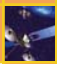
ECLIPSE MICROWAVE



detectors terms & definitions

VOLTAGE SENSITIVITY: K-FACTOR

This parameter describes the slope of the transfer function of the diode or the ability to convert RF power into video voltage. This term is usually expressed with an open circuit video load. K-Factor is expressed in millivolts per milliwatts and is measured at -20 dBm, which is the top of the square law region. K values range from a few hundred to several thousand.

VIDEO RESISTANCE: Rv

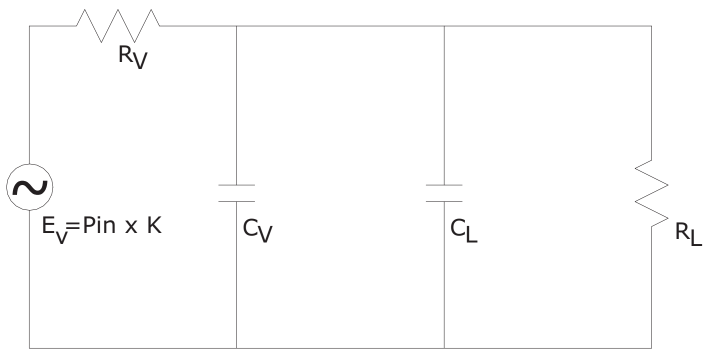
Expressed in ohms, Rv is the real part of the output impedance measured while RF power and bias (if required) is applied. Therefore, this is the dynamic output resistance. Rv is calculated by simply measuring the open circuit K-Factor in the square law region. Then, a load resistor is applied and adjusted until the output K-Factor is reduced by half. This value is equal to the detector's Rv.

FIGURE OF MERIT: M

This parameter is a combination of both K-Factor and Rv. M is a quality factor, which relates the detector's sensitivity to video load conditions.

$$M = K/\sqrt{Rv}$$

Figure of Merit (M) is the denominator in the calculation of tangential sensitivity power input. A high figure of merit (M) value indicates an improved Tss performance.



Square Law Equivalent Circuit

TANGENTIAL SENSITIVITY: T_{ss}

Tangential sensitivity is the measurement of combined detector and video amplifier performance as a receiver. T_{ss} is controlled by temperature, video amplifier noise figure and M of the detector.

T_{ss} has been accepted in the industry as the signal power that creates an 8 dB signal-to-noise ratio at +27°C.

$$PT_{ss} = ([3.22/\sqrt{BW x NF})]/M) \times 10^{-7}$$

where, PT_{ss} = RF power at Tss in milliwatts
BW = Video amp bandwidth in Hz
NF = Video amp noise figure (Ratio)

T_{ss} is measured with a video amplifier having at least 50 dB gain, <3 dB noise figure, and a 2 MHz video bandwidth. Measured T_{ss} is degraded using a video amplifier having greater than 2 MHz video bandwidth as:

$$-dB = 10 \log_{10}\sqrt{(\text{Higher BW MHz}/2\text{MHz})}$$

Measured T_{ss} is improved using a video amplifier having less than 2 MHz video bandwidth as follows:

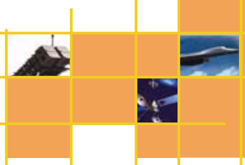
$$+dB = 10 \log_{10}\sqrt{(2\text{ MHz}/\text{Lower BW MHz})}$$

VIDEO CAPACITANCE: C_V

C_v is the imaginary part of the detector output impedance. It is mainly comprised of the RF bypass capacitance. The diode chip capacitance is typically <1/200 of the bypass capacitor and is negligible. This capacitance may be selected at manufacture to optimize rise time and bandwidth while slightly degrading video isolation.

FLATNESS

Flatness is the variation of input RF power required across the frequency range to produce a constant output voltage at the video load. This is typically measured at -20 dBm while measuring the K-Factor.

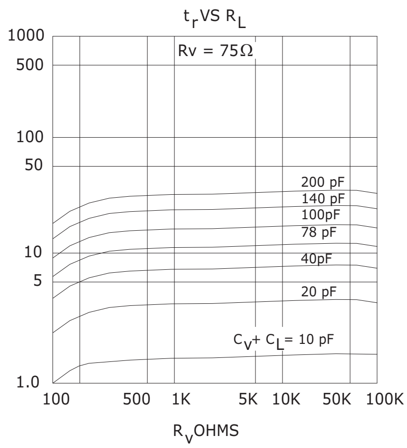


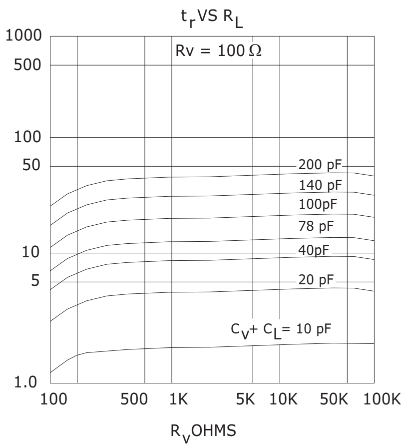
RISE TIME (t_r) - VIDEO BANDWIDTH

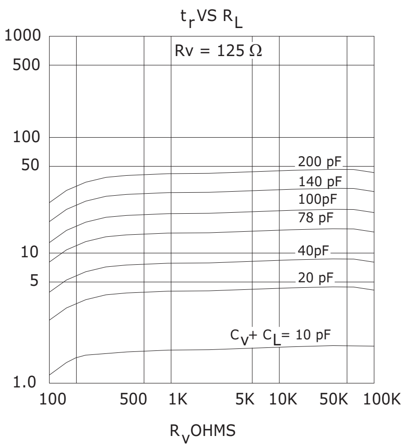
Pulse response systems, consideration to video pulse quality, are of extreme importance and frequently have a trade off between T_{SS} and video bandwidths. Detector video bandwidth depends on video impedance and varies considerably with the diode type and RF bypass capacitor used. The 10% to 90% rise time for the output voltage across the video load R due to a step RF power rise at the detector input is:

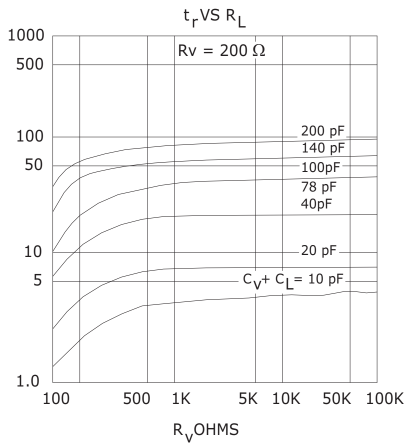
$$t_r(10\text{-}90\%) = 2.2 \times [R_V R_L/(R_V+R_L)] \times (C_V+C_L) = 0.35/BW$$

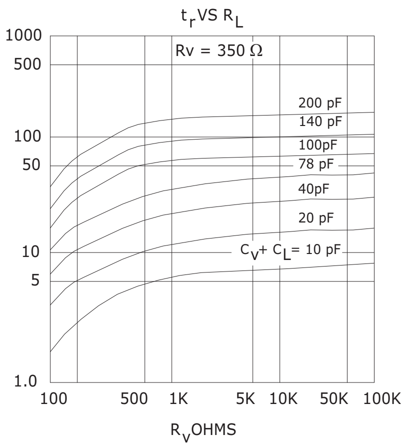
where,
- R_V = Detector video resistance
- C_V = Detector circuit bypass capacitor
- C_L = Load capacitor
- R_L = Load resistance
- BW = Circuit 3 dB video bandwidth (Hz)

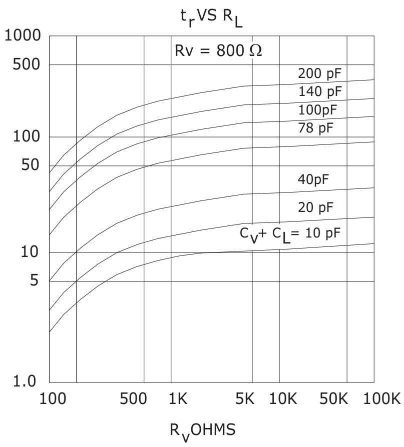




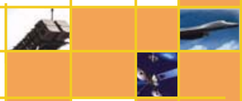








ECLIPSE MICROWAVE



Detector Terms & Definitions

DYNAMIC RANGE

The dynamic range is defined differently depending on application. Expressed in dB, dynamic range extends from T_{SS} at the low end to either the top of the square law region or the maximum safe power handling of +20 dBm (+17 dBm for tunnel diodes). The safe power handling range may be increased by the use of a limiter. This usually causes saturation of output at less than +20 dBm while allowing safe inputs of over a watt of CW power. Detector input padding will increase the upper power end of the dynamic range by the value in dB of the padding. This will shift up the lower end of the dynamic range.

TRANSFER FUNCTION CURVE

This is the plot of a detector output voltage versus RF input power. A single graph usually includes transfer function curves of detector with several different load values. Typical transfer function plots are shown in the appropriate section for each detector diode type.

TEMPERATURE STABILITY

Signal power variation is required to maintain a constant output video voltage as temperature is varied. The delta is expressed in ±dB. This parameter is usually measured and specified at the top of the square law region. Video amplifier designers have designed compensation circuits that greatly reduce the effects of detector output variations over the required operating temperature. Variations with temperature are not constant above the square law region. Example: A zero-bias Schottky detector varies ±1.5 dB to ±2 dB from -55°C to +125°C in the square law region. However, at +10 dBm, the same detector would vary only ±0.35 dB over the same temperature range.

VIDEO ISOLATION

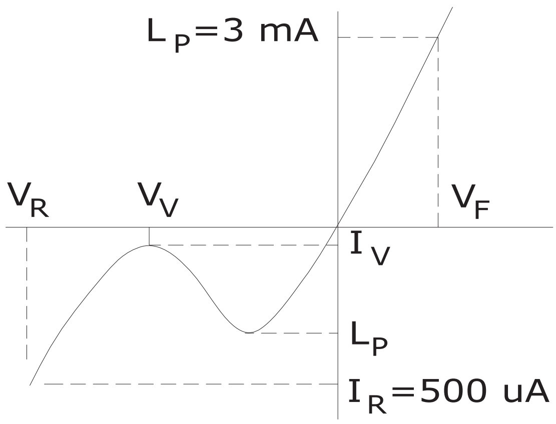
Input RF power is bypassed to ground on the video side of the detector chip. The RF bypass capacitance is selected to provide 20 to 30 dB of isolation at the video port for the RF input power. When increased rise time and improved video bandwidth is desired, a lower RF bypass capacitance is required. This degrades the isolation, which can cause increased fine grain frequency response, and in some cases reduced sensitivity.

VOLTAGE STANDING WAVE RATIO: VSWR

The Voltage Standing Wave Ratio at the detector's RF input port varies considerably with diode type, incident input power level, and video load. Typically, the VSWR is enhanced with the application of bias, but degrades quickly above the square law region. Padding and video load selections enhance VSWR when used for instrumentation.

TRACKING

Detector may be supplied as pairs, triples, quads, or many units per set. Tracking is the maximum variation from unit to unit in a set. This K-Factor between the units in any set is usually tested over the specified frequency range at -20 dBm input power. Octave band or waveguide bandwidths may be matched to ±0.3 dB at lower frequencies and ±0.5 dB at frequencies up to 18 GHz. Broadband and higher frequencies 40 GHz units may be matched to ±0.7 dB to ±1.0 dB.



Typical Tunnel Diode Curve

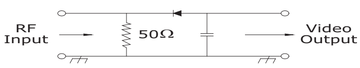
Detector Terms & Definitions

HOW TO SPECIFY AND SELECT DETECTORS

This section includes several selection charts as guides to the performance parameters of the different types of detectors designed and manufactured at eclipse. This includes the three-diode types we use.

Table 1 presents a comparison of performance for the different diode types. Table 2 provides a qualitative selection guide of detectors for use in low-level detection such as crystal video applications

TABLE 1: PERFOMANCE COMPARISON OF MICROWAVE DETECTORS

Detector Type Performance	6 dB Padded Biased Schottky	6 dB Padded Zero-Bias Schottky	3 dB Padded Tunnel Diode	Biased Schottky	Zero-Bias Schottky	Germanium Tunnel	GaAs Tunnel
Circuit Diagram							
Bias (μA)	50	0	0	100 to 300	0	0	0
Tangential Sensitivity Tss (dBm)(2MHz VBW, NF = 3dB)	-45	-45	-47	-52 to -50	-52 to -50	-51 to -49	-49
Voltage Sensitivity K (mV/mW)	500 to1000	500to1000	300 to 600	1000 to 3000	1500 to 3000	400 to 1200	250 to 800
Video Resistance Rv Ω (Square Law Region)	800 to 1200	400to2000	100 to 200	150 to 500	400 to 2000	400 to 1200	100 to 150
Input VSWR(Square Law Region)	1.5:1	1.5:1	2:1	2:1 to 6:1	2:1 to 6:1	1.5:1 to 3:1	3:1
Frequency Response (Square Law Region) Octaves (dB)	±0.3 to ±0.6	±0.3 to ±0.6	±0.3 to ±0.5	±0.4 to ±0.7	±0.4 to ±0.7	±0.3 to ±0.7	±0.3 to ±0.5
Frequency Response (Square Law Region) Decades (dB)	±1.0	±0.75	±0.7	±1.5	±1.5	±1.5	±1.5
Temperature Stability(dB) (-55°C to 85°C)	±1.0	±2.0	±0.5	±1.0	±2.0	±0.5	±0.5
Power Rating Maximum Safe (dBm)	+26	+26	+21	+20	+20	+17	+17
Rise and Fall Time	Medium	Medium Slow	Fast	Medium	Medium Slow	Fast	Fast

Detector Terms & Definitions

TABLE 2: LOW LEVEL MICROWAVE SIGNAL DETECTOR SELECTION CHART

Most Critical Parameter	Best Selection Detector Diode Type	Tss	VSWR (Square law Region)	Power Rating	Temperature Range	Temperature Stability	Video Resistance (Square Law)	Bias Requires
Tss (Tangential Sensitivity)	Regular Schottky	Excellent	Fair	Fair	Excellent(+125°C)	Fair	Medium (Good)	Yes
	Zero-Bias Schottky	Excellent	Poor	Poor	Excellent(+125°C)	Poor	High (Poor)	No
	Limiter-Schottky	Excellent to Good	Fair	Excellent	Excellent(+125°C)	Fair	Medium (Good)	Yes
	Limiter Zero Bias Schottky	Excellentto Good	Fair	Excellent	Excellent(+125°C)	Poor	High (Poor)	No
	Multi-Diode Schottky	Excellent	Very Good	Very Good	Good(+100°C)	Fair	Medium High (Fair)	Yes
VSWR(Square Law Region)	Padded-Schottky	Poor	Excellent	Very Good	Excellent(+125°C)	Fair	Medium (Good)	Yes
	Padded Zero-bias Schottky	Poor	Excellent	Very Good	Excellent(+125°C)	Poor	High (Poor)	No
	Multi-Diode Schottky	Excellent	Very Good	Very Good	Good(+100°C)	Fair	Medium (Fair)	Yes
Power Handling	Padded-Schottky	Poor	Excellent	Very Good	Excellent(+125°C)	Fair	Medium (Good)	Yes
	Padded Zero-Bias Schottky	Poor	Excellent	Very Good	Excellent(+125°C)	Poor	High (Poor)	No
	Multi-Diode Schottky	Excellent	Very Good	Very Good	Good(+100°C)	Fair	Medium (Fair)	Yes
	Limiter-Schottky	Excellent to Good	Fair	Excellent	Excellent(+125°C)	Fair	Medium (Good)	Yes
Temperature Rating	Regular Schottky	Excellent	Fair	Fair	Excellent(+125°C)	Fair	Medium (Good)	Yes
	Zero-Bias Schottky	Excellent	Poor	Poor(+125°C)	Excellent	Poor (Poor)	High	No
	Limiter-Schottky	Excellent to Good	Fair	Excellent	Excellent(+125°C)	Fair	Medium (Good)	Yes
Temperature Stability	Tunnel	Good	Good	Poor	Fair(+85 - +100°C)	Excellent	Low (Excellent)	No
Low Video Resistance	Tunnel	Good	Good	Poor	Fair(+85 - +100°C)	Excellent	Low (Excellent)	No
No BiasingRequired	Tunnel	Good	Good	Poor	Fair(+85 - +100°C)	Excellent	Low (Excellent)	No
	Zero-Bias Schottky	Excellent	Poor	Poor	Excellent(+125°C)	Poor	High (Poor)	No