



M2 Gimbal 011-0000-XXX ICD

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1 Scope

This document describes the specifications, mechanical and electrical interfaces for the Shotover Systems M2 011-0000-XXX series gimbal system.

1.1 Applicable Systems

This document applies to systems with serial number 7 onwards. Please consult Shotover Systems for details of systems with serial numbers 1 through 6.

2 References

Table 1: Applicable Documentation

Reference	Document Number	Description
RD1	002-9349	M2 011-0000-XXX ICD Drawing
RD2	011-5086	M2 SYSTEM INTERCONNECTION - GENERIC
RD3	002-9353	LASER ARMING PANEL ICD
RD4	011-9033	M2 User Manual – Laser System

3 List of Acronyms

Table 2: List of Acronyms

AWG	American Wire Gauge
GigE	Gigabit Ethernet 1000BaseT
GNSS	Global Navigation Satellite Systems
GPS	Global Positioning System
ICD	Interface Control Document
IMU	Inertial Measurement Unit
LAP	Laser Arming Panel
LED	Light Emitting Diode
LI	Laser Illuminator
LOS	Line Of Sight
LP	Laser Pointer
NFZ	No Fire Zone
NOHD	Nominal Ocular Hazard Distance
TBD	To Be Determined
TBR	To Be Released

4 Laser Safety

This section applies to M2 gimbal systems fitted with a laser pointer and/or laser illuminator fitted.

The infrared laser/s integrated into the M2 system are invisible. At the aperture they are hazardous to the eye and skin. The Pointer has a narrow beam and as such the NOHD is several hundred meters. See [Figure 1](#) for a reprint of the Laser Pointer's Warning Label, and [Figure 2](#) for a reprint of the Laser Illuminator's Warning Label.

See reference document RD4 for further information regarding the NOHD and safe use of the laser system.



[Figure 1](#): Laser Pointer Warning Label



[Figure 2](#): Laser Illuminator Warning Label

5 Gimbal Specifications

Table 3: Gimbal Specifications

Parameter	Value
Input Voltage Range	22-31 VDC
Input Voltage Nominal	28VDC
Input Power Average	150W @ 28VDC
Input Power Maximum	530W @ 28VDC
Weight	49.9kg (110lbs) Maximum
Storage Temperature Range	-40°C to 70°C
Operating Temperature Range	-20°C to 50°C

6 Gimbal Interfaces

6.1 Gimbal External Electrical Interfaces

The 011-0000-XXX gimbal includes 6 connectors:

J1 – External power input, this includes an on/off input which enables the internal power supply.

J2 – External Comms, this is a 1000BASE-T ethernet connection which carries all video and control data.

J3 – Laser, power for and control of the laser system. This connection is only fitted when the gimbal payload includes a laser pointer or laser illuminator.

J4 – Secondary GPS Antenna.

J5 – Primary GPS Antenna.

J6 – Ground Connection Point.

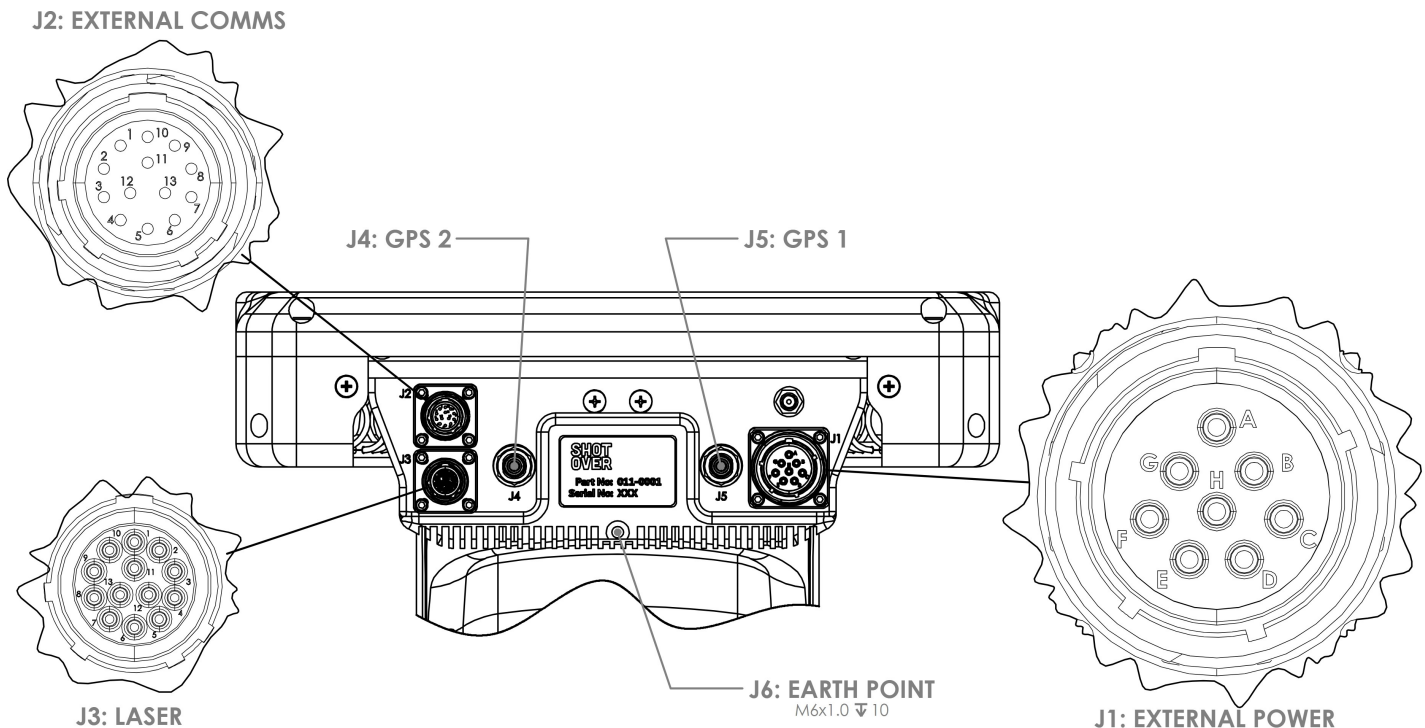


Figure 3: Location of External Connectors, Rear View

6.1.1 J1 External Power

Bulkhead Connector:

- Shotover Part Number: 002-63193
- Manufacturer Part Number: D38999/20FE8PN

Mating Connector:

- Shotover Part Number: 002-63194
- Manufacturer Part Number: D38999/26FE8SN

Table 4: External Power Connector Pin Assignments

Pin	Function	Type	Source
A	Vin	DC Power	Platform
B	GND	DC Power Return	Platform
C	POWER ENABLE	Pull To Ground Input	Platform
D	RESERVED	No Connect	N/A
E	RESERVED	No Connect	N/A
F	RESERVED	No Connect	N/A
G	Vin	DC Power	Platform
H	GND	DC Power Return	Platform
SHELL	SHIELD	SHIELD	Platform

Notes:

- The M2 gimbal has an isolated input filter and power supply.
- Recommend shielded cable with the shield connected to the plug back shell.
- Recommend minimum 16AWG wire for power conductors.
- The M2 gimbal will power on when pin C is pulled to ground.

6.1.2 J2 External Comms

Bulkhead Connector:

- Shotover Part Number: 002-62367
- Manufacturer Part Number: TVP00DT-11-35SA

Mating Connector:

- Shotover Part Number: 002-62368
- Manufacturer Part Number: D38999/26TB35PA

Table 5: External Comms Connector Pin Assignments

Pin	Function	Type	Source
1	ETH D-	GigE	Common
2	ETH D+	GigE	Common
3	ETH C-	GigE	Common
4	ETH C+	GigE	Common
5	ETH B-	GigE	Common
6	ETH B+	GigE	Common
7	ETH A-	GigE	Common
8	ETH A+	GigE	Common
9	SHIELD	SHIELD	Platform
10	RESERVED	No Connect	N/A
11	RESERVED	No Connect	N/A
12	RESERVED	No Connect	N/A
13	RESERVED	No Connect	N/A
SHELL	SHIELD	SHIELD	Platform

Notes:

- Recommend shielded cable with the shield connected to the plug back shell.
- Pin 9 must be connected to the plug back shell and the cable shield. This connection must be made at the gimbal end of the cable.
- Recommend an aerospace rated ethernet cable.

6.1.3 J3 Laser Connector

The laser connector is only included on gimbal systems fitted with a payload which includes a laser module. The M2 has been designed to support multiple laser modules. The current configuration assigns the laser pointer to the Fire A circuit and the laser illuminator to the Fire B circuit.

Bulkhead Connector:

- Shotover Part Number: 002-63098
- Manufacturer Part Number: D38999/20TB35PN

Mating Connector:

- Shotover Part Number: 002-63099
- Manufacturer Part Number: D38999/26TB35SN

Table 6: Laser Connector Pin Assignments

Pin	Function	Type	Source
1	Laser Arm Input	DC Power	LAP
2	Interlock Loopback +	28V Logic	LAP
3	Interlock Loopback -	28V Logic	Gimbal
4	Fire A Input	28V Logic	LAP
5	Fire B Input	28V Logic	LAP
6	RESERVED	No Connect	N/A
7	RESERVED	No Connect	N/A
8	RESERVED	No Connect	N/A
9	RESERVED	No Connect	N/A
10	SHIELD	SHIELD	LAP
11	Laser GND	DC Power Return	LAP
12	Fire Annunciator Output	28V Logic	Gimbal
13	RESERVED	No Connect	N/A
SHELL	SHIELD	SHIELD	LAP

Notes:

- Recommend shielded cable with the shield connected to the plug back shell.
- Pin 10 must be connected to the plug back shell and the cable shield. This connection must be made at the gimbal end of the cable.
- All signals on the Laser Connector must be connected directly to a Shotover Laser Arming Panel, refer to reference documents RD2, RD3.

6.1.3.1 Laser Control Signal Functions

Table 7: Laser Control Signal Functions

Pin	Function
1	Laser Arm Input, power input to the laser system. The laser system does not share power with the rest of the gimbal system and is not powered from the external power connection, J1.
2	Laser interlock input from the Laser Arming Panel.
3	Laser interlock output to the Laser Arming Panel.
4	Fire A Input, high level input enables laser pointer operation.
5	Fire B Input, high level input enables laser illuminator operation.
6	RESERVED
7	RESERVED
8	RESERVED
9	RESERVED
10	SHIELD
11	Laser GND, ground reference and power return for the laser circuits.
12	Fire Annunciator Output, high level indicates that one or more lasers are firing.
13	RESERVED
SHELL	SHIELD

6.1.4 J4 & J5 GNSS Antenna Connectors

J5 is the primary GNSS antenna input, J4 is the secondary GNSS antenna input.

- GNSS antenna connectors are 50-ohm TNC connectors.
- GNSS antenna connectors include a gas discharge tube LEMP surge arrestor.
- GNSS antenna should be tri-band L1/L2/L5 active antenna.
- LNA antenna power provided to each antenna by the gimbal is 5VDC @ 200mA.
- It is recommended that the gimbal provides power to the antenna. If this is not the case, then power to the antenna must always be active when power to the gimbal is active.
- An appropriate coaxial cable matches the impedance of the antenna and receiver (50 ohms) and has a line loss not exceeding 10.0dB.

An example of suitable tri-band L1/L2/L5 band antenna is a Antcom 3GNSSAV-XT-2.

6.1.5 J6 Ground Point

The install equipment should electrically bond the gimbal to the airframe using a grounding strap connected to J6. The resistance of this connection shall be less than 2.5 milliohms in accordance with MIL-STD-464D, Section 5.11.3.

6.2 Mechanical Interfaces

6.2.1 Mounting Scheme

A detailed drawing of the mounting interface is in reference document RD1, the interface includes three hole patterns,

- A) 6 through holes at 305mm PCD.
- B) 8 equidistant through holes (every 45 degrees) at 140mm PCD.
- C) 4 equidistant through holes (every 90 degrees) at 57mm PCD.

HOLE PATTERN C MUST ONLY BE USED IN CONJUNCTION WITH HOLE PATTERN B. PATTERN C ALONE IS NOT ENOUGH TO SECURE THE GIMBAL TO THE AIRCRAFT.

Hole pattern B may be used standalone.

Hole pattern A may be used standalone.

All mounting holes include $\frac{1}{4}$ -28 helicoil insert.

Maximum thread engagement 12.7mm (1/2").

Fasteners must be $\frac{1}{4}$ -28 SHCS, MIN UTS 1241.06 MPa (180kPSI).

Fasteners must be torqued to 9Nm.

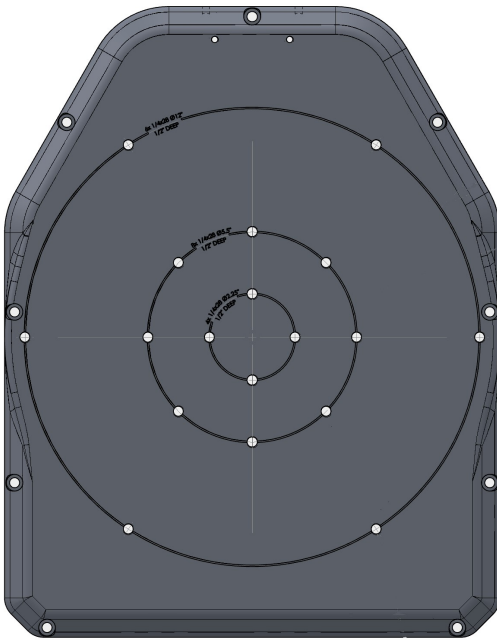


Figure 4: Mounting Interface

6.2.2 Mounting Interface Parameters

The aircraft mounting interface must be solid and stiff, Shotover does not provide recommendations for the mount natural frequency, but it should be as stiff as possible (i.e. high natural frequency).

6.2.3 Clearance and Swept Volume

For required clearance around the gimbal refer to reference RD1.

6.2.4 System Height Dimension

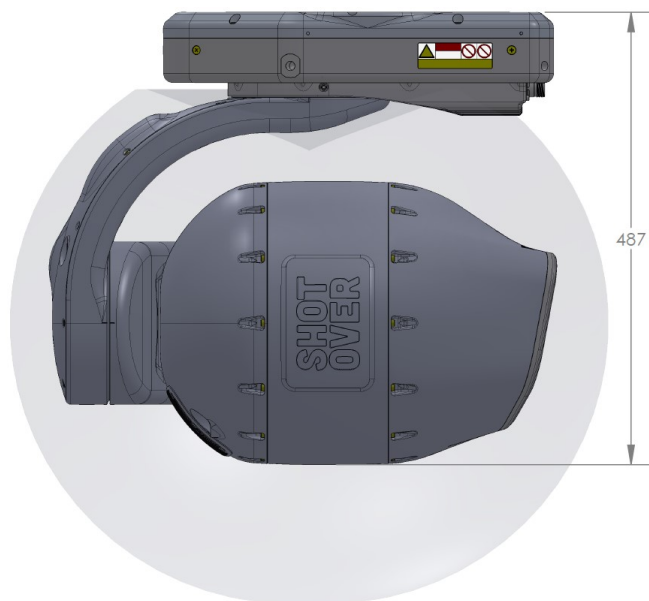


Figure 5: Stow Position Height

During normal operation where the gimbal is stowed for take-off and landing ground clearance will be the height of the mounting interface above ground less the dimension shown in the image above.

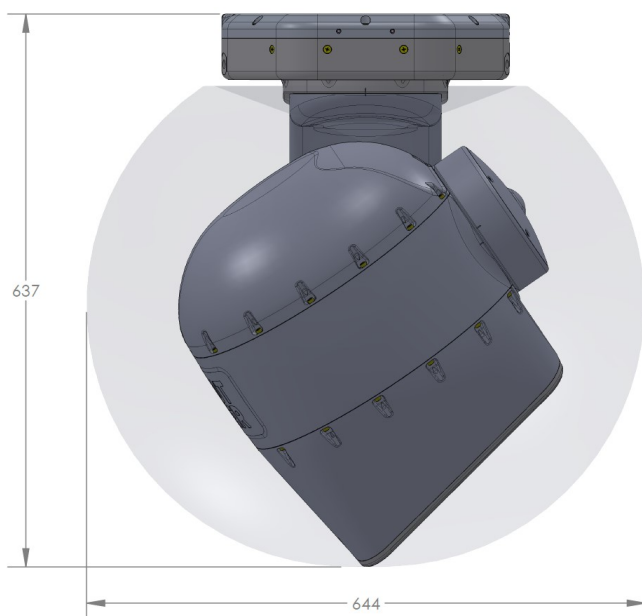


Figure 6: Operating Envelope

6.3 Gimbal Control Interfaces

6.3.1 Power Enable

The power enable input, J1 Pin C, enables the internal power supply,

- Pull the power enable input to GND to enable the gimbal power supply. This provides power to the gimbal system including the payload.
- Leave open to disable the gimbal power supply.

6.3.2 Startup Sequence

Once power is enabled to the system,

- The software will begin a boot sequence and the IR camera will begin cooling.
- Once the boot sequence is complete the inner axes will sweep through the range of travel and stow in the center of travel.
- Once the inner axes are stowed the outer axes will move to the stow position.

6.3.2.1 Startup Fault Handling

If a fault is detected during startup the outer axes will still move to stow position if the detected fault does not prevent that. The objective is to ensure that the gimbal moves to the stow position whenever possible.

6.3.3 Automatic Stow

The gimbal will automatically move to the stow position when the power enable input is disabled or when power is lost. This is the default behavior, automatic stow can be disabled via software configuration.

6.3.3.1 Stow On Power Off

During normal use shutdown of the gimbal is achieved by disconnecting the power enable input from ground potential. The gimbal will internally latch the power on and move the outer axes to the stow position. Once in the stow position the internal power supply will be shutdown.

6.3.3.2 Stow on Power Loss

The gimbal will automatically go to the stow position on loss of input power. Loss of input power is defined as,

- Low voltage failure, input voltage below 22V for more than 1 second.
(DO160G section 16.6.1.3 category Z)
- Total power failure, input voltage below 16V
(16V is the under voltage lock out of the internal power supply)

The stow on total power failure is facilitated by a supercapacitor bank which keeps the gimbal powered until the outer axes move to the stow position.

The supercapacitor bank is only used in the event of a total power failure. A stow caused by low voltage failure or power enable input disable will use aircraft power.

7 GNSS Antenna Installation

The GNSS antenna location must provide a clear view of the sky so each satellite above the horizon can be tracked without obstruction. To meet this requirement the antenna should be mounted on top of the aircraft.

7.1 Dual Antenna Operation

The M2 Gimbal supports both single and dual antennas. Dual antennas may provide better heading accuracy but operation with a single antenna will provide good accuracy, dual antennas is not strictly necessary.

The heading accuracy obtained from dual antennas is dependent on the baseline length, the distance between the two antennas. Mount the primary and secondary antennas as far apart as possible. A minimum separation distance of 1 meter is recommended.

The secondary antenna may be mounted on the front of the gimbal vibration isolator as shown in the image below. The primary antenna must always be mounted on top of the aircraft for an unobstructed view of the sky.

7.2 Antenna Offsets

The M2 Gimbal's inertial navigation software must be configured with the location of the antenna(s) relative to the gimbal's IMU. The image below shows the IMU location (red) relative to the center of the gimbal's mounting interface. The IMU is 7mm behind, 260mm below and 16mm to the right of the mounting interface. The antenna location when mounted on the aircraft will need to be measured relative to the gimbal mount and combined with the IMU location. Shotover Systems will use these measurements when configuring the system.

The image below also shows the position of the antenna when mounted on the front of the gimbal's vibration isolator.

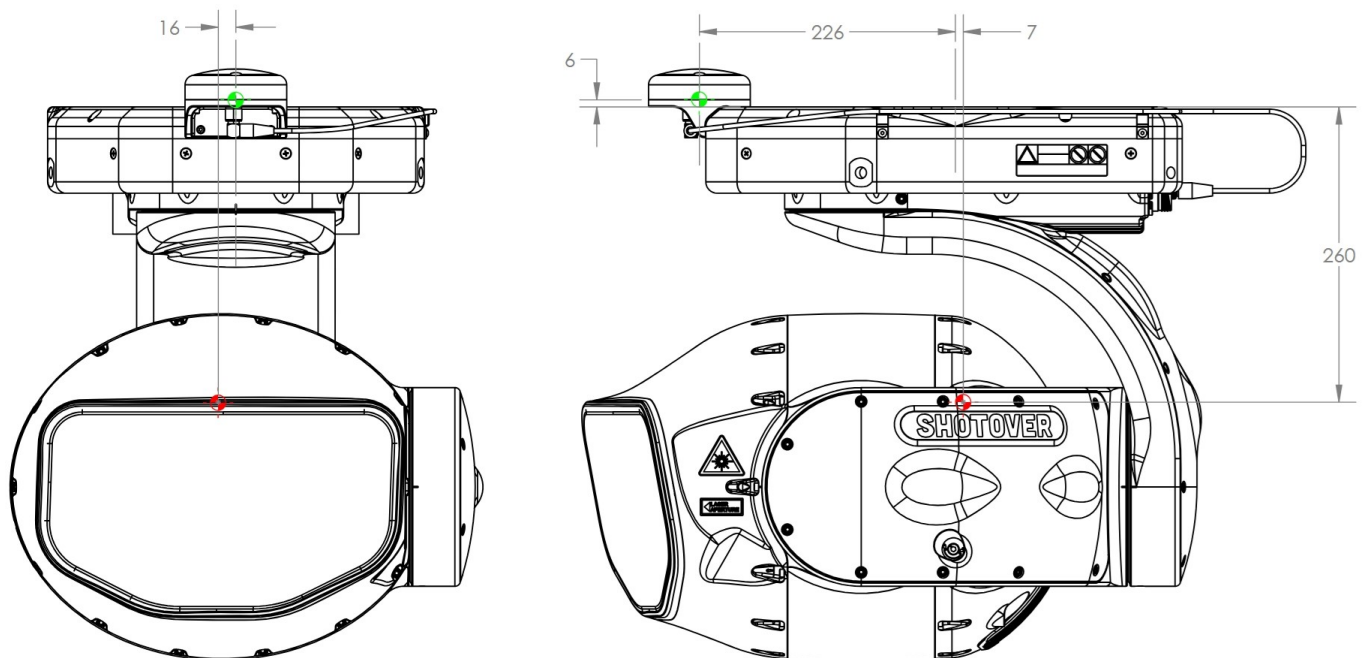


Figure 7: IMU and Antenna Locations

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8 Laser Control System

This section applies to M2 gimbal systems fitted with a laser pointer and/or laser illuminator; it provides an overview of the laser control system.

See reference document RD4 for further information regarding the NOHD and safe use of the laser system.

The laser system consists of one or two laser modules mounted on the gimbal payload, control electronics located in the gimbal and a laser arming panel mounted in the aircraft in a location accessible to the operator.

The diagram below shows the key components and the interconnections between them.

Referring to the diagram,

A master enable key switch in series with a guarded toggle master arm switch controls power to the entire laser system. Either switch being open disables the laser system.

An annunciator, labelled Master Arm Annunciator displays the state of the power to the laser system.

The laser arming panel includes an interlock connection for aircraft sensors such as a weight-on-wheels switch. The interlock connection being open circuit resets and disables laser firing. This is described in more detail below.

The laser arming panel has two laser fire signal outputs, one for each laser module. For a laser fire signal to be active the master key switch must be closed, the arm toggle switch must be closed, all interlock connections must be closed and the output of the electronic latch associated with that firing signal must be closed.

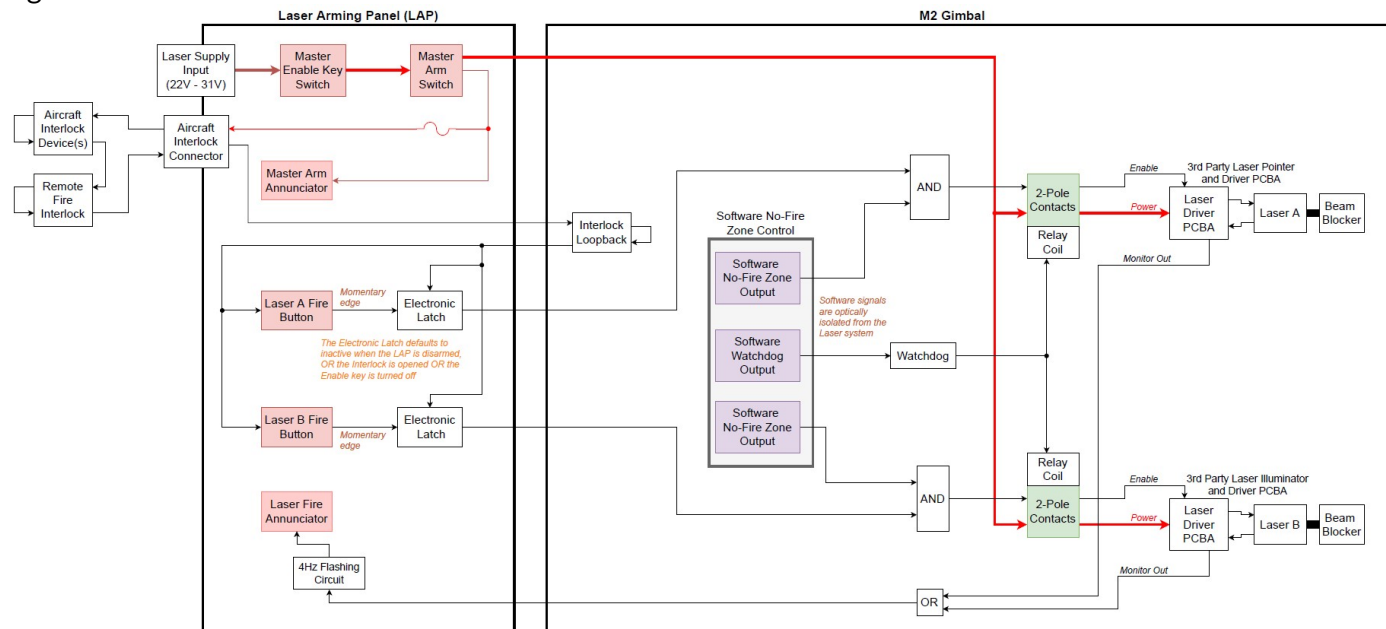


Figure 8: Laser Control System Block Diagram

The state of the electronic latches in the laser arming panel is toggled by the firing push buttons. These are momentary buttons, push to start laser firing, push again to stop laser firing.

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The state of the electronic latch output is always open at power on, loss of power to the latch resets the latch output to open circuit disabling the associated laser fire output.

Any of the following will result in loss of power to the latch causing the latch to reset,

- Loss of power to the laser arming panel.
- Master enable key switch open circuit.
- Master arm toggle switch open circuit.
- Any interlock connection open circuit.

Within the gimbal the firing signals from the LAP are combined with No Fire Zone control signals by a logical AND component the output of which enables the laser modules. The NFZ signals are generated by the gimbal control system and software.

The NFZ software will interrupt laser firing when the gimbal's line of sight is pointed into the NFZ. If the fire signal from the LAP is active when the gimbal's line of sight is moved out of the NFZ then the lasers will resume firing. The fire signals from the LAP are not reset to inactive when the gimbal's line of sight enters the NFZ.

The NFZ is defined in software and must be configured at the time of installation.

The control system software generates a repeating pulse signal which resets a hardware watchdog timer. If the software fails to generate the pulse the watchdog timer will timeout and the laser modules will be disconnected from the system. This ensures that the lasers can only be fired when the NFZ software is running.

The firing state of the two laser modules is combined in a logical OR component the output of which is connected back to the LAP and displayed by the laser fire annunciator. The laser fire annunciator flashes at 4Hz when one or more lasers are firing.

9 Appendices

9.1 Appendix One – Connector Kits

The following connector kits are available from Shotover.

9.1.1 011-0180 KIT – M2 External Connectors – 8 Pin Power

Table 8: 011-0180 KIT Contents

Description	Manufacturer	Manufacturer Part Number	Shotover Part Number
External Power Connector Parts			
PLUG 38999 17-8S ELECTROLESS NICKEL	AMPHENOL AEROSPACE	D38999/26FE8SN	002-63194
38999 STRAIN RELIEF, SIZE 17, BAND LOCK	AMPHENOL PCD	M85049/88-17N03	002-62470
3 38999 BAND STRAP. 0.25"	AMPHENOL PCD	M85049/128-4	002-62472
BOOT 154-42GW24	HELLERMANNTYTON	154-42-G-W24	006-6221
External Comms Connector Parts			
PLUG 38999 11-35PA	AMPHENOL AEROSPACE	TV06DT-11-35PA	002-62368
38999 STRAIN RELIEF, SIZE 11, BAND LOCK	AMPHENOL PCD	M85049/88-11N03	002-62471
38999 BAND STRAP. 0.25"	AMPHENOL PCD	M85049/128-4	002-62472
BOOT 154-42GW24	HELLERMANNTYTON	154-42-G-W24	006-6221

9.1.2 011-0181 KIT – M2 Laser Connectors

Table 9: 011-0181 KIT Contents

Description	Manufacturer	Manufacturer Part Number	Shotover Part Number
M2 Gimbal Laser Connector Parts			
PLUG 38999 11-35SN 13-PIN FEMALE PIN	AMPHENOL AEROSPACE	D38999/26TB35SN	002-63099
38999 STRAIN RELIEF SIZE 11 BAND LOCK	AMPHENOL PCD	M85049/88-11N03	002-62471
BOOT 154-42GW24	HELLERMANNTYTON	154-42-G-W24	006-6221
38999 BAND STRAP. 0.25"	AMPHENOL PCD	M85049/128-4	002-62472
Laser Arming Panel Power Connector Parts			
PLUG 38999 9-98SN 3 FEMALE SOCKETS	AMPHENOL AEROSPACE	D38999/26TA98SN	002-63110
BACKSHELL - STRAIGHT SHELL SIZE 9	AMPHENOL AEROSPACE	M85049/38-9N	002-62991
Laser Arming Panel Aircraft Connector Parts			
PLUG 38999 11-35SB 13 FEMALE SOCKETS	AMPHENOL AEROSPACE	D38999/26TB35SB	002-63111
BACKSHELL - STRAIGHT SHELL SIZE 11	AMPHENOL PCD	M85049/38-11N	002-63235
Laser Arming Panel Gimbal Connector Parts			
PLUG 38999 11-35PN – MIL PN	AMPHENOL AEROSPACE	D38999/26TB35PN	002-62672
BACKSHELL - STRAIGHT SHELL SIZE 11	AMPHENOL PCD	M85049/38-11N	002-63235

9.2 Appendix Two – Connector Tooling

Table 10: Connector Tooling

Connector	Crimper	DIE	Pins/Sockets	Insertion / Removal Tool
D38999/26FE8SN	M22520/1-01	M22520/1-04	M39029/56-352	M81969/14-03
D38999/26TB35PA	M22520/2-01	M22520/2-09	M39029/58-360	M81969/14-01
D38999/26TB35SN	M22520/2-01	M22520/2-07	M39029/56-348	M81969/14-01
38999 BAND STRAP. 0.25"	M81306/1-01 or DBS-2100			