

# Depletion-Mode D2™ Power MOSFETs

'NORMALLY-ON' POWER MOSFET SOLUTIONS FOR DYNAMIC LOAD AND ZERO POWER LOAD SWITCHING APPLICATIONS

OCTOBER 2009

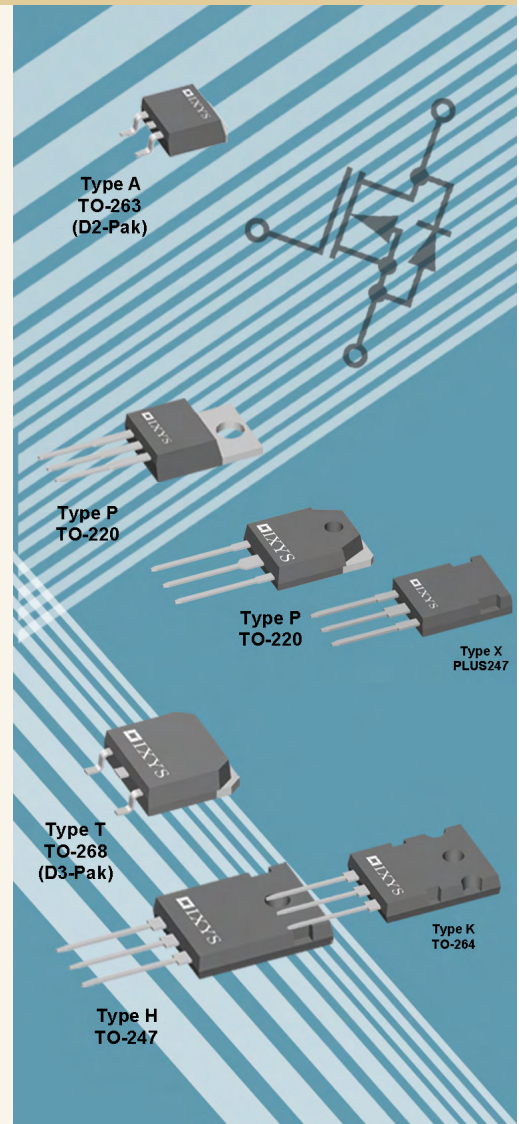
## OVERVIEW

As green energy trends continue to grow in popularity, today's Design Engineers are now looking toward new innovative, energy efficient devices in an effort to reduce overall system power consumption. In response to the growing market demand for more power efficient solutions, IXYS introduces its new Depletion-Mode D2™ MOSFET family. These new devices can be uniquely applied in many diverse applications and are suitable for dynamic load and zero power load switch designs.

IXYS Depletion-Mode D2™ MOSFETs feature unique characteristics, which can not be replicated by its commonly used enhancement-mode counterpart. The fundamental difference between its enhancement-mode counter part lies in its ability to function in a "normally-on" mode at zero voltage gate bias, requiring a negative gate bias to block current. The "normally-on" operational mode of these devices combined with an enhanced linear operating capability allows for an ideal device selection in current sources, current regulators, solid-state relays, level shifting, active loads, start-up circuits, and active power filters.

These new devices are available with blocking voltages between 100V to 1000V, on resistance ( $R_{ds(on)}$ ) as low as 64mOhms (max) and drain current ratings of up to 16 Amperes. They can provide simplified control and reduced line voltage dissipation when used for line interface in off-line applications. Since these devices require no energy or gate voltage for turn-on, high energy efficiency can be achieved through device implementation in zero power "normally-on" load switch applications. With the high degree of current regulation, these devices can also act as active inductors with high dynamic impedance in power filter applications to limit voltage and current noise and spikes. Furthermore these devices can provide active circuit protection to limit the surge of current during short-circuit or overload conditions.

IXYS Depletion-Mode D2™ MOSFETs are a part of IXYS' comprehensive portfolio of power efficient MOSFET devices that are instrumental in achieving energy efficiency by meeting and exceeding electrical and thermal performance demands of today's electronics.



## FEATURES

- "Normally-On" Operation
- Low  $R_{ds(on)}$  and fast switching
- Linear Mode Tolerant

## BENEFITS

- Simplified Control
- High power dissipation. Reduce line power dissipation for high line input
- Ideal for zero power normally-on load switch designs

## APPLICATIONS

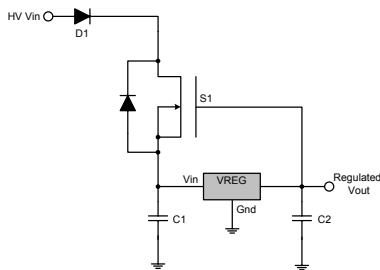
- Current Regulation
- Solid-State Relays
- Level Shifting
- Load Switch
- Active Loads
- Start-up loads
- Power Active filters

# N-Channel Depletion-Mode D2™ Summary Table

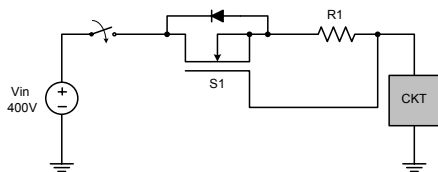
Part Number	Vdss max (V)	Id @ Tc=25°C (A)	Rds(on) @ Tj=25°C (Ω)	VGS (off) max (V)	Ciss typ (pF)	Crss typ (pF)	Qg typ (nC)	Pd (W)	Package Type
IXTH16N10D2	100	16	0.064	-4	5700	940	225	695	TO-247
IXTT16N10D2	100	16	0.064	-4	5700	940	225	695	TO-268
IXTH16N20D2	200	16	0.073	-4	5500	607	208	695	TO-247
IXTT16N20D2	200	16	0.073	-4	5500	607	208	695	TO-268
IXTA08N50D2	500	0.8	4.6	-4	312	11	12.7	60	TO-263
IXTP08N50D2	500	0.8	4.6	-4	312	11	12.7	60	TO-220
IXTY08N50D2	500	0.8	4.6	-4	312	11	12.7	60	TO-252
IXTA1R6N50D2	500	1.6	2.3	-4	645	16.5	23.7	100	TO-263
IXTP1R6N50D2	500	1.6	2.3	-4	645	16.5	23.7	100	TO-220
IXTY1R6N50D2	500	1.6	2.3	-4	645	16.5	23.7	100	TO-252
IXTA3N50D2	500	3	1.5	-4	1070	24	40	125	TO-263
IXTP3N50D2	500	3	1.5	-4	1070	24	40	125	TO-220
IXTA6N50D2	500	6	0.5	-4	2800	64	96	300	TO-263
IXTH6N50D2	500	6	0.5	-4	2800	64	96	300	TO-247
IXTP6N50D2	500	6	0.5	-4	2800	64	96	300	TO-220
IXTH16N50D2	500	16	0.24	-4	5250	130	199	695	TO-247
IXTT16N50D2	500	16	0.24	-4	5250	130	199	695	TO-268
IXTA08N100D2	1000	0.8	21	-4	325	6.5	14.6	60	TO-263
IXTP08N100D2	1000	0.8	21	-4	325	6.5	14.6	60	TO-220
IXTY08N100D2	1000	0.8	21	-4	325	6.5	14.6	60	TO-252
IXTA1R6N100D2	1000	1.6	10	-4.5	645	11	27	100	TO-263
IXTP1R6N100D2	1000	1.6	10	-4.5	645	11	27	100	TO-220
IXTY1R6N100D2	1000	1.6	10	-4.5	645	11	27	100	TO-252
IXTA3N100D2	1000	3	5.5	-4.5	1020	17	37.5	125	TO-263
IXTP3N100D2	1000	3	5.5	-4.5	1020	17	37.5	125	TO-220
IXTA6N100D2	1000	6	2.2	-4.5	2650	41	95	300	TO-263
IXTH6N100D2	1000	6	2.2	-4.5	2650	41	95	300	TO-247
IXTP6N100D2	1000	6	2.2	-4.5	2650	41	95	300	TO-220

## Application Circuits

### High Voltage Protected Regulator

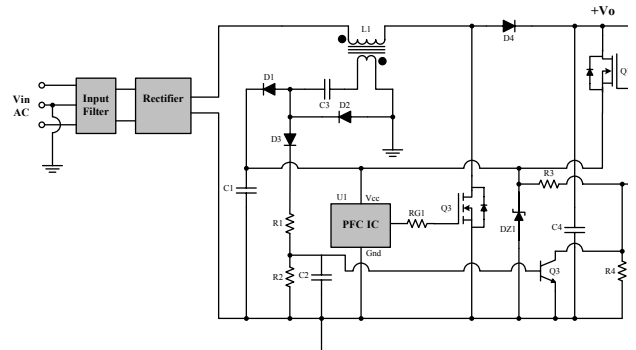


The figure to the left illustrates a high voltage protected regulator using an IXYS depletion-mode D2™ MOSFET to achieve requirements of low transient voltage and low quiescent current. This regulated voltage source is suitable for telecommunication, automotive, and off-line circuits. Applications like CMOS ICs and small circuits require 5V to 15V DC power supply and need protection from fast, high voltage transients and low quiescent current from linear regulator.



### Current Source Protection Circuit

The illustration above portrays a general current surge protection circuit. An IXYS depletion-mode D2™ MOSFET can be incorporated into this circuit to limit the inrush of current associated with motors, capacitive loads, instrumentation, lamps, etc.



### Power Supply Start-up Circuit

The figure above illustrates a section of a power supply that uses a depletion-mode D2 MOSFET (Q1) to kick-start the off-line operation by providing initial power to the PFC IC (U1) through the source of Q1. Q1 provides initial power from the output. R3 and R4 sets up a working point to obtain the minimum required current from Q1. The Zener diode DZ1 limits the voltage across the IC (U1) to +15V. After the start-up, the secondary winding of boost inductor (L1) generates the supply voltage for the IC through D1, D2, and C3; providing sufficient amount of current through D3 and R1 for the base of Q3 that turns-on and clamps the gate of Q1 to ground.