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Find the *National Instruments SCXI-1141* at our website: *Click HERE*

SCXI 8-Channel Lowpass Filter Modules

NI SCXI-1141, NI SCXI-1142, NI SCXI-1143

- 8 channels
- Programmable gain per channel (±50 mV to ±5 V input range)
- 8th-order programmable filter setting per module (10 Hz to 25 kHz)
- ±30 V maximum overvoltage protection, powered on
- 333 kS/s maximum sampling rate (any gain)
- Cascade with SCXI-1140 for applications requiring filtering and simultaneous sampling

SCXI-1141
- Elliptic filter response
- Recommended for sharp filter roll off

SCXI-1142
- Bessel filter response
- Recommended for maintaining phase integrity

SCXI-1143
- Butterworth filter response
- Recommended for maximum flatness in the passband

Operating Systems
- Windows 2000/NT/XP

Recommended Software
- LabVIEW
- LabWindows/CVI
- Measurement Studio
- VI Logger

Driver Software
- NI-DAQ 7



Overview

The National Instruments SCXI-1141, SCXI-1142, and SCXI-1143 are 8-channel, programmable lowpass filter modules, ideal for antialiasing applications. You can choose from elliptic, Bessel, or Butterworth filter types. These modules have a common architecture, with a programmable instrumentation amplifier and programmable 8th-order lowpass filter on each channel. While you must set all channels to the same cutoff frequency, you can programatically bypass the lowpass filter on a per-channel basis. By using a combination of analog filters and switched capacitor filters (SCFs), these modules offer the flexibility of 10,000 discrete software programmable cutoff frequencies while maintaining the low-noise performance of traditional, continuous time-active filters. An external clock input and output are also provided so you can set the filter cutoff frequency with an external clock in tracking filter applications. Each module can condition signals ranging from ±50 mV to ±5 V, and offers multiplexed and parallel modes of operation.

Analog Inputs

These modules share a common architecture. Each channel has its own programmable instrumentation amplifier with differential inputs that you can individually program for signals ranging from ±50 mV to ±5 V. These inputs are protected to ±30 V powered on and ±15 V powered off.

In multiplexed mode, these modules multiplex all eight conditioned channels to the rear connector, to which you can connect to a single input channel of the DAQ device. Alternatively, in parallel mode, you can pass each conditioned channel directly to the analog inputs of the DAQ device to increase scanning speeds. This configuration requires a dedicated DAQ device and cable for each module.

The NI SCXI-1141/1142/1143 contain 8th-order lowpass filters. See Figures 2, 3, and 4 for stopband and rolloff characteristics for the different filter types. These filters are a hybrid of SCFs and continuous-time filters (CTFs). With SCF technology, the cutoff frequency of the filters is easily configured through software. However, SCFs are sampling systems, and are subject to the same aliasing effects as digitizers. The hybrid design uses a CTF prefilter to prevent aliasing in the SCF and a CTF postfilter to reconstruct the sampled waveform.

Lowpass Filters

Each module offers different filter response characteristics. The SCXI-1141 has 8th-order elliptic filters, which provide a very sharp rolloff. Elliptic filters are ideal for blocking signals just above the Nyquist frequency. The SCXI-1142 has 8th-order Bessel filters, which maintain signal phase integrity. Bessel filters are ideal for applications requiring simultaneous sampling. Finally, the SCXI-1143 has 8th-order Butterworth filters, which have a flat passband. Butterworth filters are ideal for applications where signal amplitude must be uniform throughout the passband.

Module	±50 mV to ±5 V	8th-Order Filter Type
SCXI-1141	✓	Elliptic
SCXI-1142	✓	Bessel
SCXI-1143	✓	Butterworth

Table 1. Signal Compatibility

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SCXI 8-Channel Lowpass Filter Modules

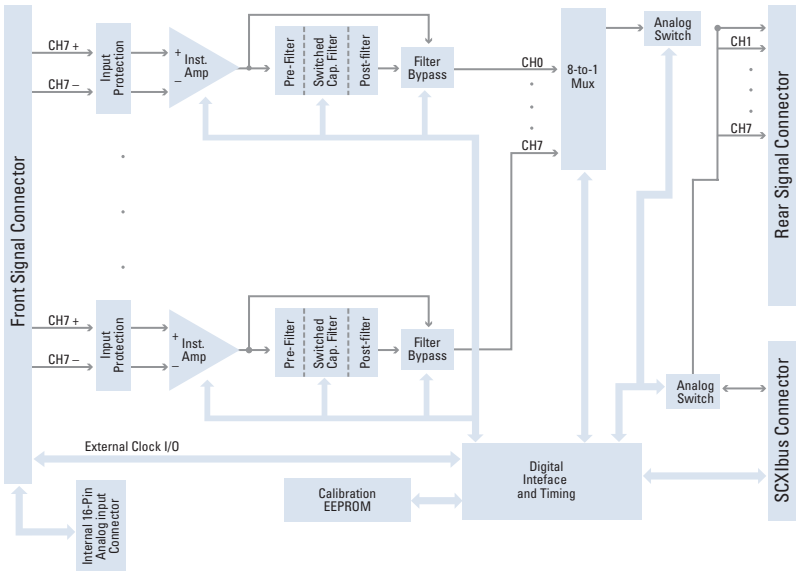


Figure 1. Block Diagram of the SCXI-1141, SCXI-1142, and SCXI-1143

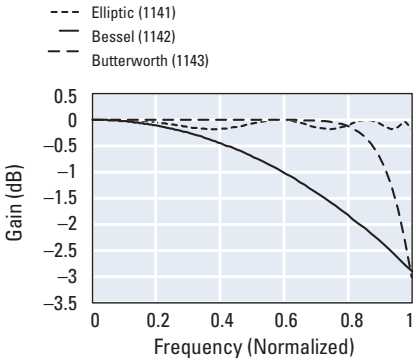


Figure 2. Frequency Response

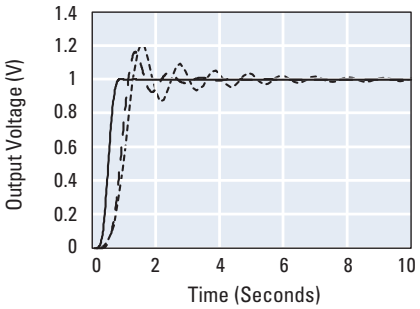


Figure 3. Step Response

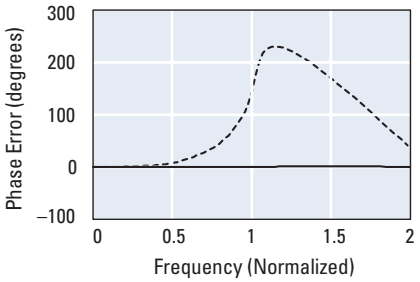


Figure 4. Phase Error

You can program the cutoff frequency of these filters for a range of frequencies, from 10 Hz to 25 kHz. Specifically, the available frequencies are fc = 100 kHz/n, where n = 4, 5, …,10,000. Optionally, you can control the cutoff frequency with an external clock. In either case, all eight channels operate with the same cutoff frequency. However, you can individually bypass each of the eight filters in a module under software control to leave the channel unfiltered.

Calibration

Each of these modules contains calibration hardware to null out error sources. With automatic input zeroing, software-programmable analog switches ground the inputs of each of the instrumentation amplifiers for offset error calibration. By providing an external reference voltage, you can calibrate the system to your exact operating conditions. In addition, DC compensation circuits remove the offset errors of the filters, guaranteeing excellent DC accuracy regardless of whether lowpass filtering is enabled. An onboard EEPROM stores the calibration constants for each channel and each input range in a user-defined area. The EEPROM also stores a set of factory calibration constants in permanent memory, which you cannot modify. NI-DAQ transparently uses the calibration constants to correct for gain errors.

Terminal Block	Part Number	Type	Special Functions	Page
SCXI-1304	777687-04	Screw terminals front-mounting	AC coupling Signal ground referencing	328
SCXI-1305	777687-05	BNC connectors front-mounting	BNC connectors AC coupling Signal ground referencing	328
SCXI-1310	777687-10	Solder pins shell assembly	Low-cost connector-and-shell assembly	328

Table 2. Terminal Block Options for SCXI-1141, SCXI-1142, and SCXI-1143

Ordering Information

NI SCXI-1141 776572-41
NI SCXI-1142 776572-42
NI SCXI-1143 776572-43

For information on extended warranty and value-added services, see page 20.

BUY ONLINE!

Visit ni.com/info and enter scxi1141, scxi1142 and/or scxi1143.

See page 276 for more information on a complete SCXI system.

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SCXI Simultaneous-Sampling Analog Input and Lowpass Filter Specifications

Specifications

Maximum for 25 °C unless otherwise noted

Complete Accuracy Table

Module	Nominal Range*	Percent of Reading*		Offset	System Noise (peak, 3 sigma)*		Temperature Drift	
		Typical	Maximum		Single Point	Average	Percent of Reading/°C	Offset (µV/°C)
SCXI-1140	±10 V	±0.03	±0.075	±3.90 mV	600 µV	60 µV	±0.0025	±180
	±1 V	±0.06	±0.125	±0.55 mV	60 µV	6 µV	±0.0025	±25
	±100 mV	±0.1	±0.25	±0.24 mV	15 µV	1.5 µV	±0.0045	±12
	±50 mV	±0.5	±1.1	±0.22 mV	8 µV	0.8 µV	±0.01	±11
	±20 mV	±0.5	±1.1	±0.22 mV	8 µV	0.8 µV	±0.01	±11
SCXI-1141	±5 V	±0.02	±0.6	±0.60 mV	1420 µV	235 µV	±0.002	±10
SCXI-1142	±2.5 V	±0.02	±0.6	±0.60 mV	708 µV	117 µV	±0.002	±10
SCXI-1143	±1 V	±0.02	±0.6	±0.60 mV	280 µV	46.9 µV	±0.002	±10
	±500 mV	±0.02	±0.6	±0.60 mV	149 µV	23.5 µV	±0.002	±10
	±250 mV	±0.02	±0.6	±0.60 mV	71 µV	11.7 µV	±0.002	±10
	±100 mV	±0.02	±0.6	±0.60 mV	25 µV	4.69 µV	±0.002	±10
	±50 mV	±0.02	±0.6	±0.60 mV	15 µV	2.33 µV	±0.002	±10

*Absolute Accuracy (15 to 35 °C). To calculate the absolute accuracy for the SCXI-1100/1102/1102B/1102C/1104/1104C and or 1112 refer to page 194 or visit ***ni.com/accuracy***

Input Characteristics

Input coupling DC..... (AC with SCXI-1304 or SCXI-1305)

Maximum working voltage

Module	Signal + Common-mode
SCXI-1140	Average of two inputs should remain within ±7 V of ground
SCXI-1141, SCXI-1142, SCXI-1143	Each of two inputs should remain within ±5 V of ground

Overvoltage protection

Inputs protected..... CH<0..7>

Module	Powered On	Powered Off
SCXI-1140, SCXI-1141, SCXI-1142, SCXI-1143	±30 V	±15 V

Transfer Characteristics

Nonlinearity

Module	Input Range	Percent of Full Scale Range
SCXI-1140	±10 V to ±1 V	±0.01
	±100 V to ±50 V	±0.02
	±20 mV	±0.04

Offset Error..... See accuracy table

Gain Error..... See accuracy table

Amplifier Characteristics

Input Impedance

Module	Normal Powered On	Powered Off/Overload
SCXI-1140	100 G in parallel with 20 pF	10 k
SCXI-1141, SCXI-1142, SCXI-1143	10 G in parallel with 40 pF	2.4 k

Input bias current

SCXI-1140..... ±50 pA

SCXI-1141, SCXI-1142, SCXI-1143..... ±500 pA

Input offset current

SCXI-1140..... ±10 pA

SCXI-1141, SCXI-1142, SCXI-1143..... ±250 pA

CMRR (DC to 60 Hz)

Module	Input Range	Percent of Full Scale Range
SCXI-1140	±10 V	90 dB
	±1 V	104 dB
	±100 to ±20 mV	110 dB
SCXI-1141, SCXI-1142, SCXI-1143	±5 V	60 dB

Output range

SCXI-1140..... ±10 V

SCXI-1141, SCXI-1142, SCXI-1143..... ±5 V

Output impedance

Module	Multiplexed Mode	Parallel Mode
SCXI-1140	100	100
SCXI-1141, SCXI-1142, SCXI-1143	500	500

Dynamic Characteristics

Input signal bandwidth

Module	Input Range	Bandwidth (-3 dB)
SCXI-1140 (switch selectable)	±10 V	2 MHz
	±1 V	800 kHz
	±100 mV	500 kHz
	±50 mV	300 kHz
	±20 mV	120 kHz
SCXI-1141, SCXI-1142, SCXI-1143	±5 V to ±50 mV	Dependent on filter setting

Scan interval

Module	Scan Interval (Per Channel, Any Gain and Filter Setting)		
	±0.012%[1]	±0.006%[2]	±0.0015%[2]
SCXI-1141, SCXI-1142, SCXI-1143	3 µs	10 µs	20 µs

[1]Includes effects of PCI-6070E with 1 m or 2 m SCXI cable assembly.

[2]Includes effects of PCI-6032E SCXI cable assembly.

For a definition of specific terms, please visit *ni.com/glossary*

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SCXI Simultaneous-Sampling Analog Input and Lowpass Filter Specifications

Specifications

System noise (See Accuracy Table)
THD (SCXI-1141,1142,1143)
- 1 kHz ..... -70 dB
- 0 to 25 kHz ..... -60 dB

Step response (10 V step) ..... Dependent on filter setting
Track time

	Accuracy		
Module	±0.012%	±0.003%	±0.0015%
SCXI-1140	7 µs	10 µs	50 µs

Droop rate ..... ±10 mV/s
Interchannel skew ..... ±50 ns
Intermodule skew ..... ±100 ns
Aperture delay time
- (from external sample check) ..... ±50 ns
- Hold step ..... - 5 mV

Filter Characteristics (SCXI-1141, 1142, 1143 Only)

Filter type
Cutoff frequency fc (-3 dB)
- SCXI-1141 ..... 8th order Elliptic
- SCXI-1142 ..... 8th order Bessel
- SCXI-1143 ..... 8th order Butterworth

Range ..... 10 Hz to 25 kHz

Programmable values

Internal clock ..... 100 kHz/n, n 4
External clock ..... fext/(100n), n 1
Passband ripple

Module	To 85% of f_c
SCXI-1141	0.2 dB

Stopband attenuation

Module	80 dB
SCXI-1141	1.5 x fc
SCXI-1142	6 x fc
SCXI-1143	3.2 x fc

Attenuation rate
- SCXI-1141 ..... 135 dB/octave
- SCXI-1142 ..... 135 dB/octave
- SCXI-1143 ..... 135 dB/octave

Maximum external clock frequency ..... 10 MHz

Stability

Recommended warm-up time ..... 20 minutes

Module	Range	Gain Temperature Coefficient	Offset Temperature Coefficient
SCXI-1140	±10 V to ±1 V	25 ppm/°C	±(10 + 150/gain) µV/°C
	±100 mV	45 ppm/°C	±(10 + 150/gain) µV/°C
	±50 mV	60 ppm/°C	±(10 + 150/gain) µV/°C
	±20 mV	100 ppm/°C	±(10 + 150/gain) µV/°C
SCXI-1141 SCXI-1142 SCXI-1143	All ranges	20 ppm/°C	±(10 + 200/gain) µV/°C

Physical

Dimensions ..... 3.0 by 17.3 by 24.4 cm (1.2 by 6.8 by 8.0 in.)

I/O Connector

- Rear ..... 50-pin male ribbon cable connector
- Front ..... 96-pin male DIN C connector
- Internal ..... 16-pin male

Environment

- Operating temperature ..... 0 to 50 °C
- Storage temperature ..... -55 to 150 °C
- Relative humidity ..... 5 to 90% noncondensing

Certification and Compliance

European Compliance CE

- EMC ..... EN 61326-1, Group I Class A, 10 m, Table 1 Immunity
- Safety ..... EN 61010-1

North American Compliance

- EMC ..... FCC Part 15 Class A using CISPR

Australia & New Zealand Compliance

- EMC ..... AS/NZS 2064.1/2 (CISPR-11)

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