SILICON PARAMP VARACTOR DIODES

M/A-COM Silicon Products, Inc. paramp diodes are silicon varactor devices which provide extraordinary gain/bandwidth performance with low noise figure at frequencies from UHF through Ku-Band.

These diodes meet the most demanding mechanical and environmental requirements. Their ultimate stress tolerances far exceed any practical equipment needs.

All internal contacts are bonded or soldered and the final package is hermetically sealed.

The wide choice of package styles, series inductance, and case capacitance permits the paramp designer to optimize his design quickly. Extremely rigid production controls insure uniform dynamic performance characteristics.

SILICON PARAMP DIODES [1, 2, 3, 4]

MIN. F_{C-3} (GHz)	C_{J_0} RANGE[5] (pF)											
	0.100 — 0.149	0.150 — 0.199	0.200 — 0.249	0.250 — 0.299	0.300 — 0.349	0.350 — 0.399	0.400 — 0.449	0.450 — 0.499	0.500 — 0.549	0.550 — 0.599	0.600 — 0.649	0.650 — 0.699
100	MA-44900A	MA-44901A	MA-44902A	MA-44903A	MA-44904A	MA-44905A	MA-44906A	MA-44907A	MA-44908A	MA-44909A	MA-44910A	MA-44911A
150	MA-44900B	MA-44901B	MA-44902B	MA-44903B	MA-44904B	MA-44905B	MA-44906B	MA-44907B	—	—	—	—
200	MA-44900C	MA-44901C	MA-44902C	MA-44903C	MA-44904C	MA-44905C	MA-44906C	MA-44907C	—	—	—	—
250	MA-44900D	MA-44901D	MA-44902D	MA-44903D	MA-44904D	MA-44905D	MA-44906D	MA-44907D	—	—	—	—
300	MA-44900E	MA-44901E	MA-44902E	MA-44903E	MA-44904E	MA-44905E	MA-44906E	MA-44907E	—	—	—	—
350	MA-44900F	MA-44901F	MA-44902F	MA-44903F	MA-44904F	MA-44905F	MA-44906F	MA-44907F	—	—	—	—

NOTES:

1. Breakdown voltage, measured at a reverse current of 10 μA, is 6 volts minimum.

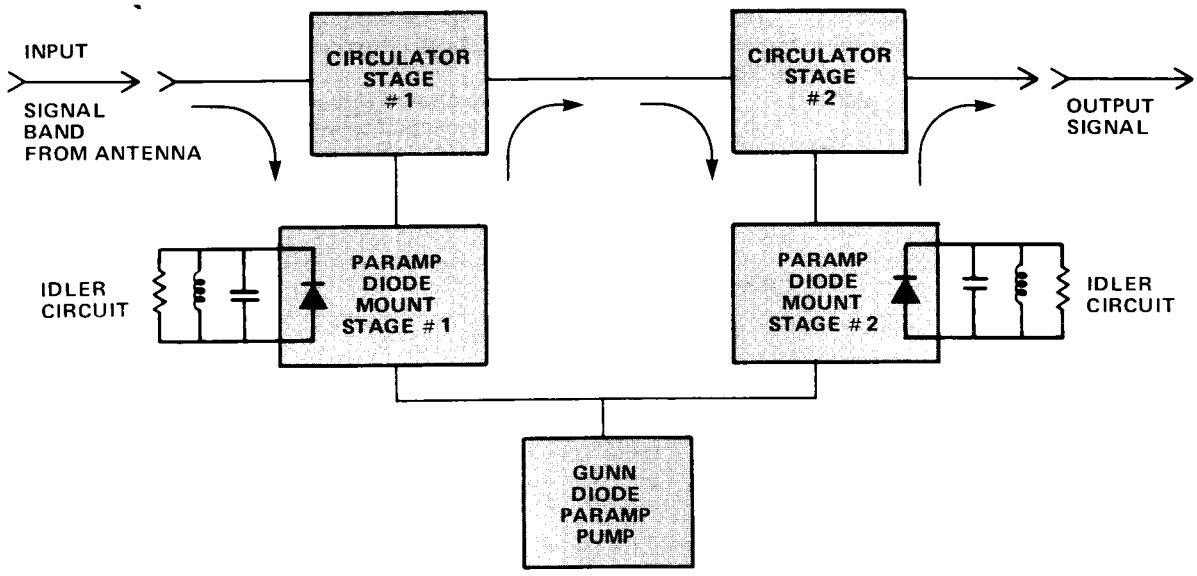
2. $\beta = \frac{C_{J+1\ \mu A}}{C_{J_{-3}}} = 7.0$ Typ.

3. $F_C' = (F_{C\_3}\ \frac{\beta-1}{\beta}) = (0.8)(F_{C\_3})$ Typ.

4. Case style 91 is the standard enclosure for this series. However, a wide choice of case styles is available. Please contact the factory for assistance in choosing alternative case styles.

5. C_{J_0} is measured at zero volts on a 1 MHz capacitance bridge.

SILICON PARAMP VARACTOR DIODES (CONT'D)



TYPICAL TWO STAGE SINGLE PORT PARAMP BLOCK DIAGRAM

GaAs PARAMP DIODES

The MA-48500[1] series of grown junction epitaxial gallium arsenide varactors is specifically designed for use in both room temperature and cryogenically cooled parametric amplifiers. High gain-bandwidth products can be achieved using these devices over the signal frequency range of 1 GHz to 35 GHz with pump frequencies as high as 105 GHz. All varactors in this series are available in a choice of 15 different case assemblies and in chip form. The cathode is the heat sink end of the package. Reverse polarity is available on request. For additional characterization information, see notes 4, 5, 6, 7, 8, 9, and 10 on page 77.

MIN. F_{C_0}[2] (GHz)	C_{J_0} RANGE[3] (pF)				
	0.150 — 0.199	0.200 — 0.249	0.250 — 0.299	0.300 — 0.349	0.350 — 0.399
100	MA-48501A	MA-48502A	MA-48503A	MA-48504A	MA-48505A
125	MA-48501B	MA-48502B	MA-48503B	MA-48504B	MA-48505B
150	MA-48501C	MA-48502C	MA-48503C	MA-48504C	MA-48505C
175	MA-48501D	MA-48502D	MA-48503D	MA-48504D	MA-48505D
200	MA-48501E	MA-48502E	MA-48503E	MA-48504E	MA-48505E
225	MA-48501F	MA-48502F	MA-48503F	MA-48504F	MA-48505F
250	MA-48501G	MA-48502G	MA-48503G	MA-48504G	MA-48505G
275	MA-48501H	MA-48502H	MA-48503H	MA-48504H	—
300	MA-48501I	MA-48502I	MA-48503I	—	—
325	MA-48501J	MA-48502J	—	—	—
350	MA-48501K	MA-48502K	—	—	—

See notes on page 77.

GaAs PARAMP DIODES (CONT'D)

MIN. F_{C_0}[2] (GHz)	C_{J_0} RANGE[3] (pF)					
	0.400 — 0.449	0.450 — 0.499	0.500 — 0.549	0.550 — 0.599	0.600 — 0.649	0.650 — 0.699
100	MA-48506A	MA-48507A	MA-48508A	MA-48509A	MA-48510A	MA-48511A
125	MA-48506B	MA-48507B	MA-48508B	MA-48509B	MA-48510B	MA-48511B
150	MA-48506C	MA-48507C	MA-48508C	MA-48509C	MA-48510C	MA-48511C
175	MA-48506D	MA-48507D	MA-48508D	MA-48509D	MA-48510D	MA-48511D
200	MA-48506E	MA-48507E	MA-48508E	MA-48509E	MA-48510E	MA-48511E
225	MA-48506F	MA-48507F	—	—	—	—

NOTES:

1. All GaAs paramp diodes are available in a variety of case styles (listed below) as well as in chip form. When ordering, specify the desired case style by adding the case designation as a suffix to the type number.

CASE STYLE	PACK. DESC.
30	Ceramic-Metal Double Pronged
31	Ceramic-Metal CAP
32	Ceramic-Metal CAP
91	Ceramic-Metal Single Pronged
94	Ceramic-Metal CAP
95	Ceramic-Metal Single Pronged
126	Ceramic-Metal CAP
155	Ceramic-Metal Single Pronged
156	Ceramic-Metal Double Pronged
157	Ceramic-Metal Single Pronged
159	Ceramic-Metal Double Pronged
168	Ceramic-Metal Double Pronged

   For example: an MA-48503-G-155 specifies a paramp diode with a minimum cutoff frequency at 0 volts of 250 GHz and a C_{J0} of between .250 and .299 pF. The device is packaged in the 155 case style.

2. Cutoff frequency measurements (F_{C0}) are made at 0 volts using the DeLoach method. See the typical curve to the right showing F_{C-6} (cutoff at —6 volts) vs F_{C0} (cutoff at 0 volts).

3. Junction capacitance (C_{J_0}) is measured at 1 MHz and 0 volts on a bridge which has been balanced with a shielded test holder connected in place— but open circuited.

4. Minimum breakdown voltage is 10 volts at a reverse bias current of 10 μA.

5. Package parasitics (C_p and L_s) are given along with case style dimensions elsewhere in this catalog. The values of C_p listed have a typical tolerance of ± 0.02 pF. However, the actual package capacitance of each diode is measured to within ± 0.0025 pF. L_s is determined in a DeLoach holder of appropriate height in X-Band.

6. The measured series resonant frequency of each varactor will be supplied with the diode.

7. Common figures of merit for paramp varactors are:

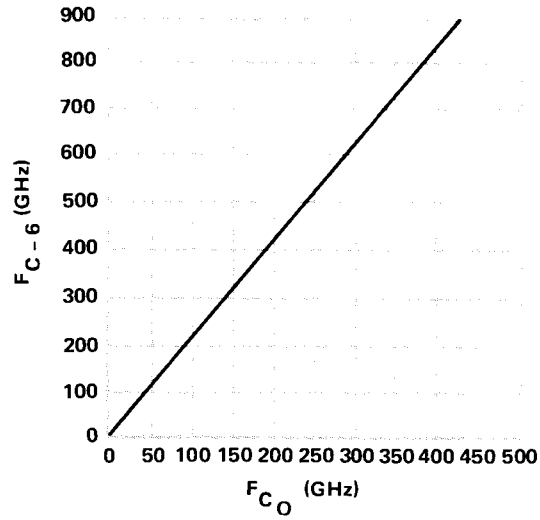
$$\triangle N_J = \frac{C_{J0} - C_{J-6}}{C_{J0}} = .52 \text{ Typical.}$$

$$\beta = \frac{C_J + .5}{C_{J-3}} = 2.02 \text{ Typical.}$$

8. All paramp varactors are cycled to liquid nitrogen temperatures to assure cryogenic performance.

9. All GaAs paramp diodes are subjected to a 48-hour 100°C electrical burn-in before final tests. During this period, each device is stressed 60 times per second with 30 mA in the forward direction and 5 volts in the back direction. The reliability of this series of GaAs paramp diodes is greatly increased by this burn-in.

10. DeLoach holders for cutoff frequency measurements, as well as shielded test fixtures for measuring capacitance are available for purchase. Contact your local representative for ordering information.



TYPICAL RELATIONSHIP BETWEEN CUTOFF FREQUENCY AT ZERO AND SIX VOLTS IN GaAs VARACTOR DIODE

SILICON SINGLE DRIFT IMPATT DIODES

M/A-COM Silicon Products, Inc.'s Single Drift Silicon IMPATT diodes deliver up to 500 milliwatts of CW RF power for use in fundamental frequency (direct dc to RF conversion) microwave oscillators through K-Band. Lower power units for application in alarm systems and police radar are also available.

These devices feature silicon mesa construction with a nearly abrupt P+ NN+ diffusion profile. As indicated by the acronym "IMPATT" (Impact Avalanche Transit Time), these devices operate under reverse bias avalanche conditions. RF power is generated due to the negative resistance that is developed in the avalanche breakdown region.

MODEL NUMBER[1]	CASE STYLE[1]	OPER. FREQ. RANGE (GHz)	MIN. OUTPUT PWR.[2,3] (mW)	TYP. OPER. VOLT. (VOLTS)	TYP. OPER. CURRENT (mA)	TYP. EFF.[2,3] (%)	MAX. THERMAL RESIST., θ_{jc}[4] (°C/W)	JUNC. CAP., C_J[5] (pF)
MA-4B043H	92	4.0—6.0	500	160	65	5.0	22	0.52
MA-4B031A	92	6.0—8.0	10	100	13	0.8	100	0.14
MA-4B031B	92	6.0—8.0	25	105	17	1.4	85	0.14
MA-4B032C	92	6.0—8.0	50	100	18	2.8	70	0.24
MA-4B032D	92	6.0—8.0	100	105	25	3.8	60	0.24
MA-4B032E	92	6.0—8.0	200	110	33	5.5	50	0.24
MA-4B033F	92	6.0—8.0	300	100	65	4.6	32	0.48
MA-4B033G	92	6.0—8.0	400	105	71	5.4	28	0.48
MA-4B033H	92	6.0—8.0	500	110	80	5.7	24	0.48
MA-4B013F1	92	8.0—10.0	300	83	78	4.7	32	0.60
MA-4B013G1	92	8.0—10.0	400	89	84	5.4	28	0.60
MA-4B013H1	92	8.0—10.0	500	103	85	5.7	24	0.60
MA-4B011A	92	8.0—12.4	10	85	15	0.8	100	0.20
MA-4B011B	92	8.0—12.4	25	90	20	1.4	85	0.20
MA-4B012C	92	8.0—12.4	50	70	25	3.0	70	0.35
MA-4B012D	92	8.0—12.4	100	75	35	4.2	60	0.35
MA-4B012E	92	8.0—12.4	200	80	45	5.5	50	0.35
MA-4B013F2	92	10.0—12.4	300	74	88	4.7	32	0.60
MA-4B013G2	92	10.0—12.4	400	80	94	5.4	28	0.60
MA-4B013H2	92	10.0—12.4	500	93	93	5.7	24	0.60
MA-4B023F1	92	12.4—15.0	300	70	85	5.1	32	0.60
MA-4B023G1	92	12.4—15.0	400	72	91	6.1	28	0.60
MA-4B023H1	92	12.4—15.0	500	74	99	6.8	26	0.60
MA-4B021A	92	12.4—18.0	10	60	24	0.7	100	0.20
MA-4B021B	92	12.4—18.0	25	63	26	1.5	85	0.20
MA-4B022C	92	12.4—18.0	50	64	38	2.0	70	0.35
MA-4B022D	92	12.4—18.0	100	65	46	3.4	60	0.35
MA-4B022E	92	15.0—18.0	200	69	60	5.0	45	0.35
MA-4B023F2	92	15.0—18.0	300	65	92	5.1	32	0.60
MA-4B023G1	92	15.0—18.0	400	66	101	6.1	28	0.60

See notes on page 79.

SILICON SINGLE DRIFT IMPATT DIODES (CONT'D)

MODEL NUMBER[1]	CASE STYLE[1]	OPER. FREQ. RANGE (GHz)	MIN. OUTPUT PWR.[2,] (mW)	TYP. OPER. VOLT. (VOLTS)	TYP. OPER. CURRENT (mA)	TYP. EFF.[2,3] (%)	MAX. THERMAL RESIST., θ_{jc}[4] (°C/W)	JUNC. CAP., C_J[5] (pF)
MA-4B023H2	92	15.0—18.0	500	67	110	6.8	26	0.60
MA-4B053D1	237	18.0—23.0	100	53	100	2.0	38	0.63
MA-4B053E1	237	18.0—23.0	200	56	135	2.6	32	0.63
MA-4B053F1	237	18.0—23.0	300	57	150	3.5	28	0.63
MA-4B053D2	237	23.0—26.0	100	53	110	1.8	38	0.61
MA-4B053E2	237	23.0—26.0	200	56	130	2.6	32	0.61

NOTES:

1. Other case styles (listed below) are available. When ordering, specify the desired case style by adding the case style number as a suffix. Example: MA-4B013F1-30.

   A summary of packages:

CASE STYLE	PACK. DESC.
30	Ceramic-Metal Double Pronged
91	Ceramic-Metal Single Pronged
92	Ceramic-Metal Double Pronged
237	Ceramic-Metal Stud

   Contact factory for assistance and for other case style options.

2. RF power output and efficiency are measured in a broadband cavity having a nominal Q of 20.
3. The nominal heat sink temperature is 25°C.
4. Measured by the incremental voltage method in avalanche condition.
5. Junction capacitance is measured at 80% of breakdown voltage and has a nominal tolerance of ±20%. (Breakdown voltage is defined at a reverse current of 1 mA.)

SILICON DOUBLE DRIFT IMPATT DIODE (MA-4B600)

The MA-4B600 Double Drift Silicon epitaxial mesa IMPATT diode is useful for CW transmitters in point to point telecommunications links.

MODEL NUMBER[1,2]	CW OUTPUT POWER[3] (WATTS)	TYP. EFF.[4] (%)	TYP. OPER. VOLT. (VOLTS)	TYP. OPER. CURRENT (mA)	TYP. BREAKDOWN VOLT., V_B (VOLTS)	TYP. JUNC. CAP., C_J @V_B (pF)	TYP. THERMAL RESIST., θ_{jc}[5] (°C/W)
MA-4B600	1.3	10	114	120	90	0.35	14

NOTES:

1. This device is designed for a center frequency of 11.2 GHz. Other double drift devices are available on request. The standard case styles are 91 and 148. Special case styles are available on request. Specify the case style desired by adding the case style number as a suffix to the basic model number.
2. The maximum recommended junction temperature of 200°C has been chosen to provide long term reliable operation. Power dissipation = $\frac{200\text{-}T_{CASE}}{\theta_T}$ where $\theta_{jc} = \theta_T - 1.5$°C/W.
3. These diodes will deliver at least the specified minimum ouput power into a critically coupled load at the specified frequency.
4. Efficiency = $\frac{\text{RF Power Out}}{\text{dc Power In}} \times 100$
5. Thermal resistance is obtained by measuring the change in breakdown voltage with dc current. Our Test Method-372 describes this technique and is available on request.

GALLIUM ARSENIDE IMPATT DIODES

These gallium arsenide IMPATT (Impact Avalanche Transit Time) diodes are junction devices that operate with a reverse bias sufficient to cause avalanche breakdown. In such a diode, carriers are produced by avalanche multiplication. 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 the carrier generation and the carrier drift through the active layer. In an appropriate circuit, these diodes will 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 20% in the case of high output CW devices (>2 watts). This series of IMPATT devices includes diodes that operate in C, X, and Ku-Band and in both the CW and pulsed modes. All devices designed for pulse mode operation have a low-high-low or high-low profile.

These diodes are ideally suited for use as basic oscillators for communications systems. Many are also useful as intermediate or final stage amplifiers. Pulsed IMPATT diodes are ideally suited for transmitter applications and are easily power combined.

0.5 WATT CW DEVICES (FLAT PROFILE)

MODEL NUMBER	CASE STYLE[1]	OPER. FREQ. RANGE (GHz)	OUTPUT PWR.[2] (WATTS) MIN.	OUTPUT PWR.[2] (WATTS) TYP.	MIN. EFF.[3] (%)	MAX. THERMAL RESIST.[4] (°C/W)	OPER. VOLT. RANGE (VOLTS)	BREAKDOWN VOLT., V_B[5] RANGE (VOLTS)	MAX. OPER. CURRENT (mA)	JUNC. CAP., C_J[6] RANGE (pF)
MA-46021	92	8.0— 9.5	0.5	0.7	10	25	65—80	50—65	100	4—7
MA-46024	111	8.0— 9.5	0.5	0.7	10	25	65—80	50—65	100	4—7
MA-46022	92	9.5—11.0	0.5	0.7	10	25	55—70	40—55	100	3—6
MA-46025	111	9.5—11.0	0.5	0.7	10	25	55—70	40—55	100	3—6
MA-46023	92	11.0—12.5	0.5	0.7	10	25	45—60	30—45	100	2—4
MA-46026	111	11.0—12.5	0.5	0.7	10	25	45—60	30—45	100	2—4
MA-46041	148	17.0—19.0	0.5	0.6	7	22	30—35	22—26	240	2—3

See notes on page 81.

1.0 WATT CW DEVICES (FLAT PROFILE)

MODEL NUMBER	CASE STYLE[1]	OPER. FREQ. (GHz)	OUTPUT PWR.[2] (WATTS) MIN.	OUTPUT PWR.[2] (WATTS) TYP.	MIN. EFF.[3] (%)	MAX. THERMAL RESIST.[4] (°C/W)	OPER. VOLT. RANGE (VOLTS)	BREAKDOWN VOLT., V_B[5] RANGE (VOLTS)	MAX. OPER. CURRENT (mA)	JUNC. CAP., C_J[6] RANGE (pF)
MA-46040	111	6.0	1.5	—	12	13	75—95	65—75	150	7—10
MA-46027	92	8.0	1.0	1.3	10	15	65—80	50—65	125	5—8
MA-46030	111	8.0	1.0	1.3	10	15	65—80	50—65	125	5—8
MA-46028	92	9.5	1.0	1.3	10	15	55—70	40—55	150	4—7
MA-46031	111	9.5	1.0	1.3	10	15	55—70	40—55	150	4—7
MA-46029	92	11.0	1.0	1.3	10	15	45—60	30—45	150	3—5
MA-46032	111	11.0	1.0	1.3	10	15	45—60	30—45	150	3—5

See notes on page 81.

2.0 WATT CW GaAs DEVICES (LOW-HIGH-LOW PROFILE)

MODEL NUMBER	STD. CASE STYLE[1]	OPER. FREQ. RANGE (GHz)	OUTPUT PWR.[2] (WATTS) MIN.	OUTPUT PWR.[2] (WATTS) TYP.	MIN. EFF.[3] (%)	MAX. THERMAL RESIST., θ_{jc}[4] (°C/W)	OPER. VOLT. RANGE (VOLTS)	BREAKDOWN VOLT., V_B[5] RANGE (VOLTS)	MAX. OPER. CURRENT (mA)	JUNC. CAP., C_J[6] RANGE (pF)
MA-46033	111	7—9	2.5	3.0	16	11	45—60	25—30	350	10—14
MA-46034	111	9—11	2.0	2.5	15	11	40—50	20—30	350	7—12
MA-46035	111	11—13	2.0	2.5	12	10	35—45	17—25	350	7—12
MA-46039	111	12—15	2.5	3.0	18	13	30—40	17—25	400	10—15
MA-46049	275	14—17	2.5	2.75	15	12	30—40	13—18	550	10—15

4.0 WATT CW GaAs DEVICES (LOW-HIGH-LOW PROFILE)

MODEL NUMBER	STD. CASE STYLE[1]	OPER. FREQ. RANGE. (GHz)	OUTPUT PWR.[2] (WATTS) MIN.	OUTPUT PWR.[2] (WATTS) TYP.	MIN. EFF.[3] (%)	MAX. THERMAL RESIST., θ_{jc}[4] (°C/W)	OPER. VOLT. RANGE (VOLTS)	BREAKDOWN VOLT., V_B[5] RANGE (VOLTS)	MAX. OPER. CURRENT (mA)	JUNC. CAP., C_J[6] RANGE (pF)
MA-46037	111	6—8	4.0	4.5	20	11	60—75	35—50	375	16—24
MA-46038	111	8—10	3.8	4.1	20	11	50—60	25—35	425	20—30
MA-46036	111	10—12	3.8	4.1	20	11	40—50	20—30	500	20—30

NOTES:

1. Package capacitance and inductance are shown with the case style drawing at the rear of this catalog. Available case styles:

CASE STYLE	PACK. DESC.
92	Ceramic-Metal Double Pronged
111	Ceramic-Metal Stud
148	Ceramic-Metal Stud
273	Ceramic-Metal Stud
275	Ceramic-Metal Stud

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 range.

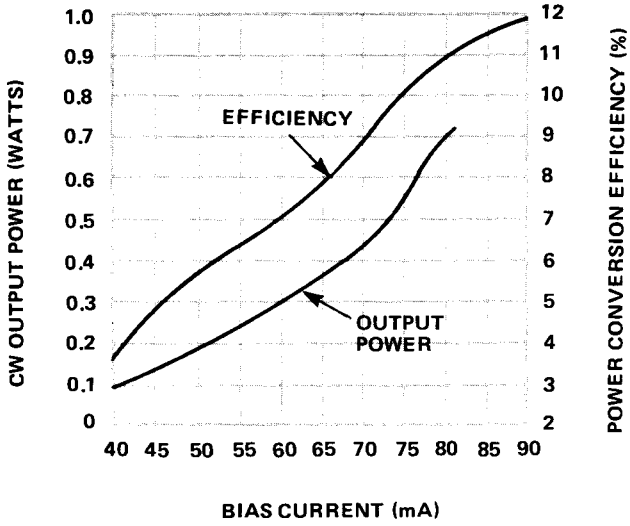
3. Efficiency $= \frac{\text{RF Power Out}}{\text{dc Power In}} \times 100$

4. Thermal resistance is obtained by measuring the change in breakdown voltage with dc current. M/A-COM GaAs Products, Inc.'s test method 372 describes this technique and is available on request.

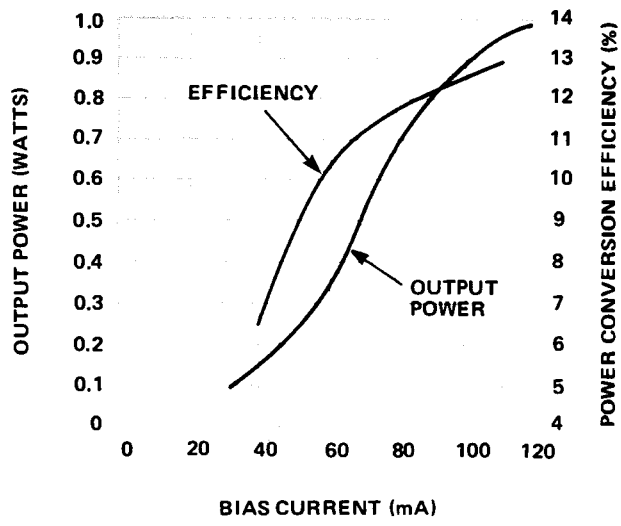
5. Breakdown voltage is specified at 1 mA of reverse bias.

6. Capacitance is measured at 1 MHz and 0 volts bias. The capacitance at breakdown voltage is approximately 0.1 this value.

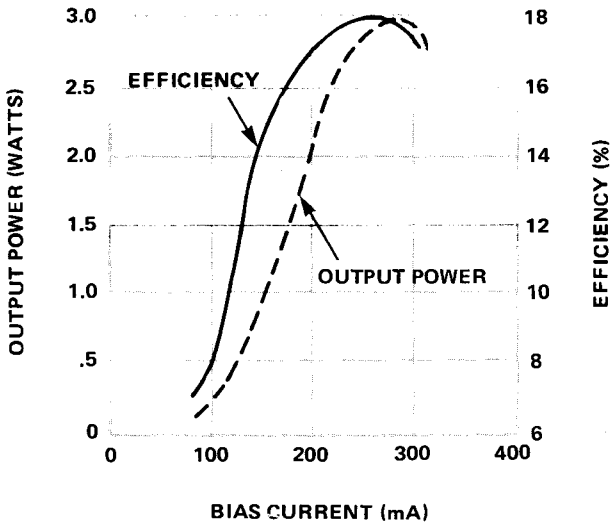
TYPICAL PERFORMANCE



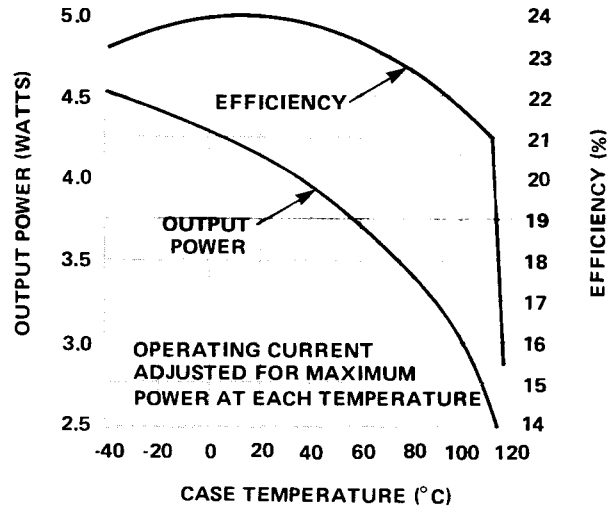
OUTPUT POWER AND EFFICIENCY VS BIAS CURRENT FOR AN MA-46024 IMPATT DIODE



OUTPUT POWER AND EFFICIENCY VS BIAS CURRENT FOR AN MA-46030 IMPATT DIODE



OUTPUT POWER AND EFFICIENCY VS BIAS CURRENT FOR AN MA-46033 IMPATT DIODE



OUTPUT POWER AND EFFICIENCY VS TEMPERATURE FOR AN MA-46036 IMPATT DIODE

PULSED GaAs DEVICES

MODEL NUMBER	STD. CASE STYLE[1]	OPER. FREQ. RANGE (GHz)	MIN. PEAK OUTPUT PWR. (WATTS)	MIN. EFF. (%)	MAX. THERMAL RESIST., θ_{jc} (°C/W)	BREAKDOWN VOLT. RANGE (VOLTS)	OPER. VOLT. (VOLTS, PEAK)	MAX. OPER. CURRENT (AMPS, PEAK)	JUNC. CAP., C_J @ 0V (pF)
MA-46045	275	8 —10	12[2]	17	9	30—45	50—70	1.5	45—60
MA-46043 (2-chip)	274	8.5—10	25[2]	16	5	50—90	90—125	1.7	22—30
MA-46046	111	9 —11	10[3]	12	10	40—55	50—70	2.0	45—60
MA-46044	275	12 —16	10[2]	14	10	20—35	40—60	1.8	30—60
MA-46047	148	13 —16	10[3]	9	10	20—35	38—50	3.5	45—60

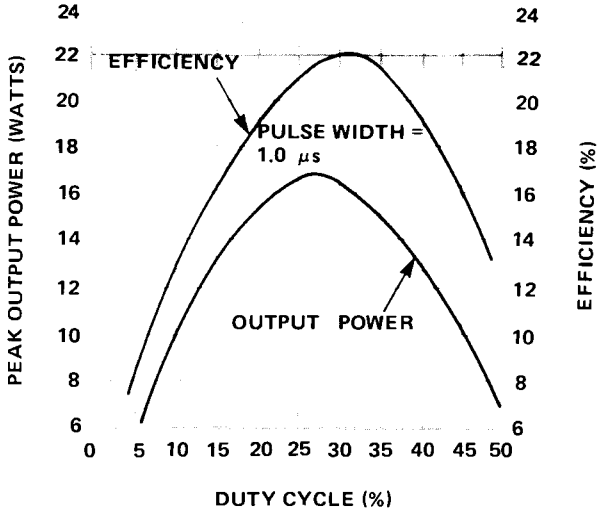
NOTES:

1. A summary of the packages available for this series:

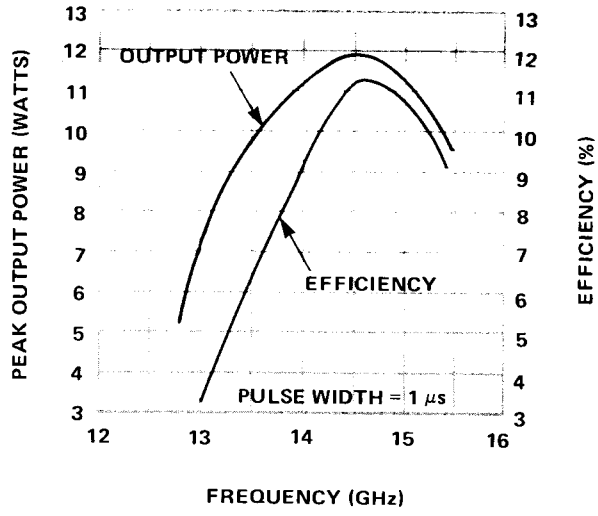
CASE STYLE	PACK. DESC.
111	Ceramic-Metal Stud
148	Ceramic-Metal Stud
274	Ceramic-Metal Stud
275	Ceramic-Metal Stud

2. Duty Cycle: 15 to 30%; Pulse Width: 1 to 5 μs
3. Duty Cycle: 1 to 10%; Pulse Width: 5 to 15 μs

TYPICAL PERFORMANCE



OUTPUT POWER AND EFFICIENCY VS DUTY CYCLE FOR AN MA-46054 PULSED IMPATT



OUTPUT POWER AND EFFICIENCY VS FREQUENCY FOR AN MA-46047 IMPATT DIODE

DEVICE RELIABILITY

The reliability of the GaAs Schottky barrier IMPATT has been established through long term operation and step stress testing. A four-layer Schottky barrier metallization system eliminates potential problems arising from reactions 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 at a junction temperature of 220°C, TTF will approach 10^6 hours. Long term operation and field service data allow an estimate of the MTBF at a 200°C junction to be made. The data presently available places the MTBF at a 40% confidence level to be greater than 10^5 hours.

Devices of L-H-L type (output power greater than 2.0 watts) have been shown to be extremely rugged with respect to load mismatch. Short or open circuit loads in any phase 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.