MX-15i Surveillance System

Operations & Maintenance Manual

TM00358 Rev. A

L3 communications
WESCAM

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Document's Intended Use & Functionality Description. Features and functionality of the system are dependent upon the turret's payload, logic processors and the overall system configuration. Some documented functions may not work in your configuration, as these may be optional features or unconfigured functions.

Document Revisions

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-	Initial Release	ECO1645	2007-07-13
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Warnings & Cautions

IMPORTANT. The following paragraphs list all warnings and cautions which appear in this manual. The warnings and cautions are listed in the order in which they appear throughout the manual (which may cause some to be repeated). Read all before warnings and cautions before commencing with any installation, troubleshooting, maintenance or operation of the system.

- WARNINGS INDICATE POTENTIAL INJURY OR DEATH TO THE PERSONNEL.
- Cautions indicate potential damage to the equipment.

WARNING: TURRET IS A HEAVY ITEM. USE ONLY APPROVED EQUIPMENT AND PROCEDURES FOR UNPACKING AND LIFTING THE TURRET.

WARNING: SUPPLIED MOUNTING SCREWS FOR SERVICE STAND ONLY. DO NOT USE SERVICE STAND MOUNTING SCREWS FOR INSTALLING THE TURRET INTO AN AIRCRAFT.

Caution: Do not over tighten mounting screws. There is no need to torque fasteners but do not exceed 100 in-lbs (11 Nm).

Caution: Never use reclaimed solvents or tissue paper, and only use cloths that conform to AMS 3819 standards.

Caution: Avoid contaminating solvent by applying solvent to new, clean cloths only.

Caution: Use CA 1000 only in application area or to protect worn nickel plating. The turret's interface plate and the aircraft's mounting plate must provide a conductive path to electrically ground out the turret.

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WARNING: AIRWORTHINESS OF THE DESIGN AND IMPLEMENTATION OF INTEGRATING THE SYSTEM ONTO THE AIRCRAFT IS THE CUSTOMER'S RESPONSIBILITY.

WARNING: DANGER ZONE. THE TURRET IS REMOTELY CONTROLLED AND CAPABLE OF CONTINUOUS MOVEMENT FROM DRIVE MOTORS THAT ARE CAPABLE OF FORCES THAT CAN INJURE PERSONNEL.

WARNING: THORIUM FLUORIDE, WHEN CONSIDERED IN ITS FINAL FORM AS AN OPTICAL COATING WITHIN THE INFRARED LENS, PRESENTS NO HAZARD TO PERSONNEL IN THE NORMAL USE, MAINTENANCE, TRANSPORTATION OR STORAGE OF THE SURVEILLANCE SUBSYSTEM. HOWEVER, SHOULD THE INFRARED LENS BECOME DAMAGED OR BROKEN, THE MATERIAL MUST BE HANDLED AND WASTE DISPOSED OF IN ACCORDANCE WITH STATE AND/OR FEDERAL REGULATIONS. IN THE EVENT OF A BROKEN OR DAMAGED INFRARED TELESCOPE ASSEMBLY, THE FOLLOWING PROCEDURES MUST BE FOLLOWED:

- **WEAR EYE PROTECTION, A FILTER MASK TO COVER THE MOUTH & NOSE AND GLOVES WHEN HANDLING BROKEN GLASS.**
- **PICK UP ALL PIECES OF BROKEN GLASS AND PLACE IN A DOUBLE PLASTIC BAG**

AND SEAL.

- **WIPE UP SUSPECTED CONTAMINATED AREAS WITH RYMPLECLOTH OR LENS TISSUE MOISTENED WITH ISOPROPYL ALCOHOL.**
- **PLACE CLEANUP MATERIALS IN A DOUBLE PLASTIC BAG AND SEAL.**
- **WASH HANDS IMMEDIATELY AFTER CLEANUP IS COMPLETE.**
- **DISPOSE OF MATERIALS AS LOW LEVEL RADIOACTIVE WASTE PER LOCAL BIO-ENVIRONMENTAL ENGINEERING OFFICE DIRECTIVES.**

WARNING: TURRET IS A HEAVY ITEM. USE ONLY APPROVED EQUIPMENT AND PROCEDURES FOR UNPACKING AND LIFTING THE TURRET.

WARNING: DANGER ZONE. THE TURRET IS REMOTELY CONTROLLED AND CAPABLE OF CONTINUOUS MOVEMENT FROM DRIVE MOTORS THAT ARE CAPABLE OF FORCES THAT CAN INJURE PERSONNEL.

Caution: Chips or cracks in turret windows are not air safe. If detected, contact an L3 Wescam Customer Service representative.

Caution: Do not power wash the turret.

Caution: Never wipe a dry window with a dry cloth. Embedded debris will scratch the surface.

Caution: Never use tissues or paper towels. Such products contain abrasives.

Caution: Never allow wet windows to air dry as the surface will stain permanently. Do not start this procedure unless you have sufficient time to follow all steps or while you are completing other maintenance tasks.

Caution: Do not scrape bonded particles that cannot be removed with compressed air. Soak the particles and allow them to loosen.

WARNING: ALTHOUGH INERT, THE NITROGEN GAS YOU WILL BE HANDLING IS COMPRESSED AND THEREFORE SHOULD BE TREATED WITH THE CARE ANY COMPRESSED GAS REQUIRES. REVIEW ALL MATERIAL SAFETY DATA SHEETS (MSDS) TO ENSURE SAFE HANDLING.

Caution: Turret's purge valve damages easily. Hang and isolate the supply hose to make sure the purge valve does not bear the weight of the air hose and chuck. The purge valve could break off if the hose is moved or kicked accidentally.

Caution: When purging, the nitrogen feed pressure should never exceed 0.35 kg/cm² (5 psi). Otherwise, you risk damaging internal valves and other sensitive parts.

WARNING: DANGER ZONE. THE TURRET IS REMOTELY CONTROLLED AND CAPABLE OF CONTINUOUS MOVEMENT FROM DRIVE MOTORS THAT ARE CAPABLE OF FORCES THAT CAN INJURE PERSONNEL.

WARNING: DANGER ZONE. THE TURRET IS REMOTELY CONTROLLED AND CAPABLE OF CONTINUOUS MOVEMENT FROM DRIVE MOTORS THAT ARE CAPABLE OF FORCES THAT CAN INJURE PERSONNEL.

WARNING: READ DESICCANT MATERIAL MSDS. REVIEW THE MATERIAL SAFETY DATA SHEETS (MSDS) SECTIONS FOR MATERIAL HANDLING, REACTIVITY AND MATERIAL DISPOSAL BEFORE REPLACING ANY DESICCANT MATERIAL.

WARNING: AVOID DESICCANT MATERIAL CONTACT WITH SKIN, INGESTION OR INHALATION OF DUST. WHEN FIRST EXPOSED TO WATER, THE DESICCANT MATERIAL BECOMES VERY HOT.

Caution: Make sure no water enters the desiccant enclosure during desiccant exchange.

Caution: Remove the breather valve while it is facing upwards so desiccant material does not spill out.

Caution: Do not over fill or pack the desiccant material. Room must be left for the filler port to seat properly.

Caution: Store and pack the turret by following the procedures defined in Chapter 4 of this manual. When shipping items, it is the customer's responsibility to correctly pack and obtain insurance. L-3 Wescam is not liable for any damage that occurs during shipment.

Caution: Use anti-static, Electrostatic Discharge (ESD), pink bubble wrap only. For all self pack LRUs, use safe ESD bubble wrap to protect electrical components during shipment.

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1 System Overview

This chapter provides a system overview and details various component specifications.

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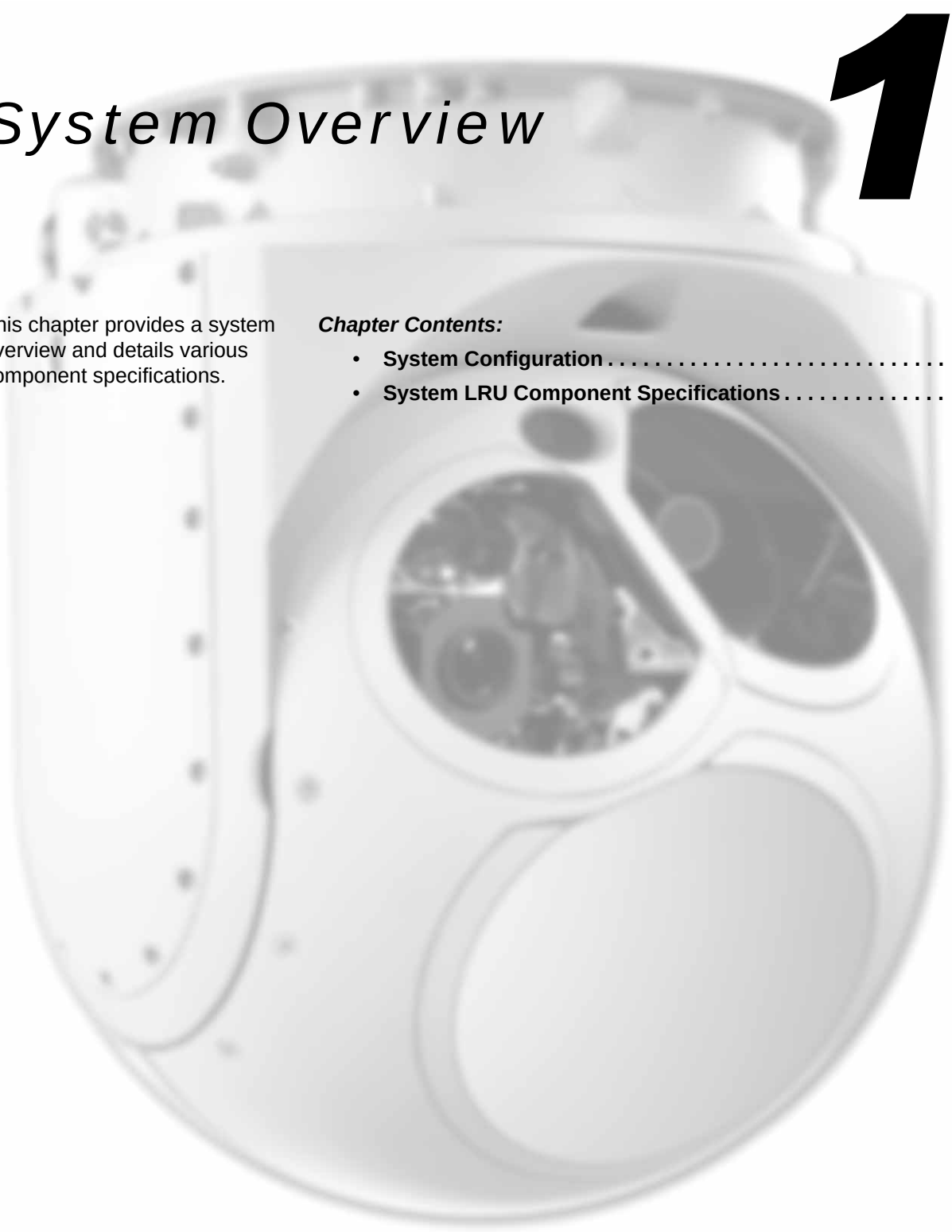


1.1 SYSTEM CONFIGURATION

The MX-15i system consists of two main components:

- Turret
- Hand Controller

The turret provides hardware and software functions that allow crew members to operate the MX-15i system using the Hand Controller as the operator controls. External communication interfaces can be utilized to control operation remotely through aircraft computer systems.

The turret contains a video switching matrix that manages output to external display monitors, video tape recorders (VTR) and other associated video equipment. Graphical overlays on top of the displayed video provide the primary method for viewing system status information. Infrequently used status information and other control parameters are viewed through user menus.

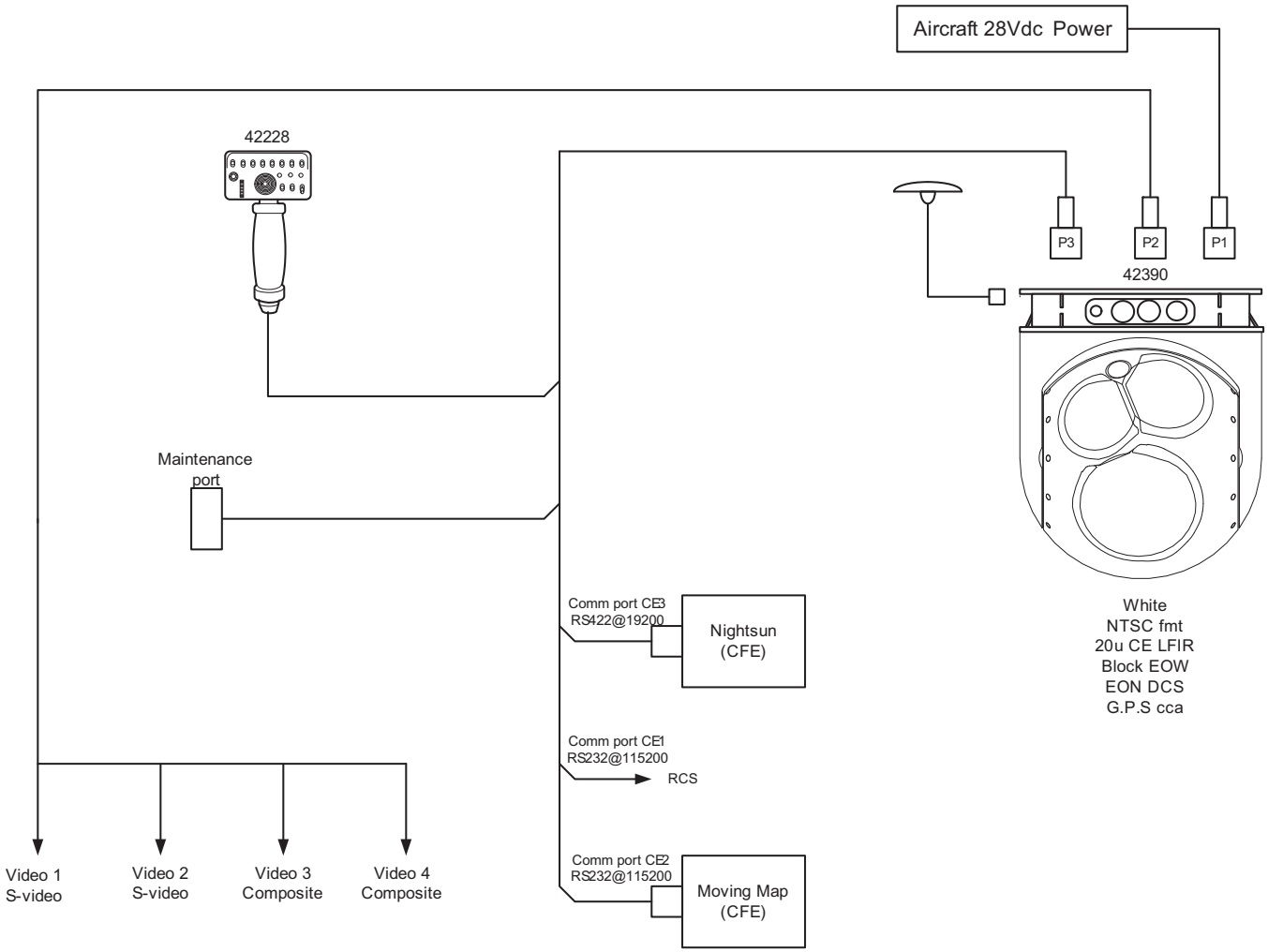


Figure 1-1 System Configuration

Table 1-1 System Components

Equipment	Product Name	Supplier	Part Number	Qty
Turret	MX-15i containing a payload of: • EOW – Daylight Zoom Camera with continuous zoom lens • IR – Thermal camera with stepped zoom lens • EON – MX-Day/Night Spotter™ with a fixed focal length lens Features: • Gen 3.0 IR Video Processing circuit card assembly • Moving Map and NightSun Communication interfaces enabled. • NTSC video format	L-3 Wescam	42390	1
Operator Interface	• Hand Controller	L-3 Wescam	42228	1
GPS Antenna	Omni, Hemispherical	L-3 Wescam	GPS-511	1

1.1.1 Power

All turret system components operate on +28 VDC that is supplied from the aircraft. The turret is wired into the aircraft power feed and routes +28 VDC power to the Hand Controller and +5 VDC to the GPS antenna. The POWER switch on the Hand Controller both applies and removes power to the turret.

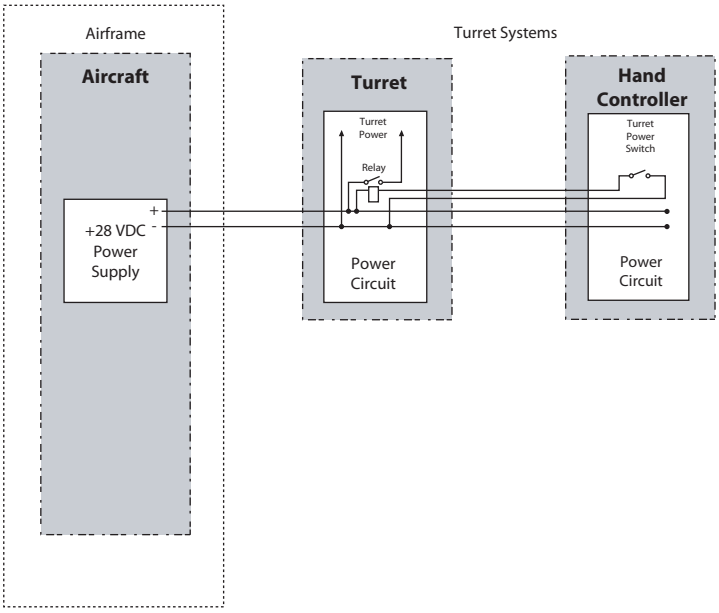


Figure 1-2 MX-15i System Power Distribution

Powering Up the Turret While On Ground

1. Make sure the aircraft is supplying power to the turret systems.
2. From the Hand Controller, lift up on the POWER switch and push forward.
3. The turret will cycle steering positions and return to the STOW position.

Note: After system power up and the IR cooling message is no longer displayed, the focal panel array continues to stabilize after it has been cooled to operating temperature. Performing periodic 1-Point calibrations, specifically 5 minutes after the cooling message, will help optimize the IR video imagery.

1.1.2 Communications

The system uses digital controls, including those for the turret. All operational communications are through RS-422 links. Control functions are distributed amongst multiple microprocessors.

Table 1-2 Supported Communication Protocols and Interfaces to External Systems

Protocol	Number	Purpose	Notes
100BaseT Ethernet	1	RCS comms	• Optional
MIL-STD-1553 Terminal	1	INS or RCS comms	• Optional
ARINC 429	1	INS comms	• Optional • 2x Receive, 1x Transmit
RS-232	4	Isolated comms	• Optional • Customer Restricted Maintenance Ports
RS-422	2	Operator Control Interface	
RS-422/232	5	Isolated Software comms	Optional interfaces: • RADAR • UWave • Map • NightSun • Sensor data • RCS/RCS Status

1.1.3 Video Switch Matrix

A video switch matrix manages analog video inputs from all imaging sensors. The video switch matrix also manages routing of all analog video outputs. Prior to output to an external display, the switch matrix applies graphical overlay annotations to the sensor video. The MX-15i features an 8x8 S-Video matrix with:

- 3 overlay annotation layers (one for each imaging sensor)
- 4 video outputs

Operators can enable or disable display of the overlay in the video output

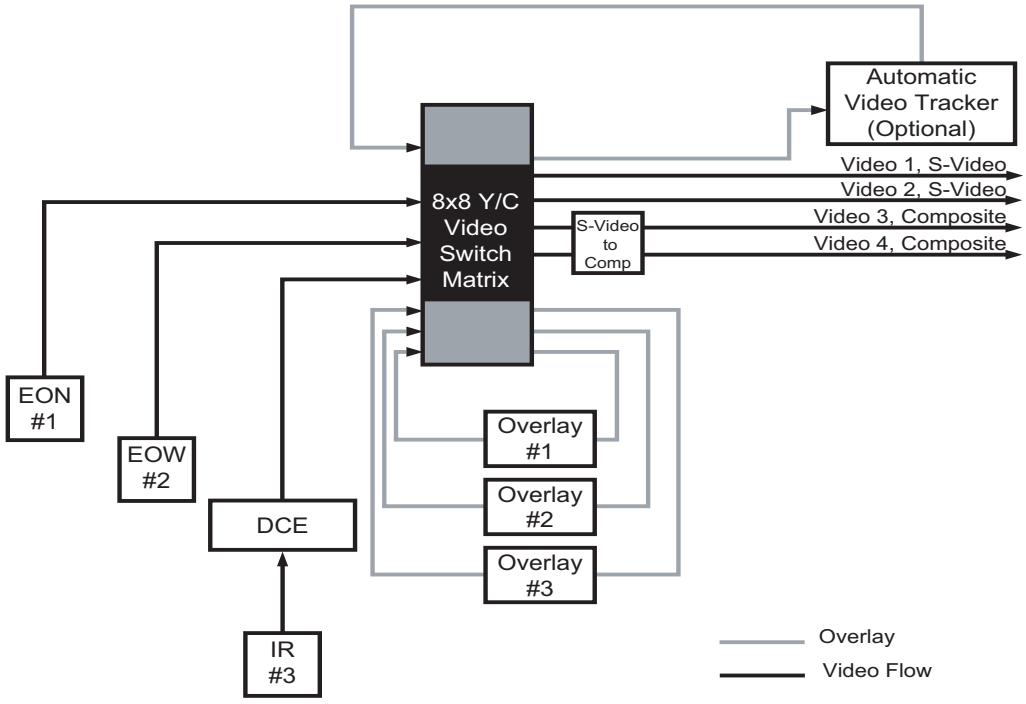


Figure 1-3 Simplified Sensor Video Flow

Video Annotation

Status graphics or text are rendered atop the analog video by 3 independent annotation streams – one for each of the EOW, IR and EON sensors. System and sensor data are presented as either overlay status information over the captured video or as on-screen user menu displays with no sensor video. The annotations are applied by the video switch matrix before outputting to display.

Video Sync Detection

A built-in video sync detector monitors for potential video signal loss from the turret. If video from the turret is lost, a BIT message will be displayed to report the failure.

1.2 SYSTEM LRU COMPONENT SPECIFICATIONS

Table 1-3 Turret LRU Specifications

Item	Description	Notes
Nomenclature	MX-15i	Part Number: 42390
Weight	~40.8 - 45.4 kg (~90 -100 lbs)	Weight depends on final configured payload
Dimensions	39 cm ø x 48 cm (15.5” ø x 18.95”)	
Input Power	• +28 VDC, 10 amps average • 30 amp maximum (<0.35s)	Nominal demand (steady state) of less than 10 amperes. This includes a conservative allocation of the average power demand due to field of view, focus change and a steering command of a few deg/sec.
Payload Sensors		
Payload Sensor #1	• EOW – Daylight Camera with continuous zoom lens	Focal Length: • Optical: 2.4-60 mm, Digital: 60-180 mm Field-of-View: • Optical: 47.18°-2.0°, Digital: 2.0°-0.67°
Payload Sensor #2	• IR – Thermal Camera with stepped zoom lens	Focal Lengths: • 27 mm, 135 mm, 675 mm, 2024 mm* Fields-of-View: • 26.67°, 5.43°, 1.09°, 0.36° Note: **Optical focal length is 1012 mm. Apparent focal length achieves* 2024 mm *when a 2x electronic zoom is applied*
Payload Sensor #3	• EON – MX-Day/Night Spotter™ with a high magnification, fixed focal length lens	Focal Length: • 1000 mm Field-of-View: • Daylight: 0.28°, Lowlight: 0.30°
Environmental		
Cooling	Passive convection cooling	Continuous operation at temperatures above 35°C (95°F) only in flight. For ground operations where the temperature is above 35°C (95°F), restrict operations to a duty cycle of 1 hour on, 4 hours off.
Operating Temperature	-51°C to 55°C (-60°F to 131°F)	
Storage Temperature	-55°C to 80°C (-67°F to 176°F)	

Table 1-3 Turret LRU Specifications (Continued)

Item	Description	Notes
Storage Humidity	95%, 24 hours	
Max Altitude	12 802m (42 000 ft.) above sea level	
Max Airspeed	350 Knots indicated airspeed (operational) 425 Knots indicated airspeed (non-operational)	Mounted external to aircraft

Table 1-4 Hand Controller LRU Specification

Item	Description	Notes
Nomenclature	Hand Controller	• Part Number: 42228 • Configurations: Single or multi-control
Weight	0.8 kg (1.8 lbs) max per unit	Does not include the weight of the cable and connector
Dimensions	11.4 cm (w) x 21.8 cm (h) x 7.6 cm (d) (4.5” [w] x 8.6” [h] x 3” [d])	Attached cable length is customer specified.
Input Power	+28 VDC	Derived from Turret connection.
Environmental		
Operating Temperature	-40°C to 55°C (-40°F to 131°F)	
Storage Temperature	-55°C to 85°C (-67°F to 185°F)	
Max Altitude	< 3353m (<11 000 ft) above sea level	Limit for a non-pressurized environment only

Table 1-5 GPS Antenna LRU Specification

Item	Description	Notes
Nomenclature	Omni, hemispherical, low profile antenna	Part Number: GPS-511
Weight	0.14 kg (0.3 lbs)	
Dimensions	1.5 cm (h) x 8.9 cm (dia) (0.6” [h] x 3.5” [dia])	
Input Power	+4.0 to +24 VDC	
Frequency Band	L1 carrier signal	
Environmental		
Operating Temperature	-55°C to 85°C (-67°F to 185°F)	

Table 1-5 GPS Antenna LRU Specification (Continued)

Item	Description	Notes
Storage Temperature	-55°C to 85°C (-67°F to 185°F)	
Max Altitude	>-30m and <16 764m above sea level (>-100 and <55 000 ft. above sea level)	

2 Operational Information

This chapter describes how an operator would utilize the Hand Controller and navigate through the system's user menus and controls.

Chapter Contents:

2.1 HAND CONTROLLER CONTROLS

Operators can use the Hand Controller to perform the following functions:

- Turn turret power ON or OFF
- Steer the turret
- Control system sensors
- Change mode settings
- Access and navigate the user menus
- View power and laser status indicator LEDs

The Hand Controller is used for the most common operator functions. All operator control descriptions, assume default settings of the Level 2 Operator Gimbal Menu. A number of parameters in the Level 2 Operator Gimbal Menu can be used to tailor operation of the Hand Controller; however, tailoring is optional and not normally required.

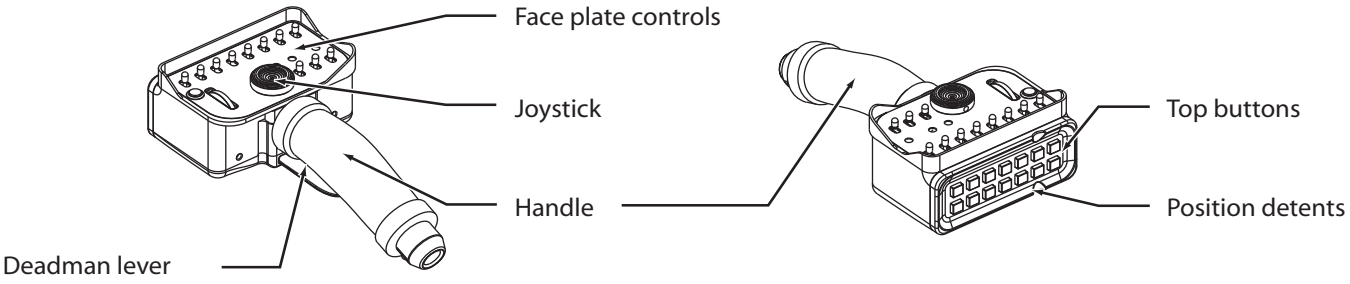


Figure 2-1 Hand Controller

2.1.1 Hand Controller – Primary Switch Controls

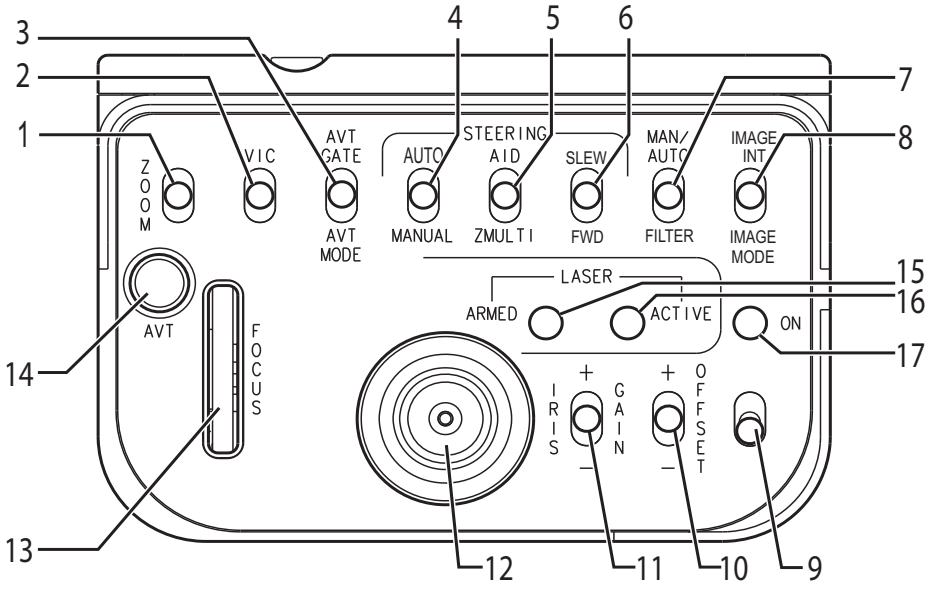


Figure 2-2 Hand Controller Face Plate Switches

Table 2-1 Hand Controller Primary Switch Controls

Item	Control		Description
		SWITCHES AND CONTROLS	
(1)	ZOOM switch		Sensor: • For the Video-In-Control (VIC), click up to zoom-in on the video image. • For the VIC, click down to zoom-out of the video image. Menu: • When in a user menu, click up or down to navigate one step in the menu options. • When in a user menu, hold up or down to scroll through the menu options. Note: The VIC's sensor must have zoom capability. Note: For sensors with a stepped zoom, click once and allow switch to return to its neutral position.
(2)	VIC switch		• Click up to change the Video-In-Control (VIC) to another sensor view. Note: The VIC is the sensor that is affected by all common controls, e.g. zoom and focus.
(3)	*AVT GATE switch		• Click up to select an AVT gate size. Note: The AVT button must also be pressed and held when selecting gate size.
	*AVT MODE switch		• Click down to select an AVT tracking algorithm.
(4)	*AUTO switch		• Click up to enable an Auto (Geo Position) steering mode.
	MANUAL switch		• Click down to enable a Rate (Manual) steering mode. Note: Excluding Stow, this selection will cancel all other disabled, assisted or automated steering modes.
(5)	AID switch		• When operating in a Rate (Manual) steering mode, click up to enable a Rate-Aid steering mode. • When operating in an Auto steering mode, click up to enable an Auto-Aid steering mode.
	ZMULTI switch		• Click down to enable or disable the slew transducer's automated steering sensitivity adjustment. Note: For the Video-In-Control, turret steering will speed or slow to compensate for focal length changes. Unzoomed viewing will steer quickly while zoomed viewing will be less responsive.
(6)	SLEW switch		• Click up to have the turret steered to a position supplied by a radar, moving map system, or other external data sources.
	FWD switch		• Click down to steer the turret to a known fixed position.

** Optional functions. These controls will have no effect if the hardware or software features have not been integrated as part of the turret system.*

Table 2-1 Hand Controller Primary Switch Controls (Continued)

Item	Control		Description
(7)	MAN/AUTO switch		• Click up to enable or disable the automatic sensitivity for the Video-In-Control. • When in Manual mode, use the SENS switch to change sensitivity. Note: Sensitivity is similar to a brightness control on a television or computer monitor.
	*FILTER switch		• Click down to cycle through the VIC sensor's available filters. Note: Filters options are hardware and software specific.
(8)	*IMAGE INT switch		• Click up to select the intensity of an applied Image Processor mode.
	*IMAGE MODE switch		• Click down to select an available Image Processing mode. Note: The factory default setting for the Image Processor is disabled in the Video I/O user menu. Operators must select and input source to enable an Image Processing mode.
(9)	POWER switch		• Lift up and push forward to enable turret power. • Lift up and pull back to disable turret power. Note: This is a protected switch with detents that prevents accidental switching. You must lift up to pass the detent to either enable or disable system power.
(10)	OFFSET switch		IR Sensor: • When in Manual Sensitivity mode, click up to increase the IR temperature offset. • When in Manual Sensitivity mode, click down to decrease the IR temperature offset. EOW & EON Sensors: • Click up to increase the video's black level. • Click down to decrease the video's black level. Note: Offset sensitivity is similar to the contrast control on a television or computer monitor.
(11)	SENS switch		IR Sensor: • When in Manual Sensitivity mode, click up to increase the sensitivity value. • When in Manual Sensitivity mode, click down to decrease the sensitivity value. EOW & EON Sensors: • When in Manual Sensitivity mode, click up to increase the sensitivity value. • When in Manual Sensitivity mode, click down to decrease the sensitivity value. Menu: • When in a user menu, click up or down to change selected field values. Note: Iris/Gain sensitivity is similar to the brightness control on a television or computer monitor.

** Optional functions. These controls will have no effect if the hardware or software features have not been integrated as part of the turret system.*

Table 2-1 Hand Controller Primary Switch Controls (Continued)

Item	Control		Description
(12)	Slew Transducer joystick		• Press up or down to change the elevation position of the turret. • Press left or right to change the azimuth position of the turret. Map Mode: • Moves map screen cursor.
(13)	FOCUS dial		• For the Video-In-Control, scroll up or down to adjust the VIC sensor's focus.
(14)	*AVT button		AVT Mode: • Push and hold the button to enable AVT function. • Release button to set the target lock. Map Mode: • Press button to initiate a left mouse click on a Moving Map.
	*Deadman lever		• Pull in to allow arming of the Laser Illuminator. • Release to disarm the Laser Illuminator.
		STATUS LIGHTS	
(15)	*ARMED status light	○	• Lit LED indicates that the Laser Illuminator is armed. • Unlit LED indicates that the Laser Illuminator is disarmed.
(16)	*ACTIVE status light	○	• Lit LED indicates that the Laser Illuminator is firing. • Unlit LED indicates that the Laser Illuminator not firing.
(17)	ON status light	○	• Lit LED indicates that the turret is powered. • Unlit LED indicates that the turret has no power.

** Optional functions. These controls will have no effect if the hardware or software features have not been integrated as part of the turret system.*

2.1.2 Hand Controller – Secondary Button Controls

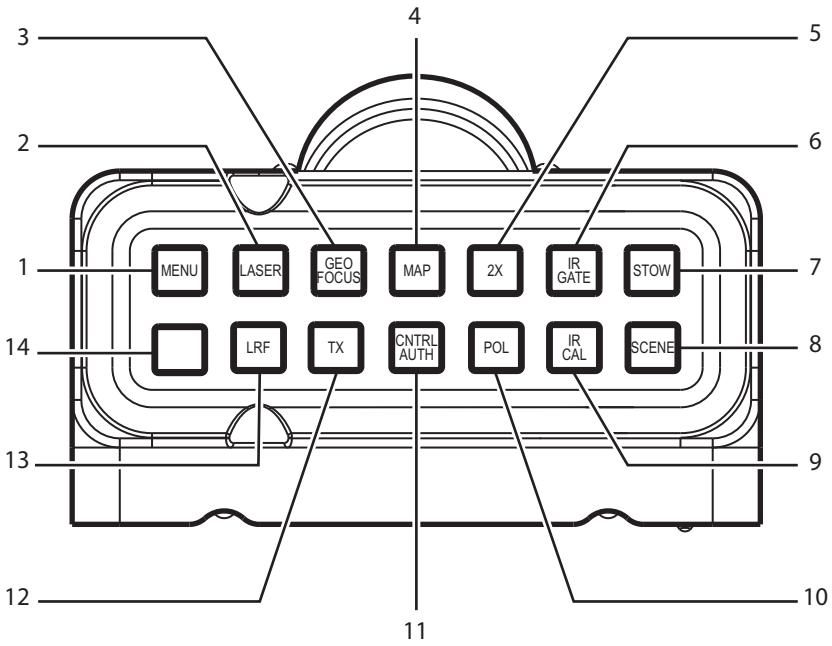


Figure 2-3 Hand Controller Top Buttons

Table 2-2 Hand Controller Secondary Button Control Functions

Item	Control		Description
(1)	MENU button	MENU	Menu: • Press once to display the user menus. • When in a user menu, press once to select a menu option. • Press and hold for 2 seconds to exit from all user menus. Sensor: • For the Video-In-Control, press to clear displayed Pop-up alerts.
(2)	*LASER button	LASER	• Press and hold for 2 seconds to fire the Laser Illuminator. Note: Laser will only fire when all arming conditions are met.
(3)	*GEO FOCUS button	GEO FOCUS	• Press to enable or disable sensor Geo Focus. • Push and hold for 2 seconds to enable Geo Focus Trim mode. Use the focus wheel to adjust the sensor's focus. • When in Trim mode, press once to return to Geo Focus with trim settings applied. Note: In Geo-focus mode, all sensors are auto-focused to a distance set by the range-to-target value. Note: In Trim mode, the focus wheel sets a trim offset that compensates for errors in calculated or measured target distances.

** Optional functions. These controls will have no effect if the hardware or software features have not been integrated as part of the turret system.*

Table 2-2 Hand Controller Secondary Button Control Functions (Continued)

Item	Control		Description
(4)	*MAP button		• Press to enable Hand Controller steering control of a moving map cursor position. Note: Functionality depends on system integration. If you press the button and cannot steer the turret, press button once more to regain steering control.
(5)	2X button		• Press once to enable 2x E-Zoom for the IR sensor. • Press twice to enable 4x E-Zoom for the IR sensor. • Press a third time to disable E-Zoom for the IR sensor.
(6)	IR GATE button		• Press to toggle through gate size options. Note: Gate size samples an area of contrast level in an IR image. The system software then applies the sampled level to balance the entire IR image.
(7)	STOW button		• Press to enable automated steering control of the turret to the Stow position.
(8)	SCENE button		EOW & EON Sensors: • Press to change scene type to compensate for high or low image contrast. IR Sensor: • Press to change scene type to compensate for high or low image contrast. Note: Scene will provide new parameters for video correction after a 1-Point calibration is initiated. Press the IR CAL button after pressing the SCENE button.
(9)	IR CAL button		• For the IR sensor, press to initiate a 1-Point calibration.
(10)	POL button		• For the IR sensor, press to change polarity of the video image from white hot to black hot.
(11)	*CNTRL AUTH button		• Press to transfer steering control authority in a multi Hand Controller configuration.
(12)	*TX button		• Press to enable or disable MX-POD microwave transmission. Note: On some Hand Controllers, this button may have no label.

** Optional functions. These controls will have no effect if the hardware or software features have not been integrated as part of the turret system.*

Table 2-2 Hand Controller Secondary Button Control Functions (Continued)

Item	Control		Description
(13)	*LRF button		• Press once to enable the Laser Range Finder. • When the laser is enabled, press once for a single fire of the laser. • When the laser is enabled, press and hold for 2 seconds to fire the laser in a continuous Pulse mode.
(14)	(*SPARE)		• Spare button for optional system integration.

** Optional functions. These controls will have no effect if the hardware or software features have not been integrated as part of the turret system.*

2.1.3 Slew Transducer & Turret Steering

The slew transducer is a joystick that operators use to steer the turret in azimuth and elevation directions. Response of the slew transducer to user inputs will change based upon the type of steering modes and filters that have been selected. Based on changing mission objectives, operators should select an appropriate steering mode that will help them to maintain a continuous video capture of the subject. There are four types of steering control:

- Disabled in a fixed position
- Manual for full operator control
- Assisted for panning and tilting movements
- Automated full system steering control

Table 2-3 Slew Transducer Functions for MX-15i System Steering Modes

Steering Mode	Steering Control	Overlay Label	Slew Transducer Function
Stow	Disabled (Fixed Position)	STOW	• System steers turret to its storage position. • Operator has no steering control of turret. • Slew transducer disabled.
Forward	Disabled (Fixed Position)	FWD	• System steers turret to a fixed, forward-pointing position. • Operator has no steering control of turret. • Slew transducer disabled. Note: Operators use this position to regain steering orientation and the default system position can be reconfigured from the user menu.
Rate	Manual	MAN	• Operator has full steering control of turret. • Steering speed is proportional to pressure applied to slew transducer.
Rate Aid	Manual Assisted (Thumb Pressure Priority)	RAID	• From a Rate steering mode, system will pan and tilt the turret at a fixed speed. • Operator pressure on the slew transducer is sampled to sustain a continuous movement. Note: Slew transducer ignored until the sensor has been in Rate Aid mode for 1 second.

** Optional steering mode.*

Table 2-3 Slew Transducer Functions for MX-15i System Steering Modes (Continued)

Steering Mode	Steering Control	Overlay Label	Slew Transducer Function
Auto	Automated (Geo Position Locked to Selectable Position)	AUTO	• To maintain a locked image position on ground, system steers turret to compensate for changes in vehicle movement. • Pressing the slew transducer will update to a new Geo Position coordinates.
Auto Aid	Auto Assisted (Turret Movement Priority)	AAID	• From an Auto steering mode, system will pan and tilt the turret at a fixed speed to compensate for target movement on ground. • Turret movement is measured to sustain a continuous movement.
Zmulti	Assisted (Focal Length Priority)	MAN (Reverse Video)	• Zoom multiplier scales the slew transducer's sensitivity to the focal length of the Video-In-Control. • For sensors at a long focal length (narrow FOV), the turret will automatically slow steering response. • For sensors at a short focal length (wide FOV), the turret will speed steering response.
Slew	Automated	AUTO	• System steers turret to fixed coordinates supplied by radar, moving map, or other external source. • Operator has no steering control of turret. • Slew transducer disabled until turret reaches position.
Autoscan	Automated	SCAN	• System steers turret in a defined sweep pattern. • Operator has no steering control of turret. • Slew transducer disabled. Note: Steering sweep is software configurable and can be defined by an operator.
***Automatic Video Tracker**	Automated	AVT	• System steers turret to remain on a locked target. • When locked on a target, operator has limited steering control. The center reticle can be moved off target (slight offset) to permit limited scene investigation.
***Geo-Scan**	Automated	GSCN	• System steers turret in a user defined sweep pattern. • Operator has no steering control once Geo-Scan is initiated. • Slew transducer disabled.

** Optional steering mode.*

2.2 VIDEO STATUS OVERLAYS

The MX-15i system presents video images with a combined graphical overlay. The overlay contains four types of user feedback information:

- graphical aids for aiming and steering orientation
- system alerts or warning messages
- status information about the turret or payload sensors
- status information about the aircraft's and the target's geographic positions

Each imaging sensor can be configured individually to either remove or restore various elements from the overlay display. However, system alerts or warning messages cannot be disabled and will remain displayed in the video output until cleared by the operator.

Note: The system will not display overlay graphics for optional functions that are not present.

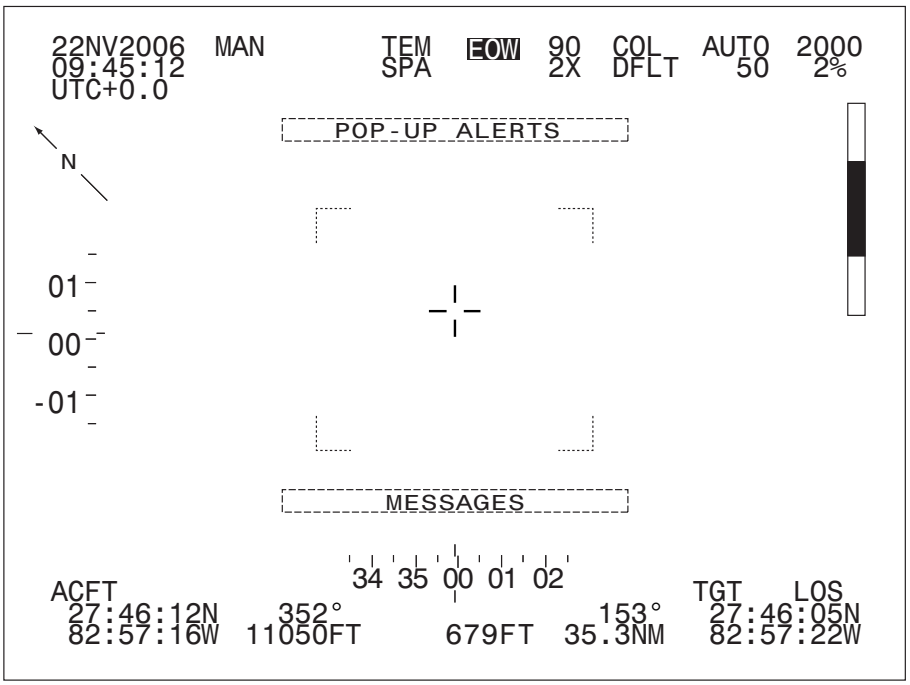


Figure 2-4 Typical MX-15i Video Overlay Graphics

2.2.1 Tracking & Orientation Graphics

Tracking and orientation graphics are the primary overlay graphics an operator will use to assess image aiming, turret orientation and zoom position. There are four tracking and orientation graphics:

- Center Reticle marker – a reference point that denotes image center and aiming of the line-of-sight (LOS).
- Turret Position scales – azimuth and elevation reference scales that report the turret's current position.
- Next Zoom markers – a reference indicator for Field-of-View (FOV) that previews the next zoom area for step-zoomed sensors.
- Relative Zoom status bar – a reference scale that displays the current FOV relative to the optical limits of the sensor.

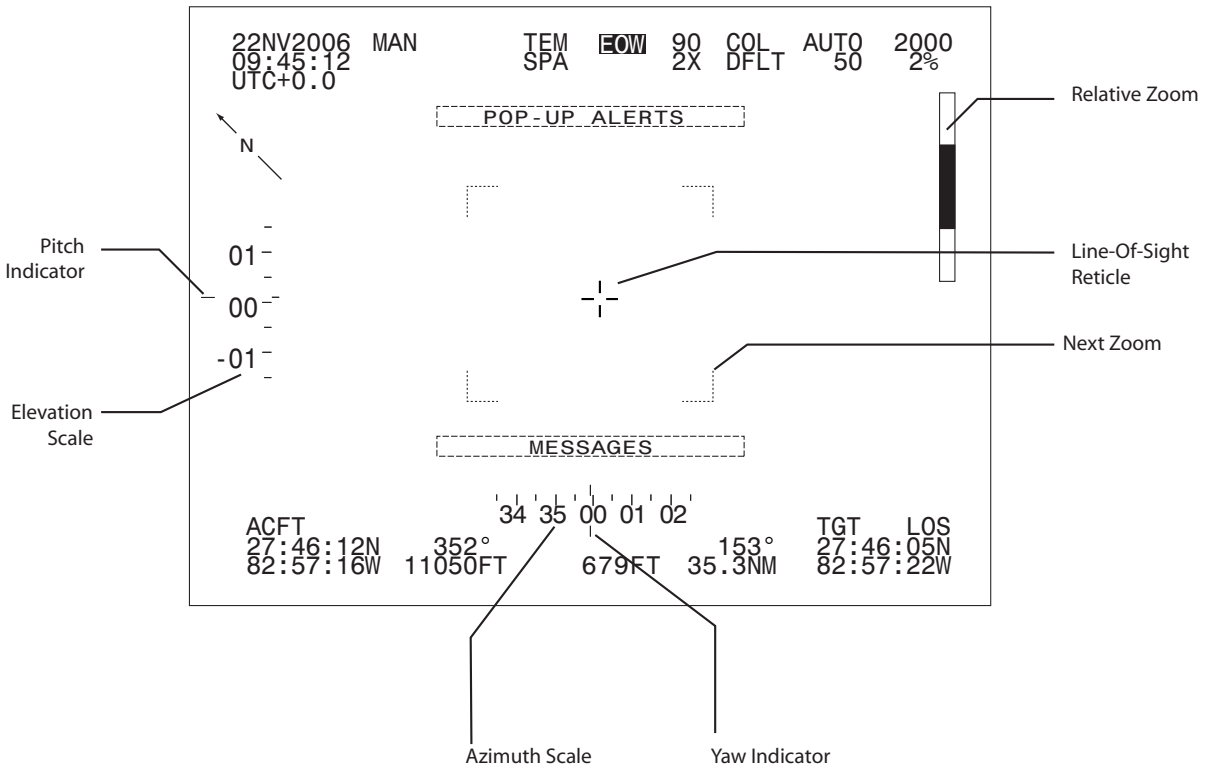


Figure 2-5 Tracking and Orientation Overlay Graphics

Line-Of-Sight Reticle. An aiming indicator that defines the boresight of the sensor. The reticle's size and position are fixed for standard imaging sensors. The reticle's size will not change with focal length adjustments.

Figure 2-6 LOS Reticle

Turret Position Scales. Moving scales that indicate the turret's azimuth and elevation position relative to the aircraft's heading. The scales measure 360° of rotation where the last digit has been dropped. For example, 01=10°. A fixed hash mark defines the reading point.

Next Zoom Marker. Indicates the next display area for a sensor with stepped zoom capability. This graphic will not be displayed for sensors with a fixed focal length or when the sensor is at its maximum zoom setting.

Relative Zoom Status Bar. A zoom utilization status bar that indicates the current FOV relative to the minimum and maximum viewing angles of the sensor. A thick black bar indicates a wide FOV where the sensor has minimal zoom applied. A thin black bar indicates a narrow FOV where the sensor has maximum zoom applied.

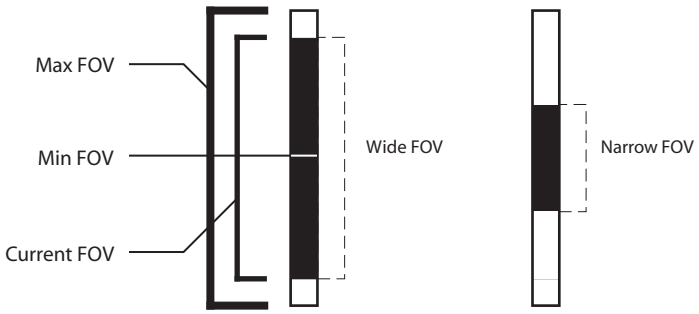


Figure 2-7 Relative Zoom Status Bar

2.2.2 Messaging Graphics

Messaging graphics provide status information about the system and its current operational condition. There are two types of messages that can be displayed in an overlay.

- Pop-up alerts
- Sensor states

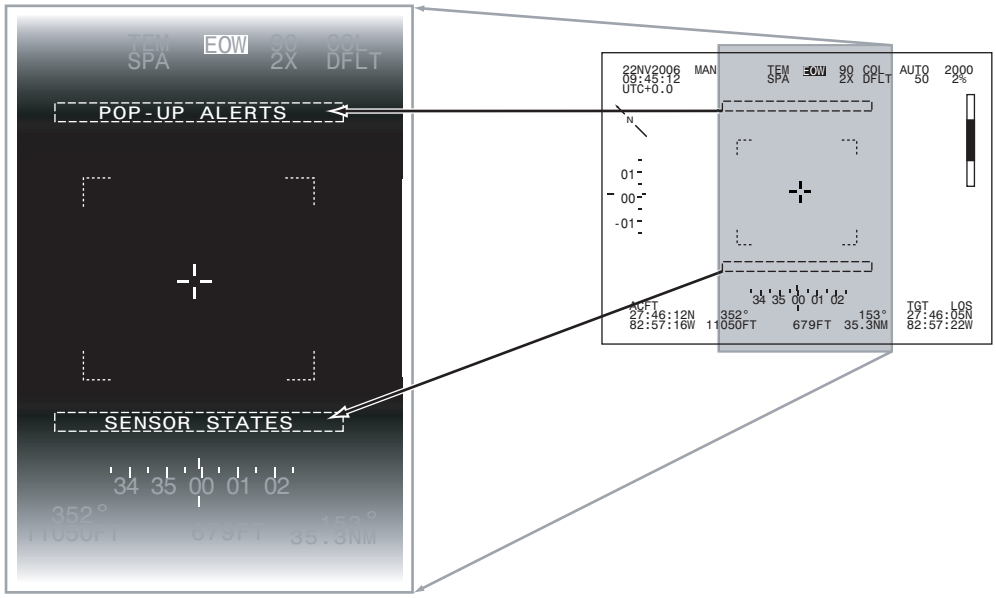


Figure 2-8 Pop-Up Alerts & Status Messages

Pop-up Alerts. Displayed on all video displays and messages will remain until they are cleared by pressing the MENU button. Messages will be displayed when:

- a system BIT detects a failure
- an external system forwards a message for display

Once cleared from the video display, BIT alerts can be later retrieved from a user menu Alarms page – where messages are retained until the system component's function is restored.

Sensor States. Displayed on sensor specific video only, and the messages will remain displayed until the sensor is operational. Messages will be displayed during:

- sensors temperature conditioning and calibration
- during IR sensor cooling, COOLING will flash in the IR video until the sensor has finished cooling
- during 1-Point or 2-Point IR calibrations, CALIBRATING will flash in the IR video

Note: Calibrating and Cooling messages will not be seen if the entire IR overlay is turned off.

2.2.3 Target and Aircraft Status Graphics

This overlay grouping provides aircraft and target status information that is located at the bottom portion of the video display. Aircraft status is presented to the bottom-left side:

- Aircraft position, altitude and heading. This information together with velocities and attitude data are obtained from external navigational or GPS systems.

Target status is presented on the bottom-right side:

- Target coordinates are calculated using aircraft position, altitude, velocities, turret's attitude, and estimated or measured target slant range values.
- The target is always assumed to be centered in the video.

Terrain elevation is presented at bottom-center:

Note: Display units for coordinates can be configured from the Mission menu.

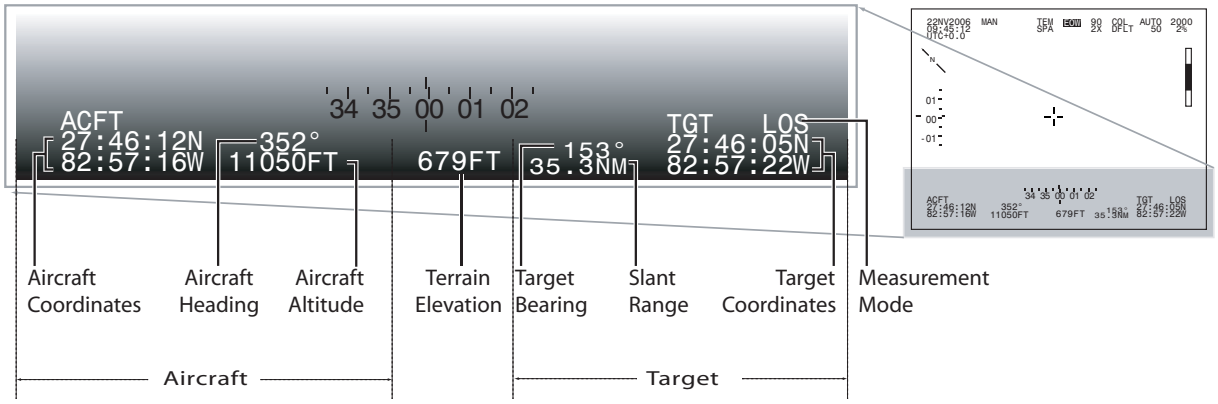


Figure 2-9 Target and Aircraft Status

Aircraft Coordinates. Reports the aircraft's geographic location data (lat/long). Display units can be configured by the operator.

Aircraft Heading. Reports the aircraft's heading relative to True North.

Aircraft Altitude. Reports the aircraft's altitude above sea-level. Display units can be configured by the operator.

Terrain Elevation. Reports the terrain ground elevation as the distance above or below sea level. This value can be:

- updated in real time as digital terrain elevation data (DTED) supplied by a Digital Map interface.
- measured by a laser range finder.
- entered manually as a fixed value in the user menus by the operator.

The accuracy of Terrain Elevation value will affect some of the system's automated functions; like focus clarity, when operators are utilizing Geo-Focus, or target hold precision in Auto steering mode.

The Terrain Elevation value will be displayed in reverse video when the operator slews the turret to steering coordinates issued by RCS or a Moving Map source. The reverse video value will report the static command position, and the value will not update until cleared by a steering mode change. For example, reverting to Manual or Forward steering.

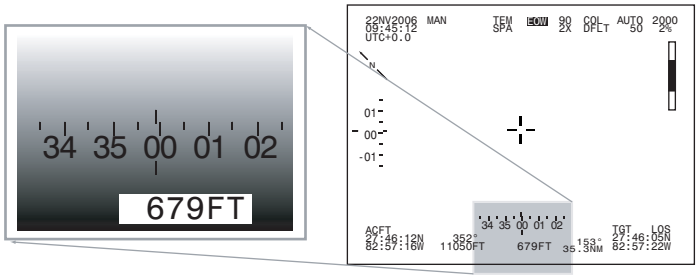


Figure 2-10 Terrain Elevation After Slewing to Issued Coordinates

Target Bearing. Reports the target's angular measure for bearing relative to True North.

Slant Range. Reports the calculated or measured distance of the target's slant range. Slant range is the distance from the turret to the ground intercept point along the line-of-sight. Display units can be configured by the operator.

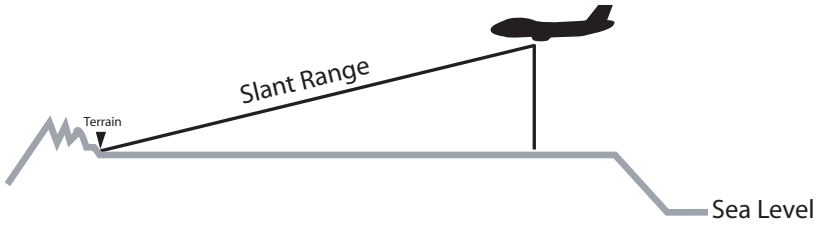


Figure 2-11 Slant Range Distance

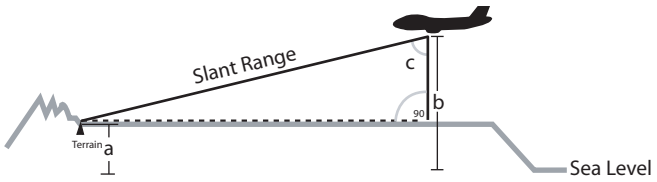
Measurement Mode. Reports the system's current measurement mode for calculating target distance. There are two modes, of which both are passive and managed by the system:

- LOS mode (passive measurement)

  The target's slant range distance and position data (lat and long) are calculated as the line-of-sight ground intercept point, on the Earth's surface, as defined by the navigational coordinate system of an assumed Earth model (WGS84). For long range distances, the calculation applies correction factors for the earth's curvature and atmospheric influences. While accurate, the calculation of target location cannot account for: angular measurement errors, inaccuracies in GPS position and altitude data, or timing errors introduced by either extreme turret movement or from latent data updates. For example, viewing a subject at very narrow vertical angle off the horizon or steering the turret too fast will impact distance calculations.

- MAP mode (passive measurement)

  The target's slant range distance and position data (lat and long) are calculated as the line-of-sight ground intercept point, on the Earth's surface, as defined by the elevation contour supplied as Digital Terrain Elevation Data (DTED) from a digital map. Accuracy of this measurement mode will depend upon your map system's DTED Level. For map data with a DTED Level of 1 or 2, the resolution is between 30 to 100m (98.4 to 328.1 ft). For map data with DTED Levels 3 through 5, the resolution is much higher (1 to 3m [3.3 to 9.8 ft]), and the measurement accuracy is comparable to that of a laser range finder. The calculation of target location cannot account for angular measurement errors and timing errors introduced by either extreme turret movement or from latent data updates. For example, viewing a subject at very narrow vertical angle off the horizon or steering the turret too fast will impact distance calculations.



LOS Mode

Figure 2-12 Slant Range Measurement Modes

Target Coordinates. Reports the target's geographic location data (lat/long). The target coordinates are system calculated using the aircraft's position and turret's orientation to determine location. Display units can be configured by the operator. The location data and the accuracy of that measurement is determined by the current measurement mode.

- In LOS mode – target coordinates are updated every 1 to 3 seconds – depending upon the target's calculated slant range. LOS is the default measurement state.
- INS Alignment mode – Reports the current state of INS alignment checks. No target coordinates will be reported. When aligned, the default LOS measurement state is initiated.

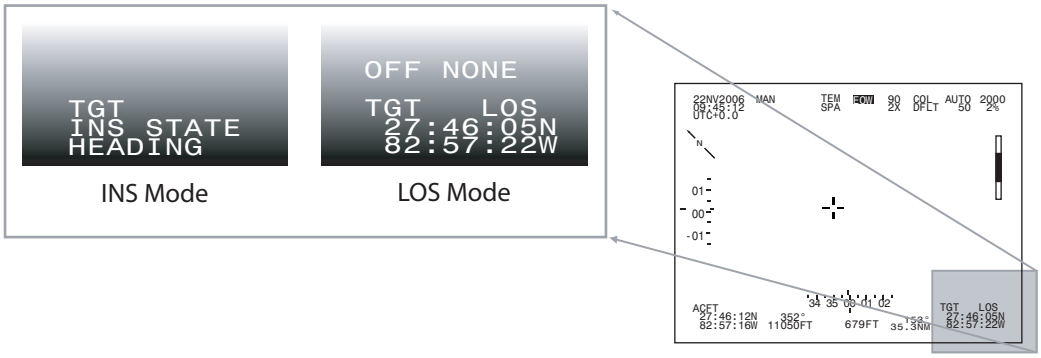


Figure 2-13 Measurement Modes and Changes to Target Coordinate Data

2.2.4 North Indicator

The North Indicator arrow is located in the top-left side of the display, and the arrow's point indicates the direction of True North. Operators would use the arrow as a universal point-of-reference for describing ground movements relative to an earth orientation rather than the aircraft's position. The arrow provides a witness marker on the video so that the line-of-sight, of the captured video, can be later related to a cartographic map's orientation where the page layout of north is always up. Display of this overlay element can be disabled.

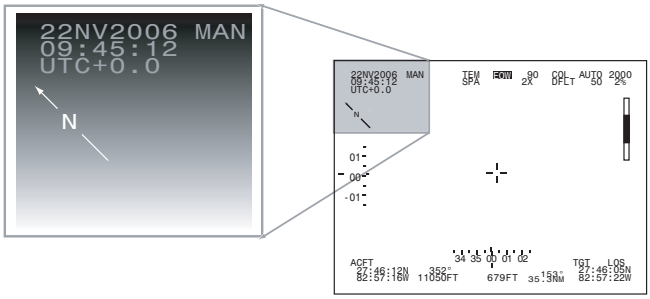


Figure 2-14 North Arrow Graphic

2.2.5 System and Sensor Status Graphics

The MX-15i system status information is located at the top of the video display. System status information is presented to the left side:

- Date & time, steering modes, and video image optimization.

Sensor optic settings are presented on the right side:

- Focal length, filtering, sensitivity mode, and focus distance.

The video-in-control is presented at top-center:

- Current sensor being controlled by the operator.

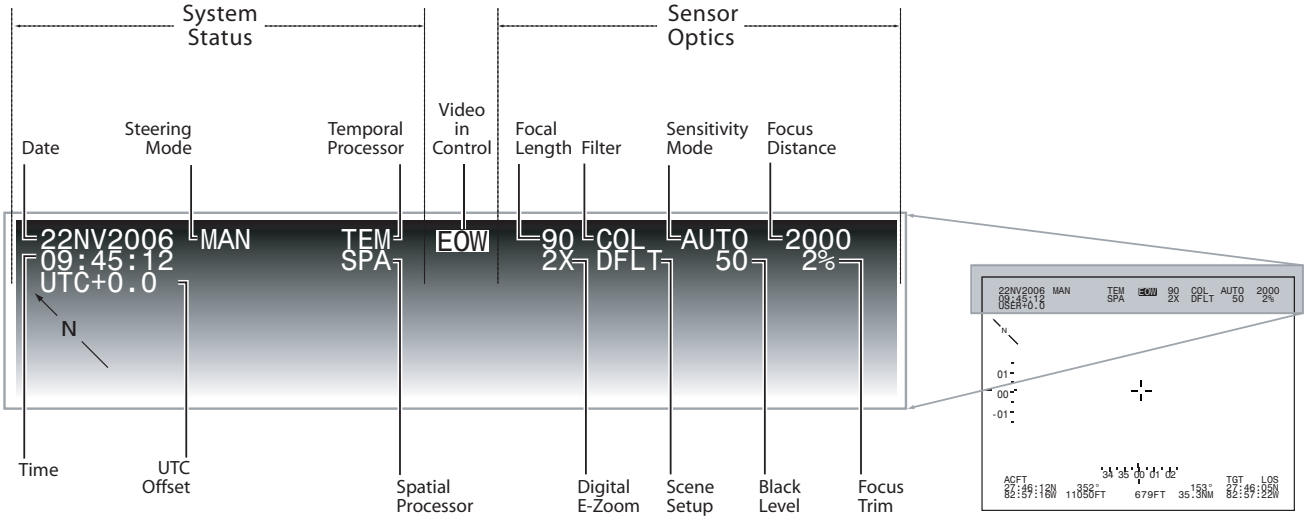


Figure 2-15 MX-15i System Video Overlay

Date and Time. Displays the current date and time. The values can be set by the operator.

UTC Offset. The UTC (Coordinated Universal Time) is based on Greenwich Mean Time (GMT). The offset allows local time setting to be shown by inputting the offset value from GMT. This field will only display UTC when a GPS time-code is being received. If no GPS time-code is being supplied this graphic will be displayed as USER.

Steering Modes. Displays the current turret steering mode. Possible values can be:

- SCAN – Autoscan mode.
- MAN – Rate (Manual) mode. When ZMULTI is enabled, the MAN graphic will be displayed in reverse video.
- FWD – Forward mode.
- RAID – Rate Aid mode.
- AUTO – Auto Track (Geo-Position) or Geo-Slew (Auto Slew) mode (same status symbol for both).
- AAID – Auto Aid mode.
- STOW – Stow mode.
- DIS – Disable mode.

Note: When ZMULTI is enabled, the MAN, RAID & AAID graphics will be displayed in reverse video.

Figure 2-16 Steering Mode with ZMULTI Enabled

Temporal Processing. TEM will show if the Temporal processor is turned on. Temporal processing activates a temporal filter in the IR VP to reduce the temporal noise in the IR video. Temporal processing options include LOW, MEDIUM, HI or OFF and are selected from the Level 2 IR Menu. All other controls remain the same.

Spatial Processing. SPA will show below the 'TEM' if the spatial processor is turned on. Spatial processing activates Local Area Processing (LAP) resulting in edge and contrast enhancement of the IR image. Spatial processing can be turned on / off in the Level 2 IR Menu. LAP is applied to the large area of interest only. All other gates are disabled. All other controls remain the same.

Video-In-Control. Displays the current Video-in-Control (VIC) sensor (EOW, IR, EON) that is being controlled by the operator. In a multi-display configuration:

- If the display video is the same as the VIC sensor, the graphic text will be displayed in blocked, reverse-video.
- If the display video is not the same as the VIC sensor, the graphic will be displayed in normal text.

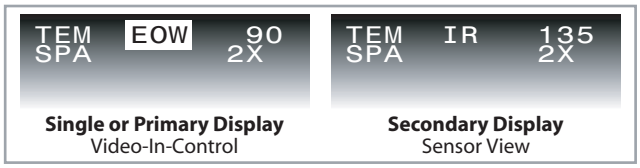


Figure 2-17 VIC Status Indicator in a Dual Display Configuration

Focal Length. Displays the current sensor's focal length. Units are displayed in millimeters.

Digital E-Zoom. Displays the current IR sensor E-Zoom setting. There will be no graphic if E-Zoom is disabled. Possible values can be:

- 2x
- 4x

Filter. Displays the selected optical filter that is supported by the current sensor. The graphic will be blank if no filters are supported or selected.

Scene Setup. Displays the current video compensation level being applied to adjust for high or low contrast images. The graphic will be blank if sensor doesn't support level adjustment.

Sensitivity Mode. Displays the current sensitivity mode. Sensitivity is like the brightness control on a television or monitor, and it can either be automatically controlled by the system or manually adjusted by the operator. The graphic will be blank if sensor doesn't support sensitivity adjustment.

Black Level. The pedestal black level for the EOW or EON sensor and sets the video level of the darkest parts of the picture. Some camera options do not support manual adjustment.

Focus Distance. Reports the current sensor's optical measure for focal distance and units are presented in meters. When Geo-Focus is enabled, the text block will be displayed in reverse-video.

Figure 2-18 Geo-Focus Status Indicator

Note: The reported focus distance is an approximated, optical measurement. At distances beyond 1000m (3281 ft), the measurement is not accurate and no distance data is reported at infinite focus. For EON sensors, which have a very narrow depth-of-field, operators can compare the focus distance with the terrain elevation and use the offset as a relative indication for which direction to move the focus control.

Geo-Focus Trim. When the Geo-Focus is enabled, the operator can set a trim offset percentage between 0 and 99%. Trim is a fine focus adjustment that compensates for errors introduced by inaccurate terrain elevation data or variations in atmospheric conditions.

2.3 USER MENU NAVIGATION

Menus provide access to system status information and other infrequently used operator controls. The user menus are structured in a three-level hierarchy where a main menu provides entry access to two levels of sub menus.

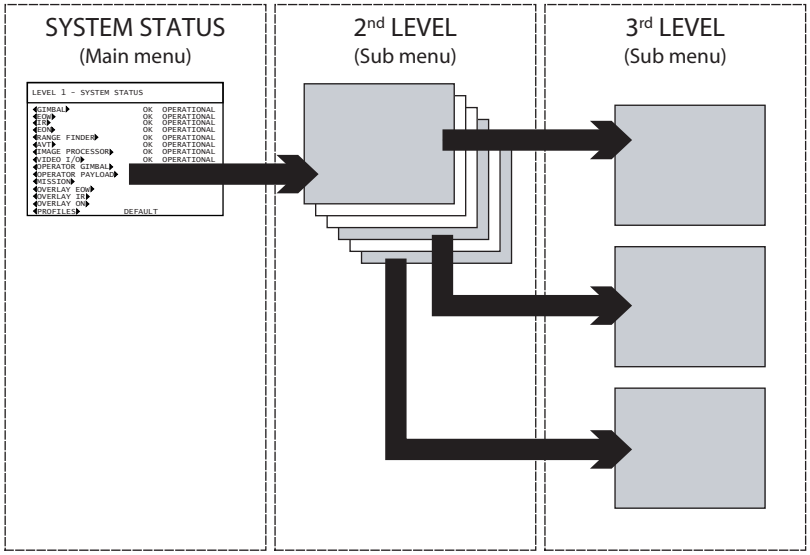


Figure 2-19 Menu Structure

2.3.1 Menu Components

Each menu will display four functional elements:

- Title Bar – identifies the navigational position level within the menu hierarchy.
- Status Indicators – software measured feedback information related to a sensor or system control. These fields cannot be modified.
- Value Fields – configuration parameters the operator can modify to set new values. These fields are identified by ▶inward◀ pointing arrows.
- Action Fields – commands that operators execute to either initiate an action or display a new menu. These fields are identified by ◀outward▶ pointing arrows.

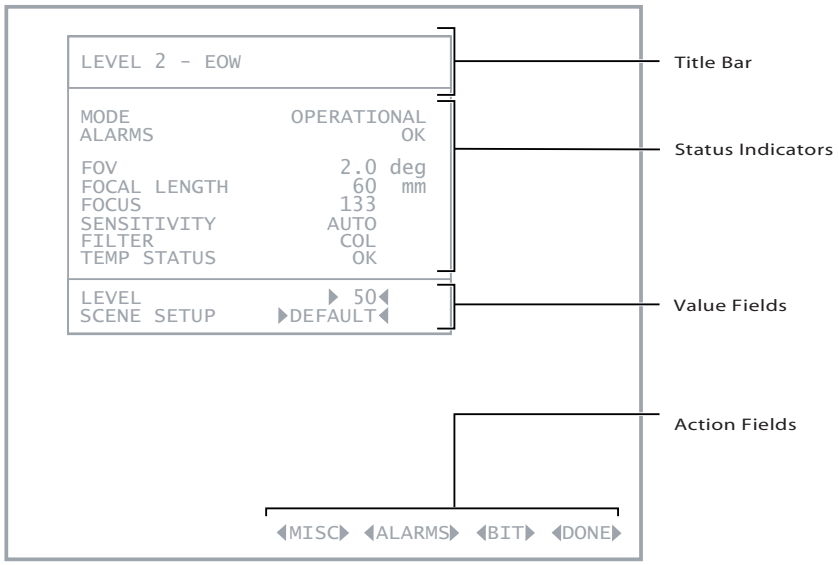


Figure 2-20 Typical Menu Dialog

Displaying the System Status Main Menu

1. Press the MENU button on the Hand Controller to display the System Status main menu.
2. Click the ZOOM switch up or down to navigate through the menu options. A blinking-underline cursor will highlight the current menu option.
3. Press the MENU button to select sub menus or confirm parameter options. When any menu screen is displayed, use the MENU button to confirm actions. The function is similar to an Enter key on a computer keyboard.

Accessing Sub Menus

1. If the System Status main menu is not displayed, press the MENU button.
2. Click the ZOOM switch up or down to select a desired menu option.
3. Press the MENU button to display the sub menu option.
4. Click the ZOOM switch up or down to select a desired ▶value◀ or ◀action▶ field.
5. To access third level miscellaneous menus, move the cursor to the MISC field, at the bottom of the screen, and press the MENU button.
6. To exit a third level sub menu, use the ZOOM switch to cursor down to DONE and then press the MENU button, or press and hold the MENU button for two seconds.
7. To exit a second level sub menu, use the ZOOM switch to cursor down to DONE and then press the MENU button, or press and hold the MENU button for two seconds.

Clearing Menu Display and Return to Video

1. To quickly return to the overlay screen, press and hold the MENU button for two seconds.
2. Otherwise, back out of menu levels using the ZOOM switch and scrolling to DONE at the bottom right corner of the menu screen.
3. Press the MENU button.

Executing an Action Field

1. If the System Status main menu is not displayed, press the MENU button on the Hand Controller.
2. Click the ZOOM switch up or down to select an ◀Action Field▶ option.
3. Press the MENU button to execute that field's action.

Changing the Value for a Value Field

1. If the System Status main menu is not displayed, press the MENU button on the Hand Controller.
2. Click the ZOOM switch up or down to select a desired menu option.
3. Press the MENU button to display the sub menu option.
4. Click the ZOOM switch up or down to select a desired menu option.
5. Click the SENS switch to change the option's value. Clicking up on the toggle switch will increase the value, while clicking down will decrease the value.

2.4 SYSTEM STATUS MENU

The System Status Menu is the main user menu that enables operators to:

- Review major operational status indicators for main turret components.
- Access sub menus and other screens.
- Reset the MX-15i system without removing power, and run an MX-15i System BIT.
- Access to Alarms page.

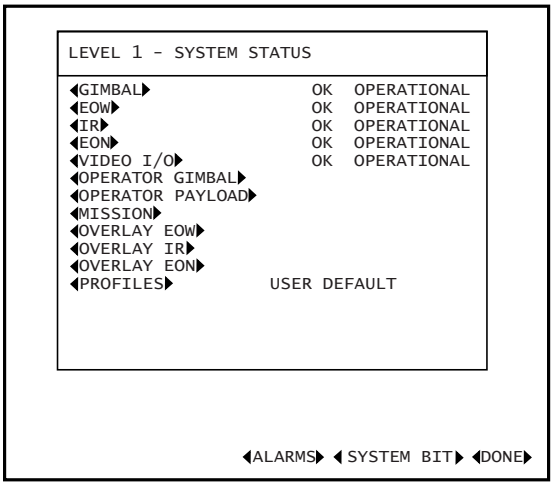


Figure 2-21 Level 1 System Status Menu

Table 2-4 Fields in the Level 1 System Status (Main) Menu

Field	Description
GIMBAL	Displays the Gimbal menu.
EOW	Displays the EOW menu.
IR	Displays the IR menu.
EON	Displays the EON menu.
VIDEO I/O	Displays the Video I/O menu.
OPERATOR GIMBAL	Displays the Operator Gimbal menu.
OPERATOR PAYLOAD	Displays the Operator Payload menu.
MISSION	Displays the Mission menu.
OVERLAY EOW	Displays the Overlay menu for the EOW.
OVERLAY IR	Displays the Overlay menu for the IR.
OVERLAY EON	Displays the Overlay menu for the EON.
PROFILES	Displays the Profiles menu.

Table 2-4 Fields in the Level 1 System Status (Main) Menu (Continued)

Field	Description
ALARMS	Displays the Alarms page with BIT test results for the entire system.
SYSTEM BIT	Initiates a full sequence of BITs for all system components – the same sequence executed on power up. This BIT can be used to reset the system instead of cycling power to the turret.
DONE	Exits menu.

Table 2-5 Status Indications in the System Status Main Menu

Status	State	Description	Recommended Action
OK, MINOR, MAJOR	STARTUP	Component Initializing: • Some components are warmed or cooled before they can be operated.	None.
–	N/A	Communication failure with component.	Review the Alarms page.
OK	OPERATIONAL	Component is in a fully functioning state.	None.
OK	STOWED	Turret is operational but in the Stow position	Steer turret to Forward or manual position to establish video.
MINOR	OPERATIONAL	Component BIT test failed but still functional: • Component capabilities are out of tolerance, e.g. focus position exceeded tolerance set point.	Review BIT from the Alarms page.
MAJOR	OPERATIONAL	Component BIT test failed but still functional: • The system has forced a partial shutdown of capability. For example, the EOW mechanism caused Iris function to shutdown, but zoom and focus capability remain.	Review BIT from the Alarms page.
MAJOR	FAILED	Component BIT failed and is shutdown. • The system has forced a shutdown of a capability. For example, the internal gimbal temperature is too hot so the EON is shutdown.	Review BIT from the Alarms page.

2.5 GIMBAL MENU

The Gimbal menu provides status information and displays the current data for various environmental and turret positional parameters.

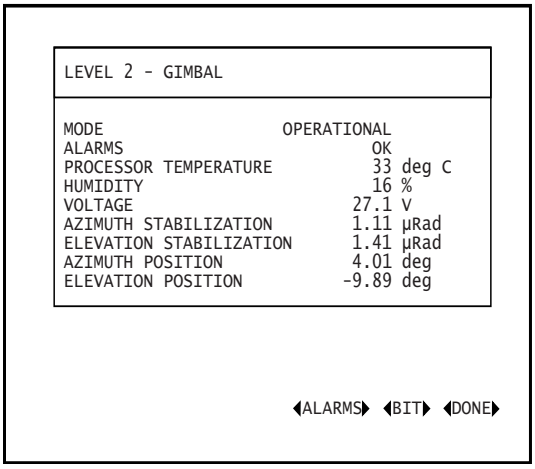


Figure 2-22 Level 2 Gimbal Menu

Table 2-6 Status Information and Controls in the Level 2 Gimbal Menu

Field	Values	Description
ACTION FIELDS		
ALARMS	–	Displays Alarms page with BIT details for the gimbal.
BIT	–	Initiates a Gimbal BIT.
DONE	–	Exits menu.
STATUS INDICATORS		
PROCESSOR TEMPERATURE	°C	Current internal temperature within the gimbal.
HUMIDITY	0 to 100%	For L-3 Wescam engineering use only. Note: Do not use as a replacement for monitoring turret humidity indicator.
VOLTAGE	DC Voltage	Displays the supply voltage at the turret.
AZIMUTH STABILIZATION	µRad	Estimated stabilization in units of micro radians. Typical value is 2-3. May give incorrect value under significant steering acceleration.
ELEVATION STABILIZATION	µRad	Estimated stabilization in units of micro radians. Typical value is 2-3. May give incorrect value under significant steering acceleration.
AZIMUTH POSITION	±180°	Current azimuth (horizontal) position of turret's line-of-sight.
ELEVATION POSITION	+90° to -120°	Current elevation (vertical) position of turret's line-of-sight.

2.6 EOW MENU

The EOW menu (electro-optic wide) provides status information and controls for the EOW imaging sensor. Operators can also access a Level 3 Miscellaneous sub menu for additional diagnostic data in the form of sensor component temperatures.

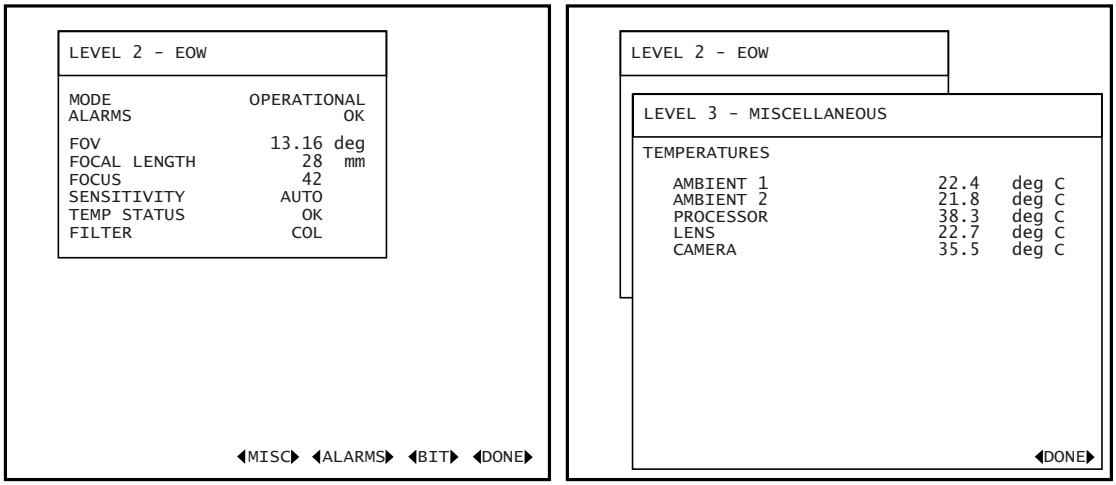


Figure 2-23 EOW – Levels 2 and 3

Table 2-7 Status Information and Controls in the Level 2 EOW Menu

Field	Values	Description
	ACTION FIELDS	
MISC	–	Displays Miscellaneous menu.
ALARMS	–	Displays Alarms page with BIT test results for the EOW sensor.
BIT	–	Initiates an EOW BIT.
DONE	–	Exits menu.
	STATUS INDICATORS	
FOV	Optical: 47.18°-2.0°, Digital: 2.0°-0.67°	Current horizontal FOV in degrees.
FOCAL LENGTH	Optical: 2.4-60 mm, Digital: 60-180 mm	Current focal length in millimeters.
FOCUS	1 m to Infinity	Focus position expressed as an estimated distance to the object that sensor is focused upon. Units are in meters. Note: Do not use number for reporting target distance, this is a very crude distance estimation.
SENSITIVITY	AUTO	System has been enabled for automatic control of image brightness.
	MAN	Current value for manual sensitivity. Operators can increment the sensitivity to control image brightness from the Hand Controller.

Table 2-7 Status Information and Controls in the Level 2 EOW Menu (Continued)

Field	Values	Description
TEMP STATUS	WARMING UP / COOLING	Sensor disabled because internal operational temperature is above or below limits.
	OK	Sensor at operational temperature.
FILTER	COL	Color filter
	NIR	Near infrared filter

2.7 IR MENU

The IR menu (infrared) provides status information and controls for the IR sensor. Operators can use this menu to calibrate the IR camera's focal plane array (similar function to film or digital CCD) by selecting one of 2 options:

- 1-Point – A scene based thermal profile
- 2-Point – Both a scene based and a built-in infrared source thermal profiles

Operators can also access a Level 3 Miscellaneous sub menu for additional diagnostic information in the form of sensor component temperatures.

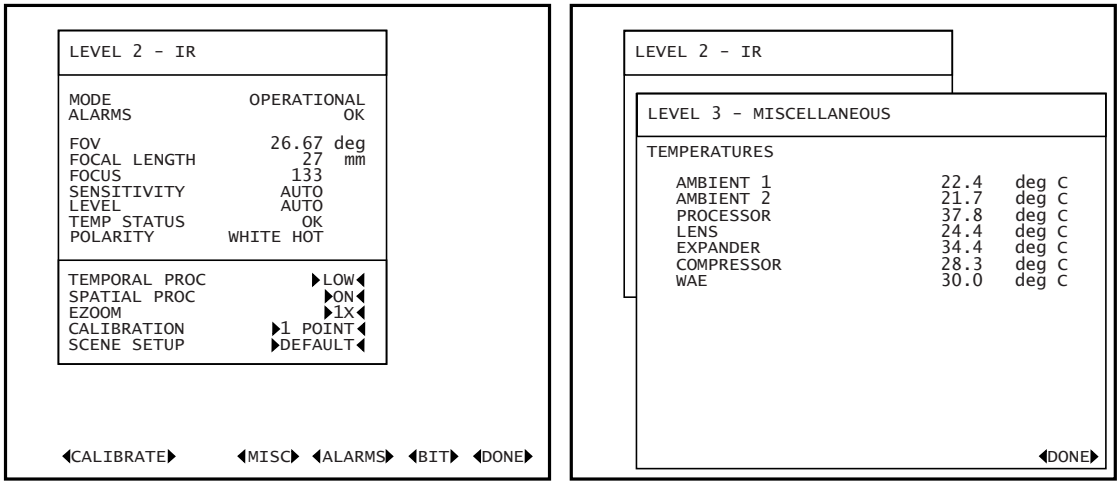


Figure 2-24 IR Menu – Levels 2 and 3

Table 2-8 Status Information and Controls in the Level 2 IR Menu

Field	Values	Description
		VALUE FIELDS
TEMPORAL PROC	LOW, MEDIUM, HIGH, OFF	Enables or disables temporal processing which can be used to remove pixel flicker or variations from the image.
SPATIAL PROC	ON, OFF	Enables or disables spatial processing which can be used to improve image sharpness and improve edge detection.
EZOOM	1x, 2x and 4x	Sets the degree of electronic zoom: • At 1x zoom, the video's field of view = the optical field of view. • At 2x zoom, the video's field of view = ½ of optical field of view. • At 4x zoom, the video's field of view = ¼ of optical field of view. Note: The 4x option is only available on some IR sensors and not available on the VNFOV.
CALIBRATION	1 POINT	Selects a 1-Point calibration option to remove of common video artifacts and reset dynamic range of the thermal image. This is the quickest calibration and most recommended option for operator use.
	2 POINT	Selects a 2-Point calibration option to remove bright video artifacts, recalculates pixel uniformity measures and resets dynamic range of thermal image. This is the longest calibration and not recommended for operator use. Use only when a 1-Point calibration does not yield satisfactory results.

Table 2-8 Status Information and Controls in the Level 2 IR Menu (Continued)

Field	Values	Description
SCENE SETUP Note: Initiate a 1-Point calibration for every scene change.	DEFAULT	Optimizes camera for general purpose setup.
	HIGH	Optimizes camera for high-contrast scenes.
	LOW	Optimizes camera for low-contrast scenes.
ACTION FIELDS		
CALIBRATE	–	Initiates calibration.
MISC	–	Displays Miscellaneous menu.
ALARMS	–	Displays Alarms page with BIT test results for the IR sensor.
BIT	–	Initiates an IR BIT.
DONE	–	Exits menu.
STATUS INDICATORS		
FOV	0.36°, 1.09°, 5.43°, 26.67°	Current optical horizontal FOV in degrees.
FOCAL LENGTH	27, 135, 675, 2024	Current focal length in mm. VNFOV has a 2x E-Zoom applied.
FOCUS	3 m to Infinity	Focus position, expressed as an estimated distance to the object that sensor is focused on. Units = meters. Note: This is a very crude calibration and therefore should not be taken as a target distance.
SENSITIVITY	AUTO	System has been enabled for automatic control of image brightness.
	MAN	Current value for manual sensitivity. Operators can increment the sensitivity to control image brightness from the Hand Controller.
LEVEL	AUTO	System has been enabled for automatic level control.
	MAN	Current value for manual level. Operators can increment the level to control image contrast from the Hand Controller.
TEMP STATUS	COOLING	Sensor disabled because internal operational temperature is above or below limits.
	OK	Sensor at operational temperature.
POLARITY	BLACK HOT	Hottest objects in video appear black, coolest appear white.
	WHITE HOT	Hottest objects in video appear white, coolest appear black.

2.8 EON MENU

The EON menu (electro-optic narrow) provides status information and controls for the EON sensor. Operators can also access a Level 3 Miscellaneous sub menu for additional diagnostic data in the form of sensor component temperatures.

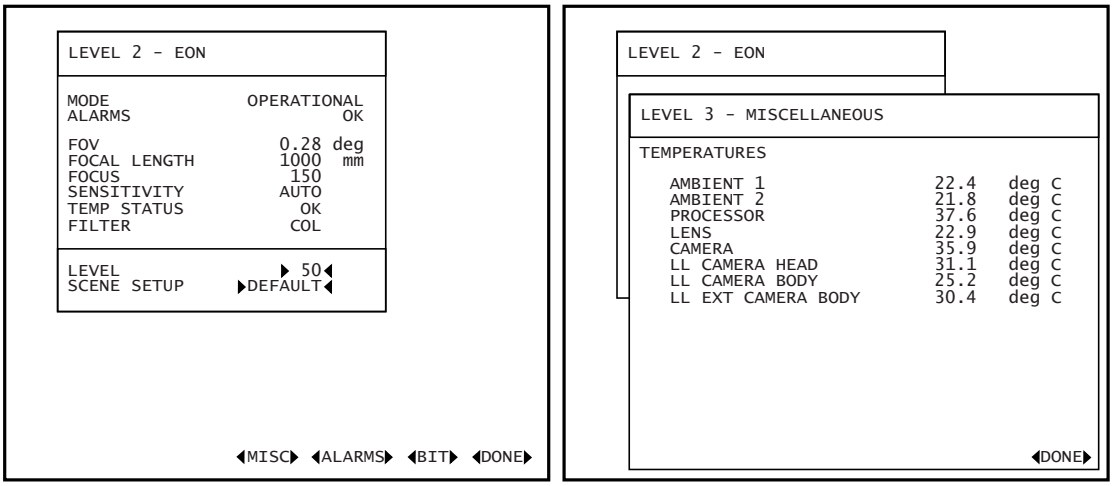


Figure 2-25 EON Menu – Levels 2 and 3

Table 2-9 Status Information and Controls in the Level 2 EON Menu

Field	Values	Description
	VALUE FIELDS	
LEVEL	0 to 100	Sets the pedestal black level. Default value is 50.
SCENE SETUP	DEFAULT	Optimizes camera for general purpose setup.
	HIGH	Optimizes camera for high-contrast scenes.
	LOW	Optimizes camera for low-contrast scenes.
	ACTION FIELDS	
MISC	–	Displays Miscellaneous menu.
ALARMS	–	Displays Alarms page with BIT test results for the EON sensor.
BIT	–	Initiates an EON BIT.
DONE	–	Exits menu.
	STATUS INDICATORS	
FOV	Daylight: 0.28°, Lowlight: 0.30°	Current horizontal FOV in degrees.
FOCAL LENGTH	1000 mm	Current focal length in millimeters.

Table 2-9 Status Information and Controls in the Level 2 EON Menu (Continued)

Field	Values	Description
FOCUS	150m to Infinity	Focus position, expressed as an estimated distance to the object that sensor is focused upon. Units are in meters. Note: Do not use number for reporting target distance, this is a very crude distance estimation.
SENSITIVITY	AUTO	System has been enabled for automatic control of image brightness.
	MAN	Current value for manual sensitivity. Operators can increment the sensitivity to control image brightness from the Hand Controller.
TEMP STATUS	WARMING UP / COOLING	Sensor disabled because internal operational temperature is above or below limits.
	OK	Sensor at operational temperature.
FILTER	LP, XLP, COL	Displays the current filter selection. From the Hand Controller, operators can select between the daylight camera (COL), low-light camera (LP) and a low-light camera with an extra long pass filter to minimize effects of haze (XLP).

2.9 VIDEO I/O MENU

The Video I/O menu provides status information and various controls for managing video inputs and outputs. Operators would use this menu to configure the device that accepts video inputs (monitor, VTR, VCR, mapping computers) and video outputs (EOW, EON, IR). Operators can set which of the video displays that will be presented with the overlay information. For security reasons, some recorded feeds may need to be set so the overlay is not presented.

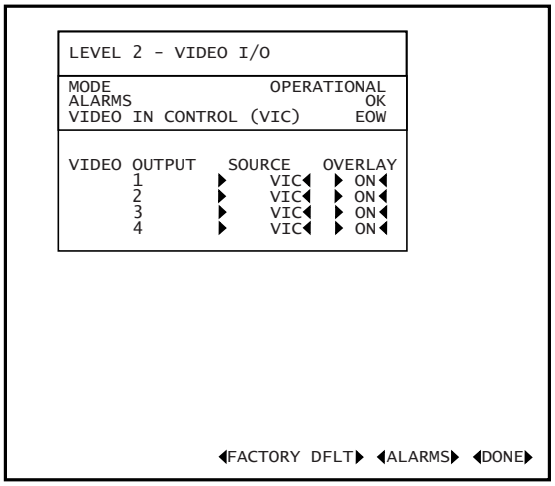


Figure 2-26 Level 2 Video I/O Menu

Table 2-10 Status Information and Controls in the Level 2 Video I/O Menu

Field	Values	Description
		VALUE FIELDS
VIDEO OUTPUTS	–	Source: • Sets the source and assigns a sensor to a video output channel. Overlay: • Enables or disables display of overlay graphics in video distributed to the output channel.
		ACTION FIELDS
FACTORY DFLT	–	Resets all user configured value fields to factory default settings.
ALARMS	–	Displays Alarms page with BIT test results for the Video I/O.
DONE	–	Exits menu.
		STATUS INDICATORS
VIDEO IN CONTROL	IR, EOW, EON, OFF	Displays the current sensor that is the video in control.

2.10 OPERATOR GIMBAL MENU

The Operator Gimbal menu provides status information and controls to:

- Configure the sensitivity of turret movement
- Setup and initiate an automated steering pattern
- Eliminate steering drift with an Auto Null command

To customize the control sensitivity of the Hand Controller, operators can alter the drive direction or change various steering preferences to either increase or decrease the pressure needed to cause turret movement. For example, forward and back steering positions can be reversed. As well, operators might increase the left to right azimuth speed for quicker panning movements, and decrease the up and down elevation speed to improve following targets moving along a horizontal path. Optionally, the operator could set the turret to a fixed position in degrees of azimuth and elevation and hold that position with no movement.

To turn over steering control to an automated sweep pattern, operators would enable the Autoscan feature. For example, Autoscan is useful in search and rescue missions where the plane is flying a search grid. To ensure complete video capture, Autoscan can be set up for a turret sweep that overlaps the previous flight corridor.

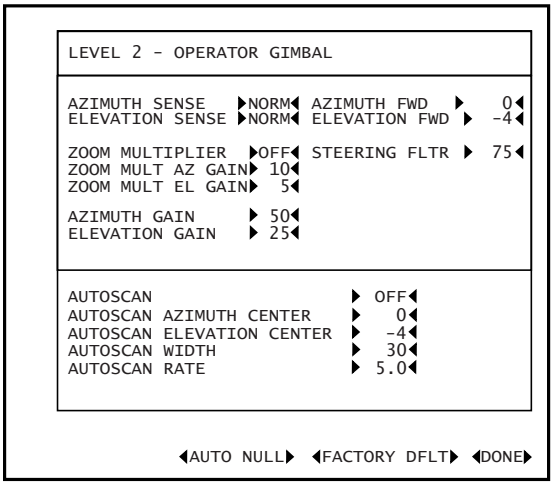


Figure 2-27 Level 2 Operator Gimbal Menu

Table 2-11 Status Information and Controls in the Level 2 Operator Gimbal Menu

Field	Values	Description
	VALUE FIELDS	
AZIMUTH SENSE	NORM	Sets the azimuth (horizontal) steering orientation for the user control: • Rightward pressure causes positive horizontal steering movement. • Leftward pressure causes negative horizontal steering movement.
	REV	Reverses the normal steering movements.
ELEVATION SENSE	NORM	Sets the elevation (vertical) steering orientation for the user control: • Backward pressure causes positive vertical steering movement. • Forward pressure causes negative vertical steering movement.
	REV	Reverses the normal steering movements.

Table 2-11 Status Information and Controls in the Level 2 Operator Gimbal Menu (Continued)

Field	Values	Description
ZOOM MULTIPLIER	ON, OFF	Enables or disables attenuation of steering sensitivity relative to the focal length of the Video in Control. At wide focal lengths, less steering input is needed for turret movement, while narrow focal lengths need greater input for steering movement.
ZOOM MULT. AZ. GAIN	0 to 100	Alters the sensitivity of azimuth (horizontal) steering to slow camera panning as the degree of zoom increases.
ZOOM MULT. EL. GAIN	0 to 100	Alters the sensitivity of elevation (vertical) steering to slow camera tilting as the degree of zoom increases.
AZIMUTH GAIN	0 to 100	Sets the responsiveness of horizontal steering movement.
ELEVATION GAIN	0 to 100	Sets the responsiveness of vertical steering movement.
AZIMUTH FWD	-179° to +180°	Sets the horizontal angle when the turret is in the Forward position. Customer unique forward position is set to -90°.
ELEVATION FWD	±90°	Sets the vertical angle when the turret is in the Forward position.
STEERING FLTR	0 to 100	Increases or decreases the responsiveness of steering controls. 75 is the recommended setting. Note: A value of 100 will disable steering.
AUTOSCAN	ON, OFF	Initiates an Autoscan steering mode using the configured steering position, sweep margins and sweep rate parameters.
AUTOSCAN AZIMUTH CENTER	-179° to +180°	Configures the horizontal angle for a sector scan.
AUTOSCAN ELEVATION CENTER	± 45°	Configures the vertical angle for a sector scan.
AUTOSCAN WIDTH	1° to 90°	Configures the sweep width of a sector scan.
AUTOSCAN RATE	0.1° to 10.0°	Configures the sweep rate for a sector scan.
ACTION FIELDS		
AUTO NULL	–	Resets the zero pressure steering reading and removes steering drift when steering is stopped. Note: When executing Auto Null, make sure you have no input pressure applied to the steering controls.
FACTORY DFLT	–	Resets all user configured value fields to factory default settings.
DONE	–	Exits menu.

2.11 OPERATOR PAYLOAD MENU

The Operator Payload menu provides controls to:

- Configure the sensitivity of lens zoom, focus and filter controls
- Set the initial zoom point and default filter for the lens

To customize control sensitivity of the Hand Controller, operators can alter the drive action for the cameras to either increase or decrease the input needed to zoom or focus the lens. For example, operators might decrease the focus gain to achieve finer focus control. For sensors with zoom capable lenses, operators might increase the zoom gain to speed up focal length changes. Gain setting can be set to a minimum factor of zero, which essentially disables movement or the ability to zoom or focus the lens.

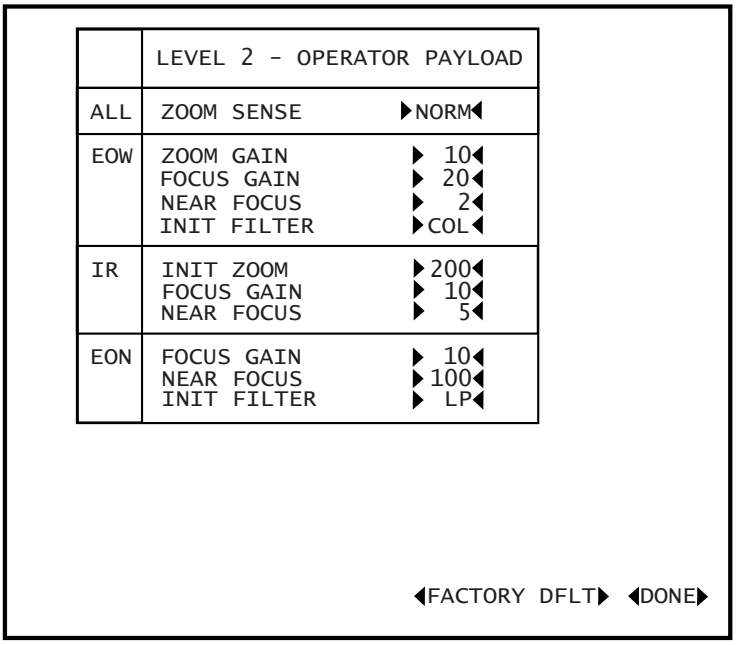


Figure 2-28 Level 2 Operator Payload Menu

Table 2-12 Status Information and Controls in the Level 2 Operator Payload Menu

Field	Values	Description
		VALUE FIELDS
ZOOM SENSE	NORM	Sets the direction of zoom travel on the user control: • Upward pressure on ZOOM switch increases zoom. • Downward pressure on ZOOM switch decreases zoom.
	REV	Reverse the normal zoom directions.
ZOOM GAIN	0 to 100	Sets the responsiveness of the ZOOM switch to zoom travel speed.
FOCUS GAIN	0 to 100	Sets the responsiveness of the Focus dial to refine focus adjustments.
NEAR FOCUS	1 to 500	Sets the degree of focus adjustment to have greater precision at one end of the focal range: • Small values have more focus adjustment for close subjects. • Large values have more focus adjustment for far subject.

Table 2-12 Status Information and Controls in the Level 2 Operator Payload Menu (Continued)

Field	Values	Description
INIT ZOOM	mm	Sets the startup zoom position within the focal length.
INIT FILTER	Various	Sets the startup default lens filter.
ACTION FIELDS		
FACTORY DFLT	–	Resets all user configured value fields to factory default settings.
DONE	–	Exits menu.

2.12 MISSION MENU

The Mission menu provides status information and controls for configuring mission data, such as date and time or setting preferences for readout units of measure. For example, the operator may prefer to have altitude measured in meters as opposed to feet.

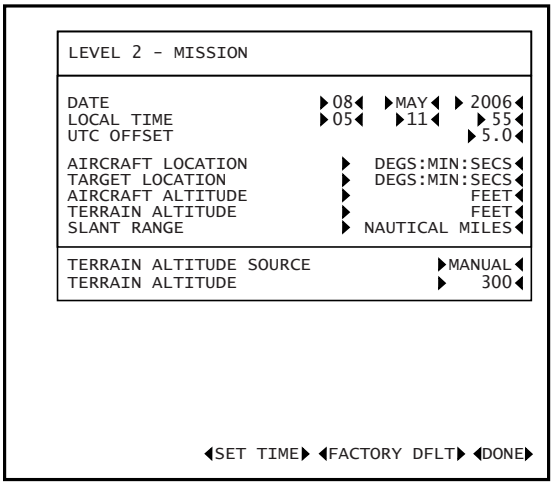


Figure 2-29 Level 2 Mission Menu

Table 2-13 Status Information and Controls in the Level 2 Mission Menu

Field	Values	Description
	VALUE FIELDS	
DATE	DD, MM, YYYY	Selects date options. All are set by the SET TIME action field.
LOCAL TIME	Hours, Minutes, Seconds	Selects time options. All are set by the SET TIME action field.
UTC OFFSET	±16	Sets the Greenwich Mean Time regional differential value in ½ hour increments.
AIRCRAFT LOCATION TARGET LOCATION	Decimal Degs, Degs:Min:Min, Degs:Min:Secs, MGRS	Sets the display format for location data to: • one of three degrees options • Military Grid Reference Survey.
AIRCRAFT ALTITUDE	Feet, Meters	Sets the display units for altitude data.
TERRAIN ALTITUDE	Feet, Meters	Sets the display units for elevation data.
SLANT RANGE	Feet, Miles, Nautical Miles, Meters, Kilometers	Sets the display units for distance data.
TERRAIN ALTITUDE SOURCE	MANUAL, MAP	Sets the source for terrain measurement data.

Table 2-13 Status Information and Controls in the Level 2 Mission Menu

Field	Values	Description
TERRAIN ALTITUDE	-457 to 15 240m (1500 to 50 000 ft)	Action is linked to the Terrain Altitude Source setting: • When referencing external navigational equipment, this field dynamically displays the updated values of the terrain altitude. • When manual, the operator can enter a static value.
ACTION FIELDS		
SET TIME	–	Saves the configured time settings.
FACTORY DFLT	–	Resets all user configured options to factory default settings.
DONE	–	Exits menu.

2.13 OVERLAY MENUS

There is an Overlay menu for each sensor and each menu provides controls for configuring the display of various overlay components. For example, the operator may wish to disable the North indicator for some overlays, but leave it on for others.

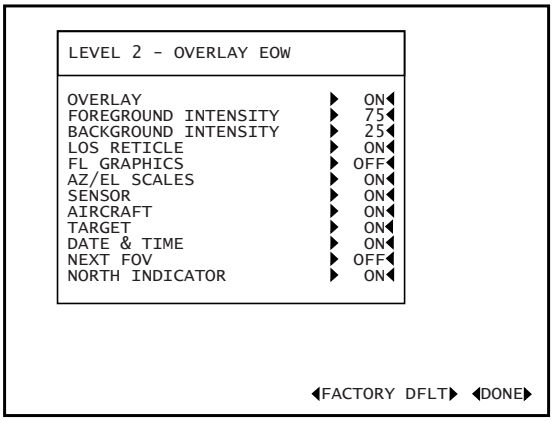


Figure 2-30 Typical Level 2 Overlay Menu

Table 2-14 Status Information and Controls in the Level 2 Overlay Menus

Field	Values	Description
		VALUE FIELDS
OVERLAY	ON, OFF	Enables or disables display of the entire overlay. Note: User menus and messages will continue to be displayed.
FOREGROUND INTENSITY	0 to 100	Sets character and graphics color intensity. 100 is white while 0 is black.
BACKGROUND INTENSITY	0 to 100	Sets color intensity of reverse video characters. 100 is white while 0 is black.
LOS RETICLE	ON, OFF	Enables or disables display of the LOS Reticle.
FL GRAPHICS	ON, OFF	Enables or disables display of the focal length (relative zoom) graphic.
AZ / EL SCALES	ON, OFF	Enables or disables display of the azimuth/elevation scales.
SENSOR	ON, OFF	Enables or disables display of the system and sensor graphics. Note: VIC status cannot be disabled.
AIRCRAFT	ON, OFF	Enables or disables display of the aircraft graphics.
TARGET	ON, OFF	Enables or disables display of the target graphics.
DATE & TIME	ON, OFF	Enables or disables display of the date and time.
NEXT FOV	ON, OFF	Enables or disables display of the Next FOV graphics.

Table 2-14 Status Information and Controls in the Level 2 Overlay Menus (Continued)

Field	Values	Description
NORTH INDICATOR	ON, OFF	Enables or disables display of the north indicator graphic.
ACTION FIELDS		
FACTORY DFLT	–	Resets all user configured value fields to factory default settings.
DONE	–	Exits menu.

2.14 PROFILES MENU

The Profiles Menu provides operators with the ability to save and retrieve specific configuration profiles, or they can restore the factory defaults. From various other menu options, operators can configure the entire system and tailor the settings to their preference or tailor options for different mission types. Operators can save these settings, as a profile, that can be later to recalled and loaded to reconfigure the system. The CURRENT PROFILE field displays the profile that is currently selected.

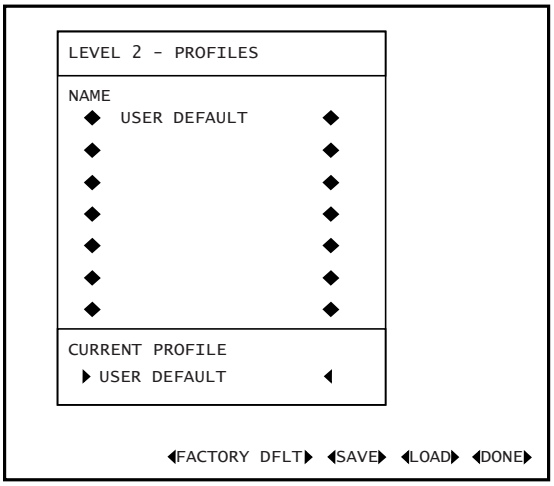


Figure 2-31 Level 2 Profiles Menu

Save a Modified Profile

1. Using the ZOOM switch, move the cursor down to the CURRENT PROFILE and use the SENS switch to select the modified profile name.

Note: Make sure you have selected the correct CURRENT PROFILE before saving. All previous settings for the selected CURRENT PROFILE will be replaced by the new settings.

2. With the profile selected, move the cursor down to SAVE at the bottom of the screen and press the MENU button. This action will save the current system settings and a screen prompt will appear asking you to confirm the save.
3. Move the cursor to CONFIRM and press the MENU button.

Load a Profile

1. If the System Status main menu is not displayed, press the MENU button.
2. Using the ZOOM switch, move the cursor to the PROFILES option.
3. Press the MENU button.
4. Move the cursor to the CURRENT PROFILE and use the SENS switch to select the desired profile.
5. With the desired profile selected, move the cursor down to LOAD at the bottom of the screen.
6. Press the MENU button.

Restore Factory Default Settings

1. If the System Status main menu is not displayed, press the MENU button.
2. Using the ZOOM switch, move the cursor to the PROFILES option.
3. Press the MENU button.
4. Using the ZOOM switch, select FACTORY DFLT at the bottom of the screen.
5. Push the MENU button.

2.15 RECOMMENDED OPERATOR MISSION TASKS

For typical mission flight, operators can do their tasks in 5 operational time frames:

- Pre-Flight inspection of the physical condition of the turret
- Pre-Takeoff check to prepare the turret for takeoff
- In-Flight operation of turret while airborne
- Pre-Landing check to prepare the turret for landing
- Post-Flight shutdown to disable and stow the turret

Before flight, the operator *must* do a Pre-Flight inspection and make sure that:

- the turret is correctly attached
- purging of the turret is not necessary
- all sensor windows are clean

Complete the Pre-Flight inspections in good time before the flight. This gives the operator sufficient time to complete a turret purge or clean the sensor windows, if necessary. When the humidity in the turret is above the flight limit, 1-2 hours is necessary to purge the turret. Do all other operator mission tasks at or during flight time.

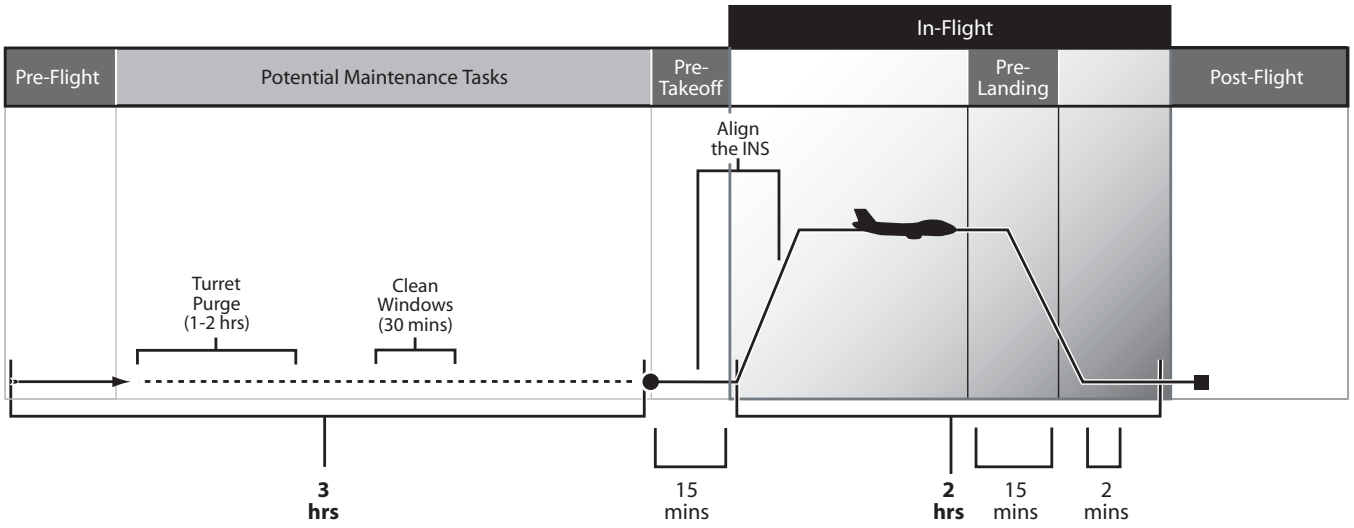


Figure 2-32 Sample Operator & Maintenance Task Timeline

Performing a Pre-Flight Inspection

1. Remove power from the turret system.
2. Make sure that the upper quadrants of the turret humidity indicator (30 & 40) do not show a lavender (pink) color.
3. Make sure that the upper quadrants of the desiccant humidity indicator (30 & 40) do not show a lavender (pink) color.
4. Clean all turret windows. Follow the window cleaning procedure.
5. Clean all video monitor screens.
6. Stow all LRU devices.

Preparing the Turret for Takeoff

1. From the Hand Controller, move the POWER switch to the ON position.

2. Make sure that the ON status LED on the Hand Controller is on.
3. Set all video monitor screens to on.
4. Click the FWD switch on the Hand Controller.
5. If a User Profile is available, select and load the profile from the user menu.
6. After 10 minutes of system operation, select the System Status main menu and make sure that all BIT status messages show OK. If there are any major failures, see Chapter 5, Failure Diagnosis.
7. Click the MANUAL switch and slew to a scene with some objects that have different thermal signatures.
8. Use the VIC switch to select the IR sensor as the Video-In-Control.
9. Use the IR CAL button on the Hand Controller to do a 1-Point calibration.
10. If manual adjustments are necessary, tune the sensitivity of each sensor and make the necessary contrast and brightness adjustments. For example, set the contrast priority for operation at dusk because the light conditions are different from daytime light.
11. For each sensor lens, adjust the Zoom and Focus controls. Make sure that the video from each sensor is correct.
12. If installed, make sure that the video recording devices record and playback correctly.
13. From the Hand Controller, press the STOW button to automatically steer the turret to the Stow position.
14. Do the steps that follow to prepare the turret system for INS alignment:

    14a. Make sure that the GPS is connected and functions correctly.

    14b. Make sure that the Aircraft position shows on the overlay.

    14c. Make sure that the Pilot is aware of the speeds and maneuvers necessary to align the INS.

Note: Keep turret powered. There are no mechanical locks to keep the turret in the stow position while powered down.

Preparing the Turret for Landing

1. From the Hand Controller, press the STOW button to automatically steer the turret to the Stow position.
2. Make sure that the turret system is energized. Make sure that the ON LED status light on the Hand Controller is on.

Note: Keep turret powered. There are no mechanical locks to keep the turret in the stow position while powered down.

Performing a Post-Flight System Shutdown

1. Make sure that the turret is in the STOW position. Make sure that no images, only the user menus show on the video monitor.
2. Select the Alarms action field of the System Status main menu. If there are BIT alarms, record the BIT numbers and tell your maintenance personnel.
3. Move the POWER switch to the OFF position on the Hand Controller.

Note: Keep turret powered. There are no mechanical locks to keep the turret in the stow position while powered down.

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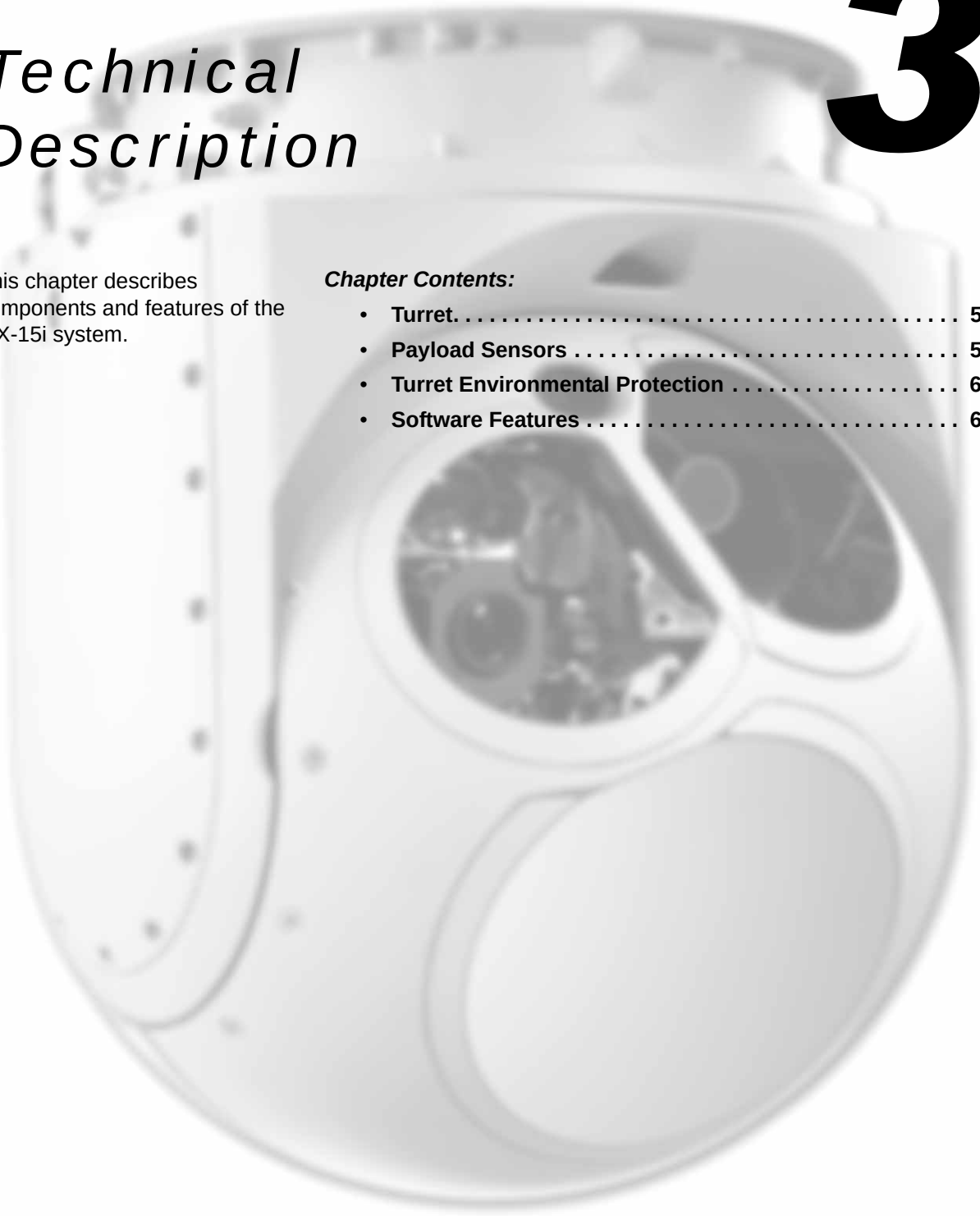
3 Technical Description

This chapter describes components and features of the MX-15i system.

Chapter Contents:



3.1 TURRET

A turret system has three main structural components:

- Lid – a housing for electronics and provides the vehicle interface mounting surface.
- Yoke – an external steerable frame that mates the lid to the gimbal and drive motors rotate the yoke in azimuth and the gimbal in elevation
- Gimbal – the external dome that stabilizes and steers a sensor platform, measures the line-of-sight, and protects the internal payload from the environment

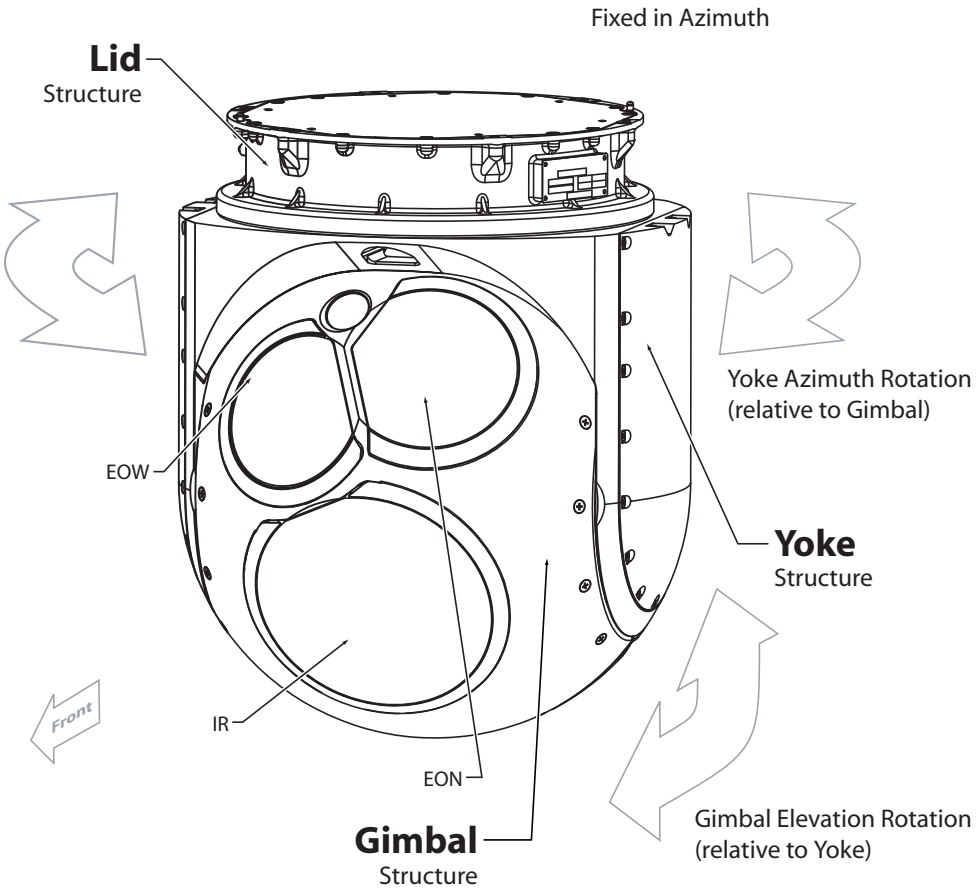


Figure 3-1 MX-15i Turret

3.1.1 Lid

The turret's lid attaches to the aircraft and contains the major electronics used to control the turret and sensors.

The lid assembly contains the following components:

- Gimbal electronics
- Mounting interface to the aircraft
  - Installation locator pins
  - Mounting holes
- 4 interface connections

- J1 – Power connector
- J2 – Signal connector
- J3 – Video connector
- J4 - GPS Antenna

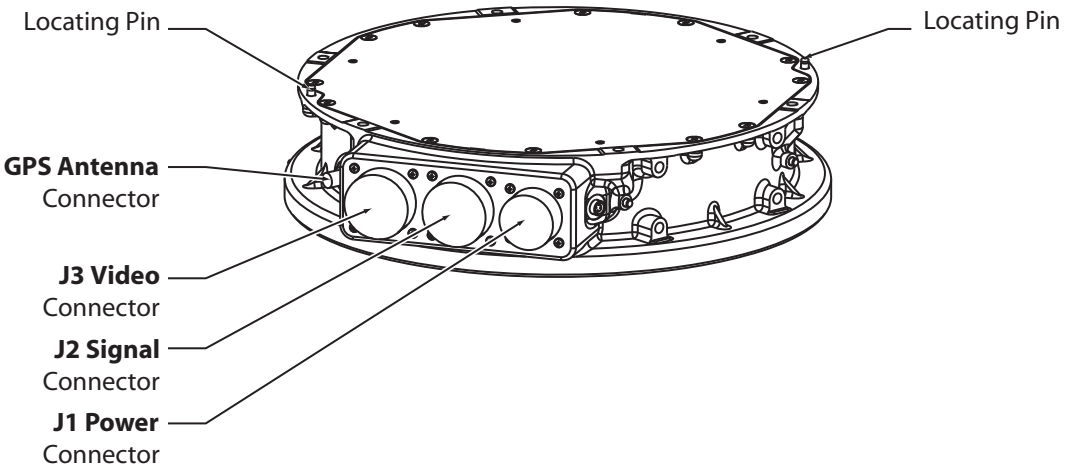


Figure 3-2 MX-15i Turret Lid

3.1.2 Yoke

The yoke structure is an outer steerable platform that holds the gimbal between its arms. The yoke contains electro-mechanical drives and gears that steer the yoke in azimuth and the gimbal in elevation. Each steering axis also contains encoders that measure their angular position. The yoke physically holds the equipment and a spring array provides passive vibration isolation of the gimbal. The spring array lets the gimbal move approximately 6.4 mm (0.25 inches) laterally in all directions. By dampening out vibrations and limiting their translation to the gimbal, active stabilization systems in the gimbal are invoked less and can make finer adjustments.

The yoke also contains the following components:

- Turret humidity indicator
- Desiccant assembly and humidity indicator.

A turret humidity indicator measures the internal humidity of the turret. Do not confuse the turret humidity indicator with the desiccant humidity indicator, which is also found in the yoke. Despite the fact that the turret is a sealed unit with protective measures, moisture levels in the turret can increase. When the upper quadrants 30 & 40 of the turret humidity indicator are lavender (pink), you must purge the turret with nitrogen through the purge valve in the rear door.

There is no regular or scheduled interval for this maintenance action. The need to purge the turret is dependent on operational and environmental use factors:

- Relative humidity of the environment during flights
- Relative humidity of the environment when stationary or in storage
- Time periods between flights
- Number of aircraft ascents and descents.

3.1.3 Gimbal

The gimbal is the outer dome that electro-mechanically steers and stabilizes an internal sensor payload. The major functions of the gimbal are to:

- Stabilize sensors
- Measure the optical bench's line-of-sight
- Align the INS
- Protect the payload from environmental exposure

3.2 PAYLOAD SENSORS

All sensors are mounted on the optical bench. The complete assembly is called the payload, which includes the following sensors:

- EOW – Daylight Wide Angle
- EON – MX-Day/Night Spotter™
- IR – Infrared Thermal

3.2.1 EOW Sensor

The Electro Optical Wide (EOW) sensor is a daylight imaging camera that outputs color video. The sensor consists of two parts:

- a 1-CCD camera body
- a continuous zoom lens

Table 3-1 EOW Lens Capabilities

Characteristic	Capability	Notes
Focal Lengths	Optical: 2.4-60 mm, Digital: 60-180 mm	
Fields of View	Optical: 47.18°-2.0°, Digital: 2.0°-0.67°	
Focus Range	1 m to Infinity	
Color (COL) Filter Wavelength	450-750 nm	• Color video
Near Infrared (NIR) Filter Wavelength	450-1000 nm	• Monochromatic video

Operator Use

The lens's variable focal length provides the widest views for general observation and scene investigation. Operators would utilize this sensor first to:

- orient turret steering
- examine a scene
- select a subject

For example, operators would use the EOW sensor to locate an area of interest within a scene and then center the LOS reticle over a subject. They might zoom into the maximum capabilities of the EOW lens. For a more detailed investigation, operators would switch to the higher magnification capabilities of the EON sensor to examine the subject. If the subject moves out of the EON sensor's view, the operator would switch back to the EOW sensor to re-acquire the subject.

Operating Temperature Limits

The EOW sensor is exposed to temperature fluctuations that occur inside the gimbal. The system monitors the sensor's temperature and protects it from thermal extremes. The sensor will only be operational within the following temperature control limits:

- For cold operation, the sensor will shutdown below -20°C and not restart until -10°C.

- For hot operation, the sensor will shutdown above 70°C and not restart until 60°C.
- For cold starts below -0°C, the sensor will not operate until it has been warmed.

Operator's have the capability to control the following imaging parameters:

- Sensitivity
- Filters
- Initiate a BIT

Sensitivity. Controls the amount of light exposure to the camera CCD. The control is similar to the brightness control on a television or monitor. However, the system makes proportional adjustments to three parameters:

- lens's iris opening
- digital shutter speed
- electronic gain

To control light use, operators can utilize either an Auto or Manual mode. In Auto mode, the system automatically controls image brightness to maintain video quality over a range of light levels. In Manual mode, operators can manually change brightness by making stepped adjustments to the sensitivity increment. The brightness range can be adjusted between:

- least sensitivity, i.e. smallest iris opening, shortest shutter speed, and minimum electronic gain.
- most sensitivity, i.e. largest iris opening, longest shutter speed, and maximum electronic gain.

Filters. Selects range of light wavelength to extend viewing into a near infrared range. There are two filter positions:

- COL – restrictive pass filter to transmit visible spectrum only
- NIR – all pass filter to transmit near infrared range

3.2.2 IR Sensor

The infrared (IR) sensor is a thermographic imaging camera that outputs monochromatic video. This sensor forms an image using infrared light much like a digital camera forms an image except using visible light. Instead of measuring light in the visible spectrum wavelength range (450–750 nm), the IR sensor is sensitive to the mid-infrared wavelength range (3.4–5.2 µm). The sensor consists of 2 main parts:

- camera
- a stepped zoom lens

Table 3-2 IR Lens Capabilities

Designation	Focal Length	Field of View	Minimum Focus Distance
WFOV	27 mm	26.67°	<3m (<10 ft)
MFOV	135 mm	5.43°	<12.2m (<40 ft)
NFOV	675 mm	1.09°	<243.8m (<800 ft)
VNFOV	2024 mm*	0.36°	<243.8m (<800 ft)

**Optical focal length is 1012 mm. Apparent focal length achieves* 2024 mm *when a 2x electronic zoom is applied*

Operator Use

Because of the sensor's thermographic imaging capabilities, its function is not restricted to daytime or night time use. Operators would utilize this sensor in any lighting conditions to:

- view subjects in daylight
- view subjects at night or in low-light scenes
- lock tracking on hot thermal signatures

For example, operators would use the IR sensor to locate an area of interest within a scene during night operation. Or, during a search and rescue mission at sea, thermal energy would be more distinct than daylight color imagery which would be very a monochromatic color scene.

Operating Temperature Limits

The IR sensor is thermally controlled but is also exposed to temperature fluctuations that occur inside the gimbal. The system monitors the sensor's temperature and protects it from thermal extremes. The sensor will only be operational within the following temperature control limits:

- For cold operation, the sensor will shutdown below -55°C and not restart until -38°C.
- For hot operation, the sensor will shutdown above 75°C and not restart until 58°C.
- For cold starts below -38°C, the sensor will not operate until it has been warmed.

Operator's have the capability to control the following imaging parameters:

- Sensor Calibration
- Sensitivity
- Offset
- Scene Setup
- Polarity
- Initiate a BIT

Camera Cooler Assembly and Warm Area Electronics

The focal plane array – like the film in a camera or a CCD in a digital camera – converts infrared light into a human visible image. Made up of a series of photodiodes, where each represents an image pixel, the focal plane array converts infrared light into electrical signals where the measured energy is assigned a grayscale tone. The combination of numerous grayscale pixels creates the overall monochromatic video image. The focal plane array is contained within a vacuum-sealed, dewar assembly and is cryogenically cooled. During system startup, the housing undergoes a cooling cycle that cools the focal plane array down to 77 K (-196.15°C or -321.07°F). Because the focal plane array is much colder than subjects the operator might view, its detection capabilities are highly sensitive and provide a high resolution image. The Warm Area Electronics (WAE) of the camera converts analog signals from the focal plane array into an uncorrected digital signal. The digital data is transmitted over a HotLink™ interface for later image processing enhancements prior to final video output.

Focal Plane Array Calibration

Infrared image quality will degrade with changing temperatures or from internal drifting of IR sensor hardware. The image will either seem washed out or have non-responsive pixels or "spots" in the image. To restore image quality, operators can re-calibrate the IR sensor and reset the dynamic range of thermal energy that is assigned to a grayscale representation. If the dynamic range of the grayscale is too narrow, the sensor will lack the ability to represent all measured infrared wavelengths and yield poor image quality. There are two types of calibration:

- 1-Point calibration
- 2-Point calibration

1-Point Calibration. Utilizes a single thermal signature profile for a de-focused scene. Utilized most often, it will remove most common artifacts and optimizes the exposure time within about 15 seconds. A 1-Point calibration

should be performed for every 20°C (68°F) change in subject temperature or every time the scene setup is changed. Care should be exercised to select a scene with a varied range of thermal energy. For example, focusing on the sun over water may skew the calibration.

2-Point Calibration

Utilizes two thermal signature profiles for calibration – a known temperature source followed by a scene based 1-Point calibration. The lens has an internal, IR-blackened heat diode that is used as a variable temperature control source. By measuring known temperatures of the control source, the system undergoes a complex recalculation of its pixel Non-Uniformity Correction (NUC) tables – temporarily overriding the factory calibrated tables in memory. The factory NUC table is restored when the turret is powered down.

Only use a 2-Point calibration if several 1-Point calibrations, with varied thermal scene changes, do not yield a satisfactory result. The process takes approximately 100 seconds to complete and might actually degrade image quality. Operators should exercise care and determine whether a 2-Point calibration is necessary because the result will not match the calibration accuracy of sophisticated factory equipment.

Sensitivity. Controls the amount of thermal exposure, to the camera's focal plane array, that is needed to capture video, and it has a function similar to the brightness control on a television or monitor. To control exposure, operators can utilize either an Auto or Manual mode. In Auto mode, the system automatically controls image brightness to maintain video quality over a range of thermal levels. In Manual mode, operators can manually change brightness by making stepped adjustments to the sensitivity increment.

Offset. Sets the temperature offset value for the image and similar to the contrast control on a television or monitor.

Scene Setup. Controls thermal exposure of the entire video image and optimizes contrast based on three settings:

- Default – a general purpose setting for most thermal conditions.
- Low – a low contrast setting for a limited thermal range, e.g. a gray boat in rough water.
- High – a high contrast setting for a wide thermal range, e.g. a dark plane in scattered clouds.

Note: After any scene setup change, operators must run a 1-Point calibration for the change to take effect.

Polarity. Inverts image polarity and sets tone priority for hot and cold objects:

- Black Hot – hottest objects appear black and coolest appear white.
- White Hot – hottest objects appear white and coolest appear black.

3.2.3 EON - MX-Day/Night Spotter™ Sensor

The Electro Optical Narrow (EON) sensor is a single lens with dual camera imaging capabilities - one daylight priority and the other for low-light conditions. The daylight camera outputs color video while the low-light camera outputs monochromatic video. The sensor consists of five main components:

- a 3-CCD, daylight camera
- a high sensitivity CCD, low-light camera
- a fixed focal length lens
- beam splitter optics for dual camera imaging
- filters for camera selection and near infrared light wavelength priority

Table 3-3 EON Lens & Filter Capabilities

Characteristic	Capability	Notes
Focal Length	1000 mm	
Fields of View	Daylight: 0.28°, Lowlight: 0.30°	
Focus Range	150m to Infinity	
Color (COL) Filter Wavelength	450-950 nm	Select daylight camera channel
Long Pass (LP) Filter Wavelength	450-950 nm	Selects low-light camera channel
Extra Long Pass (XLP) Filter Wavelength	840-1000 nm	Selects low-light camera channel

Operational Use

The lens's fixed focal length provides the highest magnification and operators would utilize this sensor for viewing:

- subjects at long range and examine for detail in color
- subjects at night using the low-light camera
- laser illuminated subjects at night
- subjects obscured by haze using the XLP filter

For normal daylight conditions (visible wavelengths 400-700 nm), operators would use the higher magnification of the EON sensor to examine a subject they had first located using the EOW sensor. If the subject moves out of the EON sensor's view, the operator would switch back to the EOW sensor to re-acquire the subject.

At night, operators would select the LP filter to switch to the low-light camera and view a wavelength band of 450-950 nm. If equipped in the turret, operators could view a subject highlighted with a laser illuminator because the laser's wavelength corresponds to the wavelength band of the low-light camera. Otherwise, operators would need night vision goggles to view any laser illuminated subjects.

In haze conditions, operators would select the XLP filter to restrict the view to a wavelength band of 840 to 1000 nm. This filter minimizes the impacts of haze and improves the performance of long range viewing.

Operating Temperature Limits

The EON sensor is exposed to temperature fluctuations that occur inside the gimbal. The system monitors the sensor's temperature and protects it from thermal extremes. The sensor will only be operational within the following temperature control limits:

- For cold operation, the sensor will shutdown below -55°C and not restart until -45°C.
- For hot operation, the sensor will shutdown above 70°C and not restart until 60°C.
- For cold starts below -45°C, the sensor will not operate until it has been warmed.

Operator's have the capability to control the following imaging parameters:

- Sensitivity
- Level
- Scene Setup
- Filters
- Initiate a BIT

Sensitivity. Controls the amount of light exposure to the camera CCD. The control is similar to the brightness control on a television or monitor. However, the system makes proportional adjustments to three parameters:

- lens's iris opening
- digital shutter speed
- electronic gain

To control light use, operators can utilize either an Auto or Manual mode. In Auto mode, the system automatically controls image brightness to maintain video quality over a range of light levels. In Manual mode, operators can manually change brightness by making stepped adjustments to the sensitivity increment. The brightness range can be adjusted between:

- least sensitivity, i.e. smallest iris opening, shortest shutter speed, and minimum electronic gain.
- most sensitivity, i.e. largest iris opening, longest shutter speed, and maximum electronic gain.

Level. Sets the pedestal black level and similar to the contrast control on a television or monitor. Operators can adjust the cutoff point for black to pull greater detail in deep shadows.

Scene Setup. Controls exposure of the entire video image and optimizes contrast based on three settings:

- Default – a general purpose setting for most light conditions.
- Low – a low contrast setting, e.g. a gray boat in rough water.
- High – a high contrast setting, e.g. a dark plane in scattered clouds.

Filters. Selects use of low-light camera channel and extends light wavelength viewing to a near infrared range. There are three filter positions:

- COL – All pass filter selection for daylight camera
- LP – Long pass filter selection for low-light camera
- XLP – Extra long pass for haze conditions using a low-light camera

3.3 TURRET ENVIRONMENTAL PROTECTION

During flight, air flows around the external surface to passively decrease the inner temperature of the turret. During ground operation, the inner temperature of the turret (in relation to the external air temperature) is much higher than in flight since there is no airflow.

The MX-15i system includes the features that follow for environmental protection:

- a stow position that prevents damage to the windows
- a desiccant assembly that keeps the turret internal air dry

3.3.1 Stow Position

The Stow position is an axial orientation of +150 degrees azimuth and +90 degrees elevation. It puts the windows of the turret below the lid and between the turret yokes. This prevents damage to the windows from unwanted material or moisture.

3.3.2 Turret Desiccant Assembly

The desiccant assembly is designed to allow the turret to breath and exchange air. This movement of air is a passive action designed to minimize pressure impacts from changes in altitude. Specifically, the desiccant assembly functions to:

- Inlet outside air into the turret and equalize pressure
- Dry incoming air of any moisture or suspended salts

If moisture was permitted inside the turret, it would condensate on the sensor windows and degrade image quality. Internal moisture would also be detrimental to internal electronics and corrode internal components.

The desiccant assembly is an integration of 5 elements:

- Desiccant housing
- Desiccant drying agent material
- Desiccant humidity indicator
- Breather valve
- Air exchange nipple

The turret also incorporates a breather check-valve. When the desiccant assembly is installed, an air exchange nipple opens to enable air exchange into the turret. When a desiccant assembly is removed, the turret’s breather check-valve closes to seal the turret from any air exchange.

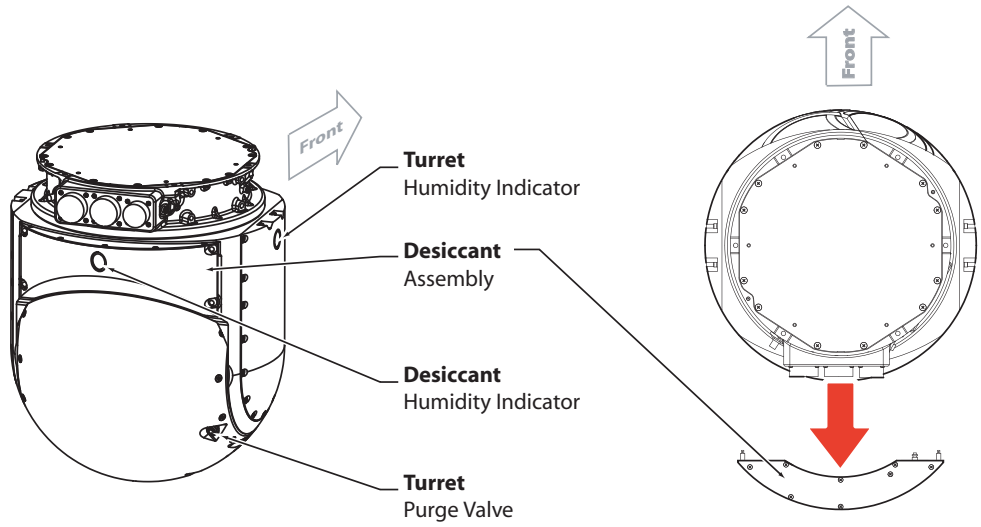


Figure 3-3 Turret Desiccant Breather Assembly

Pressure Equalization and Airflow Pathway

When the aircraft descends in altitude, air goes into the turret through the desiccant drying agent material. Moisture or salt in the air is filtered out by the desiccant material. The desiccant humidity indicator, found on the cartridge, measures the water saturation level of the desiccant material. If the upper quadrants 30 & 40 of the humidity indicator are lavender (pink), replace the desiccant material or the desiccant assembly.

Do not confuse the desiccant humidity indicator with the humidity indicator of the turret. Although the turret is a sealed unit, with the protection of the desiccant assembly, moisture levels can increase in the turret. When the upper quadrants 30 & 40 of the turret humidity indicator are lavender (pink), use nitrogen to purge the turret. You can find the purge valve on the rear door.

There is no regular or scheduled interval for these maintenance actions. The replacement of the desiccant assembly and purging of the turret is dependent on operational and environmental use factors:

- The relative humidity of the environment during flight.
- The relative humidity of the environment when stopped.
- The period of time between flights.
- The number of times the aircraft ascends and descends.

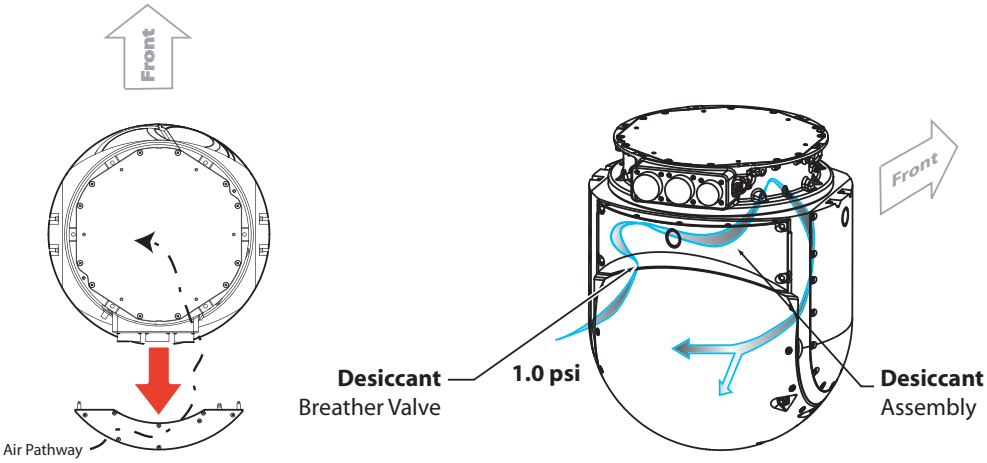


Figure 3-4 Pressure Equalization and Airflow Pathways

3.4 SOFTWARE FEATURES

3.4.1 Interpretation of Operator Control

Firmware within the system interprets input command feed as operator control functions. When no thumb pressure is applied, the slew transducer may have a significant output offset voltage. Unless compensated for, this could make manual tracking difficult with narrow fields of view. Therefore, an Auto Null function is provided to optimize the manual track performance.

When an auto null command is received, the Master Control firmware reads the current slew transducer signal as zero-thumb-pressure. This reading is used as an offset that is to be applied for slew calculations. A non-linear scaling of the slew transducer signals is implemented to assist in manual tracking. An additional aid for manual tracking is the zoom multiplier function. When enabled, the zoom multiplier function scales the maximum angular rate inversely with the focal length of the Video In Control. The reference focal length for zoom multiplier scaling is 40 mm on the EOW sensor.

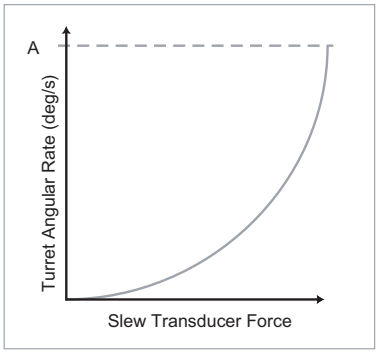


Figure 3-5 Slew Force Interpretation

Note: Do not enable the zoom multiplier when attempting to manually track a high crossing rate target with a long focal length.

3.4.2 Functions Related to Target Geographic Location

The target geo-location functions assume a spherical Earth with radius of 6366.7 km (3956.1 mi). The target geo-location functions include an approximate model of the refraction of light through the atmosphere. The model makes the error due to bending of the light negligible relative to the other errors in the system (Turret pointing accuracy, INS accuracy, etc.). The geo-location functions point the turret line-of-sight to a location and estimates the location of the turret line-of-sight.

The system performs two functions involving target geographic location:

- The turret line-of-sight is pointed to a target geographic location.
- The geographic location of the turret line-of-sight.

For pointing to a target location, the following parameters are given:

- Target lat/long
- Terrain elevation
- Aircraft lat/long
- Aircraft altitude
- Aircraft orientation

Given these parameters, the Master Control CCA calculates the required turret line-of-sight pointing angles relative to the aircraft.

For estimating target location, the following parameters are known:

- Terrain elevation
- Aircraft lat/long
- Aircraft altitude
- Aircraft orientation
- Turret line-of-sight pointing angles relative to the aircraft

Given these parameters, the Master Control CCA calculates the target lat/long and slant range.

In both types of calculations, aircraft orientation (pitch, roll and true heading) is used to reference the turret line-of-sight to the Earth coordinate system.

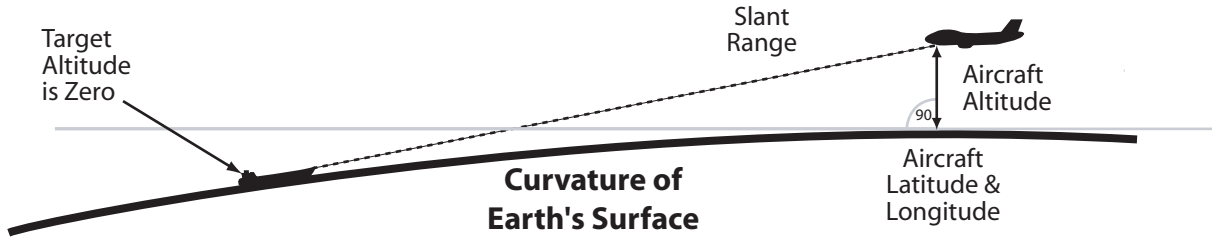


Figure 3-6 Aircraft & Target Locations

IR Digital Video Processing

The IR video processor is a circuit card assembly that interfaces with the IR sensor. The processor performs two main functions:

- Optimization of video quality
- Conversion of a digital to analog signal

The IR sensor outputs raw, thermal image data over a HotLink™ digital interface. The IR video processor optimizes the raw image data in three phases. To balance the thermal quality of the image, the first optimization applies pixel uniformity correction – stored in a software Non-Uniformity Correction (NUC) table that is defined by either a 1-Point or 2-Point calibration of the IR sensor. To provide a complete thermal image, a second optimization interpolates missing pixels and fills in that data to remove sensor artifacts. To sharpen image edges and set proper exposure, the IR video processor applies an image sharpening algorithm followed by a histogram equalization to maximize the dynamic tonal range of the image. As a final conversion step, the optimized digital data is converted into analog video output that is compliant with a video standard (either NTSC or PAL). The converted video is routed to the video switch matrix for overlay annotations and final video display output.

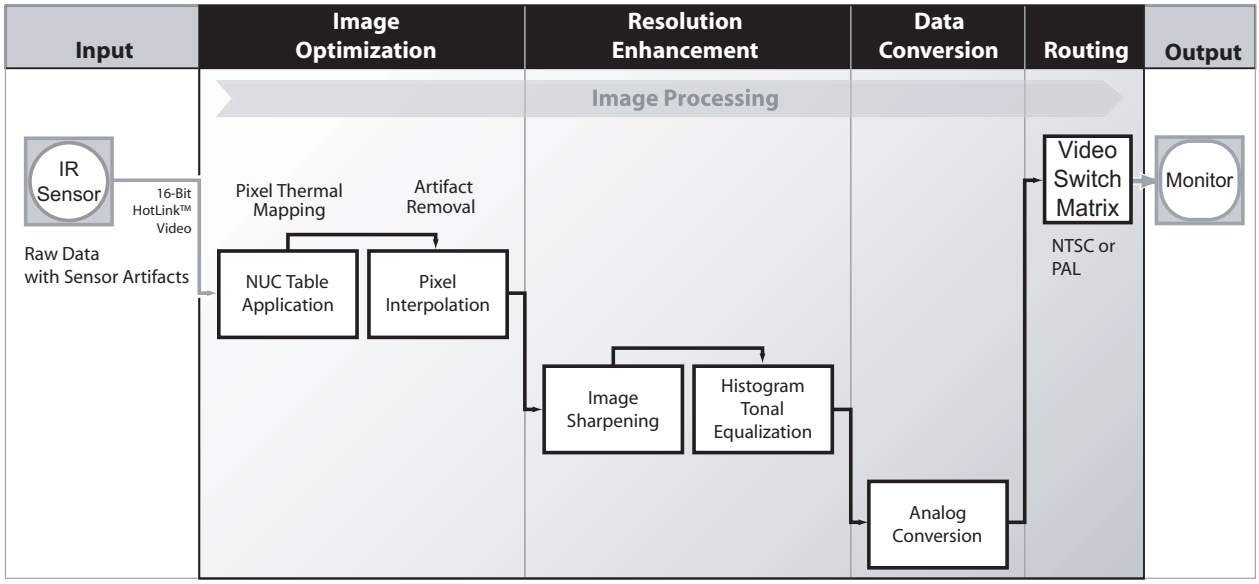


Figure 3-7 IR Video Processing Conversion Steps

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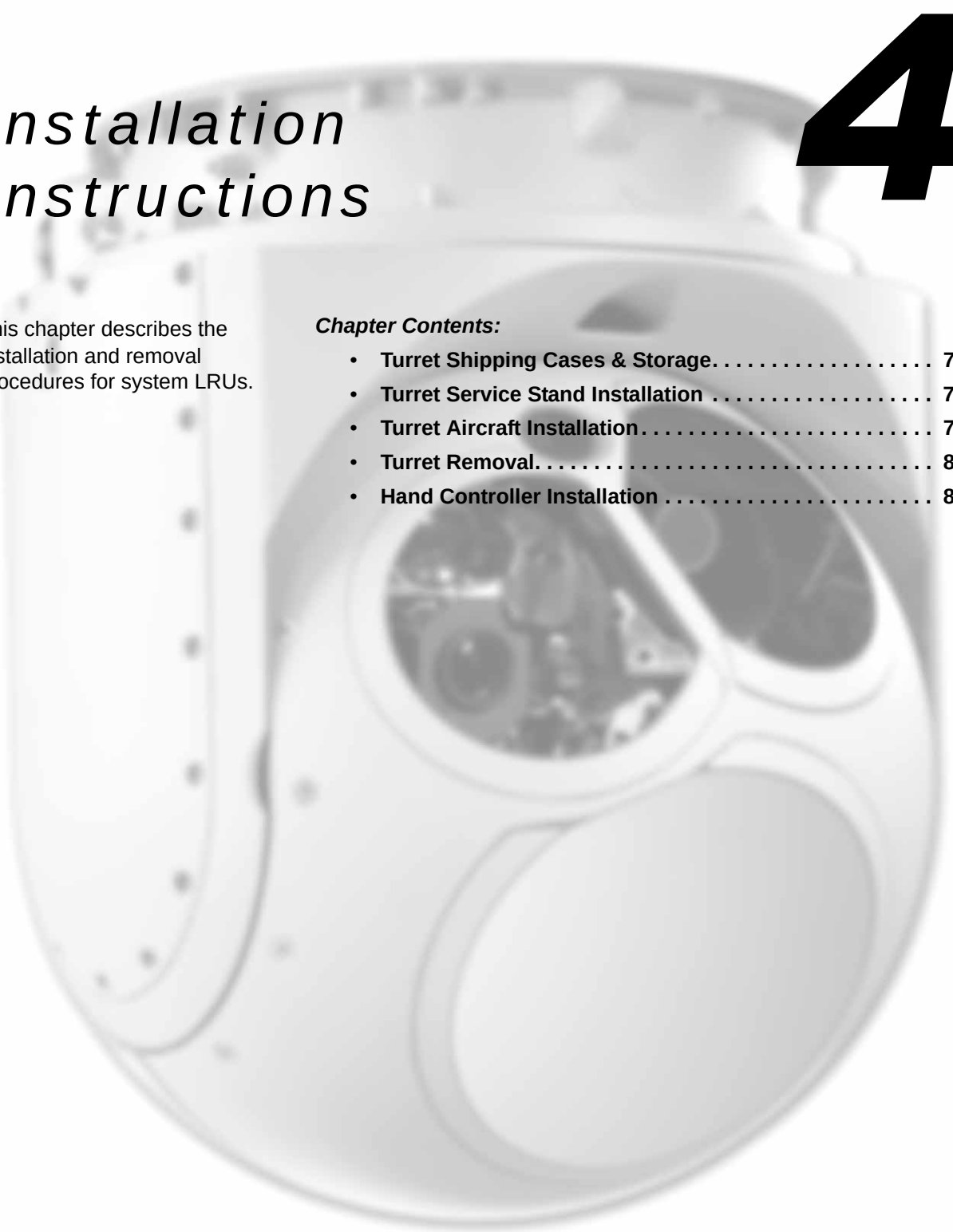
4 Installation Instructions

This chapter describes the installation and removal procedures for system LRUs.

Chapter Contents:



4.1 TURRET SHIPPING CASES & STORAGE

All MX-15i turrets are provided with aluminum, impact resistant, shipping containers. These containers are specially designed for transportation and storage of the turret when not in use. The container is constructed in two halves, from riveted aluminum sheet metal, that are joined together and retained by spring-loaded latches. Cut urethane foam, inside the case, provides shock and vibration protection to the turret. However, the turret shipping case is not waterproof, and it is intended to be stored indoors only. The urethane foam will retain moisture and may degrade the material. All other LRUs are shipped in packaging that protects to best commercial standards. All system LRUs are supplied in a configuration for immediate installation.

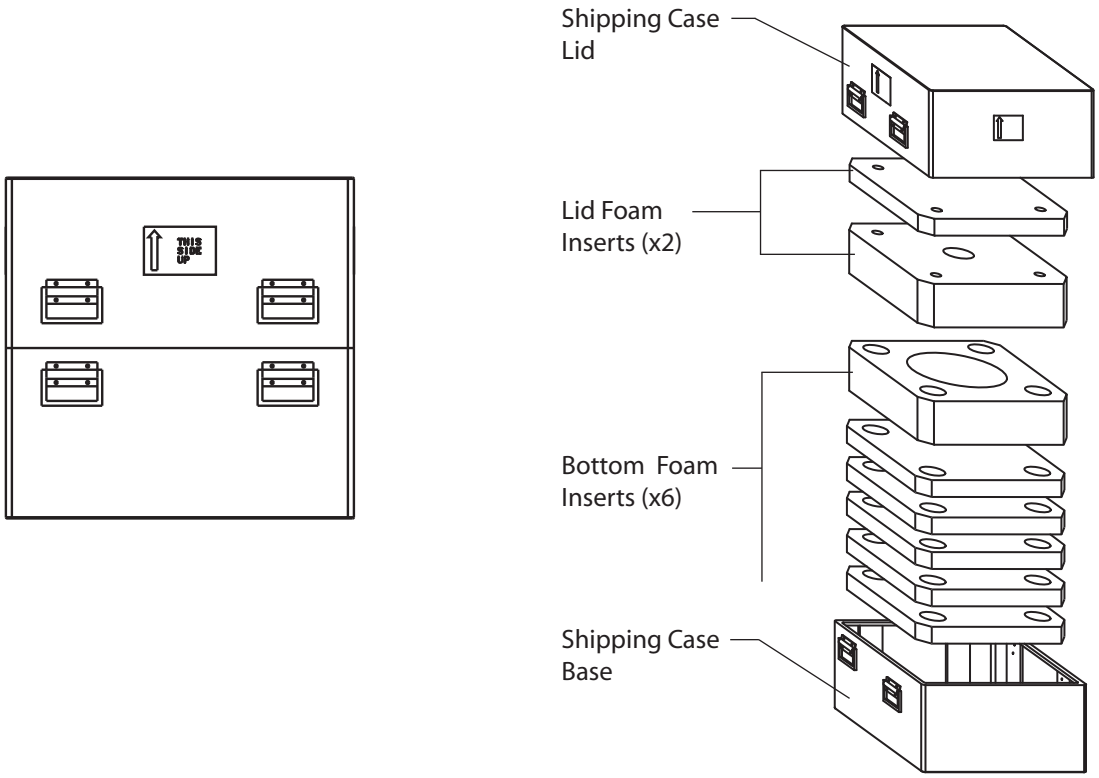


Figure 4-1 Removing Foam Layers

Table 4-1 Turret Shipping Case & LRU Packaging

Packaging	Contents	Part Number	Qty.	Notes
Turret Shipping Case	Shipping case	41179	1	• Case weighs approximately 125 kg (276 lbs)
	Turret	42390	1	
	Service stand assembly	42626	1	
	Service stand, top plate	25705	1	
	Service stand, mounting screws	CSNAS1514CA	6	• 6 Cap screws, hex socket – 1/4”-28 x 3/4 Note: Caps are painted red to designate use for service stand only.
	Service Stand, legs	23216	4	
	Service stand, leg mounting screws	1114119 1.00SS	4	• 4 Cap screws, 1/2-13 x 1.00
LRU Packages	For example: • Operator Interface • Support items and spares as ordered	Part numbers and weight vary based on support items and spares ordered.		

Note: When the turret is removed from its shipping case, retain the case in a safe location. The case is intended to be reused when shipping the turret for depot service or for safe storage as a spare unit.

Unpacking Non-Turret LRU Shipping Packages

1. Inspect the package’s exterior for physical damage. Exterior damage may indicate internal damage to the contents:
   - Report any damage to your supervisor immediately.
2. Open and unpack the package.
3. Inspect each part as you remove it from the case.
   - Report any damage to your supervisor immediately.

4.2 TURRET SERVICE STAND INSTALLATION

The function of the turret shipping case is to prevent damage to the turret during movement. It also isolates the system from shock. The case houses both the turret and service stand parts. The service stand is designed to support the turret while performing routine maintenance or testing tasks. While the turret is installed in the service stand, no additional weight should be placed on the service stand as the service stand is only designed to hold the weight of the turret alone. The turret may be stored temporarily in the L-3 Wescam supplied service stand for maintenance or testing purposes. For long term storage, L-3 Wescam recommends storing the turret in its impact resistant shipping case.

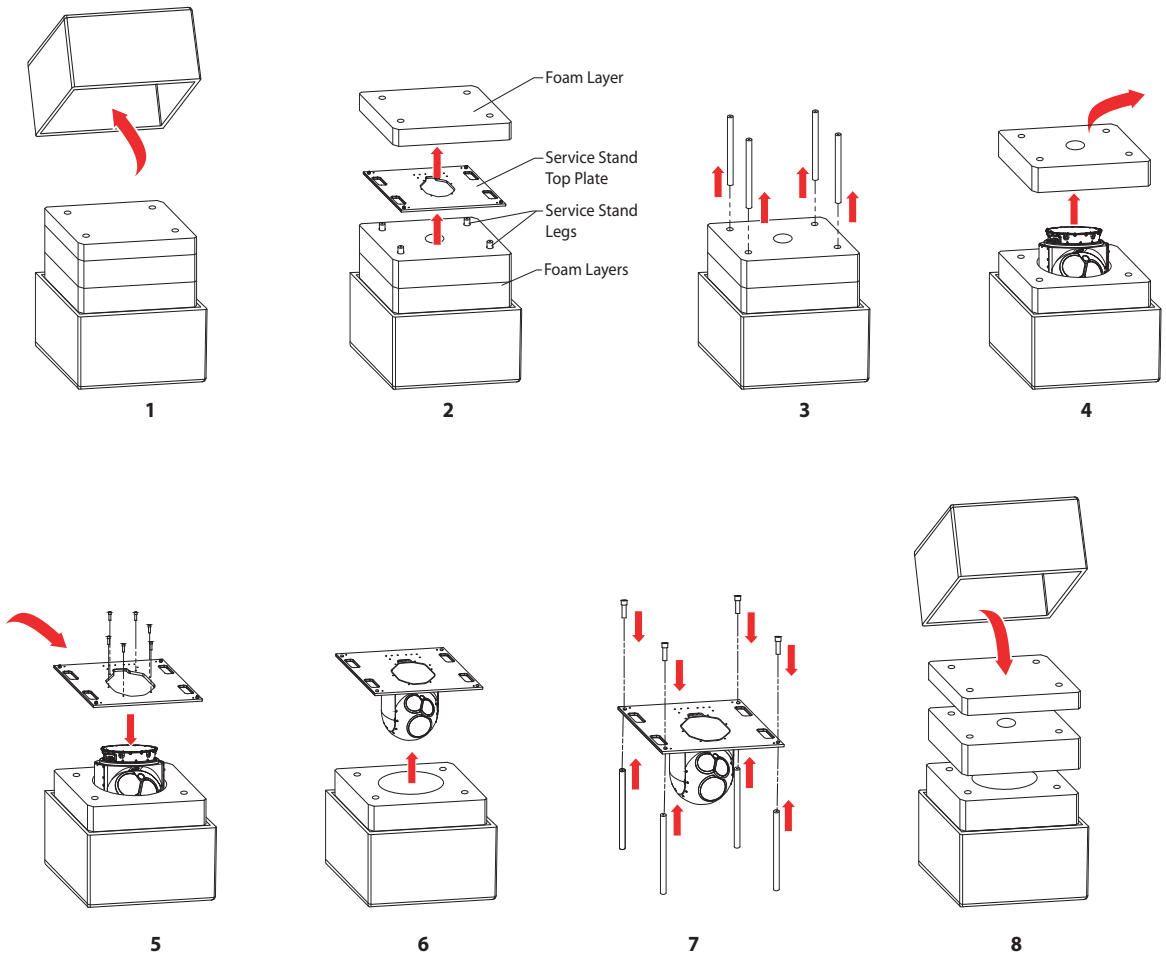


Figure 4-2 MX-15i Service Stand Installation Steps

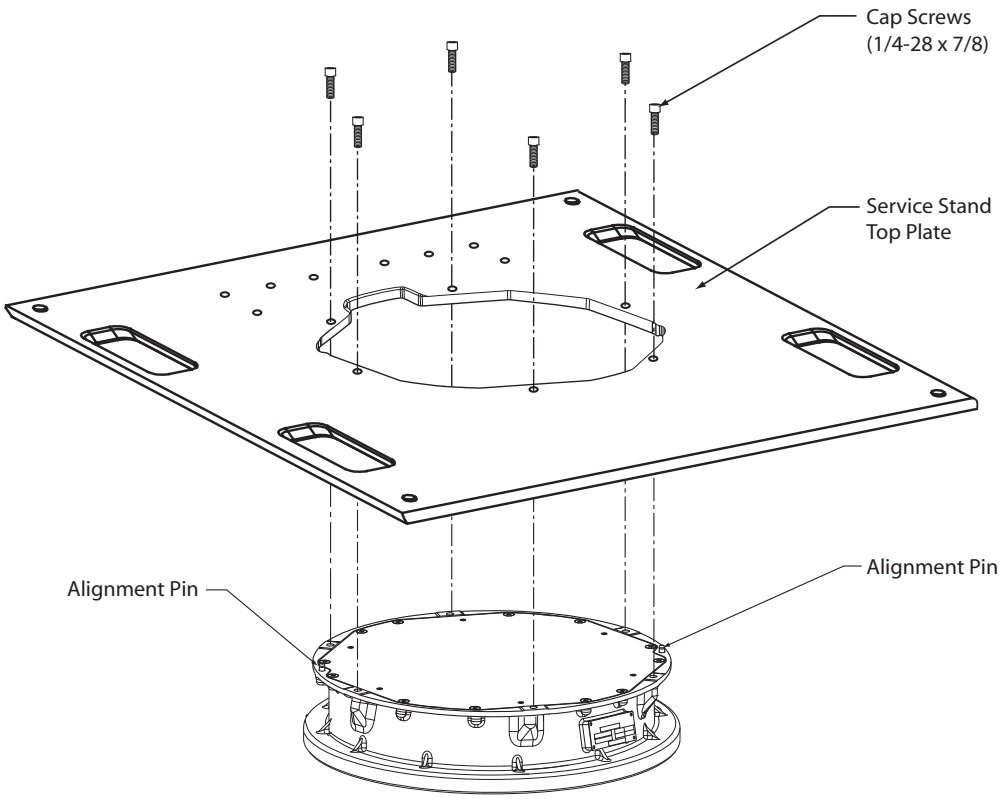


Figure 4-3 Orienting Alignment Pins

WARNING: TURRET IS A HEAVY ITEM. USE ONLY APPROVED EQUIPMENT AND PROCEDURES FOR UNPACKING AND LIFTING THE TURRET.

WARNING: SUPPLIED MOUNTING SCREWS FOR SERVICE STAND ONLY. DO NOT USE SERVICE STAND MOUNTING SCREWS FOR INSTALLING THE TURRET INTO AN AIRCRAFT.

Caution: Do not over tighten mounting screws. There is no need to torque fasteners but do not exceed 100 in-lbs (11 Nm).

Unpacking the Turret Shipping Case

1. Move the turret's shipping case to an open area with a flat surface.
2. Make sure that the "This Side Up Arrow" is pointing upwards.
3. Undo the latches on the sides of the shipping case and remove the lid section.
4. Remove the top foam layer.
5. Lift the service stand top plate from the shipping case.
6. Remove the middle foam layer, service stand mounting screws and cap covers.
7. Inspect all foam pieces for water retention or material deterioration:
   - If the foam has deteriorated, contact L-3 Wescam Customer Service for support.
   - If the foam is moist or wet, place the pieces out so they can dry.
8. Make sure the turret remains in the bottom of the case until it is either installed onto a service stand or aircraft.

Installing the Turret into a Service Stand

1. Remove the first foam layer.
2. Remove the service stand top plate from the case.
3. Remove each of the 4 service stand legs.
4. Remove the second foam layer.
5. Put the top plate on the turret. Align the 2 alignment pins on the lid of the turret with the alignment holes on the top plate.
6. Install all mounting screws (1/4”-28 x 3/4”) to attach the service stand plate to the lid of the turret.
7. Tighten the first mounting screw. Use a bolt tightening pattern and tighten the second screw that is opposite to the first screw.
8. Tighten a screw that is 90° from the first screw set, followed by the opposite screw.
9. Tighten all remaining opposite screw sets.

Note: 3 persons are necessary for the subsequent 6 steps.

10. Use 2 persons to lift the top plate and turret assembly out of the case.
11. Use a third person to put one of the legs into its respective mounting hole on the service stand plate.
12. Put a captive leg screw (114119-1.00-SS) into the hole, through the top plate and into the leg.
13. Do these steps again for the remaining legs.
14. Tighten all leg screws.
15. Put the service stand and turret on a flat surface.
16. At this time, the turret is prepared for aircraft installation or ground test.
17. Put the shipping foam into the case.
18. Attach the lid and keep the shipping case in a dry location.

4.3 TURRET AIRCRAFT INSTALLATION

Installation of the turret into an aircraft requires three separate steps:

- Step 1 – Inspection for corrosion
- Step 2 – Surface sealant application
- Step 3 – Installation and mechanical fasteners

Table 4-2 Turret Installation — Parts

Description	Part Number	Quantity	Notes
Turret	42390	1	
Turret shipping case	41179	1	
1/4”-28 x (~”) Cap screw, socket headed	–	8	• Installation screws are Customer Furnished Equipment that must conform to NAS 1351-4 • Screw length is installation specific. • Make sure screw length extends 1 cm (3/8”) below the mating surface. • Torque screws to 100 ± 10 in-lbs (11 Nm ± 1.1 Nm)

Table 4-3 Turret Installation — Consumables

Description	Part Number	Manufacturer	Notes
Joint compound, non-chromate corrosion inhibitive	CA 1000	PRC-DeSoto International	• Consult manufacturer’s Technical Data Sheet for use instructions and MSDS for material handling safety.
New, lint-free cloths that conform to AMS 3819	–	Numerous	• Consult a CA 1000 technical data sheet for surface preparation guidance. • Use one cloth to clean and another cloth to wipe.
Isopropyl Alcohol	–	–	• Remove dirt, grease, and lubricants prior to compound application.

Table 4-4 Turret Installation — Tools

Description	Part Number	Manufacturer	Notes
Torque wrench	3/8” drive	• Capable of measuring between 10 and 200 in-lbs (1.1 and 22 Nm)	
Hex socket driver	3/16”		

4.3.1 Step 1 — Corrosion Inspection

The turret lid has a nickel plated interface plate that acts as the mating surface to the aircraft. Repeated installation and removal of the turret may cause wear and chipping around the mounting holes. Prior to each installation, the interface plate must be inspected because chips in the nickel plating are vulnerable to corrosion.

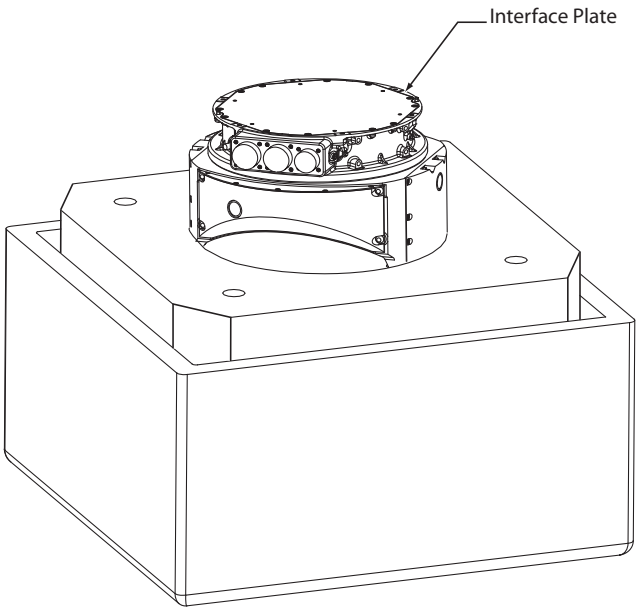


Figure 4-4 MX-15i Ready for Installation

Unpacking the Turret Shipping Case

1. Move the turret’s shipping case to an open area with a flat surface.
2. Make sure that the “This Side Up Arrow” is pointing upwards.
3. Undo the latches on the sides of the shipping case and remove the lid section.
4. Remove the top foam layer.
5. Lift the service stand top plate from the shipping case.
6. Remove the middle foam layer, service stand mounting screws and cap covers.
7. Inspect all foam pieces for water retention or material deterioration:
   - If the foam has deteriorated, contact L-3 Wescam Customer Service for support.
   - If the foam is moist or wet, place the pieces out so they can dry.

8. Make sure the turret remains in the bottom of the case until it is either installed onto a service stand or aircraft.

Inspecting the Interface Plate for Corrosion

1. Clean inside and around the mounting holes using a dry cloth.
2. Inspect inside and around the mounting holes for corrosion:
   - If no corrosion is detected, exit this procedure and proceed with installation.
   - If corrosion is detected, do not install the turret without written approval from L-3 Wescam and continue with this procedure.
3. Take several digital photos of the corrosion.
4. E-mail the photos to L-3 Wescam Customer Service for review, and request written approval to proceed with installation.
5. Await L-3 Wescam's corrosion assessment and recommended course of action:
   - For minor corrosion, most cases, you will receive written approval to proceed with installation.
   - For severe corrosion, less common, you will receive written notice to take the turret out of operation and prepare for repair.

4.3.2 Step 2 — Surface Preparation and Jointing Compound Application

All mounting surfaces and fasteners must be cleaned with a solvent before applying the CA 1000 joint compound. Use a progressive cleaning procedure by cleaning one small area and wiping clean before the solvent dries. Apply the CA 1000 joint compound after wiping so the part does not become re-contaminated.

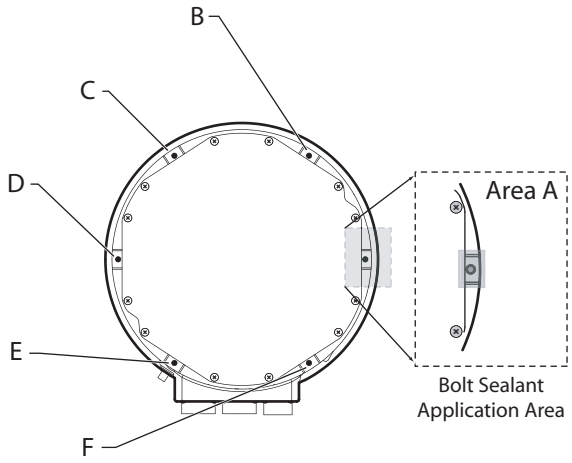


Figure 4-5 Bolt Sealant Application Areas

Caution: Never use reclaimed solvents or tissue paper, and only use cloths that conform to AMS 3819 standards.

Caution: Avoid contaminating solvent by applying solvent to new, clean cloths only.

Caution: Use CA 1000 only in application area or to protect worn nickel plating. The turret's interface plate and the aircraft's mounting plate must provide a conductive path to electrically ground out the turret.

Cleaning and Applying Joint Compound

1. Pour solvent on a new, lint-free cloth.
2. Clean one small area of the aircraft's mounting plate at a time.
3. Before the solvent evaporates, wipe the cleaned area with a second clean cloth.
4. Pour solvent on a new, lint-free cloth.
5. One at a time, clean out each of the turret's interface plate mounting threads and the areas around the holes.
6. Before the solvent evaporates, wipe the cleaned area with a second clean cloth.
7. Apply CA 1000 joint compound to the turret's interface plate mounting threads and the surface area around the holes.
8. Wipe up any excess CA 1000 joint compound with a new, lint-free cloth.
9. Pour solvent on a new, lint-free cloth.
10. Clean each mounting screw one at a time.
11. Before the solvent evaporates, wipe the cleaned area with a second clean cloth.
12. Apply CA 1000 sealant to the mounting screw's thread.

4.3.3 Step 3 — Installation and Mechanical Fastening

The turret's lid has locating pins that guide its orientation into the interface plate. When raising the turret to mate with the interface plate, stop raising the turret if the locating pins bind. The turret's interface plate and the aircraft's mounting plate must be parallel to ensure a proper fit. There is no approved method or required ground support equipment specified for hoisting the turret. However, at minimum, L-3 Wescam does recommend that the bottom portion of the shipping case be use to protect the turret when hoisting.

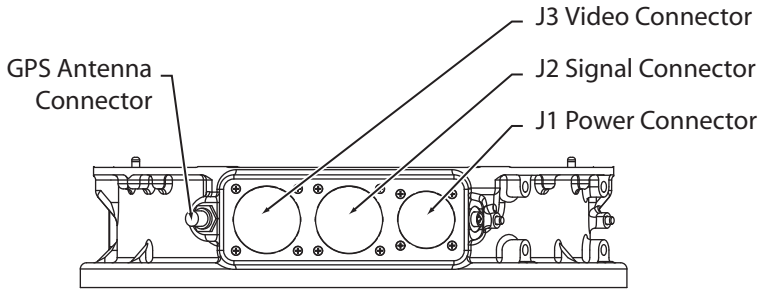


Figure 4-6 Turret Connectors

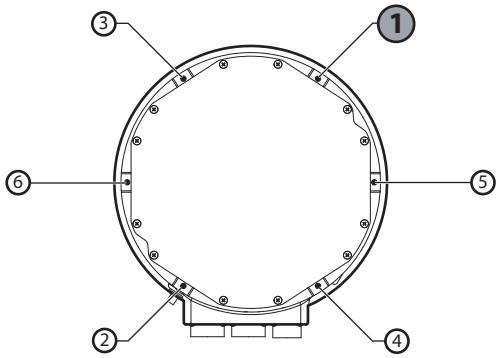


Figure 4-7 6-Bolt Tightening Pattern

WARNING: TURRET IS A HEAVY ITEM. USE ONLY APPROVED EQUIPMENT AND PROCEDURES FOR UNPACKING AND LIFTING THE TURRET.

WARNING: SUPPLIED MOUNTING SCREWS FOR SERVICE STAND ONLY. DO NOT USE SERVICE STAND MOUNTING SCREWS FOR INSTALLING THE TURRET INTO AN AIRCRAFT.

WARNING: AIRWORTHINESS OF THE DESIGN AND IMPLEMENTATION OF INTEGRATING THE SYSTEM ONTO THE AIRCRAFT IS THE CUSTOMER'S RESPONSIBILITY.

WARNING: DANGER ZONE. THE TURRET IS REMOTELY CONTROLLED AND CAPABLE OF CONTINUOUS MOVEMENT FROM DRIVE MOTORS THAT ARE CAPABLE OF FORCES THAT CAN INJURE PERSONNEL.

Note: This installation procedure assumes that there is a hoisting device available to raise and lower the turret.

Installing the Turret

1. Pull and tag the main breaker to disable power and steering control to the turret.
2. Make sure that the power, communications and video cables are in the correct position.
3. Turn the turret and make sure that the sensor windows face in the correct direction for the Forward steering mode.
4. Remove the J1, J2 and J3 connector cover caps from the turret lid and put them in the shipping case.
5. Lift the turret to within 30 cm (12”) of the aircraft mounting plate.
6. Put the power cable into the J1 connector of the turret lid. If necessary, twist the cable connector to align the guide keys and then push in to complete the connection.
7. Tighten the power MIL-C-38999 threaded lock-ring to the J1 connector of the turret lid. Stop when you cannot see the red line on the threads.
8. Put the communication cable into the J2 connector of the turret lid, and tighten the MIL-C-38999 threaded lock-ring. Stop when you cannot see the red line on the threads.
9. Put the video cable into the J3 connector of the turret lid, and tighten the MIL-C-38999 threaded lock-ring. Stop when you cannot see the red line on the threads.
10. If used, put the GPS antenna cable into the GPS antenna connector and tighten the lock-ring.
11. Make sure that the tension of the cables is correct for installation. Put the cables in position for installation.
12. Lift the turret until the alignment pins are within 13 mm (0.5”) of the aircraft mounting plate.
13. Make sure that the lid alignment pins are in line with the holes in the aircraft mounting plate.
14. Slowly lift the turret and make sure that interface plate and the aircraft mounting plate are parallel.
15. Install all mounting screws (1/4”-28 NAS 1351-4).
16. Use the bolt tightening pattern and tighten all screws in sequence.
17. Use the bolt tightening pattern and torque all screws to 11 Nm (100 in-lbs) in sequence.
18. Remove the bottom piece of the shipping case from the turret.
19. Keep the service stand top plate, legs and foam inserts in the shipping case.
20. Put the lid on shipping case and attach the latches. Keep the shipping case in a dry location.

4.4 TURRET REMOVAL

Turrets are removed from their aircraft when:

- swapping out for another functioning turret.
- placing the turret in its shipping case for service or storage.
- performing other maintenance tasks that require access to the turret's lid.

Regardless of the task, it is good practice to have the shipping case ready to hold the turret when not installed.

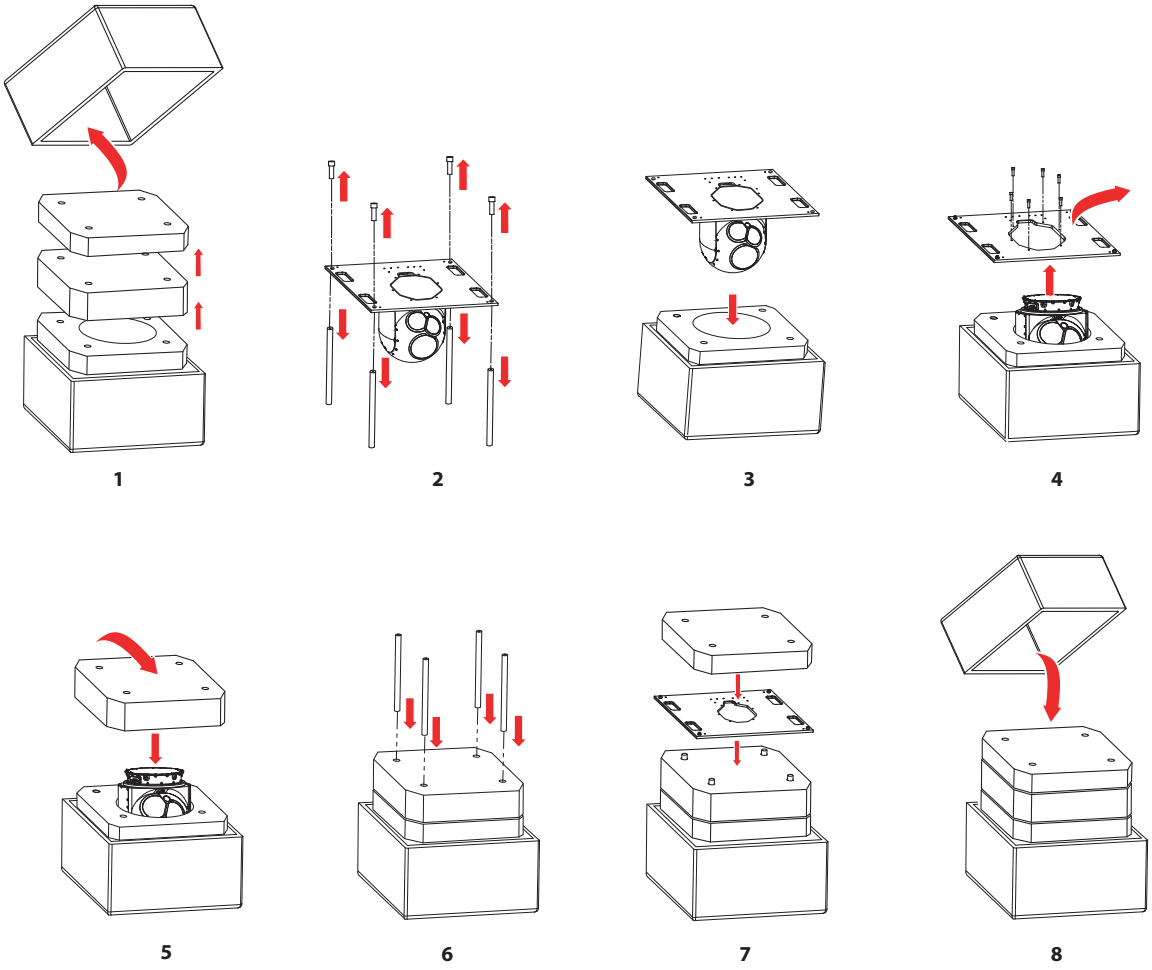


Figure 4-8 MX-15i Turret Removal and Shipping Case Packing

Table 4-5 Turret Removal — Parts

Description	Part Number	Number of Piece	Notes
Turret shipping case	41179	1	

Table 4-6 Turret Removal — Tools

Description	Part Number	Manufacturer	Notes
Socket wrench	3/8” drive	–	
Hex socket driver	3/16”	–	

4.4.1 Special Handling Instructions for Damaged Turrets

The IR camera’s optical lenses are coated with an anti-reflection coating that contains a small amount of Thorium Fluoride. Thorium Fluoride is a compound that contains naturally radioactive thorium. The radio-chemicals emit ionizing radiation, primarily in the form of alpha particles. Thorium and its decay products, called thorium daughters, also emit some beta particles and gamma radiation. Use of these thorium compounds, evaporated onto an infrared lens, under the authority of an NRC (Nuclear Regulatory Commission) does not require special handling procedures or a specific radiation safety monitoring program. The turret’s enclosure and environmental protection measures both protect personnel from exposure to these lenses. However, is the case of a crashed or damaged turret, special handling might be required because the IR lenses may have been broken and potentially expose individuals to a Thorium Fluoride dust inhalation risk.

WARNING: THORIUM FLUORIDE, WHEN CONSIDERED IN ITS FINAL FORM AS AN OPTICAL COATING WITHIN THE INFRARED LENS, PRESENTS NO HAZARD TO PERSONNEL IN THE NORMAL USE, MAINTENANCE, TRANSPORTATION OR STORAGE OF THE SURVEILLANCE SUBSYSTEM. HOWEVER, SHOULD THE INFRARED LENS BECOME DAMAGED OR BROKEN, THE MATERIAL MUST BE HANDLED AND WASTE DISPOSED OF IN ACCORDANCE WITH STATE AND/OR FEDERAL REGULATIONS. IN THE EVENT OF A BROKEN OR DAMAGED INFRARED TELESCOPE ASSEMBLY, THE FOLLOWING PROCEDURES MUST BE FOLLOWED:

- **WEAR EYE PROTECTION, A FILTER MASK TO COVER THE MOUTH & NOSE AND GLOVES WHEN HANDLING BROKEN GLASS.**
- **PICK UP ALL PIECES OF BROKEN GLASS AND PLACE IN A DOUBLE PLASTIC BAG AND SEAL.**
- **WIPE UP SUSPECTED CONTAMINATED AREAS WITH RYMPLECLOTH OR LENS TISSUE MOISTENED WITH ISOPROPYL ALCOHOL.**
- **PLACE CLEANUP MATERIALS IN A DOUBLE PLASTIC BAG AND SEAL.**
- **WASH HANDS IMMEDIATELY AFTER CLEANUP IS COMPLETE.**
- **DISPOSE OF MATERIALS AS LOW LEVEL RADIOACTIVE WASTE PER LOCAL BIO-ENVIRONMENTAL ENGINEERING OFFICE DIRECTIVES.**

WARNING: TURRET IS A HEAVY ITEM. USE ONLY APPROVED EQUIPMENT AND PROCEDURES FOR UNPACKING AND LIFTING THE TURRET.

WARNING: DANGER ZONE. THE TURRET IS REMOTELY CONTROLLED AND CAPABLE OF CONTINUOUS MOVEMENT FROM DRIVE MOTORS THAT ARE CAPABLE OF FORCES THAT CAN INJURE PERSONNEL.

Note: This installation procedure assumes that there is a hoisting device available to raise and lower the turret.

Inspecting the Turret Shipping Case

1. Move the turret's shipping case to an open area with a flat surface.
2. Make sure that the "This Side Up Arrow" is pointing upwards.
3. Undo the latches on the sides of the shipping case and remove the lid section.
4. Remove the top foam layer.
5. Lift the service stand top plate from the shipping case.
6. Remove the middle foam layer, service stand mounting screws and cap covers.
7. Inspect all foam pieces for water retention or material deterioration:
   - If the foam has deteriorated, contact L-3 Wescam Customer Service for support.
   - If the foam is moist or wet, place the pieces out so they can dry.

4.4.2 Removing the Turret from the Aircraft

1. Pull and tag the main breaker to disable power and steering control to the turret.
2. Remove the top lid portion of the shipping case.
3. Remove the service stand top plate, legs and the top two foam layers.
4. Locate the bottom portion of the shipping case under the turret.
5. Hoist up the shipping case to take the weight of the turret.
6. Unfasten the mounting screws.
7. Lower the turret to within 30 cm (12") of the aircraft's interface plate.
8. Slacken all turret cables.
9. Disconnect the power MIL-C-38999 threaded lock-ring to the turret's J1 connector.
10. Disconnect the signal cable from the turret lids J2 connector.
11. Disconnect the video cable from the turret lids J3 connector.
12. If installed, disconnect the GPS cable from the turret lid.
13. Install cover caps on the aircraft's power, signal and video connectors.
14. Install cover caps on the turret's lid J1, J2 and J3 connectors.
15. Lower the turret and shipping case to the ground.
16. Insert the middle urethane foam layer into the shipping case.
17. Insert the service stand legs back into their respective holes in the foam layers.
18. Place the service stand top plate on the foam layer.
19. Insert the final foam layer covering the service stand top plate and legs.
20. Install the top lid portion of the shipping case. Attach all latches and lock closed.

4.5 HAND CONTROLLER INSTALLATION

Installing the Hand Controller

1. Pull and tag the main breaker to disable power and steering control to the turret.
2. Locate the turret's operator interface connection.
3. Insert the Hand Controller's communication cable in the connector. You many need to twist to align the guide keys and then push in to complete the connection.
4. Tighten the Hand Controller's MIL-C-38999 threaded lock-ring to the connector. Stop when the red line on the threads is no longer visible.
5. Restore power to the turret. The Hand Controller is now powered.
6. From the Hand Controller, lift up on the POWER switch and then push forward to turn the power on. The turret is now powered.

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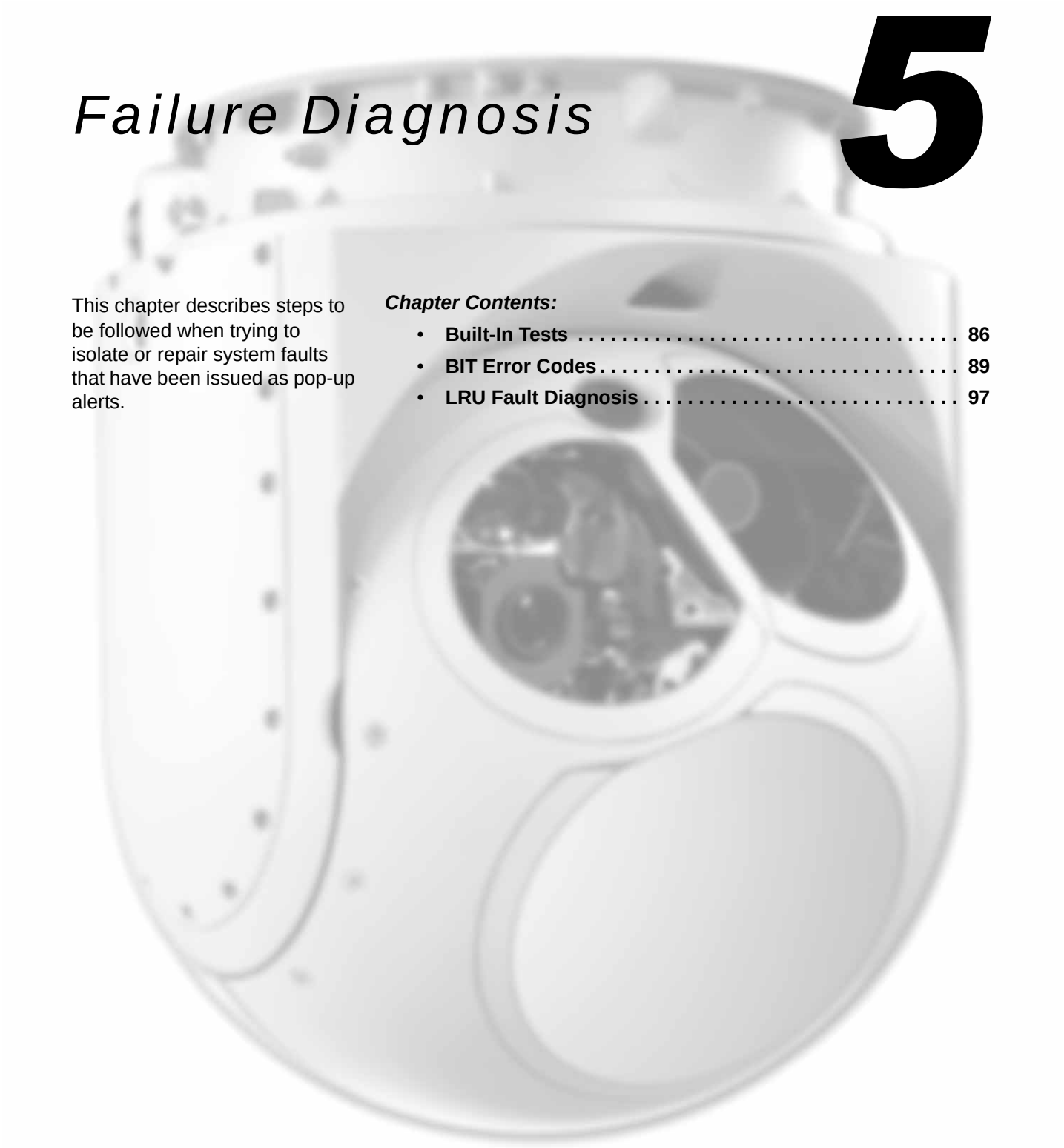
5 Failure Diagnosis

This chapter describes steps to be followed when trying to isolate or repair system faults that have been issued as pop-up alerts.

Chapter Contents:



5.1 BUILT-IN TESTS

A Built-in Test (BIT) checks the operational state for specific system components. BIT tests are executed by the following system of operator initiated actions:

- During system power-up
- During system operation
- Software initiated

Software initiated BITs will suspend operational use of the component until the test is complete. If a BIT test yields a failure, a code error is registered as an alarm and classified into one of two categories:

- Major
- Minor

Major BIT Failures

Major failures indicate a capability loss. For example, a major failure of the EOW focus servo means that the sensor can no longer focus. Depending on the degree of the major failure, the system component might still operate in a degraded state. Operators are notified of Major BIT failures through pop-up alerts on the video overlay.

Minor BIT Failures

Minor failures indicate out-of-tolerance conditions. For example, a moving component has mechanical wear, and the movement's timing takes longer than the stored design time. Operators are notified of Minor BIT failures through pop-up alerts on the video overlay.

5.1.1 Software BIT Status

User menus provide BIT status text that operators can review to confirm the operational capability of some major component. The System Status main menu provides a top level, lookup reference for the main turret and payload components. Each component's second level user menu will provide the same status message and an alarms indicator.

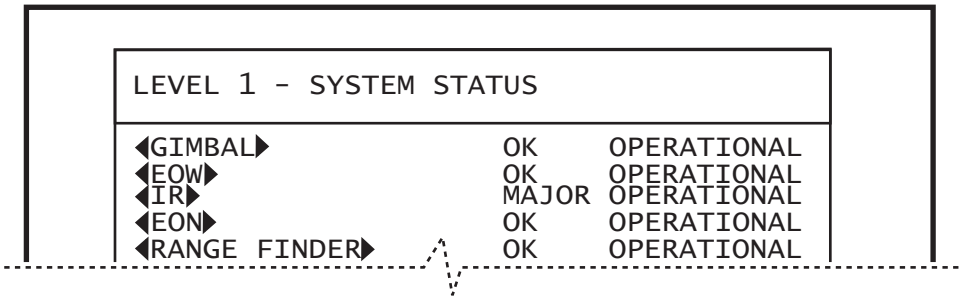


Figure 5-1 Example of a Major BIT Failure in the System Status Menu

Table 5-1 Status Indications in the System Status Main Menu

Status	State	Description	Recommended Action
OK, MINOR, MAJOR	STARTUP	Component Initializing: • Some components are warmed or cooled before they can be operated.	None.
–	N/A	Communication failure with component.	Review the Alarms page.
OK	OPERATIONAL	Component is in a fully functioning state.	None.
OK	STOWED	Turret is operational but in the Stow position	Steer turret to Forward or manual position to establish video.
MINOR	OPERATIONAL	Component BIT test failed but still functional: • Component capabilities are out of tolerance, e.g. focus position exceeded tolerance set point.	Review BIT from the Alarms page.
MAJOR	OPERATIONAL	Component BIT test failed but still functional: • The system has forced a partial shutdown of capability. For example, the EOW mechanism caused Iris function to shutdown, but zoom and focus capability remain.	Review BIT from the Alarms page.
MAJOR	FAILED	Component BIT failed and is shutdown. • The system has forced a shutdown of a capability. For example, the internal gimbal temperature is too hot so the EON is shutdown.	Review BIT from the Alarms page.

5.1.2 Alarms Page BIT Details

Expanded details of specific BIT failure can be reviewed from the Alarms page. Operators can access the Alarms page by selecting the Alarms action field located at the bottom of user menus. The Alarms page will list the following BIT details:

- Alarm Timestamp
- Alarm Description
- Alarm Summary
- Alarm BIT Error Code

Alerts are retained on the alarms page until the system component returns to its fully functioning state. Restoring a component's function might be accomplished by restarting the system, running a BIT test, or the component may require maintenance. The software is capable of storing up to 16 alert messages only. Additional alerts are added by dropping the previous alerts with the oldest time stamp.

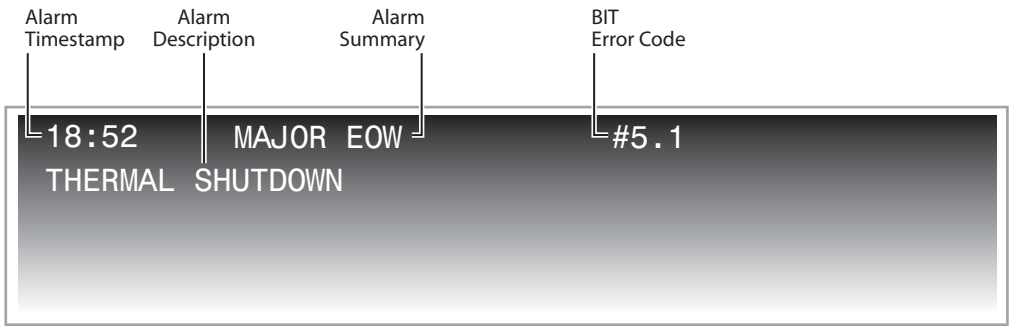


Figure 5-2 Alarms Page

5.2 BIT ERROR CODES

Every BIT test is assigned a unique numerical value in the form xx.xx. Operators should use the BIT error code tables to reference the faults code and review the recommended actions. Some failures may not be isolated by a BIT, in which case maintenance intervention is required to diagnose and isolate the fault.

BIT Error Code Quick Reference

5.2.1 Generic BIT Codes 1.x

Table 5-2 Failure Descriptions for 1.x BIT Codes

BIT #	Message	Category	Failure Description	Recommended Action
1.1	Board Failure	MAJOR	Gimbal processor CCA failed to boot properly.	Replace turret.
1.2	Battery Low	MINOR	Battery for NV ram and real time clock low on gimbal processor CCA.	No action. Contact L-3 Wescam.
1.3	Over Temperature Shutdown	MAJOR	Gimbal internal temperature is too high to operate safely.	Turn off and allow to cool.
1.4	Temperature Sensor Failure	MINOR	Communication with 1 or more serial temperature sensors lost. May cause a malfunction in various locations.	The EOW and IR sensors can go into thermal shutdown and IR imagery can be affected. If temperature sensor loss impacts mission, replace turret.
1.5	No Reference Timing Pulse	MINOR	Hardware failure on processor board.	Return turret to L-3 Wescam.

5.2.2 Gimbal BIT Codes 4.x

Table 5-3 Failure Descriptions for 4.x BIT Codes

BIT #	Message	Category	Failure Description	Recommended Action
4.1	Gimbal Shutdown	MAJOR	Gimbal motor overload. No steering available.	Cycle power. If failure persists replace turret.
4.2	Gyro Failure	MAJOR	Gimbal gyro malfunctioned and failed to initialize. No steering available.	Cycle power. If failure persists replace turret.
4.3	Gyro Error Threshold Exceeded	MINOR	Gyro communications error rate exceeded threshold.	No action. Contact L-3 Wescam.
4.4	Gyro Internal Failure	MAJOR	Internal gyro failure. Does not affect sensor or turret function.	No action. Contact L-3 Wescam.
4.5	Yaw Startup Failure	MAJOR	Gimbal would not initialize. No yaw motion detected. No steering available.	Cycle power. If failure persists replace turret.
4.6	Pitch Startup Failure	MAJOR	Gimbal would not initialize. No pitch motion detected. No steering available.	Cycle power. If failure persists replace turret.
4.8	Inner Motor Failed	MINOR	One of the inner motors failed during startup. May be caused by low voltage.	Check power at turret. Contact L-3 Wescam.
4.9	Inner Yaw Motor Overload	MINOR	Yaw motor exceeded absolute average drive threshold.	No action. Contact L-3 Wescam.
4.10	Inner Pitch Motor Overload	MINOR	Pitch motor exceeded absolute average drive threshold. May be caused by low voltage.	Check power at turret. Contact L-3 Wescam.
4.12	Outer Yaw Motor Overload	MINOR	Yaw motor exceeded absolute average load threshold. May be caused by low voltage, obstruction of turret or by the yaw lock failing to disengage.	No action. Contact L-3 Wescam.
4.13	Outer Pitch Motor Overload	MINOR	Pitch motor exceeded absolute average load threshold. May be caused by low voltage, obstruction of turret or by the pitch lock failing to disengage.	No action. Contact L-3 Wescam.

5.2.3 EOW BIT Codes 5.x

Table 5-4 Failure Descriptions for 5.x BIT Codes

BIT #	Message	Category	Failure Description	Recommended Action
5.1	Thermal Shutdown	MAJOR	Camera/lens temperature is outside the operating limits. (Too hot or too cold.)	If cold, wait for built in heaters to warm up the lens. If hot, the internal temperature is too hot. If loss of EOW camera impacts mission, turn off system and allow to cool. If problem persists, contact L-3 Wescam.
5.2	Focus Position Error	MINOR	Focus elements failed to reach a specific position in a specific time.	Verify that EOW sensor focus can still be adjusted. If focus control loss impacts mission, replace turret.
5.3	Focus Failure	MAJOR	Focus servo loop of EOW sensor not responding properly. No focus control available for EOW sensor.	Execute a BIT from the Level 2 EOW Menu. If failure persists, replace turret.
5.4	Zoom Position Error	MINOR	Zoom elements failed to reach a specific position in a specific time.	Verify that EOW sensor focal length can still be adjusted. If zoom control loss impacts mission, replace turret.
5.5	Zoom Failure	MAJOR	Zoom servo loop of EOW sensor not responding properly. No zoom control available for EOW sensor. Focal length will be approximately its value at time of failure.	Execute a BIT from the Level 2 EOW Menu. If failure persists, replace turret.
5.6	Iris Position Error	MINOR	Iris elements failed to reach a specific position in a specific time.	Verify whether EOW, when configured in auto mode, can still adjust to changing scene intensity levels. If capability loss impacts mission replace turret.
5.7	Iris Failure	MAJOR	Iris servo loop of EOW sensor not responding properly. Sensitivity control will not work properly under certain lighting conditions. For example, if Iris is stuck open, video will be overloaded in full sunlight conditions.	Execute a BIT from the Level 2 EOW Menu. If failure persists, replace turret.
5.8	Extender Position Error	MINOR	Extender elements failed to reach a specific position in a specific time.	Warning only. No action. Contact L-3 Wescam.

Table 5-4 Failure Descriptions for 5.x BIT Codes (Continued)

BIT #	Message	Category	Failure Description	Recommended Action
5.9	Extender Failure	MAJOR	Extender servo loop of EOW sensor not responding properly. Sensitivity control will not work properly under certain lighting conditions. For example, if extender is seized, the extender request will not work.	Execute a BIT from the Level 2 EOW Menu. If failure persists, replace turret.
5.10	Filter Position Error	MINOR	Filter elements failed to reach a specific position in a specific time.	Warning only. No action. Contact L-3 Wescam.
5.11	Filter Failure	MAJOR	Filter servo loop of EOW sensor not responding properly. Sensitivity control will not work properly under certain lighting conditions. For example, if filter is stuck, the video will remain the same when request to change filter occurs.	Execute a BIT from the Level 2 EOW Menu. If failure persists, replace turret.
5.12	Camera Failure	MINOR	Failed to communicate with EOW sensor.	Verify that EOW video is lost. If the capability loss impacts mission, replace turret.
5.13	Thermal Sensor Failure	MINOR	Thermal protection sensor reading out of range.	Check turret temperature through the Level 2 Gimbal Menu. If gimbal temperature is <75°C (<167°F) and EOW camera is still functional, continue to use system. If gimbal temperature is >75°C (>167°F), turn off turret and allow system to cool for at least 1/2 an hour before operating. If problem persists replace turret.

5.2.4 IR BIT Codes 6.x

Table 5-5 Failure Descriptions for 6.x BIT Codes

BIT #	Message	Category	Failure Description	Recommended Action
6.1	Thermal Shutdown	MAJOR	Compressor / expander temperature is too hot to operate safely.	The IR camera will shut itself down and will restart when safe operating temperature is acquired.
6.5	Focus Position Error	MINOR	Focus elements failed to reach specific position in a specific time.	Verify that IR sensor focus can still be adjusted. If focus control loss impacts mission, replace turret.

Table 5-5 Failure Descriptions for 6.x BIT Codes (Continued)

BIT #	Message	Category	Failure Description	Recommended Action
6.6	Focus Servo Failure	MAJOR	Focus servo loop of IR sensor not responding properly. No focus control available for IR sensor.	Execute a BIT from the Level 2 IR Menu. If failure persists, replace turret.
6.7	FOV Position Error	MINOR	FOV elements failed to reach specific position in a specific time.	Verify that FOV can be changed. If FOV control loss impacts mission, replace turret.
6.8	FOV Control Failure	MAJOR	Zoom servo loops of IR sensor not responding properly. No zoom control available for IR sensor. If mechanism is between zoom positions, it will not produce usable video. If mechanism is stuck at a zoom position, that focal length will be the only one available.	Execute a BIT from the Level 2 IR Menu. If failure persists, replace turret.
6.11	TEC Position Error	MINOR	TEC elements failed to reach a specific position in a specific time. TEC position error should only occur if a fault arises during a 2-Point calibration.	Verify that IR imagery is well corrected after a 2-Point calibration is completed. If not, cycle the turret power and apply only a 1-Point calibration. If problem persists replace turret.
6.12	TEC Servo Failure	MAJOR	TEC servo loop of IR sensor not responding properly. If mechanism is between positions or at the calibrate position, it will not produce usable video. If it is at the normal setting, some focal lengths are available. However, a 2-Point calibration cannot be performed.	Execute a BIT from the Level 2 IR Menu. If failure persists, replace turret.
6.13	Not Communicating	MAJOR	Processing electronics not communicating with IR Video Processor. There will be no video from IR sensor.	Execute a BIT from the Level 2 IR Menu. Perform steps in the Fault Isolation Trees.
6.14	Calibration Failure	MINOR	Calibration procedure failed.	Retry calibration. If a second failure occurs, change Scene Setup from Default to High and retry calibration. If calibration procedure failure continues, use the system uncalibrated and replace turret at next convenient opportunity.
6.16	WAE Not Communicating	MAJOR	IR VP failing to communicate with WAE (resides at IR sensor within gimbal). No video from IR sensor.	Execute a BIT from the Level 2 IR Menu. Perform steps in the Fault Isolation Trees.

Table 5-5 Failure Descriptions for 6.x BIT Codes (Continued)

BIT #	Message	Category	Failure Description	Recommended Action
6.17	Thermal Sensor Failure	MINOR	Thermal protection sensor reading out of range.	Check turret temperature in the Gimbal Menu. If gimbal temperature is <70°C (<158°F) and IR camera is still operational, continue to use system. If gimbal temperature is >70°C (>158°F), turn off turret and allow system to cool for at least 1 hour before operating. No action. Contact L-3 Wescam.
6.18	FPA Temperature Sensor Failure	MAJOR	FPA temperature sensor reading out of range. Failed to read valid temperature from the FPA of the IR sensor.	Image may still be available. No action. Contact L-3 Wescam.
6.20	Camera BIT Failure	MINOR	Defective memory on DCE card.	Replace Turret.

5.2.5 EON BIT Codes 7.x

Table 5-6 Failure Descriptions for 7.x BIT Codes

BIT #	Message	Category	Failure Description	Recommended Action
7.1	Thermal Shutdown	MAJOR	Internal gimbal temperature is too hot for the EON sensor to operate.	Turn turret off and allow to cool.
7.2	Focus Position Error	MINOR	Focus elements failed to reach a specific position in a specific time.	Verify that EON sensor focus can still be adjusted. If focus control loss impacts mission, replace turret.
7.3	Focus Failure	MAJOR	Focus servo loop of EON sensor not responding properly. No focus control available for EON sensor.	Execute a BIT from the Level 2 EON Menu. If failure persists, replace turret.
7.4	Camera Failure	MINOR	Failed to communicate with EON sensor.	Camera Failure. The recommended action indicates to verify if video is lost. This is not necessarily the case. Camera Failure can occur if communication control is lost. The video may still be present but control of camera is impacted.
7.5	Thermal Sensor Failure	MINOR	The lens temperature sensor is defective.	The temperature sensor source may be a sensor located somewhere other then the lens.
7.6	Filter Position Error	MINOR	The filter mechanism was unable to reach or sustain a commanded position.	Warning only. No action. Contact L-3 Wescam.

Table 5-6 Failure Descriptions for 7.x BIT Codes (Continued)

BIT #	Message	Category	Failure Description	Recommended Action
7.7	Filter Failure	MAJOR	The filter servo has exceeded the maximum drive voltage threshold. Sensitivity control will not work properly under certain lighting conditions. For example, if filter is stuck, the video will remain the same when request to change filter occurs.	Execute a BIT from the Level 2 EON Menu. If failure persists, replace turret.
7.8	Secondary Camera Failure	MINOR	Failed to communicate with the EON sensor.	Camera Failure. The recommended action indicates to verify if video is lost. This is not necessarily the case. Camera Failure can occur if communication control is lost. The video may still be present but control of camera is impacted.
7.9	Secondary Camera Thermal Shutdown	MAJOR	Internal gimbal temperature is too hot for the EON sensor to operate.	Turn turret off and allow to cool.
7.10	Secondary Focus Position Error	MINOR	Focus elements failed to reach a specific position in a specific time.	Verify that EON sensor focus can still be adjusted. If focus control loss impacts mission, replace turret.
7.11	Secondary Focus Failure	MAJOR	Focus servo loop of EON sensor not responding properly. No focus control available for EON sensor.	Execute a BIT from the Level 2 EON Menu. If failure persists, replace turret.

5.2.6 Master Control BIT Codes 8.x

Table 5-7 Failure Descriptions for 8.x BIT Codes

BIT #	Message	Category	Failure Description	Recommended Action
8.1	Gimbal Not Communicating	MAJOR	Gimbal processor not communicating with Turret.	Check cable connections for bent pins. Replace Turret.
8.3	Controller Not Communicating	MAJOR	Hand Controller not communicating with Turret.	Check cable connections between Turret and Hand Controller for bent pins. Replace Hand Controller.
8.4	Gimbal No Power	MAJOR	+28VDC not present at filter board at top of turret.	Make sure power is present at turret connection J1.
8.5	Payload No Power	MAJOR	+28VDC not present at filter board at top of turret.	Make sure power is present at turret connection J1.

Table 5-7 Failure Descriptions for 8.x BIT Codes (Continued)

BIT #	Message	Category	Failure Description	Recommended Action
8.7	No Video From EOW	MAJOR	Master control processor detected loss of video. (no sync signal)	Check cable connections for bent pins.
8.8	No Video From IR	MAJOR	Master control processor detected loss of video. (no sync signal)	Check cable connections for bent pins.
8.9	No Video From EON	MAJOR	Master control processor detected loss of video. (no sync signal)	Check cable connections for bent pins.
8.10	No Video From AVT	MAJOR	No video being sent out from Autotracker.	Execute a BIT from the Level 2 AVT Menu. If problem persists, replace Turret.
8.12	Map Not Communicating	MAJOR	No messages received from the map system.	Fix map or cabling.
8.13	Loss of INS Data	MINOR	Loss of customer provided INS aiding data.	Customer action.
8.14	MX Pod Not Communicating	MAJOR	Turret not communicating with the MX-Pod.	Check cabling, then MX-Pod power. If the indication persists replace the MX-Pod.

5.2.7 GPS BIT Codes 20.x

Table 5-8 Failure Descriptions for 20.x BIT Codes

BIT #	Message	Category	Failure Description	Recommended Action
20.1	Not Communicating	MAJOR	GPS not communicating with Turret.	Check GPS communications connections. Cycle system power.
20.2	Invalid Message Threshold Exceeded	MINOR	Exceeded invalid message threshold.	Check functionality of GPS by performing a system BIT. Cycle power, if GPS functionality is not restored then replace Turret.
20.3	Checksum Error Threshold Exceeded	MINOR	Exceeded checksum error threshold. May indicate a problem within the GPS functionality.	Check functionality of GPS by performing a system BIT. Cycle power, if GPS functionality is not restored then replace Turret.
20.4	No Position	MINOR	Not receiving satellite data.	Check antenna.

5.3 LRU FAULT DIAGNOSIS

Most system failures will be detected by a system or sensor BIT. However, there are some failures that might prevent the BIT from functioning and assist with determining the failure. In absence of a BIT alarm, operators should follow the Fault Diagnostic Trees for system power or video failures, and attempt to isolate and resolve the failure before contact L-3 Wescam for assistance.

The Fault Diagnosis Trees are a guide to find and correct faults. Use them to reduce delays and unnecessary replacement of system components. It is assumed that the fault is caused by a single failure or malfunction.

The Fault Diagnosis Trees are in a logic-diagram format. Each action is followed by a question with a yes or no answer. The answer gives either another question or a solution. Do the necessary steps to isolate the cause of the fault.

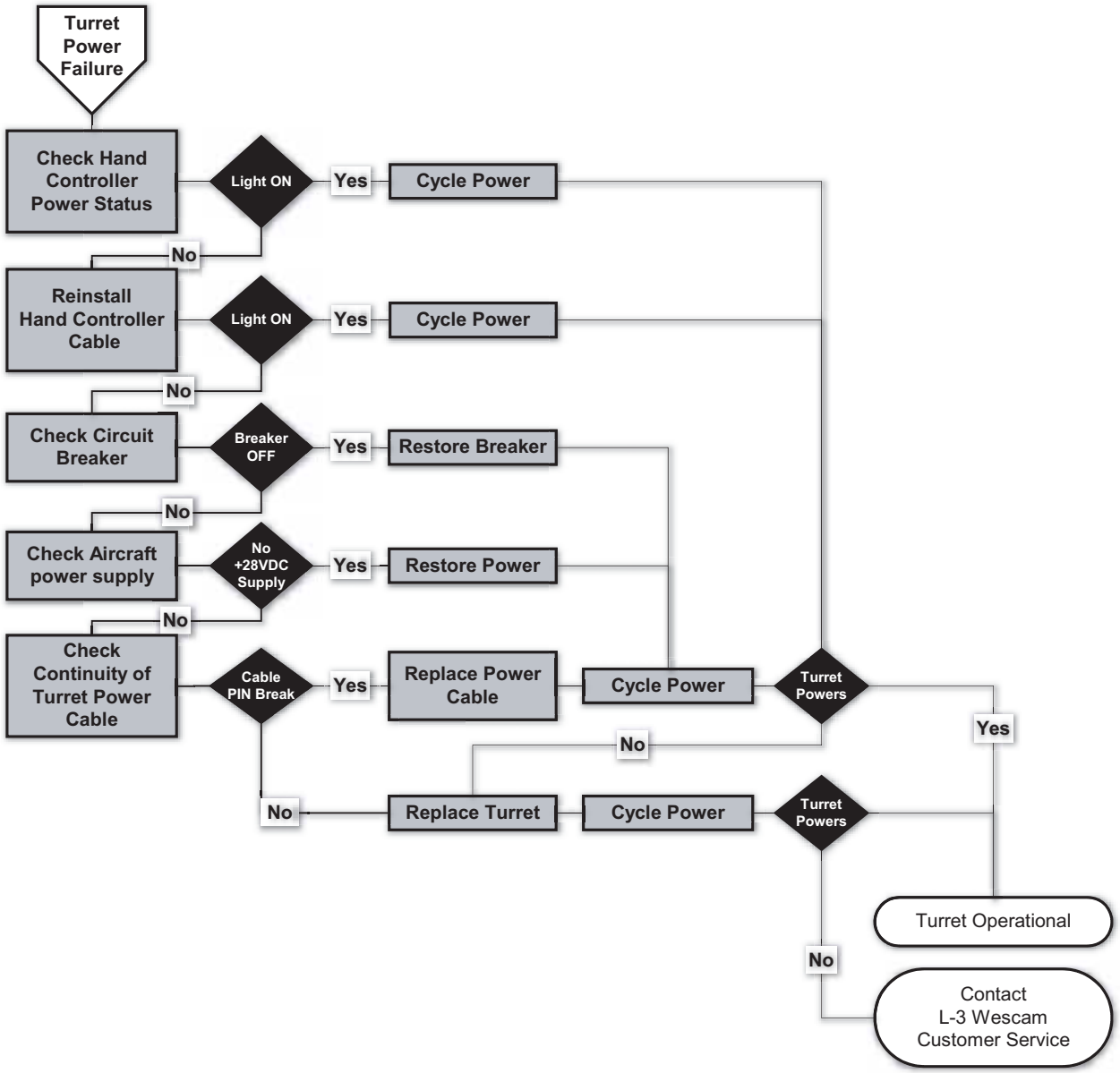


Figure 5-3 Fault Diagnostic Tree for Power Loss

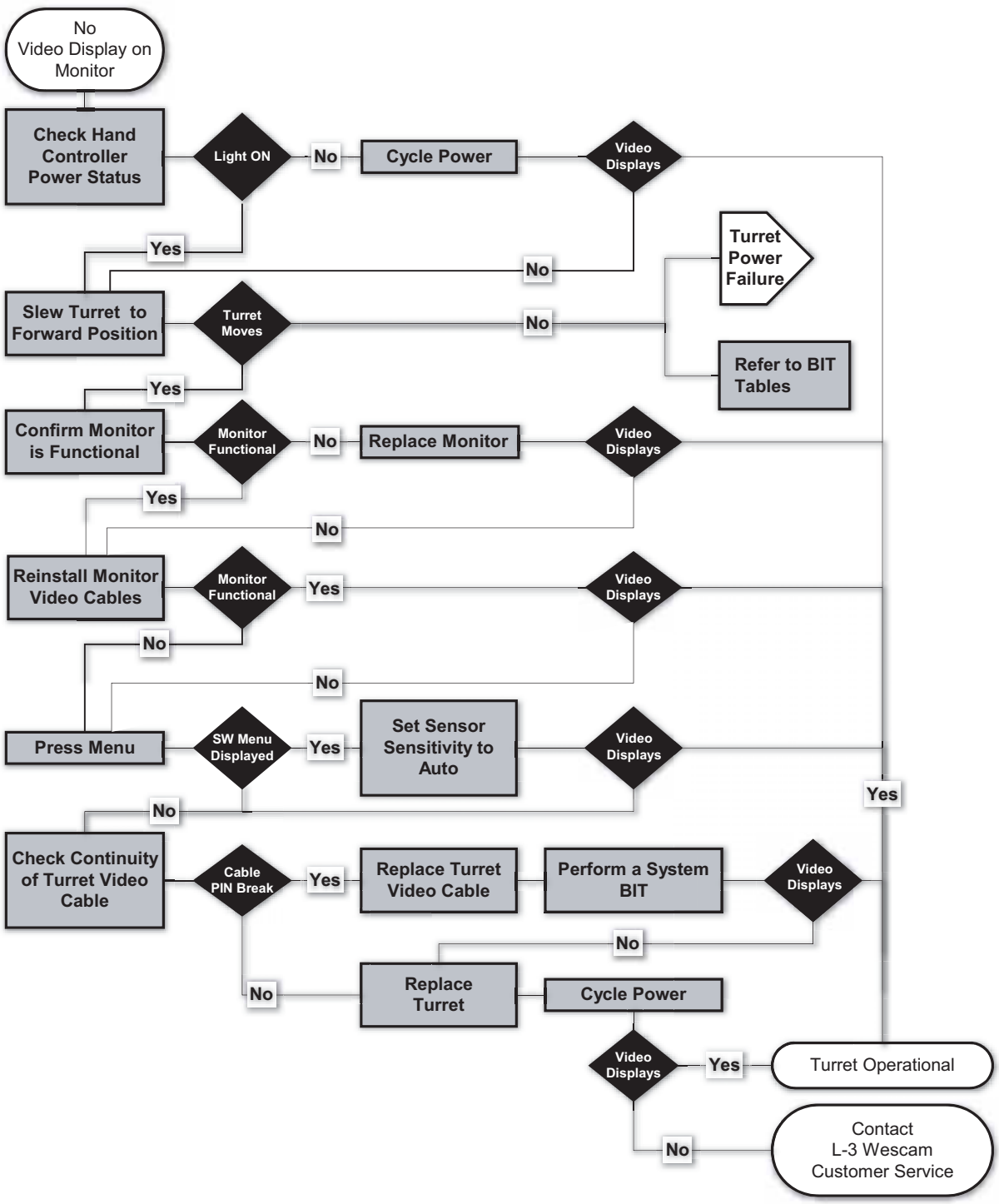


Figure 5-4 Fault Diagnostic Tree for Video Loss

6 Maintenance Information

This chapter describes all of the procedures that are required to perform any maintenance on the MX-15i system.

Chapter Contents:

6.1 MAINTENANCE POLICY

L-3 Wescam's equipment repair policy for MX Series turret is:

- Customer performs as-required maintenance procedures
- Customer removes and replaces all faulty LRUs
- L-3 Wescam or approved L-3 Wescam service depots repair faulty LRUs

General maintenance activities have no scheduled intervals or duty cycles, and customers are limited to the performing the following approved procedures:

- Inspecting and cleaning turret windows
- Inspecting humidity indicators
- Purging the turret
- Removing and replacing the purge valve
- Removing and replacing the desiccant assembly
- Removing, refilling and replacing the desiccant assembly

6.2 INSPECTING & CLEANING WINDOWS

Windows *must* be inspected prior to each flight to ensure the aircraft will be air worthy and that mission video will yield the highest quality possible. Windows must be free of any visible chips, cracks, or excessive buildup of debris. If windows require cleaning, use the approved maintenance procedure for cleaning turret windows. This cleaning procedure is a progressive four step process – starting with a dry technique followed by wet removal, cleansing, and drying. You must take care to lift and loosen bonded particles gently. If you wipe particles across the window surface they will act like an abrasive. All windows can be cleaned using the same procedure.

6.2.1 Environmental Considerations

Certain environmental conditions will have different impacts on turret windows. You should evaluate the conditions your turret will be exposed to during missions. The main environmental considerations are:

- Arctic or cold weather
- Maritime
- Polluted urban

Arctic or Cold Weather Environments

When your turret is operating in an arctic or cold weather environment, the aircraft will be exposed to deicing fluid. Operators should make sure the turret is stored in the Stow position, and instruct the deicing crew that they not spray de-icing fluid onto the turret.

Maritime Environments

When your turret is operating in a maritime environment, moisture that collects on the turret windows during flight will contain dissolved salt particles. When this moisture dries, the salt particles will remain on the turret window and can act as an abrasive if wiped. Always soak the windows before wiping.

Polluted Urban Environments

When your turret is operating in a polluted urban environment, rain can contain pollutants that increase the acidity of the liquid – more commonly called acid rain. If turret windows are exposed to acid rain and not washed, the glass will become pitted and develop a rough “orange peel” texture. Over time this will progressively degrade image quality of the video. To avoid acid pitting, increase the frequency of window washing. You should not wait and rely on a visual inspection, which can only identify bonded material.

Table 6-1 Window Cleaning — Consumables

Description	Part Number	Quantity	Notes
Compressed air.	–	1	
Mild, non-abrasive detergent.	–	1	• For example, a liquid dishwashing soap that is free of greasy additives such as lanolin.
Clear View Glass Cleaner or equivalent	–	1	• Manufactured by Rochester Midland Limited. Contact 851 Progress Court / P.O. Box 486 / Oakville, Ontario / L6J 5A8 / Canada or see www.rochestermidland.com for more information.

Table 6-1 Window Cleaning — Consumables (Continued)

Description	Part Number	Quantity	Notes
Kimwipes® or clean, non-abrasive, lint-free, and dry cloths	34120	Numerous	• Kimwipes® are manufactured by Kimberly-Clark: See www.kcprofessional.com. for more information.

Table 6-2 Window Cleaning — Tools

Tool	Size	Notes
Laboratory wash bottles or spray bottle for rinse water.	1000ml (32 oz.)	• Bottles must be clean and uncontaminated. • Use one container for warm wash water. • Use one container for rinse water.

Caution: Chips or cracks in turret windows are not air safe. If detected, contact an L3 Wescam Customer Service representative.

Caution: Do not power wash the turret.

Caution: Never wipe a dry window with a dry cloth. Embedded debris will scratch the surface.

Caution: Never use tissues or paper towels. Such products contain abrasives.

Caution: Never allow wet windows to air dry as the surface will stain permanently. Do not start this procedure unless you have sufficient time to follow all steps or while you are completing other maintenance tasks.

Caution: Do not scrape bonded particles that cannot be removed with compressed air. Soak the particles and allow them to loosen.

Washing Windows

1. Mix the liquid detergent with warm water to proportions recommended by the detergent manufacturer.
2. Use compressed air to remove loose particles to prevent scratching during subsequent cleaning steps. Always utilize a dry cleaning technique first to remove loose particles, but do not scrape particles that have bonded to the window.
3. Apply the detergent mixture to the window. Allow time to soak, but do not let the window dry. The detergent will act on releasing bonded particles.
4. Reapply the detergent mixture to the window.
5. Use a dry cloth to wipe the window in a gentle circular motion. Follow one direction only and do not move back-and-forth.
6. As the window is washed, apply rinse water and wipe dry immediately. Use new dry cloths rather than reusing cloths and discard all cloths as debris collects.
7. For the remaining windows, repeat steps 3 to 6.
8. Inspect all windows to confirm they are clean:
   - If windows are not clean, repeat steps 4 to 6 except use the Clear View Glass Cleaner instead of the detergent mixture.
   - If stains remain, please contact an L3 Wescam Customer Service representative for further support.

6.3 TURRET PURGING

To maintain a dry internal environment, all turrets *must* be purged when humidity exceeds safe operating limits. If a dry internal environment is not maintained there is a high risk of condensation forming on the interior of the turret. Internal condensation can cause irreparable damage to optical elements or circuit card assemblies.

During both pre-flight and post-flight inspections (provided turret has been allowed to cool and acclimate to ground temperature and humidity), the turret's external humidity indicator should be checked (do not confuse with the desiccant humidity indicator). If the upper quadrants labeled 30 & 40 are lavender (pink), the system *must* be purged until all 4 quadrants return to a blue color prior to any further flight operations. Purging should not take longer than 90 minutes. If purging takes longer than 90 minutes ensure the following:

- Nitrogen is flowing in and out of the turret.
- Nitrogen is only escaping from the relief valve.

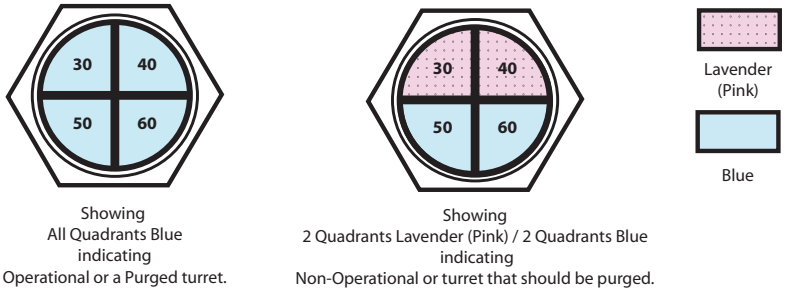


Figure 6-1 Humidity Indicator

Table 6-3 Turret Purging — Parts and Support Equipment

Description	Part Number	Quantity	Notes
Purge kit	42424	1	For older systems, use of P/N: 41453 as an alternative is appropriate.

Table 6-4 Turret Purging — Consumables

Description	Part Number	Quantity	Notes
*Nitrogen, technical – Type 1, grade B, Class 1	A-A-59503-1-B-1	1	Oil free with 99.95% purity. Moisture content maximum of 26 ppm (v/v or mole/mole).

** Or equivalent material grade and purity.*

Figure 6-2 Purge Kit Regulator Assembly

WARNING: ALTHOUGH INERT, THE NITROGEN GAS YOU WILL BE HANDLING IS COMPRESSED AND THEREFORE SHOULD BE TREATED WITH THE CARE ANY COMPRESSED GAS REQUIRES. REVIEW ALL MATERIAL SAFETY DATA SHEETS (MSDS) TO ENSURE SAFE HANDLING.

Caution: Turret's purge valve damages easily. Hang and isolate the supply hose to make sure the purge valve does not bear the weight of the air hose and chuck. The purge valve could break off if the hose is moved or kicked accidentally.

Caution: When purging, the nitrogen feed pressure should never exceed 0.35 kg/cm^2 (5 psi). Otherwise, you risk damaging internal valves and other sensitive parts.

Note: During this procedure, you should place a tag on the operator interface warning that operators should not power up the system until purging is complete.

Purging the Turret

This purge procedure has been written for use with an L-3 Wescam purge kit (P/N 42424). While intended to be generic, you might experience minor differences using other purge equipment.

1. Steer the turret to a Forward position.
2. Pull and tag the main breaker to disable power and steering control to the turret.
3. By hand, orient the turret to a position where you will have easy access to the purge valve, and you can see the turret's humidity indicator easily.
4. If stored in a carrying case, remove the regulator assembly from the case.
5. Turn the purge kit's regulator counter-clockwise to confirm that hose supply is closed.
6. Connect the regulator assembly to the nitrogen supply tank.
7. Tighten the regulator assembly with a wrench to prevent this connection from leaking.
8. Apply leak check to ensure the regulator assembly does not leak nitrogen.
9. Open the nitrogen supply tank valve fully.
10. Confirm the hose pressure gauge is reading 0 kg/cm^2 (psi).
11. Remove the valve extension from the air hose chuck.
12. Turn the regulator clockwise and adjust hose pressure to 0.35 kg/cm^2 (5 psi) (correct purge pressure).
13. From the back door of the turret, locate the purge valve, remove the cover cap, and store in a safe place for replacement.
14. Ensure there is no debris inside the purge valve.
15. Ensure there is no debris inside the valve extension.

16. Connect the valve extension to the turret's purge valve.
17. Reconnect the air hose chuck to the valve extension.
18. Verify that nitrogen is flowing into the turret. Place your ear to the rear turret door and listen for pressurized flow.
19. Confirm that the turret's breather valve is working by listening for escaping air.
20. Leave the system to purge for a minimum of one hour.
21. Check the color of all quadrants in the turret's humidity indicator:

    21a. If all quadrants are not blue, continue the purge for another 30 minutes.

    21b. Otherwise, all quadrants are blue and the turret is now purged.
22. When the turret is confirmed to be fully purged, turn the regulator counter-clockwise and adjust hose pressure to 0 kg/cm^2 (psi).
23. Disconnect the air hose chuck from the valve extension.
24. Disconnect the valve extension from the turret's purge valve and replace the cover cap.
25. Reconnect the air hose chuck to the valve extension.
26. Close the nitrogen supply tank valve fully, then open the regulator to bleed off pressure.
27. Disconnect the regulator assembly from the nitrogen supply tank.
28. Return the turret back to the Stow position.
29. If stored in a carrying case, return the regulator assembly to the case.
30. Install the main breaker to restore power and steering control to the turret.

6.4 PURGE VALVE REPLACEMENT

The purge valve is located in the rear service door. The fitting is a Schrader valve that provides a nitrogen purge conduit to the turret's internal space, and it is used to remove humidity and dry the inside air of moisture. Failure symptoms of the purge valve can be:

- stem physically broken
- visible damage to the exterior threads or internal poppet valve
- turret's humidity indicator remains high despite purging for 2 hours
- when purging, leak check applied to the valve bubbles

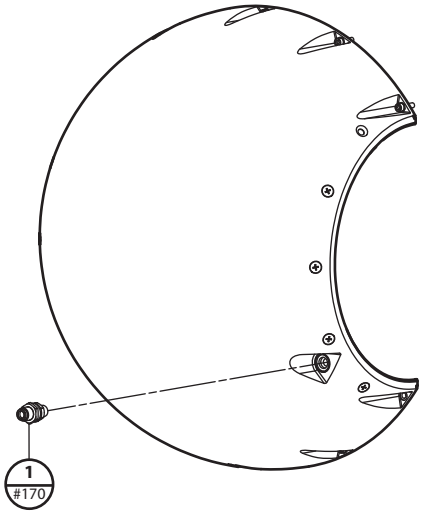


Figure 6-3 Removing the Purge Valve from Rear Turret Door

Table 6-5 Purge Valve Replacement — Parts

Item	Nomenclature	P/N	Qty	Notes
(1)	Schrader valve	TA322-2198	1	• Drawing part #170. • Commonly referred to as the purging valve. • Torque to 30 in.lbs (3.4 Nm)
(2)	Valve cap	TA322-1999	1	• Order new part if missing.
(3)	Chuck for valve insert	5265	1	

Table 6-6 Purge Valve Replacement — Tools

Item	Nomenclature	P/N	Manufacturer	Notes
(1)	Purge valve removal socket, ½"–5/8"	13048-01	Wescam	Part alternatives: • Machine down an impact socket, deep, 5/8", 6 point to an outside diameter of 0.75" to a depth of 1.75". • Needle-nose, 8 inch long, fine-pitch pliers. However, "pad" plier jaws with electrical tape to avoid stripping the purge valve.
(2)	Impact socket, deep, 5/8", 6 point	SFS201	Snap-on®	
(3)	Torque wrench, ½"	–	–	
(4)	Ratchet, ½"	–	–	

Table 6-7 Purge Valve Replacement — Bulk Items

Item	Nomenclature	P/N	Manufacturer	Notes
(1)	Pipe sealant stick	561	Loctite®	Consult manufacturer's Technical Data Sheet for use instructions and MSDS for material handling safety.
(2)	Thread sealant activator	7649	Loctite®	Consult manufacturer's Technical Data Sheet for use instructions and MSDS for material handling safety.

Replacing the Purge Valve

1. Using a ½" ratchet with the purge valve removal socket, remove the purging valve from the rear door.
2. Spray Loctite® 7649 primer onto threads of new valve and mating surface.
3. Let the Loctite® 7649 primer dry for 5 minutes.
4. Apply Loctite® 561 PST to the bottom 3–5 threads of the new purge valve.
5. Using your fingers, insert the new purge valve and start to thread the fitting.
6. Using a ½" torque wrench with the purge valve removal socket, tighten valve to 30 in-lbs (3.4 Nm).

6.5 REMOVING & REPLACING THE DESICCANT ASSEMBLY

When desiccant material in the desiccant assembly becomes saturated with water it must be replaced. The humidity indicator on the desiccant assembly will indicate the moisture level. If the upper quadrants labeled 30 & 40 are lavender (pink), the desiccant material must be replaced. There are two options:

- Option 1 – Remove and replace with a new desiccant assembly
- Option 2 – Remove, refill desiccant material and reinstall the desiccant assembly

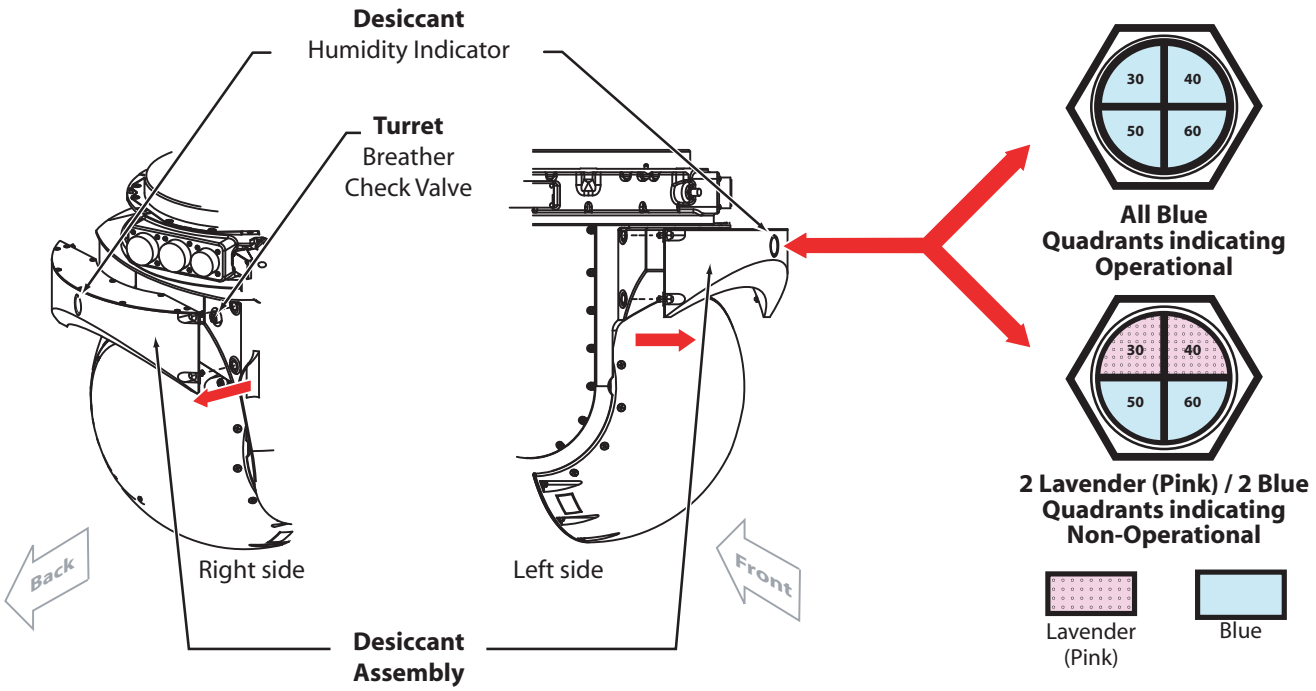


Figure 6-4 Desiccant Assembly and Humidity Indicator

6.5.1 Remove and Replace the Desiccant Assembly

Removing and replacing the desiccant assembly involves unfastening 4 retention screws. The desiccant assembly has captive fasteners – held by a spring loaded retention pin rather than a threaded shaft. Like a bayonet style, the screw requires a 1/4 turn with inward pressure to release. The turret includes a breather check-valve that seals airflow when the desiccant assembly is removed. Make sure the replacement desiccant assembly is a new unit sealed in plastic.

Table 6-8 Desiccant Removal — Parts

Description	Part Number	Quantity	Notes
Desiccant assembly	42418	1 pcs	

Table 6-9 Desiccant Removal — Tools

Tool	Size	Notes
Phillips® head screw driver, long shank	#02	

WARNING: DANGER ZONE. THE TURRET IS REMOTELY CONTROLLED AND CAPABLE OF CONTINUOUS MOVEMENT FROM DRIVE MOTORS THAT ARE CAPABLE OF FORCES THAT CAN INJURE PERSONNEL.

Removing and Replacing the Desiccant Assembly

1. Orient the turret to the Stow position.
2. Pull and tag the main breaker to disable power and steering control to the turret.
3. Support the desiccant assembly with one hand.
4. Locate a bottom retention screw that secures the desiccant assembly to the turret.
5. Push the screw head in, twist counter-clockwise a 1/4 turn, and then back off until the spring ejects the screw.
6. Unfasten the remaining retention screws.
7. Remove the desiccant assembly from the turret.
8. Remove the replacement desiccant assembly from its vacuum-sealed bag.
9. Inspect the flat ring seal and make sure the seal is properly seated in place and has not come loose. The flat ring seals the air exchange pathway between the desiccant assembly and the turret.
10. Place the replacement desiccant assembly into position on the turret.
11. Push inward until the breather check valves engage and the desiccant assembly sits flush.
12. Fasten the retention screws.
13. Restore power to the turret.

6.5.2 Removing, Refilling and Reinstalling the Desiccant Assembly

Refilling the desiccant material involves removing a filler port. The filler port is a bayonet style that can be removed by hand. Make sure the desiccant material used for refilling has been stored in a cool dry location. Removing and replacing the desiccant assembly involves unfastening 4 retention screws. The desiccant assembly has captive fasteners – held by a spring loaded retention pin rather than a threaded shaft. Like a bayonet style, the screw requires a 1/4 turn with inward pressure to release. The turret includes a breather check-valve that seals airflow when the desiccant assembly is removed.

Table 6-10 Desiccant Refill — Consumables

Description	Part Number	Manufacturer/Qty	Notes
Natrasorb®, desiccant material	02-00832AG08	0.6 kg (1.4 lbs)	Customer furnished material. Natrasorb® is manufactured by Multisorb Technologies. See www.multisorb.com for more information.

Table 6-10 Desiccant Refill — Consumables (Continued)

Description	Part Number	Manufacturer/Qty	Notes
Nitrile gloves	–	2	
Eye goggles	–	1	
Dust mask	–	1	

Table 6-11 Desiccant Refill — Tools

Tool	Size	Notes
Phillips® head screw driver	#02	
Funnel 795 ml (28 oz)	Top ID 18 cm (7”) Spout OD 2.5 cm (1”)	

WARNING: DANGER ZONE. THE TURRET IS REMOTELY CONTROLLED AND CAPABLE OF CONTINUOUS MOVEMENT FROM DRIVE MOTORS THAT ARE CAPABLE OF FORCES THAT CAN INJURE PERSONNEL.

WARNING: READ DESICCANT MATERIAL MSDS. REVIEW THE MATERIAL SAFETY DATA SHEETS (MSDS) SECTIONS FOR MATERIAL HANDLING, REACTIVITY AND MATERIAL DISPOSAL BEFORE REPLACING ANY DESICCANT MATERIAL.

WARNING: AVOID DESICCANT MATERIAL CONTACT WITH SKIN, INGESTION OR INHALATION OF DUST. WHEN FIRST EXPOSED TO WATER, THE DESICCANT MATERIAL BECOMES VERY HOT.

Caution: Make sure no water enters the desiccant enclosure during desiccant exchange.

Caution: Remove the breather valve while it is facing upwards so desiccant material does not spill out.

Caution: Do not over fill or pack the desiccant material. Room must be left for the filler port to seat properly.

Removing, Refilling Desiccant Material and Reinstalling

1. Orient the turret to the Stow position.
2. Pull and tag the main breaker to disable power and steering control to the turret.
3. Support the desiccant assembly with one hand.
4. Locate a bottom retention screw that secures the desiccant assembly to the turret.
5. Push the screw head in, twist counter-clockwise a 1/4 turn, and then back off until the spring ejects the screw.
6. Unfasten the remaining retention screws.
7. Remove the desiccant assembly.
8. Place desiccant assembly on a flat surface and with filler port exposed.
9. Push the filler port in, by hand, and then turn counter-clockwise to remove the filler port.
10. Invert the desiccant assembly over a disposal canister and shake the material loose.
11. Insert plastic funnel into filler port.

12. Pour desiccant material into the funnel and fill desiccant assembly.
13. Install the filler port and tap the canister gently to compact the material.
14. Repeat steps 8 to 12 until:
    - The desiccant material is just below the black filler port ring.
    - Filler port seats properly.
15. Install the desiccant filler port.
16. Push the filler port in and turn clockwise until you hear a locking click.
17. Place the desiccant assembly into position on the turret.
18. Push inward until the breather check valves engage and the desiccant assembly sits flush.
19. Fasten the retention screws.
20. Restore power to the turret.

6.6 LRU RETURN TO VENDOR PROCEDURE

All system components are designed as LRUs where repairs are limited to the removal and replacement of components only. L-3 Wescam requires that any LRU needing repair be returned to the factory or an approved service depot facility. However, before shipping any LRU for repair, make sure you have completed the following:

- Discussed the LRU failure with an L-3 Wescam Customer Service technician
- Confirmed the failure can only be resolved by return for repair

Caution: Store and pack the turret by following the procedures defined in Chapter 4 of this manual. When shipping items, it is the customer's responsibility to correctly pack and obtain insurance. L-3 Wescam is not liable for any damage that occurs during shipment.

Caution: Use anti-static, Electrostatic Discharge (ESD), pink bubble wrap only. For all self pack LRUs, use safe ESD bubble wrap to protect electrical components during shipment.

Note: Include the completed RMA form and copies of all shipping paperwork inside the LRU shipping package. LRUs returned with missing or improper RMA paperwork will not be accepted by the L-3 Wescam Shipping department.

Returning Failed LRUs to Vendor

1. Collect the following LRU asset and failure details:
   - LRU description, part number and serial number
   - Relevant fault information and symptoms of failure, e.g. BIT error codes, list of functionality loss and technician's repair recommendation
   - Anticipated LRU shipment date
   - Customer's contact information, i.e. email address and fax number
2. Make sure you have discussed the repair with an L-3 Wescam Customer Service technician first, and confirm a return repair is the only solution.
3. Contact an L-3 Wescam Customer Service representative:
   - To speak to a representative directly, call between 8:00am to 5:00pm (E.S.T.) – Monday to Friday.
   - Otherwise, call to have a representative paged or leave a voice message when prompted.
4. Request that a Return Material Authorization (RMA) number be assigned for the failed LRU and specify your delivery preference for the RMA form:
   - email
   - fax
5. Prepare the LRU for shipment:
   - If the LRU has a specially designed shipment case, use this container to pack the LRU for shipment.
   - If additional shipping containers are required, call 905.633.4000 and contact the L-3 Wescam Customer Support Group and order a new shipping container.
   - Otherwise, pack the LRU to best commercial standards and make sure the LRU is protected from potential electrostatic discharge, impacts, drops and shocks.
6. Collect all shipping paperwork and make 3 copies. Shipping paperwork might include:
   - RMA form (original required inside shipping container)
   - Waybill
   - Commercial Invoice
   - Customs Papers

- Brokerage Information

7. Place all shipping paperwork in the following locations:
   - Attach 1 copy set to the outside of the shipping container.
   - Place 1 copy set inside the shipping container.
8. Fax 1 copy set of the shipping paperwork to L-3 Wescam Customer Service.
9. Ship the properly packaged LRU to the address listed on the RMA form.
10. Notify an L-3 Wescam Customer Service representative of the shipment details:
    - Waybill number
    - Tracking number
    - Courier company's name
    - Date of shipment
11. Await confirmation from an L-3 Wescam Customer Service representative that the LRU has been received. L-3 Wescam will complete an LRU failure assessment and contact customer with service options.

6.6.1 L-3 Wescam Customer Service Contact Information

For additional assistance or information, please contact an L-3 Wescam Customer Service representative:

L-3 Wescam
649 North Service Road
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Appendix: Acronyms and Abbreviations

A	
AAID	Auto Aid Steering Mode
ACFT	Aircraft
A/C	Aircraft
AGL	Above Ground Level
ATR	Airborne Transport Rack
AVT	Automatic Video Tracker
AZ	Azimuth
B	
BIT	Built In Test
BISS	Basic Interoperable Scrambling System
C	
°C	Degrees Celsius
C	Chrominance
Cal	Calibration
CB	Circuit Breaker
CCA	Circuit Card Assembly
CCD	Charge Coupled Device
CENT	Centroid Algorithm for AVT
CFE	Customer Furnished Equipment
CMT	Cadmium Mercury Telluride
COL	Color/Color
COR	Correlation Algorithm
D	
dB	Decibel
DECR	Decrease
DIS	Disable
E	
EL	Elevation
EON	Electro-Optic Narrow
EOW	Electro-Optic Wide
E-ZOOM	Electronic Zoom
F	
°F	Degrees Fahrenheit
FL	Focal Length
FLIR	Forward Looking Infrared
FOD	Foreign Object Damage
FOG	Fiber Optic Gyro
FOR	Field of Regard
FOV	Field of View
FUL	Full Passband
FWD	Forward
G	
GHz	Gigahertz
GPS	Global Positioning System
H	
HCL	Hand Controller
HPU	High Power Unit
I	
IDCA	Integrated Dewar Cooler Assembly
IMU	Inertial Measurement Unit
INCR	Increase
INIT	Initialization
InSb	Indium Antimonide
I/O	Input/Output
IR	Infrared
L	
LED	Light Emitting Diode
LOS	Line of Sight
LP	Long Pass
LRF	Laser Range Finder
LRU	Line Replaceable Unit
M	
MAN	Manual Track
Mbits/s	Mega Bites per Second
MCU	Master Control Unit
MFOV	Medium Field of View
MHz	Megahertz
MON	Monochrome
MSDS	Material Safety Data Sheets
N	
N/A	Not Applicable
NFOV	Narrow Field of View
NIR	Near IR
NOHD	Nominal Ocular Hazard Distance
NTSC	National Television Systems Committee
NUC	Non-Uniformity Correction
NVG	Night Vision Goggle

P

PAL	Phase Alternate Line
PCI	Peripheral Components Interconnected
PCR	Power Conditioner
PMC	PCI Mezzanine Card
P/N	Part Number
PSI	Pounds Per Square Inch

R

RAID	Rate Aid
RCS	Remote Control Subsystem
RES	Resolution

S

SBC	Single Board Computer
SCAN	Autoscan
SENS	Sensitivity
SNR	Signal-to-Noise Ratio
SP	Short Pass
SSD	Static Sensitive Devices

T

TBD	To Be Determined
TCU	Transmitter Control Unit
TGT	Target
TRGT	Target
TXU	Transmitter Unit

V

VAC	Volts Alternating Current
VDC	Volts Direct Current
VIC	Video In Control
VIS	Visible
VME	Versa Module Eurocard
VNFOV	Very Narrow Field of View
VTR	Video Tape Recorder

W

WAE	Warm Area Electronics
WFOV	Wide Field of View

X

XLP	Extra Long Pass

Y

Y	Luminance

Z

ZMULTI	Zoom Multiplier