PRELIMINARY

DATEL
A C&D TECHNOLOGIES COMPANY

Single Output
RBC Models

RoHS COMPLIANT 2002/95/EC

48VIN, 12V/25A Output Quarter Brick, Regulated Bus Converter

Features

- Up to 300 Watts total output power
- To 93% Ultra-high efficiency @ full load
- 48V Input (up to 36-75V range)
- 12V/25A Output for Intermediate Bus Architectures with POL converters
- Synchronous-rectifier topology
- 300kHz fixed switching frequency
- Fully isolated, 1500V (BASIC)
- Low 35mVp-p ripple/noise
- 2.3" x 1.45" x 0.39" quarter brick
- Stable no-load condition
- Thermal shutdown
- Fully I/O protected
- IEC/EN/UL/cUL60950 certification pending

Optimized for distributed power Intermediate Bus Architectures (IBA), the RBC-12/25-D48 DC/DC bus converter series offer partially regulated outputs (±2.5%, line and load) in an industry-standard quarter brick open frame package at excellent prices. The present trend in distributed power architectures (DPA) requires both high efficiency and some regulation of the output voltage to reduce the risk of under voltage dropout. Earlier unregulated bus converters were simply ratiometric “DC transformers.”

The fully isolated (1500Vdc) RBC series accept a wide range 36 to 75 Volt DC input (48V nominal) and convert it to an output of 12Vdc at 25 Amps maximum. This output then drives point-of-load (POL) converters such as our LSN, LEN, LSM or LQN series which feature precise load regulation. Applications include 48V-powered datacom and telecom installations, base stations, cellular telephone repeaters and embedded systems. Wideband output ripple and noise is a low 35mVp-p. Low overall height of 0.39" (9.9 mm) fits tight card cages.

The RBC’s synchronous-rectifier topology and fixed frequency operation means excellent efficiencies up to 93%, enabling “no heatsink” operation for most applications up to +70°C (400 LFM airflow). “No fan” or zero airflow applications may use the optional base plate for cold surface mounting or natural-convection heatsinks.

A wealth of electronic protection features include input undervoltage (UV) lockout, output current limit, short circuit hiccup, overtemperature shutdown and output overvoltage. Available options include positive or negative polarity remote On/Off control and the baseplate. Assembled using ISO-certified automated surface-mount techniques, the RBC series includes all FCC, UL, and IEC emissions, safety and flammability certifications.

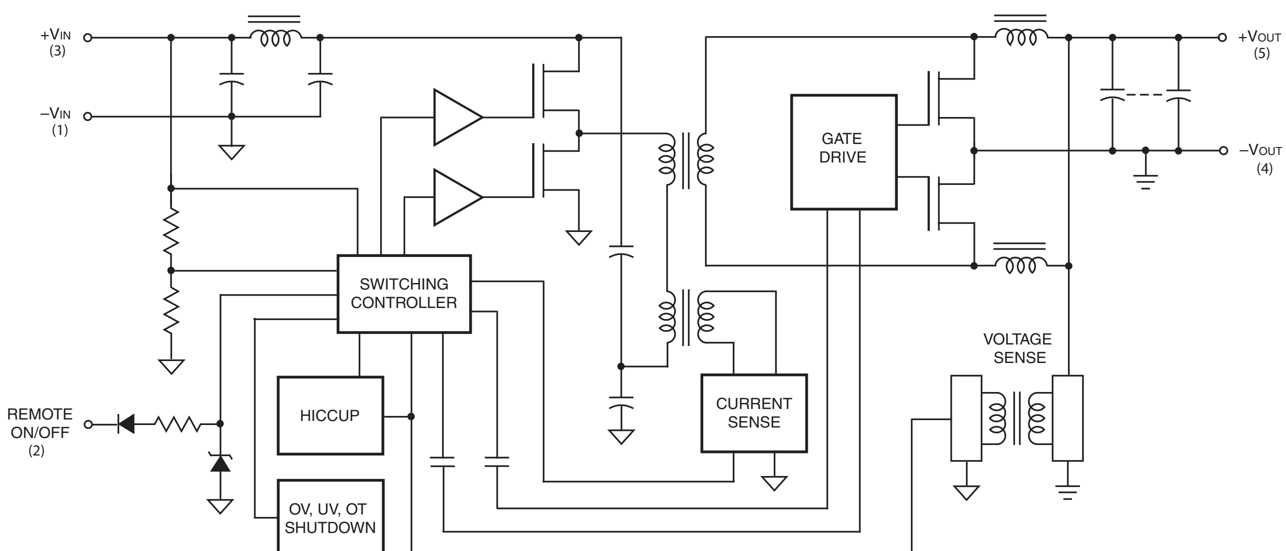
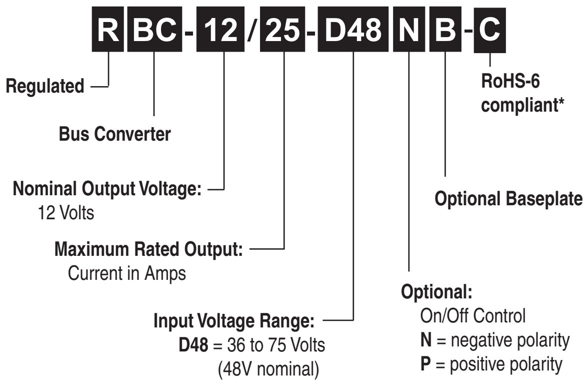


Figure 1. Simplified Schematic

PART NUMBER STRUCTURE



* Contact C&D Technologies (Datel) for availability.

Note:
Not all model number combinations are available.
Contact C&D Technologies for ordering assistance

CAUTION – This converter is not internally fused. To avoid danger to persons or equipment and to retain safety certification, the user must connect an external fast-blow input fuse as listed in the specifications. Be sure that the PC board pad area and etch size are adequate to provide enough current so that the fuse will blow with an overload.

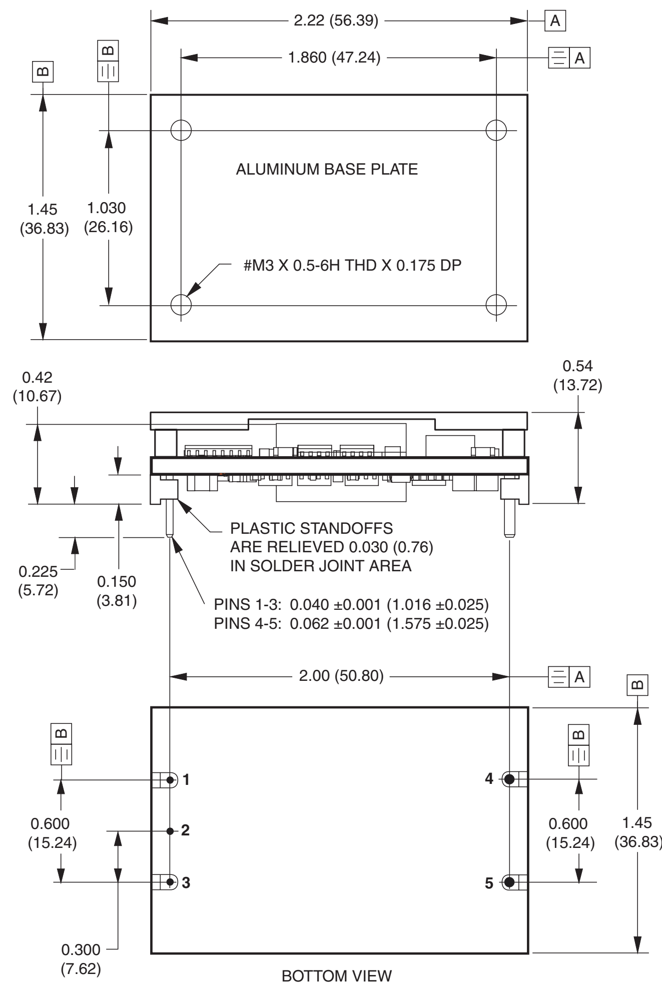
Start Up Considerations

When power is first applied to the DC/DC converter, there is some risk of start up difficulties if you do not have both low AC and DC impedance and adequate regulation of the input source. Make sure that your source supply does not allow the instantaneous input voltage to go below the minimum voltage at all times. Even if this voltage depression is very brief, this may interfere with the on-board controller and possibly cause a failed start.

Use a moderate size capacitor very close to the input terminals. You may need two parallel capacitors. A larger electrolytic or tantalum cap supplies the surge current and a smaller parallel low-ESR ceramic cap gives low AC impedance.

Remember that the input current is carried both by the wiring and the ground plane return. Make sure the ground plane uses adequate thickness copper. Run additional bus wire if necessary.

MECHANICAL SPECIFICATIONS



BOTTOM VIEW
DIMENSIONS ARE IN INCHES (MM)

I/O Connections	
Pin	**Function P65**
1	–Input
2	Remote On/Off
3	+Input
4	–Output
5	+Output

Performance/Functional Specifications

Typical at T_A = +25°C under nominal input voltage and full-load conditions unless noted.
Refer to required airflow and Derating curves for thermal specifications. [1]

Input	
Input Voltage Range	See ordering guide
Recommended External Fuse	20 Amp fast blow
Start-up Threshold	35.5V
Undervoltage shutdown	34.0V min., 38.5 V max.
Overvoltage shutdown	None [note 12]
Input Current, nominal	See ordering guide
Input Current, V_{IN} = V_{MIN}	9.14 Amps max.
Input Current, shut-down mode	2mA max.
Inrush Transient	0.05A²-seconds
Reflected Ripple Current [2]	10mAp-p
Internal Filter Type	Pi filter
Reverse Polarity Protection	None (see note 11)
Remote On/Off Control [5]	
Positive Logic	On = +3.5 to +13.5 V. Off = Gnd. Pin or 0 to +1V.
Negative Logic	On = Gnd. Pin or 0 to +1V. Off = Pin open or +3.5V to +13.5V.
Current	2mA max.
Output	
Total Output Power [3]	306 Watts max.
Setpoint Accuracy (50% load)	±2% of $V_{NOMINAL}$
Extreme Accuracy [14]	11.4V min. to 12.6V max.
Output Current [7]	See ordering guide
Minimum Load	No minimum load
Ripple and Noise (20MHz bandwidth)	See ordering guide [8]
Line and Load Regulation [10]	See ordering guide
Efficiency	See ordering guide
Isolation Voltage (Input/output) (Input to baseplate) (Baseplate to output)	1500Vdc min. 1500Vdc min. 1500Vdc min.
Isolation Resistance	100MΩ
Isolation Capacitance	1000pF
Isolation Safety Rating	Basic
Current Limit Inception (98% of V_{OUT})	30 Amps after warm up
Short Circuit Current [6]	5 Amps (hiccup autorestart – remove short for recovery)
Short Circuit Duration (+V_{OUT} grd)	Continuous, no damage
Overvoltage Protection	15Vdc max. via magnetic feedback
Max. Capacitive Loading (resistive load)	10,000µF, low ESR 0.02 Ohms
Temperature Coefficient	±0.02% per °C
Dynamic Characteristics	
Dynamic Load Response (to within 2% of V_{OUT})	500µsec, 50-75-50% load step
Start Up Time	
(V_{IN} to V_{OUT} regulated)	60msec
(Remote On to Vout regulated)	20msec
Fixed Switching Frequency	300kHz
Environmental	
Calculated MTBF [4]	TBD
Operating PCB Temperature [13]	+120°C max.
Electronic Thermal Shutdown	+125°C min.
Operating Temperature Range [9] (No derating, full power, 400 LFM airflow, vertical mount)	–40 to +70°C
Operating Temperature Range (With Derating)	See Derating curves
Storage Temperature Range	–55 to +125°C
Relative Humidity	To 85% / +85°C
Safety Compliance	UL60950, CSA-C22.2 No.60950, IEC/EN60950
Electromagnetic Interference (may require external filters)	FCC part 15, EN55022, conducted or radiated
Physical	
Outline Dimensions	See mechanical specifications
Pin Material	Copper alloy over nickel underplate
Weight	1 ounce (28.4 grams)

Absolute Maximum Ratings	
Input Voltage:	
Continuous	75 Volts
Transient (100msec max.)	100 Volts
Input Reverse-Polarity Protection	None, see notes
Output Current ⑨	Current limited. Devices can withstand an indefinite output short circuit without damage.
Storage Temperature	–55 to +125°C
Lead Temperature (soldering, 10 sec.)	+280°C

These are stress ratings. Exposure of devices to any of these conditions may adversely affect long-term reliability. Proper operation under conditions other than those listed in the Performance/Functional Specifications Table is not implied.

(1) All models are tested and specified with 400 LFM airflow, external 1 || 10µF ceramic/tantalum output capacitors and no external input capacitor. All capacitors are low ESR types. These capacitors are necessary to accommodate our test equipment and may not be required to achieve specified performance in your applications. All models are stable and regulate within spec under no-load conditions.
General conditions for Specifications are +25°C, V_{IN} = nominal, V_{OUT} = nominal, full load.

(2) Input Ripple Current is tested and specified over a 5 Hz to 20 MHz bandwidth. Input filtering is C_{IN} = 33µF/100V tantalum, C_{BUS} = 220µF/100V electrolytic, L_{BUS} = 12µH.

(3) Note that Maximum Power Derating curves indicate an average current at nominal input voltage. At higher temperatures and/or lower airflow, the DC/DC converter will tolerate brief full current outputs if the total RMS current over time does not exceed the Derating curve. All Derating curves are presented at sea level altitude. Be aware of reduced power dissipation with increasing density altitude.

(4) Mean Time Before Failure is calculated using the Telcordia (Belcore) SR-332 Method 1, Case 3, ground fixed conditions, $T_{PCBOARD}$ = +25°C, full output load, natural air convection.

(5) The On/Off Control may be driven with external logic or by applying appropriate external voltages which are referenced to Input Common. The On/Off Control Input should use either an open collector/open drain transistor or logic gate which does not exceed +13.5V.

(6) Short circuit shutdown begins when the output voltage degrades approximately 2% from the selected setting.

(7) The outputs are not intended to sink appreciable reverse current. Sinking excessive reverse current may damage the outputs.

(8) Output noise may be further reduced by adding an external filter. See I/O Filtering and Noise Reduction.

(9) All models are fully operational and meet published specifications, including "cold start" at –40°C.

(10) Regulation specifications describe the deviation as the line input voltage or output load current is varied from a nominal midpoint value to either extreme.

(11) If reverse polarity is accidentally applied to the input, a body diode will become forward biased and will accept considerable current. To ensure reverse input protection with full output load, always connect an external input fuse in series with the +V_{IN} input. Use approximately twice the full input current rating with nominal input voltage.

(12) Input overvoltage shutdown on 48V input models is normally deleted in order to comply with certain telecom reliability requirements. These requirements attempt continued operation despite significant input overvoltage.

(13) Note that the converter may operate up to +120°C PCB temperature with the baseplate installed. However, thermal self-protection occurs near +125°C and there is a temperature gradient from high power components. Therefore, +100°C baseplate temperature is recommended to avoid thermal shutdown.

(14) "Extreme accuracy" refers to all combinations of line and load regulation, output current, initial setpoint accuracy and temperature coefficient.

TECHNICAL NOTES

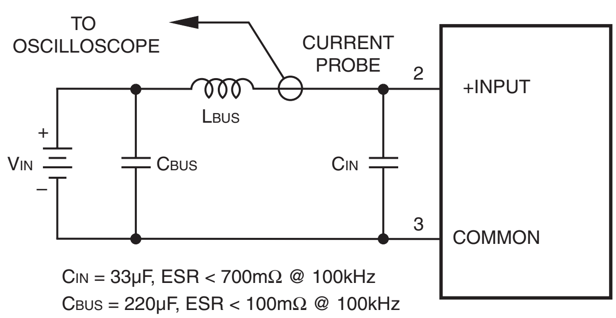
I/O Filtering and Noise Reduction

The RBC-12/25-D48 is tested and specified with external output capacitors. These capacitors are necessary to accommodate our test equipment and may not be required to achieve desired performance in your application. The RBC-12/25-D48 is designed with high-quality, high-performance *internal* I/O caps, and will operate within spec in most applications with *no additional external components*.

In particular, the RBC-12/25-D48 input capacitors are specified for low ESR and are fully rated to handle the units' input ripple currents. Similarly, the internal output capacitors are specified for low ESR and full-range frequency response.

In critical applications, input/output ripple/noise may be further reduced using filtering techniques, the simplest being the installation of external I/O caps.

External input capacitors serve primarily as energy-storage devices. They minimize high-frequency variations in input voltage (usually caused by IR drops in conductors leading to the DC/DC) as the switching converter draws pulses of current. Input capacitors should be selected for bulk capacitance (at appropriate frequencies), low ESR, and high rms-ripple-current ratings. The switching nature of modern DC/DC's requires that the dc input voltage source have low ac impedance at the frequencies of interest. Highly inductive source impedances can greatly affect system stability. Your specific system configuration may necessitate additional considerations.



C_{IN} = 33μF, ESR < 700mΩ @ 100kHz
C_{BUS} = 220μF, ESR < 100mΩ @ 100kHz
L_{BUS} = 12μH

Figure 2. Measuring Input Ripple Current

Input Fusing

Most applications and or safety agencies require the installation of fuses at the inputs of power conversion components. The RBC-12/25-D48 Series may have an optional input fuse. Therefore, if input fusing is mandatory, either a normal-blow or a fast-blow fuse with a value no greater than twice the maximum input current should be installed within the ungrounded input path to the converter.

As a rule of thumb however, we recommend to use a normal-blow or slow-blow fuse with a typical value of about twice the maximum input current, calculated at low line with the converter's minimum efficiency.

Input Overvoltage and Reverse-Polarity Protection

The RBC-12/25-D48 does not incorporate input reverse-polarity protection. Input voltages in excess of the specified absolute maximum ratings and input polarity reversals of longer than "instantaneous" duration can cause permanent damage to these devices.

Start-Up Time

The V_{IN} to V_{OUT} Start-Up Time is the interval between the time at which a ramping input voltage crosses the lower limit of the specified input voltage range and the fully loaded output voltage enters and remains within its specified accuracy band. Actual measured times will vary with input source impedance, external input capacitance, and the slew rate and final value of the input voltage as it appears to the converter.

The On/Off to V_{OUT} Start-Up Time assumes the converter is turned off via the On/Off Control with the nominal input voltage already applied to the converter. The specification defines the interval between the time at which the converter is turned on and the fully loaded output voltage enters and remains within its specified accuracy band.

Output Reverse Conduction

Many DC/DC's using synchronous rectification suffer from Output Reverse Conduction. If those devices have a voltage applied across their output before a voltage is applied to their input (this typically occurs when another power supply starts before them in a power-sequenced application), they will either fail to start or self destruct. In both cases, the cause is the "freewheeling" or "catch" FET biasing itself on and effectively becoming a short circuit.

The RBC-12/25-D48 will withstand higher external sources several volts above the nominal output. However, if there is a chance of consistent overvoltage, users should provide an external voltage clamp or other protection.

Undervoltage Shutdown

When the input voltage falls below the undervoltage threshold, the converter will terminate its output. However, this is not a latching shutdown mode. As soon as the input voltage rises above the Start-Up Threshold, the converter will restore normal operation. This small amount of hysteresis prevents most uncommanded power cycling. Since some input sources with higher output impedance will increase their output voltage greater than this hysteresis as soon as the load is removed, it is possible for this undervoltage shutdown to cycle indefinitely. To prevent this, be sure that the input supply always has adequate voltage at full load.

Thermal Considerations and Thermal Protection

The typical output-current thermal-derating curves shown below enable designers to determine how much current they can reliably derive from each model of the RBC-12/25-D48 under known ambient-temperature and air-flow conditions. Similarly, the curves indicate how much air flow is required to reliably deliver a specific output current at known temperatures.

The highest temperatures in RBC-12/25-D48's occur at their output inductor, whose heat is generated primarily by I^2R losses. The derating curves were developed using thermocouples to monitor the inductor temperature and varying the load to keep that temperature below +110°C under the assorted conditions of air flow and air temperature. Once the temperature exceeds +125°C (approx.), the thermal protection will disable the converter using the hiccup shutdown mode.

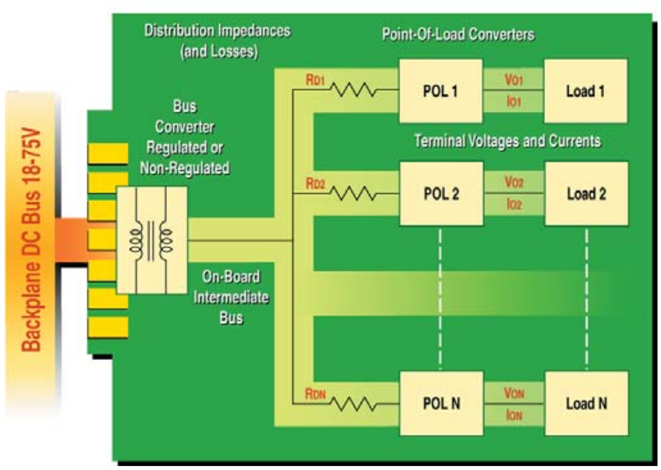


Figure 3. Intermediate Bus Architecture

Distributed Bus Architecture

A revolution is at hand for powering dedicated mixed circuit systems. Instead of installing a single large isolated power supply or multiple isolated converters, the new architecture uses one isolated power bus converter driving multiple Point-of-Load non-isolated DC/DC converters which are positioned right where the power load is needed. While conceptually similar to having a single master power supply and distrubuted linear regulators, the bus converter concept offers significantly lower cost, higher efficiency and therefore lower temperatures, better reliability and longer service life. Bulky, expensive heat sinks are eliminated and even a costly fan can be downsized or deleted.

To achieve these results, the isolation is concentrated in the bus converter and the precise voltage regulation resides in the POL converters. Since the high current power switching is located in the bus converter, designers can arrange the best possible noise shielding, isolation layout and thermal distribution. And, since most of the regulation is placed in the POL converters, the total system offers very high efficiency, important for battery-operated and standby applictions. Typically, DATEL's surface mount POL converters are actually smaller than equivalent linear regulators, heat sinks and their discrete components. Another benefit to the distributed power architecture is that it eliminates digital crosstalk in tightly packed systems.

A further advantage is that multiple power voltages are implemented simply by connecting POL's with different output voltages. Today's modern systems require several low power voltages. Many large ASIC's, gate arrays and programmable logic are powered from 3.3 Volts or lower. CPU's use 2.5 or lower voltages at considerable current. And legacy logic or I/O ports may run from 5 Volts. It makes sense to provide separate power converters for each of these sections. But they do not all need to be isolated, saving cost, board area and heat buildup.

Thermal Shutdown

Extended operation at excessive temperature will initiate overtemperature shutdown triggered by a temperature sensor inside the PWM controller. This operates similarly to overcurrent and short circuit mode. The inception point of the overtemperature condition depends on the average power delivered, the ambient temperature and the extent of forced cooling airflow.

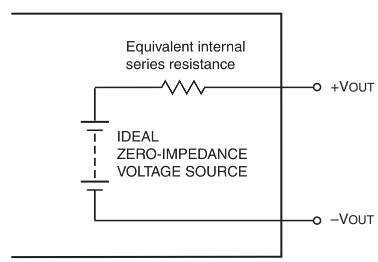


Figure 4. Equivalent Voltage Source Model

Remote On/Off Control

The RBC-12/25-D48 may be turned off or on using the external remote on/off control. Allow at least 15 milliseconds for either transition. This terminal consists of a digital input to the internal PWM controller athrough a protective resistor and diode.

The on/off input circuit should be CMOS logic referred to the –Input power terminal however TTL or TTL-LS logic will also work or a switch to ground. If preferred, you can even run this using a bipolar transistor in “open collector” configuration or an “open drain” FET transistor. You may also leave this input unconnected and the converter will run whenever input power is applied.

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