Data Sheet
December 1999

MH005-Series Power Modules: 4.5 Vdc to 14 Vdc Input; 5 W

The MH005-Series Power Modules use advanced, surface-mount technology and deliver high-quality, compact, dc-dc conversion at an economical price.

Applications

- Distributed power architectures
- Communication equipment
- Computer equipment

Options

- Long pins: 5.8 mm ± 0.5 mm (0.230 in. ± 0.020 in.)
- Metal case with case ground pin

Features

- Small size: 50.8 mm x 27.9 mm x 11.7 mm
  (2.00 in. x 1.10 in. x 0.46 in.)
- Wide 3:1 input range
- Operating ambient temperature range:
  –10 °C to +70 °C, no derating
- High reliability
- High efficiency: 73% typical
- Input-to-output isolation
- No external filtering required
- No heat sink required
- Overcurrent protection
- Output overvoltage protection
- PC board mountable
- *UL** 1950 Recognized, *CSA*† C22.2 No. 950-95 Certified, *VDE*‡ 0805 (EN60950, IEC950) Licensed
- Meets FCC Class A requirements

* *UL* is a registered trademark of Underwriters Laboratories, Inc.
† *CSA* is a registered trademark of Canadian Standards Association.
‡ *VDE* is a trademark of Verband Deutscher Elektrotechniker e.V.

Description

The MH005-Series Power Modules are dc-dc converters that operate over an input voltage range of 4.5 Vdc to 14 Vdc and provide precisely regulated dc outputs. The outputs are isolated from the inputs, allowing versatile polarity configurations and grounding connections. The modules have maximum power ratings of 5 W with a typical full-load efficiency of 73%.

The modules are PC board mountable and encapsulated in nonconductive cases. The modules are rated to full load at 100 °C case temperature with no external filtering or heat sinking.

Absolute Maximum Ratings

Stresses in excess of the absolute maximum ratings can cause permanent damage to the device. These are absolute stress ratings only. Functional operation of the device is not implied at these or any other conditions in excess of those given in the operations sections of the data sheet. Exposure to absolute maximum ratings for extended periods can adversely affect device reliability.

Parameter	Symbol	Min	Max	Unit
Input Voltage (continuous)	V_I	—	15	Vdc
Operating Case Temperature (See Thermal Considerations section.)	T_C	–10	100	°C
Storage Temperature	T_{stg}	–40	110	°C
I/O Isolation Voltage (1 minute)	—	—	500	Vdc

Electrical Specifications

Unless otherwise indicated, specifications apply over all operating input voltage, resistive load, and temperature conditions.

Table 1. Input Specifications

Parameter	Symbol	Min	Typ	Max	Unit
Operating Input Voltage	V_I	4.5	5	14	Vdc
Maximum Input Current (V_I = 0 V to 14 V; $I_O = I_{O,\,max}$; see Figure 1.)	$I_{I,\,max}$	—	—	2.5	A
Inrush Transient	i^2t	—	—	0.2	A^2s
Input Reflected-ripple Current, Peak-to-peak (5 Hz to 20 MHz, 500 nH source impedance, T_A = 25 °C; see Figure 15 and Design Considerations section.)	I_I	—	45	—	mAp-p
Input Ripple Rejection (120 Hz)	—	—	50	—	dB

Fusing Considerations

CAUTION: This power module is not internally fused. An input line fuse must always be used.

This encapsulated power module can be used in a wide variety of applications, ranging from simple stand-alone operation to an integrated part of a sophisticated power architecture. To preserve maximum flexibility, internal fusing is not included; however, to achieve maximum safety and system protection, always use an input line fuse. The safety agencies require a normal-blow fuse with a maximum rating of 5 A in series with the input (see Safety Considerations section). Based on the information provided in this data sheet on inrush energy and maximum dc input current, the same type of fuse with a lower rating can be used. Refer to the fuse manufacturer's data for further information.

Electrical Specifications (continued)

Table 2. Output Specifications

Parameter	Device	Symbol	Min	Typ	Max	Unit
Output Voltage Set Point (V_I = 5 V; $I_O = I_{O,\,max}$; T_A = 25 °C)	MH005A	$V_{O,\,set}$	4.85	5.0	5.15	Vdc
	MH005B	$V_{O,\,set}$	11.64	12.0	12.36	Vdc
	MH005C	$V_{O,\,set}$	14.55	15.00	15.45	Vdc
	MH005BK	$V_{O1,\,set}$	11.40	12.00	12.60	Vdc
		$V_{O2,\,set}$	–11.40	–12.00	–12.60	Vdc
	MH005CL	$V_{O1,\,set}$	14.25	15.00	15.75	Vdc
		$V_{O2,\,set}$	–14.25	–15.00	–15.75	Vdc
Output Voltage (Over all operating input voltage, resistive load, and temperature conditions until end of life; see Figures 17 and 18.)	MH005A	V_O	4.75	—	5.25	Vdc
	MH005B	V_O	11.40	—	12.60	Vdc
	MH005C	V_O	14.25	—	15.75	Vdc
	MH005BK	V_{O1}	10.80	—	13.20	Vdc
		V_{O2}	–10.80	—	–13.20	Vdc
	MH005CL	V_{O1}	13.50	—	16.50	Vdc
		V_{O2}	–13.50	—	–16.50	Vdc
Output Regulation:						
Line (V_I = 4.5 Vdc to 14 Vdc)	MH005A, B, C	—	—	0.02	0.1	%V_O
Load ($I_O = I_{O,\,min}$ to $I_{O,\,max}$)	MH005A, B, C	—	—	0.05	0.2	%V_O
Temperature (T_C = –10 °C to +100 °C)	MH005A, B, C	—	—	0.6	1.5	%V_O
Output Ripple and Noise Voltage (See Figure 16.):						
RMS	MH005A, B, C	—	—	3	15	mVrms
	MH005BK, CL	—	—	15	50	mVrms
Peak-to-peak (5 Hz to 20 MHz)	MH005A, B, C	—	—	—	50	mVp-p
	MH005BK	—	—	—	200	mVp-p
	MH005CL	—	—	—	250	mVp-p
Output Current	MH005A	I_O	0.05*	—	1.0	A
	MH005B	I_O	0.02*	—	0.42	A
	MH005C	I_O	0.02*	—	0.33	A
	MH005BK	I_{O1}	0.01*	—	0.21	A
		I_{O2}	0.01*	—	0.21	A
	MH005CL	I_{O1}	0.01*	—	0.17	A
		I_{O2}	0.01*	—	0.17	A

* At less than the minimum current, units will continue to operate; however, the single-output modules (MH005A, B, C) may exceed their output ripple specification. The dual-output modules (MH005BK, CL) may exceed their output voltage regulation limits if the output currents are severely imbalanced with one output sourcing less than the minimum current.

Electrical Specifications (continued)

Table 2. Output Specifications (continued)

Parameter	Device	Symbol	Min	Typ	Max	Unit
Output Current-limit Inception (See Figures 4—9.):						
V_O = 4.5 V (~0.9 $V_{O,\,set}$)	MH005A	I_O	—	1.5	2.5	A
V_O = 10.8 V (~0.9 $V_{O,\,set}$)	MH005B	I_O	—	0.7	1.0	A
V_O = 13.5 V (~0.9 $V_{O,\,set}$)	MH005C	I_O	—	0.6	0.9	A
V_{O1} or V_{O2} = 10.2 V†	MH005BK	I_O	—	0.7	1.2	A
V_{O1} or V_{O2} = 12.75 V†	MH005CL	I_O	—	0.6	1.1	A
Output Current Limit (V_I = 5 V, T_A = 25 °C; See Figures 4—9.):						
V_O = 1.0 V (~0.2 $V_{O,\,set}$)	MH005A	—	—	—	3.5	A
V_O = 1.0 V (~0.08 $V_{O,\,set}$)	MH005B	—	—	—	2.5	A
V_O = 1.0 V (~0.07 $V_{O,\,set}$)	MH005C	—	—	—	2.5	A
V_{O1} or V_{O2} = 1.0 V	MH005BK	—	—	—	2.5	A
V_{O1} or V_{O2} = 1.0 V	MH005CL	—	—	—	2.5	A
Output Short-circuit Current (V_O = 250 mV; see Figures 4—9.)	MH005A	—	—	3.0	—	A
	MH005B	—	—	1.4	—	A
	MH005C	—	—	1.4	—	A
	MH005BK	—	—	1.3	—	A
	MH005CL	—	—	1.3	—	A
Efficiency (V_I = 5 V; I_O = $I_{O,\,max}$; T_A = 25 °C; see Figures 10, 11, 17, and 18.)	MH005A	η	70	72	—	%
	MH005B	η	70	73	—	%
	MH005C	η	70	73	—	%
	MH005BK	η	70	73	—	%
	MH005CL	η	70	73	—	%
Switching Frequency	All	—	—	400	—	kHz
Dynamic Response (ýIo/ýt = 1 A/10 µs, V_I = 5 V, T_A = 25 °C; see Figures 12 and 13.):						
Load Change from I_O = 50% to 75% of $I_{O,\,max}$:						
Peak Deviation	All	—	—	60	—	mV
Settling Time (V_O < 10% peak deviation)	All	—	—	4	—	ms
Load Change from I_O = 50% to 25% of $I_{O,\,max}$:						
Peak Deviation	All	—	—	60	—	mV
Settling Time (V_O < 10% of peak deviation)	All	—	—	4	—	ms

* At less than the minimum current, units will continue to operate; however, the single-output modules (MH005A, B, C) may exceed their output ripple specification. The dual-output modules (MH005BK, CL) may exceed their output voltage regulation limits if the output currents are severely imbalanced with one output sourcing less than the minimum current.

† Output not in current limit is held at minimum load to give the worst-case (highest current level) inception point.

Electrical Specifications (continued)

Table 3. Isolation Specifications

Parameter	Min	Typ	Max	Unit
Isolation Capacitance	—	1200	—	pF
Isolation Resistance	10	—	—	M¾

General Specifications

Parameter	Min	Typ	Max	Unit
Calculated MTBF (I_O = 80% of $I_{O,\,max}$; T_C = 40 °C)	5,000,000			hours
Weight	—	—	113 (4.0)	g (oz.)

Feature Specifications

Unless otherwise indicated, specifications apply over all operating input voltage, resistive load, and temperature conditions. See Feature Descriptions and Design Considerations for further information.

Parameter	Device	Symbol	Min	Typ	Max	Unit
Output Overvoltage Protection (clamp)	MH005A	$V_{O,\,clamp}$	—	—	7.0	V
	MH005B	$V_{O,\,clamp}$	—	—	17	V
	MH005C	$V_{O,\,clamp}$	—	—	19	V
	MH005BK	$V_{O1,\,clamp}$	—	—	17	V
		$V_{O2,\,clamp}$	—	—	–17	V
	MH005CL	$V_{O1,\,clamp}$	—	—	19	V
		$V_{O2,\,clamp}$	—	—	–19	V

Characteristic Curves

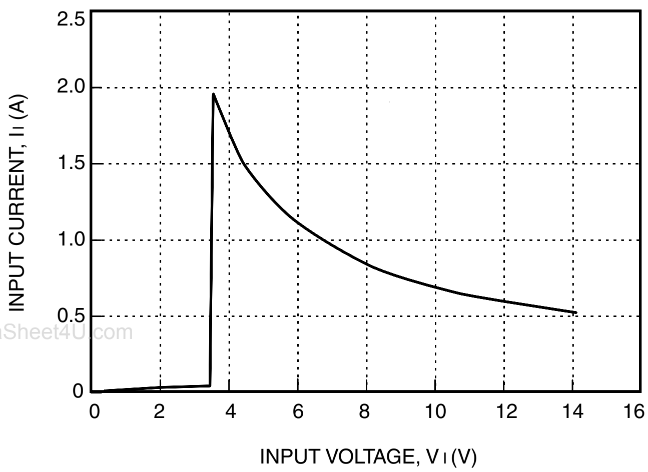

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Figure 1. MH005-Series Typical Input Characteristics with $I_O = I_{O,\,max}$ and T_A = 25 °C

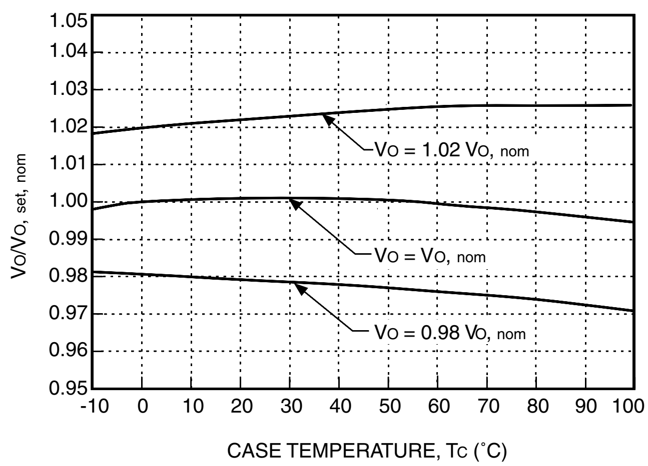

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Figure 2. MH005-Series Typical Output Voltage Variation over Operating Case Temperature

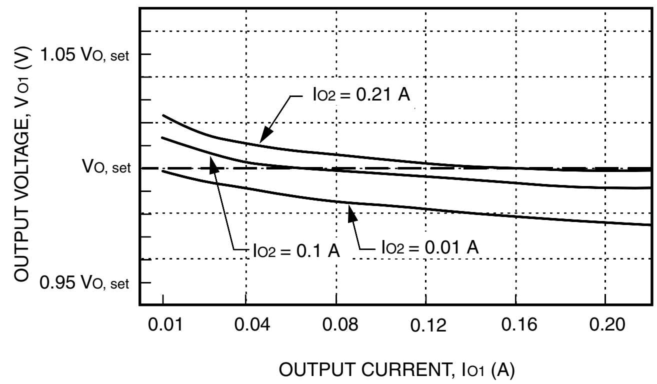

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Figure 3. MH005BK, CL Typical V_O vs. I_O Regulation with V_I = 5 V and T_A = 25 °C

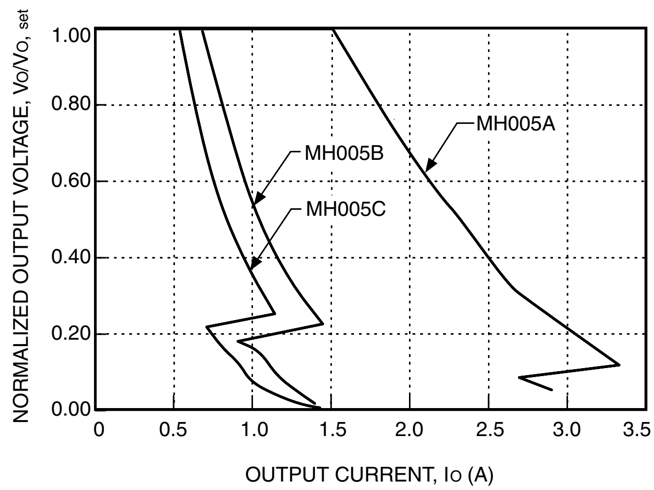

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Figure 4. MH005A, B, C Typical Output Characteristics with V_I = 5 V and T_A = 25 °C

Characteristic Curves (continued)

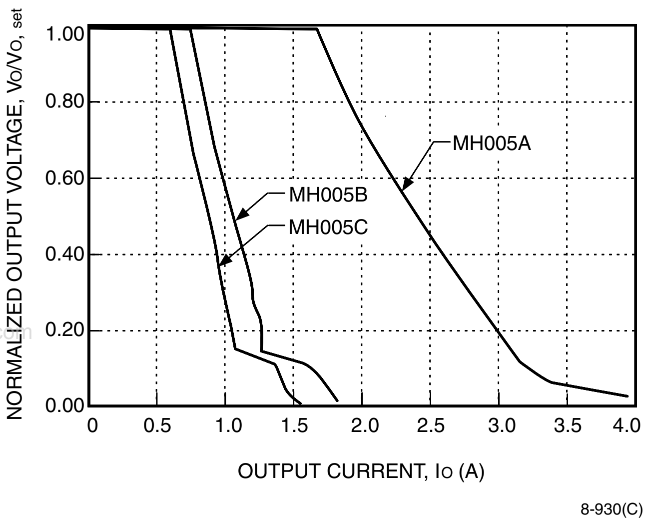


Figure 5. MH005A, B, C Typical Output Characteristics with V_I = 12 V and T_A = 25 °C

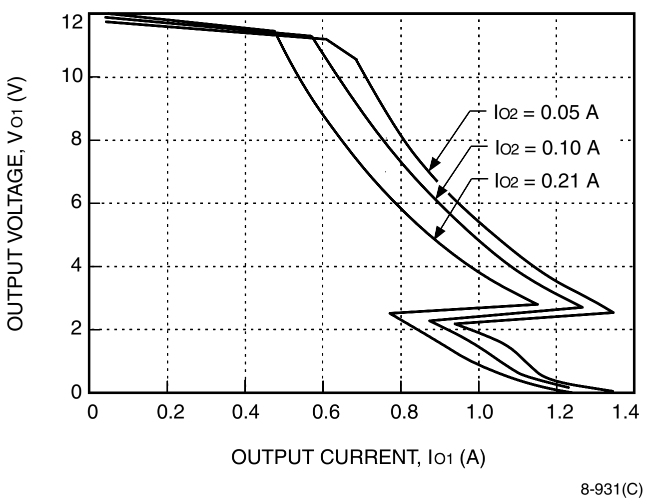


Figure 6. MH005BK Typical Output Characteristics with V_I = 5 V and T_A = 25 °C

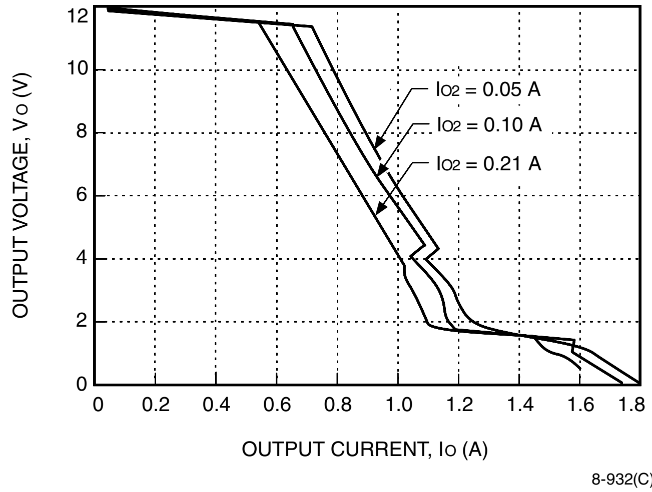


Figure 7. MH005BK Typical Output Characteristics with V_I = 12 V and T_A = 25 °C

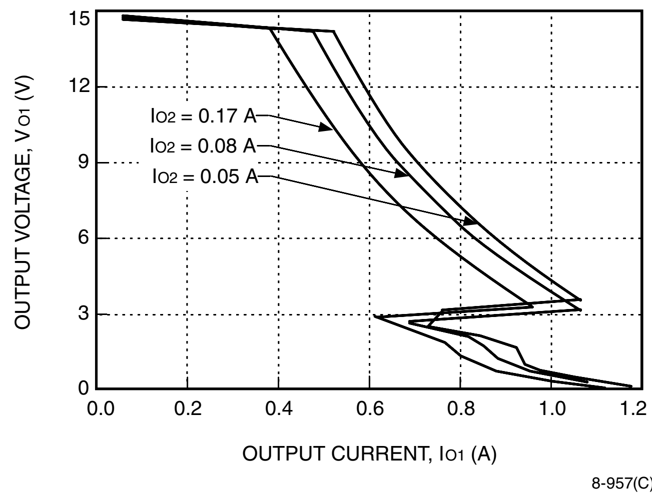


Figure 8. MH005CL Typical Output Characteristics with V_I = 5 V and T_A = 25 °C

Characteristic Curves (continued)

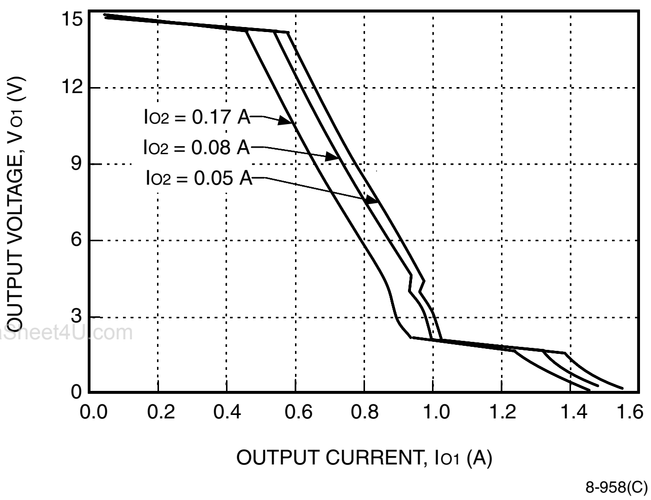


Figure 9. MH005CL Typical Output Characteristics with V_I = 12 V and T_A = 25 °C

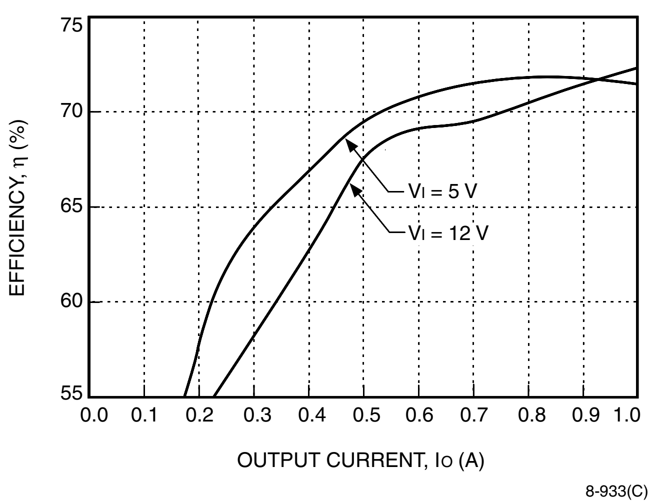


Figure 10. MH005A Typical Converter Efficiency as a Function of Output Current; T_A = 25 °C

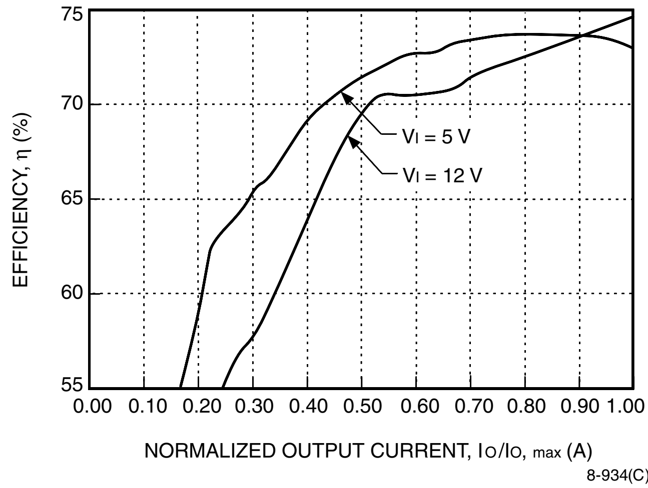


Figure 11. MH005B, C, BK, CL Typical Converter Efficiency as a Function of Output Current; T_A = 25 °C

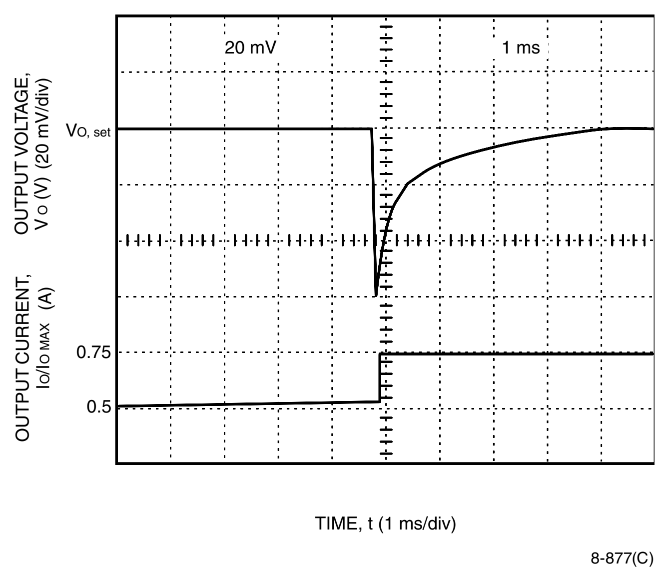


Figure 12. Typical Output Voltage for a Step Load Change from 50% to 75%

Characteristic Curves (continued)

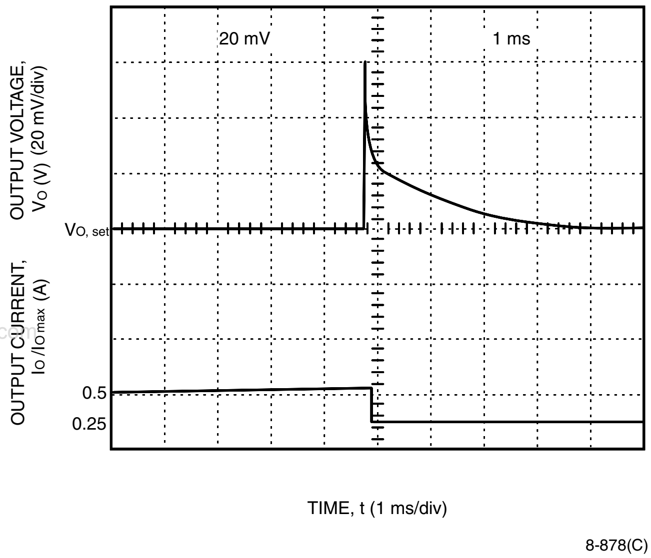


Figure 13. Typical Output Voltage for a Step Load Change from 50% to 25%

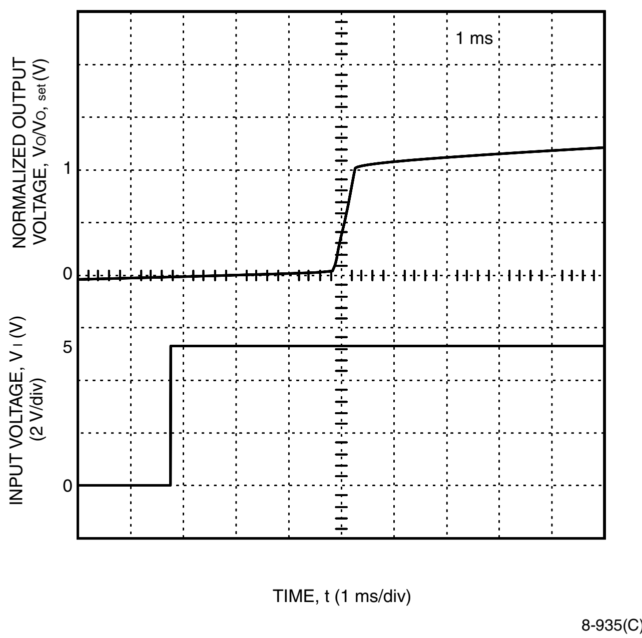
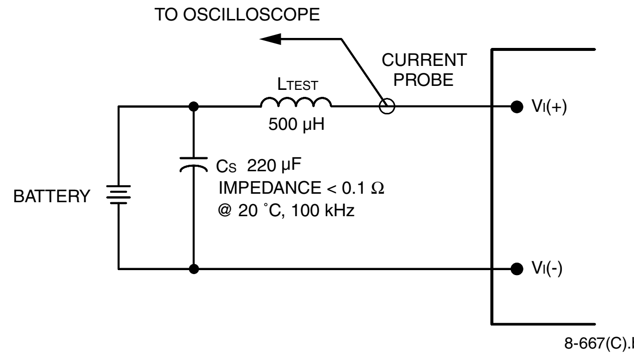


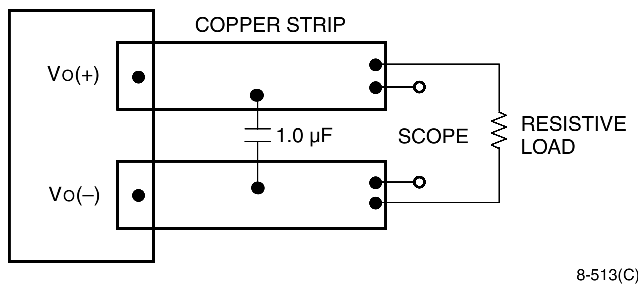
Figure 14. Typical Output Voltage Start-Up when Input Voltage Applied; I_O = 80% of $I_{O, max}$

Test Configurations



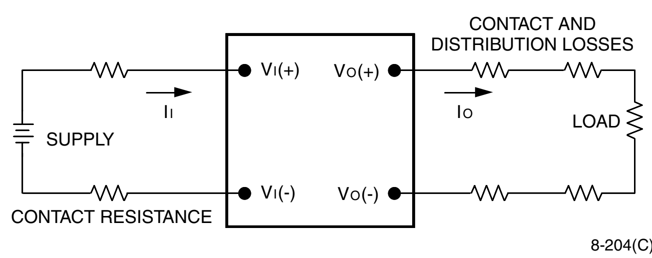
Note: Input reflected-ripple current is measured with a simulated source impedance of 500 nH. Capacitor C_S offsets possible battery impedance. Current is measured at the input of the module.

Figure 15. Input Reflected-Ripple Test Setup



Note: Use a 0.1 µF ceramic capacitor. Scope measurement should be made using a BNC socket. Position the load between 50 mm and 75 mm (2 in. and 3 in.) from the module.

Figure 16. Peak-to-Peak and RMS Output Noise Measurement Test Setup

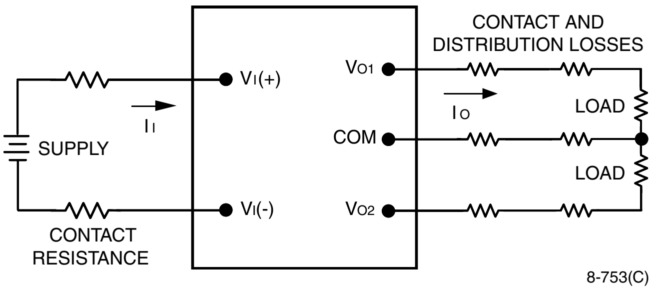


Note: All measurements are taken at the module terminals. When socketing, place Kelvin connections at module terminals to avoid measurement errors due to socket contact resistance.

$$\eta = \left(\frac{[V_O(+) - V_O(-)]\ I_O}{[V_I(+) - V_I(-)]\ I_I}\right) \times 100 \quad \%$$

Figure 17. Single-Output Voltage and Efficiency Measurement Test Setup

Test Configurations (continued)



Note: All measurements are taken at the module terminals. When socketing, place Kelvin connections at module terminals to avoid measurement errors due to socket contact resistance.

$$\eta = \frac{\sum_{j=1}^{2} \left| [V_{Oj}(+) - V_{COM}]\, I_{Oj} \right|}{[V_I(+) - V_I(-)]\, I_I} \times 100 \quad \%$$

Figure 18. Dual-Output Voltage and Efficiency Measurement Test Setup

Input Source Impedance

The power module should be connected to a low ac-impedance input source. Source impedances greater than 4 µH can affect the stability of the power module. A 33 µF electrolytic capacitor (ESR < 0.7 ¾ at 100 kHz) mounted close to the power module helps ensure stability of the unit.

Safety Considerations

For safety-agency approval of the system in which the power module is used, the power module must be installed in compliance with the spacing and separation requirements of the end-use safety agency standard, i.e., *UL* 1950, *CSA* C22.2 No. 950-95, and *VDE* 0805 (EN60950, IEC950).

For the converter output to be considered meeting the requirements of safety extra-low voltage (SELV), the input must meet SELV requirements.

The power module has extra-low voltage (ELV) outputs when all inputs are ELV.

The input to these units is to be provided with a maximum 5 A normal-blow fuse in the ungrounded lead.

Feature Descriptions

Overcurrent Protection

To provide protection in a fault (output overload) condition, the unit is equipped with internal current-limiting circuitry and can endure current limiting for an unlimited duration. At the point of current-limit inception, the unit shifts from voltage control to current control. If the output voltage is pulled very low during a severe fault, the current-limit circuit can exhibit either foldback or tailout characteristics (output current decrease or increase). The unit operates normally once the output current is brought back into its specified range.

Output Overvoltage Protection

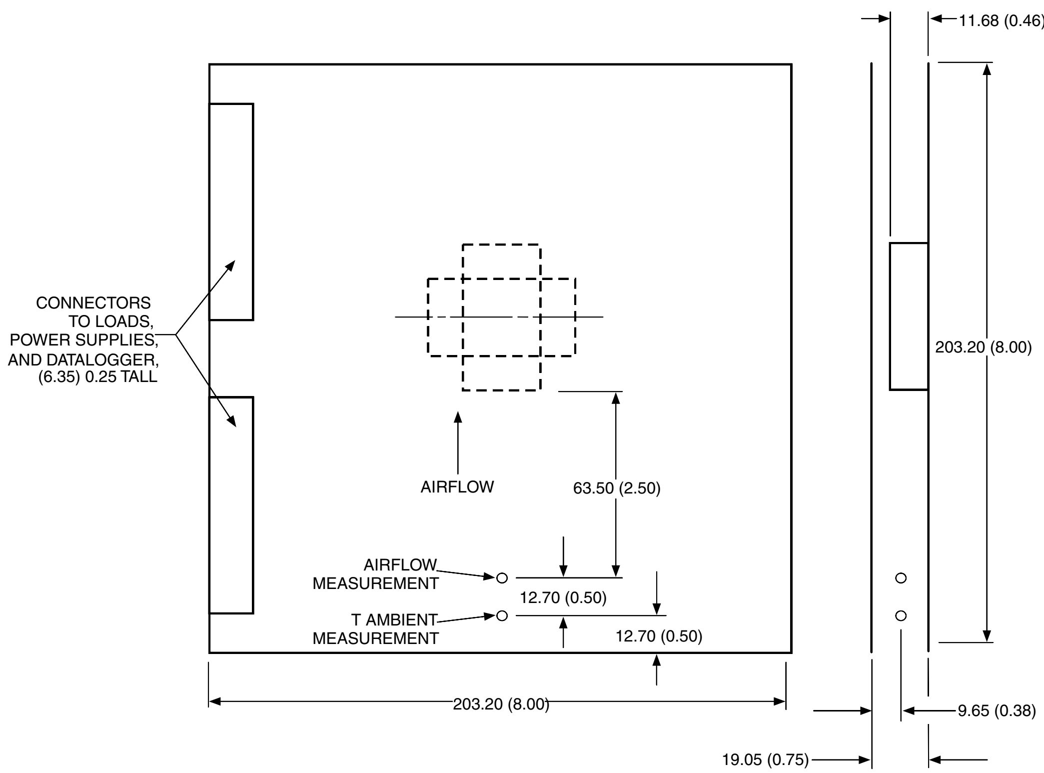
The output overvoltage clamp consists of control circuitry, which is independent of the primary regulation loop, that monitors the voltage on the output terminals. The control loop of the clamp has a higher voltage set point than the primary loop (see Feature Specifications table). This provides a redundant voltage-control that reduces the risk of output overvoltage.

Thermal Considerations

The MH005-Series Power Modules are designed to operate in a variety of thermal environments. As with any electronic component, sufficient cooling must be provided to help ensure reliable operation. Heat-dissipating components inside the module are thermally coupled to the case to enable heat removal by conduction, convection, and radiation to the surrounding environment.

The thermal data presented is based on measurements taken in a wind tunnel. The test setup shown in Figures 19 and 20 was used to collect data for Figures 21 and 22.

The graphs in Figures 21 and 22 provide general guidelines for use. Actual performance can vary depending on the particular application environment. The maximum case temperature of 100 °C must not be exceeded.



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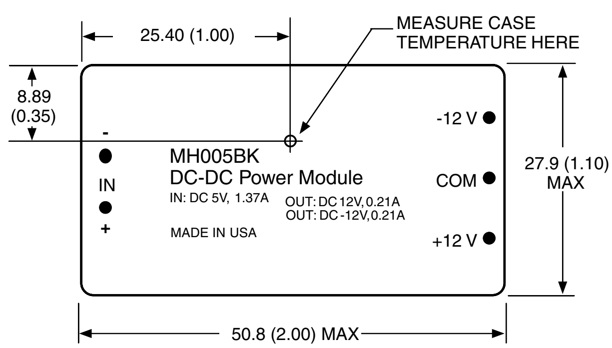
Note: Measurements are in millimeters and (inches).

Figure 19. Thermal Test Setup



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Note: Pin locations are for reference only. Measurements are in millimeters and (inches).

Figure 20. Case Temperature Measurement Location

Thermal Considerations (continued)

Basic Thermal Performance

The MH005-Series Power Modules are designed to operate at full load in natural convection at 70 °C without the use of an external heat sink (see Figure 21).

Higher ambient temperatures can be sustained by increasing the airflow. As stated, this data is based on a maximum case temperature of 100 °C and measured in the test configuration of Figure 19. The location for the temperature measurement is shown in Figure 20.

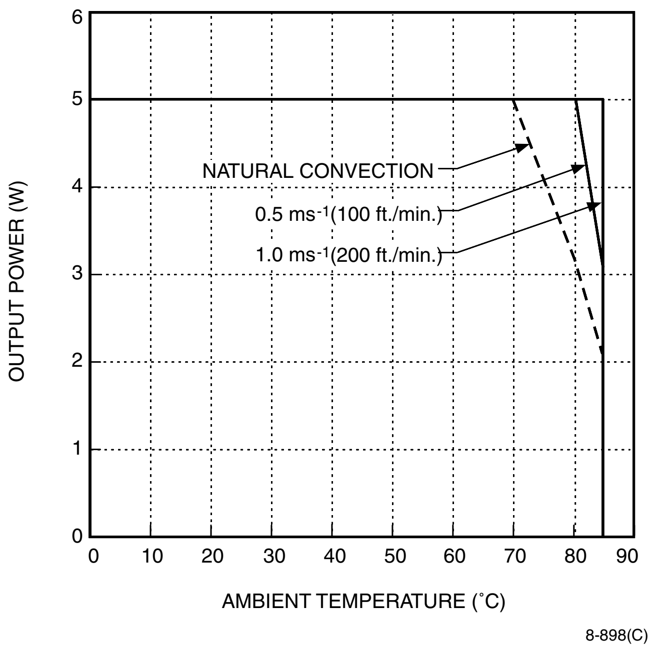


Figure 21. MH005A, B, C Derating Curve

Case-to-Ambient Thermal Impedance

Figure 22 shows the case-to-ambient thermal impedance, θca (°C/W) for the MH005 modules. This information is used to predict the case temperature for a given operating point and airflow by using the equation:

$$T_C = P_O\left(\frac{1-\eta}{\eta}\right)\theta_{ca} + T_A$$

where T_C is the case temperature (°C), P_O is the output power (W), η is the efficiency for the desired voltage and load (see Characteristics Curves section), and T_A is the ambient inlet temperature (°C).

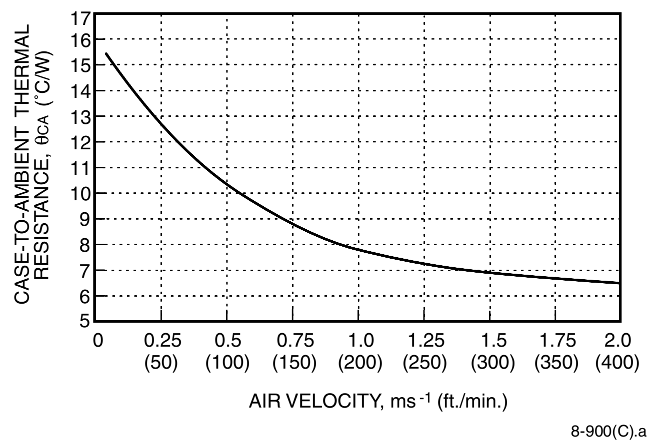


Figure 22. MH005A, B, C Case-to-Ambient Thermal Impedance

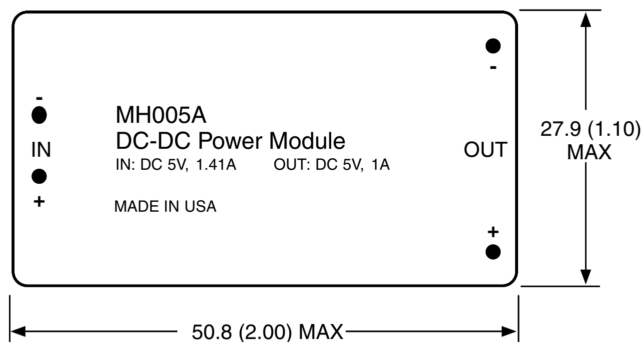
Outline Diagrams

Dimensions are in millimeters and (inches).

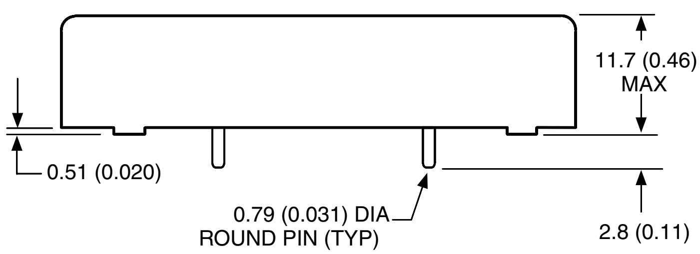
Tolerances: x.x ± 0.5 mm (0.02 in.), x.xx ± 0.25 mm (0.010 in.).

Single-Output Module

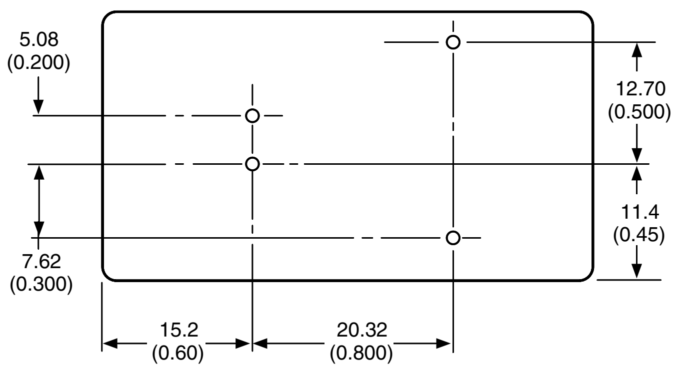
Top View



Side View



Bottom View



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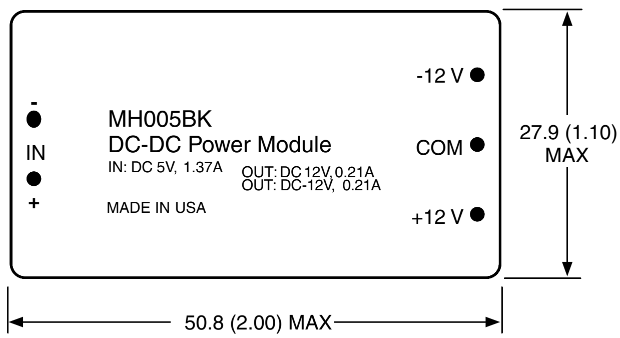
Outline Diagrams (continued)

Dimensions are in millimeters and (inches).

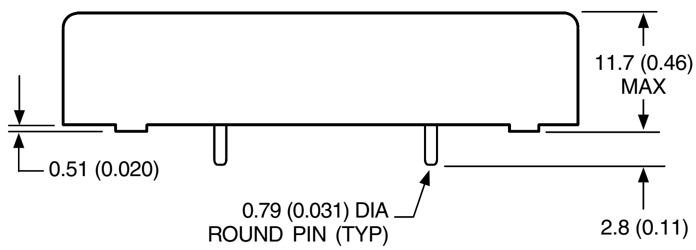
Tolerances: x.x ± 0.5 mm (0.02 in.), x.xx ± 0.25 mm (0.010 in.).

Dual-Output Module

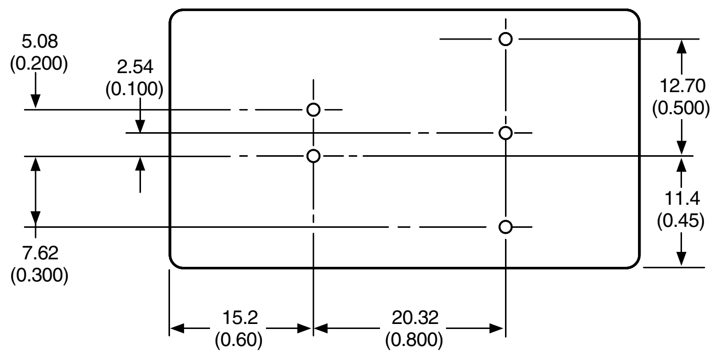
Top View



Side View



Bottom View



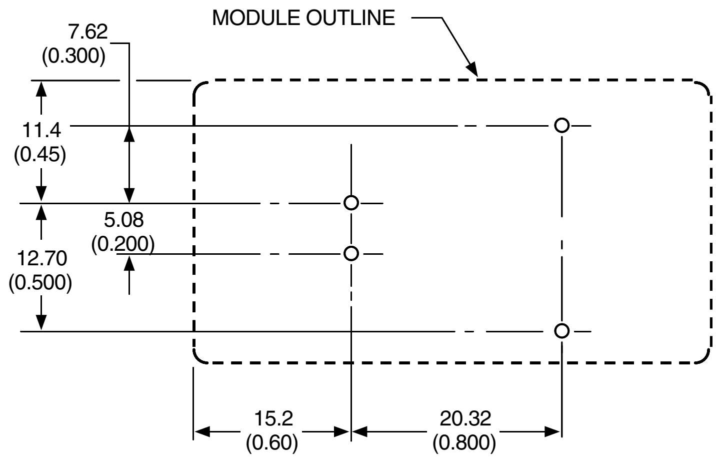
8-317(C).e

Recommended Hole Patterns

Component-side footprint.

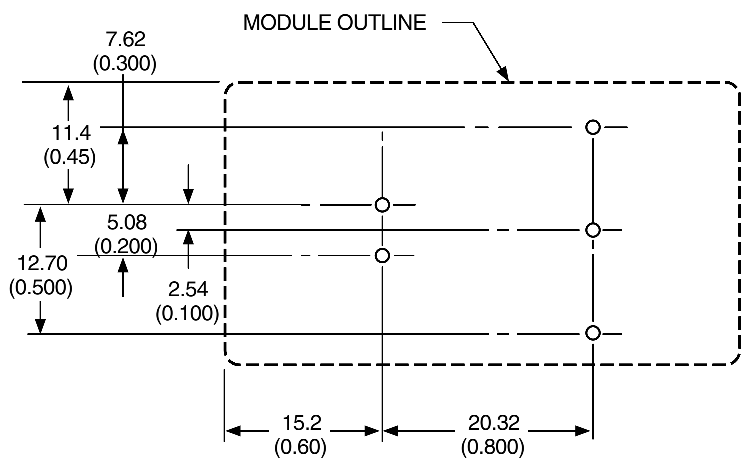
Dimensions are in millimeters and (inches).

Single-Output Module



8-317(C).d

Dual-Output Module



8-317(C).e

Ordering Information

For assistance in ordering, please contact yourTyco Electronics' Account Manager or Application Engineer.

Table 4. Device Codes

Input Voltage	Output Voltage	Output Power	Device Code	Comcode
5 V	5 V	5 W	MH005A	106604440
5 V	12 V	5 W	MH005B	106617806
5 V	15 V	5 W	MH005C	106617830
5 V	+12 V, –12 V	5 W	MH005BK	106604457
5 V	+15 V, –15 V	5 W	MH005CL	106617855

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DS98-222EPS (Replaces DS93-089EPS)