

# Enhancement Mode N-Channel Power MOSFET

## Features

- ◆ Low  $R_{DS(on)}$  & FOM
- ◆ Extremely low switching loss
- ◆ Excellent stability and uniformity
- ◆ Fast switching and soft recovery

## Applications

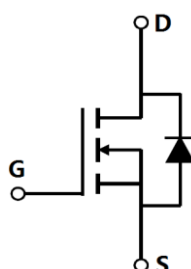


- ◆ Consumer electronic power supply
- ◆ Motor control
- ◆ Synchronous-rectification
- ◆ Isolated DC/DC convertor
- ◆ Invertors

## ■ General Description

SFS04R02xF use advanced FSMOS™ technology to provide low  $R_{DS(ON)}$ , low gate charge, fast switching and excellent avalanche characteristics. This device is specially designed to get better ruggedness and suitable to use in Synchronous-rectification applications.

◆ $V_{DS, min}$	40 V
◆ $I_{D, pulse}$	390 A
◆ $R_{DS(ON), max @ V_{GS}=10 V}$	2.0 mΩ
◆ $Q_g$	96.8 nC

## ■ Schematic and Package Information

<b>Schematic Diagram</b> 	<b>Pin Assignment Top View</b>  <b>TO220</b> <b>SFS04R02PF</b>	 <b>TO263</b> <b>SFS04R02KF</b>
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## ■ Absolute Maximum Ratings at $T_j=25^\circ\text{C}$ unless otherwise noted

Parameter	Symbol	Value	Unit
Drain source voltage	$V_{DS}$	40	V
Gate source voltage	$V_{GS}$	$\pm 20$	V
Continuous drain current <sup>1)</sup>	$I_D$	130	A
Pulsed drain current <sup>2)</sup>	$I_{D, pulse}$	390	A
Power dissipation <sup>3)</sup>	$P_D$	140	W
Single pulsed avalanche energy <sup>4)</sup>	$E_{AS}$	300	mJ
Operation and storage temperature	$T_{stg}, T_j$	-55 to 150	$^\circ\text{C}$

## ■ Thermal Characteristics

Parameter	Symbol	Value	Unit
Thermal resistance, junction-case	$R_{\theta JC}$	0.89	$^{\circ}\text{C}/\text{W}$
Thermal resistance, junction-ambient <sup>5)</sup>	$R_{\theta JA}$	62	$^{\circ}\text{C}/\text{W}$

## ■ Electrical Characteristics at $T_J=25^{\circ}\text{C}$ unless otherwise specified

Parameter	Symbol	Min.	Typ.	Max.	Unit	Test condition
Drain-source breakdown voltage	$BV_{DSS}$	40			V	$V_{GS}=0\text{ V}, I_D=250\ \mu\text{A}$
Gate threshold voltage	$V_{GS(th)}$	1.3		2.5	V	$V_{DS}=V_{GS}, I_D=250\ \mu\text{A}$
Drain-source on-state resistance	$R_{DS(on)}$		1.5	2.0	$\text{m}\Omega$	$V_{GS}=10\text{ V}, I_D=55\text{ A}$
Drain-source on-state resistance	$R_{DS(on)}$		2.5	3.0	$\text{m}\Omega$	$V_{GS}=4.5\text{ V}, I_D=55\text{ A}$
Gate-source leakage current	$I_{GSS}$			100	nA	$V_{GS}=20\text{ V}$
				-100		$V_{GS}=-20\text{ V}$
Drain-source leakage current	$I_{DSS}$			1	$\mu\text{A}$	$V_{DS}=40\text{ V}, V_{GS}=0\text{ V}$

## ■ Dynamic Characteristics

Parameter	Symbol	Min.	Typ.	Max.	Unit	Test condition
Input capacitance	$C_{iss}$		6587.4		pF	$V_{GS}=0\text{ V},$ $V_{DS}=20\text{ V},$ $f=100\text{ kHz}$
Output capacitance	$C_{oss}$		2537.3		pF	
Reverse transfer capacitance	$C_{rss}$		178.8		pF	
Turn-on delay time	$t_{d(on)}$		26.6		ns	$V_{GS}=10\text{ V},$ $V_{DS}=20\text{ V},$ $R_G=2\ \Omega,$ $I_D=20\text{ A}$
Rise time	$t_r$		9.3		ns	
Turn-off delay time	$t_{d(off)}$		96		ns	
Fall time	$t_f$		39.3		ns	

## ■ Gate Charge Characteristics

Parameter	Symbol	Min.	Typ.	Max.	Unit	Test condition
Total gate charge	$Q_g$		96.8		nC	$I_D=20\text{ A}$ , $V_{DS}=20\text{ V}$ , $V_{GS}=10\text{ V}$
Gate-source charge	$Q_{gs}$		14.5		nC	
Gate-drain charge	$Q_{gd}$		18.4		nC	
Gate plateau voltage	$V_{\text{plateau}}$		2.7		V	

## ■ Body Diode Characteristics

Parameter	Symbol	Min.	Typ.	Max.	Unit	Test condition
Diode forward current	$I_S$			130	A	$V_{GS} < V_{th}$
Pulsed source current	$I_{SP}$			390		
Diode forward voltage	$V_{SD}$			1.3	V	$I_S=20\text{ A}$ , $V_{GS}=0\text{ V}$
Reverse recovery time	$t_{rr}$		205		ns	$I_S=20\text{ A}$ , $di/dt=100\text{ A}/\mu\text{s}$
Reverse recovery charge	$Q_{rr}$		557.4		nC	
Peak reverse recovery current	$I_{rrm}$		4.3		A	

## ■ Note

- 1) Calculated continuous current based on maximum allowable junction temperature.
- 2) Repetitive rating; pulse width limited by max. junction temperature.
- 3)  $P_d$  is based on max. junction temperature, using junction-case thermal resistance.
- 4)  $V_{DD}=30\text{ V}$ ,  $R_G=50\ \Omega$ ,  $L=0.3\text{ mH}$ , starting  $T_j=25\text{ }^\circ\text{C}$ .
- 5) The value of  $R_{\theta JA}$  is measured with the device mounted on 1 in 2 FR-4 board with 2oz. Copper, in a still air environment with  $T_a=25\text{ }^\circ\text{C}$ .

■ **Electrical Characteristics Diagrams**

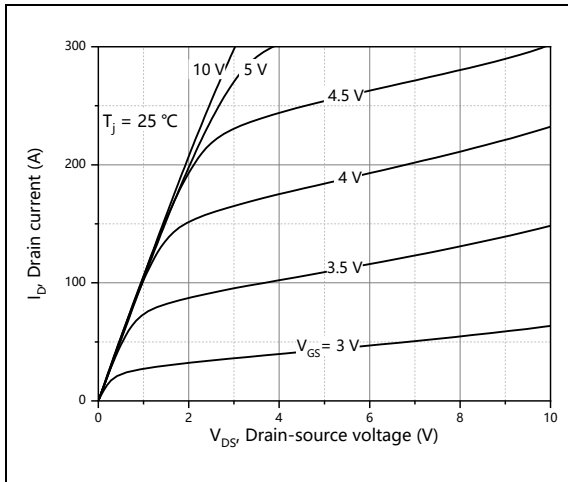


Figure 1, Typ. output characteristics

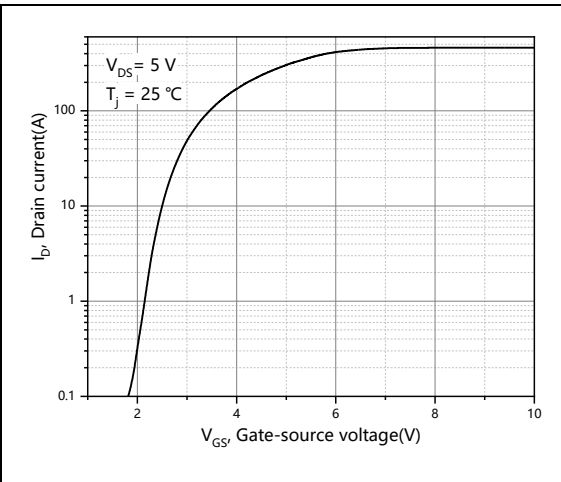


Figure 2, Typ. transfer characteristics

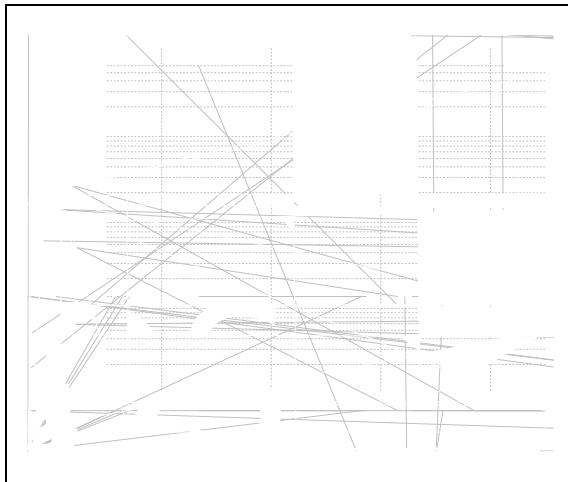


Figure 3, Typ. capacitances

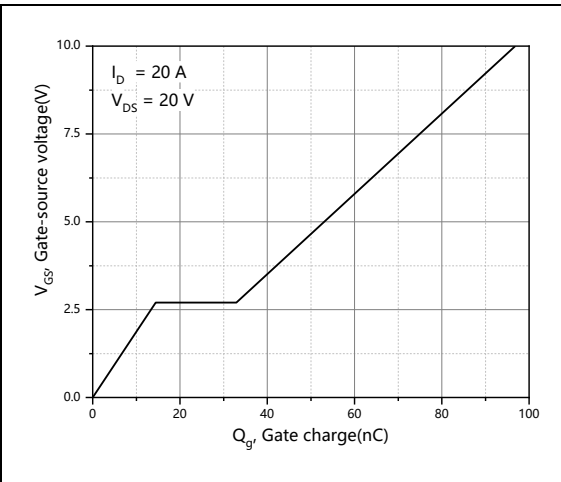


Figure 4, Typ. gate charge

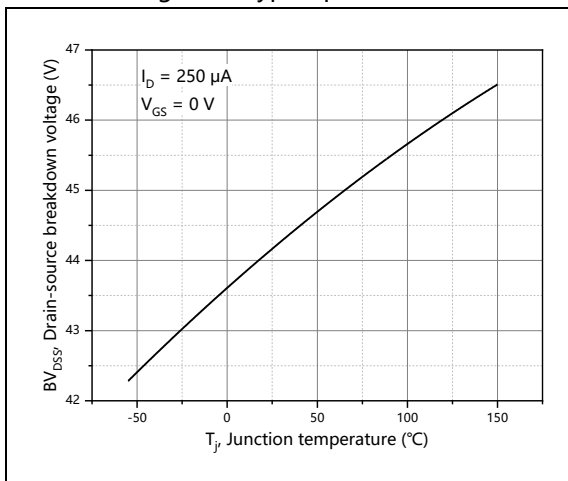


Figure 5, Drain-source breakdown voltage

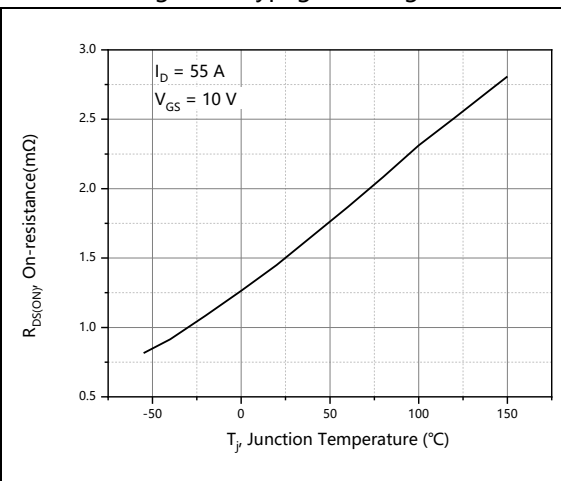


Figure 6, Drain-source on-state resistance

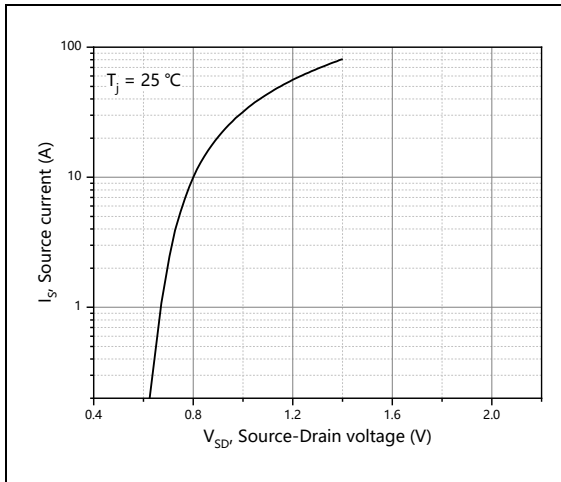


Figure 7, Forward characteristic of body diode

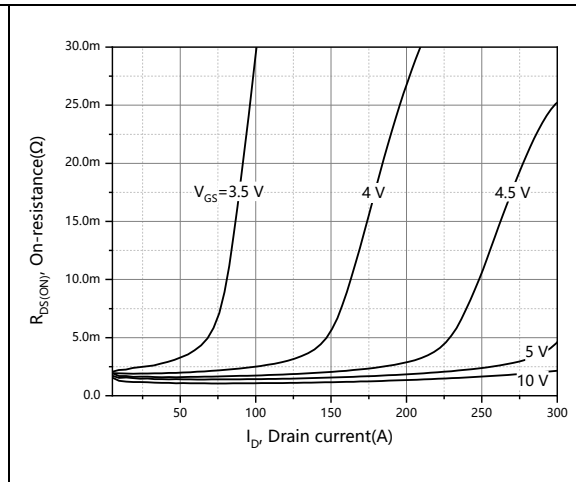


Figure 8, Drain-source on-state resistance

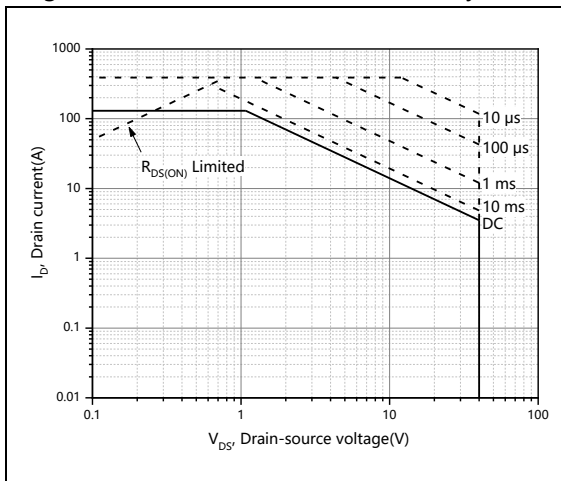


Figure 9, Safe operation area  $T_C=25\text{ }^\circ\text{C}$

■ Test circuits and waveforms

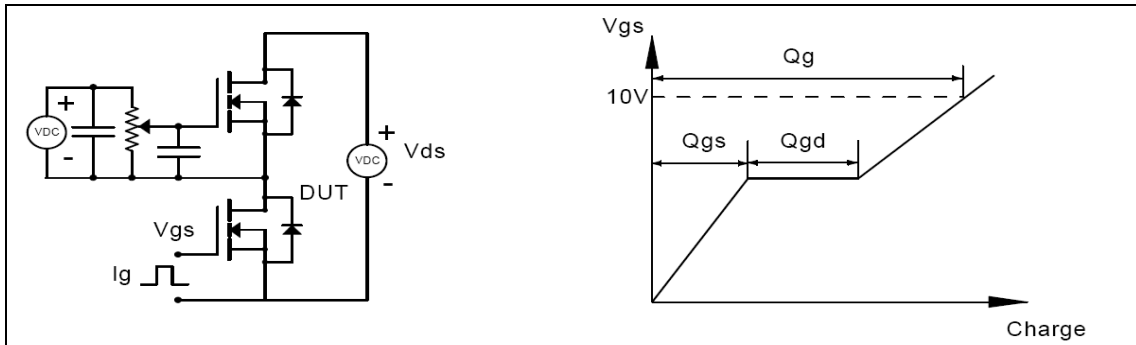


Figure 1, Gate charge test circuit & waveform

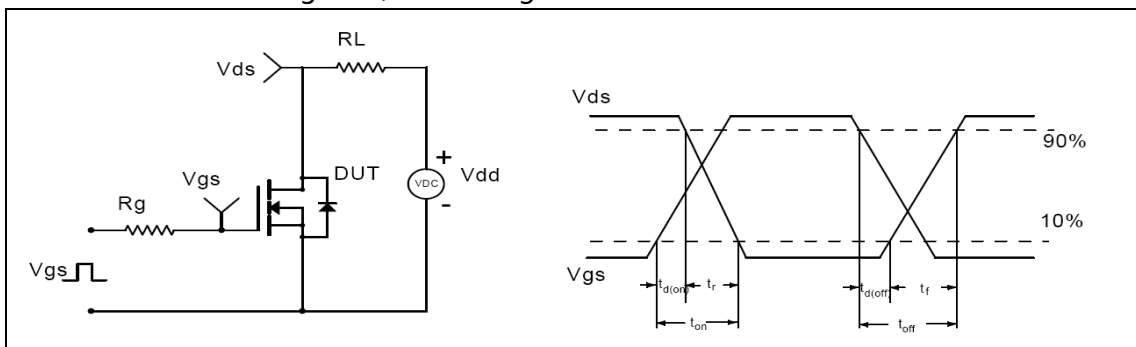


Figure 2, Switching time test circuit & waveforms

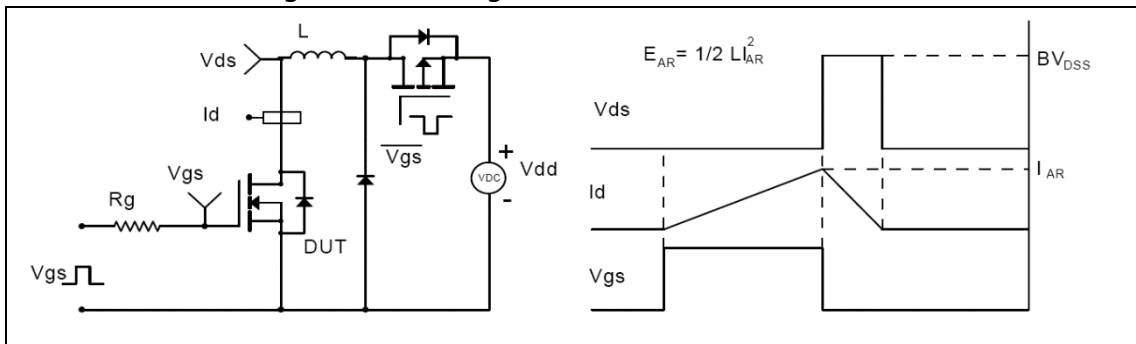


Figure 3, Unclamped inductive switching (UIS) test circuit & waveforms

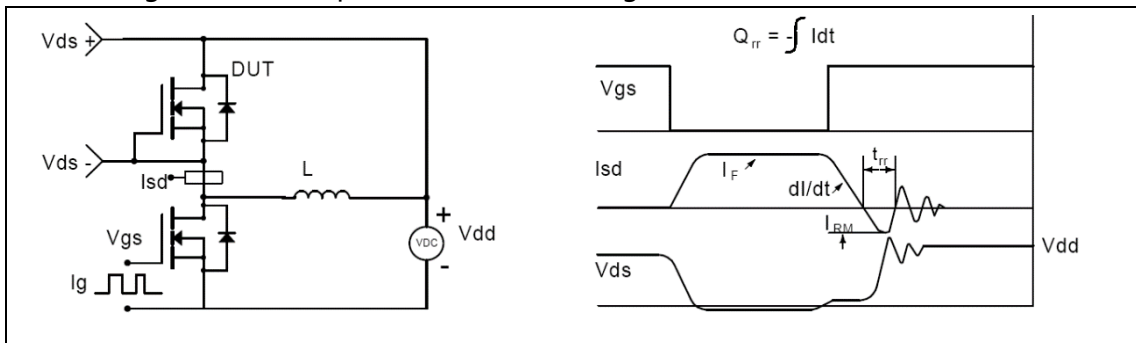
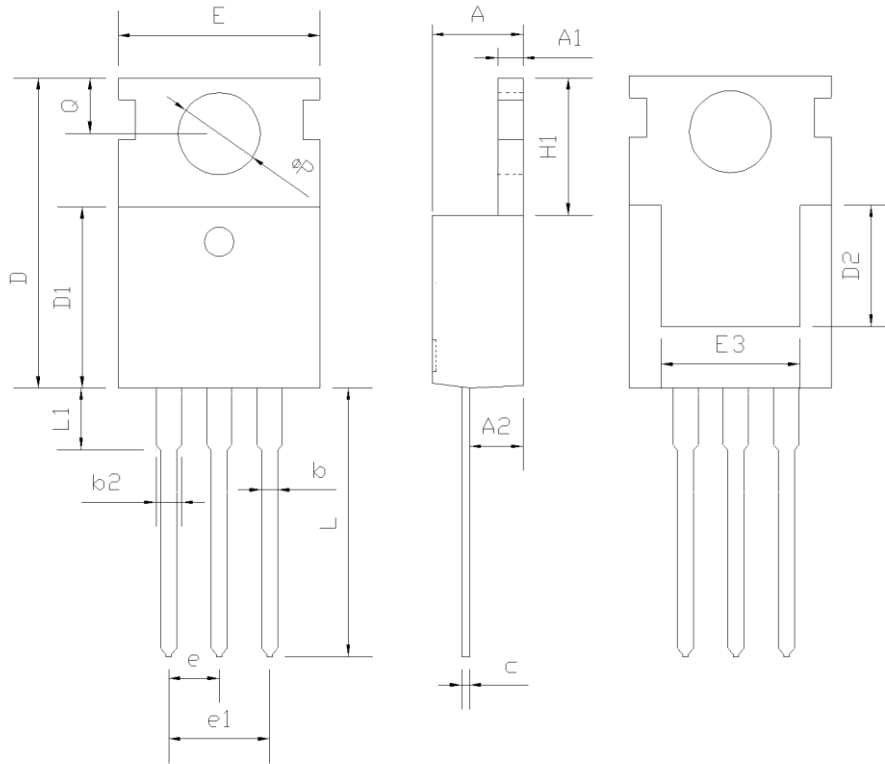


Figure 4, Diode reverse recovery test circuit & waveforms

**■ Package Information**

Figure1, TO220 package outline dimension

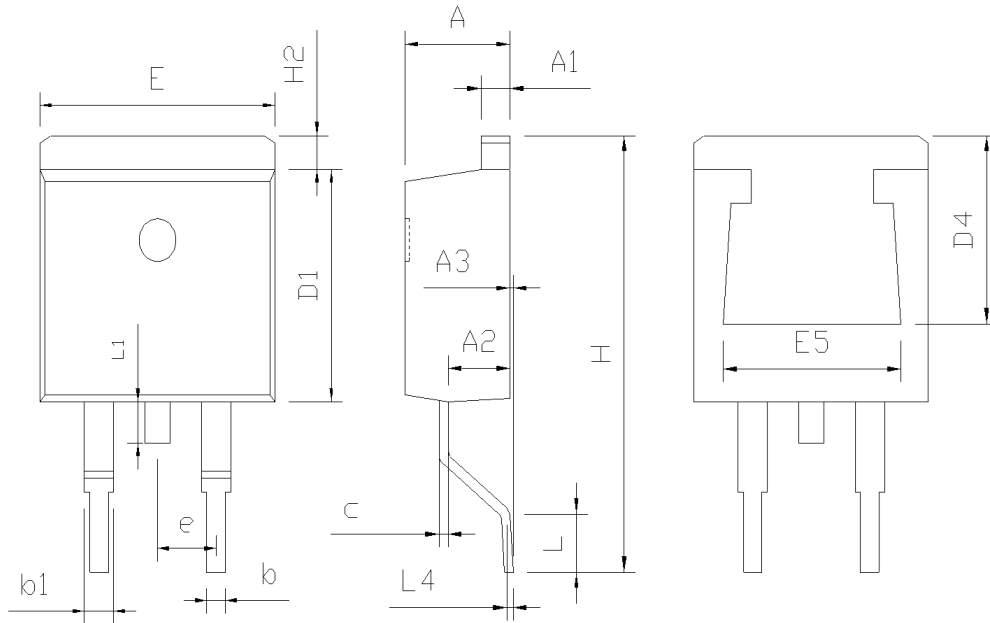


SYMBOL	mm		
	MIN	NOM	MAX
A	4.37	4.57	4.70
A1	1.25	1.30	1.40
A2	2.20	2.40	2.60
b	0.70	0.80	0.95
b2	1.17	1.27	1.47
c	0.45	0.50	0.60
D	15.10	15.60	16.10
D1	8.80	9.10	9.40
D2	5.50	-	-
E	9.70	10.00	10.30
E3	7.00	-	-
e	2.54 BSC		
e1	5.08 BSC		
H1	6.25	6.50	6.85
L	12.75	13.50	13.80
L1	-	3.10	3.40
ΦP	3.40	3.60	3.80
Q	2.60	2.80	3.00



**■ Package Information**

Figure2, TO263 package outline dimension



SYMBOL	mm		
	MIN	NOM	MAX
A	4.37	4.57	4.77
A1	1.22	1.27	1.42
A2	2.49	2.69	2.89
A3	0.00	0.13	0.25
b	0.70	0.81	0.96
b1	1.17	1.27	1.47
c	0.30	0.38	0.53
D1	8.50	8.70	8.90
D4	6.60	-	-
E	9.86	10.16	10.36
E5	7.06	-	-
e	2.54 BSC		
H	14.70	15.10	15.50
H2	1.07	1.27	1.47
L	2.00	2.30	2.60
L1	1.40	1.55	1.70
L4	0.25 BSC		

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**■ Ordering Information**


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Package	Units/Reel	Reels/Inner Box	Units/Inner Box	Inner Box/Carton Box	Units/Carton Box
TO263	800	1	800	5	4000

Package	Units/Tube	Tubes/Inner Box	Units/Inner Box	Inner Box/Carton Box	Units/Carton Box
TO220	50	20	1000	6	6000

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**■ Product Information**


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Product	Package	Pb Free	RoHS	Halogen Free
SFS04R02PF	TO220	yes	yes	yes
SFS04R02KF	TO263	yes	yes	yes