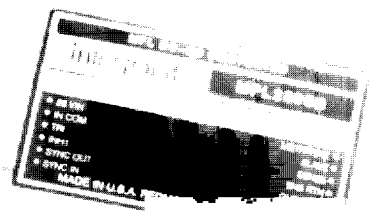
interpoint

MFL SERIES 28-VOLT DC-DC CONVERTERS

10301 Willows Road P.O. Box 97005 Redmond, WA 98073-9705 TEL: (206) 882-3100 TEL: (800) 822-8782 FAX: (206) 882-1990



- **Up to 65 watts output power**
- **16 to 40 Vdc input**
- **Parallelable for up to 180 watts**
- **125° C full power operation**
- **0.39 inch height**
- **Single or dual outputs, ±5, ±12, ±15 Vdc**
- **Meets MIL-STD-461C CS01 and CS02 susceptibility standards**
- **Current limiting short circuit protection**
- **Low voltage lockout**
- **Compatible with MIL-STD-704A-D power bus standards**
- **SMD models available**

The MFL Series™ 28-volt dc-dc converters are rated up to 65 watts output power over a -55° to +125°C temperature range with a 28 Vdc nominal input. Up to 70% of the rated output power can be drawn from either the positive or negative outputs. Current sharing allows the units to be paralleled for total power of up to 180 watts. The welded, hermetically sealed package is only 3.0 x 1.5 x 0.39 inches, giving the series an overall power density of up to 45 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 cascaded 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 A for voltage changes with different resistor values).

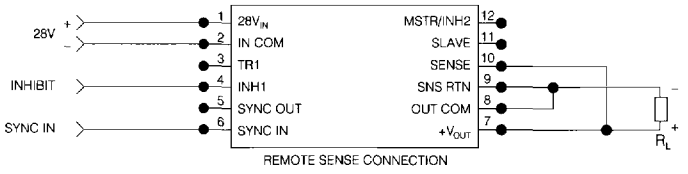
INHIBIT

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.

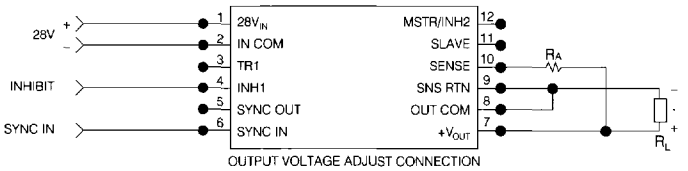
CURRENT SHARING AND PARALLEL OPERATION

Multiple MFLs may be used in parallel to drive a common load (see Figure B). In this mode of operation the load current is shared by two or three MFLs. In current sharing mode, one MFL 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 B 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, 95% of the total combined power ratings of the MFL are available at the load. Overload and short circuit performance are not adversely affected during parallel operation.



REMOTE SENSE CONNECTION



OUTPUT VOLTAGE ADJUST CONNECTION

V$_{OUT}$ INCREASE (VOLT)	R$_A$ (OHMS)		
	5-V	12-V	15-V
0.1	70	25	20
0.2	140	50	40
0.3	210	75	60
0.4	280	100	80
0.5	350	125	100

REMOTE SENSE AND OUTPUT VOLTAGE ADJUSTMENT

(APPLICABLE TO SINGLE OUTPUT MODELS ONLY)

Figure A

10301 Willows Road P.O. Box 97005 Redmond, WA 98073-9705 TEL: (206) 882-3100 TEL: (800) 822-8782 FAX: (206) 882-1990

CHARACTERISTICS (ALL MODELS): T = 25°C, V_{IN} = 28 Vdc unless otherwise specified.

OPERATING TEMPERATURE RANGE:
Full Power: –55°C to +125°C (case)
Absolute: –55°C to +135°C (case)
STORAGE TEMPERATURE RANGE: –65°C to +150°C (case)
OUTPUT VOLTAGE TEMPERATURE COEFFICIENT:
0.01%/°C (typical)
TEMPERATURE RISE (STILL AIR): 10°C/W dissipated (typ)
ISOLATION: 100 megohm minimum at 500 Vdc
INPUT TO OUTPUT CAPACITANCE: 150 pF (typical)
AUDIO REJECTION: 50 dB (typical)
WEIGHT: 100 grams (max.)
CONVERSION FREQUENCY
Free run mode: 550 kHz min., 600 typ., 650 max.
Synchronized mode: 525 kHz min. to 675 kHz max.

SYNCHRONIZATION
Duty cycle: 40% min., 60% max.
Logic low = 0.8V max.
Logic high = 4.5V min.
OUTPUT INHIBIT PINS: TTL Open collector compatible
TTL logic high = output enabled
TTL logic low = output disabled
Open circuit voltage = 9-12 Vdc for INH1; 6-9 Vdc for INH2
Logic low current = –10 mA (max.) for INH1; –5 mA (max.) for INH2
Logic low voltage level = 0.8V (max.) for INH1; 0.5V (max.) for INH2
MEAN TIME BETWEEN FAILURES: 200,000 hrs. (AIT, 85°C)

PARAMETER	CONDITION	MFL2805S			MFL2812S			MFL2815S			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
INPUT VOLTAGE	Tc = –55°C to +125°C NO LOAD TO FULL NORMAL TRANSIENT[1]	16 —	28 —	40 50	16 —	28 —	40 50	16 —	28 —	40 50	Vdc
INPUT CURRENT	Tc = –55°C to +125°C NO LOAD FULL LOAD INHIBIT PIN 4 = 0 Vdc INHIBIT PIN 12 = 0 Vdc	— — — —	70 2235 9 35	120 — 14 70	— — — —	50 2492 9 35	80 — 14 70	— — — —	50 2668 9 35	80 — 14 70	mA
OUTPUT VOLTAGE	FULL LOAD	4.95	5.00	5.05	11.88	12.00	12.12	14.85	15.00	15.15	Vdc
OUTPUT CURRENT[2]	V_{IN} = 16 to 40 Vdc Tc = –55°C to +125°C	0	—	10	0	—	5	0	—	4.33	A
OUTPUT POWER[2]	V_{IN} = 16 to 40 Vdc Tc = –55°C to +125°C	—	—	50	—	—	60	0	—	65	W
EFFICIENCY	FULL LOAD	77	80	—	83	86	—	84	87	—	%
LINE REGULATION	FULL LOAD, V_{IN} = 16 to 40 Vdc Tc = –55°C to +125°C	—	0	20	—	0	20	—	0	20	mV
LOAD REGULATION	NO LOAD TO FULL Tc = –55°C to +125°C	—	0	20	—	0	20	—	0	20	mV
OUTPUT RIPPLE VOLTAGE	FULL LOAD, 10kHz-2MHz Tc = 25°C Tc = –55°C to +125°C	— —	15 30	35 50	— —	30 45	75 100	— —	30 45	85 110	mVp-p
INPUT RIPPLE CURRENT	FULL LOAD, 10kHz-10MHz Tc = –55°C to +125°C	—	15	50	—	15	50	—	15	50	mAp-p
LOAD FAULT POWER DISSIPATION[3]	SHORT CIRCUIT	—	12.5	16	—	10	14	—	10	14	W
LOAD FAULT RECOVERY[4]	SHORT CIRCUIT TO FULL LOAD Tc = –55°C to +125°C	—	1.5	4	—	1.5	4	—	1.5	4	mS
STEP LOAD RESPONSE, TRANSIENT RECOVERY[4]	Tc = –55°C to +125°C P_{OUT} = 50% ↔100% P_{OUT} = 50% ↔ 100%	— —	250 1.5	350 3.0	— —	450 1.5	600 3.0	— —	500 1.5	600 3.0	mVpk mS
STEP LINE RESPONSE, TRANSIENT[5] RECOVERY[4]	Tc = –55°C to +125°C 16 to 40 Vdc ↔ 40 to 16 Vdc 16 to 40 Vdc ↔ 40 to 16 Vdc	— —	250 200	300 300	— —	250 200	400 300	— —	250 200	400 300	mVpk µS
STARTUP DELAY OVERSHOOT	Tc = –55°C to +125°C FULL LOAD FULL LOAD	— —	3.5 0	6.0 25	— —	3.5 0	6.0 50	— —	3.5 0	6.0 50	mS mVpk

Notes:
1 50V limit rated for up to 50mS. Unit will shut down above ≈45V but will be undamaged and will restart when voltage drops into normal range.
2 Derate output power/current linearly from 100% at +125°C to 0 at +135°C.
3 Indefinite short circuit protection not guaranteed above 125°C (case).
4 Recovery time is measured from application of the transient to point at which V_{OUT} is within 1% of final value.
5 Transition time > 10 µS.

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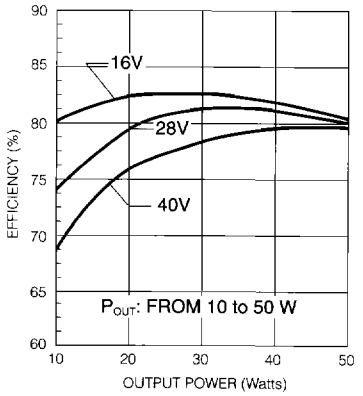
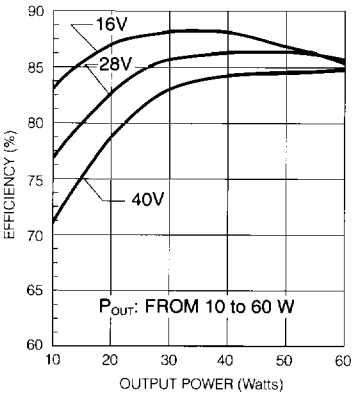
TYPICAL PERFORMANCE CURVES



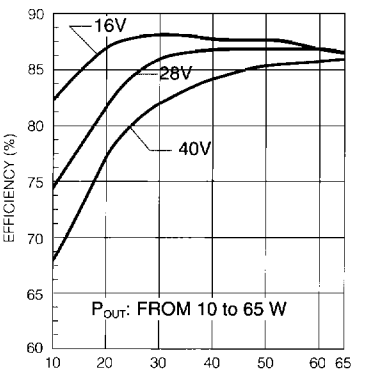
MFL2805S & MFL2805D
EFFICIENCY VS. LINE & LOAD

Figure 1



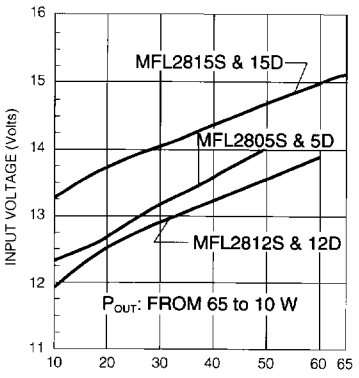
MFL2812S & MFL2812D
EFFICIENCY VS. LINE & LOAD

Figure 2



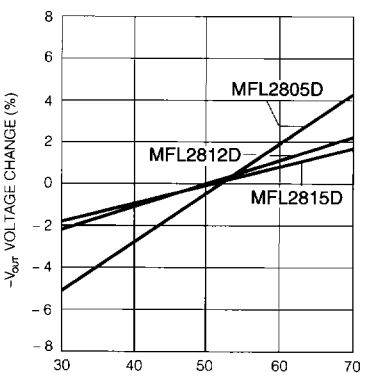
MFL2815S & MFL2815D
EFFICIENCY VS. LINE & LOAD

Figure 3



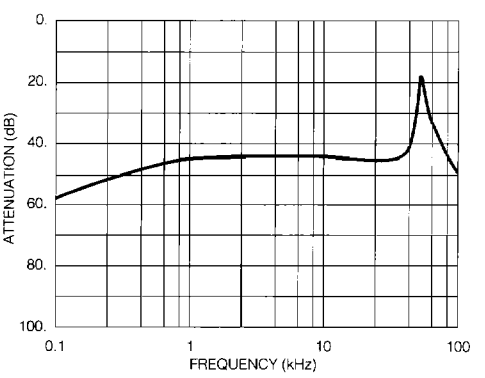
LOW LINE DROPOUT VS. LOAD
(50 mV DROP)

Figure 4



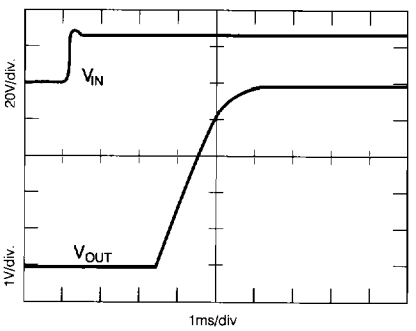
CROSS REGULATION
+P_{OUT}: From 80% to 20%
−P_{OUT}: From 20% to 80%

Figure 5



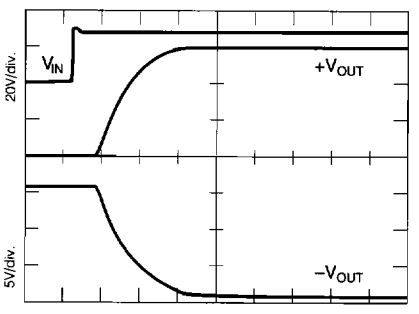
AUDIO REJECTION, MFL SERIES

Figure 6



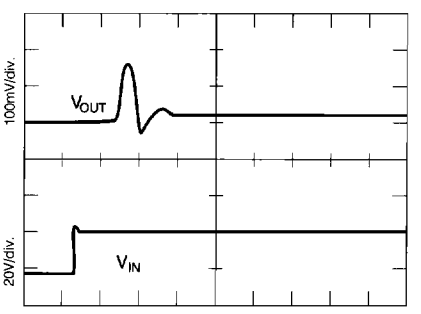
TURN-ON INTO NO LOAD, MFL2805S

Figure 7



TURN-ON INTO NO LOAD, MFL2815D

Figure 8



INPUT LINE TRANSIENT RESPONSE
(16V TO 40V), MFL2805S

Figure 9

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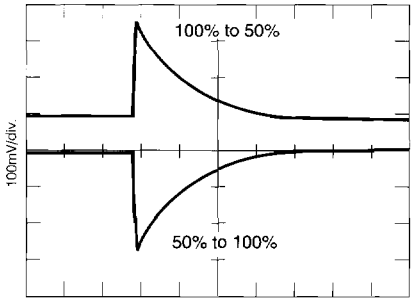
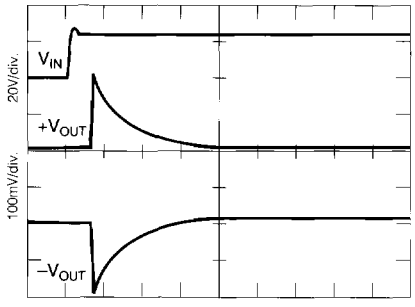
TYPICAL PERFORMANCE CURVES



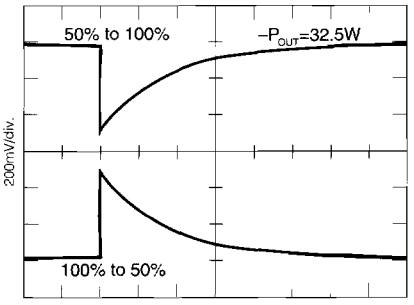
LOAD TRANSIENT RESPONSE
(50%↔100%), MFL2805S

Figure 10



INPUT LINE TRANSIENT RESPONSE
(16V TO 40V), MFL2815D

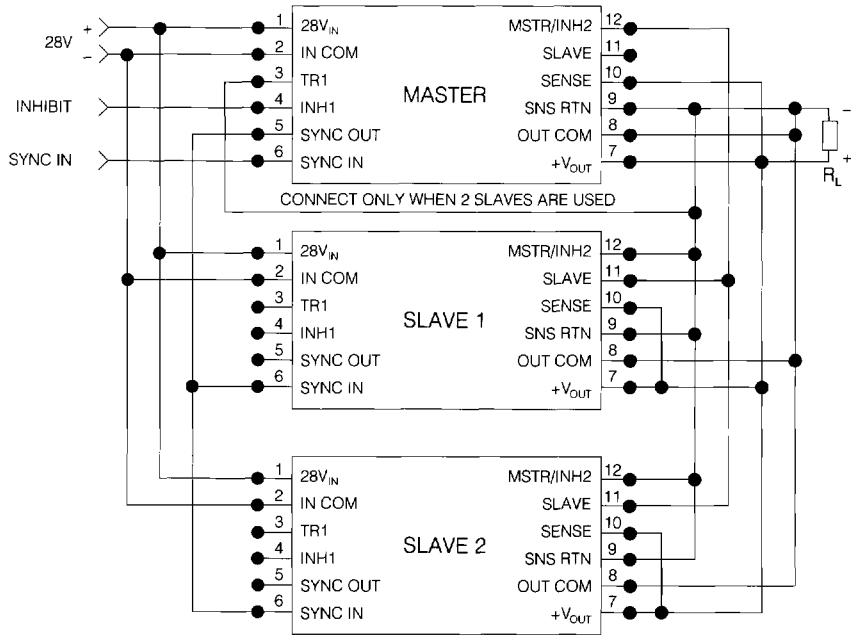
Figure 11



$+V_o$ LOAD TRANSIENT RESPONSE
(50%↔100%), MFL2815D

Figure 12

CONNECTION FOR PARALLEL OPERATION



PARALLEL CONNECTION

(APPLICABLE TO SINGLE OUTPUT MODELS ONLY)

Figure B

10301 Willows Road P.O. Box 97005 Redmond, WA 98073-9705 TEL: (206) 882-3100 TEL: (800) 822-8782 FAX: (206) 882-1990

DUAL OUTPUT MODELS: Tc = 25°C, V_{IN} = 28 Vdc unless otherwise specified.

PARAMETER	CONDITION	MFL2805D			MFL2812D			MFL2815D			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
INPUT VOLTAGE	Tc = -55°C to +125°C NO LOAD TO FULL NORMAL TRANSIENT[1]	16 —	28 —	40 50	16 —	28 —	40 50	16 —	28 —	40 50	Vdc
INPUT CURRENT	NO LOAD FULL LOAD ± P_{OUT} = 30W INHIBIT P_{IN} 4 = 0 Vdc INHIBIT P_{IN} 12 = 0 Vdc	— — — —	50 2235 9 35	120 — 14 70	— — — —	50 2492 9 35	100 — 14 70	— — — —	50 2668 9 35	100 — 14 70	mA
OUTPUT VOLTAGE	FULL LOAD +V_{OUT} −V_{OUT}	4.95 4.92	5.00 5.00	5.05 5.08	11.88 11.82	12.00 12.00	12.12 12.18	14.85 14.77	15.00 15.00	15.15 15.23	Vdc
OUTPUT CURRENT[2, 3]	V_{IN} = 16 to 40 Vdc, Tc = −55°C to +125°C EACH OUTPUT TOTAL OUPUT	0 0	— —	7 10	0 0	— —	3.5 5.0	0 0	— —	3.03 4.34	A
OUTPUT POWER[2, 3]	V_{IN} = 16 to 40 Vdc, Tc = −55°C to +125°C EACH OUTPUT TOTAL OUTPUT	0 0	— —	35 50	0 0	— —	42 60	0 0	— —	45.5 65	W
EFFICIENCY	V_{IN} = 28, FULL LOAD ± P_{OUT} = 30W	77	80	—	83	86	—	84	87	—	%
LINE REGULATION	FULL LOAD V_{IN} = 16 to 40 Vdc +V_{OUT} Tc = −55°C to +125°C −V_{OUT}	— —	0 25	50 100	— —	0 25	50 100	— —	0 25	50 100	mV
LOAD REGULATION	NO LOAD TO FULL +V_{OUT} Tc = −55°C to +125°C −V_{OUT}	— —	0 25	50 100	— —	10 50	100 120	— —	10 50	100 150	mV
CROSS REGULATION[4] (EFFECT ON −V_{OUT})	+P_{OUT} = 30% TO 70% −P_{OUT} = 70% TO 30% −P_{OUT} = 10% TO 50% +P_{OUT} = 50%	— —	5 3	8 6	— —	2 2	4 4	— —	2 2	4 4	% %
OUTPUT RIPPLE VOLTAGE	FULL LOAD, 10kHz-2MHz Tc = −55°C to +125°C +V_{OUT} −V_{OUT}	— —	50 50	100 100	— —	50 50	120 120	— —	50 50	150 150	mVp-p
INPUT RIPPLE CURRENT	FULL LOAD, 10 kHz – 10 MHz Tc = −55°C to +125°C	—	15	50	—	15	50	—	15	50	mAp-p
LOAD FAULT POWER DISSIPATION[5]	SHORT CIRCUIT	—	12.5	16	—	10	14	—	10	14	W
LOAD FAULT RECOVERY[6]	SHORT TO +P_{OUT} = −P_{OUT} = 30W	—	1.5	4.0	—	1.5	4.0	—	1.5	4.0	mS
STEP LOAD RESPONSE, TRANSIENT RECOVERY[6]	Tc = −55°C to +125°C 50% ↔100% ±V_{OUT} 100% ↔ 50%	— —	250 1.5	350 3.0	— —	450 1.5	600 3.0	— —	500 1.5	600 3.0	mVpk mS
STEP LINE RESPONSE, TRANSIENT[7] RECOVERY[6]	Tc = −55°C to +125°C 16 ↔ 40 Vdc 16 ↔ 40 Vdc	— —	250 200	300 300	— —	250 200	400 300	— —	250 200	400 300	mVpk µS
STARTUP DELAY OVERSHOOT	Tc = −55°C to +125°C FULL LOAD FULL LOAD	— —	3.5 0	6.0 25	— —	3.5 0	6.0 50	— —	3.5 0	6.0 50	mS mVpk

Notes:

1 50V limit rated for up to 50mS. Unit will shut down above ≈45V but will be undamaged and will restart when voltage drops into normal range.

2 Derate output power/current linearly from 100% at +125°C to 0 at +135°C.

3 Up to 70% of the total output power is available from either output providing the opposite is simultaneously carrying 30% of the total output power.

4 Shows regulation effect on the minus output during the defined cross loading conditions (see Figure 5).

5 Indefinite short circuit protection not guaranteed above 125°C (case).

6 Recovery time is measured from application of the transient to point at which V_{OUT} is within 1% of final value.

7 Transition time > 10 µS.

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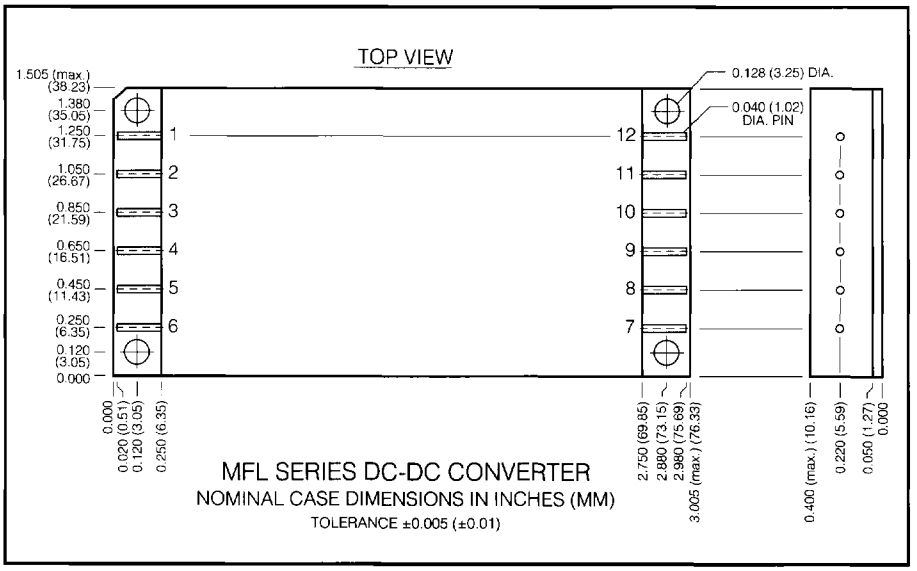
SCREENING OPTIONS*

	/ES	/SX /883		/ES	/SX /883
PRE-CAP INSPECTION Method 2017, 2032	•	•	FINAL VISUAL INSPECTION Method 2009	•	•
TEMPERATURE CYCLE (10 times) Method 1010, Cond. C. (–65°C to +150°C) Method 1010, –55 to +125°C	•	•	FINAL ELECTRICAL TEST MIL-H-38534, Group A 25°C case (typ.)	•	•
CONSTANT ACCELERATION Method 2001, Cond. A (5000 g) Method 2001, 500 g	•	•	HERMETICITY TESTING Fine Leak, Method 1014, Cond. A Gross Leak, Method 1014, Cond., C	• •	• •
BURN-IN Method 1015, 160 hours at 125°C 96 hours at 125°C case (typ.)	•	•	*All methods and conditions referenced to MIL-STD-883.		

To order model options, enter screening designation as suffix to the part number. For example, MFL 2805S/883.
On unscreened parts, the screening code block is marked "01"; on /ES screened parts, it is marked /ES or "02".
For /SX or /883 parts, "SX" or "883" appears in the screening code block. /SX parts receive the same screening levels as /883 parts but /SX parts may not be built exclusively with MIL-H-38534 qualified processes and element evaluated components.

METAL HERMETIC PACKAGE:



DESIGNATION	MFL2805S MFL2812S MFL2815S	MFL2805D MFL2812D MFL2815D
	PIN NO.	PIN NO.
Positive input	1	1
Input common	2	2
Triple	3	3
Inhibit 1	4	4
Sync out	5	5
Sync in	6	6
Positive output	7	7
Output common	8	8
Negative output	–	9
Sense return	9	–
Positive sense	10	–
Slave to master	11	11
Master to slave/inhibit 2	12	12

PIN 6 SHOULD BE CONNECTED TO INPUT COMMON IF EXTERNAL SYNC IS NOT USED.

CAUTION: Heat from reflow or wave soldering may damage this part. Solder pins individually with heat application NOT exceeding 300°C for 10 seconds per pin.

PACKAGE NOTES:

MFL Series packages use gold-plated cold rolled steel cases, nickel-plated Kovar covers and are seam welded.

STANDARD MILITARY DRAWING (SMD) MODELS AVAILABLE

STANDARD MILITARY DRAWING	MFL SIMILAR PART
5962–9316301HXC	MFL2805S/883
5962–9316201HXC	MFL2812S/883
5962–9316101HXC	MFL2815S/883
5962–9319101HXC	MFL2805D/883
5962–9319201HXC	MFL2812D/883
5962–9319301HXC	MFL2815D/883