Data Sheet
May 1998

MA010-Series Power Modules: 10 Vdc to 15 Vdc Inputs; 10 W

The MA010-Series Power Modules use advanced, surface-mount technology and deliver high-quality, compact, dc-dc conversion at an economical price.

Applications

- Distributed power architectures
- Telecommunications
- Computers and peripherals
- Industrial and office equipment
- Digital circuits
- Private branch exchange (PBX)
- Voice and data multiplexing

Features

- Small size: 50.8 mm x 40.6 mm x 12.7 mm (2.00 in. x 1.60 in. x 0.50 in.)
- Output current limiting
- High efficiency: 78%—84% typical
- Output overvoltage clamp
- Input-to-output isolation
- No external filtering required
- Operating ambient temperature range: –10 °C to +50 °C, no derating
- No heat sink required
- Printed-circuit board mountable
- Meets FCC Class A requirements
- High reliability
- *UL** Recognized, *CSA*† Certified, and VDE Licensed

Options

- Short pin: 2.8 mm ± 0.25 mm (0.110 ± 0.010 in.)
- Remote on/off

Description

The MA010A, B, C, BK, and CL Power Modules are dc-dc converters that operate over an input voltage range of 10 Vdc to 15 Vdc and provide precisely regulated 5 V, 12 V, 15 V, ±12 V, and ±15 V outputs, respectively. The outputs are isolated from the inputs, allowing versatile polarity configurations and grounding connections. The modules have maximum power ratings of 10 W with a typical full-load efficiency of over 80%.

The modules are PC-board-mountable and encapsulated in nonconductive cases. The modules are rated to full load at 85 °C case temperature with no external filtering or heat sinking.

* *UL* is a registered trademark of Underwriters Laboratories, Inc.
† *CSA* is a registered trademark of Canadian Standards Association.

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	—	18	V
I/O Isolation Voltage	—	—	500	V
Operating Case Temperature	T_C	–10	85	°C
Storage Temperature	T_{stg}	–40	110	°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	10	12	15	Vdc
Maximum Input Current (V_I = 0 V to 10 V; $I_O = I_{O,\ max}$) (See Figure 1.)	$I_{I,\ max}$	—	—	2.0	A
Inrush Transient	i^2t	—	—	0.1	A^2s
Input Reflected-ripple Current, Peak-to-peak (5 Hz to 20 MHz, 500 nH source impedance; T_C = 25 °C; see Figure 10 and Design Considerations section.)	—	—	80	—	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, dc fuse with a maximum rating of 10 A (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 = 12 V; $I_O = I_{O,\,max}$; T_C = 25 °C)	MA010A	$V_{O,\,set}$	4.85	5.0	5.15	Vdc
	MA010B	$V_{O,\,set}$	11.64	12.0	12.36	Vdc
	MA010C	$V_{O,\,set}$	14.55	15.00	15.45	Vdc
	MA010BK	$V_{O1,\,set}$	11.40	12.00	12.60	Vdc
		$V_{O2,\,set}$	–11.40	–12.00	–12.60	Vdc
	MA010CL	$V_{O1,\,set}$	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.)	MA010A	V_O	4.75	—	5.25	Vdc
	MA010B	V_O	11.40	—	12.60	Vdc
	MA010C	V_O	14.25	—	15.75	Vdc
	MA010BK	V_1	10.80	—	13.20	Vdc
		V_2	–10.80	—	–13.20	Vdc
	MA010CL	V_1	13.50	—	16.50	Vdc
		V_2	–13.50	—	–16.50	Vdc
Output Regulation:						
Line (V_I = 10 V to 15 V)	MA010A, B, C	—	—	0.02	0.1	%
Load ($I_O = I_{O,\,min}$ to $I_{O,\,max}$)	MA010A, B, C	—	—	0.05	0.2	%
Temperature (T_C = –10 °C to +85 °C)	MA010A, B, C	—	—	0.6	1.5	%
Output Ripple and Noise Voltage (See Figure 11.):						
RMS	MA010A, B, C	—	—	3	15	mVrms
	MA010BK, CL	—	—	15	50	mVrms
Peak-to-peak (5 Hz to 20 MHz)	MA010A	—	—	—	100	mVp-p
	MA010B, C, BK	—	—	—	200	mVp-p
	MA010CL	—	—	—	250	mVp-p
Output Current	MA010A	I_O	0	—	2.0	A
	MA010B	I_O	0	—	0.83	A
	MA010C	I_O	0	—	0.67	A
	MA010BK	I_{O1}	0.04*	—	0.42	A
		I_{O2}	0.04*	—	0.42	A
	MA010CL	I_{O1}	0.03*	—	0.33	A
		I_{O2}	0.03*	—	0.33	A
Output Current-limit Inception (T_A = 25 °C; see Figures 4, 5, and 6.):						
V_O = 4.5 V (~0.9 $V_{O,\,set}$)	MA010A	—	—	4.2	5	A
V_O =10.8 V (~0.9 $V_{O,\,set}$)	MA010B	—	—	1.6	2.2	A
V_O = 13.5 V (~0.9 $V_{O,\,set}$)	MA010C	—	—	1.6	1.9	A
V_{O1} or V_{O2} = 10.2 V†	MA010BK	—	—	1.2	2.2	A
V_{O1} or V_{O2} = 12.75 V†	MA010CL	—	—	1.2	1.9	A

* At less than the minimum current, units will continue to operate; however, the dual-output modules (MA010BK, 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 2. Output Specifications (continued)

Parameter	Device	Symbol	Min	Typ	Max	Unit
Output Current Limit (T_A = 25 °C) (See Figures 4, 5, and 6.):						
V_O = 1.0 V (~0.2 $V_{O,\,set}$)	MA010A	—	—	—	6.0	A
V_O = 1.0 V (~0.08 $V_{O,\,set}$)	MA010B	—	—	—	4.0	A
V_O = 1.0 V (~0.07 $V_{O,\,set}$)	MA010C	—	—	—	4.0	A
V_{O1} or V_{O2} = 1.0 V	MA010BK	—	—	—	4.0	A
V_{O1} or V_{O2} = 1.0 V	MA010CL	—	—	—	4.0	A
Output Short-circuit Current (V_O = 250 mV; see Figures 4, 5, and 6.)	MA010A	—	—	4.8	—	A
	MA010B	—	—	1.9	—	A
	MA010C	—	—	1.9	—	A
	MA010BK	—	—	1.6	—	A
	MA010CL	—	—	1.6	—	A
Efficiency (V_I = 12 V; I_O = $I_{O,\,max}$; T_C = 25 °C; see Figures 7, 8, 12, and 13.)	MA010A	η	75	81	—	%
	MA010B	η	75	82	—	%
	MA010C	η	75	84	—	%
	MA010BK	η	75	78	—	%
	MA010CL	η	75	79	—	%
Dynamic Response ($\Delta I_O/\Delta t$ = 1 A/10 µs, V_I = 5 V, T_C = 25 °C):						
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% peak deviation)	All	—	—	4	—	ms

Electrical Specifications (continued)

Table 3. Isolation Specifications

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

General Specifications

Parameter	Min	Typ	Max	Unit
Calculated MTBF (I_O = 80% of $I_{O,\,max}$; T_C = 40 °C)		4,200,000		hours
Weight	—	—	45.4 (1.6)	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
Remote On/Off Signal Interface (V_I = 10 V to 15 V; open collector or equivalent compatible; signal referenced to V_I(–) terminal; see Figures 9 and 14 and Feature Descriptions Section.):						
Logic Low—Module On:						
$I_{on/off}$ = 1.0 mA	—	$V_{on/off}$	0	—	1.2	V
$V_{on/off}$ = 0.0 V	—	$I_{on/off}$	—	—	1.0	mA
Logic High—Module Off:						
$I_{on/off}$ = 0.0 µA	—	$V_{on/off}$	—	—	18	V
$V_{on/off}$ = 15 V	—	$I_{on/off}$	—	—	50	µA
Turn-on Time (I_O = 80% of $I_{O,\,max}$; V_O within ±1% of steady state)	—	—	—	1.5	—	ms
Output Overvoltage Clamp	MA010A	$V_{O,\,clamp}$	—	—	7.0	V
	MA010B	$V_{O,\,clamp}$	—	—	16	V
	MA010C	$V_{O,\,clamp}$	—	—	19	V
	MA010BK	$V_{O1,\,clamp}$	—	—	18	V
		$V_{O2,\,clamp}$	—	—	–18	V
	MA010CL	$V_{O1,\,clamp}$	—	—	21	V
		$V_{O2,\,clamp}$	—	—	–21	V

Characteristic Curves

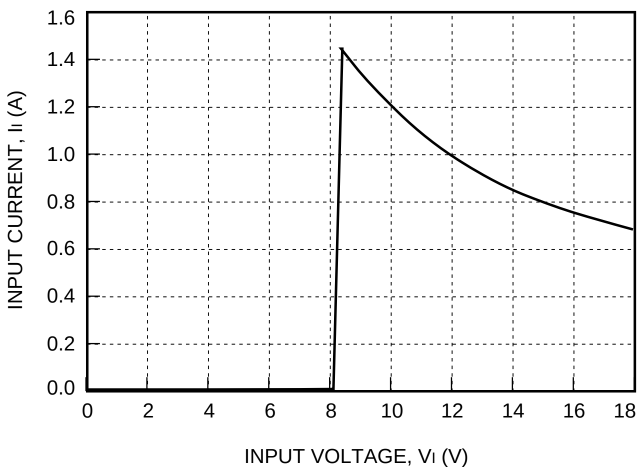

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Figure 1. MA010-Series Typical Input Characteristic with $I_O = I_{O,\,max}$; T_C = 25 °C

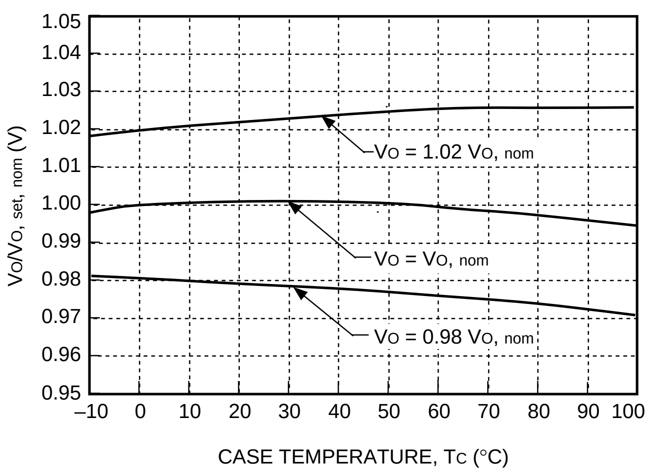

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Figure 2. MA010-Series Typical Output Voltage Variation Over Operating Case Temperature

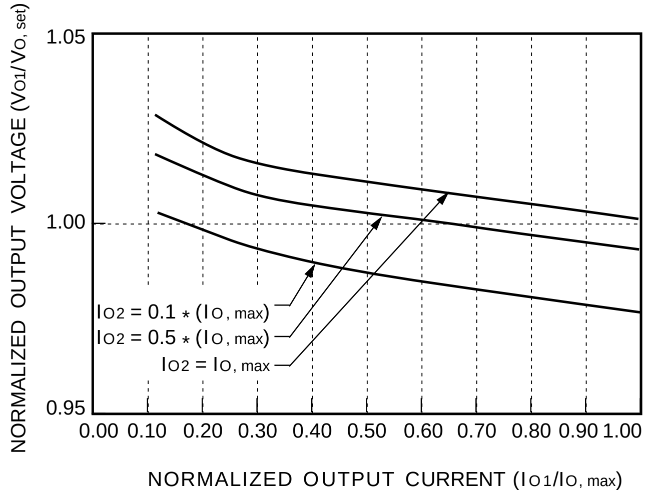

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Figure 3. MA010BK, CL Typical Regulation: V_O vs. I_O for V_I = 12 V, T_C = 25 °C

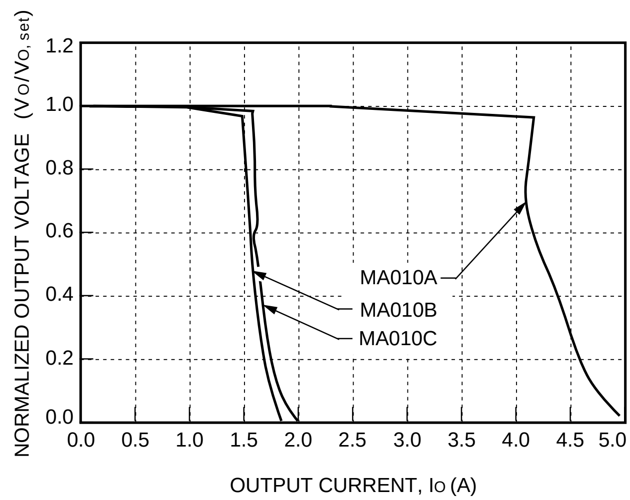

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Figure 4. MA010A, B, C Typical Output Characteristics with V_I = 12 V, T_A = 25 °C

Characteristic Curves (continued)

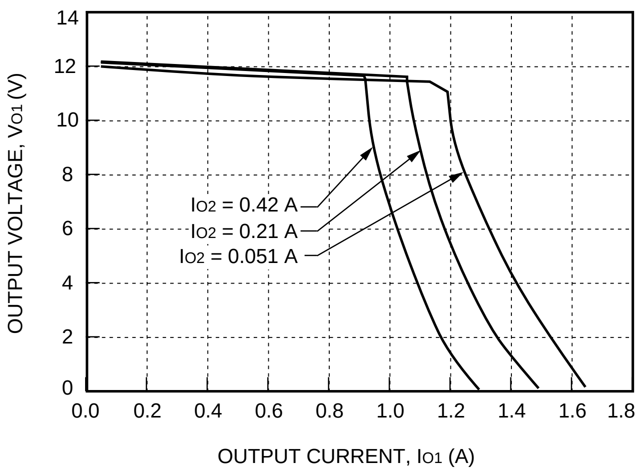

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Figure 5. MA010BK Typical Output Characteristics with V_I = 12 V, T_A = 25 °C

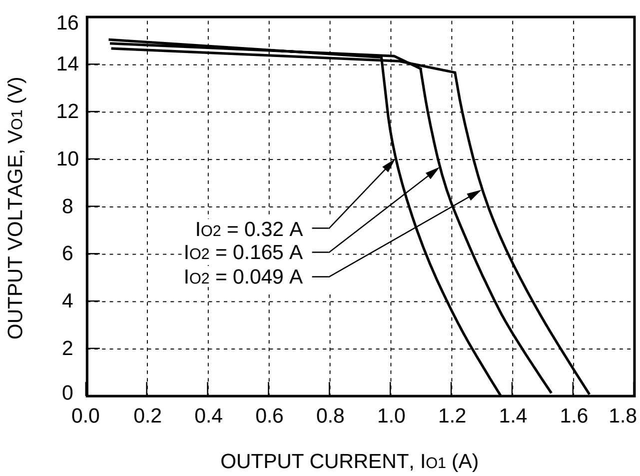

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Figure 6. MA010CL Typical Output Characteristics with V_I = 12 V, T_A = 25 °C

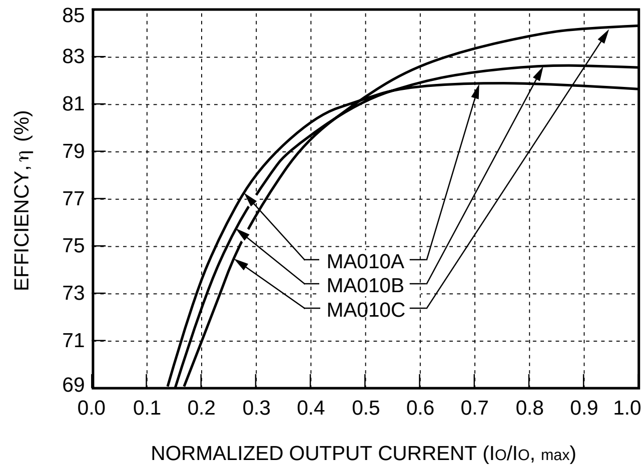

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Figure 7. MA010A, B, C Typical Converter Efficiency as a Function of Output Current with V_I = 12 V and T_A = 25 °C

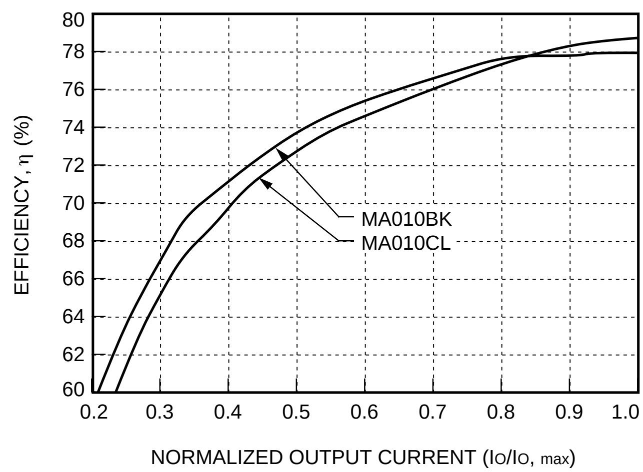

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Figure 8. MA010BK, CL Typical Converter Efficiency as a Function of Output Current with V_I = 12 V and T_A = 25 °C

Characteristic Curves (continued)

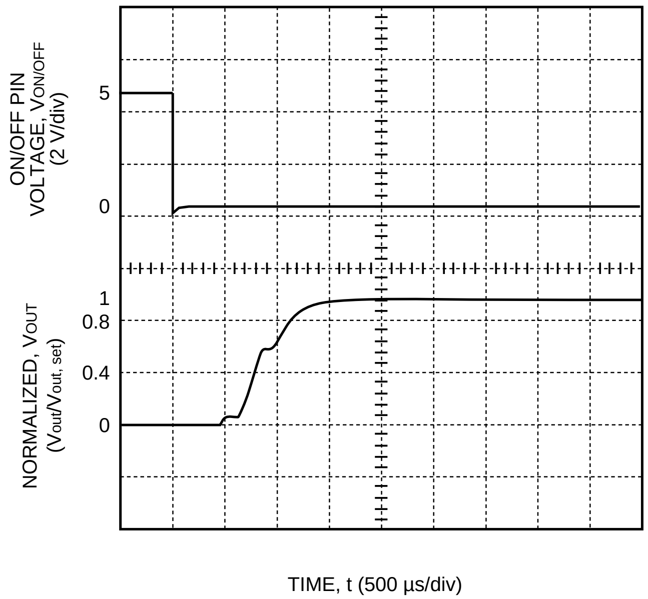

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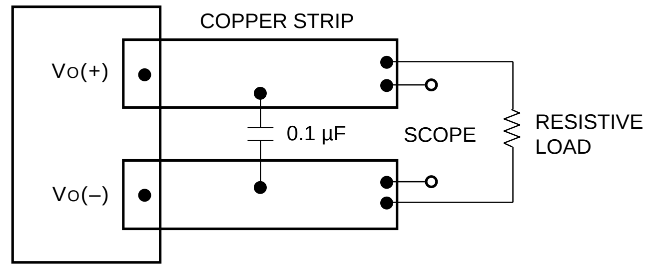
Figure 9. Typical Output Voltage Start-Up when Remote On/Off Is Enabled; I_O = 80% of $I_{O, max}$

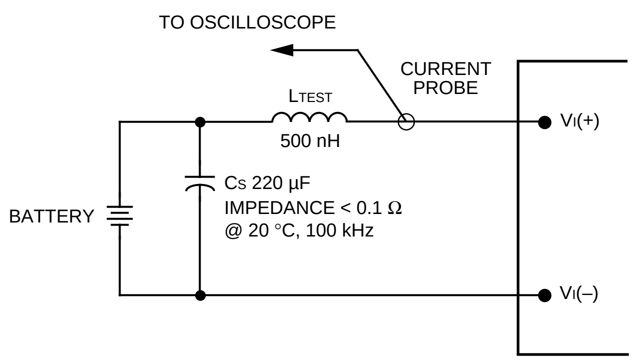


8-513(C)

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 11. Peak-to-Peak and RMS Output Noise Measurement Test Setup

Test Configurations



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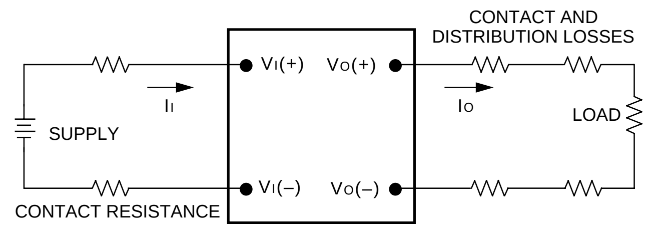
Note: Input reflected-ripple current is measured with a simulated source impedance of 500 nH. Capacitor CS offsets possible battery impedance. Current is measured at the input of the module.

Figure 10. Input Reflected-Ripple Test Setup



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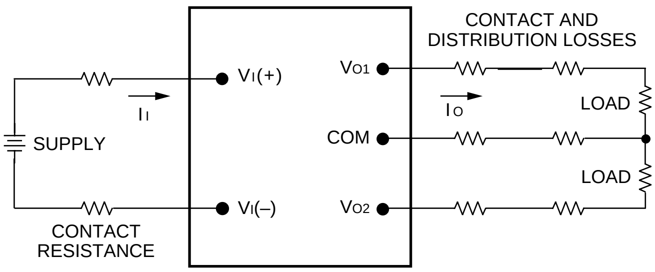
Note: All measurements are taken at the module terminals. When socketing, place Kelvin connections at module terminals to avoid measurement errors due to socket contact resistance.

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

Figure 12. Single-Output Voltage and Efficiency Measurement Test Setup

Test Configurations (continued)



8-753(C)

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.

$$\eta = \frac{\sum_{J=1}^{2} \left|[V_{Oj}(+) - V_{com}]I_{Oj}\right|}{[V_I(+) + (-V_I(-))]I_I} \times 100$$

Figure 13. Dual-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 4 µH can affect the stability of the power module. A 33 µF electrolytic capacitor (ESR < 0.7 Ω 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* 22.2 No. 950-95, EN60950.

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

If the input meets extra-low voltage (ELV) requirements, then the converter's output is considered ELV.

The input to these units is to be provided with a maximum 10 A normal-blow fuse in the ungrounded lead.

Feature Descriptions

Output Overvoltage Clamp

The output overvoltage clamp consists of control circuitry, 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.

Current Limit

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.

Feature Descriptions (continued)

Remote On/Off

To turn the power module on and off, the user must supply a switch to control the voltage between the on/off terminal and the $V_I(-)$ terminal ($V_{on/off}$). The switch can be an open collector or equivalent (see Figure 14). A logic low is $V_{on/off}$ = 0 V to 1.2 V, during which the module is on. The maximum $I_{on/off}$ during a logic low is 1 mA. The switch should maintain a logic-low voltage while sinking 1 mA.

During a logic high, the maximum $V_{on/off}$ generated by the power module is 18 V. The maximum allowable leakage current of the switch at $V_{on/off}$ = 18 V is 50 µA.

Note: A PWB trace between the on/off terminal and the $V_I(-)$ terminal can be used to override the remote on/off.

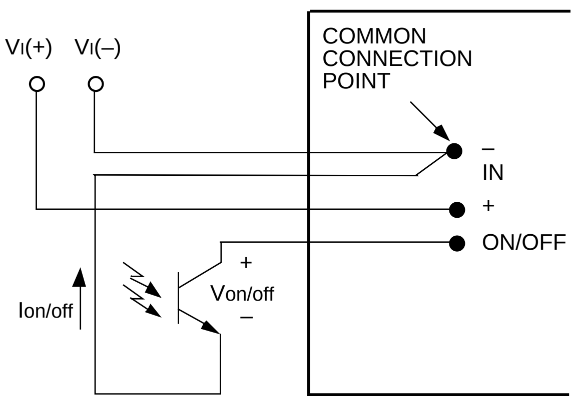
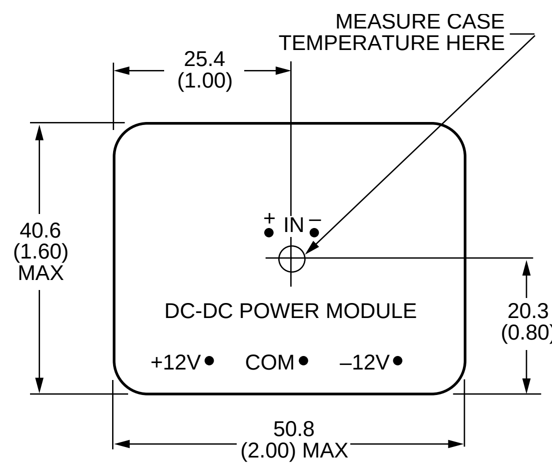


Figure 14. Remote On/Off Circuitry

Thermal Considerations

Introduction

The MA010-Series power modules operate in a variety of thermal environments; however, sufficient cooling should be provided to help ensure reliable operation of the unit. Heat-dissipating components inside the unit are thermally coupled to the case. Heat is removed by conduction, convection, and radiation to the surrounding environment. Proper cooling can be verified by measuring the case temperature. Peak case temperature (T_C) occurs at the position indicated in Figure 15.



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

Figure 15. Case Temperature Measurement Location

Note that the view in Figure 15 is of the surface of the module—the pin locations shown are for reference. The temperature at this location should not exceed 85 °C. The output power of the module should not exceed the rated power for the module as listed in the Ordering Information table.

Thermal Considerations (continued)

Heat Transfer

Increasing airflow over the module enhances the heat transfer via convection. Figure 16 shows the maximum power that can be dissipated by the module (without exceeding the maximum case temperature) versus local ambient temperature (T_A), for natural convection through 3 ms^{-1} (600 ft./min).

Note that the natural convection condition was measured at 0.05 ms^{-1} (10 ft./min.) to 0.1 ms^{-1} (20 ft./min.); however, systems in which these power modules may be used typically generate natural convection airflow rates of 0.3 ms^{-1} (60 ft./min.) due to other heat dissipating components in the system. Use of Figure 16 is shown in the following example.

Example

What is the minimum airflow necessary for a MA010A operating at nominal, an output current of 1 A, and a maximum ambient temperature of 75 °C?

Solution:

Given: V_I = 12 V, V_O = 5 V, I_O = 1 A, T_A = 75 °C
Determine P_D (using equation below): P_D = 1.17 W
Determine airflow (Figure 16): v = 0.5 ms^{-1} (100 ft./min.)

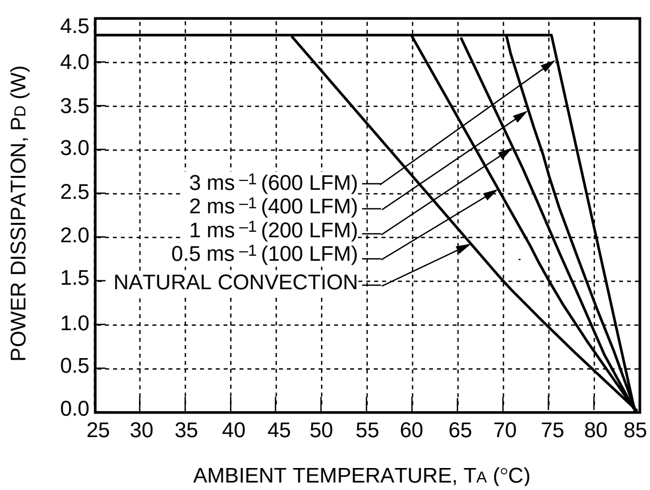


Figure 16. Convection Derating Power Derating; Either Orientation

Refer to Figures 7 and 8 to determine the converter efficiency at the appropriate operating conditions. Then use the following equation to determine the power dissipation (P_D):

$$P_D = P_{out} \bullet \frac{1-\eta}{\eta}$$

Case-to-Ambient Thermal Impedance

Figure 17 shows the case-to-ambient thermal impedance, θ_{ca} (°C/W) for the MA010 modules. This information is used to predict the case temperature for a given operating point and airflow using this 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).

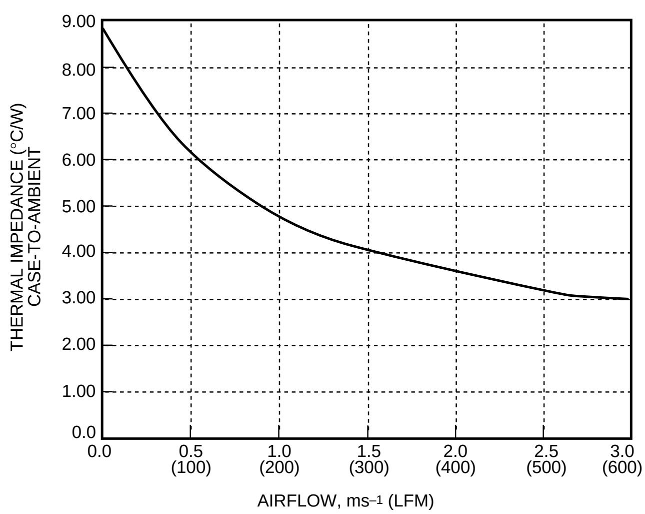


Figure 17. MA010A, B, C Case-to-Ambient Thermal Impedance

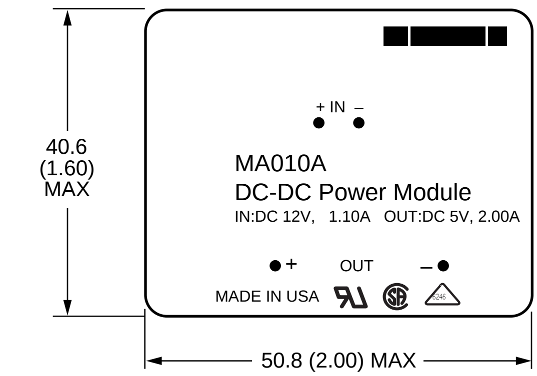
Outline Diagrams

Dimensions are in millimeters and (inches).

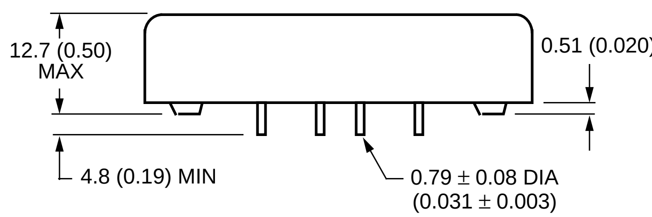
Module tolerance, unless otherwise indicated: x.x ± 0.5 mm (0.02 in.), x.xx ± 0.25 mm (0.010 in.).

Single-Output Module

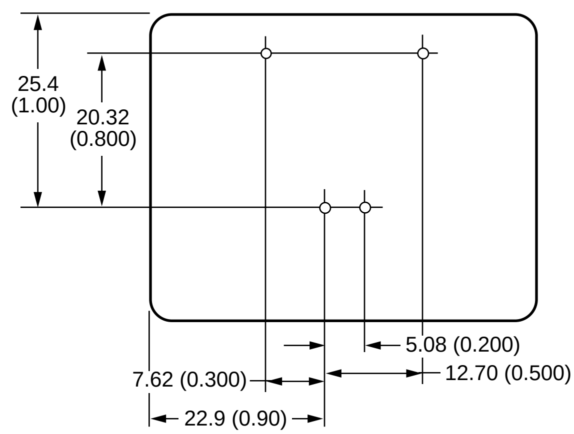
Top View



Side View



Bottom View



8-663(C).a

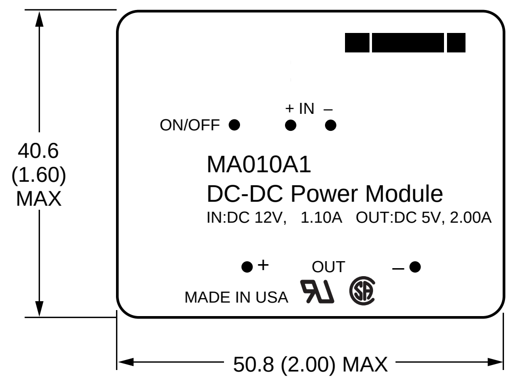
Outline Diagrams (continued)

Dimensions are in millimeters and (inches).

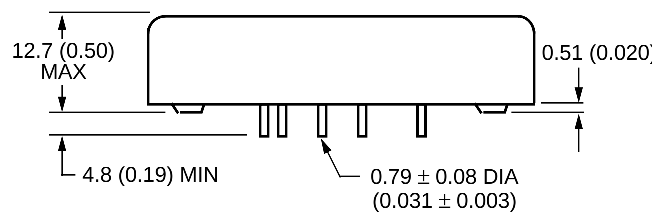
Module tolerance, unless otherwise indicated: x.x ± 0.5 mm (0.02 in.), x.xx ± 0.25 mm (0.010 in.).

Single-Output Module with Remote On/Off

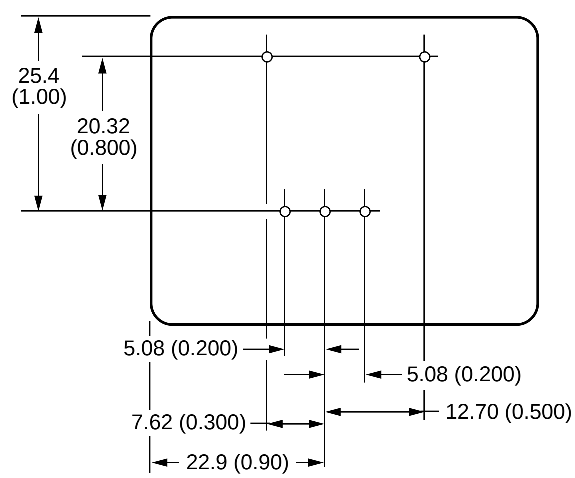
Top View



Side View



Bottom View



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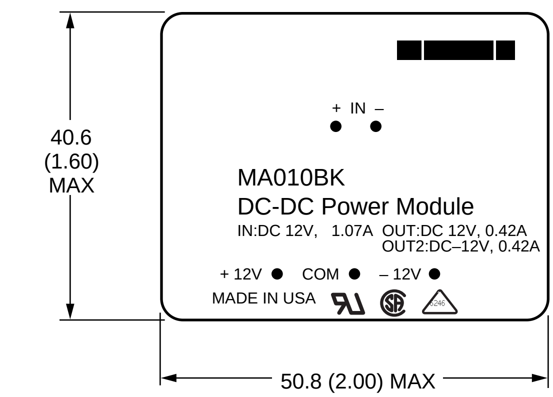
Outline Diagrams (continued)

Dimensions are in millimeters and (inches).

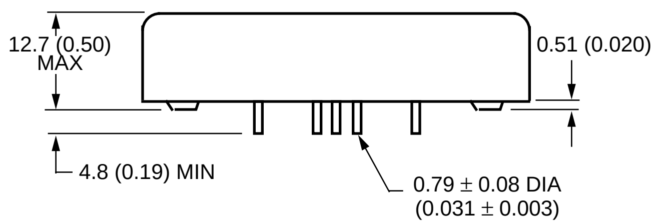
Module tolerance, unless otherwise indicated: x.x ± 0.5 mm (0.02 in.), x.xx ± 0.25 mm (0.010 in.).

Dual-Output Module

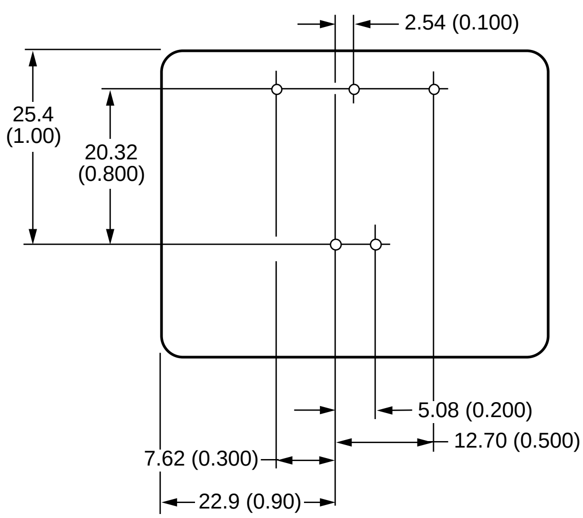
Top View



Side View



Bottom View



8-666(C).a

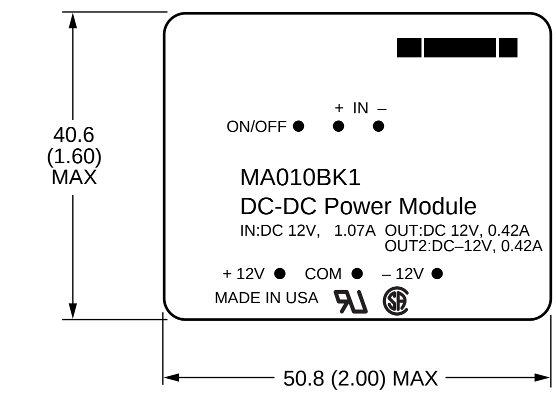
Outline Diagrams (continued)

Dimensions are in millimeters and (inches).

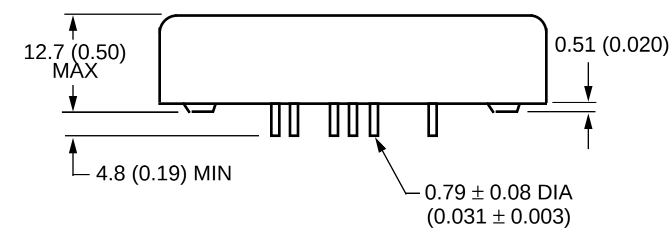
Module tolerance, unless otherwise indicated: x.x ± 0.5 mm (0.02 in.), x.xx ± 0.25 mm (0.010 in.).

Dual-Output Module with Remote On/Off

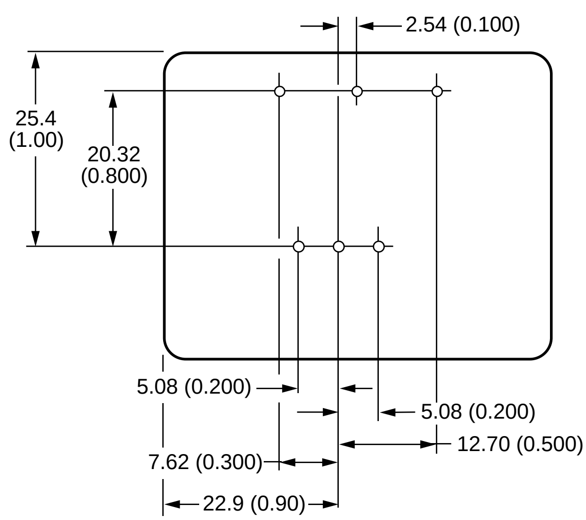
Top View



Side View



Bottom View



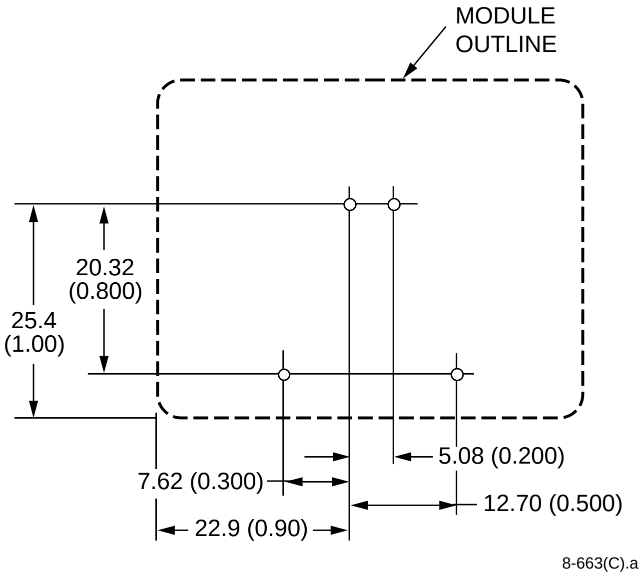
8-665(C).a

Recommended Hole Patterns

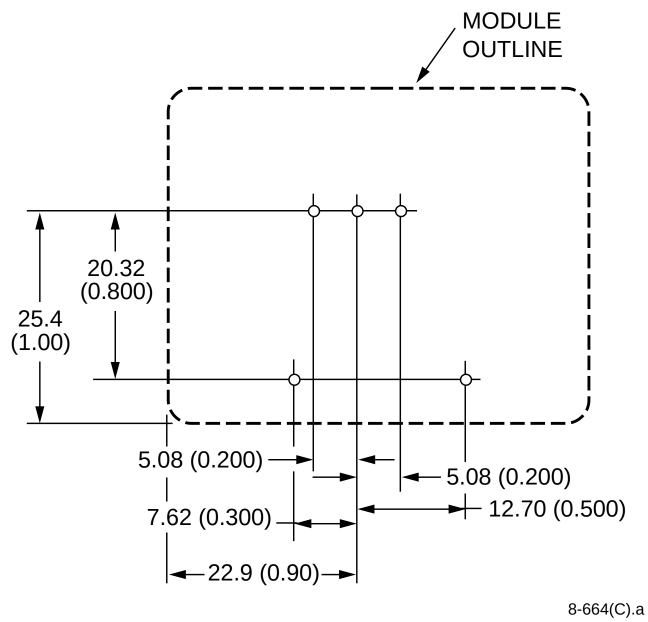
Component-side footprint.

Dimensions are in millimeters and (inches).

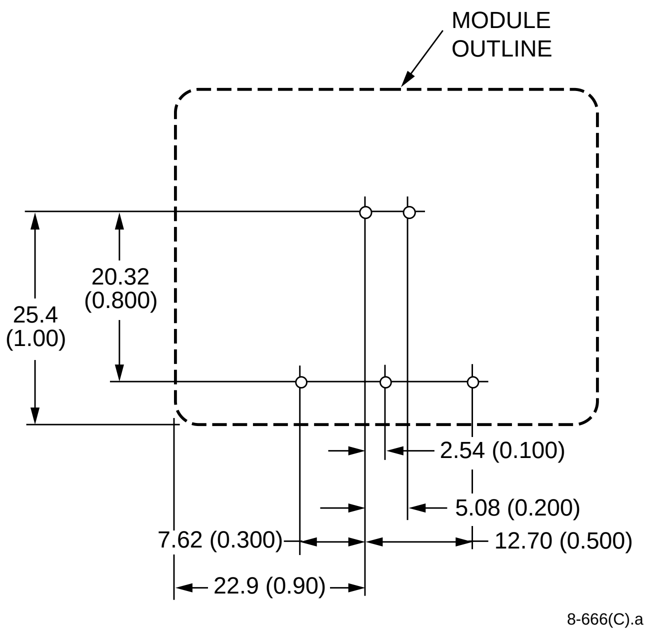
Single-Output Module



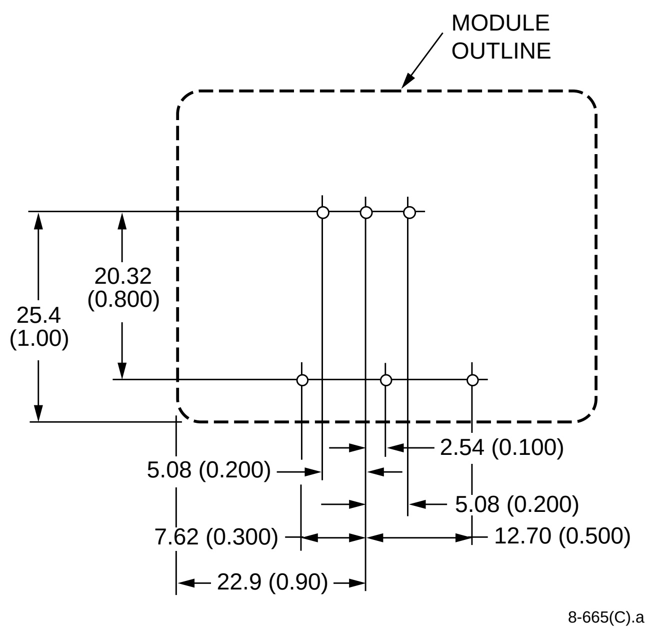
Single-Output Module with Remote On/Off



Dual-Output Module



Dual-Output Module with Remote On/Off



Ordering Information

Table 4. Ordering Information

Input Voltage	Output Voltage	Output Power	Device Code	Comcode
5 V	5 V	10 W	MA010A	106698343
5 V	12 V	10 W	MA010B	106698350
5 V	15 V	10 W	MA010C	106698368
5 V	+12 V, –12 V	10 W	MA010BK	106698392
5 V	+15 V, –15 V	10 W	MA010CL	106698426

Optional features may be ordered using the device code suffixes shown below. The feature suffixes are listed numerically in descending order.

Table 5. Options

Option	Device Code Suffix
Short pin: 28 mm ± 0.25 mm (0.110 ± 0.010 in.)	8
Negative logic remote on/off	1

Notes

Notes

Tyco Electronics Power Systems, Inc.
3000 Skyline Drive, Mesquite, TX 75149, USA
+1-800-526-7819 FAX: +1-888-315-5182
(Outside U.S.A.: **+1-972-284-2626**, FAX: +1-972-284-2900)
http://power.tycoelectronics.com

May 1998
DS96-226EPS (Replaces DS91-204EPS)