

**ABSTRACT**

This document provides detailed information on how to set up and use the TCA9416 evaluation module. The TCA9416 provides industry low-level translation, including rise- and fall-time accelerators, for I2C systems at a small package size which the personal electronics market is headed towards as power consumption and smaller size becomes a concern. This evaluation module allows for easy testing of pullup resistors and load capacitance since both are adjustable features on the board.

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**1 Introduction**

This EVM allows designers to evaluate the TCA9416 device at different loading conditions (pullup resistors and bus capacitance), VCC voltages, and series resistances, if needed. The back of EVM board is populated with the DTM package (denoted as U1). The EVM supports the DDF package (denoted as U2); however, it must be populated by the designer.

**1.1 Features**

This EVM supports:

- Adjustable pullup resistors on both sides of the TCA9416 with jumper shunts
- Adjustable load capacitance on both sides of the TCA9416 with DIP switches
- Test Points on SDA and SCL on both sides of the TCA9416
- Male header connections to all TCA9416 pins for ease of use
- Unpopulated DDF package (denoted as U2 on the top side of the board)

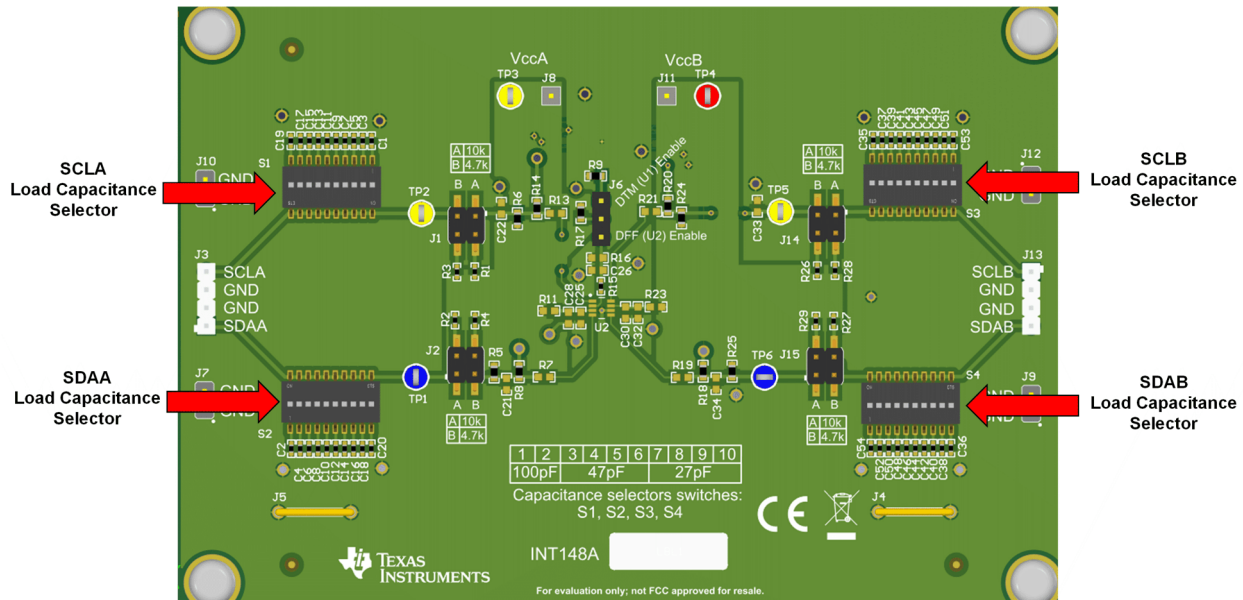
## 2 EVM Setup

The following equipment is needed to evaluate the TCA9416:

- Power supply capable of supplying the desired voltage to the TCA9416 and I<sup>2</sup>C bus
- 4-channel oscilloscope to observe I<sup>2</sup>C transactions on both sides of the TCA9416
- Microcontroller, processor, or digital analyzer which can send and receive I<sup>2</sup>C

### 2.1 Load Capacitance Selector

Figure 2-1 shows the board with the load capacitance selectors labeled.



**Figure 2-1. Load Capacitor Selector**

The TCA9416 EVM provides a way for the designer to test the device under capacitive loading which is one of the main constraints in an I<sup>2</sup>C system. Switches denoted as S1, S2, S3, and S4 provide the user with the ability to change the I<sup>2</sup>C bus capacitance with up to about 500 pF of capacitance. The switched capacitor can be selected in increments of approximately 25 pF, 50 pF, and 100 pF. Each of the switched capacitors have two of each value so any capacitive loading between 0 pF to 500 pF in any factor of 25 pF can be chosen. For example: if the designer wants a total capacitance of 275 pF, the designer chooses to switch in 2 × 100 pF, 1 × 50 pF, and 1 × 25 pF for a combined capacitance of approximately 275 pF.

Note that there is additional capacitance due to parasitics from the PCB line traces and ICs on the board. For SDA and SCL pins of a device, assume 10 pF maximum per device on the I<sup>2</sup>C line. One important aspect to remember is the TCA9416 device does not re-drive an I<sup>2</sup>C signal. This means the capacitance on both sides of the device are not separated but are technically connected (meaning they add up in parallel) when the signal goes from LOW to HIGH from either SDA or SCL. This is highlighted because the I<sup>2</sup>C standard limits the bus capacitance to 400 pF for standard and fast mode and 550 pF for fast mode plus. If the I<sup>2</sup>C system is expected to exceed this amount, an I<sup>2</sup>C buffer and re-driver will be necessary to separate the capacitance between the two sides to be below the required capacitance limits.

### 3 Pullup Resistor Selector

The TCA9416EVM provides optional pullup resistor selectors on SDAA, SDAB, SCLA, and SCLB. Remember that the TCA9416 includes its own internal 10-k $\Omega$  pullup resistors on the signal lines. The TCA9416EVM also has weak external 20-k $\Omega$  pullup resistors populated and denoted as R6, R8, R24, and R25 on the signal lines.

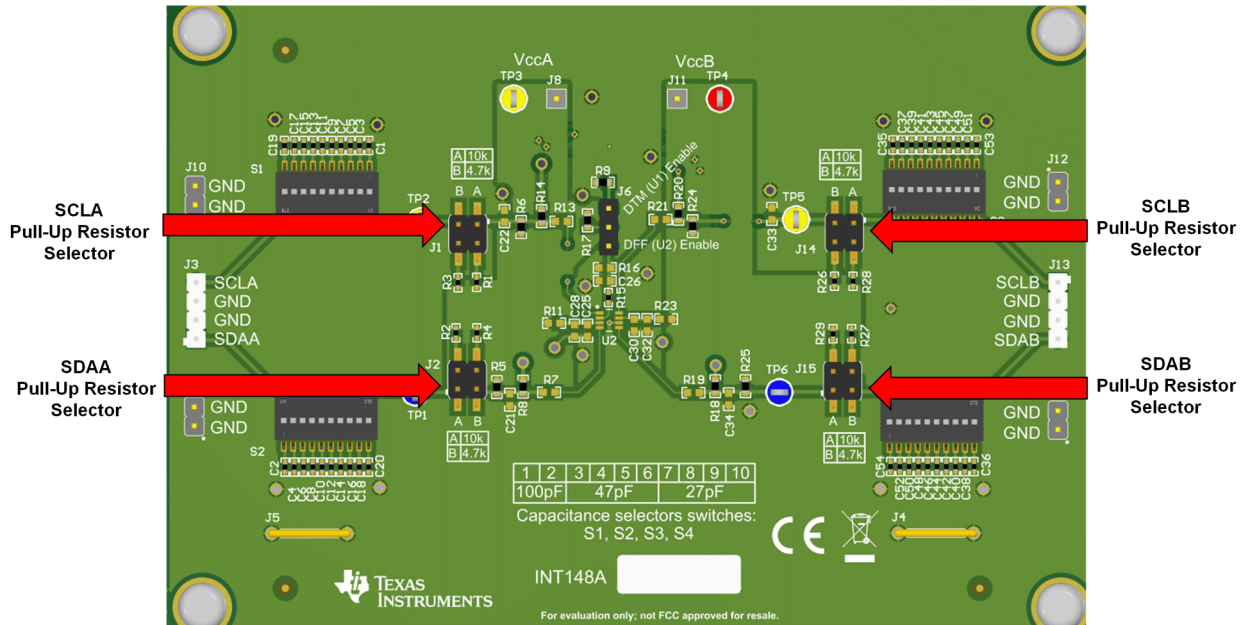


Figure 3-1. Pullup Resistor Select

J1, J2, J14, and J15 are used to select the pullup resistors on SCLA, SDAA, SDAB, and SCLB. All jumpers have the letters 'A' and 'B' to denote the value of the pullup resistors. Multiple pullup resistors can be selected on J1, J2, J14, and J15 which would put the pullup resistors in parallel. The possible equivalent pullup resistances are displayed in .Table 3-1.

Table 3-1. J8 and J11 Pullup Resistor Selector

Pullup Resistor Combinations	Equivalent Pullup Resistance ( $\Omega$ )
None Selected	6.6 k $\Omega$ (Internal 10 k $\Omega$ plus external 20 k $\Omega$ in parallel)
A	4 k $\Omega$
B	2.7 k $\Omega$
B // C	2.1 k $\Omega$

### 3.1 Board Layout

Figure 3-2 and Figure 3-3 illustrate the top and bottom EVM board layouts.

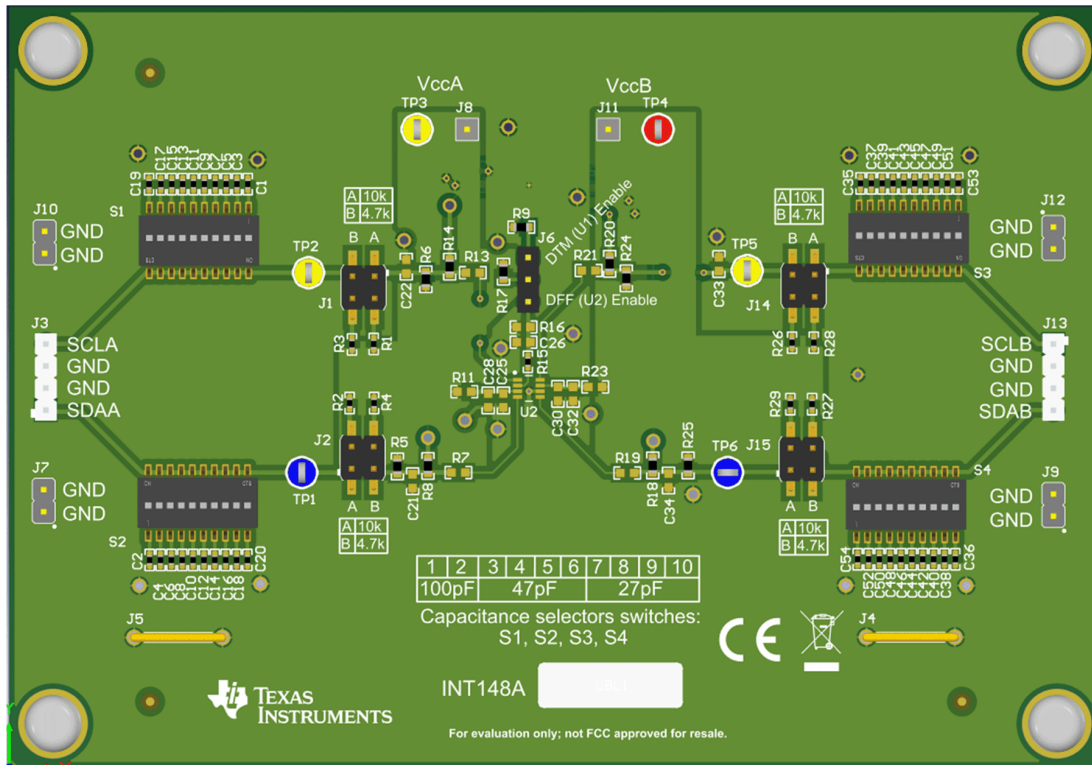


Figure 3-2. EVM Top

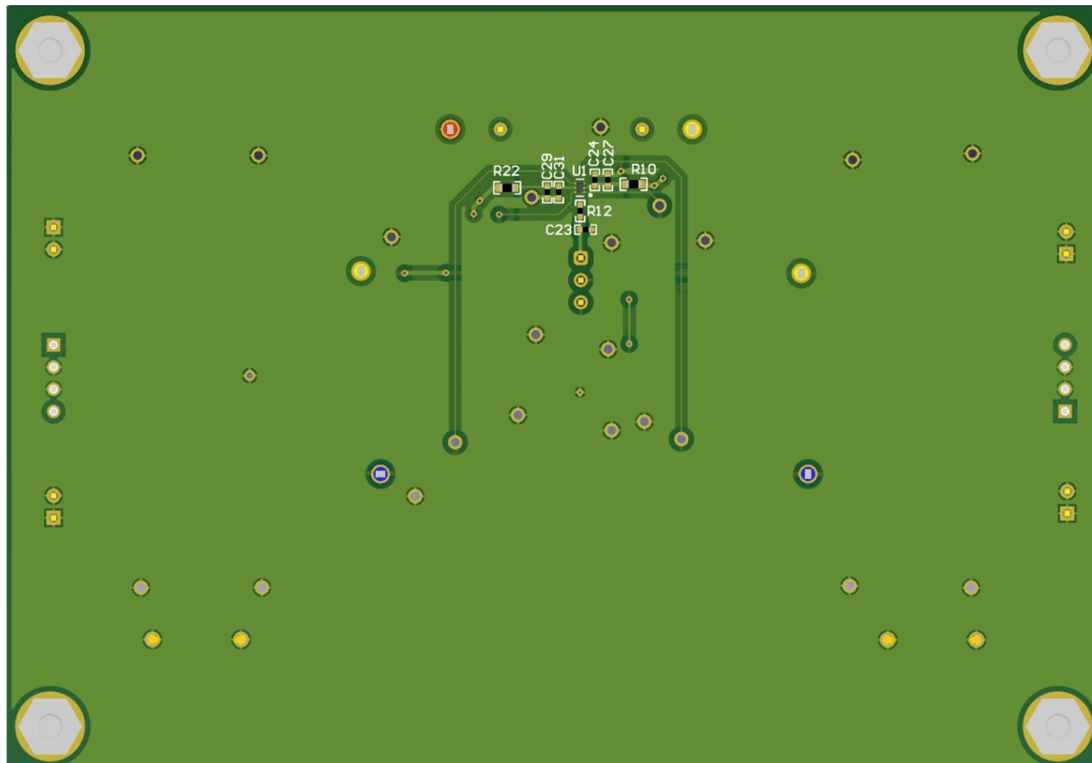


Figure 3-3. EVM Bottom

## 4 Schematic

Figure 4-1 illustrates the EVM schematic.

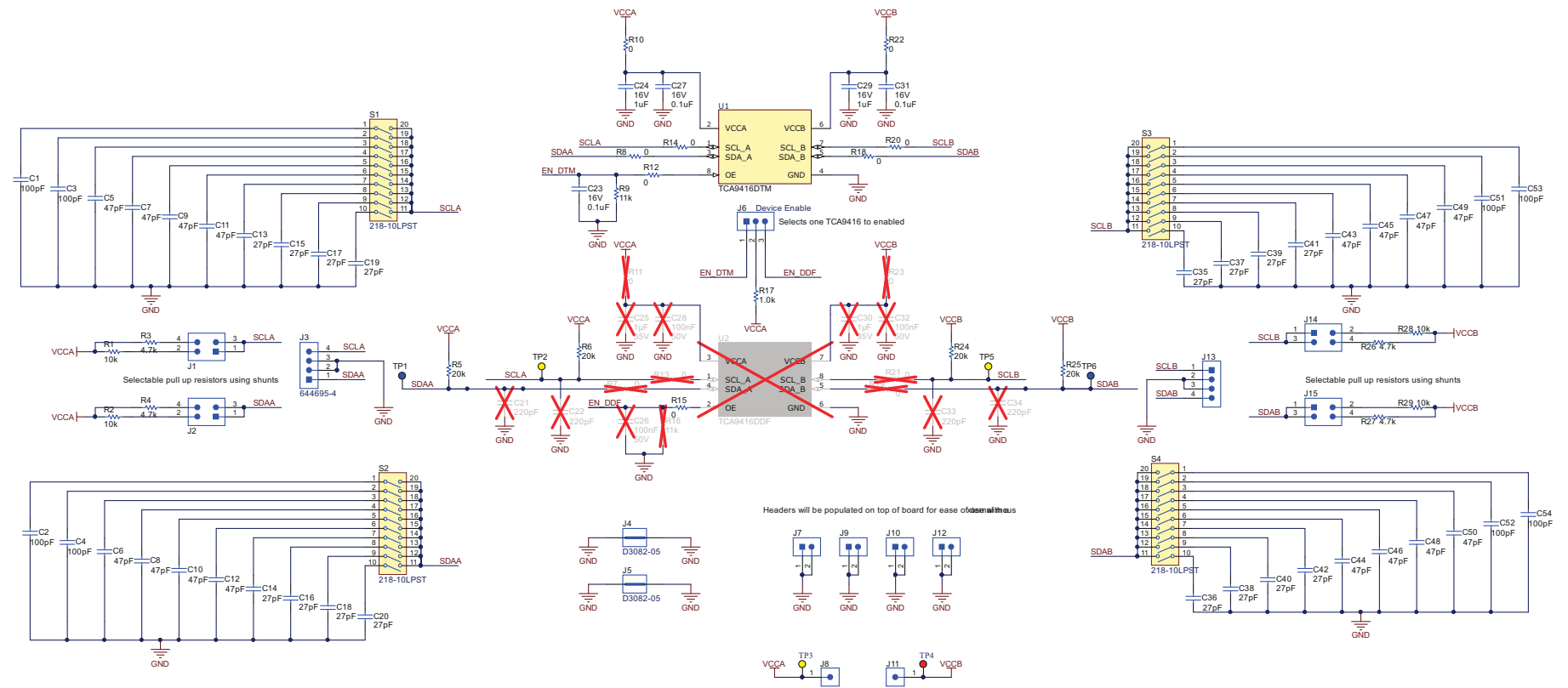


Figure 4-1. TCA9416EVM Schematic

## 4.1 Bill of Materials

Table 4-1 lists the EVM bill of materials.

**Table 4-1. TCA9416EVM Bill of Materials**

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer
PCB1	1		Printed Circuit Board		INT148	Any
C1, C2, C3, C4, C51, C52, C53, C54	8	100pF	CAP, CERM, 100 pF, 50 V, ±1%, C0G/NP0, 0402	0402	04025A101FAT2A	AVX
C5, C6, C7, C8, C9, C10, C11, C12, C43, C44, C45, C46, C47, C48, C49, C50	16	47 pF	CAP, CERM, 47 pF, 50 V, ±5%, C0G/NP0, 0402	0402	885012005044	Würth Elektronik
C13, C14, C15, C16, C17, C18, C19, C20, C35, C36, C37, C38, C39, C40, C41, C42	16	27pF	CAP, CERM, 27 pF, 50 V, ±5%, C0G/NP0, AEC-Q200 Grade 1, 0402	0402	GCM1555C1H270JA16D	MuRata
C23, C27, C31	3	0.1 uF	CAP, CERM, 0.1 uF, 16 V, ±10%, X7R, 0402	0402	ATC530L104KT16T	AT Ceramics
C24, C29	2	1 uF	CAP, CERM, 1 uF, 16 V, ±10%, X5R, 0402	0402	EMK105BJ105KVHF	Taiyo Yuden
H1, H3, H5, H7	4		Standoff, Hex, 0.5"L #4-40 Nylon	Standoff	1902C	Keystone
H2, H4, H6, H8	4		Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead	Screw	NY PMS 440 0025 PH	B&F Fastener Supply
J1, J2, J14, J15	4		Header, 2.54mm, 2x2, Gold, SMT	Header, 2.54mm, 2x2, Gold, TH	61030421121	Würth Elektronik
J3, J13	2		Header, 100mil, 4x1, Tin, TH	Header, 2.54 mm, 4x1, TH	644695-4TE Connectivity	TE Connectivity
J4, J5	2		1mm Uninsulated Shorting Plug, 10.16mm spacing, TH	Shorting Plug, 10.16mm spacing, TH	D3082-05	Harwin
J6	1		Header, 100mil, 3x1, Gold, TH	3x1 Header	61030421121	Samtec
J7, J9, J10, J12	4		Header, 100mil, 2x1, Gold, TH	Sullins 100mil, 1x2, 230 mil above insulator	PBC02SAAN	Sullins Connector Solutions
J8, J11	2		Header, 2.54mm, 1x1, Gold, TH	Header, 2.54mm, 1x1, TH	HTSW-101-07-G-S	Samtec
LBL1			Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	PCB Label 0.650 x 0.200 inch	THT-14-423-10	Brady
R1, R2, R28, R29	4	10k	RES, 10 k, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040210K0JNED	Vishay-Dale
R3, R4, R26, R27	4	4.7k	RES, 4.7 k, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04024K70JNED	Vishay-Dale
R5, R6, R24, R25	4	20k	RES, 20 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW060320K0JNEA	Vishay-Dale
R8, R10, R14, R18, R20, R22	6	0	RES, 0, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	ERJ-3GEY0R00V	Panasonic
R9	1	11k	RES, 11 k, 5%, 0.1 W, 0603	0603	RC0603JR-0711KL	Yageo
R12, R15	2	0	RES, 0, 5%, 0.1 W, AEC-Q200 Grade 0, 0402	0402	ERJ-2GE0R00X	Panasonic
R17	1	1k	RES, 1.0 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW06031K00JNEA	Vishay-Dale
S1, S2, S3, S4	4		Switch, SPST, 10 Pos, 0.025 A, 24 VDC, SMD	13.87x5.8mm	218-10LPST	CTS Electrocomponents
TP1, TP6	2		Test Point, Multipurpose, Blue, TH	Blue Multipurpose Testpoint	5127	Keystone
TP2, TP3, TP5	3		Test Point, Multipurpose, Yellow, TH	Yellow Multipurpose Testpoint	5014	Keystone
TP4	1		Test Point, Multipurpose, Red, TH	Red Multipurpose Testpoint	5010	Keystone
U1	1		TCA9416DTM X2SON8	X2SON8	TCA9416DTM	Texas Instruments

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