

RFD10P03L, RFD10P03LSM, RFP10P03L

10A, 30V, 0.200Ω, Logic Level
P-Channel Power MOSFET

May 1997

Features

- 10A, 30V
- $r_{DS(ON)} = 0.200\Omega$
- *Temperature Compensating* PSpice Model
- PSpice Thermal Model
- Peak Current vs Pulse Width Curve
- UIS Rating Curve
- 175°C Operating Temperature

Ordering Information

PART NUMBER	PACKAGE	BRAND
RFD10P03L	TO-251AA	10P03L
RFD10P03LSM	TO-252AA	10P03L
RFP10P03L	TO-220AB	F10P03L

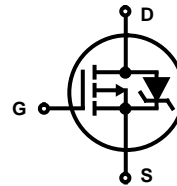
NOTE: When ordering, use the entire part number. Add the suffix, 9A, to obtain the TO-252AA variant in tape and reel, i.e. RFD10P03LSM9A..

Formerly developmental type TA49205.

Description

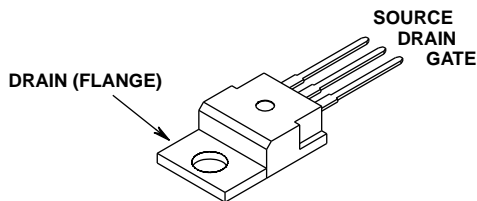
These products are P-Channel power MOSFETs manufactured using the MegaFET process. This process, which uses feature sizes approaching those of LSI circuits, gives optimum utilization of silicon, resulting in outstanding performance. They were designed for use in applications such as switching regulators, switching converters, motor drivers, and relay drivers. These transistors can be operated directly from integrated circuits.

Symbol

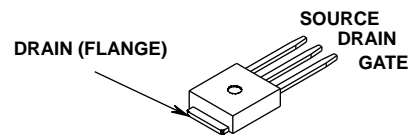


Packaging

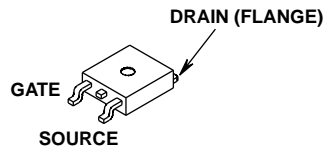
JEDEC TO-220AB



JEDEC TO-251AA



JEDEC TO-252AA



RFD10P03L, RFD10P03LSM, RFP10P03L

Absolute Maximum Ratings $T_C = 25^\circ\text{C}$, Unless Otherwise Specified

	RFD10P03L, RFD10P03LSM, RFP10P03L	UNITS
Drain to Source Voltage	-30	V
Drain to Gate Voltage ($R_{GS} = 20\text{K}\Omega$)	-30	V
Gate to Source Voltage	± 10	V
Drain Current		
RMS Continuous	10	A
Pulsed Drain Current	See Figure 5	
Single Pulse Avalanche Rating	Refer to UIS Curve	
Power Dissipation	65	W
Derate Above 25°C	0.43	$\text{W}/^\circ\text{C}$
Operating and Storage Temperature	-55 to 175	$^\circ\text{C}$
Maximum Lead Temperature for Soldering (0.063in (1.6mm) from case for 10s)	300	$^\circ\text{C}$

CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

Electrical Specifications $T_C = 25^\circ\text{C}$, Unless Otherwise Specified

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNITS	
Drain to Source Breakdown Voltage	BV_{DSS}	$I_D = 250\mu\text{A}$, $V_{GS} = 0\text{V}$	-30	-	-	V	
Gate Threshold Voltage	$V_{GS(TH)}$	$V_{GS} = V_{DS}$, $I_D = 250\mu\text{A}$	-1	-	-2	V	
Zero Gate Voltage Drain Current	I_{DSS}	$V_{DS} = -30\text{V}$, $V_{GS} = 0\text{V}$	$T_C = 25^\circ\text{C}$	-	-	-1	μA
			$T_C = 150^\circ\text{C}$	-	-	-50	μA
Gate to Source Leakage Current	I_{GSS}	$V_{GS} = \pm 10\text{V}$	-	-	± 100	nA	
Drain to Source On Resistance (Note 1)	$r_{DS(ON)}$	$I_D = 10\text{A}$, $V_{GS} = -5\text{V}$	-	-	0.200	Ω	
		$I_D = 10\text{A}$, $V_{GS} = -4.5\text{V}$	-	-	0.220	Ω	
Turn-On Time	t_{ON}	$V_{DD} = 15\text{V}$, $I_D \cong 10\text{A}$ $R_L = 1.5\Omega$, $R_{GS} = 5\Omega$, $V_{GS} = -5\text{V}$	-	-	100	ns	
Turn-On Delay Time	$t_{d(ON)}$		-	15	-	ns	
Rise Time	t_r		-	50	-	ns	
Turn-Off Delay Time	$t_{d(OFF)}$		-	35	-	ns	
Fall Time	t_f		-	20	-	ns	
Turn-Off Time	t_{OFF}		-	-	80	ns	
Total Gate Charge	$Q_g(TOT)$		$V_{GS} = 0$ to -10V	-	25	30	nC
Gate Charge at -5V	$Q_g(-5)$	$V_{GS} = 0$ to -5V	-	13	16	nC	
Threshold Gate Charge	$Q_g(TH)$	$V_{GS} = 0$ to -1V	-	1.2	1.5	nC	
Input Capacitance	C_{ISS}	$V_{DS} = -25\text{V}$, $V_{GS} = 0\text{V}$ $f = 1\text{MHz}$	-	1035	-	pF	
Output Capacitance	C_{OSS}		-	340	-	pF	
Reverse Transfer Capacitance	C_{RSS}		-	35	-	pF	
Thermal Resistance, Junction to Case	$R_{\theta JC}$		-	-	2.30	$^\circ\text{C}/\text{W}$	
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	RFD10P03L, RFD10P03LSM	-	-	100	$^\circ\text{C}/\text{W}$	
		RFP10P03L	-	-	80	$^\circ\text{C}/\text{W}$	

Source to Drain Diode Specifications

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Source to Drain Forward Voltage	V_{SD}	$I_{SD} = -10\text{A}$	-	-	-1.5	V
Reverse Recovery Time	t_{rr}	$I_{SD} = -10\text{A}$, $dI_{SD}/dt = -100\text{A}/\mu\text{s}$	-	-	75	ns

NOTE:

1. Pulse Test: Pulse width $\leq 300\mu\text{s}$, Duty Cycle $\leq 2\%$.

RFD10P03L, RFD10P03LSM, RFP10P03L

Typical Performance Curves Unless Otherwise Specified

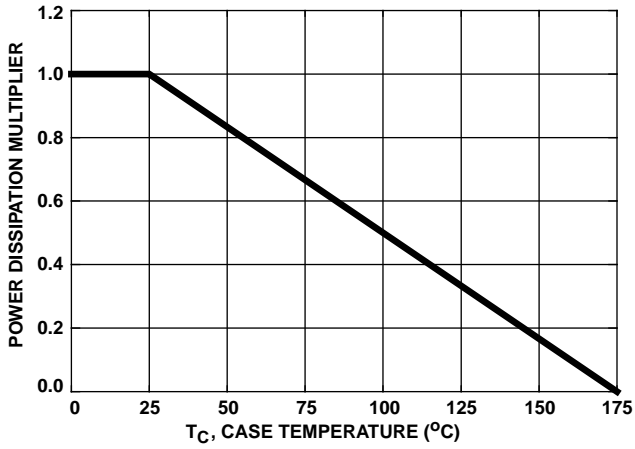


FIGURE 1. NORMALIZED POWER DISSIPATION vs CASE TEMPERATURE

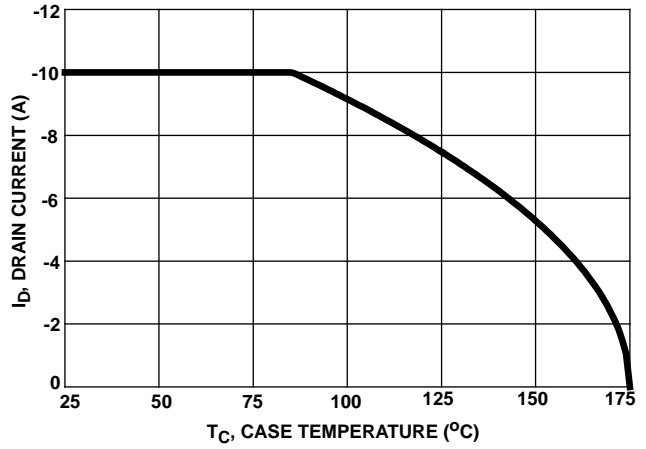


FIGURE 2. MAXIMUM CONTINUOUS DRAIN CURRENT vs CASE TEMPERATURE

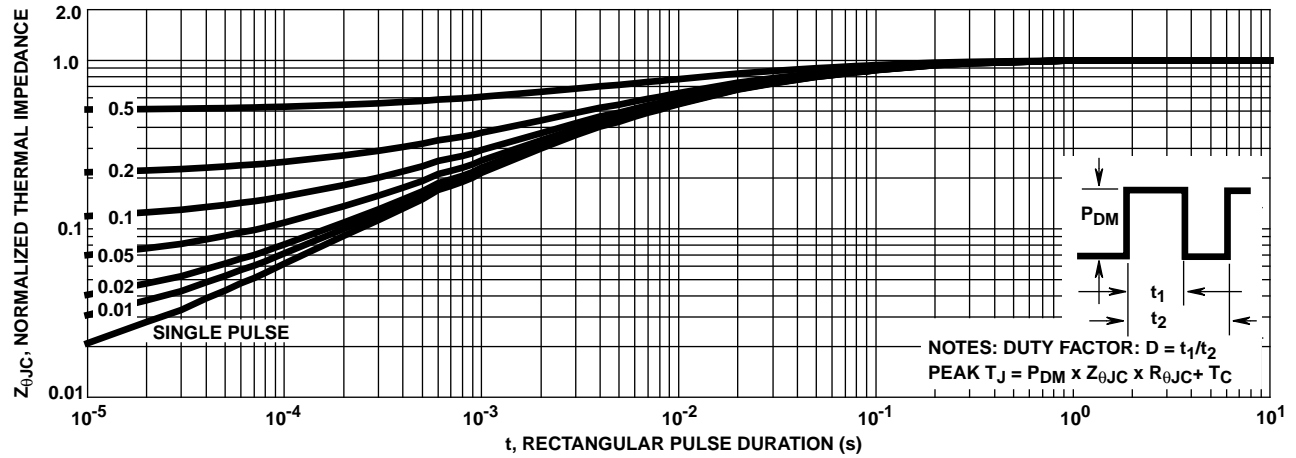


FIGURE 3. NORMALIZED MAXIMUM TRANSIENT THERMAL IMPEDANCE

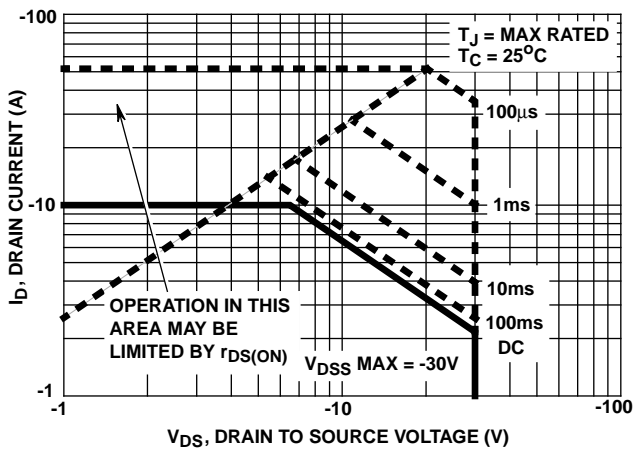


FIGURE 4. FORWARD BIAS SAFE OPERATING AREA

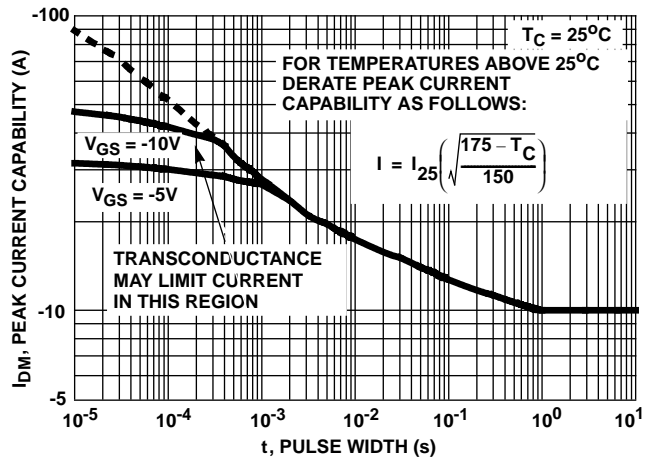
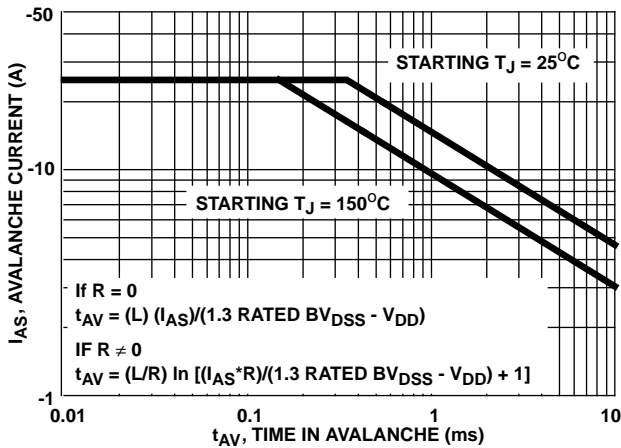


FIGURE 5. PEAK CURRENT CAPABILITY

Typical Performance Curves Unless Otherwise Specified (Continued)



NOTE: Refer to Application Notes AN9321 and AN9322.

FIGURE 6. UNCLAMPED INDUCTIVE SWITCHING CAPABILITY

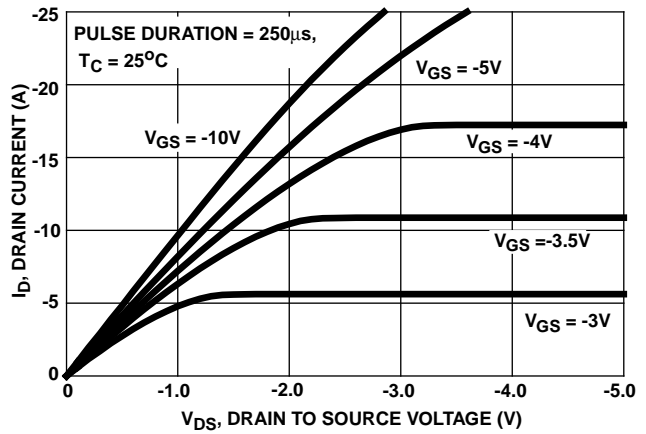


FIGURE 7. SATURATION CHARACTERISTICS

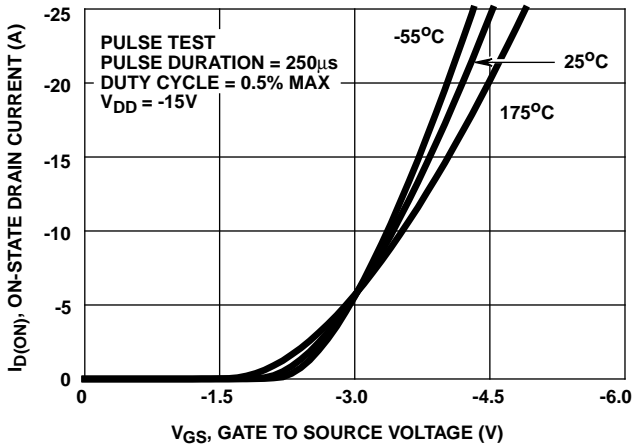


FIGURE 8. TRANSFER CHARACTERISTICS

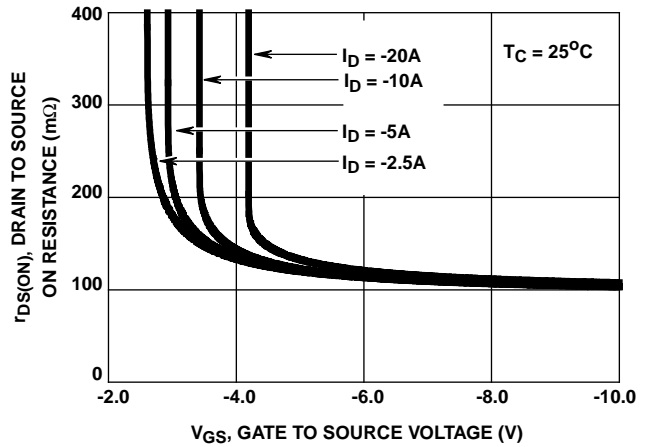


FIGURE 9. DRAIN TO SOURCE ON RESISTANCE vs GATE VOLTAGE AND DRAIN CURRENT

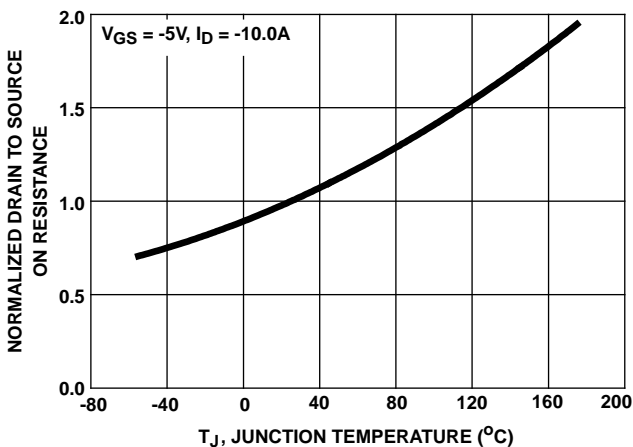


FIGURE 10. NORMALIZED DRAIN TO SOURCE ON RESISTANCE vs JUNCTION TEMPERATURE

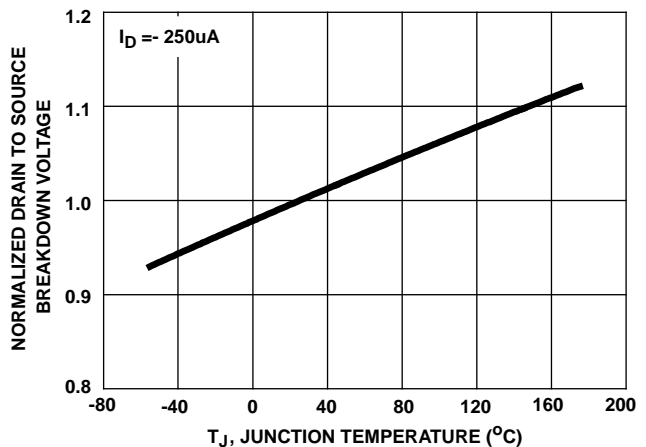


FIGURE 11. NORMALIZED DRAIN TO SOURCE BREAKDOWN VOLTAGE vs JUNCTION TEMPERATURE

Typical Performance Curves Unless Otherwise Specified (Continued)

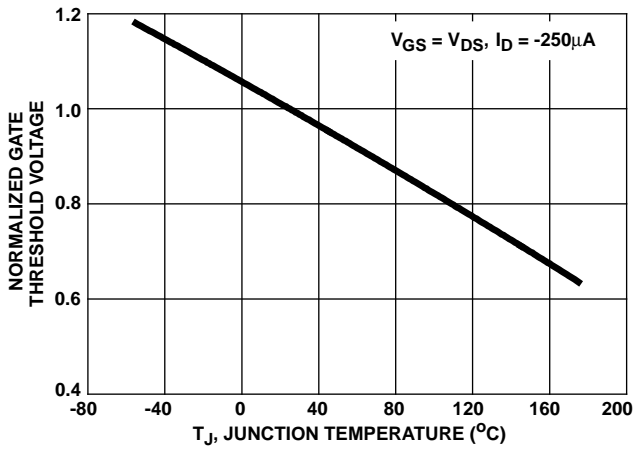


FIGURE 12. NORMALIZED GATE THRESHOLD VOLTAGE vs JUNCTION TEMPERATURE

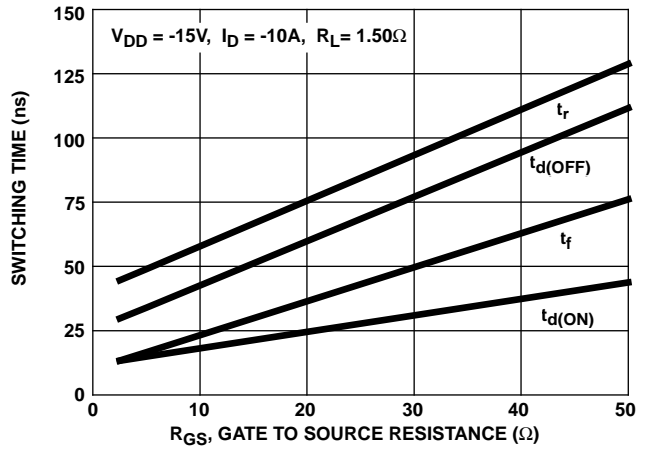
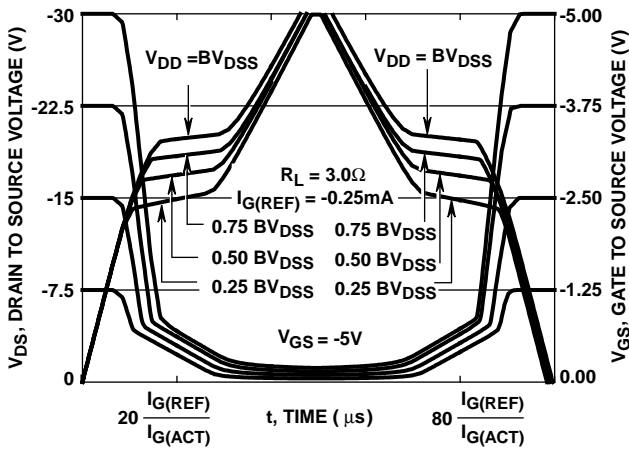


FIGURE 13. SWITCHING TIME vs GATE RESISTANCE



NOTE: Refer to Application Notes AN7254 and AN7260.

FIGURE 14. NORMALIZED SWITCHING WAVEFORMS FOR CONSTANT GATE CURRENT

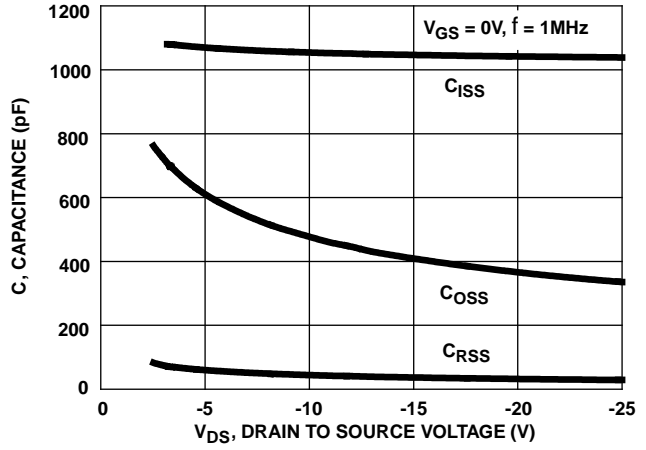


FIGURE 15. CAPACITANCE vs DRAIN TO SOURCE VOLTAGE

Test Circuits and Waveforms

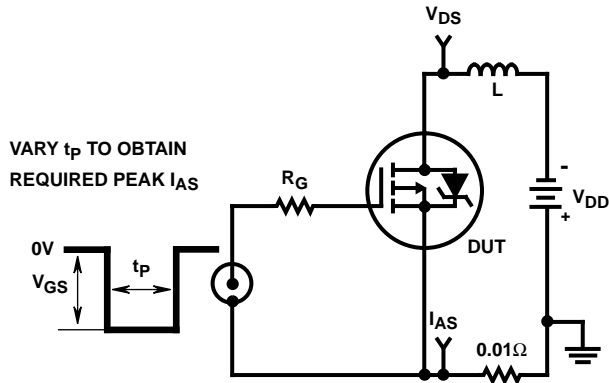


FIGURE 16. UNCLAMPED ENERGY TEST CIRCUIT

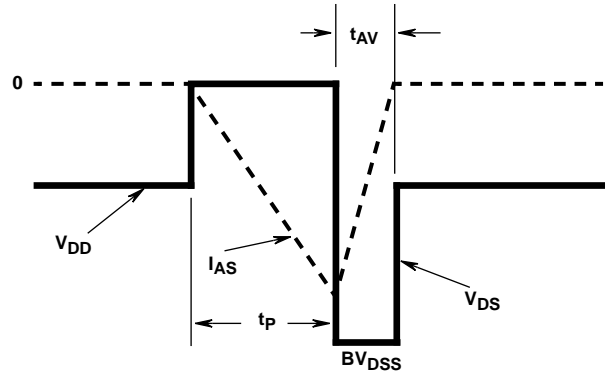


FIGURE 17. UNCLAMPED ENERGY WAVEFORMS

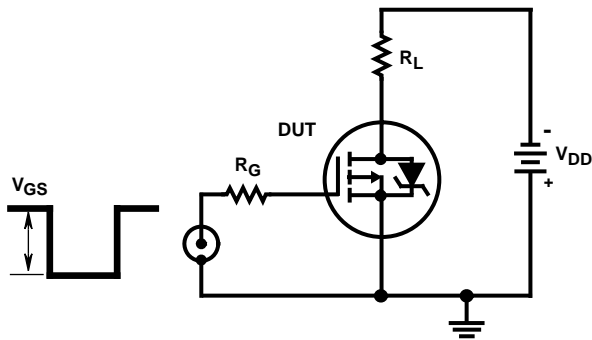


FIGURE 18. SWITCHING TIME TEST CIRCUIT

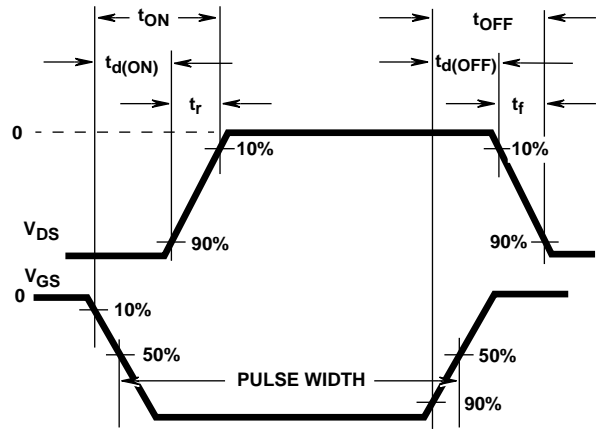


FIGURE 19. RESISTIVE SWITCHING WAVEFORMS

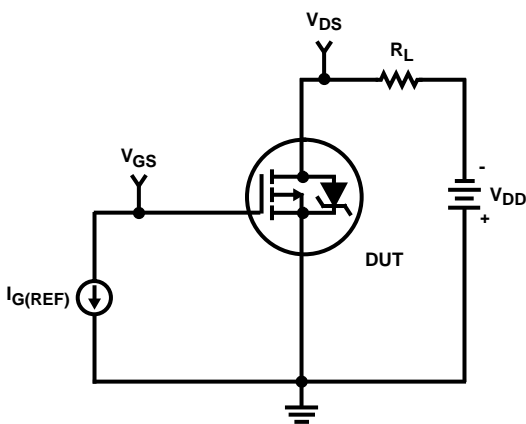


FIGURE 20. GATE CHARGE TEST CIRCUIT

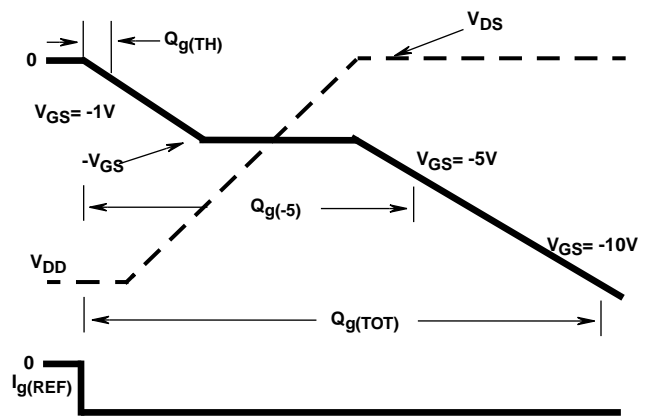


FIGURE 21. GATE CHARGE WAVEFORMS

RFD10P03L, RFD10P03LSM, RFP10P03L

Pspice Electrical Model

.SUBCKT RFD10P03L 2 1 3 REV 22 Aug 96

CA 12 8 1.29e-9
 CB 15 14 9.90e-10
 CIN 6 8 1.01e-9

DBODY 5 7 DBODYMOD
 DBREAK 7 11 DBREAKMOD
 DPLCAP 10 6 DPLCAPMOD

EBREAK 5 11 17 18 -36.49
 EDS 14 8 5 8 1
 EGS 13 8 6 8 1
 ESG 5 10 8 6 1
 EVTHRES 6 21 19 8 1
 EVTEMP 6 20 18 22 1

IT 8 17 1

LDRAIN 2 5 1e-9
 LGATE 1 9 3.40e-9
 LSOURCE 3 7 3.22e-9

MMED 16 6 8 8 MmedMOD
 MSTRO 16 6 8 8 MstroMOD
 MWEAK 16 21 8 8 MweakMOD

RBREAK 17 18 RBREAKMOD 1
 RDRAIN 50 16 RDRAINMOD 68.25e-3
 RGATE 9 20 2.54
 RSCL1 5 51 RSCLMOD 1e-6
 RSCL2 5 50 1e3
 RSOURCE 8 7 RSourceMOD 25.00e-3
 RVTHRES 22 8 RVTHRESMOD 1
 RVTEMP 18 19 RVTEMPMOD 1

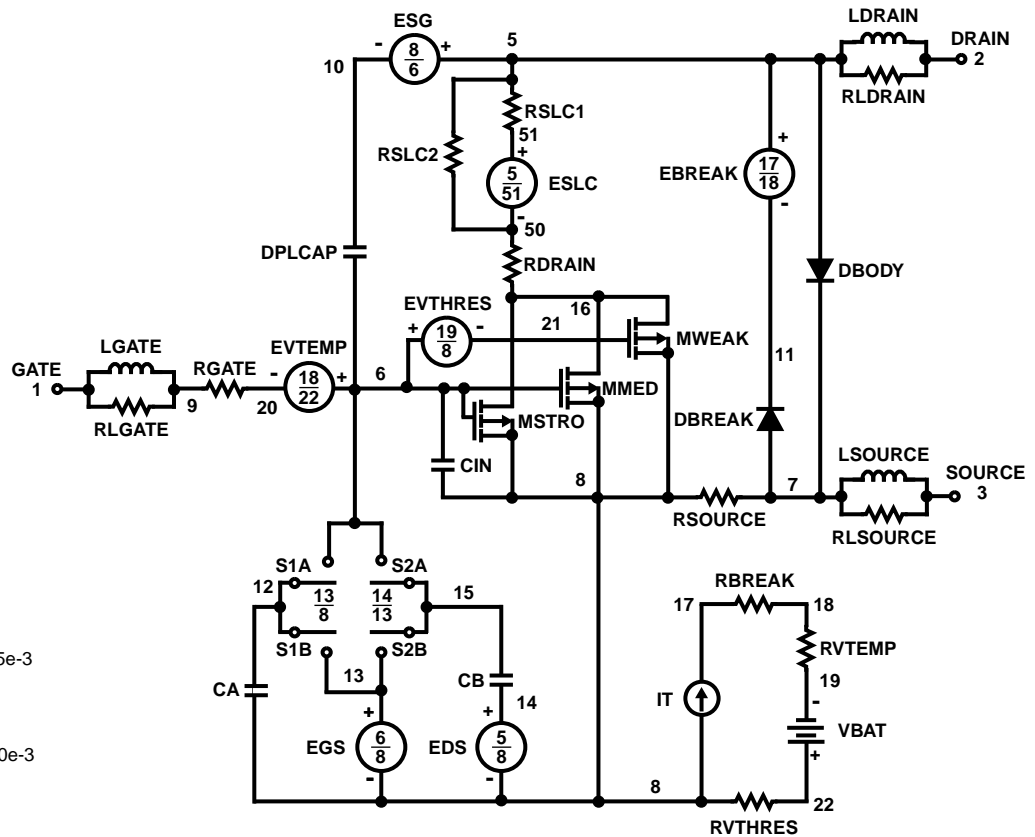
S1A 6 12 13 8 S1AMOD
 S1B 13 12 13 8 S1BMOD
 S2A 6 15 14 13 S2AMOD
 S2B 13 15 14 13 S2BMOD

VBAT 22 19 DC 1

ESCL 51 50 VALUE={(V(5,51)/ABS(V(5,51)))*(PWR(V(5,51)/(1e-6*33),5.0))}

.MODEL DBODYMOD D (IS=9.15e-13 RS=3.25e-2 IKF=0.05 N=0.97 TRS1=4.11e-5 TRS2=2.03e-6 CJO=1.13e-9 M=0.40 TT=3.72e-8)
 .MODEL DBREAKMOD D (RS=2.62e-1 TRS1=1.74e-3 TRS2=-3.81e-6)
 .MODEL DPLCAPMOD D (CJO=1.46e-10 IS=1e-30 N=10 M=0.50)
 .MODEL MSTRONGMOD PMOS (VTO=-1.95 KP=11.60 IS=1e-30 N=10 TOX=1 L=1u W=1u)
 .MODEL MMEDMOD PMOS (VTO=-1.65 KP=1.00 IS=1e-30 N=10 TOX=1 L=1u W=1u RG=2.54)
 .MODEL MWEAKMOD PMOS (VTO=-1.43 KP=0.09 IS=1e-30 N=10 TOX=1 L=1u W=1u RG=25.4 RS=0.1)
 .MODEL RBREAKMOD RES (TC1=9.17e-4 TC2=-2.74e-7)
 .MODEL RDRAINMOD RES (TC1=6.35e-3 TC2=1.98e-5)
 .MODEL RSOURCEMOD RES (TC1=0 TC2=0)
 .MODEL RSCLMOD RES (TC1=2e-3 TC2=0)
 .MODEL RVTHRESMOD RES (TC1=1.23e-3 TC2=1.97e-6)
 .MODEL RVTEMPMOD RES (TC1=-1.18e-3 TC2=1.44e-6)
 .MODEL S1AMOD VSWITCH (RON=1e-5 ROFF=0.1 VON=4.80 VOFF=1.80)
 .MODEL S1BMOD VSWITCH (RON=1e-5 ROFF=0.1 VON=1.80 VOFF=4.80)
 .MODEL S2AMOD VSWITCH (RON=1e-5 ROFF=0.1 VON=-0.40 VOFF=-3.40)
 .MODEL S2BMOD VSWITCH (RON=1e-5 ROFF=0.1 VON=-3.40 VOFF=-0.40)
 ENDS

For further discussion of the PSPICE model consult A New PSPICE Sub-circuit for the Power MOSFet Featuring Global Temperature Options; authored by William J. Hepp and C. Frank Wheatley.



RFD10P03L, RFD10P03LSM, RFP10P03L

PSpice Thermal Model

REV 29 Aug 96

RFP10P03L

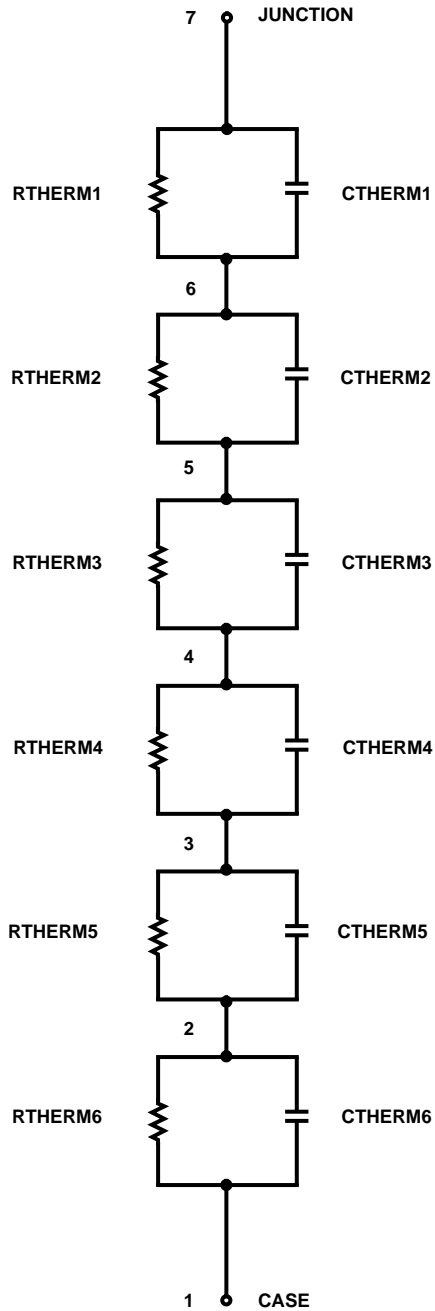
CTHERM1 7 6 5.00e-7
 CTHERM2 6 5 5.35e-4
 CTHERM3 5 4 5.50e-4
 CTHERM4 4 3 1.75e-3
 CTHERM5 3 2 1.25e-2
 CTHERM6 2 1 0.45

RTHERM1 7 6 1.00e-2
 RTHERM2 6 5 2.05e-2
 RTHERM3 5 4 5.39e-2
 RTHERM4 4 3 5.45e-1
 RTHERM5 3 2 1.01
 RTHERM6 2 1 0.50

RFD10P03L, RFD10P03LSM

CTHERM1 7 6 5.00e-7
 CTHERM2 6 5 5.35e-4
 CTHERM3 5 4 5.50e-4
 CTHERM4 4 3 1.75e-3
 CTHERM5 3 2 1.25e-2
 CTHERM6 2 1 0.11

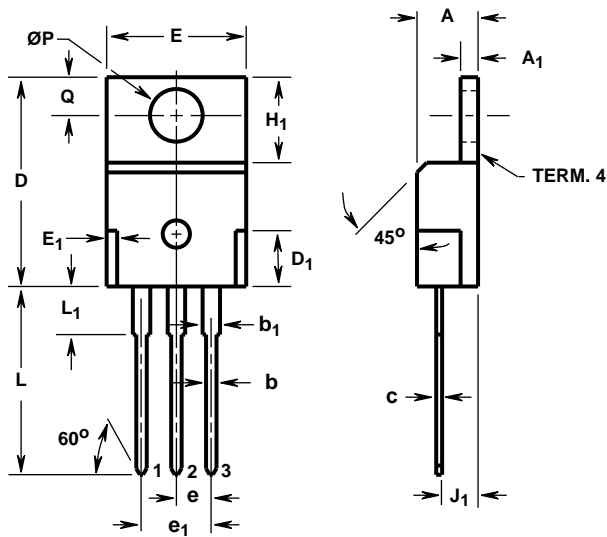
RTHERM1 7 6 1.00e-2
 RTHERM2 6 5 2.05e-2
 RTHERM3 5 4 5.39e-2
 RTHERM4 4 3 5.45e-1
 RTHERM5 3 2 1.01
 RTHERM6 2 1 0.50



RFD10P03L, RFD10P03LSM, RFP10P03L

TO-220AB

3 LEAD JEDEC TO-220AB PLASTIC PACKAGE



- LEAD NO. 1 - GATE
- LEAD NO. 2 - DRAIN
- LEAD NO. 3 - SOURCE
- TERM. 4 - DRAIN

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN	MAX	MIN	MAX	
A	0.170	0.180	4.32	4.57	-
A ₁	0.048	0.052	1.22	1.32	-
b	0.030	0.034	0.77	0.86	3, 4
b ₁	0.045	0.055	1.15	1.39	2, 3
c	0.014	0.019	0.36	0.48	2, 3, 4
D	0.590	0.610	14.99	15.49	-
D ₁	-	0.160	-	4.06	-
E	0.395	0.410	10.04	10.41	-
E ₁	-	0.030	-	0.76	-
e	0.100 TYP		2.54 TYP		5
e ₁	0.200 BSC		5.08 BSC		5
H ₁	0.235	0.255	5.97	6.47	-
J ₁	0.100	0.110	2.54	2.79	6
L	0.530	0.550	13.47	13.97	-
L ₁	0.130	0.150	3.31	3.81	2
$\varnothing P$	0.149	0.153	3.79	3.88	-
Q	0.102	0.112	2.60	2.84	-

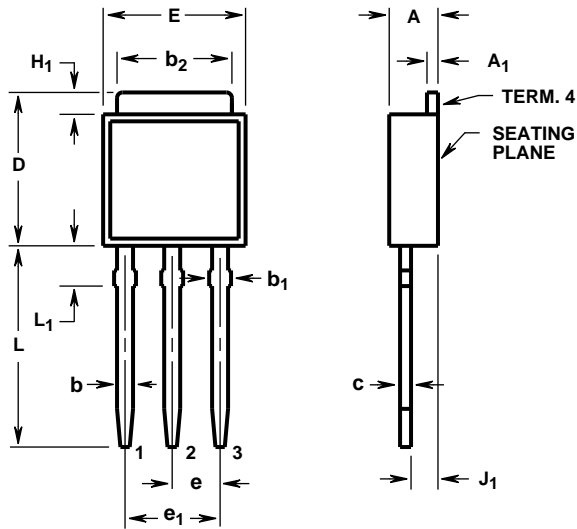
NOTES:

1. These dimensions are within allowable dimensions of Rev. J of JEDEC TO-220AB outline dated 3-24-87.
2. Lead dimension and finish uncontrolled in L₁.
3. Lead dimension (without solder).
4. Add typically 0.002 inches (0.05mm) for solder coating.
5. Position of lead to be measured 0.250 inches (6.35mm) from bottom of dimension D.
6. Position of lead to be measured 0.100 inches (2.54mm) from bottom of dimension D.
7. Controlling dimension: Inch.
8. Revision 1 dated 1-93.

RFD10P03L, RFD10P03LSM, RFP10P03L

TO-251AA

3 LEAD JEDEC TO-251AA PLASTIC PACKAGE



- LEAD NO. 1 - GATE
- LEAD NO. 2 - DRAIN
- LEAD NO. 3 - SOURCE
- TERM. 4 - DRAIN

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN	MAX	MIN	MAX	
A	0.086	0.094	2.19	2.38	-
A ₁	0.018	0.022	0.46	0.55	3, 4
b	0.028	0.032	0.72	0.81	3, 4
b ₁	0.033	0.040	0.84	1.01	3
b ₂	0.205	0.215	5.21	5.46	3, 4
c	0.018	0.022	0.46	0.55	3, 4
D	0.270	0.290	6.86	7.36	-
E	0.250	0.265	6.35	6.73	-
e	0.090 TYP		2.28 TYP		5
e ₁	0.180 BSC		4.57 BSC		5
H ₁	0.035	0.045	0.89	1.14	-
J ₁	0.040	0.045	1.02	1.14	6
L	0.355	0.375	9.02	9.52	-
L ₁	0.075	0.090	1.91	2.28	2

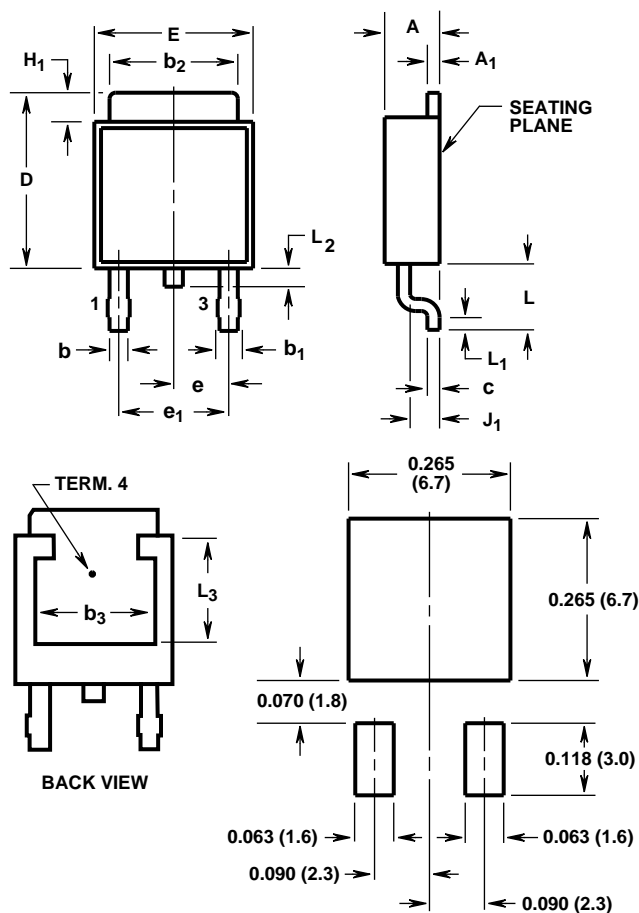
NOTES:

1. These dimensions are within allowable dimensions of Rev. C of JEDEC TO-251AA outline dated 9-88.
2. Solder finish uncontrolled in this area.
3. Dimension (without solder).
4. Add typically 0.002 inches (0.05mm) for solder plating.
5. Position of lead to be measured 0.250 inches (6.35mm) from bottom of dimension D.
6. Position of lead to be measured 0.100 inches (2.54mm) from bottom of dimension D.
7. Controlling dimension: Inch.
8. Revision 2 dated 10-95.

RFD10P03L, RFD10P03LSM, RFP10P03L

TO-252AA

SURFACE MOUNT JEDEC TO-252AA PLASTIC PACKAGE



MINIMUM PAD SIZE RECOMMENDED FOR SURFACE-MOUNTED APPLICATIONS

- LEAD NO. 1 - GATE
- LEAD NO. 3 - SOURCE
- TERM. 4 - DRAIN

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN	MAX	MIN	MAX	
A	0.086	0.094	2.19	2.38	-
A ₁	0.018	0.022	0.46	0.55	4, 5
b	0.028	0.032	0.72	0.81	4, 5
b ₁	0.033	0.040	0.84	1.01	4
b ₂	0.205	0.215	5.21	5.46	4, 5
b ₃	0.190	-	4.83	-	2
c	0.018	0.022	0.46	0.55	4, 5
D	0.270	0.290	6.86	7.36	-
E	0.250	0.265	6.35	6.73	-
e	0.090 TYP		2.28 TYP		7
e ₁	0.180 BSC		4.57 BSC		7
H ₁	0.035	0.045	0.89	1.14	-
J ₁	0.040	0.045	1.02	1.14	-
L	0.100	0.115	2.54	2.92	-
L ₁	0.020	-	0.51	-	4, 6
L ₂	0.025	0.040	0.64	1.01	3
L ₃	0.170	-	4.32	-	2

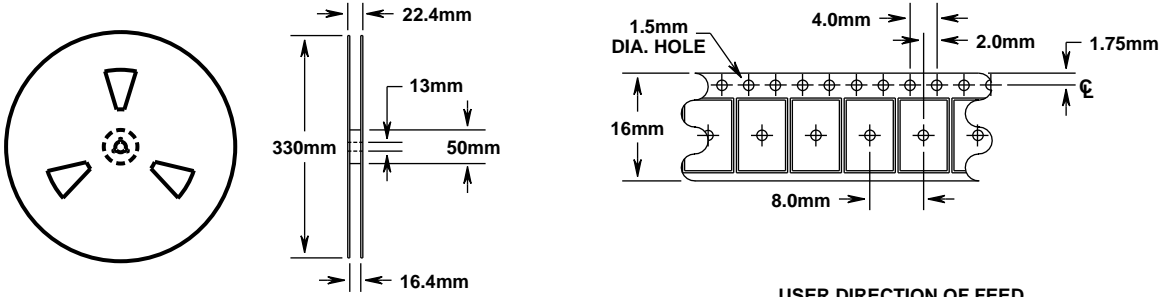
NOTES:

1. These dimensions are within allowable dimensions of Rev. B of JEDEC TO-252AA outline dated 9-88.
2. L₃ and b₃ dimensions establish a minimum mounting surface for terminal 4.
3. Solder finish uncontrolled in this area.
4. Dimension (without solder).
5. Add typically 0.002 inches (0.05mm) for solder plating.
6. L₁ is the terminal length for soldering.
7. Position of lead to be measured 0.090 inches (2.28mm) from bottom of dimension D.
8. Controlling dimension: Inch.
9. Revision 6 dated 10-96.

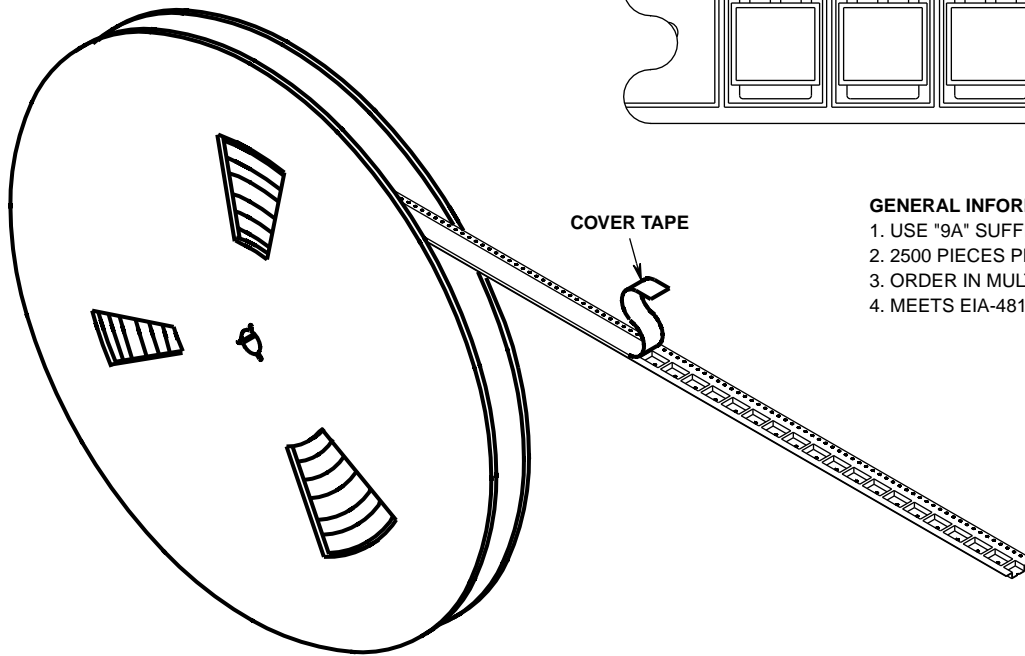
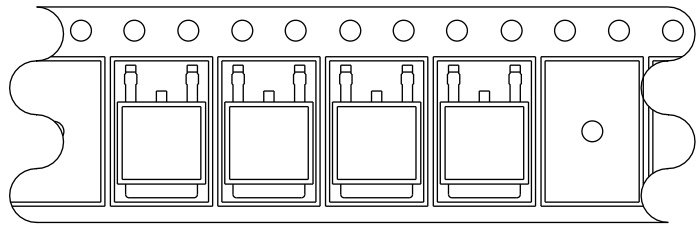
RFD10P03L, RFD10P03LSM, RFP10P03L

TO-252AA

16mm TAPE AND REEL



USER DIRECTION OF FEED



GENERAL INFORMATION

1. USE "9A" SUFFIX ON PART NUMBER.
2. 2500 PIECES PER REEL.
3. ORDER IN MULTIPLES OF FULL REELS ONLY.
4. MEETS EIA-481 REVISION "A" SPECIFICATIONS.

Revision 6 dated 10-96

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Harris Semiconductor
 P. O. Box 883, Mail Stop 53-210
 Melbourne, FL 32902
 TEL: 1-800-442-7747
 (407) 729-4984
 FAX: (407) 729-5321

EUROPE

Harris Semiconductor
 Mercure Center
 100, Rue de la Fusee
 1130 Brussels, Belgium
 TEL: (32) 2.724.2111
 FAX: (32) 2.724.22.05

ASIA

Harris Semiconductor PTE Ltd.
 No. 1 Tannery Road
 Cencon 1, #09-01
 Singapore 1334
 TEL: (65) 748-4200
 FAX: (65) 748-0400



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