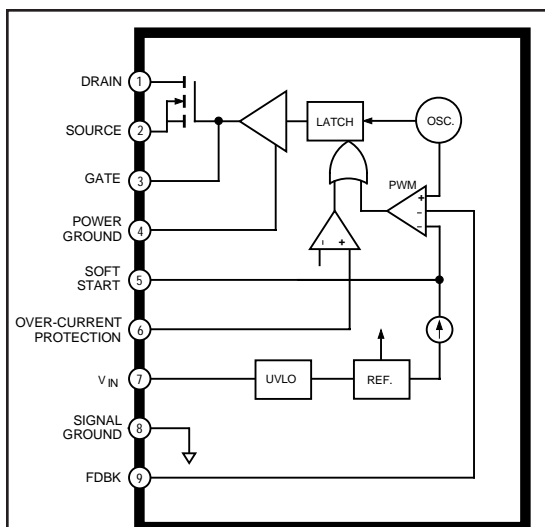


# STR-S6401 AND STR-S6401F

## OFF-LINE SWITCHING REGULATORS – WITH POWER MOSFET OUTPUT



Dwg. PK-003

### ABSOLUTE MAXIMUM RATINGS

Supply Voltage, $V_{IN}$	35 V
Drain-Source Voltage, $V_{DS}$	500 V
Drain Current, $I_D$	
continuous	$\pm 10$ A
single pulse, $t_w \leq 1$ ms	$\pm 40$ A
Avalanche Energy, $E_A$	
single pulse	500 mJ
Gate-Source Voltage, $V_{GS}$	$\pm 20$ V
Gate-Drive Current Range,	
$I_G$	-0.7 A to +1.5 A
Over-Current Protection Voltage Range,	
$V_{OCP}$	-0.3 V to +4.0 V
Insulation RMS Voltage,	
$V_{WM(RMS)}$	2000 V
Package Power Dissipation,	
$P_D$	See Graph
FET Channel Temperature, $T_J$	+150°C
Internal Frame Temperature, $T_F$	+125°C
Operating Temperature Range,	
$T_A$	-20°C to +125°C
Storage Temperature Range,	
$T_{stg}$	-30°C to +125°C

These devices are specifically designed to meet the requirements for increased integration and reliability in off-line flyback (STR-S6401) and forward (STR-S6401F) converters operating in a fixed-frequency PWM mode. Each device incorporates the primary control and drive circuits with an avalanche-rated power MOSFET. Crucial system parameters such as switching frequency and maximum duty cycle are fixed during manufacture. The STR-S6401 and STR-S6401F differ only in their maximum duty cycle. Control circuit decoupling and layout are optimized within each device.

Cycle-by-cycle and average-current limiting, soft start, under-voltage lockout with hysteresis, and thermal shutdown protect the device during all normal and overload conditions. The performance and reliability of these devices, and their variable-frequency counterparts, has been proven in substantial volume production.

The requirements of high dielectric isolation and low transient thermal impedance and steady-state thermal resistance are satisfied in an over-molded, 9-pin single in-line power package. Similar off-line switching regulators, with output ratings to 800 V at 5 A, are also available.

### FEATURES

- PWM Flyback Conversion or Forward Conversion
- Output Power to 250 W
- Pulse-by-Pulse Current Limiting
- Fixed-Frequency 100 kHz PWM
- Avalanche-Rated Power MOSFET Switch
- Soft Start
- Internal Under-Voltage Lockout and Thermal Shutdown
- Low External Component Count
- Over-Molded SIP with Isolated Heat Spreader

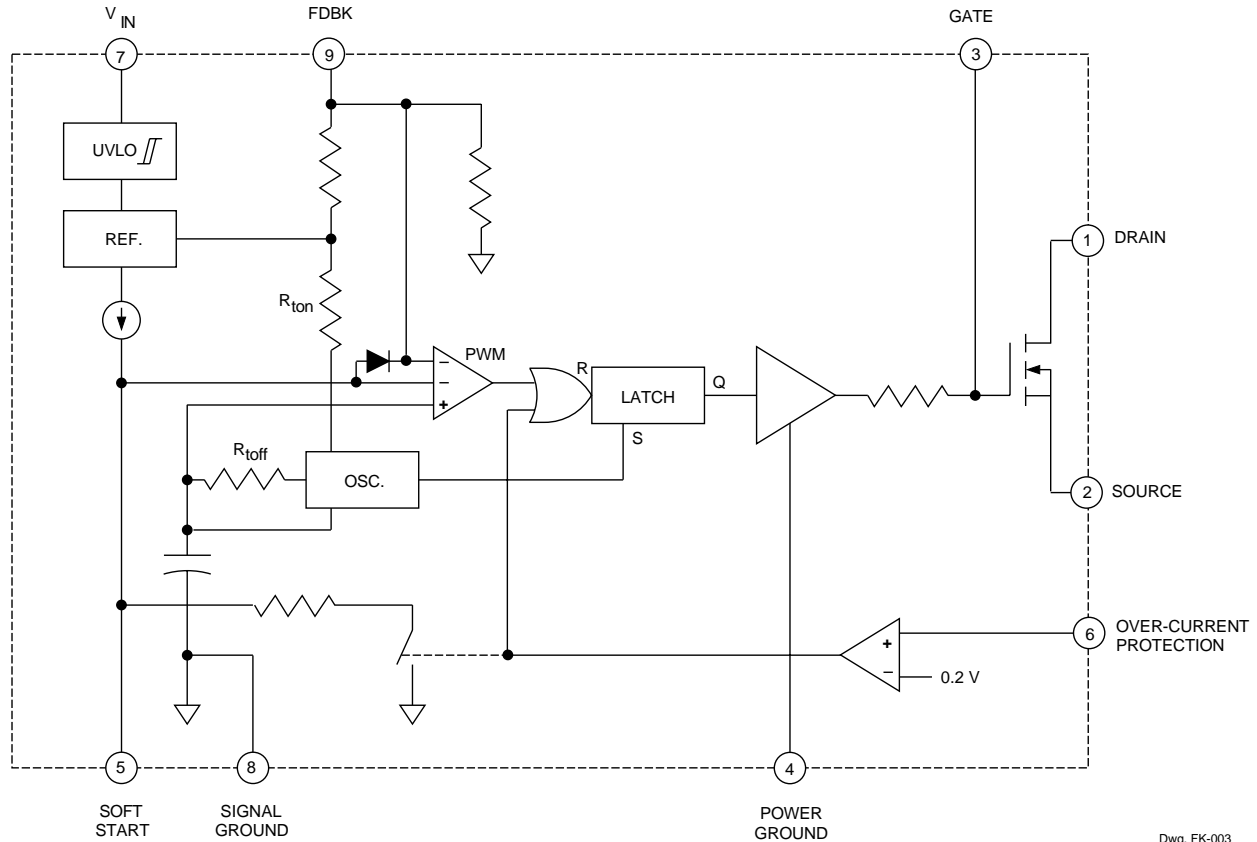
Always order by complete part number:

**STR-S6401** or **STR-S6401F**.



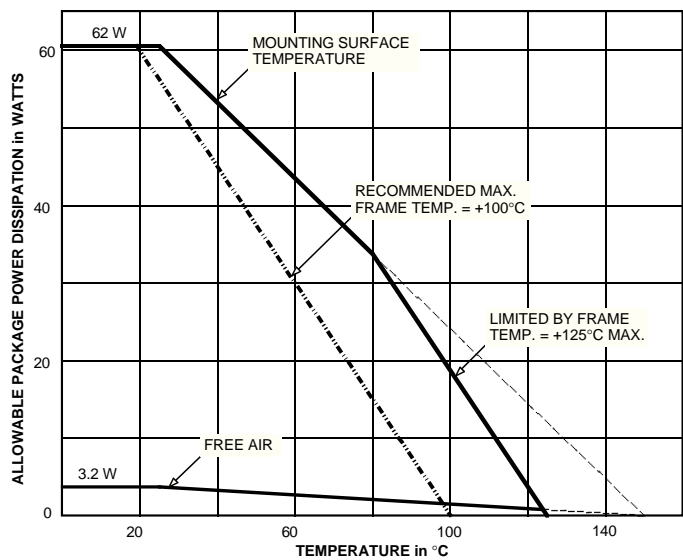
# STR-S6401 AND STR-S6401F OFF-LINE SWITCHING REGULATORS

## FUNCTIONAL BLOCK DIAGRAM



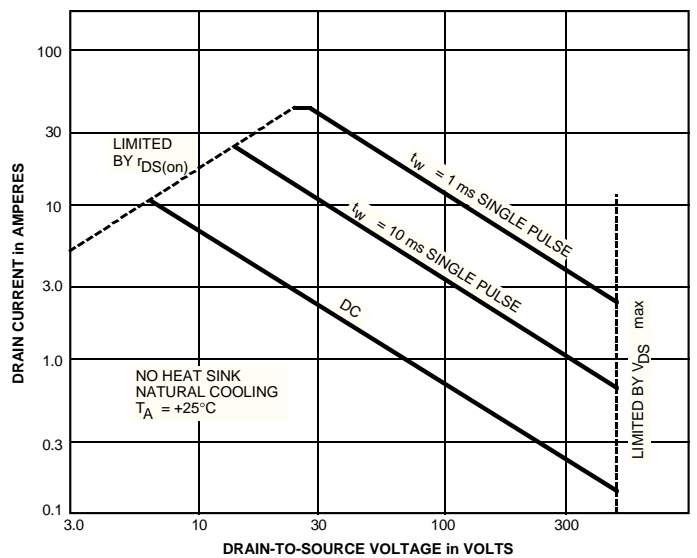
Dwg. FK-003

## ALLOWABLE PACKAGE POWER DISSIPATION



Dwg. GK-003

## MAXIMUM SAFE OPERATING AREA



Dwg. GK-004



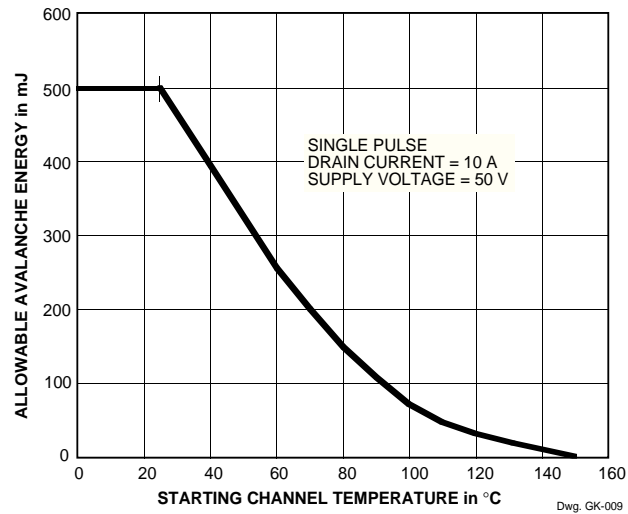
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# STR-S6401 AND STR-S6401F

## OFF-LINE SWITCHING REGULATORS

### ALLOWABLE AVALANCHE ENERGY



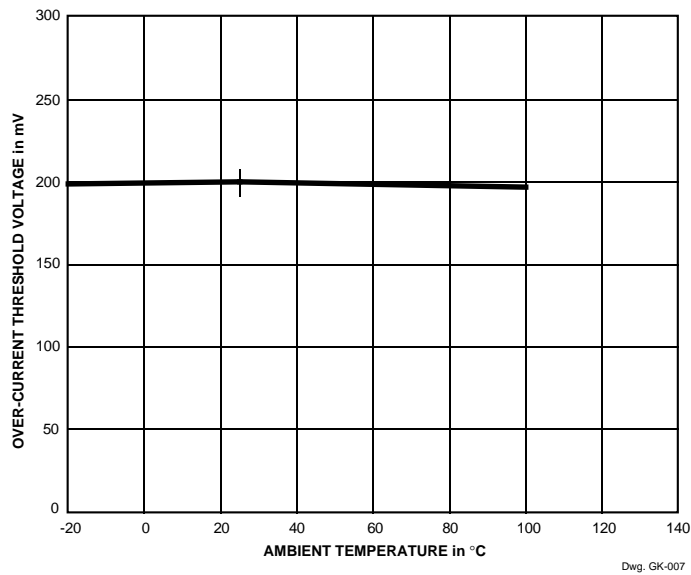
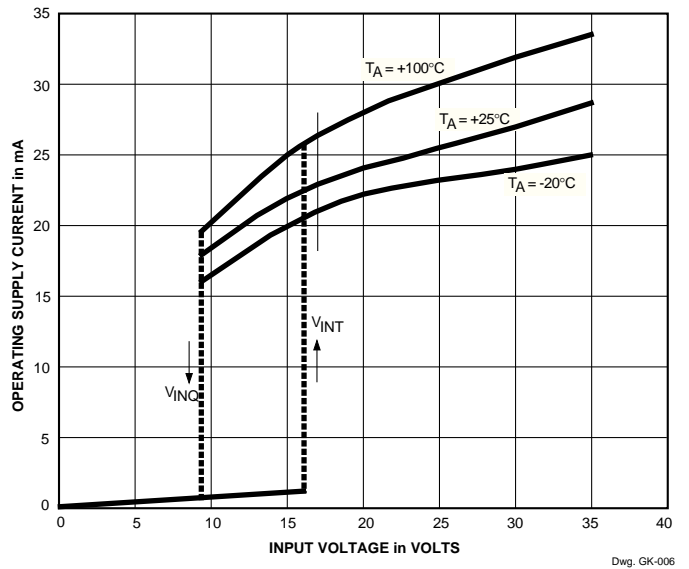
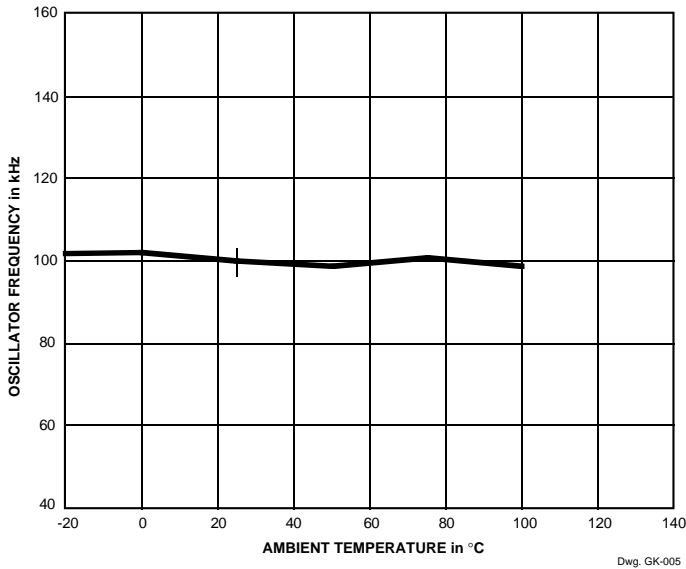
**ELECTRICAL CHARACTERISTICS** at  $T_A = +25^\circ\text{C}$ ,  $V_{IN} = 17\text{ V}$ , voltage measurements are referenced to Signal Ground (pin 8) (unless otherwise noted).

Characteristic	Symbol	Test Conditions	Limits			Units
			Min.	Typ.	Max.	
On-State Voltage	$V_{INT}$	Turn-on, increasing $V_{IN}$	14.4	16	17.6	V
Under-Voltage Lockout	$V_{INQ}$	Turn-off, decreasing $V_{IN}$	8.4	9.4	10.4	V
FET Leakage Current	$I_{DSS}$	$V_{DS} = 400\text{ V}$	–	–	300	$\mu\text{A}$
FET ON Resistance	$r_{DS(on)}$	$V_{GS} = 10\text{ V}$ , $I_D = 5\text{ A}$	–	0.5	0.6	$\Omega$
Forward Transconductance	$g_{fs}$	$V_{GS} = 10\text{ V}$ , $I_D = 5\text{ A}$	–	9.2	–	S
FET Input Capacitance	$C_{iss}$	$V_{DS}=10\text{ V}$ , $V_{GS}=0\text{ V}$ , $f=1\text{ MHz}$	–	1800	–	pF
Propagation Delay Time	$t_{phl}$	Turn-on, 10% $V_{GS}$ to 10% $V_{DS}$	–	60	–	ns
	$t_{plh}$	Turn-off, 90% $V_{GS}$ to 90% $V_{DS}$	–	140	–	ns
Oscillator Frequency	$f_{osc}$		93	100	107	kHz
Maximum ON Time	$t_{on}$	STR-S6401	5.1	5.7	6.5	$\mu\text{s}$
		STR-S6401F	3.8	4.5	5.2	$\mu\text{s}$
Over-Current Threshold	$V_{OCP(th)}$		160	200	240	mV
OCP Current	$I_{OCP}$		-250	-400	-550	$\mu\text{A}$
Feedback Current	$I_{FDBK}$		–	-1.8	–	mA
Soft Start Threshold Voltage	$V_{SS(th)}$		–	–	0.4	V
Soft Start Current	$I_{SS}$	$V_{SS} = 0\text{ V}$	–	-100	–	$\mu\text{A}$
Power Ground Current	$I_{PG}$	$t_w = 200\text{ ns}$	–	-1.0	-1.5	A
Supply Current	$I_{IN(ON)}$	Operating	–	23	–	mA
	$I_{IN(OFF)}$	Start up, $V_{IN} = 12\text{ V}$	–	–	500	$\mu\text{A}$
Insulation RMS Voltage	$V_{WM(RMS)}$	All terminals simultaneous reference metal plate against backside	2000	–	–	V
Thermal Resistance	$R_{\theta JM}$	FET channel to mounting surface	–	2.0	–	$^\circ\text{C/W}$

NOTES: Negative current is defined as coming out of (sourcing) the specified device terminal.  
Typical Data is for design information only.

# STR-S6401 AND STR-S6401F OFF-LINE SWITCHING REGULATORS

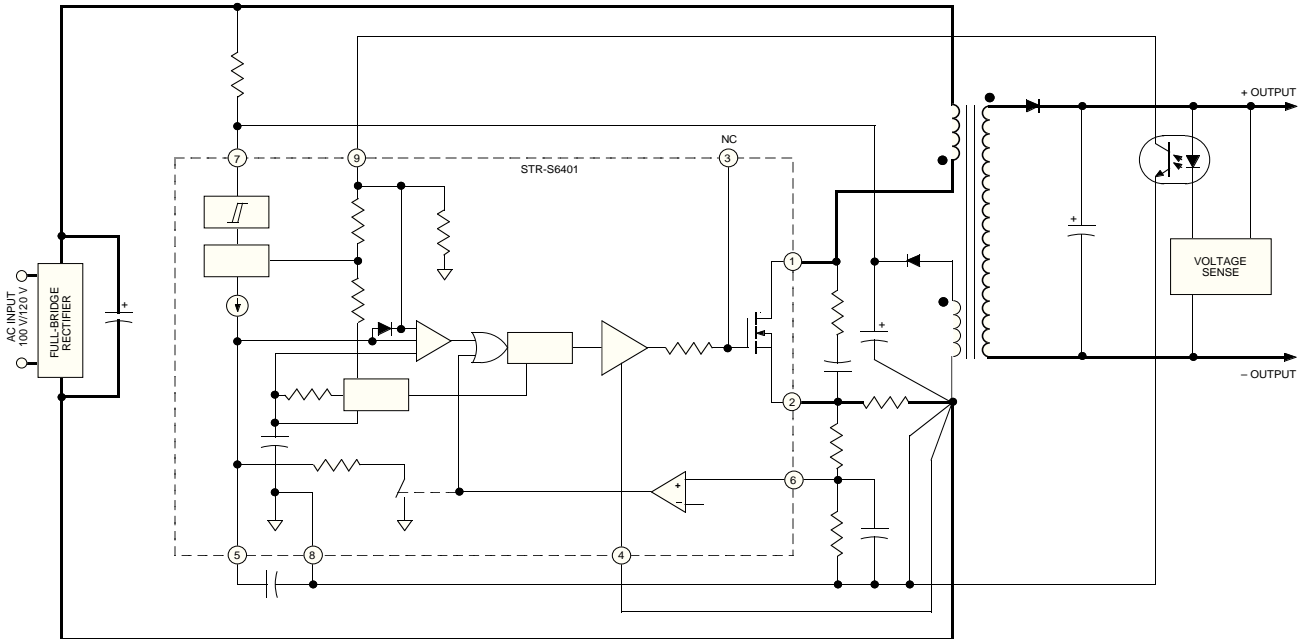
## TYPICAL CHARACTERISTICS



# STR-S6401 AND STR-S6401F OFF-LINE SWITCHING REGULATORS

## TYPICAL PWM FLYBACK CONVERSION USING STR-S6401

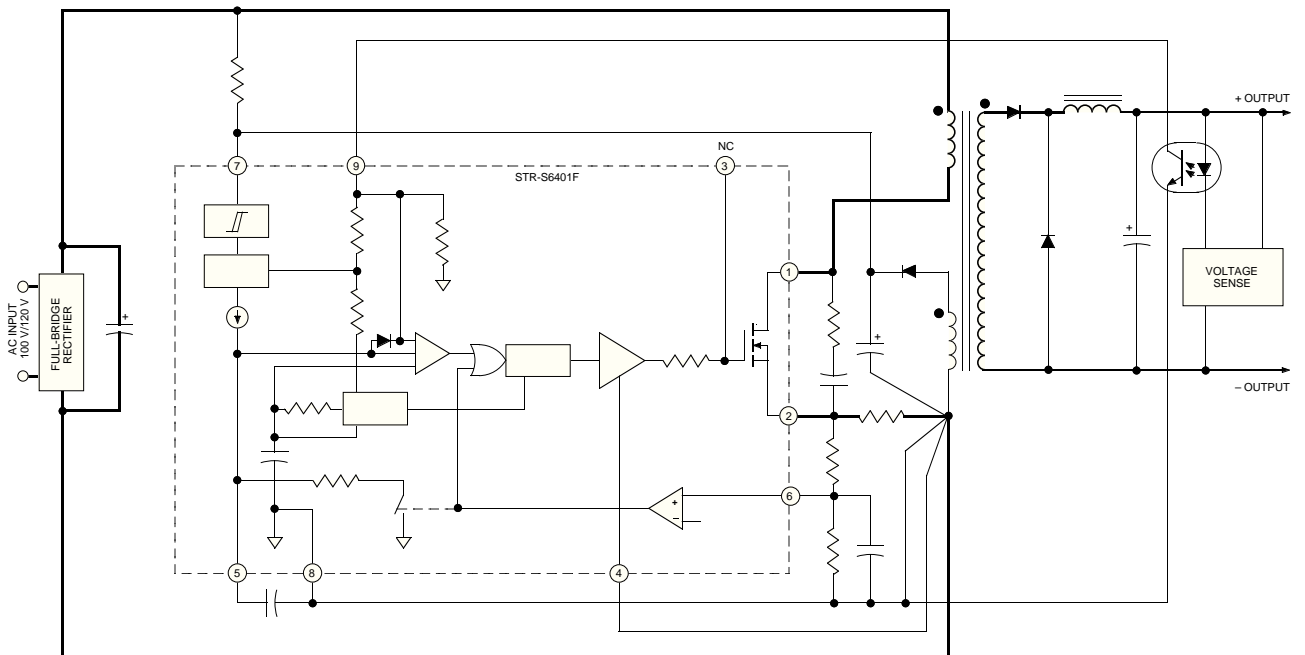
**WARNING:** lethal potentials are present. See text.



Dwg. EK-003

## TYPICAL PWM FORWARD CONVERSION USING STR-S6401F

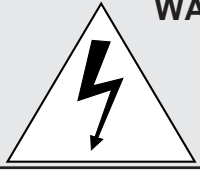
**WARNING:** lethal potentials are present. See text.



Dwg. EK-003-1

# STR-S6401 AND STR-S6401F OFF-LINE SWITCHING REGULATORS

## APPLICATIONS INFORMATION



**WARNING** — These devices are designed to be operated at lethal voltages and energy levels. Circuit designs that embody these components must conform with applicable safety requirements. Precautions must be taken to prevent accidental contact with power-line potentials. Do not connect grounded test equipment.

The use of an isolation transformer is recommended during circuit development and breadboarding.

The power MOSFET outputs of these devices are similar to the International Rectifier type IRFP448. These devices feature an excellent combination of fast switching, ruggedized device design, low on-resistance, and cost effectiveness.

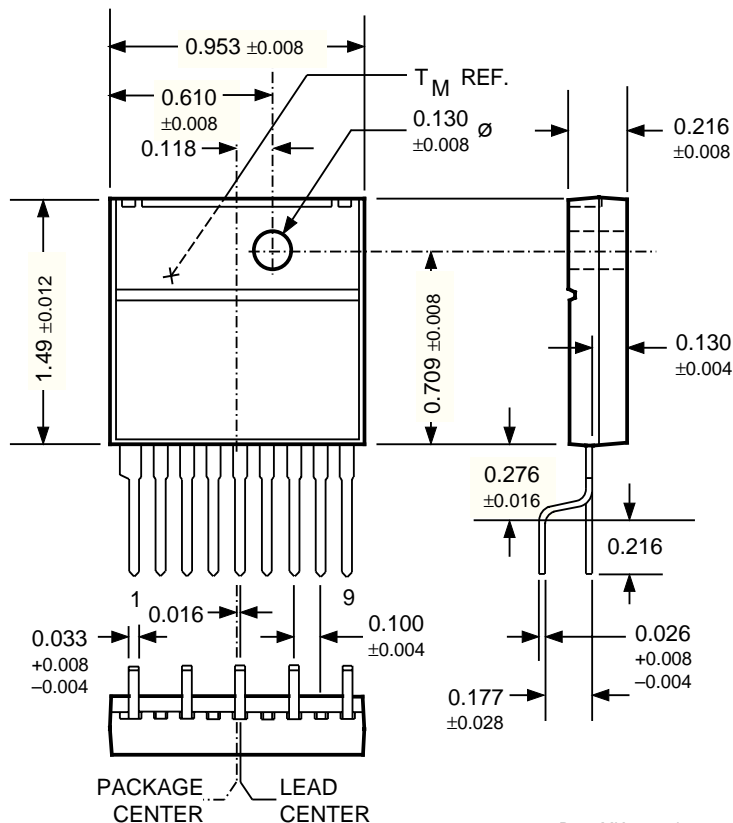
Recommended mounting hardware torque:

4.34 - 5.79 lbf•ft (6 - 8 kg•cm or 0.588 - 0.784 Nm).

Recommended metal-oxide-filled, alkyl-degenerated oil base, silicone grease:

Dow Corning 340, or equivalent

### Dimensions in Inches (for reference only)



NOTE: Exact body and lead configuration at vendor's option within limits shown.

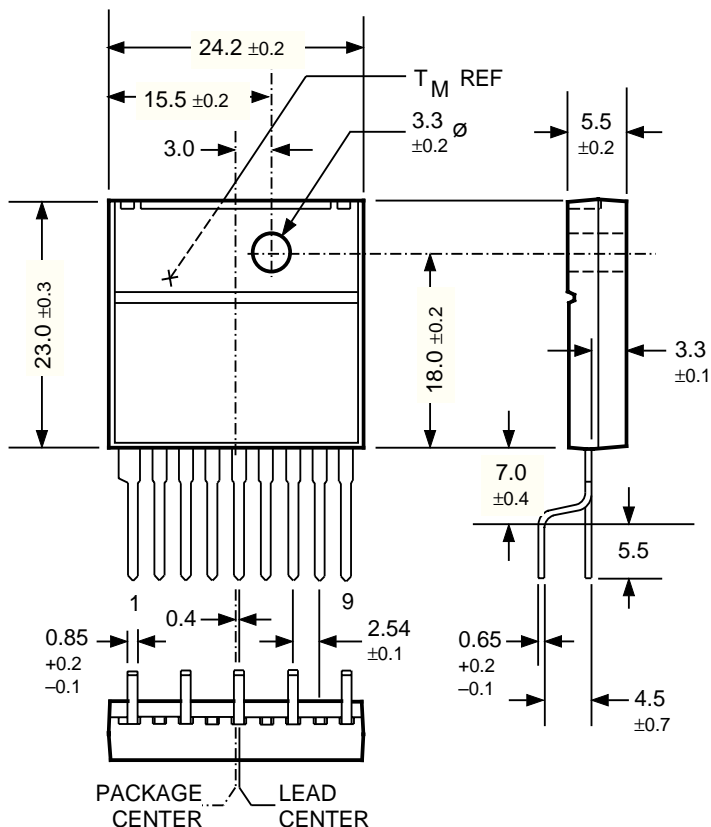


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**STR-S6401 AND STR-S6401F**  
**OFF-LINE**  
**SWITCHING REGULATORS**

**Dimensions in Millimeters**  
 (controlling dimensions)



NOTE: Exact body and lead configuration at vendor's option within limits shown.

The products described here are manufactured in Japan by Sanken Electric Co., Ltd. for sale by Allegro MicroSystems, Inc.

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**STR-S6401 AND STR-S6401F**  
**OFF-LINE**  
**SWITCHING REGULATORS**

**POWER CONVERSION/POWER MANAGEMENT**  
**SELECTION GUIDES**

**SWITCHING REGULATOR PMCMs**

Part Number*	Application	V <sub>I</sub>	Max P <sub>O</sub>		Power Switch	
3002M	5 V Switching Regulator and a 9 V Switching Regulator†	7.0-33 V	–	–	500 mA 400 mA	Bipolar Bipolar
3004M	5 V Switching Regulator and Dual 9 V Switching Regulator	7.0-33 V	–	–	500 mA 2 x 400 mA	Bipolar Bipolar
S5703	Quasi-Resonant Flyback Converter	110/120 V	140 W	500 V	6 A	Bipolar
S5707	Quasi-Resonant Flyback Converter	85-265 V 220/240V	90 W 140 W	850 V	6 A	Bipolar
S5708	Quasi-Resonant Flyback Converter	85-265 V 220/240 V	120 W 180 W	850 V	7.5 A	Bipolar
F6624	Quasi-Resonant Flyback Converter	100/120 V	130 W	450 V	0.92 Ω	MOSFET
F6626	Quasi-Resonant Flyback Converter	100/120 V	190 W	450 V	0.58 Ω	MOSFET
F6628	Quasi-Resonant Flyback Converter	100/120 V	290 W	450 V	0.35 Ω	MOSFET
F6652	Quasi-Resonant Flyback Converter	85-265 V	86 W	650 V	2.8 Ω	MOSFET
F6653	Quasi-Resonant Flyback Converter	85-265 V	120 W	650 V	1.95 Ω	MOSFET
F6654	Quasi-Resonant Flyback Converter	85-265 V	190 W	650 V	1.15 Ω	MOSFET
F6656	Quasi-Resonant Flyback Converter	85-265 V	300 W	650 V	0.71 Ω	MOSFET
F6672	Quasi-Resonant Flyback Converter	200/220 V	50 W	900 V	7.7 Ω	MOSFET
F6674	Quasi-Resonant Flyback Converter	85-265 V	76 W	900 V	4.49 Ω	MOSFET
F6676	Quasi-Resonant Flyback Converter	85-265 V	115 W	900 V	2.81 Ω	MOSFET
S6703	Quasi-Resonant Flyback Converter	110/120V	140 W	500 V	6 A	Bipolar
S6704	Quasi-Resonant Flyback Converter	110/120 V	100 W	500 V	5 A	Bipolar
S6707	Quasi-Resonant Flyback converter	85-265 V 220/240 V	90 W 140 W	850 V	6 A	Bipolar
S6708	Quasi-Resonant Flyback Converter	85-265 V 220/240 V	120 W 180 W	850 V	7.5 A	Bipolar
S6709	Quasi-Resonant Flyback Converter	85-265 V 220/240 V	160 W 220 W	850 V	10 A	Bipolar
8033S	3.3 V Switching Regulator	5.5-28 V	–	–	3 A	Bipolar
8050S	5.0 V Switching Regulator	7.0-40 V	–	–	3 A	Bipolar
8090S	9.0 V Switching Regulator	12-40V	–	–	3 A	Bipolar
8120S	12 V Switching Regulator	15-40 V	–	–	3 A	Bipolar
8150S	15 V Switching Regulator	18-40 V	–	–	3 A	Bipolar

\* Complete part number includes additional characters to indicate operating temperature range and/or package style.

† Also includes linear regulator output for 15.7 V at 1.0 A.



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**SELECTION GUIDES (CONTINUED)**

