

**Q SERIES - 20kW and 40kW FM**

# Nautel Limited 20 kW, 40kW (dual 20 kW) Totally Solid State FM Broadcast Transmitters

## A Quantum Leap for High Power FM Transmission

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### MORE POWER

- Up to 44 kW dual transmitter
- Up to 22 kW single transmitter
- 68% overall efficiency

### MORE REDUNDANCY

- Broadband Power Modules – on-air serviceable
- Switching Power Supply Modules – on-air serviceable
- 4 Parallel Redundant Rectifiers
- Distributed DC Ventilation Fans

### MORE DUPLICATION

- Dual Digital Exciters
- Dual IPA
- Dual IPA Power Supply
- Dual Low Voltage Power Supply

### Q20/20 40kW Solid State FM Dual Transmitter System

The Q20/20 comprises of two 20 kW standalone FM transmitters fully integrated to operate as a 40 kW active reserve transmitter system. Single or dual Digital Exciters with coherent drive components are included. System controls, metering and diagnostics for 40 kW operation are incorporated within the dual Q20 cabinets.

Three standard configurations are offered to satisfy individual site requirements and balance cost and space considerations with maximum on-air confidence and system flexibility.

The Basic Combiner configuration is the simplest, the least costly and requires minimum floor space. The many duplication and redundancy features, with on-air serviceability, of the Q20 transmitters make this an attractive solution for many installations.

The Automatic Switcher / Combiner configuration provides maximum flexibility. Motorized RF switching makes it possible to bypass the combiner with a single Q20 directly



### Q20/20

to the antenna. The idle Q20 is isolated and terminated to the station Dummy Load and accessible for safe maintenance or off-air performance testing.

The Automatic Contactless Switcher / Combiner configuration provides motorized 0°-90°-180° phase adjustment to direct full power from a single Q20 to the antenna without interruption in broadcasting. This ability to maintain programming continuity in the event of problems with one transmitter section is particularly attractive for aggressively competitive radio stations.

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### Q20 kW Solid State FM Standalone Transmitter



**Q20**

#### ***RF Output***

The Combiner / Filter assembly is tunable over the entire FM band from 88 MHz to 108 MHz to provide the correct impedance matching and

harmonic rejection.

Nautel's approach to solid state FM combining allows extremely high power single ended transmitters by avoiding cascaded levels of Hybrid networks with associated imbalance loads. The design avoids complexity and waste heat dissipation within the transmitter cabinet, contributing to system reliability.

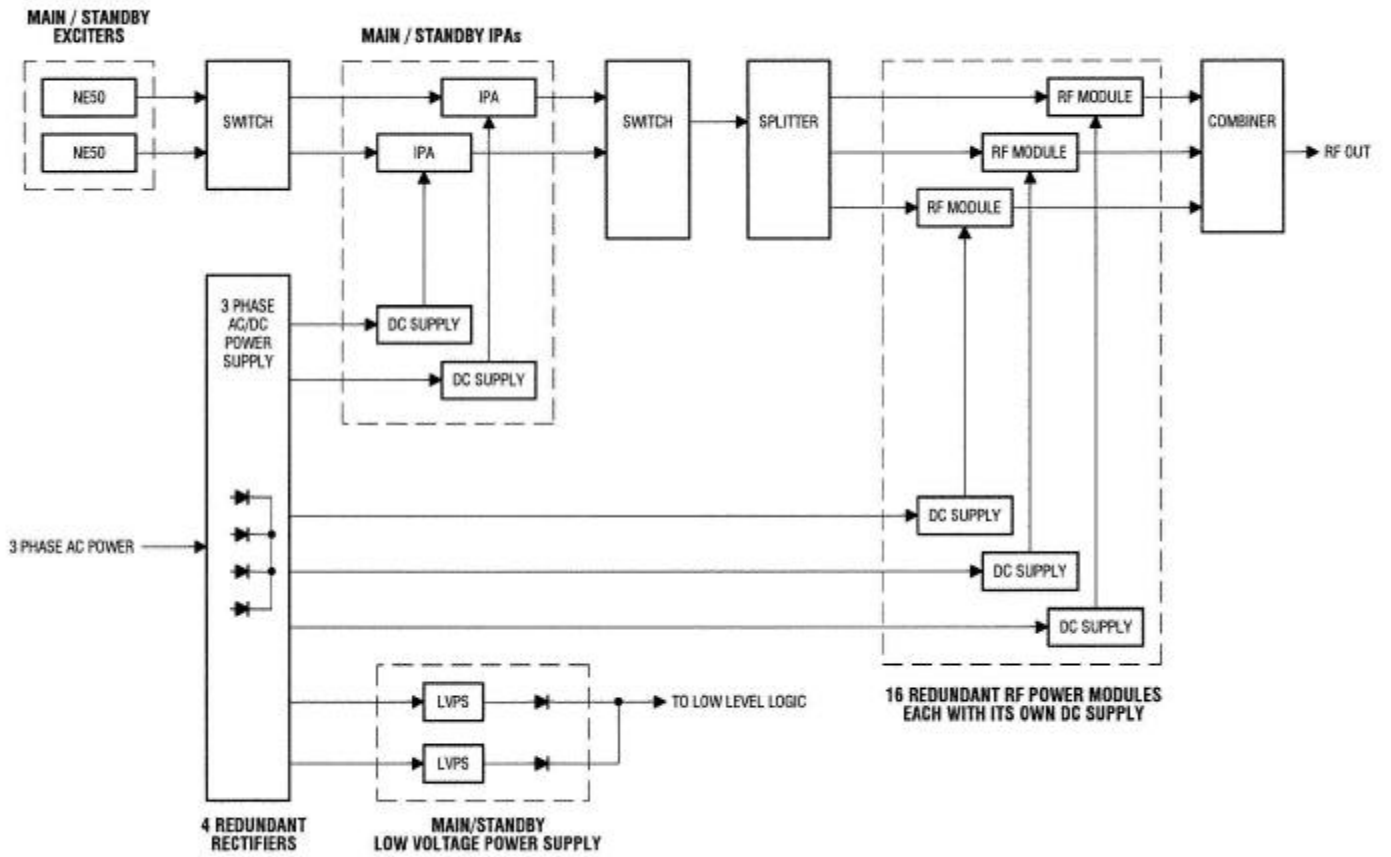
RF output power up to 22,000 Watts is derived from 64 independent power amplifiers (PAs). Each PA is connected via a short fixed length (13 inch) co-axial cable to the Nautel patented 60° single stage Combiner. The high integrity coaxial connection is visually verifiable and easily accessible.

In the unlikely event of amplifier malfunction, no stress is imposed on the other amplifiers. The remaining amplifiers experience only a slight increase in load impedance. No power is wasted and no heat is produced.

Nautel's combining scheme is simple, efficient and has proven to be very reliable. The technique provides superior failure isolation.

No damage to the Combiner can be caused by failure of a module in either short or open circuit mode. Any Power Module can be removed from the transmitter while the remaining modules continue to operate. Service may be carried out during normal hours without a broadcast interruption.

# Q20 BLOCK DIAGRAM



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### Redundant Power Modules

#### *On-Air Serviceable*



Sixteen Power Modules each provide mounting for four independent single stage RF power amplifiers. Each PA consists of one MRF151G

(Gemini Series) device operating in a push-pull configuration. The Gemini MOSFET is a dual package with inherent device matching. This permits field replacement with standard non-selected devices available from local component distributors. No tuning or other adjustment is required. The high efficiency broadband Power Module is identical and fully interchangeable in any Nautel Q series solid state FM transmitter.

The amplifier is fundamentally identical to that employed in the many Nautel solid state FM series transmitters successfully put into service around the world during the past decade. Field experience has demonstrated exceptional reliability with Mean Time Between Failure statistics exceeding 2.5 million hours.

Should one of the 64 PAs malfunction, transmitter operation continues with only minor power reduction. Whenever convenient the affected Power Module may safely be removed for service, without any interruption in broadcasting.

### Redundant Switching PS Modules

#### *On-Air Serviceable*



Each and every Power Module and IPA module receives its regulated +50 V DC supply from its own dedicated Switching Power Supply Module.

Nautel engineers have developed a switching power supply optimized for efficiency, safety and ease of use.

The Power Supply operates as a fixed frequency phase modulated PDM system utilizing a full bridge composed of two FETs and two IGBTs.

The unique design provides new levels of reliability for switching power supplies. Each PS Module is individually fused and protected by four MOVs across a common Bus input. Power Supply control electronics are referenced to normal output ground to allow safe, easy service with only low DC voltage applied. Power components can be verified at the workbench with only an ohmmeter without need for a three-phase supply.

There is minimal effect, should a Switching PS malfunction. Only one RF Power Module is disabled. Safe, on-air serviceability permits simple exchange or repair without any down time.

### Dual IPA Modules

The Q20 Intermediate Power Amplifier Module comprises four RF amplifiers and is identical and interchangeable with any of the Power Modules.

It is designed for maximum reliability. Each amplifier in the IPA Module operates at only 240 watts while conservatively rated for up to 370 watts when employed in a Power Module.

IPA input from the Digital FM Exciter is matched to 50 ohms. Output impedance matching takes place in the IPA Combiner / Splitter which provides single point input tuning to all the power amplifiers to achieve maximum efficiency.

Facilities are provided for Main and Standby IPA Modules with automatic changeover.

### Dual Digital Exciters



The Q20 and the Q20/20 provide automatic control and mounting for two Nautel Digital FM Exciters in main and standby mode with automatic changeover.

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The Exciter utilizes Direct Digital Synthesis technology, which provides 32 bit signal processing to digitally construct the carrier signal with a numerically controlled oscillator. Modulation in the digital domain provides a perfectly linear system with superior audio fidelity sustained over time.

Direct digital audio input in AES/EBU format may be via electrical or optical connection. The optical TOSLINK type has the added advantage of EMI isolation. Should the AES/EBU signal be interrupted, a separate emergency analog input connection is available as a backup. There are three unbalanced BNC connections for SCA/RDS input. A Digital Signal Processor monitors, filters and interpolates the digital audio and generates a digital stereo composite signal, which is applied to the FM Modulator.

Broadcasters utilizing analog systems today can still take advantage of the enhanced performance of the digital technology. The exciter is available for use with conventional composite (analog) input which is field upgradeable to full digital at a later date.

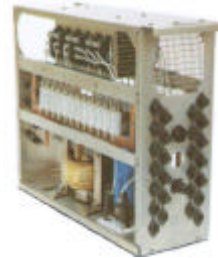
### Dual LV PS Modules

The standard Q20 transmitter includes Dual Low Voltage DC Power Supply Modules. These employ the same topology as the B+ Switching PS Modules and use an identical input circuit board.

The LVPS is a switching supply with multiple outputs for control and logic, Switching PS operation and ventilation fans.

Due to its critical nature, the two LVPS Modules are arranged so only one supply is on at one time. Automatic Main / Standby switchover is provided.

### Four Redundant Rectifiers



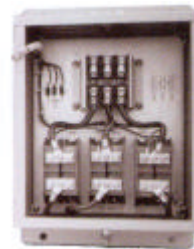
The AC/DC Power Supply is the transmitter's interface to the AC mains. The complete unit is housed in a lightweight, wheeled roll-out assembly for ease of service.

A common three-phase Rectifier Stack and Low Pass Filter develops a 300 V DC Bus for the Switching Power Supply Modules.

The Rectifier consists of four parallel diode pairs per AC supply phase, with each diode individually fused with a semiconductor fuse.

The Rectifier will start and run with only two of the four parallel diode pairs per phase intact.

### Five Stage Transient Protection



Nautel has more than 30 years successful experience in design and manufacture of exclusively solid state radio transmitters. This has developed a clear understanding of transient

protection principles necessary to achieve the potential reliability inherent to solid state equipment.

The Q series transmitter includes an AC Line Protection Unit designed for strategic installation at the service entrance. This provides first level phase-to-ground protection for site, equipment and personnel.

The Q series transmitter AC input terminal incorporates second level phase-to-phase MOV protection devices.

Six MOVs are installed across each Rectifier, giving a total of 24 devices at the third level of protection.

After the Rectifiers, the Low Pass Filter of the AC/DC Power Supply adds a fourth level of transient protection.

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Finally, the DC Bus distribution to each individual Switching PS Module includes four MOVs to protect the FET/IGBT Bridge.

### Redundant Ventilation

Low velocity parallel air flow ensures cool reliable operation. Modules have individual thermal protection. Redundant brushless DC ventilation fans avoid thermal stress independent of AC supply frequency.

Separate fans are provided for each pair of Power Modules and each pair of Switching PS Modules. The IPA Modules and Power Supplies have independent ventilation. Series redundant fans ventilate the AC/DC Power Supply and Combiner/Filter sections.

The Q20 and Q20/20 will accommodate various ventilation configurations, including open ambient room air cooling as well as fully closed ducted systems. Room air intake requires minimum floor space with disposable filters installed in the rear doors. Fully ducted systems are accommodated with the addition of a 12-inch sealed air intake plenum installed at the rear of the transmitter.

### Compact Construction

The Nautel transmitter is constructed in a rugged aluminum rack with advantages of corrosion resistance, light weight, and small footprint.

Dimensions of the Q20 are 46.5 inches wide x 46.5 inches deep (open air ventilation) x 72.4

inches high. An additional 6.8 inches of height is required to the top of the RF output flange.

Size and floor loading are often critical issues for FM transmitter facilities located in high rise buildings. The front 12-inch section of the rack is designed for easy removal, reducing depth to less than 33 inches. This permits entry through standard width residential entrances.

The Q20/20, 40kW Basic Combiner configuration with a footprint of 30 sq. ft requires less floor space than a 4 ft x 8 ft sheet of plywood.

### Operating Convenience

The transmitter control panel allows simple push button selection of operating modes. Two power level selections are continuously adjustable using raise/lower commands. High resolution meters provide measurement of critical parameters. A LED diagnostic flow diagram assists service personnel to easily identify problems.

Automatic main and standby controls are built in for the exciter, IPA and IPA Power Supply. A basic configuration Q20 may be purchased to minimize initial cost, and duplication simply and economically added later.

The transmitter is ideally suited to unattended automatic or remote controlled operation. RF output is stabilized against moderate VSWR up to 1.1:1. When VSWR exceeds 1.5:1, power output is automatically reduced to a safe level.

**For further information, please contact us at:**

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Simply the best engineered transmitters

# Nautel Limited Q20

## Totally Solid State 20 kW FM Transmitter

### Nautel Solid State Technology for Value

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#### NAUTEL Q20 SPECIFICATIONS

**General Configuration:** 16 power modules and 16 associated switching power supplies. Main and standby IPA module with main and standby associated power supplies.

Main and standby exciters.

Main and standby low voltage power supplies.

**Power Output:**

Rated 20,000W into a 1.2 VSWR, capable 22,000W into a 1.1 VSWR. Continuously adjustable 3000-22,000W.

**RF Frequency Range:** 87.9-107.9MHz

**RF Terminating Impedance:** 50 ohms unbalanced, 3-1/8 inch EIA flange, female

**VSWR:** 1.5:1 (automatic power reduction into higher VSWR)

**RF Harmonics/Spurious Output:** 80dB or better

**Excitation:** NAUTEL NE50 Exciter

**Frequency Stability:**  $\pm 250$ Hz, 0°C to 50°C ambient temperature range.

**Modulation Type:** Direct Digital Synthesis using a 32 bit NCO (numerically controlled oscillator)

**Modulation Capability:** 150% ( $\pm 75$ kHz reference standard)

**Asynchronous AM S/N Ratio:** 60dB minimum below reference carrier with 100% amplitude modulation using 75 $\mu$ s de-emphasis (no FM modulation present)

**Synchronous AM S/N Ratio:** 50dB below reference carrier with 100% amplitude modulation at 400Hz with 75 $\mu$ s de-emphasis.

**AC Input Voltage:** 190-250 VAC, 3-phase, 50/60 Hz, 115A maximum line current

**Power Consumption:** (typical) 29.4kW at 20kW out (31.6kVA)

**Power Factor:** Better than 0.93

**Power Line Harmonics:** IEEE 519-1992

**Overall Efficiency:** 68% typical AC in to RF out at 20kW ( $\pm 3\%$  measurement uncertainty)

**Ambient Temperature:** 0° to 50°C (derate 3°C per 500m, 2°C per 1000 ft. above sea level)

**Altitude:** Up to 3000 meters (9,750 ft)

**Humidity Range:** Up to 95% non-condensing

**Airflow:** 2300 cfm

**Size:** 46.5"Wx46.6"Dx79.2"H (15sq.ft.) Includes RF output connection. Add 12" to depth for optional air intake plenum. For shipping and installation purposes, transmitter cabinet is separated into smaller racks.

*Open Air Configuration:*

Rack#1: 46.5"Wx12.9"Dx72"H  
118.1cmx32.8cmx182.9cm

Rack#2: 46.5"Wx33.7"Dx79.2"H  
118.1cmx85.6cmx201.2cm

*Closed Air Configuration:*

Rack#1: 46.5"Wx12.9"Dx72"H  
118.1cmx32.8cmx182.9cm

Rack#2: 46.5"Wx32.8"Dx79.2"H  
118.1cmx83.3cmx201.2cm

Rack#3 (Air intake plenum):  
46.5"Wx12.9"Dx72"H  
118.1cmx32.8cmx182.9cm

**Weight:** 1200 lbs/545 kgs

#### Operating with NAUTEL NE50

##### Exciter

**Stereo Performance with Digital Input Module (Standard)**

**Input Connector:** Two total; one XLR female, one optical input receiver

**XLR Input Impedance:** 110 ohms, nominal

**Input Level:** -4.0dB full scale reference, factory programmed

**Data Format:** AES/EBU

(reference standards; AES5-1984, ANSI S4.28-1984, AES3-1985, ANSI S4.40-1992 and AES3-1992)

**Data Rate:** Any in range 25kHz to 55kHz (32, 44.1 or 48kHz typically)

**Digital Stereo Generator:** The digital input module generates the composite stereo baseband signal from the left and right digital audio present in the AES/EBU data

**Pre-Emphasis:** 0, 25, 50 or 75 $\mu$ s, locally selectable

**Pilot Carrier:** 19kHz  $\pm 0.1$ Hz. 9% injection level, factory programmed.

Locally selectable on or off.

Available on rear panel BNC jack, as TTL or 1vpp sine for RBDS operation.

**38kHz Suppression:** 80dB below  $\pm 75$ Hz deviation reference

**Stereo Separation:** Better than 60dB, 30Hz to 15kHz

**Amplitude Response (L or R):**  $\pm 0.2$ dB, 30Hz to 15kHz, referenced to 0dB at 400Hz

**FM Signal to Noise Ratio (L or R):** 80dB below 100% modulation (Reference 400Hz, measured in a 22Hz to 22kHz bandwidth with 75 $\mu$ s de-emphasis and DIN 'A' weighting)

##### **Stereo Total Harmonic**

**Distortion (L or R):** 0.025% or less, 30Hz to 15kHz, measured in 22Hz to 22kHz bandwidth with 75 $\mu$ s de-emphasis

##### **Intermodulation Distortion**

**(L or R):** CCIF: 0.008% or less (14/15kHz 1:1); SMPTE: 0.025% or less (60 and 7000Hz 1:1)



**Nautel Limited Q20**  
**Totally Solid State 20 kW FM Transmitter**

**Nautel Solid State Technology for Value**

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**Nautel Q20 Specifications *continued***

**Transient Intermodulation**

**Distortion (DIM) (L or R):** 0.05% or less (2.96kHz square wave/14kHz sine wave)

**Stereophonic Crosstalk:** 60dB below 100% (30Hz-15kHz) modulation reference: L+R to L-R and L-R to L+R square

**Stereo/Monaural Mode Control:**

Local control. Configures the digital audio receiver to accept both L and R (Channel A and B) in stereo mode or L only (Channel A) in monaural mode

**Backup Analog Composite**

**Mode:** Local/Remote control. Disables digital stereo generator and reconfigures digital input module to accept analog composite stereo on existing composite input connector located on rear panel. All SCA inputs remain valid.

**Monaural Performance with Digital Input Module**

**FM Signal to Noise Ratio:** 90dB below 100% modulation (Reference 400Hz at  $\pm 75$ kHz deviation with 75 $\mu$ s de-emphasis and DIN 'A' weighting in a 22Hz to 22kHz bandwidth)

**Harmonic Distortion:** 0.005% or less 30Hz to 15kHz (22Hz to 22kHz bandwidth with 75 $\mu$ s de-emphasis)

**Wideband Composite Operation with Analog Input**

**Module Inputs:** One balanced balanced (floating BNC jack), one unbalanced (BNC jack), one unbalanced front panel test input (BNC jack)

**Input Impedance:** Balanced - 10k/ 50 ohm selectable, Unbalanced – 10 k ohm

**Input Level:** 3.5V p-p nominal for  $\pm 75$ kHz deviation

**Amplitude Response:**  $\pm 0.05$ dB 30Hz to 53kHz

**FM Signal to Noise Ratio:** 90dB below 100% modulation

(Reference 400Hz at  $\pm 75$ kHz deviation with 75 $\mu$ s de-emphasis and DIN 'A' weighting 20Hz to 80kHz bandwidth)

**Harmonic Distortion:** 0.005% or less at 400Hz measured in a 22Hz to 80kHz bandwidth with 75 $\mu$ s de-emphasis

**CCIF Intermodulation**

**Distortion:** 0.009% or less (15kHz/14kHz 1:1 ratio)

**SMPTE Intermodulation**

**Distortion:** 0.015% or less (60Hz/7kHz 1:1 ratio)

**Transient Intermodulation**

**Distortion:** 0.015% or less (2.96kHz square wave/14kHz sine wave)

**Composite Phase Response:**  $\pm 0.5^\circ$  from linear phase 30Hz to 53kHz

**Stereo Separation:** Better than 50dB, 30Hz to 15kHz when measured in conjunction with a high quality stereo generator and demodulator

**Monaural Performance with Analog Input Module**

**Input Impedance:** 600 ohms balanced, resistive, transformerless

**Input Level:**  $\pm 10$  dBm nominal for  $\pm 75$ kHz deviation at 400Hz (adjustable)

**Frequency Response:**  $\pm 0.5$ dB (30Hz to 15kHz) selectable flat,

25, 50, or 75 $\mu$ s pre-emphasis  
**FM Signal to Noise Ratio:** 90dB below 100% modulation (Reference 400Hz at  $\pm 75$ kHz deviation with 75 $\mu$ s de-emphasis and DIN 'A' weighting in a 22Hz to 22kHz bandwidth)

**Harmonic Distortion:** 0.005% or less at 400Hz measured in a 22Hz to 22kHz bandwidth with 75 $\mu$ s de-emphasis

**CCIF Intermodulation**

**Distortion:** 0.009% or less (15kHz/14kHz 1:1 ratio)

**SMPTE Intermodulation**

**Distortion:** 0.015% or less (60Hz/7kHz 1:1 ratio)

**Transient Intermodulation**

**Distortion:** 0.015% or less (2.96kHz square wave/14kHz sine wave)

**SCA (RBDS/RDS)**

**Performance**

**Inputs:** 3 Unbalanced (BNC jack)

**Input Impedance:** 10 K ohm

**Input Level:** 2.8V p-p nominal for  $\pm 7.5$ kHz deviation

**Amplitude Response:**  $\pm 0.5$ dB 20kHz to 100kHz

**Subcarrier Frequency Range:** 57kHz to 92kHz (25kHz to 92kHz monaural)

**Analog Backup Operation with Digital Input Module**

**Input Connector:** One unbalanced (BNC jack)

**Input Impedance:** 10K ohm

**Input Level:** 3.5V p-p nominal for  $\pm 75$ kHz deviation

**Amplitude Response:**  $\pm 0.2$ dB, 30Hz to 53kHz

**Nautel Limited Q20  
Totally Solid State 20 kW FM Transmitter**

**Nautel Solid State Technology for Value**

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**Nautel Q20 Specifications *continued***

**FM Signal to Noise Ratio:** 85dB below 100% modulation (Reference 400Hz at  $\pm 75$ kHz deviation with 75 $\mu$ s de-emphasis and DIN 'A' weighting 20Hz to 80kHz bandwidth)

**Harmonic Distortion (plus noise):** 0.02% or less, 30Hz to 53kHz, measured in 22Hz to 80kHz bandwidth with 75 $\mu$ s de-emphasis

**Stereo Separation:** Better than 38dB, 20Hz to 15kHz when measured in conjunction with a high quality stereo generator and demodulator.

**CCIF Intermodulation Distortion:** 0.009% or less (15kHz/14kHz 1:1 ratio)

**SMPTE Intermodulation Distortion:** 0.02% or less (60Hz/7kHz 1:1 ratio)

**Transient Intermodulation Distortion:** 0.015% or less (2.96kHz square wave/14kHz sine wave)

**Specifications established at rated power unless otherwise noted. All measurements at 50 ohms resistive load; AC input voltage at nominal level. Specifications subject to change without notice.**



Simply the best engineered transmitters

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