Data Sheet
September 2000

MC005-Series Power Modules; dc-dc Converters: 18 Vdc to 36 Vdc Inputs; 5 W

The MC005-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
- Digital circuitry

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 input voltage range
- Output current limiting; unlimited duration
- Output overvoltage protection
- Load regulation: 0.15% max (MC005A, B, C)
- Line regulation: 0.05% max (MC005A, B, C)
- Short circuit protection
- Operating ambient temperature range: –40 °C to +85 °C
- High reliability
- Input-to-output isolation
- No external filtering required
- High efficiency
- *UL** 1950 Recognized, *CSA*† C22.2 No. 950-95 Certified. *VDE*‡ 0805 (EN60950, IEC950) Licensed for the MC005AJ, BK, and CL only.
- Within FCC Class A radiated limits

Options

- Long pins: 5.84 mm ± 0.51 mm (0.230 in. ± 0.020 in.)

Description

The MC005A, B, C, AJ, BK, and CL Power Modules are dc-dc converters that operate over an input voltage range of 18 Vdc to 36 Vdc and provide precisely regulated 5 V, 12 V, 15 V, ±5 V, ±12 V, or ±15 V outputs respectively. The output is isolated from the inputs, allowing versatile polarity configurations and grounding connections. The modules have maximum power ratings of 5 W at a typical full-load efficiency of 79%.

The modules are encapsulated in nonconductive cases that mount on PC boards. In a natural convection environment, the modules are rated to full load at 85 °C with no heat sinking or external filtering.

* *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.

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 Transient (≤1 second)	 V_I $V_{I, trans}$	 — —	 36 47	 Vdc V
I/O Isolation Voltage	—	—	500	Vdc
Operating Ambient Temperature (At 60 ft./min. natural convection; see Thermal Considerations section.)	T_A	–40	85	°C
Storage Temperature	T_{stg}	–40	100	°C

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	18	28	36	Vdc
Maximum Input Current (V_I = 0 V to 60 V; $I_O = I_{O, max}$; see Figure 1.)	$I_{I, max}$	—	—	1.2	A
Inrush Transient	i^2t	—	0.1	0.2	A^2s
Input Reflected-ripple Current, Peak-to-peak (5 Hz to 20 MHz, 12 µH source impedance, T_A = 25 °C; see Figure 24 and Design Considerations section.)	I_I	—	40	—	mAp-p
Input Ripple Rejection (120 Hz)	—	—	47	—	dB
Input Inductance (see Design Considerations section.)	—	—	—	12	µH

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 or Device Suffix	Symbol	Min	Typ	Max	Unit
Output Voltage Set Point (V_I = 28 V; I_O = $I_{O, max}$; T_A = 25 °C)	MC005A	$V_{O, set}$	4.85	5.0	5.20	Vdc
	MC005B	$V_{O, set}$	11.52	12.0	12.48	Vdc
	MC005C	$V_{O, set}$	14.4	15.0	15.6	Vdc
	MC005AJ	$V_{O1, set}$	4.85	5.0	5.15	Vdc
		$V_{O2, set}$	–4.85	–5.0	–5.15	Vdc
	MC005BK	$V_{O1, set}$	11.4	12.0	12.6	Vdc
		$V_{O2, set}$	–11.4	–12.0	–12.6	Vdc
	MC005CL	$V_{O1, set}$	14.25	15.0	15.75	Vdc
		$V_{O2, set}$	–14.25	–15.0	–15.75	Vdc
Output Voltage (Over all operating input voltage, resistive load, and temperature conditions until end of life. See Figures 3—8 for cross regulation on dual outputs.)	MC005A	V_O	4.80	—	5.25	Vdc
	MC005B	V_O	11.4	—	12.6	Vdc
	MC005C	V_O	14.25	—	15.75	Vdc
	MC005AJ	V_{O1}	4.60	—	5.40	Vdc
		V_{O2}	–4.60	—	–5.40	Vdc
	MC005BK	V_{O1}	10.8	—	13.2	Vdc
		V_{O2}	–10.8	—	–13.2	Vdc
	MC005CL	V_{O1}	13.5	—	16.5	Vdc
		V_{O2}	–13.5	—	–16.5	Vdc
Output Regulation:						
Line (V_I = 18 V to 36 V)	MC005A, B, C	—	—	0.01	0.05	%V_O
Load (I_O = $I_{O, min}$ to $I_{O, max}$)	MC005A, B, C	—	—	0.05	0.15	%V_O
Temperature (T_A = –40 °C to +100 °C; see Figure 2.)	MC005A	—	—	15	70	mV
	MC005B	—	—	40	150	mV
	MC005C	—	—	45	190	mV
Output Ripple and Noise Voltage (See Figures 25, 26 and Design Considerations section.):						
RMS	MC005A	—	—	—	15	mVrms
	MC005B, C	—	—	—	25	mVrms
	MC005AJ	—	—	—	120	mVrms
	MC005BK, CL	—	—	—	80	mVrms
Peak-to-peak (5 Hz to 20 MHz)	MC005A	—	—	—	100	mVp-p
	MC005B, C	—	—	—	100	mVp-p
	MC005AJ	—	—	—	500	mVp-p
	MC005BK, CL	—	—	—	250	mVp-p
Output Current (At I_O < $I_{O, min}$, the modules may exceed output ripple specifications and dual-output modules may exceed specified output voltages.)	MC005A	I_O	0.1	—	1.0	A
	MC005B	I_O	0.02	—	0.42	A
	MC005C	I_O	0.02	—	0.33	A
	MC005AJ	I_{O1}	0.1	—	0.5	A
		I_{O2}	0.1	—	0.5	A
	MC005BK	I_{O1}	0.02	—	0.21	A
		I_{O2}	0.02	—	0.21	A
	MC005CL	I_{O1}	0.017	—	0.17	A
		I_{O2}	0.017	—	0.17	A

Electrical Specifications (continued)

Table 2. Output Specifications (continued)

Parameter	Device or Device Suffix	Symbol	Min	Typ	Max	Unit
Output Current-limit Inception (See Figures 9—15.):						
V_O = 4.5 V	MC005A	I_O	—	1.6	2.5	A
V_O = 10.8 V	MC005B	I_O	—	0.8	1.4	A
V_O = 13.5 V	MC005C	I_O	—	0.7	1.3	A
V_{O1} or V_{O2} = 4.5 V	MC005AJ	I_O	—	1.6	2.5	A
V_{O1} or V_{O2} = 10.2 V	MC005BK	I_O	—	0.8	1.4	A
V_{O1} or V_{O2} = 12.75 V	MC005CL	I_O	—	0.7	1.3	A
Output Current Limit (See Figures 9—15.):						
V_O = 1.0 V	MC005A	—	—	—	3.0	A
V_O = 1.0 V	MC005B, C	—	—	—	2.0	A
V_{O1} or V_{O2} = 1.0 V	MC005AJ	—	—	—	3.0	A
V_{O1} or V_{O2} = 1.0 V	MC005BK, CL	—	—	—	2.0	A
Output Short-circuit Current (V_O = 250 mV; see Figures 9—15.)	MC005A, AJ	—	—	1.5	—	A
	MC005B, C, BK, CL	—	—	1.0	—	A
Efficiency (V_I = 28 V; I_O = $I_{O, max}$; T_A = 25 °C; see Figures 16, 17, 27, and 28.)	MC005A, BK, CL	η	76	79	—	%
	MC005AJ	η	75	78	—	%
	MC005B, C	η	78	81	—	%
Dynamic Response (For MC005AJ, BK, CL applies to V_{O1} while V_{O2} at full load; $\Delta I_O/\Delta t$ = 1 A/10 µs, V_I = 28 V, T_A = 25 °C):						
Load Change from I_O = 50% to 25% of $I_{O, max}$ (see Figures 18—20):						
Peak Deviation	MC005A	—	—	—	80	mV
	MC005B, C	—	—	—	70	mV
	MC005AJ	—	—	—	80	mV
	MC005BK, CL	—	—	—	60	mV
Settling Time (V_O < 10% peak deviation)	MC005A, B, C	—	—	—	3.5	ms
	MC005AJ	—	—	—	5.0	ms
	MC005BK, CL	—	—	—	3.0	ms
Load Change from I_O = 50% to 75% of $I_{O, max}$ (see Figures 21—23):						
Peak Deviation	MC005A	—	—	—	80	mV
	MC005B	—	—	—	70	mV
	MC005C	—	—	—	60	mV
	MC005AJ	—	—	—	80	mV
	MC005BK, CL	—	—	—	70	mV
Settling Time (V_O < 10% peak deviation)	MC005A, B, C	—	—	—	3.5	ms
	MC005AJ	—	—	—	5.0	ms
	MC005BK, CL	—	—	—	3.0	ms

Electrical Specifications (continued)

Table 3. Isolation Specifications

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

General Specifications

Parameter	Device or Device Suffix	Min	Typ	Max	Unit
Calculated MTBF (I_O = 80% of $I_{O, max}$; T_C = 40 °C)	MC005A, B, C MC005AJ, BK, CL		4,000,000 3,500,000		hours hours
Weight	All	—	—	28 (1.0)	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 sections for further information.

Parameter	Device	Symbol	Min	Typ	Max	Unit
Output Overvoltage Protection (clamp)	MC005A	$V_{O, clamp}$	—	6	7	V
	MC005B	$V_{O, clamp}$	—	14	16	V
	MC005C	$V_{O, clamp}$	—	17	19	V
	MC005AJ	$V_{O1, clamp}$	—	6	7	V
		$V_{O2, clamp}$	—	–6	–7	V
	MC005BK	$V_{O1, clamp}$	—	16	18	V
		$V_{O2, clamp}$	—	–16	–18	V
	MC005CL	$V_{O1, clamp}$	—	19	21	V
		$V_{O2, clamp}$	—	–19	–21	V

Characteristic Curves

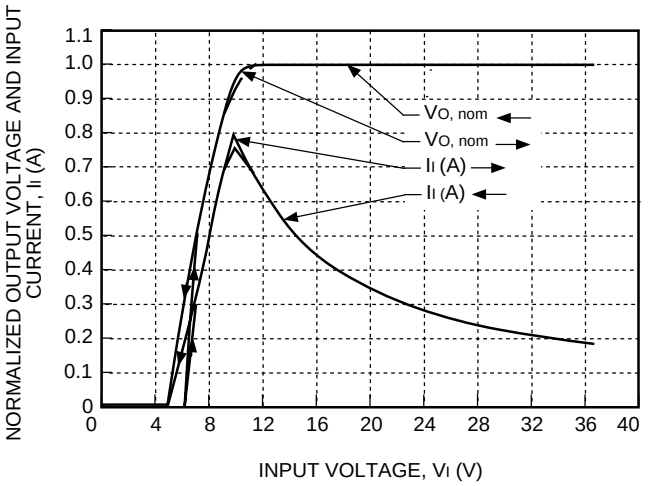


Figure 1. MC005-Series Typical Input Characteristics at Full Load and 25 °C

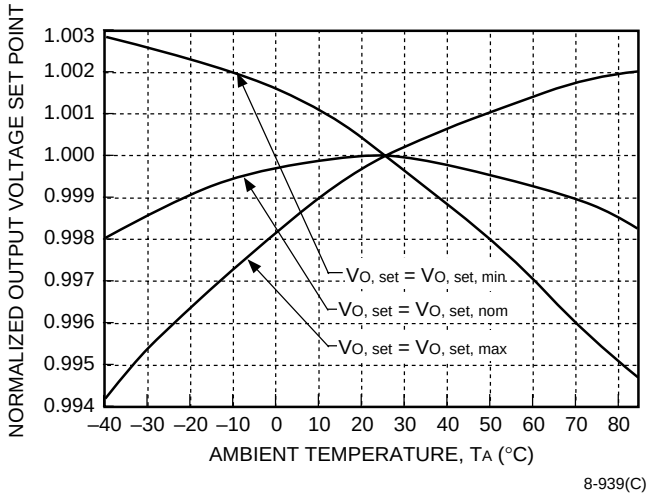


Figure 2. MC005-Series Typical Output Voltage Variation over Ambient Temperature Range at V_I = 28 V and Full Load

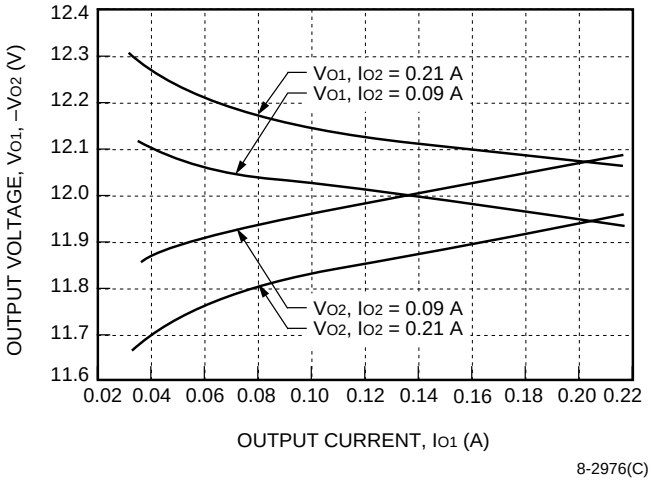


Figure 3. MC005BK Typical V_{O1} and V_{O2} vs. I_{O1} Regulation with V_I = 28 V and T_A = 25 °C

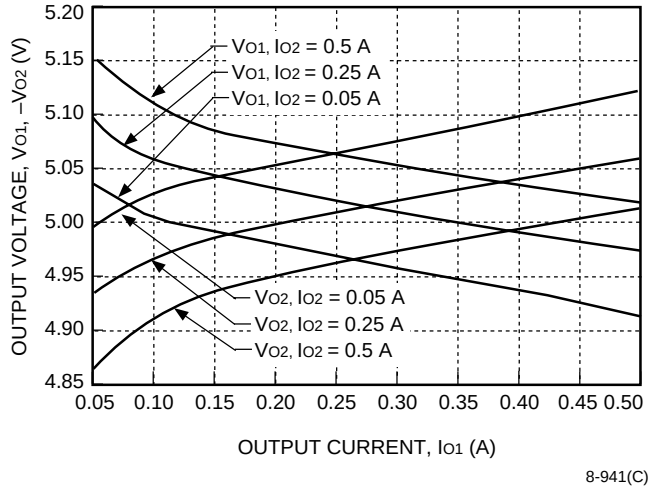


Figure 4. MC005AJ Typical V_{O1} and V_{O2} vs. I_{O1} Regulation with V_I = 28 V and T_A = 25 °C

Characteristic Curves (continued)

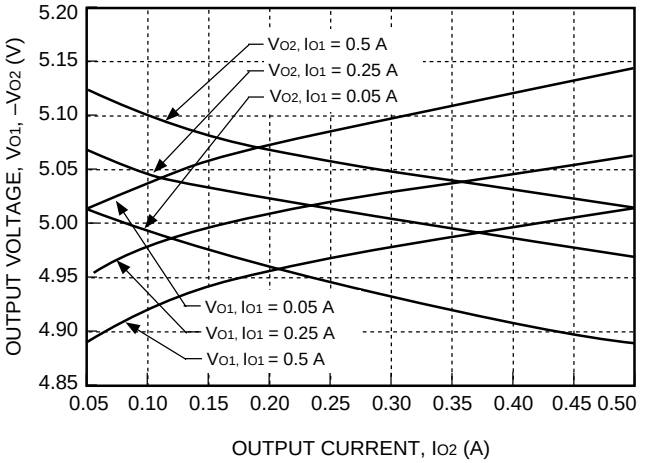


Figure 5. MC005AJ Typical V_{O1} and V_{O2} vs. I_{O2} Regulation with V_I = 28 V and T_A = 25 °C

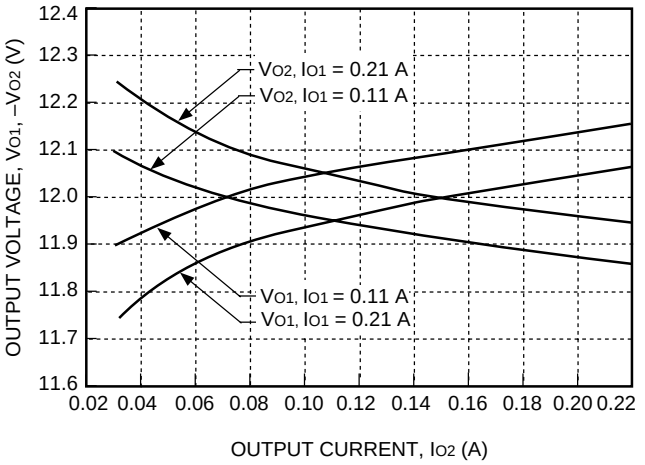


Figure 6. MC005BK Typical V_{O1} and V_{O2} vs. I_{O2} Regulation with V_I = 28 V and T_A = 25 °C

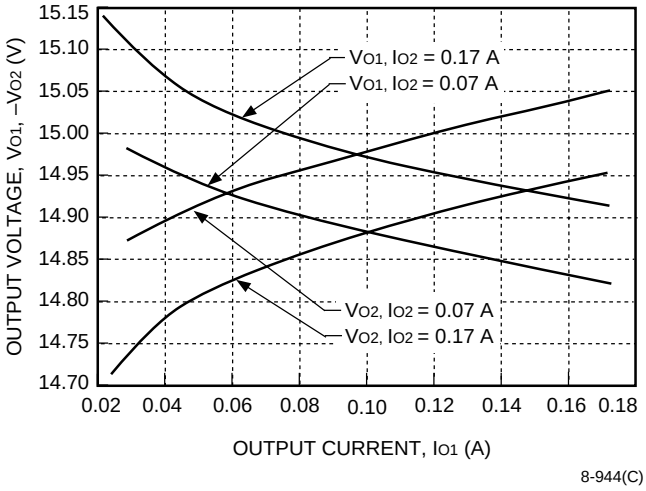


Figure 7. MC005CL Typical V_{O1} and V_{O2} vs. I_{O1} Regulation with V_I = 28 V and T_A = 25 °C

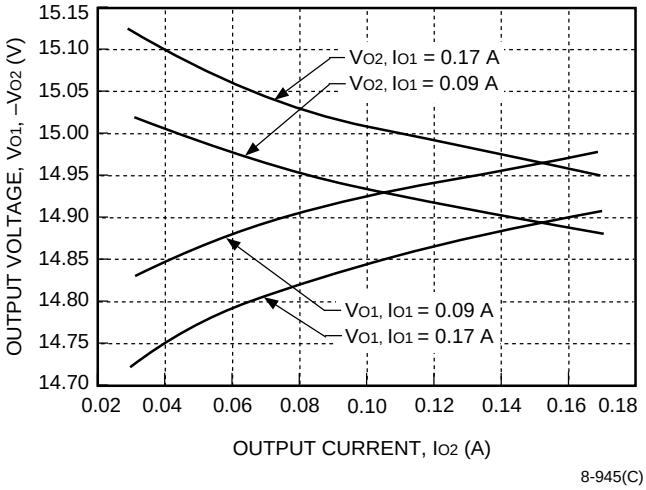


Figure 8. MC005CL Typical V_{O1} and V_{O2} vs. I_{O2} Regulation with V_I = 28 V and T_A = 25 °C

Characteristic Curves (continued)

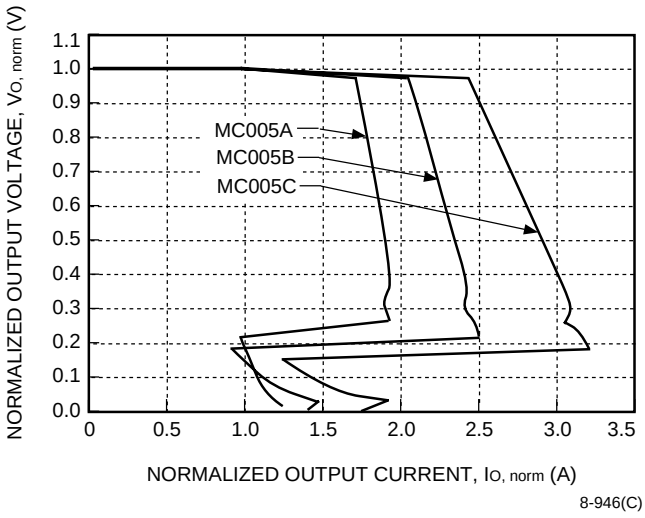


Figure 9. MC005A, B, C Typical Normalized Output Characteristics to Full Load at T_A = 25 °C

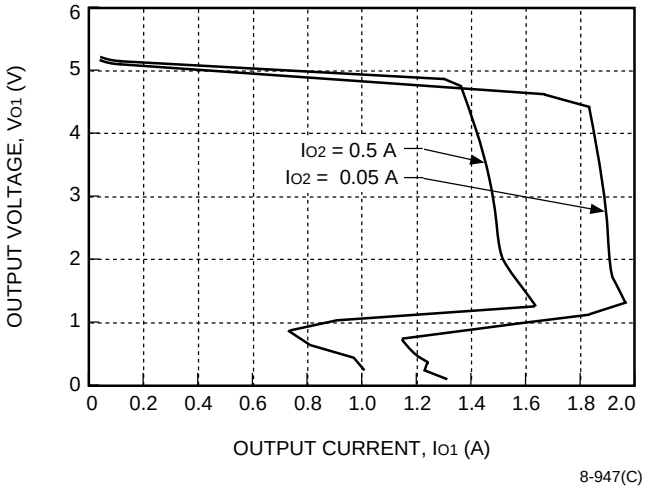


Figure 10. MC005AJ Typical Output Characteristics (V_{O1} vs. I_{O1}) with V_I = 28 V and T_A = 25 °C

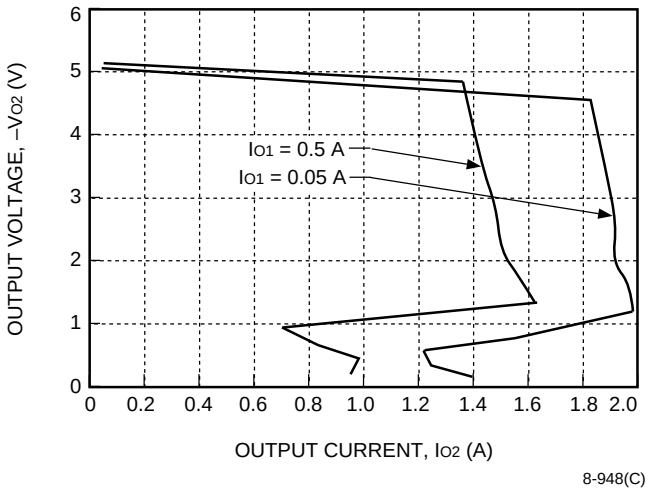


Figure 11. MC005AJ Typical Output Characteristics (–V_{O2} vs. I_{O2}) with V_I = 28 V and T_A = 25 °C

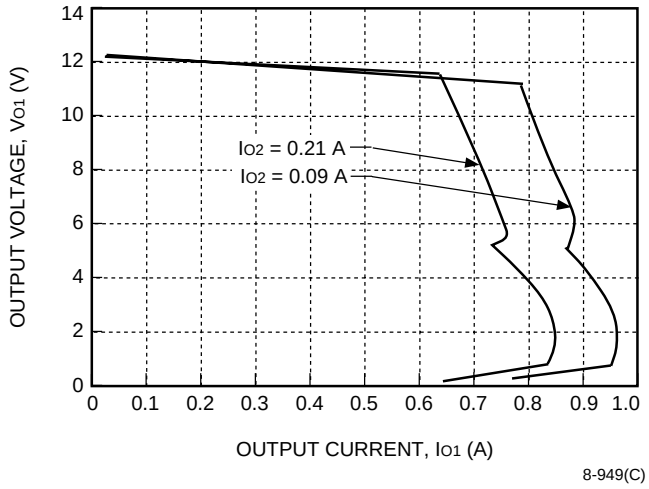


Figure 12. MC005BK Typical Output Characteristics (V_{O1} vs. I_{O1}) with V_I = 28 V and T_A = 25 °C

Characteristic Curves (continued)

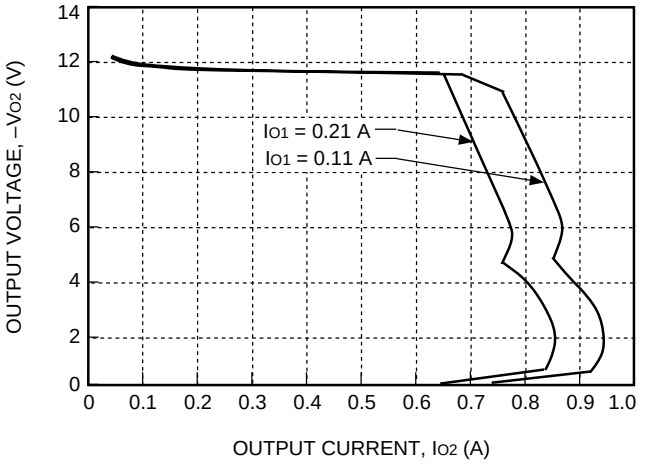


Figure 13. MC005BK Typical Output Characteristics ($-V_{O2}$ vs. I_{O2}) with V_I = 28 V and T_A = 25 °C

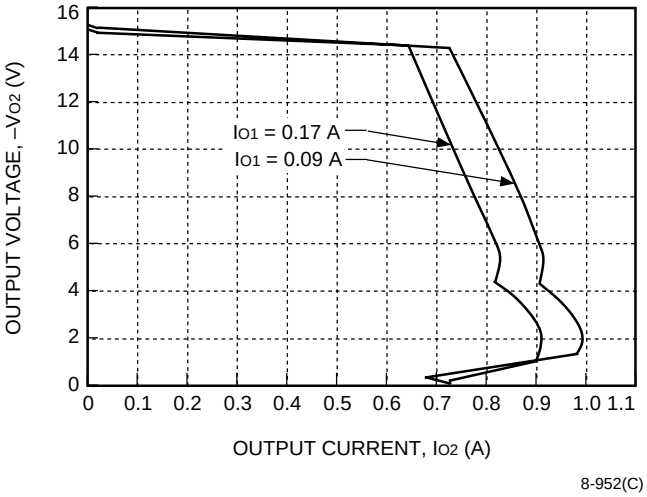


Figure 15. MC005CL Typical Output Characteristics ($-V_{O2}$ vs. I_{O2}) with V_I = 28 V and T_A = 25 °C

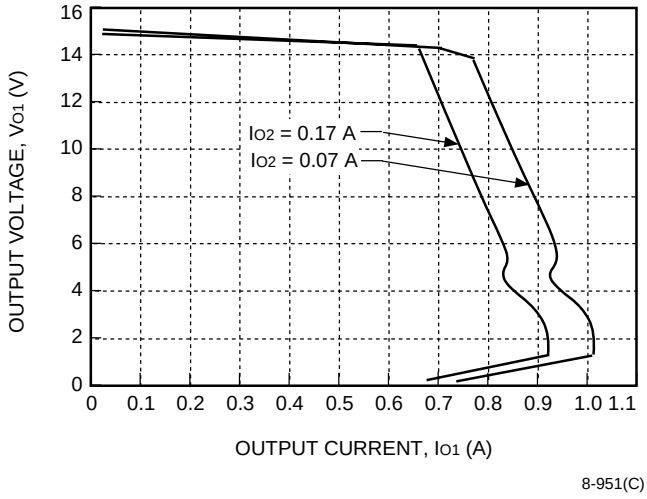


Figure 14. MC005CL Typical Output Characteristics (V_{O1} vs. I_{O1}) with V_I = 28 V and T_A = 25 °C

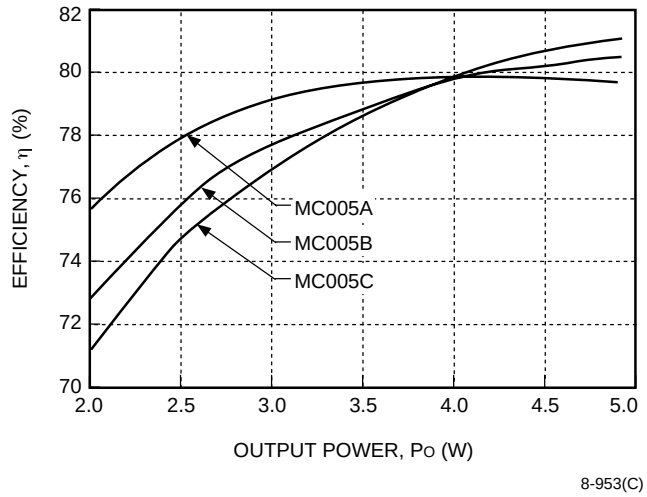


Figure 16. MC005A, B, C Typical Efficiency vs. Output Power at V_I = 28 V and T_A = 25 °C

Characteristic Curves (continued)

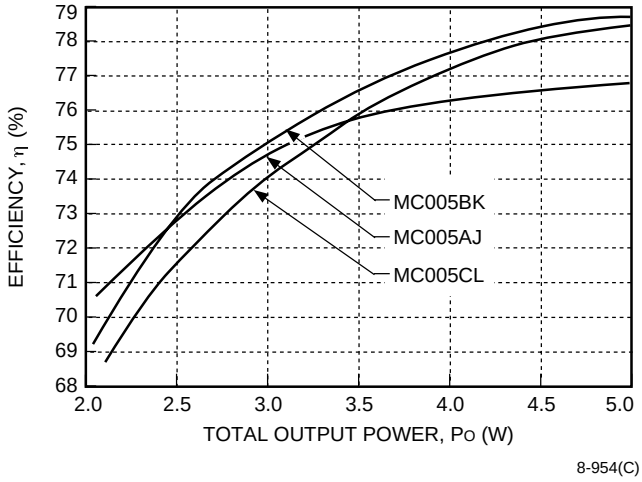


Figure 17. MC005AJ, BK, CL Typical Efficiency vs. Output Power at V_I = 28 V and T_A = 25 °C

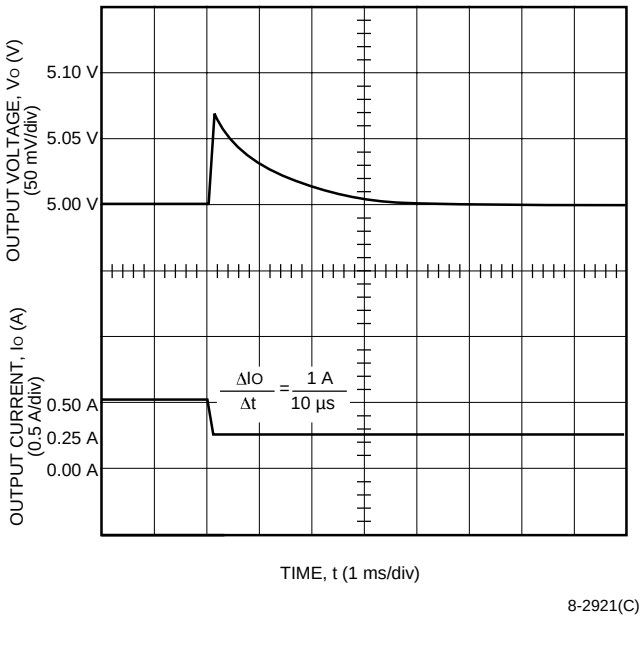


Figure 18. MC005A Typical Output Voltage Waveform for a Step Load Change from 50% to 25% of $I_{O, max}$ with V_I = 28 V and T_A = 25 °C

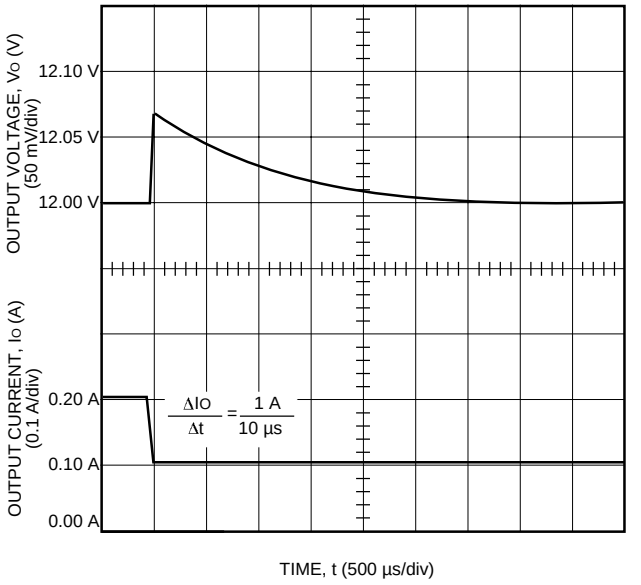


Figure 19. MC005B Typical Output Voltage Waveform for a Step Load Change from 50% to 25% of $I_{O, max}$ with V_I = 28 V and T_A = 25 °C

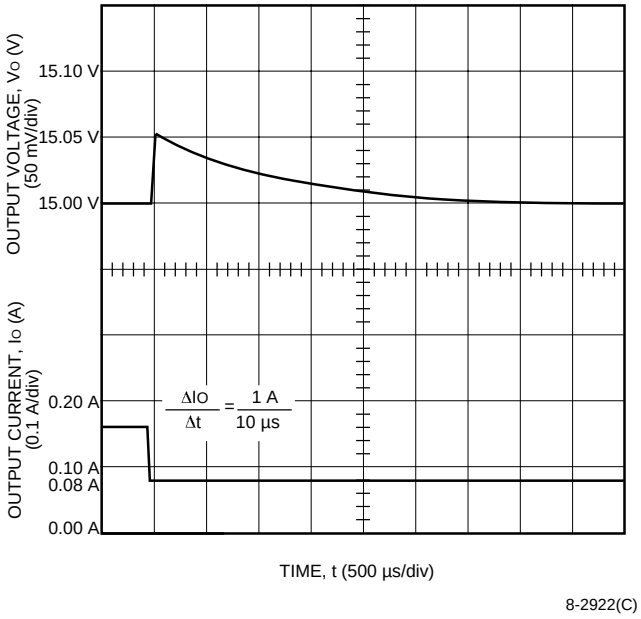


Figure 20. MC005C Typical Output Voltage Waveform for a Step Load Change from 50% to 25% of $I_{O, max}$ with V_I = 28 V and T_A = 25 °C

Characteristic Curves (continued)

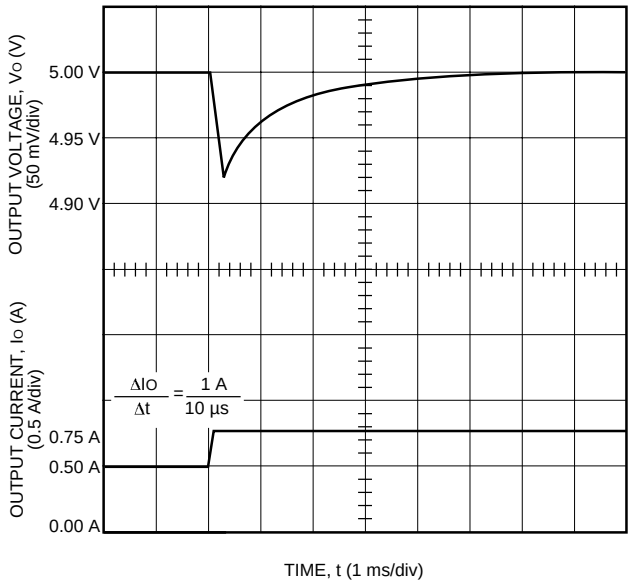


Figure 21. MC005A Typical Output Voltage Waveform for a Step Load Change from 50% to 75% of $I_{O, max}$ with V_I = 28 V and T_A = 25 °C

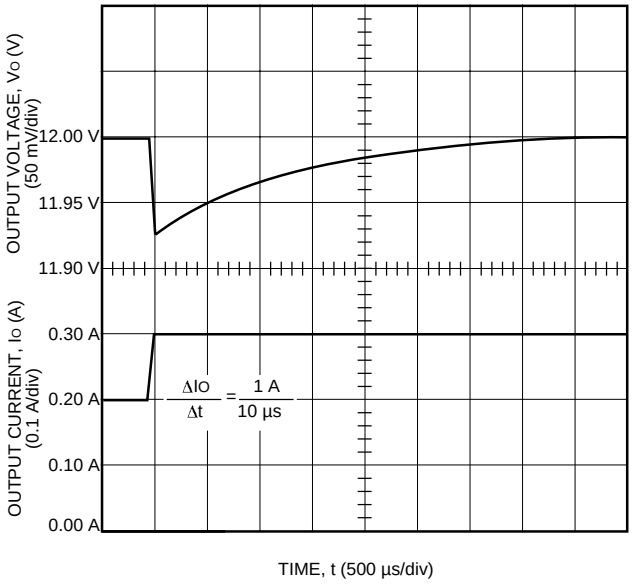


Figure 22. MC005B Typical Output Voltage Waveform for a Step Load Change from 50% to 75% of $I_{O, max}$ with V_I = 28 V and T_A = 25 °C

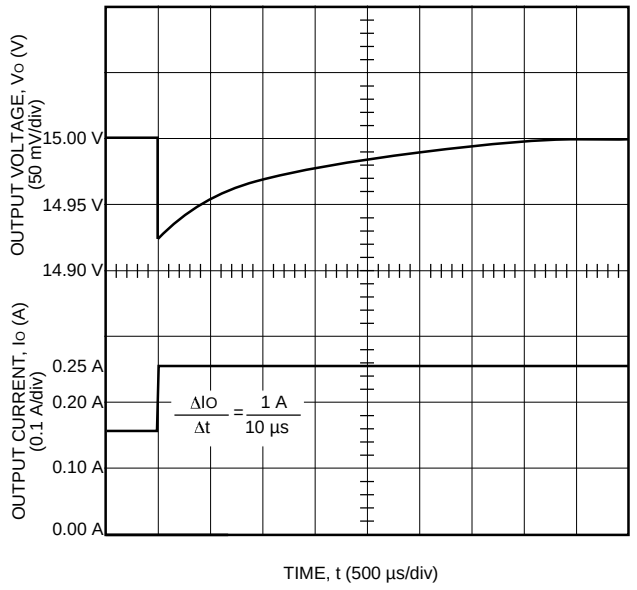
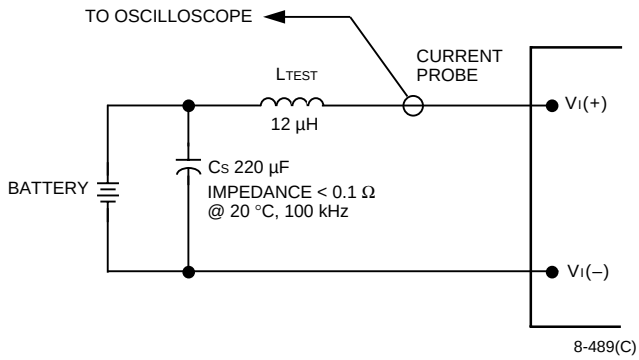


Figure 23. MC005C Typical Output Voltage Waveform for a Step Load Change from 50% to 75% of $I_{O, max}$ with V_I = 28 V and T_A = 25 °C

Test Configurations



Note: Input reflected-ripple current is measured with a simulated source impedance of 12 µH. Capacitor Cs offsets possible battery impedance. Current is measured at the input of the module.

Figure 24. Input Reflected-Ripple Test Setup

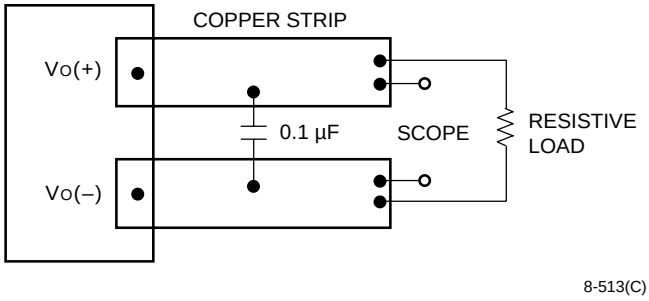


Figure 25. MC005A, B, C Output Noise Measurement Test Setup

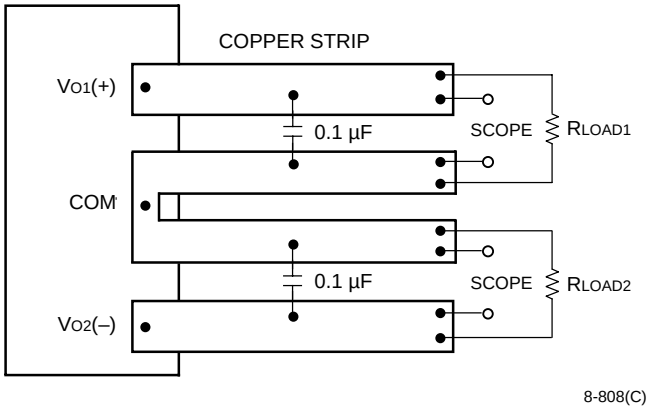
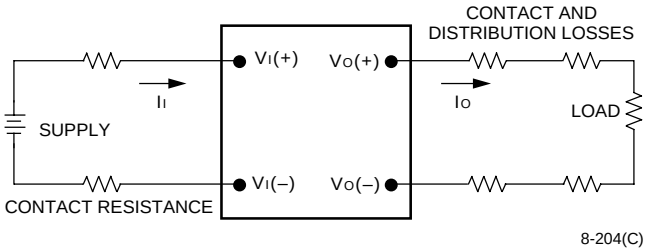


Figure 26. MC005AJ, BK, CL Output Noise Measurement Test Setup



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

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

Figure 27. MC005A, B, C Output Voltage and Efficiency Measurement Test Setup

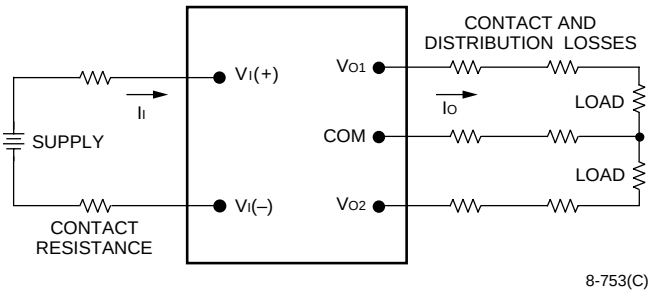


Figure 28. MC005AJ, BK, CL Output Voltage and Efficiency Measurement Test Setup

Design Considerations

Input Source Impedance

The power module should be connected to a low ac-impedance input source. Source impedances greater than 12 μH can affect the stability of the power module. When the source impedance exceeds 12 μH, mount a 33 μF electrolytic capacitor (ESR < 0.7 Ω at 100 kHz) close to the module input pins. This is also recommended to minimize reflected-ripple current as well as conducted and radiated electromagnetic interference (EMI).

Output Ripple

If lower output ripples are needed, external L-C filters across the module output terminals are recommended. A 3.9 μH, 50 mΩ inductor and a 47 μF capacitor with its impedance less than 1.5 Ω at 100 kHz will reduce the output ripple by at least 50%.

Output Voltage Reversal

CAUTION: Applying a reverse voltage across the module output forward biases an internal diode. Attempting to start the module under this condition can damage the module.

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

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.

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.

Thermal Considerations

Although the power module is designed for an 85 °C maximum operating ambient temperature, the characterization of the local thermal environment becomes more critical as temperatures exceed 70 °C. The maximum operating ambient temperature for the module is based on the maximum safe operating temperature of the devices contained inside it. Variations in local temperature and airflow, as well as the methods and location of measurement for these parameters, can affect the resulting internal temperature rises for a given ambient temperature. For ambient temperatures exceeding 70 °C, call technical support for application assistance.

Outline Diagrams

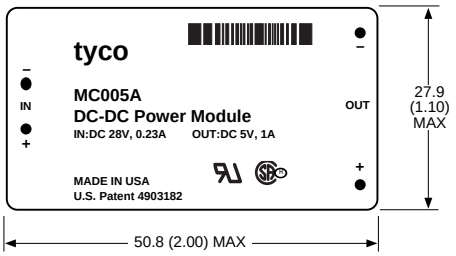
Dimensions are in millimeters and (inches).

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

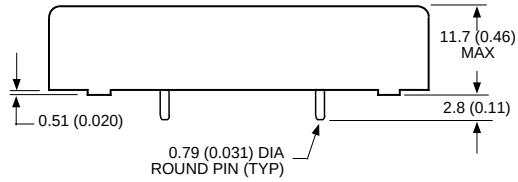
Copper paths must not be routed beneath the power module standoffs.

Single-Output Module

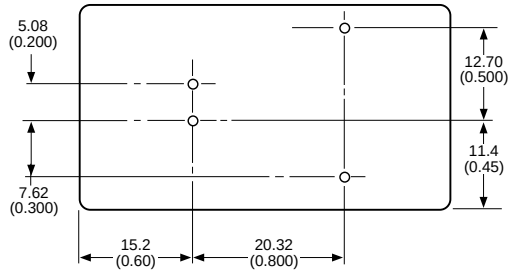
Top View



Side View



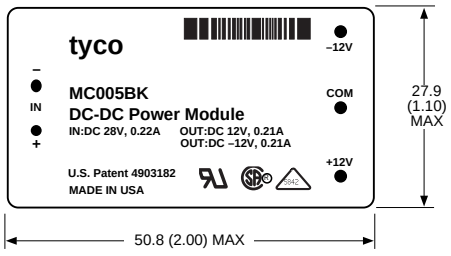
Bottom View



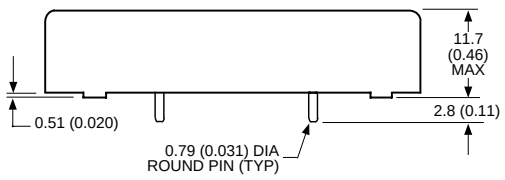
8-1016(C).b

Dual-Output Module

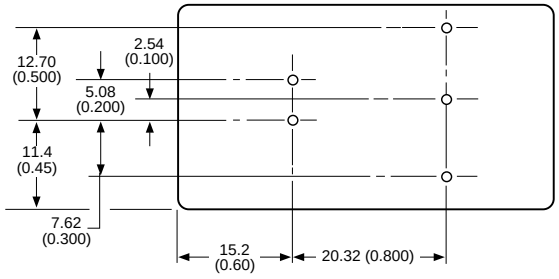
Top View



Side View



Bottom View



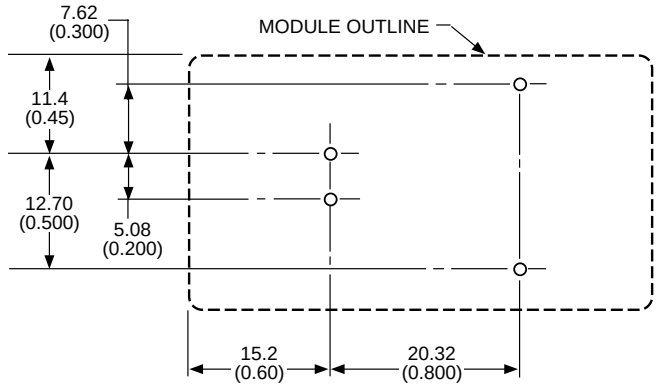
8-1016(C).c

Recommended Hole Patterns

Component-side footprint.

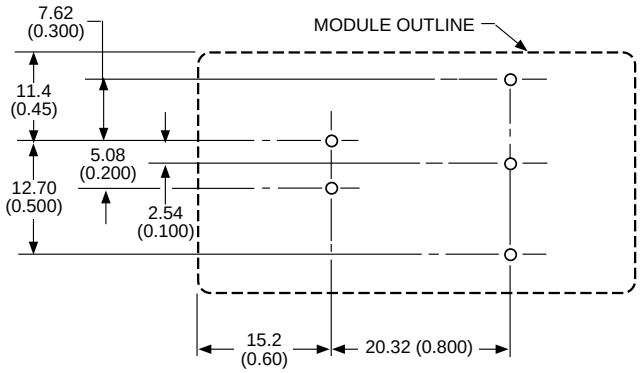
Dimensions are in millimeters and (inches).

Single-Output Module



8-1016(C).b

Dual-Output Module



8-1016(C).c

Ordering Information

Table 4. Device Codes

Input Voltage	Output Voltage	Output Power	Device Code	Comcode
18 V—36 V	5 Vdc	5 W	MC005A	106290059
18 V—36 V	12 Vdc	5 W	MC005B	106290067
18 V—36 V	15 Vdc	5 W	MC005C	106290075
18 V—36 V	5 Vdc, –5 Vdc	5 W	MC005AJ	107557589
18 V—36 V	12 Vdc, –12 Vdc	5 W	MC005BK	106358955
18 V—36 V	15 Vdc, –15 Vdc	5 W	MC005CL	106358963

Optional features may be ordered using the device code suffixes shown below. The feature suffixes are listed numerically in descending order. Please contact your Tyco Electronics Account Manager or Application Engineer for pricing and availability of options.

Table 5. Device Options

Option	Device Code Suffix
Long pins: 5.84 mm ± 0.51 mm (0.230 in. ± 0.020 in.)	–SLP

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