



MK005-Series Power Modules: dc-dc Converters; 36 Vdc to 75 Vdc Input; 5 W

The MK005-Series Power Modules are encapsulated in aluminum cases measuring 2.00 in. long, 1.19 in. wide, and 0.46 in. high.

Applications

- Telecommunications
- Digital circuitry
- Distributed power architectures

Features

- Small size: 2.00 in. x 1.19 in. x 0.46 in.
- Shielded metal case
- Wide input-voltage range: 36 Vdc to 75 Vdc
- Output current limiting; unlimited duration
- Output overvoltage clamp
- Load regulation: 0.15% maximum
- Line regulation: 0.05% maximum
- Short-circuit protection
- Input-to-output isolation
- No external filtering required
- Operating ambient temperature range: -40 °C to +85 °C
- PC board mountable
- Meets FCC Class B requirements
- High reliability
- *UL** recognized; *CSA*[†] and VDE certified
- CE mark meets 73/23/EEC and 93/68/EEC directives[‡]

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

† *CSA* is a registered trademark of the Canadian Standards Association.

‡ This product is intended for integration into end-use equipment. All the required procedures for CE marking of end-use equipment should be followed. (The CE mark is placed on selected products.)

Description

The MK005A, MK005B, MK005C, MK005N, and MK005CL4 Power Modules are dc-dc converters that operate over a wide input voltage range of 36 Vdc to 75 Vdc and provide precisely regulated dc outputs. The outputs are fully 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 82% (80% for the MK005A and MK005N).

The modules are encapsulated in aluminum cases with ground pins. In a natural convection environment, the modules are rated to full load at 70 °C with no heat sinking or external filtering. The modules can be used up to 85 °C with derated output power or at full load with an external input-filter capacitor.

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	—	80	V
Transient (2 ms)	V_I	—	100	V
I/O Isolation Voltage				
Continuous	—	—	500	V
Transient (1 min)	—	—	850	V
Operating Ambient Temperature (Natural convection, derate 0.1 W/°C beyond 70 °C; see Design 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, temperature conditions, and on/off configurations.

Table 1. Input Specifications

Parameter	Symbol	Min	Typ	Max	Unit
Operating Input Voltage	V_I	36	48	75	Vdc
Maximum Input Current ($V_I = 38$ V; $I_O = I_{O, max}$):	$I_{I, max}$	—	—	185	mA
Inrush Transient	i^2t	—	0.3	1.0	A ² s
Input Reflected-ripple Current, Peak-to-Peak (5 Hz to 20 MHz, 12 μ H source impedance; $T_A = 25$ °C) (See Figure 1 and Design Considerations section.)	—	—	40	—	mA p-p
Input Ripple Rejection (120 Hz)	—	—	53	—	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. A dc fuse with a maximum rating of 5 A is recommended. 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 (Over all operating input voltage, resistive load, and temperature conditions until end of life.)	MK005A	V_o	4.85	—	5.15	Vdc
	MK005B	V_o	11.64	—	12.36	Vdc
	MK005C	V_o	14.55	—	15.45	Vdc
	MK005N	V_o	5.05	—	5.35	Vdc
	MK005CL4	V_{o1}	14.55	—	15.45	Vdc
		V_{o2}	-13.5	—	-16.5	Vdc
Output Voltage Set Point ($V_i = 48$ V; $I_o = I_{o, \max}$; $T_A = 25$ °C)	MK005A	$V_{o, \text{set}}$	4.90	5.0	5.10	Vdc
	MK005B	$V_{o, \text{set}}$	11.75	12.0	12.25	Vdc
	MK005C	$V_{o, \text{set}}$	14.7	15.0	15.3	Vdc
	MK005N	$V_{o, \text{set}}$	5.10	5.2	5.30	Vdc
	MK005CL4	$V_{o1, \text{set}}$	14.7	15.0	15.3	Vdc
		$V_{o2, \text{set}}$	-14.25	-15.0	-15.75	Vdc
Output Regulation: Line ($V_i = 36$ Vdc to 75 Vdc) Load ($I_o = I_{o, \min}$ to $I_{o, \max}$) Temperature ($T_A = -40$ °C to +85 °C)	all*	—	—	0.01	0.05	%
	all*	—	—	0.05	0.15	%
	MK005A, N	—	—	15	70	mV
	MK005B	—	—	40	150	mV
	MK005C, CL4*	—	—	45	190	mV
Output Ripple and Noise Voltage: RMS Peak-to-peak (5 Hz to 20 MHz)	MK005A, N	—	—	—	15	mVrms
	MK005B, C	—	—	—	25	mVrms
	MK005CL4	—	—	—	80	mVrms
	MK005A, N	—	—	—	50	mVp-p
	MK005B, C	—	—	—	100	mVp-p
	MK005CL4	—	—	—	250	mVp-p
Output Current: (At $I_o < I_{o, \min}$, the converter may exceed its output ripple specifications. At ambient temperatures above 70 °C, refer to Figure 4 for maximum derated output currents.)	MK005A	I_o	0.1	—	1.0	A
	MK005B	I_o	0.02	—	0.42	A
	MK005C	I_o	0.02	—	0.33	A
	MK005N	I_o	0.09	—	0.96	A
	MK005CL4	$I_{o1}^\dagger$	0.017	—	0.17	A
		$I_{o2}^\dagger$	0.017	—	0.17	A

* For MK005CL4, V_{o1} only.

† Minimum load on either output can be as low as 10 mA, but the load on the other output must not exceed 100 mA. Otherwise, V_{o2} may not maintain its specified regulation.

Electrical Specifications (continued)

Table 2. Output Specifications (continued)

Parameter	Device	Symbol	Min	Typ	Max	Unit
Output Current-limit Inception:						
Vo = 4.5 V	MK005A	—	—	1.6	2.5	A
Vo = 10.8 V	MK005B	—	—	0.8	1.4	A
Vo = 13.5 V	MK005C	—	—	0.7	1.3	A
Vo = 4.68 V	MK005N	—	—	1.6	2.5	A
Vo1 or Vo2 = 12.75 V	MK005CL4	—	—	0.7	1.3	A
Output Current Limit:						
Vo = 1.0 V	MK005A, N	—	—	—	3.0	A
Vo = 1.0 V	MK005B, C	—	—	—	2.0	A
Vo1 or Vo2 = 1.0 V	MK005CL4	—	—	—	2.0	A
Output Short-circuit Current (Vo = 250 mV)	MK005A, N	—	—	1.5	—	A
	MK005B, C, CL4	—	—	1.0	—	A
Efficiency (See Figures 2 and 3; Vi = 48 V; Io = Io, max; TA = 25 °C.)	MK005A, N	η	77	80	—	%
	MK005B, C, CL4	η	79	82	—	%
Dynamic Response (For MK005CL4, applies to Vo1 and Vo2 at full load; ΔIo/Δt = 1 A/10 μs, Vi = 48 V, TA = 25 °C.): Load Change from Io = 50% to 75% of Io, max						
Peak Deviation	MK005A, N	—	—	80	—	mV
	MK005B, C	—	—	70	—	mV
	MK005CL4	—	—	60	—	mV
Settling Time (Vo < 10% of peak deviation)	MK005A, B, C, N	—	—	3.5	—	ms
	MK005CL4	—	—	3.0	—	ms
Load Change from Io = 50% to 25% of Io, max						
Peak Deviation	MK005A, N	—	—	80	—	mV
	MK005B	—	—	70	—	mV
	MK005C	—	—	60	—	mV
	MK005CL4	—	—	70	—	mV
Settling Time (Vo < 10% of peak deviation)	MK005A, B, C, N	—	—	3.5	—	ms
	MK005CL4	—	—	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

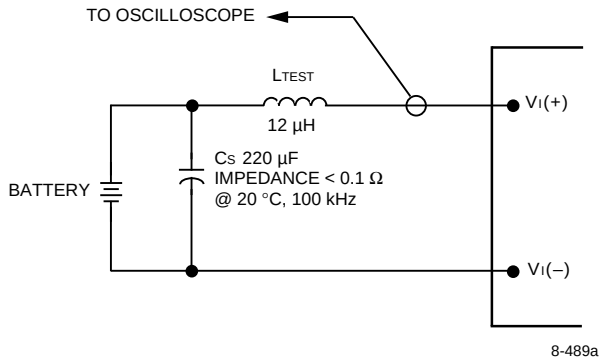
Parameter	Min	Typ	Max	Unit
Calculated MTBF ($I_o = 80\%$ of $I_{o, max}$; $T_c = 40^\circ\text{C}$)	2,500,000			hours
Weight	—	—	1.1	oz.

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.

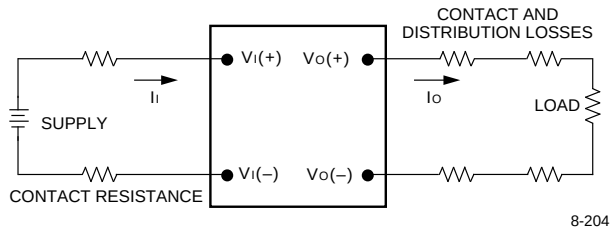
Parameter	Device	Symbol	Min	Typ	Max	Unit
Output Overvoltage Clamp	MK005A, N	V_o	5.4	6.3	7.0	V
	MK005B	V_o	12.6	14	16	V
	MK005C	V_o	15.75	17	19	V
	MK005CL4	V_{o1}	15.75	17	19	V
		V_{o2}	-16.5	-19	-21	V

Test Configurations



Note: Measure input reflected-ripple current with a simulated source impedance (LTEST) of 12 μH. Capacitor Cs offsets possible battery impedance. Measure current as shown above.

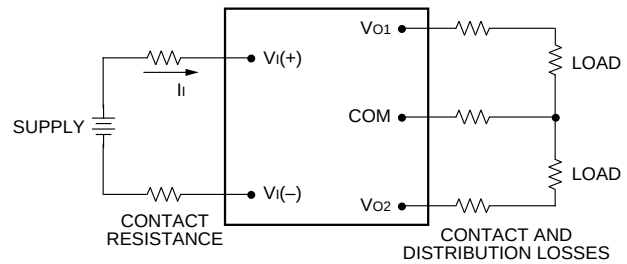
Figure 1. MK005-Series Input Reflected-Ripple Test Setup



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.

$$\eta = \left(\frac{[V_o(+)-V_o(-)]I_o}{[V_i(+)-V_i(-)]I_i} \right)$$

Figure 2. MK005A, B, C, N Output Voltage and Efficiency 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.

$$\eta = \frac{\sum_{j=1}^2 |[V_{Oj(+)} - V_{COM}]I_{Oj}|}{[V_i(+)-V_i(-)]I_i}$$

Figure 3. MK005CL4 Output Voltage and Efficiency Measurement Test Setup

Feature Descriptions

Output Overvoltage Clamp

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.

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.

Design Considerations

Input Reflected Ripple

An internal aluminum electrolytic input capacitor is used for filtering; therefore, input ripple increases as temperature decreases. There is approximately two times more ripple at 0 °C than at 25 °C and eight times more ripple at -40 °C than at 25 °C. The power module functions properly down to -40 °C with no additional filtering. If ripple comparable to that at 25 °C is needed at low temperatures, an external capacitor across the input with an impedance of 0.5 Ω at 100 kHz over the desired temperature range is recommended.

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 22.2-950*, *EN60950*.

For the converter output to be considered to be meeting the requirements of safety extra low voltage (SELV), one of the following must be true:

- All inputs are SELV and floating with the output also floating.
- All inputs are SELV and grounded with the output also grounded.
- Any non-SELV input must be provided with reinforced insulation from any other hazardous voltages, including the ac mains, and must have a SELV reliability test performed on it in combination with the converters.

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

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

Design Considerations (continued)

Thermal Management

To maintain the full power rating at ambient temperatures above 70 °C, add an external capacitor with a minimum ripple current rating of 160 mA rms and maximum impedance of 1.0 Ω at 105 °C and 100 kHz across the input close to the power module input leads. Otherwise, derate the output power as shown in Figure 4.

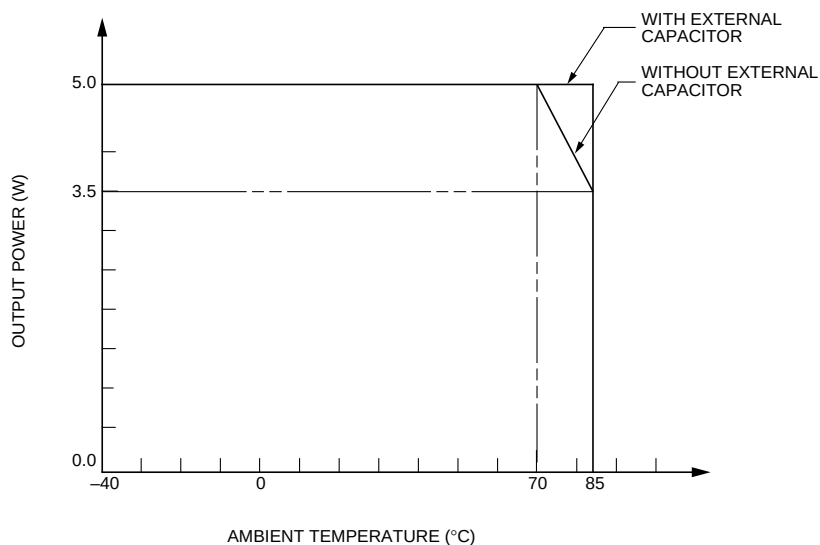


Figure 4. Thermal Derating Curve

8-595

Outline Diagrams

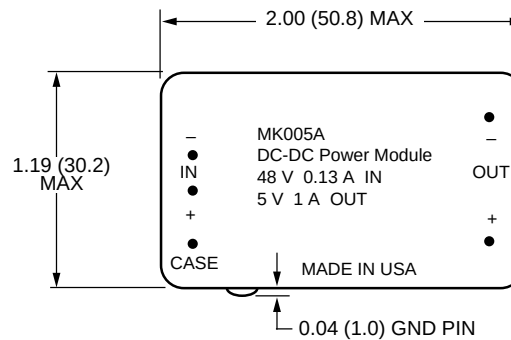
Dimensions are in inches and (millimeters).

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

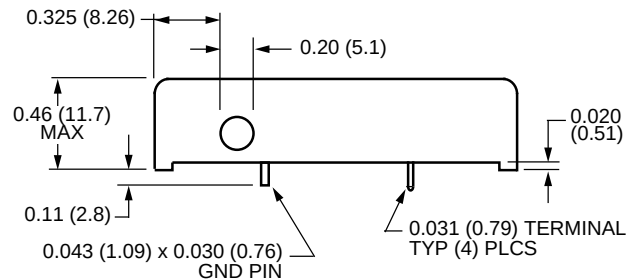
Tolerances (unless otherwise indicated): $x.xx \pm 0.02$ in. (0.5 mm), $x.xxx \pm 0.010$ in. (0.25 mm)

Single-Output Module

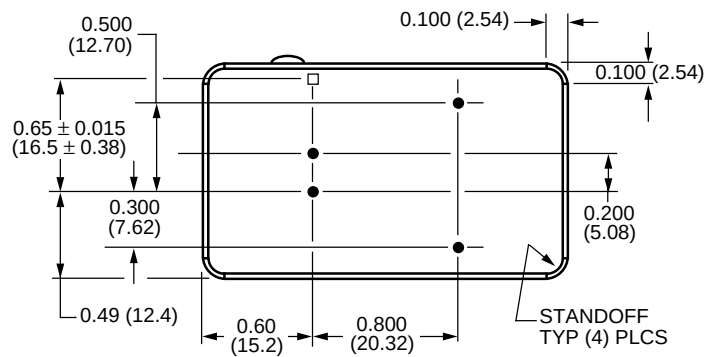
Top View



Side View



Bottom View



Outline Diagrams (continued)

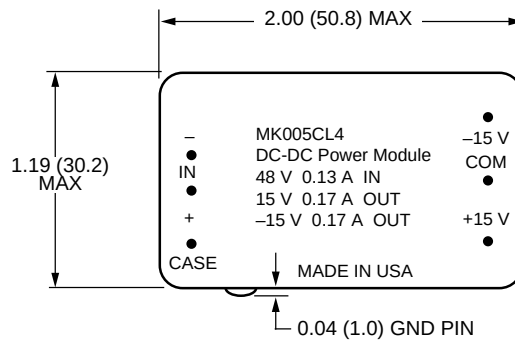
Dimensions are in inches and (millimeters).

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

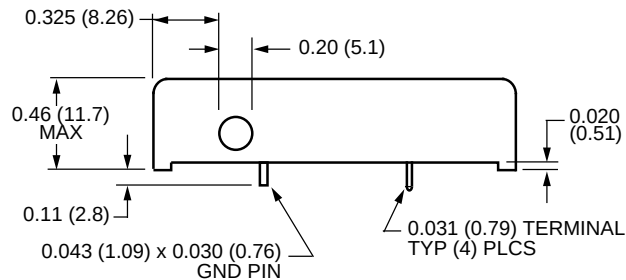
Tolerances (unless otherwise indicated): $x.xx \pm 0.02$ in. (0.5 mm), $x.xxx \pm 0.010$ in. (0.25 mm)

Dual-Output Module

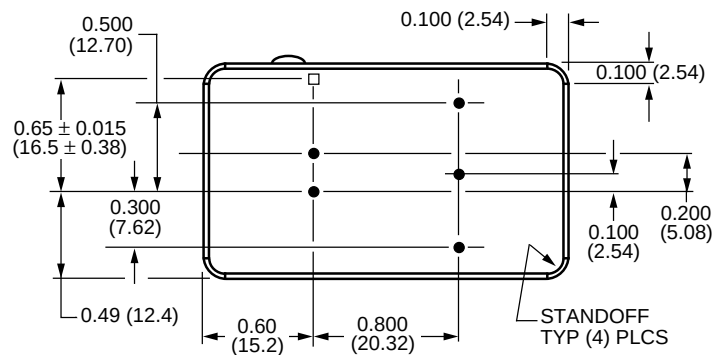
Top View



Side View



Bottom View

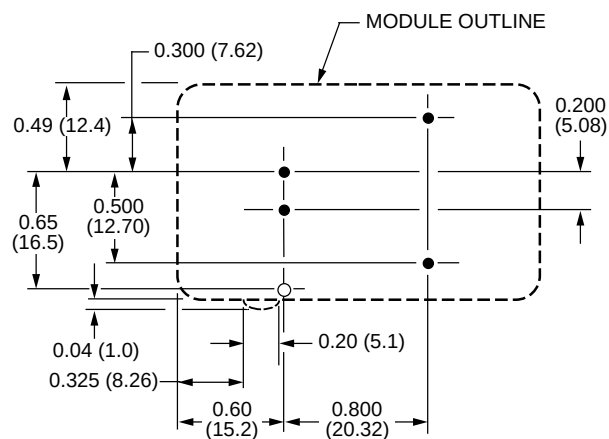


Recommended Hole Patterns

Component-side footprint.

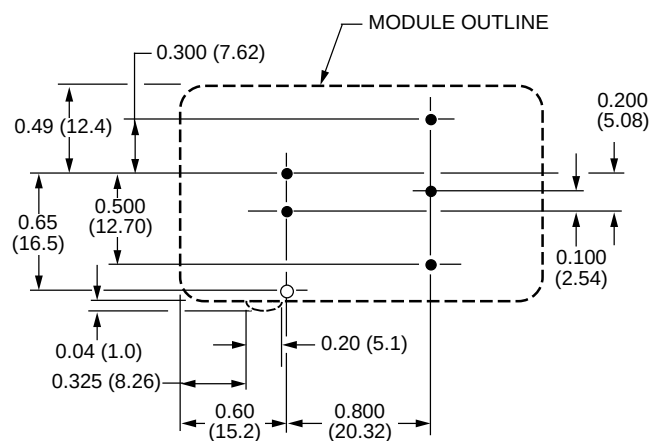
Dimensions are in inches and (millimeters).

Single-Output Module



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Dual-Output Module



8-597

Ordering Information

For assistance in ordering, contact your Lucent Technologies Account Manager.

Power Module Description		Device Code	Comcode
Input Voltage	Output Voltage		
36 V to 75 V	5.0 V	MK005A	106194590
36 V to 75 V	12.0 V	MK005B	106194608
36 V to 75 V	15.0 V	MK005C	106080633
36 V to 75 V	5.2 V	MK005N	106080625
36 V to 75 V	15.0 V -15.0 V	MK005CL4	106194616

For additional information, contact your Lucent Technologies Account Manager or the following:

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