

**$\Sigma^+$  Series**

**Programmable DC Power Supplies  
200W/400W/600W/800W in 2U  
Built-in USB, RS-232 & RS-485 Interface**



**User Manual**  
**Optional Interface:**  
**IEEE488.2 SCPI (GPIB) Multi-Drop**

**TDK-Lambda**

USER MANUAL FOR

# IEEE Programming Interface



## Manual Supplement

Refer to the Z<sup>+</sup> Technical Manual for information on installing the power supply, safety requirements, specifications, operating the front panel, using the serial RS-232/485, USB programming and the analog programming.

## Table of Contents

<b>INTRODUCTION .....</b>	<b>3</b>
<b>SCOPE OF MANUAL .....</b>	<b>3</b>
<b>CHAPTER 1: THE IEEE-488.2 INTERFACE.....</b>	<b>3</b>
<b>CHAPTER 2: CONNECTION .....</b>	<b>4</b>
2.1 Point to Point .....	4
2.2 Multi Drop.....	4
2.2.1 Selecting One Power Supply in a Multi Drop Chain .....	4
2.3 Communication Cables.....	4
<b>CHAPTER 3: CONFIGURATION .....</b>	<b>5</b>
3.1 Configuration the IEEE Controller.....	5
3.2 Configuration the Power Supply .....	6
3.2.1 To Select the Communication Interface .....	6
3.2.2 To Select the Address.....	6
3.2.3 To Select the Baud Rate 57600. (485 Interface only).....	6
3.2.4 To Select the Communication Language SCPI. (485 interface only) .....	6
<b>CHAPTER 4: PROGRAMMING COMMANDS .....</b>	<b>7</b>
4.1 SCPI Protocol .....	7
4.2 SCPI Common Commands.....	7
4.3 SCPI Subsystem Commands.....	8
4.4 The Summary Registers .....	10
4.5 Output Queue .....	11
4.6 Error Messages .....	11
4.7 Execution Time.....	11
4.8 Register Structure .....	12
<b>CHAPTER 5: COMMUNICATION EXAMPLE.....</b>	<b>14</b>

## INTRODUCTION

The internal factory installed General Purpose Interface Bus (GPIB) allows operation of the Z<sup>+</sup> Power Supply from a computer via IEEE-488.

The interface allows the user complete remote control of the Power Supply, including output voltage and current setting and monitoring, protection setting, trigger, waveform list operation, Power Supply status and SRQ reporting.

Communication over the GPIB interface meets IEEE 488.2 standards for Programmable Instrumentation (SCPI) compliant.

## SCOPE OF MANUAL

This manual contains the information needed to operate the optional embedded IEEE(GPIB) Interface used in the Power Supply. It includes the following:

- A general description of the GPIB.
- Connection.
- Configuration.
- Listing and description of SCPI command.
- Communication Example.

## CHAPTER 1: THE IEEE-488.2 INTERFACE

The IEEE-488 digital programming interface (also called the GPIB interface) is a popular way to connect instruments to a computer. It uses a specialized 24-pin cable with connectors that allow cables to be 'stacked' together. There are eight data wires; eight control wires and eight ground wires. If the system runs from a personal computer, there are numerous vendors of IEEE controller cards and software.

The IEEE-488 standard has gone through several upgrades. The IEEE-488.1 focused on the handshaking of the eight control lines. The IEEE-488.2 added status registers inside each instrument and it added common commands to make programming groups of instruments easier. The latest specification, SCPI, adds guidelines for the command syntax so one vendor's Power Supply will use the same commands as another's. The Interface follows all of these standards.

Because many instruments may be connected and independently controlled by a single IEEE controller, each instrument must have a unique address. The IEEE controller automatically sets its address equal to the Power Supply address.

For complete and specific information, refer to the following documents: *ANSI/IEEE Std 488.1-1987 IEEE Standard Digital Interface for Programmable Instrumentation* and *ANSI/IEEE Std 488.2-1987 IEEE Standard Codes, Formats, Protocols and Common Commands*.

This section provides information on variable IEEE (GPIB) connection modes, communication cables and selecting communication parameters for operation via IEEE (GPIB) interface. It is possible connect to IEEE (GPIB) interface in two ways.

**2.1 Point to Point**

One IEEE Interface can control only one Z<sup>+</sup> Power Supply. Refer to Fig.2-1. Each Power Supply must be configured for IEEE communication interface. Each unit must have a unique address, ranging from 01 to 31. Baud rate and address are automatically fixed to "57600" and "SCPI".

**2.2 Multi Drop**

One IEEE Interface can control more than one Z<sup>+</sup> Power Supply. A maximum of 30 Z<sup>+</sup> units can be connected via RS485 interface to a Power Supply with the installed IEEE option. Refer to Fig.2-2. The Power Supply connected to a PC via the GPIB cable must be configured for an IEEE communication interface, the other must be configured for a RS485 interface. Each unit must have a unique address, ranging from 01 to 31. IEEE module gets the address of the unit into which it is installed. For RS485 interface set Baud rate at "57600" bps and Communication Language to "SCPI".

**2.2.1 Selecting One Power Supply in a Multi Drop Chain**

All the SCPI commands may be sent to any one of the Power Supplies in an RS-485 chain by first sending the INST:nSEL address command. All commands and queries will then apply only to the selected Power Supply, until a new INST:nSEL is sent.

At power-up, the IEEE master Power Supply is automatically the one selected.

After sending INST:nSEL, it is recommended that you verify the command by sending INST:nSEL?, otherwise the following commands may be sent to the wrong Power Supply.

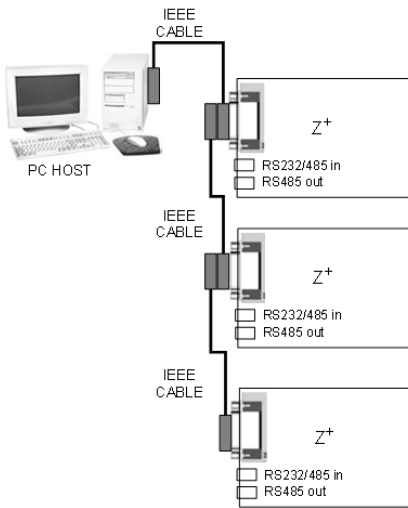


Fig.2-1: Point To Point Connection

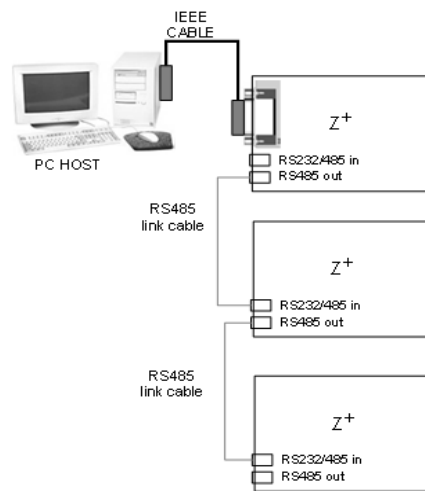


Fig.2-2: Multi Drop Connection

**2.3 Communication Cables**

- GPIB cable - Use standard IEEE-488, 26 AWG GPIB cable up to 3 meters in length.
- RS485 link cable - Use serial link cable with RJ-45 shielded connectors (P/N: GEN/RJ45). Refer to Z<sup>+</sup> Series User Manual Fig.7-8.

### 3.1 Configuration the IEEE Controller

A typical IEEE controller is a personal computer with an IEEE interface card. Each card vendor supplies its own configuration instructions and interface software.

Each time the software is executed, the controller is configured as follows:

- Controller Address = Power Supply address.
- Serial bus Baud Rate = 57600
- SCPI protocol.
- EOI Flag = TRUE. The “End or Identify” is a control line in the IEEE cable that is initiated when the last character of a message string is sent. It is not supported by this interface.
- EOS Flag = FALSE: The “End of String”, used in some instruments to indicate the last character of a message. It is required for this interface.



Fig.3-1: Front Panel



Fig.3-2: Rear Panel

1. AC ON/OFF Switch
2. REM LED/Buttom
3. Voltage Encoder
4. Voltage Display
5. Current Encoder
6. Current Display
7. RS-232/RS-485 INPUT Remote Serial Programming
8. RS-485 OUTPUT to other Z+ Power Supplies

## 3.2 Configuration the Power Supply

Refer to Fig.3-1.

### 3.2.1 To Select the Communication Interface

1. Press REM button. The LED is illuminated. "iNEF" appears on Voltage display.
2. Press Voltage Encoder. Existing communication mode appears on Current display.
3. Turn Current Encoder until desired message appears; "IEEE" (for unit with IEEE option) or "485".
4. To select desired parameter press Current encoder.

### 3.2.2 To Select the Address

1. Press REM button. The LED is illuminated. "Adr" appears on Current display.
2. Press Current Encoder. Existing address mode appears on Current display.
3. Turn Current Encoder until desired address appears.
4. To select desired address press Current encoder.

### 3.2.3 To Select the Baud Rate 57600. (485 Interface only)

1. Press REM button. The LED is illuminated. "iNEF" appears on Voltage display.
2. Turn Voltage Encoder until "bAUD" message appears on Current display
3. Press Current Encoder. Existing Baud Rate appears on Current display.
4. Turn Current Encoder until "57600" appears.
5. To select desired Baud Rate press Current encoder.

### 3.2.4 To Select the Communication Language SCPI. (485 interface only)

1. Press REM button. The LED is illuminated. "iNEF" appears on Voltage display.
2. Turn Voltage Encoder until "LANG" message appears on Current display
3. Press Current Encoder. Existing Language appears on Current display.
4. Turn Current Encoder until "SCPI" appears.
5. To select desired Language press Current encoder.

For more information refer to section 4 of Z<sup>+</sup> series User Manual

#### NOTE:

The power supply must be recycled before initiating IEEE communication interface.

#### NOTE:

When new unit added to Multidrop chain connection, the Master unit (IEEE controller), must be recycled.

## CHAPTER 4: PROGRAMMING COMMANDS

Communication over the GPIB interface meets IEEE 488.2 standards and is Standard Commands for Programmable Instrumentation (SCPI) compliant.

### 4.1 SCPI Protocol

Refer to section 7.10 of Z<sup>+</sup> series User Manual

### 4.2 SCPI Common Commands

Common commands are used to control instrument status registers, status reporting, synchronization, data storage, and other common functions.

SCPI Command	Description
*CLS	Clear status
*ESE <NR1>	Standard event status enable
*ESE?	Return standard event status enable
*ESR?	Return event status register
*IDN?	Return instrument identification string
*OPC	Set "operation complete" bit in ESR
*OPC?	Return a "1" when operation command complete
*OPT?	Return option number
*PSC {1 0}	Power - ON status enable (1) /disable (0)
*PSC?	Power - ON status clear
*RCL {1 2 3 4}	Recalls a saved instrument state
*RST	Reset
*SAV {1 2 3 4}	Saves an instrument state
*SRE <NR1>	Set service request enable register
*SRE?	Return service request enable register
*STB?	Return status byte
*TRG	Trigger

For more information refer to section 7.11 of Z<sup>+</sup> series User Manual.



## 4.3 SCPI Subsystem Commands

Subsystem commands control all Z<sup>+</sup> functions. For a full command description refer to section 7.12 in Z<sup>+</sup> series User Manual. Short list of Z<sup>+</sup> series commands:

SCPI Command	Description
ABORt	Aborts the triggered action
DISPlay	
[:WINDow]:STATe <bool>	Display ON/OFF*
[:WINDow]:FLASh <bool>	Display Flash
GLOBal	
:CURRent	
[:AMPLitude] <NRf+>	Set the output current for all power supplies
:VOLTage	
[:AMPLitude] <NRf+>	Set the output voltage for all power supplies
:OUTPut:STATe <bool>	Enables/disables the all power supplies output
*RCL {1 2 3 4}	Recall setting for all power supplies
*RST	Reset all power supplies
*SAV {1 2 3 4}	Save settings for all power supplies
INITiate	
[:IMMEDIATE]	Trigger initiate
:CONTinuous <bool>	Enable/disable continuously trigger*
INSTrument	
:COUple ALL NONE	Couple for all Z <sup>+</sup> power supplies
:NSElect <NRf+>	Select the power supply for communication*
MEASure	
:CURRent[:DC]?	Returns the measured output current
:VOLTage[:DC]?	Returns the measured output voltage
:POWer[:DC]?	Returns the measured output power
OUTPut	
[:STATe] <bool>	Enables/disable the supply output*
:PON	
[:STATe] <bool>	Programs the Power-ON state*
:PROTection	
:CLEar	Resets latched protection
:FOLDback	
[:MODE] OFF CC CV	Set operation protection mode*
:DElay <NRf+>	Set protection delay*
:ILC	
:MODE <bool>	Enables/disable analog output ON/OFF control*
:TTLTrg	
:MODE OFF FSTR TRIG	Set output trigger mode*
:RElay {1 2}	
[:STATe] <bool>	Set control pins status*
:MODE?	Returns the operation mode CV/CC/OFF

[SOURce]

:CURRent	
[:LEVel]	
[:IMMediate]	
[:AMPLitude] <NRf+>	Set the output current*
:TRIGger <NRf+>	Set the triggered output current*
:MODE NONE FIX LIST WAVE	Select arbitrary trigger control mode*
:VOLTage	
[:LEVel]	
[:IMMediate]	
[:AMPLitude] <NRf+>	Set the output voltage*
:TRIGger <NRf+>	Set the triggered output voltage*
:PROTection	
:LEVel <NRf+>	Set over-voltage protection level*
:LOW	
:STATe UVP UVL	Set under-voltage limit or protection mode*
[:LEVel] <NRf+>	Set under-voltage level*
:MODE NONE FIX LIST WAVE	Select arbitrary control mode*
:LIST	
:COUNT {0...9999,Inf}	Set number of time execution*
:CURRent <NRf+>	Set output current points*
:LOAD {1 2 3 4}	Load stored LIST program from memory
:STEP ONCE AUTO	Set trigger depends execution step*
:STORe {1 2 3 4}	Store LIST program in memory
:DWELl <NRf+>	Set time interval*
:VOLTage <NRf+>	Set output voltage points*
:WAVE	
:COUNT {1...9999,Inf}	Set number of time execution*
:CURRent <NRf+>	Set output current points*
:LOAD {1 2 3 4}	Load stored WAVE program from memory
:STEP ONCE AUTO	Set trigger depends execution step*
:STORe {1 2 3 4}	Store WAVE program in memory
:TIME <NRf+>	Set slope time*
:VOLTage <NRf+>	Set output voltage points*

STATus

:OPERation	
[:EVENT]?	Returns the value of the Event register
:CONDition?	Returns the value of the Condition register
:ENABle <NR1>	Enables specific bits in the Enable register*
:QUEStionable	
[:EVENT]?	Returns the value of the Event register
:CONDition?	Returns the value of the Condition register
:ENABle <NR1>	Enables specific bits in the Enable register*

SYSTem

:ERRor:ENABle	Enable error message
:ERRor?	Read system error messages
:LANGuage GEN	Set communication language*
:REMote	
[:STATe] LOC REM LLO	Set the remote/local state*
:VERSion?	Returns software revision
:DATE?	Returns calibration date
:PON	
:TIME?	Response time from last reset

TRIGger

[:START]	Run trigger
:DELay <NRF+>	Set input trigger delay*
:SOURce EXTernal BUS	Set input trigger source*

**NOTE:**

\* Command query is available.

**4.4 The Summary Registers**

The INSTRUMENT SUMMARY EVENT REGISTER, ISUM1 through ISUM3 (Refer to Fig.4-2), will record the address of the supply causing an SRQ. These are 'EVENT' registers and the bits will remain set until read by the STAT:QUES:INST:ISUMn command. (Refer to Table 4-1)

Command	Description
STATus:QUEStionable :INSTrument:ISUMmary1?	Reads the source of the SRQ in Logical Z <sup>+</sup> Supplies 1 through 15
STATus:QUEStionable :INSTrument:ISUMmary2?	Reads the source of the SRQ in Logical Z <sup>+</sup> Supplies 16 through 30
STATus:QUEStionable :INSTrument:ISUMmary3?	Reads the source of the SRQ in Logical Z <sup>+</sup> Supply 31
STATus:QUEStionable :INSTrument:ISUMmary1:ENABle xx	Enable supplies to cause IEEE SRQ in Logical Z <sup>+</sup> Supplies 1 through 15
STATus:QUEStionable :INSTrument:ISUMmary2:ENABle xx	Enable supplies to cause IEEE SRQ in Logical Z <sup>+</sup> Supplies 16 through 30
STATus:QUEStionable :INSTrument:ISUMmary3:ENABle xx	Enable supplies to cause IEEE SRQ in Logical Z <sup>+</sup> Supply 31
STATus:QUEStionable :INSTrument:ISUMmary1:ENABle?	Read which supplies can cause IEEE SRQ in Logical Z <sup>+</sup> Supplies 1 through 15
STATus:QUEStionable :INSTrument:ISUMmary2:ENABle?	Read which supplies can cause IEEE SRQ in Logical Z <sup>+</sup> Supplies 16 through 30
STATus:QUEStionable :INSTrument:ISUMmary3:ENABle?	Read which supplies can cause IEEE SRQ in Logical Z <sup>+</sup> Supply 31

Table 4-1: ISUM commands

### 4.5 Output Queue

Refer to section 9.6.16 of Z<sup>+</sup> series User Manual.

### 4.6 Error Messages

Refer to section 9.6.17 of Z<sup>+</sup> series User Manual.

### 4.7 Execution Time

Command execution time except for \*CLS (150mS) is less than 15 milliseconds.

INST:NSEL 06	11 millisecond
OUTP:STAT ON	12 millisecond
:VOLT 15	10 millisecond
WAVE:TIME 1,1,1,1,1,1,1,1,1,1	14 millisecond

Query execution time is between 20-50 milliseconds. Response is dependent upon string length.

WAVE:VOLT?	45 millisecond
SYST:ERR?	22 millisecond
*IDN?	38 millisecond
INST:NSEL?	20 millisecond

It is required that the user adds a delay after a command before sending any further messages. (Refer to Table 4-2)

ADDRESSED COMMAND/QUERY	10 milliseconds
GLOBAL COMMAND	20 milliseconds

Table 4-2: Addition of Delay

### 4.8 Register Structure

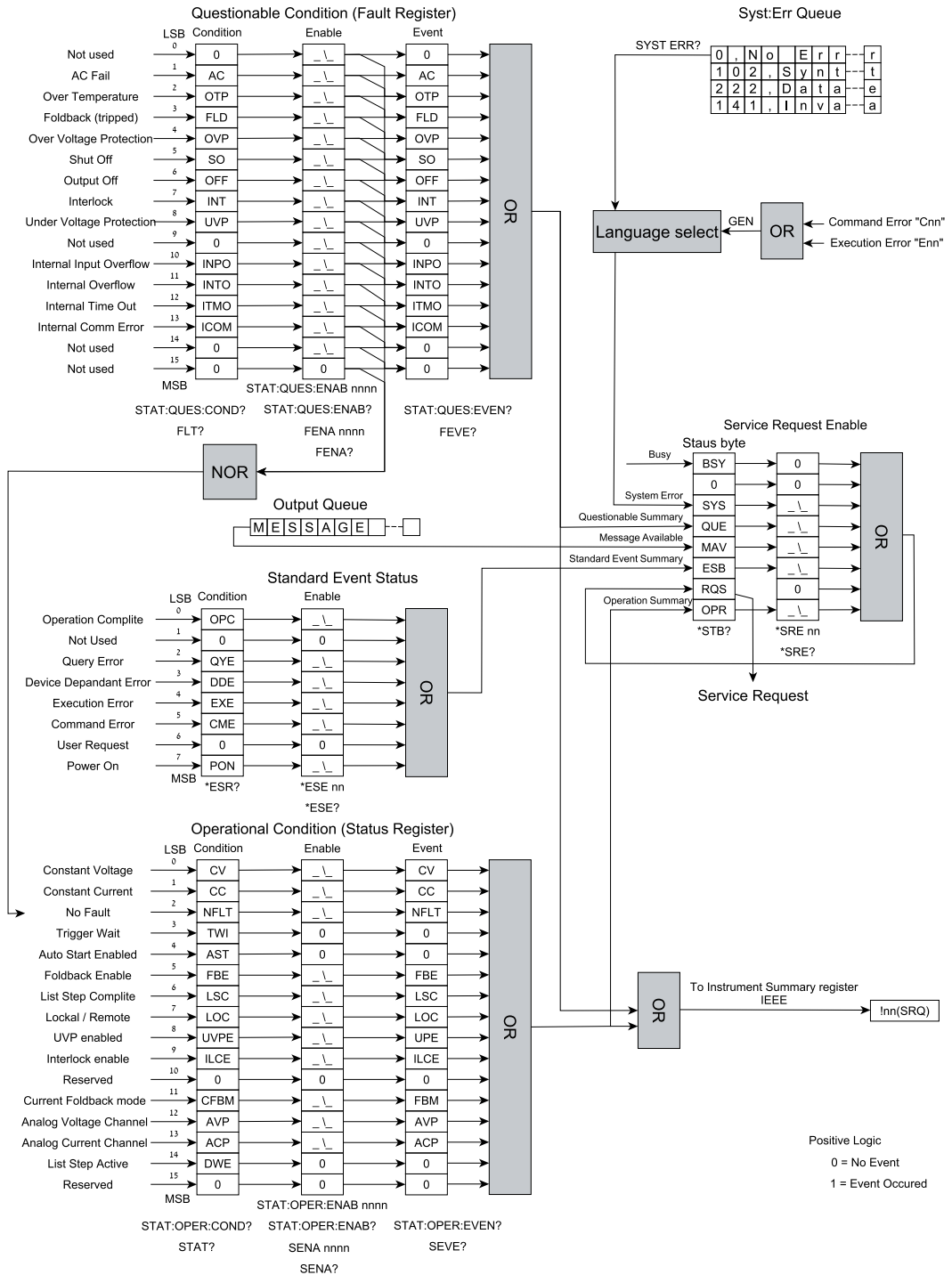


Fig.4-1: Status Register and SRQ Tree

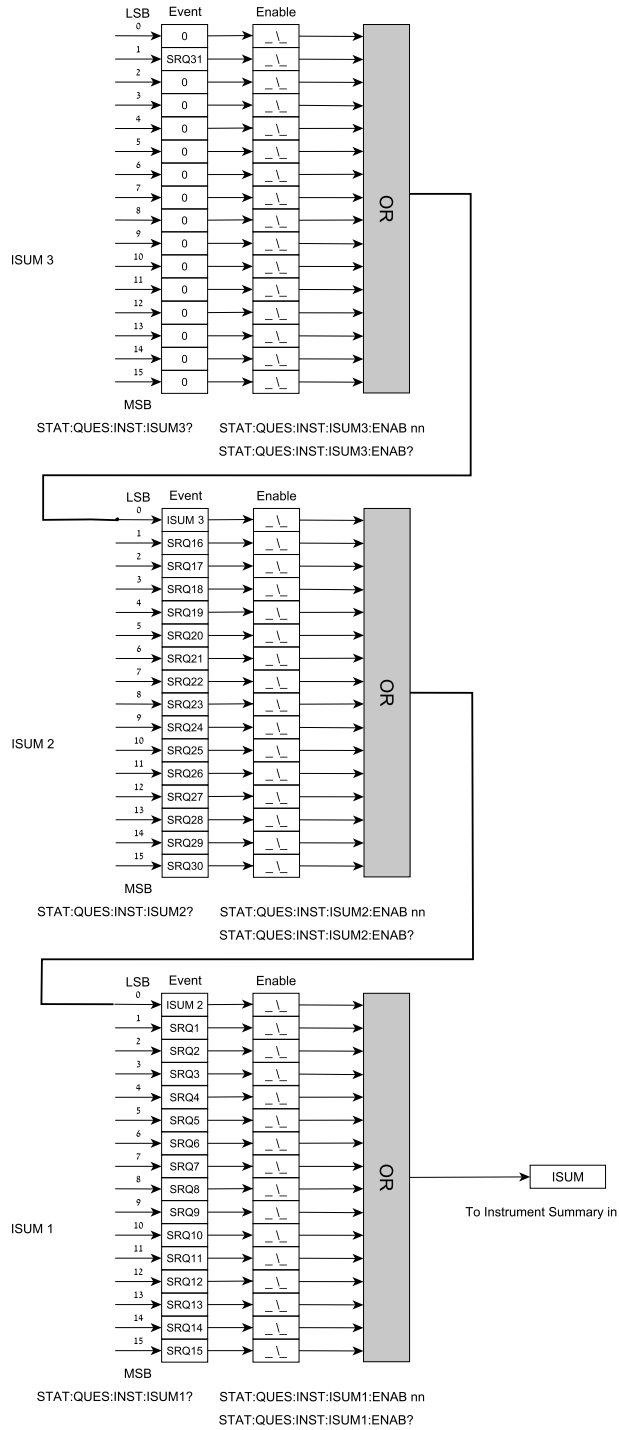



Fig.4-2: Instrument Summary Register Tree for Multi Drop Mode

**CHAPTER 5: COMMUNICATION EXAMPLE**

This section provides an example the National Instruments™ MAX program to communicate with the Z+.

1. Run National Instruments™ MAX (Measurement & Automation Explorer) program 
2. Select “Devices and Interfaces” -> “GPIB0” press Scan for Instruments. Refer to Fig.5-1

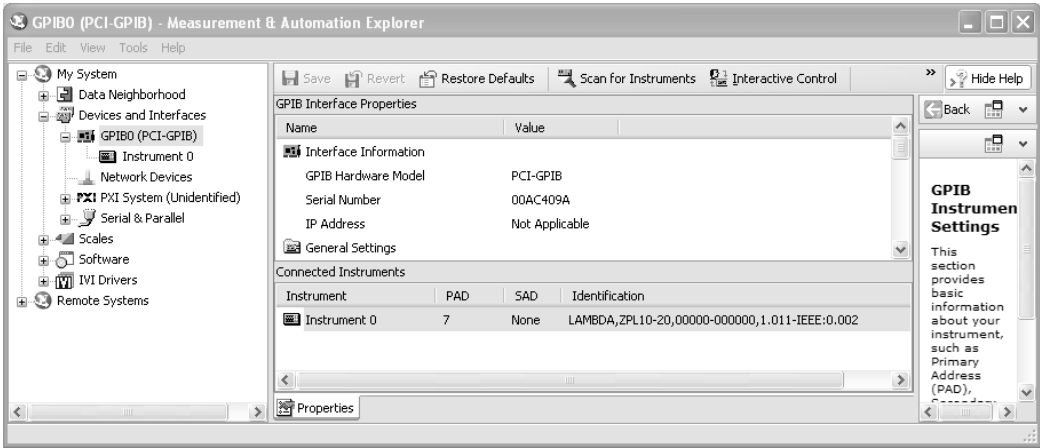


Fig.5-1: Scanning for Instrument

3. In the right window, click on Instrument0 and review the device properties. Refer to Fig.5-2

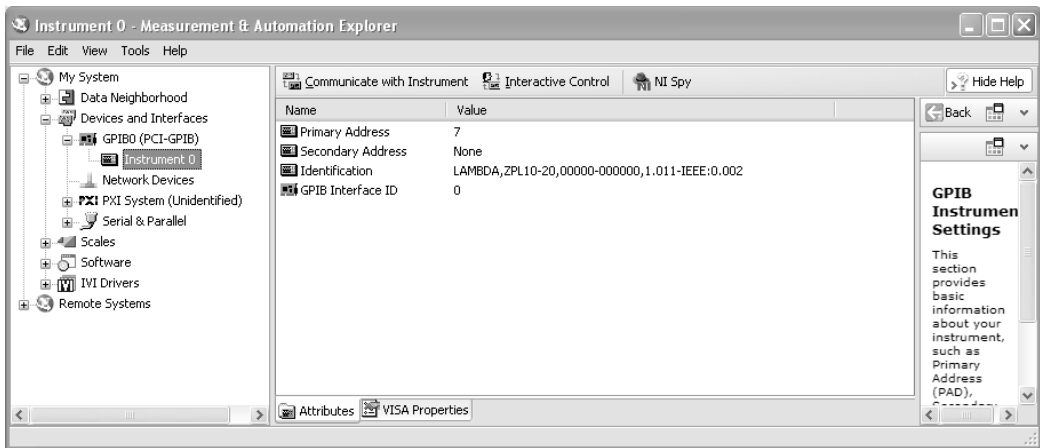


Fig.5-2: Instrument Properties

- Click Communicate with Instrument in the GPIB Explorer toolbar. NI-488.2 Communicator appears. Refer to Fig. 5-3

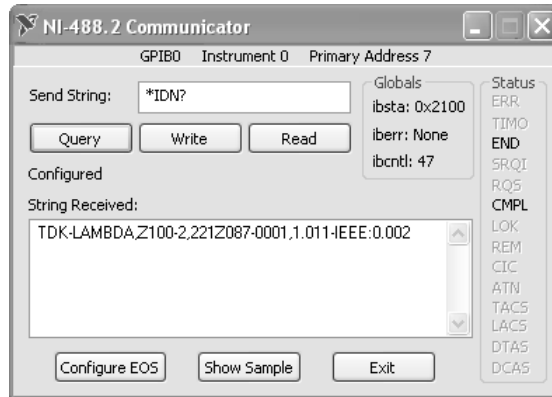


Fig.5-3: ID String Query

- In the Send String box, \*IDN? appears. Click Query. The ID string indicates the model, serial number, firmware version and the GPIB card firmware version. This will be shown in the text box below String Received. Refer to Fig.5-3.





**GLOBAL NETWORK**

**TDK-Lambda**

---



TDK-Lambda EMEA  
[www.emea.tdk-lambda.com](http://www.emea.tdk-lambda.com)



---

***Innovating Reliable Power***