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⚠ GENERAL SAFETY INSTRUCTIONS

High Voltage Warning

Dangerous voltages are present within the power supply.

Critical Components

This product is not authorized for use as a critical component in nuclear control systems, life support systems or equipment for use in hazardous environments without the express written approval of the Engineering Director of TDK-Lambda Americas.

Servicing

This product is not customer serviceable.

Unit repairs shall only be carried out by TDK- Lambda Americas or their Authorized agents.

Contact: TDK-Lambda Americas
401 Mile of Cars Way, Suite 325
National City, CA 91950
Tel 619-575-4400
Fax 619-575-7185

Safety Class of Protection

The unit is designed for the following parameters: Material Group IIIb, Pollution Degree 2, Overvoltage Category II, Class 1 (earthed), Indoor use. The unit is considered as fixed and rated IPX0. The TPF45000-385 are capable of providing hazardous energy (>240VA). The final equipment should provide protection to service personnel against inadvertent contact with the PSU output terminals.

Installation

This product is designed for use within other equipment which restricts access to Authorized competent personnel only. The unit covers/chassis must not be made user accessible.

The mains input connector is not acceptable for use as field wiring terminals.

The appliance must be securely mounted and the Ground Stud properly bonded to the main protective earth contact before any connection to AC mains supply is made.

The ventilation openings must not be impeded – ensure a space at least 5cm between any obstruction and the ventilation openings.

BEFORE USING THE POWER SUPPLY UNIT

Be sure to read this instruction manual thoroughly before using this product. Pay attention to all cautions and warnings before using this product. Incorrect usage could lead to an electrical shock, damage to the unit or a fire hazard.

⚠ DANGER

- Never use this product in locations where flammable gas or ignitable substances are present.

⚠ WARNING

- Do not make unauthorized changes to power supply unit, otherwise you might have electric shock and void your warranty.
- Do not touch this unit and the internal components in operation or shortly after shut down. They might have high voltage or high temperature and as the unit dissipates its heat so the surface of the unit is hot. You might receive electric shock or burn.
- When the unit is operating, keep your hands and face away from it; you might be injured by an accident.
- Do not use unit under unusual conditions such as emission of smoke or abnormal smell and sound etc. It might cause fire and electric shock. In such case, please contact us; do not repair by yourself, as it is dangerous for the user.
- Do not drop or insert anything into unit. It might cause failure and fire.
- Do not operate these units under condensation condition. It might cause fire and electric shock.

⚠ CAUTION

- As a component part, compliance with the standard will be based upon installation in the final application. This product must be installed in a restricted access location, accessible to authorized competent personnel only. The outputs of these products are energy hazards. The equipment has been evaluated for use in a Pollution Degree 2 environment.
- This product is designed for use within other equipment or enclosures which restrict access to authorized competent personnel only and must not be user accessible. Confirm connections to input/output terminals and signal terminals are correct as indicated in the instruction manual.
- Input voltage, Output current, Output power, ambient temperature and ambient humidity should be used within specifications, otherwise the unit will be damaged.
- For application equipment, which requires very high reliability (Nuclear related equipment, traffic control equipment, medical equipment, etc.), please provide fail safety function in the equipment.
- Do not use the product in environment with strong electromagnetic field, corrosive gas and conductive substance.
- Do not operate and store this unit at an environment where condensation occurs. In such case, waterproof treatment is necessary
- Never operate the unit under over current or shorted conditions for 30 seconds or more and out of Input Voltage Range as specification. Insulation failure, smoking, burning or other damage might occur to the unit.
- The output voltage of this power supply unit is considered to be a hazardous energy level (The voltage is 2V or more and the electric power is 240VA or more). Prevention from direct contact with output terminal is highly necessary. While installing or servicing this power supply unit, avoid dropping tools by mistake or direct contact with output terminal. This might cause an electrical shock. While repairing this power supply unit, the AC input power must be switched off and the input and output voltage should be level.
- The application circuits and their parameter are for reference only. Be sure to verify effectiveness of application circuits and their parameters before finalizing circuit design.
- Do not inject abnormal voltage to output terminal and signal terminal from the outside. The injection of reverse voltage or over voltage exceeding nominal output voltage to output terminals might cause damage to internal components.
- This information in this document is subject to change without prior notice. For actual design-in, please refer to the latest publications of data sheet, etc., for the most up-to date specifications of the unit.

Note: CE Marking, when applied to a product or packing material for a product covered by this handbook, indicates compliance with the Low Voltage Directive and RoHS Directive.

Note: UKCA Marking, when applied to a product or packing material for a product covered by this handbook, indicates compliance with the Electrical Equipment (Safety) Regulations and Restriction of the Use of Certain Hazardous Substances in Electrical & Electronic Equipment Regulations.

Ratings, Specifications and Features

Emissions		
AC Line Conducted Emissions	EN 55032:2015	(0.15-30 MHz) Class A with external filter *
Radiated RF Emissions	EN 55032:2015	0-1000 MHz Class A with external filter *
Immunity		
Electrostatic Discharge	IEC61000-4-2: 2008	+/-8 kV Air +/-4 kV Contact
RF Radiated Fields	EN 61000-4-3: 2006 +A1:2008 +A2:2010	3 V/m from 80-1000 MHz; (80% AM at 1kHz)
Electrical Fast Transients	EN61000-4-4: 2004+A1:2010	Power line pulses of ± 1 kV; I/O line pulses of ± 0.5 kV
Lightning Surge	IEC61000-4-5: 2005	± 4 kV common mode ± 2 kV differential mode
Conducted RF Common Mode	EN61000-4-6: 2009	150 kHz - 80 MHz at 3 Vrms 1 kHz 80% amplitude modulated
Power Frequency Magnetic Field	IEC61000-4-8:2009	30A/m (Continuous), 300A/m (Short)
Voltage Dips/Short Variations	IEC61000-4-11:2004	Dip to 0% of nom. line for 0.5 cycles - Criteria C Dip to 0% of nom. line for 1 cycles - Criteria C Dip to 40% of nom. line for 0.2 seconds - Criteria C Dip to 70% of nom. line for 0.5 seconds - Criteria C Dip to 80% of nom. line for 5 seconds - Criteria C
Voltage Dips/Short Variations	SEMI F47-0706	Dip to 50% of nom. line for 10 cycles - Criteria C Dip to 70% of nom. line for 25 cycles - Criteria C Dip to 80% of nom. line for 50 cycles - Criteria C

Table 1

*With appropriate installation

Maximum Ratings		
	Units	
Output Voltage Range	V	385
Rated Output Current (Power) ¹	A(W)	110 (42000)
Maximum Output Current (Power) ^{1,2}	A(W)	116 (45000)
Maximum Output Power with Dropped Phase	W	15000W
Minimum Load – Unit Enabled	A	0.5A (200W)
Minimum Load – Unit Inhibited ³	Ω	50
Operating Temperature	°C	-10°C to 50°C.
Start-up Temperature	°C	-20°C to +50°C

Table 2

¹ Load needs to remain off until the output voltage has reached 370VDC. If a load is drawn before the output has reached an appropriate voltage, the unit may go into a fault mode and shutdown. The DCOK signal will start to conduct when the output voltage has reached the appropriate level.

² Maximum output current (Power) allowable between 380VAC and 504VAC input.

³**Critical Note: If minimum load is not present while the unit is inhibited, the output can slowly be charged to unsafe levels. DO NOT remove output load connectors while unit is inhibited. Turn off AC input voltage before removing output connectors.**

Input Specifications		
	Units	
Input Voltage (nominal)		VAC 400/480 (50/60Hz) Three Phase Delta
Input Voltage (threshold)		VAC 360-528VAC (47-63Hz) Three Phase Delta, VAC 208-305VAC (47-63Hz) Three Phase Wye,
Input Current (RMS) Per Phase 400-480VAC input	A	75A @ 400VAC / 65A @ 480VAC (per phase)
Inrush Current (Peak, at cold start) Per Phase, 400-480VAC input *	A	Less than 150A per phase
Power Factor (at rated output power)	-	0.94 typical @ 400/480VAC line
Input EMI Conducted Emissions	-	FCC Class A, CISPR 22 Class A
Efficiency (at rated output power)	%	98 typical @ 400/480VAC line

Table 3

*excluding initial spike charging EMI capacitors lasting <2mS

Output Performance Specifications		
	Units	
Max Voltage Line Regulation	%	Less than 2%
Max Voltage Load Regulation	%	Less than 3%
Total Regulation	%	Less than 8%
Warm up Drift	%	Less than 3%
Temperature Stability	-	0.2% of rated Vout for 8hrs after 30min warm-up. Constant line, load & temp.
Temperature Coefficient	ppm/°C	400ppm/C
Output Ripple, JEITA RC-9131C ⁴	Vrms	<10
Remote Sense Compensation (Total)	V	Not applicable

Table 4

⁴See Ripple and Noise Notes for Details on Jeita RC-9131C method; All Three Phases present

Protective Functions		
	Units	
OCP TYPE	-	Foldback with delayed shutdown (latch). Manual reset by input cycling or remote control via the PMBus Interface.
OCP KNEE POINT	-	>116A
KNEE POINT PROTECTION	-	NONE. NO DAMAGE AT KNEE POINT
S/C PROTECTION	-	DAMAGE occurs if shorted during live operation. Will protect itself if started into a short circuit.
OVP TYPE	-	Latched shutdown. Manual reset by input cycling or remote control via the PMBus Interface.
OVP RANGE	-	395 +5/-1V
OVP RESET TIME	s	Not applicable
FAN FAIL	-	Blocked fan and fan failure detection. Manual reset by input cycling or remote control via the PMBus Interface.
OTP	-	Latch type. Manual reset by input cycling or remote control via the PMBus Interface.

Table 5

Operating Modes	
Series Operation	No
Parallel Operation	No

Table 6

Status Indicators	
DC OK	LED: GREEN when output >370VDC Turns OFF when output <350VDC
PHASE	LED: GREEN when all three phases of AC input are present, RED if: a) One of the Input AC Phases is low or lost (Applicable for 400/480 with 30% Load or greater). b) An internal fuse is open in one or more power modules.
ENA	LED: Green when the TPF45000-385 is commanded to turn ON either via I ² C command or via the hardware PSON signal.
FAULT	LED: RED if: a) AC power is applied to the unit and the output is OFF. b) One or more of the Fans is rotating slow or not working at all. c) DC Buss in one or more of the power modules is out of limit. d) OTP Condition. e) The unit is turned OFF via I ² C command or via the hardware PSON signal.
OTW	LED: RED when internal temperature approaches OTP setpoint This LED is normally OFF
OTP	LED: RED if any power module has been turned OFF due to over temperature condition This LED is normally OFF

Table 7

Remote Control Features	
Remote On/Off Control	On/Off control: Via signal connector. PSON High / Low thresholds: 6.0V / 0.6V 20V Maximum allowable. -20V Minimum allowable Signal applied between terminals 1 (PSON1) and 2 (PSON2) on Signal Connector. ISOLATED from Primary

Table 8

PMBus Features	
Output Voltage Monitoring	Output voltage monitoring via the PMBus. For reference only, no accuracy specified
Input Voltage Monitoring	Input voltage monitoring via the PMBus. Accuracy of the input reading is +/- 6% of full scale Measurement range is 200-310VAC (equivalent Line to Neutral)
Output Current Monitoring	Output current monitoring via the PMBus. Accuracy of the current reading is +/-12% of full scale above 50% load Measurement range is 0-110%
Internal Temperature Monitoring	Internal temperature monitoring via the PMBus. For reference only, no accuracy specified. Measurement range is 0-150°C
Remote On/Off Control	Supply ON/OFF control via the PMBus
Status Information	Status Information via the PMBus. See Table 13 for details on available status information
Product Information	Product information via the PMBus. Factory Programmed. Manufacturer ID, Model, Revision, Manufacturer location, Manufacturing Date and Serial Number

Table 9

Input, Output and Signal Connections	
Input	4 Pin connector. Recommended mating connector: Phoenix Contact 1762615
DC Output	Four parallel 4 pin connectors. It is recommended to split the output load equally across the four connectors. Do not exceed 50A on any individual connector. Recommended mating connector: MOLEX P/N: 42816-0412 Recommended receptacle contacts: MOLEX P/N: 42815-0114
Small Signal Connector	10 Pin connector. See Table 11 for pin configuration. Recommended mating connector: MOLEX P/N: 43025-1000 Recommended receptacle contacts: MOLEX P/N: 43030-0002
I ² C Bus Port	4 Pin connector: See Table 12 for pin configuration Recommended mating connector: MOLEX P/N: 43025-0400 Recommended receptacle contacts: MOLEX P/N: 43030-0002
USB Port	USB-Type B connector Used for I ² C communications Requires Microchip MCP2221 Driver and MCP2221 I ² C /SMBus Terminal These files are available at: https://www.microchip.com/en-us/product/MCP2221#document-table

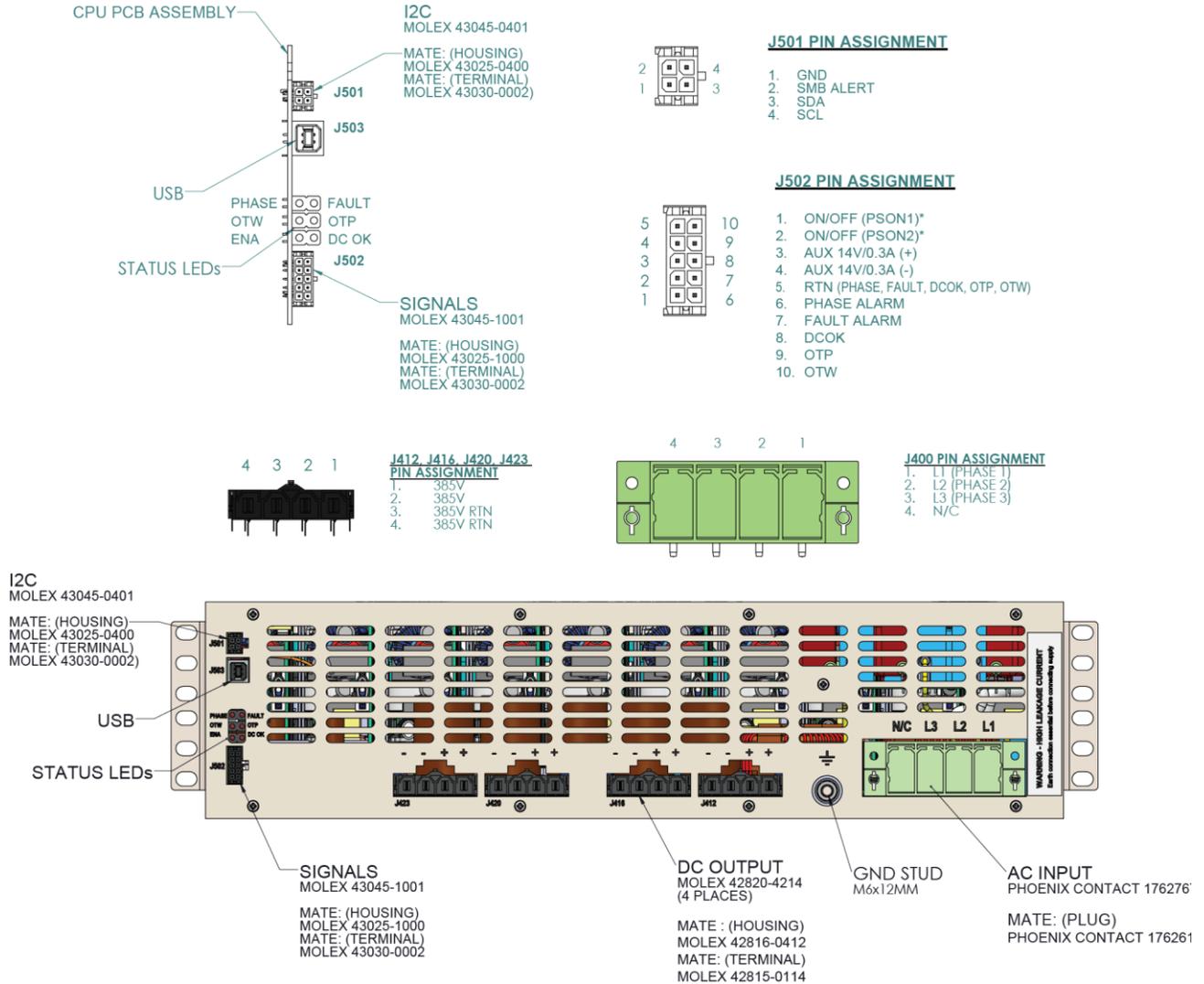
Table 10

Small Signal Connector		
Name	Terminal Location	Description
ON/OFF (PSON1)	1	Remote On/Off control. See Remote Control Features section for additional details.
ON/OFF (PSON2)	2	Remote On/Off control. See Remote Control Features section for additional details.
AUX (+)	3	Auxiliary Output Voltage 13-15V, 0.2A Isolated Terminal 3 used for Return.
AUX (-)	4	Return for AUX (+)
RTN	5	Return for Phase Alarm, Fault alarm, DCOK, OTP and OTW signals
PHASE ALARM	6	Open collector. Max. sink current: 5mA. Off (open) when OK, ON (closed) when input phase missing (Applicable for 400/480 with 30% Load or greater). Open collector. Non Polarized, 60V peak, Max. sink current: 5mA _{DC} . 2Ω ON resistance, Isolated Terminal 5 used for Return.
FAULT ALARM	7	Conducts when Fault occurs Open collector. Non Polarized, 60V peak, Max. sink current: 5mA _{DC} . 2Ω ON resistance, Isolated Terminal 5 used for Return.
DC OK	8	Conducts when Vout is greater than 370VDC Open collector. Non Polarized, 60V peak, Max. sink current: 5mA _{DC} . 2Ω ON resistance, Isolated Terminal 5 used for Return.
OTP	9	Over Temperature Protection Conducts when any module shuts down due to over temperature condition Open collector. Non Polarized, 60V peak, Max. sink current: 5mA _{DC} . 2Ω ON resistance, Isolated Terminal 5 used for Return.
OTW	10	Over Temperature Warning Conducts when any module gets close to its OTP threshold. Open collector. Non Polarized, 60V peak, Max. sink current: 5mA _{DC} . 2Ω ON resistance, Isolated Terminal 5 used for Return.

Table 11

I ² C Bus Port		
Name	Terminal Location	Description
SMB GND	1	Return for I ² C
SMB ALERT	2	Interrupt Line for I ² C
SDA	3	Data Line for I ² C
SCL	4	Clock Line for I ² C

Table 12



Ripple and Noise Notes

Ripple and Noise is measured according to the description below in accordance with JEITA RC-9131C (Sections 7.16, 7.17 and 7.18).

The measurement connection is shown in Fig. 3-1.

C1 (0.1 μ F Ceramic Capacitor), C2 (47 μ F Aluminum Electrolytic Capacitor) must be connected in parallel at 30cm from the output terminals, along the load cable. Attach a maximum 1.5m 50 Ω coaxial cable from the ceramic capacitor electrodes to a filter attachment installed on the oscilloscope. The filter attachment consists of C3 (4700pF film capacitor) in series with R (50 Ω resistor). Use 100MHz bandwidth oscilloscope or equivalent.

In general, output ripple voltage and output spike noise voltage can be reduced by increasing external capacitance.

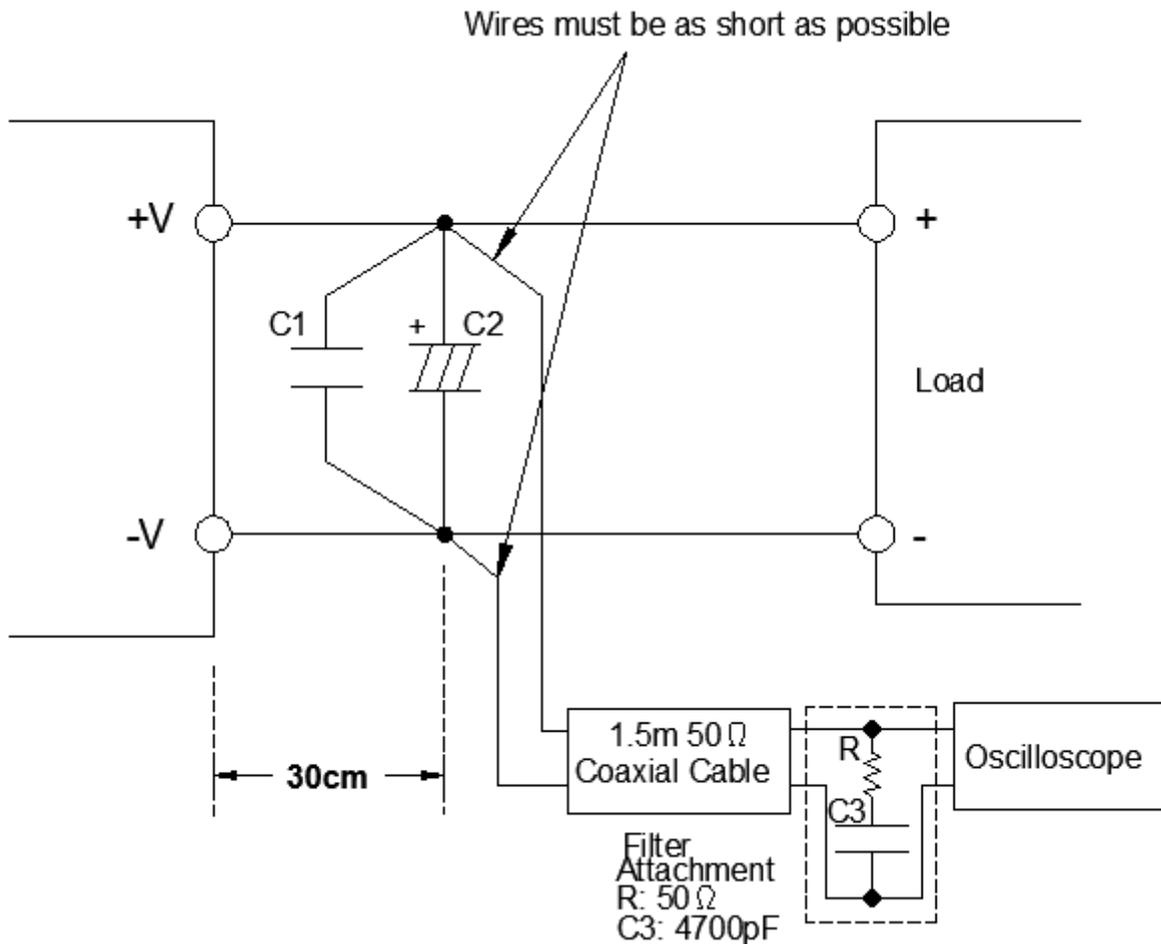


Figure 2: Output Ripple Voltage (including Spike Noise) Measurement Method

PMBus Interface

The TPF45000-385 has Power Management Bus (PMBus) hardware.

The PMBUS interface includes:

- Monitoring the Input Voltage (+/- 6% of Full Scale).
- Monitoring the Output Current (+/-12% of Full scale above 50% load).
- Monitoring the Output Voltage.
- Monitoring the Internal Temperature (For reference only, no accuracy specified).
- Programming the Output ON/OFF.
- Reading and Clearing Faults.
- Reading the Manufacturing Related Data (Model Name, Serial No, Manufacturing Date, etc.).

ATTENTION:

The PMBus supports:

- 100 KHz Operation.
- Block Read Protocol.
- Group Command Protocol.
- Direct Command Format for Monitoring and Programming
- Functions. Ver. 1.1 of PMBus Specifications.

ADDRESSING (A1, A0 inputs)

To communicate with the TPF45000-385, the master must first address the slave devices via a slave address byte. The slave address byte consists of seven address bits and a direction bit that indicates the intent to execute a read or write operation.

The 7 bit address has a constant part and variable part:

Constant part of address consists of 5 Most Significant Bits A6, A5, A4, A3 and A2 and always equals 01000.

Variable part of address consists of 2 Least Significant bits: A1 and A0 that allow up to 4 TPF45000-385 to be connected on a single bus. These two bits are assigned using the hardware connections of the TPF45000-385 address connector inside the unit.

The variable address lines (A1 and A0) are internally pulled up by resistors to +5V and can be left open for <1> address or connected for <0> address.

The Address Space contains these 4 possible addresses:

A6	A5	A4	A3	A2	A1	A0	R/W Byte	Hex Address
0	1	0	0	0	0	0	x	40h
0	1	0	0	0	0	1	x	42h
0	1	0	0	0	1	0	x	44h
0	1	0	0	0	1	1	x	46h

In case more than one unit is connected to PMBus, each unit must be set to its own unique address. Duplicate addressing is not allowed.

Note: The TPF45000-385 is always considered a slave device.

SERIAL CLOCK (SCL)

This line is clocked by the Master which controls the PMBUS. It is connected to +5.0V (referenced to "SIG_GND") via a 5.0kΩ pull-up resistor inside the TPF45000-385.

SERIAL DATA (SDA)

This is a Bi-Directional line which is connected to +5.0V (referenced to "SIG_GND") via a 5.0kΩ pull up resistor inside the TPF45000-385.

ALERT

ALERT is used to indicate to the HOST about any Faults/Error/Warning Conditions.

This line is connected to +5.0V (referenced to "SIG_GND") via a 3.0kΩ pull up resistor.

This Signal is HIGH to indicate that no fault/error/warning is present. If some fault/error/warning occurs, the signal will go LOW.

The Master must poll multiple units after receiving ALERT to retrieve fault/error/warning information.

Note: The TPF45000-385 does not respond to Alert Response Address.

PMBus COMMAND SET

- **OPERATION MODE**

This command is used to set the way you control the output of the TPF45000-385. Setting the Operation Mode to “*Remote Mode*” allow you to control the output using the “OPERATION ON/OFF” command via the I²C only.

In the “*Local Mode*” you can control the output using the “PSON” pins on the Signals connector only.

The default is the “*Local Mode*”.

Command code	Type	Data sent
D8h	R/W Byte	00h=Remote
D8h	R/W Byte	80h=Local

- **OPERATION (ON/OFF)**

If the TPF45000-385 is turned OFF with the “*OPERATION OFF*” command, it can be turned ON with the “*OPERATION ON*” command.

Command code	Type	Data sent
01h	R/W Byte	00h=OFF
01h	R/W Byte	80h=ON

Note: *This command will not work in the “Local Mode”.*

- **CLEAR FAULTS**

This command is used to clear the “STATUS REGISTERS” after any fault occurs.

If the CLEAR_FAULTS command is not sent after any fault occurs, the “STATUS REGISTERS” will not be cleared.

ALERT signal will remain “LOW” until a “CLEAR_FAULTS” command is sent.

If a Fault or Warning is still present after “CLEAR_FAULTS” is sent, “STATUS REGISTERS” will be updated and the ALERT signal will be “LOW” again.

Command code	Type	#Data bytes
03h	Send Byte	0

- **READ_STATUS**

This Command is used to read the status of the TPF45000-385. The Status information is stored in a special register called the “STATUS REGISTER”

The Status reports 6 different types of Faults and Warnings.

Command Used	Type	#Data bytes
D0h	Read Word	1

Fault is indicated by “1”. No fault is indicated by”0”.

Faults	Type	Bit # in Status Register	Meaning	Output behavior
ON/OFF	FAULT	0	Global Output Enabled/Output Disabled	Output ON or OFF
OTW	WARNING	1	Internal temperature ~ 10°C below OTP limit.	Output ON
OTP	FAULT	2	Internal temperature higher than safe limit	Output OFF
DCOK	WARNING	3	Output Voltage < 85~95% of Set Vout on one or more modules	Output ON or OFF
PHASEOK	WARNING	4	One Input Phase Low or Out	Output ON
FANOK	FAULT/WARNING	5	Fan is rotating slow or Stopped	Output ON
ENA	WARNING	6	Module Output Enabled/Output Disabled	
ERROR	WARNING	7	I ² C Error	Output ON

Table 13

- **READ_OTP_STATUS**

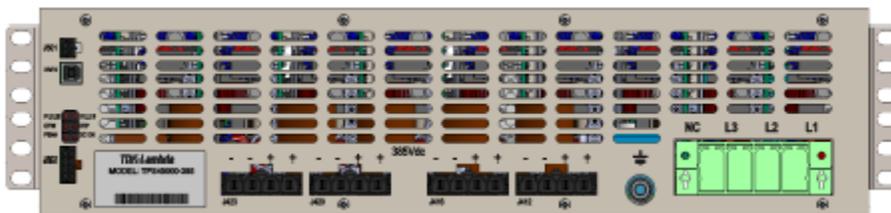
This Command is used to determine which of the 10 modules inside the TPF45000-385 set the Over Temp Protection (OTP) Bit in the “STATUS REGISTER”.

Command Used	Type	#Data bytes
DBh	Read Word	2

Module in Fault is indicated by “1”.

Module	Bit # in 1 st Byte	Meaning
1	0	Internal temperature of Module #1 in OTP condition
2	1	Internal temperature of Module #2 in OTP condition
3	2	Internal temperature of Module #3 in OTP condition
4	3	Internal temperature of Module #4 in OTP condition
5	4	Internal temperature of Module #5 in OTP condition
6	5	Internal temperature of Module #6 in OTP condition
7	6	Internal temperature of Module #7 in OTP condition
8	7	Internal temperature of Module #8 in OTP condition

Module	Bit # in 2 st Byte	Meaning
9	0	Internal temperature of Module #9 in OTP condition
10	1	Internal temperature of Module #10 in OTP condition



Module #10 Module #1

- **READ_DC_STATUS**

This Command is used to determine which of the 10 modules inside the TPF45000-385 set the Output Fault (DCOK) Bit in the “STATUS REGISTER”.

Command Used	Type	#Data bytes
DCh	Read Word	2

Module in Fault is indicated by “1”.

Module	Bit # in 1 st Byte	Meaning
1	0	Output Voltage < 85~95% of Set Vout on Module #1
2	1	Output Voltage < 85~95% of Set Vout on Module #2
3	2	Output Voltage < 85~95% of Set Vout on Module #3
4	3	Output Voltage < 85~95% of Set Vout on Module #4
5	4	Output Voltage < 85~95% of Set Vout on Module #5
6	5	Output Voltage < 85~95% of Set Vout on Module #6
7	6	Output Voltage < 85~95% of Set Vout on Module #7
8	7	Output Voltage < 85~95% of Set Vout on Module #8

Module	Bit # in 2 st Byte	Meaning
9	0	Output Voltage < 85~95% of Set Vout on Module #9
10	1	Output Voltage < 85~95% of Set Vout on Module #10

- **READ_PHASE_STATUS**

This Command is used to determine which of the 10 modules inside the TPF45000-385 set the Input Phase Fault (PHASEOK) Bit in the “STATUS REGISTER”.

Command Used	Type	#Data bytes
DDh	Read Word	2

Module in Fault is indicated by “1”.

Module	Bit # in 1 st Byte	Meaning
1	0	One Input Phase Low or Out on Module #1
2	1	One Input Phase Low or Out on Module #2
3	2	One Input Phase Low or Out on Module #3
4	3	One Input Phase Low or Out on Module #4
5	4	One Input Phase Low or Out on Module #5
6	5	One Input Phase Low or Out on Module #6
7	6	One Input Phase Low or Out on Module #7
8	7	One Input Phase Low or Out on Module #8

Module	Bit # in 2 nd Byte	Meaning
9	0	One Input Phase Low or Out on Module #9
10	1	One Input Phase Low or Out on Module #10

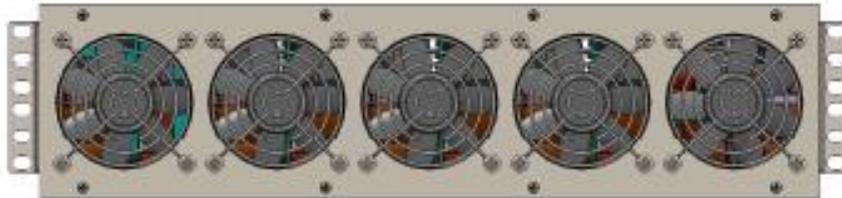
- **READ_FAN_STATUS**

This Command is used to determine the Fan(s) that set the Fan warning (FANOK) Bit in the “STATUS REGISTER” of the TPF45000-385.

Command Used	Type	#Data bytes
DFh	Read Byte	1

Fan in Fault is indicated by “1”.

Module	Bit #	Meaning
1	0	Fan #1 is rotating slow or Stopped
2	1	Fan #2 is rotating slow or Stopped
3	2	Fan #3 is rotating slow or Stopped
4	3	Fan #4 is rotating slow or Stopped
5	4	Fan #5 is rotating slow or Stopped



Fan #1 Fan #5

- **READ_ENA_STATUS**

This Command is used to determine which of the 10 modules inside the TPF45000-385 set the Output Enabled/Output Disabled (ENA) Bit in the “STATUS REGISTER”.

Command Used	Type	#Data bytes
DEh	Read Word	2

Module in Disable Mode is indicated by “1”.

Module	Bit # in 1 st Byte	Meaning
1	0	Vout of Module #1 Disabled
2	1	Vout of Module #2 Disabled
3	2	Vout of Module #3 Disabled
4	3	Vout of Module #4 Disabled
5	4	Vout of Module #5 Disabled
6	5	Vout of Module #6 Disabled
7	6	Vout of Module #7 Disabled
8	7	Vout of Module #8 Disabled

Module	Bit # in 2 nd Byte	Meaning
9	0	Vout of Module #9 Disabled
10	1	Vout of Module #10 Disabled

- **READ_OPERATING_HOURS**

This Command is used to retrieve the Hours that the TPF45000-385 is been operational since first powered up.

Command Used	Type	#Data bytes
E0h	Read Word	2

The two bytes represent hours.

The total operating hours can be calculated by converting the data to decimal values, then multiply the High Byte by 255 and add the low byte.

Example: Assume the data received is 0x03, 0x45 → 03, 69 → 3*255+69=834Hrs

COMMANDS TO READ MANUFACTURING INVENTORY DETAILS

Command Name	Command code	Type	#Data bytes
PMBUS_REVISION	98h	Read Byte	1
MFR_ID	99h	Read Block	10
MFR_MODEL	9Ah	Read Block	12
MFR_REVISION	9Bh	Read Block	11
MFR_LOCATION	9Ch	Read Block	3
MFR_DATE	9Dh	Read Block	8
MFR_SERIAL	9Eh	Read Block	20

All details except for <PMBUS_REVISION> are stored in ASCII format.

MFR_REVISION:

Ex: 0x48,0x3A,0x50,0x32,0x3B,0x46,0x3A,0x30,0x2E,0x31,0x3B
H : P 2 ; F : 0 . 1 ;

Hardware follows by Firmware Rev.

MFR_DATE:

Ex: 0x30,0x33,0x2D,0x30,0x31,0x2D,0x31,0x37
M M - D D - Y Y

MONITORING FUNCTIONS

For Monitoring functions use the following equation

$$X = (Y * 10^{-R} - b) / m$$

Where **Y** - digital value received from the supply.

X is the normal value (V, A, °C)

m, b, R - coefficients that are explained in Table 1.

Table 1

Physical value	Physical Unit	Min. Value	Max. Value	m	b	R
Input Voltage monitoring	V	225	300	353	-28233	-2
Output Voltage monitoring	V	0	385	25575	0	-4
Output Current monitoring	%	0	110	100	0	0
Temperature monitoring	°C	0	150	23	4750	-1

m, b, R coefficients can also be recovered from the EEPROM and are stored in ASCII Format.

Ex:

```
0x4D,0x3A,0x30,0x31,0x33,0x39,0x42,0x3A,0x2D,0x30,0x33,0x39,0x52,0x3A,0x30,0x30
M : 0 1 3 9 B : - 0 3 9 R : 0 0
```

Command name	Command code	Type	#Data bytes
MFR_Vin_MON_COEFF	DAh	Read Block	16
MFR_Vout_MON_COEFF	D3h	Read Block	16
MFR_Iout_MON_COEFF	D5h	Read Block	16
MFR_TEMP_MON_COEFF	D7h	Read Block	16

- **READ_VIn**

This Command is used to retrieve the measured Input voltage of the TPF45000-385.

Command Used	Type	#Data bytes
88h	Read Word	2

Example:

Hex read back = 0x01, 0xE2. Converted to Decimal = 482. $V_{in} = ((482 * 10^2) + 28233) / 353 = 216.52 \text{Vac}$

- **READ_VOut**

This Command is used to retrieve the measured Output voltage of the TPF45000-385.

Command Used	Type	#Data bytes
8Bh	Read Word	2

- **READ_Iout**

This Command is used to retrieve the measured Output Load Current of the TPF45000-385.

Command Used	Type	#Data bytes
8Ch	Read Byte	1

Example:

Hex read back = 0x0C. Converted to Decimal = 12. $I_{out} = ((12 * 10^0) + 0) / 100 = 12\%$

- **READ_Temperature**

This Command is used to retrieve the measured maximum internal temperature of the TPF45000-385.

Command Used	Type	#Data bytes
8Dh	Read Word	2

Example:

Hex read back = 0x02, 0x1F. Converted to Decimal = 543. $V_{in} = (543 * 10^1) - 4750 / 23 = 29.56^\circ\text{C}$