IF SIGNAL PROCESSING COMPONENTS AND SUBSYSTEMS

- Logarithmic Amplifiers
- DLVAs
- Frequency Discriminators
- Constant Phase-Limiting Amplifiers
- Linear Gain-Control Amplifiers
- Custom Subsystems and Assemblies

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TABLE OF CONTENTS

INTRODUCTION

This catalog summarizes the broad array of components and subsystems offered by the IF Signal Processing Products Department. While it would not be practical to present every product manufactured by the department, we have compiled a listing of our most popular models.

Our high performance, field proven designs are in use in numerous Commercial and Electronic Warfare Systems worldwide. Our knowledgeable engineering staff is dedicated to providing state-of-the-art designs that consistently outperform our customers' expectations. Recent additions to our product line include MIC components, enhanced performance multifunction and digital output components.

DEFINITIONS AND APPLICATIONS

The following is a guide to the applications of our standard products. Engineers using our products may find explanations of the most common specifications associated with each component. Typical performance measurements are outlined and descriptions of test configurations are explained.

LOGARITHMIC AMPLIFIERS

An important part of almost all radar and Electronic Countermeasures (ECM) systems, logarithmic amplifiers are used to convert a wide dynamic range input power to an output voltage that increases linearly with increasing input power. Additional information on logarithmic amplifiers can be found in MITEQ's application notes: Specification Definitions for Logarithmic Amplifiers and Defining Logarithmic Amplifier Accuracy.

MITEQ offers several types of logarithmic amplifiers in order to address different system applications. The Successive Detection Log Video Amplifier (SDLVA) offers a wide input dynamic range, superior pulse fidelity, exceptional log conformance (commonly known as log linearity) and a limited IF output. The detector log video amplifier (DLVA) offers a broad operational frequency range, excellent temperature stability and similar log characteristics.

Typical indication of the performance of a logarithmic amplifier is the measurement of the log transfer function. This is accomplished by the use of computer controlled test equipment, in which the output of an RF signal generator is stepped over the input dynamic range of the unit under test. The computer then records the log amplifiers video output voltage taken from a digital multimeter and calculates the slope and deviation from a best-fit straight line using a least-squares method. The result is a plot consisting of the measured video output voltage and the log conformance deviation in dB.

Another indication of a logarithmic amplifier's performance is its ability to accurately measure pulsed-modulated RF signals. Typical pulse measurements include rise time, fall time, settling time and recovery time.

An important part of accurate pulse measurement is the measurement test setup. It must be able to provide an extremely high on-to-off ratio of the pulse-modulated RF source, and be typically 10 dB greater than the dynamic range of the unit being measured. The setup must have adequate rise and fall times several times faster than the unit under test as well. Carefully matched input and output impedances are essential to ensure that mismatches do not contribute to distortion of the measured pulse response.

The test set is initially calibrated using a Continuous Wave (CW) signal at the highest input power level of the log amplifier under test. The pulse modulation is then applied to the input of the log amplifier. The video output is measured on an oscilloscope with a bandwidth at least twice that of video bandwidth of the log amplifier. The full dynamic range video pulse response is displayed and the corresponding measurements are taken.

Using either an internal or external step attenuator, the RF level is then lowered until the pulse plus noise is just above the output noise of the log amplifier. The level measured is known as Tangential Signal Sensitivity or TSS.

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CONSTANT PHASE-LIMITING AMPLIFIERS

MITEQ's constant transmission phase-limiting IF amplifiers are intended for use in frequency and phase measurement systems. The primary function of these amplifiers is to preserve insertion phase shift while maintaining output power over a wide input dynamic range. In-phase measurement systems, the phase and output amplitude matching of two or more units, becomes a critical parameter. Repeatability in manufacturing and testing of these components is essential to guarantee identical insertion phase of each. Depending on the location within the signal path, frequency measurement systems may also employ more than one limiting amplifier per system. As in-phase measurement systems, attention to matching of phase and amplitude is critical to ensure measurement accuracy.

Another critical parameter of a constant phase-limiting amplifier's performance is the phase settling time. Under RF pulse modulation, matched sets of amplifiers must exhibit identical phase settling time; otherwise differential phase errors introduced can be misinterpreted as a difference in phase angle.

Phase variation and differential phase (matching) is measured using a vector voltmeter and a calibrated CW RF source. A desktop computer is used to control the instrument and collect the data. The result is a plot of phase shift versus input power level.

Pulse performance of limiting amplifiers is verified in a similar manner as in testing logarithmic amplifiers with the exception that the pulse-modulated RF envelope is displayed on the oscilloscope. Typical measurements of an individual unit are rise time, delay time, overshoot and ringing (expressed in dB) and recovery time.

To test matched units for phase settling time, a different setup is required. This typically consists of two limiting amplifiers driving a double-balanced mixer being used as a phase detector. Careful calibration is necessary to ensure proper drive levels are provided to the mixer. An in-phase power divider delivers the pulse-modulated RF to the inputs of the limiting amplifiers and the resulting video output (from the IF port of the mixer) is displayed on an oscilloscope. Typical measurements are overshoot and ringing and settling time to a specified percentage.

Phase settling time measurement is an important parameter in systems using matched constant phase-limiting amplifiers to drive I/Q demodulators or phase detectors.

FREQUENCY DISCRIMINATORS

MITEQ manufactures two distinctly different types of frequency discriminators. Both types are utilized to convert an input frequency to a bipolar DC voltage corresponding to frequencies above and below crossover (center frequency). Typical applications of frequency discriminators include Automatic Frequency Control (AFC) systems and high-fidelity FM demodulation systems.

The narrow bandwidth type uses an input limiting amplifier to drive two staggered tuned L-C circuits. Opposing rectification of the circuits create the discriminator 'S' curve. A video amplifier is utilized to provide adequate output slope (specified in mV/MHz). The ability to precisely align the skirts of the tuned circuits, which represents the linear bandwidth, is the major advantage of this type of design.

The wide bandwidth type of frequency discriminators employ delay line techniques to achieve the desired frequency detection. A limiting amplifier drives an in-phase power divider, where one port is delayed an appropriate amount and applied to a double-balanced mixer being used as a phase detector. A wide bandwidth video amplifier takes advantage of this design's extremely wide demodulation bandwidth. The ability to process narrow input pulse widths with minimal distortion is the fundamental advantage of this type of frequency discriminator.

Typical specifications for frequency discriminators include frequency accuracy within the linear bandwidth (expressed as a percent of deviation from a best-fit straight line), crossover accuracy and demodulated video bandwidth.

Frequency accuracy (commonly known as linearity) measurement is achieved using a computer-controlled RF generator, which is step incremented through the specified linear frequency range, and a digital multimeter to record the video output voltage. The result is a plot of measured output voltage, corresponding to input frequency and its deviation from a best-fit straight line using a linear regression formula.

In many instances, the demodulated video bandwidth can be approximated. This is achieved by dividing 0.35 by the measured video rise time. Alternatively, a more appropriate form of measurement is to modulate the carrier with a suitably wide baseband signal and use a spectrum analyzer to display the modulated video output. The -3 dB point of baseband signal can then be measured directly.

AUTOMATIC AND VOLTAGE GAIN-CONTROL AMPLIFIERS

MITEQ's series of Automatic Gain-Control (AGC) and Voltage Gain-Control (VGC) amplifiers employ cascaded stages of low-noise amplifiers and PIN diode attenuators. This combination makes them attractive to system engineers who require signal amplitude control with minimal distortion. These amplifiers can be found in a variety of Commercial Communications and Electronic Warfare Systems. Typical applications include driver amplifiers for AFC, frequency measurement and linear telecommunication systems.

The automatic gain control series of amplifiers are intended for use in closed-loop operation. Alternatively, closed-loop operation can be disabled allowing manual gain control via the control voltage input pin using an external AGC driver amplifier or any appropriate power measuring control device. The control voltage output pin can also be used in applications requiring Received Signal Strength Indicator (RSSI) measurements.

The voltage gain control series offers a similar performance to the open-loop AGC amplifiers with the exception of reduced size packages. These amplifiers are intended for use in systems with external gain control loops. The high fidelity detected video output can be utilized in various CW and pulsed RF measurement applications.

Some of the performance measurements are typical to most linear amplifiers. Some apply to the AGC amplifiers in open-loop operation only. Typical linear amplifier test may include amplifier gain, noise figure, amplifier frequency response and output 1 dB gain compression. Since there are many sources of detailed explanations of these performance parameters, they will not be explained here. Instead, more product specific test data will be highlighted.

For automatic gain-control amplifiers, the primary application is to maintain output power over a wide input dynamic range. This is achieved by controlling amplifier gain using a coupled linear detector to rectify the RF signal and amplify the detected signal, using one or more operational amplifiers to provide the appropriate DC-control voltage. Typical specifications for closed-loop AGC amplifiers include acquisition time or AGC time constant, and output power variation over a specified input dynamic range.

Acquisition time can range anywhere from microseconds to hundreds of milliseconds and is therefore an important parameter to both specify and measure. Using a pulse-modulated RF test setup, as described in limiting amplifier testing, the modulated RF is applied to the input of the AGC amplifier and the modulated RF envelope output is displayed on an oscilloscope.

The acquisition time is measured from the 50% point of the input pulse to the point where the RF envelope settles to within the specified output power variation.

AGC measurement is taken from the same setup and is measured from the point before the RF envelope begins to fall outside the specified output power variation to the point of no signal. Both acquisition and decay times are measured over the entire input dynamic range and the worst case measurement is recorded. As with previously described components, the test setup must be capable of pulse modulating the RF with an on-to-off ratio at least 10 dB greater than the dynamic range of the amplifier being tested.

Output power variation is measured using a CW RF source whose level is adjusted over the specified dynamic range until the output level drops outside the allowable variation. The output power is measured using an RF power meter or a similar accurate power-measuring device.

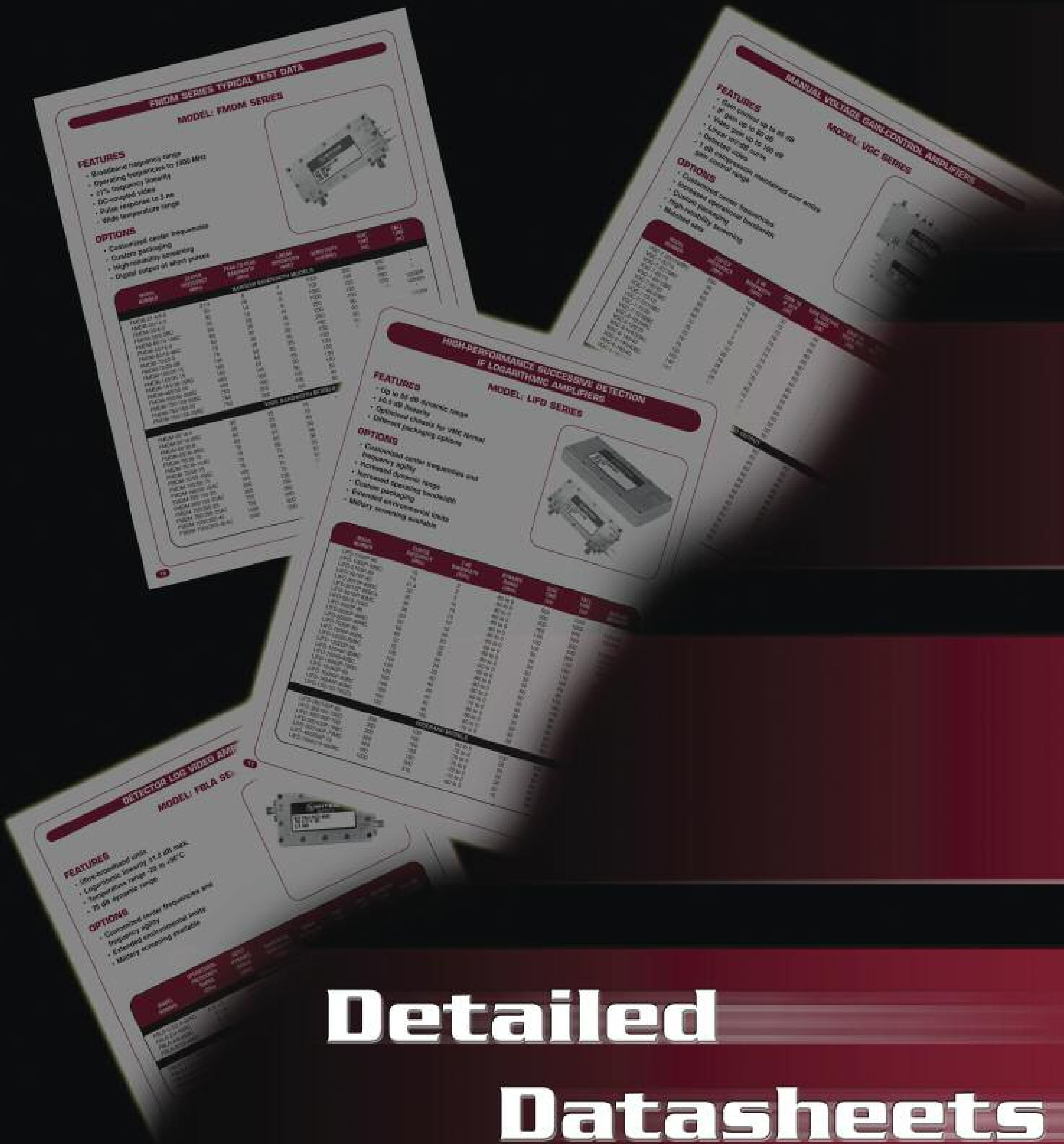
As with AGC amplifiers, the VGC series offers gain control by means of an externally applied DC voltage but does not include provision for closed-loop operation. By using a VGC type of amplifier, the system engineer has the flexibility to use an external power-measuring device such as an AGC driver or logarithmic amplifier.

A few of the product specific tests performed on the VGC series of amplifiers may include gain control range, gain to video output and video rise time.

Gain control range can be measured using either a swept or CW source and the appropriate power-measuring device. The input level is stepped from minimum to maximum and linear amplification is maintained by adjusting the externally applied DC voltage. This level is typically 10 dB below the output 1 dB gain compression point. The measured DC voltage is plotted and a curve representing amplifier gain versus gain control voltage is produced.

Measurement of gain to video and video rise time applies to VGC amplifiers with optional video output. Both parameters are measured using the pulse-modulated RF test setup previously described. The modulated RF signal is applied to the amplifier input and adjusted until the detected video output voltage reaches the specified output voltage (typically 4 to 5 volts). The gain to video is then calculated from the expression, 20 log (Vout/Vin) -3 dB. Video rise time is then measured from the 10% point on the leading edge of the detected video output to the 90% point.

Additional measurements may include detector dynamic range and detector linearity, depending on requested options. Contact the factory for further clarification of these terms.



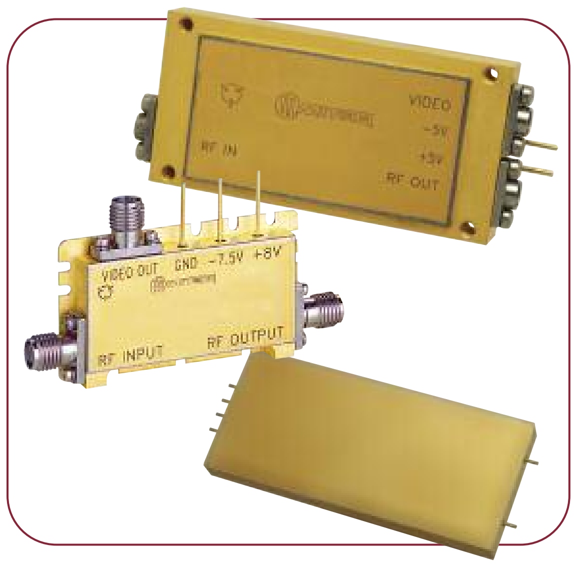
Detailed Datasheets

HIGH-PERFORMANCE LOGARITHMIC AMPLIFIERS

MODEL: MLS SERIES

FEATURES

- **70 dB dynamic range at 1 GHz**
- **Improved sensitivity**
- **Rise time up to 1 ns**
- **Fast recovery time**
- **±1.5 dB video flatness over 500 MHz bandwidth**
- **Low output noise for increased accuracy**
- **Improved sensitivity through low noise figure input stages**



OPTIONS

- **Customized center frequencies and frequency agility**
- **Dynamic range and operational bandwidth**
- **Custom packaging**
- **Extended environmental limits**
- **Military screening available**

MODEL NUMBER	OPERATIONAL FREQUENCY RANGE (MHz)	INPUT DYNAMIC RANGE (dBm)	TANGENTIAL SENSITIVITY (dBm)	VIDEO FLATNESS (±dB)	RISE TIME (ns)	FALL TIME (ns)	RECOVERY TIME (ns)	OUTLINE DRAWING
MLS-130630-60BCL	130 – 630	-60 to 0	-65	1.5	10	25	35	*
MLS-350/300-70GC	200 – 500	-70 to 0	-74	1	15	25	30	138482
MLS-375/250-70	250 – 500	-70 to 0	-75	1	15	30	40	*
MLS-375/250-70G	250 – 500	-70 to 0	-75	1	15	30	40	138482
MLS-550/500-70	300 – 800	-70 to 0	-73	1.5	10	25	35	*
MLS-550/500-70G	300 – 800	-70 to 0	-73	1	10	25	35	138482
MLS-750/500-65NL	500 – 1000	-65 to 0	-70	1.5	10	25	35	
MLS-1000/1000-65AL	500 – 1500	-60 to +5	-70	1.5	15	20	50	191206
MLS-700/250-70	575 – 825	-70 to 0	-73	1	10	25	35	*
MLS-800/450-70	575 – 1025	-70 to 0	-73	1	10	25	35	*
MLS-1000/500-70	750 – 1250	-67 to +3	-70	1.5	10	25	35	*
MLS-1000/500-70A	750 – 1250	-67 to +3	-70	1	10	25	35	191206
MLS-1000/500-70AL	750 – 1250	-67 to +3	-70	1	10	25	35	191206
MLS-1600/800-65AL	1200 – 2000	-65 to 0	-70	1	10	25	35	191206
MLS-1500/500-70	1250 – 1750	-70 to 0	-73	1	10	25	35	*
MLS-2000/1000-70	1500 – 2500	-67 to +3	-70	1.5	15	30	40	*
MLS-2000/1000-70AL	1500 – 2500	-67 to +3	-70	1.5	15	30	40	191206
MLS-2500/500-60AC	2250 – 2750	-60 to 0	-65	1	15	25	35	191206
MLS-3000/600-65A	2700 – 3300	-65 to 0	-68	1.5	10	25	35	191206
MLS-3000/2000-70	2000 – 4000	-65 to +5	-68	2	10	25	30	*
MLS-3000/2000-70A	2000 – 4000	-65 to +5	-68	2	10	25	30	191206
MLS-3000/2000-70AL	2000 – 4000	-65 to +5	-68	2	10	25	30	191206
MLS-5000/2000-70	4000 – 6000	-65 to +5	-68	2	10	25	35	*
MLS-5000/2000-70A	4000 – 6000	-65 to +5	-68	2	10	25	35	191206
MLS-6000/4000-60A	4000 – 6000	-55 to +5	-60	2	30	80	30	191206

* The above models are available in outline drawings 123115, 138482, 191206, and 191207.

NOTE: FOR MODIFICATION OF OUR STANDARD MODELS OR IF YOU HAVE ANY QUESTIONS, PLEASE FEEL FREE TO CONTACT MITEQ.

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ADDITIONAL SPECIFICATIONS

Log linearity at midband is ≤ ±1 dB at 25°C.
Add ±0.5 dB over operating bandwidth and ±0.5 dB over operating temperature of -40 to +85°C.
Video flatness is given at 25°C.
An additional ±1 dB will occur over operating temperature of -40 to +85°C.
Log slope is 25 mV/dB nominal at midband at 25°C.
Slope variations of ±5% can be expected over operating bandwidth.
An additional ±5% variation will occur over operating temperature range of -40 to +85°C.
RF input/output impedance is 50 Ω (VSWR < 2.0:1 typical).
Video output is DC coupled and rated into 93 Ω.
Optional limited RF output provides excellent phase characteristics while second-harmonic rejection is typically better than -14 dBc. Limited output level is available from 0 to +10 dBm.
Power: +8 VDC at 475 mA typical, -8 VDC at 45 mA typical.

ORDER OPTIONS

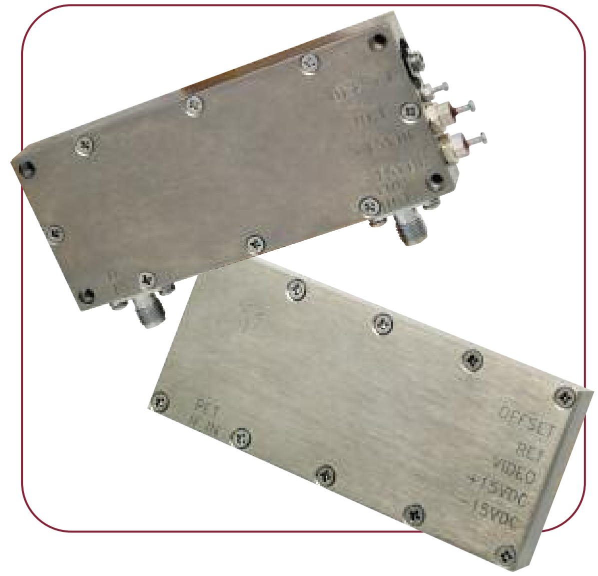
For limited RF output, add suffix “L”.
Typical part number: MLS-375/250-70L.

ULTRAFAST WIDEBAND HIGH-FREQUENCY LOGARITHMIC AMPLIFIERS

MODEL: MLIF SERIES

FEATURES

- 70 dB dynamic range at 1 GHz
- Improved sensitivity
- Rise time up to 1 ns
- Fast recovery time
- ±1.5 dB video flatness over 500 MHz bandwidth
- Low output noise for increased accuracy
- Improved sensitivity through low noise figure input stages



OPTIONS

- Customized center frequencies and frequency agility
- Dynamic range and operational bandwidth
- Custom packaging
- Extended environmental limits
- Military screening available

MODEL NUMBER	CENTER FREQUENCY (MHz)	OPERATIONAL FREQUENCY (MHz)	INPUT DYNAMIC RANGE (dBm)	TANGENTIAL SENSITIVITY (dBm)	VIDEO FLATNESS (±dB)	RISE TIME (ns)	FALL TIME (ns)	RECOVERY TIME (ns)	OUTLINE DRAWING
MLIF-500/100-70	500	100	-70 to 0	-73	1	5	15	25	*
MLIF-500/100-70BC	500	100	-70 to 0	-73	1	5	15	25	120309
MLIF-750/500-65	750	500	-65 to 0	-68	1.5	3	10	15	*
MLIF-900/100-75	900	100	-70 to +5	-73	1	10	30	45	*
MLIF-900/100-75BC	900	100	-70 to +5	-73	1	10	30	45	120309
MLIF-1000/500-60	1000	500	-60 to 0	-63	1	3	10	15	*
MLIF-1000/500-60BC	1000	500	-60 to 0	-63	1	3	10	15	120309
MLIF-1000/500-75	1000	500	-70 to +5	-73	2	10	30	45	*
MLIF-1000/500-75BC	1000	500	-70 to +5	-73	2	10	30	45	120309
MLIF-1500/500-60	1500	500	-60 to 0	-63	1.5	3	10	15	*
MLIF-1500/500-60BC	1500	500	-60 to 0	-63	1.5	3	10	15	120309
MLIF-1800/200-70	1800	200	-65 to +5	-68	1	10	30	45	*
MLIF-1800/200-70BC	1800	200	-65 to +5	-68	1	10	30	45	120309

* The above models are available in outline drawings 120309, 120721, 120935, 121831, or 123705.

NOTE: FOR MODIFICATION OF OUR STANDARD MODELS OR IF YOU HAVE ANY QUESTIONS, PLEASE FEEL FREE TO CONTACT MITEQ.

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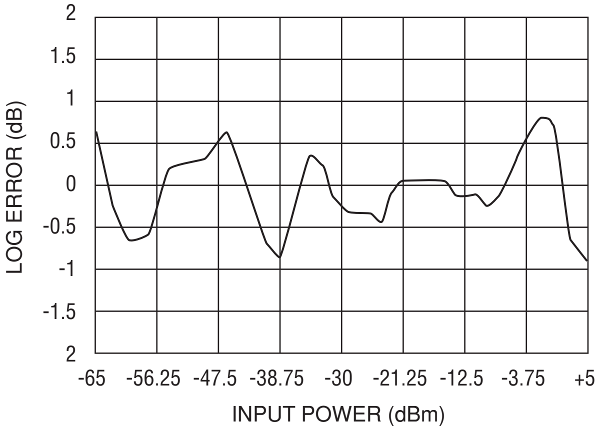
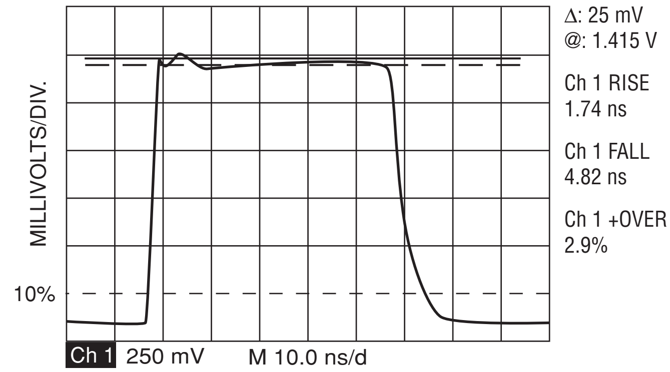
MLIF SERIES TYPICAL TEST DATA

LOG LINEARITY
(MLIF-1000/500-70)



PULSE RESPONSE
(MLIF-1000/300-60)



ADDITIONAL SPECIFICATIONS

Linearity measured at center frequency and 25°C is ±1 dB.
Add ±0.5 dB over operating temperature of -40 to +85°C and ±0.5 dB over operating bandwidth.
Slope is 15 mV/dB at center frequency and 25°C.
Slope variations of ±5% will occur over operating temperature of -40 to +85°C.
An additional ±5% variation will occur over operating bandwidth.
Video output is DC coupled and rated into 93 Ω.
DC offset drift over operating temperature of -40 to +85°C is ±50 mV typical.
Input impedance is 50 Ω (VSWR < 1.5:1 typical).
Improved second-harmonic rejection on limited IF out.
Power: +12 VDC at 400 mA typical, -12 VDC at 75 mA typical.

ORDER OPTIONS

For ±15 VDC, add suffix "C".
For limited IF output at 0 dBm nominal, (VSWR < 2.0:1 typical) add suffix "L".
Typical part number: MLIF-1000/500-75BCL (for outline drawing 120309 at ±15 VDC with limited IF output).

DETECTOR LOG VIDEO AMPLIFIERS

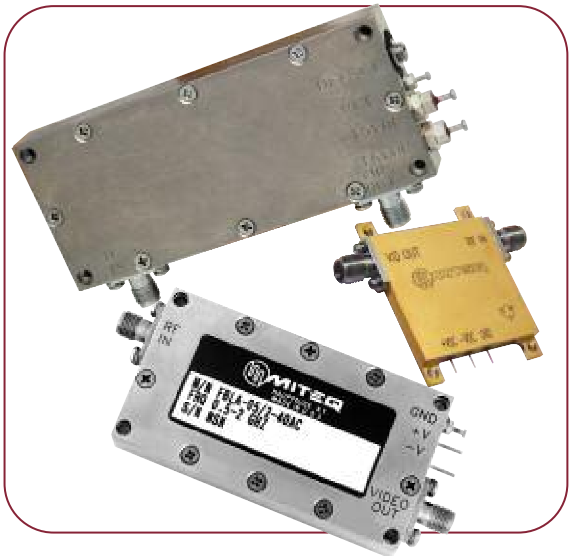
MODEL: FBLA SERIES

FEATURES

- **Ultra-broadband units**
- **Logarithmic linearity ±1.5 dB max.**
- **Temperature range -20 to +90°C**
- **70 dB dynamic range**

OPTIONS

- **Customized center frequencies and frequency agility**
- **Extended environmental limits**
- **Military screening available**



MODEL NUMBER	OPERATIONAL FREQUENCY RANGE (GHz)	INPUT DYNAMIC RANGE (dBm)	TANGENTIAL SENSITIVITY (dBm)	VIDEO FLATNESS (±dB)	RISE TIME (ns)	FALL TIME (ns)	RECOVERY TIME (ns)	OUTLINE DRAWING
STANDARD DYNAMIC RANGE								
FBLA-0.5/2.0-40AC	0.5 – 2	-40 to 0	-44	0.5	30	45	150	127333
FBLA-2/4-40AC	2 – 4	-40 to 0	-44	0.5	30	45	150	127333
FBLA-4/8-40AC	4 – 8	-40 to 0	-43	0.75	35	50	180	127333
FBLA-8/12-40AC	8 – 12	-40 to 0	-43	1	35	50	180	127333
EXTENDED DYNAMIC RANGE								
FBLA-0.1/1-70BC	0.1 – 1	-67 to +3	-70	1.5	40	120	350	120309
FBLA-0.5/1.5-70BC	0.5 – 1.5	-67 to +3	-70	1.5	40	120	350	120309
FBLA-1/2-70BC	1 – 2	-65 to +3	-68	1.5	40	120	350	120309
FBLA-2/6-50J	2 – 6	-50 to 0	-55	2	15	25	20	190644

NOTE: FOR MODIFICATION OF OUR STANDARD MODELS OR IF YOU HAVE ANY QUESTIONS, PLEASE FEEL FREE TO CONTACT MITEQ.

ADDITIONAL SPECIFICATIONS

For standard and extended dynamic range DLVAs, linearity measured at center frequency and 25°C is ±1 dB.
Add ±0.5 dB over operating temperature of -40 to +85°C and ±0.5 dB over operating bandwidth.
Logging slope for standard dynamic range DLVA is 100 mV/dB at center frequency and 25°C.
Logging slope for extended dynamic range DLVA is 15 mV/dB at center frequency and 25°C.
Slope variations of ±5% variation will occur over operating bandwidth.
An additional ±5% will occur over operating temperature of -40 to +85°C.
Video output is DC coupled and rated into 93 Ω.
DC offset drift is ±50 mV typical over operating temperature of -40 to +85°C.
Input VSWR < 2.0:1 typical from 0.1 to 4 GHz and < 2.5:1 from 4 to 12 GHz.
Power: ±12 VDC at 100 mA typical for standard dynamic range and 200 mA typical for extended dynamic range.

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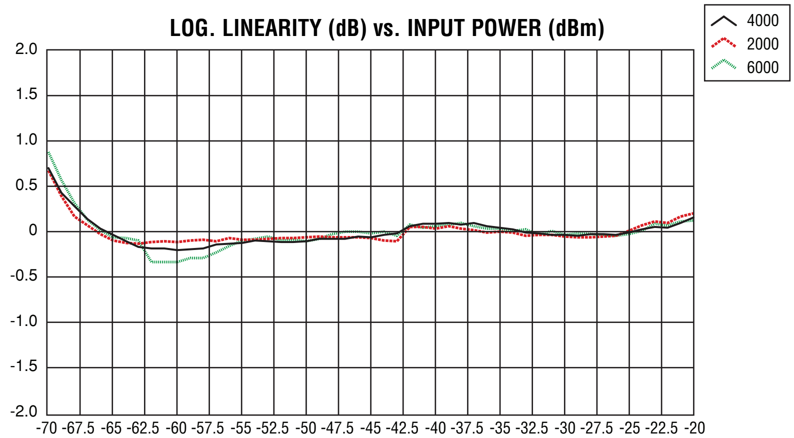
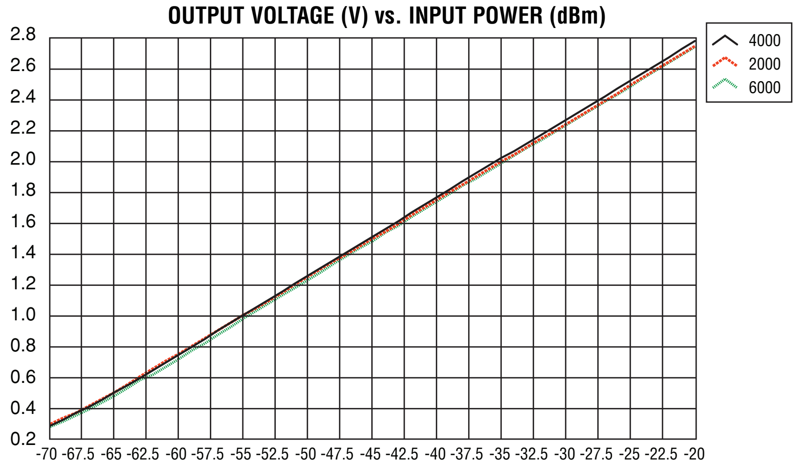
FBLA SERIES TYPICAL TEST DATA





ORDER OPTIONS

For ±15 VDC, add suffix “C”.

Typical part number: FBLA-0.1/1.0-70BC (for outline drawing 120309 at ±15 VDC).
FBLA-2/6-50J (for outline drawing 190644 at ±15 VDC).

HIGH-PERFORMANCE SUCCESSIVE DETECTION IF LOGARITHMIC AMPLIFIERS

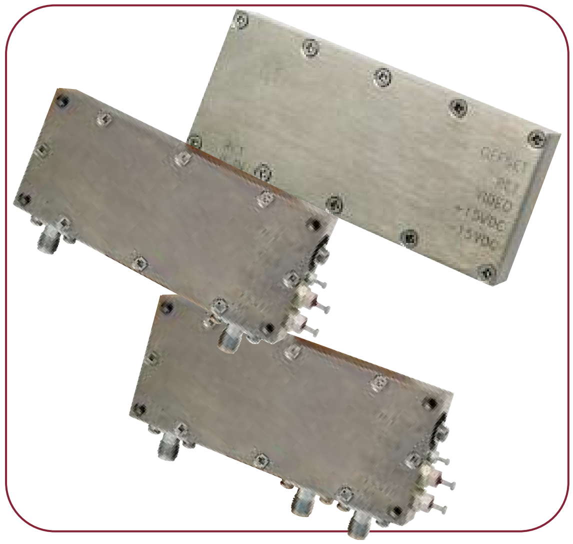
MODEL: LIFD SERIES

FEATURES

- Up to 85 dB dynamic range
- ±0.5 dB linearity
- Optimized chassis for VME format
- Different packaging options

OPTIONS

- Customized center frequencies and frequency agility
- Increased dynamic range
- Increased operating bandwidth
- Custom packaging
- Extended environmental limits
- Military screening available



MODEL NUMBER	CENTER FREQUENCY (MHz)	3 dB BANDWIDTH (MHz)	DYNAMIC RANGE (dBm)	RISE TIME (ns)	FALL TIME (ns)	OUTLINE DRAWING
LIFD-1002P-80	10	2	-80 to 0	500	1000	*
LIFD-1002P-80BC	10	2	-80 to 0	500	1000	120309
LIFD-2105P-80	21.4	5	-80 to 0	200	600	120309
LIFD-3010P-80	30	10	-80 to 0	100	300	*
LIFD-3010P-80BC	30	10	-80 to 0	100	300	120309
LIFD-3010P-80BCL	30	10	-80 to 0	100	300	120309
LIFD-3010P-80MC	30	10	-80 to 0	100	300	123705
LIFD-6010-70BC	60	10	-80 to 0	50	150	120309
LIFD-6020P-80	60	20	-80 to 0	50	150	*
LIFD-6020P-80BC	60	20	-80 to 0	50	150	120309
LIFD-6020P-80MC	60	20	-80 to 0	50	150	123705
LIFD-7030P-80	70	30	-80 to 0	30	90	*
LIFD-7030P-80BC	70	30	-80 to 0	30	90	120309
LIFD-12020-80BC	120	20	-80 to 0	50	150	120309
LIFD-12020P-80	120	20	-80 to 0	50	150	*
LIFD-12040P-80BC	120	20	-80 to 0	50	150	120309
LIFD-16040-80BC	100	40	-80 to 0	30	90	120309
LIFD-16040P-70BC	160	40	-70 to 0	30	90	120309
LIFD-16040P-80	160	40	-80 to 0	30	90	*
LIFD-16040P-80BC	160	40	-80 to 0	30	90	120309
LIFD-16040P-80MC	160	40	-80 to 0	30	90	123705
LIFD-150100-70GCL	150	100	-70 to 0	30	90	120721
WIDEBAND MODELS						
LIFD-300100P-80	300	100	-80 to 0	100	300	*
LIFD-300100-70BC	300	100	-70 to 0	20	60	120309
LIFD-300100P-70B	300	100	-70 to 0	20	60	120309
LIFD-300100P-70BC	300	100	-70 to 0	20	60	120309
LIFD-300100P-70MC	300	100	-70 to 0	20	60	123705
LIFD-450300P-70	450	300	-70 to 0	20	60	*
LIFD-1000310-060BC	1000	310	-60 to 0	15	25	120309

* The above models are available in outline drawings 120308, 120309, 120721, 120935, 121831, or 123705.

NOTE: FOR MODIFICATION OF OUR STANDARD MODELS OR IF YOU HAVE ANY QUESTIONS, PLEASE FEEL FREE TO CONTACT MITEQ.

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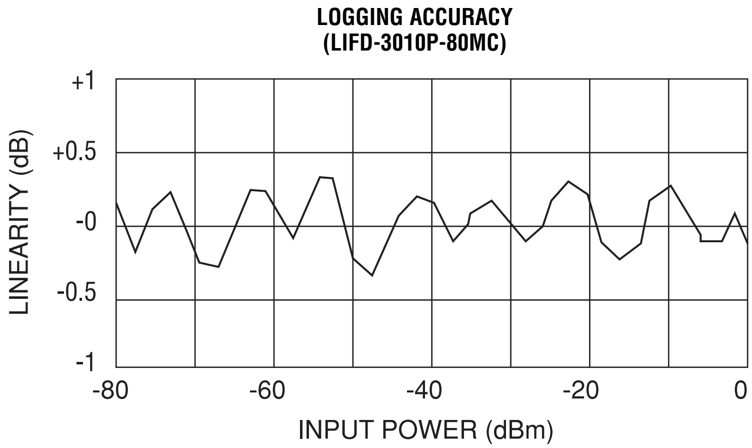

ADDITIONAL SPECIFICATIONS

Linearity measured at center frequency and 25°C is ≤ ±0.5 dB.
Add ±0.5 dB over operating temperature of -40 to +85°C and ±0.5 dB over operating bandwidth.[1]
Slope is 25 mV/dB nominal (15 mV/dB wideband models) at center frequency and 25°C.
Slope variations of ±5% will occur over operating temperature.
An additional ±5% variation will occur over operating bandwidth.[1]
Video output is DC coupled and rated into 93 Ω.
Input impedance is 50 Ω (VSWR < 1.5:1 typical).
Power: +12 VDC at 65 mA typical, -12 VDC at 120 mA typical.

ORDER OPTIONS

For ±15 VDC, add suffix “C”.
For limited IF output at 0 dBm nominal, (VSWR < 2.0:1 typical) add suffix “L”.
Typical part number: LIFD-6020P-80BCL (for outlilne drawing 120309 at ±15 VDC with limited IF output).

Note:[1] Wideband models are operational over specified bandwidth and have typically greater 3 dB bandwidths.

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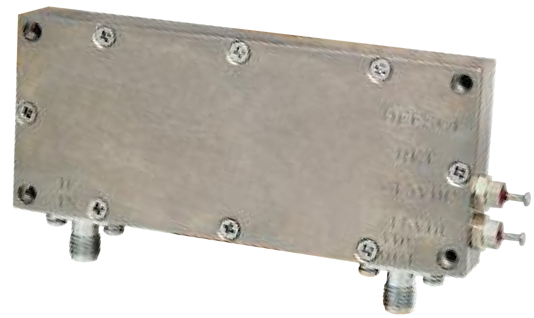
CONSTANT PHASE-LIMITING AMPLIFIERS

MODEL: LCPM SERIES

FEATURES

- Up to 70 dB dynamic range
- ±3° phase variation
- ±5 dB amplitude variation
- Fast recovery



OPTIONS

- Customized center frequencies
- Custom packaging
- High-reliability screening
- Matched sets

MODEL NUMBER	CENTER FREQUENCY (MHz)	3 dB BANDWIDTH (dBm)	DYNAMIC RANGE (dBm)	OUTPUT POWER VARIATION (±dB)	PHASE VARIATION (±Deg.)	OUTLINE DRAWING
LCPM-3010-70	30	10	-70 to 0	0.5	3	*
LCPM-3010-70BC	30	10	-70 to 0	0.5	3	120392
LCPM-6020-70	60	20	-70 to 0	0.5	3	*
LCPM-6020-70BC	60	20	-70 to 0	0.5	3	120392
LCPM-7030-70	70	30	-70 to 0	0.5	3	*
LCPM-7030-70BC	70	30	-70 to 0	0.5	3	120392
LCPM-12020-70	120	20	-65 to +5	0.5	5	*
LCPM-12020-70BC	120	20	-65 to +5	0.5	5	120392
LCPM-14040-60BC	140	40	-60 to 0	1	5	120392
LCPM-14040-70	140	40	-65 to +5	1	5	*
LCPM-16040-70	160	40	-65 to +5	1	5	*
LCPM-16040-70BC	160	40	-65 to +5	1	5	120392
LCPM-200100-60BC	200	100	-65 to +5	1	5	120392
LCPM-200100-70	200	100	-65 to +5	1	5	*
LCPM-200100-70BC	200	100	-65 to +5	1	5	120392
LCPM-320500-50P	320	500	-50 to 0	3	5	*
LCPM-400100-60	400	100	-60 to 0	1	5	*
LCPM-400100-60BC	400	100	-60 to 0	1	5	120392
LCPM-400100-70	400	100	-60 to 0	1	5	*
LCPM-1300/03-50	1300	3	-50 to 0	1	15	*

* The above models are available in outline drawings 120392 or 121954.

NOTE: FOR MODIFICATION OF OUR STANDARD MODELS OR IF YOU HAVE ANY QUESTIONS, PLEASE FEEL FREE TO CONTACT MITEQ.

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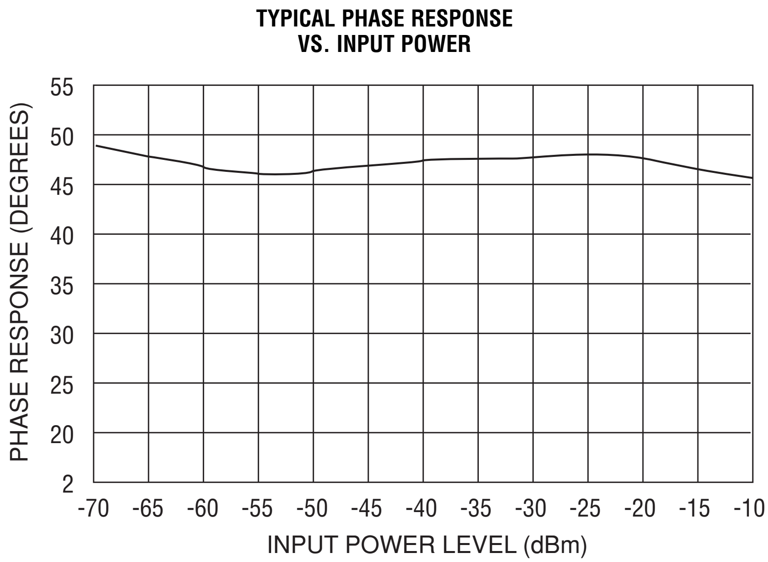
LCPM SERIES TYPICAL TEST DATA



ADDITIONAL SPECIFICATIONS

Phase variation is measured at center frequency and 25°C.
Add ±3° over operating temperature of -40 to +85°C.
Output power is 10 dBm nominal at center frequency and 25°C.
Additional output power variation of ±1 dB will occur over operating temperature of -40 to +85°C.
Input/output impedance is 50 Ω.
Input VSWR is < 1.5:1 typical.
Output VSWR is < 2.0:1 typical.
Noise figure is typically less than 15 dB at center frequency and 25°C.
Power: -12 VDC at 150 mA typical.

ORDER OPTIONS

For -15 VDC, add suffix “C”.
Matching up to three channels to within ±3° at 25°C is available. Contact factory for details.
Typical part number: LCPM-16040-70BC (for outline drawing 120392 at -15 VDC).

Custom housings and electrical specifications are also available. Contact factory for details.

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FREQUENCY DISCRIMINATORS

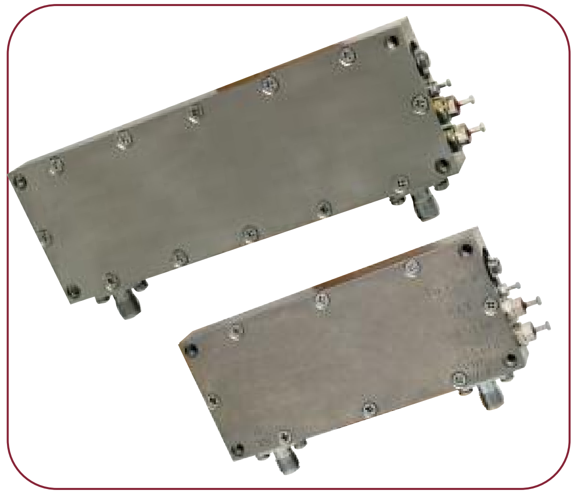
MODEL: FMDM SERIES

FEATURES

- Broadband frequency range
- Operating frequencies to 1000 MHz
- ±1% frequency linearity
- DC-coupled video
- Pulse response to 5 ns
- Wide temperature range

OPTIONS

- Customized center frequencies
- Custom packaging
- High-reliability screening
- Digital output of short pulses



MODEL NUMBER	CENTER FREQUENCY (MHz)	PEAK-TO-PEAK BANDWIDTH (MHz)	LINEAR BANDWIDTH (MHz)	SENSITIVITY (mV/MHz)	RISE TIME (ns)	FALL TIME (ns)	OUTLINE DRAWING
NARROW BANDWIDTH MODELS							
FMDM-21.4/4-2	21.4	8	4	1000	200	500	*
FMDM-30/16-3	30	25	16	100	120	350	*
FMDM-30/6-3	30	10	6	1000	120	350	*
FMDM-30/6-3BC	30	10	6	1000	120	350	120309
FMDM-60/10-15BC	60	20	10	250	100	300	120309
FMDM-60/16-4	60	20	16	250	90	250	*
FMDM-60/16-4BC	60	20	16	250	90	250	120309
FMDM-70/20-5	70	30	20	150	60	150	*
FMDM-70/20-5B	70	30	20	150	60	150	120309
FMDM-140/25-10	140	50	25	100	50	150	*
FMDM-160/35-15	160	60	35	100	35	100	*
FMDM-160/35-15BC	160	60	35	100	35	100	120309
FMDM-450/50-20	450	100	50	100	20	60	*
FMDM-450/50-20BC	450	100	50	100	20	60	120309
FMDM-750/100-20BC	750	150	100	50	20	60	120309
FMDM-750/150-20	750	200	150	50	20	60	*
FMDM-750/150-20BC	750	200	150	50	20	60	120309
WIDE BANDWIDTH MODELS							
FMDM-30/16-6	30	25	16	100	100	350	**
FMDM-30/16-6AC	30	25	16	100	100	350	125068
FMDM-60/30-8	60	50	30	50	50	150	**
FMDM-60/30-8BC	60	50	30	50	50	150	120309
FMDM-70/36-10	70	60	36	50	50	150	**
FMDM-70/36-10AC	70	60	36	50	50	150	125068
FMDM-70/50-15	70	75	50	50	30	100	**
FMDM-70/50-15AC	70	75	50	50	30	100	125068
FMDM-160/50-15	160	75	50	50	30	100	**
FMDM-160/50-15AC	160	75	50	50	30	100	125068
FMDM-300/100-20	300	150	100	20	20	50	**
FMDM-300/100-20AC	300	150	100	20	20	50	125068
FMDM-750/250-25	750	350	250	20	15	50	**
FMDM-750/250-25AC	750	350	250	20	15	50	125068
FMDM-1000/300-40	1000	500	300	10	10	30	**
FMDM-1000/300-50AC	1000	500	300	10	10	30	125068

* The above narrow bandwidth models are available in outline drawings 120309, 123706 or 124280.
* * The above wide bandwidth models are available in outline drawings 120309 or 125068.

NOTE: FOR MODIFICATION OF OUR STANDARD MODELS OR IF YOU HAVE ANY QUESTIONS, PLEASE FEEL FREE TO CONTACT MITEQ.

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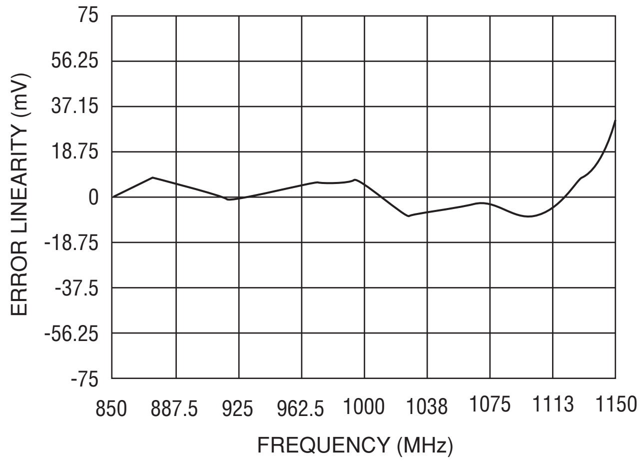
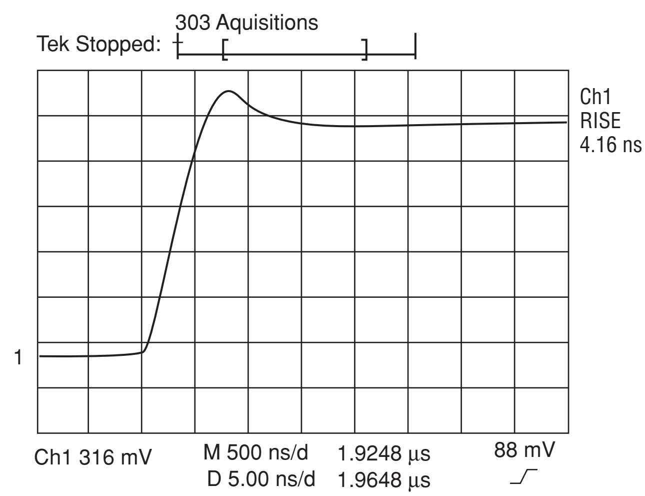
FMDM SERIES TYPICAL TEST DATA

TYPICAL ERROR LINEARITY VS. FREQUENCY



TYPICAL VIDEO PULSE PERFORMANCE



ADDITIONAL SPECIFICATIONS

Linearity:

For narrow bandwidth models, error is typically better than ±3% over linear bandwidth at 25°C.

For wide bandwidth models, error is ±5% over linear bandwidth at 25°C.

Add ±2% over operating temperature of -40 to +85°C.

Rated input is 0 dBm.

Usable from -20 to 0 dBm (-10 to 0 dBm for wide bandwidth models).

Input impedance is 50 Ω (VSWR < 1.5:1 typical).

Video output is DC coupled and rated into 93 Ω.

Power: ±12 VDC at 100 mA typical. For wide bandwidth models; +12 VDC at 270 mA typical and -12 VDC at 50 mA typical.

ORDER OPTIONS

For ±15 VDC, add suffix “C”.

Typical part number: FMDM-160/35-15BC (for outline drawing 120309 at ±15 VDC).

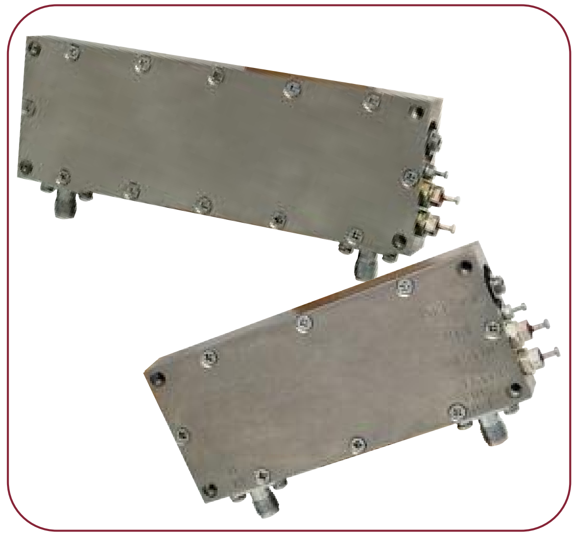
MODEL: FMDMW SERIES

FEATURES

- Ultra-wide linear bandwidth
- Extreme stability over input power
- DC-coupled video
- Pulse response to 3 ns
- Wide temperature range

OPTIONS

- Customized center frequencies
- Custom packaging
- High-reliability screening
- Digital output of short pulses



MODEL NUMBER	OPERATIONAL FREQUENCY RANGE (GHz)	LINEAR BANDWIDTH (MHz)	SENSITIVITY (±mV/MHz)	RISE TIME (ns)	VIDEO LINEARITY (±%)	BANDWIDTH (MHz)	OUTLINE DRAWING
FMDMW-4/4-5	2 – 6	4000	1.2	5	3	60	125068
FMDMW-5.5/9-10	0.8 – 10	9000	32	10	5	30	125068
FMDMW-2.75/4.5-10	0.4 – 5	4500	16	10	5	30	125068
FMDMW-1.4/2.25-10	0.2 – 2.5	2250	8	10	5	30	125068
FMDMW-650/1100-10	0.100 – 1.2	1100	4	10	5	30	120309
FMDMW-500/500-5	0.250 – 0.750	500	10	5	3	60	120309
FMDMW-600/800-10	0.200 – 1	800	5	10	4	30	120309

NOTE: FOR MODIFICATION OF OUR STANDARD MODELS OR IF YOU HAVE ANY QUESTIONS, PLEASE FEEL FREE TO CONTACT MITEQ.

ADDITIONAL SPECIFICATIONS

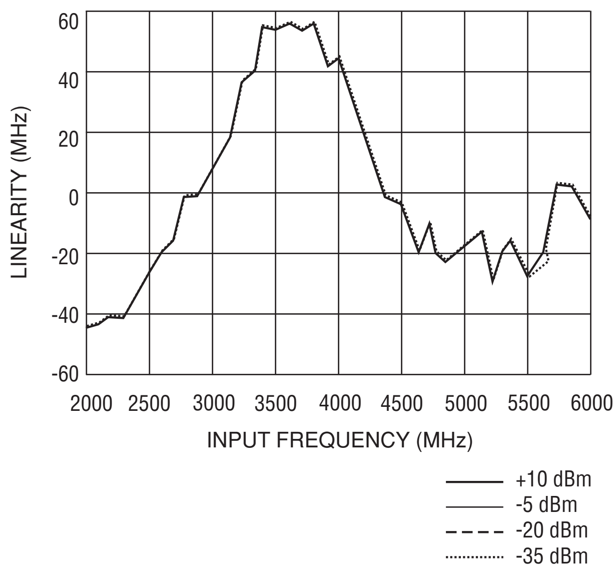
Input dynamic range is -10 to +5 dBm. Wider input power ranges available.
Output voltage swing (into 50 Ω) is ±2 V.
Slope variation over temperature is ±5%.
DC offset variation over temperature is ±50 mV.
Recovery time is 50 ns.
Input impedance is 50 Ω (VSWR < 2.0:1 typical).
Power: ±12 or ±15 VDC.

ORDER OPTIONS

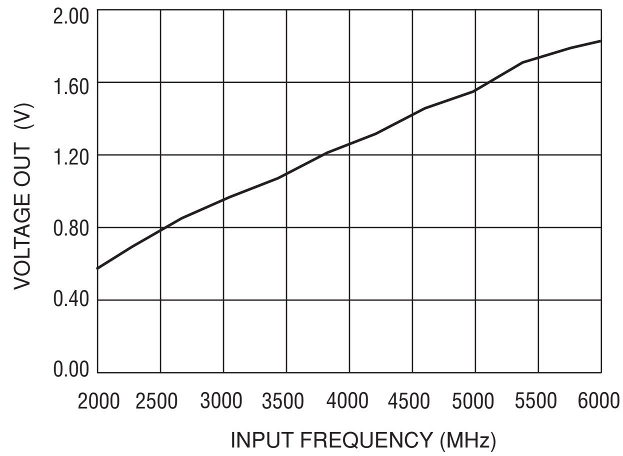
For ±15 VDC, add suffix "C".
Typical part number: FMDMW-4/4-5C.

FMDMW SERIES TYPICAL TEST DATA

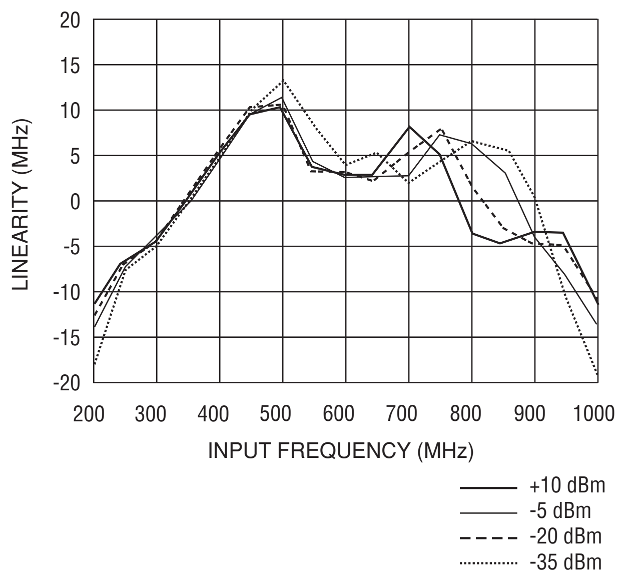
LINEARITY (MHz) VS.
INPUT FREQUENCY (MHz)
OVER DIFFERENT POWER LEVELS
(FMDMW-4/4)



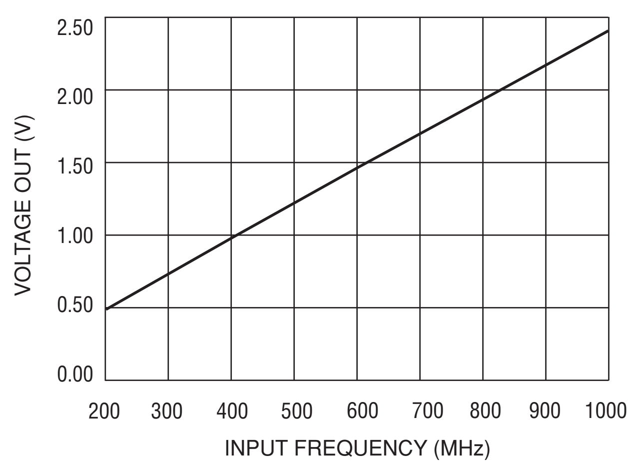
Vout (V) VS.
INPUT FREQUENCY (MHz)
OVER DIFFERENT POWER LEVELS
(FMDMW-4/4)



LINEARITY (MHz) VS.
INPUT FREQUENCY (MHz)
OVER DIFFERENT POWER LEVELS
(FMDMW-600/800)



Vout (V) VS.
INPUT FREQUENCY (MHz)
OVER DIFFERENT POWER LEVELS
(FMDMW-600/800)

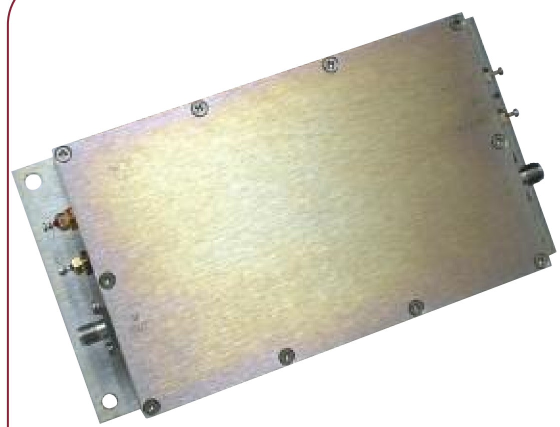


AUTOMATIC GAIN-CONTROL AMPLIFIERS

MODEL: AGC SERIES

FEATURES

- Input dynamic range up to 75 dB
- Output variation < 2 dB
- Multioctave bandwidth
- Improved NPR for spectral purity



OPTIONS

- Customized center frequencies
- Manual gain control
- Open or closed-loop operation
- Increased or decreased acquisition time

MODEL NUMBER	CENTER FREQUENCY (MHz)	3 dB BANDWIDTH (MHz)	DYNAMIC RANGE (dBm)	OUTPUT POWER VARIATION (±dB)	OUTPUT POWER (dBm)	OUTLINE DRAWING
AGC-5-70/30AC	70	30	-50 to 0	(+/-)1.5	-4	113125
AGC-6-140/30AC	140	30	-65 to +5	1	4	113125
AGC-6-70/30AC	70	30	-65 to -5	2	3	113125
AGC-7-10.7/4A	10.7	4	-70 to 0	0.5	10	113125
AGC-7-10.7/4AC	10.7	4	-70 to 0	0.5	10	113125
AGC-7-21.4/10A	21.4	10	-70 to 0	0.5	10	113125
AGC-7-21.4/10AC	21.4	10	-70 to 0	0.5	10	113125
AGC-7-30/10A	30	10	-70 to 0	0.5	10	113125
AGC-7-30/10AC	30	10	-70 to 0	0.5	10	113125
AGC-7-60/20A	60	20	-70 to 0	0.5	10	113125
AGC-7-60/20AC	60	20	-70 to 0	0.5	10	113125
AGC-7-70/30A	70	30	-70 to 0	1	5	113125
AGC-7-140/40A	140	40	-70 to 0	1	5	113125
AGC-7-160/30AC	100	30	-70 to 0	2	8	113125
AGC-7-160/40A	160	40	-70 to 0	1	5	113125
AGC-7-300/400A	300	400	-65 to 0	1.5	3	113125
AGC-7-300/400AC	300	400	-65 to 0	1.5	3	113125
AGC-7P-30/15AC	30	15	-60 to +5	2	10	113125
AGC-8-70/20AC	70	20	-75 to 0	2	3	113125

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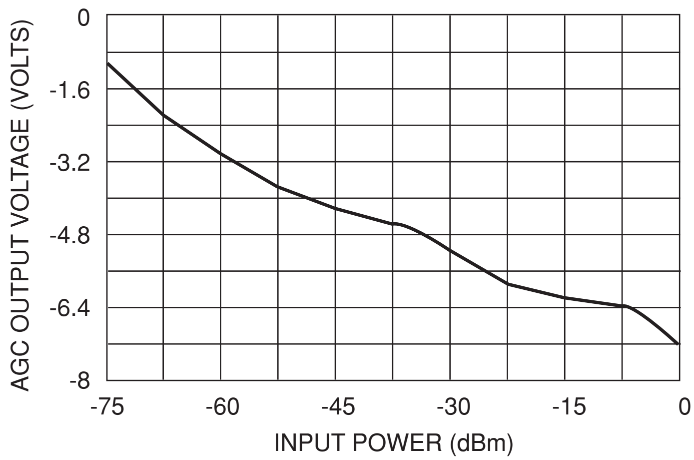
TYPICAL MONITOR VS. GAIN
(OUTPUT POWER 3 dBm NOMINAL)



ADDITIONAL SPECIFICATIONS

Output power and output power variation is measured at center frequency and 25°C.
Additional output power variation of ±0.5 dB will occur over operating temperature of -40 to +85°C.
Input/output impedance is 50 Ω.
Input VSWR is < 1.5:1 typical.
Output VSWR is < 2.0:1 typical.
Noise figure is < 6 dB at center frequency and 25°C.
Acquisition time is < 500 μs typically at -30 dBm.
Power: ±12 VDC at 300 mA typical for models up to 160 MHz and 350 mA typical for 300 MHz model.

ORDER OPTIONS

For ±15 VDC, add suffix “C”.
All units are available in phase and gain tracking sets up to three channels to within ±5° and ±1 dB at 25°C.
Typical part number: AGC-7-160/40AC (for outline drawing 113125 at ±15 VDC).

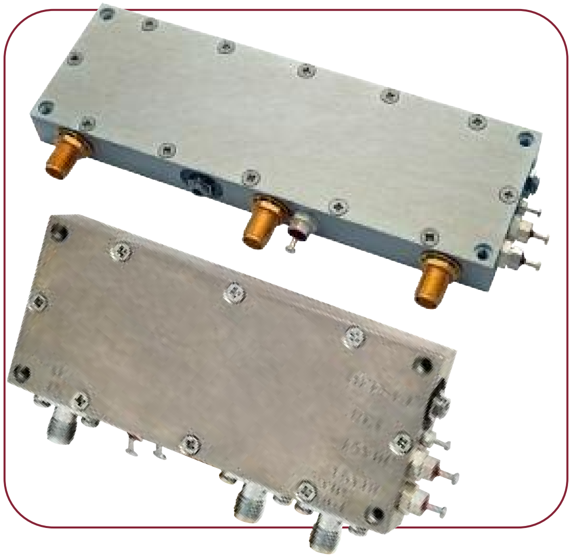
Custom housings and electrical specifications are also available. Contact factory for details.

MANUAL VOLTAGE GAIN-CONTROL AMPLIFIERS

MODEL: VGC SERIES

FEATURES

- Gain control up to 85 dB
- IF gain up to 80 dB
- Video gain up to 100 dB
- Linear mV/dB curve
- Detected video
- 1 dB compression maintained over entire gain control range



OPTIONS

- Customized center frequencies
- Increased operational bandwidth
- Custom packaging
- High-reliability screening
- Matched sets

MODEL NUMBER	CENTER FREQUENCY (MHz)	3 dB BANDWIDTH (MHz)	GAIN TO IF OUT (dB)	GAIN CONTROL RANGE (dB)	GAIN TO VIDEO OUT (dB)	VIDEO RISE TIME (ns)	OUTLINE DRAWING
VGC-7-250/100BC	250	100	70	60	-	-	120391
VGC-7-30/10	30	10	70	60	-	-	*
VGC-7-30/10BC	30	10	70	60	-	-	120391
VGC-7-60/10	60	10	70	60	-	-	*
VGC-7-60/10BC	60	10	70	60	-	-	120391
VGC-7-60/20	60	2	70	60	-	-	*
VGC-7-60/20BC	60	2	70	60	-	-	120391
VGC-7-70/10	70	10	70	60	-	-	*
VGC-7-70/10BC	70	10	70	60	-	-	120391
VGC-7-70/30	70	30	70	60	-	-	*
VGC-7-70/30BC	70	30	70	60	-	-	120391
VGC-6-70/20BC	70	20	70	60	-	-	120391
VGC-6-120/20	120	20	60	50	-	-	*
VGC-6-120/20BC	120	20	60	50	-	-	120391
VGC-6-140/40	140	40	60	50	-	-	*
VGC-6-140/40BC	140	40	60	50	-	-	120391
VGC-6-160/40	160	40	60	50	-	-	*
VGC-6-160/40BC	160	40	60	50	-	-	120391
MODELS WITH VIDEO OUTPUT							
VGC-7DV-30/10	30	10	70	60	80	100	*
VGC-7DV-30/10BC	30	10	70	60	80	100	120391
VGC-7DV-60/10	60	10	70	60	80	100	*
VGC-7DV-60/10BC	60	10	70	60	80	100	120391
VGC-7DV-60/20	60	2	70	60	80	50	*
VGC-7DV-60/20BC	60	2	70	60	80	50	120391
VGC-7DV-70/10	70	10	70	60	80	100	*
VGC-7DV-70/10BC	70	10	70	60	80	100	120391
VGC-7DV-70/30	70	30	70	60	80	30	*
VGC-7DV-70/30BC	70	30	70	60	80	30	120391
VGC-6DV-120/20	120	20	60	50	70	50	*
VGC-6DV-120/20BC	120	20	60	50	70	50	120391
VGC-6DV-140/40	140	40	60	50	70	30	*
VGC-6DV-140/40BC	140	40	60	50	70	30	120391
VGC-6DV-160/40	160	40	60	50	70	30	*
VGC-6DV-160/40BC	160	40	60	50	70	30	120391

* The above models are available in outline drawings 120338 or 120391.

NOTE: FOR MODIFICATION OF OUR STANDARD MODELS OR IF YOU HAVE ANY QUESTIONS, PLEASE FEEL FREE TO CONTACT MITEQ.

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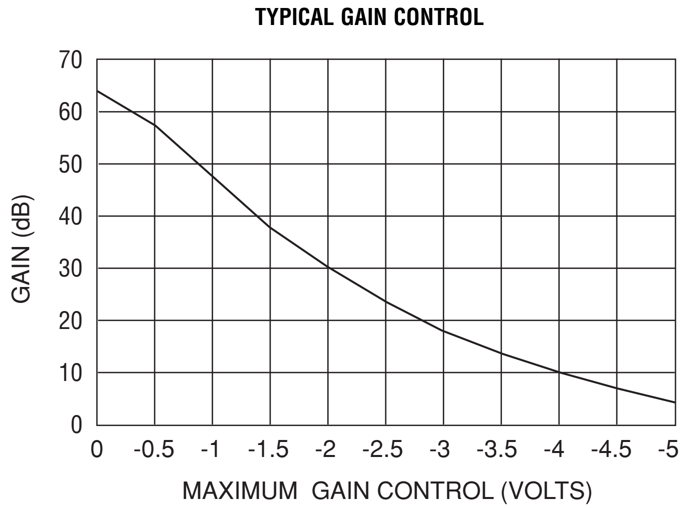
VGC SERIES TYPICAL TEST DATA



ADDITIONAL SPECIFICATIONS

IF output capability is +10 dBm minimum at 1 dB compression.
Noise figure is < 4 dB (30~70 MHz); < 5 dB (120~160 MHz)
Gain control voltage is 0 to -4 V (minimum gain) over specified control range.
Input/output impedance is 50 Ω.
Input and output VSWR is ≤ 1.5:1 and ≤ 2.0:1 respectively.
Video output capability is ≥ 4 VDC coupled into 93 Ω. DC coupled detected video requires ± VDC supply.
Power: +12 VDC at 160 mA typical and ±12 VDC at 185 mA typical for models with detected video.

ORDER OPTIONS

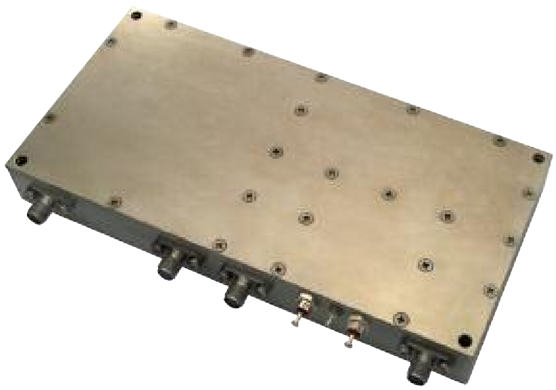
For ±15 VDC, add suffix “C”.
Typical part number: VGC-6DV-160/40BC (for outline drawing 113125 with detected video at ±15 VDC).

LIMITING LOG DISCRIMINATOR

MODEL: LAFD SERIES

FEATURES

- Digital outputs for frequency discriminators and logarithmic amplifiers
- Broadband frequency range
- Pulse response to 5 ns
- 70 dB dynamic range at 1 GHz
- Improved sensitivity



OPTIONS

- Customized center frequencies
- Increased operational bandwidth
- Extended dynamic range
- Military screening available

MODEL NUMBER	CENTER FREQUENCY (MHz)	3 dB BANDWIDTH (MHz)	LIMITED IF OUTPUT POWER VARIATION (±dB)	LOG AMP VIDEO RISE TIME (nS)	FREQUENCY DISCRIMINATOR LINEAR BANDWIDTH (nS)	FREQUENCY DISCIMINATOR RISE Time (nS)	FREQUENCY DISCIMINATOR SLOPE (mV/MHz)	OUTLINE DRAWING
LAFD-7-30/10	30	10	0.5	150	6	150	1000	122045
LAFD-7-60/20	60	20	0.5	70	16	70	250	122045
LAFD-7-70/30	70	30	0.5	50	20	50	150	122045
LAFD-7-120/40	120	40	0.5	40	24	40	100	122045
LAFD-7-160/50	160	50	1	30	30	30	100	122045
LAFD-6-300/100	300	100	1	20	75	20	50	122045
LAFD-6-750/200	750	200	1	15	150	15	20	122045
LAFD-6-1000/300	1000	300	1	10	250	10	10	122045

NOTE: FOR MODIFICATION OF OUR STANDARD MODELS OR IF YOU HAVE ANY QUESTIONS, PLEASE FEEL FREE TO CONTACT MITEQ.

ADDITIONAL SPECIFICATIONS

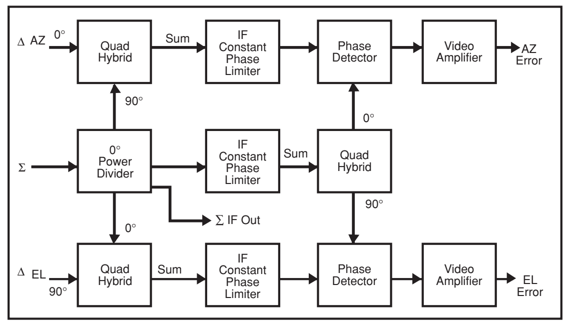
Input dynamic range is -70 to 0 dBm minimum (30 MHz~160 MHz) and -65 to 0 dBm (300 MHz~1000 MHz).
Log linearity is ≤ ±1 dB center frequency and 25°C.
Add ±0.5 dB over operating temperature of -40 to +85°C.
Logging slope is 25 mV/dB typically measured at center frequency and 25°C.
Slope variations of ±10% can be expected over operating temperature of -40 to +85°C.
Limited IF output power is 10 dBm nominal at center frequency and 25°C.
Additional output power variation of ±1 dB will occur over operating temperature of -40 to +85°C.
Frequency discriminator linearity is ≤ ±3% (30~70 MHz), ≤ ±5% (120~160 MHz), and ≤ ±7% (300~1000 MHz) over linear bandwidth.
Add ±2% over operating temperature of -40 to +85°C.
IF input/output impedance is 50 W (VSWR is < 2.0:1 typical).
Log and discriminator video output is DC coupled and rated into 93 W.
Power: ± 12 VDC at 500 mA typical.

ORDER OPTIONS

For ±15 VDC, add suffix “C”.
Typical part number: LAFD-7-160/50C (for ±15 VDC).

MODEL: MMDQ SERIES

The use of a complete three-channel monopulse IF processing system removes the critical interface problems normally encountered by the system designer. The block diagram configuration is designed for in-phase signal inputs, and reflects a field proven, straightforward use of the necessary IF elements. Other input phase configurations can also be supplied when required. Packaging is straightforward. An IF matrix, a detector matrix, and three matched limiter channels are all mounted to an aluminum base plate, with all power connectors brought out to a single barrier strip. If desired, all the individual modules can be removed from the plate and be separately mounted in the user's system.



The monopulse detector determines the difference nulls in an amplitude monopulse system for two axes by measuring the DIFFERENCE (Δ) to SUM (Σ) ratio. Each video output is proportional to this ratio and to the cosine of the phase angle between the Δ and Σ signals. The detector is usually used in a return-to-boresight system, but may be used to determine the angle off boresight.

The output is of the form:

$$E_0 = \frac{1.4(\Delta/\Sigma)\cos\phi}{[1+2(\Delta/\Sigma)\sin\phi + (\Delta/\Sigma)^2]^{1/2}}$$

Where:

E_0= Instantaneous output voltage
Δ/Σ= Ratio of Δ input voltage to Σ input voltage
ø= Phase angle between Δ and Σ inputs

Ratio Accuracy: On a return-to-boresight system, the monopulse detector is used to determine the location of the crossover null in the Δ signal, and also the polarity of error. The ratio accuracy is a measure of how closely the system can detect crossover. The accuracy is given as the highest ratio of Δ/Σ that will produce a zero output.

MODEL NUMBER	OPERATING FREQUENCY (MHz)	-3 dB BANDWIDTH (MHz)	SETTLING TIME (µs)	RATIO ACCURACY (dB)
MMDQ-3010-65	30	10	0.1	26
MMDQ-6020-65	60	20	0.08	26
MMDQ-7020-65	70	20	0.08	26
MMDQ-16020-60	160	20	0.08	23

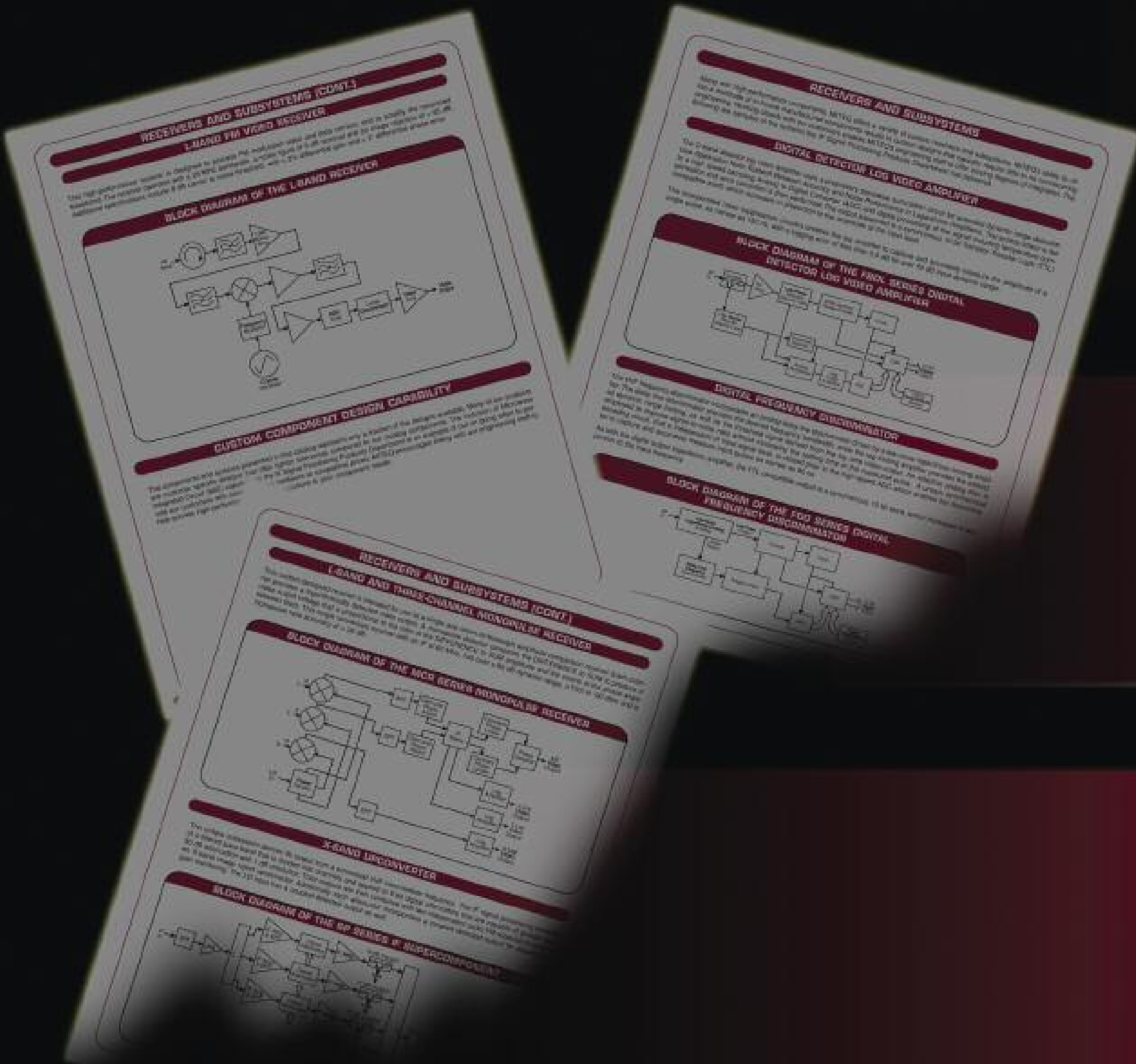
NOTE: FOR MODIFICATION OF OUR STANDARD MODELS OR IF YOU HAVE ANY QUESTIONS, PLEASE FEEL FREE TO CONTACT MITEQ.

ADDITIONAL SPECIFICATIONS

Input dynamic range is from -60 to +5 dBm (-60 to 0 dBm for 160 MHz model).
Input impedance is 50 Ω for DIFFERENCE and SUM IF input ports (VSWR 1.5:1 typical).
Supplemental Σ IF output is approximately 7 dB below Σ IF input.
Video output is DC coupled and rated into 75 Ω.
Video output provides +2, ±0.2 volts at equal level signals and 0° phase between DIFFERENCE and SUM ports, and -2, ±0.2 volts at equal level signals and 180° phase between DIFFERENCE and SUM ports.
Power: +12 VDC at 100 mA typical and -12 VDC at 500 mA typical.

ORDER OPTIONS

For ±15 VDC, add suffix "C".
Typical part number: MMDQ-3010-65C.
Other input phase configurations, input dynamic range and operational frequencies can also be provided when specified.
Contact factory for availability.



Receivers and Subsystems

RECEIVERS AND SUBSYSTEMS

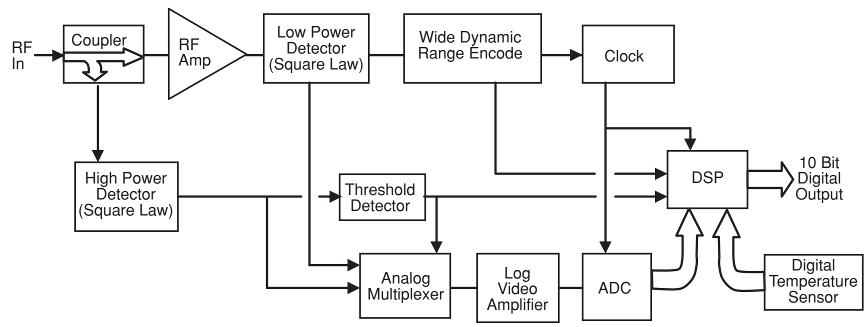
Along with high-performance components, MITEQ offers a variety of custom receivers and subsystems. MITEQ's ability to utilize a multitude of in-house manufactured components results in custom designs that typically require little to no nonrecurring engineering. Working closely with our customers enables MITEQ's engineering staff to offer varying degrees of integration. The following are samples of the systems the IF Signal Processing Products Department has delivered.

DIGITAL DETECTOR LOG VIDEO AMPLIFIER

The C-band detector log video amplifier uses a proprietary piecewise summation circuit for extended dynamic range detection (see Application Note: Tradeoff Between Accuracy and Noise Performance in Logarithmic Amplifiers). The analog output is fed to a high speed sampling Analog to Digital Converter (ADC) and digital processing of the signal including temperature compensation and error correction is then performed. The output presented is a synchronous 10 bit Transitor-Transitor Logic (TTL) compatible word, which increases in proportion to the amplitude of the input level.

The incorporated noise suppression circuitry enables the log amplifier to capture and accurately measure the amplitude of a single pulse, as narrow as 150 ns, with a logging error of less than 0.5 dB for over 60 dB input dynamic range.

BLOCK DIAGRAM OF THE FBDL SERIES DIGITAL DETECTOR LOG VIDEO AMPLIFIER

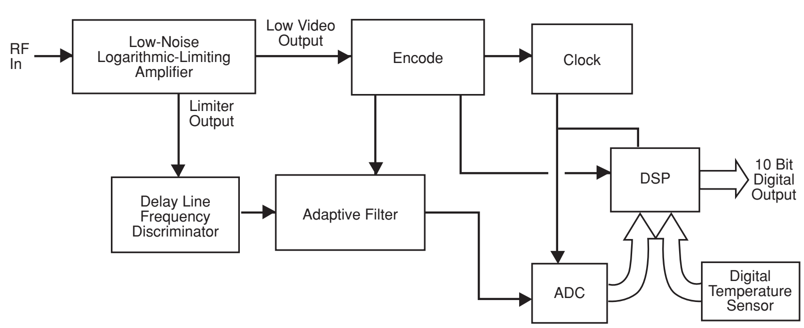


DIGITAL FREQUENCY DISCRIMINATOR

The VHF frequency discriminator incorporates an analog delay line discriminator driven by a low-noise logarithmic limiting amplifier. The delay line discriminator provides the desired frequency bandwidth, while the log-limiting amplifier provides the extended dynamic range limiting, as well as the threshold signal derived from the log amp video output. An adaptive analog filter is employed to improve signal-to-noise ratio without increasing the settling time of the measured pulse. A unique synchronized encoding circuit, that is independent of input signal level, is utilized prior to the high-speed ADC which enables the discriminator to capture and accurately measure input pulses as narrow as 80 ns.

As with the digital output logarithmic amplifier, the TTL compatible output is a synchronous 10 bit word, which increases in proportion to the input frequency.

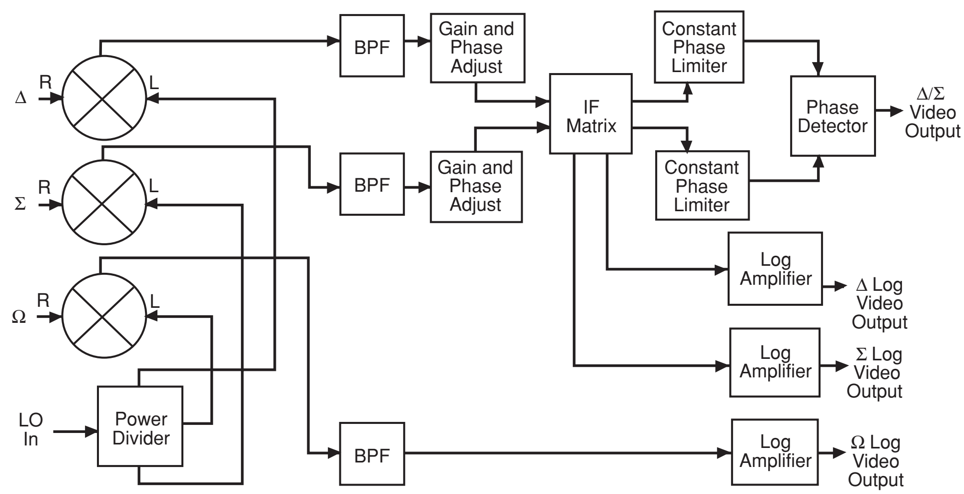
BLOCK DIAGRAM OF THE FDD SERIES DIGITAL FREQUENCY DISCRIMINATOR



L-BAND AND THREE-CHANNEL MONOPULSE RECEIVER

This custom-designed receiver is intended for use as a single axis return-to-boresight amplitude comparison receiver. Each channel provides a logarithmically detected video output. A monopulse detector compares the DIFFERENCE to SUM to produce a video output voltage that is proportional to the ratio of the DIFFERENCE to SUM amplitude and the cosine of the phase angle between them. This single conversion receiver with an IF of 60 MHz, has over a 60 dB dynamic range, a TSS of -90 dBm and a monopulse ratio accuracy of > 26 dB.

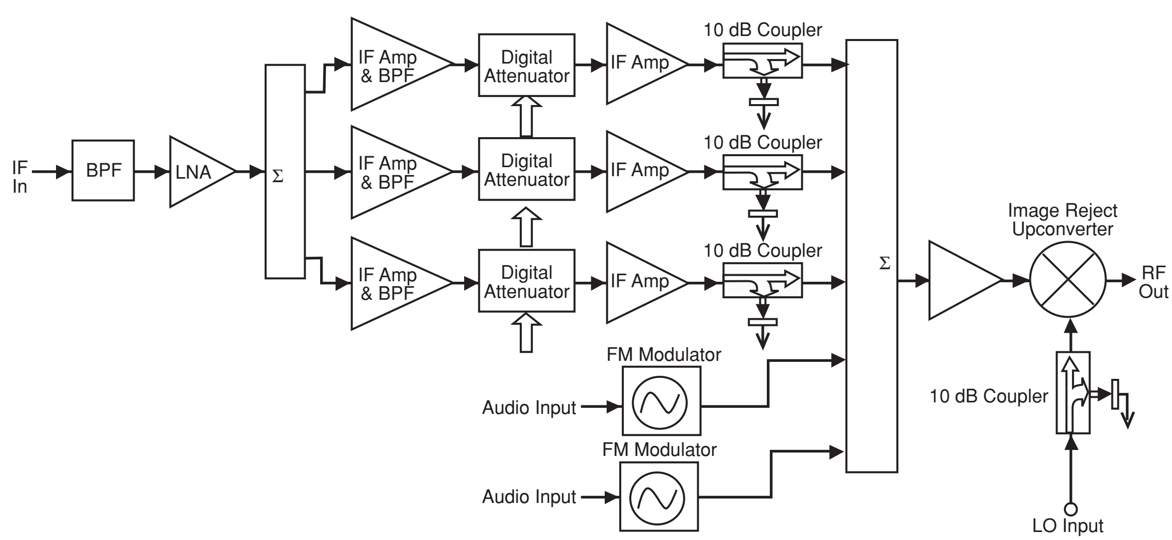
BLOCK DIAGRAM OF THE MCR SERIES MONOPULSE RECEIVER



X-BAND UPCONVERTER

This unique subsystem derives its output from a processed VHF intermediate frequency. The IF signal processing consists of a filtered pass band that is divided into channels and applied to 6 bit digital attenuators that are capable of greater than 50 dB attenuation with 1 dB resolution. Their outputs are then combined with two independent audio FM modulators to drive an X-band image reject upconverter. Additionally each attenuator incorporates a coupled detected output for equalization gain monitoring. The LO input has a coupled detected output as well.

BLOCK DIAGRAM OF THE SP SERIES IF SUPERCOMPONENT

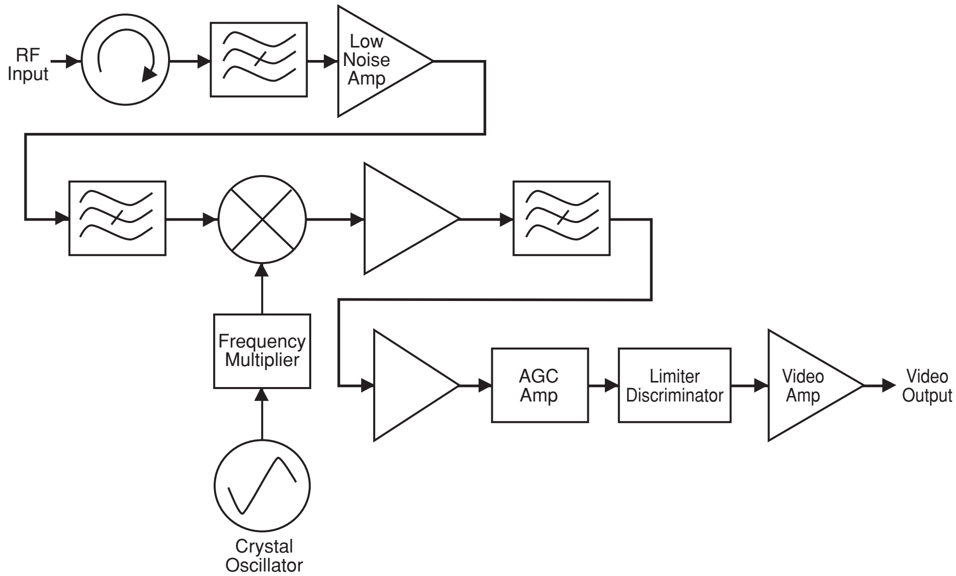


RECEIVERS AND SUBSYSTEMS (CONT.)

L-BAND FM VIDEO RECEIVER

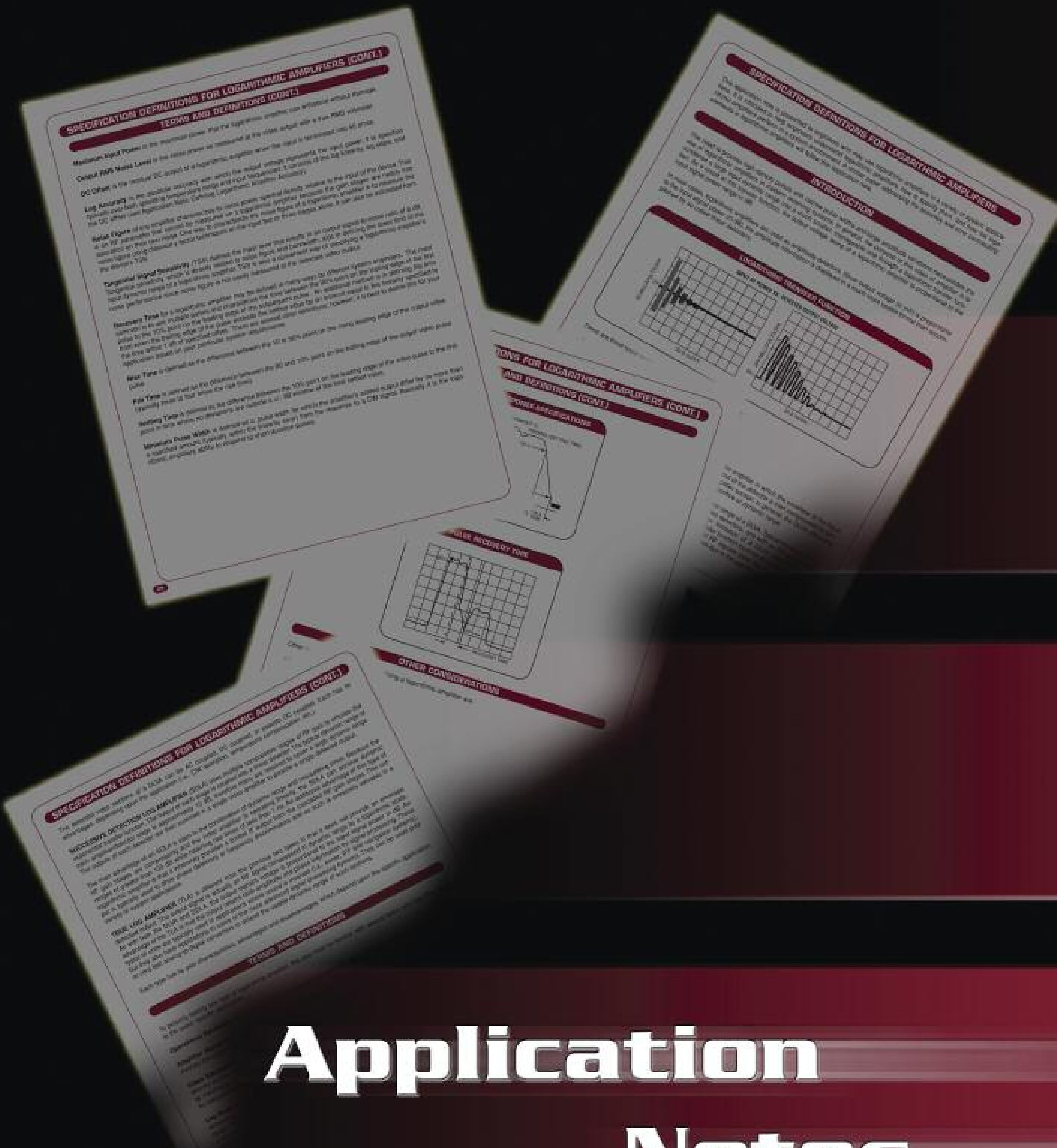
This high-performance receiver is designed to process FM modulated video and data carriers, and to amplify the recovered baseband. The receiver operates with a 20 MHz bandwidth, a noise figure of 8 dB nominal and an image rejection of > 65 dB. Additional specifications include 8 dB carrier to noise threshold, with < 2% differential gain and < 2° differential phase error.

BLOCK DIAGRAM OF THE L-BAND RECEIVER



CUSTOM COMPONENT DESIGN CAPABILITY

The components and systems presented in this catalog represent only a fraction of the designs available. Many of our products are customer specific designs that offer tighter tolerances compared to our catalog components. The inclusion of Microwave Integrated Circuit (MIC) capability to the IF Signal Processing Products Department is an example of our on going effort to provide our customers with state-of-the-art hardware at competitive prices. MITEQ encourages dialog with our engineering staff to help provide high-performance economic solutions to your component needs.



Application Notes

SPECIFICATION DEFINITIONS FOR LOGARITHMIC AMPLIFIERS

This application note is presented to engineers who may use logarithmic amplifiers in a variety of system applications. It is intended to help engineers understand logarithmic amplifiers, how to specify them, and how the logarithmic amplifiers perform in a system environment. A similar paper addressing the accuracy and error contributing elements in logarithmic amplifiers will follow this application note.

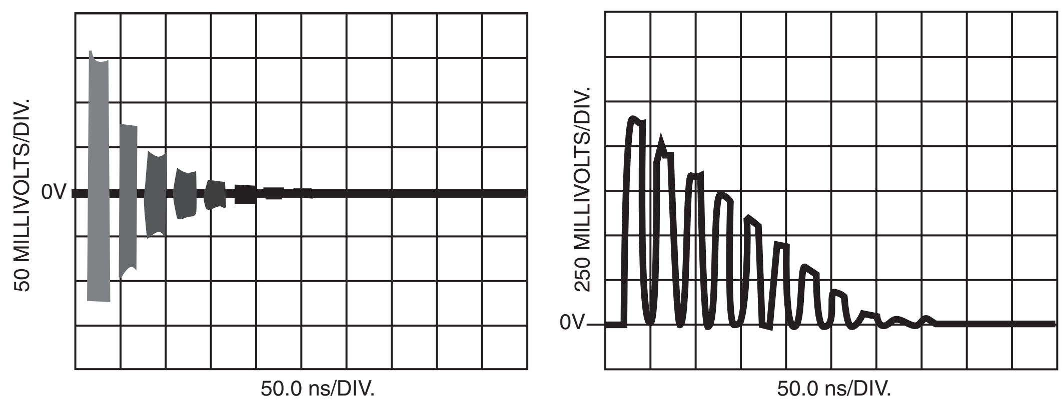
INTRODUCTION

The need to process high-density pulses with narrow pulse widths and large amplitude variations necessitates the use of logarithmic amplifiers in modern receiving systems. In general, the purpose of this class of amplifier is to condense a large input dynamic range into a much smaller, manageable one through a logarithmic transfer function. As a result of this transfer function, the output voltage swing of a logarithmic amplifier is proportional to the input signal power range in dB.

In most cases, logarithmic amplifiers are used as amplitude detectors. Since output voltage (in mV) is proportional to the input signal power (in dB), the amplitude information is displayed in a much more usable format than accomplished by so-called linear detectors.

LOGARITHMIC TRANSFER FUNCTION

INPUT RF POWER VS. DETECTED OUTPUT VOLTAGE



There are three basic types of logarithmic amplifiers. These are:

• Detector Log Video Amplifiers
• Successive Detection Logarithmic Amplifiers
• True Log Amplifiers

DETECTOR LOG VIDEO AMPLIFIER (DLVA) is a type of logarithmic amplifier in which the envelope of the input RF signal is detected with a standard "linear" diode detector. The output of the detector is then compressed to simulate a logarithmic input/output relationship in the following video amplifier section. In general, the DLVA offers the advantage of operating over the widest frequency range, but at the sacrifice of dynamic range.

The linear/square law range of the input diode detector limits the dynamic range of a DLVA. Typical dynamic ranges for a DLVA are in the order of 40 dB. Very often, the user will parallel two detectors, one with an RF preamplifier, to extend the overall dynamic range to greater than 70 dB. A major limitation of a DLVA results from the gain/bandwidth product of a video amplifier. Because the logarithmic transfer function must be accomplished in the video section, a tremendous amount of video gain is required for low-level RF signals (near the diode sensitivity). The amount of gain required causes rise time and recovery time degradation due to the gain/bandwidth constraints in the video section.

SPECIFICATION DEFINITIONS FOR LOGARITHMIC AMPLIFIERS (CONT.)

INTRODUCTION (CONT.)

The detected video sections of a DLVA can be AC coupled, DC coupled, or pseudo DC coupled. Each has its advantages, depending upon the application (i.e., CW operation, temperature compensation, etc.).

SUCCESSIVE DETECTION LOG AMPLIFIER (SDLA) uses multiple compressive stages of RF gain to emulate the exponential transfer function. The output of each stage is coupled into a linear detector. The typical dynamic range of each amplifier/detector stage is approximately 10 dB, therefore many are required to cover a large dynamic range. The outputs of each detector are then summed in a single video amplifier to provide a single detected output.

The main advantage of an SDLA is seen in the combination of dynamic range and rise/settling times. Because the RF gain stages are compressing and the video amplifier is operating linearly, the SDLA can achieve dynamic ranges of greater than 100 dB while retaining rise times of less than 1 ns. An additional advantage of this type of logarithmic amplifier is that it inherently provides a limited IF output from the cascaded RF gain stages. This output is typically used to drive phase detectors or frequency discriminators and as such is extremely valuable in a variety of system applications.

TRUE LOG AMPLIFIER (TLA) is different from the previous two types in that it does not provide an envelope detected output. The output signal is actually an RF signal compressed in dynamic range by a logarithmic scale. As with both the DLVA and SDLA, the output signal's voltage is proportional to the input signal power in dB. An advantage of the TLA is that the output retains both amplitude and phase information for signal processing. These types of units are typically used in applications where sound is involved (i.e., sonar, IFF and navigation systems), but they also have applications in some of the more advanced signal processing systems. They can be used prior to ultra fast analog-to-digital converters to extend the usable dynamic range of such systems.

Each type has its own characteristics, advantages and disadvantages, which depend upon the specific application.

TERMS AND DEFINITIONS

To properly specify any type of logarithmic amplifier, the user must be familiar with several terms and how they relate to the users' specific application.

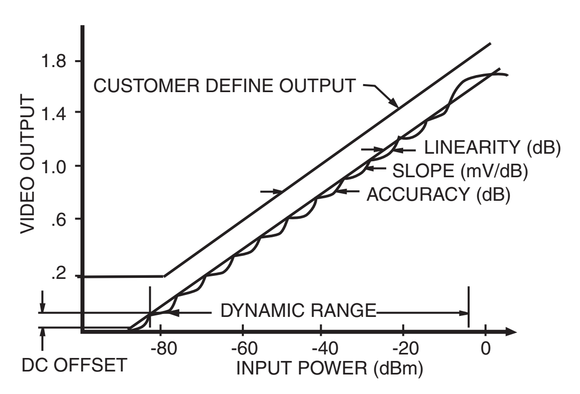
Operational Bandwidth is the range of input frequency over which the electrical parameters of the amplifier are met.

Amplifier Bandwidth includes the operational bandwidth and additional frequency range necessary to accommodate the pulse width and rise/fall time.

Video Bandwidth is usually specified to address the detected signal's rise and fall time. It cannot be measured directly via the input RF signal, but must be characterized by injecting a swept CW signal into the video section or by calculations from accurate rise time measurements.

Log Slope is the slope of the input/output transfer characteristics of the detected signal over the dynamic range. The log slope is expressed in millivolts per dB of a best-fit straight line as derived by a least-squares approximation of all data points measured over the specified logging curve.

LOGARITHMIC AMPLIFIER-SPECIFICATIONS



TERMS AND DEFINITIONS (CONT.)

Log Linearity is the maximum deviation in dB of all measured points from the calculated best-fit straight line.

Dynamic Range is the range of the input signals in dB over which the output linearity requirement is met.

Maximum Input Power is the maximum power that the logarithmic amplifier can withstand without damage.

Output RMS Noise Level is the noise power as measured at the video output with a true RMS voltmeter.

DC Offset is the residual DC output of a logarithmic amplifier when the input is terminated into 50 ohms.

Log Accuracy is the absolute accuracy with which the output voltage represents the input power. It is specified typically over both operating temperature range and input frequencies. It consists of the log linearity, log slope, and the DC offset (see Application Note: Defining Logarithmic Amplifier Accuracy).

Noise Figure of any amplifier characterizes its noise power spectral density relative to the input of the device. This is an RF parameter that cannot be measured on a logarithmic amplifier because the gain stages are nearly into saturation on their own noise. One way to characterize the noise figure of a logarithmic amplifier is to measure the noise figure using classical y-factor techniques on the input two or three stages alone. It can also be estimated from the device's TSS.

Tangential Signal Sensitivity (TSS) defines the input level that results in an output signal-to-noise ratio of 8 dB. Tangential sensitivity, which is directly related to noise figure and bandwidth, aids in defining the lower limit of the input dynamic range of a logarithmic amplifier. TSS is also a convenient way of specifying a logarithmic amplifier's noise performance since noise figure is not easily measured at the detected video output.

Recovery Time for a logarithmic amplifier may be defined in many ways by different system engineers. The most common is to use multiple pulses and characterize the time between the 90% point on the trailing edge of the first pulse to the 10% point on the leading edge of the subsequent pulse. An additional method is in defining the time from when the trailing edge of the pulse exceeds the settled value by an amount equal to the linearity specified to the time within 1 dB of specified offset. There are several other definitions; however, it is best to define this for your application based on your particular system requirements.

Rise Time is defined as the difference between the 10 to 90% point on the rising leading edge of the output video pulse.

Fall Time is defined as the difference between the 90 and 10% point on the trailing edge of the output video pulse (typically three to four times the rise time).

Settling Time is defined as the difference between the 10% point on the leading edge of the video pulse to the first point in time where no deviations are outside a +/- dB window of the final settled value.

Minimum Pulse Width is defined as a pulse width for which the amplifier's settled output differ by no more than a specified amount (typically within the linearity error) from the response to a CW signal. Basically it is the logarithmic amplifiers ability to respond to short duration pulses.

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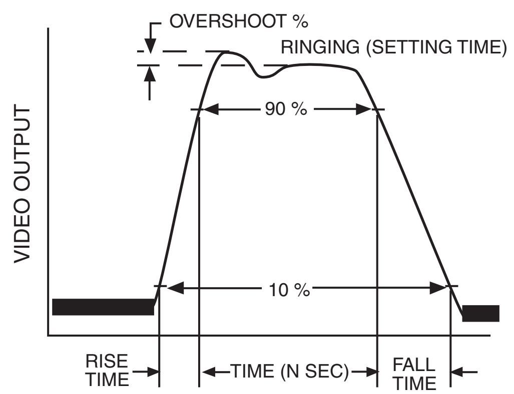
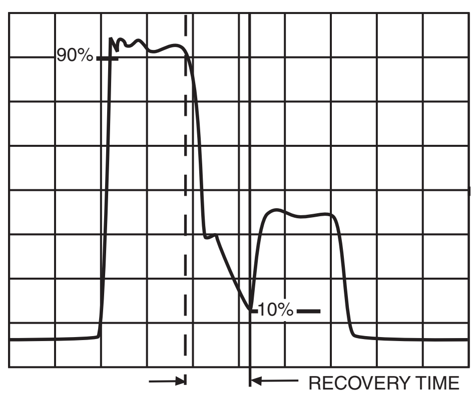
SPECIFICATION DEFINITIONS FOR LOGARITHMIC AMPLIFIERS (CONT.)

TERMS AND DEFINITIONS (CONT.)

PULSE RESPONSE-SPECIFICATIONS



PULSE RECOVERY TIME



OTHER CONSIDERATIONS

Other items to consider when specifying a logarithmic amplifier are:

- DC power requirements
- Size and weight
- Operating and storage temperature
- Connector types
- Environmental requirements

DEFINING LOGARITHMIC AMPLIFIER ACCURACY

This section is presented to system engineers who use logarithmic amplifiers as high dynamic range and/or fast settling-time amplitude detectors. It is designed to better help them understand the design constraints of log amplifiers and how they relate to their systems.

INTRODUCTION

In order to properly define the operational accuracy of a logarithmic amplifier, it is important to understand all the sources of potential errors affecting the performance of the device. An engineer must then realize how these errors relate to the overall system requirements before defining the component specification. In addition, it is best when the engineer understands the practical performance limits of the logarithmic amplifier to avoid overspecifying parameters and unnecessarily increasing the cost.

In categorizing the types of errors contributing to the accuracy of the logarithmic amplifier, three major sources are addressed:

1. Linearity
2. Offset variations
3. Slope variations

LINEARITY is defined as the difference between the measured output voltage and the corresponding point on a best-fit straight line derived from the measured data (see Figure 1). Linearity error is dependent upon both temperature and frequency. As the temperature decreases, the magnitude of the linearity errors increases due to the increase in the IF gain at cold temperatures which effectively magnifies the error (see Figure 2).

Errors are also noticed when the frequency of the input signal varies from center frequency of the logarithmic amplifier (see Figure 3). The cause of this error is mainly due to the tuned frequency response of the individual stages and input filtering.

LINEARITY DEFINITION

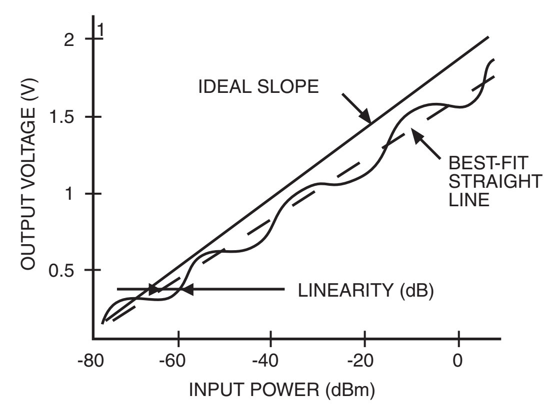


FIGURE 1

LINEARITY VS. TEMPERATURE

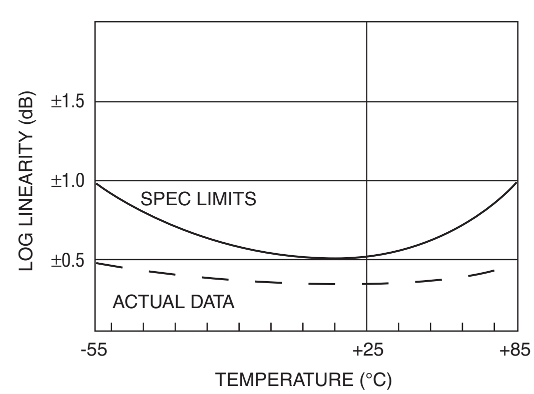


FIGURE 2

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INTRODUCTION (CONT.)

Typical linearity errors at room temperature over different frequency range are as follows:

CENTER FREQUENCY	TYPICAL BANDWIDTH	DYNAMIC RANGE (dB)	ERROR (±dB)
10 – 160 MHz	5 – 20%	80	0.5
160 – 250 MHz	10 – 30%	75	0.5
250 – 500 MHz	20 – 40%	70	0.75
500 – 1000 GHz	30 – 50%	65	1
1000 – 2000 GHz	40 – 75%	60	1

Over the operating temperature range of -54 to +85°C, this error will typically double.

LINEARITY VS. FREQUENCY

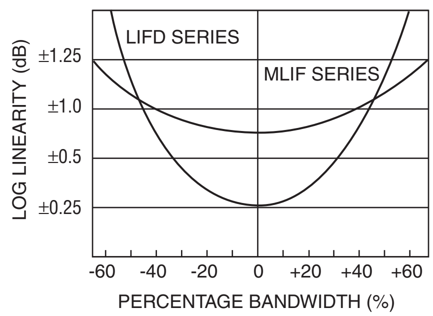

FIGURE 3

ERROR DUE TO OFFSET VARIATIONS

Offset variation is the residual DC output voltage present with the input of the logarithmic amplifier is terminated into 50 ohms. The error due to offset variations is derived from the following equation:

$$\pm E_{offset}\ (\text{dB}) = \frac{\pm \text{ offset voltage (mV)}}{\text{slope (mV/dB)}}$$

This DC voltage can usually be adjusted to any reasonable value by means of an external screw adjustment or by adding a resistor to ground on a provided voltage pin. Since the DC offset is independent of the input signal and is measured with the input terminated, it has no frequency dependence, however there is still a variation due to temperature. This variation versus temperature is a direct result of the change in gain of the video amplifier and is typically on the order of ±70 mV over the operating temperature range of -54 to +85°C. This fluctuation can be reduced with the addition of a temperature compensation network to the video section.

ERROR DUE TO SLOPE VARIATION

Slope variation of a logarithmic amplifier is defined as the deviation of the "measured slope" to the specified slope. The slope is the input power versus output voltage transfer function, the "measured slope" is actually calculated by a least-squares approximation from a series of discrete data points (see Figure 1). This measurement is performed with a CW signal at center frequency. Even under these static conditions, the measured slope will deviate

$$\pm \text{ Slope variation (\%)} = \frac{\text{measured slope - specified slope}}{\text{specified slope}}$$

$$\pm E_{slope}\ (\text{dB}) = \pm \text{ slope variation (\%) x dynamic range (dB)}$$

INTRODUCTION (CONT.)

from the specified slope by a certain amount, typically expressed as a percentage.

From the previous equation, it can be seen that the error due to slope variation can become quite large, particularly for high dynamic range units. In fact, slope variation is typically the single largest error-contributing factor in logarithmic amplifiers.

The initial error in the slope is attributed to the video gain and usually can be set internally to a specified value with a reasonable degree of accuracy. Along with this error, a variation in the measured slope can be expected over both temperature and frequency as the gain of both the IF and video transistors change. With standard log amplifiers, the following can be used as estimates for variation in slope over frequency and temperature (see Figure 4):

Slope variation vs. temperature (-54 to +85°C) ±5%

Slope variation vs. frequency range ±7%

SLOPE VARIATION VS. TEMPERATURE

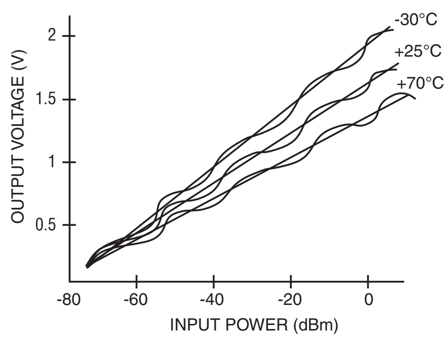

FIGURE 4

As with the offset variation, the slope variation versus temperature can be reduced with additional temperature compensation networks installed in the IF and video section.

EFFECT OF THREE SOURCES OF ERROR ON OVERALL ACCURACY

All three sources of error will effect a logarithmic amplifier's overall absolute accuracy. The definition of absolute accuracy is simply the difference between the measured output voltage to the ideal output voltage for a given input power. Each error will contribute differently over a set of conditions, such as temperature, frequency and power level. The contributions of each error has been discussed with respect to temperature and frequency; however, it is easier to consider several of the errors when discussing their relation to input power.

At lower input signal levels, nearing TSS, the total errors are predominantly a result of the errors in offset and linearity; any errors due to slope inaccuracies are negligible. The slope variation versus temperature curve depicts typical logging curves over temperature extremes. From these curves it can be seen that the slope of a logarithmic amplifier tends to pivot about the minimum power point. At this pivot point the slope error is minimized and not a factor. At higher input power levels, the contribution of slope error must again be considered and factored into the overall accuracy equation.

For clarification, the following is a list of the errors discussed with their relationship to temperature and frequency, as well as a look at how they can be combined to estimate the overall accuracy of a logarithmic amplifier:

$$\text{TOTAL ERROR} = E_{linearity} + E_{offset} + E_{slope}$$

Linearity and slope errors are a function of both temperature and frequency, while offset is a function of frequency alone. This total error can be depicted as in Figure 5. It defines the total range of output voltages that correspond to any input power range, and can be used in worst case system analysis.

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INTRODUCTION (CONT.)

SPECIFYING LOG AMP ACCURACY

When specifying a logarithmic amplifier, it is important to take all error contributing factors into account; however, it is equally important not to overspecify the amplifier as this would tend to cause it to become very costly to align. To simplify the process of specifying a logarithmic amplifier, the following two approaches have been presented as a guide:

1. Specify the individual errors.

A brief checklist of the specification parameters is as follows:

- Specify linearity error over temperature and frequency
- Specify slope with errors over frequency and temperature
- Specify offset and its temperature tolerance

2. Specify the total accuracy.

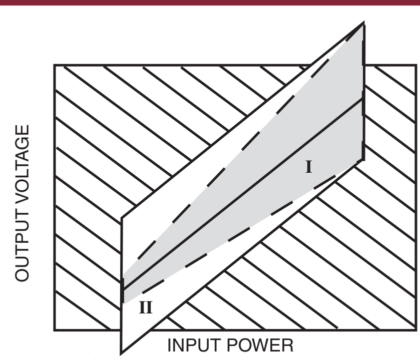
The alternate approach is to specify a total accuracy window as follows:

- Specify an ideal slope and power/voltage pivot point independent of temperature and frequency
- Define limits of total logging error referred to that line

When using the second approach, the total error window will look like a rectangle and not as trapezium as presented in Figure 5. As a result, either the absolute error specification at high power levels will be very difficult or the absolute error specification at low power levels will be very easy to achieve.

Although either of these two approaches will define the acceptable range of errors in logging accuracy over temperature and frequency, specifying the individual error components versus temperature is recommended. This approach is clearly more complicated for the system engineer; however, it is much easier to translate to the design of the log amplifier, especially in defining the pass/fail criteria used during alignment and test. More importantly, the system engineer will relay his system concerns in a more precise manner and he will receive a component that performs exactly the way he expects.

LOGARITHMIC AMPLIFIER–TOTAL ERROR



I = Allowable Accuracy By Specifying Individual Errors.
II = Allowable Accuracy By Specifying Total Error.

FIGURE 5

CONCLUSION

All of the error sources presented are defined independently; however, they all interact with each other as well as with other specification parameters, such as rise time and noise figure. Hopefully, this will allow the system engi-

TRADEOFF BETWEEN ACCURACY AND NOISE PERFORMANCE IN LOGARITHMIC AMPLIFIERS

Accuracy and noise performance of logarithmic amplifiers is very important for modern Electronic Warfare (EW) systems. This is especially true, when after digitizing the analog signal; a system engineer applies digital signal processing in an attempt to correct for analog errors. In this case, errors due to noise contributions have to be less than the desired accuracy prior to the digital error correction, otherwise, the error correction may actually degrade the overall accuracy instead of improving it.

Generally, the tradeoff between measurement time and accuracy is well known as a major tradeoff in measurement systems. Each case requires specific analysis and an appropriate solution. In nonlinear systems like logarithmic amplifiers, analysis could be complicated and the results of the analysis may not be apparent.

We will discuss noise performance of logarithmic amplifiers and their settling time performance. We will then present the most desirable approach for digital logarithmic amplifiers.

TYPICAL BLOCK DIAGRAM OF EXTENDED RANGE DLVAs

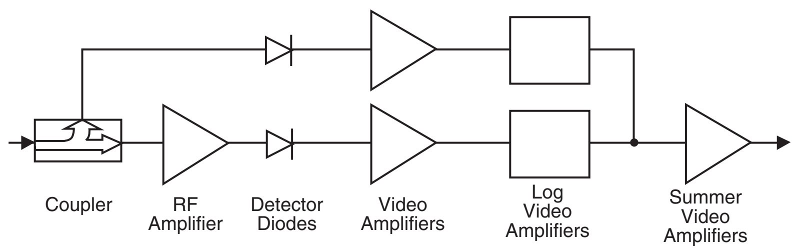


FIGURE 1

NOISE PERFORMANCE OF LOGARITHMIC AMPLIFIERS

Before developing MITEQ's first digital output log amplifier, we had a long and successful history in the design and manufacturing of low-noise Successive Detection Logarithmic Video Amplifiers commonly known as SDLVAs. MITEQ also developed Extended Range Detector Logarithmic Video Amplifiers (ERDLVA) as shown in Figure 1.

Incorporating an A/D converter into the design of an extended range detector log video amplifier is considerable more difficult than it appears. The high noise content inherent in a DLVA and the non-linear nature of logarithmic signal processing makes this design considerable more complicated than most mixed signal designs.

A plot of the noise power versus RF input power for both SDLVAs and ERDLVAs are shown in Figure 2. As seen in the plot, the SDLVA exhibits a non-linear increase in signal-to-noise ratio as input power increases. On the other hand the carrier-to-noise ratio of the ERDLVA looks entirely different, increasing linearly for more than half the input dynamic range. This results in higher noise output levels, which inhibits accurate digitizing and error correction. In both cases the TSS is quite low, which is no surprise because TSS correlates with noise at low input power levels.

TYPICAL NOISE POWER OF LOGARITHMIC AMPLIFIERS

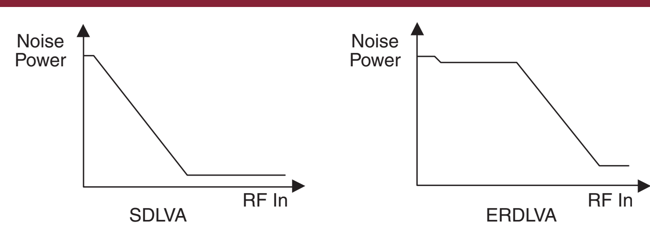


FIGURE 2

MAJOR SOURCE OF NOISE IN ERDLVAs

There are three major sources of noise that can effect a DLVAs performance. Two sources are the result of RF noise downconversion. The third source is the video amplifier. To simplify our discussion we will define continuous white RF noise as in triple independent sources located equidistant within the frequency spectrum with 1 MHz spacing. This approximation is illustrated in Figure 3.

The definitions are as follows:

- **Noise-Carrier Term-Noise Downconversion or N&C**
  Resulting from the RF noise downconversion due to beating between the RF carrier and the noise components.

- **Noise-Noise Term-Noise Downconversion or N&N**
  Resulting from the RF noise downconversion due to beating between the different noise components.

- **Video Amplifier Noise Contribution**

NOISE SPECTRUM APPROXIMATION

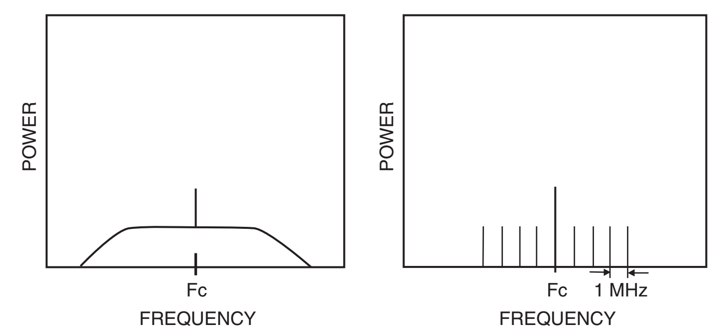


FIGURE 3

NOISE-CARRIER TERM-NOISE DOWNCONVERSION

Each arbitrarily taken noise component, with frequency $\mathbf{F_i}$ beats with carrier $\mathbf{F_c}$ and creates a baseband product with a frequency of $\mathbf{F_c - F_i}$. The resulting Root-Mean Square (RMS) voltage will be proportional to the RMS voltages of the carrier and the RF noise component. Therefore the RMS voltage of one beating pair ($\mathbf{V_{oneBP}}$) conversion is:

$$V_{oneBP} = 2\sqrt{2}\,(K_d/R_v) \bullet V_c \bullet V_{RFnoise} \tag{1}$$

The power of this baseband component expressed in mW:

$$P_{oneBP} = 2(K_d^2/R_v) \bullet P_c \bullet P_{RFnoise} = 2M^2 \bullet P_c \bullet P_{RFnoise} \tag{2}$$

Where:

$\mathbf{V_c}$ is the RMS voltage of the carrier

$\mathbf{P_c}$ is the power of the carrier expressed in mW

$\mathbf{V_{RFnoise}}$ is the RMS voltage of the noise within a 1 MHz bandwidth

$\mathbf{K_d}$ is the detector's sensitivity expressed in mV/mW

$\mathbf{R_v}$ is the detector's video resistance in ohms

M is the detector's figure of merit, which is equal to $\sqrt{(K_d^2/R_v)}$

$\mathbf{P_{RFnoise}}$ is noise power in mW within a 1 MHz bandwidth

Noise power in mW in a 1 MHz bandwidth itself depends on RF gain ($\mathbf{G_{RF}}$) and noise figure ($\mathbf{NF_{RF}}$).

$$P_{RFnoise} = kT \bullet 10^{0.1(G_{RF} + NF_{RF})} \tag{3}$$

Total noise power density (**NPD** in mW/MHz) in the baseband depends on the number of beating pairs **(N)** that will provide the equal baseband frequencies $\mathbf{(F_c - F_i)}$.

$$NPD = P_{oneBP} \bullet N \tag{4}$$

In the case of noise-carrier beating, **N** is frequency independent and equals two because the same product could be obtained from the carrier beating with two noise components, first with frequencies lower than the carrier and second with frequencies higher than the carrier.

Combining Equations (2) and (4) gives us:

$$NPD = 4M^2 \bullet P_{RFnoise} \bullet P_c \tag{5}$$

The total noise power in mW of the noise-carrier term ($\mathbf{P_{N\&C}}$) in the video bandwidth ($\mathbf{BW_{vid}}$) in MHz is equal to:

$$P_{N\&C} = NPD \bullet BW_{vid} = 4M^2 \bullet P_c \bullet P_{RFnoise} \bullet BW_{vid} \tag{6}$$

$\mathbf{P_{N\&C}}$ does not depend on the RF bandwidth and is directly proportional to the following:

- The video bandwidth
- The RF noise figure as part of Equation (3)
- The input signal level

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Two arbitrarily taken noise components with frequencies F_i and F_j mix with each other to create two products, one with the RF frequency $F_i + F_j$ and the other with baseband frequency $F_{bb} = |F_i - F_j|$. For our discussion only the baseband product is of interest.

Equation (2) is applicable to the noise-noise downconversion with the substitution of P_C by another $P_{RFnoise}$. So the power of the baseband product of the noise-noise beating pair is equal to:

$$P_{oneBP} = 2M^2 \bullet P^2_{RFnoise} \tag{7}$$

Where:

$P_{RFnoise}$ is equal to the noise power in mW within a 1 MHz bandwidth, and expressed by Equation (3).

The number of beating pairs differs from the previous case significantly. In this case **N** depends on the frequency of the baseband product F_{bb} where $F_{bb} = |F_i - F_j|$. It is apparent that each component gives a 1 MHz product when beating with adjacent components. Please refer to our approximation which assumes 1 MHz spacing between independent noise sources. So where F_{bb} = 1 MHz

$$N_{@F_{bb} = 1\,MHz} = \frac{BW_{RF}}{1\,MHz}$$

For producing a 2 MHz product, each component has to mix with another one shifted by 2 MHz. In comparison with a 1 MHz product, we lose one beating pair.

$$N_{@F_{bb} = 2\,MHz} = \frac{BW_{RF}}{1\,MHz} - 1$$

And so on,

$$N_{@F_{bb} = 3\,MHz} = \frac{BW_{RF}}{1\,MHz} - 2$$

$$N_{(F_{bb})} = \frac{BW_{RF} - F_{bb}}{1\,MHz} \tag{8}$$

Combining Equations (4), (7) and (8) we get a baseband noise power density, **NPD(F_{bb})**, expressed in mW/MHz.

$$NPD(F_{bb}) = 2(K_d^2/R_v) \bullet P^2_{RFnoise} \bullet (BW_{RF} - F_{bb}) \tag{9}$$

NOISE-NOISE TERM-NOISE DOWNCONVERSION (CONT.)

Therefore the total noise power in mW in the video bandwidth (**BW_{vid}** in MHz) can be derived from the following:

$$P_{N\&N} = \sum_{F_{bb}} NPD\,(F_{bb}) = M^2\,(P^2_{RFnoise} \bullet (2BW_{RF} \bullet BW_{vid} - BW^2_{vid}) = M^2 \cdot P^2_{RFnoise} \cdot \sqrt{BW^2_{eff}} \qquad (10)$$

Where effective bandwidth **BW_{eff}** is equal to:

$$BW_{eff} = \sqrt{2BW_{RF} \cdot BW_{vid} - BW^2_{vid}} \qquad (11)$$

$P_{N\&N}$ is therefore directly proportional to the following:

- The video bandwidth
- The RF noise figure as part of Equation (3)
- The RF bandwidth

$P_{N\&N}$, on the other hand, does not depend on input signal level.

VIDEO AMPLIFIER NOISE CONTRIBUTION

The noise power, expressed in mW, of the video amplifier into the video bandwidth is equal to:

$$P_{vidAmpNoise} = 4kT \bullet F_{vid} \bullet BW_{vid} \qquad (12)$$

Where the noise factor of the video amplifier (**F_{vid}**) is directly related to its noise figure as:

$$NF_{vid} = 10\log\,(F_{vid}) \qquad (13)$$

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NOISE-CARRIER AND NOISE-NOISE TERMS AND THEIR DEPENDENCE ON BANDWIDTH

If the video bandwidth is less than the RF bandwidth, the noise-carrier term is independent of RF bandwidth. The noise-noise term is a function of video bandwidth. These differences become clear when we look at the Noise Power Density (NPD) of the terms.

Noise power density of the noise-carrier term is flat because the number of beating pairs equals two and is independent of the baseband product frequency. Extending the RF noise bandwidth does not increase the NPD, instead it stretches the baseband noise spectrum, as seen in Figure 4. Therefore the portion of the baseband noise spectrum, which remains after video filtering (shown by gray bar) does not depend on the RF bandwidth.

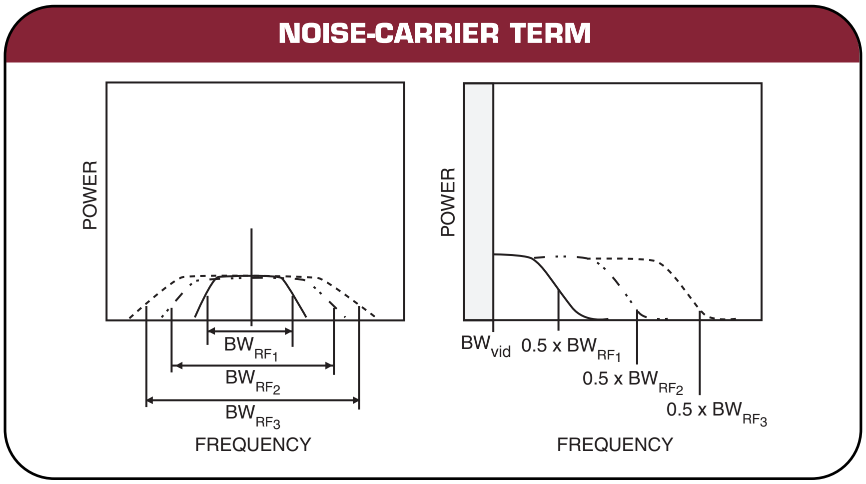

FIGURE 4

As seen in Figure 5, in the case of noise-noise downconversion, the number of beating pairs does depend on the RF bandwidth, as well as the frequency of the baseband product. Therefore the portion of the baseband noise spectrum which remains after video filtering (shown by gray bar) increases proportionally with increasing RF bandwidth.

The difference between the N&N term and the N&C term is very important. It shows that by narrowing the RF bandwidth, one could improve TSS due to the reduction of the N&N term. At the same time it does not reduce noise at the medium to high input power levels (almost the entire input dynamic range of the log amplifier), where the N&C term is dominant.

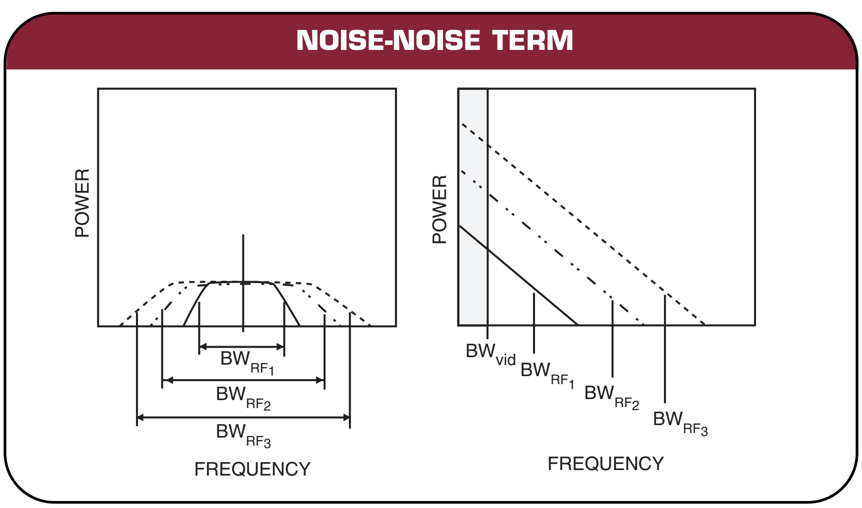

FIGURE 5

CONTRIBUTION OF DIFFERENT NOISE SOURCES

When we understand each noise source, obtain expressions of their noise power density [Equations (5) and (9)] and their noise power in the video bandwidth [Equations (6), (10) and (12)], we are able to compare the contribution of these noise sources and understand which of the noise sources dominates under different conditions.

The N&C term is the only one which is directly proportional to the input power level of the carrier. This means that at low input power levels, near TSS, the N&C term is insignificant. Therefore, at low power levels, only the N&N [Equation (10)] and the video amplifiers noise [Equation (12)] make significant contributions to the output noise power.

Since N&C term is directly proportional to the input power, there must be a level **(P_{Ccr})**, where these terms have equal contribution with the N&C term. Above **P_{Ccr}**, the N&C term will be dominant.

In comparing the three noise terms, the N&N terms contribution is very small (see NOTE 1) and may be disregarded for practicality. Therefore, **P_{Ccr}** occurs when the N&C term [Equation (6)] is equal to the video amplifiers noise term [Equation (12)] and can be calculated by the expression:

$$P_{Ccr} = 30 - 2G_{RF} - NF_{RF} + NF_{vid} - 20\log M \quad (14)$$

Critical input power is an important parameter, because noise dependence versus input power level changes significantly around this point.

To calculate the noise power at the output of the log amplifier, one has to go through a few transformations. We convert the noise power at the detector's output [Equations (6), (10) and (12)] into RMS voltages. We then multiply these voltages with the log video transfer function then transform back into power.

Upon completion we get the noise power of the log amplifier's output, in dBm, for each noise term.

For the video amplifier's noise term, which dominates when input power is less than the critical point:

$$P_{\substack{NoiseOut\\VidAmp}} = -95 + 10\log(Sl^2/R_{load}) + 10\log BW_{vid} + NF_{vid} - 20\log M - 2G_{RF} - 2P_C \quad (15)$$

Where:

Sl is the slope of the DLVA in mV/dB
R_{load} is the video amplifier's load resistor

The important feature of this equation is the rapid decline of noise power as a function of input power. This is due to the term of **$-2P_C$**.

For the N&C term, which dominates when input powers are above the critical point:

$$P_{\substack{NoiseOut\\N\&C}} = -125 + 10\log(Sl^2/R_{load}) + 10\log BW_{vid} + NF_{RF} - P_C \quad (16)$$

The important feature of this equation is a moderate decline of noise power as a function of input power. This is due to the term of **$-1P_C$**.

NOTE 1: This assumes that the RF system noise is insignificant. Usually the RF systems noise is greater than the video amplifier noise. Under this condition the N&C term and the N&N term will be most significant in the noise calculations.

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RECONSTRUCTION OF THE NOISE POWER OUTPUT VERSUS INPUT POWER DEPENDENCE

Plots of the output noise power versus input power for the ERDLVA with two detector stages are shown in Figures 6A and 6B. Figure 6A presents the results taken on an ERDLVA with a center frequency of 500 MHz, with an input dynamic range of -70 to 0 dBm. Figure 6B presents the results taken of an ERDLVA with a center frequency of 5.6 GHz with an input dynamic range of -54 to +16 dBm.

Both examples demonstrate the measured output noise power correlate with results of our calculations. The important thing is, that for the high power stage, the noise versus input power degradation exhibits a constant slope of -2 while the low power stage changes its slope. It is -2 at low power levels and -1 at higher input power levels. When the input signal level is within the operating range of the low power stage, the noise from the high power stage remains at the same high level and dominates over the noise of the low power stage.

LOW-NOISE ERDLVA DESIGN

Now that we understand all the sources of noise let us analyze the design of a low-noise DLVA.

One can see from Figure 6A and 6B that the high power stage makes a significant contribution in the total output noise magnitude even for input powers below this level. This being the case, to design a low-noise DLVA, we must suppress the noise from the high power stage over the input dynamic range of the low power stage. By doing this we only utilize the low noise portion of the high power stage.

Figure 7 presents the measured results of the DLVAs noise performance under the following conditions:

- The performance of a standard ERDLVA.
- The noise performance of the low power stage when the high power stage is disconnected.
- The noise performance of the low power stage shifted into the range of the high power stage while the high power stage is disconnected.

The noise reduction then becomes apparent. The only drawback of this approach is a substantial reduction in input dynamic range of the analog output. However, we have developed a technique that would allow the restoration of the entire input dynamic range. This technique substantially improves processing speed and accuracy due to the aforementioned noise reduction.

We have applied this approach of noise reduction to an ERDLVA with a center frequency of 5.6 GHz and an input dynamic range of -54 to +16 dBm. The results are shown in Figure 8. The first two plots in Figure 8 present the log accuracy measured at the digital output over temperature, after digital error correction. The last graph presents the RMS error of the digital output, which is directly related to the noise of the analog portion. This RMS error was calculated on the basis of 400 samples for each 0.2 dB of input dynamic range. It becomes apparent from this plot that logarithmic error reduces to less than ±0.25 dB and that three times the RMS error is less than ±0.2 dB. Successful usage of digital error correction is possible only due to the substantial suppression of the RMS noise level. A different approach to suppress the noise is using additional filtering. This can be done using either analog or digital techniques. However, additional filtering means narrower video bandwidth, which leads to increased settling time thereby increasing the minimum pulse width, which can be accurately measured.

MITEQ has overcome this limitation and offers an ERDLVA, which measures pulses as narrow as 250 ns, with an accuracy of ±0.25 dB over 70 dB of input dynamic range.

LOW-NOISE ERDLVA DESIGN TYPICAL TEST DATA

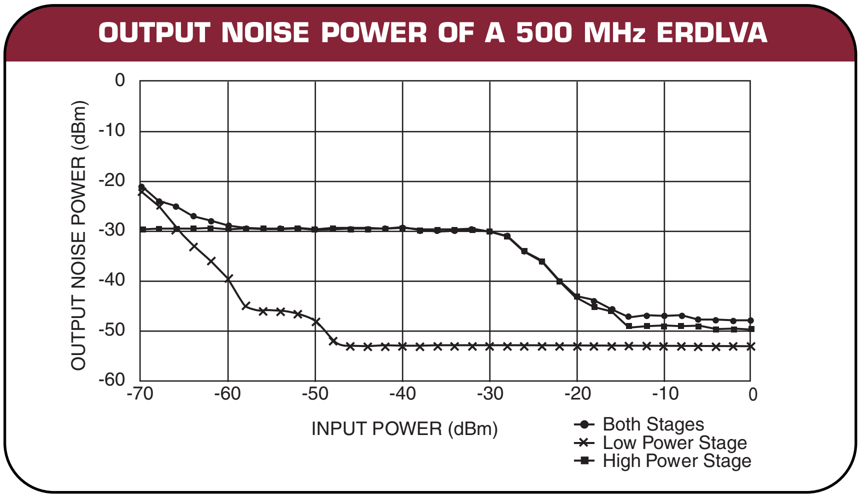

FIGURE 6A

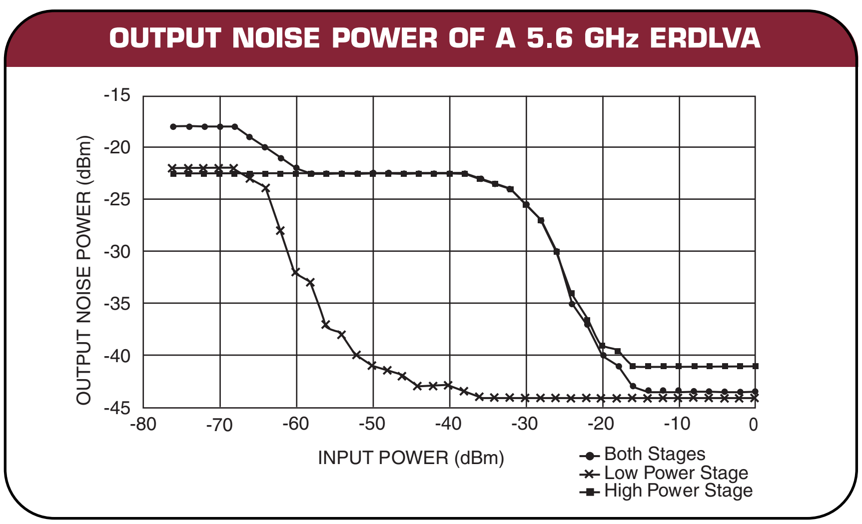

FIGURE 6B

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IF Signal 2010
C-17C

LOW-NOISE ERDLVA DESIGN TYPICAL TEST DATA (CONT.)

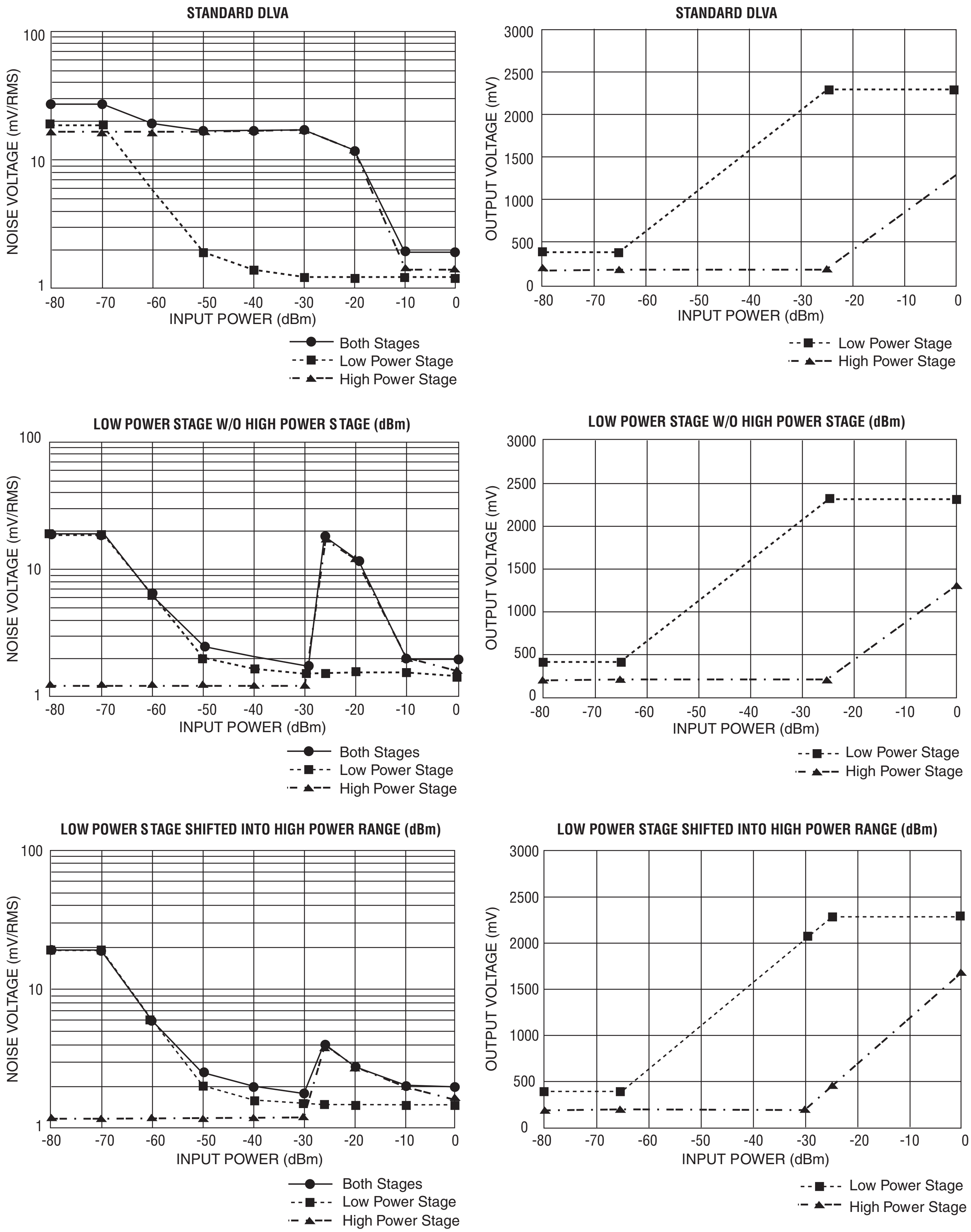

FIGURE 7

DIGITAL ERDLVA DESIGN TYPICAL TEST DATA

MODEL NO. FBDL-5.4/5.9-70
SERIAL NO. 489150

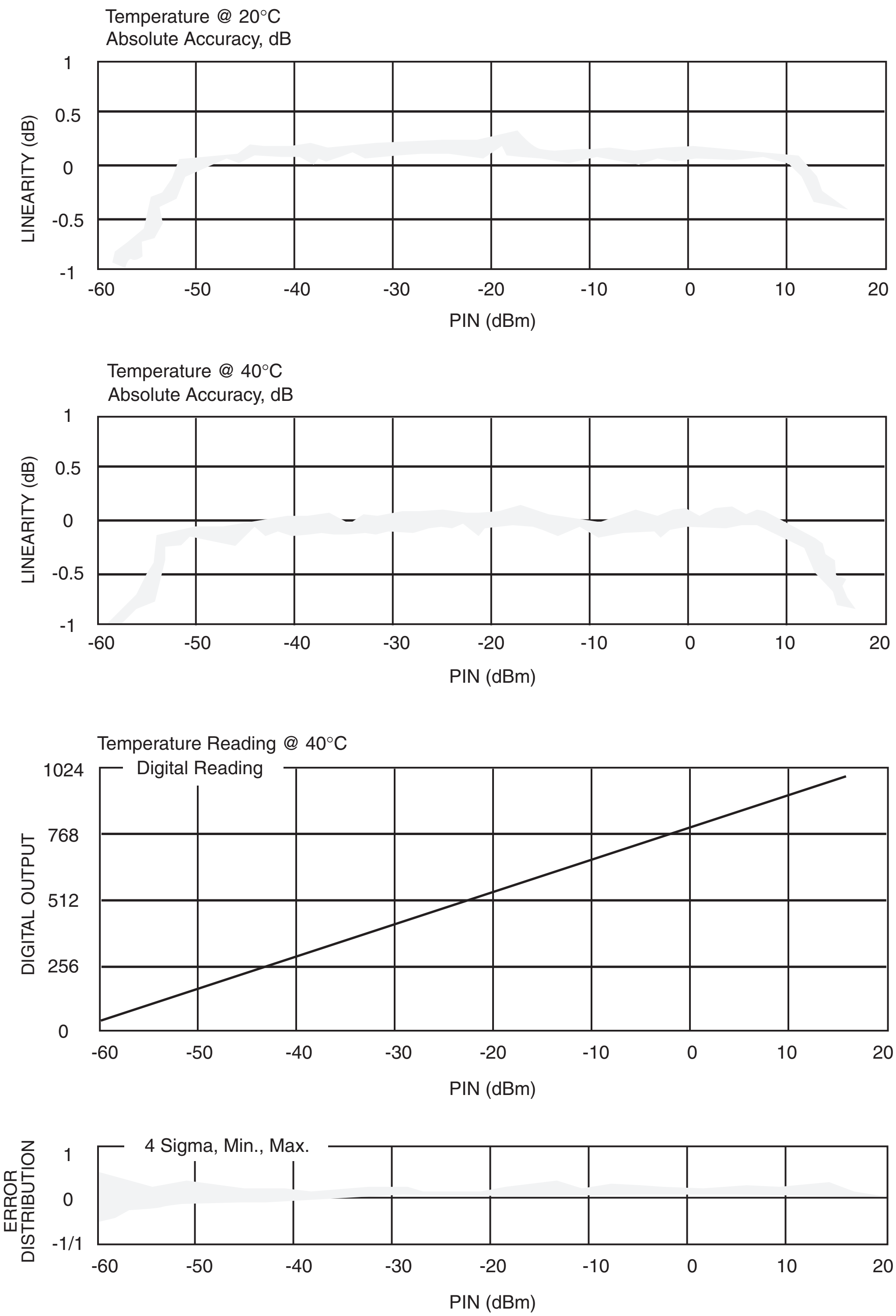

FIGURE 8

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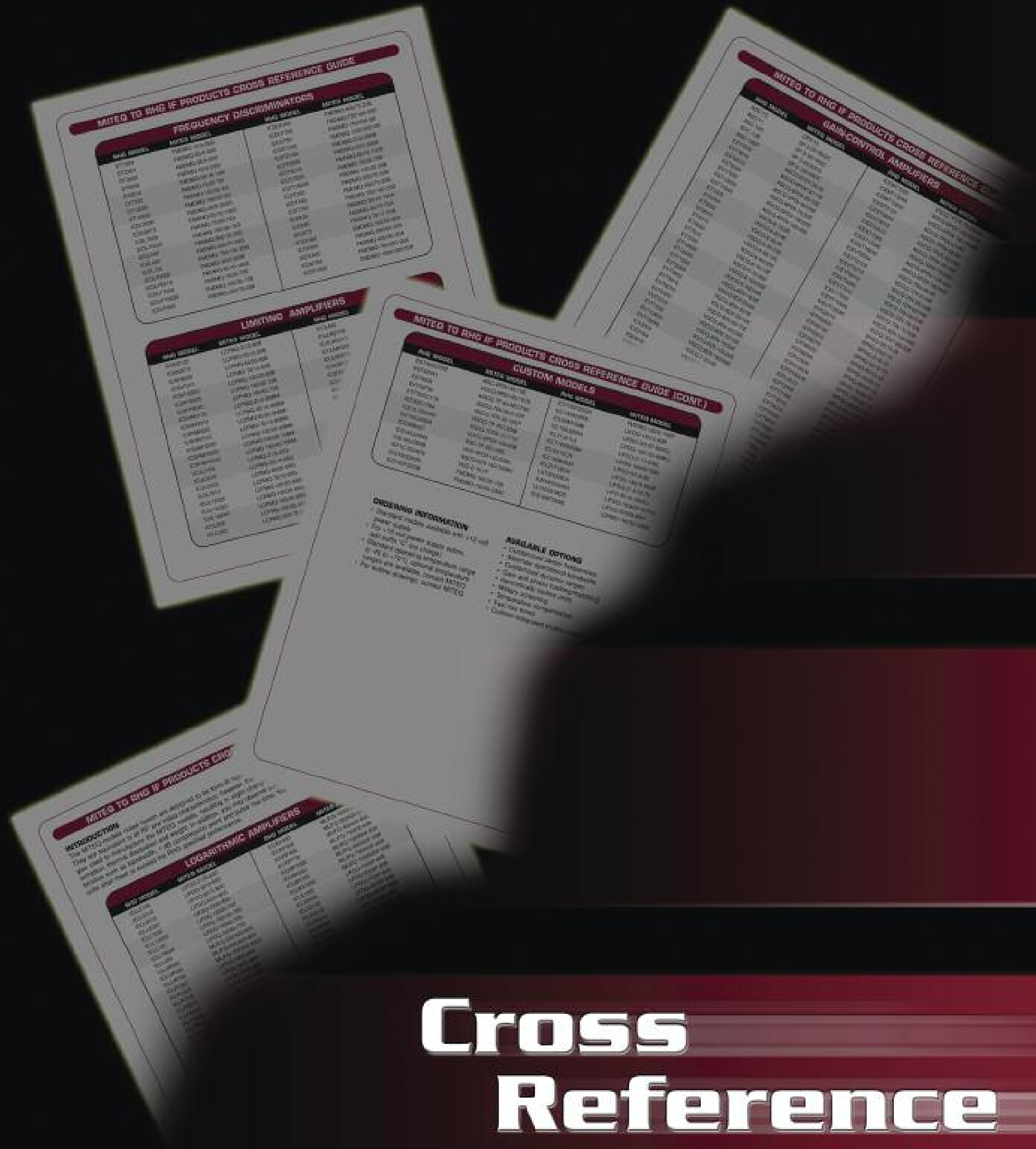

Cross Reference Guide

MITEQ TO RHG IF PRODUCTS CROSS REFERENCE GUIDE

INTRODUCTION

The MITEQ models noted herein are designed to be form-fit replacements of the referenced RHG counterparts. They are equivalent in all RF and video characteristics; however, there may be some differences in the technologies used to manufacture the MITEQ models, resulting in slight changes in parameters such as DC power consumption, thermal dissipation and weight. In addition, you may observe subtle improvements in operating characteristics such as bandwidth, 1 dB compression point and pulse rise time. You should be assured that the MITEQ units shall meet or exceed the RHG specified performance.

LOGARITHMIC AMPLIFIERS

RHG MODEL	MITEQ MODEL	RHG MODEL	MITEQ MODEL
ICLL2105	LIFDQ-2105-80D	ICLW1000	MLIFQ-1000500-60B
ICLL3010	LIFDQ-3010-80D	ICLWP300	MLIFQ-300400-60K
ICLL6010	LIFDQ-6010-80D	ICLWP400	MLIFQ-400400-60K
ICLL6020	LIFDQ-6020-80D	ICLWP750	MLIFQ-750500-60K
ICLL7030	LIFDQ-7030-80D	ICLWP1000	MLIFQ-1000500-60K
ICLL12020	LIFDQ-12020-70D	ICLWX450	MLIFQ-450500F-60B
ICLL150	LIFDQ-150100-70D	ICLWX750	MLIFQ-750500F-60B
ICLL16040	LIFDQ-16040-70D	ICLWX1000	MLIFQ-1000500F-60B
ICLL200	LIFDQ-20050-70D	ICLX1002	LIFDQ-1002P-80B
ICLLW300	MLIFQ-300/400-60D	ICLX2005	LIFDQ-2005P-80B
ICLLW400	MLIFQ-400/400-60D	ICLX2105	LIFDQ-2105P-80B
ICLLW750	MLIFQ-750/500-60DC	ICLX3010	LIFDQ-3010P-80B
ICLP1002	LIFDQ-1002-80K	ICLX6010	LIFDQ-6010P-80B
ICLP2005	LIFDQ-2005-80K	ICLX6020	LIFD-6020P-80B
ICLP2105	LIFDQ-2105-80K	ICLX7010	LIFDQ-7010P-80B
ICLP3010	LIFDQ-3010-80K	ICLX7030	LIFDQ-7030P-80B
ICLP6010	LIFDQ-6010-80K	ICLX12020	LIFDQ-12020P-70B
ICLP6020	LIFDQ-6020-80K	ICLX16020	LIFDQ-16020P-70B
ICLP7010	LIFDQ-7010-80K	ICLX16040	LIFDQ-16040P-70B
ICLP12020	LIFDQ-12020-70K	ICLX200	LIFDQ-20050P-70B
ICLP16020	LIFDQ-16020-70K	ILM3010	LIFDQ-3010-80F
ICLP16040	LIFDQ-16040-70K	ILM6020	LIFDQ-6020-80F
ICLP20050	LIFDQ-20050-70K	ILM7030	LIFDQ-7030-80F
ICLT1002	LIFDQ-1002-80B	ILM12020	LIFDQ-12020-70F
ICLT2005	LIFDQ-2005-80B	ILM16040	LIFDQ-16040-70F
ICLT2105	LIFDQ-2105-80B	ILM200	LIFDQ-20050-70F
ICLT3010	LIFDQ-3010-80B	LLT1003	LIFDQ-1003-80H
ICLT6010	LIFDQ-6010-80B	LLT2005	LIFDQ-2005-80H
ICLT6020	LIFDQ-6020-80B	LLT3002	LIFDQ-3002-80H
ICLT7010	LIFDQ-7010-80B	LLT3010	LIFDQ-3010-80H
ICLT7030	LIFDQ-7030-80B	LLT6010	LIFDQ-6010-80H
ICLT12020	LIFDQ-12020-70B	LLT6020	LIFDQ-6020-80H
ICLT16020	LIFDQ-16020-70B	LLT7010	LIFDQ-7010-80H
ICLT16040	LIFDQ-16040-70B	LST1003	LIFDQ-1003-80I
ICLT150B	LIFDQ-150100-70GL	LST2005	LIFDQ-2005-80I
ICLT200	LIFDQ-20050-70B	LST3002	LIFDQ-3002-80I
ICLT300B	LIFDQ-300200-60GL	LST3010	LIFDQ-3010-80I
ICLT375B	LIFDQ-375250-60GL	LST6010	LIFDQ-6010-80I
ICLT450B	MLIFQ-450300-60GL	LST6020	LIFDQ-6020-80I
ICLT475BC	MLIFQ-475150-60GL	LST7010	LIFDQ-7010-80I
ICLT625B	MLIFQ-625150-60GL	ML2105	LIFDQ-2105-70C
ICLT775B	MLIFQ-775150-60GL	ML3010	LIFDQ-3010-70C
ICLT925B	MLIFQ-925150-60GL	ML6010	LIFDQ-6010-70C
ICLT1000B	MLIFQ-1000100-60GL	ML6020	LIFDQ-6020-70C
ICLW300	MLIFQ-300400-65B	ML7010	LIFDQ-7010-70C
ICLW400	MLIFQ-400400-60B	ML12020	LIFDQ-12020-60C
ICLW750	MLIFQ-750500-60B	ML16040	LIFDQ-16040-60C

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FREQUENCY DISCRIMINATORS

RHG MODEL	MITEQ MODEL	RHG MODEL	MITEQ MODEL
DT1004	FMDMQ-10/4-250I	ICDLP400	FMDMQ-400/70-20E
DT2004	FMDMQ-20/4-250I	ICDLP750	FMDMQ-750/150-20E
DT3006	FMDMQ-30/6-200I	ICDS750	FMDMQ-750/250-5B
DT6006	FMDMQ-60/6-200I	ICDS1000	FMDMQ-1000/300-5B
DT6016	FMDMQ-60/16-100I	ICDT2104	FMDMQ-21/4-250B
DT7020	FMDMQ-70/20-70I	ICDT3006	FMDMQ-30/6-200B
DT13035	FMDMQ-130/35-30I	ICDT6016	FMDMQ-60/16-100B
DT16035	FMDMQ-160/35-30I	ICDT7020	FMDMQ-70/20-70B
ICDL3006	FMDMQ-30/6-200G	ICDT16035	FMDMQ-160/35-30B
ICDL6016	FMDMQ-60/16-100G	ICDT300	FMDMQ-300/70-20B
ICDL7020	FMDMQ-70/20-70G	ICDT450	FMDMQ-450/70-20B
ICDL16035	FMDMQ-160/35-15G	ICDT750	FMDMQ-750/150-20B
ICDL300	FMDMQ-300/70-20G	ICDX30	FMDMQ-30/10-150A
ICDL400	FMDMQ-400/70-20G	ICDX60	FMDMQ-60/15-70A
ICDL750	FMDMQ-750/150-20G	ICDX70	FMDMQ-70/17-70A
ICDLP3006	FMDMQ-30/6-200E	ICDX160	FMDMQ-160/50-30A
ICDLP6016	FMDMQ-60/16-100E	ICDX300	FMDMQ-300/60-20A
ICDLP7020	FMDMQ-70/20-70E	ICDX400	FMDMQ-400/90-20A
ICDLP16035	FMDMQ-160/35-15E	ICDX750	FMDMQ-750/250-20A
ICDLP300	FMDMQ-300/70-20E	ICDX1000	FMDMQ-1000/300-20A

LIMITING AMPLIFIERS

RHG MODEL	MITEQ MODEL	RHG MODEL	MITEQ MODEL
ICSH2105	LCPMQ-21/5-80B	ICUL400	LCPMQ-400/100-55G
ICSH3010	LCPMQ-30/10-80B	ICULM2105	LCPMQ-21/5-65GM-
ICSH6020	LCPMQ-60/20-80B	ICULM3010	LCPMQ-30/10-65GM-
ICSH7010	LCPMQ-70/10-80B	ICULM6020	LCPMQ-60/20-65GM-
ICSH12020	LCPMQ-120/20-80B	ICULM7010	LCPMQ-70/10-65GM-
ICSH16020	LCPMQ-160/20-70B	ICULM12020	LCPMQ-120/20-65GM-
ICSH16040	LCPMQ-160/40-70B	ICULM16020	LCPMQ-160/20-65GM-
ICSHM2105	LCPMQ-21/5-80BM-	ICULM16040	LCPMQ-160/40-65GM-
ICSHM3010	LCPMQ-30/10-80BM-	ICULM200	LCPMQ-200/50-55GM-
ICSHM6020	LCPMQ-60/20-80BM-	ICULM300	LCPMQ-300/75-55GM-
ICSHM7010	LCPMQ-70/10-80BM-	ICULM400	LCPMQ-400/100-55GM-
ICSHM12020	LCPMQ-120/20-80BM-	ISM3010	LCPMQ-30/10-65D
ICSHM16020	LCPMQ-160/20-70BM-	ISM6010	LCPMQ-60/10-65D
ICSHM16040	LCPMQ-160/40-70BM-	ISM6020	LCPMQ-60/20-65D
ICUL2105	LCPMQ-21/5-65G	ISM7010	LCPMQ-70/10-65D
ICUL3010	LCPMQ-30/10-65G	ISM16020	LCPMQ-160/20-65D
ICUL6020	LCPMQ-60/20-65G	ISM16040	LCPMQ-160/40-65D
ICUL7010	LCPMQ-70/10-65G	ISMP3010	LCPMQ-30/10-65E
ICUL12020	LCPMQ-120/20-65G	ISMP6010	LCPMQ-60/10-65E
ICUL16020	LCPMQ-160/20-65G	ISMP6020	LCPMQ-60/20-65E
ICUL16040	LCPMQ-160/40-65G	ISMP7010	LCPMQ-70/10-65E
ICUL200	LCPMQ-200/50-55G	ISMP16020	LCPMQ-160/20-65E
ICUL300	LCPMQ-300/75-55G	ISMP16040	LCPMQ-160/40-65E

MITEQ TO RHG IF PRODUCTS CROSS REFERENCE GUIDE (CONT.)

GAIN-CONTROL AMPLIFIERS

RHG MODEL	MITEQ MODEL	RHG MODEL	MITEQ MODEL
AGC/10	DRV/10	ICEMT7020	VGCQ-7PDV-70/20DM-
AGC/11	SP-2-30160GC	ICEMT12040	VGCQ-6PDV-120/40DM-
AGC-12C	SP-3-30/10GC	ICEMT16040	VGCQ-6PDV-160/40DM-
AGC-12B	SP-3-60/20GC	ICEST2104	AGCQ-7PDV-21/4D
AGC-12EF	SP-3-160/40GC	ICEST3004	AGCQ-7PDV-30/4D
EST3002	AGCQ-8PDV-30/2E	ICEST3010	AGCQ-7PDV-30/10D
EST3010	AGCQ-8PDV-30/10E	ICEST6010	AGCQ-7PDV-60/10D
EST6010	AGCQ-8PDV-60/10E	ICEST7020	AGCQ-7PDV-70/20D
EST6020	AGCQ-8PDV-60/20E	ICEST12040	AGCQ-6PDV-120/40D
EST7030	AGCQ-6PDV-70/30E	ICEST16040	AGCQ-6PDV-160/40D
EST12020	AGCQ-6PDV-120/20E	ICEVT2004	VGCQ-7DV-20/4B
EST16040	AGCQ-6PDV-160/40E	ICEVT2104	VGCQ-7DV-21/4B
ET1002	VGCQ-8-10/2E	ICEVT3010	VGCQ-7DV-30/10B
ET2004	VGCQ-8-20/4E	ICEVT6010	VGCQ-7DV-60/10B
ET3002	VGCQ-8-30/2E	ICEVT6020	VGCQ-7DV-60/20B
ET3010	VGCQ-8-30/10E	ICEVT7010	VGCQ-7DV-70/10B
ET6010	VGCQ-8-60/10E	ICEVT7030	VGCQ-7DV-70/30B
ET6020	VGCQ-8-60/20E	ICEVT12040	VGCQ-6DV-120/40B
ET7010	VGCQ-8-70/10E	ICEVT16040	VGCQ-7DV-160/40B
ET7030	VGCQ-6-70/30E	ICFG3010	SPGQ-30/10-20
ET12020	VGCQ-6-120/20E	ICFH2006	SPHQ-20/6-15
ET16040	VGCQ-6-160/40E	ICFH2106	SPHQ-21/6-15
EVT1002	VGCQ-8DV-10/2E	ICFH3010	SPHQ-30/10-15
EVT2004	VGCQ-8DV-20/4E	ICFH6010	SPHQ-60/10-15
EVT3002	VGCQ-8DV-30/2E	ICFH6020	SPHQ-60/20-15
EVT3010	VGCQ-8DV-30/10E	ICFH6040	SPHQ-60/40-15
EVT6010	VGCQ-8DV-60/10E	ICFH7030	SPHQ-70/30-15
EVT6020	VGCQ-8DV-60/20E	ICFH120LN	SPHQ-120/40-13
EVT7010	VGCQ-8DV-70/10E	ICFH160LN	SPHQ-160/50-13
EVT7030	VGCQ-6DV-70/30E	ICFL3010	SPLQ-30/10-0LN
EVT12020	VGCQ-6DV-120/20E	ICFT2006	SPTQ-20/6
EVT16040	VGCQ-6DV-160/40E	ICFT2106	SPTQ-21/6
ICE2004	VGCQ-7-20/4B	ICFT3010	SPTQ-30/10
ICE2104	VGCQ-7-21/4B	ICFT6010	SPTQ-60/10
ICE3010	VGCQ-7-30/10B	ICFT6020	SPTQ-60/20
ICE6010	VGCQ-7-60/10B	ICFT6040	SPTQ-60/40
ICE6020	VGCQ-7-60/20B	ICFT7030	SPTQ-70/30
ICE7010	VGCQ-7-70/10B	ICFT12040	SPTQ-120/40
ICE7030	VGCQ-7-70/30B	ICFT16050	SPTQ-160/50
ICE12040	VGCQ-6-120/40B	ICFT300	SPTQ-145/290
ICE16040	VGCQ-6-160/40B	CFV2006	VGCQ-2SP-20/6F
ICEGT2104	VGCQ-7PDV-21/4D	ICFV2106	VGCQ-2SP-21/6F
ICEGT3004	VGCQ-7PDV-30/4D	ICFV3010	VGCQ-2SP-30/10F
ICEGT3010	VGCQ-7PDV-30/10D	ICFV6010	VGCQ-2SP-60/10F
ICEGT6010	VGCQ-7PDV-60/10D	ICFV6020	VGCQ-2SP-60/20F
ICEGT6020	VGCQ-7PDV-60/20D	ICFV6040	VGCQ-2SP-60/40F
ICEGT7020	VGCQ-7PDV-70/20D	ICFV7030	VGCQ-2SP-70/30F
ICEGT12040	VGCQ-6PDV-120/40D	ICFV12040	VGCQ-2SP-120/40F
ICEGT16040	VGCQ-6PDV-160/40D	ICFV16060	VGCQ-2SP-160/60F
ICEMT2104	VGCQ-7PDV-21/4DM-	ICXT2205	AGCQ-7PDV-22/5SP
ICEMT3004	VGCQ-7PDV-30/4DM-	ICXT3005	AGCQ-7PDV-30/5SP
ICEMT3010	VGCQ-7PDV-30/10DM-	ICXT3010	AGCQ-7PDV-30/10SP
ICEMT6010	VGCQ-7PDV-60/10DM-	ICXT6010	AGCQ-7PDV-60/10SP
ICEMT6020	VGCQ-7PDV-60/20DM-	ICXT6020	AGCQ-7PDV-60/20SP

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MITEQ TO RHG IF PRODUCTS CROSS REFERENCE GUIDE (CONT.)

CUSTOM MODELS

RHG MODEL	MITEQ MODEL	RHG MODEL	MITEQ MODEL
EST40A22DB	AGC-6PDV-40/10E	ICD160F22GA	FMDMQ-160/5-15BC
EST60V41	VGCQ-8PDV-60/10TR	ICL145A20RA	LIFDQ-14510-80B
EST4004	AGCQ-7P-40/4ECTNC	ICL30M15MB	LIFDQ-3010P-80KCL
EVT35F89	AGCQ-7DV-35/3.4SP	ICL160J25NA	LIFDQ-160100-80BCL
EVT35CC17A	AGCQ-7DV-35/10SP	ICL21J21LA	LIFDQ-2110-80BL
ICE30C17BH	VGCQ-7P-30/12GM	ICLT160G20BK	LIFDQ-16040-70BL
ICE10.7D04RV	VGCQ-7PDV-10.7/1D	ICL5G10CH	LIFDQ-5/0.8-90
ICE160J05DA	VGCQ-6PDV-160/40B	ICL145B28JA	LIFDQ-14510-080B
ICE30BH27	VGC-7P-30/10BC	ICL21F18CH	LIFDQ-21.4/10-70
ICE160J26NA	VGC-6PDV-160/50BC	LST30D09EA	LIFD-30/10-080ICL
ICE160J25NB	VGCQ-6DV-160/100BC	ILM160C02NA	LIFDQ-16040P-070FC
ICF10.7D04RV	VGC-2-10/1F	LLT6020/MOD	LIFDQ-6020S-80H
ICD160G20BL	FMDMQ-160/35-15B	ICS160F09GB	LCPMQ-160/50-65BC
ICD160F22GB	FMDMQ-160/50-25AC		

ORDERING INFORMATION

- Standard models available with +12 volt power supply
- For +15 volt power supply option, add suffix “C” (no charge)
- Standard operating temperature range is -40 to +70°C, optional temperature ranges are available, contact MITEQ
- For outline drawings, contact MITEQ

AVAILABLE OPTIONS

- Customized center frequencies
- Alternate operational bandwidth
- Customized dynamic ranges
- Gain and phase tracking/matching
- Hermetically-sealed units
- Military screening
- Temperature compensation
- Fast rise times
- Custom-integrated multifunction units

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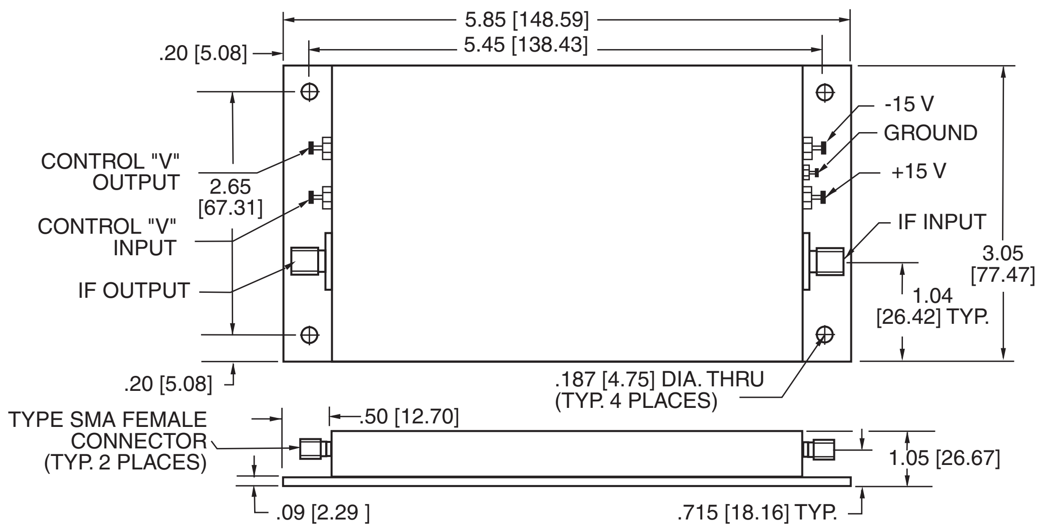
Outline
Drawings

OUTLINE DRAWINGS

113125



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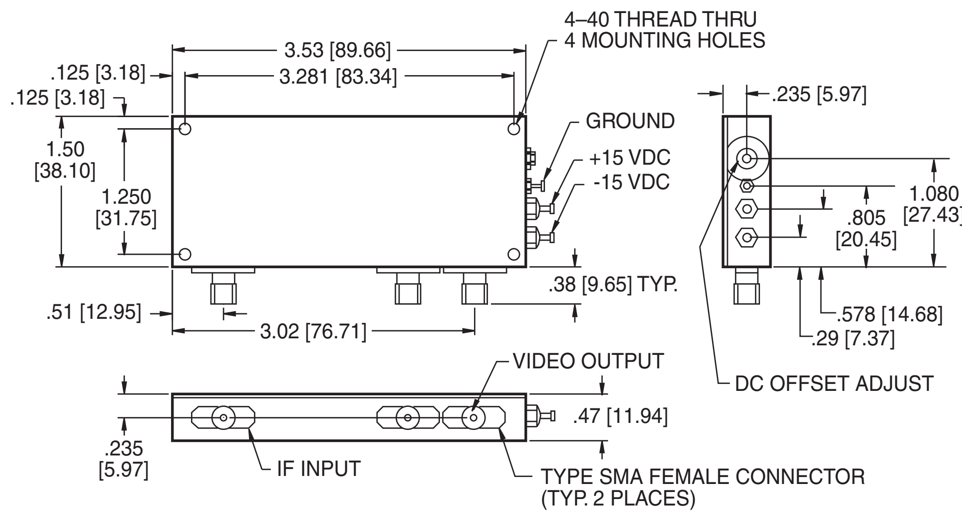

NOTE: DIMENSIONS SHOWN IN BRACKETS [ ] ARE IN MILLIMETERS.

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OUTLINE DRAWINGS (CONT.)

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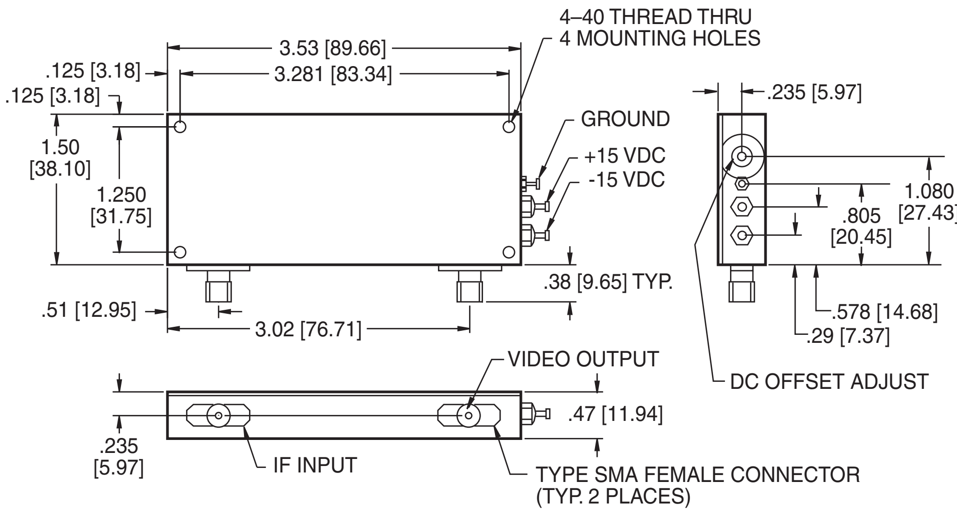

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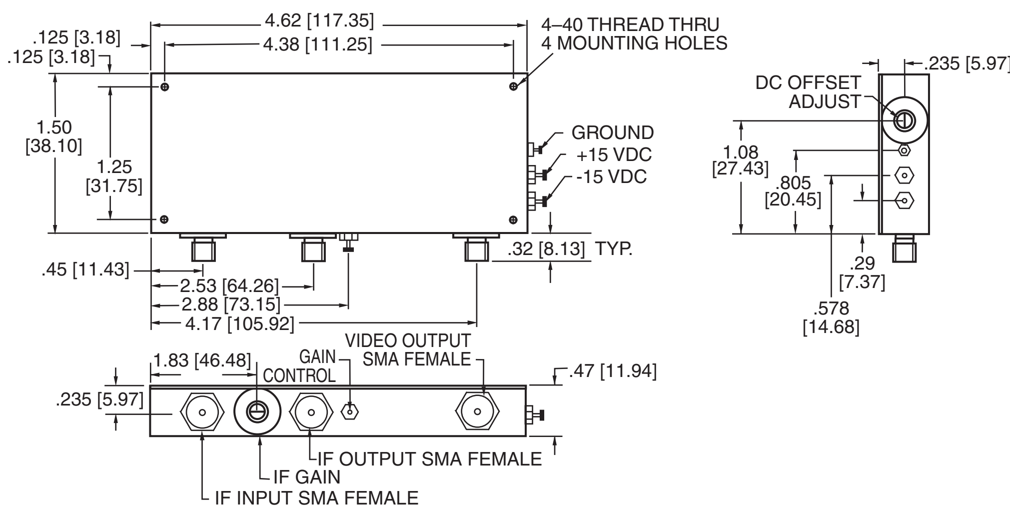

NOTE: DIMENSIONS SHOWN IN BRACKETS [ ] ARE IN MILLIMETERS.

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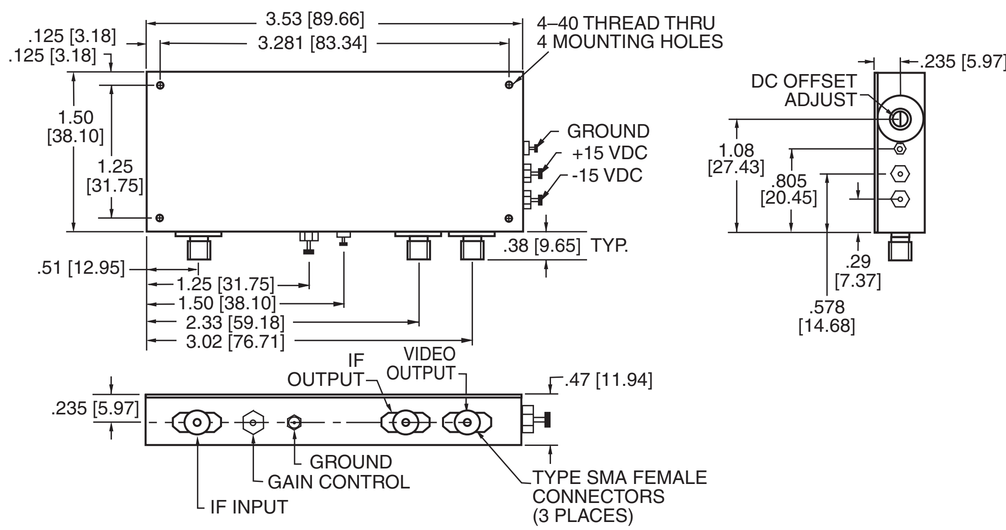
120391



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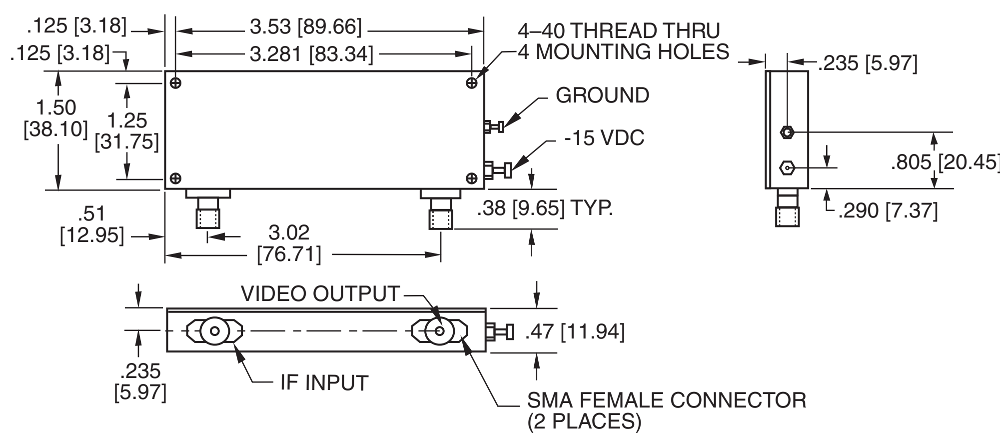

NOTE: DIMENSIONS SHOWN IN BRACKETS [ ] ARE IN MILLIMETERS.

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OUTLINE DRAWINGS (CONT.)

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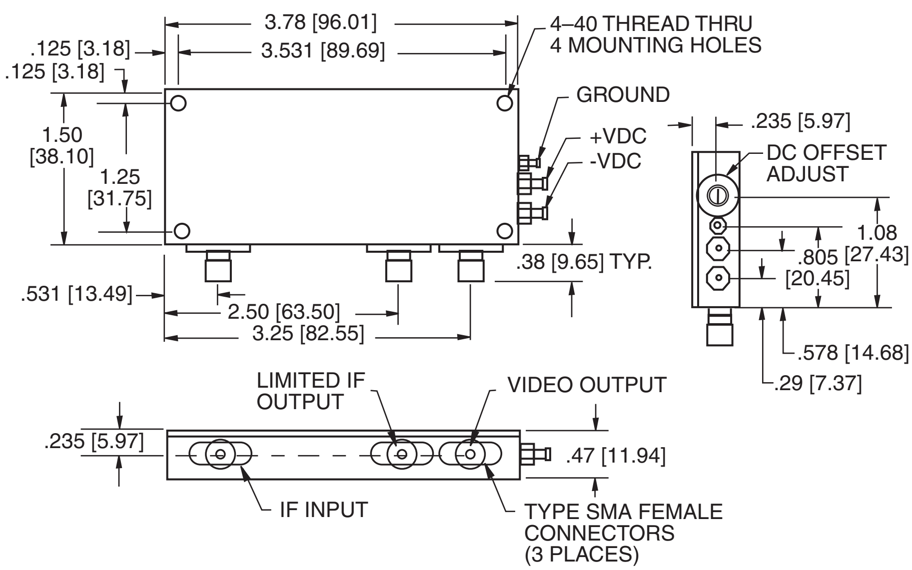

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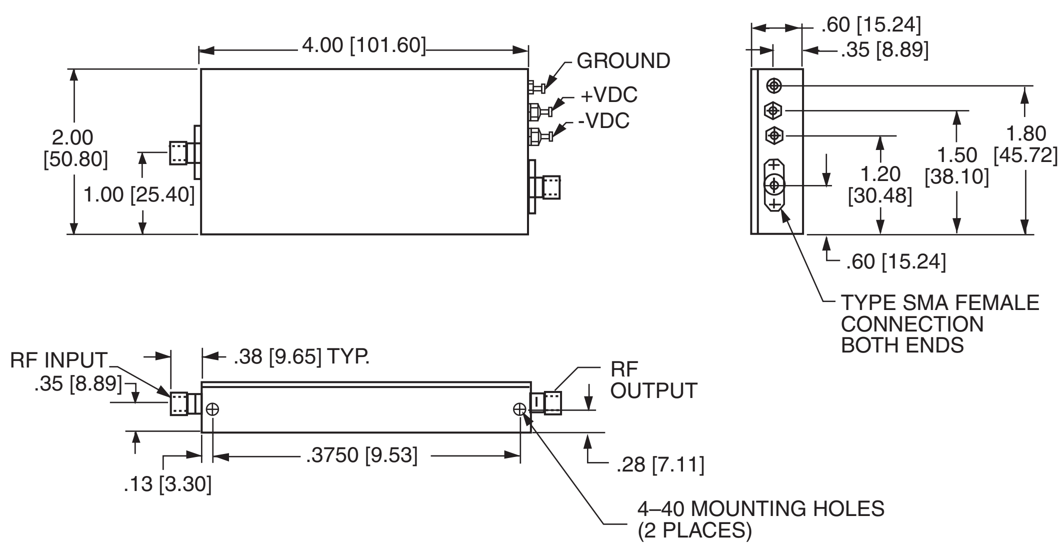

NOTE: DIMENSIONS SHOWN IN BRACKETS [ ] ARE IN MILLIMETERS.

OUTLINE DRAWINGS (CONT.)

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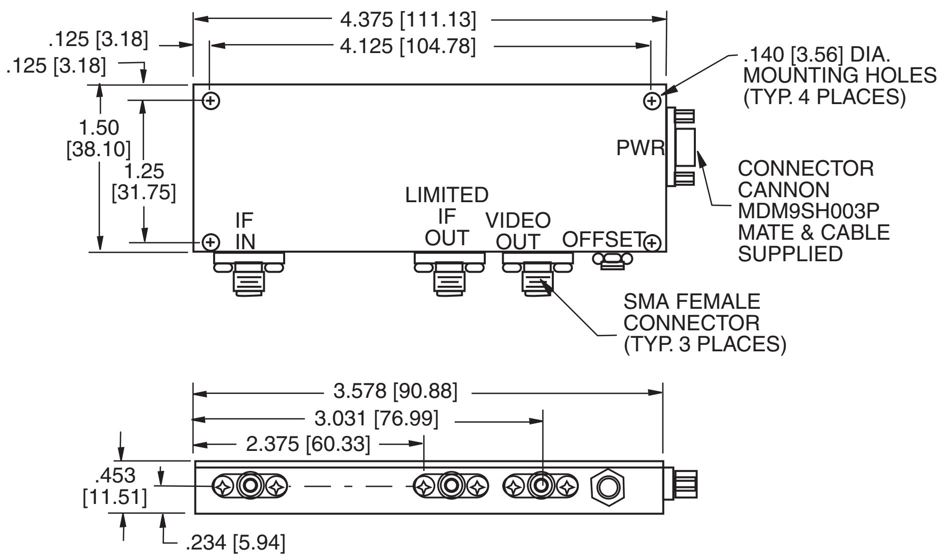
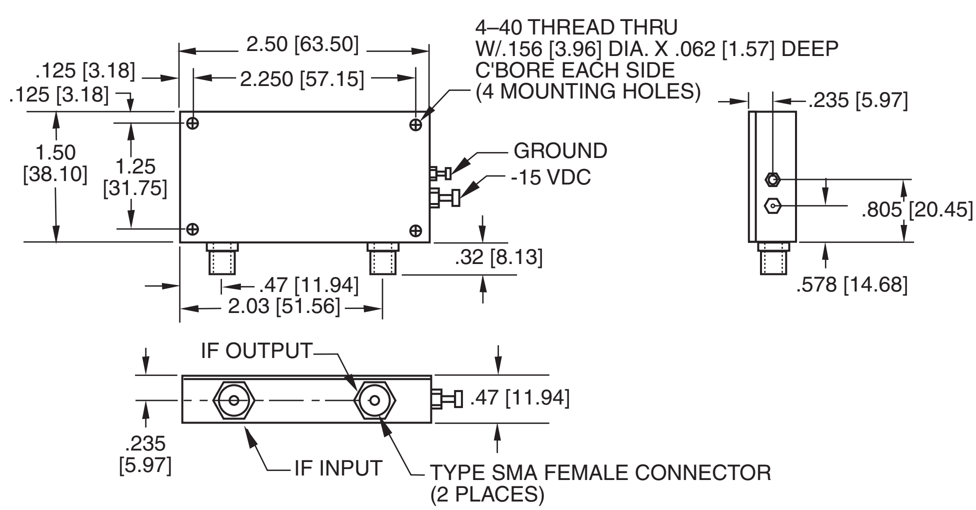


* ABOVE DRAWING INCLUDES LIMITED IF OUTPUT (OPTIONAL).

121954



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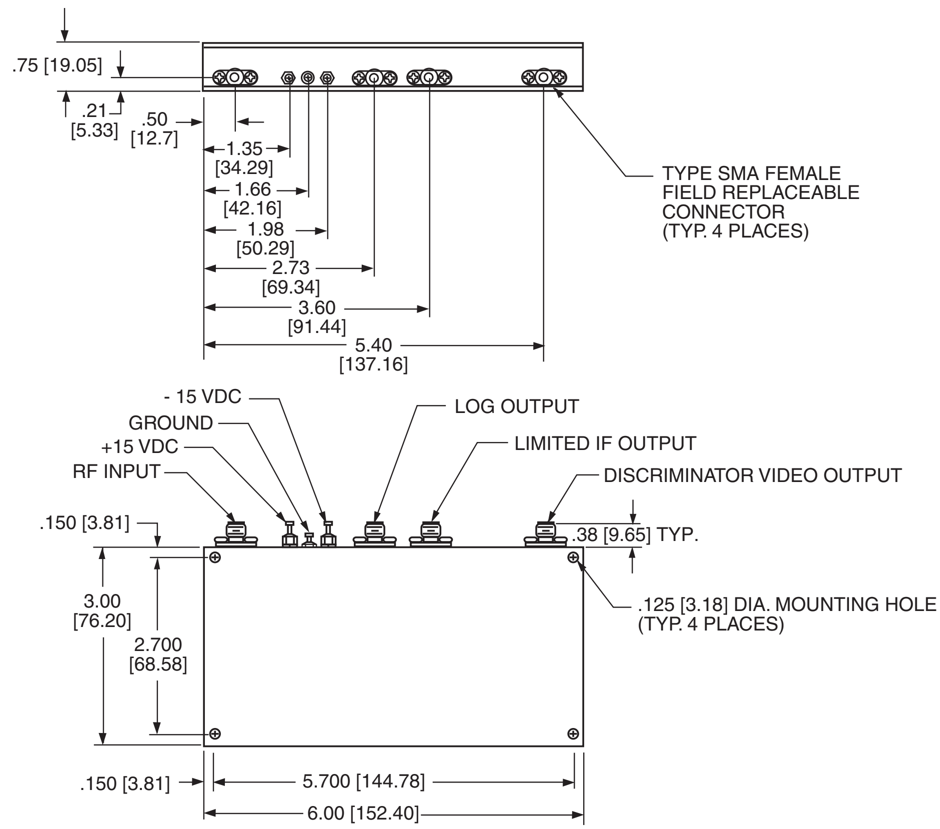
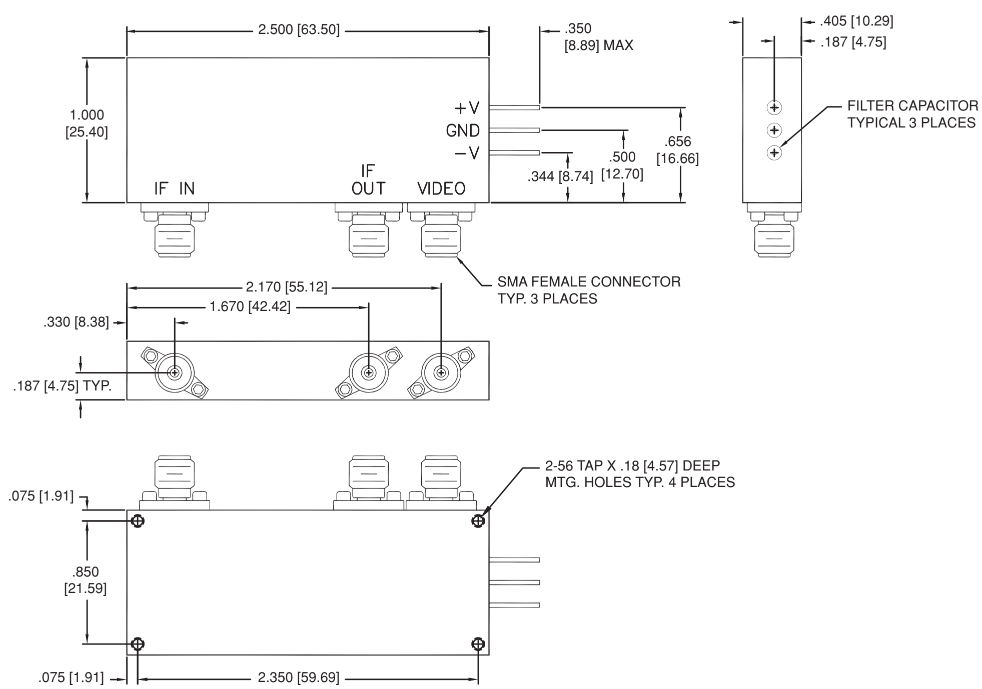
OUTLINE DRAWINGS (CONT.)

122045



123115



NOTE: DIMENSIONS SHOWN IN BRACKETS [ ] ARE IN MILLIMETERS.

OUTLINE DRAWINGS (CONT.)

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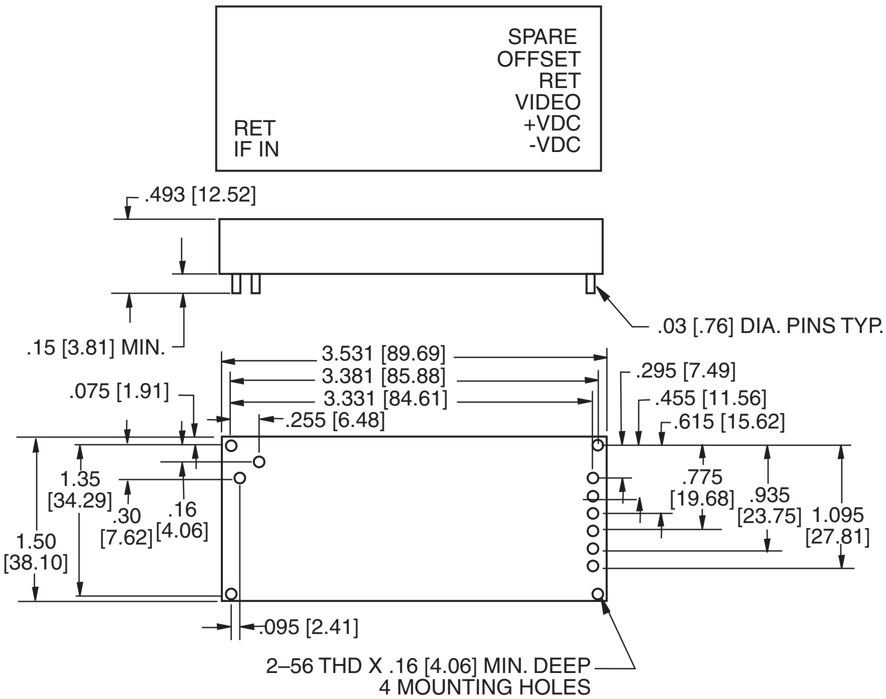

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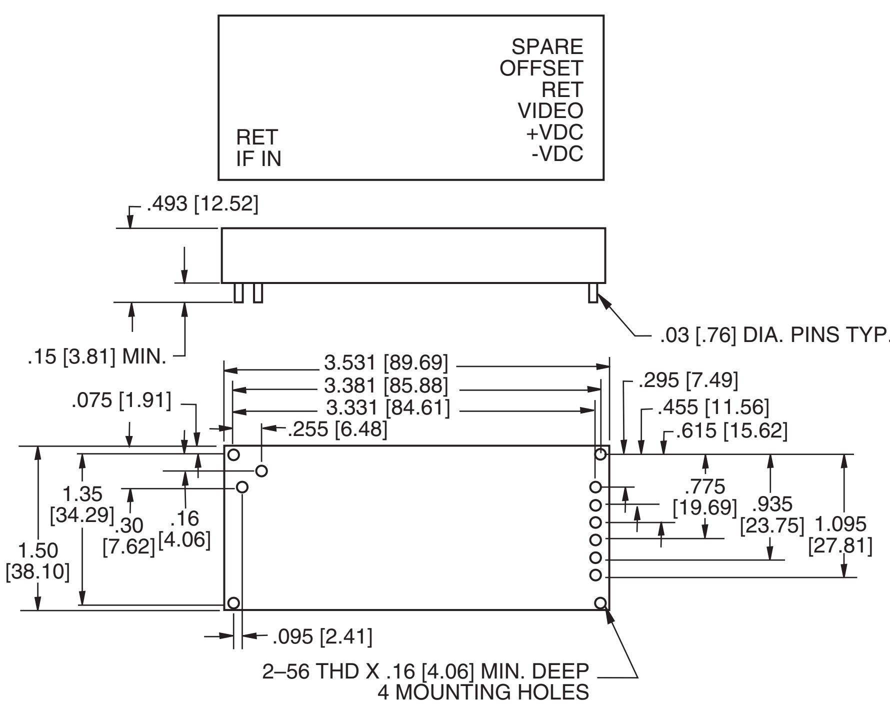

NOTE: DIMENSIONS SHOWN IN BRACKETS [ ] ARE IN MILLIMETERS.

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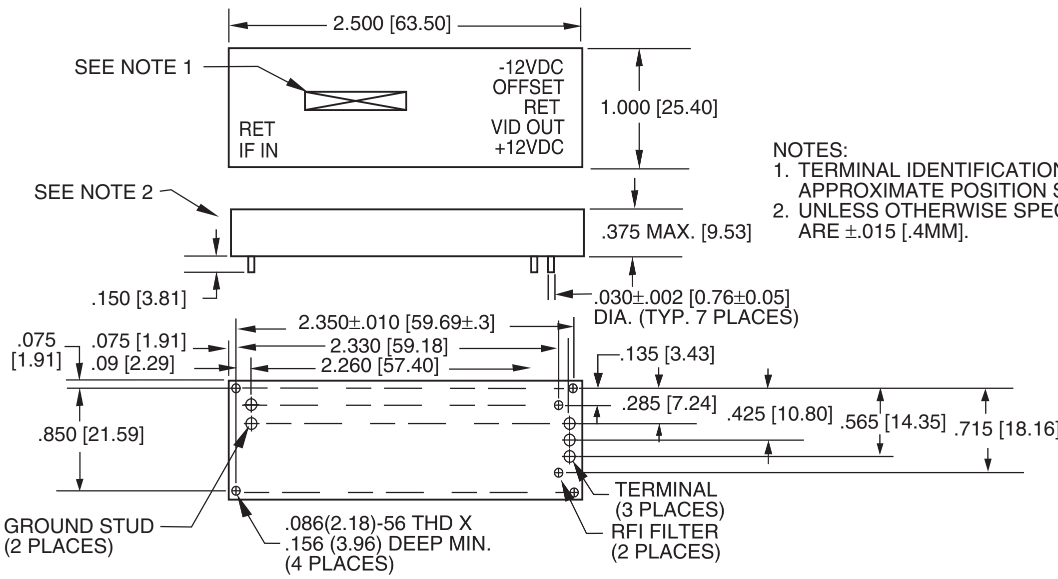
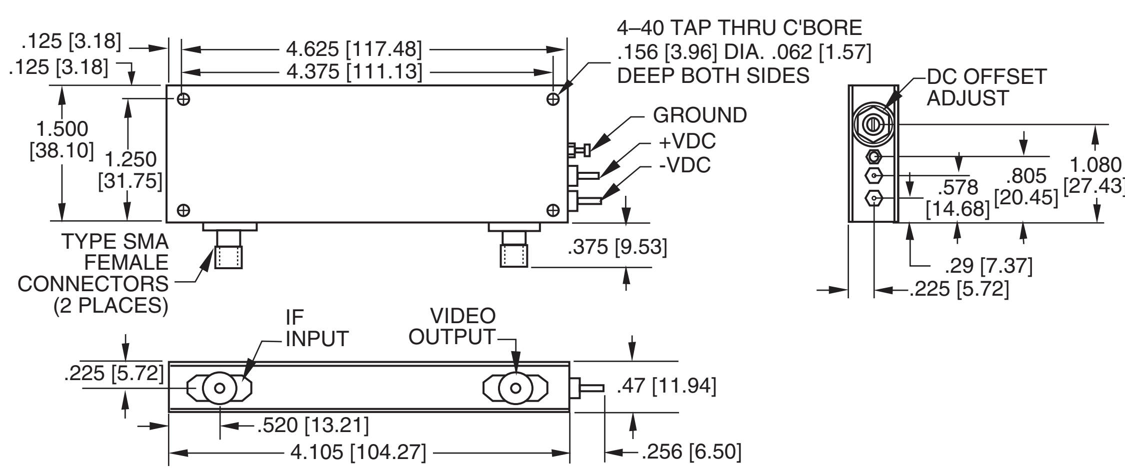
OUTLINE DRAWINGS (CONT.)

124280



NOTES:
1. TERMINAL IDENTIFICATION SHALL BE MARKED IN APPROXIMATE POSITION SHOWN.
2. UNLESS OTHERWISE SPECIFIED, ALL DIMENSIONS ARE ±.015 [.4MM].

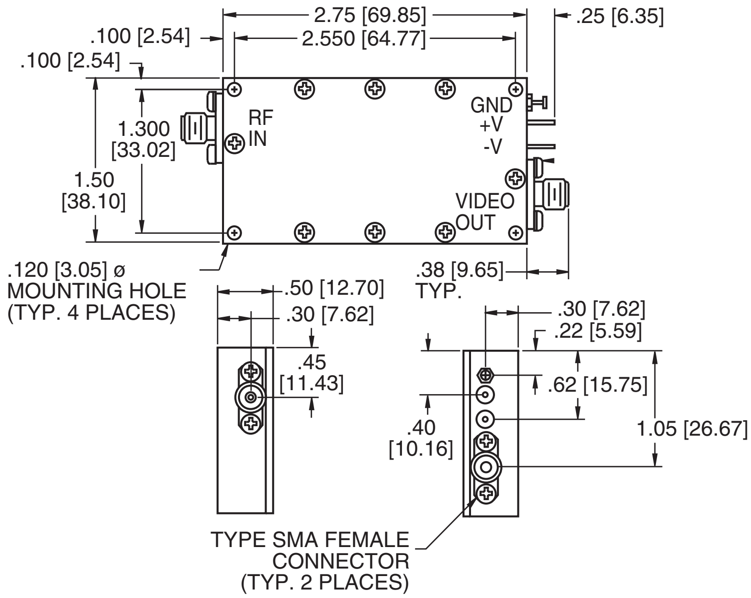
125068



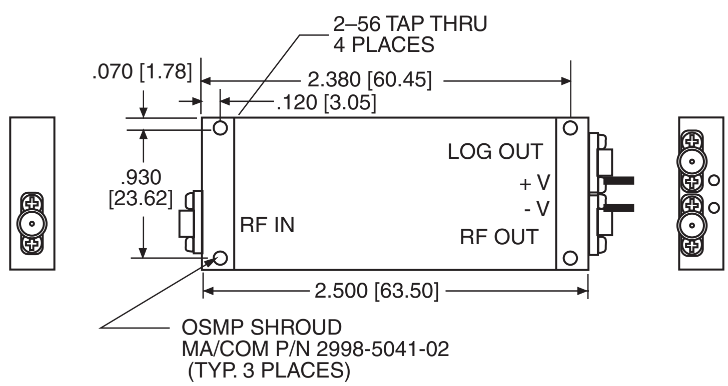
NOTE: DIMENSIONS SHOWN IN BRACKETS [ ] ARE IN MILLIMETERS.

OUTLINE DRAWINGS (CONT.)

127333



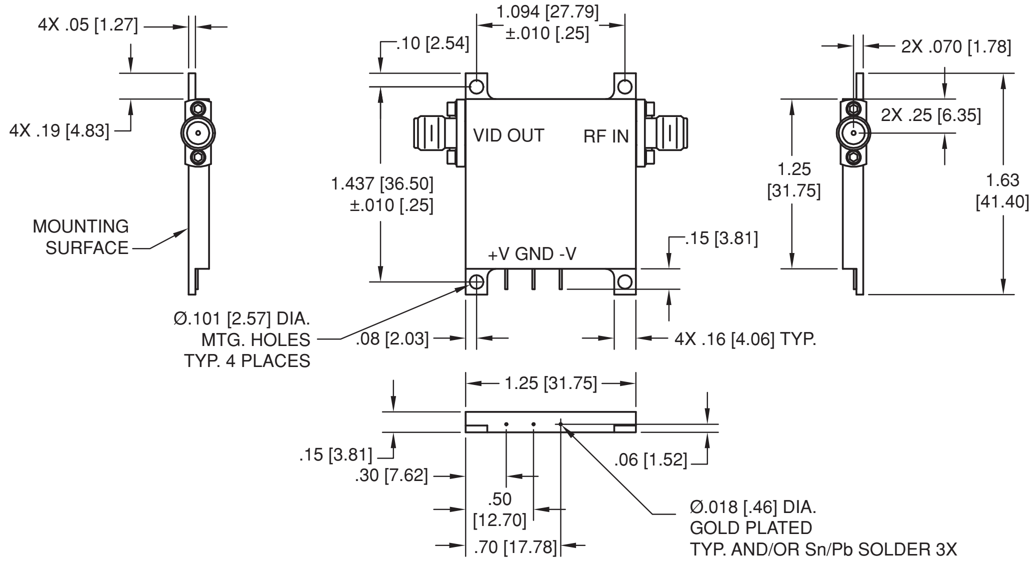
138482



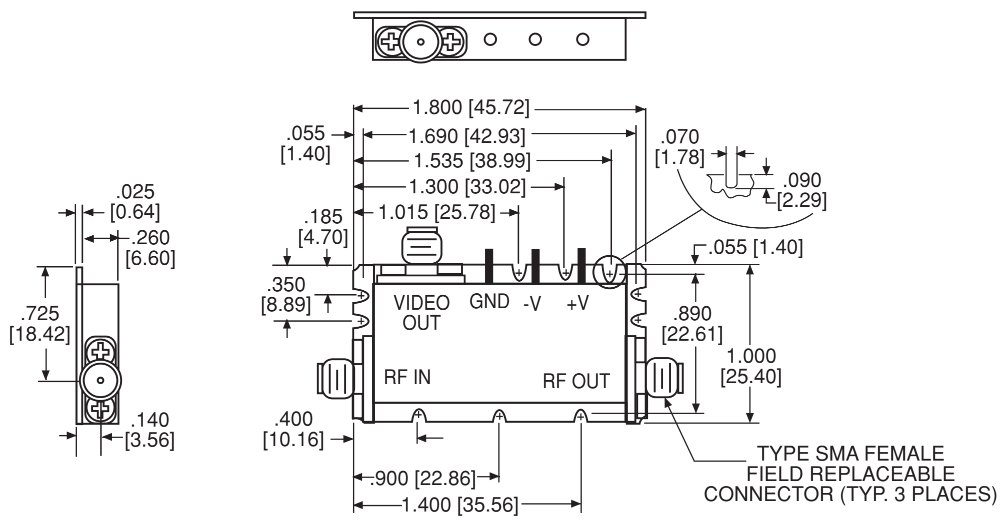
NOTE: DIMENSIONS SHOWN IN BRACKETS [ ] ARE IN MILLIMETERS.

OUTLINE DRAWINGS (CONT.)

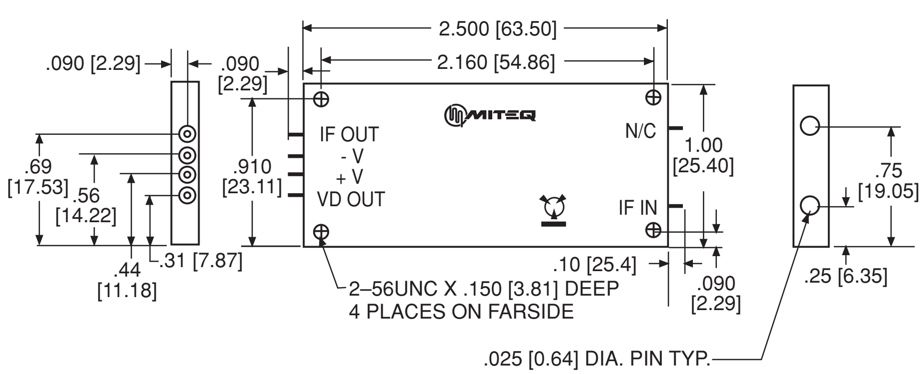
190644



191206



191207



NOTE: DIMENSIONS SHOWN IN BRACKETS [ ] ARE IN MILLIMETERS.

ISO 9001 CERTIFIED

MITEQ attained its original ISO 9001 registration in June 1993, when fewer than 1500 companies were registered. ISO 9001 has since become a recognized standard for quality in over 90 countries. Nationally, it is accepted by an ever-increasing number of government agencies in place of longstanding military specifications covering quality and inspection criteria. Among those are MIL-Q-9858 and MIL-I-45208.

MITEQ's quality system is certified to ISO 9001 by **N**ational **Q**uality **A**ssurance USA (NQA), an accredited registrar of the **A**merican **N**ational **S**tandards **I**nstitute - **R**egistration **A**ccreditation **B**oard (ANSI-RAB). NQA performs a quality audit at MITEQ every six months to assure continued compliance to the standard. Additionally, MITEQ's internal auditing system, coupled with regular management reviews, assures that the quality system is effective, updated and constantly improved.

GENERAL INFORMATION

PRICING AND TERMS

A quotation on any item in the catalog is available by contacting the factory. All quotations, unless otherwise noted, are valid for 60 days from the date of issue, F.O.B. (FCA) Hauppauge, NY 11788. Pricing does not include customer or government source inspection unless otherwise noted. On international orders, an irrevocable letter of credit may be required. MITEQ accepts these credit cards:

QUANTITY DISCOUNTS

A quantity discount is generally available on most catalog items. Due to the wide variety of devices in the catalog, it is not possible to provide a standard discount schedule. When quantities are involved, please contact MITEQ and the appropriate information will be provided.

SOURCE INSPECTION

Government / customer source inspection is available on any item upon receipt of the complete written confirmation of purchase order items, including the prime government contract number. Source inspection with respect to some products increases the unit price and extends delivery because of duplicate standard final inspection and testing. It is recommended wherever possible that a Certificate of Compliance be substituted for source inspection to minimize price and delivery delays.

SHIPPING INFORMATION

Unless instructed otherwise by the customer, we will ship UPS in the U.S. F.O.B. (FCA) Hauppauge. Air freight will be used as the primary international means of shipment. Please indicate at time of purchase what method of shipment you require.

RETURNED MATERIAL

When returning material for repair or replacement, please ensure that there is complete information included with the shipment, giving a detailed description of the reason for its return, the date and purchase order on which it was obtained, and the exact address to which the material is to be reshipped. All returns must arrive freight, postage, duties and handling prepaid.

REPAIR COSTS

Warranty repairs will be made at no cost to the customer. Units out of warranty, or those which have been mishandled, will require approval by the customer for the charges involved before the repairs can be accomplished. We will provide an estimate for the cost of the repair, which can be applied to the repair, if approval is granted. For those items that are deemed beyond repair, or where the customer may decide not to repair the unit, an evaluation fee and handling charge will be applicable.

APPLICATION ENGINEERING

We maintain a large support staff of engineers who are experts in specific areas of microwave technology. Each has an engineering background that combines both a formal engineering education with training and experience in product design. As further technical support, we make available the services of our engineering and scientific staff, who may be consulted on more advanced circuit designs or application problems.

DRAWINGS AND SPECIFICATIONS

The material presented in this catalog was current at the time of publication. MITEQ Inc.'s continuing product improvement program makes it necessary to reserve the right to change our mechanical and electrical specifications without notice. If either of these parameters is critical, please contact the factory to verify that the information is current.

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WARRANTY

1. MITEQ, Inc. warrants to the purchaser that each of its products, when shipped will be free from defects in material and workmanship and will perform in full accordance with applicable specifications. The limit of liability under this warranty is at MITEQ, Inc.'s option to repair or replace any product or part thereof which shall within: (a) three years of delivery for indoor equipment, (b) two years of delivery for outdoor equipment and (c) one year of delivery for integrated assemblies or equipment having RF output powers equal to or greater than +24 dBm, be returned by the purchaser to MITEQ, Inc., at 100 Davids Drive, Hauppauge, New York, 11788, and shall, as determined by examination by MITEQ, Inc., prove defective in material and/or workmanship. Warranty returns must first be authorized in writing by MITEQ, Inc. Disassembly of any MITEQ, Inc. product by anyone other than an authorized representative of MITEQ, Inc. voids this warranty in its entirety. MITEQ, Inc. reserves the right to make changes in any of its products without incurring any obligation to make the same changes on previously delivered products.

2. Components and subsystems having been repaired by MITEQ, Inc. shall be warranted for that repair for ninety (90) days. For products that are still within the original warranty period as described above, the original warranty (if longer) will take precedence. For all SATCOM products, that portion of the system that is repaired, will be warrantied for one year.

3. As a condition to the warranties provided for herein, the Buyer will prepay the shipping charges for all products returned to MITEQ, Inc. for repair and MITEQ, Inc. will pay the return shipping with the exception of rack mountable hardware returned from outside the United States in which case the buyer will pay the shipping charges.

4. The buyer will pay the cost of inspecting and testing any goods returned under the warranty or otherwise which are found to meet the applicable specifications or which are not defective or not covered by the warranty.

5. Products sold by MITEQ, Inc. shall not be considered defective or non-conforming to the Buyers' order if they (a) satisfactorily fulfill the performance requirements that were (i) provided by the Buyer to MITEQ, Inc. or (ii) as published in the Sellers' product specification literature, or (b) or in accordance with any written or verbal agreement between the Buyer and MITEQ, Inc., or (c) are in accordance with samples approved by the Buyer.
   This warranty shall not apply to any products or parts thereof which have been subject to accident, negligence, alteration, abuse or misuse. MITEQ, Inc. makes no warranty whatsoever in respect to accessories or parts not supplied by it.

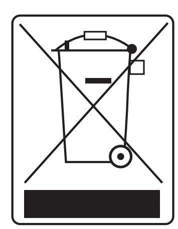
6. Limitations of Warranty, Damages and Liability
   EXCEPT AS EXPRESSLY SET FORTH HEREIN, THERE ARE NO WARRANTIES, CONDITIONS, GUARANTEES OR REPRESENTATIONS AS TO MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR OTHER WARRANTIES, CONDITIONS, GUARANTEES OR REPRESENTATIONS, WHETHER EXPRESSED OR IMPLIED, IN LAW OR IN FACT, ORAL OR IN WRITING.

   MITEQ, INC.'S AGGREGATE LIABILITY IN DAMAGES OR OTHERWISE SHALL NOT EXCEED THE PAYMENT, IF ANY, RECEIVED BY MITEQ, INC. FOR THE UNIT OF PRODUCT OR SERVICE FURNISHED OR TO BE FURNISHED, AS THE CASE MAY BE, WHICH IS THE SUBJECT OF CLAIM OR DISPUTE. IN NO EVENT SHALL MITEQ, INC. BE LIABLE FOR INCIDENTAL, CONSEQUENTIAL, OR SPECIAL DAMAGES, HOWSOEVER CAUSED.

7. All matters regarding this warranty shall be interpreted in accordance with the laws of the State of New York and any controversy that cannot be settled directly shall be settled by arbitration in New York, New York in accordance with the rules then prevailing of the American Arbitration Association, and judgement upon the award rendered may be entered in any court having jurisdiction thereof.

8. As required by Article 10(3) and Article 11(2) of Directive 2002/96/EC (WEEE Directive) of the European Parliament and the Council of the European Union, and in accordance with European Standard EN 50419, MITEQ Inc. labels its products with the following symbol:

   This symbol indicates that the product cannot be thrown into the trash, and must be collected and treated in accordance with Directive 2002/96/EC and local regulations.



FEDERAL SUPPLY CODE

Our Federal Supply Code is: 33592

100 Davids Drive • Hauppauge, NY

320 Oser Avenue • Hauppauge, NY

380 Oser Avenue • Hauppauge, NY

330 Oser Avenue • Hauppauge, NY

MITEQ®

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