RHENXV
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DC - DC CONVERTERS

1300 WATTS

DCMF4850HBO-1300W



RoHS

3 YEARS WARRANTY

FEATURES

- Wide input voltage range：36-75VDC
- High efficiency up to 96.5%
- Basic insulation, i/o isolation test voltage 2250VDC
- Operating ambient temperature range：-40°C to +85°C
- Input under-voltage protection. Output over–voltage. over-current, output short circuit protection, over-temperature protection
- Built-in PMBus communication function
- Industry standard package: 1/2brick
- Meets EN62368 standards
- 3 Years Warranty

DESCRIPTION

High-performance 1300W DC-DC power module featuring 36–75VDC input, operation up to 85°C, comprehensive protection, and advanced monitoring and control functions.

MODEL NUMBERING

DCMF4850HBO-1300W

- Series Name
- Input Voltage
- Output Voltage
- Rated Wattage
- Packaging Form

SELECTION GUIDE

Product Model	Input Voltage Nominal (Range)	Input Voltage Max.	Output Voltage (VDC)	Output Current (A) Max./Min.	Nominal Efficiency(%) 50%Io / 100%Io	Capacitance Load(μF)Max.
DCMF4850HBO-1300W	48 (36-75)	78	50	13/26	97/96.5	3300

Use suffix "P" means positive logic, "N" means negative logic.

INPUT CHARACTERISTICS

Parameter		Conditions	Min.	Typ.	Max.	Units
Input Current (Rate load)		Room temperature, Vin = 48 V	--	--	28.5	A
No Load Input Loss		Room temperature, Vin = 48V	--	9.6	14	W
Input impulse voltage		1sec. max.(Room temperature)	-0.5	--	100	VDC
Max input Voltage		Room temperature	--	--	78	VDC
Start-up Voltage		Vin = 48V , Input Series	33	34	35	VDC
Input Under-voltage Protection			31	--	33	VDC
Input Filter			Pi filter			
Ctrl*	Module On	Room temperature	0	--	1.2	VDC
	Module shutdown	Room temperature	3.3	--	5	VDC
	Input current	Room temperature	--	0.3	--	mA
	Input loss during shutdown	Room temperature	--	1	--	W
	Start-up Delay Time	All operating Temperature range	--	1	--	ms

Remarks: This product does not support hot plug

OUTPUT CHARACTERISTICS

Parameter	Operating Conditions	Min.	Typ.	Max.	Units
Output Voltage Accuracy		0	--	100	%Io
Line regulation rate	Room temperature,Vin = 36-75 V, 100%Io	--	±0.2	±0.5	%
Load Regulation rate	Room temperature, Vin = 48 V, 0%-100%Io	--	±0.4	±1	%
Voltage Accuracy	Room temperature,Vin = 36-75 V, 0%-100%Io	--	±1	±2	%
Dynamic response step deviation	Vin = 48 V, 25-75-25% Io, di/dt = 1 A/μs	--	±1	±3	%
	Vin = 48 V, 10-100-10% Io, di/dt = 1 A/μs	--	--	±8	%
Dynamic Response Recovery Time	Vin = 48V, 25-75-25% Io, di/dt = 1A/μs	--	300	500	μs
Temperature drift coefficient	100%Io	--	--	±0.03	%/°C
Ripple & Noise	Room temperature,Vin = 36-75 V, 0%-100%Io	--	40	500	mVp-p

Parameter	Operating Conditions	Min.	Typ.	Max.	Units
Trim		25	--	55	V
Sense		--	--	105	%Vo
Over-temperature Protection	Product sur PCB face max. temperature	--	110	125	°C
Over-Voltage Protection	Vin = 36-75 V	58	59	60	V
Over-current Protection	Vin = 36-75 V	28	32	36	A
Short-circuit Protection	Vin = 36-75 V	Hiccup, continuous, self-recovery			
Start-Up Time	Vin = 48 V, Constant resistance load	--	150	500	ms
Output Voltage Rise Time	Room temperature,Vin = 48 V,0%-100%Io	--	100	150	ms
Power-off hold Time	Room temperature,Vin = 48 V,0%-100%Io	--	5	--	ms

GENERAL CHARACTERISTIC

Parameter	Operating Conditions		Min.	Typ.	Max.	Units
Isolation voltage	Electric Strength Test for 1 minute with a leakage current of 5mA max	Input-output	2250	--	--	VDC
		Input-case	750	--	--	VDC
		Output-case	750	--	--	VDC
Insulation Resistance	Input-output, resistance at 500VDC		100	--	--	MΩ
Isolation Capacitance	Input-output, 100KHz/0.1V		--	5000	--	pF
Working temperature			-40	--	+85	°C
Storage Humidity	Non-condensing		5	--	95	%RH
Storage Temperature			-55	--	+125	°C
Soldering temperature resistance of pins	Soldering spot is 1.5mm away from case for 10 seconds		--	--	300	°C
	Wave soldering,10 seconds		255	260	265	°C
MTBF	Telcordia SR-332@25°C		4700	--	--	K hours
Vibration			10-150Hz, 5G, 0.75mm. along X, Y and Z			

EMC CHARACTERISTICS

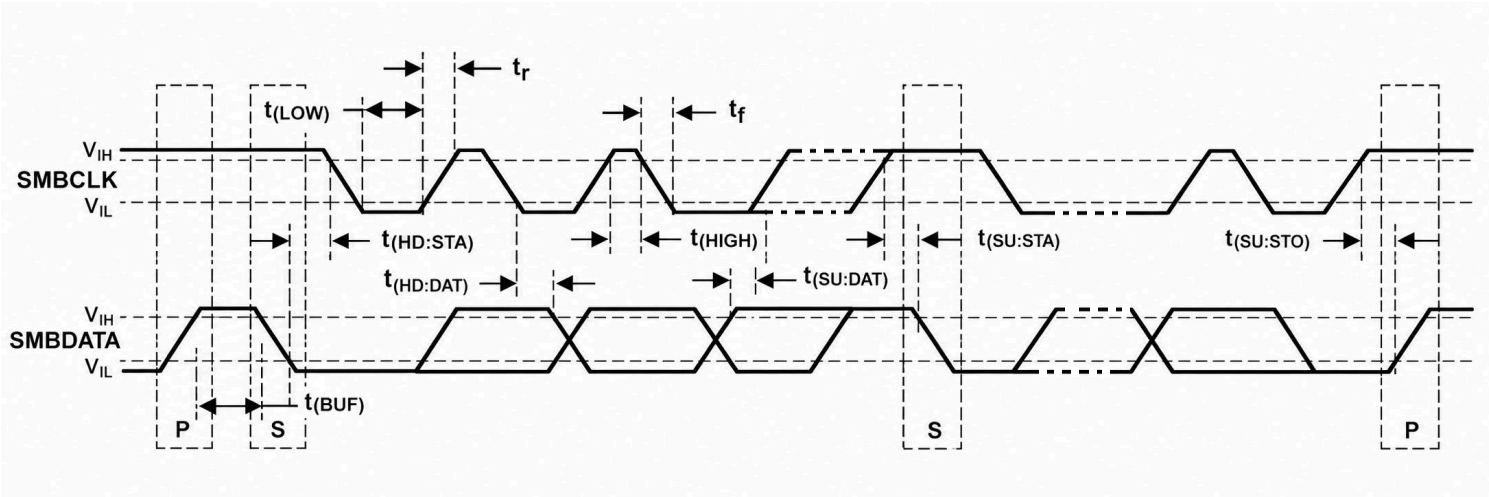
Parameter	Category		Content	
EMI	CE	CISPR32/EN55032	CLASS B (see Fig.3 for recommended circuit)	
	RE	CISPR32/EN55032	CLASS B (see Fig.3 for recommended circuit)	
EMS	ESD	IEC/EN61000-4-2	Contact ±4KV/Air ±6KV (see Fig.4 for recommended circuit)	perf. Criteria B
	RS	IEC/EN61000-4-3	10V/m (see Fig.3 for recommended circuit)	perf. Criteria A
	EFT	IEC/EN61000-4-4	100kHz ±2kV (see Fig.3 for recommended circuit)	perf. Criteria B
	Surge	IEC/EN61000-4-5	line to line ±2kV (see Fig.3 for recommended circuit)	perf. Criteria B
	CS	IEC/EN61000-4-6	3 Vr.m.s (see Fig.3 for recommended circuit)	perf. Criteria A

PMBUS ELECTRICAL SPECIFICATIONS

Parameter	Operating Conditions		Min.	Typ.	Max.	Units
Logic Output Low Signal Level (VOL)	SCL, SDA, SYNC, SALERT, PG IOH= 4 mA		--	--	DGND +0.25	VDC
Logic Output High Signal Level (VOH)			VDD-0.6	--	--	VDC
Logic Output High Source Current (IOH)			--	--	4	mA
Logic Output Low Sink Current (IOL)			-4	--	--	mA
Logic Input High Threshold (VIH)	VDD=3V		2.1	--	--	VDC
Logic Input Low Threshold (VIL)			--	--	1.1	VDC
Parasitic Capacitance			--	--	400	pF
SYNC Pin Capacitance	Parallel interleaving		--	100	--	pF
Internal Pull-up Resistance	PMBus CTRL		--	47	--	KΩ
PMBus Operating Frequency	Operating frequency range	Slave mode: 50% duty cycle	100	400	1000	Khz
	Default operating frequency		--	400	--	Khz

Parameter	Operating Conditions	Min.	Typ.	Max.	Units
STOP TO START Min Time $t_{(B\mu F)}$	See System Management Bus Specification Version 3.0 for detail	--	1.3	--	μs
START Continue Time $t_{(HD:STA)}$		--	0.6	--	μs
Repeat START Time $t_{(SU:STA)}$		--	0.6	--	μs
STOP Continue Time $t_{(SU:STO)}$		--	0.6	--	μs
Data Continue Time $t_{(HD:DAT)}$		--	0	--	μs
Data Set Time $t_{(SU:DAT)}$		--	100	--	μs
Error Signal Time $t_{(TIMEOUT)}$		--	--	35	ms
Clock Low Level Time $t_{(LOW)}$		--	1.3	--	μs
Clock High Level Time $t_{(HIGH)}$		--	0.6	--	μs
Clock Low Level Accumulated Time $t_{(LOW:SEXT)}$		--	--	25	ms

Note:
This data is obtained at 25°C, VCC=3.3V, 400kHz; The test data is applicable to all functional pins of PMBus, and the sequence diagram is as follows:



PMBUS DESIGN SPECIFICATIONS

Parameter		Operating Conditions	Min.	Typ.	Max.	Units
Power Good, PG	PG Threshold	PMBus configurable Rising	--	22	--	VDC
		PMBus configurable Falling	--	15	--	VDC
	PG Threshold Range	POWER_GOOD_ON VOUT_UV_FAULT_LIMIT	0	--	100	%Vout
	PG Delay	VO to POWER_GOOD_ON to PG set	--	139	--	µs
Input Under Voltage Protection, IUVP	IUVP Threshold	PMBus configurable	--	33	--	VDC
	IUVP Threshold Range	VIN_UV_FAULT_LIMIT	30	--	75	VDC
	IUVP Back-difference voltage	PMBus cannot be configured	--	2	--	--
	Set Point Accuracy		--	--	--	%
	IUVP Response Delay		--	500	--	µs
	Fault Response	PMBus configurable VIN_UV_FAULT_RESPONSE	Output off, self-recover when input voltage normal			
Input over-voltage Protection, IOVP	IOVP Threshold	PMBus The default over-voltage protection value is entered	--	78	--	VDC
	IOVP Threshold Range	VIN_OV_FAULT_LIMIT	0	--	100	%Vin
	IUVP Backlash voltage	PMBus cannot be configured	--	5	--	--
	Set Point Accuracy		--	1	--	V
	IOVP Response Delay		--	500	--	µs
	Fault Response	PMBus configurable VIN_OV_FAULT_RESPONSE	Output off, self-recover when input voltage normal			
Output Voltage Over/under-voltage Protection, OVP / UVP	UVP Threshold	PMBus configurable	--	0	--	VDC
	UVP Threshold Range	VOUT_UV_FAULT_LIMIT	0	--	100	%Vout
	OVP Threshold	PMBus configurable	--	59	--	VDC
	OVP Threshold Range	VOUT_OV_FAULT_LIMIT	0	--	59	VDC
	OVP&UVP response time		--	1 & 139	--	µs

Parameter		Operating Conditions	Min.	Typ.	Max.	Units
Output Voltage Over/under-voltage Protection, OVP / UVP	Fault Response	PMBus configurable VOUT_UV_FAULT_RESPONSE	Default off type, can be configured to hicuup, self-recovery			
		PMBus configurable VOUT_OV_FAULT_RESPONSE				
Over-current Protection	OCP Threshold	PMBus configurable	--	32	--	A
	OCP Threshold Range	IOUT_OC_FAULT_LIMIT	0	--	36	A
	Protection delay		--	8 & 1	--	ms
Over-temperature Protection	OTP Threshold	PMBus configurable	--	87	--	°C
	OTP temperature return difference	PMBus can not be configured	--	5	--	°C
	OTP Threshold Range	OT_FAULT_LIMIT	-40	--	87	°C
	Fault Response	PMBus configurable OT_FAULT_RESPONSE	3s after the system shuts down, the OTP sampling point temperature returns to the "Threshold - Temp. Return Difference" , and the system automatically restarts if no fault occurs			
Monitoring Accuracy	Input voltage READ_VIN	Room temperature	--	±1	--	V
	Output voltage READ_VOUT	Room temperature	--	±1	--	V
	Output current READ_IOUT		--	3	--	A
	Temperature READ_TEMPERATURE_1	Temperature sensor, -30~125°C	--	±10	--	°C
	Duty cycle READ_DUTY_CYCLE		No tolerance, Read value is the actual value applied by PWM controller			

Note:

1. When the product is working at current sharing mode, over-current will cause the product to be directly turned off, and the PMBus cannot be configured;
2. The product over-temperature protection point is set at the MCU temperature, which has a certain temperature difference with the maximum internal temperature of the product; If the maximum operating temperature is to be considered, the temperature rise assessment is required before specific debugging;
3. Hysteretic parameters of some protection features are fixed and cannot be configured. Details are as follows:

A. The hysteretic voltage of the input under-voltage protection is fixed to 2V, that is, the input voltage must be higher than the input under-voltage protection threshold of 2V before starting. The starting voltage is defined in accordance with instruction 0X35 VIN ON;

B. The hysteretic voltage of the input over-voltage protection is fixed to 5V, that is, the input voltage must be lower than the input over-voltage protection threshold of 5V before starting;

C. The hysteretic temperature of over-temperature protection is fixed to 5°C, that is, 3s after the system shuts down, the OTP sampling point temperature returns to the "Threshold - Temp. Return Difference" , and the system automatically restarts if no fault occurs;

4. The PMBus setting limit has a specified maximum value. When the setting value is higher than the maximum value, the maximum value is set.

PHYSICAL CHARACTERISTICS

Parameter	Conditions
Housing material	Aluminum alloy case
Overall dimensions	61.00 × 57.90 × 12.70 mm
Weight	118.0g(Typ.)
Cooling mode	Free air convection cooling or forced air cooling

CIRCUIT DESIGN AND APPLICATION

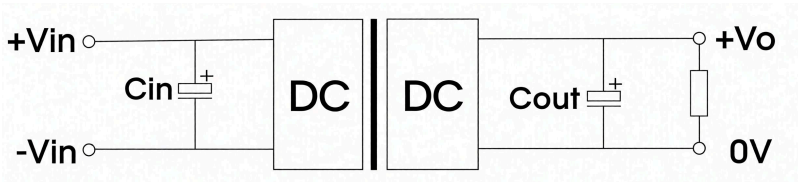


Fig.1

VDC	Capacitors Value	Cin	Cout (typ.)
50V		470uF/100V	1620uF/100V

RIPPLE NOISE TEST CIRCUIT

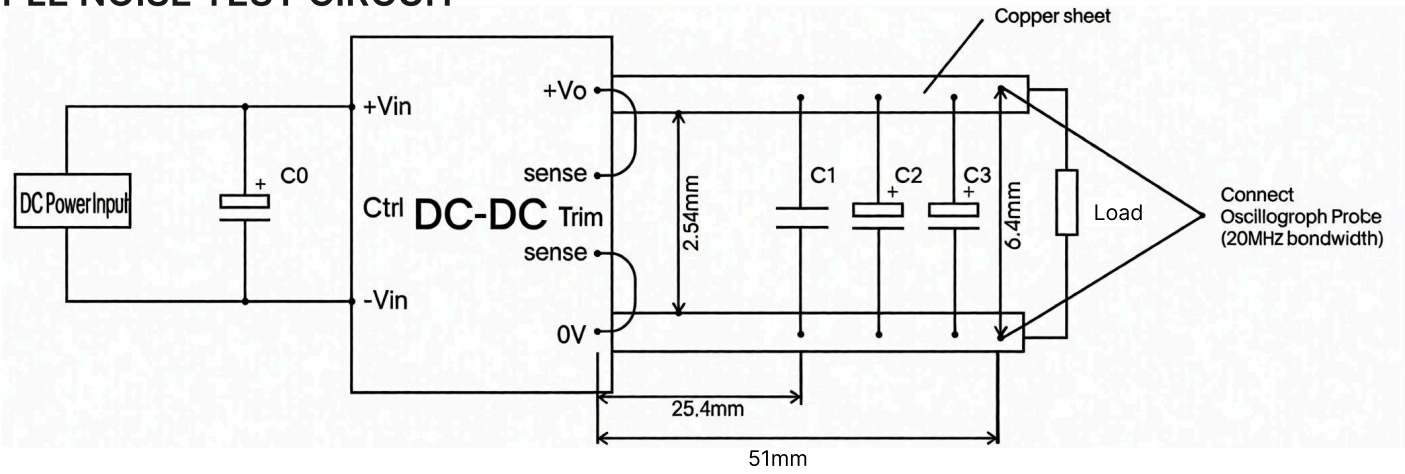


Fig.2

Components	Recommended Components
C0	470μF/100V electrolytic capacitors
C1	0.1μF/100V ceramic capacitance
C2	10μF/100V Tantalum capacitor
C3	1620μF/100V aluminum electrolytic capacitor

EMC COMPLIANCE CIRCUIT

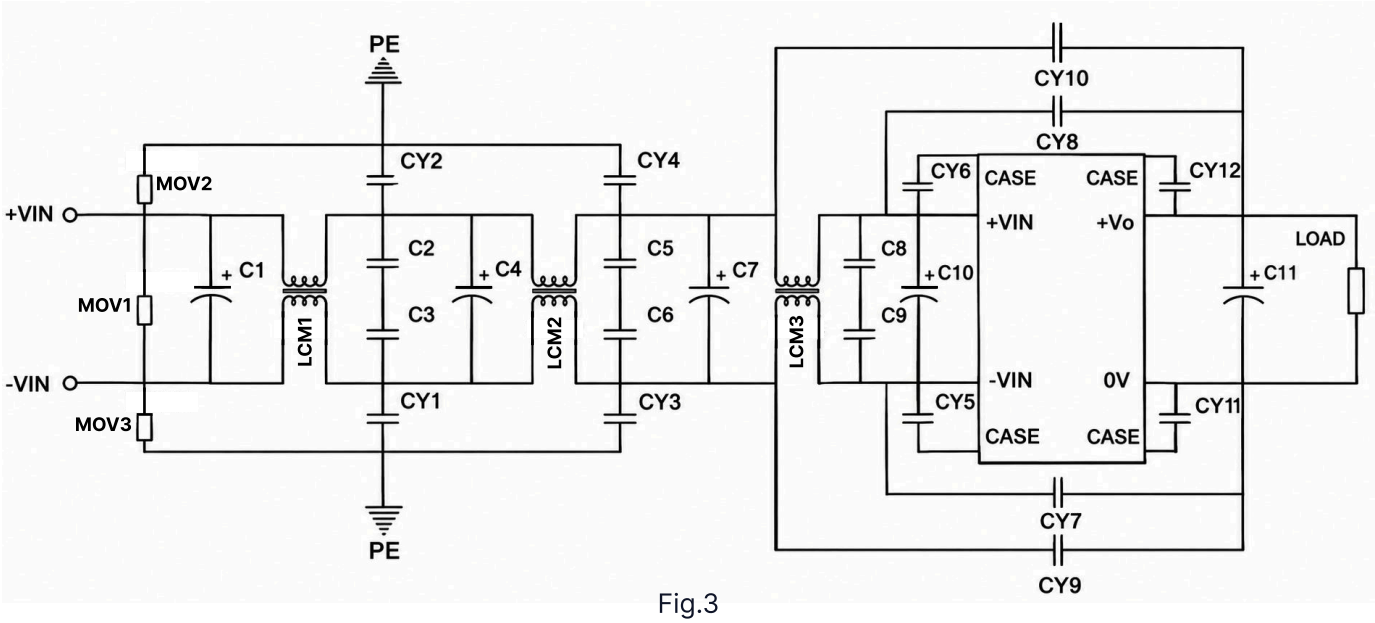


Fig.3

Components	Recommended Components
MOV1/MOV2/MOV3	20D101K voltage sensitive resistor
C1/C4/C7/C10	680uF/100V aluminum electrolytic capacitor
C2/C3/C8/C9	4*4.7uF/100V
C5/C6	8*4.7uF/100V
C11	2*470uF/100V+680uF/100V aluminum electrolytic capacitor
CY1/CY2	2*4.7nF/Y2+1nF/Y1
CY3/CY4	2*4.7nF/Y2
CY5/CY6	4.7nF/Y2
CY7/CY8	2.2nF/Y1
CY9/CY10	4.7nF/Y2
CY11/CY12	4.7nF/Y2+2.2nF/Y1
LCM1	1.4mH
LCM2	75uH
LCM3	10uH

ELECTROSTATIC SOLUTIONS - RECOMMENDED CIRCUITS

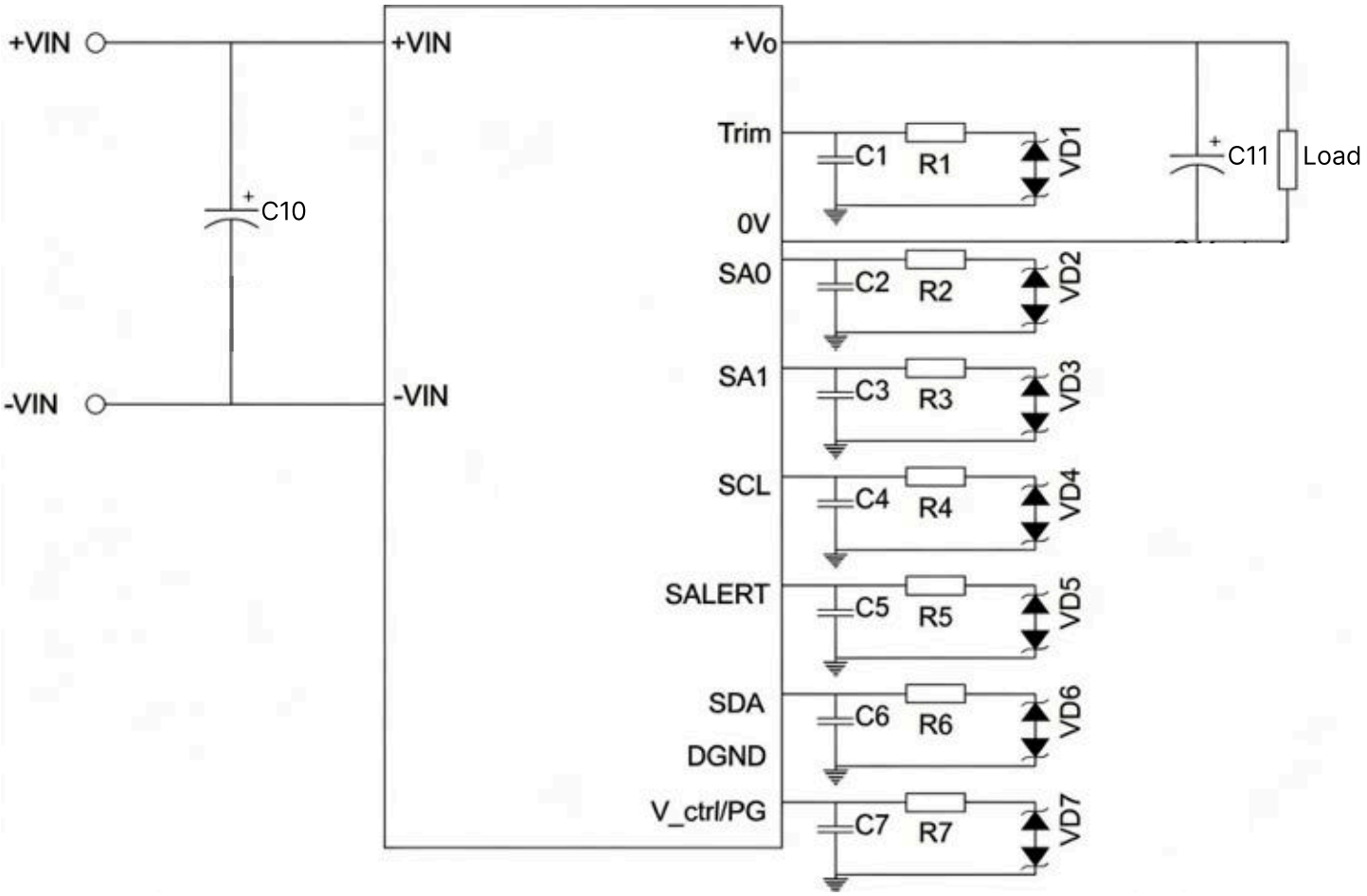
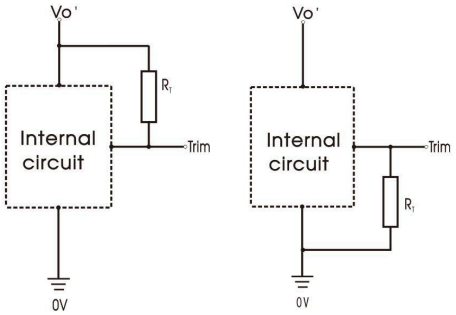


Fig.4

Components	Recommended Component
C1, C2, C3, C4, C5, C6, C7	1nf/25V Ceramic capacitor
R1,R2, R3, R4, R5, R6, R7	10K Ω Patch resistance
VD1,VD2,VD3,VD4,VD5,VD6,VD7	5V bi-directional TVS
C10	680uF/100V aluminum electrolytic capacitor
C11	2*470uF/100V+680uF/100V aluminum electrolytic capacitor

Note: If there is a static level requirements, please be sure to connect the electrostatic protection periphery.

TRIM FUNCTION FOR OUTPUT VOLTAGE ADJUSTMENT (OPEN IF UNUSED)



Trim up

Trim down

Note: Radj= Trim Resistor value

$$\Delta\% = \left|\frac{V_{nom} - V_{out}}{V_{nom}}\right| \times 100$$

Vnom= nominal output voltage
Vout = desired output voltage

Calculating Trim resistor values:
Trim up

$$Radj = \left(\frac{50 \times (100 + \Delta\%)}{1.225 \times \Delta\%} - \frac{100}{\Delta\%} - 2\right) \text{ k}\Omega$$

Calculating Trim resistor values:
Trim down

$$Radj = \left(\frac{100}{\Delta\%} - 2\right) \text{ k}$$

Examples:
voltage up 10% to 55V, serial resistance:

$$\Delta\% = \left|\frac{50 - 55}{50}\right| * 100 = 10$$

$$R_T = \frac{50 * (100 + 10)}{1.225 * 10} - \frac{100}{10} - 2 = 436.98K\Omega$$

Voltage down 44% to 28V, serial resistor:

$$\Delta\% = \left|\frac{50 - 28}{50}\right| \times 100 = 44$$

$$R_T = \frac{100}{44} - 2 = 0.2727K\Omega$$

RECOMMENDED SOLUTION FOR THERMAL TESTING

In the process of application, product thermal design can be evaluated by combining product temperature derating curve, or determine the stable working range of the product by testing the temperature of each temperature test point of P1, P2, P3 in Fig 5. When the P1 temperature of each point is lower than 105°C, the P2, P3 temperature of each point is lower than 100°C. it is the stable working range of the product.

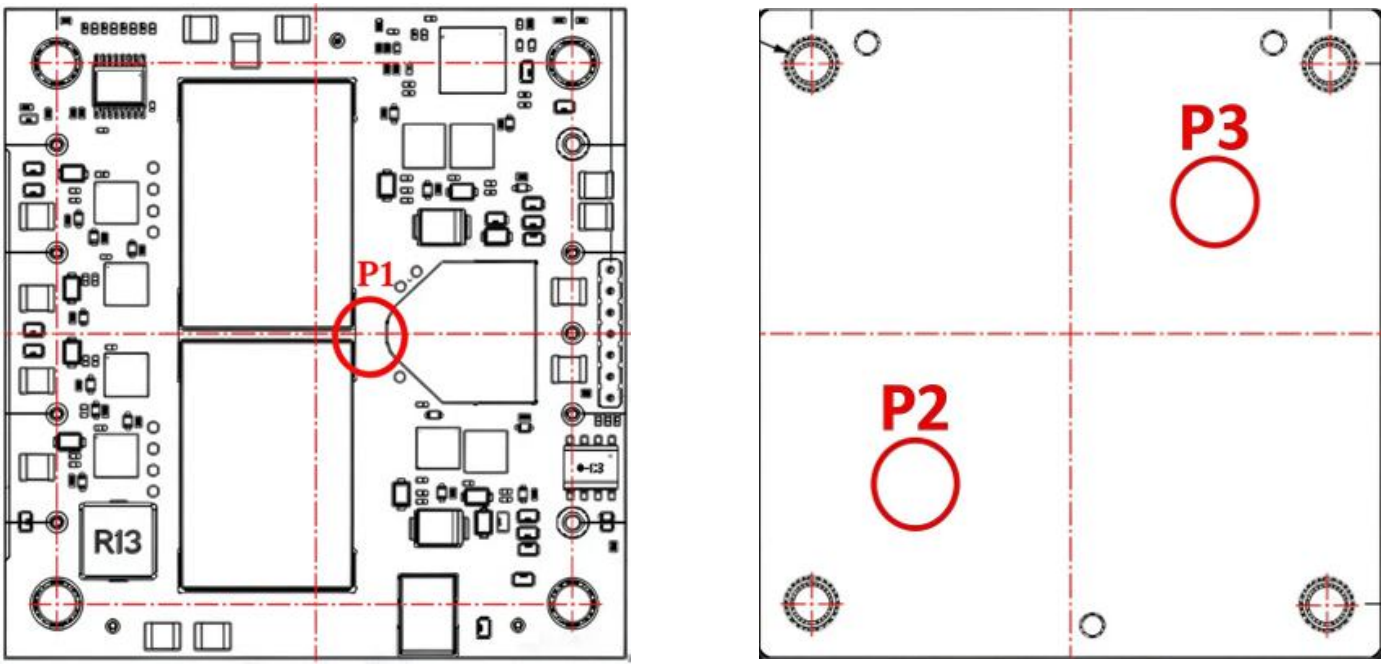


Fig.5

THE ON/OFF INPUT VOLTAGE

The product contains an input voltage sampling circuit, which has been set to sample the input voltage, and set the input starting voltage and under-voltage turn-off voltage. Generally, the input starting voltage is set to be slightly higher than the under-voltage turn-off voltage, in order to avoid repeated start up of the product caused by input voltage disturbance.

REMOTE SWITCH CONTROL (CTRL)

The product is equipped with remote control function, the reference ground for the input power negative input terminal (-Vin), compatible with the design of negative and positive logic options, the default is negative logic, In cases where a control signal or switch is not required and the product is desired to be enabled automatically, the CTRL pin should be connected directly to the -Vin. The CTRL function allows the product to be turned on/off by an external device, such as a semiconductor or mechanical switch.

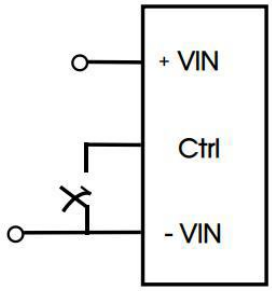


Fig.6

External equipment must provide the minimum current absorption capacity required. 0.5 mA to ensure that the voltage of the CTRL pin meets the enable voltage specification (see Input Characteristics). Enable or disable the product by using the CTRL pin, and hold the CTRL input signal for at least △T1=1ms.

POWER MANAGEMENT

1. OVERVIEW

The product is equipped with PMBus interface that enables power management such as monitoring or configuration with fewer external components. In addition, the product includes protection to continuously protect the load from unexpected system failures that simultaneously set SALERT pins. The host can continuously monitoring the following product parameters: input voltage, output voltage, output current, duty cycle, internal temperature, etc.

The product is delivered with the default configuration suitable for the maximum range of input voltage, output voltage and load operation. The configuration is stored in an internal Non-Volatile Memory (NVM). All power management functions can be reconfigured through the PMBus interface. A detailed description of each command is provided in the appendix at the end of this specification.
The associated software suite can be used to configure and monitor the product through the PMBus interface.

2. PMBus INTERFACE

The product provides a PMBus digital interface that users can configure devices operation as well as monitor input and output voltages, output currents, and device temperature. The product can be compatible with any standard two-wire I2C(master must allow for clock stretching) or PMBus host device. For the communication protocol operation guide, refer to SMBus Specification Version 3.0. In addition, the product is compatible with PMBus version 1.3 and includes an SALERT line to help mitigate bandwidth constraints associated with continuous failure monitoring. The product only supports 100 kHz and 400 kHz bus clock frequency. The PMBus signals, SCL, SDA, and SALERT require passive pull-up resistors as specified in the SMBus specification. To ensure the rise time, a pull-up resistor is needed:

$$\tau = R_P C_P \leq 1\text{us}$$

here, Rp is the pull-up resistance and Cp is the parasitic capacitance of the bus. For details, see "PMBus Electrical Specifications". The maximum allowed bus capacitance is 400pF. The pull-up resistor should be connected to an external power supply between 2.7-3.8V.
When communicating via PMBus, it is recommended to always use PEC(Packet Error Checking) to increase the robustness of communication.

3. PMBUS ADDRESSING

The following address resistor connection diagram and table show the recommended resistor values for the minimum and maximum voltage range of hard-wiring PMBus addresses. (±1% tolerance resistor is recommended)

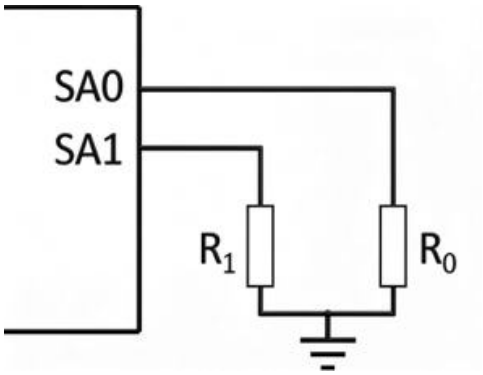


Fig.7

SA0/SA1 Index	R0(KΩ)	R1(KΩ)
0	24.9	24.9
1	49.9	49.9
2	75	75
3	100	100
4	124	124
5	150	150
6	174	174
7	200	200

The PMBus address can be configured by SA0 and SA1 pins. The formula is as follows:
PMBus address (decimal) = 8 x SA1 index + SA0 index
If the calculated PMBus address is 0, 11, or 12, the PMBus address is assigned instead as 127. From a system perspective, users should also be aware of further restrictions on addresses as described in the PMBus specification. It is not recommended to keep the SA0 and SA1 pins left open.

4. I2C/SMBus -TIMING

See Fig.8 below for setting and holding time timing.

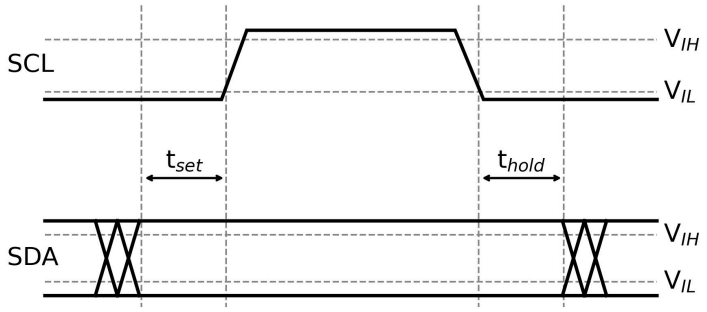


Fig.8

The setup time, t_{set}, is the time data, SDA, must be stable before the rising edge of the clock signal, SCL. The hold time t_{hold}, is the time data, SDA, must be stable after the rising edge of the clock signal, SCL. If these times are violated incorrect data may be captured or meta-stability may occur and the bus communication may fail. All standard SMBus protocols must be followed, including clock stretching. This product supports the BUSY flag in the status commands to indicate product being too busy for SMBus response. A bus-free time delay between every SMBus transmission (between every stop & start condition) must occur. Refer to the SMBus specification, for SMBus electrical and timing requirements. Note that an additional delay of 5 ms has to be inserted in case of storing the RAM content into the internal non-volatile memory.

5. Monitoring through PMBus

It is possible to continuously monitor a wide variety of parameters through the PMBus interface. These include, but are not limited to, the parameters listed in the table below.

Parameter	PMBus Command
Input Voltage	READ_VIN
Output Voltage	READ_VOUT
Output Current	READ_IOUT
Temperature	READ_TEMPERATURE_1
Switching Frequency	READ_FREQUENCY
Duty Cycle	READ_DUTY_CYCLE

6. FAULT MONITORING

Fault conditions can be detected using the SALERT pin, which will be asserted low when any number of pre-configured fault or warning conditions occurs. The SALERT pin will be held low until faults and/or warnings are cleared by the CLEAR_FAULTS command, or until the output voltage has been re-enabled. It is possible to mask which fault conditions should not assert the SALERT pin by the command SMBALERT_MASK. In response to the SALERT signal, the user may read a number of status commands to find out what fault or warning condition occurred, see table below.

Fault or Warning Status	PMBus Command
General Condition Of Equipment	STATUS_BYTE STATUS_WORD
Output Voltage	STATUS_VOUT
Output Current	STATUS_IOUT
Input Voltage	STATUS_INPUT
Temperature	STATUS_TEMPERATURE
PMBus Communication	STATUS_CML

7. NON-VOLATILE MEMORY (NVM)

The product contains a non-volatile memory region for storing PMBus command values. NVM preloads the defaults, which are writable and customizable, and can be restored with the command RESTORE_DEFAULT_ALL (0×12). Values in NVM are loaded during initialization.

8. PMBus switch control (PMBus CTRL)

PMBus CTRL can be configured as a switch control through the PMBus interface. PMBus CTRL is disabled and suspended by default. The logical options controlled by PMBus CTRL can be positive or negative, and are configured using the OPERATION(0×02) command. When this feature is not used, it is recommended that the CTRL pin be connected to DGND.

9. PMBus CONFIGURATION AND SUPPORT

The product provides a PMBus digital interface that allows users to configure devices, monitor input and output parameters, and more. The associated software suite can be used to configure and monitor the product through the PMBus interface.

10. PMBus ADJUST THE OUTPUT VOLTAGE

The output voltage of the product can be reconfigured using the PMBus command VOUT_COMMAND (0×21) or VOUT_OFFSET (0×23). This can be used to adjust the output voltage above or below the initial setting of the output voltage to a certain level. See Design Reference -6 Controllable Output Voltage Curve for an understanding of the adjustable range of output characteristics. When increasing the output voltage, the input voltage must remain within the region plotted, as shown in the figure below. The output voltage setting must be kept below the over-voltage protection threshold (OVP) to prevent product downtime.

The following figure marks the adjustable range of output voltage of the product under the condition of input voltage. Within this range, it is not fully guaranteed that the output voltage characteristics of the product will respond according to the response index of the "Output Characteristics" technical manual, please refer to Figure 7. Secondly, the output voltage shall not be lower than 25V.

11. USE CTRL/PMBus_CTRL TO ENABLE OUTPUT

The default rise time for a single product is 10 milliseconds. When the input supply voltage remains constant, use the CTRL/PMBus_CTRL pin function to enable the output. The rise and fall of the output voltage and the time of the output control can be configured through the soft start and soft off functions (cannot be configured when the current is uniform).

This can be used to control the starting impulse current and manage the power sequence of multiple controllers. The rise time TON_RISE (0×61) is the time it takes the output to reach its target voltage, while the fall time TOFF_FALL (0×65) is the time it takes the output to fall from its target voltage to 1V (the fall time below 1V is determined by the output load and the output capacitive load). TON_DELAY (0×60) sets the delay from output enable until output voltage begins to rise,
and TOFF_DELAY (0×64) sets the delay from output disable until output voltage begins to fall.

In general, the TOFF_DELAY (0×64) command is only used to control when the output of the product is turned off by CTRL or PMBus_CTRL, and the supply voltage Vin of the product remains constant. The output voltage is turned Off by the input voltage under-voltage or over-voltage, which cannot control the Off Delay time and Off Ramp time of the down time.
When the power module is started by applying the input voltage, there is a minimum 18ms delay from the input voltage to the output voltage (△T3 -- △T4, normally 40ms), which is not affected by the CTRL/PMBus_CTRL function. By default, the soft stop is off. When the output is off, the adjustment of the output voltage stops immediately. The output voltage drop time is determined by the output load and the output capacitive load.Soft shutdown performance can be enabled by using the PMBus command ON_OFF_CONFIG (0×02). You can use the PMBus commands TON_DELAY (0×60), TON_RISE (0×61), TOFF_DELAY (0×64), and TOFF_FALL (0×65) to set the delay time and rise/fall time.

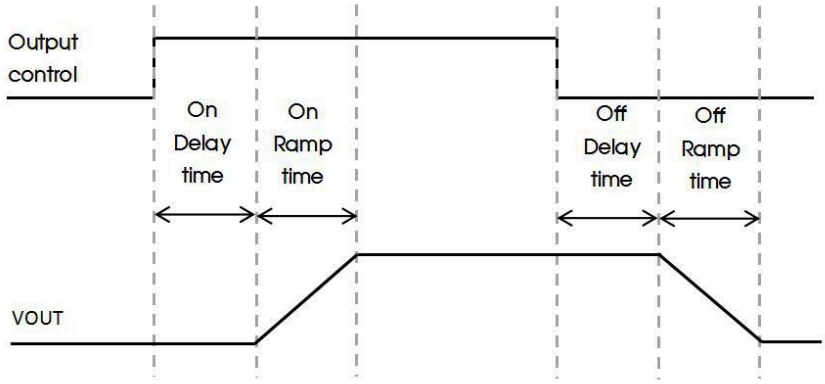


Fig.9

12. PRE-BIAS START-UP

The product has a Pre-bias start up functionality and will not sink current during start up if a pre-bias source is present at the output terminals. If the Pre-bias voltage is lower than the target value set in VOUT_COMMAND (0×21), the product will ramp up to the target value. If the Pre-bias voltage is higher than the target value set in VOUT_COMMAND (0×21), the product will ramp down to the target value and in this case sink current for a time interval set by the command TOFF_MAX_WARN_LIMIT (0×66).

Do not allow the output terminal of the product to be directly connected to the output terminal of other voltage regulator devices in parallel. In this case, the pre-bias start up performance may become invalid and the parallel device may be damaged.

13. OVER-TEMPERATURE PROTECTION

The product includes an internal temperature sensor that protects the product from thermal overload. The product will shut down output when the temperature is higher than the temperature threshold set by the OT_WARN_LIMIT (0×51) command. When the temperature falls below the temperature threshold set by the OT_WARN_LIMIT (0×51) command, the product will continuously attempt to start and automatically return to normal. OTP fault limitation and fault response can be configured using PMBus.

Note：

1. Using fault response "ignore fault" may cause permanent damage to the product;
2. Due to the limitation of sampling points, OTP can not protect the products which are overheated due to instantaneous high power output in high temperature environment;
3. The recovery temperature of OTP protection has a fixed return difference of 15°C, and the recovery temperature is lower than the protection temperature of 15°C to avoid output voltage oscillation caused by temperature fluctuations at the over-temperature protection point.

14. INPUT UNDER-VOLTAGE PROTECTION

The product can be input under-voltage protection through the PMBus configuration, with response latency of 400us. This can be configured with the VIN_UV_FAULT_RESPONSE (0×5A) directive. By default, the VIN_ON (0×35) and VIN_OFF (0×36) commands are used to set the input under-voltage shutdown break point. The VIN_ON (0×35) and VIN_OFF (0×36) commands are recommended for input under-voltage protection.

Note: To avoid repeated start up of output voltage caused by input disturbance, it is recommended that the hysteretic voltage of 2V be reserved when the input start up voltage and under-voltage shutdown voltage are configured using VIN_ON (0×35) and VIN_OFF (0×36) commands corresponding to PMBus.

15. OVER-VOLTAGE PROTECTION

The product includes an output over-voltage protection function to protect the load. The default over-voltage protection threshold is 30% above the nominal output voltage. If the output voltage exceeds the threshold limit, the product can respond in different ways. The default response to an over-voltage fault is to turn off the output. The device constantly checks for the presence of the fault state and restarts when the fault state no longer exists. The over-voltage protection threshold and fault response can be configured using the PMBus interface. For details, see the PMBus command in the Appendix.

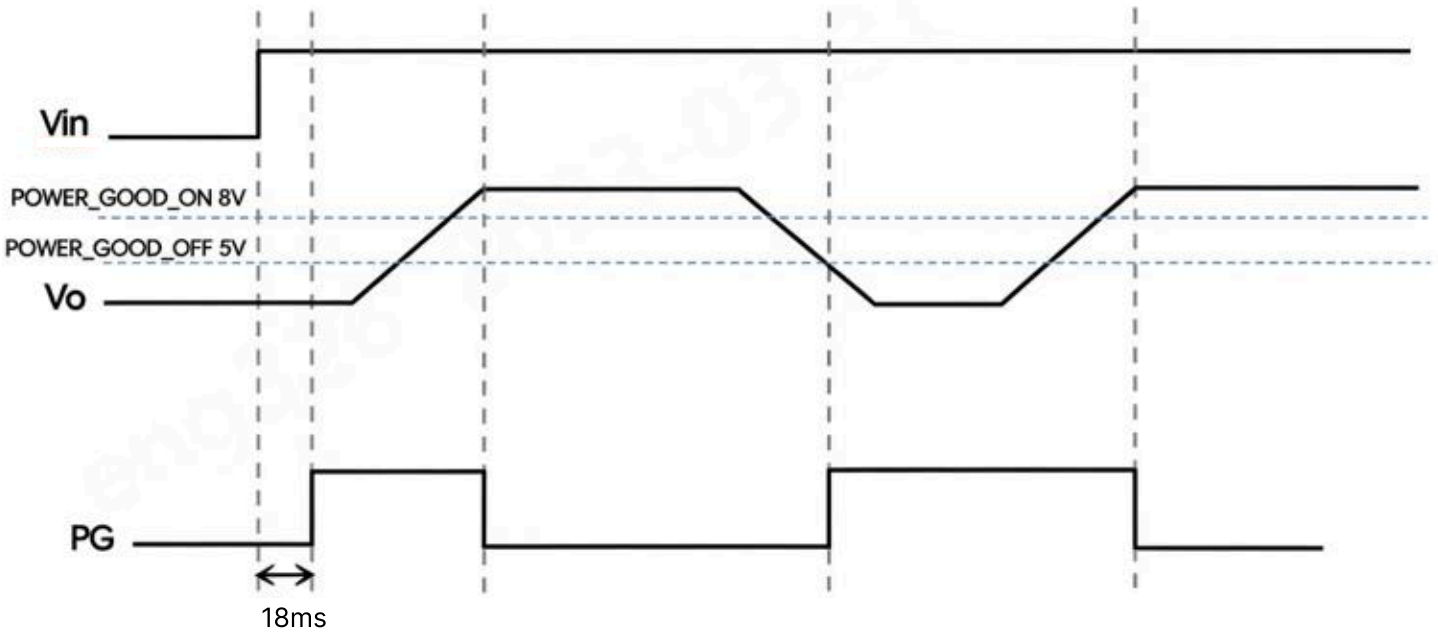
Note: The product over-voltage protection function only applies when the output voltage of the product exceeds the limit voltage. In this case, the product power level output is turned off to protect the power module and avoid secondary damage. This function cannot protect other power supply devices connected to the output end.

16. OVER-CURRENT PROTECTION

The product has a current limiting circuit for continuous overload protection. When the current sharing mode is not set, there will be a continuous 8ms without over-current protection judgment, at this time, I/O can exceed the over-current current value, but the output short-circuit protection is continuous and effective. When the starter current is overflowing, it is likely to trigger short-circuit protection and cause output shutdown. When the bus current sharing function is enabled, the overcurrent protection of the device will be directly turned off and locked, and the overcurrent protection can be escaped by turning off the current sharing function or restarting the IC.

After the overload is removed, the product will resume normal work. Load distribution should be designed for the specified maximum output short-circuit current. The overcurrent protection of this product can be configured through the PMBus interface, see Appendix PMBus commands.

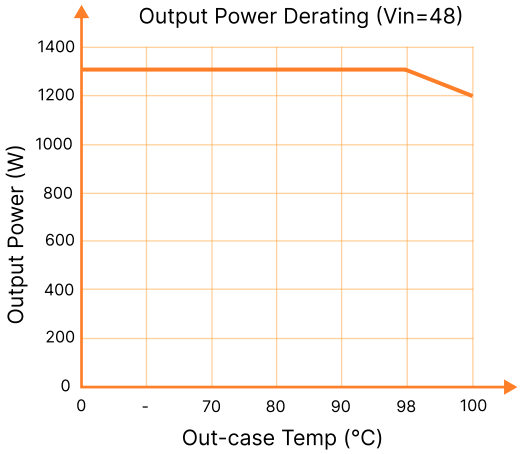
17. POWER GOOD JUDGMENT

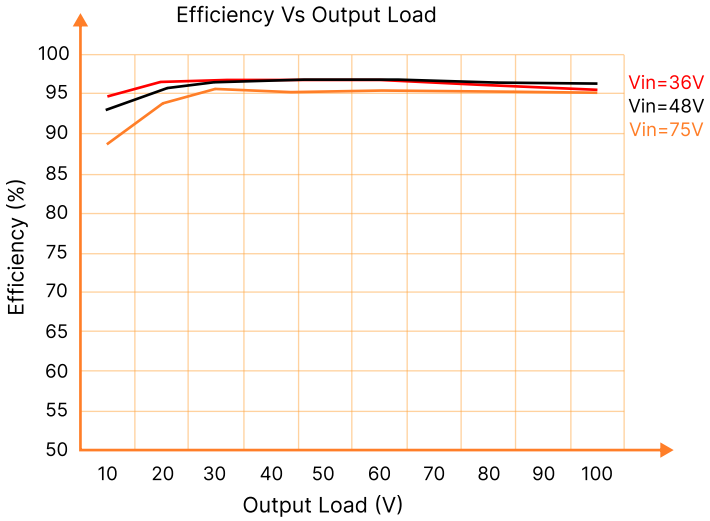


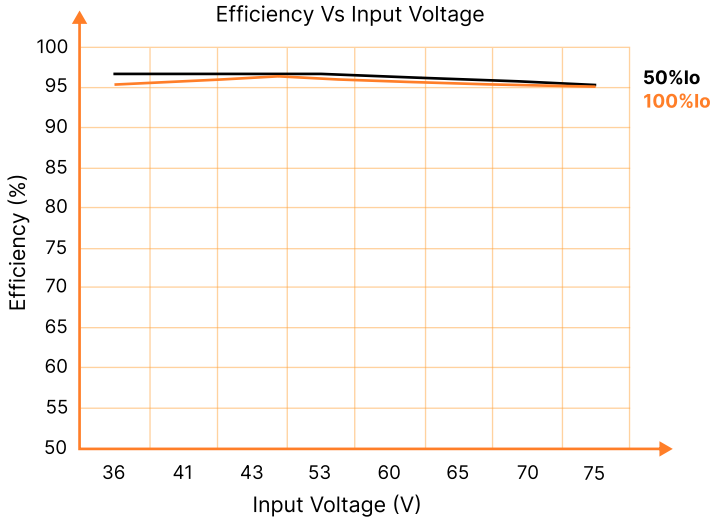
The power good pin (PG) indicates when the product is ready to provide output voltage to the load. PG remains high in the up and down state. By default, the rise time ends. If the output voltage rises above the PG threshold (typical 22V), PG is set to low. If the output voltage falls below the PG threshold (typical 15V), PG is reset. You can use the PMBus commands POWER_GOOD_ON (0×5E) and POWER_GOOD_OFF (0×5F) to change the PG threshold. PG pin defaults to push-pull output and is active at low level. By default, the PG pin is the Power Good function. When the Number of Interleave (0×37) is not 0, the PG pin is reused as the Interleave function.

If the output voltage is lower than the PG threshold and the TON_MAX_FAULT_LIMIT time persists, the start up timeout will be triggered. The device is shut down and locked. After the fault is cleared, the system recovers.

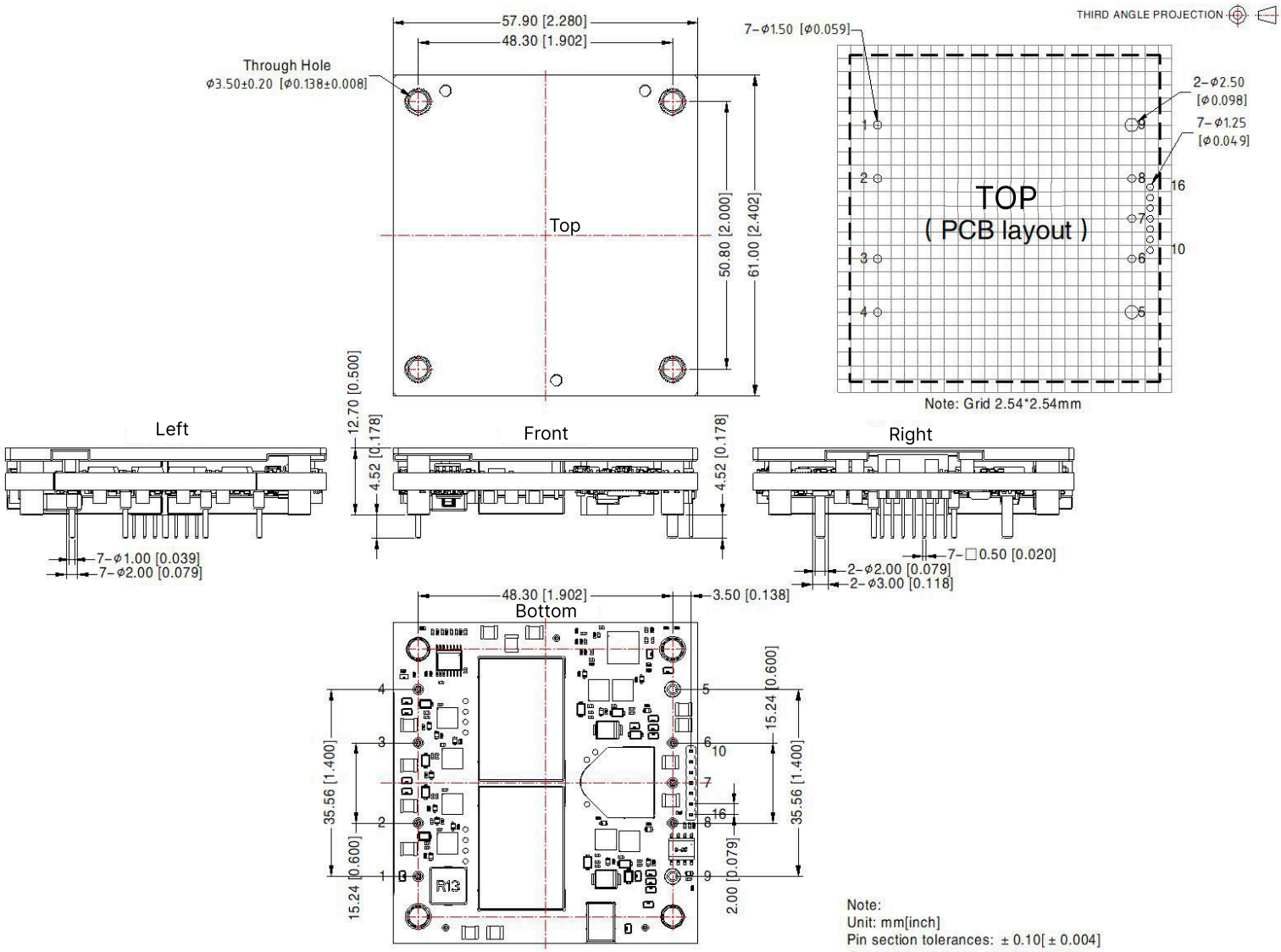
PRODUCT CHARACTERISTICS CURVE







DIMENSIONS AND INSTALLATION



Note:
Unit: mm[inch]
Pin section tolerances: ± 0.10[± 0.004]
General tolerances: ± 0.50[± 0.020]
PIN 1/2/3/4/6/7/8: ø1.0mm; PIN 5/9: ø2.0mm
The layout of the device is for reference only, please refer to the actual product

Pin	Function	Pin	Function
1	+Vin	9	+Vo
2	Ctrl	10	Ctrl/PG
3	NC	11	DGND
4	-Vin	12	SDA
5	0V	13	SALERT
6	-Sense	14	SCL
7	Trim	15	SA1
8	+Sense	16	SA0

STANDARD CONFIGURATION PMBUS COMMAND SUMMARY AND FACTORY DEFAULTS

Code	Command	Function	Transfer type	Default Value	Default value description
0×01	OPERATION	Switch enable	R/W byte	0×88	
0×02	ON_OFF_CONFIG	Switch configuration	R/W Byte	0×0E	
0×03	CLEAR_FAULTS	Clear the fault	W Byte		
0×10	WRITE_PROTECT	Command write protection	R/W Byte	0×00	
0×11	STORE_DEFAULT_ALL	Store to NVM	W Byte		
0×12	RESTORE_DEFAULT_ALL	Remove from NVM	W Byte		
0×19	CAPABILITY	Equipment capacity	R Byte	0xB0	
0×20	VOUT_MODE	Output voltage data format	R Byte	0×16	Ulinear16,N=-10
0×21	VOUT_COMMAND	Set output voltage	R/W Word	0xC800	50.0V
0×23	VOUT_CAL_OFFSET	The output voltage is offset	R/W Word	0×0000	0.0V
0×24	VOUT_MAX	Maxi output voltage can be set	R/W Word	0xDC00	55V
0×27	VOUT_TRANSITION_RATE	Output voltage adjustment rate	R/W Word	0×007A	0.12V/ms
0×32	MAX_DUTY	Set the maxi duty cycle	R/W Word	0xEB18	99%
0×33	FREQUENCY_SWITCH	Set switching frequency	R/W Word	0xEBC0	120KHz
0×35	VIN_ON	Set starting voltage	R/W Word	0xE220	34V
0×36	VIN_OFF	Set off voltage	R/W Word	0xE200	32V
0×37	INTERLEAVE	Parallel interleaving	R/W Word	0×0000	
0×40	VOUT_OV_FAULT_LIMIT	Output over-voltage fault value	R/W Word	0xEC00	59V
0×41	VOUT_OV_FAULT_RESPONSE	Output over-voltage protection action	R/W Byte	0xFC	
0×42	VOUT_OV_WARN_LIMIT	Output over-voltage alarm value	R/W Word	0xE400	57V
0×43	VOUT_UV_WARN_LIMIT	Output under-voltage alarm value	R/W Word	0×0000	0.0V
0×44	VOUT_UV_FAULT_LIMIT	Output under-voltage fault value	R/W Word	0×0000	0.0V
0×45	VOUT_UV_FAULT_RESPONSE	Output under-voltage protection action	R/W Byte	0xFC	
0×46	IOUT_OC_FAULT_LIMIT	Output the over-current fault value	R/W Word	0xE200	32A
0×47	IOUT_OC_FAULT_RESPONSE	Output over-current protection action	R/W Byte	0xBC	
0×4A	IOUT_OC_WARN_LIMIT	Output an over-current alert value	R/W Word	0xDBA0	29A
0×4F	OT_FAULT_LIMIT	Over-temperature fault value	R/W Word	0xEAB8	87°C
0×50	OT_FAULT_RESPONSE	Over-temperature fault protection action	R/W Byte	0xC0	
0×51	OT_WARN_LIMIT	Over-temperature alarm value	R/W Word	0xEA90	82°C
0×55	VIN_OV_FAULT_LIMIT	Enter the over-voltage fault value	R/W Word	0xEA70	78V
0×56	VIN_OV_FAULT_RESPONSE	Enter the over-voltage protection action	R/W Byte	0xC0	

Code	Command	Function	Transfer type	Default Value	Default value description
0×57	VIN_OV_WARN_LIMIT	Enter the over-voltage protection action	R/W Word	0xEA68	77V
0×58	VIN_UV_WARN_LIMIT	Enter the over-voltage alarm value	R/W Word	0xE210	33V
0×59	VIN_UV_FAULT_LIMIT	Enter the under-voltage alarm value	R/W Word	0xE200	32V
0×5A	VIN_UV_FAULT_RESPONSE	Enter the under-voltage fault value	R/W Byte	0xC0	
0×5E	POWER_GOOD_ON	Voltage good start threshold	R/W Word	0×5800	22V
0×5F	POWER_GOOD_OFF	Voltage good off threshold	R/W Word	0×3C00	15V
0×60	TON_DELAY	Output start up delay time	R/W Word	0xBA00	1ms
0×61	TON_RISE	Output start up rise time	R/W Word	0xEB20	100ms
0×62	TON_MAX_FAULT_LIMIT	Start up timeout threshold	R/W Word	0xEB70	110ms
0×64	TOFF_DELAY	Output shutdown delay time	R/W Word	0xBA00	1ms
0×65	TOFF_FALL	Output shutdown drop time	R/W Word	0xD280	10ms
0×66	TOFF_MAX_WARN_LIMIT	Disable the descending fault threshold	R/W Word	0xD3C0	15ms
0×78	STATUS_BYTE	Total byte read status	R Byte		
0×79	STATUS_WORD	Word read total status	R Word		
0×7A	STATUS_VOUT	Read the output voltage status	R Byte		
0×7B	STATUS_IOUT	Read the output current status	R Byte		
0×7C	STATUS_INPUT	Read the input voltage status	R Byte		
0×7D	STATUS_TEMPERATURE	Read temperature status	R Byte		
0×7E	STATUS_CML	Read command/logical status	R Byte		
0×88	READ_VIN	Read-input voltage	R Word		
0×8B	READ_VOUT	Read-output voltage	R Word		
0×8C	READ_IOUT	Read-output current	R Word		
0×8D	READ_TEMPERATURE_1	Read-temperature	R Word		
0×94	READ_DUTY_CYCLE	Read-duty cycle value	R Word		
0×95	READ_FREQUENCY	Read-switch frequency	R Word		
0×98	PMBus_REVISION	Read the PMBus version number	R Byte	0×33	
0×99	MFR_ID	Read the company name	R Block	/	
0×9A	MFR_MODEL	Read device type	R Block	/	
0×9B	MFR_REVISION	Read device version	R Block	/	
0×9C	MFR_LOCATION	Read company address	R Block	/	
0×9D	MFR_DATE	Read production date	R Block	/	
0×9E	MFR_SERIAL	Read serial number	R Block	/	
0xEC	MFR_CTRL_LEVEL	Active level of CTRL pin	R/W Byte	0	CTRL is low by default
0xEF	MFR_RESTORE_OKIGIN	factory data reset	W Byte		

PMBus command detail

FUNCTION: SWITCH CONTROL AND ALARM CONTROL

Parameter	Bit	Transfer type	Function	Description	Value	Function	Description
OPERATION (0X01)	7	R/W Byte	Enable	The device output function was enabled	1	Enable	Open output voltage
					0	Disable	Off output voltage
OPERATION (0X01)	6	R/W Byte	Soft Off	Set soft threshold	1	Enable Soft Off	Delay shutdown output
					0	Disable Soft Off	Direct off output
OPERATION (0X01)	3:2	R/W Byte	Enable Fault	Set the fault alert line	10	Enable SALERT	When a fault occurs, the SALERT line will be set
					01	Disable SALERT	When a fault occurs, the SALERT line will not act

FUNCTION: START-UP CONTROL

Parameter	Bit	Transfer type	Function	Description	Value	Function	Description
ON_OFF_ CONFIG (0X02)	4	R/W Byte	Power-on setting	Set the default power-on configuration. Whether to directly start output after power-on	1	Enable Always	Configure the CTRL pin or OPERATION command to enable output after being powered on
					0	Enable Pin or PMBus	Set output to start directly after power-on
ON_OFF_ CONFIG (0X02)	3	R/W Byte	Operation enable	Set Operation command	1	Enable Operation	Enable the Operation command to start output
					0	Disable Operation	The Operation command cannot be used to start the output
ON_OFF_ CONFIG (0X02)	2	R/W Byte	CTRL enable	Set CTRL Line	1	Enable CTRL	Enable the CONTROL line control output
					0	Disable CTRL	Disable power CONTROL line to control output
ON_OFF_ CONFIG (0X02)	1:0	R/W Byte	CTRL Level	Set the active level of CTRL	10	High	CTRL high level active
					00	Low	CTRL low level active

FUNCTION: CLEAR ALL FAULTS

Parameter	Transfer type	Function
CLEAR_FAULTS (0X03)	W Byte	Clear all faults

Parameter	Bit	Transfer type	Description	Value	Function	Description
WRITE_PROTECT (0X10)	7:0	R/W Byte	Configure write protection for some PMBus commands	0×80	Disable all	All write protection except the 0×10 command
WRITE_PROTECT (0X10)	7:0	R/W Byte		0×40	Enable Operation	All write protection except commands 0×10 and 0×01
WRITE_PROTECT (0X10)	7:0	R/W Byte		0×20	Enable control and Vout	All commands are write protected except 0×10, 0×01,0×02, and 0×21
				0×00	Enable all	Disable all write protection

Parameter	Transfer type	Function
STORE_DEFAULT_ALL (0X11)	Send Byte	Command the device to restore its configuration from the default storage

Parameter	Transfer type	Function
RESTORE_DEFAULT_ALL (0X12)	Send Byte	Command the device to restore its configuration from the default storage

Parameter	Bit	Transfer type	Function	Value	Function	Description
CAPABILITY (0X19)	7	R Byte	PEC	1	Support	Whether the device supports packet error verification
				0	Do not support	
CAPABILITY (0X19)	6:5	R Byte	Bus Speed	01	400kHz	Max bus speed
				00	100kHz	
CAPABILITY (0X19)	4	R Byte	Fault Line	1	With SALERT	Whether the SALERT fault line function is available
				0	Without SALERT	

Parameter	Bit	Transfer type	Function	Value	Function	Description
VOUT_MODE (0X20)	7:5	R Byte		000	Ulinear16	Ulinear16 data format:$Y=X*2^N$
VOUT_MODE (0X20)	4:0	R Byte	N value	-12		Ulinear16 data format:$Y=X*2^N$

Parameter	Bit	Transfer type	Function	Format	Unit
VOUT_COMMAND (0X21)	15:0	R/W Byte	Set output voltage Set the output voltage. The output voltage can not be adjusted online during the current sharing process, only allow to restart the machine after adjustment; The sagging current sharing model (DCMF48_QBO-800W) adjusts the output voltage setting value at no- load	Ulinear16	V

Parameter	Bit	Transfer type	Function	Format	Unit
VOUT_CAL_OFFSET (0X23)	15:0	R/W Byte	Sets the output bias voltage	Ulinear16	V

Parameter	Bit	Transfer type	Function	Format	Unit
VOUT_MAX (0X24)	15:0	R/W Word	Max output voltage that can be set The maximum output voltage that can be set. If the voltage is set beyond this value, The output is restricted to this value and SALERT is set; This command can be responded during the operation of the product and corresponds to the limiting output voltage. When the output voltage during the operation of the product exceeds the value set by VOUT_MAX, it will be adjusted according to the voltage change rate set by instruction 0×27	Ulinear16	V

Parameter	Bit	Transfer type	Function	Format	Unit
VOUT_TRANSITION _RATE (0X27)	15:0	R/W Word	Set VOUT_COMMAND to adjust the voltage change rate of the output voltage Set the voltage change rate, this command is to adjust the product working process, output voltage adjustment when the change slope. It is not allowed to adjust the output voltage during current sharing operation	Ulinear16	V/ms

Parameter	Bit	Transfer type	Function	Format	Unit
MAX_DUTY (0X32)	15:0	R/W Word	Set the maximum duty cycle Set the input voltage starting point. If the input voltage reaches this value, the device starts working and the Power good pin is set	Linear 11	%

Parameter	Bit	Transfer type	Function	Format	Unit
FREQUENCY_ SWITCH (0X33)	15:0	R/W Word	Set switching frequency Set switching frequency,(Disallow change at output time)	Linear 11	Khz

Parameter	Bit	Transfer type	Function	Format	Unit
VIN_ON (0X35)	15:0	R/W Word	Example Set the VIN_ON threshold Set the input voltage starting point. If the input voltage reaches this value, the device starts working and the Power good pin is set	Linear 11	V

Parameter	Bit	Transfer type	Function	Format	Unit
VIN_OFF (0X36)	15:0	R/W Word	Example Set the VIN_OFF threshold Set the input voltage off break point. If the input voltage reaches this value, the device stops working and the Power Good pin resets	Linear 11	V

Function: Parallel interleaving is used to reduce input ripple noise when multiple devices share a DC input in parallel. You need to enable the SYNC pin of the device and connect the SYNC pins of all devices in series. Multiple devices with the same input must be set to the same Group ID. The number of staggered devices in this group should be set correctly. The staggered Order of each device must be set correctly. The Order of the devices in the group cannot be repeated. Order 0 device is the host by default and is used to send SYNC pulse, while other devices are used to receive SYNC pulse

Parameter	Bit	Transfer type	Format	Function
INTERLEAVE (0X37)	11:8	R/W Word	/	Group ID The value ranges from 0 to 15. Interleaved groups are set
INTERLEAVE (0X37)	7:4	R/W Word	/	Number The value ranges from 0 to 15. This parameter specifies the number of interleaving devices in a group
INTERLEAVE (0X37)	3:0	R/W Word	/	Order The value ranges from 0 to 15. This parameter specifies the number of interleaving devices in a group

Parameter	Bit	Transfer type	Function	Format	Unit
VOUT_OV_FAULT_LIMIT (0X40)	15:0	R/W Word	Set the output over-voltage fault point. After initialization, the system starts to determine whether the output voltage is over-voltage and take corresponding protection actions Set the output over-voltage fault point. When the output voltage is higher than the voltage value, the SALERT pin will detect the fault state and be set low. The SALERT pin will keep the low level and make corresponding protection action	Ulinear16	V

Parameter: VOUT_OV_FAULT_RESPONSE (0×41) Function: Set the output under-voltage fault protection action

Bit	Transfer type	Function	Description	Take Value	Function	Description
7:6	R/W Byte	Protective action	Hiccup protection	01	Turn off the output and try restarting	The device shuts down and responds according to the retry setting in bit [5:3].
			Turn-off protection	11	Turn-off output	Faults can be cleared in a number of ways: 1. Enable output by Ctrl/PMBus_Ctrl pin; 2. Run the OPERATION command to enable output. 3. Close and then reopen by combining the PMBus_Ctrl pin with the OPERATION command; 4. Reset the output by restarting the input power
5:3	R/W Byte	Number of hiccups	The device attempts to restart after a hiccup. When no fault occurs, the device restarts normally. 111b indicates that the device keeps restarting	000	Hiccup 1 time	Attempts to restart the set number of times. If the restart fails, the device shuts off output
				001	Hiccup 2 times	
				010	Hiccup 4 times	
				011	Hiccup 8 times	
				100	Hiccup 16 times	
				101	Hiccup 32 times	
				110	Hiccup 64 times	
				111	Hiccup	The device attempts to restart until it is trouble-free
2:0	R/W Byte	Time between hiccups	Set the interval between the falling edge of the hiccup and the next rising edge	0	1	unit:100ms
				1	2	
				2	4	
				3	8	
				4	16	
				5	32	
				6	64	
				7	128	

Parameter	Bit	Transfer type	Function	Format	Unit
VOUT_OV_WARN_LIMIT (0X42)	15:0	R/W Word	Set the output over-voltage alarm point Set the output over-voltage alarm point. When the output voltage is higher than the voltage value, the SALERT pin will detect the fault state and be set low. The SALERT pin will remain low	Linear 16	V

Parameter	Bit	Transfer type	Function	Format	Unit
VOUT_UV_WARN_LIMIT (0X43)	15:0	R/W Word	Set the output under-voltage alarm point Set the output under-voltage alarm point. When the output voltage is lower than the voltage value, the SALERT pin detects the fault state and will be set to low. The SALERT pin will remain low	Ulinear 16	V

Parameter	Bit	Transfer type	Function	Format	Unit
VOUT_UV_FAULT_LIMIT (0X44)	15:0	R/W Word	Set the fault point of output under-voltage. After the soft start of output voltage is complete, determine whether the output voltage is undervoltage and take corresponding protection actions Set the output under-voltage fault point. When the output voltage is lower than the voltage value, the SALERT pin will detect the fault state and be set to low. The SALERT pin will keep the low level and make corresponding protection action	Ulinear 16	V

Parameter: VOUT_UV_FAULT_RESPONSE (0×45) Function: Set the output under-voltage fault protection action

Bit	Transfer type	Function	Description	Take Value	Function	Description
7:6	R/W Byte	Response	Hiccup protection	10	Turn off the output and try restarting	The device shuts down and responds according to the retry setting in bit [5:3].
			Turn-off protection	11	Turn-off output	Faults can be cleared in a number of ways: 1. Enable output by Ctrl/PMBus_Ctrl pin; 2. Run the OPERATION command to enable output. 3. Close and then reopen by combining the PMBus_Ctrl pin with the OPERATION command; 4. Reset the output by restarting the input power
5:3	R/W Byte	Number of hiccups	The device attempts to restart the number of times set by these bits. 111b means the device attempts restarting continuously	000	Hiccup 1 time	Attempts to restart the set number of times. If the restart fails, the device shuts off output
				001	Hiccup 2 times	
				010	Hiccup 4 times	
				011	Hiccup 8 times	
				100	Hiccup 16 times	
				101	Hiccup 32 times	
				110	Hiccup 64 times	
				111	Hiccup	The device attempts to restart until it is trouble-free
2:0	R/W Byte	Time between hiccups	Number of delay time units	0	1	unit:100ms
				1	2	
				2	4	
				3	8	
				4	16	
				5	32	
				6	64	
				7	128	

Parameter	Bit	Transfer type	Function	Format	Unit
IOUT_OC_FAULT_ LIMIT (0X46)	15:0	R/W Word	Set the output over-current fault point. After the output voltage is softly started for 8ms (2ms if the current-sharing ACS/DLS is enabled), the system starts to determine whether the output voltage is over-current and take appropriate protection actions	Linear 11	A

IOUT_OC_FAULT_RESPONSE (0X47) Function: Output over-current fault response

Bit	Transfer type	Function	Description	Take Value	Function	Description
7:6	R/W Byte	Response	Hiccup protection	10	Turn off the output and try restarting	The device shuts down and responds according to the retry setting in bit [5:3].
			Turn-off protection	11	Turn-off output	Faults can be cleared in a number of ways: 1. Enable output by Ctrl/PMBus_Ctrl pin; 2. Run the OPERATION command to enable output. 3. Close and then reopen by combining the PMBus_Ctrl pin with the OPERATION command; 4. Reset the output by restarting the input power
5:3	R/W Byte	Hiccup Times	The device attempts to restart the number of times set by these bits. 111b means the device attempts restarting continuously	000	Hiccup 1 time	Attempts to restart the set number of times. If the restart fails, the device shuts off output
				001	Hiccup 2 times	
				010	Hiccup 4 times	
				011	Hiccup 8 times	
				100	Hiccup 16 times	
				101	Hiccup 32 times	
				110	Hiccup 64 times	
				111	Hiccup	Attempt to restart until it is fault free
2:0	R/W Byte	Hiccup Delay	Number of delay time units	0	1	unit:100ms
				1	2	
				2	4	
				3	8	
				4	16	
				5	32	
				6	64	
				7	128	

Parameter	Bit	Transfer type	Function	Format	Unit
IOUT_OC_WARN_ LIMIT (0X4A)	15:0	R/W Word	Output over-current warning limit Set the output over-current alarm point. When the output current is higher than the voltage value, the SALERT pin will detect the fault state and be set to low. The SALERT pin will remain low	Linear 11	A

Parameter	Bit	Transfer type	Function	Format	Unit
OT_FAULT_LIMIT (0X4F)	15:0	R/W Word	After setting an over-temperature fault point, the system determines whether the monitoring point is over-temperature and takes corresponding protection actions after initialization Over-temperature fault limit.	Linear 11	°C

Parameter	Bit	Transfer type	Function / Description	Take Value	Description
OT_FAULT_ RESPONSE (0X50)	7:6	R/W Word	Over-temperature fault response When the default over-temperature shutdown time is 3s and the temperature at the sampling point is 5°C lower than the over-temperature fault point, restart the output.	11	Faults can be cleared in a number of ways: 1. Enable output by Ctrl/PMBus_Ctrl pin; 2. Run the OPERATION command to enable output. 3. Close and then reopen by combining the PMBus_Ctrl pin with the OPERATION command; 4. Reset the output by restarting the input power

Parameter	Bit	Transfer type	Function	Format	Unit
OT_WARN_LIMIT (0X51)	15:0	R/W Word	Over-temperature warning limit Set the alarm point of over-temperature. When the temperature of the sampling point is higher than the temperature value, the SALERT pin will detect the fault state and be set to low, and the SALERT pin will remain low	Linear 11	°C

Parameter	Bit	Transfer type	Function	Format	Unit
VIN_OV_FAULT_LI MIT (0X55)	15:0	R/W Word	Input over-voltage warning limit Set the input over-voltage alarm point. When the input voltage is higher than the voltage value, the SALERT pin will detect the fault state and be set low. The SALERT pin will remain low	Linear 11	V

Parameter	Bit	Transfer type	Function / Description	Take Value	Description
VIN_OV_FAULT_ RESPONSE (0X56)	7:6	R/W Word	Input over-voltage fault response. Turn off the output, and restart the output when the default input voltage is 5V lower than the input over-voltage fault point / Turn-off output	11	Faults can be cleared in a number of ways: 1. Enable output by Ctrl/PMBus_Ctrl pin; 2. Run the OPERATION command to enable output. 3. Close and then reopen by combining the PMBus_Ctrl pin with the OPERATION command; 4. Reset the output by restarting the input power

Parameter	Bit	Transfer type	Function	Format	Unit
VIN_OV_WARN_ LIMIT (0X57)	15:0	R/W Word	Input over-voltage warning limit Set the input over-voltage alarm point. When the input voltage is higher than the voltage value, the SALERT pin will detect the fault state and be set low. The SALERT pin will remain low	Linear 11	V

Parameter	Bit	Transfer type	Function	Format	Unit
VIN_UV_WARN_ LIMIT(0X58)	15:0	R/W Word	Input under-voltage warning limit Set the input under-voltage alarm point. When the input voltage is lower than the voltage value, the SALERT pin detects the fault state and will be set to low. The SALERT pin will remain low	Linear 11	V

Parameter	Bit	Transfer type	Function	Format	Unit
VIN_UV_FAULT_LI MIT (0X59)	15:0	R/W Word	Set the input under-voltage fault point. After initialization, the system determines whether the input voltage is under-voltage and takes corresponding protection actions Set the input under-voltage fault point. When the input voltage is lower than the voltage value, the SALERT pin will detect the fault state and be set to low. The SALERT pin will keep the low level and make corresponding protection action. The minimum value of the specification is VIN_ON(0×35)-2V. If the value is lower than VIN_ON(0×35)-2V, the system automatically defines the value as VIN_ON(0×35)-2V. In addition, the higher values of "VIN_UV_FAULT_LIMIT" and "VIN_OFF" are used as the product under-voltage protection point	Linear 11	V

Parameter	Bit	Transfer type	Function / Description	Take Value	Description
VIN_UV_FAULT_ RESPONSE (0X5A)	7:6	R/W Word	Input under-voltage fault response / Turn off the output and restart the output when the default input voltage is higher than the VIN_ON value	11	Faults can be cleared in a number of ways: 1. Enable output by Ctrl/PMBus_Ctrl pin; 2. Run the OPERATION command to enable output. 3. Close and then reopen by combining the PMBus_Ctrl pin with the OPERATION command; 4. Reset the output by restarting the input power

Parameter	Bit	Transfer type	Function	Format	Unit
POWER_GOOD _ON (0X5E)	15:0	R/W Word	Set the output starting point. If the output voltage is higher than this value, set the PG (Power Good) to low Set the output start point	Linear 16	V

Parameter	Bit	Transfer type	Function	Format	Unit
POWER_GOOD_ OFF (0X5F)	15:0	R/W Word	If the output voltage is lower than this value, PG_Sync pin (Power Good) is set to high. During product start up, PG_Sync pin (Power Good) is set to high Set an output closing break point	Linear 16	V

Parameter	Bit	Transfer type	Function	Format	Unit
TON_DELAY (0X60)	15:0	R/W Word	Set the start up delay time.Output ENABLE to the time when VOUT starts rising.The minimum value is 1ms.The delay is directly equivalent to the delay established by enabling the output signal and output voltage using the function "Ctrl,PMBus_Ctrl, OPERATION". When the input power is restarted to enable the system,the delay is added to the startup delay.The total startup delay is 39ms+TON_DELAY. Set the turn-on delay time	Linear 11	ms

Parameter	Bit	Transfer type	Function	Format	Unit
TON_RISE (0X61)	15:0	R/W Word	Set the rise time of start up (not adjustable when current sharing is enabled). VOUT starts rising to the time it reaches OUT_COMMAND. By default, the minimum value of TON_RISE is 10ms when the stream sharing function is not enabled. When the flow balancing function (including DLS or ACS) is enabled, the minimum value of TON_RISE is 200ms Sets the turn-on rise time	Linear 11	ms

Parameter	Bit	Transfer type	Function	Format	Unit
TON_MAX_FAULT_ LIMIT (0X62)	15:0	R/W Word	The maximum startup time is set. If the output voltage does not reach the value set by POWER_GOOD_ON, the fault is determined. By default, the minimum value of TON_MAX_FAULT_LIMIT is TON_RISE+10ms when the current sharing function is not enabled. When the current sharing function(including DLS or ACS) is enabled, the minimum value of TON_MAX_FAULT_LIMIT is TON_RISE+200ms The maximum start up time is set. If the value is set to 0, there is no maximum rise time. When the output voltage rise time is higher than this value, the SALERT pin will detect the fault state and be set to low, and the SALERT pin will remain low	Linear 11	ms

Parameter	Bit	Transfer type	Function	Format	Unit
TOFF_FALL (0X64)	15:0	R/W Word	Set the shutdown delay time. When the input power supply voltage is stable, press Ctrl, PMBus_Ctrl, OPERATION to DISABLE the output and output the time between the disable signal and the start of VOUT decline. Sets the turn-off delay	Linear 11	ms

Parameter	Bit	Transfer type	Function	Format	Unit
TOFF_FALL (0X65)	15:0	R/W Word	Set the turn-off fall time to a minimum of 10ms. When the input power supply voltage is stable, use the Ctrl, PMBus_Ctrl, OPERATION function to turn off the output, and VOUT starts to decline to a time when VOUT is lower than 1V. Sets the turn-off fall time.	Linear 11	ms

Parameter	Bit	Transfer type	Function	Format	Unit
TOFF_MAX_WARN _LIMIT (0X66)	15:0	R/W Word	Set the shutdown fall alarm value to TOFF_FALL+5ms minimum. When the input power supply voltage is stable, use "Ctrl, PMBus_Ctrl, OPERATION" to DISABLE output. The maximum time between output disable and VOUT descending to POWER_GOOD_OFF is required. In this case, if the output voltage continues to be higher than POWER_GOOD_OFF during the output voltage shutdown, the output voltage remains abnormal and cannot be restored Set the shutdown down time and use the function "Ctrl, PMBus_Ctrl, OPERATION" to turn off the output. When the output voltage down time is higher than this value, SALERT pin will detect the fault state and be set to low, and SALERT pin will remain low	Linear 11	ms

Parameter	Bit	Transfer type	Function	Description	Function	Description
STATUS_BYTE (0X78)	5	R Byte	VOUTover-voltage	An output over-voltage fault has occurred	1	Fault
					0	No Fault
STATUS_BYTE (0X78)	4	R Byte	IOUTover-current	An output over-voltage fault has occurred	1	Fault
					0	No Fault
STATUS_BYTE (0X78)	3	R Byte	VINunder-voltage	An input over-voltage fault has occurred	1	Fault
					0	No Fault
STATUS_BYTE (0X78)	2	R Byte	Over-temperature	A temperature fault of warning has occurred	1	Fault
					0	No Fault
STATUS_BYTE (0X78)	1	R Byte	Command/Logic	A command / logic fault has occurred	1	Fault
					0	No Fault

Parameter	Bit	Transfer type	Function / Description	Function	Description
STATUS_ WORD (0X79)	15	R Byte	VOUT / An output voltage fault or warning has occurred	1	Fault
				0	No Fault
STATUS_ WORD (0X79)	14	R Byte	IOUT / An output current fault or warning has occurred	1	Fault
				0	No Fault
STATUS_ WORD (0X79)	13	R Byte	VIN / An input voltage fault or warning has occurred	1	Fault
				0	No Fault

Parameter	Bit	Transfer type	Function / Description	Function	Description
STATUS_ WORD (0X79)	5	R Byte	VOUT over-voltage / An output over-voltage fault has occurred	1	Fault
				0	No Fault
STATUS_ WORD (0X79)	4	R Byte	IOUT over-current / An output over-current fault has occurred	1	Fault
				0	No Fault
STATUS_ WORD (0X79)	3	R Byte	VIN under-voltage / An input under-voltage fault has occurred	1	Fault
				0	No Fault
STATUS_ WORD (0X79)	2	R Byte	Over-Temperature / A temperature fault of warning has occurred	1	Fault
				0	No Fault
STATUS_ WORD (0X79)	1	R Byte	Command or Logic / A command or logic fault has occurred	1	Fault
				0	No Fault

Parameter	Bit	Transfer type	Description	Function	Description
STATUS_VOUT (0X7A)	7	R Byte	Vout over-voltage fault	1	Fault
				0	No Fault
STATUS_VOUT (0X7A)	6	R Byte	Vout over-voltage warning	1	Fault
				0	No Fault
STATUS_VOUT (0X7A)	5	R Byte	Vout under-voltage warning	1	Fault
				0	No Fault
STATUS_VOUT (0X7A)	4	R Byte	Vout under-voltage fault	1	Fault
				0	No Fault
STATUS_VOUT (0X7A)	3	R Byte	The output voltage set by VOUT_COMMAND getting higher than VOUT_MAX	1	Fault
				0	No Fault
STATUS_VOUT (0X7A)	2	R Byte	Ton Max fault	1	Fault
				0	No Fault
STATUS_VOUT (0X7A)	1	R Byte	Toff Max warning	1	Fault
				0	No Fault

Parameter	Bit	Transfer type	Description	Function	Description
STATUS_IOUT (0X7B)	7	R Byte	Iout over-current fault	1	Fault
				0	No Fault
STATUS_IOUT (0X7B)	6	R Byte	Iout over-current and low voltage fault	1	Fault
				0	No Fault
STATUS_IOUT (0X7B)	5	R Byte	Iout over-current warning	1	Fault
				0	No Fault

Parameter	Bit	Transfer type	Description	Function	Description
STATUS_INPUT (0X7C)	7	R Byte	Vin over-voltage fault	1	Fault
				0	No Fault
STATUS_INPUT (0X7C)	6	R Byte	Vin over-voltage warning	1	Fault
				0	No Fault
STATUS_INPUT (0X7C)	5	R Byte	Vin under-voltage warning	1	Fault
				0	No Fault
STATUS_INPUT (0X7C)	4	R Byte	Vin under-voltage fault	1	Fault
				0	No Fault

Parameter	Bit	Transfer type	Description	Function	Description
STATUS_ TEMPERATURE (0X7D)	7	R Byte	Over-temperature fault	1	Fault
				0	No Fault
STATUS_ TEMPERATURE (0X7D)	6	R Byte	Over-temperature warning	1	Fault
				0	No Fault

Parameter	Bit	Transfer type	Description	Function	Description
STATUS_CML (0X7E)	7	R Byte	Invalid Or Unsupported Command Received	1	Fault
				0	No Fault
STATUS_CML (0X7E)	6	R Byte	Invalid Or Unsupported Data Received	1	Fault
				0	No Fault
STATUS_CML (0X7E)	5	R Byte	Packet Error Check Failed	1	Fault
				0	No Fault
STATUS_CML (0X7E)	4	R Byte	Memory Fault	1	Fault
				0	No Fault
STATUS_CML (0X7E)	1	R Byte	Other Communication Fault	1	Fault
				0	No Fault
STATUS_CML (0X7E)	0	R Byte	Logic Fault	1	Fault
				0	No Fault

Parameter	Bit	Transfer type	Function	Format	Unit
READ_VIN (0X88)	15:0	R Word	Returns the measured input voltage	Linear 11	V
READ_VOUT (0X8B)	15:0	R Word	Returns the measured output voltage	Linear 16	V
READ_IOUT (0X8C)	15:0	R Word	Returns the measured output current	Linear 11	A
READ_TEMPERATURE_1 (0X8D)	15:0	R Word	Returns the measured temperature (internal)	Linear 11	°C
READ_DUTY_CYCLE (0X94)	15:0	R Word	Returns the measured duty cycle in percent	Linear 11	%
READ_FREQUENCY (0X95)	15:0	R Word	Returns switching frequency	Linear 11	Khz

Parameter	Bit	Transfer type	Value	Description	Function
PMBUS-REVISION (0X98)	7:4	R Byte	0	Part 1 Revision 1.0	PMBus Revision Part 1
	7:4	R Byte	1	Part 1 Revision 1.1	
	7:4	R Byte	2	Part 1 Revision 1.2	
	7:4	R Byte	3	Part 1 Revision 1.3	
	3:0	R Byte	0	Part 2 Revision 1.0	PMBus Revision Part 2
	3:0	R Byte	1	Part 2 Revision 1.1	
	3:0	R Byte	2	Part 2 Revision 1.2	
	3:0	R Byte	3	Part 2 Revision 1.3	

Parameter	Bit	Transfer type	Function	Format
MFR_ID (0X99)	15:0	R Block	Return the Manufacturers ID	ASCII
MFR_MODEL (0X9A)	15:0	R Block	Return the MFR MODEL string	ASCII
MFR_REVISION (0X9B)	15:0	R Block	Return the MFR revision string	ASCII
MFR_LOCATION (0X9C)	15:0	R Block	Return the MFR location string	ASCII
MFR_DATE (0X9D)	15:0	R Block	Return the date the regulator was manufactured	ASCII
MFR_SERIAL (0X9E)	15:0	R Block	Return a string that provides a unique identification of the regulator	ASCII

Parameter	Bit	Transfer type	Value	Description	Function
MFR_CTRL_LEVEL (0XEC)	1	R/W Byte	0	The CTRL pin is active at low level	Set the active level of CTRL
			1	The CTRL pin is active at high level	

Parameter	Transfer type	Function
MFR_RESTORE_ORIGIN(0XEF)	W Byte	Factory Data Reset

NOTES & INSTRUCTIONS

1. The input voltage shall not exceed the specified range value, otherwise permanent and unrecoverable damage maybe caused;

2. Unless otherwise specified, the parameters in this manual are measured at 25 °C, 40%~75% humidity, input nominal voltage and output pure resistance mode under full load;

3. All index test methods are based on the company's enterprise standards.

4. The copyright and the final interpretation right of the product belongs to RHENXV.