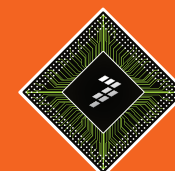


# Industrial, Scientific and Medical Solutions (ISM)

Technology to enhance  
performance, reliability and  
ease of use in industrial  
RF systems



Freescale's portfolio of ISM RF power amplifiers is designed to simplify the use of solid-state RF in high-powered industrial, scientific and medical applications at frequencies from DC to 2450 MHz.

## Applications

- CO<sub>2</sub> industrial lasers
- Medical laser and electrosurgery
- MRI
- Plasma etching
- Particle accelerators
- Lighting
- Industrial heating
- Amateur radio

Freescale has been a trusted supplier of RF power semiconductors for over 50 years. Building on this history, we introduced in 2010 the industry-first Extremely Rugged transistor ('E' Series), making it possible for engineers to use solid-state RF instead of vacuum tubes in the harshest environments. The Extremely Rugged transistor enabled engineers to design more compact industrial systems, which feature longer lifetimes and reduced service costs.

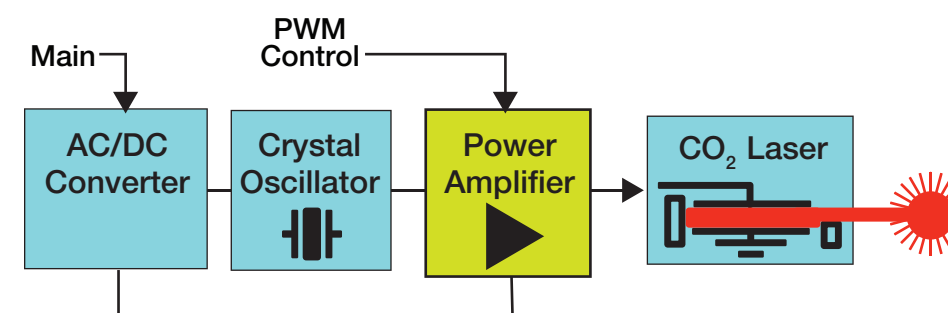
Freescale's enhanced rugged devices are designed to handle operation into a voltage standing wave ratio (VSWR) greater than 65:1 without damage or degradation in performance. They will survive to most mismatch conditions and will not break even if the load receiving the RF energy changes dynamically, as happens in the applications described below.



### Laser, Plasma and Medical

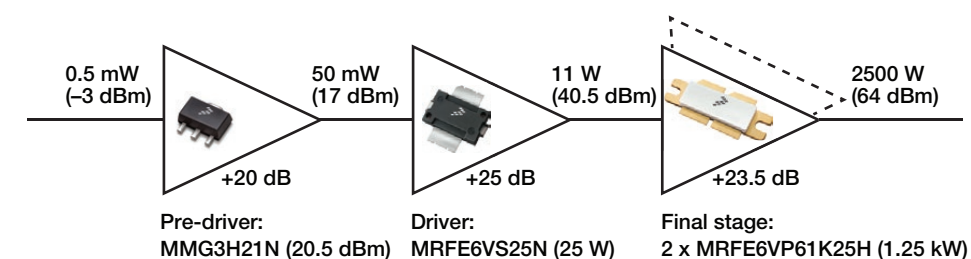
RF is used as an energy source to generate a homogenous plasma inside a CO<sub>2</sub> gas discharge tube, which either stimulates CO<sub>2</sub> molecules to generate a laser light or directly etches microstructures. Typically, a 100 W laser requires 1 kW of RF energy. Extreme ruggedness and high efficiency enable simplification of the system design.

### Block Diagram Overview



### Example of Lineup

#### 2500 W RF (250 W optical) Industrial Laser @ 81.36 MHz

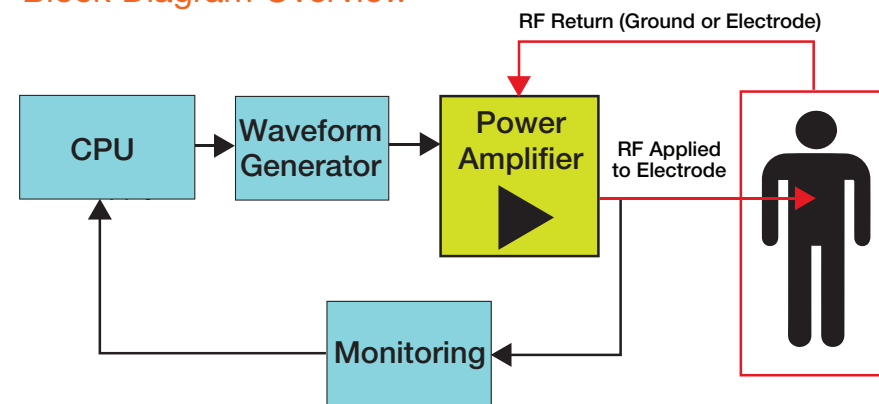




### Medical Laser and Electrosurgery

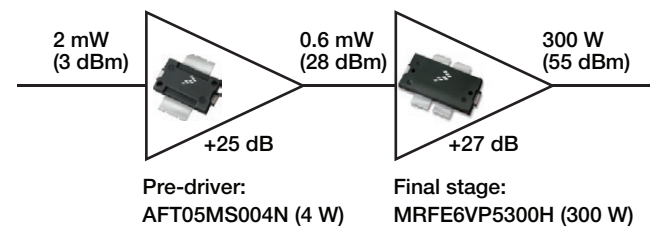
In medical lasers, RF is also used as an energy source for skin treatments such as dermabrasion, hair removal, and reduction of acne or cellulite. Another alternative is electrosurgery, which applies electric currents to biological tissues as a means to cut, coagulate, desiccate or fulgurate. It allows bloodless and precise surgical cuts.

#### Block Diagram Overview

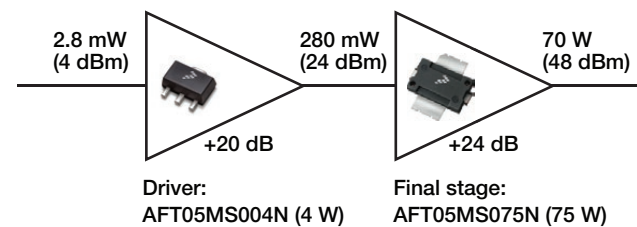


#### Examples of Lineups

##### 300 W Medical Laser @ 1.8 MHz



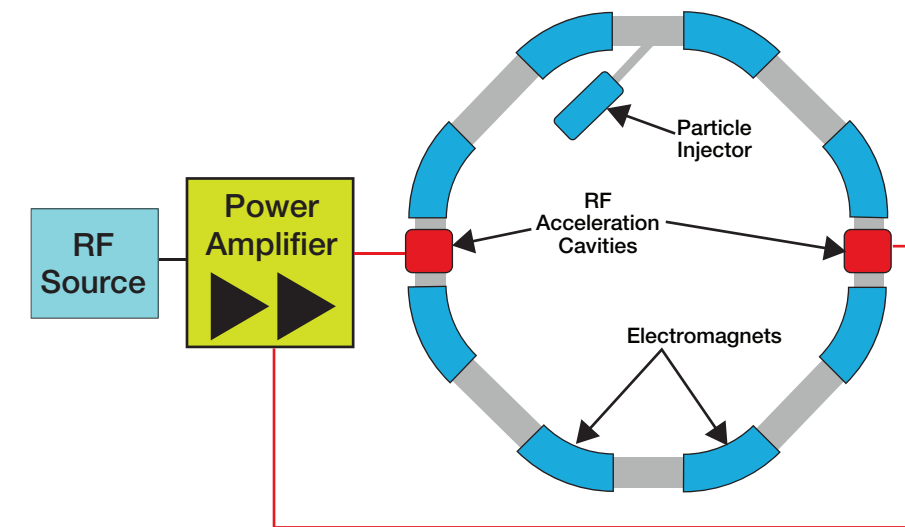
##### 70 W Electrosurgery



### Particle Accelerators

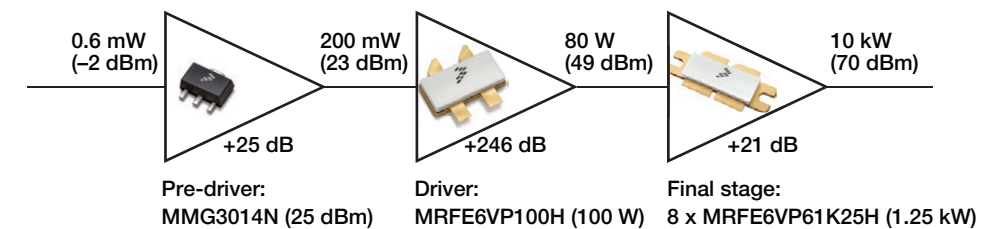
Solid-state RF is changing synchrotrons and cyclotrons. Instead of one large vacuum tube, the use of numerous solid-state amplifiers makes on-the-fly replacements possible, removing the need to stop the accelerator. Their 100 to 1,000 years of MTTF provide advanced reliability to scientists.

#### Block Diagram Overview



#### Example of Lineup

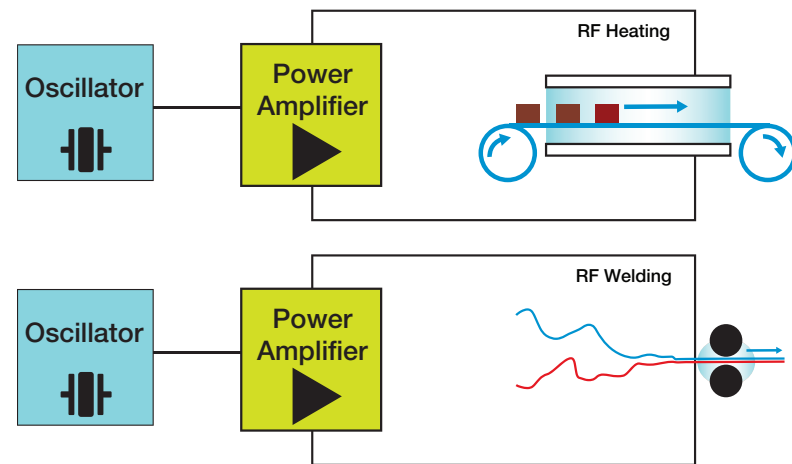
##### 10 kW PA for 500 kW Synchrotron @ 352 MHz



## Industrial Heating

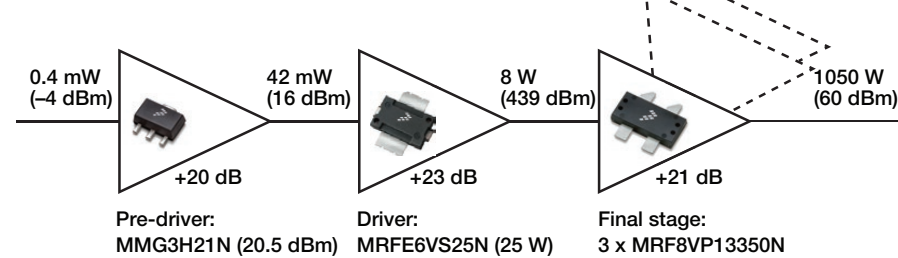
Extreme ruggedness now makes it possible to use RF energy to heat or weld any material. Each material reacts optimally to a different frequency. RF is used for welding PVC and polyurethane, for the pasteurization and drying of food products, sterilization of medical waste, and preheating of thermoset sheet molding compounds.

### Block Diagram Overview

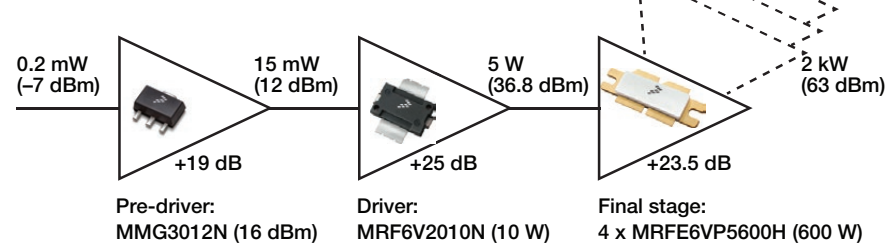


### Examples of Lineups

#### 1 kW Industrial Oven @ 915 MHz



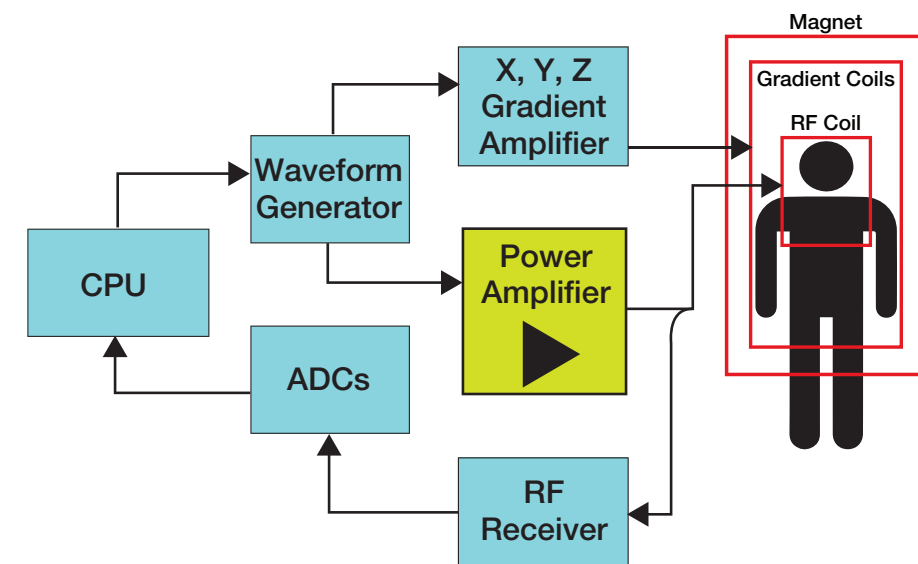
#### 2 kW Welding System @ 27 MHz



## MRI (Magnetic Resonance Imaging)

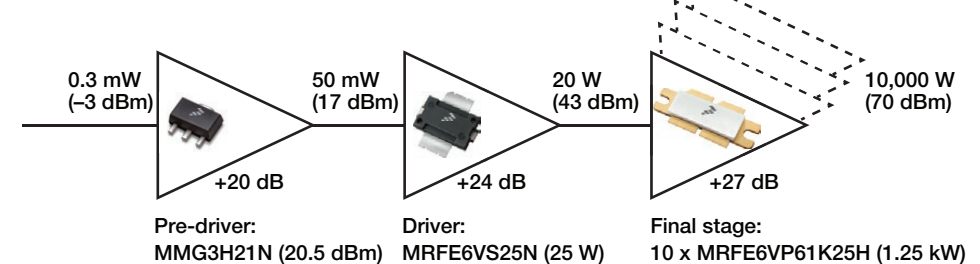
MRI scanners rely on detecting a radio frequency signal emitted by excited hydrogen atoms in the body (water molecules), using energy from an RF magnetic field applied at the appropriate resonance frequency: 1.5 Tesla MRIs operate at 63.87 MHz, and 3 Tesla MRIs at 127 MHz.

### Block Diagram Overview



### Example of Lineup

#### 3T 10 kW MRI @ 127 MHz



## Recommended Products

## RF Power LDMOS Transistors

Product	P1dB (W)	Freq. (MHz)	V <sub>DD</sub> (V)	Package Options	VSWR	Suggested Driver
MRFE6VP61K25H*	1250	1.8–600 Unmatched	50	NI-1230H-4S, Air Cavity, Push-pull	> 65:1	MRF6V2010N or MRFE6VS25N
MRFE6VP5600H*	600	1.8–600 Unmatched	50	NI-1230H-4S, Air Cavity, Push-pull	> 65:1	AT05MS004N or MRFE6VS25N
MRFE6VP6300H*	300	1.8–300 Unmatched	50	NI-1230H-4S, Air Cavity, Push-pull	> 65:1	AT05MS004N
<b>NEW</b> MRFE6VP5300N*	300	1.8–600 Unmatched	50	TO-270WB-4, Over-molded Plastic, Push-pull	> 65:1	AT05MS004N
<b>NEW</b> MRFE6VP5150N*	150	1.8–600 Unmatched	50	TO-270WB-4, Over-molded Plastic, Push-pull	> 65:1	AT05MS004N
MRFE6VP100H*	100	1.8–2000 Unmatched	50	NI-780H-4L, Air Cavity, Push-pull	> 65:1	AT05MS004N or MRFE6VS25N
AFT05MP075N*	75	136–520 Unmatched	12.5	TO-270WB-4, Over-molded Plastic, Push-pull	> 65:1	AFT05MS004N
MRFE6VS25L* MRFE6VS25N*	25	1.8–2000 Unmatched	50	NI-360H-2L, Air Cavity, TO-270-2, Over-molded Plastic, Single-ended	> 65:1	AFT05MS004N
MRF8VP13350N*	350	700–1300 Input Matched	50	OM-780-4L, Over-molded Plastic, Push-pull	10:01	MRFE6VS25N
MRF6V13250H	250	1300 Input Matched	50	NI-780H-2L, Air Cavity, Single-ended	10:01	MRFE6VS25N
MRF6P24190H	190	2450 I/O Matched	28	NI-1230H-4S, Air Cavity, Push-pull	10:01	MW7IC2425N
MW7IC2425N	25	2450 I/O Matched	28	TO-272WB-16, Over-molded Plastic, Single-ended 2-stage IC	10:01	MMG3H21N
<b>NEW</b> AFT05MS004N*	4–6	2–1000 Unmatched	7.5	PLD-1.5W, Over-molded Plastic, Single-ended	> 65:1	MMG3H21N

\* Product included in Freescale's product longevity program. See [www.freescale.com/PRODUCTLONGEVITY](http://www.freescale.com/PRODUCTLONGEVITY) for more information.

## Supported Reference Circuits

Board Freq. (MHz)	Application	P1dB (W)	Gain (dB)	Eff. (%)	Size (Inch)
27	Heating	1200 CW	27	81	2.9 × 6.9
40	Plasma Etching	1300 CW	26	85	2.9 × 4.7
60–65	MRI	1250 Pulse	25	75	2.9 × 4.7
81.36 Planar	CO <sub>2</sub> Laser	1350 CW	23.5	75	2.9 × 6.4
88–108 Planar	FM	1250 CW	23	75	2.8 × 5.2
128	MRI	1200 Pulse	22	73	2.9 × 4.7
144–148	Amateur Radio	1250 CW	26	78	2.9 × 4.7
175	Synchrotrons	1300 CW	23	76	2.9 × 4.7
170–230	VHF TV	225 DVB-T	25	30	2.9 × 4.7
230	Amateur Radio	1250 Pulse	24	74	4 × 6
352	Synchrotrons	1250 Pulse	21.5	66	4 × 6
500	Lighting	1000 CW	18	58	4 × 6
50–90	MRI	600 Pulse	27	50	2.9 × 4.7
88–108	FM	680 CW	24	79	2.9 × 4.7
170–230	VHF TV Broadcast	125 DVB-T	25	75	2.9 × 4.7
230	Amateur Radio	600 Pulse	23	73	4 × 6
225–450	Various	600 Pulse	18	50	2.9 × 4.7
434	Lighting	600 CW	17.5	70	4 × 6
13.56	Medical	300 CW	36	80	4 × 5
88–108	FM	350 CW	23.5	77	2.9 × 4.7
230	Land Mobile Radio	300W Pulse	26	74	4 × 5
500	Lighting	320 CW	20.5	64	4 × 5
88–108	FM	361 CW	24	80	3 × 5.5
230	Various	300 Pulse	27	71	4 × 6
88–108	FM	179 CW	22.5	75	3 × 5.5
230	Various	150 Pulse	26	72	4 × 6
2–200	Various	100 PEP	17	49	4 × 5
30–512	Broadband Radio	100 CW	19	30	4 × 5
512	Amateur Radio	100 CW	27	70	4 × 5
400–1000	Telemetry	100 CW	14	30	4 × 5
135–175	VHF Land Mobile Radio	80 CW	36	70	2 × 3
380–450	UHF Land Mobile Radio	75 CW	16	65	2 × 3
450–520	UHF Land Mobile Radio	75 CW	14	69	2 × 3
2–54	Various	25 CW	25	51	2 × 3
30–520	Broadband Radio	25 PEP 2-Tone	17	30	2 × 3
512	Land Mobile Radio	25 CW	25.5	75	3 × 5
1030 (OM Only)	Transponder Driver	25 CW	22.5	60	4 × 5
400–1000 (OM Only)	Various	2.5 DVB-T	15	12	2 × 3
960–1215 (OM Only)	DME	25 CW	16	40	2 × 3
915	Industrial Heating	350 CW	21	55	In NPI
1300	Particle Accelerators	350 Pulse	19	58	In NPI
1300	Particle Accelerators	250 Pulse	22.5	56	4 × 6
2450	Industrial Heating	190 CW	13	46	4 × 6
2450	Industrial Heating	25 CW	28	44	3 × 5
135–175	VHF Land Mobile Radio	5.5 CW	17	60	0.8 × 1.9
350–520	UHF Land Mobile Radio	5 CW	17	50	0.8 × 1.9



### Additional Driver Options

Product	P1dB (W)	Freq. (MHz)	V <sub>DD</sub> (V)
AFT05MS031N	31	136–520	12.5
AFT09MP055N	55	720–941	12.5
AFT09MS006N	6	136–941	7.5
AFT09MS007N	7	136–941	7.5
AFT09MS015N	15	136–941	12.5
AFT09MS031N	31	764–941	12.5
AFT27S006N	6	700–2700	28
AFT27S010N	10	700–2700	28
MRFE6V2010N	10	10–450	50

### Recommended Pre-drivers (GaAs MMICs)

Product	P1dB (dBm)	Freq. (MHz)
MMG3H21N	20.5	0–6000
MMG20241H	24.5	450–3800

### Part Numbering Components

#### MRFE6VP61K25H

MRFE6V	P	6	1K25	H
	P = Push-pull	Frequency	P1dB	Ceramic

#### AFT05MS004N

AFT	05	MS	004	N
	Frequency	S = Single-ended	P1dB	Plastic

## RF Power ISM Packages

### Over-molded Plastic

Product	Package
AFT05MP075N	TO-270WB-4
AFT05MS004N	PLD-1.5W
MRFE6VP5150N	TO-270WB-4
MRFE6VP5300N	TO-270WB-4
MRFE6VP13350N	OM-780-4L
MRFE6VS25N	TO-270-2
MW7IC2425N	TO-272WB-16

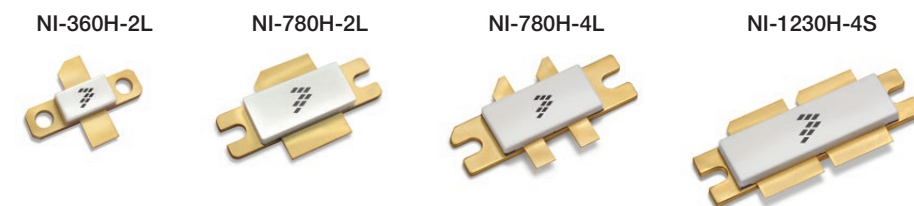
### Air Cavity

Product	Package
MRF6P24190H	NI-1230H-4S
MRF6V13250H	NI-780H-2L
MRFE6VP100H	NI-780H-4L
MRFE6VP5600H	NI-1230H-4S
MRFE6VP61K25H	NI-1230H-4S
MRFE6VP6300H	NI-780H-4L
MRFE6VS25L	NI-360H-2L

### Over-molded Plastic Packages



### Air Cavity Packages



Not to scale