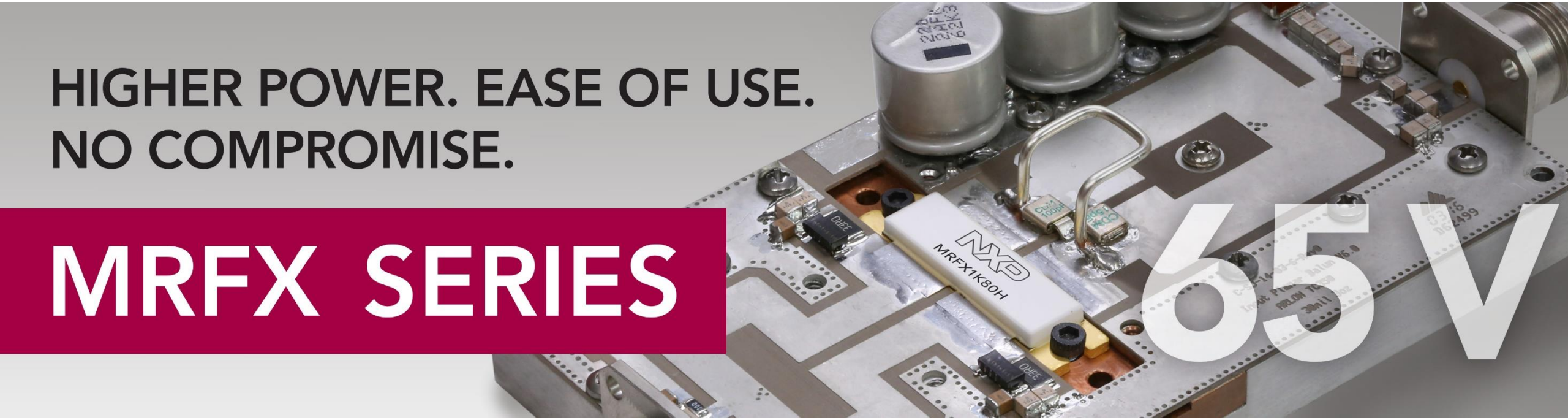
65 V LDMOS INTRODUCTION

NOVEMBER 2017



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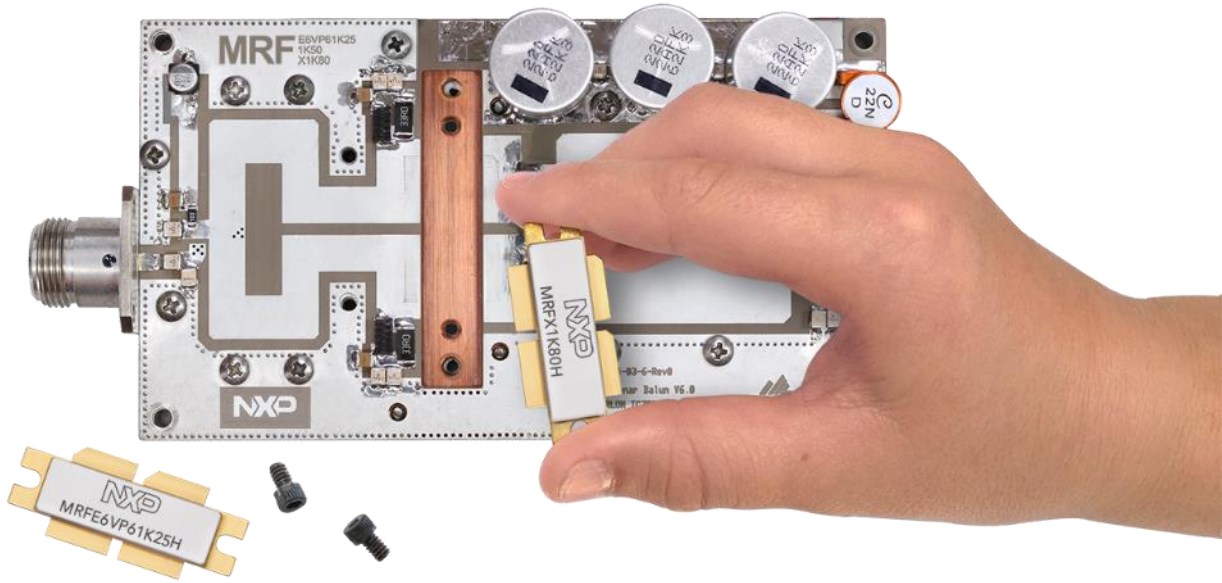
Introduction

- NXP released a new LDMOS technology for 65 V drain voltage, focused on **ease of use**.
  - Higher voltage enables a higher RF output power with no compromise.

- The first transistor of the 65 V MRF**X** series is the MRF**X**1K80H, the industry's most powerful CW RF transistor: 1800 W.

- The MRF**X**1K80H is pin-compatible with existing 50 V transistors, to reduce design cycle times.



A Brief History of LDMOS for ISM and broadcast applications

- **1992:** first **LDMOS** transistor released by the Motorola RF power team.
- **2006**: introduction of the first **1kW** LDMOS transistor by Freescale, followed by four other lower power devices.
- **2010-2012**: Freescale launched industry-first portfolio of 5 **extremely rugged** 50 V LDMOS transistors in ceramic packaging, from 25 to 1250 W.
- **2014-2015**: complemented this portfolio with 5 transistors in **plastic package**, enabling lower thermal resistance.
- **2016**: NXP (ex Freescale) launched the 1500 W **MRF1K50H**, pushing 50 V LDMOS close to its limits of usability (higher power levels at 50 V are challenging to match to 50 ohm).
- **2017**: introducing the MRF**X** series with the 1800 W **MRFX1K80H**, based on new 65 V LDMOS technology developed in NXP's internal fab. Designed for ease of use.

Why 65V? Ease of use.

More power – Higher voltage enables higher power density, which helps reduce the number of transistors to combine.

Fewer combining losses, smaller PAs, simpler power supply management.

Faster development time – With higher voltage, the output power can be increased while retaining a reasonable output impedance.

Easier matching to 50 ohms; transistors can be used wideband.

Design reuse – This impedance benefit also ensures pin-compatibility with current 50 V LDMOS transistors for better scalability.

Little to no retuning from existing 50 V power amplifiers.

Manageable current level – Higher voltage reduces the current losses in the system.

Fewer stresses on DC supplies, better system efficiency, less magnetic radiation.

Wide safety margin – The higher breakdown voltage of 193 V typical improves ruggedness and allows for higher efficiency classes of operation.

Better reliability, higher efficiency.

NXP RF Technology Design Strategy: Focus on **Ease of Use**

To keep a reasonable output impedance above 1500 W, NXP is raising the voltage

Output impedance
Higher impedance makes it easier to match to 50 ohm.

$$R_L = \frac{V^2}{2P}$$

Drain voltage
NXP is raising the voltage V to increase the output power P, while keeping the output impedance R_L reasonable.
$R_L = (65^2 / 2x900W) \times 2$ sides = 4.7 ohm*
(transformation ratio to 50 ohms = ~10)

*: examples for a 1800W push-pull transistor.

Output power
NXP's competitors increase output power P while retaining V = 50 V. Consequence: reduced output resistance, making the transistors difficult to match and very challenging to use wideband.
$R_L = (50^2 / 2x900W) \times 2$ sides = 2.8 ohm*
(transformation ratio to 50 ohms = ~18)

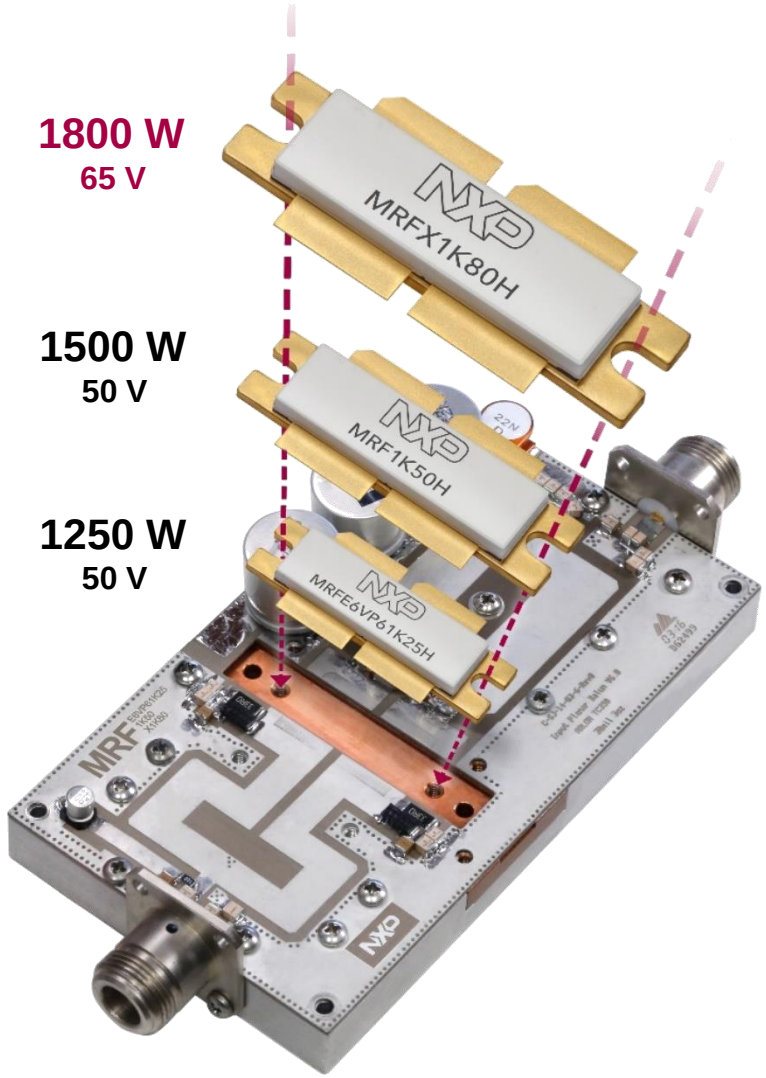
Ease of use = higher power WITH higher voltage.

NXP RF Transistor Design Strategy: Focus on **Scalability**

Transistors from the MRFX series fit into existing PCBs designed for previous 50 V transistors

- Same PCB for
  MRFE6VP61K25H
  MRE6VP61K25N
  MRF1K50H
  MRF1K50N
  MRFX1K80H
  MRFX1K80N

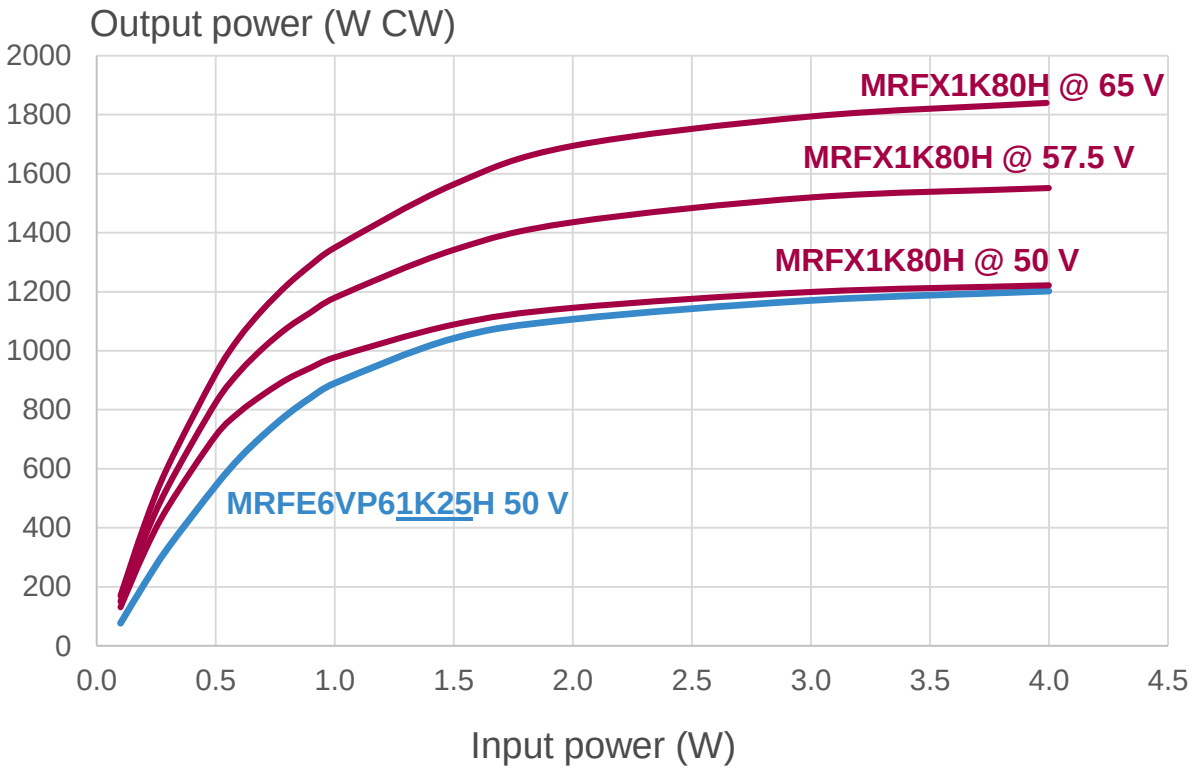
- Little to no retuning needed

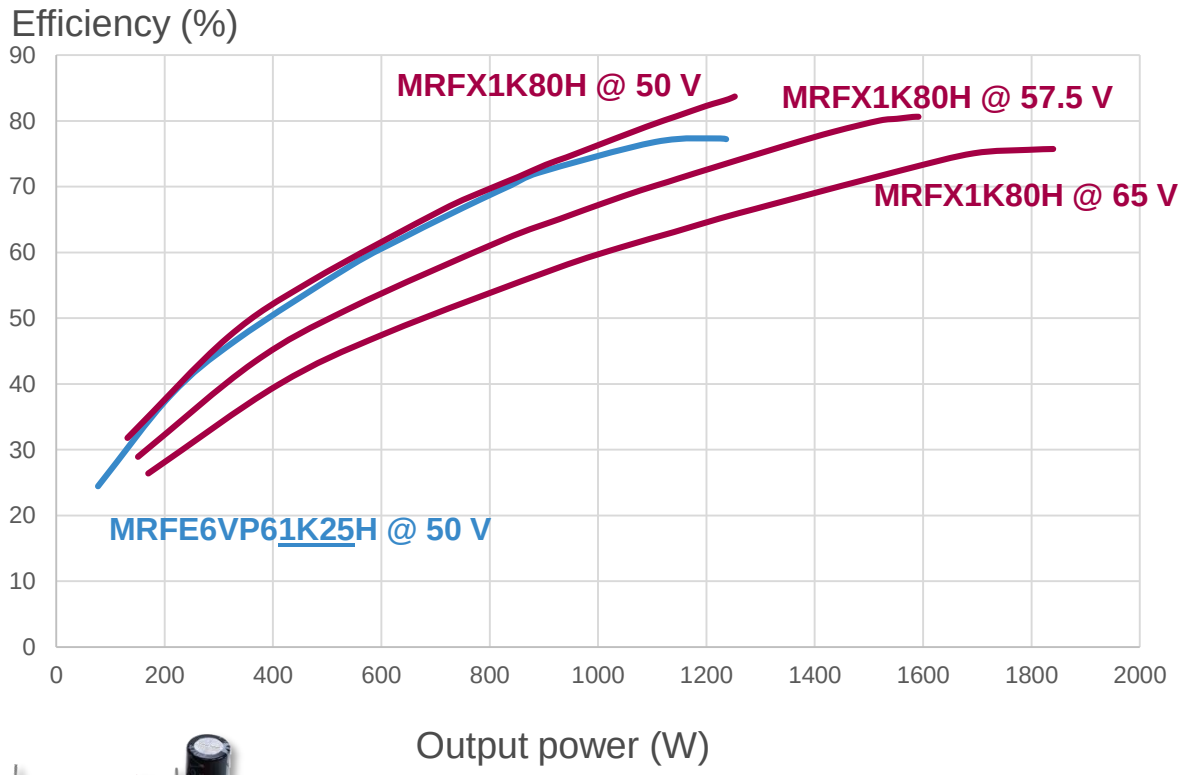


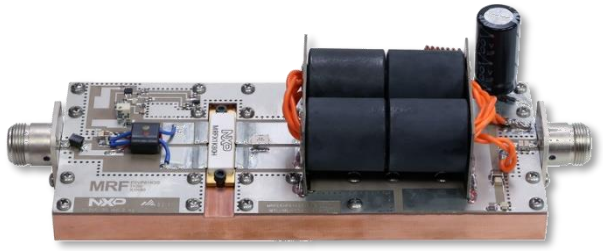
- Faster Time-To-Market
- One platform, multiple products

Easy Upgrade from Existing 50 V Solutions

Data taken on the same 27 MHz reference circuit: no retuning



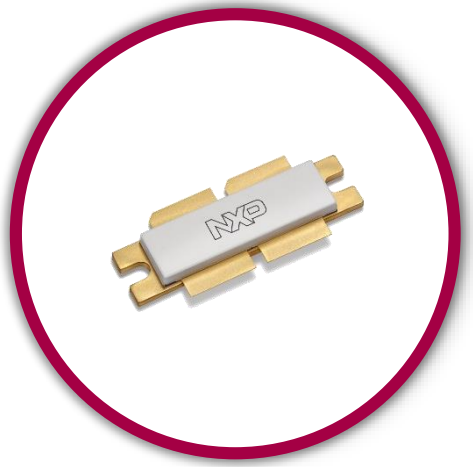




MRFX1K80H details

Datasheet

- **1800 W CW**
- **1.8-400 MHz**
- **65 V LDMOS**
- Unmatched input and output
- Push-pull
- NI-1230 air cavity ceramic package
- 0.09°C/W thermal resistance
- 193 V typical typical breakdown voltage $V_{(BR)DSS}$
- Extreme ruggedness: handles 65:1 VSWR
- Warranted availability until 2032 minimum



Comments:

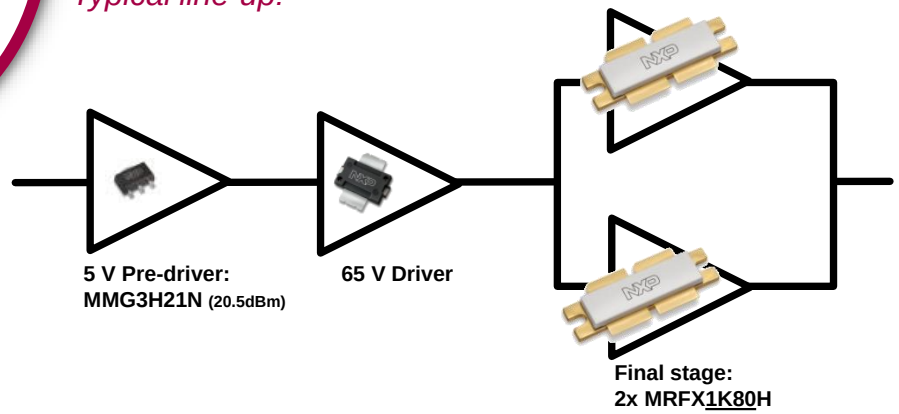
Designed for ease of use:

- *65V increases the power density, enables higher output impedance, higher breakdown voltage and less current in the system (video)*
- *Pin-compatible with MRFE6VP61K25H and MRF1K50H (see it in action here)*

Available reference circuits:

Frequency (MHz)	Voltage (V)	Pout (W)	Gain (dB)	Drain eff. (%)	Size (inch)
27	60	1800 CW	27.8	75.6	2.9 x 6.9
64	65	1800 Pulse	27.1	69.5	3 X 5.5
81.36	63	1700 CW	24.5	76.3	2.9 x 6.4
87.5-108	60	1600 CW	23.6	82.5	2.9 x 5.1
128 (2-up)	65	3775 Pulse	25.4	67.5	5 x 5
144	65	1800 CW	23.5	78.0	2.9 x 4.7
230	65	1800 Pulse	25.1	75.1	4 x 6
325	63	1700 Pulse	22.8	64.9	4 x 6

Typical line-up:



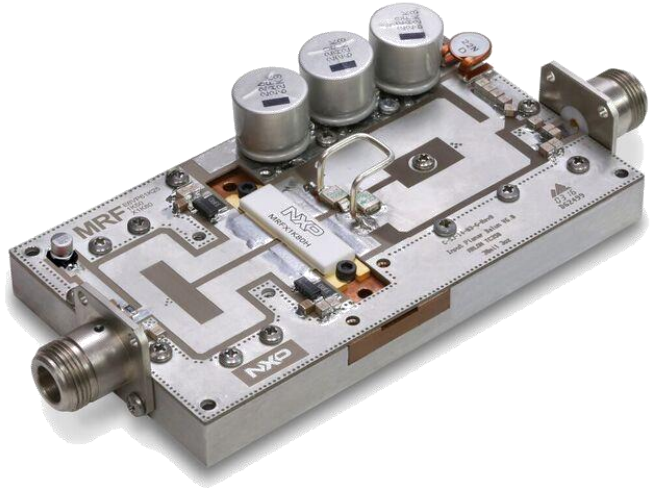
MRFX1K80 Target Markets

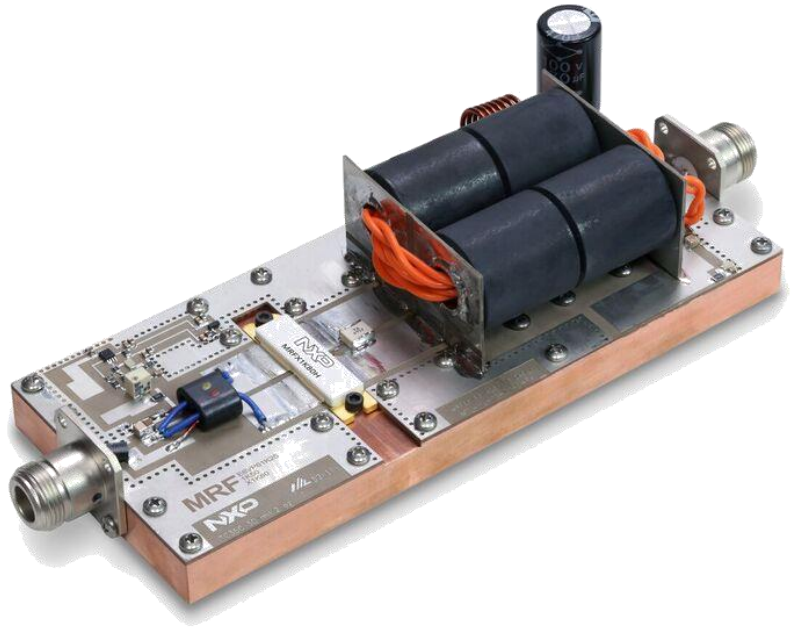
- **Industrial, Scientific, Medical (ISM)**
  - Laser generation
  - Plasma etching
  - Magnetic Resonance Imaging (MRI)
  - Diathermy, skin laser, RF ablation
  - Industrial heating, welding and drying systems
  - Particle accelerators
- **Broadcast**
  - Radio broadcast (FM/DAB)
  - VHF TV broadcast
- **Aerospace**
  - VHF omnidirectional range (VOR)
  - HF and VHF communications
  - Weather radar
- **Mobile Radio**
  - VHF base stations

For more information

- 65 V LDMOS web page: www.nxp.com/65V

- MRFX1K80H web page with datasheet: www.nxp.com/MRFX1K80H



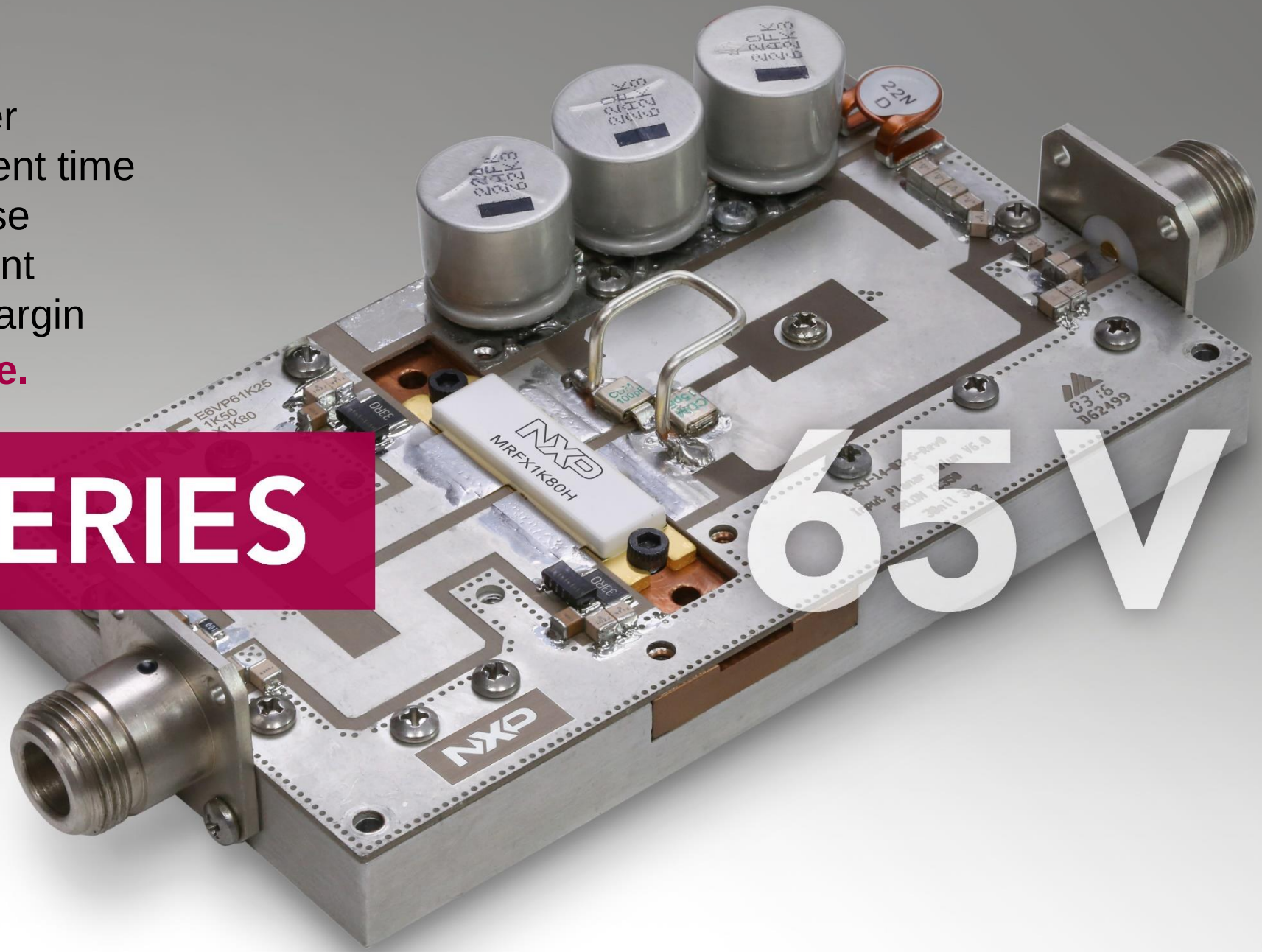


More power
Faster development time
Design reuse
Lower current
Wide safety margin

Easy to use.

MRFX SERIES

65V



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