

# SL POWER TF Series Communication Protocol User's Manual

Advanced Energy's SL Power TF series power supply communication protocol user's manual has been prepared by SL Power experts to assist engineers and technicians in understanding the RS-232 / RS-485 communication, operating parameters such as output voltage, output current and internal temperature, etc.

## AT A GLANCE

### Applied Models

**TF800, TF1500, TF3000**



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## SECTION 1 I<sup>2</sup>C BUS INTERFACE OPTIONS

### 1.1 Introduction

The I<sup>2</sup>C interface of SMPS controlled by Host PC and provides the features listed below:

- 1) Manufacturing related data (Include model name, serial number, MFG date etc...)
- 2) Actual output voltage, output current and internal temperature of the unit.
- 3) Status of the unit.
- 4) ON / OFF control and Output Voltage / Current setting.

### 1.2 Serial Clock (SCL)

This input signal is used to strobe all data in and out of the unit. It should be connected to +5V via a pull-up resistor of 2K Ohm, the I<sup>2</sup>C interface is designed to run with a Serial Clock speed of 100KHz.

### 1.3 Serial Data (SDA)

This bi-directional signal is used to transfer data in or out of the unit. It is an open drain output that may be wire-ORed with other open drain or open collector signal on the bus. A pull-up 2K ohm resistor must be connected from Serial Data (SDA) to +5V.

### 1.4 Addressing

There are three address lines to address the eight units by I<sup>2</sup>C bus. To address the units, please adjust the Addr. Switch on the panel.

## SECTION 2 I<sup>2</sup>C BUS PROTOCOL UNIT

The I<sup>2</sup>C bus option of unit is provided by UART with I<sup>2</sup>C type EEPROM device protocol (24C02).

### 2.1 Device Slave Address (7 bit device address)

Table 1 Device Slave Address							
Device Type Identifier				Unit Enable			R/W
b7	b6	b5	b4	b3	b2	b1	b0
1	0	1	0	E2	E1	E0	R/W

### 2.2 Write Mode Sequences

Table 2 Write Mode Sequences							
S	1 0 1 0 E2-E0 0	A	A7-A0	A	D7-D0	A	P

### 2.3 Read Mode Sequences

Table 3 Read Mode Sequences										
S	1 0 1 0 E2-E0 0	A	A7-A0	A	S	1 0 1 0 E2-E0 1	A	D7-D0	A	P

## SECTION 3 OPERATION AND FUNCTIONS

### 3 Operation and Functions

**Table 4 Available Address Space**

Address	Byte	Function	Type
0x00-0x0F	16	Manufacture	Read
0x10-0x1F	16	Model name	Read
0x20-0x23	4	Output Voltage	Read
0x24-0x27	4	Revision	Read
0x28-0x2F	8	Date of manufacture	Read
0x30-0x3F	16	Serial number	Read
0x40-0x4F	16	Country of MFG	Read
0x50-0x51	2	Rate Output Voltage	Read
0x52-0x53	2	Rate Output Current	Read
0x54-0x55	2	Max. Output Voltage	Read
0x56-0x57	2	Max. Output Current	Read
0x58-0x5F	8	(Not used)	
0x60-0x61	2	Output Voltage	Read
0x62-0x63	4	Output Current	Read
0x64-0x67	1	(Not used)	
0x68	1	Internal Temperature	Read
0x69-0x6B	8	(Not used)	
0x6C	1	Status: 0	Read
0x6D-0x6E	2	(Not used)	
0x6F	2	Status: 1	Read
0x6E-0x6F	2	(Not used)	
0x70-0x71	2	O/P Voltage setting	R/W
0x72-0x73	6	O/P Current setting	R/W
0x74-0x79	1	(Not Used)	
0x7A	1	** Reserve **	
0x7B	1	** Reserve **	
0x7C	1	Control	R/W
0x7D-0x7F	3	** Reserve **	

## SECTION 3 OPERATION AND FUNCTIONS

### 3.1 Status Register (0x6C, 0x6F)

Fault is indicated by "1" and Good level is indicated by "0".

Table 5 Status Register (0x6C, 0x6F)		
Address	Bit	Function
0x6C	Bit0	OVP shutdown
	Bit1	OLP shutdown
	Bit2	OTP shutdown
	Bit3	FAN failure
	Bit4	AUX or SMPS fail
	Bit5	HI-TEMP alarm
	Bit6	AC input power down
	Bit7	AC input failure
0x6F	Bit0	Inhibit by VCI/ACI or INHI
	Bit1	Inhibit by Control Register
	Bit2	(Not used)
	Bit3	(Not used)
	Bit4	ON/OFF status
	Bit5	(Not used)
	Bit6	(Not used)
	Bit7	Remote status

## SECTION 3 OPERATION AND FUNCTIONS

### 3.2 Control Register (0x7C)

Table 6 Control Register (0x7C)			
Address	Bit	Function	Meaning
0x7C	Bit0	Power control	0: PWR-OFF, 1: PWR-ON
	Bit1	(Not used)	
	Bit2	Command update	0: Complete, 1: Required
	Bit3	Command error	0: Valid, 1: Error
	Bit4	(Not used)	
	Bit5	(Not used)	
	Bit6	** Reserve**	
	Bit7	Remote control	0: Control by VCI, ACI, INHI 1: Control by Software (I <sup>2</sup> C or RS-232/RS-485)



## SECTION 4 MEASUREMENT AND CALCULATION EXAMPLE

To simplify the explanations of I<sup>2</sup>C works, user may enter values of address commands index [adds] and the bit value of address commands index [adds.bit] as follow:

Ex: [0x6C] indicates the value on the address “0x6C”

[0x7C.7] indicates the value of bit 7 on the address“0x7C”

### 4.1 Output Voltage Readback

To read the values of the addresses of [0x61] and [0x60]; [0x61] as High byte and [0x60] as Low byte. The O/P Voltage is converted from the above values into decimal and divides it by 100.

Ex: The Hex Value of [0x61] = 0x90, [0x60] = 0x74 is 0x974 and convert 0x974 into decimal is 2420, to divide 2420 by 100 equals 24.20, so V = 24.20V

Note: To ensure the reading data accurate, please read 0x60 at 1<sup>st</sup> priority and then 0x61 at 2<sup>nd</sup>.

### 4.2 Output Current Readback

To read the values of the addresses of [0x63] and [0x62]; [0x63] as High byte and [0x62] as Low byte. The O/P Current is converted from the above values into decimal and divides by 100.

Ex: The Hex Value of [0x63] = 0x11, [0x62] = 0xC6 is 0x11C6 and convert 0x11C6 into decimal is 4550, to divide 4550 by 100 equals 45.50, so I = 45.50A

Note: To ensure the reading data is accurate, please read 0x62 at 1<sup>st</sup> priority and then 0x63 at 2<sup>nd</sup>.

### 4.3 Internal Temperature Readback

To read the values of the addresses of [0x68] to convert the value into decimal to receive the internal temperature (centigrade)

Ex: The Hex Value of [0x68] is 0x37 and converting 0x37 into decimal is 55, so the internal temperature is 55°C.

## SECTION 4 MEASUREMENT AND CALCULATION EXAMPLE

### 4.4 Status: 0 Readback

To read the value of [0x6C] and convert the value into Binary code

bit 7 AC Input Fail

0 = Normal AC input

1 = AC input < 85 Vac, Power is off

bit 6 AC Power Down

For TF3000 series

0 = AC input  $\geq$  180 Vac, Normal output

1 = AC input < 180 Vac, Output power down

For TF1500 series

0 = AC input  $\geq$  100 Vac, Normal output

1 = AC input < 100 Vac, Output power down

Note: TF800 did not have this function, so this bit is always low.

bit 5 High Temperature Alarm

0 = Internal temperature normally

1 = Internal temperature is over 75°C

bit 4 Unit Fail

0 = Unit normal working

1 = Unit fail, Power is shutdown

bit 3 Fan Fail

0 = Fan normally working

1 = Fan fail, Power is shutdown

bit 2 OTP Shutdown

0 = Normal internal temperature

1 = Internal temperature is over 85°C, Power is shutdown

bit 1 OLP Shutdown

0 = Normal

1 = Overload shutdown

bit 0 OVP Shutdown

0 = Normal

1 = Overvoltage shutdown

## SECTION 4 MEASUREMENT AND CALCULATION EXAMPLE

### 4.5 Status: 1 Readback

To read value of [0x6F] and convert the value into Binary code

bit 7 Remote Control Status

0 = Control by VCI, ACI, INHI

1 = Control by software (I<sup>2</sup>C or RS-232/RS-485)

bit 6, 5 Unimplemented, Read as '0'

bit 4 Power Control Status

0 = Power OFF

1 = Power ON

bit 3, 2 Unimplemented, Read as '0'

bit 1 Inhibit by Control Register (In Remote mode [0x7C.7] = 1 only)

0 = Power supply works normal

1 = Inhibit by control register [0x7C.0]

bit 0 Inhibit by Control Signal (In Local mode [0x7C.7] = 0 only)

0 = Power supply works normal

1 = Inhibit by VCI, ACI or INHI signal.

## SECTION 5 CONTROL COMMAND AND CALCULATION EXAMPLE

### 5.1 Output Voltage Setting

To multiply the setting voltage of 100 and convert the value into Hex code, then write High byte and Low byte on the addresses of 0x71, 0x70.

Ex: The O/P Voltage setting is 24.25V, to multiply 24.25 of 100 and convert 2425 into Hex code. To write Hex code of 0x979, 0x09, 0x79 into the addresses of 0x71, 0x70.

After voltage setting, the voltage stores in the buffer of SMPS. Please refer to the explanations of 5.3, to renew the O/P Voltage.

### 5.2 Output Current Setting

To multiply the setting current of 100 and convert the value into Hex code then to write High byte and Low byte on the addresses of 0x73, 0x72.

Ex: The O/P Current setting is 45.75A and to multiply 45.75 of 100 then converts into Hex code. To write Hex code of 0x11DF, 0x11, 0xDF, into the address of 0x73, 0x72.

After current setting, the current stores in the buffer of SMPS. Please refer to the explanations of 5.3, to renew the O/P Voltage.

### 5.3 Setting Parameter Update

After setting voltage and current stores in buffer the setting parameters will not be update immediately. The parameters will present after checking procedure of writing 1 on the bit2 of Control Register will be done.

1) The setting will be denied when the setting value is over limits, the O/P will remain the default value and the bit3 of Control Register (0x7C) commands 1 as error.

2) The setting will be effective when the setting value is in limits, the O/P setting will be update, the bit3 of Control Register (0x7C) commands 0 as valid.

After writing 1 into the bit of Control register (0x7C), the bit will be clear to "0" no matter if the setting is valid. To verify the command is running successfully by evaluating the values of bit3 and bit2 of the Control Register (0x7C).

## SECTION 5 CONTROL COMMAND AND CALCULATION EXAMPLE

### 5.4 Power On/Off Control (In Remote Mode [0x7C.7] = 1 only)

To write 0 into the bit of Control Register (0x7C ) to execute Power off.

To write 1 into the bit of Control Register (0x7C ) to execute Power on.

### 5.5 Remote/Local control

To write 0 on the bit of Control Register (0x7C) to enter the Local mode, the setting of voltage, current and On/Off control will be controlled by VCI, ACI and INHI signal.

To write 1 on the bit7 of Control Register (0x7C) to enter the Remote mode, the setting of voltage, current and On/Off be controlled by I<sup>2</sup>C bus.

### 5.6 Others

User should only write 0 on the bit of Control Register (0x7C) since it's for manufacturer use.

## SECTION 6 RS-232/RS-485 COMMUNICATION FOR TF POWER SUPPLY

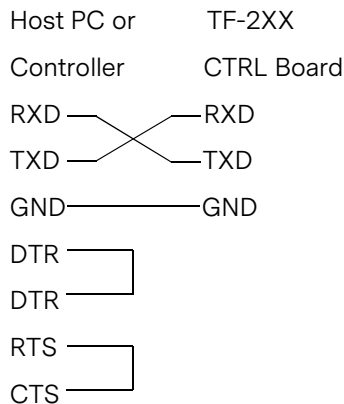
### 6.1 Introduction

The UART control interface RXD and TXD are TTL signals. These signals must be transformed to communicate with Host PC by TF-2XX Communication Board. Then, the functions below can be operated:

- 1) ON/OFF Control and ON/OFF Status query.
- 2) Output voltage / current setting and query.
- 3) Actual output voltage, output current and internal temperature query.
- 4) Status of the unit query.
- 5) Manufacturing related data Query (Include model name, serial number, MFG date etc...).

### 6.2 Communication Interface Signal

The UART communication interface only uses two signals RXD and TXD to communicate with HOST PC, such as below:



### 6.3 Communication Protocol

The UART communication protocol invariably uses 4800, N, 8, 1. (The setting is not changed.)

Baudrate: 4800

Parity check: None

Data bit: 8

### 6.4 Addressing

There are three address lines allow up to eight units to be addressed on a RS-485 bus with SWx.

## SECTION 7 UART PROTOCOL OF UNIT

### 7.1 Data Transmission

The UART transmit command and reply are both executed by ASCII code and use CR (ASCII code 0x0D) and LF (ASCII code 0x0A) for termination.

### 7.2 Device Addressing

1) In order to support the RS-485 application mode, one Host PC is used to control multiple devices. The UART sets an addressing flag for RS-485 addressing select. When the flag is set to “1”, it means this addressing is effective. And UART will start to identify, execute and reply when UART receives command. Otherwise, the flag is clear to “0”, it means this addressing is non-effective. The command which UART receives will be ignored and will not provide any reply. (Except ADDS and GLOB command, the detail account in 8-2 command descriptions).

2) Addressing flag can be set or clear by ADDS command.

3) When AC source is first input, addressing flag is set to “1” in advance to make the addressing effective. If user applies the RS-485 multi-devices mode, must set the address according to ADDS command, to avoid the situation where more than two devices are addressing at the same time. This situation makes communication abnormal.

### 7.3 Command Format

There are two formats in UART commands.

1) The commands without parameter-> Command only has command byte, and use CR LF for ending.

Format: <COMMAND> CR LF

2) The commands with parameter-> Add parameter byte behind the command byte, and use CR LF for termination. You must separate command byte and parameter byte with space (ASCII code 0x20).

Format: <COMMAND> <PARAMETER> CR LF

### 7.4 Command Execute and Reply

1) While the addressing effective devices receive the complete command (use CR LF for termination), and then start to identify command, execute command and reply by sending the executed result to Host PC.

The strings of reply and the represented results are show below:

= > CR LF -> Command executed successfully.

? > CR LF -> Command error, not accepted.

! > CR LF -> Command correct but execution error (e.g. parameters out of range).

2) While addressing effective devices execute the command with query function, UART will transmit the string of query result first, then use “CR LF” for termination, and transmit “= >CR LF” to express “Command executed successfully” again.

3) While addressing non-effective devices receive command, except ADDS and GLOB, the command will be ignored, and there is no reply.

## SECTION 8 COMMANDS

### 8.1 Command Set

COMMAND	DISCRIPTION
ADDS <adds>	Device Addressing
GLOB <type>	Global Power ON / OFF Control
POWER <type>	Power ON / OFF / Query
GSV <value>	Global Control O/P Voltage Setting
GSI <value>	Global Control O/P Current Setting
GRPWR 1	Global Power ON
GRPWR 0	Global Power OFF
SV <value>	O/P Voltage Setting
SI <value>	O/P Current Setting
SV?	Voltage Setting Query
SI?	Current Setting Query
RV?	O/P Voltage Query
RI?	O/P Current Query
RT?	Temperature Query
REMS <type>	Remote ON / OFF / Query
STUS <type>	Device Status Query
INFO <type>	Information Query
RATE?	Rate V/I Query
DEVI?	Device Name Query
*IDN? I	Identification Query



## SECTION 8 COMMANDS

### 8.2 Command Description

Except ADDS and GLOB commands, only the device with addressing flag = 1 will execute command and reply with the executed result.

Except ADDS and GLOB commands, the device finish the command will reply “ = > CR LF ” to inform that the execution is completed.

The parameters of command over the acceptable range, the device with addressing flag = 1 will reply “ ! > CR LF ” to express the execute error.

The command descriptions below are following upper rule, this article will not be described again.

#### Data Transmission

Syntax: ADDS <adds>

Parameter: 0 <= adds <= 7

Description: When device receives a command, even if the addressing flag is set to 1 or clear to 0, UART will execute this command. Only if the addressing of device is the same with <adds>, UART will set the device addressing flag to 1 and reply “ = > CR LF ” to express that the execution is completed. Otherwise, the addressing of the device isn't the same with <adds>, UART will set the device addressing flag to 0, but will not reply. If there are no devices exist, all device addressing flag will be clear to 0, and device will not reply.

## SECTION 8 COMMANDS

### Global Power ON/OFF Control

Syntax: GLOB <type>

Parameter: type = 0 or 1

Description: When device receives a command, whether the addressing flag is set to 1 or clear to 0, UART will execute this command. This command will be executed no matter whether or not the device address is effective. This command is suitable for the situation where all devices need synchronous control.

<type> = 0: Control mode will be set to REMOTE. ->Devices are controlled by program command, and make the output set to 0. ->Power Off.

Only the device with addressing flag = 1 will reply “ = > CR LF ” to express that the execution is completed.

The device with addressing flag = 0 will not reply.

<type> = 1: Control mode will be set to REMOTE. ->Devices are controlled by program command, and make the output set to 1. ->Power On.

Only the device with addressing flag = 1 will reply “ = > CR LF ” to express the execution is completed.

The device with addressing flag = 0 will not do any reply.

<type> is not 0 or 1: Only the device with addressing flag = 1 will reply “ ! > CR LF ” to express the execution is in error.

The device with addressing flag = 0 will not do any reply.

### Global Control O/P Voltage Setting

Syntax: GSV <value>

Parameter: value -> Global Voltage value for setting.

Description: Global Output Voltage setting.

e.g. To set Global Output Voltage to 12V, the command is: GSV 12

### Global Control O/P Current Setting

Syntax: GSI <value>

Parameter: value -> Global Current value for setting.

Description: Global Output Current setting.

e.g. To set Global Output Current to 100A, the command is: GSI 100

## SECTION 8 Commands

### Power ON / OFF / Query

Syntax: POWER <type>

Parameter: 0 <= type <= 2

Description:

<type> = 0: Control mode will be set to REMOTE -> Devices are controlled by program command, and make the output set to 0. ->Power Off.

<type> = 1: Control mode will be set to REMOTE -> Devices are controlled by program command, and make the output set to 1. ->Power On.

<type> = 2: Query the status of power ON/OFF.

Echo : 0 -> Remote Disable, Power Off.

1 -> Remote Disable, Power On.

2 -> Remote Disable, Power Off.

3 -> Remote Disable, Power On.

### Output Voltage Setting

Syntax: SV <value>

Parameter: value -> Voltage value for setting.

Description: Output Voltage setting.

e.g. To set output voltage is to 11.95V, the command is: SV 11.95 CR LF

### Output Current Setting

Syntax: SI <value>

Parameter: value -> Current value for setting.

Description: Output Current setting

e.g. To set output current is to 105.5A, the command is: SI 105.5 CR LF

### Voltage Setting Query

Syntax: SV?

Parameter: None.

Description: Query the output voltage setting, and device transmits the voltage setting value at the time.

If the control mode is set to REMOTE, the device transmits the voltage setting value which is set in the previous command SV <value>.

If the control mode is set to LOCAL, the device transmits the voltage setting value which is set in VCI control signal.

## SECTION 8 Commands

### Current Setting Query

Syntax: SI?

Parameter: None.

Description: Query the output current setting, and device transmits the current setting value at the time.

If the control mode is set to REMOTE, the device transmits the current setting value which is set in the previous command SI <value>.

If the control mode is set to LOCAL, the device transmits the current setting value which is set in ACI control signal.

### Output Voltage Query

Syntax: RV?

Parameter: None.

Description: Query the output voltage value, and device will transmit the voltage value at the time.

### Output Current Query

Syntax: RI?

Parameter: None.

Description: Query the output voltage value, and device will transmit the current value at the time.

### Internal Temperature Query

Syntax: RT?

Parameter: None.

Description: Query the internal temperature value of device, and device will transmit the internal temperature value at the time. The temperature is provided in °C.

### Control Mode Select / Query

Syntax: REMS <type>

Parameter: 0 <= type <= 2

Description: <type> = 0: Control mode will be set to LOCAL->The voltage and current of device are set by VCI and ACI, and control Power ON/Off by ENB.

<type> =1: Control mode will be set to REMOTE->The voltage and current of device are set by SV and SI, and control Power ON/Off by command POWER, GLOB.

<type> =2: Query the control mode, the device will transmit "0" to express LOCAL or "1" to express REMOTE.

## SECTION 8 COMMANDS

### Control Mode Select / Query

Syntax: REMS <type>

Parameter: 0 <= type <= 2

Description: <type> = 0: Control mode will be set to LOCAL->The voltage and current of device are set by VCI and ACI, and control Power ON/Off by ENB.

<type> =1: Control mode will be set to REMOTE->The voltage and current of device are set by SV and SI, and control Power ON/Off by command POWER, GLOB.

<type> =2: Query the control mode, the device will transmit "0" to express LOCAL or "1" to express REMOTE.

### Device Status Query

Syntax: STUS <type>

Parameter: type = 0 or 1

Description: Query the device status, the device will transmit two ASCII characters to express an 8 bit Hex code and transform it to Binary code. Each character definition as show below:

<type> = 0 : Bit-0 -> OVP Shutdown

Bit-1 -> OLP Shutdown

Bit-2 -> OTP Shutdown

Bit-3 -> FAN Failure

Bit-4 -> AUX or SMPS Fail

Bit-5 -> HI-TEMP Alarm

Bit-6 -> AC Input Power Down

Bit-7 -> AC Input Failure

<type> = 1 : Bit-0 -> Inhibit by VCI / ACI or ENB

Bit-1 -> Inhibit by Software Command

Bit-2 -> (Not used)

Bit-3 -> (Not used)

Bit-4 -> (POWER)

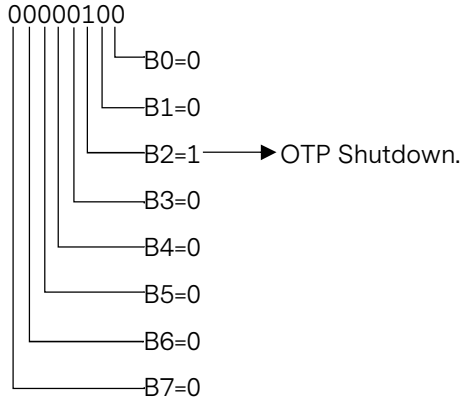
Bit-5 -> (Not used)

Bit-6 -> (Not used)

Bit-7 -> (REMOTE)

## SECTION 8 COMMANDS

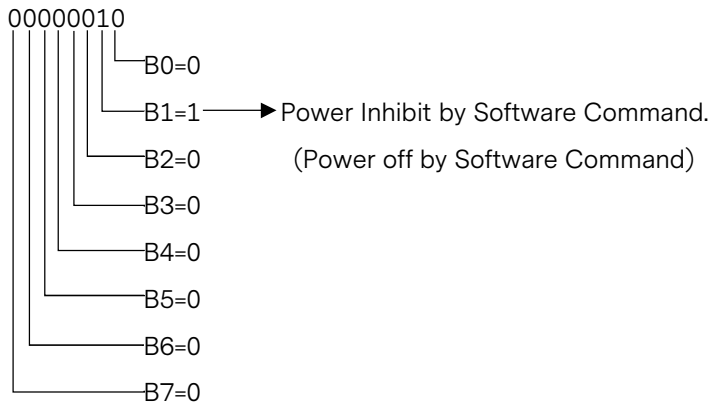
e.g. 1: The reply of STUS 0 is "04" -> Express Hex code: 0x04 has transformed to Binary code.



24 : the power supply will soon be over temp protected.

34 : the power supply is in the over temp protection mode (OTP).

e.g. 2: The reply of STUS 1 is "02" -> Express Hex code: 0x02 has transformed to Binary code.



## SECTION 8 COMMANDS

### Device Information Query

Syntax: INFO <type>

Parameter: type = 0 to 6

Description: Query device information, device will transmit the related information.

<type> = 0 -> Manufacture

<type> = 1 -> Model Name

<type> = 2 -> Output Voltage

<type> = 3 -> Revision

<type> = 4 -> Date of MFG

<type> = 5 -> Serial Number

<type> = 6 -> Country of MFG

### Query Rated Voltage and Rated Current

Syntax: RATE?

Parameter: None.

Description: Query rated voltage and rated current of device, device will transmit the rated voltage and rated current values.

### Device Name Query

Syntax: DEVI?

Parameter: None.

Description: Query name of device, device will transmit the address and name.

### Device Identify

Syntax: \*IDN?

Parameter: None.

Description: Device will transmit the Identification information itself.

## SECTION 9 ATTENTION

### Attention

When use RS-232/RS-485 to control TF series SMPS, users must follow the rules below.

A: Before assign the power-on command (POWER 1, GLOB 1), the voltage and current value of device must be transmitted to EUT. After get the correspond reply from EUT, user can assign power-on command.

If user mistakes the operation procedure, EUT will show the light status of OVP or OLP. EUT can return to normal operation and receive command by user assigns the power-off command (POWER 0, GLOB 0).

B: All characters of RS-232/RS-485 must be transmitted completely between 400ms. The decide rule is according CR LF (0D0A) to terminate. If over this time range, system will ignore the command.

C: When close the power of EUT, all setting commands will return to initial value. At this time, the status resumes to LOCAL MODE.

D: When EUT receive the information of command is executed and starting-up, EUT will turn to REMOTE MODE automatically. Light status is orange. The detailed light status are described in SPEC, please reference it.

E: The communicated board controls 8 EUT (ADDS0-7) at most. Every controllable EUT must be check to confirm every addressing of EUT is not conflict to another.

F: In multi-EUT setting, users must assign the addressing query command (ADDS x) to the EUT before use any query commands, otherwise the reply data is non-normal value. In single device controlling is not in this limit.



**SECTION 10 RECORD OF REVISION AND CHANGES**

Issue	Date	Description	Originators
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For international contact information,  
visit [advancedenergy.com](http://advancedenergy.com).

[powersales@aei.com](mailto:powersales@aei.com) (Sales Support)  
[productsupport.ep@aei.com](mailto:productsupport.ep@aei.com) (Technical Support)  
+1 888 412 7832

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