

TELEDYNE CONTROLS **WQAR**

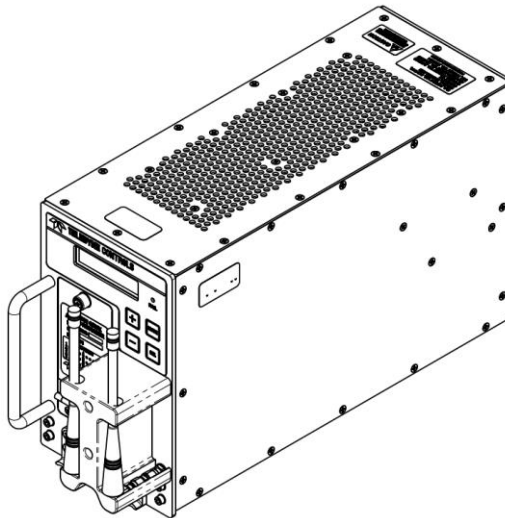
WIRELESS GROUNDLINK® - QUICK ACCESS RECORDER

PART NUMBER

2243800-460

2243800-462

2243800-464



USER'S GUIDE



501 Continental Blvd.
El Segundo, CA 90245 USA

UG2243800-4XX
May – 28, 2019

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Teledyne Controls, LLC
501 Continental Boulevard
El Segundo, CA 90245

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US Federal Communication Commission (FCC) and Industry Canada (IC) User Notifications.

NOTICE 1:

This device complies with Part 15 of the FCC Rules and with Industry Canada license-exempt RSS standard(s).

Operation is subject to the following two conditions:

- (1) This device may not cause harmful interference, and*
- (2) This device must accept any interference received, including interference that may cause undesired operation.*

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence.

L'exploitation est autorisée aux deux conditions suivantes:

- (1) l'appareil ne doit pas produire de brouillage, et*
- (2) l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.*

NOTICE 2:

Changes or modifications made to this equipment not expressly approved by (manufacturer name) may void the FCC authorization to operate this equipment.

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Contents

Table of Figures	5
Definitions	6
Section 1 – General	8
Introduction	8
Scope of this document	9
WQAR Operation Overview	9
Features	10
Aircraft Signaling.....	10
ACMS Reporting	11
RF Interlocks	11
Removable SIM Module (RSM)	11
Mobile Networks	12
Transmission Restriction.....	12
Radio Frequency Radiation Exposure Information	12
Section 2 – System Overview	13
Boot up and Pre-Flight Operations	13
In-Flight Operations	13
Post Flight Operations	13
Part Number Discussion	14
Software Part Number.....	15
Configuring Your WQAR (OPC)	16
Using the Front Panel	16
Upgrading the WQAR Operational Software (OPS)	16

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Section 3 – WQAR Operations	17
Front Panel	17
Front Panel Display	18
FAIL Indicator.....	20
Front Panel Buttons	21
Access Door	21
Antennas	22
Date/Time	22
System Menus	23
Menu Descriptions	23
SYSTEM STATE	23
UNIT INFO.....	23
STATUS	25
DIAGNOSTICS.....	28

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Table of Figures

Figure 1 – Wireless GroundLink Quick Access Recorder (WQAR).....	8
Figure 2 – Wireless GroundLink Communication Diagram	9
Figure 3 – WQAR Front Panel	17
Figure 4 – Typical WQAR Display (Run Control Feature in Use)	18
Figure 5 – Typical WQAR Display (Run Control Feature not in Use)	18
Figure 6 – WQAR Display (Data out of Sync).....	18
Figure 7 – WQAR Display (Data in Sync)	19
Figure 8 – Behind the Access Door	22

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Definitions

3G	3 rd Generation Cellular Protocol
A/C	Aircraft
ACARS	Aircraft Communication Addressing and Reporting System
ACMS	Aircraft Condition Monitoring System
AIDS	Aircraft Integrated Data System
All	Aircraft Interface Items
AMA	Airline Modifiable AID+ (Items)
AMI	Airline Modifiable Items
ARINC	Aeronautical Radio Incorporated
ATE	Automated Test Equipment
ATP	Acceptance Test Procedure
BIT	Built in Test
BITE	Built in Test Equipment
COTS	Commercial Off The Shelf
DFDAU	Digital Flight Data Acquisition Unit
DFDMU	Digital Flight Data Management Unit
DOD	Download On Demand
eADL	enhanced Airborne Data Loader
EDGE	Enhanced Data Rates for GSM Evolution
FDIU	Flight Data Interface Unit
FDIMU	Flight Data Interface Management Unit
GSM	Global System for Mobile Communication
GPRS	General Packet Radio Service
HRFIL	High reliability RF Interlock
IMEI	International Mobile (station) Equipment Identity
ISO	International Organization for Standardization
LED	Light Emitting Diode
MAC	Media Access Control
OQAR	Optical Quick Access Recorder
OPC	Operational Program Configuration
OPS	Operational Program Software
PQAR	PCMCIA Card Quick Access Recorder

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QAR	Quick Access Recorder
RCD	Recording Completion Delay
RF	Radio Frequency
TMI	Teledyne Modifiable Items
UMTS	Universal Mobile Telecommunications System
UTC	Universal Time, Coordinated
WGBS	Wireless GroundLink® Base Station
WGCM	Wireless GroundLink® Ground Communication Manager
WGL	Wireless GroundLink®
WPS	Words per Second
WQAR	Wireless GroundLink® -- Quick Access Recorder
WAPU	Wireless AMI/AMA Preparation Utility
WCCU	WGL Comm+ Conversion Utility
WDCU	Wireless Data Conversion Utility
WMPU	Wireless Media Preparation Utility

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Section 1 – General

Introduction

The Teledyne Controls new Wireless GroundLink® Quick Access Recorder, also known as the WQAR, is the latest addition to the QAR family of products (Figure 1). This compatible replacement for any QAR provides convenient access to airborne data by transmitting it over a high-speed cellular connection. It can receive flight data from any acquisition unit that is ARINC 717 compliant. The front panel display gives status while the buttons allow the operator to perform testing as well as view the configuration of the unit.

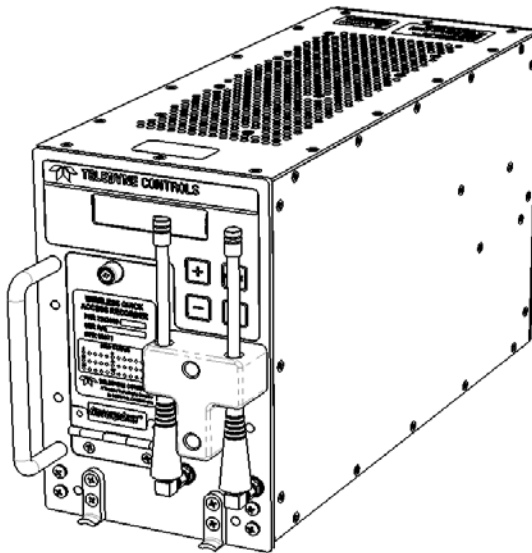


Figure 1 – Wireless GroundLink Quick Access Recorder (WQAR)

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Scope of this document

This operations guide describes the functions of the WQAR (P/N 2243800-46X) using the OPS software (P/N 711745), all versions. Sections in this guide include System Overview, Operations, Common Procedures, Fault Procedures, and other reference information.

The hardware variants in this WQAR family are listed below:

Part Number	Connector Type	Radio Complement
2243800-460	ARINC600	No Radios installed
2243800-462	ARINC600	Two radios with two antennas
2243800-464	ARINC600	Four radios with two antennas

For information on Teledyne Controls' WQAR (P/N 2243800-XX), refer to UG2243800.

WQAR Operation Overview

The primary purpose of the WQAR is to record and store flight data provided to it by a data acquisition unit such as a DFDAU or FDIMU. Then, while the aircraft is on the ground, it wirelessly transmits that data to a base station using high-speed 3G/4G-like cellular technology (where available). If unable to transmit, a backup encrypted copy of your data is stored on the removable Compact Flash (CF) card.

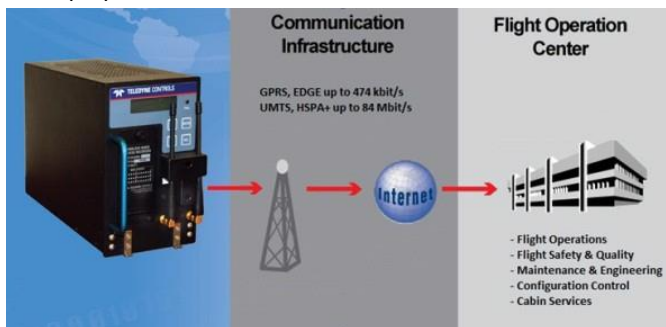


Figure 2 – Wireless GroundLink Communication Diagram

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Features

The Wireless GroundLink Quick Access Recorder has many features which enable it to fit into almost any aircraft infrastructure.

Aircraft Signaling

The WQAR can support two different aircraft signaling types: Bi-Polar and Harvard Bi-Phase. Either one of these signal types can be entered in the configuration. However, if the WQAR is moved between multiple aircraft where both BI-PHASE and BI-POLAR are used alternatively, the unit can be put into signal DISCRETE mode where, during bootup, it monitors the BI-PHASE SELECT discrete. If this discrete is active, the WQAR will set itself to BI-PHASE. If this discrete is not active or not present in the aircraft, the WQAR will set itself to BI-POLAR. After determining the signal, it will determine the speed of the signal using the methods described below:

- ❖ The standard hard-coded 64, 128, 256, 384, 512, 1024, and 2048 WPS rates can be configured.
- ❖ AUTO speed mode where it dynamically determines the WPS rate of the signal as it is coming in.
- ❖ Speed DISCRETE mode where, during WQAR bootup, it determines the speed by monitoring speed discrettes activated by the acquisition unit. These discrettes are generally known as the X2, X4, X8, X16, and X32 discrettes. The aircraft wiring of these discrettes varies by aircraft type. The acquisition unit may activate any one of these to indicate the speed of the ARINC717 data stream.

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ACMS Reporting

In addition to the standard ARINC717 flight data, the WQAR can also record ARINC429 data (ACMS reports) if the acquisition unit sends such reports.

When enabled, upon landing, the WQAR will power up the radios but wait a fixed amount of time before sending any data to allow for these reports to come in. This delay is referred to as the Recording Completion Delay (RCD).

The typical setting is five minutes. Once the RCD has elapsed, the WQAR will transmit both the ARINC717 and ARINC429 data in a single (WGL) file. Each flight is compartmentalized into distinct compressed files.

RF Interlocks

Aircraft regulations prohibit the WQAR radios from transmitting while the aircraft is in the air. To comply with this regulation, Teledyne Controls has incorporated hardware, referred to as High Reliable RF Interlocks, which provides strict controls to allow power to be applied to the radios only while the aircraft is on the ground.

Removable SIM Module (RSM)

This WQAR is equipped with a Removable SIM Module (RSM) which located behind the front Access Door. After WQAR power is removed, the RSM can be removed by the operator using the procedure in section 4, View/Replace Removable SIM Module (RSM) or Individual SIM Card. When replacing or installing the individual SIM cards (mini-SIM cards) into the RSM, the WQAR may require a new OPC file for proper operation.

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Mobile Networks

The WQAR transmits data utilizing the 3G/4G networks all over the world, by dynamically determining the cellular frequencies wherever the aircraft is located. The operator can selectively limit where the WQAR transmits by utilizing the roaming zones set by the mobile provider or by use of Network Identification numbers (NetIDs). All transmissions are subject to charges by the SIM mobile provider(s).

Transmission Restriction

The WQAR is restricted to a maximum of 3 radios simultaneously transmitting on band 30. To facilitate this restriction, the user must not utilize a SIM card combination or transmission rules that allows access to more than 3 radios on band 30 at a time.

Contact Teledyne Controls Customer Services for more information.

Radio Frequency Radiation Exposure Information

The WQAR complies with the FCC RF exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with a minimum distance of 20cm between the radiator (antenna) and your body.

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Section 2 – System Overview

Boot up and Pre-Flight Operations

Upon cold start, the WQAR FAIL light will blink slowly while it initializes the hardware. The FAIL light will blink quickly as the OPS software boots, determines the signal and speed of the incoming flight data, and adapts itself to the aircraft. During this time, the output FAIL discrete will not be set. After boot up is complete, the FAIL light will extinguish and the LCD display will momentarily show STARTUP BIT COMPLETE followed by the normal SYSTEM STATE display as shown in Section 3 which indicates the WQAR is ready for operation. On LRUs without MOD DOT 3 status, the LCD display may be dimmed during the boot up process which takes approximately two minutes.

In-Flight Operations

When the aircraft is ready, the WQAR will begin recording all incoming ARINC 717 and report data from the acquisition unit. During flight, the data will be periodically compressed to ready it for transmission. An encrypted copy is also saved onto an accessible removable CF card (P/N 2234641-008).

Post Flight Operations

After landing, the RF Interlocks will disengage and the radio(s) will power on and make contact with the Wireless Ground Communication Manager (WGCM). However, if the optional Recording Completion Delay (RCD) is enabled, flight data will not transmit until the RCD has expired (See Section 1, ACMS Reporting, for RCD details). During this delay, the WQAR will continue to receive final airborne data and ACMS reports (if present). If the WQAR determines that it has recorded the minimum amount of data, it will compress this remaining data and close the file. Finally, it will send the flight data to the WGCM if it is permitted to transmit at the current destination (e.g. not roaming, etc).

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If it does not transmit, it will make the determination again at the next destination. It will continue to do all of the above at every destination until the aircraft arrives in a permitted cellular network where it will transmit all accumulated data. If a transmission is interrupted for any reason, the WQAR does not need to re-transmit from the beginning. It has the ability to resume from the point of interruption. The radios will remain powered on while the aircraft is on the ground whether transmissions occur or not. If the Download on Demand (DOD) feature is enabled, the WQAR will accept any DOD messages if they are sent. (See Section 1, Download on Demand, for details). Contact Teledyne Controls Customer Services for more information.

If the cellular radios cannot transmit for any reason, data can still be retrieved by ejecting the compact flash (CF) card using the procedure in Section 4. After the card is ejected and files copied, the raw flight data files need to be decrypted using Teledyne Controls WCCU. Compressed Flight data (WGL files) are processed using Teledyne Controls' WDCU. See Section 5 for specific details about viewing the log file on the card.

The WQAR can transmit up to two WGL files while receiving one file, all simultaneously.

Part Number Discussion

In general, there are two software components in the WQAR: The OPS (operational software) and OPC files (configuration files). The OPS and OPC files are ARINC 665 Loadable Software Parts (LSPs). Depending on the context, the OPS and OPC LSP are referred to using different part numbers.

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Software Part Number

Teledyne Controls primarily assigns this part number to the software. This part number typically is a 6-digit number and begins with a 7 and usually ends with a version letter. Example: The software part number of the OPS software, version G, is 711745 G.

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Configuring Your WQAR (OPC)

The WQAR has configuration settings which configure it to adapt it to your aircraft and cellular environment. There are varying methods to change the WQAR configuration.

Using the Front Panel

Some WQAR settings can be changed through the front panel. These changes will persist through power cycling. Refer to the following procedures in Section 4:

- Set Tail Number
- View and Set Date/Time
- Disable Radios
- Enable Radios
- Override Run Control

Upgrading the WQAR Operational Software (OPS)

The WQAR operational software (OPS) is available as an LSP and can be requested from Teledyne Controls. The OPS is installed using the same methods described above.

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Section 3 – WQAR Operations

Front Panel

The WQAR (Figure 3) has a front panel interface to allow the operator to check status as well as perform diagnostics and other maintenance activity. Antennas have been removed for clarity.

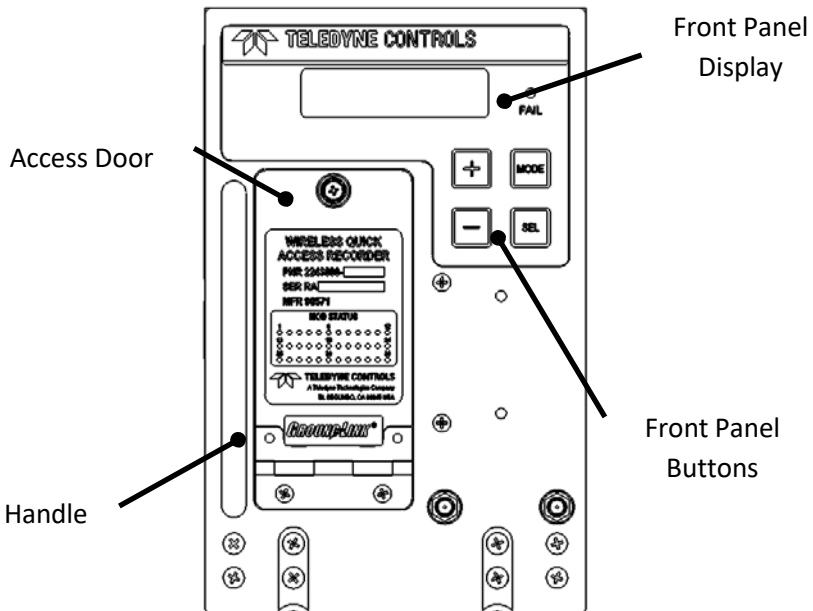


Figure 3 – WQAR Front Panel

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Front Panel Display

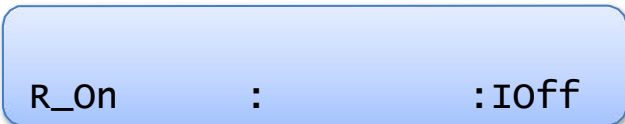
The blue backlit front panel display has two lines with 16 characters each and shows the operational status of the unit. Figures 4 and 5 show normal post-boot-up status when Run-Control is in use and when not in use.



```

RUN DISABLED
R_On      :      :IOff
  
```

Figure 4 – Typical WQAR Display (Run Control Feature in Use)

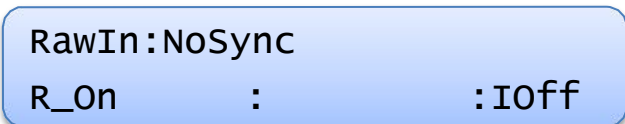


```

R_On      :      :IOff
  
```

Figure 5 – Typical WQAR Display (Run Control Feature not in Use)

Figure 6 shows a display example of flight data is coming in when it is out-of-sync (NoSync). When the WQAR is configured properly, the NoSync condition is temporary and, after a few seconds, will display what is shown in Figure 7. During this time, data is recorded but it will appear invalid during analysis.



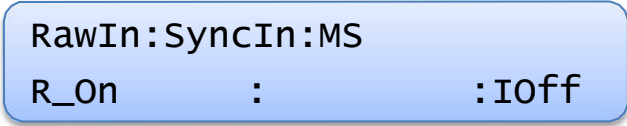
```

RawIn : NoSync
R_On   :      :IOff
  
```

Figure 6 – WQAR Display (Data out of Sync)

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Figure 7 indicates the data is now in-sync and will be recorded as valid data. Figure 7 also shows that the WQAR has recorded ACMS report(s) by displaying “MS”. When data stops coming in, the top line will display “RawStp” (not shown).



```
RawIn:SyncIn:MS
R_On      :      :IOff
```

Figure 7 – WQAR Display (Data in Sync)

The bottom line has three sections separated by colons (:), which indicate the other WQAR status:

- ❖ **Left Section:** Displays the cellular radio power status and connection status.
 - **R_On:** Radio(s) are powered on. Figures 4 thru 7 show an example of this.
 - **R_Off:** Radio(s) are powered off.
 - **CON:** Connected. The WQAR has achieved a connection with the WGCM.
 - **NO_CON:** Displayed if a connection attempt fails.
 - **DN:** Downloading. The WQAR is currently downloading data to the base station.
 - **UP:** Uploading. The WQAR is currently uploading data from the base station.

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- ❖ **Middle Section:** Displays the status of the airborne data files such as whether the files are ready for transmission.
 - **RDY:** Ready. The WQAR has met the minimum raw data requirements to transmit data.
 - **RCD:** Recording Completion Delay. The WQAR is waiting for any final data from the acquisition unit before performing final compression and closing of the data file. Refer to Section 1 – ACMS Reporting for details.
 - **CMP:** Compression. The WQAR is actively compressing data at this time.
 - **<Blank>:** The WQAR is not in any of the above states.
- ❖ **Right Section:** Displays the status of the RF Interlocks. Refer to Section 1 – RF Interlocks for details..
 - **ION:** Interlocks are engaged. The radios are restricted from receiving power.
 - **IOff:** Interlocks are not engaged. The radios are no longer restricted from receiving power. Figures 4 thru 7 show an example of this.





FAIL Indicator

The WQAR is equipped with an amber-colored FAIL indicator which will illuminate whenever a hardware fault is detected, configuration files are missing, or if the internal flight data card is full. The FAIL indicator will also flash during unit boot up. A list of faults are in Section 5. The FAIL discrete will usually (but not always) be activated whenever the FAIL indicator is illuminated.

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Front Panel Buttons

There are four buttons on the front panel:

Button	Description
	This button is used to exit out of the current menu or to escape certain functions in process.
	The SELECT button is used to enter into the selected menu. It is also used to choose or confirm any changes made to the LRU.
	The + (PLUS) button is used to advance though the various menus and parameters.
	The – (MINUS) button is used to reverse though the various menus and parameters.

Access Door

The outside of the access door has the label which displays the Part Number, Serial Number, and MOD Status. The door, which swings down, can be opened by rotating the thumbscrew counter-clockwise. Behind the door are the Removable SIM Module (RSM), the Compact Flash (CF) Recording Media, the RJ-45 port, and the RJ-12 Console Port. The CF Recording Media contains encrypted backup flight data and the system log file. The Removable SIM Module can hold up to four SIM cards, one for each of the four cellular radios inside the LRU. Maintenance procedures for the Removable SIM Module and CF cards are in Section 4.

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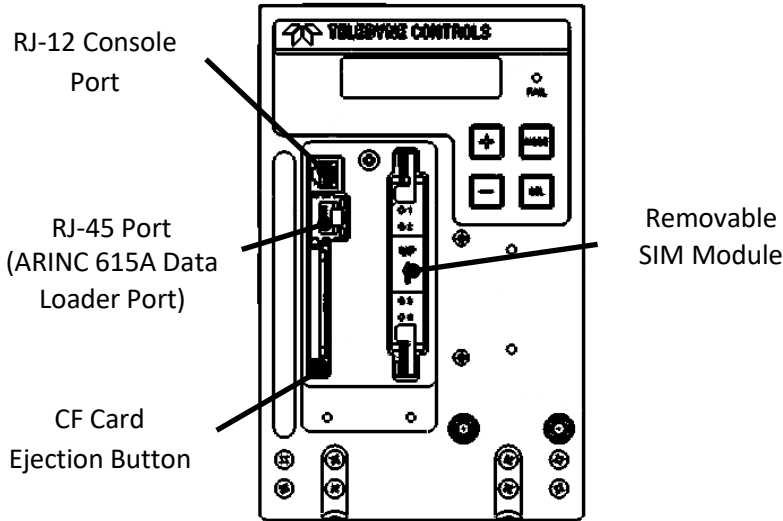


Figure 8 – Behind the Access Door

Antennas

There are two antennas connected to elbow connectors at the front of the unit and are secured in place with a bumper to discourage handling. Contact Teledyne Controls Sales Department for replacement parts. The antenna replacement procedure will be available in a service bulletin.

Date/Time

The WQAR has a system clock (UTC) and is set at the factory using the front panel System Menus. The clock's power source is a super-capacitor inside the WQAR which lasts approximately 30 days. The clock will lose its time if it doesn't have access to aircraft power for that length of time. The WQAR does not use the Captain's clock to refresh the clock. However, if configured, the WQAR will update the clock whenever it connects to the base station. This time update may take up to approximately five minutes and the FAIL light will

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blink during this time and the unit will reboot. After reboot, the WQAR will be operational with the proper time.

System Menus

The WQAR menus are accessed using the Front Panel Buttons and are viewed in the Front Panel Display. After bootup, the unit defaults to the SYSTEM STATE display which shows the system status as shown in Figures 4 thru 7. When navigating the WQAR menus, if the WQAR buttons experience no activity for 30 minutes, the WQAR automatically returns to this display.

Menu Descriptions

SYSTEM STATE

This menu displays the current status of the unit and is what is shown after the unit boots up. Typical displays are shown in Figures 4 thru 7. There are no sub-menus.

UNIT INFO

This menu allows the operator to display, and sometimes change, basic settings under the following sub-menus:

- ❖ **DATE|TIME:** The WQAR has its own clock and is set at the factory. The WQAR does not use the captain's clock as a basis. After setting the time (UTC), the unit will re-boot.

- ❖ **BOX INFO:** The part numbers and serial numbers of the various hardware components inside the unit are displayed here. The install status of all the OPC (configuration) files as well as the MAC/hardware addresses of the ethernet interfaces are also displayed here.
- ❖ **S/W VERSION:** Displays the part numbers of the Boot and OPS software operating within the unit. The part numbers of the configuration files will also appear here if they are installed in the unit.

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STATUS

This menu allows the operator to display the current status of the hardware inside the WQAR, each having its own sub-menu:

- ❖ **ACQUISITION:** Displays aspects of the flight data coming into the WQAR from the acquisition unit:
 - **RAW:** Displays how many frames of ARINC 717 data have been received and how many have been recorded on to the internal SD card.
 - **RATE:** Displays the speed of the ARINC 717 data that the WQAR expects. When the WQAR is in AUTO mode, the correct rate will not be displayed until data is coming in. This speed is expressed in Words per Second (WPS).
 - **SOURCE:** Displays the type of signal the WQAR expects from the acquisition unit when sending ARINC 717 data.
 - **MESSAGE:** Displays whether ARINC429 message data (report data) is recorded in the unit.

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- ❖ **DISCRETES:** Displays the status of the incoming discrettes, either Active or Inactive:
 - **INTERLOCK:** Allows the operator to monitor the status of the interlock discrettes. A discussion of the RF Interlocks is in Section 1.
 - **RUN CONTROL:** Allows the operator to monitor the status of the Run Control discrete. A discussion of Run Control is in Section 1.
 - **BIPHASE SELECT:** When this discrete is active, the WQAR interprets this as BiPhase signaling. When this discrete is inactive, the WQAR interprets this as Bi-Polar signaling. Refer to Section 1 – Aircraft Signaling, for details on how the WQAR uses this discrete.
 - **SPEED SELECT:** Up to five discrettes may be monitored. Depending on their active/inactive states, the WQAR interprets them to one of the following speeds (WPS): 64, 128, 256, 512, 1024, or 2048. Refer to Section 1 – Aircraft Signaling for details on how the WQAR uses these discrettes.
 - **POWER FAIL WARNING:** For Teledyne Controls Engineering use only.
 - **GP DISCRETE INPUTS:** For Teledyne Controls Engineering use only.
- ❖ **4RF IL Ln/Sel:** Displays the status of each RF Interlock and RF Interlock Select wire pair. An RF Interlock discussion is in Section 1.
- ❖ **WIRELESS:** Displays the status of the hardware inside the WQAR involved with wireless transmission. This menu option cannot be selected if the RF Interlocks are engaged.

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- **REMOVABLE SIM MODULE:** Displays whether the SIM module is installed or not.
- **SIM Status:** Displays the SIM number and the SIM phone number of each installed SIM card as well as radio configuration. Refer to Section 4 – Check SIM Card Configuration, for this procedure.
- **RADIO STATUS:** If power is applied to the radio(s), this menu will display the signal level of each the radio (0 through 32), the firmware version, and radio connection stage. Refer to Section 4 – Monitor Radio Signal Level and Connection Phase, for this procedure.
- **TRANSMISSION STATUS:** This menu displays the files that are currently being transmitted as well as the percent completion.
- ❖ **ETHERNET STATUS:** Displays the status, Up or Down, of the Ethernet network interface on the front and back of the LRU as well as all configured interfaces on the internal Ethernet switch.
- ❖ **CAPACITY:** Displays the amount of free space left within selected recording files in the LRU. The amount of free space is expressed in bytes, % of the theoretical maximum capacity, and in flight hours. The Flight Hours value is calculated using the speed of the data stream (WPS) to which the WQAR is configured. This menu is also used to recycle the WQAR (erase flight data).
- ❖ **FILE INFO:** This option allows the operator to view the actual sizes of the flight data files as they exist on the internal SD card. This menu is also used to display archive files (WGL Files) awaiting transmission.

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DIAGNOSTICS

This menu allows the operator to perform testing on the WQAR. Some of these tests should only be performed by Teledyne Controls engineering staff.

- ❖ **DISPLAY TEST:** Generates test patterns across the front panel display. After the test is initiated, press the MODE button to exit the test.
- ❖ **ACQ SIMULATION:** Allows the operator to test the ability of the LRU to record by generating test data and sending it to the data card. The test data is generated at the speed (WPS) the LRU is configured to. After initiated, this test will continue for 30 minutes or until the test is terminated by pressing the MODE button. If this test is left running long enough, the test data may sent to the base station.
- ❖ **RF INTERLCK TEST:** Tests RF Interlock circuitry inside the LRU. During this test, the radios are disabled.
- ❖ **DISCRETE TESTS:** The menu option allows the operator to activate and deactivate the outgoing discretes: MEDIA LOW and FAIL. Other discretes can be tested here for future release.

Use and disclosure shall be in accordance with the proprietary information notice and DCS on page i.

- ❖ **DOWNLOAD TEST:** Allows the operator to transmit a test file to the Base Station using the cellular radios. This file is not actual recorded flight data. During the test transmission, the file is encrypted but will not be compressed. The operator can choose to send a file of a fixed size or to send a continuous succession of 64MB files for a selected length of time. Once the file(s) arrive at the base station, they will be stored in a folder reserved for test data. If the LRU reboots during a timed-download, the download test will resume after reboot is complete and even through a media recycle. In contrast, a file-size download test will terminate if the unit reboots or is recycled. All test files are uncompressed and do not contain real flight data or system log files. The operator can also abort any transmission if desired. This procedure is located in Section 4 – Perform Test Download.
- ❖ **DOD TEST:** For Teledyne Controls Engineering use only.
- ❖ **ARINC 717 TEST:** When selected, the WQAR will reboot and perform the ARINC717 test. The results of this test will be displayed after the reboot.

(menu continues on following page)

- ❖ **“Disable Radios” (See also “Restore Radios” below):**
Allows the operator to temporarily disable the radios. This effect is immediate and does not require a reboot. While disabled, no diagnostic tests involving the radios can be performed since power will not be applied to the radios at any time. This setting is persistent through power recycles. This procedure is located in Section 4 – Disable Radios.
- ❖ **“Restore Radios” (See also “Disable Radios” above):** This menu option will appear here if the radios had been previously disabled using the “Disable Radios” option above. If the radios were originally listed as enabled in the configuration file, the radios will become enabled. However, if the radios were listed as disabled in the configuration file, the radios will remain disabled. This procedure requires a reboot. This procedure is located in Section 4 – Enable Radios.
- ❖ **Power On Self Test:** For Teledyne Controls Engineering use only.