

Typical Unit

FEATURES

- Eighth brick, through hole or SMT with fast transient response
- 2-phase buck regulators for new distributed 12V power architectures
- 12V input (10.2-13.8V range)
- 0.8/1/1.2/1.5/1.8/2/2.5/3.3/5VOUT @ 25A
- Non-isolated, fixed-frequency, synchronous-rectifier topology
- Efficiencies to 87% @ 25 Amps
- Noise as low as 10mVp-p
- Stable no-load operation
- On/Off control, trim & sense functions
- Output Overvoltage Protection
- Input Over/Undervoltage lockout
- Thermal shutdown
- Designed to meet UL/EN/IEC 60950-1 and CAN/CSA C22.2 60950-1
- EMC compliant

PRODUCT OVERVIEW

The HEN D12 Series of non-isolated eighth bricks with high di/dt 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. HEN D12 DC/DC's accept a 12V input (10.2V to 13.8V input range) and convert it, with the highest efficiency in the smallest space, to a 0.8, 1, 1.2, 1.5, 1.8, 2, 2.5, 3.3 or 5 Volt output fully rated at 25 Amps.

HEN D12's are ideal POLPP's (point-of-use/load power processors) and they typically require no external components. They occupy the standard eighth-brick board space (0.9" x 2.3") and come in either through-hole packages or surface-mount packages with a profile of only 0.39 inches (0.5" including optional heat sink).

The HEN's best-in-class power density is achieved with a fully synchronous, fixed-frequency, 2-phase buck topology that delivers extremely high efficiency (92.5% for 5VOUT models), low noise (10mVp-p typ.), extremely tight line/load regulation ($\pm 0.05\%/0.1\%$ max.), fast transient response (50A/ μ sec with full-load step), stable no-load operation, and no output reverse conduction.

The fully functional HEN's feature input over/undervoltage lockout, output overvoltage and overcurrent detection, continuous short-circuit protection, overtemperature protection, an output-voltage trim function, a remote on/off control pin, and a sense pin. High efficiency enables the HEN D12's to deliver rated output currents of 25 Amps at ambient temperatures to +65°C with 200 lfm air flow without heat sink. 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, DATEL's non-isolated 1/4- and 1/8-bricks will save you money. Selected models are RoHS-6 (Restriction of Hazardous Substances) compliant.

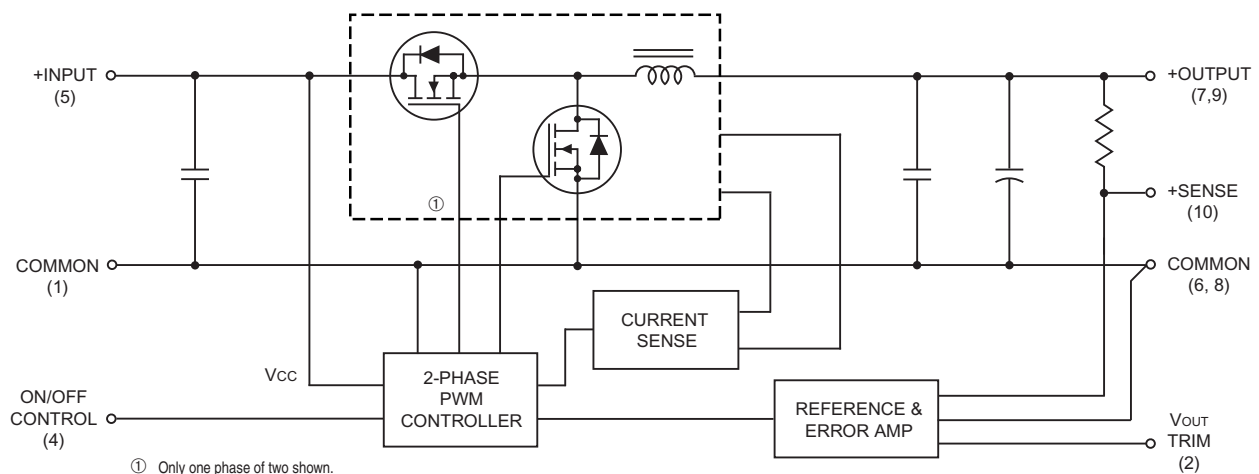


Figure 1. Simplified Schematic

Typical topology is shown



Performance Specifications and Ordering Guide ^①

| Root Model ^⑤ | Output | | | | Input | | | Efficiency | | Package (Case, Pinout) | | |
|-------------------------|-----------------------------|----------------------------|--|------|--------------------------------|-------|---------------------------------|-------------------------------|--|---------------------------|-----------|--------------|
| | V _{OUT} (Volts) | I _{OUT} (Amps) | R/N (mVp-p) ^② | | Regulation (Max.) ^③ | | V _{IN} Nom. (Volts) | Range ^⑥ (Volts) | I _{IN} ^④ (mA/A) | | Full Load | |
| | | | Typ. | Max. | Line | Load | | | | | Min. | Typ. |
| HEN-0.8/25-D12-C | 0.8 | 25 | Please contact Murata Power Solutions for further information. | | | | | | | | | C47,C48, P62 |
| HEN-1/25-D12-C | 1 | 25 | Please contact Murata Power Solutions for further information. | | | | | | | | | C47,C48, P62 |
| HEN-1.2/25-D12-C | 1.2 | 25 | 10 | 20 | ±0.05% | ±0.1% | 12 | 10.2-13.8 | 160/2.9 | 82% | 85% | C47,C48, P62 |
| HEN-1.5/25-D12-C | 1.5 | 25 | 10 | 20 | ±0.05% | ±0.1% | 12 | 10.2-13.8 | 160/3.6 | 84% | 87% | C47,C48, P62 |
| HEN-1.8/25-D12-C | 1.8 | 25 | Please contact Murata Power Solutions for further information. | | | | | | | | | C47,C48, P62 |
| HEN-2/25-D12-C | 2 | 25 | Please contact Murata Power Solutions for further information. | | | | | | | | | C47,C48, P62 |
| HEN-2.5/25-D12-C | 2.5 | 25 | Please contact Murata Power Solutions for further information. | | | | | | | | | C47,C48, P62 |
| HEN-3.3/25-D12-C | 3.3 | 25 | Please contact Murata Power Solutions for further information. | | | | | | | | | C47,C48, P62 |
| HEN-5/25-D12-C | 5 | 25 | Please contact Murata Power Solutions for further information. | | | | | | | | | C47,C48, P62 |

- ① Typical at T_A = +25°C under nominal line voltage and full-load conditions, unless otherwise noted. All models are tested and specified with an external 33µF input and output capacitors. These capacitors are necessary to accommodate our test equipment and may not be required to achieve performance in your application. All models are stable and regulate within spec under no-load conditions.
- 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 Please refer to the Part Number Structure for additional options when ordering.
- ⑥ The operating input voltage is 10.2V to 13.8V. However, 10.8VIN is required for the DC/DC to properly start up under all line, load and temperature conditions. The 10.8V potential must be maintained across the inputs until the output is up and regulating. After the output is regulating, the operating input range is 10.2V to 13.8V.

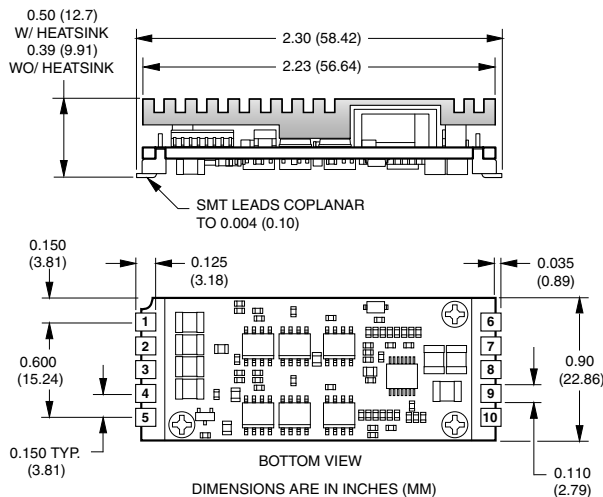
PART NUMBER STRUCTURE

H EN - 1.8 / 25 - D12 M H - C

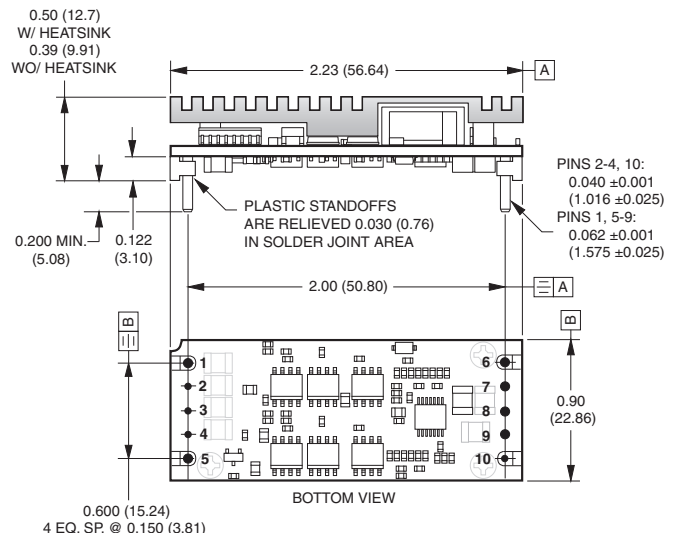
- Output Configuration:**
 - H = Unipolar High di/dt
- Non-Isolated Eighth Brick**
- Nominal Output Voltage:** 0.8, 1, 1.2, 1.5, 1.8, 2, 2.5, 3.3 or 5 Volts
- Input Voltage Range:** D12 = 10.2 to 13.8 Volts (12V nominal)
- Maximum Rated Output Current in Amps**
- RoHS hazardous substance compliant
- Heat Sink Option
- Surface-Mount Package

Note: Not all model number combinations are available. Contact Murata Power Solutions.

MECHANICAL SPECIFICATIONS



| I/O Connections | | | |
|-----------------|-----------------------|-----|--------------|
| Pin | Function P62 | Pin | Function P62 |
| 1 | Common | 6 | Common |
| 2 | V _{OUT} Trim | 7 | +Output |
| 3 | NC | 8 | Common |
| 4 | On/Off Control | 9 | +Output |
| 5 | +Input | 10 | +Sense |



See Heatsink Installation and Automated Assembly and Production Notes for details

Component locations are typical and may vary with different models.

Single Output, Non Isolated, 12VIN, 0.8-5VOUT 25 Amp, High di/dt DC/DC Converters

Performance/Functional Specifications

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

| Input | |
|--|--|
| Input Voltage Range | 10.2-13.8 Volts (12V nominal) ⑩ |
| Input Current: | |
| Normal Operating Conditions | See Ordering Guide |
| Inrush Transient ⑦ | 0.04A ² sec maximum |
| Standby/Off Mode | 41mA |
| Output Short-Circuit Condition | 250mA |
| Input Reflected Ripple Current ② | 25mA _{p-p} |
| Input Filter Type | Capacitive |
| Overvoltage Protection | 14.3 Volts |
| Reverse-Polarity Protection | None |
| Undervoltage Shutdown | 9.5 Volts |
| No-Load Input Current | 160mA |
| Remote On/Off Control: ⑤ | On = open (internal pull down), 0 to +0.8V Off = +2.5V to +V _{IN} or pulled high |
| Remote Control On/Off Current | 0.75mA maximum |
| Remote Sense Input Range | ±10% of V _{OUT} |
| Output | |
| V_{OUT} Accuracy (50% load) | ±1.5% |
| Minimum Loading ① | No minimum load |
| Maximum Output Power ③ | 30.45W (1.2V), 38.06W (1.5V models) |
| Maximum Capacitive Loading | 40,000µF (electrolytic, ESR <10mΩ) |
| V_{OUT} Trim Range ⑧ | ±5% |
| Ripple/Noise (20MHz BW) | See Ordering Guide |
| Total Accuracy | ±3% over line, load and temperature |
| Temperature Coefficient at All Outputs | ±0.02%/°C |
| Efficiency | See Ordering Guide |
| Overcurrent Detection and Short-Circuit Protection: | |
| Current-Limiting Detection | 42 Amps, cold startup (35A after warmup) |
| Short-Circuit Protection Method ④ | Hiccup with auto recovery |
| Short-Circuit Current ⑥ | 2.5A, 4A maximum average |
| Short-Circuit Duration | Continuous, output shorted to ground |
| Dynamic Characteristics | |
| Transient Response: (50-100% load step to ±1.5%V _{OUT}) | 30µsec typical, 60µsec maximum |
| Start-Up Time: V _{IN} to V _{OUT} or On/Off to V _{OUT} | 10msec maximum for V _{OUT} = nominal |
| Switching Frequency | 660kHz ±10% |
| Environmental | |
| Calculated MTBF ④ | TBD million hours |
| Operating Temperature: | -40 to +85°C with derating |
| Storage Temperature Range | -55 to +125°C |
| Thermal Protection Shutdown | +119°C |
| Relative Humidity | To 85% / +85°C non-condensing |
| Physical | |
| Dimensions | See Mechanical Specifications |
| Pin Material | Gold-plated copper alloy with nickel underplate |
| Weight | 0.6 ounces (17g) |
| Flamability Rating | UL94V-0 |
| Electromagnetic Interference (may need external filter) | Conducted and radiated to FCC part EN55022 Class A |
| Safety | Designed to meet UL/cUL/IEC/EN 60950-1, CSA-C22.2 No. 60950-1 |

- ① All models are tested and specified with an external 33µF tantalum input capacitor and 3000µF POSCAP and 300µF ceramic external output capacitors except where noted. 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 Input Ripple Current is specified with no external filter.
- ③ Current Limit Inception is given at either cold startup or after warmup.
- ④ MTBF is calculated using Telcordia (Bellcore) SR-332, Method 1, Case 3, ground-fixed conditions, T_{CASE} = +25°C, full load, natural convection, +67°C maximum pcb temperature.
- ⑤ The On/Off Control (pin 4) may be driven with open-collector logic or the application of appropriate voltages (referenced to Common, pin 1).
- ⑥ The short circuit current is an average which includes brief, full-current hiccup pulses.
- ⑦ Startup inrush current should be used to compute proper external fusing, if installed. The fuse rating will depend on the fuse thermal time constant ("slow blow"), and other factors.
- ⑧ Your times out must not exceed maximum power.
- ⑨ See Technical Notes.
- ⑩ See note 6, page 2.

Absolute Maximum Ratings

| | |
|--|---|
| Input Voltage: | |
| Continuous | 14 Volts |
| Transient (100msec maximum) | 15 Volts |
| On/Off Control (Pin 4) | +V _{IN} |
| Input Reverse-Polarity Protection | None |
| Output Overvoltage Protection | V _{OUT} +20% |
| Output Current | Current limited. Devices can withstand sustained output short circuit without damage. |
| Storage Temperature | -55 to +125°C |
| Lead Temperature (soldering, 10 sec.) | +280°C (Refer to Solder Profile) |

These are stress ratings. Exposure of devices to 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 or recommended.

TECHNICAL NOTES

Return Current Paths

The HEN D12 are non-isolated DC/DC converters. Their Common pins (pins 1, 6 and 8) are connected to each other internally (see Figure 1). To the extent possible (with the intent of minimizing ground loops), input return current should be directed through pin 1 (also referred to as -Input or Input Return), and output return current should be directed through pin 6 and 8 (also referred to as -Output or Output Return). Any on/off control signals applied to pin 4 (On/Off Control) should be referenced to Common (specifically pin 1).

I/O Filtering and Noise Reduction

All models in the HEN D12 Series are tested and specified with external 33µF 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 HEN 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 HEN D12's 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 33µF 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.

Single Output, Non Isolated, 12VIN, 0.8-5VOUT 25 Amp, High di/dt DC/DC Converters

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/DC's requires that the dc input voltage source have low ac impedance and the frequencies of interest. Highly inductive source impedances can greatly affect system stability. Your specific system configuration may necessitate additional considerations.

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.

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. HEN D12 Series DC/DC converters are not internally fused. Therefore, input fusing is mandatory for safety reasons, and safety agencies require a time delay fuse with a value no greater than 40Amps, which 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

HEN D12'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).

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.

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 (10.2 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

HEN D12 Series DC/DC converters offer an output sense function on pin 10. 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} .

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

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 converter's specified rating. Therefore:

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

The internal 10Ω 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 devices have the +Sense pin (pin 10) installed (no part-number suffix) and the sense function is not used for remote regulation, +Sense (pin 10) must be tied to +Output (pin 7, 9) at the DC/DC converter pins.

On/Off Control

The On/Off Control pin may be used for remote on/off operation. HEN D12

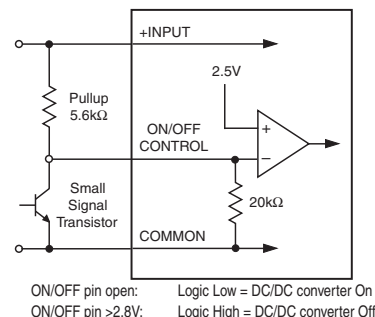


Figure 2. Driving the On/Off Control Pin

Single Output, Non Isolated, 12VIN, 0.8-5VOUT 25 Amp, High di/dt DC/DC Converters

Series DC/DC converters are designed so that they are enabled when the control pin is left open (or pulled low to 0 to +0.4V) and disabled when the control pin is pulled high (+2.8V to +VIN). As shown in Figure 2, all models have an internal 20kΩ pull-down resistor to Common (ground).

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.

The on/off control can be driven using a circuit comparable to that shown in Figure 2. Leaving the On/Off control pin open or applying a voltage between 0V and +0.4V will turn on the converter. Applied voltages between +2.8V and +VIN will disable the converter.

Power-up sequencing

If a controlled start-up of one or more HEN 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 pulled high to +VIN with an external 5.6kΩ resistor. While input voltage and/or other converters are ramping up, the control pin is pulled high and the converter remains disabled. To enable the output voltage, the control pin needs to be pulled low in the configuration shown in Figure 3.

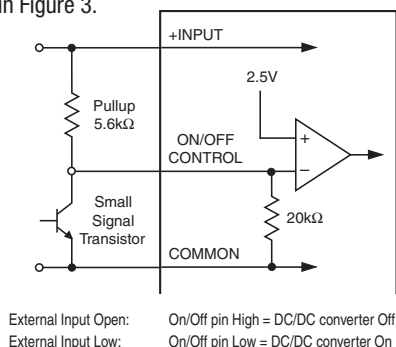


Figure 3. Driving The Power-Up With An External Pull-up Resistor

Output Overvoltage Protection

The HEN D12 Series output voltage is monitored. If the output voltage rises to a level, which could be damaging to the load, the internal sensing circuitry will power down the PWM controller causing the output voltage to decrease. Following a time-out period the PWM will restart, causing the output voltage to ramp to its appropriate value. If the fault condition persists, and the output voltage again climbs to excessive levels, the overvoltage circuitry will initiate another shutdown cycle. This on/off cycling is referred to as "hiccup" mode.

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. HEN D12 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 its maximum rating by typically 40% (35 Amps) or if the output voltage drops to less than 98% of its original value, the HEN

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, both the average output current and the average input current will be kept extremely low. Once the output short is removed, the converter will automatically restart itself.

Output Voltage Trimming

Allowable trim ranges 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 4 below.

A trimpot can be used to determine the value of a single fixed resistor which can then be connected, as shown in Figure 5, 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.

The equations below can be starting points for selecting specific trim-resistor values. Recall, untrimmed devices are guaranteed to be ±1.5% accurate.

Adjustment beyond the specified ±10% adjustment range is not recommended.

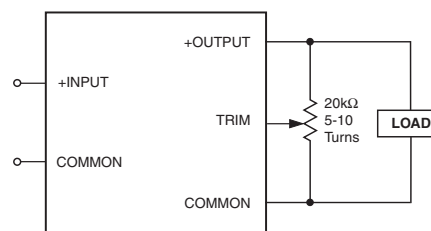


Figure 4. Trim Connections Using a Trimpot

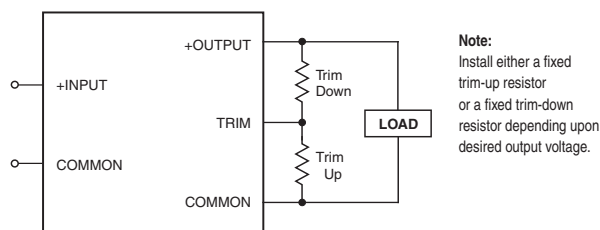


Figure 5. Trim Connections Using Fixed Resistors

Trim Equations

$$R_{T_DOWN} (k\Omega) = \frac{1250(V_O - 0.8)}{V_{O_NOM} - V_O} - X$$

$$R_{T_UP} (k\Omega) = \frac{1000}{V_O - V_{O_NOM}} - X$$

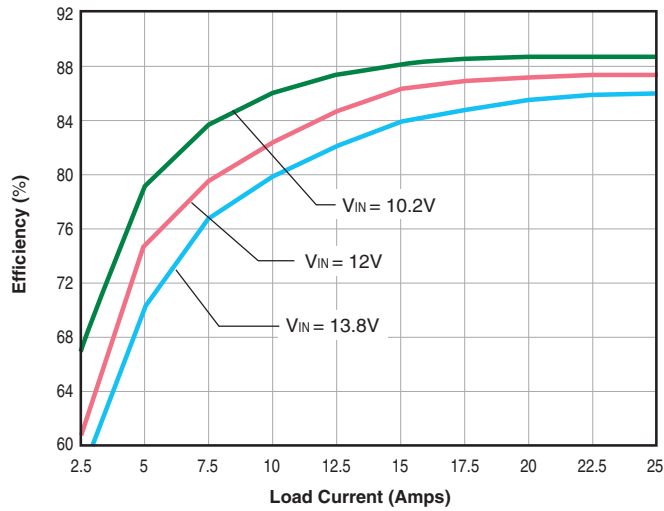
Model HEN-1.2/25-D12: X = 5,620

Model HEN-1.5/25-D12: X = 6,650

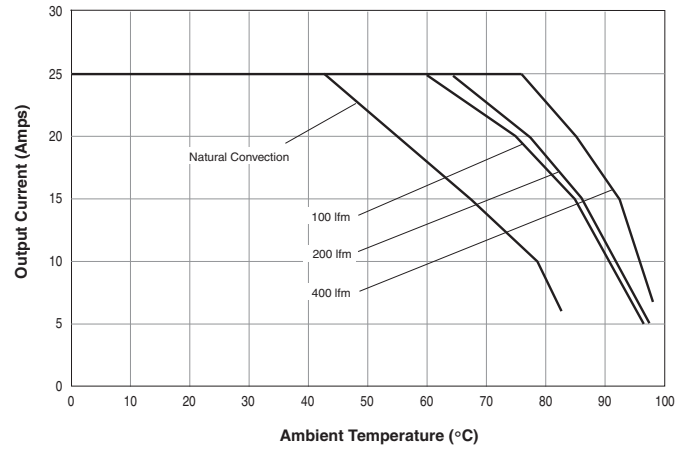
Note: Resistor values are in kΩ. Accuracy of adjustment is subject to tolerances of resistors and factory-adjusted, initial output accuracy. V_O = desired output voltage. V_{O_NOM} = nominal output voltage.

Typical Performance Curves for HEN 1.2V Models

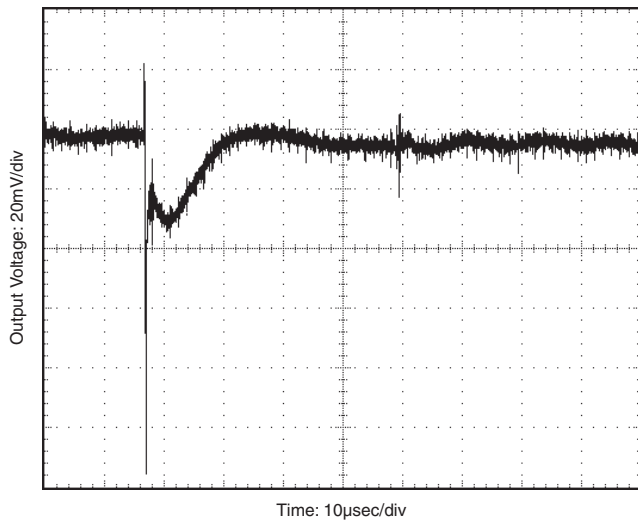
HEN-1.2/25-D12
Efficiency vs. Line Voltage and Load Current



HEN-1.2/25-D12 Temperature Derating
 $V_{IN} = 12V$ (air flow direction from output pins to input pins, no heat sink)

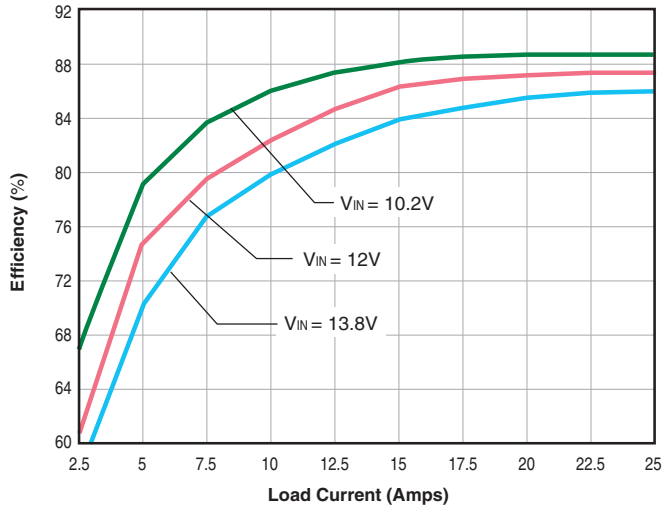


HEN-1.2/25-D12 Transient Response
(8A to 16A Step, $V_{IN} = 12V$, +25°C, Output Caps: 3000 || 300μF)



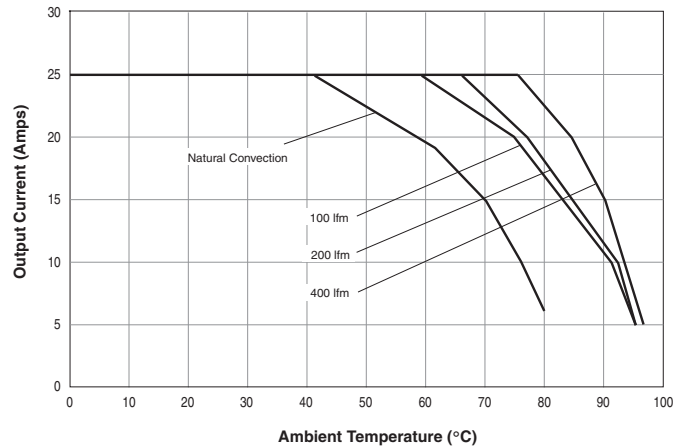
Typical Performance Curves for HEN 1.5V Models

HEN-1.5/25-D12
Efficiency vs. Line Voltage and Load Current



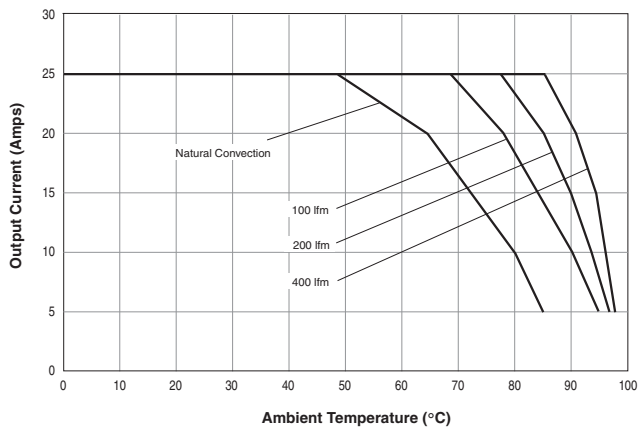
HEN-1.5/25-D12 Temperature Derating

VIN = 12V (air flow direction from output pins to input pins), no heat sink



HEN-1.5/25-D12 Temperature Derating

VIN = 12V (air flow direction from output pins to input pins), with heat sink



Output Reverse Conduction

Many DC/DC's 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.

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

Heatsink Installation

Heatsinks, in combination with adequate airflow, significantly extend the power-handling capability of DATEL power supplies and add a safety margin. Please study the Derating Curves to understand the increased thermal capacity available when a heatsink is installed.

DATEL will supply our custom-designed heatsinks already installed. If preferred, users may also purchase the heatsink assembly separately. If so, please carefully follow the installation instructions below to avoid damage to the DC/DC converter. Contact DATEL if you need assistance. The following procedures require adequate mechanical skills.

Installation has several goals:

1. Insure positive thermal contact between heat-generating circuit components and the heatsink.
2. Avoid mechanical stress to the printed circuit board and on-board components.
3. Fasten the heatsink securely so that vibration in the application will not loosen the mounting screws. Note that some heat may be conducted through the screws.
4. Avoid stripping threads in the aluminum heatsink.

Thermal Pads

The heatsink is supplied with one or more thermal mounting pads which provide a heat transfer path with low thermal resistance between power components and the heatsink. DATEL does NOT recommend "thermal grease" or thermal mounting compounds.

Mounting Screws

DATEL power supplies are precision miniature electronic assemblies fabricated on multiple circuit board layers. Excessive pressure or incorrect mechanical stress may distort the board layers, apply too much force on components or even break small connections. Such fractures may not be visible with the naked eye. It is very important to use the assembly sequence below. We want both a correct sequence and the right amount of torque. This assembly sequence is similar to engine cylinder heads (progressive torquing of diagonally alternating bolts).

A tiny amount of medium-strength (blue) Loctite ® thread assembly adhesive or equivalent is acceptable in high vibration applications. The threads must be degreased for Loctite to work. Do not soak the threads with Loctite. Also, be aware that Loctite will soften at higher temperatures.

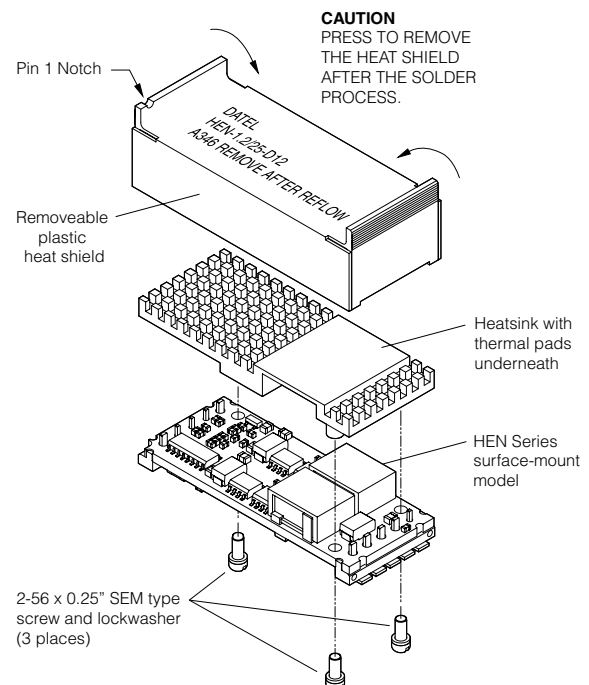
Correct assembly requires a precision low range torque wrench.

- [1] Make sure all the thermal pads have been securely installed. Mount the heatsink using the screws supplied. See the assembly diagram. Do not tighten the screws yet.
- [2] Tighten the first screw only to 50% of maximum final torque (see the table below).
- [3] Tighten the screw in the diagonally opposite corner to 50% torque.
- [4] Tighten the screw adjacent to the first screw to 50% torque.
- [5] Repeat steps [2] to [4], tightening all screws to their maximum torque.
- [6] Thoroughly retest the power supply before committing it to application.

WARNING: Incorrect assembly sequence and/or excessive torque may damage the converter.

For attachment screws, the following maximum final torques must be used:

| Screw Size | Maximum Assembled Torque |
|--------------|--------------------------|
| #2-56 thread | 2.5 inch-pounds maximum |
| #4-40 thread | 5.5 inch-pounds maximum |
| #M3 thread | 6.0 inch-pounds maximum |
| #6-32 thread | 9.6 inch-pounds maximum |



Single Output, Non Isolated, 12VIN, 0.8-5VOUT 25 Amp, High di/dt DC/DC Converters

Automated Assembly Production Notes

DATEL's new high-efficiency DC/DC converters are designed for modern surface-mount technology (SMT) automated assembly using screened solder paste, "pick and place" component positioning and forced hot air reflow oven soldering. If you are new to SMT techniques and have a volume application, these features save time, cost and improve manufacturing efficiency. DATEL's DC/DC assembly operations themselves make extensive use of such techniques.

Even if you have previous SMT experience, you should read the sections below on solder reflow profiles and heat shields. This information is not intended to replace the documentation for your SMT system. We assume that you are already experienced with all the components of your SMT system.

This section will discuss several SMT issues, including:

- I/O Mechanical Configuration
- Part Handling and Supply
- Printed Circuit Board (pcb) Mounting
- Soldering using Reflow Technology
- Temperature Profiling
- Heat Shields and Removal

Mechanical Configuration of Input/Output Connections

These new converters are supplied either using traditional through-hole pins or SMT leads. (Note that some models are offered only with lead mounting). The pin options insert into plated-through holes in the host pcb. Be aware that some heat dissipation is carried off by either the pins or leads. The Derating Curves assume that some additional pad area is available on your host pcb to absorb the heat.

The lead option uses either short tabs in "gullwing" style or standoff leads under the converter. The gullwing leads typically are copper alloy with 150 microinches of tin plating. Solder paste (typically 0.008" to 0.009" thick) is applied to the host pcb using a solder mask pressure screening technique and the board is heated and cooled long enough for the solder to reflow and adhere to both the host pads and the converter's mounting leads.

After such mounting, the entire mechanical mounting load is carried by the solder. Obviously the converters must be accurately positioned all during the solder reflow period. Where solder surface tension is sufficient to force tiny components into position, these larger converters may not move and must be accurately positioned by your SMT system.

Part Handling and Supply

SMT eighth- and quarter-brick DC/DC converters (plus installed heat shields if used) are supplied in JEDEC-standard 5.35" by 12.4" waffle trays which are compatible with the feeders on industry-standard pick-and-place machines.

Since the converters are larger and heavier than many other components, make sure your system can reliably remove the units from their trays, move

them to the host pcb and accurately position them. The plastic heat shield (see below) doubles as a vacuum pickup area.

Heatsinks

If you are using the preinstalled heatsink from DATEL, proceed normally with surface mounting per the information in this section (the heat shield fits completely over the heatsink). However, if you wish to add the heatsink after receiving the converters and heatsink separately, you must install the heatsink before solder reflow. Essentially, install the heatsink then place the assembled converters back in the tray for surface mount positioning. Please observe the torquing and assembly procedure discussed earlier for the heatsink.

Pick and Place pcb Mounting

The main issues here are pad area, orientation, positioning accuracy, vacuum pickup and coplanarity. DATEL recommends that pcb pads to interface with the DC/DC converter should be sized as shown in the diagram below. The pads footprint accommodates the positioning accuracy of your SMT equipment and manufactured tolerances of the DC/DC mounting leads.

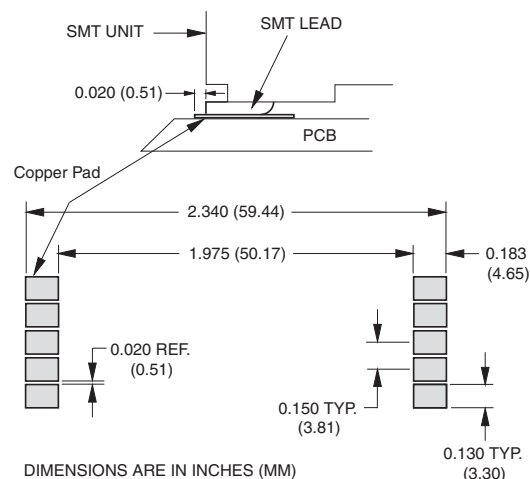


Figure 6. Recommended SMT Mounting Pad Dimensions

Orientation: When loaded into JEDEC trays, these converters are all oriented in the same direction. See the diagram below. For the LEN and HEN series, a notch is placed on the top of the case (on the removal tabs) to indicate the pin 1 position. You should visually inspect the tray to be sure of this orientation.

On the bottom of the converter, the LEN and HEN series include optical fiducial marks viewable by your SMT imaging system. See the attached diagram. Observing from the bottom, your SMT imaging camera should find these marks to identify the converter and verify pin 1. On most pick-and-place systems, during head transit, the imaging system will automatically fine tune the end mounting position of the converter using image comparisons from these fiducials or other reference marks you have chosen.

The fiducial marks are placed fairly close together because most imaging systems have a one inch or less observing area since most SMT parts are considerably smaller than these converters. You may prefer to train your imaging system to use a corner of the converter or an I/O lead.

In the drawing below, these dimensions are intended for initial search for these marks by your camera. There will be tiny variations in absolute position from unit to unit.

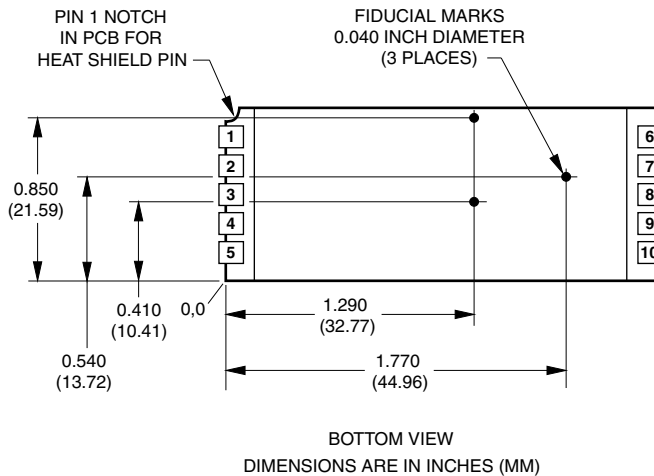


Figure 7. Fiducial Mark Location

If you use a camera above the pcb after placement on the solder paste, do not rely on the inkjet marking on the heat shield to verify proper orientation. Use the pin 1 notch instead.

Coplanarity: DATEL manufactures these converters with very flat mounting leads (see coplanarity specs) however your host pcb must also be flat for a successful mounting. Be aware of possible warping of the pcb under heat gradients and/or humidity conditions. The solder paste will tolerate a small amount of mismatch and will tend to “wet” the entire pad area by capillary action if the temperatures are correct.

Vacuum Pickup: Select the vacuum collet on your SMT placement system for the weight and size of the DC/DC converter. Note that units with heatsinks are slightly heavier. Tests at DATEL have shown that excellent acceleration and transit head speed are available for these converters if the collet size is proper and the vacuum is sufficient. When positioning the vacuum collet, use the geometric center of the heat shield as the pickup area since the center of gravity is very close.

Soldering

Reflow technology works well for small parts. However, larger components such as these DC/DC’s with higher thermal mass may require additional

reflow time (but not enough to disturb smaller parts also being reflowed concurrently with the DC/DC). When this is combined with higher temperature lead-free solders (or solders with reduced heavy metals), there is increased risk of reheating components inside the DC/DC enough so that they either change positions (and possibly stop functioning) or the components are damaged by the heat.

For these reasons, DATEL developed disposable heat shields using high temperature plastic. The DC/DC is installed and reflowed with the shield in place. After successful reflow and cooling, and before washing, the heat shield should be removed.

Temperature Profiling

We wish to ramp the temperature up and down to successfully reflow the solder without heat damage. Each reflow oven, humidity conditions, solder paste type, oven feed rate, and the number of heat zones all require a different profile. Therefore you may have to experiment.

Since these converters are constructed using high temperature solders, there will be no heat problems on your host pcb using traditional solder with 63% lead and 37% tin with a melting point of +183°C. Device lead temperature must remain below 230°C for less than 75 seconds, assuming that the heat shield is in place. DATEL uses a 216°C melt lead-free tin/silver/copper alloy to assemble these converters.

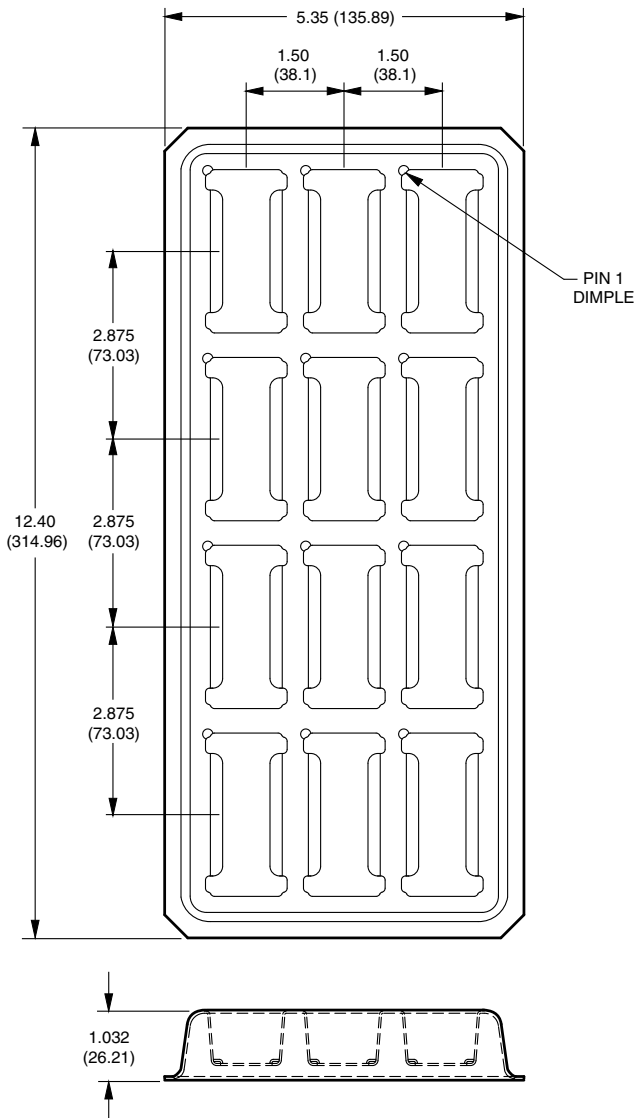
There are several lead-free solders suitable for your host pcb depending on your SMT system and whatever local certification and environmental regulations you must observe. Contact DATEL if you need specific advice.

Heat Shield

Careful thermocouple testing has shown that the interior of the DC/DC under the heat shield is tens of degrees cooler than the outside ambient temperature for typical reflow profiles. This protects internal components and limits the amount of reflow where it is not desired. The heat shield also includes marking for product identification and a date/lot code.

On LEN and HEN models, the heat shield is attached to the converter using molded plastic pins on the heat shield interior which insert into recessed dimples in the pinframe. An extra molded pin on the heat shield at the pin 1 location (and corresponding notch on the pcb) can only be installed one way properly on the pinframe. If the shield accidentally comes loose, it may be reinstalled by aligning the pins and dimples.

To remove the shield from the converter, after successful mounting and cooling, squeeze the heat shield ears inward toward the converter body and pull the shield upwards. Discard or recycle the shield. If you are using a flux wash cycle, remove the heat shield before washing to avoid coming loose inside the washer.



DIMENSIONS ARE IN INCHES (MM)

Figure 8. Shipping Tray

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