FB7SR28043NRFA

1200W DC/DC Power Modules

FEATURES

- High efficiency : 95% @270Vin full load
- Size:116.8mm*61.0mm*12.7mm(4.6” *2.4” *0.5”)
- Industry standard pin out and footprint
- Fixed frequency operation
- Input UVLO
- Hiccup output over current protection (OCP)
- Hiccup output over voltage protection (OVP)
- Output current limited protection(OCL)
- Auto recovery OTP
- Positive enable (negative enable optional)
- Trim: ±10%
- Active current sharing
- Remote sense
- Sync start
- Monotonic startup into normal
- 4000V isolation and reinforce insulation
- No minimum load required
- ISO 9001, TL 9000, ISO 14001, QS9000, OHSAS18001 certified manufacturing facility
- EN61373 pending，EN50155 pending.
- EN60950-1 pending

Delphi Series FB7SR28043NRFA, full Brick Family DC/DC Power Modules: 200~450V in, 28V/43A out, 1200W

The Delphi Module FB7SR28043NRFA, full brick, 200~450V input, single output, isolated DC/DC converter is the latest offering from a world leader in power system and technology and manufacturing — Delta Electronics, Inc. This product provides up to 1200 watts power in an industry standard footprint and pin out. 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.

APPLICATIONS

- Railway /Transportation system

TECHNICAL SPECIFICATIONS

PARAMETER	NOTES and CONDITIONS	FB7SR28043NRFA			
		Min.	Typ.	Max.	Units
1. ABSOLUTE MAXIMUM RATINGS					
1.1 Input Voltage		200	270	450	Vdc
1.2 Input surge withstand	<100ms			500	Vdc
1.3 Operating Baseplate Temperature		-40		100	°C
1.4 Storage Temperature		-55		125	°C
1.5 Input/Output Isolation Voltage	reinforce			4000	Vrms
2. INPUT CHARACTERISTICS					
2.1 Operating Input Voltage		200	270	450	Vdc
2.2 Input Under-Voltage Lockout					
2.2.1 Turn-On Voltage Threshold		172	175	178	Vdc
2.2.2 Turn-Off Voltage Threshold		167	170	173	Vdc
2.3 Input Over-Voltage Lockout					
2.3.1 Turn-On Voltage Threshold		/	/	/	Vdc
2.3.2 Turn-Off Voltage Threshold		/	/	/	Vdc
2.4 Maximum Input Current	Full Load, 270Vin		4.7	4.8	A
2.5 No-Load Input Current	Vin=270V, Io=0A		20	25	mA
2.6 Off Converter Input Current	Vin=270V		3	5	mA
2.7 Input Reflected-Ripple Current（pk-pk）	Vin=270V, Io=full load，Cin=100uF/1000V		1.0		A
3. OUTPUT CHARACTERISTICS					
3.1 Output Voltage Set Point	Vin=270V, Io=0, Tc=25°C	27.72	28	28.28	Vdc
3.1.1 Load regulation	Vin=270V, Io=Io min to Io max			±50	mV
3.1.2 Line regulation	Vin=200V to450V, Io=full load			±50	mV
3.1.3 Temperature regulation	Vin=270V, Tc= min to max case temperatrue		±280		mV
3.2 Output Voltage Ripple and Noise	5Hz to 20MHz bandwidth				
3.2.1 Peak-to-Peak	Full Load,		200	300	mV
3.2.2 rms	Full Load,		80	160	mV
3.3 Operating Output Current Range				3.2	A
3.4 Output DC Current-Limit Inception		47.5	49.5	51.5	A
4.DYNAMIC CHARACTERISTICS					
4.1 Output Voltage Current Transient	270V, 0.1A/μs				
4.1.1 Positive Step Change in Output Current	50% Io.max to 75%	-1000	-500		mV
4.1.2 Negative Step Change in Output Current	75% Io.max to 50%		500	1000	mV
4.2 Turn-On Transient					
4.2.1 Start-Up Time, From On/Off Control			60	100	ms
4.2.2 Start-Up Time, From Input			60	100	ms
4.2.3 Rise time(Vout from 10% to 90%)			30	50	ms
4.3 Maximum output capacitor	Vout nominal at full load (resistive load)		10000		μF
5. EFFICIENCY					
5.1 100% Load	Vin=270V	94.5	95	95.5	%
5.2 60% Load	Vin=270V	95	95.5	96	%
6.ISOLATION CHARACTERISTICS					
6.1 Input to Output				4000	Vac
6.2 Input to base				4000	Vac
6.3 Output to base				1500	Vac
6.4 Isolation Resistance			10		MΩ
7. FEATURE CHARACTERISTICS					
7.1 Switching Frequency			100		kHz
7.2 ON/OFF Control, Negative Remote On/Off logic					
7.2.1 Logic High (Module On)		3		5	V
7.2.2 Logic Low (Module Off)		0		1.5	V
7.3 Output Voltage Trim Range		-10		10	%
7.4 Output Over-Voltage Protection	Over full temp range; % of nominal Vout	110	115	120	%
8 GENERAL SPECIFICATIONS					
8.1 Weight			TBD		grams
8.2 Over-Temperature Shutdown (NTC resistor)	Refer to Figure 18 for NTC resistor location		125		°C

($T_{Baseplate}$=25°C, Natural convection, Vin=750Vdc, nominal Vout unless otherwise noted;

ELECTRICAL CHARACTERISTICS CURVES

TBD

Figure 1: *Efficiency vs. load current for 200，270and 450 input voltage at 25°C.*

TBD

Figure 2*: Power dissipation vs. load current for 200，270and 450 input voltage at 25°C.*

TBD

Figure 3: *Turn-on transient at zero load current) (20ms/div). Top Trace: Vout; 8V/div; Bottom Trace: ON/OFF input: 5V/div.*

TBD

Figure 4: *Turn-on transient at full load current (20ms/div). Top Trace: Vout: 8V/div; Bottom Trace: ON/OFF input: 5V/div.*

TBD

Figure 5: *Turn-on transient at zero load current (20ms/div). Top Trace: Vout; 8V/div; Bottom Trace: input voltage: 50V/div.*

TBD

Figure 6*: Turn-on transient at full load current (20ms/div). Top Trace: Vout; 8V/div; Bottom Trace: input voltage: 50V/div.*

ELECTRICAL CHARACTERISTICS CURVES

TBD

Figure 7: *Output voltage response to step-change in load current (50%-75%-50% of full load; di/dt = 0.1A/µs). Bottom Trace: Vout;500mV/div; Time: 1ms/div*

TBD

Figure 8: *Output voltage response to step-change in load current (50%-75%-50% of full load; di/dt = 2.5A/µs). Bottom Trace: Vout; 500mV/div; Time: 1ms/div*

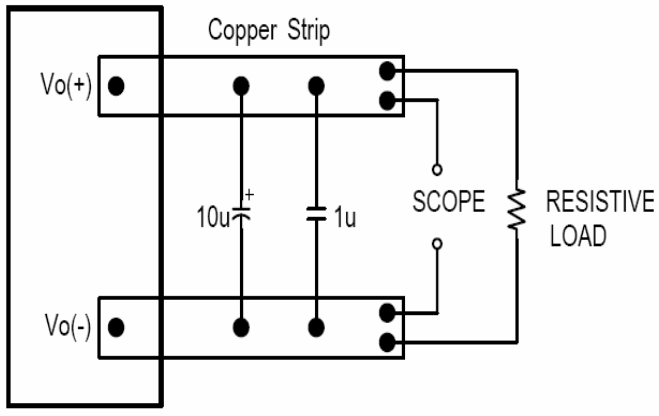


Figure 9: *Output voltage noise and ripple measurement test setup*

TBD

Figure 10: *Output voltage ripple at nominal input voltage and max load current (50 mV/div, 5us/div) Bandwidth: 20 MHz.*

TBD

Figure 11: *Output voltage vs. load current showing typical current limit curves and converter shutdown points.*

DESIGN CONSIDERATIONS

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. If the source inductance is more than a few μH, we advise 100μF electrolytic capacitor (ESR < 0.7 Ω at 100 kHz) mounted close to the input of the module to improve the stability.

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 FG5SR28043NRFA to meet class A in CISSPR 22.

Schematic and Components List

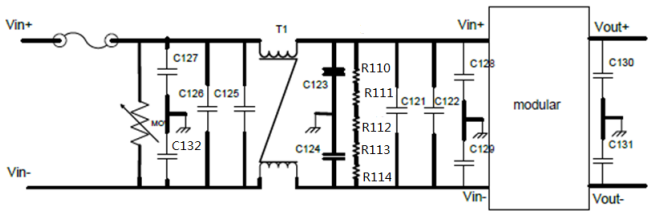


Figure12 EMI test schematic

Test Result:
At T = +25°C , Vin = 270V and full load
blue line is peak mode;

TBD

Figure 13 EMI test positive line

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.
Reinforce insulation based on 270 Vdc input is provided between the input and output of the module for the purpose of applying insulation requirements when the input to this DC-to-DC converter is identified as TNV-2 or SELV. An additional evaluation is needed if the source is other than TNV-2 or SELV.

When the input source is SELV circuit, the power module meets SELV (safety extra-low voltage) requirements. If the input source is a hazardous voltage which is greater than 270 Vdc and less than or equal to 450 Vdc, for the module's output to meet SELV requirements, all of the following must be met:

- The input source must be insulated from the ac mains by reinforced or double insulation.
- The input terminals of the module are not operator accessible.
- A SELV reliability test is conducted on the system where the module is used, in combination with the module, to ensure that under a single fault, hazardous voltage does not appear at the module's output.

When installed into a Class II equipment (without grounding), spacing consideration should be given to the end-use installation, as the spacing between the module and mounting surface have not been evaluated.

The power module has extra-low voltage (ELV) outputs when all inputs are ELV.

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 10A 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.

FEATURES DESCRIPTIONS

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, and will try to restart after shutdown(hiccup mode). 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 output over-voltage protection circuit, which monitors the voltage on the output terminals. If this voltage exceeds the over-voltage set point, the protection circuit will constrain the max duty cycle to limit the output voltage, if the output voltage continuously increases the modules will shut down, and then restart after a hiccup-time (hiccup mode).

Over-Temperature Protection

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

Remote On/Off

The remote on/off feature on the module can be either negative or positive logic. Negative logic turns the module on during a logic low and off during a logic high. Positive logic turns the modules on during a logic high and off during a logic low.

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. For negative logic if the remote on/off feature is not used, please short the on/off pin to Vi (-). For positive logic if the remote on/off feature is not used, please leave the on/off pin to floating.

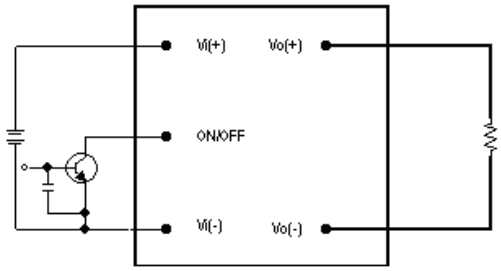


Figure 14: *Remote on/off implementation*

Output Voltage Adjustment (TRIM)

To increase or decrease the output voltage set point, connect an external resistor between the TRIM pin and SENSE(+) pin or SENSE(-) pin. The TRIM pin should be left open if this feature is not used.

When the input voltage is different, the trim up voltage is different. The relationship between maximum trim up voltage and input voltage is specified as follow :

TBD

Figure 15: *VIN vs maximum Vout*

For trim down, the external resistor value required to obtain a percentage of output voltage change △% is defined as:

Ex. When Trim-down -10% (28V×0.9=25.2V)

For trim up, the external resistor value required to obtain a percentage output voltage change △% is defined as:

Ex. When Trim-up +10% (28V×1.1=30.8V)

The output voltage can be increased by both the remote sense and the trim, however the maximum increase is the larger of either the remote sense or the trim, not the sum of both
The output voltage can be increased by both the remote sense and the trim, however the maximum increase is the larger of either the remote sense or the trim, not the sum of both.
When using remote sense and trim, the output voltage of the module is usually increased, which increases the power output of the module with the same output current. Care should be taken to ensure that the maximum output power of the module remains at or below the maximum rated power.

Parallel and Active Current Sharing

The modules are capable of operating in parallel, and realizing current sharing by average current sharing method. The current sharing pin of parallel module are connected together to create a current sharing bus.

If system has no redundancy requirement, the module can be parallel directly for higher power without adding external oring-fet;
The current sharing accuracy equation is:
X% = | Io – (Itotal / N) | / Irated, Where,
Io is the output current of per module;
Itotal is the total load current;
N is parallel module numbers;
Irated is the rated full load current of per module.

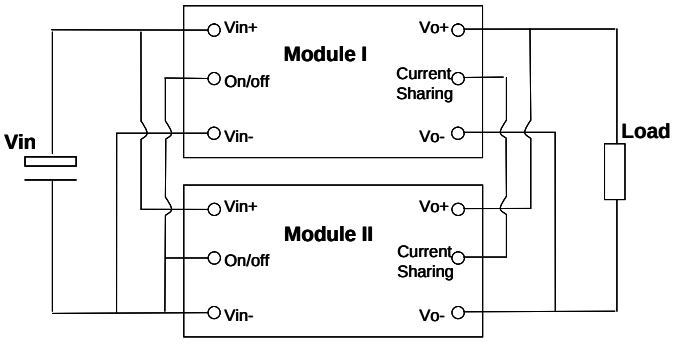


Figure 16: *Parallel and average current sharing configuration for no redundancy requirement system*

In order to keep the good stability of the parallel system, below 2 items layout guideline should be followed:
1. The trace connected the current sharing pin of Module I and Module II should be as short as possible.
2. The layout loop from Module I current sharing pin to Module II current sharing pin, to Module II Vo- pin, and come back to Module I Vo- pin should be as small as possible.

The pin was difine as follow in figure 22 ,we will explain the pin function:

Pin function

VIN+, VIN- .DC voltage inputs.
ON/OFF . The ON/OFF pin on a driver module may be used as a logic enable/disable input.When ON/OFF is pull low (<1.5V,referenced to –Vin),the module is turned off .when ON/OFF is floating (open collector) ,the module is turned on.The open circuit voltage of ON/OFF PIN is less than 5V.
VOUT+, VOUT- .DC voltage outputs.
TRIM. Provides fixed or variable adjustment of the module output.
CS/SS(Current Sharing/SYNC-Start).Provides for parallel operation. Costomer can connect the modules together to get more output power. And connected all the CS/SYNC pin together to get average current sharing.
Sense+, Sense-. Provides for locating the point of optimal voltage regulation external to the converter.

THERMAL CONSIDERATIONS

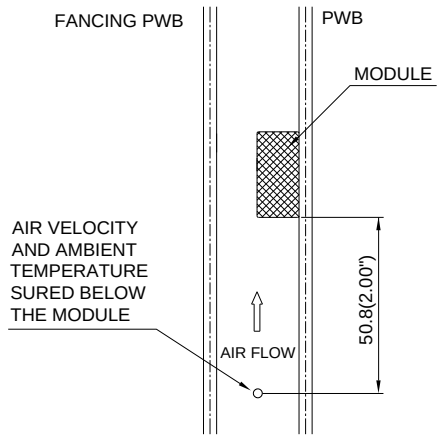
Thermal management is an important part of the system design. To ensure proper, reliable operation, sufficient cooling of the power module is needed over the entire temperature range of the module. Convection cooling is usually the dominant mode of heat transfer.

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

Thermal Testing Setup

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 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

TBD

***Figure 18: *** *temperature measured point*

THERMAL CURVES

TBD

Figure 19: *Output current vs. ambient temperature and air velocity @Vin=270V(Either Orientation, airflow from Vin- to Vin+,with heat spreader)*

THERMAL CURVES

TBD

LEAD FREE (SAC) PROCESS RECOMMEND TEMP. PROFILE

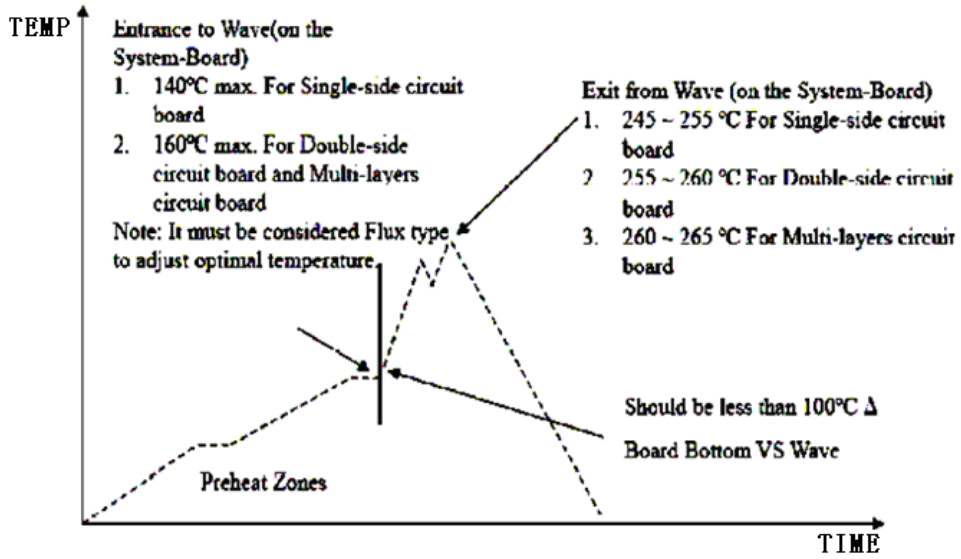
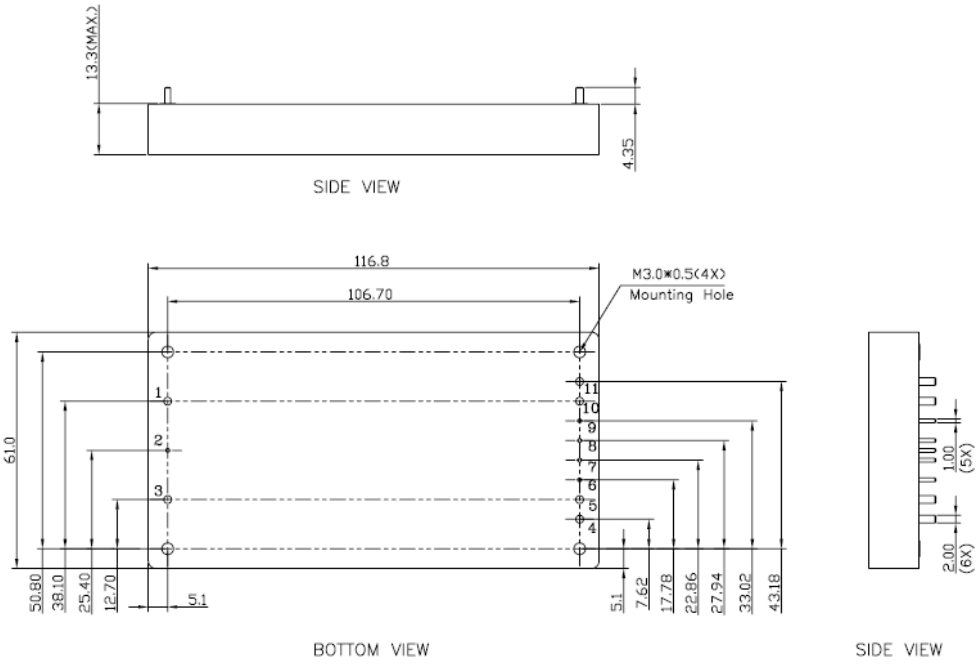


Figure 21 recommended temperature profile for lead-free wave soldering

MECHANICAL DRAWING(BASEPLATE)



PINS DESIGNATION

PIN#	FUNCTION
1	VIN−
2	ON/OFF
3	VIN+
4	VOUT+
5	VOUT+
6	SENSE+
7	TRIM
8	SHARE/SYNC_STAR
9	SENSE−
10	VOUT−
11	VOUT−

Figure 20 the pin function and mechanical drawing

DIMENSIONAL TOLERANCE

X ±0.3mm
x.x ±0.2mm
x.xx ±0.1mm

PART NUMBERING SYSTEM

F	B7	S	R	280	43	N	R	F	A
Form Factor	Input Voltage	Number of Outputs	Product Series	Output Voltage	Output Current	ON/OFF Logic	Pin Length		Option Code
F - Full Brick	270- 200V~450V	S – Single	R- Family	280- 28V	43- 43A	N – Negative P - Positive	R - 0.170”	F - RoHS 6/6 (Lead Free) Space - RoHS5/6	A – Baseplate

MODEL LIST

MODEL NAME	INPUT		OUTPUT		EFF @ 100% LOAD
FB7SR28043NRFA	200V~450V	4.7A	28V	43A	95%

Default remote on/off logic is negative and pin length is 0.170”
For different remote on/off logic and pin length, please refer to part numbering system above or contact your local sales office.
For modules with through-hole pins and the optional heatspreader, they are intended for wave soldering assembly onto system boards; please do not subject such modules through reflow temperature profile.

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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.

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