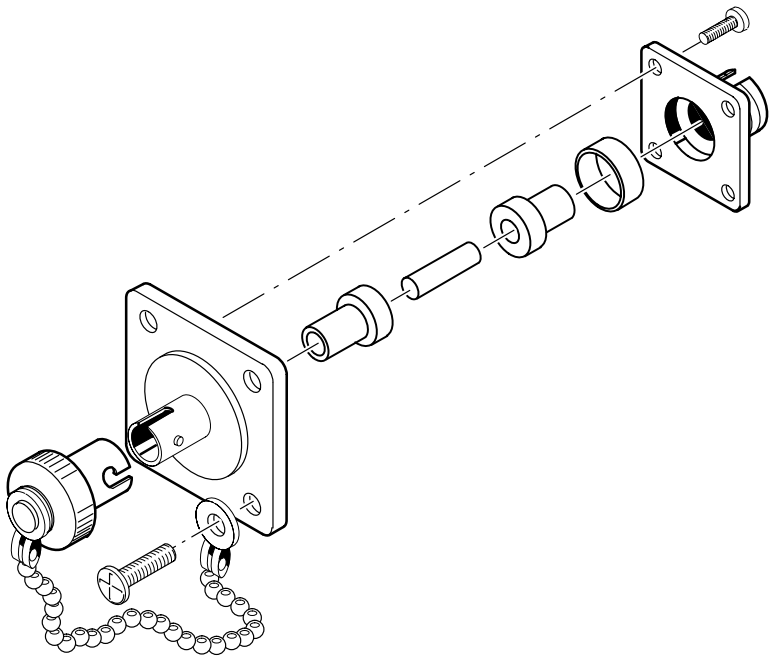


Figure F-3: ST Optical Bulkhead Assembly

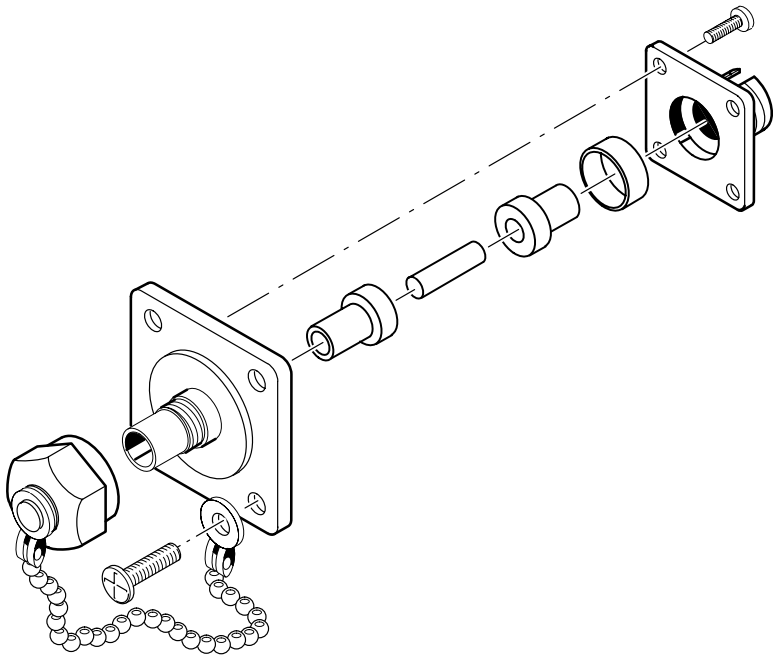


Figure F-4: DIN 47256 Optical Bulkhead Assembly

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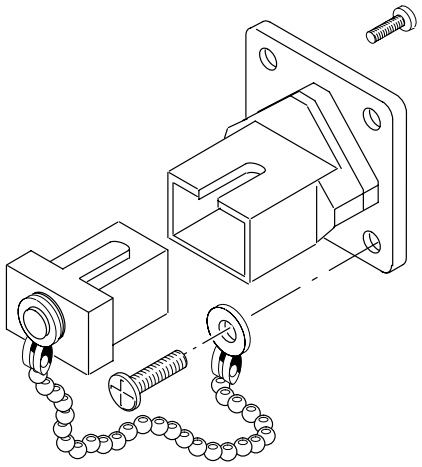


Figure F-5: SC Optical Bulkhead Assembly

5. Replace the current bulkhead with the one you wish to use and re-assemble.
6. Installation is the reverse of steps 1 through 3.

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Appendix G: Performance Verification

Equipment List

- Tektronix VX1400 or VX1405 Mainframe or any VXI C-size or D-size mainframe with a minimum cooling capacity of 1.5 liters/sec (at 0.04 mm H_2O); see the *Installation* section of the Getting Started chapter in this manual.
- A VXI slot-0 controller and/or Resource Manager (for example, a Tektronix VX4521 Resource Manager or a Radisys EPC-2 controller).
- A software utility to send and receive VXI, message-based commands and queries to a VXI device: if using an EPC-2 controller this can be the BusProbe utility; if using the VX4521 then this can be any GPIB talker-listener utility on a controller with a GPIB card (for example, an IBIC DOS or Windows utility).

NOTE. *Throughout this procedure the terms "**send the command...**" , "**send the query...**", and "**...the query response...**" refer to using this utility to send and receive the IEEE 488.2 message-based command/queries to the VXOA41. The actual text in this procedure that is sent to or received from the VXOA41 appears in a different typeface, for example,* `HEADER`.

- Averaging Optical Power Meter with the following requirements:
  - ±0.01 dB resolution
  - ±0.005 dB stability
  - 65 dBm sensitivity
  - Relative dB level to arbitrary reference capability
  - Sensitive (>60 dB range) at 850 nm, 1300 nm and 1550 nm
  - A Tektronix OCP5502 or OCP5002 can be used for the VXOA41 standard, option 1, or option 2 although the Shutter Attenuation test will only be able to be verified to –70 dB (the OCP's sensitivity limits the 100 dB attenuation measurement). An OCP can not be used for testing the VXOA41 option 3 due to the OCP's 62.5 µm fiber input and the VXOA41 option 3's 100 µm fiber size.

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- A Stable Optical Source with the following requirements:
  - Greater than 0.01 dB stability over 1 minute
  - Output greater than 1 mW of optical power into the fiber type of the VXOA41
  - Wavelength of 1300 ±120 nm or 1550 ±120 nm for testing VXOA41 standard module
  - Wavelength of 850 ±20 nm or 1300 ±20 nm or 1550 ±120 nm for testing VXOA41 option 1, option 2, or option 3
- Fiber optic jumper cables, which vary depending on the specific VXOA41 in use:
  - For a standard VXOA41: two 9 µm core singlemode jumpers
  - For a VXOA41 option 1: One 50 µm core multimode fiber from source to input of the VXOA41 option 1 and one 50 µm core or greater for output of VXOA41 option 1 to the Optical Power Meter (note: 62.5 µm is largest fiber core allowed for accurate use with the Tektronix OCP Power Meter). The 50 µm fiber used for input to the VXOA41 option 1 can be replaced by a singlemode fiber if the stable source to be used is designed to couple light into a singlemode fiber.
  - For a VXOA41 option 2: One 62.5 µm core multimode fiber from the source to the input of VXOA41 option 2 and one 62.5 µm core or greater for the output of the VXOA41 to the Optical Power Meter (note: since 62.5 µm is largest fiber core allowed for accurate use with the Tektronix OCP Power Meter, the OCP should not be used with the 100 µm VXOA41 option 3). The 62.5 µm fiber used for input to the VXOA41 option 2 can be replaced by a singlemode fiber if the stable source to be used is designed to couple light into a singlemode fiber (a singlemode 50 µm fiber can also be used).
  - For VXOA41 option 3: one 100 µm core multimode fiber from source to input of VXOA41 option 3 and one 100 µm core or greater for output of VXOA41 option 3 to the Optical Power Meter (note: 62.5 µm is the largest fiber core allowed for accurate use with the Tektronix OCP Power Meter). The 100 µm fiber used for input to the VXOA41 option 3 can be replaced by a singlemode fiber if the stable source to be used is designed to couple light into a singlemode fiber. A 50 µm fiber, or even a 62.5 µm fiber can be used with a stable source designed to couple into a singlemode fiber.

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NOTE. *The equipment listed is sufficient to carry out the Performance Verification. However, the VXOA41 is an instrument capable of operating at over a thousand different wavelength settings and at over 6000 different attenuation level settings. This verification procedure is not intended as a comprehensive verification of the instrument's specifications. Please refer to the Product Verification Data sheet accompanying the VXOA41 at shipment for a more complete listing of the instrument's performance as shipped from the factory.*

Power Up

1. Insert the VXOA41 into a powered-down VXI Mainframe (see *Installation* in the *Getting Started* section).
   - Make certain that the VXOA41 is securely inserted into the mainframe.
2. Turn the VXI mainframe power on (via mainframe's power switch).

   A few seconds are required after mainframe power-up before the slot-0 resource manager deasserts system reset and the VXOA41 READY LED lights.
3. The wavelength and attenuation settings will power-up at whatever values existed before the previous power-down; if the instrument is being powered on for the first time the settings will be at their factory default values.
4. Send the command `HEADERS 1` to the VXOA41; this ensures that query responses from the instrument are prefixed in the fullest and most explanatory way (the examples of this procedure assume that the headers are turned on).

Front Panel LEDs

NOTE. *Whenever the VXOA41 is accessed over the VXI Bus with either a command or query, the amber ACCESSED LED on the front panel should light briefly. The length of time the LED is lighted is relatively short (tenths of seconds), depending on the speed of the controller, but it is usually observable by the user.*

1. Check that the READY LED is lighted (green).
   - This should stay lighted while the mainframe is on and the controller is not in RESET.

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2. Send the command **ATT:MIN**; this causes the instrument to adjust to zero dB (a few seconds may be needed to complete the adjustment if the previous setting was non-zero).

   - The MIN ATT red LED should be lighted.

3. Send the command `ATT:DB 10`; this causes the instrument to adjust to 10 dB (a few seconds may be needed to complete the adjustment).

   - The ATT ADJ red LED should be lighted for a brief moment (a second or two) while the attenuation is being adjusted. This LED will always light up during attenuation adjustments (and after wavelength adjustments); after adjustments are complete, the LED should return to an OFF state (unlighted).

4. Send the command `ATT:MIN`; this causes the instrument to return to the minimum attenuation.

5. Send the query `ATT:DB?`; the response should read:
   `:ATTENUATION:DB 0.00`

6. Send the command `DIS 1`; this causes the instrument to adjust to place the shutter across the optical path for maximum attenuation.

   - The DISABLE red LED should be lighted.

7. Send the command `DIS 0`; this will withdraw the shutter so that it is no longer blocking the optical path.

   - The DISABLE red LED should be off (unlighted).

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Shutter Attenuation and Disable

1. Send the command `DIS 1`; this causes the instrument to place the shutter across the optical path for maximum attenuation.

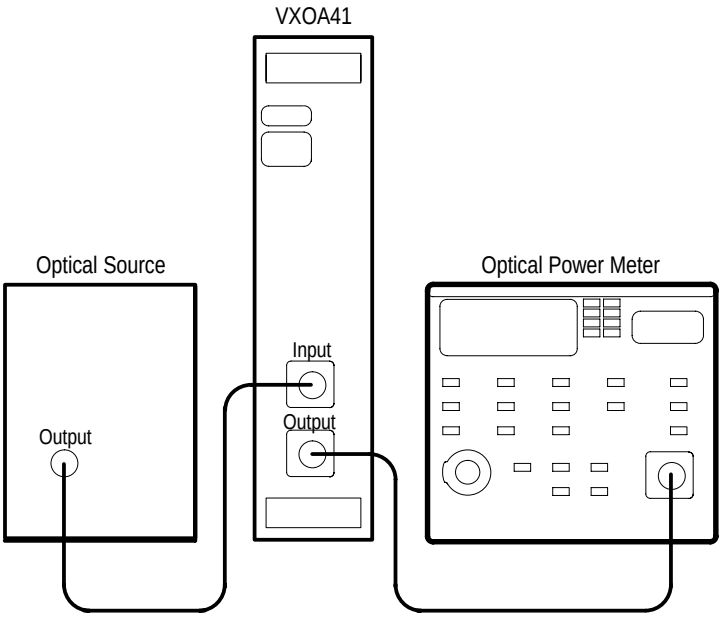


Figure G-1: Setup for Shutter Attenuation and Disable Procedure

2. If you have not already done so, connect an optical source to the input of the VXOA41 using an optical fiber jumper cable of equal or lesser core diameter than the VXOA41 (see *Specifications* for the core diameter of the particular VXOA41 under test).

   - The source should be relatively stable (>0.1 dB stability over 1 minute) and should emit at least 1 mW of optical power into the fiber jumper used for input to the VXOA41. The source must emit light at a wavelength within the specifications of the VXOA41 (700 nm to 1600 nm).

   An average optical power meter is required. The meter should be able to accept the fiber type of the jumpers being used.

3. Before continuing, cap the input to the Optical Power Meter and properly *zero* the meter.

4. Send the command `DIS 0`, this withdraws the shutter from the optical path.

5. Connect a fiber of equal or greater core diameter than VXOA41 to the output of the VXOA41.

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6. Connect the other end of the fiber jumper to the input of the Optical Power Meter.

7. Record the power reading from the Optical Power Meter as **Po**.

8. If a relative dB mode is available on the Power Meter, set the dB reference level of the Power Meter to the measured **Po** value.

9. Send the command `DIS 1`; this causes the VXOA41 to place the shutter across the optical path for maximum attenuation.

10. Record the new reading of the Optical Power Meter as P_f; if the dB relative mode is available, then record the new reading's value relative to the P_0=0 dB reference. If P_f is ≤ 0.00, substitute 1×10^{-14} W for P_f. If the Relative dB mode is not available, the relative dB is calculated as

$$\textit{Relative Attenuation with shuttler blocking light (dB)} = 10 \times \log \frac{P_f}{P_0}$$

- The Relative Attenuation should be >100 dB lower; that is, the power meter in relative mode should read less than –100 dB (note: for the VXOA41 option 3, the relative level should be >90 dB lower).

***NOTE**. Most Optical Power Meters cannot accurately measure at such low power levels; consequently, the meter may simply display the lowest value it possibly can when the shutter is activated. To verify the >100 dB isolation of the shutter, an Optical Power Meter with greater than –100 dBm sensitivity must be used.*

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Insertion Loss (Long Wavelengths)

1. Send the command `DIS 1`; this causes the VXOA41 to place the shutter across the optical path for maximum attenuation.
2. Properly *zero* the Average Optical Power Meter to be used.
3. Send the command `DIS 0`, this withdraws the shutter from the optical path.

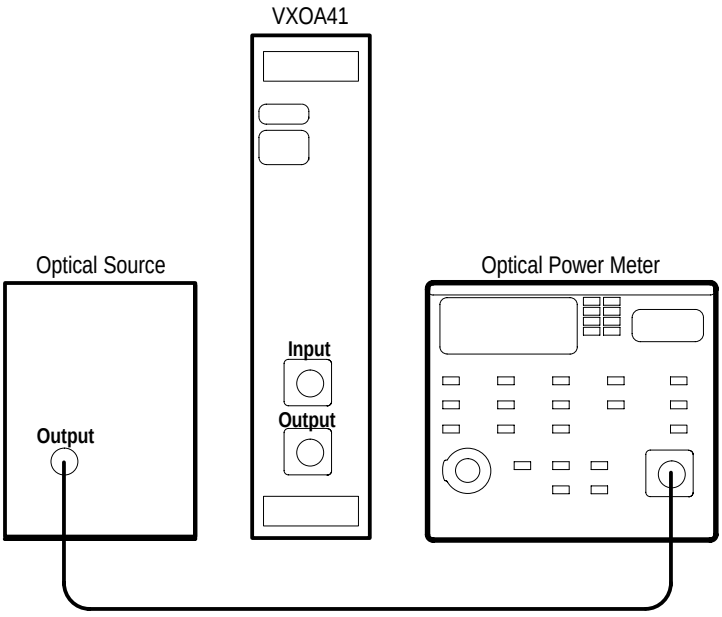


Figure G-2: First setup for Insertion Loss Procedure

4. If you have not already done so, connect the optical source to the input of the Average Optical Power Meter using an optical fiber jumper cable of equal or lesser core diameter than the VXOA41.
   - The source should be relatively stable (>0.1 dB stability over 1 minute) and should emit at least 1 μW of optical power into the fiber jumper used. The source must emit light at a wavelength within the specifications of the VXOA41 long wavelength insertion loss (1100 nm to 1700 nm).
5. Record the power reading from the Optical Power Meter as Plong1.
   - If a relative-dB mode is available on the Power Meter, set the dB reference level of the Power Meter to the measured Plong1 value.

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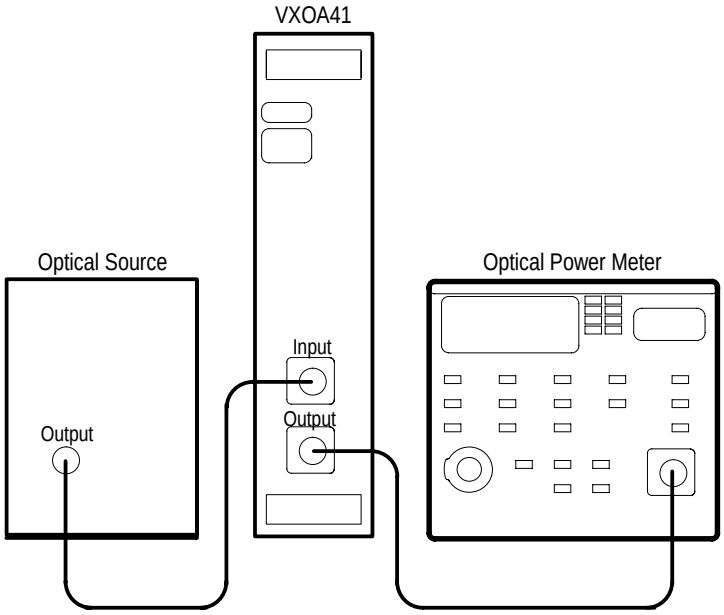


Figure G-3: Second setup for Insertion Loss Procedure

6. If you have not already done so, attach the optical source to the input of the VXOA41 using the fiber jumper.
7. Attach the output of the VXOA41 to the Optical Power Meter using a fiber of greater than or equal core diameter compared to the VXOA41.
8. Send the command ATT:MIN to the VXOA41 (check to see that MIN ATT LED is lighted).
9. Record the new reading of the Optical Power Meter as Plong2; if the dB relative mode is available, then record the new reading's value relative to the Plong1=0dB reference. If the Relative dB mode is not available, the relative dB Insertion Loss is calculated as:

$$Long\ Wavelength\ Insertion\ Loss\ (dB) = -10 \times \log \frac{Plong2}{Plong1}$$

   - The Long Wavelength Insertion Loss should be less than –2.0 dB (that is, less than 2.0 dB Insertion Loss).

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Insertion Loss (Short Wavelengths)

1. Properly *zero* the Average Optical Power Meter to be used.

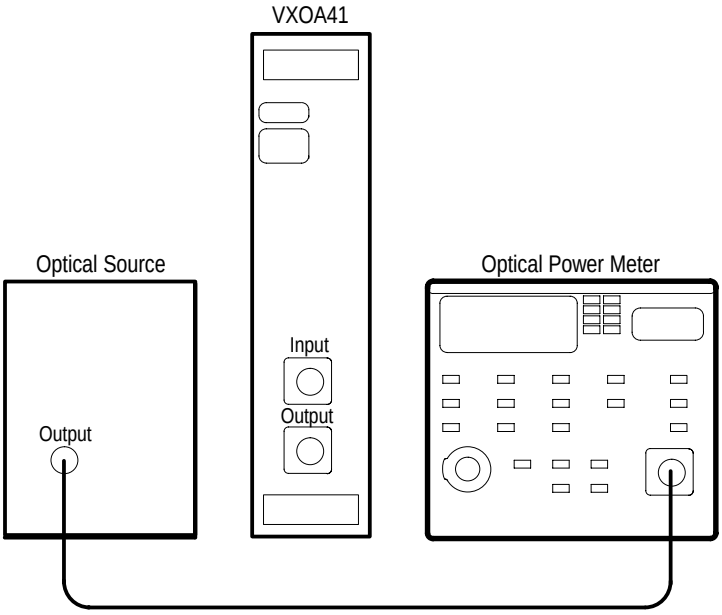


Figure G-4: First setup for Insertion Loss Procedure

2. Connect an optical source to the input of the Average Optical Power Meter using an optical fiber jumper cable of equal or lesser core diameter than the VXOA41 (see page B–1 for the core diameter of the particular VXOA41 under test).

   - The source should be relatively stable (>0.1 dB stability over 1 minute) and should emit at least 1 µWatt of optical power into the fiber jumper used. The source must emit light at a wavelength within the specifications of the VXOA41 short wavelength insertion loss (700 nm to 1100 nm).

3. Ensure that the power meter's wavelength is set to match the wavelength of the source.

4. Record the power reading from the Optical Power Meter as Pshort1.

   - If a relative-dB mode is available on the Power Meter, set the dB reference level of the Power Meter to the measured Pshort1 value.

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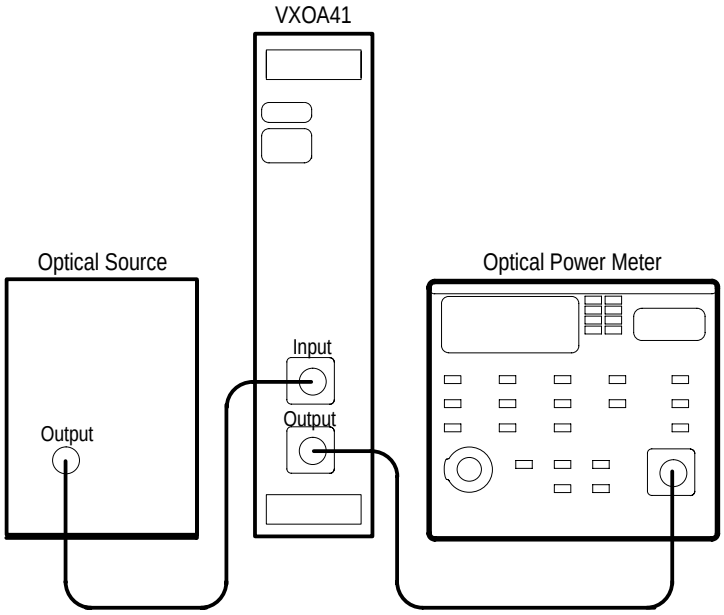


Figure G-5: Second setup for Insertion Loss Procedure

5. Attach the optical source to the input of the VXOA41 using the fiber jumper.
6. Attach the output of the VXOA41 to the Optical Power Meter using a fiber of greater than or equal core diameter compared to the VXOA41.
7. Ensure that the VXOA41 is set to the minimum attenuation setting; this can be accomplished by sending the command `ATT:MIN` to the VXOA41 (check to see that MIN ATT LED is lighted).
8. Record the new reading of the Optical Power Meter as Pshort2; if the dB relative mode is available, then record the new reading's value relative to the Pshort1=0 dB reference. If the Relative dB mode is not available, the relative dB Insertion Loss is calculated as

$$Short\ Wavelength\ Insertion\ Loss\ (dB)\ =\ 10 \times \log \frac{Pshort2}{Pshort1}$$

   - The relative level of Pshort2 to Pshort1 should be greater than –4.0 dB (that is, less than 4.0 dB Insertion Loss).

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Repeatability and Accuracy

Although the repeatability of the VXOA41 is specified over the entire wavelength range (600 nm–1700 nm), the <0.15 dB accuracy error (typically <0.05 dB) specification is only specified for wavelengths within ±20 nm of 850 nm, 1300 nm, and 1550 nm. This test must be repeated three times with three different stable optical sources at the three specified wavelengths to fully verify the accuracy of the VXOA41. A single source is sufficient, though, to verify the repeatability of the VXOA41.

NOTE. *This test requires an Optical Source and an Average Optical Power Meter: In order to verify the repeatability of the VXOA41, the Optical Source and Power Meter must both be very stable (>0.01 dB); the repeatability of the measurement devices must be greater than the value being measured. It is necessary that the optical fibers used to carry the signal from the source, to the VXOA41, and then to the Power Meter are not disturbed or moved during this test.*

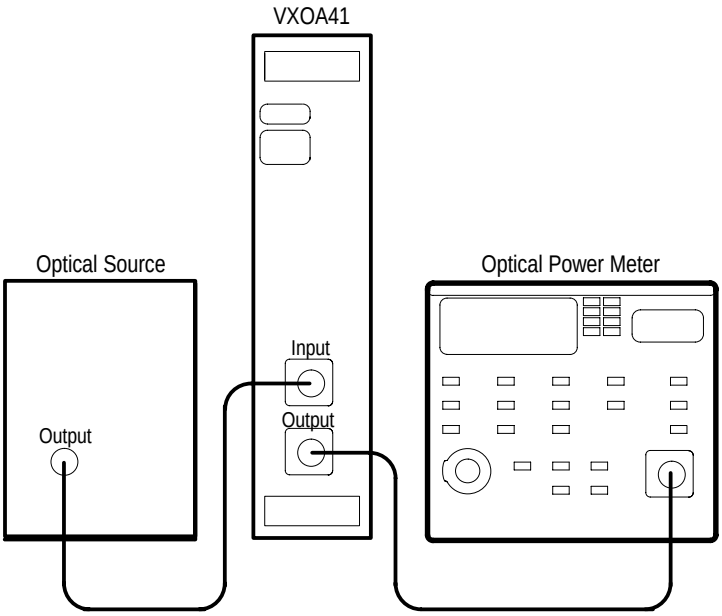


Figure G-6: Setup for Repeatability and Accuracy Procedure

1. Attach the stable source to the input of the VXOA41 and attach the output of the VXOA41 to the Optical Power Meter using the appropriate fiber optic jumper cables. Be sure that the attenuator wavelength setting matches the source wavelength; this can be accomplished by sending the command

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`WAVE <wavelength>` where "<wavelength>" is a number matching the wavelength of the stable source in units of nanometers. For example, you might send the command: `WAVE 1300`. You can check the wavelength setting by sending the query `WAVE?` and noting the response (in this example, `:WAVELENGTH 1300`).

2. Set the VXOA41 to minimum attenuation by sending the command `ATT:MIN`.

3. After the attenuator is stable, record the optical power measured by the Optical Power Meter; set this power level as the 0 dB reference level of the Power Meter. Set the Optical Power Meter to display in dB.

4. Adjust the attenuation to 10.00 dB by sending the command `ATT:DB 10` to the VXOA41.

5. Record the relative dB power level of the Power Meter; this value should be –10.00 dB ±0.15 dB relative to the previously set 0 dB reference level (when the VXOA41 was at MIN ATT setting).

   - Record the exact relative dB reading; this will be used as the 10 dB comparison for repeatability.

6. Adjust the attenuation to 20.00 dB by sending the command `ATT:DB 20` to the VXOA41.

7. Record the relative dB power level of the Power Meter; this value should be –20.00 dB ±0.15 dB relative to the previously set 0 dB reference level (when the VXOA41 was at MIN ATT setting).

   - Record the exact relative dB reading; this will be used as a comparison for repeatability.

8. Adjust the attenuation to minimum attenuation by sending the command `ATT:MIN` to the VXOA41.

   - The Power Meter should read within ±0.05 dB of 0.00 dB; this verification assumes that the source has not drifted (<0.005 dB change) and the fiber jumper cables have not been disturbed.

9. Adjust the attenuation to 10.00 dB by sending the command `ATT:DB 10` to the VXOA41.

   - The Power Meter should read within ±0.05 dB of the reading taken in step 5; this verification assumes that the source has not drifted (<0.005 dB change) and the fiber jumper cables have not been disturbed.

10. Adjust the attenuation to 20.00 dB by sending the command ATT:DB 20 to the VXOA41.

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- The Power Meter should read within ±0.05 dB of the reading taken in step 7; this verification assumes that the source has not drifted (<0.005 dB change) and the fiber jumper cables have not been disturbed.

This completes the performance verification.

NOTE. *To fully verify the accuracy of the VXOA41, you should repeat steps 1 through 10 for each of the three wavelengths described in the opening paragraph of this procedure.*

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Appendix H: Replaceable Parts

This appendix contains a list of the components that are replaceable for the VXOA41 Optical Attenuator. As described below, use this list to identify and order replacement parts.

Parts Ordering Information

Replacement parts are available from or through your local Tektronix service center or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available and to give you the benefit of the latest circuit improvements. Therefore, when ordering parts, it is important to include the following information in your order:

- Part number
- Instrument type or model number
- Instrument serial number
- Instrument modification number, if applicable

If a part you order has been replaced with a different or improved part, your local Tektronix service center or representative will contact you concerning any change in the part number.

Change information, if any, is located at the rear of this manual.

Using the Replaceable Parts List

The tabular information in the Replaceable Parts List is arranged for quick retrieval. Understanding the structure and features of the list will help you find the all the information you need for ordering replacement parts.

Item Names

In the Replaceable Parts List, an Item Name is separated from the description by a colon (:). Because of space limitations, an Item Name may sometimes appear as incomplete. For further Item Name identification, U.S. Federal Cataloging Handbook H6-1 can be used where possible.

Abbreviations

Abbreviations conform to American National Standards Institute (ANSI) standard Y1.1

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CROSS INDEX – MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip Code
TK0435	LEWIS SCREW CO	4300 S RACINE AVE	CHICAGO IL 60609–3320
0KB05	NORTH STAR NAMEPLATE	1281–S NE 25TH	HILLSBORO OR 97124
62559	SCHROFF INC	170 COMMERCE DR	WARWICK RI 02886–2430
73743	FISCHER SPECIAL MFG CO	111 INDUSTRIAL RD	COLD SPRING KY 41076–9749
80009	TEKTRONIX INC	14150 SW KARL BRAUN DR PO BOX 500	BEAVERTON OR 97077–0001

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Fig. & Index No.	Tektronix Part No.	Serial No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
G–1–1	200–4124–00			1	COVER,SIDE:VXI C–SIZE,0.032 ALUM 5052	80009	200412400
–2	211–0311–00			16	SCREW,MACHINE:4–40 X 0.125 L,FLH,100 DEG,STL	TK0435	ORDER BY DESC
–3	426–2489–00			2	FRAME,SECTION:RAIL,TOP & BOTTOM,ALUMINUM	80009	426248900
–4	211–0101–00			8	SCREW,MACHINE:4–40 X 0.25,FLH,100 DEG,STL	TK0435	ORDER BY DESC
–5	200–4043–00			1	COVER,SIDE:VXI C–SIZE,0.032 ALIM 5052	80009	200404300
–6	334–8657–00			1	MARKER,IDENT:MKD TEKTRONIX VXOA41 OPT ATTEN	80009	334865700
–7	210–0405–00			4	NUT,PLAIN,HEX:2–56 X 0.188,BRS	73743	12157–50
–8	367–0448–00			2	HANDLE,CARRYING:GEMINI	62559	20808–004
–9	211–0334–00			4	SCREW,SHOULDER:4–40 X 0.4,HEX HD,BRASS	80009	211033400
–10	334–8600–00			1	MARKER,IDENT:MKD VXI,VXOA41	0KB05	334–8600–00
–11	334–8595–00			1	MARKER,IDENT:MKD TEKTRONIX,VXOA41	0KB05	334–8595–00
					ACCESSORIES		
	070–8777–00			1	MANUAL,TECH:USER,VXOA41	80009	070877700
	020–1885–00			1	ACCESSORY PKG:O/E CONVERTER	80009	020188500

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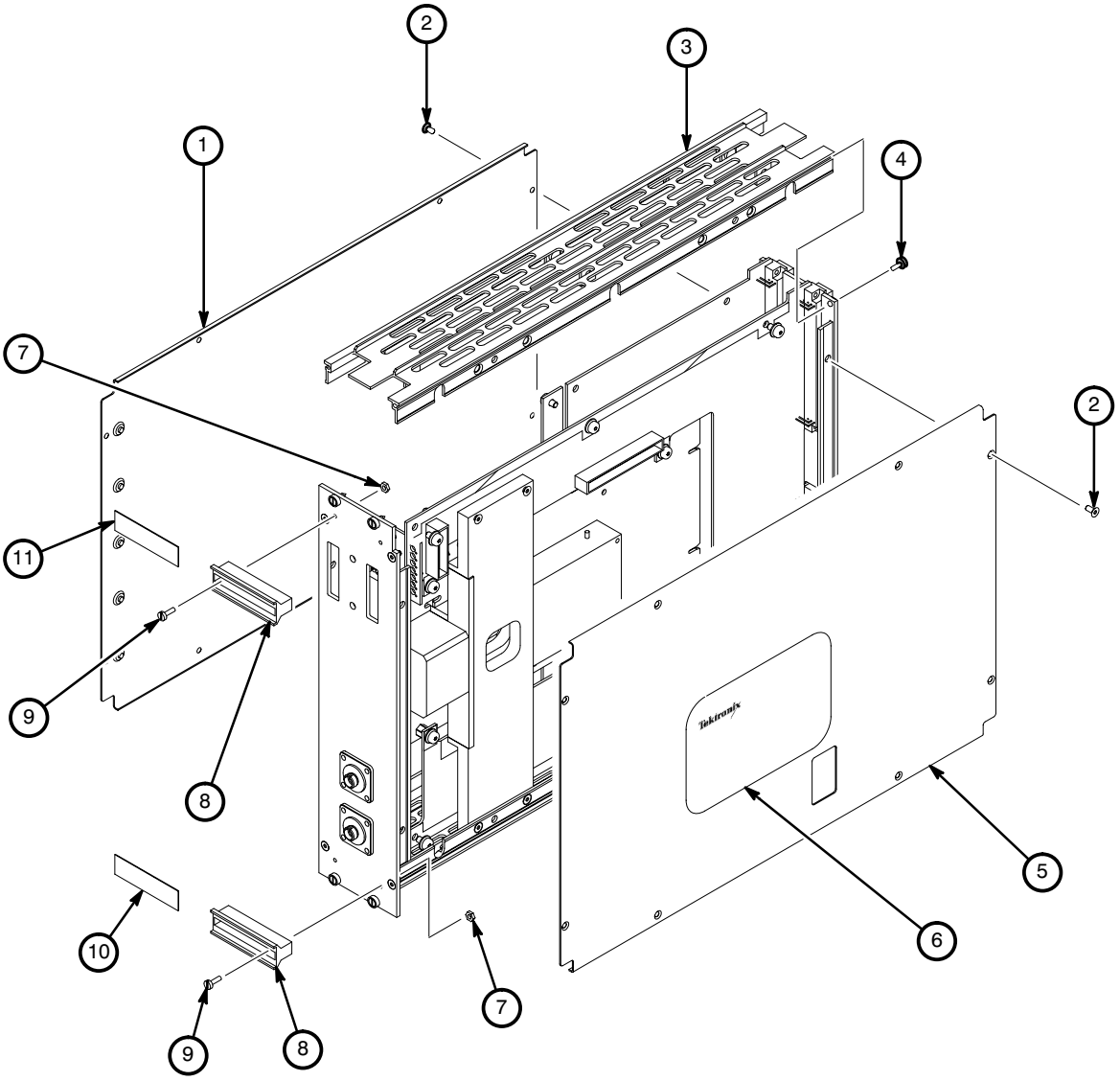


Figure H-1: VXOA41 Replaceable Parts

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Glossary and Index

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Glossary

Buffer
A protective coating placed on an optical fiber.

Dispersion
The process by which an optical signal is distorted as it travels through an optical fiber. One kind of dispersion is material dispersion, which is caused by a differential delay of the different wavelength components of an optical signal.

Cladding
The outer layer of an optical fiber, which surrounds the core, and has a lower refractive index than the core.

Core
The center, light-guiding section of an optical fiber.

dBm
An expression of power level in decibels referenced to a power of one milliwatt.

Mode
An allowable electromagnetic field pattern within an optical fiber. An allowable pattern satisfies Maxwell's equations.

Multimode Fiber
An optical fiber with a core that is larger enough to support the transmission of more than one mode of light through the fiber (that is, axial and non-axial light rays).

Numerical Aperature
A measure of the light-gathering ability of an optical fiber, which describes the maximum angle to the fiber axis at which light will be accepted and propagated. The numerical aperature of an optical fiber is defined as:

$$NA = \sqrt{(n_1^2 - n_2^2)}$$

where n_1 and n_2 are the refractive index of the core and the cladding, respectively.

Singlemode Fiber
An optical fiber with a narrow core that supports the transmission of only one mode of light through the fiber.

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