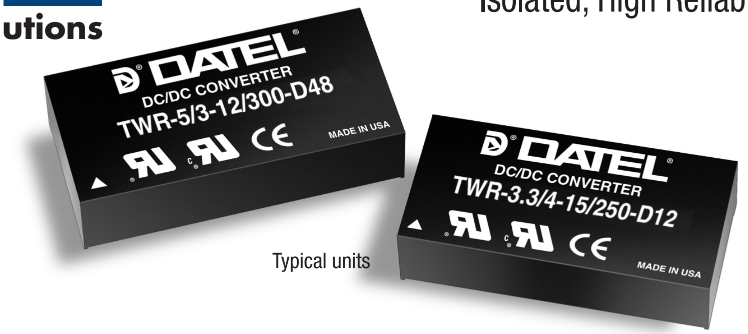
Triple Output/TWR Models

Isolated, High Reliability 1" x 2" DC/DC Converters



Typical units

FEATURES

- ±12V/±15V and 3.3V/5V outputs
- 10-18V, 18-36V or 36-75V inputs
- Up to 22.5 Watts total output power with overtemperature shutdown
- To 87% efficiency; 80-100mV Ripple and Noise
- 1" x 2" x 0.5" encapsulated package
- 1500Vdc isolation for both outputs
- Designed to meet UL 60950-1, CSA-C22.2 No. 60950-1, EN60950-1 safety approvals
- Extensive self-protection with short circuit shutdown
- Output overvoltage and overcurrent protection
- Input under and overvoltage shutdown
- Ideal for mixed analog/digital systems

Packaged in 1" x 2" encapsulated modules, the TWR 22W series DC/DC converters offer three outputs arranged as a unipolar low voltage supply and a higher voltage bipolar output pair. The unipolar section supplies either +3.3V at 4A maximum or +5V at 3A maximum. The bipolar outputs are either ±12Vdc at 300mA maximum or ±15Vdc at 250mA and are ideal for op amps, linear or analog circuits. A single TWR converter can power applications with combined analog and digital circuits such as a CPU-controlled voice switch, embedded telephone modem or analytical instruments.

The input section is fully isolated from the outputs up to 1500Vdc minimum using Basic insulation. Three wide input ranges are available including 10-18V (12Vdc nominal), 18-36V (24Vdc nomimal) or 36-75V (48Vdc nominal). Peak-to-peak output ripple/noise is typically 80-100mV at full load. Efficiencies range up to 87%.

The TWR 22W series outputs will limit their current if driven to overload and may be short circuited indefinitely without damage. The inputs will shut down if input voltage is either over or under limits or has reversed input voltage. These converters will operate at higher temperatures with adequate airflow.

The unipolar output features line and load regulation of ±1%. Excellent dynamic response assures transient load change settling within 100 microseconds. Other convenience features include a remote On/Off control to turn the outputs on via digital logic, CPU bit, control transistor or a relay.

Fabrication uses DATEL's advanced surface mount automated pick-and-place assembly and computer-controlled parameter testing. All TWR 22W series are designed to meet safety requirements in UL, EN60950-1 and CSA-C22.2 No.60950-1.

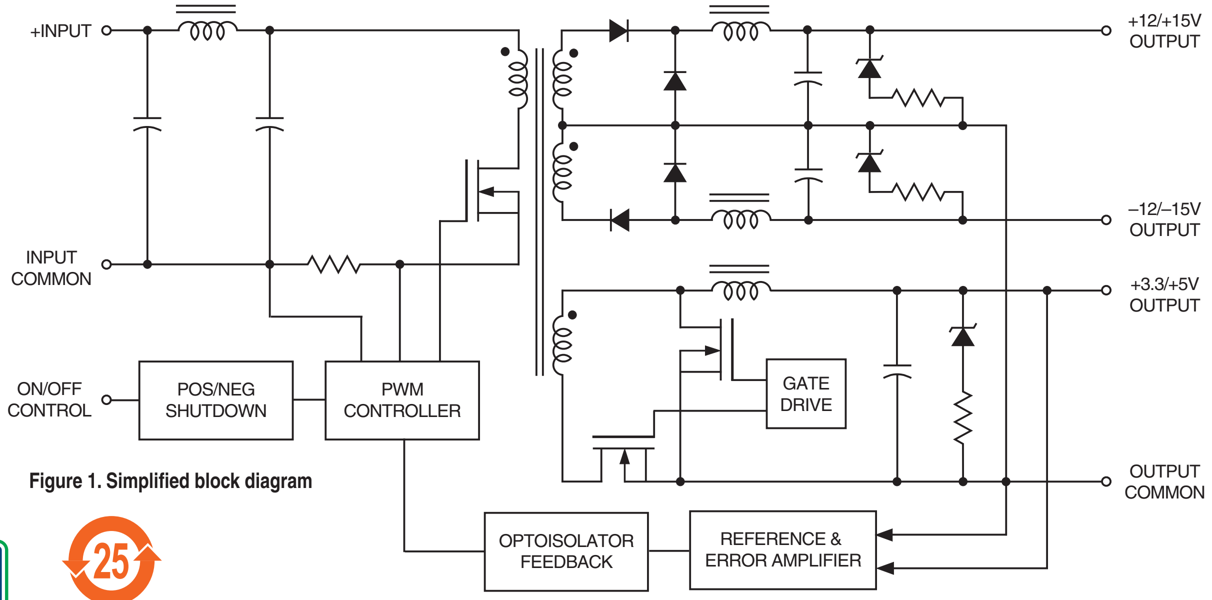


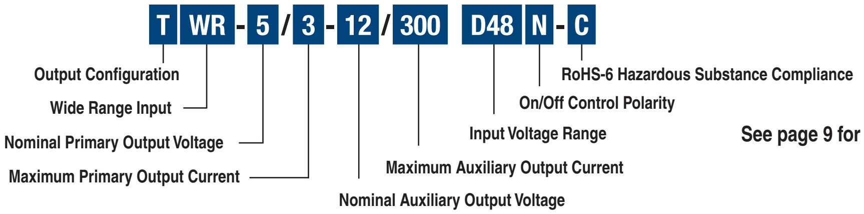
Figure 1. Simplified block diagram

Typical topography is shown.

For full details go to
www.murata-ps.com/rohs

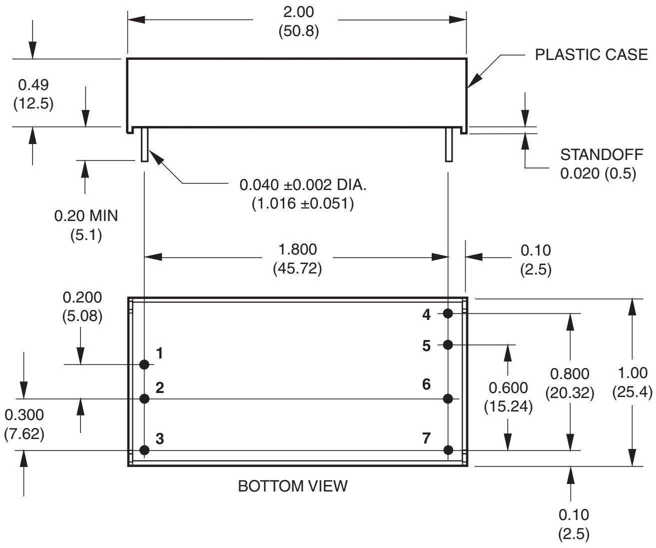
Performance Specifications and Ordering Guide ①

Model	Output						Input				Efficiency		Packag (Case/ Pinout)
	V_{OUT} Volts	I_{OUT} Amps	R/N (mvp-p)		Regulation (Max.)		V_{IN} Nom. (Volts)	Range (Volts)	Input Current				
			Typ.	Max.	Line	Load			No Load (mA)	Full Load (Amps)	Min.	Typ.	
TWR-3.3/4-12/300-D12-C	3.3	4	40	60	±0.05%	±0.4%	12	9-18	170	2.00	82%	85%	C39/P61
	±12	0.3	70	150	±0.35%	±2.5%							
TWR-3.3/4-12/300-D24-C	3.3	4	Please contact Murata Power Solutions for further information.										C39/P61
	±12	0.3											
TWR-3.3/4-12/300-D48N-C	3.3	4											C39/P61
	±12	0.3											
TWR-3.3/4-15/250-D12-C	3.3	4											C39/P61
	±15	0.25											
TWR-3.3/4-15/250-D24-C	3.3	4	80	100	±1%	±1%	24	18-36	25	1.00	83%	86%	C39/P61
	±15	0.25	100	150	±5%	±5%							
TWR-3.3/4-15/250-D48N-C	3.3	4	80	100	±1%	±1%	48	36-75	25	0.50	85%	87%	C39/P61
	±15	0.25	100	150	±5%	±5%							
TWR-5/3-12/300-D12-C	5	3	80	100	±1%	±1%	12	9-18	120	2.20	81.5%	84%	C39/P61
	±12	0.3	100	150	±5%	±5%							
TWR-5/3-12/300-D24-C	5	3	80	100	±1%	±1%	24	18-36	90	1.08	83%	86%	C39/P61
	±12	0.3	100	150	±5%	±5%							
TWR-5/3-12/300-D48N-C	5	3	80	100	±1%	±1%	48	36-75	25	0.53	85%	87%	C39/P61
	±12	0.3	100	150	±5%	±5%							
TWR-5/3-15/250-D12-C	5	3	40	75	±0.05%	±0.2%	12	9-18	170	2.26	81%	83%	C39/P61
	±15	0.25	45	65	±0.5%	±4%							
TWR-5/3-15/250-D24-C	5	3	40	75	±0.4%	±0.2%	24	18-36	80	1.09	83%	86%	C39/P61
	±15	0.25	45	65	±0.4%	±4%							
TWR-5/3-15/250-D48N-C	5	3	65	100	±0.05%	±0.3%	48	36-75	45	0.54	85%	87.5%	C39/P61
	±15	0.25	45	60	±0.4%	±4%							



See page 9 for complete Part Number Structure and Ordering Information

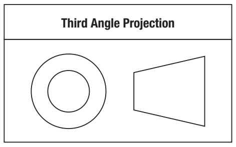
MECHANICAL SPECIFICATIONS



I/O Connections	
Pin	Function P61
1	+Input
2	–Input
3	On/Off Control
4	+12V/15V Output
5	–12V/15V Output
6	Common
7	+3.3/5V Output

Alternate pin length and/or other output voltages are available under special quantity order.

Dimensions are in inches (mm shown for ref. only).



Tolerances (unless otherwise specified):
.XX ± 0.02 (0.5)
.XXX ± 0.010 (0.25)
Angles ± 2˚

Components are shown for reference only.

Performance/Functional Specifications

Typical @ T_A = +25°C under nominal line voltage, nominal output voltage, natural air convection, external caps and full-load conditions unless noted. ①

Input	
Input Voltage Range	See Ordering Guide
Start-Up Threshold: ③	
12V Models	9V minimum, 9.5V typical
24V Models	16.5V minimum, 17V typical
48V Models	34V minimum, 35V typical
Undervoltage Shutdown: ③	
12V Models	8V minimum, 8.5V typical
24V Models	16V minimum, 16.5V typical
48V Models	32.5V minimum, 34.5V typical
Overvoltage Shutdown:	
12V Models	20V typical, 21V maximum
24V Models	38V typical, 40V maximum
48V Models	78.5V typical, 81V maximum
Reflected (Back) Ripple Current ②	12mA typical, 20mAp-p maximum
Input Current:	
Full Load Conditions	See Ordering Guide
No Load V_{IN} = nominal	
12V and 24V Models	25mA typical, 50mA maximum
48V Models	170mA typical, 200mA maximum
Low-Line Voltage (V_{IN} =V_{MIN}, full load)	TBD
Remote On/Off Control ⑤	
Positive Logic (no model suffix)	Off = ground pin to +1.2V maximum On = open pin to +V_{IN} maximum
Current	2mA maximum
Negative Logic (N model suffix)	On = ground pin to +1.2V maximum Off = open pin to +V_{IN} maximum
Current	18mA maximum

Output	
VOUT Range	See Ordering Guide
VOUT Accuracy:	
3.3V or 5V Output	±1% of VNOM
±12V or ±15V Outputs	±10% of VNOM (See Technical Notes)
Temperature Coefficient	±0.02% of VOUT range/°C
Minimum Loading:	See Technical Notes
3.3V or 5V Output	No minimum load
±12V or ±15V Outputs	20% minimum of nominal output current, balanced load
Ripple/Noise (20MHz BW) ①②④	See Ordering Guide
Line/Load Regulation ⑩	See Ordering Guide & Technical Notes
Efficiency	See Ordering Guide
Maximum Capacitive Loading:	
3.3V or 5V Output	TBD
±12V or ±15V Outputs	TBD
Isolation:	
Input to Output Voltage	1500Vdc minimum
Resistance	100MΩ
Capacitance	470pF
Isolation Safety Rating	Functional insulation
Current Limit Inception: (98% of VOUT)	
3.3V Output	5 Amps minimum, 6.2 Amps maximum
5V Output	4 Amps minimum, 5.2 Amps maximum
±12V Outputs	0.36 Amps minimum, 1 Amp maximum
±15V Outputs	0.5 Amps minimum, 1.2 Amps maximum
Short-Circuit Detection:	
3.3V or 5V Output	Magnetic feedback
±12V or ±15V Outputs	Magnetic feedback plus voltage clamp
Short-Circuit Potection Method	Current limiting with hiccup autorestore. Remove overload for recovery.
Short-Circuit Current:	
3.3V or 5V Output	2 Amps maximum
±12V or ±15V Outputs	1 Amp maximum
Short Circuit Duration (no damage)	Continuous, output shorted to ground
Overvoltage Protection:	
3.3V or 5V Output	3.8Vdc minimum, 4.2Vdc maximum
±12V or ±15V Outputs	30Vdc maximum
	Method: magnetic feedback

Dynamic Characteristics	
Dynamic Load Response (50-100% loadstep)	
3.3V or 5V Output	150µsec to ±1.5% of final value
±12V or ±15V Outputs	150µsec to ±10% of final value
Start-Up Time	
VIN to VOUT regulated	TBD msec for VOUT = nominal
Switching Frequency	330kHz ±20kHz

Environmental	
Calculated MTBF	TBD
Operating Temperature: (Ambient) ⑦	
No Derating (Natural convection)	–40 to +65°C
With Derating	See Derating Curves
Operating Case Temperature	–40 to +100°C maximum
Storage Temperature	–40 to +120°C
Thermal Protection/Shutdown	+110°C minimum to 120°C maximum
Density Altitude	0 to 10,000 feet
Relative Humidity	10% to 90%, non-condensing

Physical	
Dimensions	See Mechanical Specifications
Case and Header Material	Black Diallyl Phthalate plastic
Pin Dimensions/Material	0.04" (1.016mm) dia. Gold-plated copper
alloy with nickel underplate.	
Weight	TBD
Electromagnetic Interference	TBD
Safety	UL/cUL 60950-1 CSA-C22.2 No.234 IEC/EN 60950-1

① All models are tested/specified with two external 0.047µF output capacitors. 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.

② Input Reflected Ripple Current is tested/specified over a 20MHz bandwidth. Input filtering is C_{IN} = 33µF, 100V tantalum; C_{BUS} = 220µF, 100V electrolytic; L_{BUS} = 12µH. See Technical Notes.

③ For consistent operation, the instantaneous input voltage for full output load must not go below the low shutdown voltage *AT ALL TIMES*. Beware of excessive voltage drop from long input wiring. For reliable startup, be sure to apply input power promptly and fully as a step function.

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

⑤ The On/Off Control may be driven with external logic or the application of appropriate voltages (referenced to Common). The On/Off Control input should use either an open collector/open drain transistor or logic gate which does not exceed +V_{IN}. The On/Off Control may be supplied with with negative logic (LO = on, HI = off) using the "N" model suffix.

⑥ 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.

⑦ All models are fully operational and meet published specifications, including cold start at –40°C.

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

⑨ The outputs share a common isolated return. The two output sections are not isolated from each other.

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 The outputs will not accept appreciable reverse current without possible damage.

Absolute Maximum Ratings

Input Voltage:	
Continuous or transient	
12V Models	–0.3V minimum or +18V maximum
24V Models	–0.3V minimum or +36V maximum
48V Models	–0.3V minimum or +75V maximum
On/Off Control (Pin 1)	–0.3V minimum or +V_{IN} maximum
Input Reverse-Polarity Protection	See Fuse section
Output Overvoltage Protection	V_{OUT} +20% maximum
Output Current	Current limited. Devices can withstand sustained output short circuits without damage.
Storage Temperature	–40 to +120°C
Lead Temperature (soldering 10 sec. max.)	+300°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.

TECHNICAL NOTES

Load Dependency and Regulation

The high voltage bipolar output section derives its regulation as a slave to the low voltage unipolar output. Be aware that large load changes on the unipolar section will change the voltage somewhat on the bipolar section. To retain proper regulation, the bipolar voltage section must have a minimum load of at least 10% of rated full output. With this minimal load (or greater), the high voltage bipolar section will meet all its regulation specifications. If there is no load, the output voltage may exceed the regulation somewhat.

Input Fusing

Certain applications and/or safety agencies require fuses at the inputs of power conversion components. Fuses should also be used if there is the possibility of sustained, non-current limited reverse input polarity. DATEL recommends slow-blow type fuses approximately twice the maximum input current at nominal input voltage but no greater than 5 Amps. Install these fuses in the high side (ungrounded input) power lead to the converter.

Input Voltage	Fuse Value
12 Volts	4 Amps
24 Volts	2 Amps
48 Volts	1 Amp

Input Source Impedance

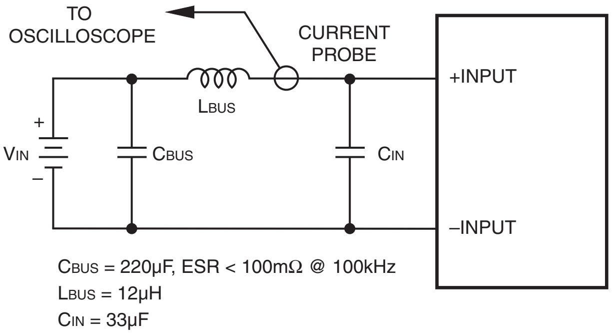
The external source supplying input power must have low AC impedance. Failure to insure adequate low AC impedance may cause stability problems, increased output noise, oscillation, poor settling and aborted start-up. The converter's built-in front end filtering will be sufficient in most applications. However, if additional AC impedance reduction is needed, consider adding an external capacitor across the input terminals mounted close to the converter. The capacitor should have low internal Equivalent Series Resistance (ESR) and low inductance. Often, two or more capacitors are used in parallel. A ceramic capacitor gives very low AC impedance while a parallel electrolytic capacitor offers improved energy storage.

Input Undervoltage Shutdown and Start-Up Threshold

Under normal start-up conditions, devices will not begin to regulate until the ramping-up input voltage exceeds the Start-Up Threshold Voltage. Once operating, devices will not turn off until the instantaneous input voltage drops below the Undervoltage Shutdown limit. Subsequent restart will not occur until the input is brought back up to the Start-Up Threshold. This built-in hysteresis avoids any unstable on/off situations occurring at a single input voltage. However, you should be aware that poorly regulated input sources and/or higher input impedance sources (including long power leads) which have outputs near these voltages may cause cycling of the converter outputs.

Ripple Current and Output Noise

All TWR converters are tested and specified for input reflected ripple current (also called Back Ripple Current) and output noise using specified filter components and test circuit layout as shown in the figures below. Input capacitors must be selected for low ESR, high AC current-carrying capability at the converter's switching frequency and adequate bulk capacitance. The switching nature of DC/DC converters requires this low AC impedance to absorb the current pulses reflected back from the converter's input.



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

Figure 2. Measuring Input Ripple Current

Output Overcurrent Detection

Overloading the power converter's output for extended periods (but not a short circuit) at high ambient temperatures may overheat the output components and possibly lead to component failure. Brief moderate overcurrent operation (such as charging up reasonably-sized external bypass capacitors when first starting) will not cause problems. The TWR series include current limiting to avoid heat damage. However, you should remove a sustained overcurrent condition promptly as soon as it is detected. Combinations of low airflow and/or high ambient temperature for extended periods may cause overheating even though current limiting is in place.

Current Return Paths

Make sure to use adequately sized conductors between the output load and the Common connection. Avoid simply connecting high current returns only through the ground plane unless there is adequate copper thickness. Also, route the input and output circuits directly to the Common pins. Failure to observe proper wiring may cause instability, poor regulation, increased noise, aborted start-up or other undefined operation.

Safety Considerations

The TWR's must be installed with consideration for any local safety, certification or regulatory requirements. These vary widely but generally are concerned with properly sized conductors, adequate clearance between higher voltage circuits, life testing, thermal stress analysis of components and flammability of components. Contact DATEL if you need further advice on these topics.

Remote On/Off Control

The TWR models include an input pin which can turn on or shut off the converter by remote signal. For positive logic models (no model number suffix), if this pin is left open, the converter will always be enabled as long as proper input power is present. On/Off signal currents are referred to the Input Common pin on the converter. There is a short time delay of several milliseconds (see the specifications) for turn on, assuming there is no significant external output capacitance.

The On/Off Control may also be supplied with negative logic (LO = on, HI = off) using the "N" model number suffix. Here again, leaving the pin open on either model will enable the converter. Positive logic models must have this control pin pulled down for shutoff. Negative logic models must pull up this control pin for shutoff.

Dynamic control of this On/Off input is best done with either a mechanical relay (ground the pin to turn it off), solid state relay (SSR), an open collector or open drain transistor, CPU bit or a logic gate. The pull down current is 18mA max. Observe the voltage limits listed in the specifications for proper operation. Suggested circuits are shown below.

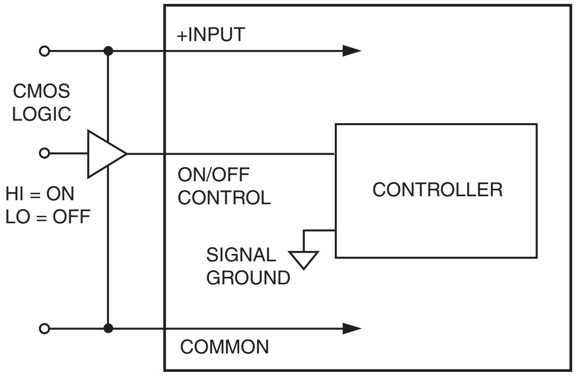


Figure 3. On/Off Control With An External CMOS Gate

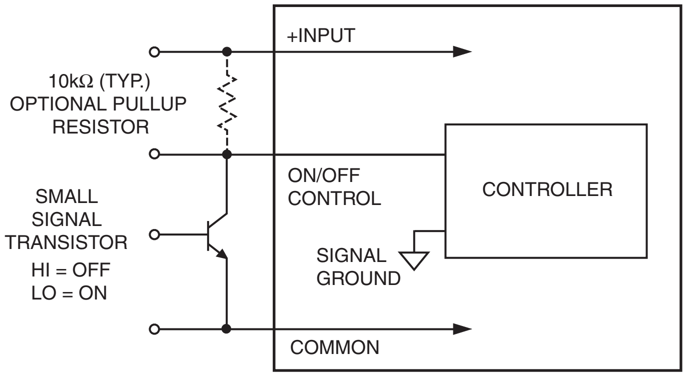


Figure 4. On/Off Control With An External Transistor ♥

Isolation Considerations

These converters use both transformer and optical coupling to isolate the inputs from the outputs. Ideal "floating" isolation implies ZERO CURRENT flowing between the two Common return sections of the input and output up to the working isolation voltage limit. Real-world isolation on this converter includes both an AC current path (through some small coupling capacitance) and some DC leakage current between the two ground systems. To avoid difficulties in your application, be sure that there are not wideband, high amplitude AC difference voltages between the two ground systems. In addition, ground difference voltages applied by your external circuits which exceed the isolation voltage, even momentarily, may damage the converter's isolation barrier. This can either destroy the converter or instantly render it non-isolated.

Current Limiting and Short Circuit Condition

As the output load increases above its maximum rated value, the converter will enter current limiting mode. The output voltage will decrease and the converter will essentially deliver constant power. This is commonly called power limiting.

If the current continues to increase, the converter will enter short circuit operation and the PWM controller will shut down. Following a time-out period, the converter will automatically attempt to restart. If the short circuit is detected again, the converter will shut down and the cycle will repeat. This operation is called hiccup autorecovery. Please be aware that excessive external output capacitance may interfere with the hiccup autorestart.

Output Filtering and Noise Reduction

All switching DC/DC converters produce wideband output noise which radiates both through the wiring (conducted emission) and is broadcast into the air (radiated emission). This output noise may be attenuated by adding a small amount of capacitance in parallel with the output terminals. Please refer to the maximum output capacitance in the Specifications.

The amount of capacitance to add depends on the placement of the cap (near the converter versus near the load), the distance from the converter to the load (and resulting series inductance), the topology and locations of load elements if there are multiple parallel loads and the nature of the loads. For switching loads such as CPU's and logic, this last item recommends that small bypass capacitors be placed directly at the load. Very high clock speeds suggest smaller caps unless the instantaneous current changes are high. If the load is a precision high-gain linear section, additional filtering and shielding may be needed.

Many applications will need no additional capacitance. However, if more capacitance is indicated, observe these factors:

1. Understand the noise-reduction objective. Are you improving the switching threshold of digital logic to reduce errors? (This may need only a small amount of extra capacitance). Or do you need very low noise for a precision linear "front end"?
2. Use just enough capacitance to achieve your objective. Additional capacitance trades off increasing instability (actually adding noise rather than reducing it), poor settling response, possible ringing or outright oscillation by the converter. Excessive capacitance may also disable the hiccup autorestart. Do not exceed the maximum output capacitance specification.

3. Any series inductance considerably complicates the added capacitance therefore try to reduce the inductance seen at the converter's output. You may need to add BOTH a cap at the converter end and at the load (effectively creating a Pi filter) for the express purpose of reducing the phase angle which is seen by the converter's output loop controller. This tends to hide (decouple) the inductance from the controller. Make sure your power conductors are adequate for the current and reduce the distance to the load as much as possible. Very low noise applications may require more than one series inductor plus parallel caps.
4. Oscillation or instabilility can occur at several frequencies. For this reason, you may need both a large electrolytic or tantalum cap (carrying most of the capacitance) and a small wideband parallel ceramic cap (with low internal series inductance). Always remember that inside real world capacitors are distributed trace inductance (ESL) and series resistance (ESR). Make sure the input AC impedance is very low before trying to improve the output.
5. It is challenging to offer a complete set of simple equations in reasonable closed form for the added output capacitance. Part of the difficulty is accurately modeling your load environment. Therefore your best success may be a combination of previous experience and empirical approximation.

Maximum Current and Temperature Derating Curves

The curves shown below indicate the maximum average output current available versus the ambient temperature and airflow. All curves are done approximately at sea level and you should leave an additional margin for higher altitude operation and possible fan failure. (Remember that fans are less efficient at higher altitudes). These curves are an average – current may be greater than these values for brief periods as long as the average value is not exceeded.

The "natural convection" area of the curve is that portion where self-heating causes a small induced convective airflow around the converter without further mechanical forced airflow from a fan. Natural convection assumes that the converter is mounted with some spacing to adjacent components and there are no nearby high temperature parts. Note that such self-heating will produce an airflow of typically 25 Linear Feet per Minute (LFM) without a fan. Heat is removed both through the mounting pins and the surface of the converter.

Many systems include fans however it is not always easy to measure the airflow adjacent to the DC/DC converter. Simply using the cubic feet per minute (CFM) rating of the fan is not always helpful since it must be matched to the volume of the enclosure, the outside ambient temperature, board spacing, the intake area and total internal power dissipation.

Most PWM controllers, including those on the TWR's, will tolerate operation up to about +100 degrees Celsius. If in doubt, attach a thermal sensor to the package near the output components and measure the surface temperature after allowing a proper warm-up period. Remember that the temperature inside the output transistors at full power will be higher than the surface temperature therefore do not exceed operation past approximately +100 deg. C on the surface. As a rough indication, any circuit which you cannot touch briefly with your finger warrants further investigation.

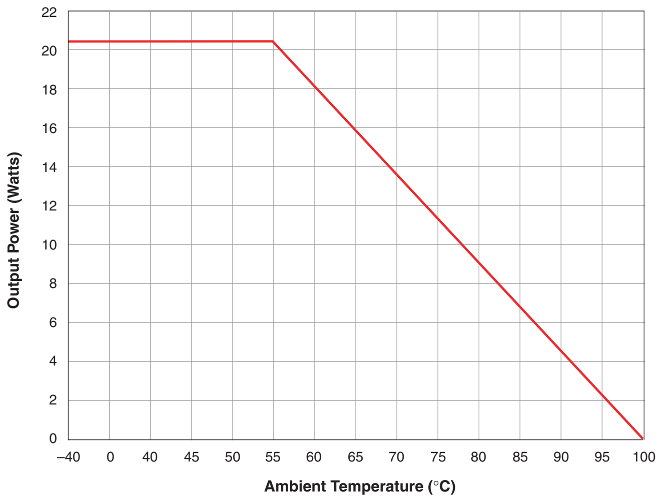
It is probably more important in your system that all heat is periodically removed rather than having very high airflow. Consider having the total enclosure completely recycled at least several times a minute. Failure to remove the heat causes heat buildup inside your system and even a small fan (relative to the heat load) is quite effective. A very rough guide for typical enclosures is one cubic foot per minute of exhausted airflow per 100 Watts of internal heat dissipation.

Efficiency Curves

These curves indicate the ratio of output power divided by input power at various input voltages and output currents times 100%. All curves are measured at +25°C ambient temperature and adequate airflow.

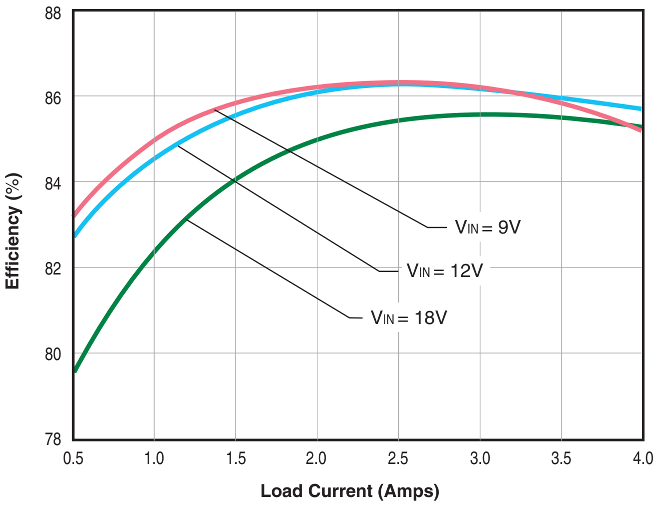
Typical Performance Curves for TWR Series

TWR 22W Series Output Power vs. Ambient Temperature @ +25°C

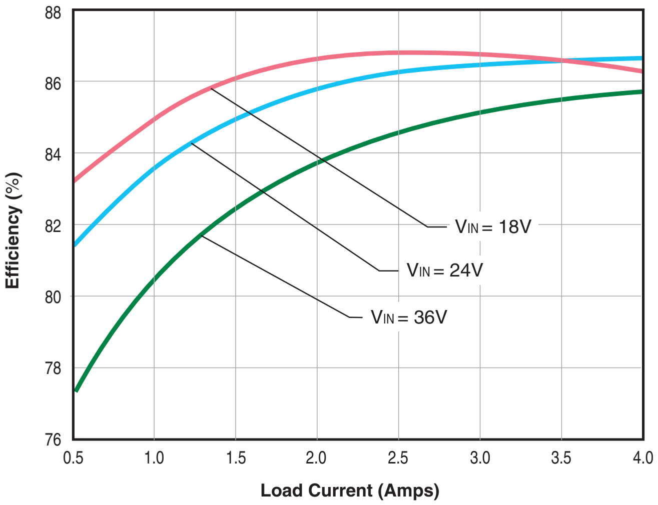


Typical Performance Curves for TWR Series

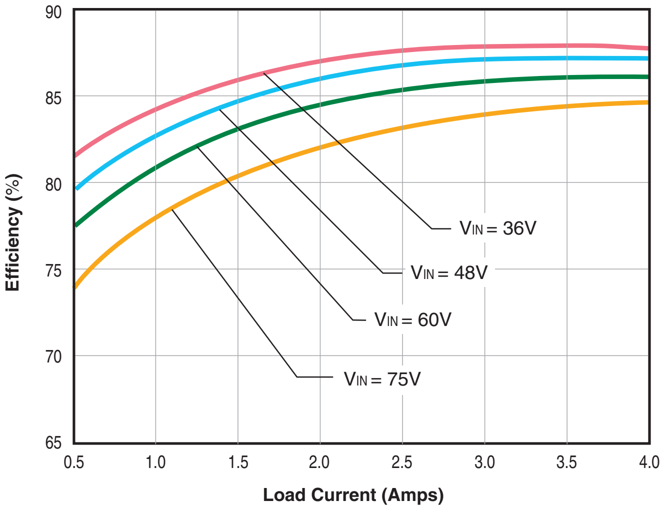
TWR-3.3/4-12/300-D12
Efficiency vs. Line Voltage and Load Current @ 25°C



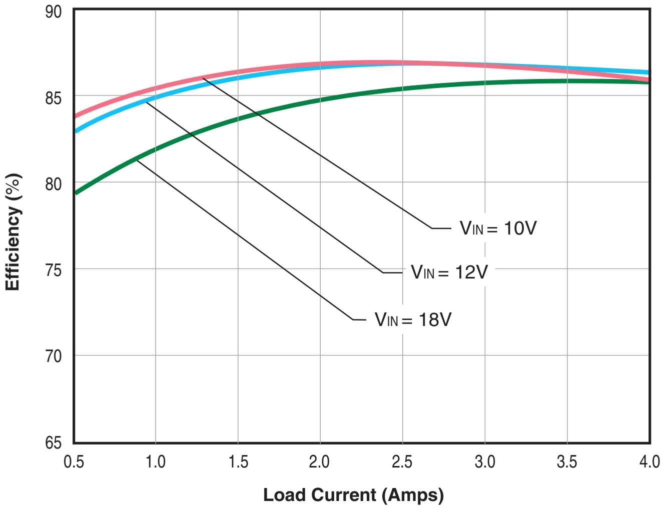
TWR-3.3/4-12/300-D24
Efficiency vs. Line Voltage and Load Current @ 25°C



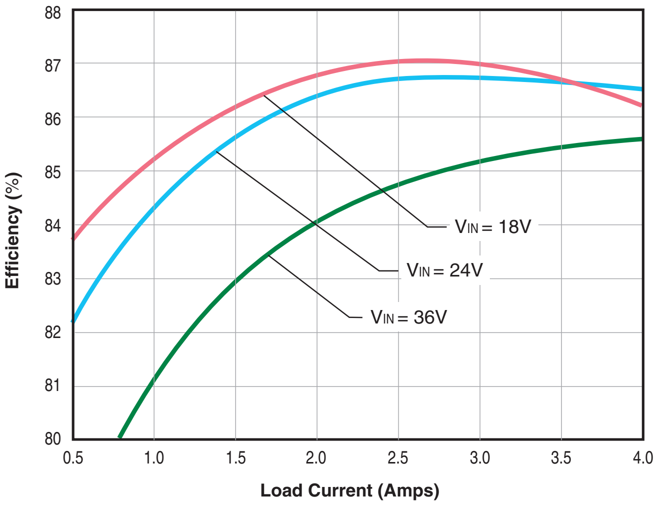
TWR-3.3/4-12/300-D48
Efficiency vs. Line Voltage and Load Current @ 25°C



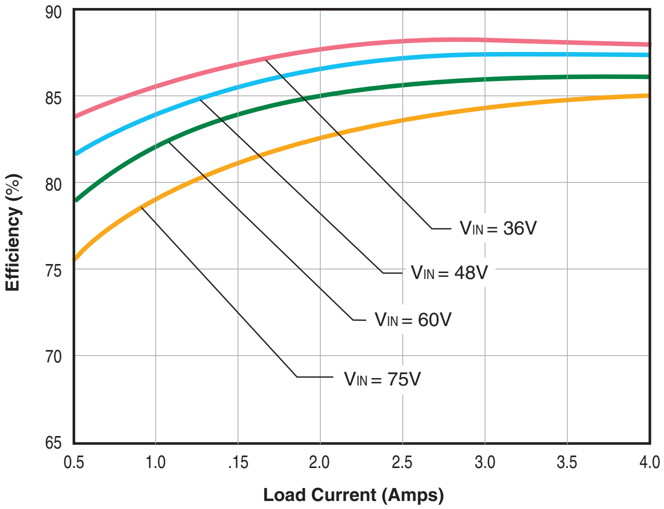
TWR-3.3/4-15/250-D12
Efficiency vs. Line Voltage and Load Current @ 25°C



TWR-3.3/4-15/250-D24
Efficiency vs. Line Voltage and Load Current @ 25°C

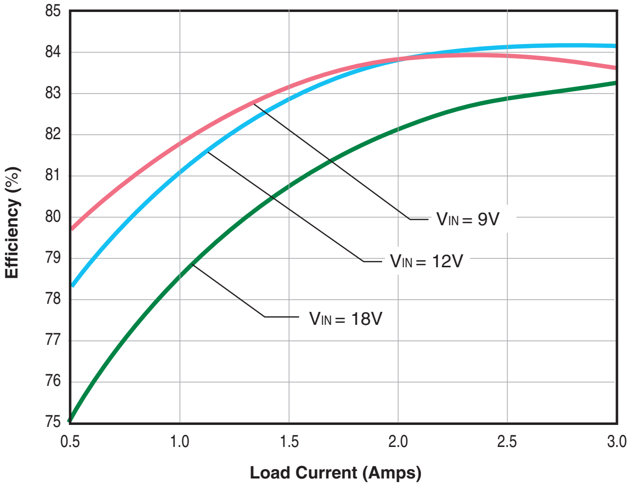


TWR-3.3/4-15/250-D48
Efficiency vs. Line Voltage and Load Current @ 25°C

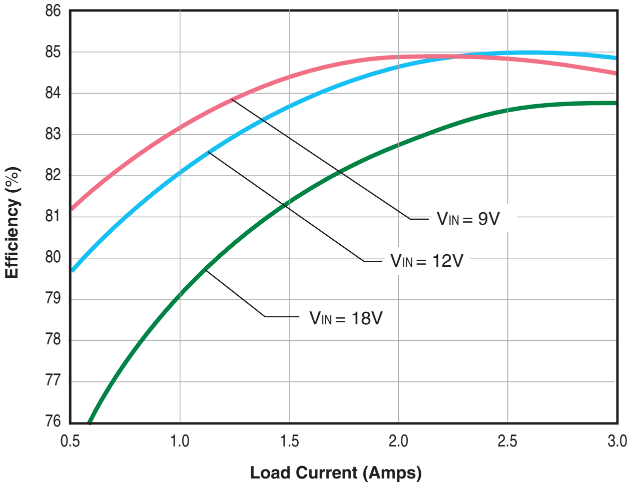


Typical Performance Curves for TWR Series

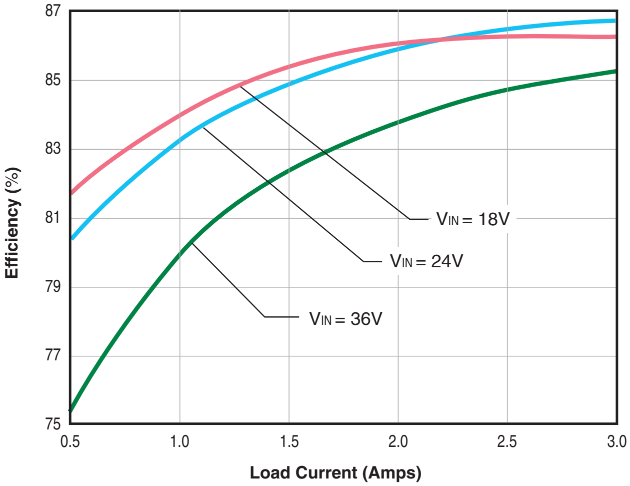
TWR-5/3-12/300-D12
Efficiency vs. Line Voltage and Load Current @ 25°C



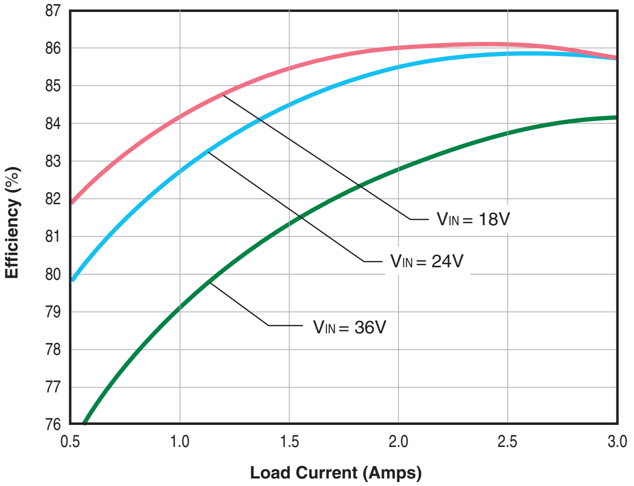
TWR-5/3-15/250-D12
Efficiency vs. Line Voltage and Load Current @ 25°C



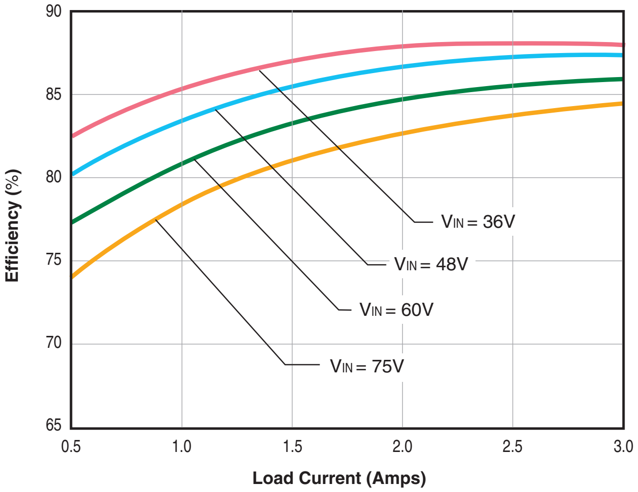
TWR-5/3-12/300-D24
Efficiency vs. Line Voltage and Load Current @ 25°C



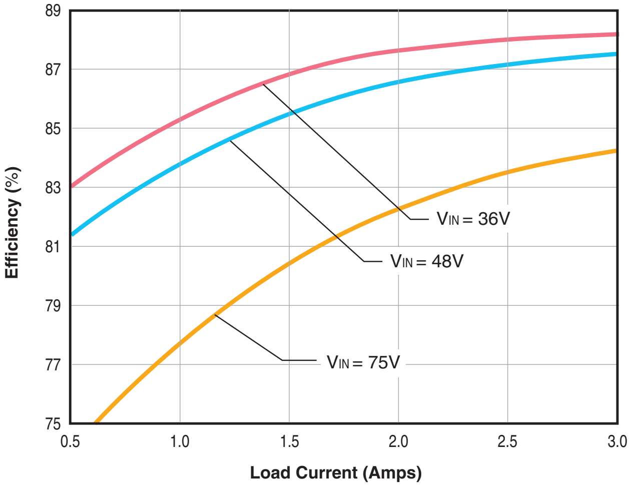
TWR-5/3-15/250-D24
Efficiency vs. Line Voltage and Load Current @ 25°C



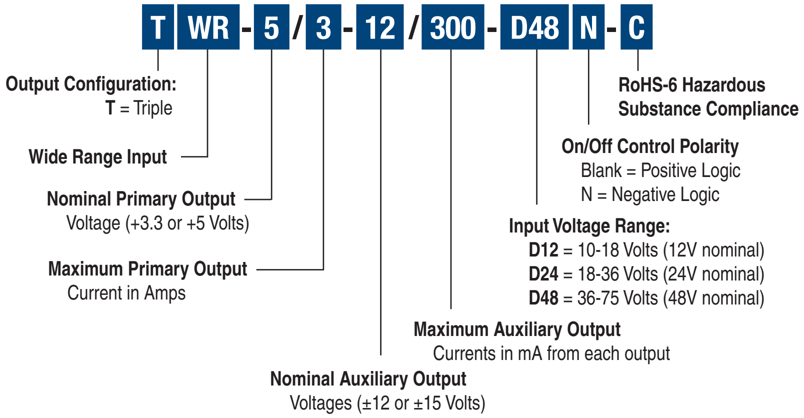
TWR-5/3-12/300-D48
Efficiency vs. Line Voltage and Load Current @ 25°C



TWR-5/3-15/250-D48
Efficiency vs. Line Voltage and Load Current @ 25°C



PART NUMBER STRUCTURE



Note: Some model number combinations may not be available. Contact Murata Power Solutions.

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06/12/08

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