Features

- GaAs FET Design
- Wide Input Dynamic Range
- Narrow Output Power Window
- Sharp Limiting "Knee"
- Low Harmonics
- Low Input/Output VSWR
- Thin-Film Hybrid Construction
- Hermetic Aluminum Case

LMT/LWT Series Amplifiers

Description

Avantek LMT/LWT series limiting wideband amplifiers combine the proven circuit design and thin-film gold construction of the Avantek AMT/AWT series of low noise amplifiers with a GaAs FET output limiting stage. Available in the 0.5-2.0 through 6-18 GHz frequency bands, LMT/LWT series amplifiers offer nominal 35 dB and 70 dB of small signal gain combined with saturated power outputs that remain within a very narrow window for an extremely wide range of input signal levels. Other important features include excellent full-band saturated power flatness, low small signal noise figure, VSWR, harmonics, and an integral voltage regulator for reliable operation from a +12 to +15 VDC unregulated power source.

To complement its performance features, the LMT/LWT series amplifier is packaged in a compact, hermetically welded aluminum case. This makes the LMT/LWT series amplifier the ideal choice for incorporation into the latest generation of compact, lightweight ECM/EW systems.

Amplifier Design Features

The amplifiers in the LMT/LWT series feature balanced cascadable amplification stages consisting of a pair of matched GaAs FET amplifier channels with quadrature hybrid couplers to equally divide the power between the two channels. This balanced design permits each GaAs FET to operate at a conservative power dissipation for improved reliability, and increases the dynamic range of each stage. It simultaneously minimizes the input and output VSWR of each stage and the complete amplifier due to the inherent cancellation of reflected energy at the couplers, assuring low mismatch ripple and unconditional stability.

The incorporation of temperature compensation into the "40" series of limiting amplifiers ensures a well-controlled small signal gain over a wide military temperature range, thereby maintaining dynamic range and limiting noise power variation. Temperature compensation is accomplished by means of thin-film variable RF attenuators.

High Performance GaAs FET Limiting Amplifier

The LMT/LWT output stages are balanced FET designs, the devices being specifically selected and qualified for the desired limiting characteristics. When the output stage transitions from linear to saturated operation, it produces a far sharper limiter "knee" than provided by conventional amplifier PIN diode limiter combinations. The saturated power output of the LMT/LWT output stage is very stable with temperature variations.

Avantek employs both single- and dual-gate GaAs FET devices in the LMT/LWT series Limiting Amplifiers for output stages, selecting the device type which provides the best limiting characteristic for the amplifier. In those cases where the dual-gate device is utilized, the signal input circuit, applied to the gate of the GaAs FETs, is optimized in a manner similar to that used in Avantek small signal amplifiers; the small signal characteristics are practically equivalent. The second gate is connected to a biasing circuit that controls saturated output power level.

Built And Tested For Reliability

All circuitry in the LMT/LWT series limiting amplifiers is thin-film gold and all resistors are thin-film tantalum nitride deposited on precision ceramic substrates. Components such as transistors and capacitors are in unpackaged chip form, bonded to gold pads on the substrate. This thin-film hybrid construction is noted for exacting reproducibility, excellent shock and vibration resistance and extremely consistent performance.

To fully protect the thin-film circuitry and unpackaged components from moisture and corrosive atmospheric gases, the interior of the case is filled with a dry, inert atmosphere, and the lid is subsequently laser welded. All RF connectors and the RFI-filtered DC feedthroughs are soldered directly into holes in the aluminum case and the finished amplifier is leak tested to assure hermeticity.

All GaAs FETs are selected from wafers designed and fabricated by Avantek's Microwave Semiconductor Division. This in-house capability provides absolute control over device performance and a further assurance of reliability.

Avantek's quality control and quality assurance procedures meet the requirements of MIL-Q-9858A. The LMT/LWT series amplifiers can be qualified to MIL-E-5400, MIL-E-16400 and MIL-E-4158, and are capable of meeting the EMI conditions of MIL-STD-461.

Other Capabilities

- Packaging
- Dynamic Range (Gain)
- Output Power Levels
- Detection (Logarithmic)
- Looping Amplifiers
- Environmental Design and Test

Avantek has the capability and experience necessary to meet specific amplifier needs in the areas of electrical performance, mechanical outline, and environmental testing/screening, as demanded by system requirements. Avantek has manufactured thousands of limiting amplifiers to customer requirements, with various input dynamic range, gain, and output power specifications, etc. Avantek limiting amplifiers can be qualified for MIL-STD-883 class B or class S environmental conditions. Avantek can offer packaging from form-fit-function TWT replacement to miniature 0.22-inch height connectorless "drop-in" designs.

Avantek also has many years of experience producing special categories of limiting amplifiers, such as time-delay loop amplifiers and RF logarithmic amplifiers.

Specifying and Selecting Limiting Amplifiers

The function of a limiting amplifier is to accept input signals of widely varying power levels (wide input dynamic range) and provide an output in which the signal levels are highly compressed (limited output dynamic range). Such amplifiers are widely used in EW and radar system receiver front-end and IF applications to provide an optimum signal level to subsequent signal processing and detection circuitry. To perform properly in EW and radar systems, limiting amplifiers must combine extremely fast pulse response with the necessary input and output dynamic range characteristics.

The output dynamic range of a limiting amplifier depends on a combination of the limiting characteristics of the selected active devices and the specific design selected for the circuits. Typically, Avantek limiting amplifiers, using proven design and device technology, provide an output power window of less than 5dB with output levels as low as +3 dBm to as high as +20 dBm.

The input characteristics of a limiting amplifier are usually specified by stating the minimum and maximum input signal power levels that will result in properly-limited output signals. Avantek limiting amplifiers can be delivered with minimum input signals as small as ambient noise up to +10 dBm.

Rise time characteristics of a limiting amplifier are determined by the ability of the amplification circuitry to make the transition from small signal to large signal conditions. Unlike ordinary linear amplifiers, Avantek limiting amplifiers are optimized to offer fast pulse response, even when the input signal drives the amplifier into hard compression. 90% rise times of 25 ns with a +10 dBm input pulse are typical.

Because of the inherent non-linearity of limiting amplifiers, they can generate in-band spurious products that may cause erroneous indications in the EW or radar system. Unless the system itself is capable of filtering out or recognizing these spurious products, the limiting amplifier must also be specified in terms of minimum harmonic suppression (typically in dB below carrier).

Finally, it should be noted that in limiting amplifiers combining very high gain with a limited output dynamic range, normal noise figure measurements become unreliable and practically meaningless. When the calculated noise power of the amplifier is less than 20 dB below the saturated output power, the amplifier should be specified in terms of output noise power rather than noise figure.

Harmonic Distortion

Harmonic distortion results from non-linear amplifier gain and appears as output signals at integral multiples of the input signal frequency. Since harmonic distortion is a function of input power, it is usually specified in terms of the relative level of the harmonics with respect to the power of the fundamental signal.

The actual broadband characteristics of the amplifier (which may be wider than the specified passband) may present significant gain at harmonic frequencies and thereby increase the harmonic output problem.

Second harmonic content is related to the device distortion and the frequency response of the circuits used to build the amplifier. The hybrid coupler input network and output network are the major components in determining passband response. Second harmonics occurring within the passband of the amplifier will typically be –12 to –15 dBc at the amplifier's specified 1 dB Gain Compression Point. Third harmonics are typically an additional 5 to 7 dB below this level. As the circuit's passband narrows, the resulting second and third harmonics attenuate rapidly.

AM-PM Conversion

As the input signal level applied to a transistor amplifier is increased until some degree of gain compression is produced, further increases in signal amplitude will result in a slight shift of the amplifier phase delay. This phenomenon is known as AM-PM conversion and can be thought of as a result of the change of the transistor operating parameters from the small-signal to large-signal conditions. Many Avantek amplifiers include a guaranteed specification that AM-PM conversion will not exceed a certain value, on the order of a few tenths of a degree per dB increase in power output at a nominal power output level. If the input signal is further increased, the amount of AM-PM conversion will continue to increase, reaching a maximum value when one of the amplifier stages is driven into full saturation. The maximum value will normally never exceed a few degrees/dB near amplifier saturation, and may generally be ignored.

Any limiters in a system are usually the major contributors to overall AM-PM conversion. Perhaps the worst case example is when a transistor amplifier is used in a receiving system in close proximity to a nearby transmitting system operating on a different frequency, and the leakage power is sufficient to drive the limiters into their operating region. The result will usually be a noticable slope in the baseband frequency response which will take place only when the transmitter is operating.

"30" Series; 35 dB Small Signal Gain

Guaranteed Specifications @ 25°C Case Temperature

Model	Frequency Response (GHz) Minimum	Small Signal Gain (dB) Minimum	Small Signal Gain (dB) Maximum	Gain Flatness (±dB) Maximum	Saturated Output Power (dBm) Min.	Saturated Output Power (dBm) Max.	Noise Figure (dB) Maximum	VSWR Maximum In	VSWR Maximum Out	Input Power Current @ +12 V[10] Maximum (mA)	Case Type
LWT-2034	0.5-2	35	40	1.5	+3	+7	3.5	2.0	2.0	250	IS4
LMT-4035	2-4	35	40	1.5	+7	+11	3.0	2.0	2.0	300	IS6
LWT-6034	2-6	35	40	1.5	+14	+18	4.0	2.0	2.0	300	IC4
LWT-8035	2-8	35	40	1.5	+16	+20	4.0	2.0	2.0	450	IC6
LMT-8033	4-8	35	40	1.5	+14	+17	4.5	2.0	2.0	300	IC4
LMT-12436	7-12.4	35	40	1.5	+14	+19	5.5	2.0	2.0	400	IX6
LMT-18036	12-18	35	40	1.5	+14	+19	6.0	2.0	2.0	400	IX6
LWT-18036	8-18	35	40	1.5	+14	+19	6.0	2.0	2.0	400	IX6
LWT-18636	6-18	35	40	1.5	+14	+19	6.0	2.0	2.0	400	IX6

"40" Series; Nominal 70 dB Small Signal Gain

Guaranteed Specifications -54°C to +100°C Case Temperature

Model	Frequency Response (GHz) Maximum	Input Signal Range (dBm) Maximum	Saturated Output Power Range (dBm) Min.	Saturated Output Power Range (dBm) Max.	VSWR Maximum In	VSWR Maximum Out	Input Power Current @ +12 V[10] Maximum (mA)	Case Type
LWT-2046	0.5-2	-61 to +20	+3	+7	2.0	2.0	600	LS12
LMT-4046	2-4	-57 to +20	+7	+11	2.0	2.0	700	LS12
LWT-6045	2-6	-50 to +20	+14	+18	2.0	2.0	600	IC6
LWT-8046	2-8	-55 to +20	+16	+20	2.0	2.0	900	LC12
LMT-8045	4-8	-50 to +20	+14	+17	2.0	2.0	625	IC6
LMT-12448	7-12.4	-50 to +20	+14	+19	2.0	2.0	900	LX16
LMT-18048	12-18	-50 to +20	+14	+19	2.0	2.0	900	LX16
LWT-18048	8-18	-50 to +20	+14	+19	2.0	2.0	900	LX16
LWT-18648	6-18	-50 to +20	+14	+19	2.0	2.0	900	LX16

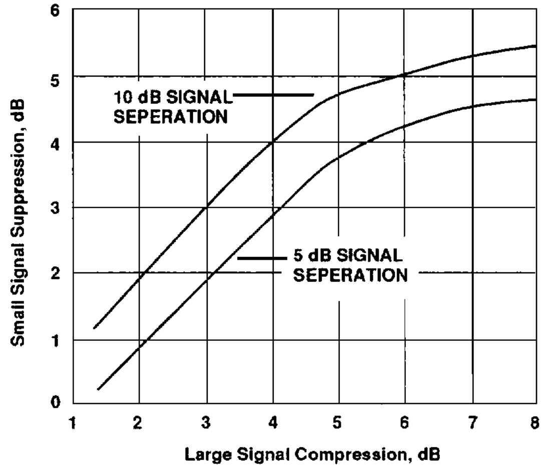
Other Specifications – Both "30" and "40" Series

1. Power output for 1 dB gain compression is a maximum of 4 dB below saturated power output at any frequency.
2. Saturated power flatness is 2.0 dB p-p, maximum.
3. Saturated power variation over temperature is 1.5 dB p-p, maximum.
4. Maximum input power without damage: +20 dBm (CW).
5. Harmonics: -9 dBc maximum (-6 dBc 2nd Harmonic, -8 dBc 3rd Harmonic — LWT-2034, LWT-2046) Up to +20 dBm input.
6. Pulse response: Overshoot, 0.25 dB maximum.
   Settling time, 25 ns maximum.
   Recovery time, 100 ns maximum (to within 10% of small signal).
7. Small signal suppression: 3 dB minimum with minimum 5 dB gain compression and minimum 10 dB signal separation.
8. AM/PM conversion: 5°/dB maximum.
9. Output noise power will be less than P_{SAT}(Min) -6 dB for the "40" series.
10. Units contain internal voltage regulator and operates with input voltage from +12 to +15 Vdc.

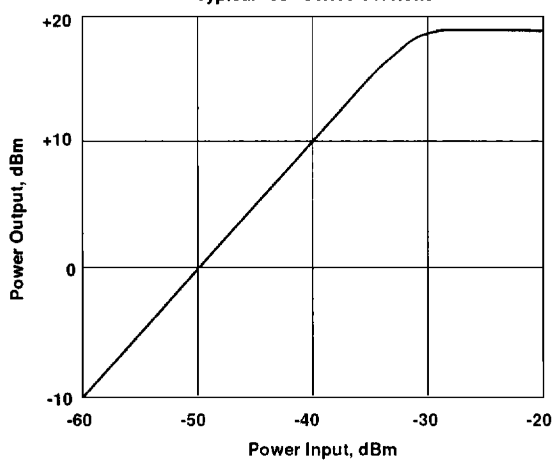
Performance Curves

Typical Performance at 25°C Case Temperature

SMALL SIGNAL SUPPRESSION[1] VS.
LARGE SIGNAL COMPRESSION – TYP. ALL VERSIONS

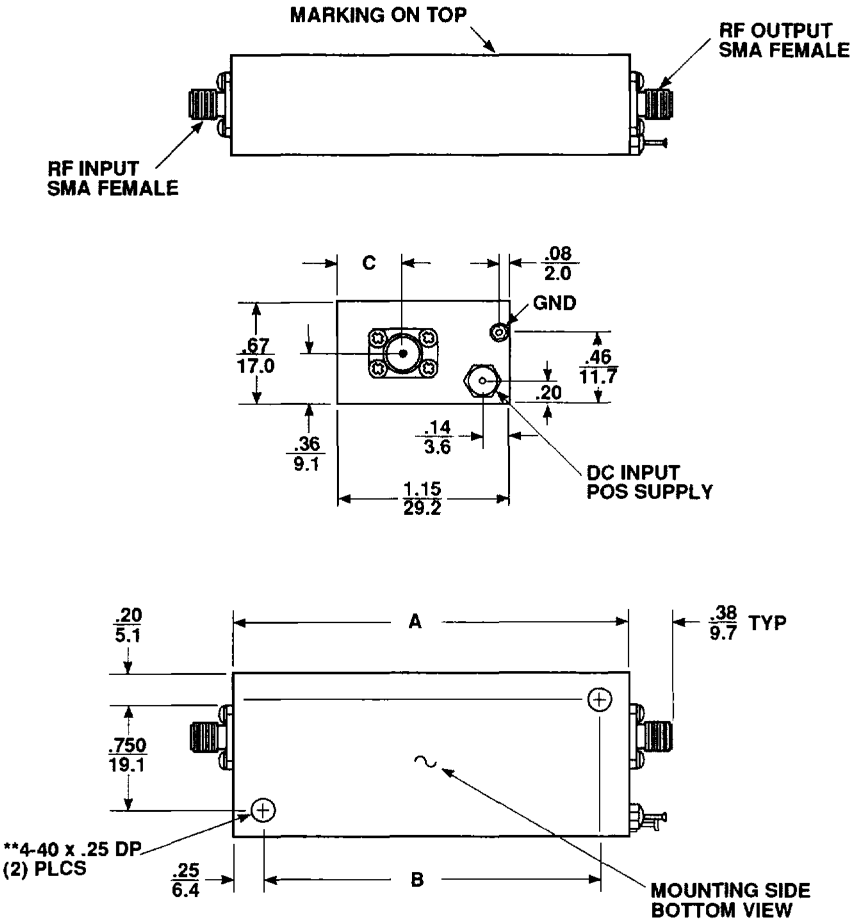


POWER OUTPUT VS. POWER INPUT
Typical "30" Series Versions [2]



NOTES:
1. SMALL SIGNAL SUPPRESSION IS DEFINED AS THE INCREASE IN THE POWER RATIO OF TWO SIGNALS AT THE OUTPUT OF THE LIMITING AMPLIFIER WITH RESPECT TO THE POWER RATIO AT THE INPUT.
2. THE SHAPE OF THE LIMITING CURVE IS TYPICAL OF ALL LMT/LWT SERIES AMPLIFIERS.

Case Drawing
IS4, IS6, IC4, IC6, and IX6



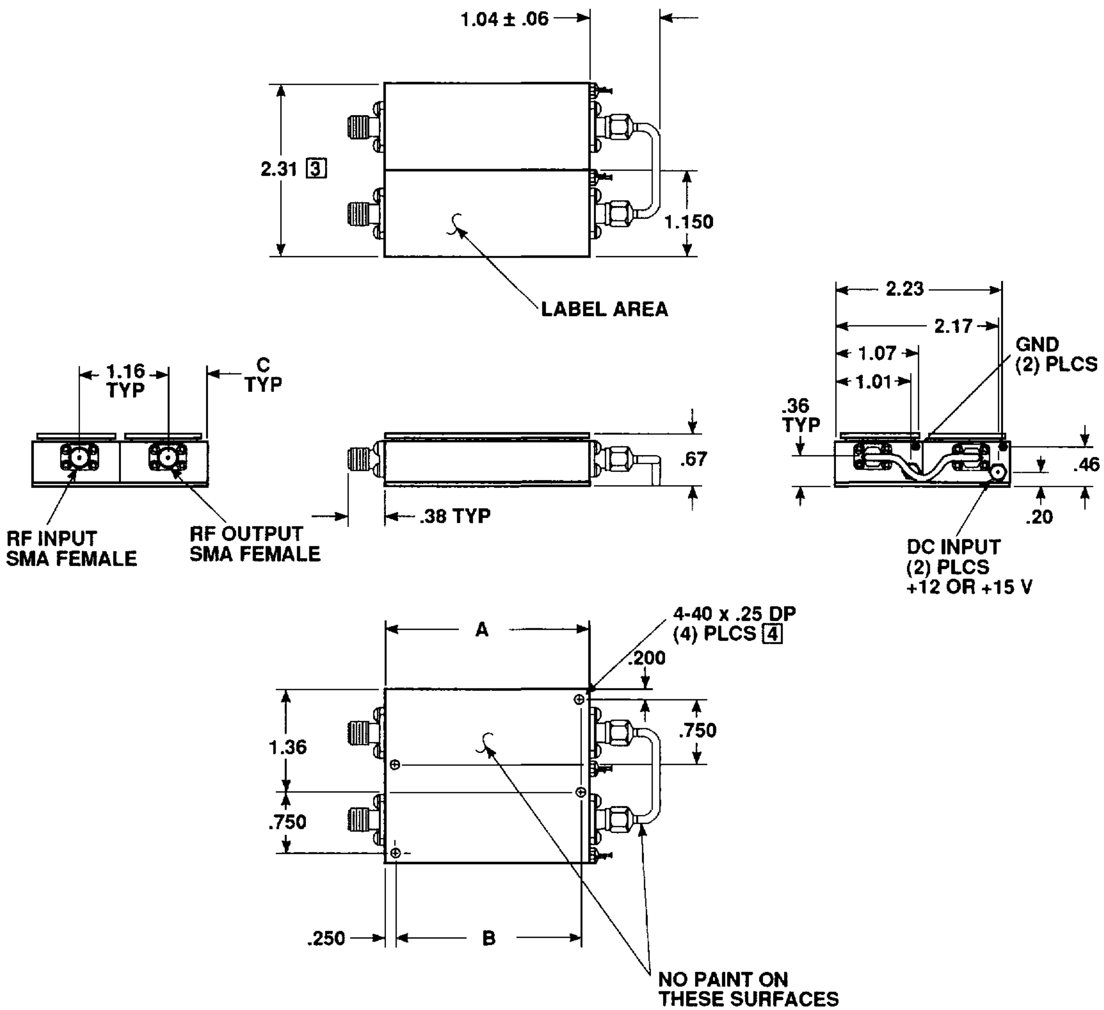
CASE	DIMENSION						WEIGHT	
	A		B		C			
	IN	MM	IN	MM	IN	MM	OZ	GMS
IS4	2.083	52.9	1.583	40.2	.375	9.5	3	68
IS6	2.750	69.8	2.250	57.1	.375	9.5	4	90
IC4	2.083	52.9	1.583	4.02	.465	11.8	3	68
IC6	2.750	69.8	2.250	57.1	.465	11.8	4	90
IX6	2.250	57.1	1.750	44.4	.510	13.0	3	78

NOTES (UNLESS OTHERWISE SPECIFIED):

1. DIMENSIONS ARE SPECIFIED IN $\frac{\text{INCHES}}{\text{MM}}$
2. TOLERANCES: .XX ± .02
   .XXX ± .010
   ALL TOLERANCES BEFORE PAINT AND/OR LABELING

**AVAILABLE WITH METRIC THREAD M3 ON REQUEST. NO THREADS FIRST .062"

Case Drawing
LC12, LS12, and LX16



BAND	CASE	DIMENSION			WEIGHT GRAMS (APPROX)
		A	B	C	
S	LS12	2.75	2.250	.38	220
C	LC12	2.75	2.250	.47	220
X/KU	. LX16	2.75	2.250	.51	260

NOTES (UNLESS OTHERWISE SPECIFIED):

1. DIMENSIONS ARE SPECIFIED IN INCHES
2. TOLERANCES: .XX± 0.02
   .XXX± .010
   ALL TOLERANCES BEFORE PAINT AND/OR LABELING

[3] WIDTH DIMENSION DOES NOT INCLUDE ANY CUSTOMER REQUIRED LABELS.
[4] NO THREADS FIRST .062"