Nano-Series Sub-THz Automated Tuners

DATA SHEET / 4T-050G11

MODELS:
NT-110G-170G-1C
NT-140G-220G-1C
NT-170G-260G-1C
NT-220G-330G-1C

Maury Microwave

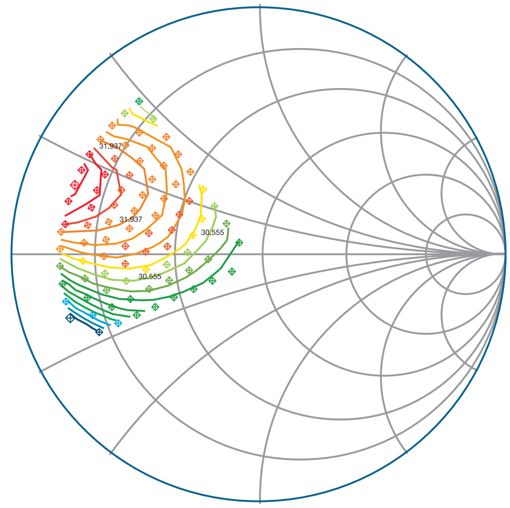
// October 2024

What is load pull?

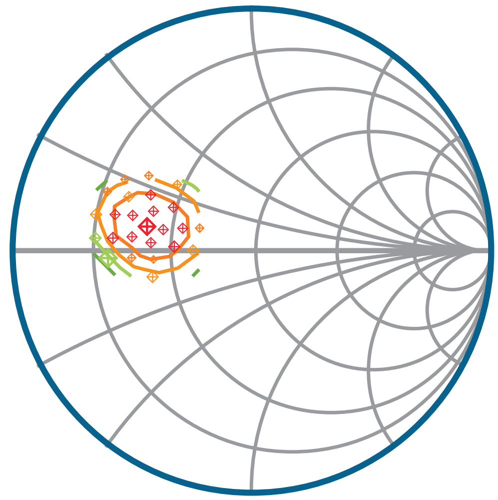
Load Pull is the act of presenting a set of controlled impedances to a device under test (DUT) and measuring a set of parameters at each point. By varying the impedance, it is possible to fully characterize the performance of a DUT and use the data to:

- > Verify simulation results of a transistor model (model validation)
- > Gather characterization data for model extraction (behavioral model extraction)
- > Design amplifier matching networks for optimum performance (amplifier design)
- > Ensure a microwave circuit's ability to perform after being exposed to high mismatch conditions (ruggedness test)
- > Confirm the stability or performance of a microwave circuit or consumer product under non-ideal VSWR conditions (stability/performance/conformance/antenna test)

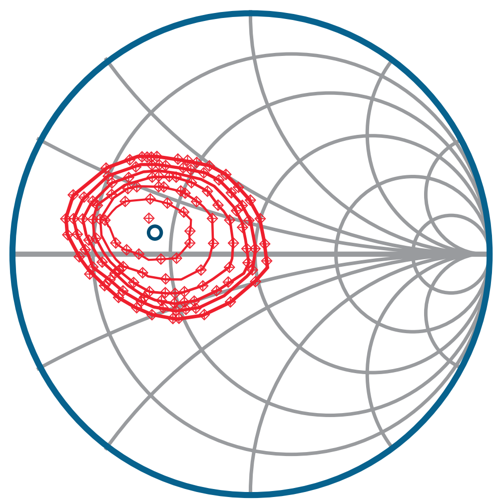
Example of load pull measurements with Output Power (Pout) contours plotted on a Smith Chart.



Iso Pout Contours Measured @ 1.85 GHz

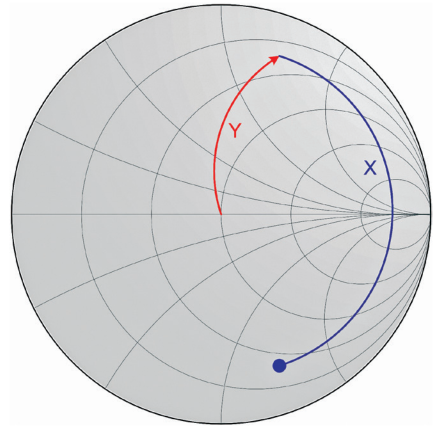


Iso Pout Contours Simulated @ 1.85 GHz



Waveguide Impedance Tuner

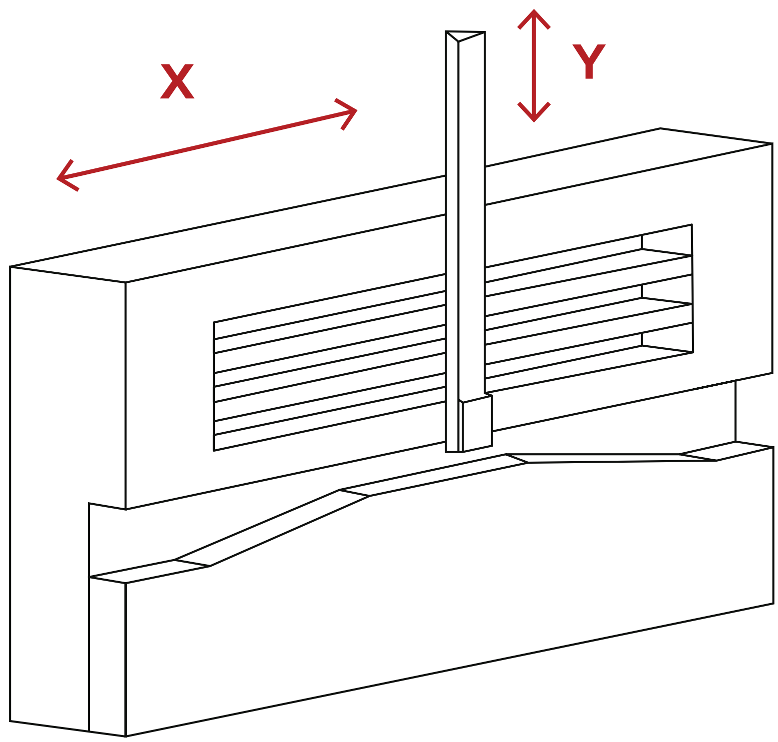
One tool available to vary the impedances presented to a DUT is the waveguide impedance tuner. The tuner is based on a patented modified rectangular waveguide and a reflective vane or probe, sometimes referred to as a slug. Ideally, when the probe is fully retracted, the tuner presents a near 50Ω impedance at the DUT reference plane, represented by the center of a normalized Smith Chart. As the probe is lowered into the waveguide (Y-direction) it interrupts the electric field, reflects some of the energy back towards the DUT and increases the magnitude of reflection (represented by the red curve on the Smith Chart at right.) As the probe travels along the waveguide (X-direction), the distance between the probe and the DUT is altered, thereby rotating the phase of the reflection (represented by the blue curve on the Smith Chart. It is therefore possible to present nearly any arbitrary impedance without the need of discrete components.



Patented Waveguide Tuner Architecture

U.S. PATENT NO. 5,910,754
INTERNATIONAL PATENTS PENDING

- Complex waveguide with perpendicular slots act as multi-choke filter
- Complex waveguide with reduced height increases resonance-free bandwidth
- Non-conductive rectangular bar vane with metallized tip further isolates electric field

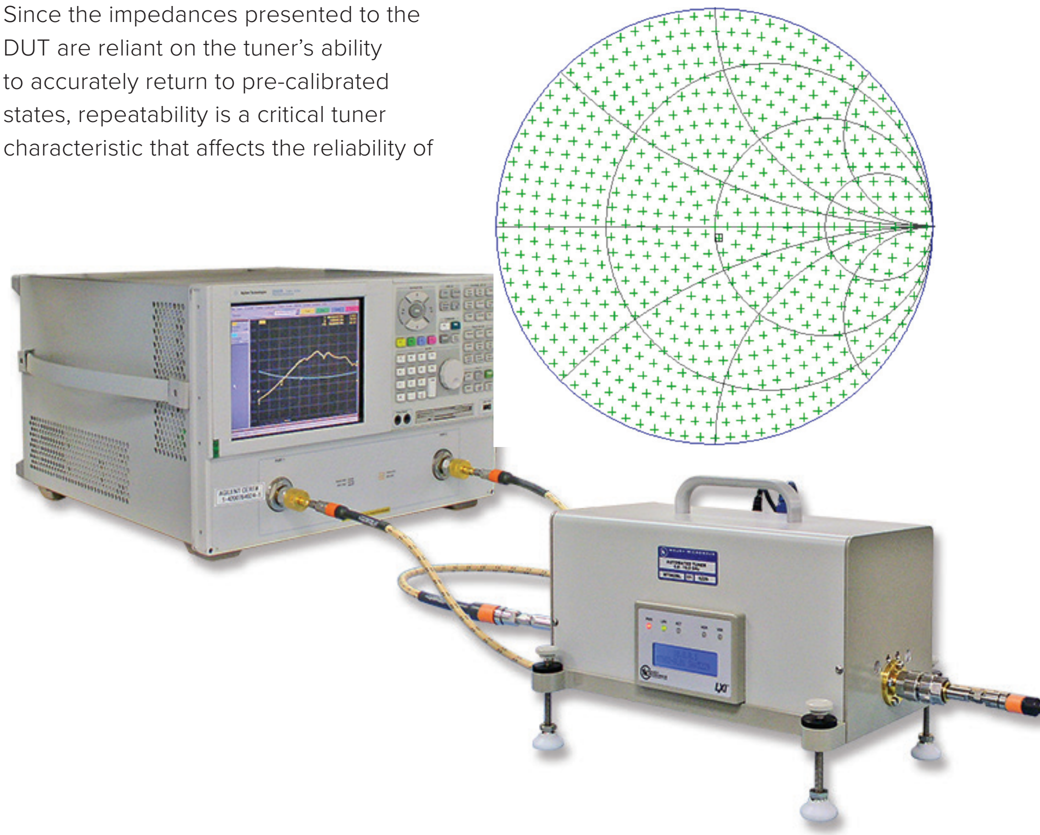


Pre-Calibration (Pre-Characterization)

Automated tuners have the ability to be pre-calibrated. Pre-calibration involves recording the s-parameters of the probe at varying X and Y positions for the frequencies of interest using a calibrated vector network analyzer. In general, X and Y positions are selected such that an even distribution of impedances are recorded over the Smith Chart. Once the calibration data is stored in a lookup table, the VNA is no longer required to use the tuner; the tuner 'knows' how to present impedances accurately without VNA verification.

Tuner Repeatability

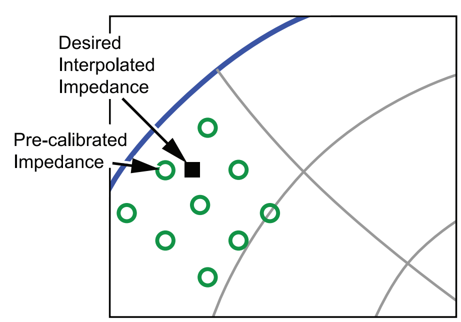
Tuner repeatability is defined as the vector difference between the pre-calibrated s-parameter data and subsequent s-parameter measurements after movement, when returning the probe to a given X and Y position. Since the impedances presented to the DUT are reliant on the tuner's ability to accurately return to pre-calibrated states, repeatability is a critical tuner characteristic that affects the reliability of measurement data. In order to guarantee a high level of repeatability, precision mechanics and motors within the tuner are used to return the probe to its pre-calibrated positions with s-parameter vector differences of –50dB or better.



Tuning Accuracy and Interpolation

During pre-calibration, the tuner's s-parameters are recorded at a user-definable number (normally between 300-3000) of X and Y positions giving an even distribution over the Smith Chart. However, an arbitrary load impedance that falls between pre-calibrated states might be required. To achieve a high level of accuracy, a two-dimensional algorithm is used to interpolate between the closest pre-calibrated impedances in order to determine the new physical X and Y positions of the desired interpolated impedance. Interpolation increases the number of tunable impedances well beyond the initial pre-calibration range.

Given a sufficiently dense pre-calibration look-up table, a tuner's repeatability (ability to return to pre-calibrated states) and accuracy (ability to interpolate between pre-calibrated states) offer similar performances.



Patented Tuner Controller

(U.S. Patent No. 8,823,392)

All Maury slide-screw automated impedance tuners are equipped with a patented controller (U.S. Patent No. 8,823,392) with onboard microprocessor and memory. After pre-calibration, the lookup table is copied onto the embedded flash memory storage, as are any s-parameter files of passive components that will be used with the tuner (adapters, cables, fixtures, probes, attenuators…). The onboard microprocessor will use the lookup table and component s-parameter blocks to calculate the probe positions required to present an arbitrary load impedance taking into account (de-embedding) all adapter/fixture losses between the tuner and DUT, and all back-side losses between the tuner and the measurement instrument, as well as possible non-50Ω terminations.

Tuner control settings including IP address and firmware upgrade.

Direct ASCII commands can be sent through raw TCP/IP interface over Ethernet or USB and used with any socket programming language or through any Telnet client program in any operating system. Commands include direct impedance tuning, reference-plane shifting, VSWR testing and more.

Parameter	Value
Manufacturer	Maury Microwave Corporation
Instrument Model	MT982-EL30
Serial Number	5270
Firmware Revision	3.4-1.24
Description	Maury MT982-EL30 - 5270
LXI Extended Features	LXI Core Functions
LXI Version	1.4
mDNS-Hostname	169.254.6.77, MT982-EL30-5270.local
IP Address	169.254.6.77
MAC Address	fc:6c:31:00:00:e6
Device Address	TCPIP0::169.254.6.77::5025::SOCKET
Telnet Address	telnet://169.254.6.77:5024

Parameter	Currently in use
VXI-11 Discovery	On
mDNS Discovery	On
DHCP	On
Auto-IP	On
Network-Hostname	MT982-EL30-5270.local
IP Address	169.254.6.77
Netmask	255.0.0.0
Gateway	0.0.0.0
Dynamic DNS Updates	On
Manual DNS	Off
Domain	Belkin
Primary DNS	10.10.1.17
Secondary DNS	10.10.1.19
Description	Maury MT982-EL30 - 5270
Web Password	hidden

Edit Configuration

MTUNE Tuner Characterization and Control Software

Introduction

MTUNE is a software package that allows device calibration/characterization and control of multiple tuner configurations for automated impedance tuning. It may be used in any application requiring the ability to match the impedance of a microwave circuit element or to establish specific impedances at a terminal interface at various frequencies. The software provides a standalone server (API) for remote communication for advanced use as well as interactive user interface to guide the user through the calibration and tuning process.

Software Features:

> Desktop and cloud-based applications enhances user flexibility

> Modern wizard-driven GUI with support for most commercial VNAs

> Automatic instrument identification for easy setup

> Stay up-to-date with software update reminders

> Enhanced user support with direct ticketing and error logging

New and Updated Capabilities:

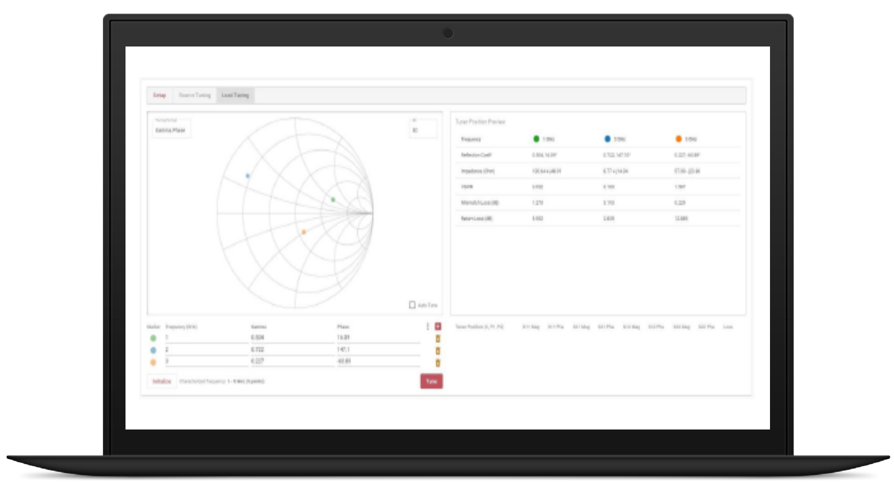
> Faster multi-frequency tuner characterization

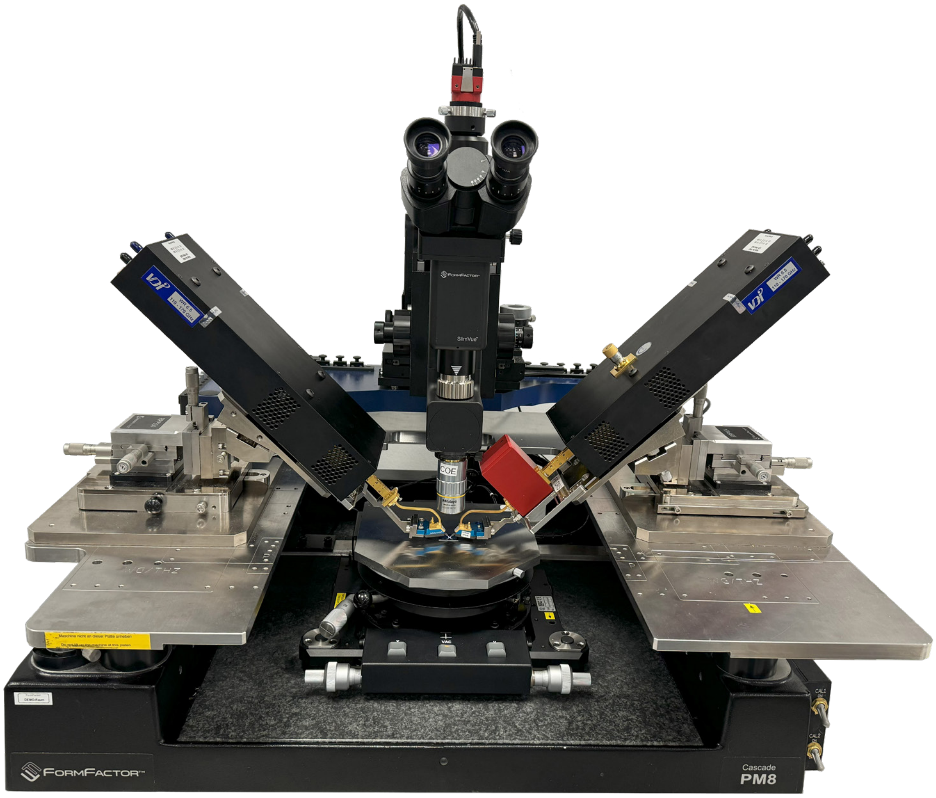
> New tuner characterization validation process

> Enhanced frequency interpolation

> New non-harmonically related multi-frequency impedance tuning

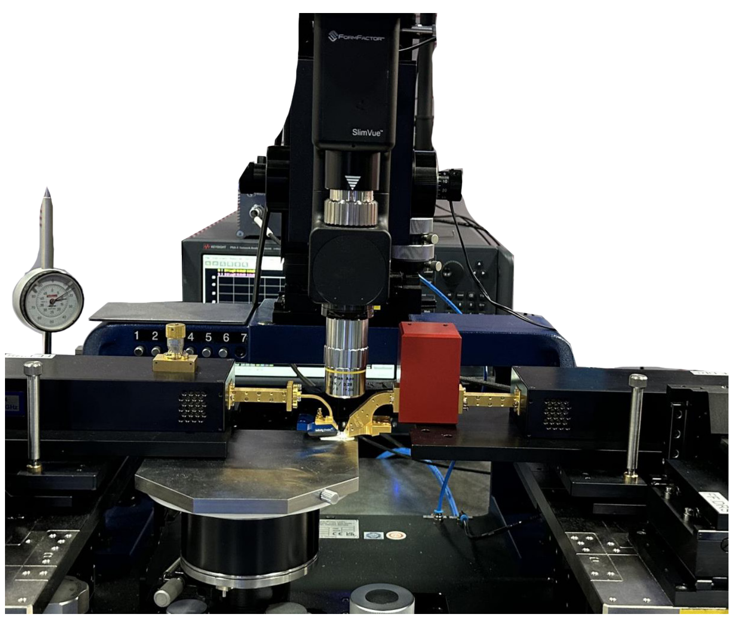
MTUNE3 is compatible with all Nano-series tuners with embedded controllers, and can be downloaded from https://maurymw.com/





Optimized for on-wafer integration

Nano-series automated impedance tuners have been optimized for on-wafer integration. The direct connection offers two advantages: maximizing VSWR at the DUT reference plane and minimizing phase skew at the DUT reference plane.



Available Models

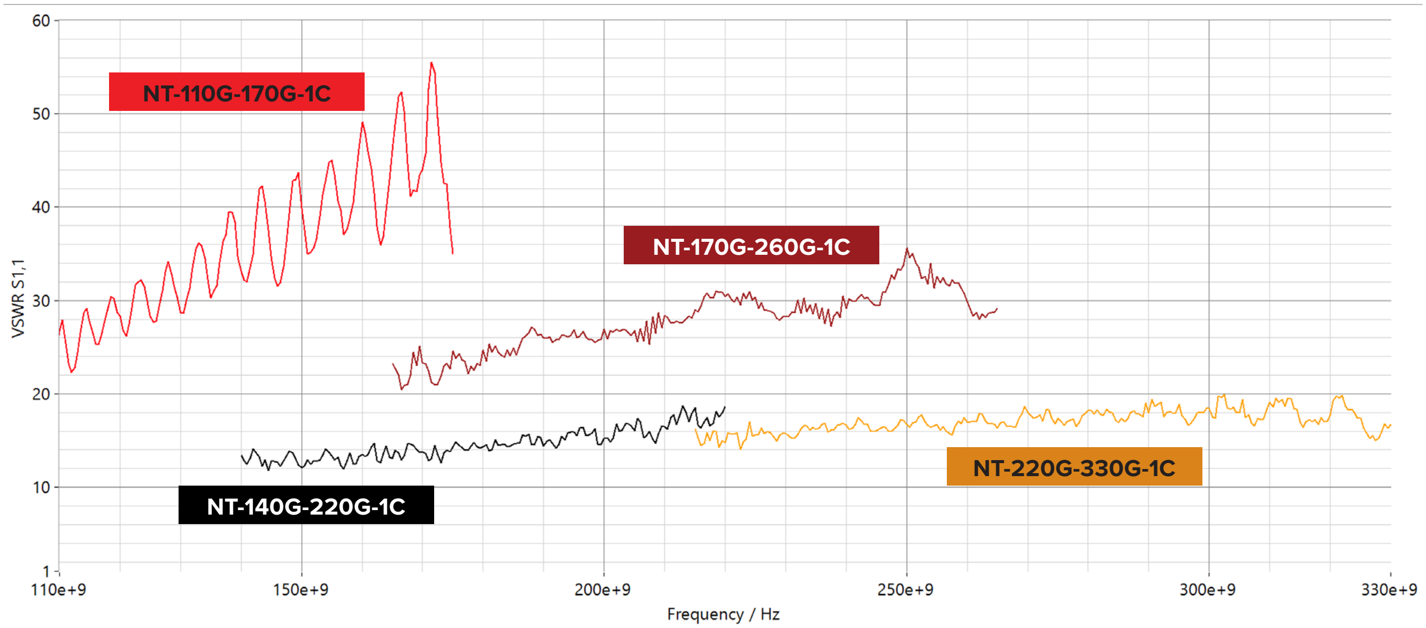
Model	Frequency Range (GHz)	Matching Range		Power Capability[2]	Vector Repeatability (Minimum)	Insertion Loss[3] (Maximum)	Dissipative Loss	Waveguide Flange
		Minimum	Typical[1]					
NT-110G-170G-1C	110-170	20:1	35:1	20 W CW, 200 W PEP	-40.0 dB	0.5 dB	-8 dB	WR6.5 (WR6)
NT-140G-220G-1C	140-220	12:1	14:1			0.65 dB	-4 dB	WR5.1 (WR5)
NT-170G-260G-1C	170-260	18:1	27:1			1 dB	-9 dB	WR4.3 (WR4)
NT-220G-330G-1C	220-330	12:1	17:1			1.35 dB	-8 dB	WR3.4 (WR3)

[1] Defined as average VSWR across the frequency band
[2] Power rated at maximum VSWR
[3] With probes fully retracted
[4] At maximum VSWR

Accessories Provided:

- > Power Supply
- > USB cable and TCPIP cable
- > USB to ethernet adapter
- > NT-1C Tuner controller
- > Operating Manual

Typical Performance



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OUR PRODUCTS

www.maurymw.com

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CONTACT US:
W / maurymw.com
E / maury@maurymw.com
P / +1-909-987-4715
F / +1-909-987-1112
2900 Inland Empire Blvd
Ontario, CA 91764