



# FS SERIES

## ISOLATED, PROPORTIONAL DC TO HIGH VOLTAGE DC CONVERTERS

200V to 6000V @ 10 Watts



### PRODUCT DESCRIPTION

This new line of miniature DC to High Voltage DC converters offers performance and reliability improvements, and enhanced features over current offerings. Outputs ranging from 200VDC through 6000VDC are offered in miniature, cost effective, PC mount packages. Improved performance and reliability are achieved using EMCO's proven high voltage power conversion technology, while new smart features are added to enhance reliability in harsh, mission-critical applications.

Low ripple, and low EMI/RFI, allow for easy design integration into compact, sensitive equipment. Wide input voltage operating range, starting at just 0.7V in, and excellent input-to-output linearity provide easy control of the high voltage.

Arc protection, short circuit protection, output surge current limiting, over-temperature protection, and input over-voltage protection create a robust module capable of withstanding abuse while maximizing reliability in the field. Automatic non-latching shutdown and an error signal output are activated when pre-set temperature or input voltage limits are exceeded. An externally controlled disable function is standard.

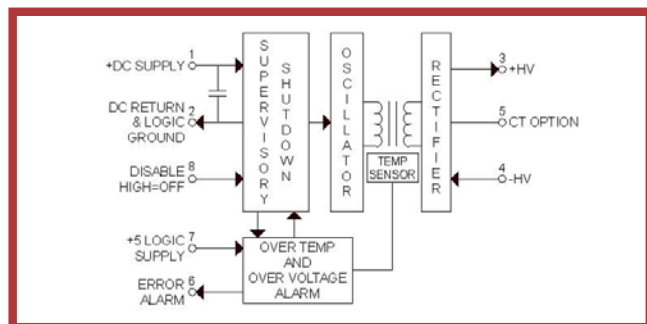
Advanced internal thermal management techniques, a proprietary encapsulating formula and an external heat sink surface combine to produce a reliable, easy to use high voltage converter engineered for decades of maintenance-free operation in demanding environments.

The FS design solution is manufactured in EMCO's "Flex-Chain" lean, demand-flow process that provides maximum quality, consistent high reliability, short lead-times, and assures our customers the lowest cost of ownership.

**Generous quantity discounts are offered.**

**Typical delivery: stock to one week.**

**Call or email with your requirements today!**



### APPLICATIONS

Electrophoresis  
Piezo Devices  
Capacitor Charging  
Mass Spectrometry  
Electrostatic Chucks

### PRODUCT SELECTION TABLE

BASE MODEL	OUTPUT VOLTAGE <sup>2</sup>	OUTPUT CURRENT <sup>1</sup>	OUTPUT POWER <sup>4</sup>
FS02	0 to 200VDC	50mA	0 to 10W
FS05	0 to 500VDC	20mA	0 to 10W
FS10	0 to 1000VDC	10mA	0 to 10W
FS20	0 to 2000VDC	5mA	0 to 10W
FS30	0 to 3000VDC	3.33mA	0 to 10W
FS40	0 to 4000VDC	2.5mA	0 to 10W
FS50	0 to 5000VDC	2mA	0 to 10W
FS60	0 to 6000VDC	1.67mA	0 to 10W

Complete List of Models on pages 2 and 3

### FEATURES

- Output Proportional and Linear to Input  
<0.7V Turn-on Voltage
- **SMART FEATURES** for Enhanced Reliability:
  - Over-Temperature Protection with Automatic Shutdown and Error Code
  - Over-Voltage Protection with Automatic Shutdown and Error Code Output
- Disable Pin, TTL Compatible High=Off
- No Minimum Load Current Required
- Low Noise, Quasi-Sinewave Oscillator
- Inaudible >25kHz Oscillator, Low EMI/RFI
- Low Conducted Emissions and Low Input Ripple Current
- Stable Operating Frequency Over Entire Operating Range
- High Input to Output Galvanic Isolation
- Very Low Input/Output Leakage Current, <100nA
- Very Low Input/Output Coupling Capacitance, <100pF
- Reversible Output Polarity (4kV Modules and below)
- High Efficiency, No Derating Required
- Robust Design: Conservative Internal High Voltage Clearance and Voltage Gradient Control for Exceptional Long Term Reliability
- Arc Protection and Short Circuit Protection<sup>\*5</sup>
- Output Surge Current Limited
- High Reliability, MTBF > 840,000 hours, per Belcore TR 332
- Excellent Internal Thermal Management
- Anodized Aluminum Heatsink Surface
- Two Threaded, Blind Inserts Allow For Easy Heatsinking and/or Chassis Mounting Options
- Designed to meet RoHS Directive
- Industry Standard Pin Pattern (Option B, without Enhanced Features)

### OPTIONS

- Available in Four Standard Input Voltage Ranges: 0 to 12, 15, 24, and 28VDC.  
(For Other Input / Output Voltages, Consult Factory)
- Polarity: Choose Negative or Positive Outputs for Models FS50 and FS60
- Output Center Tap: Available for Models FS02CT through FS40CT
- B Version - Without Enhanced Features. See 'B' drawing.
- Extended Operating Temperature: -55° to +85°C (Case)(-T Option)
- Extended Environmental Screening and Burn-In Available, Consult Factory



www.emcohighvoltage.com  
e-mail: sales@emcohighvoltage.com  
phone: (209) 267-1630, fax (209) 267-0282  
70 Forest Products Rd., Sutter Creek, CA 95685 USA

## FS02 - FS60 (200V to 6000V)

MODEL	INPUT VOLTAGE (VDC)	INPUT CURRENT <sup>*1</sup>		OUTPUT VOLTAGE <sup>*2</sup>	INPUT CAPACITANCE	MAXIMUM OUTPUT CURRENT <sup>*1</sup>	RIPPLE P-P	FREQUENCY (kHz)
		NO LOAD	FULL LOAD					
REVERSIBLE - units may be connected with positive or negative output polarity.								
FS02-12	0 to 12	<0.30A	<1.25A	0 to 200VDC	188μF	50mA	2.5%	40-60
FS02-15	0 to 15	<0.25A	<1.15A	0 to 200VDC	188μF	50mA	2.5%	40-60
FS02-24	0 to 24	<0.15A	<0.60A	0 to 200VDC	88μF	50mA	2%	40-60
FS02-28	0 to 28	<0.125A	<0.50A	0 to 200VDC	88μF	50mA	2%	40-60
FS05-12	0 to 12	<0.30A	<1.15A	0 to 500VDC	188μF	20mA	<2%	25-35
FS05-15	0 to 15	<0.25A	<1.0A	0 to 500VDC	188μF	20mA	<2%	25-35
FS05-24	0 to 24	<0.15A	<0.57A	0 to 500VDC	88μF	20mA	<1%	35-45
FS05-28	0 to 28	<0.125A	<0.50A	0 to 500VDC	88μF	20mA	<1%	40-50
FS10-12	0 to 12	<0.30A	<1.15A	0 to 1000VDC	188μF	10mA	<1%	25-35
FS10-15	0 to 15	<0.25A	<1.0A	0 to 1000VDC	188μF	10mA	<1%	25-35
FS10-24	0 to 24	<0.15A	<0.57A	0 to 1000VDC	88μF	10mA	<0.5%	45-55
FS10-28	0 to 28	<0.125A	<0.50	0 to 1000VDC	88μF	10mA	<0.3%	55-65
FS20-12	0 to 12	<0.30A	<1.15A	0 to 2000VDC	188μF	5mA	<2.5%	40-50
FS20-15	0 to 15	<0.25A	<1.0A	0 to 2000VDC	188μF	5mA	<2.5%	40-50
FS20-24	0 to 24	<0.15A	<0.57A	0 to 2000VDC	88μF	5mA	<1%	45-55
FS20-28	0 to 28	<0.125A	<0.50A	0 to 2000VDC	88μF	5mA	<1%	50-60
FS30-12	0 to 12	<0.30A	<1.15A	0 to 3000VDC	188μF	3.33mA	<2%	35-45
FS30-15	0 to 15	<0.25A	<1.0A	0 to 3000VDC	188μF	3.33mA	<2%	35-45
FS30-24	0 to 24	<0.15A	<0.57A	0 to 3000VDC	88μF	3.33mA	<1%	45-55
FS30-28	0 to 28	<0.125A	<0.50A	0 to 3000VDC	88μF	3.33mA	<1%	45-55
FS40-12	0 to 12	<0.30A	<1.15A	0 to 4000VDC	188μF	2.5mA	<1.5%	35-45
FS40-15	0 to 15	<0.25A	<1.0A	0 to 4000VDC	188μF	2.5mA	<1.5%	35-45
FS40-24	0 to 24	<0.15A	<0.57A	0 to 4000VDC	88μF	2.5mA	<1%	35-45
FS40-28	0 to 28	<0.125A	<0.50A	0 to 4000VDC	88μF	2.5mA	<0.75%	40-50
POSITIVE POLARITY UNITS								
FS50P-12	0 to 12	<0.40A	<1.50A	0 to 5000VDC	188μF	2mA	<2.5%	40 - 60
FS50P-15	0 to 15	<0.34A	<1.125A	0 to 5000VDC	188μF	2mA	<2.5%	40 - 60
FS50P-24	0 to 24	<0.20A	<0.75A	0 to 5000VDC	88μF	2mA	<1.5%	40 - 60
FS50P-28	0 to 28	<0.105A	<0.40A	0 to 5000VDC	88μF	2mA	<1.5%	40 - 60
FS60P-12	0 to 12	<0.40A	<1.50A	0 to 6000VDC	188μF	1.67mA	<2.5%	40 - 60
FS60P-15	0 to 15	<0.34A	<1.125A	0 to 6000VDC	188μF	1.67mA	<2.5%	40 - 60
FS60P-24	0 to 24	<0.20A	<0.75A	0 to 6000VDC	88μF	1.67mA	<1.5%	40 - 60
FS60P-28	0 to 28	<0.105A	<0.40A	0 to 6000VDC	88μF	1.67mA	<1.5%	40 - 60
NEGATIVE POLARITY UNITS								
FS50N-12	0 to 12	<0.40A	<1.50A	0 to -5000VDC	188μF	2mA	<2.5%	40 - 60
FS50N-15	0 to 15	<0.34A	<1.125	0 to -5000VDC	188μF	2mA	<2.5%	40 - 60
FS50N-24	0 to 24	<0.20A	<0.75A	0 to -5000VDC	88μF	2mA	<1.5%	40 - 60
FS50N-28	0 to 28	<0.105A	<0.40A	0 to -5000VDC	88μF	2mA	<1.5%	40 - 60
FS60N-12	0 to 12	<0.40A	<1.50A	0 to -6000VDC	188μF	1.67mA	<2.5%	40 - 60
FS60N-15	0 to 15	<0.34A	<1.125A	0 to -6000VDC	188μF	1.67mA	<2.5%	40 - 60
FS60N-24	0 to 24	<0.20A	<0.75A	0 to -6000VDC	88μF	1.67mA	<1.5%	40 - 60
FS60N-28	0 to 28	<0.105A	<0.40A	0 to -6000VDC	88μF	1.67mA	<1.5%	40 - 60



## Center Tap Models: FS02CT - FS40CT (+/-100V to +/-2000V)

MODEL	INPUT VOLTAGE (VDC)	INPUT CURRENT <sup>*1</sup>		OUTPUT VOLTAGE <sup>2</sup>	INPUT CAPACITANCE	MAXIMUM OUTPUT CURRENT <sup>*1</sup>	RIPPLE P-P	FREQUENCY (kHz)
		NO LOAD	FULL LOAD					
CENTERED TAPPED - units supply both polarities with respect to a center-tap return								
FS02CT-12	0 to 12	<0.30A	<1.25A	0 to +/-100VDC	188µF	50mA	2.5%	40-60
FS02CT-15	0 to 15	<0.25A	<1.15A	0 to +/-100VDC	188µF	50mA	2.5%	40-60
FS02CT-24	0 to 24	<0.15A	<0.60A	0 to +/-100VDC	88µF	50mA	2%	40-60
FS02CT-28	0 to 28	<0.125A	<0.50A	0 to +/-100VDC	88µF	50mA	2%	40-60
FS05CT-12	0 to 12	<0.30A	<1.15A	0 to +/-250VDC	188µF	20mA	<2%	25-35
FS05CT-15	0 to 15	<0.25A	<1.0A	0 to +/-250VDC	188µF	20mA	<2%	25-35
FS05CT-24	0 to 24	<0.15A	<0.57A	0 to +/-250VDC	88µF	20mA	<1%	35-45
FS05CT-28	0 to 28	<0.125A	<0.50A	0 to +/-250VDC	88µF	20mA	<1%	40-50
FS10CT-12	0 to 12	<0.30A	<1.15A	0 to +/-500VDC	188µF	10mA	<1%	25-35
FS10CT-15	0 to 15	<0.25A	<1.0A	0 to +/-500VDC	188µF	10mA	<1%	25-35
FS10CT-24	0 to 24	<0.15A	<0.57A	0 to +/-500VDC	88µF	10mA	<0.5%	45-55
FS10CT-28	0 to 28	<0.125A	<0.50	0 to +/-500VDC	88µF	10mA	<0.3%	55-65
FS20CT-12	0 to 12	<0.30A	<1.15A	0 to +/-1000VDC	188µF	5mA	<2.5%	40-50
FS20CT-15	0 to 15	<0.25A	<1.0A	0 to +/-1000VDC	188µF	5mA	<2.5%	40-50
FS20CT-24	0 to 24	<0.15A	<0.57A	0 to +/-1000VDC	88µF	5mA	<1%	45-55
FS20CT-28	0 to 28	<0.125A	<0.50A	0 to +/-1000VDC	88µF	5mA	<1%	50-60
FS30CT-12	0 to 12	<0.30A	<1.15A	0 to +/-1500VDC	188µF	3.33mA	<2%	35-45
FS30CT-15	0 to 15	<0.25A	<1.0A	0 to +/-1500VDC	188µF	3.33mA	<2%	35-45
FS30CT-24	0 to 24	<0.15A	<0.57A	0 to +/-1500VDC	88µF	3.33mA	<1%	45-55
FS30CT-28	0 to 28	<0.125A	<0.50A	0 to +/-1500VDC	88µF	3.33mA	<1%	45-55
FS40CT-12	0 to 12	<0.30A	<1.15A	0 to +/-2000VDC	188µF	2.5mA	<1.5%	35-45
FS40CT-15	0 to 15	<0.25A	<1.0A	0 to +/-2000VDC	188µF	2.5mA	<1.5%	35-45
FS40CT-24	0 to 24	<0.15A	<0.57A	0 to +/-2000VDC	88µF	2.5mA	<1%	35-45
FS40CT-28	0 to 28	<0.125A	<0.50A	0 to +/-2000VDC	88µF	2.5mA	<0.75%	40-50

### ELECTRICAL SPECIFICATIONS<sup>\*3</sup>

- TURN-ON VOLTAGE: 0.7 Volts typical
- ISOLATION: 2,500 Volts + Vout
- EFFICIENCY: 75% - 85% Typical
- OPERATING TEMP: -25° to +75°C (Case)
- OPTIONAL EXTENDED OPERATING TEMP: -55° to +85°C
- STORAGE TEMPERATURE: -55° to +85°C
- OUTPUT VOLTAGE TOLERANCE: +/-3% Full Load

## DETAILED PRODUCT DESCRIPTION

The new FS Series of isolated, proportional DC to High Voltage DC Converters offers stout design and enhanced features for excellent long term reliability. Outputs ranging from 200VDC through 6000 VDC are offered in miniature, cost effective, PC mount packages. Based on EMCO's proven high reliability, high voltage power conversion topology, the FS Series boasts a full ten watts of output power for each model and features a low 0.7 volt turn-on voltage. The output voltage is proportional to the input voltage, from turn on to maximum output voltage, enabling easy control of the high voltage. EMCO's proprietary, quasi-sinewave, resonant oscillator produces clean, reliable high voltage with inherently low ripple, low EMI/RFI, low input ripple current and low conducted emissions. The frequency of the oscillator is stable throughout the operating range, allowing for easy additional filtering and always operates well above the audio frequency range.

This series features sturdy, galvanic input to output high voltage isolation, conservatively rated at +/-2500V + Vout with less than 100pF of coupling capacitance and less than 100nA of leakage current. Robustness and high reliability have been designed in to each model by incorporating output arc surge current limiting and indefinite short circuit protection. Careful control over internal voltage gradients extends the useful life calculated. Mean Time Between Failure (per Bellcore TR-332) exceeds 840,000 hours.

In addition, the internal transformer temperature and input voltage are actively monitored with supervisory circuits and fed into a shut down circuit, preventing excessive input voltage or over temperature failures. Should preset limits be exceeded, the module will automatically shut down and issue an error signal on pin 6 (TTL high).

When the fault condition is removed, the unit restores itself to normal operation, ensuring maximum reliability in the field. However, the pin 6 error signal will remain high until reset by power cycling the +5V logic. The fault monitor circuit is powered by an external 5V to allow for 0.7 to full input voltage proportional operation of the high voltage converter. The FS Series also features an enable/disable function. A TTL High signal on Pin #8 disables the high voltage output.

High power conversion efficiency, coupled with low internal thermal resistance creates a vigorous package able to withstand wide operating temperatures. A unique integrated anodized aluminum heatsink surface features two threaded blind inserts which allow for optimal thermal management via external heatsink for high temperature operation and/or convenient chassis mounting configurations. A special proprietary encapsulating formula optimizes internal dielectric strength that is UL-94V0 compliant while low thermal resistance minimizes internal component temperature rise, resulting in a robust module optimized for long term reliability.

Generous quantity discounts are offered.  
Typical delivery: stock to one week. Call or e-mail with your requirements today.



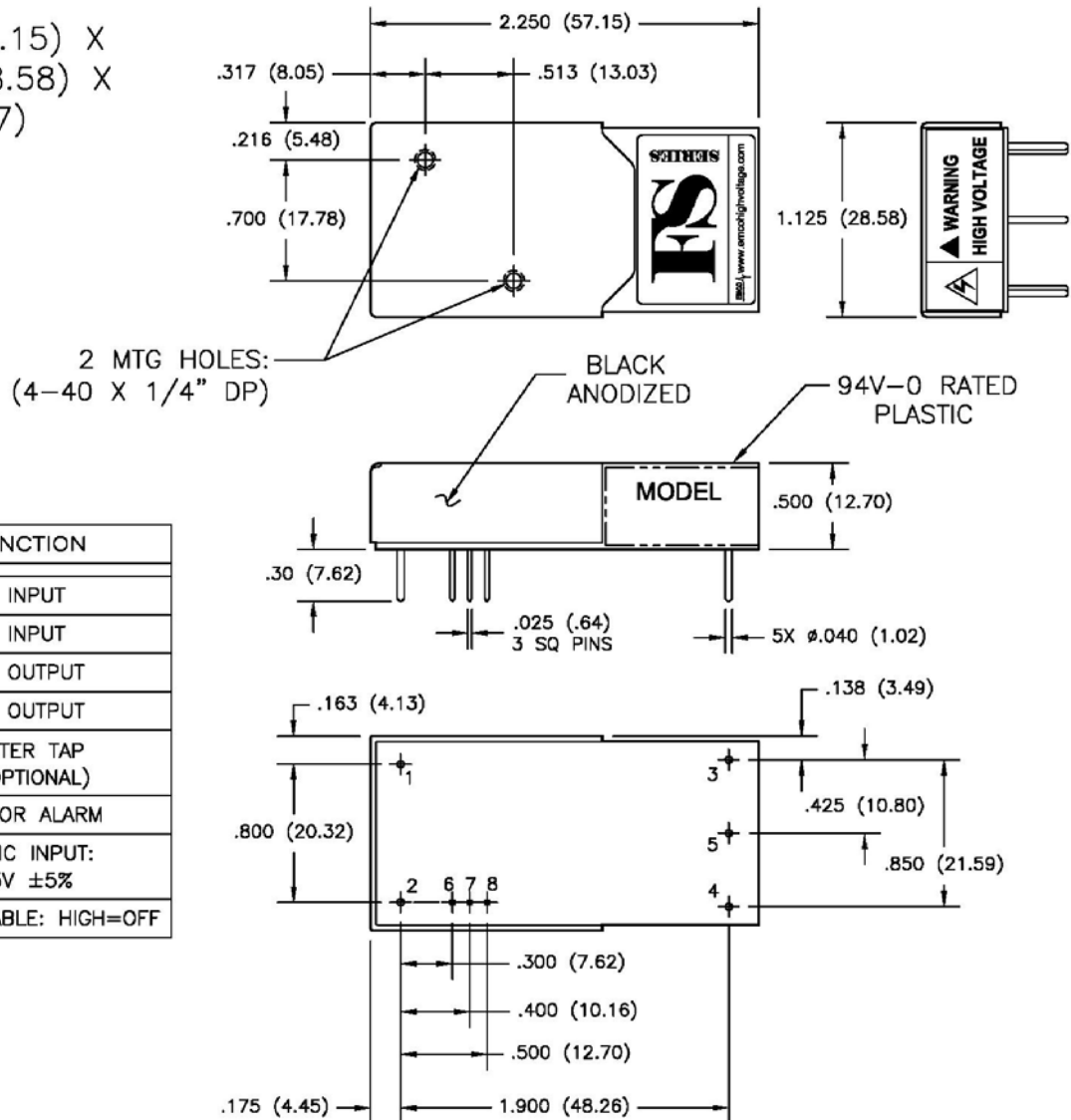
www.emcohighvoltage.com  
e-mail: sales@emcohighvoltage.com  
phone: (209) 267-1630, fax (209) 267-0282  
70 Forest Products Rd., Sutter Creek, CA 95685 USA

## FS SERIES (Includes Smart Features)

WEIGHT: <1.6 OZ. (45 GRAMS)

### DIMENSIONS:

2.250L (57.15) X  
1.125W (28.58) X  
.500H (12.7)



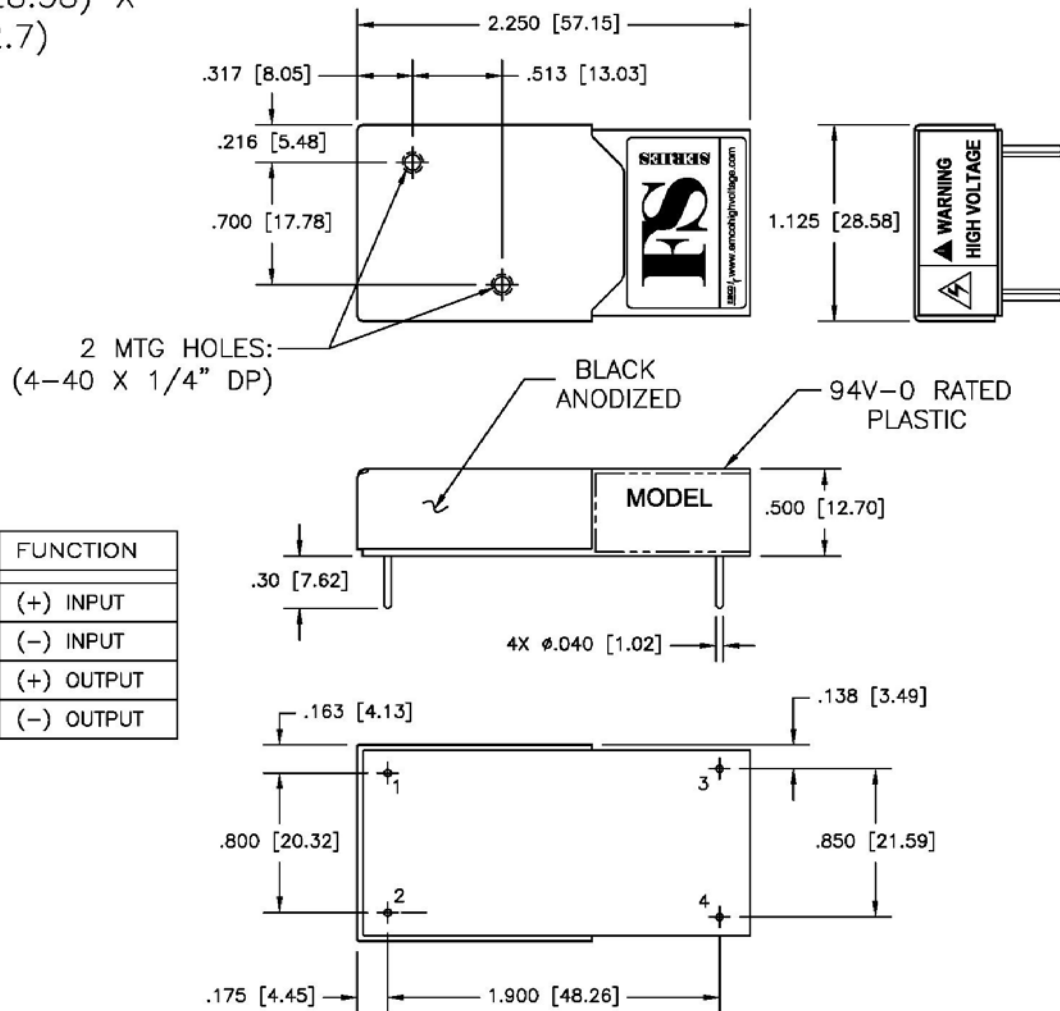
PIN#	FUNCTION
1	(+) INPUT
2	(-) INPUT
3	(+) OUTPUT
4	(-) OUTPUT
5	CENTER TAP (OPTIONAL)
6	ERROR ALARM
7	LOGIC INPUT: +5V ±5%
8	DISABLE: HIGH=OFF

## FS SERIES, B Option (Without Smart Features)

WEIGHT: <1.6 OZ. (45 GRAMS)

### DIMENSIONS:

2.250L (57.15) X  
1.125W (28.58) X  
.500H (12.7)



PIN#	FUNCTION
1	(+) INPUT
2	(-) INPUT
3	(+) OUTPUT
4	(-) OUTPUT

## OPTIONS

### Polarity Designator

**Blank** - For Units that can be used as Positive or Negative (Models FS02 thru FS60)

**CT** - For Units with Center Tap Option (Models FS02CT thru FS60CT)

**P** - For Positive Output (Models FS50P thru FS60P)

**N** - For Negative Output (Models FS50N thru FS60N)

### Input Voltage

Choose **12, 15, 24**, or **28** for Input Voltage Range (For Other Input/Output Voltages, Consult Factory)

### Smart Features

**Blank** - Includes Shutdown Features

**B** - No Internal or External Shutdown Smart Features

### Temperature

**Blank** - Standard Operating Temp -25° to +75°C (Case Temp)

**T** - Extended Operating Temperature -55° to +85°C (Case Temp)

## HOW TO ORDER

### PART NUMBER SELECTOR:

Model Number:

**FS 50 N -12**



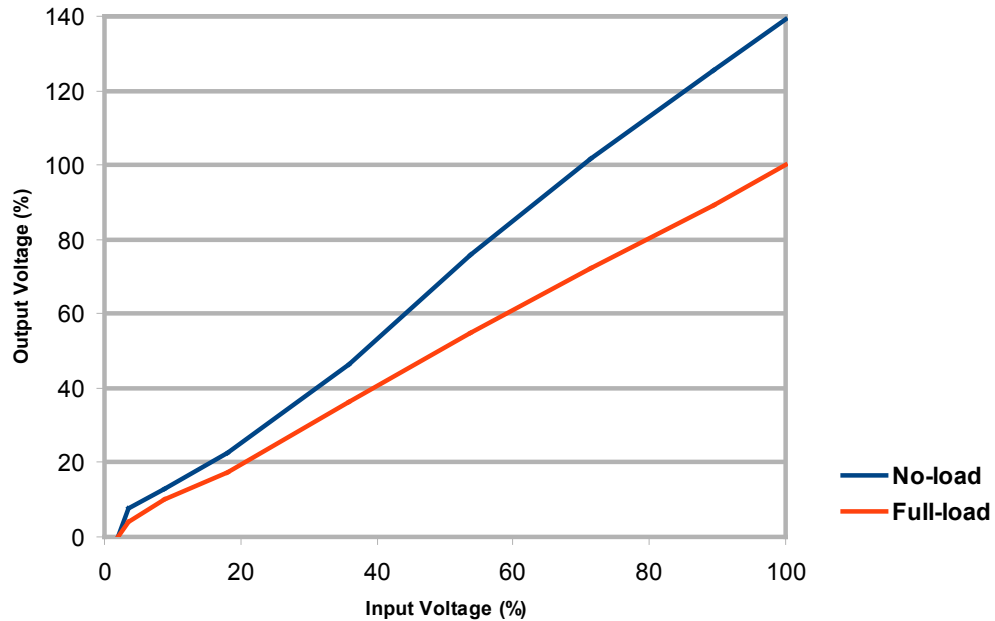
EXAMPLE: **FS50N-12** (**FS**-Series, **50** - Output Voltage, **N** - Negative, **12** - Input Voltage, **Blank** - with Smart Features, **Blank** - Standard Operating Temperature)





## APPLICATION NOTES

### Output Voltage vs. Input Voltage



The FS Series power supplies are provided with internal input over-voltage and over-temperature protection. In the event the input voltage or internal temperature exceeds a preset level, the power supply will be temporarily disabled. A TTL compatible, latching Alarm signal transitions from low to high to indicate an alarm condition has occurred.

Once all alarm conditions are cleared, the power supply will resume normal operation. The alarm output signal will remain high to indicate an alarm event has occurred. To clear the alarm output, the +5V logic input must be toggled low for >250 ms, then returned high.

The protection circuits are powered by the +5V logic input voltage and draw <25 mA.



FS - VM ADAPTER BOARD

DIMENSIONS:

2.87L (72.9)

.44W (11.2)

1.35H (34.3)

WEIGHT: <1 OZ. (28.3 GRAMS)

ORDERING INFORMATION:  
When ordering  
FS Series Vertical Mount Kit,  
the adapter board  
must be ordered separately.

PIN#	FUNCTION
1	(+) IN
2	(-) IN
3	(+) OUT
4	(-) OUT
5	CENTER TAP
6	ERROR ALARM
7	LOGIC IN
8	DISABLE

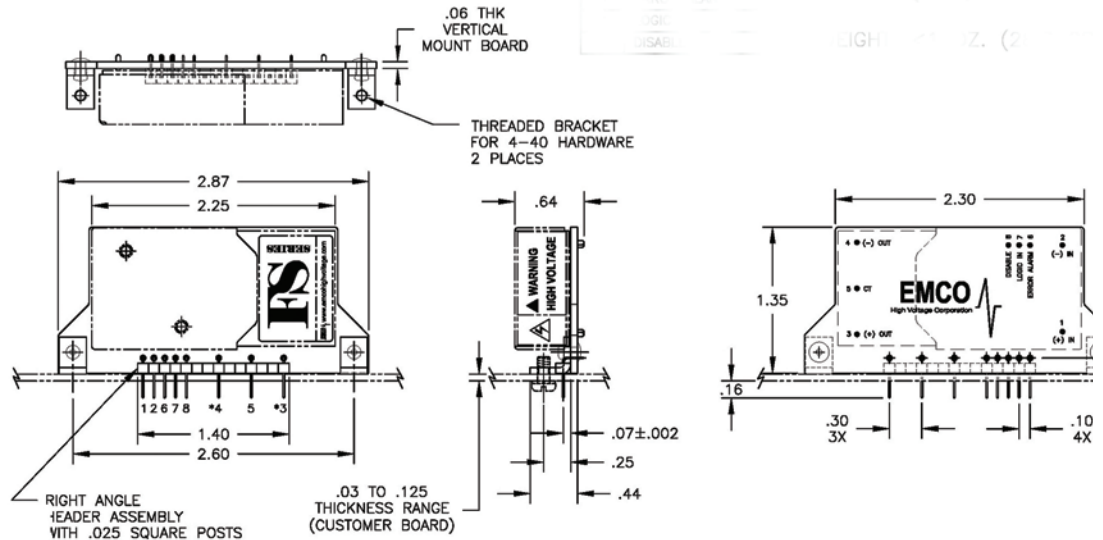
EMCO INS:

4V 1

35 (34)

WEIGHT: <1 OZ. (28.3 GRAMS)

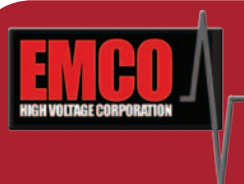
PIN#	FUNCTION
1	(+) IN
2	(-) IN
3	(+) OUT
4	(-) OUT FOR NEG FS
5	(-) OUT (+) OUT FOR NEG FS
6	CENTER TAP
7	ERROR ALARM
8	LOGIC IN
8	DISABLE



This FS-VM adaptor board provides a convenient way to mount any FS Series high voltage power supply DC to high voltage DC converter on its side, minimizing the X-Y footprint to conserve board real estate.

ORDERING INFORMATION:

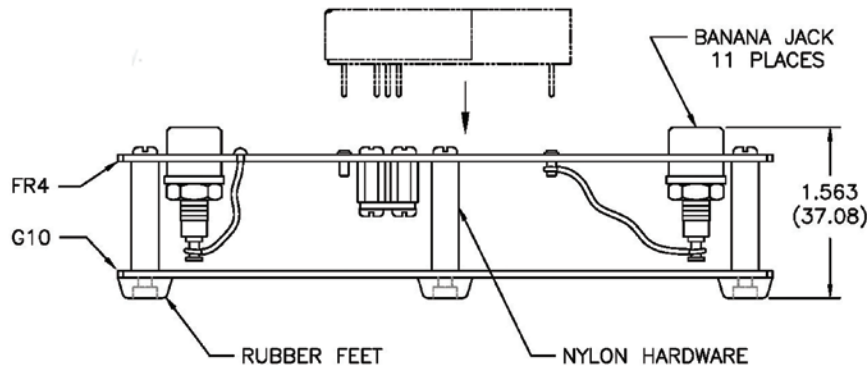
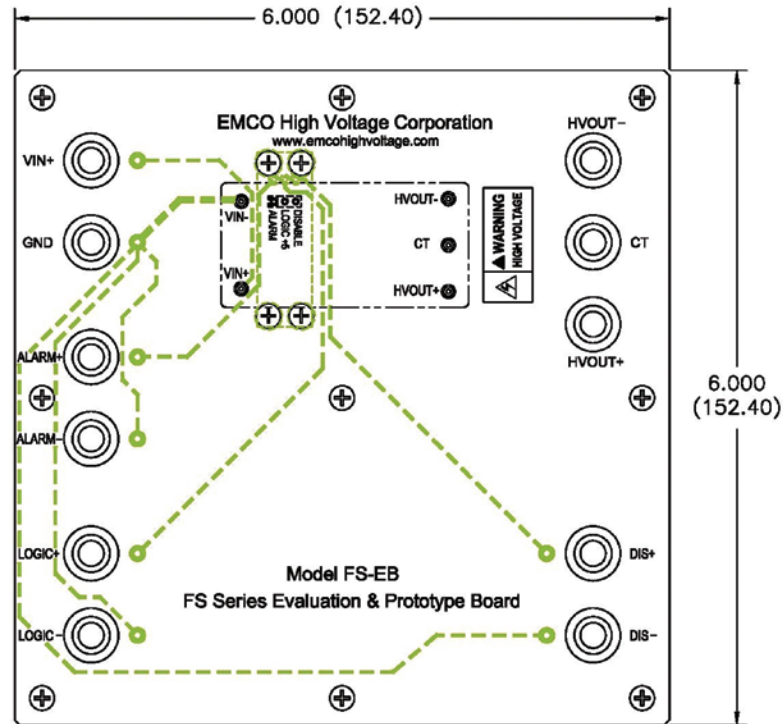
Please note when ordering an FS-VM adaptor board the FS Series is not included and must be ordered separately.





## FS - EB ADAPTER BOARD

**DIMENSIONS:**  
 6.00L (152.4)  
 6.005W (152.4)  
 1.46H (37.1)  
**WEIGHT: <7 OZ.**  
 (200 GRAMS)



This FS-EB evaluation board provides a convenient package to use any FS Series high voltage power supply without having to fit it onto a PC board. The board provides for easy prototyping and evaluation.

### ORDERING INFORMATION:

Please note when ordering an FS-EB evaluation board the FS Series is not included and must be ordered separately.

### \* Notes:

1. At Maximum Rated Output Voltage.
2. Output Voltage is load Dependent. Under Light or no load conditions, reduce input voltage so maximum rated output voltage is not exceeded.
3. Specifications after 1 hour warm-up, full load, at 25°C unless otherwise indicated.
4. Maximum Output Power is typically proportional to Input Voltage from 40% of Input Voltage and above.
5. Indefinite short circuit protection available on enhanced version only

