Air Transport Series

PRODUCT DESCRIPTION

Solid-State Voice/Data & Digital Communications
Combined Recording Systems
for
Air Transport Applications

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1. INTRODUCTION

1.1. Scope

The purpose of this Product Specification is to provide a functional description of the Honeywell Solid State Digital Voice/Data Recorder (SSDVDR), used as part of an improved flight recording system for air transport aircraft.

This specification summarizes the performance capabilities and interface characteristics of the 2 Hour Cockpit Voice, 25 Hour Flight Data and 2 Hour Digital Communications Message Recording SSDVDR models which are compliant with the Minimum Operational Performance Requirement (MOPR) as stated in EUROCAE ED-55, ED-56A and ARINC Characteristic 757, Draft 3.

1.2. Product Overview

The SSDVDR can simultaneously record and retain, in a solid state crash survivable memory unit (CSMU), the most recent data as follows:

- 120 minutes (2 Hours) of **Audio** information from 4 input channels
- 25 hours of **Flight Data** information received at a data rate up to 256 words/second and
- 120 minutes (2 Hours) of **Digital Communication Messages.**

Audio input signals are provided for 3 narrow band voice channels for primary crew recording and a single wide band channel. The wide band channel is used to record the acoustical environment of the flight deck utilizing an area microphone centrally located in the aircraft's cockpit. The area microphone signal is provided to the recorder through a preamplifier contained within the cockpit control panel.

Aircraft flight data shall be provided by a standard ARINC 717 DFDAU, or equivalent, by means of an ARINC 717/573 data bus.

ARINC 429 inputs are available for recording of

- Digital Communication Messages from a Communication Management Unit (CMU),
- GMT from the Captain's Clock.

The ARINC-429 Label data for the definition of the Digital Communication Messages may be uploaded to the SSDVDR via the PCMCIA Interface.

TheSSDVDR is available with an integrated PCMCIA slot (readily accessible on the front panel with the unit installed in the aircraft) for rapid download of flight data to a removable PCMCIA card. The on-aircraft downloading process shall be password protected and the password may be uploaded to the SSDVDR recorder via the PCMCIA slot.

The SSDVDR is powered by either 115 VAC or +28 VDC.

SSDVDR weight – 15.0 pounds maximum.

The CVR connector and pin assignments were used as the baseline for the SSDVDR pin assignments. This enables the SSDVDR to be a plug-in replacement for the CVR on those aircraft already equipped with a CVR. Implementation of the FDR function of the SSDVDR will require the addition of databus, control discretes and fault discrete wiring into the SSDVDR aircraft interface connector.

The SSDVDR may also accept an alternate time input from a FDAU (or equivalent) as a Frequency Shift Keyed (FSK) input channel. Storage of the FSK Input may be mixed with any of the Narrow Band Audio Inputs to the SSDVDR

2. APPLICABLE DOCUMENTS

The following documents are for reference purposes only.

2.1. Honeywell Documents

980-4700-601	Solid State Flight Data Recorder (SSFDR), Product Specification - Part number 980-4700
980-6020-601	Solid State Cockpit Voice Recorder (SSCVR), Product Specification - Part numbers 980-6020 and 980-6022
980-6021-601	Lightweight Solid State Digital Voice/Data Recorder (AR Series SSDVDR), Product Specification - Part number 980-6021

2.2. Industry Documents

RTCA/DO-178B	Software Considerations in Airborne Systems and Equipment Certification, 1992
EUROCAE ED-55	Minimum Operational Performance Requirements for Flight Data Recorder Systems, May 1990
EUROCAE ED-56A	Minimum Operational Performance Requirements for Cockpit Voice Recorder Systems, December 1993
EUROCAE ED-14C/DO-160C	Environmental Conditions and Test Procedures for Airborne Equipment
ARINC 404A	Air Transport Equipment Cases and Racking; March 1974
ARINC 429	Mark 33 Digital Information Transfer System (DITS)
ARINC 557	Airborne Voice Recorder; January 1964
ARINC 573-7	Mark 2 Aircraft Integrated Data System (AIDS Mark 2), December 1974
ARINC 607	Design Guidance for Avionics Equipment
ARINC 609	Design Guidance for Aircraft Electrical Power Systems
ARINC Report 624	Design Guidance for Onboard Maintenance System, August 1991
ARINC 717	Flight Data Acquisition and Recording System
ARINC 747	Flight Data Recorder, June 1990
ARINC Project Paper 748	Communications Management Unit (CMU)
ARINC 757, Draft 3 Supplement 1	Cockpit Voice Recorder (CVR), March 15, 1999
EIA RS-422	Electrical Characteristics of Balanced Voltage Digital Interface Circuits
CFR 23.1457, 1459	Code of Federal Regulations, Section 23.1457, and 23.1459
TSO C-123a	Technical Standard Order, Cockpit Voice Recorder Systems
TSO C-124a	Technical Standard Order, Flight Data Recorder Systems
PCMCIA V2.01	PCMCIA Cartridge Standard, November 1992
PCMCIA/ATA V1.01	PCMCIA AT Attachment Cartridge Standards, November 1992
PCMCIA/RE V1.00	PCMCIA Recommended Extensions, November 1992

3. SYSTEM DESCRIPTION

3.1. Product Application

The SSDVDR can simultaneously record and retain, in a solid state crash survivable memory unit (CSMU), the most recent

- 120 minutes (2 Hours) of Audio information from 4 input channels
- 25 hours of Flight Data information (at data rates up to and including 256 words/second) and
- 120 minutes (2 Hours) of Digital Communication Messages (from a low speed ARINC-429 input).

In its standard format the audio input signals provide recording of 3 narrow band voice channels for primary crew recording and a single wide band channel. The wide band channel is used to record the acoustical environment of the flight deck utilizing an area microphone centrally located in the aircraft's cockpit. Aircraft flight data may be presented from a standard ARINC 717 DFDAU, and ARINC 429 inputs are available for recording of Digital Communication Messages from a Communication Management Unit (CMU) or equivalent, and GMT from the Captain's Clock. An alternate time input from a FDAU (or equivalent) as a Frequency Shift Keyed (FSK) input channel may be mixed with any of the Narrrow Band Audio Inputs to the SSDVDR.

The SSDVDR is available with an integrated PCMCIA slot (readily accessible on the front panel with the unit installed in the aircraft) for rapid download of flight data to a removable PCMCIA card.
The simplified diagram, Figure 1, shows the major aircraft interfaces provided by the SSDVDR.

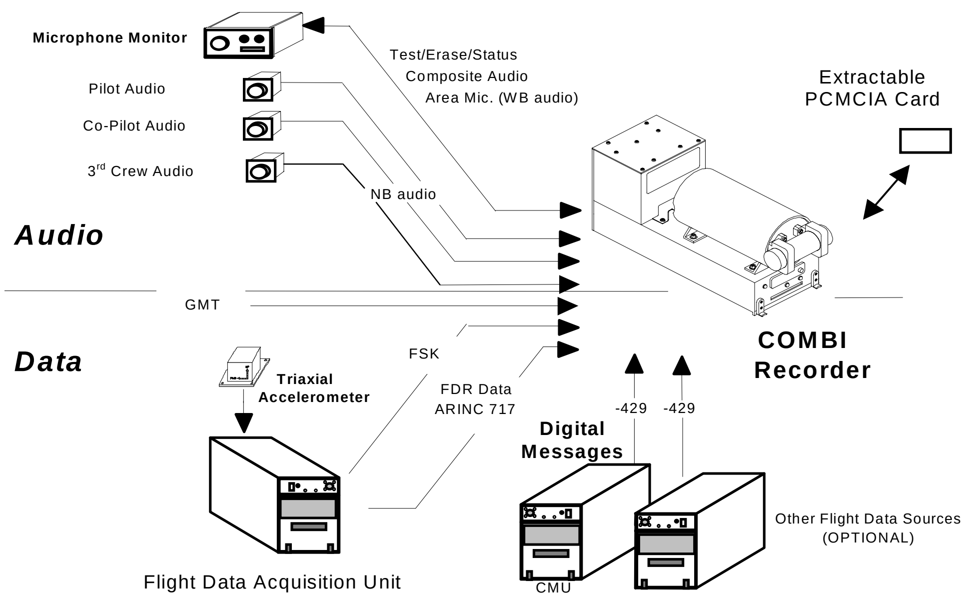


Figure 1. SSDVDR Recorder, Major Aircraft Interfaces

The SSDVDR complies with the performance requirements defined in both TSO C-123a and TSO C-124a, the airworthiness requirements of FAR 25.1457 and FAR 25.1459, and fully satisfies the Minimum Operational Performance Requirements (MOPR) as stated in EUROCAE Document ED-56A. ED-56A defines the requirements for a Cockpit Voice Recorder (CVR) and ED-55 for Flight Data Recorders (FDR) utilizing solid state memory as the recording medium.

3.2. Part Number Matrix

The SSDVDR is available in the configurations shown in Table 1.

Series Model Number	Honeywell Part Number	Audio Data			25 Hour Flight Data Capacity (WPS)			Digital Datalink Message
		Duration (Min)	No. of Channels		ARINC-717			ARINC-429
		120	Crew	Area	64	128	256	120 min
SSDVDR-120-4X	980-6025-001	X	3	1			X	X
SSDVDR-120-2X	980-6025-002	X	3	1		X		X
SSDVDR-120-1X	980-6025-003	X	3	1	X			X

Table 1 – SSDVDR Part Number Matrix

3.3. System Description

The SSDVDR recorder is composed of a single Line Replaceable Unit (LRU) consisting of a standard ½-ATR-Short ARINC 404A style avionics chassis.
The SSDVDR chassis includes four (4) Shop Replaceable Units and an underwater locating aid. Each of these sub-assemblies is interchangeable between units. The circuit board assemblies are constructed from multi-layer glass fiber and are protected by an acrylic conformal coating. The SRUs are, as shown in Figure 2:

- **Interface and Control Board (ICB)**
- **Crash Survivable Memory Unit (CSMU)**
- **Dual 115Vac/+28Vdc Power Supply (PS) Assembly**
- **PCMCIA Interface (for Flight Data Download)**
- **Underwater Locator Beacon (ULB)**

The Controller board is a single circuit card that controls all states and modes of the internal system. The internal system performs the record, erase, and test functions.

The Crash Survivable Memory Unit (CSMU) is a solid state, non-volatile, mass storage device enclosed in a protective case. The CSMU provides storage for all input data and also ancillary system data.

The Power Supply Assembly converts +28 Vdc/115VAC aircraft power to secondary power for the SRUs and provides power-on reset, power failure monitoring, and significant power hold-up capability.

PCMCIA Interface provides a Memory Cartridge slot designed per industry standard PCMCIA Cartridge Interface that accepts removable PC Cards for the downloading of the SSDVDR Flight Data, and uploading of the ARNIC-429 message label data.

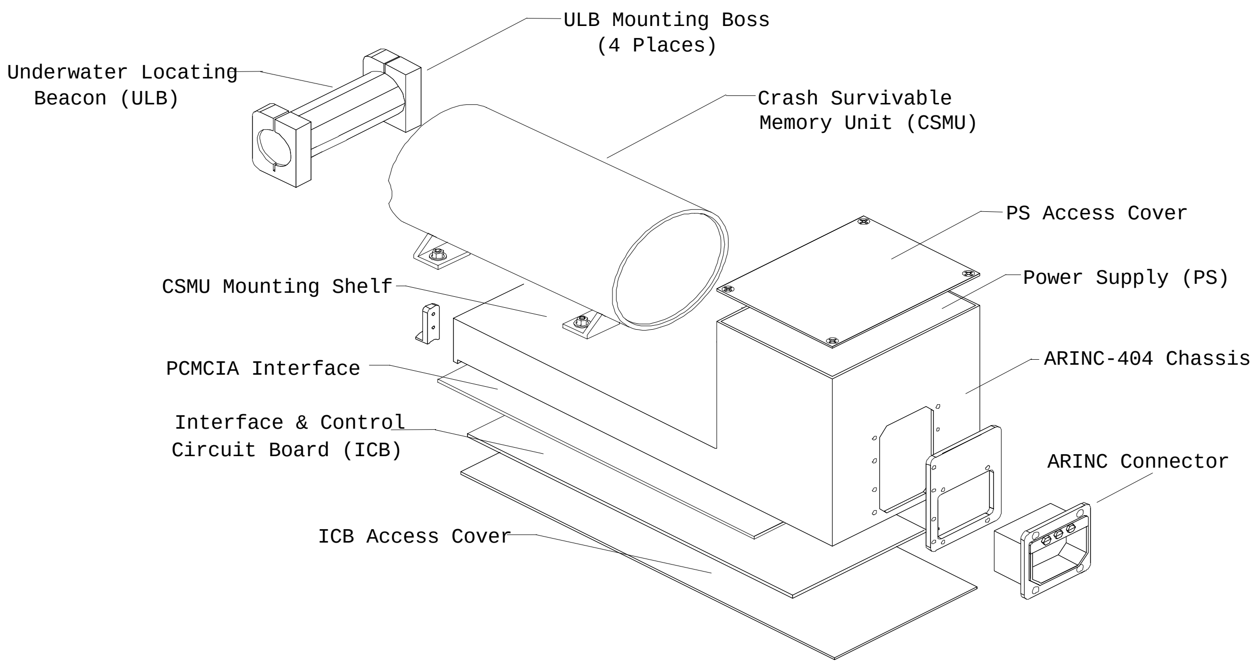


Figure 2 – SSDVDR Recorder, Exploded View

3.4. Maintainability

No scheduled periodic maintenance or servicing is required during the life of the SSDVDR (except for the ULB, which requires battery replacement approximately every 6 years).

The SSDVDR has been designed to detect and isolate errors to the Shop Replaceable Unit (SRU) level. It is constructed in a modular fashion to allow SRU replacement for ease of repair with an estimated Mean Time to Repair (MTTR) of 30 minutes.

Internal BIT provides comprehensive SRU fault isolation to the component level to assist depot level repair. Intermediate-level repair may be accomplished by the customer, while depot level repair may be performed by an **Honeywell** approved facility.

3.5 Crash Protection Design

The SSDVDR's crash survivable memory unit (CSMU) is designed for complete data recovery when subjected to the crash survivable requirements of TSO C-123a. These are briefly described in the following table.

Test	**ED-56a Para**	**Requirement summary**
Impact Shock	5.3.2 (a)	3400g, 6.5 milli-second, half-sine
Penetration Resistance	5.3.2 (b)	500 pound weight dropped from height of 10 feet on most damage-vulnerable face. Impact point is 1.57" long 0.25" diameter pin that strikes CSMU vertically.
Static Crush	5.3.2 (c)	5000 pounds for 5 minutes on main diagonals and faces of the unit
High Temperature Fire	5.3.2.(d) Amendment 1 (25 Nov 97)	50,000 BTU/feet^2/hour for 60 minutes. All information in CSMU completely recoverable. CSMU having been previously exposed to shock, penetration, and crush tests, and memory is readable without removing memory IC's from their circuit board
Low Temperature Fire	5.3.2 (e)	260 degrees centigrade for 10 hours. All data stored in CSMU is completely recoverable using component-level readout equipment.
Deep Sea Pressure, and Sea Water Immersion	5.3.2 (f)	30 days each at depths of 9 feet and 20,000 feet
Fluid Immersion	5.3.2 (g)	All information is completely recoverable following 48 hour immersion in various fluids, oils and fuels

Table 2 – Crash Protection Design Summary

3.6 Interface and Control Board

The SSDVDR's Interface and Control Board (ICB) is a single plug-in circuit card assembly accessed through a removable cover panel forming the bottom of the SSDVDR chassis. The ICB performs front-end data conditioning and controls all states and modes of the system, performing functions such as record, erase, and test. Figure 3 provides a simplified block diagram of the ICB, showing the major functional sections.

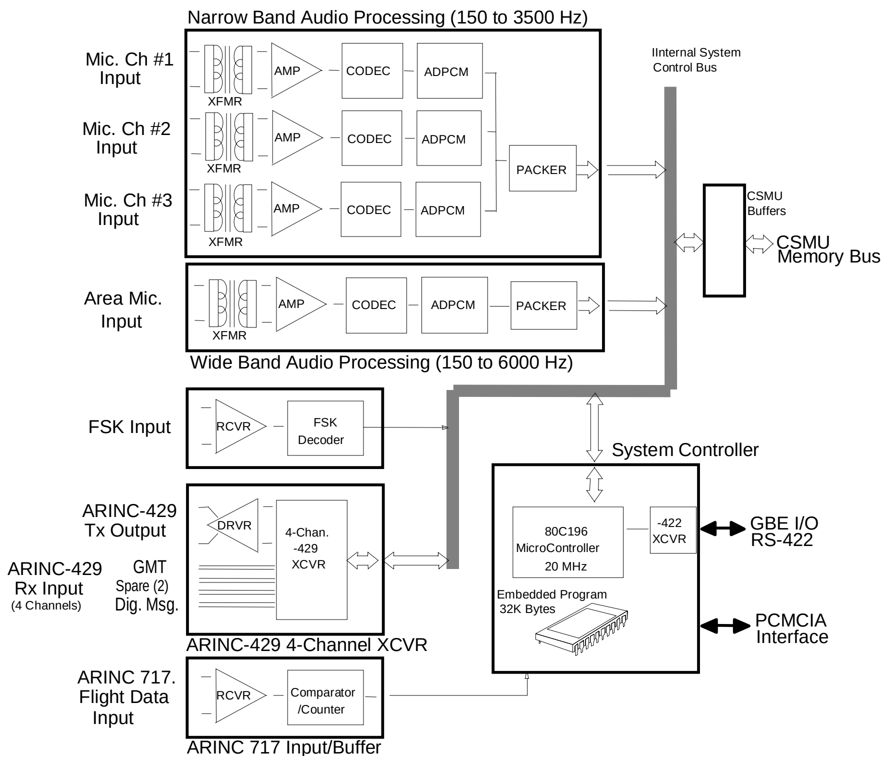


Figure 3. Interface Controller Board Block Diagram

3.6.3 System Controller

The SSDVDR recorder uses a 20 MHz 80C196 micro-controller to perform overall control and data flow management functions. The micro-controller manages the reception of data samples (audio, flight data and digital communication messages) from the aircraft interface functions, and manages the mapping and storage of that data into protected memory. The controller also performs background Built-In-Test as part of the primary recording mode, and supports other operating modes such as commanded self test, protected memory download, memory erasure, and test. Results of these tests and other ancillary data (i.e. BIT failures, memory error log, repair history, etc.) are stored in a special EEPROM memory in the CSMU. The micro-controller includes a high speed serial port which is interfaced to the ground based test equipment (GBE) connector mounted at the front of the SSDVDR chassis. In addition, an optional PCMCIA interface is provided to allow for rapid data download using an extractable PCMCIA card.

3.6.4 CSMU Interface

The ICB provides a fully buffered interface to the protected incident recording memory located in the CSMU. This interface isolates the CSMU from the remainder of the recorder functions and is designed to minimize the potential for memory corruption, whether inadvertent or due to aircraft breakup.

3.6.5 Power Supply

The SSDVDR's Power Supply (PS) is a plug-in modular assembly accessed through a small cover at the top rear of the SSDVDR chassis. The PS converts either 115 Vac 400 cycle or +28 Vdc aircraft power to secondary power for internal subsystem functions, as well as providing power-on reset and power-fail monitoring, and also supplies +18 VDC to the Microphone Monitor. The power supply utilizes an efficient switching regulator design and supports power interrupt hold-up times of at least 200 milliseconds. Power consumption is less than 8 watts typical, 10 watts maximum. The power supply is designed to meet the requirements of DO-160C and provides in-line protection for accidental reversal of the input power.

3.7. Design Characteristics

3.7.1. Packaging

The SSDVDR fits within the envelope defined by 1/2-ATR-short mounting requirements of ARINC-404A. Recognizing that the SSDVDR may be applied on small fixed and rotary wing aircraft platforms where space is at a premium, height (which is a non-critical mounting dimension) has been reduced somewhat. The SSDVDR is also sufficiently robust that it may be hard mounted in most small aircraft and helicopter applications.

All sheet metal parts and fasteners are protected to inhibit corrosion. A manufacturer's label provides part number, weight, serial number, date of manufacture, TSO approval number, manufacturer's name and address, modification status, software level, and DO-160C environmental certification categories. In addition, the crash survivable portion of the unit contains the standard dual language markings of English "FLIGHT RECORDER DO NOT OPEN" and French "ENREGISTREUR DE VOL NE PAS OUVRIR".

3.7.2. Weight

The SSDVDR maximum weight does not exceed 15.0 pounds, including the ULB.

3.7.3. Cooling

The SSDVDR is cooled by convection and ambient air. No forced air cooling is required.

3.7.4. Reliability

The SSDVDR is designed for use in air transport and general aviation aircraft and has an anticipated predicted Mean Time Between Failure (MTBF) rate of 10,500 hours per MIL-HDBK-217F, for an inhabited cargo aircraft. The SSDVDR is designed to have a useful life in excess of 20 years, not including the ULB.

Since the SSDVDR design is based on the mature SSCVR design, the in-field reliability of the SSDVDR recorder is expected to be comparable and is expected to be in the order of 35,000 hours MTBF.

3.7.5. Input/Output Circuit Protection

The SSDVDR provides short circuit and voltage transients protection for all external inputs and outputs.

3.7.6. Elapsed Time Indicator (ETI)

The SSDVDR records, in non-volatile solid state memory, the elapsed time (in the form of completed memory cycles of the Wideband audio data) for which the unit has had power applied.

3.7.8. Software Design

The SSDVDR software design has been developed according to the SSDVDR Software Development Plan (SDP) per DO-178B as level D equipment.

3.7.9. Underwater Locator Beacon (ULB)

An Underwater Locator Beacon (ULB) is mounted on the SSDVDR CSMU to aid in its retrieval in poor visibility underwater conditions. The ULB is approved to TSO C-121.

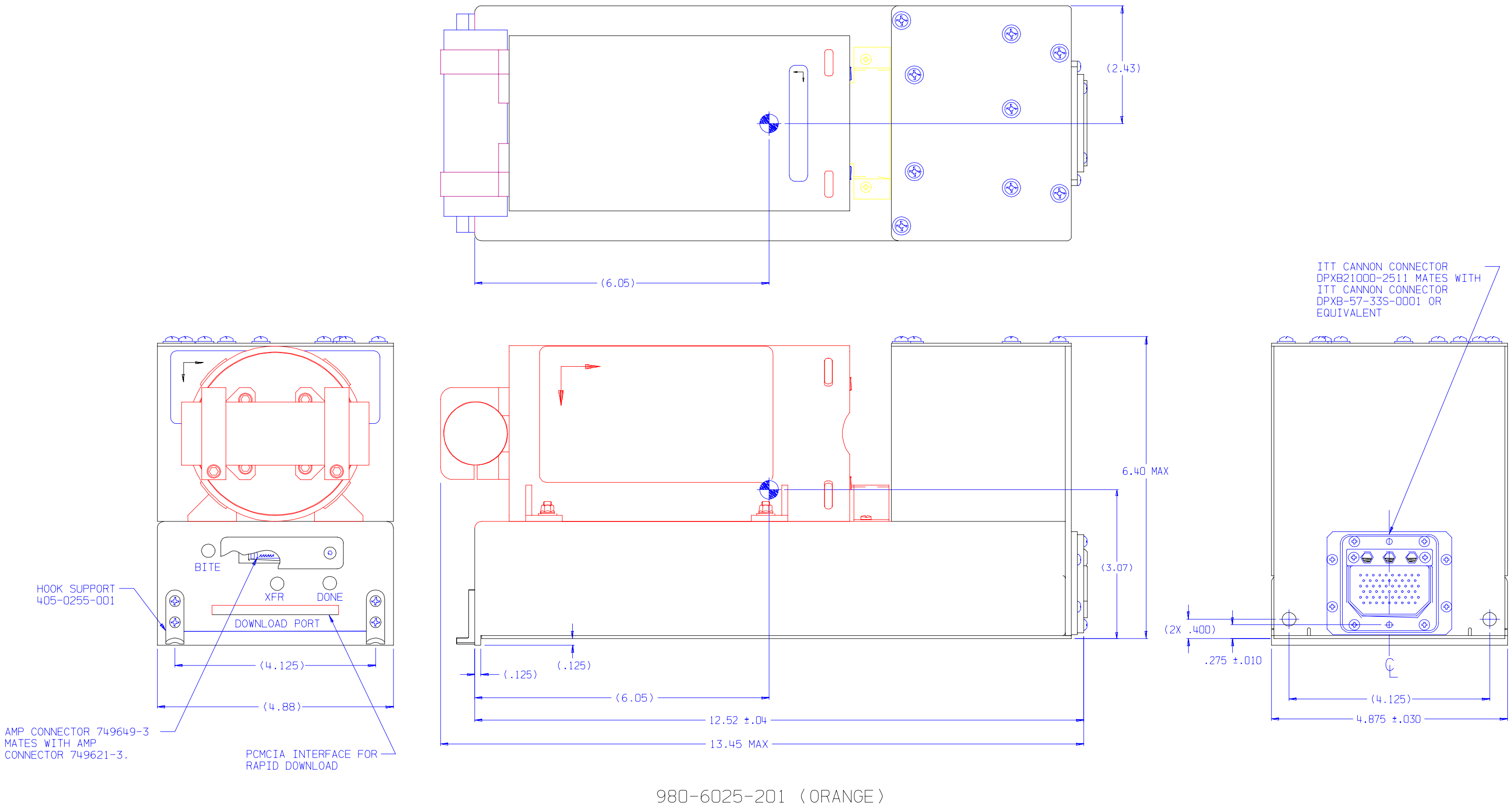


Figure 4 – SSDVDR Envelope Outline

3.7.10. Main Aircraft Connector

The SSDVDR aircraft connector is a Cannon DPXB-57-34P-0001 or equivalent, mounted on the rear panel of the unit. The connector has the following pin assignments and will be in accordance with the ARINC Characteristic 757.

Note: 1) The pinouts shown are in accordance with Draft 3 of ARINC Characteristic 757. However since this Characteristic is under development the pinout definitions are subject to change. The CVR connector and pin assignments were used as the baseline for the SSDVDR pin assignments. This enables the SSDVDR to be almost a plug-in replacement on those aircraft already using a CVR (e.g. only the FDR wires must be added and possibly a few vendor unique CVR wires tied back).

2) FDR STAUS Discrete output (Pin 36) is currently undefined in ARINC Characteristic 757

PIN	SIGNAL	PIN	SIGNAL
1	Spare Reserved (No Connection)	30	Channel No.1 Audio Input – LO (3rd Crew Member)
2	115 VAC – HOT	31	Spare Reserved (No Connection)
3	115 VAC – COLD	32	Channel No.1 Audio Input – HI (3rd Crew Member)
4	RS422-RXD+ (GBE Interface)	33	ARINC 429 LO – Dig Comm Data Input (Low Speed)
5	Audio Monitor – LOW	34	ARINC 429 HI - Dig Comm Data Input (Low Speed)
6	Audio Monitor – HIGH	35	Channel No.2 Audio Input – LO (Co-pilot)
7	RECORD ON INPUT (GBE Interface,GBE Present)	36	Spare Reserved (No Connection) ***FDR STATUS ("Open"= Fault, "Gnd"=OK)*** ***see Note 2***
8	RECORD ON OUTPUT (Chassis Ground)	37	Channel No.2 Audio Input – HI (Co-pilot)
9	+28 VDC Power Input	38	ARINC 717 Data Rate Select Discrete B
10	Stop Recording Input (Not Used)	39	ARINC 429 LO – Spare Input OMS (B) (Low Speed)
11	RS422-RXD- (GBE Interface)	40	ARINC 429 HI – Spare Input OMS (A) (Low Speed)
12	PUSH-TO-TEST	41	Channel No.3 Audio Input – LO (Pilot)
13	+18 VDC – Return (Control Unit Power)	42	Spare Reserved (No Connection)
14	+18 VDC – Hot (Control Unit Power)	43	Channel No.3 Audio Input – HI (Pilot)
15	Test-Indicator+	44	FDR INHIBIT (Gnd = FDR Recording Inhibited)
16	Test-Indicator-	45	Channel No.4 Audio Input – LO (Area Microphone)
17	Chassis Ground	46	Spare Reserved (No Connection)
18	ARINC 717 - FDR Data Output (B)	47	Channel No.4 Audio Input – HI (Area Microphone)
19	ARINC 717 - FDR Data Output (A)	48	ROTOR SPEED Input – LO
20	RS422-TXD+ (GBE Interface)	49	ROTOR SPEED Input – HI
21	RS422-TXD- (GBE Interface)	50	ARINC 429 Output LO – Spare OMS (Low Speed)
22	RS422-RTS+ (GBE Interface)	51	ARINC 429 Output HI – Spare OMS (Low Speed)
23	CVR FAULT ("OPEN" = Fault, "GND" = OK)	52	RS422-RTS- (GBE Interface)
24	FDR FAULT ("OPEN" = Fault, "GND" = OK)	53	RS422-CTS+ (GBE Interface)
25	ARINC 429 Input LO – GMT (Low Speed) – Option	54	RS422-CTS- (GBE Interface)
26	ARINC 429 Input HI – GMT (Low Speed) – Option	55	Audio ERASE A – INPUT
27	ARINC 717 - FDR Data Input (B)	56	Digital Comm. Recording (Gnd=Dig Comm Enabled)
28	ARINC 717 - FDR Data Input (A)	57	Audio ERASE C – OUTPUT
29	ARINC 717 Data Rate Select Discrete A		

Table 3 – SSDVDR Connector Pin Assignments

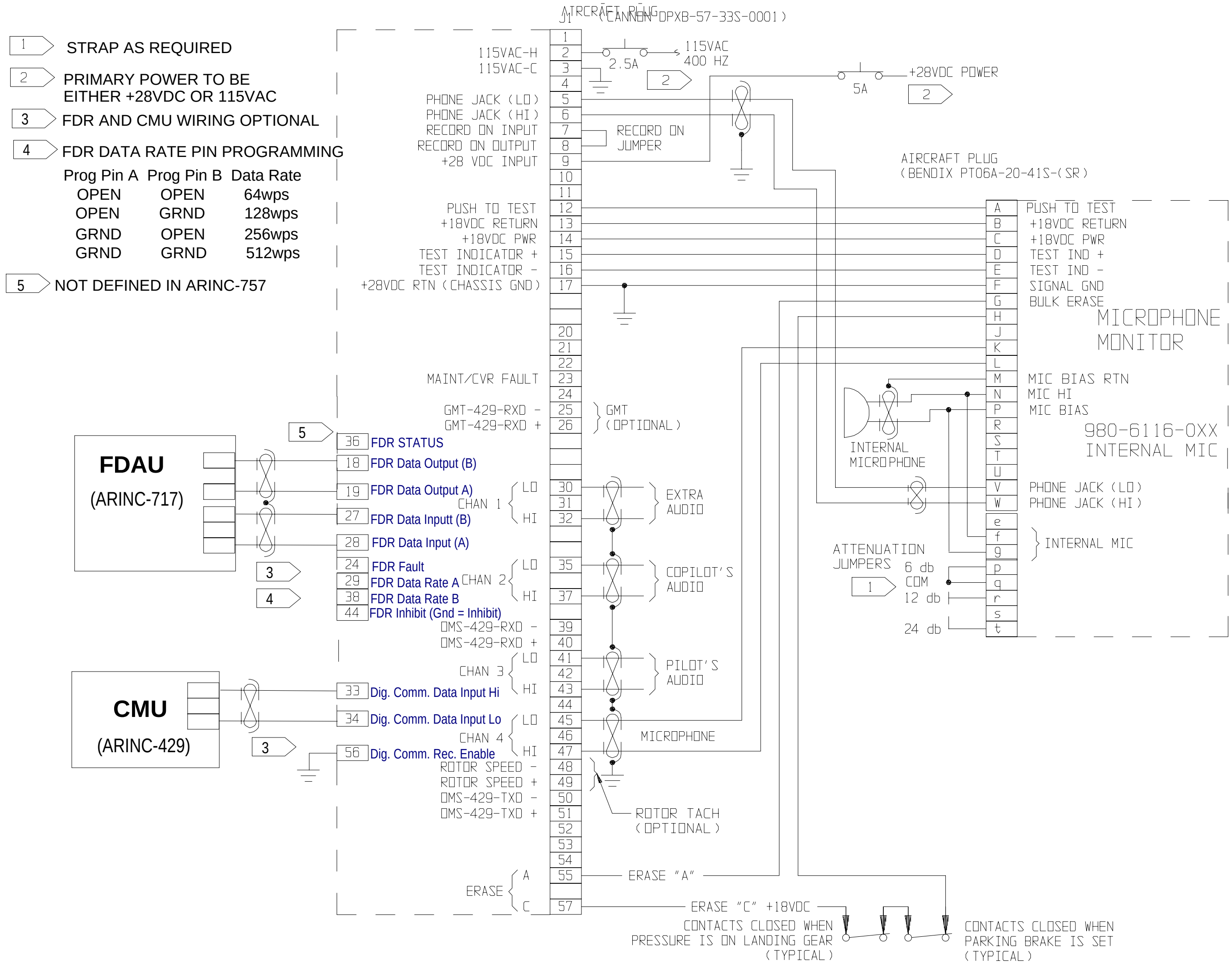


Figure 5 – SSDVDR Interconnection Diagram with Audio, Flight Data and Digital Communication Message Recording

3.7.11. FDR Data Input

The SSDVDR has the capability to receive and record flight data through an ARINC-573/717 interface. The SSDVDR records FDR data as it is received, i.e. it does not attempt to synchronize to the incoming data stream, and No Data Compression is used. If the FDR data stream is interrupted, FDR data recording is halted, any partially buffered data is recorded, and the stream is monitored for the return of data. If data does not resume within 5 seconds, a subframe of zeroes is recorded as a marker and the FDR Status discrete is asserted. If and when data returns, normal recording resumes and the FDR Status discrete will be reset within 1 second.

Note: A subframe of data depends on the input data rate. At 64 words per second (wps), a subframe is 96 bytes, at 128 wps it is 192 bytes, and at 256 wps a subframe consists of 384 bytes.

3.7.11.1. FDR Data Rate Selection

Data Rate programming for the FDR input configuration is set via jumpers on the main aircraft connector per the recommendations of ARINC-757, as defined in the Table below (note, the 512 wps data rate is a growth provision).

Program A (Pin 29)	Program B (Pin 38)	Input Data Rate
open	open	64 wps
open	ground	128 wps
ground	open	256 wps
ground	ground	512 wps

Table 4 -- FDR Data Rate Programming

The FDR decoder device will automatically detect and adjust to the incoming data rate, regardless of the programmed rate. If the "actual" data rate does not agree with the programmed data rate, the FDR Status discrete will be asserted. If the "actual" data rate is such that the configured memory will not support 25 hours of FDR recording, both the FDR Maintenance and Status discretes as well as the BITE light will be asserted. No fault indication will occur for the case where the "actual" data rate results in more than 25 hours of FDR recording (e.g. a 64 wps data stream supplied to a SSDVDR configured for a 128 wps data rate would provide 50 hours of FDR recording capacity).

3.7.11.2. FDR ARINC-717 Data Loop-Back

When configured to receive ARINC-717 data, the SSDVDR transmits a continuous loop-back data stream to the source (FDAU) to verify that the recorder is properly receiving data. The data rate, format, and content are the same as the input data stream. The data is transmitted back to the FDAU within 2 milliseconds from when it was received. Loop-back data is inhibited when the FDR Status discrete indicates a fault.

3.7.12 Built-in Audio Digitization Channels

The ICB provides signal reception and processing for four audio channels. These consist of one wide-band channel and three narrow-band channels.

Digitization within the SSDVDR is accomplished by individually converting each incoming audio signal to 8-bit mu-law format (equivalent to a 13 bit linear PCM sample), in a standard CODEC device, then compressing the 8-bits down to 3-bit samples using Adaptive Differential Pulse Code Modulation (ADPCM). This is the value ultimately stored in protected memory. The compression method works on voice and non-voice background sounds using an industry standard algorithm. It is important to note that this is a continuous method that preserves all received audio (e.g. dead time editing and other forms of deleting non-voice information are <u>not</u> employed).

Digitization for the narrow band (NB) channels occurs at an 8k Hz sample rate, providing a recording bandwidth of 150 to 3500 Hz. The wide band (WB) channel digitizes at a 16k Hz sample rate, providing a bandwidth of 150 to 6000 Hz. Other channel characteristics are summarized as follows:

3.8. Audio Performance

The SSDVDR provides audio recording and playback performance as summarized in Table 5:

# Chs	Input Level (maximum) Impedance (nominal)	Bandwidth (minimum)	SNR (minimum)	STI (minimum)	Balance	Signal to No Signal (minimum)	Crosstalk
3* (Ch 1,2 & 3*)	2.5 Vrms 10,000 ohms	150-3500 Hz Narrow band	24.0 dB	0.75	±3 dB	48 dB	40 dB
1 (Ch 4) Area Mic	175 mVrms 10,000 ohms	150-6000 Hz Wide band	24.0 dB	0.85	±3 dB	48 dB	40 dB

* Narrow Band channel 3 is optional (see Table 1).

Table 5 -- Audio Performance Summary

3.8.1. Input Impedance and Signal Level

The SSDVDR audio input impedance for each channel is ten thousand (10,000) ohms (±10%). The three narrow band (voice) channels of the SSDVDR are designed for an input signal level of 50 milli-volts$_{rms}$ minimum and 2.5 Volts$_{rms}$ maximum (input dynamic range of 34 dB). The wide band (area) channel is designed for an input signal level of 175 Milli-volts$_{rms}$ maximum.

Each of the four audio input channels includes a two terminal input isolation circuit to isolate the input from analog ground and the supply voltages. The audio input channels also include transient and EMI/EMS protection.

3.8.2. Balance Between Channels

The SSDVDR audio recording channels are balanced such that the audio signals produced during playback do not differ by more than a total range of ±3 dB.

3.8.3. Audio Frequency Response

The frequency bandwidth of the narrow band voice channels is at least 150 Hz to 3500 Hz with a pass band characteristic of ±3 dB. The frequency bandwidth of the wide band area channel is at least 150 Hz to 6000 Hz with a pass band characteristic of ±3 dB.

3.8.4. Speech Transmission Index (STI)

Speech Transmission Index (STI) is an objective measure of speech transmission quality, which can be related to subjective quality tests. The STI factor is a number from 0.00 to 1.00; an STI above 0.75 is considered "excellent" quality. The STI measurement provides another measure of audio recording quality beyond historical signal to noise ratio (SNR) measurements. A method for measuring STI is provided in ED-56A.

The reproduced audio signal for the wide band area channel has a minimum STI rating of 0.85 and the narrow band voice channels have a minimum STI rating of 0.75.

3.8.5. Signal to Noise + Distortion Ratio

The minimum signal to noise plus distortion ratio (S/N+D) for all audio channels is 24.0 dB for the full duration of the recording and for input signal amplitudes between 0 dB and -20 dB of the maximum specified input amplitude. This S/N+D is achieved for the full bandwidth of each channel.

3.8.6. Audio Noise Level (No Input Signal)

With an open circuit, short circuit, and out-of-band signals present at the input, the level of the system noise recorded in the crash protected memory is at least 48 dB below a recorded signal at the frequency of the maximum response of the channel at maximum input amplitude.

3.8.7. Crosstalk Between Channels

The crosstalk between audio channels does not exceed 40 dB for both audio and data signals.

3.8.8. Audio Monitor Channel

The SSDVDR provides an audio monitor output channel which is the composite of all the audio input channels. This composite signal is an exact replica of the recorded digitized audio information, i.e.; it is the output after the digital conversion process. A secondary function of this output is to provide an aural tone to indicate successful completion of initiated self-test and erase functions. The audio monitor channel has output impedance compatible with a standard 600-ohm headset. The output level of the SSDVDR monitor tracks the audio level of the input channels with a variance not greater than ±3 dB.

3.9. Recording Characteristics

3.9.1. Memory Characteristics

The crash-protected memory has a maximum bit error rate of 1 in 1,000,000 bits and a minimum re-write capability of up to 100,000 cycles. Each separate physical memory device in the crash protected memory includes an electrically embedded identification to ensure proper sequencing of the data in the unlikely event that the memory devices become dislodged from their correct positions on the circuit board (possibly following an accident well beyond today's survivability requirements).

The memory is partitioned into *wideband audio, narrow band audio, mixed narrow band audio, flight data and digital communication message* sections, as depicted in the Memory Map of Figure 6. Partitioning and interleaving between several memory devices is utilized to minimize data loss, should a device become damaged.

Audio Memory Utilization. Each narrow band audio channel records data at a rate of 3k bytes per second, for a protected memory utilization of 5,400 Kbytes per channel in 30 minutes. The wide band recording occurs at a rate of 6k bytes per second and requires a total protected memory of 43,200 Kbytes for 120 minutes of audio. Note that the critical Cockpit Area Microphone is recorded at full bandwidth (6,000 Hz) for the entire 2 Hour recording duration. In addition, the 3 crew member audio inputs are summed in a “mixed” recording channel for the total 2 hour duration, requiring another 21,600 Kbytes of memory. Thus, the total 2 Hours of audio utilizes 80 megabytes of memory.

Flight Data Memory Utilization. Flight data memory is allocated based on utilization with a standard ARINC 717 interface for flight data recorded to ensure more than 25 hours of recording duration for a standard 256 words per second, 12 bits/word, recording rate. Thus, 36 megabytes of memory are allocated for this function. In order to ensure full and complete recording for incident investigation **no data compression** is used in the recording of flight data information. All critical flight data information is recorded on a bit-for-bit basis.

Digital Communication Message Memory Utilization. The Digital Communication Message memory is allocated based on utilization with a standard low speed ARINC 429 interface to ensure 2 hours of recording duration for 32 bit words at a peak data rate of 15 K bits per second recording rate. No data compression is used in the recording of Digital Communication Message information.

Labels of the incoming messages are filtered by means of look-up table stored in the SSDVDR's EEPROM. The table consists of up to 256 labels. Ten (10) Megabytes of memory are allocated for this function.

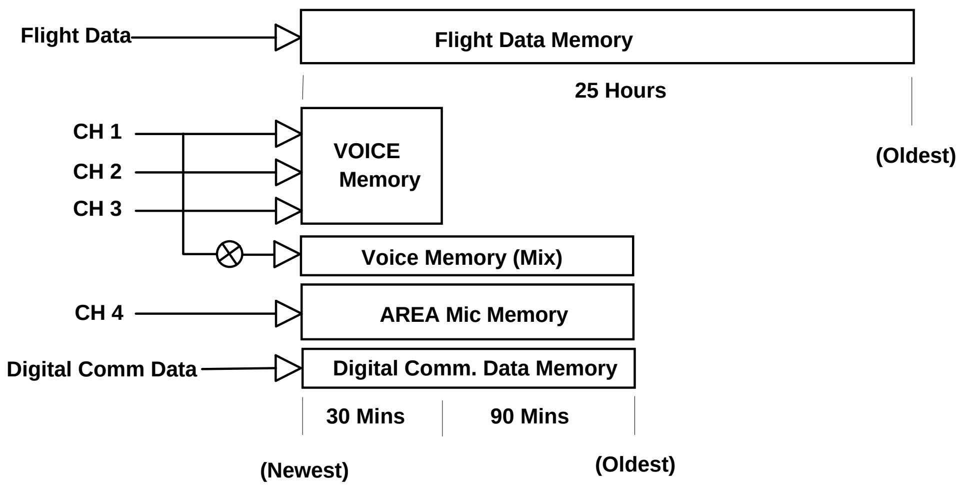


Figure 6 -- - SSDVDR Memory Allocation Map

3.9.1.1. Data Compression

The SSDVDR is designed to use an industry standard compression algorithm for the audio inputs. No data compression is used for the recording of flight data or digital communication messages. The data compression algorithm used is identical to that employed within **Honeywell**'s stand-alone Solid State Cockpit Voice Recorder, part number 980-6022, in production since July 1995.

3.9.2. Timing Characteristics

The SSDVDR begins storing data to the crash survivable memory within two hundred fifty (250) milliseconds from the application of electrical power. The delay in recording of flight data from the time of SSDVDR input reception to the time of recording in the crash survivable memory does not exceed five hundred (500) milliseconds. The delay in recording digital audio information, from the time of reception of the SSDVDR inputs to the time of recording in the crash survivable memory, does not exceed fifty (50) milliseconds. The recorded digital audio data on each of the four channels is synchronized in time to within four (5) milliseconds. The time correlation of the arrival time at the SSDVDR of any CMU message is within five (5) seconds.

When the memory erase discrete is activated for a duration of longer than one-half (1/2) second, the SSDVDR initiates an erase function of all CVR related information, and recording of flight data and digital communication messages is suspended during this time. The erase function is completed within five seconds of activation and can be recognized by the presence of a 3-second 400 Hz tone at the Audio Monitor output.

When the test input discrete is activated, for a duration of longer than one-half (1/2) second, the SSDVDR initiates a self-test of all SSDVDR functions. The self-test function is completed within five seconds and successful completion can be recognized by the presence of a 2-second 800 Hz tone at the Audio Monitor output. In the case of a failed self-test, no indication is given at the Audio Monitor output; however, the appropriate Maintenance Discrete(s) will be set to the failure mode.

The "CVR" function also continuously reconstructs the digitized and compressed audio samples back into audio signals. These reconstructed audio signals are then summed into a composite audio, which can be monitored through phone jack outputs at the microphone monitor panel.

3.9.3 Flight Data Recording Operation

The flight data received from the ARINC 717 input source is recorded into crash survivable memory no less frequently than once every 125 milliseconds. The record function does not attempt to recognize or strip parameters, provide any form of synchronization on the data, or perform any kind of data compression.

3.9.3.1. FDR Recording Characteristics

Recording capacity for Flight Data is specified as 25 hours minimum at the indicated FDR data rate (see Table 1). Memory chip failure during normal recording is tolerated (failed locations or blocks are identified and mapped out) until the total FDR memory capacity falls below the 25-hour threshold for the maximum data rate for which the unit is designed. Both the FDR Maintenance and FDR Status discretes will be asserted if the minimum 25-hour FDR recording capacity threshold is crossed, but the SSDVDR will continue to record data as long as data is available and power is present.

The incoming FDR data is recorded as received and is not aligned or processed in any way. No data compression is necessary to store the entire 25 hours of data within the CSMU. The incoming sync words are recorded, but are not detected or given any significance. GSE is used to assemble the data into frames/subframes prior to displaying/analyzing the data.

3.9.4. Digital Communication Message Recording Operation

The Digital Communication Message data contents received from the ARINC 429 input source is recorded into crash survivable memory continuously, in a linear manner on an interrupt basis. The SSDVDR will store the entire ARINC-429 data word.

3.9.5. Voice/Data Time Synchronization

The SSDVDR's is designed to provide internal timing synchronization for direct correlation of the recorded Cockpit Voice to Flight Data Information. This is accomplished by recording a “time sync” in the CVR data that corresponds to exactly 5 minutes of FDR data having been recorded. The SSDVDR counts the number of FDR 1/8-second data buffers received at the current (actual) data rate, and determines when the count corresponds to 5 minutes of FDR data and then records a “sync” count value into the CVR-data area once every 5 minutes.

The Digital Communication Message will contain a Time Stamp within the message to assist with the synchronization with Voice and Flight data.

3.9.5.1. GMT Input

Capability of additional timing information may be provided by timing signals at the operational ARINC-429 GMT input. The characteristic of this input is defined in ARINC-429 (see Greenwich Mean Time, labels 125 and 150). Either label 125 or 150 can be recorded, but if both are present, label 150 will take priority over label 125.

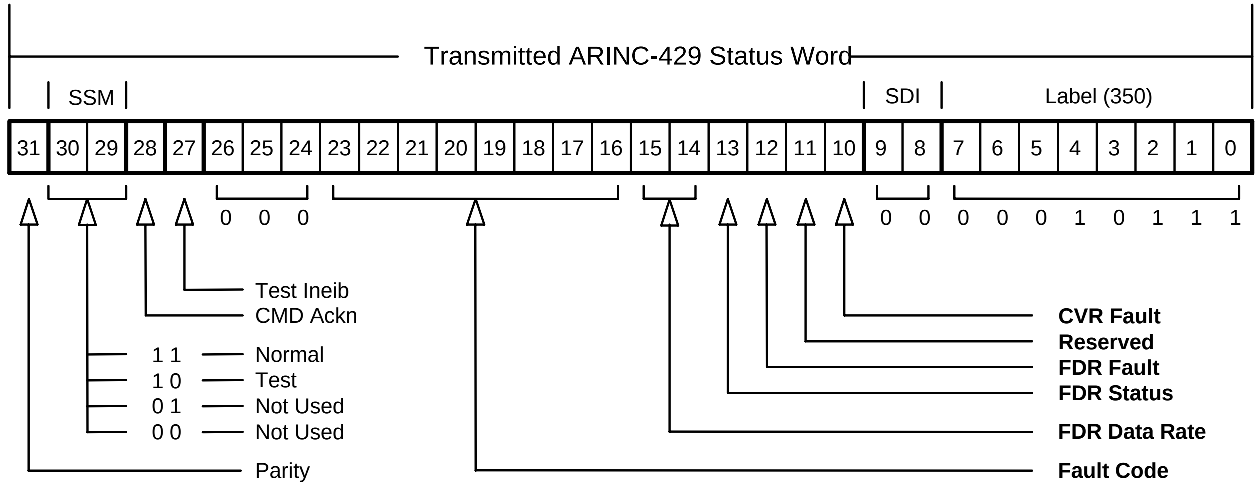
3.9.5.2. FSK Input

An alternate time input from the FDAU is a Frequency Shift Keyed (FSK) input channel that is used to record time data into crash survivable memory. The purpose of the input is to provide timing correlation between the Audio and Flight Data. The FSK is a transformed GMT message with a “0” represented by a frequency of 3607Hz and a “1” represented by 4193Hz. The length of time the message is 4 milliseconds and is received by the SSDVDR once every four (4) seconds. The definition is not specified by an industry document but has been adopted by several manufacturers and airlines.

Storage of the FSK Input may be mixed with any of the Narrrowband Audio Inputs to the SSDVDR.

3.9.6. Onboard Maintenance System (OMS)

The SSDVDR has the capability to provide self-test status information to an OMS system. The interface has been designed to comply with ARINC-429 for a low speed bit rate. The electrical characteristics of this channel are described in ARINC Report 624 and ARINC-757. Only the non-interactive mode is implemented in the SSDVDR (i.e. only non-requested periodic status transmissions occur). The default OMS label is 350 (octal) and the SSDVDR related status bits (see ARINC-757, Attachment 19) are defined as follows:



For each fault and status bit, a 0 indicates OK and a 1 indicates a failure. The CVR Fault, FDR Fault, and FDR Status bits reflect the condition of the corresponding SSDVDR output discretes. The 2-bit FDR Data Rate reflects the programmed data rate per Table 4 (where ground = 0 and open = 1). The Fault Code is the 8-bit code recorded in the SSDVDR fault table, which can be useful for SRU and component level diagnostics. The OMS status word is broadcast once per second.

3.9.7. Rotor Speed

The purpose of this input is to record helicopter rotor speed data into crash survivable memory. The rotor tachometer input is a general purpose frequency recording input as defined in ARINC 573-7, paragraph 4.2.4 and ARINC 757 (2 to 122 Vrms from 7 to 77 Hz). The SSDVDR can accept rotor inputs of 2 Vrms to 122 Vrms and from 7 to 6000 Hz (extended frequency range). This input is sampled and recorded once every 0.5 seconds.

3.9.8. Audio Interfaces

The audio subsystem interfaces support the mandatory requirements of cockpit voice recorder (CVR) installations. The governing documents are ARINC 557, defining older CVR installations, the new ARINC 757 characteristic, and ED-56A, the EUROCAE standard defining the most recent regulations for CVR performance.

3.9.8.1 Microphone Inputs (Narrow Band Audio)

Three microphone inputs are used to record the voices of the pilot, co-pilot, third crewmember, or PA system into crash survivable memory. The characteristics of the microphone input channels meet the requirements defined in ARINC 557, ARINC 757, and ED-56A. These "narrow band" microphone channel inputs provide the following characteristics:

a)	Input Level	2.50 volts rms max.
b)	Impedance	10,000 ohms
c)	Bandwidth	150 to 3500 Hz

3.9.8.2 Microphone Monitor Interfaces

The SSDVDR supports the standard input/output interfaces to support a cockpit mounted microphone monitor function as defined in ARINC 757 and ED-56A. Although these signals may be used individually for similar functions, it is recommended that they be used in conjunction with **Honeywell**'s standard Microphone Monitor.

- **Area Microphone Input (Wide Band Audio):** The area microphone input is typically used to record wide band area audio from the cockpit and surrounding area into crash protected memory. This "wide band" microphone channel input provides the following characteristics:

a)	Input Level	1.0 volts rms max.
b)	Impedance	10,000 ohms
c)	Bandwidth	150 to 6000 Hz

- **Push to Test:** The push to test discrete input is used to initiate a test sequence within the SSDVDR recorder. The test discrete must be held active for at least one-half second in order to activate the test mode. Subsequently, the SSDVDR will complete its test and respond with both aural and visual (“test indicator +/- “ output) indications within five seconds of a successful test.
- **Erase Source:** The erase source provides a continuous signal which is used to drive the "Push to Erase" discrete into an active state.
- **Push to Erase:** The push to erase discrete input is used to initiate a crash survivable memory erasure of the recorded **audio** channel information. In order to prevent unintentional erasure, the erase discrete must be active for at least one-half second in order to activate the erase mode. The SSDVDR will respond with an aural indication only. Recorded flight data and ancillary information contained in the protected memory are unaffected by this erasure command.
- **Status:** The CVR status discrete output is used to drive a status indicator in the microphone monitor after initiation of a test sequence.
- **Mic Monitor Power:** This SSDVDR output is used to provide conditioned (18 Vdc) power to the remotely mounted microphone monitor for the purpose of driving its preamplifier and microphone circuits.
- **Phone Jack Out:** This SSDVDR output provides a continuous composite audio signal that is a summation of the four audio input channels. The output has impedance compatible with a standard 600-ohm headset. The monitor output also produces an audible tone at the successful completion of a commanded self test or erase operation.

3.9.9. Flight Data Interface

The SSDVDR is designed to support data input rates for 64, 128 and 256 words per second to support current and future mandatory requirements for ARINC 573/717 flight data recorder (FDR) installations on air transport category of aircraft.

3.9.10. Digital Message Communication Interface

The SSDVDR digital data interface supports the future requirements for the recording of Digital Communication Messages via an ARINC-429 low speed input. The message will be recorded in solid-state memory within five (5) seconds of receipt at the signal input.

3.9.10.1 ARINC-429 Label Recognition Software

Due to current specifications development in the definition of mandatory Digital Communication Message recording, the CMU ARINC-429 Label Recognition data shall be modifiable on-board the aircraft. The

ARINC-429 message label data shall be uploadable to the SSDVDR firmware via the PCMCIA or download connector.

3.9.11. Maintenance Discrete

When functioning properly, the SSDVDR Maintenance outputs (CVR and FDR Maint) are driven to a “grounded” state. In the event of a failure, which persists for at least 500 milliseconds, the signal will move to an "open" state or fault condition. Most faults detected by the SSDVDR built-in test result in a "maintenance request" (fail) indication. Note that if unpowered, or not installed, a fault condition is automatically annunciated (i.e. “open” state).

3.9.11.1. CVR Maintenance Fault Output

The CVR Maintenance Fault function provides an output from the SSDVDR to an optional cockpit indicator. This output is normally short circuited (using a relay) to chassis ground (500 mA max, 1 VDC max). If any CVR section(s) of the SSDVDR malfunction, if the SSDVDR is removed from the aircraft, or if the system power is off, this output will toggle to an "open" state (>100,000 ohms).

3.9.11.2. FDR Maintenance Fault Output

The FDR Maintenance Fault function provides an output from the SSDVDR to an optional cockpit indicator. This output is normally short circuited (using a relay) to chassis ground (500 mA max, 1 VDC max), but if any FDR section(s) of the SSDVDR malfunction, this output will toggle to an "open" state (>100,000 ohms).

3.9.11.3. FDR Status Output

The FDR Status function provides an output from the SSDVDR to an optional cockpit indicator. When the SSDVDR is functioning properly, the FDR Status output is in an "open" state (>100,000 ohms). If an internal FDR related error occurs, the output will toggle to chassis ground (500 mA max, 1 VDC max). The Fault Status will result from any any maintenance fault or No FDR Data or No Power applied to the unit.

3.9.12. Built In Test (BIT)

The SSDVDR implements extensive BIT for detection of errors within the unit using three methods:

(1) power on initialization,
(2) commanded self-test, and
(3) background continuous test.

A history of the BIT status is maintained in crash-protected solid state memory for product trend analysis and warranty support. In addition, the SSDVDR provides an FDR Maintenance Discrete output, a CVR Maintenance Discrete output, and front panel indicator to indicate BIT failures.

Power on initialization verifies operation of the SSDVDR insofar as it is practicable given the specified 250 millisecond power on to recording delay. Functions tested include:

(1) the main processor,
(2) RAM memory check,
(3) program checksum verification,
(4) testing of the CSMU interface, and
(5) partial testing of the audio interface.

Commanded self-test is invoked by grounding the Push To Test discrete input and is a much more rigorous and complete test. Commanded self-test indication is provided through the Status Discrete output and the Audio Monitor output.

The background continuous monitor test utilizes spare processor time to continuously monitor the integrity of the SSDVDR.

The Ground Support Equipment records all BIT failures in solid-state memory for extraction.

3.10 SSDVDR STATES

The interaction between the described states is shown in Figure 7.

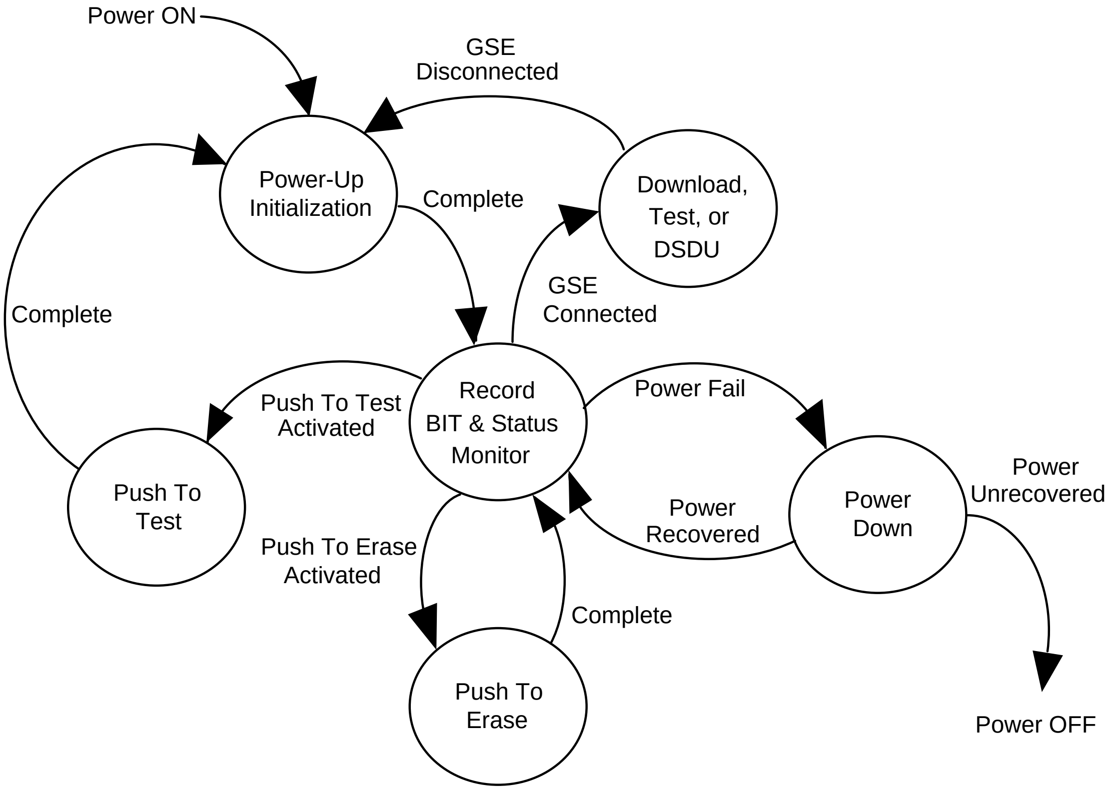


Figure 7 -- SSDVDR Functional Diagram

3.10.1. Power Up Initialization

The Power Up Initialization function initializes the SSDVDR and performs power on Built-In-Test (BIT) to determine the integrity of the system. If a failure is detected, the failure condition is stored in crash-protected memory, the front panel BITE indicator is continuously activated and the appropriate Maintenance Discrete (FDR or CVR) is set to the failure mode.

3.10.2. Record, BIT, and Status Monitor

The Record, BIT, and Status Monitor function provides the primary functionality of the SSDVDR. It stores audio, digital communication, timing, rotor speed, and flight data to the crash survivable memory. This function also stores ancillary data such as configuration information, memory start/stop pointers, BIT data, Elapsed Time Indicator (ETI), error logging data, and repair history. In addition to the recording process in this function, background BIT tests are also performed to verify correct operation of the unit. If a failure is detected, the front panel BITE indicator is continuously activated and the CVR and/or FDR Maintenance Fault discrete output is set to the failure state (open circuit).

3.10.3. Push To Test

The Push To Test function is activated using an optional discrete input to the SSDVDR (typically activated using a push button switch). Once activated, this function halts recording and performs an extensive set of functional tests to determine the integrity of the system. An aural indication is also provided through the audio monitor output received at the optional Status Panel: a two-second 800 Hz tone is sent to indicate successful self-test.

If a failure condition exists the aural tone is not provided and the CVR and/or FDR Maintenance Fault output is activated. Also, if a failure occurs, the failure condition is stored in crash-protected memory and the front panel BITE indicator is continuously activated. Recording resumes upon completion of the test unless a “serious” error is detected which indicates recorded data integrity is in jeopardy.

3.10.4. Push To Erase

The Push To Erase function is activated using an optional discrete input to the SSDVDR (typically activated using a push button switch interlocked with the parking brake and landing gear relays). Once activated, this function halts recording and prevents previously recorded CVR data in the crash survivable memory from being recovered. This function does not erase ancillary system data such as fault history or ETI, nor does it erase flight (FDR) data. In order to provide an indication that the erase function was successful, a three-second 400 Hz aural tone is sent through the audio monitor output.

3.10.5. Power Down

When a power failure occurs, the SSDVDR enters the Power Down function. It is important to note that recording continues while in the power down function. If the power failure condition exists for more than 200 milliseconds, "housekeeping" tasks are performed to provide a graceful power down sequence (pointers saved, buffered data stored to crash survivable memory, etc.). If the power is recovered after 200 milliseconds but before a hardware reset is issued, the record function is re-activated. If power does not recover, recording will cease until power is again applied.

3.10.6. Download, Test, or DSDU

The Download, Test, or Data Signal Display Unit (DSDU) function provides an interface for the Ground Support Equipment (GSE). The SSDVDR GSE consists primarily of Acceptance Test Equipment (ATE) and Ground Based Equipment (GBE).

ATE is used primarily for interfacing with the main aircraft connector for test and download/playback of both CVR and FDR functions in the SSDVDR, this is accomplished using the **Honeywell** Playback and Test Station (PATS). To enable the Download and test functions, the SSDVDR should be removed from the aircraft. The Download function is activated when the ATE Present discrete from the main aircraft connector is grounded.

GBE is used primarily for interfacing with the download connector *for Flight Data only*. FDR data may be downloaded while still installed in the aircraft via the download connector interface using the Hand-Held DownLoad Unit (HHDLU) or other suitable FDR download equipment. The HHDLU also provides a DSDU function where FDR data may be displayed concurrently as it is being recorded. The FDR Download (and DSDU) function is activated when the GBE Present discrete from the 28-pin download connector is grounded. This interface also provides power to the HHDLU.

3.11. Performance Summary

The SSDVDR is designed to meet or exceed the minimum performance, environmental, and crash survival requirements as specified in EUROCAE ED-55 and ED-56 revision A. These requirements are summarized in Table 6.

Physical	
Dimensions (Envelope - L x W x H)	12.52” L x 4.88” W x 6.40” H (1/2-ATR-Short)
Weight	15.0 pounds max. (including ULB)
Cooling	Natural Convection/Radiation
Mounting	Tray, no shock-mounting required
Power	115VAC or 28 VDC - 10 watts maximum, 8 watts typical
Main Connector	DPXB-57-34P-0001 (mates with DPXB-57-33S-0001)
Download Connector	Amp 749649-3 (mates with 749621-3)
Environmental Test Condition	**DO-160C Category / Limit**
Temperature: Operating Short-Term Operating Non-Operating	-55°C to +70°C, Category D2 +70°C, Category D2 -55°C to +85°C, Category D2
Altitude	+50,000 Feet MSL, Category D2
Humidity	Severe Environment, Category B
Vibration: Aircraft Helicopter	Curves B, C, L, and M Curves N and V
Shock	Operational: 6g Peak, 11 msec. duration Crash Safety: 15g Peak, 11 msec. duration
Explosion Proofness	Category E1
Waterproofness	Category X
Fluids Susceptibility	Category X, (Meets ED-56a Requirements)
Sand and Dust	Category X
Fungus Resistance	Category F
Salt Spray	Category X
Magnetic Effect	Category A
Power Input	Category A
Voltage Spike	Category A
Audio Frequency-Conducted	Category A
Induced Signal Susceptibility	Category Z
RF Susceptibility	Category V
Emission of RF Energy	Category Z
Lightning Induced Transients	Category A2C2
Lightning Direct Effects	Category X
Icing	Category X
Crash Survivability Testing per ED-55/56 Revision A, TSO-C123a / C124a	
Impact Shock	3400 g’s, 6.5 msec. duration (half-sine)
Penetration Resistance	500 lbs. drop from 10 feet
Static Crush	5000 lbs., 5 minute duration
High Temperature Fire	1100°C, 50,000 BTU’s, 60 Minutes
Low Temperature Fire	260°C, 10 Hours
Deep Sea Pressure	20,000 Feet, 30 Days
Salt Water Immersion	10 Feet, 30 Days
Fluid Susceptibility / Immersion	Per ED-55/56a
Performance Characteristics	
Recording Duration	Cockpit Voice - 120 Minutes (3 or 4 Channels) Flight Data - 10 or 25 Hours (64 or 128 or 256 wps) Digital Messages – 2 Hours (ARINC-429, low speed)
Audio Input Channel Impedance	> 10K Ohms
Audio Output (Monitor) Impedance	< 600 Ohms
Channel Frequency Spectrum	3 Narrow Band (150-3500 Hz) 1 Cockpit Area Microphone (150 - 6000 Hz)
Audio Quality	Per ED-56a:- (S/N+D) - 24.0 dB minimum (full bandwidth) Speech Transmission Index (STI) - 0.75 min (voice) 0.85 min (area)

Table 6 -- SSDVDR Performance Summary

3.12 CSMU Memory Error Management

Memory chip failure during recording is tolerated (failed locations or blocks are identified and mapped out). Should the remaining capacity fall below minimum record time thresholds (120 minutes voice, 25 hours flight data and 120 minutes of digital communication messages) and the appropriate maintenance and status flags will be asserted. The SSDVDR will continue to record under these conditions.
Entering the erase/write process through a specific erase command sequence minimizes inadvertent erasure or corruption of memory. Additionally, each memory device has an embedded label written into its memory. The label is checked against memory pointers to detect memory addressing errors (address line failures), thereby preventing undetected erasure or overwrite into other areas of memory. This feature also prevents transparent shortened record times caused by addressing errors which result in erase/write overlap into a smaller memory range.
Should a memory device become dislodged during a particularly severe fire, its recorded label enables its location in the memory array to be identified and the original recording sequence reproduced.

3.13 GBE Interface

The SSDVDR provides a dedicated connector on the front of the SSDVDR chassis for connection of the GBE. This enables connection to be easily accomplished for CSMU memory download. These GBE signals are available at the rear aircraft interface connector (see Table 1), for use in installations where access is difficult and a remote readout connector may be more appropriate. The primary feature of the GBE interface is a high speed EIA RS-422 channel that includes full handshake functionality.

3.13.1. Download Connector

The SSDVDR download connector is a 28 pin Amp connector (part number 749649-3) or equivalent mounted on the front panel of the unit (the mating connector is 749621-3 or equivalent). The connector has the following pin assignments.

Pin	Description	Pin	Description
1	115 VAC Power (output) Hot	15	HSDL ARINC-249 Rx (A)
2	Not connected	16	HSDL ARINC-249 Rx (B)
3	115 VAC Power (output) Cold	17	Not connected
4	Chassis Ground	18	Not connected
5	FDR Monitor Output (ARINC-717) - A	19	GBE +28 VDC Power (output)
6	FDR Monitor Output (ARINC-717) - B	20	GBE +28 VDC Power (output)
7	PDL Present (Gnd = PDL connected)	21	GBE +28 VDC Power (output) Return
8	GBE Present (Gnd=GBE Connected)	22	Status Discrete Output (Gnd = Fail)
9	GBE Reserved, RS-422 TXD (+)	23	Maintenance Discrete Output (Open = Fail)
10	GBE Reserved, RS-422 TXD (-)	24	GBE Reserved, RS-422 RTS (+)
11	GBE Reserved, RS-422 RXD (+)	25	GBE Reserved, RS-422 RTS (-)
12	GBE Reserved, RS-422 RXD (-)	26	GBE Reserved, RS-422 CTS (+)
13	HSDL ARINC-249 Tx (A)	27	GBE Reserved, RS-422 CTS (-)
14	HSDL ARINC-249 Tx (B)	28	GBE +28 VDC Power (output) Return

Table 7 -- Download Connector Pin Assignments

NOTES:

1) Except in DSDU Flight Data monitoring mode, recording stops when the GBE Present Input (Pin 8) is connected to Ground.

4. PCMCIA Interface for Flight Data Download

To allow rapid flight data download with minimal operator interface, an integral PCMCIA Interface will allow a rapid data transfer of the complete flight data memory contents to an extractable ATA Type PCMCIA card. This will allow the complete 25 hours of flight data contents of a 256wps SSDVDR (36 Mbytes) to be transferred in approximately 150 seconds (2.5 minutes), or alternately the most recent flight data as a selected time segment (e.g. the last 4 hours) may be downloaded in a shorter period.

The cartridge slot will accept commercially available memory cartridges and AT Attachment (ATA) cartridges for data transfer applications. Standard Type I and II cartridges as well as Type I and II Extended Cartridges may be used.

Cartridge access is provided with a simple door cover that prevents debris from inadvertently entering the cartridge slot. The cartridge insertion and removal is assisted by an ejection mechanism, which provides a simple push-to-lock/push-to-release fingertip actuation. When in the released state the cartridge is ejected to a sufficient distance to enable grasp by the operator.

4.1. Front Panel Interface

The front panel of the SSDVDR provides the PCMCIA Card slot and transfer indicators, the download connector, and a BITE indicator for status monitoring.

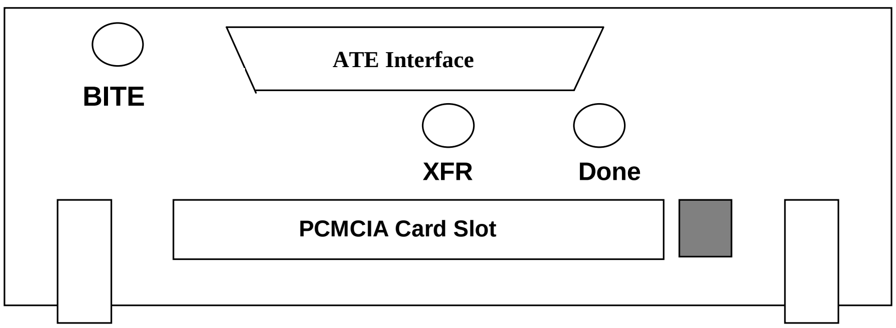


Figure 8 -- SSDVDR Front Panel

The ultimate design goal of the SSDVDR recorder is to integrate the PCMCIA port and the download connector into a single port, such that current Ground Based Equipment may access the SSDVDR data via the PCMCIA port utilizing a PCMCIA card connection.

4.1.1 BITE Indicator

The BITE indicator provides an indication of the health of the SSDVDR. If the SSDVDR detects a fault, which requires removal of the unit from the aircraft installation, the BITE indicator will be activated. The BITE indicator remains inactive in all other cases.

4.1.2 Ground Based Equipment (GBE) Interface

The front panel of the SSDVDR also contains a Download connector for interface to the FDR memory while the unit is installed on the aircraft. The GBE interface consists of an RS-422 serial channel that can provide FDR (only) download and monitor functions using the **Honeywell** Hand-Held Download Unit (HHDLU). Refer to paragraph 3.5.11 for connector pin assignments.

4.1.2.1. GBE Present Input

The SSDVDR also provides a discrete input to accommodate in-aircraft downloading of recorded flight data or monitoring of flight data being recorded. If the GBE Present discrete signal at the download connector is open circuited, normal recording operations will be performed. If the GBE Present discrete signal input is grounded, indicating GBE (e.g. the HHDLU) is present, recording will stop until a GBE command via the RS-422 channel places the unit into FDR download, monitor (DSDU), or test mode. In

monitor mode, recording will continue while recorded flight data is also output to the HHDLU via the RS-422 channel.

If both the ATE Present (main aircraft interface connector) and GBE Present discretes are active (grounded), the GBE Present discrete takes precedence.

4.2 PCMCIA Data Protection

To prevent unauthorized access to the SSDVDR Recorder data, the download process will be password protected to provide the downloaded data to a pre-formatted PC Card only.
The SSDVDR shall commence the download function only when a correct password on the inserted PCMCIA Card has been verified. The contents of the SSDVDR memory will remain unaltered by the Password function.

The Password may be changed using a software routine that shall be contained within the Ground Based Support Equipment. Security access to this software will also be controlled by a password.
The Password may be uploaded to the SSDVDR via the Ground Based Equipment interface as frequently as required to maintain a sufficient level of data security.

4.3 PCMCIA Interface Operation

The operation to perform flight data downloads via the ATA Type PCMCIA card is as follows:

1) With the recorder powered “ON”, the PCMCIA card is inserted into the PCMCIA slot, which is accessed from the front panel via a protective cover (see Figure 8).

2) The PCMCIA card is verified to contain sufficient available memory to perform the transfer of the entire flight data contents of the SSDVDR. If not enough physical memory exists on the card (i.e. capacity is less than the SSDVDR memory content or the card cannot be accessed, a failure indication will be noted (simultaneous flashing of both the XFR (Transfer in Progress) and CMP (Transfer Complete) LED’s).

3) If sufficient free memory space is available, a new file is automatically created.

4) Once the flight data transfer from the crash survivable memory to the PCMCIA card begins, the XFR (Transfer in Progress) LED will illuminate and all recording operations (both cockpit voice and flight data) will be suspended. The XFR LED will remain illuminated until all of the flight data has been transferred to the PCMCIA card. If the XFR LED does not illuminate, then either the recorder does not recognize that the PCMCIA card has been inserted, or power has not been applied to the recorder, etc.

5) Once the transfer process is completed, the XFR LED will extinguish and the DONE (Transfer Complete) LED will illuminate for a maximum time of 30 seconds, or until the PCMCIA card is ejected. The PCMCIA card is ejected by depressing the EJECT button located immediately to the right of the PCMCIA slot (see figure 8).

As indicated, the XFR LED must illuminate to indicate that the PCMCIA card has been correctly installed and that the flight data transfer is in progress. The simultaneous flashing of BOTH the XFR and DONE LED’s will indicate a fault. Once a fault occurs, both LED’s will flash until the PCMCIA card has been removed.

5. GROUND SUPPORT EQUIPMENT

The SSDVDR's ATE interface consists of an RS-422 serial channel that can provide download, playback, and test functions using the **Honeywell** Playback and Test Station (PATS). This interface is activated when the ATE Present discrete input (main aircraft interface connector) is grounded.

The SSDVDR provides a discrete input to control the recording operation of the unit. If the ATE Present discrete signal at the main aircraft connector is open circuited, normal recording operations will be performed. If the ATE Present discrete signal input is grounded, indicating ATE is present, recording will cease immediately and the SSDVDR will enter the "Analyze" mode of operation where the RS-422 channel may be used to download and test the unit using the PATS.

5.1. Playback and Test Station (PATS)

The **Honeywell** PATS, part number 960-0308, is a PC based system which performs download of SSDVDR solid state memory, playback of stored digital, timing, audio, and rotor speed data in a visual and audio format, and functional acceptance testing of the SSDVDR. The PATS has been segmented into "Playback" and a "Test" software applications since the Test function overwrites any existing data recorded in the crash protected solid state memory of the SSDVDR. This provides a level of protection against unintentional erasure or re-write of the crash-protected memory. The software applications are Microsoft Windows compatible providing a simple user interface for the operator.

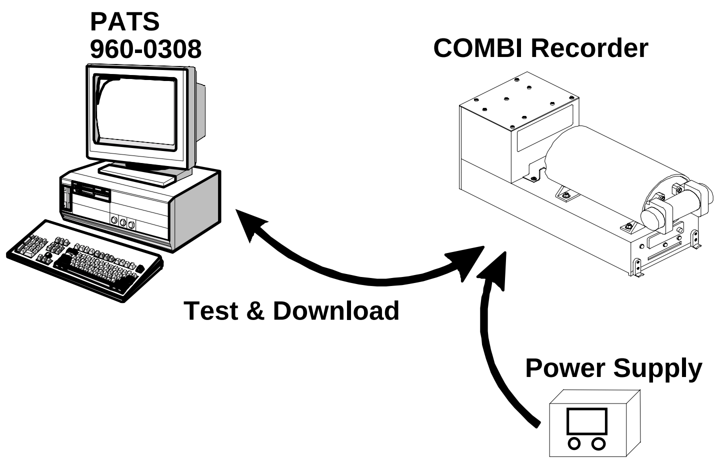


Figure 9 -- PATS to SSDVDR Interface

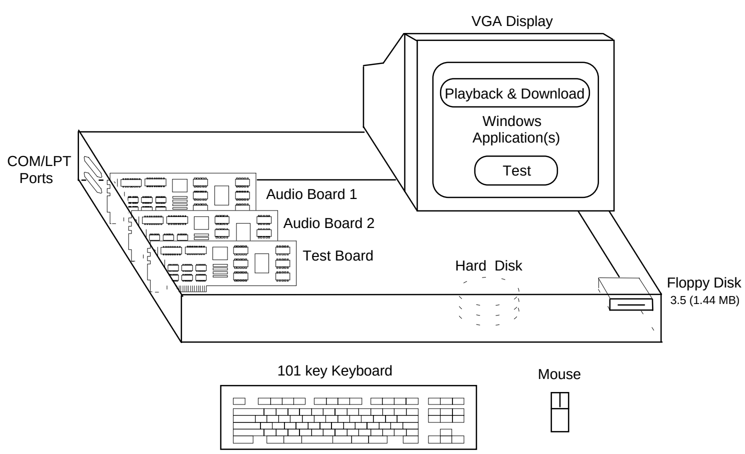


Figure 10 -- Playback and Test Station Elements

5.2. Hand Held DownLoad Unit (HHDLU)

The Honeywell Hand-Held Download Unit is a small, highly portable unit intended to provide high-speed data transfer to an internal cartridge-memory drive (a PCMCIA card).
The HHDLU, shown in Figure 11, is built around a miniaturized personal computer chip set and disk operating system (DOS). A plug in PCMCIA memory cartridge is used as a convenient means for data storage and distribution. The HHDLU *applications* include:

- **Download -** Copies an FDR's solid state memory contents onto the HHDLU's cartridge memory.
- **DSDU -** Displays operator selected FDR input parameters to assist installation conformance tests.

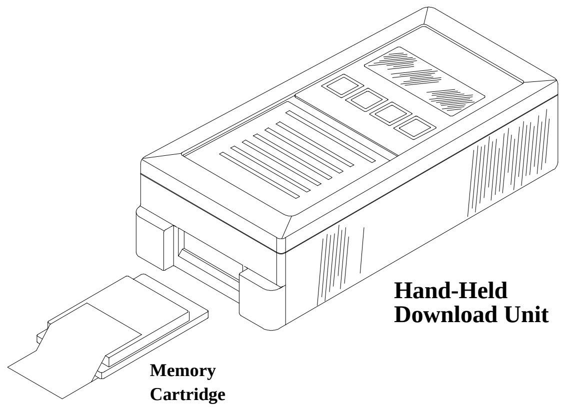


Figure 11 -- Hand-Held Download Unit

Figure 12 shows the typical HHDLU operating environment when performing DOWNLOAD and DSDU operations. The HHDLU is connected to the download connector of the SSDVDR, allowing the unit to remain installed in the aircraft and connected to aircraft data sources via the main aircraft connector. In DOWNLOAD mode, the SSDVDR's flight data is copied from its crash survivable memory module, onto the cartridge memory installed in the HHDLU. Once the DOWNLOAD is complete, the cartridge may be removed from the HHDLU and installed into a ground-based personal computer for further processing and data distribution.

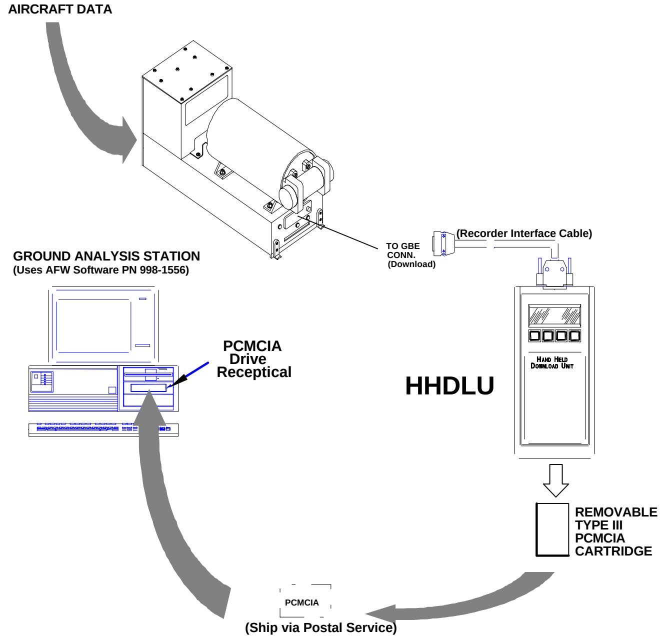


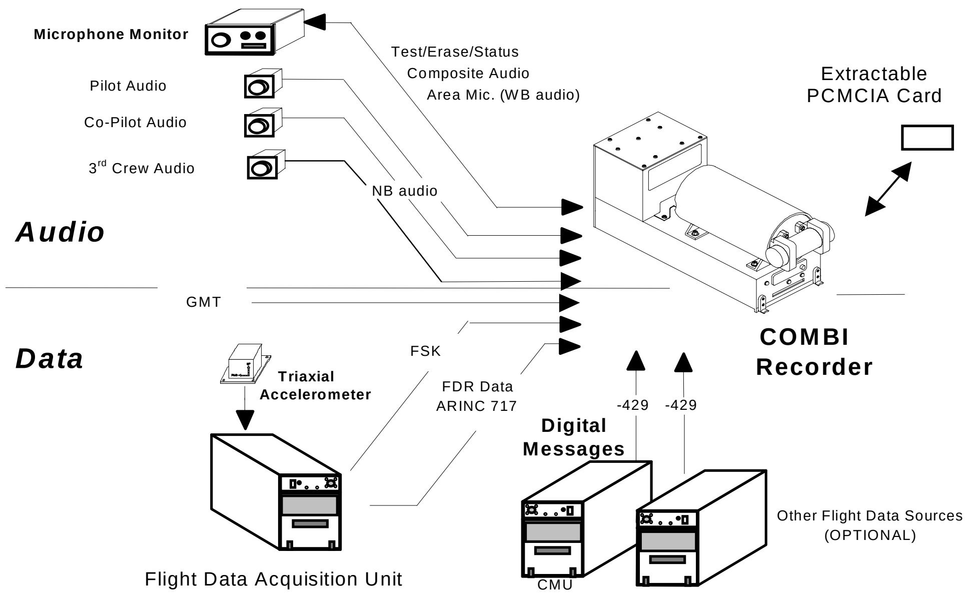
Figure 12 -- HHDLU's FDR Applications Environment

A.0 Appendix A Acronyms and Abbreviations

AC	Alternating Current
ARINC	Aeronautical Radio, Inc.
ATE	Acceptance Test Equipment
ATM	Air Traffic Management
BITE	Built In Test Equipment
CMU	Communications Management Unit
CNS	Communications, Navigation, Surveillance
CVR	Cockpit Voice Recorder
CSMU	Crash Survivable Memory Unit
DC	Direct Current
DSDU	Digital Signal Display Unit
ED	EUROCAE Document
EIA	Electronic Industry Association
EMI	ElectroMagnetic Interference
EMS	ElectroMagnetic Susceptibility
ETI	Elapsed Time Indicator
EUROCAE	European Organization for Civil Aviation Electronics
FDAU	Flight Data Acquisition Unit
FDAMS	Flight Data Acquisition Management System
FDR	Flight Data Recorder
GMT	Greenwich Mean Time
GBE	Ground Based Equipment
GSE	Ground Support Equipment
HHDLU	Hand-Held DownLoad Unit
Hz	Hertz
ICB	Interface Control Board
ICD	Interface Control Document
IPS	Independent Power Supply
MOPR	Minimum Operation Performance Requirements
MTBF	Mean Time Between Failure
MTTR	Mean Time To Repair
OMS	Onboard Maintenance System
PATS	Playback and Test Station
PCMCIA	Personal Computer Memory Card Industry Association
RTCA	Radio Technical Commission for Avionics
SRD	System Requirements Document
SRU	Shop Replaceable Unit
SSCVR	Solid State Cockpit Voice Recorder
SSFDR	Solid State Flight Data Recorder
SSS	System/Segment Specification
STI	Speech Transmission Index
TBD	To Be Determined
TSO	Technical Standard Order
ULB	Underwater Locator Beacon

B.0 Appendix B Independent Power Supply

Anticipated future regulations will require the continued operation of the Crash Recorder for 10 minutes following removal of the primary input power to the recorder.
In order to maintain minimal impact to the recorder design and provide maximum interchangeability on the aircraft, power may be applied to the SSDVDR through the use of an external Line Replaceable Unit such as an Independent Power Supply (IPS).
The 10 minute operation will overwrite the oldest data in the audio portion of the SSDVDR memory. If no ARINC-717 data is present the SSDVDR will not record data in the flight data portion of the memory.



DVDR Recorder Main Aircraft Interfaces

Flight Data Recording
The Flight Data System consists of distributed sensors and requires the individual components to remain powered and functional to provide meaningful flight data information.

For an uninterruptable/independent power scheme to be effective for the data recording system, it would be necessary to supply a very large array of sensors and other aircraft avionics. In addition, the elements of the flight recording system are interconnected with an extensive, complex network of aircraft wiring. For the system to continue useful operation during a hazardous situation the integrity of the interconnection network would have to be maintained. It is unlikely that the system wiring integrity can be maintained during a serious threat to the aircraft. Therefore, it is not practical to attempt to design a flight data recorder system that is capable of continued operation during an extensive aircraft failure.

Digital Message Communication
The Digital Communication Messages system consists of a distributed Communication Radios and Aircraft Routers (such as CMUs), cockpit displays and the recorder. For components of the system, other than the recorder, a design complication similar to that discussed in relation to the flight data recorder exists. Namely, the involvement of other aircraft systems whose function is not specifically related to the flight recorder adds sufficient complexity to prevent the likelihood of successful continued operation. Therefore, it is not practical to attempt to design a recording system for digital communication messages, capable of continued operation during an extensive aircraft failure.

Audio recording
Compared to the flight data system, the Cockpit Voice Recorder (CVR) system is contained and concentrated. The system is comprised of a Cockpit Voice Recorder, a subsystem for the Cockpit Area Microphone (CAM), and the interconnections to the aircraft audio system for pilot, co-pilot, and public address/flight engineer audio signals. The CAM subsystem receives power directly from the CVR. Therefore, for the CVR and the CAM an independent power source would provide a high probability of achieving the goal of continued operation during an extensive aircraft failure. In addition, if the CVR or SSDVDR were to be located in the forward section of the aircraft, particularly close to the cockpit, the length of wire necessary to connect the CAM subsystem to the recorder could be minimized. This would provide additional assurance that the system would continue uninterrupted operation during hazardous situations. For the other components of the system, namely the aircraft audio controller, a design complication similar to that discussed in relation to the flight data recorder exists. Namely, the involvement of other aircraft systems whose function is not specifically related to the flight recorder adds sufficient complexity to prevent the likelihood of successful continued operation. Consequently it is not practical to attempt to continue to record audio signals other than those from the CAM.

To date, there have been two design approaches suggested for the provision of an independent power source capable of supplying sufficient electrical energy to enable the CVR or SSDVDR to continue operation for 10 minutes following the loss of main aircraft power.

The first of these is a large capacitor to store charge during normal operation, and then discharge through the CVR or SSDVDR when main power is removed.

The second is a separate battery to supply the CVR or SSDVDR following removal of the main power, and to be recharged during normal operation. The remainder of this section will deal with proposed system requirements, design considerations for each type of system, and a comparative analysis.

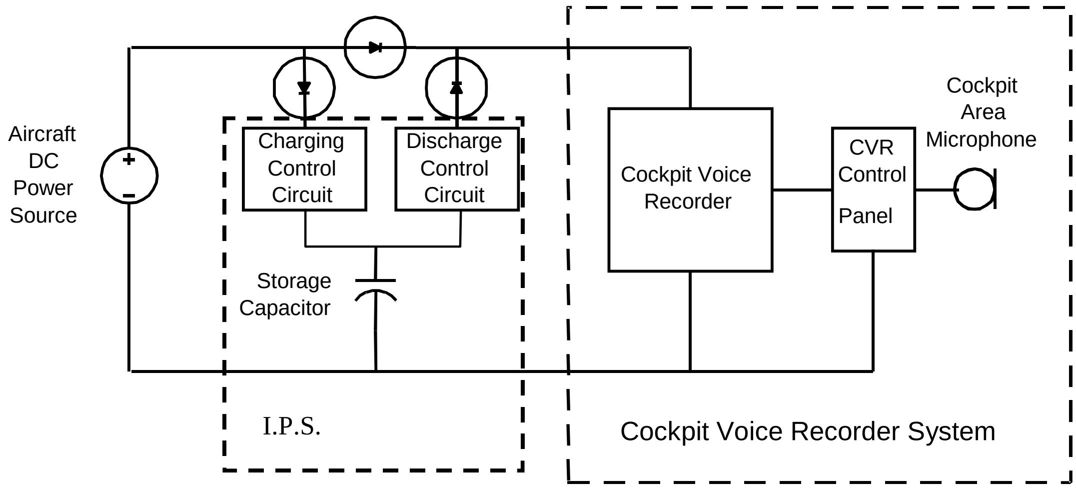
B.1 Requirements

Proposed requirements of an independent power source for the CVR or SSDVDR are shown in the following table. Since emphasis on the subject of independent power source is relatively recent, this list is preliminary and will likely experience extensive revision. For some entries, suggested tolerance ranges are indicated.

Requirement	Specification
Duration of continued operation	10 minutes ($10 \leq t \leq 12$ minutes)
Voltage	Greater than the minimum operating voltage for the SSCVR/SSDVDR for the duration.
Charging time	< 30 minutes {The system must be capable of providing the required function from the actual departure from the originating terminal gate until the safe arrival at the destination terminal gate.}
Isolation from aircraft systems	During charging, must not interfere with the continued proper operation of other LRU supplied from the same buss; during discharge, must supply only the SSCVR/SSDVDR.
Maintenance	Minimal
Interconnection	The installation must minimize the risk of interconnection failure during hazards to the aircraft.
Prevention of accidental erasure	The system should be installed to prevent continued recording should the SSCVR/SSDVDR become separated from the aircraft.

B.2 Capacitive System

A capacitive system is illustrated below. Simple computations show that to maintain sufficient voltage for uninterrupted operation of a CVR/DVDR consuming 10 Watts would require 26 to 30 Farads of capacitance.



Independent Power Source Using a Storage Capacitor

B.3 Hardware Implementation

The IPS is self-contained in a small (approx. 2.0"H x 5.0"W x 7.5"L) unit containing flange mounting holes and a connector. The connector is used for inputting aircraft 28 VDC power to charge the capacitors, and provide a Fault output and IPS (28VDC) Power output to the recorder.

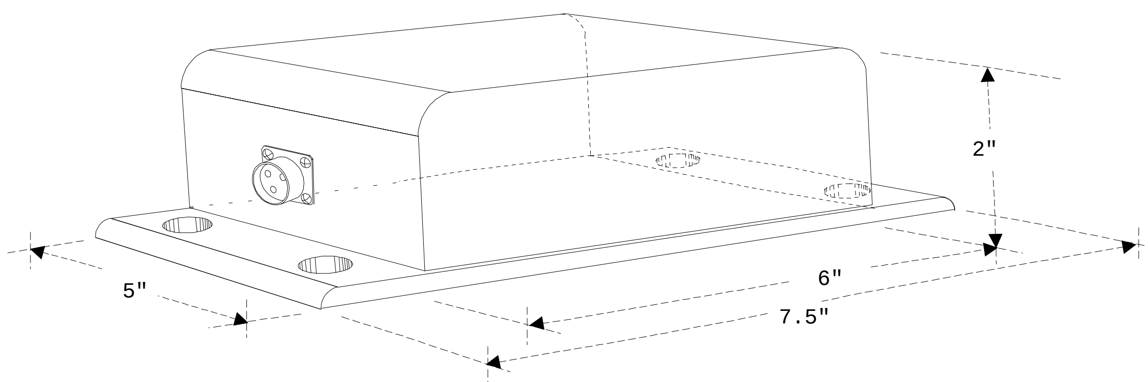


Figure B-1 – IPS Outline

B.3.1. IPS Connector

The IPS connector is a 10 pin Amp connector (part number PT00A12-10S) or equivalent mounted on the front panel of the unit. The connector has the following pin assignments.

Pin	Description	Pin	Description
1	Not connected	6	IPS Power Output (Cold)
2	28VDC Power Input	7	IPS Fault ("Open"=OK, "Gnd"=Fault)
3	28 VDC Power Common	8	Not connected
4	Chassis Ground	9	Charging Status Output
5	IPS Power Output (Hot)	10	Not connected

IPS Connector Pin Assignment

B.3.2. IPS Fault Output

The IPS will provide a fault output discrete to an optional cockpit indicator to identify the correct operation of the IPS. When the IPS is functioning properly, the IPS Status output is in an "open" state (>100,000 ohms). If an internal IPS related error occurs, the output will toggle to chassis ground (500 mA max, 1 VDC max).

B.3.3. IPS Charging Status

The IPS will provide a status output discrete to an optional cockpit indicator to identify the status of the charging capability of the IPS.

C.0 Mechanical FDR Tray Adapter

The SSDVDR is designed such that it may function independently as a Flight Data Recorder (FDR). However on aircraft equipped with a standard FDR ½-ART-Long mounting tray the SSDVDR will require the use of an adapter to fit into the existing tray mount.
Such an adapter would need to provide a mechanical anchor at the rear of the tray for the SSDVDR to mate with. The adapter would require positive fastening to the existing tray.
A suggested design of such an adapter is depicted in Figure C-1 and a suggested wiring of Figure C-2.

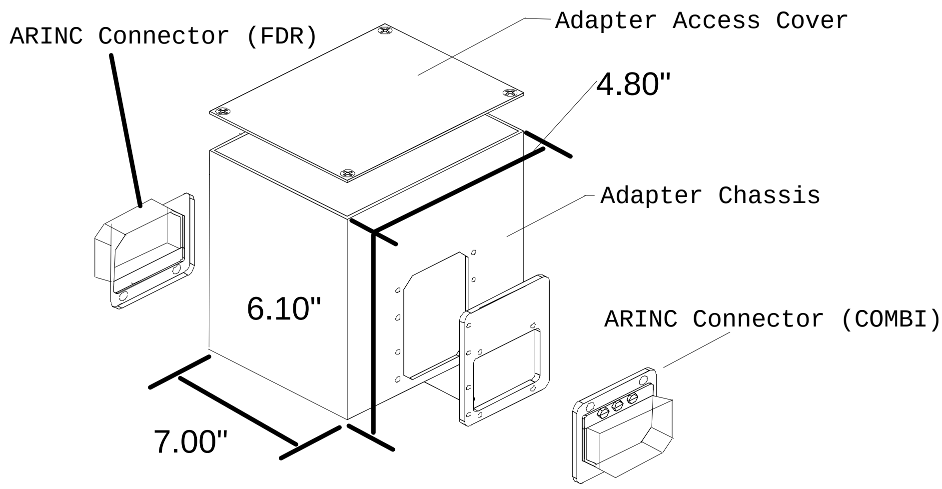


Figure C-1 - Adapter - FDR to SSDVDR

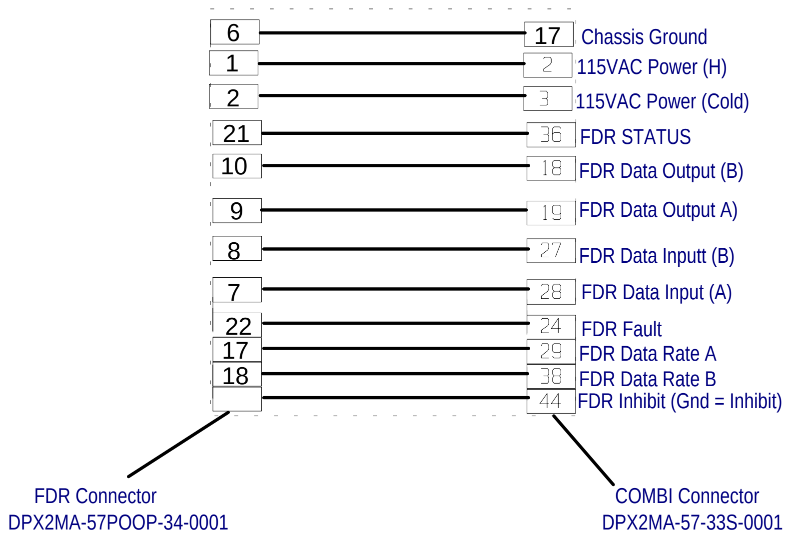


Figure C-2 – Adapter Interconnection