



# DC-DC Converters

## MI-200



50 to 100 Watts

### Features & Benefits

- Inputs:
  - 28V<sub>DC</sub> per MIL-STD-704D/E/F
  - 155V<sub>DC</sub> per MIL-STD-1399A
  - 270V<sub>DC</sub> per MIL-STD-704D/E/F
- Single output: 2 – 48V<sub>DC</sub>
- Up to 23W/in<sup>3</sup>
- MIL-STD-810 environments
- Up to 90% efficiency
- Remote sense
- Current limit
- OVP and thermal shut down
- Power boosters for higher power outputs
- ZCS power architecture
- Low-noise FM control
- Size: 4.6 x 2.4 x 0.5in  
[116,8 x 61,0 x 12,7mm]

### Product Highlights

The MI-200 family of DC-DC converters is designed for applications utilizing distributed power architectures. Based on Vicor VI-200 / VI-J00 family of zero-current switching, component level DC-DC converters, the MI-200 family offers exceptional performance in terms of power density, efficiency, noise, ease of use and reliability.

Fully encapsulated in Vicor industry-standard package, the MI-Series meets MIL-STD-810 environmental requirements for humidity, fungus, salt-fog, explosive atmosphere, acceleration, vibration and shock.

Standard features, such as wide output trimming/programming, current limiting, remote sense, output inhibit, and latching OVP and OTP combine to offer the highest degree of protection, versatility and reliability for power systems.

### Packaging Options

**Standard:** Slotted baseplate

**SlimMod:** Flangeless baseplate, option suffix: - S

**Example:** MI - 2XX - XX - S

**FinMod:** Finned heat sink, option suffix:

- F1, -F2, -F3 and - F4

**Examples:**

MI - 2XX - XX -F1, 0.25in fins, longitudinal

MI - 2XX - XX -F2, 0.50in fins, longitudinal

MI - 2XX - XX -F3, 0.25in fins, transverse

MI - 2XX - XX -F4, 0.50in fins, transverse

### Converter Selection Chart

## MI-2

Semi-custom modules available, consult factory.

### Input Voltage

| Nominal  | Range                     | Transient <sup>[a]</sup> | Notes                                         |
|----------|---------------------------|--------------------------|-----------------------------------------------|
| 2 = 28V  | 18 – 50V <sup>[b]</sup>   | 60V                      | 28V <sub>DC</sub> input per MIL-STD 704D/E/F  |
| 5 = 155V | 100 – 210V                | 230V                     | 155V <sub>DC</sub> input per MIL-STD-1399A    |
| 6 = 270V | 125 – 400V <sup>[c]</sup> | 475V                     | 270V <sub>DC</sub> input per MIL-STD-704D/E/F |
| 7 = 165V | 100 – 310V                | n/a                      |                                               |

<sup>[a]</sup> Transient voltage for 1 second.

<sup>[b]</sup> 16V operation at 75% load.

<sup>[c]</sup> MI-26Z-xV, MI-26Y-xV rated at 75% load from 125 – 150V<sub>IN</sub>

### Output Voltage

|                         |           |
|-------------------------|-----------|
| Z = 2.0V                | 1 = 12V   |
| Y = 3.3V                | P = 13.8V |
| 0 = 5.0V                | 2 = 15V   |
| X = 5.2V                | N = 18.5V |
| W = 5.5V                | 3 = 24V   |
| V = 5.8V                | L = 28V   |
| T = 6.5V <sup>[d]</sup> | J = 36V   |
| R = 7.5V <sup>[d]</sup> | K = 40V   |
| M = 10V                 | 4 = 48V   |

<sup>[d]</sup> 75W max power for 28V input

### Product Grade Temperature (°C)

| Operating                                                            | Storage         |
|----------------------------------------------------------------------|-----------------|
| I = -40 to +85                                                       | I = -55 to +100 |
| M = -55 to +85                                                       | M = -65 to +100 |
| Overtemperature shut down 95°C typical<br>(recycle power to restart) |                 |

### Output Power/Current V<sub>OUT</sub>

| ≥5V                                                                                                         | <5V     |
|-------------------------------------------------------------------------------------------------------------|---------|
| Y = 50W                                                                                                     | Y = 10A |
| X = 75W                                                                                                     | X = 15A |
| W = 100W                                                                                                    | W = 20A |
| V = —                                                                                                       | V = 30A |
| For additional output power,<br>100W and 75W booster modules available<br>Change (MI-2xx-xx) to (MI-Bxx-xx) |         |

## Converter Specifications

(Typical at  $T_{BP} = 25^{\circ}\text{C}$ , nominal line and 75% load, unless otherwise specified)

### Input Specifications

| Parameter                           | Min | Typ                                                          | Max                  | Units    | Test Conditions         |
|-------------------------------------|-----|--------------------------------------------------------------|----------------------|----------|-------------------------|
| Inrush charge                       |     | $120 \times 10^{-6}$                                         | $200 \times 10^{-6}$ | Coulombs | Nominal line            |
| Input reflected ripple current – pp |     | 10%                                                          |                      | $I_{IN}$ | Nominal line, full load |
| Input ripple rejection              |     | $30 + 20 \text{ Log } \left( \frac{V_{IN}}{V_{OUT}} \right)$ |                      | dB       | 120Hz, nominal line     |
|                                     |     | $20 + 20 \text{ Log } \left( \frac{V_{IN}}{V_{OUT}} \right)$ |                      | dB       | 2400Hz, nominal line    |
| No load power dissipation           |     | 1.35                                                         | 2                    | Watts    |                         |

### Output Characteristics

| Parameter                            | Min  | Typ   | Max  | Units                  | Test Conditions                         |
|--------------------------------------|------|-------|------|------------------------|-----------------------------------------|
| Setpoint accuracy                    |      | 0.5%  | 1%   | $V_{NOM}$              |                                         |
| Load/line regulation                 |      | 0.05% | 0.2% | $V_{NOM}$              | LL to HL, 10% to Full Load              |
|                                      |      | 0.2%  | 0.5% | $V_{NOM}$              | LL to HL, No Load to 10%                |
| Output temperature drift             |      | 0.01  | 0.02 | % / $^{\circ}\text{C}$ | Over rated temperature                  |
| Long term drift                      |      | 0.02  |      | %/1K hours             |                                         |
| Output ripple – pp                   |      | 100   | 150  | mV                     | Whichever is greater<br>20MHz bandwidth |
|                                      |      | 1.0%  | 1.5% | $V_{NOM}$              |                                         |
| Trim range <sup>[a]</sup>            | 50%  |       | 110% | $V_{NOM}$              |                                         |
| Total remote sense compensation      | 0.5  |       |      | Volts                  |                                         |
| OVP set point <sup>[b]</sup>         | 115% | 125%  | 135% | $V_{NOM}$              | latching                                |
| Current limit                        | 105% |       | 125% | $I_{NOM}$              | Automatic restart                       |
| Short circuit current <sup>[c]</sup> | 20%  |       | 130% | $I_{NOM}$              |                                         |

<sup>[a]</sup> 10V to 15V outputs, standard trim range  $\pm 10\%$ . Consult factory for wider trim range.

3.3V output trim range 2.20 to 3.63V

<sup>[b]</sup> No over temperature or voltage protection in booster modules

<sup>[c]</sup> Output voltages of 5V or less incorporate foldback current limiting; outputs of 10V and above provide constant current limiting.

**Note:** The permissible load current must never be exceeded during normal, abnormal or test conditions. For additional output related application information, please refer to output connections on page 5.

### Control Pin Specifications

| Parameter                    | Min  | Typ  | Max  | Units | Test Conditions    |
|------------------------------|------|------|------|-------|--------------------|
| Gate out impedance           |      | 50   |      | Ohms  |                    |
| Gate in impedance            |      | 1000 |      | Ohms  |                    |
| Gate in open circuit voltage |      | 6    |      | Volts | Use open collector |
| Gate in low threshold        | 0.65 |      |      | Volts |                    |
| Gate in low current          |      |      | 6    | mA    |                    |
| Power sharing accuracy       | 0.95 |      | 1.05 |       |                    |

## Converter Specifications (Cont.)

(Typical at  $T_{BP} = 25^{\circ}\text{C}$ , nominal line and 75% load, unless otherwise specified)

### Dielectric Withstand Characteristics

| Parameter                   | Min   | Typ | Max | Units     | Test Conditions   |
|-----------------------------|-------|-----|-----|-----------|-------------------|
| Input to output             | 3,000 |     |     | $V_{RMS}$ | Baseplate earthed |
| Output to baseplate         | 500   |     |     | $V_{RMS}$ |                   |
| Input to baseplate          | 1,500 |     |     | $V_{RMS}$ |                   |
| Input to output capacitance |       | 50  | 75  | pF        |                   |

### Thermal Characteristics

| Parameter                                         | Min | Typ      | Max | Units                          | Test Conditions                   |
|---------------------------------------------------|-----|----------|-----|--------------------------------|-----------------------------------|
| Efficiency                                        |     | 80 – 90% |     |                                |                                   |
| Baseplate to sink thermal impedance               |     | 0.07     |     | $^{\circ}\text{C}/\text{Watt}$ | With thermal pads                 |
| Thermal shutdown <sup>[d]</sup><br>(Drivers only) | 90  | 95       | 105 | $^{\circ}\text{C}$             | Cool and recycle power to restart |

<sup>[d]</sup> No over temperature or voltage protection in booster modules

### Environmental – MIL-STD-810D

| Parameter                   | Min    | Typ | Max | Units   | Test Conditions         |
|-----------------------------|--------|-----|-----|---------|-------------------------|
| Altitude - method 500.2     | 70,000 |     |     | feet    | Procedure II            |
| Humidity - method 507.2     | 86/240 |     |     | %/hours | Procedure I, cycle 1    |
| Acceleration - method 513.3 | 9      |     |     | g       | Procedure II            |
| Vibration - method 514.3    | 20     |     |     | g       | Procedure I, category 6 |
| Shock - method 516.3        | 40     |     |     | g       | Procedure I             |

### Reliability – MIL-HDBK-217F (MI-22L-MW)

| Parameter                             | Min | Typ   | Max | Units       | Test Conditions |
|---------------------------------------|-----|-------|-----|-------------|-----------------|
| 25°C Ground Benign: G.B.              |     | 3,552 |     | 1,000 hours |                 |
| 50°C Naval Sheltered: N.S.            |     | 639   |     | 1,000 hours |                 |
| 65°C Airborne Inhabited Cargo: A.I.C. |     | 501   |     | 1,000 hours |                 |

### Mechanical Specifications

| Parameter | Min        | Typ        | Max        | Units           | Test Conditions |
|-----------|------------|------------|------------|-----------------|-----------------|
| Weight    | 7.2<br>205 | 7.3<br>208 | 7.4<br>210 | Ounces<br>Grams |                 |

## Converter Specifications (Cont.)

### Product Grade Specifications

| Parameter                                                           | I-Grade                      | M-Grade                      |
|---------------------------------------------------------------------|------------------------------|------------------------------|
| Storage temperature                                                 | –55°C to +100°C              | –65°C to +100°C              |
| Operating temperature (baseplate)                                   | –40°C to +85°C               | –55°C to +85°C               |
| Power cycling burn-in                                               | 12 hours, 29 cycles          | 96 hours, 213 cycles         |
| Temperature cycled with power off<br>17°C per minute rate of change | 12 cycles<br>–65°C to +100°C | 12 cycles<br>–65°C to +100°C |
| Test data supplied at these temperatures <sup>[e]</sup>             | –40°C, +80°C                 | –55°C, +80°C                 |
| Warranty                                                            | 2 years                      | 2 years                      |
| Environmental compliance                                            | MIL-STD-810                  | MIL-STD-810                  |
| Derating                                                            | NAVMAT P-4855-1A             | NAVMAT P-4855-1A             |

<sup>[e]</sup> Test data available for review or download from vicorpower.com

### Maximum Capacitance, Rated Output Voltage <5V

| Rated $V_{OUT}$ (V) | $I_{OUT}$ Rating (A) | $C_{MAX}$ (μF) | $I_{OUT}$ Rating (A) | $C_{MAX}$ (μF) |
|---------------------|----------------------|----------------|----------------------|----------------|
| 2 to <3             | ≤10                  | 1500           | >10 to 40            | 5000           |
| 3 to <5             | ≤10                  | 1000           | >10 to 40            | 5000           |

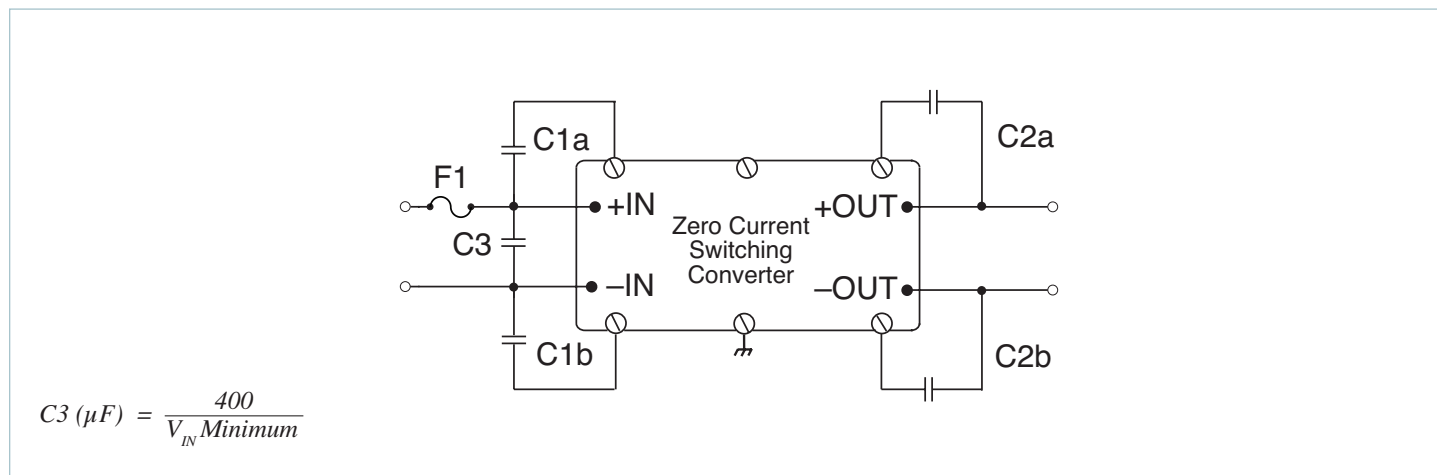
### Maximum Capacitance, Rated Output Voltage ≥5V

| Rated $V_{OUT}$ (V) | $P_{OUT}$ Rating (W) | $C_{MAX}$ (μF) | $P_{OUT}$ Rating (W) | $C_{MAX}$ (μF) |
|---------------------|----------------------|----------------|----------------------|----------------|
| 5 to <7.5           | ≤50                  | 1000           | >50 to 100           | 1500           |
| 7.5 to <10          | ≤50                  | 400            | >50 to 100           | 700            |
| 10 to <28           | ≤50                  | 400            | >50 to 100           | 500            |
| ≥28                 | ≤50                  | 150            | >50 to 100           | 250            |

### Environmental Qualifications

| Parameter            | Qualification                                                                                                                                                                                                                                                                                                                                                                    |
|----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Altitude             | MIL-STD-810D, Method 500.2, Procedure III, explosive decompression (40K ft.).<br>MIL-STD-810D, Method 500.2, Procedure II, 40,000ft., 1000 – 1500ft./min. to 70,000ft., unit functioning                                                                                                                                                                                         |
| Explosive Atmosphere | MIL-STD-810C, Method 511.1, Procedure I                                                                                                                                                                                                                                                                                                                                          |
| Vibration            | MIL-STD-810D, Method 514.3, Procedure I, category 6, helicopter, 20g<br>MIL-STD-810D, Method 514.3 random: 10 – 300Hz @ 0.02g <sup>2</sup> /Hz, 2000Hz @ 0.002g <sup>2</sup> /Hz, 3.9 total Grms<br>3 hrs/axis. Sine: 30Hz @ 20g, 60Hz @ 10g, 90Hz @ 6.6g, 120Hz @ 5.0g, 16.0 total Grms, 3 axes<br>MIL-STD-810E, Method 514.4, Table 514.4-VII, ±6db/octave, 7.7G rms, 1hr/axis |
| Shock                | MIL-STD-810D, Method 516.3, Procedure I, functional shock, 40g<br>MIL-STD-202F, Method 213B, 18 pulses, 60g, 9msec<br>MIL-STD-202F, Method 213B, 75g, 11ms saw tooth shock<br>MIL-STD-202F, Method 207A, 3 impacts / axis, 1, 3, 5 feet                                                                                                                                          |
| Acceleration         | MIL-STD-810D, Method 513.3, Procedure II Operational test, 9g for 1 minute along 3 mutually perpendicular axes                                                                                                                                                                                                                                                                   |
| Humidity             | MIL-STD-810D, Method 507.2, Procedure I, cycle I, 240 hrs, 88% relative humidity                                                                                                                                                                                                                                                                                                 |
| Solder Test          | MIL-STD-202, Method 208, 8hr. aging                                                                                                                                                                                                                                                                                                                                              |
| Fungus               | MIL-STD-810C, Method 508.1                                                                                                                                                                                                                                                                                                                                                       |

## Basic Module Operation



**Figure 1** — Basic module operation requires fusing, grounding, bypassing capacitors.\* See [Design Guide & Applications Manual](#).

### Output Connections and Considerations

The permissible load current<sup>[e]</sup> must never be exceeded during normal, abnormal or test conditions. Converters subject to dynamic loading exceeding 25% of rated current must be reviewed by Vicor Applications Engineering to ensure that the converter will operate properly.

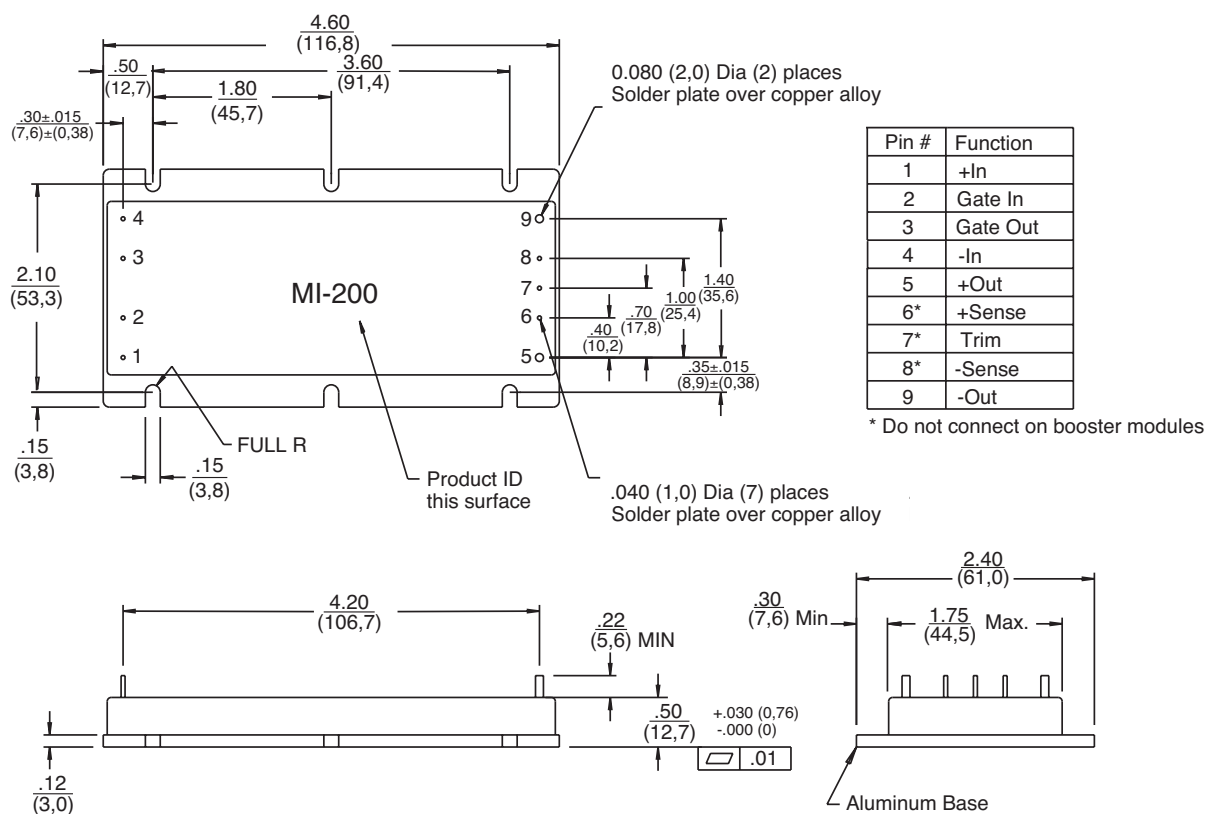
Under dynamic load, light load, or no load conditions, the converter may emit audible noise. Converters that utilize remote sense may require compensation circuitry to offset the phase lag caused by the external output leads and load impedance. Remote Sense leads must be protected for conditions such as lead reversal, noise pickup, open circuit, or excessive output lead resistance between the sense point and the converters output terminals. For applications that may draw more than the rated current, a fast acting electronic circuit breaker must be utilized to protect the converter. Under no circumstance should the rated current be exceeded. Utilizing or testing of current limit or short circuit current will damage the converter. Ensure that the total output capacitance connected to the converter does not exceed the limits on Page 4.

### Storage

Vicor products, when not installed in customer units, should be stored in ESD safe packaging in accordance with ANSI/ESD S20.20, "Protection of Electrical and Electronic Parts, Assemblies and Equipment" and should be maintained in a temperature controlled factory/warehouse environment not exposed to outside elements controlled between the temperature ranges of 15°C and 38°C. Humidity shall not be condensing, no minimum humidity when stored in an ESD compliant package.

<sup>[e]</sup> Permissible load current:  $\frac{\text{Nominal Power Rating}}{\text{Nominal } V_{OUT}}$

## Mechanical Drawing



**Note:** For alternate package options refer to the mechanical drawing page of vicorpower.com

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