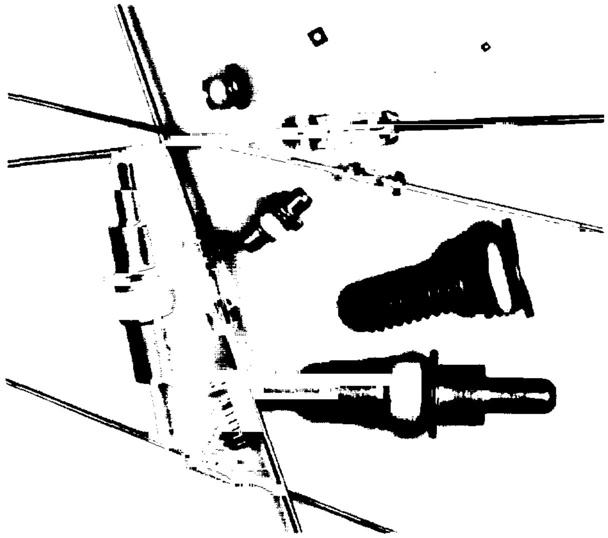
Step Recovery Diodes, Multichip SRD and SRD Chips

Features

- Low Transition Time
- High Cutoff Frequency
- High Reliability



Description

Alpha Step Recovery Diodes (SRD) are oxide passivated, epitaxial silicon mesa designs. Careful attention to diffusion profiles makes these diodes an ideal choice for high order multiplier circuits. They are available in a broad range of packages or in chip form for those who wish to bond SRDs into their own circuits. Also, multichip packaged devices are available for high power applications.

Application

There are basically four types of multiplier devices in common usage: 1) the resistive multiplier, 2) the varactor (square law or tuning diode) multiplier 3) the A-mode multiplier, and 4) the SRD. The resistive multiplier, typically a Schottky diode, is for low order, low power use and has low efficiency. Varactor multipliers are principally used as doublers or upconverters (N=2), while A-mode multiplier diodes are used on $N \leq 4$ multipliers. The SRD can also be used on $N \leq 4$ multipliers, but its main use is in high order (N>4) multipliers and comb generators where high efficiency is required. Alpha has a complete line of multiplier diodes for each case mentioned above (consult factory).

When an SRD is driven into forward conduction on one half of the RF cycle, the diode stores charge and appears as a low impedance.

On the second half of the cycle, the diode conducts until the stored charge is removed and then switches off very rapidly at a speed governed by the transition time, T_T.

In general it is desirable that the minority carrier lifetime (t) be greater than 10 times the period of the input frequency, while the transition time (T_T) should be less than the period of the output frequency. Figures 2 and 3 are graphs which can be used to easily determine the limiting values t and T_T. Test circuits to determine t and T_T are shown in Figures 4 and 5. For optimum performance an ideal SRD will be a punch-through device at zero volts (any increase in reverse bias above zero volts will not decrease capacitance) but will have a highly non-linear capacitance increase as the diode is forward biased. In actual practice a step recovery diode will not be zero punch-through but will have $C_{J0}/C_{J6} \leq 1.4$. This can be clearly seen in Figure 1. SRDs are highly efficient, and idlers are not needed although, if used, may further increase efficiency. A typical SRD circuit is shown in Figure 6.

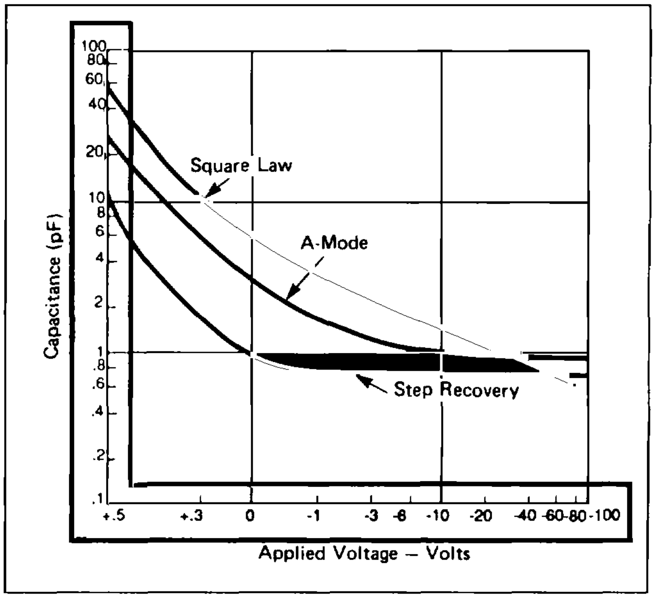


Figure 1. Capacitance vs. Applied Voltage for Square Root Law and A-Mode Multipliers and Step Recovery Diodes

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When higher microwave power is desired, the normal SRD may not be useable, since the necessary breakdown voltages may be too high for the transmission time required. Alpha has solved this problem by using the multichip approach. The use of two chips provides improvement in both average power handling and peak power handling capability. The chips are electrically in series and thermally in parallel, giving lower thermal resistance than chips which are in series both electrically and thermally. Average power is increased because, for a given RF reactance, each chip can have twice the capacitance of the equivalent single chip device. This results in a four time increase in total device area and, hence, in average power handling capability.

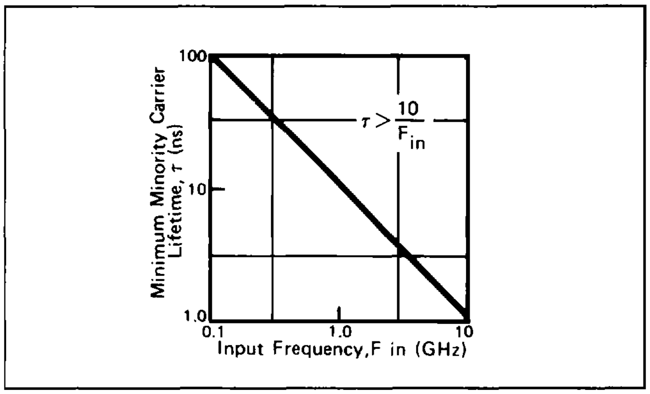

Figure 2. τ vs F_{in}

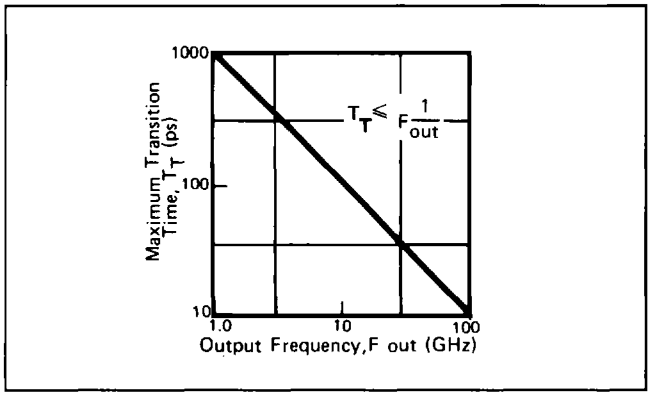

Figure 3. T_T vs F_{out}

Absolute Maximum Ratings

Parameter	Symbols	Value	Unit
Reverse Voltage	V_r	Same as V_B	Volts
Operating Temperature	T_{op}	-65 to +200	°C
Storage Temperature	T_{stg}	-65 to +200	°C

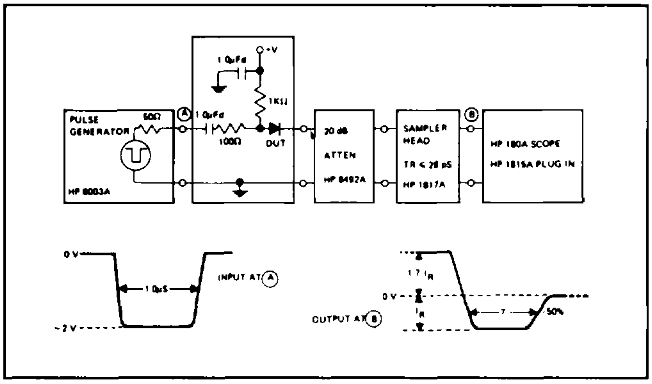

Figure 4. Minority Carrier Lifetime, τ, Test Set-Up

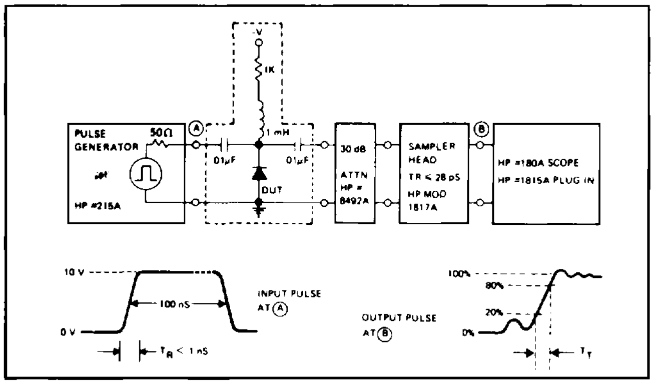

Figure 5. Transition Time, T_T, Test Set-Up

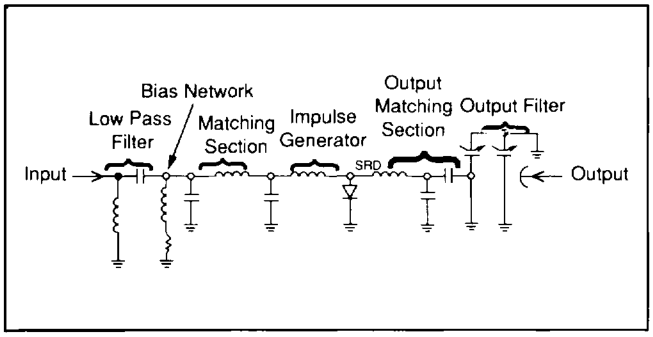

Figure 6. Typical SRD Multiplier Circuit

Step Recovery Diodes, Multichip SRD and SRD Chips

Step Recovery Diode Chips

Type Number	V_B[1] (Volts) Min.	C_{J-6}[2] (pF)	τ[3] (ns) Min.	T_T[4] (ps) Max.	F_{C-6}[5] (GHz) Min.	Typical Input Freq. (GHz)	Typical Output Freq. (GHz)	Chip Style
CVB1015-06 CVB1015-12 CVB1015-18	15	0.25-0.50 0.50-1.0 1.0-1.5	10	70	300	0.5-3.0	9.0-18.0	150-806 150-801 150-801
CVB1030-06 CVB1030-12 CVB1030-18	30	0.25-0.50 0.50-1.0 1.0-1.5	10	100	300	0.5-3.0	5.0-15.0	150-801 150-801 150-801
CVB1045-06 CVB1045-12 CVB1045-18	45	0.50-1.0 1.0-2.0 2.0-3.0	25	200	250	.25-1.5	2.0-7.5	150-801 150-802 150-802

Notes:
1. Measured at I_R = 10µA.
2. Measured at 1 MHz, V_R = 6 volts.
3. Measured at I_F = 10mA, I_R = 6mA (see Figure 4).
4. Measured at V_R = 10 volts, I_F = 10mA (see Figure 5).
5. Measured at F = 1 GHz, V_R = 6 volts.

15 Volt[1] Packaged Diodes

Type Numbers	Package Outline	C_{J-6}[2] pf	θ (°Cwatt) Typ.	Pout[3] (dbm) Typ.	Fout Range (GHz)
DVB6100-06	023-001	.25-.50	60	23	9-18
DVB6723-01	247-001	.25-.50	160	18	9-18
DVB6100-12	023-001	.50-1.00	40	25	9-18
DVB6723-02	247-001	.50-1.00	140	18	9-18
DVB6145-02	075-001	.50-1.00	700	13	9-18
DVB6100-18	023-001	1.00-1.50	30	26	9-18
DVB6723-03	247-001	1.00-1.50	130	20	9-18
DVB6145-03	075-001	1.00-1.50	700	13	9-18

For all diodes: τ = 10 nsec min.[4] T_t = 70 psec[5] max. F_{C-6} = 300 GHz min.[6] Efficiency[7] = 10% Multiplier Factor[8] = 10

Notes:
1. Measured at I_R = 10µA.
2. Measured at 1 MHz, V_R = 6 volts.
3. Actual power will depend on the multiplier design.
4. Measured at I_F = 10 mA, I_R = 6mA (see Figure 4)
5. Measured at V_R = 10 volts, I_F = 10 mA (see Figure 5).
6. Measured at F = 1 GHz, V_R = 6 volts.
7. Efficiency will depend on the actual multiplier design.
8. N is the multiplier factor where F_{OUTPUT} = N times F_{INPUT}.

Step Recovery Diodes, Multichip SRD and SRD Chips

30 Volt[1] Packaged Diodes

Type Numbers	Package Outline	C_{J-6}[2] pf	θ (°Cwatt) Typ.	Pout[3] (dbm) Typ.	Fout Range (GHz)
DVB6101-06	023-001	.25-.50	60	23	5-15
DVB6723-04	247-001	.25-.50	160	18	5-15
DVB6145-04	075-001	.25-.50	700	13	5-15
DVB6101-12	023-001	.50-.75	45	25	5-15
DVB6723-05	247-001	.50-.75	145	19	5-15
DVB6145-05	075-001	.50-.75	700	13	5-15
DVB6101-18	023-001	.75-1.00	40	25	5-15
DVB6723-06	247-001	.75-1.00	140	19	5-15
DVB6145-06	075-001	.75-1.00	700	13	5-15
DVB6101-24	023-001	1.00-1.25	35	25	5-15
DVB6723-07	247-001	1.00-1.25	135	20	5-15
DVB6145-07	075-001	1.00-1.25	700	13	5-15
DVB6101-30	023-001	1.25-1.50	30	26	5-15
DVB6723-08	247-001	1.25-1.50	130	20	5-15
DVB6145-08	075-001	1.25-1.50	700	13	5-15

For all diodes: τ = 10 nsec min.[4] T_t = 100 psec[5] max. F_{C-6} = 300 GHz min.[6] Efficiency[7] = 10% Multiplier Factor[8] = 10

45 Volt[1] Packaged Diodes

Type Numbers	Package Outline	C_{J-6}[2] pf	θ (°Cwatt) Typ.	Pout[3] (dbm) Typ.	Fout Range (GHz)
DVB6102-06	023-001	.50-1.00	50	24	2-7.5
DVB6723-09	247-001	.50-1.00	150	18	2-7.5
DVB6145-09	075-001	.50-1.00	700	13	2-7.5
DVB6102-12	023-001	1.00-1.50	40	25	2-7.5
DVB6723-10	247-001	1.00-1.50	140	20	2-7.5
DVB6145-10	075-001	1.00-1.50	700	13	2-7.5
DVB6102-18	023-001	1.50-2.00	30	26	2-7.5
DVB6723-11	247-001	1.50-2.00	130	22	2-7.5
DVB6145-11	075-001	1.50-2.00	700	13	2-7.5
DVB6102-24	023-001	2.00-3.00	25	27	2-7.5
DVB6723-12	247-001	2.00-3.00	125	22	2-7.5
DVB6145-12	075-001	2.00-3.00	700	13	2-7.5

For all diodes: τ = 25 nsec min.[4] T_t = 200 psec[5] max. F_{C-6} = 250 GHz min.[6] Efficiency[7] = 10% Multiplier Factor[8] = 10

Notes:
1. Measured at I_R = 10μA.
2. Measured at 1 MHz, V_R = 6 volts.
3. Actual power will depend on the multiplier design.
4. Measured at I_F = 10 mA, I_R = 6mA (see Figure 4)
5. Measured at V_R = 10 volts, I_F = 10 mA (see Figure 5).
6. Measured at F = 1 GHz, V_R = 6 volts.
7. Efficiency will depend on the actual multiplier design.
8. N is the multiplier factor where F_{OUTPUT} = N times F_{INPUT}.

Step Recovery Diodes, Multichip SRD and SRD Chips

60 Volt[1] Packaged Diodes

Type Numbers	Package Outline	C_{J-6}[2] pf	θ (°Cwatt) Typ.	Pout[3] (dbm) Typ.	Fout Range (GHz)
DVB6103-06	023-001	.50-1.00	30	34	1.3-4
DVB6723-13	247-001	.50-1.00	130	31	1.3-4
DVB6145-13	075-001	.50-1.00	700	18	1.3-4
DVB6103-12	023-001	1.00-1.50	25	35	1.3-4
DVB6723-14	247-001	1.00-1.50	125	31	1.3-4
DVB6145-14	075-001	1.00-1.50	700	18	1.3-4
DVB6103-18	023-001	1.50-2.00	20	36	1.3-4
DVB6723-15	247-001	1.50-2.00	120	31	1.3-4
DVB6145-15	075-001	1.50-2.00	700	18	1.3-4
DVB6103-24	023-001	2.00-3.00	15	37	1.3-4
DVB6723-16	247-001	2.00-3.00	115	32	1.3-4
DVB6145-16	075-001	2.00-3.00	700	18	1.3-4

For all diodes: τ = 60 nsec min.[4] T_t = 300 psec[5] max. F_{C-6} = 150 GHz min.[6] Efficiency[7] = 40% Multiplier Factor[8] = 5

75 Volt[1] Packaged Diodes

Type Numbers	Package Outline	C_{J-6}[2] pf	θ (°Cwatt) Typ.	Pout[3] (dbm) Typ.	Fout Range (GHz)
DVB6104-06	023-001	1.50-3.50	15	37	.75-3
DVB6723-17	247-001	1.50-3.50	115	32	.75-3
DVB6145-17	075-001	1.50-3.50	700	18	.75-3
DVB6104-12	023-001	3.50-5.50	15	37	.75-3
DVB6723-18	247-001	3.50-5.50	115	32	.75-3
DVB6145-18	075-001	3.50-5.50	700	18	.75-3
DVB6104-18	023-001	5.50-7.50	10	39	.75-3
DVB6723-19	247-001	5.50-7.50	110	32	.75-3
DVB6145-19	075-001	7.50-10.00	10	39	.75-3
DVB6104-24	023-001	7.50-10.00	110	32	.75-3

For all diodes: τ = 100 nsec min.[4] T_t = 400 psec[5] max. F_{C-6} = 125 GHz min.[6] Efficiency[7] = 40% Multiplier Factor[8] = 5

Notes:
1. Measured at I_R = 10μA.
2. Measured at 1 MHz, V_R = 6 volts.
3. Actual power will depend on the multiplier design.
4. Measured at I_F = 10 mA, I_R = 6mA (see Figure 4)
5. Measured at V_R = 10 volts, I_F = 10 mA (see Figyre 5).
6. Measured at F = 1 GHz, V_R = 6 volts.
7. Efficiency will depend on the actual multiplier design.
8. N is the multiplier factor where F_{OUTPUT} = N times F_{INPUT}.

Step Recovery Diodes, Multichip SRD and SRD Chips

2 Chip - 023-001 Package

Type Numbers	V_B[1] (Volts)	C_{j-6}[2] pf	τ[3] (ns) Min.	t_t[4] (ps) Max.	θth (°C/Watt) Min.	F_{C-6}[5] (GHz) Min.	Typical Input Freq. (GHz)	Typical Output Freq. (GHz)	Available Output Power (dbm)
DVB6850-06	30	.25-.50	10	80	35	250	0.5-3.0	9.0-18.0	27
DVB6850-12	30	.50-1.00	10	80	25	250	0.5-3.0	9.0-18.0	29
DVB6850-18	30	1.00-1.50	10	80	20	250	0.5-3.0	9.0-18.0	30
DVB6851-06	60	.25-.50	10	100	35	250	0.5-3.0	5.0-15.0	27
DVB6851-12	60	.50-1.00	10	100	25	250	0.5-3.0	5.0-15.0	29
DVB6851-18	60	1.00-1.50	10	100	20	250	0.5-3.0	5.0-15.0	30
DVB6852-06	90	.05-1.00	25	200	30	225	.25-1.50	2.0-7.5	28
DVB6852-12	90	1.00-1.50	25	200	25	225	.25-1.50	2.0-7.5	29
DVB6852-18	90	1.50-2.00	25	200	20	225	.25-1.50	.2.0-7.5	30

Conversion Efficiency: 40% Typical[6]   Multiplication Factor[7]: N=5

2 Chip - 017-001 Package

Type Numbers	V_B[1] (Volts)	C_{j-6}[2] pf	τ[3] (ns) Min.	t_t[4] (ps) Max.	θth (°C/Watt) Min.	F_{C-6}[5] (GHz) Min.	Typical Input Freq. (GHz)	Typical Output Freq. (GHz)	Available Output Power (dbm)
DVB6860-06	90	.50-1.00	25	250	30	225	.25-1.5	2.0-6.0	35
DVB6860-12	90	1.00-1.50	25	250	25	225	.25-1.5	2.0-6.0	37
DVB6860-18	90	1.50-2.00	25	250	20	225	.25-1.5	2.0-6.0	38
DVB6861-06	120	.05-1.00	60	350	18	125	0.1-1.0	1.2-4.0	38
DVB6861-12	120	1.00-1.50	60	350	15	125	0.1-1.0	1.2-4.0	39
DVB6861-18	120	1.50-2.00	60	350	12	125	0.1-1.0	1.2-4.0	40
DVB6862-06	150	1.50-3.50	100	450	10	100	0.5-7.5	.75-2.5	41
DVB6862-12	150	3.50-5.50	100	450	10	100	0.5-7.5	.75-2.5	41

Conversion Efficiency: 40% Typical[6]   Multiplication Factor[7]: N=5

3 Chip - 017-001 Package

Type Numbers	V_B[1] (Volts)	C_{j-6}[2] pf	τ[3] (ns) Min.	t_t[4] (ps) Max.	θth (°C/Watt) Min.	F_{C-6}[5] (GHz) Min.	Typical Input Freq. (GHz)	Typical Output Freq. (GHz)	Available Output Power (dbm)
DVB6870-06	135	.05-1.00	25	300	20	220	.25-1.5	1.5-5.0	38
DVB6870-12	135	1.00-1.50	25	300	15	220	.25-1.5	1.5-5.0	39
DVB6870-18	135	1.50-2.00	25	300	10	220	.25-1.5	1.5-5.0	41
DVB6871-06	180	.05-1.00	60	400	10	120	0.1-1.0	1.0-3.0	41
DVB6871-12	180	1.00-1.50	60	400	8	120	0.1-1.0	1.0-3.0	46
DVB6871-18	180	1.50-2.00	60	400	6	120	0.1-1.0	1.0-3.0	49
DVB6872-06	225	1.50-3.50	100	500	7	100	0.5-7.5	.75-2.5	47
DVB6872-12	225	3.50-5.50	100	500	6	100	0.5-7.5	.75-2.5	49

Conversion Efficiency: 40% Typical[6]   Multiplication Factor[7]: N=5

Notes:
1. Measured at $I_R = 10\mu A$.
2. Measured at 1 MHz, $V_R = 6$ volts.
3. Measured at $I_F = 10mA$, $I_R = 6mA$ (see Figure 4).
4. Measured at $V_R = 10$ volts, $I_F = 10mA$ (see Figure 5).
5. Measured at F = 1 GHz, $V_R = 6$ volts.
6. Actual power and efficiency will depend on the multiplier design.
7. N is the multiplier factor where $F_{OUTPUT} = N$ times F_{INPUT}.