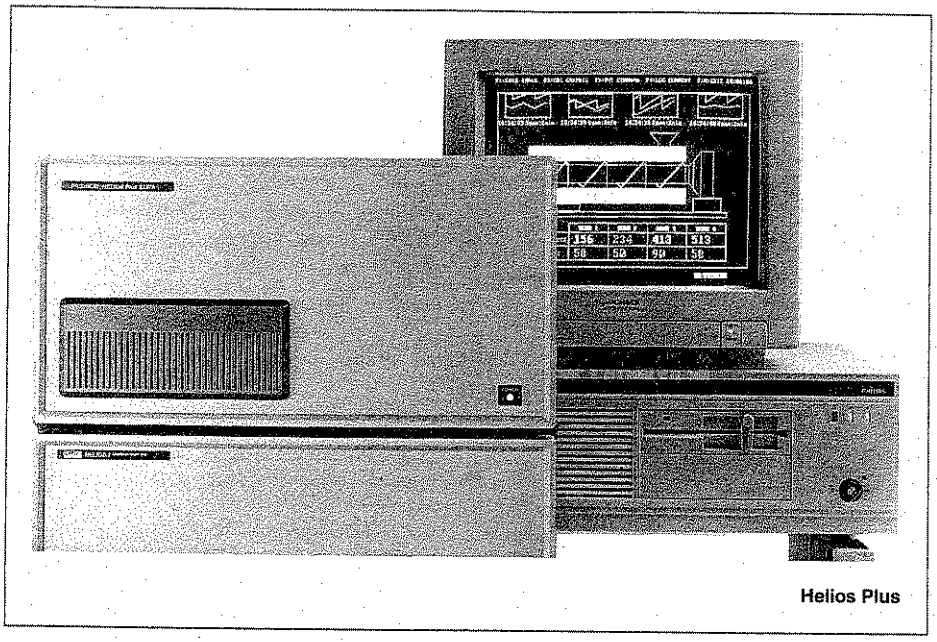
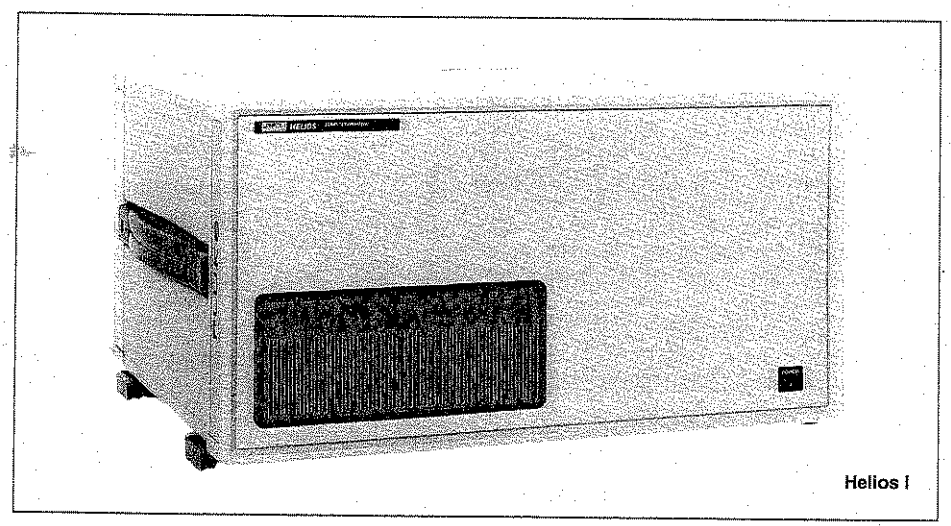
Helios Series

RS-232



Helios Plus



Helios I

Helios Series Data Acquisition Front Ends

- Helios-I offers high accuracy for lower speed applications
- Helios Plus offers higher speed and more intelligence
- Wide range of measurement and control options
- PC application software available for a complete system
- Ruggedized dc powered version for mobile applications

Performance

The Helios Series of Data Acquisition Front Ends add high performance measurement capability to any computer, from lap-top to mainframe.

The Helios Series, composed of Helios-I (2289A) and the more powerful Helios Plus (2287A) gives your computer the power to read:

- Voltage
- Strain
- Temperature
- Frequency
- Pressure
- Speed
- Flow
- and more

The **Helios Data Acquisition Hardware and Software Series** gives you an immediate, cost-effective way to meet your data acquisition goals. With a wide selection of I/O options and software packages, you can tailor your data acquisition system to fit your application.

Helios-I (2289A)

Helios-I is a data acquisition and control subsystem that combines measurement accuracy, excellent noise immunity, and exceptional configuration flexibility in a rugged package.

Helios Plus (2287A)

Helios Plus offers all the features of Helios-I as well as special features for autonomous scanning, data buffering and alarm checking. Measurement speed is faster too – up to 1000 channels per second.

Helios Software

A wide range of general purpose and application specific software gets your data acquisition system up and running in hours, not weeks. Created specifically for Helios, the Helios Logger package takes full advantage of all Helios' features. Or choose from such industry standards as Labtech Notebook™ from Laboratory Technologies, CIM-PAC™ from Action Instruments, Helios Toolbox and many others.

A Wide Range of Measurements

Choose your sensor type. Thermocouples, RTDs, strain gages, pressure, flow, contact closure, frequency, voltage, current, speed, or resistance. The modular architecture of Helios lets you configure your system with all the sensors you want without paying extra for the ones you don't want. It also provides user-defined tables for unusual sensors.

The conversion routines resident in Helios makes your system more cost-effective and efficient. Because you do not have to develop routines for the engineering units conversions, software development is reduced saving you both time and money. And with Helios to take care of those tasks, the host computer is free to do other tasks, improving the system's real-time performance.

These proprietary conversion algorithms, optimized for Helios hardware, are efficient and very accurate. It is difficult to match this performance with a host computer running similar routines.

Choose accuracy: You can add the -161 High Accuracy A/D option to Helios-I or Helios Plus, for extreme accuracy and high isolation in low-level measurements. This is especially important when making thermocouple measurements where high common-mode voltages are present.

Choose speed: With Helios Plus, the -165 Fast A/D option makes measurements at 1000 readings per second in burst mode and 70 readings per second continuous throughput. The overall accuracy of the -165 is unmatched by comparable instruments operating at these speeds.

With Helios Plus, you can combine the -165 with the -161 High Accuracy A/D, to give you precise measurements and fast measurements in a single instrument.

Choose your output type: Analog and binary outputs to control valves, motors, relays, annunciators, alarms and set-point controllers. Manipulate these outputs with simple assignment commands from the host computer to control your test or process.

PC Application Software

The flexibility of Fluke's versatile set of hardware offerings, combined with a selection of software packages, helps you precisely match system capabilities to your application requirements.

Labtech Notebook™ is a flexible data acquisition package for research applications. Its triggering and scanning functions, in combination with a comprehensive set of analysis tools, make it ideal when you require fewer channels and intensive mathematical reduction.

Helios Toolbox for BASIC Programmers, a set of software utilities, speeds software development in almost any application. Take advantage of these programming shortcuts when you need the top performance only custom software can deliver.

CIM-PAC™ is a highly capable monitoring and control package, well-suited to data acquisition in a manufacturing or engineering environment. Its real time animated graphics, networking, and powerful event processor make it easy to customize to large or small applications.

Helios Logger combines your PC with either Helios-I (2289A) or Helios Plus (2287A) to create a powerful data acquisition system. Because Helios Logger offers full access to 2287A functionality, such as high speed measurements, interval scanning, and limit checking, Helios Logger is the package of choice when the power of Helios Plus (2287A) is required.

Other general purpose data acquisition software packages as well as those for specialized applications are available for the Helios Series.

See page 212 for a full description of software information.

Enhance System Performance with Helios Plus (2287A)

For higher performance or remote data acquisition systems, consider the benefits of Helios Plus.

Acquire data rapidly using the Fast A/D Option (2287A-165). The 2287A-165 may be operated in a high throughput "continuous mode" or in a burst mode.

Higher continuous throughput. Each 2287A-165 normally provides readings to the host computer at continuous throughput of up to 70 readings per second.

Burst Mode gives you 1000 readings per second. With the external triggering capability several 2287A-165 A/D Converters will freeze their data buffers for multiple measurement snapshots. To get just the data you need you specify the amount of pre- and post-trigger data to be captured on each A/D. With the addition of a 2287A-265 Memory Expansion Option, each A/D can store up to 79,500 readings for later retrieval.

Automatic sensor scanning, data buffering and alarm detection make Helios Plus ideal for applications that require more local intelligence. With this added intelligence your host computer will have more time for operator interaction, data analysis, and report generation. Helios Plus can schedule its own measurement scans, buffer data, and check for alarms. Since memory is battery backed, you can be sure that Helios Plus will save your latest readings.

Remote/Mobile Data Acquisition Applications

The rugged design of Helios Plus combined with the intelligence to automatically take measurements, check for alarms, buffer data, then provide them on request, makes it ideally suited for remote-site data acquisition. Measurement data may be sent to the local printer port, providing data to on-site operators.

Optional dc powered Helios. The 2287A/AA and 2289A/AA are designed for mobile testing and remote data gathering at sites that lack line power. Both are powered from either a 12V dc or 24V dc supply (8-18 or 21-28V dc respectively) and have an extended operating range to +70°C.

Helios Series I/O Options

Helios Series mainframes and extender chassis use a "card cage" architecture that provides superior configurability because both channel count and channel type are easily adjusted to match your application needs. If a new I/O type is needed, just slide the appropriate option in the next open slot and secure with two captive screws. Configuration and control of these options is easy using any of the available software packages.

The "card cage" architecture provides six slots per mainframe or extender chassis for I/O options. When analog input options are included, one of the six slots must contain an A-to-D converter (2289A-161 or 2287A-165). The high accuracy A-to-D converter (2289A-161) controls one to five 20 channel "scanner" options for up to 100 channels per mainframe or extender chassis. Each fast A-to-D converter (2287A-165) handles inputs directly with a built-in 20 channel scanner. Digital input options each handle 20 channels for up to 120 channels per mainframe or extender chassis. Total system capacity is as high as 1500 channels when extender chassis are used.

Information regarding 228X I/O Options is on page 209 in this catalog.

Specifications

Mainframe Specifications

Mainframe Capacity: 6 option slots
2289A System Capacity: 1500 channels
2287A System Capacity: -161 A/D: 1000 channels; -165 A/D: 800 single-ended, 400 differential
Ambient Temperature: Operating, 0°C to 65°C; storage, -40°C to 70°C
Relative Humidity (without condensation): 0°C to 25°C: <95%; 25°C to 40°C: <75%; 40°C to 50°C: <45%
Altitude: Non-operating, 12 km (40,000 ft); operating, 3 km (10,000 ft)
Shock and Vibration: Meets MIL-T-28800C, Class 5, Style F Standard
Safety: Designed to comply with ANSI/ISA-582, CSA Bulletin 556B, IEC 348, IEC-1010, and UL 1244
Power: AC: 90V to 132V, 180V to 264V, 47 Hz to 440 Hz; DC: 12V or 24V (optional). 40 watts maximum (50 watts maximum dc power)
Weight: 8.5 kg (18.7 lb) without options
Size: 23.8 cm H x 43.9 cm W x 35.9 cm D (9.37 in H x 17.25 in W x 14.13 in D); H (without feet) = 22.2 cm (8.75 in)

2287A Scan Buffer (Non-Volatile)

Data Capacity (Readings)

Channels Per Scan	Readings
1	12,300
5	27,500
10	32,000
20	35,900

Interface Specifications

Type: Asynchronous, either RS-232C or RS-422
Connector: 25-pin male
RS-232C Signals (pin): Shield (1), transmitted data (2), received data (3), request to send (4), clear to send (5), data set ready (6), ground (7), received line signal detector (8), secondary received line signal detector (12), secondary request to send (19), data terminal ready (20), ring indicator (22)
Required RS-232C Signals: Pins 2, 3, 7, all other lines are passively asserted
Required RS-422 Signals: Transmit+, transmit-, received+, received-, common, shield
Baud Rate: 110, 300, 600, 1200, 2400, 4800, 9600, 19200, switch selectable
Data Format: 7 or 8 data bits, 1 or 2 stop bits, switch selectable
Parity: Odd, even or none, switch selectable
Multi-Drop Capability: Available via RS-422. Ten Helios mainframes can be addressed by a host through a single RS-422 port.

See page 209 for a description of all 228X I/O options.

Helios Series

Measurement Accuracy

Accuracy (±% input ±offset)

DC Volts					
A/D Option	**Range**	**Resolution[1]**	**90 Days (15°C to 35°C)**	**1 Year (15°C to 35°C)**	**1 Year (-20°C to 70°C)**
-161 A/D	±64 mV ±512 mV ±8V ±64V	0.5/0.6 µV 4.2/5.0 µV 61/73 µV 0.5/0.6 mV	±0.005% ±7 µV ±0.005% ±30 µV ±0.005% ±700 µV ±0.009% ±3 mV	±0.01% ±8 µV ±0.01% ±40 µV ±0.01% ±800 µV ±0.02% ±4 mV	±0.03% ±9 µV ±0.03% ±50 µV ±0.03% ±900 µV ±0.05% ±5 mV
-165 A/D Continuous Mode Differential Input	±64 mV ±512 mV ±8V ±10.5V	2 µV 16 µV 0.25 mV 0.32 mV	±0.02% ±25 µV ±0.02% ±100 µV ±0.02% ±1.2 mV ±0.02% ±1.7 mV	±0.03% ±25 µV ±0.03% ±100 µV ±0.03% ±1.2 mV ±0.03% ±1.7 mV	±0.06% ±60 µV ±0.06% ±140 µV ±0.06% ±1.5 mV ±0.06% ±2.0 mV
-165 A/D Burst Mode Differential Input	±64 mV ±512 mV ±8V ±10.5V	2 µV 16 µV 0.25 mV 0.32 mV	±0.02% ±35 µV ±0.02% ±150 µV ±0.02% ±1.7 mV ±0.02% ±2.2 mV	±0.03% ±35 µV ±0.03% ±150 µV ±0.03% ±1.7 mV ±0.03% ±2.2 mV	±0.06% ±70 µV ±0.06% ±190 µV ±0.06% ±2.0 mV ±0.06% ±2.5 mV
-165 A/D Continuous Mode Single-ended Input	±64 mV ±512 mV ±8V ±10.5V	2 µV 16 µV 0.25 mV 0.32 mV	±0.02% ±35 µV ±0.02% ±150 µV ±0.02% ±1.2 mV ±0.02% ±1.7 mV	±0.03% ±35 µV ±0.03% ±150 µV ±0.03% ±1.2 mV ±0.03% ±1.7 mV	±0.06% ±70 µV ±0.06% ±190 µV ±0.06% ±1.5 mV ±0.06% ±2.0 mV
-165 A/D Burst Mode Single-ended Input	±64 mV ±512 mV ±8V ±10.5V	2 µV 16 µV 0.25 mV 0.32 mV	±0.02% ±45 µV ±0.02% ±200 µV ±0.02% ±1.7 mV ±0.02% ±2.2 mV	±0.03% ±45 µV ±0.03% ±200 µV ±0.03% ±1.7 mV ±0.03% ±2.2 mV	±0.06% ±80 µV ±0.06% ±240 µV ±0.06% ±2.0 mV ±0.06% ±2.5 mV
DC Current					
-161 A/D -165 A/D[2]	±64 mA ±64 mA	0.5/0.6 µA 2 µA	±0.25% ±4 µA ±0.30% ±12 µA	±0.25% ±5 µA ±0.30% ±15 µA	±0.30% ±6 µA ±0.35% ±18 µA
AC Volts					
-161 A/D	5 to 250V ac[4]	0.1V	±1.0% ±0.1V	±1.0% ±0.1V	±1.5% ±0.2V
Resistance					
-161 A/D, -163, -177	256Ω 2048Ω 64 kΩ	2.0/2.4 mΩ 16/19 mΩ 500/600 mΩ	±0.0142% ±5.7 mΩ[3] ±0.0137% ±38 mΩ[3] ±0.055% ±1.2 mΩ[3]	±0.02% ±10 mΩ ±0.02% ±50 mΩ ±0.06% ±1.8 mΩ	±0.04% ±13 mΩ ±0.04% ±60 mΩ ±0.10% ±2.4 mΩ
-161 A/D, -162, -164 -174, -176	64Ω 512Ω	0.5/0.6 mΩ 4.2/5.0 mΩ	±0.02% ±7 mΩ ±0.02% ±30 mΩ	±0.03% ±8 mΩ ±0.03% ±40 mΩ	±0.06% ±10 mΩ ±0.06% ±60 mΩ
-165 A/D, -164, -174 -176 (continuous)	64Ω 512Ω	2 mΩ 16 mΩ	±0.035% ±25 mΩ ±0.035% ±100 mΩ	±0.05% ±30 mΩ ±0.05% ±100 mΩ	±0.10% ±60 mΩ ±0.10% ±140 mΩ

[1] *-161 A/D resolution for (50/60 Hz)*
[2] *Using 8Ω ±0.25% shunt mounted on screw terminals*
[3] *18°C to 28°C operating temperature*
[4] *45 Hz to 450 Hz*

Analog Output		Accuracy		
Current or Voltage Output	**Resolution**	**90 Days 15°C to 35°C**	**1 Year 15°C to 35°C**	**1 Year -20°C to +70°C**
Option -164 Transducer Excitation Module Current Excitation Voltage Excitation		 ±0.02% ±0.03%	 ±0.03% ±0.04%	 ±0.05% ±0.05%
Option -170 Analog Output % of Range	2.5 mV or 4 µA	±0.1%	±0.2%	±0.4%

Strain Measurement[1]

Type	Resolution	90 Days (20°C to 30°C)
-161 A/D[2]		
Full Bridge	0.25 µε	±0.05% ±2 µε
1/2 Bridge	0.5 µε	±0.05% ±13 µε
1/4 Bridge	0.5 µε	±0.05% ±25 µε
-165 A/D[3]		
Full Bridge	1.0 µε	±0.1% ±6 µε
1/2 Bridge	2.0 µε	±0.1% ±18 µε
1/4 Bridge	2.0 µε[4]	±0.1% ±30 µε

[1] *-161 and -165 cover full useful range of gage*
[2] *Use with options -162, -164, -174, -176*
[3] *Use with options -164, -174, -176*
[4] *With 4V excitation*

Thermocouples (±°C)

Type & Usable Range (°C)	Measured Temperature (°C)	90 Days 15°C to 35°C		1 Year 15°C to 35°C		1 Year -20°C to 70°C	
		-161 A/D	-165 A/D[2]	-161 A/D	-165 A/D[2]	-161 A/D	-165 A/D[2]
J NBS (-200 to 760)	-100 to -25 -25 to 760	0.45 0.35	1.11 0.95	0.5 0.4	1.16 1.0	0.8 0.7	2.46 2.04
J DIN (-200 to 900)	-100 to -25 -25 to 900	0.5 0.4	1.13 0.9	0.56 0.45	1.17 0.98	0.9 0.7	2.5 2.04
K NBS (-225 to 1350)	0 to 900 +900 to 1350	0.4 0.52	1.2 1.51	0.45 0.65	1.33 1.7	0.7 1.3	2.83 3.6
T NBS (-230 to 400)	-100 to 75 +75 to 150 +150 to 400	0.58 0.35 0.3	1.3 0.95 0.85	0.65 0.39 0.34	1.35 1.0 0.9	1.1 0.7 0.6	3.0 2.05 1.9
T DIN (-200 to 600)	0 to 200 +200 to 600	0.48 0.37	1.04 0.82	0.53 0.41	1.07 0.85	0.8 0.7	2.3 1.81
E NBS (-250 to 838)	-100 to -25 -25 to 750 +750 to 810	0.47 0.3 0.33	1.1 0.88 0.88	0.54 0.33 0.4	1.15 0.94 0.94	0.9 0.6 0.8	2.4 1.93 1.93
N[3] NBS (-200 to 400)	-100 to 150 +150 to 400	0.6 0.4	1.7 1.17	0.7 0.44	1.75 1.2	1.1 0.7	3.9 2.55
R NBS (0 to 1767)	+250 to 450 +450 to 1767	0.9 0.8	3.0 2.71	1.0 0.9	3.0 2.76	1.3 1.4	7.0 6.3
S NBS (0 to 1767)	+200 to 1767	0.97	3.26	1.1	3.3	1.6	7.7
B NBS (200 to 1820)	+600 to 800 +800 to 1820	1.4 0.96	4.3 3.4	1.6 1.1	4.3 3.42	1.9 1.3	10.3 8.12
C HOS (0 to 2315)	+200 to 1000 +1000 to 2000 +2000 to 2315	0.57 0.9 1.3	1.86 3.0 4.1	0.66 1.2 1.7	2.0 3.35 4.55	0.94 2.1 2.9	4.43 7.4 10.1

[1] *Resolution: 0.5°C on R, S, B, and C types; 0.1°C on J, K, L, and T types*
[2] *Continuous Mode only. For burst mode accuracy add 1.0°C to R, S, B, and C types; Add 3.0°C to J, K, E, T, and N types*
[3] *For 28 gauge thermocouple wire*

RTD Performance w/-161, -163, -177 Options

RTD Class	Measured Temperature	Resolution	Accuracy[4]	Repeatability
385 DIN, 392, user-defined 4-wire, high resolution	-200 to +150 +150 to +425	0.006°C 0.006°C	±0.09°C[5] ±0.13°C	±0.03°C ±0.04°C
385 DIN, 392, user-defined 4-wire, high temperature	-200 to +600°C	0.05°C	±0.25°C	±0.14°C
385 DIN, 392, user-defined 3-wire, accurate	-200 to +600°C	0.05°C	±0.007°C[6]	±0.001°C[6]
385 DIN, 392, user-defined 3-wire, isolated	-200 to +600°C	0.05°C	±1.97°C[7]	±1.97°C[7]
10Ω Cu, 4-wire	-75 to +150°C	0.06°C	±0.28°C	±0.16°C
10Ω Cu, 3-wire accurate	-75 to +150°C	0.1°C	±0.065°C[6]	±0.008°C[6]
10Ω Cu, 3-wire isolated	-75 to +150°C	0.1°C	±18.2°C[7]	±18.2°C[7]

RTD Performance w/-161, -162, -164, -174, -176 Options

RTD Class	Measured Temperature	Resolution	Accuracy[4]	Repeatability
385 DIN	-200 to 600°C	0.013°C	±0.2°C	±0.08°C
10Ω Cu	-75 to 150°C	0.1°C	±1.0°C	±0.2°C

RTD Performance w/-165, -164, -174, -176 Options

RTD Class	Measured Temperature	Resolution	Accuracy[4]	Repeatability
385 DIN, 392 & user-defined	-200 to 125°C 125°C to 600°C	0.04°C 0.04°C	±0.4°C ±0.54°C	±0.1°C ±0.1°C

[4] *Total instrument accuracy, 18°C to 28°C, 90 days, (±°C)*
[5] *±0.05°C ±(probe conformity), with ice-point initialization*
[6] *Add, per ohm lead resistance, to 4-wire specs*
[7] *Add to 3-wire accurate specs*

Helios Series

Ordering Information

Models

2287A Helios Plus Mainframe
2289A Helios-I Mainframe
2287A/AA (12V Power)
2289A/AA (12V Power)
2281A Extender Chassis
22810A Helios-I (inc -161, -162 & -175)
22811A Helios Plus (inc -165 & -175)

Included with Instrument

One-year product warranty, line cord, systems manual. 2281A operator manual and serial link cable. With 2281A-431 installed; instruction sheet and power cord.

Options

See page 209 for descriptions of 228X I/O options for the Helios Series.

Accessories (Also see Section 19)
Y1703 RS-232C Null Modem Cable, 4m
Y1705 RS-232C Null Modem Cable, 30 cm
Y1707 RS-232C Standard Cable, 2m
Y1708 RS-232C Standard Cable, 10m
Y2044 24" Rack Slide and 8" Rack Mount Kit
Y2045 8" Rack Mount Kit
Y2047 Serial Link 3-Way Adapter

Manuals
2281A Operator* (PN 655688)
2287A Service (PN 865324)
2287A System Vol 1 & 2 (PN 865295)
2287A System Vol 1 (PN 873799)
2287A System Vol 2 (PN 885186)
2289A System (PN 794768)
2289A Application Software (PN 819862)
2289A Service (PN 834382)
2289A-901 Toolbox (PN 819854)
**No charge with purchase of unit*

Customer Support Services

See Section 20.

Factory Warranty

One-year product warranty.

Helios Series I/O Option Selection Guide

Measurement	I/O Module	Connector	Channels	Max Channels Per Chassis
Thermocouples	-161 and -162	-175	20	100
Thermocouples	-165	-175	20	100
DC Voltages	-161 and -162	-175 or -176	20	100
DC Voltages	-165	-175 or -176	20 DE or 40 SE	120 DE PR 240 SE
DC Current	-161 and -162	-171	20	100
DC Current	-165	-176[1]	20	120
AC Voltages	-161 and -162	-160	10 AC and 10 DC	50 AC and 50 DC
RTDs	-161 and -163	-177	20	100
RTDs	-161 and -162 and -164	-176 and -174	20	40
RTDs	-165 and -164	-176 and -174	20	60
Resistance	-161 and -163	-177	20	100
Resistance	-165 and -164	-176 and -174	20	60
Resistance	-161 and -162 and -164	-176 and -174	20	40
Strain Gage	-161 and -162 and -164	-176 and -174	20	40
Strain Gage	-165 and -164	-176 and -174	20	60
Frequency/ Event Counting	-167	Included	6	30
Status Input	-168	-179	20	120
Binary Input	-168	-179	1	6
BCD Input	-168	-179	5	30
Status Output	-168	-169	20	120
Analog Output	-170	Included	4	24

[1] *Required: 8Ω shunt on each terminal pair, Fluke PN 641449.*

Note on configuration: Each 228X Mainframe chassis or extender chassis has capacity for up to 6 I/O modules. One A/D option is required in each chassis used to measure analog inputs. A connector option is required for every I/O module except the -161, -167, and -170. Up to 5 -162 scanners may reside in a single chassis with a -161. No scanners are used with the -165 A/D.

See page 209 for complete description of 228X I/O options.

228X I/O Options

The 228X Series of I/O options give you a wide range of choices, for a data acquisition system tailored to your needs. All options are designed to be interchangeable among the 2285B, 2286A, 2287A, 2289A mainframes and 2281A Extender Chassis. Precision engineering at both the module and the system level ensures a data acquisition system that is both accurate and reliable.

Each option is designed for easy installation, allowing quick setup and reconfiguration. Options slide easily into access slots in the mainframe and are secured with two captive screws. Removable connector modules make sensor installation and replacement hassle-free.

Menu-prompted configuration and control makes day-to-day use of your Fluke data acquisition system just as convenient. Using the instrument front-panel or software user-interface, each I/O option is easily configured and operated. Without handling complex switch banks or jumpers, your system becomes an adaptable tool for your data acquisition needs.

228X Series I/O Option Compatibility

Option	Description	2281A	2285B	2286A	2287A[13]	2289A[13]	22810A[13]	22811A[13]	Note
228XX-160	ACV & DCV Input Connector	•	•	•	•	•	•	•	1
228XX-161	A-to-D Converter Card	•	•	•	•	•	#	•	2
228XX-162	Thermocouple/DCV Scanner	•	•	•	•	•	#	•	3
228XX-163	RTD/Ohms Scanner/Excitation	•	•	•	•	•	•	•	4
228XX-164	RTD/Ohms/Strain Excitation	•	•	•	•	•	•	•	5
228XX-167	Counter/Totalizer	•	—	•	•	•	•	•	6
2280A-167/AA	Counter/Totalizer	•	•	•	—	—	—	—	7
228XX-168	Digital/Status Input/Output	•	•	•	•	•	•	•	8
228XX-169	Status Output Connector	•	•	•	•	•	•	•	9
228XX-170	Analog Output Card/Connector	•	—	•	•	•	•	•	6
228XX-171	Current Input Connector	•	•	•	•	•	•	•	1
228XX-174	Transducer Excitation Connector	•	•	•	•	•	•	•	10
228XX-175	Thermocouple/DCV Connector	•	•	•	•	•	#	#	1
228XX-176	DC Voltage Input Connector	•	•	•	•	•	•	•	1
228XX-177	RTD/Ohms Connector	•	•	•	•	•	•	•	11
228XX-179	Digital/Status Connector	•	•	•	•	•	•	•	12
2281A-402	Connecting Cable	14	—	—	—	—	—	—	—
2281A-403	Connector-Pair for -402	14	—	—	—	—	—	—	—
2281A-431	Power Supply for 2281A(s)	15	—	—	—	—	—	—	—
2287A-165	Fast A/D Converter	•	—	—	•	—	—	#	—
2287A-265	Fast A/D Memory Expansion	16	—	—	16	—	—	16	17

Notes: All options are customer-installable except where noted.

- *Compatible.*
- *# One included with mainframe.*
- *1 Scanner Option -162 required.*
- *2 One required if Option -162, -163, or -164 is in that mainframe.*
- *3 Connector Option -160, -171, -175, or -176 is required.*
- *4 Connector Option -177 is required.*
- *5 Connector Option -174 and Option -162 with -175 (or -176) also required.*
- *6 Includes connector.*
- *7 Connector Option -179 is required.*
- *8 Option -179 required for inputs. Option -169 required for outputs.*
- *9 Used with Option -168 only.*
- *10 Used with Option -164 only.*
- *11 Used with Option -163 only.*
- *12 Used with Option -168 or -167/AA only.*
- *13 RS-232C Interface is included with the 2287A, 2289A, 22810A and 22811A.*
- *14 A one-meter cable with connectors is included. Order only when longer cable is needed. Connectors come assembled on cable when both ordered.*
- *15 Only needed for very large systems or very remote 2281As.*
- *16 Only one -265 Option per -165 Option.*
- *17 Install on -165 Option*