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$V_{RM} = 200\text{ V}$, $I_F = 5\text{ A}$, 10 A , 15 A
Fast Recovery Diode Built-in Temperature Detection
FMKS Series



Data Sheet

Description

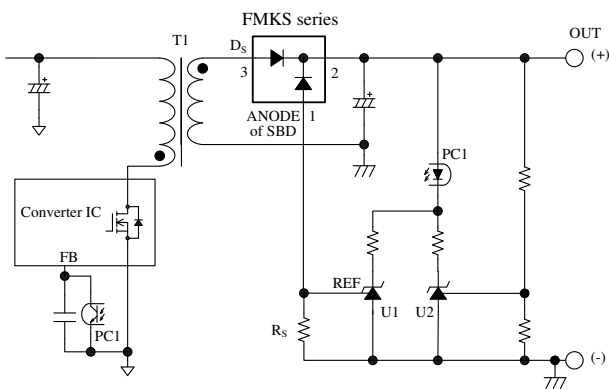
The FMKS Series is the fast recovery diode built-in temperature detection.

A fast recovery diode and a Schottky barrier diode for temperature detection are formed on the same die. Thus, the FMKS Series achieves highly accurate temperature detection that is higher than that with a thermistor, component reduction, power supply downsizing, and easy attachment.

Features

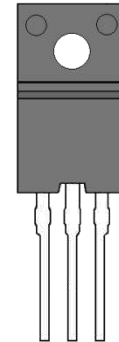
- Built-in temperature detection
- Highly accurate temperature detection of FRD
- Component reduction of temperature detection
- High speed switching
- Low forward voltage drop

Typical Application



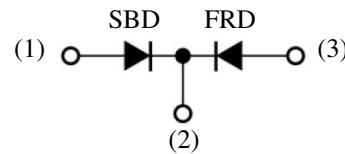
Package

TO220F-3L



(1)(2)(3)

Not to scale



- (1) Anode of Schottky barrier diode, SBD, for temperature detection
- (2) Cathode
- (3) Anode of fast recovery diode, FRD

FMKS Series

Products	V_{RM}	I_F	V_F	t_r
FMKS-2052	200 V	5 A	0.98 V	50 ns
FMKS-2102		10 A		
FMKS-2152		15 A		

where,
 V_{RM} is peak reverse voltage,
 I_F is average forward current,
 V_F is forward voltage drop, and
 t_r is reverse recovery time

Application

The following with thermal protection circuit and peak power limiting circuit, and so forth

- Audio
- White goods
- Power Supplies

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FMKS Series

1. Absolute Maximum Ratings

Unless specifically noted $T_A = 25\text{ }^\circ\text{C}$.

Parameter	Symbol	Conditions	Rating	Unit	Note
Fast Recovery Diode (FRD)					
Transient Peak Reverse Voltage	V_{RSM}		200	V	
Peak Repetitive Reverse Voltage	V_{RM}		200	V	
Average Forward Current	$I_{F(AV)}$		5	A	FMKS-2052
			10		FMKS-2102
			15		FMKS-2152
Surge Forward Current	I_{FSM}	10 ms, half sine wave, one shot	100	A	FMKS-2052
			140		FMKS-2102
			170		FMKS-2152
I^2t Limiting Value	I^2t	$1\text{ ms} \leq t \leq 10\text{ ms}$	50	A^2s	FMKS-2052
			98		FMKS-2102
			144.5		FMKS-2152
Junction Temperature	T_j		-40 to 150	$^\circ\text{C}$	
Storage Temperature	T_{stg}		-40 to 150	$^\circ\text{C}$	
Isolation Voltage	-	Between the case and each pin, 1 minute, ac	1.0	kV	
Schottky Barrier Diode for Temperature Detection (SBD)					
Transient Peak Reverse Voltage	V_{RSM}		90	V	
Peak Repetitive Reverse Voltage	V_{RM}		90	V	
Junction Temperature	T_j		-40 to 150	$^\circ\text{C}$	
Storage Temperature	T_{stg}		-40 to 150	$^\circ\text{C}$	

FMKS Series

2. Electrical Characteristics

Unless specifically noted $T_A = 25\text{ }^\circ\text{C}$.

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit	Note
Fast Recovery Diode (FRD)							
Forward Voltage Drop	V_F	$I_F = 5\text{ A}$	–	–	0.98	V	FMKS-2052
		$I_F = 10\text{ A}$	–	–	0.98		FMKS-2102
		$I_F = 15\text{ A}$	–	–	0.98		FMKS-2152
Reverse Leakage Current	I_R	$V_R = V_{RM}$	–	–	50	μA	FMKS-2052
			–	–	100		FMKS-2102
			–	–	150		FMKS-2152
Reverse Leakage Current Under High Temperature	$H \cdot I_R$	$V_R = V_{RM}$ $T_j = 150\text{ }^\circ\text{C}$	–	–	3	mA	FMKS-2052
			–	–	6		FMKS-2102
			–	–	10		FMKS-2152
Reverse Recovery Time	t_{rr1}	$I_F = I_{RP} = 100\text{ mA}$, $T_j = 25\text{ }^\circ\text{C}$, 90 % recovery point	–	–	50	ns	
	t_{rr2}	$I_F = 100\text{ mA}$, $I_{RP} = 200\text{ mA}$, $T_j = 25\text{ }^\circ\text{C}$, 75 % recovery point	–	–	35	ns	
Thermal Resistance*	$R_{th(j-c)}$		–	–	4.0	$^\circ\text{C/W}$	
Schottky Barrier Diode for Temperature Detection Diode (SBD)							
Reverse Leakage Current	I_{R1}	$V_R = 15\text{ V}$	–	–	50	μA	
	I_{R2}	$V_R = 90\text{ V}$	–	–	2.0	mA	
Reverse Leakage Current Under High Temperature	$H \cdot I_{R1}$	$V_R = 15\text{ V}$, $T_j = 130\text{ }^\circ\text{C}$	1.20	1.90	2.60	mA	
	$H \cdot I_{R2}$	$V_R = 90\text{ V}$, $T_j = 150\text{ }^\circ\text{C}$	–	–	55	mA	

* $R_{th(j-c)}$ is thermal resistance between junction and case.

3. Performance Curves

3.1 Schottky Barrier Diode for Temperature Detection Diode Characteristics

In Figure 3-1, the reverse voltage of Schottky Barrier Diode for temperature detection (SBD), V_R , is 15V. The temperature of fast recovery diode (FRD) can be estimated by using Figure 3-1.

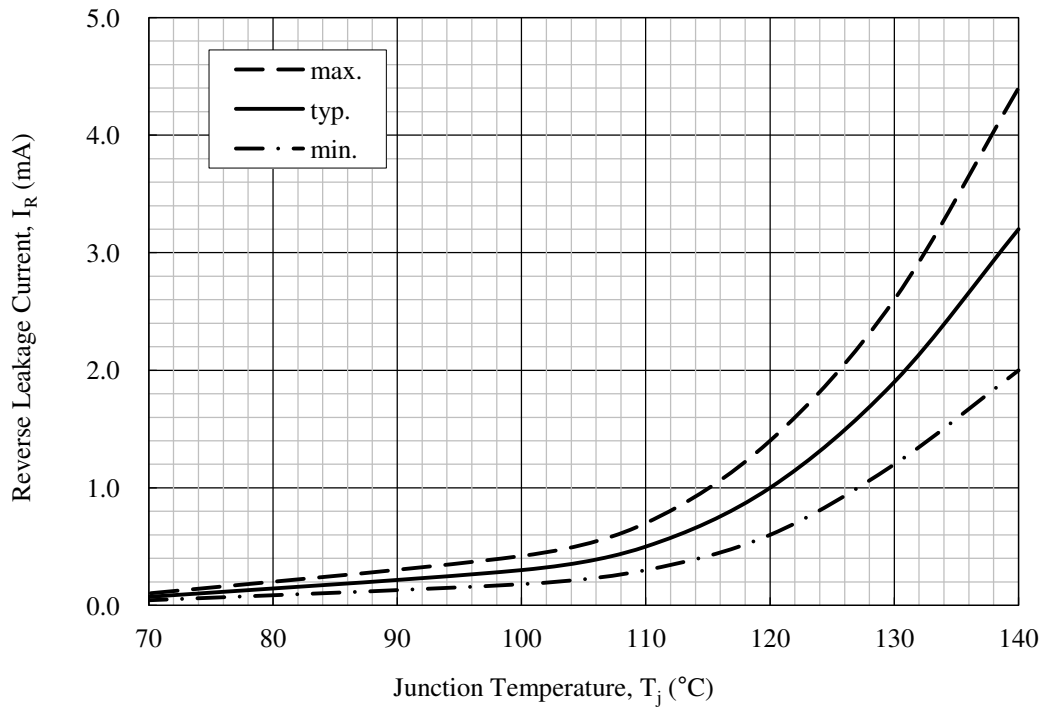


Figure 3-1 Temperature dependent of Reverse Leakage Current, I_R (SBD)

3.2 Fast Recovery Diode Characteristics

T is a pulse cycle, t is a pulse width.

3.2.1 FMKS-2052

3.2.1.1. Typical Characteristics

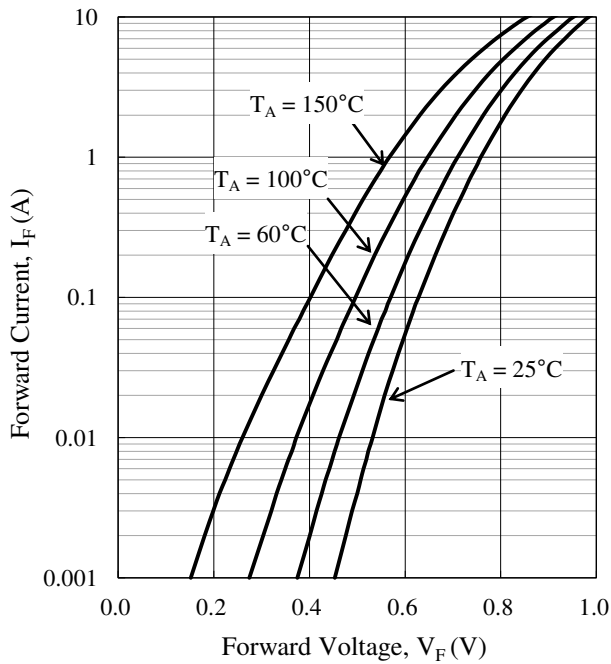


Figure 3-2 $I_F - V_F$ Typical Characteristics

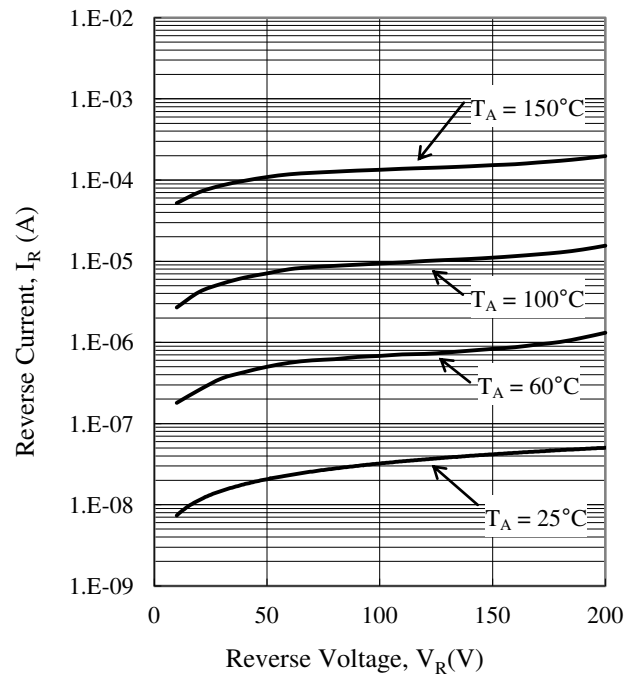


Figure 3-3 $I_R - V_R$ Typical Characteristics

3.2.1.2. Power Dissipation Curves ($T_j = 150\text{ }^\circ\text{C}$)

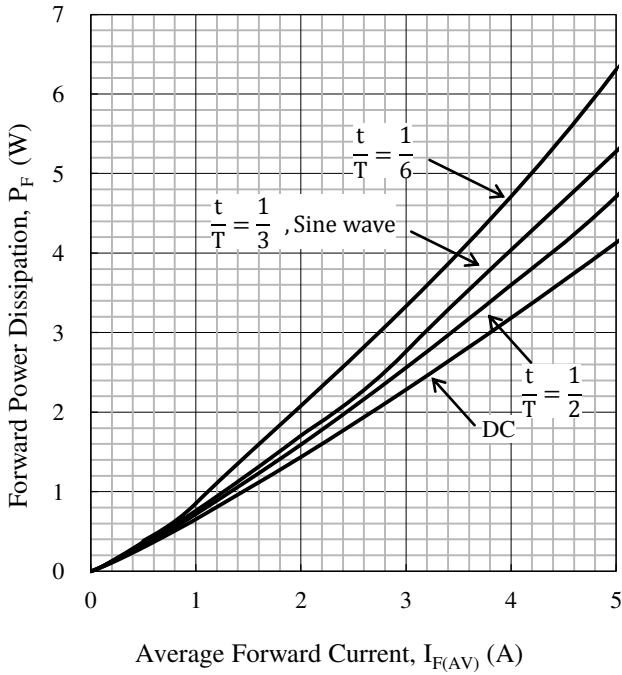


Figure 3-4 $P_F - I_{F(AV)}$

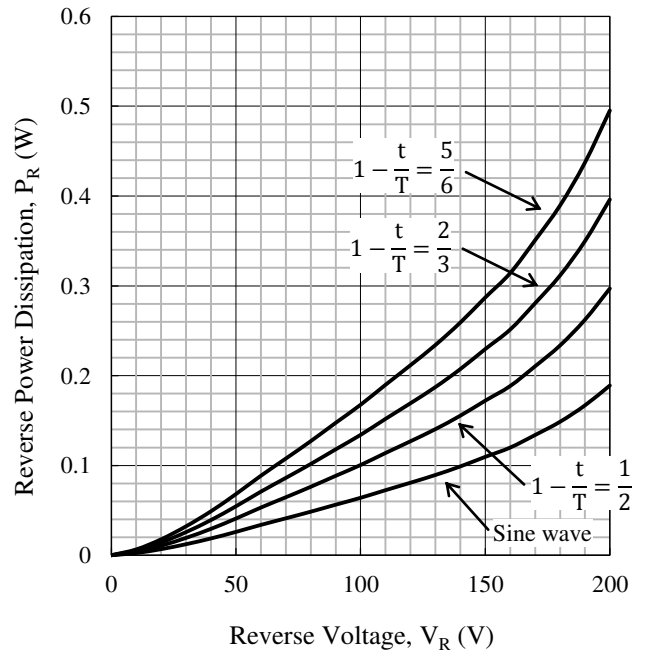


Figure 3-5 $P_R - V_R$

3.2.1.3. Derating Curves ($T_j = 150\text{ }^\circ\text{C}$)

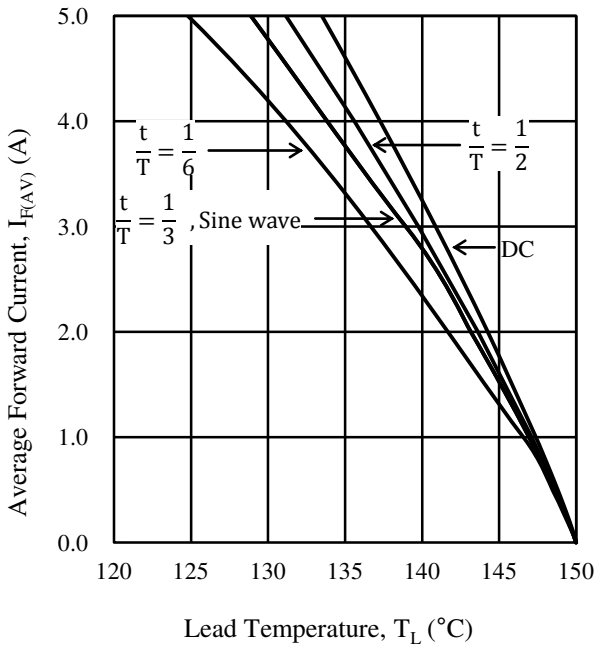


Figure 3-6 $I_{F(AV)} - T_L (V_R = 0\text{ V})$

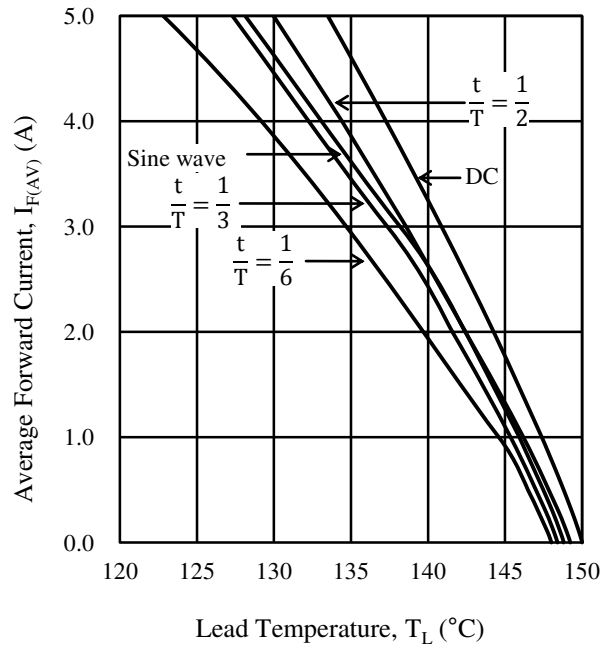


Figure 3-7 $I_{F(AV)} - T_L (V_R = 200\text{ V})$

3.2.2 FMKS-2102

3.2.2.1. Typical Characteristics

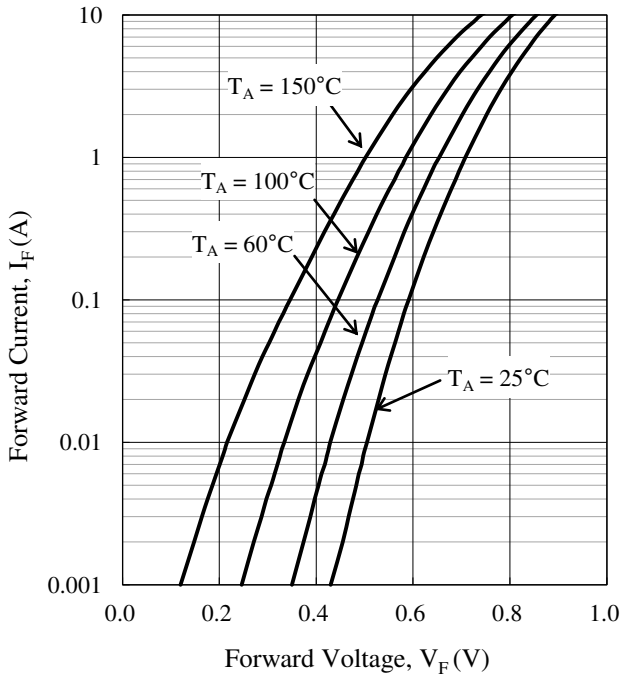


Figure 3-8 $V_F - I_F$ Typical Characteristics

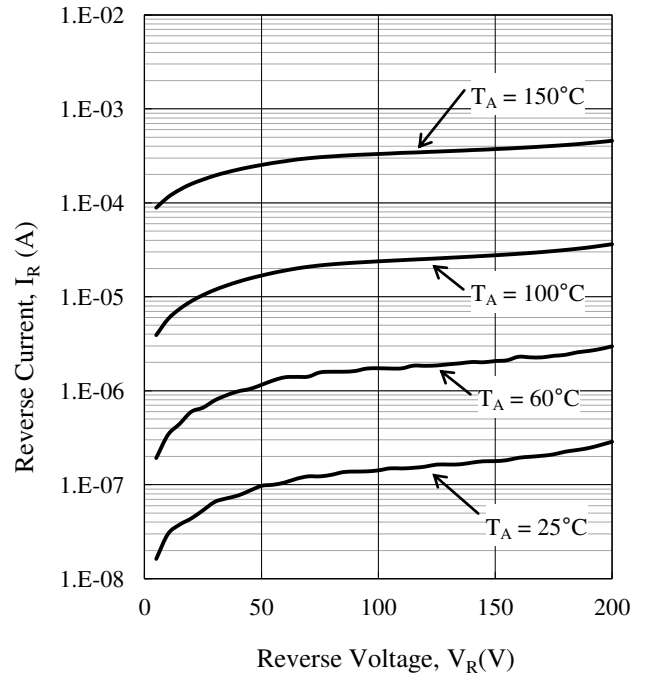


Figure 3-9 $V_R - I_R$ Typical Characteristics

3.2.2.2. Power Dissipation Curves ($T_j = 150^\circ\text{C}$)

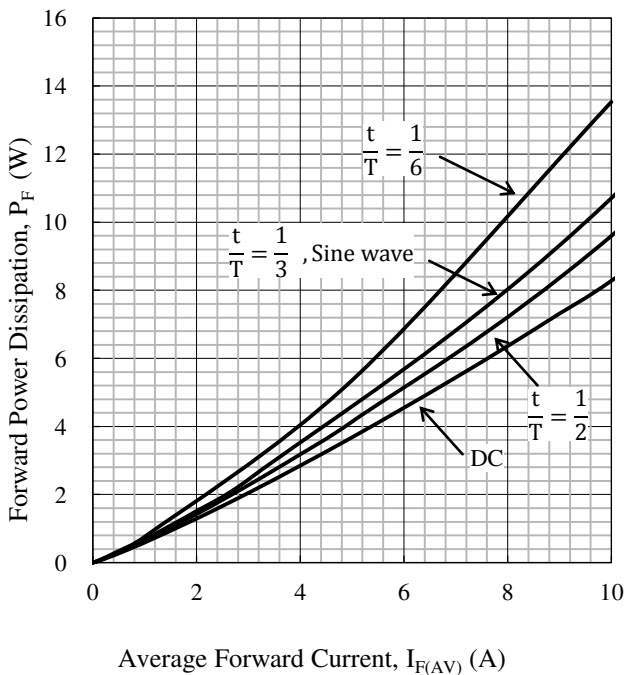


Figure 3-10 $P_F - I_{F(AV)}$

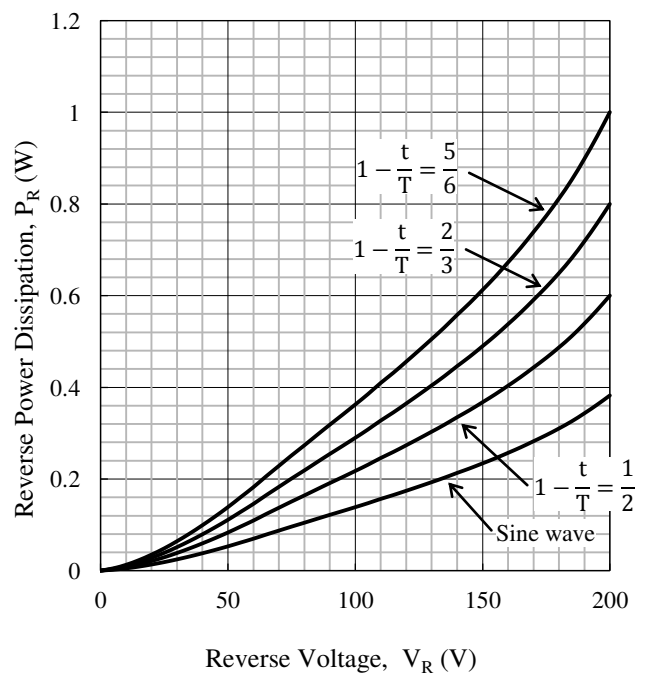


Figure 3-11 $P_R - V_R$

3.2.2.3. Derating Curves ($T_j = 150^\circ\text{C}$)

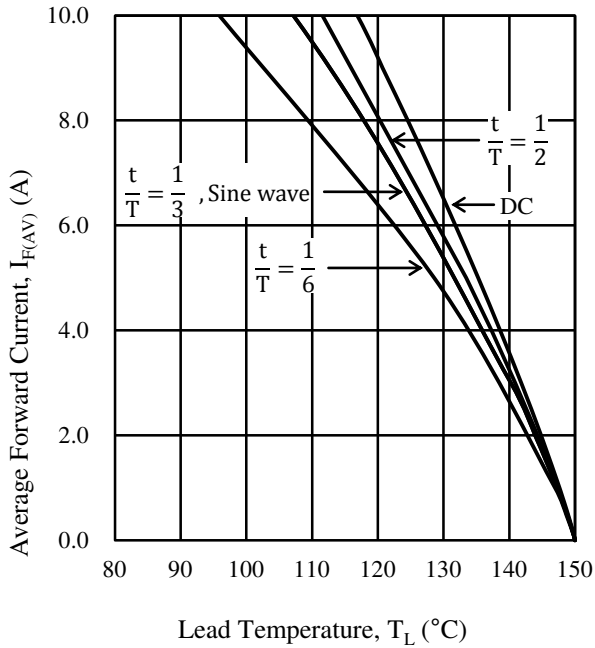


Figure 3-12 $I_{F(AV)} - T_L$ ($V_R = 0\text{ V}$)

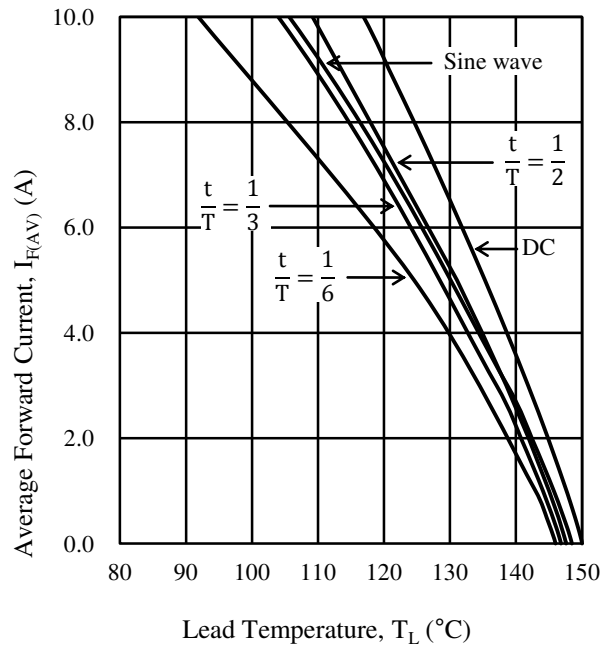


Figure 3-13 $I_{F(AV)} - T_L$ ($V_R = 200\text{ V}$)

3.2.3 FMKS-2152

3.2.3.1. Typical Characteristics

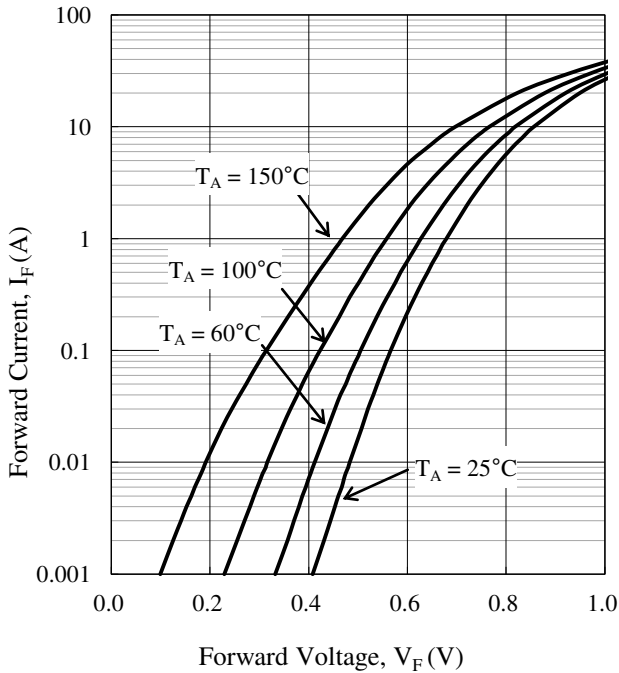


Figure 3-14 $V_F - I_F$ Typical Characteristics

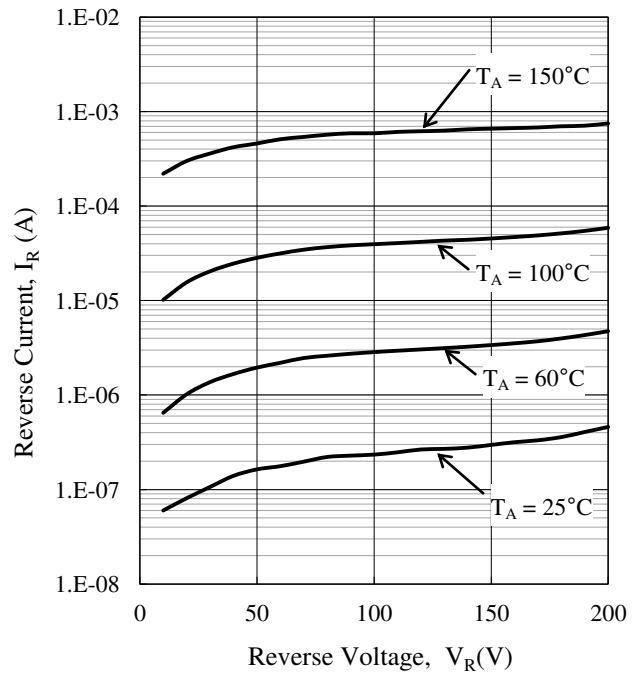


Figure 3-15 $V_R - I_R$ Typical Characteristics

3.2.3.2. Power Dissipation Curves ($T_j = 150\text{ }^\circ\text{C}$)

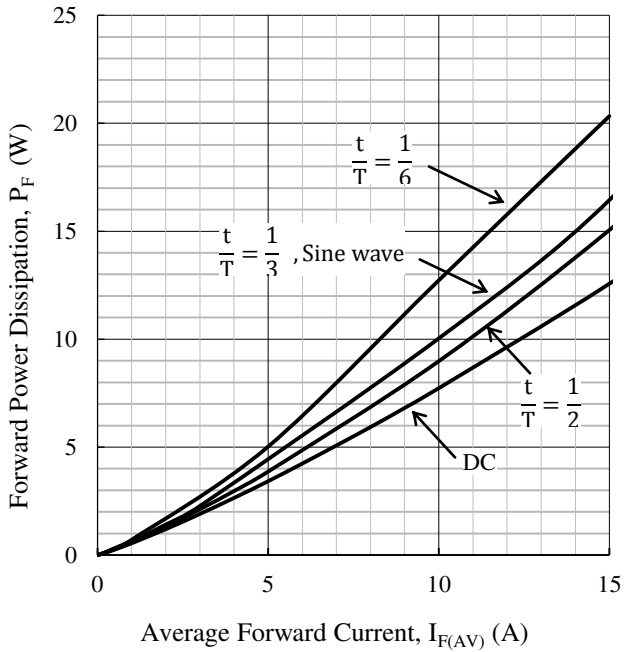


Figure 3-16 $P_F - I_{F(AV)}$

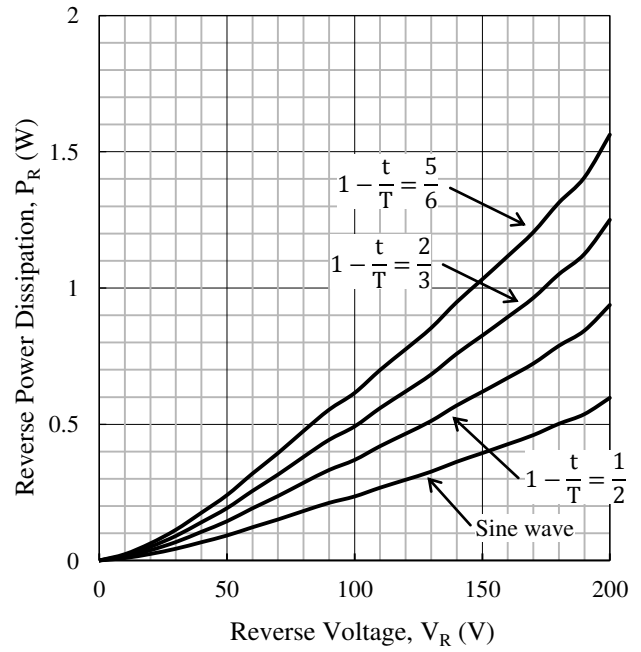


Figure 3-17 $P_R - V_R$

3.2.3.3. Derating Curves ($T_j = 150\text{ }^\circ\text{C}$)

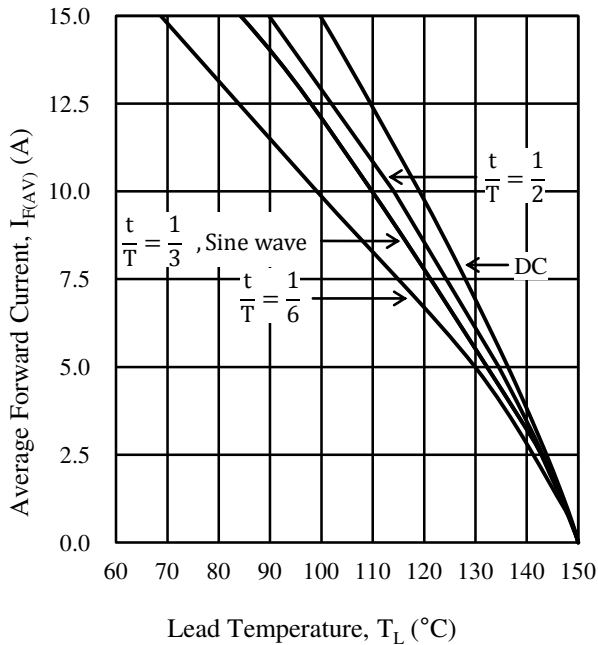


Figure 3-18 $I_{F(AV)} - T_L$ ($V_R = 0\text{ V}$)

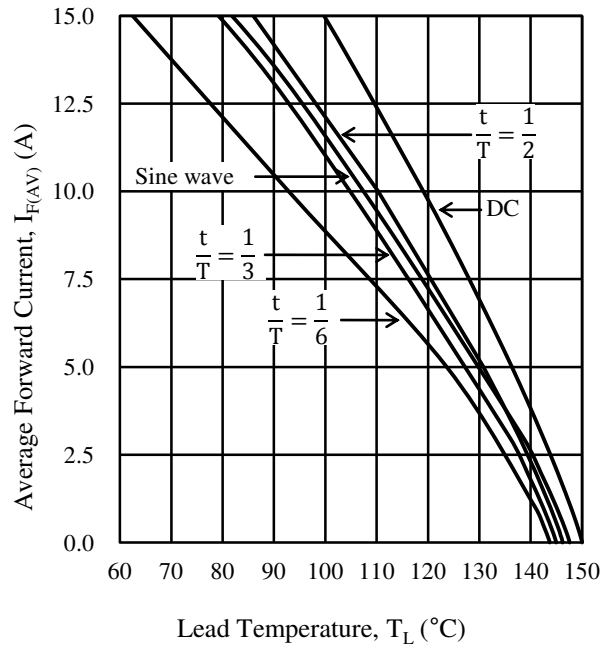
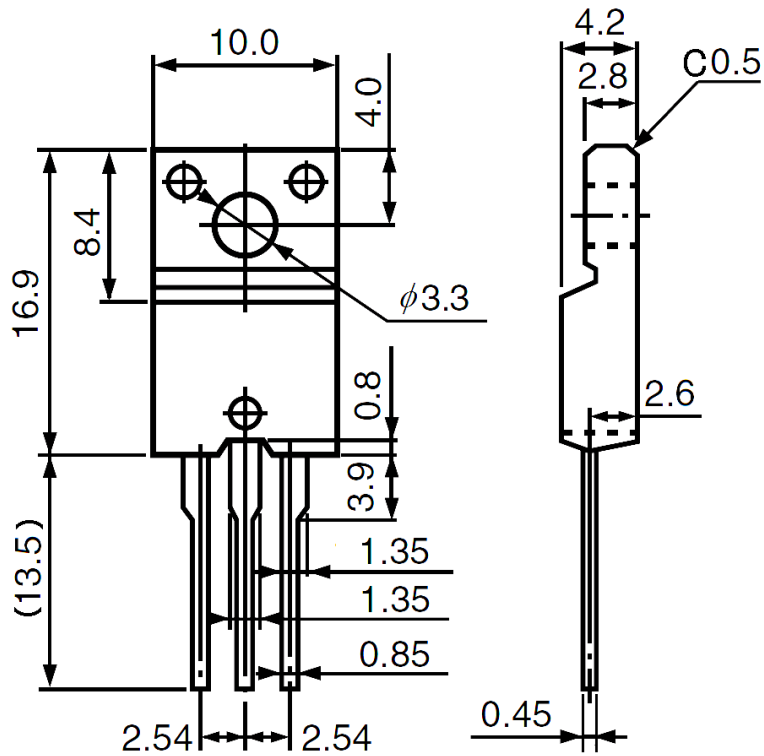


Figure 3-19 $I_{F(AV)} - T_L$ ($V_R = 200\text{ V}$)

4. External Dimensions

TO220F-3L



NOTES:

- Dimension is in millimeters.
- Lead treatment Pb-free. Device composition compliant with the RoHS directive.

5. Marking Diagram

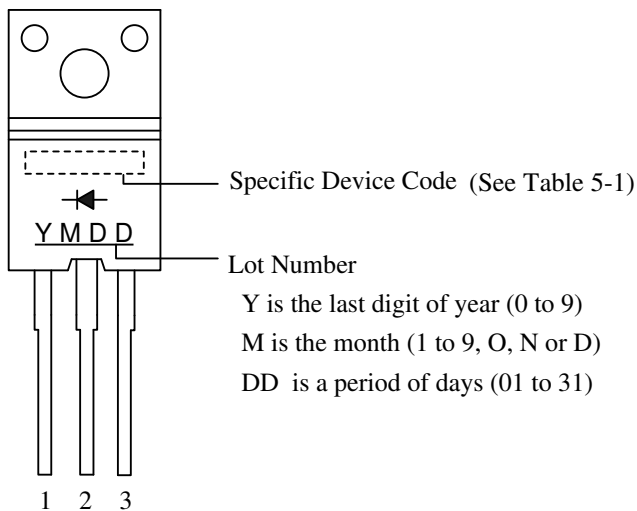


Table 5-1 Specific Device Code

Specific Device Code	Products
KS2052	FMKS-2052
KS2102	FMKS-2102
KS2152	FMKS-2152

6. Temperature Detection Application of FMKS Series

This section shows an example about a temperature detection circuit of a secondary rectifier diode in off-line flyback converters.

Figure 6-1 shows the reference of temperature detection circuit with a NTC thermistor. The NTC thermistor, coupled thermally with D_S secondary rectifier diode, is connected to the REF pin of the output voltage detection circuit in the converter.

As shown in Figure 6-2, as the temperature rises, the resistance of the NTC thermistor decreases.

When the temperature of D_S rises due to such a cause as overload state, the resistance of NTC thermistor decreases, and the ratio of resistance voltage divider is changed. When the voltage of R_S shown in Figure 6-1 reaches the reference voltage of U1 shunt regulator, the current flows to PC1 optocoupler, and the converter IC in the primary limits the output power. Thus, the rise of D_S temperature can be limited.

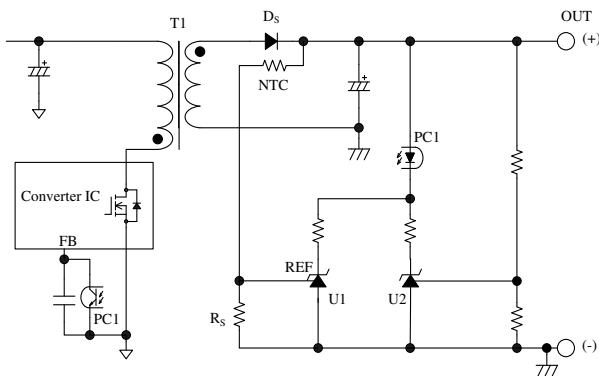


Figure 6-1 Reference temperature detection circuit with NTC thermistor

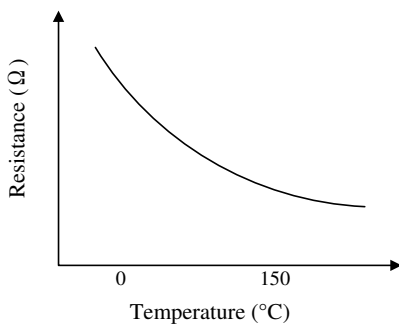


Figure 6-2 Reference characteristics of NTC thermistor

The temperature detection circuit with thermistor has the following issues.

- Since some attachment distance occurs between the thermistor and D_S , the accurate temperature of D_S cannot be detected.
- Thermistor cannot follow the rapid temperature change.

- Increasing the accuracy of temperature detection by reducing the thermal resistance between D_S and the thermistor, it is necessary to attach the thermistor to D_S with high thermal conductivity material between them.

In contrast with the temperature detection of thermistor, the FMKS series can achieve high accuracy of temperature detection by the following.

- The internal structure is formed a Schottky barrier diode for temperature detection, SBD, and a fast recovery diode, FRD, on the same die as shown in Figure 6-3. Thus, the temperature is about the same between SBD and FRD.
- The temperature detection uses the temperature characteristics of the leakage current for SBD, which increases as the temperature rises as shown in Figure 6-4.

The temperature detection circuit with FMKS series has the following advantages.

- Highly accurate and stable temperature detection of FRD.
- Real time temperature detection of FRD.
- Circuit component reduction such as thermistor, and easy attachment.
- Power supply downsizing.

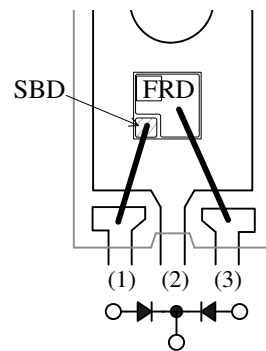


Figure 6-3 Internal structure of FMKS series

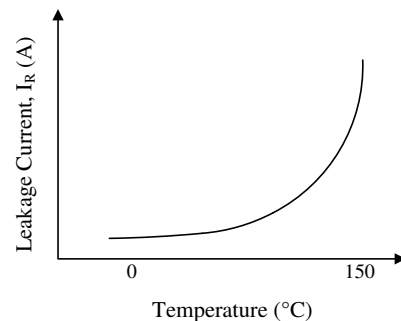


Figure 6-4 Reference temperature characteristics of SBD leakage current

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