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May 2014

FCA16N60N

N-Channel SupreMOS® MOSFET

600 V, 16 A, 199 mΩ

Features

- $R_{DS(on)}$ = 170 mΩ (Typ.) @ V_{GS} = 10V, I_D = 8 A
- Ultra Low Gate Charge (Typ. Q_g = 40.2 nC)
- Low Effective Output Capacitance (Typ. $C_{oss(eff.)}$ = 176 pF)
- 100% Avalanche Tested
- RoHS Compliant

Application

- PDP TV
- AC-DC Power Supply

Description

The SupreMOS® MOSFET is Fairchild Semiconductor's next generation of high voltage super-junction (SJ) technology employing a deep trench filling process that differentiates it from the conventional SJ MOSFETs. This advanced technology and precise process control provides lowest Rsp on-resistance, superior switching performance and ruggedness. SupreMOS MOSFET is suitable for high frequency switching power converter applications such as PFC, server/telecom power, FPD TV power, ATX power, and industrial power applications.

TO-3PN

MOSFET Maximum Ratings T_C = 25°C unless otherwise noted.

Symbol	Parameter			FCA16N60N	Unit
V_{DSS}	Drain to Source Voltage			600	V
V_{GSS}	Gate to Source Voltage			±30	V
I_D	Drain Current	- Continuous (T_C = 25°C)		16.0	A
		- Continuous (T_C = 100°C)		10.1	
I_{DM}	Drain Current	- Pulsed	(Note 1)	48.0	A
E_{AS}	Single Pulsed Avalanche Energy		(Note 2)	355	mJ
I_{AR}	Avalanche Current		(Note 1)	5.3	A
E_{AR}	Repetitive Avalanche Energy		(Note 1)	1.34	mJ
dv/dt	MOSFET dv/dt			100	V/ns
	Peak Diode Recovery dv/dt		(Note 3)	20	V/ns
P_D	Power Dissipation	(T_C = 25°C)		134.4	W
		- Derate Above 25°C		1.08	W/°C
T_J, T_{STG}	Operating and Storage Temperature Range			-55 to +150	°C
T_L	Maximum Lead Temperature for Soldering, 1/8" from Case for 5 Seconds			300	°C

Thermal Characteristics

Symbol	Parameter	FCA16N60N	Unit
$R_{\theta JC}$	Thermal Resistance, Junction to Case, Max.	0.93	°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient, Max.	40	

Package Marking and Ordering Information

Part Number	Top Mark	Package	Packing Method	Reel Size	Tape Width	Quantity
FCA16N60N	FCA16N60N	TO-3PN	Tube	N/A	N/A	30 units

Electrical Characteristics T_C = 25°C unless otherwise noted.

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit

Off Characteristics

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
BV_{DSS}	Drain to Source Breakdown Voltage	I_D = 1 mA, V_{GS} = 0 V, T_C = 25°C	600	-	-	V
ΔBV_{DSS} / ΔT_J	Breakdown Voltage Temperature Coefficient	I_D = 1 mA, Referenced to 25°C	-	0.73	-	V/°C
I_{DSS}	Zero Gate Voltage Drain Current	V_{DS} = 480 V, V_{GS} = 0 V	-	-	10	μA
		V_{DS} = 480 V, V_{GS} = 0 V, T_C = 125°C	-	-	100	
I_{GSS}	Gate to Body Leakage Current	V_{GS} = ±30 V, V_{DS} = 0 V	-	-	±100	nA

On Characteristics

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$V_{GS(th)}$	Gate Threshold Voltage	V_{GS} = V_{DS}, I_D = 250 μA	2.0	-	4.0	V
$R_{DS(on)}$	Static Drain to Source On Resistance	V_{GS} = 10 V, I_D = 8 A	-	0.170	0.199	Ω
g_{FS}	Forward Transconductance	V_{DS} = 40 V, I_D = 8 A	-	20	-	S

Dynamic Characteristics

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
C_{iss}	Input Capacitance	V_{DS} = 100 V, V_{GS} = 0 V, f = 1 MHz	-	1630	2170	pF
C_{oss}	Output Capacitance		-	70	95	pF
C_{rss}	Reverse Transfer Capacitance		-	5	10	pF
C_{oss}	Output Capacitance	V_{DS} = 380 V, V_{GS} = 0 V, f = 1 MHz	-	40	60	pF
$C_{oss(eff.)}$	Effective Output Capacitance	V_{DS} = 0 V to 480 V, V_{GS} = 0 V	-	176	-	pF
$Q_{g(tot)}$	Total Gate Charge at 10V	V_{DS} = 380 V, I_D = 8 A, V_{GS} = 10 V	-	40.2	52.3	nC
Q_{gs}	Gate to Source Gate Charge		-	6.7	-	nC
Q_{gd}	Gate to Drain "Miller" Charge	(Note 4)	-	12.9	-	nC
ESR	Equivalent Series Resistance (G-S)	f = 1 MHz	-	2.9	-	Ω

Switching Characteristics

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-On Delay Time	V_{DD} = 380 V, I_D = 8 A, V_{GS} = 10 V, R_G = 4.7 Ω	-	15.8	41.6	ns
t_r	Turn-On Rise Time		-	15.5	41.0	ns
$t_{d(off)}$	Turn-Off Delay Time		-	60.3	130.6	ns
t_f	Turn-Off Fall Time	(Note 4)	-	20.2	50.4	ns

Drain-Source Diode Characteristics

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
I_S	Maximum Continuous Drain to Source Diode Forward Current		-	-	16	A
I_{SM}	Maximum Pulsed Drain to Source Diode Forward Current		-	-	48	A
V_{SD}	Drain to Source Diode Forward Voltage	V_{GS} = 0 V, I_{SD} = 8 A	-	-	1.2	V
t_{rr}	Reverse Recovery Time	V_{GS} = 0 V, I_{SD} = 8 A, dI_F/dt = 100 A/μs	-	319	-	ns
Q_{rr}	Reverse Recovery Charge		-	4.4	-	μC

Notes:

1. Repetitive rating: pulse-width limited by maximum junction temperature.
2. I_{AS} = 5.3 A, R_G = 25 Ω, starting T_J = 25°C.
3. $I_{SD} \leq$ 16 A, di/dt $\leq$ 200 A/μs, V_{DD} = 380 V, starting T_J = 25°C.
4. Essentially independent of operating temperature typical characteristics.

Typical Performance Characteristics
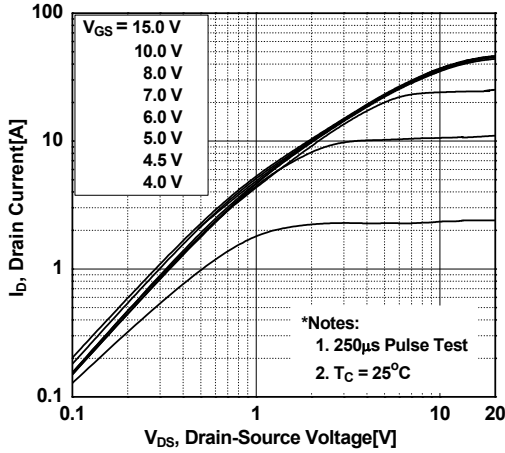
Figure 1. On-Region Characteristics

V_{GS} = 15.0 V
10.0 V
8.0 V
7.0 V
6.0 V
5.0 V
4.5 V
4.0 V

I_D, Drain Current[A]

V_{DS}, Drain-Source Voltage[V]

*Notes:
1. 250μs Pulse Test
2. T_C = 25°C

Figure 2. Transfer Characteristics

150°C
25°C
-55°C

I_D, Drain Current[A]

V_{GS}, Gate-Source Voltage[V]

*Notes:
1. V_{DS} = 20V
2. 250μs Pulse Test
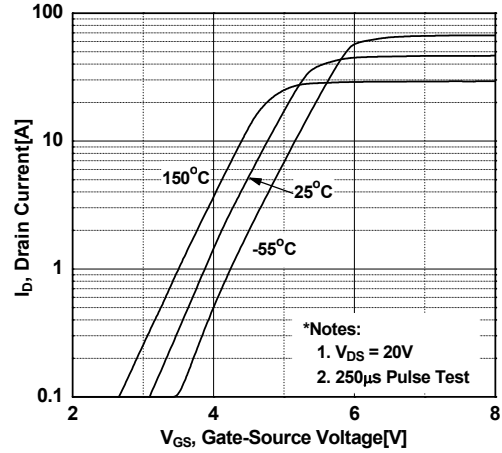
Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage

$R_{DS(ON)}$ [Ω], Drain-Source On-Resistance

V_{GS} = 10V
V_{GS} = 20V

*Notes: T_C = 25°C

I_D, Drain Current [A]
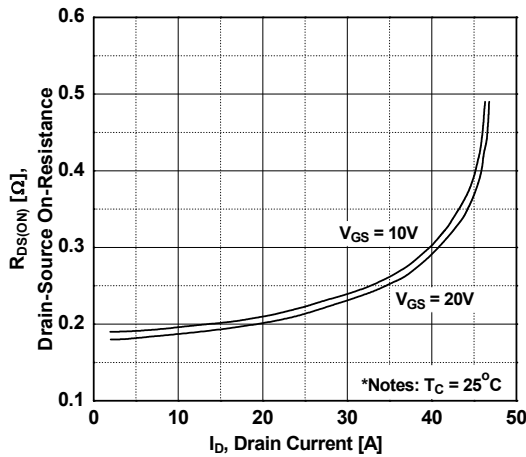
Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperature

I_S, Reverse Drain Current [A]

150°C
25°C

*Notes:
1. V_{GS} = 0V
2. 250μs Pulse Test

V_{SD}, Body Diode Forward Voltage [V]
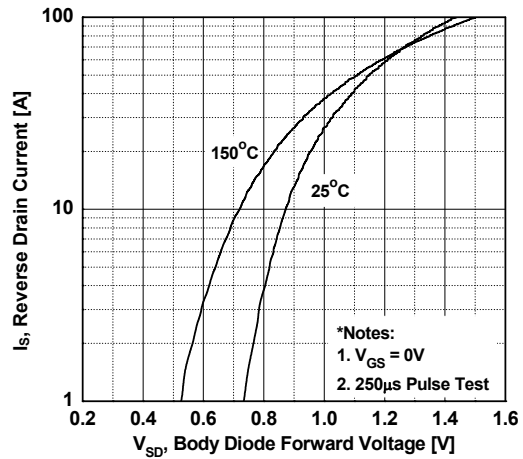
Figure 5. Capacitance Characteristics

C_{iss} = C_{gs} + C_{gd} (C_{ds} = shorted)
C_{oss} = C_{ds} + C_{gd}
C_{rss} = C_{gd}

*Notes:
1. V_{GS} = 0V
2. f = 1MHz

Capacitances [pF]

C_{oss}
C_{iss}
C_{rss}

V_{DS}, Drain-Source Voltage [V]
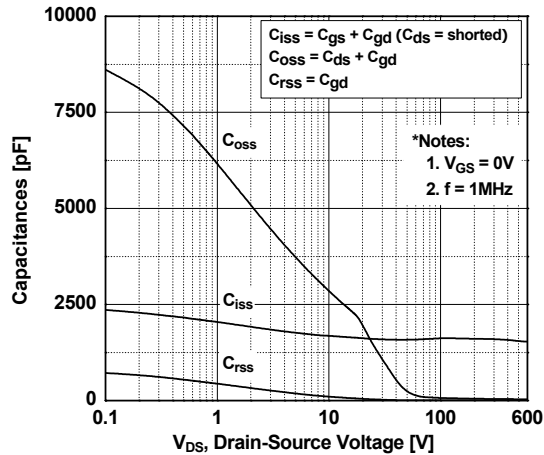
Figure 6. Gate Charge Characteristics

V_{GS}, Gate-Source Voltage [V]

V_{DS} = 120V
V_{DS} = 380V
V_{DS} = 480V

*Notes: I_D = 8A

Q_g, Total Gate Charge [nC]
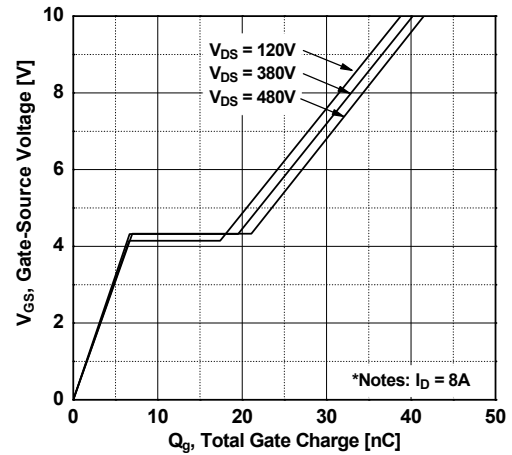
Typical Performance Characteristics (Continued)

Figure 7. Breakdown Voltage Variation vs. Temperature

BV_{DSS}, [Normalized] Drain-Source Breakdown Voltage vs. T_J, Junction Temperature [°C]

*Notes:
1. V_{GS} = 0V
2. I_D = 1mA
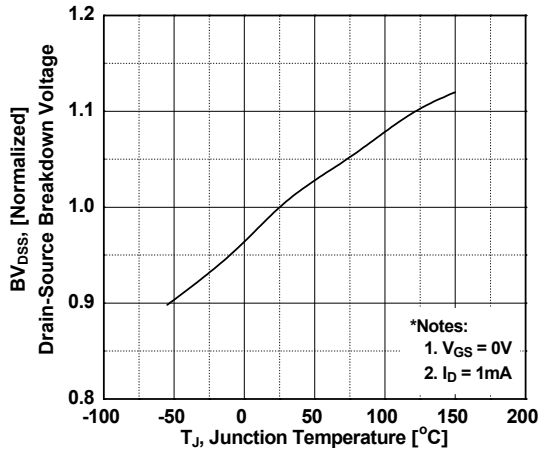
Figure 8. On-Resistance Variation vs. Temperature

$R_{DS(on)}$, [Normalized] Drain-Source On-Resistance vs. T_J, Junction Temperature [°C]

*Notes:
1. V_{GS} = 10V
2. I_D = 8A
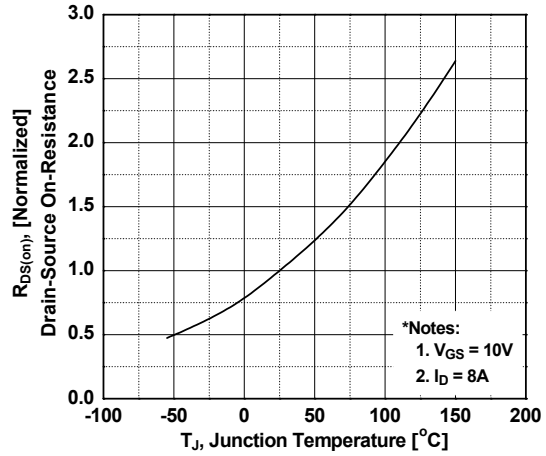
Figure 9. Maximum Safe Operating Area

I_D, Drain Current [A] vs. V_{DS}, Drain-Source Voltage [V]

20µs
100µs
1ms
10ms
DC

Operation in This Area is Limited by $R_{DS(on)}$

*Notes:
1. T_C = 25°C
2. T_J = 150°C
3. Single Pulse
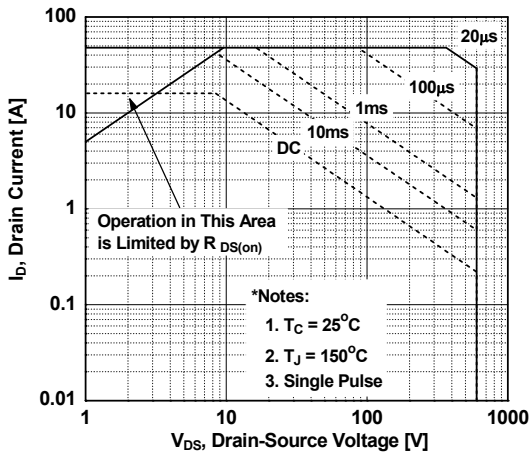
Figure 10. Maximum Drain Current vs. Case Temperature

I_D, Drain Current [A] vs. T_C, Case Temperature [°C]
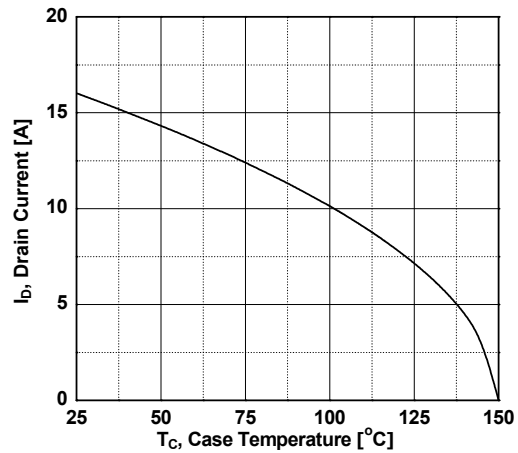
Figure 11. Transient Thermal Response Curve

$Z_{\theta JC}(t)$, Thermal Response [°C/W] vs. t_1, Rectangular Pulse Duration [sec]

0.5
0.2
0.1
0.05
0.02
0.01
Single pulse

P_{DM}
t_1
t_2

*Notes:
1. $Z_{\theta JC}(t)$ = 0.93°C/W Max.
2. Duty Factor, D= t_1/t_2
3. $T_{JM} - T_C = P_{DM} * Z_{\theta JC}(t)$
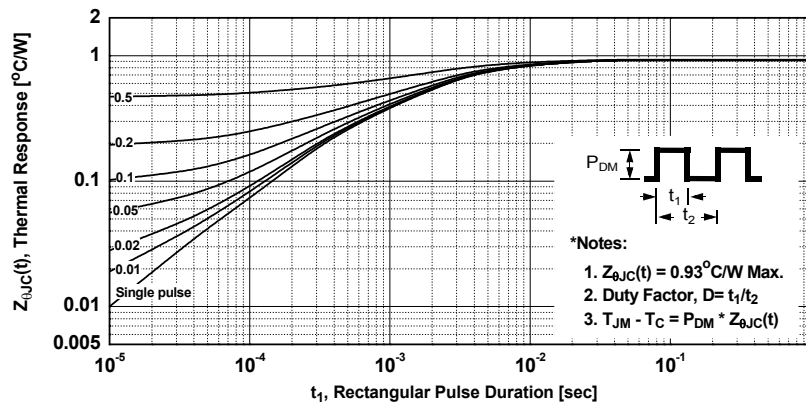
Figure 12. Gate Charge Test Circuit & Waveform

Figure 13. Resistive Switching Test Circuit & Waveforms

$$E_{AS} = \frac{1}{2} L I_{AS}^2$$

Figure 14. Unclamped Inductive Switching Test Circuit & Waveforms

DUT

V_{DS}

I_{SD}

L

Driver

R_G

Same Type
as DUT

V_{DD}

V_{GS}

• dv/dt controlled by R_G
• I_{SD} controlled by pulse period

V_{GS}
(Driver)

$$D = \frac{\text{Gate Pulse Width}}{\text{Gate Pulse Period}}$$

10V

I_{SD}
(DUT)

I_{FM} , Body Diode Forward Current

di/dt

I_{RM}

Body Diode Reverse Current

V_{DS}
(DUT)

Body Diode Recovery dv/dt

V_{SD}

V_{DD}

Body Diode
Forward Voltage Drop

Figure 15. Peak Diode Recovery dv/dt Test Circuit & Waveforms

FCA16N60N Rev. C2

Mechanical Dimensions

5.20 / 4.80

16.20 / 15.40

(R0.50)

3°

5.00 / 4.60

1.65 / 1.45

20.10 / 19.70

18.90 / 18.50

1

3

(1.85)

2.20 / 1.80

3.70 / 3.30

3.20 / 2.80

1.20 / 0.80

⊕ ⌀ 0.55 Ⓜ

5.45

5.45

3°

4°

2.90 / 1.90

16.96 / 16.56

20.30 / 19.70

0.75 / 0.55

13.80 / 13.40

⌀ 3.30 / 3.10

⌀ 7.20 / 6.80

(R0.50)
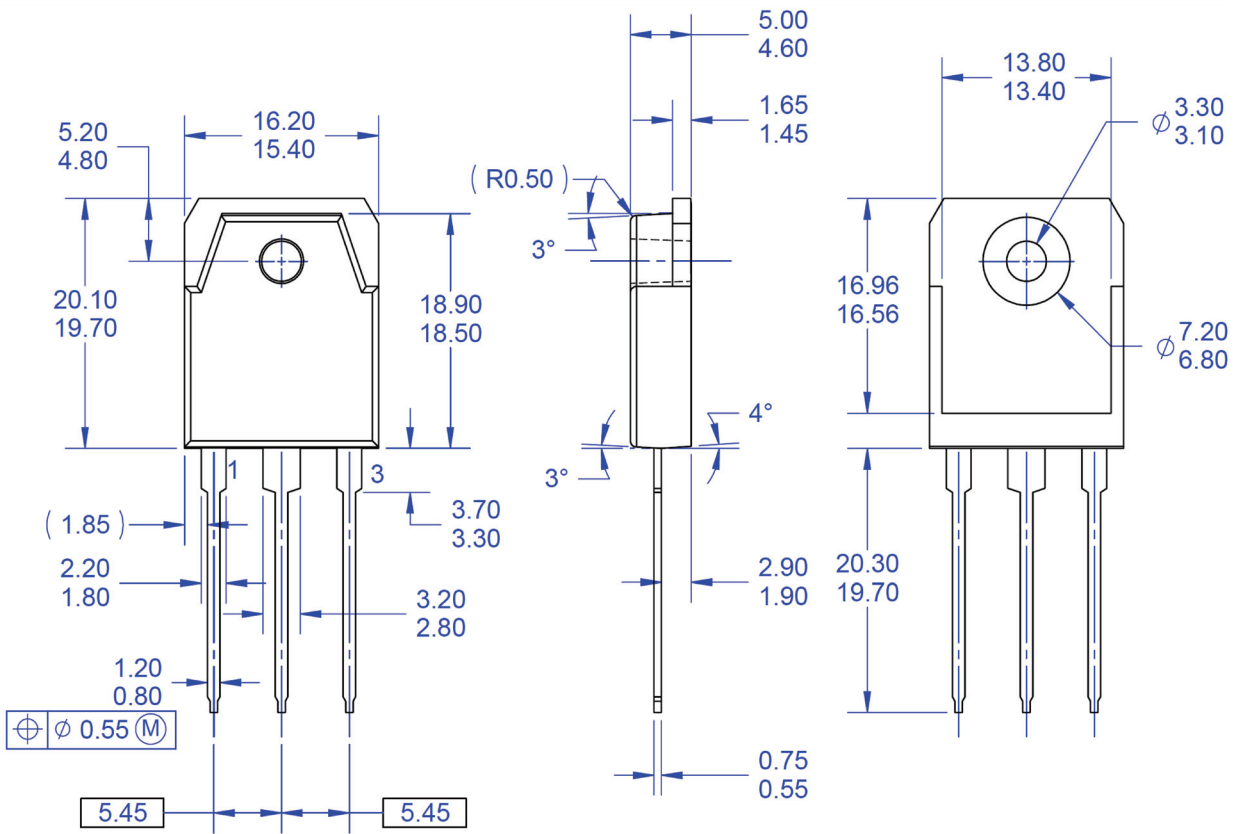
NOTES: UNLESS OTHERWISE SPECIFIED

A) THIS PACKAGE CONFORMS TO EIAJ
SC-65 PACKAGING STANDARD.
B) ALL DIMENSIONS ARE IN MILLIMETERS.
C) DIMENSION AND TOLERANCING PER
ASME14.5-2009.
D) DIMENSIONS ARE EXCLUSSIVE OF BURRS,
MOLD FLASH, AND TIE BAR EXTRUSSIONS.
E) DRAWING FILE NAME: TO3PN03AREV1.
F) FAIRCHILD SEMICONDUCTOR.
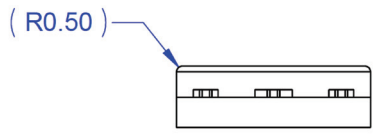
Figure 16. TO3PN, 3-Lead, Plastic, EIAJ SC-65

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Preliminary	First Production	Datasheet contains preliminary data; supplementary data will be published at a later date. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve design.
No Identification Needed	Full Production	Datasheet contains final specifications. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve the design.
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