Overview

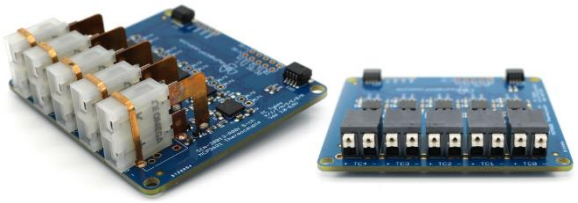
SEN-30013 is a five-channel, high precision and high accuracy thermocouple interface based on Microchip's MCP9601. It is a combination Qwiic-compatible breakout/shield for the ultimate user flexibility. MCP9601 is a more feature-rich variant of the MCP9600 that includes fault handling of common thermocouple connection issues, including shorts to supply rails and open thermocouple inputs. SEN-30013 is stocked for the J-, K-, and T-type thermocouple variants (mini blade-style connector) as well as a universal "spring clamp" variant that is suitable for use with all thermocouple types. Other type-specific variants are available upon request, so contact us for a quote and lead-time. See our SEN-30010 for a single-channel version of this board.

Features

- Five-channel MCP9601 Thermocouple-to-Digital Converter
- Qwiic-compatible I²C interface
- B-, E-, J-, K-, N-, R-, S-, and T-type thermocouple support
- Combination breakout/shield form factor with convenient mounting holes and 0.1" header interface
- Full thermocouple nonlinearity correction for all thermocouple types
- Multi-fault detection: Short-to-Gnd, Short-to-Vcc, Open thermocouple
- 2.7V - 5.0V supply and digital IO range
- 18-bit resolution for 0.0625°C/bit output on both hot and cold junction
- ***Up to 200Hz sampling*** when using lower-resolution modes (see details)

Kit Includes

- SEN-30013-(x) Five-channel MCP9601 Breakout



Typical Applications

- High thermocouple count applications
- Automotive temperature sensing (exhaust, coolant, brakes, etc)
- Industrial instrumentation and thermal management
- Commercial and industrial ovens
- Petrochemical thermal management
- Brewing controls
- Hobby applications

Description

Microchip stepped into the single-chip thermocouple measurement game with the MCP9600 and MCP9601 Thermocouple EMF to Temperature Converter ICs. SEN-30013 integrates the MCP9601 variant as it includes open-circuit and short-circuit detection, whereas MCP9600 does not.

The result is a ±1.5°C accurate thermocouple interface that handles all common thermocouple types, includes nonlinearity correction, and accounts for cold junction compensation.

PwFusion stocks four variants of SEN-30013, three using a mini-blade style thermocouple connector (J-, K-, and T-type stocked, other options available upon request) and one with a direct-wire, spring-clamp connector with excellent retention. See Table 1 below for all SEN-30013 purchase options.

PwF Part No.	Connector	Thermocouple Type
SEN-30013-J	Mini-blade TC	J-type only
SEN-30013-K	Mini-blade TC	J-type only
SEN-30013-T	Mini-blade TC	J-type only
SEN-30013-W	Push-release spring clamp	Universal, bare wire

Table 1 - Orderable Parts

While similar in overall performance to the Analog Devices MAX31856, MCP9601 is unique in that it uses I2C instead of SPI to communicate to a host controller. Combined with a Qwiic-compatible interface, SEN-30013 is perhaps the easiest-to-use thermocouple interface in its performance class. For users who haven't adopted the Qwiic system yet, we have also included both Arduino shield and pin header interfaces. The header interface includes connections for short-circuit, open-circuit, and two temperature alert pins per IC, though not all are located at the board edge due to space constraints. All of this makes it easy to wire up a prototype or install SEN-30013 on a custom carrier board.

Thermocouple Channel	Default I²C Address
TC0	0x60
TC1	0x61
TC2	0x64
TC3	0x66
TC5	0x67

Table 2 - Thermocouple I²C Address

MCP9601 uses a pair of resistors to set the device address, which makes it possible to use multiple MCP9601 devices on a single I2C bus. SEN-30013 populates these resistors to set the thermocouple channels according to Table 2.

If more than five thermocouple channels are needed, consider using our Qwiic-compatible I²C MUX and adding additional SEN-30013 boards, as needed. It's possible to connect 40 MCP9601 channels to a single microcontroller without any soldering required! It is also possible to build SEN-30013 to cover all address variants, so contact us if you have a special application to consider.

SEN-30013 has been optimized for a wide range of typical applications. To get a clean, consistent reading, SEN-30013 includes differential-mode filtering and the necessary sense circuitry to detect OC and SC conditions. To prevent damage to the device due to ESD and other electrical events, ferrite beads and clamping diodes have been installed on both thermocouple rails. In short, SEN-30013 integrates all the functionality the MCP9601 is capable of in a small, easy-to-use package.

MCP9601 supports a wide, 2.7V - 5.5V supply and interface voltage range. As a result, no special translation circuits were required to enable 5V Arduino and 3.3V Raspberry Pi and Qwiic connections on a single board!

Electrical Limits and Specifications

Name	Description	Min	Nominal	Max	Unit
V_{Supply}	Supply Voltage	2.7	-	5.5	V
$T_{Ambient}$	Ambient Temperature	-40	-	125	°C
I_{Supply}	Supply Current		7.5	12.5	mA
$V_{CommonMode}$	Common mode voltage which may be applied to thermocouple input pins	0.5	-	1.4	V
	Thermocouple Temperature Resolution		18		Bits
			0.0625		°C
	Cold Junction Temperature Resolution		0.0625		°C
t_{sample}	Minimum sample period[1]	5	-	320	ms

Table 3 - Electrical Limits and Specifications

[1] Sample period defined for single channel and increases with ADC resolution. 5ms sample period for single channel with 12-bit resolution. 320ms sample period at full 18-bit resolution.

Application & Guide

SEN-30013 is designed for rapid setup and integration. We have provided several code examples on our GitHub Page designed to get you up and running quickly.

I2C Pull-up Disable

The SEN-30013 includes a pair of 2.2k Ohm pull up resistors on the I²C SDA and SDL lines. Only one pair of pull-up resistors are required for proper I²C operation. If multiple breakouts are used together (think Qwiic daisy-chain), it is possible that an excessive amount of resistance can cause bus issues. If this is the case, resistance must be removed from one or more devices. SEN-30013 has cuttable traces on the front side of the board to make this easy.

Figure 1 - Location of I2C pull-up cuttable trace

1) Identify the I2C pull-up cuttable jumpers on the front of the PCB (Green circle in Figure 1)

2) Using an Exact-O or equivalent device, cut both traces to disable pull-ups on the SEN-30013 board (marked red here)

QuickStart

Start by plugging SEN-30013 into your microcontroller board by a) using a Qwiic-compatible cable or b) soldering headers or fly-wires to power and I2C pins between SEN-30013 and your micro. Next, download the desired PwFusion example code, flash the board, and start measuring! Please note: be sure to set your baud rate to match the Serial.begin() statement in the setup() routine.

Advanced User

The PwFusion library can be used to change many of the settings on the MCP9601 based on descriptions in the datasheet. Things like measurement resolution (directly affects maximum sampling rate) and temperature alerts, with hysteresis, can all be set with our example code. It is highly recommended to spend some time with the MCP9601 datasheet once you have gotten the SEN-30013 up and running to ensure optimal performance in your application.

Common Issues

- Not installing all required connections. Vin, GND, SCL and SDA are *required* for operation
- Conflicting device addresses when using multiple SEN-30013 boards
  - See Table 2 above for default addressing
  - Use an I2C MUX to add additional SEN-30013s without any soldering!
- Strange or inconsistent readings with multiple grounded thermocouples
  - Common mode range can result in erroneous readings when the thermocouple is grounded
  - MCP9601 is typically used for ungrounded thermocouple measurement
  - Try to select ungrounded thermocouples, when possible
  - If you see issues and must use grounded thermocouples, *contact us* to explore what we have available for isolated thermocouple products

Ordering Options & Related Parts

SEN-30010-K: 1-Ch J-type MCP9601
SEN-30010-W: 1-Ch Universal type MCP9601

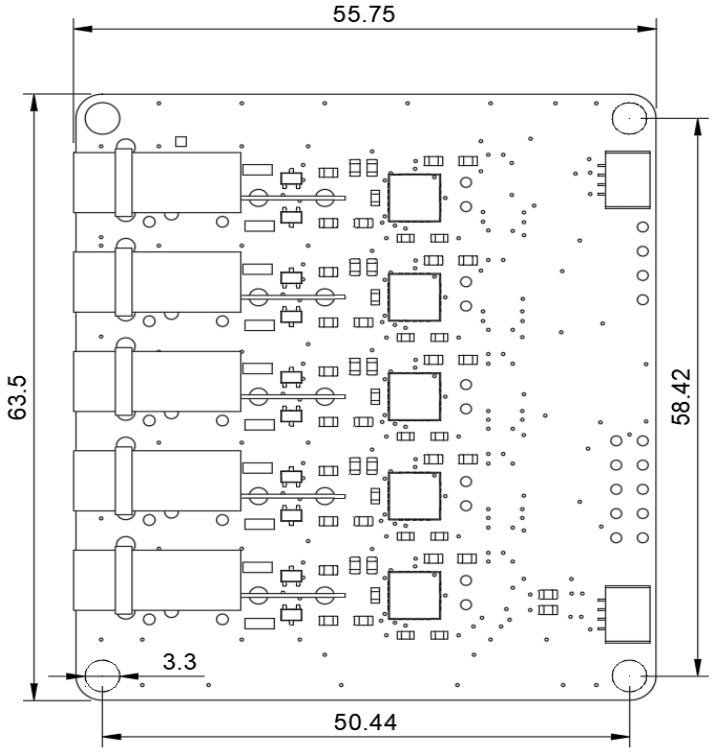
SEN-30011-J: Quad J-type MCP9601
SEN-30011-K: Quad K-type MCP9601
SEN-30011-T: Quad T-type MCP9601
SEN-30011-W: Quad Universal type MCP9601

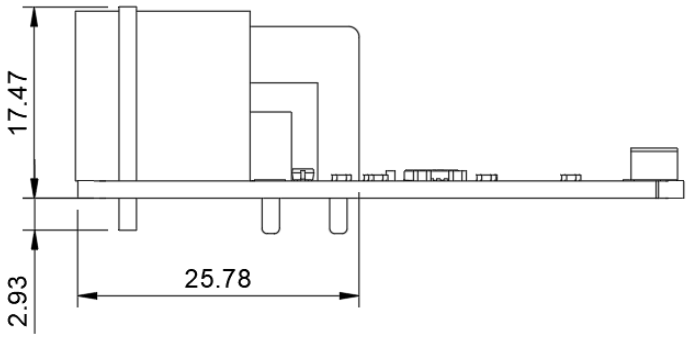
SEN-30013-J: 5-Ch J-type MCP9601
SEN-30013-K: 5-Ch K-type MCP9601
SEN-30013-T: 5-Ch T-type MCP9601
SEN-30013-W: 5-Ch Universal type MCP9601

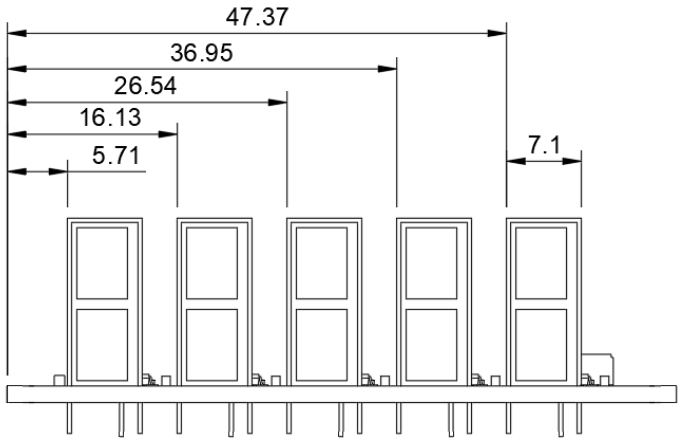
IFB-10011: Qwiic-compatible I2C MUX based on TCA9548A
WIR-10001: 10cm Qwiic-compatible interconnect cable

SEN-30007: Quad MAX31856 thermocouple shield, SPI interface
SEN-30202: Dual MAX31865 RTD, SPI interface

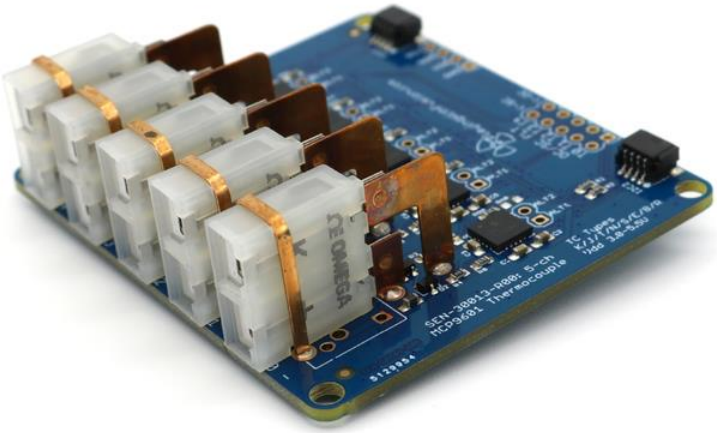
Appendix 1a: Mech Drawing (Top View)



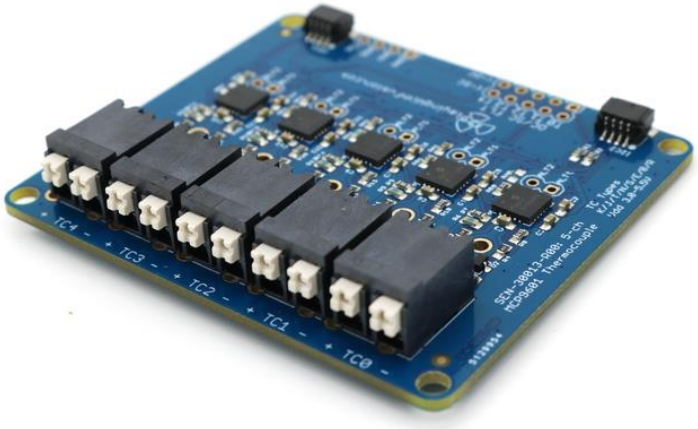




Appendix 2a: SEN-30013, K-type, Mini blade-style TC connector



Appendix 2b: SEN-30013, Spring Clamp connector, pushbutton release, universal TC type



Revision History

Date	Author	Notes
08/07/2025	J. Leonard	First revision published