

ALQ15 Dual Output Open-Frame DC-DC Converter Module
Industry Standard ¼Brick: 36V-75V Input / 60W Output Power

The ALQ15 series is Astec's latest dual output; high-density converter offering that comes in an industry standard ¼ brick open-frame package. With its independently controlled output rails, the module practically eliminates cross regulation effects which has been an issue to most dual converters available in the market. The ALQ15 series has been designed to deliver 60W of clean, well-regulated, low noise DC power for today's demanding loads at respectable efficiency levels: 3.3V-2.5V combination @ 87% (60W output power). Output combinations currently available are 3.3V/2.5V - 3.3V/1.8V - 2.5V/1.5V, with each output rail able to deliver 15A max. The module comes with standard feature sets such as output enable with positive or negative options; output voltage-adjust; over current, over voltage and over temperature protection. In addition, it is also being offered at both 5mm (std) and 3.7mm pin lengths.



Special Features

- Tightly regulated for a dual output at < 1%
- Low Ripple and Noise at < 30mV_{PK-PK}
- Industry Standard ¼ Brick Footprint
- Positive and Negative Enable Options
- Regulation to Zero Load
- High Capacitive Load Start-up
- Fixed Switching Frequency at 350kHz
- Output Trim
- Input Under-Voltage Lockout

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	36-75 VDC
Input Surge	100V / 100ms
Efficiency	3.3V/2.5V @ 87% (Typ at 60W)
	3.3V/1.8V @ 86%
	2.5V/1.5V @ 83%

Control

Enable	TTL compatible
(Positive and Negative Enable Options)	

Output

Load Current	15A max per channel (60W max)
Regulation	< 1% V_O
Ripple and Noise	30mV_{PK-PK} max
Output Voltage	
Adjust Range	±10% V
Transient Response	2% V_O deviation (Typ)
	50% to 75% Load Change
	< 300msec settling time (Typ)

Over Current Protection	135% I_{O,max}
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Safety

UL + cUL 60950, Recognized (Pending)
EN60950 through TUV-PS (Pending)



Technical Reference Notes
ALQ15XX48X Series
(Open Frame Dual Output Quarter Brick)



ALQ15 Series

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

MODEL NAME	CONSTRUCTION	V _{OUT} / I _{OUT}
ALQ15FG48	Open Frame	3.3V-15A / 2.5V-15A
ALQ15FY48	Open Frame	3.3V-15A / 1.8V-15A
ALQ15GM48	Open Frame	2.5V-15A / 1.5V-15A
ALQ15AF48	Open Frame	5.0V-12A / 3.3V-15A

OPTIONS:

Negative Enable:

Positive Enable:

3.7mm (nom) Pin Length:

SUFFIX

"N"

No suffix

"-6"



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Electrical Specifications

STANDARD TEST CONDITION on a single module unless otherwise specified.

TA:		25°C (Ambient Air)
+V _{IN} :	PIN 1	48V ± 2V
ENABLE:	PIN 2	Open (Positive Enable)
-V _{IN} :	PIN 3	Return Pin for +VIN
+V _{OUT2} :	PIN 4	Connect to Load 2
-V _{OUT} :	PIN 5	Return Pin for Load 1 & 2
TRIM:	PIN 6	Open
+V _{OUT1} :	PIN 7	Connect to Load 1

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	Typ	Max	Unit
Input Voltage:						
Continuous	All	V _{IN}	0	-	75	Vdc
Transient(100ms) :	All	V _{IN, trans}	0	-	100	Vdc
Operating Ambient Temperature ¹	All	T _A	-40	-	+85	°C
Storage Temperature	All	T _{STG}	-55	-	125	°C
Operating Humidity	All	-	-	-	85	%
I/O Isolation	All	-	1500	-	-	Vdc
Maximum Enable Voltage	All				TBD	Vdc

NOTE: 1. Power must be derated at 85°C (refer to Figures 15 to 17).



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Electrical Specifications *(continued)*

INPUT SPECIFICATION

Parameter	Device	Symbol	Min	Typ	Max	Unit
Operating Input Voltage	All	V_{IN}	36	48	75	V_{DC}
Maximum Input Current ² Conditions: V_{IN} = between 0 to $V_{IN,min}$ $I_O = I_{O,max}$; $T_A = 25\text{ }^\circ\text{C}$	All	$I_{IN,max}$	-	-	2.25	A
Input Reflected Ripple Current ³ Conditions: $P_O = P_{O,max}$; $T_A = 25\text{ }^\circ\text{C}$	All	I_{I1}/I_{I2}	-	10	25	mA_{PK-PK}
Standing Loss Condition: $V_{IN} = V_{IN,nom}$; $T_A = 25\text{ }^\circ\text{C}$	All	-	-	-	3.5	W

- NOTE: 2. This power module is not internally fused. An input line fuse (e.g. Little fuse 3AB /322003 or 314003) is recommended.
 3. See Figure 1 for Input Reflected Ripple Current Test Setup.

OUTPUT SPECIFICATIONS

Parameter	Device	Symbol	Min	Typ	Max	Unit
Voltage Setpoint Conditions: $V_I = V_{IN,nom}$; $T_A = 25\text{ }^\circ\text{C}$; V_{O1} : $I_{O1} = I_{O,max}$; $P_O = 60\text{W}$ V_{O2} : $I_{O2} = I_{O,max}$; $P_O = 60\text{W}$	FG	V_{O1}/V_{O2}	3.25 / 2.46	3.30 / 2.50	3.35 / 2.54	Vdc
	FY	V_{O1}/V_{O2}	3.25 / 1.76	3.30 / 1.80	3.35 / 1.84	Vdc
	GM	V_{O1}/V_{O2}	2.46 / 1.47	2.50 / 1.50	2.54 / 1.53	Vdc
	AF	V_{O1}/V_{O2}	4.93 / 3.25	5.00 / 3.30	5.08 / 3.35	Vdc
Load Current	3.3V	I_{O1}/I_{O2}	0	-	15.0	A
	2.5V	I_{O1}/I_{O2}	0	-	15.0	A
	1.8V	I_{O1}/I_{O2}	0	-	15.0	A
	1.5V	I_{O1}/I_{O2}	0	-	15.0	A
	5.0V	I_{O1}/I_{O2}	0	-	12.0	A
Combined Output Power $P_O = P_{O1} + P_{O2}$	FG	P_O	-	-	60	W
	FY	P_O	-	-	60	W
	GM	P_O	-	-	60	W
	AF	P_O	-	-	60	W
Line Regulation: Conditions: $V_{IN} = V_{IN,min}$ to $V_{IN,max}$; $I_{O1} = I_{O,max}$, $I_{O2} = I_{O,min}$ $V_I = V_{IN,min}$ to $V_{IN,max}$; $I_{O1} = I_{O,min}$, $I_{O2} = I_{O,max}$	All	-	-	-	0.1	% V_o



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Electrical Specifications *(continued)*

OUTPUT SPECIFICATIONS

Parameter	Device	Symbol	Min	Typ	Max	Unit
Regulation Load ⁴						
Conditions: $I_O = 1A$ to $I_{O,max}$; $V_{IN} = V_{IN,nom}$	All		-	-	1.0	% V_O
Temperature						
Conditions: $T_A = -40\text{ }^\circ\text{C}$ to $+65\text{ }^\circ\text{C}$; $V_{IN} = V_{IN,nom}$; $I_O = I_{O,max}$	All		-	-	2	% V_O
Output Ripple and Noise: Peak-to-Peak ⁵						
Conditions: $I_O = I_{O,max}$; $V_{IN} = V_{IN,nom}$; $BW = 20\text{ MHz}$; $T_A = 25\text{ }^\circ\text{C}$	3.3		-	-	30	mV _{PK-PK}
	2.5		-	-	30	mV _{PK-PK}
	1.8		-	-	30	mV _{PK-PK}
	1.5		-	-	30	mV _{PK-PK}
	5.0		-	-	30	mV _{PK-PK}
External Load Capacitance ⁶	All		-	-	10000	μF
Over Current Limit Inception						
Conditions: $V_O = 90\% V_{O,nom}$; $I_{O2} = I_{O,min}$; $V_{IN} = V_{IN,nom}$	All	$I_{O,OCF}$	16.5	-	25	A
Characteristics: Hiccup mode, auto-recovery	5.0V	$I_{O,OCF}$	13.2	-	20	A
Output Short Circuit						
Conditions: $V_{IN} = V_{IN,nom}$; $I_{O2} = 0A$ $T_A = 25\text{ }^\circ\text{C}$	All	I_{OPK}	-	-	28	A _{PK}
		I_{ORMS}			5	A _{RMS}
		I_{ODC}			1	A
		I_{INS}			150	mA
Efficiency						
Conditions: $V_{IN} = V_{IN,nom}$; $T_A = 25\text{ }^\circ\text{C}$ $P_O = P_{O,max}$, balanced current loading	FG	η	85.0	87.0		%
	FY	η	84.0	86.0		%
	GM	η	81.0	83.0		%
	AF	η	87.5	88.5		%
Switching Frequency	All	-	225	250	275	KHz
Note: Can be determined from output ripple waveform						

NOTE: 4. Channel under test shall follow the specified conditions while the other channel is set to min load, 0A.
 5. Channel under test shall be set to full load with the other channel set to $I_{O,min}$ - See Fig 2.
 6. Refer to YSC plots on Fig 18 and 19 to determine loop stability at various output load impedance.



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Electrical Specifications *(continued)*

OUTPUT SPECIFICATIONS

Parameter	Device	Symbol	Min	Typ	Max	Unit
Dynamic Response ⁷ Conditions: $\Delta I_O/\Delta t = 1A/10\mu s$; $V_{IN} = V_{IN,nom}$; $T_A = 25^\circ C$						
Peak Voltage Deviation Load Change: $I_O = 50\%$ to $75\% I_{O,max}$	All	-	-	2	4	%V _O
Transient Settling Time Note: $V_{O,nom}$ (ref.) (from ref. to $0.1\Delta V_{PK}$)	All	-	-	-	500	μsec
Peak Voltage Deviation Load Change: $I_O = 50\%$ to $25\% I_{O,max}$	All	-	-	2	4	%V _O
Transient Settling Time Note: $V_{O,nom}$ (ref.) (from ref. to $0.1\Delta V_{PK}$)	All	-	-	-	500	μsec
Turn-On Time Conditions: $V_{IN} = V_{IN,min}$; $I_{O1} = I_{O,max}$, $I_{O2} = I_{O,min}$; $T_A = 25^\circ C$ Note: V_{O1} within 1%	All	-	-	6	32	msec
Output Voltage Overshoot Conditions: $V_{IN} = V_{IN,nom}$; $T_A = 25^\circ C$; $P_O = 0W$	All	-	-	-	4	%V _O

NOTE: 7. Dynamic response tested with 10uF-aluminum and 1uF-tantalum capacitors across the load.

FEATURE SPECIFICATION

Parameter	Device	Symbol	Min	Typ	Max	Unit
Undervoltage Lockout						
Turn-on Point	All	-	-	34.5	36.0	V
Turn-off Point	All	-	32	33.5	-	V
Output Voltage Adjustment Range Conditions: $V_{IN} = V_{IN,nom}$; $T_A = 25^\circ C$ V_{O1} : $I_{O1} = I_{O,max}$, $I_{O2} = I_{O,min}$ V_{O2} : $I_{O1} = I_{O,min}$; $I_{O2} = I_{O,max}$ Note: Tolerance = $\pm 1\%$	All	-	90	-	110	%V _O



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Electrical Specifications *(continued)*

FEATURE SPECIFICATION

Parameter	Device	Symbol	Min	Typ	Max	Unit
<u>Enable Pin Voltage</u>						
POSITIVE LOGIC						
Logic Low: Module OFF	w/o N-Suffix	V_{ENABLE}	0	-	2.5	V
Logic High: Module ON		V_{ENABLE}	1.8	-	5.0	V
NEGATIVE LOGIC						
Logic Low: Module ON	N-Suffix	V_{ENABLE}	0	-	2.5	V
Logic High: Module OFF		V_{ENABLE}	1.8	-	5.0	V
<u>Enable Pin Current</u>						
Logic Low	All	I_{ENABLE}	-	-	1.0	mA
Logic High: (I_{LKG} at $V_{ENABLE} = 5V$)	All	I_{ENABLE}	-	-	50	μA
<u>Module Output Voltage</u>						
at Logic High (Negative Enable)	N-Suffix	V_O	-	-	1.2	V
at Logic Low (Positive Enable)	w/o N-Suffix	V_O	-	-	1.2	V
Output Over Voltage Clamp	3.3V	$V_{O,CLAMP}$	3.8	3.9	4.5	V
Conditions: $V_{IN} = V_{IN,nom}$; $T_A = 25^\circ C$	2.5V	$V_{O,CLAMP}$	2.8	2.9	3.5	V
Characteristics: Latching mode;	1.8V	$V_{O,CLAMP}$	2.0	2.1	2.5	V
auto-tracking wrt V_{out}	1.5V	$V_{O,CLAMP}$	1.7	1.8	2.2	V
trim	5.0V	$V_{O,CLAMP}$	5.7	6.0	6.3	V
Over-Temperature Shutdown	All	T_B	110	115	120	$^\circ C$
Note: 1. $T_{comp(max)} < 140^\circ C$						
2. Measured in the vicinity of pin 3 and R29						

ISOLATION SPECIFICATION

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

SAFETY APPROVAL

The ALQ15 series have been certified through:

- UL + cUL 60950, Third Edition - Recognized (PENDING)
- EN 60950 through TUV-PS (PENDING)
- Basic Insulation

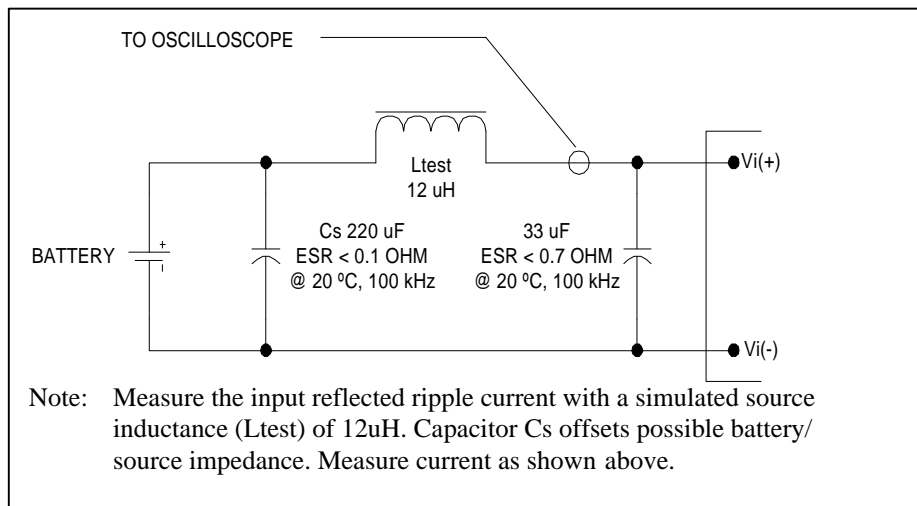


Figure 1. Input Reflected Ripple Current Measurement Setup.

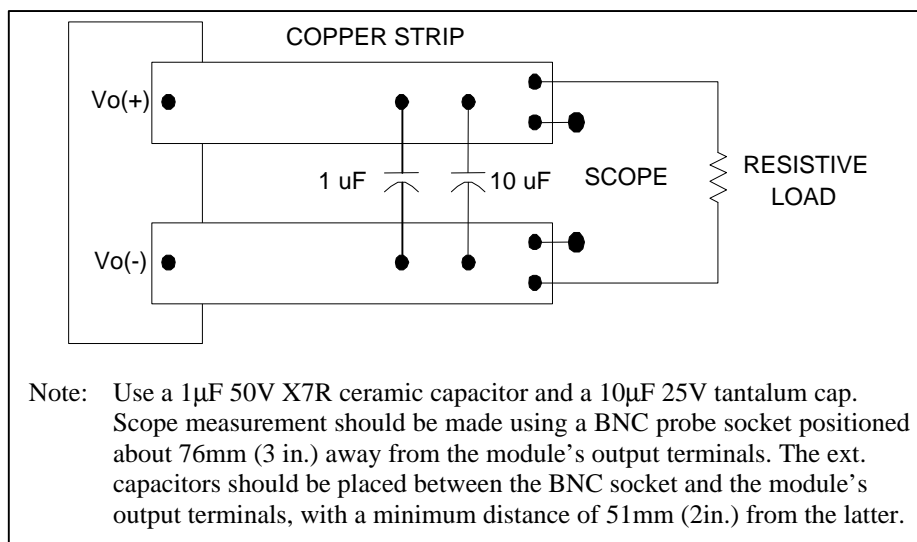


Figure 2. Peak to Peak Output Noise Measurement Setup.

Basic Operation and Features

INPUT UNDER VOLTAGE LOCKOUT

To prevent any instability to the converter that may affect and consequently damage the end system, the ALQ15 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 32-33.5 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 $R_{TRIM-UP}$ resistor should be connected between TRIM PIN (Pin6) and RTN PIN (Pin 5). Please refer to Figure 3 for the resistor configuration and Table 1 for the required resistor value in attaining the desired output adjustment

To DECREASE the output voltages, external $R_{TRIM-DOWN}$ resistor should be connected between TRIM PIN (Pin 6) and V_{OUT1} (Pin 7). Please refer to Figure 4 for the resistor configuration and Table 1 for the required resistor value in attaining the desired output adjustment.

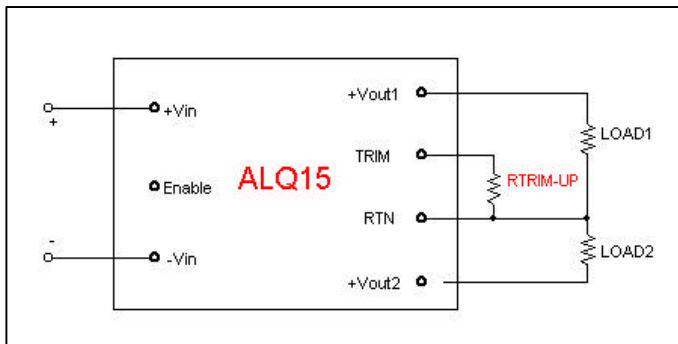


Figure 3. External Trim resistor setup to increase output.

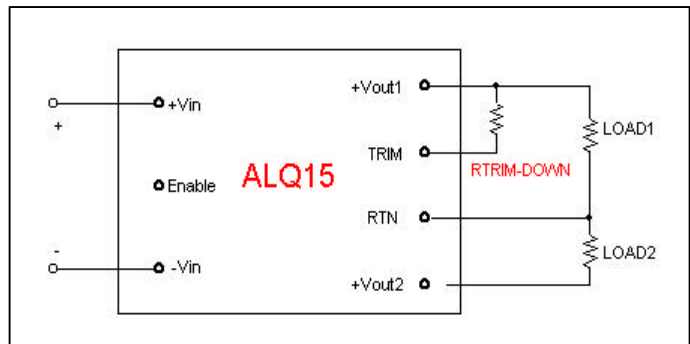


Figure 4. External Trim resistor setup to decrease output.

TABLE 1. External trim resistor values to adjust the output voltages (in kW)

D [%]	ALQ15FG48 (3.3V / 2.5V)		ALQ15FY48 (3.3V / 1.8V)		ALQ15GM48 (2.5V / 1.5V)	
	TRIM UP $R_{TRIM-UP}$	TRIM DOWN $R_{TRIM-DOWN}$	TRIM UP $R_{TRIM-UP}$	TRIM DOWN $R_{TRIM-DOWN}$	TRIM UP $R_{TRIM-UP}$	TRIM DOWN $R_{TRIM-DOWN}$
1	46.84	49.64	55.34	67.64	58.48	58.57
2	20.82	23.11	24.59	30.06	24.64	27.26
3	12.14	13.69	14.35	17.54	14.13	16.16
4	7.81	8.88	9.22	11.27	9.00	10.47
5	5.21	5.95	6.15	7.52	5.97	7.02
6	3.47	3.98	4.10	5.01	3.97	4.69
7	2.23	2.56	2.64	3.22	2.55	3.02
8	1.30	1.49	1.54	1.88	1.48	1.77
9	0.58	0.67	0.68	0.84	0.66	0.79
10	0.00	0.00	0.00	0.00	0.00	0.00



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Basic Operation and Features *(continued)*

OUTPUT ENABLE

The ALQ15 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 a Negative (suffix "N" required) Enable Logic option is being offered. Please refer to Table 2 for the Part Numbering Scheme.

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. On the other hand, the Negative Enable version turns 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.

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. It will remain latched (shut down) until the OVP fault condition is removed and the input voltage is recycled.

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 once the over current condition is removed. See Figure 12 for typical output characteristic under an over current condition.

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 temperature of the sensed location drops to less than 110°C.

Performance Curves

3.3V / 2.5V (FG SERIES)

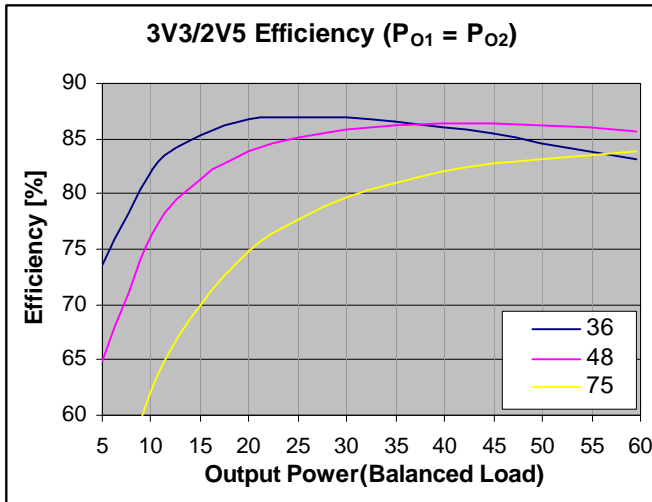


Figure 5. Efficiency for balanced Output Power ($P_{O1} = P_{O2}$) at various input voltages ($P_{O1} + P_{O2} = 60W$). Taken w/ module mounted vertically w/ 300LFM airflow from Pin 3 to 1 at $T_A = 25^{\circ}C$.

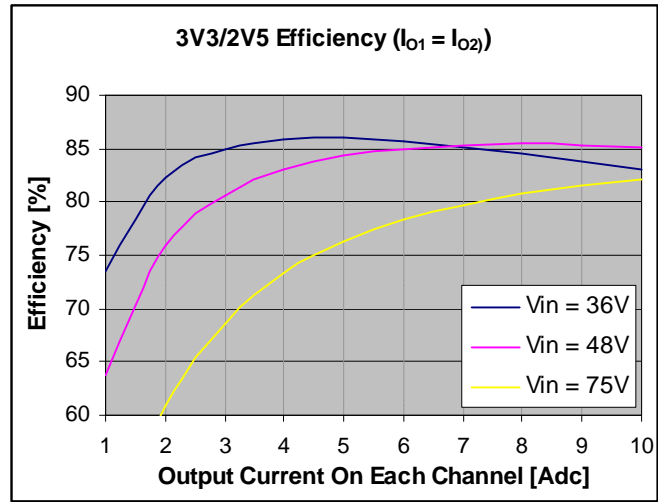


Figure 6. Efficiency vs. Balanced Output Current ($I_{O1} = I_{O2}$) at various input voltages (Total Power = 60W).

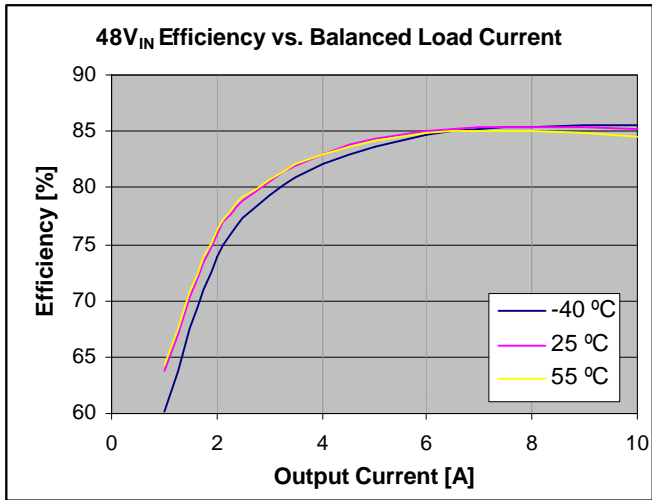


Figure 7. Efficiency at $V_{IN} = 48V$ vs. Balanced Load Current ($I_{O1} = I_{O2}$) at various ambient temperatures and with 100LFM airflow (Total Power = 60W)

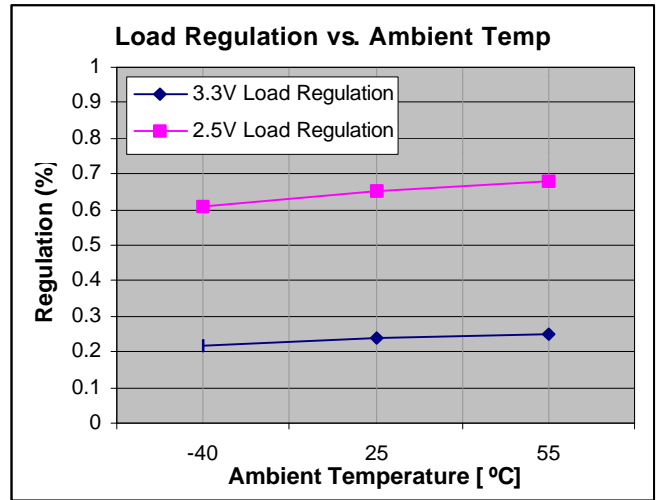


Figure 8. Load Regulation vs. Ambient Temperature at $V_{IN} = 48V$.

Performance Curves (continued)

3.3V / 2.5V (FG SERIES)

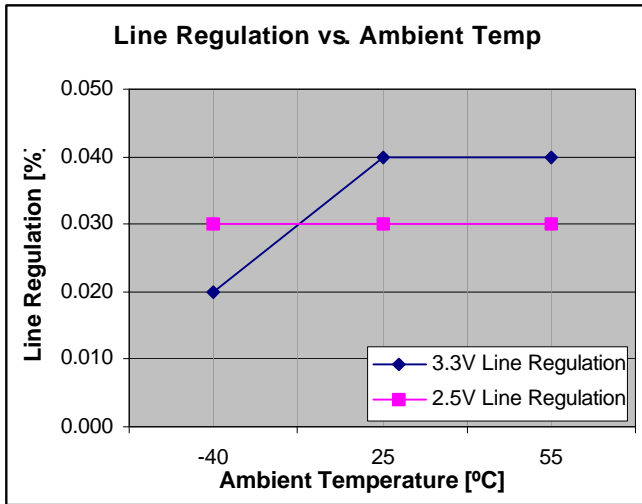


Figure 9. Line Regulation vs. Ambient Temperature.

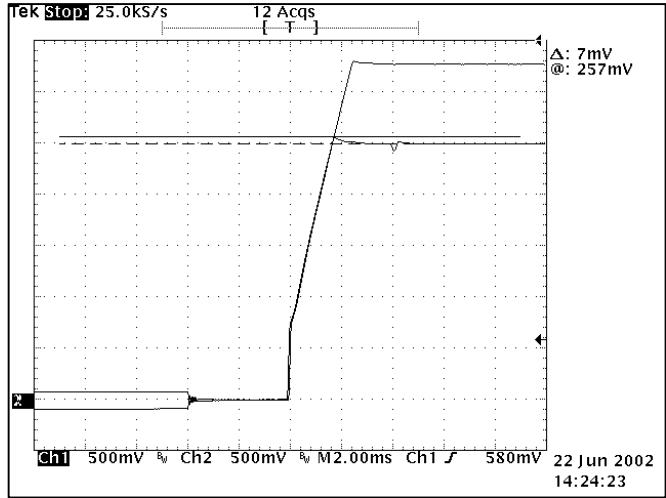


Figure 10. Start-up characteristic of Vo1 (CH1) and Vo2 (CH2) at balanced load current; $V_{IN} = 48V$.

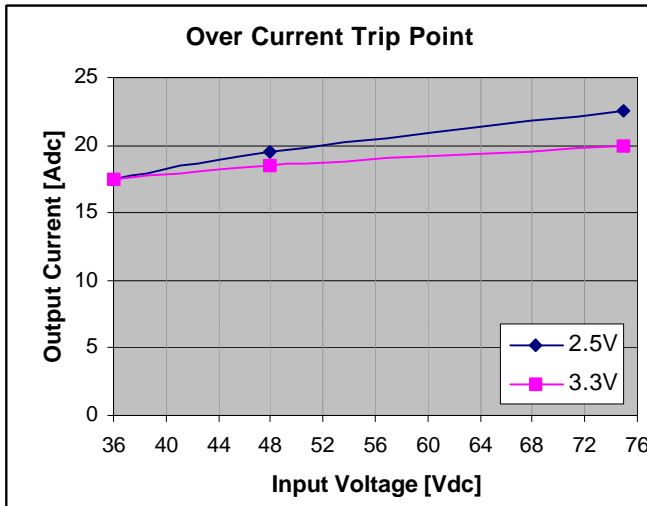


Figure 11. Over Current trip point vs. Input Voltage at 25°C ambient temperature with 100LFM airflow.

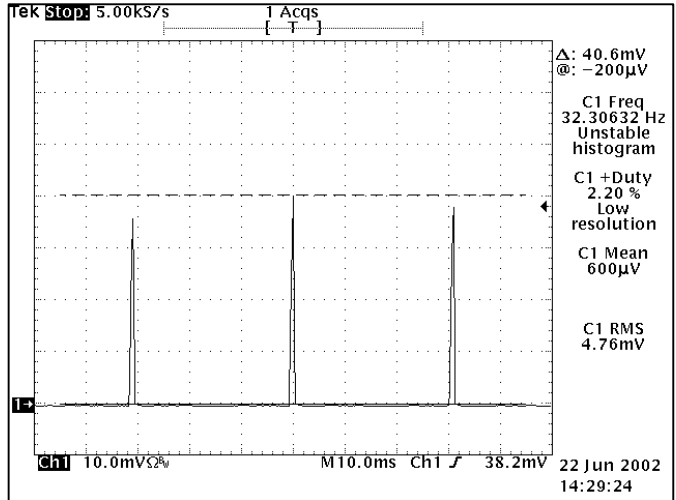


Figure 12. Typical output current waveform under an Over Current Condition. Output current scale at 0.5A/mV.

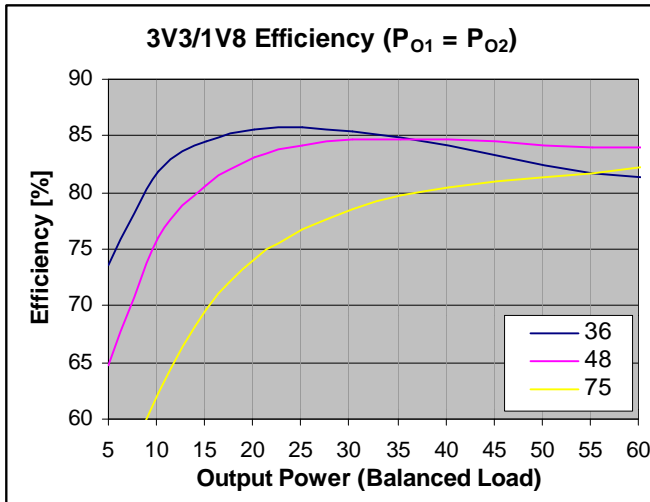


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Performance Curves (continued)

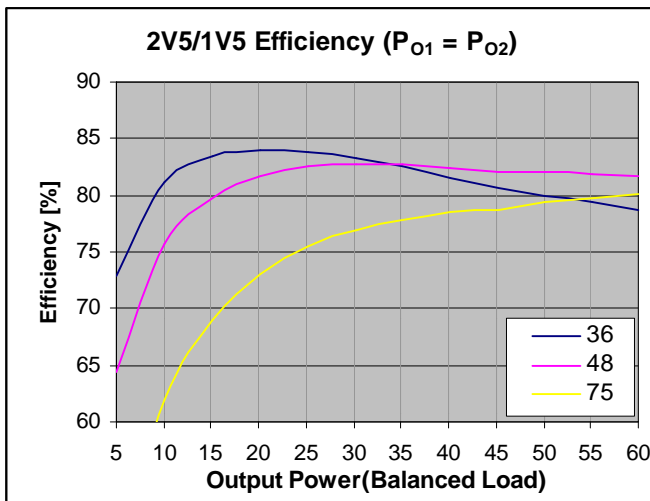
3.3V / 2.5V (FG SERIES)



Additional curves to be provided on next release.

Figure 13. Efficiency for balanced Output Power ($P_{O1} = P_{O2}$) at various input voltages ($P_{O1} + P_{O2} = 60W$). Taken w/ module mounted vertically w/ 300LFM airflow from Pin 3 to 1 at $T_A = 25^\circ C$.

2.5V/1V5 (GM SERIES)



Additional curves to be provided on next release.

Figure 14. Efficiency for balanced Output Power ($P_{O1} = P_{O2}$) at various input voltages ($P_{O1} + P_{O2} = 60W$). Taken w/ module mounted vertically w/ 300LFM airflow from Pin 3 to 1 at $T_A = 25^\circ C$.

Performance Curves (continued)

CURRENT VS. TEMPERATURE CURVES

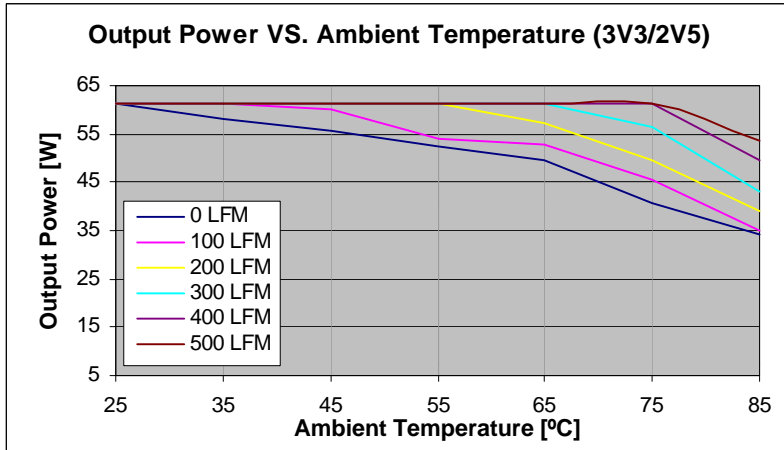


Figure 15. Combined Output Power (balanced load: $I_{O1} = I_{O2}$) vs. Ambient Temperature Curves for ALQ15FG48 version taken at various airflow conditions (converter mounted vertically with airflow direction from PIN? to PIN?; $V_{IN} = 48V$ nominal).

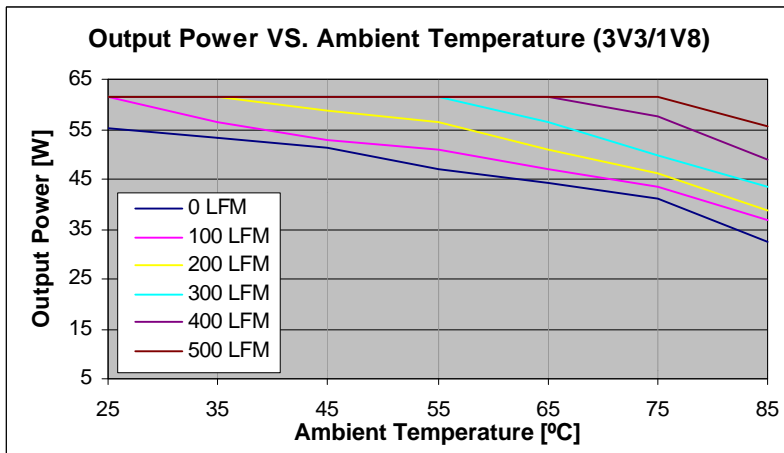


Figure 16. Combined Output Power (balanced load: $I_{O1} = I_{O2}$) vs. Ambient Temperature Curves for ALQ15FY48 version taken at various airflow conditions (converter mounted vertically with airflow direction from PIN? to PIN?; $V_{IN} = 48V$ nominal).

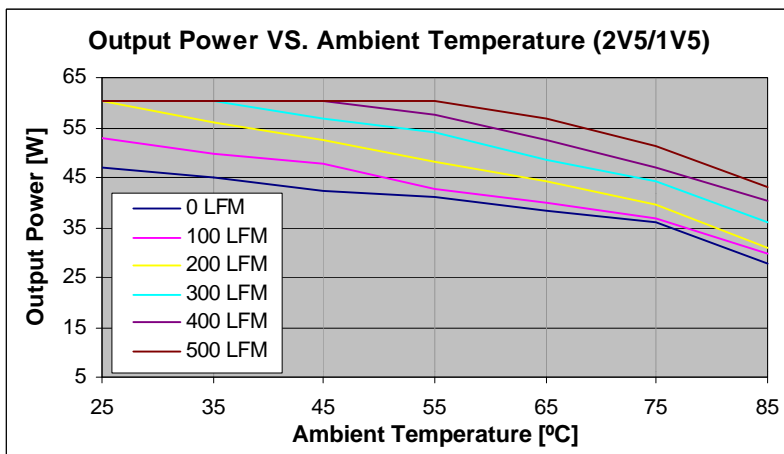


Figure 17. Combined Output Power (balanced load: $I_{O1} = I_{O2}$) vs. Ambient Temperature Curves for ALQ15FY48 version taken at various airflow conditions (converter mounted vertically with airflow direction from PIN? to PIN?; $V_{IN} = 48V$ nominal).

Young's Stability Curves

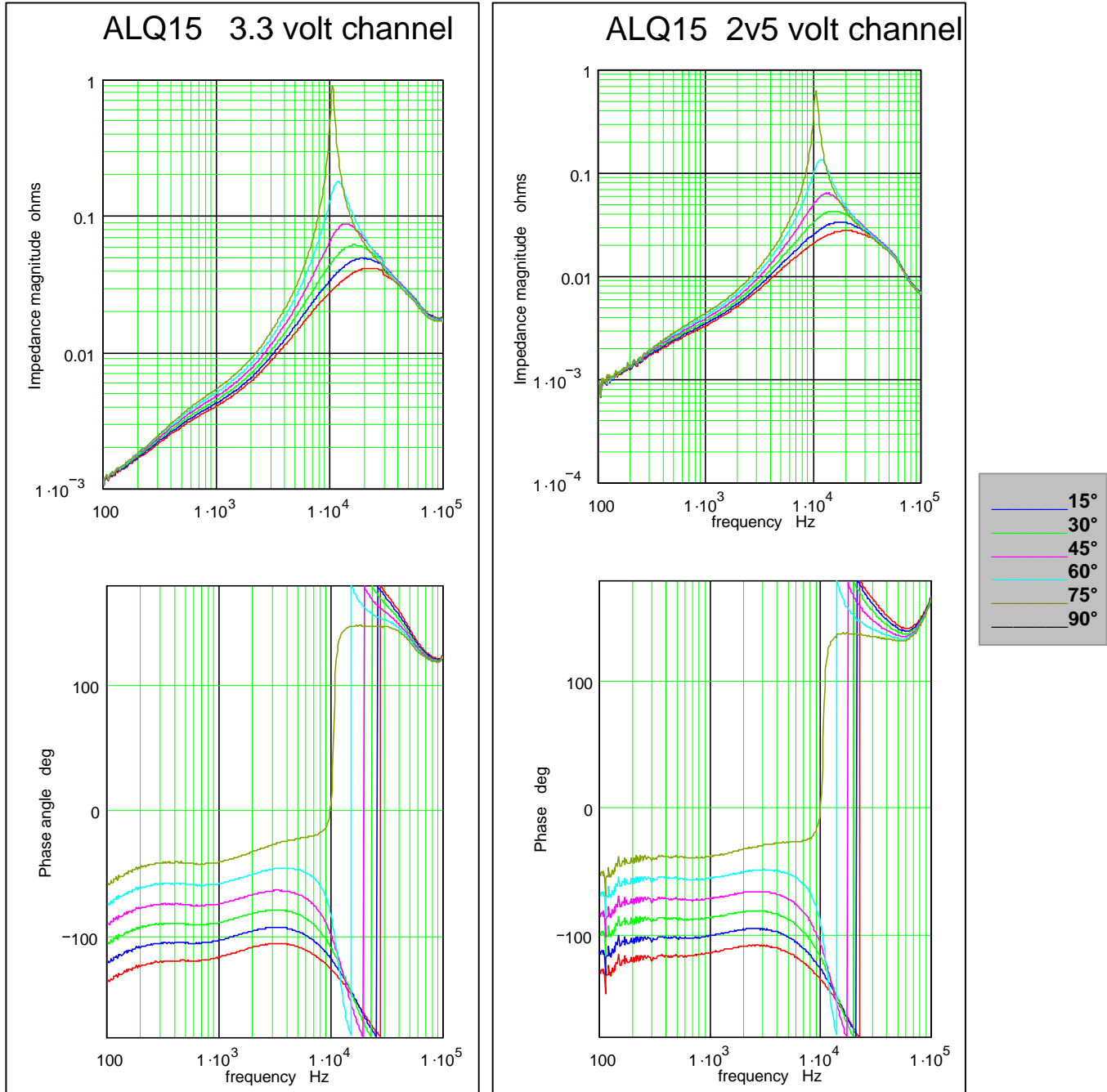


Figure 18. YSC Plots of 3V3 and 2V5 Output Channels.

Young's Stability Curves (continued)

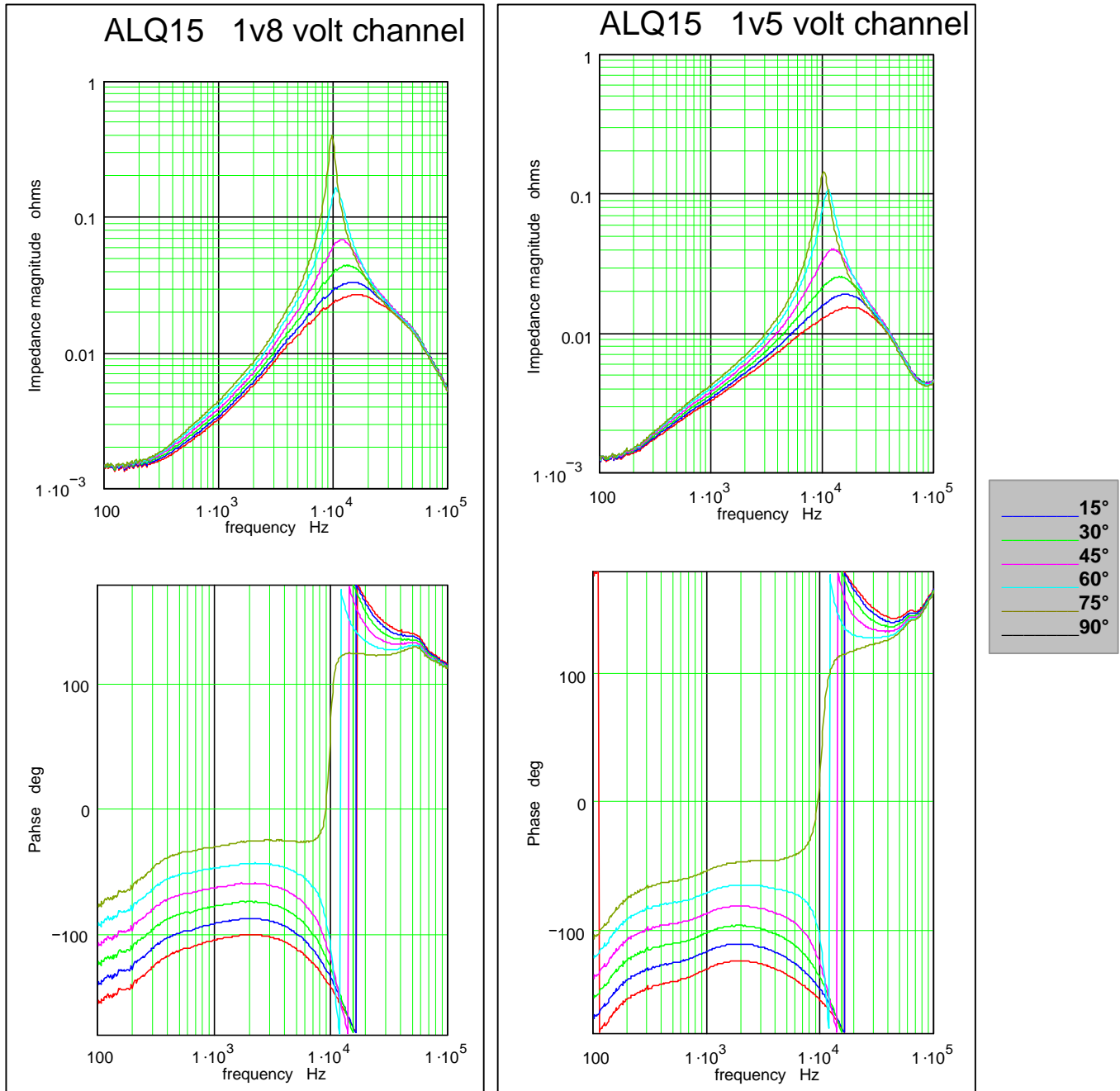


Figure 19. YSC Plots of 1V8 and 1V5 Output Channels.

Mechanical Specifications

Parameter	Device	Symbol	Min	Typ	Max	Unit
Dimension	All	L	-	2.30 [58.42]	-	in [mm]
		W	-	1.48 [37.59]	-	in [mm]
		H	-	0.544 [13.82]	-	in [mm]
Weight			-		TBD	g [oz]
PIN ASSIGNMENT						
1		+V _{IN}		5		RTN
2		ENABLE		6		TRIM
3		-V _{IN}		7		+V _{OUT1}
4		+V _{OUT2}				

NOTE: Pin diameters at $\varnothing = 0.04$ " [1.02 mm] nominal.

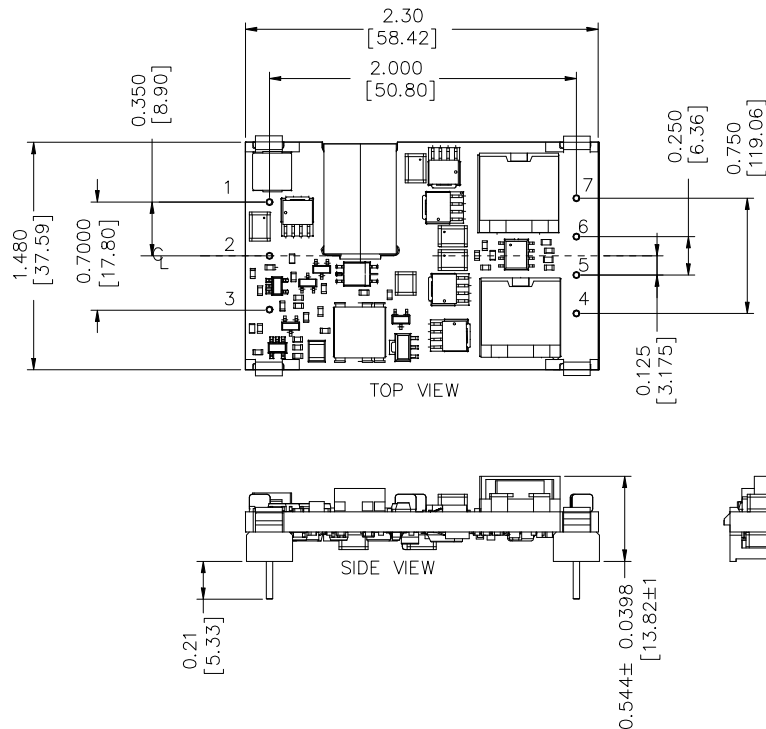


Figure 20. ALQ15 series mechanical outline (inches [(mm)]).



Technical Reference Notes
ALQ15XX48X Series
(Open Frame Dual Output Quarter Brick)



Mechanical Specifications *(continued)*

SOLDERING CONSIDERATIONS

The ALQ15 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.

PART NUMBERING SCHEME FOR ORDERING

	OUTPUT VOLTAGE 1	OUTPUT VOLTAGE 2		ENABLE LOGIC	PIN LENGTH OPTION
ALQ15	W	X	48	Y	Z
	F = 3.3V F = 3.3V G = 2.5V A = 5.0V	G = 2.5V Y = 1.8V M = 1.5V F = 3.3V		"Blank" = Positive "N" = Negative	"Blank" = 5mm (Standard) "-6" = 3.7mm

TABLE 2. Part Numbering information.

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