MFL Single and Dual DC/DC Converters

28 VOLT INPUT – 65 WATT

Features

- –55° to +125°C operation
- 16 to 40 VDC input
- Fully Isolated
- Magnetic feedback
- Fixed frequency, 600 kHz typical
- Topology – Single Ended Forward
- 50 V for up to 120 ms transient protection
- Inhibit (input & output side)
- Sync function (in and out)
- Output trim on single output models
- Indefinite short circuit protection
- Remote sense on single output models
- Up to 87% efficiency / 43 W/in^3
- Parallelable up to 148 watts



MODELS

VDC Output

SINGLE	DUAL
3.3	±5
5	±12
12	±15
15	
28	

Other output voltages available upon request, including 2 V, 8 V and 54 V single.

DESCRIPTION

The MFL Series™ 28-volt DC/DC converters are rated up to 65 watts of output power over a –55°C to +125°C temperature range with a 28 VDC nominal input. On dual output models up to 70% of the rated output power can be drawn from either the positive or negative output. Current sharing allows the units to be paralleled for total power of up to 148 watts. The welded, hermetically sealed package is only 3.005 x 1.505 x 0.400 inches, giving the series an overall power density of up to 43 watts per cubic inch.

Design Features

The MFL Series converters are switching regulators that use a quasi-square wave, single ended forward converter design with a constant switching frequency of 600 kHz.

Isolation between input and output circuits is provided with a transformer in the forward path and a wide bandwidth magnetic coupling in the feedback control loop. The MFL uses a unique dual loop feedback technique that controls output current with an inner feedback loop and an output voltage with a cascaded voltage mode feedback loop.

The additional secondary current mode feedback loop improves transient response in a manner similar to primary current mode control and allows for ease of paralleling, but without the cost and complexity.

The constant frequency, pulse-width modulated converters use a quasi-square wave single-ended forward design. Tight load regulation is achieved through a wide-bandwidth magnetic feedback circuit. The output on single MFL models can be trimmed (see Figure 1 for voltage changes with different resistor values).

Inhibit

The MFL Series converters have two TTL compatible inhibit terminals (INH1 and INH2) that can be used to disable power conversion, resulting in a very low quiescent input current and no generation of switching noise. An open collector TTL compatible low (<0.8 volts) is required to inhibit the converter between INH1 (pin 4) and Input Common (pin 2). An open collector TTL compatible low (<0.5 volts) is required to inhibit the converter between INH2 (pin 12) and Output Common (pin 8). The application of intermediate voltages to these pins (1.5 to 10.5 volts) should be avoided.

Sync

Converters may be synced to an external clock (525 to 675 kHz) or to one another by using the sync in or out pins. The nominal free-run switching frequency is 600 kHz.

Current and Parallel Operation

Multiple MFL converters may be used in parallel to drive a common load (see Figure 2). In this mode of operation the load current is shared by two or three MFL converters. In current sharing mode, one MFL converter is designated as a master. The SLAVE pin (pin 11) of the master is left unconnected and the MSTR/INH2 pin (pin 12) of the master is connected to the SLAVE pin (pin 11) of the slave units. The units designated as slaves have the MSTR/INH2 pin (pin 12) connected to the SNS RTN pin (pin 9). Figure 2 shows the typical setup for two or three units in parallel. Note that synchronizing the units together (though shown in the figure) is not required for current sharing operation. A second slave unit may be placed in parallel with a master and slave; this requires the TRI pin (pin 3) of the master unit to be connected to the SNS RTN pin (pin 9).

When paralleled, 76% of the total combined power ratings of the MFL converters are available at the load. Overload and short circuit performance are not adversely affected during parallel operation.

Crane Aerospace & Electronics
Electronics Group (Interpoint Brand)
PO Box 97005 • Redmond WA 98073-9705
425.882.3100 • electronics@craneae.com
www.craneae.com

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28 VOLT INPUT – 65 WATT

OPERATING CONDITIONS AND CHARACTERISTICS

Input Voltage Range
- 16 to 40 VDC continuous
- 50 V for 120 msec transient

Output Power
- 50 to 65 watts depending on model

Lead Soldering Temperature (10 sec per lead)
- 300°C

Storage Temperature Range (Case)
- –65°C to +150°C

Power Dissipation (Pd)
- 14 watts (16 watts MFL2805S, MFL2805D)

Case Operating Temperature (Tc)
- –55°C to +125°C full power
- –55°C to +135°C absolute

Derate Output Power/Current
- Linearly from 100% at 125°C to 0% at 135°C
- MFL283R3S: linearly from 100% at 100°C to 80% at 125°C and to 0% at 135°C

Output Voltage Temperature Coefficient
- 100 ppm/°C typical

Input to Output Capacitance
- 150 pF, typical

Current Limit
- 125% of full load typical

Isolation
- 100 megohm minimum at 500 V

Audio Rejection
- 50 dB typical

Conversion Frequency (-55°C to 125°C)
- Free run mode 600 kHz typical
  525 kHz. min, 675 kHz max

Inhibit Pin Voltage (unit enabled)
- INH1 = 9 to12 V, INH2 = 6 to 9 V

SYNC AND INHIBIT (INH1, INH2)

Sync In (525 to 675 kHz)
- Duty cycle 40% min, 60% max
- Logic low 0.8 V max
- Logic high 4.5 V min, 5 V max
- Referenced to input common

Sync Out
- Referenced to input common

Inhibit (INH1, INH2) TTL Open Collector
- Logic low (output disabled)
  - INH1 referenced to input common
    - Logic low 0.8 V max
    - Inhibit pin current 10 mA max
  - INH2 referenced to output common
    - Logic low 0.5 V max
    - Inhibit pin current 5 mA max
- Logic high (output enabled)
  - Open collector

MECHANICAL AND ENVIRONMENTAL

Size (maximum)
3.005 x 1.505 x 0.400 inches (76.33 x 38.23 x 10.16 mm)
See case U for dimensions.
Case options V, W, Y and Z are available by special order.

Weight (maximum)
86 grams

Screening
Standard, ES, or /883 (Class H, QML). See “883, Class H, QML Products – Element Evaluation” and “883, Class H, QML Products – Environmental Screening” for more information.

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PIN OUT

Pin	Single Output	MFL2828S	Dual Output
1	Positive Input	Positive Input	Positive Input
2	Input Common	Input Common	Input Common
3	Triple (TRI)	Triple (TRI)	Triple (TRI)
4	Inhibit 1 (INH1)	Inhibit 1 (INH1)	Inhibit 1 (INH1)
5	Sync Out	Sync Out	Sync Out
6	Sync In	Sync In	Sync In
7	Positive Output	Positive Output	Positive Output
8	Output Common	No connection	Output Common
9	Sense Return	Output Common	Negative Output
10	Positive Sense	No connection	No connection
11	Slave	Slave	Slave
12	Master/ Inhibit 2	Master/ Inhibit 2	Master / Inhibit 2

PINS NOT IN USE

TR1	Leave unconnected
Master	Leave unconnected
Slave	Leave unconnected
Sync in	Connect to input common
Inhibit (INH1)	Leave unconnected
Inhibit (INH2)	Leave unconnected
Sync Out	Leave unconnected
Sense Lines	Must be connected to appropriate outputs

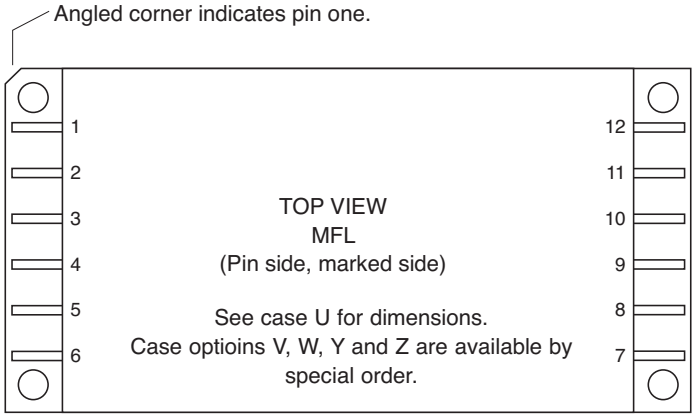
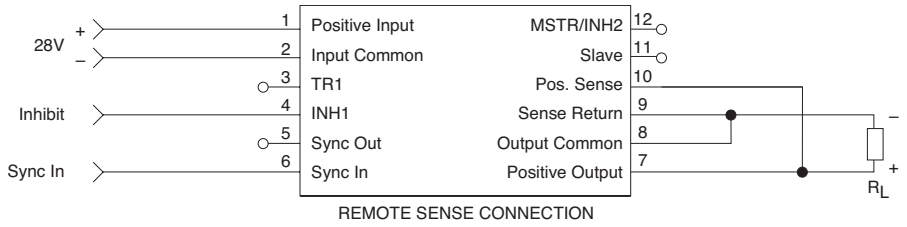


FIGURE 1: PIN OUT

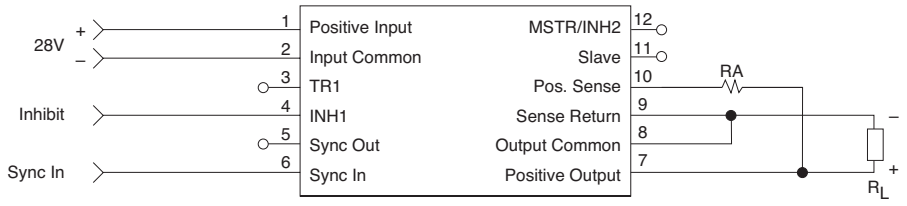
MFL Single and Dual DC/DC Converters

28 VOLT INPUT – 65 WATT

SINGLE OUTPUT MODELS CONNECTION DIAGRAMS - SENSE AND PARALLEL



REMOTE SENSE CONNECTION



OUTPUT VOLTAGE ADJUST CONNECTION

VOUT INCREASE (VOLT)	RA (OHMS)			
	5–V	12–V	15–V	3.3–V
0.1	70	25	20	120
0.2	140	50	40	240
0.3	210	75	60	360
0.4	280	100	80	480
0.5	350	125	100	600

FIGURE 2: SENSE CONNECTIONS AND TRIM TABLE

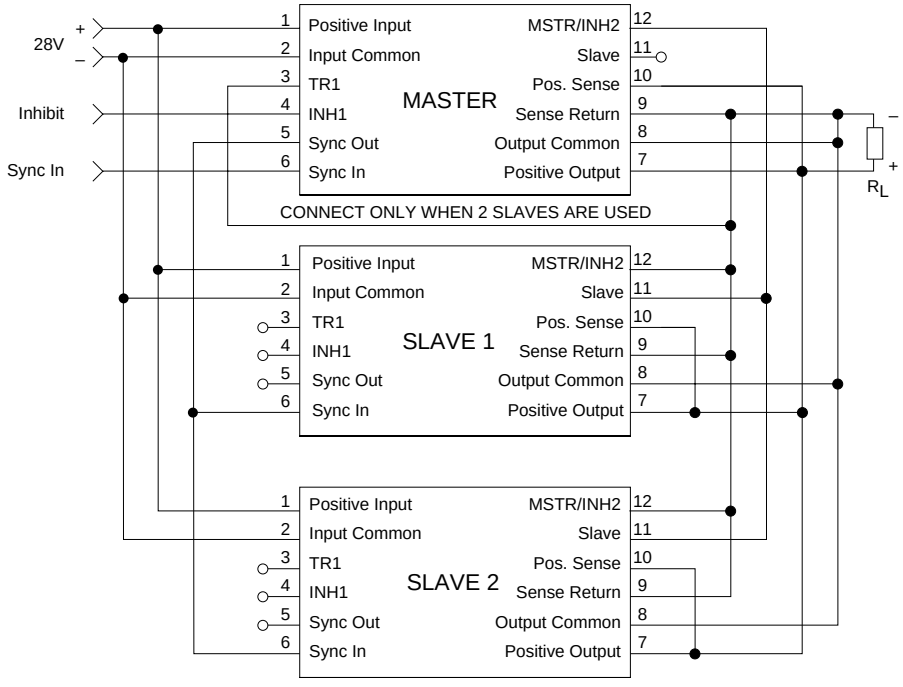
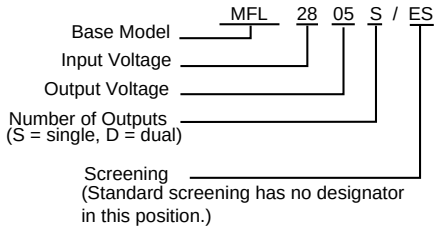


FIGURE 3: PARALLEL CONNECTIONS

MFL Single and Dual DC/DC Converters

28 VOLT INPUT – 65 WATT

MODEL NUMBERING KEY



SMD NUMBERS

Standard Microcircuit Drawing (SMD)	MFL Series Similar Part
IN PROCESS	MFL283R3S
5962-9316301HXC	MFL2805S/883
5962-9316201HXC	MFL2812S/883
5962-9316101HXC	MFL2815S/883
IN PROCESS	MFL2828S/883
5962-9319101HXC	MFL2805D/883
5962-9319201HXC	MFL2812D/883
5962-9319301HXC	MFL2815D/883

For exact specifications for an SMD product, refer to the SMD drawing. SMDs can be downloaded from: http://www.dscc.dla.mil/programs/smcr

Model Selection

MFL28 _____ _____ _____

Base model *Vout value* *number of outputs* *screening*

Choose one from each of the following rows

Vout value	for singles: 3R3, 5, 12, 15, 28	for duals: 5, 12, 15
	"R" = decimal point, 3R3 = 3.3VDC	
Number of outputs	S (single) or D (dual)	
Screening	standard screening, leave blank	/ES (ES screening), /883 (Class H, QML)

MFL Single and Dual DC/DC Converters

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Electrical Characteristics: –55°C to +125° C Tc, 28 VDC Vin, 100% load, free run, unless otherwise specified.

SINGLE OUTPUT MODELS		MFL283R3S			MFL2805S			MFL2812S			
PARAMETER	**CONDITION**	**MIN**	**TYP**	**MAX**	**MIN**	**TYP**	**MAX**	**MIN**	**TYP**	**MAX**	**UNITS**
OUTPUT VOLTAGE	Tc = 25°C	3.26	3.3	3.34	4.95	5.00	5.05	11.88	12.00	12.12	VDC
OUTPUT CURRENT	V_{IN} = 16 TO 40 VDC	0	—	12.12[2]	0	—	10	0	—	5	A
OUTPUT POWER	V_{IN} = 16 TO 40 VDC	0	—	40[2]	0	—	50	0	—	60	W
OUTPUT RIPPLE	Tc = 25°C	—	10	35	—	15	35	—	30	75	mV p-p
VOLTAGE 10 k - 2 MHz	Tc = –55°C to +125°C	—	10	50	—	30	50	—	45	100	
LINE REGULATION	V_{IN} = 16 to 40 VDC	—	0	20	—	0	20	—	0	20	mV
LOAD REGULATION	NO LOAD TO FULL	—	—	40	—	—	20	—	—	20	mV
INPUT VOLTAGE	CONTINUOUS	16	28	40	16	28	40	16	28	40	VDC
NO LOAD TO FULL	TRANSIENT[1, 3] 50 ms	—	—	50	—	—	50	—	—	50	V
INPUT CURRENT	NO LOAD	—	70	100	—	70	120	—	50	100	mA
	INHIBITED - INH1	—	9	14	—	9	14	—	9	14	mA
	INHIBITED - INH2	—	35	70	—	35	70	—	35	70	
INPUT RIPPLE CURRENT	10 kHz - 10 MHz	—	15	50	—	15	50	—	15	50	mA pp
EFFICIENCY	Tc = 25°C	73	—	—	77	80	—	83	86	—	%
LOAD FAULT	POWER DISSIPATION SHORT CIRCUIT Tc = 25°C	—	12.5	20	—	12.5	16	—	10	14	W
	RECOVERY[1]	—	1.5	4	—	1.5	4	—	1.5	4	ms
STEP LOAD RESP.	50% – 100% – 50% TRANSIENT	—	200	400	—	250	350	—	450	600	mV pk
	RECOVERY[1, 4]	—	1.5	3.0	—	1.5	3.0	—	1.5	3.0	ms
STEP LINE RESP.	16 – 40 – 16 VDC TRANSIENT[1, 5]	—	250	300	—	250	300	—	250	400	mV pk
	RECOVERY[1, 4]	—	200	600	—	200	300	—	200	300	µs
START-UP[6]	DELAY	—	3.5	6	—	3.5	6	—	3.5	6	ms
	OVERSHOOT[1]	—	0	25	—	0	25	—	0	50	mV pk
C_{OUT}	Tc=25°C[1, 7]	—	—	1000	—	—	1000	—	—	1000	µF

Notes

1. Guaranteed by design, not tested.

2. MFL283R3S current and power maximum are at 25°C only.
3. Unit will shut down above approximately 45V but will be undamaged and will restart when voltage drops into normal range.
4. Recovery time is measured from application of the transient to point at which Vout is within 1% of final value.
5. Transition time ≥ 10 µs.
6. Tested on release from inhibit.
7. Shall not compromise DC performance

MFL Single and Dual DC/DC Converters

28 VOLT INPUT – 65 WATT

Electrical Characteristics: –55°C to +125° C Tc, 28 VDC Vin, 100% load, free run, unless otherwise specified.

SINGLE OUTPUT MODELS		MFL2815S			MFL2828S[2]			
PARAMETER	**CONDITION**	**MIN**	**TYP**	**MAX**	**MIN**	**TYP**	**MAX[2]**	**UNITS**
OUTPUT VOLTAGE	Tc = 25°C	14.85	15.00	15.15	27.72	28.00	28.28	VDC
OUTPUT CURRENT	V_{IN} = 16 TO 40 VDC	0	—	4.33	0	—	2.32	A
OUTPUT POWER	V_{IN} = 16 TO 40 VDC	0	—	65	0	—	65	W
OUTPUT RIPPLE VOLTAGE 10 k - 2 MHz	Tc = 25°C	—	30	85	—	100	200	mV p-p
	Tc = –55°C to +125°C	—	45	110	—	—	—	
LINE REGULATION	V_{IN} = 16 to 40 VDC	—	0	20	—	20	60	mV
LOAD REGULATION	NO LOAD TO FULL	—	0	20	—	20	75	mV
INPUT VOLTAGE	CONTINUOUS	16	28	40	16	28	40	VDC
NO LOAD TO FULL	TRANSIENT[1, 3] 50 ms	—	—	50	—	—	50	V
INPUT CURRENT	NO LOAD	—	50	100	—	60	100	mA
	INHIBITED - INH1	—	9	14	—	9	14	mA
	INHIBITED - INH2	—	35	70	—	35	70	
INPUT RIPPLE CURRENT	10 kHz - 10 MHz	—	15	50	—	20	50	mA pp
EFFICIENCY	Tc = 25°C	84	87	—	83	86	—	%
LOAD FAULT	POWER DISSIPATION SHORT CIRCUIT Tc = 25°C	—	10	14	—	7	14	W
	RECOVERY[1]	—	1.5	4	—	1.0	4	ms
STEP LOAD RESP.	50% – 100% – 50% TRANSIENT	—	500	600	—	800	1400	mV pk
	RECOVERY[1, 4]	—	1.5	3.0	—	1.5	3.0	ms
STEP LINE RESP.	16 – 40 – 16 VDC TRANSIENT[1, 5]	—	250	400	—	250	800	mV pk
	RECOVERY[1, 4]	—	200	300	—	200	400	µs
START-UP[6]	DELAY	—	3.5	6	—	3.5	6	ms
	OVERSHOOT[1,]	—	0	50	—	0	100	mV pk
C_{OUT}	Tc=25°C[1, 7]	—	—	1000	—	—	1000	µF

Notes

1. Guaranteed by design, not tested.

2. MFL2828S specifiications are at 25°Tc.
3. Unit will shut down above approximately 45V but will be undamaged and will restart when voltage drops into normal range.
4. Recovery time is measured from application of the transient to point at which Vout is within 1% of final value.
5. Transition time ≥ 10 µs.
6. Tested on release from inhibit.
7. Shall not compromise DC performance

MFL Single and Dual DC/DC Converters

28 VOLT INPUT – 65 WATT

Electrical Characteristics: –55°C to +125° C Tc, 28 VDC Vin, 100% load, free run, unless otherwise specified.

DUAL OUTPUT MODELS		MFL2805D			MFL2812D			MFL2815D			
PARAMETER	**CONDITIONS**	**MIN**	**TYP**	**MAX**	**MIN**	**TYP**	**MAX**	**MIN**	**TYP**	**MAX**	**UNITS**
OUTPUT VOLTAGE	Tc = 25°C $+V_{OUT}$	4.95	5.00	5.05	11.88	12.00	12.12	14.85	15.00	15.15	VDC
	Tc = 25°C $-V_{OUT}$	4.92	5.00	5.08	11.82	12.00	12.18	14.77	15.00	15.23	
OUTPUT CURRENT[2]	EACH OUTPUT	0	—	7	0	—	3.5	0	—	3.03	A
V_{IN} = 16 TO 40 VDC	TOTAL OUTPUT	0	—	10	0	—	5	0	—	4.34	
OUTPUT POWER[2]	V_{IN} = 16 TO 40 VDC	0	—	50	0	—	60	0	—	65	W
OUTPUT RIPPLE VOLTAGE +/– V_{OUT}	10 kHz - 2 MHz	—	50	100	—	50	120	—	50	150	mV p-p
LINE REGULATION	$+V_{OUT}$	—	0	50	—	0	50	—	0	50	mV
V_{IN} = 16 TO 40 VDC	$-V_{OUT}$	—	25	100	—	25	100	—	25	100	
LOAD REGULATION	$+V_{OUT}$	—	0	50	—	10	50	—	10	50	mV
NO LOAD TO FULL	$-V_{OUT}$	—	25	100	—	50	120	—	50	150	
CROSS REGULATION	SEE NOTE 3	—	5	8	—	2	4	—	2	4	%
Tc = 25°C	SEE NOTE 4	—	3	6	—	2	4	—	2	4	
INPUT VOLTAGE	CONTINUOUS	16	28	40	16	28	40	16	28	40	VDC
NO LOAD TO FULL	TRANSIENT[1, 5] 50 ms.	0	—	50	0	—	50	0	—	50	V
INPUT CURRENT	NO LOAD	—	50	120	—	50	100	—	50	100	mA
	INHIBITED - INH1	—	9	14	—	9	14	—	9	14	mA
	INHIBITED - INH2	—	35	70	—	35	70	—	35	70	
INPUT RIPPLE CURRENT	10 kHz - 10 MHz	—	15	50	—	15	50	—	15	50	mA p-p
EFFICIENCY 25°C Tc	BALANCED LOAD	77	80	—	83	86	—	84	87	—	%
LOAD FAULT	POWER DISSIPATION SHORT CIRCUIT Tc = 25°C	—	12.5	16	—	10	14	—	10	14	W
	RECOVERY[1]	—	1.5	4.0	—	1.5	4.0	—	1.5	4.0	ms
STEP LOAD RESP.	50 %–100%– 50% LOAD										
± V_{OUT}	TRANSIENT	—	250	350	—	450	600	—	500	600	mV pk
	RECOVERY[1, 6]	—	1.5	3.0	—	1.5	3.0	—	1.5	3.0	ms
STEP LINE RESP.	16 – 40 – 16 V_{IN}										
± V_{OUT}	TRANSIENT[1, 7]	—	250	300	—	250	400	—	250	400	mV pk
	RECOVERY[1, 6]	—	200	300	—	200	300	—	200	300	µs
START–UP[8]	DELAY	—	3.5	6	—	3.5	6	—	3.5	6	ms
	OVERSHOOT[1]	—	0	25	—	0	50	—	0	50	mV p
C_{OUT}	Tc=25°C[1,9]	—	—	500	—	—	500	—	—	500	µF

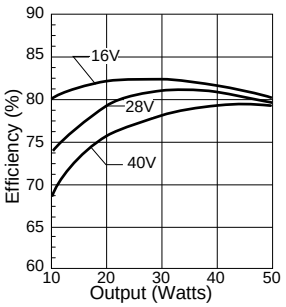
Notes

1. Guaranteed by design, not tested.
2. Up to 70% of the total output power is available from either output providing the opposite output is simultaneously carrying 30% of the total power.
3. Effect on negative Vout from 50%/50% loads to 70%/30% or 30%/70% loads.
4. Effect on negative Vout from 50%/50% loads to +Pout=50%, -Pout=10%.
5. Unit will shut down above approximately 45V but will be undamaged and will restart when voltage drops into normal range.
6. Recovery time is measured from application of the transient to point at which Vout is within 1% of final value.
7. Transition time ≥ 10 µs.
8. Tested on release from inhibit.
9. Shall not compromise DC performance

MFL Single and Dual DC/DC Converters

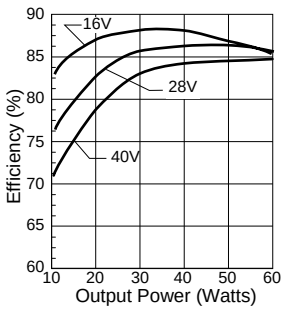
28 VOLT INPUT – 65 WATT

Typical Performance Curves: 25°C Tc , 28 VDC Vin, 100% load, free run, unless otherwise specified.



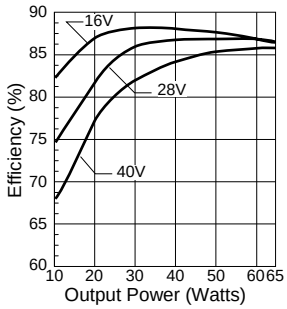
MFL2805S & MFL2805D Efficiency

FIGURE 4



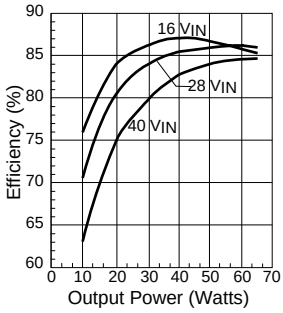
MFL2812S & MFL2812D Efficiency

FIGURE 5



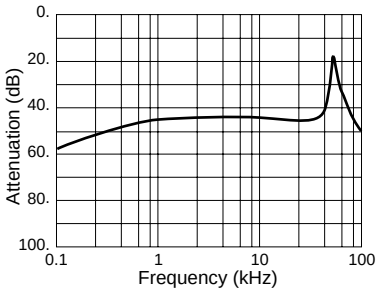
MFL2815S & MFL2815D Efficiency

FIGURE 6



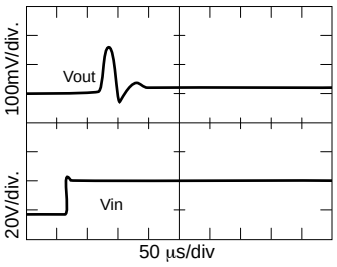
MFL2828S Efficiency

FIGURE 7



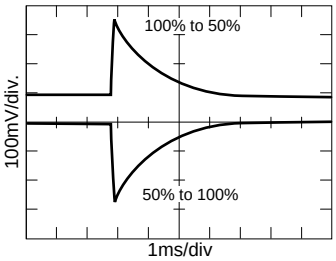
MFL Series Audio Rejection

FIGURE 8



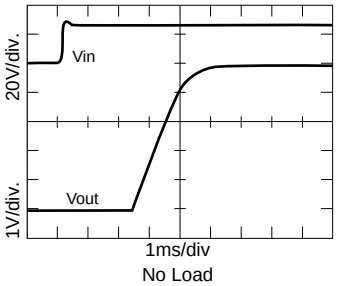
MFL2805S Step Line Response

FIGURE 9



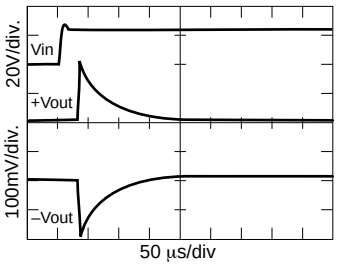
MFL2805S Step Load Response

FIGURE 10



MFL2805S Turn On Response

FIGURE 11



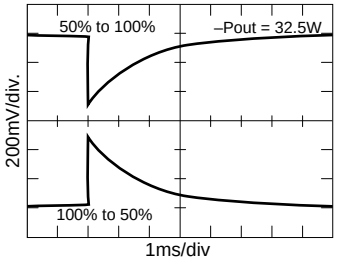
MFL2815D Step Line Response

FIGURE 12

MFL Single and Dual DC/DC Converters

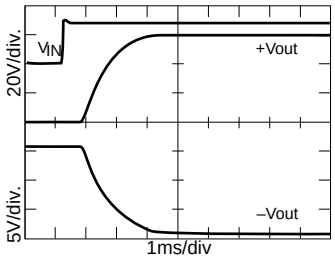
28 VOLT INPUT – 65 WATT

Typical Performance Curves: 25°C Tc , 28 VDC Vin, 100% load, free run, unless otherwise specified.



MFL2815D Step Load Response

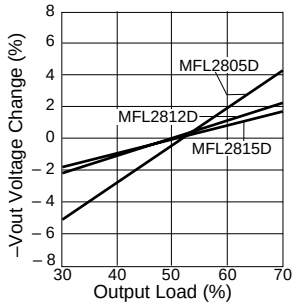
FIGURE 13



No Load

MFL2815D Turn On Response

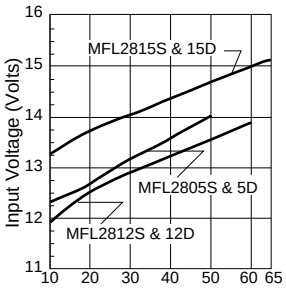
FIGURE 14



+Pout 80 to 20 %, –Pout 20 to 80%

Cross Regulation

FIGURE 15



Low Line Dropout

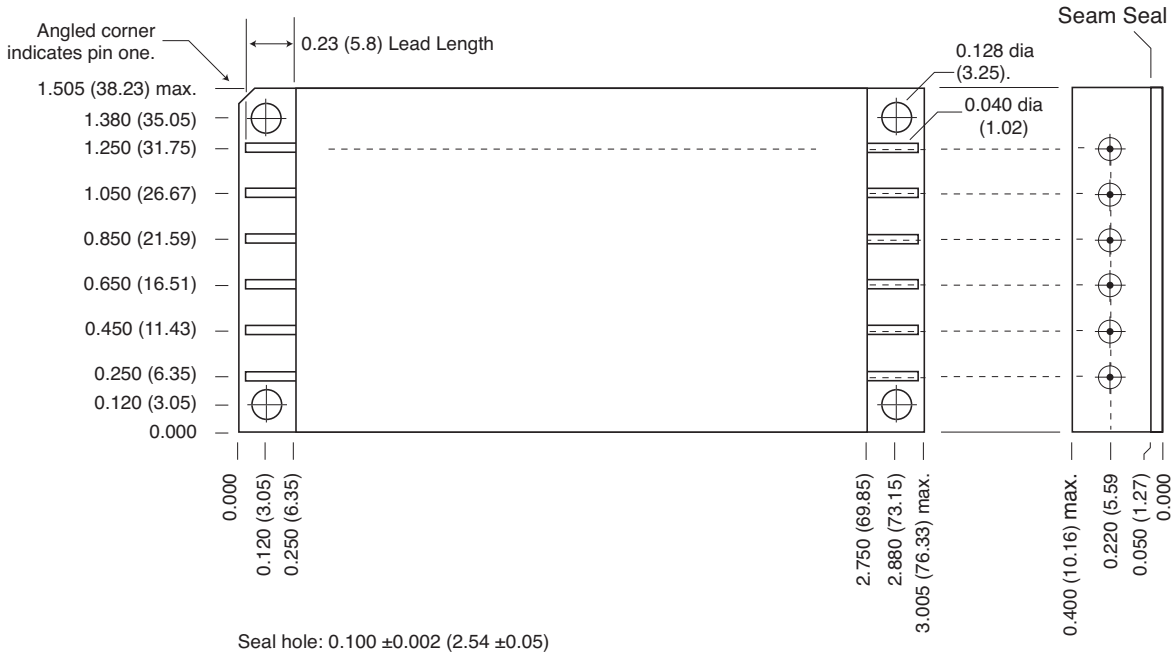
FIGURE 16

MFL Single and Dual DC/DC Converter Cases

28 VOLT INPUT – 65 WATT

TOP VIEW CASE U
Flanged case, short-leaded

*Does not require designator in Case Option position of model number.



Seal hole: 0.100 ±0.002 (2.54 ±0.05)

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

Case U, Rev C, 20060302
Please refer to the numerical dimensions for accuracy. All information is believed to be accurate, but no responsibility is assumed for errors or omissions. Interpoint reserves the right to make changes in products or specifications without notice.
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FIGURE 17: CASE U

MFL Single and Dual DC/DC Converters

28 VOLT INPUT – 65 WATT

883, Class H, QML Products – Element Evaluation

Element Evaluation Test Performed (component level)	Standard (non-QML)[1]		Class H, QML	
	M/S[2]	P[3]	M/S[2]	P[3]
Element Electrical (probe)	yes	no	yes	yes
Element Visual	no	no	yes	yes
Internal Visual	no	no	yes	no
Final Electrical	no	no	yes	yes
Wire Bond Evaluation[4]	no	no	yes	yes
SLAM™/C-SAM: Input Capacitors only (Add'l test, not req. by H or K)	no	no	no	yes

Definitions:
Element Evaluation: Component testing/screening per MIL-STD-883 as determined by MIL-PRF-38534
SLAM™: Scanning Laser Acoustic Microscopy
C-SAM: C - Mode Scanning Acoustic Microscopy

Notes:
1. Non-QML products do no meet all of the requirements of MIL-PRF-38534
2. M/S = Active components (Microcircuit and Semiconductor Die)
3. P = Passive components
4. Not applicable to EMI filters that have no wire bonds

MFL Single and Dual DC/DC Converters

28 VOLT INPUT – 65 WATT

883, Class H, QML Products – Environmental Screening

TEST	125°C STANDARD non-QML	125°C /ES non-QML	Class H /883 QML
Pre-cap Inspection			
Method 2017, 2032	yes	yes	yes
Temperature Cycle (10 times)			
Method 1010, Cond. C, -65°C to 150°C, ambient	no	no	yes
Method 1010, Cond. B, -55°C to 125°C, ambient	no	yes	no
Constant Acceleration			
Method 2001, 3000 g	no	no	yes
Method 2001, 500g	no	yes	no
Burn-In			
Method 1015, 160 hours at 125°C case, typical	no	no	yes
96 hours at 125°C case, typical	no	yes	no
Final Electrical Test MIL-PRF-38534, Group A			
Subgroups 1 through 6: -55°C, +25°C, +125°C case	no	no	yes
Subgroups 1 and 4: +25°C case	yes	yes	no
Hermeticity Test			
Fine Leak, Method 1014, Cond. A	no	yes	yes
Gross Leak, Method 1014, Cond. C	no	yes	yes
Gross Leak, Dip (1×10^{-3})	yes	no	no
Final Visual Inspection			
Method 2009	yes	yes	yes

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

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