Overview

R3aktor Core integrates a thermocouple measurement front-end with an Arduino compatible core to provide a complete measurement and logging solution in a compact package.

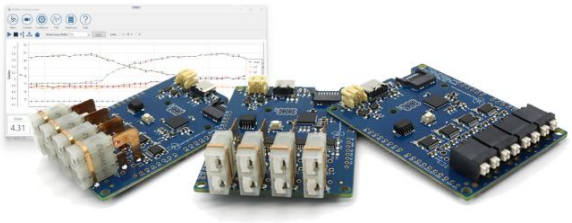
R3aktor ships with full-featured firmware and can record data to the included 4GB SD card or connect to a PC using the free R3aktor Control Center software for live data monitoring, recording, and offline analysis. Its small size, low power consumption, and integrated Li-Po battery charger make it ideal for compact and battery-powered applications.

Features

- Preprogrammed and compatible with R3aktor Control Center PC software.
- 4 Thermocouple inputs (19-bit resolution)
- Li-Po battery charger.
- Micro-SD card slot
- 32-bit SAMD21G18 Processor with 256K Flash and 32k RAM.
- QWIIC compatible I2C connector.
- 1 User controllable LED.
- 1 Analog output (10-bit DAC).
- 13 Analog Inputs including battery voltage monitor (12-bit ADC).
- 29 Digital inputs.
- 15 PWM outputs.
- Regulated 3.3V output.
- Pin compatible with Arduino Uno R3 devices. Electrically compatible with 3.3V compliant shields.

Kit Includes

- FDQ-30001-(x) Thermocouple data acquisition board



- 4 GB SD card

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

R2aktor Core features a 32-bit SAMD micro packaged into an Arduino Uno R3 form factor. High-resolution thermocouple measurements are provided via MAX31856 measurement ICs. R3aktor is further extended by the addition of a micro-SD card slot and integrated single-cell lithium battery charger.

Each R3aktor ships with full featured firmware and is ready for use out of the box. In cases where custom firmware is required or additional features are needed, R3aktor may be programmed by the end user through the standard Arduino IDE.

Electrical Limits and Specifications

Name	Description	Min	Nominal	Max	Unit
V_{Supply}	Supply Voltage	3.3	-	5.5	V
$T_{Ambient}$	Ambient Temperature	-40	-	85	°C
I_{Supply}	Supply Current (No additional shields)	13	31	100	mA
I_{Shield}	Regulated 3.3V power available for shields and external loads	-	-	500	mA
V_{Chrg}	Li Battery Charge Voltage	-	-	4.2	V
I_{Chrg}	Li Battery Charge current	-	-	500	mA
$V_{CommonMode}$	Common mode voltage which may be applied to thermocouple input pins	0.5	-	1.4	V
	Thermocouple Temperature Resolution		19		Bits
			0.0079		°C
	Cold Junction Temperature Resolution		0.0157		°C
	Thermocouple Linearity Correction Error	-0.24	-	+0.25	°C
t_{sample}	Minimum sample period	100	-	-	ms

Thermocouple measurement

True, type-specific mini thermocouple connectors minimize cold-junction error when accuracy matters most. These connectors feature true J, K, and T-type calibrated contact alloys which introduce less measurement error than copper or beryllium copper contacts.

When flexibility is key, R3aktor is available with generic PUSH-IN connectors that allow a single board measure any combination of K, J, N, R, S, T, E, or B thermocouples.

Analog filtering is provided on each thermocouple channel. This includes common- and differential-mode filtering, which compliments the digital notch filter for AC mains frequency noise (50hz or 60hz). This ensures a steady and reliable temperature reading.

R3aktor utilizes MAX31856 measurement ICs for high-resolution (19-bit) thermocouple readings which results in finer than 0.008°C resolution per bit. Each thermocouple channel includes analog filtering (common- and differential-mode) and a digital notch filter for AC mains frequency noise (50Hz or 60Hz) to ensure stable readings. Thermocouple full-scale linearity error is less than ±0.15%.

Grounded thermocouples are not supported.

Battery Powered Operation

The R3aktor Core may be powered by applying 3.3V – 5.5V to either:

a. The USB-C VBUS pin
b. The positive terminal of the battery JST connector

The VBUS pin on the right side of the R3aktor Core PCB

A single cell, 3.7V lithium battery may be connected to the two-pin JST connector at the bottom of the PCB, next to the USB-C connector. R3aktor powers on immediately upon battery connection.

Users must ensure connected batteries include appropriate battery management/protection as no under-voltage limit is enforced by the R3aktor.

Battery charging occurs when 5V is applied to VBUS (R3aktor pin or USB-C connector) via the integrated MCP73831 charge controller. The controller is pre-configured to charge the battery up to 4.2 V at 500mA. The charge LED (located to the right of the JST battery connector) will light when the battery is charging. The LED will turn off when the battery is fully charged.

The charge LED state is undefined when no battery is connected. This LED may flicker on some boards without a battery

Integrated SD Card

R3aktor includes a micro-SD card slot and is compatible with SD cards which support SPI mode and 3.3V operation. Most SD cards support these requirements. If R3aktor is unable to read a particular SD card, attempt to use a card from another manufacturer

SD cards with more than 2 TB of storage in particular do not support SPI mode.

Custom Firmware using Arduino IDE

R3aktor comes pre-loaded with firmware that allows it to connect to the Control Center PC software and preform simple logging and data acquisition.

Alternate firmware may be written using the Arduino IDE. See the Playing with Fusion product page for *instructions* to add the required board support package and MAX31856 driver library

The factory default firmware may be reloaded at any time using Control Center.

For custom firmware, individual MAX31856 ICs are accessed via a 4-wire SPI interface with individual Chip-Select lines.

Thermocouple Channel	Chip Select Pin (Arduino digital input)
TC0	2
TC1	3
TC2	4
TC3	5

Table 1 - MAX31856 Chip Select pin assignments

Ordering Options & Related Parts

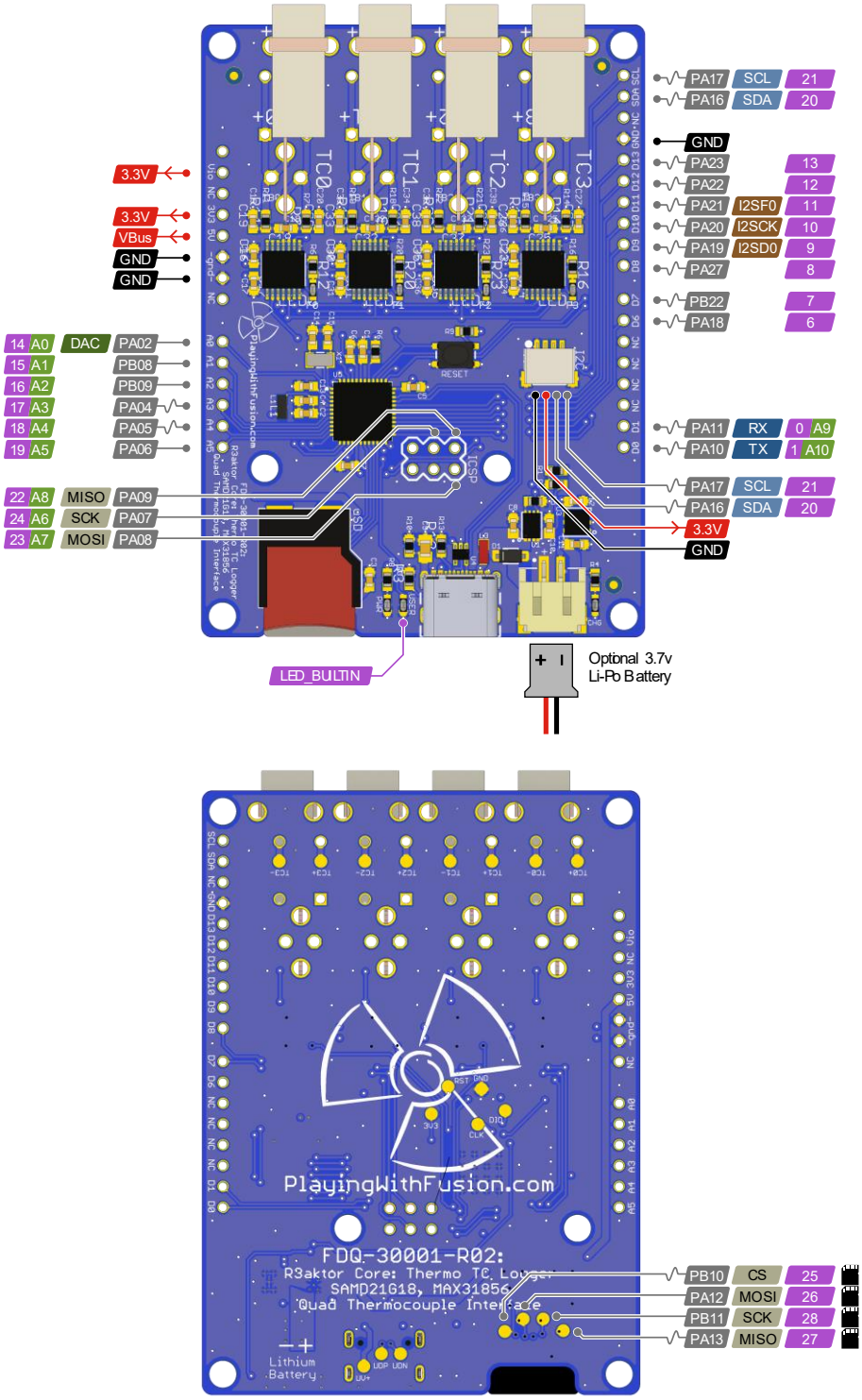
FDQ-30001-J: R3aktor Core - J-type Thermocouple
FDQ-30001-K: R3aktor Core - K-type Thermocouple
FDQ-30001-T: R3aktor Core - T-type Thermocouple
FDQ-30001-W: R3aktor Core - Universal TC

FDQ-30002-PT100: R3aktor Core – PT100 RTD
FDQ-30002-PT1K: R3aktor Core – PT1000 RTD

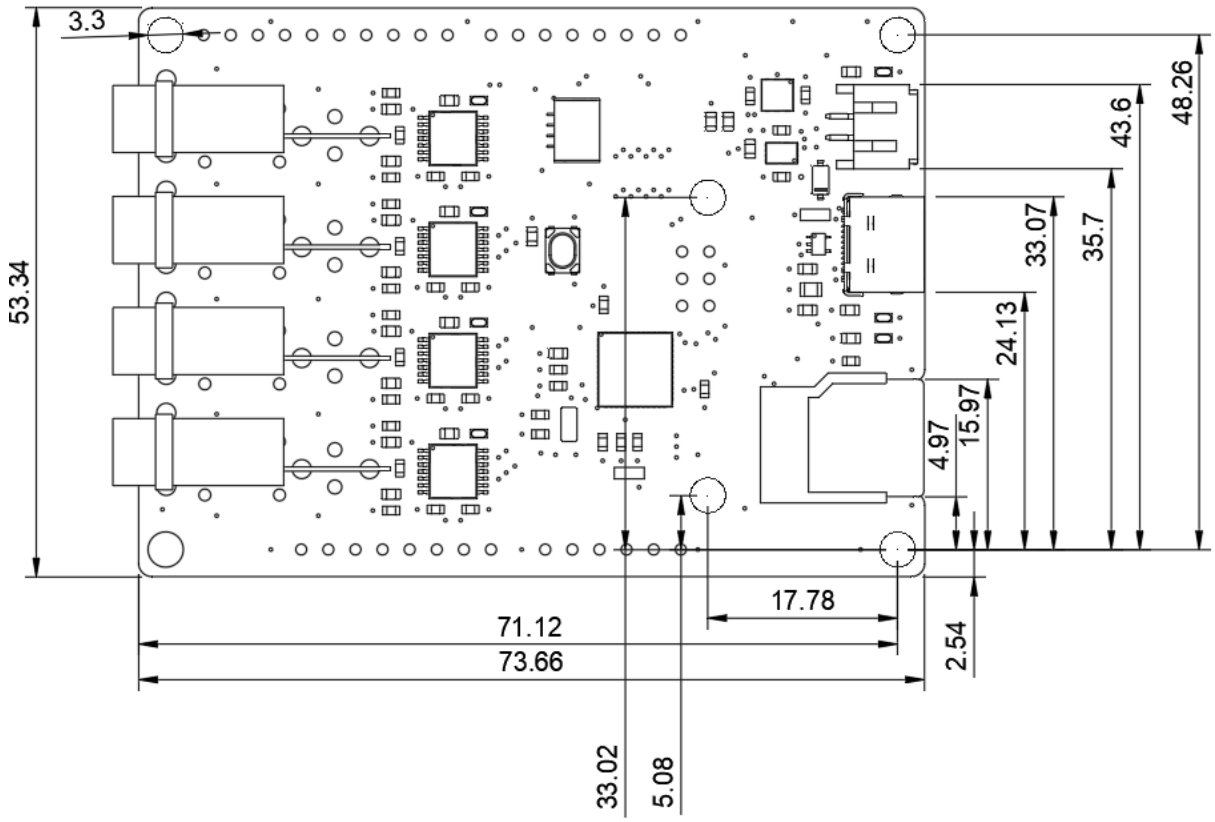
SEN-30012-J: Quad J-type Thermocouple Shield
SEN-30012-K: Quad K-type Thermocouple Shield
SEN-30012-T: Quad T-type Thermocouple Shield
SEN-30012-ST: Quad Screw-terminal TC Shield
SEN-30012-W: Quad Universal Thermocouple Shield

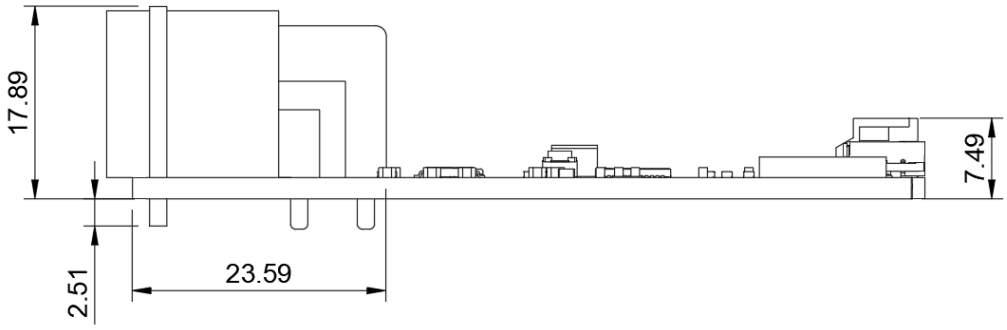
SEN-30203: Quad PT100 RTD Shield
SEN-30203: Quad PT1000 RTD Shield

Pinout


3.3V
3.3V
VBus
GND
GND
14 A0 DAC PA02
15 A1 PB08
16 A2 PB09
17 A3 PA04
18 A4 PA05
19 A5 PA06
22 A8 MISO PA09
24 A6 SCK PA07
23 A7 MOSI PA08
PA17 SCL 21
PA16 SDA 20
GND
PA23 13
PA22 12
PA21 I2SF0 11
PA20 I2SCK 10
PA19 I2SD0 9
PA27 8
PB22 7
PA18 6
PA11 RX 0 A9
PA10 TX 1 A10
PA17 SCL 21
PA16 SDA 20
3.3V
GND
LED_BUILTIN
Optional 3.7v
Li-Po Battery
PlayingWithFusion.com
FDQ-30001-R02:
R3aktor Core: Thermo TC Logger
SAMD21G18, MAX31856
Quad Thermocouple Interface
Lithium
Battery
PB10 CS 25
PA12 MOSI 26
PB11 SCK 28
PA13 MISO 27

Appendix 1: Mech Drawing (Top/Side Views)





Revision History

Date	Author	Notes
07/23/2025	J. Leonard	First revision published