



**MINMAX<sup>®</sup>**

MAU01M Series

Electric Characteristic Note

# MAU01M Series EC Note

DC-DC CONVERTER 1W, Reinforced Insulation, Medical Safety

## Features

- ▶ Industrial Standard SIP-7 Package
- ▶ Unregulated Output Voltage
- ▶ I/O Isolation 4000VAC with Reinforced Insulation, rated for 300Vrms Working Voltage
- ▶ Low I/O Leakage Current < 2μA
- ▶ Operating Ambient Temp. Range -40°C to 95°C
- ▶ Short Circuit Protection
- ▶ Medical EMC Standard with 4<sup>th</sup> Edition of EMI EN 55011 and EMS EN 60601-1-2 Approved
- ▶ Medical Safety with 2xMOPP per 3<sup>rd</sup> Edition of IEC/EN 60601-1 & ANSI/AAMI ES60601-1 Approved with CE Marking



## Applications

- ▶ Distributed power architectures
- ▶ Workstations
- ▶ Computer equipment
- ▶ Communications equipment

## Product Overview

The MINMAX MAU01M series is a new range of medical approved 1W isolated DC-DC converter within encapsulated SIP-7 package which specifically design for medical applications. There are 9 models available for input voltage of 5, 12, 24VDC and 5, 12, 15VDC output. The I/O isolation is specified for 4000VAC with reinforced insulation, which rated for 300Vrms working voltage. Further features include short circuit protection, low I/O leakage current 2μA max and operating ambient temp. range by -40°C to 95°C without derating. MAU01M series conform to 4<sup>th</sup> edition medical EMC standard, medical safety approval with 2xMOPP (Means Of Patient Protection) per 3<sup>rd</sup> edition of IEC/EN 60601-1 & ANSI/AAMI ES 60601-1. The MAU01M series offer the best solution for demanding applications in medical instrument requesting a certified supplementary and reinforced insulation system to comply with latest medical safety approval for 2xMOPP requirement.

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**Model Selection Guide**

| Model Number        | Input Voltage (Range) | Output Voltage | Output Current |      | Input Current |          | Max. capacitive Load | Efficiency (typ.) |
|---------------------|-----------------------|----------------|----------------|------|---------------|----------|----------------------|-------------------|
|                     |                       |                | Max.           | Min. | @Max. Load    | @No Load |                      | @Max. Load        |
|                     | VDC                   | VDC            | mA             | mA   | mA(typ.)      | mA(typ.) | μF                   | %                 |
| <b>MAU01-05S05M</b> | 5<br>(4.5 ~ 5.5)      | 5              | 200            | 4    | 253           | 50       | 220                  | 79                |
| <b>MAU01-05S12M</b> |                       | 12             | 84             | 1.68 | 252           |          |                      | 80                |
| <b>MAU01-05S15M</b> |                       | 15             | 68             | 1.36 | 252           |          |                      | 81                |
| <b>MAU01-12S05M</b> | 12<br>(10.8 ~ 13.2)   | 5              | 200            | 4    | 105           | 35       | 220                  | 79                |
| <b>MAU01-12S12M</b> |                       | 12             | 84             | 1.68 | 104           |          |                      | 81                |
| <b>MAU01-12S15M</b> |                       | 15             | 68             | 1.36 | 108           |          |                      | 79                |
| <b>MAU01-24S05M</b> | 24<br>(21.6 ~ 26.4)   | 5              | 200            | 4    | 55            | 20       | 220                  | 76                |
| <b>MAU01-24S12M</b> |                       | 12             | 84             | 1.68 | 53            |          |                      | 79                |
| <b>MAU01-24S15M</b> |                       | 15             | 68             | 1.36 | 54            |          |                      | 79                |

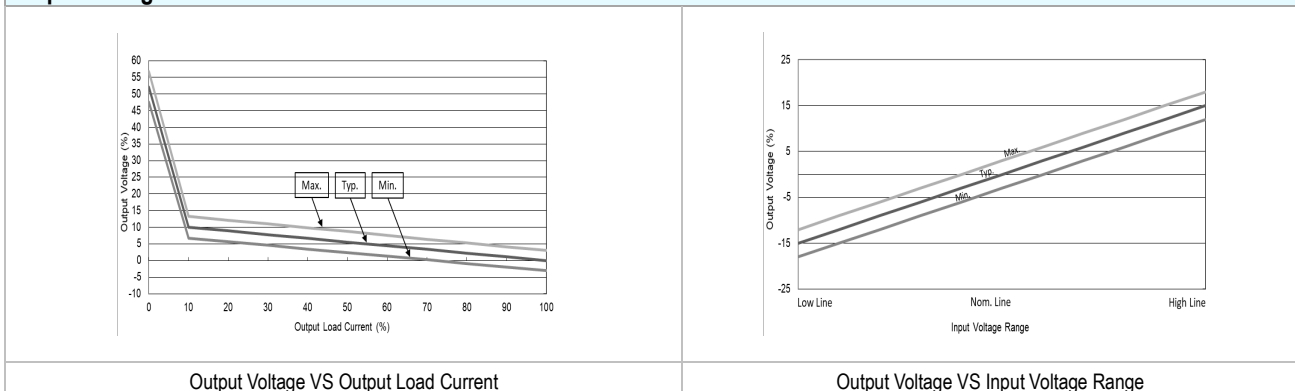
\* Min. Output Current for Lower Load Regulation

**Input Specifications**

| Parameter                         | Model            | Min.               | Typ. | Max. | Unit |
|-----------------------------------|------------------|--------------------|------|------|------|
| Input Voltage Range               | 5V Input Models  | 4.5                | 5    | 5.5  | VDC  |
|                                   | 12V Input Models | 10.8               | 12   | 13.2 |      |
|                                   | 24V Input Models | 21.6               | 24   | 26.4 |      |
| Input Surge Voltage (1 sec. max.) | 5V Input Models  | -0.7               | ---  | 9    | VDC  |
|                                   | 12V Input Models | -0.7               | ---  | 18   |      |
|                                   | 24V Input Models | -0.7               | ---  | 30   |      |
| Input Filter                      | All Models       | Internal Capacitor |      |      |      |

**Output Specifications**

| Parameter                       | Conditions                     | Min. | Typ.  | Max.  | Unit              |
|---------------------------------|--------------------------------|------|-------|-------|-------------------|
| Output Voltage Setting Accuracy |                                | ---  | ±1.0  | ±3.0  | %Vnom.            |
| Line Regulation                 | For Vin Change of 1%           | ---  | ±1.2  | ±1.5  | %                 |
| Load Regulation                 | Io=10% to 100%                 | ---  | ---   | ±10   | %                 |
| Ripple & Noise                  | 0-20 MHz Bandwidth             | ---  | ---   | 75    | mV <sub>P-P</sub> |
| Temperature Coefficient         |                                | ---  | ±0.01 | ±0.02 | %/°C              |
| Short Circuit Protection        | Continuous, Automatic Recovery |      |       |       |                   |

**Output Voltage Tolerance**


| Isolation, Safety Standards |  |      |      |      |      |
|-----------------------------|--|------|------|------|------|
| Parameter                   | Conditions   | Min. | Typ. | Max. | Unit |
| I/O Isolation Voltage       | 60 Seconds<br>Reinforced insulation, rated for 300Vrms working voltage                                       | 4000 | ---  | ---  | VAC  |
| Leakage Current             | 240VAC, 60Hz   | ---  | ---  | 2    | μA   |
| I/O Isolation Resistance    | 500 VDC  | 10   | ---  | ---  | GΩ   |
| I/O Isolation Capacitance   | 100kHz, 1V   | ---  | 20   | ---  | pF   |
| Safety Standards            | ANSI/AAMI ES 60601-1, CAN/CSA-C22.2 No. 60601-1<br>IEC/EN 60601-1 3 <sup>rd</sup> Edition 2xMOPP             |      |      |      |      |
| Safety Approvals            | ANSI/AAMI ES 60601-1 2xMOPP recognition (UL certificate), IEC/EN 60601-1 3 <sup>rd</sup> Edition (CB-report) |      |      |      |      |

| General Specifications |                                   |           |      |      |       |
|------------------------|-----------------------------------|-----------|------|------|-------|
| Parameter              | Conditions                        | Min.      | Typ. | Max. | Unit  |
| Switching Frequency    |                                   | ---       | 60   | ---  | kHz   |
| MTBF (calculated)      | MIL-HDBK-217F@25°C, Ground Benign | 4,373,058 | ---  | ---  | Hours |

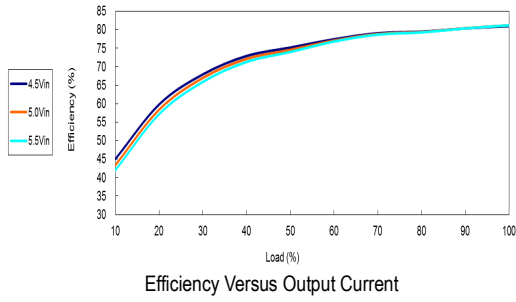
| EMC Specifications |                              |   |                          |                        |
|--------------------|------------------------------|---|--------------------------|------------------------|
| Parameter          | Standards & Level            |   |                          | Performance            |
| EMI                | Conduction                   | EN 55011                                | With external components | Class A <sub>(5)</sub> |
|                    | Radiation                    |   |                          |                        |
| EMS                | EN 60601-1-2 4 <sup>th</sup> |   |                          |                        |
|                    | ESD                          | EN 61000-4-2 Air ± 15kV , Contact ± 8kV |                          | A                      |
|                    | Radiated immunity            | EN 61000-4-3 10V/m                      |                          | A                      |
|                    | Fast transient (6)           | EN 61000-4-4 ±2kV                       |                          | A                      |
|                    | Surge (6)                    | EN 61000-4-5 ±1kV                       |                          | A                      |
|                    | Conducted immunity           | EN 61000-4-6 10Vrms                     |                          | A                      |
|                    | PFMF                         | EN 61000-4-8 30A/m                      |                          | A                      |

| Environmental Specifications                                   |      |      |          |  |
|--|------|------|----------|--|
| Parameter  | Min. | Max. | Unit     |  |
| Operating Ambient Temperature Range (See Power Derating Curve) | -40  | +95  | °C       |  |
| Case Temperature   | ---  | +105 | °C       |  |
| Storage Temperature Range                                      | -50  | +125 | °C       |  |
| Humidity (non condensing)                                      | ---  | 95   | % rel. H |  |
| Lead Temperature (1.5mm from case for 10Sec.)                  | ---  | 260  | °C       |  |

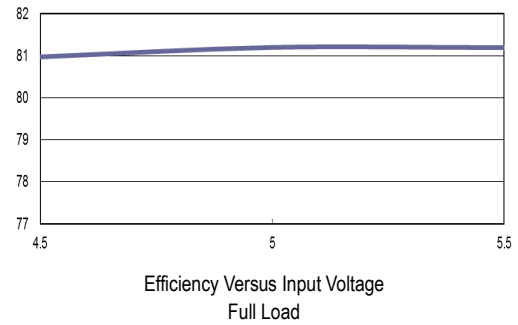
| Notes |   |
|-------|---|
| 1     | Specifications typical at Ta=+25°C, resistive load, nominal input voltage and rated output current unless otherwise noted.  |
| 2     | These power converters require a minimum output loading to maintain specified regulation, operation under no-load conditions will not damage these modules; however they may not meet all specifications listed.  |
| 3     | We recommend to protect the converter by a slow blow fuse in the input supply line.   |
| 4     | Other input and output voltage may be available, please contact MINMAX.   |
| 5     | To meet EN 55011 Class A an external filter, please contact MINMAX.   |
| 6     | To meet EN 61000-4-4 & EN 61000-4-5 an external capacitor across the input pins is required, please contact MINMAX.   |
| 7     | Specifications are subject to change without notice.  |
| 8     | 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 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. |

**Characteristic Curves**

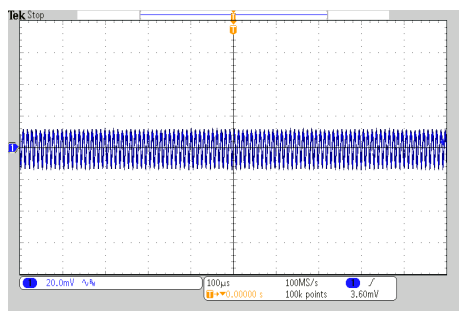
All test conditions are at 25°C The figures are identical for MAU01-05S05M



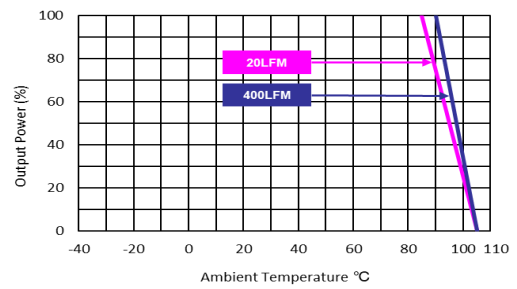
Efficiency Versus Output Current



Efficiency Versus Input Voltage Full Load



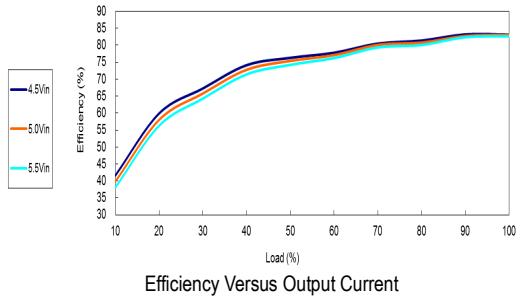
Typical Output Ripple and Noise  
 $V_{in} = V_{in\ nom}$ ; Full Load



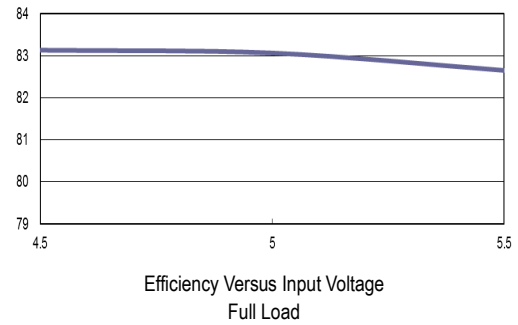
Derating Output Current Versus Ambient Temperature and Airflow  
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**Characteristic Curves**

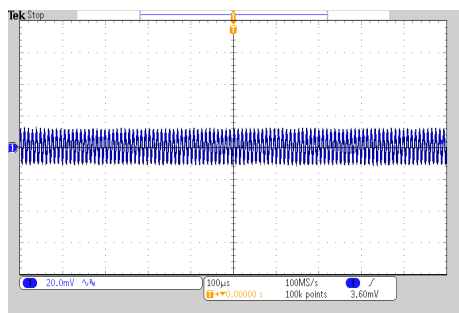
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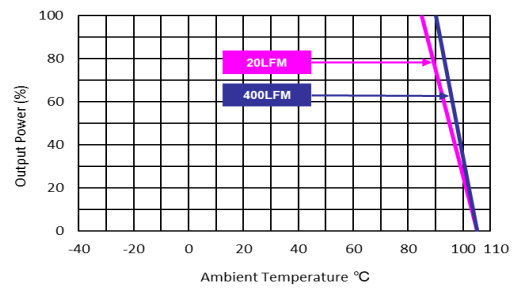
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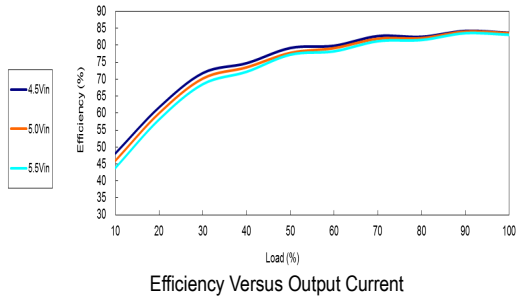
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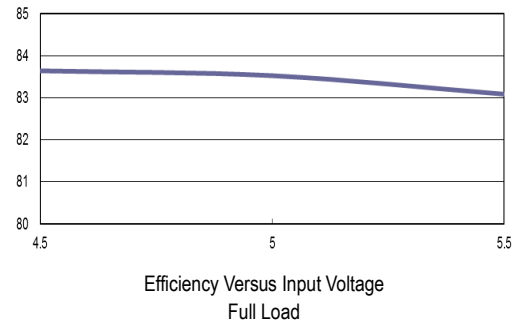
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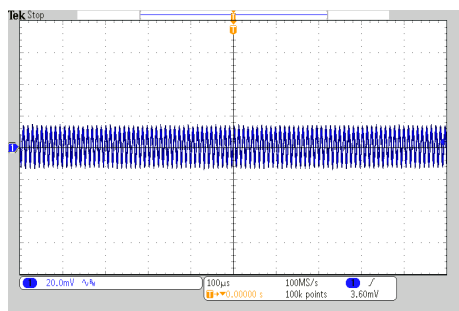
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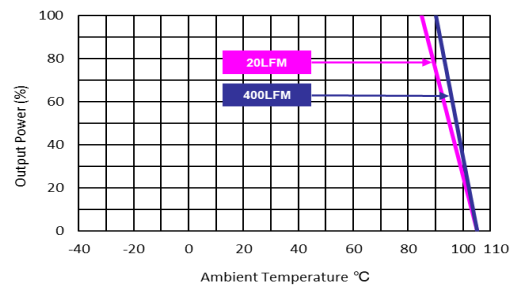
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Efficiency Versus Input Voltage Full Load



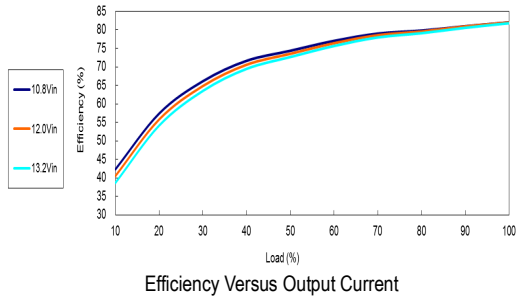
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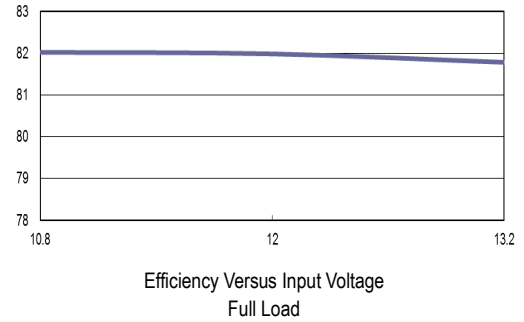
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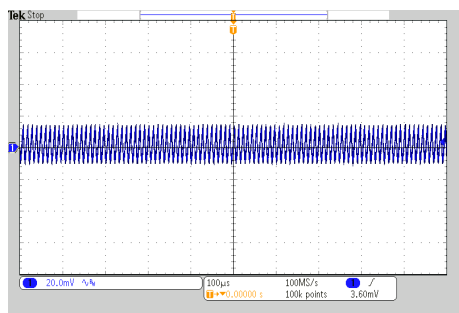
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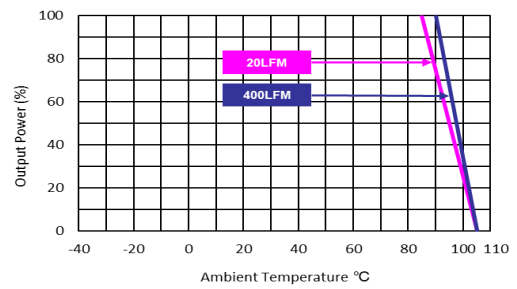
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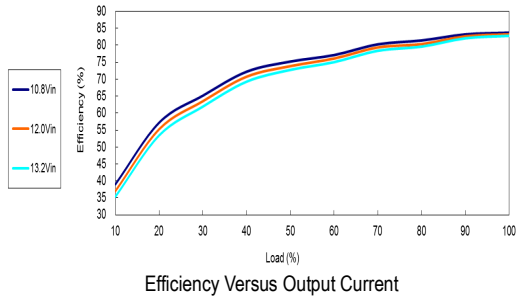
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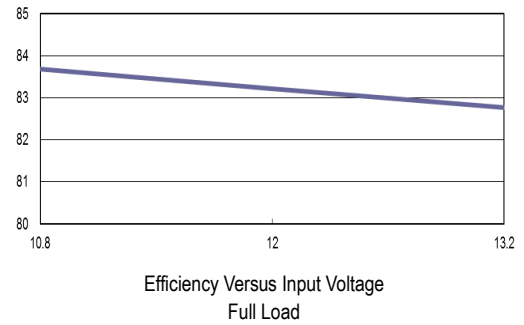
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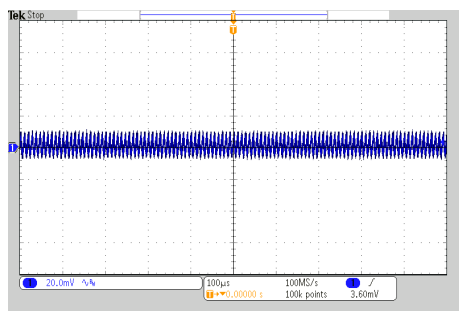
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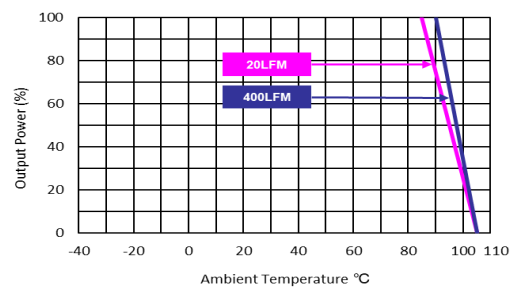
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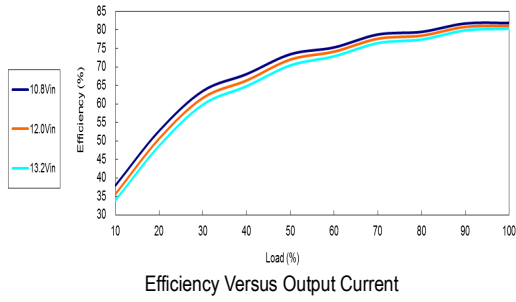
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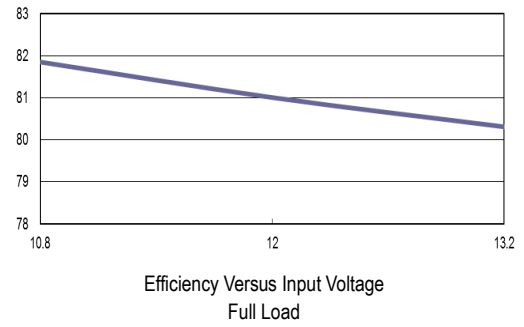
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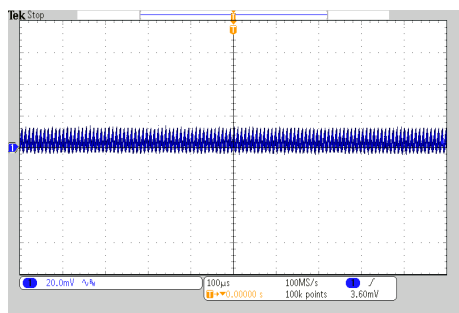
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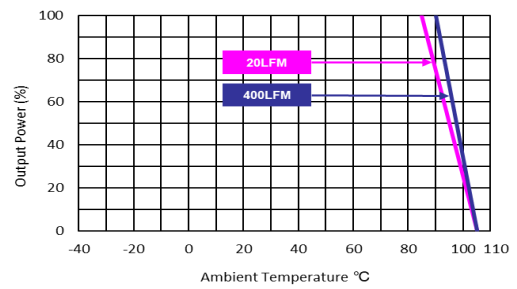
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Efficiency Versus Input Voltage Full Load



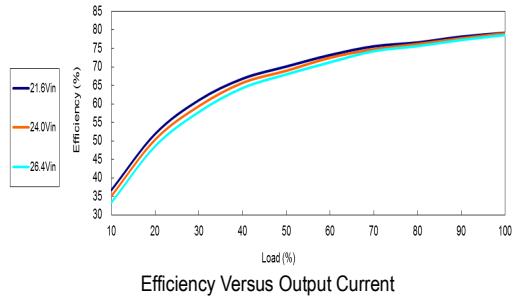
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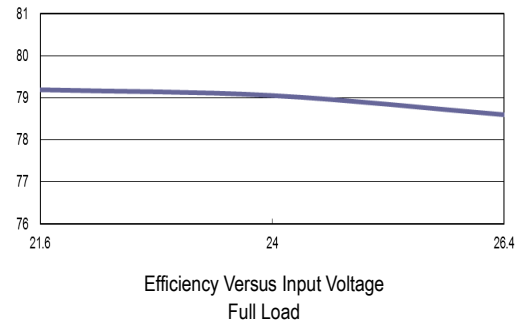
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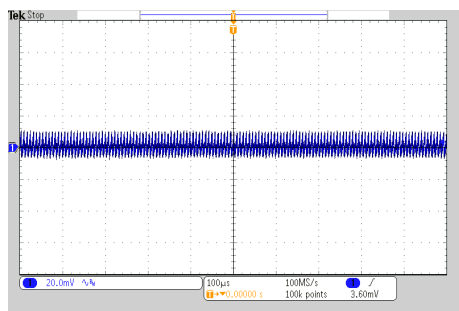
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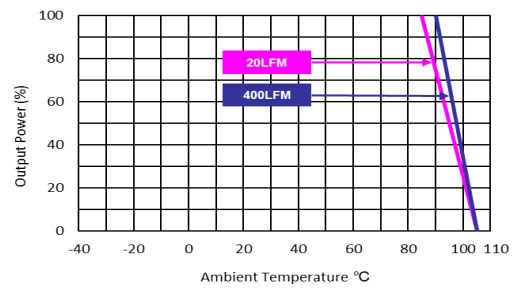
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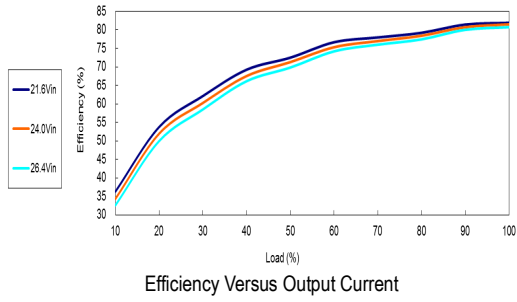
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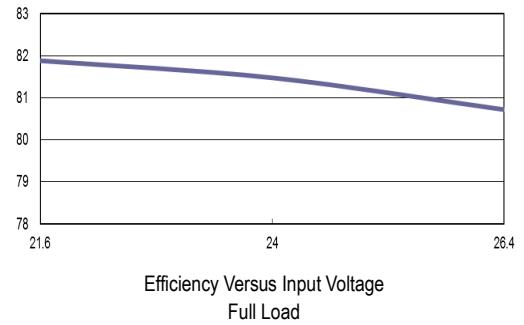
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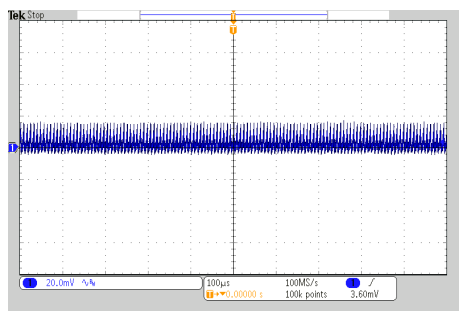
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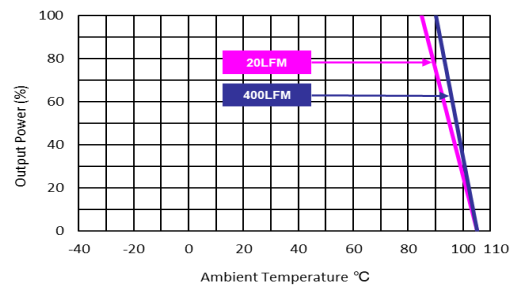
Efficiency Versus Output Current



Efficiency Versus Input Voltage Full Load



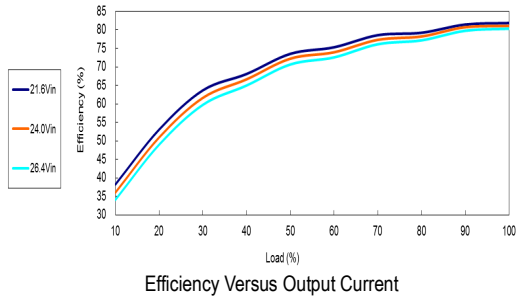
Typical Output Ripple and Noise  
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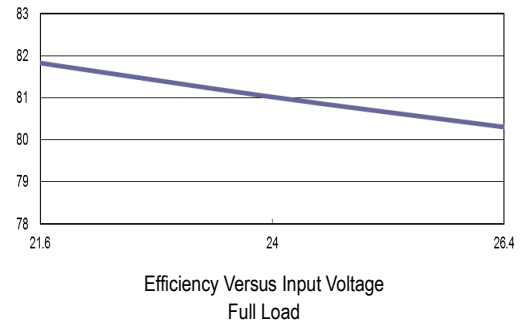
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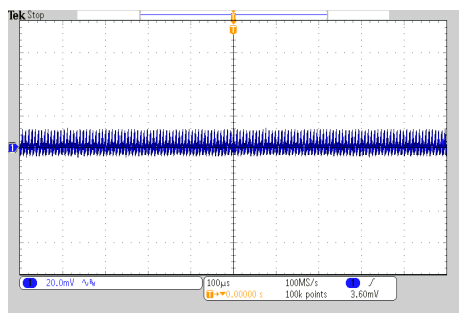
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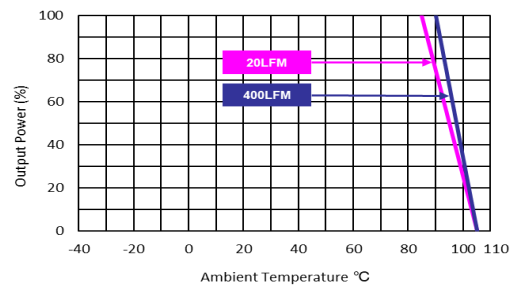
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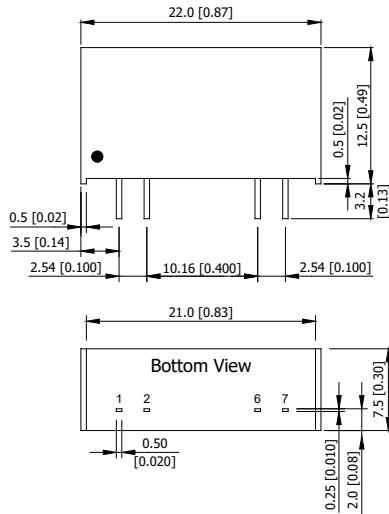
Typical Output Ripple and Noise  
 $V_{in} = V_{in\ nom}$ ; Full Load



Derating Output Current Versus Ambient Temperature and Airflow  
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### Package Specifications

#### Mechanical Dimensions



#### Pin Connection

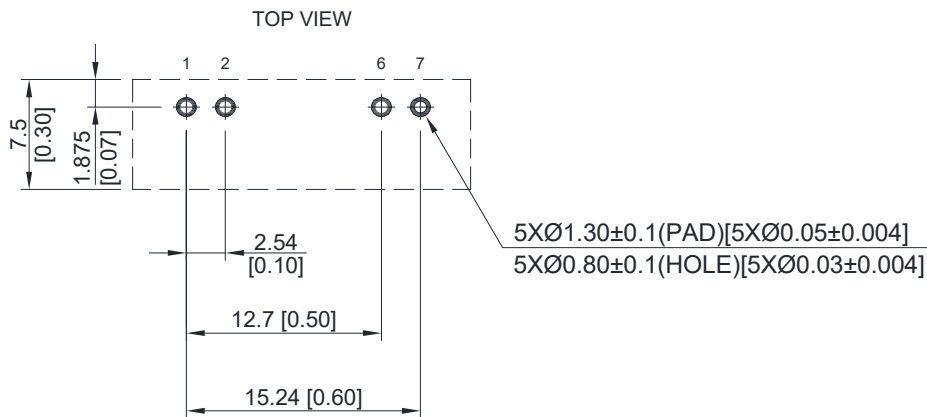
| Pin | Function |
|-----|----------|
| 1   | +Vin     |
| 2   | -Vin     |
| 6   | -Vout    |
| 7   | +Vout    |

- ▶ All dimensions in mm (inches)
- ▶ Tolerance: X.X±0.5 (X.XX±0.02)  
X.XX±0.25 (X.XXX±0.01)
- ▶ Pins ±0.05 (±0.002)

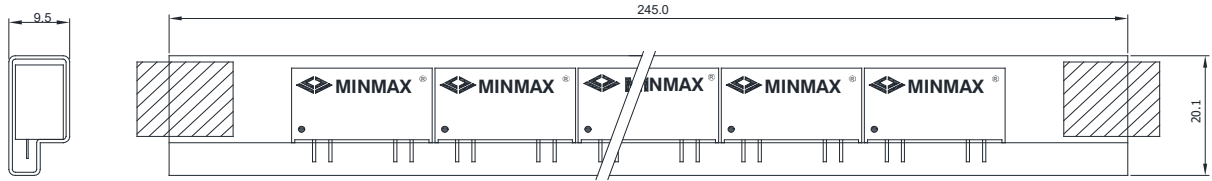
### Physical Characteristics

|               |  |
|---------------|--|
| Case Size     | : 22.0x7.5x12.5mm (0.87x0.30x0.49 inches)        |
| Case Material | : Plastic resin (flammability to UL 94V-0 rated) |
| Pin Material  | : Alloy 42                                       |
| Weight        | : 4.1g   |

### Recommended Pad Layout



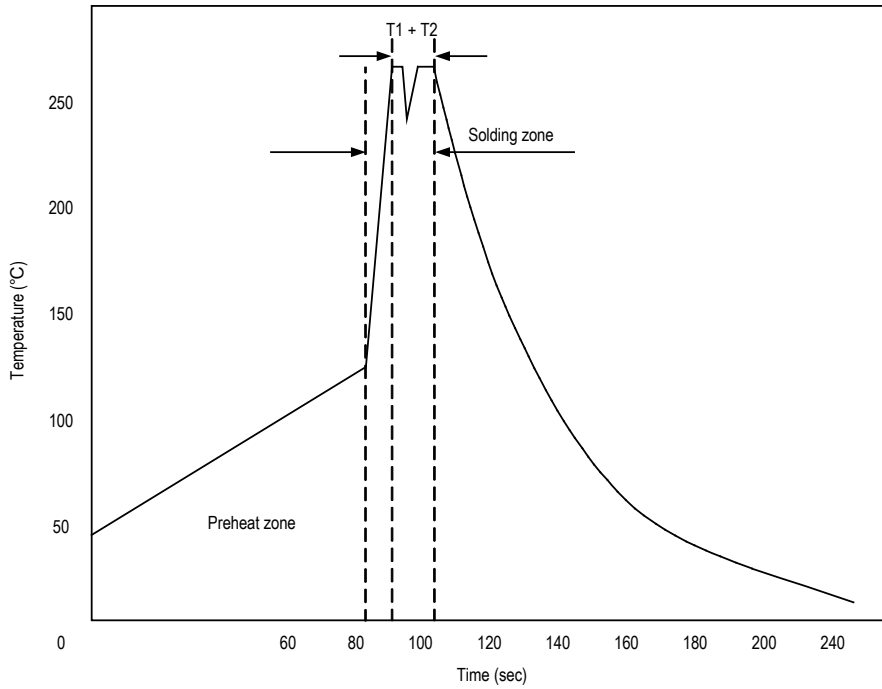
**Packaging Information**



Unit: mm  
10 PCS per TUBE

**Wave Soldering Considerations**

Lead free wave solder profile



| Zone    | Reference Parameter             |
|---------|---------------------------------|
| Preheat | Rise temp. speed : 3°C/sec max. |
| zone    | Preheat temp. : 100~130°C       |
| Actual  | Peak temp. : 250~260°C          |
| heating | Peak time(T1+T2) : 4~6 sec      |

**Hand Welding Parameter**

Reference Solder: Sn-Ag-Cu : Sn-Cu : Sn-Ag

Hand Welding: Soldering iron : Power 60W

Welding Time: 2~4 sec

Temp.: 380~400°C

**Part Number Structure**

|                       |                                  |                        |                     |   |           |                              |                |                        |
|-----------------------|----------------------------------|------------------------|---------------------|---|-----------|------------------------------|----------------|------------------------|
| <b>M</b>              | <b>A</b>                         | <b>U</b>               | <b>01</b>           | - | <b>05</b> | <b>S</b>                     | <b>05</b>      | <b>M</b>               |
| Package Type<br>SIP-7 | Output Regulation<br>Unregulated | Output Power<br>1 Watt | Input Voltage Range |   |           | Output Quantity<br>S: Single | Output Voltage | Application<br>Medical |
|                       |                                  |                        | 05: 4.5 ~ 5.5 VDC   |   |           |                              | 05: 5 VDC      |                        |
|                       |                                  |                        | 12: 10.8 ~ 13.2 VDC |   |           |                              | 12: 12 VDC     |                        |
|                       |                                  |                        | 24: 21.6 ~ 26.4 VDC |   |           |                              | 15: 15 VDC     |                        |

**MTBF and Reliability**

The MTBF of MAU01M series of DC-DC converters has been calculated using

MIL-HDBK 217F NOTICE2, Operating Temperature 25°C, Ground Benign.

| Model        | MTBF      | Unit  |
|--------------|-----------|-------|
| MAU01-05S05M | 4,573,386 | Hours |
| MAU01-05S12M | 4,629,678 |       |
| MAU01-05S15M | 4,681,932 |       |
| MAU01-12S05M | 4,573,298 |       |
| MAU01-12S12M | 4,695,408 |       |
| MAU01-12S15M | 4,548,605 |       |
| MAU01-24S05M | 4,373,058 |       |
| MAU01-24S12M | 4,563,621 |       |
| MAU01-24S15M | 4,548,908 |       |