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VXI/SCPI INTERFACE

VXP-1000

OPERATING MANUAL

REFERENCE ONLY

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September 7, 1995 Document No. M211439-01 Rev B

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SAFETY NOTICE

BEFORE APPLYING POWER to the System, verify that the VXP–1000 VXI Interface is properly configured for the user's particular application.

WARNING

HAZARDOUS VOLTAGES IN EXCESS OF 230 VRMS, 400V PEAK MAY BE PRESENT WHEN COVERS ARE REMOVED. QUALIFIED PERSONNEL MUST USE EXTREME CAUTION WHEN SERVICING THIS EQUIPMENT. CIRCUIT BOARDS, TEST POINTS AND OUTPUT VOLTAGES MAY ALSO BE FLOATING ABOVE (BELOW) CHASSIS GROUND.

Installation and servicing must be performed by QUALIFIED PERSONNEL who are aware of properly dealing with attendant hazards. This includes such simple tasks as fuse verification and channel reconfiguration.

Ensure that the AC power line ground is properly connected to the VXP–1000 input connector. Similarly, other power ground lines including those to application and maintenance equipment MUST be properly grounded for both personnel and equipment safety.

Always ensure that facility AC input power is de–energized prior to connecting or disconnecting the power cable. Similarly, the VXP–1000 circuit breaker must be switched OFF prior to connecting or disconnecting output power.

In normal operation, the operator does not have access to hazardous voltages within the chassis. However, depending on the user's application configuration, **HIGH VOLTAGES HAZARDOUS TO HUMAN SAFETY** may be normally generated on the output terminals. The Customer/User must ensure that the output power (and sense) lines be properly labeled as to the SAFETY hazards and that any inadvertent contact with hazardous voltages is eliminated.

Guard against risks of electrical shock during open cover checks by NOT TOUCHING any portion of the electrical circuits. Even when power is OFF, capacitors are well known to retain an electrical charge. Use SAFETY GLASSES during open cover checks to avoid personal injury by any sudden component failure.

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SECTION I

GENERAL DESCRIPTION

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1.1 INTRODUCTION

This manual has been prepared for use with the Elgar Model VXP-1000 VXI/SCPI Interface Module. The VXP-1000 is a power supply controller contained within the slots of a C-size or D-size VXI mainframe and is operated from a computer using the Standard Commands for Programmable Instruments (SCPI) language.

The VXP-1000 allows Elgar VXP-3000 instruments to be controlled from the VXI chassis. The VXP-1000 places the control portion of the power system in the VXI chassis, separate from the power elements of the system, giving system integrators the ability to take advantage of VXI communications and timing capabilities without suffering from its power and cooling restrictions.

1.2. APPLICATIONS

The VXIbus is an open system architecture supporting the emerging "instrument-on-a-card" technology. VXIbus enables computer, interface, and instruments produced by various manufacturers to coexist as fully compatible modules within the same VXI chassis. Unfortunately, VXI does not allow any appreciable amount of AC or DC power in the VXI chassis due to lack of power on the backplane and minimum cooling capabilities. Elgar developed the VXP series (expanded for power) to address this problem. The VXP allows the control portion of the power system to reside in the VXI chassis while the power elements of the system reside external to the VXI chassis. System integrators that use VXI can now expand the system to include power while taking advantage of the VXI communications and timing capabilities.

1.3. SPECIFICATIONS

Dimensions: VXIbus standard C-size module (refer to Figure 2-1).

Communications: One Serial Port. This port drives multiple VXP-3000 systems when the VXP-3000 controller slave module is installed in slot 0 of each daisy-chained VXP-3000 chassis, and is interconnected with the VXP-1000 via the Elgar interconnection cable (P/N 5211413-01).

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NOTES

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SECTION II

INSTALLATION

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2.1 INTRODUCTION

The VXP-1000 attaches to one or more (up to 15) VXP-3000 chassis', thus providing significant system configuration flexibility that comes with each highly reconfigurable VXP-3000 chassis. Due to the high power and voltages required by and producible by the power modules installed into a VXP-3000 chassis, the following warning is very important:

WARNING

Hazardous voltages are present at the VXP-3000 slave chassis when operating and after being turned off (because of the power storage capability of capacitors). Read the "SAFETY" notices in on page ii and in the user's VXP-3000 manual. If the user does not have the VXP-3000 manual, obtain one from Elgar.

2.2 UNPACKING

The VXP-1000 has been packed in accordance with industrial standards for safe shipment. Upon receipt of the unit, unpack and inspect the unit as described in the following steps:

1. Inspect the shipping container prior to accepting the container from the carrier. If damage to the container is evident, a description of the damage shall be noted on the carrier's receipt, then signed by the driver of the carrier agent.

2. If damage is not apparent until the contents are unpacked, a claim for concealed damage shall be placed with the carrier. The shipping container(s) and filler material shall be saved for subsequent inspection.

3. Forward a report of any damage to the Elgar Repair Department, 9250 Brown Deer Road, San Diego, CA 92121-2294. Elgar will provide instructions for repair or replacement of the instrument.

4. If possible, save the container and packing material for subsequent return of the instrument to the factory. If the instrument needs to be shipped and proper packing material is not available, contact Elgar to provide containers and shipping instructions.

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2.3 PRE-INSTALLATION INSPECTION

Inspect the VXP-1000 for shipping damage such as dents, scratches, distortion, and damaged connectors. There are no mercury relays or other internal components sensitive to instrument tilting for inspection purposes.

2.4 INSTALLATION

The VXP-1000 (refer to Figure 2-1) is designed to be installed in a user-provided VXI chassis.

2.4.1 Logical Address Configuration

The VXP-1000 plug-in module has a row of switches which set the module's logical address. The logical address selector switch is accessible through the slot in the top cover of the VXP-1000.

The DIP switch configuration is as follows:

- The switch is closed (on) when placed in the "0" position.
- The switch is open (off) when placed in the "1" position.

For example, for Logical Address 3, the DIP switch would be configured as follows:

0 - Off; 1 - Off; 2 - On; 3 -On; 4 - On; 5 - On; 6 - On; 7 - On

2.4.2 Module Insertion

Perform the following:

1. Place the VXP-1000 module into any slot of the VXI chassis except for Slot 0.
2. Insert the VXP-1000 such that the VXP-1000 rear connectors are properly aligned with the VXI chassis back panel connectors. Use the card guides to aid in properly inserting the VXP-1000.

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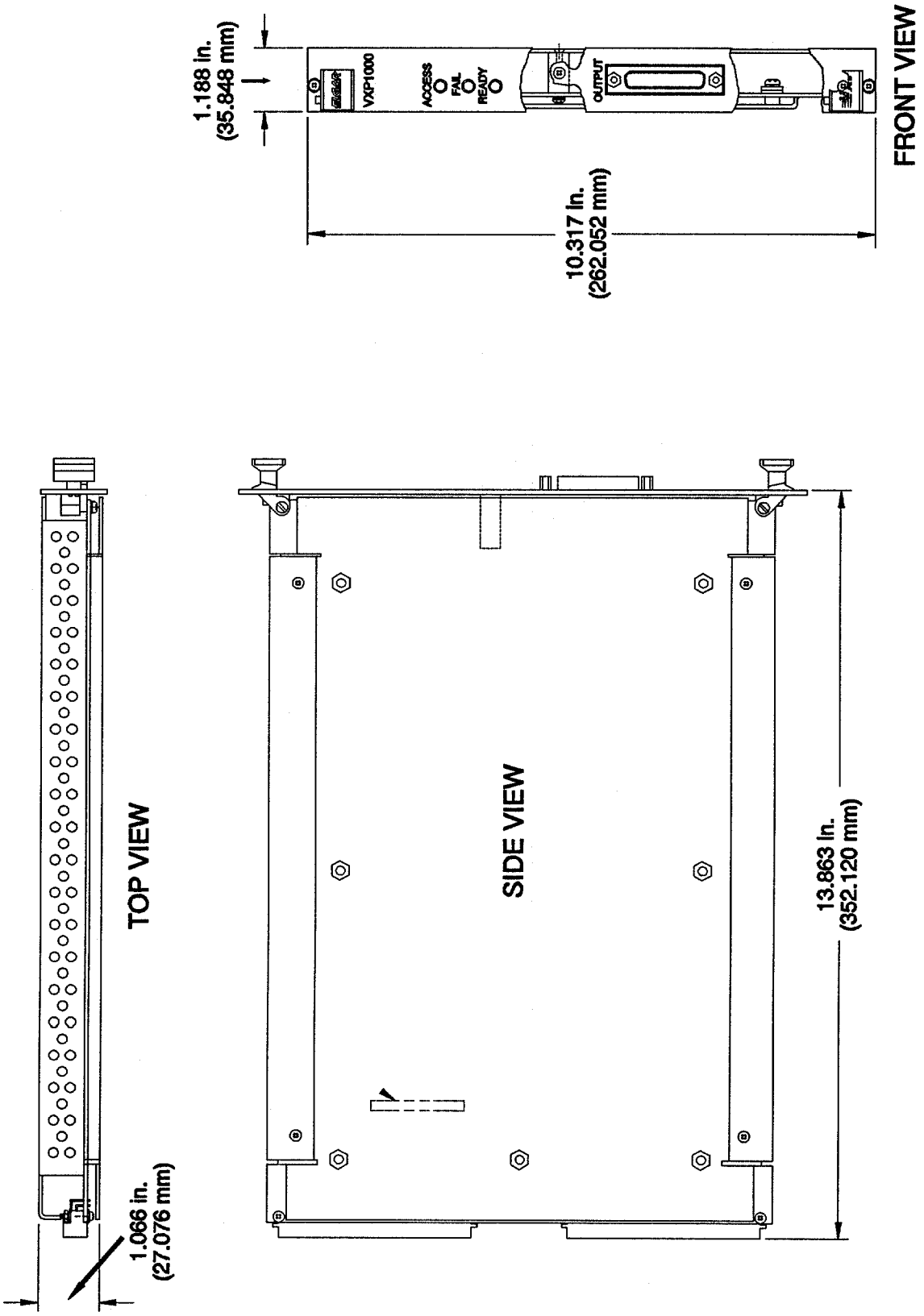


Figure 2-1. VXP-1000 Installation Dimensions

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2.5 CONFIGURATION

This section contains information on selecting the VXI logical address for the VXP-1000, setting the VXI interrupt level, and configuring the VXP-1000 for operation with the attached VXP-3000 chassis'. This section is fairly cursory. To help further understand the configuration process, study Section IV which shows how to configure three example systems. Also study Subsection 3.3 for further details on various SCPI commands, including the configuration related commands found in Subsection 3.3.9.

2.5.1 VXI Configuration

The VXP-1000 sends interrupts to and receives acknowledgments from the Slot 0 module across the VXI bus backplane interrupt line. There are seven interrupt levels. There may be times when a different interrupt level is required than that which results just after power-on. At such times the `*INTLVL` command must be used to change the selection of interrupt level.

2.5.1.1 **INTLVL [n]*

`*INTLVL [n]`

This command specifies the VXI interrupt level of 0 through 7.

Parameter information is as follows:

Parameter Name: level `[n]`

Parameter Type: Numeric

Range of Values: 0 through 7

Default Units: None

Example:

`*INTLVL 3`

This command sets the interrupt level to 3.

2.5.1.2 **INTLVL?*

`*INTLVL?`

This command returns the current interrupt level set by *INTLVL [n].

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2.5.2 System Configuration

Once the VXI configuration is complete, one may proceed with the VXP-1000 system configuration. VXP-1000 system configuration primarily involves establishing accurate information in the VXP-1000 non-volatile memory representing where and what power modules are installed in the one or more VXP-3000 chassis'. When the VXP-1000 is performing the *CONFIG command, the 'tag' memory of each power module is read by the VXP-1000; the information so obtained is stored in a System Configuration Table kept in the VXP-1000 non-volatile memory.

The word 'tag' connotes the idea of tagging, and identifies a non-volatile memory that physically exists within the power module and holds information specific to that power module. Under very unusual and very rare circumstances system configuration also involves adjusting information in the non-volatile 'tag' memory of a power module. The *TAG? and *TAG commands serve to read from and write to the tag memory of a module. The *TAG command is particularly hazardous, and should not be used except by qualified Elgar service personnel. See Subsection 3.3.9 where further text exists explaining the use of the *TAG and *TAG? commands.

Other configuration related commands include *CLEAR, *SETCH, and *SETPH. The *CONFIG, *CLEAR, and *SETCH commands are further discussed below in this subsection.

The system is configured in terms of block and slot parameters that identify where power modules are installed. Each individual chassis is referred to as a block, and each chassis (block) contains eight slots. A maximum of fifteen blocks are addressable (1 through 15). Block 0 is reserved for the VXP-1000 controller itself.

The address switch on the controller in slot 0 of each VXP-3000 chassis determines that chassis' block address.

At initial setup, the system needs to build two internal tables holding system configuration information. The commands used for this function are:

*CONFIG

Generates a System Configuration *Table*. The system configuration table holds various pieces of information that are obtained from the tag memories of each power module found in each and every block in the VXP system.

*CLEAR

Clears the previous System Configuration *Map*. The system configuration map relates user chosen source numbers to designated modules at block and slot locations.

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Blocks and slots can be configured such that they appear to be a single source with the same characteristics. The command would be:

```
*SETCH <source>,<start block>,<start slot>[,<stop block>,<stop slot>]
```

Parameter information is as follows:

Parameter Name	Parameter Type	Range of Values	Default Units
source	Numeric	1 through 128	None
start block	Numeric	1 through 15	None
start slot	Numeric	1 through 8	None
stop block	Numeric	1 through 15	None
stop slot	Numeric	1 through 8	None

Example:

```
*SETCH 2,1,2,1,6
```

This command sets source 2 to be associated with the modules in slots 2 through 6 of block 1.

See Subsection 3.3 and Section IV for further information and examples on the use of the *SETCH command.

2.5.3 Verifying Instrument Operation

Once the VXP-1000 is completely configured, it is ready for use. Instrument operation can be verified using the IEEE 488.2 Self-Test Command. This command enables the user to verify that the user is properly addressing the VXP-1000 and is also useful in locating intermittent problems that may occur during operation.

2.5.3.1 *Self-Test*

The command to execute the Self-Test is:

```
*TST?
```

If the test passes, the instrument returns a "0". If the test fails, the instrument returns a "1".

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2.5.3.2 *Resetting the VXP-1000*

During operation, programming errors and other conditions may occur, making it necessary to return the instrument to a known operating state. The VXP-1000 is reset with the command:

```
*RST
```

A reset from the computer returns the VXP-1000 to its idle state.

2.5.3.3 *Error Queue*

When an error occurs during operation, an error code and corresponding message are stored in the VXP-1000's error queue. The user can determine if an error has occurred by reading the error queue. This is accomplished with the command:

```
SYSTem:ERRor?
```

If there is a message in the queue, that message shall be returned. The queue in the VXP-1000 can hold only one message at a time.

When there are no error messages in the error queue a code of **0** and the message **"No Error"** is returned.

Table 2-1 provides a listing of error code classifications and their definitions while Table 2-2 provides a listing of error numbers and their descriptions for the SCPI language in general. The VXP-1000 implementation of the SCPI language provides only a subset of those messages described in Tables 2-1 and 2-2. Subsection 3.3.7 provides a listing of the messages actually supported by the `SYSTem:ERRor?` command on the VXP-1000.

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Table 2-1. Standard SCPI Error Code Classifications

Classification	Definition
Command Error	Indicates that an IEEE 488.2 syntax error was detected, or an unrecognized header was received.
Execution Error	Indicates that an error was detected by the execution control block.
Device Specific Error	Indicates the detection of an error which is not a command error, a query error or an execution error; some device operations did not complete successfully, possibly due to a hardware or firmware condition.
Query Error	Indicates that the output queue has detected a problem with the message exchange protocol. Events that generate Query Errors do not generate any other error class.

Table 2-2. Standard SCPI Error Numbers and Descriptions

Error Number	Error Description	Error Number	Error Description
-100	Command Error	-140	Character Data Error
-101	Invalid Character	-141	Invalid Character Data
-102	Syntax Error	-144	Character Data Too Long
-103	Invalid Separator	-148	Character Data Not Allowed
-104	Data Type Error	-150	String Data Error
-108	Parameter Not Allowed	-151	Invalid String Data
-109	Missing Parameter	-200	Execution Error
-110	Command Header	-220	Parameter Error
-111	Header Separator	-221	Settings Conflict
-112	Program Mnemonic Too Long	-222	Data Out Of Range
-113	Undefined Header	-224	Illegal Parameter Value
-120	Numeric Data Error	-240	Hardware Error
-121	Invalid Character In Number	-300	Device-Specific Error
-130	Suffix Error	-310	System Error
-131	Invalid Suffix	-330	Self-Test Failed
-138	Suffix Not Allowed	-400	Query Error

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SECTION III

OPERATION

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3.1 INTRODUCTION

This section describes the Standard Commands for Programmable Instruments (SCPI) command set and the IEEE 488.2 Common Commands for the instrument. The commands are separated into two types:

- IEEE 488.2 Common Commands, and,
- SCPI Commands.

For quick reference to specific commands, use the Index at the end of this document to help locate that command within the *Command Reference* section (Subsection 3.3).

3.2 COMMAND FORMATS AND DEFINITIONS

3.2.1 Common Command Format

The IEEE 488.2 standard defines the Common Commands that perform functions such as reset, self-test, status byte query, etc. Common commands are four or five characters in length, always begin with an asterisk (*), and may include one or more parameters. The command keyword is separated from the first parameter by a space character. Some examples of Common Commands are:

```
*RST, *ESR 32, *IDN?
```

3.2.2 SCPI Command Format

The SCPI Commands perform functions such as closing switches, making measurements, and querying instrument states or receiving data. A subsystem command structure is a hierarchical structure that usually consists of a top level (or root) command, one or more lower level commands, and their parameters. The following example shows part of a typical subsystem:

```
SOURce1:
      :CURRent <numeric value>
      :FREQuency <numeric value>
            :MODE?
```

Where `SOURce1` is the root command, `:CURRent` and `:FREQuency` are second level commands with parameters, and `:MODE?` is a third level command.

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3.2.3 Command Separator

A colon (:) always separates one command from the next lower level command, as shown below:

```
SOUR1:FREQ:MODE?
```

Colons separate the root command from the second level command (SOUR1:FREQ) and the second level from the third level (FREQ:MODE?).

3.2.4 Abbreviated Commands

The command syntax shows most commands as a mixture of upper and lower case letters. The upper case letters indicate the abbreviated spelling for the command. For shorter program lines, send the abbreviated form. For better program readability, the user may send the entire command. The instrument will accept either the abbreviated form or the entire command.

For example, if the command syntax shows SOURce, then SOUR and SOURCE are both acceptable forms. Other forms of the command may generate an error. The user may utilize either upper or lower case letters. For example: SOURCE, source, and SouRce are all acceptable.

3.2.5 Implied Commands

Implied commands are those that appear in square brackets ([ ]) in the command syntax.

NOTE

The brackets are not part of the command, and are not sent to the instrument.

Suppose the user sent a fourth level command but did not send the preceding implied command. In this case the instrument would assume that the user intended to use the implied command and will respond as if the user had sent it. For example:

```
SOUR1
      :CURR
            :[LEV]
                  :[IMM]
```


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The root command is SOUR. The implied command, LEV, at the third level is not necessary. To set the instrument's immediate current, the user can send either of the following command statements:

```
SOUR1:CURR:LEV:IMM 1.234
or
SOUR1:CURR:IMM 1.234
or
SOUR1:CURR 1.234
```

3.2.6 Variable Command Syntax

Very few commands will have what appears to be a variable syntax. For example:

```
DIAG:INT:SETUP[n]?
```

In these commands, the "n" is replaced by a number. No space is left between the commands and the number because the number is not a parameter.

3.2.7 Parameters

Table 3-1 contains explanations and examples of parameter types.

Table 3-1. Parameter Explanations and Examples

Parameter Type	Explanations and Examples
Numeric	Accepts all commonly used decimal representations of numbers including optional signs, decimal points and scientific notation. For example: 123, 123E-2, -123, -1,23E-4, 1.23E-19
Boolean	Represents a single binary condition that is either true or false. For example: ON, OFF, 1, 0
Discrete	Selects from a finite number of values. These parameters use mnemonics to represent each valid setting. For example: SOUR1:FUNC:SHAP <waveform> where the waveform can be SIN, SQU or TRI.
Optional	Parameters shown with square brackets ([ ]) are optional parameters. If the user does not specify a value for an optional parameter, the instrument chooses a default value.

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3.2.8 Linking Commands

When linking IEEE 488.2 Common Commands with SCPI commands, use a semicolon between the commands.

For example:

```
*RST;:SOUR1:CURR 1
        or
:SOUR1:CURR 1;*RST
```

When linking multiple SCPI commands, use both a semicolon and a colon between the commands.

For example:

```
SOUR1:CURR 1;:STAT:OPER:EVEN?
```

3.3 COMMAND REFERENCE

The VXP-1000 utilizes commands from seven of the SCPI subsystems. Each subsystem is identified by a leading keyword. These seven leading keywords are **ABORt**, **MEASure**, **OUTPut**, **SENSe**, **SOURce**, **STATus**, and **SYSTem**. Each subsystem is summarized using a command tree, and below that command tree is a table showing each possible command in **bold courier**, per that tree. Each command is constructed using colons joining the various keywords that are encountered per the level of indentation as the tree is read.

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For quick reference to specific commands, use the Index at the end of this document to help locate that command within this section.

If the user is using a computer running some sort of script file -- or other form of executable file -- to send commands to the VXI chassis controller, then a delay between commands may be required to account for both communication overhead, and for the time required by the VXP-1000 to process commands. Once a SCPI command has been received by the VXP-1000, the typical command processing time is well under a second. Those commands that require the VXP-1000 to communicate with a slave VXP-3000 chassis take a little longer, but are usually also under one second; voltage, current, frequency, and phase related commands are some categories of such commands. As the user develops their system that originates commands to be sent to the VXP-1000, verify that the intended response to each command has taken effect by observing power module output, and any other conditions that may indicate when a command has taken effect. If a command appears to be ignored, consider the possibility that maybe it is being sent to the VXP-1000 too soon after a previous command was sent. The further recommendation is made that since the configuration related commands produce very little externally observable evidence of completion; each configuration related command be given at least one full second to complete (unless otherwise specified, such as for the `*CONFIG` command, which takes much longer than one second to complete). This should pose no real difficulty, since the configuration process need only be properly performed on a new system once; and thereafter only for those rare events when a power module is being replaced, or moved, or first installed. The configuration related commands are `*CLEAR`, `*CONFIG`, `*SETCH`, `*SETPH`, `*TAG`, and `*TAG?`. For examples showing the use of the commands involved in the configuration process, see Section IV.

3.3.1 The ABORt Subsystem

The command tree for this subsystem is simply one command, namely:

```
ABORt
```

The `ABORt` subsystem tree summarized above is detailed in the table below.

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Table 3-2. The ABORt Subsystem

ABORt The SCPI standard defines the action caused by the ABORt command to be the resetting of the trigger system, and the aborting of any in-progress measurements. This aborting action is to be done as quickly as possible, with the outcome of leaving the system in its idle state. The VXP-1000 (and the VXP-3000 chassis to which the VXP-1000 is attached) has no trigger system, and all measurements are quick, one-shot actions that promptly leave the VXP system in its idle state. Consequently, the only real action required by the ABORt command on a VXP-1000 is to provide SCPI command set compatibility.

Example:

```
ABORT
```

3.3.2 The MEASure Subsystem

The command tree summarizing the MEASure subsystem is

```
MEASure[n]
    :CURRent?
    :FREQuency?
    :PHASe?
    :VOLTage?
```

The table below details the MEASure subsystem. Some examples follow.

Table 3-3. The MEASure Subsystem

MEASure[n]:CURRent? Measure output current of source [n], and return the resulting value in RMS amperes. Valid for single module DC and AC sources; as well as for multiple parallel module DC sources.
MEASure[n]:FREQuency? Measure output frequency of source [n], and return that value in Hz. Valid for AC sources only.
MEASure[n]:PHASe? Measure output phase of source [n] relative to the phase master source, and return the resulting value in radians. Valid for AC sources only, and both the phase master AC source and the phase slave must be programmed with at least 30VAC (to provide sufficient magnitude to establish accurate zero crossing detection for measurement of the phase relationship).
MEASure[n]:VOLTage? Measure output voltage of source [n], and return that value in RMS volts. Valid for single module DC and AC sources; as well as for multiple parallel module DC sources.

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Example 1:

MEAS1:VOLT?
This command measures the supply voltage and returns the reading.

Example 2:

MEAS1:CURR?
This command measures the supply current and returns the reading.

Example 3:

MEAS1:PHAS?
This command measures the phase angle of Source 1 and returns the reading.

3.3.3 The OUTPut Subsystem

The command tree summarizing the OUTPut subsystem is

```
OUTPut[n] <ON¦OFF¦1¦0>
  :STATus <ON¦OFF¦1¦0>
  :STATus?
```

The table below details the OUTPut subsystem.

Table 3-4. The OUTPut Subsystem

OUTPut[n] <boolean> Opening or closing the output relay using the OUTPut keyword alone is a standard SCPI command. However, the VXP-1000 implementation of SCPI only accepts the form below that includes the STATus keyword.
OUTPut[n]:STATus <boolean> Close or open the output relay of source [n]. The <boolean> value is either "ON" or "1" for closing the output relay, or "OFF" or "0" for opening the output relay.
OUTPut[n]:STATus? Reports the last status value programmed by the OUTPut[n]:STATus<boolean> command. Reports either a 1 or 0. This is irrespective of the actual state of the output relay, which may have gone from closed to open as a consequence of a source fault condition such as over current. Use the VXI interrupt facility to produce a notice that a fault has occurred, and follow that by a SYSTem:ERRor? query command to obtain a message specifying the details of that fault. If a fault has occurred, the output relay has been opened. Subsection 3.3.8 ends with an example that shows how to setup the status related masks to generate a VXI interrupt, and then to poll for the fault message by simply using the SYSTem:ERRor? command. Also see the SOURce[n]:CURRent:PROTection:TRIPped? query command.

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Example 1:

```
OUTPut1:STATe ON
```
This command enables the output of Source 1.

Example 2:

```
OUTPut1:STAT OFF
```
This command disables the output of Source 1.

3.3.4 The SENSe Subsystem

The command tree for the SENSe subsystem is

```
SENSe[n]
    :VOLTage
        :DETector <0|1>
        :DETector?
```

The table below details the SENSe subsystem. Some examples then follow.

Table 3-5. The SENSe Subsystem

SENSe[n]:VOLTage:DETector <boolean> Close (using "1" for boolean) or open (using "0" for boolean) the sense relay for source [n].
SENSe[n]:VOLTage:DETector? Returns the last sense relay setting that was programmed by the SENSe[n]:VOLTage:DETector <boolean> command. Reports either a 1 or 0. This is irrespective of the actual state of the sense relay, which may have gone from closed to open as a consequence of a source fault condition such as over current. Use the VXI interrupt facility to produce a notice that a fault has occurred, and follow that by a SYSTem:ERRor? query command to obtain a message specifying the details of that fault. If a fault has occurred, both the sense relay and the output relay has opened. Subsection 3.3.8 ends with an example that shows how to setup the status related masks to generate a VXI interrupt, and then to poll for the fault message by simply using the SYSTem:ERRor? command. See also the SOURce[n]:CURRent:PROTection:TRIPped? query command.

Example 1:

```
SENS1:VOLT:DET 0
```
This command sets the power supply sense line of source 1 to internal.

Example 2:

```
SENSe1:VOLTage:DET?
```
This command returns the current power supply sense line selection for source 1.

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3.3.5 The SOURce Subsystem

The command tree for the SENSe subsystem is

```
SOURce[n]
  :CURRent <value>
  :CURRent?
      :[LEVel] <value>
      :[LEVel]?
           :[IMMediate] <value>
           :[IMMediate]?
                :[AMPLitude] <value>
                :[AMPLitude]?
      :PROTection
      :PROTection?
          :CLEar
          :[LEVel] <value>
          :[LEVel]?
          :STATe <boolean>
          :STATe?
          :TRIPped?
  :FREQuency <value>
  :FREQuency?
      :[CW] <value>
      :[CW]?
      :[FIXed] <value>
      :[FIXed]?
   :PHASe <value>
   :PHASe?
       :[ADJust] <value>
       :[ADJust]?
   :VOLTage <value>
   :VOLTage?
       :[LEVel] <value>
       :[LEVel]?
            :[IMMediate] <value>
            :[IMMediate]?
                 :[AMPLitude] <value>
                 :[AMPLitude]?
```

The table below details the SOURce subsystem. In that same table note that <value> is used as a brief substitute for the proper SCPI term <numeric_value>. After the table, some examples follow.

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Table 3-6. The SOURce Subsystem

SOURce[n]:CURRent <value> For a DC source, programs source [n] to a constant current mode of operation at a magnitude of <value> amperes; this mode reduces output voltage of source [n], if necessary, to prevent delivering more than <value> amperes to the load. This command, when issued, ignores the state of the current protection bit by always placing source [n] into the constant current mode. But if the current protection bit is set after issuing this command, then the mode changes to the protection mode. See the SOURce[n]:CURRent:PROTection:STATe <boolean> command for further information on the current protection bit. For an AC source, the SOURce[n]:CURRent <value> command always programs source [n] to a current protection mode, where source [n] shall shutdown if the load momentarily draws current beyond <value> RMS amperes. If source [n], whether DC or AC, has not yet been programmed to a particular output voltage before this current programming command is issued, the default output voltage is 0.
SOURce[n]:CURRent? Reports the last current value programmed for source [n] in amperes. That current value may have been programmed using the SOURce[n]:CURRent command, and its longer synonyms, or the SOURce[n]:CURRent:PROTection <value> command, and its longer synonym.
SOURce[n]:CURRent:LEVel <value> In the VXP-1000 implementation of SCPI, this command is an exact synonym for the SOURce[n]:CURRent <value> command; read above about the SOURce[n]:CURRent <value> command for further information.
SOURce[n]:CURRent:LEVel? In the VXP-1000 implementation of SCPI, this command is an exact synonym for the SOURce[n]:CURRent? command; read above about the SOURce[n]:CURRent? command for further information.
SOURce[n]:CURRent:LEVel:IMMediate <value> In the VXP-1000 implementation of SCPI, this command is an exact synonym for the SOURce[n]:CURRent <value> command; read above about the SOURce[n]:CURRent <value> command for further information.
SOURce[n]:CURRent:LEVel:IMMediate? In the VXP-1000 implementation of SCPI, this command is an exact synonym for the SOURce[n]:CURRent? command; read above about the SOURce[n]:CURRent? command for further information.
SOURce[n]:CURRent:LEVel:IMMediate:AMPLitude <value> In the VXP-1000 implementation of SCPI, this command is an exact synonym for the SOURce[n]:CURRent <value> command; read above about the SOURce[n]:CURRent <value> command for further information.
SOURce[n]:CURRent:LEVel:IMMediate:AMPLitude? In the VXP-1000 implementation of SCPI, this command is an exact synonym for the SOURce[n]:CURRent? command; read above about the SOURce[n]:CURRent? command for further information.

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SOURce[n]:CURRent:PROTection <value>
For a DC source, if the protection bit is set (see the SOURce[n]:CURRent:PROTection:STATe <boolean> command for how to set that bit), then this command programs source [n] to a current protection mode of operation such that if the load on source [n] momentarily attempts to draw more current than <value> amperes, the source [n] shall shut down to protect the load. If the protection bit is clear before sending this command, then this command behaves identical to the SOURce[n]:CURRent <value> command described earlier. For an AC source, this command always programs source [n] to a current protection mode, where source [n] shall shutdown if the load momentarily draws current beyond <value> RMS amperes. If source [n] has not yet been programmed to a particular output voltage before this current programming command is issued, the default output voltage is 0.

SOURce[n]:CURRent:PROTection?
In the VXP-1000 implementation of SCPI, this command is an exact synonym for the SOURce[n]:CURRent? command; read above about the SOURce[n]:CURRent? command for further information.

SOURce[n]:CURRent:PROTection:CLEar
This command individually resets source [n]. Note that the state of the protection bit is not altered by this command. See command SOURce[n]:CURRent:PROTection:STATe <boolean> for more information on the protection bit.

SOURce[n]:CURRent:PROTection:LEVel <value>
In the VXP-1000 implementation of SCPI, this command is an exact synonym for the SOURce[n]:CURRent:PROTection <value> command. Read there for further information.

SOURce[n]:CURRent:PROTection:LEVel?
In the VXP-1000 implementation of SCPI, this command is an exact synonym for the SOURce[n]:CURRent:PROTection? command. Read there for further information.

SOURce[n]:CURRent:PROTection:STATe <boolean>
This command sets or clears the protection bit for source [n]. The <boolean> parameter represents either a 1 or a 0, for setting or clearing. If this bit is set for source [n], then the present operation of source [n] is the current protection mode, which means that if a slight excess of current is drawn by the customer load, then source [n] shall promptly open its output relay and sense relay, and the controller shall program it to zero volts. NOTE: This command provides the expected effect only for DC sources. Any attempt to use this command for an AC source has no effect, and the AC source remains in current protection mode, and shall shutdown whenever excessive load currents are encountered. FUTURE EXPANSION NOTE: If this command is used on a power module that is not classified as a DC nor AC module, the intended effect is to disable current protection, irrespective of the boolean value passed to this command.

SOURce[n]:CURRent:PROTection:STATe?
This command queries for the state of the protection bit. Returns either 1 or 0 for set or clear, respectively.

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SOURce[n]:CURRent:PROTection:TRIPped?
This command queries as to whether source [n] has shutdown due to a momentary over-the-protection-current-limit condition (for DC sources, the value of that current limit was established by the proper sequence of a previous current programming command and the use of the protection bit programming command SOURce[n]:CURRent:PROTection:STATe <boolean>. For AC, the mere act of programming the current limit for source [n] establishes a protection current limit). If no current value as been programmed to source [n], the protection current limit defaults to the maximum for which source [n] is capable. Returns 1 if source [n] is in a shutdown state, and 0 otherwise. The SOURce[n]:CURRent:PROTection:CLEar command can be used to clear the tripped condition for any source one at a time, without affecting the state of other power modules. The *RST command may be used to simultaneously clear the tripped condition for all tripped sources; but all non-tripped sources shall also be programmed to the reset condition, along with the tripped sources.

SOURce[n]:FREQuency <value>
Programs the output frequency of AC source [n] in hertz. The range of acceptable values is determined by the operating range of source [n]. That range may be found by use of the *TAG? command; most likely, that range is also marked on a label placed on the front of the AC module. A very common range is 350 Hz to 1000 Hz. If source [n] is reset due to a *RST command, or a SOURce[n]:CURRent:PROTection:CLEar command, or following power-on-reset, the default output frequency shall be 400 Hz.

SOURce[n]:FREQuency?
Queries for the last frequency programmed for AC source [n] via the SOURce[n]:FREQuency <value> command, irrespective of whether source [n] has been reset by the *RST command or the individual source reset command SOURce[n]:CURRent:PROTection:CLEar. Just after power-on-reset, before explicitly programming the frequency, the value returned shall be 400 Hz.

SOURce[n]:FREQuency:CW <value>
In the VXP-1000 implementation of SCPI, this command is an exact synonym for the SOURce[n]:FREQuency <value> command. Read the description of that command for further information.

SOURce[n]:FREQuency:CW?
In the VXP-1000 implementation of SCPI, this command is an exact synonym for the SOURce[n]:FREQuency? command. Read the description of that command for further information.

SOURce[n]:FREQuency:FIXed <value>
In the VXP-1000 implementation of SCPI, this command is an exact synonym for the SOURce[n]:FREQuency <value> command. Read the description of that command for further information.

SOURce[n]:FREQuency:FIXed?
In the VXP-1000 implementation of SCPI, this command is an exact synonym for the SOURce[n]:FREQuency? command. Read the description of that command for further information.

SOURce[n]:PHASe <value>
Programs in radians the present phase offset between phase slave AC source [n] and the phase master AC source. If source [n] happens to be the phase master AC source, then this command has no effect on the operation of source [n]. Note that if the SOURce[n]:PHASe <value> command is not used, then the *SETPH <value> command defines the default phase offset that is in effect after the *RST, power-on-reset, or the SOURce[n]:CURRent:PROTection:CLEar individual source reset commands.

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SOURce[n]:PHASe?
Queries for the last phase offset value programmed to source [n]. Irrespective of any default phase programmed by the *SETPH <value> command, after power-on-reset this query command returns 0 until the phase has been explicitly programmed using the SOURce[n]: PHASe <value> command; after which point it then returns the last value programmed by the SOURce[n]: PHASe <value> command.

SOURce[n]:PHASe:ADJust <value>
In the VXP-1000 implementation of SCPI, this command is an exact synonym for the SOURce[n]:PHASe <value> command. Read the description of that command for further information.

SOURce[n]:PHASe:ADJust?
In the VXP-1000 implementation of SCPI, this command is an exact synonym for the SOURce[n]:PHASe? command. Read the description of that command for further information.

SOURce[n]:VOLTage <value>
Programs the output voltage of source [n] to <value> RMS volts. Valid for both DC and AC sources. When programming a voltage using this command, after a *RST command, or a power-on-reset, or an individual reset to source [n] via the SOURce[n]:CURRent:PROTection:CLEar command, the default current mode of source [n] is the protection mode at the full current rating of source [n]. For DC sources, this default form of the current protection mode is an exception to the normal behavior relative to the state of the protection bit, because even though the protection bit is clear, the default behavior is as though the protection bit is set. As soon as any current programming is done using the SOURce[n]:CURRent:PROTection <value> command, the current mode properly conforms to the state of the protection bit. Alternatively, as soon as the state of the protection bit is explicitly programmed using the SOURce[n]:CURRent:PROTection:STATe <boolean> command, again, the current mode shall conform to the state of the protection bit. For AC sources, the current mode is always the protection mode.

SOURce[n]:VOLTage?
Queries the last voltage programmed to source [n] via the SOURce[n]:VOLTage <value> command. Before any voltage is programmed after a *RST command, or after a power-on-reset, the value returned by this query command shall be 0. Apart from these two reset conditions, the value returned shall always be the value last programmed via the SOURce[n]:VOLTage <value> command.

SOURce[n]:VOLTage:LEVel <value>
An exact synonym for the SOURce[n]:VOLTage <value> command. Read about that command for further information.

SOURce[n]:VOLTage:LEVel?
An exact synonym for the SOURce[n]:VOLTage? query command. Read about that command for further information.

SOURce[n]:VOLTage:LEVel:IMMediate <value>
An exact synonym for the SOURce[n]:VOLTage <value> command. Read about that command for further information.

SOURce[n]:VOLTage:LEVel:IMMediate?
An exact synonym for the SOURce[n]:VOLTage? query command. Read about that command for further information.

SOURce[n]:VOLTage:LEVel:IMMediate:AMPLitude <value>
An exact synonym for the SOURce[n]:VOLTage <value> command. Read about that command for further information.

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SOURce[n]:VOLTage:LEVel:IMMediate?
An exact synonym for the SOURce[n]:VOLTage? query command. Read about that command for further information.

Example 1:

SOUR1:CURR 10
This command sets the current of source 1 to 10 amps.

Example 2:

SOUR1:CURR?
This command returns the present current setting of source 1.

Example 3:

SOUR1:FREQ 100
Sets the frequency of the AC signal to 100 Hz.

Example 4:

SOUR1:VOLT 5
Sets the output supply voltage to 5 volts.

Example 5:

SOUR1:VOLT:LEV 10
Sets the output supply voltage to 10 volts.

3.3.6 The STATus Subsystem

The command tree for the STATus subsystem is

```
STATus
   :PREset
   :OPERation
        :CONdition?
        :ENABle <mask>
        :ENABle?
      [:EVENt]?
   :QUEStionable
        :CONDition?
        :ENABle <mask>
        :ENABle?
      [:EVENt]?
```


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Note that of all the STATus subsystem commands, only the STATus:PREset command actually influences the operation of the VXP-1000. Two commands, the STATus:OPERation? command and the STATus:QUEStionable? command are not accepted as valid by the VXP-1000 SCPI language parser. The remaining commands in the STATus subsystem are valid to the VXP-1000 SCPI language parser to provide language compatibility, but perform no other useful action. See Subsection 3.3.8 for a listing of commands that provide an adequate means of dealing with the VXP-1000 status. The table below details the STATus subsystem.

Table 3-7. The STATus Subsystem

STATus:PREset Clears the Service Request Enable Register. See the *SRE <mask> and the *SRE? commands for further information on the Service Request Enable Register.
STATus:OPERation? This particular command is not valid for the VXP-1000 implementation of SCPI, though standard SCPI implies the validity of this command by the optional square brackets about the EVEN keyword below, with the question mark beyond the closing square bracket. The STATus:OPERation:EVENt? command is functionally identical to this command, and is valid for the VXP-1000 implementation of SCPI. See that command below.
STATus:OPERation:CONdition? Always returns a 0. This command is provided for SCPI syntax compatibility only.
STATus:OPERation:ENABle <mask> Establishes the value for the Operation Status Enable Register. This command is provided for compatibility only, since the Operation Status Enable Register is not used in the VXP-1000 implementation of SCPI.
STATus:OPERation:ENABle? Queries for the last value stored in the Operation Status Enable Register. Present for SCPI compatibility only.
STATus:OPERation:EVENt? Always returns a 0. This command is provided for SCPI syntax compatibility only.
STATus:QUEStionable? This particular command is not valid for the VXP-1000 implementation of SCPI, though standard SCPI implies the validity of this command by the optional square brackets about the EVEN keyword below, with the question mark beyond the closing square bracket. The STATus:QUEStionable:EVENt? command is functionally identical to this command, and is valid for the VXP-1000 implementation of SCPI. See that command below.
STATus:QUEStionable:CONDition? Always returns a 0. This command is here for SCPI syntax compatibility only.
STATus:QUEStionable:ENABle <mask> Establishes the value for the Questionable Status Enable Register. This command is provided for compatibility only, since the Questionable Status Enable Register is not used in the VXP-1000 implementation of SCPI.
STATus:QUEStionable:ENABle? Queries for the last value stored in the Questionable Status Enable Register. Present for SCPI compatibility only.
STATus:QUEStionable:EVENt? Always returns a 0. This command is provided for SCPI syntax compatibility only.

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3.3.7 The SYSTem Subsystem

The command tree for the SYSTem subsystem is

```
SYSTem
    :ERRor?
    :VERSion?
```

The table below details the SYSTem subsystem.

Table 3-8. The SYSTem Subsystem

SYSTem:ERRor? Returns any queued error messages. The following is a list of the error messages produce-able by the VXP-1000. 100,"UNRECOGNIZED FAILURE SOURCE [N]" 8,"NO CLOCK FROM MASTER SOURCE [N]" 7,"OVER VOLTAGE SOURCE [N]" 6,"FUSE FAILURE SOURCE [N]" 5,"SENSE FAULT SOURCE [N]" 4,"OVER CURRENT SOURCE [N]" 3,"OVER TEMPERATURE SOURCE [N]" 2,"SERVO ERROR SOURCE [N]" 1,"CURRENT LIMIT SOURCE [N]" 0,"No error" -100,"Command error" -102,"Syntax error" -350,"Queue overflow"
SYSTem:VERSion? Returns a version string. At the time of the writing of this document, the present return string is 1991.0. This identifies the SCPI language year that this implementation is based on.

3.3.8 Common Commands

The table below lists the common commands. Following the table is Figure 3-1 showing the VXP-1000 status reporting mechanism, and how and which common commands are involved in that reporting mechanism.

Table 3-9. The Common Commands

***CLS** Clears all but bit 4 of the Status Byte; bit 4 is the message available bit. Also clears the Standard Event Status Register. (The Status Byte is read using the *STB? command.) The *CLS command must be used to prevent repeat VXI interrupts from recurring due to an old condition that set one or more bits in the Status Byte. See the INTLVL command for further information on VXI interrupts.

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***ESE <mask>** Sets a value for the Standard Event Status Enable Register. Allowable integer values are from 0 to 255. This enable register provides a means of selecting what bits of the Standard Event Status Register are used in the determination of the value of the summary bit. Only bits of the Standard Event Status Register which have corresponding bits set in the Standard Event Status Enable Register can (i.e., are enabled to) influence the value of the summary bit. The summary bit is calculated by forming the logical OR of all such enabled bits of the Standard Event Status Register. (This summary bit is located at bit 5 of the Status Byte. Command *STB? returns the value of the Status Byte. Read about the *STB? command for more information on the Status Byte.)
***ESE?** Queries for the value of the Standard Event Status Enable Register. The value returned is an integer from 0 to 255.
***ESR?** Queries for the value of the Standard Event Status Register. The value returned is an integer from 0 to 255. Only bits 0, 3, and 5 of the Standard Event Status Register are actually used in the VXP-1000 implementation of SCPI; the other bits are always returned as clear. The bits are ordered such that the most significant bit is bit 7, and the least significant bit is bit 0. Bit 0 is the operation complete bit, which is masked until the *OPC command has been executed at least once after power up, after which point bit 0 of the Standard Event Status Register shall be set each time all pending operations complete. Bit 3 is the device dependent error bit, which for the VXP-1000 involves module failure or communication failure in or with a slave VXP-3000 chassis. When a source has any one of the following errors, this bit is set: current limit, servo error, over temperature, over current, sense fault, fuse failure, over voltage, no clock from master, and unrecognized failure. Bit 5 is set for syntax errors and command errors.
***IDN?** Causes an identification string of the following form to be sent ELGAR CORPORATION,VXP1000,[SN],[REV] where [SN]=0 always (SN is not supported, thus it is presently set to 0), and [REV] is the firmware revision level. At the time of the writing of this manual [REV]=1.1. So an example string would be ELGAR CORPORATION,VXP1000,0,1.1.
***OPC** Sets bit 0 of the Standard Event Status Register when any pending operations are complete. This command remains in effect after any power-up once the command has been issued after that power up. If *OPC is not issued after a power-up, bit 0 of the Standard Event Status Register shall remain clear.
***OPC?** A value of 1 is returned by this command when all pending operations are complete. This command is related to the *WAI command.
***RST** This command resets the VXP-1000 system, including all VXP-3000 slave chassis; all source outputs are powered-down and output and sense relays opened. After a source has been reset, upon reprogramming of such a source the default settings are as follows: the maximum current, per the capability of that source; the center frequency, usually 400 Hz; and the default power-on phase defined by the latest, previous use of the *SETPH command.

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***SRE <mask>**
Sets the Service Request Enable Register. This register determines which bits of the Status Byte shall result in a service request device interrupt from the VXP-1000 SCPI controller. Any Status Byte bit is masked when this enable register contains a 0 at the corresponding bit location. Masked Status Byte bits are prevented from causing an interrupt.

***SRE?**
Returns the present value of the Service Request Enable Register as an integer. The return value always has bit 6 masked to a 0 -- even if bit 6 is set in the actual Service Request Enable Register. Thus, if a mask value of 255 were written using the ***SRE <mask>** value, the return value obtained by using the query command ***SRE?** is $255-2^6 = 191$.

***STB?**
Returns the present value of the Status Byte as an integer. The VXP-1000 SCPI implementation uses only bits 4, 5, and 6; all other Status Byte bits remain clear at all times. The meanings of bits 4, 5, and 6 follow.

Bit 4 is the message available bit. It is set if an output message is presently buffered and ready to be read. Reading the Status Byte by using the ***STB?** command clears this bit. This bit generally gets set for most non-error-type messages that result from most query commands. For most error-type messages it does **not** get set. Reading the Status Byte itself as a consequence of the ***STB?** query command produces a simple number message that does not cause this bit to be set. Note that since the VXP-1000 does not queue output messages, the ***STB?** command's output would overwrite any previously buffered message. Thus, if the user desires to check for query response messages, this should be done by using the interrupt mechanism; see both Figure 3-1 following this table of commands, and read about the INTLVL commands in the Special Purpose Star Command table for further information on what conditions produce a VXI interrupt from the VXP-1000 SCPI controller.

Bit 5 is the summary bit for the Standard Event Status Register. This summary bit is the logical OR of all of the bits of the Standard Event Status Register. Read about the ***ESR?** command for more information on the Standard Event Status Register. See Figure 3-1 following this table of commands for further information on the Standard Event Status Register.

Bit 6 is the master summary status (mss) bit. The mss bit is set if any reason exists for which service is requested. In the VXP-1000 implementation, this bit is subject to masking by the Service Request Enable Register, since this bit reflects whether the VXP-1000 is requesting a VXI interrupt. See Figure 3-1 following this table of commands for further information on the mss bit.

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***TST?**
Internal self test command. Returns an ASCII "0" if successful; returns an ASCII "1" if any failure was encountered. After the self test has completed, one may use the SYSTem:ERRor? query command for a more specific error message. The self test error message starts with the message string TEST FAILURE : which shall be concatenated by one or more of the following message substrings for the first failed module. Whether that module is AC and DC, the following two error substrings may appear:

```
VOLTAGE BLK [N] SLT [M]
CURRENT BLK [N] SLT [M]
```

These two error substrings may appear for AC modules only:

```
FREQUENCY BLK [N] SLT [M]
PHASE BLK [N] SLT [M]
```

A separating space precedes each of the above four substrings. If more than one module failed, the above message applies only to the first failed module. (During self test, at the point in time when the testing of a particular module begins, that module's LED is turned-off; when that module has been fully tested and it passes that self test, before proceeding with testing of the next module, that module's LED is turned-on again; otherwise it remains off to indicate a failed module. The self test goes to the next module for testing, even if the previous module failed self test. In the very unusual event that more than one module is simultaneously failing self test, to help determine which modules are failing, physically observe the LED indicator on each module during self test and note that -- except for the last module in the test sequence -- a module's LED remains off during the testing of subsequent modules if and only if that module has failed self test.) The maximum length for this error message is 127 characters. Any further concatenation of error substrings beyond 127 characters total error message length is prevented.

***WAI**
Causes the VXP-1000 to wait until all previous commands or queries complete. Commands that follow the *WAI command are then processed. Since the VXP-1000 is neither a pipelined nor a multitasking machine, commands are always executed and completed in sequence as though *WAI were always in effect, even when *WAI is never used. The VXP-1000 only holds the present line of SCPI commands that are being processed.

Figure 3-1 shows the VXP-1000 status reporting mechanism, and how and which star commands are involved in that reporting mechanism. Except for the *INTLVL special purpose star command, all other star commands mentioned in this figure are common commands.

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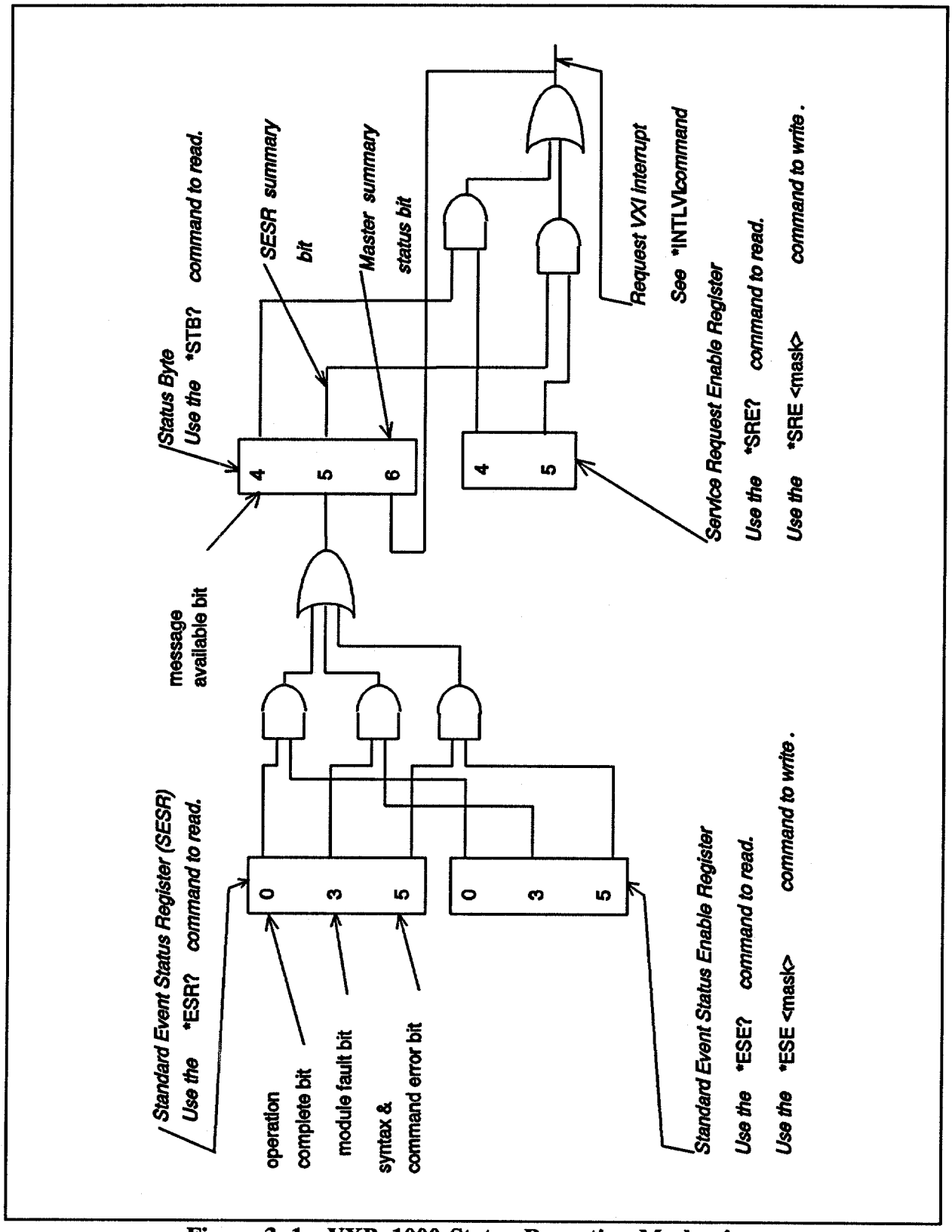


Figure 3-1. VXP-1000 Status Reporting Mechanism

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3.3.8.1 *Fault Detection and Status and VXI Interrupts*

The following example shows a sequence of SCPI commands that set up the VXP-1000 to produce a VXI interrupt when a fault occurs, such as a shutdown due to over current, in a source. Assuming that the fault occurs in only one source, the following example also shows how to determine the particular source at fault. (As an alternative to the following example, to identify each of the faulted power modules in a multiple module fault condition, poll each and every source using the SOURce[n]:CURRent:PROTection:TRIPped? query command. Because the following example does not involve the TRIPped command, it is limited to identifying only one faulted module in the less common event of a multiple module fault.)

Example:

Viewing the conceptual logic diagram given in Figure 3-1, one can see that the module fault bit in the Standard Event Status Register must be unmasked (unmasked by setting the corresponding bit in the Standard Event Status Enable Register) in order for the SESR summary bit in the Status Byte to be set when a module fault occurs. The following command performs this unmasking:

```
*ESE 8
```

In order to also produce a VXI interrupt upon such a module fault, the setting of the SESR summary bit must be allowed to cause an interrupt. This is done by setting the SESR masking bit in the Service Request Enable Register. Also, the VXI interrupt level that the VXP-1000 shall choose (whether 0, through 7) to flag that a fault has occurred depends upon any previous assignment by the *INTLVL command. If the *INTLVL command has not been used since power-on of the VXP-1000, the interrupt level default is 7. So, for the sake of this example, establish that the interrupt level on which the interrupt is to occur as 3. No matter which interrupt is selected, the SESR summary bit must be unmasked:

```
*INTLVL 3
 *SRE 32
```

For this particular example, when the VXP-1000 produces a level 3 interrupt, because of the selection of bits enabled by the *ESE and *SRE commands above, it can produce that interrupt for no other reason except that a module fault has occurred. Upon such an interrupt, to obtain a string of information that indicates the nature of the fault, and which source was at fault, send the following query command:

```
SYST:ERR?
```


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In order to reset the power module (and thus clear the module fault bit in the Standard Event Status Register), use the SOURce[n]:CURRent:PROTection:CLEar command. Assume, for this example, that the message returned by the SYST:ERR? query identified that source 12 had faulted. Then use the following command to reset source 12:

```
SOUR12:CURR:PROT:CLEAR
```

If the above fails to clear the module fault bit, then other modules are also at fault; in this case the global *RST command might be used to clear all modules at once (and any modules not in the fault state shall also be reset, with their outputs programmed to zero as a consequence of the *RST command). Only one module fault message is queued, so identifying further modules in the fault state by the SYST:ERR? command is not possible.

To clear the status byte so that further interrupts due to the above cleared fault are not regenerated by the bit still set in the Status Byte, use the clear status byte command:

```
*CLS
```

3.3.9 Special Purpose Star Commands

The table below lists the special purpose star commands.

Table 3-10. The Special Purpose Star Commands

***CLEAR** Erases the entire System Configuration Map that was defined by one or more uses of the *SETCH command. The *CLEAR command is used only during the configuration process.
***CONFIG** Causes the VXP-1000 controller to scan every chassis for each and every power module installed in those chassis', and records what it finds in the System Configuration Table of the VXP-1000 non-volatile memory. The information so recorded comes from the tag memory within each power module. This table of information allows the VXP-1000 controller to know when a power module is missing or no longer communicating; as well as to store calibration coefficients specific to each power module (these coefficients are also extracted from the tag memories during *CONFIG). The *CONFIG command is quite slow in execution; allow at least 30 seconds per VXP-3000 slave chassis in the entire VXP system for *CONFIG to complete. This command is used only during the configuration process.
***INTLVL [n]** Allows the VXI interrupt to be selected; any value from 1 to 7 is allowed.
***INTLVL?** Returns an integer value from 1 to 7 indicating the interrupt selected using the *INTLVL [n] command. The default interrupt selected after power-on-reset is 7.

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***SETCH**

This command defines source numbers by mapping them to power modules. Each successful invocation of the *SETCH command generates an entry in the System Configuration Map; assuming that the System Configuration Map does not already contain that entry. It has two syntax forms, a simple, and a complex form. The simple form is as follows:

```
*SETCH  [N],[B],[S]
```

where [N] is the source number, [B] is the block (i.e., chassis) and [S] is the slot within that chassis. For example, to define source 3 to identify with (i.e., to map to) the power module in block 2 at slot 5, use *SETCH 3,2,5.

The complex form itself involves two distinct cases. The first case is used only with DC modules to define a source that controls DC modules as a group all wired at the outputs in electrical parallel. The general syntax for this case is:

```
*SETCH [N],[B1],[S1],[B1],[S2]
```

where [N] is the source number, [B1],[S1] identifies the block and slot of the first DC module (always numbering the slots right to left) in the parallel group, and [B1],[S2] identifies the block and slot of the last DC module in that parallel group at the left-most location when facing the chassis (i.e., block) from the front. The group must be contiguous, with no gaps or wrong module types interspersed in that slot range. Only DC modules in the same block and of the exact same voltage and current rating may be paralleled. The sense leads are not paralleled; the sense lead for the parallel group comes from the module in the lowest numbered slot only. For example, define source 4 to be the parallel combination of three 20 volt DC modules in slots 1, 2, and 3 of block 1:

```
*SETCH 4,1,1,1,3
```

Notice that the module in slot 2 is not explicitly referenced, since it is included in the slot range that starts from slot 1 and ends with slot 3. The sense leads come from the module in slot 1 only.

The second distinct case for the complex form of the *SETCH command is:

```
*SETCH [N],[B1],[S1],[B1],[S1],[B2],[S2],[B2],[S2],...
```

The above form is used to define a single source number [N] that may be used to control a set of modules that are not wired in parallel. Notice that the form [B1],[S1],[B1],[S1] identifies the same module as both the beginning and end of a range of modules that actually contains only one module in that range. Notice that a second such range is included. This defines a second module that also receives programming when source [N] is sent commands. Both the first module and the second module receive the same commands simultaneously, but these two modules are not wired in parallel. This second form may be used with AC and DC modules (though not with AC and DC modules included in the definition of the same source number), and is useful for defining a single source number to which a reset command may be directed for a group of modules to be reset simultaneously by using the SOURce[n]:CURRent::PROTection:CLEar source reset command. The following example defines source 5 as composed of three DC modules in slots 6, 7, and 8 in block 1:

```
*SETCH 5,1,6,1,6,1,7,1,7,1,8,1,8
```

The *SETCH command should only be used at configuration time.

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***SETPH [n],<value>**

This command sets the power-on default phase for single module AC source [n]. Note that, unlike all other VXP-1000 SCPI commands that receive or report phase in units of radians, the *SETPH command receives the value in degrees. This command is used only during configuration time. Note that the power-on default phase value just programmed by the *SETPH command does not take effect until after the VXP-3000 chassis that holds the associated AC power module has its power cycled off for at least 5 seconds, and then powered-on again. Such power-cycling of a VXP-3000 chassis typically causes no difficulties or problems as long as commands are not being processed by the VXP-1000 during the power cycling of the attached VXP-3000.

***TAG <block>,<slot>,<module type>,<serial number>,<max voltage>,<max current>,<min frequency>,<max frequency>**

This command initializes the tag memory of the power module located at the supplied block and slot. This command is a service-oriented command, and more likely than not shall never be used at a typical installation. In fact, the use of the *TAG command always causes the calibration constants stored in the tag memory to be cleared. SCPI does not provide any commands for restoring those constants. Thus, an accuracy shift may be noticed in the output of a module after its tag has been reprogrammed and *CONFIG command has be run again to read those consequently cleared calibration constants. In any case, if the *TAG command is used, caution to avoid entry errors (whether typographical or informational or accidental field omission or misplacement) must be maintained when issuing the *TAG command; otherwise, the tag memory contents may become corrupted. The *CONFIG command causes the controller to read the tag memory of a module to obtain module type and module operating limits information; and if the tag information is incorrect in a particular module, the controller may very possibly behave incorrectly relative to that module based on that wrong tag information. The *TAG command should not be used at all, but if it must be used, that should only be just before final configuration (by final issuance of the *CONFIG command) -- with the added requirement that a previous configuration has already been completed (by a previous use of the *CONFIG command) that has already identified all of the attached chassis. The following describes the various parameters.

Parameter Name	Parameter Type	Range of Values	Default Units
block	Numeric	1 through 16	None
slot	Numeric	1 through 8	None
module type	Numeric	1(AC Master) 2(AC Slave) 128 DC, 128	None
serial number	Numeric	000000 through 999999	None
maximum voltage	Numeric		None
maximum current	Numeric		None
min and max frequency	Numeric	350 Hz through 1000 Hz	None (See note below)

Note: For DC modules, each frequency parameter should be given a value of zero.

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***TAG? <block>,<slot>**
Queries for the tag information directly from the module at the supplied block number and slot number. An example response string for the query command *TAG? 2,1 regarding a DC module in block 2 at slot 1 might be
TAG DATA TYPE DC SERNO 123456 MAXV 40.00 MAXI 5.00
An example response string for the query command *TAG? 1,3 regarding an AC module in block 1 at slot 3 might be
TAG DATA TYPE AC SERNO 654321 MAXV 135.00 MAXI 5.56 MINF 350.00 MAXF 450.00
In order for the *TAG? query command to work for any module placed in any slot of any chassis, the involved chassis must already have been included in the most recent issuance of the *CONFIG command. In other words, if the present configuration does not know of the chassis in which the power module is installed to which the *TAG? query command is directed, then an empty string is returned by the *TAG? query command. If the chassis is included in the most recent configuration, but the module is not installed, or if the module tag memory contents is corrupt, then the message returned is
TAG NOT INITIALIZED OR NO MODULE.

3.4 PROGRAMMING

Note

The following programming example is for a VXP-3000 System containing two single slot VXP DC modules and three double slot VXP AC modules. Familiarity with the VXP-3000 is required. Some VXP-3000 specific information follows as a convenience; after that, please refer to the VXP-3000 Operating Manual for further information.

Figure 3-2 shows some of the various possible settings for the DIP switch on a VXP-3000 slave chassis controller. When this manual refers to chassis 3, for example, what is being referred to is a chassis whose controller has its DIP switch set to address 3, per this figure. The maximum chassis address is 15. Address 0 is reserved for the VXP-1000 controller.

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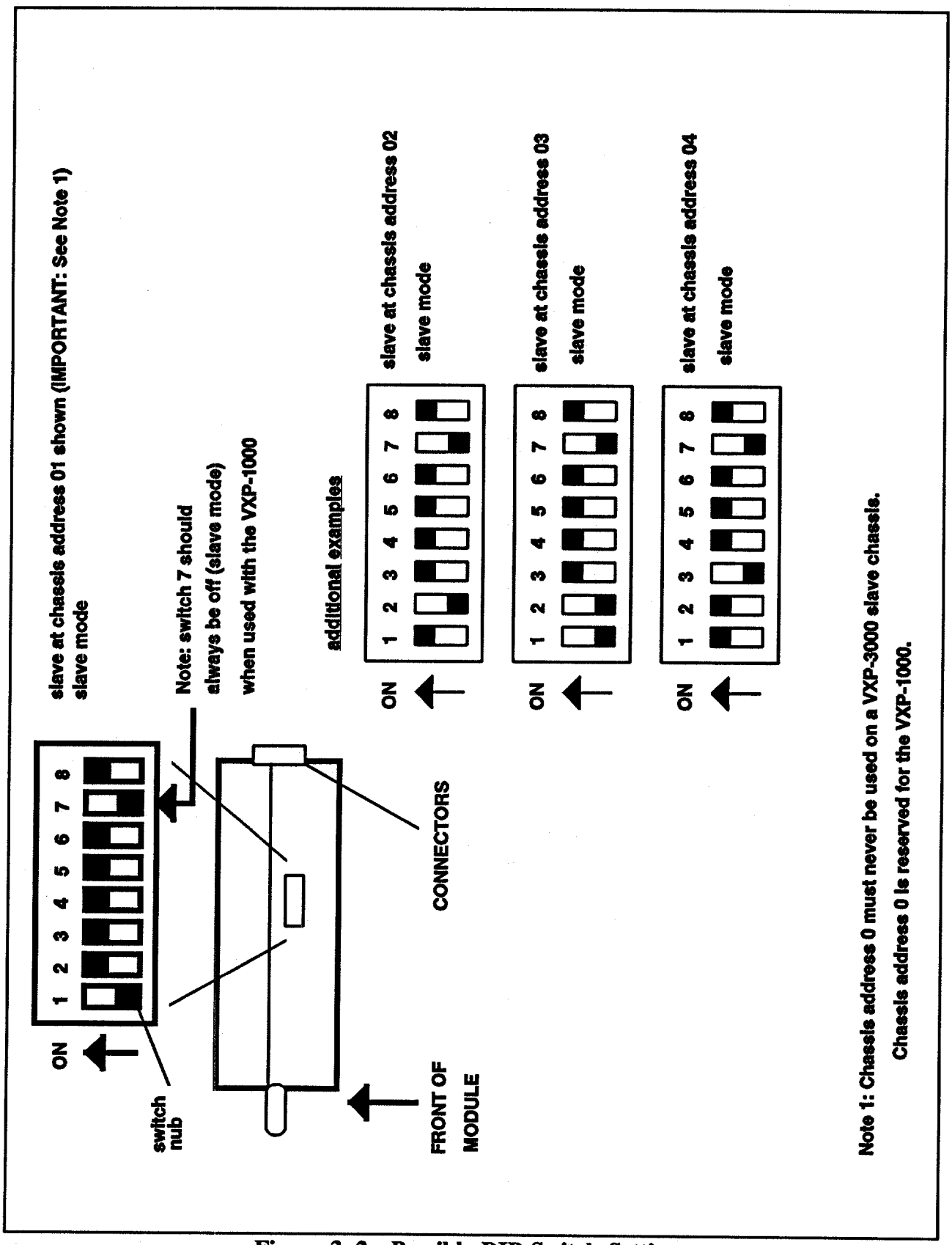


Figure 3–2. Possible DIP Switch Settings

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3.4.1 System Cable and Addressing Setup Information

3.4.1.1 *Address Selection For Each VXP-3000 Slave Chassis*

For each VXP-3000 chassis, reference Figure 3-2 in order to set the chassis address DIP switch. The VXP-3000 control module in each VXP-3000 chassis is located at slot 0 of that chassis, where the slots are always numbered right to left (when facing the chassis from the front). For the chassis address DIP switch on the first chassis, set that switch such that positions 1 and 7 are ON and the remainder of the positions are OFF. Position 7 being ON makes the VXP-3000 a slave. Setting position 1 ON gives the first VXP-3000 chassis the first block address of 1. For subsequent chassis, set positions 1 through 4 appropriately to get sequential block address of 2, 3, and so forth, without skipping address values, and without being out-of-order. When involving a VXP-1000, all VXP-3000 chassis address DIP switches always have position 7 ON to make each VXP-3000 chassis a slave chassis, since the VXP-1000 is to be the master.

For systems with multiple VXP-3000 chassis, daisy-chain the chassis together by use of an Elgar interconnection cable (shipped with the system, P/N 5211413-01) between each pair of adjacent chassis such that the addresses are ascending from 1 to the last chassis. Each cable connects at the lower-addressed VXP-3000 chassis at **J8** to the higher addressed VXP-3000 chassis at **J9**.

3.4.1.2 *Attaching the VXP-1000*

Connect the Elgar interconnection cable (shipped with the system, P/N 5211413-01) between the connector marked **OUTPUT** on the VXP-1000 and the connector marked **J9** on the back side of the VXP-3000 chassis with block address 1.

- Apply power to the VXP-1000.
- Apply power to each VXP-3000.
- Wait at least 15 seconds before sending any commands to the VXP-1000 for all chassis to fully power on.

3.4.2 System Configuration

The text below provides a minimal discussion of the configuration process commands for the VXP-1000. Subsection 3.4.2.4 provides some examples of the operation related commands. For a detailed discussion of the configuration process commands -- based on three example systems -- see Section IV.

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3.4.2.1 *Preparation*

Enter the commands in the order shown below:

1. *CONFIG <NL>
   This command causes the VXP–1000 to scan all attached VXP–3000 slave chassis to determine what power modules are installed at what slots in what blocks (chassis'). During this command the System Configuration Table in the non–volatile memory of the VXP–1000 is built. Wait at least 30 seconds per the number of slave VXP–3000 attached chassis before attempting to send another command. Each power module LED should be lit after *CONFIG has identified each module. Even if the LEDs become lit early, wait the full 30 seconds per the number of attached VXP–3000 slave chassis.

The following *TAG? query commands are used to verify that each installed module is indeed in communication with the VXP–1000.

2. *TAG? 1,1 <NL>
   This command queries what device is currently installed in Slot 1.

3. *TAG? 1,2 <NL>
   This command queries what device is currently installed in Slot 2.

4. *TAG? 1,3 <NL>
   This command queries what device is currently installed in Slot 3.

5. *TAG? 1,5 <NL>
   This command queries what device is currently installed in Slot 5.

6. *TAG? 1,7 <NL>
   This command queries what device is currently installed in Slot 7.

Entering *TAG? 1,2 returns:

```
TAG DATA TYPE DC SERNO 000001 MAXV 40.0 MAXI 5.0
```

Entering *TAG? 1,5 returns:

```
TAG DATA TYPE AC SERNO 000002 MAXV 130.0 MAXI 5..78 MINF 350.0
MAXF 450.0
```


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If the use of the *TAG? query command ever fails to produce a communication with a module just after the *CONFIG command has been allowed to complete, this implies that the *CONFIG command failed, as well as the *TAG? command, to communicate with that module that is not responding to the *TAG? command. Check all communications cables. Check all switch settings in the VXP-3000 to make sure that their slave addresses are correct, and that each such slave has the slave switch set. See Figure 3-2 on setting the block address of a VXP-3000 and establishing the correct switch setting to place the VXP-3000 into slave mode. Afterward, again attempt the *CONFIG command to thereby pick up the previously undetected module, and then verify that communications via the *TAG? query command is established.

3.4.2.2 *Source Mapping Information*

When setting up the source mapping, this configuration example assumes the following:

1. SOURCE1 is a single slot 40 volt module in Slot 1.
2. SOURCE2 is a single slot 40 volt module in Slot 2.
3. SOURCE3 is a virtual module (Parallel) in Slots 1 and 2.
4. SOURCE4 is Phase A of an AC system in Slot 3.
5. SOURCE5 is Phase B of an AC system in Slot 5.
6. SOURCE6 is Phase C of an AC system in Slot 7.
7. SOURCE7 is a virtual module of Phases A, B, and C simultaneously.

3.4.2.3 *Source Mapping*

To map the sources, enter the following commands in the order shown:

1. *CLEAR<NL>
   This command clears the previous mapping of the system.
2. *SETCH 1,1,1<NL>
   This command maps (i.e., defines) SOURCE1 to the module at Block 1, Slot 1.
3. *SETCH 2,1,2<NL>
   This command maps SOURCE2 to be the module at Block 1, Slot 2.

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4. *SETCH 3,1,1,1,2<NL>
   This command maps SOURCE3 to be the parallel combination of two DC modules, namely the DC module at Block 1, Slot 1 and the DC module at Block 1, Slot 2. Only DC modules may be paralleled; and only DC modules of the same voltage and current ratting; and only DC modules in the same VXP-3000 chassis, at that.

5. *SETCH 4,1,3 <NL>
   This command maps SOURCE4 to the AC module located at Block 1, Slot 3. Since AC modules are always loaded so as to require two slots, with the odd numbered slot always the lesser numeric value, the odd numbered slot is always used to reference the AC module. Thus, the "3" in the "1, 3" above.

6. *SETCH 5,1,5 <NL>
   This command maps SOURCE5 to be the AC module at Block 1, Slot 5.

7. *SETCH 6,1,7 <NL>
   This command maps SOURCE6 to be the AC module at Block 1, Slot 7.

8. *SETCH 7,1,3,1,3,1,5,1,5,1,7,1,7 <NL>
   This command maps SOURCE7 to simultaneously address the non-parallel set of the same three AC modules mentioned above, again at Block 1, Slot 3; Block 1, Slot 5; and Block 1, Slot 7. The convenience of having a single source number that maps to all three modules is that a single reset action may be directed towards SOURCE7 to cause all three AC modules to be reset at the same time. See the SOURce[n]:CURRent:PROTection:CLEar command as a means of resetting a certain source.

The System is now configured.

3.4.2.4 *Operating Commands*

The following commands function once the initial configuration of the system has been performed. The system configuration is stored in non-volatile memory; therefore, it is not necessary to perform the configuration setup every time power is applied to the system.

For practice, enter the following:

1. SOUR1:VOLT 10;CURR 1;:OUTP1:STAT ON <NL>
   This command sets SOURCE1 to output 10 volts at 1 amp and sets the OUTPUT relay ON.

2. MEAS1:VOLT?;CURR? <NL>
   This command measures SOURCE1 voltage and current.

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3. `SENS1:VOLT:DET 1 <NL>`
   This command directs the use of the external voltage sense line for SOURCE1.

4. `SENS1:VOLT:DET 0<NL>`
   This command directs the use of an internal voltage sense line for SOURCE1.

5. `SOUR7:VOLT 115 <NL>`
   This command brings up the 3-phase supply to 115 volts.

6. `MEAS4:VOLT?;:MEAS5:VOLT? <NL>`
   This command measures the Voltage of SOURCE4 and SOURCE5.

7. `MEAS4:PHAS?;:MEAS5:PHASE? <NL>`
   This command measures the Phase Angle of SOURCE 4 and SOURCE 5.

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NOTES

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SECTION IV

CONFIGURATION EXAMPLES

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4.1 INTRODUCTION

The Elgar Model VXP-1000 with one or more VXP-3000 slave chassis form an extremely versatile programmable power source system, and can have a practically unlimited number of user configurations. The set-up of a VXP-1000 and VXP-3000 system involves two main steps: hardware configuration and software configuration. This section details three example systems and the use of SCPI on the VXP-1000 to configure each example system.

4.2 CONFIGURATION COMMANDS

The software configuration process for a VXP-1000 and VXP-3000 system is dependent upon the hardware configuration of that same system. Since a very large number of possible hardware configurations exist, three example systems shall be presented: A simple all DC-module system. A simple all AC-module system; and a more complex system that mixes AC and DC modules.

The term "MXI-VXI computer" is used below; this term is identifying a typical PC computer containing a MXI interface board with the assumption that the PC computer is also running National Instruments software that interfaces with the MXI board. The MXI board installed in a slot of the PC is attached by a heavy cable to the MXI compatible VXI controller in slot 0 of the user's VXI chassis. Also, in a non-zero slot of the VXI chassis is the VXP-1000 controller. Referencing Figure 4-1 (or 4-2), below, may help clarify the following discussion. Assuming that the PC is running that National Instruments MXI interface software, the assumed communication path that the commands discussed below take is that they are typed at the keyboard of the PC computer, and the National Instruments MXI interface software takes those commands and sends then to the MXI board. The MXI board in turn sends them to the slot 0 controller of the user's VXI chassis. The slot 0 controller then communicates over the VXI back plane to the VXP-1000 that is also installed into the VXI chassis. The VXP-1000 translates those commands into low level commands appropriate for the one or more VXP-3000 chassis' that are attached, and sends those commands to the appropriate VXP-3000 chassis slave controller(s) via the Elgar interconnection cable. The user's VXI system might not be using the MXI interface. In this case the user has some other means of providing the command strings to the slot 0 controller of the user's VXI controller, such as GPIB perhaps. This manual assumes the MXI interface for the sake of reference.

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Figure 4-1 illustrates a simple DC only VXP-1000 and VXP-3000 system. The power modules consist of two 40 volt DC power modules, four 20 volt DC power modules, and two 32 volt DC power modules.

4.2.1 Configuration Command Sequence For Simple DC System

This section details the configuration process for the simple DC-only system shown in Figure 4-1. The following listing contains a mixture of SCPI configuration commands, commands to the human operator, and commands to the user's MXI-VXI system. This listing might be the basis of an interactive script file that runs on the user's MXI-VXI computer. The user's MXI-VXI computer, while running such a script file, would successively sends SCPI commands intermixed with prompts to the human operator and commands to the user's MXI-VXI computer. On the other hand, if the script file concept seems impractical, then the following listing may be manually performed, typing the various SCPI commands at the user's MXI-VXI computer, and performing the specific directions given to the operator, etc. This configuration process results in the storage of information into the non-volatile memory within the VXP-1000, thereby preserving the configuration information; thus, this configuration process need not be repeated after each time the VXP-1000 is powered-on. As stated earlier in Subsection 3.3, the recommendation is made that, unless specified otherwise, at least one full second be given for each configuration command to complete before a subsequent configuration command is sent. In the listing following Figure 4-1 the commands are distinguished by `courier` type.

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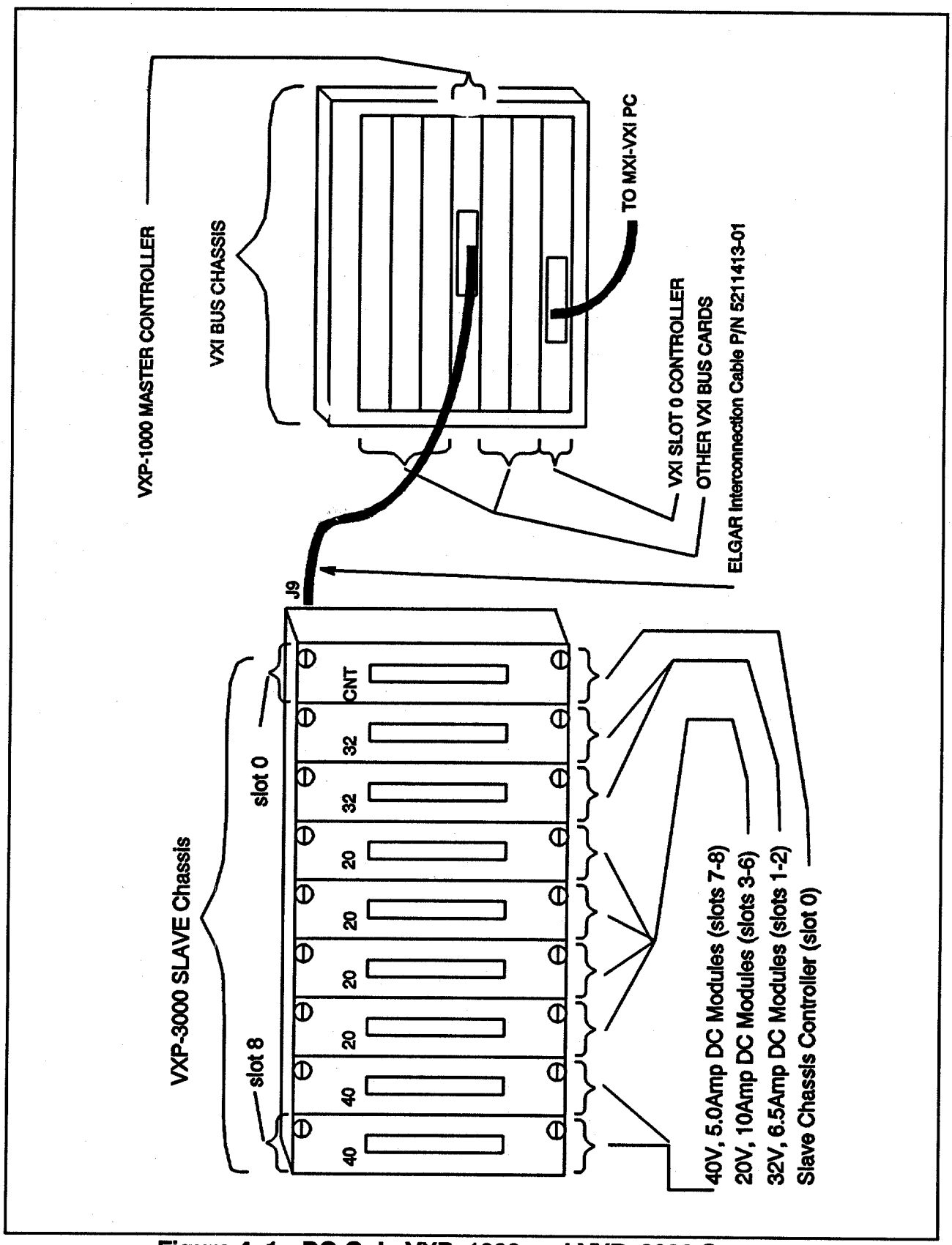


Figure 4–1. DC Only VXP–1000 and VXP–3000 System

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Step 1	*CLEAR
Step 2	*CONFIG
Step 3	Operator: Wait 30 seconds (this wait should be longer for a larger system with more chassis, an additional 20 seconds per additional chassis, or more may be required -- be generous).
Step 4	*SETCH 1,2,1
Step 5	*SETCH 2,2,2
Step 6	*SETCH 3,2,3
Step 7	*SETCH 4,1,4
Step 8	*SETCH 5,1,5
Step 9	*SETCH 6,1,6
Step 10	*SETCH 7,1,7
Step 11	*SETCH 8,1,8
Step 12	*SETCH 20,1,1,1,1,2,2,2,2
Step 13	*SETCH 15,1,7,1,8
Step 14	SYST:ERR?
Step 15	To MXI-VXI computer: Read query response string and display that to the operator.
Step 16	Operator: Study the response from the SYST:ERR? command; verify that no error responses resulted from the execution of the preceding sequence of SCPI commands. If any errors are reported, then some problem must be fixed before this script file can be deemed successful. Re-running this script file after the offending condition is eliminated may be necessary before the software configuration and initialization is successful.

The following is a discussion of the actions taken at most of the steps in the above listing:

At step 1 the *CLEAR command is given. This command clears the non-volatile configuration memory in the VXP-1000 controller of all source number to module mapping information; steps 4 through 13 above provided that information, to be discussed further below.

At step 2 the *CONFIG command is given. *CONFIG causes the VXP-1000 to scan every slot in every attached VXP-3000 chassis, to thereby detect what power modules are installed throughout an entire VXP system. The detection process involves the VXP-1000 attempting to read the TAG memory of every module installed anywhere in that system. The data received from each TAG memory is stored into the VXP-1000 non-volatile memory. Module type ID, calibration constants, maximum voltage and current values, etc., are the types of data that are acquired from each TAG memory and stored in the VXP-1000.

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As each module is detected, the LED on the front of the module is turned on (if that LED is not already on). One must understand that the above actions only take place as a consequence of the *CONFIG command. These actions do not take place as a consequence of merely powering down and up a VXP-1000 and VXP-3000 system.

*CONFIG is very rarely used, since the VXP-1000 holds the information -- acquired by the past use of *CONFIG -- in its non-volatile memory. This non-volatile memory normally reduces the need to use *CONFIG to only those times when a change in the hardware configuration of one of the attached VXP-3000 chassis occurs, such as when a new power module has been installed, or a power module has been moved to a different slot, etc.

Steps 4 through 11 each perform a basic assignment of a source number to a chassis slot.

Step 12 defines source20 to reference both the module at block 1 slot 1 and the module at block 2 slot 2. Notice that since block 1 slot 1 is listed twice (notice the "1,1,1,1" in step 12); this double listing implies that the module at block 1 slot 1 is in parallel with itself; in other words, this double listing is the syntax used to inform the *SETCH command that the module at block 1 slot 1 is **not** in parallel with any module, actually. The double listed reference to the module in block 2 at slot 2 includes that module also when source20 is referenced. Thus, whenever source20 is programmed to a particular voltage, both the module at block 1 slot 1 and the module at block 2 slot 2 are nearly simultaneously programmed to the same voltage, current, and protection mode characteristics. A slight time skew would exist in the response of the module in block 1 slot 1 and the module in block 2 slot 2 to commands sent to source20 simply because these two modules are not in the same block, and communication overhead exists between these two blocks. But the time skew should be very short (typically much less than a second if the two chassis {blocks} are adjacent to each other in the VXP-3000 daisy chain). Though these two modules receive nearly simultaneous commands when source20 is referenced, these two modules must **not** be wired in parallel at their outputs.

Step 13 defines source15 using a syntax that shows a single reference to the module at slot 7 and the module at slot 8, both in block 1. This demonstrates the syntax for placing modules in parallel. If three modules in slots 6, 7, and 8 were all to be placed into parallel when programmed through source15, the SCPI command would have been *SETCH 15,1,6,1,8. Modules placed in parallel must be in the same block (chassis).

Step 14, where the command SYST:ERR? is used, is a request for the error status of the VXP-1000 controller. The user's MXI-VXI computer should be directed to read the response of this command when the response has been returned, and to present that response to the operator. If the operator sees any error conditions mentioned in the response string, then one or more configuration and initialization command or commands had a difficulty, and likely did not have the intended effect.

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Figure 4–2 illustrates a simple AC only VXP–1000 and VXP–3000 system. The power modules consists of three 135 volt, 5.56 Amp AC power modules.

4.2.2 Configuration Command Sequence For Simple AC System

This section details the configuration process for the simple AC–only system shown in Figure 4–2. The following listing contains a mixture of SCPI configuration commands, commands to the human operator, and commands to the user's MXI–VXI system. This listing might be the basis of an interactive script file that runs on the user's MXI–VXI computer. The user's MXI–VXI computer, while running such a script file, would successively send SCPI commands intermixed with prompts to the human operator and commands to the user's MXI–VXI computer. On the other hand, if the script file concept seems impractical, then the following listing may be manually performed, typing the various SCPI commands at the user's MXI–VXI computer, and performing the specific directions given to the operator, etc. This configuration process results in the storage of information into the non–volatile memory within the VXP–1000, thereby preserving the configuration information; thus, this configuration process need not be repeated after each time the VXP–1000 is powered–on. As stated earlier in Subsection 3.3, the recommendation is made that, unless specified otherwise, at least one full second be given for each configuration command to complete before a subsequent configuration command is sent. In the listing following Figure 4–2 the commands are distinguished by `courier` type.

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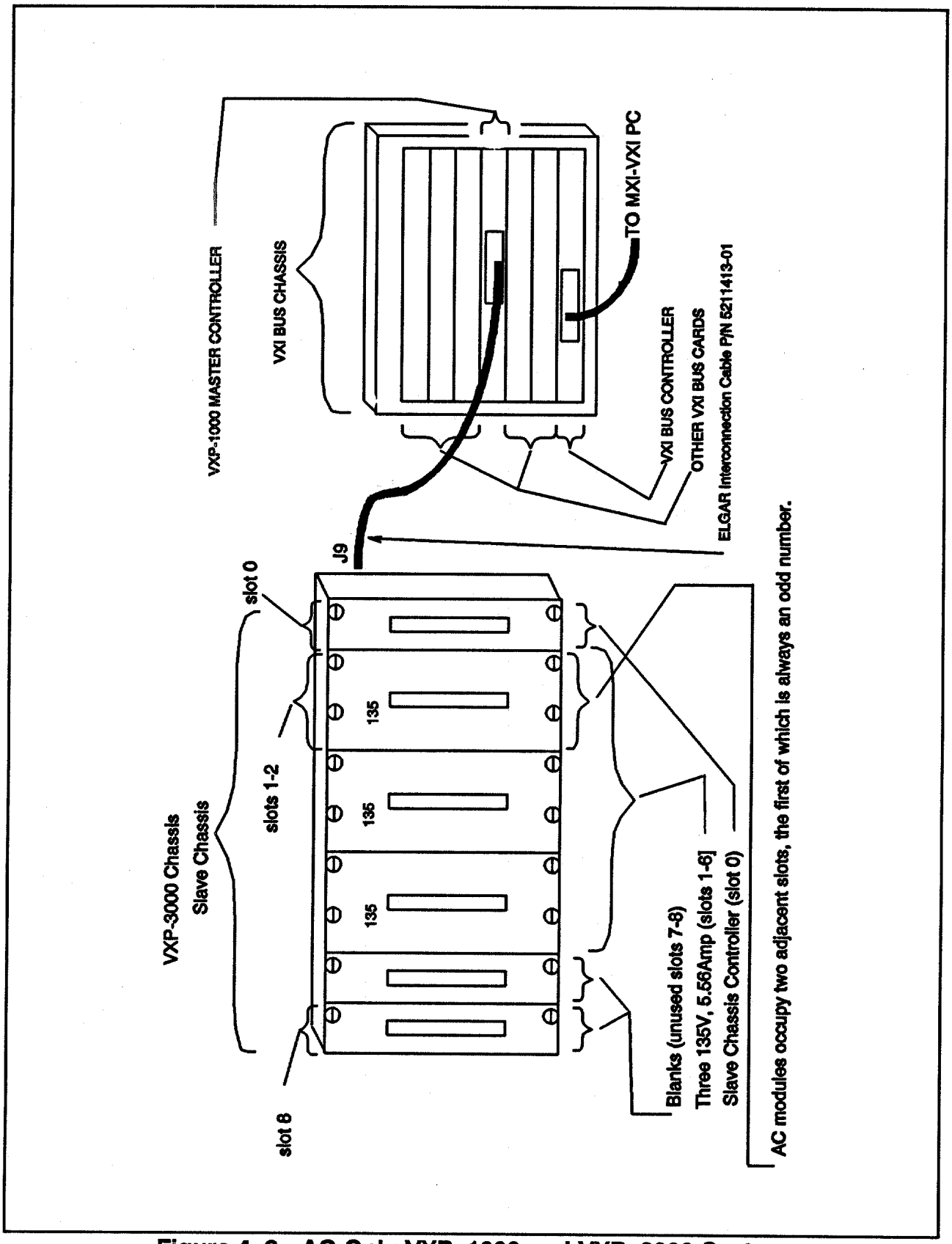


Figure 4–2. AC Only VXP–1000 and VXP–3000 System

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Before the steps below are performed, use the *TAG? query command to verify that the one and only AC module that is tagged as a phase master is indeed installed in slot 5 of the VXP-3000 chassis. If, upon use of the *TAG? command the above is not the case, then arrange the AC modules until such is the case. The phase master must be in slot 5 before configuration per the list of commands below is attempted. If difficulty is encountered in reading the tag memory, then the *CONFIG command should be issued once prior to use of the *TAG? command in order to establish information the *TAG? command needs to access the desired module.

Step 1	*CLEAR
Step 2	*CONFIG
Step 3	Operator: Wait 30 seconds (this wait should be longer for a larger system with more chassis, an additional 20 seconds per additional chassis, or more may be required -- be generous).
Step 4	*SETCH 0,1,1,1,1,1,3,1,3,1,5,1,5
Step 5	*SETCH 1,1,1
Step 6	*SETCH 3,1,3
Step 7	*SETCH 5,1,5
Step 8	*SETPH 1,120
Step 9	*SETPH 3,240
Step 10	*SETPH 5,0
Step 11	SYST:ERR?
Step 12	To MXI-VXI computer: Read query response string and display that to the operator.
Step 13	Operator: Study the response from the SYST:ERR? command; verify that no error responses resulted from the execution of the preceding sequence of SCPI commands. If any errors are reported, then some problem must be fixed before this script file can be deemed successful. Re-running this script file after the offending condition is eliminated may be necessary before the software configuration and initialization is successful.
Step 14	Power down VXP-3000 chassis #1 (block #1) for 5 seconds, and then power up again to cause the power-on phase settings programmed by the occurrences of *SETPH commands above to take effect.

Steps 1 and 2 have the same explanation as was given earlier for the simple DC system.

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Steps 4 through 7 again show the use of the *SETCH source number mapping command. Notice that the numbers that follow that command reference only odd numbered slots. An AC power module requires two slots with the lower numbered slot always being an odd numbered sot, and only the lowered numbered slot of an AC module may be referenced. Step 4 shall be discussed further after steps 8 through 10 are discussed below.

Steps 8 through 10 show the use of the *SETPH command. This is the "set phase" command. It functions to establish the phase offset of the AC sources that are phase slaves relative to the one and only AC source that is a phase master. Consequently, only systems with more that one AC module in a block (chassis) benefit from the use of the *SETPH command. If the user's system has only one AC module, then that module should already be a phase master. In that case, the *SETPH command need not be used. But when two or more AC modules are installed into the same block, then *SETPH must be used to establish the desired phase relationship between these two AC modules. The phase master is always installed at slot 5 of the VXP-3000 chassis. Consequently, since step 7 above defined source5 to reference the AC module in slot 5, then source5 is the AC master (this also assumes that the tag memory of the module installed in slot 5 has been properly programmed as a AC master -- see the *TAG? command in Subsection 3.3.9 to verify that the tag memory of that module indeed specifies a phase master). Step 8 specifies that the power up phase offset of the output of source1 shall be to lead the output of source5 by 120°.

Note

In SCPI on the VXP-1000, only the *SETPH command receives the phase value in degrees. All other phase related commands per the VXP-1000 implementation of SCPI receive or report phase values using radians (remember, there are 3.141592654 radians per 180°). Step 9 specifies that the power up phase offset of the output of source3 shall be to lead the output of source5 by 240°; and step 10 specifies that the phase master, source5, leads itself by 0°.

Step 4 defines a source0 that is very useful for directing a three phase AC source formed by a VXP-3000 chassis containing three AC modules. Source0 is defined such that all three AC sources can be directed to go to the same voltage at the same time, to close and open their output relays at the same time, etc. However, source0 is not defined with the assumption that the AC modules are wired in parallel; thus, the independent phase relationship between these phase components is maintained. Consequently, no phase related commands should be directed towards source0. Also, any current limit related commands direct each module associated with source0 to the same current limit. Consequently, the total three-phase current limit is three times the current limit programmed by the current limit related command.

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Steps 11, 12, and 13 require the operator to check for any command errors. If errors occurred, the offending condition must be fixed, and the above configuration repeated, or at least, those commands that produced the error must be repeated; how much must be repeated depends upon the dependency of later commands to earlier commands, such as the definition of source numbers and the later reference to those source numbers.

Step 14 establishes the default phase values programmed by steps 8–10.

Figure 4–3 illustrates a more complex two chassis, mixed AC and DC VXP–1000 and VXP–3000 system. The installed power modules consist of three AC modules and four DC modules, most of which are installed into chassis 1, and two modules of which are installed into chassis 2. Note that the slots in each chassis are numbered **right to left**, and that chassis 1 is depicted on the right. The numbering order of the slots from right to left is fixed; i.e., this order can not be changed.

4.2.3 Configuration Command Sequence For Complex System

This section details the configuration process for the more complex mixed DC and AC system shown in Figure 4–3. The following listing contains a mixture of SCPI configuration commands, commands to the human operator, and commands to the user's MXI–VXI system. This listing might be the basis of an interactive script file that runs on the user's MXI–VXI computer. The user's MXI–VXI computer, while running such a script file, would successively sends SCPI commands intermixed with prompts to the human operator and commands to the user's MXI–VXI computer. On the other hand, if the script file concept seems impractical, then the following listing may be manually performed, typing the various SCPI commands at the user's MXI–VXI computer, and performing the specific directions given to the operator, etc.

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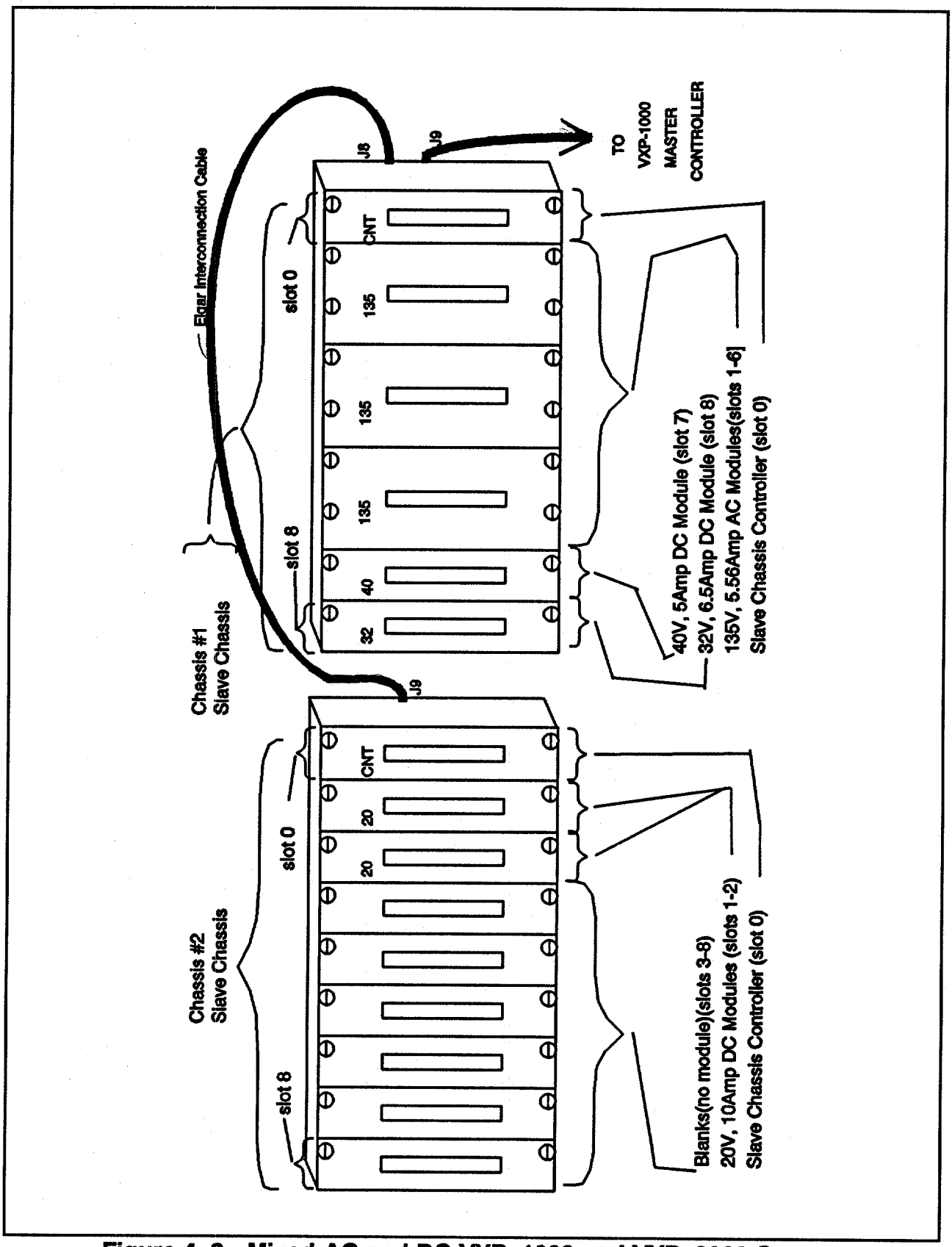


Figure 4–3. Mixed AC and DC VXP–1000 and VXP–3000 System

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This configuration process results in the storage of information into the non-volatile memory within the VXP-1000, thereby preserving the configuration information; thus, this configuration process need not be repeated after each time the VXP-1000 is powered-on. As stated earlier in Subsection 3.3, the recommendation is made that, unless specified otherwise, at least one full second be given for each configuration command to complete before a subsequent configuration command is sent. In the following listing the commands are distinguished by `courier` type.

Step 1	`*CLEAR`
Step 2	`*CONFIG`
Step 3	Operator: Wait 30 seconds (this wait should be longer for a larger system with more chassis, an additional 20 seconds per additional chassis, or more may be required -- be generous).
Step 4	`*SETCH 0,1,1,1,1,1,3,1,3,1,5,1,5`
Step 5	`*SETCH 1,1,1`
Step 6	`*SETCH 3,1,3`
Step 7	`*SETCH 5,1,5`
Step 8	`*SETPH 1,120`
Step 9	`*SETPH 3,240`
Step 10	`*SETPH 5,0`
Step 11	`*SETCH 7,1,7`
Step 12	`*SETCH 8,1,8`
Step 13	`*SETCH 11,2,1`
Step 14	`*SETCH 12,2,2`
Step 15	`SYST:ERR?`
Step 16	To MXI-VXI computer: Read query response string and display that to the operator.
Step 17	Operator: Study the response from the `SYST:ERR?` command; verify that no error responses resulted from the execution of the preceding sequence of SCPI commands. If any errors are reported, then some problem must be fixed before this script file can be deemed successful. Re-running this script file after the offending condition is eliminated may be necessary before the software configuration and initialization is successful.
Step 18	Power down VXP-3000 chassis #1 (block #1) for 5 seconds, and then power up again to cause the power-on phase settings programmed by the occurrences of `*SETPH` commands above to take effect.

Steps 1 through 10 of the above listing have the same effect as the corresponding steps discussed in the earlier presented AC only system.

Steps 11 through 14 are straight forward channel assignment commands, similar to those explained for the earlier DC only system.

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Steps 15 through 17 check for any errors.

Step 18 establishes the default phase values programmed by steps 8–10.

4.2.4 Placing DC Power Modules Where AC Modules Once Were

If the need arises to change the location of a power module such that a DC module needs to be placed where an AC module was once located, with the system once configured for an AC module in that location, then before the system may be software configured and initialized for the DC module being in that location, first the system must be configured for a empty slot at that location. This may be accomplished by simply using *CONFIG with that slot empty. Subsequently, cycle VXP–3000 system power off, install the DC module, and then configure the system again (using *CONFIG and all the other commands necessary for a complete software configuration and initialization process). This two step configuration process is necessary because the master chassis controller uses its non–volatile configuration RAM to determine what type of modules are installed in each slot, which in turn implies that its configuration memory shall assert that the module installed in the slot of concern is an AC module, when in fact it is a DC module. When this incorrect assumption is made, the DC module responds with an undesirable clicking sound as the controller sends AC related commands to the DC module in that slot.

The reverse offers no similar consequence, where an AC module is installed into a slot where a DC module once was installed; that may be done without two configuration steps –– only one configuration step would be adequate in this case.

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