1. Device Overview

1.1 General Description

NLTL-6275 is a MMIC non-linear transmission line (NLTL) based comb generator. This NLTL offers excellent phase noise performance over a 3 to 15 GHz input frequency range with output tones beyond 85 GHz. NLTL-6275 is fabricated with GaAs Schottky diode based varactors on a 2.28 mm x 3.13 mm substrate. Both wire bondable die and connectorized modules are available.

Die

Module

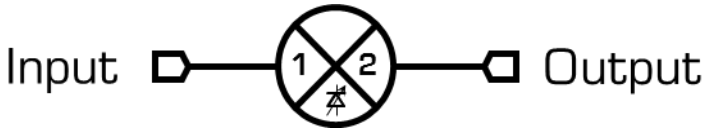
1.2 Features

- Low Phase Noise
- Broadband Input Frequencies
- No External DC Bias Required

1.3 Applications

- Comb Line Generation
- High Efficiency Multiplication
- Samplers
- Phase Locked Loops

1.4 Functional Block Diagram



1.5 Part Ordering Options[1]

Part Number	Description	Package	Green Status	Product Lifecycle	Export Classification
NLTL-6275CH	Wire bondable die	CH	**RoHS**	Active	EAR99
NLTL-6275U[2]	Connectorized module, 1.85 mm connector output	U		Active	EAR99
NLTL-6275U-SW	Connectorized module; 1.0 mm connector output	U		Active	EAR99

[1] Refer to our website for a list of definitions for terminology presented in this table.
[2] Performance on guaranteed to 67GHz.

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Revision History

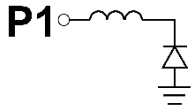
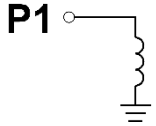
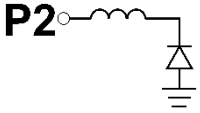
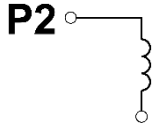
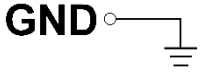
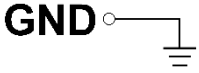
Revision Code	Revision Date	Comment
-	September 2017	Datasheet Initial Release
A	October 2017	Corrected typos
B	December 2017	Added U package outline
C	September 2018	Corrected Signal Pad Locations

2. Port Configurations and Functions

2.1 2.1 Port Diagram

A top-down view of the NLTL-6275's CH package outline drawing is shown below. The NLTL should only be used in the forward direction, with the input and output ports given in Port Functions.

2.2 2.2 Port Functions

Port	Function	Description	Equivalent Circuit for Chip	Equivalent Circuit for Package
Port 1	Input	Port 1 is diode connected for the CH package and DC short for the U package.		
Port 2	Output	Port 2 is diode connected for the CH and DC open for the U package.		
GND	Ground	CH package ground path is provided through the substrate and ground bond pads. U package ground provided through metal housing and outer coax conductor.		

3. Specifications

3.1 3.1 Absolute Maximum Ratings

The Absolute Maximum Ratings indicate limits beyond which damage may occur to the device. If these limits are exceeded, the device may be inoperable or have a reduced lifetime.

Parameter	Maximum Rating	Units
Port 1 DC Current	TBD	mA
Port 2 DC Current	TBD	mA
Power Handling, at any Port	+TBD	dBm
Operating Temperature	-55 to +100	°C
Storage Temperature	-65 to +125	°C

3.2 3.2 Package Information

Parameter	Details	Rating
ESD	Human Body Model (HBM), per MIL-STD-750, Method 1020	TBD
Weight	U Package	10 g

3.3 3.3 Recommended Operating Conditions

The Recommended Operating Conditions indicate the limits, inside which the device should be operated, to guarantee the performance given in Electrical Specifications Operating outside these limits may not necessarily cause damage to the device, but the performance may degrade outside the limits of the electrical specifications. For limits, above which damage may occur, see Absolute Maximum Ratings.

	Min	Nominal	Max	Units
T_A, Ambient Temperature	-55	+25	+100	°C
Input Power	+16		+26	dBm

3.4 3.4 Sequencing Requirements

This is a passive NLTL that requires no external DC bias. Self-bias of the diodes is sufficient for operation. It is not required, but is recommended to provide a 50Ω termination to each port before applying RF power.

3.5 3.5 Electrical Specifications

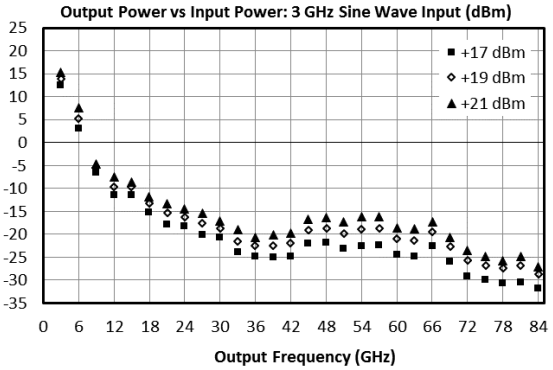
The electrical specifications apply at T_A=+25°C in a 50Ω system. Typical data shown is for the NLTL used in the forward direction with a sine wave input.

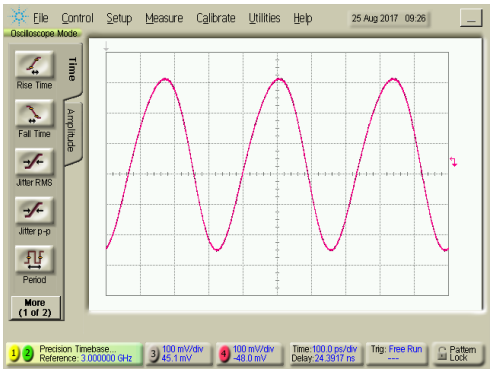
Min and Max limits apply only to our connectorized units and are guaranteed at T_A=+25°C. All bare die are 100% DC tested and visually inspected.

Parameter	Test Conditions	Min	Typical	Max	Units
Input (Port 1) Frequency Range		3		15	GHz
Output (Port 2) Frequency Range		3		85	
Input Power		+17		+26	dBm
Maximum Output Harmonic for given Input me[3]	3 GHz Input			28	-
	5 GHz Input			16	
	7 GHz Input			12	
	10 GHz Input			8	
	15 GHz Input			5	

[3] Maximum Output Harmonic specification given for the harmonic with a -20 dBm output power for a +20 dBm input.

3.6 3.6 Typical Performance Plots





3 GHz +19 dBm Sine Wave Input

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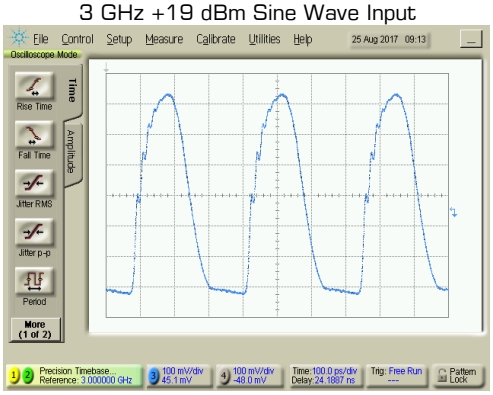
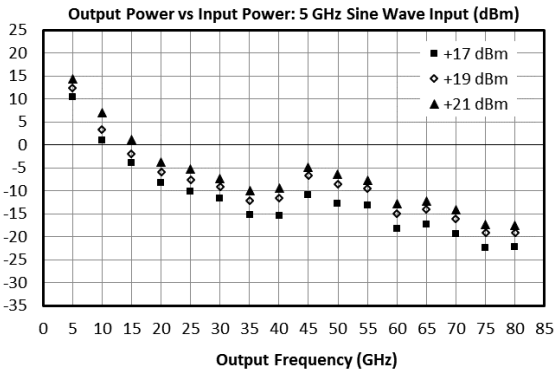
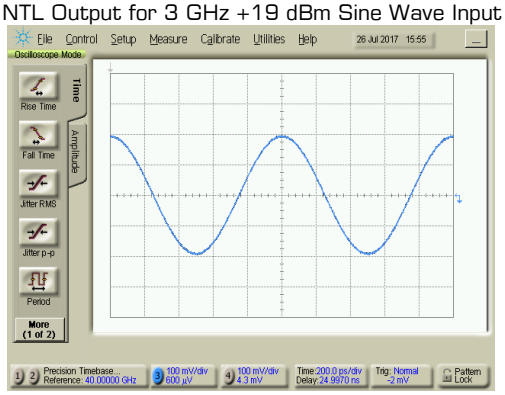


NTL Output for 3 GHz +19 dBm Sine Wave Input





5 GHz +19 dBm Sine Wave Input

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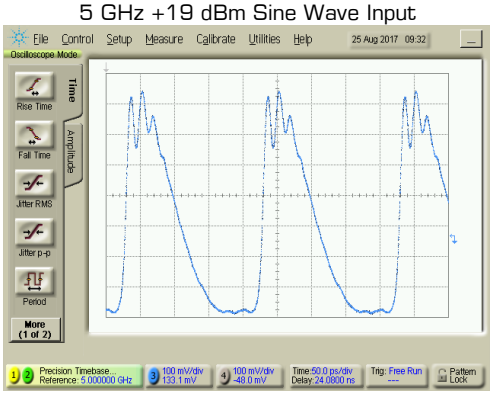
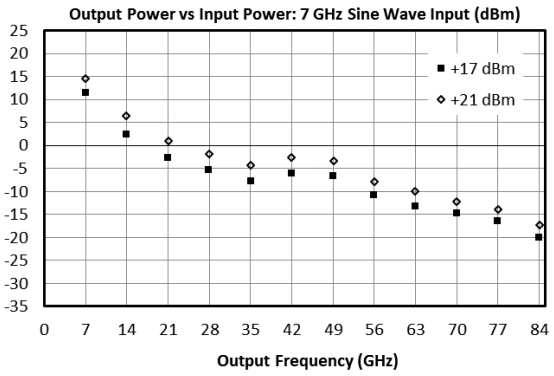
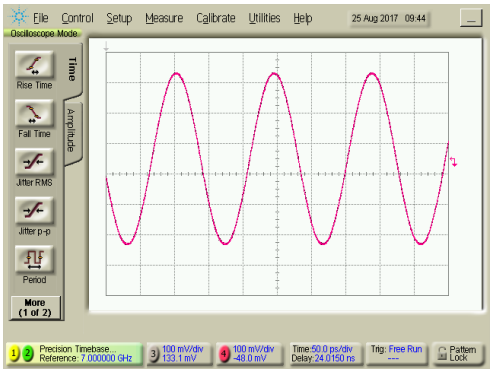


NLTL Output for 5 GHz +19 dBm Sine Wave Input





7 GHz +19 dBm Sine Wave Input

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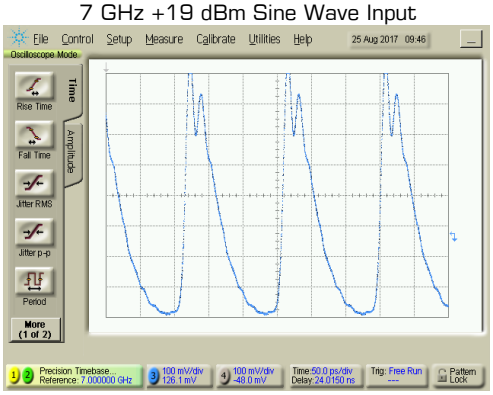
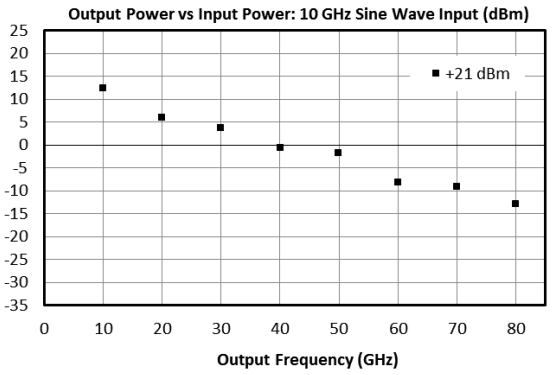
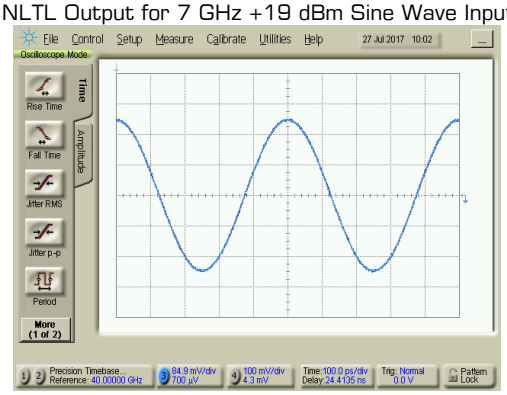


NLTL Output for 7 GHz +19 dBm Sine Wave Input





10 GHz +19 dBm Sine Wave Input

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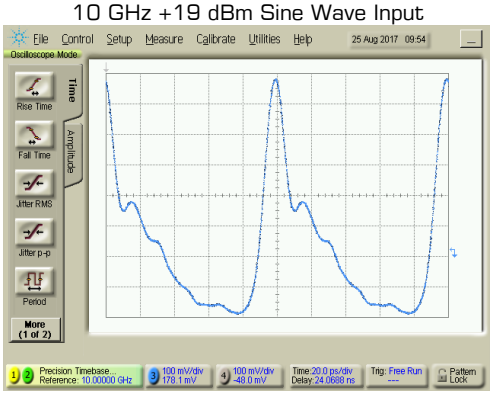
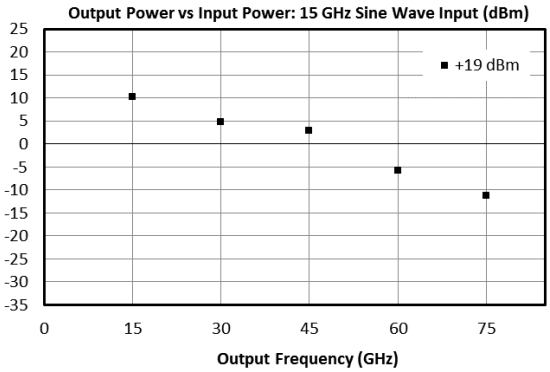


NLTL Output for 10 GHz +19 dBm Sine Wave Input



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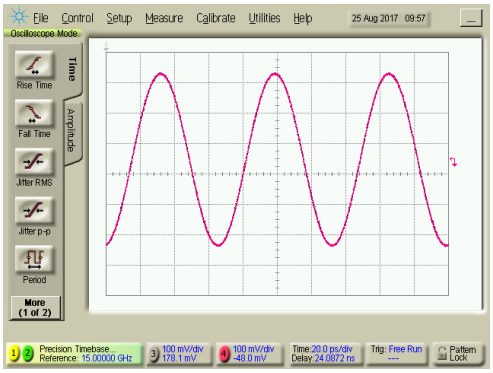
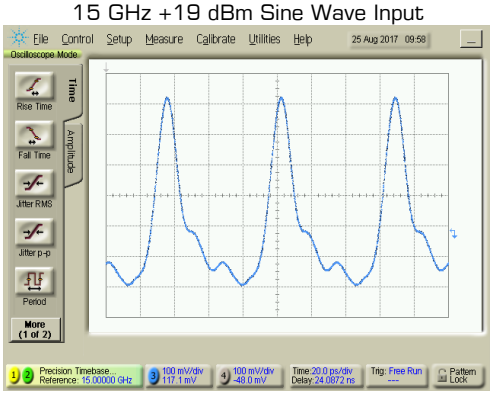
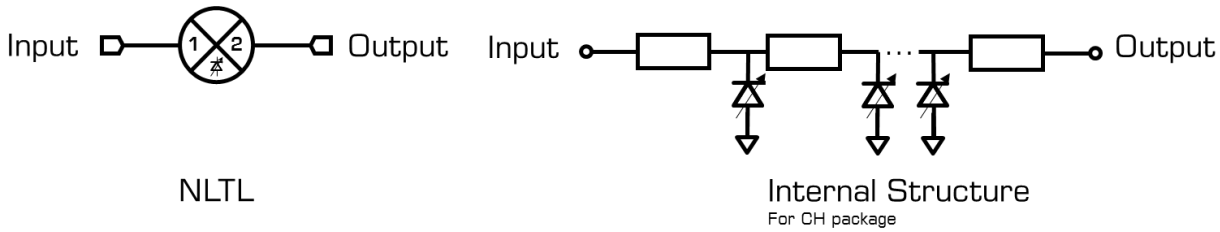


15 GHz +19 dBm Sine Wave Input



NLTL Output for 15 GHz +19 dBm Sine Wave Input

4. Application Information



4.1 4.1 Detailed Description

NLTL-6275 belongs to Marki Microwave's NLTL family of multipliers and non-linear transmission lines. The NLTL product line consists of passive GaAs MMIC non-linear transmission lines designed and fabricated with GaAs Schottky diode based varactors. NLTLs take an input signal and create an impulse train of harmonics. Harmonic outputs up to and beyond 85 GHz are generated by the NLTL.

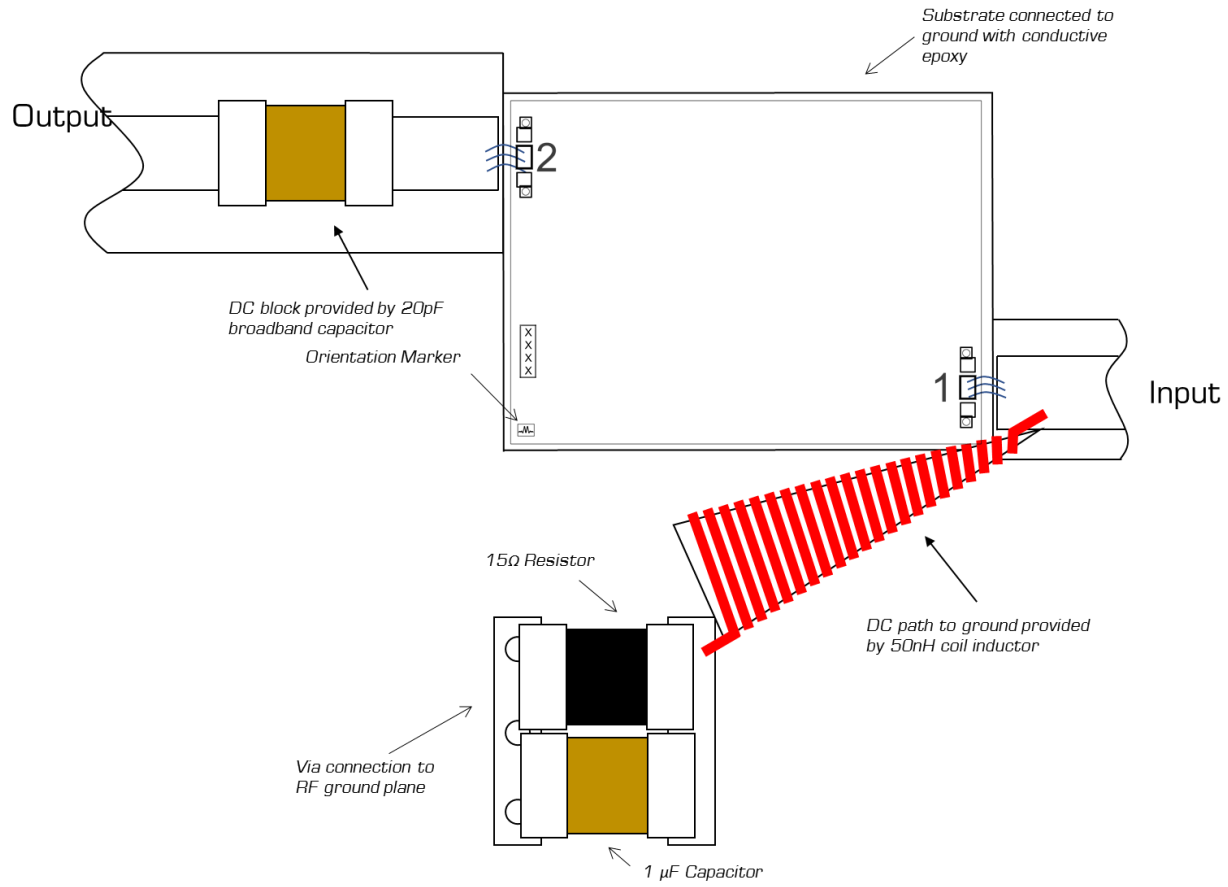
Port 1 supports S, C, and X band input signals. Port 2 will output integer multiples of the input signal (i.e., x2, x3, x4, …, x28) up to the 28th output harmonic or a maximum of 85 GHz for a typical -20 dBm output power. Higher harmonics can be generated but will be at a lower efficiency.

The operating conditions of the NLTL are extremely important to optimize performance. High power inputs will increase the output power observed; however, the conversion efficiency will decrease. This is increasingly true for higher input frequencies and at input powers above the recommended limit.

NLTL-6275 requires no external DC bias. The self-bias of the diodes caused by the rectified RF input signal is sufficient for operation. For the best performance, optimization of the DC return path is recommended for each specific application to optimize the harmonic output power distribution.

The phase noise of a non-linear transmission line is outstanding. If verification of performance is necessary, the application circuit used and input conditions are extremely important. NLTLs are AM sensitive. If there is excessive AM noise on the input of the NLTL, observing the output of the NLTL will show excessive PM/phase noise because of the high AM to PM conversion property of NLTLs.

4.2 Application Circuit



DC Path to Ground — An RF choke followed by a 15 Ω resistor should be used to provide a DC path to ground on the input port of the NLTL. A shunt 1 µF capacitor is used to filter noise generated by the resistor. This forms the circuit which self-biases the NLTL. The DC return to ground removes DC rectified current created by high power RF signal injection. The DC path to ground is provided within the U package. A conical coil inductor is recommended to push the self-resonance frequency of the inductor past the operating bandwidth of the NLTL. The recommended inductance value of the conical coil inductor is 50nH or higher.

Blocking Capacitor — A DC blocking capacitor on the output of the NLTL-6275's integrated circuit is necessary to prevent unwanted DC current flow from or to the output. If there is a DC signal on the input, place a DC block on the input to avoid disrupting the self-biasing of the diodes.

5. Die Mounting Recommendations

5.1 5.1 Mounting and Bonding Recommendations

Marki MMICs should be attached directly to a ground plane with conductive epoxy. The ground plane electrical impedance should be as low as practically possible. This will prevent resonances and permit the best possible electrical performance. Datasheet performance is only guaranteed in an environment with a low electrical impedance ground.

Mounting - To epoxy the chip, apply a minimum amount of conductive epoxy to the mounting surface so that a thin epoxy fillet is observed around the perimeter of the chip. Cure epoxy according to manufacturer instructions.

Wire Bonding - Ball or wedge bond with 0.025 mm (1 mil) diameter pure gold wire. Thermosonic wirebonding with a nominal stage temperature of 150 °C and a ball bonding force of 40 to 50 grams or wedge bonding force of 18 to 22 grams is recommended. Use the minimum level of ultrasonic energy to achieve reliable wirebonds. Wirebonds should be started on the chip and terminated on the package or substrate. All bonds should be as short as possible <0.31 mm (12 mils).

Circuit Considerations — 50 Ω transmission lines should be used for all high frequency connections in and out of the chip. Wirebonds should be kept as short as possible, with multiple wirebonds recommended for higher frequency connections to reduce parasitic inductance. In circumstances where the chip more than .001" thinner than the substrate, a heat spreading spacer tab is optional to further reduce bondwire length and parasitic inductance.

5.2 5.2 Handling Precautions

General Handling

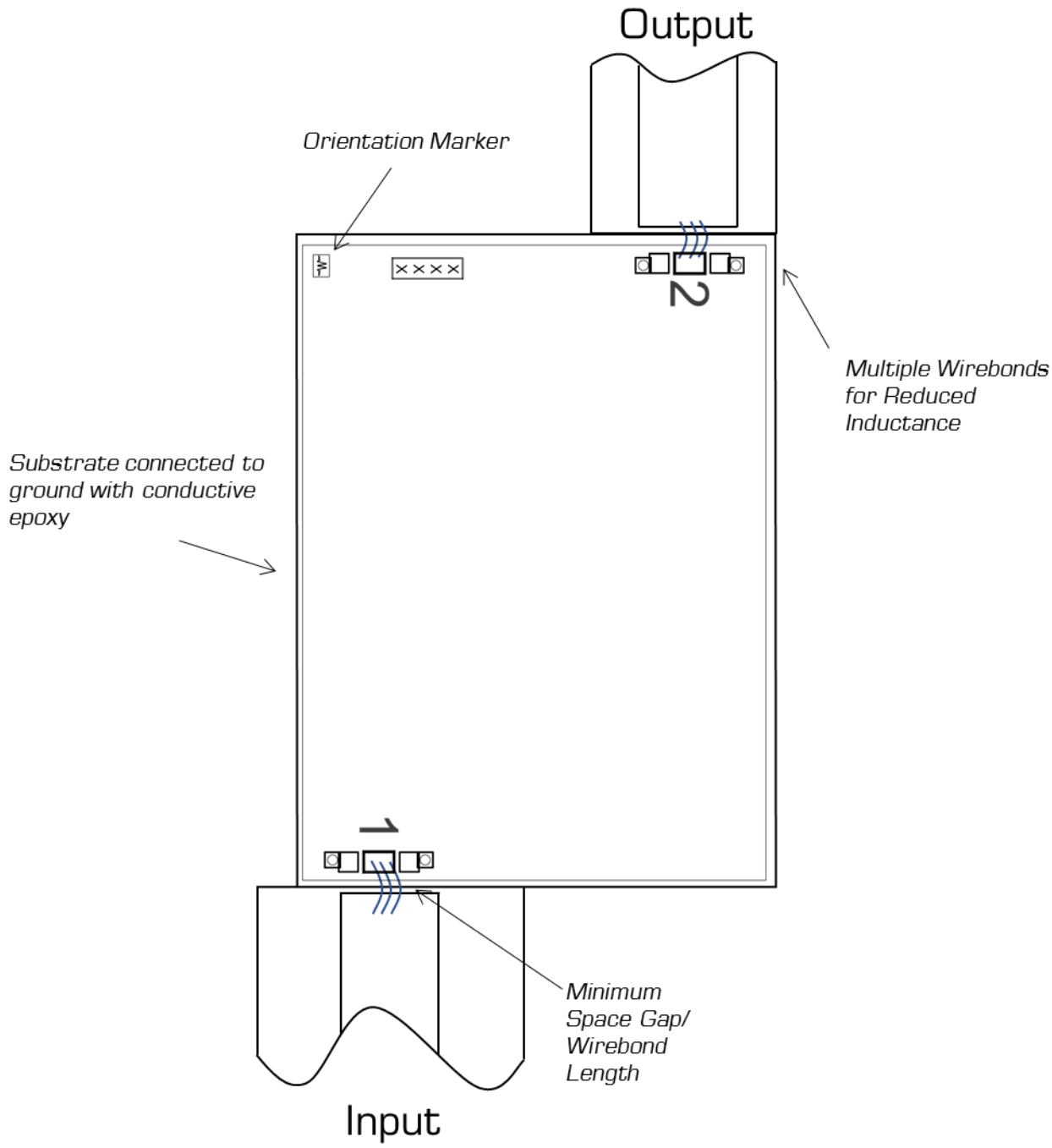
Chips should be handled with care using tweezers or a vacuum collet. Users should take precautions to protect chips from direct human contact that can deposit contaminants, like perspiration and skin oils on any of the chip's surfaces.

Static Sensitivity

GaAs MMIC devices are sensitive to ESD and should be handled, assembled, tested, and transported only in static protected environments.

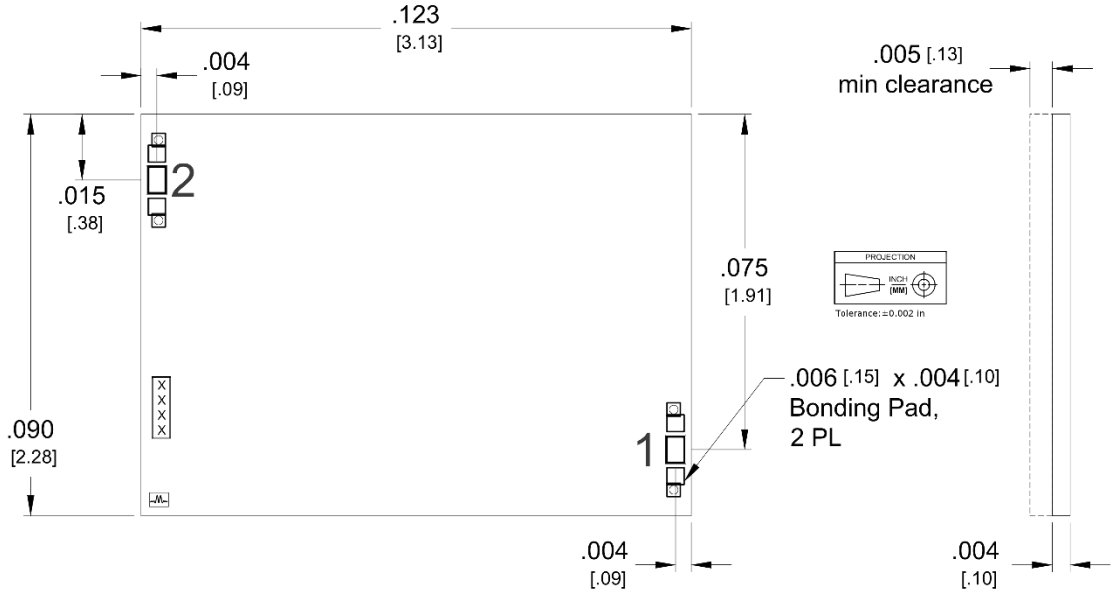
Cleaning and Storage: Do not attempt to clean the chip with a liquid cleaning system or expose the bare chips to liquid. Once the ESD sensitive bags the chips are stored in are opened, chips should be stored in a dry nitrogen atmosphere.

5.3 5.3 Bonding Diagram



6. Mechanical Data

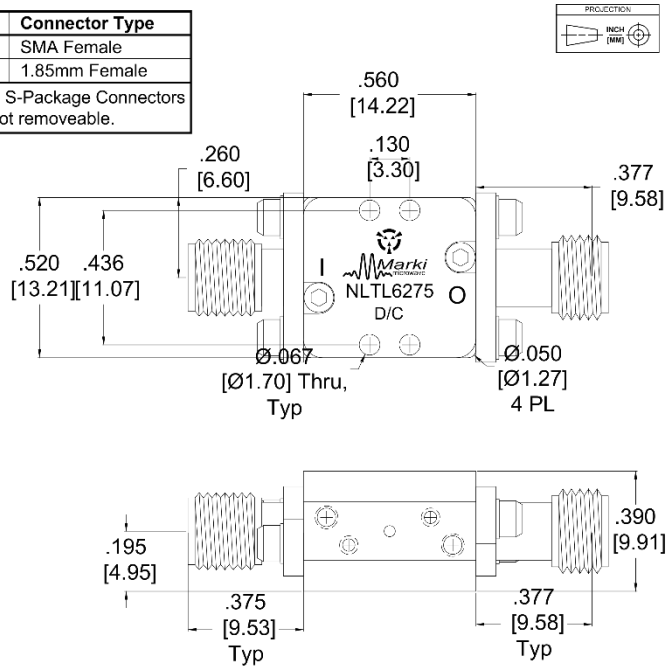
6.1 6.1 CH Package Outline Drawing



1. CH Substrate material is 0.004 in thick GaAs.
2. I/O trace finish is 4.2 microns Au. Ground plane finish is 5 microns Au.
3. XXXX denotes circuit number.

6.2 U Package Outline Drawing

Port	Connector Type
I	SMA Female
O	1.85mm Female
Note: S-Package Connectors are not removeable.	



6.3 6.2 U-SW Package Outline Drawing

Port	Connector Type
I	SMA Female
O	1.0mm Female
Note: S-Package Connectors are not removeable.