IXYS

Data Book No.91560A October 1991

"S" Series MOSIGBTs

High Short Circuit SOA Insulated Gate Bipolar Transistor

Features

- Guaranteed Short Circuit Capability (SCSOA)
- Optimized for 60Hz to 30kHz Switching
- Guaranteed Maximum Turn-off Energies
- Low Input Capacitances
- MOS Gate Drive Simplicity
- Low On-State Conduction Losses

Description

IGBTs combine the advantages of MOS gated drive simplicity with the high current handling capability of bipolar transistors. The "S" Series are a new class of ultra-rugged IGBTs that can survive overload and accidental short circuit currents for a guaranteed period of time. This allows the design of gating circuits that would detect these fault currents and turn-off the IGBT before device degradation.

The basic cell design characteristics of the MOSIGBT are very similar to power MOSFETs. The drive circuitry required to control up to 75A at 500V to 1000V is basically the same as a power MOSFET with 5000pF of input capacitance. During turn-on of the MOSIGBT, minority carrier injection into the N-base region modulates the body on-resistance to a level 10 to 20 times lower than an equivalently sized MOSFET, resulting in a proportionate 5 to 10 times increase in current handling capability. Minority carrier recombination during turn-off results in a current fall time t_{fi} of 0.5-3.0µs depending upon blocking voltage capability, similar to bipolar devices. Therefore the MOSIGBT is more suitable in low to medium frequency, high current, power switching applications ranging from 60Hz to 30kHz and where low conduction losses are essential.

The IXSH and IXSM family of high voltage MOSIGBT are members of an advanced series of N-Channel, power MOS products, which use HDMOS™, a proprietary vertical DMOS technology developed by IXYS. HDMOS™ is a planar, high density process, which incorporates new techniques to improve operating characteristics and stability at high voltages. This technology, combined with a unique polysilicon gate cell structure, gives the MOSIGBT a peak current capability of two times its 90°C current rating. This advantage makes the MOSIGBT ideal for many industrial and commercial applications in power conversion and motor control

Product Family

V_{CES} (V)	$I_{C25(cont)}$ (A)	$I_{C90(cont)}$ (A)	A[1]		STD		Part Number [1]	Page No.
			$V_{CE(sat)}$ (V)	t_{fi} (µs)	$V_{CE(sat)}$ (V)	t_{fi} (µs)		
1000	70	35	4.0	2.0	3.5	3.0	IXSH35N100/IXSM35N100	5
	50	25	4.0	1.5	3.5	3.0	IXSH25N100/IXSM25N100	9
	34	17	4.0	1.0	3.5	2.0	IXSH17N100/IXSM17N100	13
600	75	40	3.0	0.8	2.5	1.5	IXSH40N60 / IXSM40N60	15
	50	30	3.0	0.8	2.5	1.5	IXSH30N60 / IXSM30N60	19
	40	20	3.0	0.6	2.5	1.0	IXSH20N60 / IXSM20N60	23

IXYS reserves the right to change limits, test conditions, and dimensions without notice

(1) Note To specify the high speed "A" version add an "A" suffix to part number

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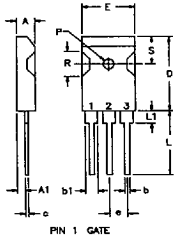
Package Outlines & Pinouts

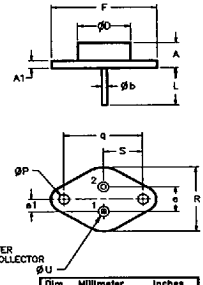
TO-247AD



PIN 1 GATE
2 COLLECTOR
3. EMITTER

Dim.	Millimeter Min.	Max.	Inches Min.	Max.
A	4.70	5.30	.185	209
R	4.32	5.49	.170	216
D	20.80	21.46	.819	.845
S	5.4	6.2	232	252
E	15.49	16.26	.610	.640
L1	–	4.50	–	.177
b1	1.65	2.13	065	084
b2	2.87	3.12	.113	123
b	1.02	1.40	040	055
e	5.33	5.59	210	220
L	19.81	20.32	780	800
A1	2.21	2.59	.087	102
c	041	79	016	.031
P	3.56	3.65	.140	144

TO-204AE



PIN 1. GATE
2. EMITTER
CASE–COLLECTOR

Dim.	Millimeter Min.	Max.	Inches Min.	Max.
F	38.35	39.37	1.51	1.55
øD	19.18	19.94	.755	.785
A	8.35	11.43	.250	.450
øb	1.45	1.60	057	063
A1	1.52	3.43	.060	.135
q	29.29	30.40	1.177	1.197
e	10.67	11.18	.420	.440
e1	5.21	5.72	205	.225
S	16.64	17.15	.655	.675
L	11.18	12.19	.440	.480
øP	3.84	4.19	.151	.165
R	24.84	25.47	.978	995
øU	2.54	3.69	.100	.145

PART NUMBER DESCRIPTION

IX SH 30 N 60

IXYS
Power MOSIGBT

MOSIGT Package Type
SM = Metal Can TO–204 (TO–3)
SH = TO–247 (TO–3P)

Ic Current Rating
17 = 17 Amps @ Tc = 90°C
20 = 20 Amps @ Tc = 90°C
25 = 25 Amps @ Tc = 90°C
30 = 30 Amps @ Tc = 90°C
35 = 35 Amps @ Tc = 90°C
40 = 40 Amps @ Tc = 90°C

Channel Polarity
N = N Channel

Vce Breakdown
60 = 600V
100 = 1000V

Turn–Off Switching Speed
Blank = Standard Fall Time (tfi)
A = High Speed (reduced fall time tfi)

IXYS Corporation • 2355 Zanker Rd. • San Jose, CA 95131-1109 • Tel 408 435-1900 • Fax 408 435-0670
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"S" Series Advantages

A very important requirement imposed on the power switching device when used in motor control applications is that it be able to turn-off safely current due to a load or equipment short circuit. When a current overload occurs, collector current rises rapidly until it exceeds that which the device can sustain by the applied gate voltage (See Figure 1).

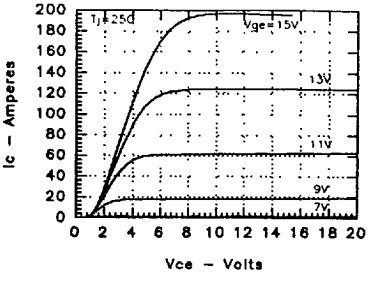

Figure 1: IGBT Output Characteristic

V_{ce} then rapidly rises until it reaches the full DC bus voltage. The key to survivability is for the power device to limit current amplitude to a safe level for a period of time that is sufficiently long for the control circuit to detect the fault and turn off the device.

The Short Circuit Capability of the "S" Series IGBTs is characterized by its Short Circuit Withstand Time t_{sc}. All members of this family have a rating of t_{sc} equal to 10µs, which has become an accepted industry standard. The circuit for an SCSOA tester is shown in Figure 2 with its typical test waveforms in Figure 3.

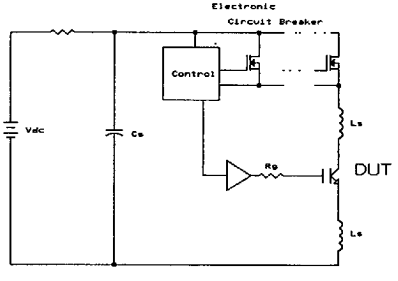

Figure 2: SCSOA Test Circuit

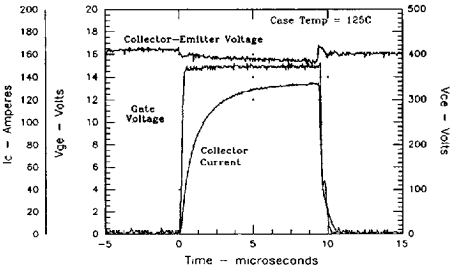

Figure 3. SCSOA Test Waveforms

The proposed JEDEC JC-25 "Short Circuit Withstand Time Test Method" stipulates that capacitor C_s must be large enough to limit V_{CE} voltage droop during the test to less than 10% of V_{ces}. IXYS tests SCSOA at 60% of Vces and at a starting junction temperature of 125°C. The amount of voltage spiking during turn- off depends upon peak short-circuit current, stray inductance and the turn-off speed of the device. Consequently, a further test condition specifies that the peak voltage during turn-off cannot exceed 80% of V_{ces}.

It is also important to measure the peak let-through current of the IGBT in SCSOA testing, because this current plays an important role in the design of voltage transient suppresser circuits. The typical value of short circuit current, termed $I_{C(on)}$, now also appears in the Electrical Characteristic Tables.

The Importance of Cross-over Time t_c

IXYS continues its leadership in characterizing IGBTs by taking another step forward in specifying these parts for switching applications. Circuit designers need to to know switching power losses in order to compute allowable currents in their particular application and the required heat sinking.

Figure 4 shows a typical circuit schematic for measuring switching times. The switching time definitions appear in Figure 5. While the measurement of switching times implicitly measures switching loss, there has been no explicit correlation of turn-off energy loss with switching times for IGBTs until now with the introduction of t_c specifications.

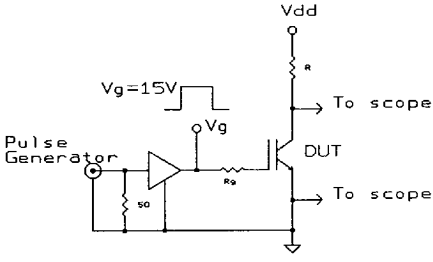

Figure 4: Switching Time Test Circuit

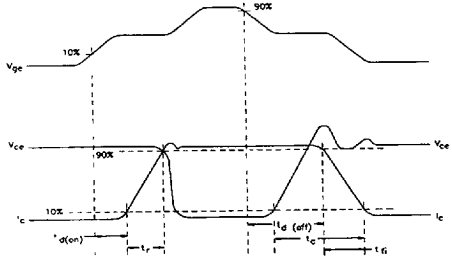

Figure 5: Switching Time Definitions

The turn-off switching energy losses, which normally predominate in IGBTs, are defined as:

$$W_{(off)} = \int^{t} I_c(t \cdot V_{ce}(t) \cdot dt$$

While there is currently a lack of fast, automated test equipment to measure $W_{(off)}$, it can be approximated by performing the integration over the time period t_c, where tc is defined as the time from 10% of V_m rise to 90% of I_m fall, as shown in Figure 5. The period t_c has become known as "cross-over time." It also turns out that when the IGBT is operating at T_j=125°C, the voltage and current waveforms are relatively linear so that $W_{(off)}$ can be simplified to the following:

$$W_{(off)} = \frac{V_m \cdot I_m \cdot t_c}{2}$$

Thus it can be seen that the hard-to-measure specification $W_{(off)}$ can now be guaranteed by measuring tc. IXYS has added cross-over time to its data sheets and has instituted 100% testing of this parameter.

Design and Handling Considerations

☐ ***Gating Considerations***

Turn-on and turn-off delay timesas well as VCE voltage rise during turn-off are dependent on the drive circuit impedance. While the IGBTs are tested with very low gate impedances as specified by the rating and characteristic tables, the user may find it advantageous to use a higher impedance drive circuit in order to reduce dV/dt and thereby also reduce EMI. In order to avoid EMI problems, it is good practice to limit dV/dt to less than 5V/ns. Stray gate inductance can lead to spurious oscillations during turn-off so that any loop inductance in the gate circuit must be minimized.

The gate threshold voltage of the S-series family is typically two volts higher than the G-series of IGBTs and require a 15V gate drive to assure full-current conduction. Consequently the substitution of an 'S' IGBT for a 'G' part may require an increase in the gate supply voltage.

☐ ***Parasitic Diode***

Unlike a MOSFET, an IGBT does not have a parasitic diode. A separate, fast reverse recovery diode must be connected emitter-collector to handle current-flow in that direction. IXYS does offer discrete IGBTs and IGBT modules, which include this diode.

☐ ***Gate Termination***

Because the gate is essentially a capacitor, circuits that leave the gate open-circuited or floating can result in unwanted turn-on of the device or gate over-voltage damage. If gate drive impedance is high, it is frequently advisable to add an external Zener diode from gate-to-source to protect the gate.

☐ ***Gate Protection and ESD***

IXYS IGBTs do not have an internal Zener diode connected gate-to-source and can be damaged from static electricity discharge. Reasonable precautions in handling and packaging, similar to those required from MOS ICs, must be employed.

IXYS

PRELIMINARY TECHNICAL INFORMATION* Data Sheet No. 91545A October 1991

HIGH VOLTAGE "S" Series MOSIGBT

Improved SCSOA Capability

IXSH35N100, 100A
IXSM35N100, 100A

Part Number	V_{CES}	I_{C25}	$V_{CE(SAT)}$
35N100	1000V	70A	3.5 V
35N100A			4.0 V

FEATURES:

- Guaranteed Short Circuit SOA Capability
- Fast Fall Time for Switching Speeds up to 20kHz
- Low $V_{CE\ (sat)}$ for Low On-State Conduction Losses
- MOS Gate Turn-on Drive Simplicity

APPLICATIONS:

- Motor Control
- Uninterruptible Power Supplies
- Welding

MAXIMUM RATINGS

Parameter	Symbol	Rating	Unit
Collector-Emitter Voltage (1)	V_{CES}	1000	V_{DC}
Collector-Gate Voltage(R_{GE}=1 0MΩ) (1)	V_{CGR}	1000	V_{DC}
Gate- Emitter Voltage Continuous	V_{GES}	±20	V_{DC}
Gate- Emitter Voltage Transient	V_{GEM}	±30	V
Collector Current Continuous (T_C=25°C)	I_{C25}	70	A_{DC}
(T_C=90°C)	I_{C90}	35	A_{DC}
Collector Current Pulsed (3)	I_{CM}	140	A
Short Circuit Withstand Time (5)	t_{SC}	10	µsec
Switching Safe Operating Area (6)	SSOA	70A @ 0 8 X V_{CES}	—
Total Power Dissipation	P_C	300	W
Power Dissipation Derating (T_C>25 °C)		2 4	W/°C
Operating and Storage Temperature	T_J & T_{STG}	–55 to +150	°C
Thermal Resistance	R_{thJC}	0 42	°C/W
Thermal Resistance	R_{thCS}	0 25 (typ)	°C/W
Max Lead Temp for Soldering	T_L	300 (1 6mm for 10 sec)	°C
Mounting Torque	M_M	10	in-lb

* The data supplied herein reflects the pre-production objective specification and characterization from Engineering lots IXYS reserves the right to change limits, test conditions, and dimensions without notice

IXYS Corporation • 2355 Zanker Rd San Jose, CA 95131-1109
TEL (408)435-1900 • FAX (408)435 0670

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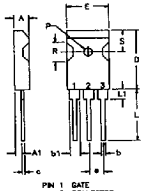
TEL +49-6206 5030 • FAX +49-6206 503627

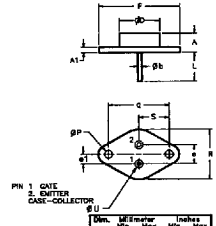
TO-247AD (IXSH)



PIN 1 GATE
2. COLLECTOR
3 EMITTER

Dim	Millimeter Min.	Max.	Inches Min.	Max.
A	4.70	5.30	185	.209
R	4.32	5.49	170	.216
D	20.80	21.46	.819	.845
S	5.4	6.2	232	.252
E	15.49	16.26	610	640
L1	--	4.50	--	177
b1	1 65	2.13	.065	084
b2	2.87	3.12	113	123
b	1.02	1.40	.040	055
e	5.33	5.59	210	.220
L	19 81	20 32	.780	800
A1	2 21	2 59	.087	102
c	.041	79	.016	031
P	3 56	3.68	140	144

TO-204AE (IXSM)



PIN 1 GATE
2. EMITTER
CASE–COLLECTOR

Dim.	Millimeter Min	Max.	Inches Min	Max
F	38.35	39.37	1.51	1.55
øD	19 18	19.94	755	785
A	8.35	11.43	250	450
øb	1 45	1.60	057	063
A1	1.52	3.43	060	135
Q	29 28	30.40	1.177	1.197
e	10.67	11 18	420	.440
e1	5 21	5 72	205	225
S	16 64	17 15	850	675
L	11.18	12.19	440	480
øP	3 84	4.19	151	165
R	24.84	25.47	978	995
øU	2.54	3.89	100	145

IXSH35N100, 100A
IXSM35N100, 100A

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

CHARACTERISTIC	TEST CONDITION		SYMBOL	MIN	TYP	MAX	UNIT
Collector-Emitter Breakdown Voltage (1)	I_C=3mA, V_{GE}=0V		BV_{CES}	1000	—	—	V
Gate-Emitter Threshold Voltage	I_C=4 mA, V_{CE}=V_{GE}		$V_{GE(th)}$	4	—	7	V
Gate-Emitter Leakage Current	V_{GE}= ± 20V, V_{CE}=0V		I_{GES}	—	—	± 100	nA
Collector Leakage Current	V_{CE}= 0 8 x V_{CES}, V_{GE}= 0V	T_C=25°C	I_{CES}	—	—	250	µA
		T_C=125°C		—	—	1	mA
Collector-Emitter Saturation Voltage	I_C= I_{C90}, V_{GE}=15V	35N100	$V_{CE(sat)}$	—	—	3 5	V
		35N100A		—	—	4 0	
Forward Transconductance (2)	I_C= I_{C90}, V_{CE}=10V		g_{fs}	20	25	—	S
Short Circuit Current	V_{GE}=15V, V_{CE}=10V		$I_{C(on)}$	—	240	—	A
Input Capacitance	V_{CE}=25V, V_{GE}=0V, f=1MHz		C_{ies}	—	4400	—	pF
Output Capacitance			C_{oes}	—	325	—	pF
Reverse Transfer Capacitance			C_{res}	—	85	—	pF
Total Gate Charge	V_{GE}=15V, I_C= I_{C90}, V_{CE}=0 5 x V_{CES}		$Q_{g(on)}$	—	180	260	nC
Gate-Emitter Charge			Q_{ge}	—	45	60	nC
Gate-Collector ("Miller") Charge			Q_{gc}	—	120	200	nC

SWITCHING CHARACTERISTICS

CHARACTERISTIC	TEST CONDITION		SYMBOL	MIN	TYP	MAX	UNIT
Turn-On Delay Time	**Resistive Load**		$t_{d(on)}$	—	80	—	ns
Current Rise Time	I_C= I_{C90}, T_J=125°C, V_{CC}=0 8 x V_{CES}, V_{GE} = 15V, R_G =2 7Ω		t_r	—	150	—	ns
Current Fall Time	**Inductive Load**	35N100	t_{fi}	—	400	—	ns
	L=100 µH, I_C= I_{C90}, T_J= 25 °C,	35N100A	t_{fi}	—	200	—	ns
Turn-Off Energy	V_{CC}= 0 8 x V_{CES}, V_{GE}= 15V,	35N100	$W_{(off)}$	—	6	—	mJ
	R_G= 2 7Ω (4)	35N100A	$W_{(off)}$	—	3	—	mJ
Turn-Off Delay Time	**Inductive Load**	35N100	$t_{d(off)}$	—	200	550	ns
		35N100A	$t_{d(off)}$	—	200	550	ns
Current Fall Time	L=100 µH, I_C= I_{C90}, T_J= 125 °C,	35N100	t_{fi}	—	2000	3000	ns
	V_{CC}= 0 8 x V_{CES}, V_{GE}= 15V,	35N100A	t_{fi}	—	1000	2000	ns
Cross-Over Time	R_G= 2 7Ω (4)	35N100A	t_c	—	1100	2200	ns
Turn-Off Energy		35N100	$W_{(off)}$	—	34	—	mJ
		35N100A	$W_{(off)}$	—	15	31	mJ

(1) T_J=25 °C to 150 °C
(2) Pulse Test: Pulse width ≤ 300 µs, duty cycle ≤ 2%
(3) Repetitive Rating. Pulse width limited by max junction temperature
(4) Switching times may increase for V_{CE} (Clamp) > 0 8 xV_{CES}, T_J>125 °C or R_G>2 7 Ω
(5) Non-Repetitive Rating T_C=125 °C, V_{CC}=600V, V_{GE}=15V, R_G=2 7 Ω
(6) Turn-Off SSOA (or RBSOA), T_C=125 °C, V_{GE}=15V, Clamped Inductive Load, L=30µH, R_G=2 7 Ω

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IXSH35N100 IXSM35N100

Fig.1. Saturation Characteristics

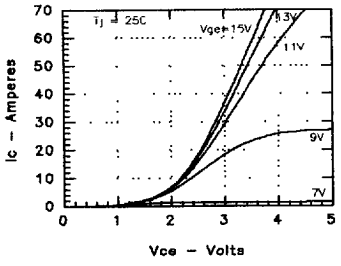


Fig. 2. Output Characteristics

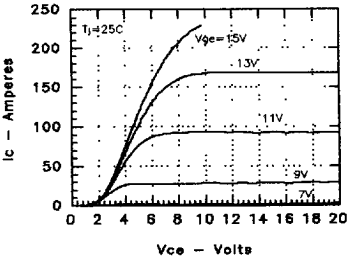


Fig. 3. Collector-Emitter Voltage vs. Gate-Emitter Voltage

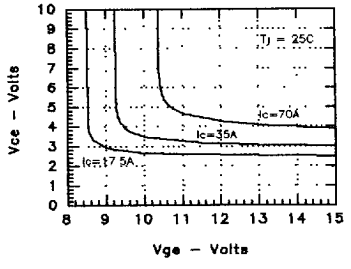


Fig. 4. Temperature Dependence of Output Saturation Voltage

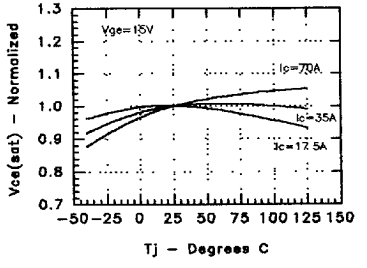


Fig. 5. Input Admittance

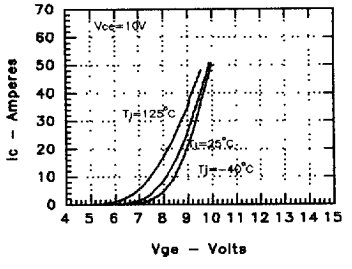
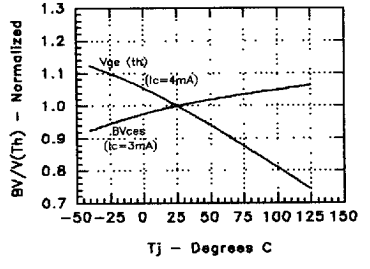


Fig. 6. Temperature Dependence of Breakdown Voltage and Threshold Voltage



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IXSH35N100 IXSM35N100

Fig. 7. Dependence of Turn-Off Energy Per Pulse and Fall Time on Collector Current

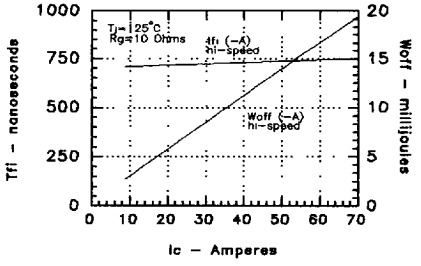


Fig 8. Dependence of Turn-Off Energy Per Pulse and Fall Time on Rg

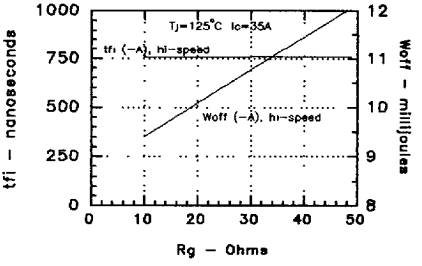


Fig. 9. Gate Charge Characteristic Curve

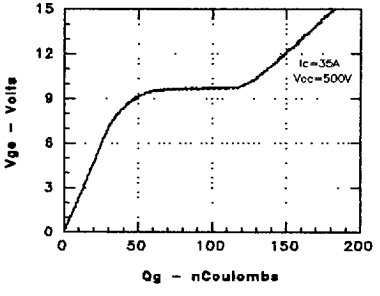


Fig. 10. Turn-Off Safe Operating Area

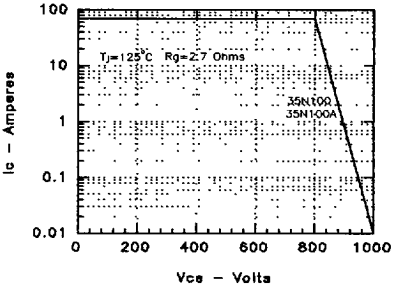
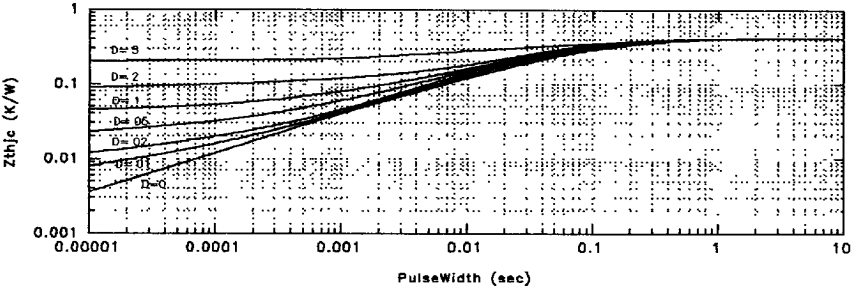


Fig. 11. Transient Thermal Impedance



IXYS

PRELIMINARY TECHNICAL INFORMATION* Data Sheet No. 91548A October 1991

HIGH VOLTAGE "S" Series MOSIGBT
Improved SCSOA Capability

IXSH25N100, 100A
IXSM25N100, 100A

Part Number	V_{CES}	I_{C25}	$V_{CE(SAT)}$
25N100	1000V	50A	3 5 V
25N100A			4 0 V

FEATURES:

- Guaranteed Short Circuit SOA Capability
- Fast Fall Time for Switching Speeds up to 20kHz
- Low $V_{CE\ (sat)}$ for Low On-State Conduction Losses
- MOS Gate Turn-on Drive Simplicity

APPLICATIONS:

- Motor Control
- Uninterruptible Power Supplies
- Welding

MAXIMUM RATINGS

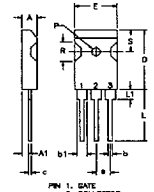
Parameter	Symbol	Rating	Unit
Collector-Emitter Voltage (1)	V_{CES}	1000	V_{DC}
Collector-Gate Voltage(R_{GE}=1.0MΩ) (1)	V_{CGR}	1000	V_{DC}
Gate- Emitter Voltage Continuous	V_{GES}	±20	V_{DC}
Gate- Emitter Voltage Transient	V_{GEM}	±30	V
Collector Current Continuous (T_C=25°C)	I_{C25}	50	A_{DC}
(T_C=90°C)	I_{C90}	25	A_{DC}
Collector Current Pulsed (3)	I_{CM}	100	A
Short Circuit Withstand Time (5)	t_{SC}	10	µsec
Switching Safe Operating Area (6)	SSOA	50A @ 0 8 X V_{CES}	—
Total Power Dissipation	P_C	200	W
Power Dissipation Derating (T_C>25 °C)		1 67	W/°C
Operating and Storage Temperature	T_J & T_{STG}	–55 to +150	°C
Thermal Resistance	R_{thJC}	0 625	°C/W
Thermal Resistance	R_{thCS}	0 25 (typ)	°C/W
Max Lead Temp for Soldering	T_L	300 (1 6mm for 10 sec)	°C
Mounting Torque	M_M	10	in-lb

* The data supplied herein reflects the pre-production specification and charactenzation measurements from Engineering lots IXYS reserves the right to change limits, test conditions, and limits without notice

IXYS Corporation • 2355 Zanker Rd San Jose, CA 95131-1109
TEL. (408)435-1900 • FAX (408)435-0670

ABB IXYS Semiconductor GmbH • POB 1180 D-6840 Lampertheim, Germany
TEL +49-6206-5030 • FAX +49-6206-503627

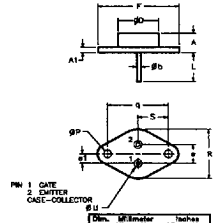
TO-247AD (IXSH)



PIN 1. GATE
2. COLLECTOR
3. EMITTER

Dim.	Millimeter Min.	Max.	Inches Min	Max
A	4 70	5.30	185	209
R	4.32	5.49	170	218
D	20.80	21 46	.819	.845
S	5.4	6.2	212	.252
E	15.48	16.26	610	.640
L1	—	4 50	—	177
b1	1 65	2 13	.065	.084
b2	2 87	3.12	113	123
b	1 02	1 40	.040	.055
e	5 33	5 59	210	220
L	19 81	20 32	780	.800
A1	2 21	2.59	.087	.102
c	.041	79	.016	031
P	3.56	3.66	140	144

TO-204AE (IXSM)



Dim.	Millimeter Min.	Max.	Inches Min.	Max.
F	38.35	39.37	1.51	1.55
øD	19.18	19 94	755	785
A	8.35	11.43	330	450
øb	1 40	1.60	055	.063
A1	1.52	3.43	.060	135
Q	28 29	30.40	1.177	1 197
S	10.67	11.18	420	440
e1	5 21	5 72	205	225
R	16.64	17 15	655	675
L	11.18	12.19	440	480
øP	3 84	4.19	151	165
R	24 84	25.47	978	995
øU	2.54	3.89	.100	.145

IXSH25N100, 100A
IXSM25N100, 100A

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

CHARACTERISTIC	TEST CONDITION		SYMBOL	MIN	TYP	MAX	UNIT
Collector-Emitter Breakdown Voltage	I_C=3mA, V_{GE}=0V		BV_{CES}	1000	—	—	V
Gate-Emitter Threshold Voltage	I_C=2.5 mA, V_{GE}=V_{CE}		$V_{GE(th)}$	4	—	7	V
Gate-Emitter Leakage Current	V_{GE}= ± 20V, V_{CE}=0V		I_{GES}	—	—	± 100	nA
Collector Leakage Current	V_{CE}= 0 8 x V_{CES}, V_{GE}= 0V	T_C=25°C	I_{CES}	—	—	250	µA
		T_C=125°C		—	—	1	mA
Collector-Emitter Saturation Voltage	I_C= I_{C90}, V_{GE}=15V	25N100	$V_{CE(sat)}$	—	—	3 5	V
		25N100A		—	—	4 0	
Forward Transconductance (2)	I_C= I_{C90}, V_{CE}=10V		g_{fs}	10	17	—	S
Short Circuit Current	V_{GE}=15V, V_{CE}=10V		$I_{C(on)}$	—	140	—	A
Input Capacitance	V_{CE}=25V, V_{GE}=0V, f=1MHz		C_{ies}	—	2850	—	pF
Output Capacitance			C_{oes}	—	210	—	pF
Reverse Transfer Capacitance			C_{res}	—	50	—	pF
Total Gate Charge	V_{GE}=15V, I_C= I_{C90}, V_{CE}=0 5 x V_{CES}		$Q_{g(on)}$	—	112	130	nC
Gate-Emitter Charge			Q_{ge}	—	28	40	nC
Gate-Collector ("Miller") Charge			Q_{gc}	—	50	75	nC

SWITCHING CHARACTERISTICS

CHARACTERISTIC	TEST CONDITION		SYMBOL	MIN	TYP	MAX	UNIT
Turn-On Delay Time	**Resistive Load**		$t_{d(on)}$	—	70	—	ns
Current Rise Time	I_C= I_{C90}, T_J=125°C, V_{CC}=0 8 x V_{CES}, V_{GE} = 15V, R_G =4 7Ω		t_r	—	580	—	ns
Current Fall Time	**Inductive Load**	25N100	t_{fi}	—	400	—	ns
	L=100 µH, I_C= I_{C90}, T_J= 25 °C, V_{CC}= 0.8 x V_{CES}, V_{GE}= 15V, R_G= 4 7Ω (4)	25N100A	t_{fi}	—	200	—	ns
Turn-Off Energy		25N100	$W_{(off)}$	—	4.5	—	mJ
		25N100A	$W_{(off)}$	—	2 5	—	mJ
Turn-Off Delay Time	**Inductive Load**	25N100	$t_{d(off)}$	—	110	550	ns
		25N100A	$t_{d(off)}$	—	110	550	ns
Current Fall Time	L=100 µH, I_C= I_{C90}, T_J= 125 °C, V_{CC}= 0 8 x V_{CES}, V_{GE}= 15V, R_G= 4 7Ω (4)	25N100	t_{fi}	—	1300	3000	ns
		25N100A	t_{fi}	—	—	1500	ns
Cross-Over Time		25N100	t_c	—	1500	—	ns
		25N100A	t_c	—	1100	—	mJ
Turn-Off Energy		25N100	$W_{(off)}$	—	15	—	mJ
		25N100A	$W_{(off)}$	—	11	—	ns

(1) T_J=25 °C to 150 °C
(2) Pulse Test Pulse width ≤ 300 µs, duty cycle ≤ 2%
(3) Repetitive Rating Pulse width limited by max junction temperature
(4) Switching times may increase for V_{CE} (Clamp) > 0 8 xV_{CES}, T_J>125 °C or R_G>4 7Ω
(5) Non-Repetitive Rating T_C=125 °C, V_{CC}=600V, V_{GE}=15V, R_G=4 7Ω
(6) Turn-Off SSOA (or RBSOA), T_C=125 °C, V_{GE}=15V, Clamped Inductive Load, L=30µH, R_G=4 7Ω

IXYS Corporation • 2355 Zanker Rd San Jose, CA 95131-1109 • TEL (408)435-1900 • FAX (408)435-0670
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IXSH25N100 IXSM25N100

Fig.1. Saturation Characteristics

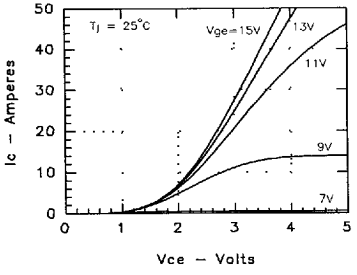


Fig. 2. Output Characteristics

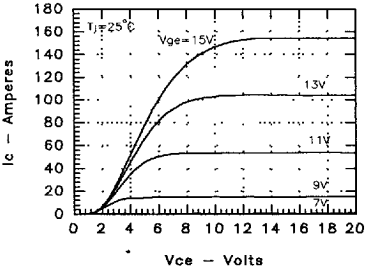


Fig. 3. Collector–Emitter Voltage vs. Gate–Emitter Voltage

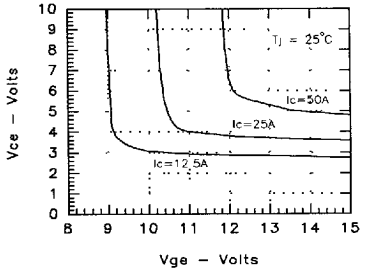


Fig. 4. Temperature Dependence of Output Saturation Voltage

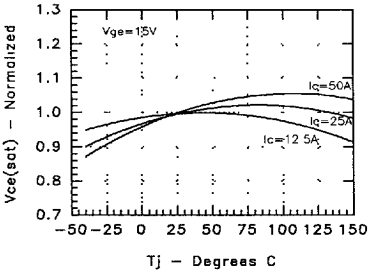


Fig. 5. Input Admittance

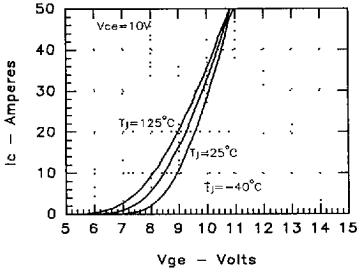
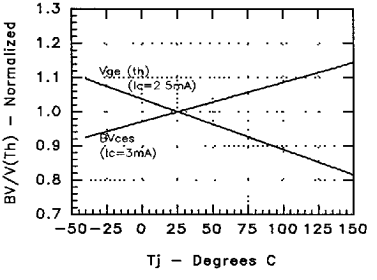


Fig. 6. Temperature Dependence of Breakdown Voltage and Threshold Voltage



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IXSH25N100 IXSM25N100

Fig. 7. Dependence of Turn-Off Energy per Pulse and Fall Time on Collector Current

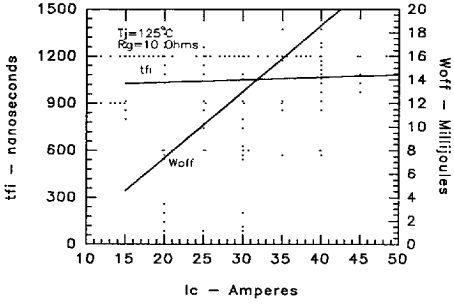


Fig. 8. Dependence of Turn-Off Energy Per Pulse and Fall Time on Rg

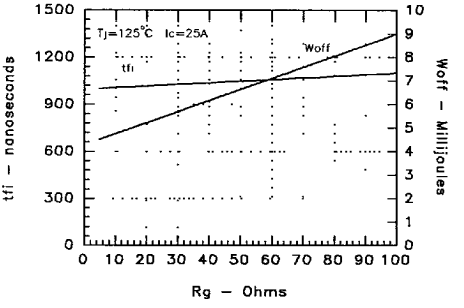


Fig. 9. Gate Charge Characteristic Curve

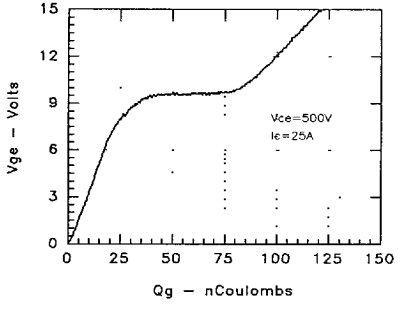


Fig. 10. Turn-Off Safe Operating Area

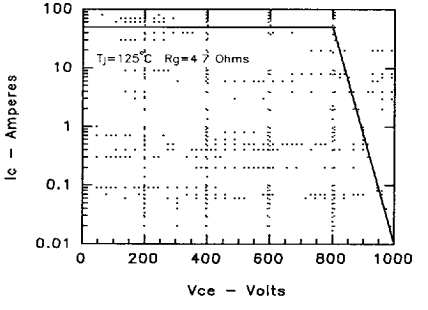
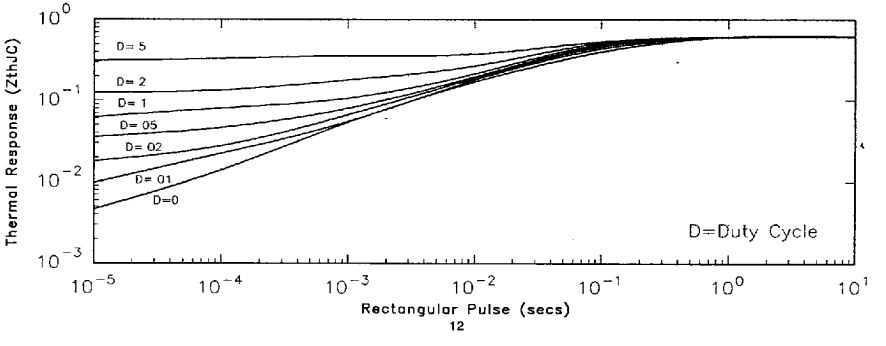


Fig. 11. Transient Thermal Impedance



IXYS

ADVANCE TECHNICAL INFORMATION* Data Sheet No. 91550A October 1991

HIGH VOLTAGE "S" Series MOSIGBT

Improved SCSOA Capability

IXSH17N100, 100A
IXSM17N100, 100A

Part Number	V_{CES}	I_{C25}	$V_{CE(SAT)}$
17N100	1000V	34A	3 5 V
17N100A			4 0 V

FEATURES:

- Guaranteed Short Circuit SOA Capability
- Fast Fall Time for Switching Speeds up to 20kHz
- Low $V_{CE\ (sat)}$ for Low On-State Conduction Losses
- MOS Gate Turn-on Drive Simplicity

APPLICATIONS:

- Motor Control
- Uninterruptible Power Supplies
- Welding

MAXIMUM RATINGS

Parameter	Symbol	Rating	Unit
Collector-Emitter Voltage (1)	V_{CES}	1000	V_{DC}
Collector-Gate Voltage(R_{GE}=1 0MΩ) (1)	V_{CGR}	1000	V_{DC}
Gate- Emitter Voltage Continuous	V_{GES}	±20	V_{DC}
Gate- Emitter Voltage Transient	V_{GEM}	±30	V
Collector Current Continuous (Tc=25°C)	I_{C25}	34	A_{DC}
(Tc=90°C)	I_{C90}	17	A_{DC}
Collector Current Pulsed (3)	I_{CM}	68	A
Short Circuit Withstand Time (5)	t_{SC}	10	µsec
Switching Safe Operating Area (6)	SSOA	34A @ 0 8 X V_{CES}	—
Total Power Dissipation	P_C	150	W
Power Dissipation Derating (Tc>25 °C)		1 2	W/°C
Operating and Storage Temperature	T_J & T_{STG}	–55 to +150	°C
Thermal Resistance	R_{thJC}	0 83	°C/W
Thermal Resistance	R_{thCS}	0 25 (typ)	°C/W
Max Lead Temp for Soldering	T_L	300 (1 6mm for 10 sec)	°C
Mounting Torque	M_M	10	in-lb

*The data supplied herein reflects the Design Technical Objective Specification The subject products are in Product Development IXYS reserves the right to change limits, test conditions, and dimensions without notice

IXYS Corporation • 2355 Zanker Rd San Jose, CA 95131-1109
TEL. (408)435-1900 • FAX (408)435-0670

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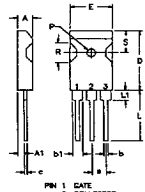
TEL. +49-6206-5030 • FAX +49-6206-503627

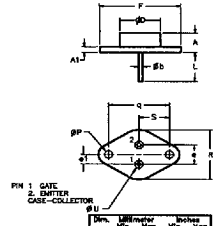
TO-247AD (IXSH)



PIN 1. GATE
2. COLLECTOR
3. EMITTER

Dim.	Millimeter Min.	Max.	Inches Min.	Max.
A	4.70	5.30	185	209
R	4.32	5 49	170	216
D	20.80	21 46	818	845
S	5.4	6 2	212	252
E	15.49	16.26	610	640
L1	—	4.50	—	177
b1	1 65	2 13	065	084
b2	2 87	3 12	113	123
b	1 02	1 40	040	055
e	5 33	5 59	210	220
L	19 81	20 32	780	800
A1	2 21	2 59	087	102
c	041	79	016	031
P	3 56	3.66	140	144

TO-204AE (IXSM)



PIN 1. GATE
2. EMITTER
CASE–COLLECTOR

Dim.	Millimeter Min.	Max	Inches Min.	Max
F	38.35	38 37	1 51	1 58
øD	19 18	19 84	755	780
A	8.32	11.43	.330	.450
øb	1 45	1 60	057	063
A1	1 52	3 43	060	135
q	25 29	30 40	1 177	1 197
e	10 67	11 18	420	440
e1	5 21	5 72	205	225
S	16.64	17 15	655	675
L	11 18	12 18	440	480
øP	3 84	4 19	151	165
R	24.84	25 47	978	995
øU	2 54	3 69	100	145

IXSH17N100, 100A
IXSM17N100, 100A

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

CHARACTERISTIC	TEST CONDITION		SYMBOL	MIN	TYP	MAX	UNIT
Collector-Emitter Breakdown Voltage	I_C=3mA, V_{GE}=0V		BV_{CES}	1000	—	—	V
Gate-Emitter Threshold Voltage	I_C=1 5 mA, V_{CE}=V_{GE}		$V_{GE(th)}$	4	—	7	V
Gate-Emitter Leakage Current	V_{GE}= ± 20V, V_{CE}=0V		I_{GES}	—	—	± 100	nA
Collector Leakage Current	V_{CE}= 0 8 x V_{CES}, V_{GE}= 0V	T_C=25°C	I_{CES}	—	—	250	µA
		T_C=125°C		—	—	1	mA
Collector-Emitter Saturation Voltage	I_C= I_{C90}, V_{GE}=15V	17N100	$V_{CE(sat)}$	—	—	3 5	V
		17N100A		—	—	4 0	
Forward Transconductance (2)	I_C= I_{C90}, V_{CE}=10V		g_{fs}	6	—	—	S
Short Circuit Current	V_{GE}=15V, V_{CE}=10V		$I_{C(on)}$	—	65	—	A
Input Capacitance	V_{CE}=25V, V_{GE}=0V, f=1MHz		C_{ies}	—	1800	—	pF
Output Capacitance			C_{oes}	—	160	—	pF
Reverse Transfer Capacitance			C_{res}	—	45	—	pF
Total Gate Charge	V_{GE}=15V, I_C= I_{C90}, V_{CE}=0 5 x V_{CES}		$Q_{g(on)}$	—	75	—	nC
Gate-Emitter Charge			Q_{ge}	—	20	—	nC
Gate-Collector ("Miller") Charge			Q_{gc}	—	35	—	nC

SWITCHING CHARACTERISTICS

CHARACTERISTIC	TEST CONDITION		SYMBOL	MIN	TYP	MAX	UNIT
Turn-On Delay Time	**Resistive Load**		$t_{d(on)}$	—	80	—	ns
Current Rise Time	I_C= I_{C90}, T_J=125°C, V_{CC}=0 8 x V_{CES}, V_{GE} = 15V, R_G =10Ω		t_r	—	150	—	ns
Current Fall Time	**Inductive Load**	17N100	t_{fi}	—	400	—	ns
		17N100A	t_{fi}	—	200	—	ns
Turn-Off Energy	L=100 µH, I_C= I_{C90}, T_J= 25 °C, V_{CC}= 0.8 x V_{CES}, V_{GE}= 15V, R_G= 10Ω (4)	17N100	$W_{(off)}$	—	3 5	—	mJ
		17N100A	$W_{(off)}$	—	2	—	mJ
Turn-Off Delay Time	**Inductive Load**	17N100	$t_{d(off)}$	—	550	—	ns
		17N100A	$t_{d(off)}$	—	550	—	ns
Current Fall Time	L=100 µH, I_C= I_{C90}, T_J= 125 °C, V_{CC}= 0.8 x V_{CES}, V_{GE}= 15V, R_G= 10Ω (4)	17N100	t_{fi}	—	—	2000	ns
		17N100A	t_{fi}	—	—	1000	ns
Cross-Over Time		17N100	t_c	—	2300	—	ns
		17N100A	t_c	—	1100		ns
Turn-Off Energy		17N100	$W_{(off)}$	—	17	—	mJ
		17N100A	$W_{(off)}$	—	8	—	mJ

(1) T_J=25 °C to 150 °C
(2) Pulse Test: Pulse width ≤ 300 µs, duty cycle ≤ 2%
(3) Repetitive Rating. Pulse width limited by max. junction temperature
(4) Switching times may increase for V_{CE} (Clamp) > 0 8 xV_{CES}, T_J>125 °C or R_G>10 Ω
(5) Non-Repetitive Rating. T_C=125 °C, V_{CC}=600V, V_{GE}=15V, R_G=10 Ω
(6) Turn-Off SSOA (or RBSOA), T_C=125 °C, V_{GE}=15V, Clamped Inductive Load, L=100µH, R_G=10 Ω

IXYS Corporation • 2355 Zanker Rd. San Jose, CA 95131-1109 • TEL (408)435-1900 • FAX. (408)435-0670
ABB-IXYS Semiconductor GmbH • POB 1180 • D-6840 Lampertheim, Germany • TEL: + 49-6206-5030 • FAX: + 49-6206-503627

IXYS

PRELIMINARY TECHNICAL INFORMATION* Data Sheet No. 91546A October 1991

HIGH VOLTAGE "S" Series MOSIGBT

Improved SCSOA Capability

IXSH40N60, 60A
IXSM40N60, 60A

Part Number	V_{CES}	I_{C25}	$V_{CE(SAT)}$
40N60	600V	75A	2.5 V
40N60A			3.0 V

FEATURES:

- Guaranteed Short Circuit SOA Capability
- Fast Fall Time for Switching Speeds up to 30kHz
- Low $V_{CE\ (sat)}$ for Low On-State Conduction Losses
- MOS Gate Turn-on Drive Simplicity

APPLICATIONS:

- Motor Control
- Uninterruptible Power Supplies
- Welding

MAXIMUM RATINGS

Parameter	Symbol	Rating	Unit
Collector-Emitter Voltage (1)	V_{CES}	600	V_{DC}
Collector-Gate Voltage(R_{GE}=1 0MΩ) (1)	V_{CGR}	600	V_{DC}
Gate- Emitter Voltage Continuous	V_{GES}	±20	V_{DC}
Gate- Emitter Voltage Transient	V_{GEM}	±30	V
Collector Current Continuous (T_C=25°C)	I_{C25}	75	A_{DC}
(T_C=90°C)	I_{C90}	40	A_{DC}
Collector Current Pulsed (3)	I_{CM}	150	A
Short Circuit Withstand Time (5)	t_{SC}	10	µsec
Switching Safe Operating Area (6)	SSOA	80A @ 0.8 X V_{CES}	—
Total Power Dissipation	P_C	300	W
Power Dissipation Derating (T_C>25 °C)		2 4	W/°C
Operating and Storage Temperature	T_J & T_{STG}	–55 to +150	°C
Thermal Resistance	R_{thJC}	0 42	°C/W
Thermal Resistance	R_{thCS}	0.25 (typ)	°C/W
Max. Lead Temp for Soldering	T_L	300 (1 6mm for 10 sec)	°C
Mounting Torque	M_M	10	in-lb

* The data supplied herein reflects the pre-production specification and characterization measurements from Engineering lots IXYS reserves the right to change limits, test conditions, and dimensions without notice.

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TEL: (408)435-1900 • FAX. (408)435-0670

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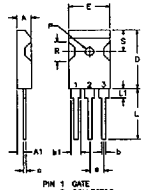
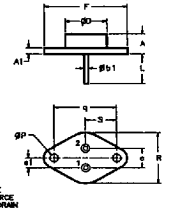
TO-247AD (IXSH)



PIN 1. GATE
2. COLLECTOR
3. EMITTER

Dim.	Millimeter Min.	Max.	Inches Min	Max.
A	4.70	5.30	.185	.209
R	4.32	5.49	.170	.216
D	20.80	21.46	.819	.845
S	5.4	6 2	.232	.252
E	15.48	16.26	.610	640
L1	—	4.50	—	177
b1	1 65	2.13	065	084
b2	2.87	3.12	113	123
b	1 02	1.40	040	.055
e	5.33	5.56	.210	.220
L	19.81	20.32	780	.800
A1	2.21	2.59	.087	102
c	.041	.79	.016	.031
P	3.56	3.65	140	144

TO-204AE (IXSM)



PIN 1 GATE
2 SOURCE
CASE–DRAIN

Dim.	Millimeter Min.	Max.	Inches Min.	Max.
F	38.35	38 37	1.51	1 55
ØD	19 18	19 94	755	785
A	6.35	11.43	.250	450
Ød	1.45	1 60	.057	.063
A1	1.52	3.43	.060	.135
Q	29 29	30.40	1 177	1 197
e	10 67	11 18	.420	.440
e1	5.21	5.72	.205	225
S	16.64	17 15	655	675
L	11.18	12.19	.440	.480
ØP	3.84	4.19	151	165
R	24.84	25.47	.978	.995

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IXSH40N60,60A
IXSM40N60,60A

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

CHARACTERISTIC	TEST CONDITION		SYMBOL	MIN	TYP	MAX	UNIT
Collector-Emitter Breakdown Voltage	I_C=250 µA, V_{GE}=0V		BV_{CES}	600	—	—	V
Gate-Emitter Threshold Voltage	I_C=4 mA, V_{CE}=V_{GE}		$V_{GE(th)}$	4	—	7	V
Gate-Emitter Leakage Current	V_{GE}= ± 20V, V_{CE}=0V		I_{GES}	—	—	± 100	nA
Collector Leakage Current	V_{CE}= 0.8 x V_{CES}, V_{GE}= 0V	T_C=25°C	I_{CES}	—	—	50	µA
		T_C=125°C		—	—	1	mA
Collector-Emitter Saturation Voltage	I_C= I_{C90}, V_{GE}=15V	40N60	$V_{CE(sat)}$	—	—	2.5	V
		40N60A		—	—	3.0	
Forward Transconductance (2)	I_C= I_{C90}, V_{CE}=10V		g_{fs}	20	23	—	S
Short Circuit Current	V_{GE}=15V, V_{CE}=10V		$I_{C(on)}$	—	200	—	A
Input Capacitance	V_{CE}=25V, V_{GE}=0V, f=1MHz		C_{ies}	—	4500	—	pF
Output Capacitance			C_{oes}	—	350	—	pF
Reverse Transfer Capacitance			C_{res}	—	90	—	pF
Total Gate Charge	V_{GE}=15V, I_C= I_{C90}, V_{CE}=0.5 x V_{CES}		$Q_{g(on)}$	—	190	260	nC
Gate-Emitter Charge			Q_{ge}	—	45	60	nC
Gate-Collector ("Miller") Charge			Q_{gc}	—	88	120	nC

SWITCHING CHARACTERISTICS

CHARACTERISTIC	TEST CONDITION		SYMBOL	MIN	TYP	MAX	UNIT
Turn-On Delay Time	**Resistive Load**		$t_{d(on)}$	—	55	—	ns
Current Rise Time	I_C= I_{C90}, T_J=125°C, V_{CC}=0.8 x V_{CES}, V_{GE} = 15V, R_G =2.7Ω		t_r	—	170	—	ns
Current Fall Time	**Inductive Load**	40N60	t_{fi}	—	400	—	ns
	L=100 µH, I_C= I_{C90}, T_J= 25 °C,	40N60A	t_{fi}	—	200	—	ns
Turn-Off Energy	V_{CC}= 0.8 x V_{CES}, V_{GE}= 15V,	40N60	$W_{(off)}$	—	5	—	mJ
	R_G= 2.7Ω (4)	40N60A	$W_{(off)}$	—	2.5	—	mJ
Turn-Off Delay Time	**Inductive Load**	40N60	$t_{d(off)}$	—	—	—	ns
		40N60A	$t_{d(off)}$	—	340	525	ns
Current Fall Time	L=100 µH, I_C= I_{C90}, T_J= 125 °C,	40N60	t_{fi}	—	600	1500	ns
	V_{CC}= 0.8 x V_{CES}, V_{GE}= 15V,	40N60A	t_{fi}	—	340	700	ns
Cross-Over Time	R_G= 2.7Ω (4)	40N60A	t_c	—	600	800	ns
Turn-Off Energy		40N60	$W_{(off)}$	—	12	—	mJ
		40N60A	$W_{(off)}$	—	6	—	mJ

(1) T_J=25 °C to 150 °C
(2) Pulse Test Pulse width ≤ 300 µs, duty cycle ≤ 2%
(3) Repetitive Rating Pulse width limited by max junction temperature
(4) Switching times may increase for V_{CE} (Clamp) > 0.8 x V_{CES}, T_J>125 °C or R_G>2.7 Ω
(5) Non-Repetitive Rating T_C=125 °C, V_{CC}=360V, V_{GE}=15V, R_G=2.7 Ω
(6) Turn-Off SSOA (or RBSOA), T_C=125 °C, V_{GE}=15V, Clamped Inductive Load, L=100µH, R_G=2.7 Ω

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IXSH40N60 IXSM40N60

Fig.1. Saturation Characteristics

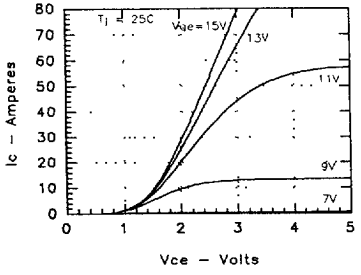


Fig. 2. Output Characteristics

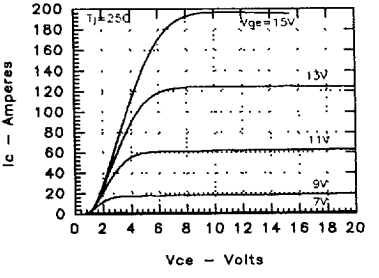


Fig. 3. Collector-Emitter Voltage vs. Gate-Emitter Voltage

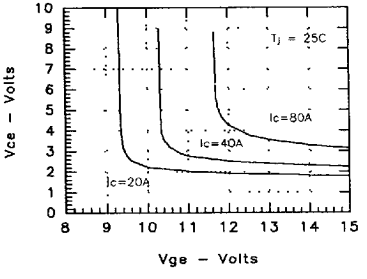


Fig. 4. Temperature Dependence of Output Saturation Voltage

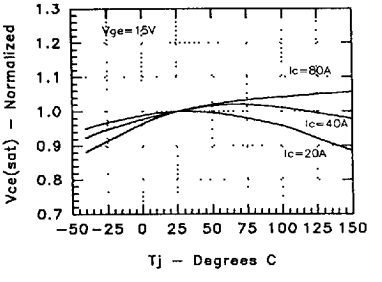


Fig. 5. Input Admittance

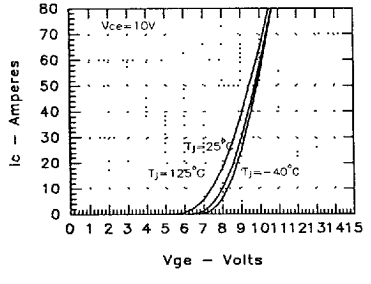
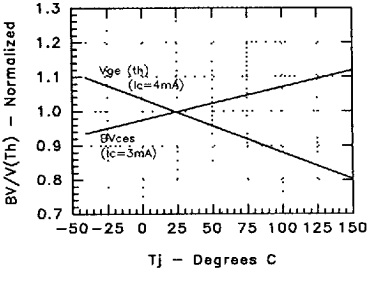


Fig. 6. Temperature Dependence of Breakdown Voltage and Threshold Voltage



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IXSH40N60 IXSM40N60

Fig. 7. Dependence of Turn-Off Energy Per Pulse and Fall Time on Collector Current

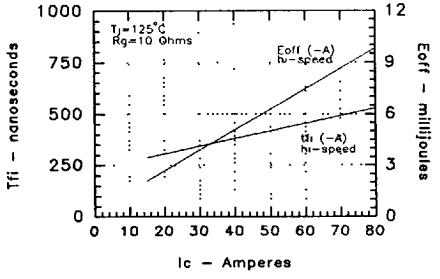


Fig. 8. Dependence of Turn-Off Energy Per Pulse and Fall Time on Rg

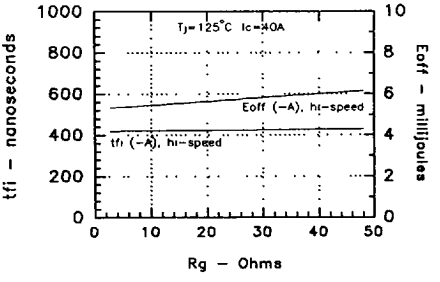


Fig. 9. Gate Charge Characteristic Curve

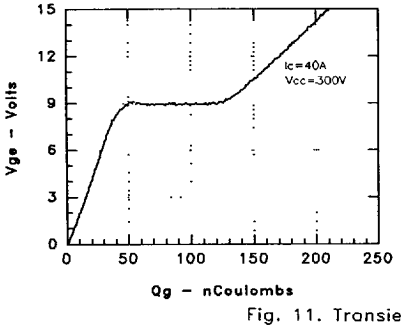


Fig. 10. Turn-Off Safe Operating Area

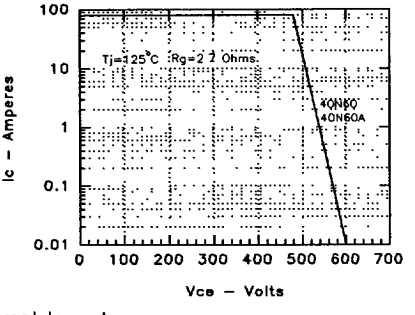
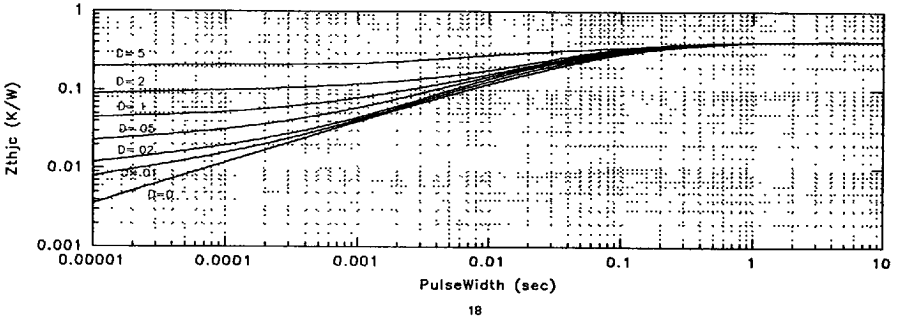


Fig. 11. Transient Thermal Impedance



IXYS

PRELIMINARY TECHNICAL INFORMATION* Data Sheet No 91549A October 1991

HIGH VOLTAGE "S" Series MOSIGBT
Improved SCSOA Capability

IXSH30N60, 60A
IXSM30N60, 60A

Part Number	V_{CES}	I_{C25}	$V_{CE(SAT)}$
30N60	600V	50A	2 5 V
30N60A			3 0 V

FEATURES:

- Guaranteed Short Circuit SOA Capability
- Fast Fall Time for Switching Speeds up to 30kHz
- Low $V_{CE\ (sat)}$ for Low On-State Conduction Losses
- MOS Gate Turn-on Drive Simplicity

APPLICATIONS:

- Motor Control
- Uninterruptible Power Supplies
- Welding

MAXIMUM RATINGS

Parameter	Symbol	Rating	Unit
Collector-Emitter Voltage (1)	V_{CES}	600	V_{DC}
Collector-Gate Voltage(R_{GE}=1 0MΩ) (1)	V_{CGR}	600	V_{DC}
Gate- Emitter Voltage Continuous	V_{GES}	±20	V_{DC}
Gate- Emitter Voltage Transient	V_{GEM}	±30	V
Collector Current Continuous (T_C=25°C)	I_{C25}	50	A_{DC}
(T_C=90°C)	I_{C90}	30	A_{DC}
Collector Current Pulsed (3)	I_{CM}	100	A
Short Circuit Withstand Time (5)	t_{SC}	10	µsec
Switching Safe Operating Area (6)	SSOA	60A @ 0 8 X V_{CES}	—
Total Power Dissipation	P_C	200	W
Power Dissipation Derating (T_C>25 °C)		1 6	W/°C
Operating and Storage Temperature	T_J & T_{STG}	–55 to +150	°C
Thermal Resistance	R_{thJC}	0 625	°C/W
Thermal Resistance	R_{thCS}	0 25 (typ)	°C/W
Max. Lead Temp for Soldering	T_L	300 (1 6mm for 10 sec)	°C
Mounting Torque	M_M	10	in-lb

* The data supplied herein reflects the pre-production specification and characterization measurements from Engineering lots IXYS reserves the right to change limits, test conditions, and dimensions without notice

IXYS Corporation • 2355 Zanker Rd San Jose, CA 95131-1109
TEL (408)435-1900 • FAX (408)435-0670

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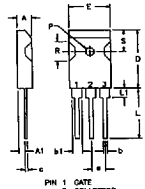
TEL. +49-6206-5030 • FAX +49-6206-503627

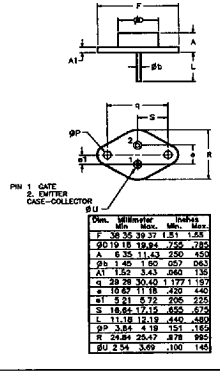
TO-247AD (IXSH)



PIN 1 GATE
2. COLLECTOR
3. EMITTER

Dim.	Millimeter Min	Max	Inches Min.	Max
A	4 70	5 30	185	209
R	4.32	5.49	170	.216
D	20 80	21 46	.819	.845
S	5.4	6.2	.212	.252
E	15.49	16.26	610	640
L1	—	4.50	—	.177
b1	1 65	2.13	065	084
b2	2 87	3 12	113	123
b	1.02	1 40	040	.055
e	5 33	5.59	210	220
L	19 81	20 32	780	800
A1	2.21	2.59	087	102
c	.041	.79	.018	.031
P	3.58	3.68	140	144

TO-204AE (IXSM)



Dim.	Millimeter Min	Max.	Inches Min.	Max.
F	38 35	39 37	1.51	1.55
øD	19 15	19.84	.755	.780
A	6 35	11.43	250	450
øb	1 45	1 50	057	063
A1	1.57	3.43	.060	135
q	29 28	30.40	1 177	1.197
e	10 67	11 18	.420	440
e1	5 21	5.72	205	225
S	16.64	17.15	.655	.675
L	11.18	12.19	.440	.480
øP	3.84	4.19	151	.165
R	24.84	25.47	.978	995
øU	2 54	3.69	.100	145

IXYS

IXSH30N60,60A
IXSM30N60,60A

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

CHARACTERISTIC	TEST CONDITION		SYMBOL	MIN	TYP	MAX	UNIT
Collector-Emitter Breakdown Voltage	I_C=250 µA, V_{GE}=0V		BV_{CES}	600	—	—	V
Gate-Emitter Threshold Voltage	I_C=2 5 mA, V_{CE}=V_{GE}		$V_{GE(th)}$	4	—	7	V
Gate-Emitter Leakage Current	V_{GE}= ± 20V, V_{CE}=0V		I_{GES}	—	—	± 100	nA
Collector Leakage Current	V_{CE}= 0 8 x V_{CES}, V_{GE}= 0V	T_C=25°C	I_{CES}	—	—	50	µA
		T_C=125°C		—	—	1	mA
Collector-Emitter Saturation Voltage	I_C= I_{C90}, V_{GE}=15V	30N60	$V_{CE(sat)}$	—	—	2 5	V
		30N60A		—	—	3 0	
Forward Transconductance (2)	I_C= I_{C90}, V_{CE}=10V		g_{fs}	7	13	—	S
Short Circuit Current	V_{GE}=15V, V_{CE}=10V		$I_{C(on)}$	—	100	—	A
Input Capacitance	V_{CE}=25V, V_{GE}=0V, f=1MHz		C_{ies}	—	2760	—	pF
Output Capacitance			C_{oes}	—	240	—	pF
Reverse Transfer Capacitance			C_{res}	—	51	—	pF
Total Gate Charge	V_{GE}=15V, I_C= I_{C90}, V_{CE}=0 5 x V_{CES}		$Q_{g(on)}$	—	110	—	nC
Gate-Emitter Charge			Q_{ge}	—	34	—	nC
Gate-Collector ("Miller") Charge			Q_{gc}	—	47	—	nC

SWITCHING CHARACTERISTICS

CHARACTERISTIC	TEST CONDITION		SYMBOL	MIN	TYP	MAX	UNIT
Turn-On Delay Time	**Resistive Load**		$t_{d(on)}$	—	60	—	ns
Current Rise Time	I_C= I_{C90}, T_J=125°C, V_{CC}=0 8 x V_{CES}, V_{GE} = 15V, R_G =4 7Ω		t_r	—	130	—	ns
Current Fall Time	**Inductive Load**	30N60	t_{fi}	—	400	—	ns
	L=100 µH, I_C= I_{C90}, T_J= 25 °C,	30N60A	t_{fi}	—	200	—	ns
Turn-Off Energy	V_{CC}= 0 8 x V_{CES}, V_{GE}= 15V,	30N60	$W_{(off)}$	—	5	—	mJ
	R_G= 4 7Ω (4)	30N60A	$W_{(off)}$	—	2 5	—	mJ
Turn-Off Delay Time	**Inductive Load**	30N60	$t_{d(off)}$	—	340	—	ns
		30N60A	$t_{d(off)}$	—	340	525	ns
Current Fall Time		30N60	t_{fi}	—	600	1500	ns
	L=100 µH, I_C= I_{C90}, T_J= 125 °C,	30N60A	t_{fi}	—	340	700	ns
Cross-Over Time	V_{CC}= 0 8 x V_{CES}, V_{GE}= 15V,	30N60	t_c	—	1400	—	ns
	R_G=4 7 Ω (4)	30N60A	t_c	—	600	800	ns
Turn-Off Energy		30N60	$W_{(off)}$	—	12	—	mJ
		30N60A	$W_{(off)}$	—	5	—	mJ

(1) T_J=25 °C to 150 °C
(2) Pulse Test: Pulse width ≤ 300 µs, duty cycle ≤ 2%
(3) Repetitive Rating: Pulse width limited by max junction temperature
(4) Switching times may increase for V_{CE} (Clamp) > 0.8 xV_{CES}, T_J>125 °C or R_G>4 7 Ω
(5) Non-Repetitive Rating T_C=125 °C, V_{CC}=360V, V_{GE}=15V, R_G=4 7 Ω
(6) Turn-Off SSOA (or RBSOA), T_C=125 °C, V_{GE}=15V, Clamped Inductive Load, L=100µH, R_G=4 7 Ω

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IXSH30N60 IXSM30N60

Fig.1. Saturation Characteristics

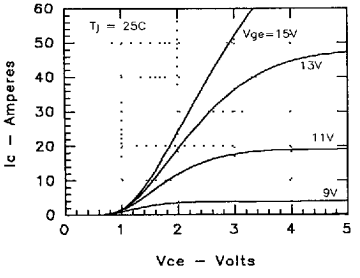


Fig. 2. Output Characteristics

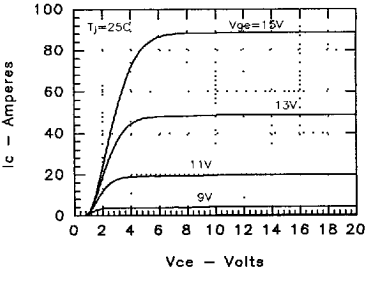


Fig. 3. Collector-Emitter Voltage vs. Gate-Emitter Voltage

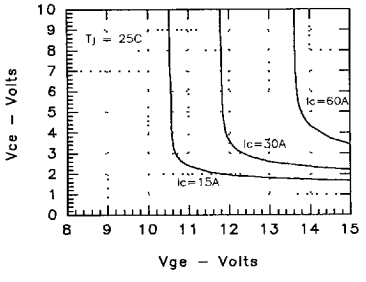


Fig. 4. Temperature Dependence of Output Saturation Voltage

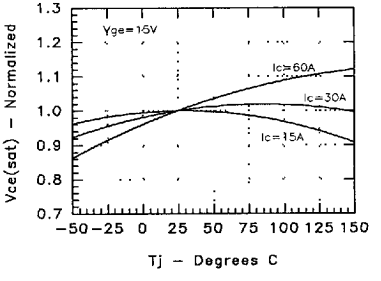


Fig. 5. Input Admittance

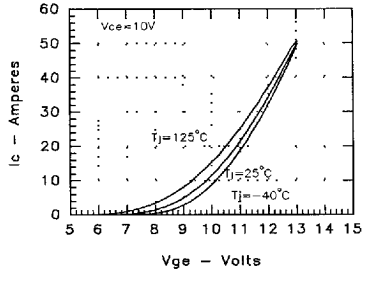
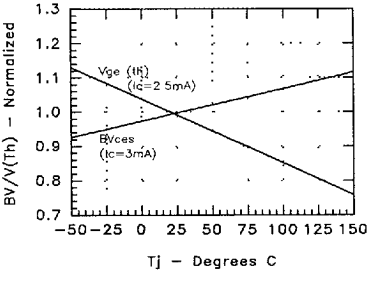


Fig. 6. Temperature Dependence of Breakdown Voltage and Threshold Voltage



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IXSH30N60 IXSM30N60

Fig. 7. Dependence of Turn-Off Energy Per Pulse and Fall Time on Collector Current

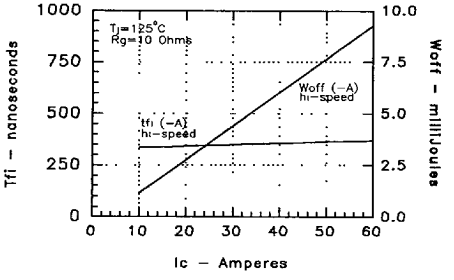


Fig. 8. Dependence of Turn-Off Energy Per Pulse and Fall Time on Rg

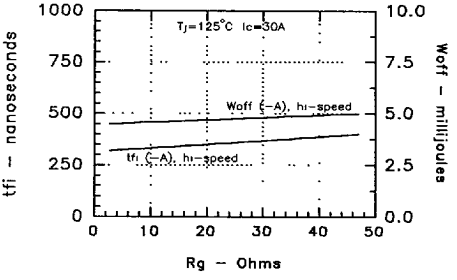


Fig. 9. Gate Charge Characteristic Curve

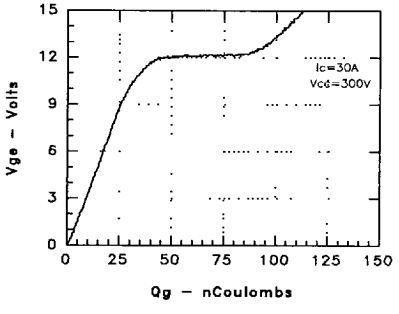


Fig. 10. Turn-Off Safe Operating Area

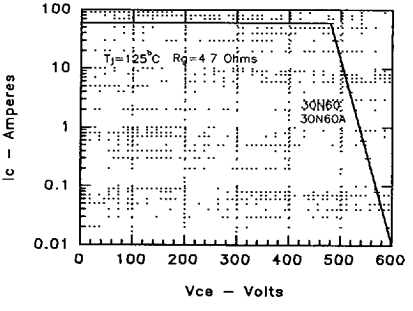
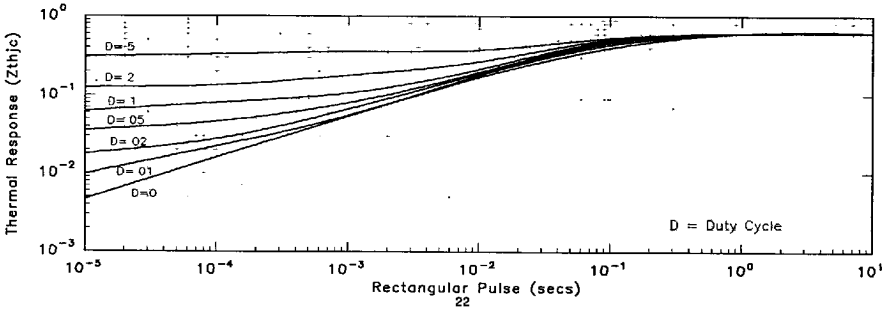


Fig. 11. Transient Thermal Impedance



IXYS

PRELIMINARY TECHNICAL INFORMATION* Data Sheet No 91547A October 1991

HIGH VOLTAGE "S" Series MOSIGBT

Improved SCSOA Capability

IXSH20N60, 60A
IXSM20N60, 60A

Part Number	V_{CES}	I_{C25}	$V_{CE(SAT)}$
20N60	600V	20A	2 5 V
20N60A			3 0 V

FEATURES:

- Guaranteed Short Circuit SOA Capability
- Fast Fall Time for Switching Speeds up to 30kHz
- Low $V_{CE\ (sat)}$ for Low On-State Conduction Losses
- MOS Gate Turn-on Drive Simplicity

APPLICATIONS:

- Motor Control
- Uninterruptible Power Supplies
- Welding

MAXIMUM RATINGS

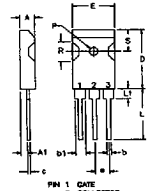
Parameter	Symbol	Rating	Unit
Collector-Emitter Voltage (1)	V_{CES}	600	V_{DC}
Collector-Gate Voltage(R_{GE}=1 0MΩ) (1)	V_{CGR}	600	V_{DC}
Gate- Emitter Voltage Continuous	V_{GES}	±20	V_{DC}
Gate- Emitter Voltage Transient	V_{GEM}	±30	V
Collector Current Continuous (T_C=25°C)	I_{C25}	40	A_{DC}
(T_C=90°C)	I_{C90}	20	A_{DC}
Collector Current Pulsed (3)	I_{CM}	75	A
Short Circuit Withstand Time (5)	t_{SC}	10	µsec
Switching Safe Operating Area (6)	SSOA	40A @ 0 8 X V_{CES}	—
Total Power Dissipation	P_C	150	W
Power Dissipation Derating (T_C>25 °C)		1 25	W/°C
Operating and Storage Temperature	T_J & T_{STG}	−55 to +150	°C
Thermal Resistance	R_{thJC}	0 8	°C/W
Thermal Resistance	R_{thCS}	0 25 (typ)	°C/W
Max Lead Temp for Soldering	T_L	300 (1 6mm for 10 sec)	°C
Mounting Torque	M_M	10	In-lb

* The data supplied herein reflects the pre-production objective specification and characterization measurements from Engineering lots IXYS reserves the right to change limits, test conditions, and dimensions without notice

IXYS Corporation • 2355 Zanker Rd. San Jose, CA 95131-1109
TEL (408)435 1900 • FAX (408)435-0670

ABB-IXYS Semiconductor GmbH • POB 1180 D-6840 Lampertheim, Germany
TEL +49-6206 5030 • FAX +49-6206-503627

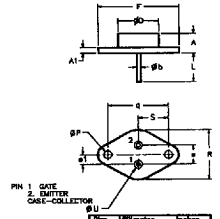
TO-247AD (IXSH)



PIN 1 GATE
2. COLLECTOR
3. EMITTER

Dim.	Millimeter Min.	Max.	Inches Min.	Max.
A	4 70	5.30	185	209
R	4.32	5.49	170	.216
D	20 80	21 46	.819	.845
S	5 4	6.2	232	.252
E	15.49	16.26	610	640
L1	—	4.50	—	177
b1	1 65	2 13	065	084
b2	2.87	3 12	113	123
b	1 02	1.40	.040	055
e	5.33	5 59	210	220
L	19.81	20 32	780	800
A1	2.21	2.59	.087	102
c	.041	79	.016	.031
P	3 56	3.68	.140	.144

TO-204AE (IXSM)



PIN 1 GATE
2. EMITTER
CASE–COLLECTOR

Dim.	Millimeter Min.	Max.	Inches Min.	Max.
F	38.35	39 37	1 51	1 55
øD	19 18	19 84	755	785
A	8 35	11.43	250	450
øb	1.45	1 60	.057	063
A1	1.52	3.43	060	135
q	39.29	30.40	1 177	1.197
e	10.87	11 18	420	.440
e1	5.21	5 72	205	225
S	16.64	17 15	655	675
L	11.18	12.19	440	480
øP	3.84	4.19	151	165
R	24.84	25 47	.978	995
øU	2.54	3 99	100	145

IXYS

IXSH20N60,60A
IXSM20N60,60A

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

CHARACTERISTIC	TEST CONDITION		SYMBOL	MIN	TYP	MAX	UNIT
Collector-Emitter Breakdown Voltage	I_C=250 µA, V_{GE}=0V		BV_{CES}	600	—	—	V
Gate-Emitter Threshold Voltage	I_C=1 5 mA, V_{CE}=V_{GE}		$V_{GE(th)}$	3	—	6	V
Gate-Emitter Leakage Current	V_{GE}= ± 20V, V_{CE}=0V		I_{GES}	—	—	± 100	nA
Collector Leakage Current	V_{CE}= 0 8 x V_{CES}, V_{GE}= 0V	T_C=25°C	I_{CES}	—	—	200	µA
		T_C=125°C		—	—	1	mA
Collector-Emitter Saturation Voltage	I_C= I_{C90}, V_{GE}=15V	non-A	$V_{CE(sat)}$	—	—	2 5	V
		A		—	—	3 0	
Forward Transconductance (2)	I_C= I_{C90}, V_{CE}=10V		g_{fs}	6	7	—	S
Short Circuit Current	V_{GE}=15V, V_{CE}=10V		$I_{C(on)}$	—	65	—	A
Input Capacitance	V_{CE}=25V, V_{GE}=0V, f=1MHz		C_{ies}	—	1800	—	pF
Output Capacitance			C_{oes}	—	160	—	pF
Reverse Transfer Capacitance			C_{res}	—	45	—	pF
Total Gate Charge	V_{GE}=15V, I_C= I_{C90}, V_{CE}= 0 5 x V_{CES}		$Q_{g(on)}$	—	75	—	nC
Gate-Emitter Charge			Q_{ge}	—	20	—	nC
Gate-Collector ("Miller") Charge			Q_{gc}	—	35	—	nC

SWITCHING CHARACTERISTICS

CHARACTERISTIC	TEST CONDITION		SYMBOL	MIN	TYP	MAX	UNIT
Turn-On Delay Time	**Resistive Load**		$t_{d(on)}$	—	100	—	ns
Current Rise Time	I_C= I_{C90}, T_J=125°C, V_{CC}=0 8 x V_{CES}, V_{GE} = 15V, R_G =10Ω		t_r	—	200	—	ns
Turn-Off Delay Time	**Inductive Load**		$t_{d(off)}$	—	—	1000	ns
Current Fall Time	L=100 µH	20N60	t_{fi}	—	—	1000	ns
		20N60A	t_{fi}	—	—	600	ns
Turn-On Energy	I_C= I_{C90}, T_J=125 °C	All Types	$W_{(on)}$	—	—	—	mJ
Turn-Off Energy	V_{CC}=0 8 X V_{CES}, V_{GE}=15V, R_G= 10Ω (4)	20N60	$W_{(off)}$	—	9	—	mJ
		20N60A	$W_{(off)}$	—	3	—	mJ

(1) T_J=25 °C to 150 °C
(2) Pulse Test Pulse width ≤ 300 µs, duty cycle ≤ 2%
(3) Repetitve Rating Pulse width limited by max junction temperature
(4) Switching times may increase for V_{CE} (Clamp) > 0 8 xV_{CES}, T_J>125 °C or R_G>10 Ω
(5) Non-Repetitive Rating T_C=125 °C, V_{CC}=360V, V_{GE}=15V, R_G=10 Ω
(6) Turn-Off SSOA (or RBSOA), T_C=125 °C, V_{GE}=15V, Clamped Inductive Load, L=100µH, R_G=10 Ω

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Fig.1. Saturation Characteristics

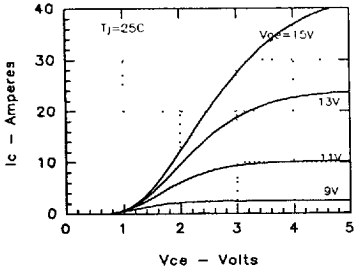

Fig. 2. Output Characteristics

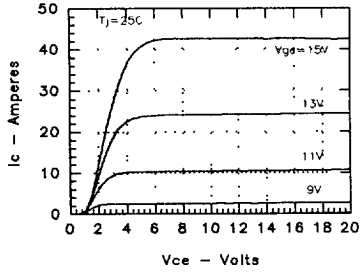

Fig. 3. Collector-Emitter Voltage vs. Gate-Emitter Voltage

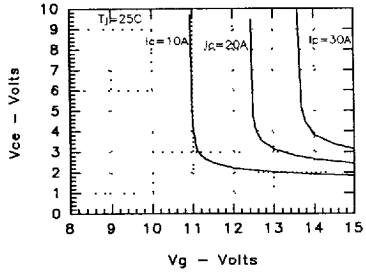

Fig. 4. Temperature Dependence of Output Saturation Voltage

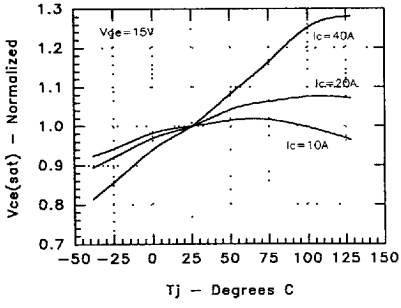

Fig. 5. Input Admittance

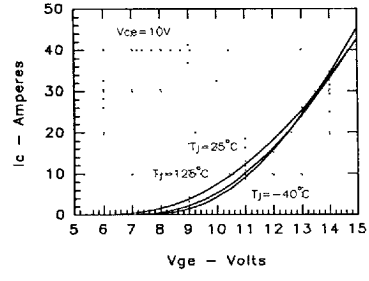

Fig. 6. Temperature Dependence of Breakdown Voltage and Threshold Voltage

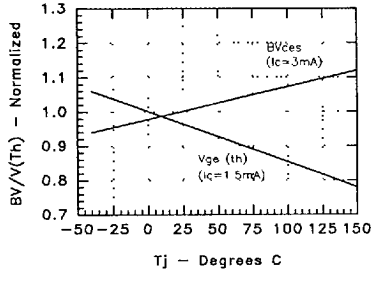

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Fig. 7. Dependence of Turn-Off Energy Per Pu se and Fall Time on Collector Current

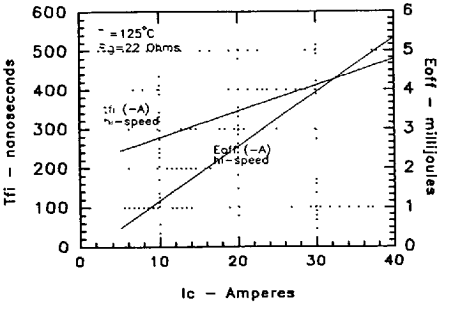
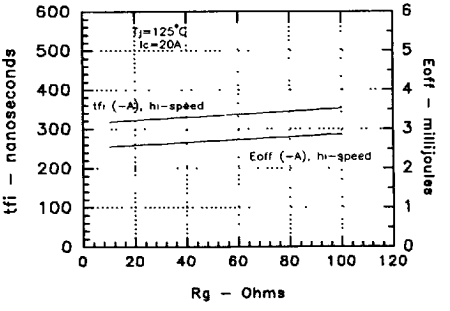


Fig. 8. Dependence of Turn-Off Energy Per Pulse and Fall Time on Rg



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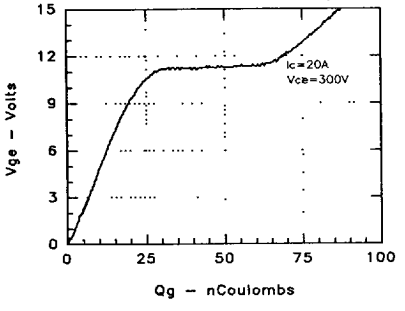

Fig. 10. Turn-Off Safe Operating Area

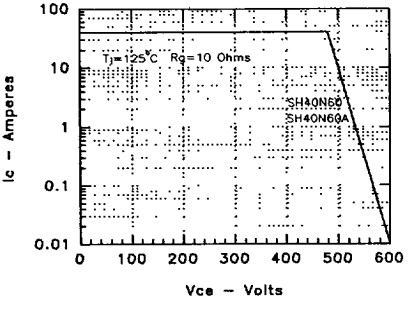

Fig. 11. Transient Thermal Impedance