MOTOROLA
■ SEMICONDUCTOR
TECHNICAL DATA

3

Designer's Data Sheet
Power Field Effect Transistor
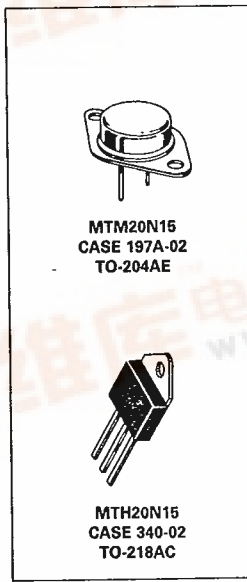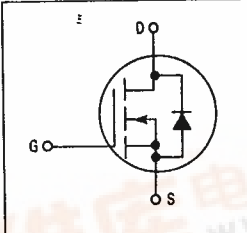## N-Channel Enhancement-Mode
Silicon Gate TMOS

These TMOS Power FETs are 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

| MTH20N15 |
| MTM20N15 |

TMOS POWER FETs
20 AMPERES
$r_{DS(on)}$ = 0.12 OHM
150 VOLTS

MTM20N15
CASE 197A-02
TO-204AE

MTH20N15
CASE 340-02
TO-218AC

MAXIMUM RATINGS

Rating	Symbol	MTH or MTM 20N15	Unit
Drain-Source Voltage	V_{DSS}	150	Vdc
Drain-Gate Voltage (R_{GS} = 1 MΩ)	V_{DGR}	150	Vdc
Gate-Source Voltage Continuous Non-repetitive ($t_p \leq 50\ \mu s$)	V_{GS} V_{GSM}	±20 ±40	Vdc Vpk
Drain Current — Continuous — Pulsed	I_D I_{DM}	20 100	Adc
Total Power Dissipation @ T_C = 25°C Derate above 25°C	P_D	150 1.2	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	$R_{\theta JC}$ $R_{\theta JA}$	0.83 30	°C/W
Maximum Lead Temperature for Soldering Purposes, 1/8″ from case for 5 seconds	T_L	275	°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) MTH20N15, MTM20N15	$V_{(BR)DSS}$	150	—	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)

Designer's Data for "Worst Case" Conditions — The Designer's Data Sheet permits the design of most circuits entirely from the information presented. Limit curves — representing boundaries on device characteristics — are given to facilitate "worst case" design.

MOTOROLA TMOS POWER MOSFET DATA

MTH/MTM20N15

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, $I_D = 10$ Adc)		$r_{DS(on)}$	—	0.12	Ohm
Drain-Source On-Voltage ($V_{GS} = 10$ V) ($I_D = 20$ Adc) ($I_D = 10$ Adc, $T_J = 100°C$)		$V_{DS(on)}$	— —	3 2.4	Vdc
Forward Transconductance ($V_{DS} = 10$ V, $I_D = 10$ A)		g_{FS}	2	—	mhos
DYNAMIC CHARACTERISTICS					
Input Capacitance	($V_{DS} = 25$ V, $V_{GS} = 0$, $f = 1$ MHz) See Figure 11	C_{iss}	—	2000	pF
Output Capacitance		C_{oss}	—	700	
Reverse Transfer Capacitance		C_{rss}	—	200	
SWITCHING CHARACTERISTICS* ($T_J = 100°C$)					
Turn-On Delay Time	($V_{DD} = 25$ V, $I_D = 0.5$ Rated I_D $R_{gen} = 50$ ohms) See Figures 9, 13 and 14	$t_{d(on)}$	—	60	ns
Rise Time		t_r	—	300	
Turn-Off Delay Time		$t_{d(off)}$	—	220	
Fall Time		t_f	—	250	
Total Gate Charge	($V_{DS} = 0.8$ Rated V_{DSS}, I_D = Rated I_D, $V_{GS} = 10$ V) See Figure 12	Q_g	60 (Typ)	75	nC
Gate-Source Charge		Q_{gs}	35 (Typ)	—	
Gate-Drain Charge		Q_{gd}	25 (Typ)	—	
SOURCE DRAIN DIODE CHARACTERISTICS*					
Forward On-Voltage	(I_S = Rated I_D $V_{GS} = 0$)	V_{SD}	1.5 (Typ)	2.1	Vdc
Forward Turn-On Time		t_{on}	Limited by stray inductance		
Reverse Recovery Time		t_{rr}	450 (Typ)	—	ns
INTERNAL PACKAGE INDUCTANCE (TO-204)					
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)	—	
INTERNAL PACKAGE INDUCTANCE (TO-218)					
Internal Drain Inductance (Measured from screw on tab to center of die) (Measured from the drain lead 0.25" from package to center of die)		L_d	4 (Typ) 5 (Typ)	— —	nH
Internal Source Inductance (Measured from the source lead 0.25" from package to center of die)		L_s	10 (Typ)	—	

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

MOTOROLA TMOS POWER MOSFET DATA
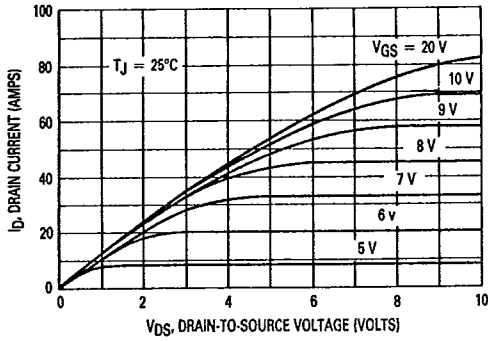
TYPICAL ELECTRICAL CHARACTERISTICS

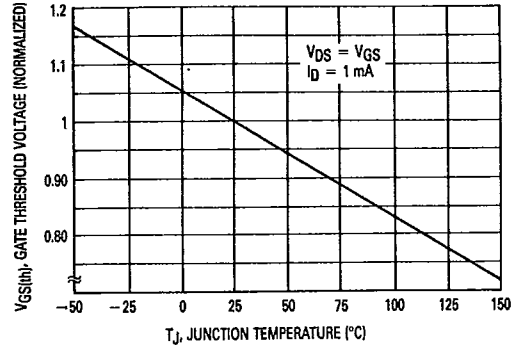**Figure 1. On-Region Characteristics**

**Figure 2. Gate-Threshold Voltage Variation
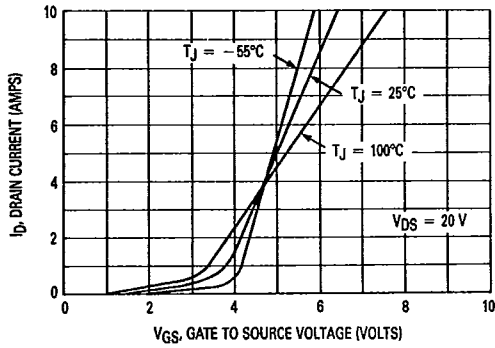With Temperature**
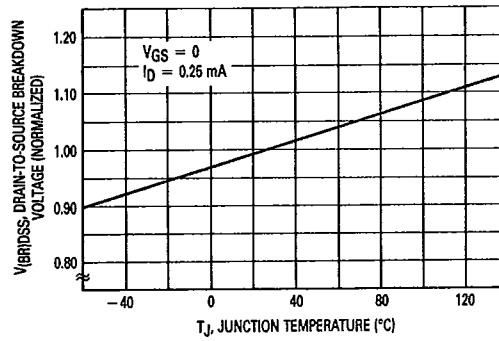

Figure 3. Transfer Characteristics

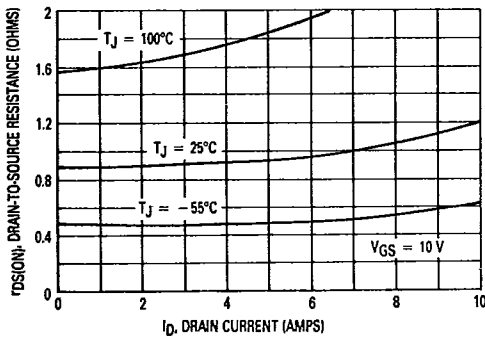**Figure 4. Breakdown Voltage Variation
With Temperature**

Figure 5. On-Resistance versus Drain Current
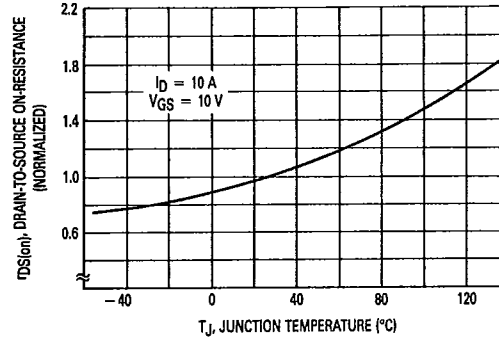

**Figure 6. On-Resistance Variation
With Temperature**

MOTOROLA TMOS POWER MOSFET DATA
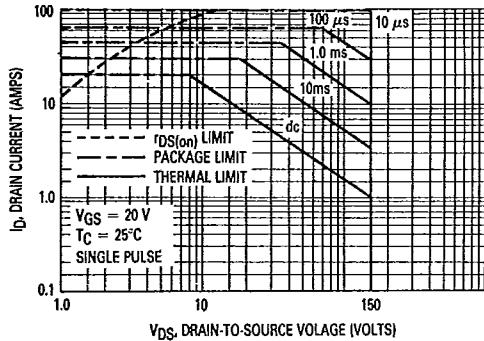
SAFE OPERATING AREA INFORMATION

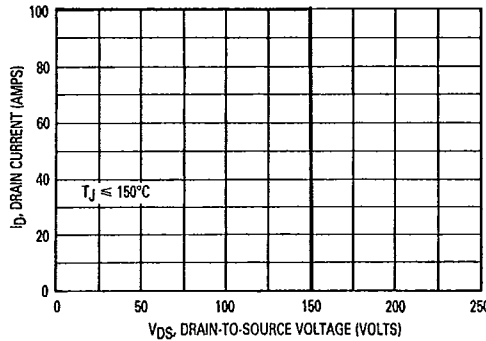Figure 7. Maximum Rated Forward Biased
Safe Operating Area

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:

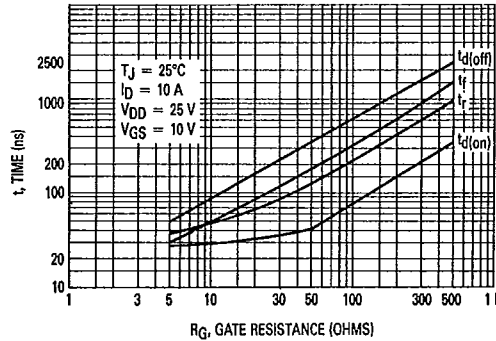$$\frac{T_{J(max)} - T_C}{R_{\theta JC}}$$

Figure 9. Resistive Switching Time
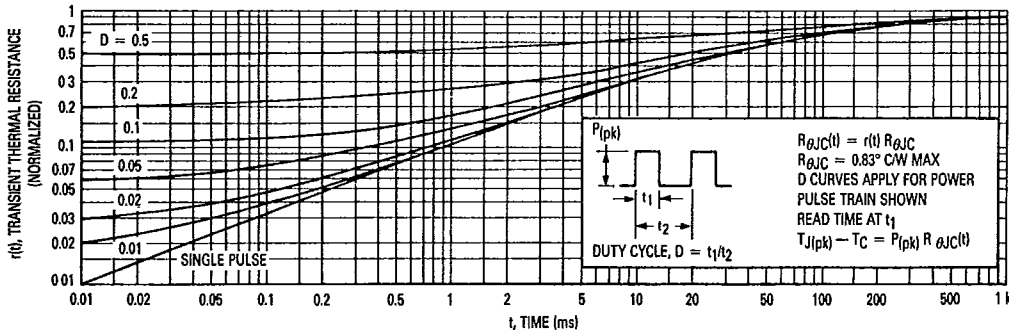Variation versus Gate Resistance
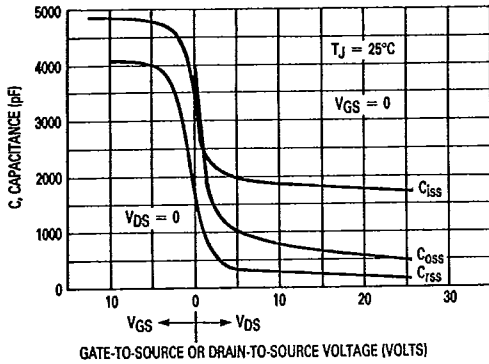

Figure 10. Thermal Response
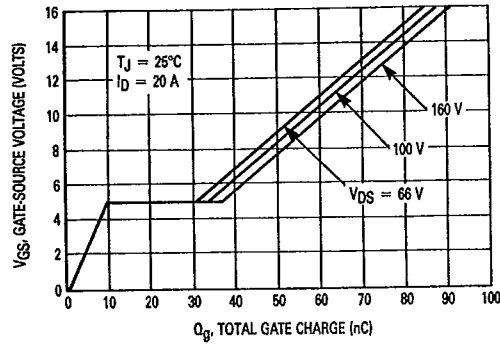
Figure 11. Capacitance Variation

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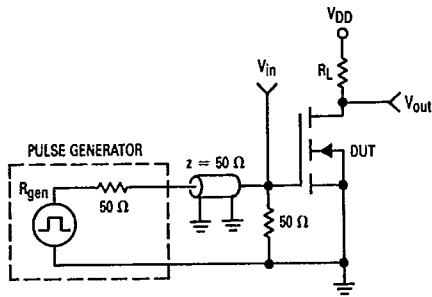
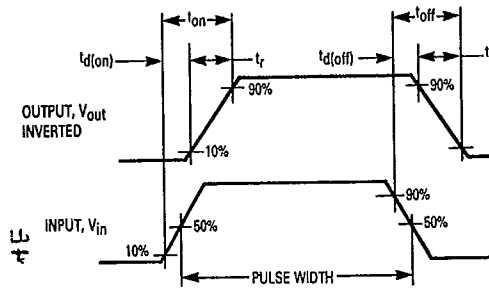## RESISTIVE SWITCHING

Figure 13. Switching Test Circuit

Figure 14. Switching Waveforms

OUTLINE DIMENSIONS

CASE 197A-02
TO-204AE

STYLE 3:
PIN 1. GATE
2. SOURCE
CASE. DRAIN

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	38.36	39.37	1.510	1.550
B	19.31	21.08	0.760	0.830
C	6.35	8.25	0.250	0.325
D	1.45	1.60	0.057	0.063
E	1.53	1.77	0.060	0.070
F	30.15 BSC		1.187 BSC	
G	10.92 BSC		0.430 BSC	
H	5.46 BSC		0.215 BSC	
J	16.89 BSC		0.665 BSC	
K	11.18	12.19	0.440	0.480
Q	3.84	4.19	0.151	0.165
R	25.15	26.67	0.990	1.050
U	3.84	4.19	0.151	0.165

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI
Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

CASE 340-02
TO-218AC

STYLE 2:
PIN 1. GATE
2. DRAIN
3. SOURCE
4. DRAIN

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	20.32	21.08	0.800	0.830
B	15.49	15.90	0.610	0.626
C	4.19	5.08	0.165	0.200
D	1.02	1.65	0.040	0.065
E	1.35	1.65	0.053	0.065
G	5.21	5.72	0.205	0.225
H	2.65	2.94	0.104	0.116
J	0.51	0.71	0.020	0.028
K	12.70	15.49	0.500	0.610
L	15.88	16.51	0.625	0.650
N	12.19	12.70	0.480	0.500
Q	4.04	4.22	0.159	0.166

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI
Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

MOTOROLA TMOS POWER MOSFET DATA