HIGH Q GaAs ABRUPT JUNCTION TUNING VARACTORS (CONT'D)

NOTES:

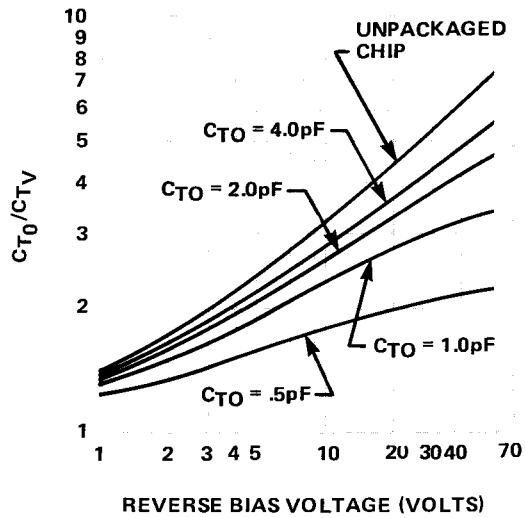
1. All GaAs tuning varactors are available in case style 30 and many other case styles as well as in chip form. When ordering, specify the desired case by adding the case designation as a suffix to the type number. For example: an MA-46601-E-30 with C_{T_0} between 1.00 and 1.49 pF and a minimum Q (at —4 volts and 50 MHz) ≥ 5000. For other package styles, contact factory representative.
2. Case parasitics (C_p and L_s) are given along with case outlines at the rear of this catalog. The C_p values listed typically have tolerances of ±0.02 pF. However, the actual case capacitance of each diode is measured to within ±.0025 pF.
3. Breakdown voltage (V_B) is measured at 10 μA of reverse bias current.
4. Diode Q is measured by a modified DeLoach technique at —4 volts and extrapolated to 50 MHz. (A copy of the article "Determination of Varactor Parameters by a Modified DeLoach Method" is available on request.)
5. Capacitance is measured at 1 MHz on a bridge which has been balanced with a shielded test holder connected in place but open circuited. These test holders are available for purchase. Please contact the factory for further information.
6. Customer should specify, within the range indicated, the required capacitance. The nominal tolerance is ±10% of the customer requested value. Closer tolerances are available on request.
7. All junctions are abrupt (i.e. $\gamma \cong .50$)

   where:

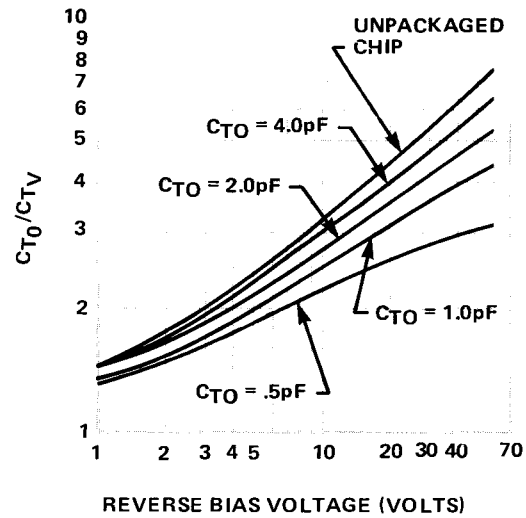
$$\frac{C_{J_0}}{C_{J_V}} = \left(1 + \frac{V_R}{1.2}\right)^{\gamma}$$

   Total capacitance ratios will vary with case choice due to differences in case capacitance (C_p). The figures below show typical ratios for the M/A 30 and 155 case styles.
8. All GaAs tuning 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.
9. Parasitic inductance (L_s) has been determined at X-Band using a DeLoach method measurement.

TYPICAL PERFORMANCE



CAPACITANCE CHANGE RATIOS FOR GaAs TUNING VARACTORS (CASE STYLE 30)



CAPACITANCE CHANGE RATIOS FOR GaAs TUNING VARACTORS (CASE STYLE 155)

CERAMIC GaAs HYPERABRUPT TUNING VARACTORS — CONSTANT GAMMA ≅ 1.0

The MA-46540 and MA-46550 series of tuning varactors are hyperabrupt junction gallium arsenide devices featuring a constant gamma of 1.0. These series offer especially high "Q factors" (up to 4000) that permit excellent tuning performance from VHF through Ka-Band.

With these devices, linear tuning of frequency with bias voltage can be achieved for VCO's with moderate tuning bands using transistors, Gunn's or IMPATT's as well as with tunable filters and amplifiers. These diodes are an excellent choice for modulator applications where better linearity or nearly constant modulation sensitivity is desired.

MA-46540 Series[1,2] — Constant Gamma GaAs Hyperabrupt Tuning Varactors

Breakdown Voltage[3] = 15 Volts Minimum

	C_{T-4} (pF) Capacitance Range[4,5,6]							
MINIMUM Q[7]	**0.5 MAX.**	**0.50 — 0.99**	**1.00 — 1.49**	**1.50 — 2.49**	**2.50 — 3.49**	**3.50 — 4.99**	**5.00 — 6.99**	**7.00 — 10.0**
500	—	—	—	—	—	—	MA-46546A	MA-46547A
1000	—	—	—	MA-46543B	MA-46544B	MA-46545B	MA-46546B	MA-46547B
1500	MA-46540C	MA-46541C	MA-46542C	MA-46543C	MA-46544C	MA-46545C	MA-46546C	MA-46547C
2000	MA-46540D	MA-46541D	MA-46542D	MA-46543D	MA-46544D	MA-46545D	—	—
3000	MA-46540E	MA-46541E	MA-46542E	MA-46543E	—	—	—	—
4000	MA-46540F	MA-46541F	—	—	—	—	—	—
$\left(\frac{C_{T-2}}{C_{T-12}}\right)^{10}$ MAX.	2.3	3.1	3.7	4.1	4.3	4.4	4.5	4.6
TYP.	2.0	2.8	3.2	3.5	3.7	3.8	3.9	3.9
MIN.	1.8	2.4	2.7	3.0	3.2	3.3	3.3	3.4

MA-46550 Series[1,2] — Constant Gamma GaAs Hyperabrupt Tuning Varactors

Breakdown Voltage[3] = 22 Volts Minimum

	C_{T-4} (pF) Capacitance Range[4,5,6]							
MINIMUM Q[7]	**0.5 MAX.**	**0.50 — 0.99**	**1.00 — 1.49**	**1.50 — 2.49**	**2.50 — 3.49**	**3.50 — 4.99**	**5.00 — 6.99**	**7.00 — 10.0**
500	—	—	—	—	—	—	MA-46556A	MA-46557A
1000	—	—	—	MA-46553B	MA-46554B	MA-46555B	MA-46556B	MA-46557B
1500	MA-46550C	MA-46551C	MA-46552C	MA-46553C	MA-46554C	MA-46555C	MA-46556C	MA-46557C
2000	MA-46550D	MA-46551D	MA-46552D	MA-46553D	MA-46554D	MA-46555D	—	—
3000	MA-46550E	MA-46551E	MA-46552E	MA-46553E	—	—	—	—
4000	MA-46550F	MA-46551F	—	—	—	—	—	—
$\left(\frac{C_{T-2}}{C_{T-20}}\right)^{10}$ MAX.	2.7	4.1	5.2	6.1	6.7	7.1	7.4	7.6
TYP.	2.4	3.4	4.3	4.9	5.3	5.6	5.8	6.0
MIN.	2.0	2.9	3.6	4.1	4.5	4.7	4.9	5.0

See notes on page 51.

CERAMIC GaAs HYPERABRUPT TUNING VARACTORS— CONSTANT GAMMA ≅ 1.0 (CONT'D)

1. All GaAs tuning varactors in these series are available in case style 30 and many other ceramic case styles as well as in chip form. When ordering, specify the desired case by adding the case designation as a suffix to the type number. For example: an MA-46541D-30 specifies a 15 volt tuning diode in case style 30 with C_{T-4} between 0.50 and 0.99 pF and a minimum Q (at −4 volts and 50 MHz) of 2000. For other package styles, contact factory representative.

2. Case parasitics (C_p and L_s) are given along with case outlines at the rear of this catalog. The C_p values listed typically have tolerances of ±0.02 pF. However, the actual case capacitance of each diode is measured to within ±0.0025 pF.

3. Breakdown voltage (V_B) is measured at 10 μA of reverse bias current.

4. Capacitance is measured at 1 MHz on a bridge which has been balanced with a shielded test holder connected in place but open circuited. These shielded test holders are available for purchase. Contact the factory for further information.

5. Customer should specify, within the range indicated, the required capacitance. The nominal tolerance at −4 volts is ±10% of the customer requested value. Closer tolerances are available on request.

6. All junctions are hyperabrupt with a nominal $\gamma \cong 1.0$, where:

$$C_J(V) = \frac{K}{(V + \phi)^\gamma}$$

and:

$C_J(V)$ = voltage dependent junction capacitance
V_R = applied reverse voltage
ϕ = built-in potential (1.2 volts)
γ = capacitance-voltage slope exponent (gamma)
K = constant

γ is within the limits $0.90 < \gamma < 1.13$ over the voltage range 2-12 volts for the MA-46540 series and 2-20 volts for the MA-46550 series. Total capacitance of packaged diodes will deviate from constant gamma characteristics depending on the value of the required junction capacitance and the package choice due to differences in case capacitance (C_p). Figures below illustrate typical total capacitance (C_p). Figures below illustrate typical total capacitance versus applied voltage for these series when case style 30 is selected and typical capacitance ratios versus applied voltage using case style 30.

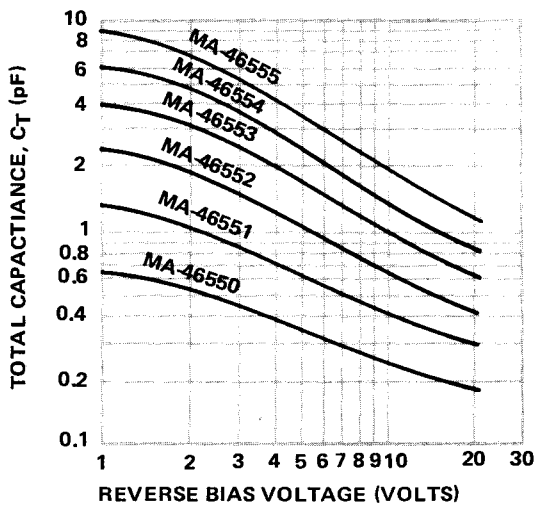
7. Diode Q is measured by a modified DeLoach technique at −4 volts and extrapolated to 50 MHz. (A copy of the article "Determination of Varactor Parameters by a Modified DeLoach Method" is available on request.)

8. All GaAs tuning 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.

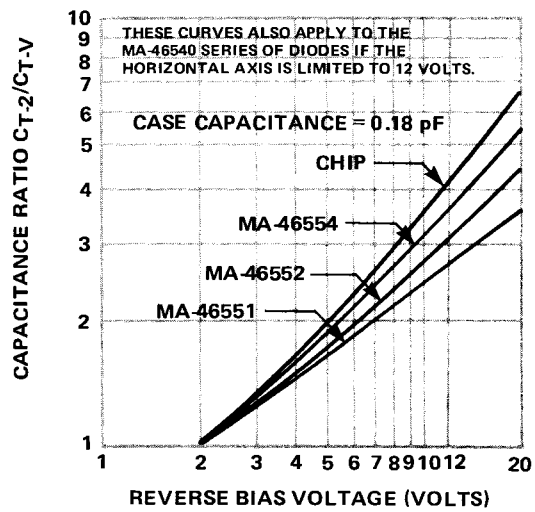
9. Parasitic inductance (L_s) has been determined at X-Band using a DeLoach method measurement.

10. The total capacitance ratios shown in the specifications are for devices housed in case style 30. Total capacitance ratios will vary with choice of case style.

TYPICAL PERFORMANCE



MA-46550 SERIES TOTAL CAPACITANCE VS REVERSE BIAS VOLTAGE (CASE STYLE 30)



MA-46550 SERIES CAPACITANCE RATIO VS REVERSE BIAS VOLTAGE (CASE STYLE 30)

CERAMIC GaAs HYPERABRUPT TUNING VARACTORS — CONSTANT GAMMA ≅ 1.25

The MA-46560 and MA-46570 series of microwave tuning varactors are hyperabrupt junction gallium arsenide devices featuring a constant gamma of 1.25. Especially high Q factors (up to 4000) permit extremely linear broadband tuning performance through Ka-band. The Q of these devices is similar to that of abrupt junction varactors. Standard capacitance matching is ±10%. All diode types in these series may be supplied in a wide selection of ceramic packages as well as in chip form.

These series are especially designed for use in heavily coupled microwave oscillators and filters with wide bandwidth tuning requirements.

MA-46560 Series[1,2] — Constant Gamma GaAs Hyperabrupt Tuning Varactors

Breakdown Voltage[3] = 15 Volts Minimum

	C_{T_4} (pF) Capacitance Range[4,5,6]							
MINIMUM Q[7]	**0.5 MAX.**	**0.50 — 0.99**	**1.00 — 1.49**	**1.50 — 2.49**	**2.50 — 3.49**	**3.50 — 4.99**	**5.00 — 6.99**	**7.00 — 10.0**
500	—	—	—	—	—	—	MA-46566A	MA-46567A
1000	—	—	—	MA-46563B	MA-46564B	MA-46565B	MA-46566B	MA-46567B
1500	MA-46560C	MA-46561C	MA-46562C	MA-46563C	MA-46564C	MA-46565C	MA-46566C	MA-46567C
2000	MA-46560D	MA-46561D	MA-46562D	MA-46563D	MA-46564D	MA-46565D	—	—
3000	MA-46560E	MA-46561E	MA-46562E	MA-46563E	—	—	—	—
4000	MA-46560F	MA-46561F	—	—	—	—	—	—
$\left(\frac{C_{T\text{-}2}}{C_{T\text{-}12}}\right)^{10}$ MAX.	2.7	4.0	4.9	5.6	6.0	6.3	6.5	6.6
TYP.	2.3	3.4	4.1	4.6	4.9	5.1	5.3	5.4
MIN.	2.0	2.9	3.5	3.9	4.2	4.4	4.5	4.6

MA-46570 Series[1,2] — Constant Gamma GaAs Hyperabrupt Tuning Varactors

Breakdown Voltage[3] = 22 Volts Minimum

	C_{T_4} (pF) Capacitance Range[4,5,6]							
	0.5 MAX.	**0.50 — 0.99**	**1.00 — 1.49**	**1.50 — 2.49**	**2.50 — 3.49**	**3.50 — 4.99**	**5.00 — 6.99**	**7.00 — 10.0**
500	—	—	—	—	—	—	MA-46576A	MA-46577A
1000	—	—	—	MA-46573B	MA-46574B	MA-46575B	MA-46576B	MA-46577B
1500	MA-46570C	MA-46571C	MA-46572C	MA-46573C	MA-46574C	MA-46575C	MA-46576C	MA-46577C
2000	MA-46570D	MA-46571D	MA-46572D	MA-46573D	MA-46574D	MA-46575D	—	—
3000	MA-46570E	MA-46571E	MA-46572E	MA-46573E	—	—	—	—
4000	MA-46570F	MA-46571F	—	—	—	—	—	—
$\left(\frac{C_{T\text{-}2}}{C_{T\text{-}20}}\right)^{10}$ MAX.	3.2	5.3	7.1	8.7	10.0	11.0	11.5	12.0
TYP.	2.6	4.3	5.7	6.9	7.8	8.4	8.9	9.3
MIN.	2.2	3.6	4.8	6.6	6.4	6.8	7.2	7.5

See notes on page 53.

CERAMIC GaAs HYPERABRUPT TUNING VARACTORS— CONSTANT GAMMA ≅ 1.25 (CONT'D)

NOTES:

1. All GaAs tuning varactors in these series are available in case style 30 and many other ceramic case styles as well as in chip form. When ordering specify the desired case by adding the case designation as a suffix to the type number. For example: an MA-46561D-30 specifies a 15 volt tuning diode in case style 30 with C_{T-4} between 0.50 and 0.99 pF and a minimum Q (at −4 volts and 50 MHz) of 2000. Case style 30 is a ceramic to metal axial pronged hermetic package. For other package styles, contact factory representative.

2. Case parasitics (C_p and L_s) are given along with case outlines at the rear of this catalog. The C_p values listed typically have tolerances of ±0.02 pF. However, the actual case capacitance of each diode is measured to within ±0.0025 pF.

3. Breakdown voltage (V_B) is measured at 10 μA of reverse bias current.

4. Capacitance is measured at 1 MHz on a bridge which has been balanced with a shielded test holder connected in place, but open circuited. These shielded test holders are available for purchase. Contact the factory for further information.

5. Customer should specify, within the range indicated, the required capacitance. The nominal tolerance at −4 volts is ±10% of the **customer requested value. Closer tolerances are** available on request.

6. All junctions are hyperabrupt with nominal $\gamma \cong 1.25$, where:

$$C_J(V) = \frac{K}{(V + \phi)^\gamma}$$

and:

$C_J(V)$ = voltage dependent junction capacitance
V_R = applied reverse voltage
ϕ = built-in potential (1.2 volts)
γ = capacitance-voltage slope exponent (gamma)
K = constant

γ is within the limits $1.13 < \gamma < 1.40$ over the voltage range 2-12 volts for the MA-46560 series and 2-20 volts for the MA-46570 series. Total capacitance of packaged diodes will deviate from constant gamma characteristics depending on the value of the required junction capacitance and the package choice due to differences in case capacitance (C_p). The figures below illustrate typical total capacitance versus applied voltage for the MA-46570 series when case style 30 is selected and typical capacitance ratios versus applied voltage using case style 30.

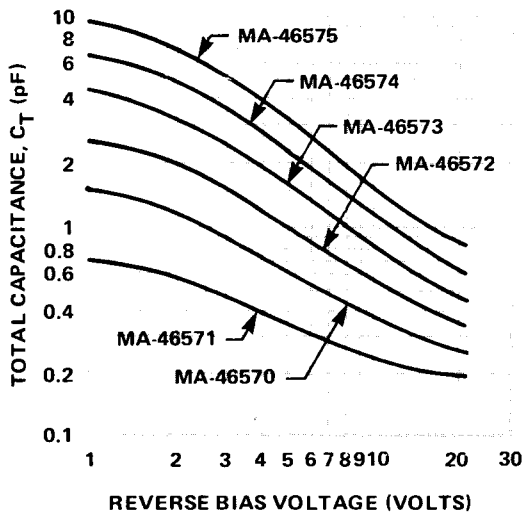
7. Diode Q is measured by a modified DeLoach technique at −4 volts and extrapolated to 50 MHz. (A copy of the article "Determination of Varactor Parameters by a Modified DeLoach Method" is available on request.)

8. All GaAs tuning 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.**

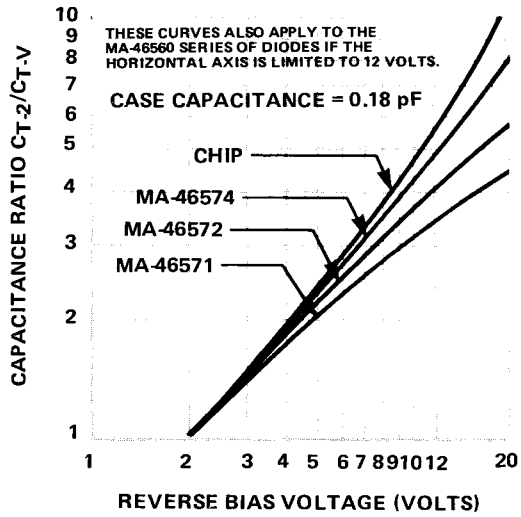
9. Parasitic inductance (L_s) has been determined at X-Band using a DeLoach method measurement.

10. The total capacitance ratios shown in the specifications are for devices housed in case style 30. Total capacitance ratios will vary with choice of case style.

TYPICAL PERFORMANCE



MA-46570 SERIES TOTAL CAPACITANCE VS REVERSE BIAS VOLTAGE (CASE STYLE 30)



MA-46570 SERIES CAPACITANCE RATIO VS REVERSE BIAS VOLTAGE (CASE STYLE 30)

GLASS PACKAGED GaAs HYPERABRUPT TUNING VARACTORS

The MA-46520 and MA-46530 series of gallium arsenide hyperabrupt tuning varactors are specifically designed to provide higher Q at comparible cost witn similar silicon hyperabrupt diodes. Gallium Arsenide not only provides higher performance (lower loss) at conventional frequency bands, but extends the upper frequency range of glass packaged diodes. Each of these low cost devices is enclosed in the axial leaded picominiature glass package, case style 54. These series, with their broad range of capacitance and nonlinearity, are an excellent choice for tuning VCO's, filters and amplifiers.

MA-46520 SERIES

MODEL NUMBER[1]	MIN. BREAK-DOWN VOLT., V_B[2] (VOLTS)	MIN. Q @-4 VOLTS[3]	TOTAL CAPACITANCE RANGE[4] (pF) @ V_R = -4 VOLTS	TOTAL CAPACITANCE RANGE[4] (pF) @ V_R = -8 VOLTS	TOTAL CAPACITANCE RANGE[4] (pF) @ V_R = -20 VOLTS	TUNING RATIO RANGE (RATIO) C_{T-4}/C_{T-8}	TUNING RATIO RANGE (RATIO) C_{T-4}/C_{T-20}
MA-46520A	15	700	18 —22	7.5—10.5	—	1.7 —2.9	—
MA-46520B	22	700	18 —22	7.5—10.5	3.1—3.9	—	4.6—7.1
MA-46520C	15	700	19 —21	7.8—9.2	—	2.0 —2.7	—
MA-46520D	22	700	19 —21	7.8—9.2	3.1—3.9	2.0 —2.7	4.8—6.8
MA-46522A	15	600	45 —55	18 —25	—	1.8 —3.1	—
MA-46522B	22	600	45 —55	18 —25	7.3—9.2	—	4.9—7.5
MA-46522C	15	600	47.5—52.5	18.4—21.6	—	—	—
MA-46522D	15	600	47.5—52.5	18.4—21.6	7.3—9.2	2.2 —2.8	—
MA-46523A	15	375	100 —120	39 —55	—	1.8 —3.1	—
MA-46523B	22	375	100 —120	39 —55	16 —20	—	5.0—7.5
MA-46523C	15	375	104.5—115.5	41.4—48.6	—	2.15—2.8	—
MA-46523D	22	375	104.5—115.5	41.4—48.6	16 —20	2.15—2.8	5.2—7.2
MA-46524A	15	300	140 —170	55 —80	—	1.7 —3.1	—
MA-46524B	22	300	140 —170	55 —80	22.5—28	—	5.0—7.6
MA-46524C	15	300	147 —163	59.8—70.2	—	2.1 —2.8	—
MA-46524D	22	300	147 —163	59.8—70.2	22.5—28	2.1 —2.8	5.2—7.2
MA-46525A	15	270	180 —220	70 —105	—	1.7 —3.1	—
MA-46525B	22	270	180 —220	70 —105	29 —36	—	5.0—7.6
MA-46525C	15	270	190 —210	78 —92	—	2.0 —2.7	—
MA-46525D	22	270	190 —210	78 —92	29 —36	2.0 —2.7	5.3—7.3

See notes on page 55.

GLASS PACKAGED GaAs HYPERABRUPT TUNING VARACTORS (CONT'D.)

MA-46530 SERIES

MODEL NUMBER[1]	MIN. BREAK-DOWN VOLT., V_B[2] (VOLTS)	MIN. Q @ -4 VOLTS[3]	TOTAL CAPACITANCE RANGE[4] (pF) @ V_R = -3 VOLTS	@ V_R = -8 VOLTS	@ V_R = -20 VOLTS	TUNING RATIO RANGE (RATIO) C_{T-3}/C_{T-8}	C_{T-3}/C_{T-20}
MA-46533A	15	900	10.5—12.5	4.3—5.7	—	1.8—2.9	—
MA-46533B	22	900	10.5—12.5	4.3—5.7	2.0—2.4	—	4.4—6.3
MA-46533C	22	1200	10.5—12.5	4.3—5.7	2.0—2.3	—	4.6—6.3
MA-46533D	15	900	10.9—12.1	4.6—5.4	—	2.0—2.6	—
MA-46533E	22	900	10.9—12.1	4.6—5.4	2.0—2.4	2.0—2.6	4.5—6.1
MA-46533F	22	1200	10.9—12.1	4.6—5.4	2.0—2.3	2.0—2.6	4.7—6.1
MA-46534A	15	600	25 —31.0	10 —13.5	—	1.8—3.1	—
MA-46534B	22	600	25 —31.0	10 —13.5	4.5—5.3	—	4.7—6.9
MA-46534C	22	800	25 —31.0	10 —13.5	4.5—5.1	—	4.9—6.9
MA-46534D	15	600	26.5—29.5	11 —13.0	—	2.0—2.7	—
MA-46534E	22	600	26.5—29.5	11 —13.0	4.5—5.3	2.0—2.7	5.0—6.6
MA-46534F	22	800	26.5—29.5	11 —13.0	4.5—5.1	2.0—2.7	5.2—6.6

NOTES:
1. Each of the devices in these series is packaged in case style 54, an axial leaded, picominiature hermetically glass enclosure.
2. Breakdown voltage is measured at 10 μA of reverse bias current.
3. Total capacitance is measured at 1 MHz and the stated voltage.
4. Q is measured by a modified DeLoach Technique at —4 volts and extrapolated to 50 MHz.

APPLICATION NOTES

SELECTION OF CONSTANT GAMMA HYPERABRUPT GaAs TUNING VARACTORS

For a PN junction the dependence of junction capacitance, Cj, on applied voltage, V, is given by:

$$C_j(V) = \frac{C_0}{\left(1 + \frac{V_R}{\phi}\right)^{\gamma}} \qquad (1)$$

ϕ = built-in potential (ϕ = 1.2 volts)
C_0 = a constant (mathematically equal to junction capacitance when V = 0)
γ = capacitance-voltage slope exponent (gamma)

For simple abrupt junction varactors, gamma is constant and nominally equal to 0.5. The junction is referred to as hyperabrupt when $\gamma > 0.5$ and for most commercially available varactors, the value γ varies widely with applied voltage.

From Equation (1), we observe that gamma is determined as the slope of the plot of junction capacitance, C_j, versus total voltage (applied voltage plus built-in potential) on log-log graph paper. A typical plot of the constant γ hyperabrupt tuning varactor C-V characteristics is illustrated on page 56 where the slope of curve 1 is a constant $\gamma \cong 1.25$ over the applied voltage range of 2-20 volts. Notice that constant gamma is not maintained at low applied voltages, so C_0 = 6.6 pF is a mathematical value determined by extending the constant slope to V = 0 (or V + ϕ = 1.2). The capacitance versus applied voltage, curve 2, is also shown for the chip, and curve 3 illustrates the C-V curve when the chip is mounted in a style 30 package having a package capacitance of 0.18 pF.

The primary purpose of the constant gamma hyperabrupts is to permit the designer to achieve linear frequency tuning without the use of a linearizer. For a simple resonant circuit comprised of an induc-

APPLICATION NOTES (CONT'D)

tance, L, and the varactor junction capacitance C_j (V), the frequency-voltage relationship is given by:

$$f_r(V) = \frac{1}{2\pi\sqrt{LC_j(V)_1}} = \frac{1}{2\pi\sqrt{LC_0}}\left(1+\frac{V_R}{\phi}\right)^{\gamma/2} \quad (2)$$

and the desired γ for linear tuning is 2.0. However, in nearly all microwave circuits, the varactor is not the only capacitance in the resonator. Instead, the capacitance of the active element, or parasitic or stray capacitance, or purposefully designed decoupling capacitance is only a portion of the resonant structure. An analysis has been performed of the simple series circuit illustrated where the fixed capacitance, C_S, is in series with the varactor. The results of this analysis provides guidance to the selection of a suitable γ for the circuit designer. Note the total capacitance, C_T, of the resonant circuit can be expressed in terms of a coupling factor, K_S, as:

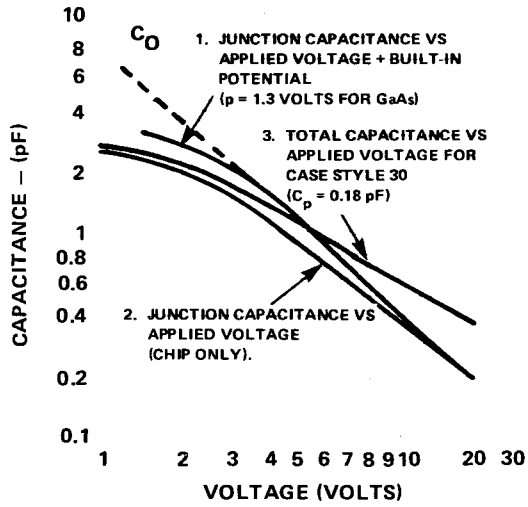
$$\frac{1}{C_T(V)} = \frac{1}{C_{T0}}\left[1 - K_S + K_S\left(1+\frac{V}{\phi}\right)^{\gamma}\right] \quad (3)$$

where:

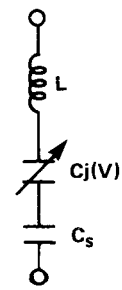
$$K_S = \frac{C_{T0}}{C_0} = \frac{\text{Total Capacitance of Resonator at } V = 0}{\text{Varactor Junction Capacitance at } V = 0} \quad (4)$$

When $K_S = 1$, the varactor is fully coupled and optimum $\gamma = 2$. When K_S approaches 0, the varactor becomes heavily decoupled and only narrow-band frequency tuning is possible and the optimum γ approaches 1.0. For intermediate values of coupling in the range $0 < K_S < 1$, an optimum value of constant γ for linear frequency tuning is predictable. The result of the analysis is illustrated in Figure C. In this illustration, the optimum γ value is plotted versus the frequency ratio, f_{max}/f_{min}, with the coupling factor, K_S, as a parameter. Notice that linear tuning can be achieved for constant gamma within the limits $1.0 < \gamma < 2.0$ depending on the coupling factor.

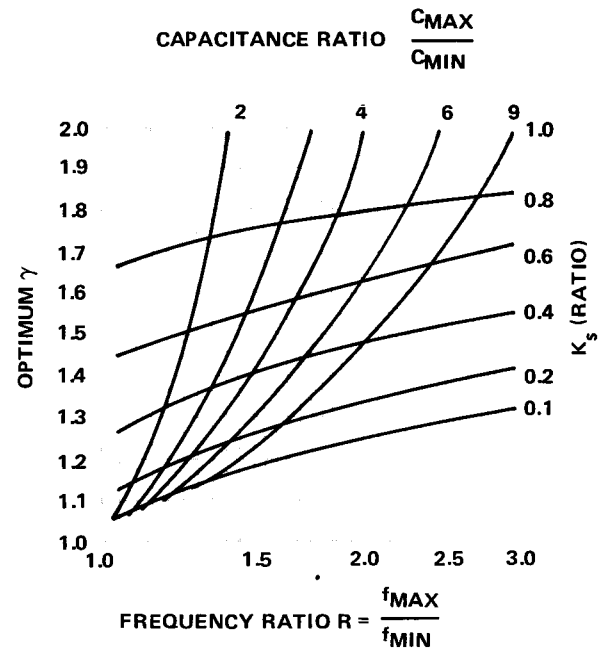
From the circuit designer's viewpoint, this simplified analysis can be used for selection of constant gamma hyperabrupts. For example, suppose this circuit specification requirement is for a tuning ratio of 2:1, the designer could select $\gamma = 2$ and fully couple the varactor with $C_{max}/C_{min} \geq 4$. Alternatively, he can decouple to $K_S = 0.6$, where he should select $\gamma = 1.6, C_{max}/C_{min} \geq 6$. Further, decoupling can also be selected to improve resonator Q with correspondingly lower γ. The decoupling limit occurs when the C_{max}/C_{min} is not available in the varactor. Most broadband tuning requirements are optimized in user circuits with $1.2 < \gamma < 1.4$, while circuits with narrow tuning bandwidth needs to utilize a value of γ approaching 1.0. Linearity improvement with these varactors is frequently a factor of 10 or more over results with conventional abrupt junction diodes.



TYPICAL GaAs HYPERABRUPT C-V CHARACTERISTICS



EQUIVALENT STRUCTURE OF CIRCUIT MOUNTED TUNING VARACTOR



OPTIMUM γ SELECTION FOR LINEAR TUNING