107820-[ ]-[ ]
SM-1070 System Master Controller
Product Manual

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Service Bulletin List

Service Bulletin Number	Subject	Manual Revision Number	Manual Revision Date

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1.0 GENERAL

This manual contains information about the installation and operation of the ALTO PN 107820-[ ]-[ ] SM-1070 System Master Controller. Product information regarding mounting, mechanical, and electrical characteristics is also detailed.

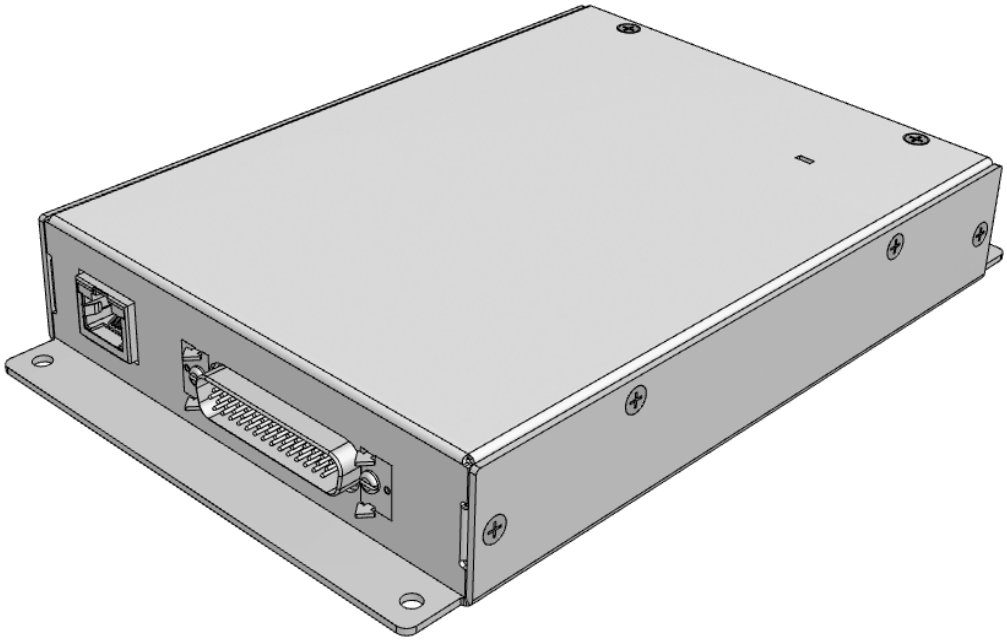


Figure 1: 107820-[ ]-[ ] System Master Controller

1.1 Definitions and Acronyms

CMS	Cabin Management System
PA	Public Address
BT	Abbreviation for Bluetooth
BLE	Bluetooth Low Energy
Paired	When two devices on the network are connected
GATT	generic attribute protocol
Characteristic	User or application data that is transmitted from one device to another across the network
UUID	universally unique identifier
SNP	Simple Network Processor
NPI	Network Protocol Interface
LL	Low-Latency
TBD	To Be Defined
DSP	Digital Signal Processor
SMC	System Master Controller

1.2 SM-1070 Overview

The SM-1070 System Master Controller is a module designed to link aircraft CMS components with various communication protocols together. The SM-1070 can also provide remote control of components using the existing Wi-Fi or LAN system onboard the aircraft. Interconnectivity between devices provides for a simpler, more flexible, and capable user experience.
Devices supported include but are not limited to:

- ALTO Forte Amplifiers
- ALTO Acapella Speaker and Headphone Amplifiers
- ALTO Relay, Temperature, Cabin Call, and Inline Controllers
- Rosen DVD Players
- Innovative Advantage AVDS
- Infrared Remote Controls
- Provides control of a variety of digital devices using ALTO's CSS keypads

1.3 Communication Protocols

The System Master Controller acts as a universal bus translator. The unit provides bus interface connectivity between existing ALTO products and those from other manufacturers.
Check with ALTO engineering for specific device support. The following communication protocols are supported:

- RS-485/RS-422
- RS-232
- Ethernet
- CAN (Controller Area Network)
- IR Control (Infrared)
- ARINC 429

2.0 FUNCTIONAL DEFINITIONS

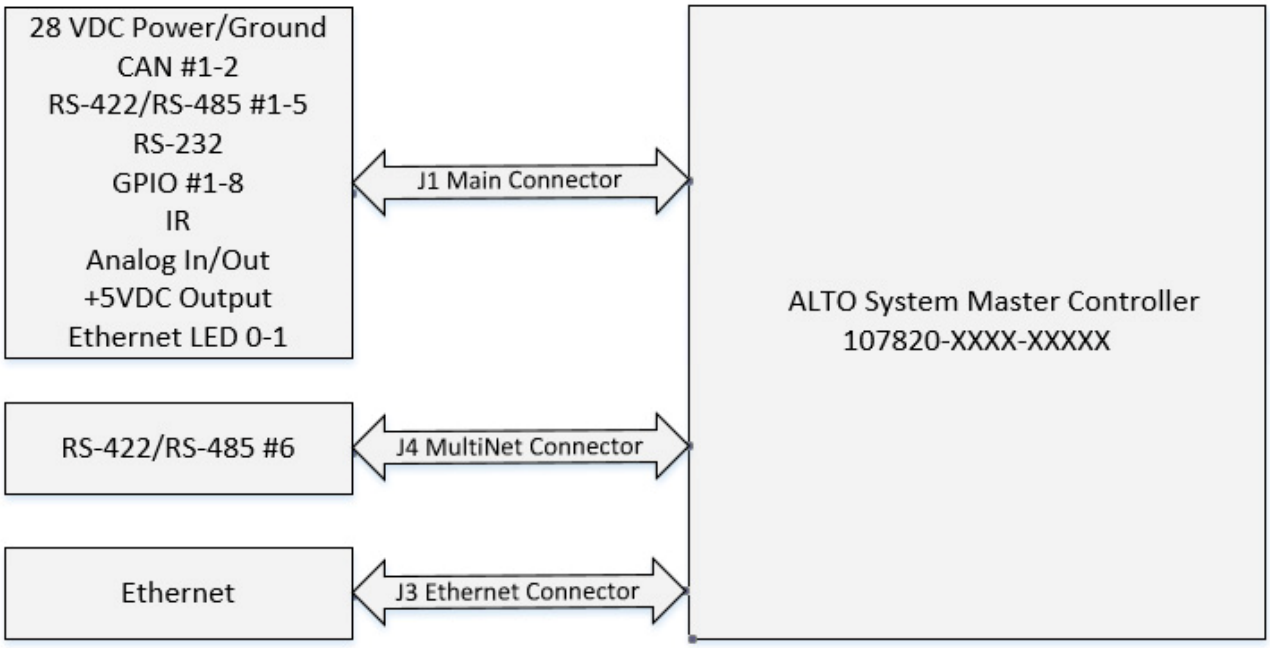


Figure 2: Block Diagram of SM-1070 Interface

2.1 Power

The SMC is powered via the aircraft 28VDC electrical bus. The power protection circuit is designed to protect against surges, overvoltage, overcurrent, and reverse polarity. The internal power distribution provides the various voltages needed on the board, including the +5VDC Output.

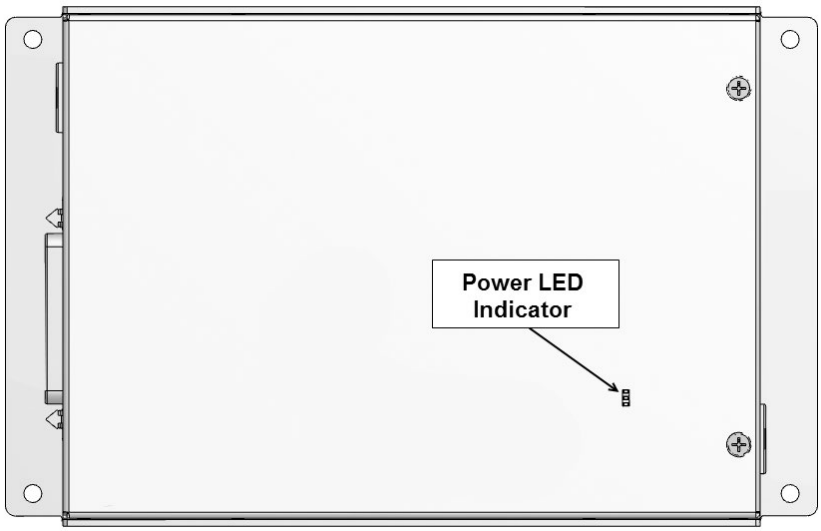


Figure 3: SMC Power Indicator

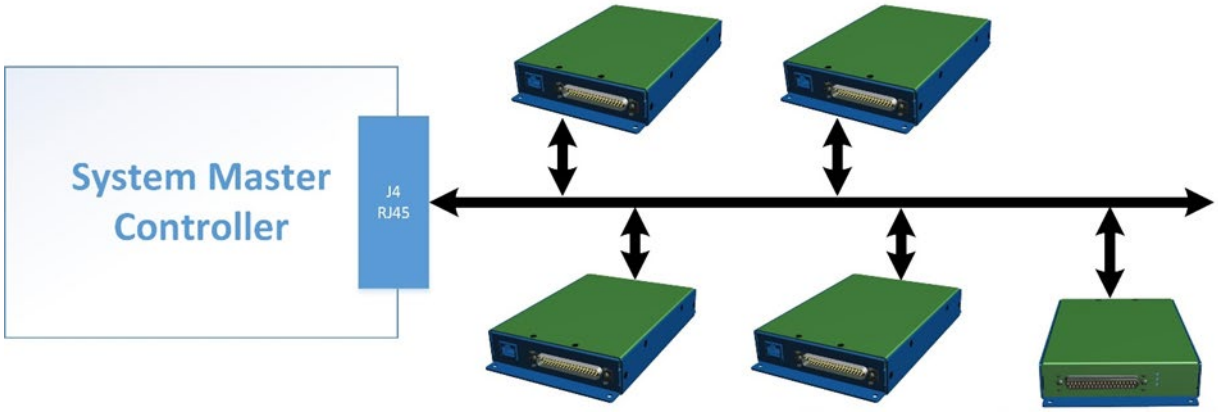
2.2 CAN Bus

CAN is a multi-master serial bus standard for connecting nodes. Two or more nodes are required on the CAN network to communicate. All nodes are connected to each other through a two-wire bus. The wires are 120 Ω nominal twisted pair. Contact ALTO for aircraft specific CAN network wiring recommendations.

The SMC has two CAN bus interfaces. These buses can be used independently or as a redundant bus system. The ALTO Inline Controller (107XXX-XXXX-XXXXX) can be connected to the CAN network on the SMC. The CAN network can also be a gateway allowing a standard computer to communicate over a USB or Ethernet port to the devices on a CAN network.

2.3 RS-422 / RS-485 Serial Communication

The SMC contains a dedicated port (J4) with the same connector used on the CSS controller boxes for the ALTO MultiNET Network. This port is fully isolated RS-485 that allows full duplex communication.



There are four additional RS-422 / RS-485 ports on the main J1 connector. When configured as RS-422, these ports can send and receive commands on the ALTONET bus to ALTO amplifier, such as the Acapella and Forte series amplifiers. ALTO amplifiers should be connected independently, or 1:1, to each RS-422 port. If the number of devices exceeds the SMC's ports, an additional SMC can be added to the system and networked together.

2.4 RS-232

The SMC includes a digitally isolated RS-232 port. It operates at speeds up to 250kbit/s and is designed to withstand electrical surges +/- 10kV. The port communicates with other devices using the RS-232 protocol, such as Rosen DVD players, briefing units, or Innovative Advantage AVDS.

2.5 General Purpose Inputs and Outputs (GPIOs)

The eight GPIO pins can be independently configured for either an input or an output. The GPIO's are open collectors pulled up to +5VDC. When used as an output, they can drive a load of 500mA @ 5VDC.

Any switch or relay with 2 states, open/ground, can be used with these inputs. ALTO Cadence Switches can be connected to General Purpose Inputs. An aircraft switch pulled up to 28VDC should not be used with these inputs.

2.6 ARINC 429 Line Receiver

The optional ARINC 429 Line Receiver uses a galvanically isolated buffer IC to read data from the ARINC bus. The IC is fully isolated from the bus and is rated for DO-160G section 22, level 3 lightning protection. The IC does not write to or load the ARINC bus.

2.7 Infrared (IR)

The IR input accepts IR remote eyes, such as the Rosen PN 0500-006, IR Receiver. The SMC can learn commands from the external IR remote controller and assign a functionality to it. On site configuration by ALTO may be required to implement this functionality, or the aircraft remote control can be provided prior to system shipping.

2.8 Analog Input/Outputs

The SMC features an analog input and an analog output (J1 pins 14 and 30 respectively).

The analog input is 16 bit, high accuracy, and features isolated power and data. The input channel accepts -10V to +10V signals.

The analog output is 10 bit, capable of +10V, and 65mA of maximum current.

2.9 +5VDC Output

The SMC contains a +5VDC output with a maximum load of 500mA. This output can be used for powering certain keypads or USB devices.

2.10 Ethernet LED's

The ethernet LEDs are digital 5V outputs.
LED 1 indicates the link status. No link present will result in no illumination, link present will be solid illumination.
LED 2 indicates the activity status. If data activity is present, the LED will be illuminated or flashing.

2.11 Ethernet

The SMC incorporates a 10/100 Ethernet MAC and PHY with IEEE 1588 PTP hardware support. The SMC is designed to connect directly to an existing Ethernet network using RJ45 style connectors. The ethernet port should be connected to a wireless router or ethernet switch onboard the aircraft. It is through this link that wireless control of the devices connected the SMC is achieved.

The end user will turn on their device, connect to the wireless network, and use the app to control their cabin and entertainment. Note the SMC does not contain any wireless radio functionality internally and requires an ethernet connection to a device with wireless capability to allow for PED app control.

3.0 OPERATION AND USE CASES

3.1 SMC Operation

Operation of the SMC will be vary based upon devices connected and functionality required. Consult with ALTO engineering for specifics. An interface definition document will define the proper connections and operation of the SMC.

An app can be used to connect to and control the cabin, via the SMC.

3.2 Smart Multinet Controller Network

The SMC can be used to augment an ALTO controller network, providing the "smarts" so that each controller can route information on the network. Normally, the ALTO MultiNET controller network can only be used for system configuration, modification, and troubleshooting. By connecting the SMC to this network, switches on any controller can control the relays or status indicators on any controller.

Prior to the Smart Controller Network, keypads, controllers, and loads would all have to be positioned in close vicinity to minimize wire lengths. By adding the SMC to the MultiNET network, keypads can be connected to the controller nearest to them. This can eliminate long wiring runs to far away controllers.

Take, for example, a temperature display keypad. Often, there is a forward and aft temperature display keypad in both the forward and aft cabin. Wires for all 18 discrete lines must be run the length of the aircraft to support this functionality. If a temperature controller is placed at a forward and aft location, only 4 wires for the databus would need to run the length of the aircraft. The same number of wires are required, but the wire run length can be shortened dramatically. The SMC would route the proper inputs and outputs between controllers.

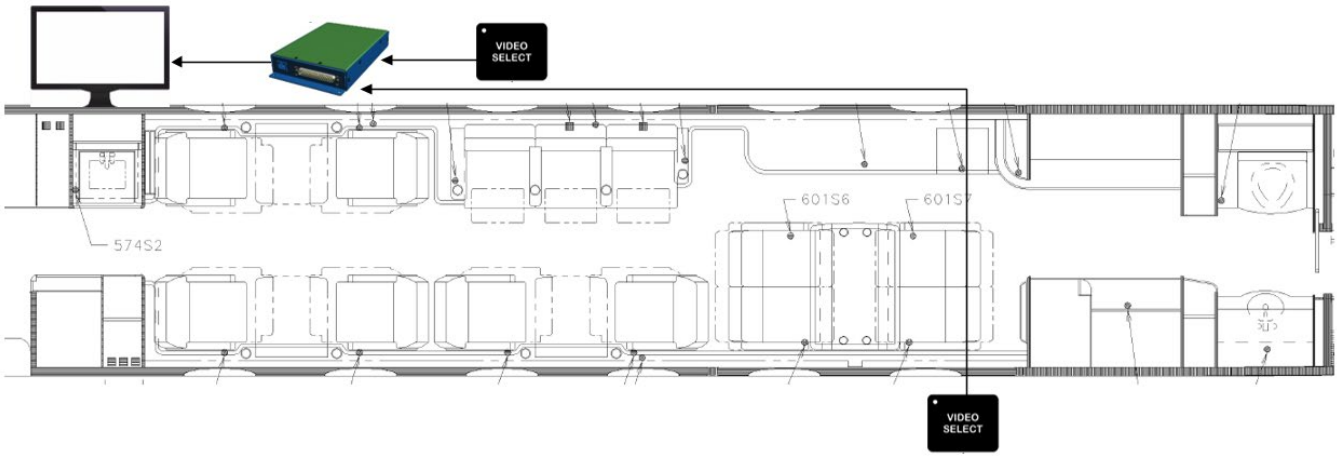


Figure 4: Example of wiring required for discrete switches to controllers

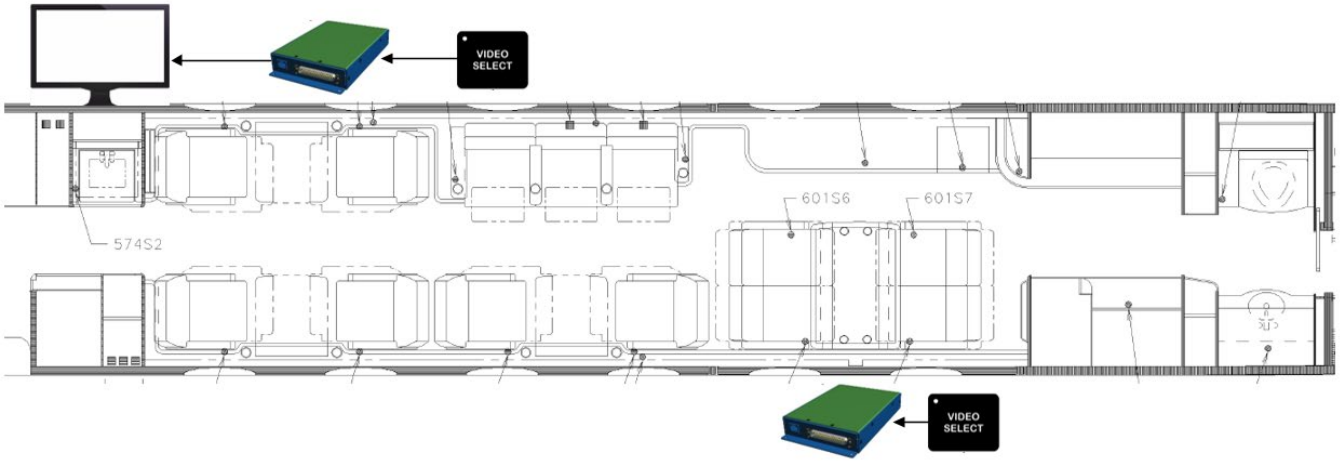


Figure 5: Example of MultiNet Network

3.3 Keypad/App to Device Functionality

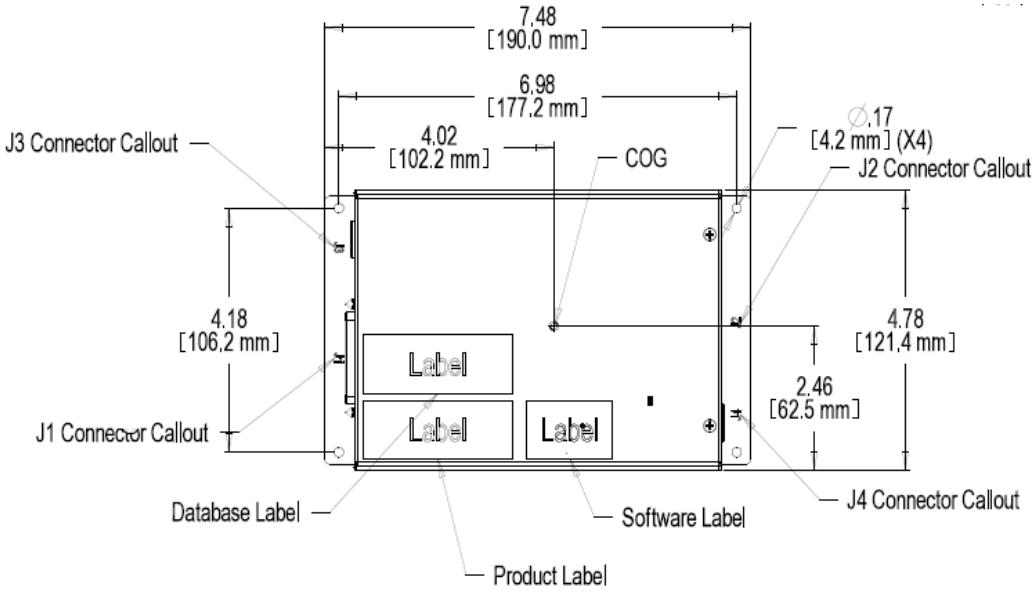
The SMC can be used as a translator between a single device and the ALTO CSS cabin management system.

Consider an off the shelf DVD player is added to the cabin entertainment system. A remote control, or push buttons on the device, would normally be used for video control. By adding a SMC to the cabin, the DVD player can be connected to the SMC via the RS-232 or RS-485 ports (if equipped). This way, video control can be performed by the existing switches at the VIP seat or using the app.

3.4 Remote Control from PED

The SMC can be controlled via Android or Apple apps when connected to an ethernet switch and/or a wireless router.

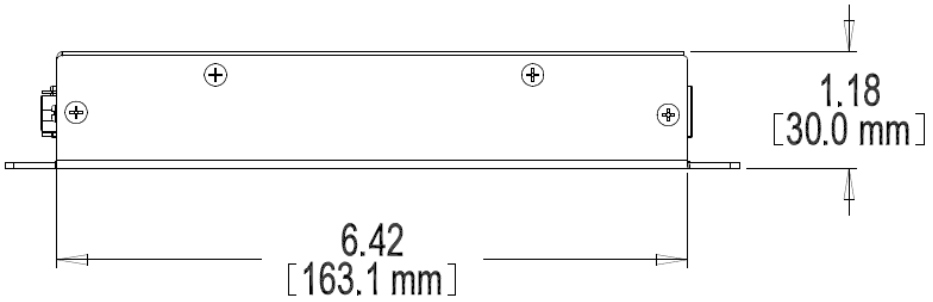
3.5 Outline Drawings



Unit weight:
< 13.5 oz / 0.384 kg

A Weight and Balance calculation aircraft is required as part of installation approval process.

Note: Dimensions are for reference only. See DA (Delivered Assembly) drawing for exact dimensions.



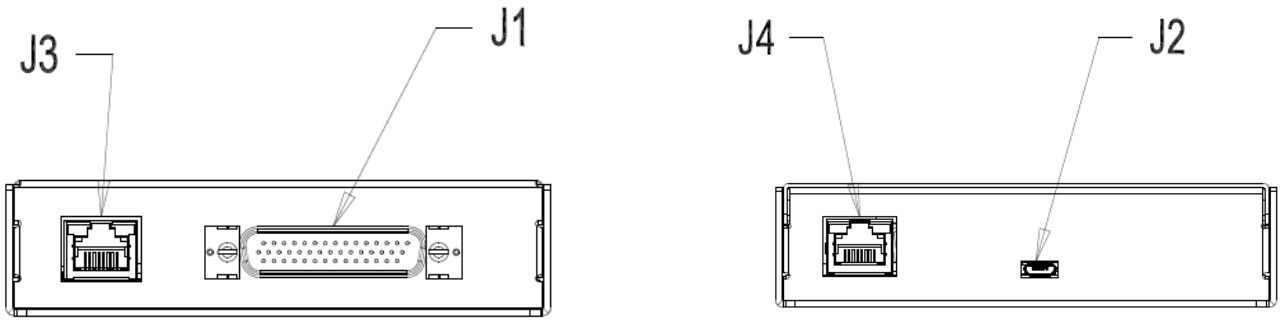


Figure 6: Top View, Side View, and Left/Right View with Dimensions

4.0 INSTALLATION

4.1 General

The information in this section assists the installer of the unit. Conformity to the electrical wiring and mechanical mounting guidelines will help to ensure proper operation of the unit.

Review all information in this section before proceeding with the installation of the unit.

For assistance during installation please contact Alto using the following contact information:

Alto Aviation
86 Leominster Rd
PO Box 399
Sterling, MA 01564

Phone: 978.466.5992
800.814.0123
Fax: 978.466.5996
E-mail: tech@altoaviation.com
www.altoaviation.com

When connecting this unit to another manufacturer's product, consult the manufacturer's specifications and installation instructions pertaining to their equipment.

Any changes or modifications not expressly approved by Alto could void the user's authority to operate the equipment.

4.2 Unpacking and Inspection

Carefully open the packaging and remove the product. Visually inspect the unit for evidence of physical damage during shipment. Retain the packing materials and all documentation received with the unit. Verify that all components on the packing list have been received.
If the unit has been damaged during shipment, contact Alto. A claim must be filed immediately after unpacking. Alto will assign a RMA Number (Returned Material Authorization) and give instructions for shipment. Please use the original carton and packing materials for return shipping.

4.3 Mounting Considerations

Allow sufficient room to connect and disconnect the wiring harnesses. The unit is designed to be mounted in any suitable orientation.

4.4 Electrical Load Analysis

Prior to installation, perform an electrical load analysis on the aircraft. Use the following values to support the analysis:

Maximum Current: 300 mA with 5V output @ 500mA current.
Nominal Current: 65mA without load on 5V output.

Ensure that the power input to the unit is circuit-protected.

4.5 Bonding

If bonding is required for installation and the unit is not mounted directly to the aircraft chassis, it is recommended to attach a bonding wire from the aircraft chassis to the unit's chassis using one of the mounting slots and appropriate hardware. The enclosure plating is electrically conductive.

4.6 Wire Shielding

Wire bundles that include I/O signals, which interconnect ALTO CSS components, should have a shield(s) to prevent damage from high voltage surges such as lightning strikes. Examples of I/O pins that require shielding include, but are not limited to, LED's, status outputs, switches etc. The shield should be grounded at both ends. A single shield can be used for a large wire bundle or multiple individual shields can be used for each wire.

It is recommended to use a shielded 8P8C RJ45 plug on CAT5E or better cables to maintain interference and transient free operation. If building your own cables, make sure the outer shield conductor is bonded to the connector's metal shell.

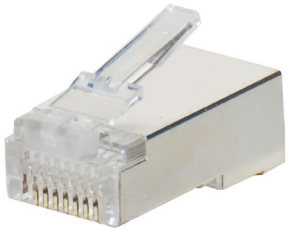


Figure 7: Typical 8P8C RJ45 Shielded Plug

4.7 RJ45 Dust Covers

The SM-1070 ships with RJ45 port dust covers. These can be left in any unused ports to protect from debris intrusion. They are made from silicone rubber and are non-flammable.

4.8 Functional Hazard Assessment (FHA)

Classification of Failure Conditions	No Safety Effect	Minor	Major
Effect	No effect on operational capabilities or safety	Slight reduction in functional capabilities or safety margins	Significant reduction in functional capabilities or safety margins

FUNCTIONAL HAZARD ASSESSMENT (FHA)				
Aircraft Function	**Classification of Failure Conditions**			**Analysis Consideration**
	Total Loss of Function	**Loss of Primary Means of Providing Function**	**Misleading and/or Malfunction Without Warning**	
Cabin control	No Safety Effect	No Safety Effect	Improper control of cabin functionality	Failure modes: Power failure – User can still control functionality using existing hard wired switches Communication errors- If faulty operation of cabin controls occurs, the unit can be powered off via circuit break and controlled using existing hard wired switches

Table 1: Functional Hazard Assessment Table

4.9 Software and Database Information

The SMC requires three files loads: the software, database, and app configuration. The software contains the functional framework for the controller. The database contains the configuration specific to the aircraft, devices connected to the SMC, and the desired user functionality.

The SMC database is defined per customer order requirements. If a new configuration is required, a new database part number will be used to define this configuration.

4.9.1 Typical SM-1070 Software Labeling

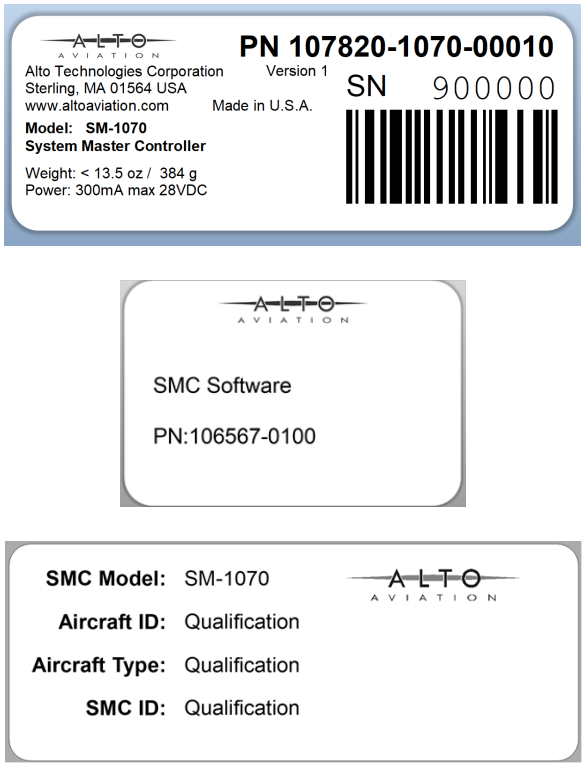


Figure 8: SM-1070 Example Labels

5.0 TECHNICAL SPECIFICATIONS

5.1 System Master Controller

Power Requirements

Supply Voltage	nominal	28VDC
	maximum	32VDC
	minimum	18VDC
Supply Current	maximum	300mA
	nominal	60mA

Operating Conditions

Temperature	-20C to 55C normal operating
	-55C to +85C storage
Humidity	95% non-condensing
Altitude	25,000 feet

Communication Protocols

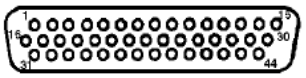
RS-422/RS-485 (6)	Speed/Type	(1) up to 20Mbps, (5) up to 200kbps
RS-232	Speed/Type	250kbps
CAN Bus (2)	Speed/Type	1Mbps
Ethernet	Speed/Type	10/100Mbps

Inputs/Outputs

GPIOs (8)	Input	+5VDC Pullup
Infrared	Input	0-5VDC, TTL logic
Analog IO	Input	16 bit, +/- 10VDC
	Output	10 bit, 0 - 10VDC, 65mA max
5VDC	Output	500mA max

6.0 CONNECTOR SPECIFICATIONS

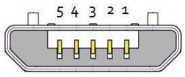
6.1 J1 Main Connector- Power, Communication, GPIOs



44 pin Male Hi-Density D-Sub with Fixed Female Jack Screws
Connector PN: Positronic ODD44M5B100V5X
Mate: Positronic DD44S10JVLX

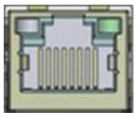
PIN	DESCRIPTION	Details
1	CAN 1+	Shielded Twisted Pair (1&16). Connect shield to ground.
2	CAN 2+	Shielded Twisted Pair (2&17). Connect shield to ground.
3	RS-485 #4, TX-	Shielded Twisted Pair (3&18). Connect shield to ground.
4	RS-485 #4, RX-	Shielded Twisted Pair (4&19). Connect shield to ground.
5	RS-485 #3, TX-	Shielded Twisted Pair (5&20). Connect shield to ground.
6	RS-485 #3, RX-	Shielded Twisted Pair (6&21). Connect shield to ground.
7	RS-485 #2, TX-	Shielded Twisted Pair (7&22). Connect shield to ground.
8	RS-485 #2, RX-	Shielded Twisted Pair (8&23). Connect shield to ground.
9	RS-485 #1, TX-	Shielded Twisted Pair (9&24). Connect shield to ground.
10	RS-485 #1, RX-	Shielded Twisted Pair (10&25). Connect shield to ground.
11	IR TX	
12	GPIO5	
13	GPIO2	
14	Analog Input	
15	+28V Input	
16	CAN 1-	Shielded Twisted Pair (1&16). Connect shield to ground.
17	CAN 2-	Shielded Twisted Pair (2&17). Connect shield to ground.
18	RS-485 #4, TX+	Shielded Twisted Pair (3&18). Connect shield to ground.
19	RS-485 #4, RX+	Shielded Twisted Pair (4&19). Connect shield to ground.
20	RS-485 #3, TX+	Shielded Twisted Pair (5&20). Connect shield to ground.
21	RS-485 #3, RX+	Shielded Twisted Pair (6&21). Connect shield to ground.
22	RS-485 #2, TX+	Shielded Twisted Pair (7&22). Connect shield to ground.
23	RS-485 #2, RX+	Shielded Twisted Pair (8&23). Connect shield to ground.
24	RS-485 #1, TX+	Shielded Twisted Pair (9&24). Connect shield to ground.
25	RS-485 #1, RX+	Shielded Twisted Pair (10&25). Connect shield to ground.
26	IR RX	
27	Ethernet – LED1	
28	GPIO3	
29	GPIO1	
30	Analog Output	
31	RS-485 #5, RX+	Shielded Twisted Pair (31&32). Connect shield to ground.
32	RS-485 #5, RX-	Shielded Twisted Pair (31&32). Connect shield to ground.
33	RS-485 #5, TX+	Shielded Twisted Pair (33&34). Connect shield to ground.
34	RS-485 #5, TX-	Shielded Twisted Pair (33&34). Connect shield to ground.
35	NC	
36	NC	
37	ARINC IN A	
38	ARINC IN B	
39	RS-232 TX	
40	RS-232 RX	
41	Ethernet – LED2	
42	GPIO4	
43	+5V Output	
44	GND	

6.2 J2 Connector- Micro-B USB



PIN	DESCRIPTION	Details
1	+5 VDC (VCC)	**(Maintenance Port. Not for Flight)** This port is for maintaining the software in the SM-1070. It is for factory and hanger servicing of the device.
2	Data – (D-)	
3	Data + (D+)	
4	Mode Detect (ID)	
5	Ground	
Shield	USB Chassis Ground	

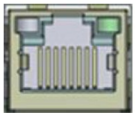
6.3 J3 Connector- Ethernet



Shielded 8 pin RJ45

PIN	DESCRIPTION	Details
1	ETH Transmit+	Cat 5e or better cable
2	ETH Transmit-	Cat 5e or better cable
3	ETH Receive+	Cat 5e or better cable
4	NC	
5	NC	
6	ETH Receive-	Cat 5e or better cable
7	NC	
8	NC	
Shield	Cable shield to RJ45 shell	

6.4 J4 Connector- ALTO MultiNET



Shielded 8 pin RJ45

PIN	DESCRIPTION	Details
1	RS-485 #6, TX+	Shielded Twisted Pair (1&2). Connect shield to ground.
2	RS-485 #6, TX-	Shielded Twisted Pair (1&2). Connect shield to ground.
3	RS-485 #6, RX+	Shielded Twisted Pair (3&5). Connect shield to ground.
4	GND	
5	GND	
6	RS-485 #6, RX-	Shielded Twisted Pair (3&5). Connect shield to ground.
7	GND	
8	GND	
Shield	Cable shield to RJ45 shell	

7.0 DO-160G QUALIFICATION TABLES

Section	Title	Category	Details - Environmental
4	Temperature and Altitude	[B1X]	-
4.5.1	Ground Survival Low Temperature Short Time Operating Low Temperature	[B1]	-55C -40C
4.5.2	Operating Low Temperature	[B1]	-20C
4.5.3	Ground Survival High Temperature Short-Time Operating High Temperature	[B1]	+85C +70C
4.5.4	Operating High Temperature	[B1]	+55C
4.5.5	In-Flight Loss of Cooling	X	No test performed.
4.6.1	Altitude	B1	Qualified by similarity to 107800. Altitude 25,000 feet.
4.6.2	Decompression	A1	Qualified by similarity to 107800. Decompression from Pressure Altitude of 6,000 feet to 55,000 feet in <15 seconds.
4.6.3	Overpressure	A1	Qualified by similarity to 107800. The equipment shall demonstrate compliance by test per DO-160G Section 4. The test level for the overpressure test is -15,000 ft altitude (170kPa).
5	Temperature Variation	C	±2C/minute -20C to +55C [Operating Low to Operating High temperatures] Must meet Performance Test requirements during transitions.
6.3.1	Standard Humidity Environment	A	Qualified by similarity to 107800. 48 Hr. Exposure, +50ºC @ 95% Relative Humidity
7	Shock	-	-
7.2.1	Operational Shocks	B	6g, 11ms terminal-peak saw tooth shock pulse
7.3.1.	Crash Safety (Impulse)	B	20g, 11ms terminal-peak, saw tooth shock pulse
7.3.3	Crash Safety (Sustained)	B	Qualified by similarity to 107800. The Crash Safety Sustained test level shall be 20 g's in each direction of the 3 mutually perpendicular axes
8	Vibration	-	
8.5.2	Standard Random	S[C]	Ref Fig 8-1 for 1hr/axis (4.12 Grms profile) each orthogonal axis
8.6	High Level, Short Duration Vibration	H(R)	Curve R (2.5 g's) Ref Fig 8-5 for 10-250Hz over 0.167Hz/sec , each orthogonal axis
8.8.3	Helicopter Vibration	U2	Unknown frequencies, Curves F (3.37Grms), F1 (4.76Grms) each orthogonal axis
9	Explosive Atmosphere	H	Ref. Para. 9.6.3 Pass= No internal or external component or surface shall exceed 204C.
10	Waterproofness	X	No test performed.
11	Fluids Susceptibility	X	No test performed.
12	Sand and Dust	X	No test performed.
13	Fungus Resistance	X	No test performed. Demonstrate by analysis that the materials are non-nutrients for fungal growth
14	Salt Spray/Fog	X	No test performed.
24	Icing	X	No test performed.
26	Fire (Flammability)	X	No test performed. Flammability test to FAR part 25 Appendix F, 12 second vertical

Table 2: DO-160G Qualification Form – Environmental

Section	Title	Category	Details - EMI
15	Magnetic Effect	Z	0<D≤0.3m
16	Power Input	ZXX	28Vdc Equipment.
16.6	Normal Operating Conditions (dc)	-	-
16.6.1.1b(1,2)	Voltage (Average Value dc)	Z	30.3VDC, 22VDC, No degradation of performance permissible.
16.6.1.1b(3)	Emergency Operation	X	No test performed.
16.6.1.2	Ripple Voltage (dc)	Z	Refer to DO-160 § 18.3.1
16.6.1.3	Momentary Power Interruptions (dc)	Z	50mS, 200mS and 1S. § 16.6.1.3(b) digital circuits and (c) all equipment apply. Equipment reset permissible but shall auto-recover.
16.6.1.4	Normal Surge Voltage (dc)	Z	28Vdc for 5min. then 50Vdc for 50ms then return to 28Vdc for 5s reduce to 12Vdc for 30ms then return to 28Vdc for 5s. Perform 3 cycles. 1ms rise and 5ms fall times. No degradation of performance permissible.
16.6.1.5	Engine Starting Under Voltage Operations (dc)	Z	Decrease nominal voltage to 10Vdc, then increase 0.3V/s for 35-sec, then nominal. Equipment reset permissible but shall auto-recover
16.6.2	Abnormal Operating Conditions (dc)	-	-
16.6.2.1	Voltage Steady State (dc)	Z	32.2Vdc (max), 20.5Vdc (min) Must meet PVT requirements with no manual intervention when returned to +28VDC
16.6.2.2	Low Voltage Condition (dc) (Category B Equipment)	B	1 min. at 28Vdc then 1 min. @ 20Vdc then ramp to 0Vdc over 10 min. Return to 28Vdc and determine compliance. It shall be demonstrated there is no undesirable behavior in the range from minimum voltage to zero. No manual intervention is allowed. Must auto-recover.
16.6.2.3	Momentary Undervoltage Operation	Z	12Vdc for 7-sec (Pass = Equipment reset permissible but shall auto-recover)
16.6.2.4	Abnormal Surge Voltage (dc)	Z	Surges of 80Vdcf or 100ms & 48Vdc for 1s. May have degraded performance during the exposure but must recover and meet PVT requirements after. No manual intervention is allowed.
16.7	Load Equipment Influence (dc)	-	
16.7.5	Inrush Current Requirements	X	No test performed.
16.7.7	DC Current Ripple tests (dc)	X	No test performed.
17	Voltage Spike	A	600Vdc Voltage Spike. No susceptibility shall be observed.
18	Audio Frequency Conducted Susceptibility - Power Inputs	Z	Fig. 18-3 for 28Vdc systems. No susceptibility shall be observed.
19	Induced Signal Susceptibility	AC	Table 19-1 - Cat AC. No susceptibility shall be observed.
20	Radio Frequency Susceptibility (Conducted and Radiated)	TT	Level TT, No susceptibility shall be observed.
21	Emission of Radio Frequency Energy	M	Conducted = M Radiated = M
22	Lightning Induced Transient Susceptibility	XXEZXX	Pin Injection XX , no test performed Cable Bundle EZ , qualified by test with pin injection limits on power leads. Burst XX , no test performed May have degraded performance during the exposure but must recover and meet PVT requirements after. Manual intervention is allowed.
23	Lightning Direct Effects	XXXX	No test performed.
25	Electrostatic Discharge (ESD)	A	(10 pulses) 15kV pulses positive (+) polarity, (10 pulses) 15kV pulses negative (-) polarity May have degraded performance during the exposure, but must recover and meet PVT requirements after. No Manual intervention is allowed.

Table 3: DO-160G Qualification Form – EMI