

6367254 MOTOROLA SC (XSTRS/R F)

96D 82498 D

MPQ2906, 2907 For Specifications, See MHQ2906 Data.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit	
Collector-Emitter Voltage	V _{CEO}	12	Vdc	
Collector-Base Voltage	V _{CBO}	25	Vdc	
Emitter-Base Voltage	V _{EBO}	4.0	Vdc	
Collector Current — Continuous	I _C	1.0	Adc	
Total Device Dissipation @ T _A = 25°C Derate above 25°C	P _D	Each Transistor	650	mW
		Four Transistors Equal Power	1250	mW
Total Device Dissipation @ T _C = 25°C Derate above 25°C	P _D '	Each Transistor	1.0	Watts
		Four Transistors Equal Power	3.0	Watts
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150	°C	

THERMAL CHARACTERISTICS

Characteristic	Junction to Case	Junction to Ambient	Unit
Thermal Resistance	Each Die	125	°C/W
	Effective, 4 Die	41.6	°C/W
Coupling Factors	Q1-Q4 or Q2-Q3	30	%
	Q1-Q2 or Q3-Q4	2.0	%

(1) R_{θJA} is measured with the device soldered into a typical printed circuit board.

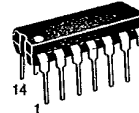
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I _C = 10 mAdc, I _B = 0)	V _{(BR)CEO}	12	—	—	Vdc
Collector-Base Breakdown Voltage (I _C = 100 μAdc, I _E = 0)	V _{(BR)CBO}	25	—	—	Vdc
Emitter-Base Breakdown Voltage (I _E = 100 μAdc, I _C = 0)	V _{(BR)EBO}	4.0	—	—	Vdc
Collector Cutoff Current (V _{CE} = 15 Vdc, V _{BE} = 0)	I _{CES}	—	—	100	μAdc
ON CHARACTERISTICS					
DC Current Gain (I _C = 100 mAdc, V _{CE} = 0.5 Vdc) (I _C = 300 mAdc, V _{CE} = 0.5 Vdc)	h _{FE}	30 40	45 55	— 200	—
Collector-Emitter Saturation Voltage (I _C = 300 mAdc, I _B = 30 mAdc) (I _C = 1.0 Adc, I _B = 0.1 Adc)	V _{CE(sat)}	—	0.22 0.52	0.33 0.7	Vdc
Base-Emitter Saturation Voltage (I _C = 300 mAdc, I _B = 30 mAdc) (I _C = 1.0 Adc, I _B = 0.1 Adc)	V _{BE(sat)}	—	0.87 1.04	1.1 1.4	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I _C = 100 mAdc, V _{CE} = 5.0 Vdc, f = 100 MHz)	f _T	400	500	—	MHz
Output Capacitance (V _{CB} = 5.0 Vdc, I _E = 0, f = 1 MHz)	C _{obo}	—	5.0	10	pF
Input Capacitance (V _{BE} = 0.5 Vdc, I _C = 0, f = 1 MHz)	C _{ibo}	—	22	30	pF
SWITCHING CHARACTERISTICS					
Turn-On Time (V _{CC} = 12 Vdc, I _C = 1.0 Adc, V _{BE(off)} = 4.0 Vdc, I _{B1} = 100 mAdc)	t _{on}	—	12	15	ns
Turn-Off Time (V _{CC} = 12 Vdc, I _C = 1.0 Adc, I _{B1} = I _{B2} = 100 mAdc)	t _{off}	—	18	25	ns

T-43-a5

MPQ3303

CASE 646-06, STYLE 1
TO-116



**QUAD
SWITCHING TRANSISTOR**

NPN SILICON

5

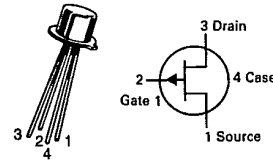
6367254 MOTOROLA SC (XSTRS/R F)

96D 82543 D

T-35-25

2N3993,A
2N3994

CASE 20-03, STYLE 5
TO-72 (TO-206AF)



JFET
SWITCHING
P-CHANNEL — DEPLETION

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	-25	Vdc
Drain-Gate Voltage	V_{DG}	-25	Vdc
Reverse Gate-Source Voltage	V_{GSR}	25	Vdc
Forward Gate Current	I_{GF}	10	mAdc
Total Device Dissipation @ $T_A = 25^\circ\text{C}$ Derate above 25°C	P_D	300 2.0	mW mW/°C
Storage Temperature Range	T_{stg}	-65 to +200	°C

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Gate-Source Breakdown Voltage ($I_G = 1.0 \mu\text{Adc}$, $V_{DS} = 0$)	$V_{(BR)GSS}$	25	—	Vdc
Drain Reverse Current ($V_{DG} = -15 \text{ Vdc}$, $I_S = 0$) ($V_{DG} = -15 \text{ Vdc}$, $I_S = 0$, $T_A = 150^\circ\text{C}$)	I_{DGO}	—	1.2 1.2	nAdc μAdc
Drain Cutoff Current ($V_{DS} = -10 \text{ Vdc}$, $V_{GS} = 10 \text{ Vdc}$) ($V_{DS} = -10 \text{ Vdc}$, $V_{GS} = 6.0 \text{ Vdc}$) ($V_{DS} = -10 \text{ Vdc}$, $V_{GS} = 10 \text{ Vdc}$, $T_A = 150^\circ$) ($V_{DS} = -10 \text{ Vdc}$, $V_{GS} = 6.0 \text{ Vdc}$, $T_A = 150^\circ$)	$I_{D(off)}$	—	1.2 1.2 1.0 1.0	nAdc μAdc
Gate Source Voltage ($V_{DS} = -10 \text{ Vdc}$, $I_D = -1.0 \mu\text{Adc}$)	V_{GS}	4.0 1.0	9.5 5.5	Vdc
ON CHARACTERISTICS				
Zero-Gate-Voltage Drain Current(1) ($V_{DS} = -10 \text{ Vdc}$, $V_{GS} = 0$)	I_{DSS}	10 2.0	— —	mAdc
SMALL-SIGNAL CHARACTERISTICS				
Drain-Source "ON" Resistance ($V_{GS} = 0$, $I_D = 0$, $f = 1.0 \text{ kHz}$)	$r_{ds(on)}$	— —	150 300	Ohms
Forward Transfer Admittance(1) ($V_{DS} = -10 \text{ Vdc}$, $V_{GS} = 0$, $f = 1.0 \text{ kHz}$)	$ y_{fs} $	6.0 7.0 4.0	12 12 10	mmhos
Input Capacitance ($V_{DS} = -10 \text{ Vdc}$, $V_{GS} = 0$, $f = 1.0 \text{ MHz}$)	C_{iss}	— —	16 12	pF
Reverse Transfer Capacitance ($V_{DS} = 0$, $V_{GS} = 10 \text{ Vdc}$, $f = 1.0 \text{ MHz}$) ($V_{DS} = 0$, $V_{GS} = 6.0 \text{ Vdc}$, $f = 1.0 \text{ MHz}$)	C_{rss}	— — —	4.5 3.0 5.0	pF

(1) Pulse Test: Pulse Width = 100 ms, Duty Cycle $\leq 10\%$.



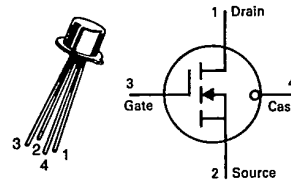
6367254 MOTOROLA SC (XSTRS/R F)

96D 82603 D

T-37-25

3N157
3N158

CASE 20-03, STYLE 2
TO-72 (TO-206AF)



MOSFET
AMPLIFIER AND SWITCHING

P-CHANNEL — ENHANCEMENT

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage*	V _{DS}	±35	Vdc
Drain-Gate Voltage*	V _{DG}	±50	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
Junction Temperature Range*	T _J	-65 to +175	°C
Storage Channel Temperature Range*	T _{stg}	-65 to +175	°C

*JEDEC Registered Limits

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)DSX}	-35	—	—	Vdc
Zero-Gate-Voltage Drain Current (V _{DS} = -15 Vdc, V _{GS} = 0) (V _{DS} = -35 Vdc, V _{GS} = 0)	I _{DSS}	—	—	-1.0 -10	nAdc μAdc
Gate Reverse Current* (V _{GS} = +25 Vdc, V _{DS} = 0) (V _{GS} = +50 Vdc, V _{DS} = 0)	I _{GSS}	—	—	+10 +10	pAdc nAdc
Input Resistance (V _{GS} = -25 Vdc)	R _{GS}	—	1 x 10 ¹²	—	Ohms
Gate Source Voltage* (V _{DS} = -15 Vdc, I _D = -0.5 mAdc)	V _{GS}	-1.5 -3.0	—	-5.5 -7.0	Vdc
Gate Forward Current* (V _{GS} = -25 Vdc, V _{DS} = 0) (V _{GS} = -50 Vdc, V _{DS} = 0) (V _{GS} = -25 Vdc, V _{DS} = 0, T _A = +55°C) (V _{GS} = -50 Vdc, V _{DS} = 0, T _A = +55°C)	I _{G(f)}	—	—	-10 -1.0 -1.0 -1.0	pAdc nAdc nAdc μAdc
ON CHARACTERISTICS					
Gate Threshold Voltage* (V _{DS} = -15 Vdc, I _D = -10 μAdc)	V _{GS(Th)}	-1.5 -3.0	—	-3.2 -5.0	Vdc
On-State Drain Current* (V _{DS} = -15 Vdc, V _{GS} = -10 Vdc)	I _{D(on)}	-5.0	—	—	mAdc
SMALL-SIGNAL CHARACTERISTICS					
Forward Transfer Admittance* (V _{DS} = -15 Vdc, I _D = -2.0 mAdc, f = 1.0 kHz)	y _{fs}	1000	—	4000	μmhos
Output Admittance* (V _{DS} = -15 Vdc, I _D = -2.0 mAdc, f = 1.0 kHz)	y _{os}	—	—	60	μmhos
Input Capacitance* (V _{DS} = -15 Vdc, V _{GS} = 0, f = 140 kHz)	C _{iss}	—	—	5.0	pF
Reverse Transfer Capacitance* (V _{DS} = -15 Vdc, 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
Noise Voltage (R _S = 0, BW = 1.0 Hz, V _{DS} = -15 Vdc, I _D = -2.0 mAdc, f = 100 Hz) (R _S = 0, BW = 1.0 Hz, V _{DS} = -15 Vdc, I _D = -2.0 mAdc, f = 1.0 kHz)	e _n	—	300 120	— 500	NV/√Hz

*JEDEC Registered Limits

MOTOROLA SMALL-SIGNAL SEMICONDUCTORS



6367254 MOTOROLA SC (XSTRS/R F)

96D 82604 D

3N157, 3N158

T-37-25

FIGURE 1 - FORWARD TRANSCONDUCTANCE

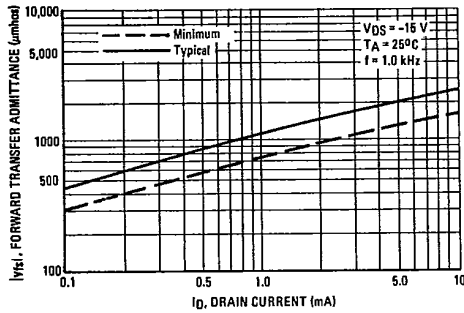


FIGURE 2 - OUTPUT TRANSCONDUCTANCE

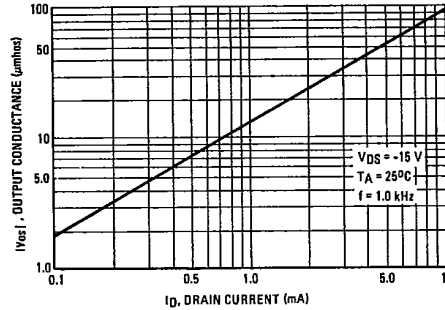


FIGURE 3 - FORWARD TRANSCONDUCTANCE versus TEMPERATURE

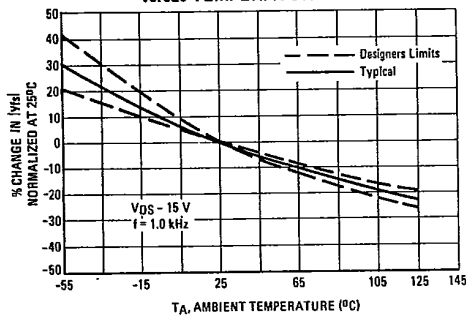


FIGURE 4 - BIAS CURVE

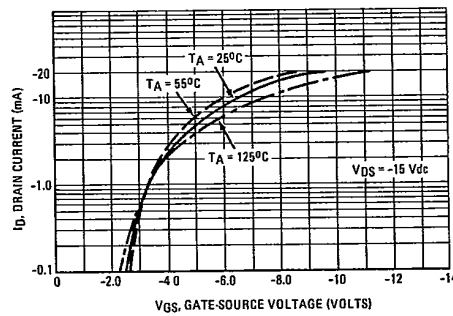


FIGURE 5 - "ON" DRAIN-SOURCE VOLTAGE

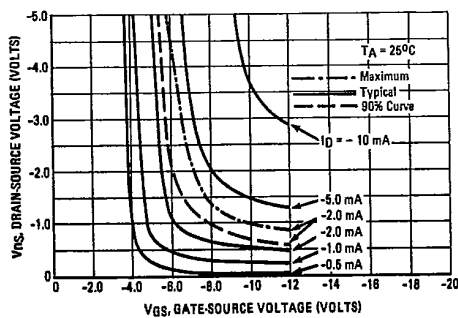
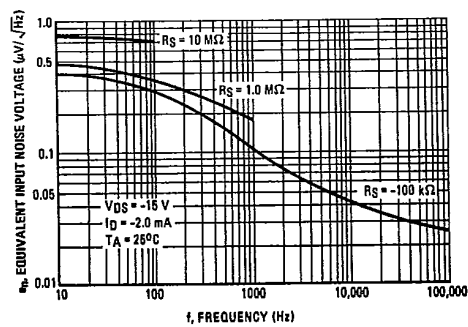


FIGURE 6 - EQUIVALENT INPUT NOISE VOLTAGE



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3N157, 3N158

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SWITCHING CHARACTERISTICS
($T_A = 25^\circ\text{C}$)

FIGURE 7 – TURN-ON DELAY TIME

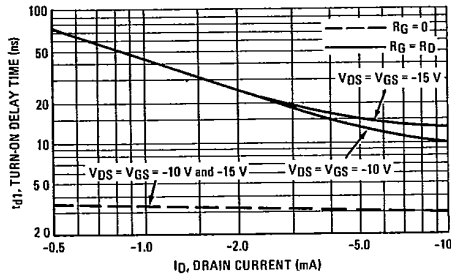


FIGURE 8 – RISE TIME

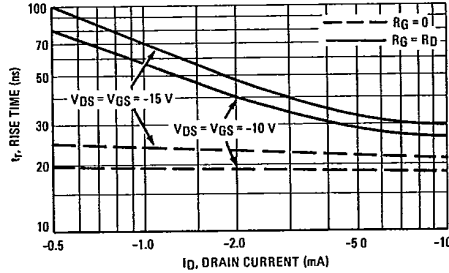


FIGURE 9 – TURN-OFF DELAY TIME

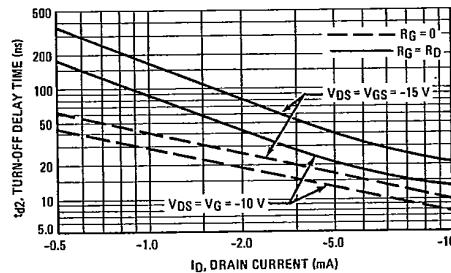


FIGURE 10 – FALL TIME

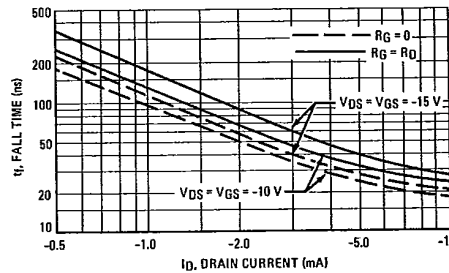


FIGURE 11 – SWITCHING CIRCUIT and WAVEFORMS

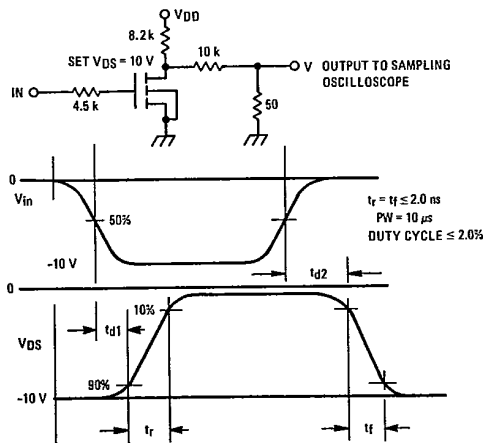
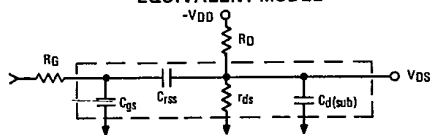


FIGURE 12 – SWITCHING CIRCUIT with MOSFET EQUIVALENT MODEL



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 ($C_{GS} \cdot C_{RGS} \cdot C_{RGS}$) has no charge. The drain voltage is at V_{DD} and thus the feedback capacitance (C_{RGS}) 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_{RGS} must be discharged to $V_{GS} \cdot V_{D(on)}$ 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 r_{ds} . 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 voltage (V_{GS}). As C_{GS} becomes charged V_{GS} is approaching V_{in} and r_{ds} decreases (see Figure 5) and since C_{RGS} 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_{RGS} 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_{RGS} 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.

