SC-1608 Series
USB and Ethernet DAQ Devices with Isolated Analog and Digital Signal Conditioning

The SC-1608X-2AO-USB (above) is populated with eight SSR digital modules and 10 8B analog modules installed (modules are sold separately).

Overview
The SC-1608 Series provides an all-in-one solution to measure and condition analog signals (voltage, temperature, current, frequency, strain, and so on), as well as high voltage and relay digital signals.

The SC-1608 Series is available with three USB versions and one Ethernet version. Each version provides mounting connectors for eight 8B analog input modules, two 8B analog output modules (if AO is supported), and eight digital I/O modules. If a product does not support analog outputs, two additional voltage input modules can be installed.

Conditioned signals are brought out to screw terminals. Users can access all signals via the 50-pin header connector. Any non-conditioned input or output can be used as a non-isolated channel.

SC-1608X-2AO-USB, SC-1608X-USB, and SC-1608-USB
SC-1608 Series USB products provide eight conditioned analog inputs via the front screw terminal (10 if the product does not support analog outputs). Eight additional single-ended channels, eight DIO, counter inputs, trigger input, and external clocking are available via the 50-pin header.

SC-1608-2AO-ENET
The SC-1608-2AO-ENET provides eight conditioned analog inputs via the front screw terminal. Two analog outputs, eight DIO, a counter input, a trigger input, and external clocking are available via the 50-pin header. The communication port is 10/100 BASE-T.

8B Analog I/O Signal Conditioning Modules
8B analog I/O modules provide 500 V channel-to-channel isolated I/O signal conditioning. Users mix and match on a per-channel basis between supported voltage, TC, RTD, strain gage, current, and frequency modules.

Features
- USB and Ethernet DAQ devices with analog (8B) and digital (SSR) signal conditioning
- Directly measure voltage, strain, temperature, current, and frequency using 8B modules
- 500 V channel-to-channel isolated I/O signal conditioning
- Digital sense and switch up to 280 VAC using solid state relay (SSR) modules
- Sample rates up to 500 kS/s
- One or two 32-bit counters
- Up to two 16-bit analog outputs, isolated using 8B output modules
- Screw terminals plus 50-pin header connector
- External 12 volt power supply
- Rack mount enclosure available

Supported Operating Systems
- Windows 10/8/7/Vista® 32/64-bit
- Linux®
- Android™

The SC-1608 Series provides mounting locations for eight 8B input modules and two 8B output modules. With SC-1608 Series devices that do not support analog outputs, two additional voltage input modules can be installed. Positive, negative, and excitation signals are brought out to screw terminals for field wiring connections.

<table>
<thead>
<tr>
<th>SC-1608 Series Selection Chart</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Series Product</strong></td>
</tr>
<tr>
<td>-------------------</td>
</tr>
<tr>
<td>SC-1608-2AO-ENET</td>
</tr>
<tr>
<td>SC-1608X-2AO-USB</td>
</tr>
<tr>
<td>SC-1608X-USB</td>
</tr>
<tr>
<td>SC-1608-USB</td>
</tr>
</tbody>
</table>

* Alternatively, two voltage input modules can be installed in the analog output location for these products, for a total of 10 8B input locations.
SC-1608 Series

Features

Cold Junction Compensation (CJC)
Users can enable CJC functionality with onboard jumpers for each 8B thermocouple input module installed.

Current Shunt Resistors
Sockets are available for users to install plug-in shunt resistors to monitor a 4-20 mA current loop or to measure current using 8B analog voltage input modules.

SSR Digital I/O Control Modules
SSR digital I/O modules are isolated relay control modules. The SC-1608 Series provides mounting locations for eight DIO modules. Users set the input/output type of each module with a DIP switch. Positive and negative relay contacts are brought out to screw terminals for field wiring connections.

Digital Output Logic Control
The control logic polarity for each digital output module is configurable with an onboard jumper for inverted logic (active high, default) or non-inverted logic (active low). This jumper setting has no effect on digital input modules.

Signal Connections
The eight analog inputs, two analog outputs, and eight digital I/O that interface with the 8B analog I/O modules and digital I/O modules are brought out to screw terminals and to a 50-pin header connector for field wiring connections.

Non-Isolated Channels
Any unconditioned input or output can be accessed on the header connector as a non-isolated channel.

External Power Supply
External power is required. An external 12 VDC supply ships with each SC-1608 Series product; users can alternately connect their own supply to an onboard screw terminal.

Mounting Options
The SC-1608 Series can be used on a bench or installed in a rack mount enclosure (MCC p/n ENC-19X5X5).
## SC-1608 Series

### Software Support
SC-1608 Series devices are supported by the software in the table below.

<table>
<thead>
<tr>
<th>Ready-to-Run Applications</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>DAQami™</td>
<td>Data acquisition companion software with drag-and-drop interface that is used to acquire, view, and log data, and generate signals. DAQami can be configured to log analog, digital, and counter channels, and to view that data in real-time or post-acquisition on user-configurable displays. Logged data can be exported for use in Excel® or MATLAB®. Windows OS DAQami is included with the free MCC DAQ Software bundle. Install DAQami and try the fully-functional software for 30 days. After 30 days, all features except for data logging and data export will continue to be available – data logging and data export features can be unlocked by purchasing the software.</td>
</tr>
<tr>
<td>InstaCal™</td>
<td>An interactive installation, configuration, and test utility for MCC hardware. Windows OS InstaCal is included with the free MCC DAQ Software bundle.</td>
</tr>
<tr>
<td>TracerDAQ™ and TracerDAQ Pro</td>
<td>Virtual strip chart, oscilloscope, function generator, and rate generator applications used to generate, acquire, analyze, display, and export data. Supported features may vary by hardware. The Pro version provides enhanced features. Windows OS TracerDAQ is included with the free MCC DAQ Software bundle. TracerDAQ Pro is available as a purchased software download.</td>
</tr>
</tbody>
</table>

### General-Purpose Programming Support

| UL for Linux®                  | Library for developing applications in C, C++, and Python on Linux. UL for Linux is available on GitHub (https://github.com/mccdaq/uldaq). Open-source, third-party Linux drivers are also available for supported MCC devices. |
| UL for Android™                | Library of Java classes for programmers who develop apps for Android-based mobile devices. UL for Android communicates with select MCC DAQ devices. Supports Android project development on Windows, Linux, Mac OS X. UL for Android is included with the free MCC DAQ Software bundle. |

### Application-Specific Programming Support

| ULx for NI LabVIEW™          | A comprehensive library of VIs and example programs for NI LabVIEW that is used to develop custom applications that interact with most MCC devices. Windows OS ULx for NI LabVIEW is included with the free MCC DAQ Software bundle (CD/download). |
| DASYLab®                     | Icon-based data acquisition, graphics, control, and analysis software that allows users to create complex applications in minimal time without text-based programming. Windows OS DASYLab is available as a purchased software download. An evaluation version is available for 28 days. |
| MATLAB® driver (SC-1608 Series USB products only) | High-level language and interactive environment for numerical computation, visualization, and programming. The Mathworks Data Acquisition Toolbox™ allows users to acquire data from most MCC PCI and USB devices. Visit www.MathWorks.com for more information about the Data Acquisition Toolbox. |
The SC-1608X-USB and SC-1608-USB provide the same functionality as the SC-1608X-2AO-USB diagram above without the analog output capability.
### Specifications

#### 8B Analog I/O Signal Conditioning Modules

**Voltage Input Modules (3 Hz Bandwidth)**

<table>
<thead>
<tr>
<th>MCC part number</th>
<th>Input range</th>
<th>Output range</th>
</tr>
</thead>
<tbody>
<tr>
<td>SC-88B30-01</td>
<td>±10 mV</td>
<td>±5 V</td>
</tr>
<tr>
<td>SC-88B30-02</td>
<td>±50 mV</td>
<td>±5 V</td>
</tr>
<tr>
<td>SC-88B30-03</td>
<td>±100 mV</td>
<td>±5 V</td>
</tr>
<tr>
<td>SC-88B31-01</td>
<td>±1 V</td>
<td>±5 V</td>
</tr>
<tr>
<td>SC-88B31-02</td>
<td>±5 V</td>
<td>±5 V</td>
</tr>
<tr>
<td>SC-88B31-03</td>
<td>±10 V</td>
<td>±5 V</td>
</tr>
<tr>
<td>SC-88B31-07</td>
<td>±20 V</td>
<td>±5 V</td>
</tr>
<tr>
<td>SC-88B31-09</td>
<td>±40 V</td>
<td>±5 V</td>
</tr>
<tr>
<td>SC-88B31-12</td>
<td>±60 V</td>
<td>±5 V</td>
</tr>
</tbody>
</table>

**Current Input Modules (3 Hz Bandwidth)**

<table>
<thead>
<tr>
<th>MCC part number</th>
<th>Input range</th>
<th>Output range</th>
</tr>
</thead>
<tbody>
<tr>
<td>SC-88B32-01</td>
<td>4 mA to 20 mA</td>
<td>0 V to 5 V</td>
</tr>
<tr>
<td>SC-88B32-02</td>
<td>0 mA to 20 mA</td>
<td>0 V to 5 V</td>
</tr>
</tbody>
</table>

**Isolated True RMS Input Modules (10 kHz Bandwidth)**

<table>
<thead>
<tr>
<th>MCC part number</th>
<th>Input range</th>
<th>Output range</th>
</tr>
</thead>
<tbody>
<tr>
<td>SC-88B33-04</td>
<td>0 V to 150 V</td>
<td>0 V to 5 V</td>
</tr>
<tr>
<td>SC-88B33-05</td>
<td>0 V to 300 V</td>
<td>0 V to 5 V</td>
</tr>
<tr>
<td>SC-88B33-06</td>
<td>0 A to 1 A</td>
<td>0 V to 5 V</td>
</tr>
</tbody>
</table>

**Linearized 2- or 3-Wire RTD Modules (3 Hz Bandwidth)**

<table>
<thead>
<tr>
<th>MCC part number</th>
<th>Input range</th>
<th>Output range</th>
</tr>
</thead>
<tbody>
<tr>
<td>SC-88B34-01</td>
<td>±100 °C</td>
<td>0 V to 5 V</td>
</tr>
<tr>
<td>SC-88B34-02</td>
<td>0 °C to 100 °C</td>
<td>0 V to 5 V</td>
</tr>
<tr>
<td>SC-88B34-03</td>
<td>0 °C to 200 °C</td>
<td>0 V to 5 V</td>
</tr>
<tr>
<td>SC-88B34-04</td>
<td>0 °C to 600 °C</td>
<td>0 V to 5 V</td>
</tr>
</tbody>
</table>

**Linearized 4-Wire RTD Modules (3 Hz Bandwidth)**

<table>
<thead>
<tr>
<th>MCC part number</th>
<th>Input range</th>
<th>Output range</th>
</tr>
</thead>
<tbody>
<tr>
<td>SC-88B35-01</td>
<td>±100 °C</td>
<td>0 V to 5 V</td>
</tr>
<tr>
<td>SC-88B35-02</td>
<td>0 °C to 100 °C</td>
<td>0 V to 5 V</td>
</tr>
<tr>
<td>SC-88B35-03</td>
<td>0 °C to 200 °C</td>
<td>0 V to 5 V</td>
</tr>
<tr>
<td>SC-88B35-04</td>
<td>0 °C to 600 °C</td>
<td>0 V to 5 V</td>
</tr>
</tbody>
</table>

**Strain Gage Input Modules**

<table>
<thead>
<tr>
<th>MCC part number</th>
<th>Input range</th>
<th>Excitation voltage</th>
<th>Sensitivity</th>
<th>Output range</th>
<th>Bandwidth</th>
</tr>
</thead>
<tbody>
<tr>
<td>SC-88B38-01</td>
<td>±10 mV</td>
<td>3.333 V</td>
<td>3 mV/V</td>
<td>±5 V</td>
<td>8 kHz</td>
</tr>
<tr>
<td>SC-88B38-02</td>
<td>±30 mV</td>
<td>10.0 V</td>
<td>3 mV/V</td>
<td>±5 V</td>
<td>8 kHz</td>
</tr>
<tr>
<td>SC-88B38-03</td>
<td>±50 mV</td>
<td>20.0 V</td>
<td>2 mV/V</td>
<td>±5 V</td>
<td>8 kHz</td>
</tr>
<tr>
<td>SC-88B38-31</td>
<td>±10 mV</td>
<td>3.333 V</td>
<td>3 mV/V</td>
<td>±5 V</td>
<td>3 Hz</td>
</tr>
<tr>
<td>SC-88B38-32</td>
<td>±30 mV</td>
<td>10.0 V</td>
<td>3 mV/V</td>
<td>±5 V</td>
<td>3 Hz</td>
</tr>
<tr>
<td>SC-88B38-35</td>
<td>±20 mV</td>
<td>10.0 V</td>
<td>2 mV/V</td>
<td>±5 V</td>
<td>3 Hz</td>
</tr>
</tbody>
</table>

**Current Output Modules (100 Hz Bandwidth)**

<table>
<thead>
<tr>
<th>MCC part number</th>
<th>Input range</th>
<th>Output range</th>
</tr>
</thead>
<tbody>
<tr>
<td>SC-88B39-02</td>
<td>±5 V</td>
<td>4 mA to 20 mA</td>
</tr>
<tr>
<td>SC-88B39-04</td>
<td>±5 V</td>
<td>0 mA to 20 mA</td>
</tr>
<tr>
<td>SC-88B39-07</td>
<td>±5 V</td>
<td>±20 mA</td>
</tr>
</tbody>
</table>

**SSR Digital I/O Modules**

### Digital Input Sensing Modules

<table>
<thead>
<tr>
<th>MCC part number</th>
<th>Input type</th>
<th>Isolation voltage</th>
<th>Input voltage range</th>
<th>Input current @ max line</th>
<th>Turn-on time</th>
<th>Turn-off time</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSR-IAC-05</td>
<td>AC</td>
<td>4000 Vrms</td>
<td>90-140 Vac/Dc</td>
<td>8 mA</td>
<td>20 ms</td>
<td>20 ms</td>
</tr>
<tr>
<td>SSR-IAC-05A</td>
<td>High voltage AC</td>
<td>4000 Vrms</td>
<td>180-280 Vac/Dc</td>
<td>6 mA</td>
<td>20 ms</td>
<td>20 ms</td>
</tr>
<tr>
<td>SSR-IDC-05</td>
<td>DC</td>
<td>4000 Vrms</td>
<td>3-32 VDC</td>
<td>18 mA</td>
<td>0.20 ms</td>
<td>0.40 ms</td>
</tr>
<tr>
<td>SSR-IDC-05NP</td>
<td>Non-polarized, AC or DC</td>
<td>4000 Vrms</td>
<td>10-32 VAC, 10-32 VDC</td>
<td>18 mA</td>
<td>5 ms</td>
<td>5 ms</td>
</tr>
</tbody>
</table>

### Digital Output Switching Modules

<table>
<thead>
<tr>
<th>MCC part number</th>
<th>Output type*</th>
<th>Isolation voltage</th>
<th>Load voltage range</th>
<th>Load current range</th>
<th>Turn-on time</th>
<th>Turn-off time</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSR-OAC-05</td>
<td>AC</td>
<td>4000 Vrms</td>
<td>24-280 Vac</td>
<td>0.03-3.5 A</td>
<td>8.33 ms</td>
<td>8.33 ms</td>
</tr>
<tr>
<td>SSR-OAC-05A</td>
<td>AC</td>
<td>4000 Vrms</td>
<td>3-60 VDC</td>
<td>0.32-3.5 A</td>
<td>10 μs</td>
<td>50 μs</td>
</tr>
<tr>
<td>SSR-OAC-05A</td>
<td>DC</td>
<td>4000 Vrms</td>
<td>4-200 VDC</td>
<td>0.02-3.5 A</td>
<td>75 μs</td>
<td>750 μs</td>
</tr>
</tbody>
</table>

* SPST, normally open
SC-1608 Series

Specifications

The specifications on this page are common to all SC-1608 Series products.

8B Analog Input Module Control
8B module CJC sensor: Vishay-Dale TFP1206L1002DM
8B input module locations CH0 to CH7 include a CJC sensor and three-pin header with jumper control (J21-J28).

CJC jumper configuration:
Position 1-2: CJC enabled
Position 2-3: CJC disabled

8B Analog Output Module Control
8B module analog output jumper configuration (J29 and J31):
J29 position 1-2: No function (default)
J29 position 2-3: Connects DAQ AOUT0 to DAQ analog input CH9 (J35 pin 13), or converts 8B I/O location CH8 to an 8B input module location.

J31 position 1-2: No function (default)
J31 position 2-3: Connects DAQ AOUT1 to DAQ analog input CH9 (J35 pin 14), or converts 8B I/O location CH9 to an 8B input module location.

J29 and J31 can be configured to read the analog output control voltage at 8B I/O locations CH8 (pin 6) and CH9 (pin 6) using analog input CH8 and CH9 when using the SC-1608X-2AO-USB. When using the SC-1608-2AO-ENET, the AOUTx voltage can be read at J35 (pins 25 and pins 27) using a voltmeter or other DAQ board.

When using a DAQ board that does not have analog output capability, such as the SC-1608X-USB and SC-1608-USB, configuring J29 and J31 for position 2-3 converts 8B I/O module locations CH8 and CH9 to an 8B input module location (for a total of 10 8B input locations). Voltage input modules installed in CH8 and CH9 must be 2-wire types that don’t require excitation terminals.

8B I/O module voltage divider jumper configuration (J30 and J32):
2x4.99 kΩ resistor, 0.1% tolerance, 25 ppm
J30 position 1-2: DAQ AOUT0 outputs ±10 V output range (default)
J30 position 2-3: DAQ AOUT0 outputs ±5 V output range
J32 position 1-2: DAQ AOUT1 outputs ±10 V output range (default)
J32 position 2-3: DAQ AOUT1 outputs ±5 V output range

8B module analog output jumper configuration (J29 and J31):
J29 position 1-2: No function (default)
J29 position 2-3: Connects DAQ AOUT0 to DAQ analog input CH9 (J35 pin 13), or converts 8B I/O location CH8 to an 8B input module location.

J31 position 1-2: No function (default)
J31 position 2-3: Connects DAQ AOUT1 to DAQ analog input CH9 (J35 pin 14), or converts 8B I/O location CH9 to an 8B input module location.

J29 and J31 can be configured to read the analog output control voltage at 8B I/O locations CH8 (pin 6) and CH9 (pin 6) using analog input CH8 and CH9 when using the SC-1608X-2AO-USB. When using the SC-1608-2AO-ENET, the AOUTx voltage can be read at J35 (pins 25 and pins 27) using a voltmeter or other DAQ board.

When using a DAQ board that does not have analog output capability, such as the SC-1608X-USB and SC-1608-USB, configuring J29 and J31 for position 2-3 converts 8B I/O module locations CH8 and CH9 to an 8B input module location (for a total of 10 8B input locations). Voltage input modules installed in CH8 and CH9 must be 2-wire types that don’t require excitation terminals.

8B I/O module voltage divider jumper configuration (J30 and J32):
2x4.99 kΩ resistor, 0.1% tolerance, 25 ppm
J30 position 1-2: DAQ AOUT0 outputs ±10 V output range (default)
J30 position 2-3: DAQ AOUT0 outputs ±5 V output range
J32 position 1-2: DAQ AOUT1 outputs ±10 V output range (default)
J32 position 2-3: DAQ AOUT1 outputs ±5 V output range

SSR Digital I/O Module Control
Number of I/O logic control: 8
SSR default configuration: OUTPUT type; SW2 default
Configuration: Each module location (SSR0-SSR7) is individually configurable as INPUT or OUTPUT using SW2 DIP switch positions.

Logic inversion control: Configurable for inverting or non-inverting logic with jumper W1; set by default to INVERT. Inverting logic is applied to SSR digital output modules only. The W1 setting has no effect on digital input modules.

LED: Each module location (SSR0-SSR7) has a dedicated LED for indicating the module status.
Input modules: Set SW2 DIP switch to INPUT for use with digital input modules such as Grayhill 700DCS. Use your software application to configure the SC-1608 Series USB or Ethernet board for digital input mode.
Output modules: Set the SW2 DIP switch to OUTPUT for use with digital output modules such as Grayhill 700DCS. Use your software application to configure the SC-1608 Series USB or Ethernet board for digital output mode.

Digital I/O
These digital specifications are specific to the SCC-8-8-2 board.
Digital type: 5V TTL
Number of I/O: 8

Configuration: Bidirectional: each bit individually configurable as digital input or output using SW2 DIP switch positions. Avoid creating a digital I/O logic contention state between the digital bits on the data acquisition board and the digital bits on the SC-1608 Series baseboard.

Connector location: J35
Input high voltage threshold: 2.0 V min
Input high voltage limit: 5.5 V absolute max
Input low voltage threshold: 0.8 V max
Input low voltage limit: -0.5 V absolute min, 0 V recommended min

Output high voltage: 4.4 V min (IOH = ~50 µA), 3.76 V min, (IOH = ~24 mA)
Output low voltage: 0.1 V max (IOL = 50 µA), 0.44 V max (IOL = 24 mA)

Power
External power input connectors:
J1: barrel type.
J2: 2-pole terminal block, (16 AWG to 30 AWG)
The baseboard can be powered from either of the external power connectors J1 or J2. Do not attempt to apply power to both external power connectors simultaneously.

External power input voltage range: +10 V to +14 V
This specification applies to the actual voltage level present at the input to the external power connector (J1 or J2), as any significant loading of the external supply will cause a voltage drop across the power supply cable.

External power supply current: 25 mA typical; this is the total quiescent current requirement for the device, and does not include any potential 8B/SSR module loading or loading of the DIO bits, or +VO terminal.

1700 mA max, including all external loading.

Power on default state: Digital output, +5 V logic level

Mechanical
Dimensions (L x W x H):
With 8B analog modules installed:
101.6 x 426.72 x 48.50 mm (4.0 x 16.8 x 1.91 in), including standoffs
With SSR digital modules installed:
101.6 x 426.72 x 42.16 mm (4.0 x 16.8 x 1.66 in), including standoffs

Standoff height is 0.38 inches. The height of the header connector is the same as the SC-1608 Series product.

Environmental
Operating temperature range: 0 °C to 55 °C max
Storage temperature range: −40 °C to 85 °C max
Humidity: 0% to 90% non-condensing max

Measurement Computing
(508) 946-5100
mccdaq.com
info@mccdaq.com
SC-1608 Series
Specifications

SC-1608X-2AO-USB, SC-1608X-USB, SC-1608-USB

The analog and digital specifications apply to non-isolated channels.

Analog Input
A/D converter type: Successive approximation
ADC resolution: 16 bits
Number of channels: 8 DIFF, 16 SE; software-selectable
Input voltage range: ±10 V, ±5 V, ±2 V, ±1 V; software-selectable per channel
Absolute maximum input voltage
CHx relative to AGND: ±25 V max (power on); ±15 V max (power off)
Input impedance: 1 GΩ (power on); 820 Ω (power off)
Input bias current: ±10 nA
Input bandwidth
All input ranges, small signal (~3 dB)
SC-1608-USB: 750 kHz
SC-1608X-2AO-USB, SC-1608X-USB: 870 kHz
Input capacitance: 60 pf
Maximum working voltage (signal + common mode)
±10 V range: ±10.2 V max relative to AGND
±5 V range: ±10.2 V max relative to AGND
±2 V range: ±9.5 V max relative to AGND
±1 V range: ±9.0 V max relative to AGND

<table>
<thead>
<tr>
<th>Range</th>
<th>Gain Error (% of Reading)</th>
<th>Offset Error (µV)</th>
<th>INL Error (% of Range)</th>
<th>Absolute Accuracy at Full Scale (µV)</th>
<th>Gain Temperature Coefficient (% reading/°C)</th>
<th>Offset Temperature Coefficient (µV/°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>±10 V</td>
<td>0.024</td>
<td>915</td>
<td>0.0076</td>
<td>4075</td>
<td>0.0014</td>
<td>47</td>
</tr>
<tr>
<td>±5 V</td>
<td>0.024</td>
<td>686</td>
<td>0.0076</td>
<td>2266</td>
<td>0.0014</td>
<td>24</td>
</tr>
<tr>
<td>±2 V</td>
<td>0.024</td>
<td>336</td>
<td>0.0076</td>
<td>968</td>
<td>0.0014</td>
<td>10</td>
</tr>
<tr>
<td>±1 V</td>
<td>0.024</td>
<td>245</td>
<td>0.0076</td>
<td>561</td>
<td>0.0014</td>
<td>5</td>
</tr>
</tbody>
</table>

Noise Performance*

<table>
<thead>
<tr>
<th>Range</th>
<th>Counts</th>
<th>LSBrms</th>
</tr>
</thead>
<tbody>
<tr>
<td>±10 V</td>
<td>6</td>
<td>0.91</td>
</tr>
<tr>
<td>±5 V</td>
<td>6</td>
<td>0.91</td>
</tr>
<tr>
<td>±2 V</td>
<td>7</td>
<td>1.06</td>
</tr>
<tr>
<td>±1 V</td>
<td>9</td>
<td>1.36</td>
</tr>
</tbody>
</table>

* For the peak-to-peak noise distribution test, a differential input channel is connected to AGND at the input terminal block, and 32,000 samples are acquired at the maximum rate available at each setting.

Setting Time**

SC-1608-USB

<table>
<thead>
<tr>
<th>Range</th>
<th>4 µs settling accuracy (% FSR)</th>
<th>6 µs settling accuracy (% FSR)</th>
<th>10 µs settling accuracy (% FSR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>±10 V</td>
<td>0.0061</td>
<td>0.0031</td>
<td>0.0015</td>
</tr>
<tr>
<td>±5 V</td>
<td>0.0061</td>
<td>0.0031</td>
<td>0.0015</td>
</tr>
<tr>
<td>±2 V</td>
<td>0.0061</td>
<td>0.0031</td>
<td>0.0015</td>
</tr>
<tr>
<td>±1 V</td>
<td>0.0061</td>
<td>0.0031</td>
<td>0.0015</td>
</tr>
</tbody>
</table>

SC-1608X-2AO-USB, SC-1608X-USB

<table>
<thead>
<tr>
<th>Range</th>
<th>2 µs settling accuracy (% FSR)</th>
<th>4 µs settling accuracy (% FSR)</th>
<th>9 µs settling accuracy (% FSR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>±10 V</td>
<td>0.1251</td>
<td>0.0031</td>
<td>0.0015</td>
</tr>
<tr>
<td>±5 V</td>
<td>0.0687</td>
<td>0.0031</td>
<td>0.0015</td>
</tr>
<tr>
<td>±2 V</td>
<td>0.0687</td>
<td>0.0031</td>
<td>0.0015</td>
</tr>
<tr>
<td>±1 V</td>
<td>0.0687</td>
<td>0.0031</td>
<td>0.0015</td>
</tr>
</tbody>
</table>

Common mode rejection ratio: fcm = 60 Hz, all input ranges: 86 dB
Crosstalk
- Adjacent differential mode channels, DC to 100 kHz: –75 dB
Input coupling: DC
Sample rate (software-selectable)
SC-1608-USB: 0.0149 Hz to 250 kHz
SC-1608X-2AO-USB, SC-1608X-USB: 0.0149 Hz to 500 kHz
Trigger source: TRIG pin
Sample Clock Source: Internal A/D clock or external A/D clock (AICKI terminal)
 Burst mode: Software-selectable using the internal A/D clock; always enabled when using the external clock (AICKI terminal):
SC-1608-USB: 4 µs
SC-1608X-2AO-USB, SC-1608X-USB: 2 µs
Throughput
Software paced: 33 to 4000 S/s typ, system dependent
Hardware paced
SC-1608-USB: 250 kS/s max
SC-1608X-2AO-USB, SC-1608X-USB: 500 kS/s max
Channel gain queue: Up to 16 elements; software-selectable range for each channel
Warm-up time: 15 minutes min
### SC-1608 Series Specifications

#### Calibrated Absolute Accuracy
- **Range:** ±10 V
- **Absolute accuracy (± LSB):** 16.0

#### Calibrated Absolute Accuracy Components
- **Range:** ±10 V
- **% of reading:** ±0.0183
- **Offset (±mV):** 1.831
- **Offset Tempco (µV/°C):** 12.7
- **Gain Tempco (ppm of range/°C):** 13

#### Analog Output Relative Accuracy
- **Range:** ±10 V
- **Relative accuracy (INL):** 4.0 typ

#### Analog Input/Output Calibration
- **Recommended Warm-up Time:** 15 minutes min
- **Calibration method:** Self-calibration (firmware)
- **Calibration interval:** 1 year (factory calibration)
- **AI calibration reference**:
  - +5 V, ±2.5 mV max (actual measured values stored in EEPROM)
  - Tempco: 5 ppm/°C max
  - Long term stability: 15 ppm/1000 hours
- **AOUTx calibration procedure (SC-1608X-2AO-USB only)**:
  - The AOUTx terminals are internally routed to the analog input circuit. For best calibration results, disconnect any AOUTx connections at the terminal block prior to performing AOUT calibration.

#### Digital I/O
- **Digital type:** CMOS
- **Number of I/O:** 8
- **Configuration:** Bit-configurable as input (power on default) or output
- **Pull-up configuration:** The port has 47 kΩ resistors configurable as pull-ups or pull-downs (default) via internal jumper (W1).
- **Digital I/O transfer rate (system-paced):** 33 to 8000 port reads/writes or single bit reads/writes per second typ, system dependent
- **Input high voltage:** 2.0 V min, 5.5 V absolute max
- **Input low voltage:** 0.8 V max, –0.5 V absolute min, 0 V recommended min
- **Output high voltage:** 4.4 V min (IOH = –50 µA), 3.76 V min (IOH = –2.5 mA)
- **Output low voltage:** 0.1 V max (IOL = 50 µA), 0.44 V max (IOL = 2.5 mA)
- **Output current:** ±2.5 mA max

#### External Trigger
- **Trigger source:** TRIG input
- **Trigger mode:** Software configurable for edge or level sensitive, rising or falling edge, high or low level. Power on default is edge sensitive, rising edge.
- **Trigger latency:** 1 µs + 1 clock cycle max
- **Trigger pulse width:** 100 ns min
- **Input type:** Schmitt trigger, 33 Ω series resistor and 47 kΩ pull-down to ground
- **Schmitt trigger hysteresis:** 0.4 V to 1.2 V
- **Input high voltage:** 2.2 V min, 5.5 V absolute max
- **Input low voltage:** 1.5 V max, –0.5 V absolute min, 0 V recommended min

#### External Clock I/O
- **SC-1608X-USB, SC-1608-USB:** AICKI, AICKO
- **SC-1608X-2AO-USB:** AICKI, AICKO AOCKI, AOCKO
- **Terminal types**:
  - AxCKI: Input, active on rising edge
  - AxCKO: Output, power on default is 0 V, active on rising edge
- **Terminal descriptions**:
  - AxCKI: Receives sampling clock from external source
  - AxCKO: Outputs the internal sampling clock (D/A or A/D clock) or the pulse generated from AxCKI when in external clock mode.
- **Input clock rate**:
  - SC-1608-USB: 250 kHz max
  - SC-1608X-2AO-USB, SC-1608X-USB: 500 kHz max
- **Clock pulse width**:
  - AxCKI: 400 ns min
  - AxCKO: 400 ns min
- **Input type:** Schmitt trigger, 33 Ω series resistor, 47 kΩ pull-down to ground
- **Schmitt trigger hysteresis:** 0.4 V to 1.2 V
- **Input high voltage:** 2.2 V min, 5.5 V absolute max
- **Input low voltage:** 1.5 V max, –0.5 V absolute min, 0 V recommended min
- **Output high voltage:** 4.4 V min (IOH = –50 µA), 3.76 V min (IOH = –2.5 mA)
- **Output low voltage:** 0.1 V max (IOL = 50 µA), 0.44 V max (IOL = 2.5 mA)
- **Output current:** ±2.5 mA max

#### Counter Input
- **Terminal names:** CTR0, CTR1
- **Number of channels:** 2 channels
- **Resolution:** 32-bit
- **Counter type:** Event counter
- **Input type:** Schmitt trigger, 33 Ω series resistor, 47 kΩ pull-down to ground
- **Input source**:
  - CTR0 (terminal S2)
  - CTR1 (terminal S1)
- **Counter read/writes rates (software-paced):** 33 to 8000 reads/writes per second typ, system dependent
- **Input high voltage:** 2.2 V min, 5.5 V max
- **Input low voltage:** 1.5 V max, –0.5 V min
- **Schmitt trigger hysteresis:** 0.4 V min, 1.2 V max
- **Input frequency:** 20 MHz, max
- **High pulse width:** 25 ns, min
- **Low pulse width:** 25 ns, min

#### Timer Output
- **Timer terminal name:** TMR
- **Timer type:** PWM output with count, period, delay, and pulse width registers
- **Input value:** Default state is idle low with pulses high, software-selectable output invert
- **Internal clock frequency:** 64 MHz
- **Register widths:** 32-bit
- **High pulse width:** 15.625 ns min
- **Low pulse width:** 15.625 ns min
- **Output high voltage:** 4.4 V min (IOH = –50 µA), 3.76 V min (IOH = –2.5 mA)
- **Output low voltage:** 0.1 V max (IOL = 50 µA), 0.44 V max (IOL = 2.5 mA)
- **Output current:** ±2.5 mA max

#### Memory
- **Data FIFO:**
  - SC-1608X-USB, SC-1608-USB: 4 kS analog input
  - SC-1608X-2AO-USB: 4 kS analog input, 2 kS analog output
- **Non-volatile memory:** 32 KB (28 KB firmware storage, 4 KB calibration/user data)

#### Power
- **Supply current**:
  - This is the total quiescent current requirement and includes up to 10 mA for the Status LED; this does not include any potential loading of the digital I/O bits, ±5 V terminal, or SC-1608X-2AO-USB analog outputs.
- **Quiescent Current**:
  - SC-1608X-USB, SC-1608-USB: 230 mA
  - SC-1608X-2AO-USB: 260 mA
  - 5 V user output voltage range: 4.5 V min to 5.25 V max
  - 5 V user output current: 10 mA max
SC-1608 Series
Specifications

SC-1608-2AO-ENET

The analog and digital specifications apply to non-isolated channels.

Analog Input
A/D converter type: Successive approximation
ADC resolution: 16 bits
Number of channels: 4 differential, 8 single-ended (software-selectable)
Input voltage range: ±10 V, ±5 V, ±2 V, ±1 V (software-selectable per channel)
Absolute max input voltage (CHx relative to AGND): ±20 V max (power on), ±12 V max (power off)
Input impedance: 1 GΩ (power on), 1200 Ω (power off)
Input bias current: ±10 nA
Input bandwidth (all input ranges, small signal (–3 dB)): 700 kHz
Input capacitance: 60 pf
Max working voltage (signal + common mode)
±10 V range: ±10.2 V max relative to AGND
±5 V range: ±10.2 V max relative to AGND
±2 V range: ±9.5 V max relative to AGND
±1 V range: ±9.0 V max relative to AGND

Accuracy

Analog Input DC Voltage Measurement Accuracy (All Values are ±)

<table>
<thead>
<tr>
<th>Range</th>
<th>Gain Error (% of Reading)</th>
<th>Offset Error</th>
<th>INL Error (% of Range)</th>
<th>Absolute Accuracy at Full Scale</th>
<th>Gain Temperature Coefficient (% of Range)</th>
<th>Offset Temperature Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>±10 V</td>
<td>0.024</td>
<td>915 µV</td>
<td>0.0076</td>
<td>4075 µV</td>
<td>0.0014</td>
<td>47 µV/°C</td>
</tr>
<tr>
<td>±5 V</td>
<td>0.024</td>
<td>686 µV</td>
<td>0.0076</td>
<td>2266 µV</td>
<td>0.0014</td>
<td>24 µV/°C</td>
</tr>
<tr>
<td>±2 V</td>
<td>0.024</td>
<td>336 µV</td>
<td>0.0076</td>
<td>968 µV</td>
<td>0.0014</td>
<td>10 µV/°C</td>
</tr>
<tr>
<td>±1 V</td>
<td>0.024</td>
<td>245 µV</td>
<td>0.0076</td>
<td>561 µV</td>
<td>0.0014</td>
<td>5 µV/°C</td>
</tr>
</tbody>
</table>

Noise Performance

For the peak-to-peak noise distribution test, a differential input channel is connected to AGND at the input terminal block, and 16,384 samples are acquired at the maximum rate available at each setting.

<table>
<thead>
<tr>
<th>Range</th>
<th>Counts</th>
<th>LSB rms</th>
</tr>
</thead>
<tbody>
<tr>
<td>±10 V</td>
<td>6</td>
<td>0.91</td>
</tr>
<tr>
<td>±5 V</td>
<td>6</td>
<td>0.91</td>
</tr>
<tr>
<td>±2 V</td>
<td>7</td>
<td>1.06</td>
</tr>
<tr>
<td>±1 V</td>
<td>9</td>
<td>1.36</td>
</tr>
</tbody>
</table>

Settling Time

Settling time is defined as the accuracy that can be expected after one conversion when switching from a channel with a DC input at one extreme of full scale to another channel with a DC input at the other extreme of full scale. Both input channels are configured for the same input range.

<table>
<thead>
<tr>
<th>Range</th>
<th>4 µs Settling Accuracy (% FSR)</th>
<th>6 µs Settling Accuracy (% FSR)</th>
<th>10 µs Settling Accuracy (% FSR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>±10 V</td>
<td>0.0061</td>
<td>0.0031</td>
<td>0.0015</td>
</tr>
<tr>
<td>±5 V</td>
<td>0.0061</td>
<td>0.0031</td>
<td>0.0015</td>
</tr>
<tr>
<td>±2 V</td>
<td>0.0061</td>
<td>0.0031</td>
<td>0.0015</td>
</tr>
<tr>
<td>±1 V</td>
<td>0.0061</td>
<td>0.0031</td>
<td>0.0015</td>
</tr>
</tbody>
</table>

Common mode rejection ratio (f = 60 Hz, all input ranges): 86 dB
Crosstalk (adjacent differential mode channels, DC to 10 kHz): –75 dB
Input coupling: DC
Sample rate: 0.019 Hz to 250 kHz, software-selectable
Trigger source: TRIG input
Sample clock source: Internal A/D clock or external A/D clock (AICKI pin)
Internal sample clock stability: ±50 ppm
Internal sample clock timebase: 80 MHz timer with 32-bit period (available frequencies are 80 MHz / integer period)
Throughput: Typical throughput when the device and host are connected by Ethernet to the same local network can vary significantly if a wireless connection is involved or data is sent over the internet, and is not guaranteed.
Software paced: 1000 to 5000 S/s typ, on local network
Hardware paced: 250 kS/s max
Channel gain queue (up to 8 elements): Software-selectable channel and range for each queue element
Warm-up time: 15 minutes min

Analog Output

Number of channels: 2
Resolution: 16 bits
Output ranges (calibrated): ±10 V
Output transient
Powered on
Duration: 5 ms
Amplitude: 2 V p-p
Powered off
Duration: 400 ms
Amplitude: 10 V p-p
Differential non-linearity (16-bit monotonic): ±0.35 LSB typ, ±1 LSB max
Output current (AOUTx pins): ±3.5 mA max; Leave unused AOUTx output channels disconnected
Output coupling: DC
Power on and reset state: DACs cleared to uncalibrated zero-scale: 0 V, ±50 mV unless the alarm function is enabled for the output. AOUTx defaults to 0 V whenever the device is powered on or a reset command is issued to the device, unless the alarm functionality is enabled for the output.
Alarm functionality: One or both outputs may be configured for defined values when an Ethernet connection with a host is established or lost.
Slew rate: 5 V/µs
Throughput (software paced): 1,000 to 5,000 S/s typ, on local network, when device and host are connected by Ethernet to same local network. Throughput can vary, and typical throughput is not guaranteed if a wireless connection is involved or data is sent over the internet.
Calibrated Absolute Accuracy (Analog Output)
Range: ±10 V
Absolute accuracy: (± 18.7 LSB)
Calibrated Absolute Accuracy Components (Analog Output)
Range: ±10 V
% of reading: ±0.024
Offset: ±2.2 mV
Offset Tempco: 30.1 µV/°C
Gain Tempco: 13.2 ppm of range/°C
SC-1608 Series
Specifications

Relative Accuracy (Analog Output)
Range: ±10 V
Relative accuracy (INL): ±4.0 LSB typ

Analog Input/Output Calibration
Recommended warm-up time: 15 minutes min
Calibration method: Factory
Calibration interval: 1 year (factory calibration)

Digital Input/Output
Digital type: 5 V TTL input/advanced BiCMOS output
Number of I/O: 8
Configuration: Independently-configured for input or output
Pull-up configuration: All pins pulled up to 5 V using 47 kΩ resistors (default).
Can be changed to pull-down using an internal jumper.
Digital I/O transfer rate (system-paced): 100 to 5000 port reads/writes or single
bit reads/writes per sec typ, on local network. Typical throughput when the
device and host are connected by Ethernet to the same local network.
Alarm functionality: DIO bits may be configured for output and go to defined
values when an Ethernet connection with a host is established or lost.
Power on and reset state: All bits input unless alarm functionality is enabled
Input high voltage threshold: 2.0 V min
Input high voltage limit: 5.5 V absolute max
Input low voltage threshold: 0.8 V max
Input low voltage limit: -0.5 V absolute min, 0 V recommended min
Output high voltage: 3.8 V typ at no load, 3.0 V min (IOH = –3 mA),
2.0 V min (IOH = –32 mA)
Output low voltage: 0.15 V typ at no load, 0.55 V max (IOL = 64 mA)
Power on and reset state: Input

External Trigger
Trigger source (external digital): TRIG
Trigger mode: Software-selectable edge or level sensitive; user configurable for
CMOS-compatible rising or falling edge, high or low level
Trigger latency: 2 µs + 1 pacer clock cycle max
Trigger pulse width: 1 µs min
Input type: Schmitt trigger, 47 kΩ pull-down to ground
Schmitt trigger hysteresis: 1.01 V typ, 0.6 V min, 1.5 V max
Input high voltage threshold: 2.43 V typ, 1.9 V min, 3.1 V max
Input high voltage limit: 5.5 V absolute max
Input low voltage threshold: 1.42 V typ, 1.0 V min, 2.0 V max
Input low voltage limit: -0.5 V absolute min, 0 V recommended min

External Clock Input/Output
Terminal names: AICKE, AICKO
Terminal types
AICKE: Input (receives A/D pacer clock from external source)
AICKO: Output (outputs internal A/D pacer clock)
Input clock rate: 250 kHz max
Clock pulse width
AICKE: 1 µs min
AICKO: 1.8 µs min
Clock mode: Edge-sensitive, rising
Input type: Schmitt trigger, 47 kΩ pull-down to ground
Schmitt trigger hysteresis: 1.01 V typ, 0.6 V min, 1.5 V max
Input high voltage threshold: 2.43 V typ, 1.9 V min, 3.1 V max
Input high voltage limit: 5.5 V absolute max
Input low voltage threshold: 1.42 V typ, 1.0 V min, 2.0 V max
Input low voltage limit: -0.5 V absolute min, 0 V recommended min
Output high voltage: 4.4 V min (IOH = –50 µA), 3.80 V min (IOH = –8 mA)
Output low voltage: 0.1 V max (IOL = 50 µA), 0.44 V max (IOL = 8 mA)

Counter
Pin name: CTR
Counter type: Event counter
Number of channels: 1
Input type: Schmitt trigger, 47 kΩ pull-down to ground
Input source: CTR screw terminal
Resolution: 32 bits
Schmitt trigger hysteresis: 1.01 V typ, 0.6 V min, 1.5 V max
Input high voltage threshold: 2.43 V typ, 1.9 V min, 3.1 V max
Input high voltage limit: 5.5 V absolute max
Input low voltage threshold: 1.42 V typ, 1.0 V min, 2.0 V max
Input low voltage limit: -0.5 V absolute min, 0 V recommended min
Input frequency: 10 MHz max
High pulse width: 50 ns min
Low pulse width: 50 ns min

Memory
Data FIFO (analog input): 49,152 samples
Non-volatile memory: 2,048 bytes (768 bytes for calibration, 256 bytes for user,
1,024 bytes for network settings)

Power
This product receives power ONLY from the SCC-8-8-2 board; refer to the
“Power” on page 6. Do not connect a power supply to the barrel connector
on the E-1608-OEM board.
Supply current:
Quiescent current: 330 mA typ; 710 mA max including all external loading
This is the total quiescent current requirement that includes the LEDs; does
not include potential loading of the DIO bits, +VO pin, or AOUTx outputs.
User output voltage range (available at +VO pin): 4.40 V min to 5.25 V max,
assumes supplied AC adapter is used
User output current (available at +VO pin): 10 mA max

Network
Ethernet Connection
Ethernet type: 100 Base-TX, 10 Base-T
Communication rates: 10/100 Mbps, auto-negotiated
Connector: RJ-45, 8 position
Cable length: 100 meters max
Additional parameters: HP Auto-MDI/X support

Network Interface
Protocols used: TCP/IP (IPv4 only), UDP
Network ports used: UDP:54211 (discovery), UDP:6234 (bootloader only),
TCP:54211 (commands), TCP:54212 (scan data)
Network IP configuration: DHCP + link-local, DHCP, static, link-local
Network name: E-1608-xxxxxx, where xxxxxx are the lower 6 digits of the device
MAC address
Network name publication: By NBNS

Network Factory Default Settings
Factory default IP address: 192.168.0.101
Factory default subnet mask: 255.255.255.0
Factory default gateway: 192.168.0.1
Factory default DHCP setting: DHCP + link-local enabled

Network Security
Security implementation: TCP sockets not opened unless application sends the
correct PIN code (non-volatile memory, changed by user, default value 0000)
Number of concurrent sessions: 1
Vulnerabilities: TCP Sequence Number Approximation Vulnerability

LED Displays and the Factory Reset Button
Power LED (Top)
3.3 V < Vcc < 5.9 V: On
Vcc < 3.3 V, Vcc > 5.9 V: Off (power fault)
Activity LED (bottom): On when there is a valid host connection and blinks
when a command is received or an AInScan is running.
Ethernet connector LEDs
Left, green: Link/activity indicator; on when there is a valid Ethernet link and
blinks when network activity is detected.
Right, yellow: Speed indicator; on for 100 Mbps, off for 10 Mbps or no link.
Factory reset button: Used to reset the network configuration settings to the
factory default values.
## SC-1608 Series

### Ordering

#### Order Information

##### Hardware

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SC-1608-2AO-ENET</td>
<td>Ethernet-based DAQ device with eight analog inputs, 250 kS/s sample rate, two analog outputs, one 32-bit counter input, and eight DIO lines. Includes an external power supply and accessory kit.</td>
</tr>
<tr>
<td>SC-1608X-2AO-USB</td>
<td>USB-based DAQ device with 16 analog inputs, 500 kS/s sample rate, two analog outputs, two 32-bit counter inputs, one timer output, and eight DIO lines; compatible with 8B analog modules and SSR digital modules. Includes an external power supply and accessory kit.</td>
</tr>
<tr>
<td>SC-1608X-USB</td>
<td>USB-based DAQ device with 16 analog inputs, 500 kS/s sample rate, two 32-bit counter inputs, one timer output, and eight DIO lines; compatible with 8B analog modules and SSR digital modules. Includes an external power supply and accessory kit.</td>
</tr>
<tr>
<td>SC-1608-USB</td>
<td>USB-based DAQ device with 16 analog inputs, 250 kS/s sample rate, two 32-bit counter inputs, one timer output, and eight DIO lines; compatible with 8B analog modules and SSR digital modules. Includes an external power supply and accessory kit.</td>
</tr>
</tbody>
</table>

##### Accessories

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>8B analog I/O modules</td>
<td>Refer to the Specifications on page 5 for the part number and description of compatible 8B analog I/O signal conditioning modules.</td>
</tr>
<tr>
<td>SSR digital I/O modules</td>
<td>Refer to the Specifications on page 5 for the part number and description of compatible SSR digital I/O modules.</td>
</tr>
<tr>
<td>ENC-19X5X5</td>
<td>Rack mount enclosure. (L × H × W): 19 × 5.25 × 5 in. (482.6 × 133.4 × 127.0 mm)</td>
</tr>
<tr>
<td>C50FFx cable</td>
<td>50-conductor ribbon cable, female to female. Connect to the SC-1608 Series header connector.</td>
</tr>
<tr>
<td>CIO-MINI50</td>
<td>50-pin universal screw-terminal board. Connect to the SC-1608 Series header connector with a C50FFx cable.</td>
</tr>
</tbody>
</table>