Application Note

Basic Limiter Performance Parameters

2011 Apllication Note Prelim

The most important thing we build is trust

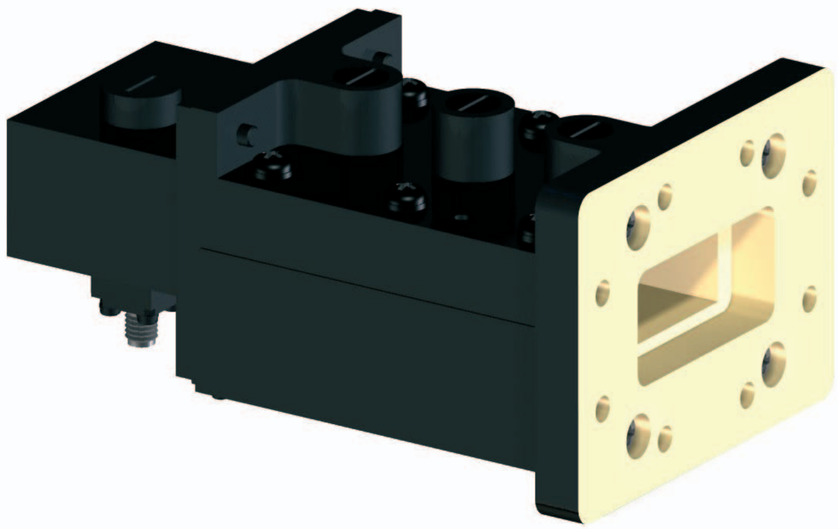
COBHAM

Introduction

Limiters, or Receiver Protectors, are essential components in receiver systems. They limit input power to sensitive front-end devices, such as Low Noise Amplifiers (LNA.)
This is especially important in a wide dynamic range environment, such as Radar.

Cobham MAL manufacture standard co-axial limiters and has a long pedigree in producing designs for custom requirements, utilising surface mount and waveguide technologies. By exploiting Cobham MAL's PIN diode capabilities, our limiter products are all solid-state providing high reliability and fast recovery times.

When selecting a limiter for your application it is useful to understand the various performance parameters and the trade-offs.



Basic Parameters

The core function of a limiter is to limit higher power signals to an acceptable level, whilst passing low level signals with low insertion loss. A typical transfer function for a limiter is shown in Figure 1

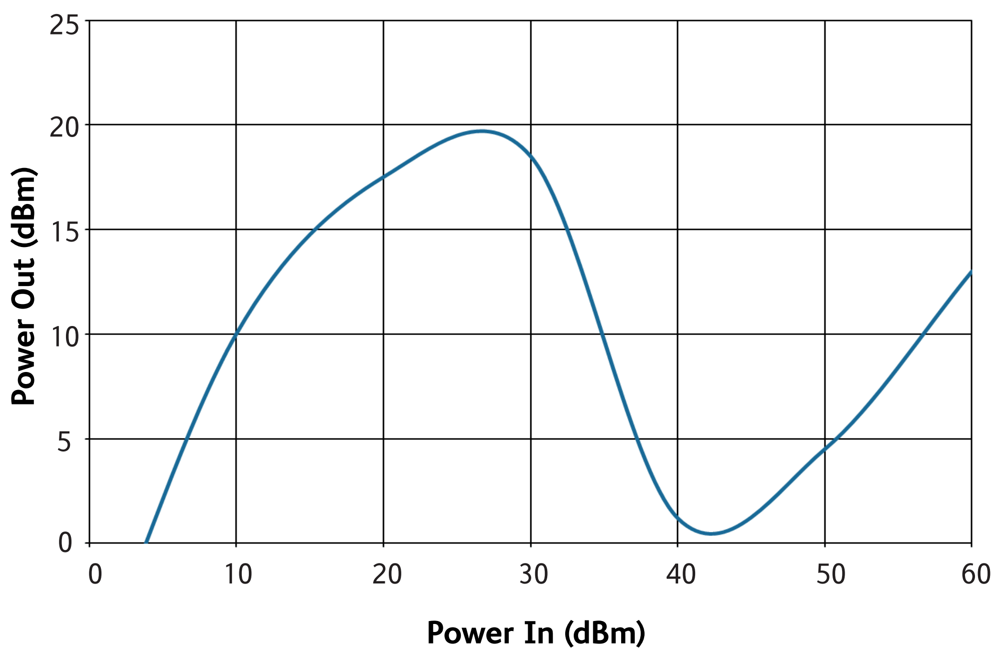


Figure 1 Typical Limiter Transfer Function

For a limiter, usual microwave parameters are defined, such as Insertion Loss and Return Loss. In addition, other parameters are defined:-

- Peak Input Power
- Leakage Power
- Recovery Time
- Spike Leakage

Peak Input Power

Peak input power specifications for a limiter are usually defined on the assumption of a train of power pulses (e.g. a Radar system.) In specifying the peak power the parameters of the pulse train need to be known:

- Peak Input Power
- Pulse width
- Pulse rise-time
- Duty ratio

With the peak input power pulse clearly defined, the other limiter parameters then follow on.

Limiter Pulse Response

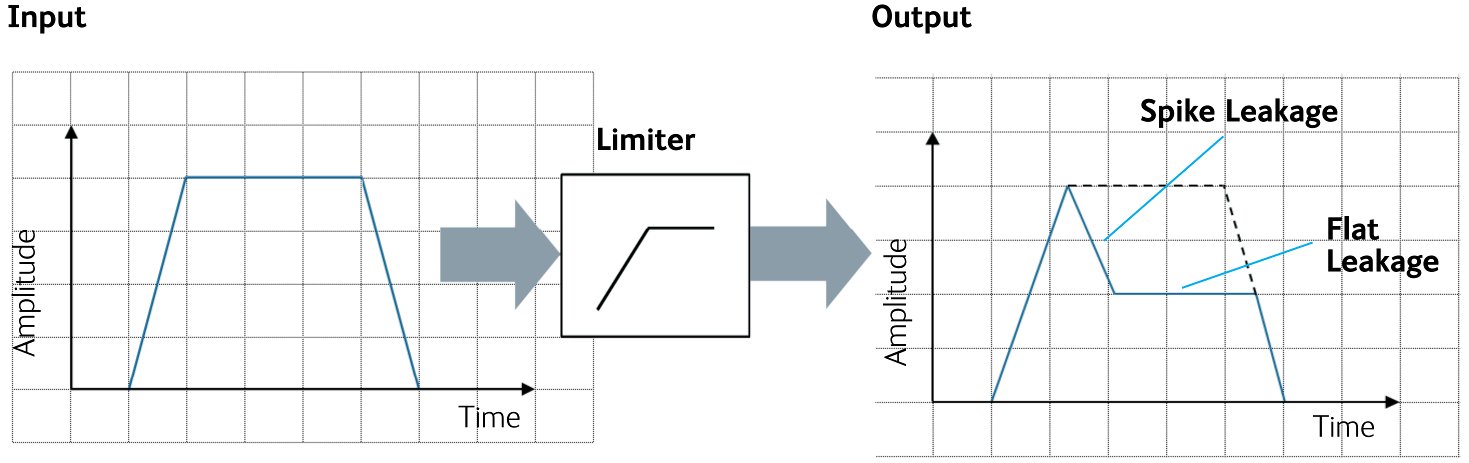


Figure 2 Limiter Pulse Response

Figure 2 shows an idealized pulse response for a limiter.

Flat Leakage

Flat leakage, or leakage power, is the 'steady-state' output power of a limiter with high input level. This equates to the power level shown in the 'flat' section of the transfer function shown in Figure 2. The flat leakage level is usually given in dBm.

Spike Leakage

The spike-leakage is the RF power at the output of the device prior to it attaining it's steady state protection level. This occurs at the beginning of the pulse.

The spike leakage is usually specified as one or both of :-

- the peak RF level.
- the total energy within the spike (either in nJ or Ergs (1 Erg = 100nJ.))

Recovery Time

Whilst a high power signal is applied to the limiter, it is in a high loss state. When the high power is removed (e.g. at the end of a signal pulse), the limiter takes a certain time to change from a high loss to a low loss state. This is called the recovery time.

Recovery time is usually specified as the time taken to be within 3dB of the specified insertion loss.

e.g. a limiter has an insertion loss specification of 1dB. The 3dB recovery time would be the time taken from removing a high level signal to the insertion loss being 4dB (specified insertion loss +3dB.)

COBHAM

Basic Parameters

The four main configurations for a limiter are:

- Passive
- Quasi-Passive
- Quasi-Active
- Active

Passive

Passive limiters usually feature shunt PIN diodes in the signal path. These are conductivity modulated by the RF signal. As the RF signal power increases the impedance to ground decreases. The RF power is then reflected by the low impedance presented by the diodes, limiting the power appearing at the output to the device.

No external power supplies are required for this type of device.

Quasi-Passive

Quasi-Passive limiters feature additional RF circuitry. A directional coupler in the signal path feeds a detector diode whose DC voltage is used to bias the shunt limiting diodes. Detector driven limiters usually have lower flat leakage and can handle higher power levels (cf. passive limiter.)

No external power supplies are required for this type of device.

Quasi-Active

A quasi active limiter is similar to a Quasi-passive except that the DC voltage from the coupled-off detector diode is used to activate a biasing circuit for the limiting shunt diodes. This is essentially a detector driven switch, allowing for fast response and fast recovery to incident signals.

External power supplies are required.

Active

Active limiters are effectively switches. The user needs to know when a high power signal will be incident and provide a command signal at the correct time to provide high isolation.

External power supplies are required.

Passive, Quasi-Passive and Quasi-Active limiters are 'automatic' – they limit the signal with no user intervention.

A limiter may use a combination of the possible configurations e.g. an active limiter could also feature quasi-passive protection for when there are no power supplies present.

Basic Parameters

Limiters are used in the front-ends of receivers to protect sensitive components. Important parameters for defining limiter performance are:- Peak input power; Flat Leakage; Spike Leakage and recovery time.

There are four main types of limiter configuration:- Passive, Quasi-Passive, Quasi-Active and Active.

Cobham MAL manufacture a broad range of standard and custom limiters, in co-axial, waveguide and 'drop-in' packages. Cobham MAL expertise derives from its manufacturing pedigree of the essential component for limiter operation – PIN diodes. Contact Cobham MAL to discuss your requirements.

Special Requirements

Many systems have specialised requirements where a 'one size fits all' solution does not provide the required performance.

These may be systems incorporating high power waveguide, or non-standard packaging requirements. Other special requirements are high frequency or special command functions such as STC (Sensitivity Time Control) and noise sources.

Cobham MAL has extensive experience in the design and manufacture of limiters for specific bands with additional features. Several examples are shown in Table 1.

Band / Frequency	Part Number	Application Type	Protection Capability	Drive	Insertion Loss (Typical)	Leakage (Typical)	Recovery Time
S - Band 2 - 4 GHz	MALIML0024	Phased Array radar, Drop-in	50W CW 100W pulsed..	Quasi-passive	0.42 dB	35mW flat 3nJ	1.5 µs
S - Band 2.7 - 2.9 GHz	MALI-008799-000000	Commercial land-based Radar, WG	4kW pk 400W CW.	Quasi-passive	0.42 dB	30mW flat	3 µs
S - Band 3.1 - 3.5 GHz	MALI-010303-000000 (Non-reflective)	Commercial land based Radar, WG	20W pk 100W CW.	Quasi-passive	1.6 dB	30mW flat, 320mW spike	1 µs
C - Band 5.2 - 5.8 GHz	MALI-007213-000000	Military ship-borne radar, WG	1200W pk. 30W avg.	Quasi-passive	0.5 dB	10mW flat, 100mW spike	-
X - Band 9.0 - 9.6 GHz	MALI-007212-000000	Military ship-borne radar, WG	500W pk. 1.5W avg.	Quasi-passive	0.5 dB	30mW flat, 250mW spike	1 µs
X - Band 9.2 - 9.6 GHz	MALIML0028	Military ship-borne radar, WG	500W pk. 35W avg.	Quasi-passive	0.5 dB	10mW flat, 250mW spike	1 µs
Ka - Band (900MHz BW) 33 - 35.5 GHz	MALI-010301-000000	Military ship-borne radar, WG	10kW pk (Active) 4W avg.	Active / Quasi-passive	1.3 dB	40mW flat, 100mW spike	1 µs
Ka - Band 33.8 - 34.4 GHz	MALI-007214-000000	Military ship-borne radar, WG	130W pk. 15W avg.	Active	1.0 dB	13mW flat,	Active
Ka - Band 34.2 - 35.3 GHz	MALI-008636-000000	Military ship-borne radar, WG	4W CW	Quasi-passive	0.8 dB	20mW flat, 80mW spike	150 ns

Table 1 Band Specific Receiver Protectors

For further information please contact:

Cobham Sensor Systems
Featherstone Road
Wolverton Mill
Milton Keynes, MK12 5EW
England

Tel: +44 (0) 1908 574200
Fax: +44 (0) 1908 574300
E-mail - cobham.mal@cobham.com