



MINMAX[®]

MDHU100 Series

Electric Characteristic Note

MDHU100 Series EC Note

DC-DC CONVERTER 2W, Reinforced Insulation, Medical Safety

Features

- ▶ Industry Standard DIP-16 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 -25°C to +80°C
- ▶ Medical EMC Standard with 4th 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
- ▶ Risk Management Report Acquisition according to ISO 14971
- ▶ UL/cUL/IEC/EN 62368-1(60950-1) Safety Approval & CE Marking



Applications

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

Product Overview

Introducing the MINMAX MDHU100 series – 2W DC-DC isolated converters designed to meet stringent safety and performance standards. These modules provide an impressive high I/O isolation voltage of 4000 VAC with reinforced insulation, rated for a stable 300Vrms working voltage, all packaged in a compact SMD package.

Featuring 15 models with 5V, 12V, or 24VDC input options and offering single or dual output voltages, the MDHU100 series caters to a variety of application needs. This product stands out as the optimal solution for applications in instrumentation, industrial controls, medical equipment, and scenarios where a certified supplementary- or reinforced insulation system is imperative to comply with required safety standards.

The MDHU100 series is approved to IEC/EN/ES 60601-1 3rd edition for 1xMOPP & 2xMOOP and comes with an ISO 14971 Medical Device risk management file, ensuring not only adherence to high-performance standards but also compliance with strict safety benchmarks.

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Model Selection Guide

| Model Number | Input Voltage (Range) | Output Voltage | Output Current | Input Current | | Load Regulation | Max. Capacitive Load | Efficiency (typ.) |
|--------------|-----------------------|----------------|----------------|-------------------------|-----------------------|-----------------|----------------------|-------------------|
| | | | | Max. | @No Load | | | |
| | VDC | VDC | mA | @Max. Load mA (typ.) | @No Load mA (typ.) | % (max.) | µF | @Max. Load % |
| MDHU102 | 5 (4.5 ~ 5.5) | 5 | 400 | 606 | 60 | 12 | 330 | 66 |
| MDHU104 | | 12 | 165 | 600 | | 10 | | 66 |
| MDHU105 | | 15 | 133 | 605 | | 10 | | 66 |
| MDHU108 | | ±12 | ±83 | 553 | | 10 | 72 | |
| MDHU109 | | ±15 | ±66 | 542 | | 10 | 73 | |
| MDHU112 | 12 (10.8 ~ 13.2) | 5 | 400 | 253 | 30 | 12 | 330 | 66 |
| MDHU114 | | 12 | 165 | 250 | | 10 | | 66 |
| MDHU115 | | 15 | 133 | 252 | | 10 | | 66 |
| MDHU118 | | ±12 | ±83 | 224 | | 10 | 74 | |
| MDHU119 | | ±15 | ±66 | 220 | | 10 | 75 | |
| MDHU122 | 24 (21.6 ~ 26.4) | 5 | 400 | 126 | 15 | 12 | 330 | 66 |
| MDHU124 | | 12 | 165 | 125 | | 10 | | 66 |
| MDHU125 | | 15 | 133 | 126 | | 10 | | 66 |
| MDHU128 | | ±12 | ±83 | 112 | | 10 | 74 | |
| MDHU129 | | ±15 | ±66 | 110 | | 10 | 75 | |

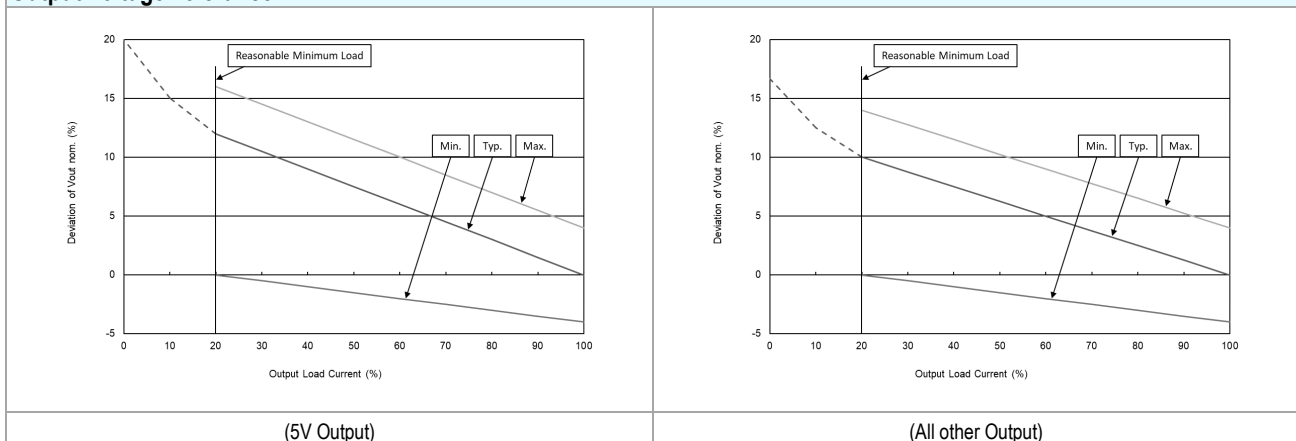
For each output

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 | | --- | ±2.0 | ±4.0 | %Vnom. |
| Output Voltage Balance | Dual Output, Balanced Loads | --- | ±0.1 | ±1.0 | % |
| Line Regulation | For Vin Change of 1% | --- | ±1.2 | ±1.5 | % |
| Load Regulation | Io=20% to 100% | See Model Selection Guide (Operation at lower load will not damage the converter, but it may not meet all specifications) | | | |
| Ripple & Noise | 0-20 MHz Bandwidth | --- | 100 | 150 | mV _{P-P} |
| Temperature Coefficient | | --- | ±0.01 | ±0.02 | %/°C |
| Short Circuit Protection | 0.5 Second Max., Automatic Recovery | | | | |

Output Voltage Tolerance


| Isolation, Safety Standards | | | | | |
|-----------------------------|---|------|------|------|------|
| Parameter | Conditions | Min. | Typ. | Max. | Unit |
| I/O Isolation Voltage | 60 Seconds | 4000 | --- | --- | VAC |
| | Reinforced insulation, rated for 300Vrms working voltage | | | | |
| Leakage Current | 240VAC, 60Hz | --- | --- | 2 | μA |
| I/O Isolation Resistance | 500 VDC | 10 | --- | --- | GΩ |
| I/O Isolation Capacitance | 100kHz, 1V | --- | 15 | 20 | pF |
| Safety Standards | UL/cUL 60950-1, CSA C22.2 No. 60950-1 | | | | |
| | ANSI/AAMI ES 60601-1, CAN/CSA-C22.2 No. 60601-1 | | | | |
| | IEC/EN 60950-1, IEC/EN 60601-1 3.2 Edition 1xMOPP & 2xMOOP | | | | |
| Safety Approvals | UL/cUL 60950-1 recognition (UL certificate), IEC/EN 60950-1 (CB-report) | | | | |
| | UL/cUL 62368-1 recognition (UL certificate), IEC/EN 62368-1 (CB-report) | | | | |
| | ANSI/AAMI ES 60601-1 1xMOPP & 2xMOOP recognition (UL certificate), IEC/EN 60601-1 3.2 Edition (CB-report) | | | | |

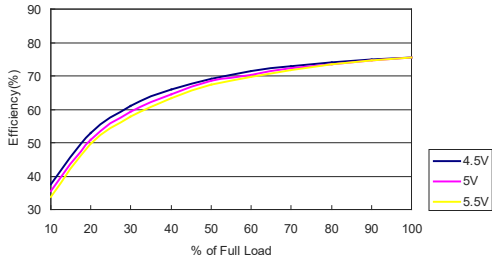
| General Specifications | | | | | |
|------------------------|-----------------------------------|-----------|------|------|-------|
| Parameter | Conditions | Min. | Typ. | Max. | Unit |
| Switching Frequency | | 50 | 80 | 100 | kHz |
| MTBF (calculated) | MIL-HDBK-217F@25°C, Ground Benign | 2,000,000 | --- | --- | Hours |

| Environmental Specifications | | | | |
|--|------|------|----------|--|
| Parameter | Min. | Max. | Unit | |
| Operating Ambient Temperature Range (See Power Derating Curve) | -25 | +80 | °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 | |

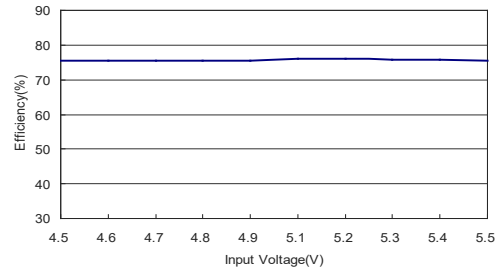
| Notes | |
|-------|---|
| 1 | Specifications typical at Ta=+25°C, resistive load, nominal input voltage and rated output current unless otherwise noted. |
| 2 | These power converters require a minimum output loading to maintain specified regulation, operation under no-load conditions will not damage 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 | Specifications are subject to change without notice. |
| 6 | 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. |

Characteristic Curves

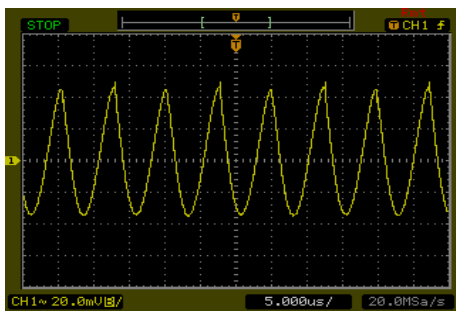
All test conditions are at 25°C The figures are identical for MDHU102



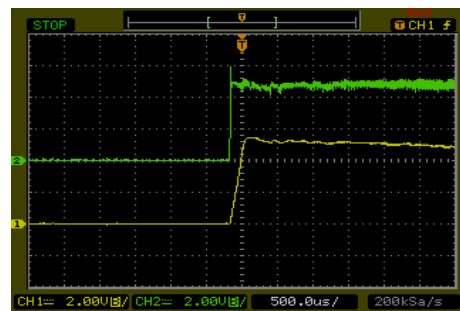
Efficiency Versus Output Current



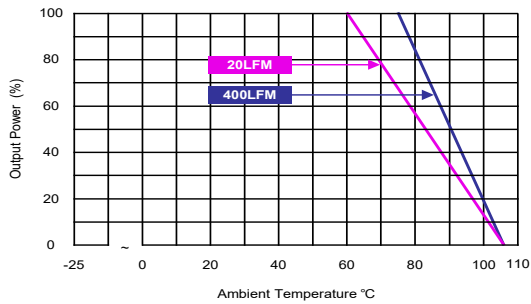
Efficiency Versus Input Voltage Full Load



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



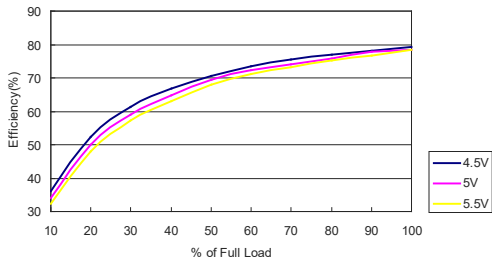
Typical Input Start-Up and Output Rise Characteristic
 $V_{in}=V_{in\ nom}$; Full Load



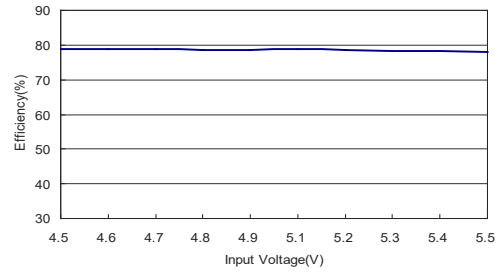
Derating Output Current Versus Ambient Temperature and Airflow
 $V_{in}=V_{in\ nom}$

Characteristic Curves

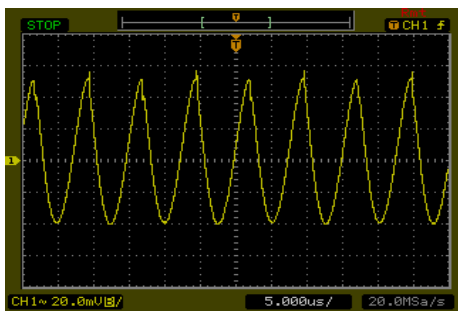
All test conditions are at 25°C The figures are identical for MDHU104



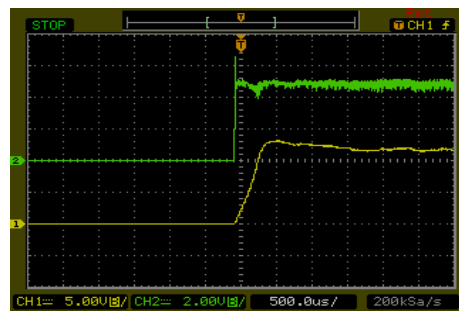
Efficiency Versus Output Current



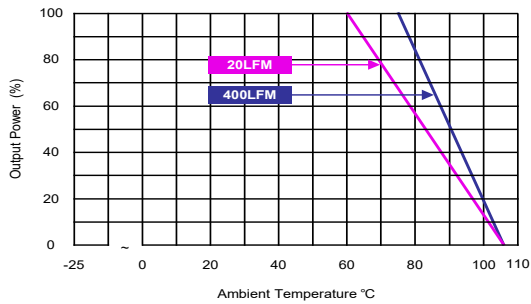
Efficiency Versus Input Voltage Full Load



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



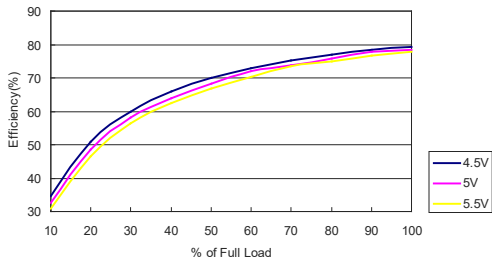
Typical Input Start-Up and Output Rise Characteristic
 $V_{in}=V_{in\ nom}$; Full Load



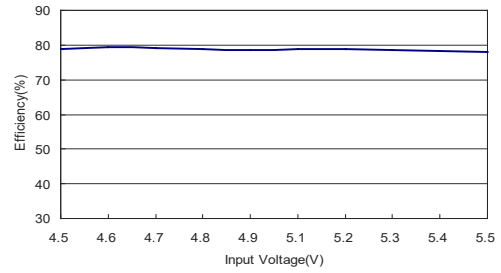
Derating Output Current Versus Ambient Temperature and Airflow
 $V_{in}=V_{in\ nom}$

Characteristic Curves

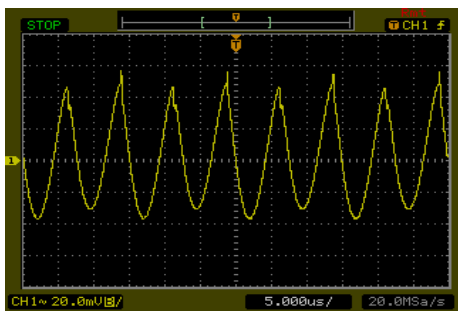
All test conditions are at 25°C The figures are identical for MDHU105



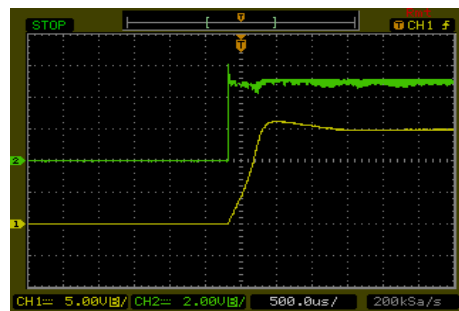
Efficiency Versus Output Current



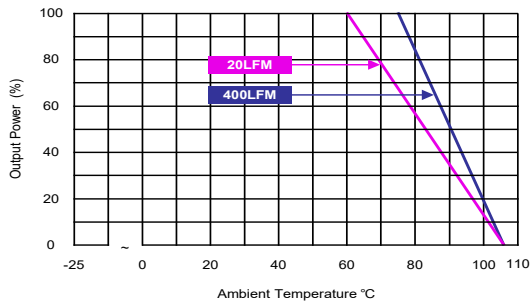
Efficiency Versus Input Voltage Full Load



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



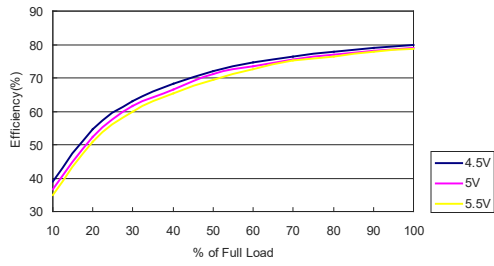
Typical Input Start-Up and Output Rise Characteristic
 $V_{in}=V_{in\ nom}$; Full Load



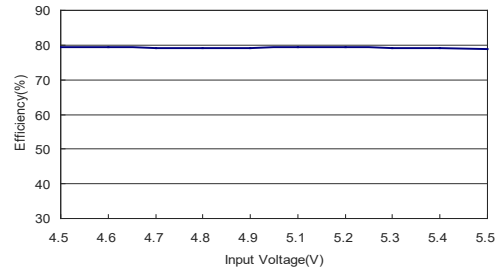
Derating Output Current Versus Ambient Temperature and Airflow
 $V_{in}=V_{in\ nom}$

Characteristic Curves

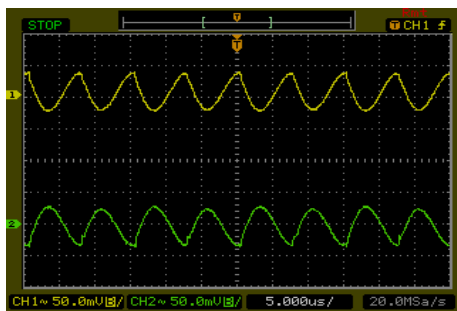
All test conditions are at 25°C The figures are identical for MDHU108



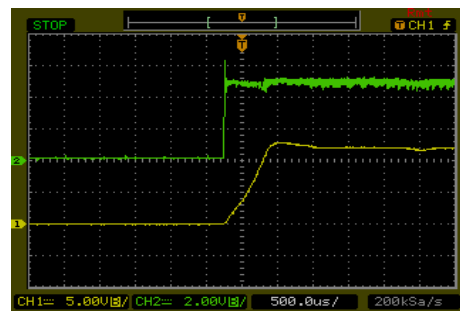
Efficiency Versus Output Current



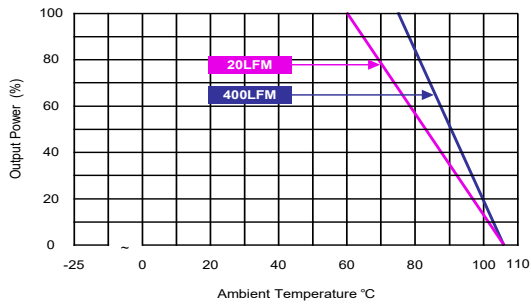
Efficiency Versus Input Voltage Full Load



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



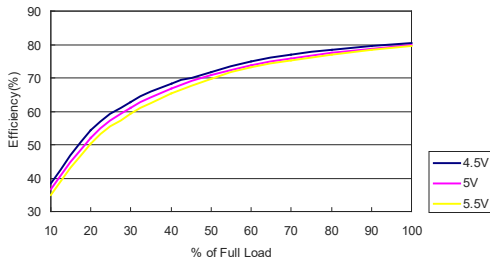
Typical Input Start-Up and Output Rise Characteristic
 $V_{in}=V_{in\ nom}$; Full Load



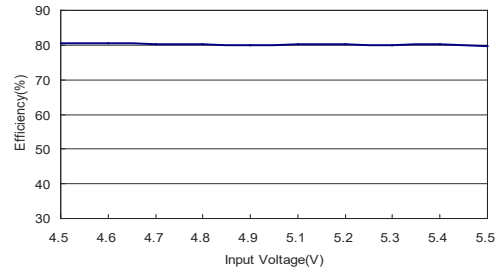
Derating Output Current Versus Ambient Temperature and Airflow
 $V_{in}=V_{in\ nom}$

Characteristic Curves

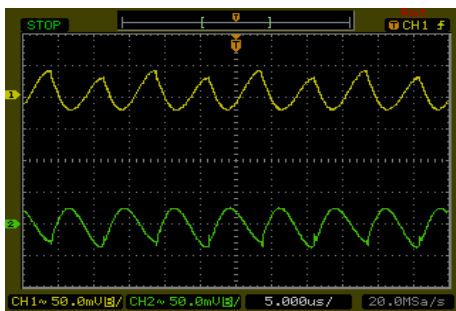
All test conditions are at 25°C The figures are identical for MDHU109



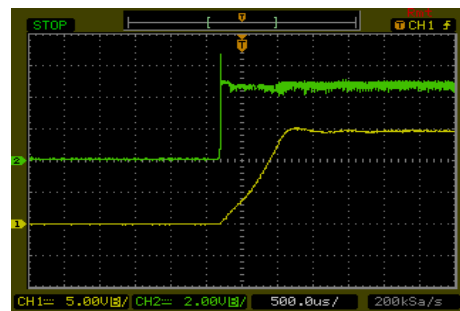
Efficiency Versus Output Current



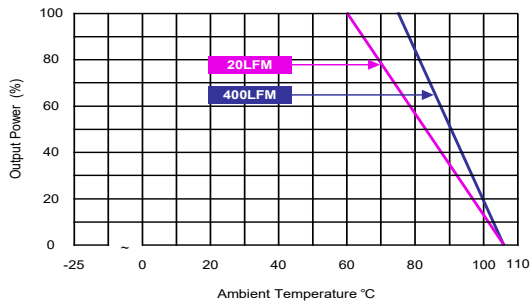
Efficiency Versus Input Voltage
Full Load



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



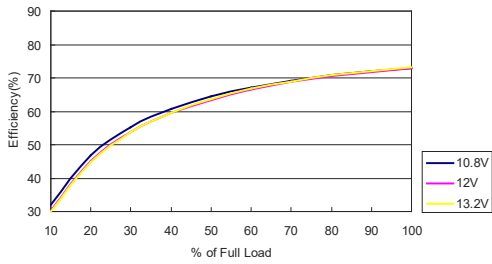
Typical Input Start-Up and Output Rise Characteristic
 $V_{in}=V_{in\ nom}$; Full Load



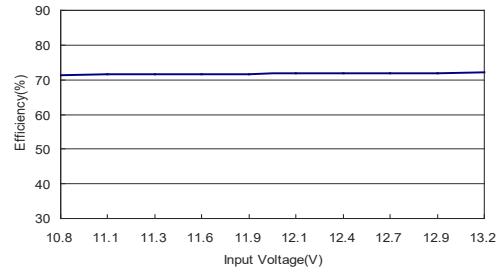
Derating Output Current Versus Ambient Temperature and Airflow
 $V_{in}=V_{in\ nom}$

Characteristic Curves

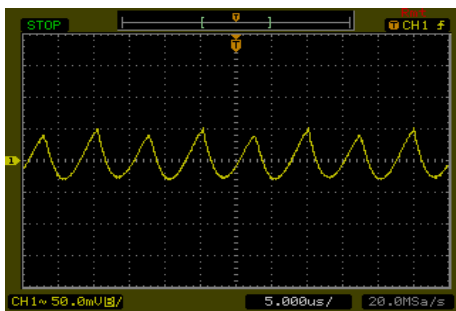
All test conditions are at 25°C The figures are identical for MDHU112



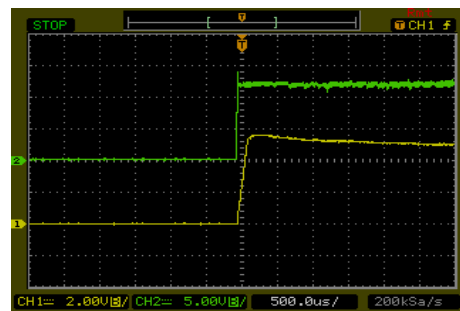
Efficiency Versus Output Current



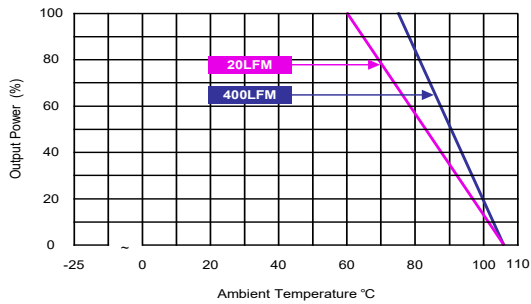
Efficiency Versus Input Voltage Full Load



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



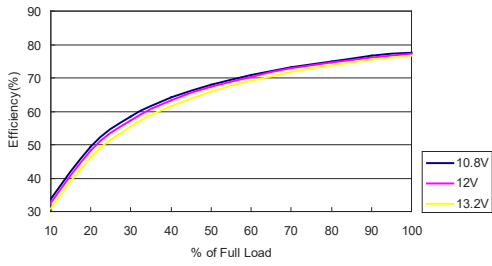
Typical Input Start-Up and Output Rise Characteristic
 $V_{in}=V_{in\ nom}$; Full Load



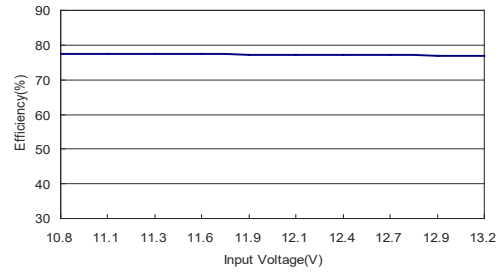
Derating Output Current Versus Ambient Temperature and Airflow
 $V_{in}=V_{in\ nom}$

Characteristic Curves

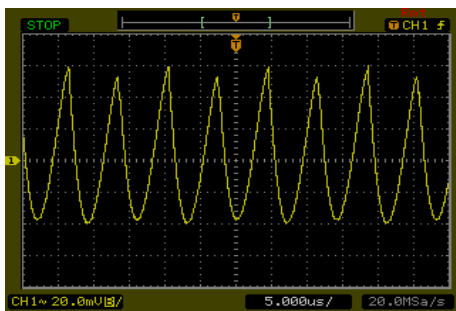
All test conditions are at 25°C The figures are identical for MDHU114



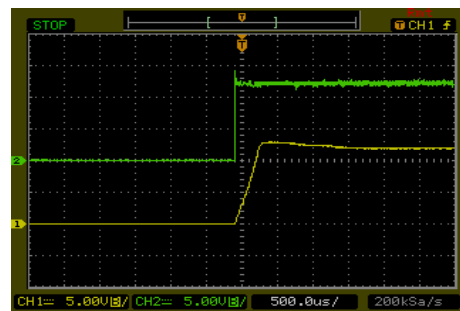
Efficiency Versus Output Current



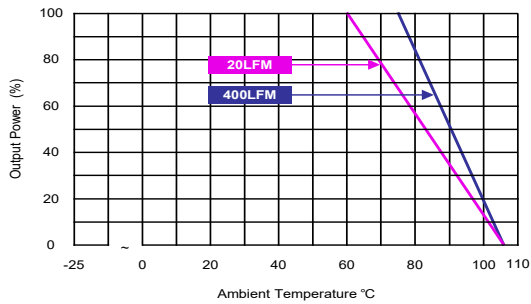
Efficiency Versus Input Voltage Full Load



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



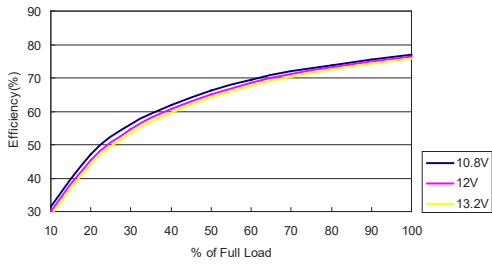
Typical Input Start-Up and Output Rise Characteristic
 $V_{in}=V_{in\ nom}$; Full Load



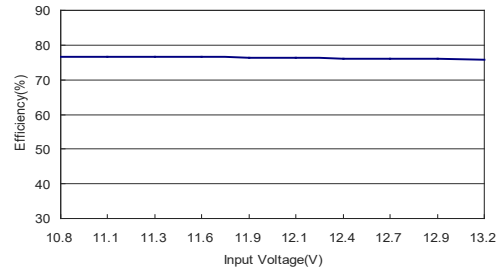
Derating Output Current Versus Ambient Temperature and Airflow
 $V_{in}=V_{in\ nom}$

Characteristic Curves

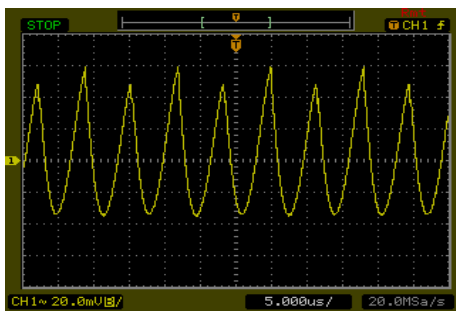
All test conditions are at 25°C The figures are identical for MDHU115



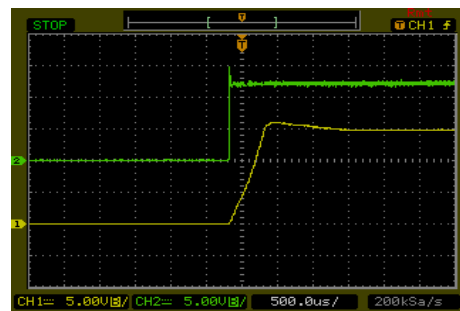
Efficiency Versus Output Current



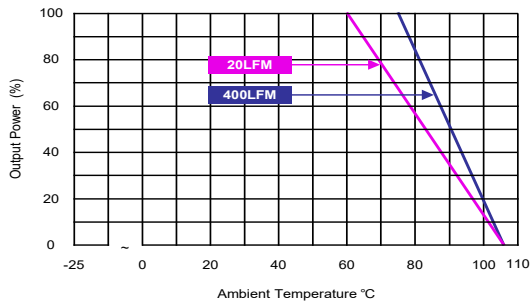
Efficiency Versus Input Voltage Full Load



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



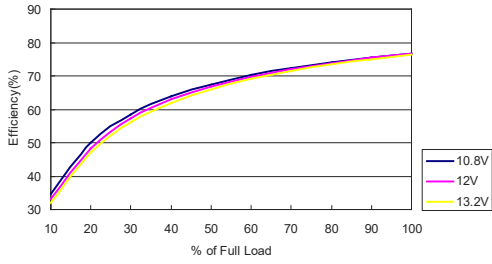
Typical Input Start-Up and Output Rise Characteristic
 $V_{in}=V_{in\ nom}$; Full Load



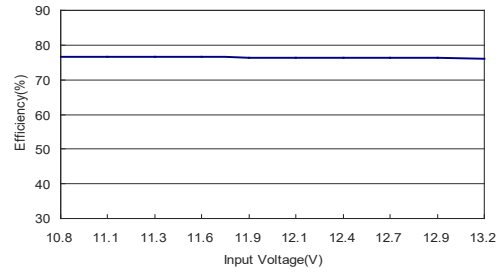
Derating Output Current Versus Ambient Temperature and Airflow
 $V_{in}=V_{in\ nom}$

Characteristic Curves

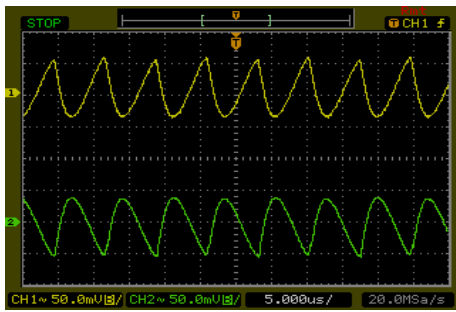
All test conditions are at 25°C The figures are identical for MDHU118



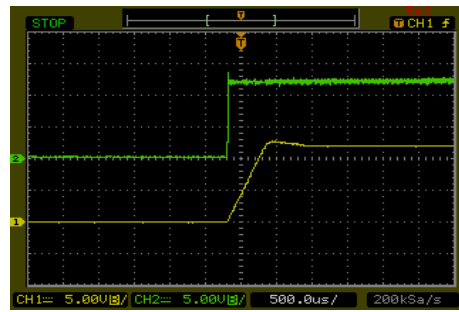
Efficiency Versus Output Current



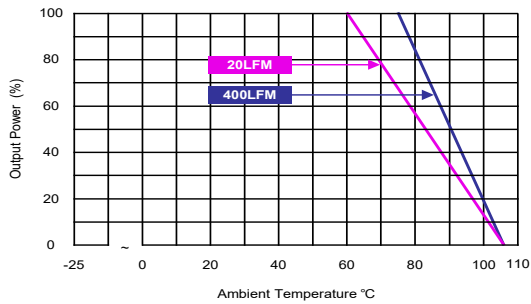
Efficiency Versus Input Voltage Full Load



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



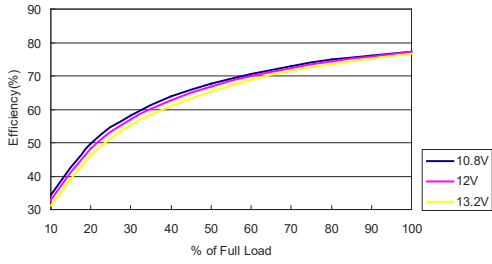
Typical Input Start-Up and Output Rise Characteristic
 $V_{in}=V_{in\ nom}$; Full Load



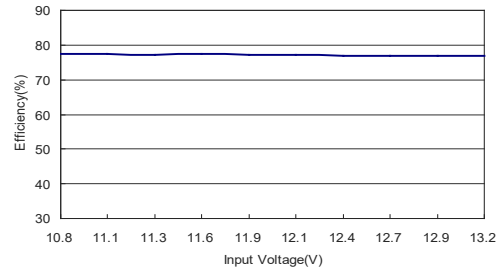
Derating Output Current Versus Ambient Temperature and Airflow
 $V_{in}=V_{in\ nom}$

Characteristic Curves

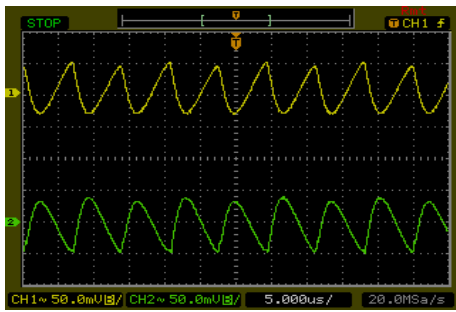
All test conditions are at 25°C The figures are identical for MDHU119



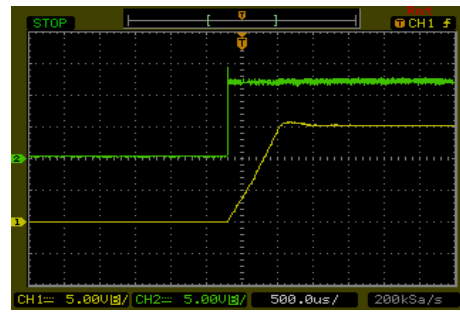
Efficiency Versus Output Current



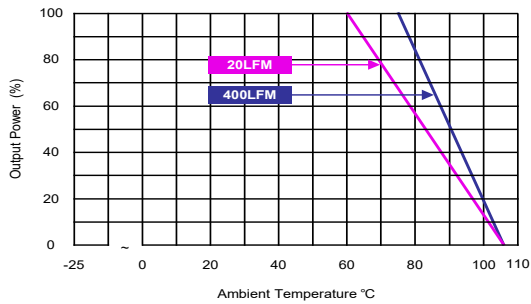
Efficiency Versus Input Voltage Full Load



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



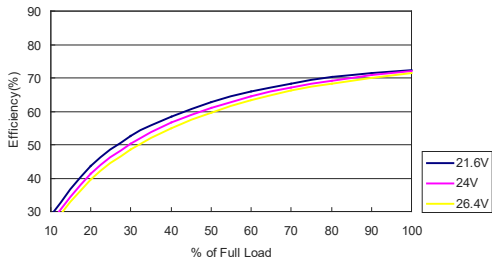
Typical Input Start-Up and Output Rise Characteristic
 $V_{in}=V_{in\ nom}$; Full Load



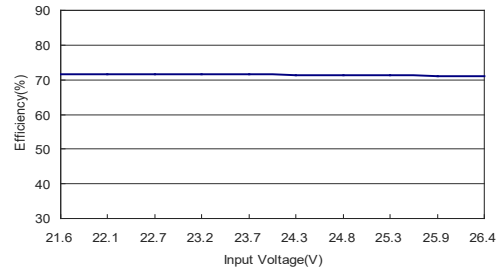
Derating Output Current Versus Ambient Temperature and Airflow
 $V_{in}=V_{in\ nom}$

Characteristic Curves

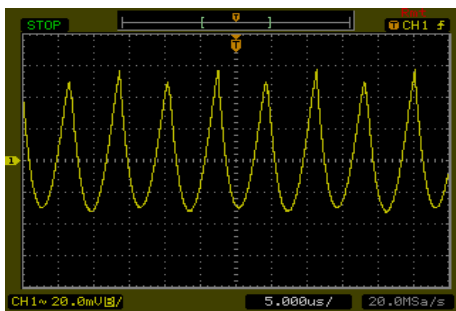
All test conditions are at 25°C The figures are identical for MDHU122



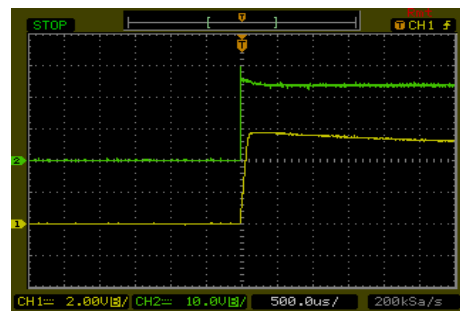
Efficiency Versus Output Current



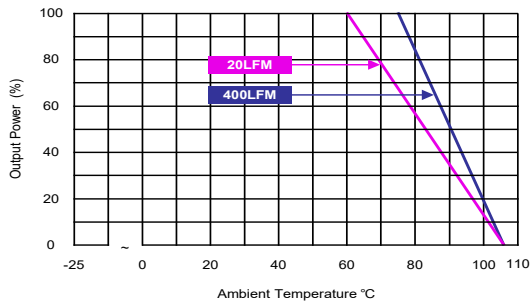
Efficiency Versus Input Voltage Full Load



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



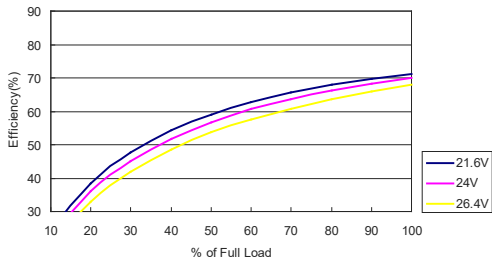
Typical Input Start-Up and Output Rise Characteristic
 $V_{in}=V_{in\ nom}$; Full Load



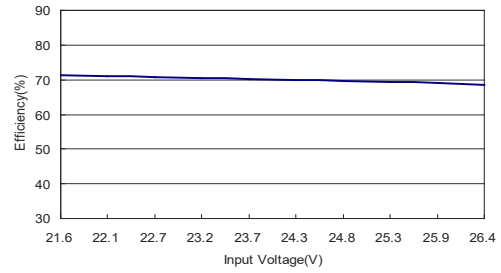
Derating Output Current Versus Ambient Temperature and Airflow
 $V_{in}=V_{in\ nom}$

Characteristic Curves

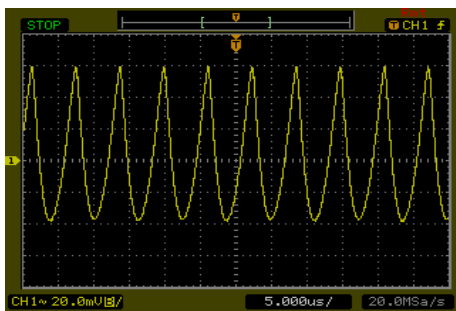
All test conditions are at 25°C The figures are identical for MDHU124



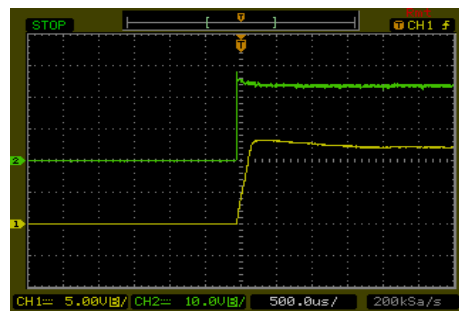
Efficiency Versus Output Current



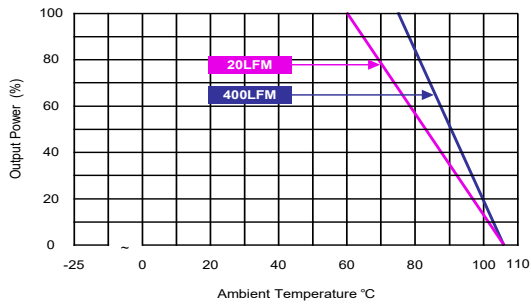
Efficiency Versus Input Voltage Full Load



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



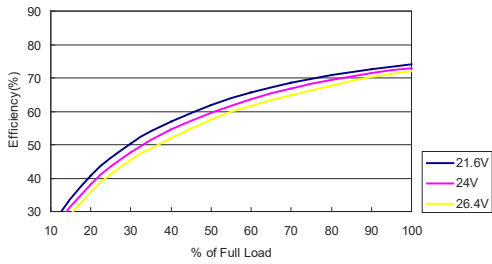
Typical Input Start-Up and Output Rise Characteristic
 $V_{in}=V_{in\ nom}$; Full Load



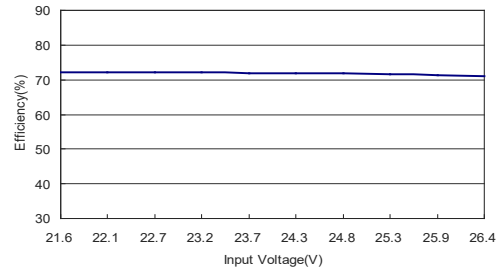
Derating Output Current Versus Ambient Temperature and Airflow
 $V_{in}=V_{in\ nom}$

Characteristic Curves

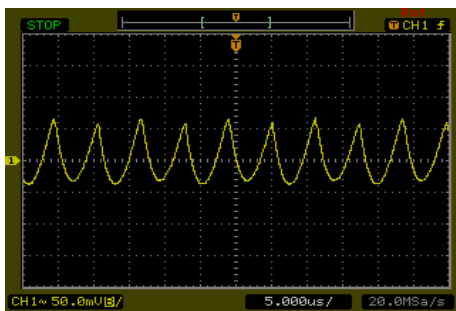
All test conditions are at 25°C The figures are identical for MDHU125



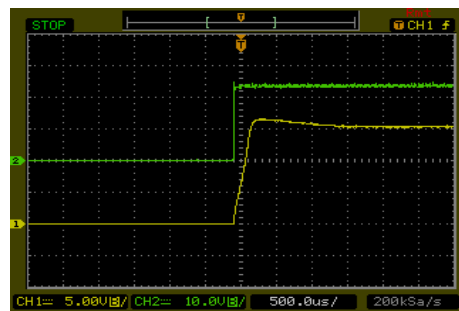
Efficiency Versus Output Current



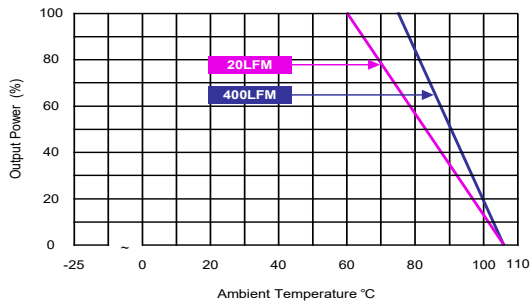
Efficiency Versus Input Voltage Full Load



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



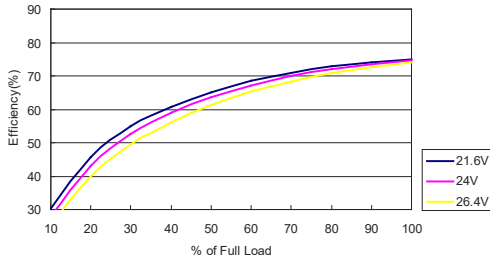
Typical Input Start-Up and Output Rise Characteristic
 $V_{in}=V_{in\ nom}$; Full Load



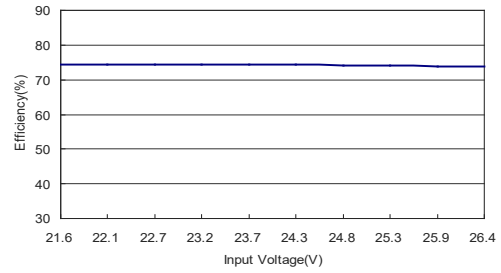
Derating Output Current Versus Ambient Temperature and Airflow
 $V_{in}=V_{in\ nom}$

Characteristic Curves

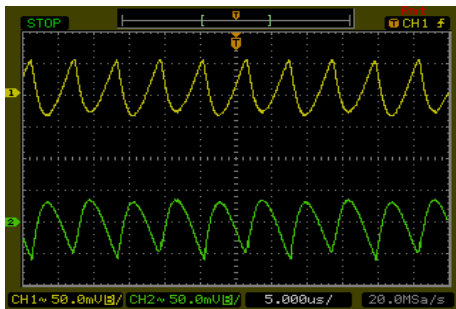
All test conditions are at 25°C The figures are identical for MDHU128



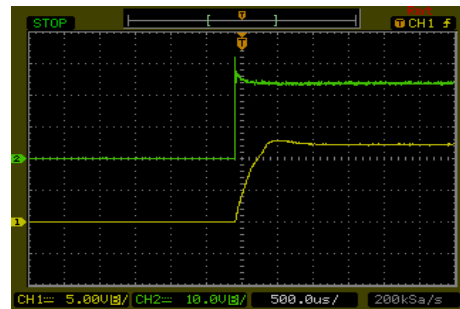
Efficiency Versus Output Current



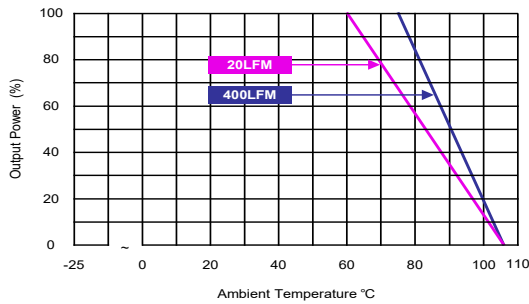
Efficiency Versus Input Voltage Full Load



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



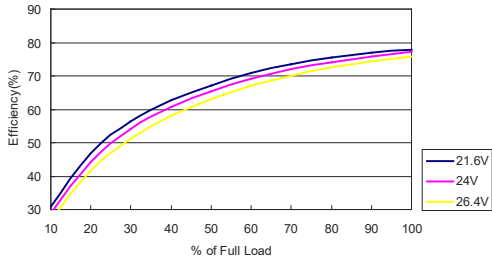
Typical Input Start-Up and Output Rise Characteristic
 $V_{in}=V_{in\ nom}$; Full Load



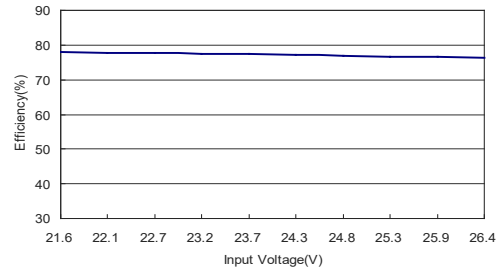
Derating Output Current Versus Ambient Temperature and Airflow
 $V_{in}=V_{in\ nom}$

Characteristic Curves

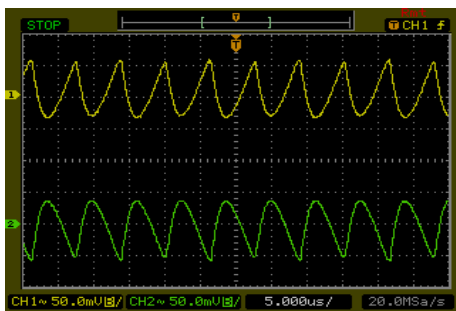
All test conditions are at 25°C The figures are identical for MDHU129



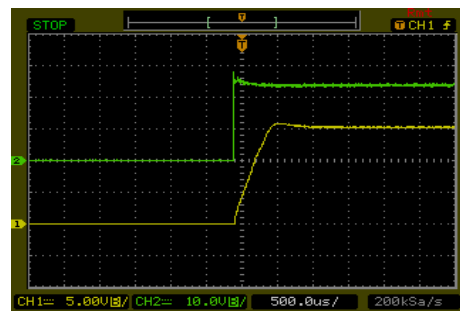
Efficiency Versus Output Current



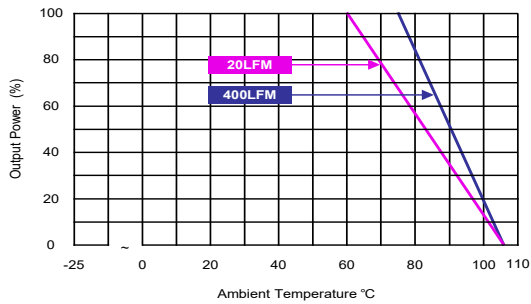
Efficiency Versus Input Voltage Full Load



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

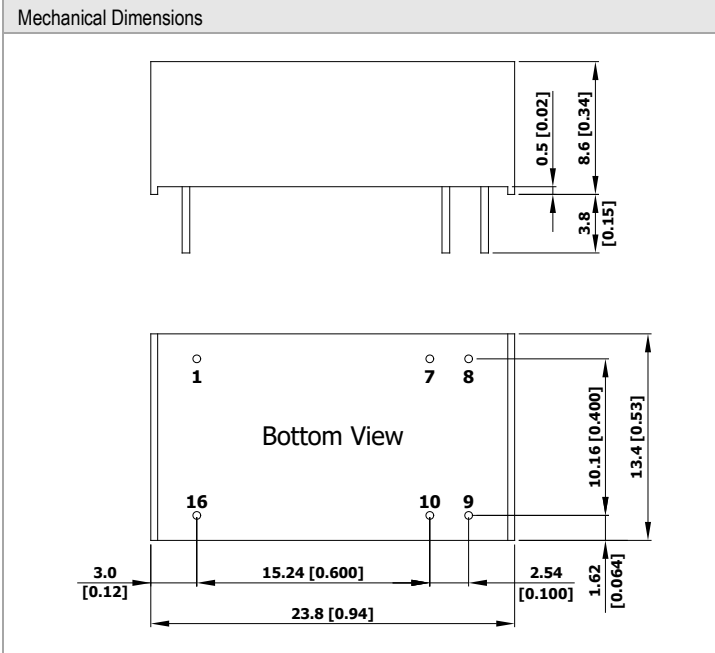


Typical Input Start-Up and Output Rise Characteristic
 $V_{in}=V_{in\ nom}$; Full Load



Derating Output Current Versus Ambient Temperature and Airflow
 $V_{in}=V_{in\ nom}$

Package Specifications



Pin Connections

| Pin | Single Output | Dual Output | Diameter mm (inches) |
|-----|---------------|-------------|----------------------|
| 1 | -Vin | -Vin | ∅ 0.5 [0.02] |
| 7 | NC | NC | ∅ 0.5 [0.02] |
| 8 | NC | Common | ∅ 0.5 [0.02] |
| 9 | +Vout | +Vout | ∅ 0.5 [0.02] |
| 10 | -Vout | -Vout | ∅ 0.5 [0.02] |
| 16 | +Vin | +Vin | ∅ 0.5 [0.02] |

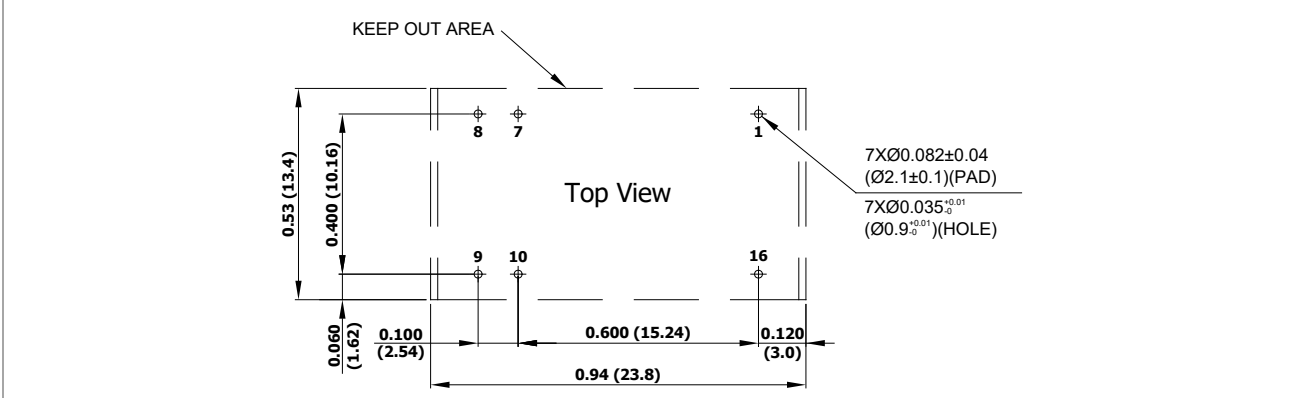
NC: No Connection

- ▶ All dimensions in mm (inches)
- ▶ Tolerance: X.X±0.25 (X.XX±0.01)
X.XX±0.13 (X.XXX±0.005)
- ▶ Pin diameter tolerance: X.X±0.05 (X.XX±0.002)

Physical Characteristics

| | |
|---------------|--|
| Case Size | : 23.8x13.4x8.6mm (0.94x0.53x0.34 inches) |
| Case Material | : Plastic resin (flammability to UL 94V-0 rated) |
| Pin Material | : Phosphor Bronze |
| Weight | : 5.1g |

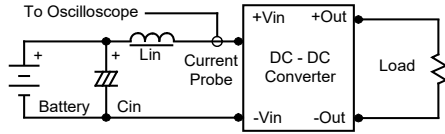
Recommended Pad Layout for Single & Dual Output Converter



Test Setup

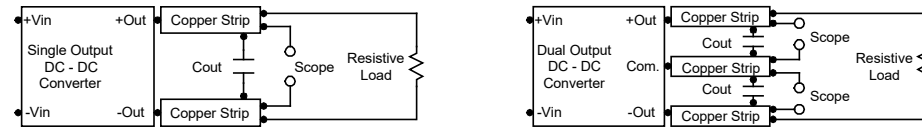
Input Reflected-Ripple Current Test Setup

Input reflected-ripple current is measured with an inductor L_{in} (4.7 μ H) and C_{in} (220 μ F, ESR < 1.0 Ω 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 μ 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.



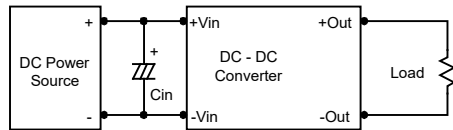
Technical Notes

Maximum Capacitive Load

The MDHU100 series has limitation of maximum connected capacitance at the output. The power module may be operated in current limiting mode during start-up, affecting the ramp-up and the startup time. For optimum performance we recommend 100 μ F maximum capacitive load for dual outputs and 330 μ F capacitive load for single outputs. The maximum capacitance can be found in the data sheet.

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 at the input to ensure startup. Capacitor mounted close to the power module helps ensure stability of the unit, it is recommended to use a good quality low Equivalent Series Resistance (ESR < 1.0 Ω at 100 kHz) capacitor of a 2.2 μ F for the 5V input devices, a 1.0 μ F for the 12V input devices and a 0.47 μ F for the 24V input devices.



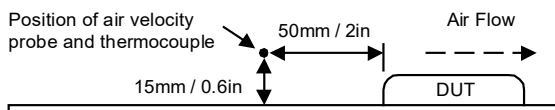
Output Ripple Reduction

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 μ F capacitors at the output.



Thermal Considerations

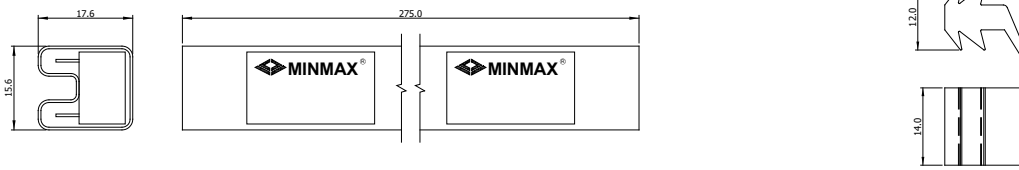
Many conditions affect the thermal performance of the power module, such as orientation, airflow over the module and board spacing. To avoid exceeding the maximum temperature rating of the components inside the power module, the case temperature must be kept below 105 $^{\circ}$ C. The derating curves are determined from measurements obtained in a test setup.



Packaging Information for Tube

Tube

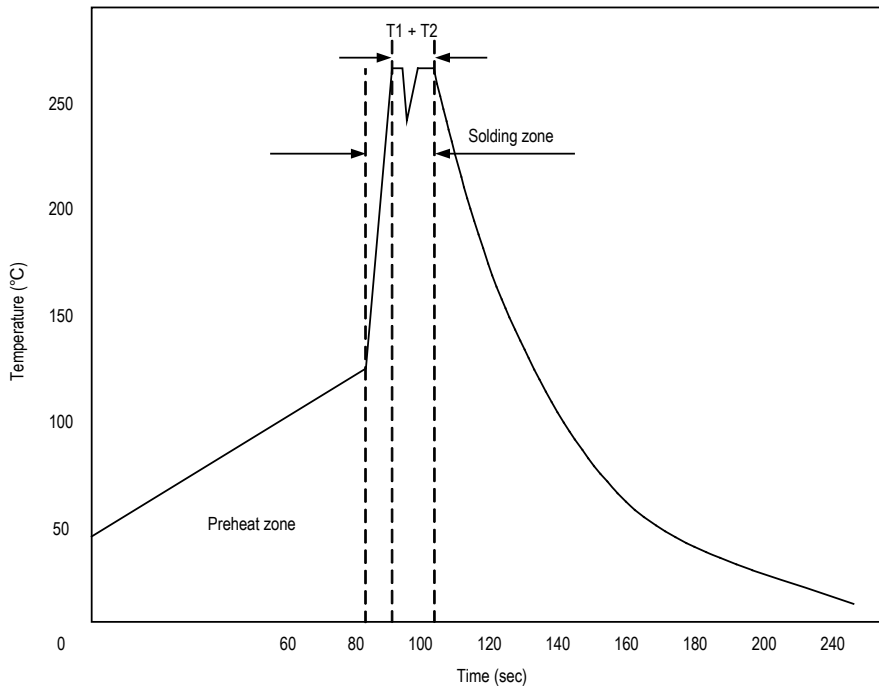
Plug



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

| M | D | H | U | 10 | 2 |
|------------------------|-----------------------------------|----------------------------------|---------------------|------------|----------------|
| Package Type DIP-16 | I/O Isolation Voltage 4000 VAC | Output Regulation Unregulated | Input Voltage Range | | Output Voltage |
| | | | 10: 4.5 ~ 5.5 VDC | 2: 5 VDC | |
| | | | 11: 10.8 ~ 13.2 VDC | 4: 12 VDC | |
| | | | 12: 21.6 ~ 26.4 VDC | 5: 15 VDC | |
| | | | | 8: ±12 VDC | |
| | | | | 9: ±15 VDC | |

MTBF and Reliability

The MTBF of MDHU100 series of DC-DC converters has been calculated using

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

| Model | MTBF | Unit |
|---------|-----------|-------|
| MDHU102 | 3,297,610 | Hours |
| MDHU104 | 3,368,421 | |
| MDHU105 | 3,368,421 | |
| MDHU108 | 3,194,888 | |
| MDHU109 | 3,202,562 | |
| MDHU112 | 3,395,586 | |
| MDHU114 | 3,488,879 | |
| MDHU115 | 3,488,879 | |
| MDHU118 | 3,399,915 | |
| MDHU119 | 3,399,915 | |
| MDHU122 | 3,344,482 | |
| MDHU124 | 3,499,562 | |
| MDHU125 | 3,499,562 | |
| MDHU128 | 3,154,574 | |
| MDHU129 | 3,154,574 | |