LSM-16A D12 Models

Non-Isolated, 13-80W SMT DC/DC Converters

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Discontinued

Typical Unit

FEATURES

- Step-down buck regulators for new distributed 12V power architectures
- 12V input (10-14V range)
- 0.75/1/1.2/1.5/1.8/2/2.5/3.3/5V$_{OUT}$ @16A
- Non-isolated, fixed-frequency, synchronous-rectifier topology
- Tape and reel SMT package
- ±1.25% setpoint accuracy
- Efficiencies to 96% @ 16 Amps
- Noise as low as 50mVp-p
- Stable no-load operation
- Remote on/off control
- Sense pin and output voltage trim
- No derating to +65°C with 200 lfm
- Designed to meet UL/IEC/EN60950-1 safety
- EMC compliant

PRODUCT OVERVIEW

LSM Series D12 SMTs (surface-mount packages) are ideal building blocks for emerging, on-board power-distribution schemes in which isolated 12V buses deliver power to any number of non-isolated, step-down buck regulators. LSM D12 DC/DC's accept a 12V input (10V to 14V input range) and convert it, with the highest efficiency in the smallest space, to a 0.75, 1, 1.2, 1.5, 1.8, 2, 2.5, 3.3 or 5 Volt output fully rated at 16 Amps.

LSM D12's are ideal point-of-use/load power processors. They typically require no external components. Their surface-mount packages occupy a mere 1.3" x 0.53" (33.0 x 13.5mm), and are only 0.34 inches (8.6mm) high.

The LSM's best-in-class power density is achieved with a fully synchronous, fixed-frequency, buck topology that also delivers: high efficiency (95% for 5V$_{OUT}$ models), low

noise (50mVp-p typ.), tight line/load regulation (±0.1%/±0.25% max.), quick step response (100μsec), stable no-load operation, and no output reverse conduction.

The fully functional LSM's feature output overcurrent detection, continuous short-circuit protection, over-temperature protection, a remote on/off control pin (pull low to disable), an output-voltage trim function, and a sense pin. High efficiency enables the LSM D12's to deliver rated output currents of 16 Amps at ambient temperatures to +65°C with 100 lfm air flow.

If your new system boards call for multiple supply voltages, check out the economics of on-board 12V distributed power. If you don't need to pay for multiple isolation barriers, Murata Power Solutions' non-isolated LSM D12 SMTs will save you money.
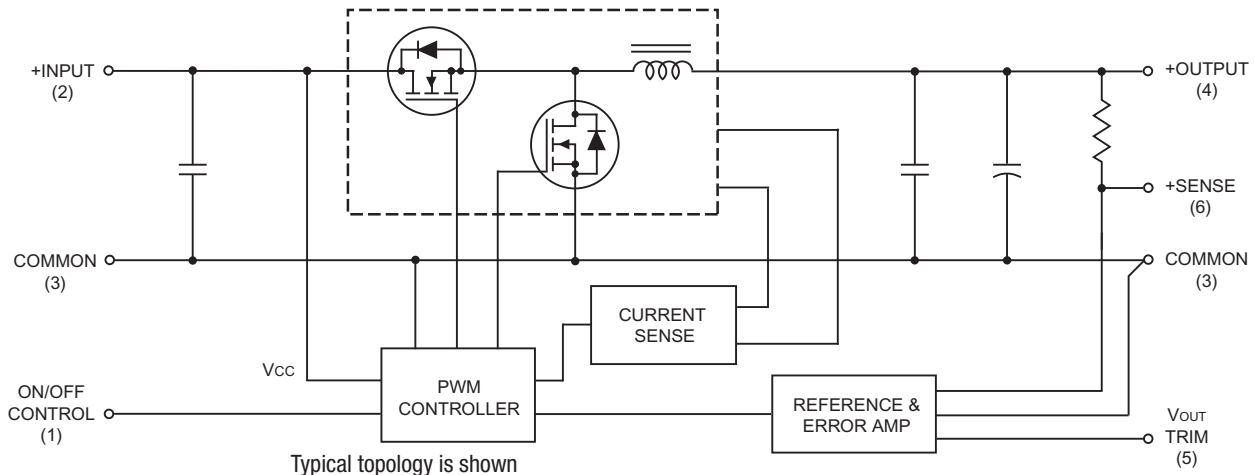

Typical topology is shown

Figure 1. Simplified Schematic

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Performance Specifications and Ordering Guide ①

ORDERING GUIDE

Models	Output						Input			Efficiency (Full Load)			Package (Case, Pinout)
	V_OUT (Volts)	I_OUT (Amps)	R/N (mVp-p) ②		Regulation (Max.) ③		V_IN Nom. (Volts)	Range (Volts)	I_IN ④ (mA/A)	V_IN = nom.		V_IN = min	
			Typ.	Max.	Line	Load				Min.	Typ.	Typ.	
LSM-0.75/16-D12	0.75	16	50	75	±0.1%	±0.375%	12	10-14	35/1.26	83%	85%	86%	C45, P63
LSM-1/16-D12	1	16	50	75	±0.1%	±0.25%	12	10-14	35/1.57	83%	85%	86%	C45, P63
LSM-1.2/16-D12	1.2	16	50	75	±0.1%	±0.25%	12	10-14	40/1.84	85%	87%	88%	C45, P63
LSM-1.5/16-D12	1.5	16	50	75	±0.1%	±0.25%	12	10-14	50/2.26	86.5%	88.5%	89.5%	C45, P63
LSM-1.8/16-D12	1.8	16	50	75	±0.1%	±0.25%	12	10-14	55/2.67	88%	90%	91%	C45, P63
LSM-2/16-D12	2	16	50	75	±0.1%	±0.25%	12	10-14	55/2.93	89%	91%	91.5%	C45, P63
LSM-2.5/16-D12	2.5	16	50	75	±0.1%	±0.25%	12	10-14	75/368	88.5%	90.5%	91.5%	C45, P63
LSM-3.3/16-D12	3.3	16	50	75	±0.1%	±0.25%	12	10-14	70/4.68	92%	94%	94.5%	C45, P63
LSM-5/16-D12	5	16	75	100	±0.1%	±0.25%	12	10-14	85/7.06	92.5%	94.5%	95.5%	C45, P63
LSM-T/16-D12	0.75-5	16	50	75	±0.1%	±0.25%	12	10-14	85/7.02	93%	95%	95.5%	C45, P63

① Typical at T_A = +25°C under nominal line voltage and full-load conditions, 200 lfm air flow for extended operation, unless otherwise noted. All models are tested and specified with external 22μF tantalum input and output capacitors. These capacitors are necessary to accommodate our test equipment and may not be required to achieve specified performance in your applications. See I/O Filtering and Noise Reduction.
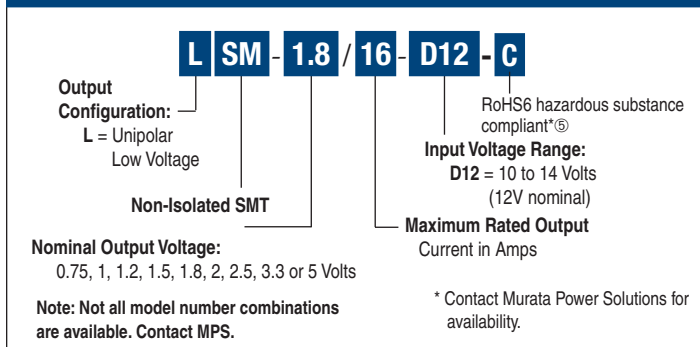
② Ripple/Noise (R/N) is tested/specified over a 20MHz bandwidth and may be reduced with external filtering. See I/O Filtering and Noise Reduction for details.

③ These devices have no minimum-load requirements and will regulate under no-load conditions. Regulation specifications describe the output-voltage deviation as the line voltage or load is varied from its nominal/midpoint value to either extreme.
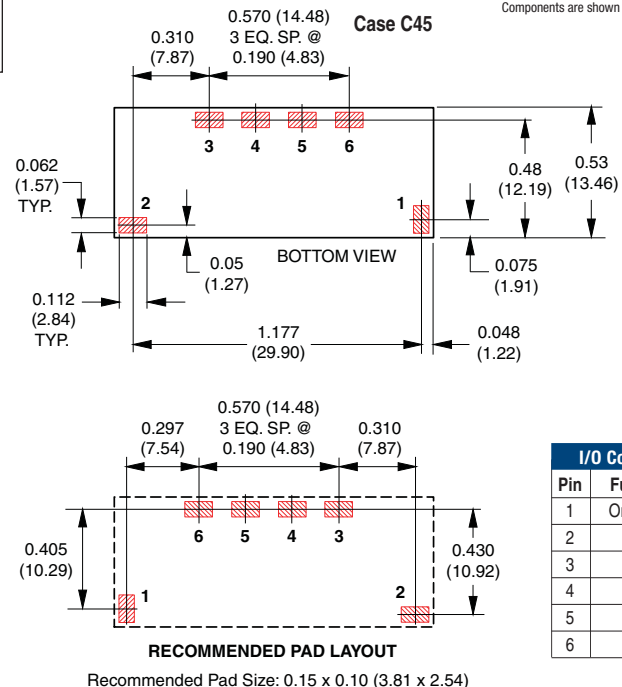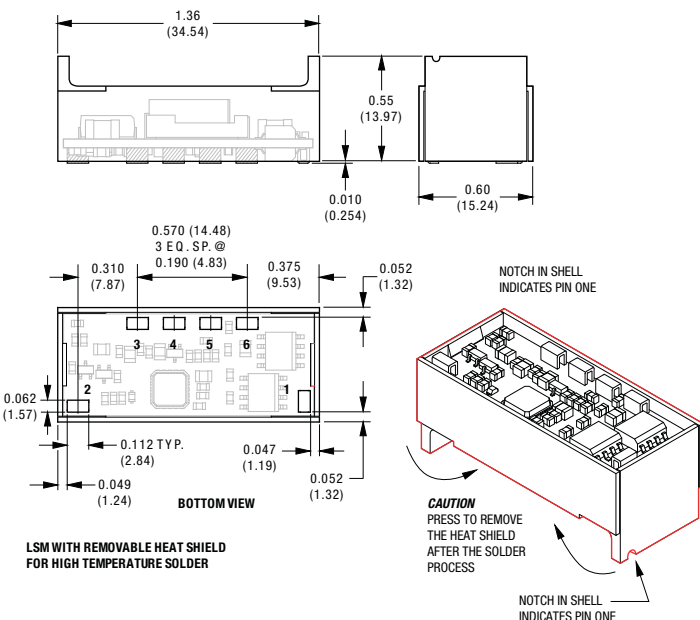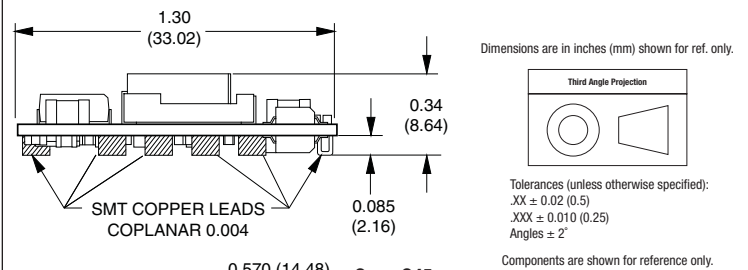
④ Nominal line voltage, no-load/full-load conditions.

⑤ RoHS6 compliance does not claim EU RoHS exemption 7b–lead in solder.

Part Number Structure

L SM - 1.8 / 16 - D12 - C

Output Configuration:
L = Unipolar Low Voltage

Non-Isolated SMT

Nominal Output Voltage:
0.75, 1, 1.2, 1.5, 1.8, 2, 2.5, 3.3 or 5 Volts

Note: Not all model number combinations are available. Contact MPS.

Maximum Rated Output
Current in Amps

Input Voltage Range:
D12 = 10 to 14 Volts (12V nominal)

RoHS6 hazardous substance compliant*⑤

* Contact Murata Power Solutions for availability.

Mechanical Specifications

Dimensions are in inches (mm) shown for ref. only.

1.30 (33.02)
0.34 (8.64)
0.085 (2.16)
SMT COPPER LEADS COPLANAR 0.004

Third Angle Projection

Tolerances (unless otherwise specified):
.XX ± 0.02 (0.5)
.XXX ±0.010 (0.25)
Angles ± 2°

Components are shown for reference only.

Case C45

0.310 (7.87)
0.570 (14.48) 3 EQ. SP. @ 0.190 (4.83)
0.062 (1.57) TYP.
0.48 (12.19)
0.53 (13.46)
0.05 (1.27)
BOTTOM VIEW
0.075 (1.91)
0.112 (2.84) TYP.
1.177 (29.90)
0.048 (1.22)

1.36 (34.54)
0.55 (13.97)
0.010 (0.254)
0.60 (15.24)

0.570 (14.48) 3 EQ. SP. @ 0.190 (4.83)
0.310 (7.87)
0.375 (9.53)
0.052 (1.32)
0.062 (1.57)
0.112 TYP. (2.84)
0.047 (1.19)
0.052 (1.32)
0.049 (1.24)
BOTTOM VIEW

LSM WITH REMOVABLE HEAT SHIELD FOR HIGH TEMPERATURE SOLDER

NOTCH IN SHELL INDICATES PIN ONE

CAUTION PRESS TO REMOVE THE HEAT SHIELD AFTER THE SOLDER PROCESS

NOTCH IN SHELL INDICATES PIN ONE

0.297 (7.54)
0.570 (14.48) 3 EQ. SP. @ 0.190 (4.83)
0.310 (7.87)
0.405 (10.29)
0.430 (10.92)

RECOMMENDED PAD LAYOUT
Recommended Pad Size: 0.15 x 0.10 (3.81 x 2.54)

I/O Connections	
Pin	Function P63
1	On/Off Control
2	+Input
3	Common
4	+Output
5	V_OUT Trim
6	+Sense

Performance/Functional Specifications

Typical @ T$_A$ = +25°C under nominal line voltage and full-load conditions unless noted. ①

Input	
Input Voltage Range	10-14 Volts (12V nominal)
Startup Voltage	8.5-9.2 Volts (model dependent)
Input Current:	
Normal Operating Conditions	See Ordering Guide
Inrush Transient	0.08A^2 sec
Standby/Off Mode	1.5mA
Output Short-Circuit Condition ②	12-40mA average (model dependent)
Input Reflected Ripple Current ② ⑥	20-50mAp-p, model dependent
Input Filter Type	Capacitive
Overvoltage Protection	None
Reverse-Polarity Protection	None
Undervoltage Shutdown	7.5-8 Volts (model dependent)
On/Off Control ② ③	On = open lead
	Off = -0.3V to +0.2V (3µA max.)

Output	
V$_{OUT}$ Accuracy (50% load)	±1.25%
Minimum Loading ①	No load
Maximum Capacitive Load	1000µF (low ESR, OSCON)
V$_{OUT}$ Trim Range	±10%
Ripple/Noise (20MHz BW) ① ② ④	See Ordering Guide
Total Accuracy	3% over line/load/temperature
Efficiency	See Ordering Guide
Overcurrent Detection and Short-Circuit Protection: ②	
Current-Limiting Detection Point	21-37 Amps (model dependent)
Short-Circuit Detection Point	98% of V$_{OUT}$ set
SC Protection Technique	Hiccup with auto recovery
Short-Circuit Current	125-420mA average (model dependent)

Dynamic Characteristics	
Transient Response (50% load step)	30-135µsec to ±2% of final value (model dependent)
Start-Up Time: ②	
V$_{IN}$ to V$_{OUT}$ and On/Off to V$_{OUT}$	60msec for V$_{OUT}$ = 1V and 0.75V
	40msec for V$_{OUT}$ = 1.2V to 5V
Switching Frequency	260kHz ±10%

Environmental	
Calculated MTBF ⑤	
LSM-1.2/16-D12	9,160,138 hours
LSM-1.5/16-D12	8,674,318 hours
LSM-1.8/16-D12	8,334,117 hours
LSM-2.5/16-D12	8,534,580 hours
LSM-3.3/16-D12	7,817,255 hours
LSM-5/16-D12	7,756,061 hours
Operating Temperature: (Ambient) ②	−40 to +85°C (with Derating)
	See Derating Curves
Thermal Shutdown	+115°C (110 to 125°C)

Physical	
Dimensions	1.3" x 0.53" x 0.34" (33.03 x 13.46 x 8.64)
Lead Dimensions/Material	0.112" x 0.062" (2.84 x 1.57mm) rectangular copper alloy with gold plate over nickel underplate
Weight	0.28 ounces (7.8g)
Flamability Rating	UL94V-0
Safety	Designed to meetUL/cUL/IEC/EN 60950-1, CSA-C22.2 No. 234

① All models are tested and specified with external 22µF tantalum input and output capacitors.These capacitors are necessary to accommodate our test equipment and may not be required to achieve specified performance in your applications. All models are stable and regulate within spec under no-load conditions.

② See Technical Notes and Performance Curves for details.

③ The On/Off Control (pin 1) is designed to be driven with open-collector logic (referenced to Common, pin 3) or a switch to ground.

④ Output noise may be further reduced with the installation of additional external output filtering. See I/O Filtering and Noise Reduction.

⑤ MTBF's are calculated using Telcordia SR-332(Bellcore), ground fixed, T$_a$ = +25°C, full power, natural convection, +67°C pcb temperature.

⑥ Input Ripple Current is tested/specified over a 5Hz-20MHz bandwidth with an external 2 x 100µF input capacitor and a simulated source impedance of 1000µF and 1µH. See I/O Filtering, Input Ripple Current and Output Noise for details.

Absolute Maximum Ratings	
Input Voltage:	
Continuous or transient	15 Volts
On/Off Control (Pin 1)	+6V
Input Reverse-Polarity Protection	None
Output Overvoltage Protection	None
Output Current	Current limited. Devices can withstand sustained output short circuits without damage.
Storage Temperature	−55 to +125°C
Lead Temperature	See Reflow Solder Profile

These are stress ratings. Exposure of devices to greater than any of these conditions may adversely affect long-term reliability. Proper operation under conditions other than those listed in the Performance/Functional Specifications Table is not implied.

Technical Notes

I/O Filtering and Noise Reduction

All models in the LSM D12 Series are tested and specified with external 22µF tantalum input and output capacitors. These capacitors are necessary to accommodate our test equipment and may not be required to achieve desired performance in your application. The LSM D12's are designed with high-quality, high-performance internal I/O caps, and will operate within spec in most applications with no additional external components.

In particular, the LSM D12s input capacitors are specified for low ESR and are fully rated to handle the units' input ripple currents. Similarly, the internal output capacitors are specified for low ESR and full-range frequency response. As shown in the Performance Curves, removal of the external 22µF tantalum output caps has minimal effect on output noise.

In critical applications, input/output ripple/noise may be further reduced using filtering techniques, the simplest being the installation of external I/O caps.

External input capacitors serve primarily as energy-storage devices. They minimize high-frequency variations in input voltage (usually caused by IR drops in conductors leading to the DC/DC) as the switching converter draws pulses of current. Input capacitors should be selected for bulk capacitance (at appropriate frequencies), low ESR, and high rms-ripple-current ratings. The switching nature of modern DC/DCs requires that the dc input voltage source have low ac impedance at the frequencies of interest. Highly inductive source impedances can greatly affect system stability. Your specific system configuration may necessitate additional considerations.
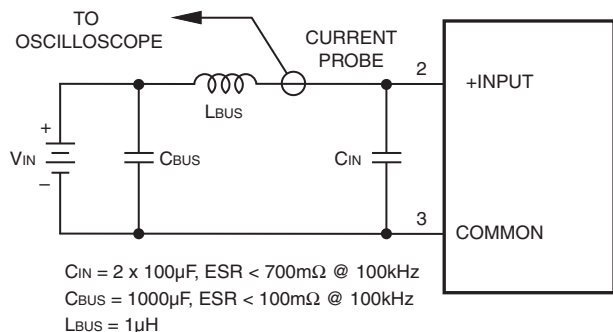
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C_{IN} = 2 x 100µF, ESR < 700mΩ @ 100kHz
C_{BUS} = 1000µF, ESR < 100mΩ @ 100kHz
L_{BUS} = 1µH

Figure 2. Measuring Input Ripple Current

Output ripple/noise (also referred to as periodic and random deviations or PARD) may be reduced below specified limits with the installation of additional external output capacitors. Output capacitors function as true filter elements and should be selected for bulk capacitance, low ESR, and appropriate frequency response. Any scope measurements of PARD should be made directly at the DC/DC output pins with scope probe ground less than 0.5" in length.

C1 = NA
C2 = 22µF TANTALUM
LOAD 2-3 INCHES (51-76mm) FROM MODULE
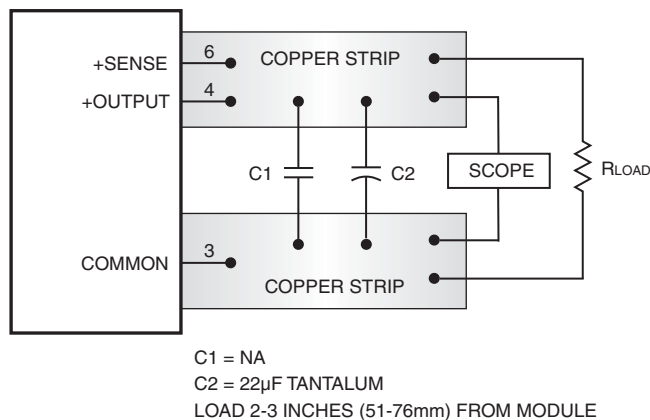
Figure 3. Measuring Input Ripple Current

All external capacitors should have appropriate voltage ratings and be located as close to the converters as possible. Temperature variations for all relevant parameters should be taken into consideration.

The most effective combination of external I/O capacitors will be a function of your line voltage and source impedance, as well as your particular load and layout conditions. Our Applications Engineers can recommend potential solutions and discuss the possibility of our modifying a given device's internal filtering to meet your specific requirements. Contact our Applications Engineering Group for additional details.

Input Fusing

Most applications and or safety agencies require the installation of fuses at the inputs of power conversion components. The LSM D12 Series are not internally fused. Therefore, if input fusing is mandatory, either a normal-blow or a fast-blow fuse with a value no greater than twice the maximum input current should be installed within the ungrounded input path to the converter.

As a rule of thumb however, we recommend to use a normal-blow or slow-blow fuse with a typical value of about twice the maximum input current, calculated at low line with the converters minimum efficiency.

Safety Considerations

LSM D12 SMT's are non-isolated DC/DC converters. In general, all DC/DC's must be installed, including considerations for I/O voltages and spacing/separation requirements, in compliance with relevant safety-agency specifications (usually UL/IEC/EN60950-1).

In particular, for a non-isolated converter's output voltage to meet SELV (safety extra low voltage) requirements, its input must be SELV compliant. If the output needs to be ELV (extra low voltage), the input must be ELV.

Input Overvoltage and Reverse-Polarity Protection

LSM D12 SMT Series DC/DC's do not incorporate either input overvoltage or input reverse-polarity protection. Input voltages in excess of the specified absolute maximum ratings and input polarity reversals of longer than "instantaneous" duration can cause permanent damage to these devices.

Start-Up Time

The V_{IN} to V_{OUT} Start-Up Time is the interval between the time at which a ramping input voltage crosses the lower limit of the specified input voltage range (10 Volts) and the fully loaded output voltage enters and remains within its specified accuracy band. Actual measured times will vary with input source impedance, external input capacitance, and the slew rate and final value of the input voltage as it appears to the converter.

The On/Off to V_{OUT} Start-Up Time assumes the converter is turned off via the On/Off Control with the nominal input voltage already applied to the converter. The specification defines the interval between the time at which the converter is turned on and the fully loaded output voltage enters and remains within its specified accuracy band. See Typical Performance Curves.

Remote Sense

LSM D12 SMT Series DC/DC converters offer an output sense function on pin 6. The sense function enables point-of-use regulation for overcoming moderate IR drops in conductors and/or cabling. Since these are non-isolated devices whose inputs and outputs usually share the same ground plane, sense is provided only for the +Output.

The remote sense line is part of the feedback control loop regulating the DC/DC converter's output. The sense line carries very little current and consequently requires a minimal cross-sectional-area conductor. As such, it is not a low-impedance point and must be treated with care in layout and cabling. Sense lines should be run adjacent to signals (preferably ground), and in cable and/or discrete-wiring applications, twisted-pair or similar techniques should be used. To prevent high frequency voltage differences between V_{OUT} and Sense, we recommend installation of a 1000pF capacitor close to the converter.

The sense function is capable of compensating for voltage drops between the +Output and +Sense pins that do not exceed 10% of V_{OUT}.

$$[V_{OUT}(+) - Common] - [Sense(+) - Common] \leq 10\%V_{OUT}$$

Power derating (output current limiting) is based upon maximum output current and voltage at the converter's output pins. Use of trim and sense functions can cause the output voltage to increase, thereby increasing output power beyond the LSM's specified rating. Therefore:

$$(V_{OUT} \text{ at pins}) \times (I_{OUT}) \leq \text{rated output power}$$

The internal 10.5Ω resistor between +Sense and +Output (see Figure 1) serves to protect the sense function by limiting the output current flowing through the sense line if the main output is disconnected. It also prevents output voltage runaway if the sense connection is disconnected.

Note: *If the sense function is not used for remote regulation, +Sense (pin 6) must be tied to +Output (pin 4) at the DC/DC converter pins.*

On/Off Control

The On/Off Control pin may be used for remote on/off operation. LSM D12 Series DC/DC converters are designed so that they are enabled when the control pin is left open (open collector) and disabled when the control pin is pulled low (to less than +0.4V relative to Common). As shown in Figure 4, all models have an internal pull-up current source to V_{IN} (+Input).
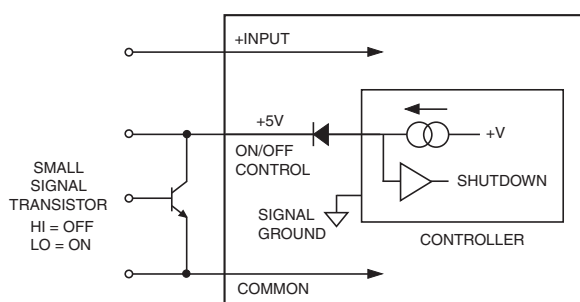
Figure 4. On/Off Control Using An External Open Collector Driver

Dynamic control of the on/off function is best accomplished with a mechanical relay or open-collector/open-drain drive circuit (optically isolated if appropriate). The drive circuit should be able to sink appropriate current when activated and withstand appropriate voltage when deactivated.

Applying an external voltage to the On/Off Control pin when no input power is applied to the converter can cause permanent damage to the converter. The on/off control function, however, is designed such that the converter can be disabled (control pin pulled low) while input voltage is ramping up and then "released" once the input has stabilized (see also power-up sequencing).

Power-up sequencing

If a controlled start-up of one or more LSM D12 Series DC/DC converters is required, or if several output voltages need to be powered-up in a given sequence, the On/Off control pin can be driven with an external open collector device as per Figure 5.
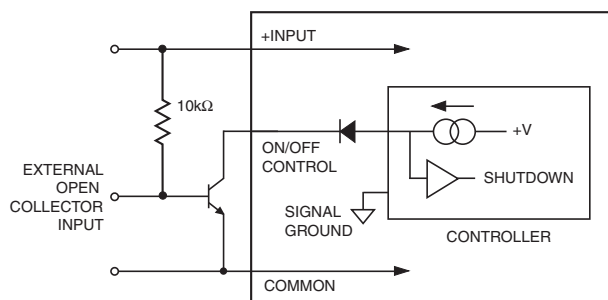
Figure 5. Driving The External Power-Up Open Collector

Leaving the input of the on/off circuit closed during power-up will have the output of the DC/DC converter disabled. When the input to the external open collector is pulled high, the DC/DC converter's output will be enabled.

Output Overvoltage Protection

LSM D12 SMT Series DC/DC converters do not incorporate output overvoltage protection. In the extremely rare situation in which the device's feedback loop is broken, the output voltage may run to excessively high levels ($V_{OUT} = V_{IN}$). If it is absolutely imperative that you protect your load against any and all possible overvoltage situations, voltage limiting circuitry must be provided external to the power converter.

Output Overcurrent Detection

Overloading the power converter's output for an extended time will invariably cause internal component temperatures to exceed their maximum ratings and eventually lead to component failure. High-current-carrying components such as inductors, FET's and diodes are at the highest risk. LSM D12 SMT Series DC/DC converters incorporate an output overcurrent detection and shutdown function that serves to protect both the power converter and its load.

If the output current exceeds it maximum rating by typically 70% (27 Amps) or if the output voltage drops to less than 98% of it original value, the LSM D12's internal overcurrent-detection circuitry immediately turns off the converter, which then goes into a "hiccup" mode. While hiccupping, the converter will continuously attempt to restart itself, go into overcurrent, and then shut down. Under these conditions, the average output current will be approximately 400mA, and the average input current will be approximately 40mA. Once the output short is removed, the converter will automatically restart itself.

Output Voltage Trimming

Allowable trim ranges for each model in the LSM D12 SMT Series are ±10%. Trimming is accomplished with either a trimpot or a single fixed resistor. The trimpot should be connected between +Output and Common with its wiper connected to the Trim pin as shown in Figure 6 below.
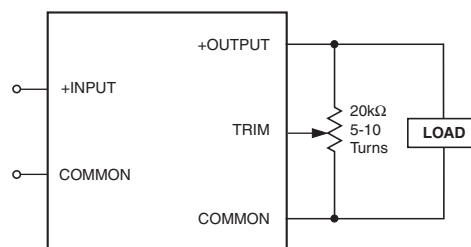

Figure 6. Trim Connections Using a Trimpot

A trimpot can be used to determine the value of a single fixed resistor which can then be connected, as shown in Figure 7, between the Trim pin and +Output to trim down the output voltage, or between the Trim pin and Common to trim up the output voltage. Fixed resistors should have absolute TCR's less than 100ppm/°C to ensure stability.
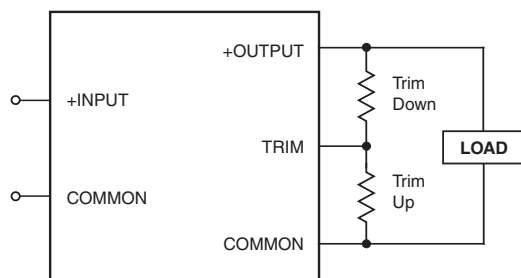
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Figure 7. Trim Connections Using Fixed Resistors

The equations below can be starting points for selecting specific trim-resistor values. Recall, untrimmed devices are guaranteed to be ±1.25% accurate.

Adjustment beyond the specified ±10% adjustment range is not recommended. When using trim in combination with Remote Sense, the maximum rated power must not be exceeded (see Remote Sense).

Trim Equations

$$R_{T_{DOWN}} (k\Omega) = \frac{7.87(V_O - 0.7)}{V_{O\,NOM} - V_O} - X \qquad R_{T_{UP}} (k\Omega) = \frac{5.509}{V_O - V_{O\,NOM}} - X$$

Where: V_O = Desired Output Voltage

$V_{O\,NOM}$ = Nominal Output Voltage

LSM-0.75/16-D12:	$X = 0.909$
LSM-1/16-D12:	$X = 11.5$
LSM-1.2/16-D12:	$X = 19.1$
LSM-1.5/16-D12:	$X = 27.4$
LSM-1.8/16-D12:	$X = 16.9$
LSM-2/16-D12:	$X = 21.5$
LSM-2.5/16-D12:	$X = 18.2$
LSM-3.3/16-D12:	$X = 13.7$
LSM-5/16-D12:	$X = 9.09$

Note: Resistor values are in $k\Omega$. Accuracy of adjustment is subject to tolerances of resistors and factory-adjusted, initial output accuracy. V_O = desired output voltage. $V_{O_{NOM}}$ = nominal output voltage.

"T" Model LSM-T/16-D12

This version of the LSM 16A series offers a special output voltage trimming feature which is fully compatible with competitive units. The output voltage may be varied from 0.75 to 5 Volts using a single external trim-up resistor connected from the Trim input to Output Common. If no trim resistor is attached (Trim pin open), the output is 0.7525 Volts.

The trim may also be adjusted using an external reference voltage connected to the Trim input.

As with other trim adjustments, use a 1% metal film precision resistor with low temperature coefficient (±100 ppm/°C or less) mounted close to the converter with short leads. Also be aware that the output accuracy is ±2% (typical) therefore you may need to vary this resistance slightly to achieve your desired output setting.

The resistor trim up equation for the LSM-T/16-D12 is as follows:

$$R_{T_{UP}} (\Omega) = \frac{10500}{V_O - 0.7525} - 1000$$

Where V_O is the desired output voltage.

The LSM-T/16-D12 fixed resistance values to set the output values are:

V_O	0.7525V	1.0V	1.2V	1.5V	1.8V	2.5V	3.3V	5.0V
R_T (kΩ)	Open	41.424	22.46	13.05	9.024	5.009	3.122	1.472

CAUTION: To retain proper regulation, do not exceed the 5 Volt output.

Voltage Trim

The LSM-T/16-D12 may also be trimmed using an external voltage applied between the Trim Input and Output Common. Be aware that the internal "load" impedance looking into trim pin is approximately 5kΩ. Therefore, you may have to compensate for this in the source resistance of your external voltage reference.

The equation for this voltage adjustment is:

$$V_{TRIM} = 0.7 - (0.0667 \times (V_O - 0.7525))$$

The LSM-T/16-D12 fixed trim voltages to set the output voltage are:

V_O	0.7525V	1.0V	1.2V	1.5V	1.8V	2.5V	3.3V	5.0V
V_T (V)	Open	0.6835	0.670	0.650	0.630	0.583	0.530	0.4166

Output Reverse Conduction

Many DC/DCs using synchronous rectification suffer from Output Reverse Conduction. If those devices have a voltage applied across their output before a voltage is applied to their input (this typically occurs when another power supply starts before them in a power-sequenced application), they will either fail to start or self destruct. In both cases, the cause is the "freewheeling" or "catch" FET biasing itself on and effectively becoming a short circuit.

LSM D12 SMT DC/DC converters do not suffer from Output Reverse Conduction. They employ proprietary gate drive circuitry that makes them immune to applied output voltages.

Thermal Considerations and Thermal Protection

The typical output-current thermal-derating curves shown below enable designers to determine how much current they can reliably derive from each model of the LSM D12 SMTs under known ambient-temperature and air-flow conditions. Similarly, the curves indicate how much air flow is required to reliably deliver a specific output current at known temperatures.

The highest temperatures in LSM D12 SMTs occur at their output inductor, whose heat is generated primarily by I^2R losses. The derating curves were developed using thermocouples to monitor the inductor temperature and varying the load to keep that temperature below +110°C under the assorted conditions of air flow and air temperature. Once the temperature exceeds +115°C (approx.), the thermal protection will disable the converter. Automatic restart occurs after the temperature has dropped below +110°C.

As you may deduce from the derating curves and observe in the efficiency curves on the following pages, LSM D12 SMT's maintain virtually constant efficiency from half to full load, and consequently deliver very impressive temperature performance even if operating at full load.

Lastly, when LSM D12 SMT's are installed in system boards, they are obviously subject to numerous factors and tolerances not taken into account here. If you are attempting to extract the most current out of these units under demanding temperature conditions, we advise you to monitor the output-inductor temperature to ensure it remains below +110°C at all times.

Typical Performance Curves for LSM D12 SMT Series

LSM-0.75/16-D12
Efficiency vs. Line Voltage and Load Current @ 25°C
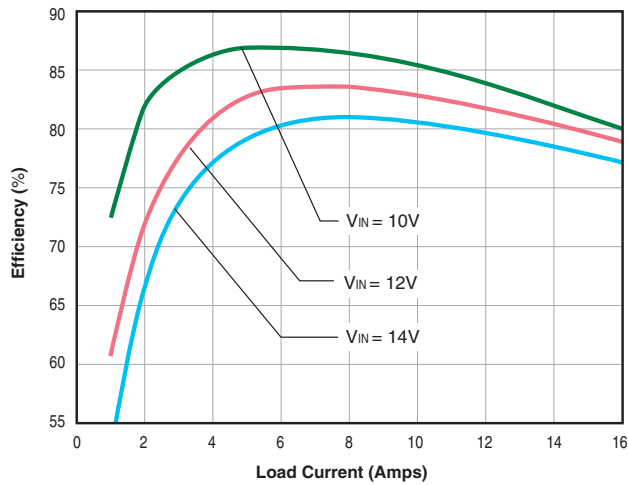
LSM-0.75/16-D12 Maximum Current Temperature Derating
(V_{IN} = 12V, air flow direction is transverse)
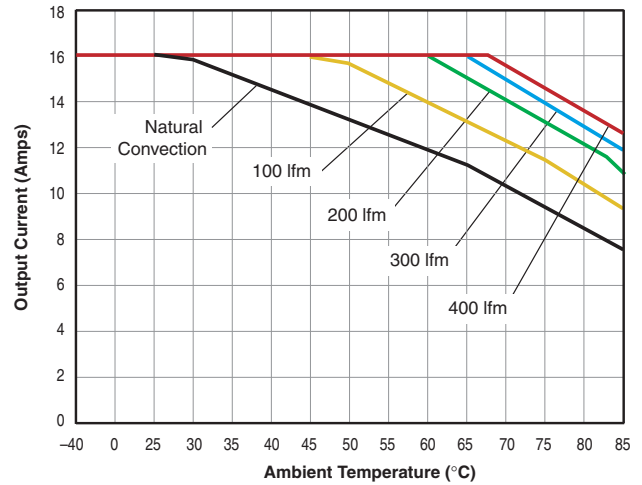
LSM-1/16-D12
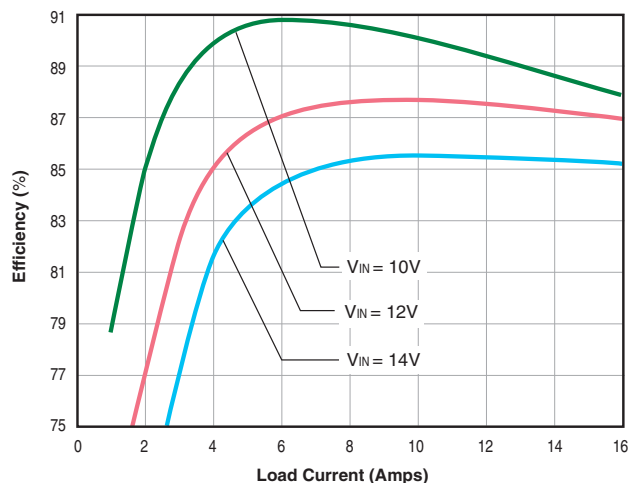**Efficiency vs. Line Voltage and Load Current @ 25°C**
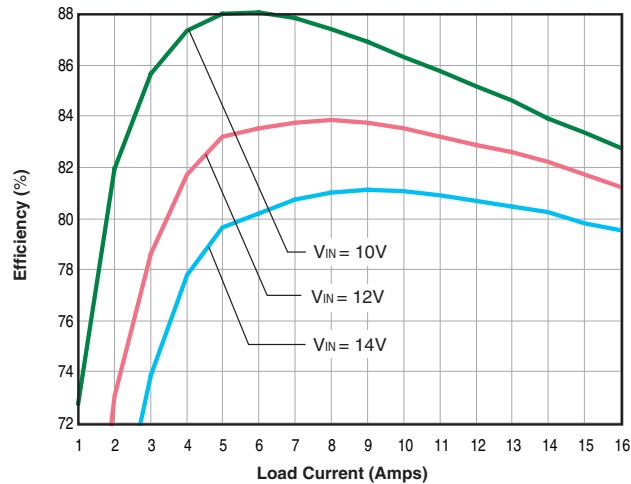
LSM-1/16-D12 Maximum Current Temperature Derating
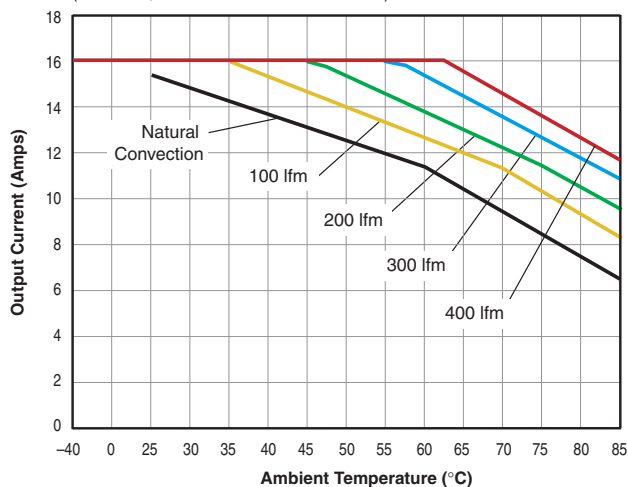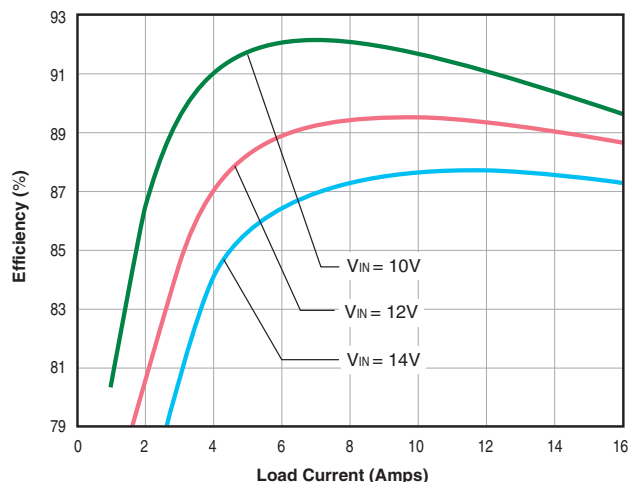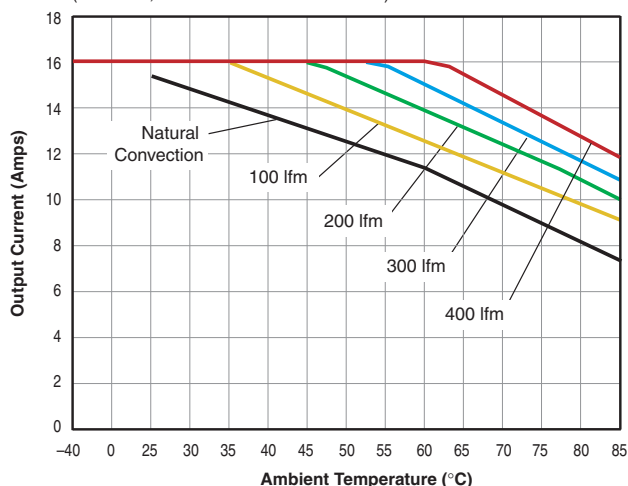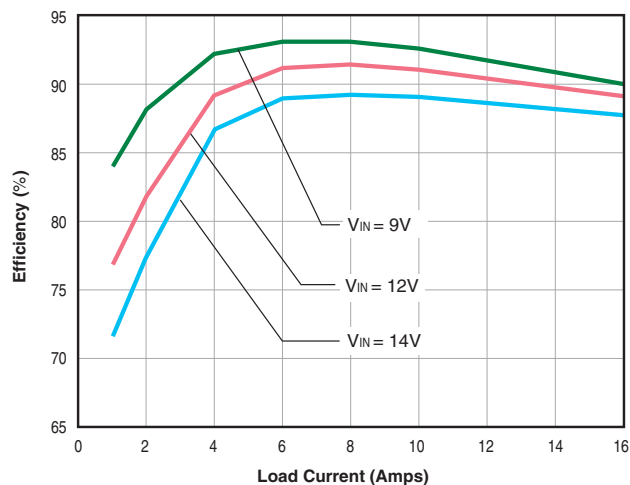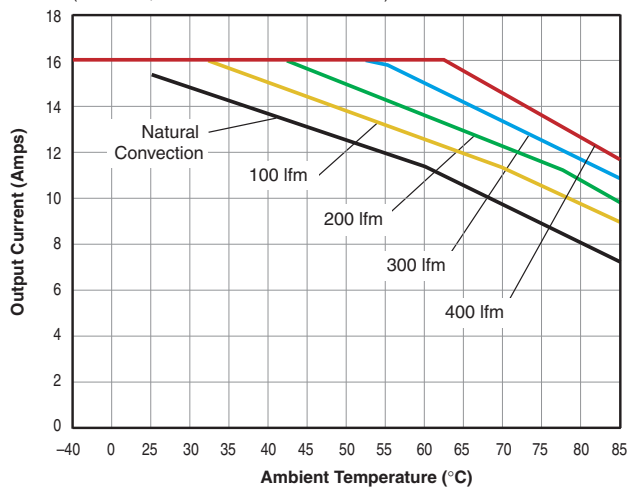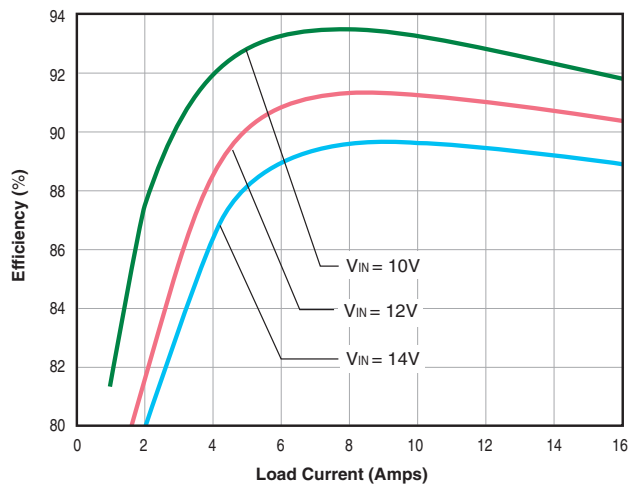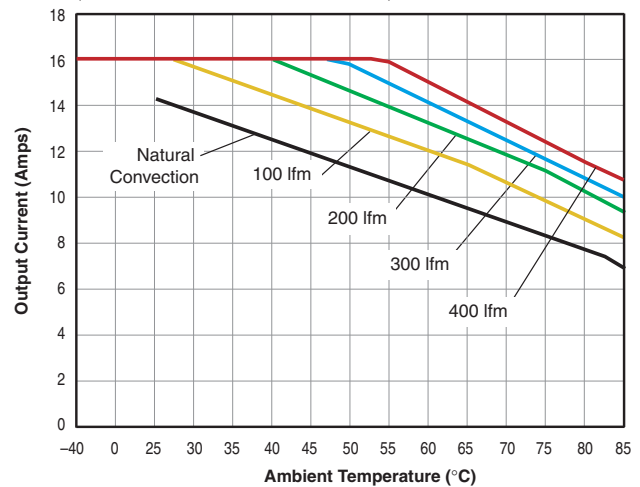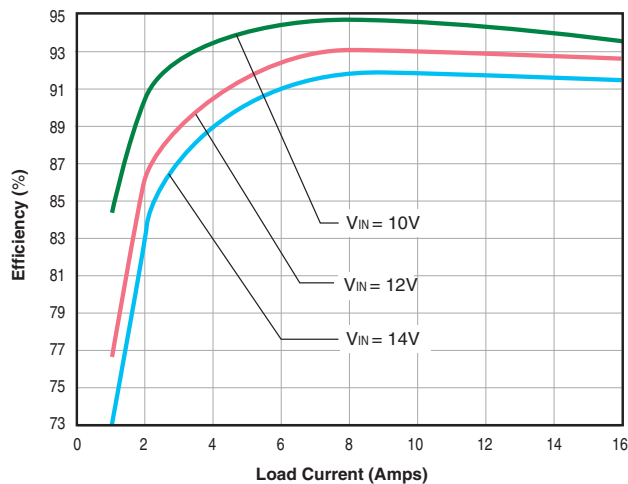(V_{IN} = 12V, air flow direction is transverse)
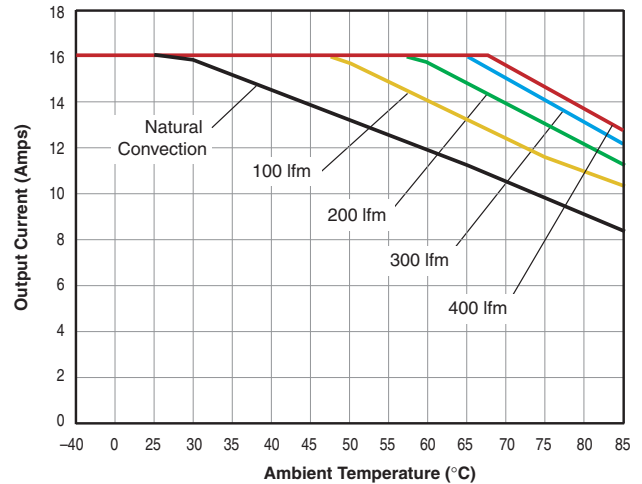
LSM-1.2/16-D12
Efficiency vs. Line Voltage and Load Current @ 25°C
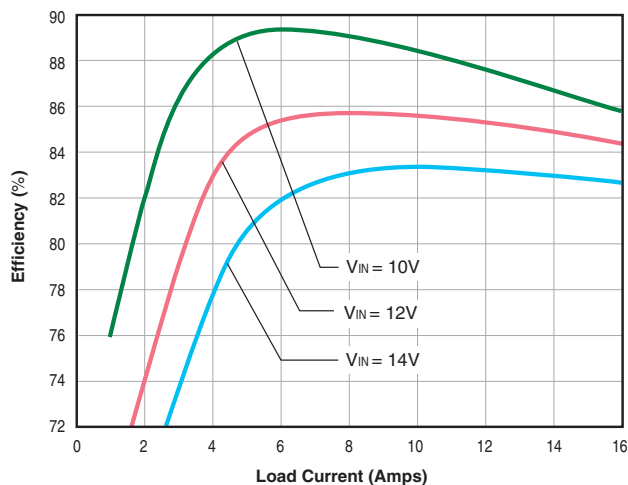
LSM-1.2/16-D12 Maximum Current Temperature Derating
(V_{IN} = 12V, air flow direction is transverse)
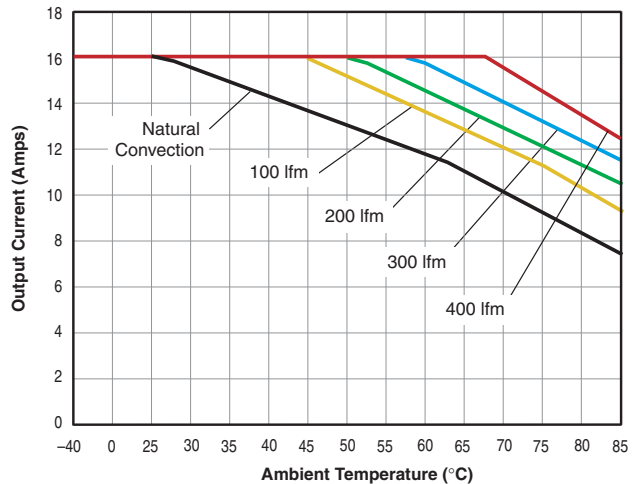
Typical Performance Curves for LSM D12 SMT Series

LSM-1.5/16-D12
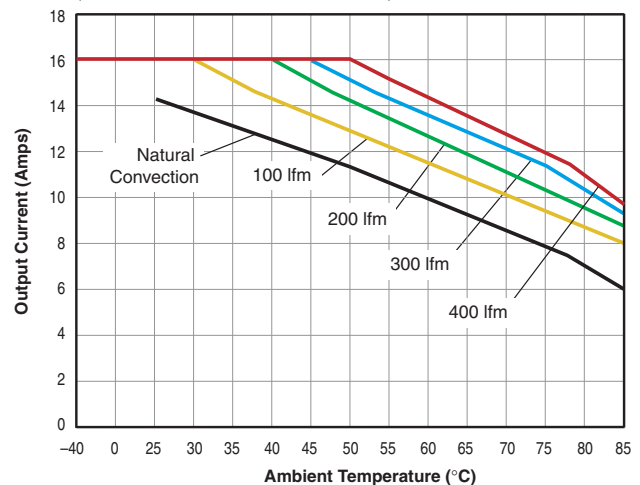**Efficiency vs. Line Voltage and Load Current @ 25°C**

LSM-1.5/16-D12 Maximum Current Temperature Derating
(V_{IN} = 12V, air flow direction is transverse)

**LSM-1.8/16-D12**
Efficiency vs. Line Voltage and Load Current @ 25°C

LSM-1.8/16-D12 Maximum Current Temperature Derating
(V_{IN} = 12V, air flow direction is transverse)

LSM-2/16-D12
Efficiency vs. Line Voltage and Load Current @ 25°C

LSM-2/16-D12 Maximum Current Temperature Derating
(V_{IN} = 12V, air flow direction is transverse)

Typical Performance Curves for LSM D12 SMT Series

LSM-2.5/16-D12
Efficiency vs. Line Voltage and Load Current @ 25°C

LSM-2.5/16-D12 Maximum Current Temperature Derating
(V_{IN} = 12V, air flow direction is transverse)

LSM-3.3/16-D12
Efficiency vs. Line Voltage and Load Current @ 25°C

LSM-3.3/16-D12 Maximum Current Temperature Derating
(V_{IN} = 12V, air flow direction is transverse)

LSM-5/16-D12
Efficiency vs. Line Voltage and Load Current @ 25°C
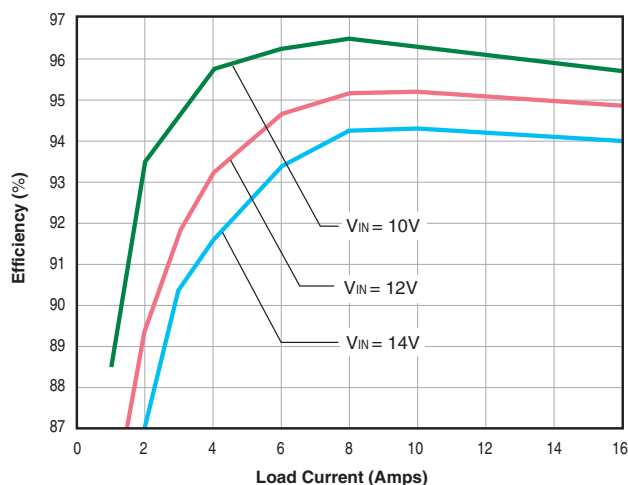
LSM-5/16-D12 Maximum Current Temperature Derating
(V_{IN} = 12V, air flow direction is transverse)

Murata Power Solutions
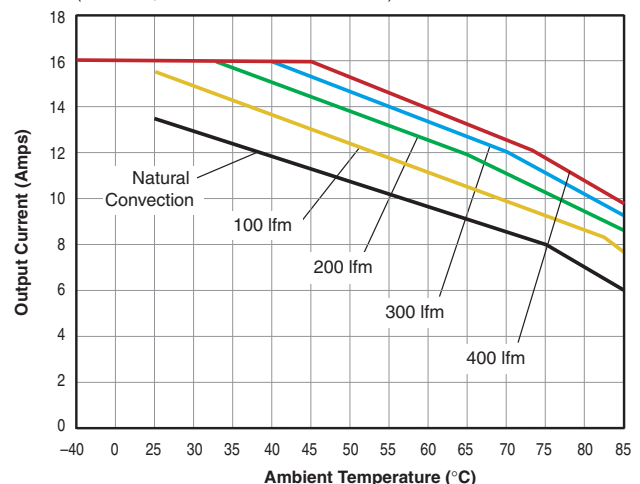
Tape & Reel Surface Mount Package

Murata Power Solutions' LSM series DC/DC converters are the only higher-current (16A) SMT DC/DCs that can be automatically "pick-and-placed" using standard vacuum-pickup equipment (nozzle size and style, vacuum pressure and placement speed may need to be optimized for automated pick and place) and subsequently reflowed using high-temperature, lead-free solder.

Virtually all SMT DC/DCs today are unprotected "open-frame" devices assembled by their vendors with high-temperature solder (usually Sn96.5/Ag3.5 with a melting point of +221°C) so that you may attach them to your board using low-temperature solder (usually Sn63/Pb37 with a melting point of +183°C). Conceptually straightforward, this "stepped" solder approach has its limitations, and it is clearly out of step with an industry trending toward the broad use of lead-free solders. Are you to experiment and develop reflow profiles from other vendors that ensure the components on those DC/DC never exceed 215–216°C? If those components get too hot, "double-reflow" could compromise the reliability of their solder joints. Virtually all these devices demand you "cool down" the Sn63 profile you are likely using today.

MPS is not exempted from the Laws of Physics, and we do not have magic solders no one else has. Nevertheless, we have a simple and practical, straightforward approach that works. We assemble our LSM SMT DC/DCs using a high-temperature (+216°C), lead-free alloy (Sn96.2%, Ag2.5%, Cu0.8%, Sb0.5%). The LSM design ensures co-planarity to within 0.004 inches (100µm) of the unit's copper leads. These leads are gold-plated with a nickel underplate. See Mechanical Data for additional information.

The disposable heat shield (patent pending), which has a cutaway exposing the package leads, provides thermal insulation to internal components during reflow and its smooth surface ideally doubles as the vacuum pick-up location also. The insulation properties of the heat shield are so effective that temperature differentials as high as 50°C develop inside-to-outside the shield. Oven temperature profiles with peaks of 250–260°C and dwell times exceeding 2 minutes above 221°C (the melting point of Sn96.5/Ag3.5) are easily achieved.
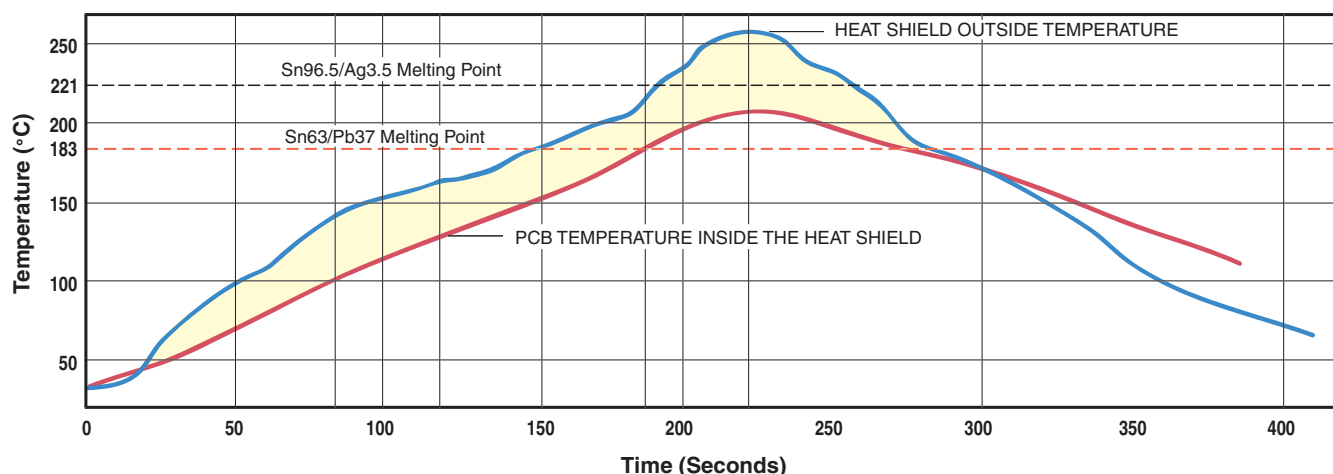

Figure 6. Reflow Solder Profile

Murata Power Solutions

DATEL's new-generation LSM SMT DC/DC converters are shipped in quantities of 150 modules per tape and reel.
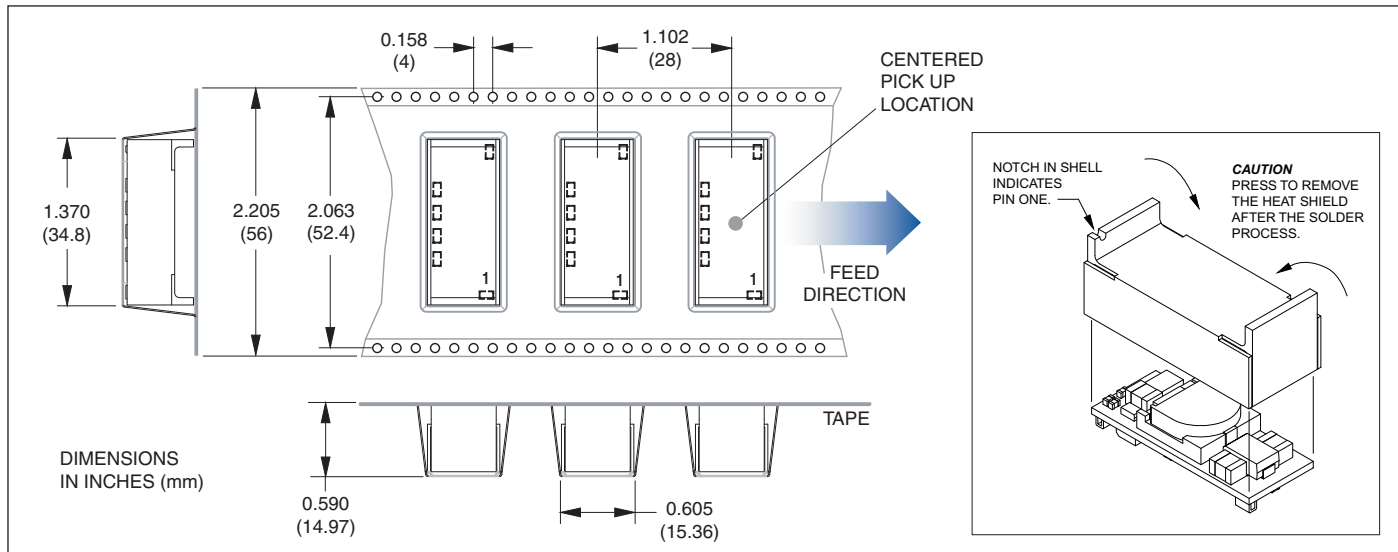
Figure 7. Tape Dimensions

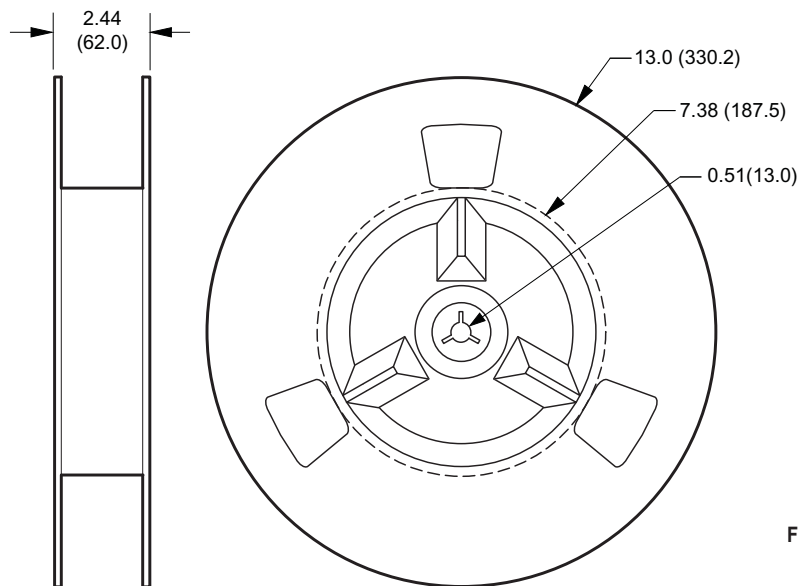**Figure 8. Reel Dimensions**

Mouser Electronics

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  [LSM-0.75/16-D12-C](#) [LSM-1.2/16-D12-C](#) [LSM-1.5/16-D12-C](#) [LSM-1.8/16-D12-C](#) [LSM-2.5/16-D12-C](#) [LSM-3.3/16-D12-C](#) [LSM-5/16-D12-C](#) [LSM-T/16-D12-C](#)