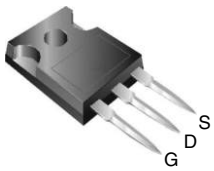
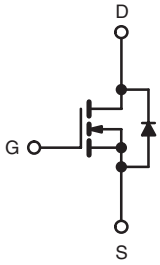
# Power MOSFET

| PRODUCT SUMMARY | | |
|---|---|---|
| $V_{DS}$ (V) | 600 | |
| $R_{DS(on)}$ (Ω) | $V_{GS}$ = 10 V | 0.40 |
| $Q_g$ (Max.) (nC) | 120 | |
| $Q_{gs}$ (nC) | 29 | |
| $Q_{gd}$ (nC) | 48 | |
| Configuration | Single | |

TO-247




N-Channel MOSFET

## FEATURES

- Ultra Low Gate Charge
- Reduced Gate Drive Requirement
- Enhanced 30 V $V_{GS}$ Rating
- Reduced $C_{iss}$, $C_{oss}$, $C_{rss}$
- Isolated Central Mounting Hole
- Dynamic dV/dt Rated
- Repetitive Avalanche Rated
- Lead (Pb)-free Available

Available
RoHS* COMPLIANT

## DESCRIPTION

This new series of low charge Power MOSFETs achieve significantly lower gate charge over conventional MOSFETs. Utilizing advanced Power MOSFETs technology the device improvements allow for reduced gate drive requirements, faster switching speeds and increased total system savings. These device improvements combined with the proven ruggedness and reliability of Power MOSFETs offer the designer a new standart in power transistors for switching applications.
The TO-247 package is preferred for commercial-industrial applications where higher power levels preclude the use of TO-220 devices. The TO-247 is similar but superior to the earlier TO-218 package because of its isolated mounting hole.

| ORDERING INFORMATION | |
|---|---|
| Package | TO-247 |
| Lead (Pb)-free | IRFPC60LCPbF |
| | SiHFPC60LC-E3 |
| SnPb | IRFPC60LC |
| | SiHFPC60LC |

**ABSOLUTE MAXIMUM RATINGS** $T_C$ = 25 °C, unless otherwise noted

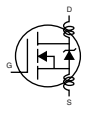
| PARAMETER | | | SYMBOL | LIMIT | UNIT |
|---|---|---|---|---|---|
| Drain-Source Voltage | | | $V_{DS}$ | 600 | V |
| Gate-Source Voltage | | | $V_{GS}$ | ± 30 | |
| Continuous Drain Current | $V_{GS}$ at 10 V | $T_C$ = 25 °C | $I_D$ | 16 | A |
| | | $T_C$ = 100 °C | | 10 | |
| Pulsed Drain Current[a] | | | $I_{DM}$ | 64 | |
| Linear Derating Factor | | | | 2.2 | W/°C |
| Single Pulse Avalanche Energy[b] | | | $E_{AS}$ | 1000 | mJ |
| Repetitive Avalanche Current[a] | | | $I_{AR}$ | 16 | A |
| Repetitive Avalanche Energy[a] | | | $E_{AR}$ | 28 | mJ |
| Maximum Power Dissipation | $T_C$ = 25 °C | | $P_D$ | 280 | W |
| Peak Diode Recovery dV/dt[c] | | | dV/dt | 3.0 | V/ns |
| Operating Junction and Storage Temperature Range | | | $T_J$, $T_{stg}$ | - 55 to + 150 | °C |
| Soldering Recommendations (Peak Temperature) | for 10 s | | | 300[d] | |
| Mounting Torque | 6-32 or M3 screw | | | 10 | lbf · in |
| | | | | 1.1 | N · m |

**Notes**

a. Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11).
b. $V_{DD}$ = 25 V, starting $T_J$ = 25 °C, L = 7.2 µH, $R_G$ = 25 Ω, $I_{AS}$ = 16 A (see fig. 12).
c. $I_{SD} \leq$ 16 A, dI/dt ≤ 140 A/µs, $V_{DD} \leq V_{DS}$, $T_J \leq$ 150 °C.
d. 1.6 mm from case.

* Pb containing terminations are not RoHS compliant, exemptions may apply

| THERMAL RESISTANCE RATINGS | | | | |
|---|---|---|---|---|
| **PARAMETER** | **SYMBOL** | **TYP.** | **MAX.** | **UNIT** |
| Maximum Junction-to-Ambient | $R_{thJA}$ | - | 40 | °C/W |
| Case-to-Sink, Flat, Greased Surface | $R_{thCS}$ | 0.24 | - | |
| Maximum Junction-to-Case (Drain) | $R_{thJC}$ | - | 0.45 | |

| **SPECIFICATIONS** $T_J$ = 25 °C, unless otherwise noted | | | | | | | |
|---|---|---|---|---|---|---|---|
| **PARAMETER** | **SYMBOL** | **TEST CONDITIONS** | | **MIN.** | **TYP.** | **MAX.** | **UNIT** |
| **Static** | | | | | | | |
| Drain-Source Breakdown Voltage | $V_{DS}$ | $V_{GS}$ = 0 V, $I_D$ = 250 µA | | 600 | - | - | V |
| $V_{DS}$ Temperature Coefficient | $\Delta V_{DS}/T_J$ | Reference to 25 °C, $I_D$ = 1 mA | | - | 0.63 | - | V/°C |
| Gate-Source Threshold Voltage | $V_{GS(th)}$ | $V_{DS}$ = $V_{GS}$, $I_D$ = 250 µA | | 2.0 | - | 4.0 | V |
| Gate-Source Leakage | $I_{GSS}$ | $V_{GS}$ = ± 20 V | | - | - | ± 100 | nA |
| Zero Gate Voltage Drain Current | $I_{DSS}$ | $V_{DS}$ = 600 V, $V_{GS}$ = 0 V | | - | - | 25 | µA |
| | | $V_{DS}$ = 480 V, $V_{GS}$ = 0 V, $T_J$ = 125 °C | | - | - | 250 | |
| Drain-Source On-State Resistance | $R_{DS(on)}$ | $V_{GS}$ = 10 V | $I_D$ = 9.6 A[b] | - | - | 0.40 | Ω |
| Forward Transconductance | $g_{fs}$ | $V_{DS}$ = 50 V, $I_D$ = 9.6 A | | 11 | - | - | S |
| **Dynamic** | | | | | | | |
| Input Capacitance | $C_{iss}$ | $V_{GS}$ = 0 V, $V_{DS}$ = 25 V, f = 1.0 MHz, see fig. 5 | | - | 3500 | - | pF |
| Output Capacitance | $C_{oss}$ | | | - | 400 | - | |
| Reverse Transfer Capacitance | $C_{rss}$ | | | - | 39 | - | |
| Total Gate Charge | $Q_g$ | $V_{GS}$ = 10 V | $I_D$ = 16 A, $V_{DS}$ = 360 V, see fig. 6 and 13[b] | - | - | 120 | nC |
| Gate-Source Charge | $Q_{gs}$ | | | - | - | 29 | |
| Gate-Drain Charge | $Q_{gd}$ | | | - | - | 48 | |
| Turn-On Delay Time | $t_{d(on)}$ | $V_{DD}$ = 300 V, $I_D$ = 16 A, $R_G$ = 4.3 Ω, $R_D$ = 18 Ω, see fig. 10[b] | | - | 17 | - | ns |
| Rise Time | $t_r$ | | | - | 57 | - | |
| Turn-Off Delay Time | $t_{d(off)}$ | | | - | 43 | - | |
| Fall Time | $t_f$ | | | - | 38 | - | |
| Internal Drain Inductance | $L_D$ | Between lead, 6 mm (0.25") from package and center of die contact  | | - | 5.0 | - | nH |
| Internal Source Inductance | $L_S$ | | | - | 13 | - | |
| **Drain-Source Body Diode Characteristics** | | | | | | | |
| Continuous Source-Drain Diode Current | $I_S$ | MOSFET symbol showing the integral reverse p - n junction diode  | | - | - | 16 | A |
| Pulsed Diode Forward Current[a] | $I_{SM}$ | | | - | - | 64 | |
| Body Diode Voltage | $V_{SD}$ | $T_J$ = 25 °C, $I_S$ = 16 A, $V_{GS}$ = 0 V[b] | | - | - | 1.8 | V |
| Body Diode Reverse Recovery Time | $t_{rr}$ | $T_J$ = 25 °C, $I_F$ = 16 A, dI/dt = 100 A/µs | | - | 650 | 980 | ns |
| Body Diode Reverse Recovery Charge | $Q_{rr}$ | | | - | 6.0 | 9.0 | µC |
| Forward Turn-On Time | $t_{on}$ | Intrinsic turn-on time is negligible (turn-on is dominated by $L_S$ and $L_D$) | | | | | |

**Notes**

a. Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11).

b. Pulse width ≤ 300 µs; duty cycle ≤ 2 %.

**TYPICAL CHARACTERISTICS** 25 °C, unless otherwise noted

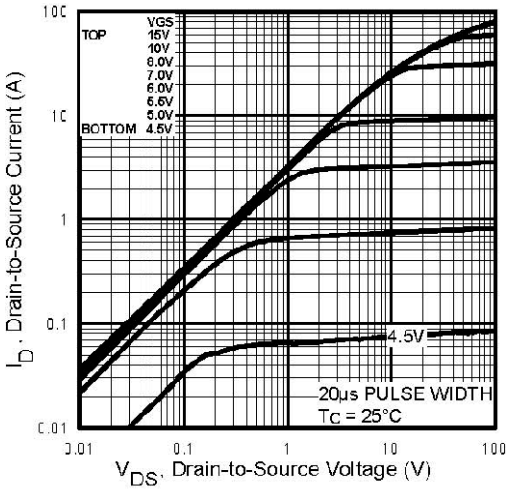



**Fig. 1 - Typical Output Characteristics, $T_C$ = 25 °C**

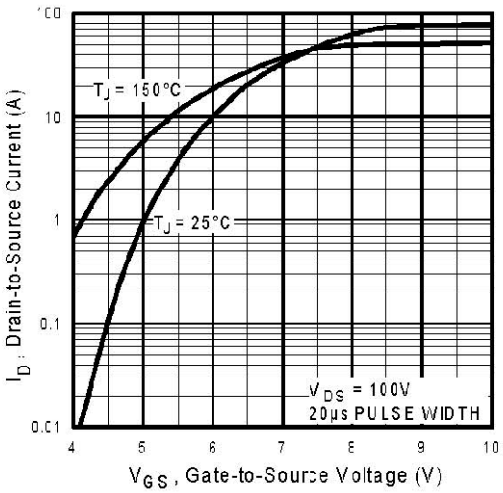



**Fig. 3 - Typical Transfer Characteristics**

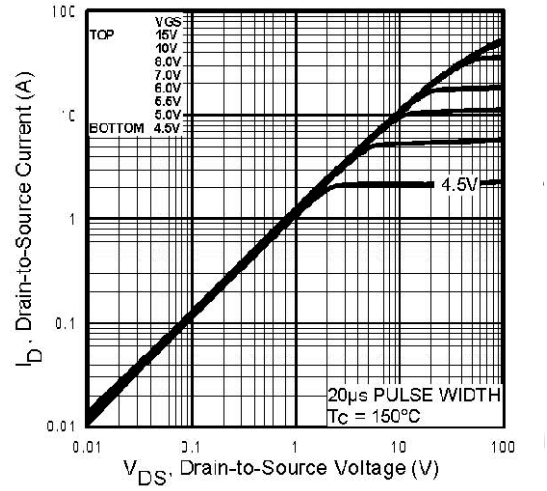



**Fig. 2 -Typical Output Characteristics, $T_C$ = 150 °C**

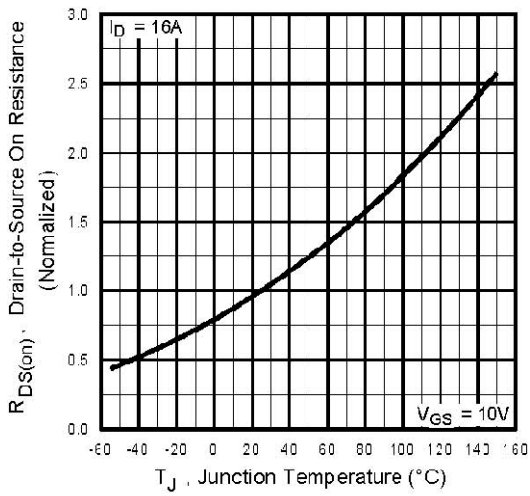



**Fig. 4 - Normalized On-Resistance vs. Temperature**

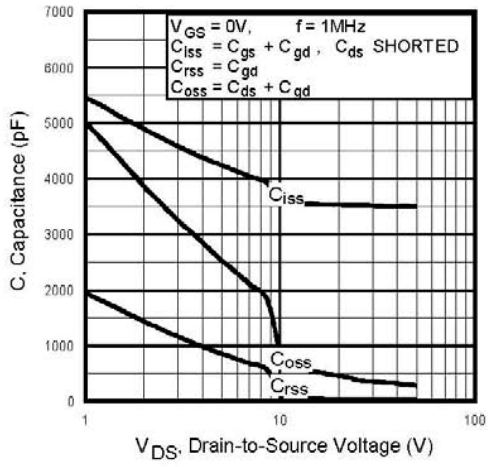



**Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage**

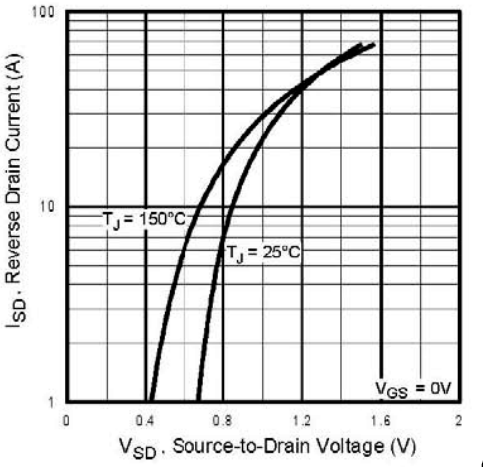



**Fig. 7 - Typical Source-Drain Diode Forward Voltage**

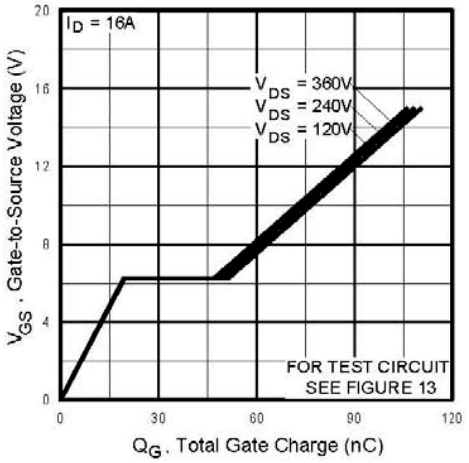



**Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage**

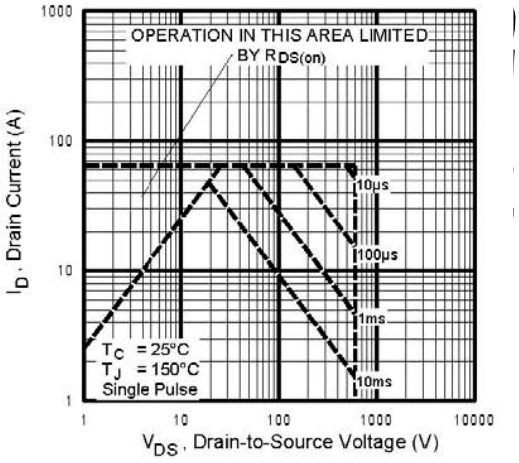



**Fig. 8 - Maximum Safe Operating Area**

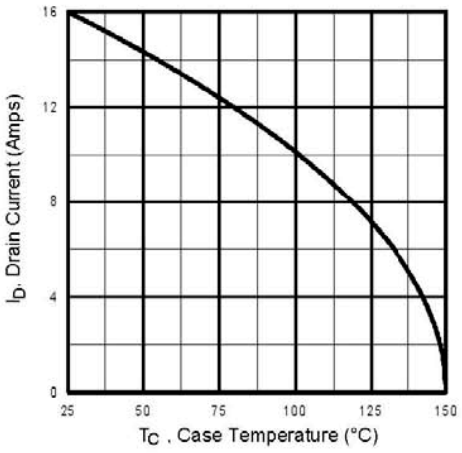



**Fig. 9 - Maximum Drain Current vs. Case Temperature**

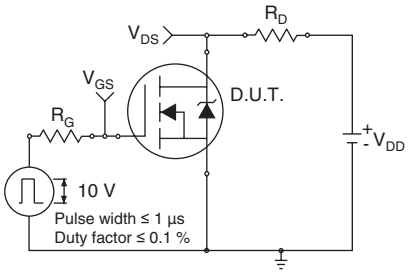



**Fig. 10a - Switching Time Test Circuit**

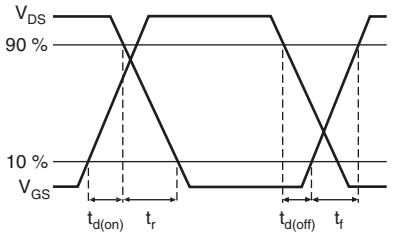



**Fig. 10b - Switching Time Waveforms**

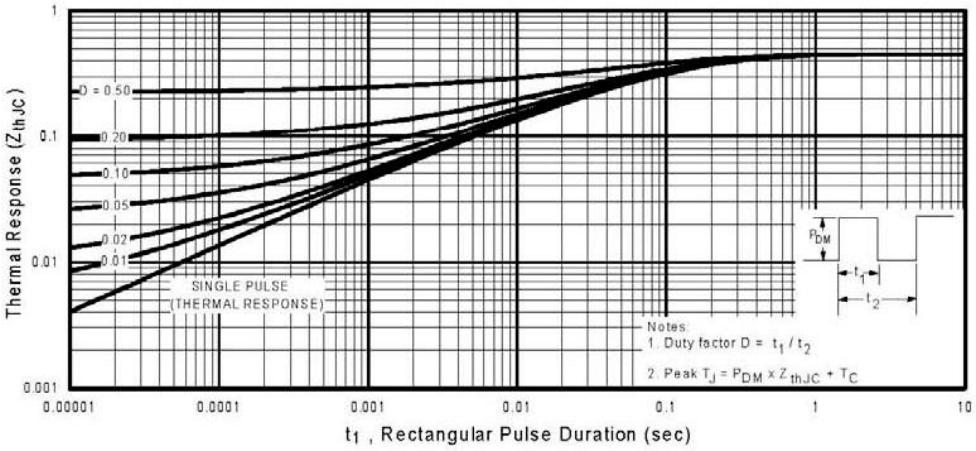



**Fig. 11 - Maximum Effective Transient Thermal Impedance, Junction-to-Case**

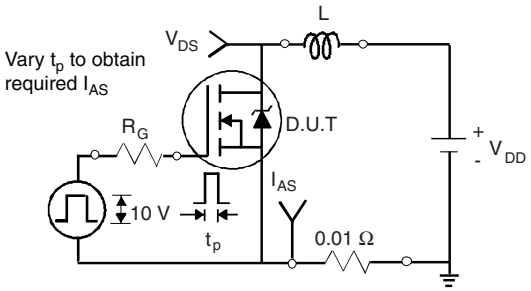



**Fig. 12a - Unclamped Inductive Test Circuit**

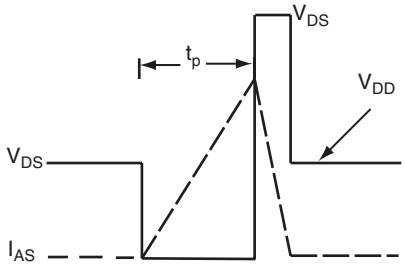



**Fig. 12b - Unclamped Inductive Waveforms**

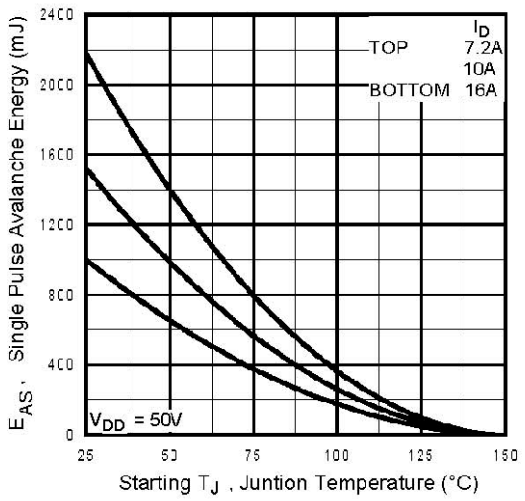



**Fig. 12c - Maximum Avalanche Energy vs. Drain Current**

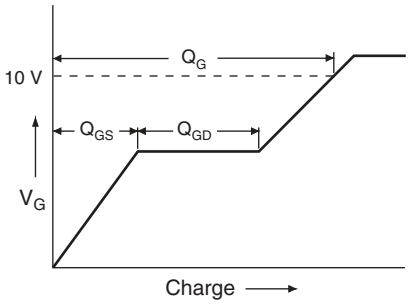



**Fig. 13a - Basic Gate Charge Waveform**

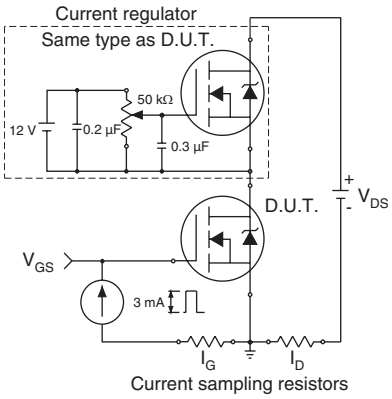
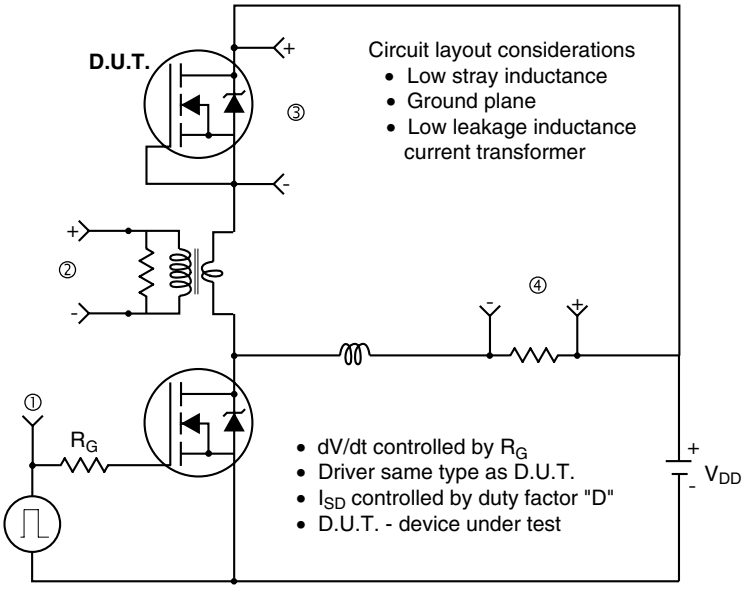
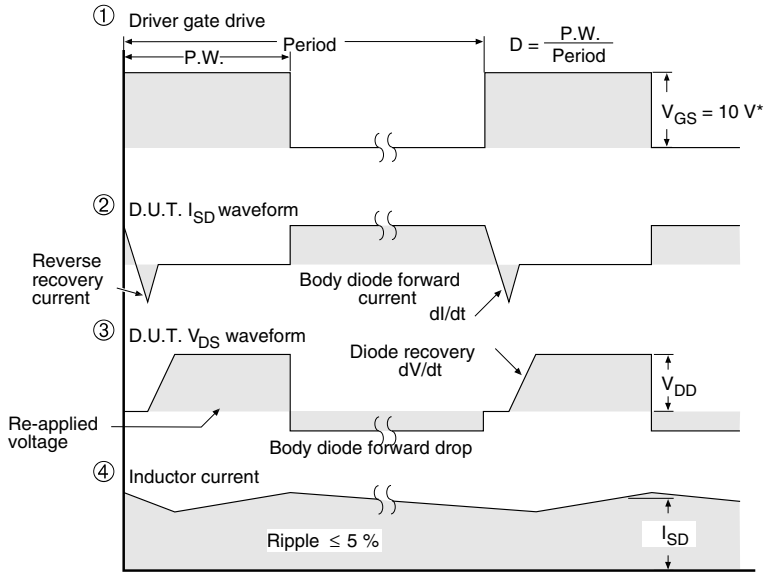



**Fig. 13b - Gate Charge Test**

## Peak Diode Recovery dV/dt Test Circuit




* $V_{GS}$ = 5 V for logic level devices

**Fig. 14 - For N-Channel**

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