

### DIGIT<sup>®</sup>CD

#### Digital FM Exciter

##### Features/Benefits

- ▶ Direct interface to digital sources/STLs eliminates intermediate A/D and D/A conversions which add distortion, noise, and system cost.
- ▶ Digital Signal Processor (DSP) synthesis of stereo provides perfect stereo, with none of the signal degradation resulting from the amplitude and phase limitations of analog baseband.
- ▶ Modulator frequency response to DC provides performance unaffected by large transients in program sources (STL carrier squelch, etc.) and elimination of off-air time from AFC/PLL overload or relock.
- ▶ Externally Controlled Carrier Frequency Synchronization. Carrier synchronization is an important feature for on-carrier FM booster systems to provide controlled and stable service with a minimum of interaction in the coverage areas of the main and booster transmitters. An optional feature of the new DIGIT CD will allow an external 10MHz synchronization frequency standard referenced to Global Positioning System (GPS) satellites. This approach eliminates the current need to transport a frequency reference subcarrier or tone to each booster. GPS synchronization can provide a large improvement in carrier stability - up to 5 parts in  $10^{-12}$ , depending on the GPS receiver used.
- ▶ Synchronous AM reduction circuit. The DIGIT CD includes special system optimization circuitry to reduce synchronous AM, no matter where it may originate in the transmitter or output system. This feature can be very useful to reduce the synchronous AM produced in narrowband transmitter stages, and can improve system performance into narrowband filters, combiners and antenna systems.
- ▶ Exact modulation metering at any frequency ensures true peak modulation level as read from modulation data.



### Features/Benefits (cont.)

- ▶ Modulation level and linearity are independent of carrier frequency, eliminating need for adjustments when exciter frequency is changed; ideal for N+1 systems where one transmitter serves as standby for other transmitters at same site.
- ▶ Absolute digital control of carrier center frequency and deviation ensures stability. Because digital circuits cannot drift and do not need adjustment, DIGIT CD works as well after 20 years as the day it is installed.

Harris DIGIT CD, globally the world's first commercial, digitally modulated FM exciter, employs Direct Digital Synthesis (DDS) technology to generate a signal with true 16-bit digital audio quality. Using a DDS device with a direct interface to all standard AES3-1992 data rates, DIGIT CD makes it possible to maintain an all-digital path from the studio source through the FM modulator. By eliminating all intermediate A/D and D/A conversions, noise and distortion added between the studio source and the output of the digital FM modulator are zero.

Although DIGIT CD is revolutionary, its technology is easy to understand. Figure 1 is a top level block diagram of signal paths.

The digital modulator uses a 32-bit Direct Digital Synthesis (DDS) device and supporting circuitry to digitally generate the FM carrier complete with stereo and SCA modulation. A digital "tuning number" sets the output frequency of the DDS device in the 5 to 6MHz range. Incoming digital program data at a rate of about 500kHz is used to offset the tuning number to modulate the output signal.

The frequency source uses a crystal-referenced PLL synthesizer to generate a low noise RF mixing signal for the upconverter. The source frequency can be set either internally by a DIP-switch array, or externally using a 25-bit parallel data interface through a D connector on the back panel of the exciter.

The DIGIT CD can also use an external 10MHz reference for frequency locking in FM booster applications (optional). Outputs of the digital modulator and the synthesized frequency source are converted to the final output

frequency in the upconverter. Innovative bandpass filters, which do not change the FM sideband structure, provide -80dBc or better filtering of the FM signal. The output of this circuitry is a very pure FM signal on the assigned carrier frequency, ready for amplification by the following stages in the exciter/transmitter.

The RF power amplifier boosts the bandpass filter output power to the range of 1 to 55 watts to drive the FM transmitter. The amplifier uses rugged MOSFET devices and is self-protecting for load mismatch and overtemperature. An optional harmonic filter with RF sample port is available, allowing DIGIT CD to be used directly on the air as a low power transmitter.

The digital/SCA interface module accepts AES3 digital audio and multiple RDS/SCA inputs, and includes an on-board DSP stereo generator to feed data directly into the digital modulator. A special "look-ahead" peak limiter controls overmodulation peaks before they can occur, and also allows high average modulation without the distortion caused by composite clipping.

The digital/SCA interface module supports standard AES3-1992 data rates and provides a direct, single cable connection from the AES3 stereo output of typical digital coding and processing systems.

As an emergency feature, one of the analog SCA ports of the digital/SCA interface module can be used as an analog composite stereo input if the normal AES3 path is not available.

The digital/SCA interface module can be substituted for the analog/SCA interface module. This allows stations to use the digital exciter now with analog baseband sources, and then

upgrade DIGIT® to work with an all-digital program path later, when their digital studio-transmitter link is installed.

The analog/SCA module allows DIGIT CD to be used with analog baseband channels. It provides compatibility with the same composite baseband interface, monaural audio, and analog 57-92kHz SCA subcarrier input port used on the Harris THE-1 FM exciter and many other analog FM exciters. This module converts baseband input signals to the composite digital format needed for the digital modulator.

When an AES3 program is available, the digital module may be substituted for the analog module to provide an all-digital path from the studio through generation of the FM broadcast signal.

### General

**Power Output Range:** 1 to 55 watts, user adjustable.

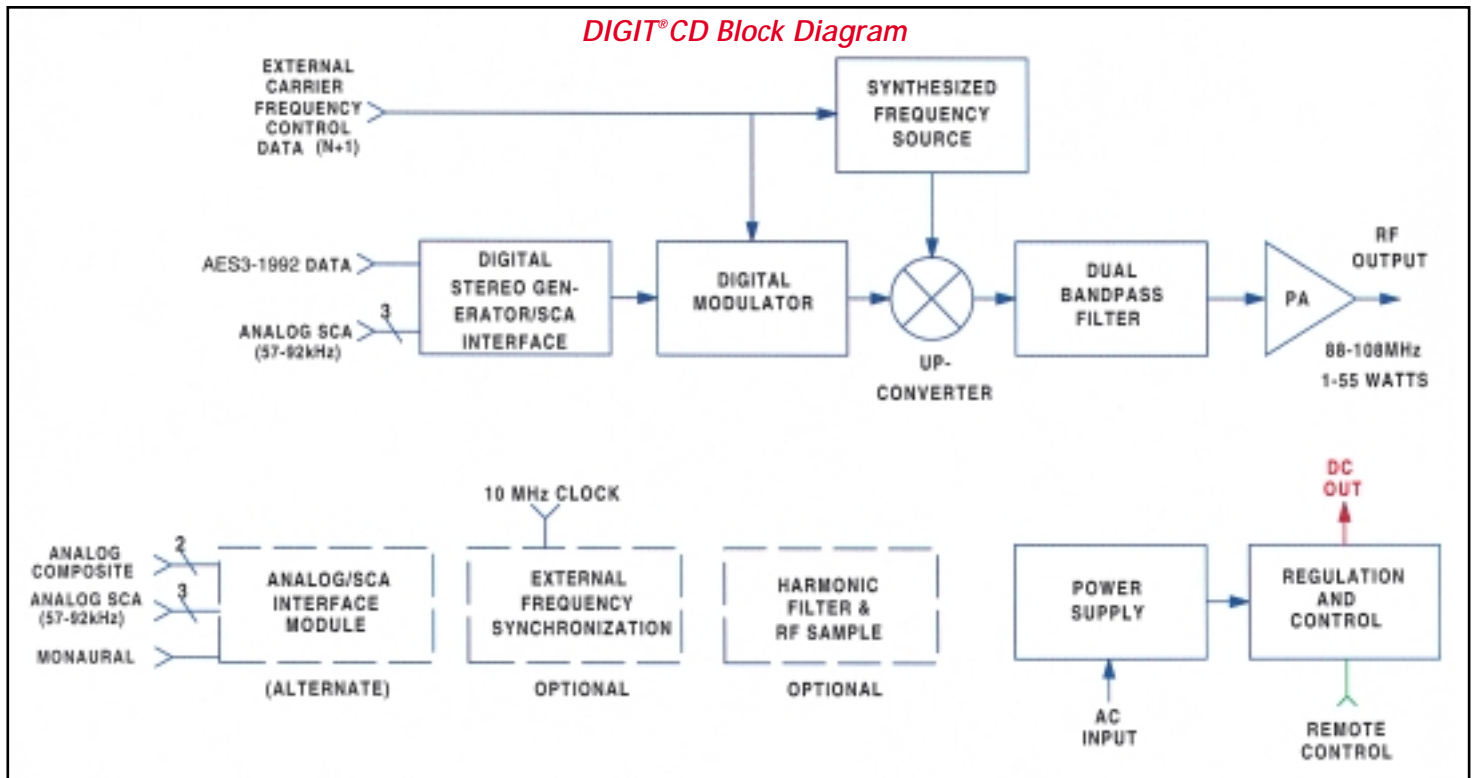
**RF Output Impedance:** 50 ohms, BNC female connector; open and short circuit protected.

**RF Harmonic and Spurious Suppression:** Meets or exceeds all FCC and IC requirements and CCIR recommendations for a 55 watt transmitter when used with optional low pass filter.

**Frequency Range:** 87 to 108MHz, digitally programmable in 50Hz increments.

**Frequency Stability:** ±150Hz, 0°C to 50°C ambient temperature range (using internal frequency reference).

**External Frequency Control:** Capable of locking to an external 10MHz reference for use in FM synchronous applications when fitted with optional DIGIT CD Sync Board (992-9850-001). Sync input requirement: 2.82Vp-p or TTL level. Sync input connector: BNC female.



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

**Modulation Capability:** 208% ( $\pm 75\text{kHz}$  reference standard). Factory programmable in 6dB increments to  $\pm 468\text{kHz}$ .

**PLL/AFC Overload Characteristics:** Immune to carrier dropouts caused by high energy, low frequency modulation (program audio is not applied to the VCO).

**Modulation Indication:** Digitally generated peak reading, 0.25% accuracy (at 150% modulation setting), color coded LED display with baseband overmodulation indicator.

**Asynchronous AM S/N Ratio:** 75dB minimum below equivalent 100% amplitude modulation by 400Hz using 75 $\mu\text{s}$  de-emphasis (no FM modulation present).

**Synchronous AM S/N Ratio:** 60dB minimum below equivalent 100% amplitude modulation with 75 $\mu\text{s}$  de-emphasis and 400Hz highpass filter (FM deviation  $\pm 75\text{kHz}$  by a 1kHz sine wave).

**Multimeter:** LCD display showing parameter name and unit of measure: PA I, PA V, Forward Power, Reflected Power and Test.

**AC Input Power:** 90 to 132VAC or 180 to 264VAC, 50/60Hz, 320 watts maximum.

**Operating Temperature Range:** 0°C to 50°C.

**Humidity:** To 95%, non-condensing.

**Altitude:** To 15,000 feet (4,573 meters) AMSL. Derate 2°C/1,000 feet (304.9 meters).

**Dimensions:** 19" (48.3cm) wide by 7" (17.8cm) high by 12.5" (31.8cm) deep, slide-out mounting rails included.

**Mounting:** Standard 19" (48.3cm) EIA rack mountable.

**Weight:** 38 pounds (17.3kg); packed 46 pounds (20.9kg).

### **Stereo Performance with Digital Input Module**

**Input Connector:** One, XLR female.

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

**Input Level:** User adjustable, 0 to -18dB full scale reference, including external pre-emphasis (if any).

**Data Format:** AES3-1992 (reference standards: AES5-1984, ANSI S4.28-1984, AES3-1985, ANSI S4.40-1992, and AES3-1992).

**Sample Rate:** Any in range 32kHz to 56kHz (32, 44.1 or 48kHz typically output from AES3 devices).

**Digital Stereo Generator:** Complete digital composite stereo waveform generated in the digital domain from incoming AES3 stereo audio data, using a digital signal processor (DSP).

**Digital Baseband Composite Limiting:** Exclusive DSP "lookahead" techniques for control of peaks before overmodulation can occur. Active with on-board DSP stereo generator in stereo or monaural mode; pilot carrier and SCA signals unaffected. Limiter on/off and limit setting adjustable from 0-18dB either locally or by standard remote control systems.

**Pre-emphasis:** 0, 25, 50 or 75 $\mu\text{s}$ , locally selectable.

**Pilot Carrier:** 19kHz  $\pm 0.03\text{Hz}$ . Pilot level locally adjustable from 0-12% modulation in 0.05% steps.

**38kHz Suppression:** 80dB below  $\pm 75\text{kHz}$  deviation reference.

**Stereo Separation (sinewave):** 65dB or greater, 10Hz to 15kHz.

**Dynamic Stereo Separation (complex waveform):** 60dB or greater, 10Hz to 15kHz.

**Amplitude Response (L or R):** 10Hz to 15kHz  $\pm 0.2\text{dB}$  referenced to selected pre-emphasis curve.

**FM Signal To Noise Ratio (L or R):** 83dB below 100% modulation at 400Hz; measured in a DC to 22kHz bandwidth with 75 $\mu\text{s}$  de-emphasis and DIN "A" weighting. Does not exhibit the subsonic noise associated with analog exciters.

**Stereo Total Harmonic Distortion:** 0.005% or less for any modulating frequency from 10Hz to 15kHz; measured in DC to 22kHz bandwidth with 75 $\mu\text{s}$  de-emphasis.

**Intermodulation Distortion (L or R):** CCIF: 0.005% (14/15kHz 1:1), SMPTE: 0.02% (60 and 7000Hz 1:1).

**Transient Intermodulation Distortion (DIM) (L or R):** 0.008% (2.96kHz square wave/14kHz sine wave modulation).

**Linear Crosstalk:** L+R to L-R and L-R to L+R due to amplitude and phase matching of L&R channels (20Hz-15kHz): 90dB below 100% modulation reference.

**Non-Linear Crosstalk:** L+R to L-R and L-R to L+R due to distortion products: 85dB below 100% modulation reference.

**RBDS/RDS Synchronizing Signal:** 19kHz quasi-sinewave, nominal 5.6Vp-p, AC coupled, 100 ohm output impedance (unbalanced); for use by customer-supplied, external generator. BNC female connector.

**Stereo/Monaural Mode Control:** Selectable locally or by standard remote control systems. Zero amplitude pilot in monaural mode.

**Emergency Analog Composite Mode:** Switchable locally or by standard remote control systems to mute the on-board DSP stereo generator and accept analog composite stereo on SCA Port #2. Nominal input sensitivity (all SCA ports in this mode): 3.5Vp-p (1.24V RMS) for  $\pm 75$ kHz deviation. FM signal to noise ratio: 85dB below 100% modulation. Total composite harmonic distortion: 0.02%.

### **Composite Input Performance With Analog Input Module**

**Inputs:** Two: XLR female balanced (switchable, composite or monaural), and BNC female unbalanced.

**Input Impedance:** Balanced/unbalanced: 10,000 ohms nominal (resistive).

**Input Level:** 3.5Vp-p (1.24V RMS) nominal for  $\pm 75$ kHz deviation.

**FM Signal To Noise Ratio:** 94dB below  $\pm 75$ kHz deviation at 400Hz; measured in a DC to 100kHz bandwidth with 75 $\mu$ s de-emphasis; DIN "A" weighting. Does not exhibit the subsonic noise associated with analog exciters.

**Wideband FM SNT (Signal To Noise vs Time):** >90dB for eight samples per second over a fifteen second time interval, no averaging; 75 $\mu$ s de-emphasis, DC-100kHz bandwidth.

**Amplitude Response:**  $\pm 0.01$ dB, DC to 53kHz;  $\pm 0.2$ dB, 53kHz to 100kHz.

**Total Harmonic Distortion:** 94dB or 0.002% THD over stereo sub band (DC to 53kHz).

**Intermodulation Distortion:** CCIF: 0.003% (14/15kHz 1:1); SMPTE: 0.007% (60/7000Hz 1:1).

**Transient Intermodulation Distortion (DIM):** 0.0016% (2.96kHz square wave/14kHz sinewave modulation).

**Slew Rate:** 9V/ $\mu$ s, symmetrical.

**Group Delay Variation:**  $\pm 5$ ns, DC to 53kHz,  $\pm 30$ ns, 53kHz to 100kHz.

**Phase Response Variation:**  $\pm 0.1^\circ$  from linear phase, DC to 53kHz.

### **Stereo Performance with Analog Input Module**

**NOTE:** Analog stereo performance with the DIGIT CD exciter is defined almost entirely by the program link and external stereo generator. The selected parameters below may be considered achievable for high quality source equipment with optimal setup.

**FM Signal To Noise Ratio (L or R):** 78dB below 100% modulation at 400Hz; measured in a DC to 100kHz bandwidth with 75 $\mu$ s de-emphasis (A-weighting). Does not exhibit the subsonic noise associated with analog exciters.

**Amplitude Response (L or R):** 10Hz to 15kHz  $\pm 0.5$ dB referenced to selected pre-emphasis curve.

**Total Harmonic Distortion (L or R):** 0.004%, 10Hz to 15kHz; measured in a DC to 20kHz bandwidth with 75 $\mu$ s de-emphasis.

**Intermodulation Distortion (L or R):** CCIF: 0.005%; SMPTE (60 and 7000Hz, 4:1): 0.02%.

**Transient Intermodulation Distortion (DIM) (L or R):** 0.008% (2.96kHz square wave/14kHz sinewave).

**Stereo Separation (sinewave):** Better than 65dB, 10Hz to 15kHz (exciter transparency).

**Non-Linear Crosstalk (exciter induced):** L+R to L-R and L-R to L+R due to distortion products: 85dB below 100% modulation reference.

### **SCA (RBDS/RDS) Performance with Digital or Analog Input Module**

**NOTE:** Analog SCA (RBDS/RDS) performance with the DIGIT CD exciter is defined almost entirely by the program link and external subcarrier generators. The selected parameters below may be considered achievable for high quality source equipment with optimal setup.

**Inputs:** 3 total, BNC female connectors.

**SCA Format:** Externally generated, analog FM subcarriers in the range 53-99kHz.

**SCA Input Impedance:** Analog Module: 10,000 ohms unbalanced, nominal, resistive. Digital Module: 3,000 ohms unbalanced, nominal, resistive.

**SCA Input Level:** 1.5Vp-p nominal for  $\pm 7.5$ kHz deviation of main carrier.

**SCA Subband Amplitude Response:**  $\pm 0.01$ dB/-0.2dB, 53kHz-100kHz.

**SCA Channel Response:** Defined by response of SCA generator and SCA program path.

**SCA Channel FM Signal To Noise Ratio:** 74dB below  $\pm 6$ kHz subchannel deviation at 400Hz with 150 $\mu$ s de-emphasis.

**Harmonic Distortion:** 0.4% or less in audio passband of SCA generator.

**Intermodulation Distortion:** SMPTE (60 and 7000Hz, 1:1): 0.4% or less, no pre-de-emphasis, SCA generator lowpass filter bypassed.

**Crosstalk, SCA to Stereo:** 65dB below 100% modulation, L or R channel with 75 $\mu$ s de-emphasis.

**Crosstalk, Stereo to SCA:** 55dB below 100% modulation (referenced to  $\pm 6$ kHz deviation and 150 $\mu$ s de-emphasis in SCA demodulator).

**Crosstalk, SCA to SCA:** 55dB below 100% modulation (referenced to  $\pm 6$ kHz deviation and 150 $\mu$ s de-emphasis per channel).

### **Monaural Performance with Analog Input Module**

**Input:** One, XLR female (switchable: composite balanced or monaural).

**Audio Input Impedance:** 600 ohms, balanced, floating, resistive; adaptable to other impedances. Common mode suppression: 60dB.

**Audio Input Level:** +10dBm nominal for  $\pm 75$ kHz deviation at 400Hz, locally adjustable from -9 to +14dBm.

**Amplitude Response:** 10Hz to 20kHz  $\pm 0.2$ dB, referenced to selected pre-emphasis curve (no low pass filter).

**FM Signal to Noise Ratio:** 94dB below  $\pm 75$ kHz deviation at 400Hz; measured in a DC to 100kHz bandwidth with 75 $\mu$ s de-emphasis and DIN "A" weighting. Does not exhibit the subsonic noise associated with analog exciters.

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

**Total Harmonic Distortion:** 94dB or 0.002% THD, 10Hz to 20kHz bandwidth.

**Intermodulation Distortion:** CCIF: 0.003% (14/15kHz 1:1); SMPTE: 0.007% (60/7000Hz 1:1).

**Transient Intermodulation Distortion (DIM):** 0.0016% (2.96kHz square wave/14kHz sinewave).

Specifications subject to change without notice.



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