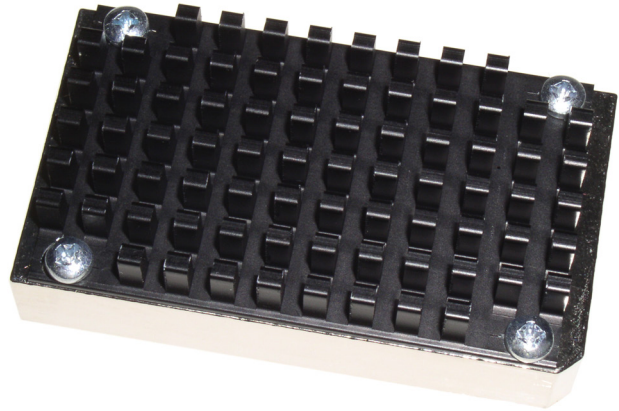




PowerWatt™

Q75009**75W SINGLE DC/DC CONVERTERS** $24 V_{IN}$ $12.5 V_{OUT}$ @ 5.6 A**Key Features**

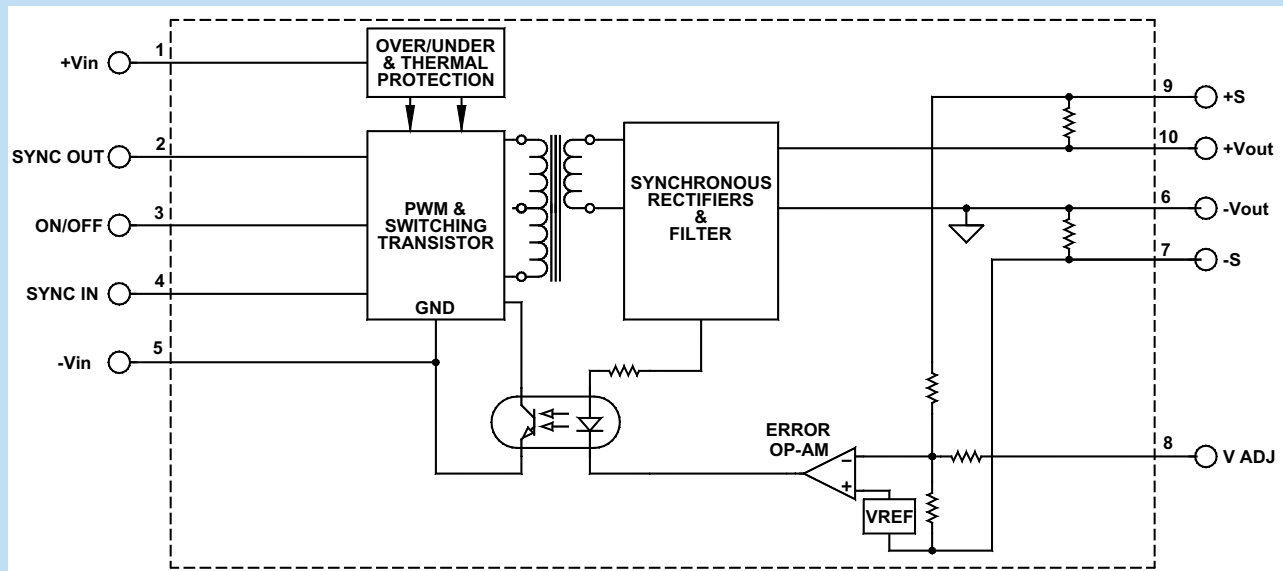
- Efficiency up to (TBD)%
- Six-sided shielding
- Power density of 98W/in³
- 100μS transient response time
- 500μA off state current
- Output synchronous rectification
- 2mV_{pp} output noise
- Input-to-output isolation
- Soft start
- Short circuit protection
- Thermal protection
- Undervoltage protection
- External synchronization



Beta Dyne is protected under various patents, including but not limited to U.S. Patent numbers: 5,777,519; 6,188,276; 6,262,901; 6,452,818; 6,473,3171.

Functional Description

The Q75009 is a 75W single-output DC/DC converter that features an input voltage range of 22-26V_{IN} and an output of 12.5V_{OUT} @ 5.6A. Its high efficiency and power density are a result of innovative patented designs utilizing improved synchronous rectification techniques and planar magnetics. The thermal resistance from the semiconductor and its planar magnetics to the case is minimized by the nickel-plated aluminum case and proprietary potting material. The aluminum heat sink further reduces the thermal resistance from case to ambient. The converter also offers six-sided shielding to eliminate EMI and RFI, resulting in an ideal power source for applications that require low levels of radiated noise. With the specified output filter, the converter's output noise is reduced to 2mV PP.

**Typical Block Diagram**

NOTICE: Do not operate this converter with a floating case. Connect the case to either +V_{IN} or -V_{IN}.

Unless otherwise specified, all parameters are given under typical ambient temperature of +25°C with an airflow rate = 400LFM. With the given power derating, the operating range is -40°C to +125°C. Specifications subject to change without notice.

Electrical Specifications

INPUT SPECIFICATIONS

PARAMETER	CONDITION / NOTE	MIN	TYP	MAX	UNIT
Input Voltage Range		22	24	26	V
Input Filter	Capacitor				
Input Startup Voltage				16.5	V
Reflected Ripple	Figure 1		TBD		mA _{pp}
No Load Input Current			TBD		mA
Input Surge Current (20μS Spike)				10	A
Short Circuit Current Limit			125	150	% I _{IN} Max
Off State Current			150		μA
Remote ON/OFF Control					
Supply ON	Pin 5 Open (Open circuit voltage: 12V Max.)				
Supply OFF		0		0.8	Vdc
Logic Input Reference	-Input pin 3 for ON/OFF; SYNC IN and SYNC OUT				
Logic Compatibility	TTL Open Collector or CMOS Open Drain				
Sync In Pulse Width		300			nS
Sync Out Source Current		2.5	5		mA

OUTPUT SPECIFICATIONS

PARAMETER	CONDITION / NOTE	MIN	TYP	MAX	UNIT
Voltage			12.5		Vdc
Output Current			5.6		A
Output Voltage Accuracy			±1	±2	%
Output Voltage Adjustment	See footnote 3		±5		%
Output Capacitance, V _O 18V		100	220	1000	μF
Ripple & Noise	With output filter, see Figure 1A		1	2	mV
Line Regulation	Minimum V _{IN} to maximum V _{IN}		±0.25	±0.5	%
Load Regulation	10% FL to FL		±0.25	±0.5	%
Output Minimum Load		5	10		%
Temperature Coefficient @ FL			0.02		%/°C
Transient Response Time	50% FL to FL to 50% FL, See Figure 3		50	100	μS
Short Circuit Protection	By input current limiting				
Turn On Delay with Soft Start	See Figure 4		3	4	mS
Output Overvoltage Protection	None,				

GENERAL SPECIFICATIONS

PARAMETER	CONDITION / NOTE	MIN	TYP	MAX	UNIT
Efficiency (at full power)					%
Isolation Voltage (1 min.), Input to Output	All models		1500		Vdc
Isolation Resistance			10 ⁹		Ω
Isolation Capacitance			300		pF
Switching Frequency		360	380	400	kHz

ENVIRONMENTAL SPECIFICATIONS

PARAMETER	CONDITION / NOTE	MIN	TYP	MAX	UNIT
Operating Temperature Range (Ambient)	Industrial, See Figure 10	-40		+71	°C
Storage Temperature Range		-55		+150	°C
Maximum Operating Case Temperature				110	°C
Derating	See Figure 10				
Thermal Resistance, With Heat Sink ³	Zero air flow		7.8		°C/W
Cooling	See Figure 10				
Case Connection	CASE MUST BE CONNECTED TO EITHER INPUT OR OUTPUT POWER PINS				
MTBF	per MIL-HNBK-217F (Ground benign, +25°C)		1.1×10 ⁶		hours

PHYSICAL CHARACTERISTICS

PARAMETER	CONDITION / NOTE	MIN	TYP	MAX	UNIT
Dimensions, With Heat Sink (L×W×H)	2.50×1.40×0.75 in. (63.50×35.56×19.05mm)				
Dimensions, Without Heat Sink (L×W×H)	2.50×1.40×0.47 in. (63.50×35.56×11.94mm)				
Weight, With Heat Sink	3.2 oz. (90g)				
Weight, Without Heat Sink	2.6 oz. (74g)				

¹ The maximum input current at any given input range measured at minimum input voltage is given as $1.6 \times I_{\text{NOMINAL}}$. Nominal input current is the typical value measured at the input of the converter under full-load room temperature and nominal input voltage (24Vdc and 48Vdc).

² Measured with 22μF capacitor for 48V_{IN} and 100μF capacitor for 24V_{IN} at the input power pins in series with 10μH inductor (see Figure 1A).

³ See Application Note DC-004: Thermal Considerations for DC/DC Converters.

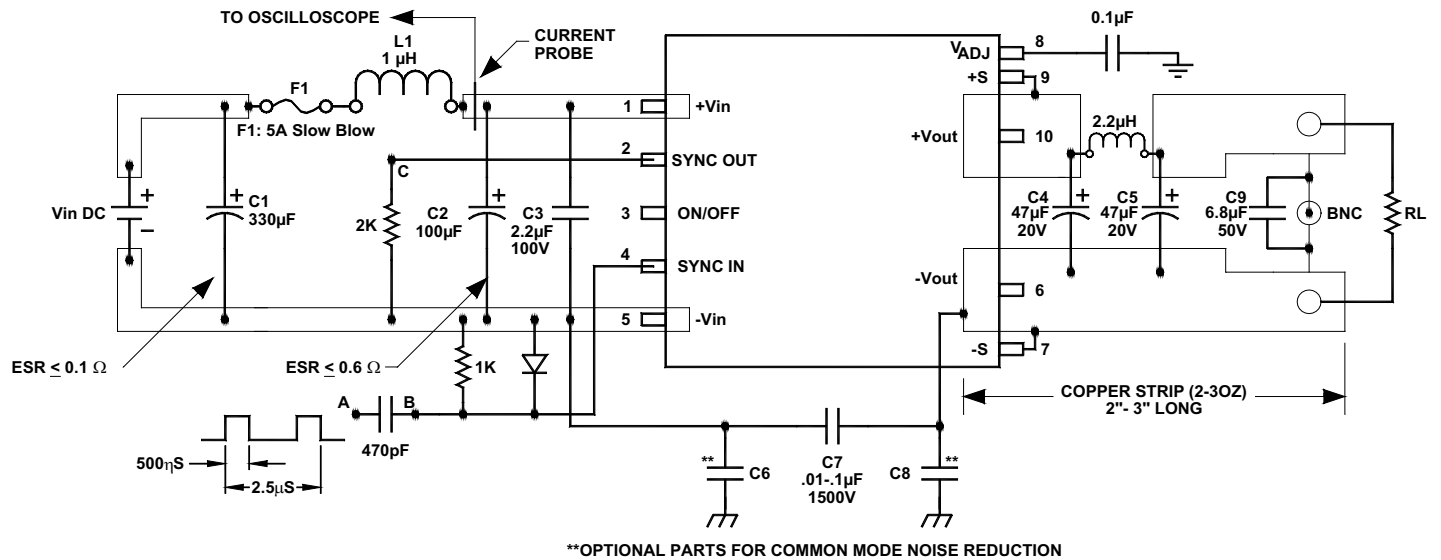


FIGURE 1A. Setup for output and reflected ripple measurement

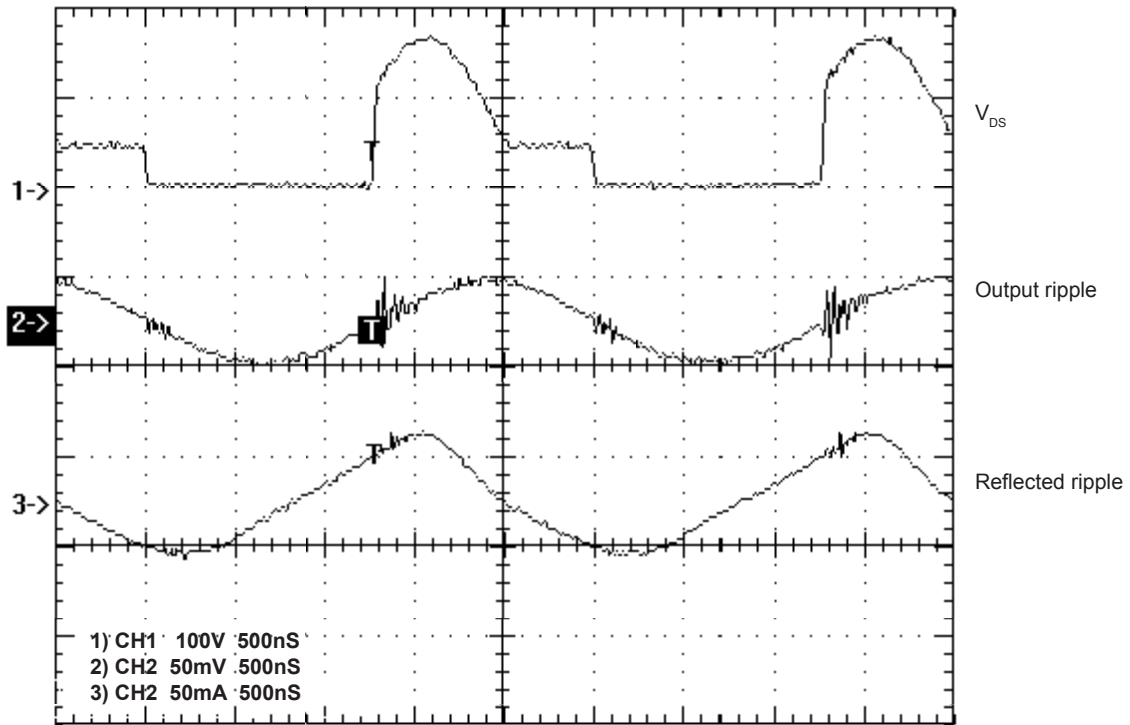


FIGURE 1B. Typical output ripple and reflected ripple of Q75S5/48 ($C_4 = 1000 \mu$ F)

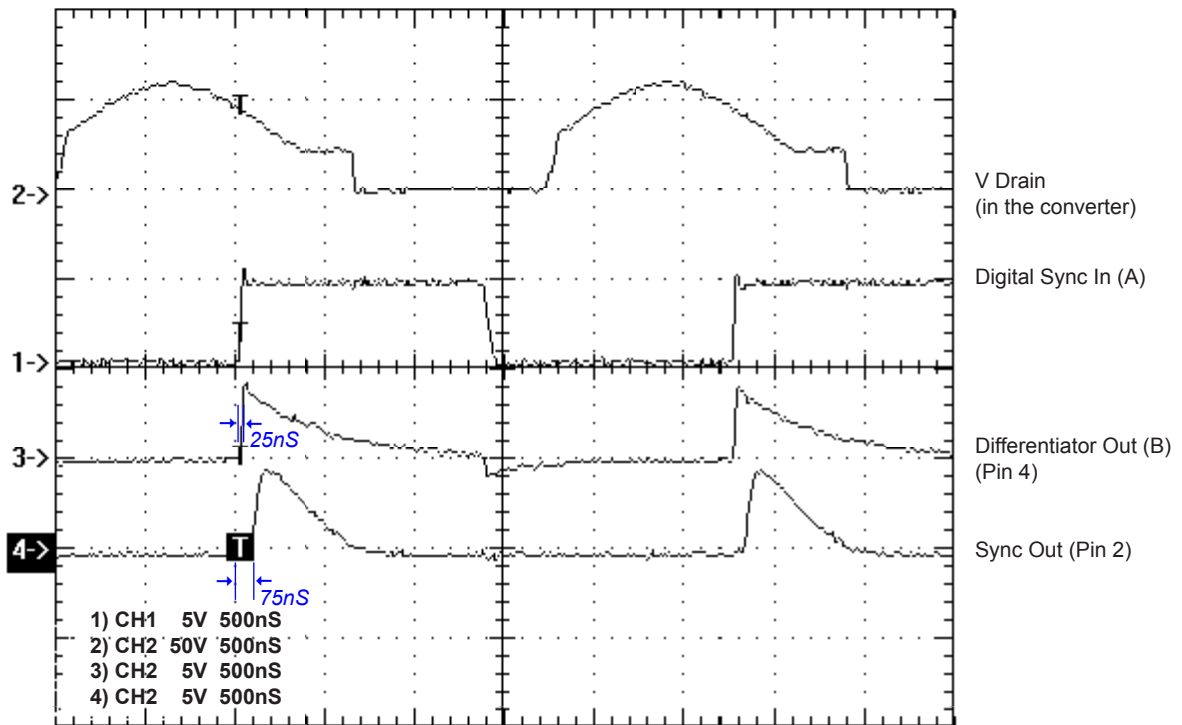


FIGURE 1C. Typical synchronization waveforms obtained from connection diagram in Figure 1 (Q75S3.3/24)

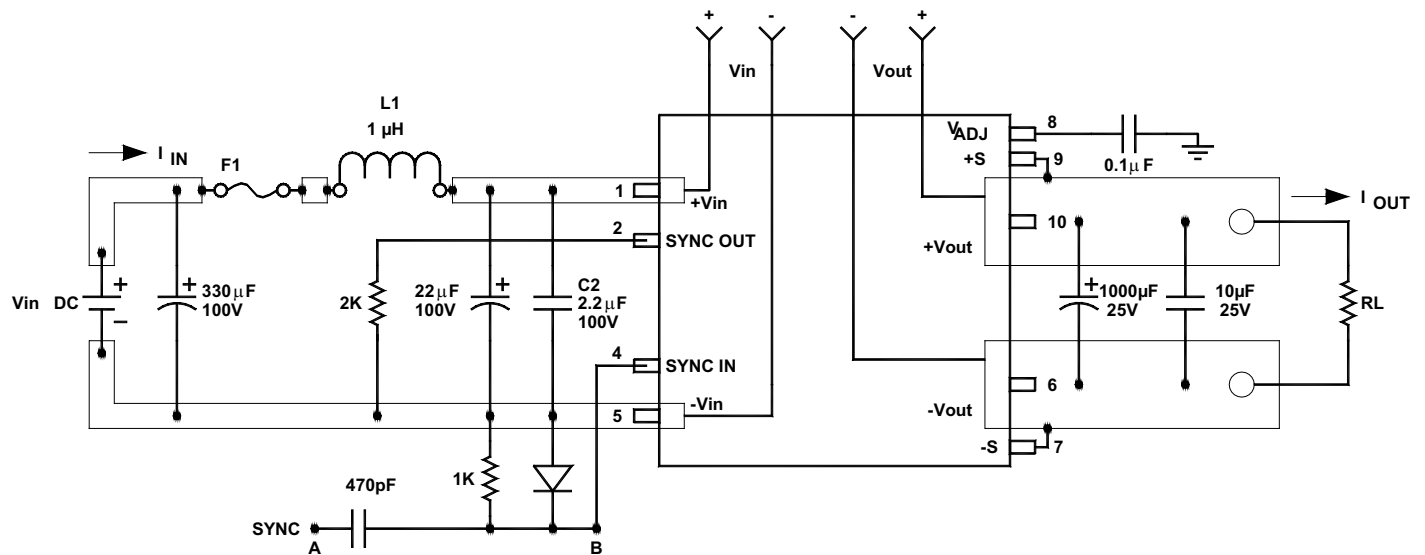


FIGURE 2. Setup for efficiency measurements

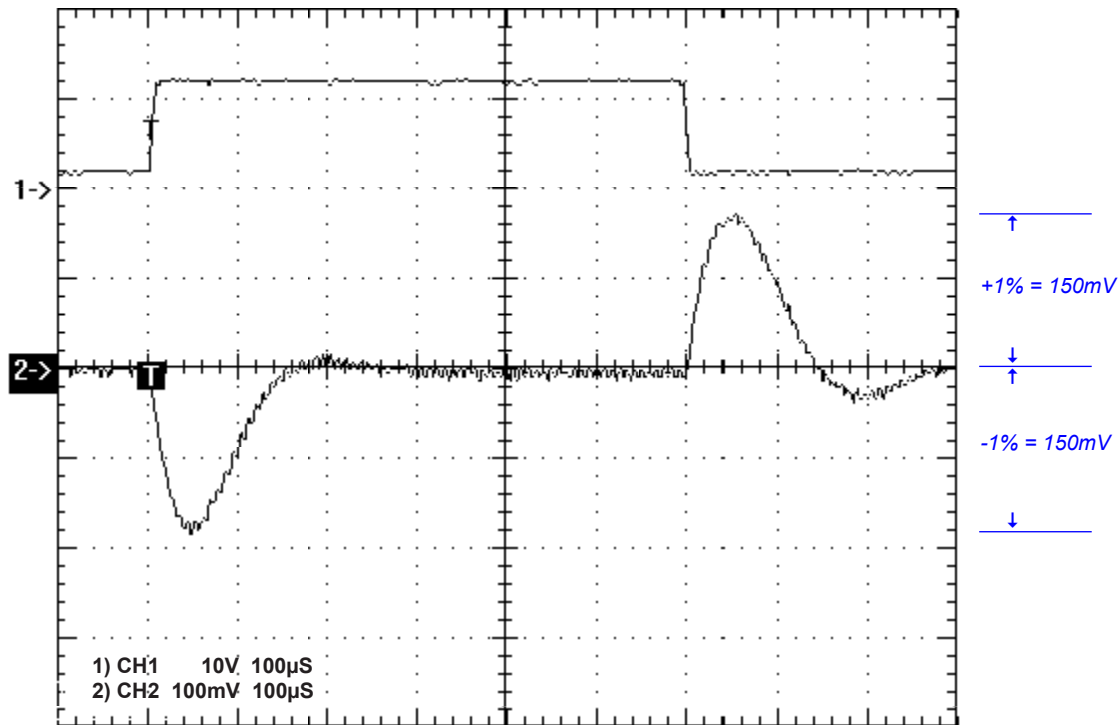


FIGURE 3C. Typical transient response of Q75S15/24
($C_o = 250\mu\text{F}$, 50% $I_o = 2\text{A}$)

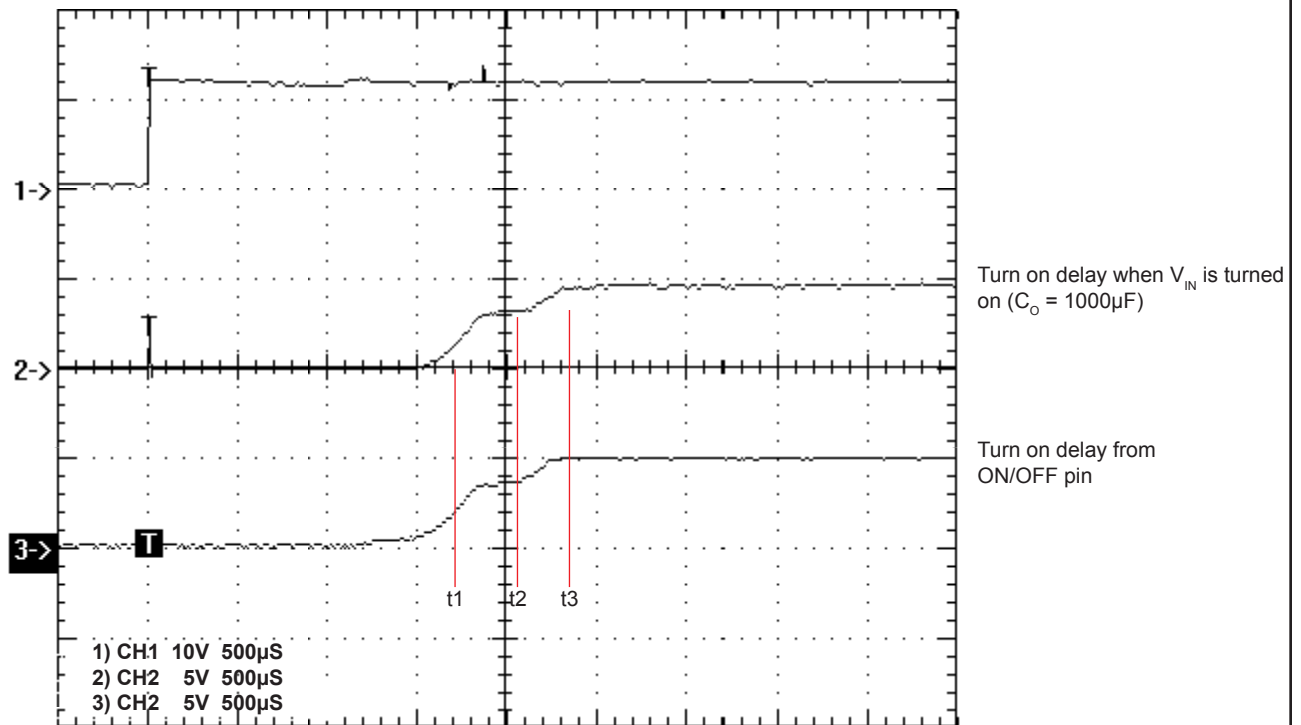


FIGURE 4. Turn on delays
(Refer to Figure 3A)

NOTE: From t1 to t2, the secondary voltage is rectified by the MOSFET parasitic diodes. From t2 to t3, a switchover from diode rectification to synchronous rectification occurs.

EXTERNAL TRIMMING OF OUTPUT VOLTAGES

To trim the output voltage DOWN, connect a 5% ¼W resistor between the + (plus) output and trim pin of the converter. To trim the output voltage UP, connect a 5% ¼W resistor between the – (minus) output and trim pins of the converter. For UP/DOWN trimming capability, connect a 10kΩ potentiometer between the + and – output pins, with the wiper arm connected to the trim pin.

The trim resistors/potentiometer can be connected at the converter output pins or the load. However, if connected at the load,

the resistance of the runs becomes part of the feedback network which improves load regulation. If the load is some distance from the converter, the use of #20 gauge wire is recommended to avoid excessive voltage drop due to the resistance of the circuit paths.

See our application notes:

DC-001: Testing Transient Response in DC/DC Converters

DC-004: Thermal Consideration for DC/DC Converters

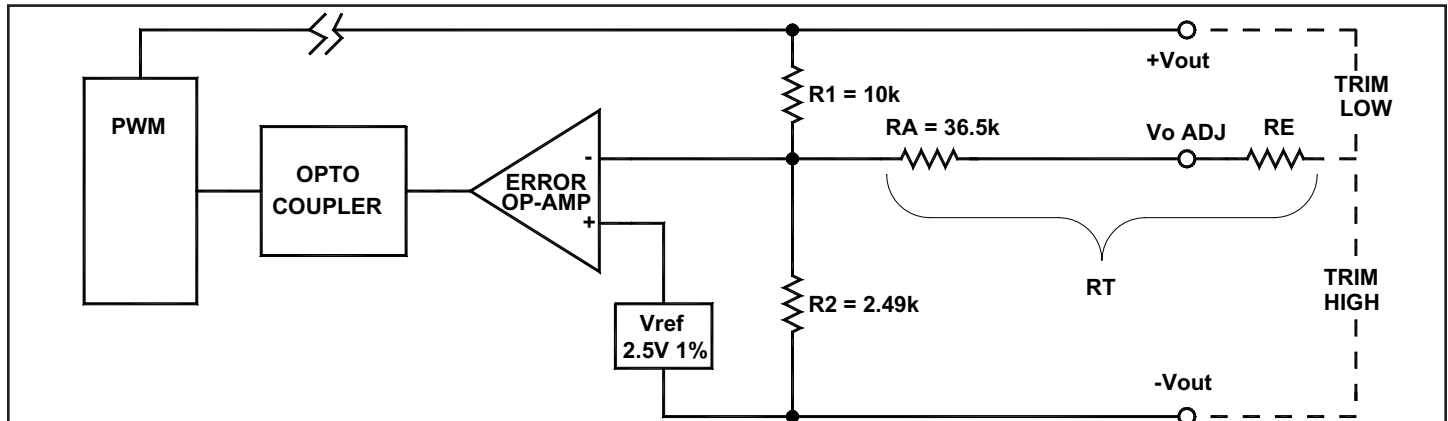


FIGURE 5. Output control circuit of 75009

To trim V_o higher to V_o' , where V_o is the actual measured untrimmed value:

$$RE = RT - RA = \frac{R1 \cdot V_{REF}}{V_o' - V_o} - RA$$

To trim V_o lower to V_o'' , where V_o is the actual measured untrimmed value:

$$RE = RT - RA = \left[\left(\frac{R1 \cdot V_{REF}}{R2(V_o - V_o'')} - R1 \right) RA \right]$$

EXAMPLE

To trim V_o from 1.8V to 2V:

$$V_o = 1.8V, V_o' = 2V, R1 = 1.13k\Omega, V_{REF} = 1.25, RA = 2k\Omega$$

$$RE = RT - RA = \frac{1.13 \cdot 1.25}{2 - 1.8} - 2k\Omega = 5.06k\Omega \text{ or approx. } 5.1k\Omega \text{ (a standard resistor value)}$$

EXTERNAL SYNCHRONIZATION

A TTL signal applied at the SYNC pin of the converter will synchronize the switching frequency of the converter to that of the TTL input signal. The external (TTL) frequency must be equal or higher than the converter's frequency. At the positive-going edge of the applied pulse, the internal power-switching transistor turns off and the PWM discharges its timing capacitor. At the negative-going edge, the PWM resumes normal operation. The minimum positive pulse width of the TTL signal must be 300nS and its frequency between 350kHz and 410kHz.

NOTE: Higher frequencies will reduce the efficiency of the converter and wide TTL pulses will force the PWM to follow the external TTL width modulation, which may effect regulation. A high TTL signal at the SYNC pin of the converter will turn the converter off. An internal pull-down resistor will keep this pin low when it is not used. A pulse differentiator (see Figure 7) can be used to shape a square wave sync signal as shown in Figure 6.

To avoid noise pickup, install a 1kΩ resistor from the SYNC IN (Pin 4) to $-V_{IN}$ (Pin 5). An internal current source will provide

2.5mA of current for driving another 75W converter from the SYNC OUT (Pin 2).

Please note that when the SYNC OUT pin is used to drive multiple converters, the 1kΩ sync input resistor is not required. However, a 2kΩ resistor load must be installed at the SYNC OUT pin (Pin 2) of the driving converter. The 2kΩ resistor can be the parallel combination of individual sync in resistors installed at the SYNC IN pin (Pin 4) of the converters to be driven.

For example, if a 75W converter "master" will be used to synchronize five other 75W converter "slaves," a 10kΩ resistor can be installed at the SYNC IN pin of each slave, and the SYNC OUT pin of the master can be connected to all the SYNC IN pins of the slaves.

The parallel combination of five 10kΩ resistors will provide the 2kΩ sync out load for the master. Avoid overloading the sync output current source with a resistor lower than 2kΩ. Overloading may affect the performance of the converter.

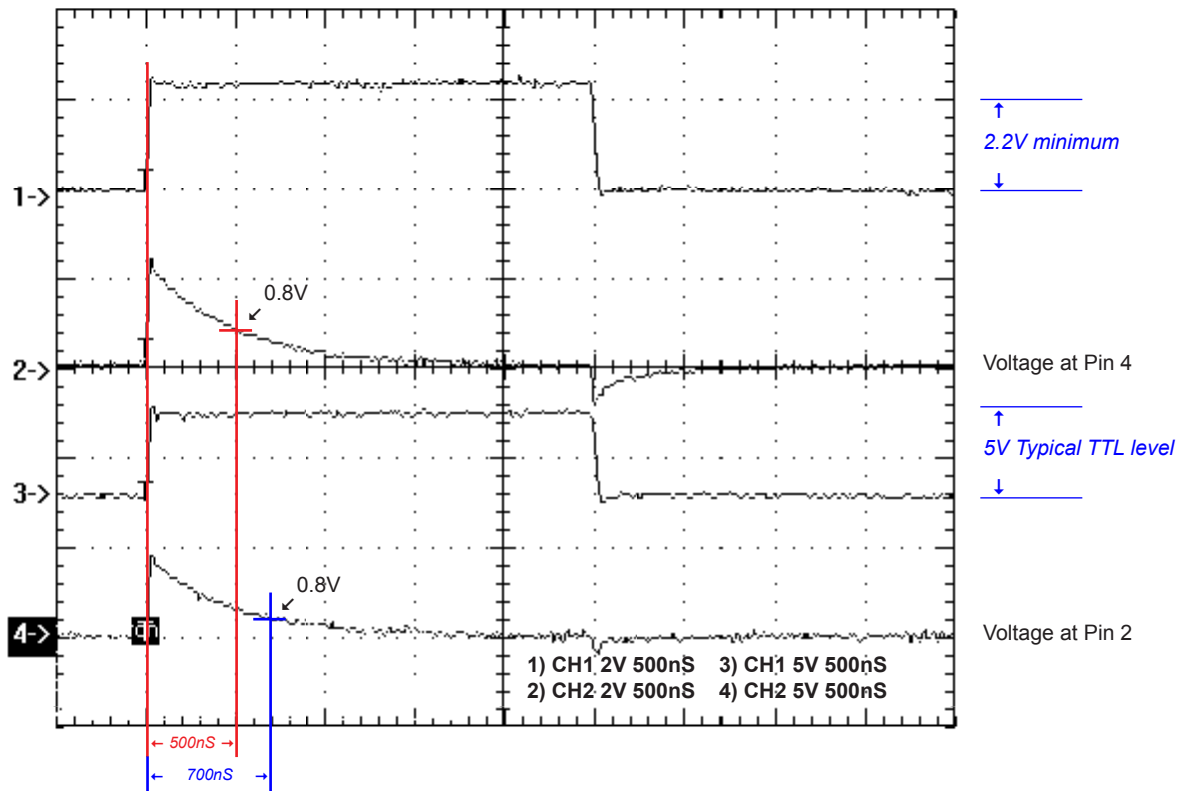


FIGURE 6. Waveforms of sync signal shaping

SYNC SIGNAL SHAPING

As described in External Synchronization, the PWM of the 75W converter requires a TTL signal of 0.8 to 2Vdc minimum amplitude and minimum duration of 300nS. When such a signal is not available (through one shot multivibrator or other pulse-shaping circuits) a C-R differentiator, such as the one in Figure 7, can be used to shape a square wave TTL signal. As is shown by the oscillogram in Figure 6, the positive edge of the sync pulse must be 2V minimum and the

decaying exponential must reach the low er threshold of 0.8Vdc in 300nS minimum from the positive edge. The parallel diode with the resistor is a small signal switching diode or a Schottky signal diode with 0.3 to 0.5V forward drop, it is used to clamp the voltage at Pin 2@-0.5Vdc. For other logic levels (such as 2.5 and 3.3), adjust the RC time constant to obtain the required timing.

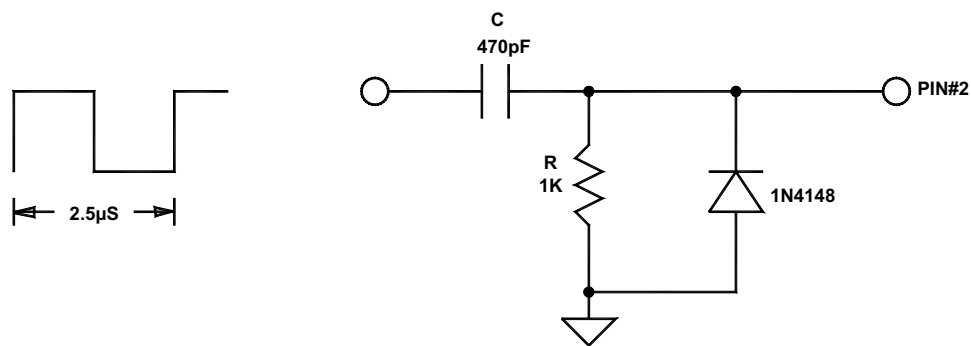


FIGURE 7. Suggested pulse-shaping circuit

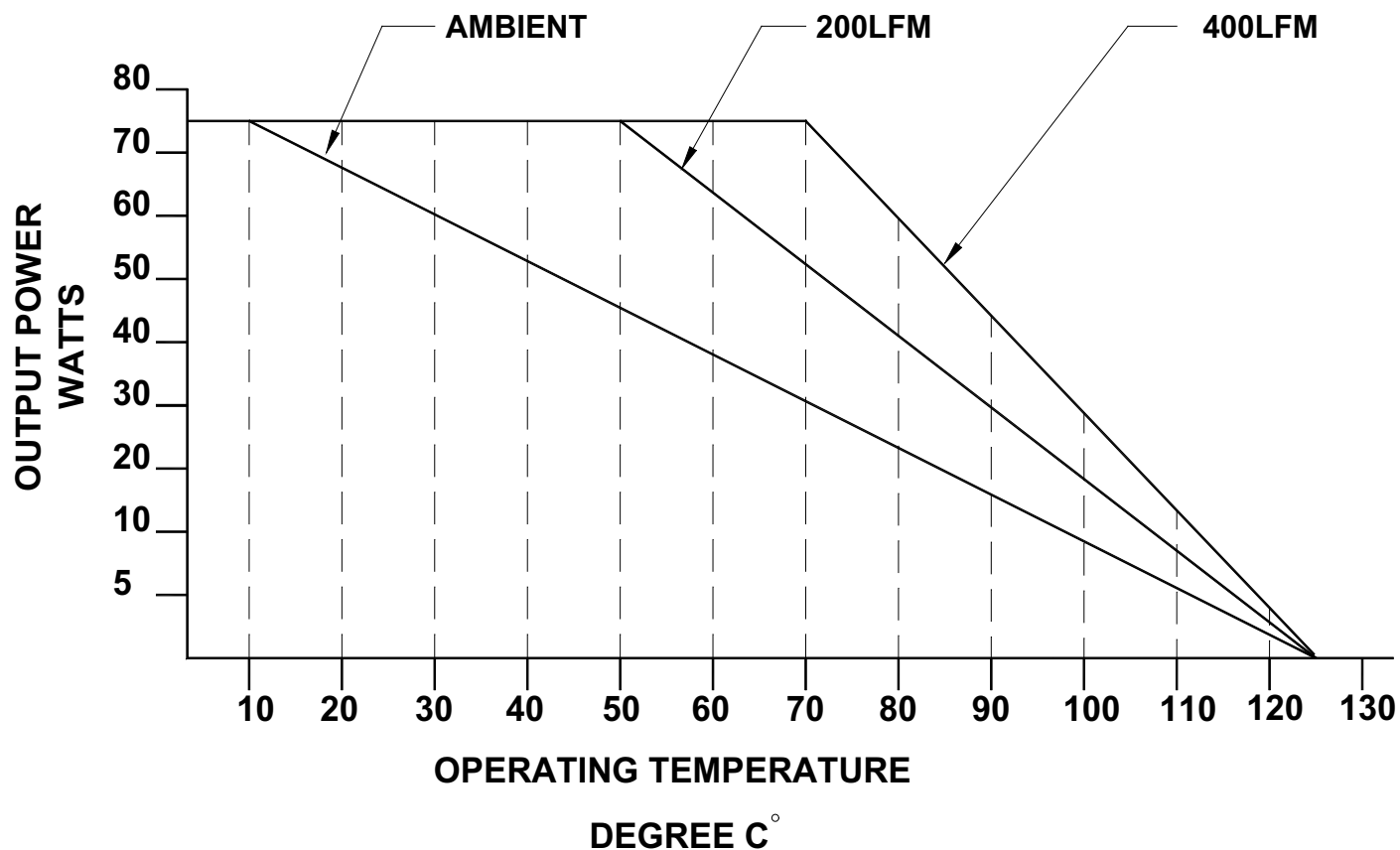
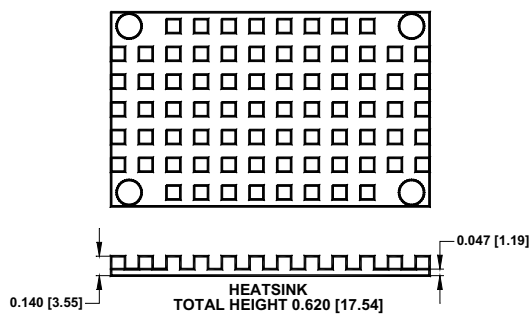
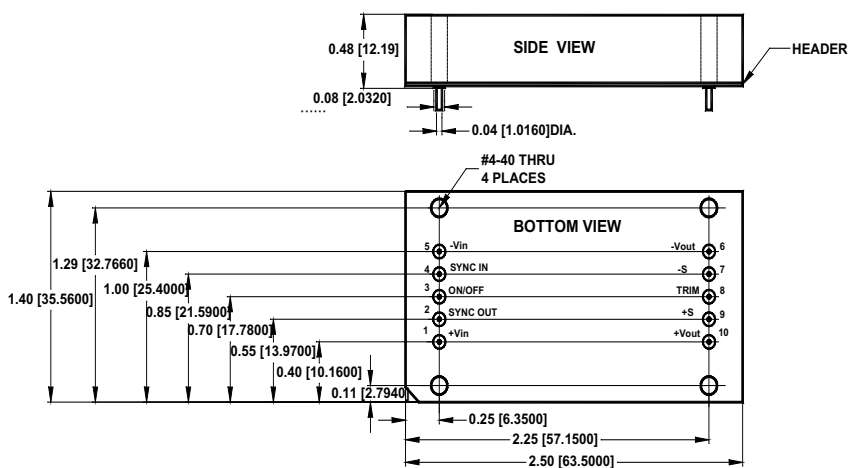


FIGURE 10A. Typical derating curves for Q75009 with heat sink

MECHANICAL SPECIFICATIONS



Pin	Function	Pin	Function
1	+V _{IN}	6	-V _{OUT}
2	SYNC OUT	7	-S
3	ON/OFF	8	TRIM
4	SYNC IN	9	+S
5	-V _{IN}	10	+V _{OUT}