Cockpit Voice Recorder

Part No: 2100-1020-93

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General Description: The FA2100 CVR recorder is an ARINC 404, ½ ATR short box which performs the cockpit voice recorder function of a ED-56A compliant recorder. The FA2100 CVR uses solid state flash memory technology as the recording medium with two recording capabilities for two hours. The 2100-1010-93 model provides for an 8ohm audio output monitor at the control unit.

FA2100 configurations: The specific configuration FA2100 CVR part no is constructed as shown below.

Theory of operation:
The theory of operation provided for the model FA2100 CVR describes the function of the recorder both at the system level, PWA level and software operation level. System level of operation describes the general operation of the system as a whole. The model FA2100 CVR system block diagram is given. Each PWA consists of the electrical circuitry of the major functional grouping contained in the individual PWAs. The software level describes the modes of the recorder software.

- Model FA2100 system
- Aircraft interface (AI) PWA
- Audio compressor (AC) PWA
- Acquisition processor (AP) PWA

System description: The model FA2100 CVR system consists of the recorder and externally mounted control unit or externally mounted pre-amplifier with remote microphone. Interconnection between the recorder and control unit is accomplished using aircraft wiring. FA2100 CVR is connected to the aircraft wiring via 57pin, DPXB style connector. The aircraft interface PWA provides for all input and output signals.

The model FA2100 CVR is housed in a ½ ATR, short, ARINC 404 A style case. It has an aluminium chassis, cover painted international orange with two reflective stripes located on a stainless steel or titanium crash survival memory unit (CSMU). The recorder weighs 10pounds (less for the titanium CSMU) with an under water locater device mounted on the front of the CSMU. The FA2100 CVR mounted does not require external shock mounting. The model FA2100 CVR consists of a chassis and a front panel four level 2 replaceable assemblies:

- The aircraft interface PWA
- Audio Compressor PWA
- Acquisition processor PWA
- CSMU (contains the solid flash memory used as the recording medium).
Underwater acoustic beacon: The model FA2100 CVR has an underwater locating device (ULD) mounted on the front panel which also acts as the recorders carrying handle. The ULD is equipped with a battery that has an expected life of 6 years. The ULD meets or exceeds the requirements of the Federal Aviation Agency technical standard order TSO-C121. The beacon (without mount) is considered a line-item option and may be supplied by the user. The ULD mount will accept either the Dukane model DK120 underwater acoustic beacon or Data sonic model ELP-362D beacon marketed by RJE international Inc. The beacon is located on the front of the CSMU for ease of reading the battery replacement date and for quick removal and replacement of the beacon. The ULD requires functional testing every 24 months and cleaning every 3 months. The batteries in the beacons are field serviceable and may be orders from their respective manufacturers for battery servicing.

Circuit boards: The FA2100 CVR electronics contains all the necessary power supply and circuitry to input, record, monitor and playback data. In addition, circuitry to perform self-test functions and provide signals to the appropriate status indicators is also integrated into the FA2100 CVR electronics. The removal circuit board include the aircraft interface PWA, audio compressor PWA, acquisition processor PWA.

Power Control and Monitor signal interface characteristics: Input power may be 115V A, 400Hz or 28V DC. At normal power level, an interruption equal to or less than 200ms will not affect the model FA2100 CVR functions. Upon application or reapplication, or normal, abnormal, emergency power, the FA2100 CVR will begin storing data in memory within 250ms.

Voice data interface characteristics: The FA2100 CVR is used in an ARINC 557/757 configuration, with interface to the aircraft provided through 57pin DPXB rear panel connector. The reference signal, as required by ED56A, is defined as an input signal with a frequency of 1 kHz and a level of 3V r.m.s. for channels 1, 2 and 3, and 2V r.m.s for channel 4. The model FA2100 CVR provides for 4 audio inputs which are connected as follows: Channel 1: Cockpit spare audio input. Channel 2: Co-pilots audio, boom, mask and hand held microphone input. Channel 3: Pilots audio, boom, mask and hand held microphone input. Channel 4: Cockpit area microphone (CAM) input.
These audio signals are applied through the rear connector to the aircraft interface PWA, then are digitally converted into 16 bit words, compressed and stored in memory. In the FSK version of the FA2100 CVR CH 1 or CH 3 may have an FSK GMT input applied along with the standard audio signal.

**Data recording storage:** refer to the given fig for a diagram of the FA2100 CVR recording schemes used in the 30mins and the 120 min recorder.

The audio received from the CAM is applied to the CAM input channel (CH4). The recorded CAM audio has a bandwidth of 150 to 6000Hz. The other three channels receive audio from the pilot audio selector and have a bandwidth of 150 to 3500Hz. The spare audio input applied to CH 1 may be from 3rd crew member of PA system. The four audio input signals applied to separate input circuits located on the audio compressor PWA for amplification and shaping with equalization performed as necessary. These four streams are then converted to a digital pulse code modulation (PCM) 16bit word format on the audio compressor PWA and then routed to the acquisition processor PWA. The PCM data for each channel is then encoded for storage using an adaptive differential pulse code modulation (ADPCM) processor. These 4 streams are recorded as high quality (HQ) audio for 30min duration. The rate of the data stream recorded varies with the type of the audio as follows:

- 24kbps for Ch1,2 and 3 HQV
- 48kbps for Ch 4 HQC.

In the 120min FA2100 CVR, three of these audio streams (pilot, co-pilot and spare Ch 1,2 and 3) are combined to provide 5th audio stream, designated standard quality voice (SQV), to be recorded in standard quality audio. In the 120min FA2100CVR version, 6th audio stream is formed using the standard quality cockpit area microphone (SQC) input. All six digital encoded ADPCM signals are applied to the CSMU for storage in the solid state flash memory. In this case, the rate of data stream recorded varies with the type of audio as follows.

- 24kbps for Ch1,2 and 3 HQV
- 48kbps for Ch 4 HQC.
- 16kbps for SQV and SQC (CAM).

In both versions of the model FA2100 CVR the four primary audio streams are always recorded as high quality audio (HQV) for 30min. In the 120min model FA2100 the SQV and SQC are recorded for a min of 120 min.

Specifically, the reference signal is 1kHz at 3V rms for the voice channels and 1kHz at 2V rms for the CAM channel. Signal to Noise plus distortion ratio (SINAD) of this signal when reproduced, exceeds 24dB (6% distortion) for the most recent 30min of recording and exceeds 20dB (10% distortion) otherwise.

Rotor speed input signals are applied to the rear connector pins 48 and 49 as an analog frequency varying between 7 to 6000Hz. The GMT / RSE input signals are
then digitally converted and compressed in the acquisition processor PWA. These data is then stored in the memory partition separate from the audio data. 

Rotor speed input is recorded as two words every half second. Rotor speed word 1 (8bits) provides a number of 400Hz reference pulses counted during the sample period. Word 2 (12bits) contains the integer number of rotor pulse cycles counted during the sample period. The average rotor pulse frequency is determined from the word values with better than 1% accuracy using the following formula.

\[
\text{Rotor pulse frequency} = \frac{400\text{Hz} \times (\text{Rotor pulse count})}{(\text{Reference count})}
\]

In the case of helicopter installation of the FA2100CVR, the bulk erase function is inhibited until the rotors stop.

**Audio monitoring:** For TSO compliant FA2100 CVR mounted in aircraft, previously recorded data can't be monitored from the FA21000 CVR. This is a security feature implemented to protect the rights of the pilots and other flight crew members. The CAM, pilot, co-pilot and spare audio can be monitored during recording using headset plugged into the ¼ inch 600ohms phone jack mounted on the front panel of the associated control unit. Also, when being tested into the standard test bench setup, all recorder audio inputs can be monitored using the speaker mounted within the cockpit voice recorder system test panel.

**Storage capacity:** The model FA2100 CVR storage media is designated as the crash survival memory unit (CSMU). The CSMU in the model FA2100 contains flash memory with enough storage capacity to allow continuous recording for the 4 high quality audio channel for a minimum of 30 min and the standard quality combined and cockpit microphone channel for a min of 120 min.

**Data retrieval:** Incorporated into the FA2100CVR aircraft installation is a “Record On” jumper. During bench test of the VR removal of the jumper disables the record function of the recorder, thereby allowing playback of the recorded data. While in the playback mode, replaying of recorded data is controlled by their portable interface unit (PI).

To retrieve data from the recorded, recorder must be removed from the aircraft, connected to appropriate AC or DC power and the PIU must be connected to recorders front panel GSE connector. The PIU allows the user to replay using 600ohms headset, any one of the high quality audio channel or the cockpit area microphone channel. The PI also has the capability to search through the stored data using the fast forward and fast reverse command keys. The fidelity of the FA2100 CVR audio data input at the PI unit is such that its internal speaker allows quality analysis of the recorded data. The PI unit also simplifies connection to standard commercial recording equipment for duplicating any one or all six audio streams. Additionally the audio data can be downloaded through the GSE connector, stored on type three PCMICA portable hard disks inserted in the OI for later playback. The
PI must have MOD-DOT 1 and the FA2100 CVR must have MOD-DOT 2 for audio data downloading capability to be activated.

- **Data reproduction:** A standard cassette, reel to reel tape, or digital audio tape recorder can be used to produce a high fidelity copy of the model FA2100 CVR recorded data. To do so the inputs of the copy recorder are connected to any one of the RCA phono jacks located on the PI unit’s PI audio read out cable. Depending upon the type of recorder used for copying the FA2100 CVR audio can be copied one channel at a time, or all individual channels can be copied simultaneously. Reconstructed GMT/RSE output may also be reproduced using the PI’s AUX readout cable.

- **Built in test (BIT):** A continuous BIT capability is provided at power to establish and monitor the mission fitness of the hardware. The BIT feature has been designed to perform a continuous test of all bits within the solid state memory located in the CSMU. An additional BIT initiated by pressing a Green TEST push button located on the front panel of the control unit. The TEST push button is used to generate the 620 to 660Hz test tone used for unit verification. This test tone is developed on the audio compressor PWA and applied to each channel individually where it is processed, stored in memory, read form memory, and checked for expected frequency and amplitude.

In the GACVR, a continuous byte status output or recorder fault is indicated in pin 23. A ground at pin 23 represents a no fault, while an open equals fault or CVR not installed, The CVR test indicator wires, pins 15 and 16 may be omitted in installations where ARINC 557 compatibility is not needed.

- **Crash survival memory unit:** The CSMU is the environmentally hardened memory storage assembly of the model FA2100. Electrical interface to the CSMU is made by the acquisition processor via a single 16 contact connector.

- **Crash and fire protection:** The CSMU construction enables the model FA2100 CVR to meet or exceed the rigorous crash protection requirement of TSO C123A.

- **Control unit, microphone and preamplifier equipment:** The control unit or preamplifier is a required component of CVR installation and functions as the FA2100 CVR cockpit user interface. However this is not required for GACVR recorders. Control units contain a preamplifier for interfacing the cockpit area microphone with the CVR and provide a means for activating the test functions via a green push button and indicator. Bulk erase of the FA2100 CVR storage medium is also accomplished by pressing the control units red erase push button. All control units contain a head set jack for verifying system operation.
Remote microphone module: The model S055 remote microphone modules are available to complete a TSO- C123A and ED 56A compatible installation. Model S055 microphone is required with the S151/ S161 control units with the S150 preamplifier module.

Ground support equipment interface: The interface to the ground support equipment (GSE) is via a bidirectional high speed serial link available at the front panel GSE connector. A facility for retrieving the stored data from the CSMU to GSE is provided for high speed downloading of the voice data. The GSE interface serves two purposes:

- As a connector for use with portable or bench test equipment for recorder check out.
- As a connector for using downloading data in to a storage device while on the aircraft or bench.