

Installation Manual

P-2000 and C-2000/RT-2000

Transceiver Systems



P-2000

Part Number: 400-049200-11-xxx-xxxx-xxxx

Hardware Mod: 1

C-2000

Part Number 400-049300-11-xxx-xxxx-xxxx

Hardware Mod: 1

RT-2000

Part Number 400-049400-11-xxx-xxxx-xxxx

Hardware Mod: 1

RF Exposure Information

This radio is restricted to occupational/controlled applications where users have been made aware of the potential for exposure and can exercise control over their exposure.

Antennas used for the radio must not exceed the antenna gain shown below for each transmit frequency range. The antenna must be installed at least or exceeding the minimum distance away from any person(s) depending on the transmit frequency.

Frequency	Max Antenna Gain	Min Distance
136 – 174 MHz	0 dBi	21 cm (8.3 in)
403 - 470 MHz	3 dBi	25 cm (9.9 in)
450 – 520 MHz	3 dBi	25 cm (9.9 in)
806 – 870 MHz	3 dBi	21 cm (8.3 in)

Transmit no more than 50 % of the time. Measurable RF energy exposure occurs only when transmitting.

Failure to observe these restrictions will result in exceeding the FCC RF exposure limits.



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SECTION 1 – GENERAL INFORMATION

1. Introduction

This section contains information relative to the physical, mechanical, and electrical characteristics of the Wulfsberg Electronics “2000” Family of Communications Systems.

2. Applicability

This manual applies only to the P-2000 panel mount transceiver, C-2000 control unit, and RT-2000 remote mount transceiver.

3. Equipment Description

The Wulfsberg “2000” family FM Communications System is a dual transceiver FM voice communications link between the aircraft and ground facilities. The system has not been designed by the manufacturer to be installed on Type Certificated aircraft. Installations on these type of aircraft are subject to applicable FAA regulations.

The “2000” family consists of the P-2000 panel mount transceiver and C-2000/RT-2000 control and remote mount transceiver.

A. P-2000 Panel Mount FM Communications Transceiver

The Wulfsberg P-2000 is a FM Tactical transceiver that incorporates one or two transceiver modules and control functions into a single panel mount unit. Part number variations of the unit exist for any combination of the following frequency bands: 138-174 MHz, 403-470 MHz, 450-520 MHz, and 806-870 MHz. Each transceiver module with the exception of the 806-870 MHz band can transmit with 1 or 10 Watts transmit power. The 800 MHz unit produces 1 and 3 watts transmit power. The P-2000 can operate by itself or in conjunction with the C-2000 control display acting as a remote slave control. Input voltage is 28 volts DC and the keypad is backlit from either 28VDC, 5 VDC or 5 VRMS AC.

The P-2000 transceiver is designed to be mounted in the instrument panel that will fit a standard DZUS mounting. Two connectors, a DB-25 and DB-15 accept all harness wiring on the rear of the P-2000, while two TNC type RF connector provides the antenna connection through conventional coaxial cables. For models containing one transceiver, only one antenna port is provided.

The P-2000 consists of functional subassemblies interconnected via standard connectors and ribbon cables. The case of the P-2000 is designed to be disassembled easily to expose most subassemblies or circuit modules for service. All adjustments to audio levels can be made via software and do not require the disassembly of the box. Internal test points are exposed and available to the service technician without having to remove circuit module subassemblies or use extender cables or cards.

The P-2000 is designed to be drop-in replacement for the C-962A/S Control unit for the Wulfsberg RT-9600/7200 transceiver systems also known as the ARC-513 with the exception of the 28 Volt input power. Due to increased 28 power requirements of the P-2000, wire size



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on this input may need to be increased to 20 AWG. All other microphone inputs/headset outputs and backlighting are compatible.

B. C-2000 Control Display Unit

The Wulfsberg C-2000 is a control display unit that can be used as a slave control head with a P-2000 panel mount transceiver, or as a primary or slave control head for the RT-2000 remote transceiver. Versions of the C-2000 include black faceplate and options for either Standard or NVG compatible displays. Input voltage is 28 volts DC and the keypad is backlit from either 28 VDC, 5 VDC or 5 VRMS.

The C-2000 Control Display Unit is designed to be mounted in the instrument panel that will fit a standard DZUS mounting. Two connectors, a DB-25 and DB-15, accept all harness wiring on the rear of the P-2000.

Front panel controls establish and display the operating status of all RT-2000 or P-2000 functions when operating as a slave control unit.

C. RT-2000 Remote Mount FM Communications Transceiver

The Wulfsberg RT-2000 is a FM Tactical transceiver that incorporates one or two transceiver modules and control functions into a single panel mount unit. Part number variations of the unit exist for any combination of the following frequency bands: 138-174 MHz, 403-470 MHz, 450-520 MHz, and 806-870 MHz. Each transceiver module with the exception of the 806-870 MHz band can transmit with 1 or 10 Watts transmit power. The 800 MHz unit produces 1 and 3 watts transmit power. The RT-2000 is designed to be controlled by a C-2000 control display. Input voltage is 28 volts DC and the keypad is backlit from either 28VDC, 5 VDC or 5 VRMS AC.

The RT-2000 transceiver is designed to be mounted rack mounted. Two connectors, a DB-25 and DB-15 accept all harness wiring on the rear of the RT-2000, while two TNC type RF connector provides the antenna connection through conventional coaxial cables. For models containing one transceiver, only one antenna port is provided.

The RT-2000 consists of functional subassemblies interconnected via standard connectors and ribbon cables. The case of the RT-2000 is designed to be easily disassembled to expose most subassemblies or circuit modules for service. All adjustments to audio levels can be made via software and do not require the disassembly of the box. Internal test points are exposed and available to the service technician without having to remove circuit module subassemblies or use extender cables or cards.

The RT-2000 is designed to fit into a rack space equivalent with the Wulfsberg RT-9600 with exception of depth. The RT-2000 is only approximately 7 inches deep vs. the nearly 14 inch depth of the RT-9600.

Multiple C-2000's can be used for multi-point control of the RT-2000.

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4. Technical Characteristics
A. P-2000 Panel Mount Transceiver

CHARACTERISTICS	DESCRIPTION
Certification	
FAA	In Process (STC Helicopter and Fixed Wing Aircraft)
Software	DO-170B Level D
Environmental	DO-160D
FCC	FRW-2000-(VHF,UHF-1,UHF-2, 800)
Industry Canada	TBD
Emission Designator	
156 – 158 MHz	Part 80.379, 87.187(l), 16K0F3E
136 – 174 MHz	Part 90.210, 16K0F3E, 11K0F3E, 8K10F1E, 8K0F1D
403 – 520 MHz	Part 90.210, 16K0F3E, 11K0F3E
806 – 870 MHz	Part 90, 16K0F3E, 11K0F3E, 8K10F1E, 8K0F1D
Altitude	51,000 feet ASL (15,545 meters)
Temperature Range	
Operation	-30°C to 60°C (-22°F to +140°F)
Storage	-55°C to 85°C (-67°F to +185°F)
Cooling	Internal Electric Fan
Weight	
P-2000 (Single Transceiver)	3.10 lbs. Max.
P-2000 (Dual Transceiver)	3.70 lbs. Max.
Mounting	Dzus
Height	3.0 Inches max.
Width	5.75 inches max.
Depth	6.40 Inches max. (Not Including Connectors)
Input Power Requirements	
Normal Voltage Range	22.0 to 30.2 VDC
Abnormal Voltage Range	20.5 to 32.2 VDC
Emergency Operation	18.0 VDC
P-2000 (Single Transceiver)	
Receive	0.5 Amp Nominal. .75 Amp Max
Transmit	2.5 Amp Nominal. 3.0 Amp Max.
P-2000 (Dual Transceiver)	
Receive	0.5 Amp nominal. 1.0 Amp Max
Transmit	3.0 Amp nominal. 4.0 Amp Max.
P-2000 Panel Lighting	5 VDC, 5 Vrms and 28 VDC (Voltage Sense Only)
Faceplate Colors	Black or Grey
Channel Memory	240/255/510 Depending on options
Frequency Band P-2000/RT-2000	Any combination of one or two bands listed below
	136-174 MHz, 136-174 MHz (NTIA Compliant)
	403-470 MHz, 380-470 MHz
	450-520 MHz



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	806-870 MHz
Channel Spacing	12.5 kHz, 20 kHz, 25 kHz
Receiver Specifications	
Modes	FM, P-25, P-25 Trunking, Motorola 3600 Baud Trunking
Sensitivity	
Analog (12 dB SINAD)	Better than .4 uV (-115 dBm)
Digital (5% BER)	Better than .4 uV (-115 dBm)
Quieting	
Analog (20 dB SINAD)	.6 uV (-111.5 dBm)
Digital	Not Applicable
Selectivity	
Analog (12.5 kHz)	-65 dB (NTIA Version: -70 dB)
Analog (25.0 kHz)	-70 dB (NTIA Version: -80 dB)
Intermod Rejection	
Analog (12.5)	-70 dB
Analog (25.0)	-70 dB
Spurious Rejection	
Analog (12.5 kHz)	-65 dB (NTIA Version: -70 dB)
Analog (25.0 kHz)	-70 dB (NTIA Version: -85 dB)
Digital (5% BER)	-70 dB (NTIA Version: -85 dB)
Unwanted Emissions	
Narrow Band	-60 dBm
Wide Band	-60 dBm
Frequency Stability	± 1.5 PPM
Audio Output	
Headset Out	100 mW Maximum into 600 ohms
Normalized Out	1.75 VRMS into 10k Load
External Speaker Out	.9 VRMS into 10k Load
Audio Distortion	< 2% at Maximum Audio Output
Hum and Noise	
Unsquelled	<-40 dB
Squelled	<-50 dB
Transmitter Specifications	
Duty Cycle	25% at Full Power, Continuous at reduced power.
RF Power Output	10 Watt Hi, 1 Watt Lo (3/1 Watt 800 MHz Band Only)
Frequency Stability	± 1.5 PPM
Modulation Limiting:	
12.5 kHz Channels	±2.5 kHz
20.0 kHz Channels	±4.0 kHz
25.0 kHz Channels	±5.0 kHz
Unwanted Emissions	< -70 dBc (-70 dBc Harmonics, -85 dBc Spurious)
Hum and Noise	
Narrow Band	-42 dB
Wide Band	-48 dB
Audio Response	
Dual Microphone	.25 VMRS into 150 ohm Carbon or Carbon Equivalent
Transmit Distortion	< 2%. @ 1 kHz
Sidetone Fidelity	6 dB max variation, 350 Hz to 2500 Hz



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Sidetone Output	Adjustable 0 to -30 dB below rated output.
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B. C-2000 Control Display Unit

CHARACTERISTICS	DESCRIPTION
Certification	
FAA	In Process (PMA/STC Helicopter and Fixed Wing Aircraft)
Software	DO-170B Level D
Environmental	DO-160D [(B4/F1)X]BAB[S/U]EXXXXXZZAZZ[J/F]M[XXC3]XXA
FCC	Part 15
Industry Canada	Pending
Altitude	51,000 feet ASL (15,545 meters)
Temperature Range	
Operation	-30°C to 60°C (-22°F to +140°F)
Storage	-55°C to 85°C (-67°F to +185°F)
Cooling	Internal Electric Fan
Weight	2.00 lbs. Max.
Mounting	Dzus
Overall Dimensions	
Height	3.0 Inches max.
Width	5.75 inches max.
Depth	6.40 inches max. (without Connectors)
Input Power Requirements	
Normal Voltage Range	22.0 to 30.2 VDC
Abnormal Voltage Range	20.5 to 32.2 VDC
Emergency Operation	18.0 VDC
Input Current	0.5 Amp nominal. 1.0 Amp Max
Panel Lighting	5 VDC, 5 Vrms and 28 VDC (Voltage Sense Only)
Faceplate Colors	Black or Grey
Display Options	LCD Color or LCD Color with NVG compatibility
Channel Memory	240/255/510 Depending on options
Data Bus	CAN Serial with Wulfsberg Proprietary Protocol

C. RT-2000 Remote Mount Transceiver

CHARACTERISTICS	DESCRIPTION
Certification	
FAA	In Process (PMA/STC Helicopter and Fixed Wing Aircraft)
Software	DO-170B Level D
Environmental	DO-160D [(B4/F1)X]BAB[S/U]EXXXXXZZAZZ[J/F]M[XXC3]XXA
FCC	Pending FRW-2000-(VHF,UHF-1,UHF-2, 800)
Industry Canada	Pending
Emission Designator	
156 – 158 MHz	Part 80.379, 87.187(I), 16K0F3E
136 – 174 MHz	Part 90.210, 16K0F3E, 11K0F3E, 8K10F1E, 8K0F1D
403 – 520 MHz	Part 90.210, 16K0F3E, 11K0F3E
806 – 870 MHz	Part 90, 16K0F3E, 11K0F3E, 8K10F1E, 8K0F1D
Altitude	51,000 feet ASL (15,545 meters)

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Temperature Range	
Operation	-30°C to 60°C (-22°F to +140°F)
Storage	-55°C to 85°C (-67°F to +185°F)
Cooling	Free air circulation
Weight	
RT-2000 (Single Transceiver)	2.50 lbs. Max.
RT-2000 (Dual Transceiver)	3.50 lbs. Max.
Mounting	Mounting Tray
Overall Dimensions	
Height	3.0 inches max.
Width	5.75 inches max.
Length	7.49 inches max (without Connectors)
Input Power Requirements	
Normal Voltage Range	22.0 to 30.2 VDC
Abnormal Voltage Range	20.5 to 32.2 VDC
Emergency Operation	18.0 VDC
RT-2000 (Single Transceiver)	
Receive	0.5 Amp nominal. .75 Amp Max
Transmit	2.5 Amp nominal. 3.0 Amp Max.
RT-2000 (Dual Transceiver)	
Receive	0.5 Amp nominal. .75 Amp Max
Transmit	3.0 Amp nominal. 4.0 Amp Max.
Frequency Band P-2000/RT-2000	Any combination of one or bands listed below
	136-174 MHz, 136-174 MHz (NTIA Compliant)
	403-470 MHz, 380-470 MHz
	450-520 MHz
	806-870 MHz
Data Bus	CAN Serial with Wulfsberg Proprietary Protocol
Encryption Options	DES/DES-XL/DES-OFB/AES/DVP/DVI
OTAR Options	MDC1200 OTAR, P25 OTAR
Trunking Options	Smartzone, P25

Receiver Specifications	
Modes	FM, P-25, P-25 Trunking, Motorola 3600 Baud Trunking
Sensitivity	
Analog (12 dB SINAD)	Better than .4 uV (-115 dBm)
Digital (5% BER)	Better than .4 uV (-115 dBm)
Quieting	
Analog (20 dB SINAD)	.6 uV (-111.5 dBm)
Digital	Not Applicable
Selectivity	
Analog (12.5 kHz)	-65 dB (NTIA Version: -70 dB)
Analog (25.0 kHz)	-70 dB (NTIA Version: -80 dB)
Intermod Rejection	
Analog (12.5)	-70 dB
Analog (25.0)	-70 dB

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Spurious Rejection	
Analog (12.5 kHz)	-65 dB (NTIA Version: -70 dB)
Analog (25.0 kHz)	-70 dB (NTIA Version: -85 dB)
Digital (5% BER)	-70 dB (NTIA Version: -85 dB)
Unwanted Emissions	
Narrow Band	-60 dBm
Wide Band	-60 dBm
Frequency Stability	± 1.5 PPM
Audio Output	
Headset Out	100 mW Maximum into 600 ohms
Normalized Out	1.75 VRMS into 10k Load
External Speaker Out	.9 VRMS into 10k Load
Audio Distortion	< 2% at Maximum Audio Output
Hum and Noise	
Unsquelled	<-40 dB
Squelched	<-50 dB
Transmitter Specifications	
Duty Cycle	25% at Full Power, Continuous at reduced power.
RF Power Output	10 Watt Hi, 1 Watt Lo (3/1 Watt 800 MHz Band Only)
Frequency Stability	± 1.5 PPM
Modulation Limiting:	
12.5 kHz Channels	±2.5 kHz
20.0 kHz Channels	±4.0 kHz
25.0 kHz Channels	+5.0 kHz
Unwanted Emissions	< -70 dBc (-70 dBc Harmonics, -85 dBc Spurious)
Hum and Noise	
Narrow Band	-42 dB
Wide Band	-48 dB
Audio Response	
Dual Microphone	.25 VMRS into 150 ohm Carbon or Carbon Equivalent
Transmit Distortion	< 2%. @ 1 kHz
Sidetone Fidelity	6 dB max variation, 350 Hz to 2500 Hz
Sidetone Output	Adjustable 0 to -30 dB below rated output.



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5. Available Configuration Variations

A. P-2000 Part Number Matrix

400-049200-AB-CDE-WWWW-XXXX

- A: Major Hardware Version**
1 = Initial Release
- B: Major Software Version**
1 = Initial Release
- C: Reserved for future use (Always marked "0")**
- D: Faceplate Option**
1 = Black Face Plate
2 = Grey Face Plate
- E: Display Option**
1 = Standard Display
2 = NVG Compatible Display

WWW: ITM #1 Options

```

W W W W
| | | |-----Encryption
| | | |--Trunking                0 = none
| | |   1 = None                  1 = DES(XL)/DES-OFB
| | |   2 = Motorola Smartnet(3600 Baud) 2 = DVP-XL
| | |   3 = Motorola SmartZone(3600 Baud) 3 = DVI-XL
| | |   4 = P25                    4 = AES
| | |   5 = P25 and Motorola SmartZone
| | | |----Frequency Band
| | |   1 = 136 - 174 MHz
| | |   2 = 403 - 470 MHz
| | |   3 = 450 - 520 MHz
| | |   4 = 806 - 870 MHz
| | |   5 = 136 - 174 MHz (NTIA Compliant)
| | |   6 = 380 - 470 MHz
| | | |----Reserved (Always marked "0")

```

XXXX: ITM #2 Options

```

X X X X
| | | |-----Encryption
| | | |--Trunking                0 = none
| | |   1 = None                  1 = DES(XL)/DES-OFB
| | |   2 = Motorola Smartnet(3600 Baud) 2 = DVP-XL
| | |   3 = Motorola SmartZone(3600 Baud) 3 = DVI-XL
| | |   4 = P25                    4 = AES
| | | |----Frequency Band
| | |   0 = None
| | |   1 = 136 - 174 MHz
| | |   2 = 403 - 470 MHz
| | |   3 = 450 - 520 MHz
| | |   4 = 806 - 870 MHz
| | |   5 = 136 - 174 MHz (NTIA Compliant)

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| 6 = 380 - 470 MHz
|----Reserved (Always marked "0")

B. C-2000 Part Number Matrix

400-049300-AB-CDE

- A: Major Hardware Version**
 - 1 = Initial Release
- B: Major Software Version**
 - 1 = Initial Release
- C: Reserved for future use (Always marked "0")**
- D: Faceplate Option**
 - 1 = Black Face Plate
 - 2 = Grey Face Plate
- E: Display Option**
 - 1 = Standard Display
 - 2 = NVG Compatible Display

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C. RT-2000 Part Number Matrix

400-049400-AB-CDE-WWWW-XXXX

A: Major Hardware Version

1 = Initial Release

B: Major Software Version

1 = Initial Release

C: Reserved for future use (Always marked "0")

D: Reserved for future use (Always marked "0")

E: Reserved for future use (Always marked "0")

WWW: ITM #1 Options

W W W W

				-----Encryption
				--Trunking
				0 = none
				1 = None
				1 = DES(XL)/DES-OFB
				2 = Motorola Smartnet(3600 Baud)
				2 = DVP-XL
				3 = Motorola SmartZone(3600 Baud)
				3 = DVI-XL
				4 = P25
				4 = AES
				5 = P25 and Motorola SmartZone
				-----Frequency Band
				1 = 136 - 174 MHz
				2 = 403 - 470 MHz
				3 = 450 - 520 MHz
				4 = 806 - 870 MHz
				5 = 136 - 174 MHz (NTIA Compliant)
				6 = 380 - 470 MHz
				-----Reserved (Always marked "0")

XXXX: ITM #2 Options

X X X X

				-----Encryption
				--Trunking
				0 = none
				1 = None
				1 = DES(XL)/DES-OFB
				2 = Motorola Smartnet(3600 Baud)
				2 = DVP-XL
				3 = Motorola SmartZone(3600 Baud)
				3 = DVI-XL
				4 = P25
				4 = AES
				-----Frequency Band
				0 = None
				1 = 136 - 174 MHz
				2 = 403 - 470 MHz
				3 = 450 - 520 MHz
				4 = 806 - 870 MHz
				5 = 136 - 174 MHz (NTIA Compliant)
				6 = 380 - 470 MHz
				-----Reserved (Always marked "0")



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D. Antenna Options

The following antennas are required for use with the P-2000/RT-2000 Transceivers.

Antenna Name	Wulfsberg Part Number	Frequency Band	FAA Certification
AT-695	121-0019-000	136-174 MHz	TSO
AT-462	121-014378-01	380-520 MHz	PMA
AT-806	121-019079-01	806-870	TSO

See Figure 2-1, 2-2,2-3 for envelope drawings of antennas.

E. RT-2000 Mounting Tray (Wulfsberg P/N 300-XXXXXX-01)

See Figure 2 –4 for envelope drawing of RT-2000 Mounting Tray.

F. Required Accessories

Part Type	Part Description	Wulfsberg Part Number
Connector	DB-25 Connector	030-02703-0000
Connector component	DB-25 Backshell	129-214803-25
Connector component	DB-25 Slide Locks	129-141470-25
Connector	DB-15 Connector	129-217927-01
Connector component	DB-15 Backshell	129-241803-15
Connector component	DB-15 Slide Locks	129-141470-15
RF Connector	Straight TNC for RG-193 Coax Cable	129-041810-01
RF Connector	Right angle TNC for RG-193 Coax Cable	129-041811-01
Cable	RT-2000 KVL Data Cable	300-349082-01
Software	XTS-3000 PC Programming Software	***Available from Motorola
Software	XTS-5000 PC Programming Software	***Available from Motorola

***XTS-3000 PC Programming Software (RVN4184) is required for transceiver options 1 through 4. Options 5 and 6 require XTS-5000 PC Programming Software(RVN4186). These Motorola part numbers are subject to change without notice.

Motorola Software must be obtained by the operator directly from Motorola Customer Service Department via the following telephone numbers:

U.S. and Canadian Customers	1-800-422-4210
Federal Government Customers	1-800-826-1931
Outside U.S. Customer	1-847-538-8023



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SECTION 2 – INSTALLATION

1. General

This section contains suggestions and factors to consider before installing the P-2000/C-2000/RT-2000. Close adherence to these suggestions will assure a more satisfactory performance from the equipment.

2. Unpacking and Inspecting Equipment

Exercise extreme care when unpacking the equipment. Make a visual inspection of the units for evidence of damage incurred during shipment. If a claim for damage is to be made, save the shipping container to substantiate the claim. The claim should be promptly filed with the transportation company. It would be advisable to retain the container and packaging material after all equipment has been removed in the event that equipment storage or reshipment should become necessary.

3. Equipment Installation

The P-2000/C-2000/RT-2000 installations will conform to standards designated by the customer, installing agency, and existing conditions as to the unit location and type of installation. See Figures 2-1 through 2-7 for an outline drawings of the LRU's, installation tray, and antennas. Before beginning installation the installing agency should review the drawings, electrical interwiring diagram and installation pictorials which are located in this section, and establish requirements to a particular aircraft.

A. Cooling Considerations

The greatest single contributor to increased reliability of all modern day avionics is limiting the maximum operating temperature of the individual units, whether panel-mounted or remote-mounted. While modern day circuit designs consume far less electrical energy, the watts per cubic inch dissipated within the avionics units still remains much the same due to high density packaging techniques utilized. Consequently, the importance of providing avionics cooling is essential to the life span of the unit.

The combined heat load of several units operating in a typical avionics location will significantly degrade the reliability of the avionics if provisions for cooling are not incorporated in the initial installation. Failure to provide cooling will certainly lead to increased avionics maintenance costs and may void the Wulfsberg warranty.

B. P-2000 Mechanical Installation

- (1) Select the P-2000 mounting location. Insure that unit will be easily accessible and clearly visible to the operator. The location should be free from excessive moisture, vibration, heat and noise generating sources. The unit has standard Dzus mount dimensions as shown in Figure 2-1. Allow adequate space and service loops for installation of cables and connectors.



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- (2) The installing agency will supply and fabricate all external cables. The connectors are supplied separately and are listed in Section 1.F.
- (3) The length and routing of the external cables must be carefully studied and planned before attempting actual installation. Avoid sharp bends and placing cables too near other aircraft cables.
- (4) Use only recommended wire sizes and wire type for interwiring. Wire sizes and wire type are listed on the interwiring diagrams.

C. C-2000 Mechanical Installation

- (1) Select the P-2000 mounting location. Insure that unit will be easily accessible and clearly visible to the operator. The location should be free from excessive moisture, vibration, heat and noise generating sources. The unit has standard Dzus mount dimensions as shown in Figure 2-1. Allow adequate space and service loops for installation of cables and connectors.
- (2) The installing agency will supply and fabricate all external cables. The connectors are supplied separately and are listed in Section 1.F.
- (3) The length and routing of the external cables must be carefully studied and planned before attempting actual installation. Avoid sharp bends and placing cables too near other aircraft cables.
- (4) Use only recommended wire sizes and wire type for interwiring. Wire sizes and wire type are listed on the interwiring diagrams.

D. RT-2000 Mechanical Installation

- (1) Select the RT-2000 mounting location. The location should be free from excessive moisture, vibration, heat and noise generating sources. The unit can be rigidly mounted. Allow at least one inch of free air space around the top and rear of the unit and one-half inch along each side. Allow adequate space for installation of cables and connectors.
- (2) Refer to Figure 2-3 for the RT-2000 mounting dimensions.
- (3) Mark, punch, and drill the mounting holes. Care must be taken to avoid damage to adjacent equipment or cables.
- (4) Secure the mounting tray firmly in place.
- (5) Secure the RT-2000 to the mounting tray and connect all appropriate connectors taking care to apply the correct RF connector to the desired transceiver.



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E. Antenna Mechanical Installation

- (1) Antenna installation is critical to the range and quality of the transmitted signal. Care should be taken to keep all antennas as separated as possible. A minimum of 70 cm should be observed if possible.
- (2) Whenever possible, mount antennas on the bottom of the aircraft. The only exception is if two antennas covering the same frequency band are used, put one on the top of the aircraft and the other on the bottom to achieve maximum isolation. If this is not possible, put on the front of the aircraft and one on the rear.
- (3) The antennas should be mounted on a flat metal surface to obtain a proper ground plane. Ensure the antenna is adequately grounded to the aircraft skin (<5 mohm is a standard rule of thumb).
- (4) P-2000/RT-2000 antennas should be mounted a minimum of 20 cm from each other.
- (5) Wulfsberg recommends the use of RG-193 on most installations. Installers can substitute other types of coax than RG-193 to get better performance especially at higher frequencies. Be aware that each type of coaxial cable requires specific connectors that may only be available from the coaxial cable manufacturer.



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Remove this page and insert 154-049200 (P-2000 outline), Sheet 1 of 1 (Fig. 2-1).



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Remove this page and insert 154-049300 (C-2000 Outline), Sheet 1 of 1 (Fig. 2-2).



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Remove this page and insert 154-049400 (RT-2000 Outline), Sheet 1 of 1 (Fig. 2-3).



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Remove this page and insert 154-049065 (RT-2000 Mounting Tray), Sheet 1 of 1 (Fig. 2-5).



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Remove this page and insert 121-0019-000 (AT-695 Outline), Sheet 1 of 1 (Fig. 2-6).



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Remove this page and insert 121-014378 (AT-462), Sheet 1 of 1 (Fig. 2-7).



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Remove this page and insert 121-049079 (AT-806), Sheet 1 of 1 (Fig. 2-8).



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Section 3 - Electrical Installation

1. General Information

The Flexcomm "2000" family of products provide for many installation options. Normally the requirements can be determined by answering the following questions.

- (1) Does the user want a transceiver that is remote mounted or panel mounted?

This determines whether a P-2000 (panel mount) or a RT-2000 (Remote mount) transceiver will be used.

If a RT-2000 remote mount transceiver is used, then at least one C-2000 control head must also be specified. Additional C-2000's can be added for control of the RT-2000 from remote locations.

If a P-2000 panel mount transceiver is desired then additional C-2000's can be added for control of the P-2000 from remote locations.

- (2) How many channels must be monitored at a time - one or two?

This determines how many **Internal Transceiver Modules (ITM's)** are inside the P-2000 or the RT-2000. The P-2000 and RT-2000 can have one or two ITM's.

If the transceiver has two ITM's, then the user has the choice of using one or two mic/headset ports. Usually this is determined by the number of audio panel ports available for FM tactical radios.

In new installations it is recommended that two audio ports be used so that each ITM can be accessed independently by two operators. For retrofit installations, one port can be used to access both ITM's.

If only one microphone/headset port is available, then connect it to FM 1 mic/headset port on the transceiver. The user will then need to select using the P-2000 or C-2000 front panel controls which ITM to use for transmit. The receive audio from both ITM's will be summed together and output on FM 1 Headset Port.

If two positions on the audio panel are available, then connect the 1st position to FM 1 mic/headset and position #2 to FM 2 mic/headset. This will allow for two users to independently operate the two ITM's.

- (3) Does the audio panel have individual RX audio volume controls?

If yes, then the P-2000 or C-2000 can have the volume controls programmed by the installer to a set level that the user will not be able to change via the volume knobs on the front of the P-2000/C-2000. In this case, the user will go to the audio panel to change the volume - not the P-2000 or C-2000.



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2. Sample System Block Diagrams

The following block diagrams are intended to show various installation configurations of the "2000" family of products. Due to the flexibility of the system components it is impossible to create wiring diagrams for all configurations. However, with the examples given by the manufacturer and the technical descriptions of connector pins, a competent designer should be able to create wiring diagrams for their specific application.

Figure 3.1 shows diagrams that use a single P-2000 and Single C-2000/RT-2000. They attempt to show how single and multiple Mic/Headset interfaces can be used.

Figure 3.2 shows diagrams that use a combination of C-2000 control units and P-2000/RT-2000 transceivers with audio panels without volume controls.

Figure 3.3 shows diagrams that employ a combination of C-2000 control units and P-2000/RT-2000 transceivers.



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Remove this page and Insert P-2000 Block diagrams Page 1 here. Fig 3.1



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Remove this page and Insert P-2000 Block diagrams Page 1 here. Fig 3.2



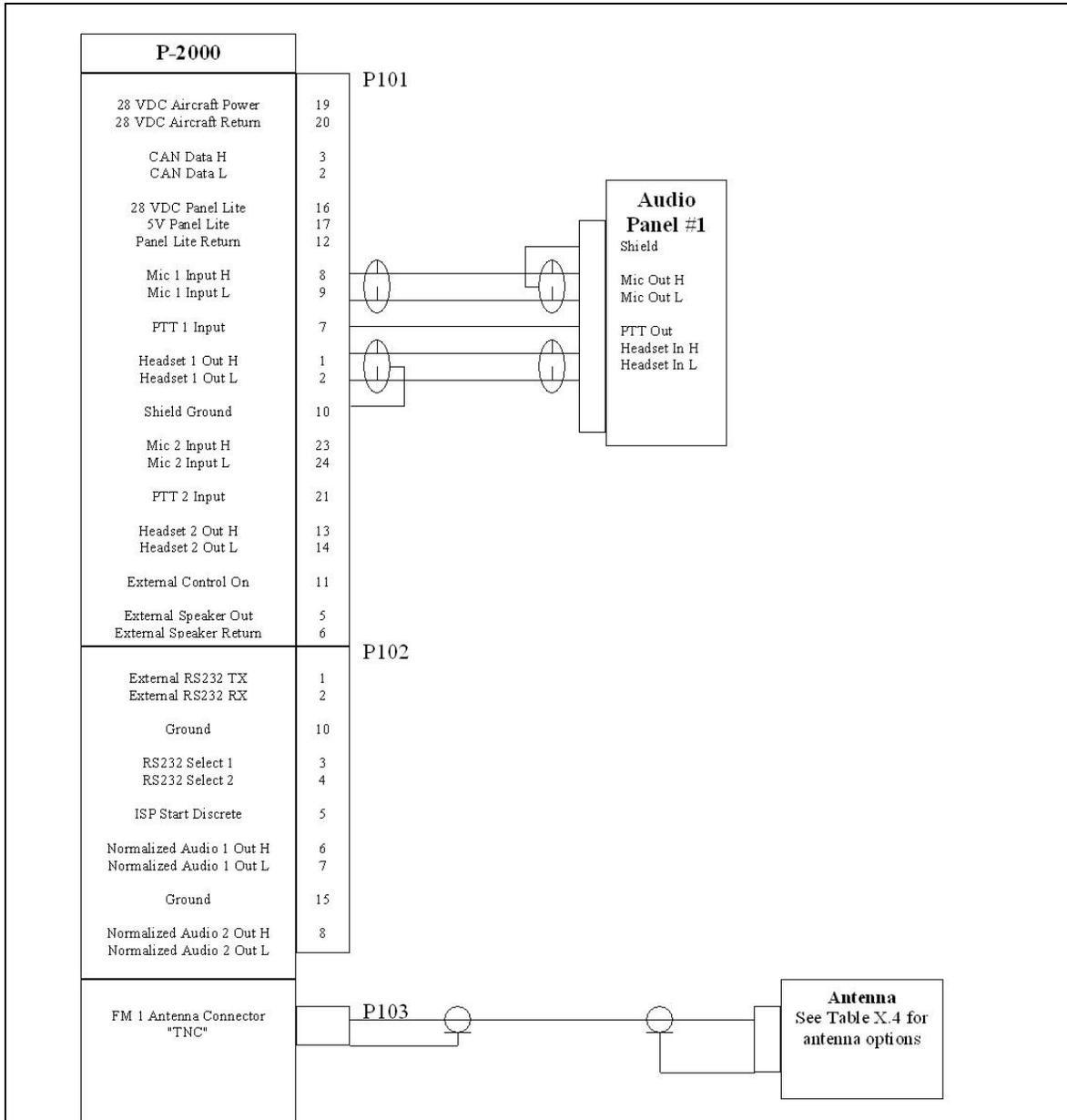
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Remove this page and Insert P-2000 Block diagrams Page 1 here. Fig 3.3

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3. Sample Interconnect Wiring Diagram

The following wiring diagram is intended to show a basic installation of the Flexcomm “2000” family of products. Due to the flexibility of the system components it is impossible to create wiring diagrams for all configurations. However, with the examples given by the manufacturer and the technical descriptions of connector pins, a competent designer should be able to create wiring diagrams for their specific application.



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4. Connector Pin Number and Descriptions

The following tables and pin descriptions are for the P-2000/C-2000/RT-2000 J101(DB-15) and J102 (DB-15) connectors.

J101 Pin Numbers and Signal Names

Pin	SIGNAL NAME
1	Headset 1 Out H
2	Headset 1 Out L
3	CAN Data H
4	CAN Data L
5	External Speaker Out
6	External Speaker Return
7	PTT 1 Input
8	Mic 1 Input H
9	Mic 1 Input L
10	Shield Ground
11	External On/OFF Control
12	Panel Lite Return
13	Headset 2 Out H
14	Headset 2 Out L
15	Reserved Spare #1
16	28 VDC Panel Lite
17	5 V Panel Lite
18	Reserved Spare #2
19	28 VDC Aircraft Power
20	28 VDC Aircraft Return
21	PTT 2 Input
22	Reserved Spare #3
23	Mic 2 Input H
24	Mic 2 Input L
25	Reserved Spare #4

Table 3.1 J101 Pin Numbers and Signal Names

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Pin - Signal Name (J101 25 Pin D-sub)

1 - Headset 1 Out H

This analog output provides the High side of the receive and sidetone audio output from either FM-1 transceiver (Mode 2) or the summation of FM-1 and FM-2 (Mode 1). Standard audio levels of 100 mW into 600 ohm load is provided for standard modulation (1.0 kHz tone, 3 kHz FM Mod). This output is normally sent an audio panel. This output must use shielded wire.

2 - Headset 1 Out L

This analog output provides the Low side of the receive and sidetone audio output from a transceiver. Normally this output is either grounded or sent to an audio panel. This output must use shielded wire.

3 - CAN Data H

This bi-directional pin provides for data communications between a C-2000 and P-2000 or RT-2000. Voltage levels range between 0 and 5 VDC. This pin is only used when a system incorporates a C-2000. Twisted Shielded wire should be used with this pin.

4 - CAN Data L

This bi-directional pin provides for data communications between a C-2000 and P-2000 or RT-2000. Voltage levels range between 0 and 5 VDC. This pin is only used when a system incorporates a C-2000. Twisted Shielded wire should be used with this pin.

5 - External Speaker Out

This analog audio output is the summation of the receive audio of either or both transceiver modules. It does not output sidetone. Normally this audio is provided for special applications where a speaker rather than Headset is used. It can drive a 10K load with .9 VRMS. This output is intended to drive a powered speaker. Use shielded wire.

6 - External Speaker Return

This pin provides the ground path for the external speaker output. Use shielded wire.

7 - PTT 1 Input

This input when grounded activates the transmitter for FM - 1 or FM - 2 (Depending on operating mode and selected transceiver). Normally this is connected to the audio panel PTT output. If a discreet microphone is being used (no audio panel) this pin should be tied to Mic 1 Input L.



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8 - Mic 1 Input H

This pin is the high side of a differential microphone 1 input and provides a 150 ohm input impedance for the crew microphone input. Normally this pin is connected to the audio panel. Carbon microphone DC bias is provided by the unit. Standard input of 1kHz tone @ .25VRMS should produce standard FM modulation out (3.0 kHz). Use shielded wire.

9 - Mic 1 Input L

This pin is the low side of a differential microphone 1 input. Normally this pin is connected to the audio panel. Use shielded wire.

10 - Shield Ground

All shields of signals originating at the P-2000 or RT-2000 and terminating at other equipment should be connected to this pin and left un-terminated at the other equipment.

11 - External ON Control

This pin is only used in a system that contains a C-2000. When this pin is grounded the unit will turn on.

12 - Panel Lite Return

The pin provides the ground path for the lite buss input.

13 - Headset 2 Out H

This analog output provides the High side of the receive and sidetone audio output from FM-2 transceiver (Mode 2). Standard audio levels of 100 mW into 600 ohm load is provided for standard modulation (1.0 kHz tone, 3 kHz FM Mod). This output is normally sent an audio panel. This output must use shielded wire.

14 - Headset 2 Out L

This analog output provides the low side of the receive and sidetone audio output from a transceiver. Normally this output is either grounded or sent to an audio panel. This output must use shielded wire.

15 - Reserved Spare #1

This reserved for future use.

16 - 28 VDC Panel Lite

This pin provides for 28 VDC aircraft lite dimmer buss control of the keyboard lighting (the LCD brightness is set by the user via keypad input). This pin does not draw power from the buss but simply monitors the voltage for proper lite tracking. Either 28 V or 5 volt (pin 17) may be used but not at the same time. This function is not used on the RT-2000 so no connection is required.



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17 - 5 VDC/5 VRMS Panel lite

This pin provides for 5 VDC or 5 VRMS aircraft lite dimmer buss control of the keyboard lighting (the LCD brightness is set by the user via keypad input). This pin does not draw power from the buss but simply monitors the voltage for proper lite tracking. Either 28 V or 5 volt may be used but not at the same time. This function is not used on the RT-2000 so no connection is required.

18 - Reserved Spare #2

This reserved for future use.

19 - 28 VDC Aircraft Power

This pin provides 28 VDC aircraft power to the unit. Loading requirements and proper circuit breaker choices are P-2000: 4 amps, RT-2000: 4 amps, C-2000: 2 amps.

20 - 28 VDC Aircraft Ground

This pin provides the ground return for the 28 VDC aircraft power to the unit.

21 - PTT 2 Input

This input when grounded activates the transmitter for FM - 2. Normally this is connected to the audio panel PTT output. If a discreet microphone is being used (no audio panel) this pin should be tied to Mic 2 Input L.

22 - Reserved Spare #3

This reserved for future use.

23 - Mic 2 Input H

This pin is the high side of a differential microphone 2 input and provides a 150 ohm input impedance for the crew microphone input. Normally this pin is connected to the audio panel. Carbon microphone DC bias is provided by the unit. Standard input of 1kHz tone @ .25VRMS should produce standard FM modulation out (3.0 kHz). Use shielded wire.

24 - Mic 2 Input L

This pin is the low side of a differential microphone 2 input. Normally this pin is connected to the audio panel. Use shielded wire.

25 - Reserved Spare #4

This reserved for future use.

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J102 15 Pin D-Sub

Pin	SIGNAL NAME
1	External RS232 TX
2	External RS232 RX
3	RS232 Select 1
4	RS232 Select 2
5	ISP Start Discrete
6	Normalized Audio 1 Out H
7	Reserved Spare #5
8	Normalized Audio 2 Out H
9	Reserved Spare #6
10	Ground
11	Reserved Spare #1
12	Reserved Spare #2
13	Reserved Spare #3
14	Reserved Spare #4
15	Ground

Table 3.2 J102 Pin Numbers and Signal Names

Pin - Signal Name

1 - External RS232TX

This pin is a digital output from the unit. It provides for data communication during software flash procedures.

2 - External RS232RX

This pin is a digital input to the unit. It provides for data communication during software flash procedures.

3 - RS232 Select 1

4 - RS232 Select 2

This pins select which internal module receive the RS232 data being transferred on pins 1 and 2 of J102. The choices for these pins are listed in the table below:

Pin 3	Pin 4	Selection
N/C	N/C	TBD
Ground	N/C	TBD
N/C	Ground	TBD
Ground	Ground	TBD

5 - ISP Start Discrete

This pin is used only during Flash software loading during maintenance.



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6 - Normalized Audio 1 Out H

This audio pin outputs audio from FM -1 at a constant level - i.e. it is not controlled by the volume control. This output will produce 1.75VRMS into a 10K load.

7 – Reserved Spare #5

Reserved for future use.

8 – Normalized Audio 2 Out H

This audio pin outputs audio from FM -2 at a constant level - i.e. it is not controlled by the volume control. This output will produce 1.75VRMS into a 10K load.

9 – Reserved Spare #6

Reserved for future use.

10 - Ground

Ground.

11 - Reserved Spare #1

Reserved for future use.

12 - Reserved Spare #2

Reserved for future use.

13 - Reserved Spare #3

Reserved for future use.

14 - Reserved Spare #4

Reserved for future use.

15 - Ground

Ground.



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SECTION 4 – Installation Checkout Procedure

1. Introduction

This procedure should be followed to verify installation of the system.

Procedure

- (1) Install all LRU's and antenna systems.
- (2) Verify grounding on antennas is <5 mohms.
- (3) Verify grounding between LRU's and airframe is <.5mohms.
- (4) Enable power bus.
- (5) Verify display units turn on and initialize. Perform "LEARN" mode if unit requests it.
- (6) Configure the unit for DUAL or SINGLE mice mode. See section 6 for more information.
- (7) Configure the unit for LOCK VOLUME setting.
- (8) Press the volume knob for FM1. Verify the discreet RX indicator for FM1 is displayed and that noise is heard in the headset. Vary FM1 volume knob (if LOCK VOLUME is set to NO) or the volume knob on the audio or both to vary volume level can be controlled. Perform this test for both FM1 and FM2.
- (9) Connect communication analyzer directly into FM1 antenna port (J103). Inject a signal into the transceiver and verify the reception at .6 uV unscelches the audio and the signal is heard in the headset.
- (10) Transmit with FM1 and verify power levels, Frequency, and deviation level (maximum of 5 kHz, normal voice level, 3.0 kHz).
- (11) Perform steps 9 and 10 with FM2 if applicable.
- (12) Using a "Bird" type watt meter, verify antenna VSWR is less than 2.5 to 1 for all antennas in the system.
- (13) Connect antennas and verify over the air transmissions using the communications analyzer as the other unit.
- (14) Transmit using each transceiver and verify no interference with other systems on the aircraft such as GPS, AM comms and NAV receivers.



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SECTION 5 – Continued Airworthiness Instructions

Introduction

This document contains instructions for testing a FLEXCOMM 200 system on a periodic maintenance cycle to assure continuous airworthiness. This document is intended to supplement the individual installation and user manuals of the Flexcomm 2000 system components. The aircraft maintenance personnel should be in possession of and refer to these manuals during inspections. The Flexcomm 2000 system includes a P-2000 panel mount transceiver or a C-2000 control head and a RT-2000 remote mount transceiver and suitable antennas. The recommended maintenance cycle is one year.

Equipment

To perform the checkout procedures described below, you must have the following:

- A HP 8920 Communications Service Monitor or equivalent to transmit and receive over the programmed frequencies.
- An AT-150 or equivalent broad band antenna or single band antennas covering the same frequencies of the unit under test.
- Miscellaneous cables and adapters.
- A handset interfaced to the FLEXCOMM 2000 system.
- Four wire Ohmmeter.

NOTE: Calibration or internal LRU adjustments are only required on failure condition of the equipment under test.

Antenna Verification

The bonding of all antennas and the radio chassis to the airframe should be verified to have an impedance of less than 0.1 Ohm. The VSWR of the combined antenna and coax cable should be measured at the connector to the radio. The VSWR should be no more than the maximum specified antenna 2.5:1.

Transmitter Verification

1. Select a channel with known Receive and Transmit frequencies on FM1.
2. Set the Service Monitor to receive the transmit frequency of the selected channel. Connect the output of the radio under test to the Service Monitor RF input port with a cable less than three feet in length (refer to the Service Monitor User's Manual).
3. Use the handset interfaced to the FLEXCOMM 2000 system to transmit a signal, modulated from the Service Monitor.



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4. Measure the output power, output frequency, and FM modulation (kHz deviation) with the Service Monitor. Verify that the output frequency and power are within specification. Adjust or repair as necessary.
5. Repeat for FM2 transceiver.

Receiver Verification

1. Select a channel with known Receive and Transmit frequencies on FM1.
2. Set the Service Monitor to transmit at the frequency programmed on the test unit with a 1 kHz tone with 3 kHz deviation for FM mode. If necessary, refer to the user's manual supplied with the Service Monitor.
3. Connect the output of the radio to the RF input port with a cable less than three feet in length. Set the output power of the Service Monitor to the specified sensitivity level of the radio under test.
4. With the proper cables, route the headset audio back into the Service Monitor. Push the FM1 Volume button to open the squelch and measure SINAD. SINAD should be better than 12 dB for FM.
5. Increase the RF signal by 10 dB and verify that the squelch gate opens.
6. Repeat for FM2 if available.

Final System Check-out

1. Reconnect the coax cable connecting the radio to the antenna.
2. Place an AT-150 or similar broad band antenna 10 feet from the aircraft antenna. The antenna should be at the same elevation and have the same polarity as the antenna on the aircraft.
3. Connect the antenna to the Service Monitor set to receiver at the desired frequency of test.
4. Transmit over FM1 on the test frequency and measure the received signal power.
5. The insertion loss should be between -30 and -40 dB @ 150 MHz. Substitution of the receiving antenna or changes in antenna placement can significantly effect measurement results.
6. Record the actual values measured and the measurement setup. Use this information to track any degradation in the antenna system on future system checkouts.
7. Repeat for FM2.

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SECTION 6 – Configuration Procedures

1. Introduction

There are two configuration settings that may need to be set by the installer before operational use.

1. Configuration Settings

The following lists the configuration settings available in the P-2000/C-2000 that a installer must set properly based on the system design. Please use instructions displayed in the P-2000/C-2000/RT-2000 Operators Manual for instructions on how to change these settings. Factory settings are shown below.

- (1) **MIC MODE (DUAL/SINGLE)** – There are two Mic mode settings depending on how many audio panel positions are available.

Mode 1 or “SINGLE” is used when there is only one mic/headset position on the audio panel. In this case, the audio from both FM1 and FM2 will be summed together during receive and sent to FM1 Headset pins. Likewise microphone audio should be connected to FM1 Mic inputs and the operator will transmit on whichever transceiver is the active transceiver. The active transceiver is easily distinguished by the area of the display that has a bright blue background.

Mode 2 or “Dual” is used when there are two mic/headset positions on the audio panel dedicated to the P-2000 system. In this case the audio from FM1 is sent to and from FM 1 Mic/Headset pins. Audio from FM2 is sent to and from FM2 Mic/Headset pins. The receive audio from each transceiver is kept separate. In this case the designation of a transceiver, FM1 or FM2 as the “active” transceiver only means the knobs and buttons will operate on that transceiver. The user selects which transceiver FM1 or FM2 via the audio panel.

FACTORY SETTING= “DUAL”.

- (2) **LOCK VOLUME (NO/YES)** – If the installer has designed the system with audio panels that do not have volume controls, this value should be set to NO. When audio panels have volume controls, it is left to the installer/user to determine if they'd like the volume pots on the P-2000 to be disabled so that there is only one location in the system for volume control – the audio panel. In this case set this value to “YES”.

FACTORY SETTING= “NO”