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# 50 to 60 XW Single Series DC/DC Converters

## Features

- Lowest Noise Outputs, 50 mV P-P Maximum
- Fully Shielded/Filtered Design
- Very Low and Specified Reflected Ripple Current
- Low and Specified Input/Output Capacitance
- Isolation Voltage Raised to 700 or 1544 VDC as Per the Requirements of UL1459
- Five Year Warranty

| Selection Chart | | | | |
|---|---|---|---|---|
| Model | Input Range VDC | | Output VDC | Output AMPS |
| | Min | Max | | |
| 12S5.10XW* | 9.0 | 18.0 | 5 | 10 |
| 12S12.5XW* | 9.0 | 18.0 | 12 | 5 |
| 12S15.4XW* | 9.0 | 18.0 | 15 | 4 |
| 24S5.10XW | 18.0 | 36.0 | 5 | 10 |
| 24S12.5XW | 18.0 | 36.0 | 12 | 5 |
| 24S15.4XW | 18.0 | 36.0 | 15 | 4 |
| 48S5.10XW | 36.0 | 72.0 | 5 | 10 |
| 48S12.5XW | 36.0 | 72.0 | 12 | 5 |
| 48S15.4XW | 36.0 | 72.0 | 15 | 4 |

* Note the input range on the 12S models is as follows:
Above 75% full load: 9.5 VDC to 18 VDC
Below 75% full load: 9.0 VDC to 18 VDC

## Description

These single output converters are designed for wide input range low noise telecommunications, industrial, and instrument applications. The wide input range (2:1) is ideal for battery or unregulated input applications while the low noise complements even the most sensitive analog circuitry.

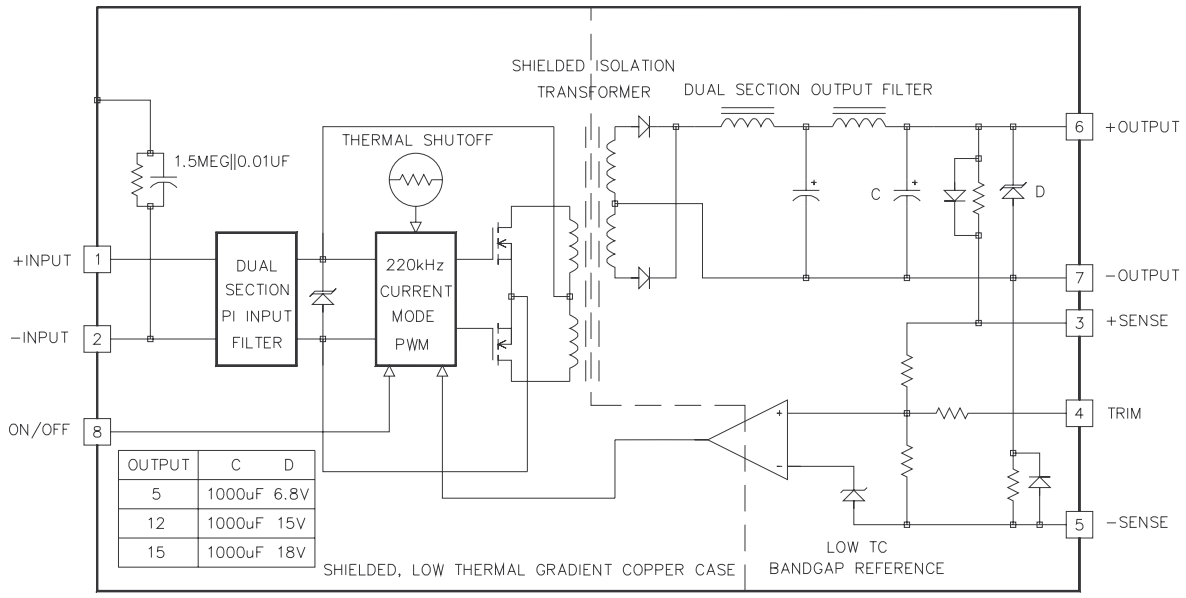
These converters are state-of-the art 220 kHz MOSFET based designs that provide outstanding line and load regulation with efficiencies exceeding 85%.

The single outputs are regulated by a high loop gain current mode control method that provides linear regulator type performance with a true, high efficiency switching DC/DC topology. The large amount of loop gain also insures excellent input ripple rejection and line transient response. Remote output voltage sense, output voltage trim and ON/OFF functions are also included.

They are protected from output shorts to common by a high speed pulse-by-pulse digital current limit circuit and a self-resetting thermal overload protection circuit. The input and output are overvoltage protected with 1500W transient suppressor diodes for zero failure rate operation.

As with all CALEX converters the 50/60 Watt XW Single Series is covered by our standard 5 Year Warranty.

**60 Watt Single Series Block Diagram**



| Input Parameters* | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Model** | | **12S5.10XW** | | **12S12.5XW** | | **12S15.4XW** | | **Units** |
| Voltage Range<br>75% to 100% Full Load | MIN<br>MAX | 9.5<br>18.0 | | | | | | VDC |
| Below 75% Full Load | MIN<br>MAX | 9.0<br>18.0 | | | | | | |
| Input Current Full Load<br>No Load | TYP<br>TYP | 5430<br>20 | | 6320<br>20 | | 6080<br>20 | | mA |
| Efficiency | TYP | 77 | | 79 | | 82 | | % |
| Reflected Ripple (2) | TYP<br>MAX | 50<br>150 | | | | | | mA P-P |
| | TYP | 25 | | | | | | mA RMS |
| Switching Frequency | TYP | 220 | | | | | | kHz |
| Maximum Input Overvoltage, 100ms | MAX | 24 | | | | | | VDC |
| Turn-on Time, 1% Output Error | TYP | 60 | | | | | | ms |
| Recommended Fuse | | (3) | | | | | | AMPS |
| **Model** | | **24S5.10XW** | **24S12.5XW** | **24S15.4XW** | **48S5.10XW** | **48S12.5XW** | **48S15.4XW** | **Units** |
| Voltage Range | MIN<br>MAX | 18.0<br>36.0 | | | 36.0<br>72.0 | | | VDC |
| Input Current Full Load<br>No Load | TYP<br>TYP | 2660<br>20 | 3060<br>20 | 2980<br>20 | 1340<br>25 | 1520<br>25 | 1490<br>25 | mA |
| Efficiency | TYP | 78 | 82 | 84 | 78 | 82 | 84 | % |
| Reflected Ripple (2) | TYP<br>MAX | 15<br>45 | | | 10<br>30 | | | mA P-P |
| | TYP | 4 | | | 0.5 | | | mA RMS |
| Switching Frequency | TYP | 220 | | | | | | kHz |
| Maximum Input Overvoltage, 100ms | MAX | 45 | | | 85 | | | VDC |
| Turn-on Time, 1% Output Error | TYP | 60 | | | | | | ms |
| Recommended Fuse | | (3) | | | | | | AMPS |

| Output Parameters* | | | | | |
|---|---|---|---|---|---|
| **Model** | | **12S5.10XW 24S5.10XW 48S5.10XW** | **12S12.5XW 24S12.5XW 48S12.5XW** | **12S15.4XW 24S15.4XW 48S15.4XW** | **Units** |
| Output Voltage | | 5 | 12 | 15 | VDC |
| Output Voltage Accuracy (14) | MIN<br>TYP<br>MAX | 4.950<br>5.000<br>5.050 | 11.900<br>12.000<br>12.100 | 14.900<br>15.000<br>15.100 | VDC |
| Rated Load Range (5) | MIN<br>MAX | 2.5<br>10 | 1.25<br>5 | 1.0<br>4 | A |
| Load Regulation: 25%-100% Full Load | TYP<br>MAX | 0.1<br>0.3 | 0.05<br>0.1 | 0.05<br>0.1 | % |
| Line Regulation<br>Vin = Min-Max VDC | TYP<br>MAX | 0.01<br>0.1 | | | % |
| Short Term Stability (6) | TYP | <0.05 | <0.02 | <0.02 | %/24Hrs |
| Long Term Stability | TYP | <0.2 | | | %/kHrs |
| Transient Response (7) | TYP | 200 | 300 | 200 | µs |
| Dynamic Response (8) | TYP | 125 | 90 | 60 | mV peak |
| Input Ripple Rejection (9) | TYP | >70 | | | dB |
| Noise, 0-20MHz bw (2) | TYP<br>MAX | 15<br>50 | | | mV P-P |
| RMS Noise, 0.1 - 1MHz bw (2) | TYP | 1.5 | 1.2 | 1.2 | mV RMS |
| Temperature Coefficient | TYP<br>MAX | 50<br>150 | | | ppm/°C |
| Overvoltage Clamp (10) | TYP | 6.8 | 15 | 18 | VDC |
| Short Circuit Protection to Common for all Outputs | | Continuous Current Limit and Thermal Protection | | | |

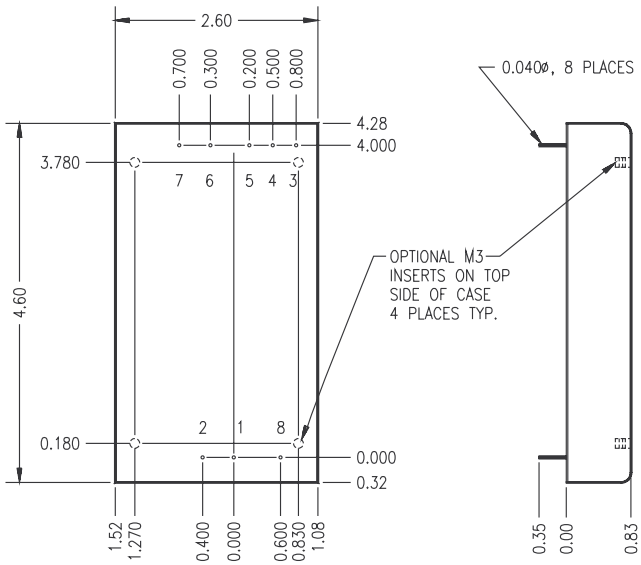
**NOTES**

*** All parameters measured at Tc= 25°C, nominal input voltage and full rated load unless otherwise noted. Refer to the CALEX Application Notes for the definition of terms, measurement circuits and other information.**

(2) Noise is measured per CALEX Application Notes. Measurement bandwidth is 0-20 MHz for peak-peak measurements, 10 kHz to 1 MHz for RMS measurements.

# 50 to 60 XW Single Series DC/DC Converters

| General Specifications * | | | |
|---|---|---|---|
| **All Models** | | | **Units** |
| **ON/OFF Function** | | | |
| ON Logic Level<br>or Leave Pin Open | MIN | > 10 | VDC |
| OFF Logic Level<br>or Tie Pin to -Input | MAX | < 5 | VDC |
| Open Circuit Voltage | TYP | 13 | VDC |
| Input Resistance | TYP | 2 | kohms |
| Converter Idle Current<br>ON/OFF Pin Low<br>12S Models<br>24S Models<br>48S Models | <br><br>TYP<br>TYP<br>TYP | <br><br>2<br>7<br>7 | mA |
| **Isolation (4)** | | | |
| Isolation Voltage<br>Input to Output 12S, 24S<br>Input to Output 48S<br>Case to Input<br>10uA Leakage | <br>MIN<br>MIN<br>MIN | <br>700<br>1544<br>100 | VDC |
| Input to Output<br>Capacitance | TYP | 350 | pF |
| **Output Trim Function (13)** | | | |
| Trim Range | MIN | ±5 | % |
| Input Resistance | MIN | 40 | kohms |
| Open Circuit Voltage | TYP | 1.2 | VDC |
| **Environmental** | | | |
| Case Operating Range<br>No Derating | MIN<br>MAX | -40<br>85 | °C |
| Case Functional Range (11) | MIN<br>MAX | -40<br>100 | °C |
| Storage Range | MIN<br>MAX | -55<br>105 | °C |
| Thermal Shutdown<br>Case Temperature | TYP | 105 | °C |
| Thermal Impedance (12) | TYP | 3.4 | °C/Watt |
| Unit Weight | TYP | 10.5 | oz |
| **Mounting Options** | | | |
| MS13 | | Chassis Mounting Kit | |
| -I Suffix on Part Number | | Inserts In Case | |
| -HS (-I Required) | | Heat Sink Option | |




Mechanical tolerances unless otherwise noted:

X.XX dimensions: ±0.020 inches

X.XXX dimensions: ±0.005 inches

Seal around terminals is not hermetic. Do not immerse units in any liquid.

| Pin | Function |
|---|---|
| 1 | +INPUT |
| 2 | -INPUT |
| 3 | +SENSE |
| 4 | TRIM |
| 5 | -SENSE |
| 6 | +OUTPUT |
| 7 | -OUTPUT |
| 8 | ON/OFF |

(3) Determine the correct fuse size by calculating the maximum DC current drain at low line input, maximum load and then adding 50 to 100 percent to get the desired fuse size. Slow blowing fuse recommended.

(4) The Case is tied to the -Input pin through 1.5 Megohm in parallel with 0.01µF.

(5) Minimum load required for specified performance only. Module may be run at less than minimum load with no damage. Maximum power from module is limited to either 50 or 60 Watts. Trimming the output up reduces the output current proportionally to keep the maximum power constant. Output current is not increased over the listed maximum when trimming the output voltage down.

(6) Short term stability is specified after a 30 minute warmup at full load, constant line and recording the drift over a 24 hour period.

(7) The transient response is specified as the time required to settle from a 50 to 75 % step load change (rise time of step = 2 µSec) to a 50mV error band.

(8) Dynamic response is the peak overshoot during a transient as defined in note 6 above.

(9) The input ripple rejection is specified for DC to 120 Hz ripple with a modulation amplitude of 1% of Vin.

(10) 1500W peak pulse power transient voltage protectors used, also see note 3.

(11) The functional temperature range is intended to give an additional data point for use in evaluating this power supply. At the low functional temperature the power supply will function with no side effects, however sustained operation at the high functional temperature may reduce the expected operational life. The data sheet specifications are not guaranteed over the functional temperature range.

(12) The case thermal impedance is specified as the case temperature rise over ambient per package watt dissipated. The -HS option can reduce the thermal impedance of the XW single to below 2.4 °C per Watt. See the applications section.

(13) Full output trim range may not be available at full load and minimum input voltage. Full trim is guaranteed from minimum input voltage +5% and full load. Also see note 5.

(14) The remote sense pins must be connected to their respective outputs for proper output accuracy and regulation. The remote sense lines can correct for 0.4V maximum drop on each line.

(15) Water Washability - Calex DC/DC converters are designed to withstand most solder/wash processes. Careful attention should be used when assessing the applicability in your specific manufacturing process. Converters are not hermetically sealed.

## Application Information

You truly get what you pay for in a CALEX converter; a complete system oriented and specified DC/DC converter - no surprises, no external noise filtering circuits needed, no external transient suppression necessary and no heatsinking problems.

The 50/60 Watt XW Single series, like all CALEX converters, carries the full 5 Year CALEX Warranty. We can offer a five year warranty where others can't because with CALEX it's rarely needed.

## General Information

The 220 kHz operating frequency of the 50/60 Watt XW Single Series allows an increased power density of up to 6 Watts per cubic inch while still including adequate heat sinking and full dual stage filtering on both the input and output. This prevents the need for additional filtering and heatsinking in most applications.

The series is also useful for battery operation in industrial, medical control and remote data collection applications. The remote ON/OFF pin places the converter in a very low power mode that draws typically less than 7mA (2mA for 12S models) from the input source.

Noise has also been greatly reduced in this single design. The industry standard specifies output noise at 75 mV peak-to- peak typical with no mention of maximum value or of measurement bandwidth. Our converters achieve 15 mV peak-to-peak typical and are fully specified and tested to a maximum specification of 50 mV peak-to-peak over a wide bandwidth of 0-20 MHz.

Dual stage input filtering reduces reflected ripple noise and is also fully specified for typical and maximum values (exact value depends on input voltage range). Typical RMS noise over a 10 kHz to 1 MHz bandwidth is also specified for both the input and output.

All inputs and outputs are protected from transient overvoltage conditions by 1500 watt transient overvoltage suppressors. Full overload protection is provided by independent pulse-by-pulse current limiting and an over-temperature shutdown circuit. These protection features assure you that our 50/60 Watt Single will provide you with zero failure rate operation.

Six sided shielding is standard along with specified operation over the full industrial temperature range of -40 to +85°C.

## General Operation

Figure 1 shows the recommended connections for the 50 Watt Single DC/DC converter. A fuse is recommended to protect the input circuit and should not be omitted. The fuse serves two purposes:

1) It prevents unlimited current from flowing in the case of a catastrophic system failure.
2) UL regulations for telecom equipment require the use of a fuse.

The ON/OFF and TRIM pins may be left floating if they are not used. No external capacitance on either the input or outputs is required for normal operation. In fact, it can degrade the converters performance. See our application note "Understanding DC/DC Converters Output Impedance" for more information. The usual 0.1 to 0.01 µF bypasses may be used around your PCB as required for local bypassing without harm.

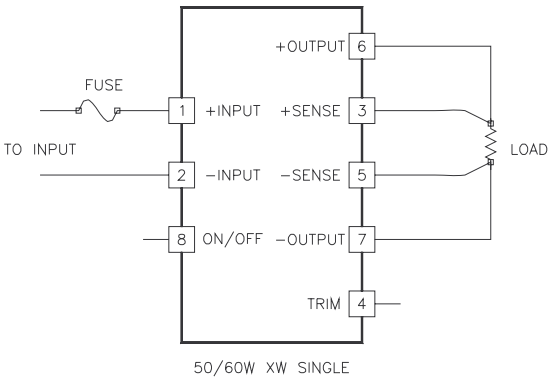



**Figure 1**.

Standard connections for the 50/60 Watt Single Series. The ON/OFF and TRIM pins can be left floating if they are not used. The input fuse should not be omitted. The remote sense lines should be connected to their respective output pins even if they are not used in your application

Extremely low ESR capacitors (< 0.5 ohms) should not be used at the input. This will cause peaking of the input filters transfer function and actually degrade the filters performance.

## Output

The trim pin may be used to adjust the outputs by up to ±5 % from the nominal factory setting. The trim may be used to adjust for system wiring voltage drops or to adjust the +5 output up to 5.2 Volts for ECL applications. Figure 2 shows the proper connections for using the trim pin. If output trimming is not desired the trim pin may be safely left floating.

Maximum power is limited to either 50 or 60 watts. Trimming the output up reduces the output current proportionally to keep the maximum power constant. Output current is not increased over the listed maximum when trimming the output voltage down.

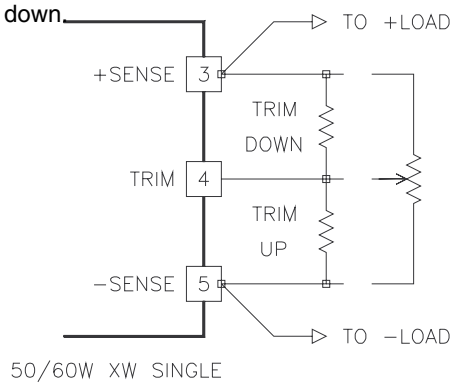



**Figure 2**.

The 5 Volt output can be trimmed by either a trimpot or fixed resistors. If fixed resistors are used their values may range from zero to infinite ohms. The trimpot should be 10 K ohms nominal.

Each single output features provisions for remote sense connections. These allow the power supply to correct for line drops of up to 0.4 volts per leg. The remote sense connections should be made with twisted pair wire or closely coupled PCB traces. If the remote sense is not to be used, these pins must be connected to their respective output pins for proper output voltage accuracy and regulation. There is approximately 1 mA of current flowing in the remote sense lines.

Care should be taken not to disconnect the output pins before the remote sense pins while the converter is in operation. If this happens the output load current will run down the sense leads, possibly creating an output overvoltage condition that could cause the internal transient suppressor on the output to conduct. If the unit must be "Hot Plugged" in the intended application, provisions should be made to disconnect the sense leads before the power leads, disconnect the input power first or use the remote ON/OFF to stop the converter's operation.

See our application note on remote sense and trim functions for more information.

### Grounding

The input and output sections are fully floating from each other. They may be operated separately or with a common ground. If the input and output sections are connected either directly at the converter or at some remote location from the converter it is suggested that a 3.3 to 10µF, 0.5 to 5 ohm ESR capacitor bypass be used directly at the converter output pins. This capacitor prevents any common mode switching currents from showing up at the converter's output as normal mode output noise. Do not use the lowest ESR, biggest value capacitor that you can find! This can only lead to reduced system performance or oscillation. See our application note "Understanding Output Impedance For Optimum Decoupling" for more information.

### Case Grounding

The case serves not only as a heat sink but also as an EMI shield. The case / header shield is tied to the -Input pin through a 1.5 megohm resistor in parallel with a 0.01 µF capacitor. These connections are shown on the block diagram. The case is floating from the output sections.

The noise performance of the converter may improve or degrade with the case connected to other inputs or outputs depending on your system grounding.

### Remote ON/OFF Pin Operation

The remote ON/OFF pin may be left floating if this function is not used. The equivalent input circuit for the ON/OFF pin is shown in figure 3. The best way to drive this pin is with an open collector/drain or relay contact. See our application note titled "Understanding the Remote ON/OFF Function" for more information on using the remote ON/OFF pin.

When the ON/OFF pin is pulled low with respect to the -Input, the converter is placed in a low power drain state. When the ON/OFF pin is released the converter completely powers up in typically 60 milliseconds. The ON/OFF pin turns the converter off while keeping the input bulk capacitor fully charged. This prevents the large inrush current spike that occurs when the +input pin is opened and closed.

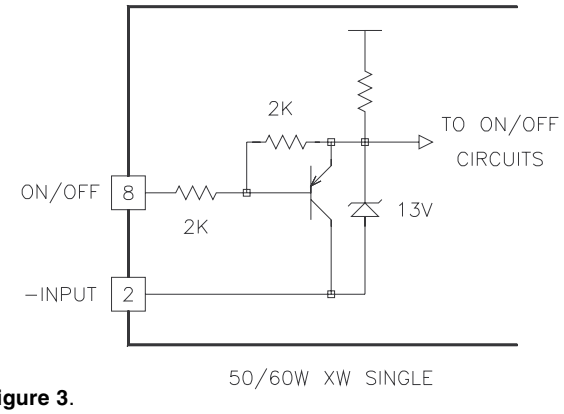



**Figure 3**.

The simplified schematic of the XW Single Series' ON/OFF pin. The maximum open circuit voltage is clamped by the 13 volt zener. By leaving this pin floating the converter will be in the ON state. When the pin is pulled below 5 volts the converter is placed in the power down or OFF state. See our application note on the remote ON/OFF function for more information.

### Temperature Derating/Mounting Options

The XW Single series can operate up to 85°C case temperature without derating. Case temperature may be roughly calculated from ambient by knowing that the XW Singles case temperature rise is approximately 3.4° C per package watt dissipated.

For example: If the converter was outputting 40 watts, at what ambient could it expect to run with no moving air and no extra heatsinking?

Efficiency is approximately 85%. This leads to an input power of 47 watts. The case temperature rise would be 7 watts x 3.4 = 24°C. This number is subtracted from the maximum case temperature of 85°C to get: 61°C.

This is a rough approximation of the maximum ambient temperature. Because of the difficulty of defining ambient temperature and the possibility that the load's dissipation may actually increase the local ambient temperature significantly, these calculations should be verified by actual measurement before committing to a production design.

### Heat Sink Option

The XW Single can be ordered in a "-I" configuration which provides a case with 4 X M3 inserts located on the top surface of the case for attaching a heat sink or mounting the converter on its back. The mounting surface should be flat to within ±0.01 inches to prevent warping the XW Single's case.

The CALEX -HS heat sink was specially developed for this model and can reduce the case temperature rise to below 2.4°C per watt with natural convection and even less with moving air. It also increases the heat removing efficiency of any cooling air flow.

When the -HS is ordered with XW Single, CALEX will ship the converter and heatsink attached. One heat sink is needed for each converter ordered.

Customer installed heat sinks may also be used. It is recommended that either liquid heatsink compound or nothing be used on the heatsink interface. Stay away from the so called “Dry” pad heat sink materials. In our experience these materials are actually worse than using no compound at all. Test them thoroughly before committing to production.

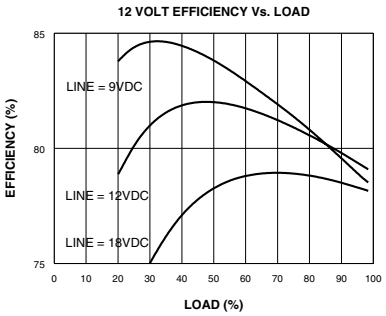
Additional heatsinking will lower internal temperatures and increase the expected operational life.

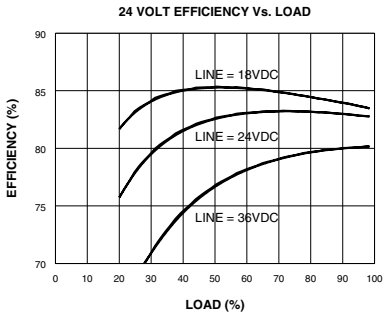
### Chassis Mounting Kit - MS13

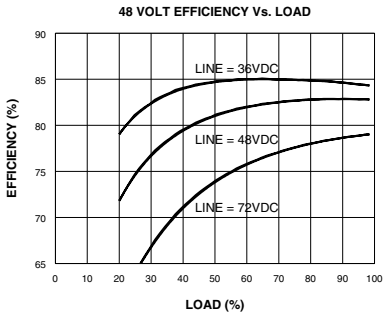
The MS13 chassis mounting kit allows for direct wire connection to the 50/60 Watt Single Series pins. The mounting kit includes two barrier strips for wire attachment, an input fuse and an output trim pot for trimming the +5 Volt output. If the MS13 is ordered at the same time as a 50/60 Watt Single converter the mounting kit will be shipped with the correct fuse size. The MS13 may be conveniently attached to a chassis with the four 0.156 inch diameter mounting holes provided at each corner.

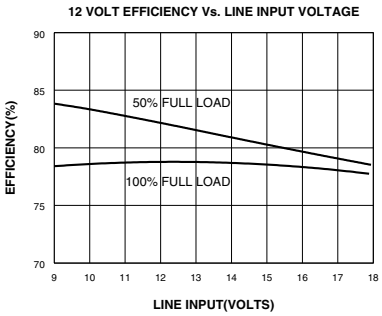
Although the MS13 comes with solderless sockets for the XW Single, it is recommended that it be soldered to the mounting kit for improved reliability in severe environmental or vibration environments.

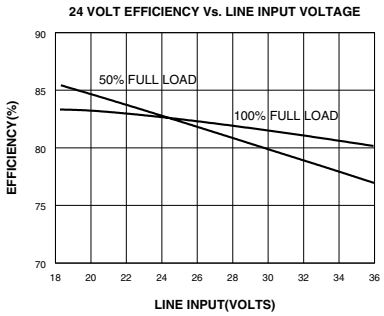
Typical Performance (Tc=25°C, Vin=Nom VDC, Rated Load).

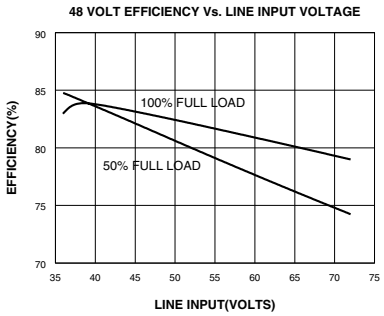


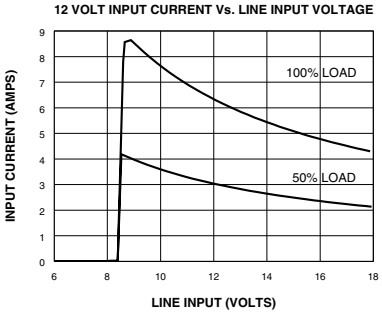



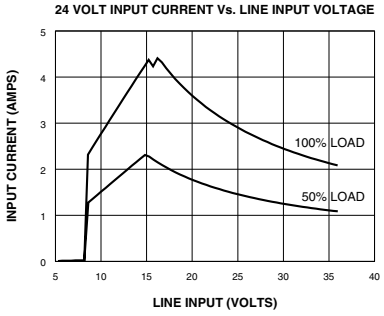



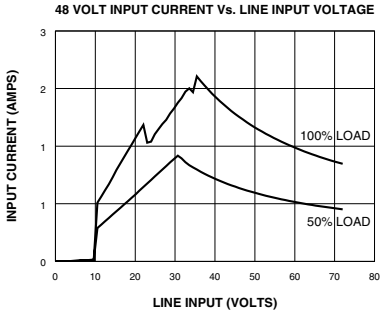



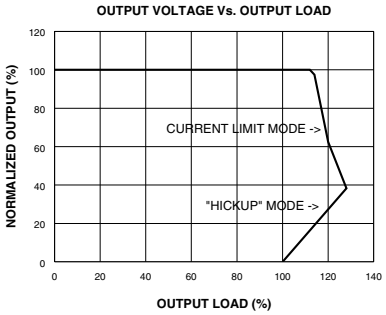



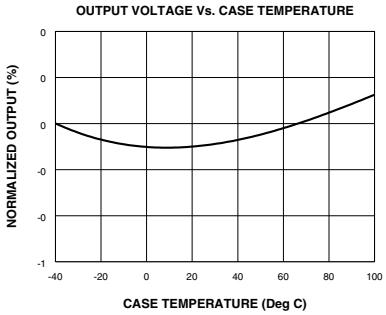



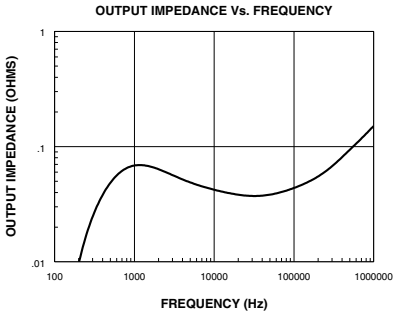



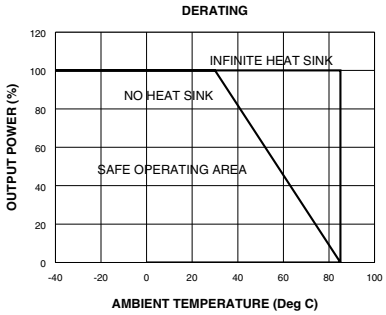



Typical Performance (Tc=25°C, Vin=Nom VDC, Rated Load).



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