

**EMPOWER**  
RF SYSTEMS, INC.



# Solid State High Power RF & Microwave Amplifiers

Systems  
Subsystems  
Modules

2021

[www.EmpowerRF.com](http://www.EmpowerRF.com)

# COMPANY OVERVIEW

Founded in 1999, Empower RF Systems is a global technology leader in power amplifier solutions that are critical to defense, commercial, and industrial market applications.

With our origins in the design of broadband and band-specific solid state power amplifiers, Empower continues to advance the science of RF power amplification to produce rugged, power efficient, and cost-effective solutions. It is our priority to design and deliver high quality, innovative products which address customer systems and business requirements.



HIGH POWER SOLID-STATE  
AMPLIFIER SOLUTIONS  
10 GHZ AND BELOW

*COTS and Customization at the  
Module and Rack Mount Systems Level  
with Output Power Levels from Tens of Watts  
to Hundreds of Kilowatts*

Operating globally and continuing to innovate RF and microwave amplifier technology, Empower RF has been awarded multiple patents on amplifier design techniques and assembly methods. These technologically advanced designs are in use by market leading OEMs, government agencies, and academic institutions with an array of demanding performance requirements.

Headquartered in Inglewood California,  
Empower RF Systems manufactures the most  
technologically advanced COTS amplifier  
solutions for defense, commercial and  
industrial market applications.

# CW & PULSED Amplifier Solutions

Empower RF product lines incorporate state-of-the-art GaN on SiC and LDMOS device technologies. Our extensive library of product designs includes over five hundred documented solutions ranging from basic-function PA modules to complete, multifunction PA assemblies with embedded software and high speed processing. Empower RF leverages “building block” combinations of these documented solutions and the extensive experience of our technical team to react swiftly to new requirements and offer a variety of cost-effective, value-added solutions.

## Rugged Air Cooled Multi-Mode SSPAs

A technologically advanced architecture from Empower RF Systems is yielding **unprecedented size and weight reduction for 500W, 1 kW, and multi-kW power amplifier platforms**. This family of amplifiers have been fielded using both LDMOS and GaN devices for user applications that include EMC / Radiated Immunity, Communications, EW, Radar, and RF Component Testing.



## Liquid Cooled Scalable SSPA Architecture for High Power Transmitters

Our new breakthrough architecture replaces tube technology delivering new capabilities to applications where tens and hundreds of kilowatts of CW and Pulse power are required. **Key features include “on air” hot swapping, waveform flexibility and no single point of RF failure.** Pulsed models allow long duty cycles, long pulse widths and asymmetrical pulse trains.

## Large Selection of COTS Broadband Modules

Empower offers a full line of basic function, module level building blocks for customers integrating power amplifier stages into their products. These modules are used in a variety of commercial, industrial and military applications.





# TECHNOLOGY LEADERSHIP

The team at Empower RF Systems is doing leading edge design work to enable the deployment of next generation power amplifiers with the embedded computing that's integral to their performance advantages. Multi-use capability from a single amplifier is at the forefront of electromagnetic spectrum dominance. A single transmitter capable of radar pulses, communications, frequency hopping, and GPS denial are one example of multi-mode technology being asked for by major prime contractors and government agencies. Empower RF is answering that call.



Patent US 9,007,125  
Patent US 9,093,731  
Patent US 8,736,365  
Patent US 62/847,751  
Patent US 62/856,732  
Patent US 20/32,815

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Our Next Generation air and liquid cooled amplifiers are designed to stay ahead of the increasing complexities of the signal environment. The combination of embedded firmware, software, and real time processing/control allows for maximum flexibility and operation in any application. This single architecture is capable of user selectable multimode operation and can be dynamically configured.

Flexible and interoperable across applications and complex waveforms, these amplifiers have user and M2M selectable modes for the detector, input signal modulation, and output power management allowing for optimal efficiency, maximum peak power, accurate metering, and self-protection suited to your waveform environment.

**Size and weight of these amplifiers are superior to anything in the market** at these frequencies and power levels - user interface and diagnostics capabilities are built around high performance microprocessor and IP addressable, embedded web server. Instrument grade power metering eliminates the need for extra components at the system level.

# The World's most CAPABLE AMPLIFIER

Designed to stay ahead of the ever increasing complex waveform signal environment, Empower's Next Gen Family of smart high power amplifiers is the result of a visionary design combining advances in RF components, digital loop control, real time software, HTML GUI, thermal, and electro mechanical design to create a flexible, scalable, rugged, and future proof smart amplifier.

**The results are ground breaking features not available in any other off-the-shelf amplifier.**

*Real Time Feedback Enabling AGC & ALC Power Modes*

*Sophisticated Input and Output Detectors for a Multitude of Modulation Modes*

*Deep Diagnostics that Speed up System Integration + Remote Servicing and Debug*

*Scalable Architecture for upgrade path*

*Built In Web Server for User Friendly Command & Control*

*Ability to Control or Monitor the Amplifier from anywhere in the World*

*Software Enabled Architecture is Easily Customized for Specific Applications*

*Amplifier is Capable of Controlling other Equipment on the LAN*

*Rugged COTS Design – Virtually Every Internal Connector Eliminated*

*A Single Amplifier Capable of Multi-Domain Applications*

*Higher Efficiency and Better Utilization of Size and Weight*



# MARKETS

We provide broadband and band specific, high power amplifier solutions to OEM systems designers and end users who build on the performance of our units for their own applications.

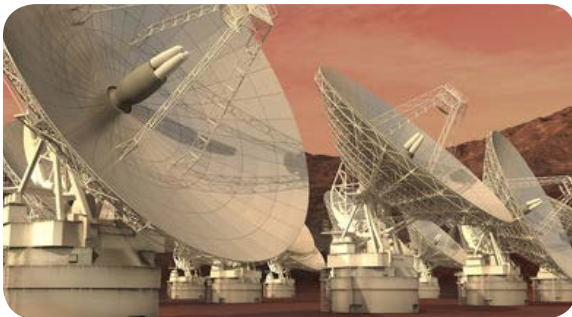
## Electronic Warfare



Empower RF is **tactically deployed in a variety of applications** disrupting adversary Radar, Comms, Satcom and GPS.

- ▶ Outdoor Range Threat Simulation
- ▶ Counter UAS, C-UAV
- ▶ Ground Vehicle Jammers
- ▶ Very High Power Fixed Site
- ▶ Shipboard EA
- ▶ Airborne EA

## Satcom & Telemetry



Empower's solid state architecture allows more complex digital modulation **providing higher data rates** in a smaller footprint than the legacy TWTs we are replacing.

- ▶ Ground Based
- ▶ Shipboard
- ▶ Airborne Platforms
- ▶ Flight Termination Systems

## Communications



Empower provides **modules for radio manufacturers and rack mount systems for larger infrastructure** networks for commercial and military applications.

- ▶ Broadband Private Networks
- ▶ Military and Government Agency
- ▶ Tactical Radios



## Radar



Empower's solid state architecture **allows for high fidelity and multifunction radar** with a lower total cost of ownership than legacy tube implementations. Industry leading features include long pulse width and duty cycles with high PRFs.

- ▶ Deep Space Radar
- ▶ Solid State TWT Replacement
- ▶ Commercial and Military
- ▶ Multi-Function Radar
- ▶ Ground, Ship, and Airborne
- ▶ Open Air Range
- ▶ Phased Array

## Test & Measurement



The multimode capabilities of our Next Generation systems offers the widest flexibility across test applications. Remote user GUI and machine to machine interface make these amplifiers **easy to integrate into embedded test applications**.

- ▶ Environmental Electromagnetic Effects
- ▶ CE, DOD-160, and Mil-STD Radiated Immunity
- ▶ RF Component Testing
- ▶ Semiconductor Test
- ▶ Medical Research

## Wireless Infrastructure



Empower provides **COTS and custom amplifiers for critical communications and datacom networks**. Often broadband, our amplifiers are designed into rapidly deployable aerial and terrestrial communication systems having unique RF and environmental requirements.

- ▶ Portable Deployable Networks
- ▶ Wireless Infrastructure Test
- ▶ Private Data Networks
- ▶ Secure Agency Networks

# SCALABLE SOLID STATE POWER

## Is a Better Choice

This breakthrough liquid cooled, solid state design replaces tube technology bringing new capabilities to applications where tens and hundreds of kilowatts of CW and Pulse power are required. This remarkable architecture brings together four major technology advancements.

1

First is the fully **digital Peak and RMS detection** providing waveform flexibility and accurate metering allowing asymmetrical and random pulse width and duty cycle operation on CW and pulse amplifiers. Short and long pulse capabilities are sub100ns to 500+usec and up to 500kHz PRFs and 20% duty cycles.

2

The second advancement is the combination of embedded firmware, software, and real time processing/control bringing multi-use flexibility to operate in any application. User selectable **multimode operation can be dynamically configured**. Important to note, CW amplifiers offer the same pulse performance as our pulsed amplifiers with no limit on duty cycle while pulsed amplifiers allow de-rated CW operation.

3

No single point of RF active device failure is the third design element. The amplifier layout consists of a system controller in a 3U and up to 16 **hot swappable** 2U amplifier drawers per rack with each amplifier drawer containing an integrated power supply. With this arrangement, in the event of a failure, only a fractional reduction of output power occurs and the amplifier system remains on air. The 2U amplifier drawers are hot swappable and there is **no high voltage power supply within the transmitter**.

4

The fourth major design element is **scalability** which creates an affordable upgrade path for future power needs by adding hardware to an existing system. Additional racks can be combined and, for racks not fully populated, 2U amplifier drawers can be added without the need for tuning, since each 2U amplifier drawer and full system rack is digitally set for phase and gain.

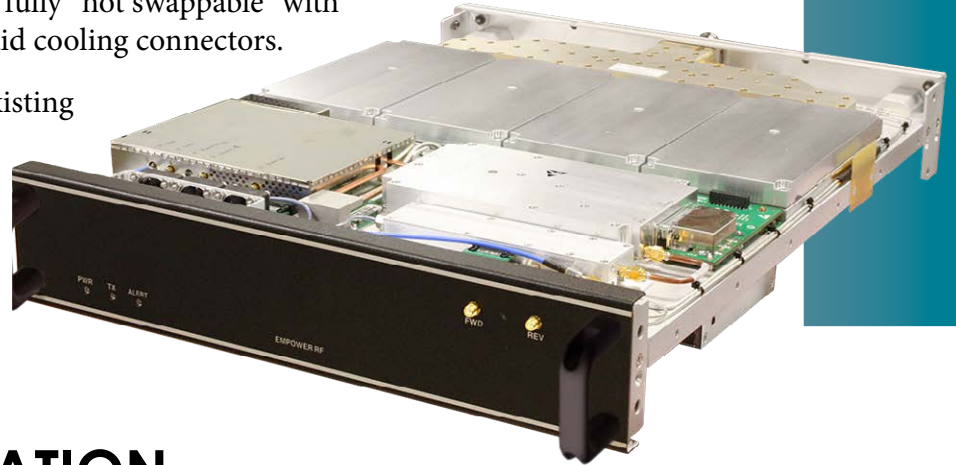




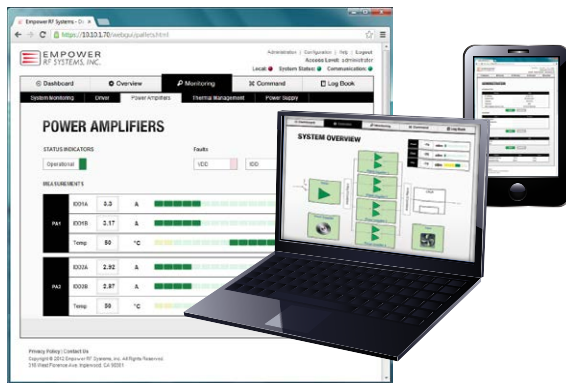
# The Most Flexible AMPLIFIER SYSTEM

Narrow and broadband configurations are available from UHF to X Band CW or Pulsed. The architecture is the same regardless of frequency – configurations are driven by output power requirements. Each amplifier drawer is fully “hot swappable” with proven RF, AC power, and dripless liquid cooling connectors.

You can increase output power to an existing amplifier by adding 2U amplifier building blocks (in even numbers) or adding additional complete racks.



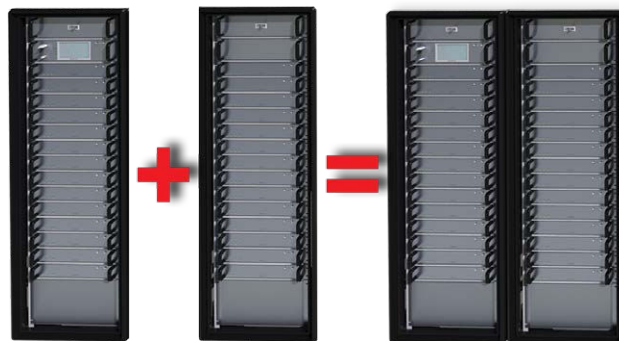
## MULTIMODE OPERATION



Empower’s Next Generation liquid cooled amplifier is designed to stay ahead of the increasing complexities of the signal environment. The combination of embedded firmware, software, and real time processing/control allows for **maximum flexibility and operation in any application**. This single architecture is capable of user selectable multimode operation and can be dynamically configured.

## SCALABLE UPGRADE PATHS for Future Planning

*Empower’s scalable liquid cooled solutions offer an affordable upgrade path for future power needs by adding hardware to an existing system. Our solutions provides three levels of scalability which can be exercised independently or in any combination.*



- ▶ Increased number of 2U amplifier drawers per rack
- ▶ Increase number of racks
- ▶ Increase the amplifier’s duty cycle for pulsed systems - consult factory

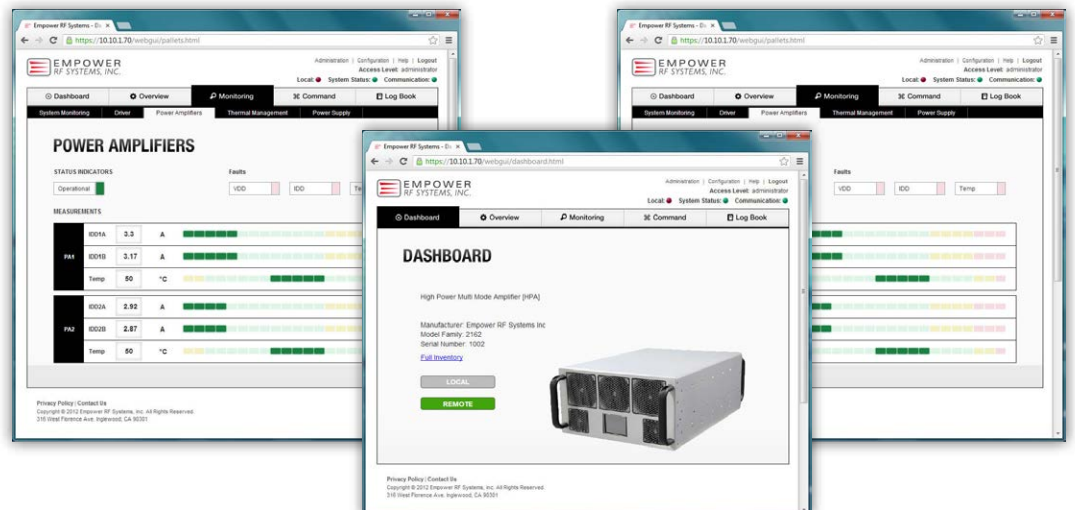
# USER INTERFACE

User interface capabilities of Empower's Next Generation power amplifiers allow the user to initiate remote management and diagnostics via an embedded web server, enabling network managed site status and control simply by connecting the unit's Ethernet port to a LAN or via Wi-Fi by adding a wireless router. For machine to machine interface (M2M), Empower offers TCP/IP or UDP protocol sockets accessed through the Ethernet port. These are new and unique features of Empower's Next Generation "size matters" RF amplifiers.

- ▶ Uses web browser
- ▶ No software install required
- ▶ Real time power amplifier control & diagnostics
- ▶ Ability to pull the HPA into a "network" of end user system components (LXI compatible)



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# Software Definable

Because we live in an increasingly complex digital waveform environment, we designed in flexibility to provide you with a future-proof and digitally reconfigurable rack amplifier solution. Since the System Engineer usually has to wrap external control and intelligence around the typical amplifier, we opted to design in hardware and software features to shorten your system integration time and cost by providing features that would otherwise burden your engineering staff with building out extra hardware and software.

The array of user configurable power management modes makes this product **extremely flexible and multi-purpose**, uniquely positioned for customer specific variations with subsets of those capabilities.

User Selectable

## Output Power Management

- ▶ Automatic Gain Control (AGC) with peak power detection
- ▶ AGC with RMS power detection
- ▶ Automatic Level Control (ALC) with peak power detection
- ▶ ALC with RMS power detection
- ▶ Manual Gain Control (MGC)

## Input Signal Modulation

- ▶ FM, AM, Pulsed, CW
- ▶ CDMA, FSK, QPSK, OFDM
- ▶ Multi-tone
- ▶ Frequency Hopping

## Input and Output Detectors

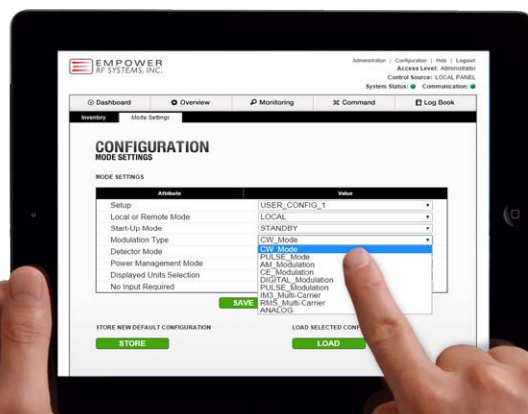
- ▶ Peak
- ▶ RMS



Visit

[www.empowerrf.com/software](http://www.empowerrf.com/software)

*For more information and for Software Virtual Tour*

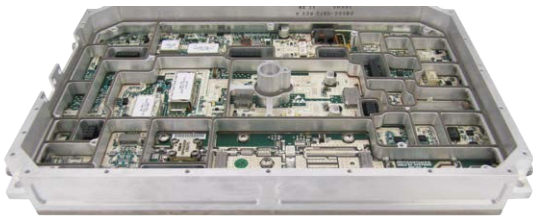


# BUILDING BLOCK MODULES

## Cost Effective, Building Block Solutions

Empower offers a full line of basic function module level building blocks for customers interested in integrating only power amplifier stages in their design. These modules are used in a variety of applications as either a standalone PA or as an integral part of a customer's higher level systems design. **Designed for RF and mechanical "ease of use"**, these products are full gain, self contained amplifiers with control

and protection features that ensure performance over temperature and reliable operation. Broadband and band specific variations of these products are available up to 10 GHz and in various gain / output power configurations. The full array of frequency and power combinations available with these building block modules can be viewed by accessing the Module tabs on our homepage, [www.empowerrf.com](http://www.empowerrf.com).



## Custom Configurations for Volume Applications

Complex module solutions, incorporating customer specific requirements for switching, filters, multiple channels and extreme bandwidth, have been designed and delivered by Empower RF Systems for demanding applications in communications and electronic attack. Size,

weight, power consumption, multi-function RF capabilities, and unique mechanical packaging are among the design challenges that have been addressed by our technical team on these custom products. These integrated solutions require close collaboration and commitment at the program level. Please contact us if your volume requirements can be simplified with an integrated, multifunction power amplifier design.

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## ILLUSTRATION: Size Reduction of Existing Product

*PA module repackaged successfully*

*Exceeded RF/Electrical performance with a **30% size reduction***



### **COTS baseline Model 1117**

500 to 2500 MHz, 30W

6" x 3" x 1"



### **Same product**

*Customer specific unique packaging*

4" x 2.6" x 1.2"

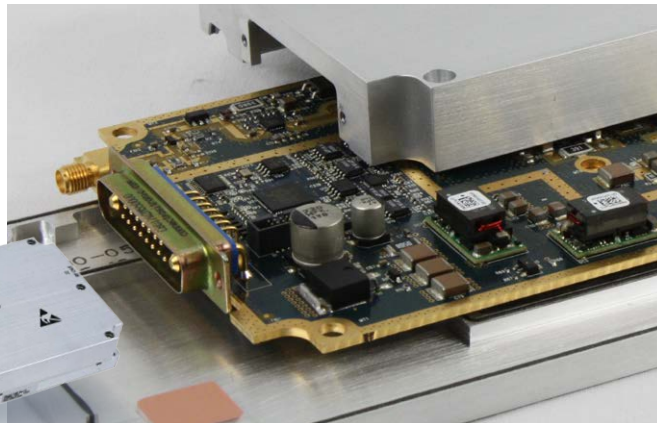
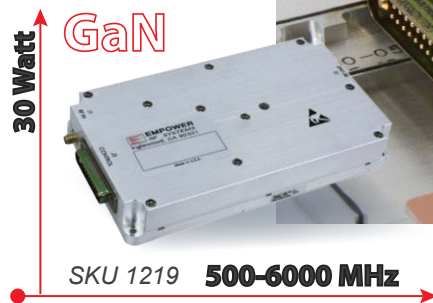


## Basic Modules

- ▶ Broad Selection of Frequency and Power Combinations
- ▶ Highly Reliable, Field Proven
- ▶ Demonstrated **Capability to Support High Volume Manufacturing** with 45,000 Modules Delivered on a Single Program
- ▶ Select COTS Solutions Available from Inventory Program  
<http://www.empowerrf.com/products/distribution.php>

## High Performance Modules for High Performance Applications

- ▶ Feature Rich
- ▶ Digitally Controlled
- ▶ Advanced Manufacturing
- ▶ Unique Packaging Available



## EMPOWER RF 48 VDC SMART MODULE FAMILY

*The same modules we use in our Next Generation platform of system amplifiers are available to you! Optimize module performance out of the box with supplied configuration software.*

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### Features

- ▶ Full Spectrum Coverage HF to 6 GHz in 48 VDC
- ▶ Linearity Improvements using the Best Device Technology
- ▶ Biasing Adjustable Class A, A/B
- ▶ Lower Current than 28V Designs
- ▶ Identical Footprints and Mounting 7x4x1.2 inch
- ▶ Common Heat Sink and Fan Assembly
- ▶ GaN devices are GaN on Silicon Carbide (SiC)

### Use Either Discrete Control or Digital RS485 Control

- ▶ Gain Adjustment
- ▶ Temperature Monitoring
- ▶ Input Current Monitoring
- ▶ Reset
- ▶ PA Blanking < 1 msec
- ▶ Alarm

50 W  
LDMOS  
1-30 MHz

100 W  
LDMOS  
20-1000 MHz

100 W  
GaN  
500-2500 MHz

100 W  
GaN  
1000-3000 MHz

50 W  
GaN  
2000-6000 MHz

# TWT REPLACEMENT

TWT replacement with SSPA reflects a powerful trend across a broad range of applications. With our high power expertise, we are playing a significant role in retrofitting legacy tube based systems. These legacy tube systems are often used in long tenured critical applications where total lifetime cost of ownership is an important consideration given the poor reliability tubes. The desired move to solid state amplifiers is motivated by the **superior signal fidelity, reliability, and lower cost of ownership**. The scope of these benefits depend on the amplifier architecture and are not the same across solid state amplifier suppliers. Architecture matters.

## Mission Critical On-Air Availability

Additional advantages of Empowers SSPA over TWT are the result of a distributed architecture of power supplies and RF sections. There are reduced points of failure in our air cooled models and no single point of RF device failure in liquid cooled models. The amplifier system will remain operational and “on the air” with graceful power degradation in the event of RF device failure or power supply failure. Hot swapping allows the amplifier to return to peak power without going off the air.



## Total Cost of Ownership

The modular architecture allows hot or cold swapping of the integrated amplifier drawers or the controller in less than 15 minutes. Repair is modular, fast and easy, bringing costs down. Specialized technician training is not required and there are no dangerous high voltage supplies to contend with. Because of the architecture **only fractional system spares are needed for a complete backup system**. You only need to spare a couple of amplifier blocks and one controller. The controllers are all common across the portfolio.

# PULSED AMPLIFIERS

## Long Duty Cycle Pulsed Amplifiers

Radar research and new radar designs are pushing pulse widths and duty cycles beyond the capability of TWTs. Empower delivers pulsed amplifiers from 2% to 25% duty cycle, pulse widths over 500 microseconds and up to 500kHz PRF.

When it comes to delivering big power reliably, efficiently, and at lower cost, Empower RF has a superior modern architecture validated with a proven track record delivering custom and COTS high power CW and pulse RF and microwave amplifiers to the military and prime contractors.



### Design Example: 8KW Pulsed S Band with Long Duty Cycles

- ▶ The model 2214 is a solid state high power pulsed amplifier for S band radar applications. It features up to 20% duty cycles and up to 500 microsecond pulse widths. These pulse capabilities make it an ideal choice for simulating adversary radar for open air range threat simulation. It's equally suited for use in radar and jamming with its 2.9 to 3.5 GHz bandwidth. This air cooled amplifier utilizes GaN on SiC devices that provide exceptional performance, long-term reliability and high efficiency.

### Solid State Power is a Better Choice

- ▶ Greater Reliability than TWTs
- ▶ Lower Life Time Cost than TWTs
- ▶ Long Duty Cycles and Pulse Widths Available
- ▶ Redundant Architecture to Maximize "On Air" Power

## Variations Based on COTS Models

In many cases, variations in bandwidth and power can be easily and quickly produced from our COTS product line, leveraging our flexible hardware and software architecture. In other words, you may not require a full custom design so check with our factory first.




**Call us today**

*and let's discuss the roadmap for your future needs of higher power and greater linearity*




## Offices and Manufacturing Facilities

### Los Angeles Headquarters

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Inglewood, CA 90301 U. S. A.  
 +1 (310) 412-8100

### New York Design Center

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Holbrook, New York 11741  
+1 (631) 319-6402

### Manufacturing Partners

 United States  
South Korea



Empower RF Systems is pleased to offer immediate delivery for modules in inventory at our global distributor, Richardson RFPD.

[www.EmpowerRF.com](http://www.EmpowerRF.com)  
[sales@empowerrf.com](mailto:sales@empowerrf.com)