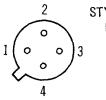
3N155,A (SILICON)
3N156,A

CASE 20
(TO-72)



STYLE 2
PIN 1. SOURCE
2. GATE
3. DRAIN
4. SUBSTRATE AND CASE LEAD

P-channel silicon nitride passivated MOS field-effect enhancement mode transistors designed for chopper and switching application.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	35	Vdc
Drain-Gate Voltage	V_{DG}	35	Vdc
Gate-Source Voltage	V_{GS}	50	Vdc
Drain Current	I_D	30	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	300 1.7	mW mW/°C
Operating Junction Temperature Range	T_J	-65 to +175	°C
Storage Temperature Range	T_{stg}	-65 to +200	°C

HANDLING PRECAUTIONS:

MOS field-effect transistors have extremely high input resistance. They can be damaged by the accumulation of excess static charge. Avoid possible damage to the devices while handling, testing, or in actual operation, by following the procedures outlined below:

1. To avoid the build-up of static charge, the leads of the devices should remain shorted together with a metal ring except when being tested or used.
2. Avoid unnecessary handling. Pick up devices by the case instead of the leads.
3. Do not insert or remove devices from circuits with the power on because transient voltages may cause permanent damage to the devices.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Drain-Source Breakdown Voltage (I_D = -10 μAdc, V_G = V_S = 0)		$V_{(BR)DSS}$	35	-	-	Vdc
Gate Reverse Current		I_{GSS}				pAdc
(V_{GS} = +50 Vdc, V_{DS} = 0)			-	-	1000	
(V_{GS} = +25 Vdc, V_{DS} = 0)			-	-	10	
Zero-Gate Voltage Drain Current		I_{DSS}				nAdc
(V_{DS} = -10 Vdc, V_{GS} = 0)	3N155, 3N156		-	-	1.0	
	3N155A, 3N156A		-	-	0.25	
(V_{DS} = -10 Vdc, V_{GS} = 0, T_A = 125°C)	3N155, 3N156		-	-	1000	
	3N155A, 3N156A		-	-	250	
Resistance Drain Source (I_D = 0, V_{GS} = 0)		$R_{DS(off)}$	$1 \times 10^{+10}$	-	-	Ohms
Resistance Gate Source Input (V_{GS} = -25 Vdc)		R_{GS}	-	$1 \times 10^{+16}$	-	Ohms
ON CHARACTERISTICS						
Gate Source Threshold Voltage (V_{DS} = -10 Vdc, I_D = -10 μAdc)	3N155, 3N155A	$V_{GS(TH)}$	1.5	-	3.2	Vdc
	3N156, 3N156A		3.0	-	5.0	
Drain Source "ON" Voltage (I_D = -2.0 mAdc, V_{GS} = -10 Vdc)		$V_{DS(on)}$	-	-	-1.0	Vdc
Gate Forward Leakage Current		$I_{G(f)}$				pAdc
(V_{GS} = -50 Vdc, V_{DS} = 0)			-	-	1000	
(V_{GS} = -25 Vdc, V_{DS} = 0)			-	-	10	
"ON" Drain Current (V_{DS} = -15 Vdc, V_{GS} = -10 Vdc)		$I_{D(on)}$	5.0	-	-	mAdc
Static Drain-Source "ON" Resistance		$r_{DS(on)}$				Ohms
(I_D = 0 mAdc, V_{GS} = -10 Vdc)	3N155, 3N156		-	-	600	
	3N155A, 3N156A		-	-	300	
SMALL-SIGNAL CHARACTERISTICS						
Drain-Source Resistance		$r_{ds(on)}$				Ohms
(V_{GS} = -10 Vdc, I_D = 0, f = 1.0 kHz)	3N155, 3N156		-	-	600	
	3N155A, 3N156A		-	-	300	
(V_{GS} = -15 Vdc, I_D = 0, f = 1.0 kHz)	3N155, 3N156		-	-	500	
	3N155A, 3N156A		-	-	250	
Forward Transfer Admittance (V_{DS} = -15 Vdc, I_D = -2.0 mAdc, f = 1.0 kHz)		$\lvert y_{fs} \rvert$	1000	-	4000	μmhos
Input Capacitance (V_{DS} = -15 Vdc, V_{GS} = -10 Vdc, f = 140 kHz)		C_{iss}	-	-	5.0	pF
Reverse Transfer Capacitance (V_{DS} = 0, V_{GS} = 0, f = 140 kHz)		C_{rss}	-	-	1.3	pF
Drain-Substrate Capacitance ($V_{D(SUB)}$ = -10 Vdc, f = 140 kHz)		$C_{d(sub)}$	4.0	-	-	pF
SWITCHING CHARACTERISTICS						
Turn-On Delay	(V_{DD} = -10 Vdc, $I_{D(on)}$ = -2.0 mAdc, $V_{GS(on)}$ = -10 Vdc, $V_{GS(off)}$ = 0) Test Circuit given in Figure 1	t_d	-	-	45	μs
Rise Time		t_r	-	-	65	ns
Turn-Off Delay		t_s	-	-	60	ns
Fall Time		t_f	-	-	100	ns

FIGURE 1 – GATE VOLTAGE EFFECTS

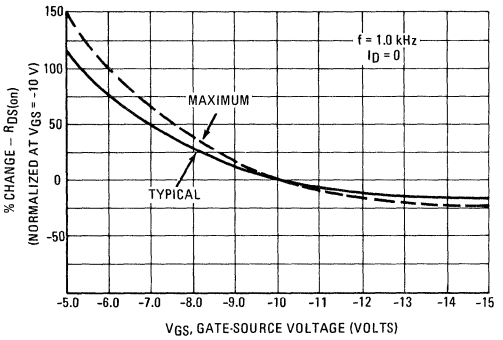


FIGURE 2 – TEMPERATURE EFFECTS

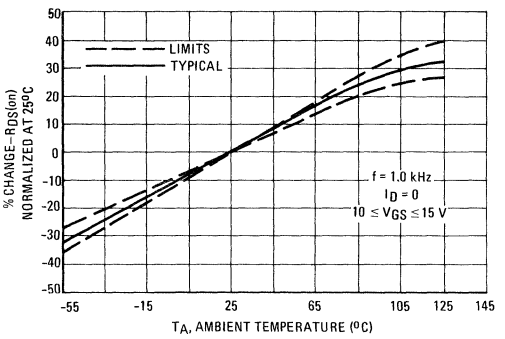


FIGURE 3 – DRAIN CURRENT versus TEMPERATURE

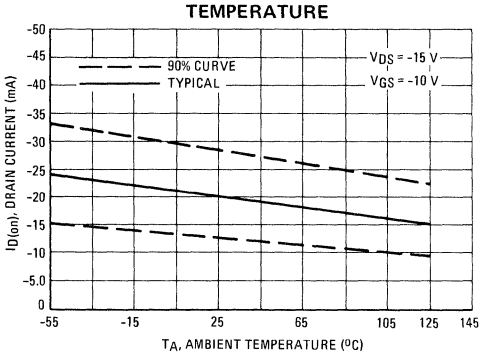


FIGURE 4 – "ON" DRAIN-SOURCE VOLTAGE

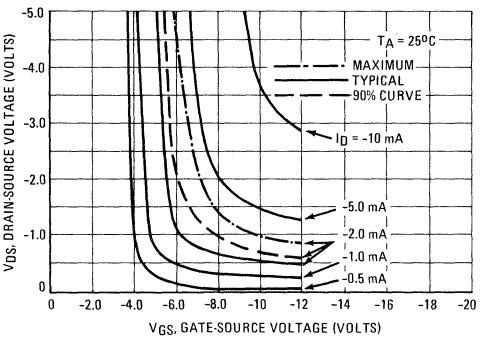


FIGURE 5 – LEAKAGE CURRENTS

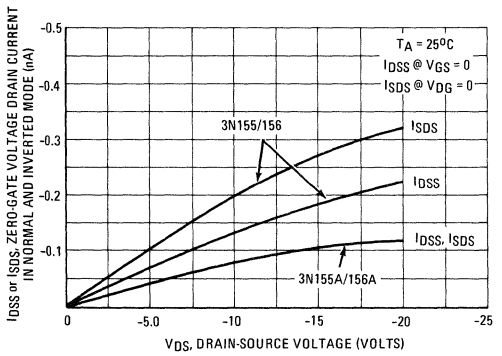
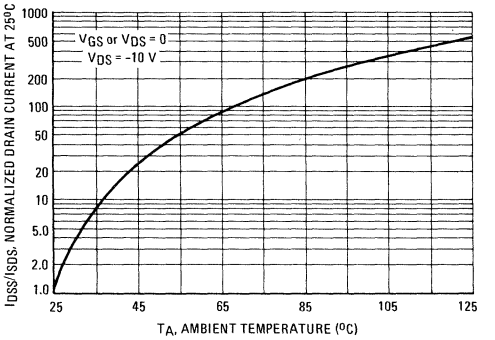


FIGURE 6 – LEAKAGE CURRENT versus TEMPERATURE



SWITCHING CHARACTERISTICS

$T_A = 25^oC$

FIGURE 7 – TURN-ON DELAY TIME

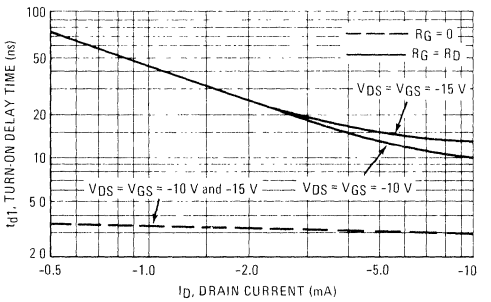


FIGURE 8 – RISE TIME

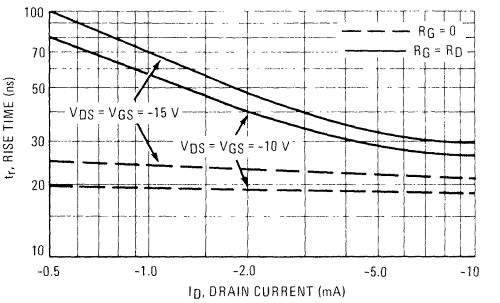


FIGURE 9 – TURN-OFF DELAY TIME

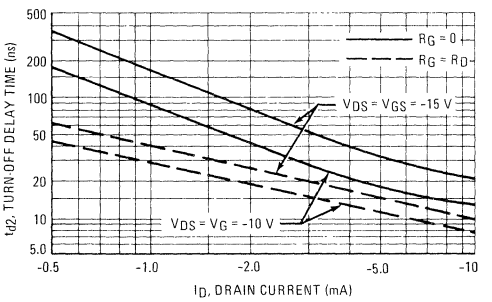


FIGURE 10 – FALL TIME

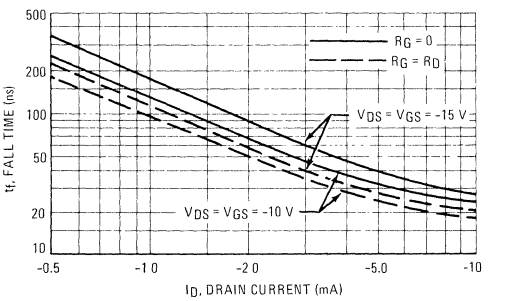
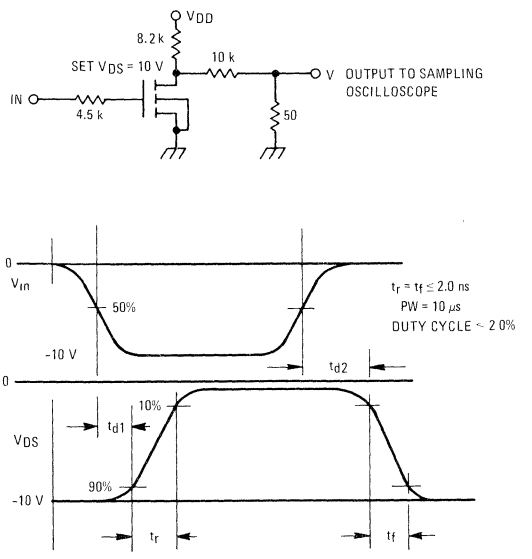


FIGURE 11 – SWITCHING CIRCUIT and WAVEFORMS



The switching characteristics shown above were measured in a test circuit similar to Figure 11. At the beginning of the switching interval, the gate voltage is at ground and the gate-source capacitance ($C_{gs} = C_{iss} - C_{rss}$) has no charge. The drain voltage is at V_{DD}, and thus the feedback capacitance (C_{rss}) is charged to V_{DD}. Similarly, the drain-substrate capacitance ($C_{d(sub)}$) is charged to V_{DD} since the substrate and source are connected to ground.

During the turn-on interval, C_{gs} is charged to V_{GS} (the input voltage) through R_G (generator impedance) (Figure 12). C_{rss} must be discharged to $V_{GS} - V_{D(on)}$ through R_G and the parallel combination of the load resistor (R_D) and the channel resistance (r_{ds}). In addition, $C_{d(sub)}$ is discharged to a low value ($V_{D(on)}$) through R_D in parallel with d_s. During turn-off this charge flow is reversed.

Predicting turn-on time proves to be somewhat difficult since the channel resistance (r_{ds}) is a function of the gate-source voltage (V_{GS}). As C_{gs} becomes charged V_{GS} is approaching V_{in} and r_{ds} decreases (see Figure 4) and since C_{rss} and $C_{d(sub)}$ are charged through r_{ds}, turn-on time is quite non-linear.

If the charging time of C_{gs} is short compared to that of C_{rss} and $C_{d(sub)}$, then r_{ds} (which is in parallel with R_D) will be low compared to R_D during the switching interval and will largely determine the turn-on time. On the other hand, during turn-off r_{ds} will be almost an open circuit requiring C_{rss} and $C_{d(sub)}$ to be charged through R_D and resulting in a turn-off time that is long compared to the turn-on time. This is especially noticeable for the curves where $R_G = 0$ and C_{gs} is charged through the pulse generator impedance only.

The switching curves shown with $R_G = R_D$ simulate the switching behavior of cascaded stages where the driving source impedance is normally the same as the load impedance. The set of curves with $R_G = 0$ simulates a low source impedance drive such as might occur in complementary logic circuits.

FIGURE 12 – SWITCHING CIRCUIT with MOSFET EQUIVALENT MODEL