UM3086

User manual

Getting started with the STEVAL-AKI002V1 evaluation board for the ADC1283 analog-to-digital converter

Introduction

The STEVAL-AKI002V1 evaluation board allows evaluating the conversion performance of the ADC1283 eight-channel analog-to-digital converter, which is designed for 50 ksps to 200 ksps conversion.

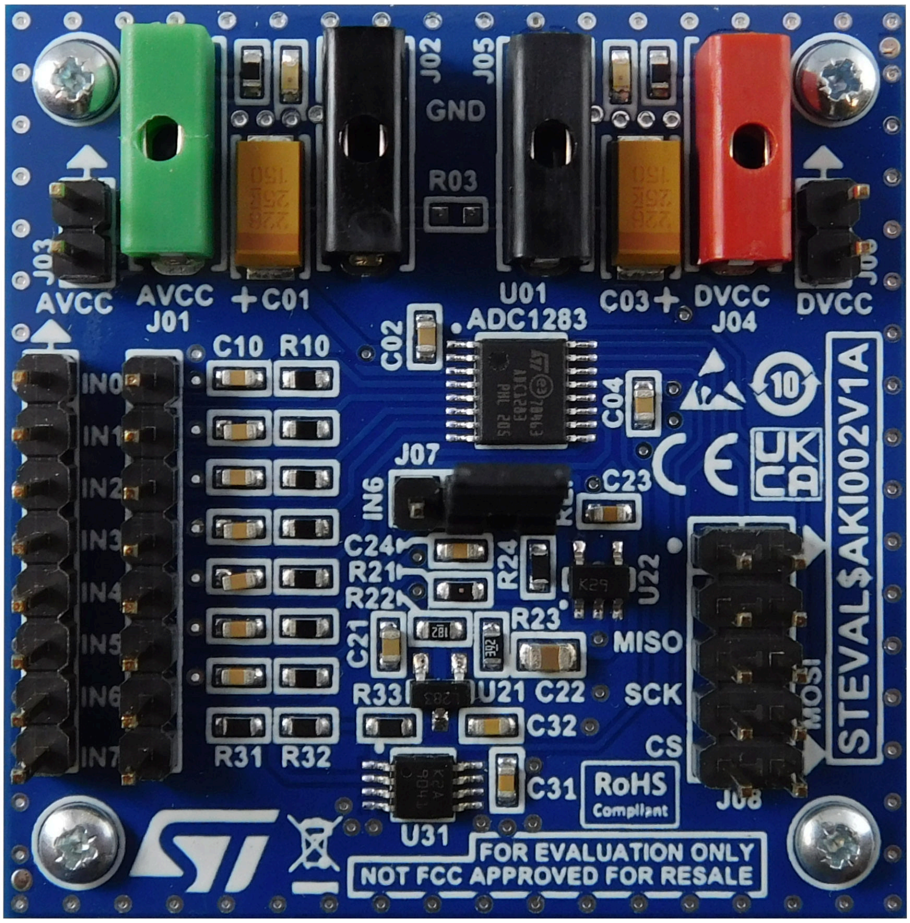
The board can accept external signals to measure and evaluate the ADC1283 conversion performance, based on its successive approximation register (SAR) with an internal track-and-hold cell.

A reference voltage is also present on the board that can be connected to one of the channels through a jumper.

The board can be supplied in standalone mode. It can also be connected to a NUCLEO-L476RG development board hosting an STM32 microcontroller, which enables further signal processing and PC communication.

To monitor the STEVAL-AKI002V1 performance, when connected to the NUCLEO-L476RG, you can use the STSW-AKI GUI.

Figure 1. STEVAL-AKI002V1 evaluation board



1 Getting started

1.1 Features

- Six direct inputs with RC filters (301 ohms/10 nF)
- One input switchable between a direct input and a reference voltage, given by a TS3431 buffered by a TSX711
- One input with a rail-to-rail amplifier (TSV772 with a gain equals to -1)
- SPI communication with Aardvark compatible pinout

1.2 Main components

1.2.1 ADC1283

The ADC1283 is a low-power, eight-channel CMOS 12-bit analog-to-digital converter for conversion from 50 ksps to 200 ksps, tested at 200 ksps (3.2 MHz clock frequency).

The architecture is based on a successive-approximation register with an internal track-and-hold cell.

The ADC1283 features eight single-ended multiplexed inputs. The output serial data is straight binary and is SPI compatible.

1.2.2 TS3431

The TS3431 is an adjustable shunt voltage reference with guaranteed temperature stability over the entire operating temperature range (- 40°C to + 125°C).

The output voltage can be set to any value between 1.24 and 24 V through an external resistor bridge.

Available in a SOT23-3 surface mount package, it can be used in application designs where space saving is critical.

1.2.3 TSX711

The TSX711 operational amplifier offers high precision functioning with low input offset voltage down to a maximum of 200 µV at 25°C. In addition, thanks to its rail-to-rail input and output functionality, it can be used on a full range input and output without limitations.

Thus, the TSX711 has the big advantage of offering a large span of supply voltages, ranging from 2.7 to 16 V.

The low input bias current performance makes the device extremely suited when used for signal conditioning in sensor interface applications.

The high ESD tolerance (4 kV HBM) and wide temperature range make the device suitable also for the automotive market segment.

1.2.4 TSV7722

The TSV7722 is a 22 MHz-bandwidth unity-gain-stable amplifier. The input offset voltage of 200 µV max. (50 µV typical) at room temperature, optimized for common-mode close to ground, makes the device ideal for low-side current measurements.

The TSV7722 can operate from 1.8 to 5.5 V single supply, on a load of 47 pF, allowing an easy usage as A/D converter input buffer.

The device offers rail-to-rail output, excellent speed/power consumption ratio, and 22 MHz gain bandwidth product, while consuming just 1.7 mA at 5 V.

It also features an ultra-low input bias current that enables the connection to photodiodes and other sensors where the current is the key value to be measured.

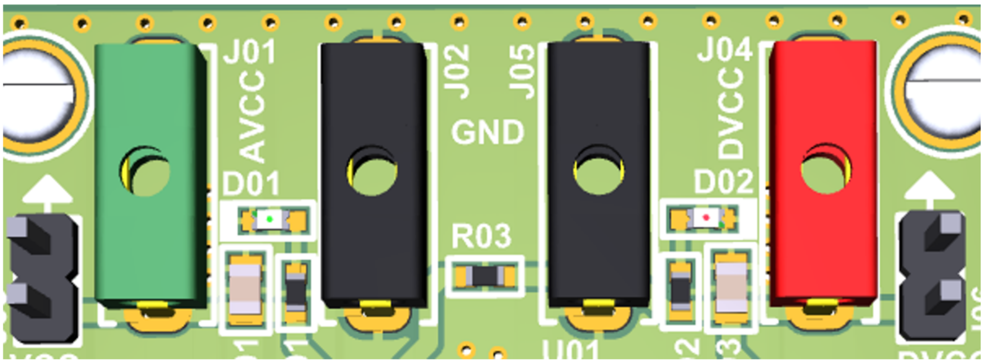
These features make the TSV7722 ideal for high-accuracy, high-bandwidth sensor interfaces.

2 How to use the board

To use the board, follow the procedure below.

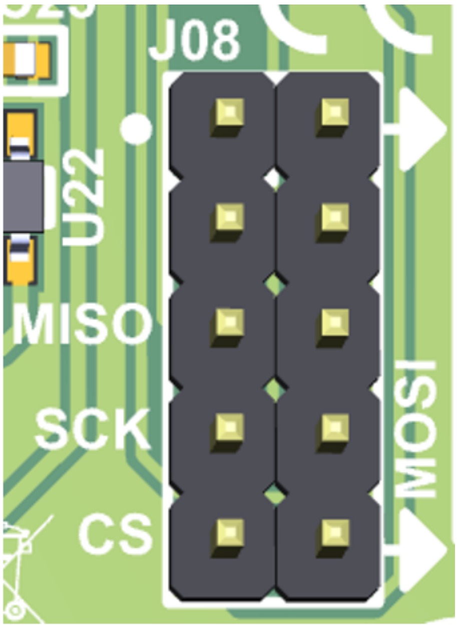
Step 1. Connect the power generators to AVCC and DVCC connectors.
The allowed voltages for AVCC and DVCC are 2.7 to 5.5 V.

Figure 2. AVCC and DVCC connectors



Step 2. Connect the SPI section.
The pinout is compatible with Aardvark by TotalPhase.

Figure 3. SPI connection pins



Step 3. When using the STSW-AKI GUI, refer to the table below for the connection between the STEVAL-AKI002V1 SPI pins and the NUCLEO-L476RG pins.

Table 1. Pinout connection between the STEVAL-AKI002V1 and the NUCLEO-L476RG

NUCLEO-L476RG pin	STEVAL-AKI002V1 SPI pin
PB12	Chip select
PB13	SCLK
PB14	MISO
PB15	MOSI

Step 4. Connect your inputs.

Step 4a. IN0-IN5: direct inputs with RC filters (301 ohms/10 nF).

Step 4b. IN6: input switchable through the J07 jumper between a direct input and a reference voltage given by a TS3431 and buffered by a TSX711.

Step 4c. IN7: input with a rail-to-rail amplifier, TSV772, with a gain equals to -1.

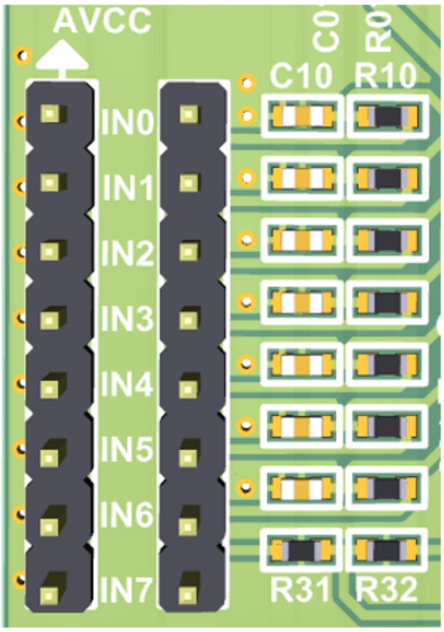


Figure 4. Board section for input connection

3 Communication with the ADC1283

Option A: use the STSW-AKI GUI

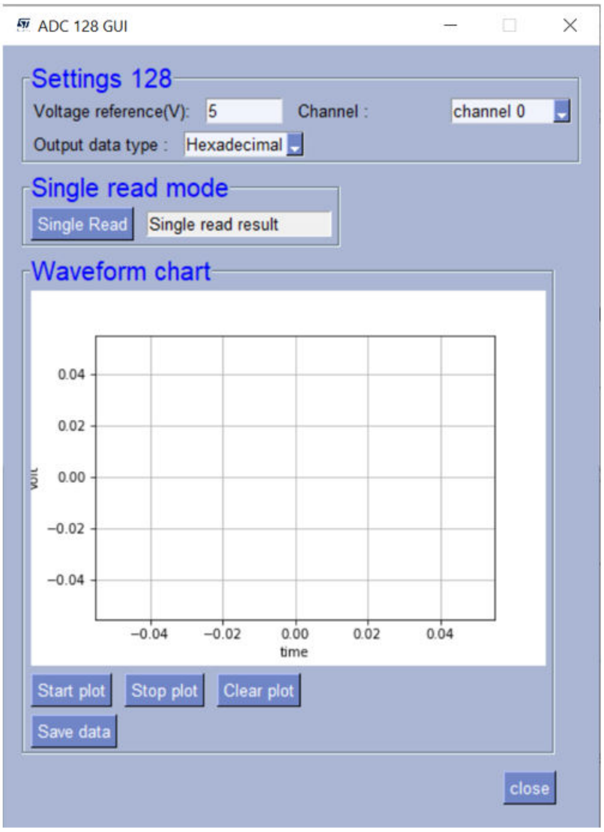
The STEVAL-AKI002V1 can be used with the STSW-AKI GUI. To use it. It is necessary to use a nucleo-64 L476RG.

The STSW-AKI runs on an STM32 Nucleo-64 development board. It communicates with the ADC1283 of the STEVAL-AKI002V1 through the SPI protocol at 125 ksps.

The STSW-AKI allows the user to monitor each channel and plot data on a graph. It is also a tool to save values measured by the ADC1283 in a .csv file.

For more information on the STSW-AKI GUI, go to the relevant ST web page.

Figure 5. STSW-AKI: GUI for ADC120 and ADC1283



Option B: use the STEVAL-AKI002V1 directly with your test solution

The STEVAL-AKI002V1 can be plugged directly to your solution.

The SPI communication to access to the ADC1283 registers giving access to the measured values of each channel is shown in the next tables.

Table 2. Control register bits

Bit #	7 (MSB)	6	5	4	3	2	1	0
Symbol	DONTC	DONTC	ADD2	ADD1	ADD0	DONTC	DONTC	DONTC

Table 3. Control register bit description

Bit #	Symbol	Description
7, 6, 2, 1, 0	DONTC	Don't care
5	ADD2	These bits determine which input channel is converted, as per Table 4
4	ADD1	
3	ADD0	

Table 4. Input channel description

ADD2	ADD1	ADD0	Address value (h)	Input channel
0	0	0	00	IN0
0	0	1	08	IN1
0	1	0	10	IN2
0	1	1	18	IN3
1	0	0	20	IN4
1	0	1	28	IN5
1	1	0	30	IN6
1	1	1	38	IN7

4 V_{REF} measurement and inverter amplifier

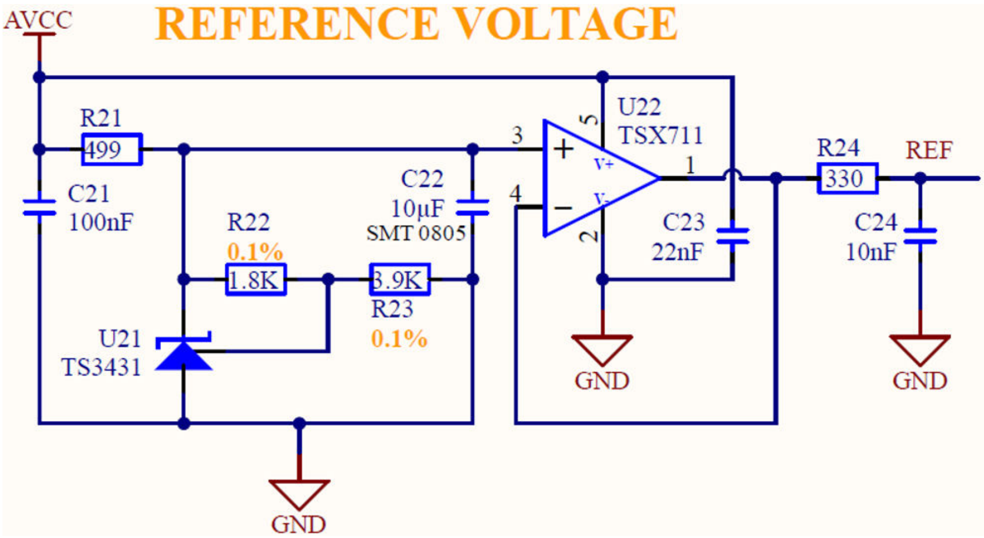
A) 1.8 V reference voltage on channel 6

The STEVAL-AKI002V1 includes a reference voltage based on a TS3431 and buffered by a TSX711.

This reference voltage can be measured on the channel IN6 by selecting “REF” on the J07 jumper.

The reference voltage varies slightly according to the voltage supply. It is still stable around 1.8 V. Hence, it is possible to use it to control the voltage supply applied on the ADC1283 and calibrate it.

Figure 6. 1.8 V reference voltage can be used on IN6



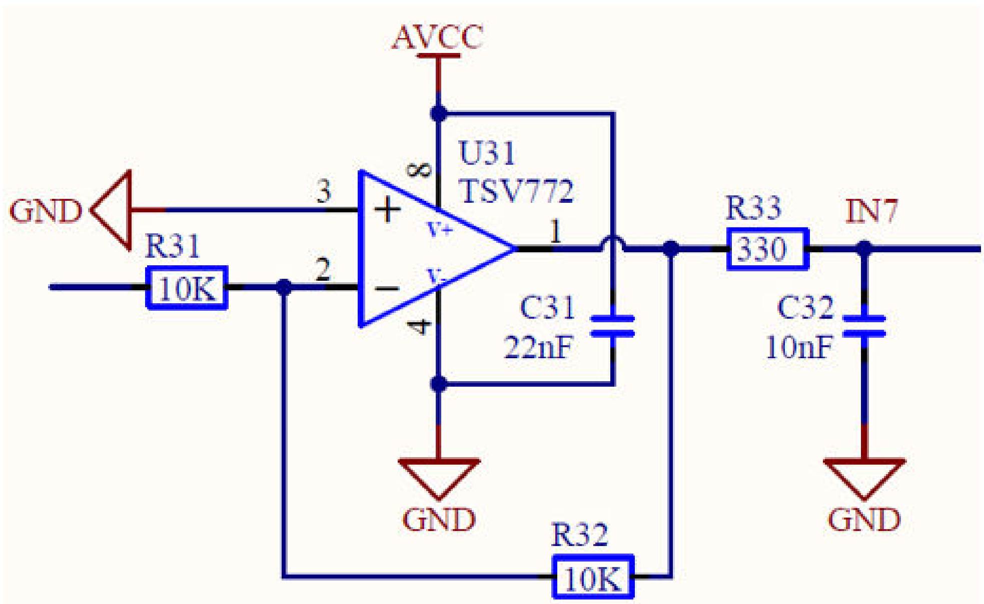
B) Inverter amplifier with a gain of -1 on IN7

On the IN7 input, a TSV772 is used in the inverter function with a gain of -1.

This gives the opportunity to test the functionality of the TSV772 and measure negative values through the ADC1283.

This inverter is directly connected to IN7. The negative value between -AVCC and GND must be applied on IN7.

Figure 7. -1 inverter on IN7



5 STEVAL-AKI002V1 versions

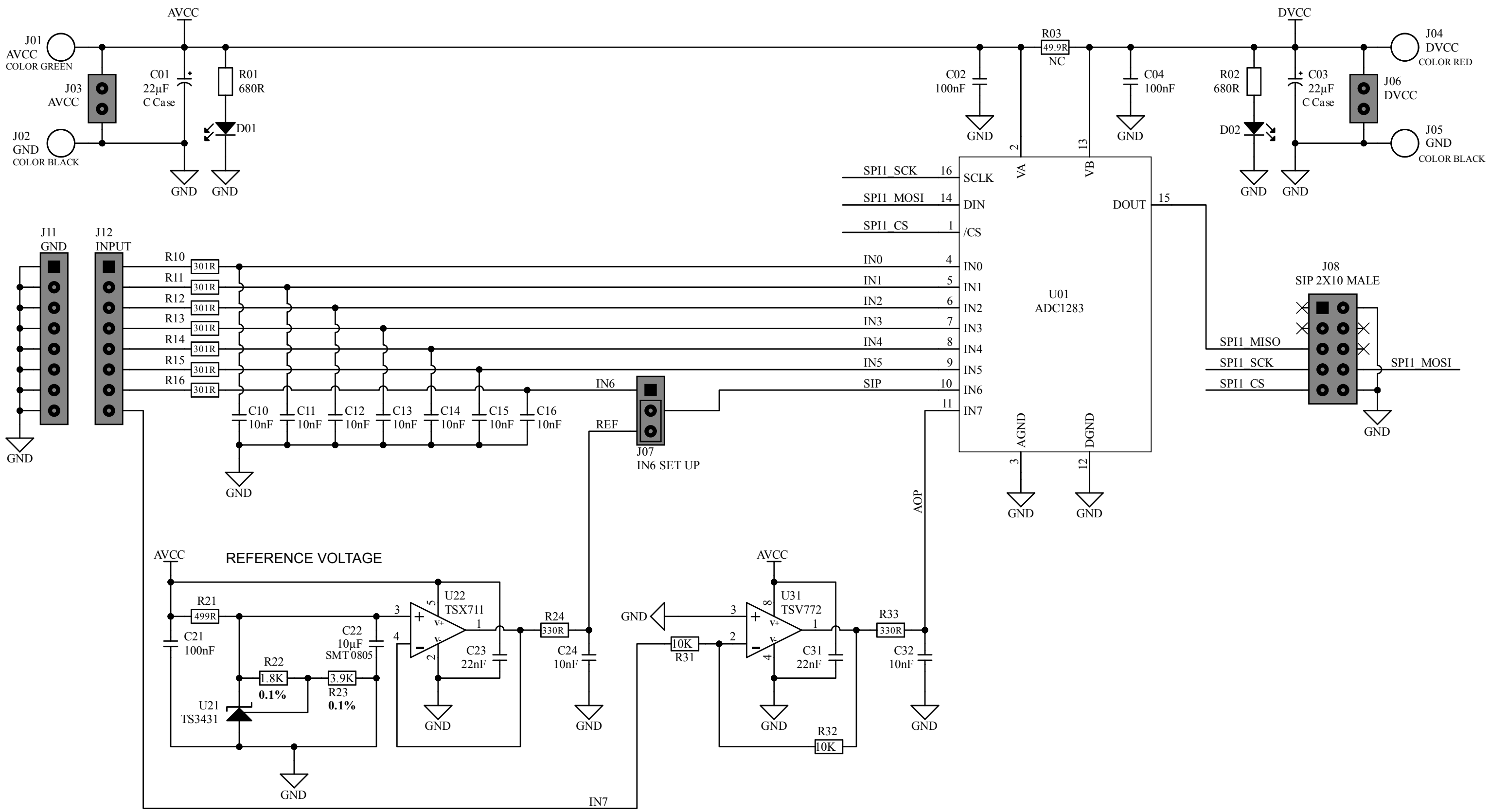
Table 5. STEVAL-AKI002V1 versions

PCB version	Schematic diagrams	Bill of materials
STEVAL$AKI002V1A [1]	STEVAL$AKI002V1A schematic diagrams	STEVAL$AKI002V1A bill of materials

1. *This code identifies the STEVAL-AKI002V1 expansion board first version. It is printed on the board PCB.*

6 Schematic diagram

Figure 8. STEVAL-AKI002V1 circuit schematic



COMMENT

- All passives components without package indication are SMT-0603 package
- All test jack components without package indication are HORIZONTAL TEST JACK 2MM package
- All connector without package indication are MALE HEADER SIP with 2.54 mm STEP package

7 Bill of materials

Table 6. **STEVAL-AKI002V1 bill of materials**

Item	Q.ty	Ref.	Part/value	Description	Manufacturer	Order code
1	2	C01, C03	22µF C case 25V ±20%	Tantalum capacitors	KEMET	T491C226M025AT
2	3	C02, C04, C21	100nF SMT 0603 50V ±10%	Ceramic capacitors	WURTH ELEKTRONIK	885012206095
3	9	C10, C11, C12, C13, C14, C15, C16, C24, C32	10nF SMT 0603 50V ±10%	Ceramic capacitors	WURTH ELEKTRONIK	885012206089
4	1	C22	10µF SMT 0603 25V ±10%	Ceramic capacitors	MURATA	GRM21BR61E106KA73L
5	2	C23, C31	22nF SMT 0603 50V ±10%	Ceramic capacitors	WURTH ELEKTRONIK	885012206091
6	1	D01	COLOR GREEN SMT 0603 2V 20mA	LED	WURTH ELEKTRONIK	150060VS55040
7	1	D02	COLOR RED SMT 0603 2V 20mA	LED	WURTH ELEKTRONIC	150060RS55040
8	1	J01	COLOR GREY HORIZONTAL TEST JACK 2MM 2100 V 5A	Test jack	JOHNSON - CINCH CONNECTIVIT Y	105-0754-001
9	2	J02, J05	COLOR BLACK HORIZONTAL TEST JACK 2MM 2100 V 5A	Test jack	JOHNSON - CINCH CONNECTIVIT Y	105-0753-001
10	2	J03, J06	SIP 1X2 MALE SIP 2 STEP 2.54MM 250VAC 3A	Pin header	WURTH ELEKTRONIK	61300211121
11	1	J04	COLOR RED HORIZONTAL TEST JACK 2MM 2100 V 5A	Test jack	JOHNSON - CINCH CONNECTIVIT Y	105-0752-001
12	1	J07	SIP 1X3 MALE SIP 1X3 STEP 2.54MM 250VAC 3A	Connector header	WURTH ELEKTRONIC	61300311121
13	1	J08	SIP 2X10 MALE SIP 2X5 STEP 2.54MM 250VAC 3A	Pin header	WURTH ELEKTRONIK	61301021121
14	2	J11, J12	SIP 1X8 MALE SIP 1X8 STEP 2.54MM 250VAC 3A	Pin header	WURTH ELEKTRONIK	61300811121
15	1	JU07	COLOR BLACK STEP 2.54 MM 250VAC 3A	Jumper	WURTH ELEKTRONIK	609002115121
16	4	M-01, M-02, M-03, M-04	10MM HOLE M2	Threaded spacer	WURTH ELEKTRONIK	970100244
17	4	M-05, M-06, M-07, M-08	6MM HOLE M3	Screw	MULTICOMP PRO	MP006574

Item	Q.ty	Ref.	Part/value	Description	Manufacturer	Order code
18	1	R01, R102	680R SMT 0603 0.25W±1%	Resistor	PANASONIC	ERJPA3F6800V
19	1	R03	NC SMT 0603 ±1%	Resistor (not mounted)	PANASONIC	ERJPA3F49R9V
20	7	R10, R11, R12, R13, R14, R15, R16	301R SMT 0603 0.25W±1%	Resistor	PANASONIC	ERJPA3F3010V
21	1	R21	449R SMT 0603 ±1%	Resistor	PANASONIC	ERJPA3F4990V
22	1	R22	1.8K SMT 0603 0.1%	Resistor	YAGEO	RT0603BRD071K8L
23	1	R23	3.9K SMT 0603 0.1%	Resistor	YAGEO	RT0603BRD073K9L
24	2	R24, R33	330R SMT 0603 ±1%	Resistor	PANASONIC	ERJPA3F3300V
25	2	R31, R32	10K SMT 0603 ±1%	Resistor	PANASONIC	ERJPA3F1002V
26	1	U01	ADC1283IPT, TSSOP-16L	8-channel, 50 ksps to 200 ksps, 12-bit A-D converter	ST	ADC1283IPT
27	1	U21	TS3431CILT, SOT23	1.24 V adjustable shunt voltage reference	ST	TS3431CILT
28	1	U22	TSX711ILT, SOT23-5L	Precision (200 µV), rail-to-rail 16 V CMOS op-amp, single, GBP 2.7 MHz	ST	TSX711ILT
29	1	U31	TSV7722IST, MiniSO-8	High bandwidth (22 MHz) low offset (200 µV) low-rail 5 V op-amp	ST	TSV7722IST

8 Regulatory compliance information

Notice for US Federal Communication Commission (FCC)

For evaluation only; not FCC approved for resale

FCC NOTICE - This kit is designed to allow:

(1) Product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product and

(2) Software developers to write software applications for use with the end product.

This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter 3.1.2.

Notice for Innovation, Science and Economic Development Canada (ISED)

For evaluation purposes only. This kit generates, uses, and can radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to Industry Canada (IC) rules.

À des fins d'évaluation uniquement. Ce kit génère, utilise et peut émettre de l'énergie radiofréquence et n'a pas été testé pour sa conformité aux limites des appareils informatiques conformément aux règles d'Industrie Canada (IC).

Notice for the European Union

This device is in conformity with the essential requirements of the Directive 2014/30/EU (EMC) and of the Directive 2015/863/EU (RoHS).

Notice for the United Kingdom

This device is in compliance with the UK Electromagnetic Compatibility Regulations 2016 (UK S.I. 2016 No. 1091) and with the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012 (UK S.I. 2012 No. 3032).

Revision history

Table 7. **Document revision history**

Date	Revision	Changes
08-Mar-2023	1	Initial release.

Contents

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