## Constant Current RGB LED Driver with I^{2}C Control

Brief Description

The KTD2026 Evaluation (EVAL) Kit is used to demonstrate and evaluate the KTD2026 functionality, performance, and PCB layout. The kit includes a fully assembled and tested PCB with the KTD2026 IC installed, a MCP2221A board with Stemma QT cable, software, and a printed copy of the Quick Start Guide.

Ordering Information

Part Number	Description	IC Package
KTD2026EWE-MMEV01	KTD2026 EVAL Kit	UTDFN1.5x1.5-8

3D CAD Image
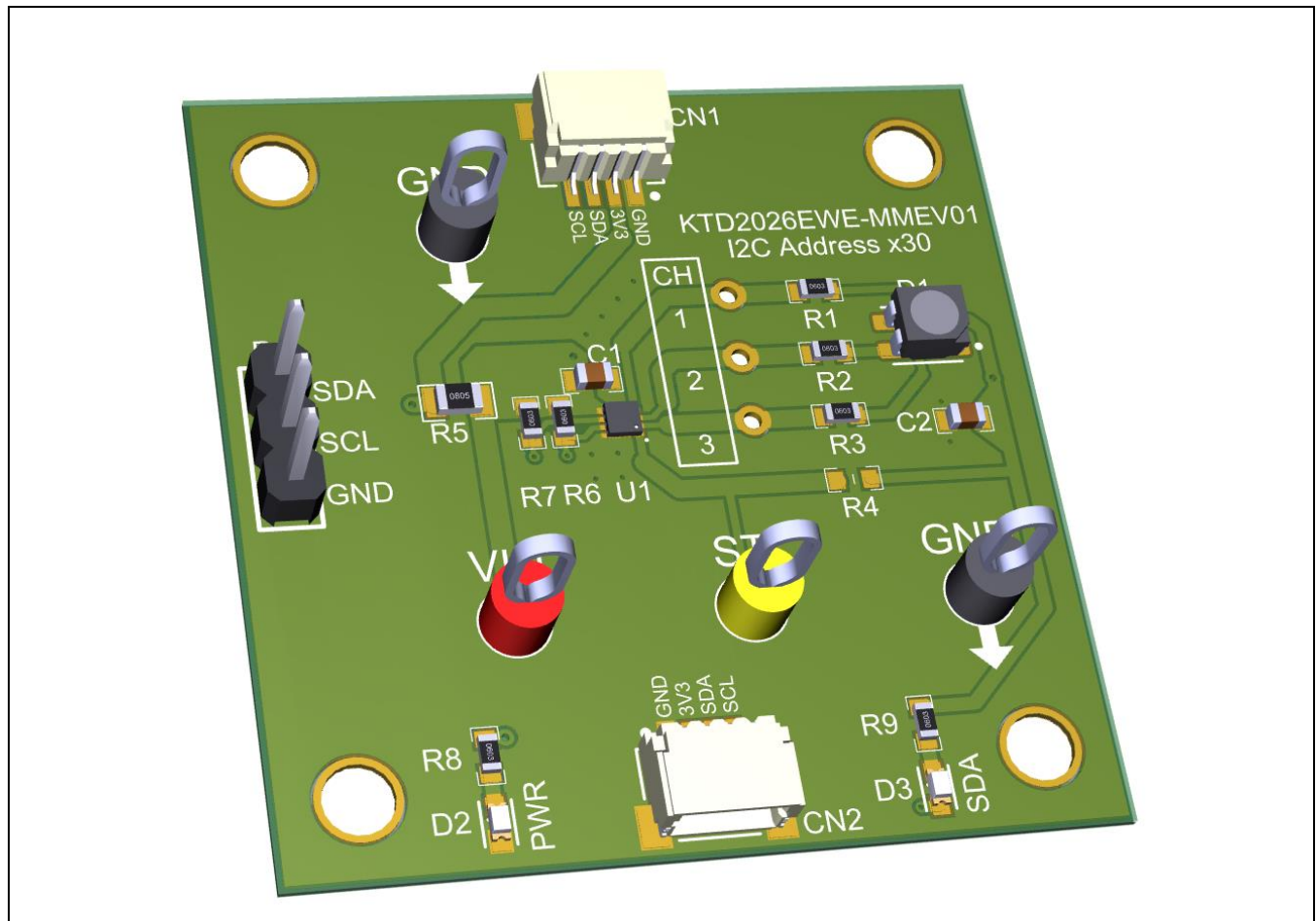
EVAL Kit Physical Contents

Item #	Description	Quantity
1	KTD2026 EVAL Kit fully assembled PCB	1
2	MCP2221A Board - General Purpose USB to GPIO ADC I2C - Stemma QT / Qwiic	1
3	Stemma QT / Qwiic JST SH 4-pin Cable - 100mm Long	1
4	Anti-static bag	1
5	KTD2026 EVAL Kit Quick Start Guide -- printed 1-page (A4 or US Letter)	1
6	EVAL Kit box	1

QR Links for Documents

IC Datasheet	EVAL Kit Landing Page
https://www.kinet-ic.com/KTD2026/	https://www.kinet-ic.com/ktd2026ewe-mmev01/

User-Supplied Equipment

Required Equipment

1. Bench Power Supply for VIN 5V and 0.5A, as needed for the intended application.
2. Digital Multimeter – one or more, used to measure input/output voltages and currents.

Optional Equipment

1. Oscilloscope – for dynamic testing of voltages (and currents with a current probe, if available).
2. Additional Digital Multimeters

Recommended Operating Conditions

Symbol	Description	Value	Units
VIN	Input voltage pin	2.7 to 5.5	V
D2, D3, ST	Output pins	Up to 6	V
SCL, SDA, D1	Control Interface pins and D1 sink pin	Up to VIN+0.3	V
D1, D2, D3	Output pin sink current	up to 24	mA

Quick Start Procedures

- Connect the Stemma QT 4-wire cable (GND, 3V3, SDA, SCL) to the KTD2026 evaluation board connector CN1, as shown in the Typical Test Setup Figure below.
- Connect the other end of the Stemma QT 4-wire cable to the MCP2221A USB to I2C interface board.
- Connect the MCP2221A board to a computer via the USB type-C cable.
- Once the evaluation board is connected to the computer via the MCP2221A interface board, the KTD2026 evaluation board green LED D3 should be turned on indicating that the board is powered from the computer. The on-board VIN supply voltage should be around 3.3V. No external power supply is required.

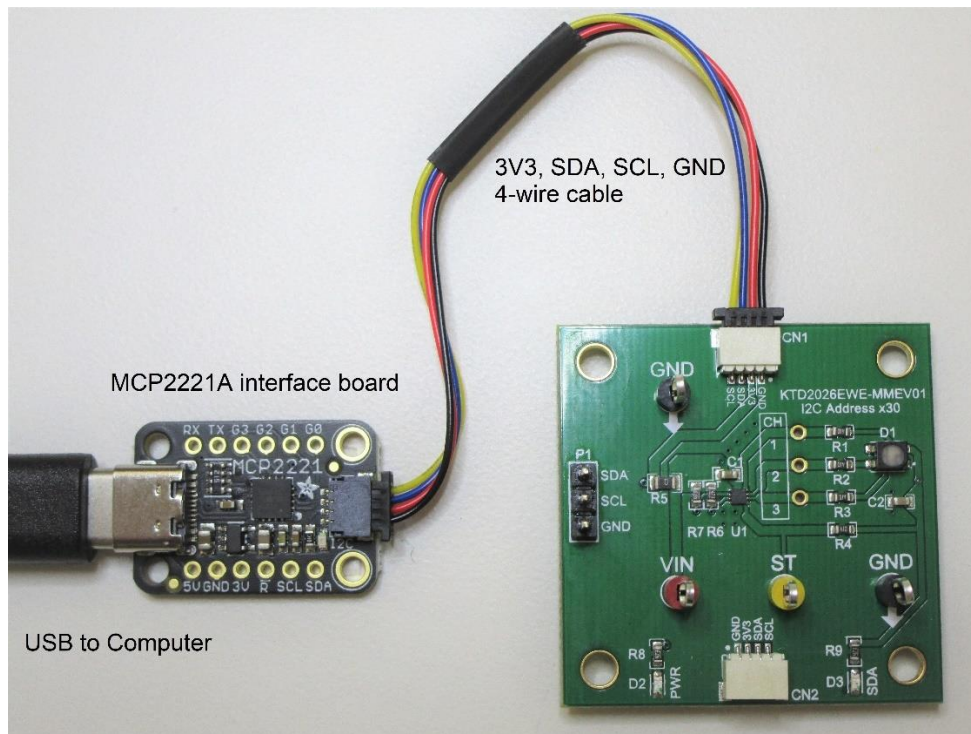**Graphical User Interface (GUI)**

The program software must be installed on a computer in order to communicate and program the KTD2026 device. Install and run the KTD202x GUI executable file software on the computer as follows.

Note: Both KTD2026 and KTD2027 devices use the same KTD202x GUI software.

- Install GUI file located on EVAL Kit Page (https://www.kinet-ic.com/ktd2026ewe-mmev01/).
- Copy the executable file "KTD202x Control Panel Rev 0.3.exe" onto the computer drive.
- To run the program on the computer, double-click on the executable file "KTD202x Control Panel Rev 0.3.exe".
- The GUI window should be displayed on the computer screen with the status message "USB Device Attached" at the bottom left side of the window.
- If the displayed message is still "USB Device Detached", make sure the computer is properly connected to the MCP2221A board with a USB cable.

Typical Test Setup Diagram

Use the following test setup for the Quick Start Procedures.

Graphical User Interface (GUI) Window

Flash Timing setting · Channel LED Mode · LED Current setting · Status section
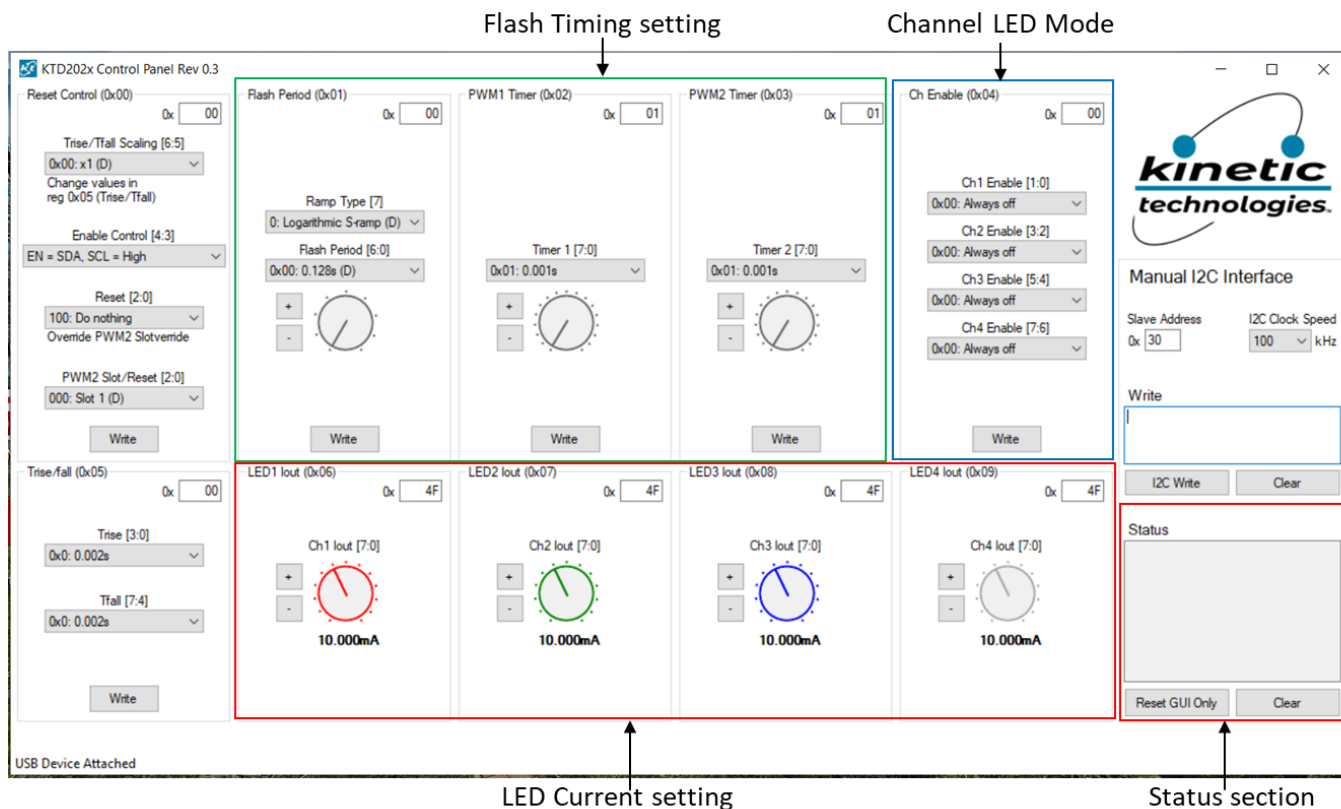
To check the I²C connection and turn on RGB LED

To check the I²C communication, we can set the evaluation board RGB LED D2 to a red color as follows.

In the "Ch Enable (0x04)" register section, click on the "Ch1 Enable [1:0]" button, then in the drop-down list select "Always on". Then click on the "Write" button located in the same register section to send the I²C command to KTD2026.

The GUI should display in the Status window the register address 0x04 and data 0x01.

The RGB red LED should now be turned on.

If the device is not responding (I2C communication failed), make sure the KTD2026 EVB is connected to the MCP2221A board, the GUI Slave address is correct, and the EVB VIN testpoint voltage is around 3.3V.

Note: each time an I²C command is sent out on the SDA line, the on-board red indicator LED D4 (labeled SDA) blinks briefly.

The GUI window contains several sections described below.

I2C Interface

The interface parameters are displayed on the right side of the GUI.

- Slave Address: shows the I2C address of the LED driver in hexadecimal. The default address of the KTD2026 is 0x30 (or 48 in decimal).
- I2C Clock Speed: shows the I2C interface clock frequency. The default clock frequency is 100kHz.

- Status: the Status section shows the activity and the command transferred on the I^{2}C bus. All Status previous messages can be erased/cleared by clicking on the "Clear" button.

Important note: If any parameter setting is changed on the GUI (other than I2C interface and the control knobs), the user must click on the associated "Write" button within the same section in order to update/write to the LED driver register.

LED Current Setting

- LED1 to LED3 Iout: allow to set the LED current registers Reg6 to Reg8 value between 0 (0.125mA) and 191 decimal (24mA) with 0.125mA increment.
  The LED current is adjusted by positioning the mouse onto the control knob, then left click-and-hold, then move up to increase and move down to decrease the value. Release the mouse left button to Write into the register.

Channel LED Modes

- LED1 to LED4: each LED channel can be enabled/configured to one of four different modes in register Reg4 as follows:
  - Always ON,
  - Always OFF,
  - PWM1 (flashing on Timer1),
  - PWM2 (flashing on Timer2).

Note: PWM1 or Timer1 is always configured to time slot 1.

Electrical Schematic
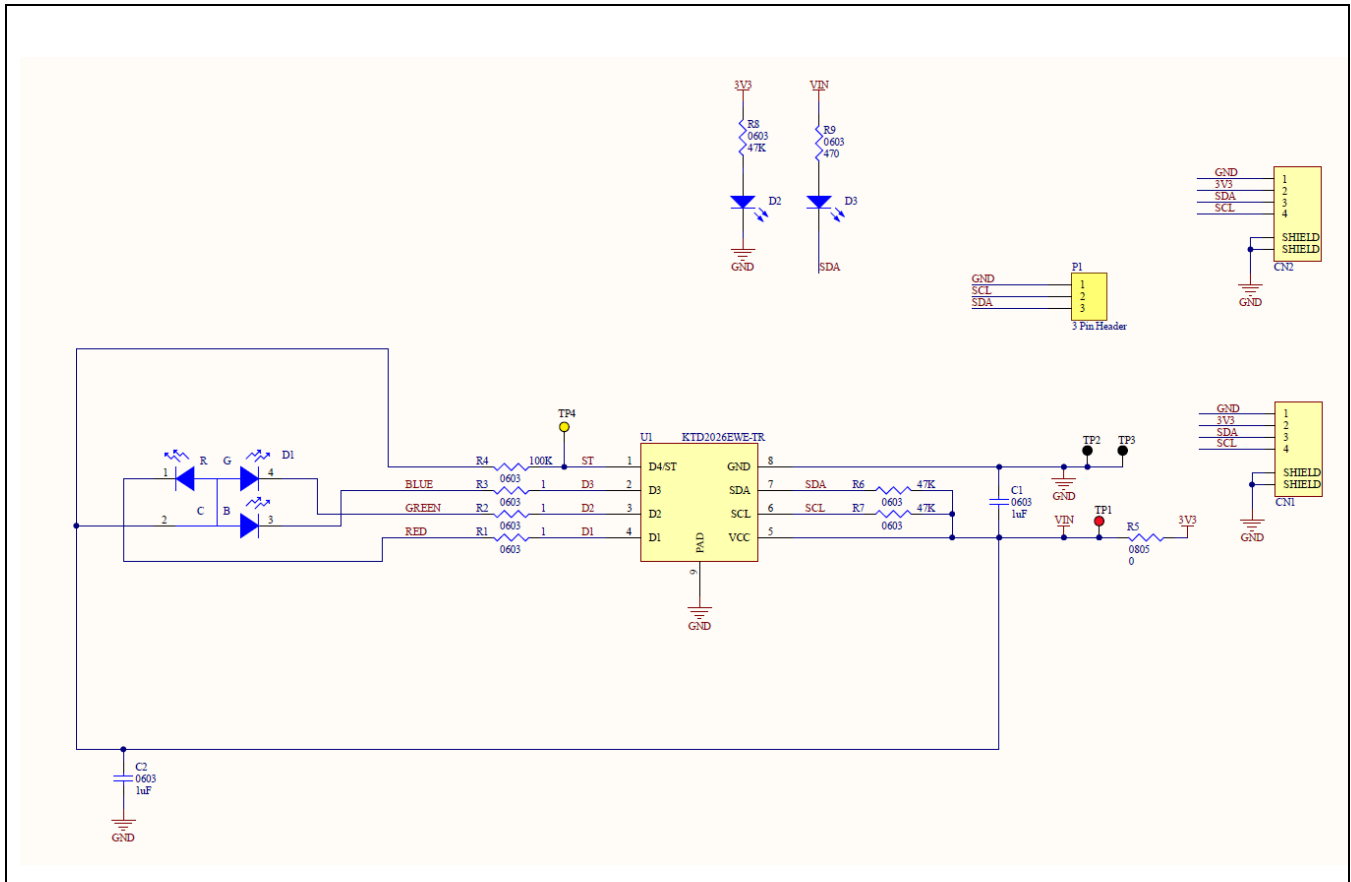
Bill of Materials (BOM)

Quantity	Designator	Value	Description	Package	Manufacturer	Manufacturer Part Number	Digikey Part Number	Mouser Part Number
2	C1, C2	1uF	CAP 1.0uF 16V X5R 0603	0603	Samsung	CL10A105KO8NNNC	1276-1034-1-ND	187-CL10A105KO8NNNC
2	CN1, CN2		CONN HEADER SMD R/A 4POS 1MM		JST Sales America Inc.	SM04B-SRSS-TB(LF)(SN)	455-1804-1-ND	
1	D1		LED RGB DIFFUSED 4PLCC SMD	PLCC-4 Cree	Cree	CLVBA-FKA-CAEDH8BBB7A363	CLVBA-FKA-CAEDH8BBB7A363CT-ND	941-VBAFKACAEDH8B7A3
1	D2		LED GREEN DIFFUSED 0603 SMD	0603	OSRAM	LG L29K-G2J1-24-Z	475-2709-1-ND	720-LGL29KG2J124Z
1	D3		Red 625nm LED Indication - Discrete 2V 0603 (1608 Metric)	0603	Würth Elektronik	150060RS75000	732-4978-1-ND	710-150060RS75000
1	P1		CONN HEADER VERT 3POS 2.54MM	Through Hole	Sullins	PREC003SAAN-RC	S1012EC-03-ND	
3	R1, R2, R3	1	RES 1 OHM 1% 1/10W 0603	0603	Yageo	RC0603FR-071RL	311-1.00HRCT-N	603-RC0603FR-071RL
1	R4	100K	RES 100K 1% 1/10W 0603	0603	Yageo	RC0603FR-071RL	311-1.00HRCT-N	603-RC0603FR-071RL
1	R5	0	RES 0 OHM JUMPER 1/8W 0805	0805	Yageo	RC0805FR-070RL	311-0.0CRCT-ND	603-RC0805FR-070RL
3	R6, R7, R8	47K	RES 47K 1% 1/10W 0603	0603	Yageo	RC0603FR-0747KL	311-47.0KHRCT-ND	603-RC0603FR-0747KL
1	R9	470	RES 470 OHM 1% 1/10W 0603	0603	Yageo	RC0603FR-07470RL	311-470HRCT-ND	603-RC0603FR-07470RL
1	TP1		PC TEST POINT MULTIPURPOSE RED	Through Hole	Keystone	5010	36-5010-ND	534-5010
2	TP2, TP3		PC TEST POINT MULTIPURPOSE BLACK	Through Hole	Keystone	5011	36-5011-ND	534-5011
1	TP4		PC TEST POINT MULTIPURPOSE YELLOW	Through Hole	Keystone	5014	36-5014-ND	534-5014
1	U1		Constant Current RGB LED Driver with I2C Control	UTDFN 1.5x1.5-8	Kinetic Technologies	KTD2026EWE-TR		

Printed Circuit Board (PCB)
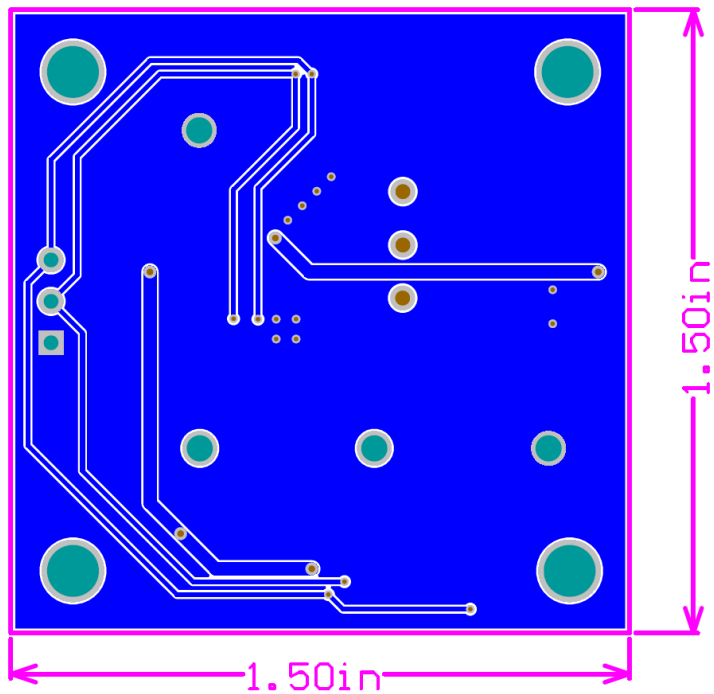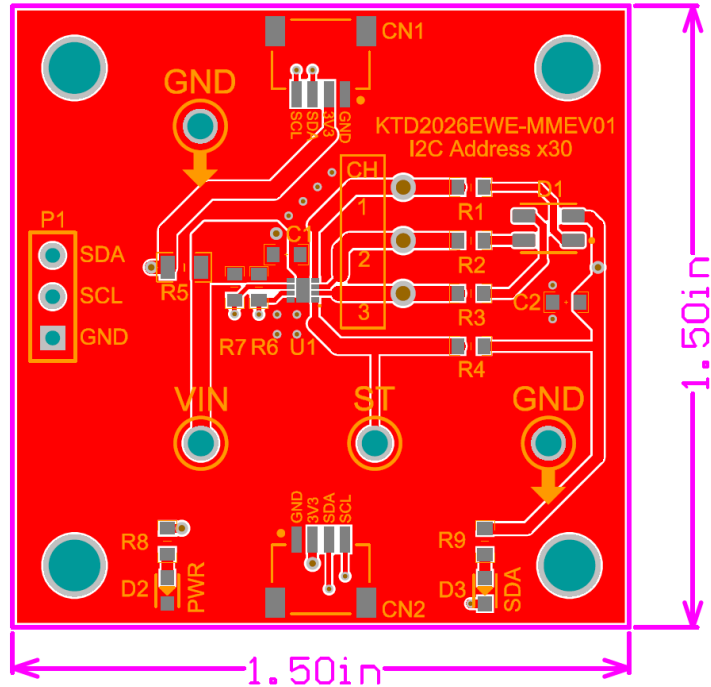
Additional Test Procedures

Timing Parameters

The timing parameters (Flash period, Timer1, Timer2) can be adjusted by positioning the mouse onto the control knobs, then left click-and-hold, then move up to increase and move down to decrease the value. Release the mouse left button to Write the value into the corresponding register.

- Flash Period: set the flash period value between 0 and 0x7E or 126 decimal. The actual flash period duration in seconds is displayed. A one shot flash, not repeating, can be performed by setting the flash period to 0x7F or 127 decimal (max value).
- Timer1, Timer2: set the on time (Ton) duration for each timer, (including rise time and LED full on time, as shown in Figure 6).
- Rise Time, Fall Time: set the rise/fall time value between 0 and 0xF or 15 decimal.
- Scaling factor: set the multiplication factor for the rise and fall times.
- Ramp Type: configure the ramp style during rise/fall time to linear or logarithmic/s-shape by selecting between Logarithmic and Linear entry in the register Reg1 section.

LED Current Programming

The LED channel current is constant, non-pulsing, except when it is being ramped-up and down. The ramps are automatically generated using a PWM scheme where the duty cycle is continuously changing (either increasing or decreasing) to provide a smooth LED current transition between the ON and OFF states. The ramp times, for rise and fall, are separately programmable through the internal registers. The ramp type can be configured to linear or logarithmic/s-shape by selecting between Logarithmic and Linear entry in the register Reg1 section.

The individual channel brightness is controlled by the LEDx Iout registers. Each channel has a dedicated register for setting the current.

Two on-board PWM timers (Timer1 and Timer2) allow the user to generate various LED blinking patterns. The timer1/2 register value (between 0 and 255 decimal) sets the LED ON time (Ton) as a percentage of the flash period, as shown in Figure 6. The on time for timer1/2 is displayed on the GUI in seconds.
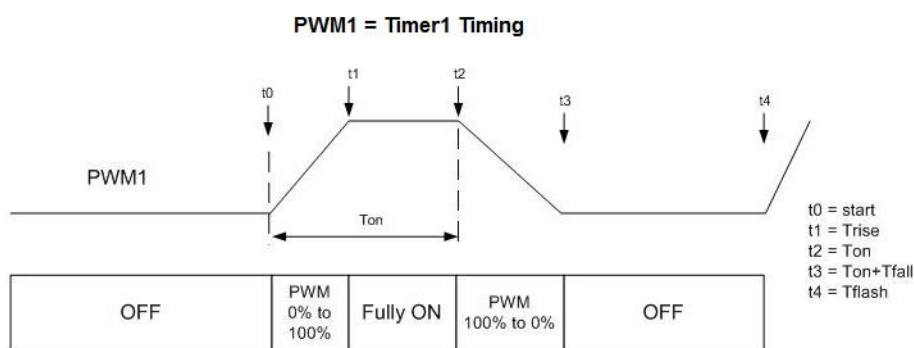

Figure 6. PWM Timing Diagram

To program RGB LED breathing pattern

The RGB LED D2 can be set to a green breathing pattern with 0.5s rise time, 0.5s fully on, 0.5s fall time.
In the "Flash Period" Reg1 register section, select Flash Period value of 0x0A or 1.5s.

In the "PWM1 Timer" Reg2 register section, select Timer1 value of 0x7D or 1.0s.

In the "Trise/fall" Reg5 section, select Trise and Tfall values of 0x04 or 0.5s.

In the "Ch Enable" Reg4 register section, set "Ch2 Enable" to PWM1 and all other channels Always Off or 0x08.

The RGB LED should now have a green breathing pattern.

To turn on the LEDs sequentially using Timer and Time Slot Programming

Two or more LEDs can be turned on and off sequentially using the time slot programming. Figure 7 shows four examples of lighting patterns where Timer2 is configured for a different time slot (from time slot1 to time slot4). For each time slot selection, the start of the PWM2 pulse (t3) can be calculated using the formula included in Figure 7.
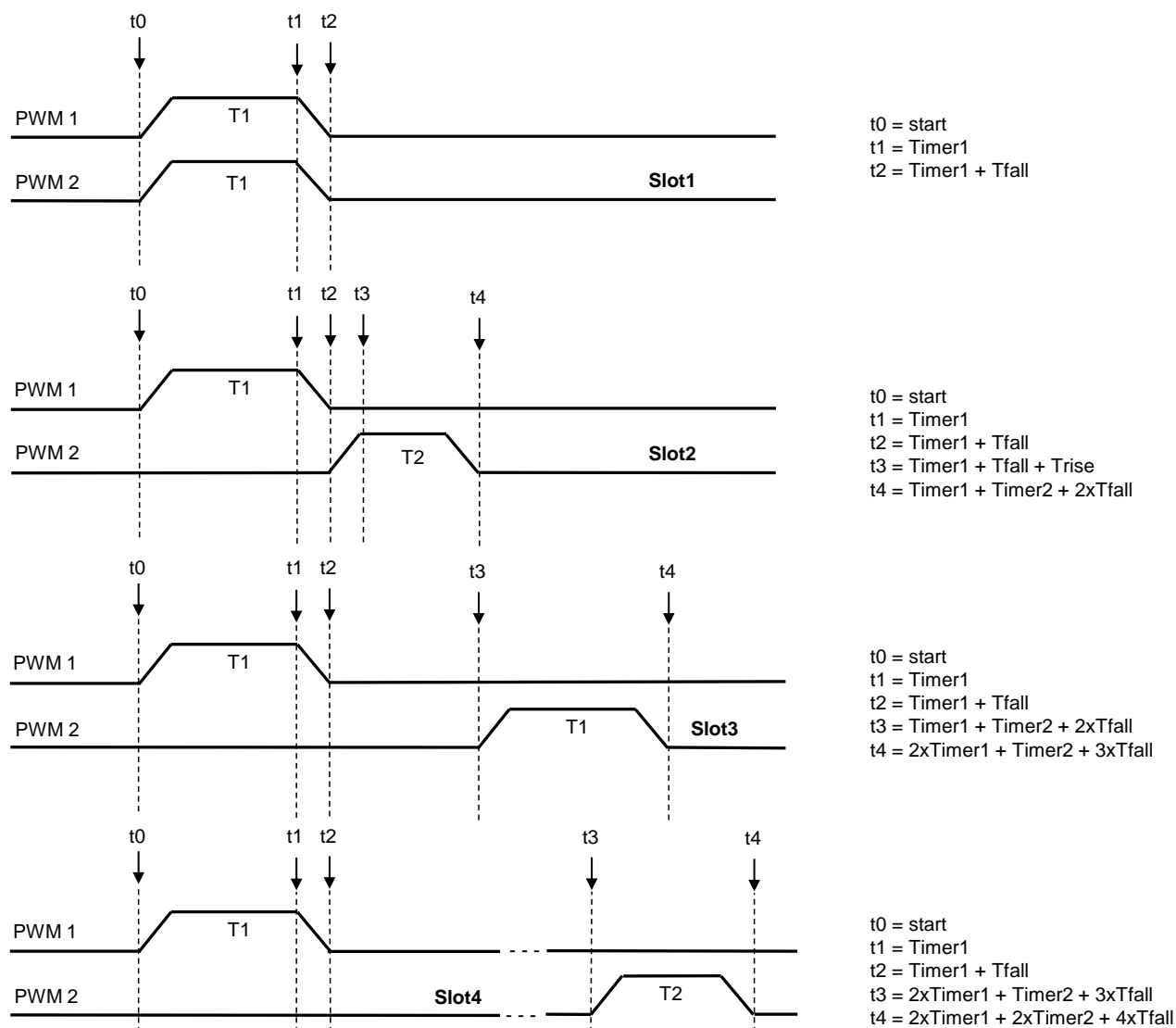

Figure 7. Time Slot Timing Diagram

The user must be careful when using two different time slots that the end of the second on-time does not exceed the flash period otherwise the end of the pattern will be truncated.

For more details on the register setting and LED pattern programming, please refer to the KTD2026/KTD2027 data sheet.

To power the evaluation board from a separate power supply

The evaluation board can be powered from an external bench power supply 5V 0.5A, instead of the 3.3V supply coming from the Stemma QT connector.

Before connecting the external power supply, remove from the evaluation board the resistor R5 0-ohm jumper.

Connect the external 5V power supply to the evaluation board VIN testpoint and GND testpoint.

Note: Removing resistor R5 allows to disconnect the 3.3V supply from the evaluation board VIN rail.

Troubleshooting

Symptom	Root Cause	Solution
Device is not responding to I2C command	VIN supply is not powered.	Make sure the KTD2026 EVB is connected to the MCP2221A board with the Stemma 4-wire cable.
Device is not responding to I2C command	The GUI Slave address does not match the device address on the EVB	Make sure the GUI Slave Address is correct.
RGB LED is not turning on in Always on mode, or in Flash mode	GUI Channel Enable Reg4 is not configured properly.	Make sure the GUI Reg4 is configured correctly.