Overview

SEN-30008 is a quad (four) channel, high precision and high accuracy thermocouple shield based on the MAX31856 by Maxim Integrated and supplied in "breakout board" form factor. Multiple thermocouple variants are stocked, as well as "universal" configurations. Mini flat-blade thermocouples are supported by the type-specific variants. Universal thermocouple types are supported by screw-terminal and spring-clamp variants using bare wire connections.

Features

- Quad MAX31856 Thermocouple
- "Breakout Board" form factor with 3.0V - 5.5V compliant supply and I/O range
- B-, E-, J-, K-, N-, R-, S-, and T-type thermocouple support
- 19-bit hot-junction temperature resolution (0.0078125°C/bit) with 0.15% TC voltage accuracy
- 6-bit cold junction resolution (0.015625°C/bit) ±0.7°C accuracy
- Thermocouple nonlinearity correction
- Multi-fault detection: Short-to-Gnd, Short-to-Vcc, Open thermocouple
- RoHS Compliant

Kit Includes

- SEN-30008-(x) breakout board, fully assembled

Typical Applications

- Automotive temperature sensing (exhaust, coolant, brakes, etc)
- Industrial instrumentation
- Oven controls
- Home brewing controls
- Hobby applications

Description

Maxim has evolved their thermocouple measurement line from the MAX6674 and MAX6675, to the MAX31855, and now, the MAX31856. With the advent of the MAX31856, it is now possible to use a single IC to measure virtually any thermocouple type. However, care must still be taken to ensure consistent junction transitions to avoid unexpected errors. We accomplish this by offering the SEN-30008 in many different configurations. See Table 1 below for the different ordering codes, and the Appendix for pictures of the different configurations. Please note, SEN-30007 is available if an Arduino R3 form factor is preferred.

All SEN-30008 boards include analog filtering on each thermocouple channel. This includes both common- and differential-mode filtering, which compliments the on-chip notch filter for mains frequency noise (50hz or 60hz). This

Table 1: Orderable Parts

PwF Part No.	Connector	Thermocouple Type
SEN-30008-J	Mini-blade TC	J-type only
SEN-30008-K	Mini-blade TC	K-type only
SEN-30008-T	Mini-blade TC	T-type only
SEN-30008-ST	screw terminal	universal, bare wire
SEN-30008-W	push-release spring clamp	universal, bare wire

ensures a steady and reliable temperature reading.

Measurements from the MAX31856 are accessed via a 4-wire SPI interface and individual Chip-Select lines. All signals are accessed via the 14-pin header along the back of the board, and only 9 are required for full operation of the board. Multiple boards can be wired together to increase channel count on a single microcontroller. (see our GitHub Page for an example 12-channel MAX31856 datalogger)

While the MAX31856 is a 3.3V (nominal) part, all SPI signals are level shifted to "Vin" using high speed translator ICs. An onboard LDO provides the MAX31856 ICs with clean, 3.3V power. This makes the MAX31856 suitable for any microcontroller or interface device operating between 3.0V and 5.5V.

Application & Guide

SEN-30008 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.

QuickStart

Note: ALL SEN-30008 boards use the same PCB, but have different connectors to match the application.

1) Start by soldering fly-wires or a straight header (not included) on the SEN-30008.

2) Connect the Vin and GND pins to a voltage supply that matches your microcontroller or interface module.

3) Connect at least the SPI (SDO/SDI/SCK) and CSx lines to your microcontroller. DRx pins are not required, and no PwFusion example uses them

4) Please note, the 3.3V pin is *NOT* an input, but it can be used to power an external device up to 100mA. It is powered by the onboard LDO.

5) Download the PwFusion example code from GitHub, flash your board, and connect a few thermocouples. Any thermocouple channel that isn't plugged will have an illuminated LED showing a fault on that channel (Open, in this case). Other channels will be reading via the serial monitor (be sure to set your baud rate to 115,200).

Advanced User

The PwFusion library can be used to change many of the settings on the MAX31856 based on descriptions in the datasheet. Things like the number of samples to average, notch filter frequency, faults to display, and high- and low-temperature triggers can all be configured via the SPI interface. It is recommended to spend some time with the MAX31856 datasheet once you have gotten the SEN-30008 up and running to ensure optimal performance in your application.

Common Issues

- Not installing all required connections. Vin, GND, SPI (SDO/SDI/SCK), and all 4 CS pins must be connected to function.
- Conflicting Chip Selects
  - Our example code shows using Arduino pins D7-D10 by default, but

you can switch this to anything. This is *required* if you have connected something else to pins D7-D10.

- ○ Remember, many pins on microcontroller carrier boards, like the Arduino and Raspberry Pi, are often used for alternate functions. For example, D0/D1 are used for serial, and D11-D13 for SPI on an Arduino Uno R3. These can NOT be shared with CS pins
- Conflicting SPI modes when used with other boards or modules
    - ○ MAX31856 uses SPI Modes 1 or 3, while many Ethernet controllers and SD cards use Mode 0.
    - ○ Be sure to switch between modes before calling functions for the specific device you are talking to.
    - ○ We show an an example of how to handle this in our 12-channel TC logger example on GitHub
- Strange or inconsistent readings with multiple grounded thermocouples
    - ○ Common mode range can result in erroneous readings when the thermocouple is grounded
    - ○ MAX31856 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
- Bare wire thermocouple leads not wanting to stay inserted
    - ○ Switch to "W" universal spring clamp connectors or type-specific connectors for industrial and automotive (high vibration) applications

Ordering Options & Related Parts

SEN-30008-J: Quad MAX31856 TC breakout, J-type flat-blade connectors
SEN-30008-K: Quad MAX31856 TC breakout, K-type flat-blade connectors
SEN-30008-T: Quad MAX31856 TC breakout, T-type flat-blade connectors
SEN-30008-ST: Quad MAX31856 TC breakout, screw terminal connectors
SEN-30008-W: Quad MAX31856 TC breakout, spring-clamp connector
SEN-30007: Quad MAX31856 TC shield
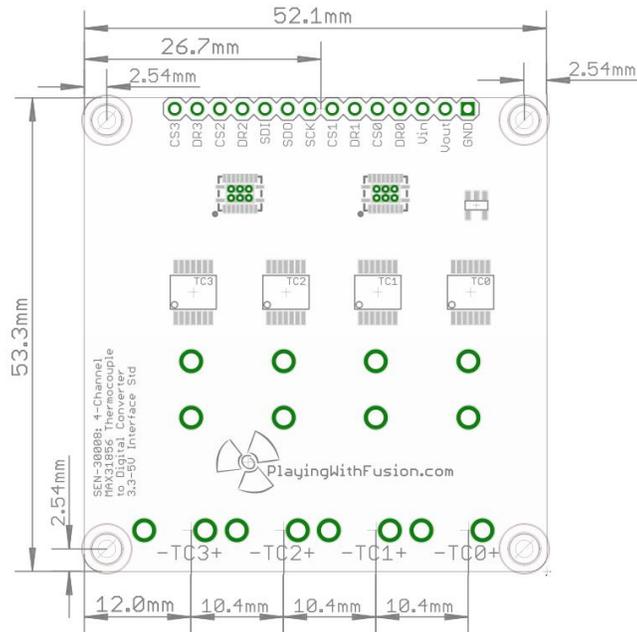SEN-30005: Single MAX31856 Breakout
SEN-30006: Dual MAX31856 Breakout
SEN-30011: Quad MCP9601, Qwiic I2C interface, multiple thermocouple options
IFB-10011: Qwiic-compatible I2C MUX based on TCA9548A
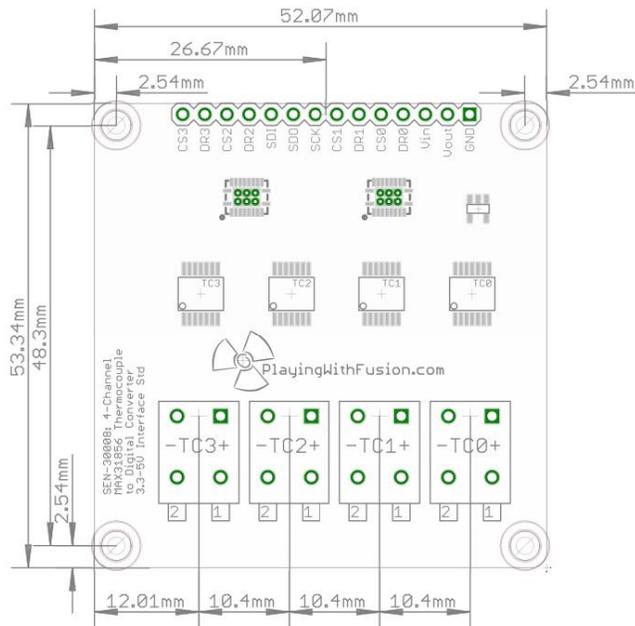WIR-10001: 10cm Qwiic-compatible interconnect cable
SEN-30202: Dual MAX31865 RTD, SPI interface

Appendix 1a: Mech Drawing, Mini TC Connectors (Top View)
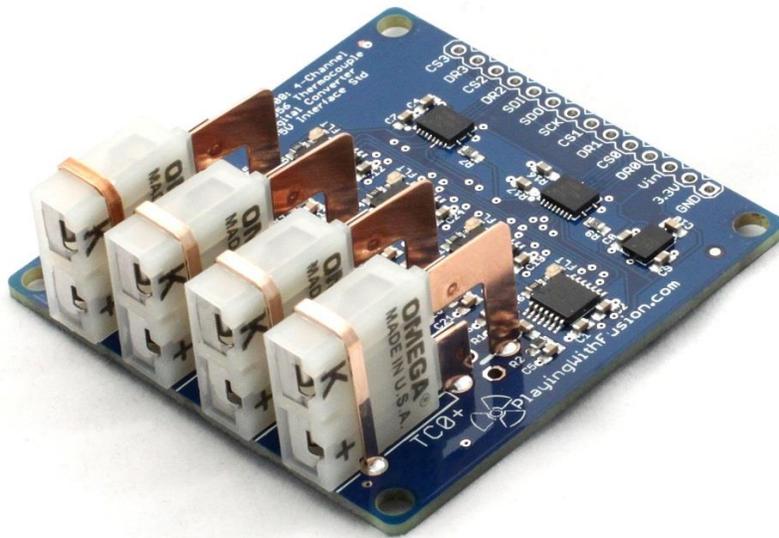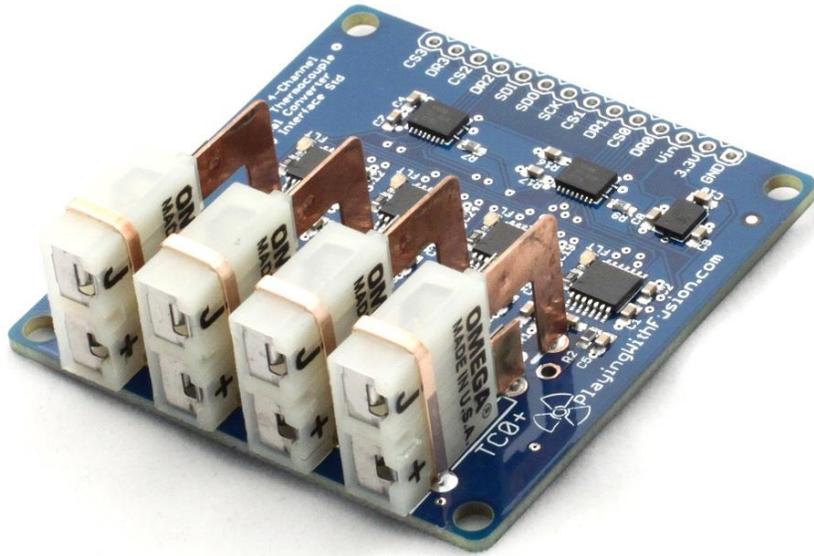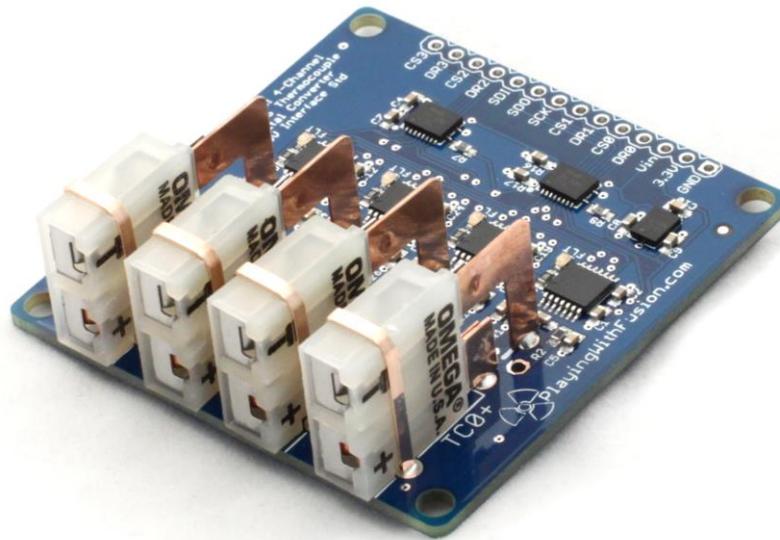

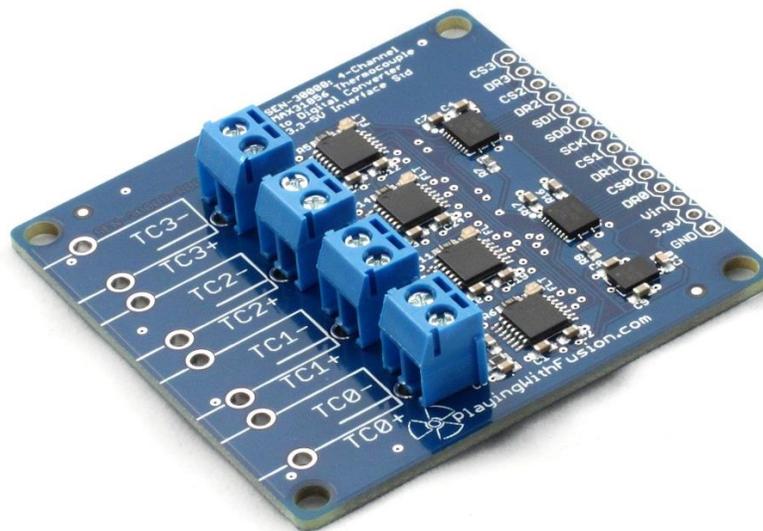
Appendix 1b: Mech Drawing, W and ST Connectors (Top View)

Appendix 2a: SEN-30008, J-Type
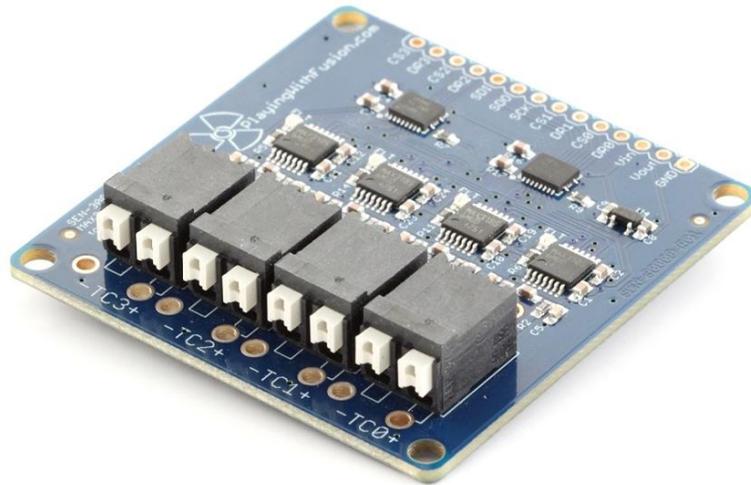
Appendix 2b: SEN-30008, K-Type

Appendix 2c: SEN-30008, T-Type

Appendix 2d: SEN-30008, Screw Terminal

Appendix 2e: SEN-30008, Spring Clamp
with Release

Revision History

Date	Author	Notes
03/16/2021	J. Steinlage	Add pictures