SSCVR
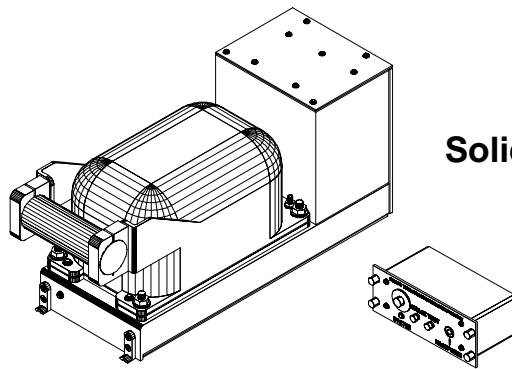## SOLID-STATE COCKPIT VOICE RECORDER

PRODUCT DESCRIPTION

SSCVR

Solid-State Cockpit Voice Recorder

ED-56a *Voice Recording System*

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SOLID-STATE CVR PRODUCT DESCRIPTION

The Solid-State Cockpit Voice Recorder (SSCVR) combines the extremely high reliability of integrated circuit memory technology with the most advanced protective enclosure in the industry. This equipment fully satisfies the most recent FAA and EUROCAE Minimum Operational Performance Requirements (MOPR) for Cockpit Voice Recorders used on commercial air transport and general aviation aircraft, whilst allowing direct retro-fit into existing ARINC-557 installations. These specifications are:

- **EUROCAE Documents ED-56, and ED-56a, October 1993**
- **FAA Technical Standard Order TSO C-123**
- **ARINC-557 and ARINC-757, Cockpit Voice Recorder (CVR), August 1993 (draft 2)**
- **JAR requirement for 2 Hour audio recording per ED-56a**

In addition, the SSCVR currently includes provisions in anticipation of the following future legislation:
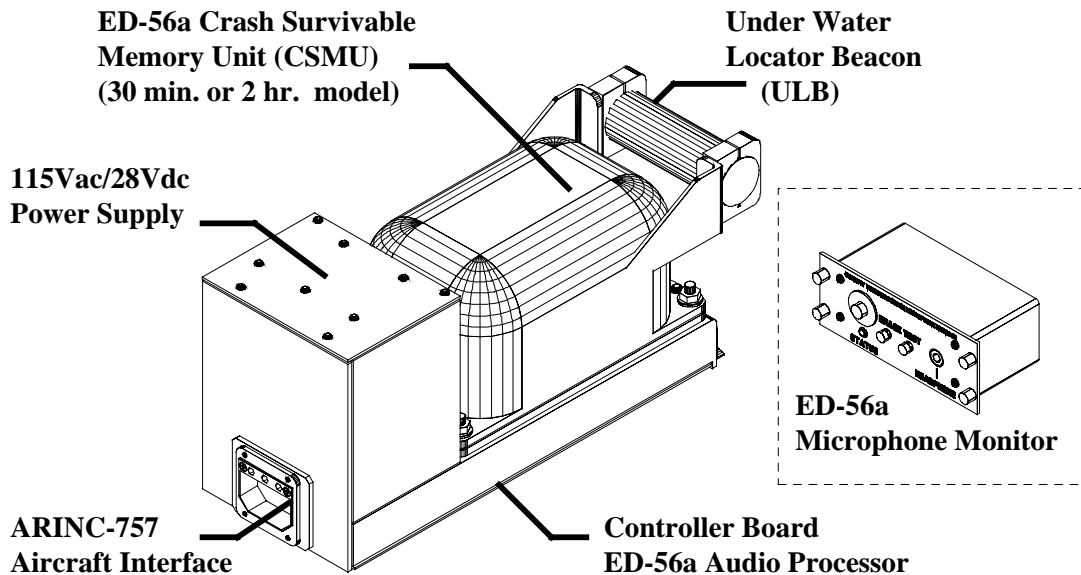
- **Legislation making the recording of data linked air traffic control messages mandatory via a dedicated ARINC-429 Input**

The SSCVR utilizes a modular crash survivable memory unit (CSMU) for protection of the solid state voice recording memory. The CSMU retains the most recent 30 minutes or 2 hours of audio, digital, and timing information. Both Honeywell's 30 minute and 2 Hour SSCVR models are approved to TSO C-123.
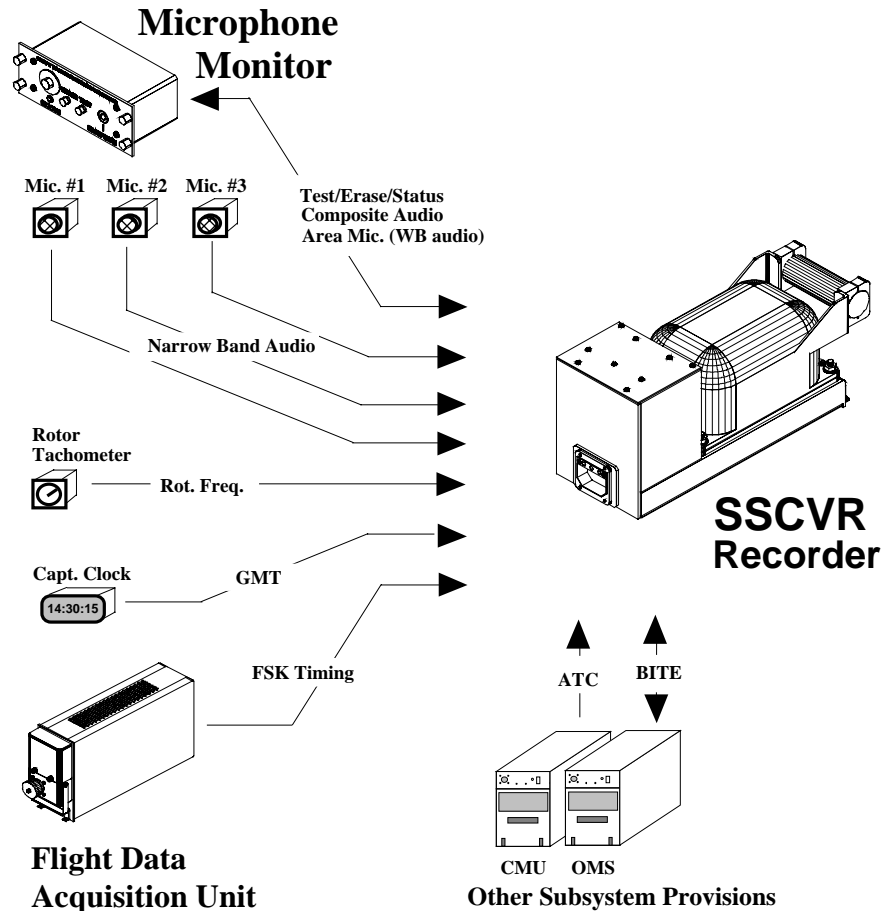
"State of the art" high density FLASH memory devices are combined with the use of mature industry standard audio digitization and encoding integrated circuits (ICs).

- **Provides a consistently high level of recording quality over the entire audio range.**

- **Avoids the risk and complexity of immature proprietary compression algorithms.**

Figure 1 shows the SSCVR and its major features, while Figure 2 provides a simplified diagram showing its major aircraft interfaces.

ED-56a Crash Survivable Memory Unit (CSMU) (30 min. or 2 hr. model)

Under Water Locator Beacon (ULB)

115Vac/28Vdc Power Supply

ED-56a Microphone Monitor

ARINC-757 Aircraft Interface

Controller Board ED-56a Audio Processor

Figure 1:   Solid-State CVR System, Major Features

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Figure 2:   Solid-State CVR, Major Aircraft Interfaces

The SSCVR is the most modern available, incorporating the latest interface characteristics defined in ARINC 757. Audio interface provisions include one (1) wide band and three (3) narrow band channels meeting the improved signal to noise and bandwidth characteristics specified in ED-56a. In addition to the audio inputs, the SSCVR also records timing information from either of two sources, GMT from the captains clock or FSK from the flight data acquisition unit. A dedicated tachometer input is provided for recording of rotor speed in helicopter applications.

Both the 30 minute and 2 hour SSCVR currently include two ARINC-429 interfaces; one is reserved for future recording of air traffic control digital message communications, and the second is provided for new generation aircraft equipped with Onboard Maintenance Systems.

The SSCVR has been designed to achieve a high degree of reliability, as well as facilitating simplified maintenance and minimal component sparing over competing models.

- **High Mean Time Between Failure -
  in excess of 10,000 hours predicted (per MIL-HDBK-217F) and
  in excess of 20,000 hours field operation anticipated.**
- **No Scheduled or Periodic Maintenance is required.**
- **Consists of only (3) three Shop Replaceable Units.**
- **Dual voltage power supply provides fleet wide commonalty.**

Extensive micro-processor based built-in-test greatly simplifies test and trouble shooting, thereby minimizing technician training and support equipment costs.

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1.0   SSCVR DESIGN OVERVIEW

The SSCVR is a single Line Replaceable Unit (LRU) in a standard ARINC-404A style avionics form factor. The SSCVR chassis includes three (3) Shop Replaceable Units (SRU's) and an optional underwater locating device. SRUs include:

  a)   **Interface and Control Board (ICB)**
  b)   **115Vac/28Vdc Dual Voltage Power Supply (PS)**
  c)   **Crash Survivable Memory Unit (CSMU)**
  d)   **Under Water Locator Beacon (ULB)**

The breakdown of major components and SRU accesses are summarized in Figure 3.
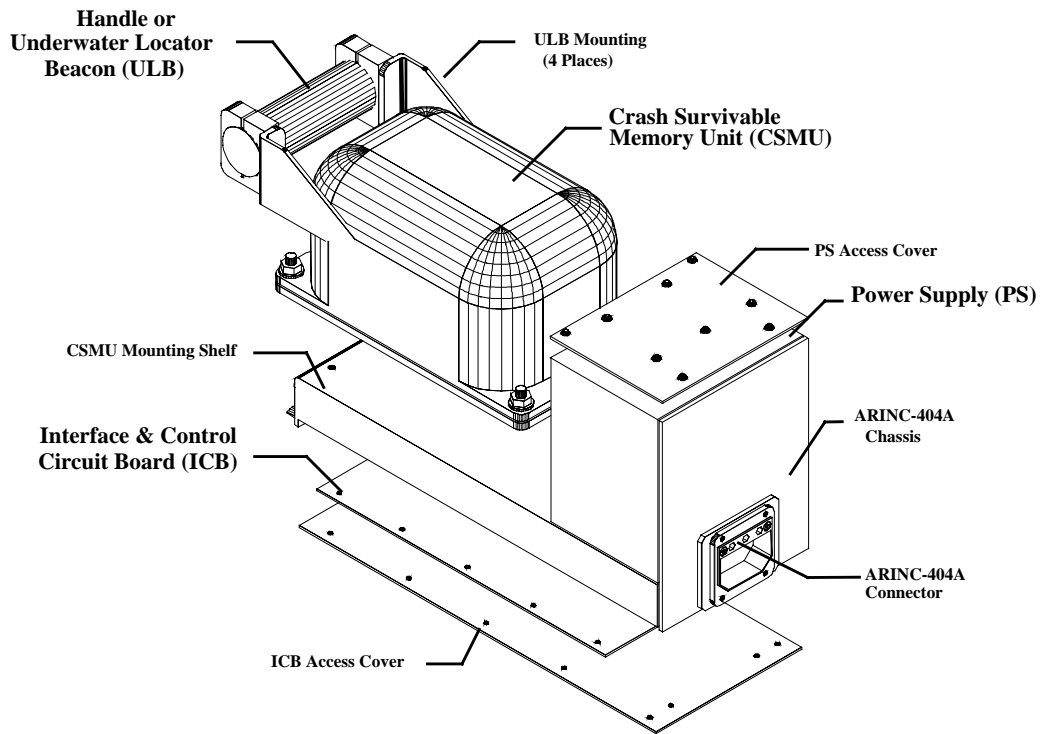
Figure 3:   SSCVR Exploded View Showing Major SRUs

All three SRUs are readily accessible without requiring major disassembly. The CSMU may be removed from its mounting shelf by simply removing four bolts and releasing its mating connector. The plug-in power supply may be accessed by removing the top (power supply) access panel. Access to the plug-in interface controller board is accomplished by removing the bottom cover panel from the SSCVR chassis.

An optional under water locator beacon (ULB) approved to TSO C-121 is mounted on the front of the unit and also serves as a handle. Four (4) mounting bolts firmly attach the ULB directly to the front of the CSMU to avoid separation in the event of an incident. The mounting of the ULB also facilitates easy access for replacement of its battery. If the SSCVR is purchased without the ULB, a hollow metal tube is mounted in its place.

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2.0 SSCVR OPERATIONAL OVERVIEW

All SSCVR processing and control is performed on a single plug-in circuit board, the Interface and Control Board (ICB). ICB functions include, front end data conditioning, audio signal digitization and encoding, control of all states and modes of the system, and performing functions such as record, erase, and test.
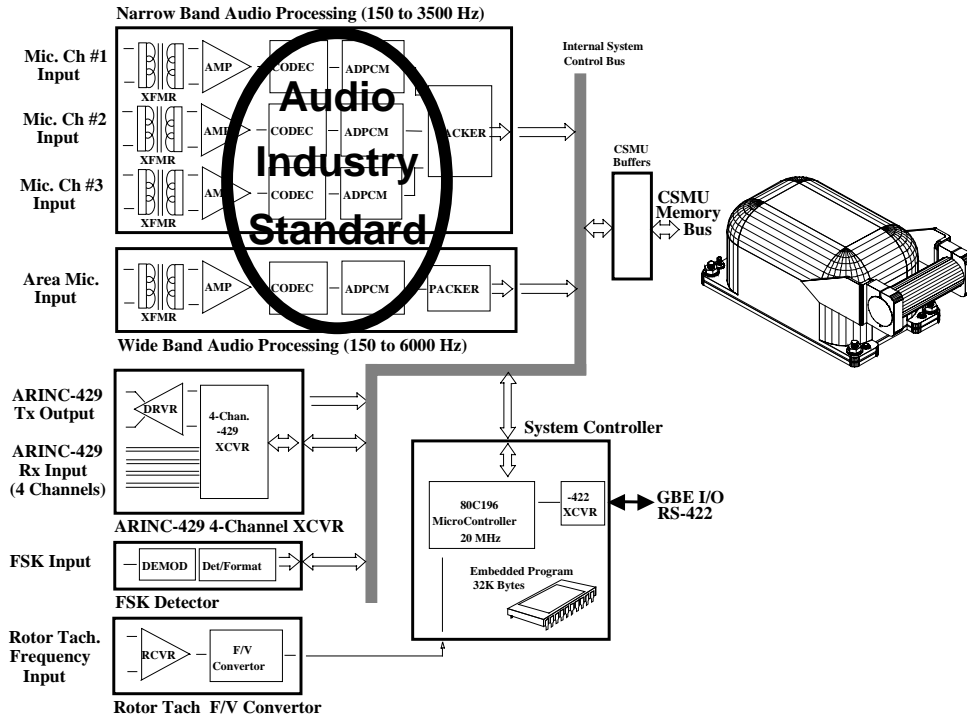
Figure 4 provides a simplified block diagram of the ICB.

Figure 4: Interface Controller Board Block Diagram

A key element of the SSCVR design is that the audio recording uses an industry standard encoding method (G.723 CCITT, 24kbs). This approach provides several advantages to the user:

- **The audio digitization and encoding are embedded in non-proprietary, commercially available integrated circuits which have been matured through wide-spread use in consumer equipment.**

- **The encoding algorithm is extensively used in personal computer based high quality audio systems, thus decoding/playback tools are inexpensive and readily available from commercial sources.**

The audio circuits, digitization/compression process, and memory resolution meet the improved audio performance requirements of ED-56a, thereby assuring the highest level of audio recording fidelity. Audio channel characteristics are summarized as follows:

     a)   Signal To No Signal   48 dB minimum
     b)   Cross Talk   40 dB
     c)   Balance   ±3 dB
     d)   Signal to Noise Plus Distortion 24 dB minimum
     e)   Speech Transmission Index   0.75(narrow band), 0.85 (wide band)

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3.0   SSCVR PHYSICAL CHARACTERISTICS

The SSCVR fits the half-ATR-short mounting requirements of ARINC-404A. Recognizing that the SSCVR will be installed on small-aircraft where space is at a premium, height, which is a non-critical mounting dimension, has been reduced from the ARINC-404A specification. The SSCVR is sufficiently robust that it may be hard mounted (i.e. a shock/vibration isolation tray is not required). This, combined with the small form factor, allows more latitude in mounting location on the aircraft. The physical characteristics of the unit are:

- **Mounting:**   **ARINC-404 Half-ATR-Short Tray Mount**

- **Dimensions:**   **6.1"H x 4.8"W x 12.62"L (plus ULB)**

- **Connector:**   **DPXBMA-57-33S-0001**

- **Weight:**   **Less Than 13 Pounds (11.5 Pounds typical)**

- **Power Dissipation:**   **Less Than 35 Watts (8 Watts typical)**

- **Cooling Method:**   **Convection and Radiation to Ambient Air**

Figure 5 illustrates the mechanical interface aspects of the unit.
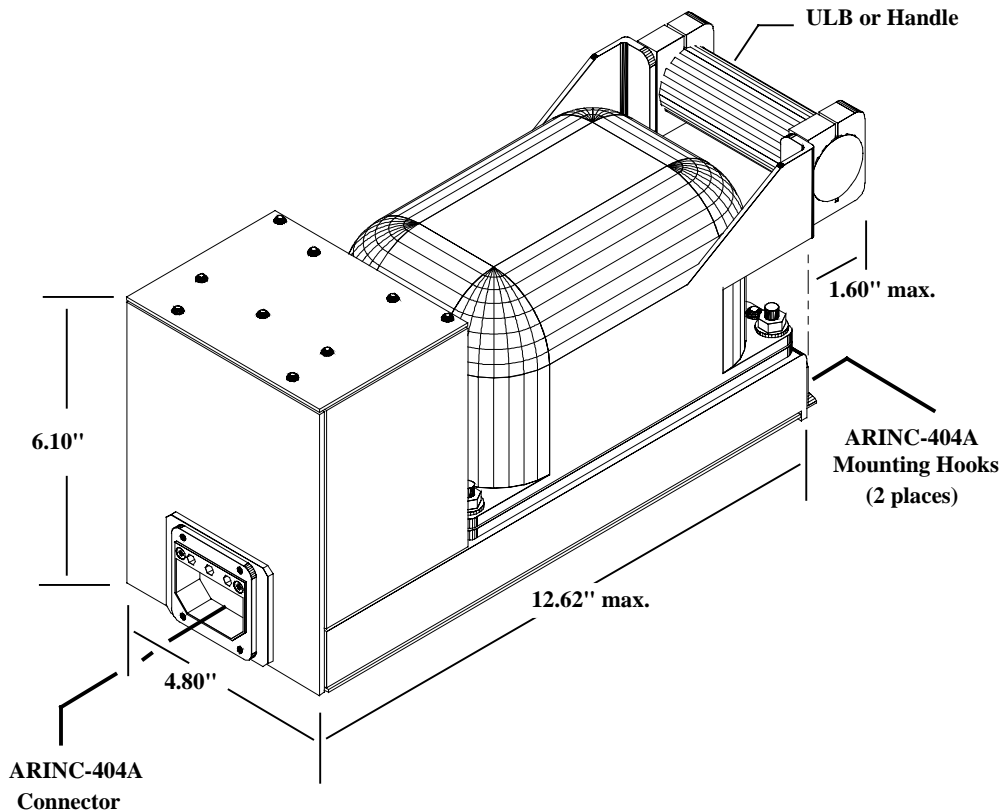
Figure 5:   SSCVR Mechanical Interface Features

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4.0   SSCVR ENVIRONMENTAL CHARACTERISTICS

The SSCVR has been fully qualified to meet the environmental service conditions for rack mounted equipment per DO-160C as outlined below. These conditions have been selected to assure its failure free use virtually on all commercial transport aircraft which require use of a CVR.

Temperature   Per DO-160C Section 4, Category D2
    Operational Limits: Continuous -55°C to +70°C
    Non-operational Limits: Continuous -55°C to +85°C

Altitude   Per DO-160C Section 4, Category D2
    Altitude: Sea Level to +50,000 feet

Temperature Variation   Per DO-160C Section 5, Category B

Humidity   Per DO-160C Section 6, Category B

Mechanical Shock   Per DO-160C Section 7
    Operating Shock: Up to 6G over 11 msec half-sine
    Crash Safety: Up to 15G over 11 msec half-sine

Vibration   Per DO-160C Section 8
    Fixed Wing Aircraft: Per Test Curve B, C, L, M
    Helicopter Vibration: Per Test Curve N, V

Explosion Proofness   Per DO-160C Section 9, Category E1

Waterproofness   Per DO-160C Section 10, Category X

Fluid Susceptibility   Per DO-160C Section 11, Category X

Sand and Dust   Per DO-160C Section 12, Category X

Fungus Resistance   Per DO-160C Section 13, Category F

Salt Spray   Per DO-160C Section 14, Category X

Magnetic Effect   Per DO-160C Section 15, Category A
    Magnetic Deflection: 0.3-1.0m Distance allowed

Power Input   Per DO-160C Section 16, Category A
    Input Power: AC or DC Power
    Power Interruptions: 200 msec. without upset.

Voltage Spikes   Per DO-160C Section 17, Category A

Audio Frequency Conducted Susceptibility   Per DO-160C Section 18, Category A

Induced Signal Susceptibility   Per DO-160C Section 19, Category Z

Radio Frequency Susceptibility   Per DO-160C Section 20, Category V

Emission of Radio Frequency Energy   Per DO-160C Section 21, Category Z

Lighting Induced Transient Susceptibility   Per DO-160C Section 22, Category L

Lighting Direct Effects   Does not apply.

Icing   Per DO-160C Section 23, Category X

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5.0   SSCVR CRASH PROTECTION DESIGN

The SSCVR's crash survivable memory unit (CSMU) provides for complete data recovery when subjected to the crash conditions stipulated in ED-56a, and thereby the intent of TSO C-123A :

- **Impact Shock**   **3400G, 6.5 milliseconds**
- **Penetration Resistance**   **500 lb. weight from 10 feet**
- **Static Crush**   **5000 lbs., 5 minutes**
- **High Temperature Fire**   **1100°C, 30 minutes**
- **Low Temperature Fire**   **260°C, 10 hours**
- **Deep Sea Pressure and**   **20,000 feet, 30 days**
- **Sea Water/Fluids Immersion**   **Per ED-56a**

The CSMU design has been fully qualified to these requirements and, in fact, exceeds them by considerable margin in key survival areas:

- **Impact shock has been successfully demonstrated at 4800 G's**
- **High temperature fire exposure has been tested to <u>60 minutes</u>**
- **Low temperature fire was tested immediately after exposure to 1100°C fire**

The superior performance of the CSMU is the result of 30 years experience with designing and producing protective enclosures. As shown in Figure 6, a very simple package design has been achieved, which not only contributes to its industry leading survivability characteristics, but also assures a high degree of maintainability. Compared to competing models, requirements for specialized repair knowledge and support equipment have been greatly reduced.
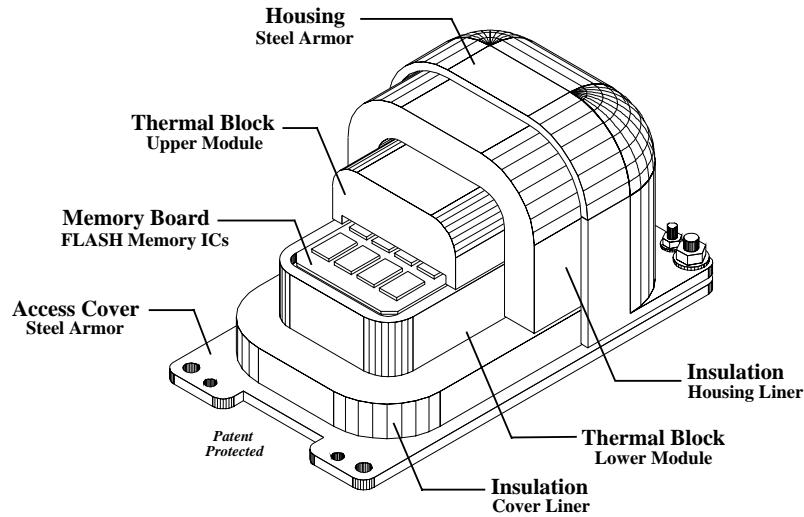
Figure 6:   CSMU Cutaway View Showing Major Features

The CSMU is easily removed from the top of the SSCVR chassis without having to disassemble the remainder of the unit. A steel bottom cover provides easy access to the Memory Board. Since the CSMU uses modular "dry-block" materials for both the insulating liner and thermal mass, there is no need to deal with the sticky thermal jells or special insulating fluids. The Memory Board design is very simple, consisting of only a single small circuit card assembly.

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6.0 MICROPHONE MONITOR DESIGN OVERVIEW

The SSCVR provides for interface with a standard microphone monitor, or alternatively a remote area microphone and pre-amplifier as described in paragraph 6.1. The microphone monitor is a small instrument panel mounted device intended for location in the cockpit ambient audio environment. It includes a built-in *area microphone* for transducing the cockpit area audio spectrum (crew conversation and ambient sounds such as engines, actuators or control switch toggles) for recording on the SSCVR's area microphone channel. In addition to the reception and conditioning of the cockpit audio, the microphone monitor also provides several cockpit voice recorder related status indicators and controls. These are described as follows:

- HEADPHONE   A standard headset jack which enables maintenance crew members to verify that audio signals are being properly detected by the SSCVR's audio recorder function.

- ERASE   Push button switch which enables the crew member to *erase* the audio portion of the SSCVR's audio recording memory.

- TEST   Push button which enables the SSCVR to be commanded into a *self test* mode.

- STATUS   Provides an indication of the correct operational status for the SSCVR's audio recording functions in response to a Push-to-Test.

The microphone monitor shown, in Figure 7, includes a wideband preamplifier with automatic gain control for conditioning the area microphone audio signal prior to output to the recorder. This design meets the signal-to-noise and signal sensitivity requirements of ED-56a, thus providing the optimum in audio quality to the recorder. The Microphone Monitor is approved to TSO C-123.

Weight = 1.0 lbs max.

Figure 7:   Microphone Monitor Mechanical Interface Features

- **Input Power:**   **+18 Vdc ± 3.6 Vdc**
                                                                      (supplied by SSCVR)

- **Audio Characteristics:**   **Frequency Response**   **150 Hz to 10,000 Hz**
                                 Signal to Noise Ratio   **48dB, 95 - 120dB SPL**
                                 Harmonic Distortion   **< 3% at 120 dB SPL**
                                 Output Range   **AGC limited, 0.5 Vrms**

- **Weight**   **1.0 pounds maximum**

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6.1   REMOTE AREA MICROPHONE AND PRE-AMPLIFIER DESIGN OVERVIEW

The SSCVR can also interface with a standard area microphone, without the need for the monitor unit. The area microphone is a small device intended for location in the cockpit ambient audio environment. It is available in several configurations : as a flange mounted devises, as shown in Figure 8, or without the flange and with flying leads, as shown in Figure 9.

The remote area microphone provides an input to the pre-amplifier shown in Figure 10, which includes a wideband preamplifier with automatic gain control for conditioning the area microphone audio signal prior to output to the recorder. This design meets the signal-to-noise and signal sensitivity requirements of ED-56a, thus providing the optimum in audio quality to the recorder. The remote area microphones and pre-amplifier are approved to TSO C-123.
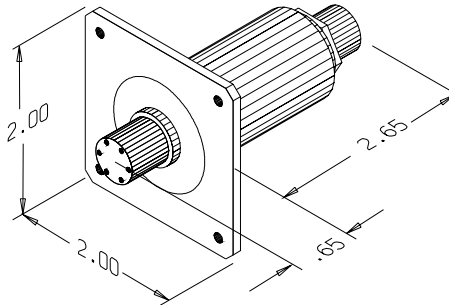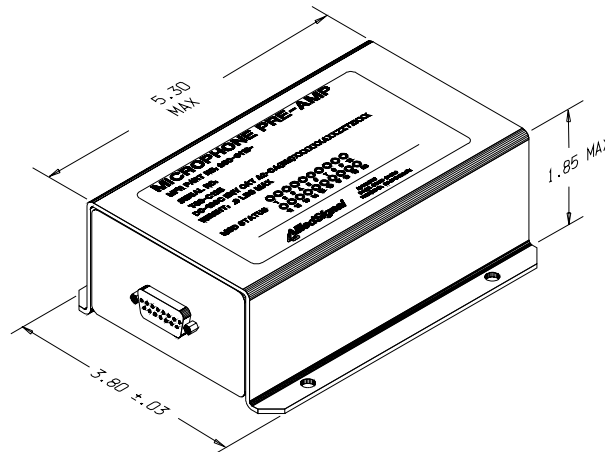

Figure 8: Area Microphone Interface Features
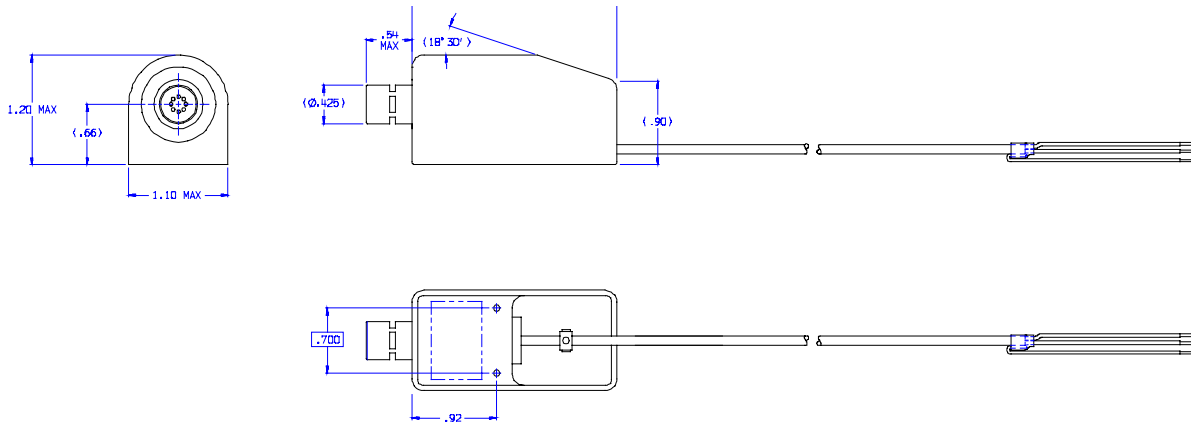
Figure 9: Area Microphone - alternative

- **Input Power:**   **+5 Vdc ± 1 Vdc**
- **Current:**   **300μA maximum**
- **Audio Characteristics:**   **Frequency Response**   **150 Hz to 10,000 Hz**
                               Signal to Noise Ratio **48dB, 95 - 120dB SPL**
                               Harmonic Distortion   **< 5% at 90dB SPL over 150 to 8,000 Hz**
                                                          <10% at 120dB SPL at 10,000 Hz
- **Weight**   **3.5 ounces maximum**

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Figure 10:   Pre-amplifier Interface Features

- **Input Power:** +18 Vdc ± 3 Vdc
- **Current** 100 mA maximum

- **Audio Characteristics:**

	Frequency Response	150 Hz to 10,000 Hz
	Signal to Noise Ratio	48dB, 95 - 120dB SPL
	Harmonic Distortion	< 3% at 120 dB SPL
	Output Range	AGC limited, 0.5 Vrms
	Bandwidth	150 - 10,000 Hz

- **Weight** 0.7 pounds maximum

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7.0   SSCVR SYSTEM SUPPORT EQUIPMENT

The Playback and Test Station (PATS) is a cost effective shop level personal computer (PC) based system with associated software which performs download of SSCVR recording memory, decompression and playback of the downloaded data, and acceptance test of the SSCVR. Because the "TEST" function does not preserve the data contained in the recording memory, the PATS operations are segmented into two distinct applications; "Playback" and "TEST". This provides a level of protection against unintentional erasure or re-write of recorded audio. Figure 11 shows the PATS in its SSCVR test configuration.
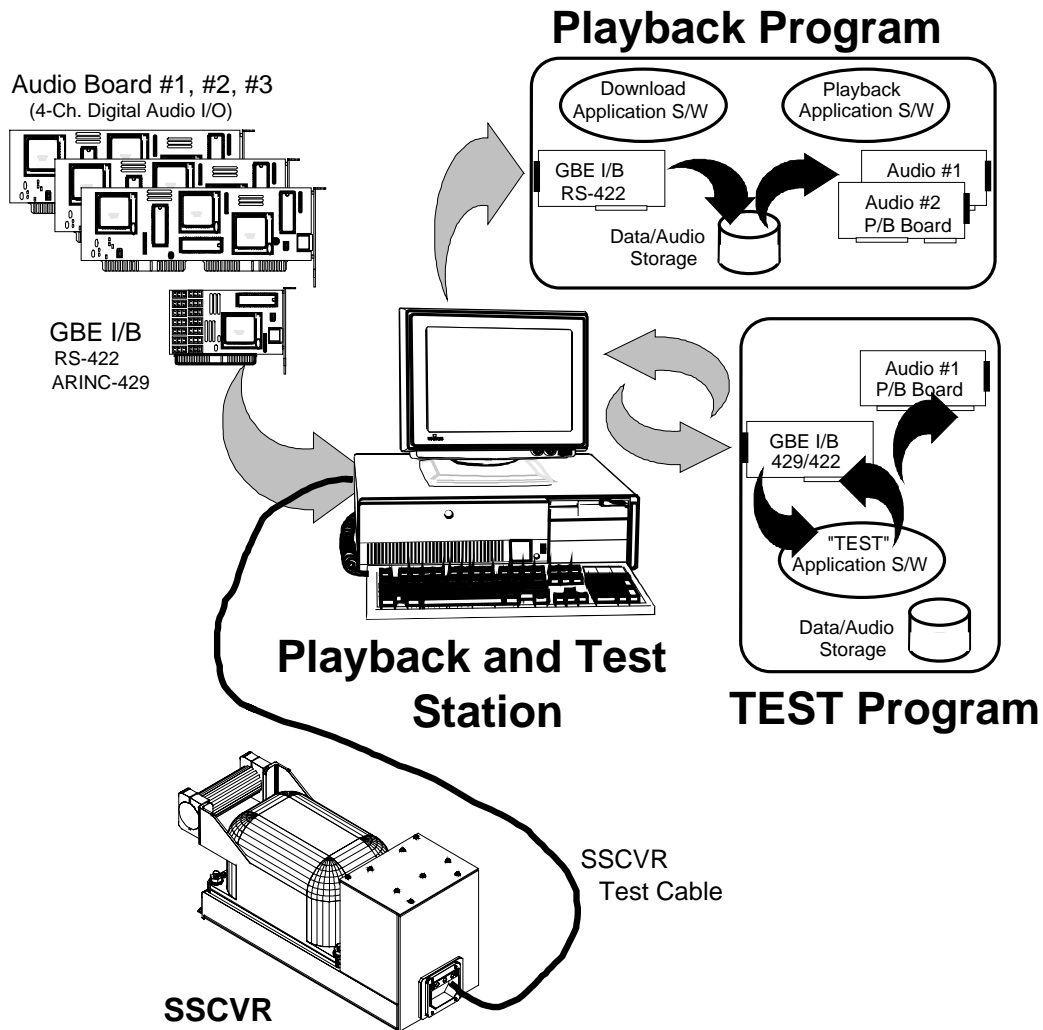
Figure 11:   SSCVR Playback and Test System Configuration

The PATS is configured with a GBE Interface Board containing the high speed RS-422, discrete interfaces, and ARINC-429 interface channels necessary to test the SSCVR functions. The PATS also contains up to 3 commercial dual-channel digital-audio boards. These are used for audio input/output during CVR audio tests, and for audio output (to speakers) during playback. A 486-33MHz PC provides the necessary minimum computing capability to support all SSCVR TEST and PLAYBACK tasks for both the 30 minute and 2 hour SSCVRs.

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The PATS test and playback programs are implemented using MS Windows© as the user interface. This approach provides very easily understood menu driven test operations which require minimal operator training. Figure 12 shows the main menu window from the SSCVR "TEST" program.
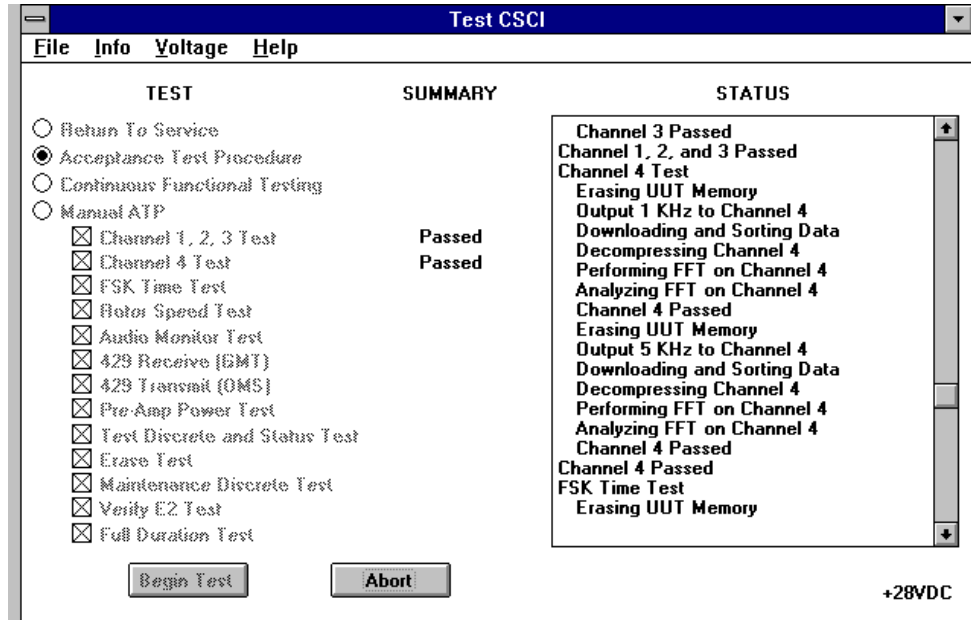
Figure 12:   SSCVR Test Program, Example of Main Window

Figure 13 shows the control screen during "PLAYBACK" operation. This example screen of an SSCVR recording shows the approximate recorded duration of the playback audio, as well as a summary list of *TIME* messages, Rotor Speed and provision for ATC *COMM*unications Data (CMU) messages. The operator may move the cursor to select a particular point in the audio recording. All message windows retain a time stamp to assist in cross correlation of events.
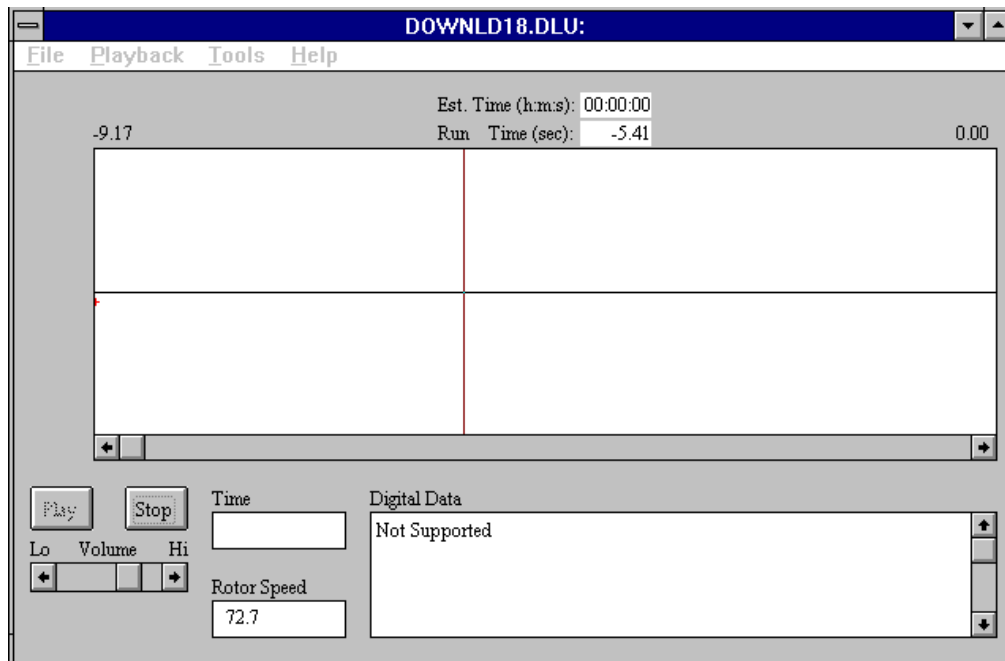
Figure 13:   SSCVR Playback Program, Example of Main Window