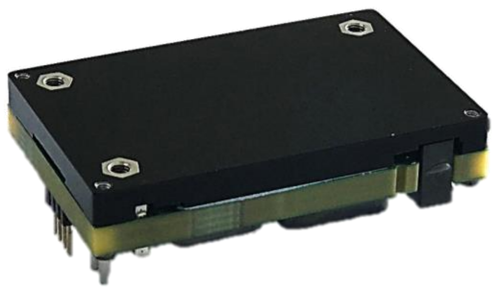


Q54SJ108A2

1/4 Brick DC/DC Regulated Power Module

10.7V/121A output, 1300W

The Q54SJ108A2 series, 40~60V input, isolated single output, Quarter Brick, is regulated DC/DC converter, and is being offered from a world leader in power system and technology and manufacturing — Delta Electronics, Inc. The Q54SJ108A2 offers up to 1300 watts of power and 97.5% peak efficiency in an industry standard footprint. With creative design technology and optimization of component placement, these converters possess outstanding electrical and thermal performances, as well as extremely high reliability under highly stressful operating conditions. The Q54SJ108A2 series is fully protected from abnormal input voltage, output current, and temperature conditions and meets 707Vdc isolation; and it can be connected in parallel directly for higher power without external oring-fets.

FEATURES

Electrical

- 40V~60V Vin operating range
- Peak Efficiency up to 97.5%
- Over current protection
- Input UVP/OVP,
- Over Temperature Protection
- Remote ON/OFF
- Pre-bias startup
- No minimum load required
- Active Droop Performance
- Parallel Operation with Direct Output Connection
- PMbus Communication
- Black Box for fault logging
- Online upgrade firmware by the system processor without being turned off
- 707Vdc isolation

Mechanical

- Size:
  58.4 x 36.8 x 14.5mm (2.30"x1.45"x0.57")

Soldering Method

- Wave soldering
- Hand soldering
- Reflow soldering (MSL rating of 3)

Safety & Certificate

- IEC/EN/UL/CSA 62368-1, 2nd edition
- IEC/EN/UL/CSA 60950-1, 2nd edition+A2
- ISO 9001, TL 9000, ISO 14001, QS 9000,
- OHSAS18001 certified manufacturing facility

OPTIONS

- Analog/Digital option
- Open frame/ with heat spreader

APPLICATIONS

- Optical Transport
- Data Networking
- Communications
- Servers

(T_A=25°C, airflow rate=300 LFM, V_{in}=54Vdc, nominal V_{out} unless otherwise noted.)

PARAMETER	NOTES and CONDITIONS	Q54SJ108A2 Series			
		Min.	Typ.	Max.	Units
ABSOLUTE MAXIMUM RATINGS					
Input Voltage		0		60	Vdc
On/off Pin Voltage		-25		25	Vdc
Other Pin Voltage	Data/Clock/Add1/PG/SMBAlert	-0.3		3.6	V
Operating Ambient Temperature (Ta)		-20		85	°C
Storage Temperature		-55		125	°C
Input / Output Isolation Voltage				707	Vdc
INPUT CHARACTERISTICS					
Operating Input Voltage (continous)	continuous	40	54	58	Vdc
Operating Input Voltage (short time operation)	5 minutes	58		60	Vdc
Input Under-Voltage Lockout					
Turn-On Voltage Threshold			39.3	40	Vdc
Turn-Off Voltage Threshold			37.8	38.5	Vdc
Lockout Hysteresis Voltage		1	1.5		Vdc
Input Over-Voltage Protection			61		Vdc
Maximum Input Current	Vin=40V, Io=121A,		34.3	36	A
Maximum Start Up Input Current	Vin=40V, Io=121A,			50	A
No-Load Input Current	V_{in}=54V, I_o=0A		255		mA
Off Converter Input Current	V_{in}=54V			30	mA
Input Terminal Ripple Current	RMS, With 100uF input cap.			700	mA
OUTPUT CHARACTERISTICS					
Output Voltage Set Point	Vin=54V, Io=0, Tc=25°C	11.06	11.10	11.14	Vdc
	Vin=54V, Io=121A, Tc=25°C	10.66	10.70	10.74	
Output Voltage Regulation, Load regulation	Io=0 to 121A	340	400	460	mV
Line regulation	Vin=40V to 58V, Io=0A		+/-20	+/-60	mV
Temperature regulation	Tc = -20°C to 85°C	-30		+90	mV
Total Output Voltage Range	over sample load, and temperature	10.6		11.4	Vdc
Output Voltage Ripple and Noise	5Hz to 20MHz bandwidth				
Peak-to-Peak	Full Load,Co=700uF, 50% ceramic, 50% Oscon			150	mV
RMS	Full Load,Co=700uF, 50% ceramic, 50% Oscon			50	mV
Operating Output Current Range	Vin=40V~58V	0		121	A
Output Over Current Protection		135	150	165	A
DYNAMIC CHARACTERISTICS					
Output Voltage Current Transient	54V Vin				
Output voltage overshoot and undershoot	1A/μs, 50% to 75% Io.max, 5200uF Load cap			350	mV
Setting Time (within 1% Vout nominal)			200		μs
Turn-On Transient					
Start-Up Delay Time From Input Voltage	On/Off=On, from V_{in}=Turn-on Threshold to V_o=10% $V_{o,nom}$	20		35	ms
Start-Up Delay Time From On/Off Control	V_{in}=$V_{in,nom}$, from On/Off=On to V_o=10% $V_{o,nom}$	0		5	ms
Vo rise time (from 10% Vo set to 90% Vo set)		0		15	ms
Output Capacitance Range	50% ceramic, 50% Oscon or POSCAP	700		10000	μF
EFFICIENCY					
50% Load	Vin=54V		97.0		%
75% Load	Vin=54V		97.5		%
100% Load	Vin=54V		97.3		%
ISOLATION CHARACTERISTICS					
Input to Output				707	Vdc
Isolation Capacitance			80		nF
FEATURE CHARACTERISTICS					
Current Share accuracy	Droop current sharing mode, full load, Vin=54V, Ta=25°C			10	%
Switching Frequency		350		1100	kHz
ON/OFF Control, Negative logic					
Logic Low		-0.7		0.8	V
Logic High		2.4		25	V
ON/OFF pin output current	Ion/off at Von/off=0.0V			0.2	mA
	Ion/off at Von/off=2.4V	10			uA
On/off pin resistor			249		Kohm
Open circuit Voltage				3	V
Output Over-Voltage Protection	Over full temp range		12.5	15	V
GENERAL SPECIFICATIONS					
MTBF	With heatspread, Io=80%*Io,max; 300LFM; Ta=25°C		4.9		Mhours
Weight	Open frame		71		grams
Weight	With heat spreader		84		grams
Over-Temperature Shutdown (Open Frame)	Refer to Figure 18 for Hot spot 1 location ($54V_{in}$, 1000W, 200LFM,Airflow from V_{in-} to V_{in+})		138		°C
Over-Temperature Shutdown (With Heat Spreader)	Refer to Figure 20 for Hot spot 2 location ($54V_{in}$, 1000W, 200LFM,Airflow from V_{in-} to V_{in+})		138		°C
Over-Temperature Shutdown (With 0.5" Heat Sink)	Refer to Figure 22 for Hot spot 3 location ($54V_{in}$, 1000W, 200LFM,Airflow from V_{in-} to V_{in+})		138		°C
Over-Temperature Shutdown (NTC Resistor)			135		°C

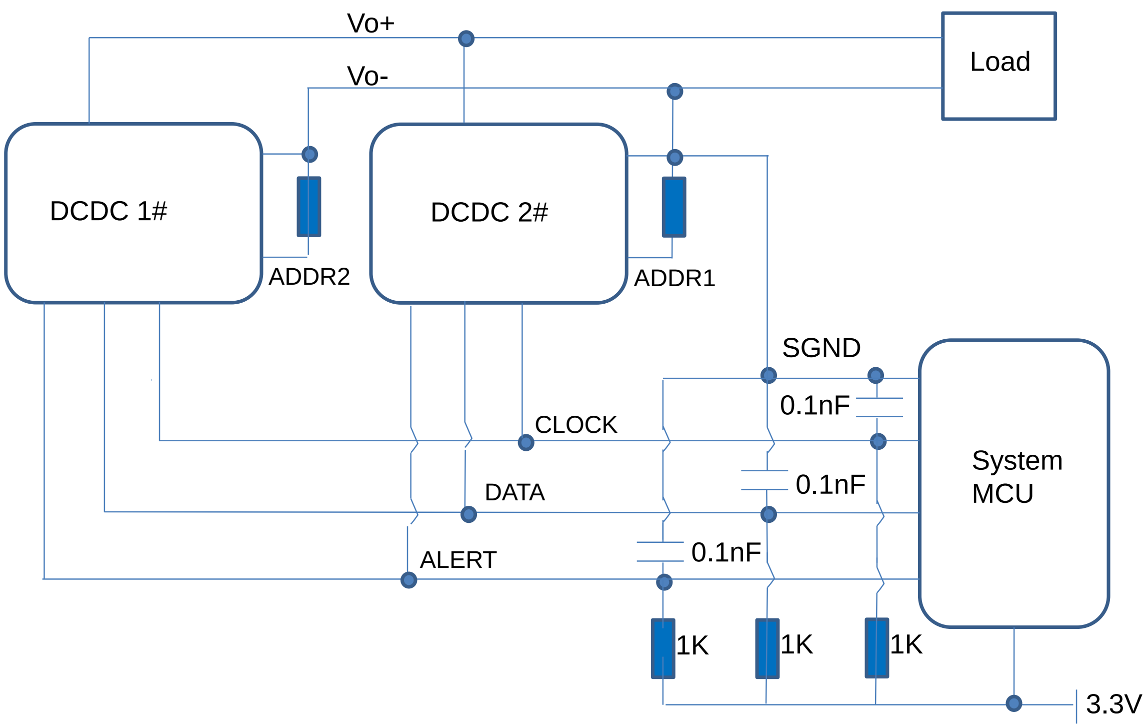
Note: Please attach thermocouple on NTC resistor to test OTP function, the hot spots' temperature is just for reference.

PARAMETER	NOTES and CONDITIONS	Q54SJ108A2 Series			
		Min.	Typ.	Max.	Units
PMBUS SIGNAL INTERFACE CHARACTERISTICS					
Logic Input Low (V_{IL})	Data, Clock pin	0		0.8	V
Logic Input High (V_{IH})	Data, Clock pin	2.4		3.6	V
Logic Output Low (V_{OL})	Data, SMBAlert, Clock pin; IOL=4mA			0.4	V
Logic Output High (V_{OH})	Data, SMBAlert, Clock pin; IOH=-4mA	2.5			V
PMBus Operating Frequency Range		100	100	400	KHz
PMBUS MONITORING CHARACTERISTICS					
Output Current Reading Accuracy	Vin=54V, Io=50% ~ 100% of Io, max;	-5		+5	%
	Vin=54V, Io=5% ~ 50% of Io, max;	-3		+3	A
Output Voltage Reading Accuracy		-2		+2	%
Input Voltage Reading Accuracy		-4		+4	%
Temperature Reading Accuracy		-5		+5	℃

PIN DEFINATION

Pin#	Name	Function	Pin#	Name	Function
1	VIN+		7	VO+	
2	ON/OFF	Primary on/off control pin	8	Data	PMBus data line
3	VIN-		9	Alert	PMBus alert line
4	VO-		10	Clock	PMBus clock line
5	VO-		11	Addr	PMBus address pin
6	VO+				

PMBUS APPLICATION CIRCUIT



T_A=25°C

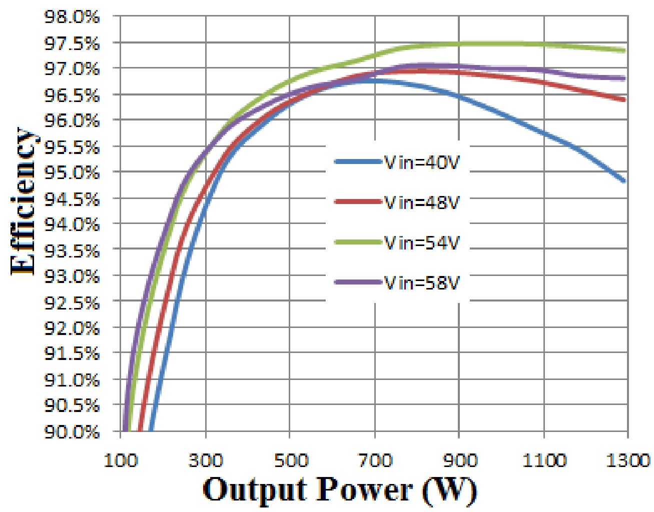


Figure 1: Efficiency vs. Output Power

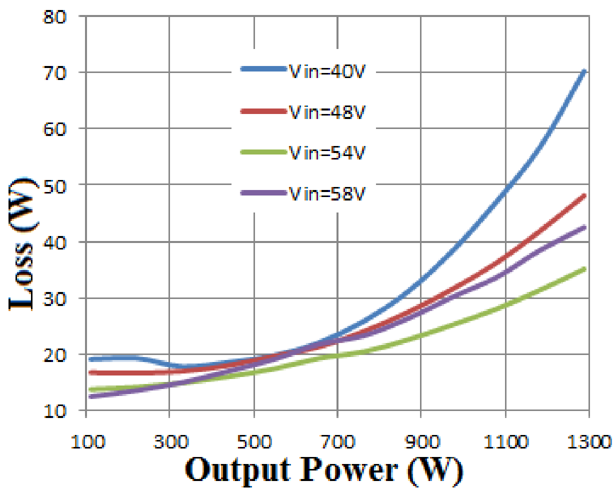


Figure 2: Loss vs. Output Power

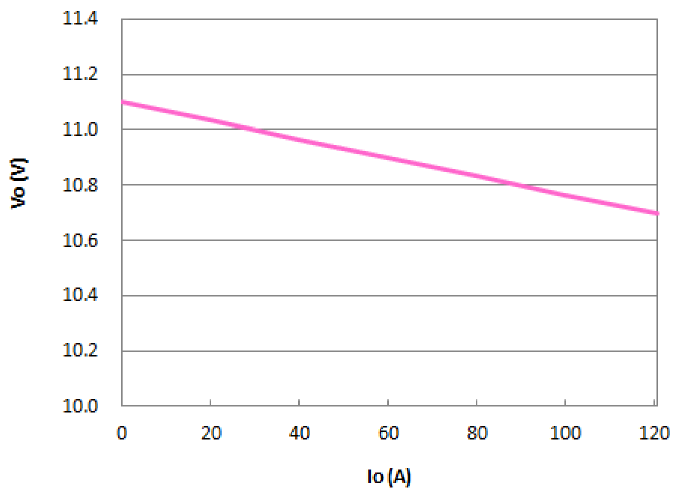


Figure 3: Output Voltage vs. Output Current showing typical current limit curves and converter shutdown points.

T_A=25°C,

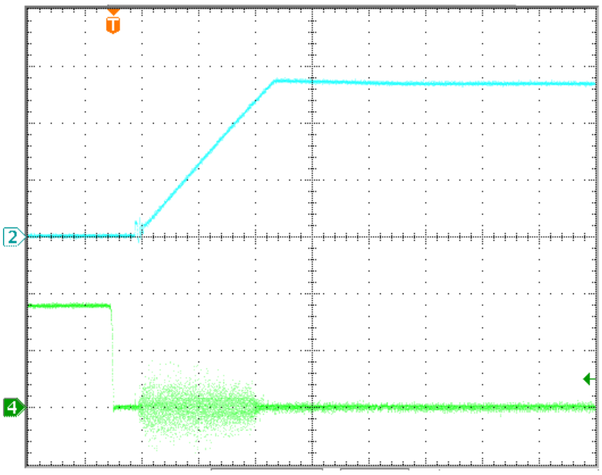


Figure 5: Remote On/Off (negative logic) at full load
Vin=54V, I_{out} = full load
Time: 4ms/div.
V_{out} (top trace): 4V/div;
$V_{remote\ On/Off\ signal}$ (bottom trace): 2V/div.

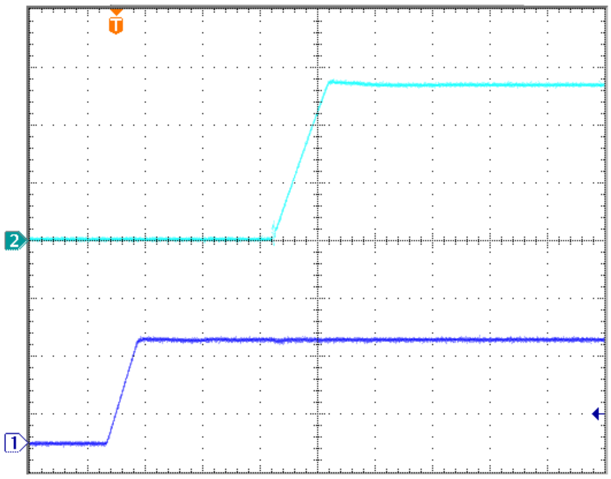


Figure 6: Input Voltage Start-up at full load
Vin=54V, I_{out} = full load
Time: 10ms/div.
V_{out} (top trace): 4V/div;
V_{in} (bottom trace): 30V/div.

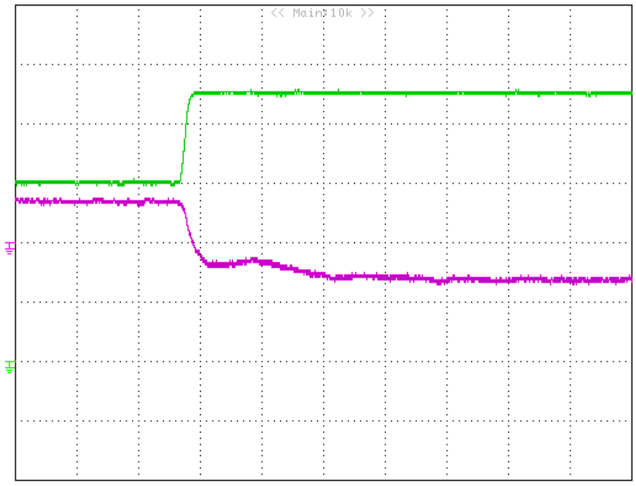


Figure 7: Transient Response
Vin=54V, 1A/µs step change in load from 50% to 75% of $I_{o,\ max}$
V_{out} (top trace): 0.2 V/div, 200us/div;
I_{out} (bottom trace): 20A/div.
Load cap: 5200uF.
Scope measurement should be made using a BNC cable (length shorter than 20 inches). Position the load between 51 mm to 76 mm (2 inches to 3 inches) from the module

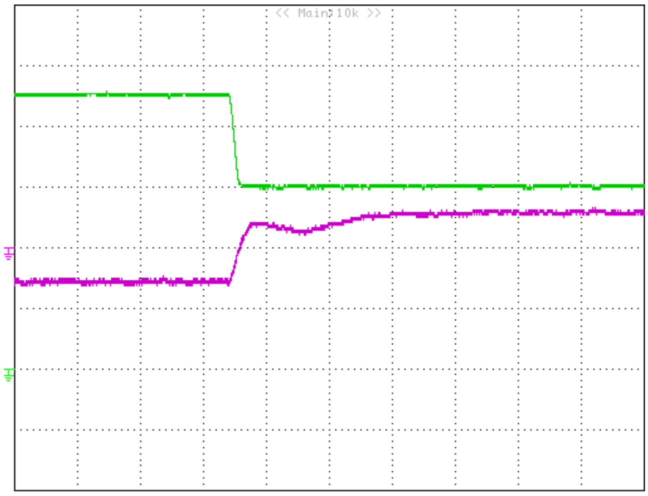


Figure 8: Transient Response
Vin=54V, 1A/µs step change in load from 75% to 50% of $I_{o,\ max}$
V_{out} (top trace):0.2V/div, 200us/div;
I_{out} (bottom trace): 20A/div.
Load cap: 5200uF.
Scope measurement should be made using a BNC cable (length shorter than 20 inches). Position the load between 51 mm to 76 mm (2 inches to 3 inches) from the module

T_A=25°C,

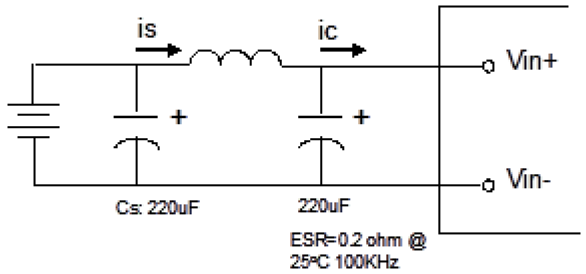


Figure 9: Test Diagram for Input Terminal Current ic

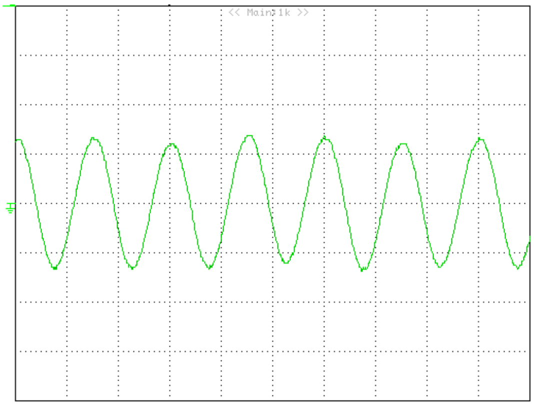


Figure 10: Input Terminal Ripple Current, ic
Vin=51V, I_{out} = full load
200 mA/div, 0.5us/div.
Bandwidth: 20MHz

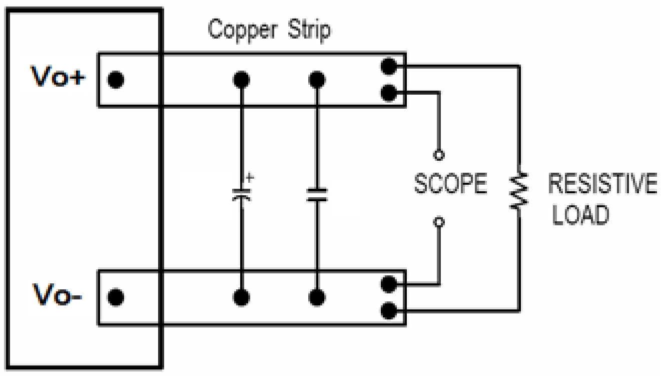


Figure 11: Test Setup for Output Voltage Noise and Ripple

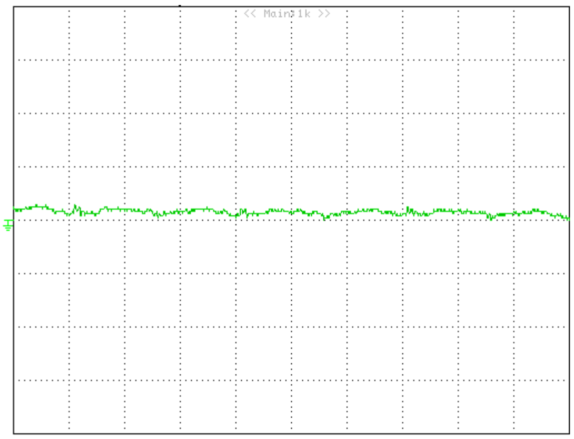


Figure 12: Output Voltage Ripple and Noise
Vin=51V, I_{out} = full load
20 mV/div, 0.5us/div
Load cap: 700uF, 50% ceramic, 50% Oscon.
Bandwidth: 20MHz

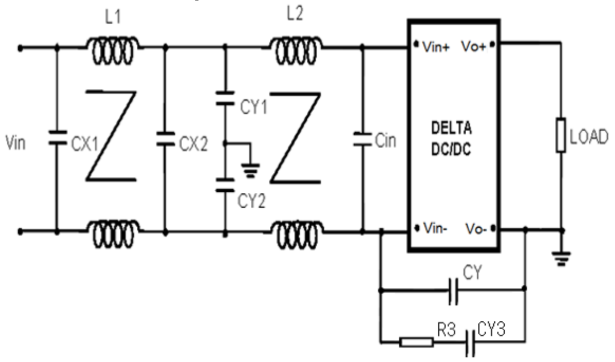
Input Source Impedance

The impedance of the input source connecting to the DC/DC power modules will interact with the modules and affect the stability. A low ac-impedance input source is recommended. A low ESR electrolytic capacitor higher than 220µF (ESR < 0.2Ω at 100kHz) is suggested.

Layout and EMC Considerations

Delta's DC/DC power modules are designed to operate in a wide variety of systems and applications. For design assistance with EMC compliance and related PWB layout issues, please contact Delta's technical support team. Below is the reference design for an input filter tested with Q54SJ108A2 to meet class A in CISSPR 22.

Schematic and Components List



Cin is 100uF low ESR Aluminum cap×2pcs in parallel;
CX1 is 2.2uF ceramic cap×2pcs in parallel;
CY1 and CY2 are 10nF ceramic cap;
CX2 is NC;
CY is 33nF;
CY3 is 100nF, R3 is 1ohm;
L1 and L2 is 0.22mH;

Figure 13: Recommended Input Filter

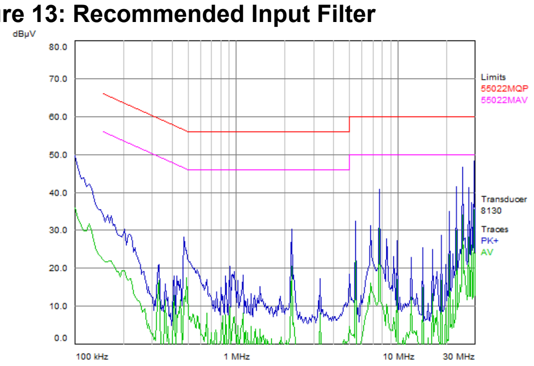


Figure 14: Test Result of EMC (V_{in}=54V, I_o=121A).

Note: Input EMI filter is recommended in front of power module application. For incomplete EMI circuit, EMI risk does exist in the system. For example, the parasitic inductance of long input cable may form LC resonant circuit with Y capacitance. Undesired oscillation may happen If the resonant frequency is within the switching frequency range of the power module. An RC circuit (R3/CY3 are 1ohm/100nF) as shown in Figure 13 is strongly recommended even there is no EMI requirement for the DCDC converter. If customer encounter any EMI issue. please contact Delta design team for solution.

Safety Considerations

The power module must be installed in compliance with the spacing and separation requirements of the end-user's safety agency standard, i.e., UL60950-1, CSA C22.2 NO. 60950-1 2nd and IEC 60950-1 2nd: 2005 and EN 60950-1 2nd: 2006+A11+A1: 2010, if the system in which the power module is to be used must meet safety agency requirements. Both the input and output of this product meet SELV requirement. This module has function insulation with 707Vdc isolation.

This power module is not internally fused. To achieve optimum safety and system protection, an input line fuse is highly recommended. The safety agencies require a normal-blow fuse with 100A maximum rating to be installed in the ungrounded lead. A lower rated fuse can be used based on the maximum inrush transient energy and maximum input current.

Soldering and Cleaning Considerations

Post solder cleaning is usually the final board assembly process before the board or system undergoes electrical testing. Inadequate cleaning and/or drying may lower the reliability of a power module and severely affect the finished circuit board assembly test. Adequate cleaning and/or drying is especially important for un-encapsulated and/or open frame type power modules. For assistance on appropriate soldering and cleaning procedures, please contact Delta's technical support team.

Remote On/Off

The remote on/off feature on the module is negative logic. Negative logic turns the module on during a logic low and off during a logic high. Remote on/off can be controlled by an external switch between the on/off terminal and the Vi (-) terminal. The switch can be an open collector or open drain. If the remote on/off feature is not used, please short the on/off pin to Vin(-); If the remote on/off signal has a large noise, and a RC (R1 is 499 ohm; C1 is 4.7nF) filter circuit is recommended.

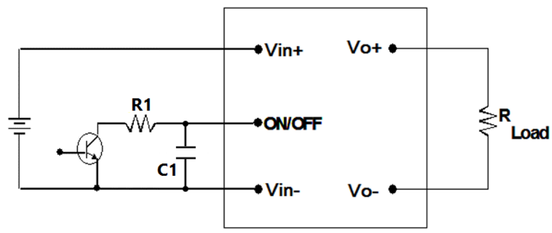


Figure 15: Remote On/Off Implementation

Over-Current Protection

The modules include an internal output over-current protection circuit. If the output current exceeds the OCP set point, the modules will shut down. After shut down, the modules will first enter a hiccup mode (only supporting restart two times), and then a latch mode.

For hiccup mode, the module will try to restart after shutdown 1 second. If the overload condition still exists, the module will shut down again. If the accumulate restart time has exceeded two times, the module will enter into latch mode.

For latch mode, the module will not try to restart any more except for input voltage repower on, module re-enabled by remote on/off or module re-enabled by PMBUS 0x01 OPERATION command.

Over-Temperature Protection

The modules include an internal over-temperature protection circuit. If the module temperature exceeds the over-temperature threshold the module will shut down, and enter in an auto-recovery mode. For auto-recovery mode, the module will monitor the module hot spot temperature after shutdown. Once the hot spot temperature is dropped below 100C, the module will be auto-recovery.

Over-Voltage Protection

The modules include an internal output over-voltage protection circuit. If output voltage exceeds the over-voltage set point, the module will shut down. After shut down, the modules will first enter a hiccup mode (only supporting restart two times), and then a latch mode.
For hiccup mode, the module will try to restart after shutdown 1 second. If the over-voltage condition still exists, the module will shut down again. If the accumulate restart time has exceeded two times, the module will enter into latch mode.
For latch mode, the module will not try to restart any more except for input voltage repower on, module re-enabled by remote on/off or module re-enabled by PMBUS 0x01 OPERATION command.

Parallel and Droop Current Sharing

The modules are capable of operating in parallel, and realizing current sharing by droop current sharing method. There is about 400mV output voltage droop from 0A to full output Load, and there is no current sharing pin. By connecting the Vin pin and the Vo pin of the parallel module together, the current sharing can be realized automatically.

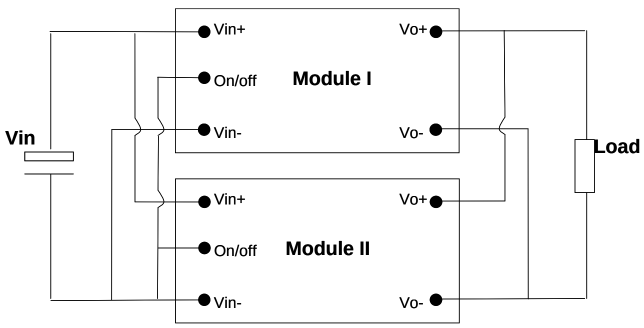


Figure 16: *Parallel and droop current sharing configuration for no redundancy requirement system*

If system has no redundancy requirement, the module can be parallel directly for higher power without adding external oring-fet; whereas, If the redundancy function is required, the external oring-fet should be added.

For a normal parallel operation the following precautions must be observed:

1. The current sharing accuracy equation is:
   X% = | Io1–Io2 | / Irated, Where,
   Io1 is the output current of module1;
   Io2 is the output current of module2
   Irated is the rated full load current of per module.

2. To ensure a better steady current sharing accuracy, below design guideline should be followed:
   a) The inputs of the converters must be connected to the same voltage source; and the PCB trace resistance from Input voltage source to Vin+ and Vin- of each converter should be equalized as much as possible.
   b) The PCB trace resistance from each converter's output to the load should be equalized as much as possible.
   c) For accurate current sharing accuracy test, the module should be soldered in order to avoid the unbalance of the touch resistance between the modules to the test board.

3. To ensure the parallel module can start up monotonically without trigging the OCP circuit, below design guideline should be followed:
   a) Before all the parallel modules finished start up, the total load current should be lower than the rated current of 1 module.
   b) The ON/OFF pin of the converters should be connected together to keep the parallel modules start up at the same time.
   c) The under voltage lockout point will slightly vary from unit to unit. The dv/dt of the rising edge of the input source voltage must be greater than 1V/ms to ensure that the parallel module start up at the same time.

PMBus Communication

The module has a digital PMBus interface to allow the module to be monitored, controlled and configured by the system. The module supports 3 PMBus signal lines, Data, Clock, SMBALERT, and 1 Address line Addr. More detail PMBus information can be found in the PMB Power Management Protocol Specification, Part I and part II, revision 1.2; which is shown in http://pmbus.org. 100kHz to 400kHz bus speeds are supported by the module. Connection for the PMBus interface should be following the High Power DC specifications given in section 3.1.3 in the SMBus specification V2.0 or the Low Power DC specifications in section 3.1.2. The complete SMBus specification is shown in http://smbus.org.

Note: If a series of commands consecutively sending to this module more than 30ms time, the bus free time between stop and start condition (TBUF) that defined in SMBUS AC specifications should not be all less than 200us in these commands.

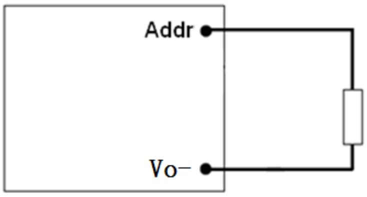
The module supports the Packet Error Checking (PEC) protocol. It can check the PEC byte provided by the PMBus master, and include a PEC byte in all message responses to the master.

SMBALERT protocol is also supported by the module. SMBALERT is a wired-AND signal just as the CLOCK and DATA signals are, by which the module can alert the PMBus master that it has a fault condition via pulling the SMBALERT pin to an active low. The master to response the SMBALERT method is that the master will communicate with the slave module using the programmed address, and using the various STATUS commands to determine the cause for the SMBALERT. The CLEAR_FAULTS command can retire the active SMBALERT.

Note: If PMBus is not used. The "Data, Alert, Clock. Addr" can be unconnected.

PMBUS Addressing

The Module has flexible PMBUS addressing capability. When connect different resistor from Addr pin to Vo- pin, 14 possible 7bits addresses can be acquired.



Different PMBUS address is defined by the value of the resistor as below, and +/-1% resistors accuracy can be accepted. If there is any resistance exceeding the requested range, 7bits address 126 will be return.

PMBUS address	Resistor(Kohm)
96	10
97	15
98	21
99	28
100	35.7
101	45.3
102	56.2
103	69.8
104	88.7
105	107
106	130
107	158
108	191
109	232

Black Box Function

There is a black box function realized by the page 44~63 of D-flash, which has 20K erase cycles up to 120C hotspot temp. Page 44~63, total 20 pages and 32 bytes per page, are assigned to record 20 history events. These 20 history events are recorded circularly, so the oldest event will be overwritten by new event if more than 20 events are recorded. Any shutdown events including the ENABLE ONOFF will trigger the black box to record data. Every page has the same record content, which is shown as below:

Byte	Content
1 ~ 8	**For Delta internal checking**
9 ~ 11	Run_Time from turn on to off
12	**For Delta internal checking**
13 ~ 14	Module's temperature when off.
15 ~ 16	STATUS_WORD
17 ~ 18	Input voltage in PMBUS linear format, when module is off.
19 ~ 20	**For Delta internal checking**
21 ~ 22	Output current in PMBUS linear format, when module is off.
23 ~ 32	**For Delta internal checking**

For the Run_Time from Byte 8 to Byte 10, it records the total module run time from starting output power to module is off. After extracting Run_Time data, user should translate the Run_Time data to the actual run time, as below:

If the Run_Time data < 65535, then the actual run time = (Run_Time) / 10000;
If the Run_Time data >=65535, then the actual run time = (Run_Time - 65535) + 6.5535;

The unit of the calculation result is second.
The upper limit is (0x00FFFFFE – 65535) + 6.5535 seconds. It's about 193 days. After reaching the upper limit, it will stay at the upper limit, not reset to 0.

PMBus Data Format

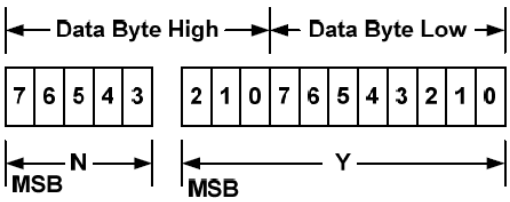
The module receives and reports data in LINEAR format. The Linear Data Format is typically used for commanding and reporting the parameters such as (but not only) the following:

- Output Current,
- Input Voltage,
- Input Current,
- Operating Temperatures,
- Time (durations), and
- Energy Storage Capacitor Voltage.

The Linear Data Format is a two-byte value with:

- An 11 bit, two's complement mantissa and
- A 5 bit, two's complement exponent (scaling factor).

The format of the two data bytes is illustrated below:

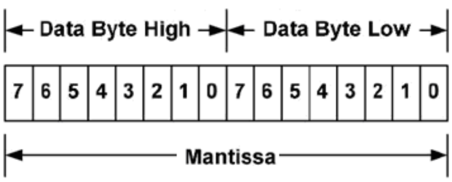


The relation between Y, N and the "real world" value is:
$X = Y \cdot 2^N$
Where, as described above:
X is the "real world" value;
Y is an 11 bit, two's complement integer; and
N is a 5 bit, two's complement integer.
Devices that use the Linear format must accept and be able to process any value of N.

The Exponent of the data words is fixed at a reasonable value for the command. The detail exponent and resolution of main parameter is summarized as below:

	Exponent	Resolution
Vin	-3	0.125V
Vo	-12	0.244mV
Io	-3	125mA
Temperature	-2	/

For commands that report the output voltage, the module supports the linear data format consisting of a two-byte value with a 16-bit, unsigned mantissa, and a fixed exponent of -12. The format of the two data bytes is shown below:



The equation can be written as:
$Vout = Mantissa \times 2^{-12}$

Supported PMBus Commands

The main PMBus commands described in the PMBus 1.2 specification are supported by the module. Partial PMBus commands are fully supported; Partial PMBus commands have some differences with the definition in PMBus 1.2 specification. All the supported PMBus commands are summarized in detail summarized in the below table.

Command	Code	Description	Type	Compatible with PMBUS standard or not?	Data Format	Default value	Data units	Expon -ent	Note
OPERATION	0x01	Turn the module on or off by PMBUS command	R/W byte	Refer to below description	Bit field	0x80	/	/	Such command has keyword protection to prevent accidental write by system firmware;
CLEAR_FAULTS	0x03	Clear any fault bits that have been set	Send byte	Yes	/	/	/	/	
WRITE_PROTECTION	0x10	Set or Clear the bit of Write protection	R/W byte	Refer to below description	Bit field	0x80	/	/	The intent of this command is to provide protection against accidental changes
STORE_DEFAULT_ALL	0x11	Stores operating parameters from RAM to data flash	Send byte	Yes	/	/	/	/	The FLASH must be unlocked (referring to Command 0xEC) before sending this command.
VOUT_MODE	0x20	Read Vo data format	Read byte	Yes	mode+exp	0x14	/	/	/
VOUT_OV_FAULT_RESPONSE	0x41	Instructs what action to take in response to an output overvoltage fault.	R/W byte	Refer to below description	Bit field	0x05	/	/	The hiccup delay time unit is 200ms, Total delay time is 1000ms default.
IOUT_OC_FAULT_RESPONSE	0x47	Instructs what action to take in response to an output overcurrent fault.	R/W byte	Refer to below description	Bit field	0x05	/	/	The hiccup delay time unit is 200ms, Total delay time is 1000ms default.
STATUS_WORD	0x79	Returns the information with a summary of the module's fault/warning	Read word	Refer to below description	Bit field	/	/	/	ALL of the warning or fault bits set in the status registers remain set, even if the fault or warning condition is removed or corrected, until one of the following occur: 1) The bit is individually cleared; 2) The device receives a CLEAR_FAULTS command; 3) Bias power is removed from the module.
STATUS_VOUT	0x7A	Returns the information of the module's output voltage related fault/warning	R/W byte	Refer to below description	Bit field	/	/	/	
STATUS_IOUT	0x7B	Returns the information of the module's output current related fault/warning	R/W byte	Refer to below description	Bit field	/	/	/	
STATUS_INPUT	0x7C	Returns the information of the module's input over voltage and under voltage fault	R/W byte	Refer to below description	Bit field	/	/	/	
STATUS _TEMPERATURE	0x7D	Returns the information of the module's temperature related fault/warning	R/W byte	Refer to below description	Bit field	/	/	/	
STATUS_CML	0x7E	Returns the information of the module's communication related faults.	R/W byte	Refer to below description	Bit field	/	/	/	
READ_VIN	0x88	Returns the input voltage of the module	Read word	Yes	Vin Linear	/	Volts	-3	/
READ_VOUT	0x8B	Returns the output voltage of the module	Read word	Yes	Vout Linear	/	Volts	-12	/
READ_IOUT	0x8C	Returns the output current of the module	Read word	Yes	Iout Linear	/	Amps	-3	/
READ_ TEMPERATURE_1	0x8D	Returns the module's hot spot temperature of the module	Read word	Yes	TEMP Linear	/	Deg.C	-2	/
PMBUS_REVISION	0x98	Reads the revision of the PMBus	Read byte	Yes	Bit field	0x22	/	/	/
MFR_ID	0x99	Read the manufacturer's ID	Read Block	Yes	ASCII	"DELTA"	/	/	Data that read should be converted to ASCII code

Command	Code	Description	Type	Compatible with PMBUS standard or not?	Data Format	Default value	Data units	Expon -ent	Note
MFR_MODEL	0x9A	Set or read the manufacturer's model number	Read Block	Yes	ASCII	"Q54SJ108A2****"	/	/	Data that read should be converted to ASCII code
MFR_REVISION	0x9B	Set or read the module's label version	Read Block	Yes	ASCII	/	/	/	The format is "SX.X"
MFR_LOCATION	0x9C	Read the manufacturing location of the device	Read Block	Yes	ASCII	"Thailand"	/	/	Data that read should be converted to ASCII code
ERASE_BLACKBOX_DATA	0xD1	Erase all black box data.	Send byte	Refer to below description;	/	/	/	/	/
READ_HISTORY_EVENT_NUMBER	0xD2	Read the total number of history event in black box space.	Read byte	Refer to below description;	/	/	/	/	/
READ_HISTORY_EVENTS	0xE0	Read history event from black box	Read block	Refer to below description;	/	/	/	/	/
SET_HISTORY_EVENT_OFFSET	0xE1	Set history event offset	R/W byte	Refer to below description;	/	/	/	/	/
PMBUS_CMD_FLASH_KEY_WRITE	0xEC	Write the key to unlock the Flash before Storing operating parameters from RAM to data flash	R/W Block	No	/	0xA5A5A5A5	/	/	A data block:7E,15,DC,42 should be send to unlock the FLASH.

OPERATION [0x01]

Bit number	Purpose	Bit Value	Meaning
7	Enable/Disable the module	1	Output is enabled
		0	Output is disabled
6:0	Reserved		

WRITE PROTECTION [0x10]

Bit number	Purpose	Bit Value	Meaning
7	Enable / Disable the protection	1	Protection is enabled
		0	Protection is disabled
6:0	Reserved		

VOUT_OV_FAULT_RESPONSE [0x41]

Bit number	Purpose	Bit Value	Meaning	Default Settings, 0x05
7:3	reserved	00000	reserved	00000
2:0	Delay time setting	000	Setting over voltage hiccup delay time. The time unit is 200ms. Total delay time = bit[2:0] * 200ms	101

IOUT_OC_FAULT_RESPONSE [0x47]

Bit number	Purpose	Bit Value	Meaning	Default Settings, 0x05
7:3	reserved	00000	reserved	00000
2:0	Delay time setting	000	Setting over current hiccup delay time. The time unit is 200ms. Total delay time = bit[2:0] * 200ms	101

STATUS_WORD [0x79]

High byte

Bit number	Purpose	Bit Value	Meaning
7	An output voltage fault or warning	1	Occurred
		0	No Occurred
6	An output over current fault or warning	1	Occurred
		0	No Occurred
5	An input voltage fault or warning, including over voltage and under voltage	1	Occurred
		0	No Occurred
4	Reserved		
3	Power_Good	1	is negated
		0	ok
2:1	Reserved		
0	A fault type not given in bits [15:1] of the STATUS_WORD has been detected	1	Detected
		0	No Detected

Low byte

Bit number	Purpose	Bit Value	Meaning
7	Reserved		
6	OFF (The unit is not providing power to the output, regardless of the reason)	1	Occurred
		0	No Occurred
5	An output over voltage fault	1	Occurred
		0	No Occurred
4	An output over current fault	1	Occurred
		0	No Occurred
3	An input under voltage fault	1	Occurred
		0	No Occurred
2	A temperature fault or warning	1	Occurred
		0	No Occurred
1	CML (A communications, memory or logic fault)	1	Occurred ;
		0	No Occurred
0	A fault or warning not listed in bits [7:1] of this byte has occurred	1	Occurred ;
		0	No Occurred

STATUS_VOUT [0x7A]

Bit number	Purpose	Bit Value	Meaning
7	Output over voltage fault	1	Occurred ;
		0	No Occurred
6	Output over voltage warning	1	Occurred ;
		0	No Occurred
5	Output under voltage warning	1	Occurred ;
		0	No Occurred
4	Output under voltage fault	1	Occurred ;
		0	No Occurred
3:0	Reserved		

STATUS_IOUT [0x7B]

Bit number	Purpose	Bit Value	Meaning
7	Output over current fault	1	Occurred ;
		0	No Occurred
6	Reserved		
5	Output over current warning	1	Occurred ;
		0	No Occurred
4:0	Reserved		

STATUS_INPUT [0x7C]

Bit number	Purpose	Bit Value	Meaning
7	Input over voltage fault	1	Occurred ;
		0	No Occurred
6	Input over voltage warning	1	Occurred ;
		0	No Occurred
5	Input under voltage warning	1	Occurred ;
		0	No Occurred
4	Input under voltage fault	1	Occurred ;
		0	No Occurred
3:0	Reserved		

STATUS_TEMPERATURE [0x7D]

Bit number	Purpose	Bit Value	Meaning
7	Over temperature fault	1	Occurred ;
		0	No Occurred
6	Over temperature warning	1	Occurred ;
		0	No Occurred
5:0	Reserved		

STATUS_CML [0x7E]

Bit number	Purpose	Bit Value	Meaning
7	Invalid/Unsupported Command Received	1	Occurred ;
		0	No Occurred
6	Invalid/Unsupported Data Received	1	Occurred ;
		0	No Occurred
5	Packet Error Check Failed	1	Occurred ;
		0	No Occurred
4:0	Reserved		

ERASE_BLACKBOX_DATA [0xD1]

This is a Delta MFR command which used to erase all black box data. After writing the command 0xD1, the module will be powered off automatically for erasing safely. After finishing the erasing task, the module will repower on itself again. The total time for erasing is about 400ms. So the module will be powered off at least 400ms if user send a 0xD1 command to erase black box data. User should pay attention to this feature before writing 0xD1 command.

READ_HISTORY_EVENT_NUMBER [0xD2]

This is a read-only Delta MFR command which used to get the total events number in black box.

READ_HISTORY_EVENTS [0xE0]

This is a read-only Delta MFR command which used to get the history events at an appointed offset. The appointed offset can be set by command 0xE1 SET_HISTORY_EVENT_OFFSET.
This command is a read block PMBUS communication protocol. So the return data from PMBUS will be as below table shows:

Byte	Content
0	Byte Count = 32
1 ~ 8	**For Delta internal checking**
9 ~ 11	Run_Time from turn on to off
12	**For Delta internal checking**
13 ~ 14	Module's temperature when off.
15 ~ 16	STATUS_WORD
17 ~ 18	Input voltage in PMBUS linear format, when module is off.
19 ~ 20	**For Delta internal checking**
21 ~ 22	Output current in PMBUS linear format, when module is off.
23 ~ 32	**For Delta internal checking**

Note: The Byte Count at Byte0 is the content of PMBUS block read protocol, not the black box data.

SET_HISTORY_EVENT_OFFSET [0xE1]

This is a Delta MFR command which used to set offset value to decide which history data for read. The offset and the history data has the fix relationship, as below table shows.

Offset	History data	Offset	History data
0x30	The latest data	0x3A	The last 10 data
0x31	The last 1 data	0x3B	The last 11 data
0x32	The last 2 data	0x3C	The last 12 data
0x33	The last 3 data	0x3D	The last 13 data
0x34	The last 4 data	0x3E	The last 14 data
0x35	The last 5 data	0x3F	The last 15 data
0x36	The last 6 data	0x40	The last 16 data
0x37	The last 7 data	0x41	The last 17 data
0x38	The last 8 data	0x42	The last 18 data
0x39	The last 9 data	0x43	The now black box data

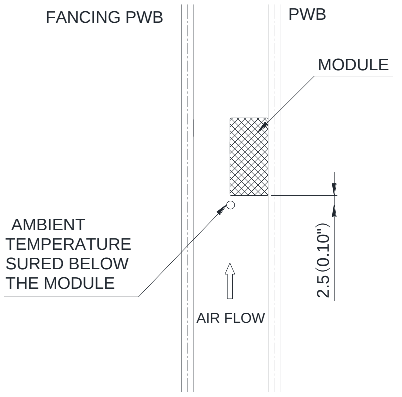
Thermal Testing Setup

Thermal management is an important part of the system design. To ensure proper, reliable operation, sufficient cooling of the power module is needed over the entire temperature range of the module. Convection cooling is usually the dominant mode of heat transfer.

Hence, the choice of equipment to characterize the thermal performance of the power module is a wind tunnel.

Delta's DC/DC power modules are characterized in heated vertical wind tunnels that simulate the thermal environments encountered in most electronics equipment. This type of equipment commonly uses vertically mounted circuit cards in cabinet racks in which the power modules are mounted.

The following figure shows the wind tunnel characterization setup. The power module is mounted on a 185mmX185mm,105μm (3Oz),6 layers test PWB and is vertically positioned within the wind tunnel. The space between the neighboring PWB and the top of the power module is constantly kept at 6.35mm (0.25'').



Note: Wind Tunnel Test Setup Figure Dimensions are in millimeters and (Inches)

Figure 17: Wind Tunnel Test Setup

Thermal Derating

Heat can be removed by increasing airflow over the module. To enhance system reliability, the power module should always be operated below the maximum operating temperature. If the temperature exceeds the maximum module temperature, reliability of the unit may be affected.

Thermal Curves (With Heat Spreader)

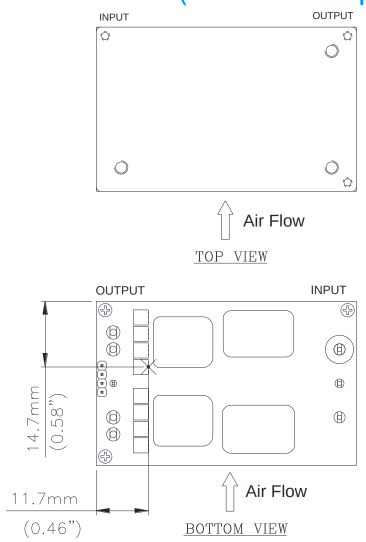


Figure 20: *Hot spot 2 temperature measurement location*
The allowed maximum hot spot 2 temperature is defined at 120℃.

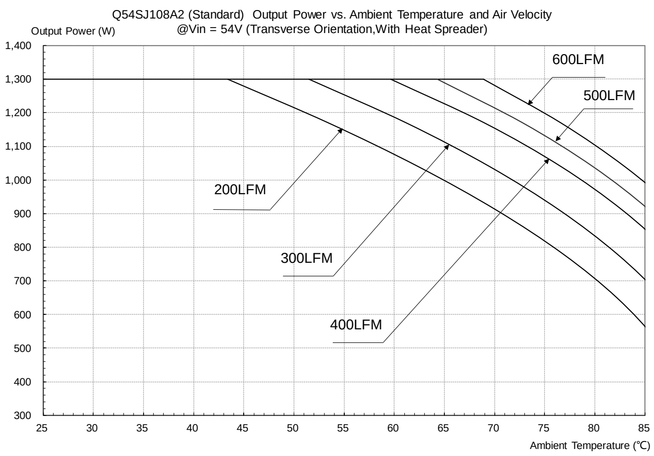


Figure 21: *Output Power vs. Ambient Temperature and Air Velocity @ Vin = 54V (Transverse Orientation, With Heat Spreader)*

Thermal Curves (With 0.5" Height Heat Sink)

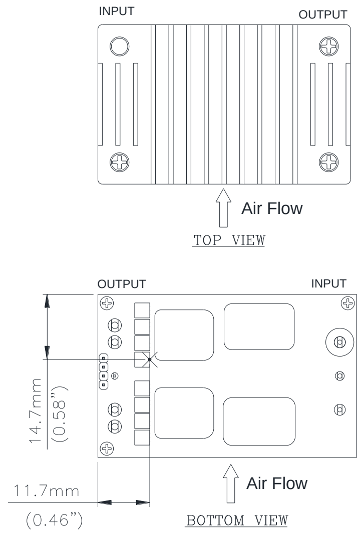


Figure 22: *Hot spot 3 temperature measurement location*
The allowed maximum hot spot 3 temperature is defined at 120℃.

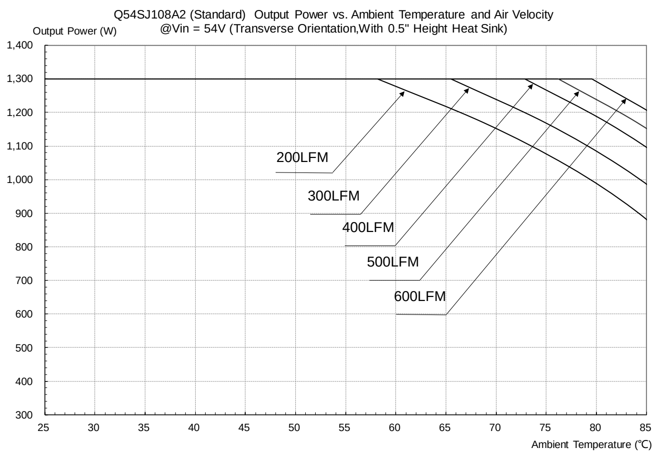
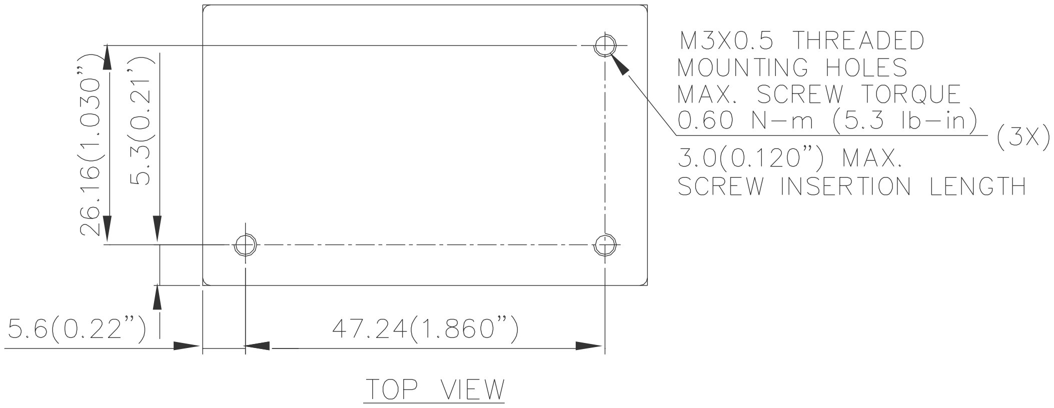
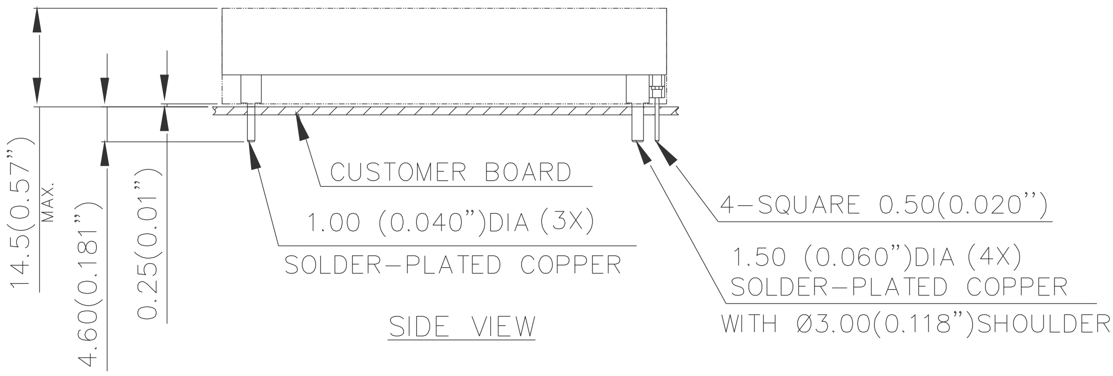
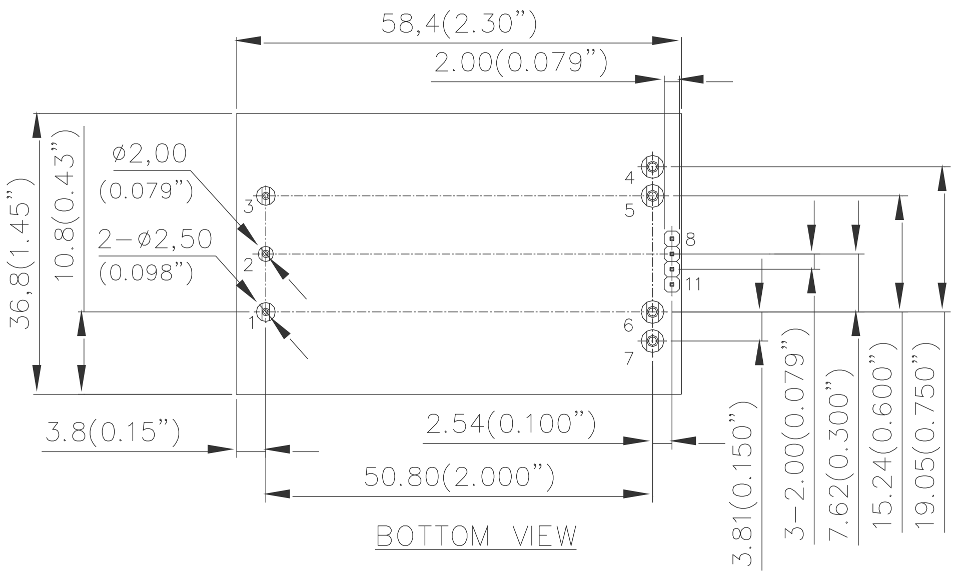


Figure 23: *Output Power vs. Ambient Temperature and Air Velocity @ Vin = 54V (Transverse Orientation, With 0.5" Height Heat Sink)*

Mechanical Drawing (With Baseplate)







Pin#	Function
1	VIN+
2	ON/OFF
3	VIN-
4	Vo-
5	Vo-
6	Vo+
7	Vo+
8	Data
9	ALERT
10	Clock
11	Addr

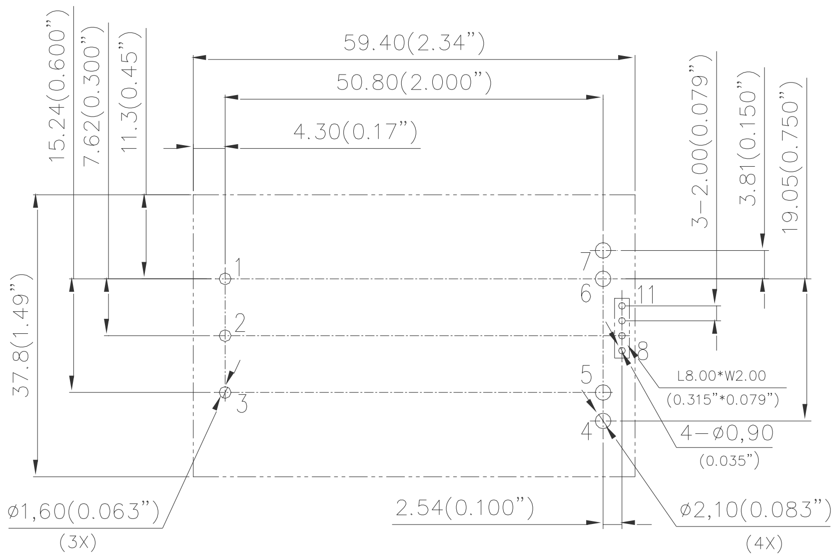
NOTES:
DIMENSIONS ARE IN MILLIMETERS AND (INCHES)
TOLERANCES: X.Xmm±0.5mm(X.XX in.±0.02 in.)
X.XXmm±0.25mm(X.XXX in.±0.010 in.)

Pin No.	Name	Function
1	Vin+	Positive input voltage
2	ON/OFF	Remote ON/OFF
3	Vin-	Negative input voltage
4	Vo-	Negative output voltage
5	Vo-	Negative output voltage
6	Vo+	Positive output voltage
7	Vo+	Positive output voltage
8	Data	PMBus data line
9	Alert	PMBus Alert line
10	Clock	PMBus clock line
11	Addr	PMBUS Address pin

Pin Specification:

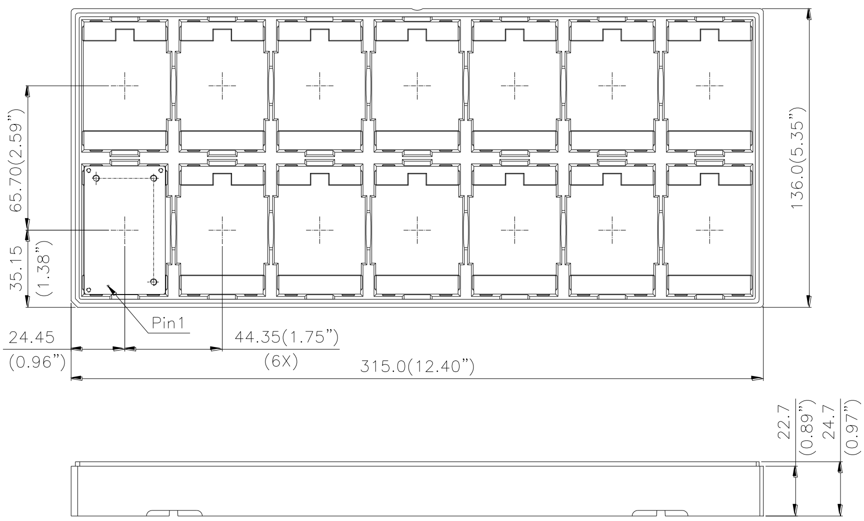
Pins 1,2,3	1.00mm (0.040") diameter; copper with matte Tin plating and Nickel under plating
Pins 4,5,6,7	1.50mm (0.060") diameter; copper with matte Tin plating and Nickel under plating
Pins 8~11	PMBus pins;Square 0.50mm (0.020"); copper with golden flash plating

Suggested Layout



Pin#	Function
1	VIN+
2	ON/OFF
3	VIN−
4	Vo−
5	Vo−
6	Vo+
7	Vo+
8	Data
9	ALERT
10	Clock
11	Addr

Packing Information (JEDEC Tray for Base Plate Version)



NOTES:
DIMENSIONS ARE IN MILLIMETERS AND (INCHES)
TOLERANCES: X.Xmm±0.25mm(X.XX in.±0.01 in.)
X.XXmm±0.15mm(X.XXX in.±0.006 in.)

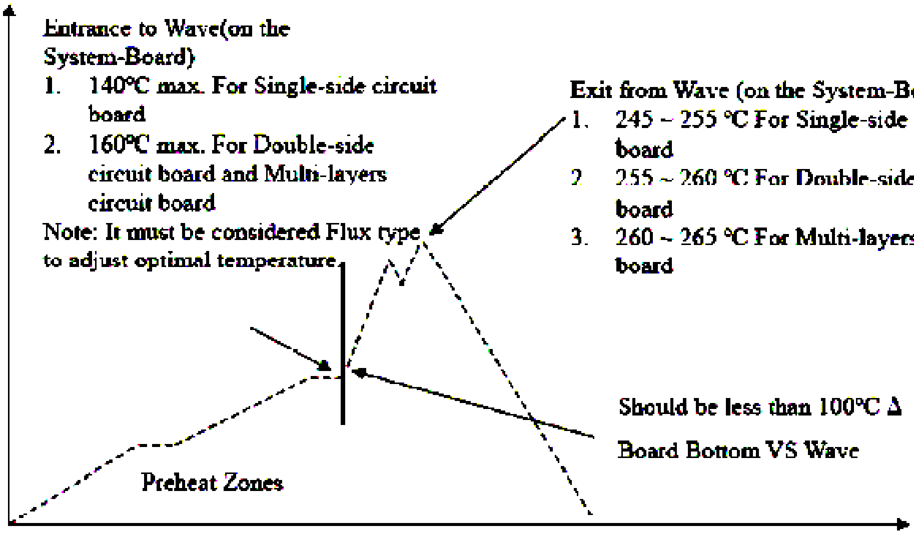
Soldering Method

Generally, as the most common mass soldering method for the solder attachment, wave soldering is used for through-hole power modules and reflow soldering is used for surface-mount ones. Delta recommended soldering methods and process parameters are provided in this document for solder attachment of power modules onto system board. SAC305 is the suggested lead-free solder alloy for all soldering methods.

Reflow soldering is not a suggested method for through-hole power modules due to many process and reliability concerns. If you have this kind of application requirement, please contact Delta sales or FAE for further confirmation.

Wave Soldering (Lead-free)

Delta's power modules are designed to be compatible with single-wave or dual wave soldering. The suggested soldering process must keep the power module's internal temperature below the critical temperature of 217 ℃ continuously. The recommended wave-soldering profile is shown in following figure.



Recommended Temperature Profile for Lead-free Wave Soldering
Note: The temperature is measured on solder joint of pins of power module.

The typical recommended (for double-side circuit board) preheat temperature is 115+/-10℃ on the top side (component side) of the circuit board. The circuit-board bottom-side preheat temperature is typically recommended to be greater than 135℃ and preferably within 100 ℃ of the solder-wave temperature. A maximum recommended preheat up rate is 3℃ /s. A maximum recommended solder pot temperature is 255+/-5℃ with solder-wave dwell time of 3~6 seconds. The cooling down rate is typically recommended to be 6℃/s maximum.

Hand Soldering (Lead Free)

Hand soldering is the least preferred method because the amount of solder applied, the time the soldering iron is held on the joint, the temperature of the iron, and the temperature of the solder joint are variable. The recommended hand soldering guideline is listed in Table 1. The suggested soldering process must keep the power module's internal temperature below the critical temperature of 217℃ continuously.

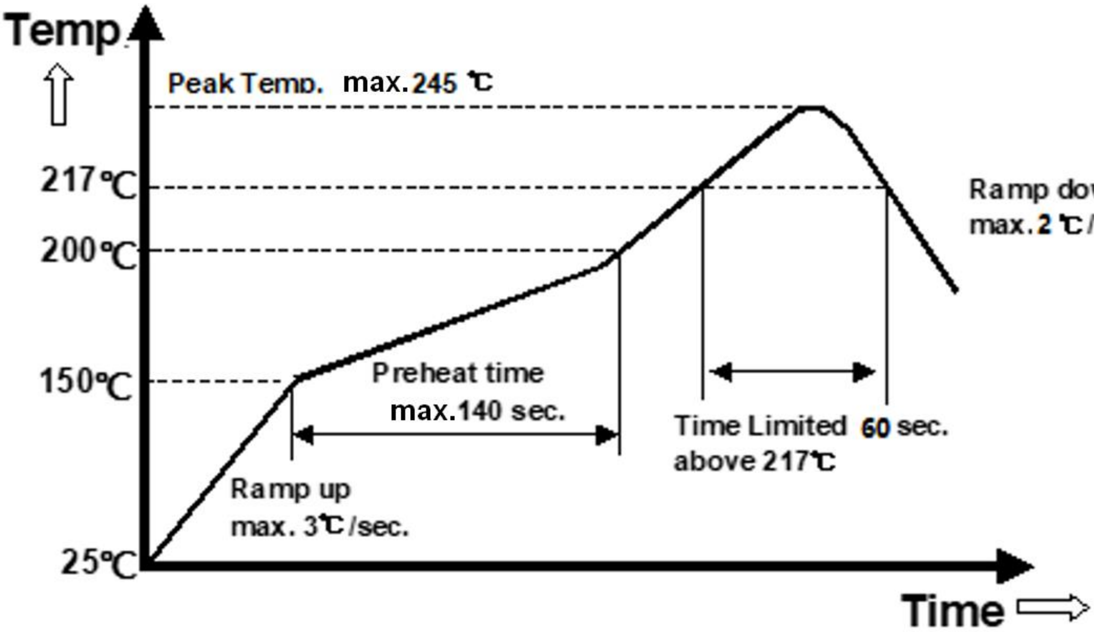
Table 1 Hand-Soldering Guideline

Parameter	Single-side Circuit Board	Double-side Circuit Board	Multi-layers Circuit Board
Soldering Iron Wattage Tip Temperature	90 385+/-10℃	90 420+/-10℃	90 420+/-10℃
Soldering Time	2 ~ 6 seconds	4 ~ 10 seconds	4 ~ 10 seconds

Reflow Soldering (Lead-free)

High temperature and long soldering time will result in IMC layer increasing in thickness and thereby shorten the solder joint lifetime. Therefore the peak temperature over 245℃ is not suggested due to the potential reliability risk of components under continuous high-temperature. In the meanwhile, the soldering time of temperature above 217℃ should be less than 60 seconds, and the cooling down rate should be less than 2℃/minutes. Please refer to following fig for recommended temperature profile parameters.

Shielding cap is requested to mount on DCDC module if with heat-spreader/heat-sink, to prevent the customer side high temperature of reflow to re-melt the DCDC module's internal component's soldering joint.



Note: The temperature is measured on solder joint of pins of power module.

PART NUMBERING SYSTEM

Q	54	S	J	108	A2	N	C	D	G
Type of Product	Input Voltage	Number of Outputs	Product Series	Output Voltage	Output Current	ON/OFF Logic	Pin Length /Type	Pin assignment	Option Code
Q - Quarter Brick	54 - 40~60V	S - Single	J - Series number	108 - 10.7V	A2 - 121A	N - Negative	C - 0.180” R - 0.170” N - 0.145”	D - With PMbus Pins; A - Without PMbus Pins P - With PMbus Pins & for PIH process	G - With base plate

RECOMMENDED PART NUMBER

Model Name	Input		Output		Peak Eff.
Q54SJ108A2NCDG	40V~60V	36A	10.7V	121A	97.5%

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WARRANTY
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