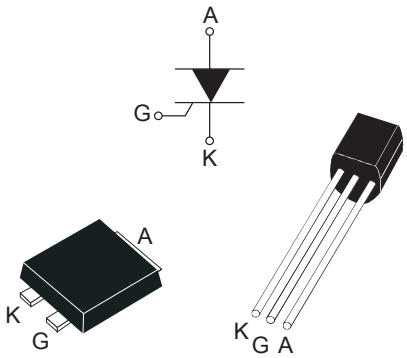
TS110-7

Datasheet

High surge voltage 1.25 A SCR for circuit breaker



SMBflat-3L TO-92

Features

- On-state rms current, $I_{T(RMS)}$ 1.25 A
- Repetitive peak off-state voltage, $V_{DRM/VRRM}$, 700 V
- Non-repetitive direct surge peak off-state voltage, 1250 V
- Non-repetitive reverse surge peak off-state voltage, 850 V
- Triggering gate current, $I_{GT\ (Q1)}$ 100 µA

Applications

- Ground fault circuit interrupters
- Arc fault circuit interrupters
- Overvoltage crowbar protection in power supplies
- Residual current device
- Residual current circuit breaker with overload protection

Product status link
TS110-7

Product summary	
$I_{T(RMS)}$	1.25 A
V_{DRM}/V_{RRM}	700 V
I_{GT}standard	100 µA

Description

Thanks to highly sensitive triggering levels, the TS110-7 series is suitable for circuit breaker applications where the available gate current is limited. Such applications include GFCI (ground fault circuit interrupter), AFCI (arc fault circuit interrupter), RCD (residual current device), and RCBO (residual current circuit breaker with overload protection). This device is optimized in forward voltage drop and inrush current capabilities for reduced power losses and high reliability in harsh environments.

TS110-7 enables high robustness of the whole circuit breaker. The low leakage current of the TS110-7 reduces power consumption over the entire lifetime of the circuit breaker.

The TS110-7 is available in through-hole TO-92 package with GAK pinout and in SMBflat-3L.

1 Characteristics

Table 1. Absolute ratings (limiting values, T_J = 25 °C unless otherwise specified)

Symbol	Parameters			Value	Unit
$I_{T(RMS)}$	RMS on-state current (180 ° conduction angle)	TO-92	T_L = 58 °C	1.25	A
		SMBflat-3L	T_{tab} = 110 °C		
$I_{T(AV)}$	Average on-state current (180 ° conduction angle)	TO-92	T_L = 58 °C	0.8	A
		SMBflat-3L	T_{tab} = 110 °C		
I_{TSM}	Non repetitive surge peak on-state current	t_p = 8.3 ms		27	A
		t_p = 10 ms		25	
	1st step: one surge every 5 seconds, 25 surges	tp = 10 ms	T_j initial = 25 °C	25 times 12 A	
	2nd step: one surge every 5 seconds, 25 surges			25 times 16 A	
I^2t	I^2t value for fusing	t_p = 10 ms		3.1	A^2s
dI/dt	Critical rate of rise of on-state current I_G = 2 x I_{GT} , t_r ≤ 100 ns	F = 60 Hz	T_j = 125 °C	100	A/µs
	Critical rate of rise of on-state current Gate open, V_D = V_{BO}, t_r ≤ 100 ns		T_j = 25 °C	100	
V_{DRM}, V_{RRM}	Repetitive peak off-state voltage, gate open		T_j = 125 °C	700	V
V_{DSM}	Non-repetitive direct surge peak off-state voltage, R_{GK} = 220 Ω	t_p = 50 µs	T_j = 25 °C	1250	V
V_{RSM}	Non-repetitive reverse surge peak off-state voltage, R_{GK} = 220 Ω	t_p = 50 µs	T_j = 25 °C	850	V
I_{GM}	Peak gate current	t_p = 20 µs	T_j = 125 °C	1.2	A
$P_{G(AV)}$	Average gate power dissipation		T_j = 125 °C	0.2	W
T_{stg}	Storage junction temperature range			-40 to +150	°C
T_j	Operating junction temperature range			-40 to +125	°C

Table 2. Electrical characteristics (T_j = 25 °C, unless otherwise specified)

Symbol	Parameters			Value	Unit
I_{GT}(1)	V_D = 12 V, R_L = 140 Ω	T_j = 25 °C	Min.	1	µA
			Max.	100	
V_{GT}		T_j = 125 °C	Max.	0.8	V
V_{GD}	V_D = V_{DRM}, R_L = 33 kΩ, R_{GK} = 220 Ω	T_j = 125 °C	Min.	0.1	V
V_{RG}	I_{RG} = 2 mA	T_j = 25 °C	Min.	7.5	V
I_H(2)	I_T = 50 mA, R_{GK} = 220 Ω	T_j = 25 °C	Max.	2	mA
I_L	I_G = 1 mA, R_{GK} = 220 Ω	T_j = 25 °C	Max.	2	mA
dV/dt(2)	V_D = 67 % V_{DRM}, R_{GK} = 220 Ω	T_j = 125 °C	Min.	15	V/µs

1. *Minimum I_{GT} is guaranteed at 5 % of I_{GT} max.*
2. *For both polarities of A2 referenced to A1*

Table 3. Static electrical characteristics

Symbol	Test conditions			Value	Unit
V_{TM}[1]	I_{TM} = 2.5 A, t_p = 380 µs	T_j = 25 °C	Max.	1.4	V
V_{TO}[1]	Threshold on-state voltage	T_j =125 °C	Max.	0.9	V
R_d	Dynamic resistance	T_j =125 °C	Max.	200	mΩ
I_{DRM},I_{RRM}	V_{DRM} = V_{RRM}, R_{GK} = 220 Ω	T_j =25 °C	Max.	1	µA
		T_j =125 °C		100	µA

1. *For both polarities of A2 referenced to A1*

Table 4. Thermal resistance

Symbol	Parameters		Max. value	Unit
$R_{th(j-l)}$	Junction to lead (DC)	TO-92	14	°C/W
$R_{th(j-a)}$	Junction to ambient (DC)	TO-92	160	
		SMBflat-3L	75	
$R_{th(j-c)}$	Junction to case (S[1] = 5 cm²)	SMBflat-3L	14	

1. *Copper surface under tab.*

1.1 Characteristics (curves)

Figure 1. Maximum average power dissipation versus average on-state current

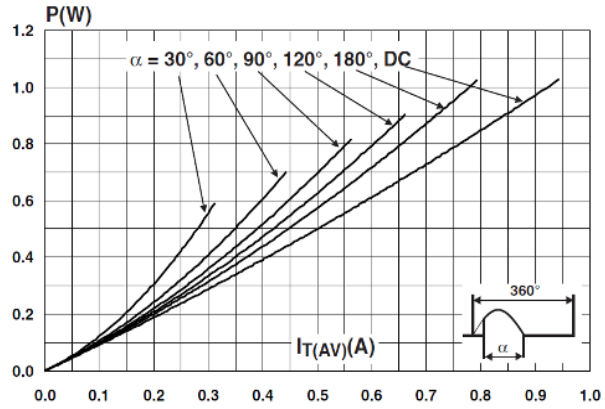


Figure 2. Average and DC on-state current versus lead temperature (TO-92)

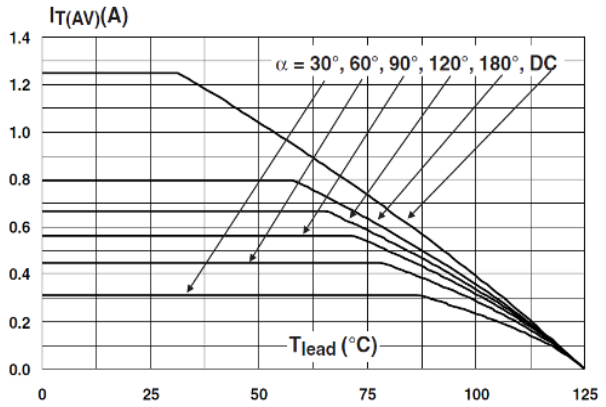


Figure 3. Average and DC on-state current versus lead temperature (SMBflat-3L)

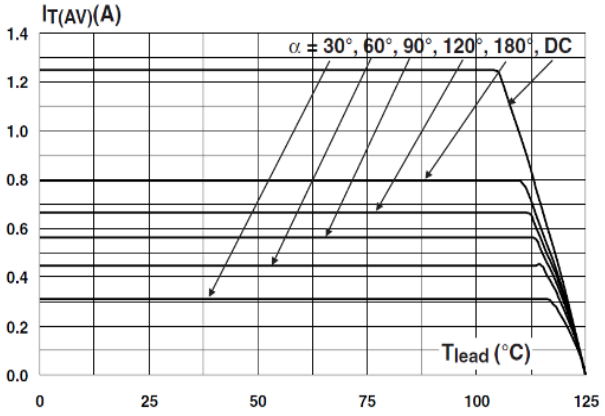


Figure 4. Average and DC on-state current versus ambient temperature

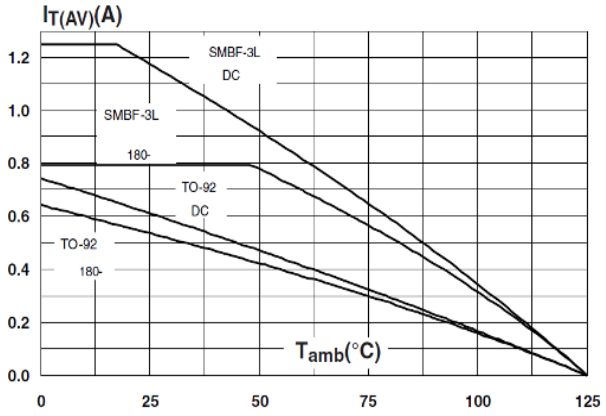


Figure 5. Relative variation of thermal impedance junction to ambient versus pulse duration

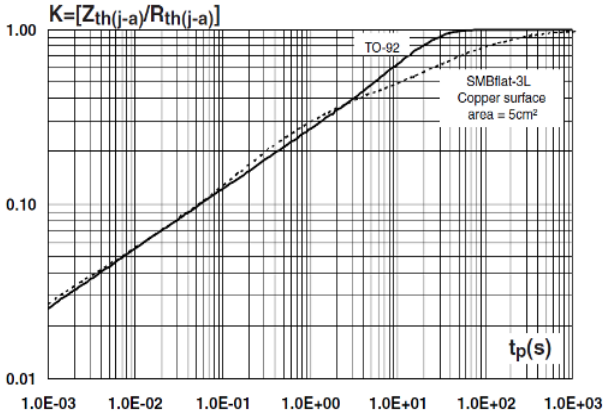


Figure 6. Relative variation of gate triggering current and voltage, holding and latching current versus T_j

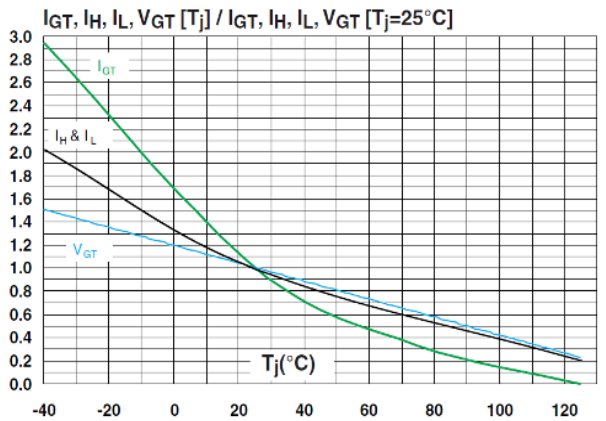


Figure 7. Relative variation of holding current versus gate-cathode resistance (typical values)

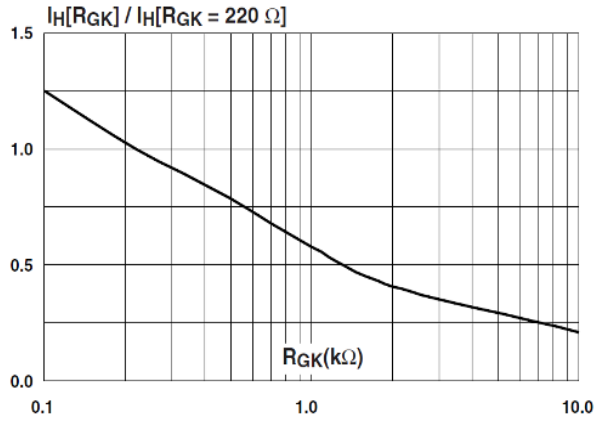


Figure 8. Relative variation of dV/dt immunity versus gate-cathode resistance (typical values)

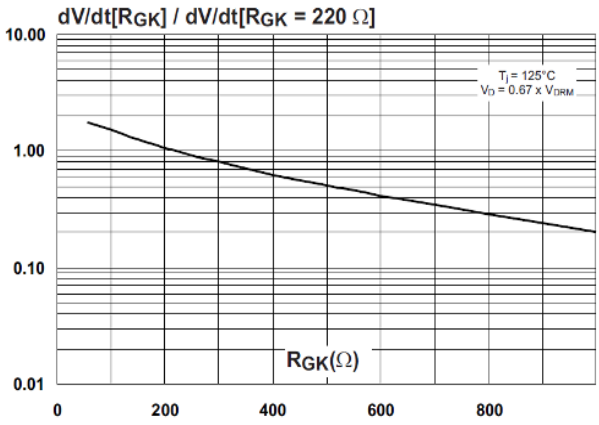


Figure 9. Relative variation of dV/dt immunity versus gate-cathode capacitance (typical values)

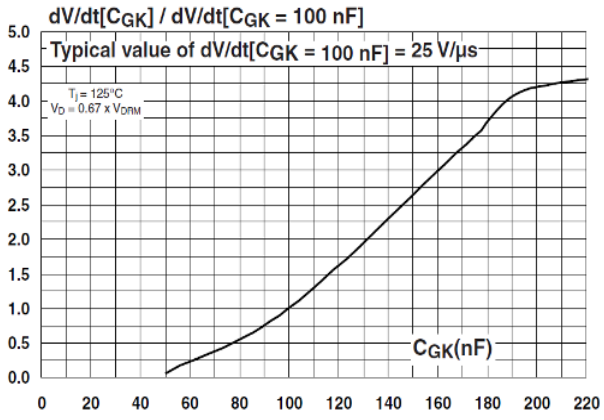


Figure 10.)Surge peak on-state current versus number of cycles

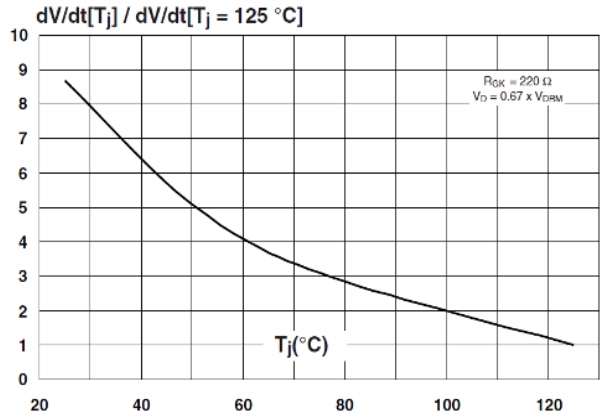


Figure 11.)Surge peak on-state current versus number of cycles

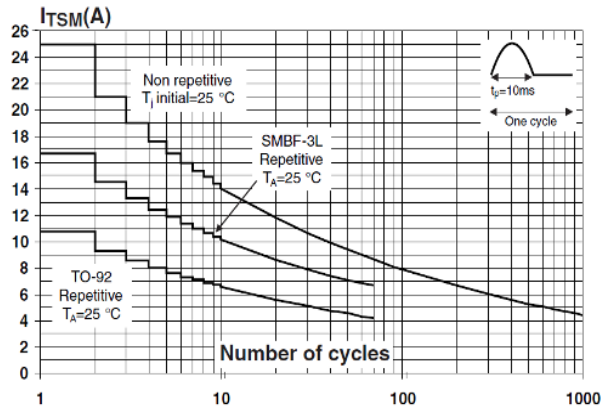


Figure 12. Non-repetitive surge peak on-state current, and corresponding values of I2t

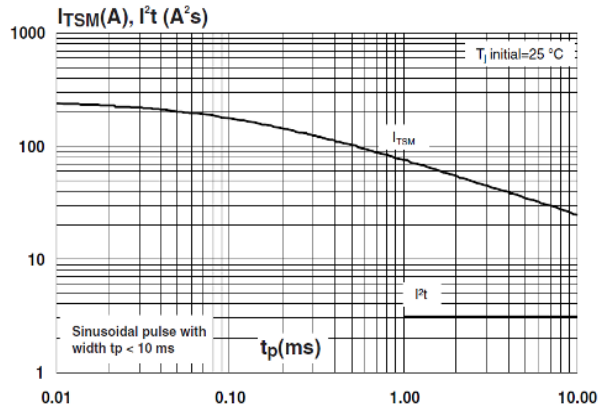


Figure 13. On-state characteristics (maximum values)

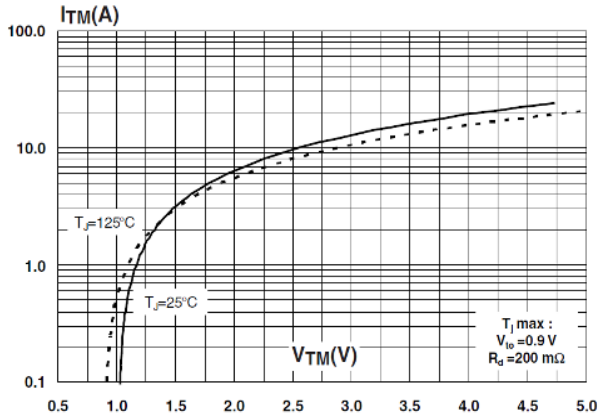
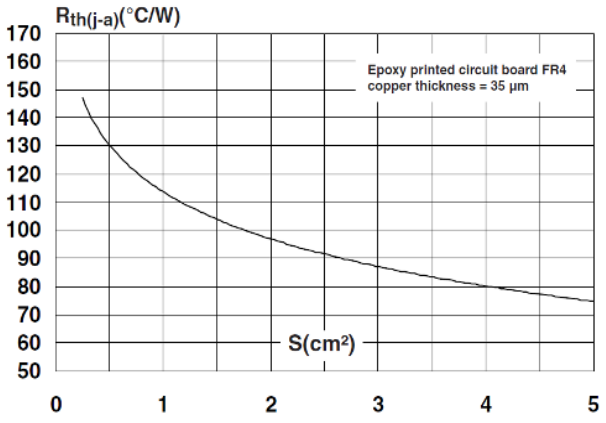


Figure 14. Thermal resistance junction to ambient versus copper surface under tab (SMBflat-3L)



2 AC line transient voltage ruggedness

In comparison with standard SCRs, the TS110-7 is self-protected against over-voltage. The TS110-7 switch can safely withstand AC line surge voltages by switching to the on state (for less than 10 ms on 50 Hz mains) to dissipate energy shocks through the load. The load limits the current through the TS110-7. The self-protection against over-voltage is based on an overvoltage crowbar technology. This safety feature works even with high turn-on current ramp up.

Figure 15 represents the TS110-7 in a test environment. It is used to stress the TS110-7 switch according to the IEC 61000-4-5 standard conditions. The TS110-7 folds back safely to the on state as shown in Figure 16.

The TS110-7 recovers its blocking voltage capability after the surge and the next zero current crossing. Such a non repetitive test can be done at least 10 times.

Figure 15. Overvoltage ruggedness test circuit for IEC 61000-4-5 standards

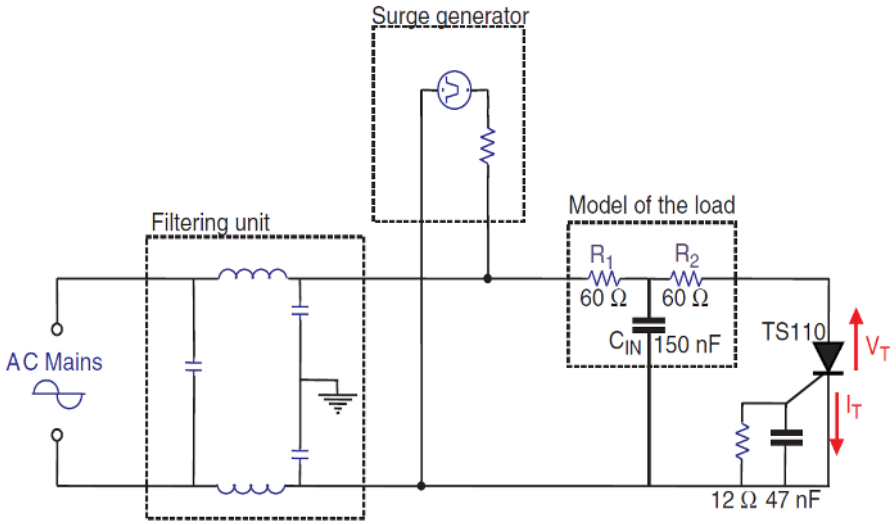
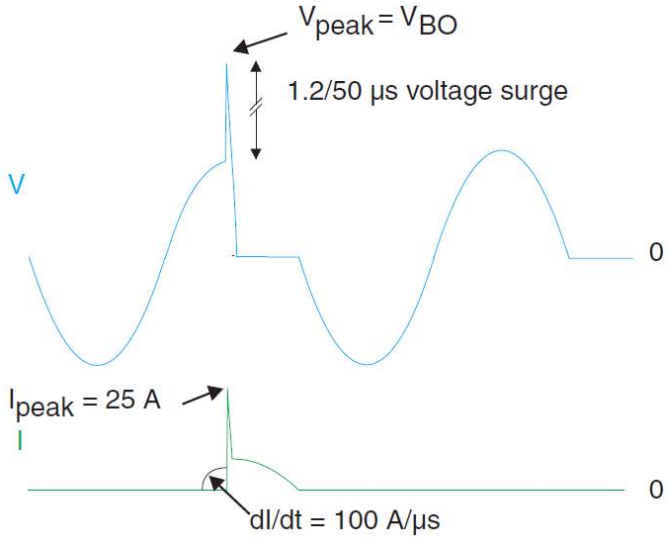


Figure 16. Typical current and voltage waveforms across the TS110-7 during IEC 61000-4-5 standard test



3 Package information

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK packages, depending on their level of environmental compliance. ECOPACK specifications, grade definitions and product status are available at: www.st.com. ECOPACK is an ST trademark.

3.1 TO-92 package information

- Lead free plating + halogen-free molding resin
- Epoxy meets UL94, V0

Figure 17. TO-92 package outline

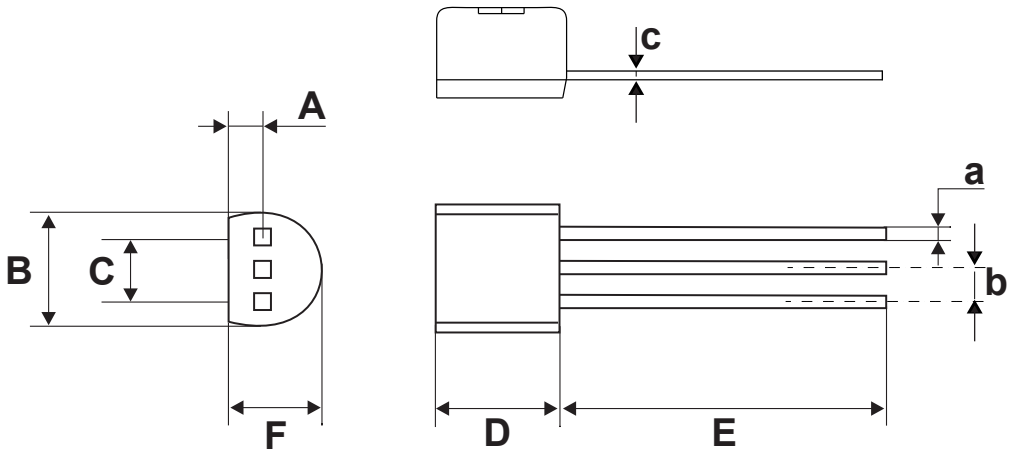


Table 5. TO-92 package mechanical data

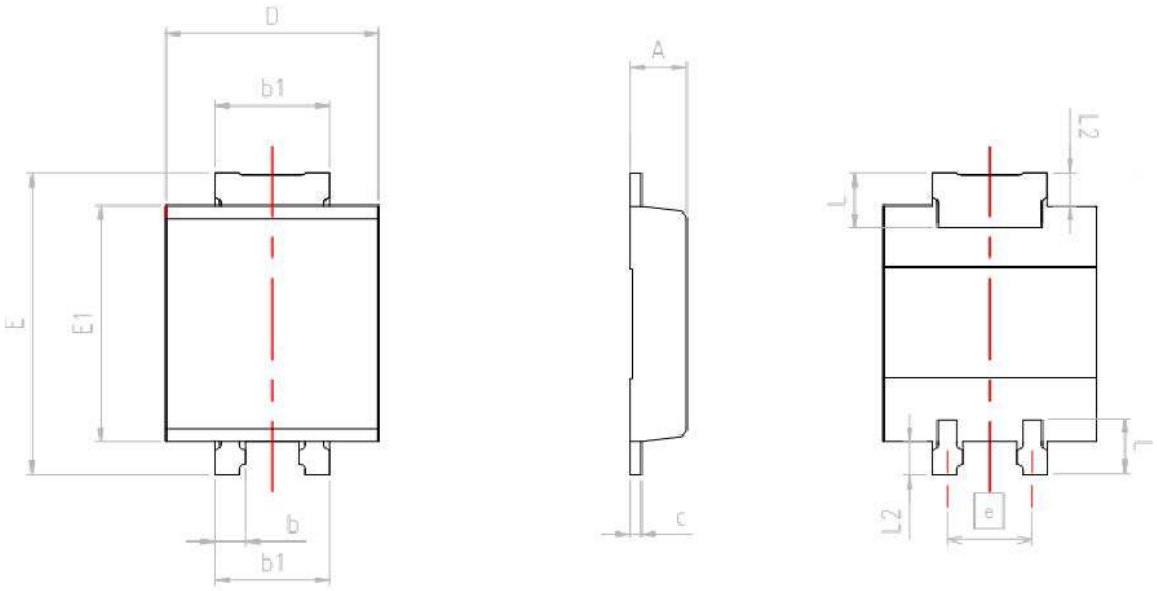
Ref.	Dimensions					
	Millimeters			Inches(1)		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A		1.35			0.0531	
B			4.70			0.1850
C		2.54			0.1000	
D	4.40			0.1732		
E	12.70			0.5000		
F			3.70			0.1457
a			0.50			0.0197
b		1.27			0.0500	
c			0.48			0.0189

1. *Inches dimensions given for information*

3.2 SMBflat-3L package information

- Epoxy meets UL94, V0
- Lead-free package

Figure 18. SMBflat-3L package outline

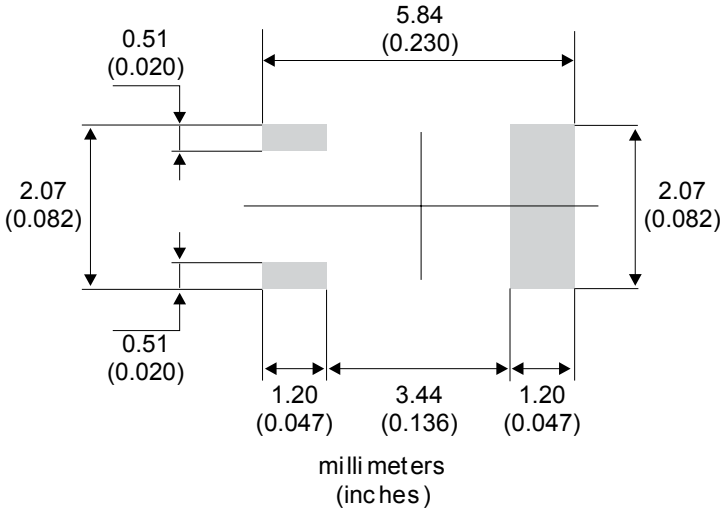


Note: This package drawing may slightly differ from the physical package. However, all the specified dimensions in the following table are guaranteed.

Table 6. SMBflat-3L mechanical data

Ref.	Dimensions					
	Millimeters			Inches (dimensions are for reference only)		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	0.90		1.10	0.0354		0.0433
b	0.35		0.65	0.0138		0.0256
b1	1.95		2.20	0.0768		0.0866
c	0.15		0.40	0.0059		0.0157
D	3.30		3.95	0.1299		0.1555
E	5.10		5.60	0.2008		0.2205
E1	4.05		4.60	0.1594		0.1811
L	0.75		1.50	0.0295		0.0591
L2		0.60			0.0236	
e		1.60			0.0630	

Figure 19. **Footprint recommendations, dimensions in mm (inches)**



Note: This drawing may not be in scale; however, all the specified dimensions are guaranteed.

4 Ordering information

Figure 20. **Ordering information scheme**

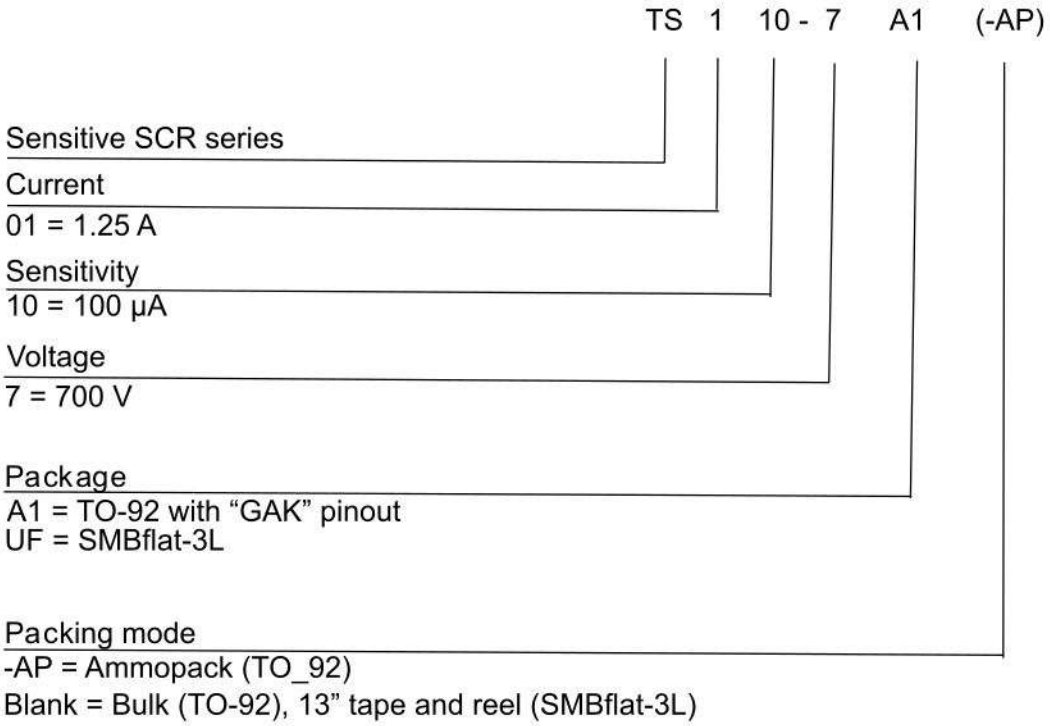


Table 7. **Ordering information**

Order code	Marking	Package	Weight	Base qty.	Delivery mode
TS110-7A1	TS110-7	TO-92	200 mg	2500	Bulk
TS110-7A1-AP				2000	Ammopack
TS110-7UF		SMBflat-3L	47 mg	5000	Tape and reel 13"

Revision history

Table 8. **Document revision history**

Date	Revision	Changes
01-Sep-2012	1	Initial release.
11-Sep-2012	2	Added SMBflat-3L package.
17-Oct-2013	3	Corrected typographical error in *Figure 8*.
18-Jun-2014	4	Updated device name.
17-Apr-2023	5	Updated Figure 18 and Table 6. Minor text changes.