



MINMAX[®]

AMF-60 Series

Electric Characteristic Note

AMF-60 Series EC Note

AC-DC POWER MODULE 60W

Features

- ▶ Ultra Compact Size 2.99x2.13x1.10 "
- ▶ Fully Encapsulated Plastic Case for PCB, Chassis and DIN-Rail Mounting Version
- ▶ Universal Input 85-264VAC, 90-370VDC, 47-440Hz
- ▶ I/O Isolation 3000VAC with Reinforced Insulation
- ▶ No Min. Load Requirement & Low no-load power consumption
- ▶ Operating Ambient Temp. Range -40°C to +70°C
- ▶ Overload/Voltage and Short Circuit Protection
- ▶ EMI Emission EN55014-1/55032 Class B Approved
- ▶ EMC Immunity EN61000-4-2,3,4,5,6,8,11 Approved
- ▶ Safety Approval to UL/cUL/IEC/EN 62368-1, IEC/EN 60335-1 & CE Marking



Applications

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

Product Overview

The MINMAX AMF-60 series is a new generation of fully encapsulated AC-DC power supply modules with ultra-compact size for higher power density and space saving.

The product features universal AC input 85-264VAC and wider DC input 90-370VDC, regulated output voltages 5.1,12,15,24,48VDC ; I/O Isolation 3000VAC with Reinforced Insulation ; EMI emission EN55014-1/32 Class B and EMS immunity EN 61000-4 standards approved ; no min. load requirement and low no-load power consumption; abnormal protection mechanism with output overload, short circuit and overvoltage protections.

The AMF-60 series equips with PCB, Chassis and DIN-Rail Mounting Version for flexible installation and comply with UL/IEC/EN 62368-1 & IEC/EN 60335-1 for safety usage. It provides a cost effective solution especially for space critical applications in industrial and household electronic equipment.

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Model Selection Guide

| Model Number | Output Voltage | Output Power | Output Current | Input Current | Max. capacitive Load | Efficiency (typ.) |
|-------------------|----------------|--------------|----------------|------------------------|----------------------|-------------------|
| | | | | 115VAC, 60Hz | | |
| | VDC | W | A | @Max. Load mA(typ.) | μF | % |
| AMF-60S051 | 5.1 | 51 | 10 | 961 | 12000 | 87 |
| AMF-60S12 | 12 | 60 | 5 | 1127 | 2200 | 89 |
| AMF-60S15 | 15 | 60 | 4 | 1127 | 1500 | 89 |
| AMF-60S24 | 24 | 60 | 2.5 | 1127 | 1000 | 89 |
| AMF-60S48 | 48 | 60 | 1.25 | 1127 | 220 | 89 |

Input Specifications

| Parameter | Conditions / Model | | Min. | Typ. | Max. | Unit |
|---------------------------|--------------------|--------------------|------|------|------|------|
| AC Input Voltage Range | All Models | | 85 | --- | 264 | VAC |
| AC Input Frequency Range | | | 47 | --- | 440 | Hz |
| DC Input Voltage Range | | | 90 | --- | 370 | VDC |
| No-Load Power Consumption | 115VAC | PCB Mounting | --- | --- | 100 | mW |
| | 230VAC | | --- | --- | 200 | mW |
| | 115VAC | Chassis Mounting | --- | --- | 150 | mW |
| | 230VAC | | --- | --- | 250 | mW |
| Inrush Current | 115VAC | Cold Start at 25°C | --- | --- | 45 | A |
| | 230VAC | | --- | --- | 90 | A |

Output Specifications

| Parameter | Conditions / Model | | Min. | Typ. | Max. | Unit |
|--------------------------|---|---------------------|------|-------|-------|------------------------|
| Output Voltage Accuracy | | | --- | ±1.0 | ±2.0 | % |
| Line Regulation | Vin=Min. to Max. @Full Load | | --- | --- | ±0.5 | % |
| Load Regulation | Io=0% to 100% | | --- | --- | ±1.0 | % |
| Ripple & Noise | 0-20 MHz Bandwidth | 5.1VDC Output Model | --- | --- | 1.8 | %V _{PP} of Vo |
| | | Other Output Models | --- | --- | 1.0 | %V _{PP} of Vo |
| Minimum Load | No minimum Load Requirement | | | | | |
| Over Voltage Protection | Zener diode clamp | | --- | 125 | --- | % of Vo |
| Temperature Coefficient | | | --- | ±0.01 | ±0.02 | %/°C |
| Overshoot | | | --- | --- | 5 | % Vout |
| Over Load Protection | auto-recovery | | 110 | --- | --- | %Inom. |
| | (long term overload condition may cause damage) | | | | | |
| Short Circuit Protection | Hiccup mode, Automatic Recovery | | | | | |

General Specifications

| Parameter | Conditions | Min. | Typ. | Max. | Unit |
|--------------------------|---|---------|------|------|-------|
| I/O Isolation Voltage | Input to Output, 60 Seconds | 3000 | --- | --- | VAC |
| I/O Isolation Resistance | 500 VDC | 10 | --- | --- | GΩ |
| Switching Frequency | | --- | 65 | --- | kHz |
| Start-up Time | | --- | --- | 1 | s |
| Hold-up Time | 115VAC, 60Hz | 10 | --- | --- | ms |
| | 230VAC, 50Hz | 20 | --- | --- | ms |
| MTBF (calculated) | MIL-HDBK-217F@25°C, Ground Benign | 355,000 | --- | --- | Hours |
| Safety Approvals | UL/cUL 62368-1 recognition(UL certificate), IEC/EN 62368-1(CB-report) | | | | |
| | IEC/EN 60335-1, 61558-1, 61558-2-16 recognition(CB-report) | | | | |

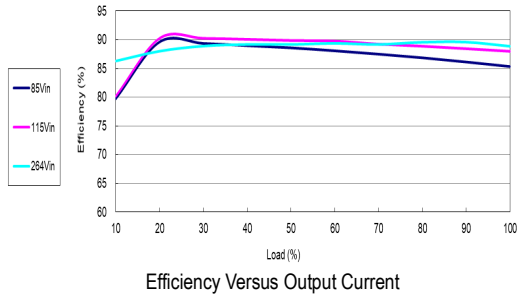
| EMC Specifications | | | | |
|--------------------|---|------------------------|------------------------------|-------------|
| Parameter | Standards & Level | | | Performance |
| General | Compliance with EN 61204-3 Switch mode power supplies | | | |
| EMI | Conduction | EN55014-1, EN 55032 | Without external components | Class B |
| | Radiation | | | |
| EMS | EN 55014-2, EN 55035 | | | |
| | ESD | Direct discharge | Indirect discharge HCP & VCP | |
| | | EN61000-4-2 air ± 8kV | Contact ± 6kV | |
| | Radiated immunity | EN 61000-4-3 10V/m | | |
| | Fast transient | EN 61000-4-4 ±2kV | | |
| | Surge | EN 61000-4-5 ±1kV | | |
| | Conducted immunity | EN 61000-4-6 10Vrms | | |
| | PFMF | EN 61000-4-8 30A/m | | |
| | Dips | EN 61000-4-11 30% 10ms | | |
| Interruptions | EN 61000-4-11 >95% 5000ms | | | |

| Environmental Specifications | | | | | |
|--|------|------|------|----------|--|
| Parameter | Min. | Typ. | Max. | Unit | |
| Operating Ambient Temperature Range (See Power Derating Curve) | -40 | --- | +70 | °C | |
| Storage Temperature Range | -40 | --- | +85 | °C | |
| Humidity (non condensing) | --- | --- | 95 | % rel. H | |
| Lead Temperature (1.5mm from case for 10Sec.) | --- | --- | 260 | °C | |

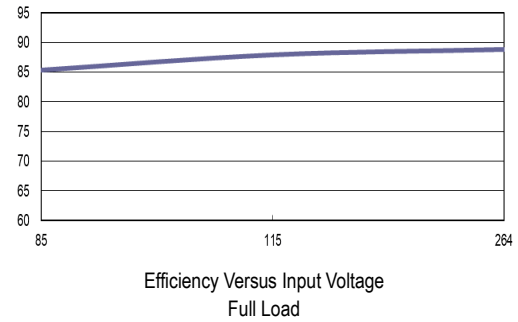
| Notes | |
|-------|---|
| 1 | All Specifications typical at Ta=+25°C, resistive load, 115VAC, 60Hz input voltage and after warm-up time rated output current unless otherwise noted. |
| 2 | We recommend to protect the converter by a slow blow fuse in the input supply line. |
| 3 | Other input and output voltage may be available, please contact MINMAX. |
| 4 | Specifications are subject to change without notice |
| 5 | 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

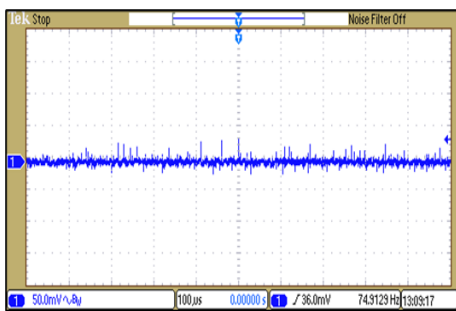
All test conditions are at 25°C The figures are identical for AMF-60S051



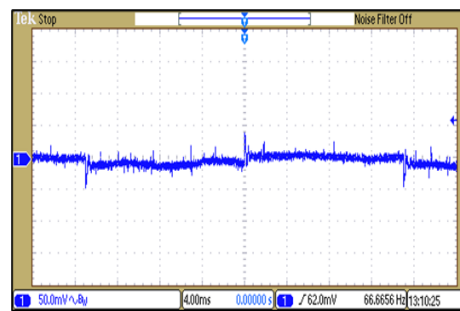
Efficiency Versus Output Current



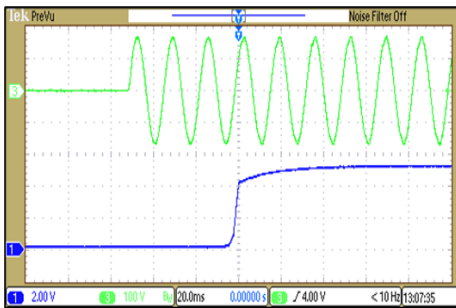
Efficiency Versus Input Voltage Full Load



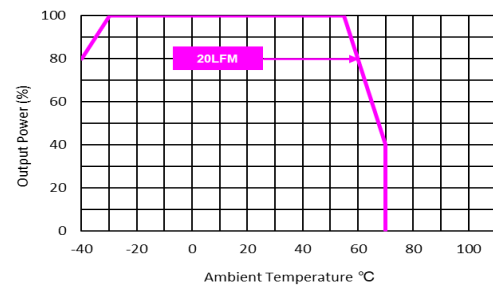
Typical Output Ripple and Noise
 $V_{in}=V_{in\ nom}$; Full Load



Transient Response to Dynamic Load Change
from 100% to 75% of Full Load ; $V_{in}=V_{in\ nom}$



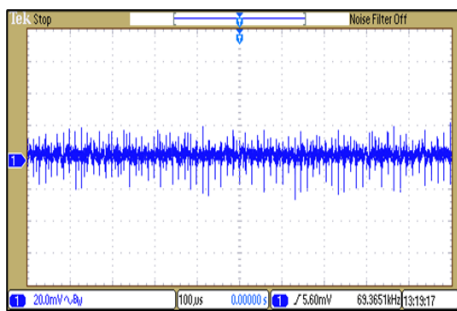
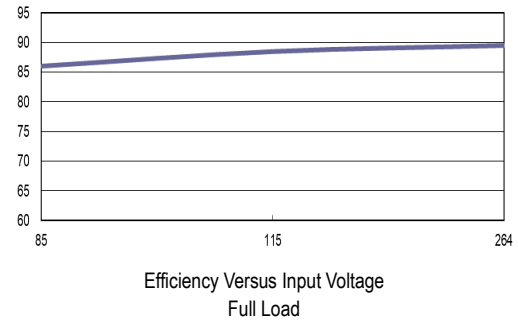
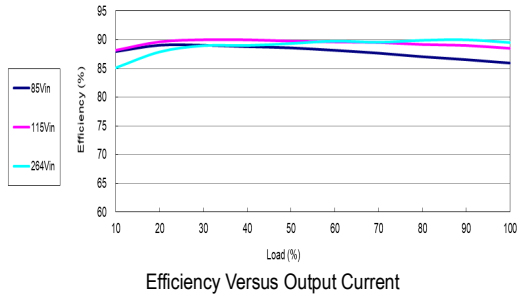
Typical Input Start-Up and Output Rise Characteristic
 $V_{in}=V_{in\ nom}$; Full Load



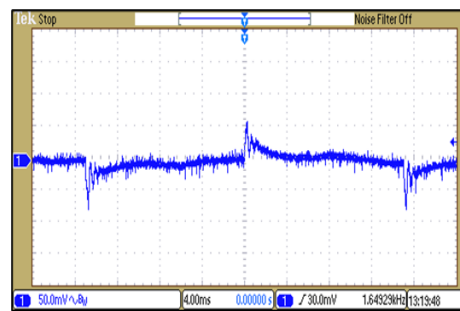
Derating Output Current Versus Ambient Temperature
 $V_{in}=V_{in\ nom}$

Characteristic Curves

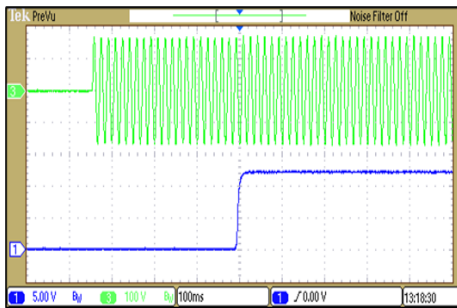
All test conditions are at 25°C The figures are identical for AMF-60S12



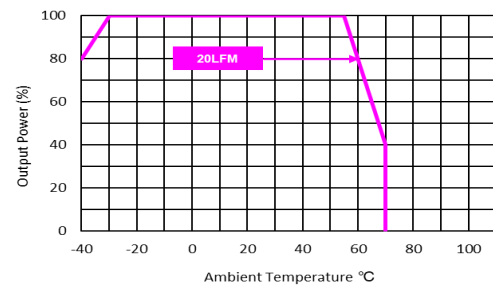
Typical Output Ripple and Noise
 $V_{in}=V_{in\ nom}$; Full Load



Transient Response to Dynamic Load Change
 from 100% to 75% of Full Load ; $V_{in}=V_{in\ nom}$



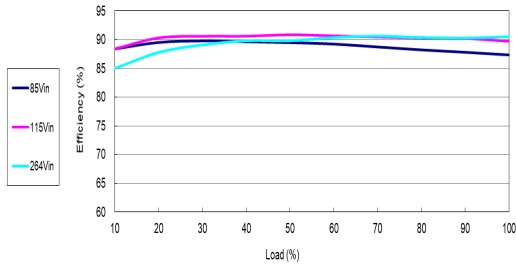
Typical Input Start-Up and Output Rise Characteristic
 $V_{in}=V_{in\ nom}$; Full Load



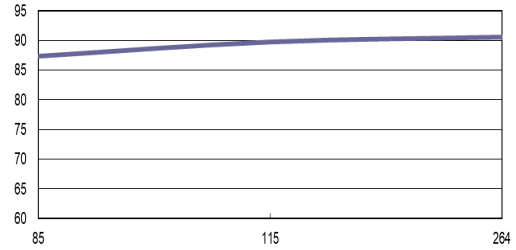
Derating Output Current Versus Ambient Temperature
 $V_{in}=V_{in\ nom}$

Characteristic Curves

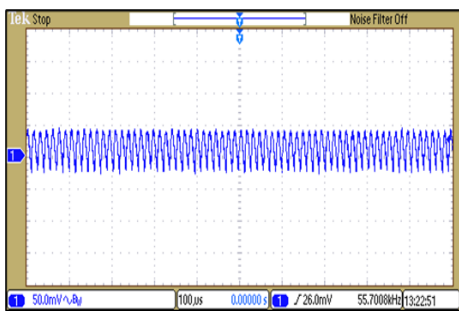
All test conditions are at 25°C The figures are identical for AMF-60S15



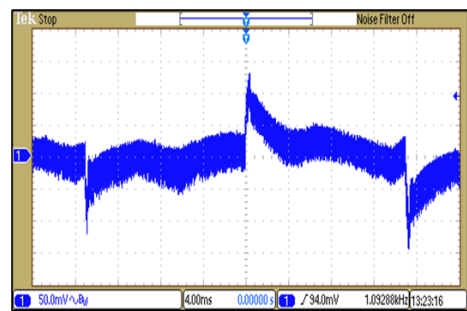
Efficiency Versus Output Current



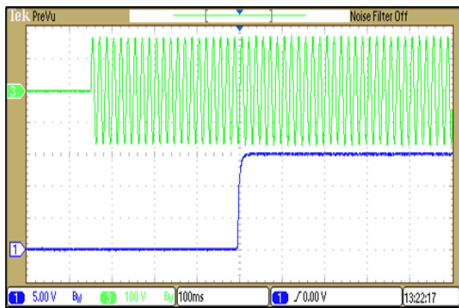
Efficiency Versus Input Voltage Full Load



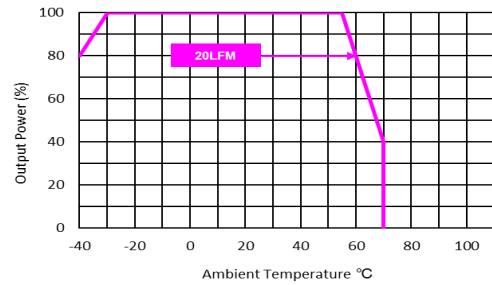
Typical Output Ripple and Noise
 $V_{in}=V_{in\ nom}$; Full Load



Transient Response to Dynamic Load Change
from 100% to 75% of Full Load ; $V_{in}=V_{in\ nom}$



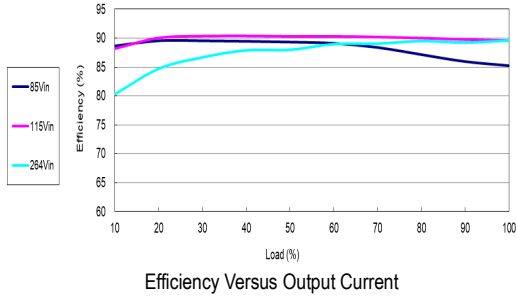
Typical Input Start-Up and Output Rise Characteristic
 $V_{in}=V_{in\ nom}$; Full Load



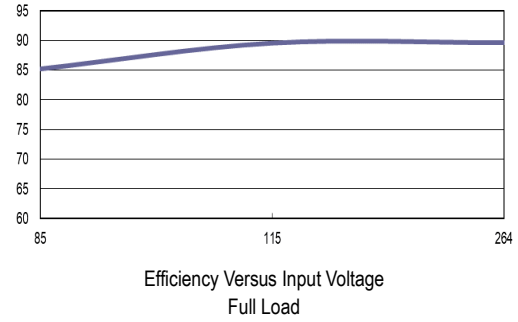
Derating Output Current Versus Ambient Temperature
 $V_{in}=V_{in\ nom}$

Characteristic Curves

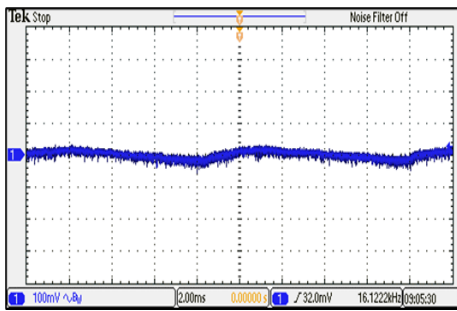
All test conditions are at 25°C The figures are identical for AMF-60S24



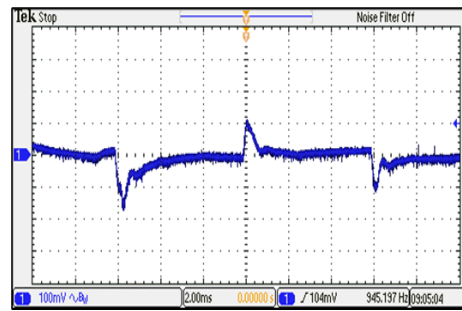
Efficiency Versus Output Current



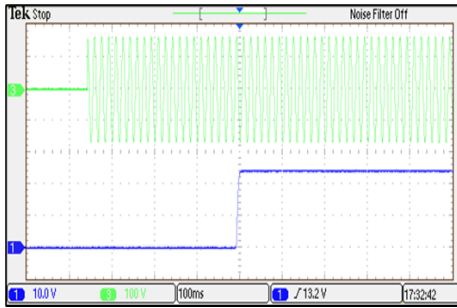
Efficiency Versus Input Voltage Full Load



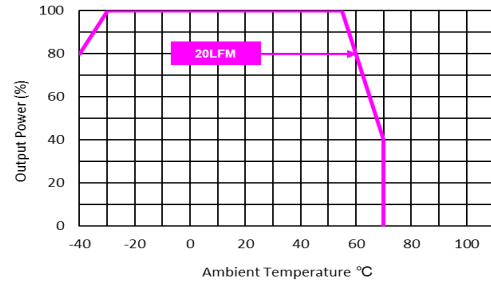
Typical Output Ripple and Noise
 $V_{in}=V_{in\ nom}$; Full Load



Transient Response to Dynamic Load Change
from 100% to 75% of Full Load ; $V_{in}=V_{in\ nom}$



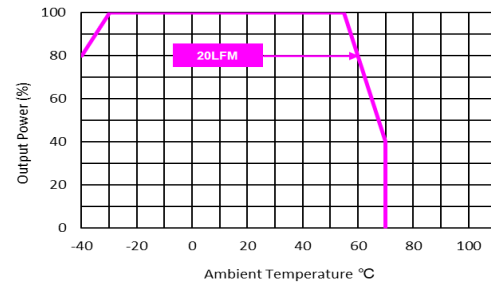
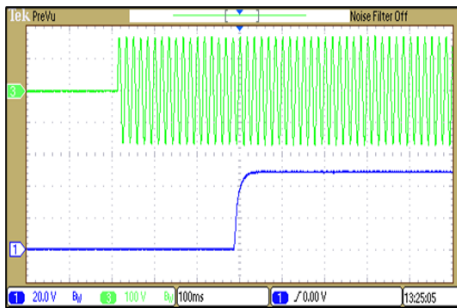
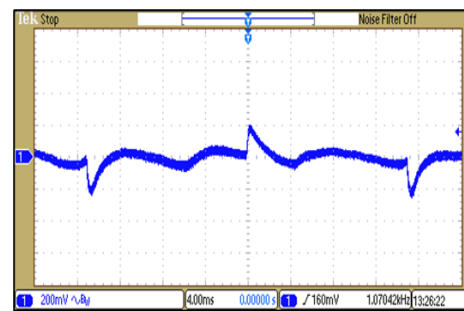
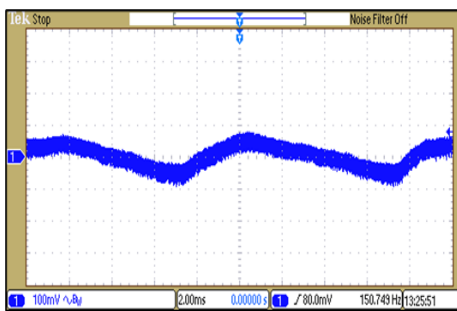
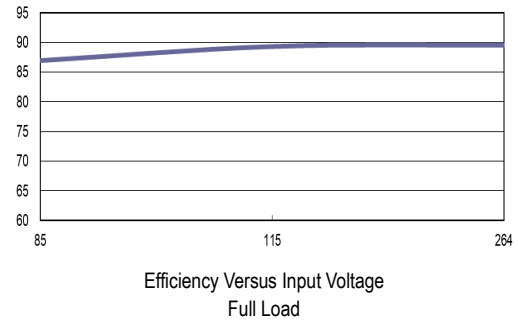
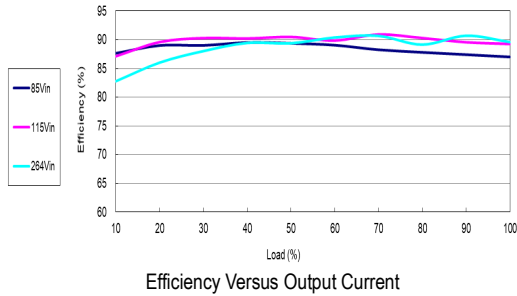
Typical Input Start-Up and Output Rise Characteristic
 $V_{in}=V_{in\ nom}$; Full Load



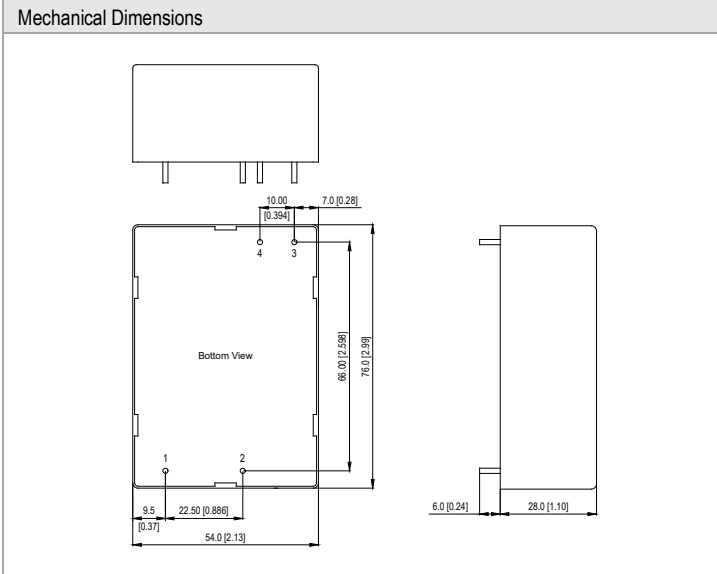
Derating Output Current Versus Ambient Temperature
 $V_{in}=V_{in\ nom}$

Characteristic Curves

All test conditions are at 25°C The figures are identical for AMF-60S48



Package Specifications PCB Mounting



Pin Connections

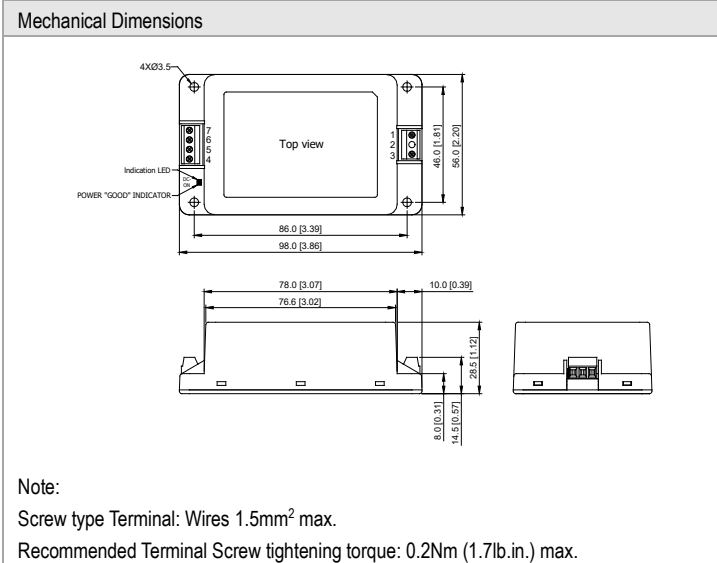
| Pin | Function | Diameter mm (inches) |
|-----|--------------------|----------------------|
| 1 | AC(L) – AC Line | ∅ 1.5 [0.06] |
| 2 | AC(N) – AC Neutral | ∅ 1.5 [0.06] |
| 3 | -Vout | ∅ 1.5 [0.06] |
| 4 | +Vout | ∅ 1.5 [0.06] |

- ▶ All dimensions in mm (inches)
- ▶ Tolerance: ±0.5 (±0.02)
- ▶ Pin pitch tolerance: ±0.25 (0.01)
- ▶ Pin diameter tolerance: X.X±0.1 (X.XX±0.004)

Physical Characteristics

| | |
|---------------|--|
| Case Size | : 76.0x54.0x28.0mm (2.99x2.13x1.10 inches) |
| Case Material | : Plastic resin (flammability to UL 94V-0 rated) |
| Pin Material | : Copper Alloy |
| Weight | : 169g |

Package Specifications Chassis Mounting with screw terminal (order code suffix C)



Pin Connections

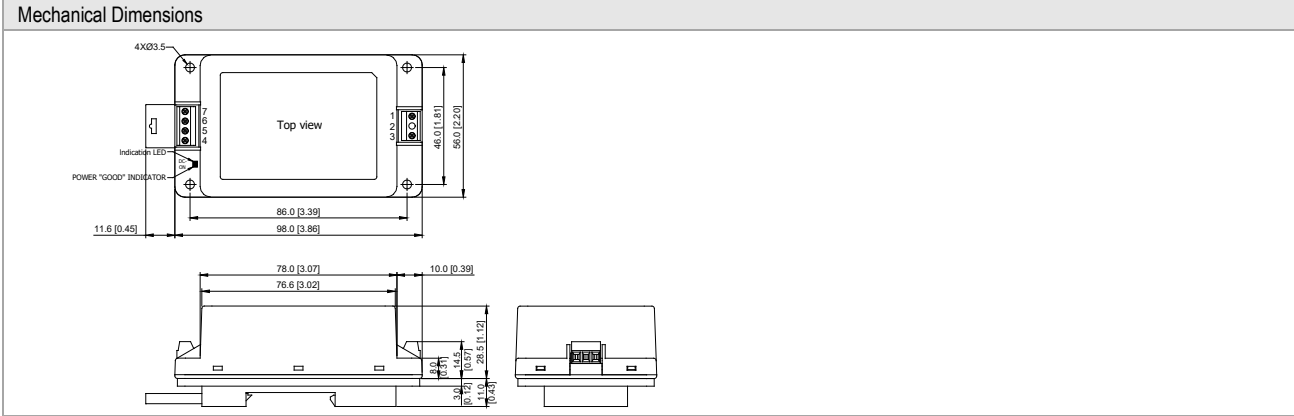
| Pin | Function |
|-----|--------------------|
| 1 | AC(L) – AC Line |
| 2 | No Pin |
| 3 | AC(N) – AC Neutral |
| 4 | -Vout |
| 5 | -Vout |
| 6 | +Vout |
| 7 | +Vout |

- ▶ All dimensions in mm (inches)
- ▶ Tolerance: ±0.5 (±0.02)

Physical Characteristics

| | |
|---------------|--|
| Case Size | : 98.0x56.0x28.5mm (3.86x2.20x1.12 inches) |
| Case Material | : Plastic resin (flammability to UL 94V-0 rated) |
| Weight | : 172g |

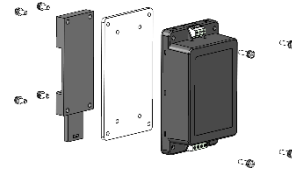
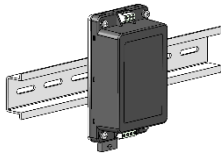
Package Specifications for screw terminal with DIN Rail Mounting (order code suffix AC-DIN-01)



Physical Characteristics

| | |
|---------------|--|
| Case Size | : 98.0x56.0x28.5mm (3.86x2.20x1.12 inches) |
| Case Material | : Plastic resin (flammability to UL 94V-0 rated) |
| Weight | : 226g |

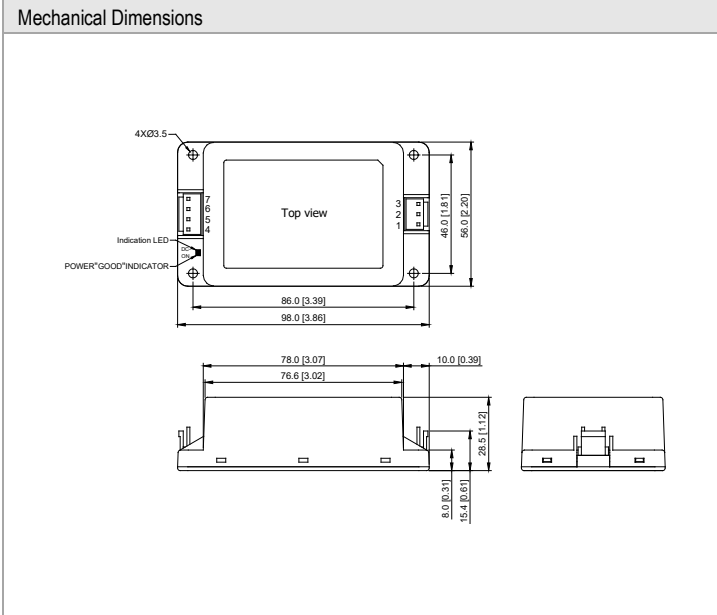
Screw terminal with DIN Rail Mounting



Note:

Recommended tightening torque: 0.35Nm (3.1lb.in.) max.

Package Specifications Chassis Mounting with JST connection (order code suffix CD)



Pin Connections

| Pin | Function |
|-----|--------------------|
| 1 | AC(N) – AC Neutral |
| 2 | No Pin |
| 3 | AC(L) – AC Line |
| 4 | -Vout |
| 5 | -Vout |
| 6 | +Vout |
| 7 | +Vout |

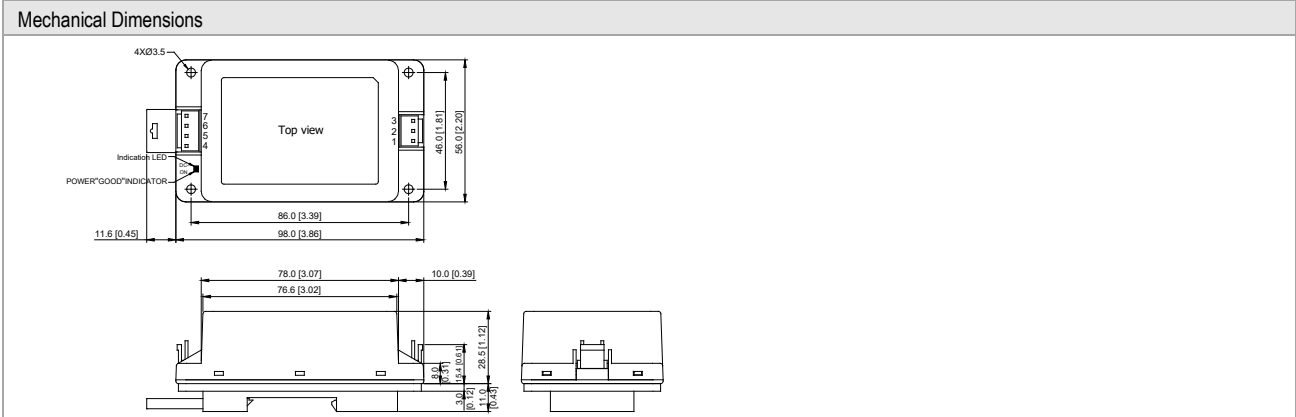
Input (pin 1, pin 3): JST Connector
 mates with JST crimp contacts: SVH-41T-P1.1
 terminal housing: VAR-2
 Output (pin 4, pin 5, pin 6, pin 7): JST Connector
 mates with JST crimp contacts: SVH-41T-P1.1
 terminal housing: VHR-4

- ▶ All dimensions in mm (inches)
- ▶ Tolerance: ± 0.5 (± 0.02)

Physical Characteristics

| | |
|---------------|--|
| Case Size | : 98.0x56.0x28.5mm (3.86x2.20x1.12 inches) |
| Case Material | : Plastic resin (flammability to UL 94V-0 rated) |
| Weight | : 172g |

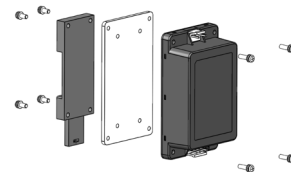
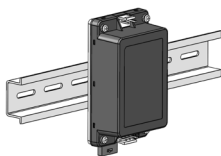
Package Specifications for JST connection with DIN Rail Mounting (order code suffix AC-DIN-01)



Physical Characteristics

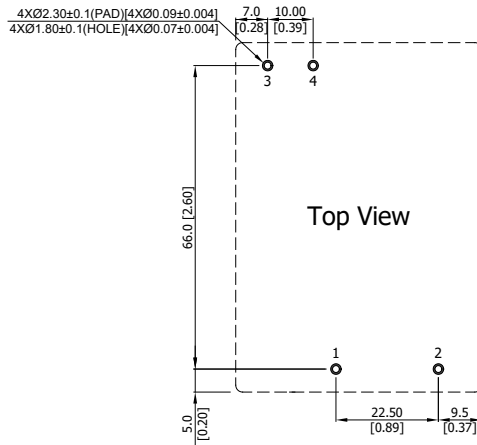
| | |
|---------------|--|
| Case Size | : 98.0x56.0x28.5mm (3.86x2.20x1.12 inches) |
| Case Material | : Plastic resin (flammability to UL 94V-0 rated) |
| Weight | : 226g |

JST connection with DIN Rail Mounting

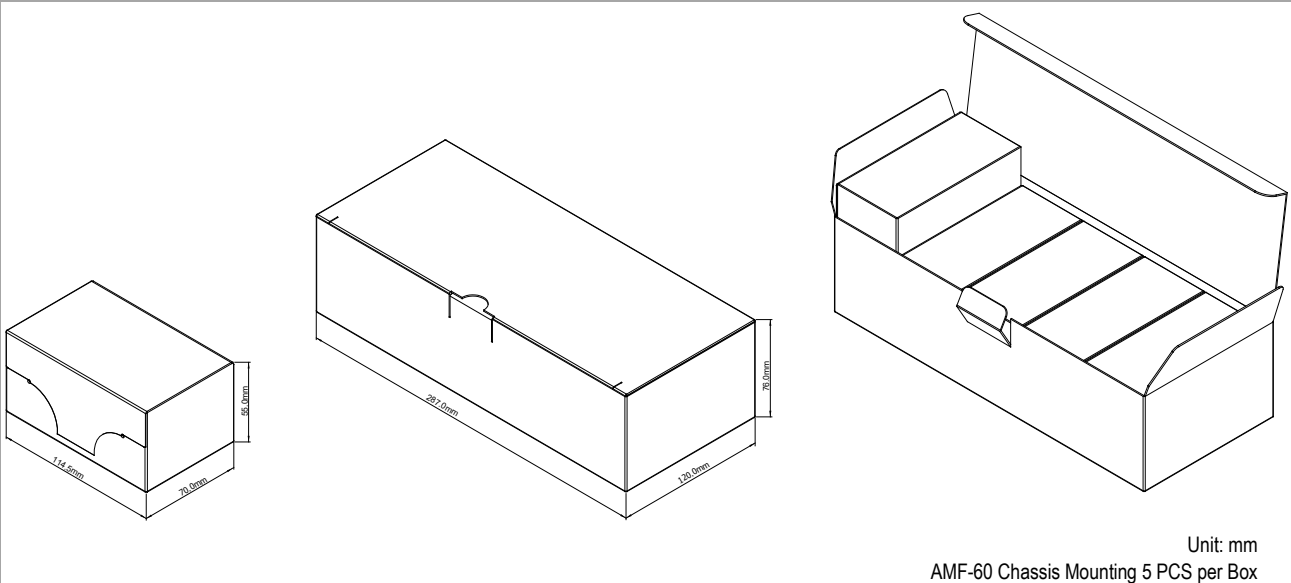
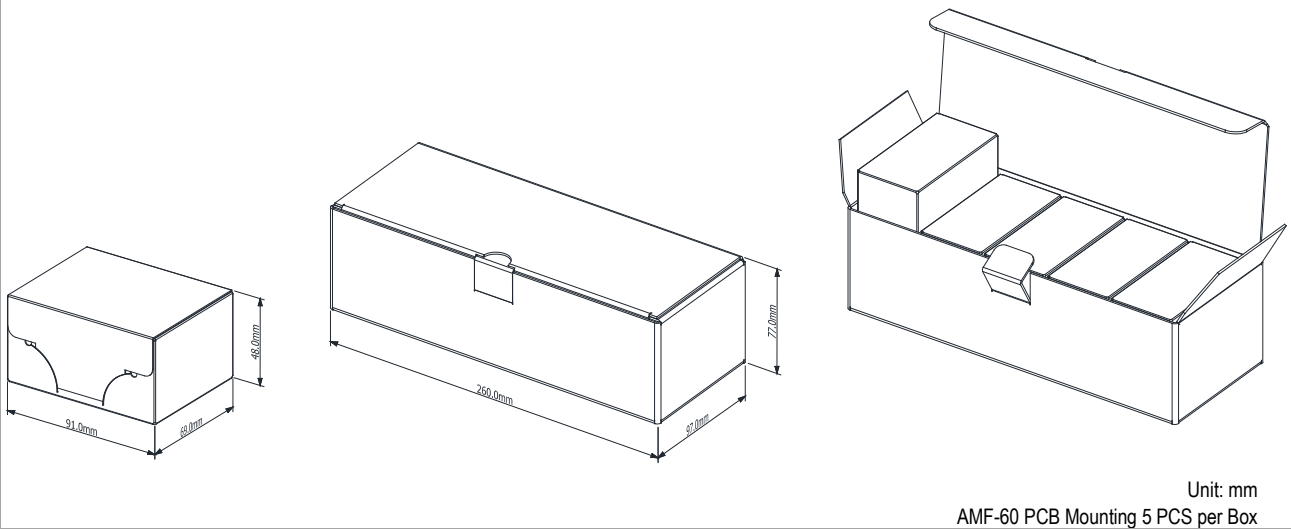


Note:
 Recommended tightening torque: 0.35Nm (3.1lb.in.) max.

Recommended Pad Layout

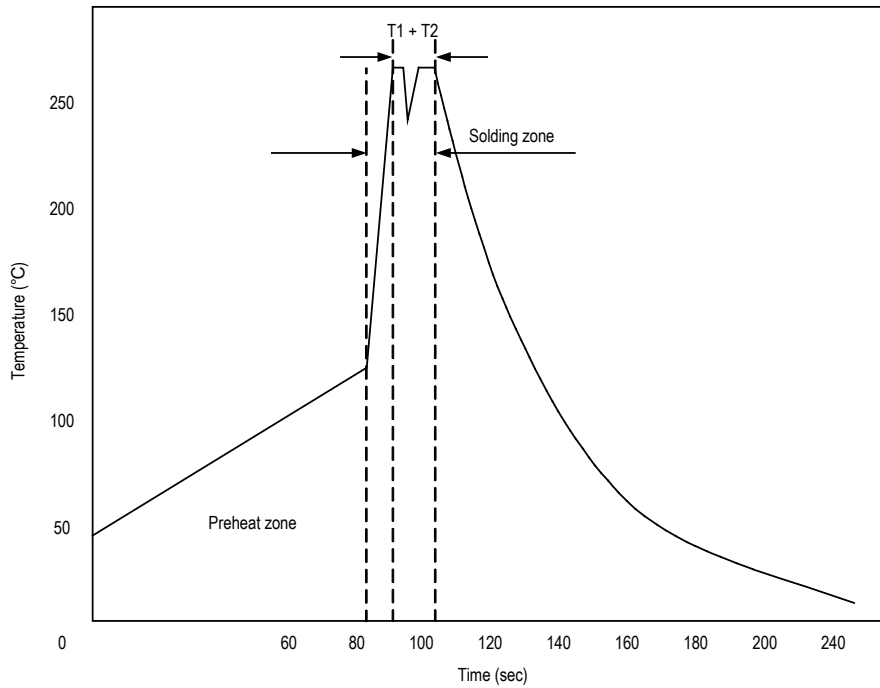


Packaging Information



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 | | | | | |
|-----------------------|---|--------------------------------|-------------------------------------|---|---|
| AMF | - | 60 | S | 051 | C |
| | | Output Power 60 Watt | Output Quantity S: Single | Output Voltage 051: 5.1 VDC 12: 12 VDC 15: 15 VDC 24: 24 VDC 48: 48 VDC | Package Type N/A: PCB Mounting C: Chassis Mounting with screw terminal CD: Chassis Mounting with JST connection |

| MTBF and Reliability | | |
|---|---------|-------|
| The MTBF of AMF-60 series of AC-DC Power Module has been calculated using MIL-HDBK 217F NOTICE2, Operating Temperature 25°C, Ground Benign. | | |
| Model | MTBF | Unit |
| AMF-60S051 | 357,169 | Hours |
| AMF-60S12 | 518,452 | |
| AMF-60S15 | 438,578 | |
| AMF-60S24 | 417,350 | |
| AMF-60S48 | 453,901 | |
| AMF-60S051C | 355,702 | |
| AMF-60S12C | 515,753 | |
| AMF-60S15C | 436,164 | |
| AMF-60S24C | 415,600 | |
| AMF-60S48C | 451,831 | |
| AMF-60S051CD | 355,702 | |
| AMF-60S12CD | 515,753 | |
| AMF-60S15CD | 436,164 | |
| AMF-60S24CD | 415,600 | |
| AMF-60S48CD | 451,831 | |