GDC650T5054-P
DC-DC Converter Technical Manual V1.1

Nonstandard-Brick DC-DC Converter	32 - 60 V Input	50 V/10.6 A Output	5.4 V/17.6 A Output	-12 V/0.2 A Output	650 W

Description

The GDC650T5054-P is a new generation isolated DC-DC converter that uses an industry nonstandard-brick structure, featuring high efficiency and power density with low output ripple and noise. It operates from an input voltage range of 32 V to 60 V, and provides the rated output voltage of 50 V, 5.4 V, and -12 V as well as the rated output power of 650 W.

GDC650T5054-P

Operational Features

- Input voltage: 32 - 60 V
- Output current: 0 - 10.6 A (50 V), 0 - 17.6 A (5.4 V), 0 - 0.2 A (-12 V)
- Efficiency: 95% (50 V/10.6 A, 5.4 V/17.6 A, -12 V/0 A)

Mechanical Features

- Industry nonstandard-brick (L x W x H): 64.8 mm x 50.0 mm x 9.8 mm (2.55 in. x 1.97 in. x 0.39 in.)
- Weight: 80 g

Protection Features

- Input undervoltage protection
- Output overcurrent protection (50 V and 5.4 V, Hiccup mode)
- Output short circuit protection (50 V and 5.4 V, Hiccup mode)
- Output overvoltage protection (50 V and 5.4 V, Hiccup mode)
- Overtemperature protection (Self-recovery)

Control Features

- Output voltage trim (5.4 V)
- PMBus communication
- Long-Distance input power supply
- Power spike

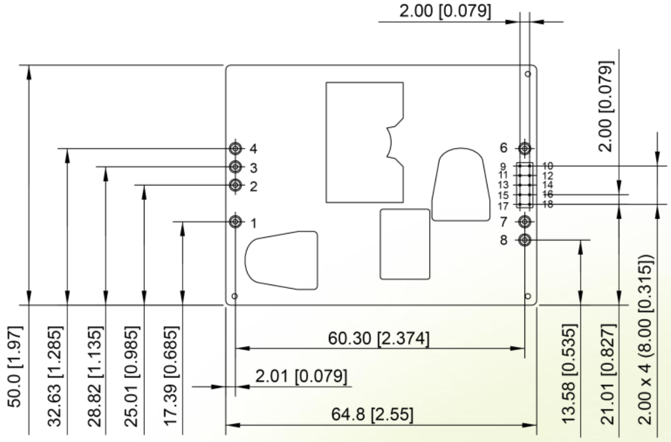
Safety Features

- TUV, CE, UL certification
- UL60950-1, C22.2 No. 60950-1, and EN60950-1
- RoHS6 compliant

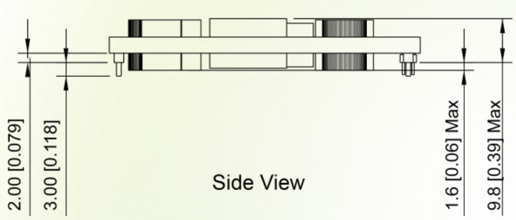
Applications

- Servers
- Telecom and data communication applications
- Industrial equipment

Mechanical Diagram



Bottom View



Side View

Pin Description

Pin No.	Function	Pin No.	Function
1	V_{in} (+)	11	N12V
2	Vbus+	12	AGND
3	Vbus-	13	ADDRESS
4	V_{in} (-)	14	TRIM_5V4
6	GND	15	PWR_ALARM
7	50V	16	PWR_I2C_RESET
8	5V4	17	PM_SCL
9	REMOTE_POWER_OFF	18	PM_SDA
10	NC		

NOTE

1. All dimensions in mm [in.]
   Tolerances: x.x ± 0.5 mm [x.xx ± 0.02 in.]
   x.xx ± 0.25 mm [x.xxx ± 0.010 in.]
2. Pin 1-4, 6-8 are 1.00 ± 0.05 mm [0.040 ± 0.002 in.] diameter with 2.00 ± 0.10 mm [0.080 ± 0.004 in.] diameter standoff shoulders.
   Pin 9-18 are 0.50 ± 0.05 mm [0.020 ± 0.002 in.] diameter with 0.80 ± 0.10 mm [0.032 ± 0.004 in.] diameter standoff shoulders.
3. Components will vary between models.
4. Pin ADDRESS is not used. Its default PMBus address is 0x5B.

Designation Explanation

GDC	650	T	5054	-P
1	2	3	4	5

1 — 48Vin, high performance, digital control nonstandard brick
2 — Output power: 650 W
3 — Three outputs
4 — Output voltage: 50 V, 5.4 V (auxiliary output: -12 V)
5 — PMBus

Electrical Specifications

Parameter	Output	Min.	Typ.	Max.	Unit	Notes & Conditions
Absolute maximum ratings						
Input voltage						
Continuous	-	-	-	60	V	-
Transient (100 ms)	-	-	-	80	V	-
Operating ambient temperature	-	-40	-	85	ºC	See the thermal derating curve
Storage temperature	-	-55	-	125	ºC	-
Operating humidity	-	10	-	95	% RH	Non-condensing
External voltage applied to PMBus port	-	-	-	3.6	V	-
Input characteristics						
Operating input voltage	-	32	48	60	V	The input voltage must be at least 36 V when the converter is ready to start.
Maximum input current	-	-	-	24	A	V_{in} = 0 - 60 V; $I_{out} = I_{omax}$
Maximum input peak current	-	-	-	25	A	I_{5V4} = 17.6 A; see ***Figure 19*** about 50 V output current
No-load loss	-	-	14	18	W	V_{in} = 48 V
Input capacitance	-	440	-	-	μF	Aluminum electrolytic capacitor
Bus capacitance	-	1800	-	3500	μF	ESR ≤ 350 mΩ, aluminum electrolytic capacitor
Output characteristics						
Output voltage set point	50V	48.5	50.0	51.5	V	V_{in} = 48 V; I_{out} = 50% I_{omax}; The input voltage of N12V is from 34 V to 55 V
	5V4	5.24	5.40	5.56		
	N12V	-12.4	-12	-10.8		
Output current	50V	0	9.2	10.6	A	50 V output constant current; see ***Figure 19*** about 50 V output peak current
	5V4	0	15.2	17.6		
	N12V	0	-	0.2		
Output power	50V	0	460	530	W	The output power of 50 V reaches 707 W in dynamic mode of 7.5 ms, and 0 W for the left of 2.5 ms (t = 10 ms)
	5V4	0	82	95		
	N12V	0	-	2.4		
Output line regulation	50V	-0.5	-	0.5	%	V_{in} = 36 - 60 V; $I_{out} = I_{onom}$
	5V4	-0.5	-	0.5		
	N12V	-	-	-		

Electrical Specifications

Parameter	Output	Min.	Typ.	Max.	Unit	Notes & Conditions
Output characteristics						
Output load regulation	50V	-0.5	-	0.5	%	V_{in} = 48 V; I_{out} = I_{omin} - I_{onom}
	5V4	-0.5	-	0.5		
	N12V	-	-	-		
Regulated voltage precision	50V	-3	-	3	%	V_{in} = 36 - 60 V; I_{out} = I_{omin} - I_{onom}
	5V4	-3	-	3		
	N12V	-10	-	10		
Temperature coefficient	50V	-0.02	-	0.02	%/°C	T_A = -40°C to +85°C
	5V4	-0.02	-	0.02		
	N12V	-	-	-		
External capacitance	50V	940	-	3000	µF	440 µF: solid aluminum capacitor (If 5V4 is not used, a 330 µF external capacitor should be connected.) 47 µF: ceramic capacitor The ESR of 50 V output capacitor should be less than 350 mohm.
	5V4	440	-	1000		
	N12V	47	-	470		
Output ripple and noise (peak to peak)	50V	-	-	500	mV	Oscilloscope bandwidth: 20 MHz The 5V4 and N12V should be measured in board
	5V4	-	50	100		
	N12V	-	-	290		
Output voltage range	50V	34	-	55	V	Adjust the voltage by the PMBus
	5V4	95	-	105	%	Adjust the voltage by the TRIM_5V4
	N12V	-	-	-	-	-
Output voltage overshoot	50V	-	-	5	%	The whole range of $V_{in,}$ I_{out} and T_A
	5V4	-	-	5	%	-
	N12V	-	-	-		
Output voltage delay time	50V	1000	-	5000	ms	See ***Figure 11***
	5V4	-	-	100		
	N12V	-	-	100		
Output voltage rise time	50V	-	-	200	ms	From 10%V_{out} to 90%V_{out}
	5V4	-	-	50		
	N12V	-	-	50		

Electrical Specifications

Parameter	Output	Min.	Typ.	Max.	Unit	Notes & Conditions
Output characteristics						
Switching frequency	50V	-	300	-	kHz	-
	5V4	-	400	-		
	N12V	-	600	-		
Protection characteristics						
Input undervoltage protection (50 V)						-
Startup threshold	-	32	34	36	V	
Shutdown threshold	-	28	30	32	V	
Hysteresis	-	2	4	6	V	
Input undervoltage protection						-
Startup threshold	-	28	30	32	V	
Shutdown threshold	-	24	26	28	V	
Hysteresis	-	2	4	6	V	
Output overcurrent protection	50V	12.7	-	17.0	A	Hiccup mode
	5V4	21	-	29		
	N12V	-	-	-	-	-
Output short circuit protection	-	-	-	-	A	Hiccup mode; (N12V should not be shorted) The converter is not damaged even with long-term short circuits
Output overvoltage protection	50V	110	-	134	$\%V_{oset}$	Hiccup mode
	5V4	110	-	140	$\%V_{oset}$	
	N12V	-	-	-	-	-
Overtemperature protection					°C	Self-recovery; The values are obtained by measuring the temperature of the PCB near thermal resistor
Threshold	-	105	115	130		
Hysteresis	-	5	-	-		
Efficiency						
100% load	-	93.5	95.0	-	%	V_{in} = 48 V; T_B = 25°C I_{N12V} = 0 A, I_{5V4} = 17.6 A
50% load	-	92.5	94.5	-	%	V_{in} = 48 V; T_B = 25°C I_{N12V} = 0 A, I_{5V4} = 17.6 A

Note: T_B is the temperature of PCB.

Electrical Specifications

Parameter	Output	Min.	Typ.	Max.	Unit	Notes & Conditions
Dynamic characteristics						
Overshoot amplitude Recovery time	50V	- -	- -	2500 200	mV µs	T = 1 ms; Current change rate: 1 A/µs Load: 25% - 75% - 25%
	5V4	- -	- -	270 200	mV µs	T = 2 ms; Current change rate: 0.1 A/µs Load: 25% - 50% - 25%; 50% - 75% - 50%
	N12V	- -	- -	- -	mV µs	-
Overshoot amplitude Recovery time (50 V)	50V	- -	- -	2500 500	mV µs	Current change rate: 1 A/µs Load: 0 - 560 W - 0; T = 10 ms; The output power of 50 V reaches 560 W in dynamic mode of 7.5 ms, and 0 W for the left of 2.5 ms
	50V	- -	- -	5000 600	mV µs	Current change rate: 1 A/µs Load: 0 - 707 W - 0; T = 10 ms; The output power of 50 V reaches 707 W in dynamic mode of 7.5 ms, and 0 W for the left of 2.5 ms
PMBus signal interface characteristics						
Logic Input Low (V_{IL})	-	-	-	1.1	V	-
Logic Input High (V_{IH})	-	2.1	-	3.6	V	-
Logic output Low (V_{OL})	-	-	-	0.25	V	I_{OL} = 4 mA
Logic output High (V_{OH})	-	0.6	-	3.6	V	I_{OH} = -4 mA
PMBus setting-up time	-	100	-	-	ns	For details about the values of T_{set} and T_{hold}, see ***Definition of I2C/PMBus Setting-up Time and Holding Time***
PMBus holding time	-	0	-	-	ns	
PMBus detected precision						
Input voltage detected precision	-	-1	-	1	V	V_{in} = 36 - 60 V; T_A = -40°C to +85°C I_{in} ≥ 4 A
Input current detected precision	-	-0.5	-	0.5	A	
Output voltage detected precision	50V	-0.5	-	0.5	V	V_{in} = 36 - 60 V; T_A = -40°C to +85°C I_{in} ≥ 4 A
Output current detected precision	50V	-0.5	-	0.5	A	

Electrical Specifications

Parameter	Output	Min.	Typ.	Max.	Unit	Notes & Conditions
PMBus detected precision						
Temperature detected precision	50V	-5	-	5	°C	V_{in} = 36 - 60 V; I_{out} = I_{max}; T_A = -40°C to +125°C
Insulation characteristics						
Input to output insulation voltage	-	-	-	1500	V DC	Functional insulation
Other characteristics						
PWR_I2C_RESET voltage Low level High level	- -	0 2.8	- -	1.1 3.6	V V	High level effective; The duration must be at least 500 ms for the PMBus to reset; 10 kΩ resistance connected to the ground
PWR_I2C_RESET current Low level High level	- -	-4 -	- -	- 4	mA mA	-
REMOTE_POWER_OFF voltage Low level High level	- -	0 2.8	- -	1.1 3.6	V V	High level effective; The 50 V, N12V, and 5V4 must be reset. The duration must be at least 100 ms for a reset to occur. 10 kΩ resistance connected to the ground. Reset time: 1s ≤ t ≤ 50s for 50 V 500 ms < t < 1s for 5V4
REMOTE_POWER_OFF current Low level High level	- -	-4 -	- -	- 4	mA mA	-
PWR_ALARM voltage Low level High level	- -	0 2.8	- -	1.1 3.6	V V	High level in normal mode; low level in abnormal mode. The alarm voltage can be cleared by PMBus command 0x03 or an input restart. Open drain output
PWR_ALARM current Low level High level	- -	-4 -	- -	- 4	mA mA	-
Reliability characteristics						
Mean time between failures (MTBF)	-	-	2.5	-	Million hours	Telcordia, SR332 Method 1 Case3; 80% load; Airflow = 1.5 m/s (300 LFM); T_A = 40°C

Specifications are subject to change without notice.

Characteristic Curves

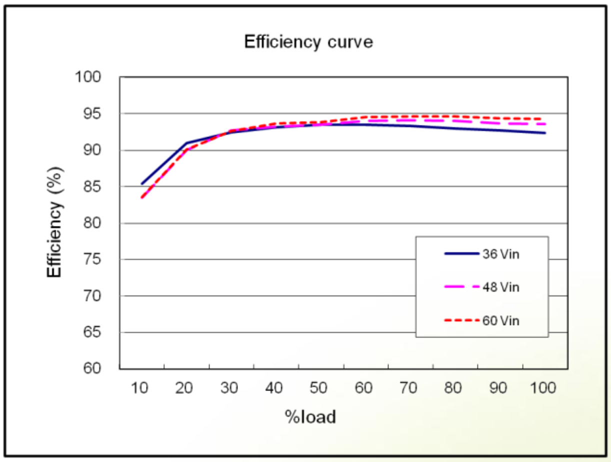


Figure 1: Efficiency (T_A = 25°C)

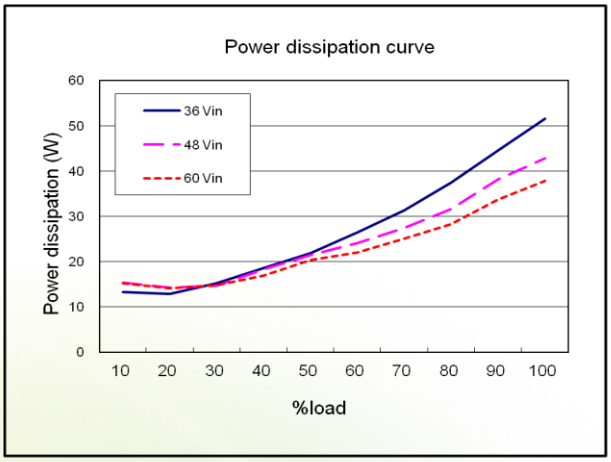


Figure 2: Power dissipation (T_A = 25°C)

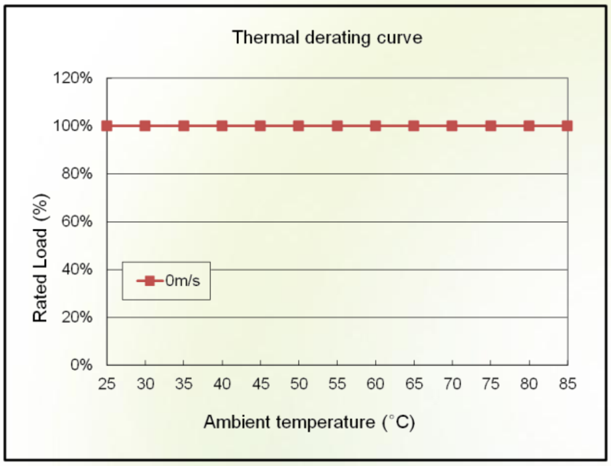


Figure 3: Thermal derating (Vin = 48 V; Rated output; The module should be cooperated with RRU)

Typical Waveforms

NOTE

1. During the test of input reflected ripple current, the input terminal must be connected to the external input filter (include a 12 μH inductor and a 220 μF electrolytic capacitor), which is not required in other tests.
2. Points B, C, D, and E, which are used for testing the output voltage ripple, must be 25 mm (0.98 in.) away from the 5V4, 50 V, N12V, and GND pins, respectively.

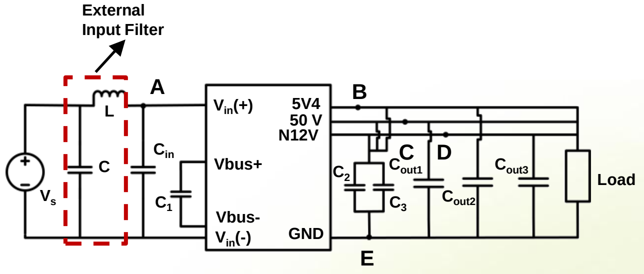


Figure 4: Test set-up diagram

C_{in}: The 440 μF aluminum electrolytic capacitor is recommended.
C_1: The 1800 μF aluminum electrolytic capacitor is recommended.
C_2: The 0.1 μF ceramic capacitor is recommended.
C_3: The 10 μF tantalum capacitor is recommended
C_{out1}: The 470×2 μF solid aluminum capacitor is recommended.
C_{out2}: The 220×2 μF solid aluminum capacitor is recommended.
C_{out3}: The 47 μF ceramic capacitor is recommended.

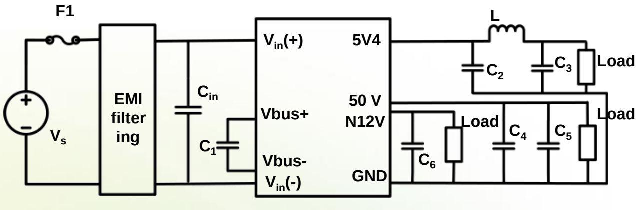


Figure 5: Typical circuit applications

F1: 30 A fuse (fast blowing)
C_{in}: The 440 μF aluminum electrolytic capacitor is recommended.
C_1: The 1800 μF aluminum electrolytic capacitor is recommended.
C_2, C_3: The 220 μF solid aluminum capacitor is recommended.
C_4, C_5: The 470 μF solid aluminum capacitor is recommended.
C_6: The 47 μF ceramic capacitor is recommended.
L: 108 nH

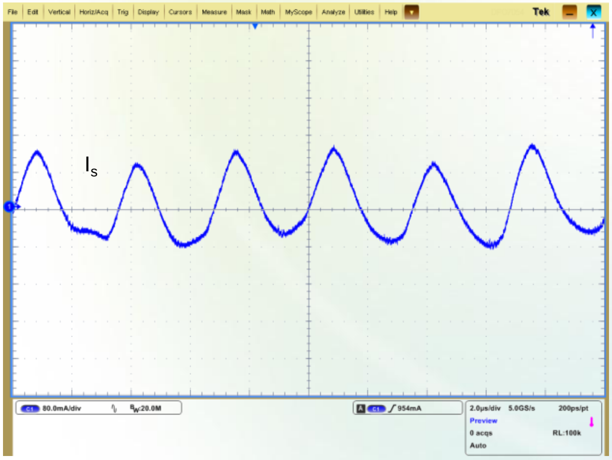


Figure 6: Input reflected ripple current
(For point A in the test set-up diagram, V_{in} = 48 V, 100% load)

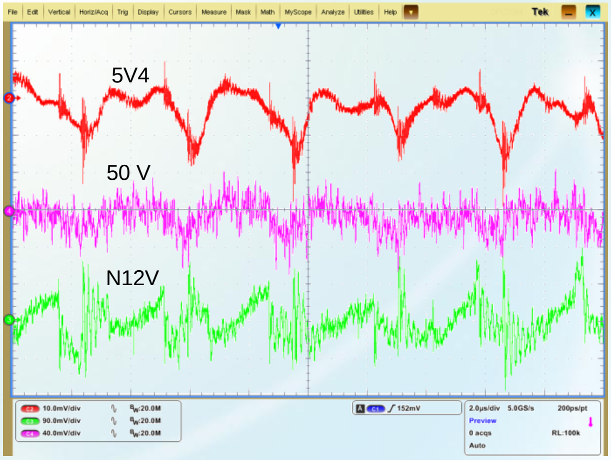


Figure 7: Output voltage ripple
(For points BE, CE, DE in the test set-up diagram, V_{in} = 48 V, 100% load)

Typical Waveforms

Conditions: T_A = 25°C, V_{in} = 48 V.

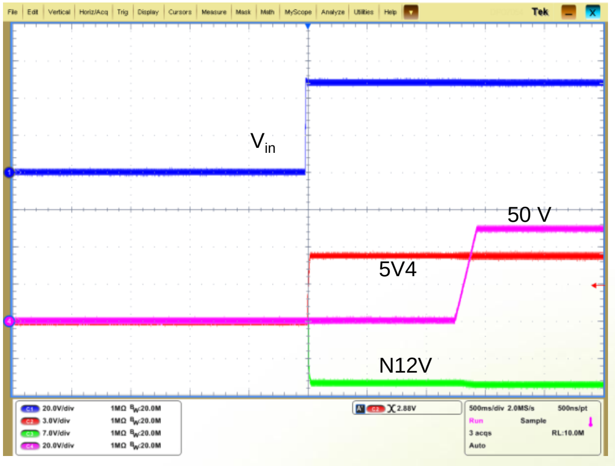


Figure 8: Startup by power on

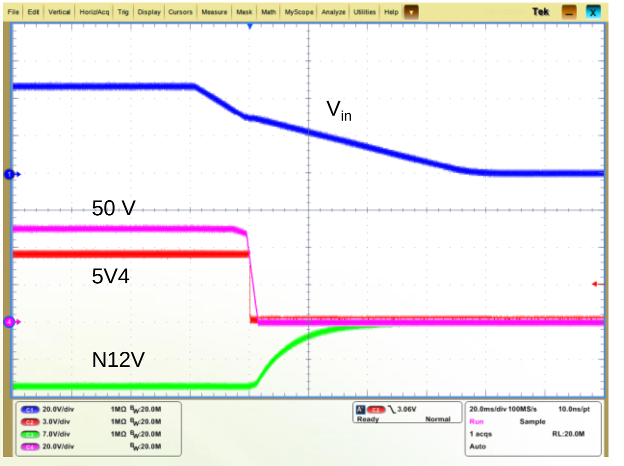


Figure 9: Shutdown by power off

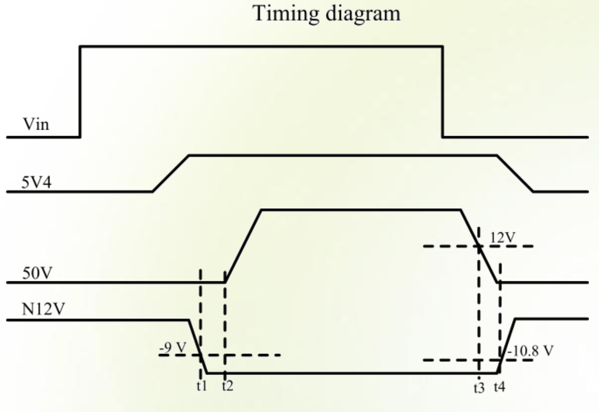


Figure 10: Timing diagram
(t2 - t1 ≥ 0 ms, t4 - t3 ≥ 0 ms)

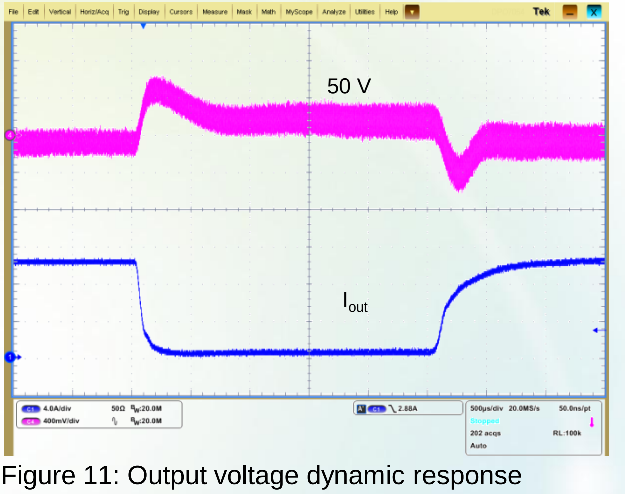


Figure 11: Output voltage dynamic response
(Load: 75% - 25% - 75%, di/dt = 1 A/µs, T = 1 ms)

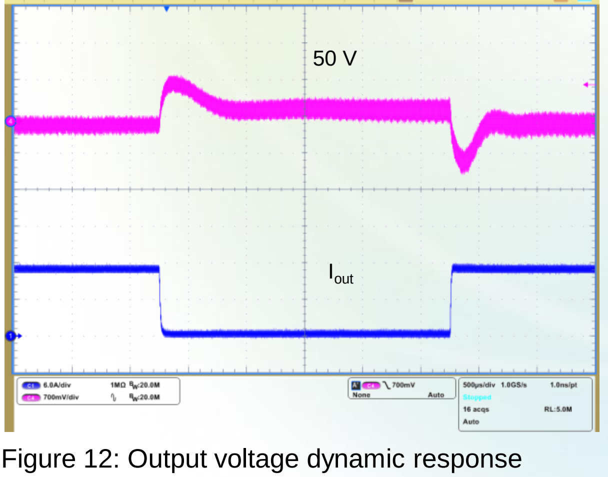


Figure 12: Output voltage dynamic response
(Load: 0 - 560 W- 0 [2.5 ms - 7.5 ms - 2.5 ms],
di/dt = 1 A/µs, T = 10 ms)

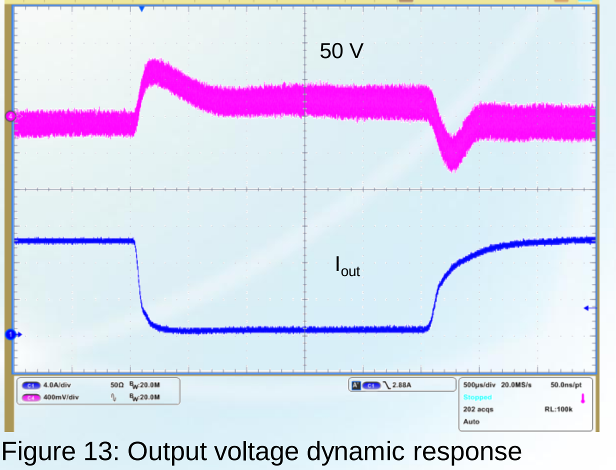


Figure 13: Output voltage dynamic response
(Load: 0 - 707 W- 0 [2.5 ms - 7.5 ms - 2.5 ms],
di/dt = 1 A/µs, T = 10 ms)

Typical Waveforms

Conditions: T_A = 25°C, V_{in} = 48 V.

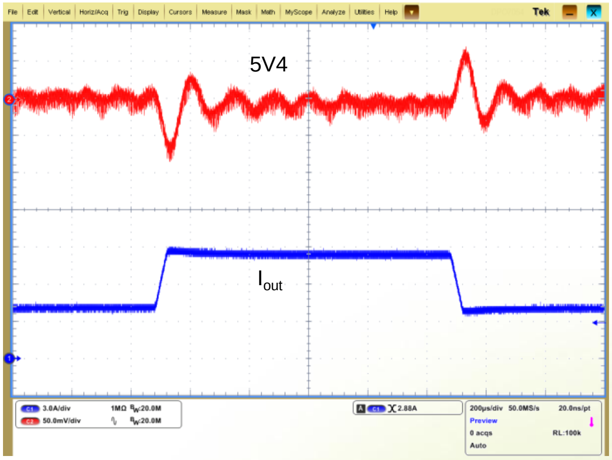


Figure 14: Output voltage dynamic response
(Load: 25% - 50% - 25%, di/dt = 0.1 A/μs, T = 2 ms)

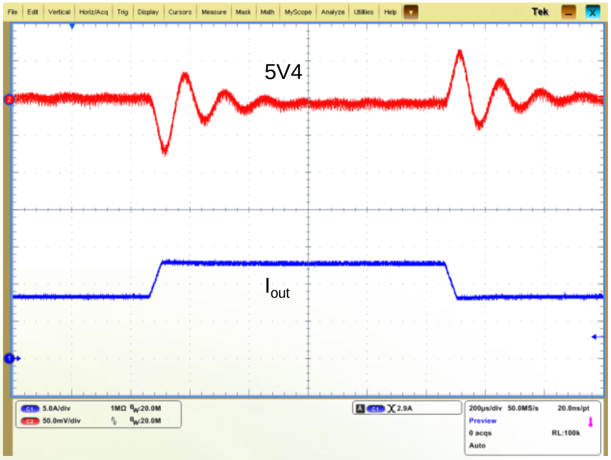


Figure 15: Output voltage dynamic response
(Load: 50% -75% - 50%, di/dt = 0.1 A/μs, T = 2 ms)

Output Voltage Trim

The 50 V output voltage can be adjusted according by PMBus port.
The 5V4 output voltage can be adjusted according to the trim range specification by using the TRIM_5V4 pin.

Trim Up

The output voltage can be increased by installing an external resistor to TRIM_5V4 pin.

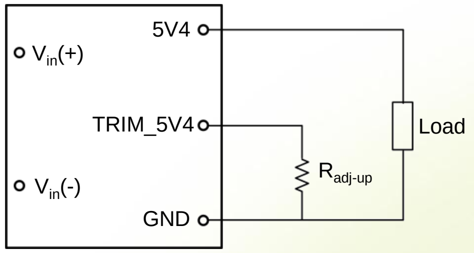


Figure 16: Configuration diagram for Trim up

The relationship between R_{adj-up} and V_{5V4}:

$$R_{adj-up} = \frac{308.276 - 17.2184 \times V_{5V4}}{8.6092 \times V_{5V4} - 46.523} (k\Omega)$$

5.4 V < V_{5V4} ≤ 5.67 V

NOTE

If the TRIM_5V4 pin is not used, it should be left open.

Trim Down

The output voltage can be increased by installing an external resistor to TRIM_5V4 pin.

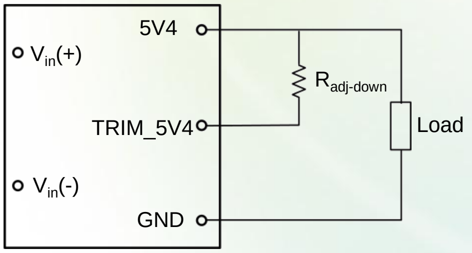


Figure 17: Configuration diagram for Trim down

The relationship between $R_{adj-down}$ and V_{5V4}:

$$R_{adj-down} = \frac{308.276 - 103.3104 \times V_{5V4}}{8.6092 \times V_{5V4} - 46.523} (k\Omega)$$

5.13 V ≤ V_{5V4} < 5.4 V

Long-Distance Input Power Supply

The GDC650T5054-P supports long-distance input power supply by adjusting the 50 V output power. Figure 18 shows the peak current of the 50 V output.

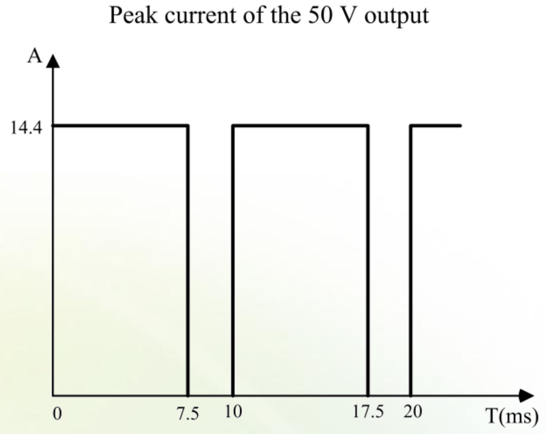


Figure 18: Peak current of the 50 V output

The following table lists the relationship between the output power and input cable (the standard 2 x 12 A cable is used as an example). The output power can be configured by the PMBus 31h command. For details, see the ***POUT_MAX (31h)***. For example, to configure an output power of 420 W, write 01A4h into the 31h command.

Input Cable Length	Hexadecimal Data	Byte	Output Power
50 m	0276	2	630 W
60 m	023A	2	570 W
70 m	01EF	2	495 W
80 m	01A4	2	420 W

Power Spike

If 50 V output overcurrent occurs, the overcurrent can last 10 ms before a shutdown. In dynamic mode, if the peak current is 22.4 A and the peak current lasts for no more than 700 μs, and the interval between two peak currents is longer than 500 ms, the output voltage is at least 34 V.
In dynamic mode, the maximum current is 15.5 A and the output power is at least 34 V.

PMBus Communication

Monitor and Faults

The converter communicates with the system over the Power Management Bus (PMBus). The GDC650T5054-P provides the following monitoring and communication functions and fault detection functions:

Monitoring functions:

- Module information
- Input voltage
- Input current
- Output voltage
- Output current
- Output power (50 V)
- Input power
- HSFB temperature (50 V output temperature)
- BOOST temperature

Fault detection functions:

- Overcurrent or short-circuits of the 50 V output
- Overtemperature of the 50 V output or BOOST
- Overvoltage of the 50 V output or BOOST (for longer than 150 ms)
- Input undervoltage

SCL and SDA

The SCL and SDA signal has an pull-up resistor, connected to the communication bus through the fault isolation circuit. Figure 19 shows the SCL and SDA external connections.

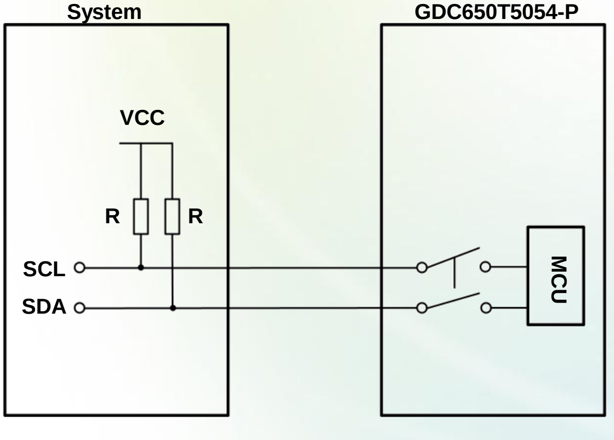


Figure 19: SCL and SDA external connections

Definition of I2C/PMBus Setting-up Time and Holding Time

The power supply supports both 100 kHz and 400 kHz clock rates, and 100 kHz is the default one. T_{set} is the duration for which SDA keeps its value unchanged before SCL increases. T_{hold} is the duration for which SDA keeps its value unchanged after SCL decreases. The communication will fail if the time is not consistent with the specifications.

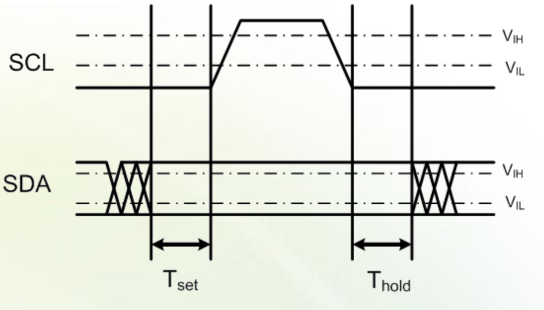


Figure 20: I2C/PMBus Setting-up Time and Holding Time

PMBus Commands

Hex Code	Command Name	Data Type	Data Bytes	Data Format
Control Commands				
00h	PAGE	Read/Write Byte	1	-
03h	CLEAR_FAULTS	Send Byte	0	-
11h	STORE_DEFAULT_ALL	Send Byte	0	-
Output Commands				
20h	VOUT_MODE	Read Byte	1	Default: 0x17
21h	VOUT_COMMAND	Read/Write Word	2	Linear 16
31h	POUT_MAX	Read/Write Word	2	Linear 11
Status Commands				
78h	STATUS_BYTE	Read Byte	1	-
79h	STATUS_WORD	Read Word	2	-
7Ah	STATUS_VOUT	Read Byte	1	-
7Bh	STATUS_IOUT	Read Byte	1	-

PMBus Communication

PMBus Commands

Hex Code	Command Name	Data Type	Data Bytes	Data Format
Status Commands				
7Ch	STATUS_INPUT	Read Byte	1	-
7Dh	STATUS_TEMPERATURE	Read Byte	1	-
Monitoring Commands				
88h	READ_VIN	Read Word	2	Linear 11
89h	READ_IIN	Read Word	2	Linear 11
8Bh	READ_VOUT	Read Word	2	Linear 16
8Ch	READ_IOUT	Read Word	2	Linear 11
8Dh	READ_TEMPERATURE_HSFB	Read Word	2	Linear 11
8Fh	READ_TEMPERATURE_BOOST	Read Word	2	Linear 11
96h	READ_POUT	Read Word	2	Linear 11
97h	READ_PIN	Read Word	2	Linear 11
Identification Commands				
F3h	SOFT_VERSION	Read Word	2	-

Data Format

●Linear 11 Data Format

The linear data format is a two byte value with an 11-bit, binary signed mantissa (two's complement) and a 5-bit, binary signed exponent (two's complement), as shown in Figure 21.

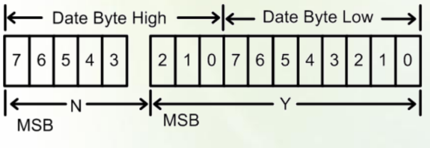


Figure 21: Linear 11 data format

The relationship between the N, Y, and Actual Value (V) is given by the following equation:

$X = Y \times 2^N$

where
X is the value
Y is the 11-bit, binary signed mantissa (two's complement).
N is the 5-bit, binary signed exponent (two's complement).

●VOUT Data Format

Commands related to output voltage are the VOUT_COMMAND and READ_VOUT. They are unsigned integers using the Linear 16 formats, as shown in the Figure 22.

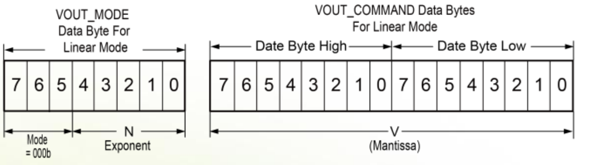


Figure 22: VOUT data format

The power supply is not required to support the VOUT_COMMAND, but must adhere to the VOUT data format. The output voltage is calculated as follows:

$$\text{Voltage} = V \times 2^N$$

where
Voltage is the output voltage value.
V is the 16-bit unsigned integer.
N is the 5-bit signed integer (two's complement).

Command Descriptions

PAGE (00h): Used by the 50 V output of the converter for communication using PMBus.

CLEAR_FAULTS (03h): Clears all fault flags. Send this command to clear flags after a fault occurs.

STORE_DEFAULT_ALL (11h): Saves data after data calibration. If this command is not sent, the data will be lost after a power failure.

VOUT_MODE (20h): This command is used to determine the data type and parameters using PMBus command.

VOUT_COMMAND (21h): This command is used to change the output voltage of the power supply.
The default value is 50 V. Voltage margin range: 34 V - 55 V.

PMBus Communication

POUT_MAX (31h): This command is used to change the output power. The default value is 630 W. The power margin range: 250 W - 650 W. After running the 31H command, the system must also run the 11H command to save parameters; otherwise, parameters will be restored to default values after power off.

The power supply is compliant with the PMBus Protocol Specification rev1.2 requirements. For details about the PMBus Commands, see the ***PMBus Protocol Specification rev1.2.***

Input Undervoltage Protection

The converter will shut down after the input voltage drops below the undervoltage protection threshold for shutdown. The converter will start to work again after the input voltage reaches the input undervoltage protection threshold for startup. For the Hysteresis, see the ***Protection characteristics***.

Output Overcurrent Protection

The converter equipped with current limiting circuitry can provide protection from an output overload or short circuit condition. If the output current exceeds the output overcurrent protection threshold, the converter enters hiccup mode. When the fault condition is removed, the converter will automatically restart.

Output Overvoltage Protection

The converter equipped with current limiting circuitry can provide protection from an output overload or short circuit condition. If the output current exceeds the output overcurrent protection threshold, the converter enters hiccup mode. When the fault condition is removed, the converter will automatically restart.

Overtemperature Protection

A temperature sensor on the converter senses the average temperature of the module. It protects the converter from being damaged at high temperatures. When the temperature exceeds the overtemperature protection threshold, the output will shut down. It will allow the converter to turn on again when the temperature of the sensed location falls by the value of ***Overtemperature Protection Hysteresis***.

Recommend Reverse Polarity Protection Circuit

Reverse polarity protection is recommended under installation and cabling conditions where reverse polarity across the input may occur.

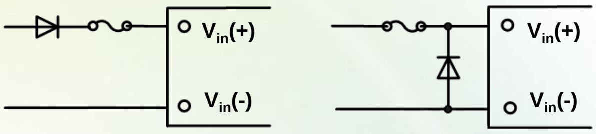


Figure 23: Recommend reverse polarity protection circuits

Recommended Fuse

The converter has no internal fuse. To meet safety and regulatory requirements, a 30 A fuse is recommended.

EMC

Figure 24 shows the EMC test set-up diagram. The acceptance standard is required as the conducted emission limits of CISPR22 Class A with 6 dB margin.

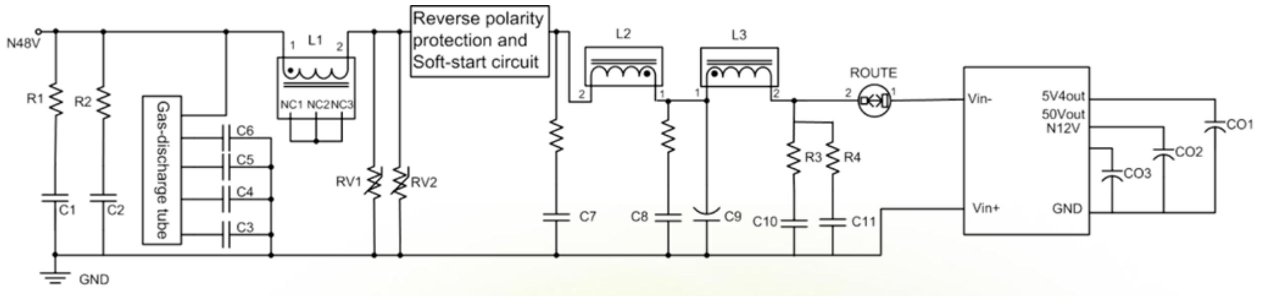


Figure 24: EMC test set-up diagram

RV1, RV2: Varistor, 50 V, 4500 A, 135 V
C1: SMD ceramic capacitor, 4 x 22 nF
C2: SMD ceramic capacitor, 2 x 22 nF
R1, R2, R3, R4: Chip film resistor, 0.068 Ω
C3, C4, C5, C6: SMD ceramic capacitor, 100 pF
L1: Chip inductors, 30 µH
L1, L3: Chip inductors, 1.4 µH

C7: SMD ceramic capacitor, 5 x 2.2 µF
C8, C10, C11: SMD ceramic capacitor, 4 x 2.2 µF
C9: Aluminum capacitor, 470 µF

CO1: Solid aluminum capacitor, 2 x 440 µF
CO2: Solid aluminum capacitor, 2 x 470 µF
CO3: Ceramic capacitor, 47 µF

Qualification Testing

Parameter	Units	Condition
High Accelerated Life Test (HALT)	3	Low temperature limit: -60°C; high temperature limit: 110°C; vibration limit: 40 G; temperature slope: 40°C/min
Temperature Humidity Bias (THB)	32	Maximum input voltage; 85°C; 85% RH; 1000 operating hours under lowest load power
High Temperature Operation Bias (HTOB)	32	Rated input voltage; air flow: 0.5 m/s (100 LFM) to 5 m/s (1000 LFM); ambient temperature between +45°C and +55°C; 1000 operating hours; 50% to 80% load
Power and Temperature Cycling Test (PTC)	32	Rated input voltage; air flow: 0.5 m/s (100 LFM) to 5 m/s (1000 LFM); ambient temperature between -40°C and +85°C; 1000 cycles; 50% load

Thermal Consideration

Thermal Test Point

Decide proper airflow to be provided by measuring the temperature of the temperature sensor as shown in Figure 26 to protect the converter against overtemperature. The Overtemperature protection threshold is also obtained based on thermal test point.

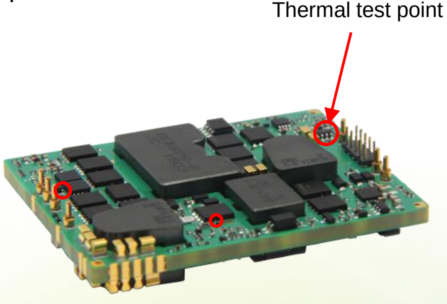


Figure 25: Thermal test point

Power Dissipation

The converter power dissipation is calculated based on efficiency. The following formula reflects the relationship between the consumed power (P_d), efficiency (η), and output power (P_o): $P_d = P_o(1-\eta)/\eta$

Moisture Sensitivity Level (MSL) Rating

Store and transport the converter as required by the MSL rating 3 specified in the J-STD-020/033. It is recommended that clean and free solder paste should be used to assemble power module. The surface of a soldered converter must be clean and dry. Otherwise the assembly, test, or even reliability of the converters will be negatively affected.

Mechanical Consideration

Installation

Although the converter can be mounted in any direction, free airflow must be taken.

Soldering

The converter is compatible with standard wave soldering, reflow soldering or hand soldering.

1. For wave soldering, the converter pins can be soldered at 260°C for less than 7 seconds.
2. For reflow soldering, the converter pins can be soldered at 250°C for less than 10 seconds.
3. For hand soldering, the iron temperature should be maintained at 350°C to 420°C and applied to the converter pins for less than 10 seconds.

For Lead-Free solder process, the product is qualified for MSL 3 according to *J-STD-020*. During reflow process, the peak temperature must not exceed 250°C at any time.

Mechanical Consideration

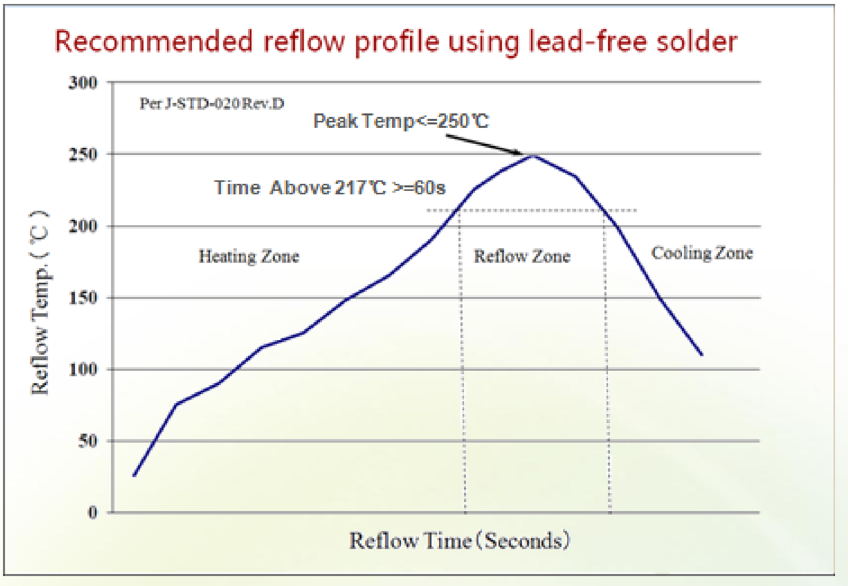


Figure 26: Recommended reflow profile using lead-free solder

The converter can be rinsed using the isopropyl alcohol (IPA) solvent or other proper solvents.

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