AEQ15AF48 - 5V/3.3V Dual Output DC-DC Converter Module
Industry Standard ¼ Brick w/ Baseplate: 36V-75V Input; 60W Output Power

The AEQ15 series is among Astec's dual output; high-density converter offering that comes in an industry standard ¼ brick baseplate package. The AEQ15 series has been designed to deliver 60W of clean, well-regulated DC power for today's demanding loads at high efficiency levels (89% typical for 30W/30W power split between rails). The 5V rail is capable of delivering 12A max and the 3.3V rail is capable of delivering 15A max for a maximum output power of 60W. The module comes with industry standard feature sets such as output enable with positive or negative logic options; input UVLO, output trim, over current, over voltage and over temperature protection.

Special Features

- **Industry Standard ¼ Brick Footprint with Baseplate**
- **High Efficiency @ 89% (60W full load)**
- **Positive and Negative Logic Enable Options**
- **High Capacitive Load Start-up**
- **Fixed Switching Frequency for EMI predictability**
- **Output Trim**
- **Input Under-Voltage Lockout**
- **Basic insulation**

Environmental Specifications

- **-40ºC to 100ºC Base plate Temperature**
- **-40ºC to 125ºC Storage Temperature**
- **MTBF > 1 million hours**

Electrical Parameters

Input

Input Range	**36-75 VDC**
Input Surge	**100V / 100ms**
Efficiency	**89% (typ. at balanced load)**

Control

Enable	**TTL compatible**
(Positive and Negative Enable Options)	

Output

Load Current	**5V @ 12A max**
	3.3V @ 15A max
	60W Total Output Power
Regulation (Typ)	**± 4% V_O (5V)**
	± 3% V_O (3V3)
Ripple and Noise	**80mV_{PK-PK} max (5V output)**
	60mV_{PK-PK} max (3.3V output)
Output Voltage Adjust Range	**±10% $V_{O,NOM}$**
Transient Response	**2% V_O deviation (Typ)**
	50% to 75% Load Change
	< 100msec settling time (Typ)
Over Current Protection	**120% $I_{O,MAX}$**
Switching Frequency	**360kHz**

Safety

UL 1950, 3rd Edition
CSA C22.2 No 950-95
EN60950 through TUV-PS

AEQ15 Series

THIS SPECIFICATION COVERS THE REQUIREMENTS FOR A NEW ¼-BRICK SIZE 12A-15A/ DUAL CHANNEL HIGH EFFICIENCY DC/DC CONVERTER.

MODEL NAME	CONSTRUCTION	V_{OUT} / I_{OUT}
AEQ15AF48	**Baseplate; 5mm pin length**	**5V / 12A; 3.3V / 15A**
AEQ15AF48-6	**Baseplate; 3.7mm pin length**	**5V / 12A; 3.3V / 15A**
AEQ15AF48N	**Baseplate; 5mm pin length**	**5V / 12A; 3.3V / 15A**
AEQ15AF48N-6	**Baseplate; 3.7mm pin length**	**5V / 12A; 3.3V / 15A**

OPTIONS:

	SUFFIX
Negative Enable:	"N"
Positive Enable:	No suffix
5mm (default) pin length:	No Suffix
3.7mm pin length:	"-6"

Electrical Specifications

STANDARD TEST CONDITION on a single module unless otherwise specified.

Ta		25°C (Ambient Air)
$+V_{IN}$	PIN 1	48Vdc
Enable	PIN 2	Dependent on model series
$-V_{IN}$	PIN 3	Input return
$+V_{OUT}2$	PIN 4	Load 2
O/P Return	PIN 5	Secondary Return
Trim	PIN 6	Open
+Vout 1	PIN 7	Load 1

ABSOLUTE MAXIMUM RATINGS

Stresses in excess of the absolute maximum ratings can cause permanent damage to the converter. Functional operation of the 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	Typ	Max	Unit
Input Voltage[1]						
Continuous	All	V_{IN}	0	-	75	Vdc
Transient (100ms)	All	$V_{IN, trans}$	0	-	100	Vdc
Isolation Voltage						
Input to Output	All		-	-	1500	Vdc
Input to Case			-	-	500	Vdc
Output to Case			-	-	500	Vdc
Operating baseplate temperature	All	T_A	-40	-	+100	ºC
Storage Temperature	All	T_{STG}	-55	-	+125	ºC
Operating Humidity	All	-	-	-	85	%
Max Output Power	All	P_O	-	-	60	W

Note: 1. An input line fuse is recommended (Littelfuse type 312003, rated 3A, 250V or equivalent).

Electrical Specifications (*continued)*

INPUT SPECIFICATION

Parameter	Device	Symbol	Min	Typ	Max	Unit
Operating Input Voltage	All	V_{IN}	36	48	75	V_{DC}
Input Under-Voltage Lock-out T_ON Threshold T_OFF Threshold	All		 - 30	 34.5 32.5	 35 -	 Vdc Vdc
Maximum Input Current[1] Conditions: V_{IN} =$V_{IN,min}$ I_O = $I_{O,max}$; T_A = 25 ºC	All	$I_{IN,max}$	-	-	2.25	A
No Load Input Power V_{IN} = 48Vdc	All		-	-	3.5	W
Input Reflected Ripple Current[2] Conditions: P_O = $P_{O,max}$; T_A = 25 ºC BW: 5Hz to 20MHz	All	I_{I1}/ I_{I2}	-	-	260	mA_{PK-PK}

Note: 2. External input capacitance required. See Input Reflected Ripple Current test measurement setup on Fig 1.

OUTPUT SPECIFICATIONS

Parameter	Device	Symbol	Min	Typ	Max	Unit
Output Voltage Set point V_{IN} = $V_{IN, min}$ to $V_{IN, max}$; I_O =I_{O1} + I_{O2} = 6A + 9A; T_A = 25°C	All	$V_{O,SET1}$ $V_{O,SET2}$	4.93 3.25	5.00 3.30	5.08 3.35	Vdc
Output Current	All	I_{O1} I_{O2}	1 1	- -	12 15	A A
Output Regulation Line: V_{IN} = $V_{IN, Min}$ to $V_{IN, max}$ I_{O1} = 6A; I_{O2} = 9A Load: (1. V_{IN} = 48Vdc; I_{O2} = $I_{O,min}$: I_{O1} = $I_{O,min}$ to $I_{O,max}$. 2.V_{IN} = 48Vdc; I_{O1} = 3.5A; I_{O2} = 1-13A) T_A =25°C @ 300LFM	All	 V_{O1} V_{O2} V_{O1} V_{O2}	 4.80 3.20 4.80 3.20	 - - - -	 5.20 3.40 5.20 3.40	 Vdc Vdc Vdc Vdc
Ripple and Noise[3] Peak-to-Peak: (5Hz to 20MHz)	All	V_{O1} V_{O2}	- -	- -	80 60	mV_{PK-PK} mV_{PK-PK}
External Load Capacitance	All	-	-	-	10,000	µF
Output Current-limit Inception[4] V_{OUT} = 90% $V_{O,SET}$	All	I_{O1} I_{O2}	13 18	- -	18 24	A A
Output Short Circuit Current[5]	All		-	-	150	$I_{O,max}$
Efficiency Conditions: I_O=I_{O1}+I_{O2}=6A+9A; V_{IN} = 48Vdc; T_A = 25°C	All		89	90	-	%

Electrical Specifications (*continued)*

OUTPUT SPECIFICATIONS

Parameter	Device	Symbol	Min	Typ	Max	Unit
Switching Frequency	All	-	310	360	400	KHz
Dynamic Response[5]	All	$\Delta I_O/\Delta t$	-	-	1	A/10µs
Load Change from: I_O = 50% to 75% of $I_{O, Max}$			-	2	6	%Vo
Peak Deviation Settling Time to $V_{O, Nom}$			-	250	500	µs
Load Change from: I_O = 50% to 25% of $I_{O, Max}$			-	2	6	%Vo
Peak Deviation Settling Time to $V_{O, Nom}$			-	250	500	µs
Turn on time[5] Condition: I_O=$I_{O,max}$; V_O within 1%; the other channel @ min load	All		-	1	5	ms
Output Overshoot[5] Condition: I_O=$I_{O,max}$; the other channel @ min load	All	-	-	-	5	%Vo

FEATURE SPECIFICATION

Parameter	Device	Symbol	Min	Typ	Max	Unit
Output Enable ON/OFF						
Negative Enable ("N" suffix)	N					
Enable Pin voltage for Module ON	suffix	-	0	-	2.5	V
Module OFF		-	1.8	-	5.0	V
Positive Enable (No "N"suffix)						
Enable Pin voltage for Module ON	No	-	1.8	-	5.0	V
Module OFF	suffix	-	0	-	2.5	
Enable Pin Current	All					
Logic Low			-	-	1.0	mA
Logic High (I_{LKG} @ Enable = 5V)			-	-	50.0	µA
Output Over Voltage Clamp	All	V_{O1}	5.7	-	6.5	V
(Auto Recovery; Hiccup Mode)		V_{O2}	3.8	-	4.3	V
Over Temperature trip point (baseplate temperature)	All			115		ºC
Output Voltage Trim Range[6]	All		90		110	$\%V_O$

Note: 3. V_{IN} = 48Vdc; I_O = $_{IO,max}$; the other channel at min load. See Figure 2 for Ripple test measurement setup.
4. Hiccup Mode; the other channel at min load.
5. The other channel at min load.
6. See appropriate Trim Equation and configuration on Figures 3 and 4.

Electrical Specifications (*continued)*

ISOLATION SPECIFICATION

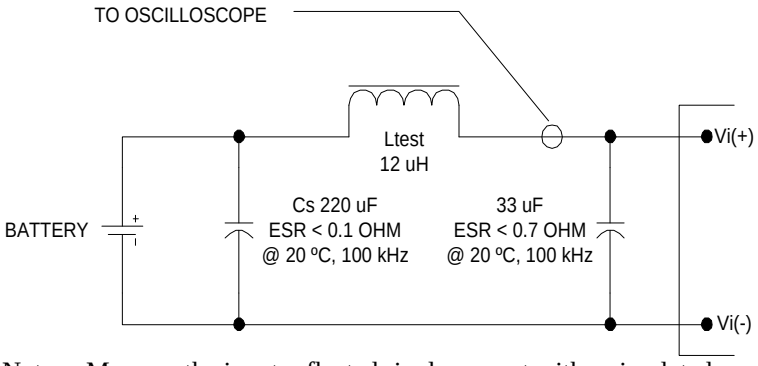
Parameter	Device	Symbol	Min	Typ	Max	Unit
Isolation Capacitance	All	-	-	680	-	pF
Isolation Resistance	All	-	10	-	-	MΩ

SAFETY APPROVAL

The AEQ15AF48 series have been certified through:

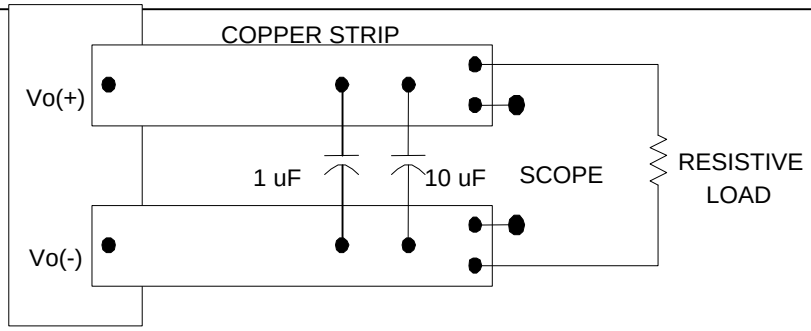
- UL 1950
- CSA22.2 No 950-95
- EN 60950 through TUV-PS
- Basic Insulation

Electrical Specifications (*continued)*



Note: Measure the input reflected ripple current with a simulated source inductance (Ltest) of 12uH. Capacitor Cs offsets possible battery/ source impedance. Measure current as shown above.

Figure 1. Input Reflected Ripple Current Measurement Setup.



Note: Use a 1µF 50V X7R ceramic capacitor and a 10µF 25V tantalum cap. Scope measurement should be made using a BNC probe socket positioned about 76mm (3 in.) away from the module's output terminals. The ext. capacitors should be placed between the BNC socket and the module's output terminals, with a minimum distance of 51mm (2in.) from the latter.

Figure 2. Peak to Peak Output Noise Measurement Setup.

Basic Operation and Features

INPUT UNDER VOLTAGE LOCKOUT

To prevent any instability to the converter, which may affect the end system, the AEQ15 series have been designed to turn-on once V_{IN} is in the voltage range of 34.5-36 VDC. Likewise, it has also been programmed to turn-off when V_{IN} drops down to 30 – 32.5 VDC.

OUTPUT VOLTAGE ADJUST/TRIM

The converter comes with a TRIM pin (PIN 6), which is used to adjust both outputs simultaneously 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 voltages, external R_{adj_up} resistor should be connected between TRIM PIN (Pin6) and +Vo2 (Pin 4). Please refer to Equation (1) for the $V_{O,adj}$ and R_{adj_up} relationship.

Equation (1)

$$Radj\_up = \left[\frac{5.1Vo(100+\%Vo,adj)}{1.225\%Vo,adj} - \frac{510}{\%Vo,adj} - 10.2\right]\cdot kohm$$

where: $\%V_{O,adj}$ = percent change in o/p voltage

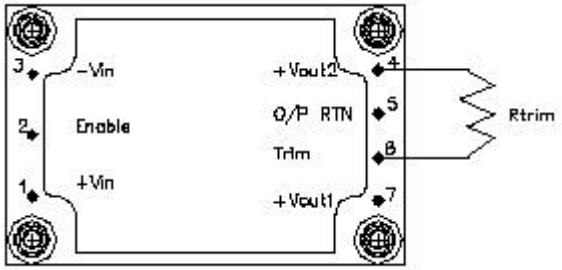


Figure 3. External Trim resistor setup to increase o/p.

To DECREASE the output voltages, external R_{adj_down} resistor should be connected between TRIM PIN (Pin 6) and O/P Return (Pin 5). Please refer to Equation (2) for the $V_{O,adj}$ and R_{adj_down} relationship.

Equation (2)

$$Radj\_down = \left\{\frac{510}{\%Vo,adj} - 10.2\right\}\cdot kohm$$

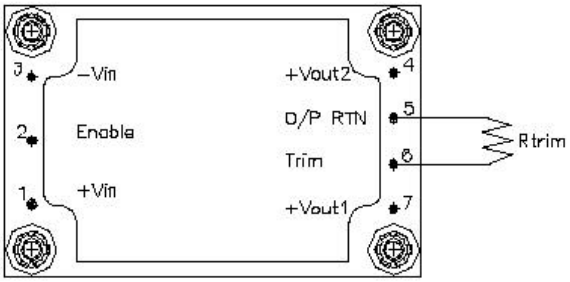


Figure 4. External Trim resistor setup to decrease o/p.

Basic Operation and Features *(continued)*

OUTPUT ENABLE

The AEQ15 comes with an Enable pin (PIN 2) which is primarily used to turn ON/OFF the converter. Both a Positive (no part number suffix required) and Negative (suffix "N" required) Enable Logic option is being offered (see Part Numbering Scheme in Table 1).

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 -VIN. On the other hand, the Negative Enable version turns on when the Enable pin is at logic LOW or directly connected to -VIN. The unit turns off when the Enable pin is at Logic HIGH.

OUTPUT OVER VOLTAGE PROTECTION (OVP)

The Over Voltage Protection circuit will shut down the entire converter if any of the two output voltages exceeds the OVP threshold limits. The converter will automatically recover once the fault is removed.

OUTPUT OVER CURRENT PROTECTION (OCP)

The Over Current Protection circuit will shutdown the converter if any of the load current of either output reaches the OCP threshold limits. The unit will automatically recover by going into a hiccup mode until the cause of the over current condition is removed. Note that in Figures 5 and 6, Channel 1 is 3.3V and Channel 2 is 5V.

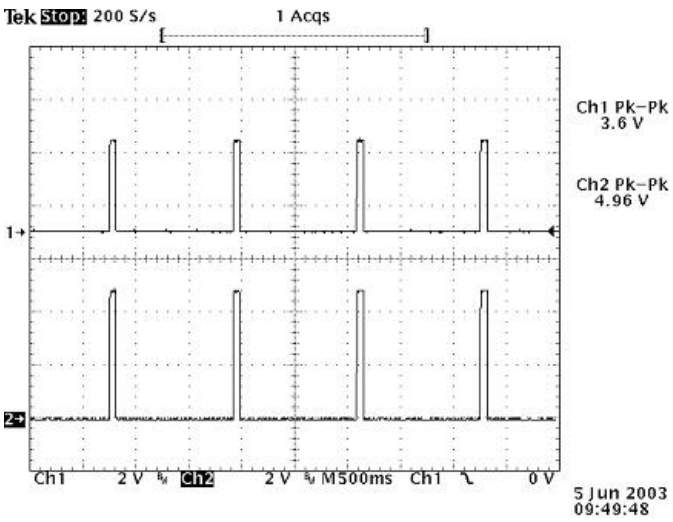


Figure 5. I_{O2} (5V) = OCP, I_{O1} (3V3) = 1A.

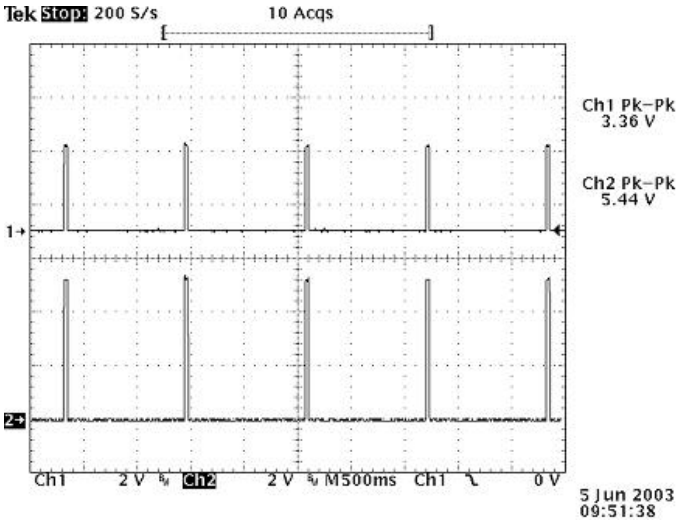


Figure 6. I_{O2} (5V) = 1A, I_{O1} (3V3) = OCP.

Basic Operation and Features *(continued)*

OVER TEMPERATURE PROTECTION (OTP)

The Over Temperature Protection circuit will shutdown the converter once the sensed location 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 baseplate temperature drops to less than 105°C.

Performance Curves

EFFICIENCY

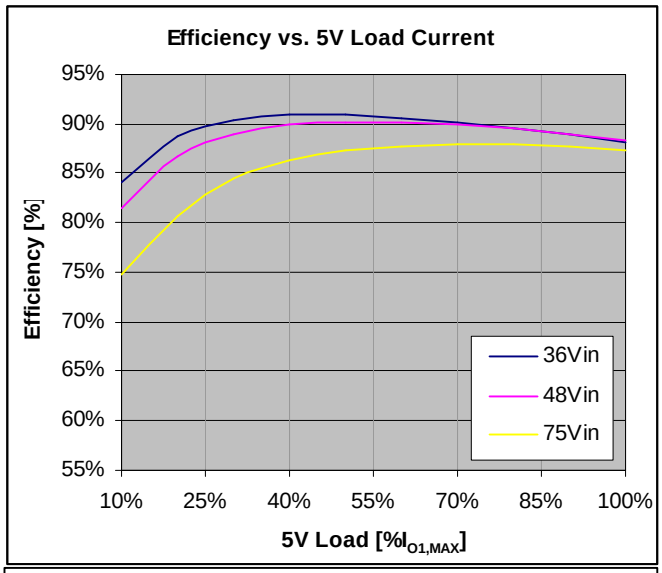


Figure 7. Efficiency Curve vs. 5V Load Current (3.3V load fixed at 1A; $T_{BASEPLATE}$ = 45ºC.

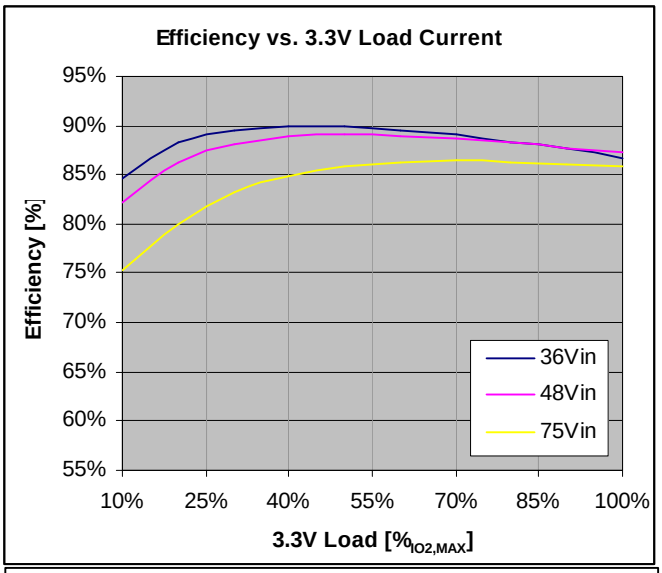


Figure 8. Efficiency Curve vs. 3.3V Load Current (5V load fixed at 1A; $T_{BASEPLATE}$ = 45ºC.

STARTUP CHARACTERISTIC

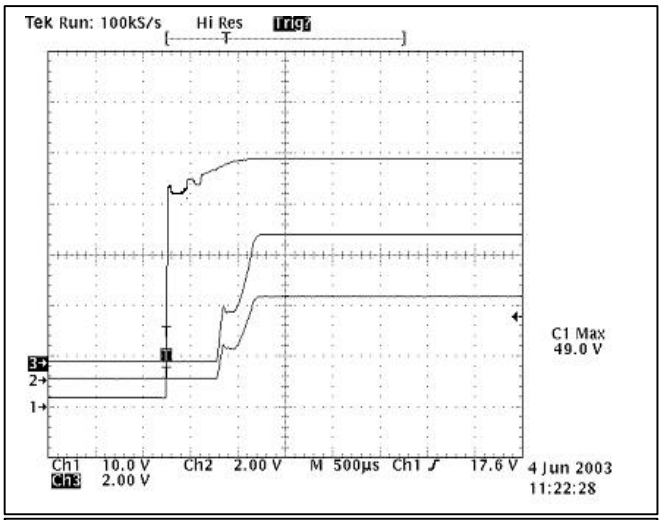


Figure 9. Output startup characteristic at 48V_{IN} (CH1), 3.3V at 1A load (CH2), 5V at 1A load (CH3).

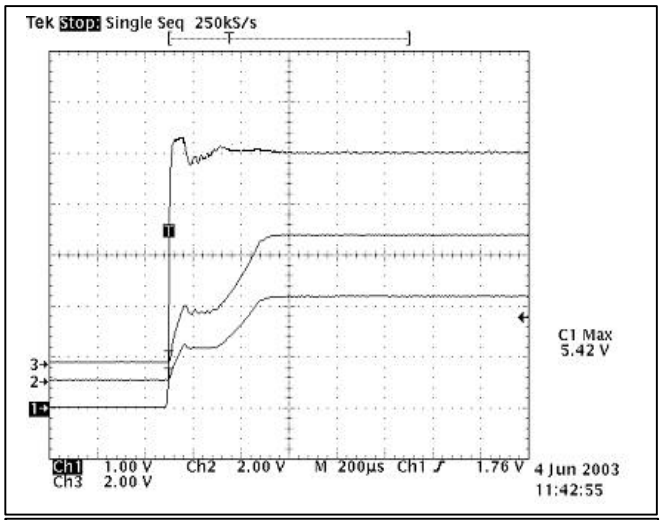


Figure 10. Output startup characteristic when enable pin is activated (CH1), 3.3V at 1A load (CH2), 5V at 1A load (CH3).

Performance Curves *(continued)*

CURRENT VS. TEMPERATURE CURVES

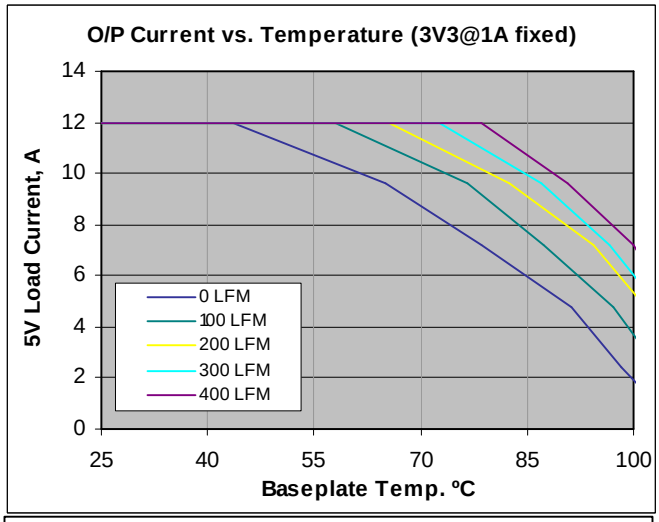


Figure 11. 5V output current vs. Baseplate temperature curves when 3.3V load = 1A (min load), V_{IN} = 48V.

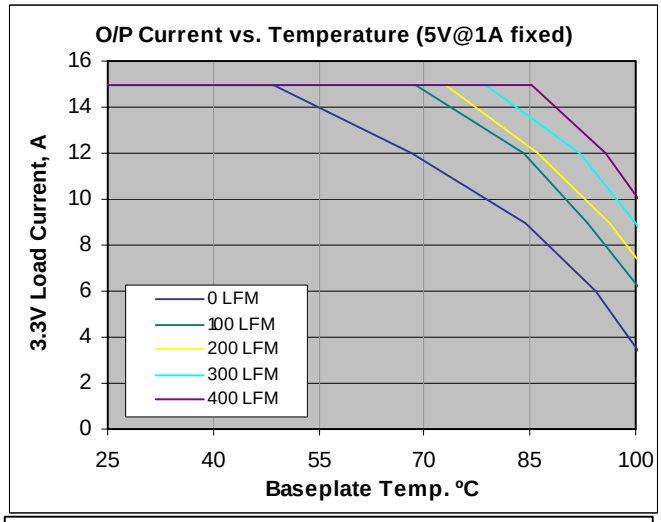


Figure 12. 3.3V output current vs. Baseplate temperature curves when 5V load = 1A (min load), V_{IN} = 48V.

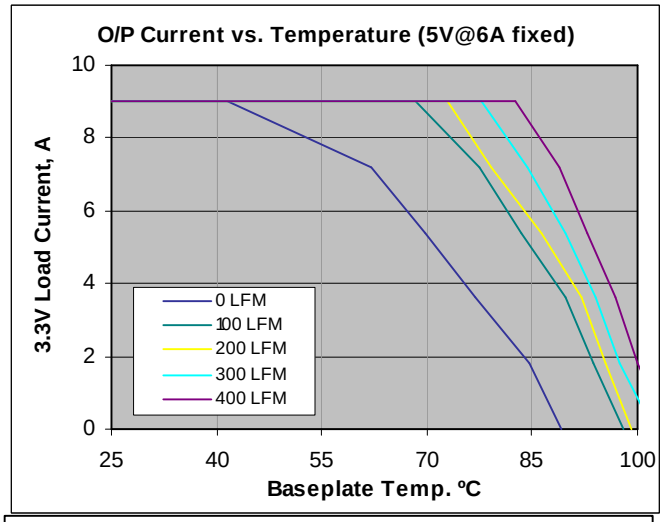


Figure 13. 3.3V output current vs. Baseplate temperature curves when 5V load = 6A, V_{IN} = 48V.

Performance Curves *(continued)*

OUTPUT RIPPLE

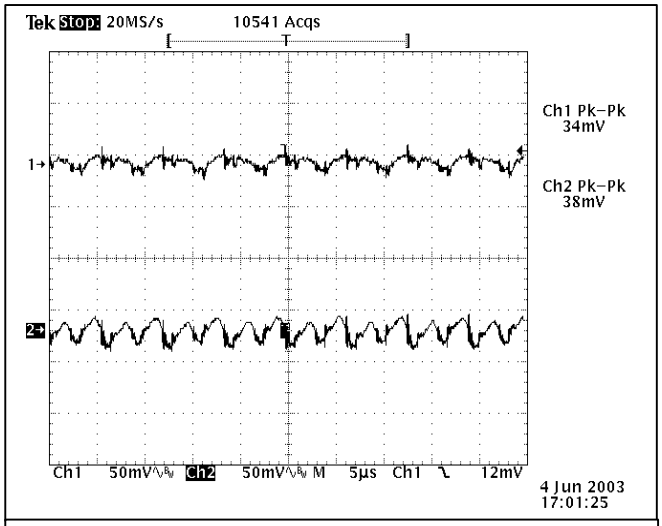


Figure 14. Output ripple at V_{IN} = 48V, 5V (CH2) at 1A load, 3.3V (CH1) at 1A load.

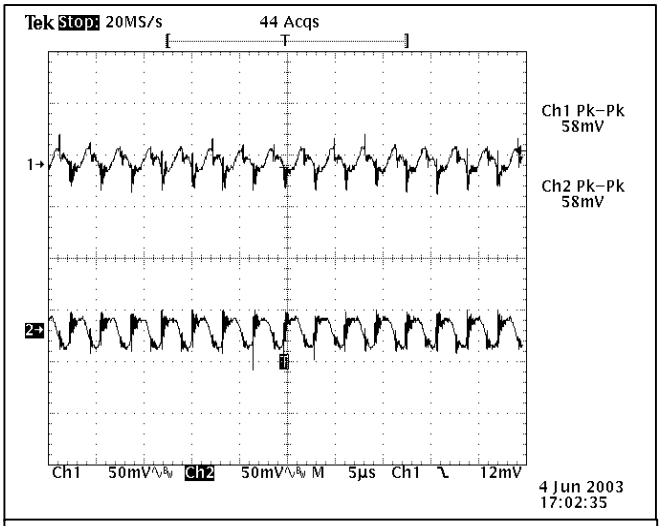


Figure 15. Output Ripple at V_{IN} = 48V, 5V (CH2) at 1A load, 3.3V (CH1) at 15A load.

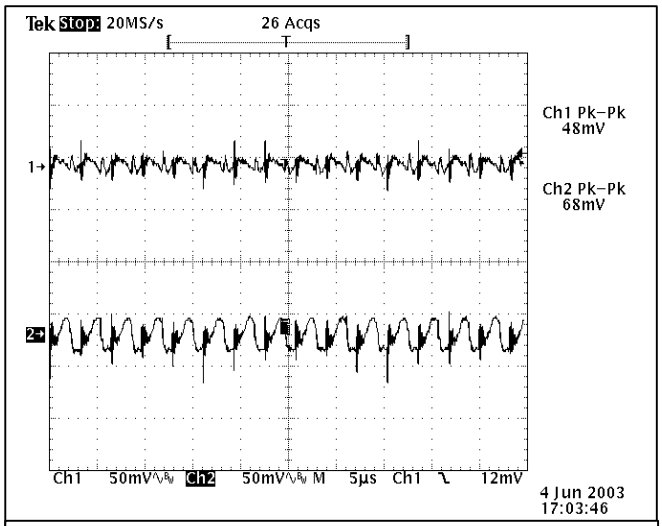


Figure 16. Output Ripple at V_{IN} = 48V, 5V (CH2) at 12A load, 3.3V (CH1) at 1A load.

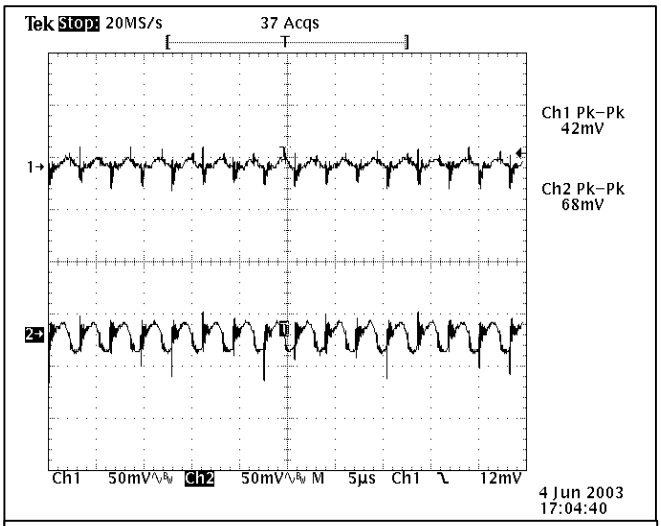


Figure 17. Output Ripple at V_{IN} = 48V, 5V (CH2) at 6A load, 3.3V (CH1) at 9A load.

Mechanical Specifications

Parameter	Device	Symbol	Min	Typ	Max	Unit
Dimension	All	L	-	2.30 [58.42]	-	in [mm]
		W	-	1.50 [38.10]	-	in [mm]
		H	-	0.50 [12.70]	-	in [mm]
Weight			-	-	60 [2.1]	g [oz]
PIN ASSIGNMENT						

1	**$+V_{IN}$**	**5**	**O/P RTN**
2	**Enable**	**6**	**TRIM**
3	**$-V_{IN}$**	**7**	**$+V_{OUT1}$**
4	**$+V_{OUT2}$**		

NOTE: Pin diameters are 0.04” (1.02mm) in all positions

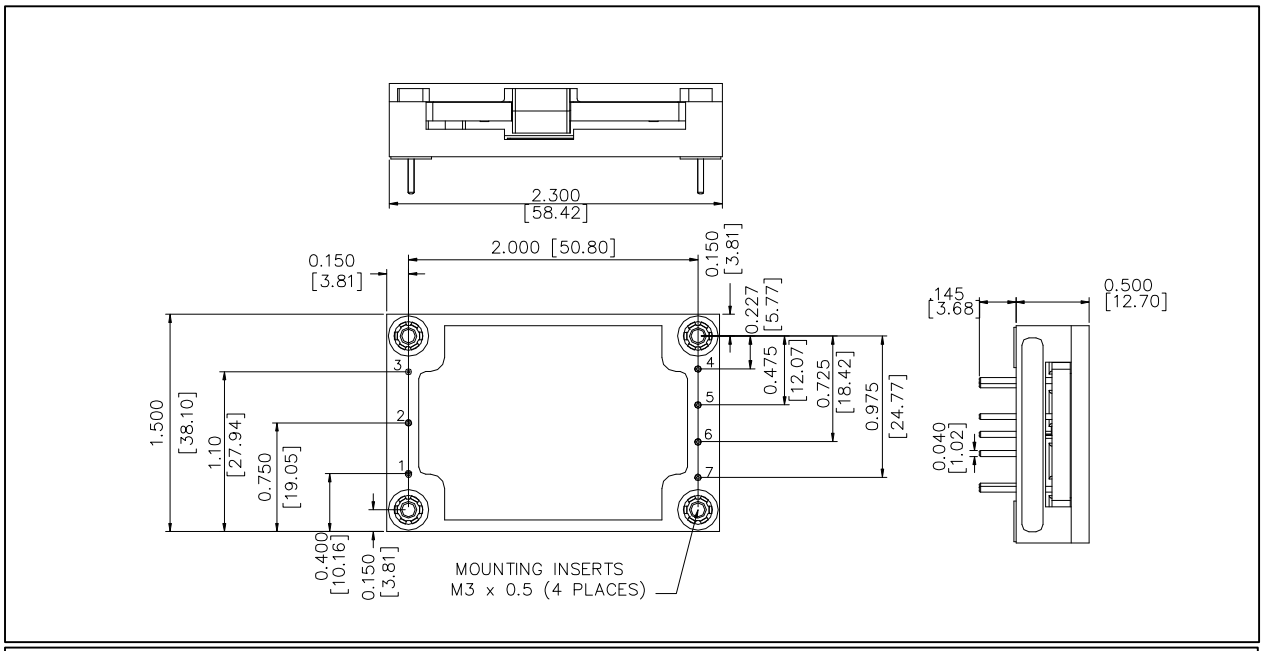


Figure 18. AEQ15 Series Mechanical Outline Drawing

Mechanical Specifications *(continued)*

SOLDERING CONSIDERATIONS

The AEQ15AF48 series converters are 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.

	OUTPUT VOLTAGE 1	OUTPUT VOLTAGE 2		ENABLE LOGIC	PIN LENGTH OPTION
AEQ15	w	x	48	y	z
	A = 5.0V	F = 3.3V		N = Negative "Blank" = Positive	"Blank" = 5mm (Standard) "-6" = 3.7mm

Table 2 PART NUMBERING SCHEME FOR ORDERING

Please call 1-888-41-ASTEC for further inquiries or visit us at www.astecpower.com