Features

- RoHS lead-free solder and lead-solder-exempted products are available
- Ultra-wide input range: 18 – 60 VDC
- 38% smaller footprint than standard 1/4th-bricks
- Cost-effective, single board construction
- Low profile
- High efficiency
- Input-to-output isolation: 1500 VDC
- Basic Insulation
- Start-up into high capacitive load
- Low conducted and radiated EMI
- Output overcurrent protection
- Output overvoltage protection
- Input undervoltage lockout
- Overtemperature protection
- Approved to UL 60950-1-03/ CAN/CSA-C22.2 No. 60950-1, and TUV approved to EN 60950-1, IEC 60950-1

Applications

- Wireless Base Stations
- Telecommunications equipment
- LAN/WAN
- Data processing
- Industrial applications

Description

The EMS Series of DC-DC converters provide a single isolated step-down voltage (3.3 or 5 VDC nominal) from a wide-input voltage range (18 – 60 VDC). The EMS is an excellent choice in applications where multiple input voltage options are required. The designer can use a single EMS converter to cover both 24Vin and 48Vin input ranges, eliminating the need to specify multiple modules to handle each input range. This is particularly useful in wireless base station applications where the power plants tend to vary and could provide nominal 24 or 48 V input.

The EMS converters are highly efficient over the entire wide-input voltage range, cost-effective, and offer a low profile, industry-standard quarter-brick footprint. The standard feature set includes remote on/off, remote output voltage sensing, industry standard output trim, input undervoltage lockout, and overtemperature shutdown with hysteresis.

Model Selection

Model	Input Voltage VDC	Input Current, Max ADC (1)	Output Voltage VDC	Output Rated Current, I_{RATED} ADC	Output Ripple/Noise, mV_{P-P} (2)	Typical Efficiency @ I_{RATED} & $36V_{IN}$
EMS15DE	18 - 60	3.2	3.3	15	50	90%
EMS10DG	18 - 60	3.2	5.0	10	50	90%
This product is intended for integration into end-use equipment. All the required procedures for CE marking of end-use equipment should be followed.						

[1] @ V_{IN} minimum.
[2] Nominal, (DC to 500 kHz)

Model numbers highlighted in yellow or shaded are not recommended for new designs.

Absolute Maximum Ratings

Stresses in excess of the absolute maximum ratings may cause performance degradation, adversely effect long-term reliability, and cause permanent damage to the converter.

Parameter	Conditions/Description	Min	Max	Units
Input Voltage	Continuous	0	60	VDC
	Transient Withstand (100 ms)		100	VDC
Operating Temperature	Hot Spot Monitor Location [2] (Tc)	-40	100	°C
	Ambient	-40	85	°C
Storage Temperature	Ambient	-55	125	°C
ON/OFF Control Voltage	Referenced to -Vin	-0.7	20	VDC
Output Power [1]	EMS15DE		49.5	W
	EMS10DG		50	W

[1] With appropriate power derating, see Figures 27 - 32.
[2] See temperature probe location T_C, Figure 26. [Ref.V10 case]

Environmental and Mechanical Specifications

All specifications apply over specified input voltage, output load, and temperature range, unless otherwise noted.

Parameter	Conditions/Description	Min	Nom	Max	Units
Operating Humidity	Relative Humidity, Non-condensing			95	%
Storage Humidity	Relative Humidity, Non-condensing			95	%
Shock	(Half-sinewave, 6ms), 3 axes	50			g
Sinusoidal Vibration	GR-63-CORE, Section 5.4.2	1			g
Weight			0.53/15		Oz/g
Water Washing	Standard process		Yes		
MTBF (Calculated)	Per Telcordia SR-332 Issue 1, (method 1, case 2, GB, 40°C)		1,750		kHrs
Dimensions	(Overall)		2.3 (58.42) x 0.896 (22.76) x 0.42 (10.7)		in (mm)
Markings & Labeling	Includes P/N, Logo, Date Code, Country of Manufacture				

Isolation Specifications

All specifications apply over specified input voltage, output load, and temperature range, unless otherwise noted.

Parameter	Conditions/Description	Min	Nom	Max	Units
Insulation Safety Rating			Basic		
Isolation Voltage	Input to Output	1500			VDC
Isolation Resistance	Input to Output	10			MΩ
Isolation Capacitance	Input to Output		2,700		pF

EMI & Safety Regulatory Compliance

Safety Agency	Standard Approved To:	Marking
UL	UL60950-1-03 / CSA C22.2 No. 60950-1	cURus
TUV product service	TUV EN60950-1/A11:2004	TUV PS Baurt mark
CB report	IEC60950-1:2001	N/A
Declaration of Conformity	DIR 73/23/EEC Low Voltage Directive	CE
Conducted Emissions [1]	(with external EMI filter)	CISPR 22 class A

[1] See figures 33 & 34.

Input Specifications

All specifications apply over specified input voltage, output load, and temperature range, unless otherwise noted.

Parameter	Conditions/Description	Min	Nom	Max	Units
Input Voltage	Continuous	18		60	VDC
Turn-On Input Voltage (UVLO) [1]	Ramping Up	15	16.5	18	VDC
Turn-Off Input Voltage [1]	Ramping Down	13	15.5	17	VDC
Turn-Off Hysteresis		1			VDC
Input Reflected Ripple Current	@ I_{RATED}, 12µH source inductance BW=20 MHz [2]		10	72	mA_{P-P}
No-load Input Current	18 VDC ≤ Vin ≤ 60 VDC		90	150	mA
No-load Power Dissipation	Vin = 36 VDC			4	W
Disabled Input Current	18 VDC ≤ Vin ≤ 60 VDC		25	50	mA
Input Capacitance (internal)				1	µF
Minimum Input Capacitance (external)	(ESR <0.7 Ω)	33			µF
Inrush Transient				0.1	A^2s

[1] See figure 2. [2] Vin = 36Vin; see Figures 1 and 36.

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Output Specifications

All specifications apply over specified input voltage, output load, and @ 40^{O}C ambient temperature, unless otherwise noted.

EMS15DE: 3.3V / 15A

Parameter	Conditions/Description	Min	Nom	Max	Units
Output Voltage (Set-point)	Vin = 36 V, Io =25 A	3.25	3.30	3.35	VDC
Line Regulation	Vi =18 V to 60 V, Io =50% Io.max			10	mV
				0.3	%
Load Regulation	Vin =36 V, Io.min to Io.max			25	mV
				0.75	%
Temperature Coefficient	-40 °C ≤ T_{AMB} ≤ +85 °C			0.02	%/°C
Total Error Band	(Line, Load, Temperature, Ripple, Life)	3.12		3.48	VDC
				+/- 5.5	%
Output Power [1]	w/ proper thermal derating			49.5	W
Output Current [1]	w/ proper thermal derating	0		15	A
Output Current Limit Threshold	Vin = 36 V, Vo < 90% Vo_{NOM}	120		160	%Iomax
Output Ripple [2]	Over line and load, -40 °C ≤ T_{AMB} ≤ +85 °C (DC to 20 MHz)		50	100	mV_{P-P}
			1.5	3.0	%
			17	35	mV_{RMS}
Dynamic Regulation [3]	75-100-75% load step change, to 1% error band, Co = 0 µF				
Peak Deviation	Slew = 1.0 A/µS >>>		+/-200	+/-300	mV
Settling Time			150	250	µs
Peak Deviation	Slew = 0.1 A/µS >>>		+/-100	+/-200	mV
Settling Time			150	250	µs
Efficiency [4] (T_{AMB}=40 °C)	Vin_{NOM}, I_O = I_{RATED}		90		%
Turn-on Overshoot [5]	Overall input voltage, load, and temperature conditions		5	10	%Vout
Turn-On Time *f* (VIN) [5]	Time from Vin = UVLO to 90% of $Vout_{NOM}$		3	10	ms
Turn-On Time *f* (On/Off) [6]	Time from enable to 90% of $Vout_{NOM}$		25	50	ms
Rise Time [5]	From 10 to 90% of $Vout_{NOM}$		1	2	ms
Admissible Load Capacitance [7]	I_{RATED}, Nom Vin	330		4,950	µF
Switching Frequency			300		kHz

Notes:
[1] See Figure 27 - 29.
[2] See Figure 15 for ripple waveform and Figure 35 for measurement method.
[3] See Figures 9, 10 and 11.
[4] See Figure 3.
[5] See Figure 5.
[6] See Figure 7.
[7] A minimum 330 µF (AVX, TPSD337K006R0045) is recommended for operation over full load, line, and temperature range.

Output Specifications (Cont'd)

All specifications apply over specified input voltage, output load, and @ 40^{O}C ambient temperature, unless otherwise noted.

EMS10DG: 5V / 10A

Parameter	Conditions/Description	Min	Nom	Max	Units
Output Voltage (Set-point)	Vi = 36 V, Io =14 A	4.925	5.0	5.075	VDC
Line Regulation	Vi =18 V to 60 V, Io =50% Io.max			15	mV
				0.3	%
Load Regulation	Vi =36 V, Io.min to Io.max			25	mV
				0.5	%
Temperature Coefficient	-40 °C ≤ T_{AMB} ≤ +85 °C			0.02	%/°C
Total Error Band	(Line, Load, Temperature, Ripple, Life)	4.76		5.24	VDC
				+/- 4.8	%
Output Power [1]	w/ proper thermal derating			50	W
Output Current [1]	w/ proper thermal derating	0		10	A
Output Current Limit Threshold	Vin = 36 V, Vo < 90% Vo_{NOM}	120		180	%Iomax
Output Ripple [2]	Over line and load, -40 °C ≤ T_{AMB} ≤ +85 °C (DC to 20 MHz)		50	120	mV_{P-P}
			1.0	2.4	%
			17	42	mVrms
Dynamic Regulation [1] Peak Deviation Settling Time Peak Deviation Settling Time	75-100-75% load step change, to 1% error band, Co = 0 µF Slew = 1.0 A/µS >>> Slew = 0.1 A/µS >>>		+/-150 150 +/-100 150	+/-250 250 +/-200 250	mV µs mV µS
Efficiency [4] (T_{AMB}=40 °C)	Vin_{NOM}, I_O = I_{RATED}		90		%
Turn-on Overshoot [5]	Overall input voltage, load, and temperature conditions		5	10	%Vout
Turn-On Time f (VIN) [5]	Time from Vin = UVLO to 90% of $Vout_{NOM}$		3	10	ms
Turn-On Time f (On/Off) [6]	Time from enable to 90% of $Vout_{NOM}$		25	50	ms
Rise Time [5]	From 10 to 90% of $Vout_{NOM}$		3	6	ms
Admissible Load Capacitance [7]	I_{RATED}, Nom Vin	220		3,300	µF
Switching Frequency			300		kHz

Notes:

[1] See Figure 30 - 32.
[2] See Figure 16 for ripple waveform and Figure 35 for measurement method.
[3] See Figures 12, 13 and 14.
[4] See Figure 4.
[5] See Figure 6.
[6] See Figure 8.
[7] A minimum 220 µF (AVX, TPSD227K010R0050) is recommended for operation over full load, line, and temperature range.

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Protections Specifications

All specifications apply over specified input voltage, output load, and @ 40 °C ambient temperature, unless otherwise noted.

Parameter		Conditions/Description	Min	Nom	Max	Units
Overcurrent Protection						
Type		Non-latching – auto-recovery, hiccup type.				
Threshold	EMS15DE	Vin = Vin $_{NOM}$	31.2		37.5	ADC
	EMS10DG		16.8		22.4	ADC
Short Circuit [1]	EMS15DE	Hiccup Mode		17	30	A_{RMS}
	EMS10DG			17	22	A_{RMS}
Overvoltage Protection [2]						
Type		Clamp, non-latching, hiccup mode. Independent control loop, auto-reset.				
Threshold			115		160	%Vo
Overtemperature Protection						
Type		Non-latching, auto-recovery				
Threshold		Temperature node: T_C [3]		100		°C

[1] Refer to Figures 17 & 18. [2] Refer to Figures 19 & 20. [3] Refer to Figure 26.

Feature Specifications

All specifications apply over specified input voltage, output load, and @ 40 °C ambient temperature, unless otherwise noted.

Parameter	Conditions/Description	Min	Nom	Max	Units
	On/Off [1]				
Negative Logic (-N suffix) On/Off (pin 2) (Primary side ref. to -Vin)	(On/Off signal is low – converter is ON)				
	Converter ON Sink current	-0.7		1.0 1.0	VDC mADC
	Converter OFF Open circuit voltage	3.5 7		20 18	VDC VDC
Positive Logic (-P suffix) On/Off (pin 2) (Primary side ref. to -Vin)	(On/Off signal is low – converter is OFF)				
	Converter ON Open Circuit Voltage	3.5 7		20 18	VDC VDC
	Converter OFF Sink current	-0.7		1.0 1.0	VDC mADC
	Remote Sense				
Remote Sense Headroom				10	%Vo
	Output Voltage Trim [2]				
Trim Up				10	%Vo
Trim Down		-10			%Vo

[1] See Figure 21.

[2] The output voltage of the units can be increased to a maximum of 10%. This is comprised of a combination of the remote-sense and trim adjustment. Do not exceed 10% of Vonom between +Vout and –Vout terminals. Also refer to *"Output Voltage Adjust"* section and Figures 22 – 25 for clarification.)

Performance Characteristic

Reflected Ripple Current

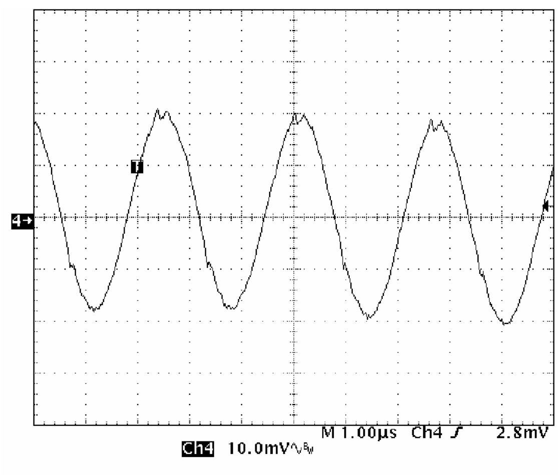


Figure 1. EMS10DG, Input Reflected Ripple Current (typ.)

Conditions: Output current = 10 ADC (50 W).
Input voltage = 36 VDC.
Waveform: Input$_{RRC}$ ~ 8 mA$_{P-P}$ (measured)
Scale: 2mA/10mV or 2mA/division.

Undervoltage Lockout Characteristics (typ)

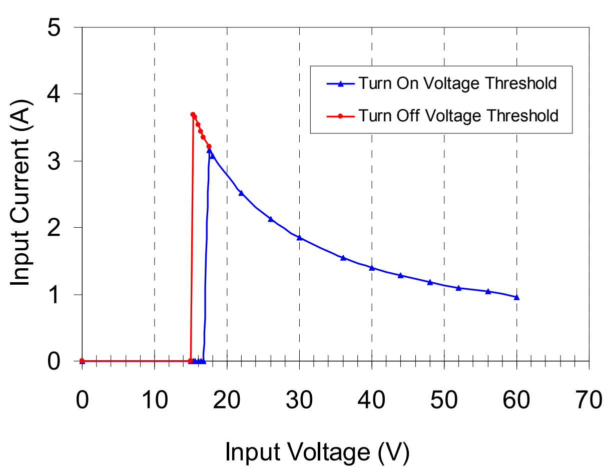


Figure 2. EMS, UVLO Input Characteristics

Efficiency

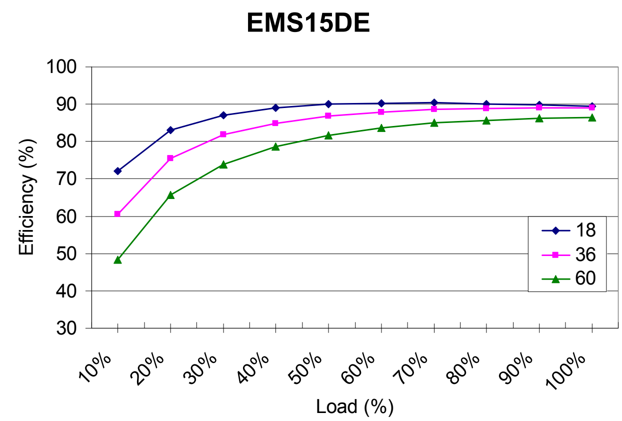


Figure 3. Efficiency, f (Line & load)

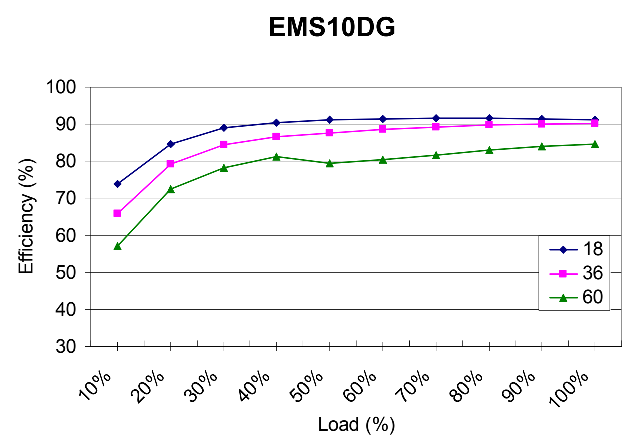


Figure 4. Efficiency, f (Line & load)

Vo Turn-on Characteristics, f (V_{IN})

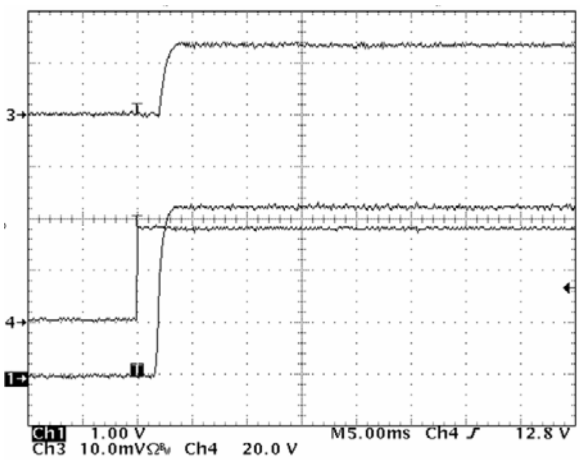


Figure 5. EMS15DE, Turn-On @ Power-up (typ)

Conditions: Cext = 0 µF ▪ Scale : 5mS/div.
Channel 1 – Vout, T_{RISE} ~ 1.6 ms (typ.) Scale : 1V/div.
Vout, T_{DELAY} ~ 3.2 ms (typ.)
Channel 3 – Iout = 15 Amps Scale : 10A/div.
Channel 4 –/- Vin = 36 VDC (snap-on) Scale : 20V/div..

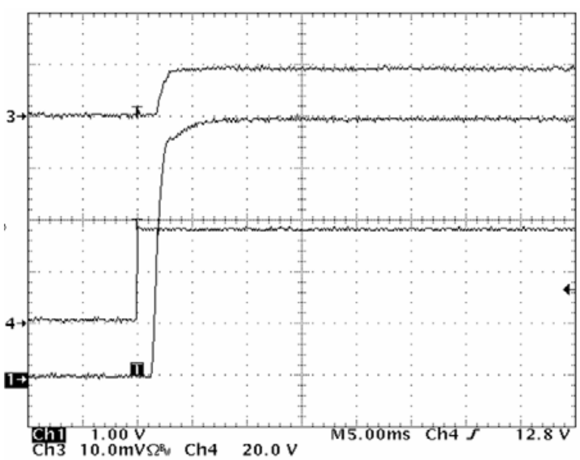


Figure 6. EMS10DG, Turn-On @ Power-up (typ)

Conditions: Cext = 0 µF ▪ Scale : 5 ms/div.
Channel 1 – Vout, T_{RISE} ~ 2.8 ms (typ.) Scale : 1 V/div.
Vout, T_{DELAY} ~ 4 ms (typ.)
Channel 3 – Iout = 10 Amps Scale : 10 A/div.
Channel 4 – Vin = 36 VDC (snap-on) Scale : 20 V/div..

Vo Turn-on Characteristics, f (ON/OFF)

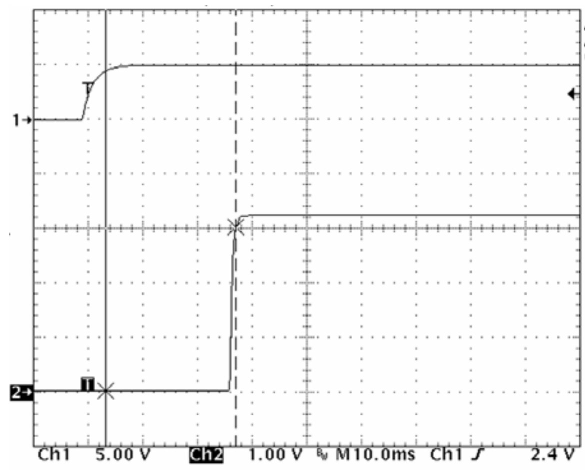


Figure 7. EMS15DE, Turn-On via On/Off Ctrl (typ)

Conditions: Vin = 36 VDC ▪ Cext=0 µF ▪ Output current: 15 ADC
Channel 1 – On/Off signal Scale : 5 V/div.
Channel 2 – Output voltage Scale: 1 V/div.
Time base = 10 ms/div. Delay time ~ 24 ms (typ.)

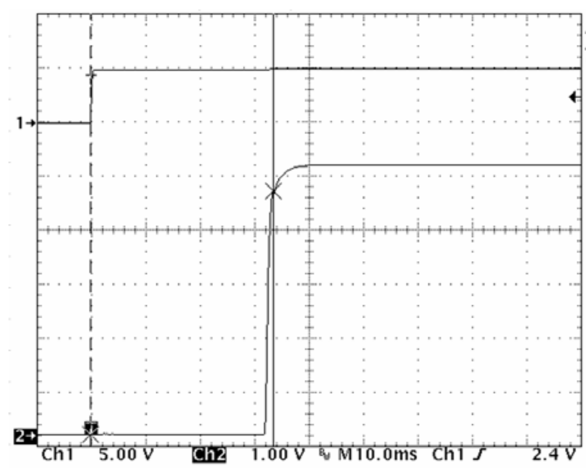


Figure 8. EMS10DG, Turn-On via On/Off Ctrl (typ)

Conditions: Vin = 36 VDC ▪ Cext = 0 µF ▪ Output current: 10 ADC
Channel 1 – On/Off signal Scale : 5 V/div.
Channel 2 – Output voltage Scale: 1 V/div.
Time base = 10 ms/div. Delay time ~ 34 ms (typ.)

Dynamic Load Response (T$_A$ = +25^{o}C, Typ.)

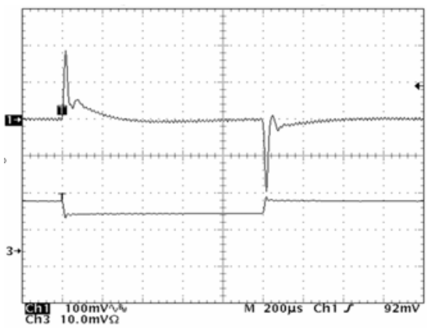


Figure 9. EMS15DE Load Response (typ)

Conditions: Vin = 36V ▪ Iout = 25% Δ with **slew rate: 1.0A/µs**
Cext = 0µF ▪ Scale: 100 mV/div, 200 µs/div.
Channel 1 – Voltage deviation: ~ 200 mV$_P$ (measured)
Channel 3 – Load switched from 11.25 A to 15 A

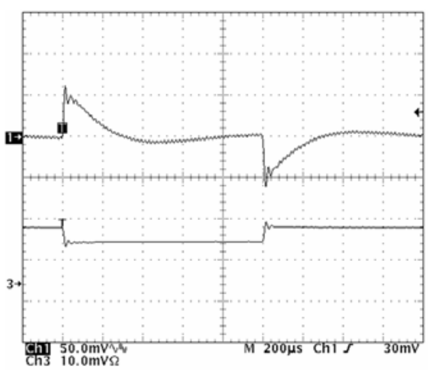


Figure 10. EMS15DE, Load Response (typ)

Conditions: Vin = 36V ▪ Iout = 25% Δ with **slew rate: 1.0A/µs**
Cext = 3,000 µF ▪ Scale: 50 mV/div, 200 µs/div.
Channel 1 – Voltage deviation: ~ 65 mV$_P$ (measured)
Channel 3 – Load switched from 11.25 A to 15 A

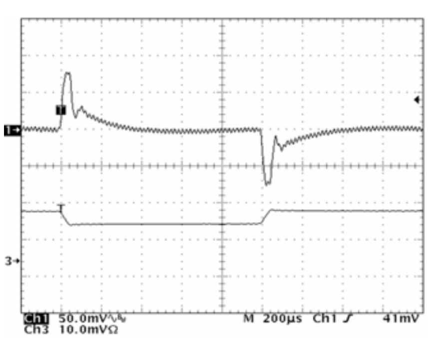


Figure 11. EMS15DE, Load Response (typ)

Conditions: Vin = 36V ▪ Iout = 25% Δ with **slew rate: 0.1A/µs**
Cext = 0 µF ▪ Scale: 50 mV/div, 200 µs/div.
Channel 1 – Voltage deviation: ~ 80 mV$_P$ (measured)
Channel 3 – Load switched from 11.25 A to 15 A

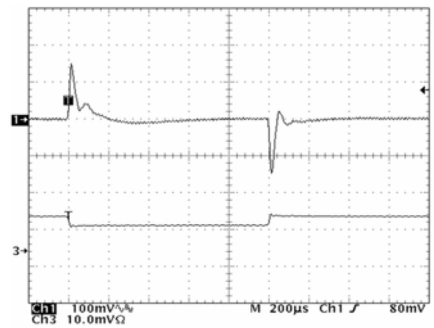


Figure 12. EMS10DG, Load Response (typ)

Conditions: Vin = 36V ▪ Iout = 25% Δ with **slew rate: 1.0A/µs**
Cext = 0µF ▪ Scale: 100 mV/div, 200 µs/div.
Channel 1 –- Voltage deviation: ~ 150 mV$_P$ (measured)
Channel 3 – Load switched from 7.5 A to 10 A

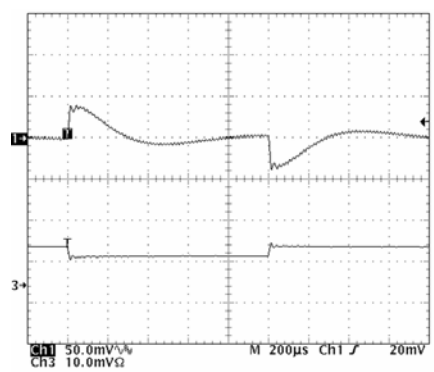


Figure 13. EMS10DG, Load Response (typ)

Conditions: Vin = 36V ▪ Iout = 25% Δ with **slew rate: 1.0A/µs**
Cext = 3,000 µF ▪ Scale: 50 mV/div, 200 µs/div.
Channel 1 – Voltage deviation: ~ 40 mV$_P$ (measured)
Channel 3 – Load switched from 7.5 A to 10 A

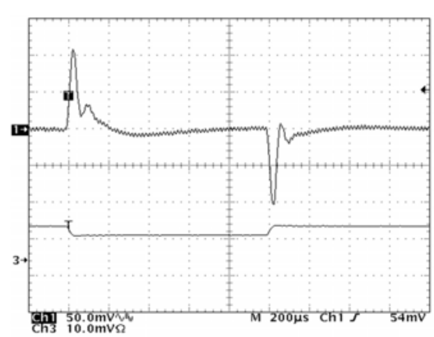


Figure 14. EMS10DG, Load Response (typ)

Conditions: Vin = 36V ▪ Iout = 25% Δ with **slew rate: 0.1A/µs**
Cext = 0 µF ▪ Scale: 50 mV/div, 200 µS/div.
Channel 1 – Voltage deviation: ~ 110 mV$_P$ (measured)
Channel 3 – Load switched from 7.5 A to 10 A

Output Ripple and Noise

(Typical for -40 °C ≤ T_{AMB} ≤ +85 °C, +25 °C shown)

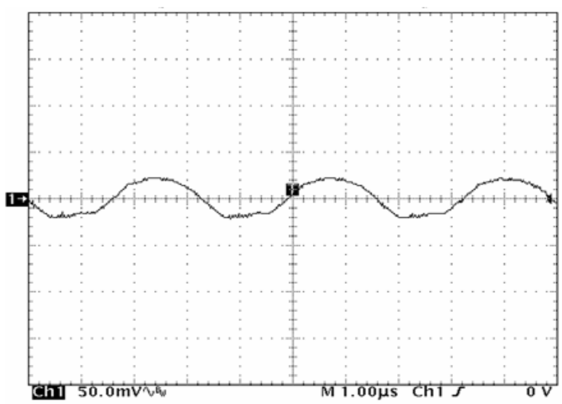


Figure 15. EMS15DE Output Ripple & Noise (typ.)

Conditions: Vin = 60 V ▪ Iout = 15.0 A ▪ T_A = +25 ^{O}C
Channel 1 - Vo, ~46 mV_{P-P} / ~16 mV_{RMS} (measured)

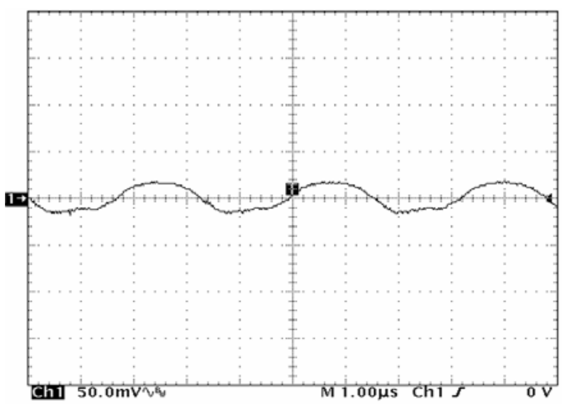


Figure 16. EMS10DG Output Ripple & Noise (typ.)

Conditions: Vin = 60 V ▪ Iout = 10.0 A ▪ T_A = +25 ^{O}C
Channel 1 - Vo, ~35 mV_{P-P} / ~12 mV_{RMS} (measured)

Pre-bias Conditions

The EMS converters will start-up into a pre-bias voltage of 50% Vo_{NOM} without damage.

Overcurrent Protection

When the output is loaded above the maximum output current rating, the voltage of the converter will reduce to maintain the output power at a safe level. In the case of a high overload or short circuit condition where the output voltage is pulled below 50% of Vo-nom, the unit will enter into a “Hiccup” mode of operation. Under this condition, the converter will attempt to restart, typically every 250ms, until the overload has cleared. Because of very low duty cycle, the RMS value of output current is kept low. Once the output current is reduced to within its rated range, the converter automatically exits the hiccup mode and continues normal operation.

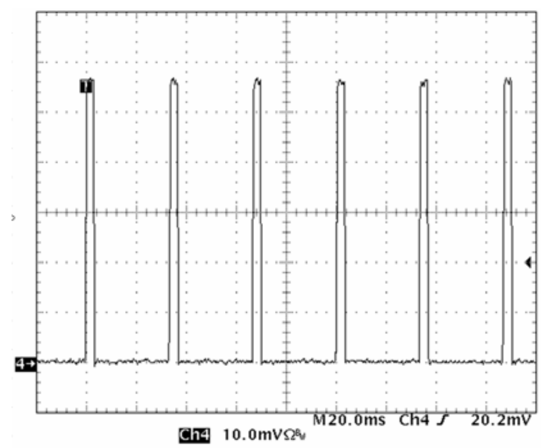


Figure 17, EMS15DE, Short Circuit Behavior (typ.)

Vin=60 VDC ▪ I_{SC} < 8.75 A_{RMS} ▪ Scale: 5A/div.

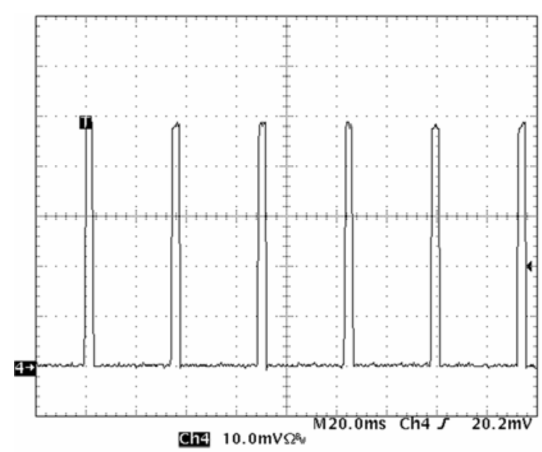


Figure 18, EMS10DG, Short Circuit Behavior (typ.)

Vin=60 VDC ▪ I_{SC} < 7.5 A_{RMS} ▪ Scale: 5A/div.

Overvoltage Protection

The output overvoltage protection consists of a separate control loop, independent of the primary control loop. This secondary control loop has a higher voltage set point than the primary loop. In a fault condition, the converter enters a “Hiccup” mode of operation, and ensures that the output voltage does not exceed V_{ovp} max.

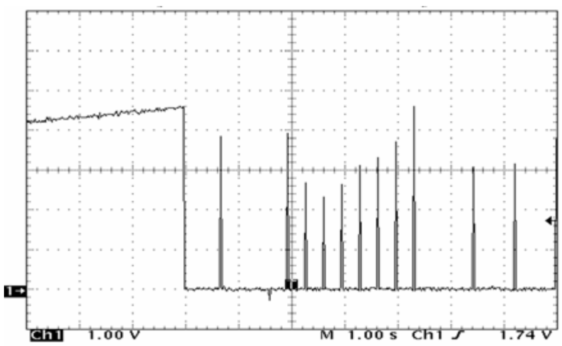


Figure 19. EMS15DE, Induced OVP Behavior (typ.)

Conditions: Vin = 36 V ▪ Iout = 75% load.
Channel 1- Vo, Scale: 1V/div., 1S/div.

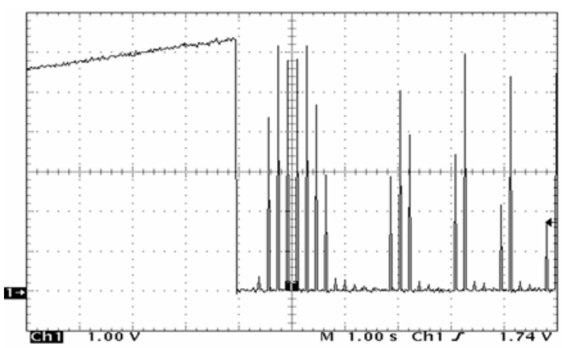


Figure 20. EMS15DG, Induced OVP Behavior (typ.)

Conditions: Vin = 36 V ▪ Iout = 75% load.
Channel 1- Vo, Scale: 1V/div., 1S/div.

Typical Application

Input and Output Impedance

The EMS-Series has been designed for stability without external capacitance when used in low inductance input and output circuits. In many applications, the inductance associated with the distribution of the power source to the input of the power converter can negatively affect a converter’s stability. The addition of a 33 µF electrolytic capacitor with an ESR ≤ 100 mΩ, across the input helps to ensure stability of the converter. This capacitor should be of suitably high quality and rated for effective use at low temperatures as needed.

Refer to the ***“Inrush Current Control Application Note”*** on www.power-one.com for suggestions on how to limit the magnitude of the inrush current.

Additionally, see the EMC section further below in this datasheet for discussion for other external component which may be required for reduction of conducted emissions.

The EMS can support high amounts of output capacitance. Refer to ***“Output Specification”*** tables for details.

Inrush Current

Refer to the ***“Inrush Current Control Application Note”:*** (http://www.power-one.com/technical/articles/dc-dc_1-app.pdf) for suggestions on how to limit the magnitude of the inrush current.

Features Description

ON/OFF Control

(-x) “no suffix” model

With the **positive logic** model, when the ON/OFF pin is pulled low, the output is turned off and the unit draws less than 25 mA of input current. If the ON/OFF pin is not used, it can be left floating.

(-N) suffix model

With **negative logic**, when the ON/OFF pin is pulled low, the unit is turned on. If the ON/OFF pin is not used, it can be connected to the -Vin pin.

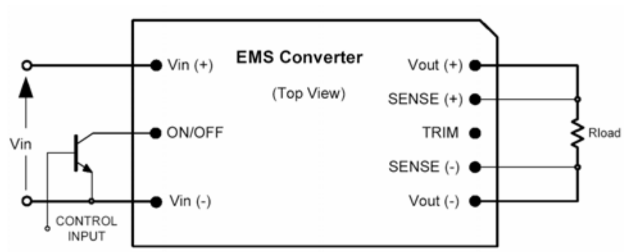


Figure 21. EMS On/Off Control

(Common to –x & –N models)

The ON/OFF pin in the EMS converter functions as a normal soft shutdown. The ON/OFF pin is pulled up internally, so no external voltage source is required or recommended. The user should avoid connecting a resistor between the ON/OFF pin and the +Vin pin. The ON/OFF pin is internally referenced to the –Vin pin. An open collector switch is recommended to control the voltage between these two points.
The controlling signal must not be referenced ahead of EMI filtering, or remotely from the unit. Optical coupling the control signal and locating the opto-coupler directly bat the converter, is recommended for trouble free operation.

Output Voltage Adjustment (Trim)

The Industry Standard Trim feature allows the user to adjust the output voltage from its nominal value. This can be used to accommodate production margin testing.

Output voltage adjustment is accomplished by connecting an external resistor between the **Trim** pin and to either the **+V_{OUT}** or **–V_{OUT}** pins. That below defines the two versions as well as trim equations used to determine a trim resistor value for a certain trim voltage.

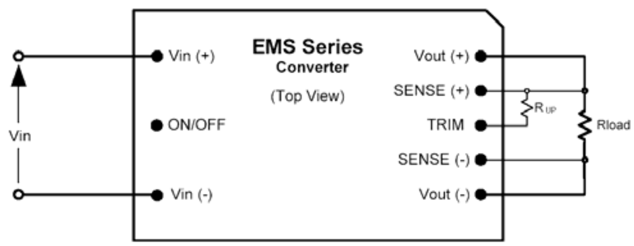


Figure 22. EMS Trim Schematic

With an external resistor (**R_{UP}**) connected between the **Trim** pin and **+V_{OUT}** pin, the output voltage set-point (Vo) increases. The following equation determines the required external resistor value to obtain an adjusted output voltage:

$$R_{UP} = \left(\frac{5.11 \cdot Vout \cdot (100 + \Delta V\%)}{1.225 \Delta V\%} - \frac{511}{\Delta V\%} - 10.22 \right) \cdot K\Omega$$

Where **Δ%** is the percentage change from Vo_{NOM}.

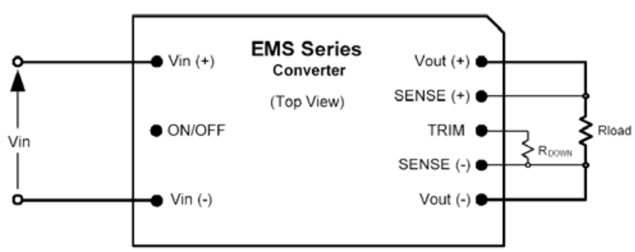


Figure 23. EMS Trim Schematic

With an external resistor (**R_{DOWN}**) between the **Trim** pin and **–V_{OUT}** pin the output voltage set-point (Vo) decreases. The following equation determines the required external resistor value to obtain an adjusted output voltage:

$$R_{DOWN} = \left(\frac{511}{\Delta Vo\%} - 10.22 \right) \cdot K\Omega$$

EMS15DE Trim Values:

Vo Increase			Vo Decrease		
ΔVo%	R_{UP} (KΩ)	New Vo (V_{DC})	ΔVo%	R_{DOWN} (KΩ)	New Vo (V_{DC})
1	869	3.33	1	501	3.27
2	436	3.37	2	245	3.23
3	292	3.40	3	160	3.20
4	220	3.43	4	118	3.17
5	177	3.47	5	92	3.14
6	148	3.50	6	75	3.10
7	127	3.53	7	63	3.07
8	112	3.56	8	54	3.04
9	100	3.60	9	47	3.00
10	90	3.63	10	41	2.97

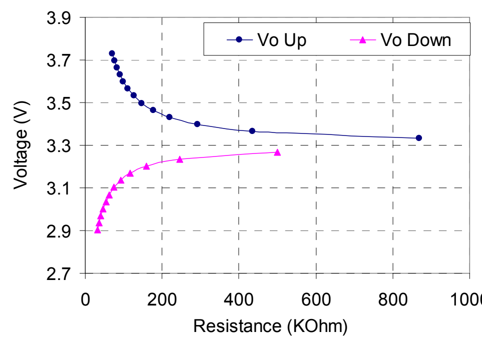


Figure 24. EMS15DE Trim Characteristics

EMS10DG Trim Values

Vo Increase			Vo Decrease		
ΔVo%	R_{UP} (KΩ)	New Vo (V_{DC})	ΔVo%	R_{DOWN} (KΩ)	New Vo (V_{DC})
1	1585	5.05	1	501	4.95
2	798	5.1	2	245	4.90
3	536	5.15	3	160	4.85
4	404	5.2	4	118	4.80
5	326	5.25	5	92	4.75
6	273	5.3	6	75	4.70
7	236	5.35	7	63	4.65
8	207	5.4	8	54	4.60
9	186	5.45	9	47	4.55
10	168	5.5	10	41	4.50

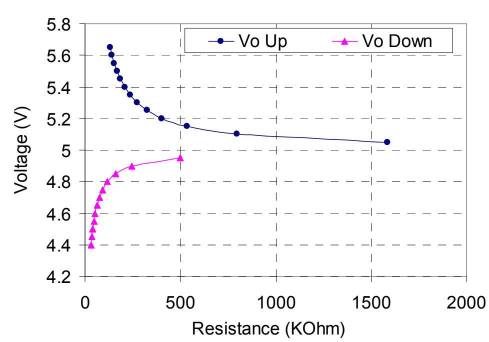


Figure 25. EMS10DG Trim Characteristics

Notes:
1. When the output voltage is trimmed up, the output power from the converter must not exceed its maximum rating. The power is determined by measuring the output voltage on the output pins, and multiplying it by the output current.
2. In order to avoid creating apparent load regulation degradation, it is important that the trim resistors be connected directly to the remote sense pins, and not to the load or to traces going to the load.
3. The output voltage increase can be accomplished either by the trim or by the remote sense or by the combination of both. In any case, the absolute maximum output voltage increase shall not exceed the limits defined in the *Features Specification* section above.
4. Either Rup or Rdown should be used to adjust the output voltage according to the equations above. If both Rup and Rdown are used simultaneously, they will form a resistive divider and the equations above will not apply.

Thermal Considerations

EMS converters are designed for both natural and forced convection cooling. To achieve long term reliability, the recommended power derating curves below, were established by comparing measured junction and hot spot temperatures against those allowed per Power-One's component derating guidelines

The graphs in Figures 27 through 29 and 30 through 32 show the maximum recommended output current of each EMS converter at various ambient temperatures under both natural and forced-convection cooling (longitudinal airflow direction, from pin 1 to pin 3). Ratings at input voltages of 24, 36, and 48 VDC are provided.

Thermal Measurements

Measurements requiring airflow were made in Power-One's vertical wind tunnel equipment using both Infrared (IR) thermography as well as the traditional thermocouple method. The converter was soldered to a test board consisting of a 0.060" thick printed wiring board (PWB) with four layers. The top and bottom layers were not metalized. The two inner layers, comprised of two-ounce copper, were used to provide traces for connectivity to the converter. The lack of metalization on the outer layers as well as the limited thermal connection ensured that heat transfer from the converter to the PWB was minimized. This provides a worst-case but consistent scenario for thermal derating purposes.

With the converter installed into the host application, customer verification that all components are at or below their safe operating temperatures may be performed similarly. However, for a more simplified testing method, monitoring the converter's designated thermal reference point (T_C) will yield effective results.
The recommended location of the measuring thermocouple is shown below. This reference point should be maintained at ≤ 100 °C.

It is recommended to use a 32AWG to 40AWG thermocouple wire probe on the location identified below; labeled **T_C**

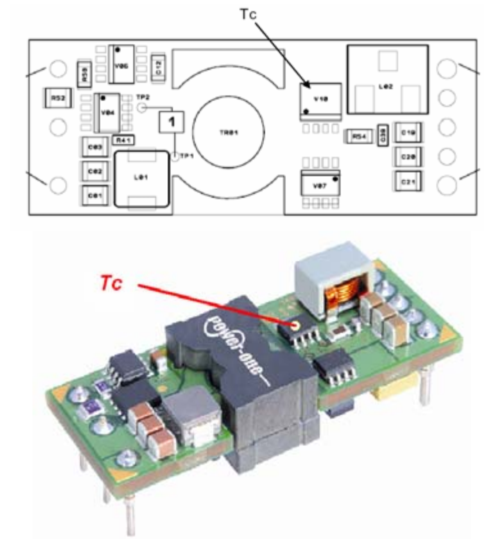


Figure 26. EMS Thermal Reference Point, T_C.

Power Derating *f* (V_{IN}, T_A, Airflow)

Direction of airflow: from –V_{IN} (Pin 1) to +V_{IN} (Pin 3)

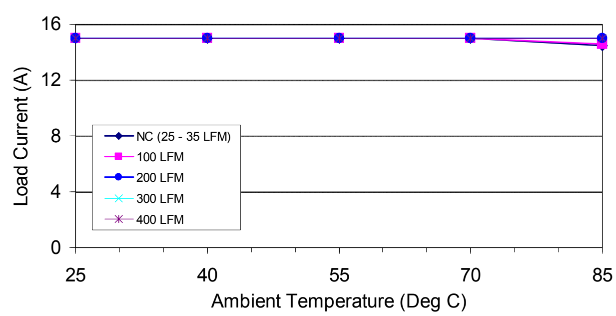


Figure 27. EMS15DE, Vin = 24 VDC

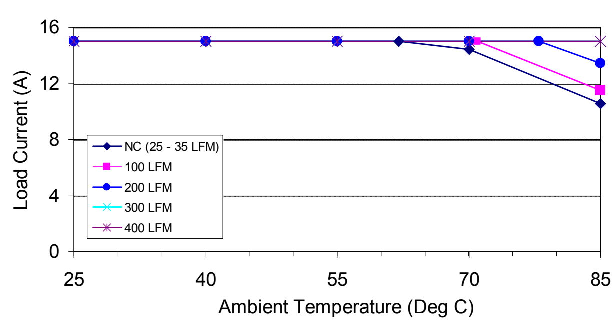


Figure 28. EMS15DE, Vin = 36 VDC

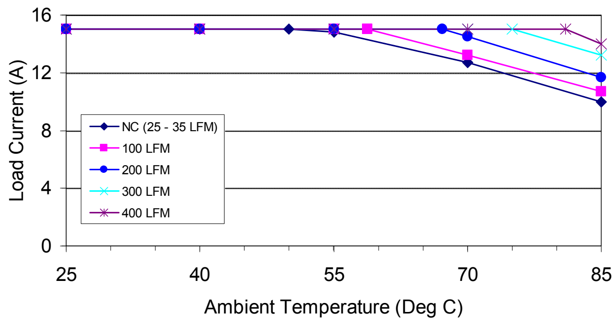


Figure 29. EMS15DE, Vin = 48 VDC

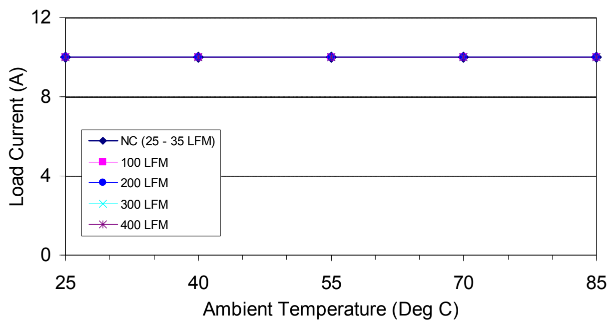


Figure 30. EMS10DG, Vin = 24 VDC

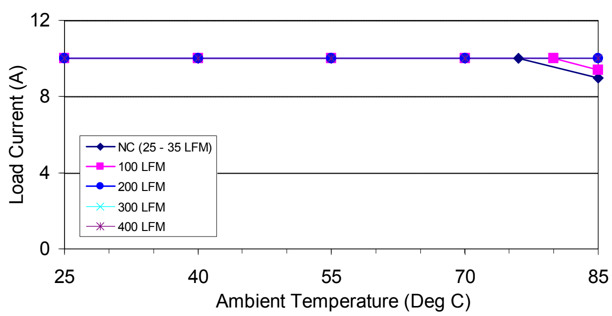


Figure 31. EMS10DG, Vin = 36 VDC

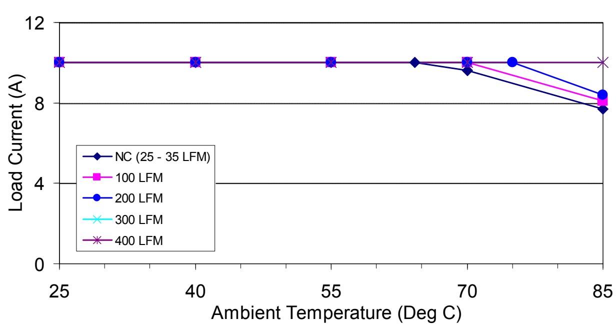


Figure 32. EMS10DG, Vin = 48 VDC

Safety Considerations

The EMS converters feature 1500 VDC isolation from input to output. The input-to-output resistance is greater than 10 MΩ. These converters are provided with Basic insulation between input and output circuits according to all IEC60950 based standards. Nevertheless, if the system using the converter needs to receive safety agency approval, certain rules must be followed in the design of the system. In particular, all of the creepage and clearance requirements of the end-use safety requirements must be observed. These documents include UL60950 - CSA60950-00 and EN60950, although other or additional requirements may be needed for specific applications.

The EMS converter has no internal fuse. **The external fuse must be provided to protect the system from catastrophic failure.** Refer to the “Input Fuse Selection for DC/DC converters” application note on www.power-one.com for proper selection of the input fuse. Both input traces and the chassis ground trace (if applicable) must be capable of conducting a current of 1.5 times the value of the fuse without opening. The fuse must not be placed in the grounded input line, if any.

In order for the output of the EMS converter to be considered as SELV (Safety Extra Low Voltage) or TNV-1, according to all IEC60950 based standards, one of the following requirements must be met in the system design:

- If the voltage source feeding the module is SELV or TNV-2, the output of the converter may be grounded or ungrounded.
- If the voltage source feeding the module is ELV, the output of the converter may be considered SELV only if the output is grounded per the requirements of the standard.
- If the voltage source feeding the module is a Hazardous Voltage Secondary Circuit, the voltage source feeding the module must be provided with at least Basic insulation between the source to the converter and any hazardous voltages. The entire system, including the EMS converter, must pass a dielectric withstand test for Reinforced insulation. Design of this type of system requires expert engineering and understanding of the overall safety requirements and should be performed by qualified personnel.

NOTE: This information is provided for guidance only and the user is responsible for any design considerations regarding safety.

Conducted EMI

The following conducted EMI filter configuration and component values are offered as a guideline to assist in designing an effective filter solution in the actual application. Many factors can affect overall EMI performance; such as layout, wire routing and load characteristics, among others. As a result, the final circuit configuration and component values may require adjustment.

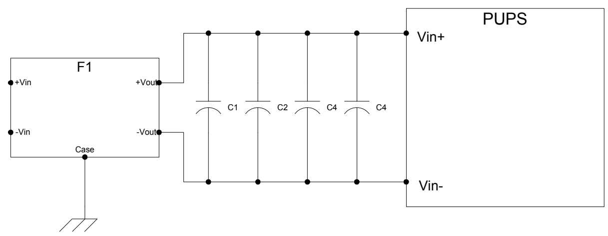


Figure 33. EMI Filter Configuration

Ref. Des	Description	Manufacturer
C1 – C4	Not Used	N/A
F1	F4810 Input Filter Module	Power-One

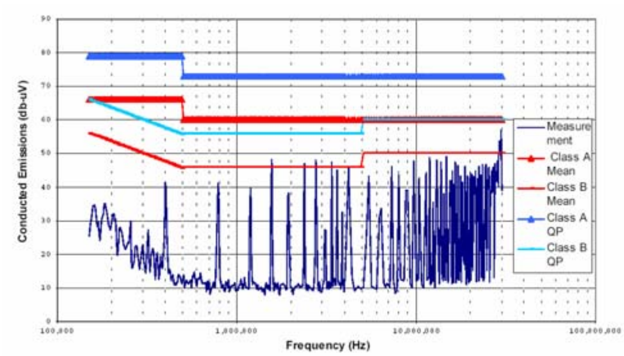


Figure 34. Conducted EMI Scan of the EMS10DG

(w/ Input Filter Components Designated in Table Above.)

Test conditions: Vin = 36 VDC, Io = 100% rated (50W)

Test Specification: (CISPR-22) NE55022 Class A (Peak Detect)

Other Measurement Methods

To improve the accuracy and repeatability of ripple and noise measurements, Power-One utilizes the test setups shown in Figure 35 & 36 below.

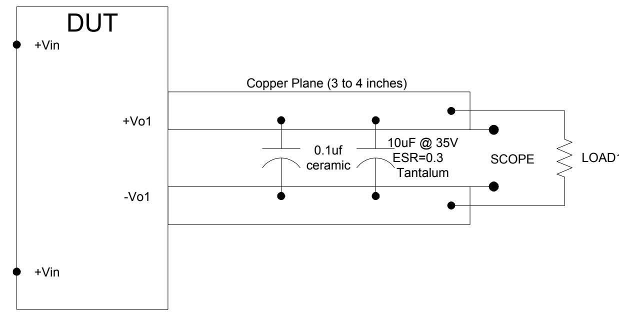


Figure 35. Output Ripple and Noise Set-up.

A BNC connector is used for measurements to eliminate noise pickup associated with long ground leads of conventional scope probes. The load is located 3" - 4" away from the converter.

For output decoupling, we recommend using a 10μF low ESR tantalum (AVX TPSC106M025R0500 is used in Power-One test setup) and a 0.1 μF ceramic capacitor. Note that the capacitors do not substitute for filtering required by the load.

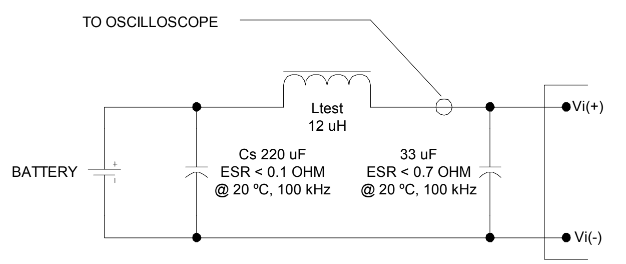
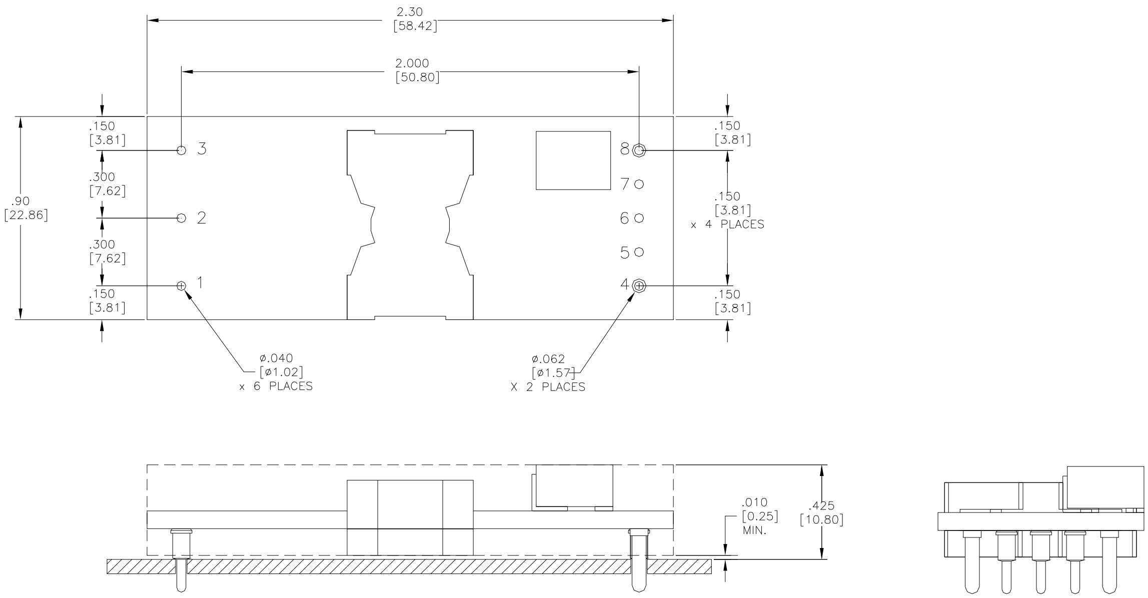


Figure 36. Input Reflected Ripple Current Setup.

Note: Measure input reflected-ripple current with a simulated inductance (Ltest) of 12 μH. Capacitor C_S offsets possible battery impedance. Measure current as shown above.

Mechanical Drawing



Mechanical Tolerances & Finishes:		
General Dimensions	Millimeters	Inches
Tolerances	X.X = ±0.5	X.XX = ±0.020
	X.XX ±0.25	X.XXX = ±0.010
Distance from tallest converter component to host board	0.25 MIN	0.010 MIN
Pins		
Diameter	±0.05	±0.002
Length	±0.5	+/-.020
Shoulder Diameter		
Pins: 1-3 & 5-7	1.80	0.076
Pins: 4 & 8	n/a	n/a
Material & Finish	Brass w/ matte Sn over Ni	

Pin Assignments	Function
1	-Vin
2	On/Off
3	+Vin
4	-Vout
5	-Sense
6	Trim
7	+Sense
8	+Vout

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Ordering Information

Series Name	# of Outputs	I_{out} (ADC)	V_{in} Range (VDC)	V_{out} (VDC)	-	OPTIONS (Suffixes) On/Off Logic	OPTIONS (Suffixes) Pin Length	OPTIONS (Suffixes) RoHS
EM	**S**	##	**D**	***w***	**-**	***x***	***y***	**G**
E = 1/8th Brick	**S**ingle output	15	18 to 60 ⟷	**E** = 3.3Vo	**-**	**none** = Pos. **N** = Neg.	**none** = 4.77mm [0.188"] **7** = 3.68mm [0.145"] **8** = 2.79mm [0.110"]	No Suffix ⇒ RoHS lead-solder-exemption compliant G ⇒ RoHS compliant for all six substances
		10	⟷	**G** = 5.0Vo				

Example: EMS at 5.0 Vo with negative logic, and 3.68 mm [0.145"] length pins, and RoHS compliant for all six substances = EMS10DG-N7G

Notes

1. Consult factory for the complete list of available options.

NUCLEAR AND MEDICAL APPLICATIONS - Power-One products are not designed, intended for use in, or authorized for use as critical components in life support systems, equipment used in hazardous environments, or nuclear control systems without the express written consent of the respective divisional president of Power-One, Inc.

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