Modern FM Transmission Technologies

An Application using Harris' Flexiva Line of Solid-State FM Amplifiers

March 30, 2010

Featuring GatesAir's

Rich Redmond
Chief Product Officer

Modern FM Transmission Technologies

An Application using Harris' Flexiva Line of Solid-State FM Amplifiers

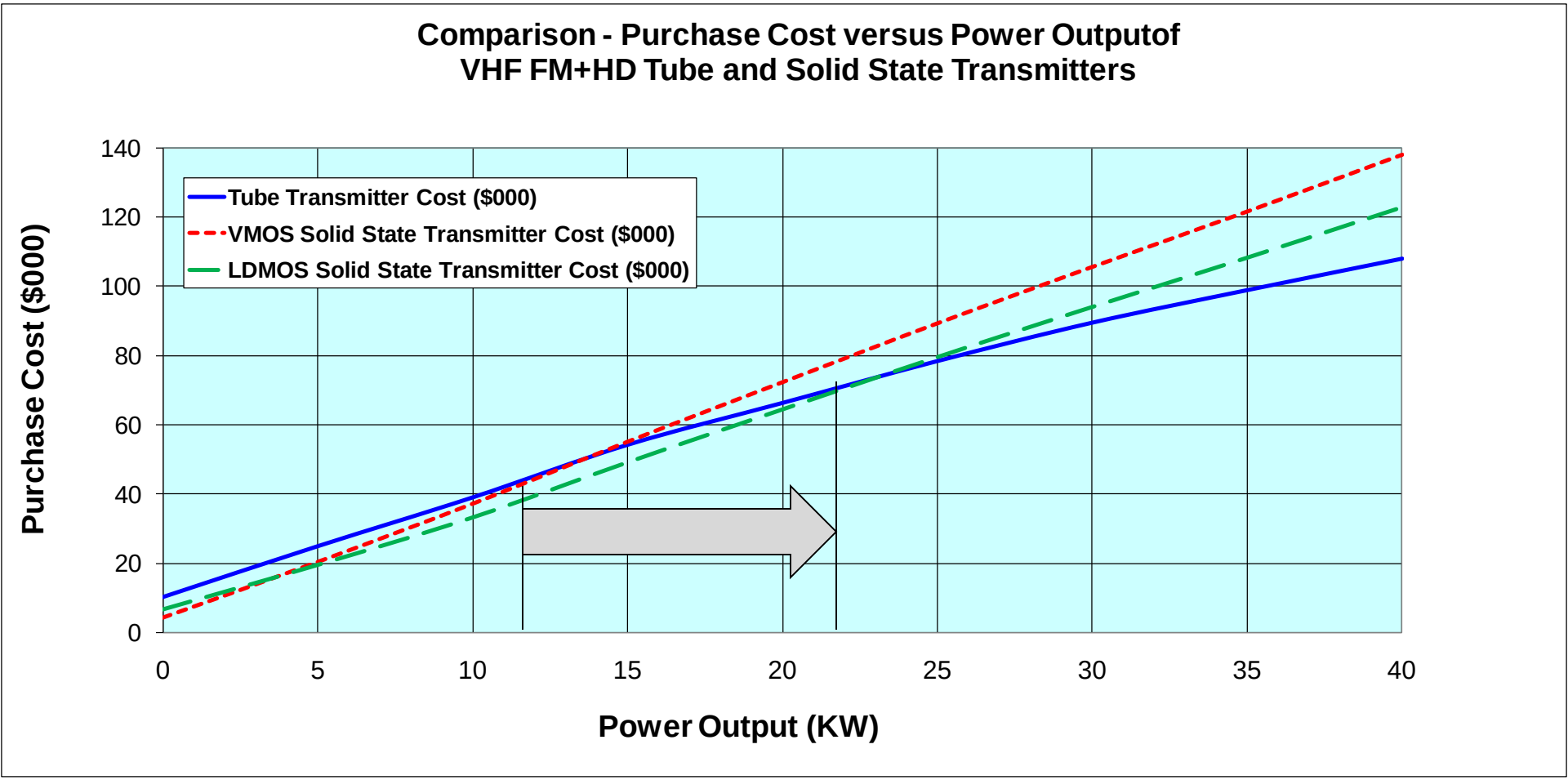
Richard Redmond

Vice President Product Management & Strategy

INTRODUCTION

- FM infrastructure needs to meet the needs of today and tomorrow
  - Long useful life
  - Cost effective purchase and operation
  - Support analogue and digital standards
  - Compact footprint
- New FM RF power amplifier technology offering major improvements over what is current available
  - Significantly higher output power density
  - More compact, space efficient transmitters
  - Greater power and cooling efficiency
  - Lower purchase and operating costs
  - Improved RF performance
  - Excellent COFDM performance

POWER DENSITY Vs. COST



HIGHER POWER DENSITY

Amplifier power density is the key to reducing both the size of the transmitter and the cost of manufacturing and purchase.

- Contemporary solid-state 10kW FM transmitter designs can achieve about 625 Watts per cubic foot at a cost of around $8.00/Watt in a single 19” rack
- *50 Volt LDMOS makes possible fewer devices in a more compact and lower cost transmitter package*
- New transmitter systems designed around these higher per-device power levels can now achieve 20 kW in the same 19” rack or around 1250W per cubic foot at a cost of less than $5.00/Watt

HIGHER POWER DENSITY

- Several LDMOS devices evaluated for the new high-power FM module.
- Selection criteria: Power Density, Gain, Efficiency & Robustness, COFDM performance
- In addition to DTV transmission use, LDMOS is used in industrial, scientific and medical (ISM) markets such as CO^2 lasers, plasma generators and magnetic resonance imaging (MRI) scanners
- The LDMOS device ultimately selected for incorporation into Harris' next generation FM module passed all of stress tests and performed flawlessly.

AMPLIFIER PALLET DESIGN

Freescale Semiconductor
Technical Data

RF Power Field Effect Transistors

High Ruggedness N-Channel
Enhancement-Mode Lateral MOSFETs

These high ruggedness devices are designed for use in high VSWR i... (including laser and plasma exciters), broadcast (analog and digital), aerosp... and radio/land mobile applications. They are unmatched input and outp... designs allowing wide frequency range utilization, between 1.8 and 600 MHz.

- Typical Performance: V_{DD} = 50 Volts, I_{DQ} = 100 mA

Signal Type	P_{out} (W)	f (MHz)	G_{ps} (dB)	η_D (%)	IRL (dB)
Pulsed (100 µsec, 20% Duty Cycle)	1250 Peak	230	24.0	74.0	
CW	1250 CW	230	22.9	74.6	-15

- Capable of Handling a Load Mismatch of 65:1 VSWR, @ 50 Vdc, 230 MHz, at all Phase Angles, Designed for Enhanced Ruggedness, 1250 Watts Pulsed Peak Power, 20% Duty Cycle, 100 µsec
- Capable of 1250 Watts CW Operation

Features

- Unmatched Input and Output Allowing Wide Frequency Range Utilization
- Device can be used Single-Ended or in a Push-Pull Configuration
- Qualified Up to a Maximum of 50 V_{DD} Operation
- Characterized from 30 V to 50 V for Extended Power Range
- Suitable for Linear Application with Appropriate Biasing
- Integrated ESD Protection with Greater Negative Gate-Source Voltage Range for Improved Class C Operation
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- RoHS Compliant
- In Tape and Reel. R6 Suffix = 150 Units, 56 mm Tape Width, 13 inch Reel. For R5 Tape and Reel options, see p. 12.

Table 1. Maximum Ratings

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	-0.5, +125	Vdc
Gate-Source Voltage	V_{GS}	-6.0, +10	Vdc
Storage Temperature Range	T_{stg}	-65 to +150	°C
Case Operating Temperature	T_C	150	°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1333 6.67	W W/°C
Operating Junction Temperature (1,2)	T_J	225	°C

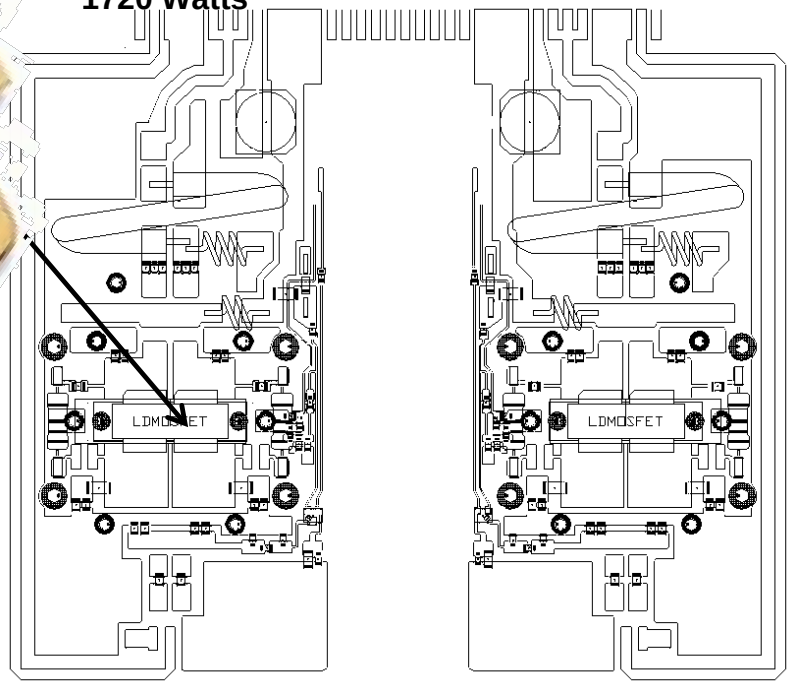
Figure 1. Pin Connections

New RF Device

50V LDMOSFET
1275W / Device
82% Efficiency
21.5 dB Gain

New RF Module

Conservative
1720 Watts



Part of the new highly successful LDMOS Family used in all current TV and DMB products

Power Supply Modules

LINEAGE POWER

- Over-temperature warning and protection
- Redundant, parallel operation with active load sharing and redundant +5V Aux power
- Remote ON/OFF
- Hot insertion/removal (hot plug)
- Four front panel LED indicators
- UL* Recognized to UL60950-1, CAN/ CSA† C22.2 No. 60950-1, and VDE‡ 0805-1 Licensed to IEC60950-1
- CE mark meets 2006/95/EC directive§
- Internally controlled Variable-speed fan
- RoHS 6 compliant

Compact Power Line

CP2725AC54TE High Efficiency Front End PS

Input: 100-120/200-277 Vac; Default Output: ±54 Vdc @ 2725W; 5 Vdc @ 4W

- 2725 Watt Switching Power Supply Modules
- 1 Power supply per dual PA Module
- 96% Efficiency
- Wide operating voltage range

Flexiva™ Value

- **Lowers the Total Cost of Ownership**
  - Highest power density, Watts per dollar of any transmitter available today
  - Most Compact 10,000 Watt transmitter available today, only 16RU - Light weight compact design allows for simple upgrade in space restricted sites, and is ideal for portable/back up use. About half the weight and volume of competitive models. Lower shipping costs
  - Latest in solid-state power amplifier technology provides highest AC-to-RF efficiency approaching 70%
  - High Efficiency Switch-mode Power Supplies > 96%
  - Use of a common modules simplifies spares stocking
- **Highest Reliability**
  - High level of redundancy in all systems with no single point-of-failure.
  - Hot-pluggable PA modules and power supply from front panel for ease of serviceability.
  - Field Proven variable-speed, DC fans (only 5 Fans in the 10kw)
  - Bullet-proof Hardware Control architecture
- **Feature Rich**
  - Quad-mode operation. Simple upgrade from analog to digital. On the fly switching between FM analog, FM+HD, HD only and DRM+ modes (with the addition of digital exciter)
  - Full remote control and supervision via standard IP interfaces
  - Ability to interface to multiple exciter types Not locked in to special exciter

Flexiva Low Power FM

- 2RU x12” Deep
  - FAX 50 75 W
  - FAX 150 165 W
- 3RU x 20” Deep
  - FAX 300 350 W
  - FAX 500 550 W
  - FAX 1K 1,100 W
- 5RU x 20 “ Deep
  - FAX 2K 2,200 W
  - FAX 3K 3,500 W
  - FAX 3.5K 3,850 W

PowerSmart™

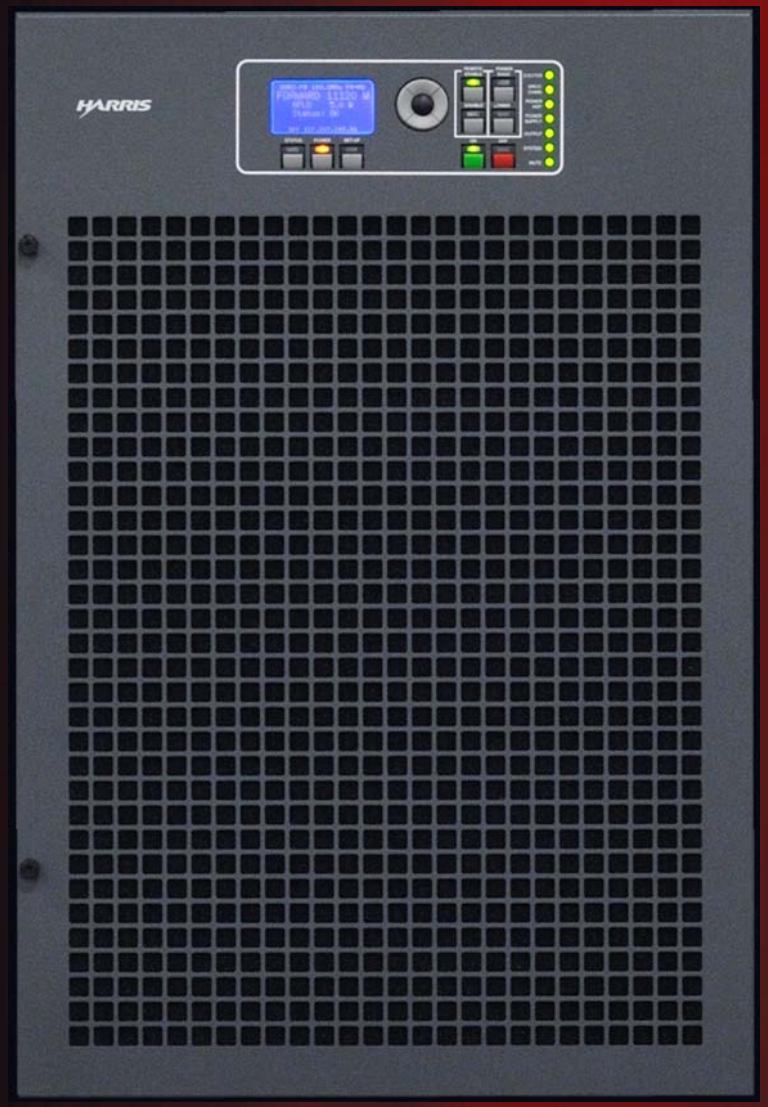
Flexiva Low Power FM

Features

- Integrated direct-to-carrier digital modulator
- Auto-Switching Analog, AES, Composite audio inputs
- Feature-rich Web GUI
- Simple front panel control & status
- HD Radio or DRM+ ready
- Optional internal Orban 5500 Audio Processing
- Optional Audio over IP and USB audio playback
- Optional SFN w GPS, Receiver/Translator

PowerSmart™

High Power 10 KW



- 16 RU Compact Transmitter
  - FAX 5K 6,200 W
  - FAX 10K 11,000 W
- AC-RF Efficiency > 70%
- Optional Internal Flexiva Exciter
  - Self contained
  - Input for External Exciter
  - Auto switching Main/Alt Exciters
- 10 kW Block - Scalable up to 40kW

PowerSmart™

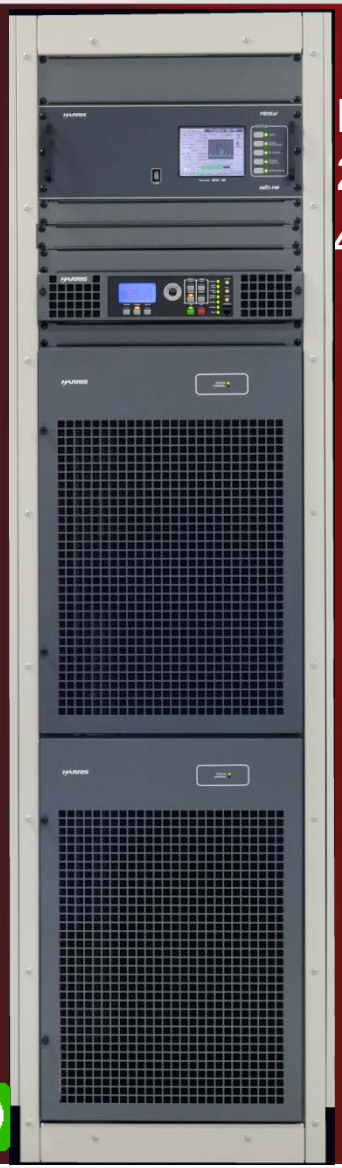
High-Power – FAX 20K / FAX 40K

Flexstar
HD Radio™
Exciter

Power Block Control
w/ optional FAX300
Exciter

2 x FAX 10K
10kW Power Blocks

PowerSmart™



FAX 20K
22,000 W
44 RU

4 x FAX 10K
10kW Power
Blocks

FAX 40K
42,000 W

2 x 44 RU

Summary

- **Look for low Total Cost of Ownership**
  - High efficient RF amplifiers
  - Best in class Power Supplies
  - Compact footprint
- **Require Highest Reliability**
  - High level of redundancy in all systems with no single point-of-failure.
  - Hot-pluggable PA modules and power supply from front panel for ease of serviceability.
  - No PC type controllers
- **Flexibility – “future proof”**
  - Quad-mode operation. Simple upgrade from analog to digital.
  - Full remote control and supervision via standard IP interfaces
  - Ability to interface to multiple exciter types Not locked in to special exciter

Modern FM Transmission Technologies

An Application using Harris' Flexiva Line of Solid-State FM Amplifiers

Richard Redmond

Vice President Product Management & Strategy