

# 15 Watt TC Dual Series DC/DC Converters



## Features

- Wide input voltage range
- Efficiencies of 82% typical
- 1544 VDC isolation
- Small 2.02" x 1.62" case
- Overvoltage and overtemperature protection
- Five Year Warranty

## Description

These 48 Volt, dual output converters are designed to provide a wide range of power solutions. Their extra wide input range of 20 to 72 VDC covers both the common American and European telecom standards plus 24 Volt industrial control applications.

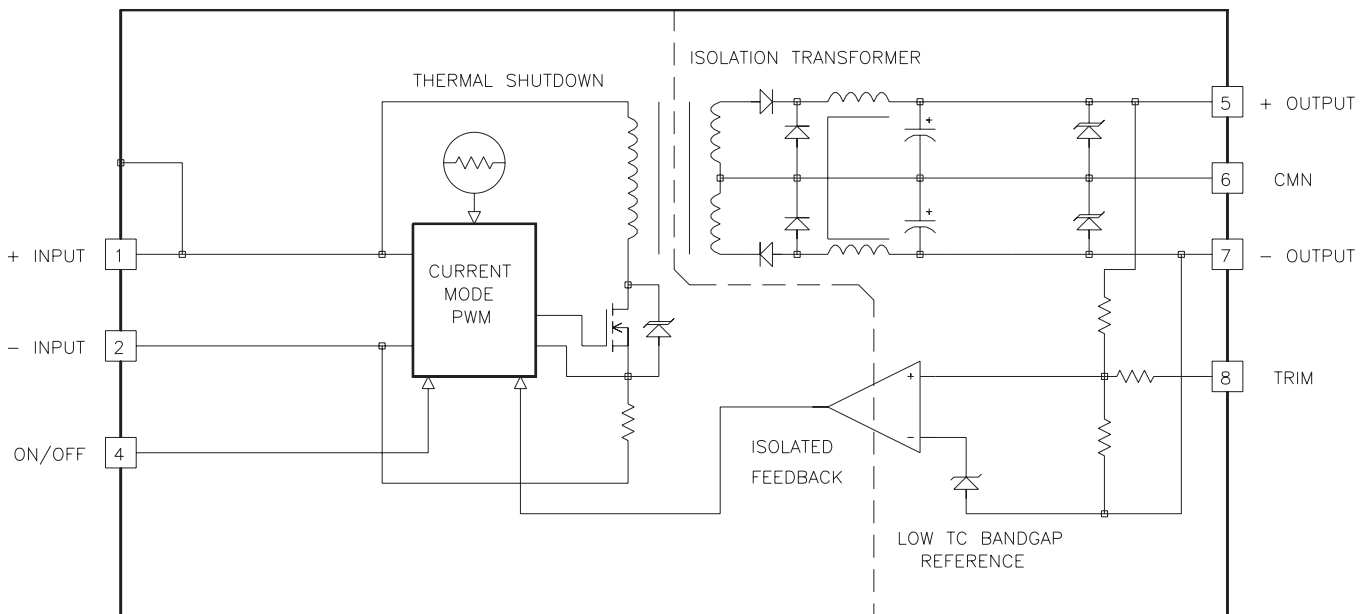
For flexibility, the output voltage can be adjusted with a trim pin to compensate for voltage drops or to achieve non-standard voltages. A remote ON/OFF function maximizes battery life.

The TC Dual Series continues the CALEX tradition of reliable design by including transient overvoltage suppressor diode protection. Overcurrent and overtemperature protection circuits are also standard. All CALEX products are backed by a Five Year Warranty.

Selection Chart				
Model	Input Range VDC		Output VDC	Output mA
	Min	Max		
48D12.625TC	20	72 *	±12	625
48D15.500TC	20	72 *	±15	500

\* UL Recognition only applies up to 60 VDC

15 Watt TC Dual Series Block Diagram



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Input Parameters*					
Model		48D12.625TC		48D15.500TC	Units
Voltage Range	MIN	20.0		VDC	
	TYP	48.0			
	MAX	72.0 *			
Reflected Ripple (1) (2)	TYP	660		mA P-P	
Input Current Full Load	TYP	384	381	mA	
	No Load	5	5		
Efficiency	TYP	81	82	%	
Switching Frequency	TYP	120		kHz	
Maximum Input Overvoltage 100ms	MAX	85		VDC	
Turn-on Time, 1% Output Error	TYP	2		ms	
Recommended Fuse	TYP	(3)		AMPS	

\* UL Recognition only applies up to 60 VDC

Output Parameters*					
Model		48D12.625TC		48D15.500TC	Units
Output Voltage		±12		±15	VDC
Rated Load Range	MIN	0		0	mA
	MAX	625		500	
Voltage Range	MIN	11.900		14.900	VDC
	TYP	12.000		15.000	
	MAX	12.100		15.100	
Load Regulation (4) 0% -100% Full Load	TYP	0.15		%	
	MAX	0.4			
Cross Regulation (5) 25%-100% Load	TYP	1.5		%	
	MAX	3.0			
Line Regulation Vin = Min-Max VDC	TYP	0.04		%	
	MAX	0.2			
Short Term Stability (6)	TYP	< 0.02		%/24Hrs	
Long Term Stability	TYP	< 0.2		%/kHrs	
Transient Response (7)	TYP	100	120	µs	
Dynamic Response (8)	TYP	130	150	mV peak	
Input Ripple Rejection (9)	TYP	>60		dB	
Noise, 0-20MHz bw (1) with 0.1µF External Capacitor with no External Capacitor	TYP	30		mV P-P	
	TYP	70		mV P-P	
	TYP	50		ppm/°C	
Temperature Coefficient	MAX	150		ppm/°C	
Overvoltage Clamp (10)	TYP	18		VDC	
Short Circuit Protection to Common for all Outputs		Continuous protection with current limiting and thermal overload techniques			

## NOTES

\* **All Parameters measured at 25°C, nominal input voltage and full rated load unless otherwise noted. Refer to the CALEX Application Notes for the definition of terms, measurement circuits and other information.**

- (1) Noise is measured per CALEX Application Notes. Measurement bandwidth is 0-20 MHz.
- (2) An input capacitor must be used for proper operation of the converter. See the Application Note on sizing the input capacitor.
- (3) See the typical application note. Also refer to CALEX Application Notes on fuse sizing.
- (4) Load regulation for the outputs is specified as the voltage change when both outputs are changed from maximum to minimum at the same time.
- (5) Cross regulation is defined as the change in one output when the other output is changed from full load to 25% of full load. The converter can be run at no load on either or both outputs with no damage.
- (6) Short term stability is specified after a 60 minute warmup at full load, constant line and recording the drift over a 24 hour period.

- (7) The transient response is specified as the time required to settle from a 50 to 75 % step load change (rise time of step = 2 µs) to a 1% error band.
- (8) Dynamic response is the peak overshoot during a transient as defined in note 7 above.
- (9) The input ripple rejection is specified for DC to 120 Hz ripple with a modulation amplitude of 1% of Vin.
- (10) For module protection only, see also note 3.
- (11) The logic ON/OFF pin is Open Collector TTL, CMOS, and relay compatible. The input to this pin is referenced to Pin 2, -Input and is protected to +100 VDC.
- (12) Case is tied to Pin 1, + input.
- (13) The case thermal impedance is specified as the case temperature rise over ambient per package watt dissipated.
- (14) Specifications subject to change without notice.
- (15) Water Washability - Calex DC/DC converters are designed to withstand most solder/wash processes. Careful attention should be used when assessing the applicability in your specific manufacturing process. Converters are not hermetically sealed.

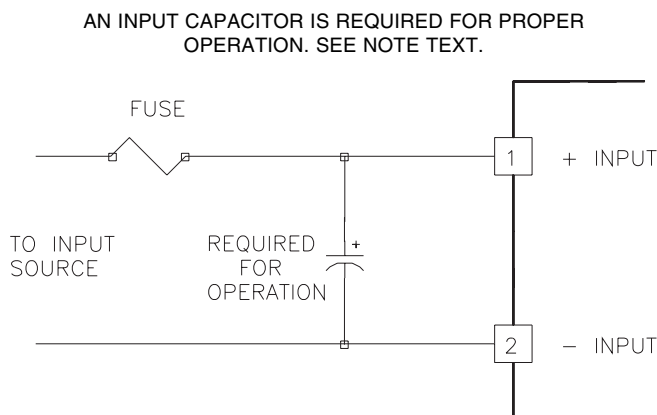
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General Specifications*			
All Models			Units
<b>ON/OFF Function (11)</b>			
ON Logic Level or Leave Pin Floating	MIN	8.0	VDC
OFF Logic Level	MAX	2.0	VDC
Input Resistance	TYP	100	kohms
Converter Idle Current ON/OFF Pin Low	TYP	2	mA
<b>Isolation (12)</b>			
Breakdown Voltage	MIN	1544	VDC
10 $\mu$ A Leakage Input-Output			
Input to Output Capacitance	TYP	450	pF
<b>Output Trim Function</b>			
Input Resistance	TYP	40	kohms
Programming Range	MIN	+5, -34	%
<b>Environmental</b>			
Case Operating Range No Derating	MIN MAX	-40 100	°C
Storage Range	MIN MAX	-55 105	°C
Thermal Impedance (13)	TYP	10	°C/Watt
Thermal Shutdown Case Temperature	TYP	105	°C
<b>General</b>			
Unit Weight	TYP	2.24	oz
Chassis Mounting Kit		MS8	
Agency Approvals		UL1950, see note	

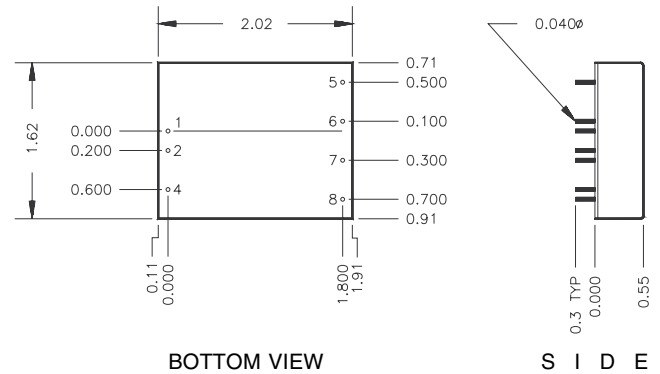
Note: On nominal 48Vin models UL recognition only applies up to 60 VDC

## 15 Watt TC Dual Typical Application

An input capacitor is required for proper operation (see Figure 1). The trim and ON/OFF pins can be safely left floating if they are not used. The input fuse should not be omitted. The fuse prevents unlimited current from flowing in the case of a catastrophic system failure.



**Figure 1.**  
Typical Application



VIEW

Mechanical tolerances unless otherwise noted:

X.XX dimensions:  $\pm 0.010$  inches

X.XXX dimensions:  $\pm 0.005$  inches

Pin	Function
1	+INPUT
2	-INPUT
4	ON/OFF
5	+OUTPUT
6	OUTPUT CMN
7	-OUTPUT
8	TRIM

## Sizing The Input Capacitor

For maximum reliability the 15 Watt TC Dual Series DC/DC converter must use a capacitor of sufficient ripple handling capability connected across the input pins. The probable result of undersizing (over stressing) this capacitor is increased self heating and shortening of the capacitors and hence your system's life. Oversizing the capacitor can have a negative effect on your product's cost and size, although this kind of overdesign does not result in shorter life of any components. There is no one optimum value for this capacitor. The size and capacity are dependent on the following factors:

- 1) Expected ambient temperature and your temperature derating guidelines.
- 2) Your ripple current derating guidelines.
- 3) The maximum load expected on the converter.
- 4) The minimum input voltage expected on the converter.
- 5) The statistical probability that your system will spend a significant amount of time at any worst case extreme.

Factors 1 and 2 are determined by your system design guidelines. These can range from 50% to 100% of the manufacturer's rated maximum, although a usual derating factor is 70% of manufacturer's maximum limit. 70% derating means that if the capacitor manufacturer says the capacitor can do 1A RMS and 100 VDC you would not use the part over

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700 mA RMS and 70 VDC. Surge voltage rating should also be evaluated against any expected voltage surges when selecting a capacitor working voltage.

Factors 3 and 4 determine the worst case ripple current. The reflected ripple current increases with output load and it increases as the input voltage decreases. So if you are running with a solid 48 VDC input and at 50% load your capacitors required ripple current rating would decrease by nearly 2.7:1 under what would be required for operation at 20 VDC with full load (see the "Input Ripple" curve).

Factor 5 is not easy to quantify. At CALEX we can make no assumptions about a customer's system so we design for continuous operation at worst case extremes. However, you can make educated assumptions about your system's usage. It might not be strategically or economically sound to design a system to survive in a worst case environment if you know that no systems are likely to be in such an environment long term.

## Example Of Capacitor Sizing

Given the following conditions select the minimum size capacitor needed to give reliable performance:

Converter ..... 48D12.625TC  
Minimum Input Voltage ..... 40 VDC  
Maximum Input Voltage ..... 52 VDC  
Maximum Load ..... 470 mA  
Maximum Ambient Temperature ..... 40° C  
Your Capacitor Voltage  
Derating Guideline ..... 70% of Maximum Specification  
Your Capacitor Current  
Derating Guideline ..... 70% of Maximum Specification

## Solution

Looking at the 15 Watt TC Dual Series "Reflected Ripple vs. Line Input" curve at 40 VDC input and 470 mA output (75% of rated load) the reflected input ripple can be read as 590 mA RMS. From the derating guidelines the capacitor's rated voltage and ripple current can be found.

Capacitor voltage rating is calculated as:

$$V = \frac{1}{\text{Voltage Derating Factor}} \times \text{Maximum Expected Input}$$

$$V = (1/0.7) \times 52 \text{ VDC} = 74 \text{ Volts or greater}$$

The next larger standard value is 80 VDC.

Capacitor ripple current rating is calculated as:

$$I = \frac{1}{\text{Current Derating Factor}} \times \text{Reflected Ripple}$$

$$I = (1/0.7) \times 590 \text{ mA} = 843 \text{ mA RMS or greater at } 45^{\circ}\text{C (} 40^{\circ}\text{C ambient} + 5^{\circ}\text{C for self heating)}.$$

A capacitor selection can now be made. Look only at controlled low ESR types (where the ESR is specified as a

maximum) because these usually have the highest ripple current capability per unit volume.

Be careful to compare apples to apples. Some manufacturers specify their capacitors at 85 °C and others specify at 105°C. The manufacturers give temperature derating guidelines, so all capacitors should be normalized to your maximum ambient (plus 5° to account for self heating) before making a selection. Since the 15 Watt TC Dual Series operates at 120 kHz the frequency usually does not have to be derated since most modern low ESR capacitors are rated at 100 kHz.

One note: The temperature derating multipliers are set up on the basis of the same life as would be expected at 105°C. The life of a capacitor operating at a significantly lower temperature will not be greater if the ripple current in the part is increased over the 105°C rating. This means that a capacitor rated for 1A RMS current at 105°C and 2A RMS at 50°C will have the same life if used at either point, while the same capacitor used at 1A RMS and 50°C will have a longer life.

## Suggested Capacitor Sources

Suitable capacitors can be found from the following sources:

**United Chemi-Con** SXE, RXC, RZ and RZA Series  
Suggested Part: SXE100VB221M12.5X35LL  
220 µF, 100V, 105°C Rated  
ESR = 0.087 ohms,  
Allowable Ripple = 1.04 A

**Nichicon** PR and PF  
Suggested Part: UPR100102MPHRH  
1000µF, 100V, 105°C Rated  
ESR = 0.047 ohms,  
Allowable Ripple = 1.32 A

**Panasonic** HFE Series  
Suggested Part: ECEA2AFE221L  
220µF, 100V, 105°C Rated  
ESR = 0.089 ohms,  
Allowable Ripple = 1.04 A

The suggested capacitors will work worst case for any line and load condition. They may be oversized for your application, however. See the discussion above on capacitor sizing.

## Remote ON/OFF Circuit Operation

The remote ON/OFF pin is best applied as follows:

- To turn the unit off, the ON/OFF pin should be tied to the - Input pin. This is best done by an open collector arrangement or contact closure.
- To turn the unit on, let the ON/OFF pin float.
- If the remote ON/OFF pin is not used, it may be safely left floating. There is a 100K internal pullup resistor inside the unit to +9 Volts DC.

Other applications of the ON/OFF function can be found in the CALEX Application Note: "Understanding the Remote ON/OFF Function."

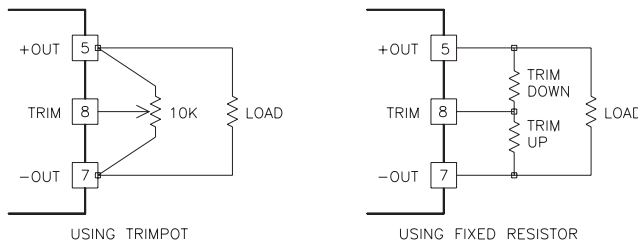
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## Proper Application Of The Trim Pin

The trim pin is used to adjust the output voltage slightly to compensate for voltage drops in the system's wiring. Figure 2 shows the proper application of the trim pin. Either a 10 K trimpot or a fixed resistor may be used.

The TC series can be adjusted easily for other non-standard output voltages. To get 8 or 9 Volts for RF applications a 12 Volt output converter can be used.

The output power must be limited to 15 Watts when trimming the output up (the output current must be reduced to keep a constant power output). When trimming the output down, the output current must be kept at or below the maximum current listed for that model.



**Figure 2.**  
Output Trim Methods

## Temperature Derating Guidelines

Care must be taken in the application of all power devices. Be sure to account for the self heating in your instrument due to the power converter and the loads. For minimum temperature gradient, the hottest components should be mounted at the bottom of your system (bottom of a vertical PCB) and the coolest components at the top of the system. This will help to even out the temperature of the entire system and prevent temperature gradients.

The 15 Watt TC Dual Series has a thermal impedance of 10 °C per package watt dissipated. In normal operation the 15 Watt TC Dual Series can be expected to run at 81 % efficiency at 48 VDC and full load. This means that the 15 Watt TC Dual Series is dissipating nearly 3.5 Watts internally at full load. This translates to a package temperature rise of 35°C (10°C/Watt x 3.5 Watts dissipated). The maximum rated case temperature for the 15 Watt TC Series is 100°C. This means that in the absence of other heat sources (including the load that the TC is powering) and with at least 3 inches of clearance the 15 Watt TC Dual Series could be expected to operate at an ambient of 65°C.

Additional heat sinking or cooling air flow can extend the ambient temperature of operation significantly.

In the event of system cooling blockage or failure, the thermal shut-off of the 15 Watt TC Dual Series will prevent any catastrophic power converter failure. When the ambient temperature cools below the thermal limit temperature the unit will restart.

# 15 Watt TC Dual Series DC/DC Converters

Typical Performance ( $T_c=25^\circ\text{C}$ ,  $V_{in}=\text{Nom VDC}$ , Rated Load).

