E50SN12051

600W Non-isolated 1/8th Brick DCDC Power Modules

Photo is for reference only

Features

Electrical

- Peak Efficiency up to 97.3% @54Vin
- PMBus communication
- Fully regulated output voltage
- Fully protected: Input UVLO. Output OVP, OCP and OTP
- Monotonic and pre-biased startup
- No minimum load required
- Non-isolated

Mechanical

- Size: 58.4x22.8x12.7mm

Safety & Reliability

- 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

Input voltage: 40~60V
Output Voltage: 12V
Output Power: 600W

Soldering Method

- Wave soldering
- Hand soldering
- Reflow soldering (MSL3)

Recommended Part Number

Model Name	Input		Output		Eff. @ 50% Load	Others
E50SN12051NKDB	40~60V	16A	12V	600W	97.3% @54Vin	Negative on/off
E50SN12051NNDB	40~60V	16A	12V	600W	97.3% @54Vin	Negative on/off

Part Numbering System

E	50	S	N	120	51	N	K	D (note)	B	F
Form Factor	Input Voltage	Number Of Outputs	Product Series	Output Voltage	Output current	ON/OFF Logic	Pin Length	Pin Assignment	Option Code	Customer Specific
E - Eighth Brick	50 - 40~60V	S - Single	N - Series Number	120 - 12.0V	51 - 51A	N – Negative R - Negative and compliant Reflow process	R - 0.170" N - 0.145" K - 0.110" M - SMD	D - Digital pins A - Analog pins	B- With baseplate	Omit - Standard F - Halogen free

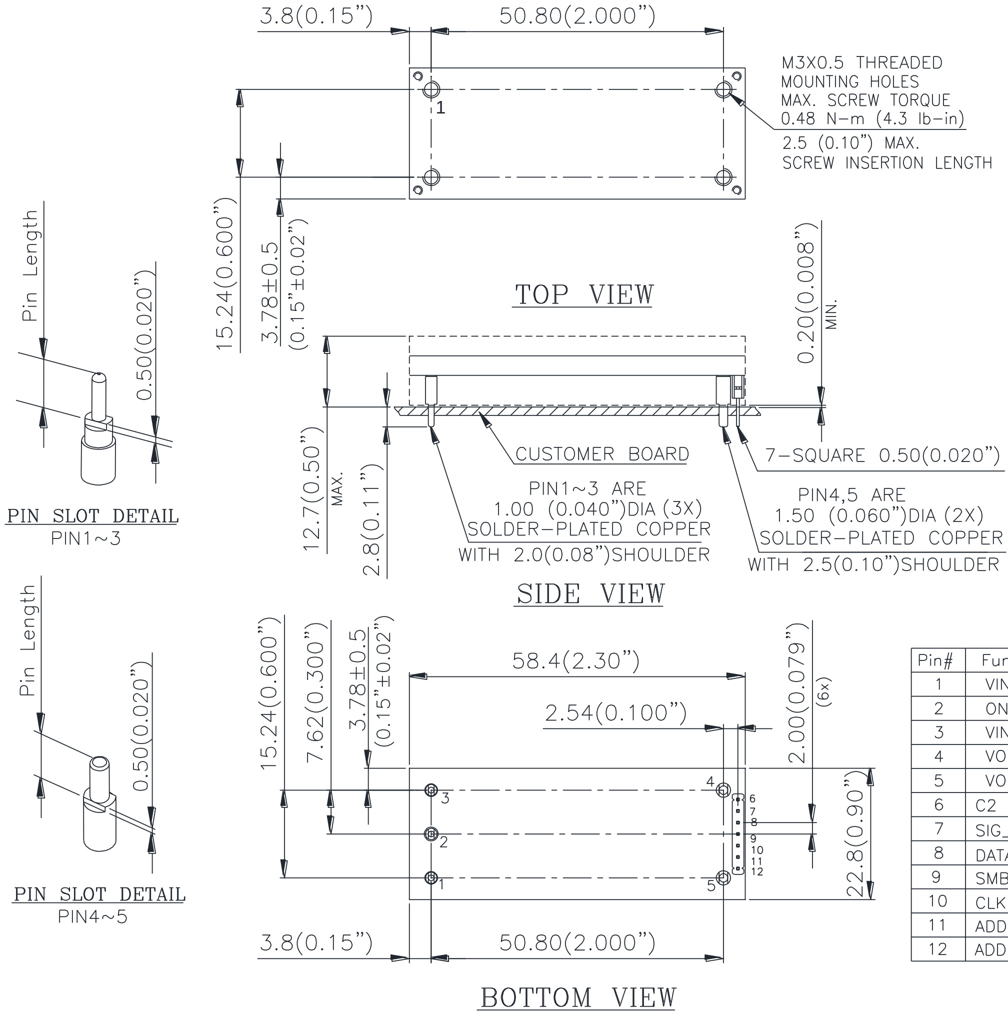
Note:
1. A - Analog pins: without digital pins (pin6~12)
2. D - Digital pins: with digital pins (pin6~12)
3. SMD version without digital pin(pin6~12)

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

PARAMETER	NOTES and CONDITIONS	Min.	Typ.	Max.	Units
ABSOLUTE MAXIMUM RATINGS					
Input Voltage					Vdc
Continuous		0		70	Vdc
Transient	100mS			75	Vdc
Operating Ambient Temperature (Ta)		-40		85	°C
Storage Temperature		-55		125	°C
INPUT CHARACTERISTICS					
Operating Input Voltage		40	54	60	Vdc
Input Under-Voltage Lockout					
Turn-On Voltage Threshold		38	39	40	Vdc
Turn-Off Voltage Threshold		36	37	38	Vdc
Lockout Hysteresis Voltage			2		Vdc
Maximum Input Current	Full Load, $40V_{in}$			17	A
No-Load Input Current	V_{in}=54V, I_o=0A		100		mA
Off Converter Input Current	V_{in}=54V		15		mA
Input Terminal Ripple current	RMS, with 100uF input cap		100		mArms
OUTPUT CHARACTERISTICS					
Output Voltage Set Point	Vin=54V, Io=Open Load, Tc=25°C		12.20		Vdc
	Vin=54V, Io=Full Load, Tc=25°C		11.80		Vdc
Output Regulation					
Load Regulation	V_{in}=54V, I_o=I_o min to I_o max		400		mV
Line Regulation	V_{in}=40V to 60V, I_o=full load		2		%Vo,set
Temperature Regulation	T_a= -40°C to 85°C	-1	0	1	%Vo,set
Total Output Voltage Range	Over sample load, line and temperature	11.6		12.4	V
Output Voltage Ripple and Noise	5Hz to 20MHz bandwidth				
Peak-to-Peak	Full Load, Co=1000uF, 1µF ceramic, 10µF tantalum		85	120	mV
RMS	Full Load, Co=1000uF, 1µF ceramic, 10µF tantalum		25	50	mV
Operating Output Current Range		0		51	A
Output Over Current Protection(hiccup mode)	when V_o<10%$V_{o.nom}$	110	120	130	%Io,max
Output Over Voltage Protection(hiccup mode)			15.6		V
DYNAMIC CHARACTERISTICS					
Output Voltage Current Transient	Co=1000 µF, 1A/µs				
Positive Step Change in Output Current	75% $I_{o.max}$ to 50% $I_{o.max}$		180		mV
Negative Step Change in Output Current	50% $I_{o.max}$ to 75% $I_{o.max}$		180		mV
Settling Time (within 1% nominal V_{out})			200		µs
Turn-On Delay Time					
Start-Up Delay Time From Input Voltage	On/Off=On, from V_{in}=Turn-on Threshold to V_o=10% $V_{o,nom}$		125		mS
Start-Up Delay Time From On/Off Control	V_{in}=$V_{in,nom}$, from On/Off=On to V_o=10% $V_{o,nom}$		10		mS
Output Voltage Rise Time	V_o=10% to 90% $V_{o,nom}$	5		15	mS
Output Capacitance Range	20% ceramic, 80% Oscon or AL	1000		5000	µF
EFFICIENCY					
Half Load Efficiency	50% Load @Vin=54Vdc		97.3		%
Full Load Efficiency	100% Load @Vin=54Vdc		96.5		%
FEATURE CHARACTERISTICS					
Switching Frequency	V_{in}=40~60V		250		KHz
On/Off Control					
Logic Low	$V_{on/off}$			0.8	V
Logic High	$V_{on/off}$	2.4		20	V
ON/OFF Current	Ion/off at Von/off=0.0V			0.3	mA
Leakage Current	Logic High, Von/off=15V	10		500	uA
Voltage when floating	On/off pin un-connected		3		V
GENERAL SPECIFICATIONS					
MTBF	I_o=80% of $I_{o, max}$; T_a=25°C		5.3		Mhours
Weight	With Base-plate		45		grams
Over-Temperature Shutdown (With Base-plate)	Refer to Figure 17 for Hot spot 1 location ($54V_{in}$, 80% I_o, 200LFM,Airflow from V_{in-} to V_{in+})		132		°C
Over-Temperature Shutdown (With 0.5" Height Heat Sink ETL050A)	Refer to Figure 19 for Hot spot 2 location ($54V_{in}$, 80% I_o, 200LFM,Airflow from V_{in-} to V_{in+})		132		°C
Over-Temperature Shutdown (NTC Resistor)	*Note		135		°C
Note: Please attach thermocouple on NTC resistor to test OTP function, the hot spots' temperature is just for reference.					
PMBUS SIGNAL INTERFACE CHARACTERISTICS					
Logic Input Low (V_{IL})	Data, SMBAlert, Clock pin	0		0.8	V
Logic Input High (V_{IH})	Data, SMBAlert, 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		400	KHz
PMBUS MONITORING CHARACTERISTICS					
Output Current Reading Accuracy	Vin=54V, Io=50% ~ 100% of Io, max;	-10		+10	%
	Vin=54V, Io=5% ~ 50% of Io, max;	-5		+5	A
Output Voltage Reading Accuracy		-2		+2	%
Input Voltage Reading Accuracy		-4		+4	%
Temperature Reading Accuracy		-5		+5	℃

E-mail: dcdc@deltaww.com
http://www.deltaww.com/dcdc

Mechanical Drawing (Through hole pin)

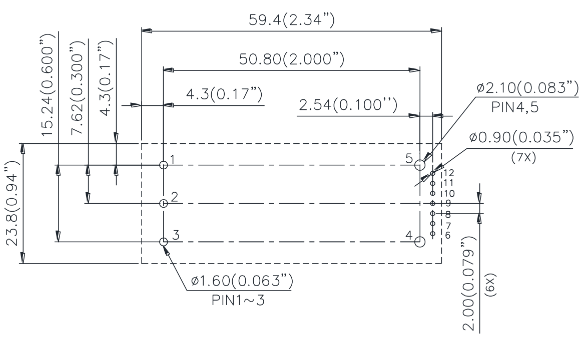


Pin#	Function
1	VIN(+)
2	ON/OFF
3	VIN(−)
4	VOUT(−)
5	VOUT(+)
6	C2
7	SIG_GND
8	DATA
9	SMBALERT
10	CLK
11	ADDR1
12	ADDR0

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.)

Recommended Layout

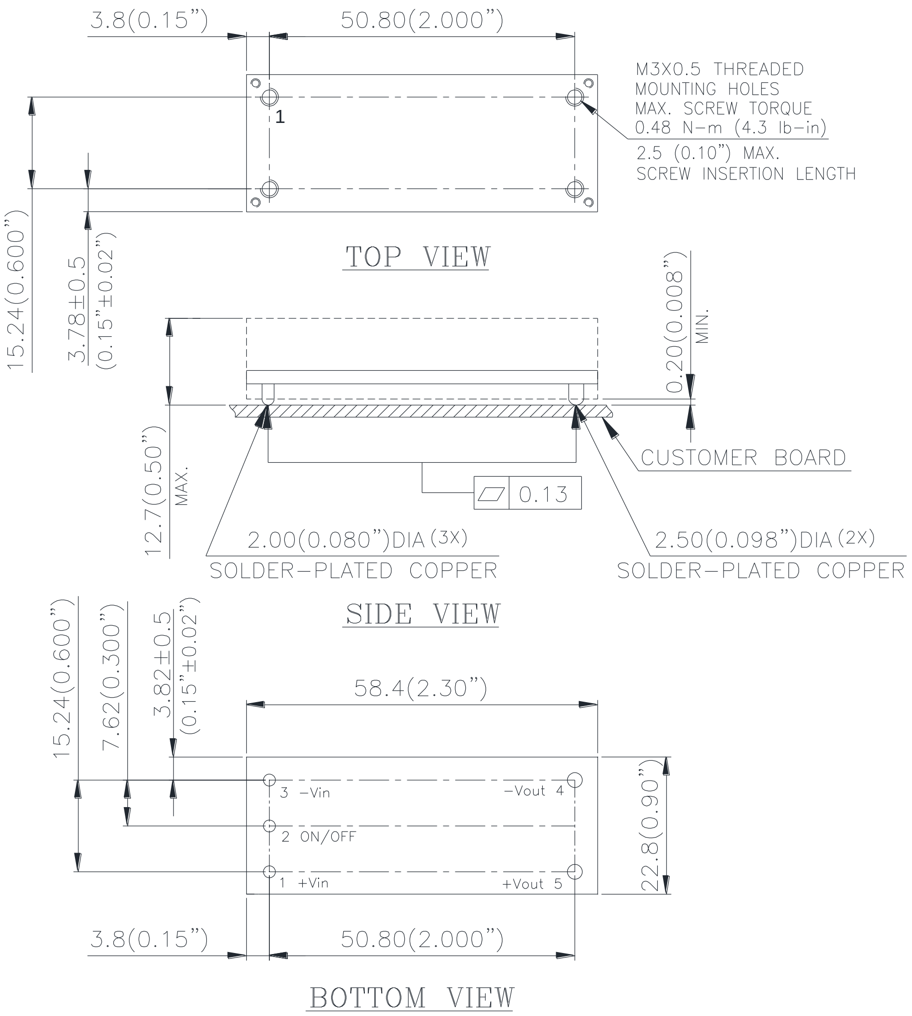
RECOMMENDED P.W.B. PAD LAYOUT



Pin#	Function
1	VIN(+)
2	ON/OFF
3	VIN(−)
4	VOUT(−)
5	VOUT(+)
6	C2
7	SIG_GND
8	DATA
9	SMBALERT
10	CLK
11	ADDR1
12	ADDR0

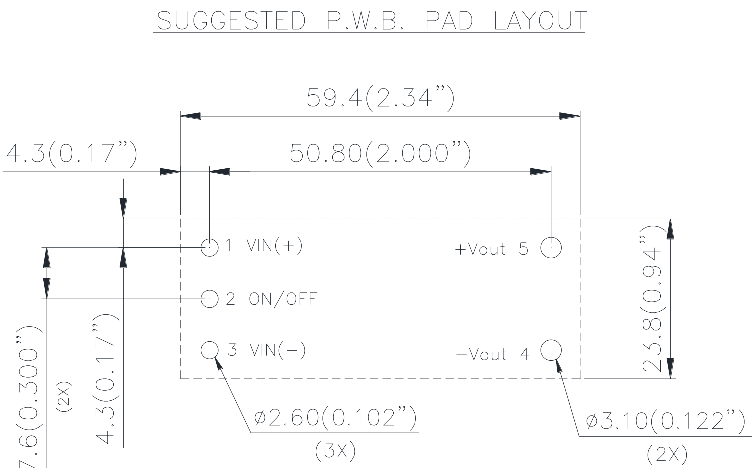
NOTES:
DIMENSIONS ARE IN MILLIMETERS AND (INCHES)
TOLERANCES: X.Xmm±0.5mm(X.XX in.±0.02 in.)
X.XXmm±0.25mm(X.XXX in.±0.010 in.)

Mechanical Drawing (SMD pin)



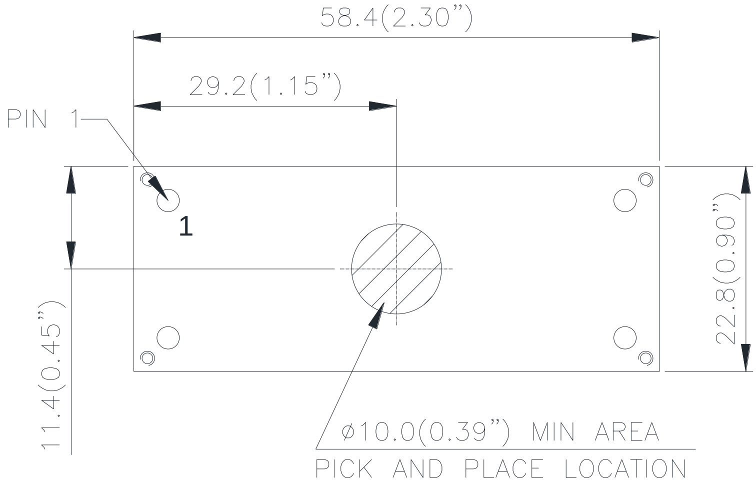
NOTES:
DIMENSIONS ARE IN MILLIMETERS AND (INCHES)
TOLERANCES: X.Xmm±0.5mm(X.XX in.±0.02 in.)
X.XXmm±0.25mm(X.XXX in.±0.010 in.)

Recommended Layout



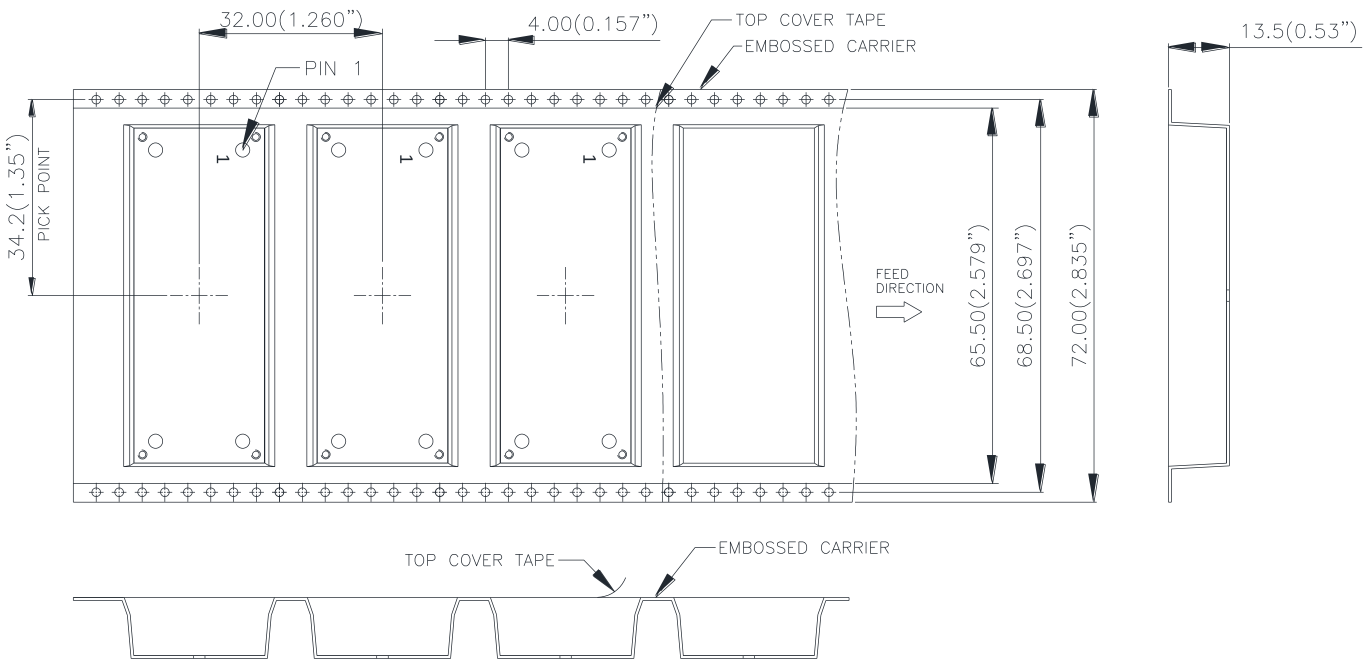
NOTES:
DIMENSIONS ARE IN MILLIMETERS AND (INCHES)
TOLERANCES: X.Xmm±0.5mm(X.XX in.±0.02 in.)
X.XXmm±0.25mm(X.XXX in.±0.010 in.)

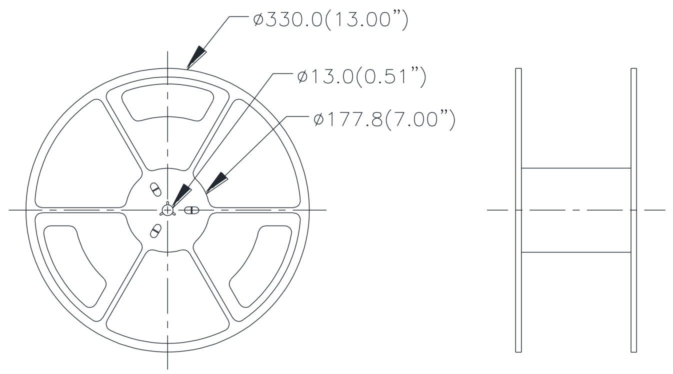
Pick and Place Location for SMD Version



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.)

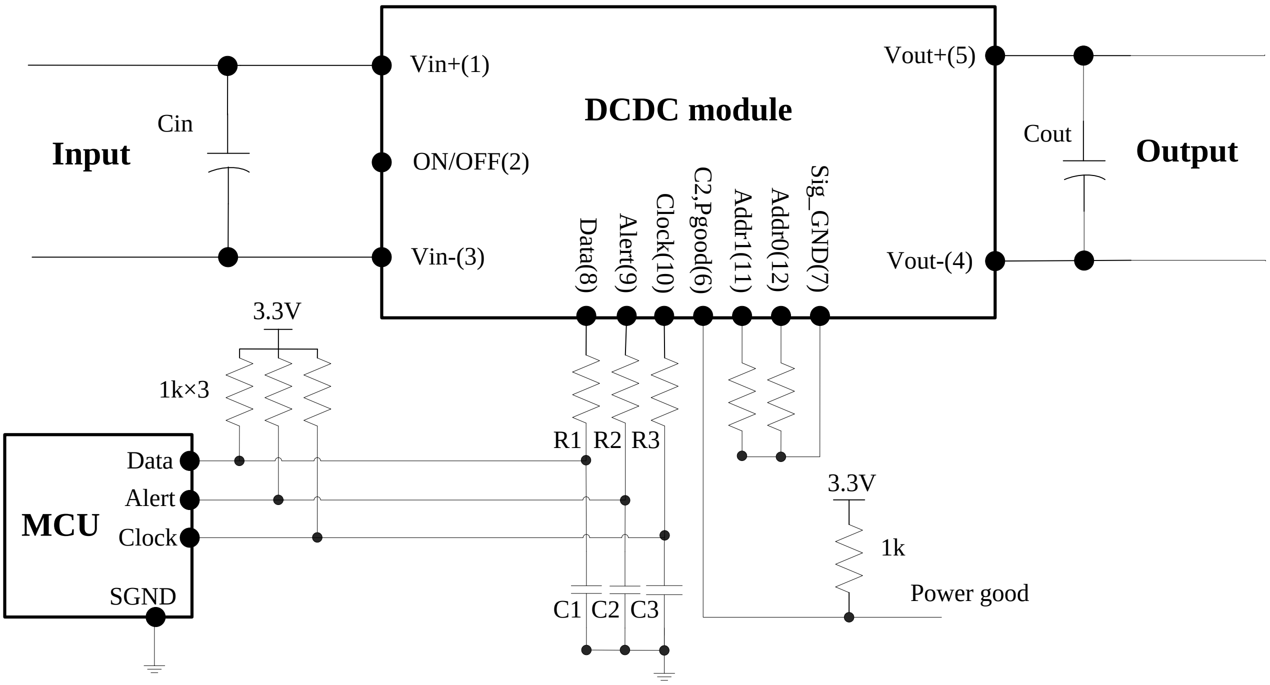
Surface-Mount Tape & Reel





NOTES:
CONFORMS TO EIA-481 SATNDARD
MODULES ARE SHIPPED IN QUANTITIES OF 100 PER REEL.
ALL 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.)

Typical Application Schematic



R1/R2/R3/C1/C2/C3 value are 49.9ohm/49.9ohm/49.9ohm /10p/10p/10p, and should be close to brick in application.

Position	Vendor P/N	Description	QTY	Vendor	Note
Cin	PCR1K470MCL1GS	80V/47uF/10*10	2	Nichicon	Near to the Vin+ and Vin- pin of the Module
	/	100V/2.2uF/X7R/1206/MLCC	3	/	
Cout	/	16V/22uF/X7R/1206/MLCC	6	/	Near to the Vo+ and Vo- pin of the Module
	PCR1C102MCL1GS	16V/1000uF/10*12.7	1	Nichicon	

T_A=25°C

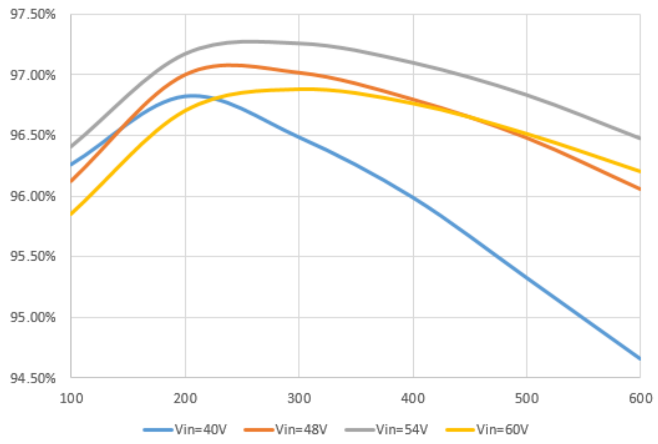


Figure 1: Efficiency vs. Output Power

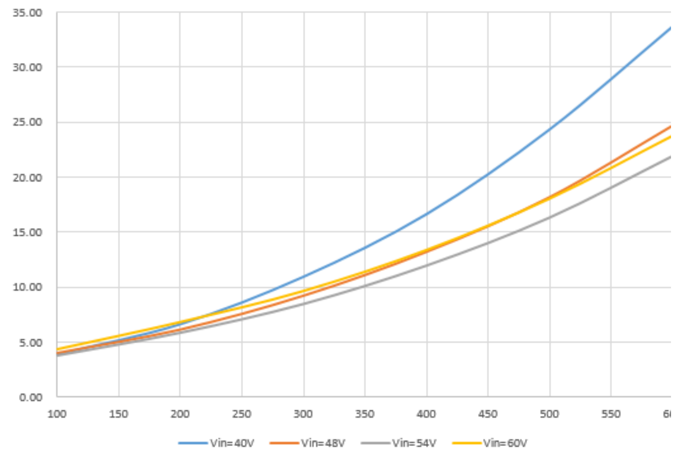


Figure 2: Loss vs. Output Power

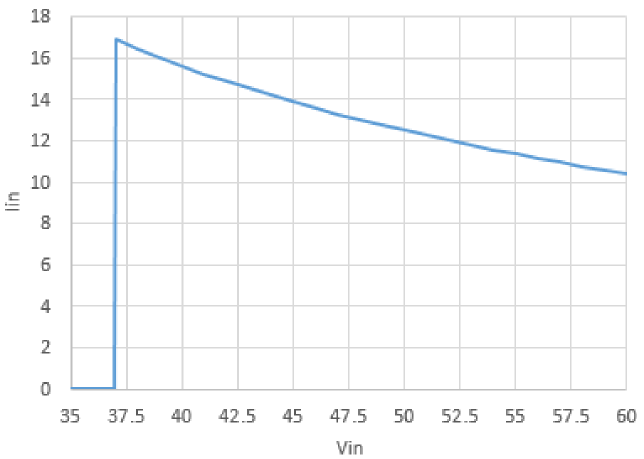


Figure 3: Full Load Input Characteristics

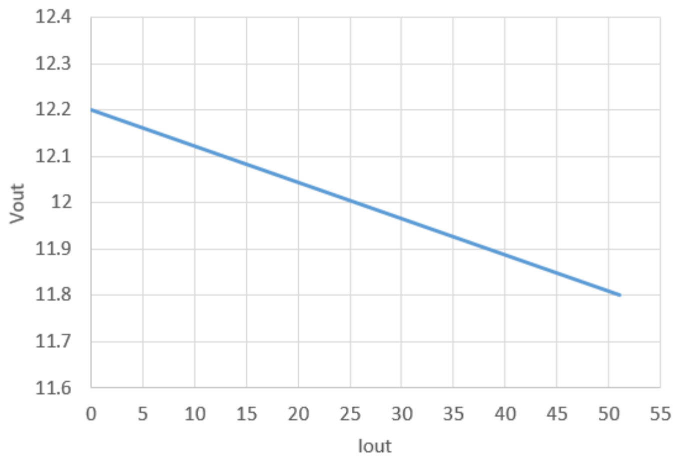


Figure 4: Output Voltage vs. Load Current

T_A=25°C,

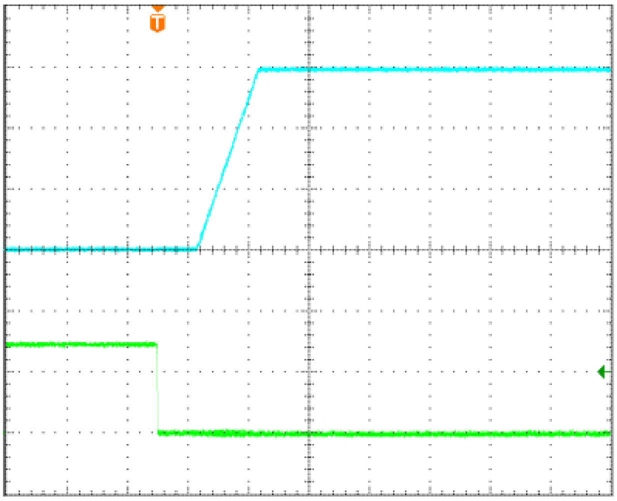


Figure 5: Remote On/Off (negative logic) at full load
Vin=54V, $I_{out} = I_{o,\ max}$
Time: 10ms/div.
V_{out} (top trace): 4V/div;
$V_{remote\ On/Off\ signal}$ (bottom trace): 2V/div.

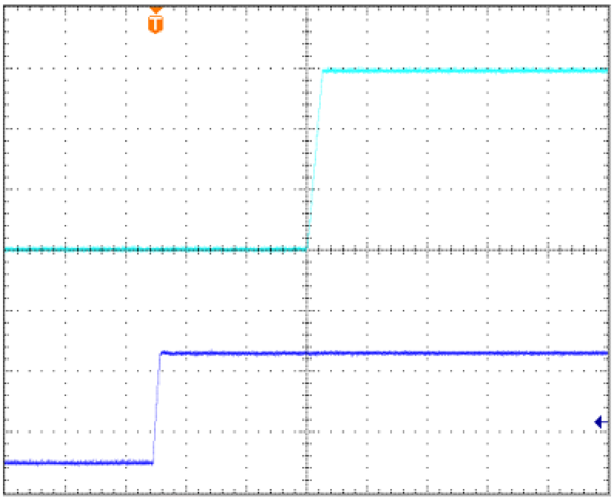


Figure 6: Input Voltage Start-up at full load
Vin=54V, $I_{out} = I_{o,\ max}$
Time: 40ms/div.
V_{out} (top trace): 4V/div;
V_{in} (bottom trace): 30V/div.

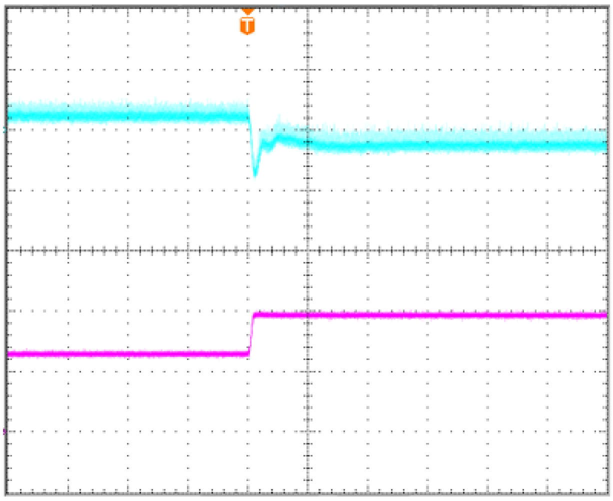


Figure 7: Transient Response
(Vin=54V, 1A/µs step change in load from 50% to 75% of Io, max) Vout (top trace): 0.2 V/div, 200us/div;
Iout (bottom trace): 20A/div.
Scope measurement should be made using a BNC cable (length shorter than 20 inches). Position the load between 51 mm to 76 mm (2 inches to 3 inches) from the module

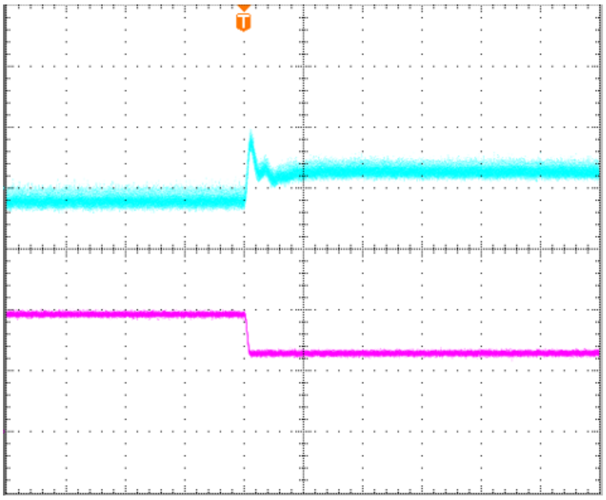


Figure 8: Transient Response
(Vin=54V, 1A/µs step change in load from 75% to 50% of $I_{o,\ max}$)
V_{out} (top trace):0.2V/div, 400us/div;
Iout (bottom trace): 20A/div.
Scope measurement should be made using a BNC cable (length shorter than 20 inches). Position the load between 51 mm to 76 mm (2 inches to 3 inches) from the module

T_A=25°C, V_{in}=54Vdc

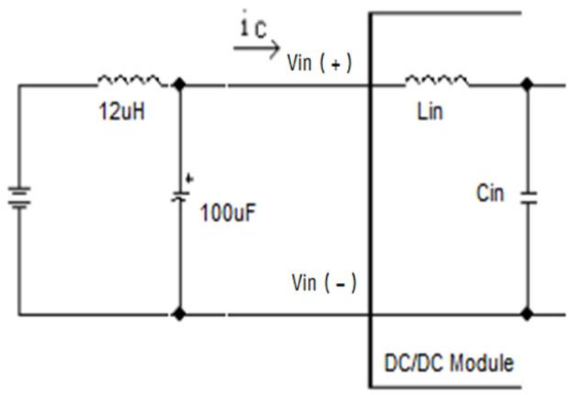


Figure 9: Test Setup Diagram for Input Ripple Current
Note: Measured input reflected-ripple current with a simulated source Inductance of 12μH. Measure current as shown above.

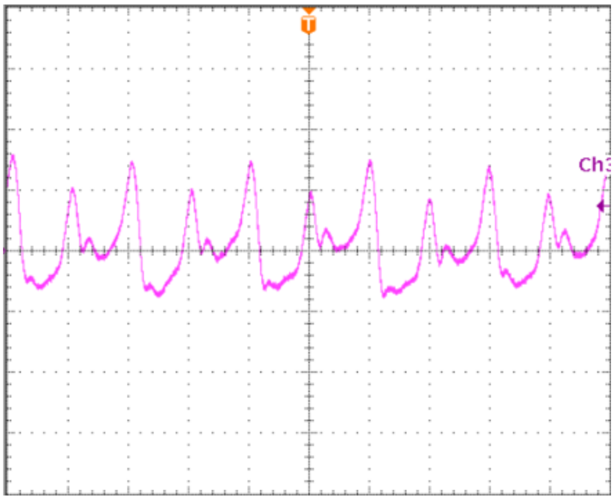


Figure 10: Input Terminal Ripple Current, i_c, at max output current and nominal input voltage with 12μH source impedance and 100μF electrolytic capacitor (100 mA/div, 2us/div).

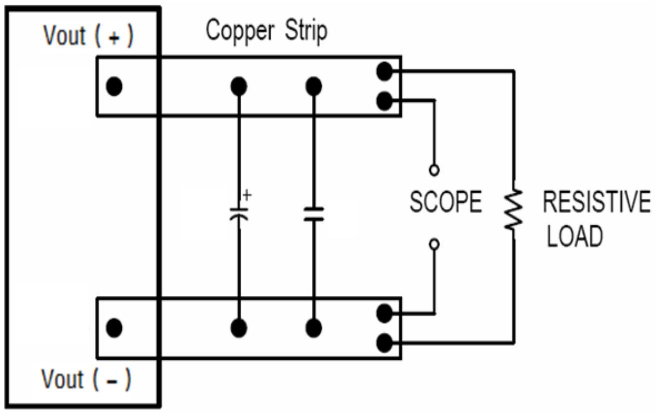


Figure 11: Test Setup for Output Voltage Noise and Ripple

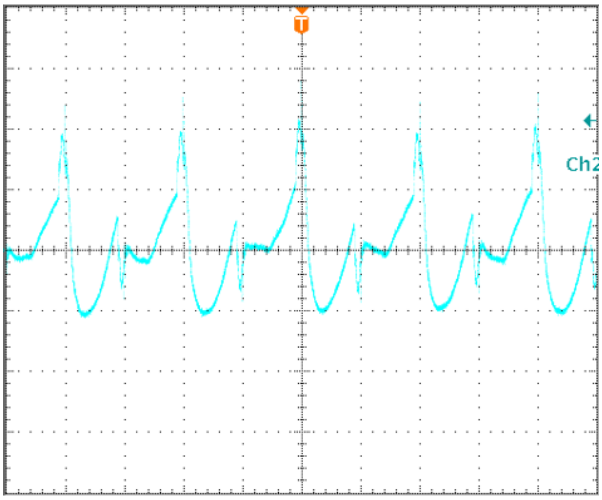


Figure 12: Output Voltage Ripple and Noise at nominal input voltage and max load current (20 mV/div, 2us/div)
Load cap: 1000uF, 20% ceramic, 80% Oscon.

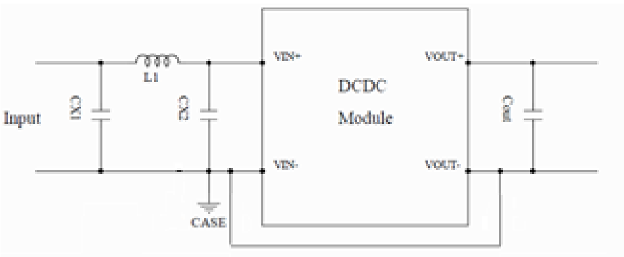
Input Source Impedance

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 100µF (ESR < 0.7Ω 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.

Schematic and Components List



Location	Component
CX1	2.2uf *2
L1	CMLS136E-3R3MS / CYNTEC
CX2	100uf/100V+2.2uf*3

Figure 13-1: Recommended Input Filter

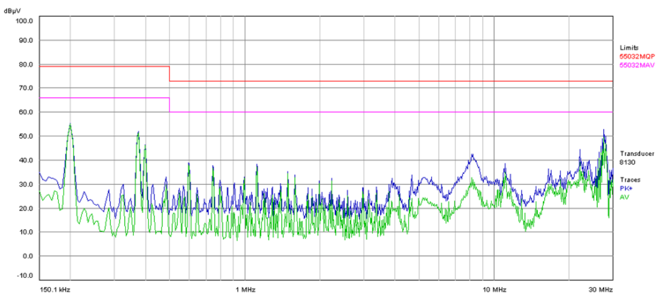


Figure 13-2: Test Result of EMC (Vin=54V, Io=51A).

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., IEC 62368-1: 2014 (2nd edition), EN 62368-1: 2014 + A11: 2017, UL 62368-1, 2nd Edition, 2014-12-01 and CSA C22.2 No. 62368-1-14, 2nd Edition, 2014-12. IEC 60950-1: 2005, 2nd Edition + A1: 2009 + A2: 2013, EN 60950-1: 2006 + A11: 2009 + A1: 2010 + A12: 2011 + A2: 2013, UL 60950-1, 2nd Edition, 2019-05-09 and CSA C22.2 No. 60950-1-07, 2nd Edition, 2014-10, if the system in which the power module is to be used must meet safety agency requirements.

For IEC/EN/UL/CSA 60950-1:
DC input and DC output are considered as SELV circuits, functional insulation is investigated between input circuit and output circuit.
DC input is considered as SELV circuit, double/reinforced insulation shall be provided between SELV circuit and AC mains/Primary circuit.

For IEC/EN/UL/CSA 62368-1:
DC input and DC output are considered as ES1 circuit, functional insulation is investigated between input circuit and output circuit.
DC input is considered as ES1, double/reinforced safeguard shall be provided between ES1 and MAINS.

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 fast-blow fuse with 30A 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 Vin (-) terminal. The switch can be an open collector or open drain. For negative logic if the remote on/off feature is not used, please short the on/off pin to Vin (-). The DC level on/off signal is suggested.

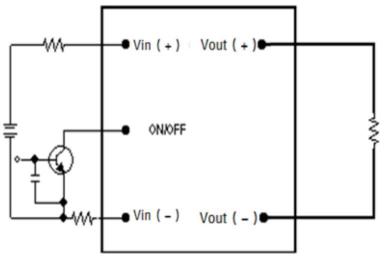


Figure 14: Remote On/Off Implementation

Over-Current Protection

The modules include an internal output over-current protection circuit, which will endure current limiting for an unlimited duration during output overload. If the output current exceeds the OCP set point, the modules will shut down (hiccup mode). The modules will try to restart after shutdown. If the overload condition still exists, the module will shut down again. This restart trial will continue until the overload condition is corrected.

Over-Voltage Protection

The modules include an internal input over-voltage protection circuit, which monitors the voltage on the input terminals. If this voltage exceeds the over-voltage set point, the protection circuit will shut down, and then restart with a time delay after the fault no long exist.

Over-Temperature Protection

The over-temperature protection consists of circuitry that provides protection from thermal damage. If the temperature exceeds the over-temperature threshold the module will shut down. The module will restart after the temperature is within specification.

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 5 PMBus signal lines, Data, Clock, SMBALERT (optional), and 2 Address line Addr0 and Addr1. 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 . Both 100kHz and 400kHz bus speeds are supported by the module. Bus free time between Stop and Start Condition must be more than 200us. 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.

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 line is also a wired-AND signal; by which the module can alert the PMBUS master via pulling the SMBALERT pin to an active low. There are two ways that the master and the module response to the alert of SMBALERT line.

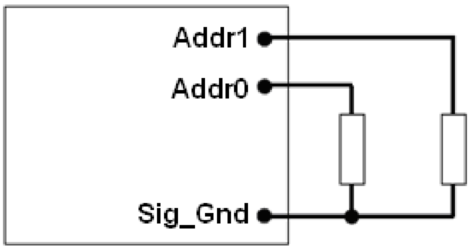
One way is for the module used in a system that does not support Alert Response Address (ARA). The module is to retain its resistor programmed address, when it is in an ALERT active condition. The master will communicate with the slave module using the programmed address, and using the various READ_STATUS commands to find who cause for the SMBALERT. The CLEAR_FAULTS command will clear the SMBALERT.

The module contains a data flash used to store configuration settings, which will not be programmed into the device data flash automatically. The STORE_DEFAULT_ALL command must be used to commit the current settings are transfer from RAM to data flash as device defaults.

PMBUS Addressing

The Module has flexible PMBUS addressing capability. When connect different resistor from Addr0 and Addr1 pin to GND pin, 64 possible addresses can be acquired. The address is in the form of decimal digits; Each pin offers one decimal digit, and then combine together to form the decimal address as shown in below.

Address = 8 * ADDR1 + ADDR0



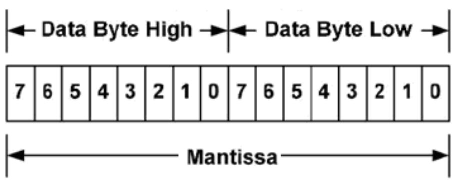
Corresponded to each decimal digit, the requested resistor values are shown in below, and +/-1% resistors accuracy can be accepted. If there are any resistances exceeding the requested range, address 126 will be return. 0-12 and 40, 44, 45, 55 and 63 in decimal address can't be used, since they are reserved according to the SMBus specifications, and which will also return address 126.

Octal digit	Resistor(Kohm)
0	10
1	15.4
2	23.7
3	36.5
4	54.9
5	84.5
6	130
7	200

PMBus Data Format

The module receives and report date in LINEAR format. The Exponent of the data words is fixed at a reasonable value for the command; altering the exponent is not supported. DIRECT format is not supported by the module.

For commands that set or report any voltage thresholds related to 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 -9. The format of the two data bytes is shown below:



The equation can be written as:

Vout = Mantissa x 2^{-9}

For example, considering set Vout to 12V by VOUT_COMMAND, the read/write data can be calculated refer to below process:

1. Mantissa =Vout/2^{-9}= 12/2^{-9}=6144;
2. Converter the calculated Mantissa to hexadecimal 0xC000.

E-mail: dcdc@deltaww.com
http://www.deltaww.com/dcdc

For example, considering set the turn on threshold of input under voltage lockout to 34V by VIN_ON command; the read/write data can be calculated refer to below process:

1. Get the exponent of Vin, -3; whose binary is 11101
2. Mantissa =Vin/2^{-3}=34/2^{-3}=272;
3. Converter the calculated Mantissa to hexadecimal 110, then converter to binary 00100010000;
4. Combine the exponent and the mantissa, 11101 and 00100010000;
5. Converter binary 1110100100010000 to hexadecimal E910.

The detail exponent and resolution of main parameter is summarized as below:

	Exponent	Resolution
Vin	-3	0.125V
Vo	-9	19.53mV
Io	-4	62.5mA
Temperature	-2	/
Switching frequency	-2	1Khz
Time	-1	0.5ms

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 difference with the definition in PMBus 1.2 specification. All the supported PMBus commands are detail summarized in below table.

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 difference with the definition in PMBus 1.2 specification. All the supported PMBus commands are detail summarized in below table.

Command	Command Code	Command description	Transfer type	Compatible with standard PMBUS or not?	Data Format	Default value	Range limit	Data units	Expon -ent	Note
OPERATION	0x01	Turn on or off	R/W byte	Refer to below description;	Bit field	0x80	/	/	/	/
ON_OFF_CONFIG	0x02	Configures primary on/off & command	R/W byte	Yes	Bit field	0x1D	/	/	/	0x1D (Neg Logic); 0x1F (Pos Logic);
CLEAR_FAULTS	0x03	Clear any fault bits that have been set	Send byte	Yes	/	/	/	/	/	/
WRITE_PROTECT	0x10	Control writing to the PMBUS device.	R/W byte	Yes	/	0x80	/	/	/	To protect 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. This command is effective to the parameter of all command in the table except 0xEC
RESTORE_DEFAULT_ALL	0x12	Restores operating parameters from data flash to RAM	Send byte	Yes	/	/	/	/	/	This command can't be issued when the power unit is running.
PMBUS_CMD_CAPABILITY	0x19	Read the PMBUS capability	Read byte	Yes	/	0xB0	/	/	/	Only for E50SN12051NKDHF
VOUT_MODE	0x20	Read Vo data format	Read byte	Yes	mode+exp	0x17	/	/	/	/
VOUT_COMMAND	0x21	Read the output voltage	Read word	Yes	Vout Linear	12.2	/	V	-9	/
FREQUENCY_SWITCH	0x33	Read the switching frequency	Read word	Yes	Frequency linear	250	/	KHz	-2	/
VIN_ON	0x35	Read the turn on voltage threshold of Vin under voltage lockout	R/W word	Yes	Vin Linear	39	38~40	V	-3	VIN_ON should be higher than VIN_OFF, and keep 2V hysteresis.
VIN_OFF	0x36	Read the turn off voltage threshold of Vin under voltage lockout	R/W word	Yes	Vin Linear	37	36~38	V	-3	VIN_ON should be higher than VIN_OFF, and keep 2V hysteresis.
VOUT_OV_FAULT_LIMIT	0x40	Set the output overvoltage fault threshold.	R/W word	Yes	Vout Linear	15.6	13~17	V	-9	Must be higher than the value of VOUT_COMMAND and VOUT_OV_WARN_LIMIT;
VOUT_OV_WARN_LIMIT	0x42	Set a threshold causing an output voltage high warning.	R/W word	Yes	Vout Linear	13	13~17	V	-9	Must be the same or less than VOUT_OV_FAULT_LIMIT value
IOUT_OC_FAULT_LIMIT	0x46	Set the output overcurrent fault threshold.	R/W word	Yes	Iout Linear	60	25~60	A	-4	Must be greater than IOUT_OC_WARN_LIMIT value Write Only for E50SN12051NKDHF Read for E50SN12051 series all parts.
IOUT_OC_WARN_LIMIT	0x4A	Set a threshold causing an output current high warning.	R/W word	Yes	Iout Linear	56	25~60	A	-4	Must be less than IOUT_OC_FAULT_LIMIT value
OT_FAULT_LIMIT	0x4F	Set the over temperature fault threshold.	R/W word	Yes	TEMP Linear	135	25~135	℃	-2	Must be greater than OT_WARN_LIMIT value

Command	Command Code	Command description	Transfer type	Compatible with standard PMBUS or not?	Data Format	Default value	Range limit	Data units	Expon -ent	Note
OT_WARN_LIMIT	0x51	Set a threshold causing a temperature high warning.	R/W word	Yes	TEMP Linear	120	25~135	℃	-2	Must be less than OT_FAULT_LIMIT value
VIN_OV_FAULT_LIMIT	0x55	Set the input overvoltage fault threshold	R/W word	Yes	Vin Linear	80	60~80	V	-3	Only for E50SN12051NKDHF
VIN_OV_FAULT_RESPONSE	0x56	Instructs what action to take in response to an input overvoltage fault.	R/W word	Yes	Bit field	0xF8	/	/	/	Only for E50SN12051NKDHF
POWER_GOOD_ON	0x5E	Sets the output voltage at which the bit 3 of STATUS_WORD high byte should be asserted.	Read word	Yes	Vout Linear	11	/	V	-9	Must be greater than POWER_GOOD_OFF value
POWER_GOOD_OFF	0x5F	Sets the output voltage at which the bit 3 of STATUS_WORD high byte should be negated.	Read word	Yes	Vout Linear	10	/	V	-9	Must be less than POWER_GOOD_ON value
TON_DELAY	0x60	Sets the time from input voltage condition is received until the output voltage starts to rise	R/W word	Yes	Time Linear	3	3~75	ms	-1	/
TON_RISE	0x61	Sets the time from the output starts to rise until the voltage has entered the regulation band.	Read word	Yes	Time Linear	10	/	ms	-1	/
STATUS_WORD	0x79	Returns the information with a summary of the module's fault/warning	R/W 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	/	/	V	-3	/
READ_VOUT	0x8B	Returns the output voltage of the module	Read word	Yes	Vout Linear	/	/	V	-9	/
READ_IOUT	0x8C	Returns the output current of the module	Read word	Yes	Iout Linear	/	/	A	-4	/
READ_TEMPERATURE_1	0x8D	Returns the module's hot spot temperature of the module	Read word	Yes	TEMP Linear	/	/	℃	-2	/
PMBUS_REVISION	0x98	Reads the revision of the PMBus	Read byte	Yes	Bit field	0x22	/	/	/	/
PMBUS_CMD_HICCUP_COUNT_LIMIT	0XB5	Set the OCP hiccup timers	R/W byte	Yes	Bit field	0xFF	0~0xFF	/	/	Only for E50SN12051NKDHF
PMBUS_CMD_FLASH_KEY_WRITE	0xEC	Write the key to unlock the Flash before Storing operating parameters from RAM to data flash	R/W	No	/	0xA5A5A5A5		/	/	A data block:7E,15, DC,42 should be send to unlock the FLASH.

OPERATION [0x01]

Bit number	Purpose	Bit Value	Meaning	Default Settings, 0x80
7:	Enable/Disable the module	1	Output is enabled	1
		0	Output is disabled	
6:0	Reserved			0000000

ON_OFF_CONFIG [0x02]

Bit number	Purpose	Bit Value	Meaning	Default Settings 0x1D (negative) /0x1F (positive)
7:5	Reserved			000
4	Controls how the unit responds to the primary on/off pin and the OPERATION command;	1	Module does not power up until commanded by the primary ON/OFF pin and the OPERATION	1
		0	Module power up at any time regardless of the state of the primary ON/OFF pin and the OPERATION	
3	Controls how the unit responds to the OPERATION command	1	Module responds to the 7 bit in the OPERATION	1
		0	Module ignores the 7 bit in the OPERATION	
2	Controls how the unit responds to the primary on/off pin	1	Module requires the primary ON/OFF pin to be asserted to start the unit	1
		0	Module ignores the state of the primary ON/OFF pin	
1	Control logic of primary on/off pin	1	Positive Logic	0, negative; 1, positive.
		0	Negative Logic	
0	Unit turn off delay time control	1	Shut down the module with 0 delay cycle	1

PMBUS_CAPALIBITY [0x19] (Only for E50SN12051NKDHF)

Bit number	Purpose	Bit Value	Meaning
7	Packet Error Checking	0	Packet Error Checking Not supported
		1	Packet Error Checking is supported
6:5	Maximum Bus Speed	00	Maximum supported bus speed is 100kHz
		01	Maximum supported bus speed is 400kHz
		10	Reserved
		11	Reserved
4	SMBALERT#	0	The device does not have a SMBALERT# pin and does not support the SMBUS Alert Response protocol
		1	The device does have a SMBALERT# pin and does support the SMBUS Alert Response protocol
3:0	Reserved	X	Reserved

VIN_OV_FAULT_RESPONSE [0x56] (Only for E50SN12051NKDHF)

Bit number	Purpose	Bit Value	Meaning	Default Settings，0XF8
7:6	Response settings	11	Unit shuts down and responds according to the retry settings	11
5:3	Retry setting	111	Unit continuously restarts while fault is present until commanded off	111
		000	Unit does not attempt to restart on fault	
2:0	Delay time setting	000	No delay supported	000

STATUS_WORD [0x79]

High byte

Bit number	Purpose	Bit Value	Meaning
7	An output over 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, including over voltage and under voltage	1	Occurred
		0	No Occurred
4	Reserved		
3	Power_Good	1	is negated
		0	ok
2:0	Reserved		

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	Reserved		

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
5:0	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	Reserved	1	Occurred
		0	No Occurred
6: 5	Reserved		
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		

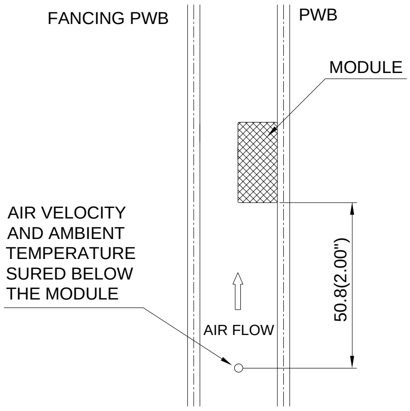
Thermal Testing Setup

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 airflow channel width is 73.6mm (2.90"), and the gap between the airflow channel and top side 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 15: 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 Base-plate)

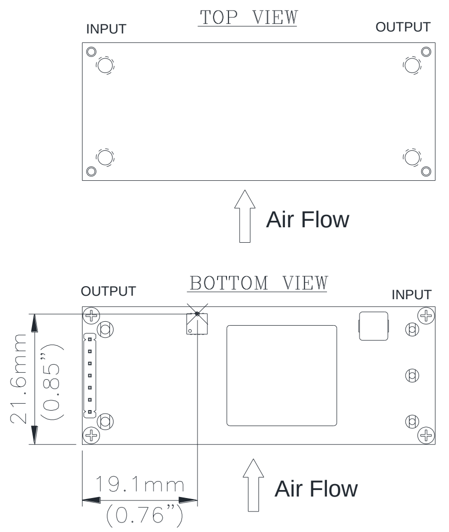


Figure 16: *Hot spot 1 temperature measurement location*
The allowed maximum hot spot1 temperature is defined at 118℃.

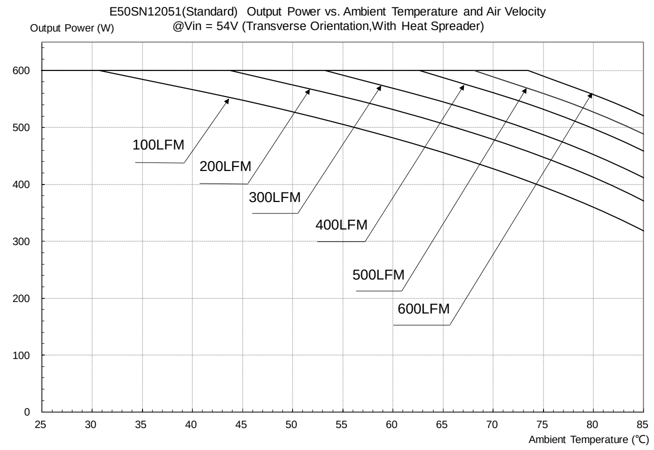


Figure 17: *Output Power vs. Ambient Temperature and Air Velocity @Vin = 54V (Transverse Orientation, Airflow from Vin- to Vin+, With Base-plate)*

Thermal Curves (with 0.5" Height Heat Sink ETL050A)

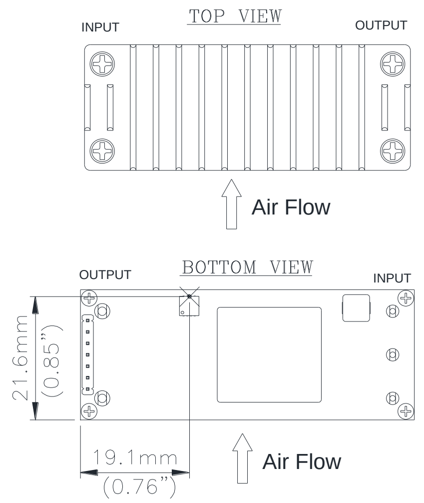


Figure 18: *Hot spot 2 temperature measurement location*
The allowed maximum hot spot2 temperature is defined at 118℃.

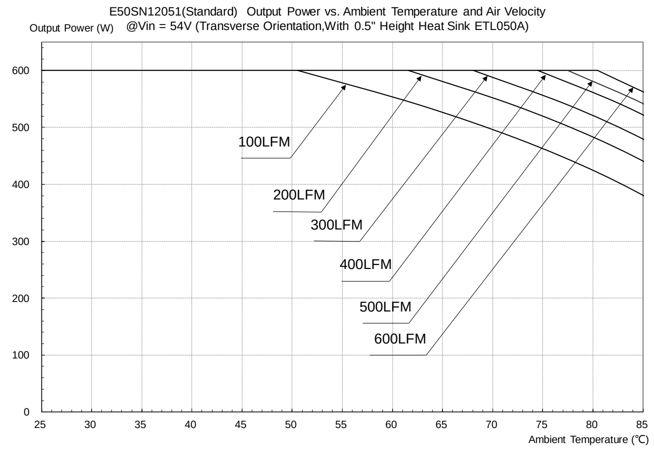


Figure 19: *Output Power vs. Ambient Temperature and Air Velocity @Vin = 54V (Transverse Orientation, Airflow from Vin- to Vin+, With 0.5" Height Heat Sink ETL050A)*

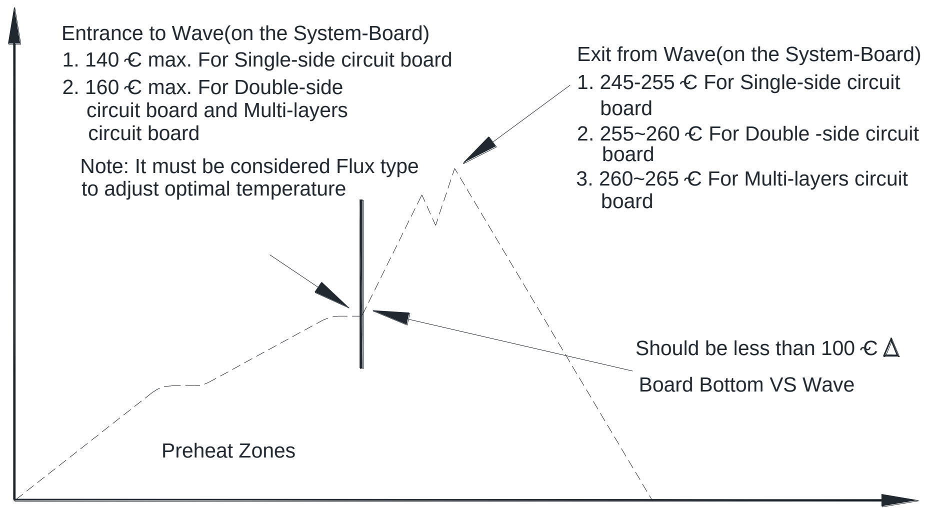
Soldering Method

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)

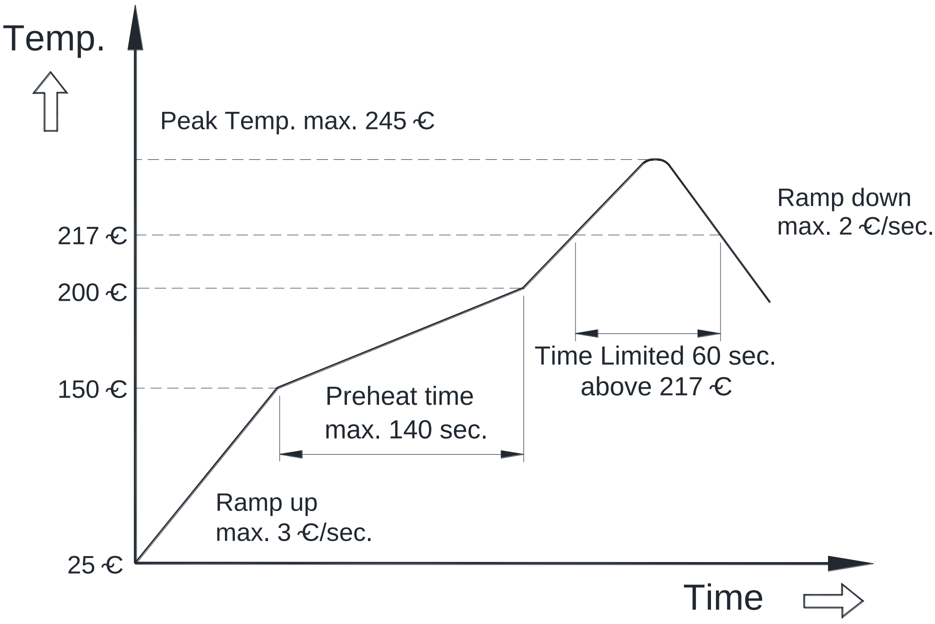
Hand soldering is the least preferred method because the amount of solder applied, the time the soldering iron is held on the joint, the temperature of the iron, and the temperature of the solder joint are variable. The recommended hand soldering guideline is listed in following table. The suggested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

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.



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

CONTACT US:

Website: www.deltaww.com/dcdc

Email: dcdc@deltaww.com

USA:
Telephone:
East Coast: 978-656-3993
West Coast: 510-668-5100
Fax: (978) 656 3964

Europe:
Telephone: +31-20-655-0967
Fax: +31-20-655-0999

Asia & the rest of world:
Telephone: +886 3 4526107
Ext. 6220~6226
Fax: +886 3 4513485

WARRANTY

Delta offers a two (2) year limited warranty. Complete warranty information is listed on our web site or is available upon request from Delta.