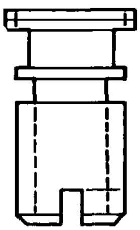
MA46021-MA46049 Series

CW Gallium Arsenide IMPATT Diodes

0.5-4 Watts C,X, and Ku-Band



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Features

- DIRECT CONVERSION FOR DC TO RF WITH >15% EFFICIENCY (LOW-HIGH-LOW)
- DIRECT CONVERSION FOR DC TO RF WITH >10% EFFICIENCY (FLAT PROFILE)
- LOW AM AND FM NOISE
- LOW COST

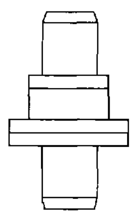
Description

These Gallium Arsenide IMPATT diodes (Impact Avalanche Transit Time) are junction devices that operate with a reverse bias sufficient to cause avalanche breakdown (typically 60 V and 125-150 mA). In such a diode, carriers are produced by avalanche multiplications. The negative resistance at microwave frequencies is the result of the avalanche phase delay between the voltage and the current. This is produced by both carrier generation and the circuit, causing the diodes to oscillate, producing a microwave output at an efficiency greater than 10% at the 0.5 and 1 watt levels. By use of a modified doping profile in the epitaxial layer (low-high-low profile), the efficiency can be increased to greater than 15% in the case of high output power devices (>2 watts). This series of IMPATT devices includes diodes that operate in C, X and Ku band.

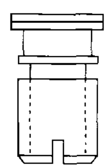
Applications

These IMPATT diodes are useful as CW oscillators with up to 4 watts of output power. They are ideally suited as intermediate or final stage amplifiers for telecommunication systems. These diodes can be combined for high power if necessary.

Case Styles



92



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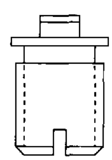

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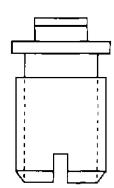

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Specifications @ T_A = 25°C

Model Number	Case[1] Style	Operating[2] Frequency Min./Max. (GHz)	Output[2] Power Min./Typ. (Watts)	Minimum[3] Efficiency (%)	Maximum[4] Thermal Resistance Theta (°C/W)	Breakdown[5] Voltage Min./Max. (Volts)	Operating[5] Voltage Min./Max. (Volts)	Maximum Operating Current (Amps)	Junction[1,6] Capacitance Min./Max. (pF)
MA46040	111	6.0/8.0	1.5	12	13	65/75	75/95	.150	7/10
MA46033	111	7.0/9.0	2.5/3.0	16	11	25/35	45/60	.350	10/14
MA46030	111	8.0/10.0	1.0/1.3	10	15	50/65	65/80	.125	5/8
MA46027	92	8.0/10.0	1.0/1.3	10	15	50/65	65/80	.125	5/8
MA46024	111	8.0/9.5	0.5/0.7	10	25	50/65	65/80	.100	4/7
MA46021	92	8.0/9.5	0.5/0.7	10	25	50/65	65/80	.100	4/7
MA46028	92	9.5/11.0	1.0/1.3	10	15	40/55	55/70	.150	4/7
MA46031	111	9.5/11.0	1.0/1.3	10	15	40/55	55/70	.150	4/7
MA46022	92	9.5/11.0	0.5/0.7	10	25	40/55	55/70	.100	3/6
MA46025	111	9.5/11.0	0.5/0.7	10	25	40/55	55/70	.100	3/6
MA46032	111	11.0/12.5	1.0/1.3	10	15	30/45	45/60	.150	3/5
MA46029	92	11.0/12.5	1.0/1.3	10	15	30/45	45/60	.150	3/5
MA46026	111	11.0/12.5	0.5/0.7	10	25	30/45	45/60	.100	2/4
MA46023	92	11.0/12.5	0.5/0.7	10	25	30/45	45/60	.100	2/4
MA46041	148	17.0/19.0	0.5/0.7	10	22	22/26	30/35	.240	2/3

Model Number	Case[1] Style	Operating[2] Frequency Min./Max. (GHz)	Output[2] Power Min./Typ. (Watts)	Minimum[3] Efficiency (%)	Maximum[4] Thermal Resistance Theta (°C/W)	Breakdown[5] Voltage Min./Max. (Volts)	Operating[5] Voltage Min./Max. (Volts)	Maximum Operating Current (Amps)	Junction[1,6] Capacitance Min./Max. (pF)
MA46037	111	6/8	4.0/4.50	20	11	35/50	60/75	.375	16/24
MA46038	111	8/10	3.8/4.10	20	11	25/35	50/60	.425	20/30
MA46034	111	9/11	2.0/2.50	15	11	20/30	40/50	.350	7/12
MA46036	111	10/12	3.8/4.10	20	11	20/30	40/50	.500	20/30
MA46035	111	11/13	2.0/2.50	12	10	17/25	35/45	.350	7/12
MA46039	111	12/15	2.5/3.00	18	13	17/25	30/40	.400	10/15
MA46049	275	14/17	2.5/2.75	15	12	13/23	30/40	.550	10/15

NOTES:

1. Package capacitance and inductance are shown with the case style drawing.
2. These diodes will deliver at least the minimum specified output power into a critically coupled load at a customer specified frequency in the indicated frequency range.
3. Efficiency $= \frac{\text{RF Power Out}}{\text{DC Power In}} \times 100$
4. Thermal resistance is obtained by measuring the change in breakdown voltage with dc current. Test method TM-372 describes this technique and is available upon request.
5. Breakdown voltage is specified at 1 mA.
6. Capacitance is measured at 1 MHz and 0 volts bias. The capacitance at breakdown is approximately 0.1 this value.

MAXIMUM RATINGS

Storage Temperature	−65°C to +200°C
Junction Operating Temperature	+225°C (For long term reliable operation)

ENVIRONMENTAL RATINGS

Screen/Test Inspection	MIL-STD-750 Method	Conditions/Comments
Storage Temperature	1031	−65°C to +200°C
Operating Temperature		+225°C
Temperature Cycle	1051	10 cycles, −65°C to +175°C
Shock	2016	500 g's
Vibration	2056	15 g's
Constant Acceleration	2006	20,000 g's
Humidity	1021	10 days
Leak Tests:		
Fine and Gross	1071	Maximum leak rate: 1 X 10^{-8} atm cc/sec

ENVIRONMENTAL PERFORMANCE

The MA46021-MA46049 series of diodes is capable of meeting the tests dictated by the methods and procedures of the latest revisions of MIL-S-19500, MIL-STD-202 and MIL-STD-750 which specify mechanical, electrical, thermal and other environmental tests common to semiconductors.

Device Reliability

The reliability of these Schottky barrier IMPATTS has been established through long term operations and step stress testing. A four layer Schottky barrier metallization system eliminates potential problems arising from reaction of the Schottky metal with the semiconductor and from the penetration of metallization into the semiconductor during long term operation. Well established chip fabrication and mounting techniques further enhance device reliability by reducing the possibility of surface breakdown or chip damage in mounting.

Long term operating and step stress tests have indicated that a junction temperature of 220°C, MTTF will approach 10^6 hours. Long term operation and field service data in operating oscillators allow an estimate of the MTBF at a 200°C junction to be made. The data presently available places the MBTF at 40% confidence to be greater than 10^5 hours.

Devices of LHL type (output power greater than 1.5 watts) have been shown to be extremely rugged with respect to load mismatch. Short or open circuit loads may be tolerated indefinitely provided thermal dissipation limits are observed. Flat profile types should not be subjected to extreme mismatch while operating at full power.

The interaction of the microwave and bias port impedances represents a complex situation. A constant current regulated source is recommended for biasing the IMPATT diodes. Reference (1) describes the bias circuit instabilities that may occur, and recommends techniques for controlling the instabilities.

(1) C.A. Brackett, "The Elimination of Tuning-Induced Burnout and Bias Circuit Oscillations in IMPATT Oscillators." Bell Systems Technical Journal, Vol. 2, No. 3, March 1973, pp. 271-306.

Application Notes

Since all IMPATT devices are susceptible to tuning induced failures (burn-out), it is always necessary to reduce the bias voltage before tuning for maximum power.

Caution: A severe load mismatch should be avoided to minimize RF burn out.

The power supply should be carefully regulated to minimize voltage transients.

Low-High-Low diode types are more resistant to tuning induced burn out than flat profile types.

Applications assistance and engineering drawings of the test fixtures are available upon request.

Diode Mounting Procedure: Diodes in style 111 package should be securely tightened into a clean sharply tapped 3-48 UNC-2A threaded hole in copper diode holders or heat sinks. Diodes in style 92 package should be gripped securely in a collet assembly or soldered in place using a minimum thickness of 63-37 lead tin solder. Do not exceed 200°C for 20 seconds.

Small Signal Impedance Measurement: M/A-COM Gallium Arsenide IMPATT diodes are ideally suited for use in reflection amplifier applications. Small signal impedance data can be supplied for individual devices upon request at a nominal charge.

Typical Performance Curves

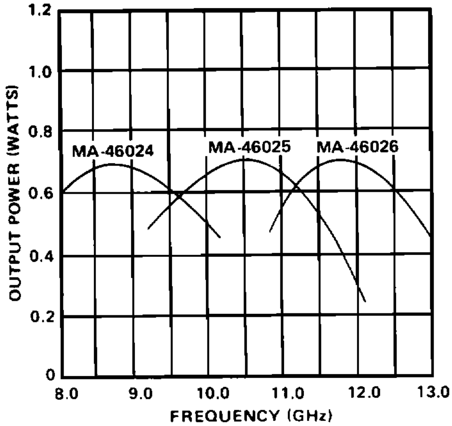


FIGURE 1. Output Power vs. Frequency

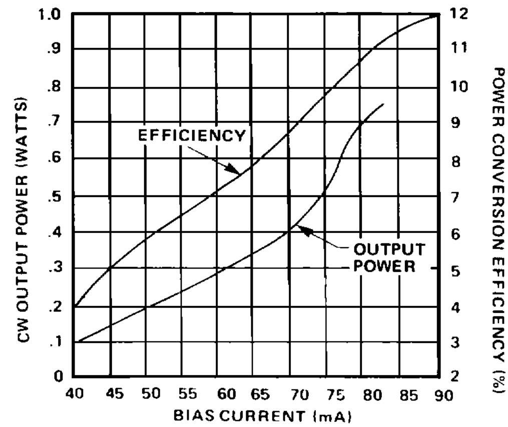


FIGURE 2. Output Power and Efficiency vs. Bias Current for an MA46024 IMPATT Diode

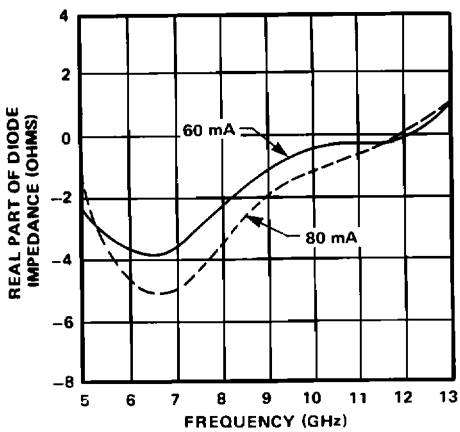


FIGURE 3. Real Part of the Small Signal Impedance for an MA46024 IMPATT Diode vs. Frequency and Bias Level

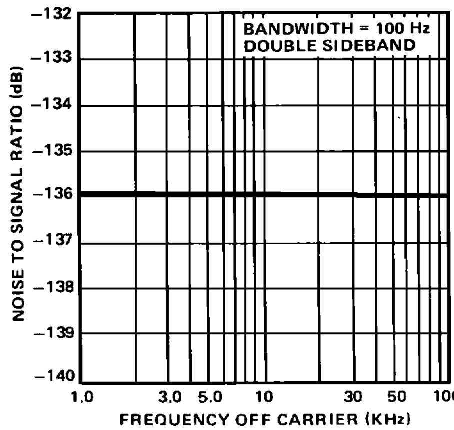


FIGURE 4. AM Noise vs. Frequency for 0.5 Watt Devices

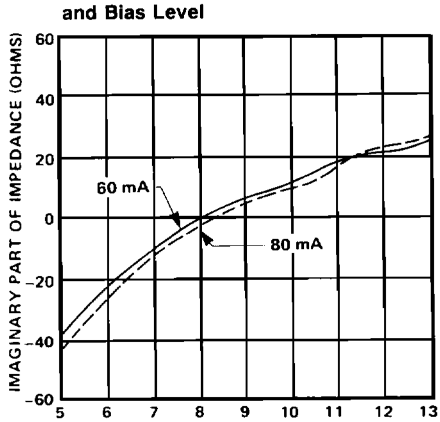


FIGURE 5. Imaginary Part of the Small Signal Impedance for an MA46024 IMPATT Diode vs. Frequency and Bias Level

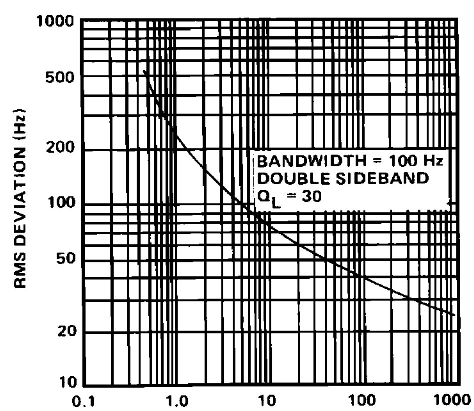


FIGURE 6. FM Noise vs. Frequency Off Carrier for 0.5 Watt Devices

Typical Performance Curves (Cont'd)

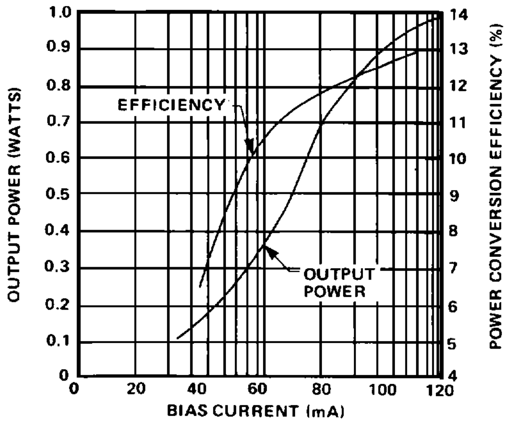


FIGURE 7. Output Power and Efficiency vs. Bias Current for and MA46030 IMPATT Diode

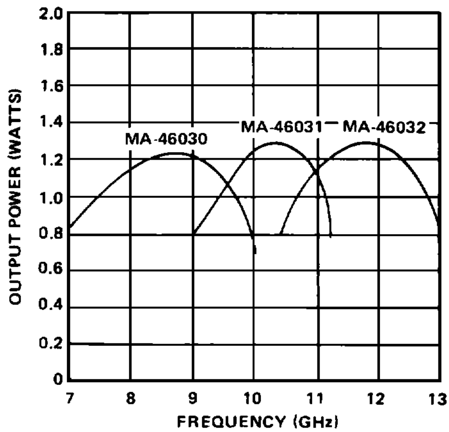


FIGURE 8. Output Power vs. Frequency

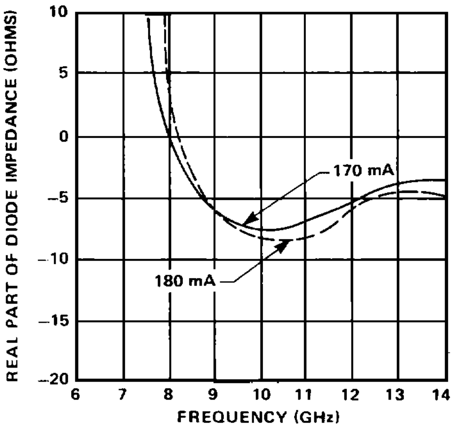


FIGURE 9. Real Part of the Small Signal Impedance for an MA46032 IMPATT Diode vs. Frequency and Bias Level

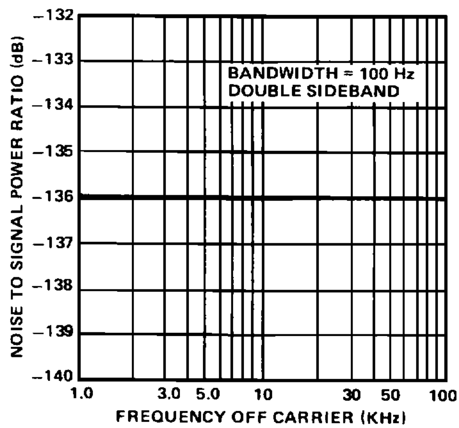


FIGURE 10. AM Noise vs. Frequency for 1 Watt Devices

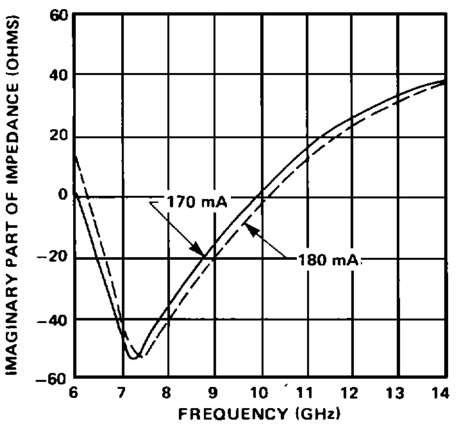


FIGURE 11. Imaginary Part of the Small Signal Impedance for an MA46032 IMPATT Diode vs. Frequency and Bias Level

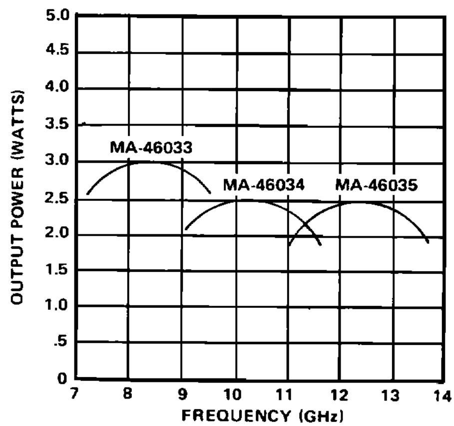


FIGURE 12. Output Power vs. Frequency for Low High Low IMPATT Diodes

Typical Performance Curves (Cont'd)

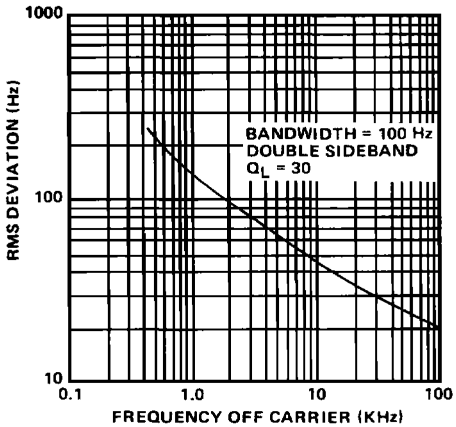


FIGURE 13. FM Noise vs. Frequency for 1 Watt Devices

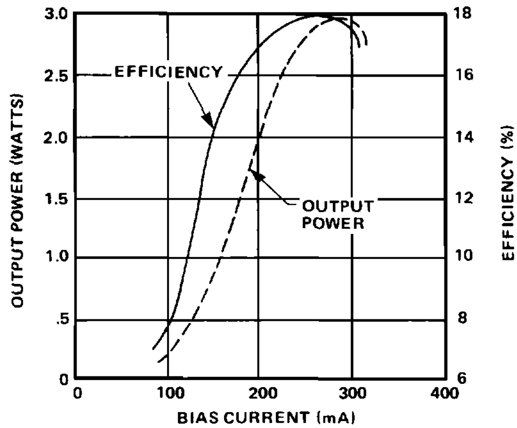


FIGURE 14. Output Power and Efficiency vs. Bias Current for an MA46033 IMPATT Diode

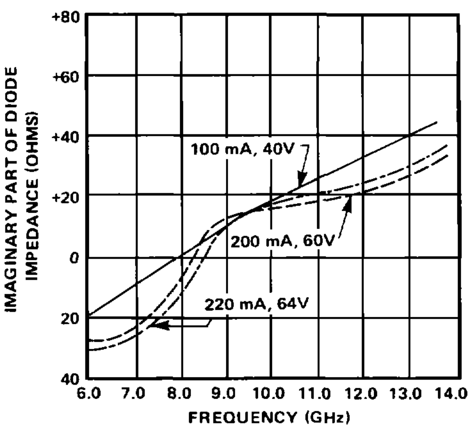


FIGURE 15. Imaginary Part of the Small Signal Impedance for an MA46033 IMPATT Diode vs. Frequency and Bias Level

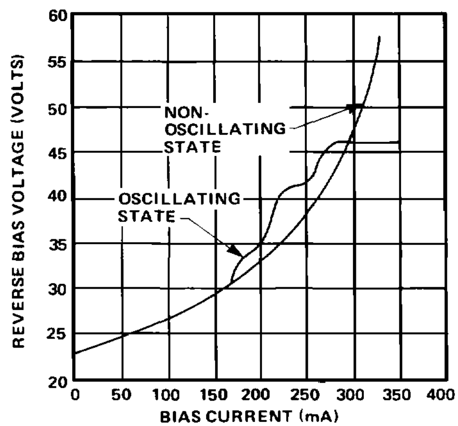


FIGURE 16. Bias Voltage Change with Current for an MA46033 IMPATT Diode

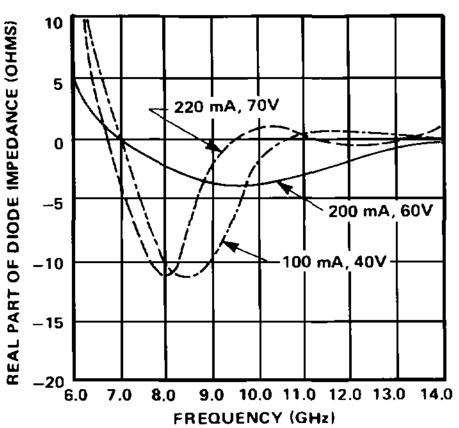


FIGURE 17. Real Part of the Small Signal Impedance for an MA46033 IMPATT Diode vs. Frequency and Bias Level

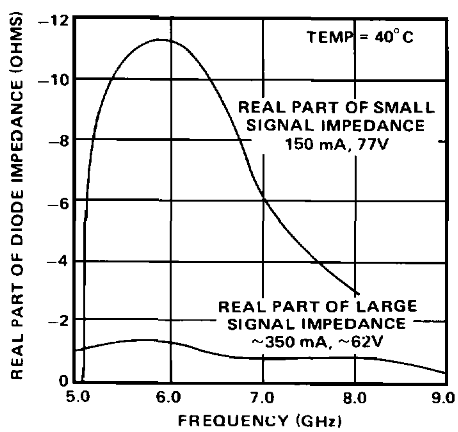


FIGURE 18. Typical Diode Resistance vs. Frequency for an MA46037 Gallium Arsenide IMPATT Diode

Typical Performance Curves (Cont'd)

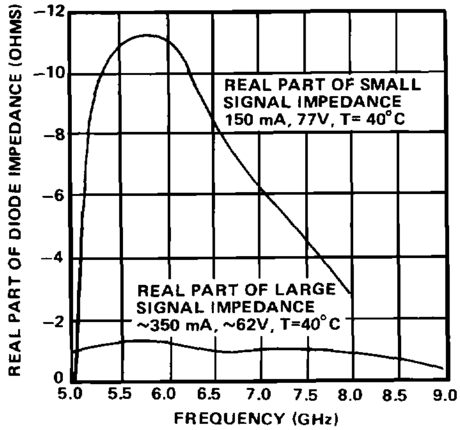


FIGURE 19. Typical Diode Resistance vs. Frequency for an MA46037 Gallium Arsenide IMPATT Diode

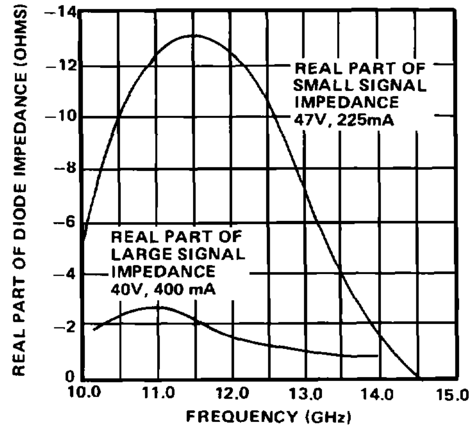


FIGURE 20. Diode Resistance vs. Frequency for an MA46039 Gallium Arsenide IMPATT Diode

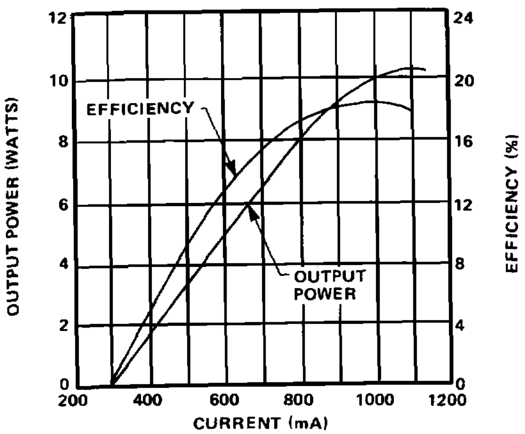


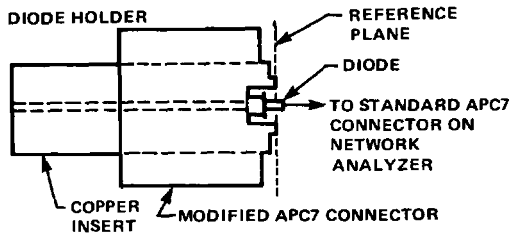
FIGURE 21. Typical Output Power and Efficiency vs. Current for an MA46048 Four Mesa High Power CW IMPATT Diode

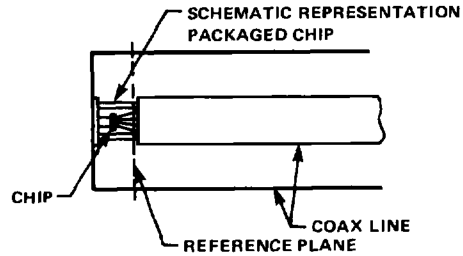
Ordering Information

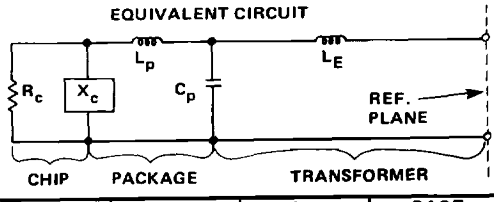
Specify model number, desired frequency of operation, (e.g., MA46030, desired frequency of operation 8.5-9.0 GHz).

Test Circuits & Fixtures

MOUNTING AND EQUIVALENT CIRCUIT FOR IMPEDANCE MEASUREMENT







C_p (pF)	L_p (nH)	L_E (nH)	CASE STYLE
.33	.24	.36	92
.33	.24	.36	111

NOTE:

Drawings of test fixture for impedance measurement are available on request.