OPERATIONAL DESCRIPTION – EXHIBIT L

1.1 GENERAL DESCRIPTION OF CIRCUITRY

The DME-4000 is a three-channel unit designed to provide position navigation information for new or retrofit aircraft applications. The DME-4000 measures the line-of-sight distance from the aircraft to the selected DME ground stations. In addition, the DME-4000 decodes the Morse code station identifier and calculates the relative closure rate and time to reach the selected station. Three channel operation is accomplished through DSP controlled multiplexing of a single transmitter and a single receiver. The DME-4000 operates on 252 1 MHz wide channel assignments. Each channel has an air to ground frequency assignment in the range from 1025 to 1150 MHz and a ground to air frequency assignment in the range of 962 to 1213 MHz. Two hundred of these DME channels are paired channels that have a corresponding VOR or ILS frequency. The remaining 52 channels are unpaired channels that are DME only.

The DME-4000 performs the following functions:

- Measures slant range between the aircraft and up to three selected ground stations.
- Computes the rate of closure of the aircraft to each of the selected ground stations.
- Computes time of arrival to the selected station based on the rate of closure.
- Provides both an aural and decoded station identity output.
- Monitors its own performance and provides a maintenance diagnostic output.
- Supports software data loading from an external data loader.

The DME-4000 is a replacement for the Pro Line II DME-442 product. The DME-4000 replaces the obsolete microprocessor technology of the DME-442, updates the transmitter and receiver technology, and utilizes new common power supply and I/O modules. Package size is reduced to a 2.4” wide, ½ height Pro Line package. Functionality is compatible to the DME-442 on the legacy outputs. An additional high speed ARINC 429 interface connects to a RIU for support of digital audio, data loading, and enhanced maintenance features.

The DME-4000 is installed with an antenna and Collins RTU-42XX or compatible control head. The DME-4000 requires a single antenna mounted on the top or bottom of the aircraft. The DME-4000 accepts tuning data from the RTU-42XX or a compatible control head that provides either ARINC-429 or CSDB formats.

The antenna is specified to transmit and receive vertically polarized signals in the frequency range of 960-1215 MHz. The VSWR when terminated in a 50 ohm transmission line shall not exceed 1.5:1 and the radiation pattern is similar to that of a matched quarter-wave stub. Cable loss is to be no greater than 3 dB.

1.2 REAR INTERCONNECT

The rear interconnect provides the interface between the unit and the aircraft installation. The rear interconnect also includes filtering for all the input and output signals which protects the unit against High Intensity Radio Frequency (HIRF) fields and lightning.

Radio Frequency (RF) is received from and transmitted to the antenna via a RF connector that passes through the rear interconnect board.

1.3 DSP/PS

The DSP board performs the computations of the various DME outputs, controls the Receiver/Transmitter(R/T) and interfaces between the unit and the external aircraft systems. The DSP board processes Arinc 429 serial data (frequency, self test), CSDB serial data (frequency, self test), and suppression inputs received from the aircraft system. Serial data (distance, ground speed, identity, time-to-station, and other information in Pro Line 21 and Arinc429 format), fault monitor, audio ident, and suppression are outputted to the external systems. Frequency information coming into the DME is converted into an analog tuning voltage then applied to the preselector to accomplish receiver front-end tuning. This same frequency information is also converted into five 24-bit serial word to tune the synthesizer.

The detected video received from the IF amplifier is used to derive the AGC value for each channel. This AGC voltage is then applied to the intermediate-frequency amplifier for each channel. P1/P2 interrogation pulses are generated and sent to the modulator when a ground station is detected. Replies from the ground station are used to calculate the distance to the ground station. In addition, the detected video is used to decode the ground station identifier. Audio identity is then output for two DME channels. Ground speed, and time-to-station calculation are made for all channels tracked.

Suppression pulses, of either internal or external origin, will disable the DME receiver function.

The power supply provides the necessary supply voltages (+3.3,+8,-8,+15,+30 and 70 Volts DC) from a nominal +27.5 Volts DC input source to the DME-4000. Additional circuitry monitors the status of the power supply's input and output power lines and in the case of a power supply failure, flags the fault and logs it into non-volatile memory.

1.4 MODULATOR/IF/SYNTHESIZER

The modulator use the +30 volts and +70 volts DC supply voltages from the power supply and P1/P2 interrogation pulses from the DSP to generate 30 volt rectangular pulses for the low-power pulse stages and specially-shaped 50 volt pulses for the high-power stages of the transmitter. The latter pulses are formed by allowing an L-C circuit of appropriate resonance to ring for one cycle, then amplifying the current level of the resultant pulses with power MOS field-effect transistors connected as source followers. The outputs of the modulator are applied to the Power Amplifier.

The 63 MHz intermediate-frequency (IF) amplifier provides gain and selectivity for the received signal. Six MOS field-effect transistor amplifier stages provide the needed gain. A special 63 MHz surface acoustic wave (SAW) bandpass filter provides the required selectivity and eliminates the need for all but one tuning adjustment in the entire amplifier. Automatic gain control (AGC) voltage is applied to maintain nearly constant detected video amplitude over the signal levels expected in operation. Detected video is then sent to the DSP.

The L-Band synthesizer receives five 24-bit serial words containing frequency information from the DSP. The synthesizer circuitry is constructed on a fiberglass board and functions directly on the transmitter frequency, which is tunable from 1025 to 1150 megahertz in one megahertz increments. The synthesizer is capable of changing frequencies from one end of the band to the other within one millisecond.

1.5 RECEIVER/PA

The receiver and the PA are constructed on a PTFE / woven fiberglass laminate material. The receiver is made of a mixture of suspended-substrate and microstrip technology.

The preselector and preamplifier constitute the receiver ”front-end”. In the receive mode, the received signal from the antenna is applied through the low-pass filter to the preselector. The preselector is a varactor tuned five-pole bandpass filter, which tracks the received frequency by means of tuning voltages generated by the DSP. The tracked preselector allows compliance with applicable selectivity specifications. A low-noise rf amplifier stage is inserted between the second and third poles of the preselector to improve noise figure and overall receiver performance. During self test , a noise diode is activated and gated into the preselector input to verify performance of the receiver.

The output of the preselector and preamplifier connects to the mixer. During the receive mode, the synthesizer output is gated away from the power amplifier chain and into the receiver mixer to provide local oscillator injection. This produces a difference output of 63 MHz which is sent to the 63 MHz intermediate frequency amplifier.

The rf power amplifier is made of five stages of amplifier using microstrip technology. The amplifier accepts a 100 milliwatt CW drive from the synthesizer and, in five stages, boosts this to nominal 600-watt pulses of near-gaussian shape. This nominal power level is necessary to ensure 300-watts of output power at the antenna connector. A transmitter monitor circuit measures the transmitted power and will annunciate abnormally low power output. FAA TSO-C66b specifies a 250-watt minimum output and a recommended 2000-watt maximum output for aircraft operating above 18,000 feet. The near-gaussian shape pulses ensure compliance with FAA and FCC transmitted bandwidth requirements.

All stages of the power amplifier are biased off, except when modulation pulses are applied. During modulation, all stages are biased Class C, except the first stage, which is biased Class AB. Modulation is not applied during the intervals in which synthesizer retuning occurs.

A diplexer contains a PIN diode controlled by the DSP which connects and disconnects the transmitter, as necessary, from the antenna, thus helping to isolate the receiver input from the transmitter. This prevents possible damage to the receiver when the DME-4000 is transmitting, while allowing a common antenna to be used for the transmit and receive function. The diplexer connects to the external antenna via the low-pass filter.

1.6 TYPES OF EMISSIONS

Based on the calculation shown in the Modulation characteristics section and sections §2.201 and §2.202 of CFR, the emission designator for the DME-4000 is 1M10M1D.

1.7 FREQUENCY RANGE

The frequency range of the transmitter is 1025 MHz to 1150 MHz. The DME band consists of 126 channels with a channel separation of 1 MHz. The frequency range of the receiver is 962 MHz to 1213 MHz. These frequencies are within the bank of frequencies allocated to airborne electronic aids to air navigation, subpart E.

1.8 OPERATING POWER

Minimum power output is 250 Watts. Estimated maximum power output is 700 Watts. Typical power output is 400 Watts.

1.9 MAXIMUM POWER RATING

Part 87 of the FCC Rules and Regulations, Section 87.131, does not define a maximum power for Radionavigation Class of station.

1.10 DC VOLTAGES AND CURRENTS

The DC voltages applied to the modulator, which applies its' outputs to the power amplifiers, are +3.3VDC, +30VDC and +70VDC. The maximum current from the power supply is less than 1 amp for the +3.3VDC, less than 200mA for the +30VDC, and less than 100mA for the +70VDC

1.11 CIRCUITRY FOR SUPPRESSION OF SPURIOUS RADIATION

The low-pass filter suppresses transmitter spurious radiation. This filter is located on the A4 Receiver/Transmitter board as shown on schematic 828-8774-002.

1.12 CIRCUITRY FOR LIMITING MODULATION

Modulation amplitude , pulse shaping and limiting is controlled by the Cos^2 pulse shaper circuit on the Modulator board as shown on schematic 828-3373-002.

1.13 CIRCUITRY FOR LIMITING POWER

The output power of the transmitter is limited by controlling the voltage level of the signals applied to the last two Power Amplifier (PA) stages from the modulator. This is achieved by the Pulse Shaper circuit on the modulator board as shown on the schematic 828-8873-002. This is a service adjustment and not accessible to the operator.