Data Sheet

EBDW006A0U: Barracuda* Series DC-DC Converter Power Modules

36 to 72V_{DC} Input, 50VDC Output, 6A, 300W

RoHS Compliant

Options

- Negative Remote On/Off logic (1=option code, factory preferred)
- Auto-restart after fault shutdown (4=option code, factory preferred)
- Remote Sense and Output Voltage Trim (9=option code)
- Base plate option (-H=option code)

Applications

- Distributed power architectures
- Intermediate bus voltage applications
- Telecommunications equipment
- Wireless Base stations
- Industrial equipment
- LANs/WANs
- Enterprise Networks
- Latest generation IC's (DSP, FPGA, ASIC) and Microprocessor powered applications

Features

- Digital interface with PMBus Rev.1.2 compliance
- Compliant to RoHS EU Directive 2011/65/EU and amended Directive (EU) 2015/863. (-Z versions)
- Compliant to REACH Directive (EC) No 1907/2006
- Wide input voltage range: 36 to 72V_{DC}
- Low output ripple and noise
- Monotonic start-up into pre-bias output
- Remote On/Off (Positive logic)
- Remote Sense
- Small size and low profile: 58.4 x 22.8 x 12.7 mm (2.30 x 0.9 x 0.50 in) with base plate
- Constant switching frequency
- Wide operating temperature range (-40°C to 85°C)
- Over current and Over temperature protection (non- latching)
- ANSI/UL* 62368-1 and CAN/CSA† C22.2 No. 62368-1 Recognized, TUV (EN IEC62368-1:2020+A11)
- ISO** 9001 and ISO 14001 certified manufacturing facilities

- OmniOn Power is a trademark of OmniOn Power Inc. All other trademarks belong to their respective owners. # UL is a registered trademark of Underwriters Laboratories, Inc.
- † CSA is a registered trademark of Canadian Standards Association.
- ‡ VDE is a trademark of Verband Deutscher Elektrotechniker e.V.
- § This product is intended for integration into end-user equipment . All of the required procedures of end-use equipment should be followed.
- ¤ IEEE and 802 are registered trademarks of the Institute of Electrical and Electronics Engineers, Incorporated.
- ** ISO is a registered trademark of the International Organization of Standards.

Absolute Maximum Ratings

Stresses in excess of the absolute maximum ratings can cause permanent damage to the device. These are absolute stress ratings only, functional operation of the device is not implied at these or any other conditions in excess of those given in the operations sections of the data sheet. Exposure to absolute maximum ratings for extended periods can adversely affect the device reliability.

Parameter	Device	Symbol	Min	Max	Unit
Input Voltage Continuous Operating transient ≤ 100ms	All	V_{IN}	-0.3	72 80	VDC VDC
Operating Ambient Temperature (see Thermal Considerations section)	All	T_A	-40	85	°C
Storage Temperature	All	T_{stg}	-55	125	°C
Logic Pin Voltage (to SIG_GND or VO(-)) ADDR0, ADDR1, CLK, DATA, SMBALERT	All	V_{PIN}	-0.5	3.3	V_{DC}
I/O Isolation Voltage (100% factory Hi-Pot tested)	All			2250	Vdc

Electrical Specifications

Unless otherwise indicated, specifications apply over all operating input voltage, resistive load, and temperature conditions.

Parameter	Device	Symbol	Min	Typ	Max	Unit
Operating Input Voltage	All	V_{IN}	36	48	72	Vdc
Maximum Input Current (V_{IN}=0 to 720V, I_O=$I_{O,\,max}$)	All	$I_{IN,max}$			9	Adc
Input No Load Current (V_{IN} = $V_{IN,\,nom}$, I_O = 0, module enabled)	All	$I_{IN,No\ load}$		100		mA
Input No Load Current (V_{IN} = $V_{IN,\,nom}$, I_O = 0, module disabled)	All	$I_{IN,stand\text{-}by}$		45		mA
External Input Capacitance	All		220	-		µF
Inrush Transient	All	I2t	-	-	1	A2s
Input Terminal Ripple Current, (5Hz to 20MHz, 12µH source impedance; V_{IN} = 48V, I_O = I_{Omax} ; see Figure 10)	All		-	0.6	-	A_{rms}
Input Ripple Rejection (120Hz)	All		-	30	-	dB

CAUTION: This power module is not internally fused. An input line fuse must always be used. This power module can be used in a wide variety of applications, ranging from simple standalone operation to an integrated part of sophisticated power architecture. To preserve maximum flexibility, internal fusing is not included, however, to achieve maximum safety and system protection, always use an input line fuse. The safety agencies require a fast-acting fuse with a maximum rating of 20 A (see Safety Considerations section). Based on the information provided in this Data Sheet on inrush energy and maximum dc input current, the same type of fuse with a lower rating can be used. Refer to the fuse manufacturer's Data Sheet for further information

Parameter	Device	Symbol	Min	Typ	Max	Unit
Output Voltage Set-point (VIN = VIN, nom, IO = 6A, TA =25°C)	All	$V_{O, set}$	49.25	50.00	50.75	V_{DC}
Output Voltage (Over all operating input voltage(36V to 72V), resistive load, and temperature conditions until end of life)	All	V_O	49	-	51	V_{DC}
Output Regulation (VIN, min= 40V) Line (VIN = VIN, min to VIN, max) Load (IO = IO, min to IO, max) Temperature (TA = -40°C to +85°C)	All All All		- - -	0.2 0.2 1	- - -	% $V_{O, set}$
Output Ripple and Noise on nominal output (VIN = VIN, nom and IO=IO, min to IO, max, tested with a 50 µF ceramic, 200µF Oscon) RMS (5Hz to 20MHz bandwidth) Peak-to-Peak (5Hz to 20MHz bandwidth)	All All		- -	60 300	- -	mV_{rms} mV_{P-P}
External Output Capacitance (At least 50µF ceramic)	All	C_O	220	-	1500	µF
Output Current	All	I_o	0		6	A_{DC}
Output Current Limit Inception (hiccup mode)	All	$I_{o,min}$		8	-	A_{DC}
Efficiency (VIN = VIN, nom, TA = 25°C, VO= VO, set) IO=100% IO, max	All	η		95.2		%
Switching Frequency (primary MOSFETs) (Output Ripple 2X switching frequency)		f_{sw}		200		kHz
Dynamic Load Response (Co=50µF,ceramic+200µF, Oscon or AL, dIO/dt=1A/ µs; VIN = 48V) Load Change from IO= 50% to 75% or 25% to 50% of IO, max Load Change from IO = 50% to 75% of IO,max: Peak Deviation Settling Time (VO <10% peak deviation)	All	V_{pk} ts	- -	600 500	- -	mVpk µs
Load Change from IO = 75% to 50% of IO,max: Peak Deviation Settling Time (VO <10% peak deviation)	All	V_{pk} ts	- -	600 500	- -	mVpk µs

Isolation Specifications

Parameter	Symbol	Min	Typ	Max	Unit
Isolation Capacitance	C_{iso}	-	4700	-	pF
Isolation Resistance	R_{iso}	10	-	-	MΩ

General Specifications

Parameter	Device	Symbol	Typ	Unit
Calculated Reliability based upon Telcordia SR-332 (I_O = 80%$I_{O, max}$, T_A= 40°C, Airflow = 200 lfm), 90% confidence Issue 4: Method I, Case 3	All	MTBF FIT	14 69.9	Hours 10^9/Hours
Weight – with Baseplate option			40	g (oz.)

Feature Specifications

Unless otherwise indicated, specifications apply over all operating input voltage, resistive load, and temperature conditions. See Feature Descriptions for additional information.

Parameter	Device	Symbol	Min	Typ	Max	Unit
Remote On/Off Signal Interface (VIN=VIN, min to VIN, max , Signal referenced to VIN- terminal) Negative Logic: device code suffix “1” Logic Low = module On, Logic High = module Off Positive Logic: No device code suffix required Logic Low = module Off, Logic High = module On Logic Low Specification	All	$I_{on/off}$	280	-	310	µA
On/Off Thresholds: Remote On/Off	All	$V_{on/off}$	-0.3	-	0.8	V_{dc}
Current Logic Low – On/Off Voltage	All	$V_{on/off}$	3.5	-	10	V_{dc}
Logic High Voltage – (Typ = Open Collector)	All	$I_{on/off}$	-	-	10	µA
Logic High maximum allowable leakage current (Von/ off = 2.0V) Maximum voltage allowed on On/Off pin	All	$V_{on/off}$	-	-	10	V_{dc}
Turn-on Delay and Rise Time (IO=IO, max , VIN=VIN, nom, TA = 25°C) Case 1: Input power is applied for at least 1 second, and then the On/Off input is set from OFF to ON (Tdelay = on/off pin transition until VO = 10% of VO, set)	All	T_{delay}	-	5	-	ms
Case 2: On/Off input is set to Module ON, and then input power is applied (Tdelay = VIN reaches VIN, min until VO = 10% of VO, set)	All	T_{delay}	-	30	-	ms
Output voltage Rise time Trise=Time for VO to rise from 10% to 90% of VO, set	All	T_{rise}	-	11	-	ms
Output Voltage Adjustment range*	All	$V_{O, set}$	25	50	55	V_{dc}
Output Overvoltage Protection (hiccup mode)	All	$V_{O, limit}$		60		V_{dc}
Overtemperature Protection (See Feature Descriptions)	All	T_{ref}	-	140	-	°C
Input Undervoltage Lockout						
Turn-on Threshold			32.5	34	36	V_{dc}
Turn-off Threshold			30	32	34	
Hysteresis				2		V_{dc}

* Output voltage trim up range maybe limited at VIN<40V.

Digital Interface Specifications

Unless otherwise indicated, specifications apply overall operating input voltage, resistive load, and temperature conditions. See Feature Descriptions for additional information.

Parameter	Conditions	Symbol	Min	Typ	Max	Unit
PMBus Signal Interface Characteristics						
Input High Voltage (CLK, DATA)		VIH	2.1		3.6	V
Input Low Voltage (CLK, DATA)		VIL			0.8	V
Input high level current (CLK, DATA)		I_{IH}	-10		10	μA
Input low level current (CLK, DATA)		I_{IL}	-10		10	μA
Output Low Voltage (CLK, DATA, SMBALERT#)	I_{OUT}=2mA	VOL			0.4	V
Output high level open drain leakage current (DATA, SMBALERT#)	V_{OUT}=3.6V	I_{OH}	0		10	μA
Pin capacitance		C_O		0.7		pF
PMBus Operating frequency range	Slave Mode	FPMB	100		400	kHz
Data hold time	Receive Mode Transmit Mode	tHD:DAT	0 300			ns
Data setup time		tSU:DAT	250			ns
Measurement System Characteristics						
Output current reading range		$I_{OUT(RNG)}$	0		8	A
Output current reading resolution		$I_{OUT(RES)}$		5		mA
Output current reading accuracy		$I_{OUT(ACC)}$	-10		10	%
V_{OUT} reading range		$V_{OUT(RNG)}$			67.7	V
V_{OUT} reading resolution		$V_{OUT(RES)}$		17		mV
V_{OUT} reading accuracy		$V_{OUT(ACC)}$	-2		2	%
V_{IN} reading range		$V_{IN(RNG)}$			110	V
V_{IN} reading resolution		$V_{IN(RES)}$		27		mV
V_{IN} reading accuracy		$V_{IN(ACC)}$	-5		5	%
Temperature reading resolution		$T_{(RES)}$		0.25		°C
Temperature reading accuracy		$T_{(ACC)}$	-5		5	%

Characteristic Curves

The following figures provide typical characteristics for the EBDW006A0U (50V, 6A) at 25°C.

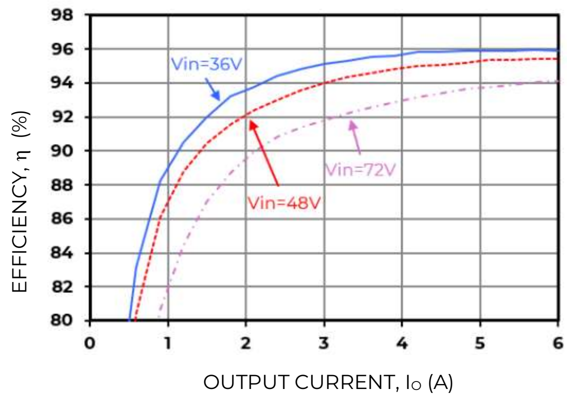


Figure 1. Converter Efficiency versus Output Current.

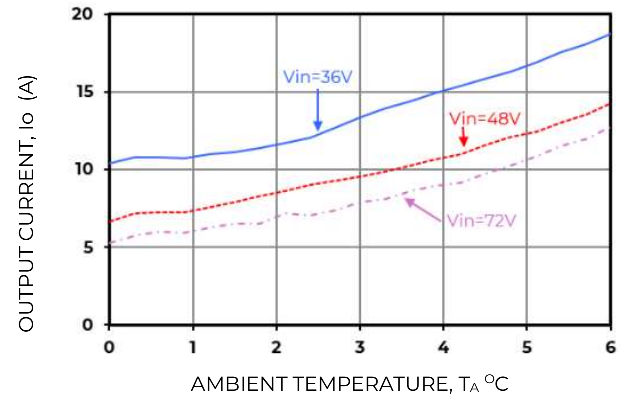


Figure 2. Typical Converter Loss Vs. Output current.

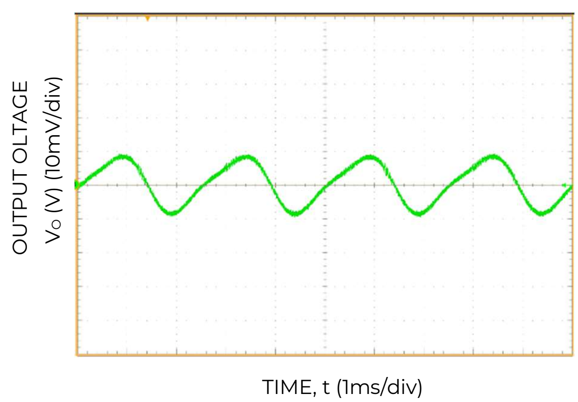


Figure 3. Typical Output Ripple at 408Vdc Input and C_O= 50μF Ceramic + 00μF PosCap uF

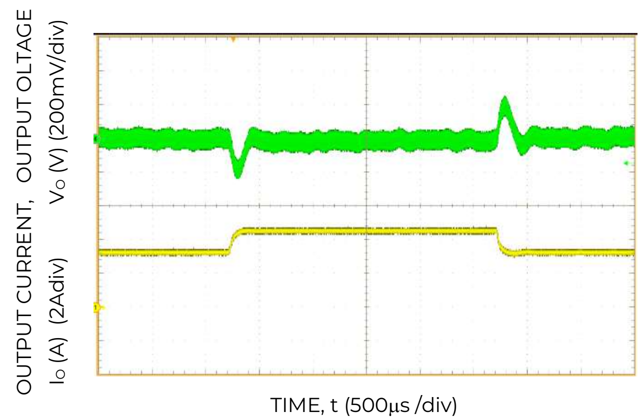


Figure 4. Transient Response to Dynamic Load Change from 50% to 75% to 50% at 48Vdc, Cout= 50uF Ceramic + 00uF PosCap

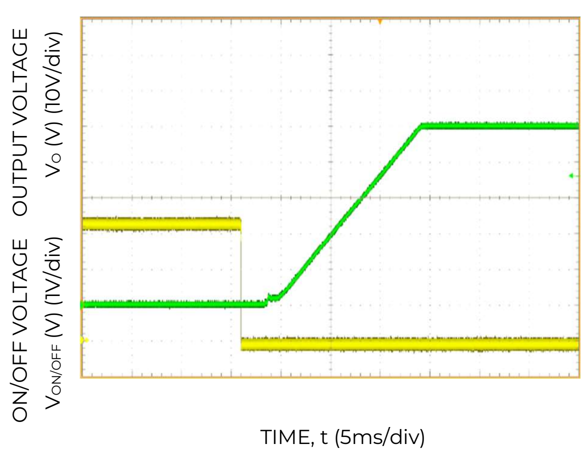


Figure 5. Typical Start-up, Vin present, Using On/Off Voltage (I_o = $I_{o,max}$).

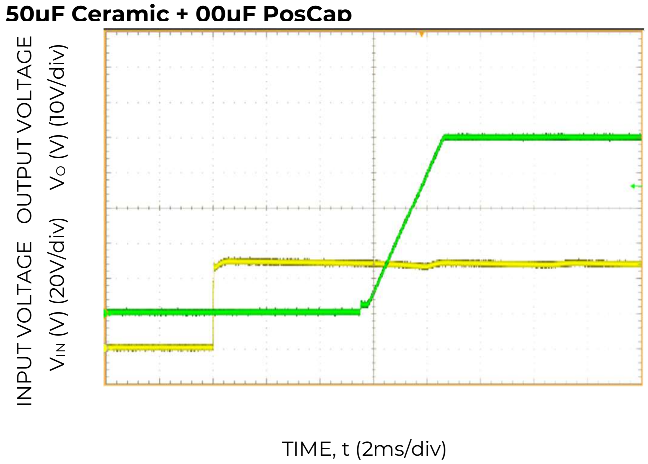


Figure 6. Typical Start-up Using Input Voltage (V_{IN} = 48V, I_o = $I_{o,max}$).

Characteristic Curves

The following figures provide typical characteristics for the EBDW006A0U (50V, 6A) at 25ºC.

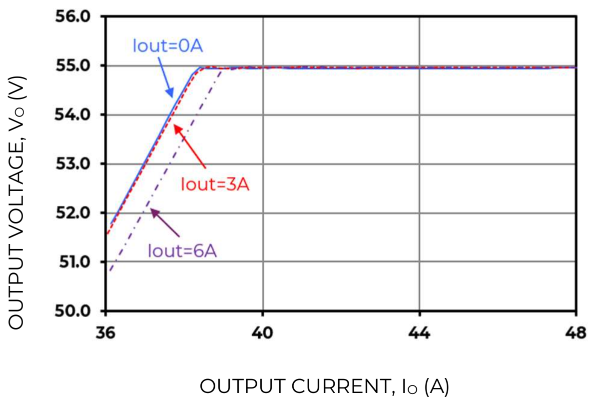


Figure 7. Trim Up Output Voltage Regulation Vs. Input Voltage.

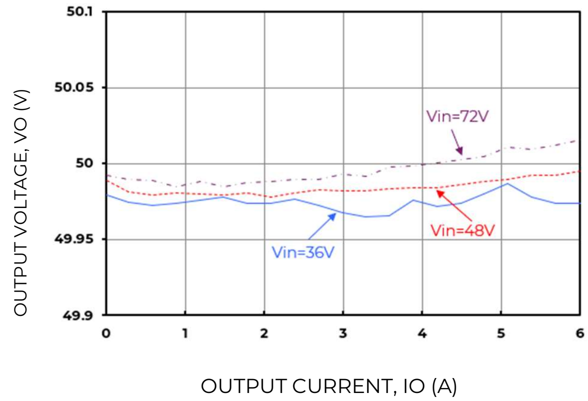


Figure 8. Typical Output Voltage Regulation vs. Output Current at Room Temp.

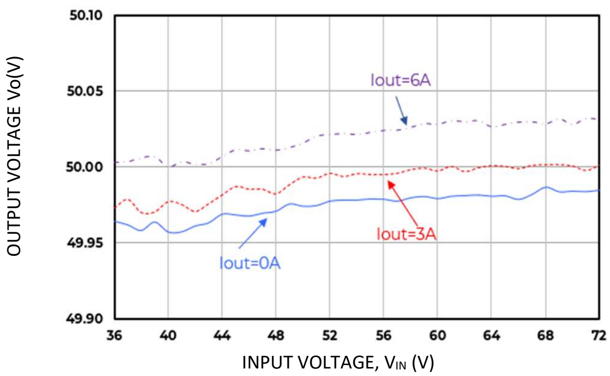
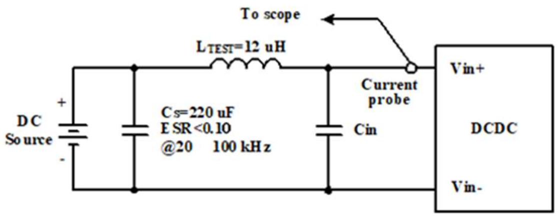


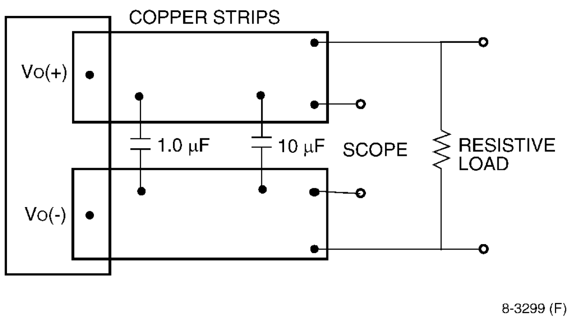
Figure 9. Typical Output Voltage Regulation vs. Input Voltage.

Test Configurations



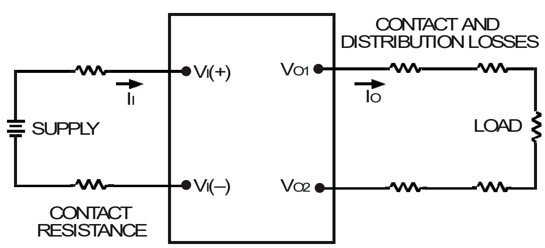
Note: Measure input Terminal -ripple current with a simulated source inductance (LTEST) of 12 µH. Capacitor CS offsets possible battery impedance. Measure current as shown above.

Figure 10. Input Terminal **Ripple Current Test Setup.**



Note: Use a 1.0 µF ceramic capacitor and a 10 µF capacitor. Scope measurement should be made using a BNC socket. Position the load between 51 mm and 76 mm (2 in. and 3 in.) from the module.

Figure 11. Output Ripple and Noise Test Setup.



Note: All measurements are taken at the module terminals. When socketing, place Kelvin connections at module terminals to avoid measurement errors due to socket contact resistance.

$$\eta = \left(\frac{[V_O(+) - V_O(-)]I_O}{[V_I(+) - V_I(-)]I_I}\right) \times 100\ \%$$

Figure 12. Output Voltage and Efficiency Test Setup.

Design Considerations

Input Source Impedance

The power module should be connected to a low ac-impedance source. A highly inductive source impedance can affect the stability of the power module. For the test configuration in Figure 10, a 220µF electrolytic capacitor, Cin, (ESR<0.7Ω at 100kHz), mounted close to the power module helps ensure the stability of the unit. If the module is subjected to rapid on/off cycles, a 330µF input capacitor is required.

Consult the factory for further application guidelines.

Safety Considerations

For safety agency approval the power module must be installed in compliance with the spacing and separation requirements of the end-use safety agency standards, i.e., UL ANSI/UL* 62368-1 and CAN/CSA+ C22.2 No. 62368-1 Recognized, DIN VDE 0868-1/ A11:2017 (EN62368-1:2014/A11:2017)

If the input source is non-SELV (ELV or a hazardous voltage greater than 60 Vdc and less than or equal to 75Vdc), for the module's output to be considered as meeting the requirements for safety extra-low voltage (SELV) or ES1, all of the following must be true:

The input source is to be provided with reinforced insulation from any other hazardous voltages, including the ac mains.

One VIN pin and one VOUT pin are to be grounded, or both the input and output pins are to be kept floating.

The input pins of the module are not operator accessible.

Another SELV or ES1 reliability test is conducted on the whole system (combination of supply source and subject module), as required by the safety agencies, to verify that under a single fault, hazardous voltages do not appear at the module's output.

Note: Do not ground either of the input pins of the module without grounding one of the output pins. This may allow a non-SELV/ES1 voltage to appear between the output pins and ground.

The power module has safety extra-low voltage (SELV) or ES1 outputs when all inputs are SELV or ES1

The input to these units is to be provided with a maximum 15 A fast-acting (or time-delay) fuse in the unearthed lead.

The power module has internally generated voltages exceeding safety extra-low voltage. Consideration should be taken to restrict operator accessibility.

Feature Descriptions

Output Overcurrent Protection

To provide protection in a fault output overload condition, the module is equipped with internal current-limiting circuitry and can endure current limiting continuously. If the overcurrent condition causes the output voltage to fall greater than 2V from VO, set, the module will shut down. The module will continually attempt to restore the operation until fault condition is cleared.

A factory configured latched off option (with overcurrent and overvoltage latched off managed as a group) is also available. An latched off feature means that module will remains latched off . The overcurrent latch is reset by either cycling the input power or by toggling the on/off pin for one second. If the output overload condition still exists when the module restarts, it will shut down again. This operation will continue indefinitely until the overcurrent condition is corrected. The IOUT_OC_WARN threshold level and IOUT_OC_FAULT threshold level can be reconfigured via the PMBus interface.

A factory configured auto-restart option (with overcurrent and overvoltage auto-restart managed as a group) is also available. An auto-restart feature continually attempts to restore the operation until fault condition is cleared.

Remote On/Off

The module contains a standard on/off control circuit reference to the VIN(-) terminal. Two factory configured remote on/off logic options are available. Positive logic remote on/off turns the module on during a logic-high voltage on the ON/OFF pin, and off during a logic low. Negative logic remote on/off turns the module off during a logic high, and on during a logic low.

Negative logic, device code suffix "1," is the factory-preferred configuration. The On/Off circuit is powered from an internal bias supply, derived from the input voltage terminals. To turn the power module on and off, the user must supply a switch to control the voltage between the On/Off terminal and the VIN(-) terminal (Von/off). The switch can be an open collector or equivalent (see Figure 13). A logic low is Von/off = -0.3V to 0.8V. The typical Ion/off during a logic low (Vin=48V, On/Off Terminal=0.3V) is 147µA. The switch should maintain a logic- low voltage while sinking 310µA. During a logic high, the maximum Von/off generated by the power module is 10V. The maximum allowable leakage current of the switch at Von/off = 2.0V is 10µA.

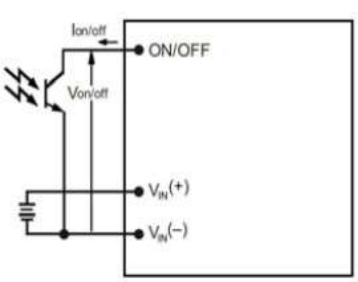


Figure 13. Remote On/Off Implementation.

If using an external voltage source, the maximum voltage Von/off on the pin is 14.5V with respect to the VIN (-) terminal.

If not using the remote on/off feature, perform one of
the following to turn the unit on:

For negative logic, short ON/OFF pin to VIN(-). For positive logic: leave ON/OFF pin open.

Output Overvoltage Protection

The module contains circuitry to detect and respond to output overvoltage conditions. If the overvoltage condition causes the output voltage to rise above the limit in the specifications table, the module will shut down and remain latched off. The overvoltage latch is reset by either cycling the input power, or by toggling the on/off pin for one second. If the output overvoltage condition still exists when the module restarts, it will shut down again. This operation will continue indefinitely until the overvoltage condition is corrected.

A factory configured auto-restart option (with overcurrent and overvoltage auto-restart managed as a group) is also available. An auto-restart feature continually attempts to restore the operation until fault condition is cleared..

The VOUT_OV_FAULT_LIMIT can be reconfigured via the PMBus interface.

Overtemperature Protection

The modules feature an overtemperature protection circuit to safeguard against thermal damage. The circuit shuts down the module when either internal temperature sensor exceeds the setpoint given in the specification table. The module will automatically restart once the reference temperature cools by ~25°C. For either factory-programmed protection mode, the module will attempt to restart continuously after the temperature falls by the hysteresis amount also given there. If latch-off behavior is preferred, it may be set using the PMBus command OT_FAULT_RESPONSE.

The OT_WARN_LIMIT and OT_FAULT_LIMIT can be reconfigured via the PMBus interface.

Input Under/Overvoltage Lockout

At input voltages above or below the input Over/under voltage lockout limits, module operation is disabled.

The module will begin to operate when the input voltage level changes to within the under and overvoltage lockout limits. However recovery from input undervoltage may be delayed by 7 microseconds, or 8 seconds if the module is hotIf the input voltage exceeds either limit while operating, the module shuts down, then restarts automatically when these conditions are met. There is no latching mode for input under/overvoltage lockout.

Input undervoltage lockout has programmable hysteresis. When Vin exceeds VIN_ON the module output is enabled; when Vin falls below VIN_OFF, the module is disabled. These thresholds can be adjusted via PMBus, with a minimum 2V hysteresis required between them.

The input overvoltage lockout threshold can be adjusted using the PMBus command VIN_OV_FAULT_LIMIT; it has a fixed hysteresis value given in the specification table.

Remote Sense ("9" Option Code)

Remote sense minimizes the effects of distribution losses by regulating the voltage at the remote-sense connections (See Figure 14). The voltage between the remote-sense pins and the output terminals must not exceed the output voltage sense range given in the Feature Specifications table
[VO(+) – VO(–)] – [SENSE(+) – SENSE(–)] ≤ 1V

The amount of power delivered by the module is defined as the voltage at the output terminals multiplied by the output current. When using remote sense and trim, the output voltage of the module can be increased, which at the same output current would increase the power output of the module. Care should be taken to ensure that the maximum output power of the module remains at or below the maximum rated power (Maximum rated power = Vo,set x Io,max).

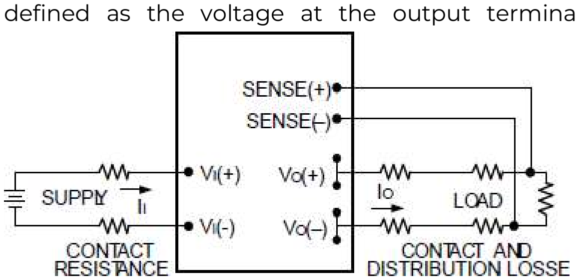


Figure 14. Circuit Configuration for remote sense.

Trim, Output Voltage Programming ("9" Option Code)

Trimming allows the output voltage set point to be increased or decreased; this is accomplished by connecting an external resistor between the TRIM pin and either the VO(+) pin or the VO(-) pin.

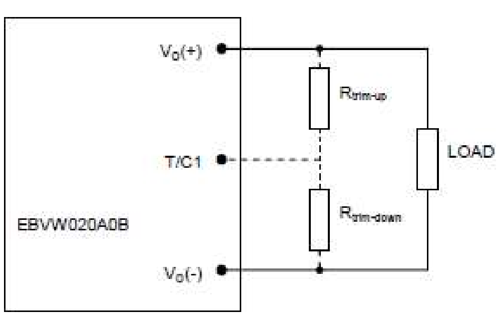


Figure 15. Circuit Configuration to Trim Output Voltage

Connecting an external resistor (Rtrim-down) between the T/C1 pin and the Vo(-) (or Sense(-)) pin decreases the output voltage set point. To maintain set point accuracy, the trim resistor tolerance should be ±1.0%.

The following equation determines the required external resistor value to obtain a percentage output voltage change of

Δ%

$$R_{trim\text{-}down} = \left[\frac{511}{\Delta\%} - 10.22\right]\ \Omega$$

Where

$$\Delta\% = \left(\frac{V_{o,set} - V_{desired}}{V_{o,set}}\right) \times 100$$

For example, to trim-down the output voltage of the module by 8% to 46V, Rtrim-down is calculated as follows:

$$R_{trim\text{-}down} = \left[\frac{511}{\Delta\%} - 10.22\right] = 53.655\ K\Omega$$

Connecting an external resistor (Rtrim-up) between the T/C1 pin and the VO(+) (or Sense (+)) pin increases the output voltage set point. The following equations determine the required external resistor value to obtain a percentage output voltage change of

$$R_{trim\text{-}up} = \left[\frac{511 \times V_{o,set} \times (100+\Delta\%)}{1.225 \times \Delta\%} - \frac{511}{\Delta\%} - 10.22\right] K\Omega$$

Where

$$\Delta\% = \left(\frac{V_{o,desired} - V_{o,set}}{V_{o,set}}\right) \times 100$$

For example, to trim-up the output voltage of the module by 5% to 52.5V, Rtrim-up is calculated is as follows:

$$R_{trim\text{-}up} = \left[\frac{511 \times V_{o,set} \times (100+5)}{1.225 \times 5} - \frac{511}{5} - 10.22\right] K\Omega$$

$$= 4267.58\ K\Omega$$

The voltage between the Vo(+) and Vo(–) terminals must not exceed the minimum output overvoltage protection value shown in the Feature Specifications

Although the output voltage can be increased by both the remote sense and by the trim, the maximum increase for the output voltage is not the sum of both.

The maximum increase is the larger of either the remote sense or the trim. The amount of power delivered by the module is defined as the voltage at the output terminals multiplied by the output current`

When using remote sense and trim, the output voltage of the module can be increased, which at the same output current would increase the power output of the module. Care should be taken to ensure that the maximum output power of the module remains at or below the maximum rated power (Maximum rated = Vo,set x Io,max). Modules with "9" option cannot include the -P option.

Thermal Considerations

The power modules operate in a variety of thermal environments and sufficient cooling should be provided to help ensure reliable operation.

Thermal considerations include ambient temperature, airflow, module power dissipation, and the need for increased reliability. A reduction in the operating temperature of the module will result in an increase in reliability.

The thermal data presented here is based on physical measurements taken in a wind tunnel, using automated thermo-couple instrumentation to monitor key component temperatures: FETs, diodes, control ICs, magnetic cores, ceramic capacitors, opto-isolators, and module pwb conductors, while controlling the ambient airflow rate and temperature. For a given airflow and ambient temperature, the module output power is increased, until one (or more) of the components reaches its maximum derated operating temperature, as defined in IPC-9592. This procedure is then repeated for a different airflow or ambient temperature until a family of module output derating curves is obtained.

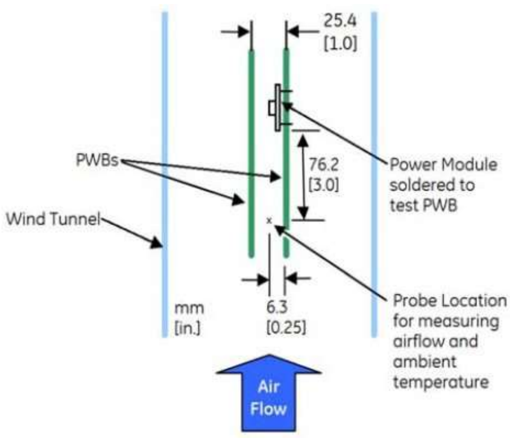


Figure 16. Thermal Test Setup

Heat-dissipating components are mounted on the top side of the module. Heat is removed by conduction, convection and radiation to the surrounding environment. Proper cooling can be verified by measuring the thermal reference temperature (TH x). Peak temperature (TH x) occurs at the position indicated in Figure 17. For reliable operation this temperature should not exceed the listed temperature threshold.

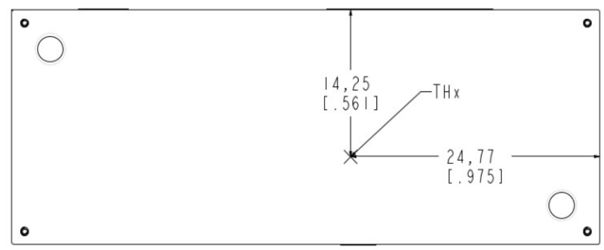


Figure 17. Location of the thermal reference temperature TH1

The output power of the module should not exceed the rated power for the module as listed in the Ordering Information table.

Although the maximum temperature of the power modules is TH x, you can limit this temperature to a lower value for extremely high reliability.

Please refer to the Application Note "Thermal Characterization Process For Open-Frame Board-Mounted Power Modules" for a detailed discussion of thermal aspects including maximum device temperatures.

Heat Transfer via Convection

Increased airflow over the module enhances the heat transfer via convection. The thermal derating of figures 18 shows the maximum output current that can be delivered by each module in the indicated orientation without exceeding the maximum THx temperature versus local ambient temperature (TA) for air flows of, 0.5 m/s (100 ft./min), 1 m/s (200 ft./min), 2 m/s (400 ft./min).

The use of the Figures is shown in the following example:

Example

What is the minimum airflow necessary for a EBDW006A0U operating at V_{IN} = 48 V, an output current of 5A, and a maximum ambient temperature of 59 °C in transverse orientation.

Solution:

Given: V_{in}= 48V, I_O = 5A, T_A = 59°C

Determine required airflow (V) (Use Figure 18): V = 100 LFM or greater

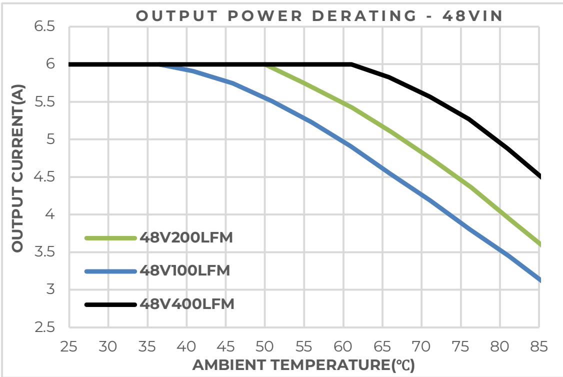


Figure 18. Output Current Derating for the Base Plate EBDW006A0U in the Transverse Orientation; Airflow Direction from VIN(-) to VIN(+); VIN = 48V .

Layout Considerations

The EBDW006A0U power modules are low profile to enable their use on system cards with fine pitch. As such, component clearance between the bottom of the power module and the mounting board is limited. Avoid placing copper areas on the outer layer directly underneath the power module. Also avoid placing via interconnects underneath the power module.

Through-Hole Lead-Free Soldering Information

The RoHS-compliant, Z version, through-hole products use the SAC (Sn/Ag/Cu) Pb-free solder and RoHS-compliant components, designed to be processed through single or dual wave soldering machines. The pins have an RoHS-compliant, pure tin finish that is compatible with both Pb and Pb-free wave soldering processes. A maximum preheat rate of 3°C/s is suggested. The wave preheat process should be such that the temperature of the power module board is kept below 210°C. For Pb solder, the recommended pot temperature is 260°C, while the Pb-free solder pot is 270°C max. If additional information is needed, please consult your OMNION POWER representative.

Reflow Lead-Free Soldering Information

The RoHS-compliant through-hole products can be processed with the following paste-through-hole Pb or Pb-free reflow process.

Max. sustain temperature :

245°C (J-STD-020C Table 4-2: Packaging Thickness>=2.5mm / Volume > 2000mm3),

Peak temperature over 245°C is not suggested due to the potential reliability risk of components under continuous high- temperature.

Min. sustain duration above 217°C : 90 seconds Min. sustain duration above 180°C : 150 seconds Max. heat up rate: 3°C/sec

Max. cool down rate: 4°C/sec

In compliance with JEDEC J-STD-020C spec for 2 times reflow requirement.

Pb-free Reflow Profile

BMP module will comply with J-STD-020 Rev. C (Moisture/Reflow Sensitivity Classification for Nonhermetic Solid State Surface Mount Devices) for both Pb- free solder profiles and MSL classification procedures. BMP will comply with JEDEC J-STD-020C specification for 3 times reflow requirement. The suggested Pb-free solder paste is Sn/Ag/Cu (SAC). The recommended linear reflow profile using Sn/Ag/Cu solder is shown in Figure 25.

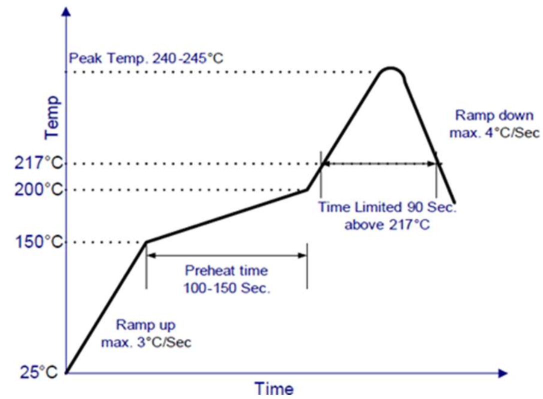


Figure 25. Recommended linear reflow profile using Sn/Ag/Cu solder

MSL Rating

The EBDW006A0U modules have a MSL rating as indicated in the Device Codes table, last page of this document.

Storage and Handling

The recommended storage environment and handling procedures for moisture-sensitive surface mount packages is detailed in J-STD-033 Rev. A (Handling, Packing, Shipping and Use of Moisture/ Reflow Sensitive Surface Mount Devices). Moisture barrier bags (MBB) with desiccant are required for MSL ratings of 2 or greater. These sealed packages should not be broken until time of use. Once the original package is broken, the floor life of the product at conditions of ≤30° C and 60% relative humidity varies according to the MSL rating (see J-STD-060A). The shelf life for dry packed SMT packages will be a minimum of 12 months from the bag seal date, when stored at the following conditions: < 40°C, < 90% relative humidity.

Post Solder Cleaning and Drying Considerations

Post solder cleaning is usually the final circuit-board assembly process prior to electrical board testing. The result of inadequate cleaning and drying can affect both the reliability of a power module and the testability of the finished circuit-board assembly. For guidance on appropriate soldering, cleaning and drying procedures, refer to the *Board Mounted Power Modules: Soldering and Cleaning* Application Note (AP01-056EPS).

Digital Feature Descriptions

PMBus Interface Capability

The EBDW006A0U series is equipped with a digital PMBus interface to allow the module to be configured and communicate with system controllers. Detailed timing and electrical characteristics of the PMBus can be found in the PMB Power Management Protocol Specification, Part 1, revision 1.2, available at http://pmbus.org. The EBDW006A0U supports both the 100kHz and 400kHz bus timing requirements. The EBDW006A0U shall stretch the clock, as long as it does not exceed the maximum clock LO period of 20ms. The EBDW006A0U will check the Packet Error Checking (PEC) byte required in all communications from the PMBus master, and the EBDW006A0U will include a PEC byte in all responses to the master.

PMBus signals are referenced to Digital Ground, a separate pin provided to enhance the noise immunity of digital signals. Digital Ground and Vin(-) may be connected together externally if desired.

There are no internal pull-up resistors on the SCL or SDA lines; these should be added externally.

The EBDW006A0U supports a subset of the commands in the PMBus 1.4 specification. Most of the controller parameters can be programmed using the PMBus and stored as defaults for later use. All commands that require data input or output use the linear format. The exponent of the data words is fixed at a reasonable value for the command and altering the exponent is not supported. Direct format data input or output is not supported by the EBDW006A0U. The supported commands are described in greater detail below.

The EBDW006A0U contains non-volatile memory that is used to store configuration settings and scale factors. The settings programmed into the device are not automatically saved into this non-volatile memory though. The STORE_DEFAULT_ALL command must be used to commit the current settings to non-volatile memory as device defaults. The settings that are capable of being stored in non-volatile memory are noted in their detailed descriptions.

PMBus Addressing

The power module can be addressed through the PMBus using a device address. The module has 64 possible addresses (0 to 63 in decimal) which can be set using resistors connected from the ADDR0 and ADDR1 pins to GND. Note that some of these addresses (0 through 12, 40, 44, 45, and 55 in decimal) are reserved and cannot be used in accordance with the SMBus specification, returning address 127.. The address is set in the form of two octal (0 to 7) digits, with each pin setting one digit. The ADDR1 pin sets the high order digit and ADDR0 sets the low order digit. The resistor values suggested for each digit are shown in Table 4 (1% tolerance resistors are recommended).

Table 4

Digit	Resistor Value (KΩ)
0	10
1	15.4
2	23.7
3	36.5
4	54.9
5	84.5
6	130
7	200

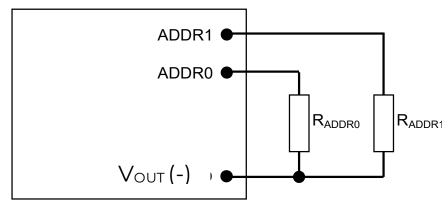
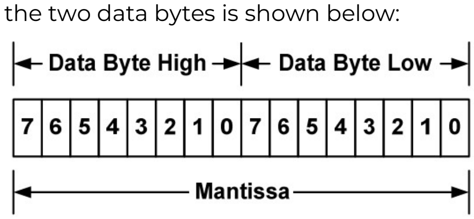


Figure 26. Circuit showing connection of resistors used to set the PMBus address of the module.

The user must know which I²C addresses are reserved in a system for special functions and set the address of the module to avoid interfering with other system operations. Both 100kHz and 400kHz bus speeds are supported by the module. Connection for the PMBus interface should follow the High Power DC specifications given in section 3.1.3 in the SMBus specification V2.0 for the 400kHz bus speed or the Low Power DC specifications in section 3.1.2. The complete SMBus specification is available from the SMBus web site, smbus.org.

PMBus Data Format

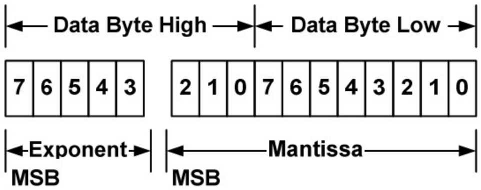
For commands that set or report any voltage thresholds related to output voltage (including VOUT_COMMAND, POWER_GOOD and READ_VOUT), the module supports the PMBus "**ULINEAR16**" data format consisting of a two byte value with a 16-bit, unsigned mantissa and a fixed exponent, -9 (decimal) in this case. The format of the two data bytes is shown below:



The value of the number is then given by

$$\text{Value} = \text{Mantissa} \times 2^{-9}$$

For commands that set all other thresholds, voltages or report such quantities, the module supports the PMBus "**LINEAR11**" data format consisting of a two byte value containing an 11-bit, two's complement mantissa and a 5-bit, two's complement exponent. The format of the two data bytes is shown below:



The value is of the number is then given by

$$\text{Value} = \text{Mantissa} \times 2^{\text{Exponent}}$$

PMBus Adjustable Input Undervoltage Lockout

The module allows adjustment of the input under voltage lockout and hysteresis. The command VIN_ON allows setting the input voltage turn on threshold, while the VIN_OFF command sets the input voltage turn off threshold. VIN_ON must be 2V greater than VIN_OFF.

Both the VIN_ON and VIN_OFF commands use the LINEAR11 format with the exponent fixed at –1 (decimal), and the 11^{th} bit fixed at zero since only positive numbers are valid. The data associated with VIN_ON and VIN_OFF can be stored to non-volatile memory using the STORE_DEFAULT_ALL command.

Factory Calibration

Values returned by READ_VIN, READ_VOUT and READ_IOUT are trailing averages of 8 samples measured at 5us intervals, corrected to null errors in the measurement & A/D conversion.

Measuring Output Voltage Using the PMBus

A reading of output voltage may be obtained using the READ_VOUT command, which returns two bytes of data in the ULINEAR16 format described above, with the exponent fixed at -9 (decimal). (Note the value of this fixed exponent is also given by the VOUT_MODE command 0x20.) .

Measuring Input Voltage Using the PMBus

A reading of input voltage may be obtained using the READ_VIN command, which returns two bytes of data in the LINEAR11 format. The input voltage is not sensed when the unit is disabled, in which case PMBus returns -255V.

Measuring Output Current Using the PMBus

A reading of output current may be obtained using the READ_IOUT command, which returns two bytes of data in the LINEAR11 format. The factory calibration of output current has an offset resolution of 125m A and a gain resolution of 0.000122.

The module measures output current using a shunt resistor, correcting the reading for temperature as well as the factory calibration. This command supports only positive current—flowing out of the positive terminal; if the converter is sinking current, a reading of 0 is provided. However negative output current is unlikely because the synchronous rectifiers operate in "diode" mode at light load.

Measuring Temperatures using the PMBus

The module can provide temperature information using the READ_TEMPERATURE_1 command,

The module's temperature sensor is located close to the internal hot spot, therefore it can typically sense temperatures higher than the heat spreader or ambient air temperature near the module. The temperature readings will be highly influenced by load and cooling conditions.

Reading the Status of the Module using the PMBus

The module supports a number of status information commands implemented in PMBus. However, not all features are supported in these commands. An 'X' in the FLAG cell indicates the bit is not supported.

STATUS_WORD returns two bytes of information with a summary of the module's fault/warning conditions:

High Byte

Bit Position	Flag	Default Value
15	VOUT fault	0
14	IOUT fault or warning	0
13	Input Voltage fault	0
12	X	0
11	POWER_GOOD# (is negated)	0
10	X	0
9	X	0
8	X	0

Low Byte

Bit Position	Flag	Default Value
7	X	0
6	OFF	0
5	VOUT Overvoltage	0
4	IOUT Overcurrent*	0
3	VIN Undervoltage	0
2	Temperature	0
1	CML (Comm. Memory Fault)	0
0	X	0

*After an over-current shutdown, sometimes the expected bits 4 & 14 are not set.

STATUS_VOUT returns one byte of information relating to the status of the module's output voltage related faults:

Bit Position	Flag	Default Value
7	VOUT OV Fault	0
6	VOUT OV Warning	0
5	X	0
4	X	0
3	X	0
2	X	0
1	X	0

0	X	0

STATUS_IOUT returns one byte of information relating to the status of the module's output current related faults:

Bit Position	Flag	Default Value
7	IOUT OC Fault*	0
6	X	0
5	IOUT OC Warning	0
4	X	0
3	X	0
2	X	0
1	X	0
0	X	0

*After an over-current shutdown, sometimes the expected bit 7 is not set.

STATUS_INPUT: Returns one byte of information relating to the status of the module's input voltage related faults.

Bit Position	Flag	Default Value
7	VIN OV Fault	0
6	X	0
5	X	0
4	VIN UV Fault	0
3	X	0
2	X	0
1	X	0
0	X	0

STATUS_TEMPERATURE: Returns one byte of information relating to the status of the module's temperature related faults.

Bit Position	Flag	Default Value
7	OT Fault	0
6	OT Warning	0
5	X	0
4	X	0
3	X	0
2	X	0
1	X	0
0	X	0

STATUS_CML: Returns one byte of information relating to the status of the module's communication related faults.

Bit Position	Flag	Default Value
7	Invalid/Unsupported Command	0
6	Invalid/Unsupported Data	0
5	Packet Error Check Failed	0
4	Memory Fault Detected	0
3	X	0
2	X	0
1	Other Communication Fault	0
0	X	0

Summary of Supported PMBus Commands

This section outlines the PMBus command support for the EBDW006A0U bus converters. Each supported command is outlined in order of increasing command codes with a quick reference table of all supported commands included at the end of the section.

Each command will have the following basic information.

Command Name [Code]
Command support
Data format
Factory default
Additional information may be provided in tabular form or other format, if necessary.

OPERATION (0x01)

Command support: On/Off Immediate and Margins (Act on Fault). Soft off with sequencing not supported and Margins (Ignore Fault) not supported. Therefore bits 6, 3, 2, 1 and 0 set as read only at factory defaults.

Format				**8 bit unsigned (bit field)**			
Bit Position	7	6	5	4	3	2	1	0
Access	r/w	r	r/w	r/w	r	r	r	r
Function	ON/OFF		Bits[5:4]		Bits[3:2]		N/A	
Default Value	1	0	0	0	0	0	0	0

ON_OFF_CONFIG (0x02)

Command support: Bit 1 polarity will be set based upon module code [0=Negative on/off logic, 1=positive on/off logic to allow customer system to know hardware on/off logic.

Format				**8 bit unsigned (bit field)**				
Bit Position	7	6	5	4	3	2	1	0
Access	r	r	r	r	r	r/w	r/w	r
Function	(reserved)	Bit 4 pu		Bit 3 cmd	Bit 2 cpr	Bit 1 pol		Bit 0 cpa
Default Value	0	0	0	1	1	1	module code	1

CLEAR_FAULTS [0x03]
Command support: All functionality

STORE_DEFAULT_ALL[0x11]
Command support: All functionality – Stores operating parameters to EEprom memory.

RESTORE_DEFAULT_ALL[0x12]
Command support: All functionality – Restores operating parameters from EEprom memory.

VOUT_MODE[0x20]
Command support: Read-only. Factory default: 0x17 – indicates linear mode with exp = -10

Format	8 bit unsigned (bit field)							
Bit Position	7	6	5	4	3	2	1	0
Access	r	r	r	r	r	r	r	r
Function	Mode[linear]			2's complement exponent				
Default Value	0	0	0	1	0	1	1	1

VOUT_COMMAND [0x21]
Data format: 16 bit unsigned mantissa (implied exponent per VOUT_MODE)
Units: volt
Command support: Read-only. Factory default: 50

VIN_ON [0x35]
Range limits (max/min): 33-36
Units: volt
Command support: All functionality. Factory default: 34

Note: Special interlock checks between VIN_ON and VIN_OFF maintain a hysteresis gap of 2V minimum and do not allow the OFF level to be higher than the ON level

VIN_OFF [0x36]
Range limits (max/min): 32-35
Units: volt
Command support: All functionality. Factory default: 32
Note: Special interlock checks between VIN_ON and VIN_OFF maintain a hysteresis gap of 2V minimum and do not allow the OFF level to be higher than the ON level

VOUT_OV_FAULT_LIMIT [0x40]
Range limits (max/min): 55-60
Command support: All functionality. Factory default: 59
Note: Range cross- check – value must be greater than VOUT_COMMAND value.

VOUT_OV_FAULT_RESPONSE [0x41]
Command support:

- Response settings (bits RSP0:1) – only a setting of 10, unit shuts down and responds according to the retry settings below, is supported.
- Retry settings (bits RS0:2) – only settings of 000 (unit does not attempt to restart on fault) and 111 unit continuously attempts to restart (normal startup) until commanded off, bias power is removed or another fault condition causes the unit to shut down.
- Delay time setting (bits 0-2) – only DT0:2 = 000 (no delay) supported.

Default Settings for auto-restart option:

- The unit shuts down in response to a VOUT over voltage condition.
- The unit will continuously restart (normal startup) while the VOUT over voltage condition is present until it is commanded off, bias power is removed or another fault condition causes the unit to shut down.
- The shutdown delay is set to 0 delay cycles.

Default Settings for latch-off option:

- The unit shuts down in response to a VOUT over voltage condition.
- The unit does not attempt to restart.
- The shutdown delay is set to 0 delay cycles.

Format	8 bit unsigned (bit field)							
Bit Position	7	6	5	4	3	2	1	0
Access	r	r	r/w	r/w	r/w	r	r	r
Function	RSP[1]	RSP[0]	RS[2]	RS[1]	RS[0]	DT[2]	DT[1]	DT[0]
Default for auto-restart option	1	0	1	1	1	0	0	0
Default for latch-off option	1	0	0	0	0	0	0	0

VOUT_OV_WARN_LIMIT [0x42]
Range limits (max/min) : 55-60
Units: volt
Command support: All functionality. Factory default: 55
Note: Range cross- check – value must be greater than VOUT_COMMAND value and less than VOUT_OV_FAULT_LIMIT.

IOUT_OC_FAULT_LIMIT [0x46]
Range limits (max/min): 6.6-9
Units: amp
Command support: All functionality. Factory default: 8
Note: Range cross-check – value must be greater than IOUT_OC_WARN_LIMIT value.

IOUT_OC_FAULT_RESPONSE [0x47]
Command support:
- Response settings (bits RSP0:1) – only settings of 11, unit shuts down and responds according to the retry settings below, is supported.
- Retry settings (bits RS0:2) – only settings of 000 (unit does not attempt to restart on fault) and 111 unit continuously restarts (normal startup) while fault is present until commanded off, bias power is removed or another fault condition causes the unit to shut down.
- Delay time setting (bits 0-2) – only DT0:2 = 000 (no delay) supported.

Default Settings for auto-restart option:
- The unit shuts down in response to an IOUT over current condition.
- The unit will continuously restart (normal startup) while the IOUT over current condition is present until it is commanded off, bias power is removed or another fault condition causes the unit to shut down.
- The shutdown delay is set to 0 delay cycles.

Default Settings for latch-off option:
- The unit shuts down in response to an IOUT over current condition.
- The unit does not attempt to restart.
- The shutdown delay is set to 0 delay cycles.

Format	8 bit unsigned (bit field)							
Bit Position	7	6	5	4	3	2	1	0
Access	r	r	r/w	r/w	r/w	r	r	r
Function	RSP[1]	RSP[0]	RS[2]	RS[1]	RS[0]	DT[2]	DT[1]	DT[0]
Default for auto-restart option	1	1	1	1	1	0	0	0
Default for latch-off option	1	1	0	0	0	0	0	0

IOUT_OC_WARN_LIMIT [0x4A]
Range limits (max/min): 6.6 - 9
Units: amp
Command support: All functionality. Factory default: 7
Note: Range cross-check – value must be less than IOUT_OC_FAULT_LIMIT value.

OT_FAULT_LIMIT [0x4F]
Range limits (max/min): 25-140
Units: degrees C.
Command support: All functionality. Factory default: 133
Note: Range cross-check – value must be greater than OT_WARN_LIMIT value.

OT_FAULT_RESPONSE [0x50]
Command support: Read only
- Response settings (bits RSP0:1) – only setting of 10, unit shuts down and responds according to the retry settings below.
- Retry settings (bits RS0:2) – only settings of 000 (unit does not attempt to restart on fault) and 111 unit continuously restarts (normal startup) while fault is present until commanded off, bias power is removed or another fault condition causes the unit to shut down.
- Delay time setting (bits 0-2) – only DT0:2 = 0 (no delay) supported.

Settings: The default settings for the OT_FAULT_RESPONSE command are;
- The unit shuts down in response to an over-temperature condition.
- The unit attempts to restart after the temperature falls below the OT Fault Limit minus hysteresis.
- The shutdown delay is set to 0 delay cycles.

Format	8 bit unsigned (bit field)							
Bit Position	7	6	5	4	3	2	1	0
Access	r	r	r/w	r/w	r/w	r	r	r
Function	RSP[1]	RSP[0]	RS[2]	RS[1]	RS[0]	DT[2]	DT[1]	DT[0]
Default Value	1	0	1	1	1	0	0	0

OT_WARN_LIMIT [0x51]

Range limits (max/min): 25-140
Units: degrees C.
Command support: All functionality. Factory default: 116
Note: Range cross-check – value must be less than OT_FAULT_LIMIT value.

VIN_OV_FAULT_LIMIT [0x55]

Range limits (max/min):48-80
Units: volt
Command support: All functionality. Factory default: 80

VIN_OV_FAULT_RESPONSE [0x56]

Command support: Read only

- Response settings (bits RSP0:1) – only setting of 11 is supported (output is disabled while the fault is present; operation resumes when the fault is removed).
- Retry settings (bits RS0:2) – only setting of 000 is supported (but has no effect)
- Delay time setting (bits 0-2) – only DT0:2 = 0 (no delay) supported.

Default Settings: The default settings for the VIN_OV_FAULT_RESPONSE command are;

- The unit shuts down in response to a VIN over voltage condition.
- The unit continuously prepares to restart (normal startup) while the VIN over voltage condition is present until it is commanded off, bias power is removed, the VIN over voltage condition is removed, or another fault condition causes the unit to shutdown.
- The shutdown delay is set to 0 delay cycles.

Format	8 bit unsigned (bit field)							
Bit Position	7	6	5	4	3	2	1	0
Access	r	r	r	r	r	r	r	r
Function	RSP[1]	RSP[0]	RS[2]	RS[1]	RS[0]	DT[2]	DT[1]	DT[0]
Default Value	1	1	1	1	1	0	0	0

POWER_GOOD_ON [0x5E]

Range limits (max/min): 55/25
Units: volt
Command support: full support. Factory default: 42
Note: Range cross-check – value must be greater than POWER_GOOD_OFF value by 0.25V.

POWER_GOOD_OFF [0x5F]

Range limits (max/min): 53/23
Command support: full support. Factory default: 40
Note: Range cross-check – value must be less than POWER_GOOD_ON value by 0.25V.

STATUS_WORD [0x79]

Command support: full implementation except bits marked (1) below
Note: After an over-current shutdown, sometimes the expected bits 4 & 14 are not set.

Format	8 bit unsigned (bit field)							
Bit Position	15	14	13	12	11	10	9	8
Access	r	r	r	r	r	r	r	r
Function	VOUT	I/POUT	INPUT	MFR_SPEC(1)	#PWR_GOOD	FANS(1)	OTHER(1)	UNKNOWN(1)

Format	8 bit unsigned (bit field)							
Bit Position	7	6	5	4	3	2	1	0
Access	r	r	r	r	r	r	r	r

Function	BUSY(1)	OUTPUT _OFF	VOUT_ OV _FAULT	IOUT_OC _FAULT	VIN_UV _FAULT	TEMP	CML	NONE OF ABOVE(1)

(1) Not supported

STATUS_VOUT [0x7A]

Command support: except bits marked (1); all-bit reset supported with Clear Faults Command; individual bit reset not supported

Format	8 bit unsigned (bit field)							
Bit Position	7	6	5	4	3	2	1	0
Access	r/reset	r/ reset	r/ reset	r/ reset	r/ reset	r/ reset	r/ reset	r/ reset
Function	VOUT_OV _FAULT	VOUT_OV _WARN	VOUT_UV _WARN(1)	VOUT_UV _FAULT(1)	VOUT_ MAX _WARN(1)	TON_ MAX_ FAULT(1)	TOFF_ MAX_ WARN(1)	VOUT TRACKING ERROR(1)

(1) Not supported

STATUS_IOUT [0x7B]

Command support: except bits marked (1); all-bit reset supported with Clear Faults Command; individual bit reset not supported

Note: After an over-current shutdown, sometimes the expected bit 7 is not set.

Format	8 bit unsigned (bit field)							
Bit Position	7	6	5	4	3	2	1	0
Access	r/ reset	r/ reset	r/ reset	r/ reset	r/ reset	r/ reset	r/ reset	r/ reset
Function	IOUT_OC _FAULT	IOUT_OC _LV _FAULT(1)	IOUT_OC _WARN	IOUT_UC _FAULT(1)	Current Share Fault(1)	In Power Limiting Mode(1)	POUT_OP _FAULT(1)	POUT_OP _WARN(1)

(1) Not supported

STATUS_INPUT [0x7C]

Command support: except bits marked (1); all-bit reset supported with Clear Faults Command; individual bit reset not supported

Format	8 bit unsigned (bit field)							
Bit Position	7	6	5	4	3	2	1	0
Access	r/ reset	r/ reset	r/ reset	r/ reset	r/ reset	r/ reset	r/ reset	r/ reset
Function	VIN_OV _FAULT	VIN_OV _WARN(1)	VIN_UV _WARN(1)	VIN_UV _FAULT	Unit Off (low input voltage)(1)	IIN_OC _FAULT(1)	IIN_OC _WARN(1)	PIN_OP _WARN(1)

(1) Not supported

STATUS_TEMPERATURE [0x7D]

Command support: except bits marked (1); all-bit reset supported with Clear Faults Command; individual bit reset not supported

Format	8 bit unsigned (bit field)							
Bit Position	7	6	5	4	3	2	1	0
Access	r/ reset	r/ reset	r/ reset	r/ reset	r/ reset	r/ reset	r/ reset	r/ reset
Function	OT_ FAULT	OT_ WARN	UT_ WARN(1)	UT_ FAULT(1)	reserved	reserved	reserved	reserved

(1) Not supported

STATUS_CML [0x7E]

Command support: PEC_FAILED, INVALID_DATA, INVALID_CMD supported; all-bit reset supported with Clear Faults Command

Format	8 bit unsigned (bit field)							
Bit Position	7	6	5	4	3	2	(1)	0
Access	r/ reset	r/ reset	r/ reset	r/ reset	r/ reset	r/ reset	r/ reset	r/ reset
Function	INVALID CMD	INVALID DATA	PEC FAILED	MEMORY FAULT	PROC FAULT(1)	reserved	COM FAULT (other)	Memory/ Logic fault (other)(1)

(1) Not supported

READ_VIN [0x88]
Command support: full support

READ_VOUT [0x8B]
Command support: full support

READ_IOUT [0x8C]
Command support: full support

READ_TEMPERATURE_1 [0x8D]
Command support: full support

PMBUS_REVISION [0x98]
Command support: Read-only
Part I Revision: 1.2
Part II Revision: 1.2

Format	8 bit unsigned (bit field)							
Bit Position	7	6	5	4	3	2	1	0
Access	r	r	r	r	r	r	r	r
Function	Part I Revision				Part II Revision			
Default Value	0	0	1	0	0	0	1	0

MFR_LOCATION [0x9C]
Value: 12 Bytes – 8 bits
Units: N/A
Command support: full read support

MFR_DATE [0x9D]
Value: 6 Bytes – 8 bits
Units: N/A
Command support: full read support

MFR_SERIAL [0x9E]
Value: 18 Bytes – 8 bits
Units: N/A
Command support: full read support

MFR_DEVICE_TYPE [0xD0]
Command support: partial support in place (Mod Name)

Format	Unsigned Binary															
Bit Pos.	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Access	r	r	r	r	r	r	r	r	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w
Function	Reserved								Module Name						WPE	Res
Default	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

Byte	Bit	Description	Value	Meaning
High Byte	7:0	Reserved		
Low Byte	7:2	Module Name	1xxxxx	Module Name
	1	WPE	0	Write Protect Enable not active.

			1	Write Protect Enable active.
	0	Reserved	0	Reserved

Present module designations (Non-isolated units will have a 1XXXXX format)
• EBDW006A0Uxxx: 110111

MFR_FW_REV [0xDB]

Value: 2 Bytes – 16 bit unsigned
Units: N/A
Command support: full read support
Example:

MFR_C1_C2_ARA_CONFIG [0xE0]

Command support: read/write support for 1 byte block,
Factory default: 0x00

MFR_C2_LOGIC [0xE1]

Command support: read/write support for 1 byte block,
Factory default: 0x00

MFR_PGOOD_POLARITY [0xE2]

Command support: read/write support for 1 byte block,
Factory default: 0x01

MFR_MODULE_DATE_LOC_SN [0xF0]

Command support: read/write support for 12 byte block, lockout per MFR_DEVICE_TYPE
Factory default: “YYLLWW123456”

PMBus Command Quick Reference Table

PMBus Command	CMD	Bytes	Data Format	Units	Transfer	Min	Max	Default
OPERATION	0x01	1	Bit field	N/A	R/W byte			0x80
ON_OFF_CONFIG	0x02	1	Bit field	N/A	R/W byte			0x1D (Neg Logic) 0x1F (Pos Logic)
CLEAR_FAULTS	0x03	0	N/A	N/A	Send byte			none
STORE_DEFAULT_ALL	0x11	0	N/A	N/A	Send byte			none
RESTORE_DEFAULT_ALL	0x12	0	N/A	N/A	Send byte			none
VOUT_MODE	0x20	1	mode + exp	N/A	Read byte			0x17
VOUT_COMMAND	0x21	2	VOUT linear	Volts	R/W word	25	55	50.0V (Std code)
VOUT_CAL_OFFSET	0x23	2	VOUT linear	Volts	R/W word			MS
VOUT_MARGIN_HIGH	0x25	2	VOUT linear	Volts	R/W word	42	55	52.0V
VOUT_MARGIN_LOW	0x26	2	VOUT linear	Volts	R/W word	42	55	48.0V
FREQUENCY_SWITCH	0x33	2	linear	KHz	Read word	140	200	200kHz
VIN_ON	0x35	2	linear	V	R/W word	33	36	34V
VIN_OFF	0x36	2	linear	V	R/W word	32	35	32V
VOUT_OV_FAULT_LIMIT	0x40	2	VOUT linear	V	R/W word	55	60	59.0V
VOUT_OV_FAULT_RESPONSE	0x41	1	Bit field	N/A	R/W byte			0xB8
VOUT_OV_WARN_LIMIT	0x42	2	VOUT linear	V	R/W word	55	60	55V
IOUT_OC_FAULT_LIMIT	0x46	2	linear	Amps	R/W word	6.6	9	8.0 A
IOUT_OC_FAULT_RESPONSE	0x47	1	Bit field	N/A	R/W byte			0xF8
IOUT_OC_WARN_LIMIT	0x4A	2	linear	Amps	R/W word	6.6	9	7.0A
OT_FAULT_LIMIT	0x4F	2	linear	Deg. C	R/W word	25	140	133C
OT_FAULT_RESPONSE	0x50	1	Bit field	N/A	R/W byte			0xB8
OT_WARN_LIMIT	0x51	2	linear	Deg. C	R/W word	25	140	116C
VIN_OV_FAULT_LIMIT	0x55	2	linear	V	R/W word	48	80	80V
VIN_OV_FAULT_RESPONSE	0x56	1	Bit field	N/A	R/W byte			0xF8
POWER_GOOD_ON	0x5E	2	VOUT linear	V	R/W word	25	55	42

PMBus Command Quick Reference Table (Continued)

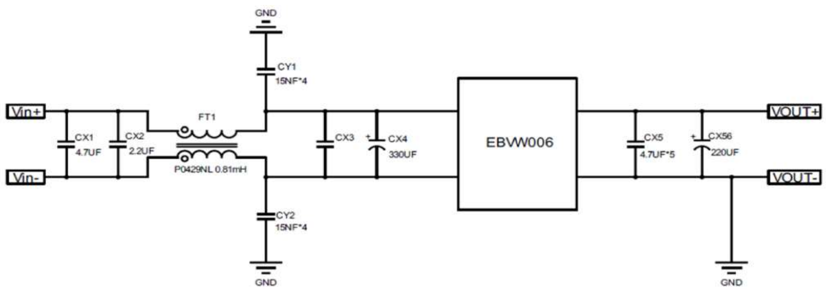
PMBus Command	CMD	Bytes	Data Format	Units	Transfer	Min	Max	Default
POWER_GOOD_OFF	0x5F	2	VOUT linear	V	R/W word	23	53	40
TON_DELAY	0x60	2	linear	msec	R/W word	0	500	0ms
TON_RISE	0x61	2	linear	msec	R/W word	12	500	15ms
STATUS_WORD	0x79	2	Bit field	N/A	Read word			N/A
STATUS_VOUT	0x7A	1	Bit field	N/A	Read byte			N/A
STATUS_IOUT	0x7B	1	Bit field	N/A	Read byte			N/A
STATUS_INPUT	0x7C	1	Bit field	N/A	Read byte			N/A
STATUS_TEMPERATURE	0x7D	1	Bit field	N/A	Read byte			N/A
STATUS_CML	0x7E	1	Bit field	N/A	Read byte			N/A
READ_VIN	0x88	2	linear	v	Read word			N/A
READ_VOUT	0x8B	2	VOUT linear	v	Read word			N/A
READ_IOUT	0x8C	2	linear	Amps	Read word			N/A
READ_TEMP1	0x8D	2	linear	Deg. C	Read word			N/A
PMBUS_REVISION	0x98	1	Bit Field	n/a	Read byte			0x22
MFR_ID	0x99	5	8 bit char	N/A	Read block			OMPW
MFR_MODEL	0x9A	18	8 bit char	N/A	Read block			MS (Module-Specific)
MFR_REVISION	0x9B	8	8 bit char	N/A	Read block			MS
MFR_LOCATION	0x9C	12	8 bit char	N/A	Read block			MS
MFR_DATE	0x9D	6	8 bit char	N/A	Read block			MS
MFR_SERIAL	0x9E	18	8 bit char	N/A	Read block			MS
MFR_DEVICE_TYPE	0xD0	2	Custom	N/A	R/W word			0x00DE
MFR_VOUT_READ_CAL_GAIN	0xC1	2	16 bit unsigned	N/A	R/W word			MS (Module-Specific)
MFR_VOUT_READ_CAL_OFFSET	0xC2	2	mod VOUT linear	N/A	R/W word			MS

PMBus Command Quick Reference Table (Continued)

PMBus Command	CMD	Bytes	Data Format	Units	Transfer	Min	Max	Default
MFR_VIN_READ_CAL_GAIN	0xD3	2	16 bit unsigned	N/A	R/W word			MS
MFR_VIN_READ_CAL_OFFSET	0xD4	2	linear	N/A	R/W word			MS
MFR_IOUT_CAL_GAIN	0xD6	2	16 bit unsigned	N/A	R/W word			MS
MFR_IOUT_CAL_OFFSET	0xD7	2	linear	N/A	R/W word			MS
MFR_FW_REV	0xDB	2	16 bit unsigned	N/A	Read byte			MS
MFR_C1_C2_ARA_CONFIG	0xE0	1	Bit field	N/A	R/W byte			0x00
MFR_ C2_LOGIC	0xE1	1	Bit field	N/A	R/W byte			0x00
MFR_PGOOD _POLARITY	0xE2	1	Bit field	N/A	R/W byte			0x01
MFR_MOD_DATE_LOC_SN	0xF0	12	8 bit char	N/A	R/W block			YYLLWW123456

EMC Considerations

The circuit and plots in Figure 27 shows a suggested configuration to meet the conducted emission limits of EN55022 Class A.



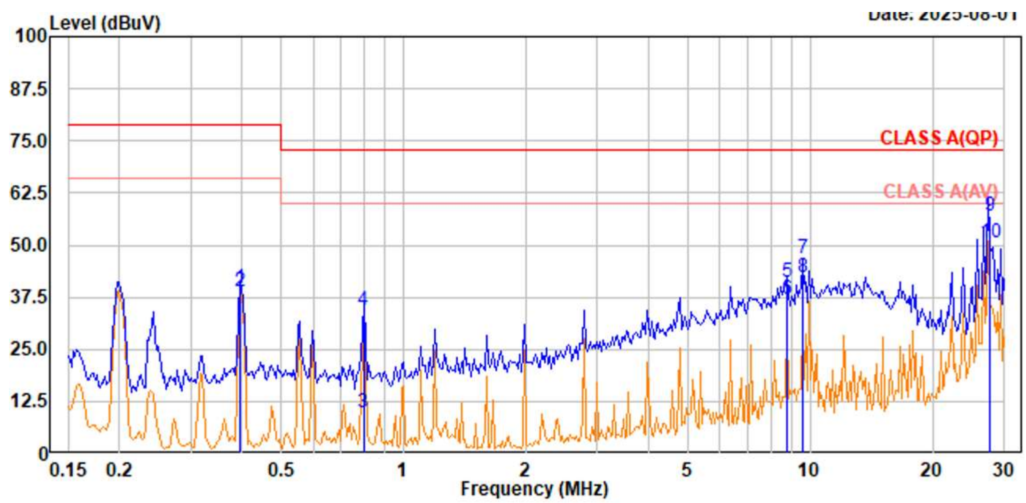
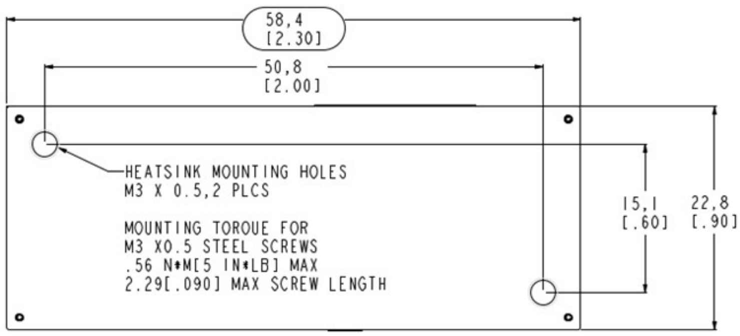


Figure 27. EMC Considerations

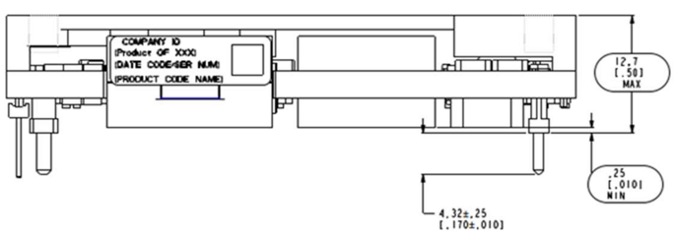
Mechanical Outline for EBDW006A0U941– HZ (Baseplate version) Module

Dimensions are in millimeters and [inches].
Tolerances: x.x mm ± 0.5 mm [x.xx in. ± 0.02 in.] (Unless otherwise indicated)
x.xx mm ± 0.25 mm [x.xxx in ± 0.010 in.]
x.xxx mm ± 0.1 mm [x.xxxx in ± 0.004 in.]

Top View*

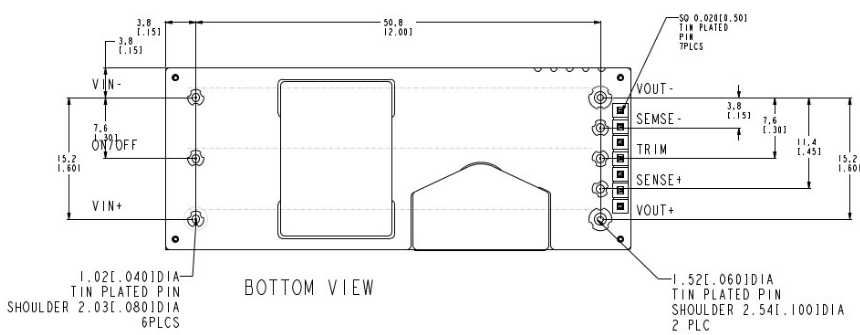


Side View



*For optional pin lengths, see Table 2, Device Coding Scheme and Options

Side view label includes OmniOn Power n a m e , product designation and date code.



Bottom View

Pin	Function
1	VIN(+)
2	ON/OFF
3	VIN(-)
4	VOUT(-)
5	SENSE(-)
6	TRIM/C1
7	SENSE(+)
8	VOUT(+)
9	C2
10	SGND
11	DATA
12	SMBALERT
13	CLK
14	ADDR1
15	ADDR0

† - Optional Pins, when including “9” Option, See Table 2

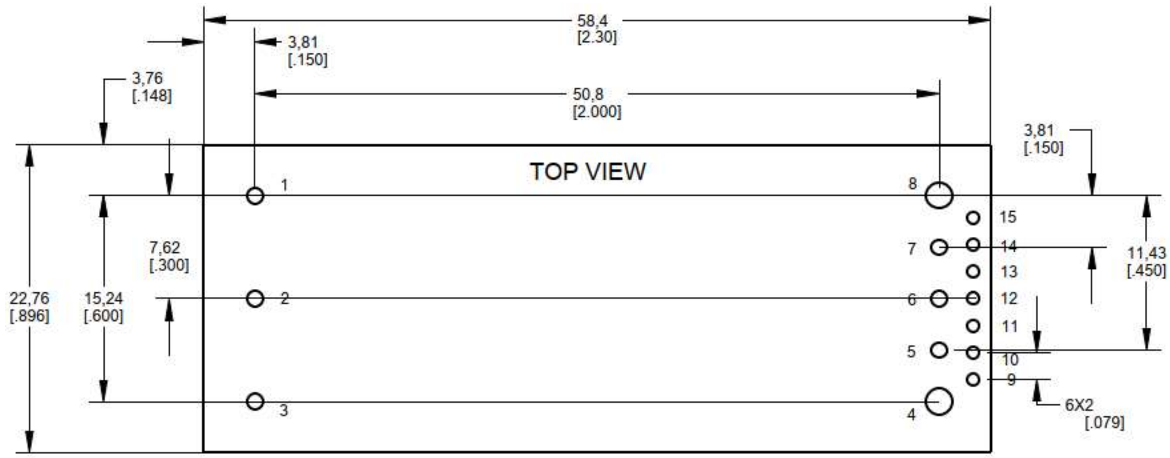
Recommended Pad Layouts

Dimensions are in millimeters and [inches].

Tolerances: x.x mm ± 0.5 mm [x.xx in. ± 0.02 in.[(unless otherwise indicated)
x.xx mm ± 0.25mm [x.xxx in ± 0.010 in.]
x.xxx mm ± 0.1 mm [x.xxxx in ± 0.004 in.]

Through-Hole Module

[as below except pin 6 is TRIM/C1, pin 9 is PG/C2]



Hole and Pad diameter recommendations:

Pin Number	Hole Dia mm [in]	Pad Dia mm [in]
1, 2, 3, 5, 6, 7	1.6[.063]	2.1 [.083]
4, 8	2.2[.087]	3.2 [.126]
9 - 15	1.0[.039]	1.5[.059]

Packaging Details

All versions of the EBDW006A0U are supplied as standard in the plastic trays shown in Figure 28. Each tray contains a total of 18 power modules. The trays are self-stacking and each shipping box for the EBDW006A0B module contains 2 full trays plus one empty hold-down tray giving a total number of 36 power modules.

Tray Specification

Material	PET (1mm)
Max surface resistivity	10^{9} -$10^{11}\Omega$/PET
Capacity	18 power modules
Min order quantity	36 pcs (1 box of 2 full trays + 1 empty top tray)

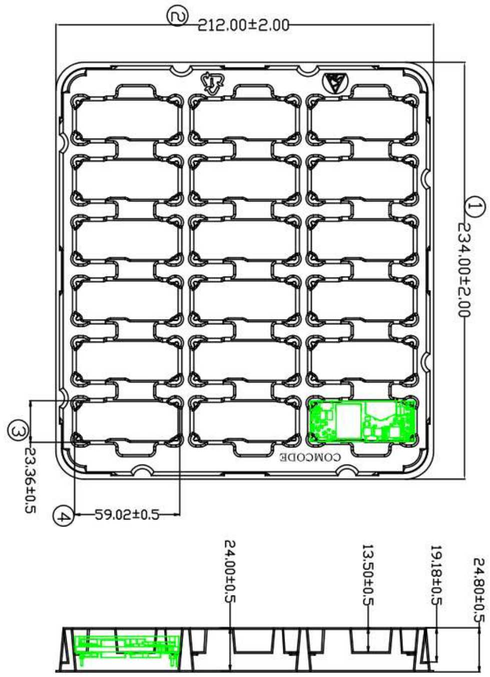


Figure 28. EBDW006A0U Packaging Tray

EBDW006A0U Data Sheet

Ordering Information

Please contact your Sales Representative for pricing, availability and optional features.

Table 1. Device Codes

Product Code	Input Voltage	Output Voltage	Output Current	Efficiency	Connector Type	MSL Rating	Ordering codes
EBDW006A0U941-HZ	48V (36-72Vdc)	50V	6A	95.5%	Through hole	2a	1600487209A

Table 2. Device Options

	Characteristic	Character and position	Definition
Ratings	Form Factor	E	E = Eight Brick
	Family Designator	BD	BD = BARRACUDA Series with PMBus interface
	Input Voltage	W	W = Wide Range, 36V-75V
	Output Current	006A0	006AO = 6.0 Amps Maximum Output Current
	Output Voltage	U	U = 50.0V nominal
Options	Trim and Remote Sense Pins	9	Omit = Exclude Trim & Sense Feature and Pins 9 = Include Trim and Sense Feature and Pins (not avail. w/ P option)
	Pin Length	8 6	Omit = Default Pin Length shown in mechanical Outline Figures 8 = Pin Length: 2.79 mm ±0.25mm (0.110 in.±0.010 in.) 6 = Pin Length: 3.68 mm ±0.25mm (0.145 in.÷0.010 in.)
	Action following Protective Shutdown	4	Omit = Latching Mode 4 = Auto – restart following shutdown (Overcurrent/Overvoltage)
	On/Off Logic	1	Omit = Positive Logic 1 = Negative Logic
		–	
	Customer Specific	XY	XY = Customer Specific Modified Code, Omit for Standard Code
	Optional Features	P H	Omit = Standard open Frame Module P = Forced Droop Output for use in parallel applications (not avail. w/ 9 option) H= Heat plate, for use with heat sinks or cold-walls
	RoHS	Z	Omit = RoHS 5/6 Lead Based Solder Used Z = RoHS Complaint

Table 3. Orderable Accessories

Manufacturer Part Number	Ordering Code	Description
BLANK EVAL BOARD for Digital J-Q-E-K modules	150024004	Evaluation Board with FPLX030 module
I2C_USB_DONGLE_2.X_WITH_CABLES	150036482	USB dongle and cables required for use of Digital Power Insights software. Evaluation board is not included.

Change History (excludes grammar and clarifications)

Revision	Date	Description of the change
1.0	10/31/2025	Initial Release
2.0	12/17/2025	First public release

EBDW006A0U Data Sheet

OmniOn Power Inc.

601 Shiloh Rd.
Plano, TX USA

omnionpower.com