MHV Single, Dual and Triple DC-DC Converters

28 VOLT INPUT – 15 WATT

FEATURES

No cross regulation on dual outputs

- Operating temperature -55°C to +125°C
- Input voltage range 16 to 50 volts
- Transient protection 80 V for 120 ms
  - 12 V_{OUT} single and dual to 75 volts
  - 15 V_{OUT} single and dual to 60 volts
- Fully isolated
- Fixed frequency switching
- Output trim on single output models
- Inhibit and sync functions
- Undervoltage lockout

MODELS OUTPUT VOLTAGE (V)		
SINGLE	DUAL	TRIPLE
3.3	±5	+5 & ±12
5	±12	+5 & ±15
12	±15	
15		

DESCRIPTION

The Interpoint® MHV Series™ of dc-dc converters offers a wide input voltage range of 16 to 50 volts and a choice of nine different output voltage configurations comprised of single, dual or triple outputs. The 3.3 volt single, 5 volt single and dual and the triple output models will withstand transients of up to 80 volts for up to 120 milliseconds while maintaining output voltages. The 12 volt single and dual outputs will withstand transients up to 75 volts and the 15 volt single and dual outputs will withstand up to 60 volts for 120 milliseconds. The MHV Series operates at 15 watts of output power (10 watts for the 3.3 volt single output) over the military temperature range of -55°C to +125°C while maintaining low input and output noise.

Converter Design

MHV Series dc-dc converters are switching regulators that use continuous flyback conversion topology with a clock frequency of approximately 600 kHz. MHV Series converters incorporate two pulse width modulators (PWM) with one PWM phase shifted 180° from the other to create a dual phase/phase-shifted operation. Each of the PWMs operates at approximately one-half (300 kHz) of the clock frequency. This proprietary technology minimizes input ripple and improves efficiency. On singles the output ripple is reduced. Cross regulation is eliminated on dual output models which are independently regulated and do not require load balancing or minimum loading. On triple output models, this design provides completely independent regulation with no cross regulation effect between the main and auxiliary outputs and no minimum loading is required on the main output.

Inhibit Function

The converter is enabled when the inhibit terminal is left unconnected. When the inhibit terminal is pulled low (<0.8 V) the converter shuts down, typically drawing 8.4 mA at 28 V_{IN} or 15 mA at 50 V_{IN}. Sinking current required is V_{IN} / 3.3 k ohm. For more information see Table 7 on page 7.

Synchronization Function

Applying an external signal of 40% to 60% duty cycle and 490 to 710 kHz for single and dual output models will synchronize the converter to your system requirements. For triple output models the external frequency range is 500 to 700 kHz. Free run clock frequency is approximately 600 kHz. If not used, the sync terminal must be left unconnected. See Table 7 on page 7

Trim

Single output converters feature a trim range of as low as 80% to as high as 110% of V_{OUT} nominal, depending on the model. To trim up, connect a resistor from Output Common (pin 4) to Trim (pin 3). To trim down, connect a resistor from the Positive Output (pin 5) to Trim (pin 3). For more information see Table 1, Table 2 and Figure 6 on page 4.

Screening

The converters are offered with standard screening, “ES” screening, or fully compliant to “883” MIL-PRF-38534 Class H screening. See Table 13 on page 20 and Table 14 on page 21. Standard microcircuit drawings (SMD) are available. See Table 5 on page 6.

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Undervoltage Lockout

An undervoltage lockout of approximately 7 volts keeps system current levels low during startup. Low line dropout typically occurs at approximately 12 V_{IN} to 17 V_{IN} depending on model. See “Figure 13” and “Figure 14” on page 13 and “Figure 23” on page 14.

Short Circuit Protection

Under short circuit conditions of 130% or more of full load current, the converter will protect itself by shutting down. Short circuit duration should be brief because power dissipation may cause internal temperatures to rise rapidly. Restart is automatic upon removal of the short circuit.

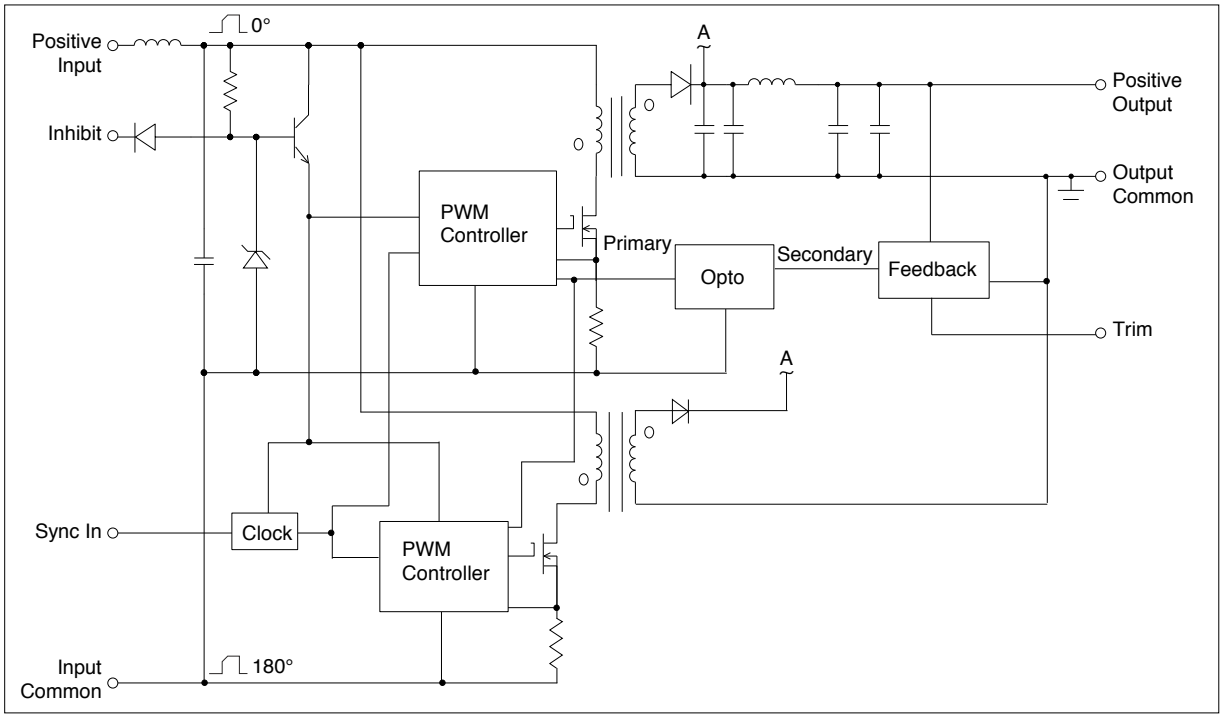

FIGURE 1: MHV SINGLE BLOCK DIAGRAM

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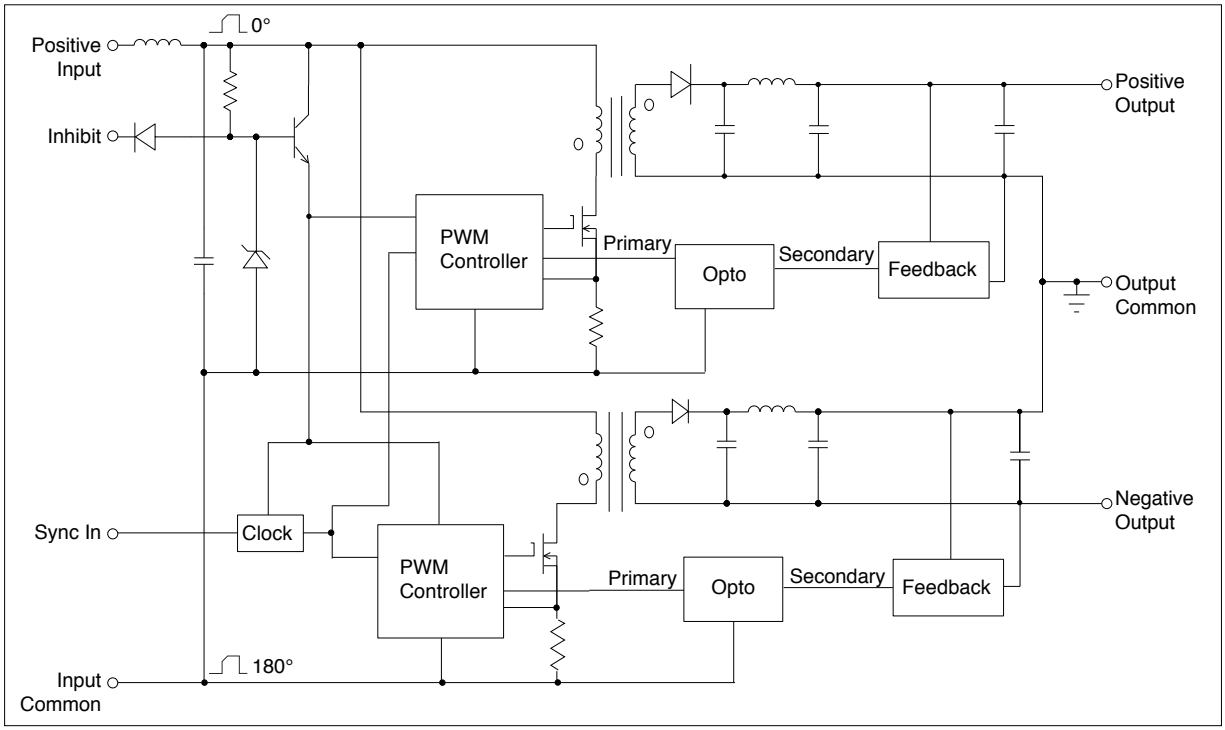

FIGURE 2: MHV DUAL BLOCK DIAGRAM

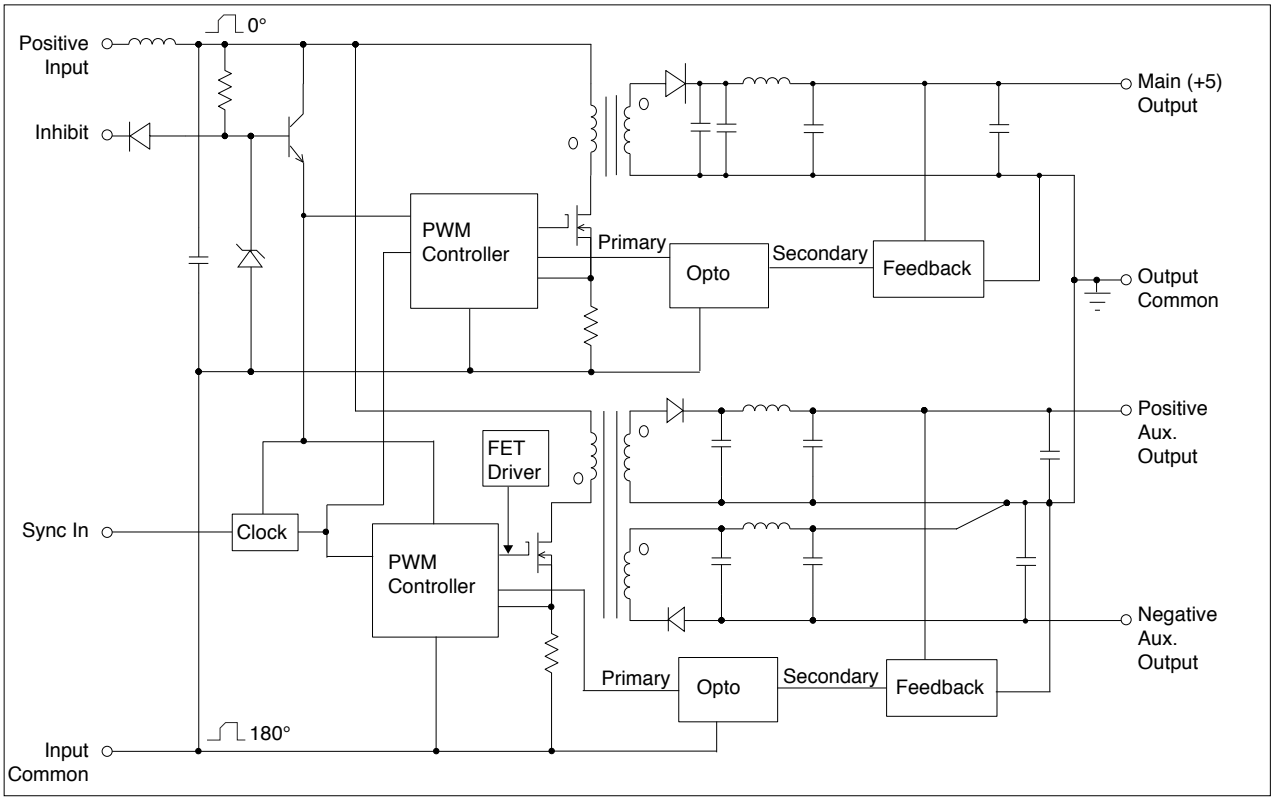

FIGURE 3: MHV TRIPLE BLOCK DIAGRAM

MHV Single, Dual and Triple DC-DC Converters

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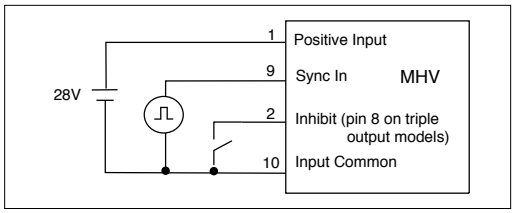
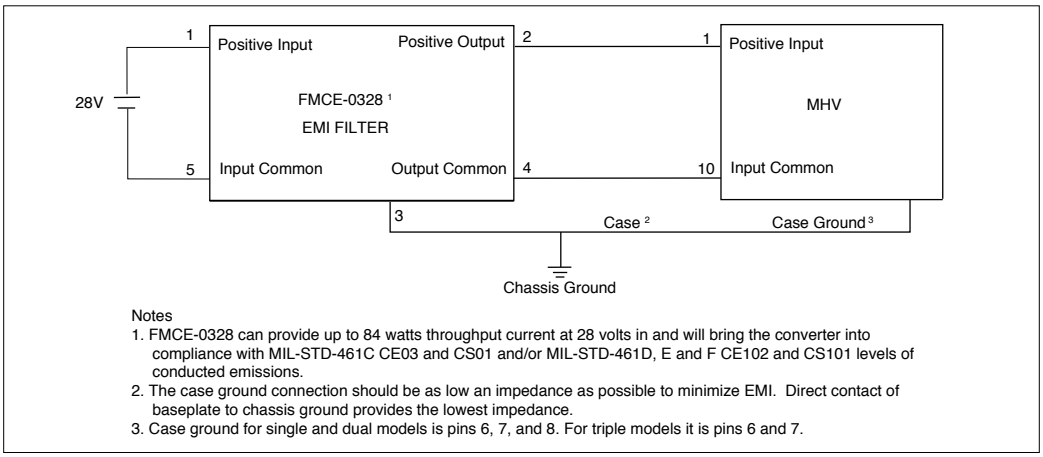


FIGURE 4: TYPICAL CONNECTIONS



Notes
1. FMCE-0328 can provide up to 84 watts throughput current at 28 volts in and will bring the converter into compliance with MIL-STD-461C CE03 and CS01 and/or MIL-STD-461D, E and F CE102 and CS101 levels of conducted emissions.
2. The case ground connection should be as low an impedance as possible to minimize EMI. Direct contact of baseplate to chassis ground provides the lowest impedance.
3. Case ground for single and dual models is pins 6, 7, and 8. For triple models it is pins 6 and 7.

FIGURE 5: EMI FILTER CONNECTION

SINGLE OUTPUT TRIM

TRIM TABLE						
MODEL	V_{OUT} NOMINAL					
	110%	106%	102%	95%	90%	80%
	R_{TRIM} (R_T) kΩ					
MHV283R3S	18	36	128	4	N/A	N/A
MHV2805S	8	20	81	23	5	N/A
MHV2812S	N/A	19	116	177	67	11
MHV2815S	0.3	21	122	255	104	28

TABLE 1: TRIM TABLE

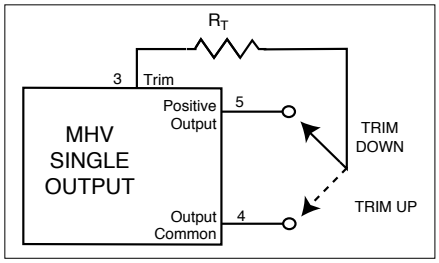


FIGURE 6: MHV SINGLE OUTPUT TRIM

Trim down: $R_T\ (k\Omega) = \left(\frac{(V_o - 2.5)}{V_{o\ nominal} - V_o}\right) A - B$

Trim up: $R_T\ (k\Omega) = \left(\frac{2.5\ A}{V_o - V_{o\ nominal}}\right) - B$

V_O = desired output voltage

FORMULA 1: MHV SINGLE OUTPUT TRIM

FORMULA VALUE BY MODEL				
MODEL	3.3 V	5 V	12 V	15 V
A	3.7	3.7	14	18.2
B	10	10	30	30

TABLE 2: FORMULA VALUES BY MODEL

Notes
If calculated result is a negative value, the desired output voltage is outside the allowed trim range.
Calculated values of R_T are ±15%.
When trimming up, do not exceed the maximum output power.
When trimming down, do not exceed the maximum output current.

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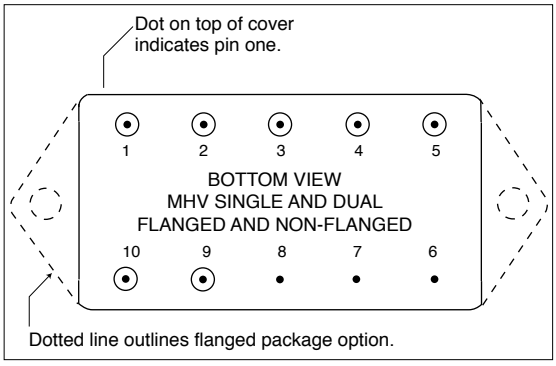
PIN OUT			
Pin	**Single Output**	**Dual Output**	**Triple Output**
1	Positive Input	Positive Input	Positive Input
2	Inhibit	Inhibit	Main (+5) Output
3	Trim	Positive Output	Output Common
4	Output Common	Output Common	Negative Aux. Output
5	Positive Output	Negative Output	Positive Aux. Output
6, 7	Case Ground	Case Ground	Case Ground
8	Case Ground	Case Ground	Inhibit
9	Sync In	Sync In	Sync In
10	Input Common	Input Common	Input Common

TABLE 3: PIN OUT

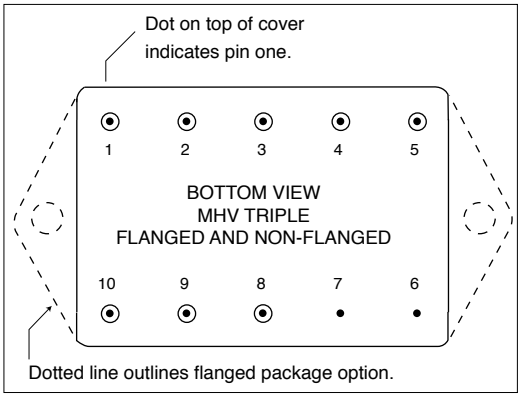
PINS NOT IN USE	
Case	User discretion. For best EMI performance, connect to chassis ground.
Inhibit	Leave unconnected
Sync In	Leave unconnected

TABLE 4: PINS NOT IN USE



See Figure 30 on page 17 and Figure 32 on page 19 for dimensions.

FIGURE 7: PIN OUT SINGLES AND DUALS



See Figure 29 on page 16 and Figure 31 on page 18 for dimensions.

FIGURE 8: PIN OUT TRIPLE

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MODEL NUMBERING KEY

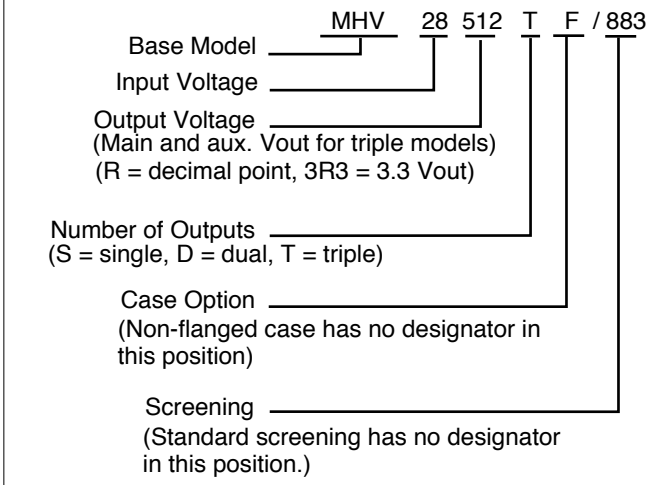

FIGURE 9: MODEL NUMBERING KEY

SMD NUMBERS

STANDARD MICROCIRCUIT DRAWING (SMD)	MHV SIMILAR PART
5962-9852801HXC	MHV283R3S/883
5962-9852201HXC	MHV2805S/883
5962-9852301HXC	MHV2812S/883
5962-9852401HXC	MHV2815S/883
5962-9852501HXC	MHV2805D/883
5962-9852601HXC	MHV2812D/883
5962-9852701HXC	MHV2815D/883
5962-9673001HXC	MHV28512T/883
5962-9673101HXC	MHV28515T/883

Flanged SMDs have the suffix HZC instead of HXC.
For exact specifications for an SMD product, refer to the SMD drawing. SMDs can be downloaded from www.landandmaritime.dla.mil/programs/smcr

TABLE 5: SMD CROSS REFERENCE

MODEL NUMBER OPTIONS [1]

TO DETERMINE THE MODEL NUMBER ENTER ONE OPTION FROM EACH CATEGORY IN THE FORM BELOW.

CATEGORY	Base Model and Input Voltage	Output Voltage [2]	Number of Outputs [3]	Case Option [4]	Screening [5]
OPTIONS	MHV28	3R3, 05, 12, 15	S	(non-flanged, leave blank)	Standard (leave blank)
		05, 12, 15	D	F (flanged)	/ES
		512, 515	T		/883 (Class H)
FILL IN FOR MODEL #	MHV28	_____	_____	_____	/ _____

Notes
1. See Figure 9, above, for an example of a model number.
2. Output Voltage: An R indicates a decimal point. 3R3 is 3.3 volts out. The value of 3R3 is only available in single output models. The 512 and 515 triple output converters are +5 volt main and ±12 or ±15 volt auxiliaries.
3. Number of Outputs: S is a single output, D is a dual output, and T is a triple output
4. Case Options: For the standard case (non-flanged, Figure 30 on page 17 and Figure 29 on page 16) leave the case option blank. For the flanged case (Figure 32 on page 19 and Figure 31 on page 18) use an F in the case option.
5. Screening: For standard screening leave the screening option blank. For other screening options, insert the desired screening level. For more information see Table 13 on page 20 and Table 14 on page 21.

TABLE 6: MODEL NUMBER OPTIONS

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TABLE 7: OPERATING CONDITIONS, ALL MODELS, 25°C CASE, 28 VIN, 100% LOAD, UNLESS OTHERWISE SPECIFIED.

		ALL MODELS			
PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
LEAD SOLDERING TEMPERATURE [1]	10 SECONDS MAX.	—	—	300	°C
STORAGE TEMPERATURE [1]		-65	—	+150	°C
CASE OPERATING TEMPERATURE	FULL POWER	-55	—	+125	°C
	ABSOLUTE [1]	-55	—	+135	
DERATING OUTPUT POWER/CURRENT [1]	LINEARLY	From 100% at 125°C to 0% at 135°C			
ISOLATION: INPUT TO OUTPUT OR ANY PIN TO CASE EXCEPT CASE PIN	@ 500 VDC AT 25°C	100	—	—	Megohms
UNDER VOLTAGE LOCKOUT		—	7	—	V
LOW LINE DROPOUT [1]	DEPENDING ON MODEL	—	12-17	—	V
CURRENT LIMIT [2]	% OF FULL LOAD	—	130	—	%
AUDIO REJECTION [1]		—	30	—	dB
CONVERSION FREQUENCY	SINGLES AND DUALS	490	600	710	kHz
FREE RUN -55° TO +125°C	TRIPLES	500	600	700	
SYNCHRONIZATION	INPUT FREQUENCY				
	SINGLES AND DUALS	490	—	710	kHz
	TRIPLES	500	—	700	
	DUTY CYCLE [1]	40	—	60	%
	ACTIVE LOW	—	—	0.8	V
	ACTIVE HIGH [1]	4.5	—	10	
	REFERENCED TO	INPUT COMMON			
	IF NOT USED	LEAVE UNCONNECTED			
INHIBIT ACTIVE LOW (OUTPUT DISABLED)	INHIBIT PIN PULLED LOW	—	—	0.8	V
Do not apply a voltage to the inhibit pin. [3, 4]	INHIBIT PIN SOURCE CURRENT [1]	—	—	8.4	mA
	REFERENCED TO	INPUT COMMON			
INHIBIT ACTIVE HIGH (OUTPUT ENABLED)	INHIBIT PIN CONDITION	OPEN COLLECTOR OR UNCONNECTED			
Do not apply a voltage to the inhibit pin. [3]	OPEN INHIBIT PIN VOLTAGE [1]	—	11	—	V

Notes
1. Guaranteed by design and/or analysis. Not an in-line test.
2. Dual and triple outputs: The over-current limit will trigger when the sum of the currents from both dual outputs or both auxiliary outputs (triple) reaches the maximum rated “total” current of both outputs. Typical values are stated in the table.
3. An external inhibit interface should be used to pull the inhibit low or leave it floating. The inhibit pin can be left unconnected if not used.
4. Sinking current required is V_{IN} / 3.3 kΩ.

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TABLE 8: ELECTRICAL CHARACTERISTICS -55°C TO +125°C CASE, 28 VIN, 100% LOAD, FREE RUN, UNLESS OTHERWISE SPECIFIED.

SINGLE OUTPUT MODELS		MHV283R3S			MHV2805S			
PARAMETER	CONDITIONS	MIN	TYP	MAX	MIN	TYP	MAX	UNITS
OUTPUT VOLTAGE		3.23	3.30	3.37	4.90	5.00	5.10	V
OUTPUT CURRENT	V_{IN} = 16 TO 50 V	0	—	3.03	0	—	3.00	A
OUTPUT POWER	VIN = 16 TO 50 V	0	—	10	0	—	15	W
OUTPUT RIPPLE	T_C = 25°C	—	5	20	—	5	20	mV p-p
10 kHZ - 2 MHZ	TC = -55°C TO +125°C	—	—	25	—	—	25	
LINE REGULATION	V_{IN} = 16 TO 50 V	–	0	10	—	0	10	mV
LOAD REGULATION	NO LOAD TO FULL	–	15	35	—	15	45	mV
INPUT VOLTAGE	CONTINUOUS	16	28	50	16	28	50	V
NO LOAD TO FULL	TRANSIENT 120 ms [1]	—	—	80	—	—	80	V
INPUT CURRENT	NO LOAD	—	34	45	—	44	55	mA
	INHIBITED	—	8.4	10	—	8.4	10	
INPUT RIPPLE CURRENT	10 kHz - 10 MHz	—	10	45	—	10	40	mA p-p
EFFICIENCY	T_C = 25°C	69	72	—	74	77	—	%
	T_C = -55°C TO +125°C	68	—	–	73	—	—	
LOAD FAULT [2]	POWER DISSIPATION	—	—	7.5	—	—	9	W
SHORT CIRCUIT	RECOVERY [1]	—	—	20	—	—	20	ms
STEP LOAD RESPONSE [3]	TRANSIENT	—	—	±350	—	—	±350	mV pk
50% - 100% - 50%	RECOVERY	—	—	1.2	—	—	2	ms
STEP LINE RESPONSE [1, 4]	TRANSIENT	—	—	±175	—	—	±550	mV pk
16 - 50 - 16 V	RECOVERY	—	—	0.90	—	—	2.0	ms
START-UP	DELAY	–	14	20	—	14	20	ms
	OVERSHOOT [1]	—	0	150	—	0	100	mV pk
CAPACITIVE LOAD [1, 5]	25°C	–	–	200	–	–	200	µF

Notes
1. Guaranteed by design and/or analysis. Not an in-line test.
2. Load fault is a short circuit (<50 mΩ). Recovery is into a resistive load.
3. Step load transition ≥ 10 µs. Recovery = time to settle to within 1% of V_{OUT} final value.
4. Step line transition ≥ 10 µs. Recovery = time to settle to within 1% of V_{OUT} final value.
5. No effect on dc performance.

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TABLE 9: ELECTRICAL CHARACTERISTICS -55°C TO +125°C CASE, 28 VIN, 100% LOAD, FREE RUN, UNLESS OTHERWISE SPECIFIED.

SINGLE OUTPUT MODELS		MHV2812S			MHV2815S			
PARAMETER	CONDITIONS	MIN	TYP	MAX	MIN	TYP	MAX	UNITS
OUTPUT VOLTAGE		11.76	12.00	12.24	14.70	15.00	15.30	V
OUTPUT CURRENT	V_{IN} = 16 TO 50 V	0	—	1.25	0	—	1.00	A
OUTPUT POWER	VIN = 16 TO 50 V	0	—	15	0	—	15	W
OUTPUT RIPPLE	T_C = 25°C	—	5	20	—	5	20	mV p-p
10 kHZ - 2 MHZ	TC = -55°C TO +125°C	—	—	25	—	—	25	
LINE REGULATION	V_{IN} = 16 TO 50 V	–	1	12	—	4	15	mV
LOAD REGULATION	NO LOAD TO FULL	–	8	35	—	10	40	mV
INPUT VOLTAGE	CONTINUOUS	16	28	50	16	28	50	V
NO LOAD TO FULL	TRANSIENT 120 ms [1]	—	—	75	—	—	60	V
INPUT CURRENT	NO LOAD	—	43	58	—	45	65	mA
	INHIBITED	—	8.4	10	—	8.4	10	
INPUT RIPPLE CURRENT	10 kHz - 10 MHz	—	10	40	—	10	40	mA p-p
EFFICIENCY	T_C = 25°C	79	81	—	78	81	—	%
	T_C = -55°C TO +125°C	78	—	–	76	—	—	
LOAD FAULT [2]	POWER DISSIPATION	—	—	7.5	—	—	7.5	W
SHORT CIRCUIT	RECOVERY [1]	—	—	20	—	—	20	ms
STEP LOAD RESPONSE [3]	TRANSIENT	—	—	±400	—	—	±550	mV pk
50% - 100% - 50%	RECOVERY	—	—	1.5	—	—	1.5	ms
STEP LINE RESPONSE [1, 4]	TRANSIENT	—	—	±550	—	—	±650	mV pk
16 - 50 - 16 V	RECOVERY	—	—	2.5	—	—	2.5	ms
START-UP	DELAY	–	14	20	—	14	20	ms
	OVERSHOOT [1]	—	0	240	—	0	300	mV pk
CAPACITIVE LOAD [1, 5]	25°C	–	–	200	–	–	200	µF

Notes
1. Guaranteed by design and/or analysis. Not an in-line test.
2. Load fault is a short circuit (<50 mΩ). Recovery is into a resistive load.
3. Step load transition ≥ 10 µs. Recovery = time to settle to within 1% of V_{OUT} final value.
4. Step line transition ≥ 10 µs. Recovery = time to settle to within 1% of V_{OUT} final value.
5. No effect on dc performance.

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TABLE 10: ELECTRICAL CHARACTERISTICS -55°C TO +125°C CASE, 28 VIN, 100% LOAD, FREE RUN, UNLESS OTHERWISE SPECIFIED.

DUAL OUTPUT MODELS		MHV2805D			MHV2812D			MHV2815D			
PARAMETER	CONDITIONS	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	UNITS
OUTPUT VOLTAGE	±VOUT	4.90	5.00	5.10	11.76	12.00	12.24	14.70	15.00	15.30	V
OUTPUT CURRENT	EITHER OUTPUT	0	—	1.5	0	—	0.625	0	—	0.50	A
VIN = 16 TO 50 V	TOTAL	—	—	3	—	—	1.25	—	—	1.0	
OUTPUT POWER 2	EITHER OUTPUT	0	—	7.5	0	—	7.5	0	—	7.5	W
VIN = 16 TO 50 V	TOTAL	—	—	15	—	—	15	—	—	15	
OUTPUT RIPPLE	TC = 25°C	—	5	30	—	5	20	—	10	40	mV p-p
$\pm V_{OUT}$, 10 kHz - 2 MHz	TC = -55°C TO +125°C	—	—	35	—	—	25	—	—	50	
LINE REGULATION BALANCED LOADS	VIN = 16 TO 50 V	—	0	10	—	0	10	—	0	10	mV
LOAD REGULATION	NO LOAD TO FULL	—	5	20	—	2	20	—	2	20	mV
INPUT VOLTAGE	CONTINUOUS	16	28	50	16	28	50	16	28	50	V
NO LOAD TO FULL	TRANSIENT 120 ms [1]	—	—	80	—	—	75	—	—	60	V
INPUT CURRENT	NO LOAD	—	22	30	—	32	43	—	37	50	mA
	INHIBITED	—	8.4	10	—	8.4	10	—	8.4	10	
INPUT RIPPLE CURRENT	10 kHz - 10 MHz	—	5	40	—	5	40	—	10	45	mA p-p
EFFICIENCY	TC = 25°C	77	79	—	81	83	—	80	83	—	%
	TC = -55°C TO +125°C	75	—	—	79	—	—	78	—	—	
LOAD FAULT 3	POWER DISSIPATION	—	—	8.5	—	—	10	—	—	10	W
SHORT CIRCUIT	RECOVERY [1]	—	—	20	—	—	25	—	—	30	ms
STEP LOAD RESPONSE [4]	50% - 100% - 50% TRANSIENT	—	—	±350	—	—	±400	—	—	±500	mV pk
	RECOVERY	—	—	3.0	—	—	1.5	—	—	1.5	ms
STEP LINE RESPONSE [1, 5]	TRANSIENT	—	—	±400	—	—	±500	—	—	±500	mV pk
16 - 50 - 16 VIN ±VOUT	RECOVERY	—	—	4.0	—	—	3.0	—	—	3.0	ms
START-UP [6]	+VOUT DELAY	—	10	18	—	10	20	—	12	22	ms
	-VOUT DELAY	—	10	20	—	10	25	—	12	30	
	OVERSHOOT [1]	—	0	100	—	0	240	—	0	300	mV pk
CAPACITIVE LOAD [1, 7]	TC = 25°C	—	—	100	—	—	100	—	—	100	µF

Notes
1. Guaranteed by design and/or analysis. Not an in-line test.
2. Up to 7.5 watts is available from either output.
3. Load fault is a short circuit (<50 mΩ). Recovery is into a resistive load.
4. Step load transition ≥ 10 µs. Recovery = time to settle to within 1% of V_{OUT} final value.
5. Step line transition ≥ 10 µs. Recovery = time to settle to within 1% of V_{OUT} final value.
6. At inputs above 40 volts with temperatures above approximately 100°C, to ensure start-up, transition time should be greater than 5 ms and use of the inhibit function should be avoided.
7. Applicable to each output. No effect on dc performance.

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TABLE 11: ELECTRICAL CHARACTERISTICS -55°C TO +125°C CASE, 28 VIN, 100% LOAD, FREE RUN, UNLESS OTHERWISE SPECIFIED.

TRIPLE OUTPUT MODEL – MHV28512T		5 (MAIN)			±12 (AUXILIARIES)			
PARAMETER	CONDITIONS	MIN	TYP	MAX	MIN	TYP	MAX	UNITS
OUTPUT VOLTAGE	MAIN AND POS. AUX	4.90	5.00	5.10	11.76	12.00	12.24	V
	NEG. AUX.				-11.70	-12.00	-12.30	
OUTPUT CURRENT [2]		0	—	2.0	0	±0.208	0.333 [1]	A
V_{IN} = 16 TO 50 V	MAX TOTAL AUX	—	—	—	—	—	0.416	
OUTPUT POWER [3]		0	—	10	0	±2.50	4.00 [1]	W
V_{IN} = 16 TO 50 V	MAX TOTAL AUX	—	—	—	—	—	5	
OUTPUT RIPPLE	T_C = 25°C	—	8	20	—	9	20	mV p-p
$\pm V_{OUT}$, 10 kHZ - 2 MHZ	T_C = -55°C TO +125°C	—	—	22	—	—	22	
LINE REGULATION	MAIN AND POS. AUX	—	0	5	—	5	35	mV
V_{IN} = 16, 50 V	NEG. AUX.				—	7	40	
LOAD REGULATION [4]	MAIN AND POS. AUX	—	10	20	—	10	30	mV
	NEG. AUX.	—	—	—	—	40	70	
CROSS REGULATION [5]	EFFECT ON NEGATIVE AUXILIARY	—	—	—	—	400	800	mV
INPUT VOLTAGE	CONTINUOUS	16	28	50	—	—	—	V
	TRANSIENT 120 ms [1]	—	—	80	—	—	—	V
INPUT CURRENT	NO LOAD	—	30	37	—	—	—	mA
	INHIBITED	—	8.4	10	—	—	—	
INPUT RIPPLE CURRENT	10 kHz - 10 MHz	—	10	30	—	—	—	mA p-p
EFFICIENCY	T_C = 25°C	75	78	—	—	—	—	%
	T_C = -55°C TO +125°C	74	—	—	—	—	—	
LOAD FAULT [6]	POWER DISSIPATION	—	—	9.5	—	—	9.5	W
	RECOVERY [1]	—	—	25	—	—	25	ms
STEP LOAD RESPONSE [7]	TRANSIENT	—	—	±350	—	—	±600	mV pk
	RECOVERY	—	—	3	—	—	4	ms
STEP LINE RESPONSE [1, 8]	TRANSIENT	—	—	±400	—	—	±500	mV pk
16 - 50 - 16 V_{IN}	RECOVERY	—	—	3	—	—	4	ms
START-UP [9]	DELAY	—	7	15	—	7	15	ms
	OVERSHOOT [1]	—	—	100	—	—	240	mV pk
CAPACITIVE LOAD [1,10]	25°C	—	—	200	—	—	100	µF

Notes
1. Guaranteed by design and/or analysis. Not an in-line test.
2. The sum of the 12 volt auxiliary output currents may not exceed 416 mA.
3. The sum of the auxiliary output power may not exceed 5 watts. Up to 80% of the total power (5W) is available from either auxiliary providing the opposite auxiliary is carrying 20% of the total auxiliary power used.
4. Load regulation for the +5 is specified at 0.0 to 2.0 A with the aux. both held at 2.5 W (208 mA). Load regulation for the auxiliary is specified as both auxiliaries from 0.0 to 2.5 W (208 mA) at the same time with the +5 held at 2.0 A.
5. Cross regulation occurs between the two auxiliaries and is measured on –aux. +5 is held constant at 2.0 A. Cross regulation is specified for two conditions:
   5.A. Positive aux. = 2.5 W (50%); negative aux. = 2.5 W to 0.5 W (50% to 10%).
   5.B. From +Po = 70% and -Po = 30% to + Po = 30% and -Po = 70%.
   Above conditions are referenced to 50%/50% balanced loads.
6. Load fault is a short circuit (<50 mΩ). Recovery is into a resistive load.
7. Step load transition ≥ 10 µs. Recovery = time to settle to within 1% of V_{OUT} final value. Negative auxiliary is guaranteed by design and/or analysis.
8. Step line transition ≥ 10 µs. Recovery = time to settle to within 1% of V_{OUT} final value.
9. At inputs above 40 volts with temperatures above approximately 100°C, to ensure start-up, transition time should be greater than 5 ms and use of the inhibit function should be avoided.
10. Applicable to each output. No effect on dc performance.

MHV Single, Dual and Triple DC-DC Converters

28 VOLT INPUT – 15 WATT

TABLE 12: ELECTRICAL CHARACTERISTICS -55°C TO +125°C CASE, 28 VIN, 100% LOAD, FREE RUN, UNLESS OTHERWISE SPECIFIED.

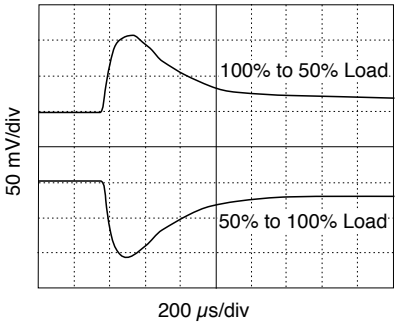
TRIPLE OUTPUT MODEL – MHV28515T		5 (MAIN)			±15 (AUXILIARIES)			
PARAMETER	CONDITIONS	MIN	TYP	MAX	MIN	TYP	MAX	UNITS
OUTPUT VOLTAGE	MAIN AND POS. AUX	4.90	5.00	5.10	14.70	15.00	15.30	V
	NEG. AUX.				-14.62	-15.00	-15.38	
OUTPUT CURRENT [2]		—	—	2.0	0	±0.167	0.267 [1]	A
V_{IN} = 16 TO 50 V	TOTAL	—	—	—	—	—	0.333	
OUTPUT POWER [3]		0	—	10	0	±2.50	4.00 [1]	W
V_{IN} = 16 TO 50 V	TOTAL	—	—	—	—	—	5	
OUTPUT RIPPLE	T_C = 25°C	—	8	20	—	9	20	mV p-p
$\pm V_{OUT}$, 10 kHZ - 2 MHZ	T_C = -55°C TO +125°C	—	—	22	—	—	22	
LINE REGULATION	MAIN AND POS. AUX	—	0	5	—	7	35	mV
V_{IN} = 16, 50 V	NEG. AUX.				—	7	40	
LOAD REGULATION [4]	MAIN AND POS. AUX	—	10	20	—	10	30	mV
	NEG. AUX.	—	—	—	—	40	80	
CROSS REGULATION [5]	EFFECT ON NEGATIVE AUXILIARY	—	—	—	—	400	800	mV
INPUT VOLTAGE	CONTINUOUS	16	28	50	—	—	—	V
	TRANSIENT 120 ms [1]	—	—	80	—	—	—	V
INPUT CURRENT	NO LOAD	—	34	41	—	—	—	mA
	INHIBITED	—	8.4	10	—	—	—	
INPUT RIPPLE CURRENT	10 kHz - 10 MHz	—	10	30	—	—	—	mA p-p
EFFICIENCY	T_C = 25°C	75	78	—	—	—	—	%
	T_C = -55°C TO +125°C	74	—	—	—	—	—	
LOAD FAULT [6]	POWER DISSIPATION	—	—	9.5	—	—	9.5	W
	RECOVERY [1]	—	—	25	—	—	25	ms
STEP LOAD RESPONSE [7]	TRANSIENT	—	—	±350	—	—	±600	mV pk
	RECOVERY	—	—	3	—	—	4	ms
STEP LINE RESPONSE [1, 8]	TRANSIENT	—	—	±400	—	—	±500	mV pk
16 - 50 - 16 V_{IN}	RECOVERY	—	—	3	—	—	4	ms
START-UP [9]	DELAY	—	—	15	—	—	15	ms
	OVERSHOOT [1]	—	—	100	—	—	300	mV pk
CAPACITIVE LOAD [1, 10]	25°C	—	—	200	—	—	100	µF

Notes
1. Guaranteed by design and/or analysis. Not an in-line test.
2. The sum of the 12 volt auxiliary output currents may not exceed 416 mA.
3. The sum of the auxiliary output power may not exceed 5 watts. Up to 80% of the total power (5W) is available from either auxiliary providing the opposite auxiliary is carrying 20% of the total auxiliary power used.
4. Load regulation for the +5 is specified at 0.0 to 2.0 A with the aux. both held at 2.5 W (167 mA). Load regulation for the auxiliary is specified as both auxiliaries from 0.0 to 2.5 W (167 mA) at the same time with the +5 held at 2.0 A.
5. Cross regulation occurs between the two auxiliaries and is measured on –aux. +5 is held constant at 2.0 A. Cross regulation is specified for two conditions:
   5.A. Positive aux. = 2.5 W (50%); negative aux. = 2.5 W to 0.5 W (50% to 10%).
   5.B. From +Po = 70% and -Po = 30% to + Po = 30% and -Po = 70%.
   Above conditions are referenced to 50%/50% balanced loads.
6. Load fault is a short circuit (<50 mΩ). Recovery is into a resistive load.
7. Step load transition ≥ 10 µs. Recovery = time to settle to within 1% of V_{OUT} final value. Negative auxiliary is guaranteed by design and/or analysis.
8. Step line transition ≥ 10 µs. Recovery = time to settle to within 1% of V_{OUT} final value.
9. At inputs above 40 volts with temperatures above approximately 100°C, to ensure start-up, transition time should be greater than 5 ms and use of the inhibit function should be avoided.
10. Applicable to each output. No effect on dc performance.

MHV Single, Dual and Triple DC-DC Converters

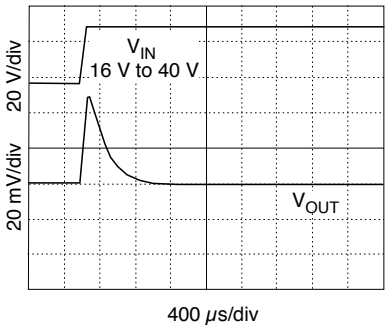
28 VOLT INPUT – 15 WATT

TYPICAL PERFORMANCE PLOTS: 25°C CASE, 28 VIN, 100% LOAD, FREE RUN, UNLESS OTHERWISE SPECIFIED.
THESE ARE EXAMPLES FOR REFERENCE ONLY AND ARE NOT GUARANTEED SPECIFICATIONS.



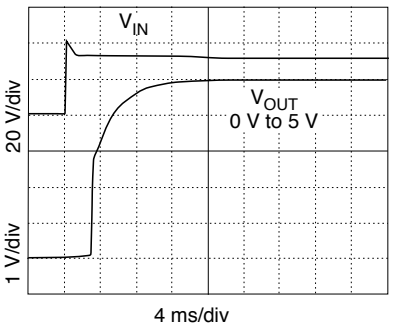
STEP LOAD RESPONSE MHV2805S

FIGURE 10



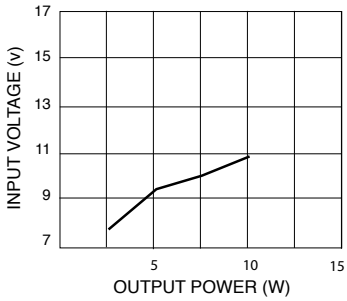
STEP LINE RESPONSE MHV2805S

FIGURE 11



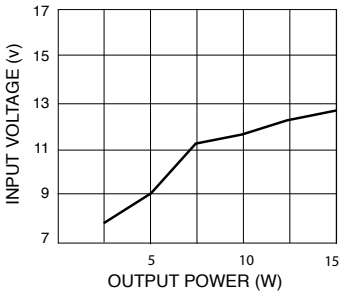
TURN ON RESPONSE MHV2805S

FIGURE 12



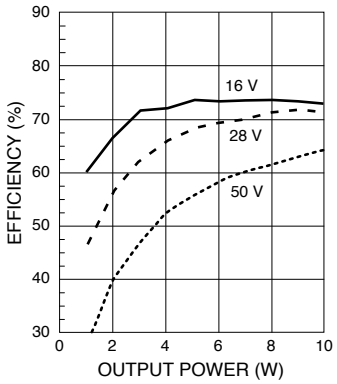
LOW LINE DROPOUT vs. LOAD
MHV283R3S

FIGURE 13



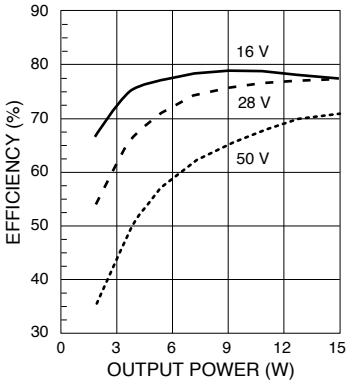
LOW LINE DROPOUT vs. LOAD
MHV2805S

FIGURE 14



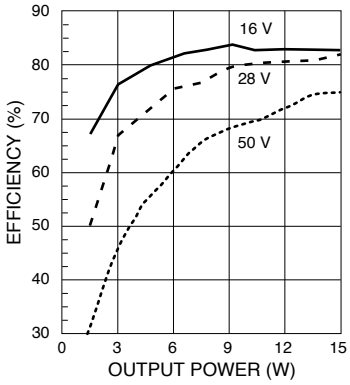
MHV283R3S EFFICIENCY

FIGURE 15



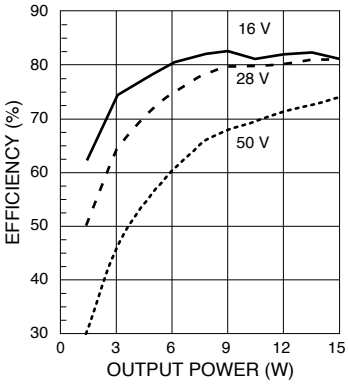
MHV2805S EFFICIENCY

FIGURE 16



MHV2812S EFFICIENCY

FIGURE 17



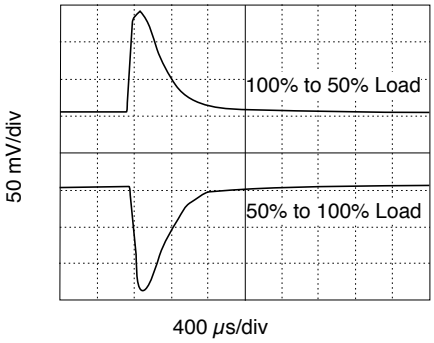
MHV2815S EFFICIENCY

FIGURE 18

MHV Single, Dual and Triple DC-DC Converters

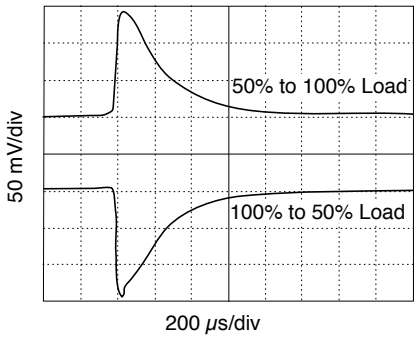
28 VOLT INPUT – 15 WATT

TYPICAL PERFORMANCE PLOTS: 25°C CASE, 28 VIN, 100% LOAD, FREE RUN, UNLESS OTHERWISE SPECIFIED.
THESE ARE EXAMPLES FOR REFERENCE ONLY AND ARE NOT GUARANTEED SPECIFICATIONS.



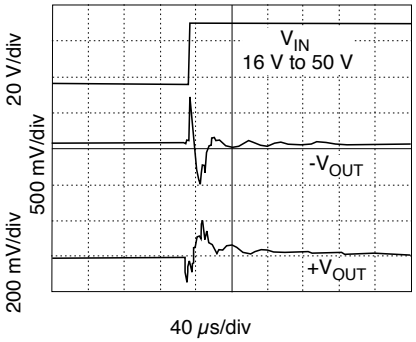
$+V_{OUT}$ STEP LOAD RESPONSE MHV2815D

FIGURE 19



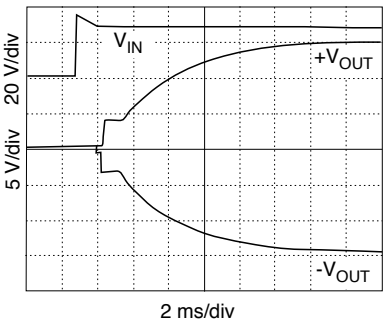
$-V_{OUT}$ STEP LOAD RESPONSE MHV2815D

FIGURE 20



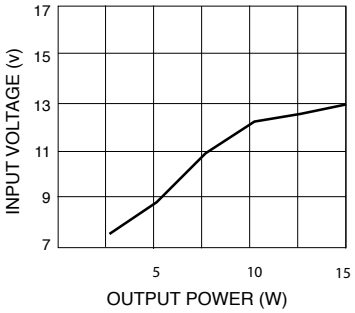
STEP LINE RESPONSE MHV2815D

FIGURE 21



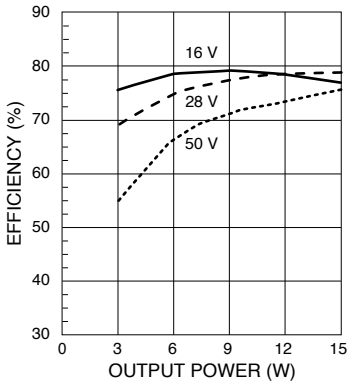
TURN ON RESPONSE MHV2815D

FIGURE 22



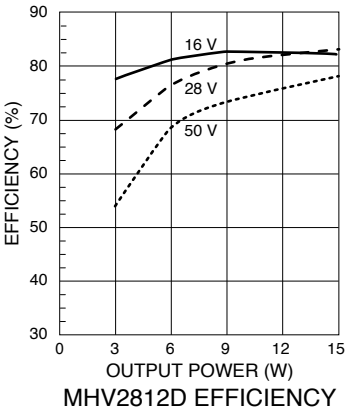
LOW LINE DROPOUT vs. LOAD MHV2815D

FIGURE 23



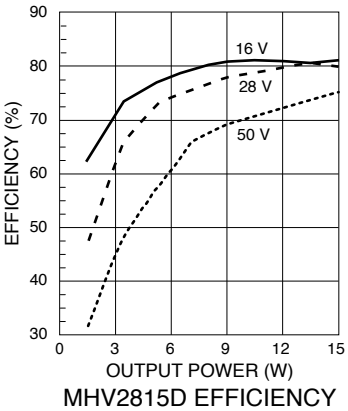
MHV2805D EFFICIENCY

FIGURE 24



MHV2812D EFFICIENCY

FIGURE 25



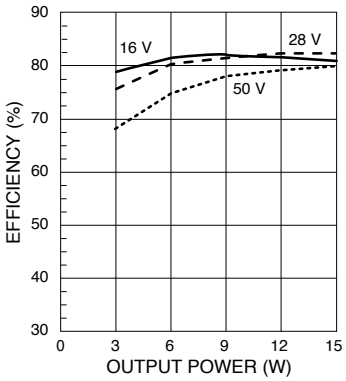
MHV2815D EFFICIENCY

FIGURE 26

MHV Single, Dual and Triple DC-DC Converters

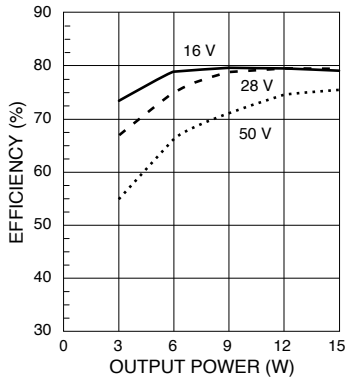
28 VOLT INPUT – 15 WATT

TYPICAL PERFORMANCE PLOTS: 25°C CASE, 28 VIN, 100% LOAD, FREE RUN, UNLESS OTHERWISE SPECIFIED.
THESE ARE EXAMPLES FOR REFERENCE ONLY AND ARE NOT GUARANTEED SPECIFICATIONS.



MHV28512T EFFICIENCY

FIGURE 27



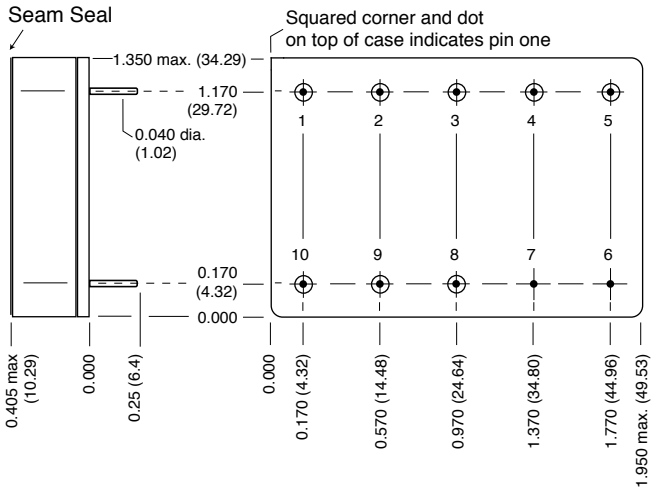
MHV28515T EFFICIENCY

FIGURE 28

MHV Single, Dual and Triple DC-DC Converters

28 VOLT INPUT – 15 WATT

BOTTOM VIEW CASE F1



Weight: 60 grams maximum

Case dimensions in inches (mm)
Tolerance ±0.005 (0.13) for three decimal places
±0.01 (0.3) for two decimal places
unless otherwise specified

CAUTION
Heat from reflow or wave soldering may damage the device.
Solder pins individually with heat application not exceeding 300°C for 10 seconds per pin.

Materials

Header	Cold Rolled Steel/Nickel/Gold
Cover	Kovar/Nickel
Pins	#52 alloy/Gold ceramic seal Gold plating of 50 - 150 microinches included in pin diameter Seal hole 0.120 ±0.002 (3.05 ± 0.05)

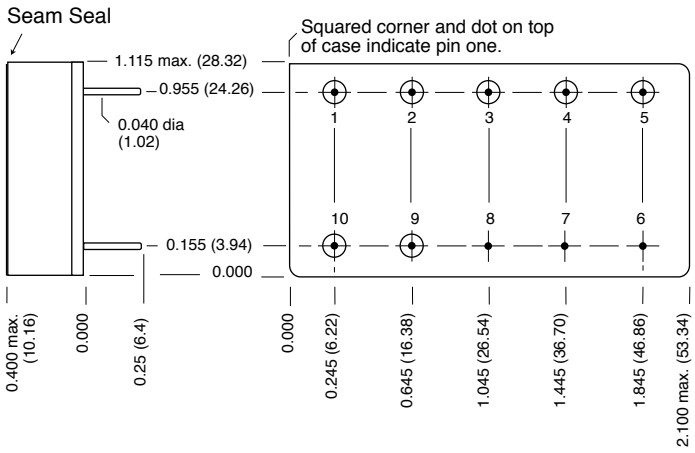
Case F1 MHV T, Rev G, 2014.01.13
Please refer to the numerical dimensions for accuracy.

FIGURE 29: CASE F1 - MHV TRIPLE

MHV Single, Dual and Triple DC-DC Converters

28 VOLT INPUT – 15 WATT

BOTTOM VIEW CASE H2



Weight: 60 grams maximum

Case dimensions in inches (mm)
Tolerance ±0.005 (0.13) for three decimal places
±0.01 (0.3) for two decimal places
unless otherwise specified

CAUTION
Heat from reflow or wave soldering may damage the device.
Solder pins individually with heat application not exceeding 300°C for 10 seconds per pin.

Materials

Header	Cold Rolled Steel/Nickel/Gold
Cover	Kovar/Nickel
Pins	#52 alloy/Gold ceramic seal Gold plating of 50 - 150 microinches included in pin diameter Seal hole 0.120 ±0.002 (3.05 ± 0.05)

Case H2 MHV S&D, Rev H 2014.01.13
Please refer to the numerical dimensions for accuracy.

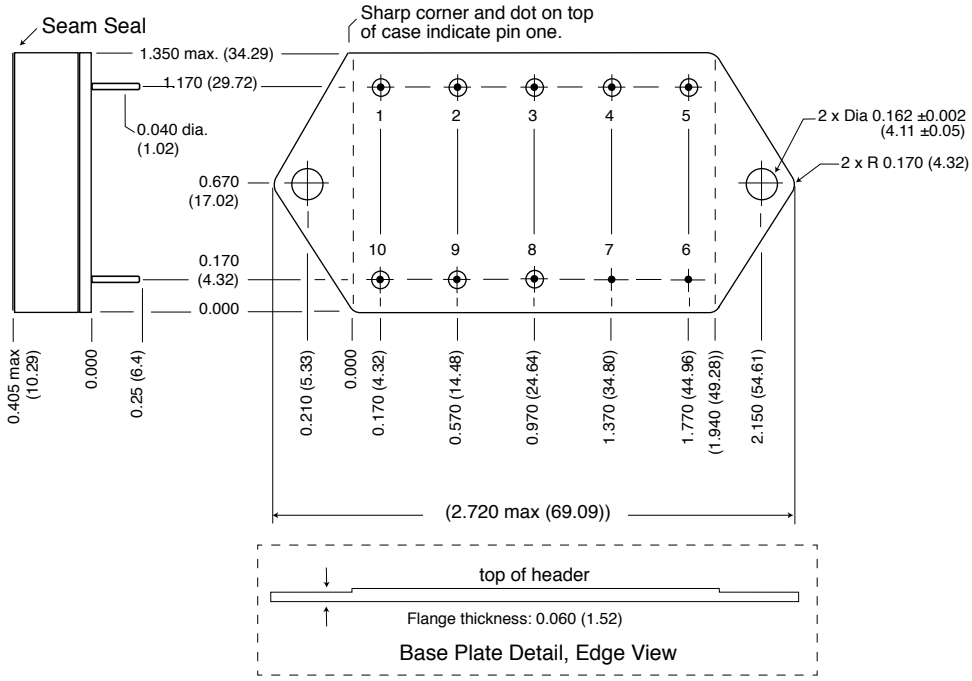
FIGURE 30: CASE H2 - MHV SINGLE AND DUAL

MHV Single, Dual and Triple DC-DC Converters

28 VOLT INPUT – 15 WATT

BOTTOM VIEW CASE J1

Flanged cases: Designator "F" required in Case Option position of model number.



Weight: 60 grams maximum

Case dimensions in inches (mm)
Tolerance ±0.005 (0.13) for three decimal places
±0.01 (0.3) for two decimal places
unless otherwise specified

CAUTION
Heat from reflow or wave soldering may damage the device.
Solder pins individually with heat application not exceeding 300°C for 10 seconds per pin.

Materials

Header	Cold Rolled Steel/Nickel/Gold
Cover	Kovar/Nickel
Pins	#52 alloy/Gold ceramic seal Gold plating of 50 - 150 microinches included in pin diameter Seal hole 0.120 ±0.002 (3.05 ± 0.05)

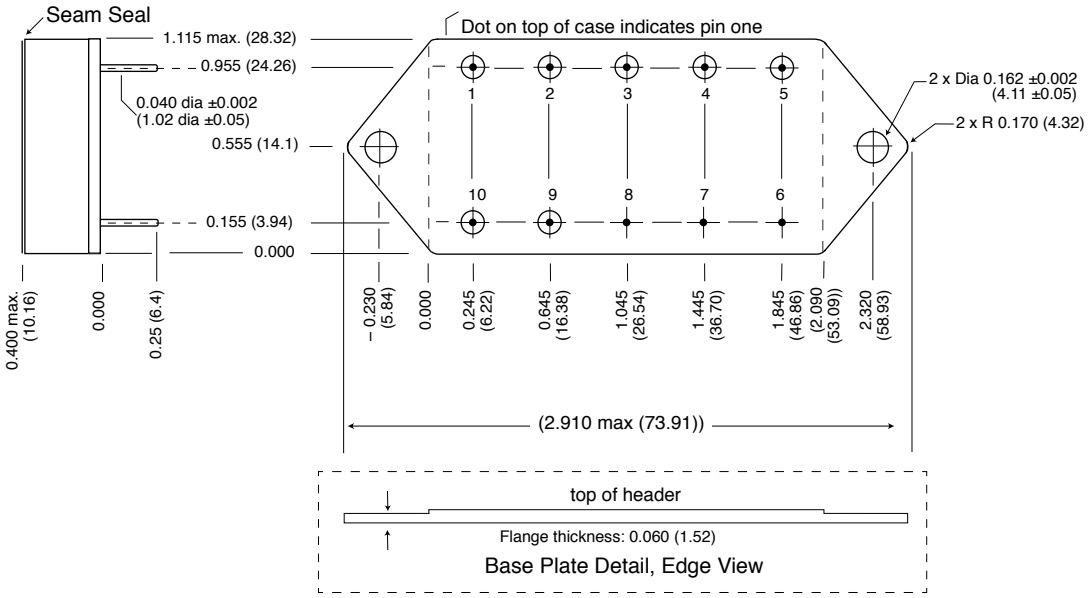
FIGURE 31: CASE J1 - MHV TRIPLE

MHV Single, Dual and Triple DC-DC Converters

28 VOLT INPUT – 15 WATT

BOTTOM VIEW CASE K3

Flanged cases: Designator “F” required in Case Option position of model number.



Weight: 60 grams maximum

Case dimensions in inches (mm)
Tolerance ±0.005 (0.13) for three decimal places
±0.01 (0.3) for two decimal places
unless otherwise specified

CAUTION
Heat from reflow or wave soldering may damage the device. Solder pins individually with heat application not exceeding 300°C for 10 seconds per pin.

Materials

Header	Cold Rolled Steel/Nickel/Gold
Cover	Kovar/Nickel
Pins	#52 alloy/Gold, compression glass seal Gold plating of 50 - 150 microinches included in pin diameter Seal hole 0.092 ±0.002 (2.34 ± 0.05)

Case K3 MHV S&D F, Rev J, 2014.09.11
Please refer to the numerical dimensions for accuracy.

FIGURE 32: CASE K3 - MHV SINGLE AND DUAL

MHV Single, Dual and Triple DC-DC Converters

28 VOLT INPUT – 15 WATT

STANDARD, /ES (NON-QML) AND /883 (CLASS H, QML) MIL-PRF-38534 ELEMENT EVALUATION

COMPONENT-LEVEL TEST PERFORMED	NON-QML [1]	QML	
	STANDARD AND /ES	CLASS H /883	
	M/S [2]	M/S [2]	P [3]
Element Electrical	■	■	■
Visual		■	■
Internal Visual		■	
Final Electrical		■	■
Wire Bond Evaluation		■	■

Notes
1. Standard and /ES non-QML products may not meet all of the requirements of MIL-PRF-38534.
2. M/S = Active components (microcircuit and semiconductor die)
3. P = Passive components, Class H element evaluation. Not applicable to standard and /ES element evaluation.

TABLE 13: ELEMENT EVALUATION

MHV Single, Dual and Triple DC-DC Converters

28 VOLT INPUT – 15 WATT

STANDARD, /ES (NON-QML) AND /883 (CLASS H, QML) MIL-PRF-38534 ENVIRONMENTAL SCREENING

TEST PERFORMED	NON-QML [1]		QML [2]
	STANDARD	/ES	CLASS H /883
Pre-cap Inspection, Method 2017, 2032	■	■	■
Temperature Cycle (10 times)			
Method 1010, Cond. C, -65°C to +150°C, ambient			■
Method 1010, Cond. B, -55°C to +125°C, ambient		■	
Constant Acceleration			
Method 2001, 3000 g			■
Method 2001, 500 g		■	
PIND, Test Method 2020, Cond. A		■	■ [3]
Burn-in Method 1015, +125°C case, typical [4]			
96 hours		■	
160 hours			■
Final Electrical Test, MIL-PRF-38534, Group A,			
Subgroups 1 through 6, -55°C, +25°C, +125°C case			■
Subgroups 1 and 4, +25°C case	■	■	
Hermeticity Test			
Gross Leak, Method 1014, Cond. C		■	■
Fine Leak, Method 1014, Cond. A		■	■
Gross Leak, Dip	■		
Final visual inspection, Method 2009	■	■	■

Test methods are referenced to MIL-STD-883 as determined by MIL-PRF-38534.

Notes
1. Standard and /ES, non-QML products, may not meet all of the requirements of MIL-PRF-38534.
2. All processes are QML qualified and performed by certified operators.
3. Not required by DLA but performed to assure product quality.
4. Burn-in temperature designed to bring the case temperature to +125°C minimum. Burn-in is a powered test.

TABLE 14: ENVIRONMENTAL SCREENING