EMPOWER
RF SYSTEMS, INC.

Solid State High Power

RF & Microwave Amplifiers

Systems
Subsystems
Modules

2019 / 2020

www.EmpowerRF.com

COMPANY OVERVIEW

Founded in 1999, Empower RF Systems is a global 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
18 GHZ AND BELOW

COTS and Customization at the Module and Rack Mount Systems Level with output power levels up to multi-kW

Operating globally and continuing to expand our technology resources, Empower RF has been awarded patents on amplifier design techniques and assembly methods. Our customer base includes market leading OEMs, government agencies, and academic institutions with an array of demanding performance requirements.

Design and Technology Innovations

Empower RF product lines incorporate state-of-the-art GaN on SiC, LDMOS, MOSFET, GaAsFET and bipolar device technologies. Our extensive library of product designs includes over four hundred documented solutions ranging from basic-function PA modules to complete, multifunction PA assemblies with embedded software and controllers. 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 to offer a variety of cost-effective, value-added solutions.

Assurance of Supply

Empower RF currently has two fully equipped R&D facilities, in-house manufacturing capabilities, and CM partnerships to handle both small and large scale requirements. The company is ITAR registered and ISO certified. In addition to our Inglewood, California facility, the company has a fully equipped design center in Holbrook, New York and additional design / manufacturing partnerships in the US and South Korea.

Empower is currently supporting contracts that range from engineering prototypes and low to medium volumes to production programs with much higher run rates. The specific arrangements for build and test support vary depending on the job, but in all cases, final QA and product certification occurs in Inglewood.

Company's evolution and today's value proposition is built on:

1. Mature, building block technology for modules, rack mount amplifiers, and multi-function, PA integrated solutions up to 18 GHz. Configurable and scalable output power combinations from hundreds of watts up to multi-kW's.
2. Library of proven, tested and fielded power amplifier designs using an array of power semiconductor technologies - demonstrated breadth of circuit and device modeling expertise.
3. Expanded team of knowledgeable and experienced power amplifier designers - credentialed engineers with industry recognition and approved patents in product applications including complex digital waveforms, digital modulations, Gaussian and broadband jamming techniques.
4. Experienced software and firmware design team managing the development of digital control circuitry, microprocessor controls, status, monitoring, user interfaces, SPI, RS-232, RS-485, Ethernet TCP/IP and Web Based SMTP protocols.
5. Expanded footprint of key customer engagements and focused attention on key markets. Investments in a strong channel partner network and global inventory program to ensure COTS product availability and outstanding customer support.

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TECHNOLOGY

What do we deliver - competitively and/or better than anyone else?

- Broadband and band specific, solid state power amplifiers - hundreds of watts, up to multi-kilowatt solutions
- Device agnostic designs (LDMOS, GaN on SiC, etc) and frequency coverage from 10 kHz up to 18 GHz
- Balanced approach to thermal management, power added efficiency, and linearity
- Demonstrated "power density" with patented, new hardware and software architecture that is unrivaled
- Well designed software architecture - easy to use embedded web server for local and remote access
- Global reach, impressive customer list, and unique inventory program


The United States of America

The Director of the United States Patent and Trademark Office

Has received an application for a patent for a new and useful invention. The title and description of the invention are enclosed. The requirements of law have been complied with, and it has been determined that a patent on the invention shall be granted under the law.

Therefore, this

United States Patent

Grants to the person(s) having title to this patent the right to exclude others from making, using, offering for sale, or selling the invention throughout the United States of America or importing the invention into the United States of America, and if the invention is a process, of the right to exclude others from using, offering for sale or selling throughout the United States of America, or importing into the United States of America, products made by that process, for the term set forth in 35 U.S.C. 154(a)(2) or (c)(1), subject to the payment of maintenance fees as provided by 35 U.S.C. 41(b). See the Maintenance Fee Notice on the inside of the cover.

Michelle K. Lee

Deputy Director of the United States Patent and Trademark Office

Patent US 9,007,125
Patent US 9,093,731
Patent US 8,736,365

Value Proposition

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 solutions in electronic attack (jammers), communications, radar / avionics, and product testing including EMC.

Foundation for our product configurations

Rack mount integration

Base modules

Multi-function modules

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

Scalable Architecture Making High Power Designs Easy

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

This is a single amplifier capable of Multi-Domain applications

Higher efficiency and better utilization of size and weight

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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 solutions in electronic attack (jammers), EW threat simulators, communications, radar / avionics, EMC and product testing.

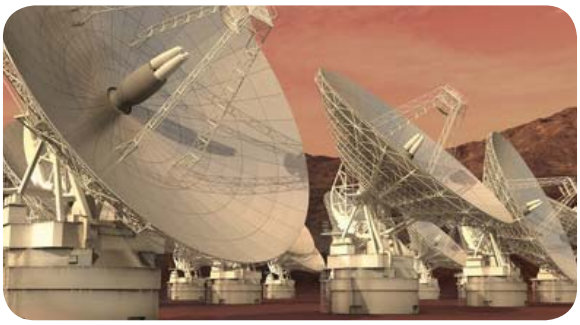
Electronic Warfare

- Manpack
- Vehicle Mount
- Fixed Site
- Shipboard
- Airborne

Radar

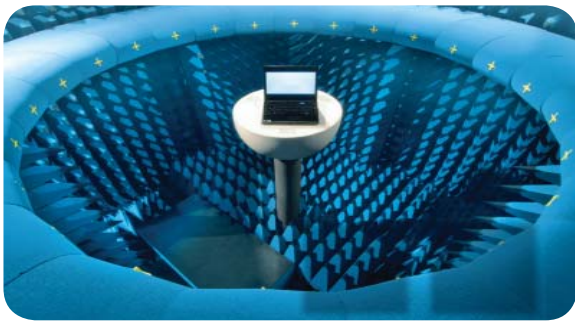
- Ground Based
- Shipboard
- Airborne
- Commercial and Military

Satcom & Telemetry



- Ground Based
- Shipboard
- Airborne Platforms

Test & Measurement



- EMC Radiated Immunity
- RF Component Testing
- Medical Research
- Wireless Infrastructure Test

Communications

- Military
- Government Agency
- Tactical Radios
- Public Safety Networks

Wireless Infrastructure

- Military and Government
- Portable, Deployable Networks

FACILITIES + WORLDWIDE PARTNERS

Representatives and Customer Engagements

- North America
- Israel
- Japan
- South America
- Russia
- China
- United Kingdom
- Australia
- South Korea
- Scandinavia
- Southeast Asia
- India
- Europe

Offices and Manufacturing Facilities

Los Angeles Headquarters

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Inglewood, CA 90301 U. S. A.
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New York Design Center

1170 Lincoln Ave., Unit 5
Holbrook, New York 11741
+1 (631) 319-6402

Manufacturing Partners

United States
South Korea

Rent or Purchase through Channel Partners

Advanced Test Equipment Rentals
The Knowledge. The Equipment. The Solution.

Empower RF Systems is pleased to offer a rental capability through our partner, Advanced Test Equipment Rentals (ATEC).

RichardsonRFPD
An Arrow Company

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

Visit
www.empowerrf.com/download
To download At A Glance for a specific market. These brochures have recommended product lists for each market.

CONFIGURABLE POWER AMPLIFIERS

A unique design architecture from Empower RF Systems is yielding unprecedented size and weight reduction for 500W, 1 kW, and multi-kW power amplifier platforms. These breakthrough designs have been fielded using both LDMOS and GaN devices for user applications that include communications, EW, radar, EMC and component testing.

Visit
www.empowerrf.com/new_products/nextgen-systems.php

What is so special about these amplifier systems?

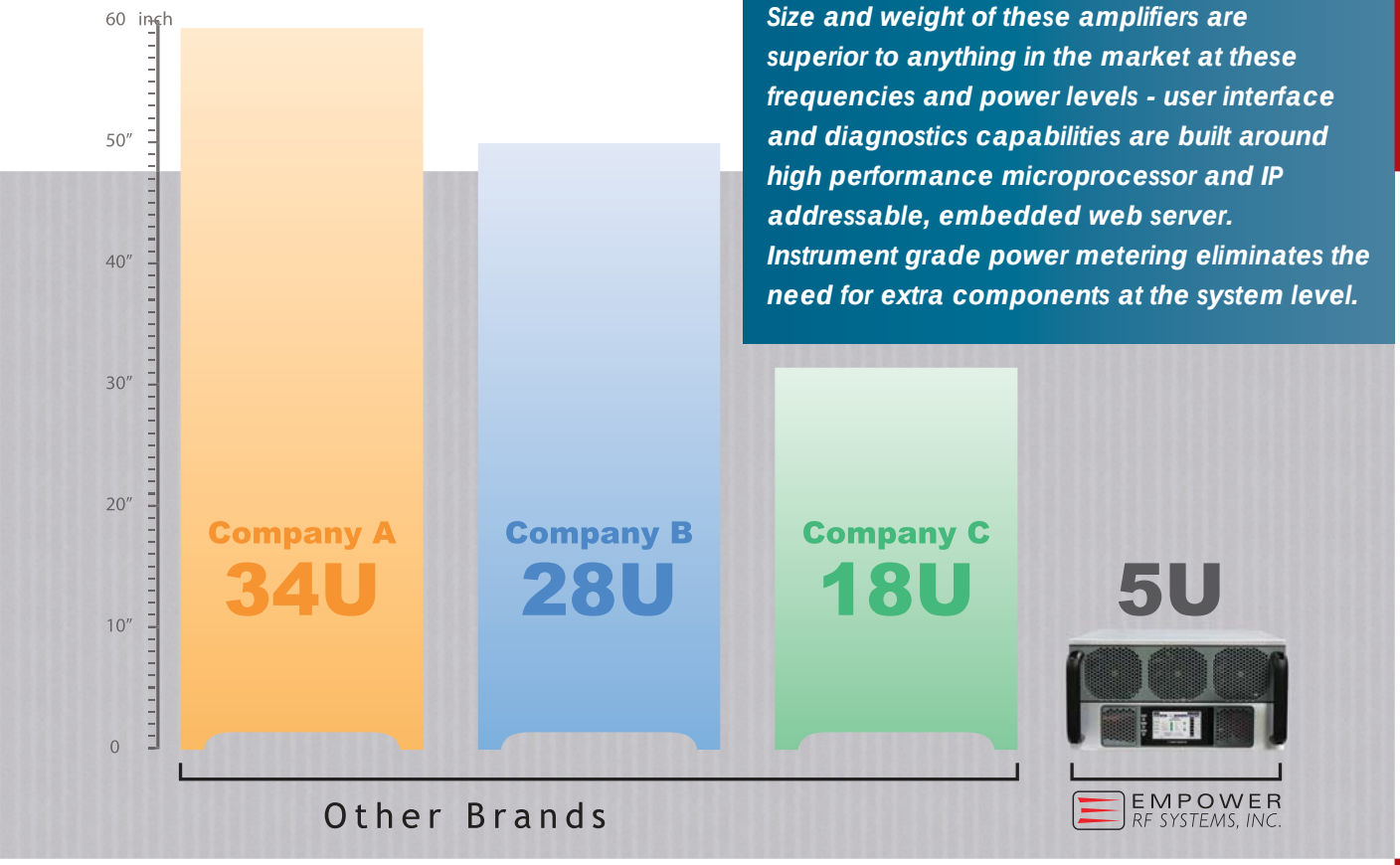
Guaranteed Multi-KW, 1 KW or 500 W RF CW performance over full bandwidth and temperature, which can be packaged in an 8U, 5U or 3U rack chassis is not "typical" of product presently available in the market. In addition, the user interface capabilities of this amplifier family allows the user to initiate 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. Using a web browser and the unit's IP address (IPV4) allows ease of access with the benefit of multilevel security. No software installation required!

Other industry leading features include:

- Internal "connector-less" RF path offers inherently rugged COTS design
- Remote servicing or debug even when installed in an embedded application
- FPGA remotely configurable for future proofing your application
- Customizable input and output detectors
- Industry leading Swap – Size, Weight, and Power (SWaP)
- User Selectable Output Power Control

CW, Pulse and Multi-mode Operation

Besides our lineup of CW amplifiers we manufacture high performance multi-kilowatt Pulsed amplifiers with equivalent size reduction, efficiency, and best-in-class power density with long pulse width and fast PRF's. Based on our Next Generation architecture, these amplifiers are normally operated in Manual Gain Control (MGC) with available options that include T/R switching and, coming soon, pulse shaping.



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.

Multi-mode operation

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.

Internal monitoring and protection features

Our next generation amplifier family is designed to continuously monitor critical performance parameters – ie, temperature, current consumption, voltage levels, input power, duty cycle, etc – and take action via the digital network to initiate protection and/or shutdown to avoid PA damage.

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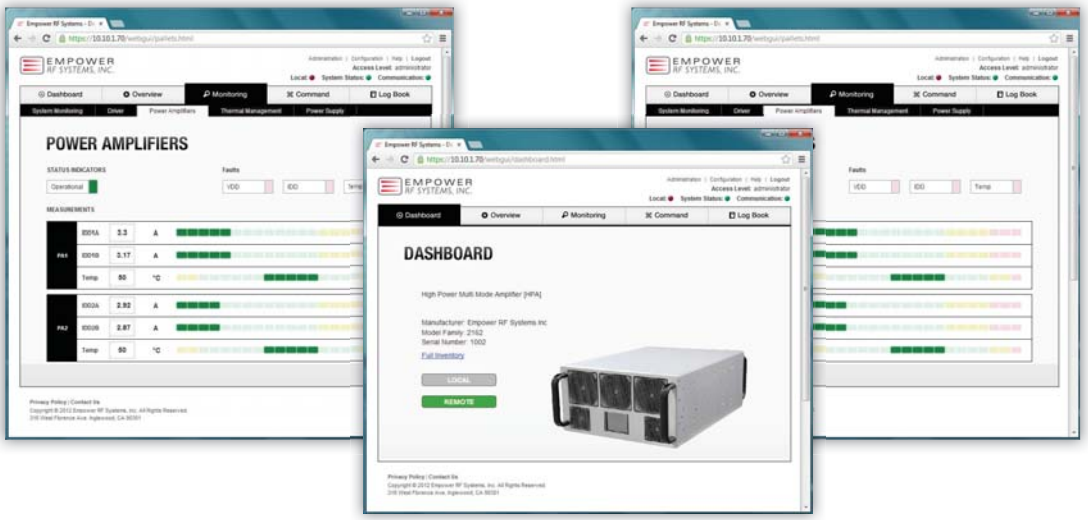
USER INTERFACE

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)*



Software Definable

Because we live in an increasingly complex digital waveform environment we designed in flexibility to provide you with a futureproof 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

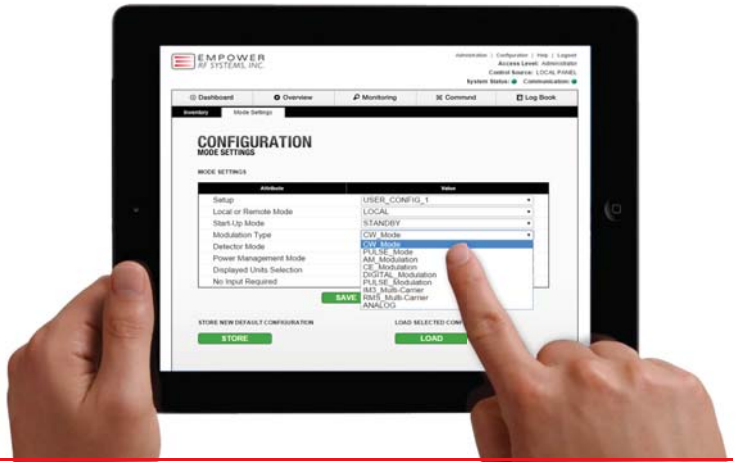
Input and Output Detectors

- Peak
- RMS

Visit

www.empowerrf.com/software

For more information and for Software Virtual Tour



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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 18 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.

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.

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"

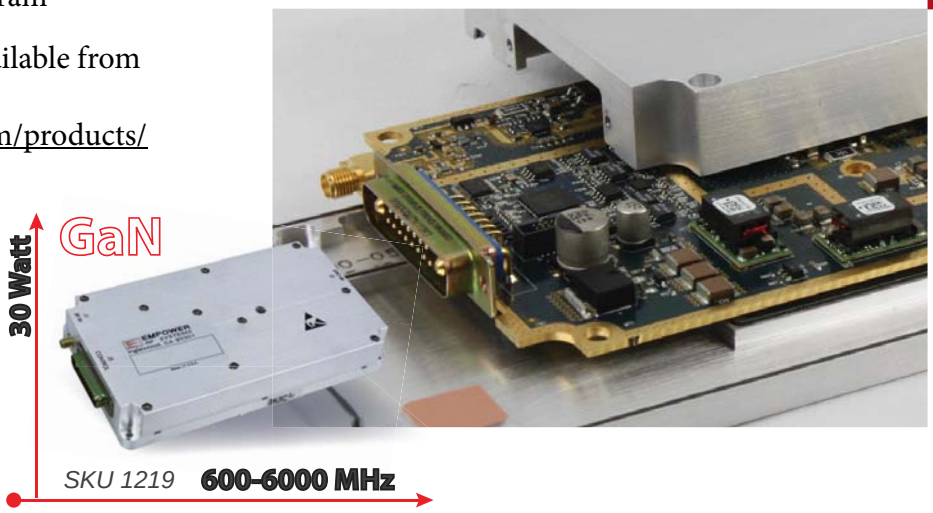
Same product
Customer specific unique packaging
4" x 2.6" x 1.2"

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.

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 Silicon on 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	100 W LDMOS	100 W GaN	100 W GaN	50 W GaN
1-30 MHz	**20-1000 MHz**	**500-2500 MHz**	**1000-3000 MHz**	**2000-6000 MHz**

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SCALABILITY

industry 1ST

A capability available exclusively from Empower is Scalability - expandable system hardware architecture designed to save you money - "you buy only the power you need today" and add power amplifier blocks later when your test or application requires more output power.

How do we do it? We designed our Next Generation platform with electronic internal phase adjustment allowing our System of Systems software to control, adjust the phase, and combine any number of like models, in any order, without the need of manual phase matching. Our scalable architecture also makes it easy for us to provide very high power versions of our COTS models.

The benefits include:

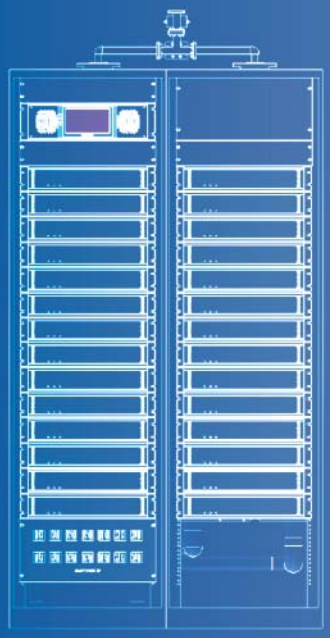
- Planning for an uncertain future, add a second unit and easily combine when your future need requires more power
- Reduce overall capital expense
- Shorten project schedules
- Increase your amplifier utilization
- Support multiple projects simultaneously with individual units or combine units for large power requirements

PULSED AMPLIFIERS

Long Duty Cycle Pulsed Amplifiers

Radar research and new radar designs are pushing pulse widths and duty cycles beyond the capability of TWT's. Empower delivers Pulsed amplifiers from 2% to 25% duty cycle, Pulse widths over 500 micro seconds 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: 90KW Water Cooled Pulsed S Band with Long Duty Cycle

- The Model 2225 is comprised of multi-drawer integrated subsystems to produce a minimum output of 90kW peak pulsed power. The amplifier subsystem features multiple high power GaN on SiC devices that provide exceptional performance, long-term reliability and high efficiency. Each 2U drawer is a full gain PA with integrated single phase power supply and liquid cooling. It features gain and phase control and is fully hot swappable in case of failure. Additionally, life time cost of ownership is significantly less than TWT's at this power and bandwidth.

Scalable Solid State Power is a Better Choice

- Greater Reliability than TWT's
- Lower Life Time Cost than TWT's
- 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 products 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

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EMPOWER
RF SYSTEMS, INC.

"we provide the most modern, sophisticated, flexible, and technologically advanced COTS amplifier systems in the world"

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up to 18 GHz

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