



## Technical Reference Notes ALO25F24 (Single Output 8<sup>th</sup> Brick)



### *ALO25F24 Single Output 8<sup>th</sup> Brick: Open-Frame Module*

The ALO25F24 is Astec's 8<sup>th</sup> Brick industry standard offering. Operating from an input voltage range of 18V to 36V. It delivers up to 25A max current at 3.3V output voltage. It provides tight regulation and exhibits clean and monotonic output start up characteristics. This model comes with industry standard features such as Input UVLO; Enable On/Off, OCP, OVP and OTP; Output Trim; Differential Remote Sense pins. Open frame construction is available with TH and SMT termination. With its wide operating temperature range of -40°C to 85°C ambient, the converter is deployable into almost any environment.



### Special Features

- Industry Standard 8<sup>th</sup> Brick Footprint
- Open frame construction
- Low Ripple and Noise
- Regulation to zero load
- High Capacitive Load Start-up
- Fixed Switching Frequency
- Industry standard features: Input UVLO; Enable; OVP, OCP and OTP; Output Trim, Remote Sense
- Meets Basic Insulation

### Environmental Specifications

- -40°C to 85°C Operating Temperature
- -40°C to 125°C Storage Temperature
- MTBF > 1 million hours

### Electrical Parameters

#### Input

Input Range	18-36 VDC
Input Surge	50V / 100ms

#### Control

Enable	TTL compatible
(Positive or Negative Logic Enable Options)	

#### Output

Load Current	3.3V @ 25A max (P <sub>O</sub> = 82.5W)
Line/Load Regulation	< 1% V <sub>O</sub>
Ripple and Noise	75mV <sub>P-P</sub>
Output Voltage	
Adjust Range	±10% V <sub>O</sub>
Transient Response	5% Typical deviation
	50% to 75% Load Change
	100µs settling time (Typ)
Remote Sense	+10% V <sub>O</sub>
Over Current Protection	120% (Typ)
Over Voltage Protection	130% (Typ)
Over Temperature Protection	103°C

### Safety

UL + cUL 60950, Recognized  
EN60950 through TUV-PS



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### Electrical Specifications

#### ABSOLUTE MAXIMUM RATINGS

Stresses in excess of the absolute maximum ratings can cause permanent damage to the converter. Functional operation of the device is converter is not implied at these or any other conditions in excess of those given in the operational section of the specs. Exposure to absolute maximum ratings for extended period can adversely affect device reliability.

Parameter	Device	Symbol	Min	Typical	Max	Unit
Input Voltage Continuous Transient (100ms)	All	V <sub>in</sub> V <sub>in trans</sub>	- -	- -	36 50	Vdc
I/O Isolation (Conditions 50μA for 5 sec, slew rate of 1500V/10sec)						
Input-to-Output	All	-	-	-	1500	Vdc
Operating Temperature	All	T <sub>A</sub>	-40	-	85	°C
Storage Temperature	All	T <sub>STG</sub>	-40	-	125	°C
Operating Humidity	All	-	10	-	85	%
Max Voltage at Enable Pin	All		-	-	25	Vdc
Max Output Power	All	P <sub>O,MAX</sub>	-	-	82.5	W

#### INPUT SPECIFICATIONS

Parameter	Device	Symbol	Min	Typical	Max	Unit
Operating Input Voltage Range	All	V <sub>IN</sub>	18	24	36	Vdc
Input Under-Voltage Lock-out T_ON Threshold T_OFF Threshold	All		17.2 15.8	- -	17.95 16.50	Vdc
Input Line Drop Out Time (25°C) - within overshoot spec - within 450mV overshoot	All All	V <sub>IN</sub> V <sub>IN</sub>	5 1	- -	- -	ms
Max Input Current <sup>1</sup> (V <sub>IN</sub> = V <sub>IN,Min</sub> ; I <sub>O</sub> = I <sub>O,Max</sub> )	All	I <sub>in,max</sub>	-	-	6.0	A
Max P <sub>diss</sub> @ I <sub>O</sub> = 0A (V <sub>IN</sub> = V <sub>IN,Nom</sub> ) Temperature: T <sub>A</sub> = 25°C	All		-	-	4.6	W
Input Ripple Current <sup>2</sup> 5Hz to 20MHz	All	I <sub>rl</sub>	-	6	-	mAp-p
Input Voltage Rise Time 10% to 90% of V <sub>out</sub>	All		-	-	1.7	V/ms
Inrush Current dI <sub>IN</sub> /dt	All		-	-	5	A <sub>pk</sub>



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**Electrical Specifications** *(continued)*

**OUTPUT SPECIFICATIONS**

Parameter	Device	Symbol	Min	Typical	Max	Unit
Output Voltage Set point $V_{IN} = V_{IN, Min}$ to $V_{IN, Max}$ $I_O = I_{O, Max}$	All	$V_{O, SET}$	3.24	3.30	3.35	Vdc
Output Regulation Line $V_{IN} = V_{IN, Min}$ to $V_{IN, Max}$ Load $I_O = I_{O, Min}$ to $I_{O, Max}$ Temperature: $T_A = -40^{\circ}C$ to $85^{\circ}C$	All	-	-	-	$\pm 0.20$	%
Output Ripple and Noise <sup>3</sup> Peak-to-Peak: (5Hz to 20MHz)	All	-	-	40	75	mVp-p
External Load Capacitance Capacitor ESR	All	-	- 15	-	15,000 -	$\mu F$ m $\Omega$
Output Current <sup>4</sup>	All	$I_O$	0	-	25	A
Output Current-limit Inception $V_{OUT} = 90\% V_{O, Set}$ ; $T_A = 25^{\circ}C$	All	$I_O$	26.5	-	35	A
Output Over Voltage Protection	All	$V_O$	3.9	4.1	4.9	v
Over Temperature Protection (AVG. PCB TEMP)	All		103	-	117	$^{\circ}C$
Efficiency $V_{IN} = V_{IN, Nom}$ ; $I_O = I_{O, Max}$ $T_A = 25^{\circ}C$	All	$\eta$	87	88	-	%
Turn On Response Time $V_{IN} = V_{IN, Min}$ to $V_{IN, Max}$	All	-	-	-	15	ms
Enable to Output Turn-On Delay $V_{IN} = V_{IN, Min}$ to $V_{IN, Max}$ $I_O = I_{O, Min}$ to $I_{O, Max}$	All	-	-	-	15	ms
+ $V_{IN}$ to Output Turn-On Delay Enable Pin: Active $V_{IN} = V_{IN, Nom}$ $I_O = I_{O, Max}$	All	-	-	-	15	ms
Switching Frequency	All	-	580	660	740	kHz
Output Voltage Remote Sensing	All	-	-	-	10	% $V_O$
Output Voltage Trim Range <sup>5</sup>	All		90		110	% $V_O$
Output Enable ON/OFF <sup>6</sup> Enable Signal Slew Rate Negative Enable (“N” suffix) Enable Pin Voltage: Mod-ON Mod-OFF  Positive Enable (No suffix) Enable Pin Voltage: Mod-ON Mod-OFF	All	- - - - - -	0.01 0 2.95 2.95 0	- - - - -	- 0.8 20 20 0.8	V/ms V V V V



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**Electrical Specifications (continued)**

**OUTPUT SPECIFICATIONS**

Parameter	Device	Symbol	Min	Typical	Max	Unit
Dynamic Response $C_O = 0\mu\text{F}$		$\Delta I_O / \Delta t$	-	0.1	-	A/ $\mu\text{s}$
Peak Deviation	All	-	-	5	-	% $V_O$
Load Change from $I_O = 50\%$ to 75% of $I_{O, \text{Max}}$ :		-	-	100	300	$\mu\text{s}$
Settling Time to $V_{O, \text{Set}}$ Tolerance						
Peak Deviation	All	-	-	5	-	% $V_O$
Load Change from $I_O = 50\%$ to 25% of $I_{O, \text{Max}}$ :		-	-	100	300	$\mu\text{s}$
Settling Time to $V_{O, \text{Set}}$ Tolerance	All	-	-	-	-	-
Output Overshoot At T-on / t-off	All	-	-	-	3	% $V_O$
Passive Resistive Full Load $T < 0^\circ\text{C}$		-	-	-	4	% $V_O$

- Note: 1. The converter is not internally fused. An input line fuse such as Littlefuse 3AB type must be used.  
 2. Refer to Figure 1 for the external input capacitance required.  
 3. Refer to Figure 2 for output ripple and noise test measurement setup.  
 4. Output power derating applies at elevated temperature. Refer to Figure 11.  
 5. Refer to the output trim equations provided (Equations 1 and 2).  
 6. For temperature greater than  $-20^\circ\text{C}$ , minimum pin disable time is 100ms.  
 For temperature less than  $-20^\circ\text{C}$ , minimum pin disable time is 1s.

**SAFETY AGENCY / MATERIAL RATING / ISOLATION**

Parameter	Device					
Safety Approval	All	UL/cUL 60950, 3rd Edition – Recognized EN 60950 through TUV				
Material Flammability Rating	All	UL94V-0				
Parameter	Device	Symbol	Min	Typical	Max	Unit
Input to Output Capacitance	All		-	1000	-	pF
Input to Output Resistance	All		-	TBD	-	Ohms
Input to Output Insulation Type	All		-	Basic	-	-

**Electrical Specifications** *(continued)*

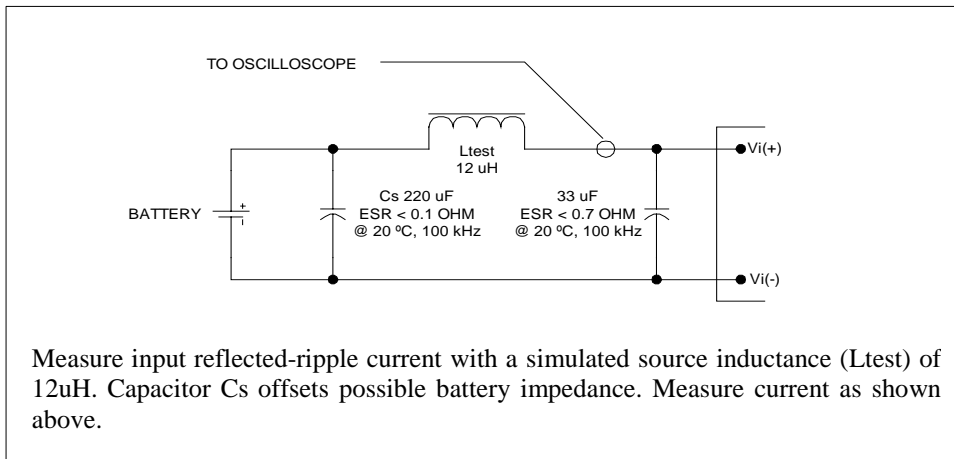


Figure 1. Input Reflected Ripple Current Measurement Setup.

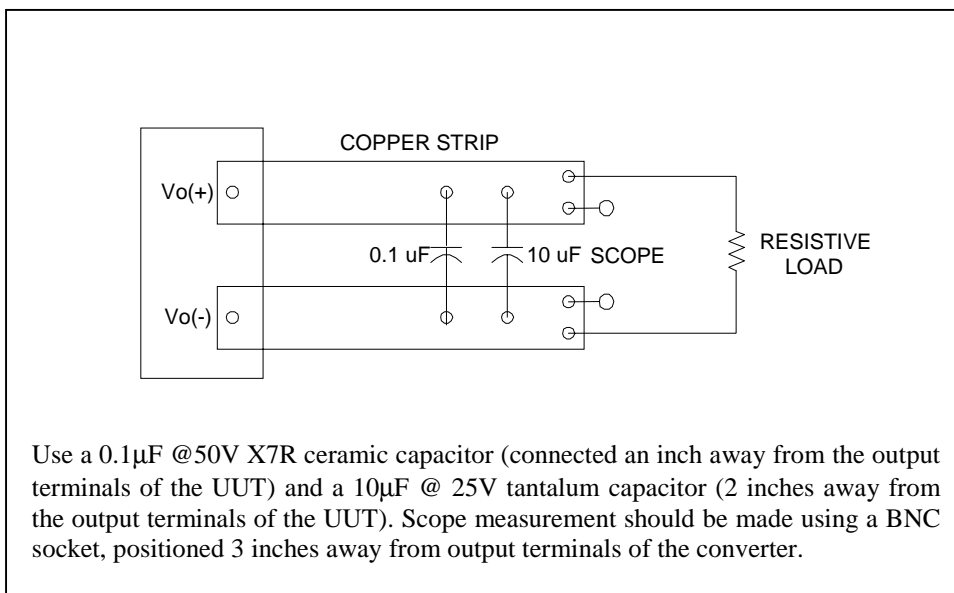


Figure 2. Peak to Peak Output Noise Measurement Setup.



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### Basic Operation and Features

#### INPUT UNDER VOLTAGE LOCKOUT

To prevent any instability to the converter, which may affect the end system, the converter have been designed to turn-on once  $V_{IN}$  is in the voltage range of 17.2-17.95 VDC. Likewise, it has also been programmed to turn-off when  $V_{IN}$  drops down to 15.8-16.5 VDC.

#### OUTPUT VOLTAGE ADJUST/TRIM

The converter comes with a TRIM pin (PIN 6), which is used to adjust the output by as much as 90% to 110% of its set point. This is achieved by connecting an external resistor as described below.

To **INCREASE** the output, external  $R_{adj\_up}$  resistor should be connected between TRIM PIN (Pin6) and +SENSE PIN (Pin 7). Please refer to Equation (1) for the required external resistance and output adjust relationship.

#### Equation (1a):

$$R_{adj\_up} = \left[ \frac{5.1 \times V_{o\_set} \times (100 + \Delta\%)}{1.225 \times \Delta\%} - \frac{510}{\Delta\%} - 10.2 \right] \text{ K}\Omega$$

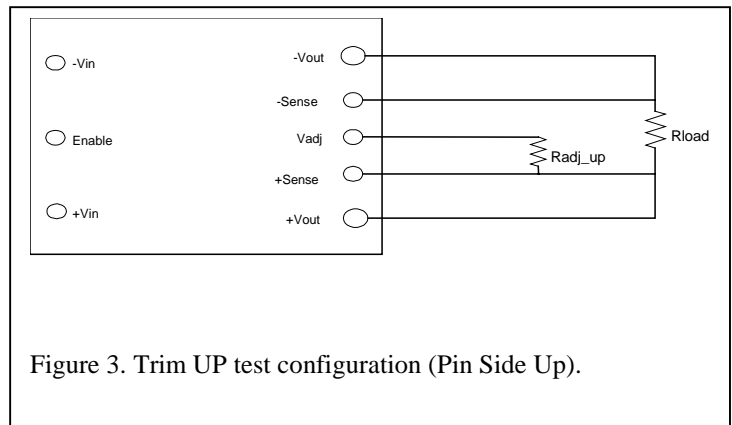


Figure 3. Trim UP test configuration (Pin Side Up).

To **DECREASE** the output, external  $R_{adj\_down}$  resistor should be connected between TRIM pin (Pin 6) and -SENSE PIN (Pin 5). Please refer to Equation (2) for the required external resistance and output adjust relationship.

#### Equation (2):

$$R_{adj\_down} = \left( \frac{510}{\Delta\%} - 10.2 \right) \cdot \text{k}\Omega$$

Where:  $\Delta\%$  = percent change in output voltage

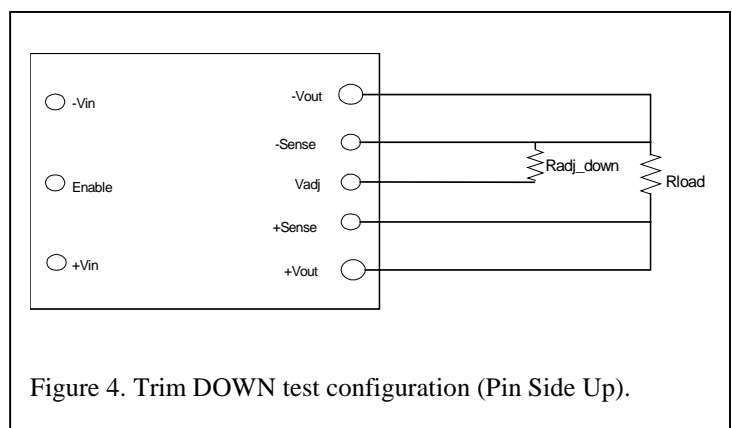


Figure 4. Trim DOWN test configuration (Pin Side Up).



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### **Basic Operation and Features** *(continued)*

#### **OUTPUT ENABLE**

The converter comes with an Enable pin (PIN 2), which is primarily used to turn ON/OFF the converter. Both a Positive (no "N" suffix required) and a Negative (suffix "N" required) Enable Logic options are being offered.

For Positive Enable, the converter is turned on when the Enable pin is at logic HIGH or left open. The unit turns off when the Enable pin is at logic LOW or directly connected to  $-V_{IN}$ . On the other hand, the Negative Enable version turns unit on when the Enable pin is at logic LOW or directly connected to  $-V_{IN}$ . The unit turns off when the Enable pin is at Logic HIGH.

#### **OVER CURRENT PROTECTION (OCP)**

The Over Current Protection is latching with auto-restart. The converter shuts down once the output current reaches the OCP range. The converter will attempt to restart until the fault is removed. Latching OCP mode is available as an option (no model part number assigned). This feature is only for module protection and no intention to customer application.

#### **OUTPUT OVER VOLTAGE PROTECTION (OVP)**

The Over Voltage Protection circuit is latching with auto-restart. The converter will latch-off and attempt to restart until the fault is removed. Latching OVP mode is available as an option (no model part number assigned).

#### **OVER TEMPERATURE PROTECTION (OTP)**

The Over Temperature Protection circuit will shutdown the converter once the average PCB temperature reaches the OTP range. This feature prevents the unit from overheating and consequently going into thermal runaway, which may further damage the converter and the end system. Such overheating may be an effect of operation outside the given power thermal derating conditions. Restart is possible once the temperature of the sensed location drops to less than 103°C.

#### **REMOTE SENSE**

The remote sense pins can be used to compensate for any voltage drops (per indicated max limits) that may occur along the connection between the output pins to the load. Pin 7 (+Sense) and Pin 5 (-Sense) should be connected to Pin 8 (+Vout) and Pin 4 (Return) respectively at the point where regulation is desired. The combination of remote sense and trim adjust cannot exceed 110% of  $V_O$ . When output voltage is trimmed up (through remote sensing and/or trim pin), output current must be derated and maximum output power must not be exceeded.



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### Performance Curves

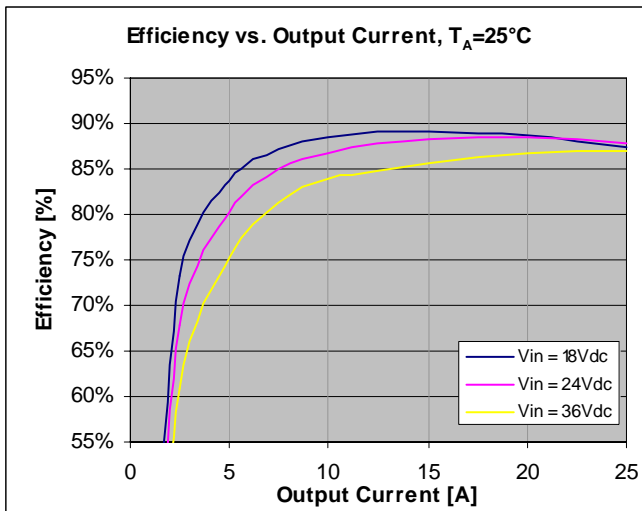


Figure 5. Efficiency vs. Load Current at  $I_O = \text{Full Load}$ ,  $T_A = 25^\circ\text{C}$  (ambient temperature).

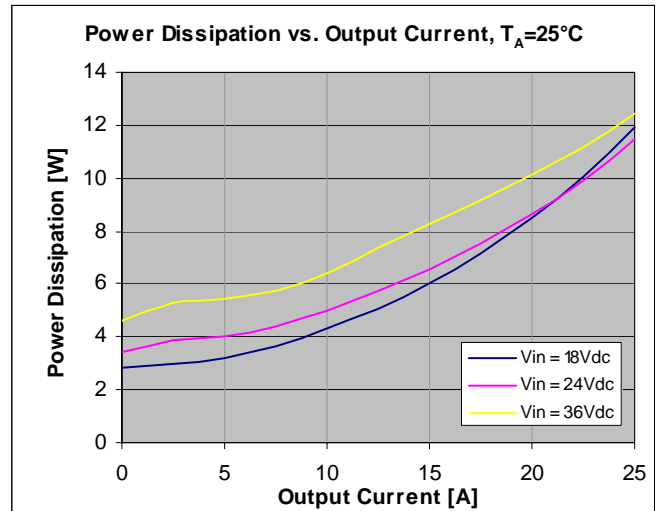


Figure 6. Power Dissipation vs. Load Current at  $I_O = \text{Full Load}$ ,  $T_A = 25^\circ\text{C}$  (ambient temperature).

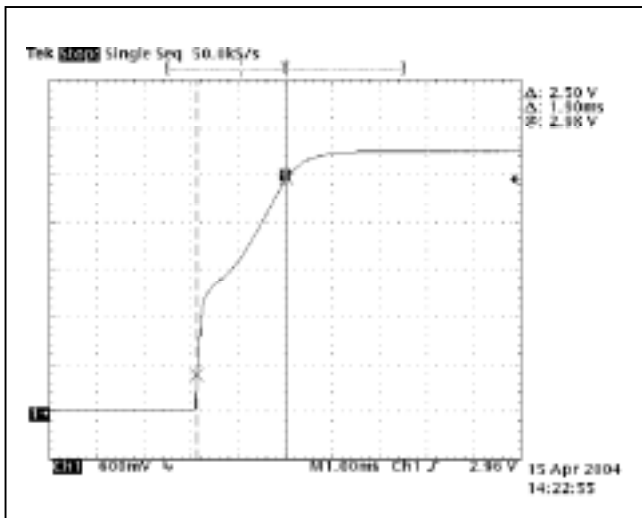


Figure 7. Output Turn On Response Time at  $V_{IN} = 24\text{V}$ ,  $I_O = \text{Full Load}$ ,  $T_A = 25^\circ\text{C}$ .

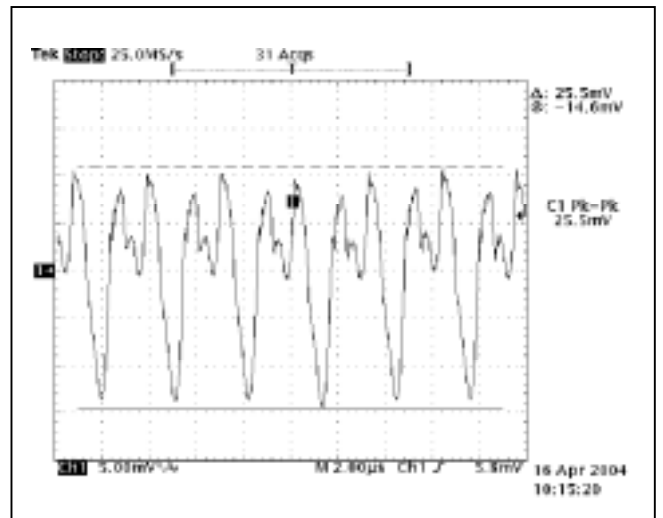


Figure 8. Output Ripple Waveform at  $V_{IN} = 24\text{Vdc}$ ,  $I_O = \text{Full Load}$ ,  $T_A = 25^\circ\text{C}$ .





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### Performance Curves

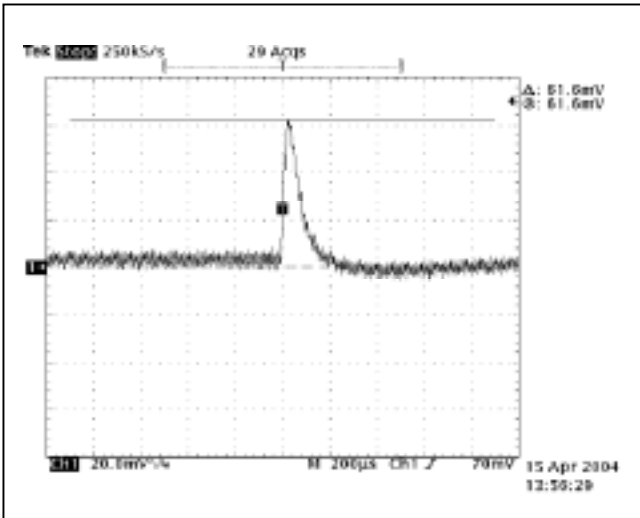


Figure 9. Output Transient Response at  $T_A = 25^\circ\text{C}$ ; Peak Deviation (Hi - Lo).

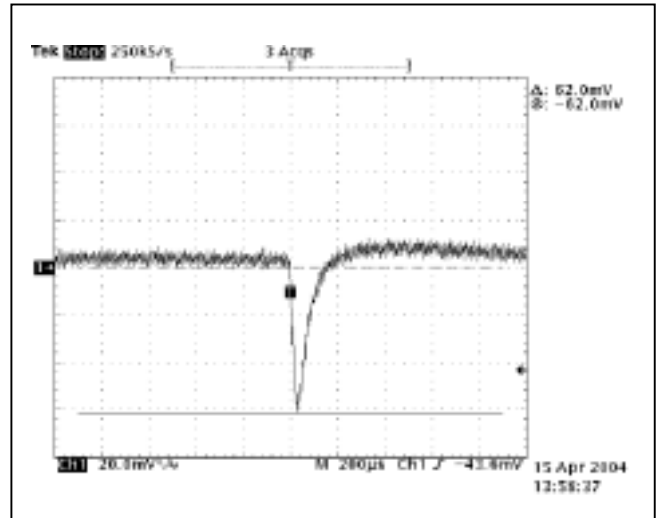


Figure 10. Output Transient Response at  $T_A = 25^\circ\text{C}$ ; Peak Deviation (Lo - Hi).

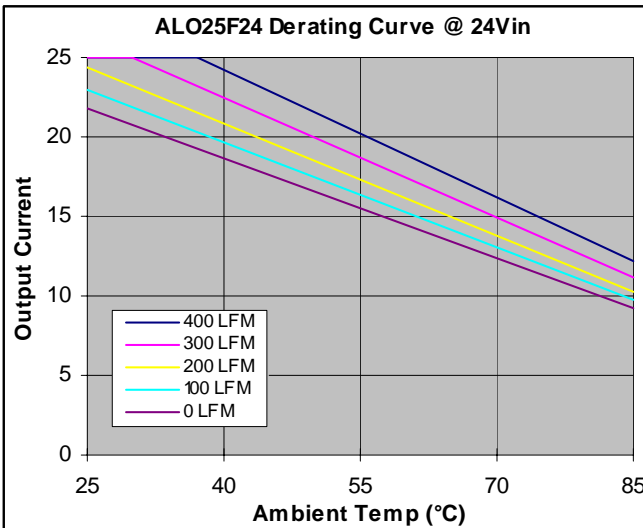


Figure 11. Output Current vs. Temperature at  $V_{IN}=24\text{V}$ ,  $I_O = \text{Full Load}$ ,  $T_A = 25^\circ\text{C}$ .

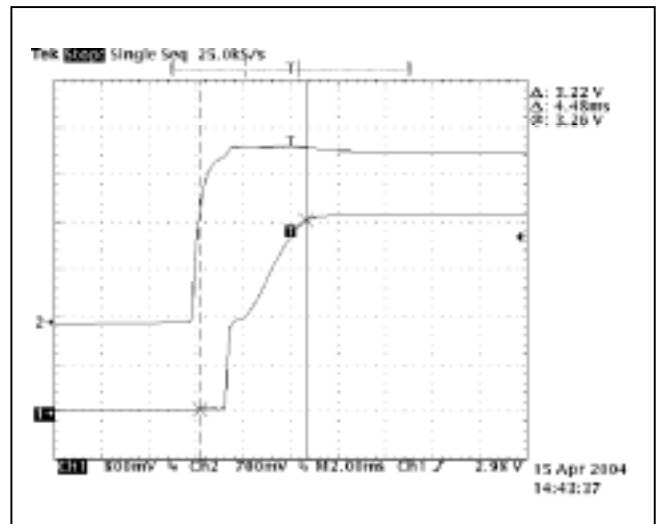


Figure 12. Enable to Output Turn On Time at  $V_{IN}=24\text{V}$ ,  $I_O = \text{Full Load}$ ,  $T_A = 25^\circ\text{C}$ .

### Input Filter for FCC Class B Conducted Noise

A reference design for an input filter that can provide FCC Class B conducted noise levels is shown below (See Figure 13). Two common mode connected inductors are used in the circuit along with balanced bypass capacitors to shunt common mode currents into the ground plane. Shunting noise current back to the converter reduces the amount of energy reaching the input LISN for measurement.

The application circuit shown has an earth ground (frame ground) connected to the converter output (-) terminal. Such a configuration is common practice to accommodate safety agency requirements. Grounding an output terminal results in much higher conducted emissions as measured at the input LISN because a hard path for common mode current back to the LISN is created by the frame ground. "Floating" loads generally result in much lower measured emissions. The electrical equivalent of a floating load, for EMI measurement purposes, can be created by grounding the converter output (load) through a suitably sized inductor(s) while maintaining the necessary safety bonding.

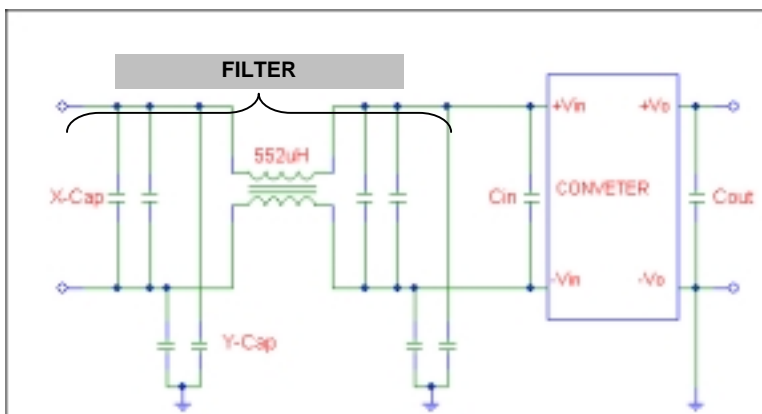


Figure 13: Class B Filter Circuit

#### PARTS LIST

CKT CODE	DESCRIPTION
Common Mode Choke	CTX01-15091 Cooper Electronic Technologies
X-Cap	0.47 µF X 4pcs
Y-Cap	22 nF X 4 pcs
Cin	220µF X 1pc



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### Mechanical Specifications

Parameter	Device	Symbol	Min	Typ	Max	Unit
Dimension	All	L	-	2.30 [58.42]	-	in [ mm ]
		W	-	0.80 [20.32]	-	in [ mm ]
		H	-	-	0.32 [8.13]	in [ mm ]
Weight	All		-	24 [0.85]	-	g [oz]
PIN ASSIGNMENT						
1		+V <sub>IN</sub>		5		-SENSE
2		ENABLE		6		TRIM
3		-V <sub>IN</sub>		7		+SENSE
4		-V <sub>O</sub>		8		+V <sub>O</sub>

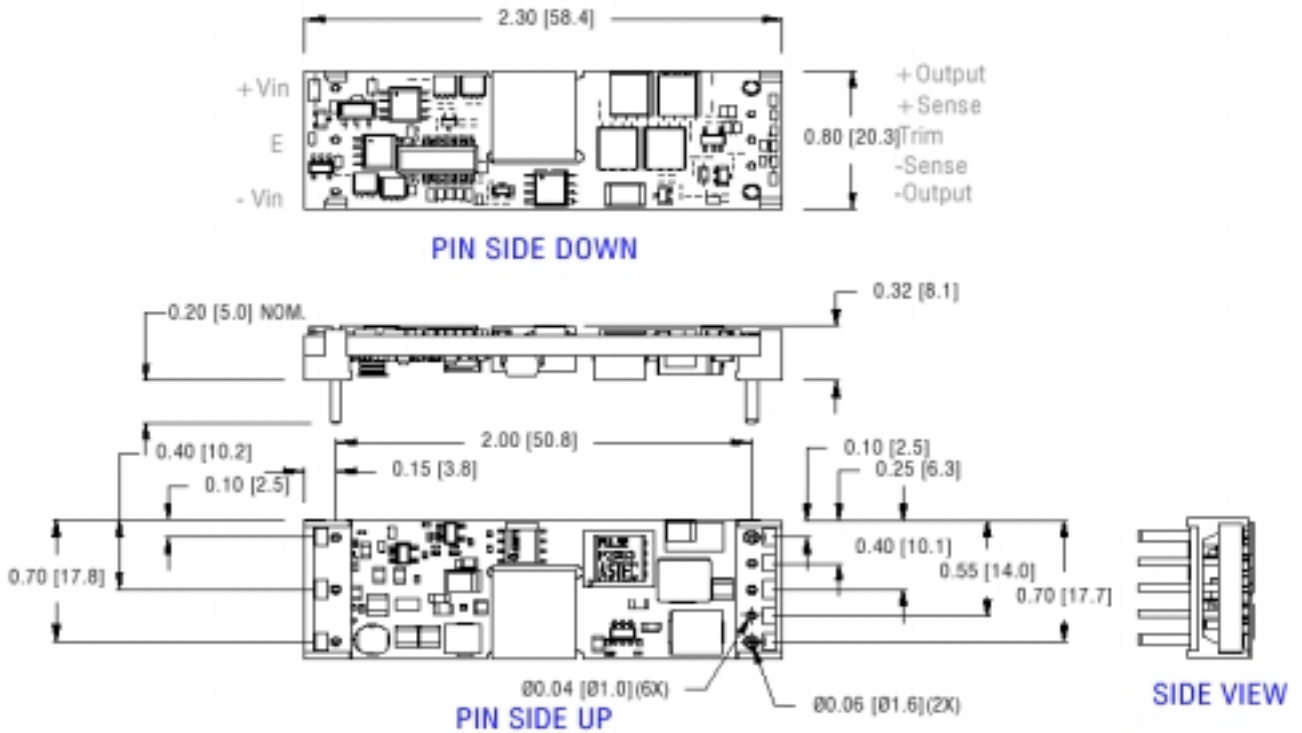


Figure 14A. Mechanical Outline (Pin Version)



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Mechanical Specifications (continued)

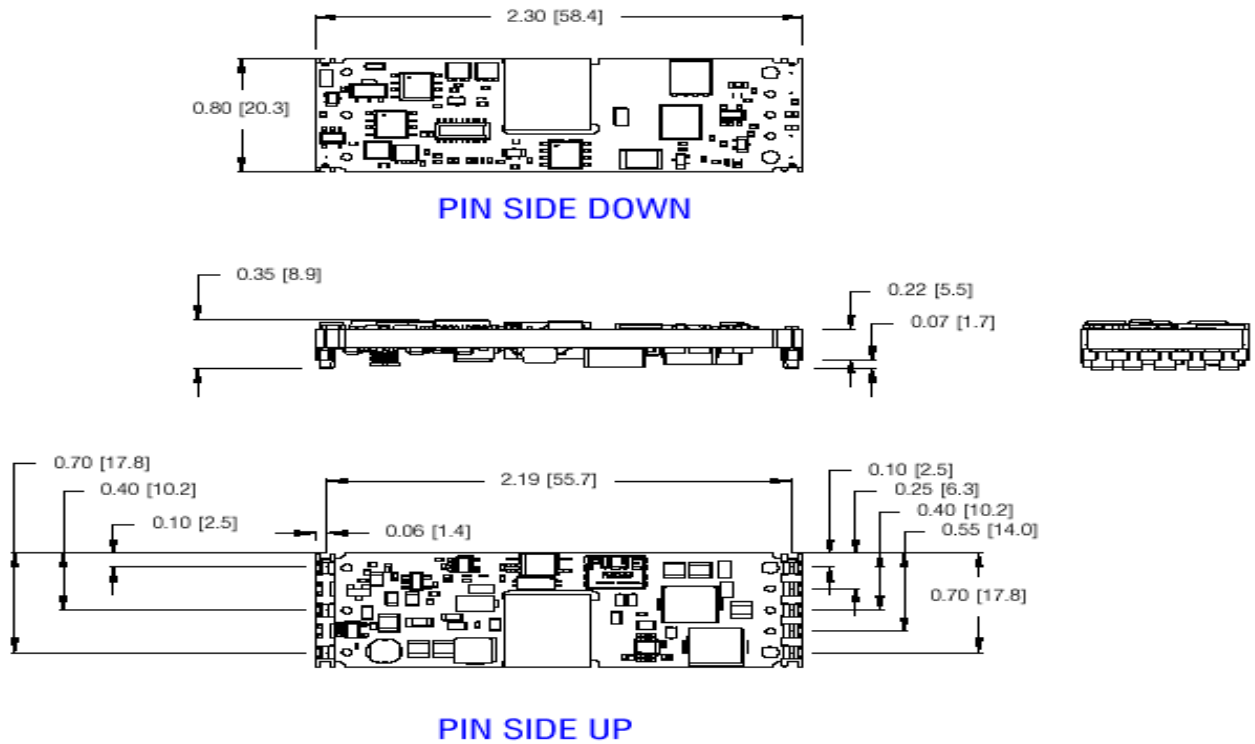


Figure 14B. Mechanical Outline (Surface Mount)

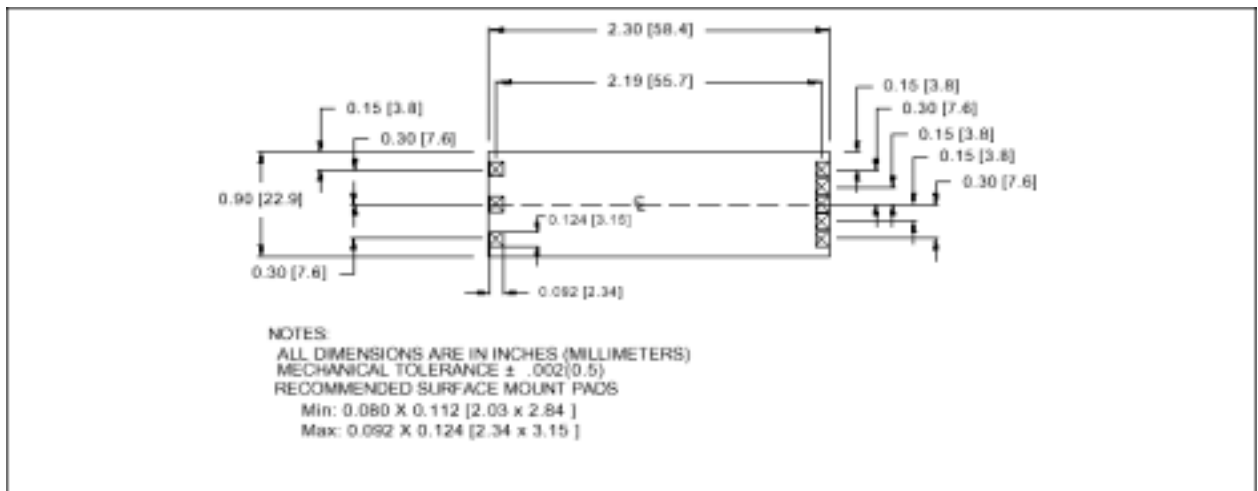


Figure 15. Recommended Pad layout for SMT (Suffix "S") version.



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### SOLDERING CONSIDERATIONS

The ALO25F24 converter is compatible with standard wave soldering techniques. When wave soldering, the converter pins should be preheated for 20-30 seconds at 110°C and wave soldered at 260°C for less than 10 seconds.

When hand soldering, the iron temperature should be maintained at 425°C and applied to the converter pins for less than 5 seconds. Longer exposure can cause internal damage to the converter. Cleaning can be performed with cleaning solvent IPA or with water.

For SMT terminated modules, refer to Figure 16 for the recommended reflow profile.

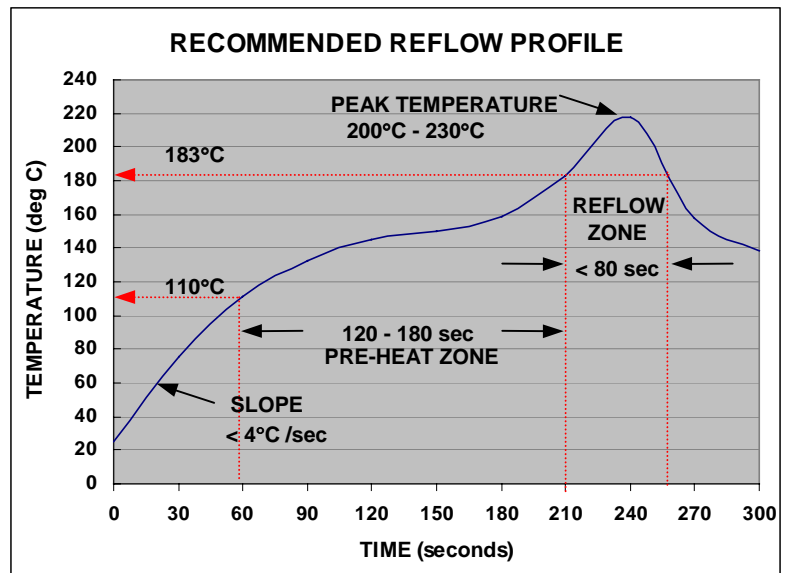


Figure 16. Recommended reflow profile for SMT modules.

### PART NUMBERING SCHEME

	CONSTRUCTION		O/P CURRENT	O/P VOLTAGE	Vin	Enable		PIN LENGTH	TERMINATION
<b>A</b>	<b>w</b>	<b>O</b>	<b>xx</b>	<b>y</b>	<b>24</b>	<b>N</b>	<b>-</b>	<b>6</b>	<b>S</b>
	L = Open frame		25 = 25A	F = 3.3V		N = Negative No suffix "N" = Positive default		6 = 3.7mm No suffix "-6" = 5mm default	S = SMT Termination No suffix "-S" = TH termination

Note: 1) For Through Hole (TH) termination: - Std pin length is 5mm nominal (min: 0.189 [4.8]; max: 0.205 [5.2] / in [mm])  
 - "-6" option is 3.7mm nominal (min: 0.137 [3.5]; max: 0.152 [3.9] / in [mm])  
 - Pins 4 & 8 diameter: Ø = 0.062 [1.57], others: Ø = 0.04 [1.0] (6X)

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