

# Your Single Source for Advanced Microwave and RF Technologies



**TELEDYNE MICROWAVE SOLUTIONS**  
Everywhere you look™



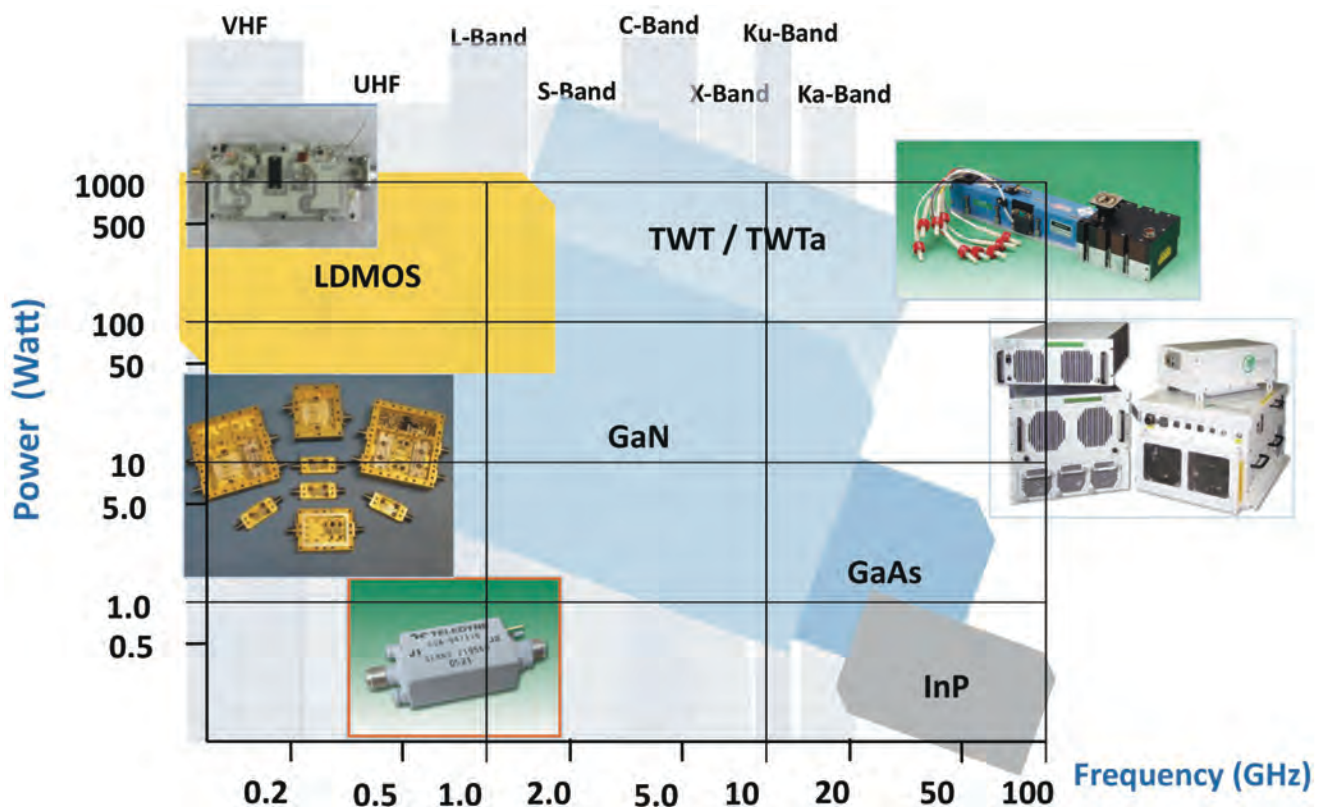
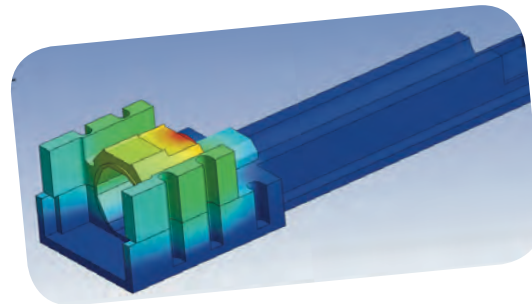
# TMS Technology Platform

## Design Tools to 220 GHz

- Microwave Office – Linear & EM
- ADS – Linear & EM
- Sonnet: 2.5D EM
- CST Microwave Studio – 3D EM
- HFSS – 3D EM
- SysCalc – System Design
- AutoCAD: 2.5D Mechanical Design
- Autodesk Inventor: 3D Mechanical Design
- Solidworks: 3D Mechanical Design
- COSMOS Design Star: 3D Analysis
  - ▶ Mechanical Analysis
  - ▶ Thermal
  - ▶ Vibration
- Power Logic: Schematic Entry
- PADS: PWB Layout

## Amplifier Supporting Technologies

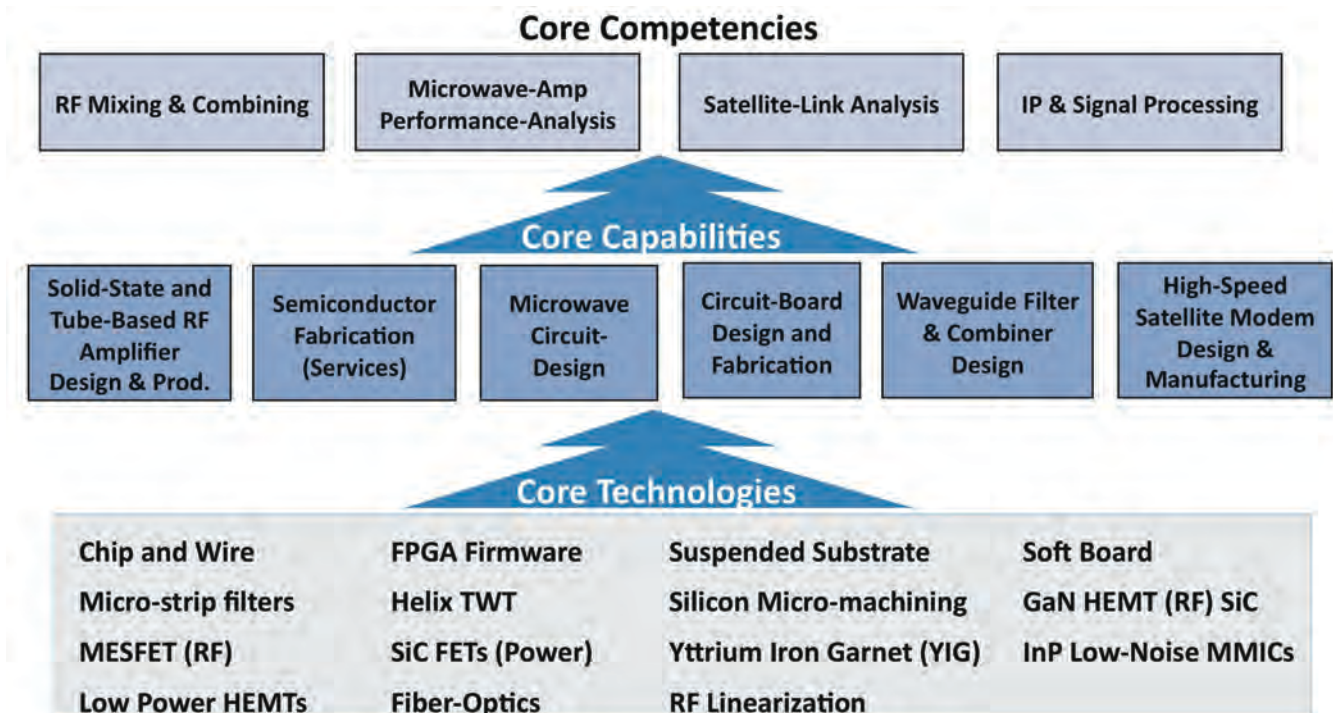
- Spatial Combining Technology
  - ▶ Novel low loss/multi-input coaxial & waveguide networks
- Integrated Thermal Management
  - ▶ Unique materials
  - ▶ Air cooling
  - ▶ Water cooling



# Why Teledyne Microwave Solutions?

## What are the Benefits of Working with Teledyne Microwave Solutions?

For decades, the seven companies that today compose TMS were industry leaders in their own right. Those companies are now consolidated under a single roof, enabling TMS to provide one interface to our customers, and giving them easier access to our entire technology portfolio. With several global manufacturing sites and localized customer support spanning six continents, TMS today invests in an even larger R&D operation, developing a line of technologies and custom applications that are laser-focused on our customers' emerging market needs.



## Manufacturing Capabilities

### Microwave Assembly

- Class 10,000 Manufacturing
- Class 1,000 work cells
- Manual & Automated die attach
- Manual & Automated wire bonding
- Chip & wire hybrid assemblies
- Soft & hard substrates
- Hermetic packaging & Laser sealing

### Microwave Testing

- VNA through 65 GHz, extensions to 110 GHz
- Noise, BER
- Automated testing & burn-in

### Environmental Testing

- Vibration & Acceleration
- Thermal Shock
- Mechanical Shock
- Temperature-Altitude





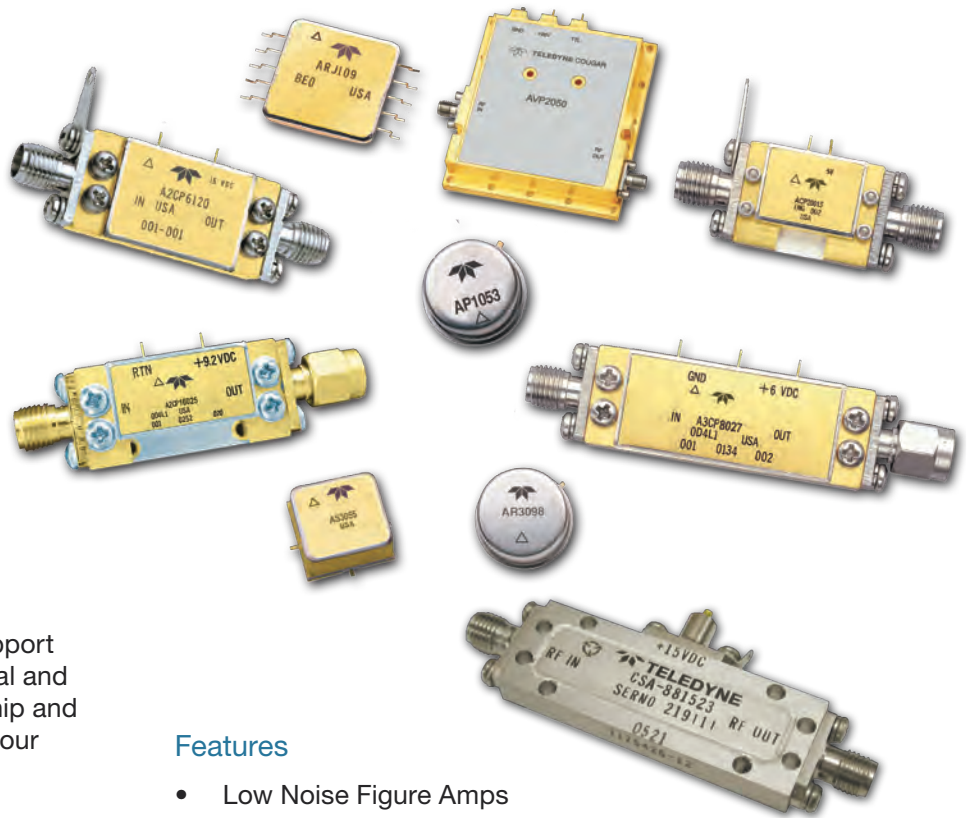
# Discrete Amplifiers

## TMS Discrete Amplifiers Key Features — Commercial, Military, & Space Qualified Versions are Available

TMS is an industry leader in the development of Discrete Amplifiers. With a heritage of over 40 years from four different acquisitions along with internal R&D growth, TMS is your one stop shop for all types of RF Amplifiers.

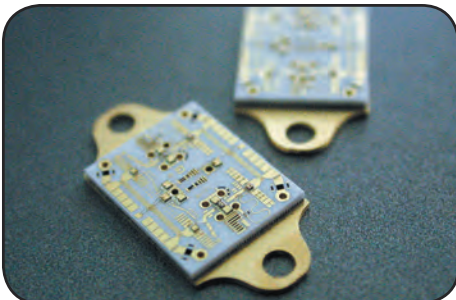
The range of products is comprehensive, serving all markets and applications from Electronic Warfare to Test Equipment. Our designs use all major semiconductor materials - LDMOS, GaN, GaAs, SiGe and InP, cover frequencies from 10 MHz to 94 GHz, and include open die carriers and connectorized or even waveguide packaging.

Many of the products we offer were once standard and later modified to support custom applications for both commercial and military applications. With over 3,500 chip and wire modules available to choose from, our engineers are able to develop custom solutions with very short lead times, delivering the product you need, on time.



### Features

- Low Noise Figure Amps
- Low Phase Noise Amps
- Switched Amps
- Detector Output Amps
- Limiting Amps
- Log Video Amps
- Voltage Controlled Amps



*Teledyne Microwave Solutions is committed to giving our customers the amplifiers and requisite support needed to achieve success.*



# Integrated Assemblies

## A full range of Frequency Generation Products

Teledyne Microwave Solutions offers State of the Art integrated microwave assemblies (IMAs) utilizing custom building blocks and mixed media construction techniques to meet the most challenging performance and size constraints on the market today.

With experience from UHF to V-Band, we have a wide portfolio of circuit architectures, configurations and functionality to meet many different platform needs serving the Communications, Radar, EW, & Test Equipment Markets

### Synthesizers 0.1 to 50 GHz

- Wideband fast tuning (<100nS)

### Converters 0.1 to 50 GHz

- Single or Double Conversions to meet Spurious Requirements

### Transceivers 0.1 to 50 GHz

- Integrated SSPAs to meet High Power Applications

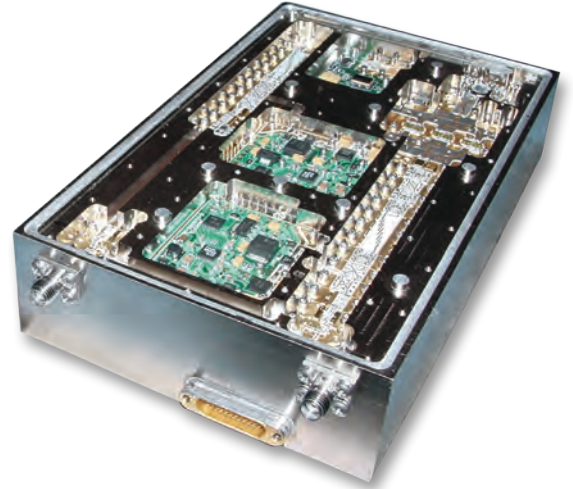
### Building Block Features

- High Density Packaging for Smaller Footprints & Lower Weight
- Phase Locked Loops
- Standard Modules for quicker development times
- Step Recovery Diode Comb Generators incorporating Switched Filters
- Multi-loop Frequency Synthesizers
- Standalone Multipliers

### TMS Advantage

- Broadband Coverage
- Fast Tuning
- Sub-Hz Resolution
- Low Phase Noise
- Integrated BIT
- Output Filtering for low Harmonic and Spurious
- Fast Output Blanking
- Power Amplifier Efficiency (PAE of 40% GaAs, 60% GaN)
- Spurious Free Dynamic Range (-60 dBc over 75 dB range)

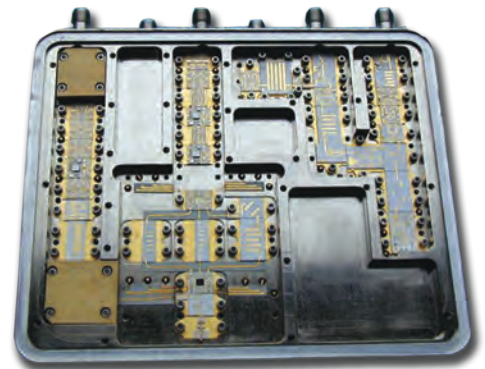
*Common Data Link Transceiver with integrated SSPA & LNA*



*Ku-Band Converter Synthesizer*



*Phase Locked Oscillator*

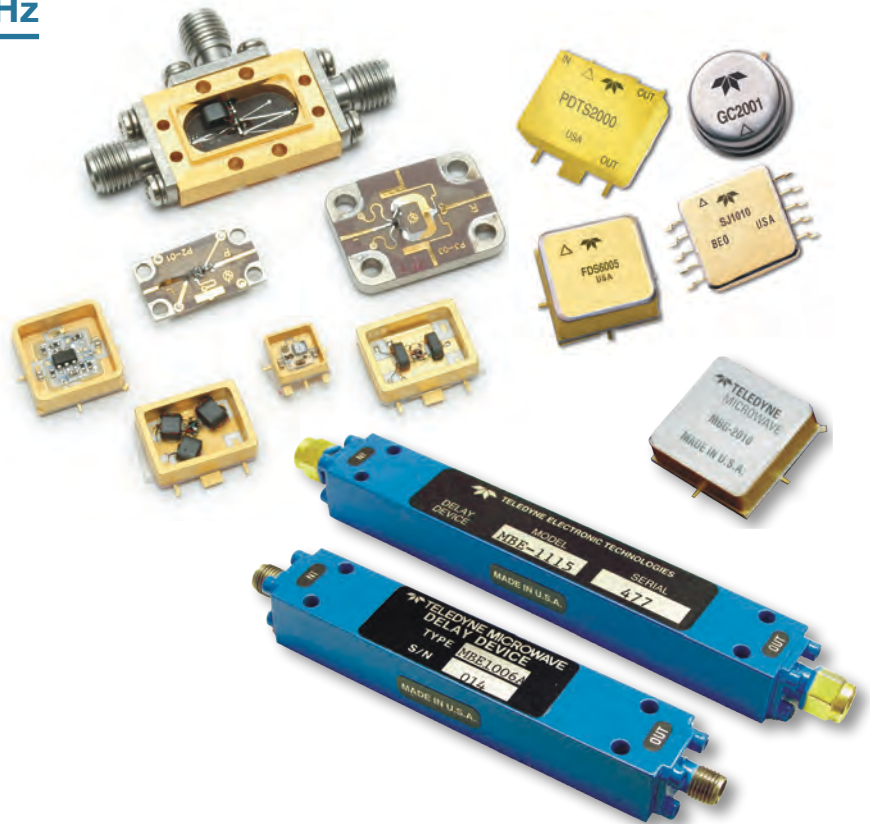




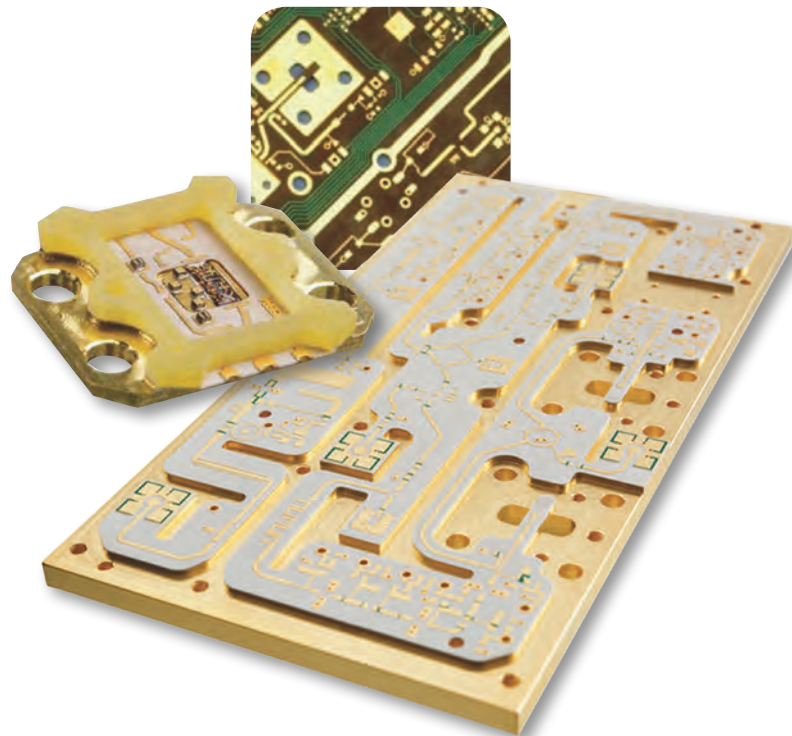
# Components / Packaging

## TMS Components - DC to 110 GHz

- GaN, GaAs, InP, LDMOS Amplifiers
- Voltage Controlled Amps
- Voltage Controlled Attenuators
- Analog/Threshold Detectors
- VCO's, DRO's
- RF & Microwave Mixers
- Detectors & Limiters
- Frequency Doublers
- Power Dividers
- Switches
- IQ Networks Narrowband
- IQ MOD / DEMOD
- Limiting Amps
- DLVAs
- BAWs



## Packaging for Demanding Applications



- Multi-layer & Large Format PCB
  - ▶ Integrated Antennas
- Metal Backed & Metal-Cored PCB
  - ▶ High thermal load environments
- Embedded Component Technology
  - ▶ Reduced packaging size
- Flex & Flex-Rigid PCB
- MMIC Packaging
- Thin Film Manufacturing

### Microwave Packaging to 110 GHz

- Fully Integrated Manufacturing supporting all major material sets
  - ▶ Design Verification
  - ▶ Layout, Lamination, Plating
  - ▶ Post Processing Test & Validation

# Filters

## TMS Filters

Teledyne Microwave Solutions (TMS) has been making filters since 1974, serving the microwave industry with miniature microwave filters utilizing unique lumped element design techniques. This product line includes different types of filters, multiplexers, diplexers, solid state switches, switch filters, low noise amplifiers, and integrated sub-systems covering the frequency range of DC to 40GHz. Applications include: Military, Commercial, Comms, T&M, EW, Missile, Space, and Payload.



### Interdigital Filters

- Frequency - 800MHz to 30GHz
- Bandwidth is <1% to 75%



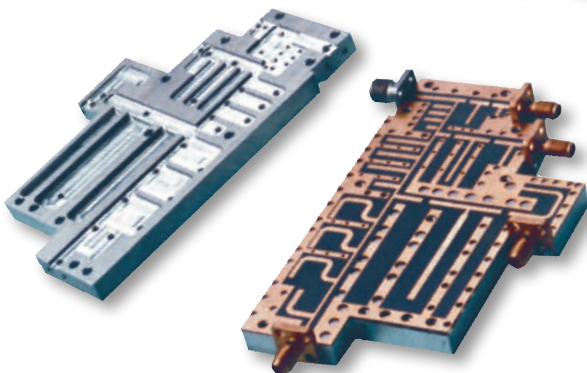
### Lumped Element Filters

- Frequency - 10MHz to 20GHz
- Bandwidth is <1% to Multi-Octave



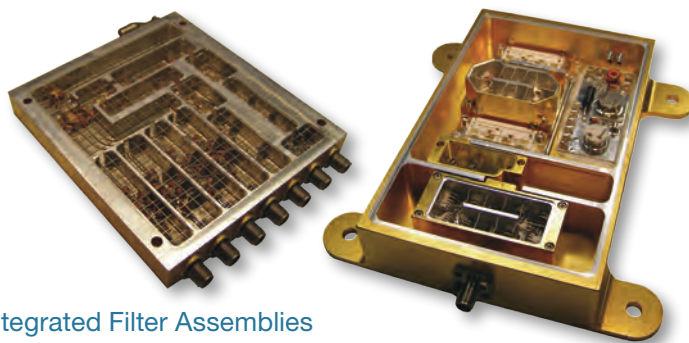
### Combine Filters

- Frequency - 10MHz to 20GHz
- Bandwidth is <1% to 60%



### Suspended Substrate Filters

- Frequency - 1GHz to 40GHz
- Bandwidth is 25% to 100%



### Integrated Filter Assemblies

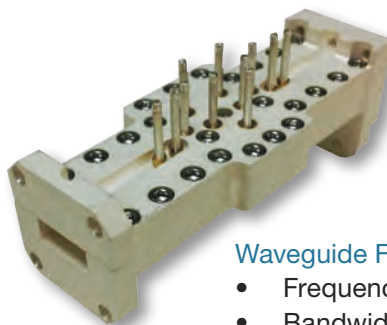
- Frequency - 10MHz to 40GHz
- Bandwidth is <1% to Multi-Octave

### Coaxial Resonator Filters

- Frequency - 1GHz to 4GHz
- Bandwidth is <1% to Multi-Octave

### Cavity Filters

- Frequency - 100MHz to 40GHz
- Bandwidth is <1% to Multi-Octave



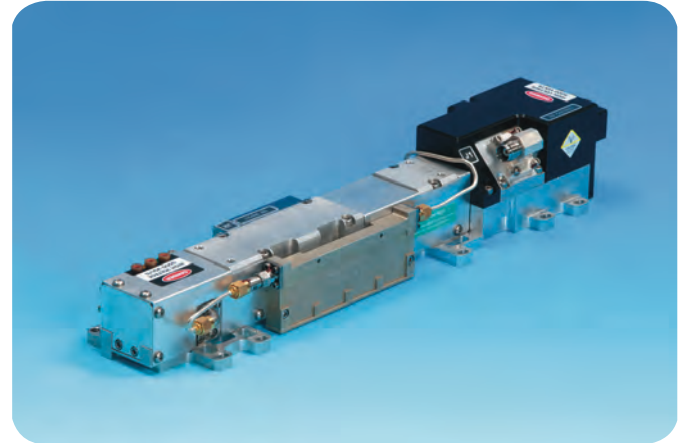
### Waveguide Filters

- Frequency - 10MHz to 40GHz
- Bandwidth is <1 to 10%

# TWT Products

## TMS TWT Products

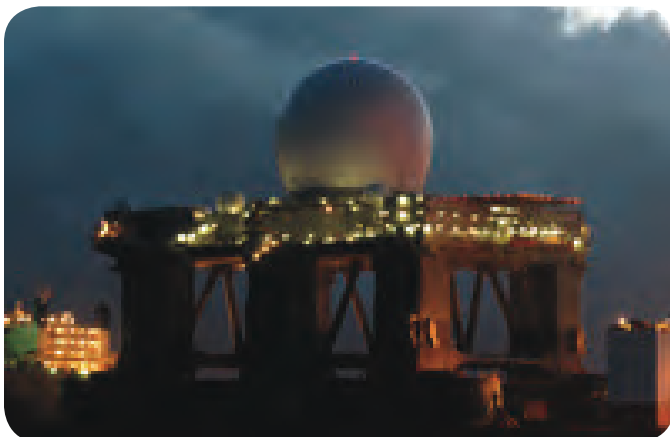
- Modern 160,000 ft. facility in Rancho Cordova, CA  
Design & Manufacture of Microwave Vacuum Products
  - ▶ TWTAs
  - ▶ HPA Systems
- Markets
  - ▶ Defense: Radar, Missiles, EW, Comms
  - ▶ Telecommunications
  - ▶ Instrumentation
- ISO 9001 certified



## Integrated Products Serving the Communications, Radar, EW, & Test Markets



- Pulsed TWTs & TWTAs
  - ▶ L-Band through Q-Band
  - ▶  $P_{PEAK} > 14kW$   $P_{AVE} > 1kW$
  - ▶ Dual Pulse / CW operation available
  - ▶ Ground & Airborne TWTAs
- Applications
  - ▶ Air-Defense Radars
  - ▶ Air Traffic Control Radars
  - ▶ Battle-Field Radars
  - ▶ Meteorology / Lab Testing
  - ▶ SAR Mapping
  - ▶ ISR
  - ▶ Shipboard Radar





# TWT Products

**TMS EW/ECM TWTs with Multi-Octave High Power Generation are smaller, lighter, and more efficient than their solid state amplifier counterparts.**

Capabilities and benefits include:

- World class engineering design group
- Industry leading Multi Octave Broadband designs
- On Board, POD, and Decoy Qualified models
- Scalable Designs to meet new threats
- Years of on-site Power Combining Experience
- Demonstrated high MTBF
- On-time deliveries



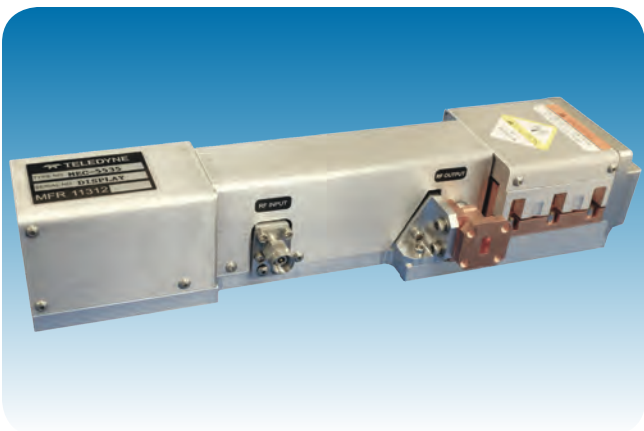
*TMS TWTs are the technology of choice to enable the warfighter to own the electromagnetic spectrum.*



## TMS Satcom TWTs

Compact, rugged designs for Fixed, Mobile or Air applications

- TWTs Supporting all Commercial and Military Communication Bands (C/X/Ku/Ka/Q)
  - ▶ 600W CW in Tri-Band
  - ▶ 750W in Ku-Band
  - ▶ 502W in Ka-Band



# Solid State High Power Amplifiers

## TMS Standard and Custom SSHPA Solutions covering most Radar, Communication, and EW frequency bands

TMS has built a strong portfolio of SSPAs supported by innovative, collaborative engineering and manufacturing teams. Covering 1MHz to 110GHz, from 1W to 10kW, TMS SSPAs include both Pulsed and CW for all markets from Commercial Satcom to Military and Space Qualified platforms.

Our new Solid State High Power Amplifier (SSHPA) product line provides power from 100W at module level to multi kW at system level, in frequency bands ranging from UHF to Ku-Band. These amplifiers utilize state of the art thermal management schemes and unique highly efficient coaxial power combiners to allow designs in smaller form factor with improved reliability.

SWaP (Size Weight and Power) has become increasingly critical in the design of new and legacy systems. TMS has some of the smallest and lowest weight SSPAs on the market. A good example is our 15W Ku-Band SSPA which operates over data link & satcom bands with a total weight of less than 0.5 lbs. and only 0.5 in. thick.

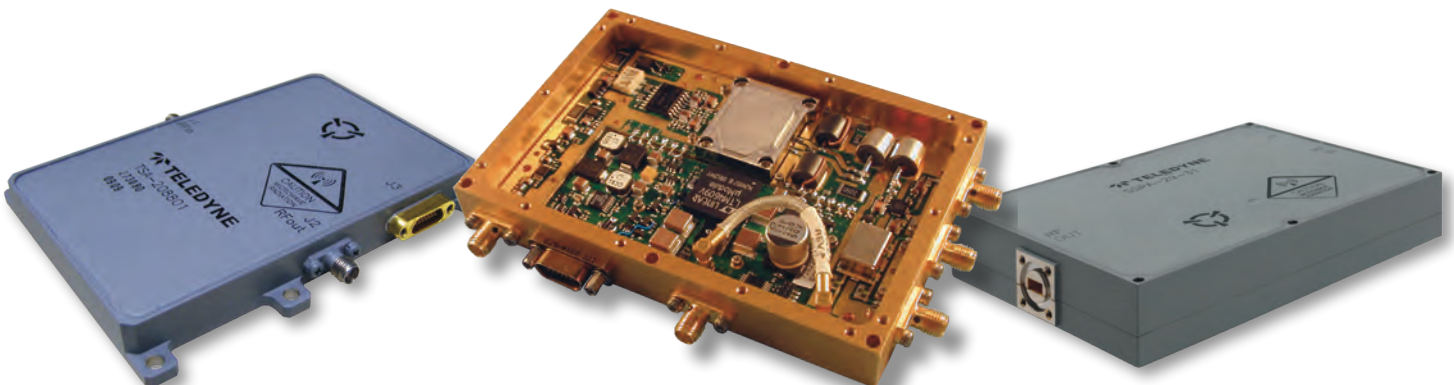
*TMS uses LDMOS, GaAs, InP & GaN technologies, producing custom designs to customer specifications. GaN is particularly successful in pulsed applications, with many different amplifier designs available up to 18GHz.*

**With 20 years of experience and extensive use of ATE (Automated Test Equipment), TMS is well equipped to support our customers' technical and production needs for all SSPAs.**



### Key Features

- Proven Rugged Design
- Low Profile Hermetic Package
- Power Efficient Design
- Lightweight
- Detect and Disable available
- Linearizer available on some models
- Integrated VGA and Power Detect Loop available
- Low Power Mode
- VSWR Detect
- Bus Control (RS422 and others)

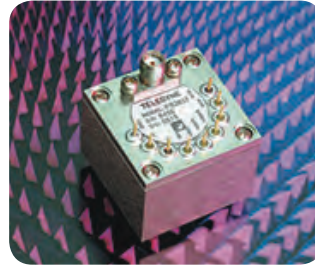




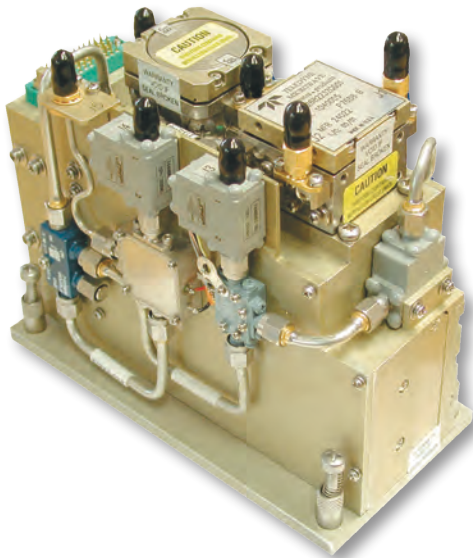
# YIG Products

## TMS Yttrium-Iron-Garnet (YIG) products include a range of Filters, Oscillators and Integrated Assemblies

TMS's YIG filters provide excellent linearity, low insertion loss and broadband tuning characteristics. TMS supplies both open-loop and closed-loop YIG filters in the smallest rugged packages in the industry, and has the Industry's only YIG filter that locks to a desired signal.



Teledyne YIG-tuned oscillators offer multi-octave tuning, excellent linearity, low phase noise, phase lock & modulation capability, and temperature stability in compact, rugged packages, including the unique Tiny YIG. Some products are available with permanent magnet (PM) technology.



Teledyne Microwave Solutions integrates YIG components with related microwave technologies, creating custom solutions that leverage the advantages of YIGs in a cost-effective assembly. These include synthesizers, receivers, converters, and more.



# Teledyne Paradise Datacom

## Standard & Custom Modems for use in Satellite Ground Station Applications

### Typical Features:

- Software defined satellite modems provide Ethernet/IP or serial interface for data/voice/video circuits at satellite ground stations
  - ▶ L-band and IF interface (switchable)
  - ▶ Data rate up to 155+ Mbps
  - ▶ Paired carrier technology provides up to 50% bandwidth savings
  - ▶ Dynamic routing and IP traffic shaping capability
  - ▶ Fully functioning on-board diagnostic tools (accessible remotely via the web)
  - ▶ LinkGuard™ interfering signal detection
  - ▶ 120 modcod settings available
  - ▶ Low profile single card satellite modem for OEM products
  - ▶ L band operation (950 – 2050 Mhz)
  - ▶ IP processing to 60Mbps
  - ▶ 255x184x18mm, 30W typical power consumption
  - ▶ Ideal for man-pack and portable applications
  - ▶ Paired carrier and DVB-S2 available



Q-Flex Satellite Modem



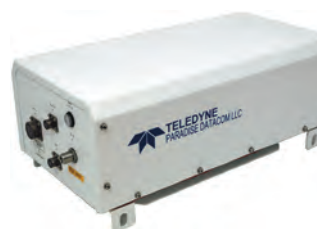
Q-Lite single card satellite modem

### Applications:

- Cellular backhaul, gateways; SCPC data/IP/voice/video circuits; Mobile Comms

## Solid State Power Amplifiers (SSPAs) and Solid State Block Up Converters (BUCs) for use in Satellite Uplink Applications

- Outdoor packaged SSPAs Covering all Standard Communication Bands:
  - ▶ L-band BUC available (C, X, Ku and Ka-Band)
  - ▶ Redundant and phase combined systems
  - ▶ Fiber Optic transceiver support available on all outdoor SSPAs
  - ▶ GaN technology optimizes size, weight and efficiency
- Rackmount SSPAs
  - ▶ L-band to Ku-Band, 20W to 1.5kW
  - ▶ L-band input with optional internal zBUC
  - ▶ Modular designs allow for hot-swappable power supply and RF sections
- PowerMAX Modular Phase Combined Systems
  - ▶ L-band to Ka-Band, 100W to 10kW
  - ▶ All active components are modular and hot-swappable
  - ▶ Inherent n+1 redundancy allows failure of a module without losing link



Compact Outdoor SSPA

PowerMAX





# Systems / Subsystems



## TMS Systems Serving the Communications, Radar, EW, & Test Markets

- Line Replaceable Units (LRU's)
  - ▶ 5 Channel Frequency Converter
  - ▶ Noise Source Assembly/Broadband Amp with Transfer Switch
- Antenna System
  - ▶ Transmit/Receive Module
  - ▶ Converter/Synthesizer/Controller Module
  - ▶ RF Switch Module (SP18T)
  - ▶ Power Supply Module
- Advantages/Benefits
  - ▶ Custom Designs to meet Customer Requirements
  - ▶ Broad Component Base to Design Systems

## TMS Subsystems Serving the Communications, Radar, EW, & Test Markets

- Digitally Tuned Oscillators (DTO's) 0.5-18 GHz
  - ▶ Fast tuning < 1 usec
  - ▶ Single and Wide Bandwidths
- Frequency Locked Oscillators (FLO's) 0.5-18 GHz
  - ▶ Improved Settling Time and Frequency Accuracy
  - ▶ Improved Phase Noise
  - ▶ Modulation in open- or closed-loop modes
- Set On Receivers (SOR)
  - ▶ IFM based Receiver
  - ▶ Fast Jamming <250nsecs

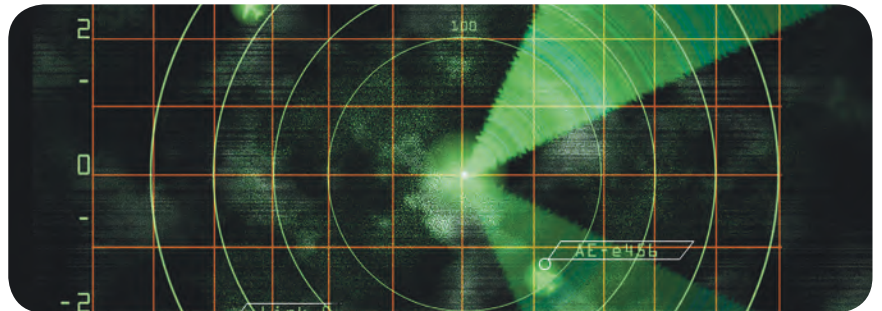
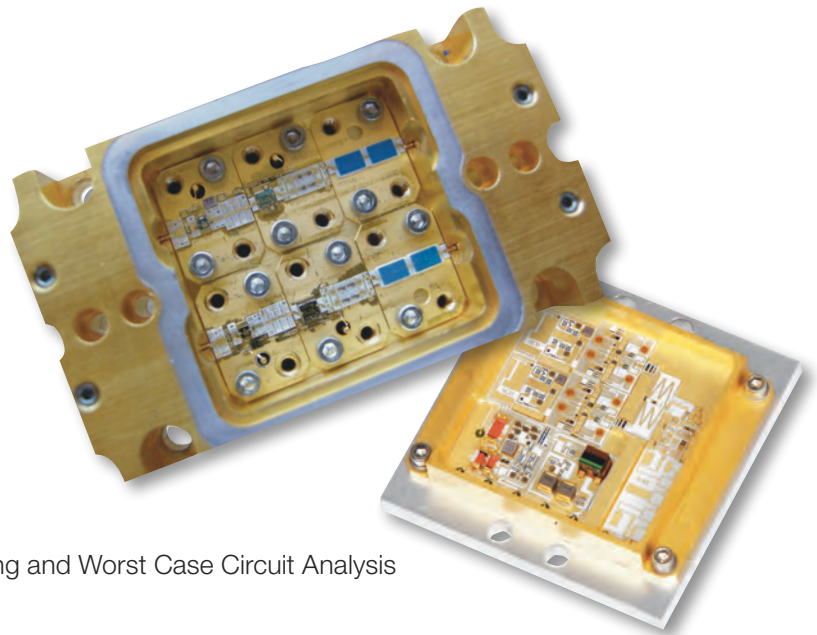
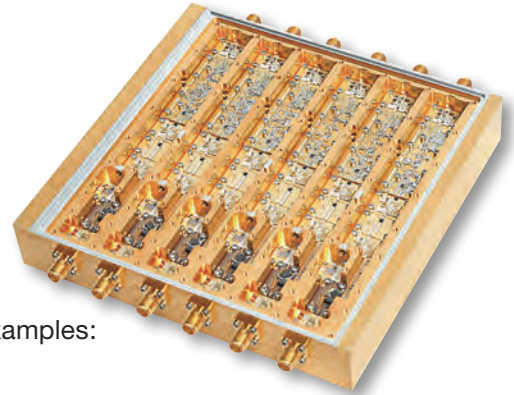


# Space Products

## Space Qualified Components

Specify MIL-PRF-38534 QML-certified space-level components with ease, speed and assurance with TMS. Designers can choose from the broadest selection of space qualified hardware in the industry. Our experienced staff and space expertise are trusted by design engineers to provide mission-compliant space grade solutions.

- Full Line of RF and Microwave Components Qualified for Space
  - ▶ Amplifiers
  - ▶ Oscillators, Microwave Mixers, Detectors
  - ▶ Frequency Doublers, Power Dividers, Switches
  - ▶ IQ Networks Narrowband, IQ Modulators & Demodulators
  - ▶ Limiting Amps and Limiters
- Design, Integration, and Assembly of Microwave Integrated Products - examples:
  - ▶ LNAs
    - With/Without Integrated Filters
    - LNA / Down-Converter Integration
  - ▶ Medium and High Power Filters and Multiplexers
  - ▶ Up and Down Converters
  - ▶ Receivers
  - ▶ Transmitters
  - ▶ SSPAs
  - ▶ High Power 5 to 50 Watts
  - ▶ DC/DC Power Supply
  - ▶ Digital Control
  - ▶ SSPA / Up-Converter Integration
- Advantages / Benefits:
  - ▶ Higher Level Integration Capabilities
  - ▶ Space Proven Heritage
  - ▶ Experienced Engineering Staff to handle Derating and Worst Case Circuit Analysis



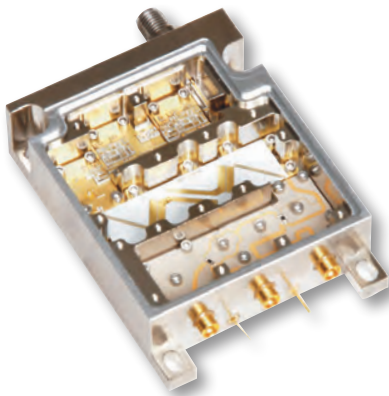
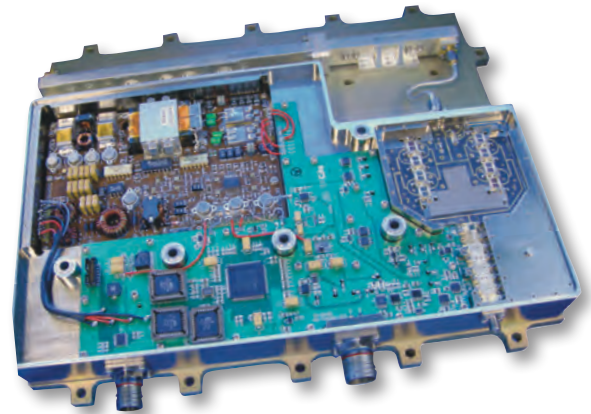


# Space Advantage

## A Proud & Distinguished 40 Year Heritage with the U.S. Space Program

A trusted partner to our customers, TMS understands the challenges and the solutions our customers face. TMS continues to be the supplier of choice for space-grade products for commercial, scientific and military space requirements.

- Chip and Wire Hybrid Technology
  - ▶ Fully Space Qualified per MIL-PRF-38534, Class K
  - ▶ Consistently Reliable Performance
  - ▶ Mission Proven Success Domestically and Internationally
- In-Place Proposal Team
  - ▶ Experienced
  - ▶ Technical / Financial / Contracts
- Engineering Leadership and Support
  - ▶ RF & Microwave / Mechanical / Thermal / Reliability / Quality
- Fully Integrated Product Team (IPT)
  - ▶ Program Management Team
  - ▶ Contain and Reduce Risk
  - ▶ Proactive Control of Schedule, Manufacturing, Quality



*Quality Certifications:  
MIL-PRF-38534, Classes H & K (TRB Option)  
ISO 9001, AS9100*

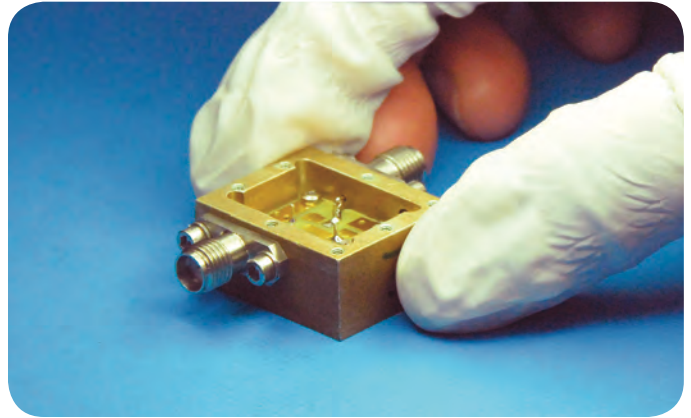


# Value Add Services

## Up Screening, LAT, Element Evaluation and Much More

For over three decades, Teledyne Microwave Solutions has been delivering advanced value added services to the military, space and industrial sectors of aerospace...and building a deep services heritage that is second to none in the industry.

*Our services include chip-and-wire assembly of products ranging from single die through complex hybrids, which can then be submitted to a combination of customer specified RF and DC testing and environmental screening. We perform Lot Acceptance Testing on packaged devices or bare-die, including diodes, transistors, and MMICs, with test capabilities to 40 GHz. A complete portfolio of component, manufacturing, screening, and testing services are available including device sorting, labeling, lead forming and tinning, and tape-and-reel packaging.*



- Up-screening and LAT performed to MIL-PRF-19500, 38534, 38535 and MIL-STD-883 & 750 for Military & Space Programs
- Space Level Screening & Qualification for Plastic Encapsulated Devices per NASA EEE-INST-002
- LAT and Up-screening on: FETS & MMICs, Bipolar Transistors, Diodes
- Full DC and RF Testing up to 40 GHZ
- Packaging & Screening of Active Die
- Up-screening & Testing of GaN Devices
- Verification & Testing of Counterfeit Parts
- Complete Environmental Test Lab that includes Full and RF burn-in capabilities

