Data Sheet
February 2000

112-Series and 113-Series Power Modules; 5 Vdc Input

The 112- and 113-Series Power Modules deliver highly reliable dc-dc conversion in less than one square inch of footprint area.

Features

- High reliability
- Low profile
- Small size: 24.4 mm x 17.8 mm x 11.2 mm (0.96 in. x 0.70 in. x 0.44 in.)
- Printed-circuit board mountable
- No minimum load
- *UL** 1950 Recognized
- Operating ambient temperature range: 0 °C to 70 °C

Applications

- Communication equipment
- Computer equipment
- Digital circuits
- Distributed power architecture

Description

The 112- and 113-Series Power Modules provide highly reliable power for digital and telecommunications applications. Each nonisolated switching regulator operates from a 5 Vdc input. The 112-Series modules provide 12 V, 15 V, and 25 V outputs, while the 113-Series provide –5 V, –12 V, –15 V, and –130 V outputs (see the Output Specifications table). High efficiency allows for operation from no load to full load over an ambient temperature range of 0 °C to 70 °C with no power derating. Minimal external filtering components are required.

Each module is fully encapsulated in a 16-pin DIP that uses less than 1 $in.^2$ of printed-circuit board area.

* *UL* is a registered trademark of Underwriters Laboratories, Inc.

Absolute Maximum Ratings

Ratings apply to all devices.

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	V_I	—	7	Vdc
Operating Ambient Temperature*	T_A	0	70	°C
Storage Temperature	T_{stg}	–40	125	°C

* At $I_{O, max} \leq 60$ mA, the 112E2 operates over a temperature range of T_A = –40 °C to +85 °C.

Electrical Specifications

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

Table 1. Input Specifications

Parameter	Device	Symbol	Min	Typ	Max	Unit
Operating Input Voltage	All	V_I	4.5	5.0	5.5	Vdc
Maximum Input Current	112A2	$I_{I, max}$	—	—	175	mA
	112C2	$I_{I, max}$	—	—	675	mA
	112D2	$I_{I, max}$	—	—	450	mA
	112E2	$I_{I, max}$	—	—	700	mA
	113A2	$I_{I, max}$	—	—	300	mA
	113AA2	$I_{I, max}$	—	—	300	mA
	113B2/B3	$I_{I, max}$	—	—	300	mA
	113C2	$I_{I, max}$	—	—	300	mA
	113E2	$I_{I, max}$	—	—	170	mA
	113F2/F3	$I_{I, max}$	—	—	700	mA
	113G2	$I_{I, max}$	—	—	600	mA
	113K2	$I_{I, max}$	—	—	700	mA
Input Reflected-ripple Current (5 Hz to 20 MHz, 12 µH source, T_A = 25 °C; see Figure 1.)	112A2	—	—	20	—	mAp-p
	112C2	—	—	5	—	mAp-p
	112D2	—	—	5	—	mAp-p
	112E2	—	—	5	—	mAp-p
	113A2	—	—	10	—	mAp-p
	113AA2	—	—	10	—	mAp-p
	113B2/B3	—	—	10	—	mAp-p
	113C2	—	—	10	—	mAp-p
	113E2	—	—	10	—	mAp-p
	113F2/F3	—	—	30	—	mAp-p
	113G2	—	—	25	—	mAp-p
	113K2	—	—	30	—	mAp-p

Electrical Specifications (continued)

Table 1. Input Specifications (continued)

Parameter	Device	Symbol	Min	Typ	Max	Unit
Inrush Transient	112-Series	i^2t	—	—	0.2	A^2s
	113-Series	i^2t	—	—	0.1	A^2s
Required Input Capacitor:						
Capacitance	112-Series	C_I	—	220 ± 20%	—	µF
	113-Series	C_I	—	100 ± 20%	—	µF
Equivalent Series Resistance (100 kHz; T_A = 25 °C)	All	ESR	—	—	125	mΩ

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)	112A2	$V_{O, set}$	11.87	12.00	12.12	Vdc
	112C2	$V_{O, set}$	14.83	15.00	15.15	Vdc
	112D2	$V_{O, set}$	24.72	25.00	25.28	Vdc
	112E2	$V_{O, set}$	11.87	12.00	12.12	Vdc
	113A2	$V_{O, set}$	–4.90	–5.00	–5.10	Vdc
	113AA2	$V_{O, set}$	–4.90	–5.00	–5.10	Vdc
	113B2/B3	$V_{O, set}$	–11.75	–12.00	–12.25	Vdc
	113C2	$V_{O, set}$	–14.70	–15.00	–15.30	Vdc
	113E2*	$V_{O, set}$	–128.00	–130.00	–132.00	Vdc
	113F2/F3	$V_{O, set}$	–4.90	–5.00	–5.10	Vdc
	113G2	$V_{O, set}$	–11.75	–12.00	–12.25	Vdc
	113K2	$V_{O, set}$	–5.10	–5.20	–5.30	Vdc
Output Voltage (Over all line, resistive load, and temperature conditions until end of life)	112A2	V_O	11.60	—	12.40	Vdc
	112C2	V_O	14.50	—	15.50	Vdc
	112D2	V_O	24.20	—	25.80	Vdc
	112E2	V_O	11.60	—	12.40	Vdc
	113A2	V_O	–4.75	—	–5.25	Vdc
	113AA2	V_O	–4.75	—	–5.25	Vdc
	113B2/B3	V_O	–11.40	—	–12.60	Vdc
	113C2	V_O	–14.25	—	–15.75	Vdc
	113E2	V_O	–127.00	—	–133.00	Vdc
	113F2/F3	V_O	–4.75	—	–5.25	Vdc
	113G2	V_O	–11.40	—	–12.60	Vdc
	113K2	V_O	–4.95	—	–5.45	Vdc
Output Current	112A2	I_O	0	—	41.2	mA
	112C2	I_O	0	—	100	mA
	112D2	I_O	0	—	30	mA
	112E2	I_O	0	—	125	mA
	113A2	I_O	0	—	100	mA
	113AA2	I_O	0	—	100	mA
	113B2/B3	I_O	0	—	63	mA
	113C2	I_O	0	—	50	mA
	113E2	I_O	0	—	0.5	mA
	113F2/F3	I_O	0	—	300	mA
	113G2	I_O	0	—	125	mA
	113K2	I_O	0	—	285	mA

* The output voltage set point of 130 V for the 113E2 is defined using an external resistor of R_{ext} = 2375 Ω between pins 6 and 7.

Electrical Specifications (continued)

Table 2. Output Specifications (continued)

Parameter	Device	Symbol	Min	Typ	Max	Unit
Output Regulation:	112A2	—	—	—	50	mV
Line (V_I = 4.5 Vdc to 5.5 Vdc)	112C2	—	—	—	21	mV
	112D2	—	—	—	21	mV
	112E2	—	—	—	21	mV
	113A2	—	—	—	10	mV
	113AA2	—	—	—	10	mV
	113B2/B3	—	—	—	21	mV
	113C2	—	—	—	31	mV
	113E2	—	—	—	800	mV
	113F2/F3	—	—	—	10	mV
	113G2	—	—	—	31	mV
	113K2	—	—	—	10	mV
Load ($I_{O, min}$ to $I_{O, max}$)	112A2	—	—	—	80	mV
	112C2	—	—	—	21	mV
	112D2	—	—	—	21	mV
	112E2	—	—	—	21	mV
	113A2	—	—	—	10	mV
	113AA2	—	—	—	10	mV
	113B2/B3	—	—	—	21	mV
	113C2	—	—	—	31	mV
	113E2	—	—	—	300	mV
	113F2/F3	—	—	—	20	mV
	113G2	—	—	—	31	mV
	113K2	—	—	—	20	mV
Output Ripple and Noise Voltage	112A2	—	—	—	200	mVp-p
(5 Hz to 20 MHz; output noise is	112C2	—	—	—	200	mVp-p
measured with the specified output	112D2	—	—	—	200	mVp-p
capacitors [125 mΩ max ESR at	112E2	—	—	—	200	mVp-p
100 kHz] at T_A = 25 °C.)	113A2	—	—	—	400	mVp-p
	113AA2	—	—	—	400	mVp-p
	113B2/B3	—	—	—	500	mVp-p
	113C2	—	—	—	500	mVp-p
	113E2	—	—	—	200	mVp-p
	113F2/F3	—	—	—	500	mVp-p
	113G2	—	—	—	500	mVp-p
	113K2	—	—	—	500	mVp-p
Efficiency	112A2	η	73	—	—	%
(V_I = 5 V; I_O = $I_{O, max}$; T_A = 25 °C)	112C2	η	65	—	—	%
	112D2	η	60	—	—	%
	112E2	η	65	—	—	%
	113A2	η	60	—	—	%
	113AA2	η	60	—	—	%
	113B2/B3	η	65	—	—	%
	113C2	η	68	—	—	%
	113E2	η	13	—	—	%
	113F2/F3	η	64	—	—	%
	113G2	η	73	—	—	%
	113K2	η	64	—	—	%

* The output voltage set point of 130 V for the 113E2 is defined using an external resistor of R_{ext} = 2375 Ω between pins 6 and 7.

Electrical Specifications (continued)

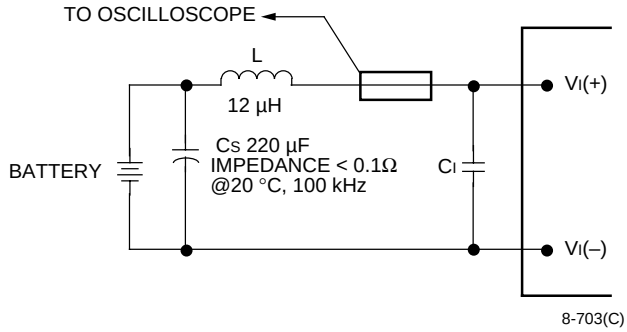
Table 2. Output Specifications (continued)

Parameter	Device	Symbol	Min	Typ	Max	Unit
Required Output Capacitor:	112A2	C_O	—	100 ± 20%	—	µF
Capacitance	112C2	C_O	—	100 ± 20%	—	µF
	112D2	C_O	—	22 ± 20%	—	µF
	112E2	C_O	—	100 ± 20%	—	µF
	113A2	C_O	—	100 ± 20%	—	µF
	113AA2	C_O	—	100 ± 20%	—	µF
	113B2/B3	C_O	—	100 ± 20%	—	µF
	113C2	C_O	—	100 ± 20%	—	µF
	113E2	C_O	—	0.25 ± 20%	—	µF
	113F2/F3	C_O	—	100 ± 20%	—	µF
	113G2	C_O	—	100 ± 20%	—	µF
	113K2	C_O	—	100 ± 20%	—	µF
Equivalent Series Resistance (100 kHz; T_A = 25 °C)	All	ESR	40	—	125	mΩ

* The output voltage set point of 130 V for the 113E2 is defined using an external resistor of R_{ext} = 2375 Ω between pins 6 and 7.

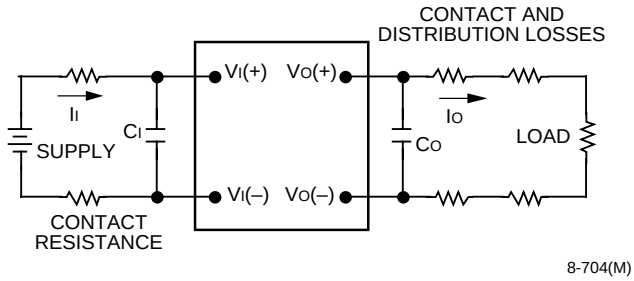
Test Configurations

See Input and Output Specifications tables for required external input and output capacitor values.



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 1. Input Reflected-Ripple 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.

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

Figure 2. Output Voltage and Efficiency Measurement Test Setup

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.

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

Shutdown Circuit Specifications (112D2)

The 112D2 Power Module features a TTL compatible shutdown. When the module is shut down, $V_O = V_I - 0.2$ V. Apply $V_{shutdown}$ between pin 1 (shutdown) and pin 3 (common) (see Figure 4). To shut down the power module, $V_{shutdown}$ = 1.5 V to 5.5 V and $I_{shutdown}$ = 0.01 mA; to operate the power module, $V_{shutdown}$ < 0.8 V and $I_{shutdown}$ = –0.01 mA.

Output Voltage Adjustment (113E2)

The output voltage for the 113E2 Power Module can be adjusted between –76 V and –184 V by adding an external resistor or a 4362A Thermistor Network between pins 6 and 7. The adjusted voltage is determined by the following formula:

$$V_O = 1 - \frac{310\ k\Omega}{R_{ext}}\ \text{Volts}$$

where R_{ext} is the value (in Ohms) of the external resistor inserted between pins 6 and 7. In terms of degrees Celsius, using a 4362A Network, the equation becomes:

$$V_O = -130\ V + (1.2\ V/°C)(25\ °C - T_A)\ \text{Volts}$$

where T_A is the ambient temperature in degrees Celsius.

Electrical Considerations

Current Limiting

The 112- and 113-Series Power Modules do not contain current-limit protection circuitry. The modules can survive a short circuit for a brief time; however, operating under short-circuit conditions for an extended time can damage the modules.

Layout Considerations

When routing power paths, orient the positive and negative paths close together to minimize the effective inductance and maximize capacitive coupling. Proper operation of the module is dependent upon placement of the external input and output capacitors. Figures 3 through 7 display recommended layouts for the 112- and 113-Series Power Modules. Failure to maintain low impedance between the capacitors C_I and C_O and the power module can result in poor noise performance.

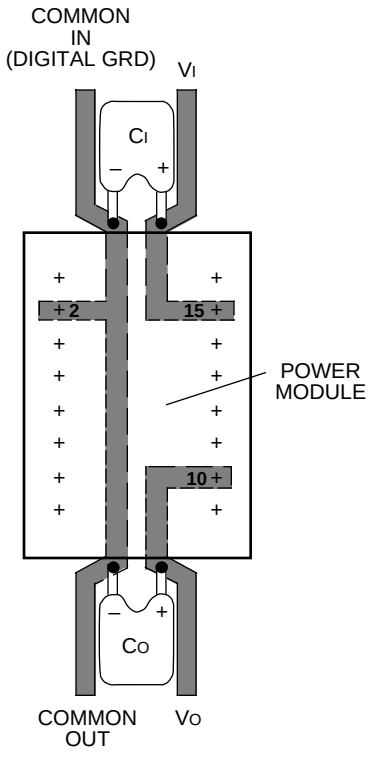


Figure 3. Recommended Layout for 112A2

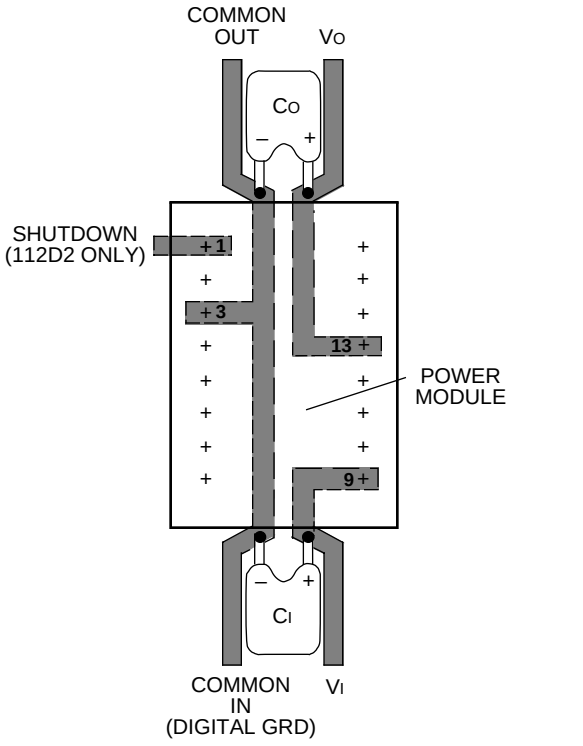


Figure 4. Recommended Layout for 112C2, 112D2, and 112E2

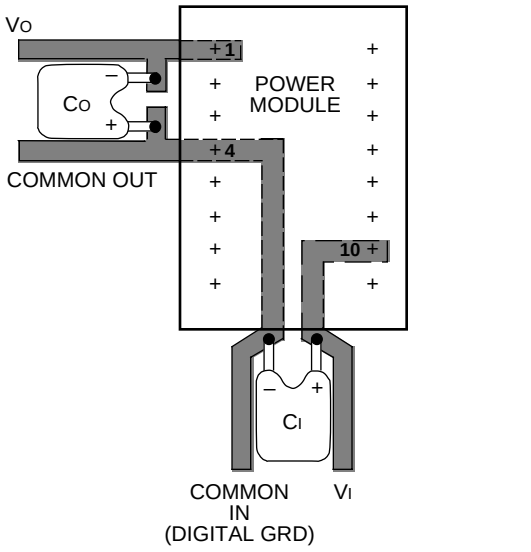


Figure 5. Recommended Layout for 113AA2, 113A2, 113B2, 113B3, and 113C2

Layout Considerations (continued)

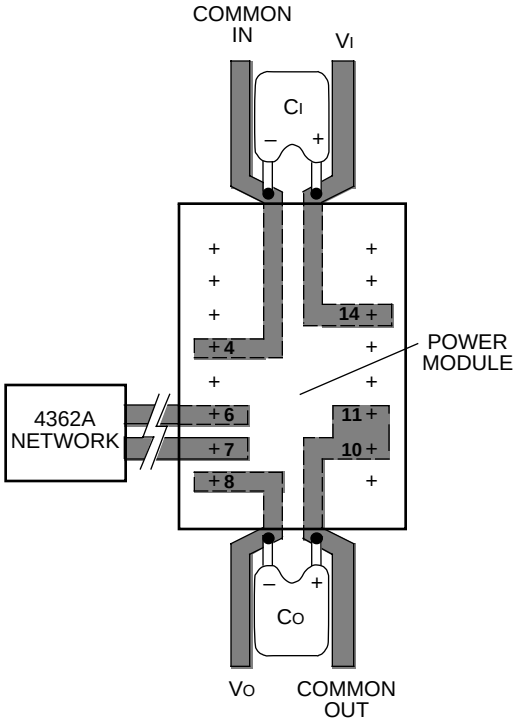


Figure 6. Recommended Layout for 113E2

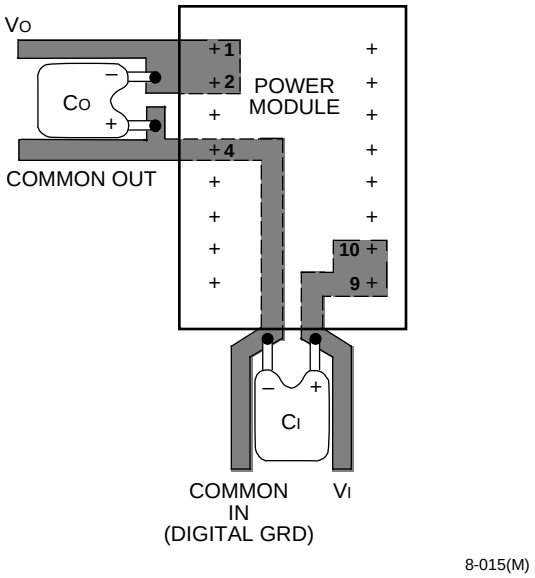


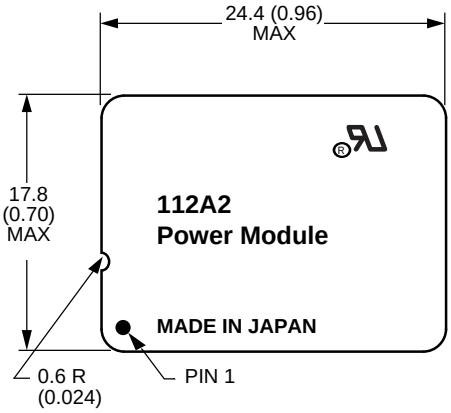
Figure 7. Recommended Layout for 113F2, 113F3, 113G2, and 113K2

Outline Diagram

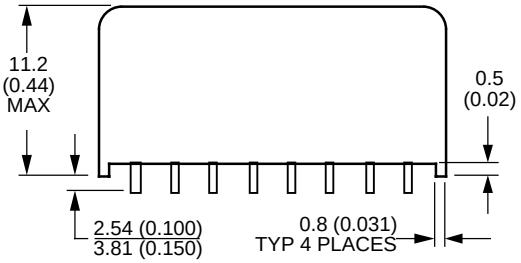
Dimensions are in millimeters and (inches). Pin descriptions are on the next page.

Tolerances: x.x ± 0.5 mm (0.02 in.), x.xx ± 0.38 mm (0.015 in.)

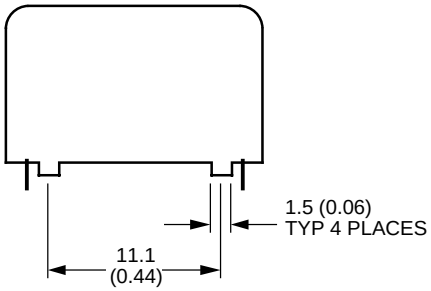
Top View



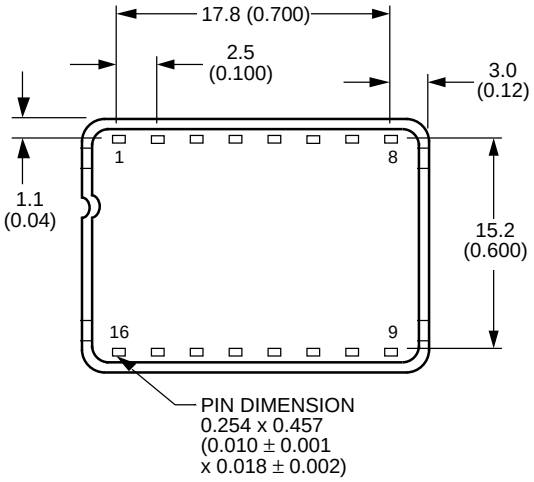
Side View



End View



Bottom View

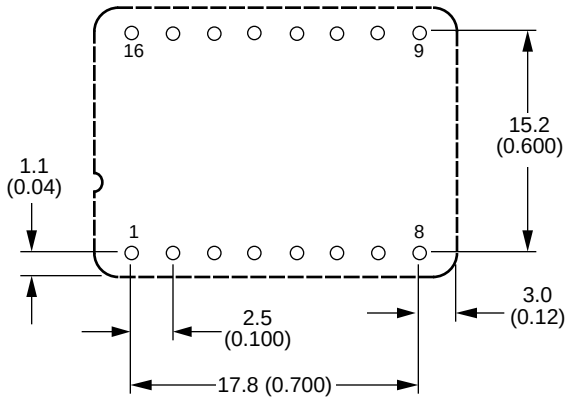


8-234(M)

Recommended Hole Pattern

Component-side footprint.

Dimensions are in millimeters and (inches).



8-234(M)

Pin Descriptions

Pins marked NC should be soldered to the printed-circuit board with no external electrical connections.

A dashed line indicates a pin which has been removed.

Pin Number	Device									
	112A2	**112C2 112E2**	**112D2**	**113A2**	**113AA2**	**113B2 113C2**	**113B3**	**113E2**	**113F2 113G2 113K2**	**113F3**
1	NC	NC	SHTDN	V_O(–)	V_O(–)	V_O(–)	V_O(–)	NC	V_O(–)	V_O(–)
2	COM	NC	NC	NC	NC	NC	NC	NC	V_O(–)	V_O(–)
3	NC	COM	COM	NC	NC	NC	NC	NC	NC	NC
4	NC	NC	NC	COM	COM	COM	COM	COM	COM	COM
5	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
6	NC	NC	NC	NC	NC	NC	NC	$V_{O, adj}$	NC	NC
7	NC	NC	NC	NC	—	NC	NC	$V_{O, adj}$	NC	NC
8	NC	NC	NC	NC	NC	NC	NC	V_O(–)	NC	NC
9	NC	V_I(+)	V_I(+)	V_I(+)	V_I(+)	V_I(+)	V_I(+)	NC	V_I(+)	V_I(+)
10	V_O(+)	NC	NC	V_I(+)	V_I(+)	V_I(+)	V_I(+)	COM	V_I(+)	V_I(+)
11	NC	NC	NC	NC	NC	NC	—	COM	NC	—
12	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
13	NC	V_O(+)	V_O(+)	NC	NC	NC	NC	NC	NC	NC
14	NC	NC	NC	NC	NC	NC	NC	V_I(+)	NC	NC
15	V_I(+)	NC	NC	NC	NC	NC	NC	NC	NC	NC
16	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC

Ordering Information

Input Voltage	Output Voltage	Maximum Output Current	Shutdown	Device Code	Comcode
5 Vdc	12 Vdc	41.2 mA	No	112A2	106408818
5 Vdc	15 Vdc	100 mA	No	112C2	106408826
5 Vdc	25 Vdc	30 mA	Yes	112D2	106408834
5 Vdc	12 Vdc	125 mA	No	112E2	106408842
5 Vdc	–5 Vdc	100 mA	No	113A2	106408859
5 Vdc	–5 Vdc	100 mA	No	113AA2	106408925
5 Vdc	–12 Vdc	63 mA	No	113B2	106408867
5 Vdc	–12 Vdc	63 mA	No	113B3	106507809
5 Vdc	–15 Vdc	50 mA	No	113C2	106408883
5 Vdc	–130 Vdc*	0.5 mA	No	113E2	106408891
5 Vdc	–5 Vdc	300 mA	No	113F2	106408909
5 Vdc	–5 Vdc	300 mA	No	113F3	106507817
5 Vdc	–12 Vdc	125 mA	No	113G2	106408917
5 Vdc	–5.2 Vdc	285 mA	No	113K2	106761158

* The output voltage of the 113E2 is adjustable from –76 Vdc to –184 Vdc. See Feature Descriptions section for more information.

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