



ION

Installation Manual
Rev. 1.6

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All information depicted in this manual, including hardware and software names, versions, and part numbers, is subject to change and may not be up to date.

About this Manual

This manual describes the physical, mechanical, and electrical components, as well as instructions for the installation of the Churchill Navigation ION. Every effort has been made to make this document as complete and accurate as possible.

The following symbols for warnings, cautions, and notes are used to throughout this manual.



Warning

A warning symbol denotes an item where a potential hazard capable of producing injury to personnel or destruction of equipment exists if the approved procedure is not followed.



Caution

A caution symbol denotes an item where, if not followed, damage to equipment or degradation of mission capability can occur.



Note

The note symbol is used to identify important information for installers / operators. While not directly related to safety or protection of equipment from damage, the note symbol identifies information to which attention should be paid during the installation and/or operation of the equipment.

Product Guarantee & Warranty Information

For details about the Churchill Navigation ION warranty, please see the Terms and Conditions page available at www.churchillnavigation.com/agreement

Section 1: Specifications



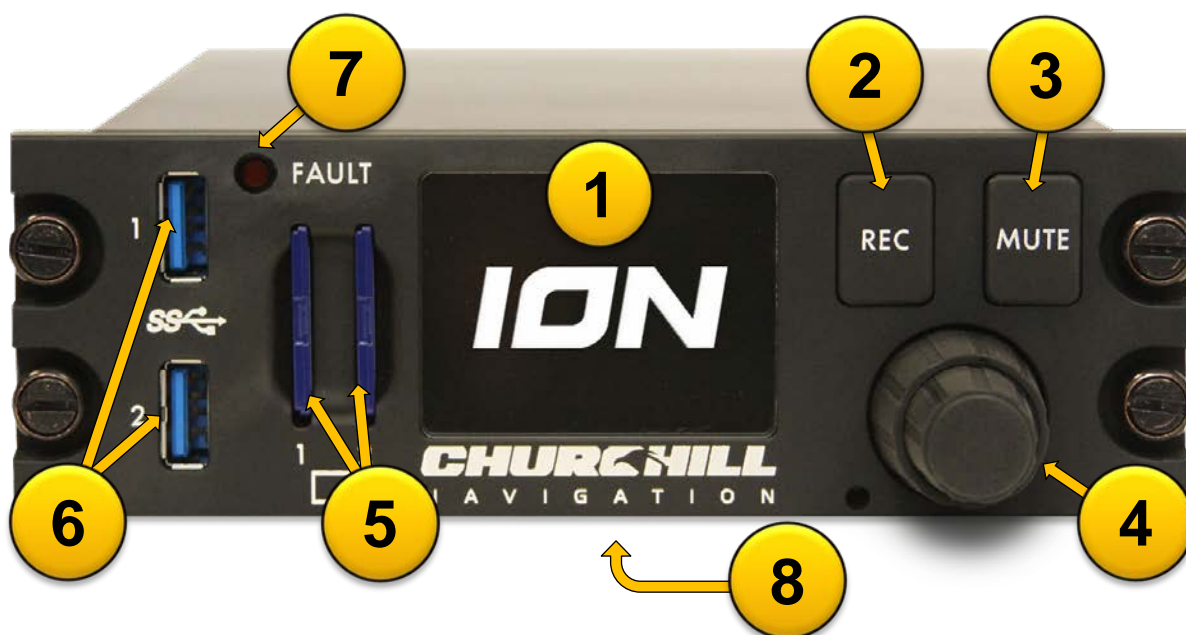
This document contains information that was current as of the printing of this manual. To obtain always up-to-date installation drawings, ICDs, and much more, visit: www.churchillnavigation.com/specifications

1.0 Description

This section contains information concerning the physical characteristics and technical specifications of the Churchill Navigation ION video recorder.

1.1 Design Characteristics

ION is a compact, solid-state DZUS mounted video recorder. ION offers simultaneous recording of two channels of HD-SDI video, one channel of analog video, audio, and metadata. Video is saved to removable USB or SD media for easy transport and hand-off. A full-color, backlit LCD display allows operators to review recorded clips on the go and even perform playback while recording.



1. Backlit, full-color, 2.15 in [54.61 mm] diagonal LCD screen
2. Backlit REC button
3. Backlit Mute button
4. Control knob (inner knob, outer knob, and push-button operation)
5. SD media (2x)
6. USB 3.0 (2x)
7. Fault light
8. CMOS Battery access tray (located on the bottom of the enclosure) *

* CMOS battery access tray included on ION hardware revision 2.8 and higher.

1.2 Technical Characteristics & Specifications

Specification	Characteristic
Product Designation/Description	ION Video Recorder
Physical Dimensions	Height at bezel: 1.875 in [47.63 mm] Width at bezel: 5.75 in [146.05 mm] Length (Enclosure depth): 7.0 in [177.8 mm] Overall depth, front knob to back of enclosure, excluding connectors: 8.32 in [211.33 mm]
Weight	2.6 lbs ± .05 lbs [1.18 kg ± .02 kg]
Display type / dimensions / resolution	Backlit LCD, 2.15 in [54.61 mm] diagonal Native 320 x 240 pixel resolution NVIS Class A compliant / NVIS class B compatible
Environmental Qualifications	DO-160 Qualified
Operating Temperature Range	-20°C to +70°C
Maximum Operating Altitude	+45,000 feet [+13,716m]
Power:	
Input Voltage	28VDC
Input Current	4A on 28VDC (normal operating range)
Power consumption	112W (maximum)
Circuit Breaker Requirement	Minimum 7.5 amp rated
Connection Types, Protocols, and Standards	LEMO (1x) J1 – Power/GPIO LEMO (1x) J2 – Ethernet LEMO (1x) J3 – Misc. (USB, ARINC 429, Audio) LEMO (1x) J4 – Serial port (RS232, RS422) BNC J5, J6, J7 – HD-SDI 1 & HD-SDI 2 video in / HD-SDI video out BNC J8, J9, J10 – Analog in Wi-Fi compatibility – 802.11ac
Video-in Support	2x HD-SDI inputs - <i>Single channel, 3G-SDI (1080p60) input supported</i> 1x Analog video input (CVBS, Y/C, YPbPr, & RGB)
Video-out Support	1x HD-SDI output - <i>3G-SDI (1080p60) output supported</i>

Video-out Supported Resolutions	720p (50 fps), 720p (60 fps), 1080p (25 fps), 1080p (30 fps) 1080p (60 fps), 1080i (50 fps), 1080i (60 fps)
Metadata Standard	KLV MISB/STANAG 4609 compliant
Video Recording Codec	H.265 (HEVC) – Skylake processor models only H.264 (MPEG-4) H.262 (MPEG-2)
Audio-in Support	L/R channel in
Audio-out Support	L/R channel out

Section 2: Installation Guidelines

2.0 Description

This section contains information and instructions for the unpacking and correct installation of the Churchill Navigation ION video recorder.

2.1 Equipment Packaging

Prior to installation, carefully inspect both the ION unit and the supplied power connector. Note any damage that may have occurred in transit and contact the parcel carrier if necessary to file a claim.

Otherwise, check that all items listed below are present prior to proceeding with the installation. Report any missing items to your supplier.

- (1) ION
- (1) ION power connector (p/n FGN.1M.308.XLCT)
- (2) SD Cards (32GB each)
- Product manuals and guides



It is recommended that you retain all original packaging for purposes of easy returns due to damage or warranty claims.

All other connectors are available for purchase from Churchill Navigation or direct from the manufacturers themselves. Additional information is provided in section 2.3 of this guide. If you have purchased additional hardware, such as the ION Connector Kit, from Churchill Navigation, please take a moment to inspect the condition of those connectors as well prior to starting the installation process.

2.2 Required Tools

You will need the correct crimping tool for the connectors selected. A few examples are listed below and are available from Churchill Navigation or from their respective manufacturers.

BNC Connectors:

Application	Connector:	Crimp Die:
75ohm BNC plug for PICWire V73263	PicWire P/N 190712	M22520/5-41
75ohm BNC plug for RG59	Amphenol P/N 112123	.255/.213/.068
75ohm BNC plug for RG179	Amphenol P/N 112133	.178/.128/.068

All LEMO Connectors:

Crimp Tool	Pin Positioner	Pin Extractor
DPC.91.701.V	DCE.91.070.5MVC	DCF.93.070.4LT

2.3 Installation

ION is intended for DZUS mount (or similar) installations. If you are unsure of the installation location, please contact Churchill Navigation.



To ensure adequate airflow to the unit, Churchill Navigation recommends a minimum of 100mm between the back of the ION and any adjacent surface.

The minimum ION installation requires 28VDC power and at least one type of supported video input. Additionally, some operators may wish to include audio-in as a part of their basic setup. The corresponding Installation Manual sections required for minimum operation as described above are:

- 1) Power – Sections 2.3.1, 2.3.2, and 2.3.3.1
- 2) Video – Section 2.3.3.5 (HD-SDI) and Section 2.3.3.6 (Analog)
- 3) *Optional* audio-in – Section 2.3.3.3

Support for these as well as all other inputs and features are described in detail in the following sections of this guide.

2.3.1 Voltage Requirements

ION operates on 28-volt DC power and consumes a maximum of 112 watts (4 amps on 28VDC). **Churchill Navigation recommends using a minimum 7.5-amp circuit breaker.**

2.3.2 Ground Requirements

ION IS CASE-GROUNDED THROUGH THE DZUS MOUNT. If the DZUS mount is not directly grounded to the chassis, use a minimum of 16-gauge wire to ground the DZUS mount prior to ION operation. EXPOSED ALUMINUM IS CHROMATED. DO NOT CHEMICALLY COAT OR COVER WITH NON-CONDUCTIVE MATERIAL.

ALL GROUND PINS EXCEPT 28V RETURN ARE GROUND CONTINUOUS TO CASE.



Failure to properly ground the ION unit may result in damage to the ION as well as possibly other installed equipment.

2.3.3 Cabling requirements

To ensure a properly functioning ION, the following cabling requirements are highly recommended. Any variation will be at the sole responsibility of the dealer or installer. Detailed installation diagrams are provided in Section 3 of this manual.



Install each cable with an 8 inch [203 mm] service loop to allow for easy servicing of the ION unit.

2.3.3.1 Power (J1)

Each ION is shipped with a circular LEMO 8-pin male connector, P/N **FGN.1M.308.XLCT** to be

used as the power connector. If you wish to use a different power connector, the connection to 28VDC input on the ION and 28VDC GND are highly recommended to be a twisted pair. Use of 22 AWG wire size is recommended. J1 also contains provisions for GPIO1 and GPIO2 and aircraft panel dimmer brightness control.

Pin	Function	Description
1	28V	Connect to 28V power source
2	28V GND	Ground for 28V power source
3	Panel Brightness	Panel brightness can be wired to aircraft cockpit dimmer knob and has a maximum voltage input of 30V
4	Panel Brightness GND	Ground for panel brightness
5	GPIO 1	GPIO
6	GPIO 1 GND	GPIO Ground
7	GPIO 2	GPIO
8	GPIO 2 GND	GPIO Ground

2.3.3.2 Ethernet (J2)

Churchill Navigation recommends using either **PicWire PIC E50824** or **EMTEQ D100-0824-006** 4-pair Ethernet cable. Both can be purchased from Churchill Navigation or directly from their respective manufacturers at <http://www.picwire.com> or <http://www.emteq.com>. Use the connection labeled “J2 - Ethernet”. Twisted pair is indicated by color block.

Pin	Function	Wire color
1	TX-/BiD1-	Orange
2	TX+/BiD1+	Orange/White
3	RX-/BiD2-	Green
4	RX+/BiD2+	Green/White
5	BiD4-	Brown
6	BiD4+	Brown/White
7	BiD3-	Blue
8	BiD3+	Blue/White

2.3.3.3 Misc. (J3) – USB, Audio, ARINC

J3 contains connection provisions for Audio in/out, ARINC and USB connectivity. Twisted pairs are indicated by color block and noted in the “pair with” column.

Pin	Function	Description	Pair with
1	AUDIO OUT L	Audio-out, left channel	--
2	AUDIO IN R HIGH	Audio-in, right channel	--
3	AUDIO IN L HIGH	Audio-in, left channel	--
4	USB 5V	USB 5V	--
5	USB +*	USB +	--
6	USB -*	USB -	--
7	ARINC TX1-*	ARINC transmit 1-	ARINC TX1+
8	ARINC RX2-*	ARINC receive 2-	ARINC RX2+
9	ARINC RX2+*	ARINC receive 2+	ARINC RX2-
10	ARINC RX1-*	ARINC receive 1-	ARINC RX1+

(Table continued next page)

11	ARINC RX1+*	ARINC receive 1+	ARINC RX1-
12	AUDIO OUT R	Audio-out, right channel	--
13	AUDIO IN R LOW		--
14	AUDIO IN L LOW		--
15	USB GND	Ground	--
16	ARINC	ARINC Ground	--
17	ARINC TX1+*	ARINC transmit 1+	ARINC TX1-
18	AUDIO OUT GND	Audio Out Ground	--
19	GND	Ground	--

* Twisted pair required.

For USB applications using J3, Churchill Navigation recommends the following:

Option A: Carlisle 28433/02171LX-4. This cable can be purchased directly from Carlisle:
<http://www.carlisleit.com>

Option B: EMTEQ U090-0422-100: This cable can be purchased directly from Emteq:
<http://www.emteq.com>



USB performance cannot be guaranteed at cable lengths greater than 10ft (3.04m) without the use of an extender. Contact Churchill Navigation for additional information.

Aircraft Audio Setup Recommendations:

For best audio quality, Churchill Navigation recommends that the ION audio input be connected to a balanced (chassis ground independent) output, with -15 dBV signal levels. It is also recommended to connect the ION audio input to a COM port, rather than a headset output.

To connect an unbalanced audio signal, ensure that the ground signal from the audio source is shorted to ground at the source. This ground of the audio signal should then be connected to pins 13 and 14 of J3 on the Ion.

The recommended ION audio setup has been tested on common aircraft audio control systems including the Eagle Copters USA (Geneva Aviation) G13000 Digital Audio Router and Technisonic A711 and A711X. If you have questions regarding the best audio setup for your installation, please contact Churchill Navigation.



ION can be configured to record stereo audio as two separate channels; ICS as channel 1 and RX/TX (Comm) as channel 2, for example. To do this, separate audio-in via J3 pin 2 and pin 3.

2.3.3.4 Serial Com (J4) – RS232, RS422

J4 contains connection provisions for RS232 and RS422 serial communications. Twisted pairs are indicated by color block and noted in the “pairing” column.



The maximum speed for cable runs of less than 25 feet [7.62m] is 256 kbit/s for

RS232 and 8 Mbit/s for RS422.

Pin	Function	Description	Pair with
1	RS232C TX	RS232C transmit from ION	--
2	RS232C RX	RS232C receive to ION	--
3	RS232A TX	RS232A transmit from ION	--
4	RS232A CTS	RS232A Clear to Send	--
5	RS232B TX	RS232B transmit from ION	--
6	RS232B RX	RS232B receive to ION	--
7	RS232B RTS	RS232B Request to Send	--
8	RS422A RX-*	RS422A receive to ION -	RS422A RX+
9	RS422A TX-*	RS422A transmit from ION -	RS422A TX+
10	RS422A TX+*	RS422A transmit from ION +	RS422A TX-
11	RS422B RX+*	RS422B receive to ION +	RS422B RX-
12	RS422B TX+*	RS422B transmit from ION +	RS422B TX-
13	RS232D TX	RS232D transmit from ION	--
14	RS232D RX	RS232D receive to ION	--
15	RS232E RX	RS232E receive to ION	--
16	RS232E TX	RS232E transmit from ION	--
17	GND RS232C	Ground (RS232C TX/RX)	--
18	RS232A RX	RS232A receive to ION	--
19	RS232A RTS	RS232A Request to Send	--
20	GND RS232B	Ground (RS232B TX/RX)	--
21	RS232B CTS	RS232B Clear to Send	--
22	RS422A RX+*	RS422A receive to ION +	RS422A RX-
23	RS422B RX-*	RS422B receive to ION -	RS422B RX+
24	RS422B TX-*	RS422B transmit from ION -	RS422B TX+
25	GND RS232D	Ground (RS232D TX/RX)	--
26	GND RS232E	Ground (RS232E TX/RX)	--
27	GND	Ground (Extra)	--
28	GND RS232A	Ground (RS232A TX/RX)	--
29	GND RS422A	Ground (RS422A TX/RX)	--
30	GND RS422B	Ground (RS422B TX/RX)	--

* Twisted pair required.

2.3.3.5 BNC (J5, J6, J7) – 75 Ω HD-SDI COAX Cable

ION has two HD-SDI in connections and one HS-SDI video out connection. When used with gyro-stabilized gimbals, HD-SDI video 1 (J5) is typically used for Video In Command, HD-SDI video 2 (J6) is typically used for a hoist camera, etc. All BNC connectors use the center pin for the signal and the shell as the ground.

In almost all applications, Churchill Navigation recommends use of **PicWire PIC V73263** lightweight 75ohm coaxial cable, P/N 190712, available from Churchill Navigation or <http://www.picwire.com>

If an installation requires alternative cabling, please use the following:

Alternative A: RG59 can be used in place of PicWire PIC V73263. The proper connector is **Amphenol Connex 112123**. These are available from Churchill Navigation or <http://www.digikey.com>

Alternative B: If RG179 is required by other equipment (ex. MX-10 gimbal), then for EMI purposes, DOUBLE high performance 360 degree EMC individual braid shielding must be done to RG179 cable from end to end. The proper connector is **Amphenol Connex 112133**, available from Churchill Navigation or <http://www.digikey.com>

2.3.3.6 BNC (J8, J9, J10) – Analog video

ION is capable of recording from composite or component video sources. PAL, NTSC, S-Video, RS-170, and component-in are supported. The following configurations are allowed:

Composite Video In (CVBS)	S-Video In	Component Video In (YUV)	Component Video In (RGB)
J8	J8-Luma (Y) J9-Chroma (C)	J8-Luma (Y) J9-Blue Chroma (Pb) J10-Red Chroma (Pr)	J8-Green (SYNC) J9-Blue J10-Red



For all BNC connectors, the center conductor pin is the signal and the shell is the ground.

Supported Analog Video Types

ION supports input from the following analog video types:

- Composite
- Component_YUV_480i
- Component_YUV_576i
- Component_YUV_480p
- Component_YUV_576p
- S-Video
- Component_RGB_480i
- Component_RGB_576i
- Component_RGB_480p
- Component_RGB_576p

2.3.3.7 All Other Cables

Other cables can be selected at the installer's discretion to meet the needs of the installation.



All cables **MUST BE SHIELDED**. This includes power cables.

Section 3: Aircraft Post-Installation Testing Procedures

3.0 Description

The following tests should be performed post-installation to confirm the correct operation of the ION video recorder in airborne applications. Additionally, these tests will identify any interference that the ION installation may cause with existing aircraft systems. If the installed system passes all of the applicable EMI tests, then no further action is required. If interference is observed, then the interference must be assessed against the appropriate standards of airworthiness for the system in question.

3.1 Methodology

Most EMI tests can be conducted on the ground unless otherwise noted. Testing recommendations for various aircraft system tests are provided below. During all tests, it is recommended that users switch the ION unit on and off as often as required to evaluate potential EMI in all phases of ION operation.

ADF	If possible set the ADF to a nearby navigation station and monitor for interference.
Autopilot	If the aircraft is equipped with an autopilot or a stability augmentation system, test fly the aircraft and verify that operation of the ION does not have adverse effects on these systems.
GPS	The GPS should be operational and navigating with at least the minimum compliment of satellites. Observe the GPS for any degradation in satellite status, loss of RAIM, or warning messages/flags.
Transponder	The transponder and encoder should be monitored with ramp test equipment. Set the output of the transponder test set to 3db above the output necessary to achieve 90% reply.
VHF Comm Radio	The VHF comm radio should have the squelch open. Listen for any noise or detected audio signals on the VHF comm radio(s).
Navigation Radios	Operation of the Navigation radios (VOR/LOC/GS/DME receiver(s)) should be tested using known operational facilities. Listen for any noise or detected audio signals on the VOR/LOC/GS receiver audio; look for any moment of flags or needles on the VOR/LOC/GS navigation display(s).

3.2 Power-on Checks

Prior to performing any other tests, the user should confirm the basic operation of the ION unit. This can be conducted using ground power or in-air using aircraft power.

- 1) Power the ION on and confirm the boot sequence.
- 2) With either USB or SD removable media inserted, use the outer knob to select a video channel from which you want to record and press the REC button. Ensure no faults.
- 3) End recording by pressing the REC button a second time.
- 4) Playback recorded video using:
 - a. The ION unit's on-screen playback capability, or
 - b. The removable media by inserting it into a Windows PC or Macintosh computer and playing back the recorded .TS file. Churchill Navigation recommends using the VLC Player available from videolan.org for playback if you encounter any difficulty playing files back with your normal media player.

If unable to successfully complete any of these steps, begin by rechecking wiring, connections, and if necessary, contact Churchill Navigation Support for further troubleshooting.

3.3 EMI Test

List the power plant, fuel, and other electric instruments not already in the chart provided and note any anomalies that occur due to operation of the ION. Assess the results.

Aircraft communications & navigation equipment tests		Pass/Fail
Com 1&2		
Transponder & Encoder		
ADF 1 & 2		
Glideslope 1&2		
VOR/LOC 1&2		
DME 1&2		
Compass		
Directional Gyro		
GPS		
Digital Clock		
Autopilot tests		Pass/Fail
Autopilot		

(Table continued next page)

Coupled Approach		
Stability Augmentation Systems		
Aircraft engine systems tests		Pass/Fail
Fuel Pressure		
Oil Temperature		
Amps		
Bus Voltage		
Fuel %		
Ng		
TOT		
Torque %		
Annunciators		
Oil Pressure		
Other systems tests (as identified by the user)		Pass/Fail

Section 4: Installation Diagrams

The following pages contain the installation diagrams and specific notes for the ION that were current as of the printing of this manual. To obtain always up-to-date installation drawings, ICDs, and much more, visit: www.churchillnavigation.com/specifications