International
IOR Rectifier

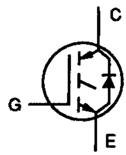
PD-9.813

IRGMIC50U

INSULATED GATE BIPOLAR TRANSISTOR WITH ON-BOARD REVERSE DIODE

Ultra Fast-Speed IGBT

- Electrically Isolated
- Hermetically Sealed
- Simple Drive Requirements
- Latch-proof
- UltraFast operation > 10 kHz
- Switching-loss rating includes all "tail" losses
- Ceramic Eyelets



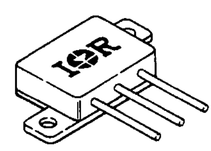
n-channel

$V_{CES} = 600V$
$f_{Ic/2} \approx 20kHz$
I_C @ $f_{Ic/2} = 18A$
$V_{CE(on)} \leq 3.0V$
@$V_{GE} = 15V$, $I_C = 27A$

Description

Insulated Gate Bipolar Transistors (IGBTs) from International Rectifier have higher usable current densities than comparable bipolar transistors, while at the same time having simpler gate-drive requirements of the familiar power MOSFET. They provide substantial benefits to a host of higher-voltage, higher-current aplications.

The performance of various IGBTs varies greatly with frequency. Note that IR now provides the designer with a speed benchmark ($f_{Ic/2}$, or the "half-current frequency"), as well as an indication of the current handling capability of the device.


TO-259AA*

*For mechanical dimensions see page G-114

Absolute Maximum Ratings

	Parameter	Max.	Units
$V_{(BR)CES}$	Collector-to-Emitter Breakdown Voltage	600	V
I_C @ T_C = 25°C	Continuous Collector Current	45*	A
I_C @ T_C = 100°C	Continuous Collector Current	27	
I_{CM}	Pulsed Collector Current ①	220	
V_{GE}	Gate-to-Emitter Voltage	±20	V
I_{LM}	Clamped Inductive Load Current ②	180	A
P_D @ T_C = 25°C	Maximum Power Dissipation	200	W
P_D @ T_C = 100°C	Maximum Power Dissipation	80	W
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to 150	°C
	Soldering Temperature, for 10 sec.	300 (0.063 in. (1.6mm) from case)	
	Weight	10.5	g

*I_C current limited by pin diameter

Thermal Resistance

	Parameter	Min.	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case-IGBT	—	—	0.625	°C/W
$R_{\theta JC}$	Junction-to-Case-Diode	—	—	1.0	
$R_{\theta CS}$	Case-to-Sink, flat, greased surface	—	0.21	—	
$R_{\theta JA}$	Junction-to-Ambient, typical socket mount	—	—	30	

Electrical Characteristics @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
$V_{(BR)CES}$	Collector-to-Emitter Breakdown Voltage	600	—	—	V	V_{GE} = 0V, I_C = 1.0 mA
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coefficient of Breakdown Voltage	—	0.60	—	V/°C	V_{GE} = 0V, I_C = 1.0 mA
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	—	3.0	V	V_{GE} = 15V, I_C = 27A
		—	—	3.25		V_{GE} = 15V, I_C = 45A
		—	—	2.85		V_{GE} = 15V, I_C = 27A, T_J = 125°C
$V_{GE(th)}$	Gate Threshold Voltage	3.0	—	5.5	V	V_{CE} = V_{GE}, I_C = 250µA
$\Delta V_{GE(th)}/\Delta T_J$	Temp. Coeff. of Threshold Voltage	—	-13	—	mV/°C	V_{CE} = V_{GE}, I_C = 250µA
g_{fe}	Forward Transconductance ③	16	—	—	S	V_{CE} = 100V, I_C = 27A, V_{DS} ≥ 15V
I_{CES}	Zero Gate Voltage Collector Current	—	—	250	µA	V_{GE} = 0V, V_{CE} = 480V, T_J = 25°C
		—	—	5000		V_{GE} = 0V, V_{CE} = 480V, T_J = 125°C
V_{FM}	Diode Forward Voltage Drop	—	—	1.7	V	I_C = 27A, T_J = 25°C
		—	—	1.5		I_C = 27A, T_J = 125°C

Switching Characteristics @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
Q_G	Total Gate Charge (turn-on)	—	—	140	nC	I_C = 27A, V_{CC} = 300V
Q_{GE}	Gate-Emitter Charge (turn-on)	—	—	35		See Fig. 8
Q_{GC}	Gate-Collector Charge (turn-on)	—	—	70		V_{GE} = 15V
$t_{d(on)}$	Turn-On Delay Time	—	—	50	ns	I_C = 27A, V_{CC} = 480V
t_r	Rise Time	—	—	75		T_J = 25°C
$t_{d(off)}$	Turn-Off Delay Time	—	—	300		V_{GE} = 15V, R_G = 2.35Ω
t_f	Fall Time	—	—	210		Energy losses include "tail"
E_{on}	Turn-On Switching Loss	—	0.12	—	mJ	See Fig. 10 and 15a
E_{off}	Turn-Off Switching Loss	—	1.6	—		
E_{ts}	Total Switching Loss	—	1.7	2.8		
$t_{d(on)}$	Turn-On Delay Time	—	24	—	ns	I_C = 27A, V_{CC} = 480V
t_r	Rise Time	—	27	—		T_J = 125°C
$t_{d(off)}$	Turn-Off Delay Time	—	180	—		V_{GE} = 15V, R_G = 2.35Ω
t_f	Fall Time	—	130	—		See Fig. 10 and 15a
E_{ts}	Total Switching Loss	—	2.7	—	mJ	
L_E	Internal Emitter Inductance	—	13	—	nH	Measured 5mm from package
C_{ies}	Input Capacitance	—	2900	—	pF	V_{GE} = 0V
C_{oes}	Output Capacitance	—	330	—		V_{CC} = 30V
C_{res}	Reverse Transfer Capacitance	—	41	—		f = 1.0MHz
t_{rr}	Diode Peak Reverse Recovery Time	—	—	100	ns	di/dt ≤ 200A/µs, I_F = 27A, T_J = 25°C, V_R ≤ 200V
Q_{rr}	Diode Peak Reverse Recovery Charge	—	—	375	nC	di/dt ≤ 200A/µs, I_F = 27A, T_J = 25°C, V_R ≤ 200V

Notes: ① Repetitive rating; V_{GE} = 20V, pulse width limited by max. junction temperature. (See Fig. 13b).

② V_{CC} = 80% (V_{CES}), V_{GE} = 20V, L ≥ 10µH, R_G = 10Ω. (See Fig. 13a).

③ Pulse width ≤5µs, single shot.

Electrical Characteristics @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
$V_{(BR)CES}$	Collector-to-Emitter Breakdown Voltage	600	—	—	V	V_{GE} = 0V, I_C = 1.0 mA
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coefficient of Breakdown Voltage	—	0.60	—	V/°C	V_{GE} = 0V, I_C = 1.0 mA
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	—	3.0	V	V_{GE} = 15V, I_C = 27A
		—	—	3.25		V_{GE} = 15V, I_C = 45A
		—	—	2.85		V_{GE} = 15V, I_C = 27A, T_J = 125°C
$V_{GE(th)}$	Gate Threshold Voltage	3.0	—	5.5	V	V_{CE} = V_{GE}, I_C = 250μA
$\Delta V_{GE(th)}/\Delta T_J$	Temp. Coeff. of Threshold Voltage	—	-13	—	mV/°C	V_{CE} = V_{GE}, I_C = 250μA
g_{fe}	Forward Transconductance ③	16	—	—	S	V_{CE} = 100V, I_C = 27A, V_{DS} ≥ 15V
I_{CES}	Zero Gate Voltage Collector Current	—	—	250	μA	V_{GE} = 0V, V_{CE} = 480V, T_J = 25°C
		—	—	5000		V_{GE} = 0V, V_{CE} = 480V, T_J = 125°C
V_{FM}	Diode Forward Voltage Drop	—	—	1.7	V	I_C = 27A, T_J = 25°C
		—	—	1.5		I_C = 27A, T_J = 125°C

Switching Characteristics @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
Q_G	Total Gate Charge (turn-on)	—	—	140	nC	I_C = 27A, V_{CC} = 300V
Q_{GE}	Gate-Emitter Charge (turn-on)	—	—	35		See Fig. 8
Q_{GC}	Gate-Collector Charge (turn-on)	—	—	70		V_{GE} = 15V
$t_{d(on)}$	Turn-On Delay Time	—	—	50	ns	I_C = 27A, V_{CC} = 480V
t_r	Rise Time	—	—	75		T_J = 25°C
$t_{d(off)}$	Turn-Off Delay Time	—	—	300		V_{GE} = 15V, R_G = 2.35Ω
t_f	Fall Time	—	—	210		Energy losses include "tail"
E_{on}	Turn-On Switching Loss	—	0.12	—	mJ	See Fig. 10 and 15a
E_{off}	Turn-Off Switching Loss	—	1.6	—		
E_{ts}	Total Switching Loss	—	1.7	2.8		
$t_{d(on)}$	Turn-On Delay Time	—	24	—	ns	I_C = 27A, V_{CC} = 480V
t_r	Rise Time	—	27	—		T_J = 125°C
$t_{d(off)}$	Turn-Off Delay Time	—	180	—		V_{GE} = 15V, R_G = 2.35Ω
t_f	Fall Time	—	130	—		See Fig. 10 and 15a
E_{ts}	Total Switching Loss	—	2.7	—	mJ	
L_E	Internal Emitter Inductance	—	13	—	nH	Measured 5mm from package
C_{ies}	Input Capacitance	—	2900	—	pF	V_{GE} = 0V
C_{oes}	Output Capacitance	—	330	—		V_{CC} = 30V
C_{res}	Reverse Transfer Capacitance	—	41	—		f = 1.0MHz
t_{rr}	Diode Peak Reverse Recovery Time	—	—	100	ns	di/dt ≤ 200A/μs, I_F = 27A, T_J = 25°C, V_R ≤ 200V
Q_{rr}	Diode Peak Reverse Recovery Charge	—	—	375	nC	di/dt ≤ 200A/μs, I_F = 27A, T_J = 25°C, V_R ≤ 200V

Notes: ① Repetitive rating; V_{GE} = 20V, pulse width limited by max. junction temperature. (See Fig. 13b).

② V_{CC} = 80% (V_{CES}), V_{GE} = 20V, L ≥ 10μH, R_G = 10Ω. (See Fig. 13a).

③ Pulse width ≤5μs, single shot.

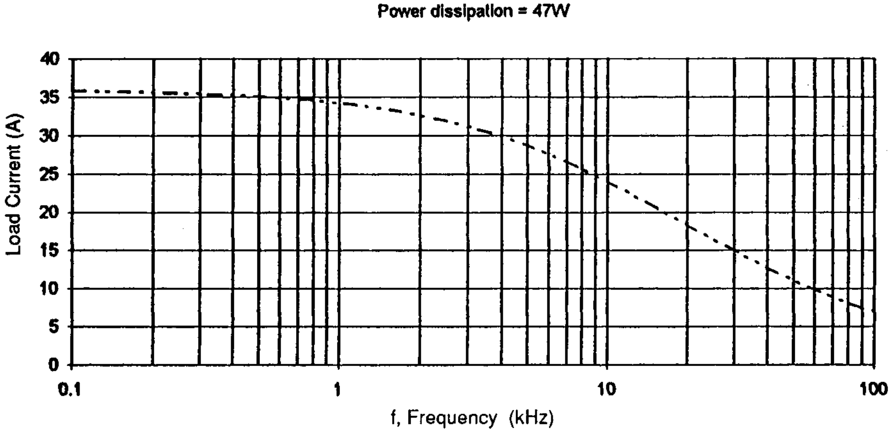


Fig. 1. Typical Load Current vs. Frequency
(For square wave, $I = I_{RMS}$ of fundamental; for triangular wave, $I = I_{PK}$)

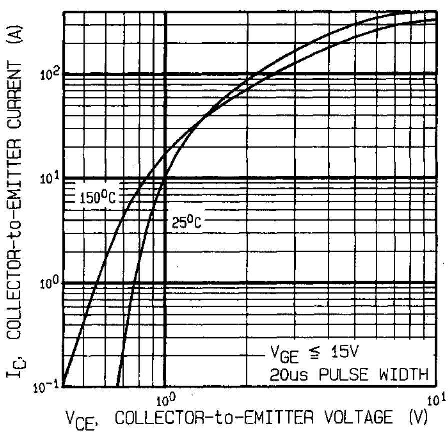


Fig. 2. Typical Output Characteristics
$T_J = 25°C$
$T_J = 150°C$

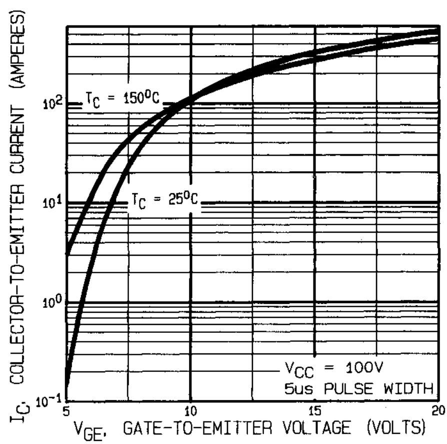


Fig. 3. Typical Transfer Characteristics
$T_J = 25°C$
$T_J = 150°C$

G

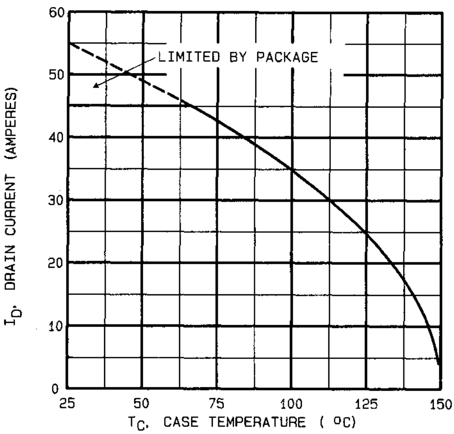


Fig. 4 Maximum Collector Current vs. Case Temperature

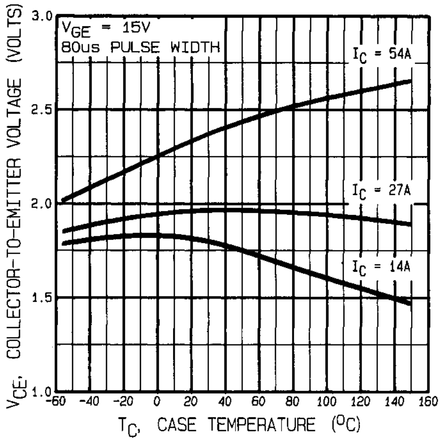


Fig. 5. Collector-to-Emitter Saturation Voltage vs. Case Temperature

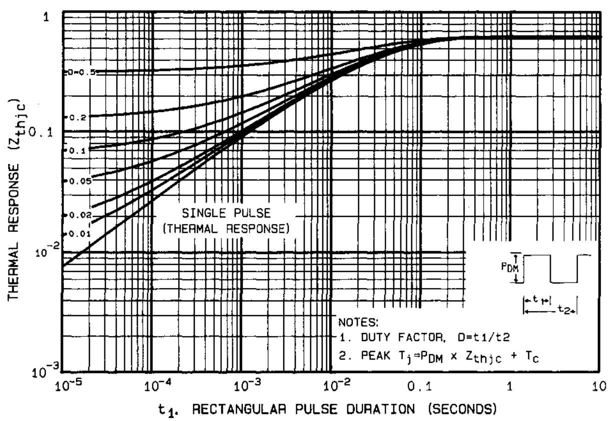


Fig. 6. Maximum Effective Transient Thermal Impedance, Junction-to-Case

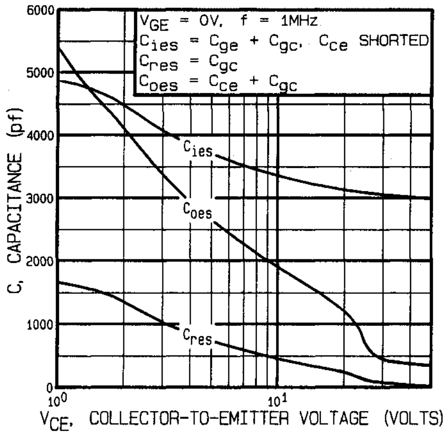


Fig. 7. Typical Capacitance vs. Collector-to-Emitter Voltage

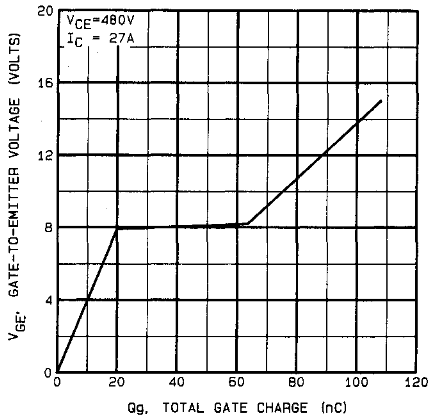


Fig. 8. Typical Gate Charge vs. Gate-to-Emitter Voltage

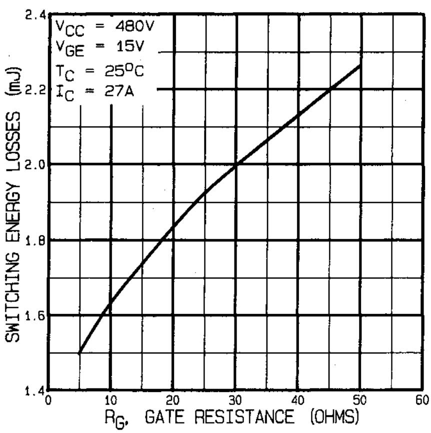


Fig. 9. Typical Switching Losses vs. Gate Resistance

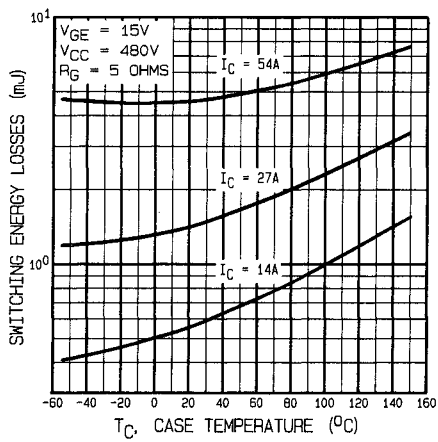


Fig. 10. Typical Switching Losses vs. Case Temperature

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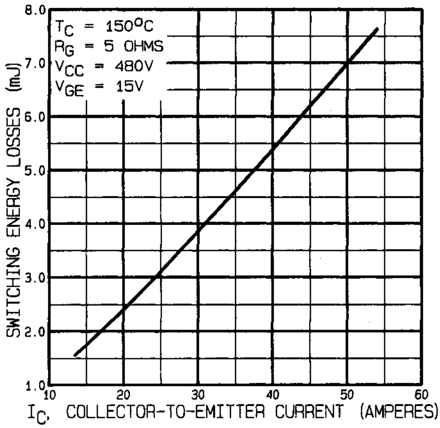

Fig. 11. Typical Switching Losses vs. Collector-to-Emitter Current

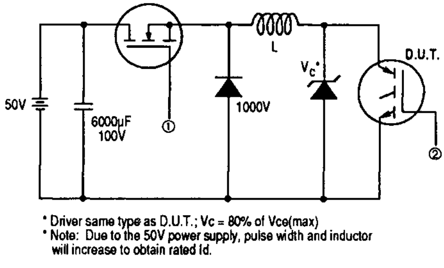

Fig. 12a. Clamped Inductive Load Test Circuit

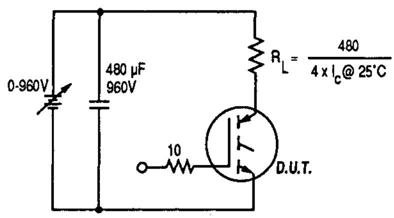

Fig. 12b. Pulsed Collector Current Test Circuit

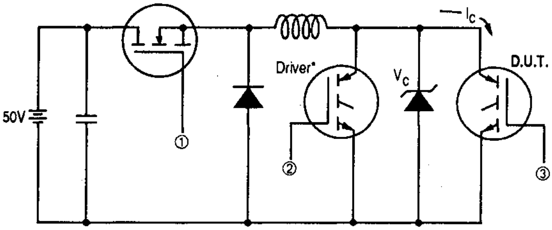

Fig 13a. Switching Loss Test Circuit

* Driver same type as D.U.T., Vc = 480V

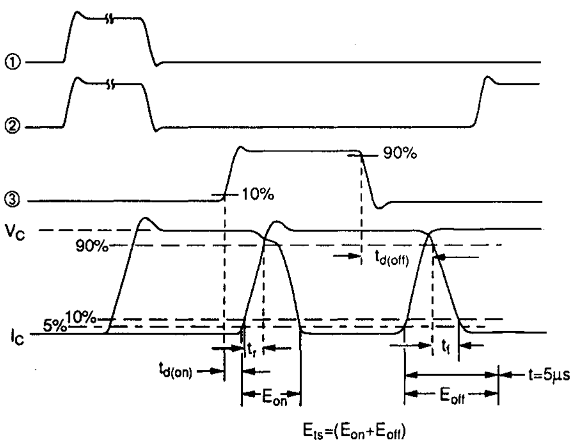

Fig 13b. Switching Loss Waveforms

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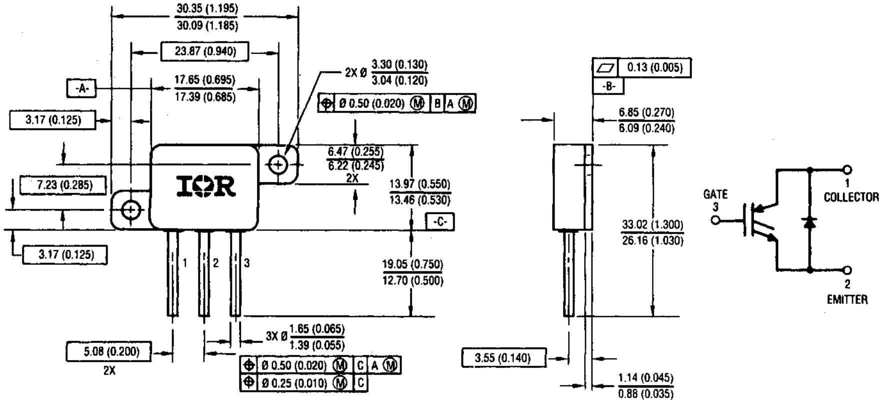
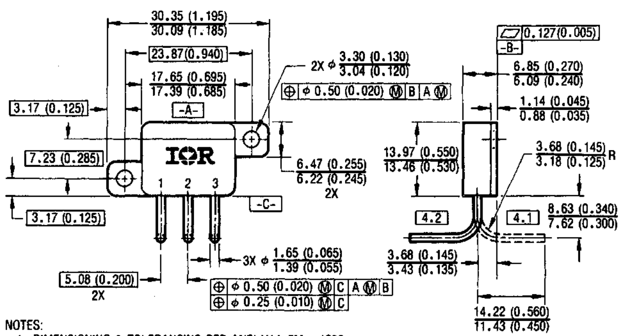


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M – 1982.
2. DIMENSIONS ARE SHOWN IN MILLIMETERS (INCHES).

Fig. 14 – Conforms to JEDEC Outline TO-259AA



NOTES:
1 DIMENSIONING & TOLERANCING PER ANSI Y14.5M - 1982.
2 CONTROLLING DIMENSION: INCH.
3 ALL DIMENSIONS ARE SHOWN IN MILLIMETERS (INCHES).
4 LEADFORM IS AVAILABLE IN EITHER ORIENTATION:
   [4.1] EXAMPLE: IRGMIC50UD
   [4.2] EXAMPLE: IRGMIC50UU

LEGEND
1 COLLECTOR
2 EMITTER
3 GATE

BERYLLIA WARNING PER MIL-S-19500
Packages containing beryllia shall not be ground, sandblasted, machined, or have other operations performed on them which will produce beryllia or beryllium dust. Furthermore, beryllium oxide packages shall not be placed in acids that willl produce fumes containing beryllium.

Fig. 15 – Optional Leadforms for Outline TO-259