

## FEATURES

- ▶ Industrial Standard DIP-24 Package
- ▶ Ultra-Wide 4:1 Input Voltage Range
- ▶ Fully Regulated Output Voltage
- ▶ I/O Isolation 4000VAC with Reinforced Insulation, rated for 1000Vrms Working Voltage
- ▶ Low I/O Leakage Current < 2μA
- ▶ Wide Operating Ambient Temp. Range
- ▶ Under-Voltage, Overload and Short Circuit Protection
- ▶ EMI EN 55011/32 Class A Approved
- ▶ Medical EMC Standard with 4<sup>th</sup> Edition of EMI EN 55011 and EMS EN 60601-1-2 Approved
- ▶ Medical Safety with 1xMOPP & 2xMOOP per 3.2 Edition of IEC/EN 60601-1 & ANSI/AAMI ES60601-1 Approved
- ▶ UL/cUL/IEC/EN 62368-1 Safety Approval & CE Marking



## PRODUCT OVERVIEW

The MIHW2000 series is a medical-grade isolated DC-DC converter family designed in an industry-standard DIP-24 package, delivering 3W output power with fully regulated voltages. It features an ultra-wide 4:1 input voltage range and provides reinforced insulation with 4000 VAC I/O isolation, rated for 1000 Vrms working voltage. With a low I/O leakage current of less than 2μA, the series is optimized for patient-connected medical applications requiring stringent safety standards.

Engineered for reliability, the MIHW2000 series supports a wide operating ambient temperature range and includes comprehensive protection functions such as under-voltage, overload, and short-circuit safeguards. It meets EMI requirements per EN 55011/32 Class A and complies with the 4th edition medical EMC standard EN 60601-1-2 for both EMI and EMS performance. Certified to medical safety standards with 1xMOPP and 2xMOOP in accordance with IEC/EN 60601-1 (3.2 edition) and ANSI/AAMI ES60601-1, and approved to UL/cUL/IEC/EN 62368-1 with CE marking, the MIHW2000 series delivers a safe, efficient, and standards-compliant power solution for critical medical and healthcare applications.

### Model Selection Guide

| Model Number | Input Voltage (Range) | Output Voltage | Output Current |       | Input Current |          | Reflected Ripple Current | Max. capacitive Load | Efficiency (typ.) |
|--------------|-----------------------|----------------|----------------|-------|---------------|----------|--------------------------|----------------------|-------------------|
|              |                       |                | Max.           | Min.  | @Max. Load    | @No Load |                          |                      | @Max. Load        |
|              | VDC                   | VDC            | mA             | mA    | mA(typ.)      | mA(typ.) | mA (typ.)                | μF                   | %                 |
| MIHW2022     | 24<br>(9 ~ 40)        | 5              | 600            | 90    | 160           | 20       | 15                       | 1000                 | 78                |
| MIHW2023     |                       | 12             | 250            | 37.5  | 151           |          |                          | 470                  | 83                |
| MIHW2026     |                       | ±12            | ±125           | ±18.8 | 151           |          |                          | 220#                 | 83                |
| MIHW2027     |                       | ±15            | ±100           | ±15   | 151           |          |                          | 220#                 | 83                |
| MIHW2032     | 48<br>(18 ~ 80)       | 5              | 600            | 90    | 80            | 10       | 8                        | 1000                 | 78                |
| MIHW2033     |                       | 12             | 250            | 37.5  | 75            |          |                          | 470                  | 83                |
| MIHW2036     |                       | ±12            | ±125           | ±18.8 | 75            |          |                          | 220#                 | 83                |
| MIHW2037     |                       | ±15            | ±100           | ±15   | 75            |          |                          | 220#                 | 83                |
| MIHW2042     | 110<br>(36 ~ 160)     | 5              | 600            | 90    | 35            | 5        | 3                        | 1000                 | 78                |
| MIHW2043     |                       | 12             | 250            | 37.5  | 33            |          |                          | 470                  | 83                |
| MIHW2046     |                       | ±12            | ±125           | ±18.8 | 33            |          |                          | 220#                 | 83                |
| MIHW2047     |                       | ±15            | ±100           | ±15   | 33            |          |                          | 220#                 | 83                |

# For each output

**Input Specifications**

| Input Specifications              |                   |                  |      |      |      |
|-----------------------------------|-------------------|------------------|------|------|------|
| Parameter                         | Model             | Min.             | Typ. | Max. | Unit |
| Input Surge Voltage (1 sec. max.) | 24V Input Models  | -0.7             | ---  | 50   | VDC  |
|                                   | 48V Input Models  | -0.7             | ---  | 100  |      |
|                                   | 110V Input Models | -0.7             | ---  | 180  |      |
| Start-Up Threshold Voltage        | 24V Input Models  | 8                | 8.5  | 9    |      |
|                                   | 48V Input Models  | 13               | 15   | 17   |      |
|                                   | 110V Input Models | 26               | 30   | 34   |      |
| Under Voltage Shutdown            | 24V Input Models  | ---              | ---  | 8.5  |      |
|                                   | 48V Input Models  | ---              | ---  | 16   |      |
|                                   | 110V Input Models | ---              | ---  | 32   |      |
| Short Circuit Input Power         | All Models        | ---              | ---  | 2000 | mW   |
| Input Filter                      |                   | Internal Pi Type |      |      |      |

**Output Specifications**

| Parameter                       | Conditions / Model                  |                     | Min. | Typ.  | Max.  | Unit              |
|---------------------------------|-------------------------------------|---------------------|------|-------|-------|-------------------|
| Output Voltage Setting Accuracy |                                     |                     | ---  | ---   | ±1.0  | %Vnom.            |
| Output Voltage Balance          | Dual Output, Balanced Loads         |                     | ---  | ±0.5  | ±2.0  | %                 |
| Line Regulation                 | Vin=Min. to Max. @Full Load         |                     | ---  | ±0.3  | ±0.5  | %                 |
| Load Regulation                 | Io=25% to 100%                      |                     | ---  | ±0.5  | ±1.0  | %                 |
| Ripple & Noise                  | 0-20 MHz Bandwidth                  | 5V Output Models    | ---  | 75    | 100   | mV <sub>P-P</sub> |
|                                 |                                     | Other Output Models | ---  | 100   | 150   | mV <sub>P-P</sub> |
| Transient Recovery Time         | 25% Load Step Change <sub>(2)</sub> |                     | ---  | 150   | 500   | μs                |
| Transient Response Deviation    |                                     |                     | ---  | ±3    | ±6    | %                 |
| Temperature Coefficient         |                                     |                     | ---  | ±0.02 | ±0.05 | %/°C              |
| Over Load Protection            | Foldback                            |                     | 120  | 150   | ---   | %                 |
| Short Circuit Protection        | Continuous, Automatic Recovery      |                     |      |       |       |                   |

**Isolation, Safety Standards**

| Parameter                 | Conditions   | Min. | Typ. | Max. | Unit |
|---------------------------|--|------|------|------|------|
| I/O Isolation Voltage     | 60 Seconds<br>Reinforced insulation, rated for 1000Vrms working voltage                                | 4000 | ---  | ---  | VAC  |
| Leakage Current           | 240VAC, 60Hz   | ---  | ---  | 2    | μA   |
| I/O Isolation Resistance  | 500 VDC  | 10   | ---  | ---  | GΩ   |
| I/O Isolation Capacitance | 100kHz, 1V   | ---  | 7    | 13   | pF   |
| Safety Standards          | UL/cUL 62368-1, CSA C22.2 No. 62368-1  |      |      |      |      |
|                           | ANSI/AAMI ES60601-1, CAN/CSA-C22.2 No. 60601-1   |      |      |      |      |
|                           | IEC/EN 62368-1, IEC/EN 60601-1 3.2 Edition 1xMOPP & 2xMOOP   |      |      |      |      |
| Safety Approvals          | UL/cUL 62368-1 recognition(UL certificate), IEC/EN 62368-1(CB-report)                                  |      |      |      |      |
|                           | ANSI/AAMI ES60601-1 1xMOPP & 2xMOOP recognition(UL certificate), IEC/EN 60601-1 3.2 Edition(CB-report) |      |      |      |      |

**General Specifications**

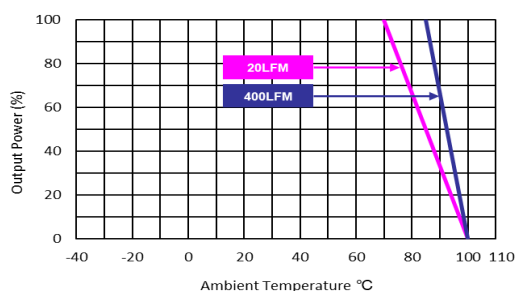
| Parameter           | Conditions                        | Min.      | Typ. | Max. | Unit  |
|---------------------|-----------------------------------|-----------|------|------|-------|
| Switching Frequency |                                   | ---       | 150  | ---  | kHz   |
| MTBF(calculated)    | MIL-HDBK-217F@25°C, Ground Benign | 1,000,000 | ---  | ---  | Hours |

**EMC Specifications**

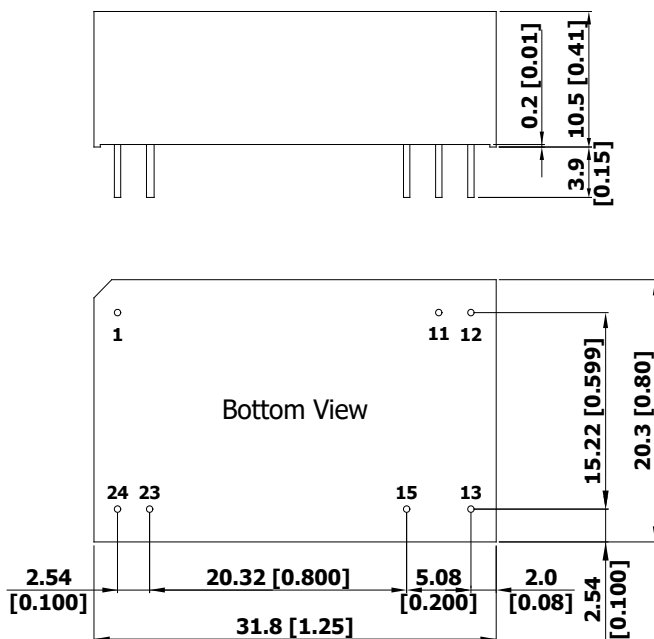
| EMC Specifications |   |  |  |                              |               |
|--------------------|---|--|--|------------------------------|---------------|
| Parameter          |   | Standards & Level                                |  |                              | Performance   |
| EMI                | Conduction  | EN 55011, EN 55032, EN 61000-6-3<br>EN 61000-6-4 |  | Without external components  | Class A       |
|                    | Radiation   |  |  |                              |               |
| EMS                | EN 60601-1-2 4 <sup>th</sup> , EN 55035, EN 61000-6-1, EN 61000-6-2 |  |  |                              |               |
|                    | ESD   | Direct discharge                                 |  | Indirect discharge HCP & VCP | A             |
|                    |   | EN 61000-4-2 Air ± 15kV                          |  |                              | Contact ± 8kV |
|                    | Radiated immunity   | EN 61000-4-3 10V/m                               |  |                              | A             |
|                    | Fast transient  | EN 61000-4-4 ±2kV                                |  |                              | A             |
|                    | Surge   | EN 61000-4-5 ±1kV                                |  |                              | A             |
|                    | Conducted immunity  | EN 61000-4-6 10Vrms                              |  |                              | A             |
|                    | PFMF  | EN 61000-4-8 100A/m.1000A/m(1 sec)               |  |                              | A             |

**Environmental Specifications**

| Parameter  | Min. | Max. | Unit     |
|--|------|------|----------|
| Operating Ambient Temperature Range (See Power Derating Curve) | -40  | +85  | °C       |
| Case Temperature   | ---  | +100 | °C       |
| Storage Temperature Range                                      | -50  | +125 | °C       |
| Humidity (non condensing)                                      | ---  | 95   | % rel. H |
| Lead Temperature (1.5mm from case for 10Sec.)                  | ---  | 260  | °C       |

**Power Derating Curve**

**Notes**

- Specifications typical at  $T_a = +25^\circ\text{C}$ , resistive load, nominal input voltage and rated output current unless otherwise noted.
- Transient recovery time is measured to within 1% error band for a step change in output load of 75% to 100%.
- Please do not operate the product without a minimum load condition.
- We recommend to protect the converter by a slow blow fuse in the input supply line.
- Other input and output voltage may be available, please contact MINMAX.
- Specifications are subject to change without notice.
- The repeated high voltage isolation testing of the converter can degrade isolation capability, to a lesser or greater degree depending on materials, construction, environment and reflow solder process. Any material is susceptible to eventual chemical degradation when subject to very high applied voltages thus implying that the number of tests should be strictly limited. We therefore strongly advise against repeated high voltage isolation testing, but if it is absolutely required, that the voltage be reduced by 20% from specified test voltage. Furthermore, the high voltage isolation capability after reflow solder process should be evaluated as it is applied on system.

**Package Specifications**
**Mechanical Dimensions**

**Pin Connections**

| Pin | Single Output | Dual Output | Diameter<br>mm (inches) |
|-----|---------------|-------------|-------------------------|
| 1   | +Vin          | +Vin        | Ø 0.6 [0.024]           |
| 11  | No Pin        | Common      | Ø 0.6 [0.024]           |
| 12  | -Vout         | No Pin      | Ø 0.6 [0.024]           |
| 13  | +Vout         | -Vout       | Ø 0.6 [0.024]           |
| 15  | No Pin        | +Vout       | Ø 0.6 [0.024]           |
| 23  | -Vin          | -Vin        | Ø 0.6 [0.024]           |
| 24  | -Vin          | -Vin        | Ø 0.6 [0.024]           |

► All dimensions in mm (inches)

► Tolerance: X.X±0.5 (X.XX±0.02)

X.XX±0.25 (X.XXX±0.010)

► Pin diameter tolerance: X.X±0.05 (X.XXX±0.002)

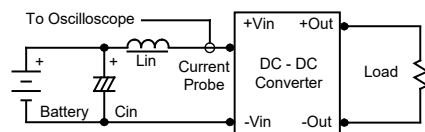
**Physical Characteristics**

|               |   |  |
|---------------|---|--|
| Case Size     | : | 31.8x20.3x10.5mm (1.25x0.8x0.41 inches)        |
| Case Material | : | Plastic resin (flammability to UL 94V-0 rated) |
| Pin Material  | : | Copper Alloy                                   |
| Weight        | : | 13.3g  |

## Test Setup

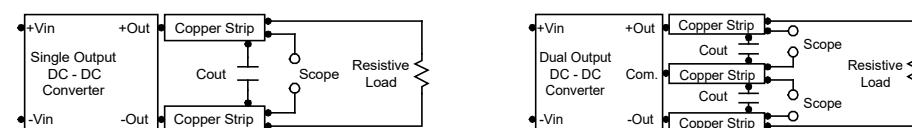
### Input Reflected-Ripple Current Test Setup

Input reflected-ripple current is measured with an inductor  $L_{in}$  (4.7 $\mu$ H) and  $C_{in}$  (220 $\mu$ F, ESR < 1.0 $\Omega$  at 100 kHz) to simulate source impedance. Capacitor  $C_{in}$  offsets possible battery impedance. Current ripple is measured at the input terminals of the module, measurement bandwidth is 0-500 kHz.



### Peak-to-Peak Output Noise Measurement Test

Use a  $C_{out}$  0.47 $\mu$ F ceramic capacitor. Scope measurement should be made by using a BNC socket, measurement bandwidth is 0-20 MHz. Position the load between 50 mm and 75 mm from the DC-DC Converter.



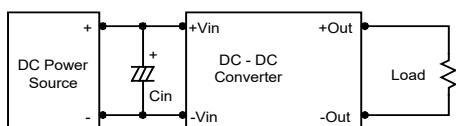
## Technical Notes

### Overload 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. The unit operates normally once the output current is brought back into its specified range.

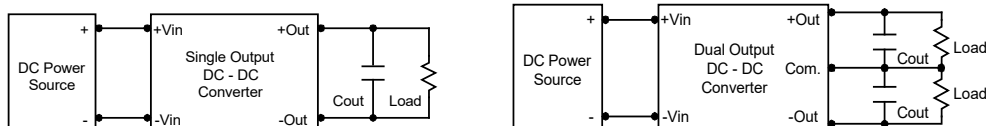
### Input Source Impedance

The power module should be connected to a low ac-impedance input source. Highly inductive source impedances can affect the stability of the power module. In applications where power is supplied over long lines and output loading is high, it may be necessary to use a capacitor on the input to insure startup. By using a good quality low Equivalent Series Resistance (ESR < 1.0 $\Omega$  at 100 kHz) capacitor of a 4.7 $\mu$ F for the 24V input devices, a 2.2 $\mu$ F for the 48V devices and a 1 $\mu$ F for the 110V devices, capacitor mounted close to the power module helps ensure stability of the unit.



### Output Ripple Reduction

A good quality low ESR capacitor placed as close as practicable across the load will give the best ripple and noise performance. To reduce output ripple, it is recommended to use 3.3 $\mu$ F capacitors at the output.



### Maximum Capacitive Load

The MIHW2000 series has limitation of maximum connected capacitance on the output. The power module may operate in current limiting mode during start-up, affecting the ramp-up and the startup time. Connect capacitors at the point of load for best performance. The maximum capacitance can be found in the data sheet.

### Thermal Considerations

Many conditions affect the thermal performance of the power module, such as orientation, airflow over the module and board spacing. To avoid exceeding the maximum temperature rating of the components inside the power module, the case temperature must be kept below 100°C. The derating curves are determined from measurements obtained in a test setup.

