# Technical Specification

## S25-48-2.5, S25-48-2.5N

## 48Vin 2.5Vout 7.0A


## Description

The S25 family of high efficiency, low power DC/DC converters offer power levels that exceed other bricks with similar footprints. They are targeted specifically at the telecommunication, industrial electronics, mobile telecommunication and distributed power markets. With a wide input voltage range of 36-75V they are available with output voltages of either 1.5, 1.8, 2.5, 3.3 or 5 Volts. All models feature an input filter, input undervoltage lockout, output overvoltage and overtemperature protection, output current limiting and short circuit protection. The fully enclosed, encapsulated construction with aluminum heat spreader design achieves very efficient heat transfer with no hot spots. The use of patented design concepts facilitate maximum power delivered with the highest efficiency up to 90%. The converters combine creative design concepts with highly derated power devices to achieve very high reliability, high performance and low cost solution to systems designers requiring maximum power in small footprints.

## Applications

- Telecommunications
- Data Communications
- Wireless Communications
- Networking Gear
- Servers, Switches and Data Storage
- Semiconductor Test Equipment
- Distributed Power Architecture

## Features

- Delivers up to 25W in 1.2" x 2.0" format
- High power density up to 30W/inch$^3$
- Synchronous rectification topology
- No airflow or heat sink required
- No minumum load required
- Low profile of only 0.35 inch
- High output current in small footprint
- 1.5V, 1.8V, 2.5V, 3.3V or 5V models
- Wide input operating range 36-75V
- -40°C to +100°C ambient operation
- Input undervoltage lockout
- Output overvoltage protection
- Output current limit and short circuit protection
- On/Off pin
- Output adjustment +/-10% range
- 1500V, 10M input-to-output isolation
- Enclosed construction with heat spreader for low temperature rise
- Enclosed six-sided metal shield construction for low EMI/RFI
- UL 60950 recognized, TUV EN60950 and CSA C22.2 No. 60950-00 Certified
- Meets conducted limits of FCC Class B and CEI IEC61204-3 Class B with external filter
- MTBF of 850,000 hours @ 50°C (MIL-HDBK-217F)

## CONVERTER SELECTION

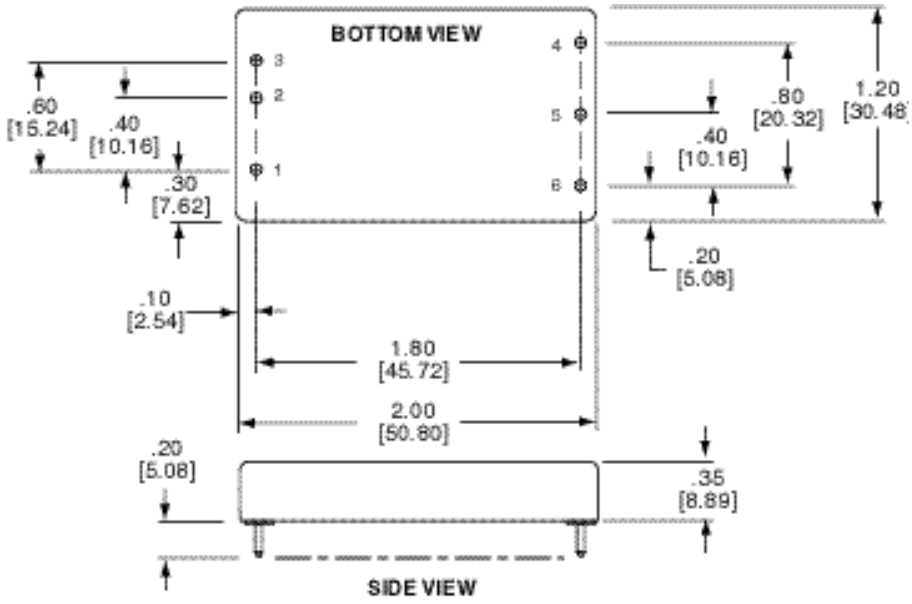
Typical @ $T_a$=+25°C under nominal line voltage and full load conditions.

| Model | Input | | | | Output | | Efficiency 75% Load |
|---|---|---|---|---|---|---|---|
| | Voltage (Volts) | | Current (A) | | Voltage | Current | |
| | Nominal | Range | No load | Full load | (Volts) | (Amps) | (%) |
| **S25-48-2.5** | 48 | 36-75 | 0.050 | 0.475 | 2.5 | 7.0 | 87 |

Consult factory for other output voltage configurations.

## Outline Information and Summary Specifications

| Pin Connection | |
|---|---|
| **Pin#** | **Single Output** |
| 1 | On/Off |
| 2 | Vin - |
| 3 | Vin + |
| 4 | Vout + |
| 5 | Vout - |
| 6 | Trim |




All dimensions are in inches [mm]

All pins are dia. 0.040 [1.02]

Pin material: Brass

Pin finish: Gold plated

Insulator pad around pins: Silicone rubber

Case: Aluminum m aterial with anodized finish

Weight: 39.2 (1.4oz)

| Tolerance | | | |
|---|---|---|---|
| Inches | | Millimeters | |
| •XX | ± 0.020 | •X | ± 0.5 |
| •XXX | ± 0.010 | •XX | ± 0.25 |
| Pin: | ± 0.002 | ± 0.05 | |

Thermal derating for vertical orientation, Vin=54V

| Output Voltage (Volts) | Output Current at 40°C (Amps) | | | Output Current at 60°C (Amps) | | | Output Current at 80°C (Amps) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Free Air | 200 LFM | 300 LFM | Free Air | 200 LFM | 300 LFM | Free Air | 200 LFM | 300 LFM |
| 2.5 | 7.0 | 7.0 | 7.0 | 6.5 | 7.0 | 7.0 | 3.8 | 4.9 | 5.8 |

The information and specifications contained in the specification are believed to be accurate and reliable at the time of publication. Specifications are subject to change without notice.

## Electrical Specifications

Ta=25°C, Vin=48V unless otherwise noted.

| PARAMETER | NOTES | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|
| **Absolute maximum rating** | | | | | |
| Input voltage | | 0 | | 80 | V |
| Operating case temperature | | -40 | | 100 | °C |
| Storage temperature | | -55 | | 125 | °C |
| Humidity | | | | 95 | % |
| **Input characteristics** | | | | | |
| Operating input voltage range | | 36 | 48 | 75 | V |
| Turn on voltage threshold | | | 35 | | V |
| Turn off voltage threshold | | | | 34 | V |
| Transient withstand | Transient duration: 100ms | | | 100 | V |
| Maximum input current | 100% load , 36Vin | | | 0.63 | A |
| Off converter input current | 48Vin | | | 17 | mA |
| **Output characteristics** | | | | | |
| Output voltage set point | | | 2.5 | | V |
| Output voltage line regulation | 36~75 Vin | | | ±0.3 | % |
| Output voltage load regulation | 10%-100%Load | | | ±0.5 | % |
| Output voltage trim range | | | | ±10 | % |
| Output voltage ripple and noise | 20Mz bandwidth, 100% Load, 48Vin | | 50 | 100 | mV(pk-pk) |
| Output over power protection | | 100 | 120 | 140 | % |
| Over-voltage protection | | 3.1 | | 3.5 | V |
| Over-temperature protection | | | 100 | | °C |
| Temperature coefficient | | | | ±0.04 | %/°C |
| Capacitive Load | | 0 | | 100,000 | µF |
| **Output dynamic characteristics** | | | | | |
| Startup time | 5% to 95% of the output voltage | | 50 | 100 | ms |
| Transient recovery time | 25% load change | | | 800 | µs |
| Transient peak deviation | 25% load change | | | 2 | %Vo |
| **Efficiency (see efficiency curve)** | | | | | |
| 100% load efficiency | 48 Vin | | 85 | | % |
| **Isolation characteristics** | | | | | |
| Isolation voltage (primary to secondary ) | 1minute | | 1500 | | VDC |
| Isolation voltage (primary to case) | 1minute | | 1000 | | VDC |
| Isolation voltage (secondary to case) | 1minute | | 1000 | | VDC |
| Isolation resistance | 500VDC, Primary to secondary | 10 | | | MΩ |
| Isolation capacitance | Primary to secondary | | | 1000 | pF |
| **Feature Characteristics** | | | | | |
| Switching frequency | | 225 | 250 | 275 | KHz |
| ON/OFF control (Positive logic)<br>Converter On<br>Converter Off | S25-48-2.5 | <br>3<br>-1 | | <br>7<br>1.2 | <br>V<br>V |
| ON/OFF control (Negative logic)<br>Converter On<br>Converter Off | S25-48-2.5N | <br>-1<br>3 | | <br>1.2<br>7 | <br>V<br>V |
| Output voltage trim range | Percentage of normal output | -10 | | +10 | % |
| Calculated MTBF | Bellcore @ 50°C | 900,000 | | | Hrs |
| Weight | | | 28(1.0) | | g(oz) |

## Basic Operation And Functions

S25-48-2.5/S25-48-2.5N is a high efficiency, isolated DC/DC converter. Neither heat sink nor airflow is required when the unit operates at ambient temperature of 25°C. The unit has basic control, output adjustment and protection functions.

### Input (Pin 2, Pin 3)

Input power Vin(+) must be connected to Positive input pin 3; Input power Vin(-) must be connected to Negative input pin2.

### Output (Pin 4, Pin 6)

Output power Vout(+) must be connected to Positive output pin 4; Output power Vout(-) must be connected to Negative output pin6.

### ON/OFF (Pin 1)

Permits the user to maintain unit On/Off, in order to properly sequence different power supplies and reduce power consumption during the standby condition. There are two ON/OFF control options: positive logic (S25-48-2.5) and negative logic (S25-48-2.5N). Both are referenced to Vin-.

Pin 1 is the "Enable" pin, connecting a TTL compatible pin. A TTL control signal to this pin, according to the specification, turns the unit on or off.

The positive logic unit turns on when the pin is at logic high or open, and turns off at logic low.
The negative logic unit turns on when the pin is at logic low, and turns off at logic high state.
Typical ON/OFF connection is shown in Fig 1.

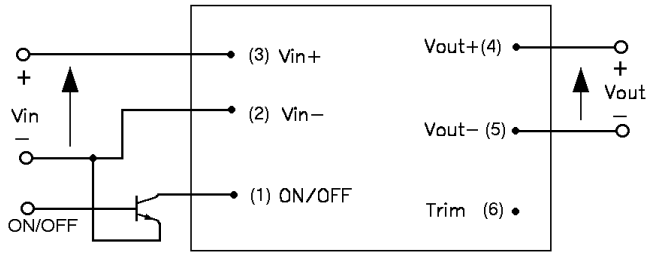



Fig 1. Recommended ON/OFF circuit configuration

### Remote Sense

The unit does NOT have remote sense pins.

### Output Trim (Pin 6)

Permits the user to adjust the output voltage up or down to achieve the custom voltage or to make the output voltage margining.

The unit's output voltage can be adjusted up10% or down 10% relative to the rated output voltage by adding an external resistor between pin 6 and one of the output pins (pin 4 and 5).

To increase the output voltage, a trim resistor should be connected between pin 6(Trim) and pin 5 (Vout-), as shown in Fig 2.

To decrease the output voltage, a trim resistor should be connected between pin 6 (Trim) and pin 4 (Vout+), as shown in Fig 3.

The recommended trim resistor values can be found in the trim table (Table 1) and charts (Fig 4 and 5).

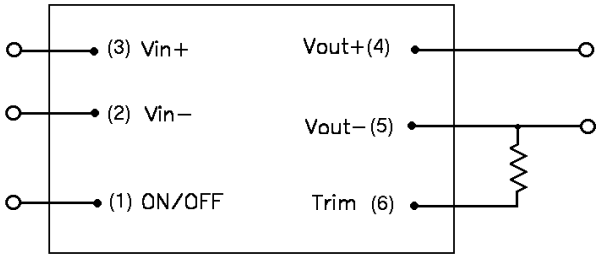



Fig 2. Configuration for increasing the output voltage

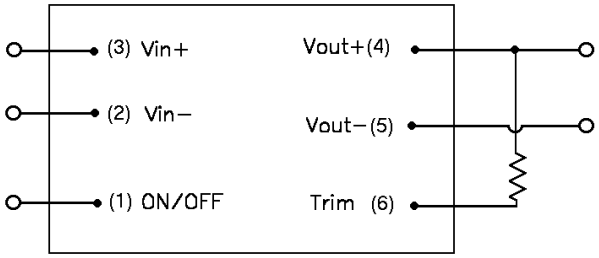



Fig 3. Configuration for decreasing the output voltage

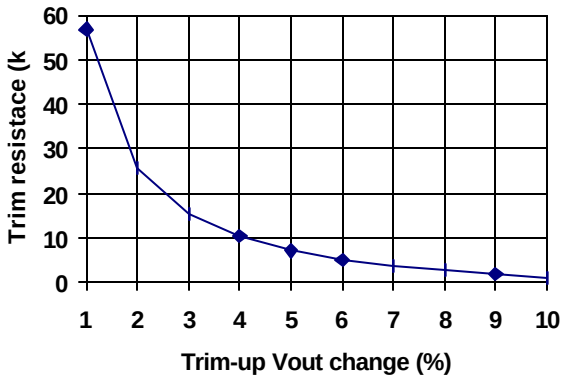



Fig 4 Trim-up output vs. trim resistance

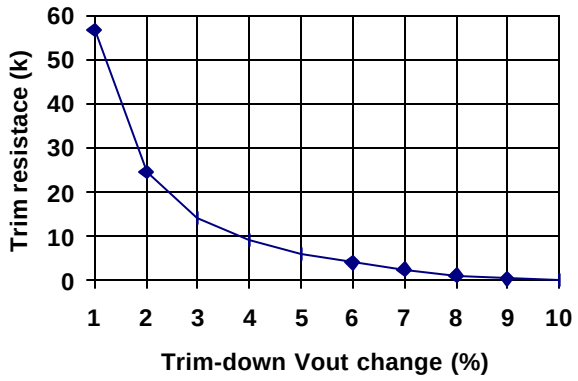



Fig 5 Trim-down output vs. trim resistance

Table 1 Output voltage trim vs. trim resistor value

| Trim Voltage | Trim Resistor | Trim Voltage | Trim Resistor |
|---|---|---|---|
| +10% | 1.17k | -10% | 0.13k |
| +9% | 1.84k | -9% | 0.38k |
| +8% | 2.67k | -8% | 1..34k |
| +7% | 3.76k | -7% | 2.55k |
| +6% | 5.16k | -6% | 4.04k |
| +5% | 7.20k | -5% | 6.14k |
| +4% | 10.49k | -4% | 9.17k |
| +3% | 15.40k | -3% | 14.40k |
| +2% | 25.89k | -2% | 24.69k |
| +1% | 56.85k | -1% | 56.85k |

## Protection Features

### Input under voltage lockout (UVL)

The input voltage must be at least 35V for the unit to turn on. Once the unit has been turned on, it will shut off when the input voltage drops below 34V.

### Output Over-Current Protection (OCP)

The unit is protected against over current or short circuit on the output. When sensing an over current condition, the unit will enter constant current operation and reduce the output voltage. Upon short-circuit condition, the unit will shut down.

After over-current or short circuit condition is removed, the unit will resume normal operation automatically.

### Output Over Voltage Protection (OVP)

This unit will shut down and latch off if the output voltage exceeds the over protection point. The over-voltage-protection latch is reset only by another cycle of the input power.
The OVP set point is between 3.1V~3.5V.

### Over Temperature Protection (OTP)

This unit will shut down if the case temperature exceeds the over temperature set point. The unit will resume normal operation automatically when the case temperature drops down.
The OVP set point is around 100°C.

# Application Considerations

## Input source Impedance

The unit has been designed to be stable with no external capacitor when used in a low inductance input and output circuit.

However in many applications, the inductance with the distribution from the power source to the input of the unit can affect the stability of the unit. An external capacitor across the input will improve the stability of the unit. Also in many applications, the user has to use decoupling capacitors at the output load, to ensure the hold up time for the load.

## Safety Requirements (SR)

The unit meets UL/CSA/TUV safety requirements per UL60950, TUV EN60950 and CSA C22.2 No.60950-00. Basic insulation is provided between input and output.

***Caution:***
The unit does NOT have a fuse inside. The safety agencies require an external normal-blow fuse to be used at the input side to achieve maximum safety. The recommended fuse rating is 2A/100V.

If the input source is non-SELV (ELV or a hazardous voltage greater than 60 Vdc and less than or equal to 75 Vdc), for the unit output to be considered meeting the requirements of safety extra low voltage (SELV), all of the following must be met:

- The input source is to be provided with reinforced insulation from any hazardous voltage, including the ac main.
- The input pins of the unit are not operator accessible.
- For the whole system, for safety agencies requirements, and for the combination of the unit input side (primary side) and the output side (secondary side), verify that under a single fault, hazardous voltages do not appear at the unit output side (secondary side).
- Never ground either of the input pins of the unit without grounding one of the output pins. This may allow a non-SELV voltage to appear between the output pin and ground.

## Electromagnetic Compatibility (EMC)

The unit's conducted emission meets the requirement of EN55022 Class B Specifications, so no external input filter is needed unless a stricter conducted EMI/EMC limitation is required to satisfy or user has its own requirement on the input.

Fig 6 shows the measured conducted EMC.
Six-sided metal shields for zero radiate emission.

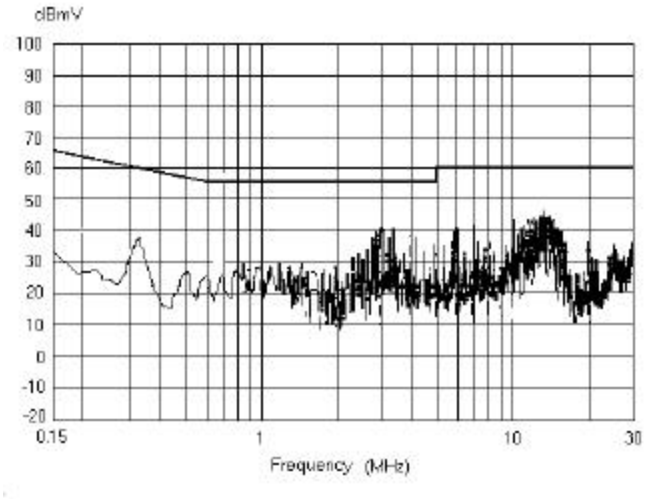



Fig 6. Conducted EMC (150KHz-30MHz) test result, the upper trace is the limit of EN55022 Class B specification

## Input Transient Withstand (ITW)

The unit can withstand input transient voltage with 100V/100ms pulse and never be damaged.

# Characterization

## General information

This unit has many operational characterized aspects including thermal derating, efficiency, start up and overshoot, output ripple & noise, dynamic response, over current protection curve and etc.

The following pages contain specific plots or waveforms associated with the unit. Additional comments for specific data are provided below.

## Test Conditions

All data presented were taken with the unit soldered to a test board, which is a 0.060" thick printed circuit board. No heat sink was used during all measurements. No airflow was used except in the de-rating test.

For the input line, a 1μF /100V ceramic capacitor has been used during all these tests. On the output side, a 10μF tantalum capacitor with Esr < 0.12Ω and 1μF ceramic capacitor has been used. The capacitors on both the input and output sides were close to the unit.

NOTE:
It is important to make sure that the components on the unit do not exceed their rating.

## Start up

The startup scenarios are explained in Fig 7 and 8.
The measured waveforms showing the turn on transient are given in Fig 9 and 10, for both positive and negative logic control units.

## Efficiency

Efficiency vs. load current curve at different inputs of 36V, 48V and 75V is given in Fig 11. The ambient temperature is 25°C.

Efficiency with nominal input (48V) at different ambient temperatures (25°C, 40°C and 55°C) is also given in Fig 12.

## Dynamic Response

The dynamic response of the unit at load step is shown in Fig 13. The output load current change from 50% to 75% and return to 50% at the slew of 0.1A/μs. The input is 48V and a filter of 10μF tantalum capacitor plus a 1μF ceramic capacitor is put parallel to the output.

## Ripple and Noise

The output voltage waveform has been measured at full load condition, with 10μF tantalum capacitor plus 1μF Ceramic capacitor closely parallel to the unit's output. Fig 14 shows the output ripple and noise waveform.

## Thermal De-rating

For thermal de-rating test, the output current vs. the ambient temperature and the airflow rates has been measured, and the results are given in Fig 15.

The ambient temperature varies between 50°C and 85°C with the airflow of 0, 100 and 200LFM (0, 0.5m/s and 1m/s).

## Others

Other curve and waveforms presented include the output voltage vs. current curve (Fig 16) and the input current ripple waveform at full load condition (Fig 17)

## Start up Information

**Scenario #1: Initial Start up from power supply**
On/Off function enabled, the unit starts via input voltage Vin, see Fig 7.

| Time | Comments |
|---|---|
| t0 | On/Off pin is On: system front-end power is switched on, Vin to unit begins to rise. |
| t1 | Vin crosses Under Voltage Lockout protection circuit threshold: the unit enabled to be on |
| t2 | The unit begins to turn on ( unit turn-on delay). |
| t3 | Unit output voltage reaches 100% of normal voltage. |

For this example, the unit total start up time (t3- t1) is typically 200us.

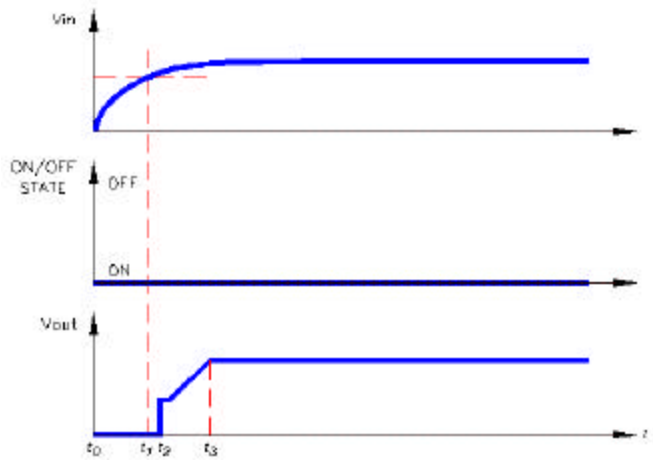



Fig 7. Start up waveform

**Scenario #2: Initial Start up using On/Off Pin**
With Vin previously powered, the unit starts via On/Off pin, see Fig 8.

| Time | Comments |
|---|---|
| t0 | Vin at nominal value. |
| t1 | Arbitrary time when On/Off pin is enabled (Unit enabled) |
| t2 | End of unit turn-on delay |
| t3 | Unit Vout reaches 100% of nominal voltage. |

For this example, the unit total start up time (t3- t1) is typically 300us.

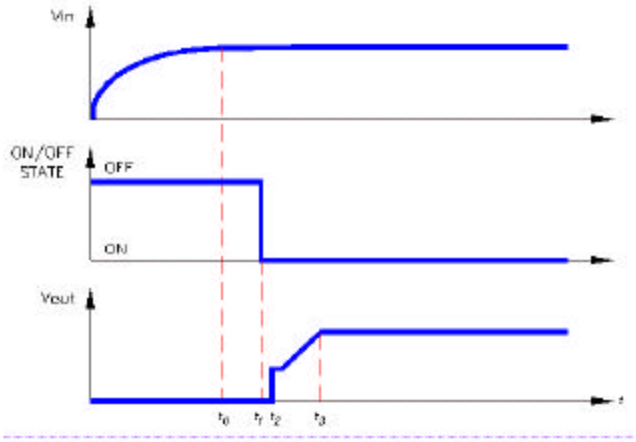



Fig 8. Start up using On/Off pin

## Turn-On Transient Waveforms

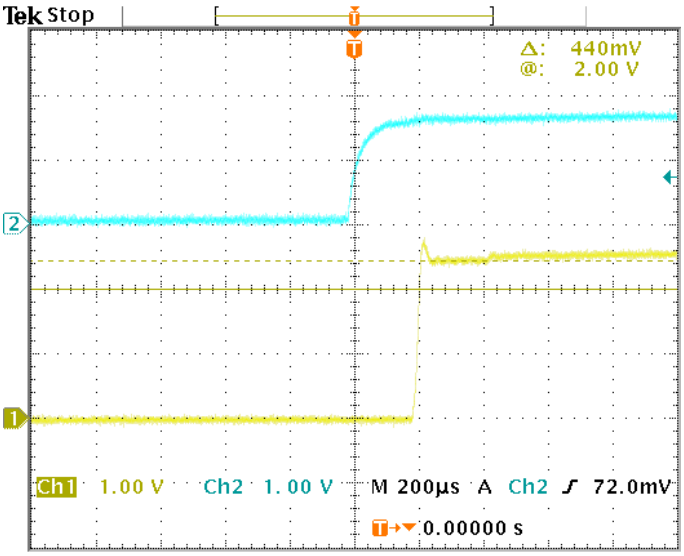



Fig 9. Startup under positive logic control at Vin=48v, Iout =5A. Ch2: ON/OFF signal (1V/div) , Ch1: Output voltage (2V/div), Co=10µF tantalum capacitor + 1µF Ceramic capacitor, time scale: 200µs/div

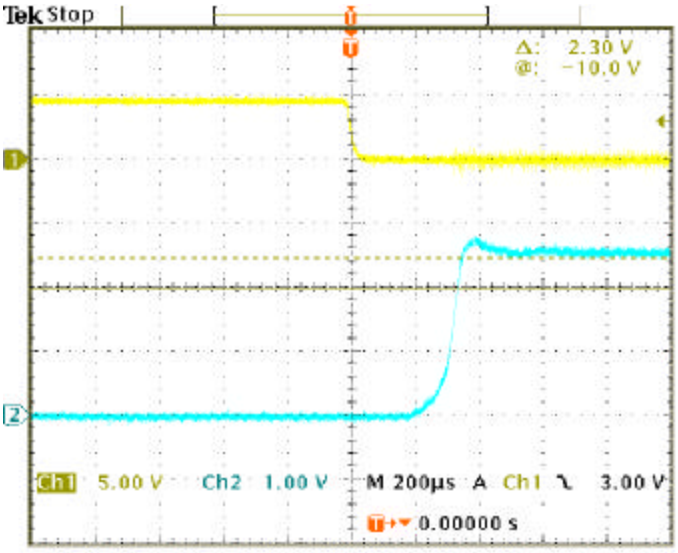



Fig 10. Startup under negative logic control at Vin=48v, Iout =5A. Ch1: ON/OFF signal (5V/div) , Ch2: Output voltage (2V/div), Co=10µF tantalum capacitor + 1µF Ceramic capacitor, time scale: 200µs/div

## Efficiency Curves

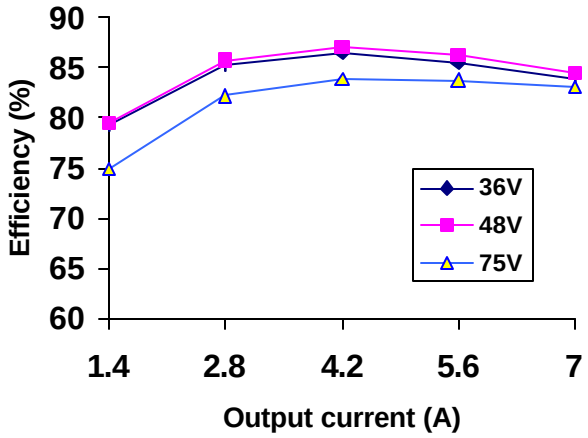



Fig 11. Efficiency vs. output current at various Input voltage The ambient temperature is 25°C.

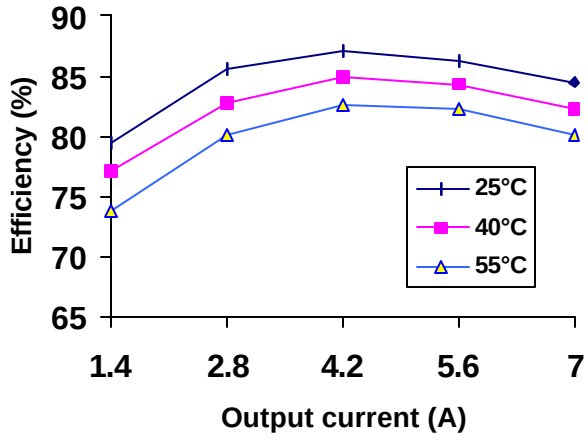



Fig 12. Efficiency at nominal input (48V) vs. load at different ambient temperatures of 25°C, 40°C, 55°C without air flow, the input voltage is 48V.

## Dynamic Response Waveform

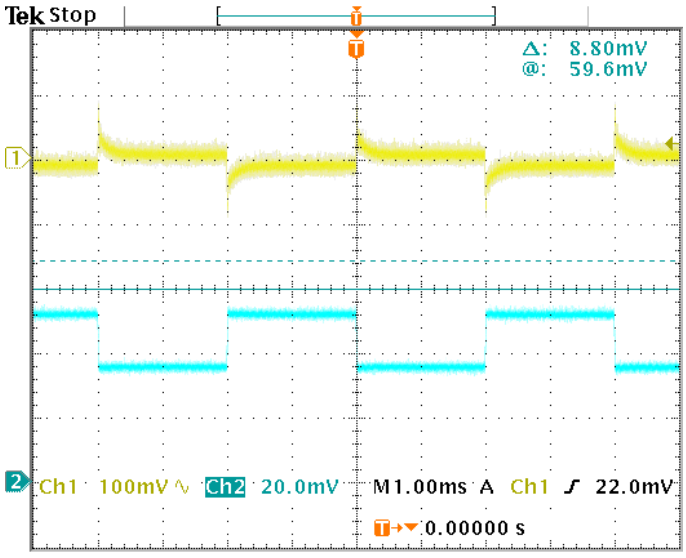



Fig 13. Dynamic response of load step at Vin=48v, Ch1: output voltage change(100mv/div), Ch2: output current step of 50%-75%-50% (2A/div). Current slew rate:0.1A/μs, Co=10μF tantalum capacitor + 1μF Ceramic capacitor, time scale: 1ms/div

## Output Ripples and Noise Waveform

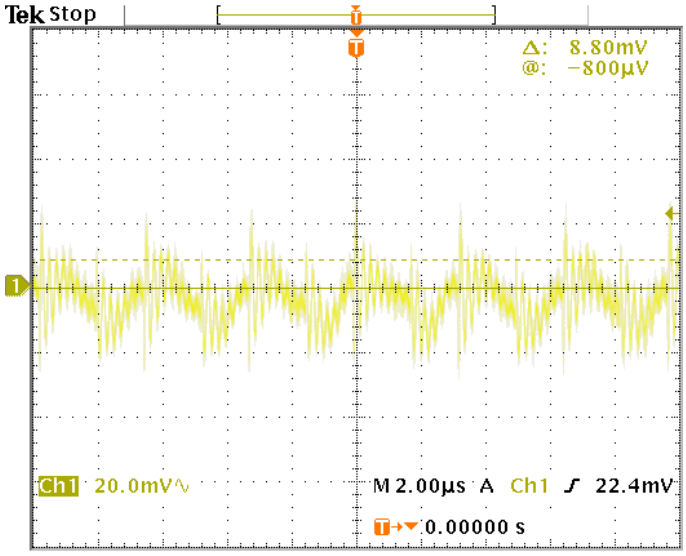



Fig 14. Output voltage Ripple & Noise at Vin=48v, Iout=5A Co=10μF tantalum capacitor + 1μF Ceramic capacitor, ch1: 20mV/div, time scale: 2μs/div.

## Thermal De-Rating Curve

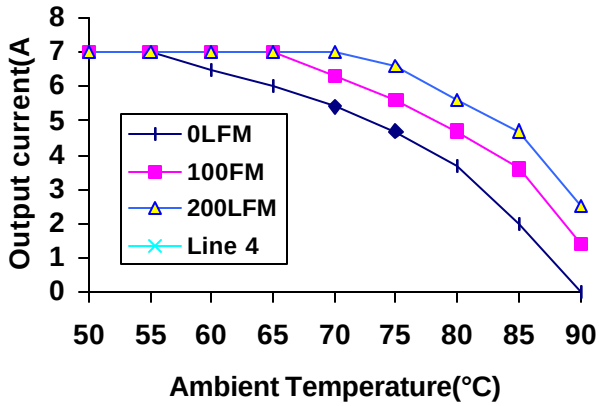



Fig 15. Maximum output current vs. temperature. Both the input and output voltages are nominal.

## Over Current Protection Curve

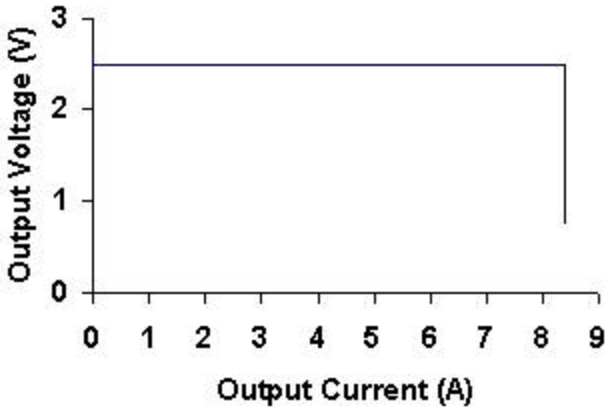



Fig 16. Output voltage vs current showing current limit point and converter shut down point

## Input Current Ripple Waveform

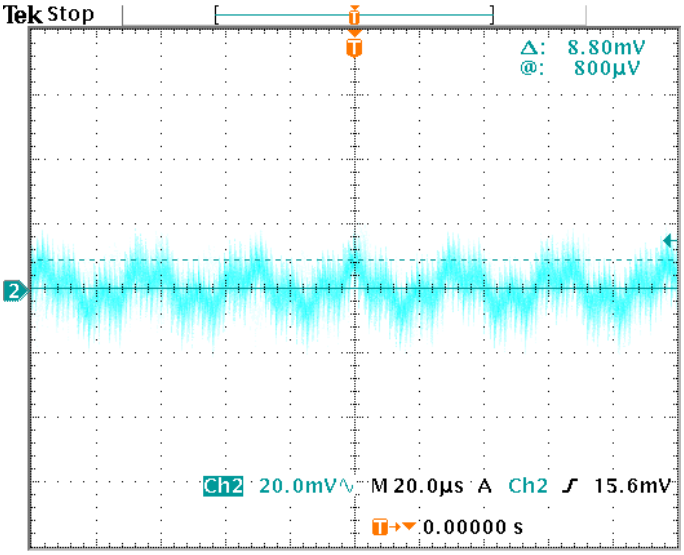



Fig 17. Input current ripple with full output load at 48V input (50mA/div), time scale: 1µs/div