Orion I/O™

NovaTech Substation I/O
Catalog

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NovaTech Orion I/O Overview

NovaTech Orion I/O™ is an extension of the family of Orion Automation Platforms for substation automation and incorporates the same security features, software tools, and NCD (NovaTech Configuration Director) configuration as the OrionLX, OrionLX+, OrionLXm and OrionMX. It is a rack-mountable I/O assembly with four slots—A, B, C, and D—that can be filled with any combination of I/O cards: currently 16-Point Discrete Input Card, 16-Point Discrete Input Wetted Card, 16-Point Discrete Output Card, 16-Point Discrete High Power Output (HPO) Card, Combination 8-Point DI / 8-Point HPO Card, 8-Point Analog Input Card and 8-Point Flex Analog Input Card. Full population of discrete cards yields 64 I/O in 2 RU (rack units); full population of analog input cards yields 32 analog inputs. See Figure 1 below for rear connections on Orion I/O.
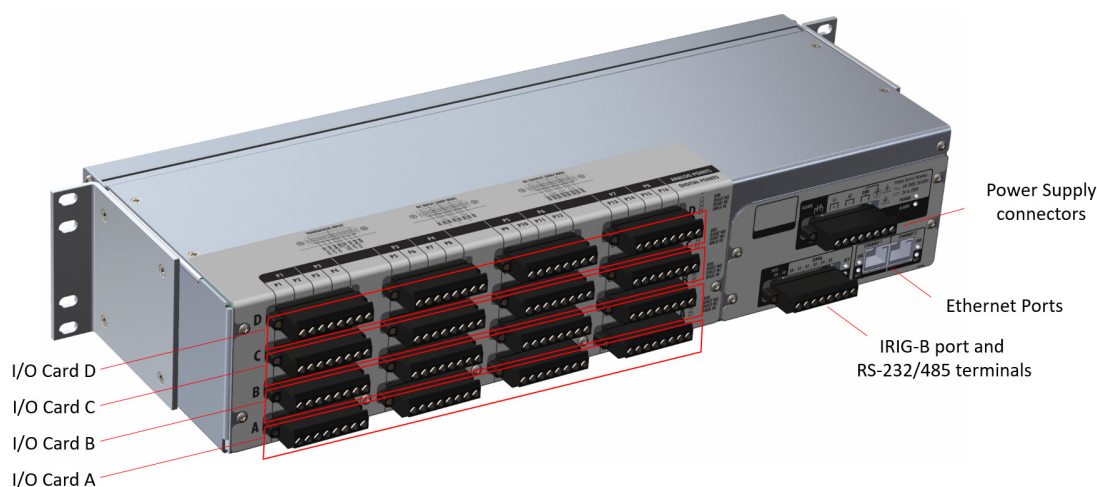

Figure 1 – Rear connections on Orion I/O. Four I/O cards shown populated in slots A, B, C, and D.

Input and output status, point state, time diagnostics, and other module data are provided on an Advanced User Interface of a similar design to the Bitronics® 50 Series and 60 Series metering products. A standard, conventional faceplate is also available.
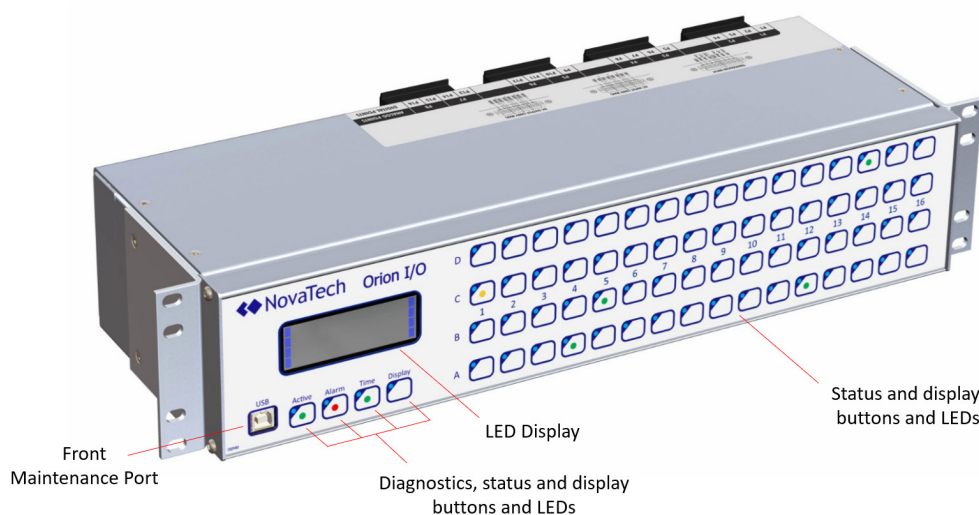

Figure 2 – Advanced User Interface

Application

Orion I/O is designed for high performance 12V dc to 125V dc monitoring and control applications in electrical substations including 1ms SOE Recording, circuit breaker TRIP/CLOSE, higher-speed control, and analog transducer monitoring and measurement. Although Orion I/O can stand-alone and operate as an independent RTU, it is usually connected serially or with Ethernet to an Orion RTU or other substation RTU. Orion I/O can also be applied as a Client to attached IEDs.

- **The 16-Point Discrete Input Card** monitors the position, status, or health of substation apparatus such as circuit breakers, reclosers, transformers, tap changers, and capacitor banks.
- **The 16-Point Wetted Discrete Input Card** monitors the same devices as the 16-Point Discrete Input Card, but internally generates a wetting voltage of 24V dc or 48V dc. This can be useful in retrofitting legacy RTUs where the contact wetting voltage must be provided from the I/O instead of externally.
- **The 16-Point Discrete Output Card** energizes TRIP and CLOSE coils in circuit breakers and reclosers, or switches other loads.
- **The 16-Point High Power Output (HPO) Card** adds output contact protection when interrupting highly inductive loads in TRIP/CLOSE scenarios.
- **The Combination 8 DI / 8 HPO Card** is applied in the same applications as the cards previously described, and adds the "Feedback Dropout" feature. This high-speed control feature improves and standardizes breaker control schemes by associating the change of breaker position status with the turning OFF of breaker control outputs.
- **The 8-Point Analog Input Card** monitors and measures transducer signals representing amps, volts, watts, vars, frequency, weather conditions, tap positions, etc.
- **The 8-Point Flex Analog Input Card** adds features to simplify legacy RTU retrofit: software selectable ranges, higher input impedance on voltage inputs and terminals to land analog shield wires.

Physical Dimensions

19" W x 3.5" H x 7.0" D (2RU in 19-inch rack)
Weight: 8 lbs

Processor and Memory

CPU: 800MHz
Memory for Archive/Alarm and files storage: 2GB
TPM: Supported

Power Usage

Avg. Power: 11 Watts (each 16 DI Wetted Card adds an additional 1.25 watts)
Max Power: 20 Watts

Data Points

IED/SCADA Points: 600 maximum

Environmental Immunity

Operating temperature: -40°C to 70°C
Operating humidity: 5% to 95% non-condensing
Fast transient: C37.90.1 (2002)
RFI: C37.90.2 (1995)

Power Supply

Two available supplies:

• 48 - 250V dc / 69 - 240V ac nominal, 50/60Hz
• 12 - 24V dc nominal, no AC

Note: Designed for operation within +/-20% of nominal

Two additional power connectors are available to power downstream Orion I/O modules as shown in Figure 3 below:

Figure 3 – DC power wiring option for multiple Orion I/O modules

Ethernet Ports, Serial Ports, and IRIG-B

Orion I/O provides two standard 1Gb RJ45 Ethernet ports (separate NICs). Three Ethernet port options are available:

• 3-Port RJ45 Ethernet switch on one NIC, one RJ45 port on the other NIC
• Small Form-Factor Pluggable (SFP) receptacle on one NIC, one RJ45 port on the other NIC
• Two RJ45 ports for Parallel Redundancy Protocol (PRP) and High-Availability Seamless Redundancy (HSR) on one NIC, and one SFP port on the other NIC

Orion I/O is also available with one software-selectable RS-232/485 serial port. Software selections are also available for full or half duplex, and termination resistor. This serial port provides complete connection support for serially-attached SEL® relays including SEL Serial Client protocol, IRIG from pins #4 and #6, and power for port-mounted accessories on pin #1.

Unmodulated IRIG-B can be received on dedicated screw terminals, or can be received from an OrionLX+ on RS-485 terminals.

Figure 4 below shows Ethernet ports, serial port terminal, and IRIG-B terminal.
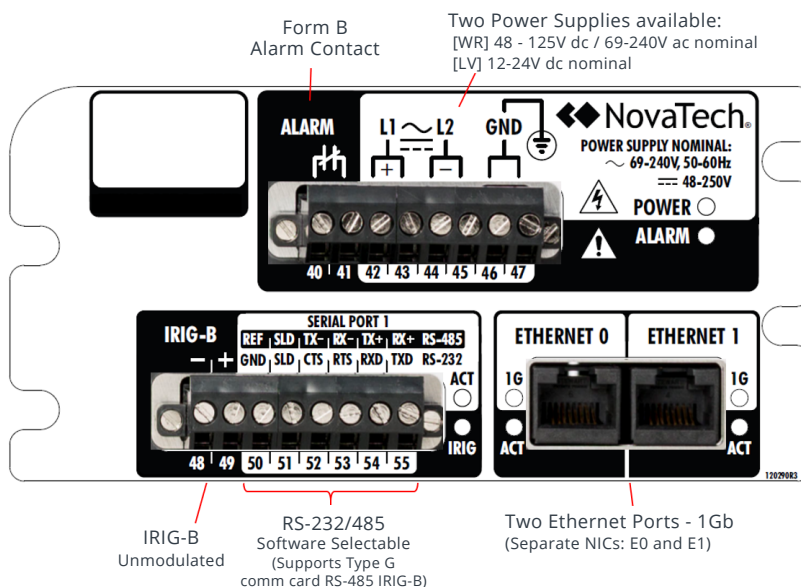

Figure 4 – Communication ports, IRIG-B terminals, power terminals, and alarm terminals

3-Port Ethernet Switch Option

An optional unmanaged RJ45 switch, shown below in Figure 5, is available to expand Orion I/O connectivity shown in Figures 6 and 7 below:
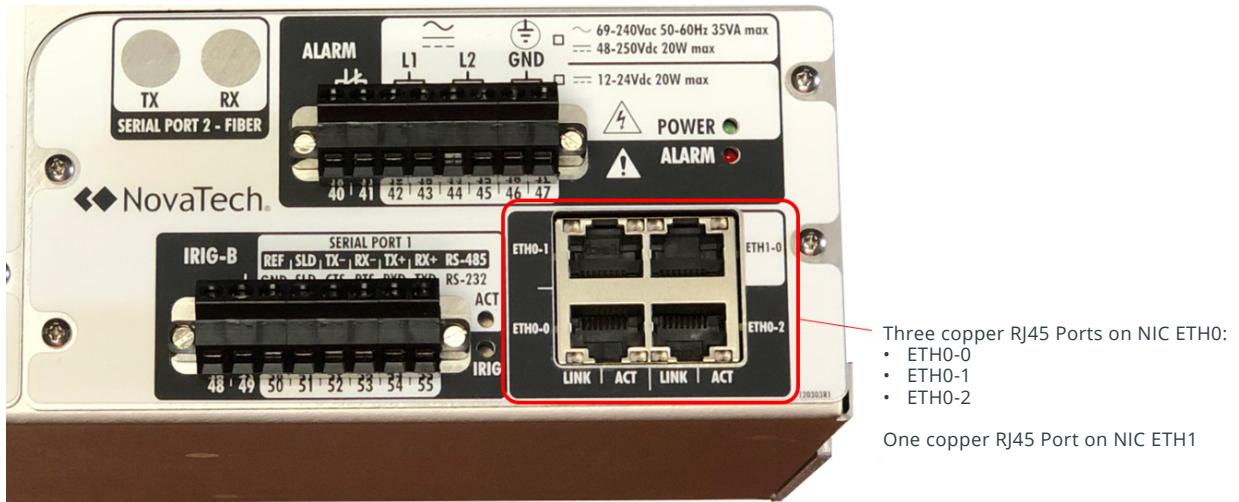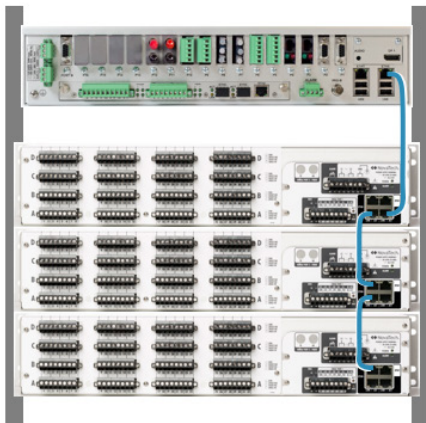

Three copper RJ45 Ports on NIC ETH0:
- ETH0-0
- ETH0-1
- ETH0-2

One copper RJ45 Port on NIC ETH1

Figure 5 – Optional 3-Port Ethernet Switch

Figure 6 – Orion I/Os daisy-chained to OrionLX+

DNP3 IP
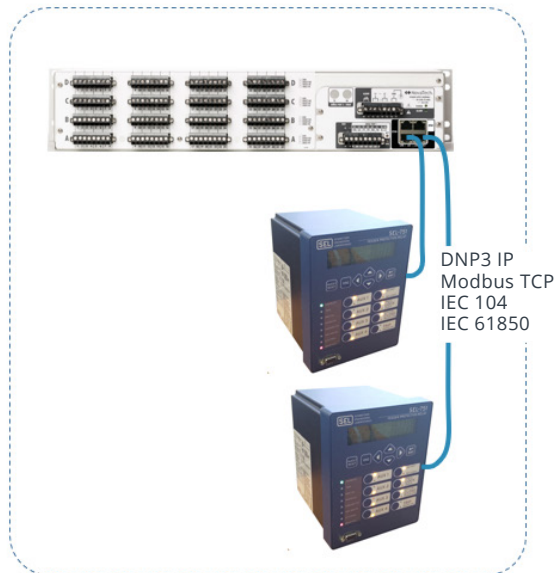Modbus TCP
IEC 104
IEC 61850

Figure 7 – Orion I/O as Client to IEDs in small distribution panels

SFP Port (Small Form-Factor Pluggable) Option

One of the two physical Ethernet ports can be optionally ordered as an SFP port receptacle. The four SFP transceivers described in the table below, all supporting 1Gb/s, can be ordered from NovaTech:

Model No.	Mode or Media	Conn.	Wavelength	Speed	Distance	Application
SFP-MM01	Multimode Fiber	LC	850nm	1Gb/s	550m	Shorter fiber optic networks, usually inside substation
SFP-SM01	Single Mode Fiber	LC	1310nm	1Gb/s	10km	Medium-length fiber optic networks, usually from substation to HQ/EMS/SCADA or between facilities
SFP-SM04	Single Mode Fiber	LC	1310nm	1Gb/s	40km	Longer fiber optic networks, usually from substation to HQ/EMS/SCADA
SFP-RJ01	Copper	RJ45	N/A	1Gb/s	100m	Inside panels and in short copper networks inside substation

16-Point Discrete Input Card
- 16 electrically isolated circuits
- High speed; suitable for 1ms SOE recording
- I/O terminals to case: 2000V ac, 1min
- I/O channel to channel: 2000V ac, 1min
- ON-state, De-bounce, and Chattering Contact Filters
- Single design accommodates either higher voltage range ("HV") or lower voltage range ("LV")
- HV: nominal 125V dc, maximum 145V dc, ON at 90V dc, OFF at 77V dc
- LV: nominal 12 - 48V dc, maximum 60V dc, ON at 10V dc, OFF at 5V dc
- HV or LV range selection through NCD configuration selection

Circuit diagram for isolated and bussed wiring below in Figures 8 and 9 below:
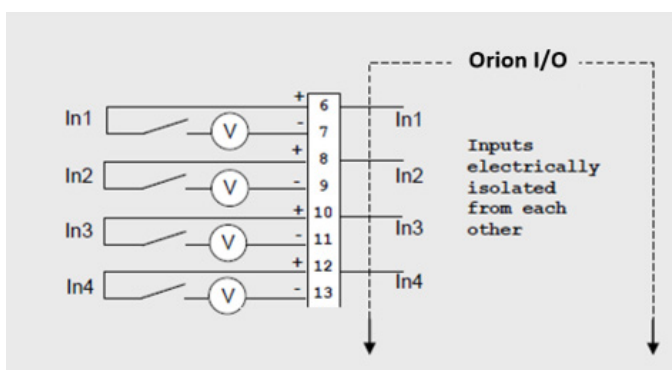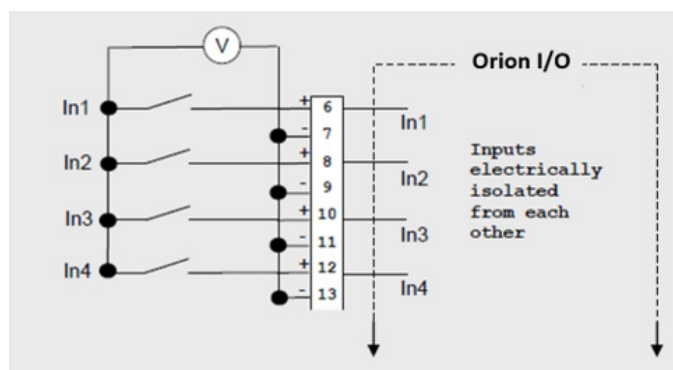

Figure 8 – Independent/isolated wiring

Figure 9 – Bussed wiring for common wetting voltage

16-Point Discrete Input Wetted Card
- I/O Card generates and sources the contact wetting voltage
- 24V dc or 48V dc wetting voltage available, software selectable in NCD
- ON at 19.2V dc, OFF at 8V dc
- Will survive accidental application of 125V dc
- One group of 16 circuits
- High speed; suitable for 1ms SOE recording
- ON-state, De-bounce, and Chattering Contact filters
- I/O terminals to case: 2000V ac, 1min
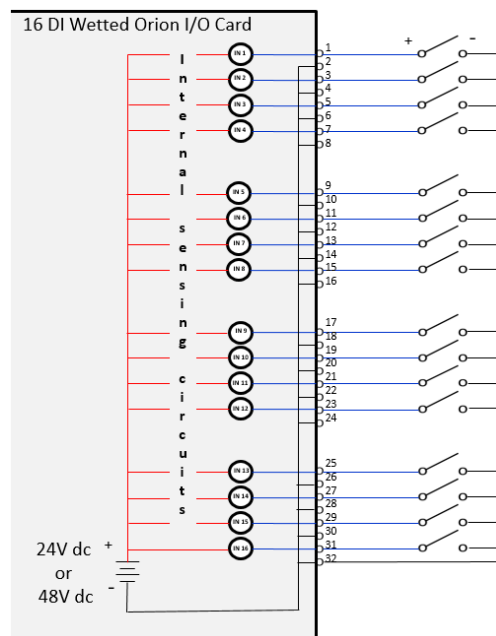
Wiring as shown in Figure 10.

Figure 10 – Wiring for 16-Point DI Wetted Card

16-Point Discrete Output Card

- 16 electrically isolated normally open (NO) or normally closed (NC) outputs. Card ordered as NO or NC.
- Tripping duty, substation-grade relay outputs
  › Resistive: 30A
  › Continuous Carry: 10A
  › Break Inductive @ 48V dc: 700mA
  › Break Inductive @ 125V dc: 200mA
- Design accommodates "Dual Path" control for improved security
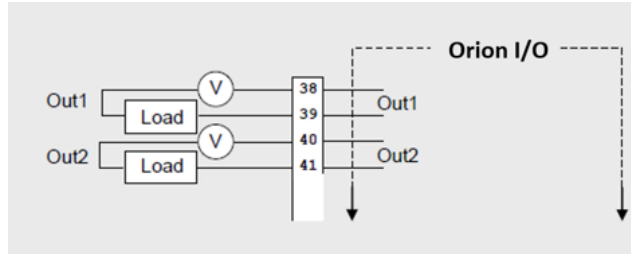
Circuit diagram below in Figure 11:

Figure 11 – Output wiring

16-Point High Power Discrete Output Card (HPO)

Increases inductive break capability to 125V dc @10A @40ms L/R time constant (leakage <1mA). Resistive rating and continuous carry rating remain the same as the standard 16-Point DO Card described above. Wiring is also the same as the standard 16-Point DO Card.

Combination 8-Point DI / 8-Point High Power Output (HPO) Card

Half of the 16-Point Discrete Input Card described above and half of the 16-Point High Power Output Card described above. Includes a "Feedback Dropout" firmware feature for improved breaker control which can be configured to turn an output OFF when a user-designated input turns ON or OFF (e.g. 52a or 52b). See Figure 12 below:
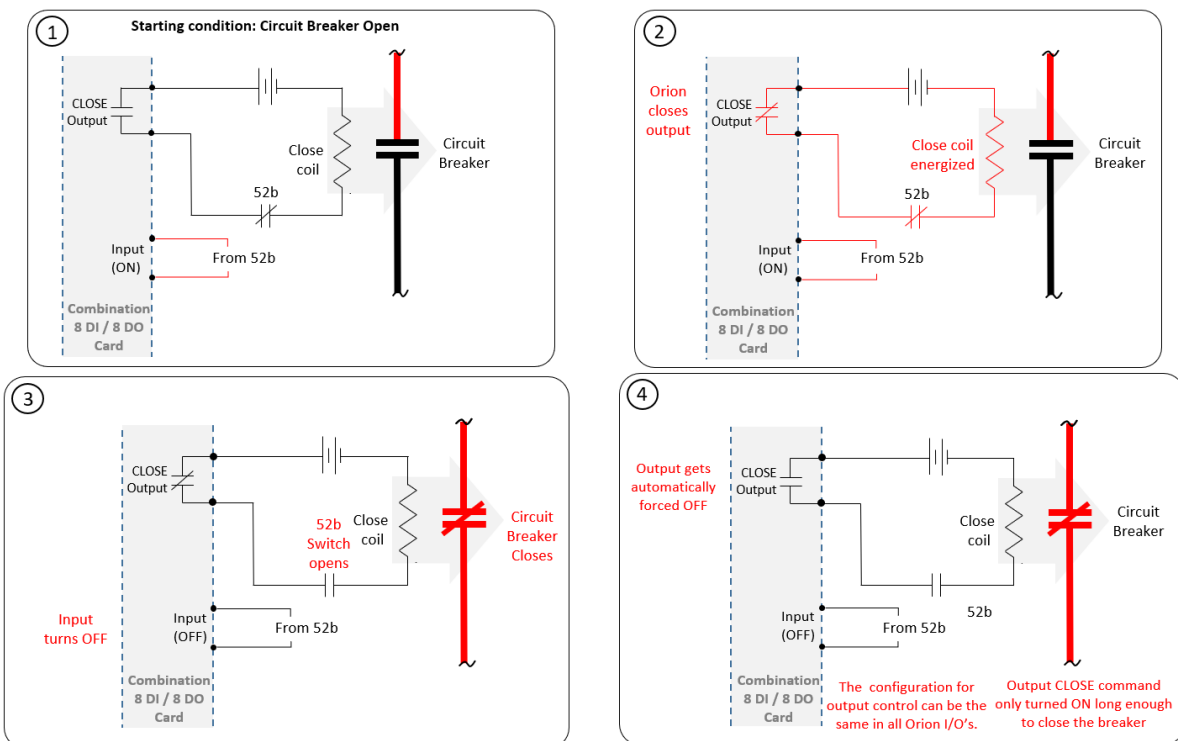

Figure 12– Feedback Dropout feature on Combination 8-Point DI / 8-Point High Power Output (HPO) Card

8-Point Analog Input Card

• Eight isolated transducer input circuits
• Three ranges available, per channel
  › +4mA to +20mA
  › -2mA to +2mA
  › -10V to +10V
  › Input impedence: 10k ohms

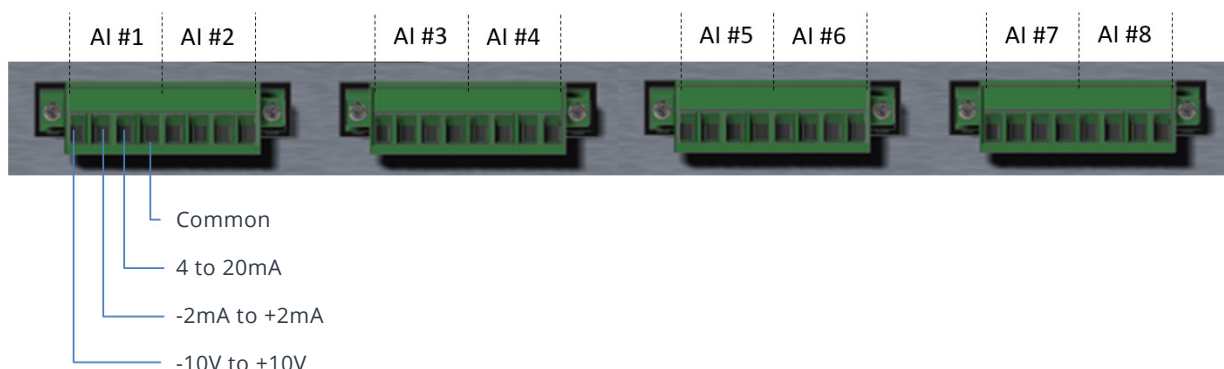Wiring as shown in Figure 13 below:

Figure 13 – Analog input wiring on 8-Point Analog Input Card

8-Point Analog Input Flex Card

• Eight isolated transducer input circuits with same ranges as the standard 8-Point Analog Input Card described above:
  › -2mA to +2mA
  › -10V to +10V
  › +4mA to +20mA

Differences from standard 8-Point Analog Input Card:
• Ranges software selectable. Selection in NCD configuration software.
• Input impedance on -10V to +10V range increased from 10K ohms to 1M ohms. This is important in retrofits of many legacy RTUs.
• Analog shields can be landed onto the same connectors as signal wires.
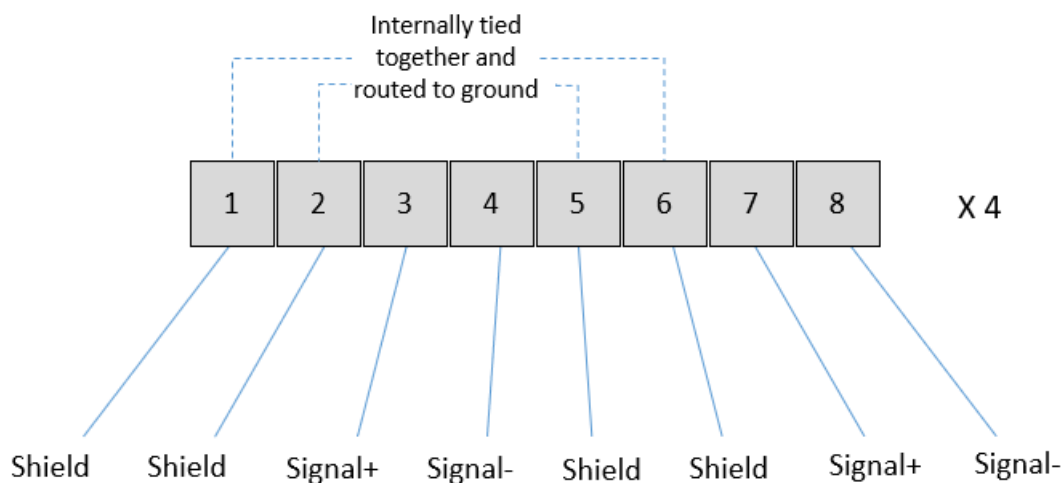
Wiring as shown in Figure 14 below:

Figure 14 – Analog input wiring on 8-Point Analog Input Flex Card

Advanced User Interface

This optional front panel provides the following at the touch of a button:

• Point name (default assigned point name or user-defined Alias name)

• Discrete point state (e.g. "Open", "ON", etc) and the time point last changed

• For analog input cards, can display both actual measured value and scaled value

• The I/O cards in slots A, B, C and D in Orion I/O module

• The name of the active NCD file and firmware version

• User-defined message

• Time diagnostics

The Advanced User Interface uses similar touch-sensitive buttons as the Bitronics 50 series and 60 Series meters.
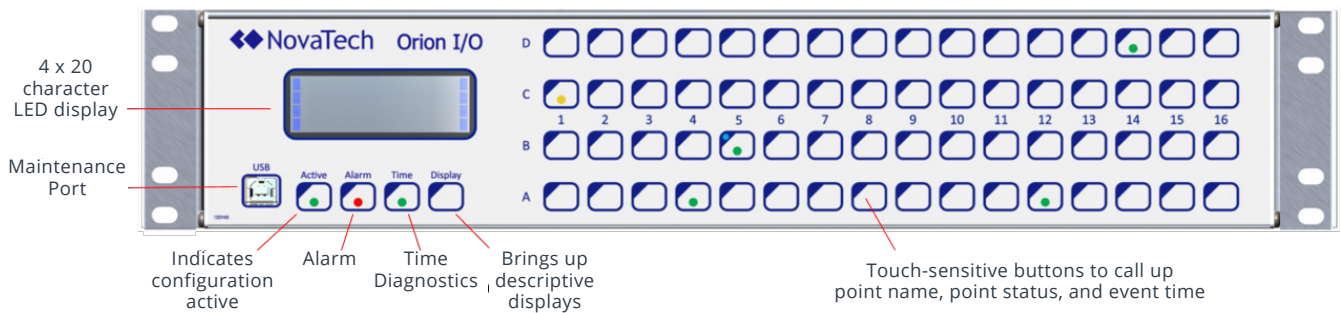

Figure 15 – Advanced User Interface

Figure 16 – Available status and diagnostic displays on the Advanced User Interface

Standard Faceplate

This faceplate provides basic indication of point status, time accuracy, LED test, and Orion I/O operating conditions as shown in Figure 17 below:
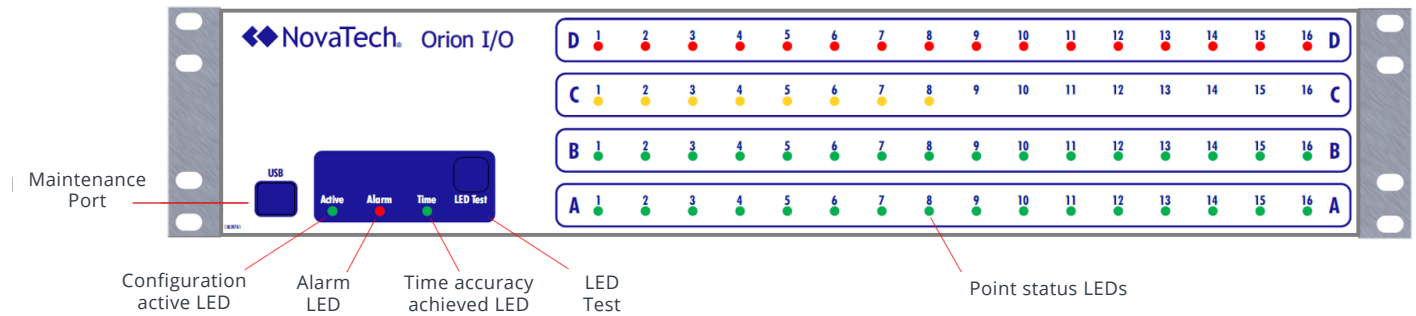
Figure 17 – Standard Faceplate

Dimensions and Physical Mounting

The Orion I/O comes in a 19" wide x 3.5" high (2RU) x 7.00" deep aluminum enclosure for mounting in a 19" rack or a rectangular hole in a panel. Several customized surface mount options are also available. The aluminum mounting ears can be repositioned for mounting on any vertical or horizontal flat surface. See dimensions and mounting ear details in Figure 18 below:

Figure 18 – Mounting Dimensions and Mounting Ears

Conformal Coating Option

A high dielectric (560 volts/mil) silicon-based coating is available for Orion I/O. Coatings are inspected to meet IPC-A-610.

SECURITY

Orion I/O offers the same suite of security features as all current Orions, including:

- **Linux operating system**. Proven choice for the highest levels of security, and fewer patches than windows-based systems.

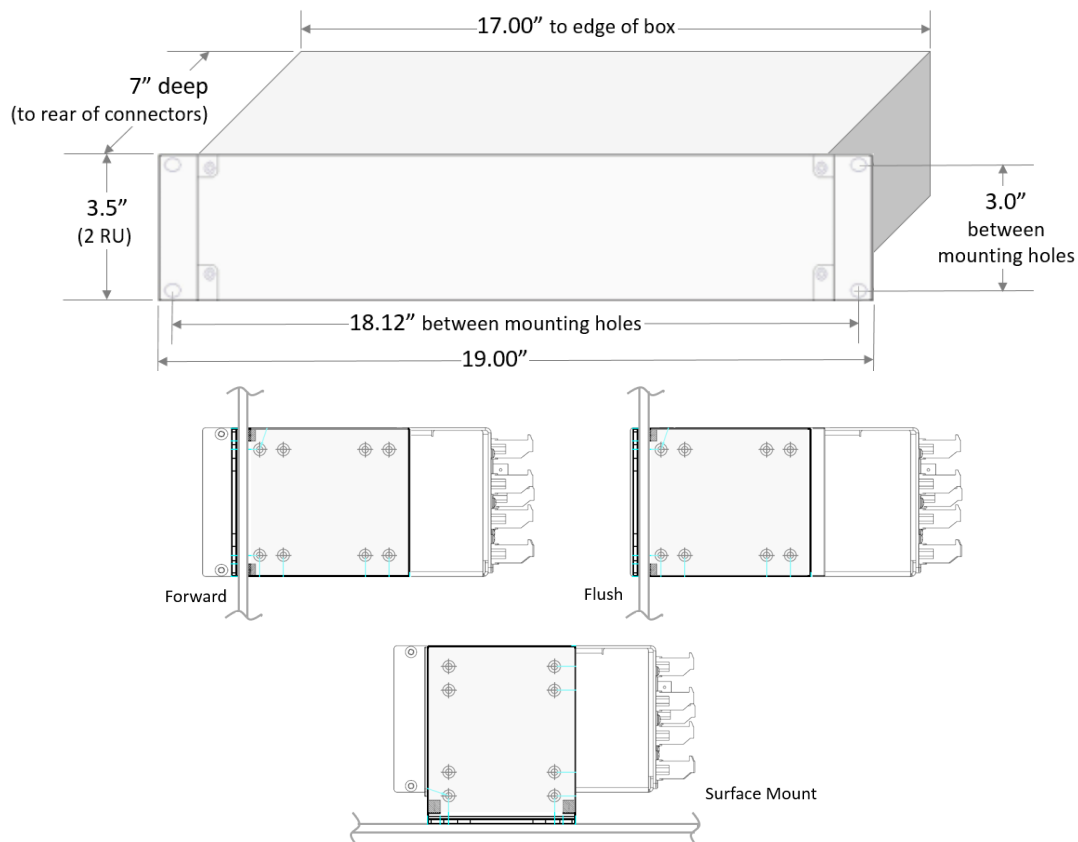- **Integrity Measurement Architecture (IMA)**. IMA detects if files have been accidentally or maliciously altered, both remotely and locally, appraises a file's measurement against a "good" value stored as an extended attribute, and enforces local file integrity. Included files: executable files, kernel modules and kernel loaded firmware.

- **Secure protocols**: HTTPS, SSH, SFTP. Non-secure versions of these protocols — HTTP, telnet, and FTP — are blocked by default.

- **Secure communications to RTU, to SCADA and to IEDs**. On both serial or TCP connections, DNP3 SA (Secure Authentication) can improve security by blocking replay, spoofing and man-in-the-middle attacks. For the highest level security, DNP3 TCP messages can be received and sent through an encrypted TLS tunnel.

- **Strong passwords, password rules**. Strong passwords, password rules. Includes how long a password can be used, how different the next password must be, lockout after repeated failed attempts, assignment of privileges to users (what can be controlled, what can be acknowledged, what can be changed, etc).

- **Remote Authentication and user groups using LDAP or RADIUS**. When a user attempts to connect to Orion I/O, authentication can be based upon credentials stored in Active Directory (AD) or in a RADIUS Server, instead of the credentials being stored in Orion. This simplifies management of access policies and password policies. User groups can be set up as supported by AD and RADIUS.

- **Built-in Firewall**. The Orion uses netfilter/iptables supporting stateless and stateful packet filtering for both inbound and outbound traffic. Connection tracking is provided by (ip_conntrack, nf_conntrack). The Orion firewall can be configured through a web-based GUI, or configured at the command line.

- **Backup Orion I/O Configuration and Change Management**. The software option "Orion Configuration Backup Manager" retrieves and zips all configuration files from the Orion (points mapping configuration, math and logic, HMI screens, firewall settings, etc) plus settings from attached SEL® relays. This zipped file may be transferred via secure SFTP to an enterprise application to analyze configurations, to ensure no unauthorized changes have been made and to ensure conformance to company security policies. If the Orion or SEL relay was compromised or destroyed, the files in storage could be loaded into replacement units to restore operation.

- **Security event logging with "syslog"**. Syslog creates a non-alterable, time-stamped record of up to 200,000 security events including attempts to load malware, who is connected (by username), how they are connected (HTTPS, Front Port, SSH, etc.) and what they viewed or operated. In addition, any point in the Orion I/O database, such as breaker TRIPPED/CLOSED, can be configured to log changes in syslog. Syslog can be streamed to a syslog server (such as Tripwire Log Center) or syslog records can be captured in a .csv file which can be accessed manually from the Orion I/O, or pushed out from the Orion I/O automatically using FTP/SFTP or Orion Email.

- **Security Monitoring Points**. Includes much of the same security data as syslog, but data can be mapped to SCADA, to Alarming, to HMI screens, to Math & Logic or to Orion Email. Points are included to indicate if syslog is logging correctly and if an attempt was made to load malware.

MATH & LOGIC AND SOFTWARE OPTIONS FOR ORION I/O

103	**IEC 61850**	Server/Goose and Client supported.
99	**Advanced Math & Logic**	Advanced math and logic editor built on the powerful Lua programming language. Includes simulation tool.
95	**Alarm-Archive-Retentive**	Stores both discrete and analog events based on time (e.g. every 15 minutes) or change (e.g. ON-OFF or analog change out of deadband). Alarm Annunciation and Alarm Archive functionality included in web tables. Retentive function retains alarm status through power cycling.
98	**Cascading**	Server module for connecting to a client Orion via TCP. Simplifies the integration of multiple Orions in large substations by combining the cofiguration of multiple Orions into one NCD setup. Now standard on the Orion I/O.
106	**Configuration Backup Manager**	Retrieves configuration files from substation cyber assets (currently Orion configuration files and SEL® relay settings), names and zips the files, and stores them in non-volatile Orion memory. MD5 checksum available. Useful for detecting configuration and setting changes.
96	**Email**	Enables email messages containing Alarms and SEL® fault record information (Short Event Summary or Full Length Event Report) to be sent out from Orion.
101	**IEC 61131-3**	IEC 61131-3 is a graphical "PLC-style" editor with five math and logic editors: Ladder Diagram, Function Block Diagram, Instruction List, Structured Text, and Sequential Flow Chart. Online simulation available.
35	**LogicPak**	LogicPak provides pre-configured logic functions for commonly-used routines, including: **"Calculator"** where equations can be typed in using in the same format as MS Excel **"Delay"** where a time delay can be applied to any point change before it is reported as an Event **"Local/Remote"** where controls to outputs can be blocked **"AND", "OR"** where alarms or health data can be OR'd or AND'd together to simplify SCADA reporting **"KYZ"** where pulses can be accumulated from energy meters **"Primary/Secondary"** where data can be accessed from a either a primary or secondary IED depending on availability of communications
105	**Points Blocking**	Also known as "Alarm Shelving". Enables users to manually and temporarily block the logging or displaying of alarms. Can be useful during commissioning and testing.
94	**Relay "Data Logger"**	Enables Orion to access full-length fault records from SEL® relays and to place records in a file in Orion memory. Requires Orion SEL® Serial Server protocol 14.
108	**Tile Annunciator**	A web-based software-defined alarm annunciator product. The Tile Annunciator webpages are served directly from Orion I/O and provide simplified setup, categorization, and viewing of active and acknowledged alarms. Requires Alarm/Archive/Retentive (AAR).
57	**WEBserver XML**	Provides an environment for developing customized web pages using data obtained or calculated by the Orion I/O. XML is the mechanism used for data flow. This option includes an extensive pre-drawn image library.

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APPLICATIONS

Orion I/O Application as a Client to IEDs

The most common application for Orion I/O is as a server to an Orion RTU. With the recent addition of client protocols, Orion I/O can also be applied as a client to serially-attached or TCP-attached IEDs, as shown in Figures 19 and 20 below:
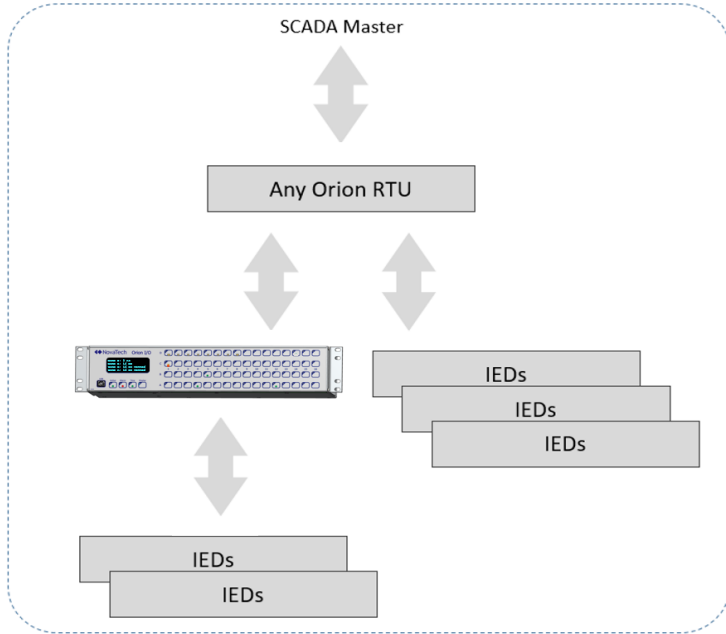

Figure 19 – Orion I/O as a Server to an Orion RTU and as a Client to IEDs
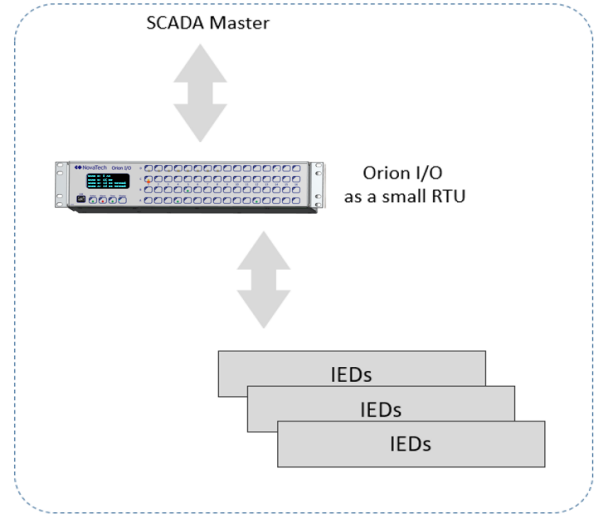
Figure 20 – Orion I/O as a Server to a SCADA Client and as a Client to IEDs

Cascading Orion I/O to Orion RTU

Up to 40 Orion I/Os can be "Cascaded" to an Orion RTU Client. Cascading facilitates the use of a single NCD configuration file for all Orion I/O and Orion RTU, instead of multiple individual configuration files. This simplifies change management of RTU configuration and documentation. See Figure 21 below:
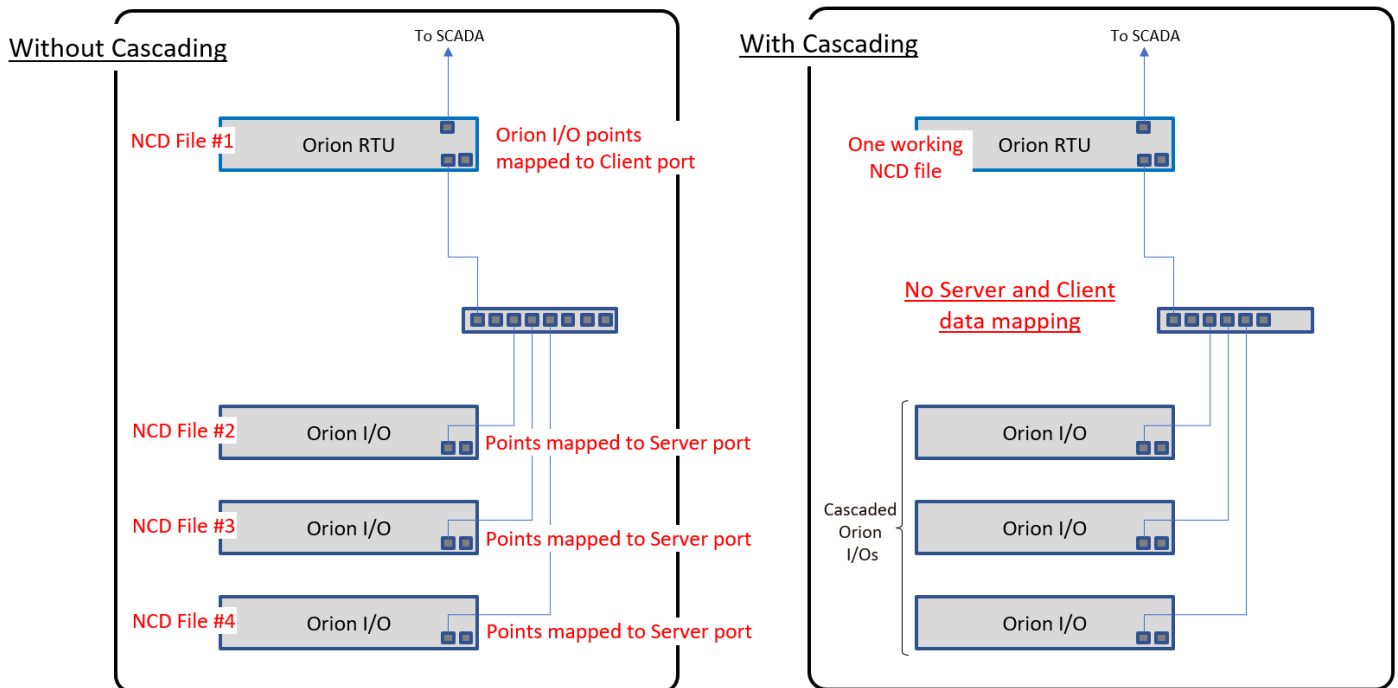

Figure 21 – Cascading Orion I/O to Orion RTU

ORION I/O MODEL NUMBER

Slot A I/O Card	Slot B I/O Card	Slot C I/O Card	Slot D I/O Card	I/O Card Slot Description
X	X	X	X	No I/O cards standard
0	0	0	0	**16 DO Card** 16 isolated, substation-grade discrete output relays for breaker control duty.
1	1	1	1	**16 DI Card** 16 discrete and isolated inputs circuits. "HV" (125V dc) or "LV" (12-48V dc) is a software selection.
2	2	2	2	**8 AI Card** 8 isolated circuits with three ranges: -10 to +10V, -2mA to +2mA, 4-20mA
3	3	3	3	**Wetted 16 DI Card** 16 discrete wetted inputs, in one group. 24V dc or 48V dc sourced by card, and software selectable.
4	4	4	4	**16-point High Power Output "HPO" Card.** Can break inductive circuit of 10A, with a time constant of 40ms L/R at 125V dc nominal. Other output specs the same as 16 DO Card.
5	5	5	5	**Combination 8 DI / 8 DO Card.** 8 isolated inputs as described above. 8 isolated High Power outputs as described above.
6	6	6	6	**8 AI Flex Card** 8 isolated circuits with three ranges as above in "8 AI Card", but ranges are software selectable, impedance higher for voltage range, and analog shields can land on terminals.

Option Number	Available Software Options
35	LogicPak
57	WEBserver XML
94	Relay "Data Logger" or I-log
95	Alarm-Archive-Retentive
96	Email
98	Cascading
99	Advanced Math & Logic
101	IEC 61131-3
103	IEC 61850
105	Points Blocking
106	Configuration Backup Manager
108	Tile Annunciator

Orion I/O – SX – 2E – XXXX – SD – WR – XX – XX – 98 – XX (standard)

Option Code	Serial Port Description
SX	Standard one serial RS-232/485 port

Option Code	Ethernet Port Description
2E	Standard two RJ45 ports. Two NICs.
ES	3-Port RJ45 Ethernet Switch, plus one RJ45 port. Two NICs.
EP	One SFP (Small Pluggable Form-Factor) port, plus one RJ45 port. Two NICs.
RP	RJ45 PRP/HSR Redundancy ports, plus one SFP port. Two NICs.

Option Code	Front Panel User Interface Description
SD	Standard Faceplate
AD	Optional Advanced Horizontal User Interface
AV	Optional Advanced Vertical User Interface

Option Code	Power Supply Description
WR	Standard 48-250V dc and 69-230V ac
LV	Optional 12-24V dc (no AC)

Option Number	Available Server Protocols
42	DNP3 Serial Server
44	DNP3 IP Server
46	L&G Serial Server
47	Modbus Serial Server
49	Modbus TCP/IP Server
67	IEC 60870-5-101 Serial Server
68	IEC 60870-5-104 TCP/IP Server
70	SPS Serial Server
71	SES-92 Serial Server

Option Number	Available Client Protocols
01	DNP3 Serial Client
03	DNP3 TCP/IP Client
04	Modbus Serial Client
07	Modbus TCP/IP Client
14	SEL Serial Client
37	SEL TCP Client (or "STCP")
36	IEC 60870-5-103 Serial Client
39	IEC 60870-5-101 Serial Client
204	IEC 60870-5-104 TCP/IP Client

ORION I/O - SX - ES - 1156 - AD - WR - 01 - 04 - 44 - 98 - 99

- One RS-232/485 Serial Port
- 3-Port Ethernet Switch
- Slot A: 16 DI Card; Slot B: 16 DI Card; Slot C: Combination 8 DI / 8 HPO Card; Slot D: 8 AI Flex Card
- Advanced User Interface
- Wide-range Power Supply 48-250V dc 69-240V ac
- DNP3 Serial Client
- Modbus Serial Client
- DNP3 IP Server
- Cascaded Orion Server
- Advanced Math and Logic

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AUTOMATION

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