

# 25 to 30 Watt XC Triple Series DC/DC Converters



## Description

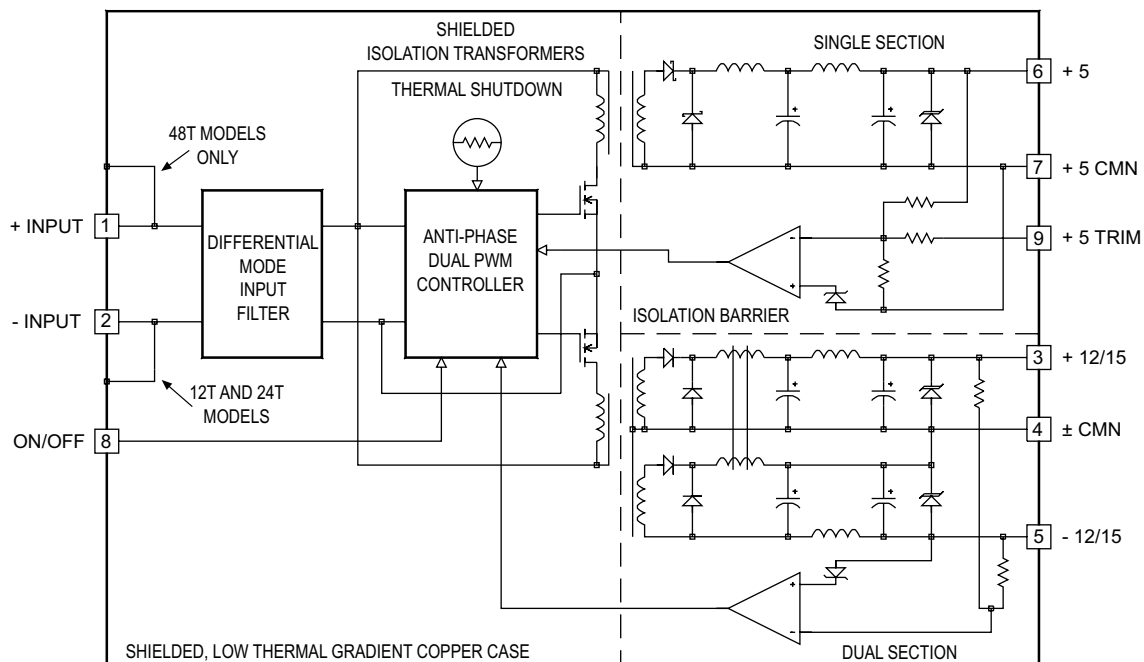
The 25-30 Watt Triple Series opens up new application areas in high efficiency DC/DC conversion. The unique dual control loop output design allows for independent regulation of both the single and dual outputs. This increases the total output accuracy by up to 10:1 over competitive designs. The design also eliminates cross regulation from the +5 section to the dual outputs. The 25-30 Watt Triple Series runs at 80-85% efficiency.

## Features

- Single and Dual Output Sections Isolated from each Other and Independently Regulated
- Overall Output Accuracy up to 10:1 Better than Competitive Products
- Standby Current Less than 0.5 mA for Low Power Pulsed Battery Operation
- Fully Filtered and Specified; Very Low Noise Inputs and Outputs
- PCB Mounting with Optional Heat Sink and Chassis Mounting Kit
- Industrial Operating Temperature Range Standard, -40 to 85°C
- Five Year Warranty

Selection Chart				
Model	Input Range VDC		Outputs VDC	Outputs mA
	Min	Max		
12T5.12XC	10.0	20.0	5, $\pm 12$	2500, $\pm 500$
12T5.15XC	10.0	20.0	5, $\pm 15$	2500, $\pm 400$
24T5.12XC	18.0	36.0	5, $\pm 12$	3000, $\pm 625$
24T5.15XC	18.0	36.0	5, $\pm 15$	3000, $\pm 500$
48T5.12XC	36.0	72.0	5, $\pm 12$	3000, $\pm 625$
48T5.15XC	36.0	72.0	5, $\pm 15$	3000, $\pm 500$

25-30 Watt Triple Series Block Diagram



# 25 to 30 Watt XC Triple Series DC/DC Converters

Input Parameters*								
Model		12T5.12XC	12T5.15XC	24T5.12XC	24T5.15XC	48T5.12XC	48T5.15XC	Units
Voltage Range	MIN	10.0		18.0		36.0		VDC
	MAX	20.0		36.0		72.0		
Reflected Ripple (2), 0-20MHz bw	TYP	350		150		150		mA P-P
	MAX	500		300		350		
Input Current Full Load	TYP	2550		1465		735		mA
	No Load	30		20		15		
Efficiency	TYP	80		85		85		%
Switching Frequency	TYP	120						kHz
Maximum Input Overvoltage, 100ms No Damage	MAX	25		45		85		VDC
Turn-on Time, 1% Output Error	TYP	35						ms
Recommended Fuse		(3)						Amps

Output Parameters*								
Model		12T5.12XC 12T5.15XC	24T5.12XC 24T5.15XC 48T5.12XC 48T5.15XC	12T5.12XC	24T5.12XC 48T5.12XC	12T5.15XC	24T5.15XC 48T5.15XC	Units
Output Voltage		+5	+5	±12	±12	±15	±15	VDC
Rated Current (4)	MIN	0	0	160	160	125	125	mA
	MAX	2500	3000	500	625	400	500	
Voltage Range 100% Load	MIN	4.950		11.925		14.925		VDC
	TYP	5.000		12.000		15.000		
	MAX	5.050		12.075		15.075		
Output Balance (Plus to Minus Output, Full Load)	TYP	N/A		0.5		0.5		%
	MAX	N/A		0.7		0.7		
Load Regulation 25-100% Load (5)  0-100%	TYP	0.4		0.05		0.05		%
	MAX	0.7		0.1		0.1		
	TYP	0.5		0.1		0.1		
	MAX	0.75		0.2		0.2		
Cross regulation (6)	TYP	N/A		0.6		0.5		%
	MAX	N/A		0.8		0.75		
Line Regulation Vin = Min-Max VDC	TYP	0.0						%
	MAX	0.1						
Short Term Stability (7)	TYP	0.02						%
Long Term Stability	TYP	0.1						%/kHrs
Transient Response (8)	TYP	100		200		200		µs
Dynamic Response (9)	TYP	270		250		200		mV peak
Input Ripple Rejection (10)	TYP	>70						dB
Noise, 0-20MHz bw (2)	TYP	30						mV P-P
	MAX	65						
Temperature Coefficient	TYP	50		50		50		ppm/°C
	MAX	100		200		200		
Overvoltage Clamp (11)	TYP	6.8		15		18		VDC
Short Circuit Protection to Common for all Outputs		Provides minimum of 8 hours continuous protection with current limiting and thermal overload techniques						

## NOTES

\* All parameters measured at Tc = 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.

- (2) Noise is measured per CALEX Application Notes found in the CALEX Power Conversion Design Guide and Catalog. Measurement bandwidth is 0 - 20 MHz. See the applications section of this note for more information.
- (3) Determine the correct fuse size by calculating the maximum DC current drain at low line input, maximum load and then adding 20 to 25% to get the desired fuse size. A slow blow type fuse is recommended.
- (4) Minimum load is required for proper regulation only. No module damage is sustained if run less than minimum load. Regulation of the dual output degrades with substantial load unbalance.

- (5) The dual section load regulation is defined as the voltage change in either output as the loads on both outputs are changed from minimum load to maximum load at the same time.
- (6) Cross regulation is defined as the change in one output when the other output is changed from minimum to maximum load.
- (7) Short term stability is specified after a 30 minute warmup at full load, constant line, load and ambient conditions.
- (8) Transient response is defined as the time for the output to settle from a 25 to 75 % step load change to a 1% error band (rise time of step = 2µ Sec).
- (9) Dynamic response is defined as the peak overshoot during a transient as defined in note 8 above.
- (10) The input ripple rejection is specified for DC to 120 Hz ripple with a modulation amplitude of 1% of Vin.

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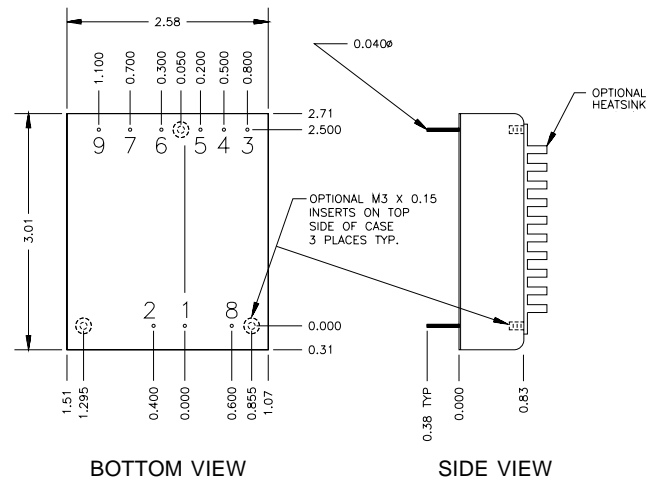
General Specifications*			
All Models			Units
<b>ON/OFF Function (12)</b>			
ON Logic Level or Leave Pin Open	MIN	2.4	VDC
OFF Logic Level	MAX	1.5	VDC
Input Resistance	TYP	2	kohms
Converter Idle Current, Shut Down Pin Low	TYP	12	mA
<b>Isolation</b>			
Isolation Voltage Input to Either Output Single to Dual Output 10µA Leakage	MIN MIN	1544 500	VDC
Input to Output Capacitance Input to Single Output Input to Dual Output Single to Dual Output	 TYP TYP TYP	 95 90 45	 pF
<b>Environmental</b>			
Case Operating Range No Derating	MIN MAX	-40 85	°C
Case Functional Range (13)	MIN MAX	-40 90	°C
Storage Range	MIN MAX	-55 105	°C
Thermal Impedance Pin Mount Version	TYP	4.4	°C/Watt
Thermal Shutdown Case Temperature	TYP	100	°C
<b>General</b>			
Unit Weight	6.2		oz.
Mounting Kit	MS12		

- (11) For module protection only, see also note 3.
- (12) The ON/OFF pin is Open Collector TTL, CMOS, and relay compatible. The input to this pin is referenced to the -input.
- (13) The functional temperature range is intended to give an additional data point for use in evaluating this power supply. At the low functional temperature the power supply will function with no side effects, however, sustained operation at the high functional temperature will reduce expected operational life. The data sheet specifications are not guaranteed over the functional temperature range.
- (14) Specifications subject to change without notice.

### Heat Sink Option

The 25-30 Watt Triple can be ordered with a “-I” configuration which provides a case with 3 by M3 inserts located on the top surface of the case for attaching a heat sink. When an “-HS” is ordered CALEX will ship the converter with a heat sink attached. The CALEX HS heat sink was specially developed for this model and can reduce the case temperature rise to below 3.3°C per watt with natural convection and less with moving air. One heat sink is needed for each 25-30 Watt Triple ordered.

Customer installed heat sinks may also be used. It is recommended that only liquid heat sink compound be used on the heat sink interface. Avoid the so called "Dry" pad heat sink materials. In our experience these materials are actually worse than using no compound at all.



Mechanical tolerances unless otherwise noted:

X.XX dimensions:  $\pm 0.020$  inches

X.XXX dimensions:  $\pm 0.005$  inches

Seal around terminals is not hermetic. Do not immerse units in any liquid.

Pin	Function	Pin	Function
1	+INPUT	6	+5V
2	-INPUT	7	CMN
3	+12/15V	8	ON/OFF
4	CMN	9	+5V TRIM
5	-12/15V		

## Chassis Mounting Kit - MS12

The MS12 chassis mounting kit allows for direct wire connection to the 25-30 Watt Triple Series. The mounting kit includes two barrier strips for wire attachment, an input fuse and an output trim pot for trimming the +5 volt output. Provisions are also made for additional output bypassing and grounding.

If the MS12 is ordered at the same time as a 25-30 Watt Triple the mounting kit will be shipped with the correct fuse size.

The MS12 may be conveniently attached to a chassis by using the 4 - 0.156 inch diameter mounting holes provided at each corner.

Although the MS12 comes with solderless sockets for the 25-30 Watt Triple, it is recommended that the converter be soldered to the mounting kit for improved reliability under severe environmental or vibration conditions.

# 25 to 30 Watt XC Triple Series DC/DC Converters

## Application Information

The dual control loops are locked together in time by a proprietary "Anti-Phase Dual PWM Controller" subassembly. The synchronization reduces beat frequency problems that occur when two switching supplies run at slightly different frequencies. The "Anti-Phase" operation also evens out the current pulses on the input bulk capacitor allowing for conservative derating and hence longer life.

The dual loop design allows both the single and dual outputs to be fully isolated from each other. This helps the system design by allowing the common analog and digital ground point to be elsewhere in the system. The dual outputs can also be used as single ended 24 or 30 volt outputs.

The 25-30 Watt Triple Series is also mindful of battery operation for industrial/medical control and remote data collection. The remote ON/OFF control pin places the converter in a very low power mode that draws only 0.5 mA maximum from the input source. This is at least a 10:1 improvement over industry standard specifications of 5 to 30 mA standby current drain.

These converters achieve an output noise of 30 mV peak to peak typical and are fully specified and tested to a maximum specification of 65 mV peak to peak over a wide bandwidth of 0-20 MHz. Input filtering reduces reflected ripple noise and is similarly low and also fully specified for typical and maximum values (exact value depends on input voltage range).

All inputs and outputs are protected from transient overvoltage conditions by 500 watt transient overvoltage suppressors. Full overload protection is provided by independent pulse-by-pulse current limiting and overtemperature shutdown. These protection features assure you that our 25-30 Watt Triple will provide zero failure rate operation.

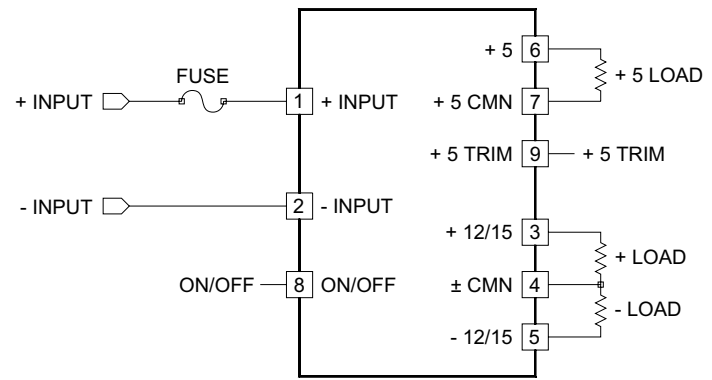
Six-sided shielding is standard along with specified operation over the full industrial temperature range of -40° to +85°C.

The 25-30 Watt Triple Series, like all CALEX converters, carries the full 5 year CALEX no hassle warranty. We can offer a five year warranty where others can't because with CALEX it's rarely needed.

## General Operation

Figure 1 shows the recommended connections for the 25-30 Watt Triple DC/DC converter. A fuse is recommended to protect the input circuit and should not be omitted. The fuse serves two purposes:

- 1) It prevents unlimited current from flowing in the case of a catastrophic system failure.
- 2) UL regulations for telecom equipment require the use of a fuse.



**Figure 1.**

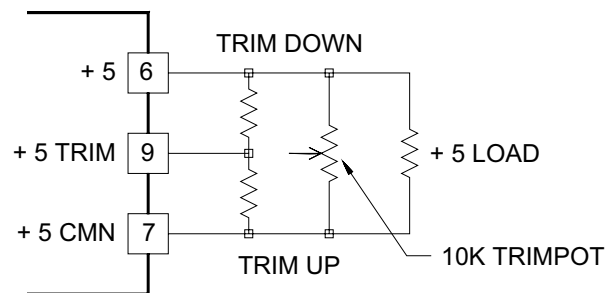
Standard connections for the 25-30 Watt Triple. The ON/OFF and Trim pins can be left floating if they are not used. The input fuse should not be omitted.

The ON/OFF and +5 trim pins may be left floating if they are not used. No external capacitance on either the input or outputs is required for normal use which can, in fact, degrade the converter's operation. See our application note "Understanding Power Supply Output Impedance for Optimum Decoupling" for more information. The usual 0.1 to 0.01  $\mu$ F bypasses may be used around your PCB as required for local bypassing without harm. Extremely low ESR capacitors ( $<0.2$  ohms) should not be used at the input. This will cause peaking of the input filters' transfer function and actually degrade the filters' performance.

## Single Output

The single output is independently regulated and isolated from the dual outputs and can be operated independently or with a common ground with the dual output.

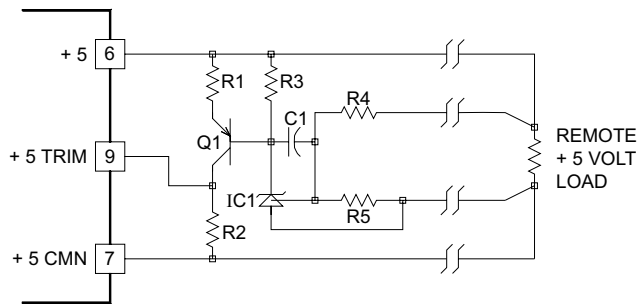
The +5 TRIM pin may be used to adjust the +5 volt output by up to  $\pm 5\%$  from the nominal factory setting of +5.000 volts. The trim may be used to adjust for system wiring voltage drops or to adjust the +5 output up to 5.2 volts for ECL applications. Since the 5 volt output is completely isolated from the dual section the output can be grounded to generate -5.2 volts or +5.2 volts. Figure 2 shows the proper connections for the trim pin.



**Figure 2.**

The 5 volt output can be trimmed by using either a trimpot or fixed resistors. If fixed resistors are used their values may range from zero to infinite ohms the trimpot should be 10K ohms nominal.

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Parts List			
C1	0.1 $\mu$ F, 50V, Ceramic	R4	4.99K, 1%
R1	470 ohm, 5%	R5	4.99K, 1%
R2	1.0K, 5%	Q1	2N3906
R3	2.4K, 5%	IC1	TL431

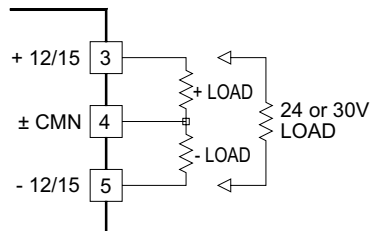
**Figure 3.**

This simple circuit allows for remote sensing with the 5 volt output. The circuit can correct for up to 0.25 volts of total drop in the power leads. At 3 amps of output this is approximately 0.08 ohms of line resistance. A trimpot may be added to R5 to allow for exact adjustment of the 5 volt output.

Figure 3 shows how to implement remote sense with the trim pin and a TL431 adjustable voltage reference. This circuit allows automatic correction of the output voltage up to 0.25 volts total.

## Dual Output

The dual output is independently regulated and isolated from the single output and can be operated separately or with a common ground with the single output. The dual outputs can also be connected for single-ended load applications of either 24 or 30 volts as shown in Figure 4. This configuration allows for full output current operation up to the full 25 or 30 watt rating.



**Figure 4.**

The dual output may be used either as a dual polarity or single-ended source. If the output is used as a single-ended source, pin 4 should be left unconnected.

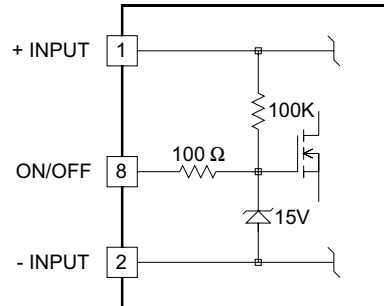
## Grounding

The +5 and  $\pm$  dual sections are floating independently from each other. They may be operated this way or with a common ground.

If the single and dual sections are connected either directly at the converter or at some remote location it is suggested that 1  $\mu$ F, 35 volt Tantalum capacitors be used directly at the converter output pins. These capacitors prevent any common mode switching currents from showing up on the converter's outputs as normal mode output noise.

Do not use the lowest ESR, biggest value capacitor that you can find! This can only lead to reduced system performance or oscillation.

See our application note "Understanding Power Supply Output Impedance for Optimum Decoupling" in the CALEX Power Conversion Design Guide and Catalog for more information.



**Figure 5.**

The simplified schematic of the ON/OFF pin shows a 100K resistor connected between the +Input and the ON/OFF pin. The maximum open circuit voltage is clamped by the 15 volt zener diode. The 100 ohm resistor prevents large ground currents from flowing out the ON/OFF pin instead of the -Input pin during power up transients.

## Case Grounding

The case serves not only as a heat sink but also as an EMI shield. The case/header shield is tied to the +Input pin for the 48T models. The 12T and 24T models have the case tied to the -Input pin. These connections are shown on the 25-30 Watt Triple block diagram.

For all models the case is floating from the output sections.

## Remote ON/OFF Pin Operation

The remote ON/OFF pin may be left floating if this function is not used. The equivalent input circuit for the ON/OFF pin is shown in Figure 5. The best way to drive this pin is with an open collector/drain or relay contact. See our application note titled "Understanding the Remote ON/OFF Function" for more information about using the remote ON/OFF pin.

When the ON/OFF pin is pulled low with respect to the -Input, the converter is placed in a low power drain state. This low power state typically draws less than 200 mA from the input source. When the ON/OFF pin is released the converter powers up in typically 35 mSec. The ON/OFF pin turns the converter off while keeping the input bulk capacitor fully charged. This prevents the large inrush current spike that occurs when the +Input pin is opened and closed.

## Temperature Derating / Mounting Options

The XC Triple Series can operate up to 85°C case temperature without derating. Case temperature may be roughly calculated from ambient by knowing that the XC Triples' case temperature rise is 4.4°C per package watt dissipated. For example, if the converter was functioning at an output of 30 Watts, at what ambient could it expect to run with no moving air and no additional heatsinks?

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Efficiency is approximately 85%, this leads to an input power of 35 watts. The case temperature rise would be 5 watts x 4.4 = 22°C. This number is subtracted from the maximum case temperature of 85°C to get 63°C.

This is a rough approximation of the maximum ambient

temperature. Because of the difficulty of defining ambient temperature and the possibility that the loads' dissipation may actually increase the local ambient temperature significantly, these calculations should be verified by actual measurement before committing to a production design.

Typical Performance (Tc=25°C, Vin=Nom VDC, Rated Load).

