Attachment to FCC Form 731

FCC ID: AQZ-VSR-4141-001

Exhibit 12

TX Operational Description

- **General Information**
- **Range of Operating Power Values [Paragraph 2.1033(c)6]**
- **Description of Circuitry [Paragraph 2.1033(c)10]**
- **Digital Modulation Description [Paragraph 2.1033(c)13]**

General Information

The Harris Model VSR-4141-001 is designed to be a differential Global Positioning System (GPS) VHF ground station transmitter for use in Special Category I (SCAT-1) landing and approach systems. The VSR-4141-001 VHF Transmitter and the Harris Model VSR-4201-001 VHF Receiver together form a radio data broadcast subsystem. The transmitter transmits differential and high-accuracy precision approach waypoint information to an airborne subsystem in order to support highly accurate and reliable GNSS navigation. The transmitted signal is also received by the VHF Receiver (monitor), which demodulates the signal and reports the messages received to a ground facility differential correction processor. This processor also supplies transmit messages to the transmitter. The transmitter uses time mark pulses to set the timing of the transmitted messages. An external interface diagram of the VHF Transmitter is shown in Figure 1.

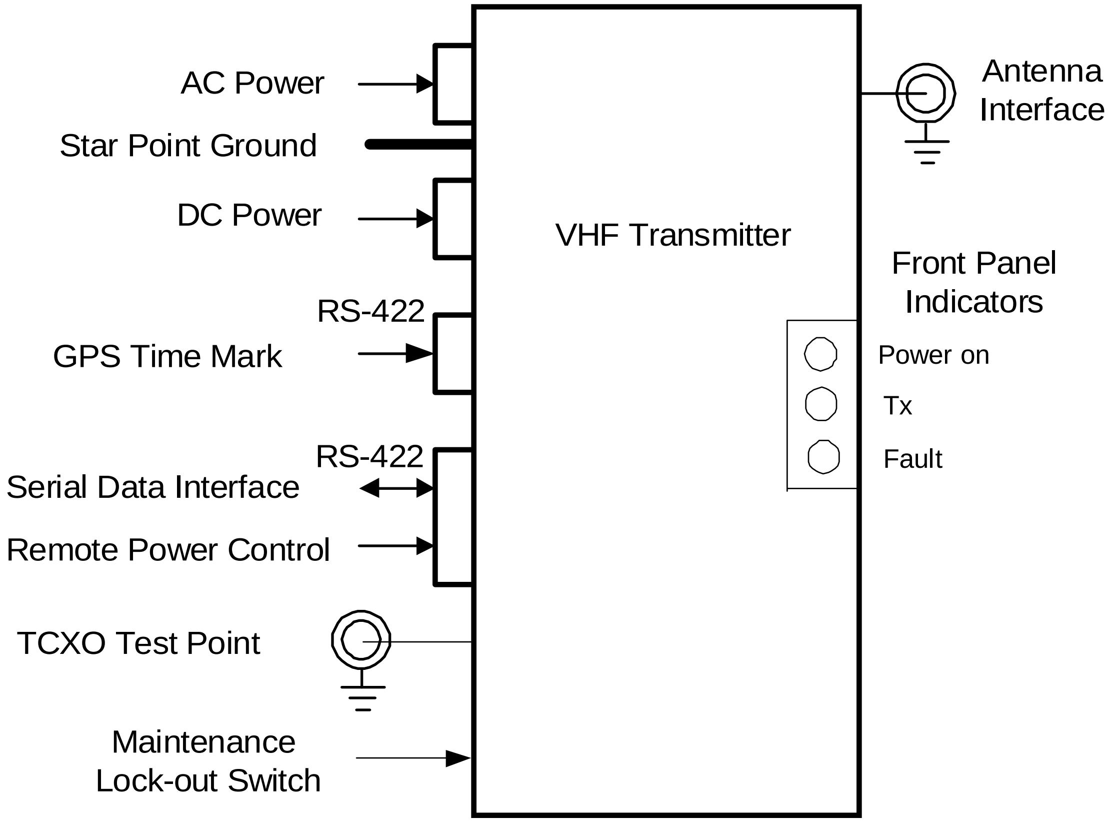

Figure 1: Interface Block Diagram, VHF Transmitter Unit

With reference to the block diagrams submitted as Exhibit 4, and the schematic diagrams submitted as Exhibit 5, the VHF Transmitter employs digital microcontrollers that perform all control and modulation waveform synthesis functions. The G7D emission utilizes a differentially encoded, 8 phase shift keyed (D8PSK) modulated signal. Maximum power output, over the 112-117.950 MHz frequency range, is 20 Watts average. The transmitter can be powered either from the AC mains, over the operating voltage range of 85 to 265 VAC, or a nominal 28 VDC.

2.1033(c)6 Range of specific operating power levels, and description of any means provided for variation.

The rated transmitter output power is 20 Watts average, with a D8PSK waveform. Power output levels of 17.8 Watts (-0.5 dB) and 15.9 Watts (-1.0 dB) are also selectable. Selection of the output level is solely through the remote control interface. Closed loop power control is used to set and maintain the output level.

2.1033(c)10 Description of all circuitry and devices provided for determining and stabilizing frequency, for suppression of spurious radiation, for limiting modulation, and for limiting power.

Frequency stabilization The VSR-4141-001 Transmitter uses a temperature compensated crystal oscillator (TCXO) to achieve the required frequency stability over its operating temperature range. The TCXO is located on the Exciter board and is used as a master reference oscillator for all transmitter circuits. The TCXO is purchased as a completed unit and consists of a Colpitts oscillator with varactor-thermistor temperature compensating networks. The TCXO vendor tests and calibrates each unit before shipment to ensure that all specifications are met. The TCXO used in the VSR-4141-001 has a frequency stability of 1 part per million (ppm) over the operational temperature range. It also has a DC control pin which is used as a fine frequency adjust to set the oscillator precisely on frequency and correct for aging drift. Refer to Exhibit 5 for a schematic diagram of the circuit in which the TCXO is operated.

Suppression of spurious radiation A low pass filter is used to suppress noise on the audio prior to going to the modulator. A RF high pass filter within the low RF signal level stages of the transmitter is used to suppress out-of-band low frequency RF before going to the higher level RF amplifiers. For higher frequency spurious emissions, the transmitter employs a seventh order elliptic function low pass filter with a cutoff frequency of 155 MHz. This filter is physically located on the Directional Coupler/Low Pass filter board assembly. Electrically, it is in the signal path between the power amplifier and the antenna connector in order to suppress conducted harmonic energy before the antenna port. Refer to Exhibit 5 for the schematic diagram of the low pass filter and its associated circuits. Also please refer to Exhibit 9, Internal Photographs, for pictures showing construction and mounting of the low pass filter.

For radiated emissions, the transmitter is packaged inside a sheet metal enclosure. Top and bottom covers are equipped with RF gasketing material to prevent cabinet radiation from exceeding specified limits. Filtering is also used on all input/output connectors to further minimize radiation.

Modulation limiting The VSR-4141-001 Transmitter employs a digital signal processor (DSP) integrated circuit which runs firmware signal processing algorithms to synthesize the D8PSK modulation waveform. The algorithms contain leveling loops to ensure that the modulating waveform has constant amplitude. Since this transmitter accepts only digital data input, and does not have the provision for an external audio input, the usual pre-emphasis/clipper/low pass filter stages are not needed, and are not provided.

Power limiting The VSR-4141-001 Transmitter has a closed-loop power control system that keeps the output power constant over the frequency range and environmental conditions. The loop consists of a directional coupler at the output of the power amplifier; the digital microcontroller; and a voltage variable attenuator (VVA) at the output of the exciter board. The directional coupler provides a dc output voltage proportional to the power output level; the digital microcontroller compares this level to the power set point value and adjusts the VVA as required to maintain the desired power output.

2.1033(c)(13) Detailed description of the digital modulation system to be used.

The VSR-4141-001 Transmitter accepts digital data from external equipment via a RS-422 asynchronous serial interface, and internally formats this data and synthesizes the waveform through the use of a digital signal processor (DSP).

The data stream consists of a differentially encoded 8 phase shift keying signal which uses a raised cosine filter with $\alpha = 0.6$. The raised cosine filter is implemented as a signal processing algorithm within the DSP. A plot of the filter frequency response is shown in Figure 2.

The information to be transmitted is differentially encoded with 3 bits per symbol (baud) transmitted as changes in phase rather than absolute phase. The data stream to be transmitted is divided into groups of 3 consecutive data bits, least significant bit first. To aid clock recovery and to stabilize the shape of the transmitted spectrum, bit scrambling is applied. The pseudo noise (PN) sequence is a 15 - stage generator with the characteristic polynomial $X^{15} + X + 1$.

The DSP algorithm takes the resulting data stream and generates two analog signals I and Q which are separated in phase by 90 degrees, via a dual channel digital-to-analog converter IC. The I and Q signals contain amplitude and phase information which describes each symbol transition. Both of these signals are filtered at baseband by a four section Bessel low-pass filter before they modulate the RF carrier. A plot of the response of this filter appears in the section titled "Modulation Characteristics" of the Test Report, which is contained in Exhibit 6.

The transmitted signal is produced by means of a vector modulator, which consists of two balanced modulators, one each for the I and Q baseband signals. By means of the balanced modulators each baseband signal modulates an RF carrier, with the resulting modulated signals being combined to form the composite transmitted signal.

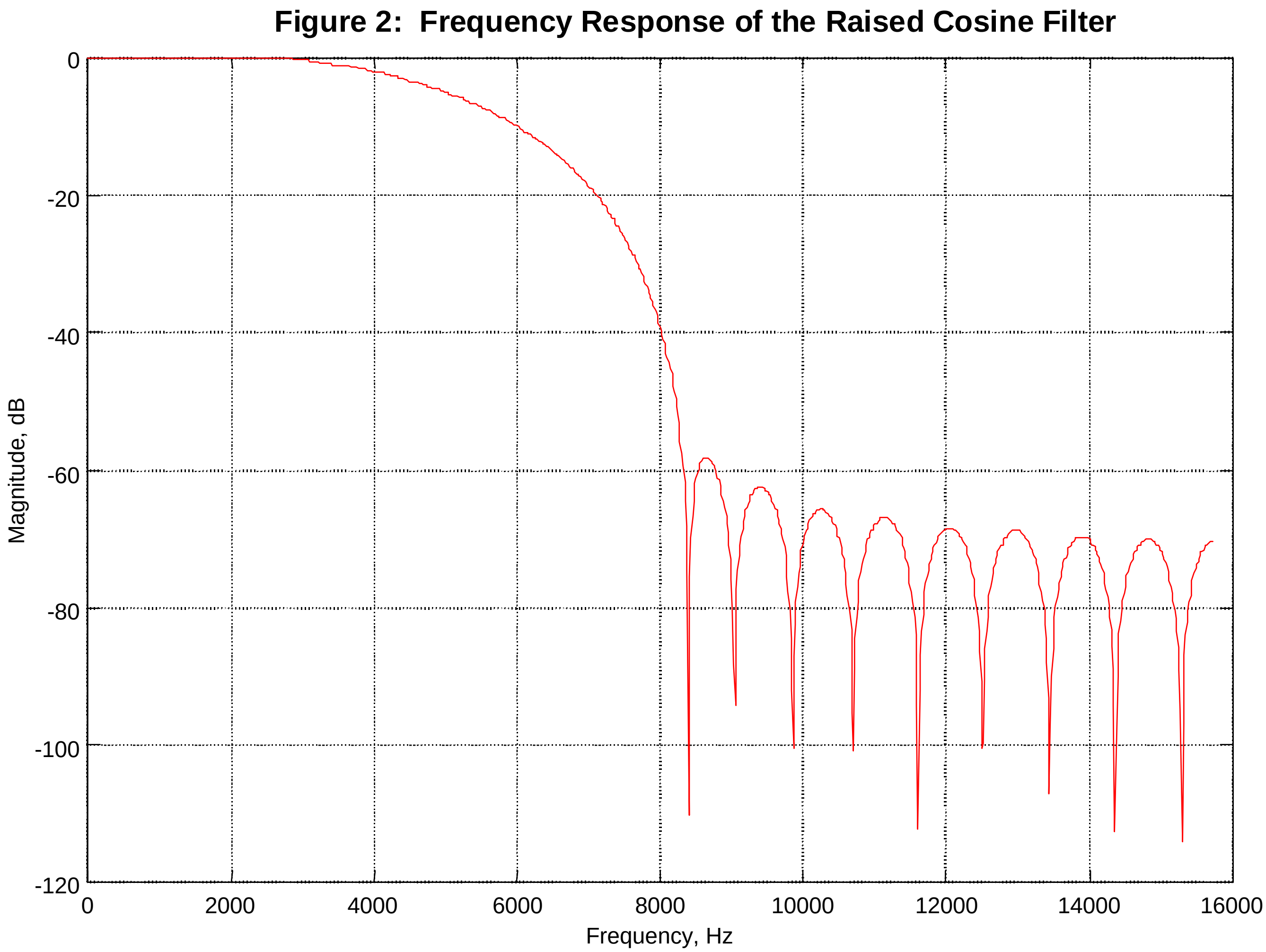
Figure 2: Frequency Response of the Raised Cosine Filter
0
-20
-40
-60
-80
-100
-120
Magnitude, dB
0
2000
4000
6000
8000
10000
12000
14000
16000
Frequency, Hz