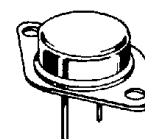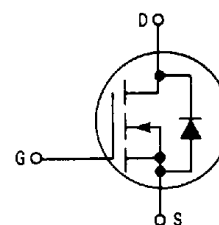**MOTOROLA**
■ SEMICONDUCTOR ■
TECHNICAL DATA

Designer's Data Sheet

Power Field Effect Transistor

N-Channel Enhancement-Mode Silicon Gate

This TMOS Power FET is designed for high speed power switching applications such as switching regulators, converters, solenoid and relay drivers.

- Silicon Gate for Fast Switching Speeds — Switching Times Specified at 100°C
- Designer's Data — I_{DSS}, $V_{DS(on)}$, $V_{GS(th)}$ and SOA Specified at Elevated Temperature
- Rugged — SOA is Power Dissipation Limited
- Source-to-Drain Diode Characterized for Use With Inductive Loads

MTM40N20

TMOS POWER FET
40 AMPERES
$R_{DS(on)}$ = 0.08 OHM
200 VOLTS

3

CASE 197A-03
TO-204AE

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	200	Vdc
Drain-Gate Voltage (R_{GS} = 1 MΩ)	V_{DGR}	200	Vdc
Gate-Source Voltage Continuous Non-repetitive ($t_p \leqslant 50 \mu s$)	V_{GS} V_{GSM}	± 20 ± 40	Vdc Vpk
Drain Current — Continuous — Pulsed	I_D I_{DM}	40 200	Adc
Total Power Dissipation @ T_C = 25°C Derate above 25°C	P_D	250 2	Watts W/°C
Operating and Storage Temperature Range	T_J, T_{stg}	– 65 to 150	°C

THERMAL CHARACTERISTICS

Thermal Resistance — Junction to Case — Junction to Ambient	$R_{\theta JC}$ $R_{\theta JA}$	0.5 30	°C/W
Maximum Lead Temperature for Soldering Purposes, 1/8" from case for 5 seconds	T_L	300	°C

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 0.25 mA) MTM40N20		$V_{(BR)DSS}$	200	—	Vdc
Zero Gate Voltage Drain Current (V_{DS} = Rated V_{DSS}, V_{GS} = 0) (V_{DS} = Rated V_{DSS}, V_{GS} = 0, T_J = 125°C)		I_{DSS}	— —	10 100	μAdc
Gate-Body Leakage Current, Forward (V_{GSF} = 20 Vdc, V_{DS} = 0)		I_{GSSF}	—	100	nAdc
Gate-Body Leakage Current, Reverse (V_{GSR} = 20 Vdc, V_{DS} = 0)		I_{GSSR}	—	100	nAdc

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
ON CHARACTERISTICS*				
Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 1 mA) T_J = 100°C	$V_{GS(th)}$	2 1.5	4.5 4	Vdc
Static Drain-Source On-Resistance (V_{GS} = 10 Vdc, I_D = 20 Adc)	$R_{DS(on)}$	—	0.08	Ohm
Drain-Source On-Voltage (V_{GS} = 10 V) (I_D = 40 Adc) (I_D = 20 Adc, T_J = 100°C)	$V_{DS(on)}$	— —	3.8 3.2	Vdc
Forward Transconductance (V_{DS} = 15 V, I_D = 20 A)	g_{FS}	10	—	mhos
DYNAMIC CHARACTERISTICS				
Input Capacitance	C_{iss}	—	5500	pF
Output Capacitance	C_{oss}	—	1500	
Reverse Transfer Capacitance	C_{rss}	—	500	
SWITCHING CHARACTERISTICS* (T_J = 100°C)				
Turn-On Delay Time	$t_{d(on)}$	—	60	ns
Rise Time	t_r	—	300	
Turn-Off Delay Time	$t_{d(off)}$	—	400	
Fall Time	t_f	—	250	
Total Gate Charge	Q_g	85 (Typ)	95	nC
Gate-Source Charge	Q_{gs}	45 (Typ)	—	
Gate-Drain Charge	Q_{gd}	40 (Typ)	—	
SOURCE DRAIN DIODE CHARACTERISTICS*				
Forward On-Voltage	V_{SD}	2.0 (Typ)	2.5	Vdc
Forward Turn-On Time	t_{on}	Limited by stray inductance		
Reverse Recovery Time	t_{rr}	200 (Typ)	—	ns
INTERNAL PACKAGE INDUCTANCE				
Internal Drain Inductance (Measured from the contact screw on the header closer to the source pin and the center of the die)	L_d	5 (Typ)	—	nH
Internal Source Inductance (Measured from the source pin, 0.25″ from the package to the source bond pad)	L_s	12.5 (Typ)	—	

Dynamic Characteristics test conditions: (V_{DS} = 25 V, V_{GS} = 0, f = 1 MHz)

Switching Characteristics test conditions: (V_{DD} = 25 V, I_D = 0.5 Rated I_D, R_{gen} = 50 ohms) See Figures 13 and 14

Gate Charge test conditions: (V_{DS} = 0.8 Rated V_{DSS}, I_D = Rated I_D, V_{GS} = 10 V) See Figure 12

Source Drain Diode test conditions: (I_S = Rated I_D, V_{GS} = 0)

*Pulse Test. Pulse Width ≤ 300 μs, Duty Cycle ≤ 2%

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MOTOROLA TMOS POWER MOSFET DATA

MOTOROLA SC (XSTRS/R F)   68E D ■ 6367254 0098610 941 ■MOT6

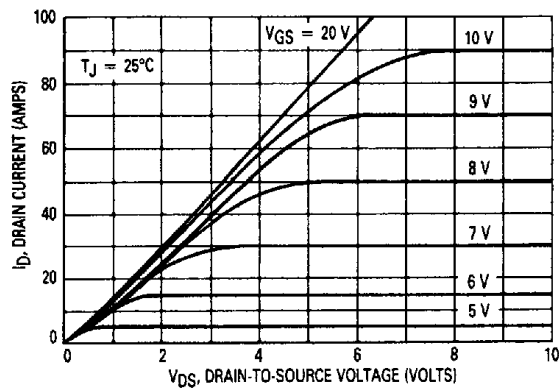## TYPICAL ELECTRICAL CHARACTERISTICS

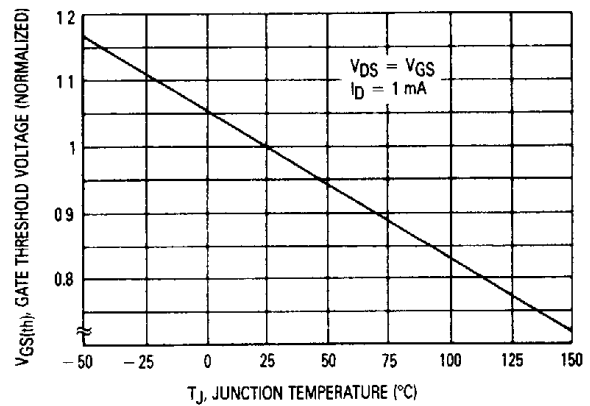
Figure 1. On-Region Characteristics

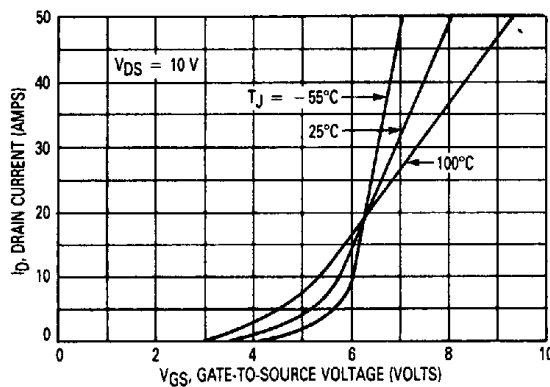Figure 2. Gate-Threshold Voltage Variation
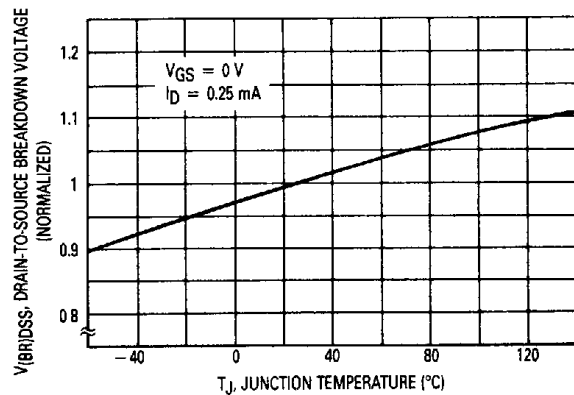With Temperature

Figure 3. Transfer Characteristics

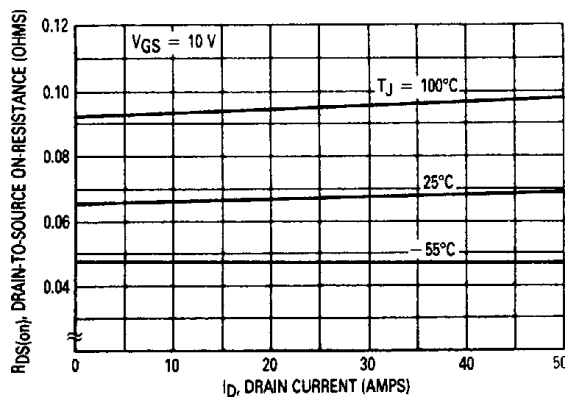Figure 4. Breakdown Voltage Variation
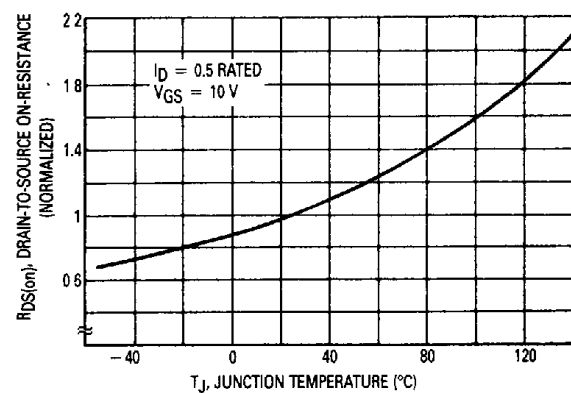With Temperature

Figure 5. On-Resistance versus Drain Current

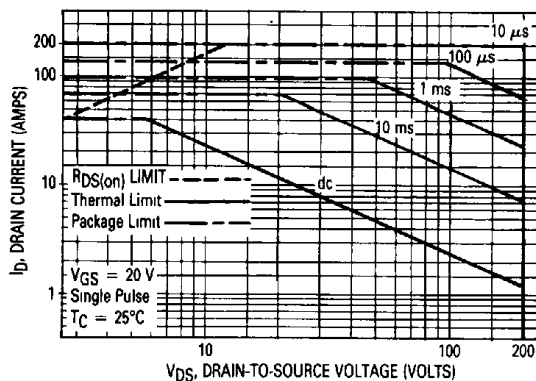Figure 6. On-Resistance Variation
With Temperature

MOTOROLA TMOS POWER MOSFET DATA

SAFE OPERATING AREA INFORMATION

Figure 7. Maximum Rated Forward Biased
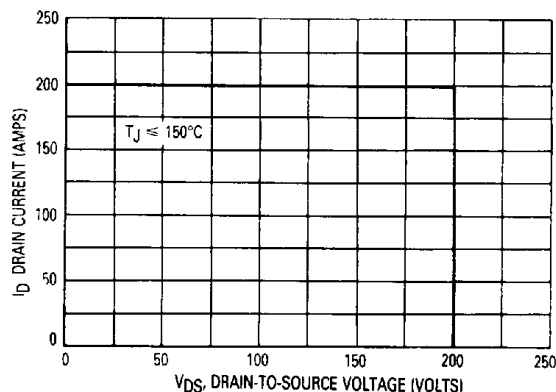Safe Operating Area

Figure 8. Maximum Rated Switching
Safe Operating Area

FORWARD BIASED SAFE OPERATING AREA

The FBSOA curves define the maximum drain-to-source voltage and drain current that a device can safely handle when it is forward biased, or when it is on, or being turned on. Because these curves include the limitations of simultaneous high voltage and high current, up to the rating of the device, they are especially useful to designers of linear systems. The curves are based on a case temperature of 25°C and a maximum junction temperature of 150°C. Limitations for repetitive pulses at various case temperatures can be determined by using the thermal response curves. Motorola Application Note, AN569, "Transient Thermal Resistance-General Data and Its Use" provides detailed instructions.

SWITCHING SAFE OPERATING AREA

The switching safe operating area (SOA) of Figure 8 is the boundary that the load line may traverse without incurring damage to the MOSFET. The fundamental limits are the peak current, I_{DM} and the breakdown voltage, $V_{(BR)DSS}$. The switching SOA shown in Figure 8 is applicable for both turn-on and turn-off of the devices for switching times less than one microsecond.

The power averaged over a complete switching cycle must be less than:
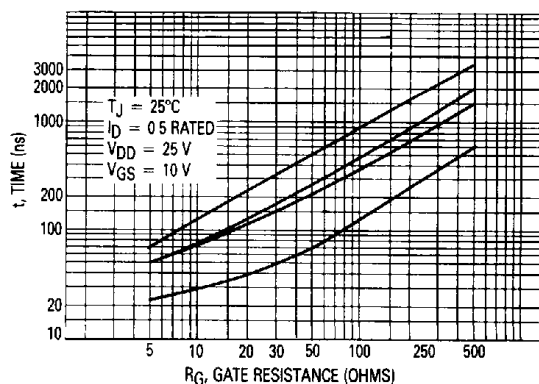
$$\frac{T_{J(max)} - T_C}{R_{\theta JC}}$$

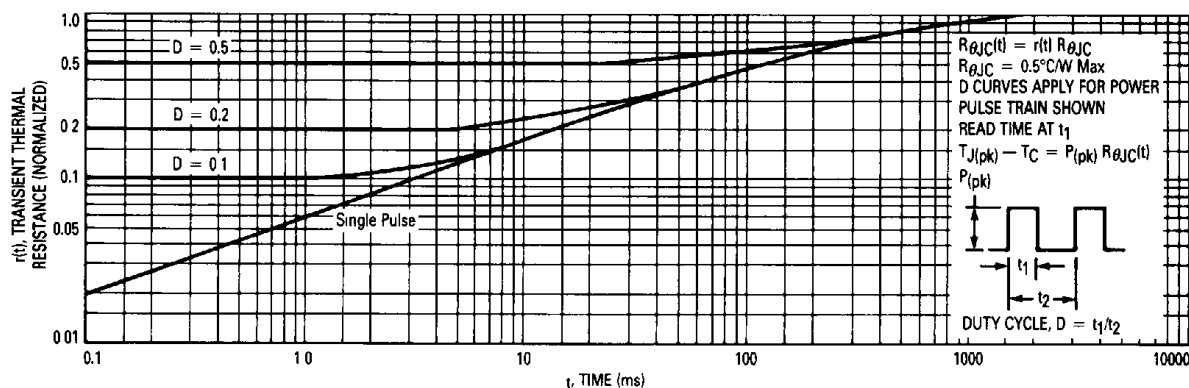Figure 9. Resistive Switching Time
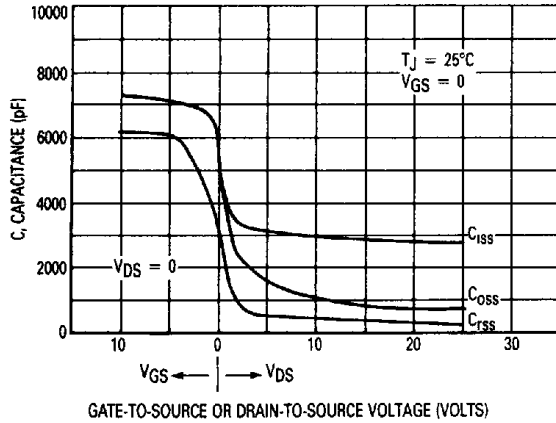Variation versus Gate Resistance

Figure 10. Thermal Response

MOTOROLA TMOS POWER MOSFET DATA
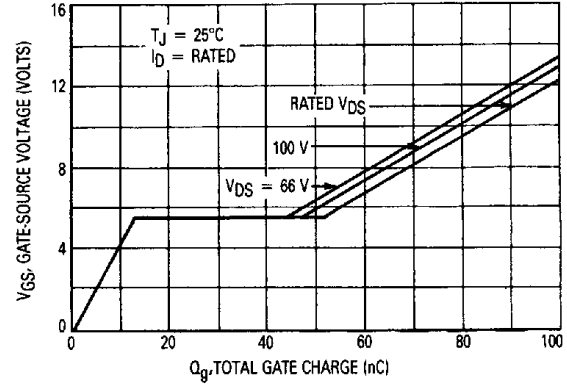
Figure 11. Capacitance Variation

Figure 12. Gate Charge versus Gate-to-Source Voltage
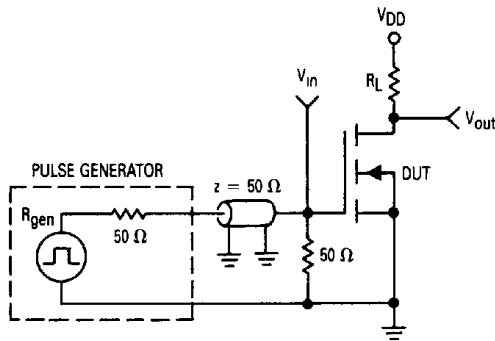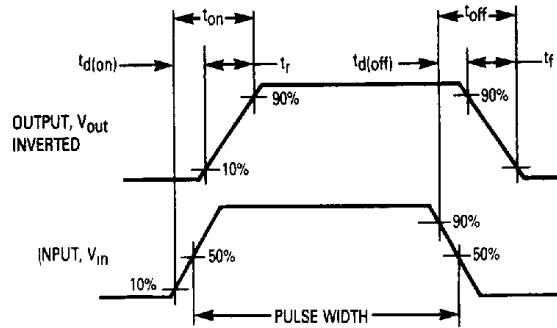
RESISTIVE SWITCHING

Figure 13. Switching Test Circuit

Figure 14. Switching Waveforms

MOTOROLA TMOS POWER MOSFET DATA