# imall

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## **ULT Series**

### Thirty-Second-Brick Isolated DC/DC Converters with 2:1 Wide Input Range



#### **FEATURES**

- 2:1 Input Voltage Range (36V 75V, 48 Volts, nominal)
- Up to 30W output power @ 36 48 75Vin
- 89% efficiency (typical, 5Vout)
- Through-hole and optional SMT package
- Miniature 1/32 brick open frame package
- Positive & Negative Logic On/Off control option
- Over-current & Over-temperature protection
- Low output ripple and noise
- Strong thermal derating characteristics
- Operational Temperature Range –40°C to +85°C
- 1500V I/O isolation
- Tight line/load regulation
- Certified to UL/IEC 60950-1, CAN/CSA C22.2 No. 60950-1, safety approvals, 2nd Edition

#### **PRODUCT OVERVIEW**

The ULT Series isolated DC/DC converter represents the next generation converters in a 1/32 brick package. This converter is the "industry-standard" 1/32 brick form factor (0.92" x 0.75" x 0.35"). The product fully complies with RoHS-6 directive.

The thirty-second brick is offered as an open frame module; mounting options include throughhole or surface mount (SMT) pinouts. Typical applications include Optical Networking Equipment, Wireless Base Station applications, Microwave Radio communications, and Telecom and Data Equipment applications. Modules will supply an output power of up to 30 watts over the input range of 36-75V. The ULT Series also provides a cost effective approach to highly efficient systems requiring 12V, 5V, and 3.3V voltages, eliminating the requirement for a "Bus Converter" and multiple PoL converters. The ULT family provides basic insulation with 1500Vdc isolation meeting the requirements of UL/IEC 60950. The ULT series modules are DOSA compatible industry standard 1/32 brick.

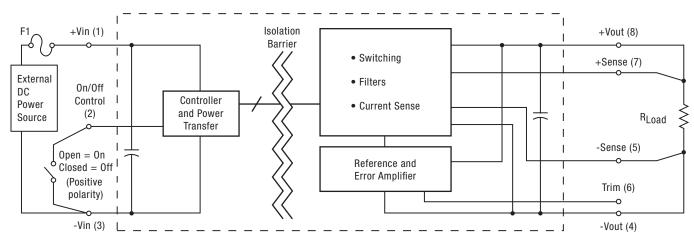


Figure 1. Connection Diagram

Typical topology is shown. Murata Power Solutions recommends an external fuse.





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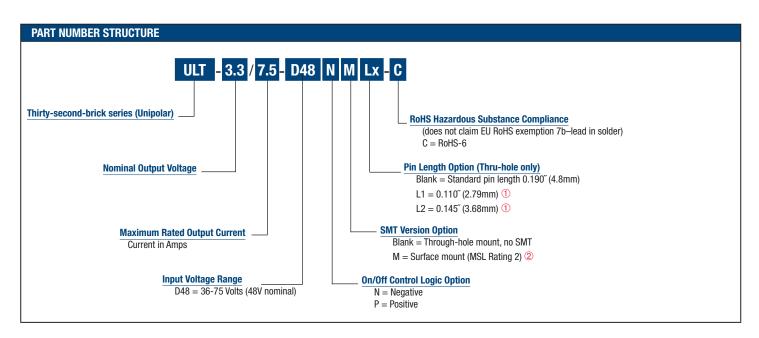
PERFORMANCE SP	ECIFICA	TIONS SUM	MARY AN	ID ORDERI	NG GUIDE	0								
		Output Input					Efficiency		Package					
Root Model ①	Vout	Іоит	Power	R/N (mV	pk-pk) ②	Regulatio	n (max.) <sup>③</sup>	VIN Nom.	Range	lin, no load	lın, full	Efficiency		rackaye
	(V)	(A, max.)	(W)	Тур.	Max.	Line	Load	(V)	(V)	(mA)	load (A)	Min.	Тур.	Case (inches)
ULT-3.3/7.5-D48	3.3	7.5	24.75	45	50	±0.15%	±0.2%	48	36-75	20	0.6	84%	85.5%	0.92 x 0.75 x 0.35
ULT-5/5-D48	5	5	25	50	75	±0.1%	±0.125%	48	36-75	20	0.59	87%	89%	0.92 x 0.75 x 0.35
ULT-12/2.5-D48	12	2.5	30	70	100	±0.075%	±0.125%	48	36-75	20	0.68	90%	92%	0.92 x 0.75 x 0.35

<sup>①</sup> Please refer to the Part Number Structure when ordering.

<sup>②</sup> All specifications are typical at nominal line voltage and full load, +25°C unless otherwise noted. See detailed specifications. External input capacitors are  $33\mu$ F electrolytic and three 1 $\mu$ F ceramic. Output ripple is measured with 400 $\mu$ F capacitance across output pins for the 3.3Vout and 5Vout model. The 12Vout model

is measured with 188 $\mu\text{F}.$  Output caps are necessary for our test equipment and may not be needed for your application.

③ Regulation specifications describe output voltage deviations from a nominal/midpoint value to either extreme (50% load step).



- ① Special quantity order is required; samples available with standard pin length only.
- $\odot~$  SMT (M) versions not available in sample quantities.
- ③ Some model number combinations may not be available. See website or contact your local Murata sales representative.

## **ULT Series**

### Thirty-Second-Brick Isolated DC/DC Converters with 2:1 Wide Input Range

#### FUNCTIONAL SPECIFICATIONS (ULT-3.3/7.5-D48-C)

ABSOLUTE MAXIMUM RATINGS	Conditions ①	Minimum	Typical/Nominal	Maximum	Units
Input Voltage, Continuous	Full temperature range	36		80	Vdc
	Operating or non-operating, 100 mS max.			100	Vdo
Input Voltage, Transient 🕼	duration			100	Vdc
Isolation Voltage	Input to output tested			1500	Vdc
Input Reverse Polarity	None, install external fuse		none		Vdc
On/Off Remote Control	Power on or off, referred to -Vin			15	Vdc
Output Power				25	W
Output Current	Current-limited, no damage, short-circuit protected			7.5	A
Storage Temperature Range	Vin = Zero (no power)	-40		125	°C
	of devices to greater than any of these conditions m	nay adversely affect lor	ig-term reliability. Proper ope	eration under condition	s other than those
listed in the Performance/Functional Specification	•				
INPUT	Conditions ① ③		10		
Operating voltage range		36	48	75	Vdc
Recommended External Fuse <sup>(13)</sup>	Fast blow		2		A
Start-up threshold	Rising input voltage	32.5	33.3	34.5	Vdc
Undervoltage lockout (@ ½ load)	Falling input voltage	30.75	31.75	32.75	Vdc
Turn-On/Turn-Off Hysteresis		1.22	1.3	1.32	Vdc
Overvoltage shutdown	Rising input voltage		N/A		Vdc
Reverse Polarity Protection	None, install external fuse		None		Vdc
Internal Filter Type			Capacitive		
Input current	· · · · · · · · · · · · · · · · · · ·				
Full Load Current Conditions	Vin = nominal		0.6	0.62	A
Low Line Input Currrent	Vin = minimum		0.8	0.83	A
Inrush Transient	Vin = 48V		0.05		A2-Sec.
Short Circuit input current			0.04	0.1	mA
No Load input current	lout = minimum, unit=ON		20	40	mA
Shut-Down Mode input current (Off, UV, OT)			6	10	mA
Reflected (back) ripple current 2	Measured at input with specified filter		30		mA, pk-pk
GENERAL and SAFETY					
Efficiency	Vin=48V	84	85.5		%
-	Vin=36V	83.5	85.5		%
Isolation			1500		Vda
Isolation Voltage, Input to Output Insulation Safety Rating			1500 basic		Vdc
Isolation Resistance		10	Dasic		ΜΩ
Isolation Capacitance		10	1700		pF
Safety	UL-60950-1, CSA-C22.2 No.60950-1,		1700		pi
(certified to the following requirements)	IEC/60950-1, 2nd edition		Yes		
	Per Telcordia SR332, issue 1, class 3, ground				
Calculated MTBF ④	fixed, Tambient=+25°C		TBD		Hours x 10 <sup>3</sup>
DYNAMIC CHARACTERISTICS					
Fixed Switching Frequency		250	287	320	KHz
Startup Time	Power On, to Vout regulation band, 100%			50	mS
Startup Time	Remote ON to Vout Regulated			50	mS
Dynamic Load Response	50-75-50% load step to 1% of Vout		75	150	μSec
Dynamic Load Peak Deviation	same as above		±100		mV
FEATURES and OPTIONS					
Remote On/Off Control 6					
"N" suffix					
Negative Logic, ON state	ON = pin grounded or external voltage	-0.7		1.0	Vdc
Negative Logic, OFF state	OFF = pin open or external voltage	10		15	Vdc
	open collector/drain		1		mA
Control Current	open concetor/drain				
<u> </u>	open concetor, dram				
Control Current	ON = pin open or external voltage	10		15	V
Control Current "P" suffix		10 -0.7		15 1.0	V V

## **ULT Series**

### Thirty-Second-Brick Isolated DC/DC Converters with 2:1 Wide Input Range

#### FUNCTIONAL SPECIFICATIONS (ULT-3.3/7.5-D48-C, CONT.)

OUTPUT	Conditions ①	Minimum	Typical/Nominal	Maximum	Units
Total Output Power		0	24.75	25	W
Voltage					- <b>i</b>
Nominal Output Voltage		3.2505	3.3	3.35	Vdc
Setting Accuracy	At 50% load	-1.5		1.5	Vdc
Output Trim Range ®	User selectable (see trim formulas)	-20		10	% of Vout
Overvoltage Protection		3.9		4.6	Vdc
Current	· ·				- <b>1</b>
Output Current Range		0	7.5	7.5	Α
Minimum Load	no minimal load required				
Current Limit Inception (9)	98% of Vnom., after warmup	8.8	10.8	12.5	Α
Short Circuit					
Short Circuit Current	Hiccup technique, autorecovery within ±1.25% of Vout			0.3	А
Short Circuit Duration (remove short for recovery)	Output shorted to ground, no damage		Continuous		
Short circuit protection method	Hiccup current limiting		Non-latching		
Regulation ⑦					
Line Regulation	Vin=min. to max., Vout=nom., full load			±0.15	% of Vout
Load Regulation	lout=min. to max., Vin=nom.			±0.2	% of Vout
Ripple and Noise <sup>(12)</sup>	Tested with eight 47µF ceramic caps in parallel		45	50	mV pk-pk
Temperature Coefficient	At all outputs		0.02		% of Vout./°C
Maximum Capacitive Loading	Low ESR	400		5,000	μF
Remote Sense Compliance	Vsense = Vout - Vload, sense connected at load			10	% of Vout
MECHANICAL (Through Hole Models)	Conditions ① ③	Minimum	Typical/Nominal	Maximum	Units
Outline Dimensions			0.92 x 0.75 x 0.35		Inches
(Please refer to outline drawing)	LxWxH		23.4x19.05x8.89		mm
Weight			0.32		Ounces
			9.07		Grams
Through Hole Pin Diameter			.04 & .062		Inches
			1.02 & 1.57		mm
Through Hole Pin Material			Brass		
TH Pin Plating Metal and Thickness	Nickel subplate		50		µ-inches
	Gold overplate		3-5		µ-inches
ENVIRONMENTAL					
Operating Ambient Temperature Range	See derating curves	-40		85	°C
Storage Temperature	Vin = Zero (no power)	-55		125	°C
Thermal Protection/Shutdown		120	130	140	°C
Electromagnetic Interference	External filter is required				
Conducted, EN55022/CISPR22				В	Class
RoHS rating			RoHS-6		

## **ULT Series**

### Thirty-Second-Brick Isolated DC/DC Converters with 2:1 Wide Input Range

#### **Performance Specification Notes**

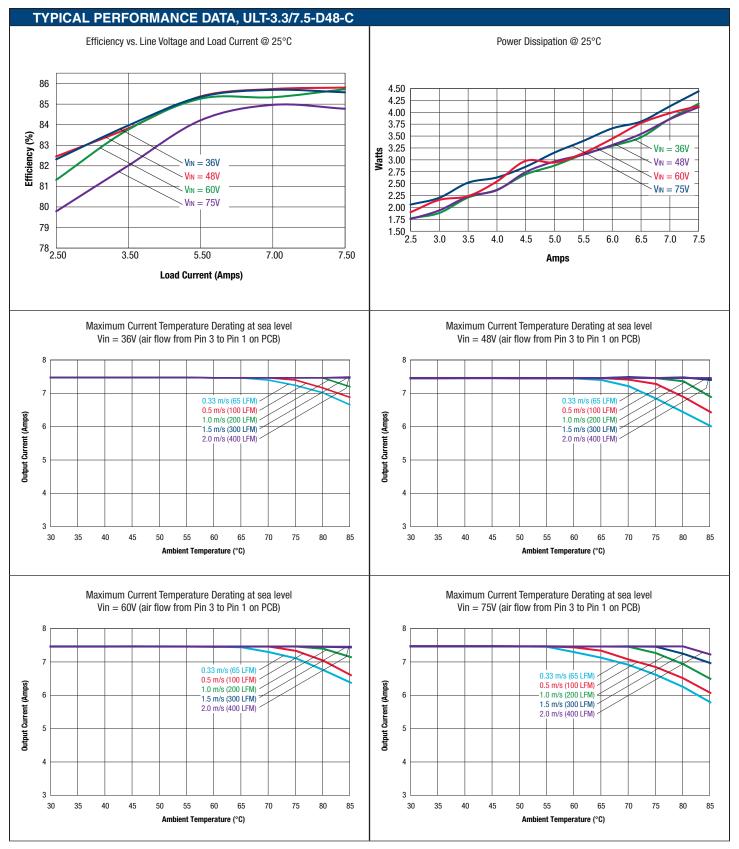
① All specifications are typical unless noted. Ambient temperature =  $+25^{\circ}$ Celsius, V<sub>IN</sub> is nominal, output current is maximum rated nominal. External output capacitance consists of 400µF capacitors across output pins; one 33µF low ESR, and three 1µF external input capacitors. All caps are low ESR.

Testing must be kept short enough that the converter does not appreciably heat up during testing. For extended testing, use plenty of airflow. See derating curves for temperature performance. All models are stable and regulate within spec without external cacacitance.

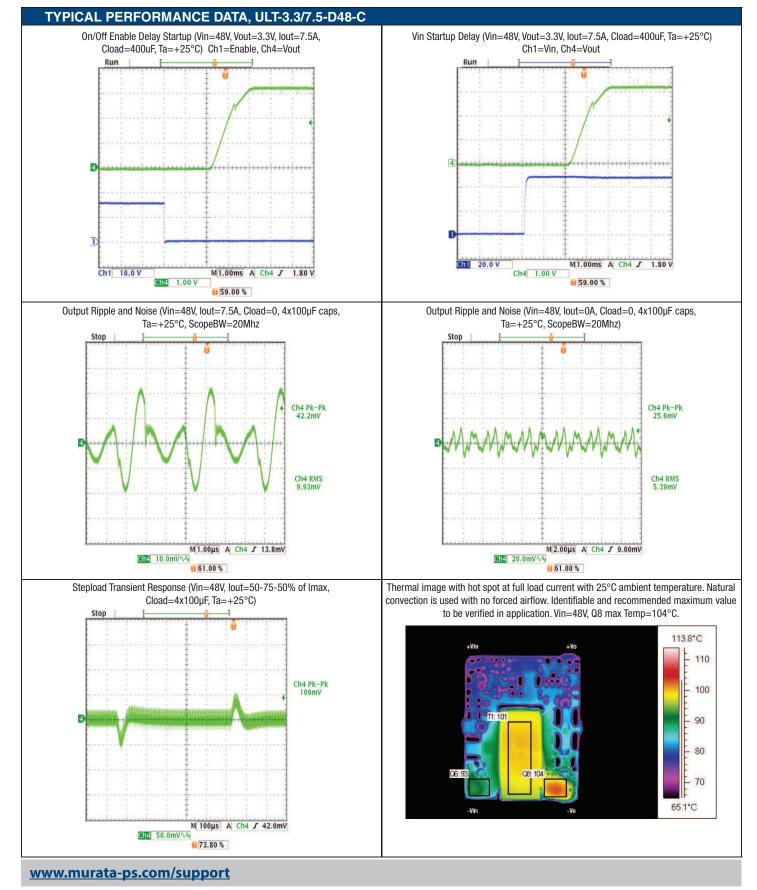
- ② Input Ripple Current is tested and specified over a 5-20 MHz bandwidth and uses a special set of external filters only for the Ripple Current specifications. Input filtering is C<sub>IN</sub> = 33 µF, C<sub>BUS</sub> = 220 µF, L<sub>BUS</sub> = 12 µH. Use capacitor rated voltages which are twice the maximum expected voltage. Capacitors must accept high speed AC switching currents.
- ③ Note that Maximum Current Derating Curves indicate an average current at nominal input voltage. At higher temperatures and/or lower airflow, the converter will tolerate brief full current outputs if the average 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 (MTBF) is calculated using the Telcordia (Belcore) SR-332 Method 1, Case 3, Issue 1, ground fixed conditions. Operating temperature = +25°C, full output load, natural air convection.
- ⑤ The output may be shorted to ground indefinitely with no damage. The Output Short Circuit Current shown in the specifications is an average consisting of very short bursts of full rated current to test whether the output circuit can be repowered.
- 6 The On/Off pin allows the converter to be turned on or off by an external device such as a switch, a transistor, a logic gate, or an optical isolator. If the "logic pin" is left floating the measured voltage will be outside the limit's in the data sheet. Those numbers define the levels needed for the "control function" to take place and do not represent the voltage that may be present on the logic pin.

- Regulation specifications describe the deviation as the input line voltage or output load current is varied from a nominal midpoint value to either extreme (50% load).
- ⑧ Do not exceed maximum power ratings, sense limits or output overvoltage when adjusting output trim values.
- ③ Output overload protection is non-latching. When the output overload is removed, the output will automatically recover.
- Ill models are fully operational and meet published specifications, including "cold start" at -40°C.
- ① The converter will shut off if the input falls below the undervoltage threshold. It will not restart until the input exceeds the Input Start Up Voltage.
- Output noise may be further reduced by installing an external filter. See the Application Notes. Use only as much output filtering as needed <u>and no</u> <u>more</u>. Larger caps (especially low-ESR ceramic types) may slow transient response or degrade dynamic performance. Thoroughly test your application with all components installed.
- If reverse polarity is accidentally applied to the input, always connect an external fast blow input fuse in series with the +Vℕ input.
- Although extremely unlikely, failure of the internal components of this product may expose external application circuits to dangerous voltages, currents, temperatures or power levels. Please thoroughly verify all applications before committing them to service. Be sure to include appropriately rated FUSES (see specifications and Application Notes) to reduce the risk of failure.
- (9) Special care should be exercised so that Input Voltage Transient does not exceed specified Max 100V/100ms. At normal input a large transient spike can be generated as a result of distribution inductance and high inrush current charging input cap on converter. This can be eliminated with 33µF electrolytic capacitor mounted close to Converter input. The series resistance (500m $\Omega$  < ESR < 700m $\Omega$ ) is essential in this solution.

## **ULT Series**



## **ULT Series**



## **ULT Series**

### Thirty-Second-Brick Isolated DC/DC Converters with 2:1 Wide Input Range

#### FUNCTIONAL SPECIFICATIONS (ULT-5/5-D48-C)

Input Woltage, Transient ③         Operating or non-operating, 100 m Smax. duration         100         Vdc           isolation Voltage         Input to output tested         none         Vdc           Input Reverse Polarity         None, install ateman luse         none         Vdc           OnCID Renote Control         Power on or off, referred to Vin         0         22.5.25         WL           Storage Temperature Range         Vm = 2/m (power)         5.5         12.5         °C           Storage Temperature Range         Vm = 2/m (power)         5.5         12.5         °C           Absolute maximums are sites: ratings. Exposure of devices to greater than any of these conditions may adversity affect long-term reliability. Proper operation under conditions than any of these conditions may adversity affect long-term reliability. Proper operation under conditions way adversity affect long-term reliability. Proper operation under conditions way adversity affect long-term reliability. Proper operation under conditions way adversity affect long-term reliability. Proper operation under conditions way adversity affect long-term reliability. Proper operation under conditions way adversity affect long-term reliability. Proper operation under conditions way adversity affect long-term reliability. Proper operation under conditions way adversity affect long-term reliability. Proper operation under conditions way adversity affect long-term reliability. Proper operation under conditions way adversity affect long-term reliability. Proper operation under conditions way adversity affect long-term reliability. Proper operation affect long way adversity. Adversit	ABSOLUTE MAXIMUM RATINGS	Conditions ①	Minimum	Typical/Nominal	Maximum	Units
Input Voltage, Translent III of Paraling or non-operaling. 1/0 mS max. duration durationInput III on the Max.Input III on the Max.<	Input Voltage, Continuous	Full temperature range	36		80	Vdc
Input Reverse Polarity         None, install external lase         none         Vide           OutDP Meer         O         15         Vide           OutDP Meer         O         25.25         W           OutDP Meer         Carnet-Hindle, no damage, stort-circut protected         0         25.25         W           Storage Temperture Range         Vin = Zorn (no power)         -55         A         35.25         Vice           Storage Temperture Range         Vin = Zorn (no power)         -55         12.25         °C           Match and manus ar stess ratings. Storage or recommended.         W         75.         Vice         No           Barde Temperture Range         Contention 80.8         6         40         75.         Vice           Generating National Storage Carage         S6         48         75.         Vice         A           Stort-up Intershotd ©         Rasing Input voltage         32.8         33.25         34.25         Vice           Fund-ondations         Rasing Input voltage         30.8         32.5         34.4         Vice           Fund-ondations         None, install external lase         N/A         Vice         Vice           Interned Filter Type         None, install external lase         N/A <td>Input Voltage, Transient (§</td> <td></td> <td></td> <td></td> <td>100</td> <td>Vdc</td>	Input Voltage, Transient (§				100	Vdc
Input Reverse Polarity         None, install external lase         none         Vide           OutDP Meer         O         15         Vide           OutDP Meer         O         25.25         W           OutDP Meer         Carnet-Hindle, no damage, stort-circut protected         0         25.25         W           Storage Temperture Range         Vin = Zorn (no power)         -55         A         35.25         Vice           Storage Temperture Range         Vin = Zorn (no power)         -55         12.25         °C           Match and manus ar stess ratings. Storage or recommended.         W         75.         Vice         No           Barde Temperture Range         Contention 80.8         6         40         75.         Vice           Generating National Storage Carage         S6         48         75.         Vice         A           Stort-up Intershotd ©         Rasing Input voltage         32.8         33.25         34.25         Vice           Fund-ondations         Rasing Input voltage         30.8         32.5         34.4         Vice           Fund-ondations         None, install external lase         N/A         Vice         Vice           Interned Filter Type         None, install external lase         N/A <td>Isolation Voltage</td> <td>Input to output tested</td> <td></td> <td></td> <td>1500</td> <td>Vdc</td>	Isolation Voltage	Input to output tested			1500	Vdc
On/Off Remote Cantrol         Power on or fir, inferred to -Vin         0         15         Vdc           Output Power         0         25.25         W           Output Corrent         0         5.5         A           Strange Temperature Range         Win = Zero (np pown)         -55         125         °C           Absolute maximums are stress ratings. Exposure of devices to grader than any of these confiders may adversely affect long-term roleality. Proper operation under conditions other than the isot in the Portinomaco Functional Specifications. The iso is not inigitation of the Portinomaco Functional Specifications. The iso is not inigitation of the Portinomaco Functional Specifications. The iso is not inigitation of the Portinomaco Functional Specifications. The iso is not inigitation of the Portinomaco Functional Specifications. The iso ison inigitation of the Portinomaco Functional Specifications. The Portinomaco Functional Specifications. The ison initiation of the Portinomaco Functional Specifications. The Portinomaco Functinal Portinomaco Functional Specificatins. The Port				none		Vdc
Output Drawer         0         22.25         W           Output Durput Current         Current-limited, no damaga, start-circuit protectial         0         5         A           Storage Temperature Range         Win = Zero (no power)         -55         -72         Associate         -72           Storage Temperature Range         Win = Zero (no power)         -55         -72         Associate         -72           Storage Temperature Range         Win = Zero (no power)         -55         -72         Associate         -72           Machael Associate         Storage Temperature Range of temperature and storage advected affect tome-term reliability. Proper operation under constituons of the month isosian input within a storage advected affect tome-term reliability. Proper Constitutions of the Score advected a	On/Off Remote Control		0		15	Vdc
Output Current         Current-limited, no samage, short-icuta protected         0         5         A           Storage Temperature Range         Vin = 20n (prower)         55         125         °°C           Absolde maintums are sites ratings. Exposure of devices to greater than any of these conditions may adversely affect tong-term reliability. Proper operation under conditions other than the idea in the Performance-Functional Specifications Table is not implied or recommended.         Vince         Vince         Vince         A           Operating voltage range         Fasts blow         8         48         75         Vicc           Recommended External Fuse         Fasts blow         2         32.25         34.25         Vicc           Output Conditions         0         Falling input voltage         30.8         32.5         34.4         Vicc           Output Conditions         0.6         A         NA         Vicc         Vicc <td>Output Power</td> <td></td> <td>0</td> <td></td> <td></td> <td></td>	Output Power		0			
Storage framperature Range         Win = Zan' (no pown)         -5.5         125         °C           Storage framperature Range         Win = Zan' (no pown)         -5.5         125         °C           Storage framperature Range         Reading maximum availersely affect long-term reliability. Proper operation under conditions of the no the interm start start and is produced and these conditions on availersely affect long-term reliability. Proper operation under conditions of the no the interm at a start and availability. Proper operation under conditions of the no the interm at a start and intermatic start and intermatintermatent and intermatic start and intermatic start and inter		Current-limited, no damage, short-circuit protected	0			А
Absolde maximums are stress ratings. Exposure of devices to greater than any of these conditions may adversely affect long-term reliability. Proper operation under conditions other than the lisks in the Performance/functional Specifications Table is not implied or recommended. INPUT Conditions 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	•				125	
Iside in the Performance/Functional Specifications Table is not implied or recommended.           NPT         Conditions ©         36         48         75         Vicc           Operating voltage range         East blow         2         A         A           Start-up threshold ©         Paining input voltage         32         33.25         34.25         Vicc           Dinder-orbitage foctual (© ½ load) ©         Failing input voltage         10.3         1.31         1.61         Vicc           Diversoftage shutdown         Resign input voltage         NA         Vicc         Vicc         Vicc           Overvoltage shutdown         Resign input voltage         NA         Vicc         Vicc         Vicc           Full Lad Conditions         Vin = nominal         0.59         0.6         A           Low Line         Vin = minimum         0.79         0.81         A2           Short Oricuit input current         50         100         mA           Shut-Down Mode input current (Vf, UV, OT)         Full cast ASTY         Vin = 30V         87         88.5         %           Startow Mode input current (Vf, UV, OT)         Measured at input with specified filter         15         30         mA A           Startow Mode input current (Vf, UV, OT)         Measured at input with spec			av adverselv affect lon	g-term reliability. Proper ope	eration under conditions	s other than tho
IMPUT         Conditions © ●           Breammonded External Fuse         Fast blow         3         2         7         A           Breammonded External Fuse         Fast blow         32         33.25         94.25         Vice           Miderroitage lockout (@ ½ load) ©         Falling input voltage         30.8         32.2         33.25         94.425         Vice           Mutervoltage lockout (@ ½ load) ©         Falling input voltage         30.8         32.2         34.4         Vice           Overvoltage stutiotown         Rising input voltage         30.8         32.5         34.4         Vice           NIA         Low Line         NiA         Low Construction         NiA         Vice           Interned Filter Type         Capacitive         Capacitive         Vice         Vice           Insush Transient         Vin = moninal         0.05         A         A           No Load input current (M uput current)         Nute = minimum, unit=0N         20.0         40.0         mA           Shut-Down Mode input current (M uput QI)         Measured at input with specified filter         15         30         mA, pic-p           GREALPLAI and SAFETY         Win=48W         87         89         %         %			.,,,	5 · · · · · · · · · · · · ·		
Operating varlage range         method         38         48         75         VMC           Start-up threshold ®         Rising input voltage         32         33.25         34.25         VdC           Start-up threshold ®         Rising input voltage         32         33.25         34.4         VdC           Start-up threshold ®         Rising input voltage         30.8         32.5         34.4         VdC           Under-voltage shutdown         Rising input voltage         10.3         1.31         1.61         VdC           Overvoltage shutdown         Rising input voltage         N/A         VdC         VdC         VdC           Deverse Polarity Protection         None, install external fuse         N/A         VdC         VdC           Intrush Transient         Vin = monimum         0.79         0.81         A           Intrush Transient         Iout = minimum, unit—0N         20         40         mA           No Load input current         Iout = minimum, unit—0N         20         40         mA           Shot Choruti upt current         Iout = minimum, unit—0N         20         40         mA           Shot Choruti urent         Iout = minimum, unit—0N         20         40         mA <t< td=""><td></td><td></td><td></td><td></td><td></td><td></td></t<>						
Recommende External Fuse in the set of the	Operating voltage range		36	48	75	Vdc
Start-up threshold         Rising input voltage         32         33.25         34.25         V/dc           Under-ordinge lockout (0* ½ load)         Falling input voltage         30.8         32.5         34         V/dc           Under-ordinge instultation         Rising input voltage         30.8         32.5         34         V/dc           Under-ordinge shutdown         Rising input voltage         1.03         1.31         1.61         V/dc           Deverse Polarity Protection         None, install external fuse         N/A         V/dc         V/dc           Internal Filter Type         None install external fuse         N/A         V/dc         V/dc           Full cad Conditions         V/n = nominal         0.59         0.6         A           Insus Transient         0.05         A2-Sec.         A2-Sec.         A2-Sec.           Shot Crowni Induc current (0ff, UV, 0T)         Measured at input with specified filter         15         30         mA, hc p           Efficiency         Vin=48V         87         88.5         %         %           Isolation Voltage, input to output         Isolation voltage         1         Mount and		Fast blow			-	
Indervoltage lockout (@ ½ load) ◎         Falling input voltage         30.8         32.5         34         Vdc           Num-Onf Hystersis         1.03         1.31         1.61         Vdc           Overvoltage shutdown         Rising input voltage         1.03         1.31         1.61         Vdc           Reverse Polarity Protection         None, install external fuse         N/A         Vdc         Vdc           Internal Filter Type			32		34 25	_
Turn-Ort/Turn-Off Hysteresistory         Control         1.03         1.31         1.61         Voic           Overvoltage shuldown         Rising input voltage         N/A         Voic         Voic           Reverse Volarity Protection         None, install external fuse         N/A         Voic         Voic           Internal Filter Type	•		-			-
Over-ottage shutdown         Rising input voltage         NA         Vdc         Vdc           Reverse Polarity Protection         None, install external fuse         N/A         Vdc           input current         Capacitive         Capacitive         N/A           Full Load Conditions         Vin = nominal         0.59         0.6         A           Low Line         Vin = nominal         0.79         0.81         A           Low Line         Vin = minimum         0.05         10.28         A           Itrush Transient         Iout = minimum, unit=0N         50         100         mA           No Load input current (0ft, UV, 0T)         Measured at input with specified filter         1         3         mA           Shut-Doam Mode input current (0ft, UV, 0T)         Measured at input with specified filter         15         30         mA, pk-p           Efficiency         Vin=48V         87         89         %         %           Vin=36V         87         88.5         %         %           Isolation Voltage, input to output         1500         0/dc         pF           Isolation Noltage, input to output         1500         0/dc         pF           Isolation Voltage, input to output         1500         <		i annig input voltage				
Reverse Polarity Protection         None, install external fuse         NA         Vdc           internal Filter Type         Capacitive         Capacitive         Imput current           Full Load Conditions         Vin = nominal         0.59         0.6         A           Low Line         Vin = minimum         0.79         0.81         A           Inrush Transient         0.05         100         mA           Short Circuit Unit current         10.05         100         mA           Shut-Down Mode input current (0ff, UV, 0T)         Iout = minimum, unit=0N         20         40         mA           Shut-Down Mode input current (0ff, UV, 0T)         Measured at input with specified filter         11         3         mA           Reflected (lock) rippic current (2)         Measured at input with specified filter         150         0         MA           Biolation         Vin=36V         87         89         %         %           Isolation Voltage, Input to Output         1500         Vinc         Vinc         %           Isolation Resistance         10         Edition Condition         MC         Mode           Isolation Resistance         10         1650         Pr         Filter (S0650-1, 2A/t editon         MC		Pieing input voltage	1.03		1.01	-
Internal Filter Type index of the second se						
Input current         Image of the second seco		ivone, install external tuse				Vac
Full Load Conditions         Win = moninal         0.59         0.6         A           Low Line         Vin = minimum         0.79         0.81         A           Inrush Transient         0.05         100         mA           Short Circuit input current         0.01         70         0.81         A2-Sec.           Short Circuit input current         lout = minimum, unit=0N         20         40         mA           Shut-Down Mode input current (0ff, UV, OT)         1         3         mA           Reflected (back) rippic current (0         Measured at input with specified filter         15         30         mA pre-           GENERAL and SAFETY         Vin=48V         87         89         %           Stolation         Vin=36V         87         89         %           Isolation Voitage, Input to Output         Isolation Voitage         Vin=36V         87         89         Vic           Isolation Gapacitance         Un=6980-1         1500         Vic         Vic         10         MO           Isolation Gapacitance         UL-69950-1, 2nd edition         Yes         Vic         1650         PF           Startup Time         Per Telordia SR32, Isoue 1, class 3, ground fixed, Tambitent=-25 °C         7.3         H				Capacitive		
Low LineVin = minimum0.790.81AInrush Transient0.05A2-Sec.Sohrt Grouil input currentlout = minimum, unit=0N2040No Load input current (ØR, UV, OT)13mAReflected (back) ripple current (ØRMeasured at input with specified filter1530mA, pk-pGENERAL and SAFETYVin=48V8789%UtiencyVin=48V8789%BolationVin=36V8789.5%Isolation1500Vdc%Isolation Voltage1040MCIsolation Voltage10MCMCIsolation Voltage10MCMCIsolation Resistance10MCMCIsolation SafetyPer Telcordit SR32, Issu 1, Cas 3, ground fixed, Tambient=+25°C7.3Hours x1VIAMLE GHARACTERISTICSPer Vine Res 100, No Volt regulated510mSDynamic Load Response50-75-50% load step to 1% error band safety75150µSecDynamic Load Response50-75-50% load step to 1% error band same as above75150µSecDynamic Load Response50-75-50% load step to 1% error band 	•	Via a-min-1		0.50	0.0	
Inrush Transient         0.05         A2-Sec.           Short Circuit input current         0.04 (nput current)         00         mA           No Load input current (Off, UV, OT)         100         mA           Shut-Down Mode input current (Off, UV, OT)         13         30           Reflected (back) ripple current (2)         Measured at input with specified filter         15         30         mA, pk-p           CENERAL and SAFETY         Vin=48V         87         89         %           Efficiency         Vin=36V         87         88.5         %           Isolation         1500         V/dc         %           Isolation Voltage, Input to Output         1500         V/dc         %           Isolation Safety Rating         0         basic         %           Isolation Capacitance         10         MC         MC           Isolation Capacitance         10         MC         MC           Vin=60%         Per Telcordia SR332, issue 1, class 3, ground fixed, frambient=+25°C         255         285         MHz           VNAMIC CHARACTERISTICS         Ferture Volt regulation band, 100%         5         10         mS           Startup Time         Power On, to Vout regulation band, 100%         5         10						
Short Circuit input current         50         100         mA           No Load input current         Iout = minimum, unit=0N         20         40         mA           Reflected (back) ripple current (QT)         Measured at input with specified filter         1         3         mA           Reflected (back) ripple current (Q)         Measured at input with specified filter         15         30         mA, pk-p           CENERAL and SAFETY         Vin=48V         87         89         %           Biolation         Vin=36V         87         8.5         %           Isolation Voltage, Input to Output         1500         V/dc         V/dc           Isolation Resistance         10         MO         MC           Isolation Resistance         10         MC         MC           Isolation Rasistance         1         1650         pF           Starby         UL-60950-1, CSA-C22.2 No 60950-1, IEC/60950-1, 2nd edition         Yes         IeC/co950-1, 2nd edition           Isolation Capacitance         1         1650         pF           Starby         IEC/60950-1, 2nd edition         Yes         IeC/co950-1, 2nd edition           Calculated MTBF @         Per Telocord Ras32, issus 1, class 3, ground fixed, Tambient=+25°C         Yes         IeC/co95		Vin = minimum			0.81	
No Load input current         lout = minimum, unit=0N         20         40         mA           Shut-Down Mode input current (0)         Measured at input with specified filter         1         3         mA, pA           Reflected (lock) ripple current (2)         Measured at input with specified filter         15         30         mA, pA           Efficiency         Vin=48V         87         89         %           Isolation         Isolation Voltage, Input to Output         1500         V/c           Isolation Voltage         1500         V/dc         V/dc           Isolation Stately Rating         1500         V/dc         V/dc           Isolation Capacitance         10         MO         MO           Isolation Capacitance         10         MO         MO           Isolation Capacitance         10         V/dc         S           Stafety         UL-60950-1, CSA-C22.2 No.60950-1, IEC/C0950-1, 2nd edition         Yes         V/dc           Isolation Raisa Issue 1, class 3, ground fixed, Tambient=+25°C         7.3         Hours x 1           DYNAMIC CHARACTERISTICS         S         10         mS           Startup Time         Remote ON to Vout Regulated         5         10         mS           Dynamic Load Response					100	
Shuf-Down Mode input current (Off, UV, OT)         media current (Off, UT, OT)         media current (Off, OT)         media current (Off, UT, OT) <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>						
Reflected (back) ripple current (2)       Measured at input with specified filter       15       30       mA, pk-p         CENERAL and SAFETY       Vin=48V       87       89       %         Efficiency       Vin=36V       87       88.5       %         Isolation Voltage, Input to Output        1500       Vdc         Isolation Voltage, Input to Output        1500       Vdc         Isolation Voltage         Vdc         Isolation Capacitance       10       MQ       MQ         Isolation Capacitance       10       MQ       MQ         Safety       UL-60950-1, CSA-C22.2 No.60950-1, IEC/60950-1, IEC/60950-1, IEC/60950-1, CSA-C22.2 No.60950-1, CSA-C22.2 No.60950-1, IEC/60950-1, CSA-C22.2 No.60950-1, IEC/60950-1,		lout = minimum, unit=0N				
GENERAL and SAFETY         Vin=48V         87         89         %           Efficiency         Vin=36V         87         89         %           Isolation         87         88         %           Isolation Voltage, Input to Output         1500         Vdc           Isolation Notage         1500         Vdc           Isolation Safety Rating         0         Vdc           Isolation Capacitance         10         MO           Isolation Capacitance         10         MO           Safety         UL-60950-1, CSA-C22.2 No.60950-1, IEC/60950-1, 2nd edition         Yes           Calculated MTBF (*)         Per Teicordia SR32, Issue 1, class 3, ground fixed, Tambient=+25°C         7.3         Hours x 11           DYNAMIC CHARACTERISTICS         fixed, Tambient=+25°C         7.3         Hours x 11           DYNAMIG Prequency         225         255         285         KHz           Startup Time         Power On, to Vout regulation band, 100%         5         10         mS           Dynamic Load Response         50-75-50% load step to 1% error band         75         150         jpseco           Warmic Load Response         50-75-50% load step to 1% error band         75         150         mV           FEATURES and	• • • • • •					
Vin=48V         87         89         %           Vin=36V         87         89         %           Isolation         87         88.5         %           Isolation Voltage, Input to Output         87         88.5         %           Isolation Voltage, Input to Output         1500         Vdc         Vdc           Isolation Resistance         1500         MΩ         MΩ           Isolation Capacitance         10         MΩ         MΩ           Isolation Resistance         10         Yes         F           Calculated MTBF ③         Per Telcordia SR332, Issue 1, class 3, ground fixed, Tambient=+25°C         7,3         Hours x 1           DYNAMIC CHARACTERISTICS         Yes         Isolation Age as a sove         5         10         mS           Startup Time         Power On, to Vout regulation band, 100%         5         10         mS           Dynamic Load Response         50-75-50% load step to 1% error band         75         150         µSec           Dynamic Load Response         50-75-50% load step to 1% error band         75         150         µSec           Dynamic Load Response         50-75-50% load step to 1% error band         75         150         µSec           Negative Logic, ON state		Measured at input with specified filter		15	30	mA, pk-pl
Entrolency         Vin=36V         87         88.5         %           isolation	GENERAL and SAFETY					
Vin=36V8788.5%IsolationVin=36V8788.5%Isolation Voltage1500VdcIsolation Voltage11500VdcIsolation Safety RatingbasicVdcIsolation Resistance10MΩIsolation Capacitance10MΩIsolation Capacitance10MΩSafetyUL-60950-1, CSA-C22.2 No.60950-1, IEC/60950-1, 2.nd editionYesCalculated MTBF @Per Telcordia SR332, issue 1, class 3, ground fixed, Tambient=+25°C7,3Hours x 1DYNAMIC CHARACTERISTICSPer Telcordia SR332, issue 1, class 3, ground fixed, Tambient=+25°C7,3Hours x 1DYNAMIC CHARACTERISTICSPer Telcordia SR332, issue 1, class 3, ground fixed, Tambient=+25°C7,3Hours x 1DYNAMIC CHARACTERISTICST7,3Hours x 1Extrup TimePower On, to Vout regulation band, 100%510mSDynamic Load Response50-75-50% load step to 1% error band75150µSecDynamic Load Peak Deviationsame as above±150mVFEATURES and OPTIONSFIn open or external voltage1012VdcControl @""" suffix1mA"P" suffix0N = pin open or external voltage1015VdcPositive Logic, OFF stateON = pin open or external voltage1015VdcPositive Logic, OFF stateON = pin open or external voltage1015VPositive Logic, OFF state <td< td=""><td>Efficiency</td><td></td><td></td><td></td><td></td><td></td></td<>	Efficiency					
Isolation Voltage, Input to Output       1500       Vdc         Isolation Voltage       0       0       Vdc         Insulation Safety Rating       0       basic       0         Isolation Resistance       10       0       MΩ         Isolation Resistance       10       0       MΩ         Isolation Capacitance       11       MΩ       MΩ         Safety       UL-60950-1, CSA-C22.2 No.60950-1, IEC/60950-1, 2nd edition       Yes       Per         Calculated MTBF ④       Per Telcordia SR32, issue 1, class 3, ground fixed, Tambient=+25°C       7.3       Hours x 10         DYNAMIC CHARACTERISTICS       Per       225       255       285       KHz         Startup Time       Power On, to Vout regulation band, 100%       5       10       mS         Startup Time       Remote ON to Vout Regulated       5       10       mS         Dynamic Load Response       50-75-50% load step to 1% error band       75       150       µSec         Dynamic Load Peak Deviation       same as above       ±150       mV         FEATURES and OPTIONS         Remote On/Off Control II       12       Vdc         Control II       0N = pin grounded or external voltage       10	-	Vin=36V	87	88.5		%
Isolation Voltage       Vdc         Insulation Safety Rating       0       0       0         Isolation Resistance       10       MΩ         Isolation Capacitance       10       MΩ         Safety       UL-60950-1, CSA-C22.2 No.60950-1, ICC/60950-1, 2nd edition       Yes       PF         Safety       UL-60950-1, CSA-C22.2 No.60950-1, ICC/60950-1, 2nd edition       Yes       PF         Calculated MTBF ⊕       Per Telcordia SR32, issue 1, class 3, ground fixed, Tambient=+25°C       7.3       Hours x 11         DYNAMIC CHARACTERISTICS       Frequency       225       255       285       KHz         Startup Time       Power On, to Vout regulation band, 100%       5       10       mS         Startup Time       Remote ON to Vout Regulated       5       10       mS         Dynamic Load Response       50-75-50% lead step to 1% error band       75       150       µSec         Dynamic Load Response       50-75-50% lead step to 1% error band       75       150       mV         FEATURES and OPTIONS       T       1.2       Vdc         "M" suffix       ON = pin grounded or external voltage       -0.7       1.2       Vdc         Negative Logic, ON state       ON = pin open or external voltage       10       15	Isolation					
Insulation Safety RatingImage: Constraint of the second secon						
Isolation Resistance         10         ΜΩ           Isolation Capacitance         10         1650         pF           Safety         UL-60950-1, CSA-C22.2 No.60950-1, IEC/60950-1, 2nd edition         Yes            Calculated MTBF ④         Per Telcordia SR332, issue 1, class 3, ground fixed, Tambient=+25°C         7.3         Hours x10           DYNAMIC CHARACTERISTICS         Per Telcordia SR332, issue 1, class 3, ground fixed, Tambient=+25°C         255         285         KHz           Startup Time         Power On, to Vout regulation band, 100%         5         10         mS           Startup Time         Remote ON to Vout Regulated         5         10         mS           Dynamic Load Response         50-75-50% load step to 1% error band         75         150         µSec           Dynamic Load Peak Deviation         same as above         ±150         mV           FEATURES and OPTIONS           Fursifix           Negative Logic, ON state         ON = pin grounded or external voltage         10         1         mA           Vdc         OFF = pin open or external voltage         10         15         Vdc           Control Current         open collector/drain         1         mA         Positive Logic, ON state         0N = pin open or				1500		
Isolation Capacitance1650pFSafetyUL-60950-1, CSA-C22.2 No.60950-1, IEC/60950-1, 2nd editionYes1650pFCalculated MTBF ③Per Telcordia SR332, issue 1, class 3, ground fixed, Tambient=+25°C7.3Hours x 10DYNAMIC CHARACTERISTICSFixed, Tambient=+25°C255285KHzStartup TimePower On, to Vout regulation band, 100%510mSStartup TimeRemote ON to Vout Regulated510mSDynamic Load Response50-75-50% load step to 1% error band75150µSecDynamic Load Peak Deviationsame as above±150mVFEATURES and OPTIONSRemote On/Off Control ⑤"WisuffixNegative Logic, ON stateON = pin grounded or external voltage101mAOPF1015VdcPer suffix"P" suffix"PD15VON = pin open or external voltage1015VON = pin open or external voltage1015VPositive Logic, OFF stateON = pin open or external voltage1015VPositive Logic, OFF stateON = pin open or external voltage1015VPositive Logic, OFF stateON = pin open or external voltage1012V	Isolation Voltage					
SafetyUL-60950-1, CSA-C22.2 No.60950-1, IEC/60950-1, 2nd editionYesCalculated MTBF (a)Per Telcordia SR332, issue 1, class 3, ground fixed, Tambient=+25°C7.3Hours x 10DYNAMIC CHARACTERISTICSFixed Switching Frequency225255285KHzStartup TimePower On, to Vout regulation band, 100%510mSStartup TimeRemote ON to Vout Regulated510mSDynamic Load Response50-75-50% load step to 1% error band75150µSecDynamic Load Peak Deviation same as above±150mVFEATURES and OPTIONSRemote On/Off Control (6)"N" suffixNegative Logic, OF stateON = pin grounded or external voltage-0.71.2VdcOptimic Load Colspan="2">Negative Logic, OF stateON = pin open or external voltage1015VdcPositive Logic, ON stateON = pin open or external voltage1015VPositive Logic, ON stateON = pin open or external voltage1015VPositive Logic, OF stateON = pin open or external voltage1015VPositive Logic, OFF stateON = pin open or external voltage1015VPositive Logic, OFF stateOFF = ground pin or external voltage-0.71.2V	Isolation Voltage Insulation Safety Rating					Vdc
Safety       IEC/60950-1, 2nd edition       Yes       Hours x 10         Calculated MTBF (*)       Per Telcordia SR332, issue 1, class 3, ground fixed, Tambient=+25°C       7.3       Hours x 10         DYNAMIC CHARACTERISTICS         Fixed Switching Frequency       225       255       285       KHz         Startup Time       Power On, to Vout regulation band, 100%       5       10       mS         Startup Time       Remote ON to Vout Regulated       5       10       mS         Dynamic Load Response       50-75-50% load step to 1% error band       75       150       µSec         Dynamic Load Peak Deviation       same as above       ±150       mV       mV         FETURES and OPTIONS         Terror Starte       ON = pin grounded or external voltage       -0.7       1.2       Vdc         Negative Logic, ON state       OFF = pin open or external voltage       10       mA         "P" suffix         Positive Logic, ON state       ON = pin open or external voltage       10       15       V         Positive Logic, ON state       ON = pin open or external voltage       10       15       V         Positive Logic, ON state       ON = pin open or e	Isolation Voltage Insulation Safety Rating Isolation Resistance		10	basic		Vdc MΩ
Calculated MTBF (a)       Per Telcordia SR332, issue 1, class 3, ground fixed, Tambient=+25°C       7.3       Hours x 10         DYNAMIC CHARACTERISTICS       7.3       Hours x 10         Fixed Switching Frequency       225       255       285       KHz         Startup Time       Power On, to Vout regulation band, 100%       5       10       mS         Startup Time       Remote ON to Vout Regulated       5       10       mS         Dynamic Load Peak Deviation       same as above       ±150       µV         FEATURES and OPTIONS       Emote ON/Off Control (s)       Time       ON = pin grounded or external voltage       -0.7       1.2       Vdc         Negative Logic, OFF state       OFF = pin open or external voltage       10       1       mA       mP*         Positive Logic, ON state       ON = pin open or external voltage       10       1       mA         Pre suffix         Positive Logic, ON state       ON = pin open or external voltage       10       1       mA         Pre suffix         Pre suffix         Pre suffix         Pre suffix         Pre suffix         Pre suffix         Pre	Isolation Voltage Insulation Safety Rating Isolation Resistance		10	basic		Vdc MΩ
Calculated WI BF (a)fixed, Tambient=+25°C7.3Hours X IIPrivation CHARACTERISTICSFixed Switching Frequency225255285KHzStartup TimePower On, to Vout regulation band, 100%510mSStartup TimeRemote ON to Vout Regulated510mSDynamic Load Response50-75-50% load step to 1% error band75150µSecDynamic Load Peak Deviationsame as above±150mVFEATURES and OPTIONS"N" suffixNegative Logic, OFF stateON = pin grounded or external voltage1015VdcOpen collector/drain1mAopen collector/drain1mA"Positive Logic, ON state0N = pin open or external voltage1015VdcOFF = ground pin or external voltage1015VdcOFF = ground pin or external voltage1015VPositive Logic, OFF state0N = pin open or external voltage1015VPositive Logic, OFF state0N = pin open or external voltage1015VPositive Logic, OFF state0FF = ground pin or external voltage1015VPositive Logic, OFF state0FF = ground pin or external voltage-0.71.2V	Isolation Voltage Insulation Safety Rating Isolation Resistance		10	basic 1650		Vdc MΩ
Fixed Switching Frequency225255285KHzStartup TimePower On, to Vout regulation band, 100%510mSStartup TimeRemote ON to Vout Regulated510mSDynamic Load Response50-75-50% load step to 1% error band75150µSecDynamic Load Peak Deviationsame as above±150mVFEATURES and OPTIONSRemote On/Off Control ®"N" suffixNegative Logic, ON stateON = pin grounded or external voltage-0.71.2VdcControl Currentopen collector/drain1mA"Positive Logic, ON stateON = pin open or external voltage1015VdcPositive Logic, OFF stateON = pin open or external voltage1015VPositive Logic, OFF stateON = pin open or external voltage1015VPositive Logic, OFF stateON = pin open or external voltage1015VPositive Logic, OFF stateON = pin open or external voltage1015VPositive Logic, OFF stateON = pin open or external voltage1015VPositive Logic, OFF stateON = pin open or external voltage1012V	Isolation Voltage Insulation Safety Rating Isolation Resistance Isolation Capacitance	IEC/60950-1, 2nd edition	10	basic 1650		Vdc MΩ
Startup Time         Power On, to Vout regulation band, 100%         5         10         mS           Startup Time         Remote ON to Vout Regulated         5         10         mS           Dynamic Load Response         50-75-50% load step to 1% error band         75         150         µSec           Dynamic Load Peak Deviation         same as above         ±150         mV           FEATURES and OPTIONS           Remote On/Off Control ⑥           "N" suffix           Negative Logic, ON state         ON = pin grounded or external voltage         -0.7         1.2         Vdc           Negative Logic, OFF state         OFF = pin open or external voltage         10         mA           "P" suffix         open collector/drain         1         mA           Positive Logic, OFF state         ON = pin open or external voltage         10         15         V           Positive Logic, OFF state         ON = pin open or external voltage         10         15         V	Isolation Voltage Insulation Safety Rating Isolation Resistance Isolation Capacitance Safety Calculated MTBF <sup>®</sup>	IEC/60950-1, 2nd edition Per Telcordia SR332, issue 1, class 3, ground	10	basic 1650 Yes		Vdc ΜΩ pF
Startup Time         Remote ON to Vout Regulated         5         10         mS           Dynamic Load Response         50-75-50% load step to 1% error band         75         150         µSec           Dynamic Load Peak Deviation         same as above         ±150         mV           FEATURES and OPTIONS         mV         same as above         ±150         mV           Remote On/Off Control ©         "N" suffix                MV             MV           MV             MV            MV           MV           MV           MV           MV           MV           MV           MV           MV           MV              MV	Isolation Voltage Insulation Safety Rating Isolation Resistance Isolation Capacitance Safety Calculated MTBF @ DYNAMIC CHARACTERISTICS	IEC/60950-1, 2nd edition Per Telcordia SR332, issue 1, class 3, ground		basic 1650 Yes 7.3		Vdc MΩ pF Hours x 10
Dynamic Load Response         50-75-50% load step to 1% error band         75         150         µSec           Dynamic Load Peak Deviation         same as above         ±150         mV           FEATURES and OPTIONS         #Sec         #Sec         #Sec           Remote On/Off Control ®         "N" suffix                               mV         mV           mV         mV         mV         mV             mV         mA         mV	Isolation Voltage Insulation Safety Rating Isolation Resistance Isolation Capacitance Safety Calculated MTBF <u>DYNAMIC CHARACTERISTICS</u> Fixed Switching Frequency	IEC/60950-1, 2nd edition Per Telcordia SR332, issue 1, class 3, ground fixed, Tambient=+25°C		basic 1650 Yes 7.3 255		Vdc MΩ pF Hours x 10 KHz
Dynamic Load Peak Deviation         same as above         ±150         mV           FEATURES and OPTIONS           Remote On/Off Control ®           "N" suffix           Negative Logic, ON state         ON = pin grounded or external voltage         -0.7         1.2         Vdc           Negative Logic, OFF state         OFF = pin open or external voltage         10         15         Vdc           Control Current         open collector/drain         1         mA           "P" suffix	Isolation Voltage Insulation Safety Rating Isolation Resistance Isolation Capacitance Safety Calculated MTBF <u>DYNAMIC CHARACTERISTICS</u> Fixed Switching Frequency Startup Time	IEC/60950-1, 2nd edition Per Telcordia SR332, issue 1, class 3, ground fixed, Tambient=+25°C Power On, to Vout regulation band, 100%		basic 1650 Yes 7.3 255 5	10	Vdc MΩ pF Hours x 10 KHz mS
FEATURES and OPTIONS         Remote On/Off Control ®         "N" suffix         Negative Logic, ON state       ON = pin grounded or external voltage       -0.7       1.2       Vdc         Negative Logic, OFF state       OFF = pin open or external voltage       10       15       Vdc         Control Current       open collector/drain       1       mA         "P" suffix       ON = pin open or external voltage       10       15       V         Positive Logic, OFF state       ON = pin open or external voltage       10       15       V         Positive Logic, OFF state       OFF = ground pin or external voltage       -0.7       1.2       V	Isolation Voltage Insulation Safety Rating Isolation Resistance Isolation Capacitance Safety Calculated MTBF @ DYNAMIC CHARACTERISTICS Fixed Switching Frequency Startup Time Startup Time	IEC/60950-1, 2nd edition Per Telcordia SR332, issue 1, class 3, ground fixed, Tambient=+25°C Power On, to Vout regulation band, 100% Remote ON to Vout Regulated		basic 1650 Yes 7.3 255 5 5 5	10 10	Vdc MΩ pF Hours x 10 KHz mS mS
Remote On/Off Control (©         "N" suffix         Negative Logic, ON state       ON = pin grounded or external voltage       -0.7       1.2       Vdc         Negative Logic, OFF state       OFF = pin open or external voltage       10       15       Vdc         Control Current       open collector/drain       1       mA         "P" suffix       ON = pin open or external voltage       10       15       V         Positive Logic, ON state       ON = pin open or external voltage       10       15       V         Positive Logic, OFF state       OFF = ground pin or external voltage       -0.7       1.2       V	Isolation Voltage Insulation Safety Rating Isolation Resistance Isolation Capacitance Safety Calculated MTBF @ DYNAMIC CHARACTERISTICS Fixed Switching Frequency Startup Time Startup Time Dynamic Load Response	IEC/60950-1, 2nd edition Per Telcordia SR332, issue 1, class 3, ground fixed, Tambient=+25°C Power On, to Vout regulation band, 100% Remote ON to Vout Regulated		basic 1650 Yes 7.3 255 5 5 5 75	10 10	Vdc MΩ pF Hours x 10 KHz mS mS
"N" suffix         Negative Logic, ON state       ON = pin grounded or external voltage       -0.7       1.2       Vdc         Negative Logic, OFF state       OFF = pin open or external voltage       10       15       Vdc         Control Current       open collector/drain       1       mA         "P" suffix       ON = pin open or external voltage       10       15       V         Positive Logic, ON state       ON = pin open or external voltage       10       15       V         Positive Logic, OFF state       OFF = ground pin or external voltage       -0.7       1.2       V	Isolation Voltage Insulation Safety Rating Isolation Resistance Isolation Capacitance Safety Calculated MTBF @ DYNAMIC CHARACTERISTICS Fixed Switching Frequency Startup Time Startup Time	IEC/60950-1, 2nd edition Per Telcordia SR332, issue 1, class 3, ground fixed, Tambient=+25°C Power On, to Vout regulation band, 100% Remote ON to Vout Regulated 50-75-50% load step to 1% error band		basic 1650 Yes 7.3 255 5 5 5 75	10 10	Vdc MΩ pF Hours x 10 KHz mS mS μSec
"N" suffix         Negative Logic, ON state       ON = pin grounded or external voltage       -0.7       1.2       Vdc         Negative Logic, OFF state       OFF = pin open or external voltage       10       15       Vdc         Control Current       open collector/drain       1       mA         "P" suffix       ON = pin open or external voltage       10       15       V         Positive Logic, ON state       ON = pin open or external voltage       10       15       V         Positive Logic, OFF state       OFF = ground pin or external voltage       -0.7       1.2       V	Isolation Voltage Insulation Safety Rating Isolation Resistance Isolation Capacitance Safety Calculated MTBF @ DYNAMIC CHARACTERISTICS Fixed Switching Frequency Startup Time Startup Time Dynamic Load Response Dynamic Load Peak Deviation	IEC/60950-1, 2nd edition Per Telcordia SR332, issue 1, class 3, ground fixed, Tambient=+25°C Power On, to Vout regulation band, 100% Remote ON to Vout Regulated 50-75-50% load step to 1% error band		basic 1650 Yes 7.3 255 5 5 5 75	10 10	Vdc MΩ pF Hours x 1 KHz MS mS μSec
Negative Logic, ON state         ON = pin grounded or external voltage         -0.7         1.2         Vdc           Negative Logic, OFF state         OFF = pin open or external voltage         10         15         Vdc           Control Current         open collector/drain         1         mA           "P" suffix         ON = pin open or external voltage         10         15         V           Positive Logic, OFF state         ON = pin open or external voltage         10         15         V           Positive Logic, OFF state         OFF = ground pin or external voltage         -0.7         1.2         V	Isolation Voltage Insulation Safety Rating Isolation Resistance Isolation Capacitance Safety Calculated MTBF @ DYNAMIC CHARACTERISTICS Fixed Switching Frequency Startup Time Startup Time Dynamic Load Response Dynamic Load Response Dynamic Load Peak Deviation FEATURES and OPTIONS	IEC/60950-1, 2nd edition Per Telcordia SR332, issue 1, class 3, ground fixed, Tambient=+25°C Power On, to Vout regulation band, 100% Remote ON to Vout Regulated 50-75-50% load step to 1% error band		basic 1650 Yes 7.3 255 5 5 5 75	10 10	Vdc MΩ pF Hours x 1 KHz MS mS μSec
Negative Logic, OFF state         OFF = pin open or external voltage         10         15         Vdc           Control Current         open collector/drain         1         mA           "P" suffix	Isolation Voltage Insulation Safety Rating Isolation Resistance Isolation Capacitance Safety Calculated MTBF @ DYNAMIC CHARACTERISTICS Fixed Switching Frequency Startup Time Startup Time Dynamic Load Response Dynamic Load Response Dynamic Load Peak Deviation FEATURES and OPTIONS Remote On/Off Control @	IEC/60950-1, 2nd edition Per Telcordia SR332, issue 1, class 3, ground fixed, Tambient=+25°C Power On, to Vout regulation band, 100% Remote ON to Vout Regulated 50-75-50% load step to 1% error band		basic 1650 Yes 7.3 255 5 5 5 75	10 10	Vdc MΩ pF Hours x 1 KHz MS mS μSec
Control Current         open collector/drain         1         mA           "P" suffix         Max         <	Isolation Voltage Insulation Safety Rating Isolation Resistance Isolation Capacitance Safety Calculated MTBF @ DYNAMIC CHARACTERISTICS Fixed Switching Frequency Startup Time Startup Time Dynamic Load Response Dynamic Load Response Dynamic Load Peak Deviation FEATURES and OPTIONS Remote On/Off Control @ "N" suffix	IEC/60950-1, 2nd edition Per Telcordia SR332, issue 1, class 3, ground fixed, Tambient=+25°C Power On, to Vout regulation band, 100% Remote ON to Vout Regulated 50-75-50% load step to 1% error band same as above	225	basic 1650 Yes 7.3 255 5 5 5 75	10 10 150	Vdc MΩ pF Hours x 1 KHz mS mS μSec mV
"P" suffix           Positive Logic, ON state         ON = pin open or external voltage         10         15         V           Positive Logic, OFF state         OFF = ground pin or external voltage         -0.7         1.2         V	Isolation Voltage Insulation Safety Rating Isolation Resistance Isolation Capacitance Safety Calculated MTBF @ DYNAMIC CHARACTERISTICS Fixed Switching Frequency Startup Time Startup Time Dynamic Load Response Dynamic Load Response Dynamic Load Response Dynamic Load Peak Deviation FEATURES and OPTIONS Remote On/Off Control © "N" suffix Negative Logic, ON state	IEC/60950-1, 2nd edition Per Telcordia SR332, issue 1, class 3, ground fixed, Tambient=+25°C Power On, to Vout regulation band, 100% Remote ON to Vout Regulated 50-75-50% load step to 1% error band same as above ON = pin grounded or external voltage	-0.7	basic 1650 Yes 7.3 255 5 5 5 75	10 10 150 1.2	Vdc MΩ pF Hours x 1 KHz mS mS μSec mV
Positive Logic, ON state         ON = pin open or external voltage         10         15         V           Positive Logic, OFF state         OFF = ground pin or external voltage         -0.7         1.2         V	Isolation Voltage Insulation Safety Rating Isolation Resistance Isolation Capacitance Safety Calculated MTBF @ DYNAMIC CHARACTERISTICS Fixed Switching Frequency Startup Time Startup Time Startup Time Dynamic Load Response Dynamic Load Response Dynamic Load Peak Deviation FEATURES and OPTIONS Remote On/Off Control @ "N" suffix Negative Logic, ON state Negative Logic, OFF state	IEC/60950-1, 2nd edition Per Telcordia SR332, issue 1, class 3, ground fixed, Tambient=+25°C Power On, to Vout regulation band, 100% Remote ON to Vout Regulated 50-75-50% load step to 1% error band same as above ON = pin grounded or external voltage OFF = pin open or external voltage	-0.7	basic 1650 Yes 7.3 255 5 5 5 75 ±150	10 10 150 1.2	Vdc MΩ pF Hours x 10 KHz mS mS μSec mV
Positive Logic, OFF state         OFF = ground pin or external voltage         -0.7         1.2         V	Isolation Voltage Insulation Safety Rating Isolation Resistance Isolation Capacitance Safety Calculated MTBF <u>DYNAMIC CHARACTERISTICS</u> Fixed Switching Frequency Startup Time Startup Time Dynamic Load Response Dynamic Load Response Dynamic Load Peak Deviation FEATURES and OPTIONS Remote On/Off Control "N" suffix Negative Logic, ON state Negative Logic, OFF state Control Current	IEC/60950-1, 2nd edition Per Telcordia SR332, issue 1, class 3, ground fixed, Tambient=+25°C Power On, to Vout regulation band, 100% Remote ON to Vout Regulated 50-75-50% load step to 1% error band same as above ON = pin grounded or external voltage OFF = pin open or external voltage	-0.7	basic 1650 Yes 7.3 255 5 5 5 75 ±150	10 10 150 1.2	Vdc MΩ pF Hours x 10 KHz mS mS μSec mV Vdc
	Isolation Voltage Insulation Safety Rating Isolation Resistance Isolation Capacitance Safety Calculated MTBF ④ DYNAMIC CHARACTERISTICS Fixed Switching Frequency Startup Time Startup Time Dynamic Load Response Dynamic Load Peak Deviation FEATURES and OPTIONS Remote On/Off Control ⑥ "N" suffix Negative Logic, ON state Negative Logic, OFF state Control Current "P" suffix	IEC/60950-1, 2nd edition Per Telcordia SR332, issue 1, class 3, ground fixed, Tambient=+25°C Power On, to Vout regulation band, 100% Remote ON to Vout Regulated 50-75-50% load step to 1% error band same as above ON = pin grounded or external voltage OFF = pin open or external voltage open collector/drain	-0.7 10	basic 1650 Yes 7.3 255 5 5 5 75 ±150	10 10 150 1.2 15	Vdc MΩ pF Hours x 1 KHz mS mS μSec mV Vdc Vdc Vdc Vdc
	Isolation Voltage Insulation Safety Rating Isolation Resistance Isolation Capacitance Safety Calculated MTBF ④ DYNAMIC CHARACTERISTICS Fixed Switching Frequency Startup Time Dynamic Load Response Dynamic Load Peak Deviation FEATURES and OPTIONS Remote On/Off Control ⑥ "N" suffix Negative Logic, ON state Negative Logic, OFF state Control Current "P" suffix Positive Logic, ON state	IEC/60950-1, 2nd edition Per Telcordia SR332, issue 1, class 3, ground fixed, Tambient=+25°C Power On, to Vout regulation band, 100% Remote ON to Vout Regulated 50-75-50% load step to 1% error band same as above ON = pin grounded or external voltage OFF = pin open or external voltage open collector/drain ON = pin open or external voltage	225 -0.7 10 10	basic 1650 Yes 7.3 255 5 5 5 75 ±150	10 10 150 1.2 15 15	Vdc MΩ pF Hours x 10 KHz mS mS μSec mV Vdc Vdc Vdc Vdc

## **ULT Series**

### Thirty-Second-Brick Isolated DC/DC Converters with 2:1 Wide Input Range

#### FUNCTIONAL SPECIFICATIONS (ULT-5/5-D48-C, CONT.)

OUTPUT	Conditions ①	Minimum	Typical/Nominal	Maximum	Units
Total Output Power		0	25	25.25	W
Voltage	1				-
Nominal Output Voltage		4.925	5	5.075	Vdc
Setting Accuracy	At 50% load	-1.5		1.5	% of Vo nom
Output Trim Range ®	User selectable (see trim formulas)	-20		10	% of Vout
Overvoltage Protection		6	6.6	7.2	Vdc
Current	1				
Output Current Range		0	5	5	Α
Minimum Load					
Current Limit Inception (9)	98% of Vnom., after warmup	5.5	7	8.4	A
Short Circuit					
Short Circuit Current	Hiccup technique, autorecovery within ±1.25% of Vout			0.3	А
Short Circuit Duration (remove short for recovery)	Output shorted to ground, no damage		Continuous		
Short circuit protection method	Hiccup current limiting		Non-latching		
Regulation ⑦					
Line Regulation	Vin=min. to max., Vout=nom., full load			±0.1	% of Vout
Load Regulation	lout=min. to max., Vin=nom.			±0.125	% of Vout
Ripple and Noise <sup>(2)</sup>	Tested with eight 47µF ceramic caps in parallel		50	75	mV pk-pk
Temperature Coefficient	At all outputs		0.02		% of Vout./°C
Maximum Capacitive Loading	Low ESR	400		5,000	μF
Remote Sense Compliance	Vsense = Vout - Vload, sense connected at load			10	% of Vout
MECHANICAL (Through Hole Models)	Conditions 1) 3	Minimum	Typical/Nominal	Maximum	Units
Outline Dimensions			0.92 x 0.75 x 0.35		Inches
(Please refer to outline drawing)	LxWxH		23.4x19.05x8.89		mm
Weight			0.32		Ounces
			9.07		Grams
Through Hole Pin Diameter			.04 & .062		Inches
			1.02 & 1.57		mm
Through Hole Pin Material			Brass		
TH Pin Plating Metal and Thickness	Nickel subplate		50		µ-inches
	Gold overplate		3-5		µ-inches
ENVIRONMENTAL					
Operating Ambient Temperature Range 🔞	No Derating, full power, Natural convection, Vertical mount. See derating curves.	-40		85	°C
Storage Temperature	Vin = Zero (no power)	-55		125	°C
Thermal Protection/Shutdown		120	130	140	٥C
Electromagnetic Interference	External filter is required				
Conducted, EN55022/CISPR22				В	Class
RoHS rating			RoHS-6		

## **ULT Series**

### Thirty-Second-Brick Isolated DC/DC Converters with 2:1 Wide Input Range

#### **Performance Specification Notes**

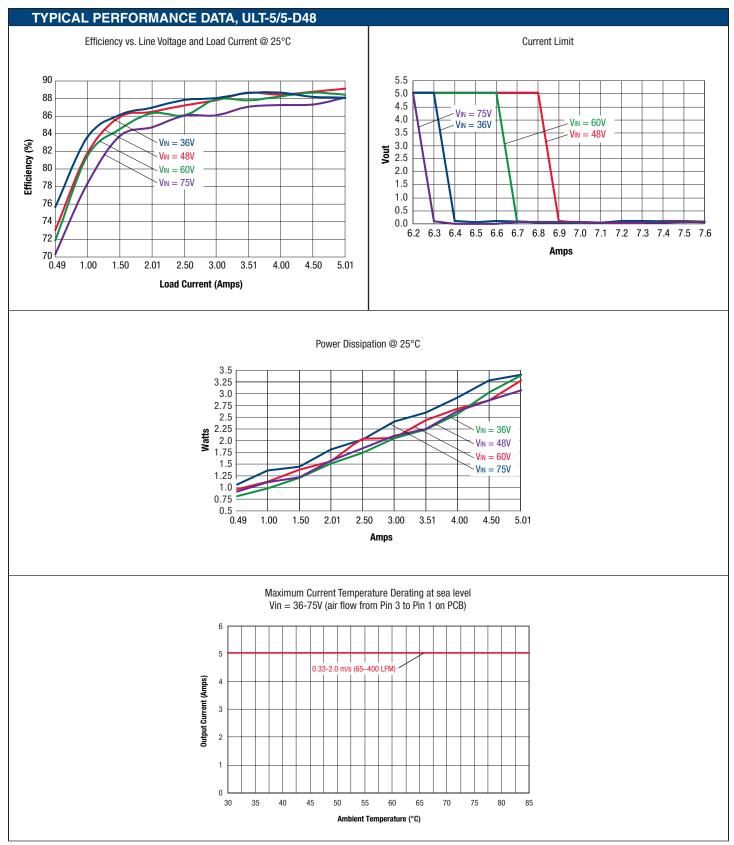
① All specifications are typical unless noted. Ambient temperature =  $+25^{\circ}$ Celsius, V<sub>IN</sub> is nominal, output current is maximum rated nominal. External output capacitance consists of 400µF capacitors across output pins; one 33µF low ESR, and three 1µF external input capacitors. All caps are low ESR.

Testing must be kept short enough that the converter does not appreciably heat up during testing. For extended testing, use plenty of airflow. See derating curves for temperature performance. All models are stable and regulate within spec without external cacacitance.

- ② Input Ripple Current is tested and specified over a 5-20 MHz bandwidth and uses a special set of external filters only for the Ripple Current specifications. Input filtering is C<sub>IN</sub> = 33 µF, C<sub>BUS</sub> = 220 µF, L<sub>BUS</sub> = 12 µH. Use capacitor rated voltages which are twice the maximum expected voltage. Capacitors must accept high speed AC switching currents.
- ③ Note that Maximum Current Derating Curves indicate an average current at nominal input voltage. At higher temperatures and/or lower airflow, the converter will tolerate brief full current outputs if the average 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 (MTBF) is calculated using the Telcordia (Belcore) SR-332 Method 1, Case 3, Issue 1, ground fixed conditions. Operating temperature = +25°C, full output load, natural air convection.
- ⑤ The output may be shorted to ground indefinitely with no damage. The Output Short Circuit Current shown in the specifications is an average consisting of very short bursts of full rated current to test whether the output circuit can be repowered.
- 6 The On/Off pin allows the converter to be turned on or off by an external device such as a switch, a transistor, a logic gate, or an optical isolator. If the "logic pin" is left floating the measured voltage will be outside the limit's in the data sheet. Those numbers define the levels needed for the "control function" to take place and do not represent the voltage that may be present on the logic pin.

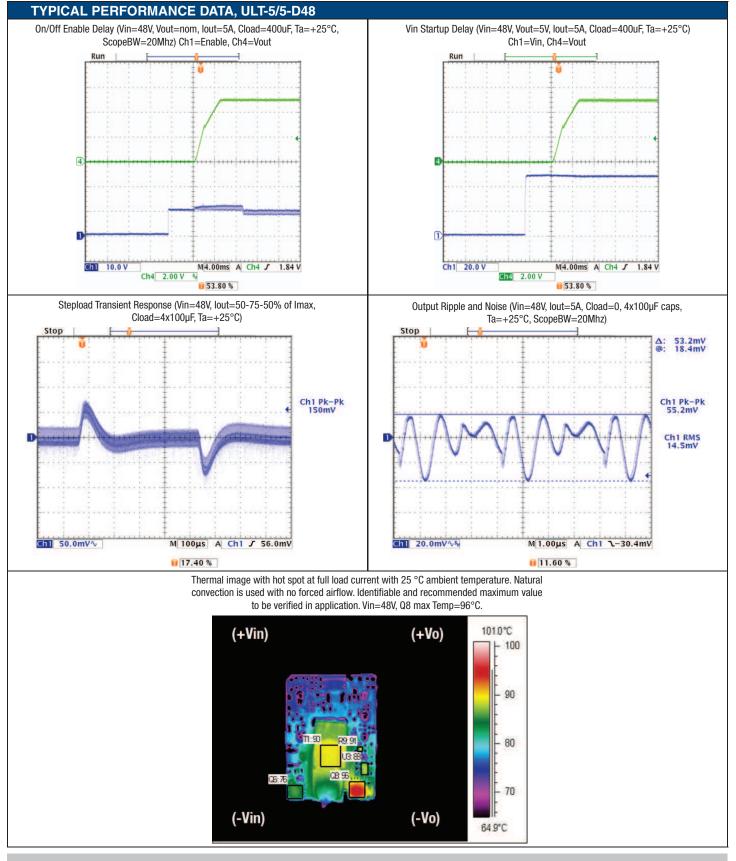
- Regulation specifications describe the deviation as the input line voltage or output load current is varied from a nominal midpoint value to either extreme (50% load).
- ⑧ Do not exceed maximum power ratings, sense limits or output overvoltage when adjusting output trim values.
- ③ Output overload protection is non-latching. When the output overload is removed, the output will automatically recover.
- Ill models are fully operational and meet published specifications, including "cold start" at -40°C.
- ① The converter will shut off if the input falls below the undervoltage threshold. It will not restart until the input exceeds the Input Start Up Voltage.
- Output noise may be further reduced by installing an external filter. See the Application Notes. Use only as much output filtering as needed <u>and no</u> <u>more</u>. Larger caps (especially low-ESR ceramic types) may slow transient response or degrade dynamic performance. Thoroughly test your application with all components installed.
- If reverse polarity is accidentally applied to the input, always connect an external fast blow input fuse in series with the +VIN input.
- Although extremely unlikely, failure of the internal components of this product may expose external application circuits to dangerous voltages, currents, temperatures or power levels. Please thoroughly verify all applications before committing them to service. Be sure to include appropriately rated FUSES (see specifications and Application Notes) to reduce the risk of failure.
- Special care should be exercised so that Input Voltage Transient does not exceed specified Max 100V/100ms. At normal input a large transient spike can be generated as a result of distribution inductance and high inrush current charging input cap on converter. This can be eliminated with 33µF electrolytic capacitor mounted close to Converter input. The series resistance (500mΩ < ESR < 700mΩ) is essential in this solution.</p>

## **ULT Series**



## **ULT Series**

### Thirty-Second-Brick Isolated DC/DC Converters with 2:1 Wide Input Range



www.murata-ps.com/support

## **ULT Series**

### Thirty-Second-Brick Isolated DC/DC Converters with 2:1 Wide Input Range

#### FUNCTIONAL SPECIFICATIONS (ULT-12/2.5-D48-C)

ABSOLUTE MAXIMUM RATINGS	Conditions ①	Minimum	Typical/Nominal	Maximum	Units
Input Voltage, Continuous	Full temperature range	36		80	Vdc
Input Voltage, Transient <sup>(6)</sup>	Operating or non-operating, 100 mS max. duration			100	Vdc
Isolation Voltage	Input to output tested			1500	Vdc
Input Reverse Polarity	None, install external fuse		none	1000	Vdc
On/Off Remote Control	Power on or off, referred to -Vin	0	nono	15	Vdc
Output Power		0		30.3	W
Output Current	Current-limited, no damage, short-circuit protected	0		2.5	A
Storage Temperature Range	Vin = Zero (no power)	-40		125	°C
	of devices to greater than any of these conditions m		d-term reliability Proper one		-
listed in the Performance/Functional Specification		ay advoroory arroot for	ig torm rondonity. Propor opt		
INPUT	Conditions ① ③				
Operating voltage range		36	48	75	Vdc
Recommended External Fuse	Fast blow		10	2	A
Start-up threshold <sup>(1)</sup>	Rising input voltage	32	33	34	Vdc
•		30.75	31.8		Vdc
Undervoltage lockout (@ ½ load) (1)	Falling input voltage	30.75		33	
Overvoltage shutdown	Rising input voltage	1.0	N/A	1.00	Vdc
Turn-On/Turn-Off Hysteresis		1.3	1.31	1.32	Vdc
Reverse Polarity Protection	None, install external fuse		None		Vdc
Internal Filter Type			Capacitive		
Input current			0.00	0.70	
Full Load Current Conditions	Vin = nominal		0.68	0.70	A
Low Line Input Currrent	Vin = minimum		0.92	0.95	A
Inrush Transient	Vin = 48V.		0.05		A2-Sec.
Short Circuit Input Current.			0.05	0.1	mA
No Load Input Currrent	lout = minimum, unit=ON		20	40	mA
Shutdown Mode Input Current (Off, UV, OT)			1	3	mA
Reflected (back) ripple current 2	Measured at input with specified filter		30		mA, pk-pk
GENERAL and SAFETY					
	Vin=48V	90	92		%
Efficiency	Vin=48V Vin=36V	90 89	92 91		%
Efficiency Isolation		89			%
Efficiency Isolation Isolation Voltage, Input to Output			91		
Efficiency Isolation Isolation Voltage, Input to Output Insulation Safety Rating		89	91 basic		Vdc
Efficiency Isolation Isolation Voltage, Input to Output Insulation Safety Rating Isolation Resistance		89	91 basic 100		% Vdc 
Efficiency Isolation Isolation Voltage, Input to Output Insulation Safety Rating	Vin=36V	89	91 basic		Vdc
Efficiency Isolation Isolation Voltage, Input to Output Insulation Safety Rating Isolation Resistance Isolation Capacitance	Vin=36V	89	91 basic 100		% Vdc 
Efficiency Isolation Isolation Voltage, Input to Output Insulation Safety Rating Isolation Resistance Isolation Capacitance Safety	Vin=36V	89	91 basic 100 1600		%           Vdc
Efficiency Isolation Isolation Voltage, Input to Output Insulation Safety Rating Isolation Resistance Isolation Capacitance Safety	Vin=36V UL-60950-1, CSA-C22.2 No.60950-1, IEC/60950-1, 2nd edition Per Telcordia SR332, issue 1, class 3, ground	89	91 basic 100 1600 Yes		% Vdc MΩ pF
Efficiency Isolation Isolation Voltage, Input to Output Insulation Safety Rating Isolation Resistance Isolation Capacitance Safety Calculated MTBF @ DYNAMIC CHARACTERISTICS	Vin=36V UL-60950-1, CSA-C22.2 No.60950-1, IEC/60950-1, 2nd edition Per Telcordia SR332, issue 1, class 3, ground	89	91 basic 100 1600 Yes	330	%           Vdc           ΜΩ           pF
Efficiency Isolation Isolation Voltage, Input to Output Insulation Safety Rating Isolation Resistance Isolation Capacitance Safety Calculated MTBF @ DYNAMIC CHARACTERISTICS Fixed Switching Frequency	Vin=36V UL-60950-1, CSA-C22.2 No.60950-1, IEC/60950-1, 2nd edition Per Telcordia SR332, issue 1, class 3, ground	89	91 basic 100 1600 Yes TBD	330	%           Vdc           mΩ           pF           Hours x 10 <sup>6</sup>
Efficiency Isolation Isolation Voltage, Input to Output Insulation Safety Rating Isolation Resistance Isolation Capacitance Safety Calculated MTBF @ DYNAMIC CHARACTERISTICS Fixed Switching Frequency Startup Time	Vin=36V UL-60950-1, CSA-C22.2 No.60950-1, IEC/60950-1, 2nd edition Per Telcordia SR332, issue 1, class 3, ground fixed, Tambient=+25°C Power On, to Vout regulation band, 100% resistive load	89	91 basic 100 1600 Yes TBD 300 6	30	%       Vdc       MΩ       pF       Hours x 10 <sup>6</sup> KHz       mS
Efficiency Isolation Isolation Voltage, Input to Output Insulation Safety Rating Isolation Resistance Isolation Capacitance Safety Calculated MTBF @ DYNAMIC CHARACTERISTICS Fixed Switching Frequency Startup Time Startup Time	Vin=36V UL-60950-1, CSA-C22.2 No.60950-1, IEC/60950-1, 2nd edition Per Telcordia SR332, issue 1, class 3, ground fixed, Tambient=+25°C Power On, to Vout regulation band, 100% resistive load Remote ON to Vout Regulated	89	91 basic 100 1600 Yes TBD 300	30 30	%       Vdc       MΩ       pF       Hours x 10 <sup>6</sup> KHz       mS       mS
Efficiency Isolation Isolation Voltage, Input to Output Insulation Safety Rating Isolation Resistance Isolation Capacitance Safety Calculated MTBF @ DYNAMIC CHARACTERISTICS Fixed Switching Frequency Startup Time Startup Time Dynamic Load Response	Vin=36V UL-60950-1, CSA-C22.2 No.60950-1, IEC/60950-1, 2nd edition Per Telcordia SR332, issue 1, class 3, ground fixed, Tambient=+25°C Power On, to Vout regulation band, 100% resistive load Remote ON to Vout Regulated 50-75-50% load step to 1% error band	89	91 basic 100 1600 Yes TBD 300 6 12 100	30 30 150	% Vdc MΩ pF Hours x 10 <sup>6</sup> KHz mS mS μSec
Efficiency Isolation Isolation Voltage, Input to Output Insulation Safety Rating Isolation Resistance Isolation Capacitance Safety Calculated MTBF @ DYNAMIC CHARACTERISTICS Fixed Switching Frequency Startup Time Startup Time Dynamic Load Response Dynamic Load Peak Deviation	Vin=36V UL-60950-1, CSA-C22.2 No.60950-1, IEC/60950-1, 2nd edition Per Telcordia SR332, issue 1, class 3, ground fixed, Tambient=+25°C Power On, to Vout regulation band, 100% resistive load Remote ON to Vout Regulated	89	91 basic 100 1600 Yes TBD 300 6 12	30 30	%       Vdc       MΩ       pF       Hours x 10 <sup>6</sup> KHz       mS       mS
Efficiency Isolation Isolation Voltage, Input to Output Insulation Safety Rating Isolation Resistance Isolation Capacitance Safety Calculated MTBF @ DYNAMIC CHARACTERISTICS Fixed Switching Frequency Startup Time Startup Time Dynamic Load Response Dynamic Load Peak Deviation FEATURES and OPTIONS	Vin=36V UL-60950-1, CSA-C22.2 No.60950-1, IEC/60950-1, 2nd edition Per Telcordia SR332, issue 1, class 3, ground fixed, Tambient=+25°C Power On, to Vout regulation band, 100% resistive load Remote ON to Vout Regulated 50-75-50% load step to 1% error band	89	91 basic 100 1600 Yes TBD 300 6 12 100	30 30 150	%       Vdc       MΩ       pF       Hours x 10 <sup>6</sup> KHz       mS       μSec
Efficiency Isolation Isolation Voltage, Input to Output Insulation Safety Rating Isolation Resistance Isolation Capacitance Safety Calculated MTBF @ DYNAMIC CHARACTERISTICS Fixed Switching Frequency Startup Time Startup Time Dynamic Load Response Dynamic Load Response Dynamic Load Peak Deviation FEATURES and OPTIONS Remote On/Off Control (6)	Vin=36V UL-60950-1, CSA-C22.2 No.60950-1, IEC/60950-1, 2nd edition Per Telcordia SR332, issue 1, class 3, ground fixed, Tambient=+25°C Power On, to Vout regulation band, 100% resistive load Remote ON to Vout Regulated 50-75-50% load step to 1% error band	89	91 basic 100 1600 Yes TBD 300 6 12 100	30 30 150	%       Vdc       MΩ       pF       Hours x 10 <sup>6</sup> KHz       mS       μSec
Efficiency Isolation Isolation Voltage, Input to Output Insulation Safety Rating Isolation Resistance Isolation Capacitance Safety Calculated MTBF  Calculated	Vin=36V UL-60950-1, CSA-C22.2 No.60950-1, IEC/60950-1, 2nd edition Per Telcordia SR332, issue 1, class 3, ground fixed, Tambient=+25°C Power On, to Vout regulation band, 100% resistive load Remote ON to Vout Regulated 50-75-50% load step to 1% error band same as above	89 1500 270	91 basic 100 1600 Yes TBD 300 6 12 100	30 30 150 ±250	%       Vdc       MΩ       pF       Hours x 10 <sup>6</sup> KHz       mS       μSec       mV
Efficiency Isolation Isolation Voltage, Input to Output Insulation Safety Rating Isolation Resistance Isolation Capacitance Safety Calculated MTBF ④ DYNAMIC CHARACTERISTICS Fixed Switching Frequency Startup Time Startup Time Startup Time Dynamic Load Response Dynamic Load Peak Deviation FEATURES and OPTIONS Remote On/Off Control ⑥ "N" suffix Negative Logic, ON state	Vin=36V UL-60950-1, CSA-C22.2 No.60950-1, IEC/60950-1, 2nd edition Per Telcordia SR332, issue 1, class 3, ground fixed, Tambient=+25°C Power On, to Vout regulation band, 100% resistive load Remote ON to Vout Regulated 50-75-50% load step to 1% error band same as above ON = pin grounded or external voltage	89 1500 270 -0.7	91 basic 100 1600 Yes TBD 300 6 12 100	30 30 150 ±250 0.9	%       Vdc       mΩ       pF       Hours x 10 <sup>6</sup> KHz       mS       μSec       mV       Vdc
Efficiency Isolation Isolation Voltage, Input to Output Insulation Safety Rating Isolation Resistance Isolation Capacitance Safety Calculated MTBF ④ DYNAMIC CHARACTERISTICS Fixed Switching Frequency Startup Time Startup Time Dynamic Load Response Dynamic Load Peak Deviation FEATURES and OPTIONS Remote On/Off Control ⑥ "N" suffix Negative Logic, ON state Negative Logic, OFF state	Vin=36V UL-60950-1, CSA-C22.2 No.60950-1, IEC/60950-1, 2nd edition Per Telcordia SR332, issue 1, class 3, ground fixed, Tambient=+25°C Power On, to Vout regulation band, 100% resistive load Remote ON to Vout Regulated 50-75-50% load step to 1% error band same as above ON = pin grounded or external voltage OFF = pin open or external voltage	89 1500 270	91 basic 100 1600 Yes TBD 300 6 12 100 ±150	30 30 150 ±250	%       Vdc       MΩ       pF       Hours x 10 <sup>6</sup> KHz       mS       μSec       mV       Vdc       Vdc
Efficiency Isolation Isolation Voltage, Input to Output Insulation Safety Rating Isolation Resistance Isolation Capacitance Safety Calculated MTBF ④ DYNAMIC CHARACTERISTICS Fixed Switching Frequency Startup Time Startup Time Dynamic Load Response Dynamic Load Response Dynamic Load Peak Deviation FEATURES and OPTIONS Remote On/Off Control ⑥ "N" suffix Negative Logic, ON state Negative Logic, OFF state Control Current	Vin=36V UL-60950-1, CSA-C22.2 No.60950-1, IEC/60950-1, 2nd edition Per Telcordia SR332, issue 1, class 3, ground fixed, Tambient=+25°C Power On, to Vout regulation band, 100% resistive load Remote ON to Vout Regulated 50-75-50% load step to 1% error band same as above ON = pin grounded or external voltage	89 1500 270 -0.7	91 basic 100 1600 Yes TBD 300 6 12 100	30 30 150 ±250 0.9	%       Vdc       MΩ       pF       Hours x 10 <sup>6</sup> KHz       mS       μSec       mV       Vdc
Efficiency Isolation Isolation Voltage, Input to Output Insulation Safety Rating Isolation Resistance Isolation Capacitance Safety Calculated MTBF ④ DYNAMIC CHARACTERISTICS Fixed Switching Frequency Startup Time Dynamic Load Response Dynamic Load Response Dynamic Load Peak Deviation FEATURES and OPTIONS Remote On/Off Control ⑥ "N" suffix Negative Logic, ON state Negative Logic, OFF state Control Current "P" suffix	Vin=36V UL-60950-1, CSA-C22.2 No.60950-1, IEC/60950-1, 2nd edition Per Telcordia SR332, issue 1, class 3, ground fixed, Tambient=+25°C Power On, to Vout regulation band, 100% resistive load Remote ON to Vout Regulated 50-75-50% load step to 1% error band same as above ON = pin grounded or external voltage OFF = pin open or external voltage open collector/drain	89 1500 270 -0.7 10	91 basic 100 1600 Yes TBD 300 6 12 100 ±150	30 30 150 ±250 0.9 15	%       Vdc       MΩ       pF       Hours x 10 <sup>6</sup> KHz       mS       µSec       mV       Vdc       Vdc       Vdc
Efficiency Isolation Isolation Voltage, Input to Output Insulation Safety Rating Isolation Resistance Isolation Capacitance Safety Calculated MTBF ④ DYNAMIC CHARACTERISTICS Fixed Switching Frequency Startup Time Dynamic Load Response Dynamic Load Response Dynamic Load Peak Deviation FEATURES and OPTIONS Remote On/Off Control ⑥ "N" suffix Negative Logic, ON state Negative Logic, OFF state Control Current "P" suffix Positive Logic, ON state	Vin=36V UL-60950-1, CSA-C22.2 No.60950-1, IEC/60950-1, 2nd edition Per Telcordia SR332, issue 1, class 3, ground fixed, Tambient=+25°C Power On, to Vout regulation band, 100% resistive load Remote ON to Vout Regulated 50-75-50% load step to 1% error band same as above ON = pin grounded or external voltage OFF = pin open or external voltage open collector/drain ON = pin open or external voltage	89 1500 270 -0.7 10 10	91 basic 100 1600 Yes TBD 300 6 12 100 ±150	30 30 150 ±250 0.9 15 15	%       Vdc       MΩ       pF       Hours x 10 <sup>6</sup> KHz       mS       µSec       mV       Vdc       Vdc       Vdc       Vdc       Vdc       Vdc       Vdc       Vdc
Efficiency Isolation Isolation Voltage, Input to Output Insulation Safety Rating Isolation Resistance Isolation Capacitance Safety Calculated MTBF ④ DYNAMIC CHARACTERISTICS Fixed Switching Frequency Startup Time Startup Time Dynamic Load Response Dynamic Load Response Dynamic Load Peak Deviation FEATURES and OPTIONS Remote On/Off Control ⑥ "N" suffix Negative Logic, ON state Negative Logic, OFF state Control Current "P" suffix	Vin=36V UL-60950-1, CSA-C22.2 No.60950-1, IEC/60950-1, 2nd edition Per Telcordia SR332, issue 1, class 3, ground fixed, Tambient=+25°C Power On, to Vout regulation band, 100% resistive load Remote ON to Vout Regulated 50-75-50% load step to 1% error band same as above ON = pin grounded or external voltage OFF = pin open or external voltage open collector/drain	89 1500 270 -0.7 10	91 basic 100 1600 Yes TBD 300 6 12 100 ±150	30 30 150 ±250 0.9 15	%       Vdc       MΩ       pF       Hours x 10 <sup>6</sup> KHz       mS       µSec       mV       Vdc       Vdc       Vdc

## **ULT Series**

### Thirty-Second-Brick Isolated DC/DC Converters with 2:1 Wide Input Range

#### FUNCTIONAL SPECIFICATIONS (ULT-12/2.5-D48-C, CONT.)

OUTPUT	Conditions ①	Minimum	Typical/Nominal	Maximum	Units
Total Output Power		0	30	30.3	W
Voltage	1				-
Nominal Output Voltage		11.88	12	12.12	Vdc
Setting Accuracy	At 50% load	-1		1	% of Vo nom
Output Trim Range ®	User selectable (see trim formulas)	-20		10	% of Vout
Overvoltage Protection		13.3	15	18	Vdc
Current	1 t				-
Output Current Range		0	2.5	2.5	A
Minimum Load	no minimal load required				
Current Limit Inception (9)	98% of Vnom., after warmup	2.65	3.55	4.3	A
Short Circuit					
Short Circuit Current	Hiccup technique, autorecovery within ±1.25% of Vout		0.4		А
Short Circuit Duration (remove short for recovery)	Output shorted to ground, no damage		Continuous		
Short circuit protection method	Hiccup current limiting		Non-latching		
Regulation ⑦					
Line Regulation	Vin=min. to max., Vout=nom., full load			±0.075	% of Vout
Load Regulation	lout=min. to max., Vin=nom.			±0.125	% of Vout
Ripple and Noise <sup>(2)</sup>	Tested with 4x47uF output caps.		70	100	mV pk-pk
Temperature Coefficient	At all outputs		0.02		% of Vout./°C
Maximum Capacitive Loading	Full resistive load, low ESR	200		2,200	μF
Remote Sense Compliance	Vsense = Vout - Vload, sense connected at load			10	% of Vout
MECHANICAL (Through Hole Models)	Conditions ① ③	Minimum	Typical/Nominal	Maximum	Units
Outline Dimensions			0.92 x 0.75 x 0.35		Inches
(Please refer to outline drawing)	LxWxH		23.4x19.05x8.89		mm
Weight			0.32		Ounces
			9.07		Grams
Through Hole Pin Diameter			.04 & .062		Inches
			1.02 & 1.57		mm
Through Hole Pin Material			Brass		
TH Pin Plating Metal and Thickness	Nickel subplate		50		µ-inches
	Gold overplate		3-5		µ-inches
ENVIRONMENTAL					
Operating Ambient Temperature Range 🔞	See derating curves	-40		85	°C
Storage Temperature	Vin = Zero (no power)	-55		125	0°
Thermal Protection/Shutdown		120	130	140	0°
Electromagnetic Interference	External filter is required				
Conducted, EN55022/CISPR22				В	Class
RoHS rating			RoHS-6		

## **ULT Series**

### Thirty-Second-Brick Isolated DC/DC Converters with 2:1 Wide Input Range

#### **Performance Specification Notes**

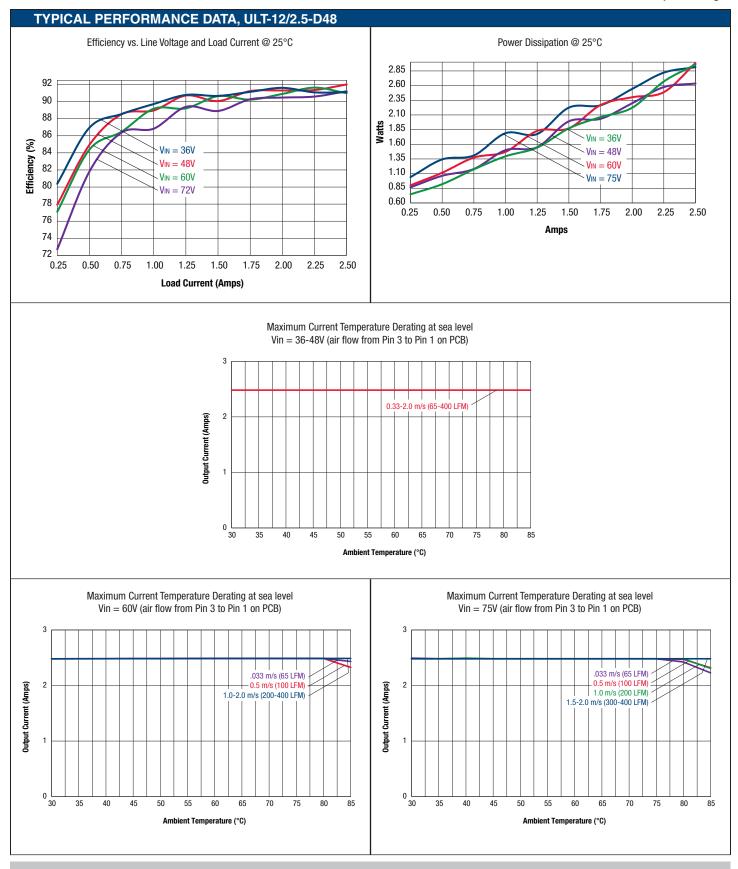
① All specifications are typical unless noted. Ambient temperature =  $+25^{\circ}$ Celsius, V<sub>IN</sub> is nominal, output current is maximum rated nominal. External output capacitance consists of 400µF capacitors across output pins; one 33µF low ESR, and three 1µF external input capacitors. All caps are low ESR.

Testing must be kept short enough that the converter does not appreciably heat up during testing. For extended testing, use plenty of airflow. See derating curves for temperature performance. All models are stable and regulate within spec without external cacacitance.

- ② Input Ripple Current is tested and specified over a 5-20 MHz bandwidth and uses a special set of external filters only for the Ripple Current specifications. Input filtering is C<sub>IN</sub> = 33 µF, C<sub>BUS</sub> = 220 µF, L<sub>BUS</sub> = 12 µH. Use capacitor rated voltages which are twice the maximum expected voltage. Capacitors must accept high speed AC switching currents.
- ③ Note that Maximum Current Derating Curves indicate an average current at nominal input voltage. At higher temperatures and/or lower airflow, the converter will tolerate brief full current outputs if the average 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 (MTBF) is calculated using the Telcordia (Belcore) SR-332 Method 1, Case 3, Issue 1, ground fixed conditions. Operating temperature = +25°C, full output load, natural air convection.
- ⑤ The output may be shorted to ground indefinitely with no damage. The Output Short Circuit Current shown in the specifications is an average consisting of very short bursts of full rated current to test whether the output circuit can be repowered.
- 6 The On/Off pin allows the converter to be turned on or off by an external device such as a switch, a transistor, a logic gate, or an optical isolator. If the "logic pin" is left floating the measured voltage will be outside the limit's in the data sheet. Those numbers define the levels needed for the "control function" to take place and do not represent the voltage that may be present on the logic pin.

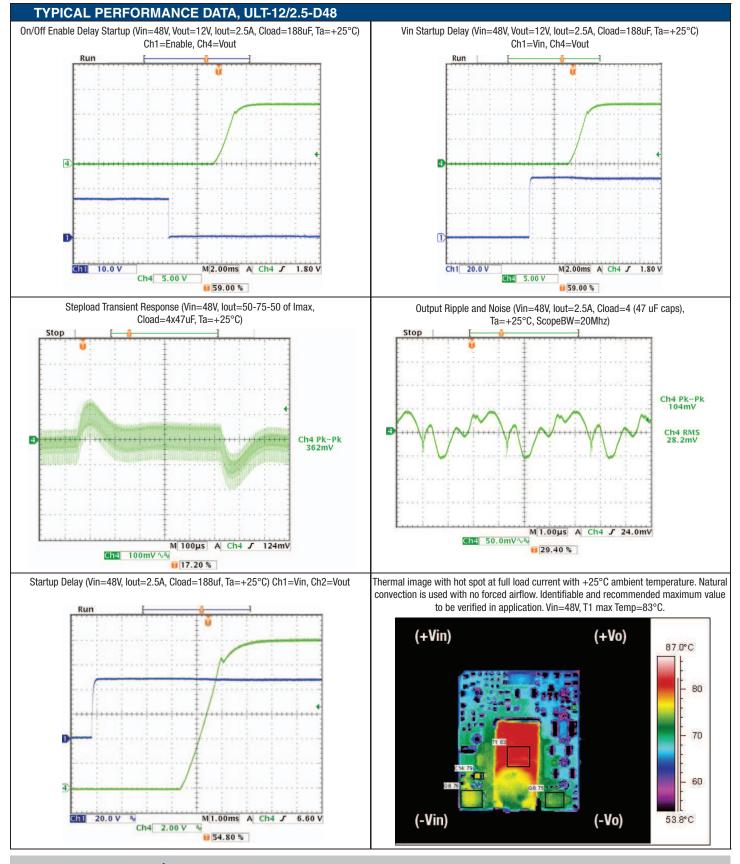
- Regulation specifications describe the deviation as the input line voltage or output load current is varied from a nominal midpoint value to either extreme (50% load).
- ⑧ Do not exceed maximum power ratings, sense limits or output overvoltage when adjusting output trim values.
- ③ Output overload protection is non-latching. When the output overload is removed, the output will automatically recover.
- Ill models are fully operational and meet published specifications, including "cold start" at -40°C.
- ① The converter will shut off if the input falls below the undervoltage threshold. It will not restart until the input exceeds the Input Start Up Voltage.
- Output noise may be further reduced by installing an external filter. See the Application Notes. Use only as much output filtering as needed <u>and no</u> <u>more</u>. Larger caps (especially low-ESR ceramic types) may slow transient response or degrade dynamic performance. Thoroughly test your application with all components installed.
- If reverse polarity is accidentally applied to the input, always connect an external fast blow input fuse in series with the +ViN input.
- Although extremely unlikely, failure of the internal components of this product may expose external application circuits to dangerous voltages, currents, temperatures or power levels. Please thoroughly verify all applications before committing them to service. Be sure to include appropriately rated FUSES (see specifications and Application Notes) to reduce the risk of failure.
- (9) Special care should be exercised so that Input Voltage Transient does not exceed specified Max 100V/100ms. At normal input a large transient spike can be generated as a result of distribution inductance and high inrush current charging input cap on converter. This can be eliminated with 33µF electrolytic capacitor mounted close to Converter input. The series resistance (500m $\Omega$  < ESR < 700m $\Omega$ ) is essential in this solution.

## **ULT Series**



## **ULT Series**

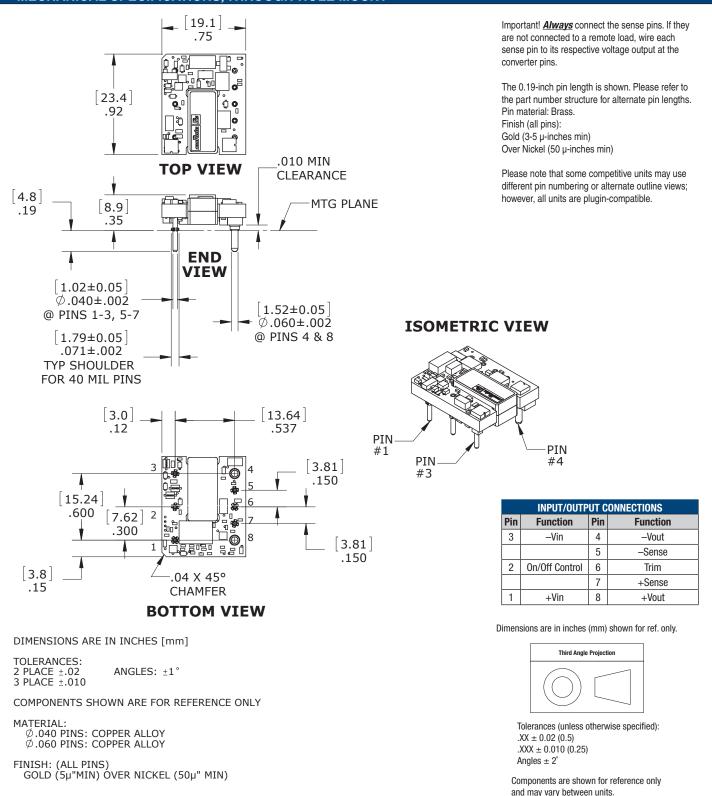
### Thirty-Second-Brick Isolated DC/DC Converters with 2:1 Wide Input Range



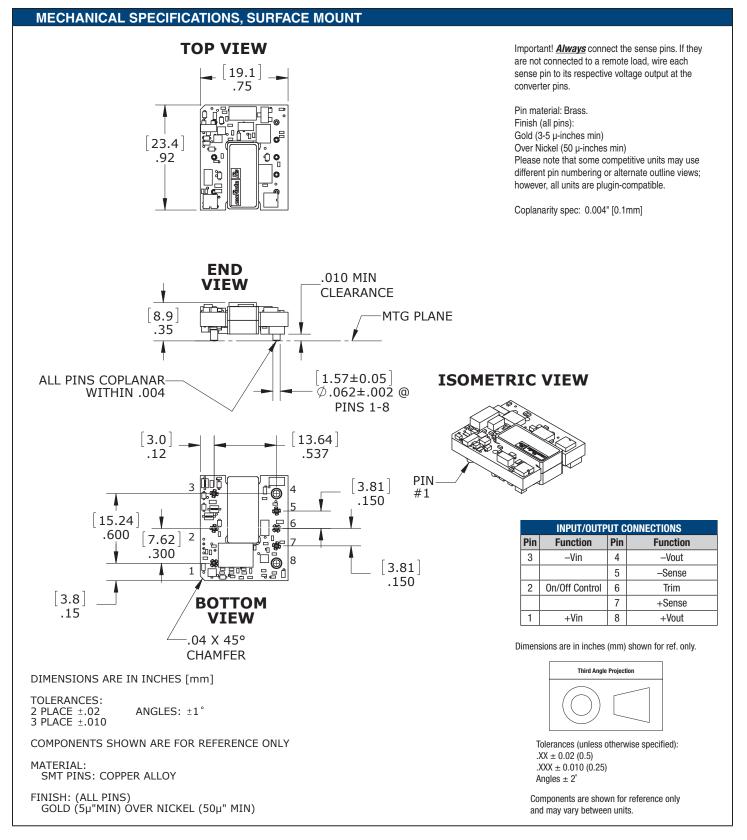
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## **ULT Series**

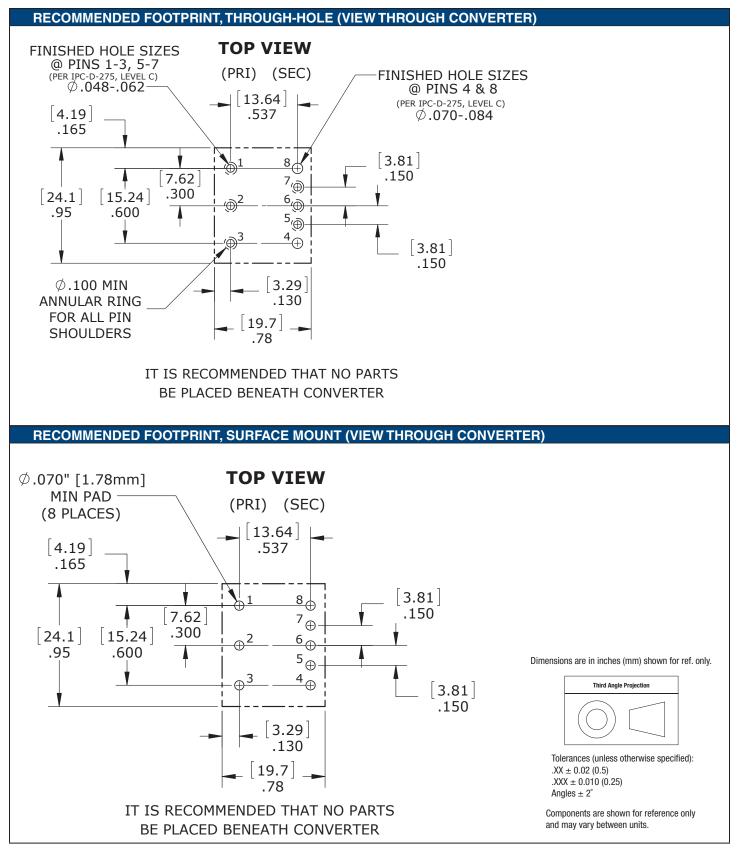




## **ULT Series**



## **ULT Series**

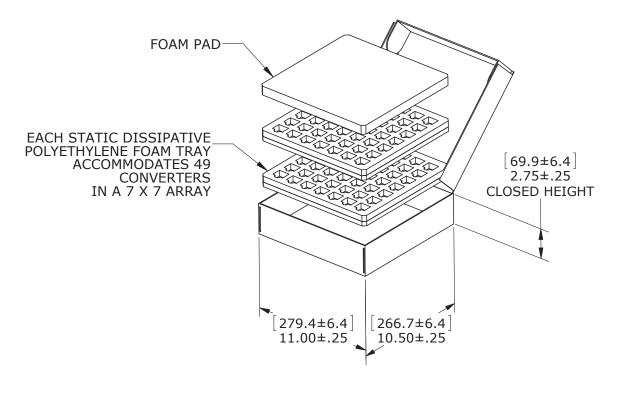




## **ULT Series**

Thirty-Second-Brick Isolated DC/DC Converters with 2:1 Wide Input Range

#### SHIPPING TRAYS AND BOXES, THROUGH-HOLE MOUNT

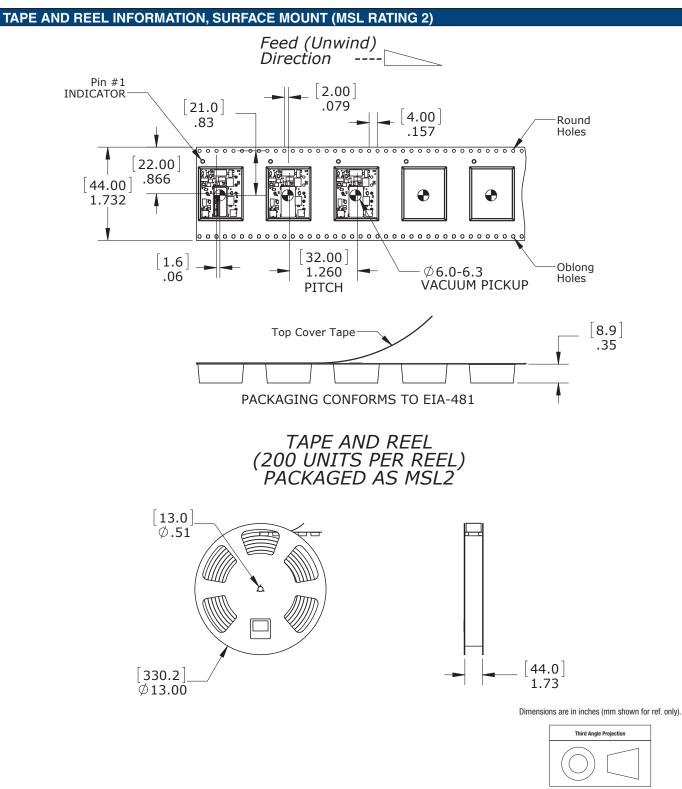


49 UNITS PER TRAY 2 TRAYS PER CARTON

MPQ=98 UNITS

## **ULT Series**

### Thirty-Second-Brick Isolated DC/DC Converters with 2:1 Wide Input Range



Tolerances (unless otherwise specified): .XX  $\pm$  0.02 (0.5) .XXX  $\pm$  0.010 (0.25) Angles  $\pm$  1°

Components are shown for reference only.

## **ULT Series**

### Thirty-Second-Brick Isolated DC/DC Converters with 2:1 Wide Input Range

#### **TECHNICAL NOTES**

#### **Input Fusing**

Certain applications and/or safety agencies may require the installation of fuses at the inputs of power conversion components. Fuses should also be used if the possibility of sustained, non-current-limited, input-voltage polarity reversals exists. For Murata Power Solutions' ULT series DC/DC converters, we recommend the use of a fast blow fuse, installed in the ungrounded input supply line with a typical value about twice the maximum input current, calculated at low line with the converter's minimum efficiency.

All relevant national and international safety standards and regulations must be observed by the installer. For system safety agency approvals, the converters must be installed in compliance with the requirements of the end- use safety standard.

#### **Input Reverse-Polarity Protection**

If the input voltage polarity is accidentally reversed, an internal diode will become forward biased and likely draw excessive current from the power source. If this source is not current limited or the circuit appropriately fused, it could cause permanent damage to the converter.

#### Input Under-Voltage Shutdown and Start-Up Threshold

Under normal start-up conditions, devices will not begin to regulate properly until the ramping-up input voltage exceeds the Start-Up Threshold Voltage. Once operating, devices will not turn off until the input voltage drops below the Under-Voltage Shutdown limit. Subsequent re-start will not occur until the input is brought back up to the Start-Up Threshold. This built in hysteresis prevents any unstable on/off situations from occurring at a single input voltage.

#### Start-Up Time

The V<sub>IN</sub> to V<sub>OUT</sub> Start-Up Time is the time interval between the point at which the ramping input voltage crosses the Start-Up Threshold 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 at the converter. The ULT Series implements a soft start circuit to limit the duty cycle of its PWM controller at power up, thereby limiting the input inrush current.

The On/Off Control to Vout start-up time assumes the converter has its nominal input voltage applied but is turned off via the On/Off Control pin. The specification defines the interval between the point at which the converter is turned on (released) and the fully loaded output voltage enters and remains within its specified accuracy band. Similar to the V<sub>IN</sub> to Vout start-up, the On/Off Control to Vout start-up time is also governed by the internal soft start circuitry and external load capacitance. The difference in start up time from V<sub>IN</sub> to Vout and from On/Off Control to Vout is therefore insignificant.

#### **Input Source Impedance**

The input of ULT converters must be driven from a low ac-impedance source. The DC/DC's performance and stability can be compromised by the use of highly inductive source impedances. The input circuit shown in Figure 2 is a practical solution that can be used to minimize the effects of inductance in the input traces. For optimum performance, components should be mounted close to the DC/DC converter.

#### I/O Filtering, Input Ripple Current, and Output Noise

All models in the ULT Series are tested/specified for input reflected ripple current and output noise using the specified external input/output components/ circuits and layout as shown in the following two figures. External input capacitors (CIN in Figure 2) serve primarily as energy-storage elements, minimizing line voltage variations caused by transient IR drops in conductors from backplane to the DC/DC. Input caps should be selected for bulk capacitance (at appropriate frequencies), low ESR, and high rms-ripple-current ratings. The switching nature of DC/DC converters requires that dc voltage sources have low ac impedance as highly inductive source impedance can affect system stability. In Figure 2, CBUS and LBUS simulate a typical dc voltage bus. Your specific system configuration may necessitate additional considerations.

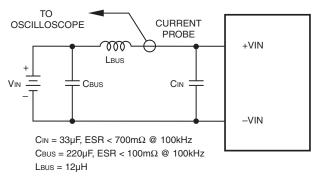


Figure 2. Measuring Input Ripple Current

In critical applications, output ripple/noise (also referred to as periodic and random deviations or PARD) may be reduced below specified limits using filtering techniques, the simplest of which is the installation of additional external output capacitors. They function as true filter elements and should be selected for bulk capacitance, low ESR and appropriate frequency response.

All external capacitors should have appropriate voltage ratings and be located as close to the converter as possible. Temperature variations for all relevant parameters should also be taken carefully into consideration. The most effective combination of external I/O capacitors will be a function of line voltage and source impedance, as well as particular load and layout conditions.

#### **Floating Outputs**

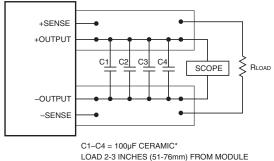
Since these are isolated DC/DC converters, their outputs are "floating" with respect to their input. Designers will normally use the –Output as the ground/ return of the load circuit. You can however, use the +Output as ground/return to effectively reverse the output polarity.

#### **Minimum Output Loading Requirements**

ULT converters employ a synchronous-rectifier design topology and all models regulate within spec and are stable under no-load to full load conditions. Operation under no-load conditions however might slightly increase the output ripple and noise.

Model	Tested with	Maximum Capacitance Loading
ULT-3.3/7.5-D48	Four 100µF output capacitors & Three 1µF and 33µF (low ESR) external input capacitors	5000µF
ULT-5/5-D48	Four 100µF output capacitors & Three 1µF and 33µF (low ESR) external input capacitors	5000µF
ULT-12/2.5-D48	Four $47\mu$ F output capacitors & three $1\mu$ F and $33\mu$ F (low ESR) external input capacitors.	2200µF

## **ULT Series**



COAD 2-3 INCHES (51-76mm) FROM MODDLE \*The ULT-12/2.5-D48 model is tested with 47μF output caps

Figure 3. Measuring Output Ripple/Noise (PARD)

#### **Thermal Shutdown**

The ULT converters are equipped with thermal-shutdown circuitry. If environmental conditions cause the temperature of the DC/DC converter to rise above the designed operating temperature, a precision temperature sensor inside the PWM (see U1 in figure 4) will power down the unit. When the internal temperature decreases below the threshold of the temperature sensor, the unit will self-start. See Performance/Functional Specifications.

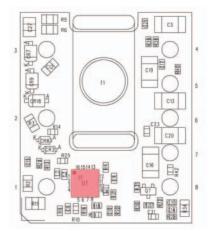


Figure 4. Thermal Shutdown

#### **Output Over-Voltage Protection**

The ULT output voltage is monitored for an over-voltage condition using a comparator. The signal is optically coupled to the primary side and if the output voltage rises to a level which could be damaging to the load, the sensing circuitry will power down the PWM controller causing the output voltage to decrease. Following a time-out period the PWM will restart, causing the output voltage to ramp to its appropriate value. If the fault condition persists, and the output voltage again climbs to excessive levels, the over-voltage circuitry will initiate another shutdown cycle. This on/off cycling is referred to as "hiccup" mode.

#### **Current Limiting**

As soon as the output current increases to approximately 130% of its rated value, the DC/DC converter will go into a current-limiting mode. In this condition, the output voltage will decrease proportionately with increases in output current, thereby maintaining somewhat constant power dissipation. This is commonly referred to as power limiting. Current limit inception is defined as the point at which the full-power output voltage falls below the specified tolerance. See Performance/Functional Specifications. If the load current, being drawn from the converter, is significant enough, the unit will go into a short circuit condition as described below.

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### Thirty-Second-Brick Isolated DC/DC Converters with 2:1 Wide Input Range

#### **Short Circuit Condition**

When a converter is in current-limit mode, the output voltage will drop as the output current demand increases. If the output voltage drops too low, the magnetically coupled voltage used to develop primary side voltages will also drop, thereby shutting down the PWM controller. Following a time-out period, the PWM will restart causing the output voltage to begin ramping to their appropriate value. If the short-circuit condition persists, another shutdown cycle will be initiated. This on/off cycling is referred to as "hiccup" mode. The hiccup cycling reduces the average output current, thereby preventing internal temperatures from rising to excessive levels. The ULT Series is capable of enduring an indefinite short circuit output condition.

#### **Remote Sense**

**Note:** The Sense and Vout lines are internally connected through low-value resistors. Nevertheless, if the sense function is not used for remote regulation the user should connect the +Sense to  $+V_{OUT}$  and -Sense to  $-V_{OUT}$  at the DC/DC converter pins. ULT series converters employ a sense feature to provide point of use regulation, thereby overcoming moderate IR drops in PCB conductors or cabling. The remote sense lines carry very little current and therefore require minimal cross-sectional-area conductors. The sense lines, which are capacitively coupled to their respective output lines, are used by the feedback control-loop to regulate the output. As such, they are not low impedance points and must be treated with care in layouts and cabling. Sense lines on a PCB should be run adjacent to dc signals, preferably ground.

 $[Vout(+)-Vout(-)] - [Sense(+)-Sense(-)] \le 10\% Vout$ 

In cables and discrete wiring applications, twisted pair or other techniques should be used. Output over-voltage protection is monitored at the output voltage pin, not the Sense pin. Therefore, excessive voltage differences between Vour and Sense in conjunction with trim adjustment of the output voltage can cause the over-voltage protection circuitry to activate (see Performance Specifications for over-voltage limits). Power derating is based on maximum output current and voltage at the converter's output pins. Use of trim and sense functions can cause output voltages to increase, thereby increasing output power beyond the converter's specified rating, or cause output voltages to climb into the output over-voltage region. Therefore, the designer must ensure:

(Vout at pins) x (lout)  $\leq$  rated output power

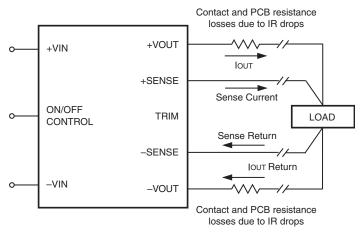


Figure 5. Remote Sense Circuit Configuration

## **ULT Series**

### Thirty-Second-Brick Isolated DC/DC Converters with 2:1 Wide Input Range

#### **On/Off Control**

The input-side, remote On/Off Control function can be ordered to operate with either logic type.

**Positive** ("P" suffix) logic models are enabled when the on/off pin is left open (or is pulled high, applying +10V to +15V with respect to –Input). Positive-logic devices are disabled when the on/off pin is pulled low (-0.7 to 0.9V with respect to –Input).

**Negative** ("N" suffix) logic devices are off when pin is left open (or pulled high, applying +10V to +15V), and on when pin is pulled low (-0.7 to +0.9V) with respect to -Input.

NOTE: Please refer to the Functional Specs for each specific ULT model.

Dynamic control of the remote on/off function is best accomplished with a mechanical relay or an open-collector/open-drain drive circuit (optically isolated if appropriate). The drive circuit should be able to sink appropriate current (see Performance Specifications) when activated and withstand appropriate voltage when deactivated. Applying an external voltage to pin 2 when no input power is applied to the converter can cause permanent damage to the converter.

#### **OUTPUT VOLTAGE ADJUSTMENT**

#### **Trim Equations**

Adjustable output voltage pin. If the Trim pin is left open circuit the output voltage is set to Vo nom. Adjustment by means of the external resistor must be possible to achieve an output voltage of Vo nom. +10% or -20%.

Connecting an external resistor between the TRIM pin and the –Sense pin decreases the output voltage set point. The following equation determines the required external resistor value to obtain a percentage output voltage change of  $\Delta$ %:

Rtrim-down =  $[(511/\Delta\%) - 10.22]$  K $\Omega$ 

Where:

 $\Delta\% = [(Vo set - Vdesired) / Vo set] \times 100$ 

Connecting an external resistor between the TRIM pin and the +Sense pin increases the output voltage set point. The following equation determines the required external resistor value to obtain a percentage output voltage change of  $\Delta$ %:

Rtrim-up =  $[5.11 \text{ x Vo set x } (100 + \Delta\%) / (1.225 \text{ x } \Delta\%) - (511 / \Delta\%) - 10.22]$  KΩ

Where:

 $\Delta\% = [(Vdesired - Vo set) / Vo set] \times 100$ 

To maintain set point accuracy, the trim resistor tolerance should be at least  $\pm \ 1.0\%$ 

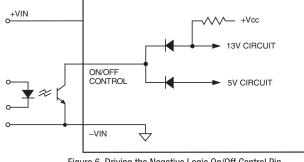


Figure 6. Driving the Negative Logic On/Off Control Pin (simplified circuit)

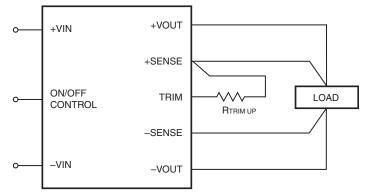


Figure 7. Trim Connections To Increase Output Voltages

Connect sense to its respective Vout pin if sense is not used with a remote load.

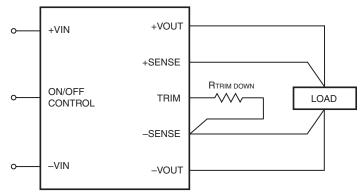


Figure 8. Trim Connections To Decrease Output Voltages