

**Proven  
Reliability**

# FS SERIES

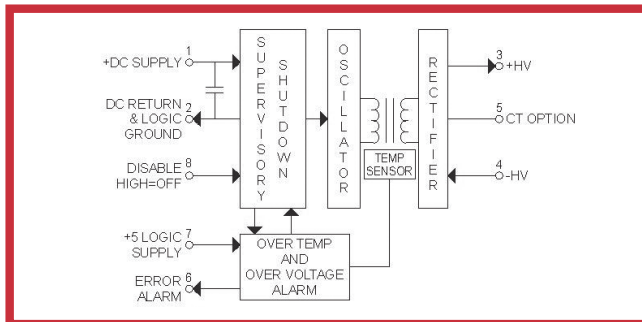
## ISOLATED, PROPORTIONAL DC TO HV DC CONVERTERS

200V to 6kV at 10W



### 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 200V through 6kV are offered in miniature, cost-effective, PC-mount packages. Based on XP-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 0.7V 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. XP-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. Additional features such as arc protection<sup>®</sup>, short circuit protection, surge current limiting, and over-temperature protection are available.



### APPLICATIONS

- Electrophoresis
- Piezo Devices
- Capacitor Charging
- Mass Spectrometry
- Electrostatic Chucks

### OPTIONS

- Available in Four Standard Input Voltage Ranges: 0–12, 15, 24, and 28V. (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)<sup>\*6</sup>
- Extended Environmental Screening and Burn-In Available, Consult Factory

### PRODUCT SELECTION TABLE

MODEL	OUTPUT VOLTAGE*2 (POSITIVE OR NEGATIVE)	OUTPUT CURRENT *1	OUTPUT POWER*4
FS02	0 to 200V	50mA	0 to 10W
FS03	0 to 300V	33.3mA	0 to 10W
FS05	0 to 500V	20mA	0 to 10W
FS10	0 to 1kV	10mA	0 to 10W
FS20	0 to 2kV	5mA	0 to 10W
FS30	0 to 3kV	3.33mA	0 to 10W
FS40	0 to 4kV	2.5mA	0 to 10W
FS50	0 to 5kV	2mA	0 to 10W
FS60	0 to 6kV	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<sup>®</sup> 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
- UL Certified Encapsulant, Meets 94V-0 Flammability
- RoHS Compliant



**ELECTRICAL SPECIFICATIONS\*3**

MODEL	OUTPUT CURRENT	RIPPLE*4	REVERSIBLE MODEL	OUTPUT VOLTAGE	CENTER TAP MODEL	OUTPUT VOLTAGE
FS02/FS02CT	50mA	<6%	FS02	0 to 200 VDC	FS02CT	0 to +/- 100V
FS03/FS03CT	33.3mA	<2%	FS03	0 to 300 VDC	FS03CT	0 to +/- 150V
FS05/FS05CT	20mA	<2%	FS05	0 to 500VDC	FS05CT	0 to +/- 250V
FS10/FS10CT	10mA	<1%	FS10	0 to 1 kV	FS10CT	0 to +/- 500V
FS20/FS20CT	5mA	<2.5%	FS20	0 to 2kV	FS20CT	0 to +/- 1kV
FS30/FS30CT	3.33mA	<2%	FS30	0 to 3kV	FS30CT	0 to +/- 1.5kV
FS40/FS40CT	2.5mA	<1.5%	FS40	0 to 4kV	FS40CT	0 to +/- 2kV
MODEL	OUTPUT CURRENT	RIPPLE*4	POSITIVE MODEL	OUTPUT VOLTAGE	NEGATIVE MODEL	OUTPUT VOLTAGE
FS50P/FS50N	2mA	<2.5%	FS50P	0 to +5kV	FS50N	0 to -5kV
FS60P/FS60N	1.67mA	<2.5%	FS60P	0 to +6kV	FS60N	0 to -6kV

	INPUT CURRENT			
	UP to FS40		FS50 & FS60	
VIN	NO-LOAD	FULL-LOAD	NO-LOAD	FULL-LOAD
12V	<0.3A	<1.25A	<0.4A	<1.5A
15V	<0.25A	<1.15A	<0.34A	<1.25A
24V	<0.15A	<0.65A	<0.2A	<0.75A
28V	<0.125A	<0.5A	<0.175A	<0.65A

## ELECTRICAL SPECIFICATIONS\*3

PARAMETER	VALUE
TURN-ON VOLTAGE	0.7V TYPICAL
ISOLATION	< +/- 2,500V BIAS ON PIN 4
OPERATING TEMPERATURE	-25° to +75°C (CASE)*6
OPTIONAL EXTENDED OPERATING TEMPERATURE	-55° to +85°C (CASE)*6
STORAGE TEMPERATURE	-55° to +85°C
OUTPUT VOLTAGE TOLERANCE	+/-3% FULL LOAD
EFFICIENCY	75% - 85% TYPICAL
INPUT CAPACITANCE	188uF (12V AND 15V in)
	88uF (24V AND 28V)
FREQUENCY	25 TO 125kHz

## 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 200V through 6kV are offered in miniature, cost-effective, PC-mount packages. Based on XP-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 0.7V 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. XP-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.

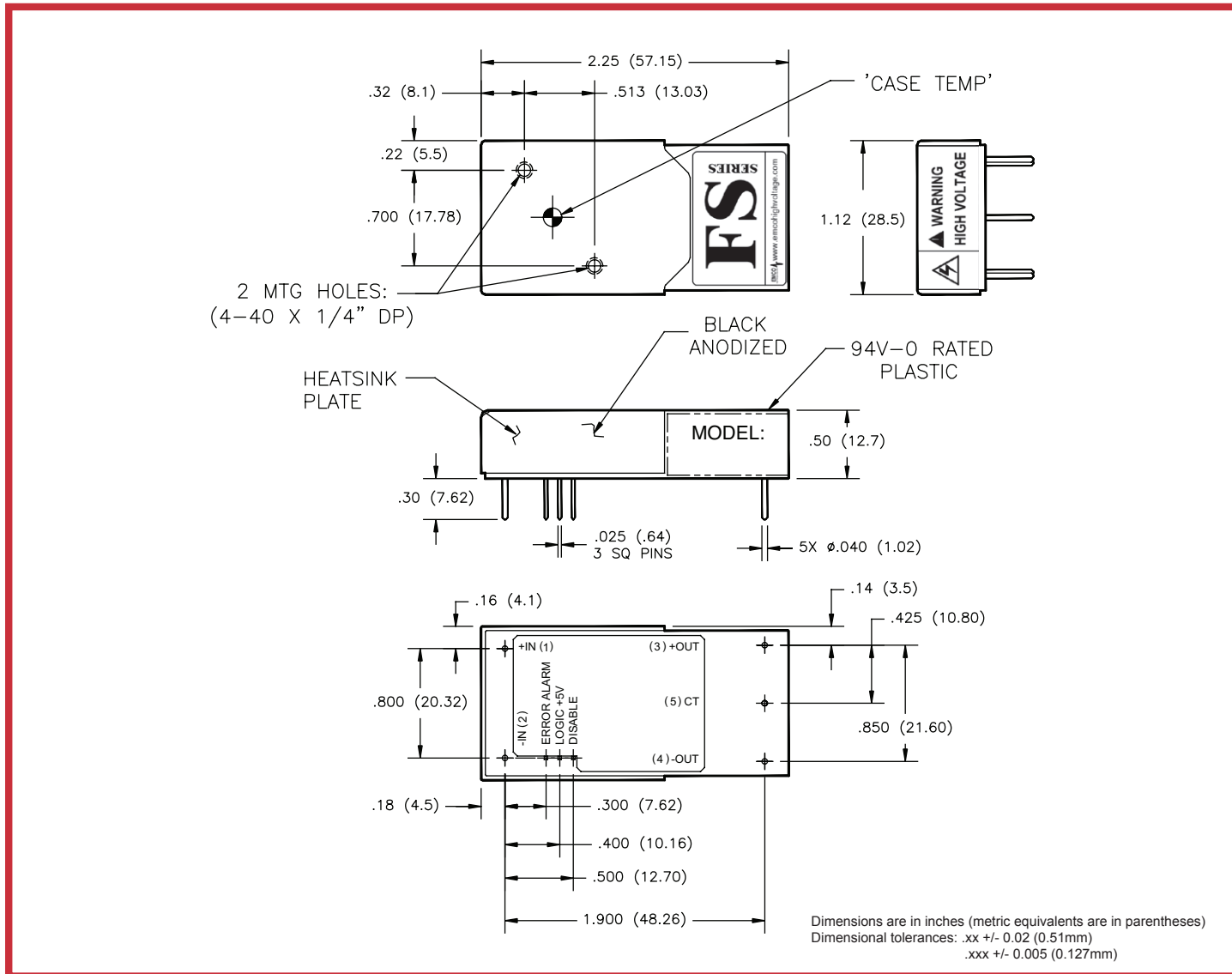
This series features sturdy, galvanic input-to-output high voltage isolation, conservatively rated at +/-2,500V + Vout with less than 100pF of coupling capacitance and less than 100nA of leakage current. Robustness and high reliability have been designed into each model by incorporating output arc surge current limiting and 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 shutdown 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.

MECHANICAL SPECIFICATIONS – Includes Smart Features

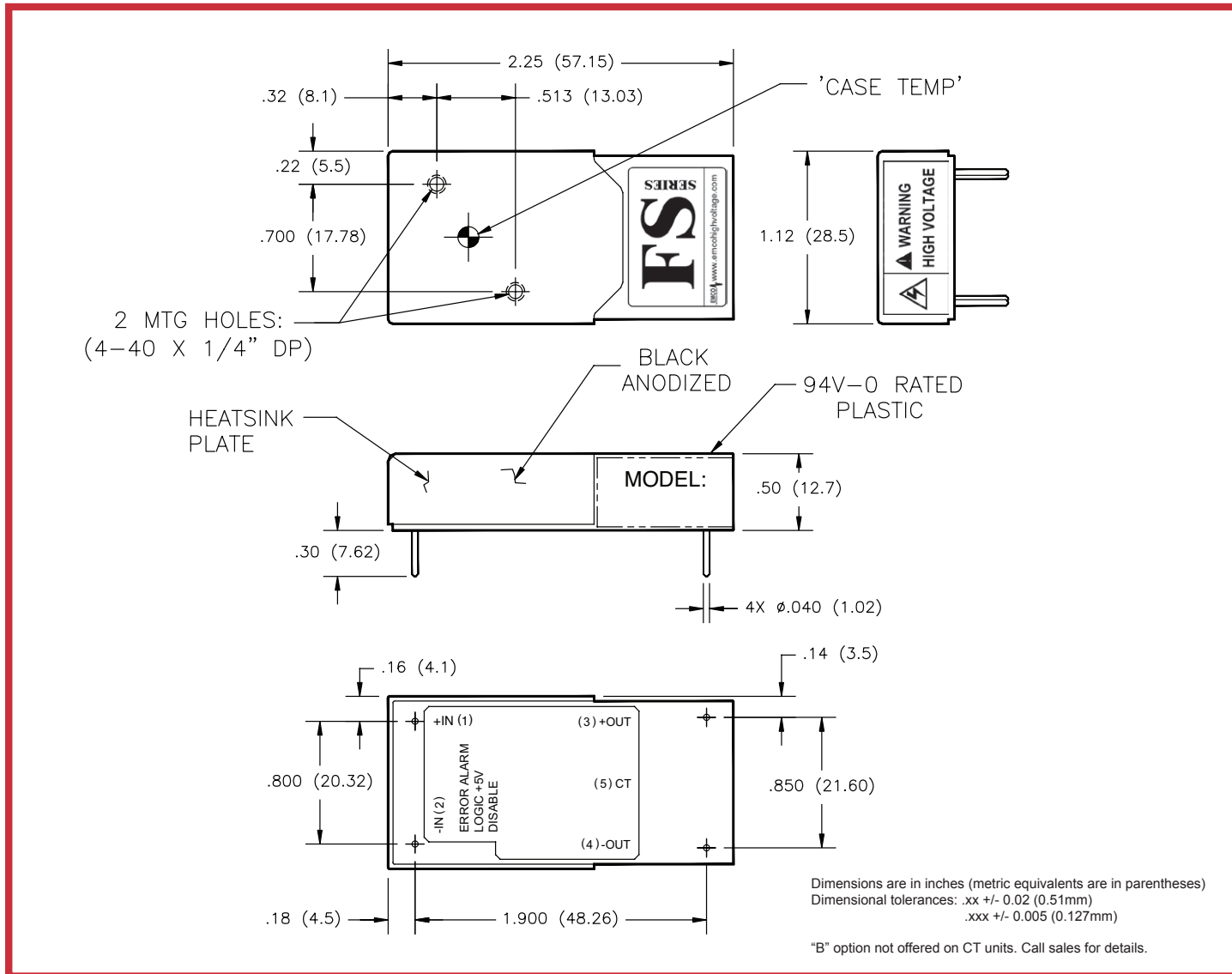


PIN #	FUNCTION	
	FS02 thru FS40	FS50 and FS60
1	(+) INPUT	(+) INPUT
2	(-) INPUT	(-) INPUT
3	(+) OUTPUT	HV OUTPUT*
4	(-) OUTPUT	HV RETURN
5	CENTER TAP (OPTIONAL)	N/A
6	ERROR ALARM	
7	LOGIC INPUT: +5V +/-5%	
8	DISABLE: TTL HIGH = OFF	

PARAMETER	VALUE
WEIGHT	<1.6 OUNCES (45 GRAMS)
VOLUME	1.27 CUBIC INCHES (20.8 CUBIC CENTIMETERS)
DIMENSIONS	2.25L (57.15L) x 1.12W (28.50W) x 0.50H (12.70H)

\*HV OUTPUT IS POSITIVE OR NEGATIVE DEPENDING ON THE MODEL.

MECHANICAL SPECIFICATIONS – Without Smart Features (B Version)



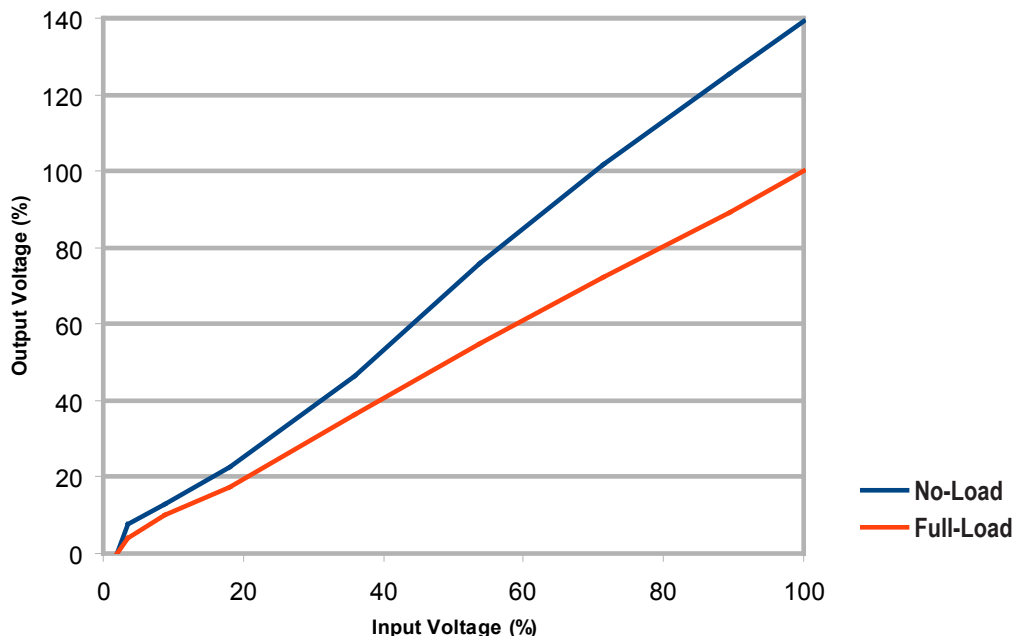
PIN #	FUNCTION	
	FS02 thru FS40	FS50 and FS60
1	(+) INPUT	(+) INPUT
2	(-) INPUT	(-) INPUT
3	(+) OUTPUT	HV OUTPUT*
4	(-) OUTPUT	HV RETURN

PARAMETER	VALUE
WEIGHT	<1.6 OUNCES (45 GRAMS)
VOLUME	1.27 CUBIC INCHES (20.8 CUBIC CENTIMETERS)
DIMENSIONS	2.25L (57.15L) x 1.12W (28.5W) x 0.50H (12.70H)

\*HV OUTPUT IS POSITIVE OR NEGATIVE DEPENDING ON THE MODEL.

APPLICATION NOTES

Output Voltage vs. Input Voltage



NOTE: The no-load curve may be as much as 200% x the full-load curve. Varies per model.

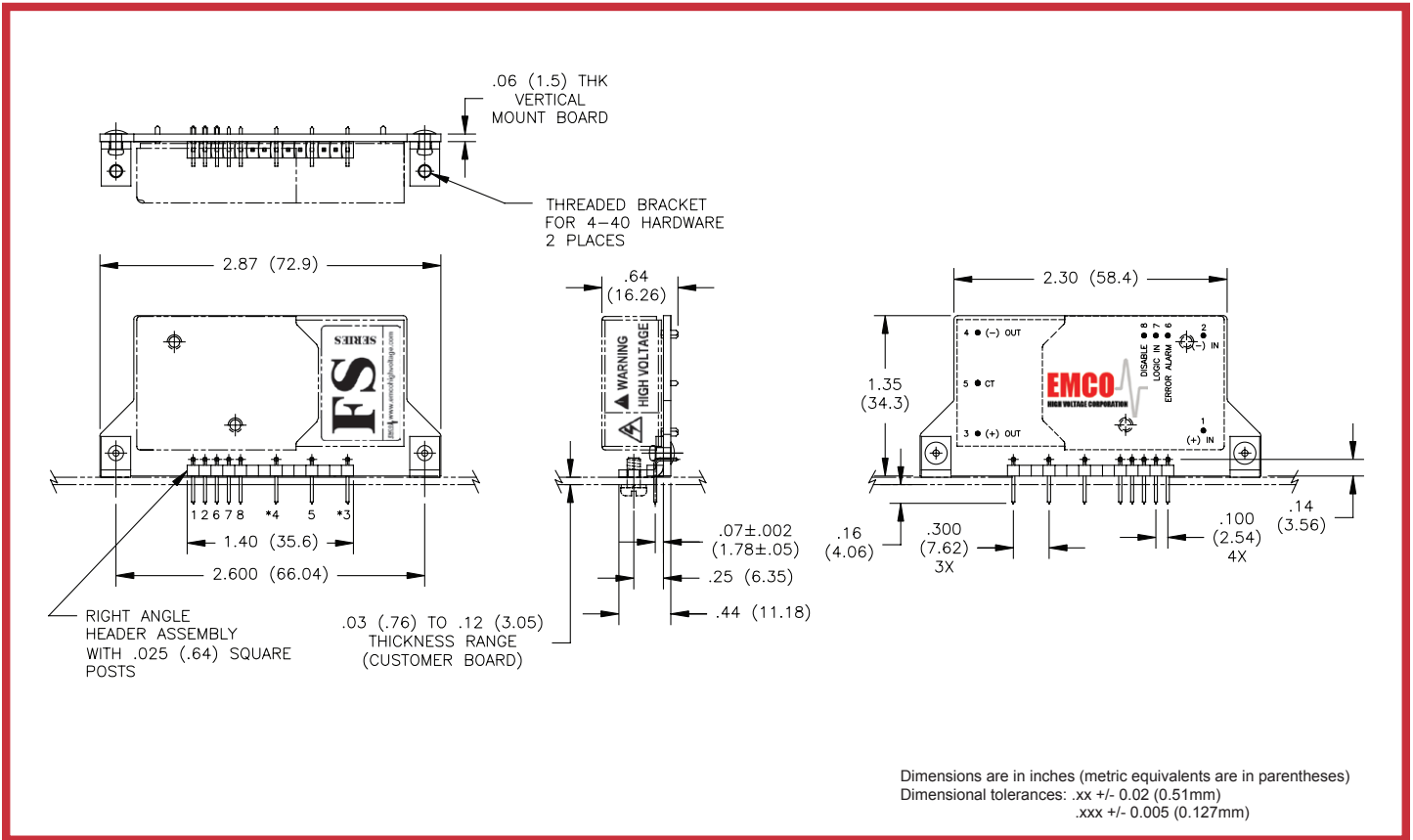
SMART FEATURES

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. Sustained presence of an input over-voltage may damage input components. The user should respond to the alarm by removing the potentially damaging input.

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 >250ms, then returned high.

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

FS - VM ADAPTER BOARD



PIN #	FUNCTION
1	(+) INPUT
2	(-) INPUT
3	(+) OUTPUT
	(-) OUTPUT FOR NEG FS
4	(-) OUTPUT
	HV RETURN
5	CENTER TAP
6	ERROR ALARM
7	LOGIC INPUT: +5V +/-5%
8	DISABLE

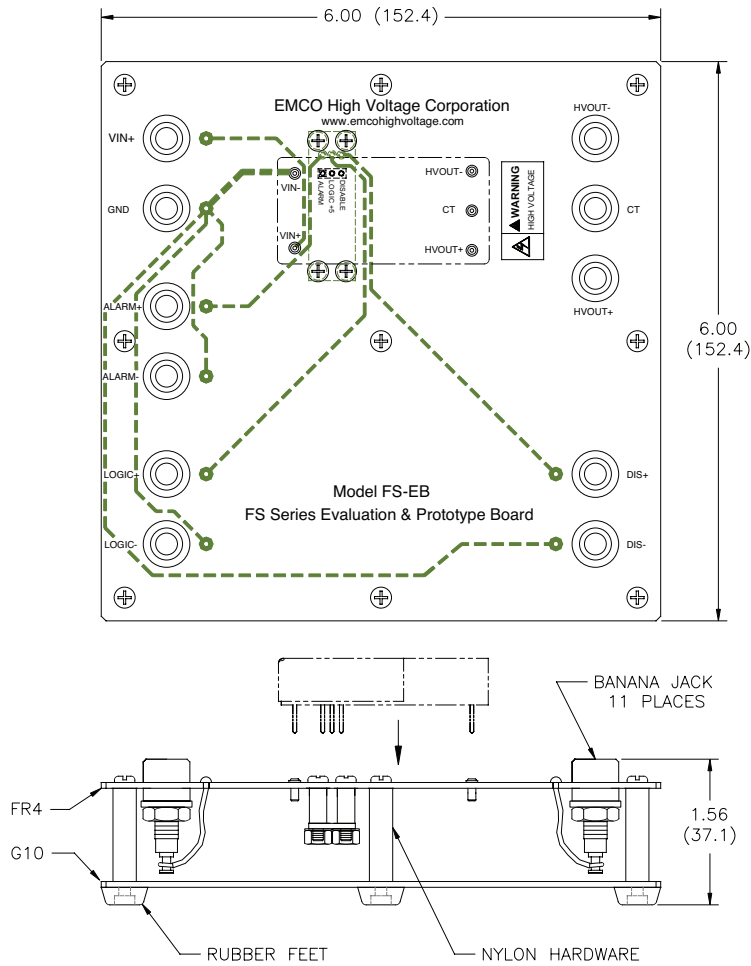
PARAMETER	VALUE
WEIGHT	<1 OUNCE (28.3 GRAMS)
VOLUME	1.70 CUBIC INCHES (28 CUBIC CENTIMETERS)
DIMENSIONS	2.30L (58.4L) x 0.44W (11.18W) x 1.35H (34.3H)

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 EVALUATION BOARD



Dimensions are in inches (metric equivalents are in parentheses)  
 Dimensional tolerances: .xx +/- 0.02 (0.51mm)  
 .xxx +/- 0.005 (0.127mm)

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.

PARAMETER	VALUE
WEIGHT	<7 OUNCES (200 GRAMS)
VOLUME	52.6 CUBIC INCHES (862 CUBIC CENTIMETERS)
DIMENSIONS	6.00L (152.4L) x 6.00W (152.4W) x 1.56H (37.1H)



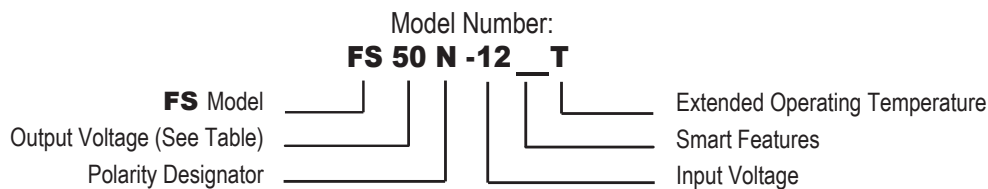
OPTION CODES

ORDERING	INFORMATION	ORDER CODE	AVAILABILITY
OUTPUT VOLTAGE	10 WATT	FS	ALL
POLARITY DESIGNATOR	CENTER TAP	CT	(MODELS FS02CT THRU FS40CT)
	POSITIVE OUTPUT	P	(MODELS FS50P THRU FS60P)
	NEGATIVE	N	(MODELS FS50N THRU FS60N)
INPUT VOLTAGE	12V	12	ALL
	15V	15	ALL
	24V	24	ALL
	28V	28	ALL
SMART FEATURES	SHUTDOWN FEATURES INCLUDED	BLANK	ALL
	SHUTDOWN FEATURES NOT INCLUDED	B	(NOT OFFERED ON CT MODELS)
TEMPERATURE	STANDARD OPERATING TEMPERATURE	BLANK	(-25°C TO +75°C (CASE))
	EXTENDED OPERATING TEMPERATURE	T	(-55°C TO +85°C (CASE))

For other input/output voltages, consult factory.

HOW TO ORDER

PART NUMBER SELECTOR:



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

\* Notes:

1. At maximum rated output voltage.
2. Output voltage is load dependent. Under light or no-load conditions, reduce the 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.
6. Proper thermal management techniques are required to maintain safe case temperature at maximum power output.
7. Ripple specification for center-tapped units applies to the voltage between the positive and negative output terminals.
8. Models FS50 and FS60 do not have the arc protection feature.

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