



Microwave Heating at 915 Mhz

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Freescale RF: 2 product lines serving 8 markets

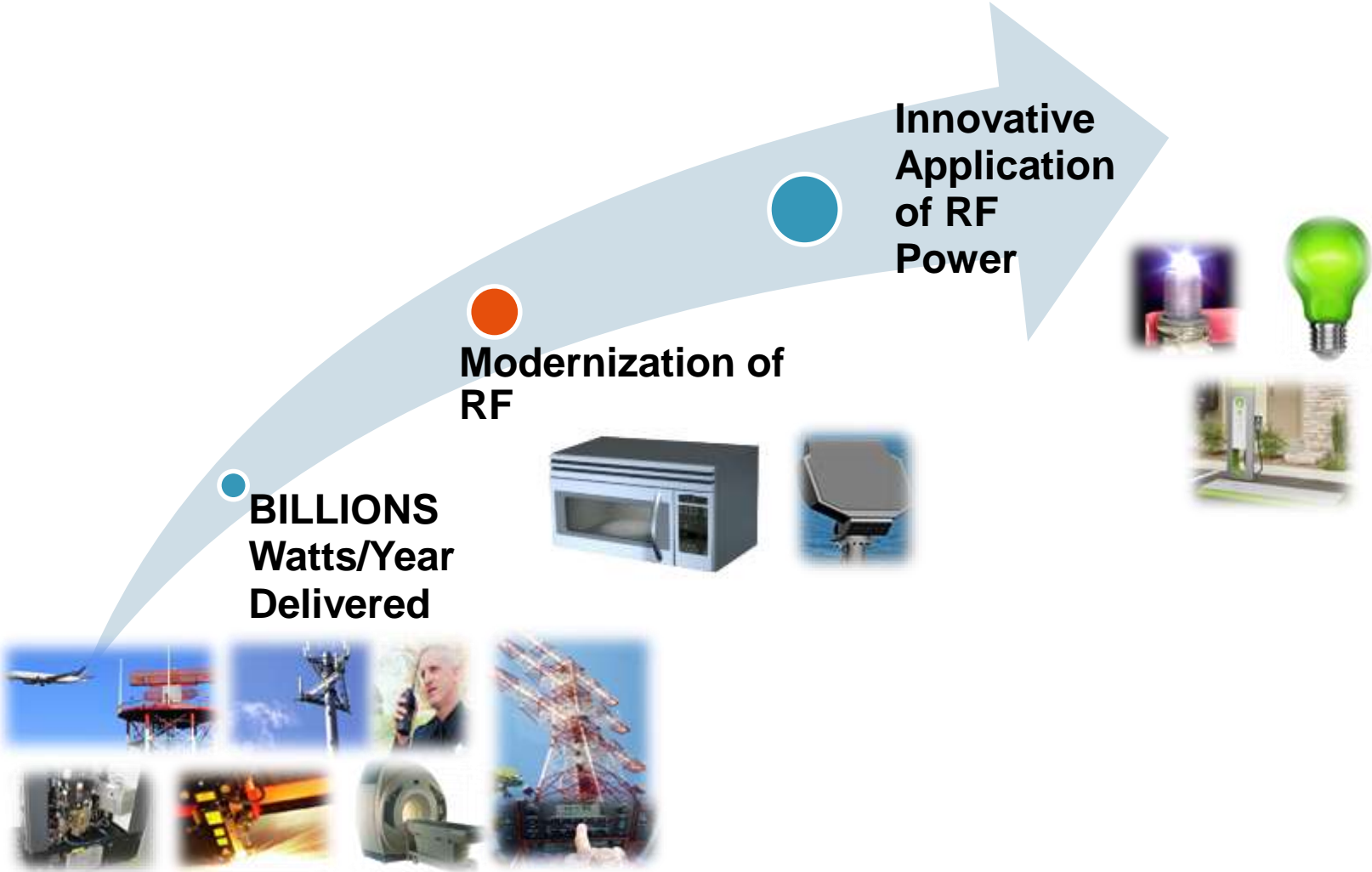
RF Cellular

Cellular Power Amplifiers	Small Signal RF
<ul style="list-style-type: none">• Base Stations• Repeaters• From GSM to LTE 	<ul style="list-style-type: none">• Picocells• Pre-drivers• Novel PA components 

RF Industrial

ISM (Industrial, Scientific, Medical)	Broadcast
<ul style="list-style-type: none">• CO2 lasers• Plasma generation• MRI• And a lot more 	<ul style="list-style-type: none">• FM• VHF TV• UHF TV 
Commercial Aerospace	Land Mobile Radio
<ul style="list-style-type: none">• Distance Measuring• Transponders• L- and S-band Radars 	<ul style="list-style-type: none">• Handheld• Vehicle• Base stations 
Heating	Military & Defense – US only
<ul style="list-style-type: none">• Microwave Ovens, commercial & consumer• Industrial heating 	<ul style="list-style-type: none">• Radar• Communications• Electronic Warfare 

FreescalE Leads Industry In RF Power Innovation





Microwave and RF Heating



Agenda

- Magnetron replacement solution of solid-state
 - RF Heating
 - Industrial Heating/Welding
 - Industrial Dryer
 - Microwave ovens



INDUSTRIAL RF HEATING / WELDING



Industrial RF Heating & RF Welding

What is this?

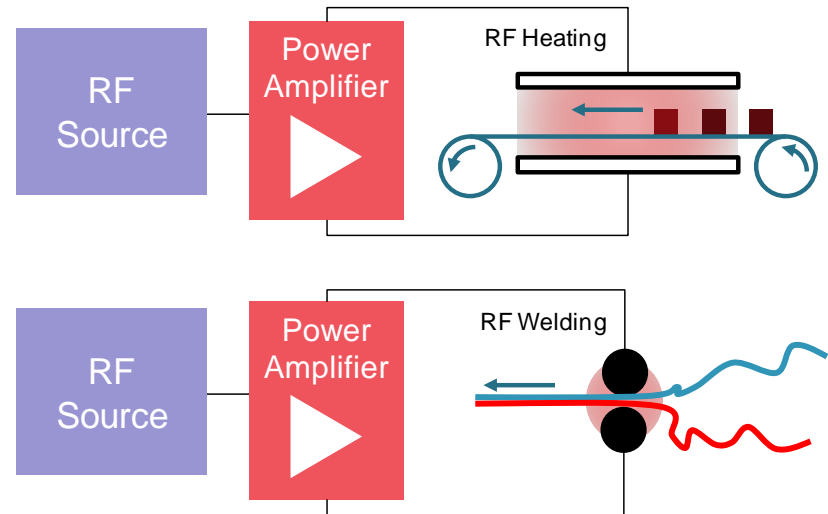
RF can be used to send energy to various materials. If the material is a poor conductor of electricity, dielectric heating will occur.

For RF heating, the material to heat is placed into a high power RF field generated by two or more electrodes.

It is a mature technology used in the industry for :

- Disinfection of meal, flour, grain, seeds...
- Pasteurization of food products...
- Sterilization of medical wastes...
- Drying food (biscuit and crackers post baking), hydrophilic foams, textile yarns, fabrics, garments, water-based coatings, inks and adhesives Heat treating...
- Preheating of thermose sheet molding compounds prior to molding...

For RF welding, the sheets of plastic materials to solder are pressed between two electrodes. The most common materials used in RF welding are PVC and polyurethane. It is also possible to weld other polymers such as Nylon, PET, PEVA, EVA and some ABS plastics.



Industrial RF Heating & Plastic Welding: Freescale Proposal

Key Parameters

- Frequency 13.56MHz, 27.12MHz or 40.68MHz
as well as 915 and 2.4GHz ISM bands
Each material ideally requires a specific frequency.
- Power RF welding :1kW to 50kW (area dependent)
RF Heating : up to 300kW or more
- Efficiency Must be high to reduce thermal dissipation
- Ruggedness Mandatory to support the returned energy

Competing solutions

- Tubes are still used in some area but they are bulky and require a lot of servicing (frequent replacement).
- VMOS may be relevant for low frequencies.

Recommended part numbers:

13, 27 and 40 MHz

Final

MRFE6VP61k25H 50V 27dB 1250W

Driver

MRFE6VS25N 50V 24dB 25W

915 MHz

Final stage:

MHT1002N 50V 19dB 350W 62%

Driver:

AFT09MS007N 7V 15dB 7W

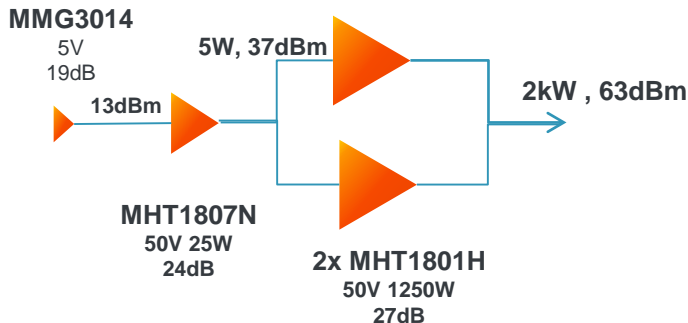
IC Solution:

MHT2001N 50V 32dB 175W

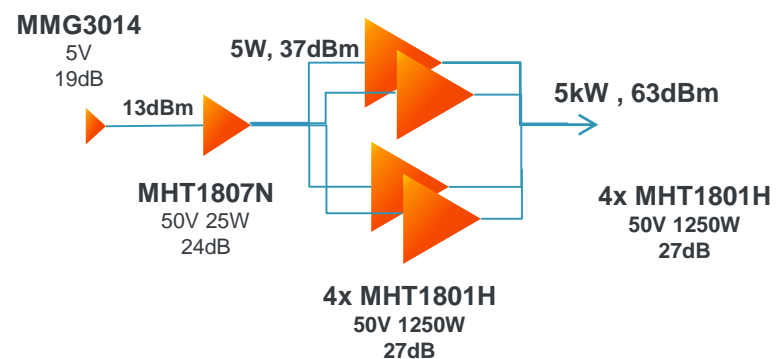
2.4GHz

MHT1003N 32V 15dB 250W 58%

2kW at 13, 27 or 40MHz



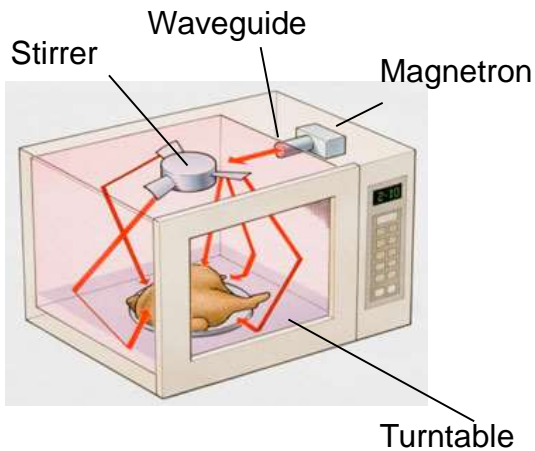
5kW at 13, 27 or 40MHz



TRANSISTOR OVEN (transistor-based microwave oven)



Microwave Oven Background & Fundamentals



- Percy Spencer's original patent: 2,495,429 filed Oct 8, 1945
- Raytheon 1161 Radarange first marketed in 1954
- 1967 Amana introduced the consumer microwave oven



Modernizing RF Power: Magnetron To Solid State



Magnetron

4,000 V supply voltage

500 hours lifetime

Performance degrades over time

On-off control:

Energy is 'flooded' to cavity



RF Transistor

28-50 V supply voltage

Up to 20 years lifetime

No performance degradation

High Resolution control:

Phase, amplitude, frequency)

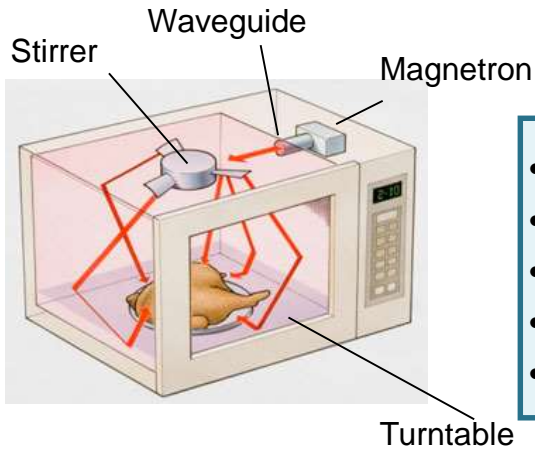
Energy can be directed



Solid State Microwave Cooking: How Is It Different?

More Functionality & Performance

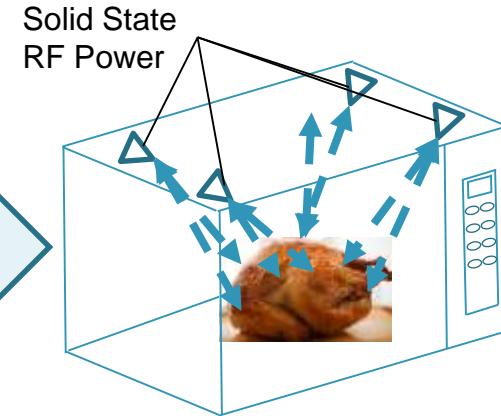
Tube Source



- Direct energy to load
- Reflected energy received
- Absorbed energy analyzed
- Power & location adjusted
- Multiple sources

- “Floods” and heats cavity
- Crude On/Off control
- Electro-mech BOM
- Degrades over time

Solid State Source



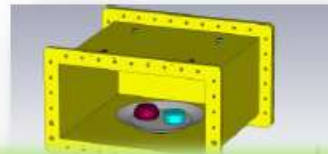
- Selective heating
- Versatile: complex combinations
- Improved consistency (quality)
- Long life
- Reduced time

More effective use of energy via closed control



Goji Software Algorithm Capabilities

Goji algorithms enable different foods to be cooked simultaneously by redirecting energy as each ingredient changes



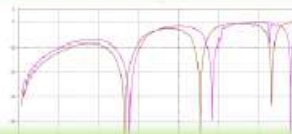
Selective Heating



Food Phases



Phased Energy



Thaw Response



Multiple raw ingredients in oven at same time



Meats, vegetables, and starches all cooked simultaneously

Actual Demo

New Customer Differentiation For A Mature Market

- Microwave cooking has been based on the same technology for 60+ years!
- **New cooking methods**
 - Actual cooking, not reheating
 - Cook 'til its done
 - Microwave baking
 - From frozen to the table
 - Separately / simultaneously cook multiple food types
- **Entirely new classes of appliances**
 - Automated cooking of complete meals
 - The personal microwave oven
 - Single serving food or beverages
 - Combination ovens for the home (convection+microwave, steam+microwave, broil+microwave, etc)
 - Low/no maintenance commercial ovens



RF Heating Portfolio

- Designed for operation in harsh **RF Heating** environments
 - High temperature
 - RF mismatch
 - High physical vibration
- Rated for **Continuous Wave (CW) operation** at high power and high frequencies
- Over-molded **plastic packaging**
 - Cost advantage
 - Superior thermal performance vs ceramic packaging
 - Supports modern manufacturing techniques
- **High gain** enables use of small, low cost drivers
- **High efficiency** reduces system cooling requirements and reduces system cost, size and complexity



New RF Heating Part Number Launches



Part #	Freq	Power W	Efficiency	Package	Status
MHT1003	2.45GHz	250	58%	Plastic	Launched
MHT2001	915GHz	175	65%	Plastic	Mar '15
MHT1008	2.4GHz	12W	55%	Plastic	Jun '15
MHT2003	2.4GHz	50W	60%	Plastic	Jun '15
MHE1003	2.4GHz	220W	64%	Plastic	Apr '15
MHT1004	2.4GHz	300W	64%	Plastic	Q4 '15



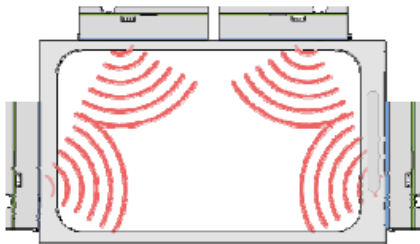
Differentiated Cooking Devices - Example

	MHT Devices	Equivalent Industrial Devices
Manufacturing	Tested to cooking specifications only	Full standard RF functional testing
Applications	Microwave Cooking	<u>Industrial</u> heating, welding, medical, plasma lighting and ignition
Collateral	Moderated	Datasheets on freescale.com, reference circuits, samples available
Longevity Program	No	Yes
Volume	10k+	100+
Pricing	Unpublished	Published Disty Price Book
Example	MHT1003N	MRF7S24250N

Freescale Integrated 2.4GHz Reference Designs

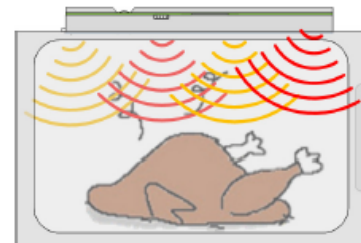
1Ch 250W, Scalable

- 250-2000 Watts cooking power
 - 250W single channel power modules w/antenna
 - Scalable 1 – 8 modules
 - Even, distributed EM field
 - Power control
 - Frequency control
 - Phase control
 - No circulators, lower cost
 - API Interface

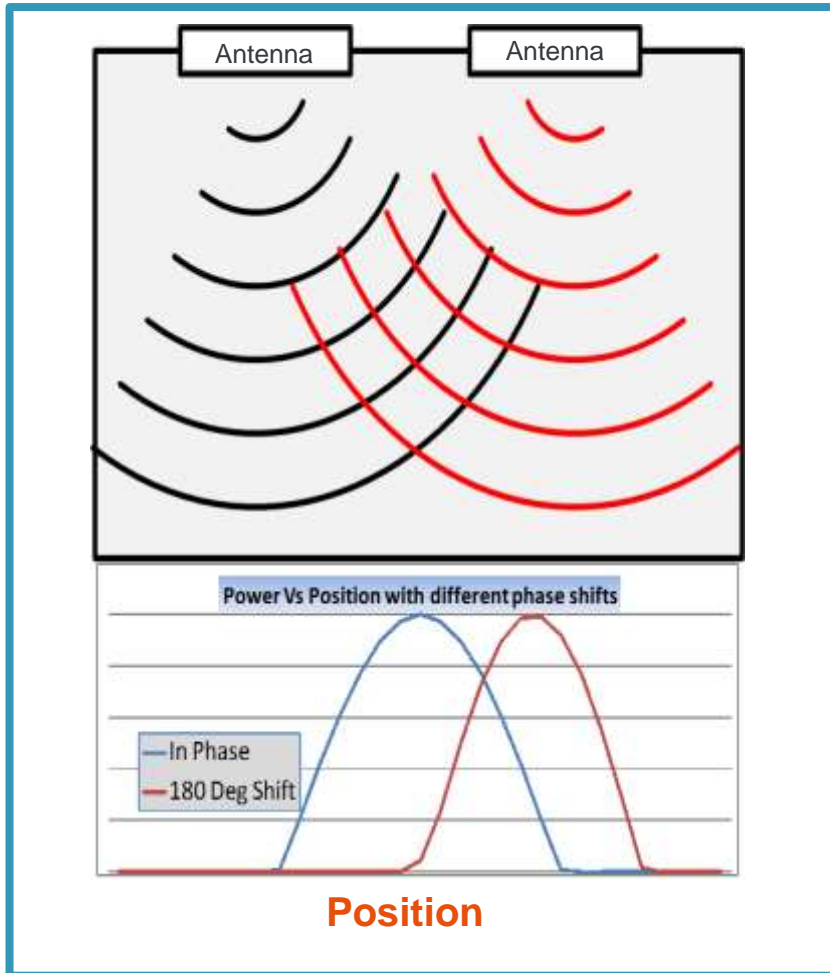


Multi-Channel

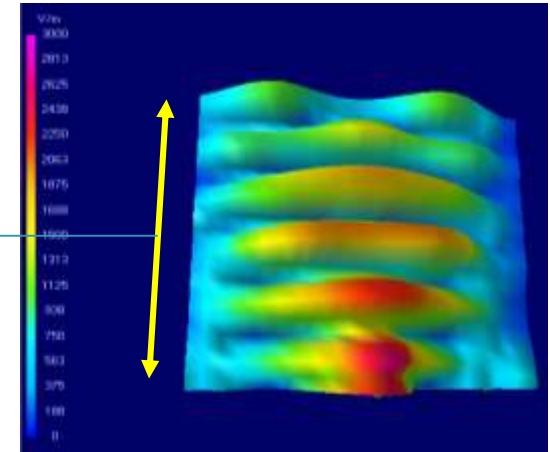
- 500-1000 Watts cooking power
 - Single high power module
 - Multiple antenna
 - Even, distributed EM field
 - Power control
 - Frequency control
 - No circulators, lower cost
 - API Interface



Phase Control Location Optimization



Phase Control

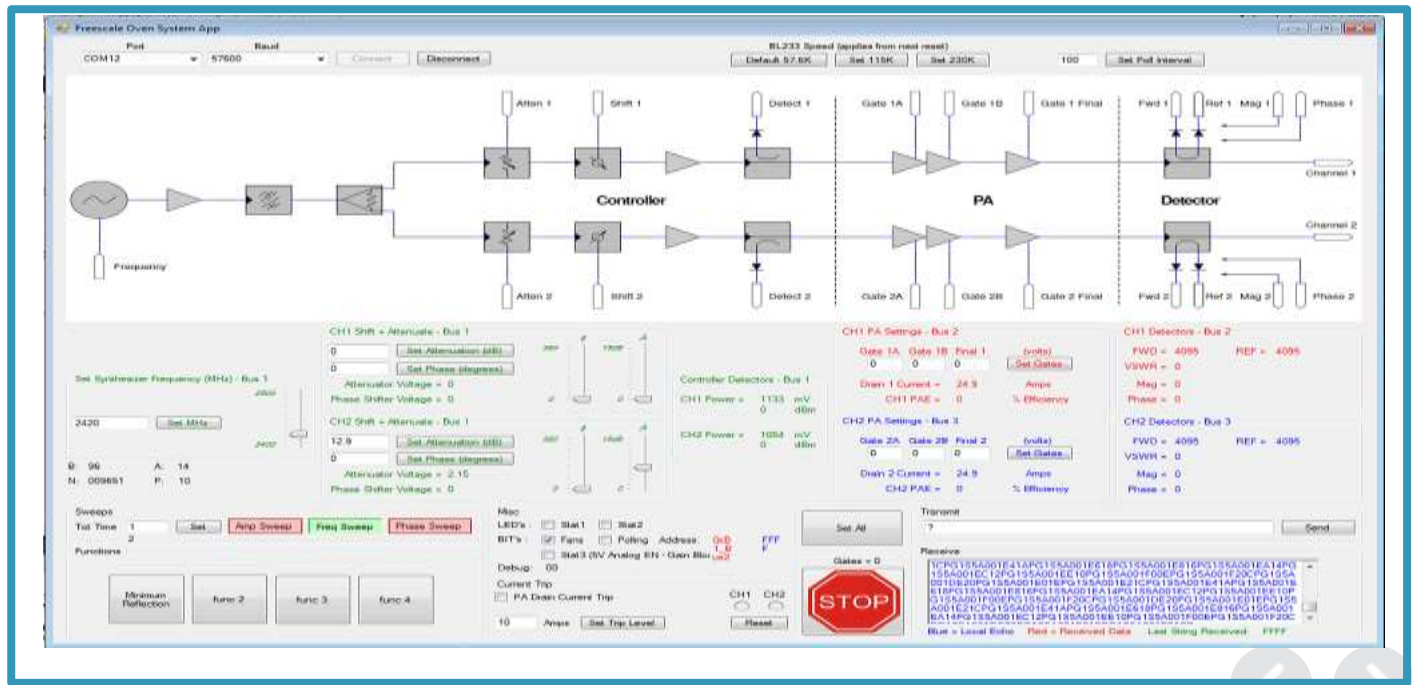


- Detecting “load” location and shifting phase in multi-feed system
 - Optimize energy to load location
- Output is coherent, allowing phase and amplitude control of multiple sources
 - Enable selective combining of the energy
- Analogous to laser vs flood light
- Reduces random ‘hot spots’
 - Lab tests show as many as 5 hot spot locations

Phase Control Location Optimization Testing

- phase and amplitude control of multiple sources thru software
- LEDs show the energy distribution in Cavity

Phase Control



Size reduction for portable feasibility

150W /300W Portable Microwave Oven

- Oscillator base portable MWO with lower output Power.

150W Portable Microwave Oven



300W Portable Microwave Oven



运动户外 > 户外装备 > 野餐烧烤 > 烧烤世家 (e-Rover) > 烧烤世家 车载变频微波炉

烧烤世家 车载变频微波炉

京东价: **¥208**

促销信息: 满减 满500.0减20.0, 满1000.0减50.0, 满2000.0减100.0

配送至: 北京朝阳区三环以内 **有货**

服务: 由 e-Rover烧烤世家官方旗舰店 从 浙江宁波市 发货, 并提供售后服务。现在至明日16:00前完成下单, 预计04月11日24:00前送达

选择颜色: 午夜黑 珍珠白

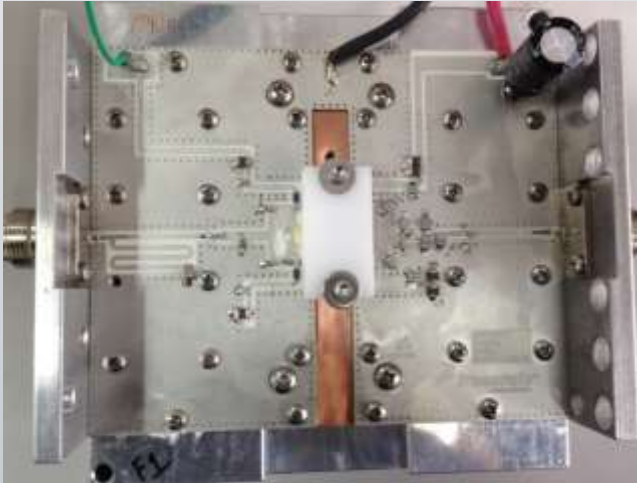
1 **加入购物车**

温馨提示: 1. **7** 支持7天无理由退货

RF heating Amplifier Reference Designs

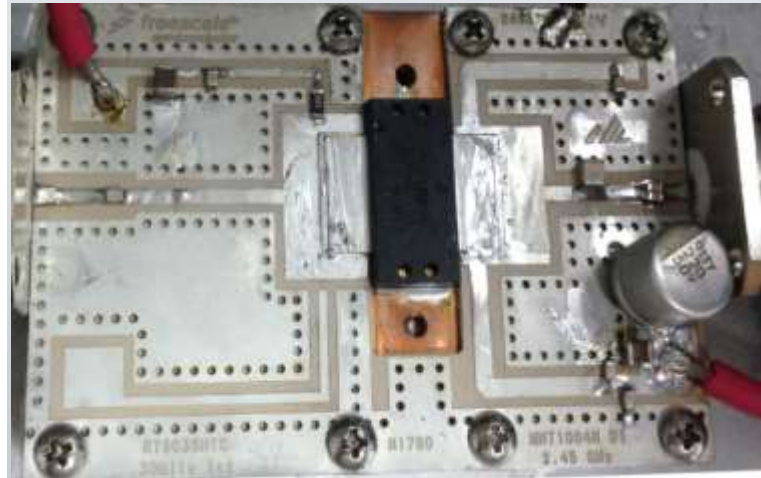
MHT1002N – 915MHz

- Freq operation 915MHz
- > 18dB Gain , 62% typical efficiency
- > 350W CW Output



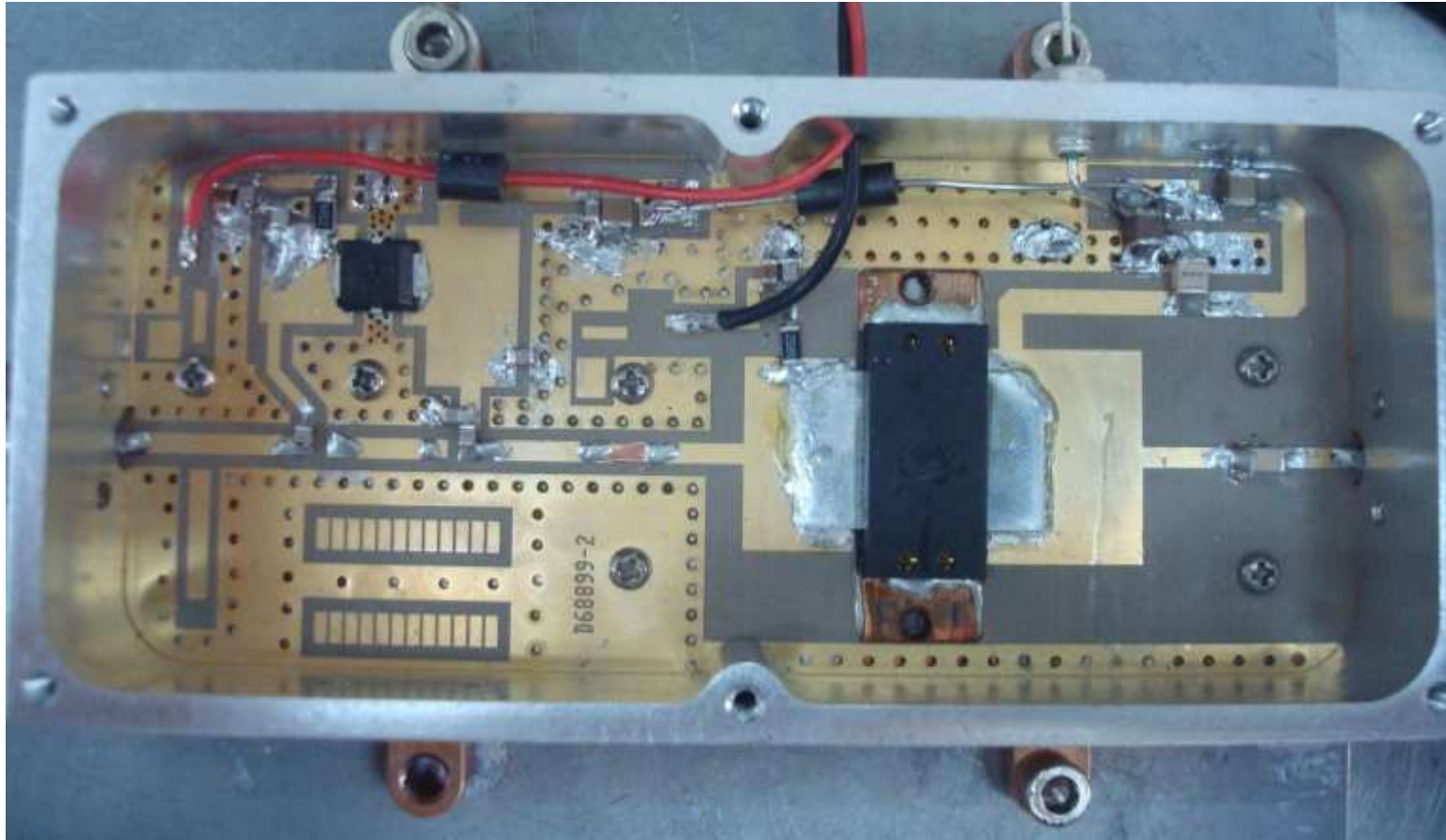
MHE1003N – 2.45GHz

- Freq. 2400 to 2500 MHz
- >13dB Gain , 64% typical Efficiency
- > 220W CW Output



AFT010+MHE1003N lineup

33dB 60% 220W/27V



Follow Midea final PA mechanical , 107X48mm. Cavity depth 15mm.



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