

Small Signal Diode (continued)

1N/FD/L 914/A/B / 916/A/B / 4148 / 4448

Electrical Characteristics T_a = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
V _R	Breakdown Voltage	I _R = 100 μA	100		V
		I _R = 5.0 μA	75		V
V _F	Forward Voltage	1N914B/4448 I _F = 5.0 mA	620	720	mV
		1N916B I _F = 5.0 mA	630	730	mV
		1N914/916/4148 I _F = 10 mA		1.0	V
		1N914A/916A I _F = 20 mA		1.0	V
		1N916B I _F = 20 mA		1.0	V
		1N914B/4448 I _F = 100 mA		1.0	V
I _R	Reverse Current	V _R = 20 V		25	nA
		V _R = 20 V, T _a = 150°C		50	μA
		V _R = 75 V		5.0	μA
C _T	Total Capacitance	1N916A/B/4448 V _R = 0, f = 1.0 MHz		2.0	pF
		1N914A/B/4148 V _R = 0, f = 1.0 MHz		4.0	pF
t _r	Reverse Recovery Time	I _F = 10 mA, V _R = 6.0 V (60mA), I _R = 1.0 mA, R _s = 100Ω		4.0	ns

Typical Characteristics

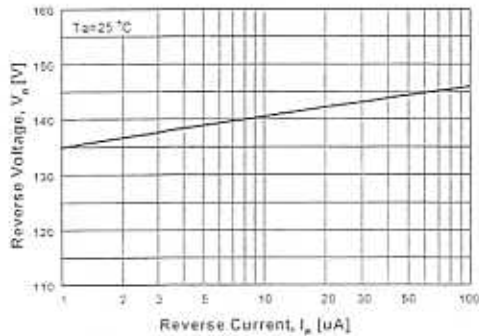


Figure 1. Reverse Voltage vs Reverse Current
BV - 1.0 to 100 uA

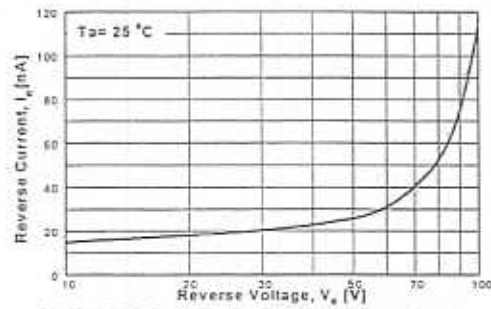


Figure 2. Reverse Current vs Reverse Voltage
IR - 10 to 100 V
GENERAL RULE: The Reverse Current of a diode will approximately double for every ten (10) Degree C increase in Temperature

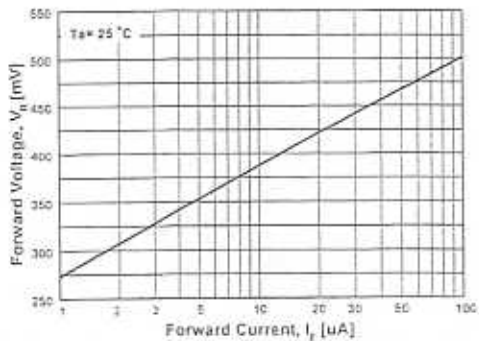


Figure 3. Forward Voltage vs Forward Current
VF - 1 to 100 uA

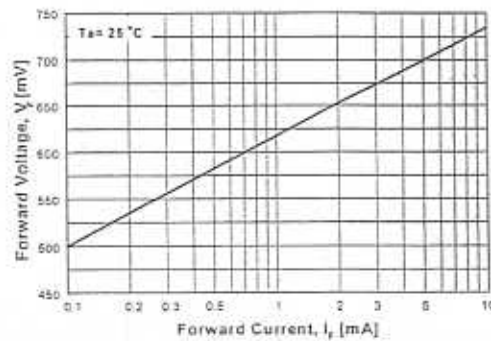


Figure 4. Forward Voltage vs Forward Current
VF - 0.1 to 10 mA

Typical Characteristics (continued)

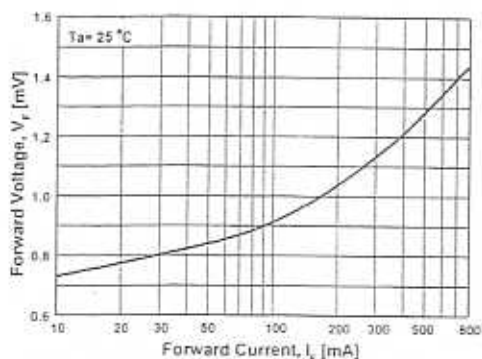


Figure 5. Forward Voltage vs Forward Current
VF - 10 to 800 mA

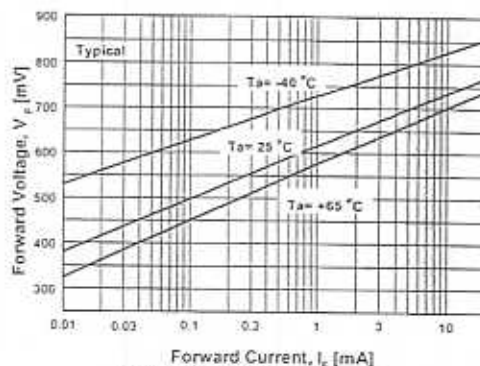


Figure 6. Forward Voltage
vs Ambient Temperature
VF - 0.01 - 20 mA (-40 to +65 Deg C)

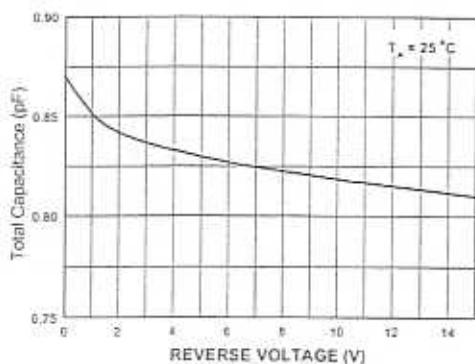


Figure 7. Total Capacitance

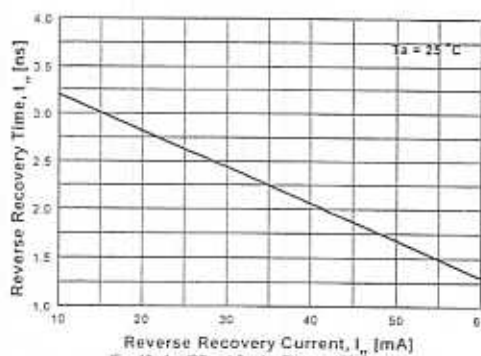


Figure 8. Reverse Recovery Time vs
Reverse Recovery Current
IF = 10mA - RR = 1.0 mA - Rloop = 100 Ohms

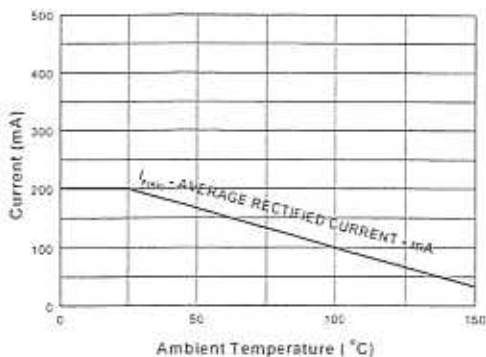


Figure 9. Average Rectified Current ($I_{F(AV)}$)
versus Ambient Temperature (T_a)

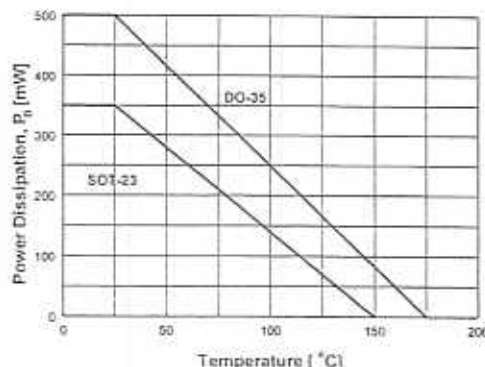


Figure 10. Power Derating Curve

Gold Bonded

1N34A

Germanium Diodes

Optimized for Radio Frequency Response

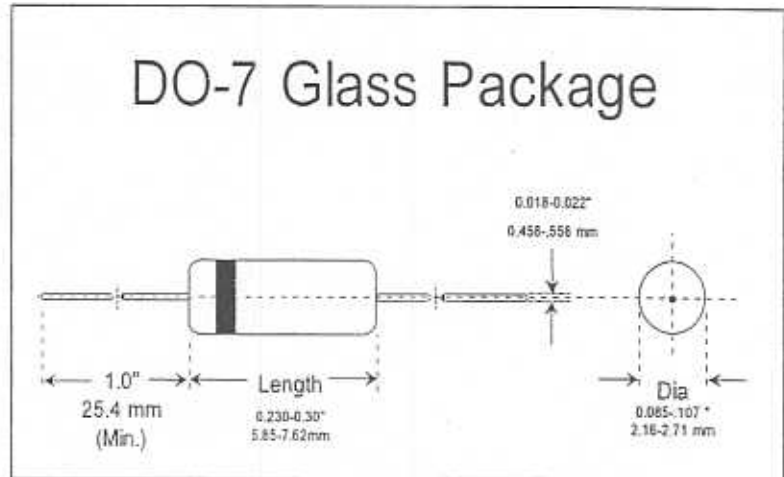
Can be used in many AM, FM and TV-IF applications, replacing point contact devices.

Applications

- AM/FM detectors
- Ratio detectors
- FM discriminators
- TV audio detectors
- RF input probes
- TV video detectors

Features

- Lower leakage current
- Flat junction capacitance
- High mechanical strength
- At least 1 million hours MTBF
- BKC's Sigma-Bond™ plating for problem free solderability



Absolute Maximum Ratings at $T_{amb} = 25^{\circ}C$

Parameter	Symbols	Min.	Max.	Units
Peak Inverse Voltage (Repetitive), Measured @ $I_R = 1 \text{ mA}$	PIV	**	65	Volts
Peak Forward Surge Current Non-Repetitive, $t = 1 \text{ Second}$	I_{FSM}		0.5	Amps
Peak Forward Surge Current Repetitive	I_{FSR}		200	mA
Average Rectified Forward Current	I_D		50	mA
Operating and Storage Temperatures	$T_{J\&STG}$	-55	+75	$^{\circ}C$

Electrical Characteristics at $T_{amb} = 25^{\circ}C$

Parameter	Test Conditions	Symbols	Min.	Max.	Units
Forward Voltage Drop	$I_F = 5.0 \text{ mA}$	V_F		1.0	Volts
Reverse Leakage	$V_R = 10 \text{ Volts}$	I_R		30	μA
	$V_R = 50 \text{ Volts}$			500	μA
Breakdown Voltage	$I_R = 1.0 \text{ mA}$	PIV	65		Volts

Microsemi

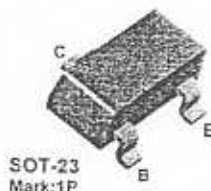
6 Lake Street - Lawrence, MA 01841

Tel: 978-681-0392 - Fax: 978-681-9135

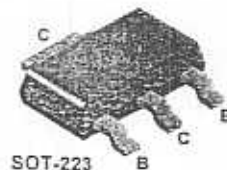
PN2222A



MMBT2222A



PZT2222A



NPN General Purpose Amplifier

- This device is for use as a medium power amplifier and switch requiring collector currents up to 500mA.
- Sourced from process 19.

Absolute Maximum Ratings * $T_a=25^\circ\text{C}$ unless otherwise noted

Symbol	Parameter	Value	Units
V_{CE0}	Collector-Emitter Voltage	40	V
V_{CB0}	Collector-Base Voltage	75	V
V_{EB0}	Emitter-Base Voltage	6.0	V
I_C	Collector Current	1.0	A
T_{STG}	Operating and Storage Junction Temperature Range	-55 - 150	$^\circ\text{C}$

* These ratings are limiting values above which the serviceability of any semiconductor device may be impaired

NOTES:

- 1) These ratings are based on a maximum junction temperature of 150 degrees C.
- 2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Electrical Characteristics $T_a=25^\circ\text{C}$ unless otherwise noted

Symbol	Parameter	Test Condition	Min.	Max.	Units
Off Characteristics					
$BV_{(BR)CE0}$	Collector-Emitter Breakdown Voltage *	$I_C = 10\text{mA}, I_B = 0$	40		V
$BV_{(BR)CB0}$	Collector-Base Breakdown Voltage	$I_C = 10\mu\text{A}, I_E = 0$	75		V
$BV_{(BR)EB0}$	Emitter-Base Breakdown Voltage	$I_E = 10\mu\text{A}, I_C = 0$	6.0		V
I_{CEX}	Collector Cutoff Current	$V_{CE} = 60\text{V}, V_{EB(off)} = 3.0\text{V}$		10	nA
I_{CB0}	Collector Cutoff Current	$V_{CB} = 60\text{V}, I_E = 0$ $V_{CB} = 60\text{V}, I_E = 0, T_a = 125^\circ\text{C}$		0.01 10	μA μA
I_{EB0}	Emitter Cutoff Current	$V_{EB} = 3.0\text{V}, I_C = 0$		10	μA
I_{BL}	Base Cutoff Current	$V_{CE} = 60\text{V}, V_{EB(off)} = 3.0\text{V}$		20	μA
On Characteristics					
h_{FE}	DC Current Gain	$I_C = 0.1\text{mA}, V_{CE} = 10\text{V}$ $I_C = 1.0\text{mA}, V_{CE} = 10\text{V}$ $I_C = 10\text{mA}, V_{CE} = 10\text{V}$ $I_C = 10\text{mA}, V_{CE} = 10\text{V}, T_a = -55^\circ\text{C}$ $I_C = 150\text{mA}, V_{CE} = 10\text{V}^*$ $I_C = 150\text{mA}, V_{CE} = 10\text{V}^*$ $I_C = 500\text{mA}, V_{CE} = 10\text{V}^*$	35 50 75 35 100 50 40	300	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage *	$I_C = 150\text{mA}, V_{CE} = 10\text{V}$ $I_C = 500\text{mA}, V_{CE} = 10\text{V}$		0.3 1.0	V V
$V_{BE(sat)}$	Base-Emitter Saturation Voltage *	$I_C = 150\text{mA}, V_{CE} = 10\text{V}$ $I_C = 500\text{mA}, V_{CE} = 10\text{V}$	0.6	1.2 2.0	V V

* Pulse Test: Pulse Width $\leq 300\mu\text{s}$, Duty Cycle $\leq 2.0\%$

Electrical Characteristics $T_a=25^\circ\text{C}$ unless otherwise noted (Continued)

Symbol	Parameter	Test Condition	Min.	Max.	Units
Small Signal Characteristics					
f_T	Current Gain Bandwidth Product	$I_C = 20\text{mA}$, $V_{CE} = 20\text{V}$, $f = 100\text{MHz}$	300		MHz
C_{obo}	Output Capacitance	$V_{CB} = 10\text{V}$, $I_E = 0$, $f = 1\text{MHz}$		8.0	pF
C_{ibo}	Input Capacitance	$V_{EB} = 0.5\text{V}$, $I_C = 0$, $f = 1\text{MHz}$		25	pF
τ_b/C_C	Collector Base Time Constant	$I_C = 20\text{mA}$, $V_{CB} = 20\text{V}$, $f = 31.8\text{MHz}$		150	pS
NF	Noise Figure	$I_C = 100\mu\text{A}$, $V_{CE} = 10\text{V}$, $R_S = 1.0\text{K}\Omega$, $f = 1.0\text{KHz}$		4.0	dB
$\text{Re}(h_{ie})$	Real Part of Common-Emitter High Frequency Input Impedance	$I_C = 20\text{mA}$, $V_{CE} = 20\text{V}$, $f = 300\text{MHz}$		60	Ω
Switching Characteristics					
t_d	Delay Time	$V_{CC} = 30\text{V}$, $V_{EB(\text{off})} = 0.5\text{V}$, $I_C = 150\text{mA}$, $I_{B1} = 15\text{mA}$		10	ns
t_r	Rise Time			25	ns
t_s	Storage Time	$V_{CC} = 30\text{V}$, $I_C = 150\text{mA}$, $I_{B1} = I_{B2} = 15\text{mA}$		225	ns
t_f	Fall Time			60	ns

Thermal Characteristics $T_a=25^\circ\text{C}$ unless otherwise noted

Symbol	Parameter	Max.			Units
		PN2222A	*MMBT2222A	**PZT2222A	
P_D	Total Device Dissipation	625	350	1,000	mW
	Derate above 25°C	5.0	2.5	8.0	mW/ $^\circ\text{C}$
$R_{\theta JC}$	Thermal Resistance, Junction to Case	83.3			$^\circ\text{C/W}$
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	200	357	125	$^\circ\text{C/W}$

* Device mounted on FR-4 PCB $1.6" \times 1.4" \times 0.06"$

** Device mounted on FR-4 PCB $36\text{mm} \times 16\text{mm} \times 1.5\text{mm}$; mounting pad for the collector lead min. 6mm^2 .

Spice Model

NPN ($I_s = 14.34\text{f}$ $X_{ti} = 3$ $E_g = 1.11$ $V_{af} = 74.03$ $B_f = 255.9$ $N_e = 1.307$ $I_{se} = 14.34$ $I_{kf} = .2847$ $X_{tb} = 1.5$ $Br = 6.092$ $I_{sc} = 0$ $I_{kr} = 0$ $R_c = 1$ $C_{jc} = 7.306\text{p}$ $M_{jc} = .3416$ $V_{jc} = .75$ $F_c = .5$ $C_{je} = 22.01\text{p}$ $M_{je} = .377$ $V_{je} = .75$ $T_r = 46.91\text{n}$ $T_f = 411.1\text{p}$ $I_{tf} = .5$ $V_{tf} = 1.7$ $X_{tf} = 3$ $R_b = 10$)

Typical Characteristics

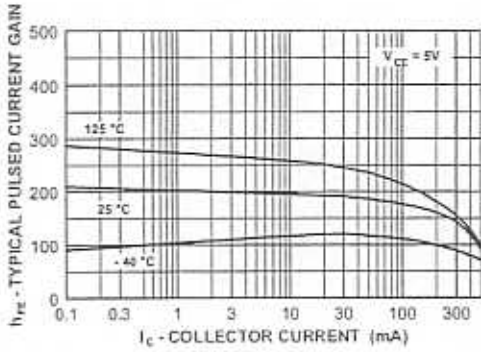


Figure 1. Typical Pulsed Current Gain vs Collector Current

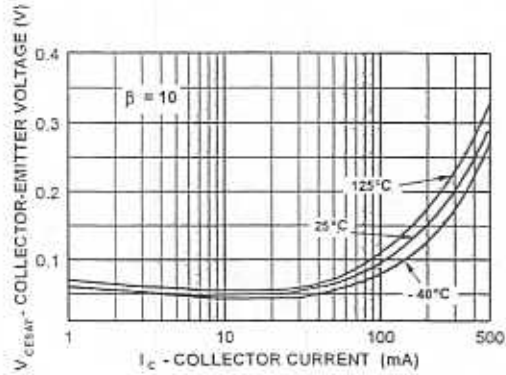


Figure 2. Collector-Emitter Saturation Voltage vs Collector Current

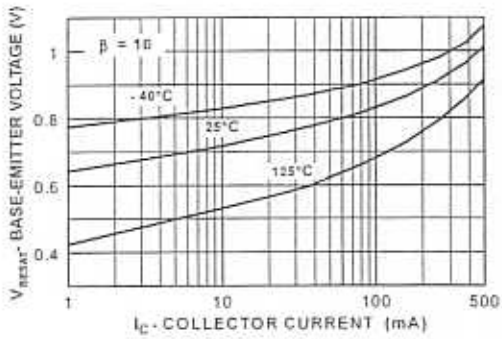


Figure 3. Base-Emitter Saturation Voltage vs Collector Current

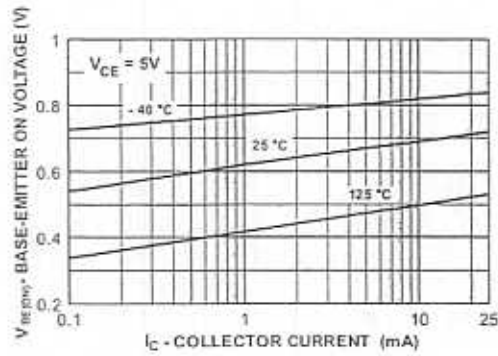


Figure 4. Base-Emitter On Voltage vs Collector Current

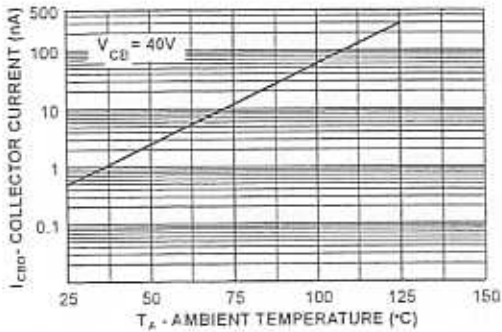


Figure 5. Collector Cutoff Current vs Ambient Temperature

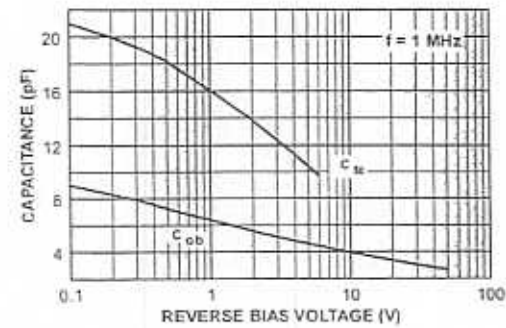


Figure 6. Emitter Transition and Output Capacitance vs Reverse Bias Voltage

Typical Characteristics

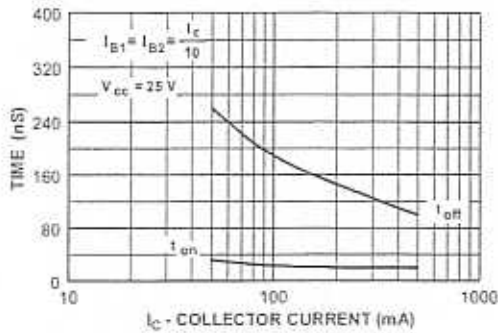


Figure 7. Turn On and Turn Off Times vs Collector Current

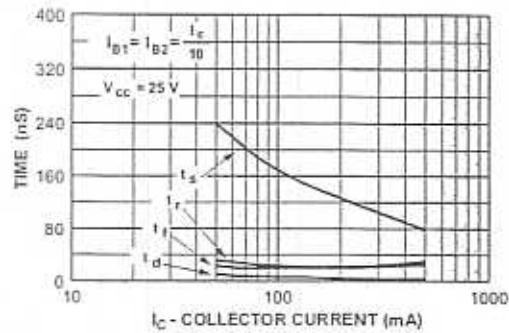


Figure 8. Switching Times vs Collector Current

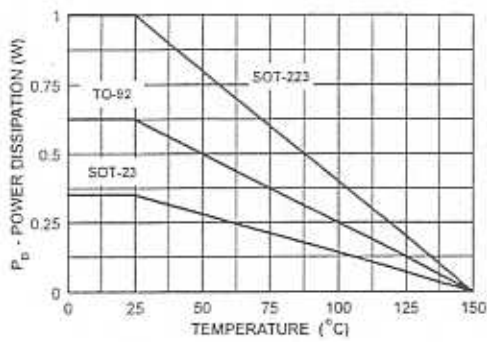


Figure 9. Power Dissipation vs Ambient Temperature

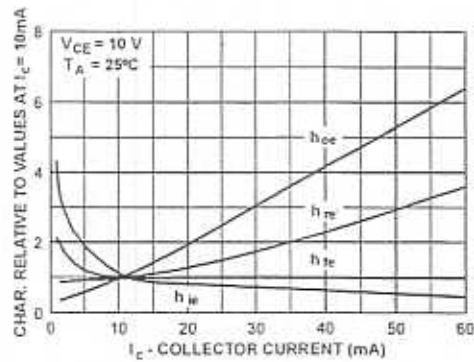


Figure 10. Common Emitter Characteristics

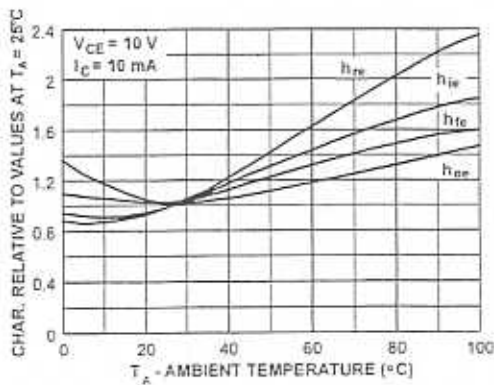


Figure 11. Common Emitter Characteristics

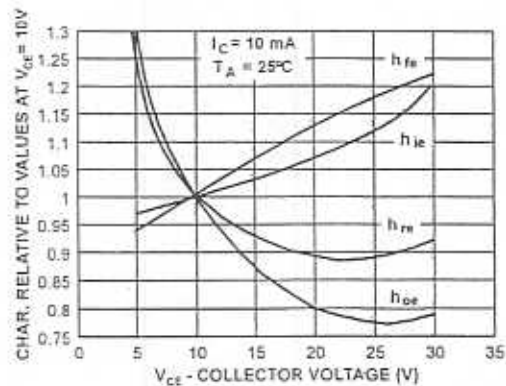


Figure 12. Common Emitter Characteristics

MC14007UB

Dual Complementary Pair Plus Inverter

The MC14007UB multi-purpose device consists of three N-channel and three P-channel enhancement mode devices packaged to provide access to each device. These versatile parts are useful in inverter circuits, pulse-shapers, linear amplifiers, high input impedance amplifiers, threshold detectors, transmission gating, and functional gating.

- Diode Protection on All Inputs
- Supply Voltage Range = 3.0 Vdc to 18 Vdc
- Capable of Driving Two Low-power TTL Loads or One Low-power Schottky TTL Load Over the Rated Temperature Range
- Pin-for-Pin Replacement for CD4007A or CD4007UB
- This device has 2 outputs without ESD Protection. Anti-static precautions must be taken.

MAXIMUM RATINGS (Voltages Referenced to V_{SS}) (Note 2.)

Symbol	Parameter	Value	Unit
V_{DD}	DC Supply Voltage Range	-0.5 to +18.0	V
V_{in}, V_{out}	Input or Output Voltage Range (DC or Transient)	-0.5 to $V_{DD} + 0.5$	V
I_{in}, I_{out}	Input or Output Current (DC or Transient) per Pin	± 10	mA
P_D	Power Dissipation, per Package (Note 3.)	500	mW
T_A	Ambient Temperature Range	-55 to +125	$^{\circ}C$
T_{stg}	Storage Temperature Range	-65 to +150	$^{\circ}C$
T_L	Lead Temperature (8-Second Soldering)	260	$^{\circ}C$

- Maximum Ratings are those values beyond which damage to the device may occur.
- Temperature Derating:
Plastic *P and D/DW* Packages: - 7.0 mW/ $^{\circ}C$ From 65 $^{\circ}C$ To 125 $^{\circ}C$

This device contains protection circuitry to guard against damage due to high static voltages or electric fields. However, precautions must be taken to avoid applications of any voltage higher than maximum rated voltages to this high-impedance circuit. For proper operation, V_{in} and V_{out} should be constrained to the range $V_{SS} \leq (V_{in} \text{ or } V_{out}) \leq V_{DD}$.

Unused inputs must always be tied to an appropriate logic voltage level (e.g., either V_{SS} or V_{DD}). Unused outputs must be left open.



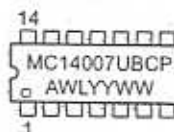
ON Semiconductor

<http://onsemi.com>

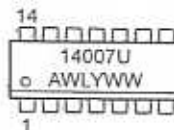
MARKING DIAGRAMS



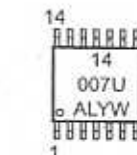
PDIIP-14
P SUFFIX
CASE 646



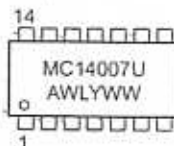
SOIC-14
D SUFFIX
CASE 751A



TSSOP-14
DT SUFFIX
CASE 948G



SOEIAJ-14
F SUFFIX
CASE 965



A = Assembly Location
WL or L = Wafer Lot
YY or Y = Year
WW or W = Work Week

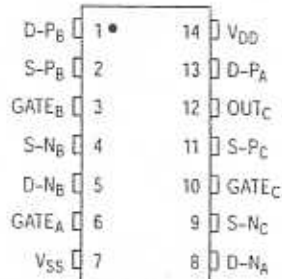
ORDERING INFORMATION

Device	Package	Shipping
MC14007UBCP	PDIIP-14	2000/Box
MC14007UBD	SOIC-14	55/Rail
MC14007UBDR2	SOIC-14	2500/Tape & Reel
MC14007UBDT	TSSOP-14	96/Rail
MC14007UBF	SOEIAJ-14	See Note 1.
MC14007UBFEL	SOEIAJ-14	See Note 1.

- For ordering information on the EIAJ version of the SOIC packages, please contact your local ON Semiconductor representative.

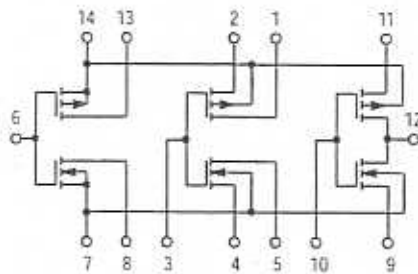
MC14007UB

PIN ASSIGNMENT

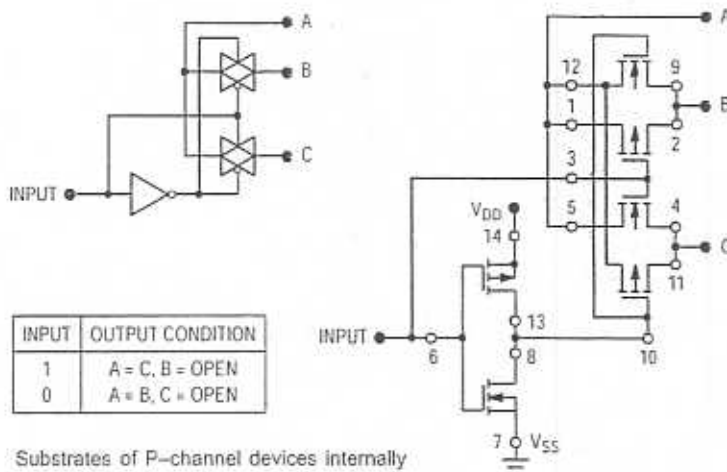


D = DRAIN
S = SOURCE

SCHEMATIC



V_{DD} = PIN 14
V_{SS} = PIN 7



Substrates of P-channel devices internally connected to V_{DD}; substrates of N-channel devices internally connected to V_{SS}.

Figure 1. Typical Application: 2-Input Analog Multiplexer

MC14007UB

ELECTRICAL CHARACTERISTICS (Voltages Referenced to V_{SS})

Characteristic	Symbol	V_{DD} Vdc	- 55°C		25°C			125°C		Unit	
			Min	Max	Min	Typ ⁽⁴⁾	Max	Min	Max		
Output Voltage $V_{in} = V_{DD}$ or 0	*0* Level V_{OL}	5.0	—	0.05	—	0	0.05	—	0.05	Vdc	
		10	—	0.05	—	0	0.05	—	0.05		
15		—	0.05	—	0	0.05	—	0.05			
$V_{in} = 0$ or V_{DD}	*1* Level V_{OH}	5.0	4.95	—	4.95	5.0	—	4.95	—	Vdc	
		10	9.95	—	9.95	10	—	9.95	—		
		15	14.95	—	14.95	15	—	14.95	—		
Input Voltage ($V_O = 4.5$ Vdc) ($V_O = 9.0$ Vdc) ($V_O = 13.5$ Vdc)	*0* Level V_{IL}	5.0	—	1.0	—	2.25	1.0	—	1.0	Vdc	
		10	—	2.0	—	4.50	2.0	—	2.0		
		15	—	2.5	—	6.75	2.5	—	2.5		
	($V_O = 0.5$ Vdc) ($V_O = 1.0$ Vdc) ($V_O = 1.5$ Vdc)	*1* Level V_{IH}	5.0	4.0	—	4.0	2.75	—	4.0	—	Vdc
			10	8.0	—	8.0	5.50	—	8.0	—	
			15	12.5	—	12.5	8.25	—	12.5	—	
Output Drive Current ($V_{OH} = 2.5$ Vdc) ($V_{OH} = 4.6$ Vdc) ($V_{OH} = 9.5$ Vdc) ($V_{OH} = 13.5$ Vdc)	Source I_{OH}	5.0	-3.0	—	-2.4	-5.0	—	-1.7	—	mAdc	
		5.0	-0.64	—	-0.51	-1.0	—	-0.36	—		
		10	-1.6	—	-1.3	-2.5	—	-0.9	—		
		15	-4.2	—	-3.4	-10	—	-2.4	—		
	($V_{OL} = 0.4$ Vdc) ($V_{OL} = 0.5$ Vdc) ($V_{OL} = 1.5$ Vdc)	Sink I_{OL}	5.0	0.64	—	0.51	1.0	—	0.36	—	mAdc
			10	1.6	—	1.3	2.5	—	0.9	—	
15	4.2	—	3.4	10	—	2.4	—	—			
Input Current	I_{in}	15	—	±0.1	—	±0.00001	±0.1	—	±1.0	µAdc	
Input Capacitance ($V_{in} = 0$)	C_{in}	—	—	—	—	5.0	7.5	—	—	pF	
Quiescent Current (Per Package)	I_{DD}	5.0	—	0.25	—	0.0005	0.25	—	7.5	µAdc	
		10	—	0.5	—	0.0010	0.5	—	15		
		15	—	1.0	—	0.0015	1.0	—	30		
Total Supply Current ⁽⁵⁾ ⁽⁶⁾ (Dynamic plus Quiescent, Per Gate) ($C_L = 50$ pF)	I_T	5.0	$I_T = (0.7 \mu\text{A/kHz}) f + I_{DD}/6$							µAdc	
		10	$I_T = (1.4 \mu\text{A/kHz}) f + I_{DD}/6$								
		15	$I_T = (2.2 \mu\text{A/kHz}) f + I_{DD}/6$								

4. Data labelled "Typ" is not to be used for design purposes but is intended as an indication of the IC's potential performance.

5. The formulas given are for the typical characteristics only at 25°C.

6. To calculate total supply current at loads other than 50 pF:

$$I_T(C_L) = I_T(50 \text{ pF}) + (C_L - 50) V/k$$

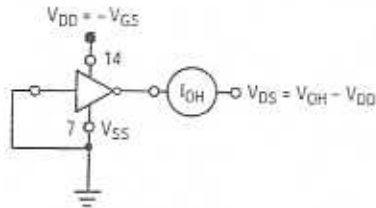
where: I_T is in µA (per package), C_L in pF, $V = (V_{DD} - V_{SS})$ in volts, f in kHz is input frequency, and $k = 0.003$.

MC14007UB

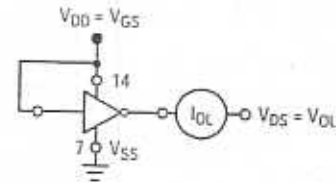
SWITCHING CHARACTERISTICS (7.) ($C_L = 50 \text{ pF}$, $T_A = 25^\circ\text{C}$)

Characteristic	Symbol	V_{DD} Vdc	Min	Typ (8.)	Max	Unit
Output Rise Time $t_{TLH} = (1.2 \text{ ns/pF}) C_L + 30 \text{ ns}$ $t_{TLH} = (0.5 \text{ ns/pF}) C_L + 20 \text{ ns}$ $t_{TLH} = (0.4 \text{ ns/pF}) C_L + 15 \text{ ns}$	t_{TLH}	5.0 10 15	— — —	90 45 35	180 90 70	ns
Output Fall Time $t_{THL} = (1.2 \text{ ns/pF}) C_L + 15 \text{ ns}$ $t_{THL} = (0.5 \text{ ns/pF}) C_L + 15 \text{ ns}$ $t_{THL} = (0.4 \text{ ns/pF}) C_L + 10 \text{ ns}$	t_{THL}	5.0 10 15	— — —	75 40 30	150 80 60	ns
Turn-Off Delay Time $t_{PLH} = (1.5 \text{ ns/pF}) C_L + 35 \text{ ns}$ $t_{PLH} = (0.2 \text{ ns/pF}) C_L + 20 \text{ ns}$ $t_{PLH} = (0.15 \text{ ns/pF}) C_L + 17.5 \text{ ns}$	t_{PLH}	5.0 10 15	— — —	60 30 25	125 75 55	ns
Turn-On Delay Time $t_{PHL} = (1.0 \text{ ns/pF}) C_L + 10 \text{ ns}$ $t_{PHL} = (0.3 \text{ ns/pF}) C_L + 15 \text{ ns}$ $t_{PHL} = (0.2 \text{ ns/pF}) C_L + 15 \text{ ns}$	t_{PHL}	5.0 10 15	— — —	60 30 25	125 75 55	ns

7. The formulas given are for the typical characteristics only. Switching specifications are for device connected as an inverter.
8. Data labelled "Typ" is not to be used for design purposes but is intended as an indication of the IC's potential performance.



All unused inputs connected to ground.



All unused inputs connected to ground.

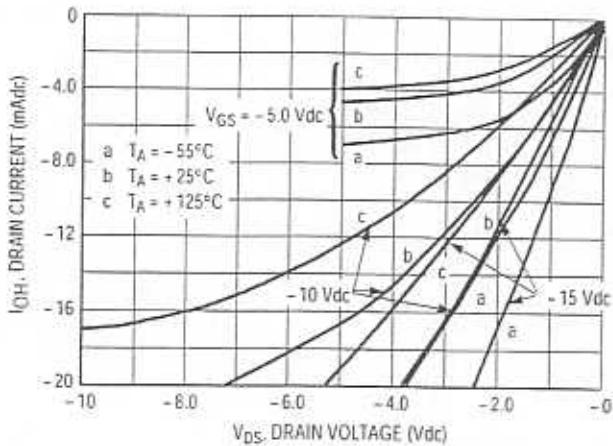


Figure 2. Typical Output Source Characteristics

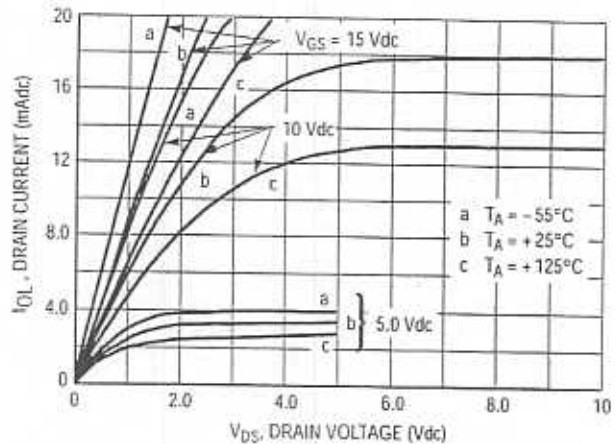


Figure 3. Typical Output Sink Characteristics

These typical curves are not guarantees, but are design aids.
Caution: The maximum current rating is 10 mA per pin.

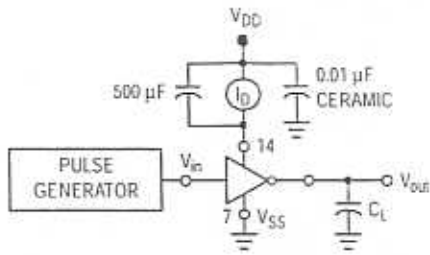
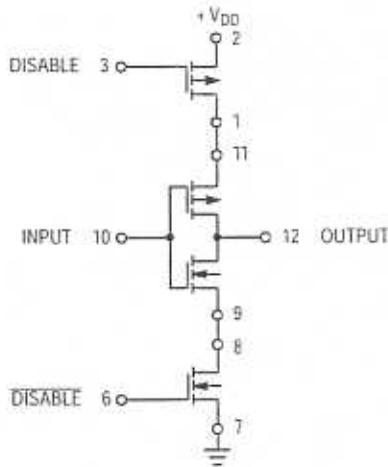


Figure 4. Switching Time and Power Dissipation Test Circuit and Waveforms

APPLICATIONS

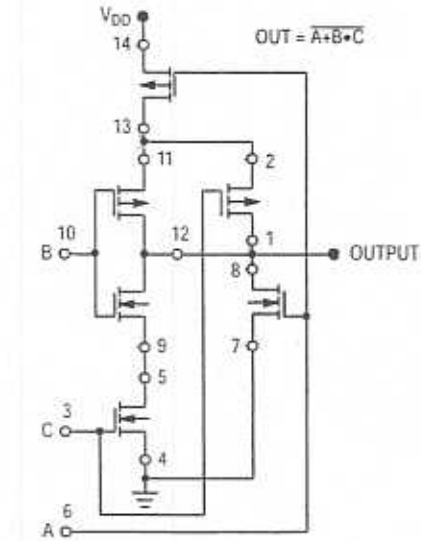
The MC14007UB dual pair-plus inverter, which has access to all its elements offers a number of unique circuit applications. Figures 1, 5, and 6 are a few examples of the device flexibility.



INPUT	DISABLE	OUTPUT
1	0	0
0	0	1
X	1	OPEN

X = Don't Care

Figure 5. 3-State Buffer



Substrates of P-channel devices internally connected to VDD;
Substrates of N-channel devices internally connected to VSS.

Figure 6. AOI Functions Using Tree Logic

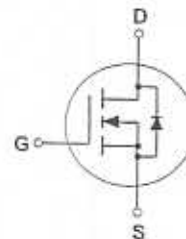
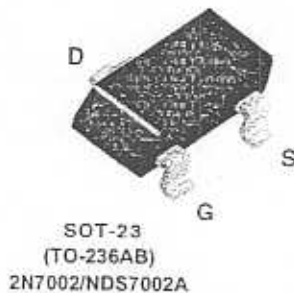
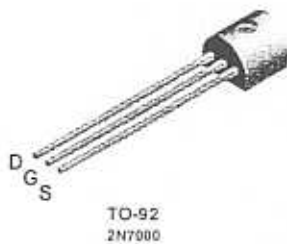
2N7000 / 2N7002 / NDS7002A
N-Channel Enhancement Mode Field Effect Transistor

General Description

These N-Channel enhancement mode field effect transistors are produced using Fairchild's proprietary, high cell density, DMOS technology. These products have been designed to minimize on-state resistance while provide rugged, reliable, and fast switching performance. They can be used in most applications requiring up to 400mA DC and can deliver pulsed currents up to 2A. These products are particularly suited for low voltage, low current applications such as small servo motor control, power MOSFET gate drivers, and other switching applications.

Features

- High density cell design for low $R_{DS(ON)}$
- Voltage controlled small signal switch.
- Rugged and reliable.
- High saturation current capability.



Absolute Maximum Ratings $T_A = 25^\circ\text{C}$ unless otherwise noted

Symbol	Parameter	2N7000	2N7002	NDS7002A	Units
V_{DS}	Drain-Source Voltage		60		V
V_{DGR}	Drain-Gate Voltage ($R_{GS} \leq 1 \text{ M}\Omega$)		60		V
V_{GS}	Gate-Source Voltage - Continuous		± 20		V
	- Non Repetitive ($t_p < 50\mu\text{s}$)		± 40		
I_D	Maximum Drain Current - Continuous	200	115	280	mA
	- Pulsed	500	600	1500	
P_D	Maximum Power Dissipation	400	200	300	mW
	Derated above 25°C	3.2	1.6	2.4	
T_J, T_{STG}	Operating and Storage Temperature Range	-55 to 150		-65 to 150	$^\circ\text{C}$
T_L	Maximum Lead Temperature for Soldering Purposes, 1/16" from Case for 10 Seconds	300			$^\circ\text{C}$

THERMAL CHARACTERISTICS

Symbol	Parameter	2N7000	2N7002	NDS7002A	Units
$R_{\theta JA}$	Thermal Resistance, Junction-to-Ambient	312.5	625	417	$^\circ\text{C/W}$

Electrical Characteristics $T_a = 25^\circ\text{C}$ unless otherwise noted

Symbol	Parameter	Conditions	Type	Min	Typ	Max	Units
OFF CHARACTERISTICS							
BV_{DSS}	Drain-Source Breakdown Voltage	$V_{GS} = 0\text{ V}, I_G = 10\ \mu\text{A}$	All	60			V
I_{DSS}	Zero Gate Voltage Drain Current	$V_{DS} = 48\text{ V}, V_{GS} = 0\text{ V}$	2N7000			1	μA
		$V_{DS} = 60\text{ V}, V_{GS} = 0\text{ V}$	2N7002 NDS7002A			1	μA
		$T_J = 125^\circ\text{C}$				0.5	mA
I_{OSSF}	Gate - Body Leakage, Forward	$V_{GS} = 15\text{ V}, V_{DS} = 0\text{ V}$	2N7000			10	nA
		$V_{GS} = 20\text{ V}, V_{DS} = 0\text{ V}$	2N7002 NDS7002A			100	nA
I_{OSSR}	Gate - Body Leakage, Reverse	$V_{GS} = -15\text{ V}, V_{DS} = 0\text{ V}$	2N7000			-10	nA
		$V_{GS} = -20\text{ V}, V_{DS} = 0\text{ V}$	2N7002 NDS7002A			-100	nA
ON CHARACTERISTICS (Note 1)							
$V_{GS(th)}$	Gate Threshold Voltage	$V_{DS} = V_{GS}, I_D = 1\text{ mA}$	2N7000	0.8	2.1	3	V
		$V_{DS} = V_{GS}, I_D = 250\ \mu\text{A}$	2N7002 NDS7002A	1	2.1	2.5	
$R_{DS(on)}$	Static Drain-Source On-Resistance	$V_{GS} = 10\text{ V}, I_D = 500\text{ mA}$	2N7000		1.2	5	Ω
		$T_J = 125^\circ\text{C}$			1.9	9	
		$V_{GS} = 4.5\text{ V}, I_D = 75\text{ mA}$			1.8	5.3	
		$V_{GS} = 10\text{ V}, I_D = 500\text{ mA}$	2N7002		1.2	7.5	
		$T_J = 100^\circ\text{C}$			1.7	13.5	
		$V_{GS} = 5.0\text{ V}, I_D = 50\text{ mA}$			1.7	7.5	
		$T_J = 100^\circ\text{C}$			2.4	13.5	
		$V_{GS} = 10\text{ V}, I_D = 500\text{ mA}$	NDS7002A		1.2	2	
$T_J = 125^\circ\text{C}$			2	3.5			
$V_{DS(on)}$	Drain-Source On-Voltage	$V_{GS} = 10\text{ V}, I_D = 500\text{ mA}$	2N7000		0.6	2.5	V
		$V_{GS} = 4.5\text{ V}, I_D = 75\text{ mA}$			0.14	0.4	
		$V_{GS} = 10\text{ V}, I_D = 500\text{ mA}$	2N7002		0.6	3.75	
		$V_{GS} = 5.0\text{ V}, I_D = 50\text{ mA}$			0.09	1.5	
		$V_{GS} = 10\text{ V}, I_D = 500\text{ mA}$	NDS7002A		0.6	1	
		$V_{GS} = 5.0\text{ V}, I_D = 50\text{ mA}$			0.09	0.15	

Electrical Characteristics $T_A = 25^\circ\text{C}$ unless otherwise noted

Symbol	Parameter	Conditions	Type	Min	Typ	Max	Units
ON CHARACTERISTICS Continued (Note 1)							
$I_{D(OH)}$	On-State Drain Current	$V_{GS} = 4.5\text{ V}, V_{DS} = 10\text{ V}$	2N7000	75	600		mA
		$V_{GS} = 10\text{ V}, V_{DS} \geq 2 V_{DS(on)}$	2N7002	500	2700		
		$V_{GS} = 10\text{ V}, V_{DS} \geq 2 V_{DS(on)}$	NDS7002A	500	2700		
g_{FS}	Forward Transconductance	$V_{DS} = 10\text{ V}, I_D = 200\text{ mA}$	2N7000	100	320		mS
		$V_{DS} \geq 2 V_{DS(on)}, I_D = 200\text{ mA}$	2N7002	80	320		
		$V_{DS} \geq 2 V_{DS(on)}, I_D = 200\text{ mA}$	NDS7002A	80	320		
DYNAMIC CHARACTERISTICS							
C_{iss}	Input Capacitance	$V_{DS} = 25\text{ V}, V_{GS} = 0\text{ V},$ $f = 1.0\text{ MHz}$	All		20	50	pF
C_{oss}	Output Capacitance		All		11	25	pF
C_{rss}	Reverse Transfer Capacitance		All		4	5	pF
t_{on}	Turn-On Time	$V_{DS} = 15\text{ V}, R_L = 25\ \Omega,$ $I_D = 500\text{ mA}, V_{GS} = 10\text{ V},$ $R_{GEN} = 25$	2N7000			10	ns
		$V_{DS} = 30\text{ V}, R_L = 150\ \Omega,$ $I_D = 200\text{ mA}, V_{GS} = 10\text{ V},$ $R_{GEN} = 25\ \Omega$	2N700 NDS7002A			20	
t_{off}	Turn-Off Time	$V_{DS} = 15\text{ V}, R_L = 25\ \Omega,$ $I_D = 500\text{ mA}, V_{GS} = 10\text{ V},$ $R_{GEN} = 25$	2N7000			10	ns
		$V_{DS} = 30\text{ V}, R_L = 150\ \Omega,$ $I_D = 200\text{ mA}, V_{GS} = 10\text{ V},$ $R_{GEN} = 25\ \Omega$	2N700 NDS7002A			20	
DRAIN-SOURCE DIODE CHARACTERISTICS AND MAXIMUM RATINGS							
I_S	Maximum Continuous Drain-Source Diode Forward Current		2N7002			115	mA
			NDS7002A			280	
I_{SM}	Maximum Pulsed Drain-Source Diode Forward Current		2N7002			0.8	A
			NDS7002A			1.5	
V_{SD}	Drain-Source Diode Forward Voltage	$V_{GS} = 0\text{ V}, I_S = 115\text{ mA}$ (Note 1)	2N7002		0.88	1.5	V
		$V_{GS} = 0\text{ V}, I_S = 400\text{ mA}$ (Note 1)	NDS7002A		0.88	1.2	

Note:

 1. Pulse Test. Pulse Width $\leq 300\ \mu\text{s}$, Duty Cycle $\leq 2.0\%$.

Typical Electrical Characteristics

2N7000 / 2N7002 / NDS7002A

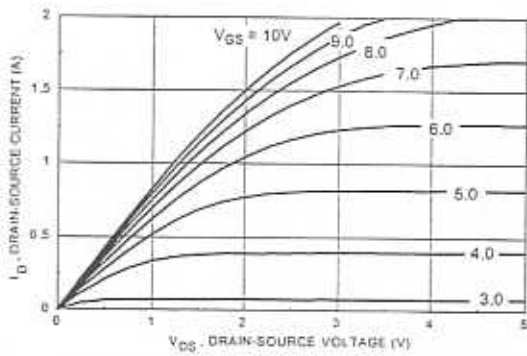


Figure 1. On-Region Characteristics

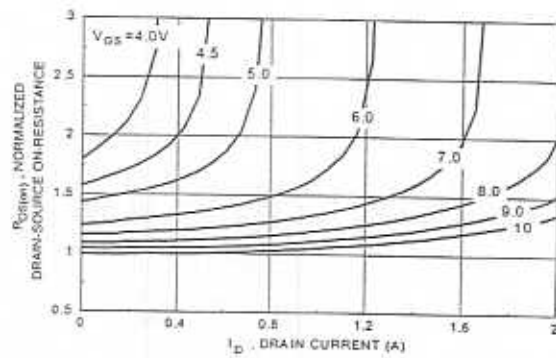


Figure 2. On-Resistance Variation with Gate Voltage and Drain Current

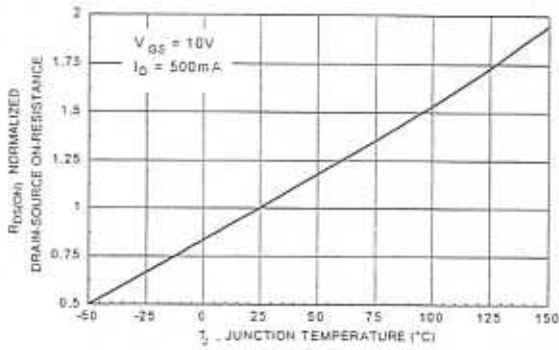


Figure 3. On-Resistance Variation with Temperature

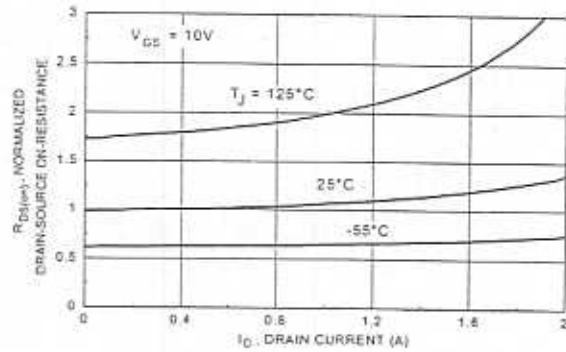


Figure 4. On-Resistance Variation with Drain Current and Temperature

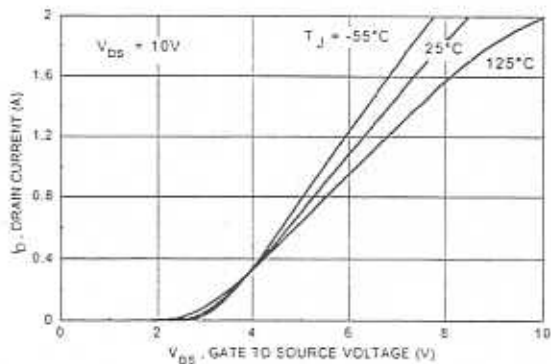


Figure 5. Transfer Characteristics

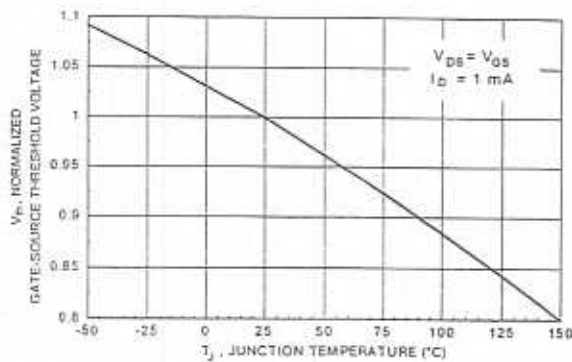


Figure 6. Gate Threshold Variation with Temperature

Typical Electrical Characteristics (continued)

2N7000 / 2N7002 / NDS7002A

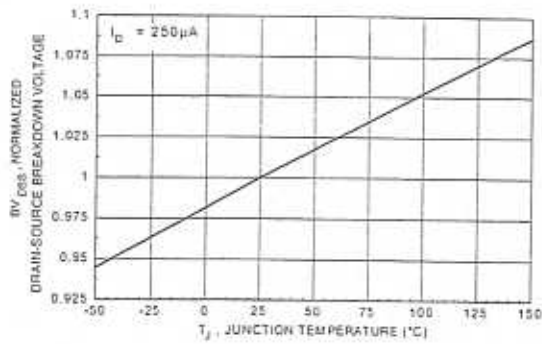


Figure 7. Breakdown Voltage Variation with Temperature

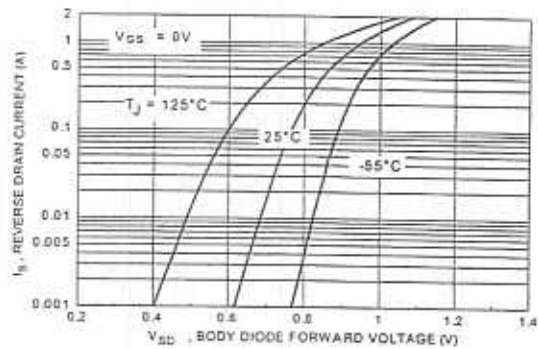


Figure 8. Body Diode Forward Voltage Variation with Temperature

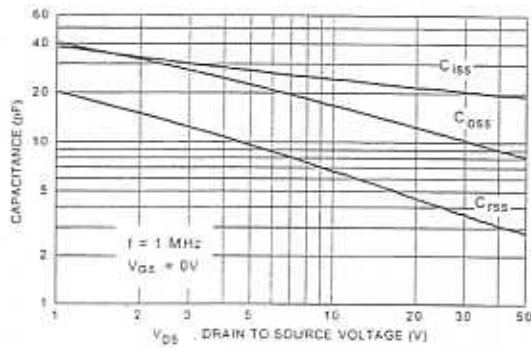


Figure 9. Capacitance Characteristics

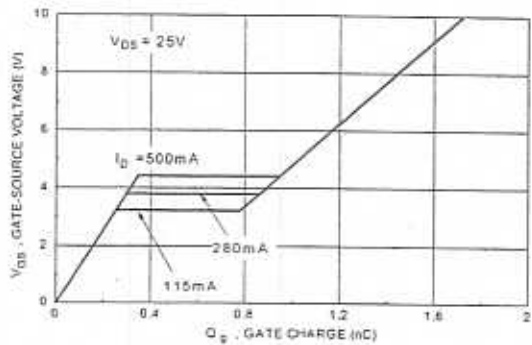


Figure 10. Gate Charge Characteristics

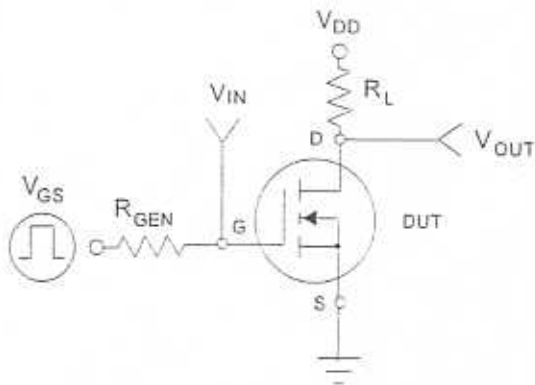


Figure 11.

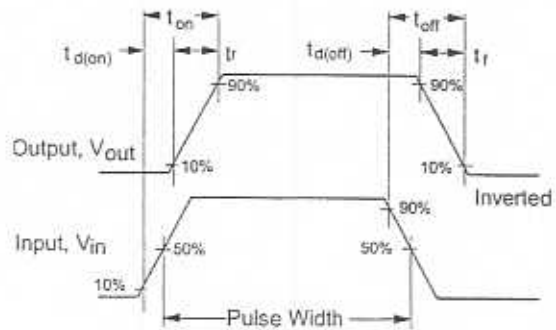


Figure 12. Switching Waveforms

Typical Electrical Characteristics (continued)

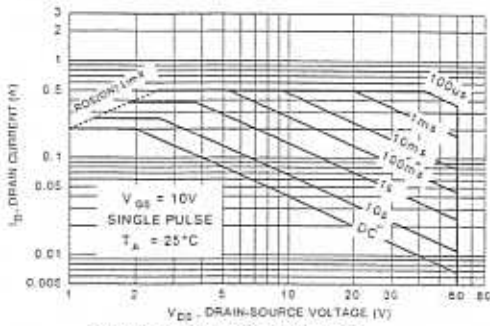


Figure 13. 2N7000 Maximum Safe Operating Area

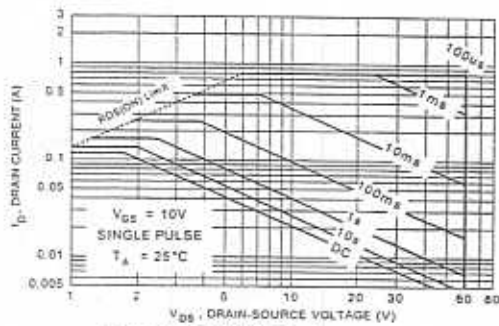


Figure 14. 2N7002 Maximum Safe Operating Area

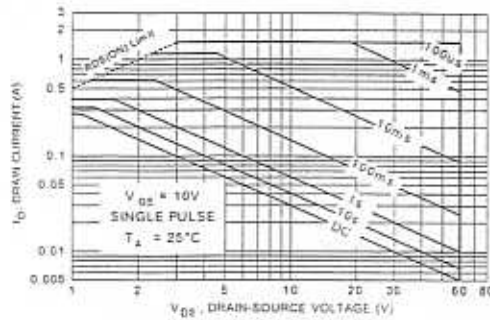


Figure 15. NDS7000A Maximum Safe Operating Area

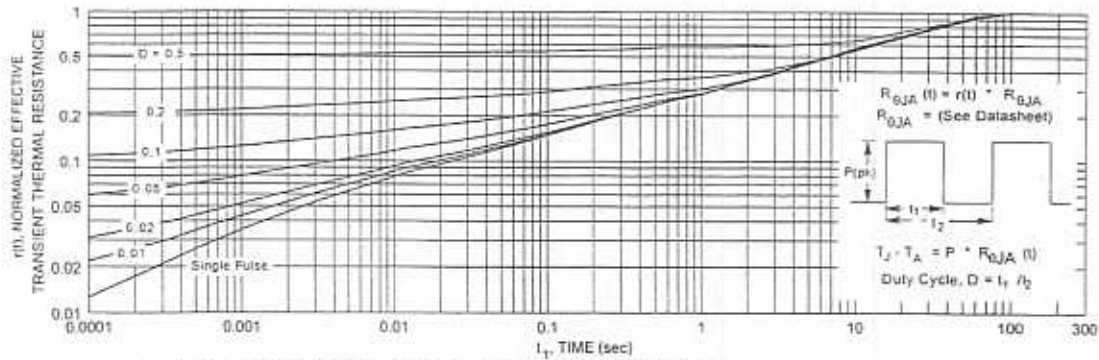


Figure 16. TO-92, 2N7000 Transient Thermal Response Curve

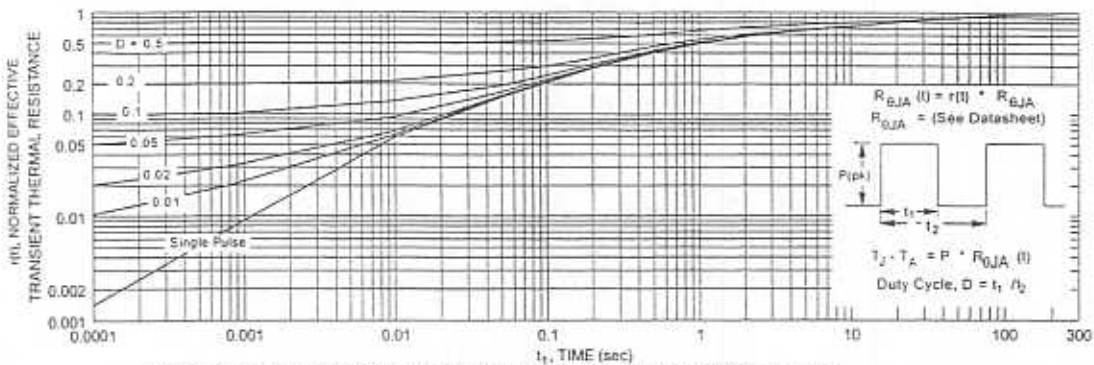


Figure 17. SOT-23, 2N7002 / NDS7002A Transient Thermal Response Curve