

### 36-Channel RGB LED Drivers with I<sup>2</sup>C Control

#### Brief Description

The KTD2061 Evaluation (EVAL) Kit is used to demonstrate and evaluate the KTD2061 functionality, performance, and PCB layout. Additionally, the EVAL Kit is a convenient tool for software development of RGB LED lighting patterns and animations. The kit includes a fully assembled and tested PCB with the KTD2061 IC installed, a white plastic light diffuser, a wiring harness, and an Adafruit QT Py RP2040  $\mu$ C board configured for CircuitPython with pre-loaded KTD2061 demo software. Twelve RGB modules (36 LEDs total) are mounted on the back side of the PCB and shine into the diffuser to blend their light output and reduce human-eye fatigue.

This EVAL Kit may also be used to evaluate the KTD2058/59/60 36-channel RGB LED drivers, and the KTD2064A/B 24-channel RGB LED drivers.

#### Ordering Information

Part Number	Description	IC Package
KTD2061EUAC-MMEV02	KTD2061 EVAL Kit	UQFN33-20

#### EVAL Kit Photo





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## EVAL Kit Physical Contents

Item #	Description	Quantity		
		Included	Downloadable	User-Supplied
1	KTD2061 EVB Rev2.0 fully assembled printed circuit board	1		
2	White plastic light diffuser	1		
3	#4-40 flathead screw + washer + nut	1		
4	StemmaQT/Qwiic I <sup>2</sup> C wire harness	1		
5	Adafruit QT Py RP2040 $\mu$ C fully assembled printed circuit board	1		
6	USB type-A to type-C cable	1		
7	Anti-static bag	1		
8	EVAL Kit box	1		
9	Quick-Start Guide printout	1		
10	Demo software (pre-loaded on QT Py)	1	by request	
11	EVAL Kit Manual (pre-loaded on QT Py)	1	1	
12	KTD2061/58/59/60 Datasheet (pre-loaded on QT Py)	1	1	
13	USB 5V/1A power source			1

## User-Supplied Equipment

### Required Equipment

1. 5V/1A USB VBUS Power Source – either an AC wall adapter, battery power bank, or an available USB port from a computer.

### Optional Equipment

1. Computer with USB port – for software development using a software text editor, and to copy/paste/save the software (filename = *code.py*) from the editor to the QT Py RP2040 board.
2. 5V/1A Adjustable Power Supply – for testing with variable input voltage.
3. Digital Multimeter – to measure input voltage, input current, or LED current.
4. Oscilloscope – to observe the multiplexed output waveforms.

## Recommended Operating Conditions

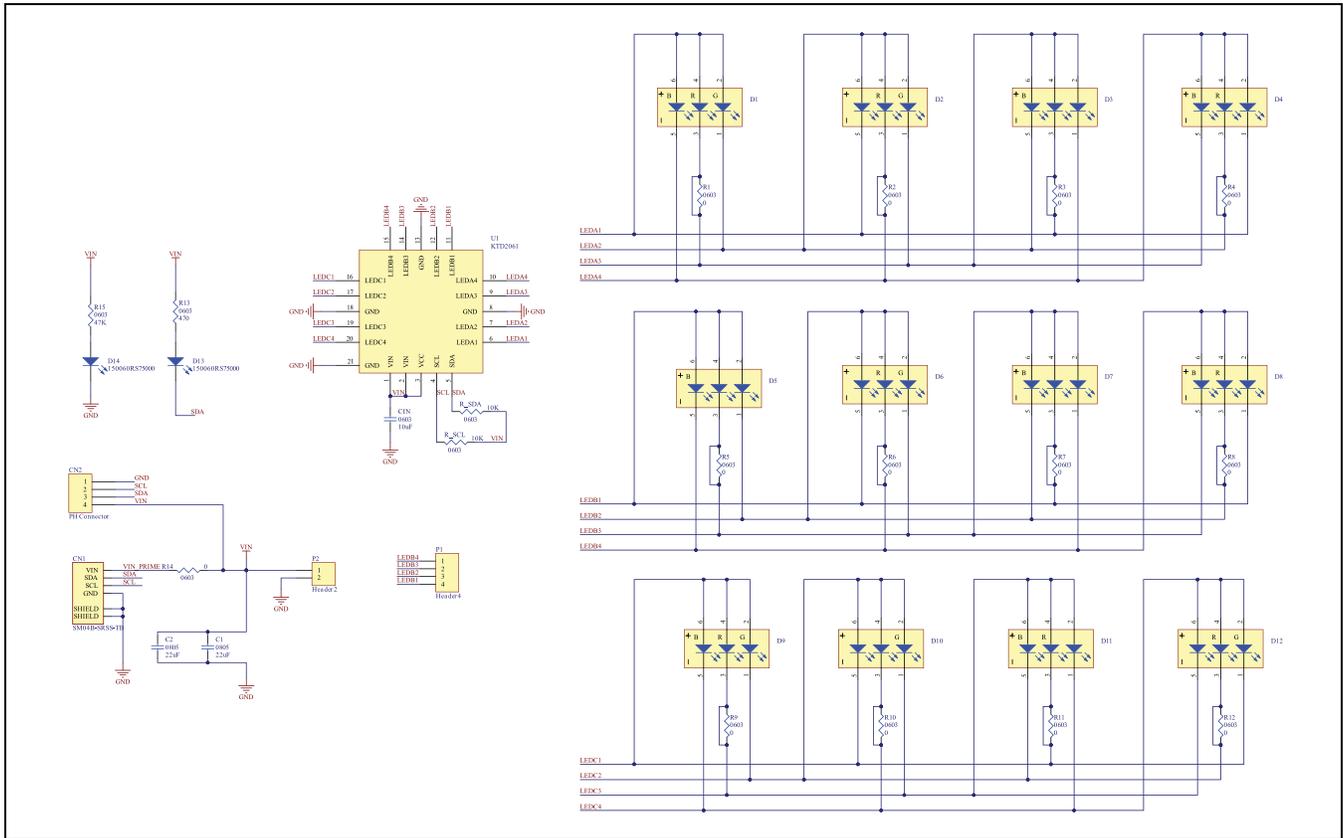
Symbol	Description	Value	Units
VBUS	USB VBUS Voltage	4.5 to 5.5	V
V <sub>IN</sub>	Input Voltage	3 to 5.5	V
I <sub>IN</sub>	Input Current	0 to 1	A

## Quick Start Procedures

Follow the below quick-start steps in sequence to ensure a safe and successful power-up of the EVAL Kit.

1. Using the StemmaQT/Qwiic I<sup>2</sup>C wiring harness, connect the EVAL Kit PCB to the QT Py PCB. To avoid damage within the connectors, do not insert the StemmaQT/Qwiic connectors upside down.
2. Connect the USB cable to the QT Py RP2040 PCB.
3. Connect the other end of the USB cable to a USB 5V/1A power source (user-supplied). You may use an AC wall adapter, battery power bank, or an available USB port from a computer.
4. When power is applied, the demo software first executes 3 test patterns:
  - a. All 12 RGB modules turn very dim white for 1 second, then bright white for 5 seconds.
  - b. Each RGB takes its turn showing blue, one at a time, and then repeats with green.
  - c. The 12 RGBs show a multi-color palette for 5 seconds. Three of them are dim white on purpose.
5. After the test patterns, the demo loops an 8-minute demonstration endlessly until power is removed.
6. When desired, remove power by pulling the AC wall adapter from the AC outlet, or by disconnecting the USB cable from the USB power source.
7. Optionally, to read or modify the demo software, connect the USB cable to a computer.
  - a. The QT Py RP2040 connects as an 8MB USB flash drive. The software and collateral documents are stored within.
  - b. Open the CircuitPython text file *code.py* with a software editor. Adafruit recommends the freeware *Mu* editor, which is optimized for CircuitPython.
  - c. When editing *code.py*, save changes to the QT Py RP2040. After saving, the code will recompile and execute automatically.
  - d. In case of significant editing errors, file corruption, or sending email attachments, a copy of the *code.py* file is already replicated as *KTD2061\_demo\_code.txt* on the QT Py RP2040.
8. For additional resources:
  - a. KTD2061/58/59/60 Product <https://www.kinet-ic.com/KTD2061/>
  - b. KTD2061 EVAL Kit <https://www.kinet-ic.com/ktd2061euac-mmev02/>
  - c. Adafruit QT Py RP2040 <https://learn.adafruit.com/adafruit-qt-py-2040/overview>
  - d. Adafruit CircuitPython <https://learn.adafruit.com/welcome-to-circuitpython/overview>
  - e. Mu Editor Installation <https://codewith.mu>

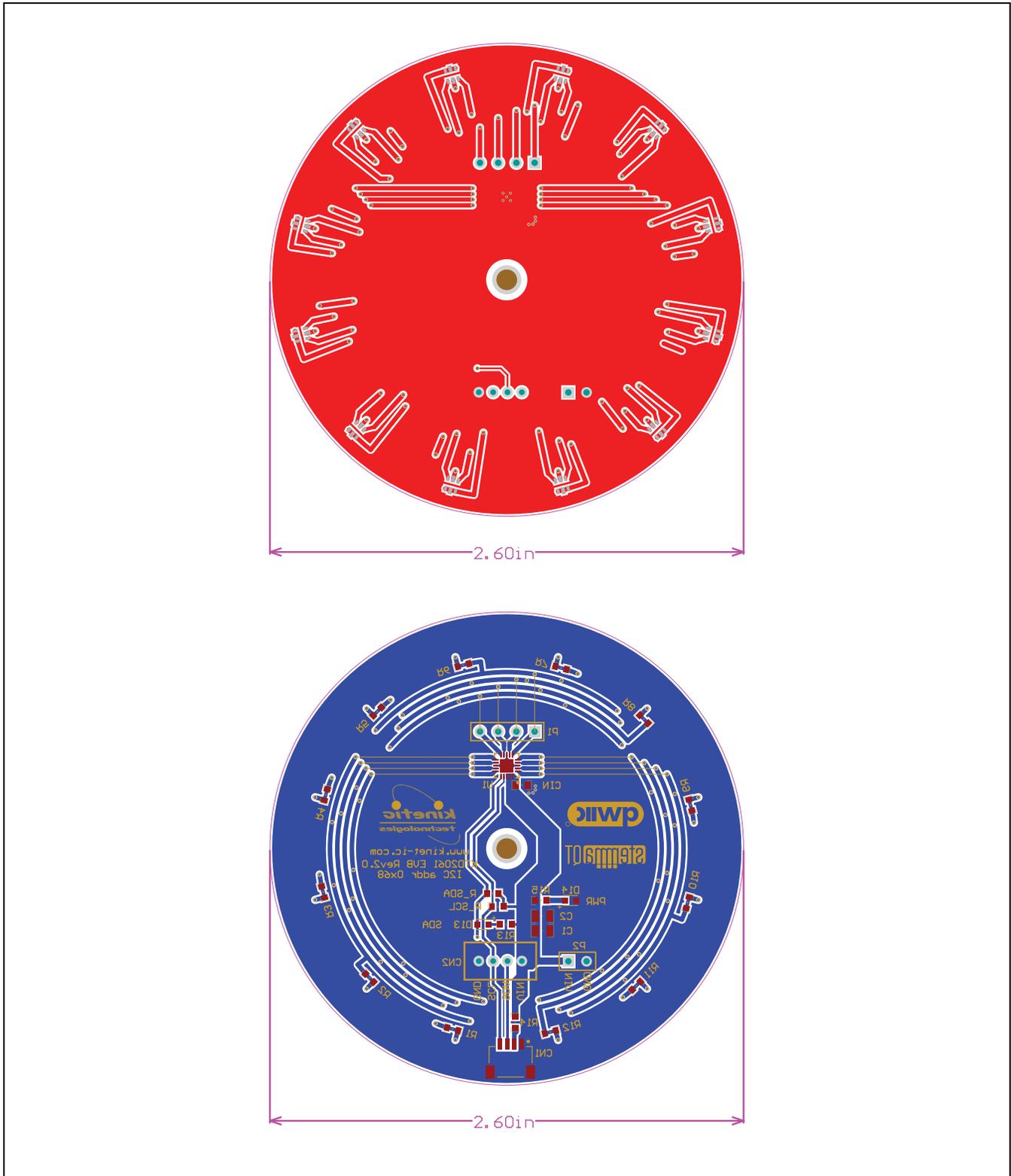
### Electrical Schematic



### Bill of Materials (BOM)

Item	Qty	Ref	Description	Package
1	1	U1	Kinetic Technologies KTD2061EUAC RGB LED Driver	TQFN33-20
2	1	CIN	10µF 16V X5R SMD Capacitor	0603
3	2	C1, C2	22µF 6.3V X5R SMD Capacitor	0805
4	12	D1 - D12	Everlight 19-337C/RSBHGHC-A88/4T RGB LED (or similar)	SMD-6L
5	2	D13, D14	Würth LED Red Clear SMD 150060RS75000	0603
6	2	R_SDA, R_SCL	10kΩ SMD Resistor	0603
7	12	R1 – R12	0Ω SMD Resistor	0603
8	2	R13, R15	470Ω SMD Resistor	0603
9	1	R14	0Ω SMD Resistor	0603
10	1	CN1	Adafruit JST Ph-4 StemmaQT (or Qwiic) Connector	--
11	0	CN2	1x4-pin Header (Do Not Populate)	--
12	0	P1	1x4-pin Header (Do Not Populate)	--
13	0	P2	1x2-pin Header (Do Not Populate)	--

## Printed Circuit Board (PCB)



## Adafruit QT Py RP2040

Per the description at <https://learn.adafruit.com/adafruit-qt-py-2040/overview>:

What a cutie pie! Or is it... a QT Py? This diminutive dev board comes with one of our new favorite chips, the RP2040. It's been made famous in the new Raspberry Pi Pico and our Feather RP2040 and ItsyBitsy RP2040, but what if we wanted something really smol?

A new chip means a new QT Py, and the Raspberry Pi RP2040 is no exception. When we saw this chip, we thought, "This chip is going to be awesome when we give it the cuutie QT Py Treatment," and so we did! This QT Py features the RP2040 and all niceties you know and love about the original QT Py.

At the time of launch, there is no Arduino core support for the chip on this board. There is great C/C++ support, an official MicroPython port, and a CircuitPython port! We of course recommend CircuitPython because we think it's the easiest way to get started. And it has support with most of our drivers, displays, sensors, and more, supported out of the box so you can follow along with our CircuitPython projects and tutorials.

## StemmaQT / Qwiic Wire Harness

Per the description at <https://learn.adafruit.com/adafruit-qt-py-2040/overview>:

The star of the QT Py is our favorite connector - the STEMMA QT, a chainable I2C port that can be used with any of our STEMMA QT sensors and accessories. Having this connector means you don't need to do any soldering to get started.

What can you pop into the QT port? How about OLEDs! Inertial Measurement Units! Sensors a-plenty. All plug-and-play thanks to the innovative chainable design: SparkFun Qwiic-compatible STEMMA QT connectors for the I2C bus so you don't even need to solder. Just plug in a compatible cable and attach it to your MCU of choice, and you're ready to load up some software and measure some light.

Use any SparkFun Qwiic boards! Seeed Grove I2C boards will also work with this adapter cable.

## Evaluation and Bench Testing

### Visual Inspection and Test Patterns

The demo software starts by running three utility test patterns.

1. *chip\_status\_check()*: all 12 RGB modules turn very dim white for 1 second, then bright white for 5 seconds.
  - a. Dim white is shown for 1 second. It is very dim and may show some color shift due to the RGB performance at very low currents and the green color of the PCB. During this time, the software reads back and prints (to the console) the ID register and Monitor register contents. These registers provide readback of the Kinetic vendor ID, the KTD2061 die ID, the KTD2061 die revision, the output short-circuit status, the BrightExtend™ dropout status (which is used to indicate an open-LED fault when the LED currents are set very dim), the CoolExtend™ status (which can indicate a hot die temperature, settable as 90, 105, 120, or 135°C), and input under-voltage lock out (UVLO) status or die over-temperature protection (OTP) thermal shutdown status.
  - b. Bright white is shown for 5 seconds to visually inspect that all 36 LED channels and 12 RGBs are connected correctly and functioning. If other colors are seen, something is wrong. A color-blind impaired person may experience limitations on differentiating faults during this test.

2. *util\_ghost\_test()*: each RGB takes its turn showing blue, one at a time, and then repeats with green. This is a test for “ghosting” artifacts, as described in the KTD2061/58/59/60 datasheet. During this test, it is normal that some small amounts of color may show on the RGBs that are supposed to be off. But ghosting should be at very low levels. Keep in mind that this test is specifically designed to show ghosting artifacts. In normal patterns, with software mitigation, and with light diffusers, it is usually easy to eliminate any visual ghosting, as described in the datasheet.
3. *util\_color\_palette()*: the 12 RGBs show a software-programmable 8-color palette for 5 seconds. As written, three RGBs are bright white, six RGBs show colors, and three RGBs are dim white. By changing the software settings for *set\_color0()* and *set\_color1()*, the 8-color palette may be varied experimentally. The concept of using a software-programmable 8-color palette is described in the datasheet. This test pattern is provided as a convenient experimental aid when seeking a suitable color palette for a given pattern.

### **Input Voltage and Current**

The input voltage may be measured at VIN and GND pins on either the P2 or CN2 header (not populated). By default, VIN = 3.3V is provided via the StemmaQT / Qwiic wire harness from the QT Py RP2040 board, which has a 3.3Vout LDO regulator.

To vary the input voltage, first remove R14 (0Ω) and then connect a bench supply (3V to 5.5V, 1A) at VIN and GND pins on either the P2 or CN2 header (not populated). To measure the input current, place a current meter in series with the bench supply.

### **Output Voltage and Current**

The multiplexed output voltage waveforms may be monitored on four of the LED output pins by connecting an oscilloscope to the P1 header (not populated). However, due to the Charlieplexing scheme, these waveforms are difficult to interpret. Nevertheless, it is easy to see the current-sink headroom by observing the lowest voltage levels and how much margin they have above ground.

When measuring LED output current, please note that the red LEDs within the RGB modules have the lowest Vf. Therefore, they are the best place to insert a series-connected current meter and measure the current without causing current-sink dropout. Keep in mind, if BrightExtend™ is enabled and low VIN is causing a blue or green LED to dropout, then the red LED current will automatically reduce. Therefore, turn off BrightExtend™ when measuring the current accuracy vs. setting.

The output current for a red LED may be measured by removing one of the corresponding R1 – R12 (0Ω) resistors. (In the future, R1 – R12 may be replaced by a PCB short trace. In this case, it is necessary to cut the trace with a knife to remove the 0Ω resistance.) Next, solder some small wires to the R1 – R12 landing pattern and connect a DC current meter (with floating ground and low capacitance) to measure the average current. A handheld DMM usually works well. Alternatively, solder a small wire loop to the landing pattern and connect an oscilloscope current probe to the loop to see the multiplexed current waveform. When running the demo software, the current will change continuously. So, for a DC measurement, it may be necessary to modify the software to hold a static current setting for an extended period.

### **Small Red LEDs D13 and D14**

The D13 red LED indicates I<sup>2</sup>C traffic on the SDA pin. It flickers whenever SDA is pulled low. The D14 red LED indicates the presence of input voltage at VIN.

### Evaluating Other ICs

The KTD2061 EVAL Kit may be used to evaluate other ICs in the same family:

Part #	Description	# of RGBs	7-bit I <sup>2</sup> C Address	Package
KTD2061	36 Ch RGB LED Driver with I2C Control	12	0x68 default	UQFN33-20
KTD2058	36 Ch RGB LED Driver with I2C Control	12	0x69 alternate	
KTD2059	36 Ch RGB LED Driver with I2C Control	12	0x6A alternate	
KTD2060	36 Ch RGB LED Driver with I2C Control	12	0x6B alternate	
KTD2064A	24 Ch RGB LED Driver with I2C Control	8	0x6C default	
KTD2064B	24 Ch RGB LED Driver with I2C Control	8	0x6D alternate	

To evaluate other devices, order samples separately, remove (de-solder) the KTD2061, clean the PCB, and carefully solder the sample to the PCB. For KTD2058/59/60, modify the *Configuration* section of the demo software with the correct I<sup>2</sup>C slave address and RGB selection register mapping. For KTD2064B, consult an authorized Kinetic representative to request fully configured and tested KTD2064B demo software.

### Troubleshooting

Symptom	Root Cause	Solution
RGBs do not light at all.	Software may be corrupted.	Resave a known good copy of the software to the QT Py RP2040. Reset or cycle the power if needed.
RGBs do not light at all, or software gets stuck.	Software may have a syntax error, usually after editing.	Fix the syntax error and resave the software to the QT Py RP2040.
RGBs do not light at all, or software gets stuck.	StemmaQT / Qwiic wire harness or connectors may be damaged.	Remove power and check the wire harness and connector contact pins for damage. Replace the cable and/or connectors as necessary.
All RGBs on one of the busses do not light.	The KTD2061 may have detected a short circuit or failed LED on the afflicted bus.	Inspect the connections and RGB LEDs; repair or replace as necessary.
Some or all RGBs show the wrong colors.	Software may have a syntax error, usually after editing.	Fix the syntax error and resave the software to the QT Py RP2040.
Some or all RGBs show the wrong colors.	One or more RGB modules are soldered to the PCB with 180-degree rotation.	Find the rotated RGB or RGBs by using a microscope and inspecting carefully. Replace the RGB(s) in the correct orientation.
There is audible noise. The KTD2061 should not create audible noise.	The AC adapter may have large output ripple in the audio range due to skip/burst/PFM operation at light-loads. This ripple can cause squealing from the ceramic input capacitors on the KTD2061 PCB due to piezoelectric effect.	Try a different model of AC adapter.

## Important Notices

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