STAR-3, STAR-4, STAR-5 and STAR-6

RADAR OPERATORS MANUAL

INTERMAP TECHNOLOGIES
DATA ACQUISITION SERVICES

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T. Miller

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DOCUMENT HISTORY

Version	Date	Comment/Description of Change	Author(s)
1.0	September 7, 2004	Initial Issue.	T. Miller
1.1	April 6, 2005	Changes as marked	J. Mitchell
1.2	June 22, 2005	Added Antenna Increment Value & Azimuth Limits	J. Mitchell
1.3	November 7, 2005	Updated Antenna Increment Value & Azimuth Limits, Shutdown Procedure amended	J. Mitchell
1.4	February 1, 2006	Changes as marked	J. Mitchell
1.5	March 23, 2006	Changes as marked	J. Mitchell
2.0	November 1, 2006	Created after the Oct 2006 maintenance period. Document now covers STAR-4 and START-5 platforms	P. Gill
3.0	May 31, 2007	Document now covers STAR-3, STAR-4, STAR-5, and STAR-6 radar systems. Introduction of ULL MCC software and procedures. Changes NOT marked: Most of document is new.	D. Hancock

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1. INTRODUCTION

1.1 Purpose

This document is a reference manual for the operation of a STAR-3, STAR-4, STAR-5, and STAR-6 X-band radar systems. It includes a treatment of the use of Ultra Long Line software and procedures.

1.2 Scope

This document describes the operation of system hardware and software.
This document does not over-ride any training material, and is to be used as reference material by Radar Operators that have completed the proper training, see 1.3 References.

This manual applies to four different radar systems. Two of these systems (STAR-4 and STAR-5) are installed on Beachcraft King Air 200s. STAR-3 and STAR-6 are installed on Lear 36s. While very close in operating procedures and limits; there are differences that the RO must be aware of. It is hoped that the following color code will serve as a reminder regarding parameter/limit differences, whether they arise from the platform or the sensor itself. Although these four sensors are nearly identical, aircraft operating characteristics are not. The RO must be aware of the fact that the platform he is on impacts system operation to some extent.

Manual items that appear in **BLACK** text apply to **ALL FOUR SYSTEMS**:
e.g., PWR DIST PANEL CB'S……..….SET

Manual items that appear in **ORANGE**, apply to one or more, but **NOT ALL SYSTEMS**:
e.g., (STAR-4 ONLY) AUX2 CB……....NOT SET **(STAR-4 ONLY)**

SENSOR	AIRCRAFT TYPE	TAIL NUMBER
STAR-3	**Lear 36**	**N101AJ**
STAR-4	**Beachcraft King Air 200**	**N857GA**
STAR-5	**Beachcraft King Air 200**	**N44U**
STAR-6	**Lear 36**	**N136DH**

Table 1: Sensor and Aircraft Designations

1.3 References

Radar Operations Process & Procedures (DAS.QPM.0022)
STAR-4&5 Radar Operator Course (DAS.PTP.0031)
STAR-4/5/6 Radar Operator Check List (DAS.QCL.0002)
STAR-3 Radar Operator Check List (DAS.QCL.0001)
Process for Kinematic Data Acquisition and Processing (DAS.QPM.0021)
Acquisition Overview Manual (DAS.QPM.0001)
Field Communication Process (DAS.QPM.0004)
Process for GPS Data Logging (DAS.QPM.0006.3)
Radar Maintenance Process (DAS.QPM.0007)
Problem Service Report (DAS.QRF.0003)
Crew Change Report (DAS.QRF.0004)

2. OVERVIEW

Note: Although the MCC software is essentially the same on all four STAR systems, the radar systems themselves have some differences. This is especially true of the STAR-3 system, as compared with the other three. Sections 2.1 and 2.2 examine STAR-3 only. Sections 2.3 and 2.4 discuss of STAR-4, STAR-5 and STAR-6.

2.1 STAR-3 System Overview

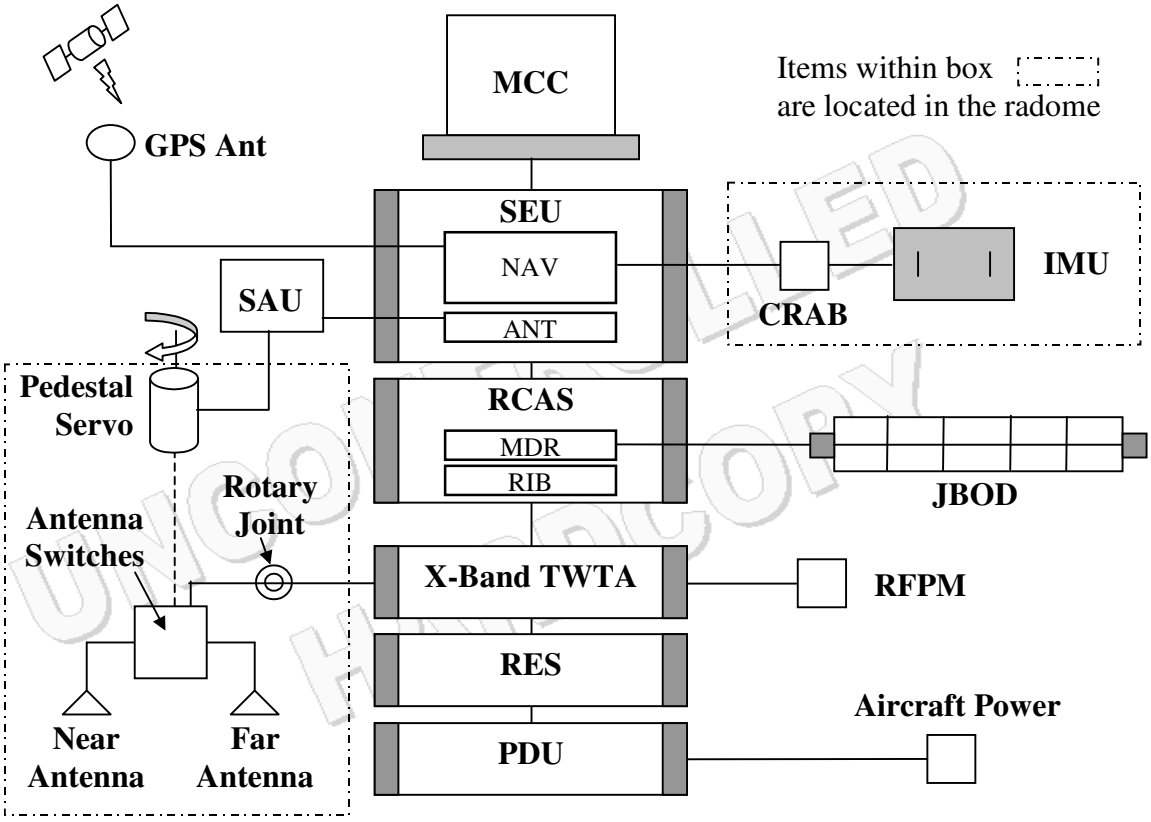


Figure 1: STAR-3 System Schematic

The STAR-3 System is controlled through the ***Master Control Computer*** (**MCC**) via a ***Local Area Network*** (**LAN**). The MCC allows the Radar Operator to control the state of all radar modules in the system. Each radar module receives commands from the MCC, and the MCC records module status and data via TCP/IP and UDP data streams (Internet protocol formatted data).

The laptop is installed with the MCC software ***Graphical User Interface*** (**GUI**), as shown in Figure 4: MCC GUI Overview.

2.2 STAR-3 System Modules

There are six Modules in the STAR-3 system:

1) ***STAR Enclosure Unit*** (**SEU**) – contains the controllers for 2 ***STAR modules***:

   a. ***Antenna Control Module*** (**ANT**) provides control and rotation/positioning of the ***Servo Amplifier Unit*** (**SAU**).
   b. ***Navigation Control Module*** (**NAV**) collects and provides the navigation information from the **GPS Receiver** and **IMU**.

2) ***Servo Amplifier Unit*** (**SAU**) - controls the servomotor in the pedestal, which accurately rotates the antenna assembly.

3) ***Radar Control Acquisition System*** (**RCAS**)

   a. ***Radar Control Acquisition System*** (**RCAS**) – generates the base-band chirp signal, and digitizes the return signal, which is then recorded on the **JBOD**.

   b. ***X-band transmitter module*** (**XTRANS**) - controls the switching of the waveguide and the ***X-band amplifier*** (**TWTA**).

4) ***Receiver Exciter STALO*** (**RES**) – provides the up / down conversion of the X-band signal, and contains the dummy load, attenuators and **STALO**.

5) ***Power Distribution Unit*** (**PDU**) - provides switched power supplies to all radar modules, from the aircraft 28 VDC power supply.

2.3 STAR-4, STAR-5, and STAR-6 Systems Overview

The STAR-4, STAR-5, and STAR-6 Radar Systems consist of 5 radar modules, and a Master Control Computer.

Various external inputs are also used for navigational and data recording purposes. Figure 2 illustrates these inputs.

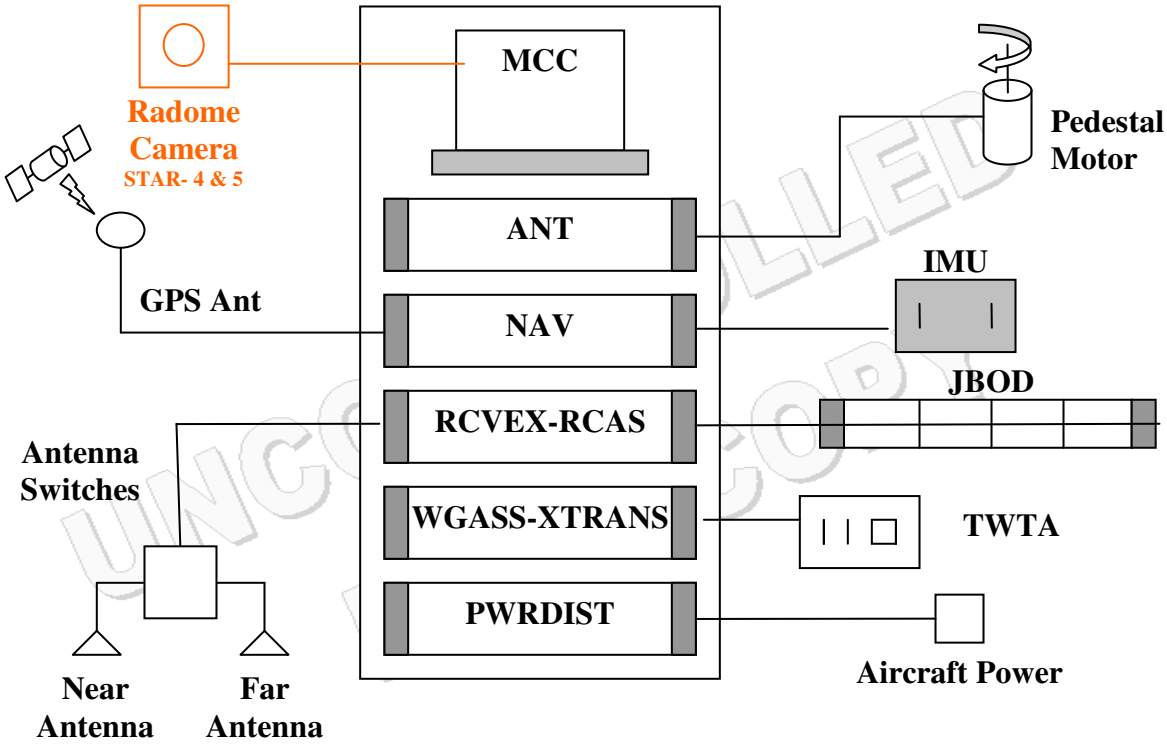


Figure 2: System Schematic

The System is controlled through the ***Master Control Computer*** (**MCC**) via a ***Local Area Network*** (**LAN**). The **MCC** allows the radar operator to control the state of all radar modules in the system. Each radar module receives commands from the **MCC**, as well as status broadcasts over **UDP** between modules. User Datagram Protocol (UDP) transports data as a connectionless protocol (no acknowledgment required – one way)

2.4 STAR-4, STAR-5 and STAR-6 System Modules

There are 5 Radar modules in the STAR-4, STAR-5, and STAR-6 systems:

1) ***Antenna Module*** (**ANT**): The ANT Module controls the servomotor in the pedestal, which accurately rotates the antenna assembly.
2) ***Navigation Module*** (**NAV**): The NAV Module communicates with the **GPS Receiver** and the **IMU**. The collected data is sent via **LAN** to the **MCC**, where it is recorded.
3) ***Receiver Exciter and Radar Control Acquisition System*** (**RCVEX-RCAS**): The RCVEX-RCAS generates the X-band chirp signal, and digitizes the return signal, which is then recorded on the **JBOD**.
4) ***Wave Guide Assembly/X-Trans TWTA Module*** (**WGASS-XTRANS**): The WGASS-XTRABS Module controls the switching of the wave guide and the X-band amplifier (**TWTA**).
5) ***Power Distribution Module*** (**PWRDIST**): The PWRDIST Module provides switched power supplies to all radar modules, from the aircraft 28 VDC power supply.

2.5 STAR-Bus

Critical timing between the radar modules is done via the ***STAR-Bus***. It is a hardware signal-bus relaying synchronization signals between all modules, except the PWRDIST module. The STAR-Bus interface is the same for each module, allowing connections to simply be daisy-chained from unit to unit via the STAR-Bus connector. The bus must be terminated at each end as see in a photo of the module rack.

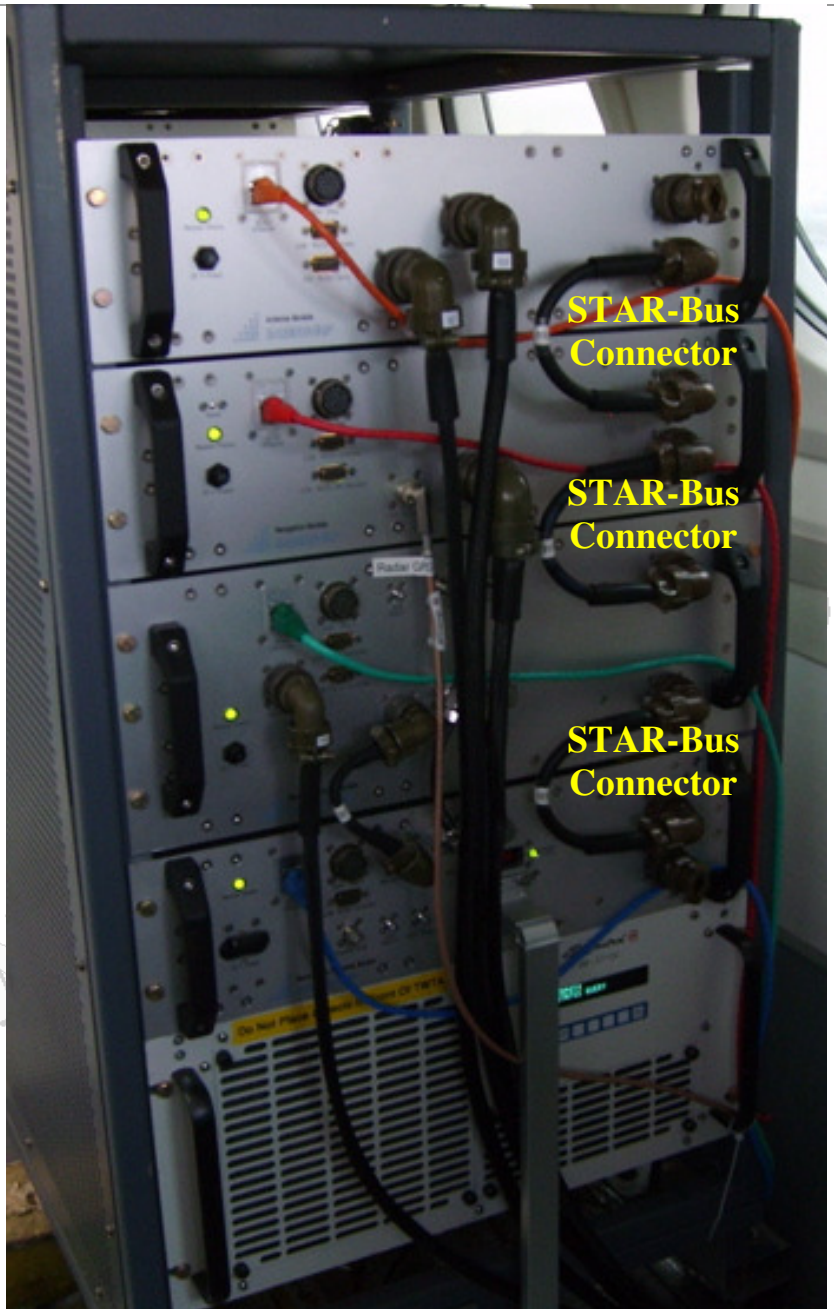


Figure 3: STAR-4 / STAR-5 Rack Arrangement and STAR-Bus Connectors

3. MASTER CONTROL COMPUTER

3.1 MCC Application Graphical User Interface

The radar system is controlled through a laptop computer, called the **MCC laptop**. The laptop runs the **MCC software**, using the Graphical User Interface (**GUI**) shown below:

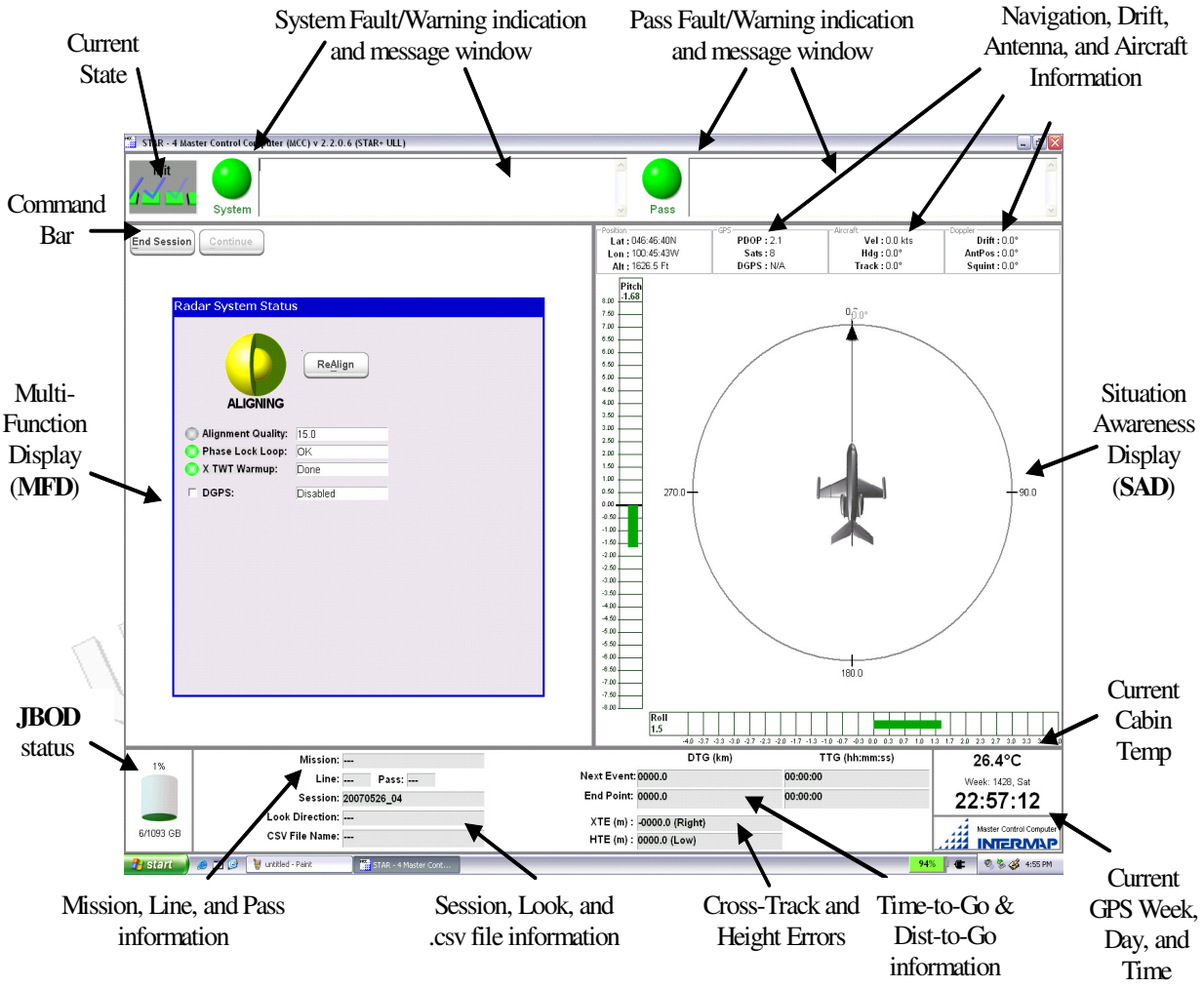


Figure 4: MCC GUI Overview

Command Bar

Option buttons on the command bar that are not available to the RO will be "greyed out".

Note: In addition to the **MCC Laptop** (a.k.a. **MCC Computer**) and the **MCC Software** (a.k.a. **MCC Application**), there is also an **MCC Directory** in the laptop's file structure. Be

cautious when using the term "**MCC**" so as to be clear about which **MCC** you are referring to.

3.2 MCC Directory Structure

The MCC Application is located under d:\MCC. It contains a few useful folders:

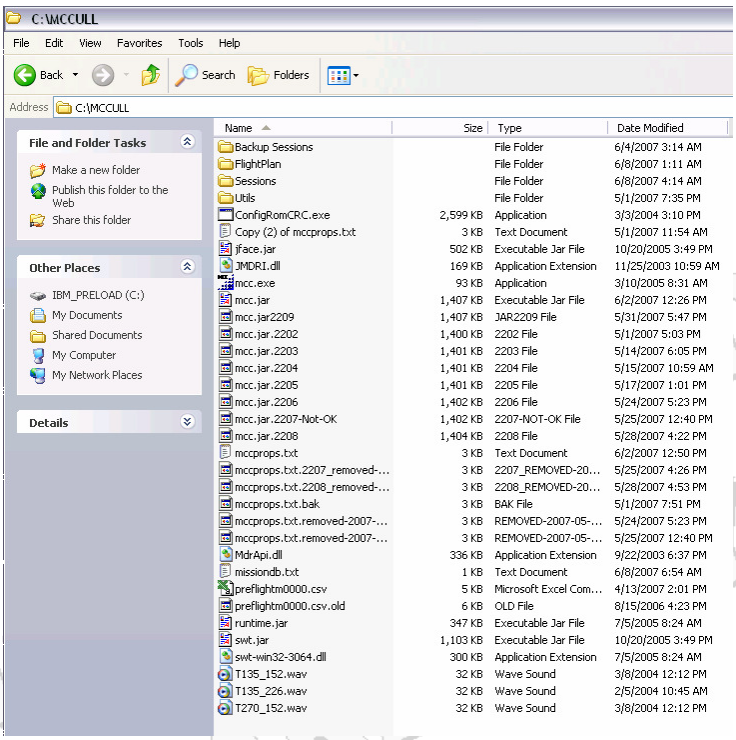


Figure 5: MCC ULL Folders

The MCCULL directory contains any number of files. The RO will routinely be working with the four following directories.

- MCCULL\FlightPlan – location of all CSV / mission files
- MCCULL\Sessions – location of all recorded session data
- MCCULL\Backup Sessions – Storage for previous session data files (five flying days worth).
- MCCULL\Utils – location of various utilities – SNAP OS, Diagnostic tools, MDRShell, etc..

<u>CAUTION:</u> Under no circumstances should this directory structure be changed.

Doing so will cause a system application malfunction.

The following is a discussion of the four folders of interest:

Flightplan Folder: This is the location for all active CSV (comma separated variable) files. These files are read by the MCC application and contain coordinates for the mission and settings for the radar system. Note that there is also an "Old_csv" folder. The RO should place superseded csv. files here as "Reflight .csv's" are issued. This will insure that only the most recent version of any given Missions .csv is present in the Mission window, but older .csv's can be retrieved if needed.

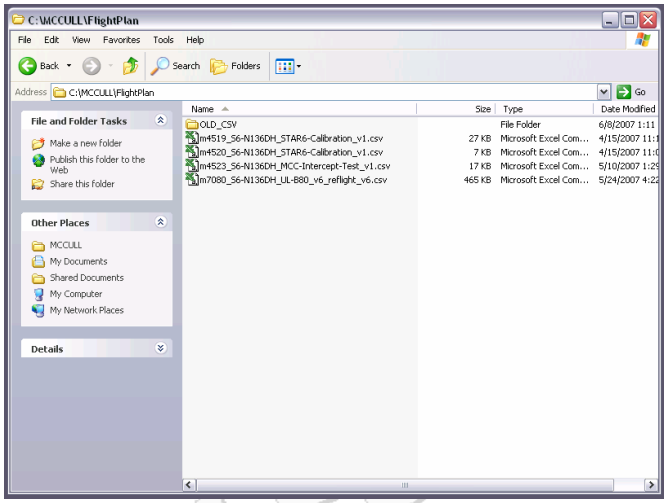


Figure 6: Flightplan Folder

Utils Folder Folder: This is the repository of all Sensor Support diagnotic programs, firmware and other engineering utilities. These programs are used for radar troubleshooting/maintenance and low(er) level analysis.

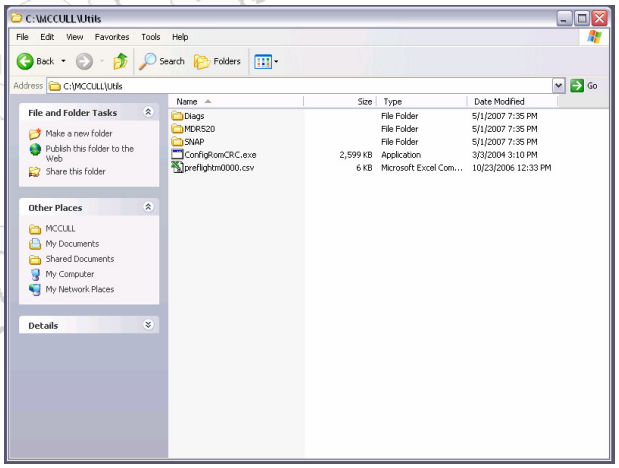


Figure 7: Utils Folder

Sessions Folder: This is the output folder of the MCC application. The folders generated in this folder are labeled using the format: date_# . These files constitute the "Session files," or "NAV data" that the RO transfers to the field office. The MCC software will automatically apply a name to any newly created file based on the current date (e.g., 20070517_01, 20070517_02, etc.). To prevent the creation of multiple session file with the same name, don't move the file from Sessions to Backup Sessions for at least 24 hours.

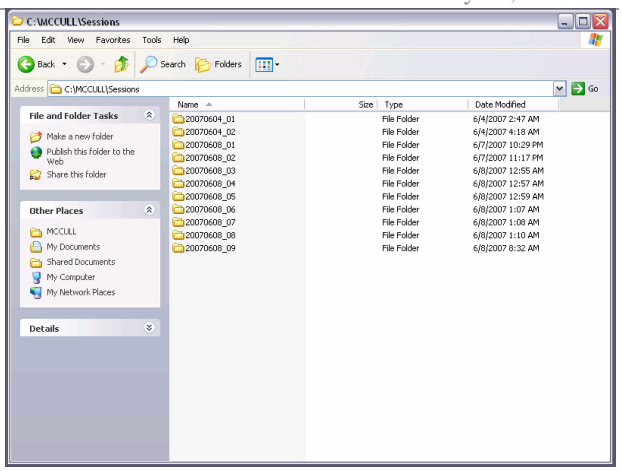


Figure 8: Sessions Folder

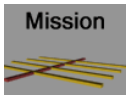
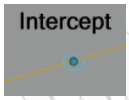
Backup Sessions Folder: This folder, the contents of which looks very much like the Sessions Folder, is provided to the RO so that he can store the previous ***five flying days*** worth of Session files/NAV data.

Note: All common folders and applications will have shortcuts from the desktop.

Note: The RO is not to alter the directory structure of the MCC in any way.

3.3 System States

The MCC changes state as it is operated. The 8 states are as follows:

State	Description
	System Start-up, the system is waiting for all modules to start up.
	All modules have been started successfully. Other systems may not be ready (IMU Aligned, PLL & TWTA warmed up).
	The System has been fully started and initialized, and ready to load a mission. A 'Pre-flight' is normally performed at this point. If required, JBOD files may be deleted.
	A mission has been loaded, and a line may be selected. "End Mission" will return to the Ready state.
	A line has been selected, and the system will intercept the line setup point. Intercept of the Setup point is automatic, but may be forced if required.
	The setup point has been reached, and the system will soon go online. The antenna position can still be adjusted. Intercept of the Start-map point is automatic, but may be forced if required.
	The map-start point has been reached, the system is online, transmitting RF energy, and collecting data. Intercept of the Map-end point is automatic, but may be forced if required.
	The system is busy performing tasks.

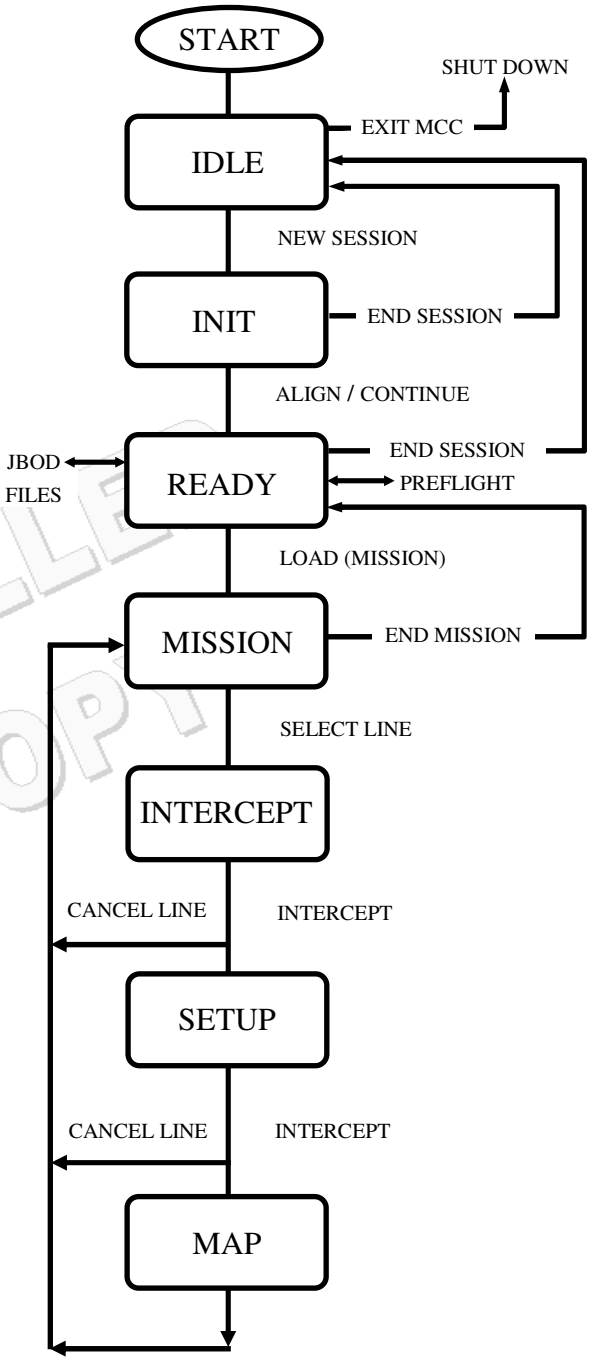
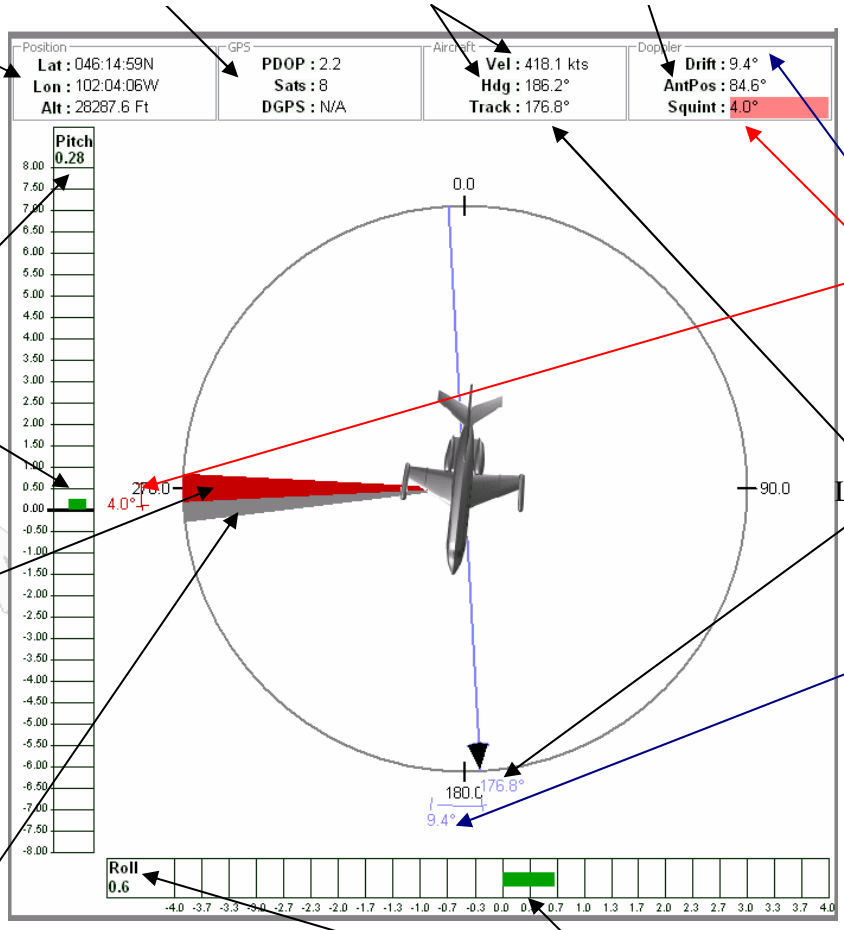


Table 2: System States

3.4 Situation Awareness Display (SAD)

The **SAD** displays real-time information about the aircrafts orientation in space and its' geographic position. It also displays information about the currently selected line.



Longitude, **Latitude**, and **Altitude**.

Note: This is the altitude reading from which the RO should derive his logged "GPS Altitude" value.

GPS Info

Aircraft **Velocity** and Heading

Current Actual **Antenna** Position

Current **Pitch**:

(+0.28,° Nose Up)

Bar will go **RED** when "out of spec."

Squint Angle: 4.0° (Red arc shows difference between actual and ideal antenna looks. Red indicates that current squint is beyond limits.)

Line **Track**: 176.8°

Drift Angle: +9.4° (Blue arc showing difference between Heading and Track)

Colored "beam" indicates **Actual Antenna Look**. A **GREEN** wedge indicates Squint within limits; A **RED** wedge indicates Squint out of spec.

GRAY "beam" indicates **Ideal Antenna Look**. This is also the known as the **Zero Doppler Line**, and is ***ALWAYS*** 90° to the track.

Current **Roll**:

(+0.6,° Right Wing Down)

Bar will go **RED** when "out of spec."

Figure 9: Situational Awareness Display

The Pitch and Roll of the MCC are by default 'filtered' pitch and roll, such that they are averaged over a small time frame.

3.3 Situation Awareness Display (cont'd)

At the top of the **SAD**, the following information is displayed:

Position

- **Lat**: Current GPS Latitude in Degrees: Minutes: Hemisphere (North or South)
- **Lon**: Current GPS Longitude in Degrees: Minutes: Hemisphere (East or West)
- **Alt**: Current GPS Altitude in feet. This figure should be checked against the "Altitude" stated in the Flight Report, and logged on the RO Flight Log.

GPS

- **PDOP**: Current PDOP value received from the GPS. This value is to be logged whenever the MCC GUI indicates that the value is "out of spec."
- **Sats**: The number of satellites currently locked on by the GPS. This value is to be logged whenever the MCC GUI indicates that the value is "out of spec."
- **DGPS**: Indicates if a DGPS signal is received (normally N/A)

Aircraft

- **Vel**: The indicated "velocity" is actually a representation of the "along track vector component" of the total aircraft velocity. As such, it is only an accurate representation of the aircrafts total velocity when the aircraft is parallel to, or has settled on the line (i.e., when the Drift Angle is relatively low).
- **Hdg**: Current heading in degrees. This is essentially "where the aircrafts' nose is pointed."
- **Track**: Current track in degrees. This is defined by the orientation of the line itself and the direction in which it is being flown.

Doppler

- **Drift**: Current Drift Angle in degrees. Drift is the angular difference between Heading and Track. A negative value is left yaw and positive value is right yaw.
- **AntPos**: Current Actual (i.e., NOT to be confused with "Desired") antenna position.
- **Squint**: Current Squint Angle in degrees. Squint is the angular difference between the Actual Antenna Point, and the Ideal Antenna Point (i.e., Zero Doppler).

4. OPERATION

4.1 General

This section outlines the operation of the STAR-3, 4, 5 and 6 radar systems, and is provided as a master reference document to control these systems. It does not contain details about the Radar Operator process - see 1.3 References. Other operator procedures (such as RO Check List, Flight Log sheet completion, Crew Change Reports, or other process / operation changes, normally in the form of an Engineering Change Notice [ECN]), are to be used in conjunction with this document.

4.2 System Inspection / Equipment Preparation.

Before starting the system, a few checks must be completed:

1) External checks: Check the radome and radar absorbing material on wings for any damage or holes.
2) Equipment check. The various components of the radar should be checked for any accidental damage or configuration changes. The following should be checked:
   a. Waveguides: Verify that wave guides are installed securely, and appear in good physical condition. Check for any cracks or other problems.
   b. Cables: Verify that all cables are attached, and undamaged.
3) **STAR-4/5/6** Set the WGASS front panel Waveguide switch to 'ANTENNA'.
4) Load any new CSV files onto the MCC laptop (copy to Flightplan folder).
5) Install the JBOD disk set. ⚠
6) Double check to insure that disks are in the correct order.

⚠ NOTE: When handling static-sensitive devices, observe the Standard Operating Procedure of wearing an anti-static wrist strap attached to aircraft ground.

4.3 STAR-3 System Power Up

While the ULLMCC GUI is essentially common among all four systems, the light-off procedures are not the same. We will first examine STAR-3 start-up procedures.