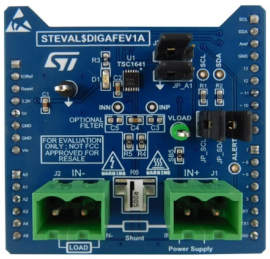

STEVAL-DIGAFEV1 Evaluation Board for TSC1641 User Manual

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UM3202
User manual

Getting started with the STEVAL-DIGAFEV1 evaluation board for the TSC1641

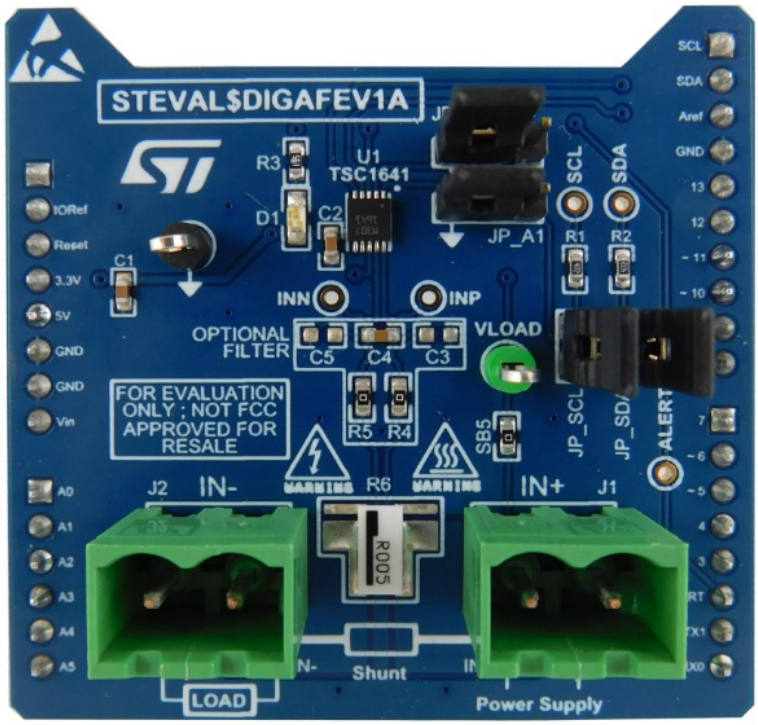
Contents

Introduction

The STEVAL-DIGAFEV1 allows to evaluate the measurement performance and features of the TSC1641, designed to measure current, voltage and power.
The board can accept external voltage and current to measure and evaluate the conversion performance of the TSC1641 conversion performance, based on its Delta-Sigma (ΔΣ) modulators.

Thanks to a led on the board, it is easy to monitor if the alert pin is active.
The STEVAL-DIGAFEV1 can be supplied in standalone mode. It can also be connected to a NUCLEO-H503RB development board that hosts an STM32 microcontroller, allowing further signal processing and communication with the PC.

Figure 1. STEVAL-DIGAFEV1 reference design kit



Getting started

1.1 Features

- 16 bit dual channel for current, voltage, and power monitoring
- Temperature monitoring
- Simple digital connection with I²C up to 1MHz and compatible with MIPI I3C up to 12.5MHz
- From 128µs to 32.768ms total conversion time
- 2.7 to 3.6 V power supply
- Alert signals generated in case of over/under voltage, over/under current, overpower or over temperature
- Load voltage sensing from 0 to 60 V

1.2 Main component

1.2.1 TSC1641

The TSC1641 is a high precision current, voltage, power, and temperature monitoring analog front-end (AFE). It monitors current into a shunt resistor and load voltage up to 60 V in a synchronized way.
The current measurement can be high-side, low-side and bidirectional.
The device integrates high precision 16-bit dual channel ADC with a programmable conversion time from 128 µs to 32.7 ms.
The digital bus interface is flexible from an I²C/SMbus 1 MHz data rate to an MIPI I3C 12.5 MHz data rate. This allows connectivity to most of the recent STM32 products.

How to use the board

2.1 Standalone

The STEVAL-DIGAFEV1 can be used directly with your testing device or I2 C/I3C controller.

Step 1. Connect ground and supply voltage
On the CN1 connector, connect your supply voltage according to the board serigraphy.

Figure 2. CN1 connector for 3.3V power supply

Step 2. Connect the I2 C/I3C bus
On connector CN2, the two top connections are for SDA (data) and SCL (clock).
Connections are clearly labeled in the serigraphy.

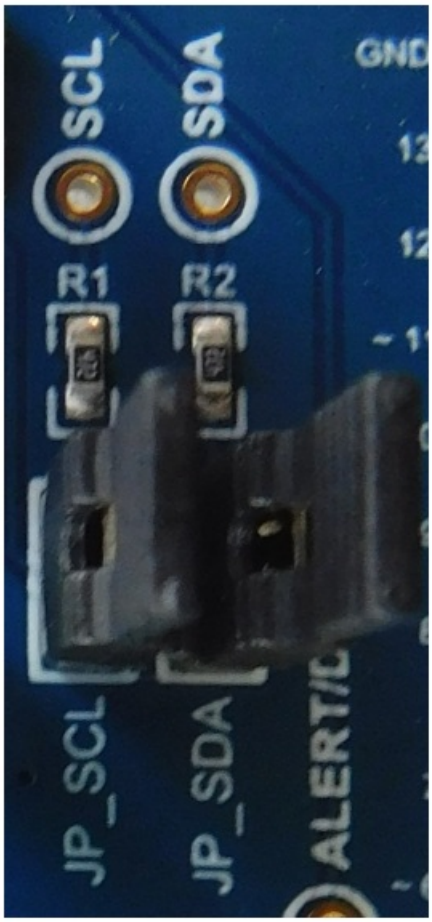
Figure 3. CN2 connector for I²C/I3C connection

I²C

I²C communication bus requires pull-up resistors. The STEVAL-DIGAFEV1 has two 4.7k ohm pull-up resistors on SDA and SCL lines.

These pull-up resistors can be connected thanks to JP_SDA and JP_SDL jumpers.

Figure 4. Jumpers to connect SDA and SCL pull-up resistors



It is also needed to give to the TSC1641 a static address by changing the with the A0/A1 value thanks to JP_A0 and JP_A1 jumpers.

Figure 5. Jumpers to set I²C static address

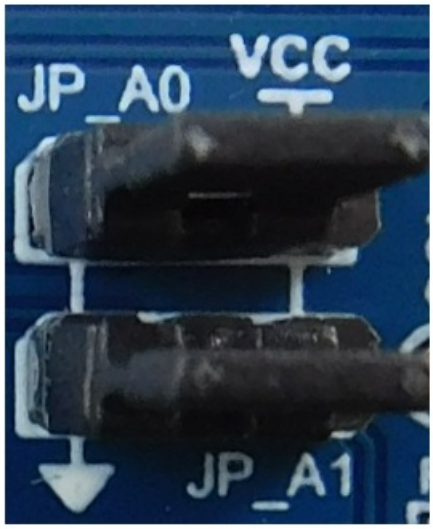


Table 1. Table of static addresses and I3C PIDs

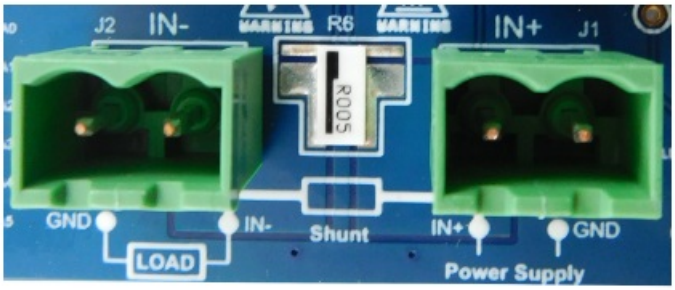
A1	A0	Target address (binary)	Target address (h)	Provisional ID (PID) value (h)
GND	GND	1000000	40	0208020A0001
GND	VS	1000001	41	0208020A1001
VS	GND	1000010	42	0208020A2001
VS	VS	1000011	43	0208020A3001

I3C
I3C communications do not require pull-up resistors, hence JP_SDA and JP_SDL jumpers must be unplugged.
The maximum communication speeds are detailed table for I²C & I3C speeds.
Table 2. Table for I²C & I3C speeds

Communication type	Speed
I²C	1 MHz
I3C	12.5 MHz

Step 3. Connect load and Vload power to supply
For high-side measurement, connect your power supply (the vload to measure) to the J1 connector, and the load to the J2 connector.

Figure 6. J1 and J2 connectors for LOAD connection



2.2 With a NUCLEO-STM32
To use the board, follow below procedure:
Step 1. Plug the STEVAL-DIGAFEV1
The STEVAL-DIGAFEV1 is compatible with the wide majority of Nucleon board thanks to its Arduino pinout.
Connecting the STEVAL-DIGAFEV1 to a nucleon make it supplied by the 3.3V of the nucleon board.
For a better interconnection, it is better to use the NUCLEO-H503RB which support I3C communications.
Table 3. Table for the connection to the NUCLEO-H503RB

NUCLEO-H503RB	STEVAL-DIGAFEV1 SPI pin
PB8	SCLK
PB9	SDA (data)
PA10	ALERT/CVRDY

Communication with the TSC1641

Option A: use the STSW-DIGAFEV1 GUI

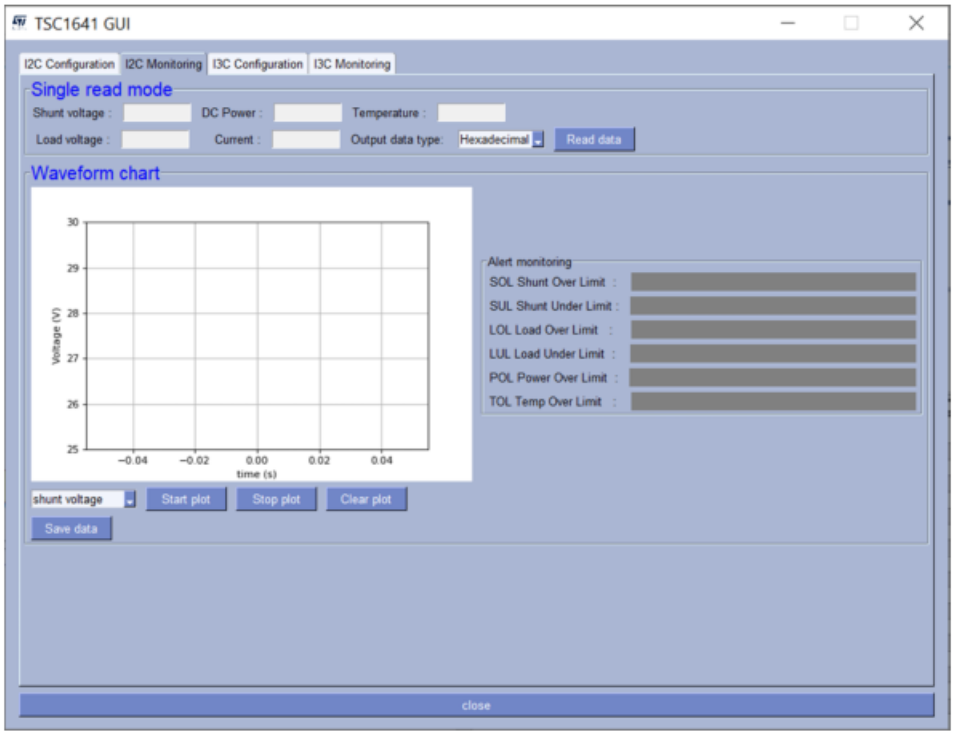
The STEVAL-DIGAFEV1 can be used with the STSW-DIGAFEV1GUI. It is necessary to program the nucleo-64 H503RB with the STSW-DIGAFEV1FW to use it.

The STSW-DIGAFEV1FW runs on an STM32 Nucleo-64 development board NUCLEO-H503RB. It communicates with the TSC1641 of the STEVAL-DIGAFEV1 through the I2 C and I3C protocols.

The STSW-DIGAFEV1GUI allows the user to write configuration registers, monitor current, voltage, and power and plot data on a graph. It is also a tool to save values measured by the TSC1641 in a .csv file.

For more information on the STSW-DIGAFEV1GUI, go to the relevant ST web page.

Figure 7. STSW-DIGAFEV1GUI graphical user interface



Option B: use the STEVAL-DIGAFEV1 directly with your test solution

The STEVAL-DIGAFEV1 can be plugged directly to your solution.

The I2 C/I3C communication to access the TSC1641 registers is shown in the table:

Table 4. Map register of the TSC1641

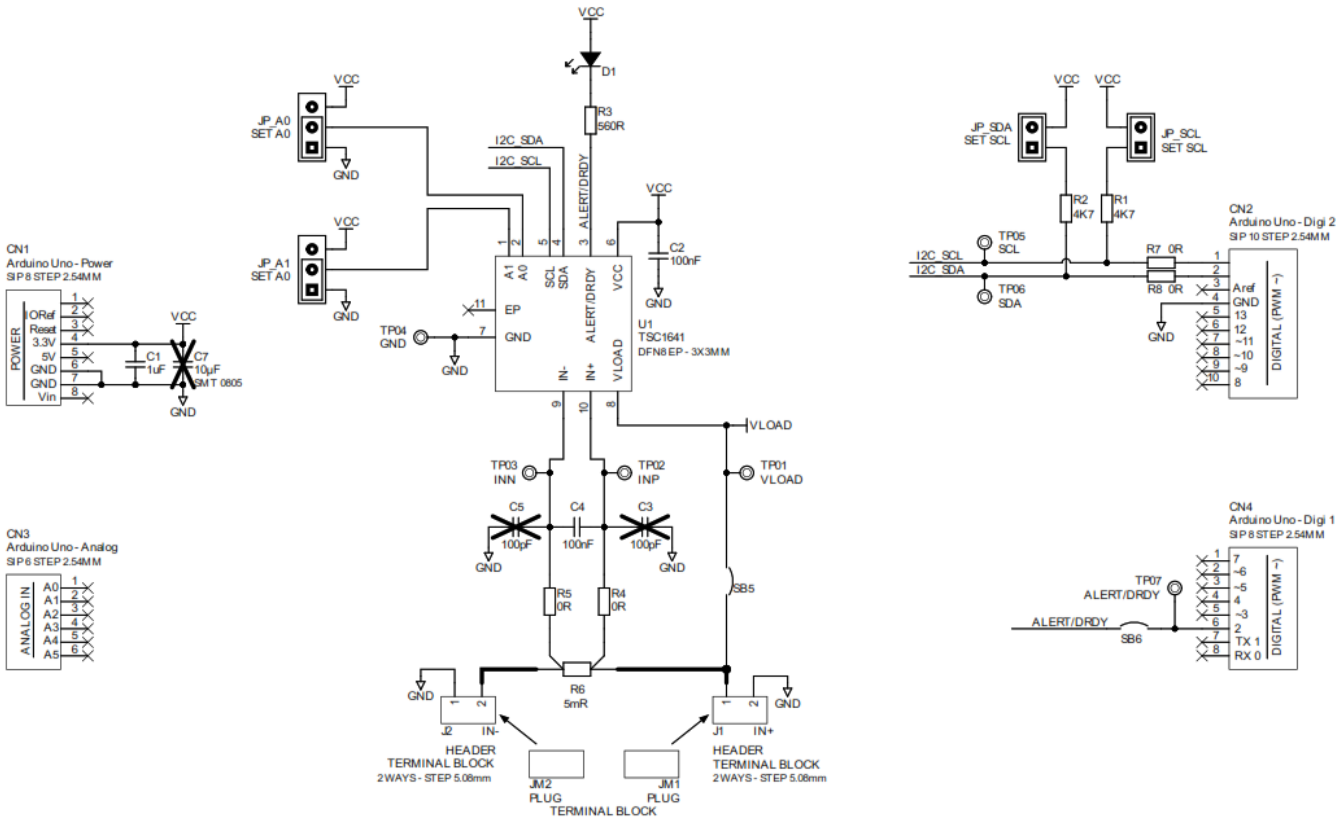
Pointer address (hex)	Register name	Type	Default value	Reset after POR	Reset after Shutdown mode	Reset after Idle mode	Reset after RST
00h	Configuration register	R/W	0037h	yes	no	no	yes
01h	Shunt voltage register	R	0000h	yes	no	no	yes
02h	Load voltage resister	R	0000h	yes	no	no	yes
03h	DC power register	R	0000h	yes	no	no	yes
04h	Current register	R	0000h	yes	no	no	yes
05h	Temperature register	R	8000 h	yes	no	no	yes
06h	Mask register	R/W	0000h	yes	no	no	yes
07h	Flags register	R	0000h	yes	no	no	yes
08h	Rshunt register	R/W	0000h	yes	no	no	no
09h	SOL alert limit register	R/W	0000h	yes	no	no	no
0Ah	SUL alert limit register	R/W	0000h	yes	no	no	no
0Bh	LOL alert limit register	R/W	0000h	yes	no	no	no
0Ch	LUL alert limit register	R/W	0000h	yes	no	no	no
0Dh	POL alert limit register	R/W	0000h	yes	no	no	no
0Eh	TOL alert limit register	R/W	0000h	yes	no	no	no
FEh	Manufacturing id	R	0006h	yes	no	no	no
FFh	DiE ID register	R	1000 h	yes	no	no	no

Precautions for use

The board is not immune to the disturbance generated from intense radiant sources, according to EN IEC 61000-4-3. During the radiated immunity testing, the board obtained level B, meaning that the board was not damaged during the test, but showed a performance degradation of over 2% in voltage and current measurement.

Schematic diagrams

Figure 8. **STEVAL-DIGAFEV1 circuit schematic**



Bill of materials

Table 5. STEVAL-DIGAFEV1 bill of materials

Item	Q. ty	Ref.	Part/value	Description	Manufacturer	Order code
1	1	C1	1uF	Ceramic capacitors	TDK	CGA3E3X5R1H105K080AB
2	1	C2	100nF	Ceramic capacitors	TDK	C1608X5R1H104K080AA
3	0	C3, C5	100pF	Ceramic capacitors	MURATA	GCM1885C2A101JA16D
2	1	C4	100nF	Ceramic capacitors	TDK	C1608X5R1H104K080AA
4	0	C7	10µF	Ceramic capacitors	MURATA	GRM21BR6YA106KE43L
5	1	CN1	SIP 1X8 FEMALE	Connector header	AMP – TE CONNECTIVITY	826629-8
6	1	CN2	SIP 1X10 FEMALE	Connector header	AMP – TE CONNECTIVITY	1-826629-0

7	1	CN3	SIP 1X6 FEMALE	Connector header	AMP – TE CONNECTIVITY	826629-6
8	1	CN4	SIP 1X8 FEMALE	Connector header	AMP – TE CONNECTIVITY	826629-8
9	1	D1	RED COLOR	LED	WURTH ELECTRONIC	150080RS75000
10	2	J1, J2	HEADER	Connector – terminal Block	BUCHANAN – TE CONNECTIVITY	282825-2
11	2	JM1, JM2	PLUG	Connector – terminal Block	BUCHANAN – TE CONNECTIVITY	796634-2
12	2	JP_A0, JP_A1	SIP 1X3 MALE	Connector header	WURTH ELEKTRONIK	61300311121
13	2	JP_SCL, JP_SDA	SIP 1X2 MALE	Connector header	WURTH ELEKTRONIK	61300211121
14	4	JU_A0, JU_A1, JU_SCL, JU_SDA	BLACK COLOR	Jumper	WURTH ELEKTRONIK	609002115121
15	2	R1, R2	4K7	Resistor	VISHAY / DALE	CRCW06034K70FKEC
16	1	R3	560R	Resistor	VISHAY / DALE	CRCW0603560RFKEA
17	4	R4, R5, R7, R8	0R	Resistor	VISHAY / DALE	RCA06030000ZSEA
18	1	R6	5mR	Resistor – Kelvin shunt	OHMITE	FC4L64R005FER
19	2	SB5, SB6	0R	Resistor	PANASONIC	ERJPA3F6800V
20	1	TP01	GREEN COLOR	Eastpoint	Any	
21	1	TP04	BLACK COLOR	Eastpoint	Any	
22	1	U1	TSC1641	Digital Current Sense AFE, with I²C / SMBus and MIPI I3C compatible interface	ST	TSC1641

Board versions

Table 6. STEVAL-DIGAFEV1 versions

PCB version	Schematic diagrams	Bill of materials
STEVAL$DIGAFEV1A (1)	STEVAL$DIGAFEV1A schematic diagrams	STEVAL$DIGAFEV1A bill of materials

1. This code identifies the STEVAL-DIGAFEV1 evaluation board first version. The STEVAL$DIGAFEV1A code is printed on the board.

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.
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
03-Aug-2023	1	Initial release.

List of tables

List of figures

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Documents / Resources

	ST STEVAL-DIGAFEV1 Evaluation Board for TSC1641 [pdf] User Manual TSC1641, STEVAL-DIGAFEV1 Evaluation Board for TSC1641, STEVAL-DIGAFEV1, Evaluation Board for TSC1641, STEVAL-DIGAFEV1 Evaluation Board, Evaluation Board, Board

References

- STMicroelectronics: Our technology starts with you
- NUCLEO-H503RB - STM32 Nucleo-64 development board with STM32H503RBT6 MCU, supports Arduino and ST Morpho connectivity - STMicroelectronics
- STEVAL-DIGAFEV1 - Evaluation board for the TSC1641, 16-bit, high precision current and power monitor with MIPI I3C/I2C interface - STMicroelectronics
- TSC1641 - 60V, 16-bit, High precision, I3C/I2C, digital current/voltage/power/temperature Monitor - STMicroelectronics
- STMicroelectronics Trademark List - STMicroelectronics
- STEVAL-DIGAFEV1 - Evaluation board for the TSC1641, 16-bit, high precision current and power monitor with MIPI I3C/I2C interface - STMicroelectronics