

High Efficiency 8-CH LED Backlight Driver with Dual LCD Bias Power

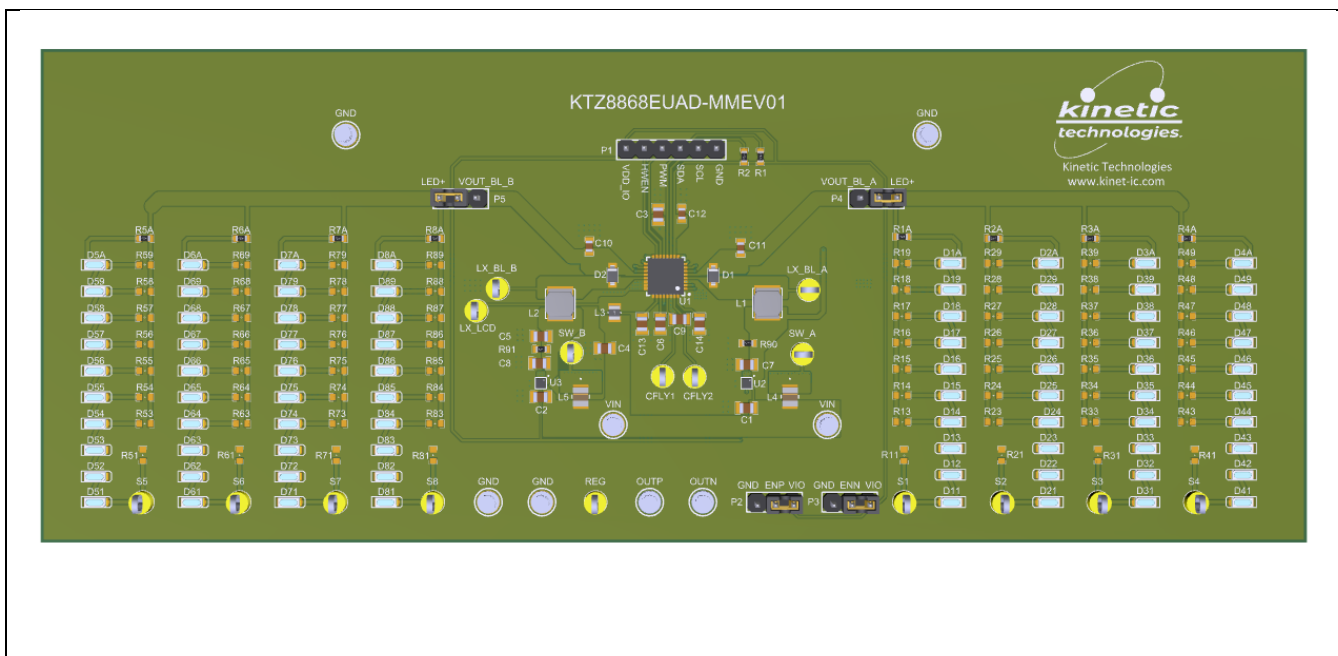
Brief Description

The KTZ8868 Evaluation (EVAL) Kit is used to demonstrate and evaluate the KTZ8868 functionality, performance, and PCB layout. The kit includes a fully assembled and tested PCB with the KTZ8868 and two KTC2115 ICs installed, and a printed copy of the Quick Start Guide (also contained within this document). One KTC2115 boost 5V output is connected to KTZ8868 Backlight group A inductor. The other KTC2115 boost 5V output is connected to KTZ8868 Backlight group B inductor. KTZ8868 LCD Bias is powered directly from VIN supply. The KTZ8868 has enable HWEN active-high input logic.

Ordering Information

Part Number	Description	IC Package
KTZ8868EUAD-MMEV01	KTZ8868 EVAL Kit	WQFN55-32



3D CAD Image



EVAL Kit Physical Contents

Item #	Description	Quantity
1	KTZ8868 Evaluation board fully assembled PCB	1
2	Kinetic I2C adapter module	1
3	Adapter 3-pin + 2-pin Cables	1
4	Anti-static bag	1
5	KTZ8868 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/ktz8868	 https://www.kinet-ic.com/ktz8868euad-mmev01

User-Supplied Equipment

Required Equipment

1. Bench Power Supply for VIN 5V and 3A, 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	Absolute Input Withstand Voltage	-0.3 to 6	V
	Supply Operating Voltage	2.7 to 5.5	V
VDDIO	VDDIO Operating Voltage	up to VIN + 0.3	V

Jumper Descriptions

Designator	Name	Description	Default
P2	ENP	Enable OUTP Positive Output GND: OUTP Disabled VIO: OUTP Enabled	GND
P3	ENN	Enable OUTN Negative Output GND: OUTP Disabled VIO: OUTP Enabled	GND
P4	VOUT_BL_A	KTZ8868 Backlight VOUT_BL_A test point / jumper to group A LED strings 1 to 4	1-2 (Right position)
P5	VOUT_BL_B	KTZ8868 Backlight VOUT_BL_A test point / jumper to group B LED strings 5 to 8	1-2 (Left position)

Quick Start Procedures

1. Configure Kinetic I2C adapter output voltage jumper to 3.3V as shown in the Figure below.



Figure 1. Kinetic I2C Adapter Module

2. Connect five of Kinetic I2C adapter wires to the evaluation board connector P1 (VDD_IO, HWEN, SDA, SCL, GND) as shown in Figures 2 & 3.

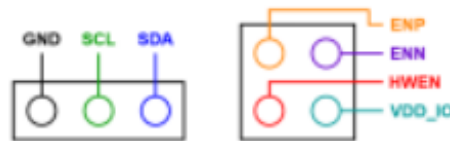


Figure 2. I2C Adapter Wire Connection

3. Connect the other end of the I2C adapter module to the USB port on the computer.
4. Connect one pair of Banana-to-clip power cables to the EVB test points at VIN and GND.
5. Before connecting the EVAL Kit to the VIN bench supply, turn on the supply and adjust the voltage as close to 0V as possible. Then turn off the supply. While off, connect the banana ends of the Banana-to-clip power cables to the VIN bench supply.
6. Turn on the VIN bench supply and ramp its voltage to 3.6V. While ramping VIN slowly, use the bench supply's output current indication to monitor the VIN current. If the current becomes high, reduce the VIN voltage quickly to prevent damage. Then inspect the setup for any wiring errors. Once the VIN voltage settled to 3.6V, the supply current should only be around a few μA since the KTZ8868 and KTC2115 devices are in shutdown mode.

Graphical User Interface (GUI)

1. Download and install GUI software located on EVAL Kit Page (<https://www.kinet-ic.com/ktz8868euad-mmev01>).
2. Run the GUI software "KTZ8868 Control Panel Rev 1.4" program on the computer. Verify that the USB-to-I2C adapter module has been detected in the lower left corner of the GUI.
3. The GUI interface will appear with the status message "USB Device Attached" at the bottom left side of the window.
4. If the displayed message is "USB Device Detached", make sure the computer is properly connected to the board.

Typical Test Setup Photo

Use the following test setup for the Quick Start Procedures.

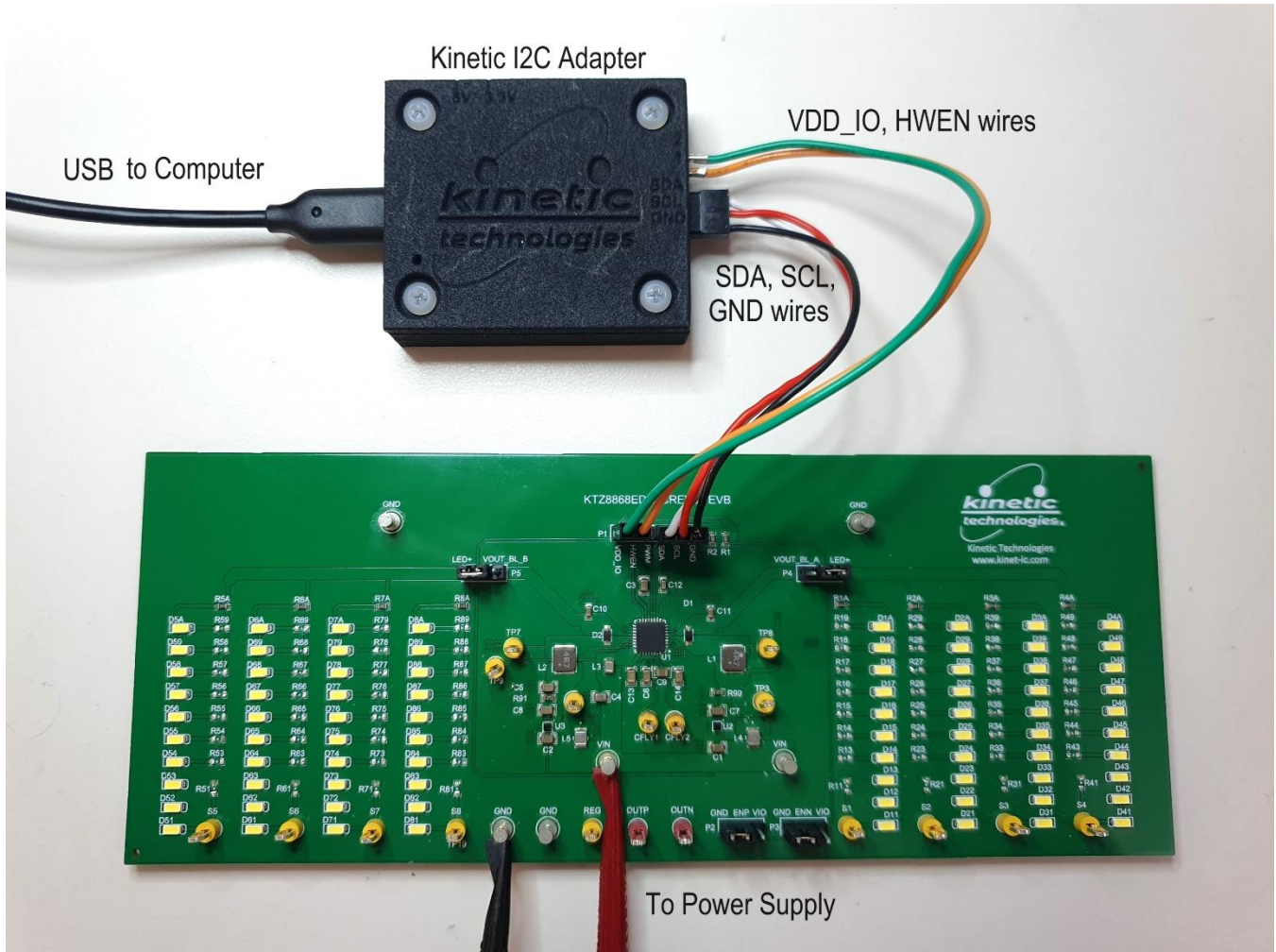
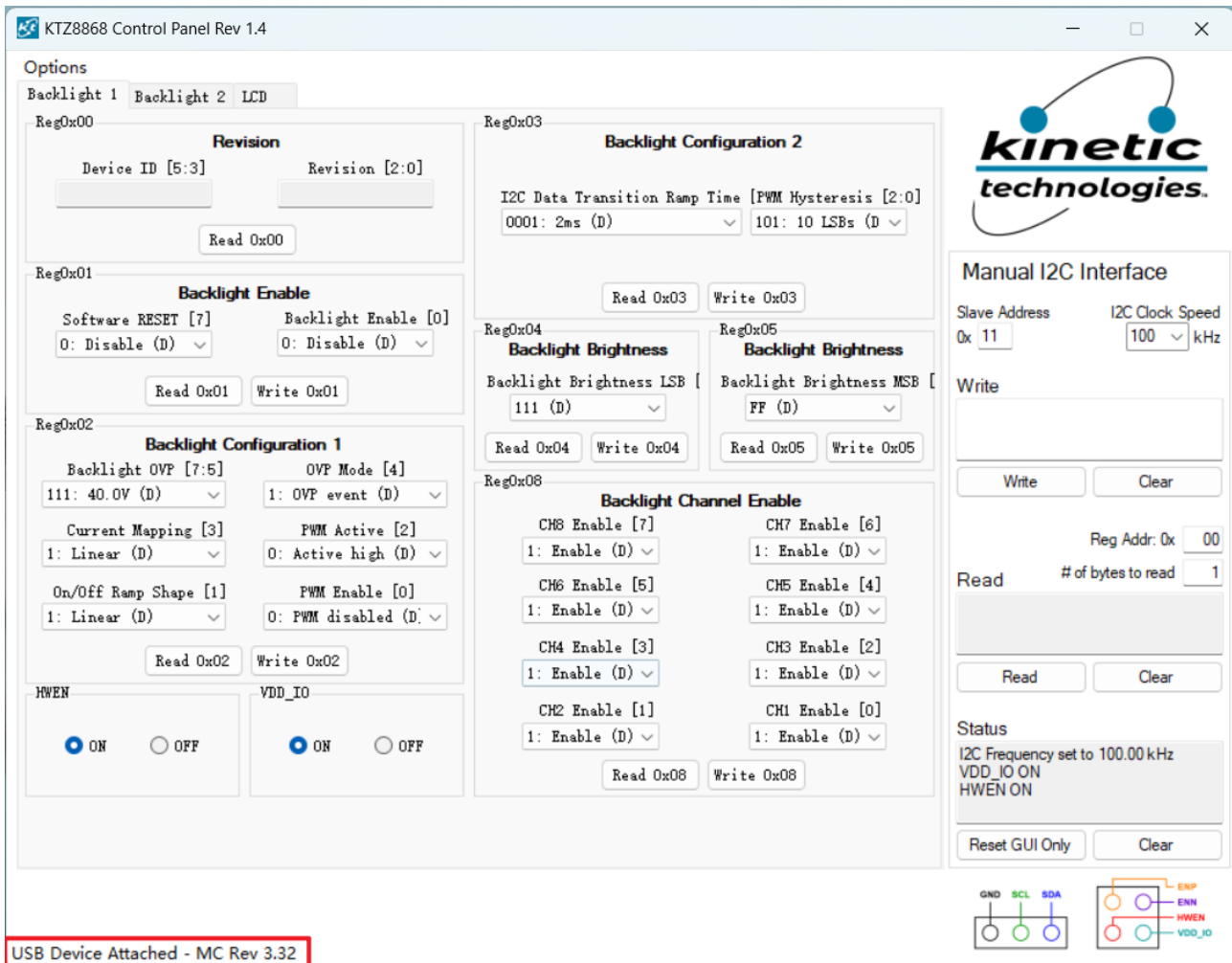


Figure 3. KTZ8868 Eval Kit Photo

Graphical User Interface (GUI) Window



The screenshot displays the 'KTZ8868 Control Panel Rev 1.4' GUI. It features several configuration sections:

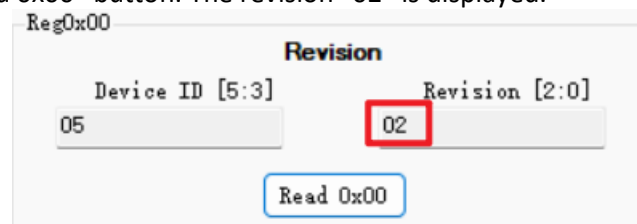
- Options:** Includes tabs for Backlight 1, Backlight 2, and LCD.
- Reg0x00:** Revision section with fields for Device ID [5:3] and Revision [2:0], and a Read OX00 button.
- Reg0x01:** Backlight Enable section with Software RESET [7] and Backlight Enable [0] dropdowns, and Read OX01 / Write OX01 buttons.
- Reg0x02:** Backlight Configuration 1 section with Backlight OVP [7:5], OVP Mode [4], Current Mapping [3], PWM Active [2], On/Off Ramp Shape [1], and PWM Enable [0] dropdowns, and Read OX02 / Write OX02 buttons.
- HWEN and VDD_IO:** Control sections with ON/OFF radio buttons.
- Reg0x03:** Backlight Configuration 2 section with I2C Data Transition Ramp Time [PWM Hysteresis [2:0]] dropdowns, and Read OX03 / Write OX03 buttons.
- Reg0x04 and Reg0x05:** Backlight Brightness sections with Backlight Brightness LSB and MSB dropdowns, and Read/Write buttons.
- Reg0x08:** Backlight Channel Enable section with CH8-CH1 Enable [7:0] dropdowns, and Read OX08 / Write OX08 buttons.
- Manual I2C Interface:** Includes Slave Address (0x 11), I2C Clock Speed (100 kHz), Write and Read buttons, and a status section showing I2C Frequency set to 100.00 kHz, VDD_IO ON, and HWEN ON.
- Reset GUI Only:** A button to reset the GUI.
- USB Device Attached - MC Rev 3.32:** A status message at the bottom left.
- Pin Diagram:** A small diagram at the bottom right showing connections for GND, SCL, SDA, ENP, ENN, HWEN, and VDD_IO.

- 1) To enable the KTZ8868 driver and both KTC2115 boost devices, in the GUI set VDD_IO High by clicking the VDD_IO ON button, then set HWEN High by checking the HWEN ON button, as shown in the Figure below.

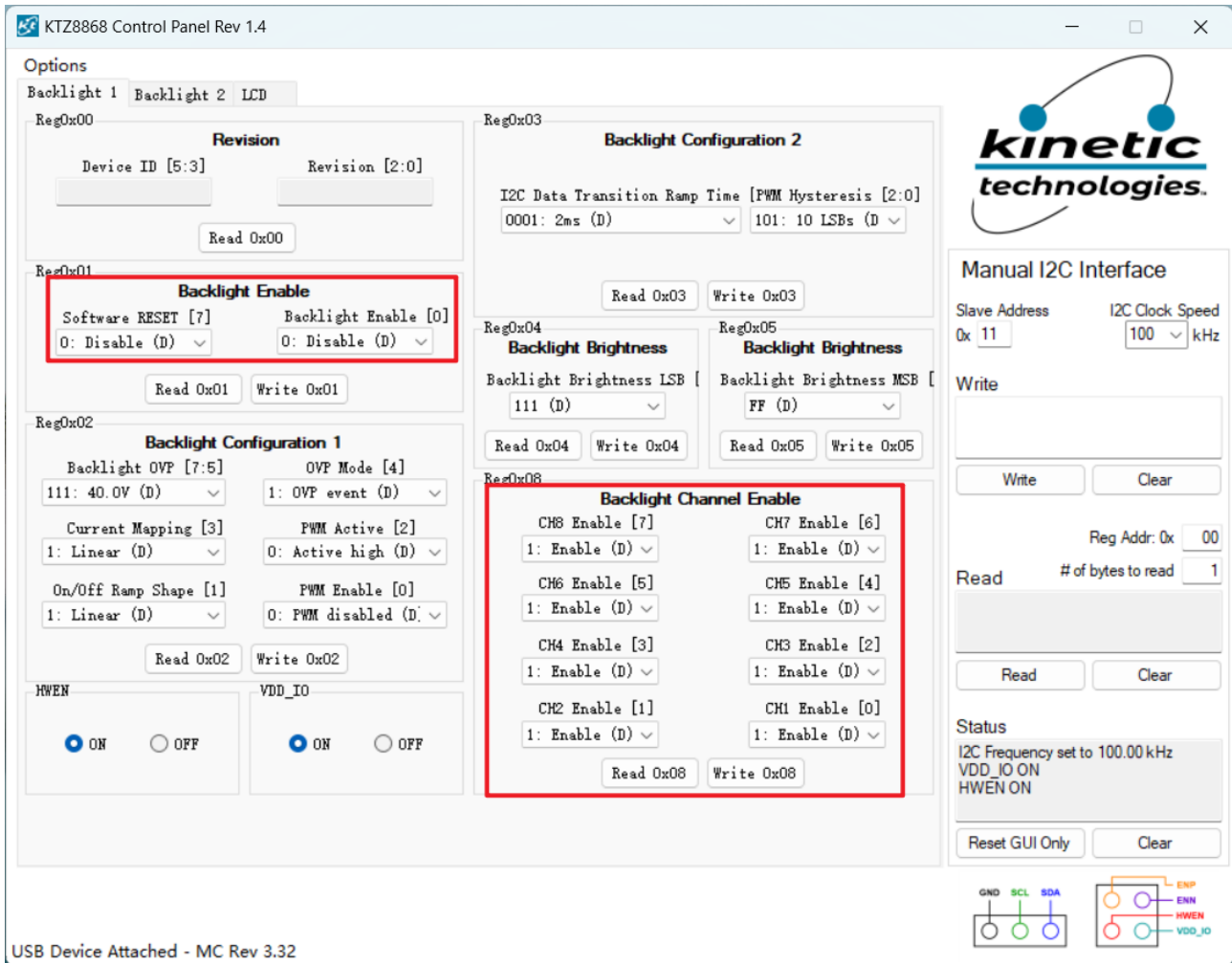


Notes:

- a. For conditions of VIN = 3.6V, HWEN = ON, and the Backlight Disabled (Default), the VIN supply current should be under 1mA.
 - b. With VIN voltage at 3.6V, use a voltmeter to check the two KTC2115 boost output voltage between test points TP7 & TP8 and GND terminals on the EVAL board. Both TP7 & TP8 voltages should be around 5V.
- 2) To verify that I2C SDA/SCL communication works, for example, in “Backlight 1” menu tab, read register 0x00 by clicking on “Read 0x00” button. The revision “02” is displayed.



- 3) To configure the Backlight LED brightness to the lowest MSB current, set register Reg0x05 to 0x00. Then in the Reg0x05 section, click on the “Write 0x05” button.
- 4) Keep the Backlight LED brightness to the highest LSB current, with register Reg0x04 = 0x07 (Default).
- 5) Individual backlight channels can be selected to be enabled or disabled, in register Reg0x08 section select the channel enable state to Disable/Enable, then click on “Write 0x08” button. By default, all channels are set to Enable state.
- 6) To turn on the backlight, configure register Reg0x01 bit Backlight Enable equal to 1, then click “Write 0x01”.
- 7) Make sure the Backlight OVP voltage setting in register Reg0x02 section is set to proper value according to LEDs configuration prior to turn on backlight. The default OVP is 40V which is compatible with 10 LEDs per string.



KTZ8868 Control Panel Rev 1.4

Options

Backlight 1 | Backlight 2 | LCD

Reg0x00

Revision

Device ID [5:3] Revision [2:0]

Read 0x00

Reg0x01

Backlight Enable

Software RESET [7] Backlight Enable [0]

0: Disable (D) 0: Disable (D)

Read 0x01 Write 0x01

Reg0x02

Backlight Configuration 1

Backlight OVP [7:5] OVP Mode [4]

111: 40.0V (D) 1: OVP event (D)

Current Mapping [3] PWM Active [2]

1: Linear (D) 0: Active high (D)

On/Off Ramp Shape [1] PWM Enable [0]

1: Linear (D) 0: PWM disabled (D)

Read 0x02 Write 0x02

HWEN **VDD_IO**

ON OFF ON OFF

Reg0x03

Backlight Configuration 2

I2C Data Transition Ramp Time [PWM Hysteresis [2:0]

0001: 2ms (D) 101: 10 LSBs (D)

Read 0x03 Write 0x03

Reg0x04

Backlight Brightness

Backlight Brightness LSB [

111 (D)

Read 0x04 Write 0x04

Reg0x05

Backlight Brightness

Backlight Brightness MSB [

FF (D)

Read 0x05 Write 0x05

Reg0x08

Backlight Channel Enable

CH8 Enable [7] CH7 Enable [6]

1: Enable (D) 1: Enable (D)

CH6 Enable [5] CH5 Enable [4]

1: Enable (D) 1: Enable (D)

CH4 Enable [3] CH3 Enable [2]

1: Enable (D) 1: Enable (D)

CH2 Enable [1] CH1 Enable [0]

1: Enable (D) 1: Enable (D)

Read 0x08 Write 0x08

Manual I2C Interface

Slave Address I2C Clock Speed

0x 11 100 kHz

Write

Write Clear

Reg Addr: 0x 00

Read # of bytes to read 1

Read Clear

Status

I2C Frequency set to 100.00 kHz

VDD_IO ON

HWEN ON

Reset GUI Only Clear

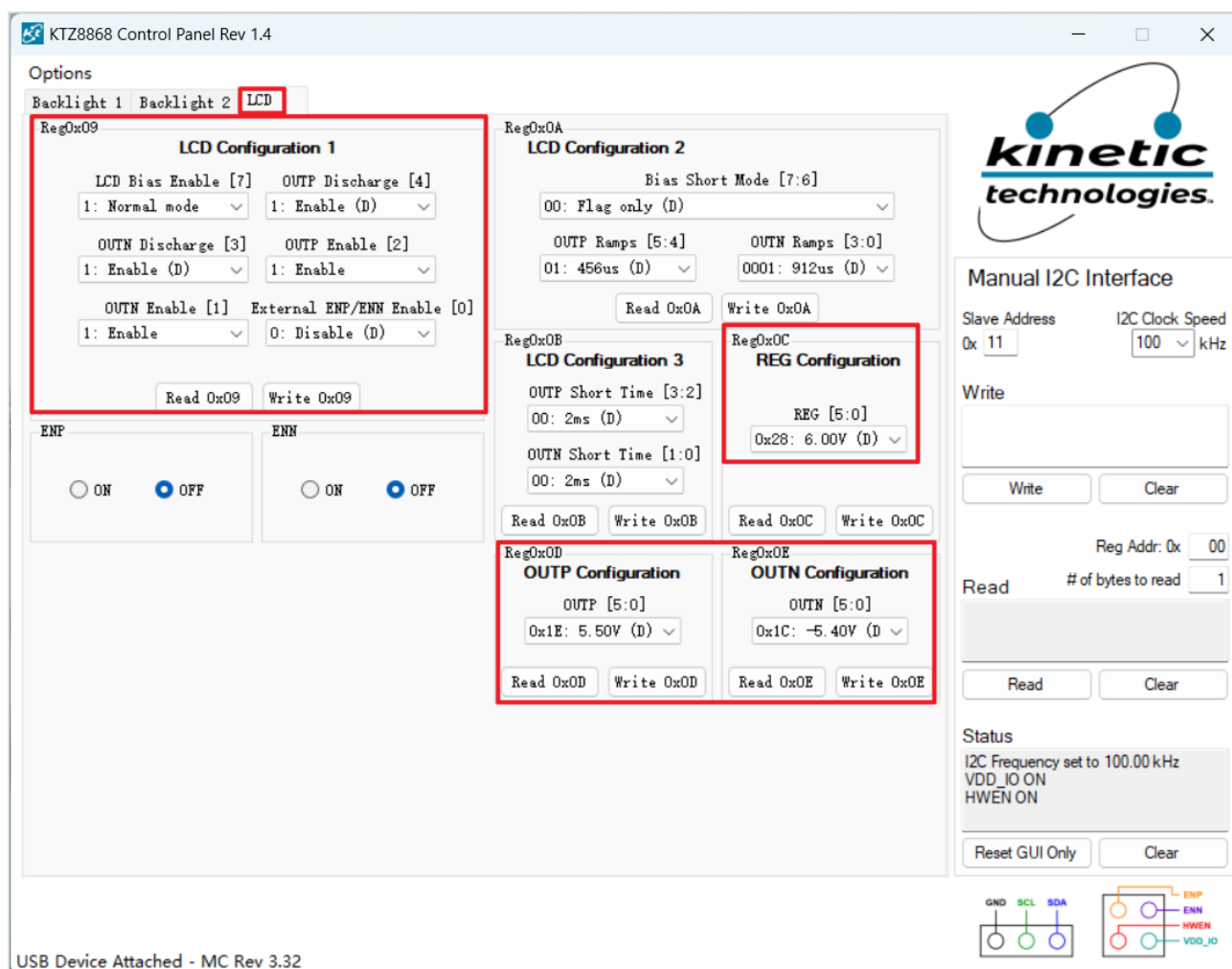
GND SCL SDA ENP ENN HWEN VDD_IO

USB Device Attached - MC Rev 3.32

- 8) To turn on the LCD Bias outputs, click on the “LCD” tab on the top left corner.
- 9) Then configure the OUTP/OUTN output voltages in the register Reg0x0D and Reg0x0E as highlighted below. Initially, we keep the default setting of OUTP = +5.5V and OUTN = -5.4V.
- 10) To turn on the OUTP/OUTN outputs, configure register Reg0x09 by setting to 1 the following bits OUTP Enabled, OUTN Enabled, and LCD Bias Enabled (Normal Mode). Then click on “Write 0x09” button.
- 11) Both OUTP and OUTN are now turned on, use a multimeter to measure OUTP and OUTN voltages, OUTP should be equal to +5.5V by default and OUTN should be at 5.4V by default.
- 12) For proper operation and best efficiency, REG voltage is suggested to be $REG = MAX(OUTP, |OUTN|) + VHR$, where $VHR \geq 200mV$ for lower currents and $VHR \geq 300mV$ for higher currents.

Note:

- a. If want to change REG/OUTP/OUTN voltages, it is necessary to click on “Write 0x09” button again after changing REG/OUTP/OUTN registers (0x0C/0x0D/0x0E)



KTZ8868 Control Panel Rev 1.4

Options: Backlight 1, Backlight 2, **LCD**

Reg0x09 LCD Configuration 1

LCD Bias Enable [7]: 1: Normal mode
 OUTP Discharge [4]: 1: Enable (D)
 OUTN Discharge [3]: 1: Enable (D)
 OUTP Enable [2]: 1: Enable
 OUTN Enable [1]: 1: Enable
 External ENP/ENN Enable [0]: 0: Disable (D)

Reg0x0A LCD Configuration 2

Bias Short Mode [7:6]: 00: Flag only (D)
 OUTP Ramps [5:4]: 01: 456us (D)
 OUTN Ramps [3:0]: 0001: 912us (D)

Reg0x0B LCD Configuration 3

OUTP Short Time [3:2]: 00: 2ms (D)
 OUTN Short Time [1:0]: 00: 2ms (D)

Reg0x0C REG Configuration

REG [5:0]: 0x28: 6.00V (D)

Reg0x0D OUTP Configuration

OUTP [5:0]: 0x1E: 5.50V (D)

Reg0x0E OUTN Configuration

OUTN [5:0]: 0x1C: -5.40V (D)

ENP: ON OFF
 ENN: ON OFF

Manual I2C Interface

Slave Address: 0x 11
 I2C Clock Speed: 100 kHz

Write: [Field]
 Write Clear

Read: [Field]
 Read Clear

Status

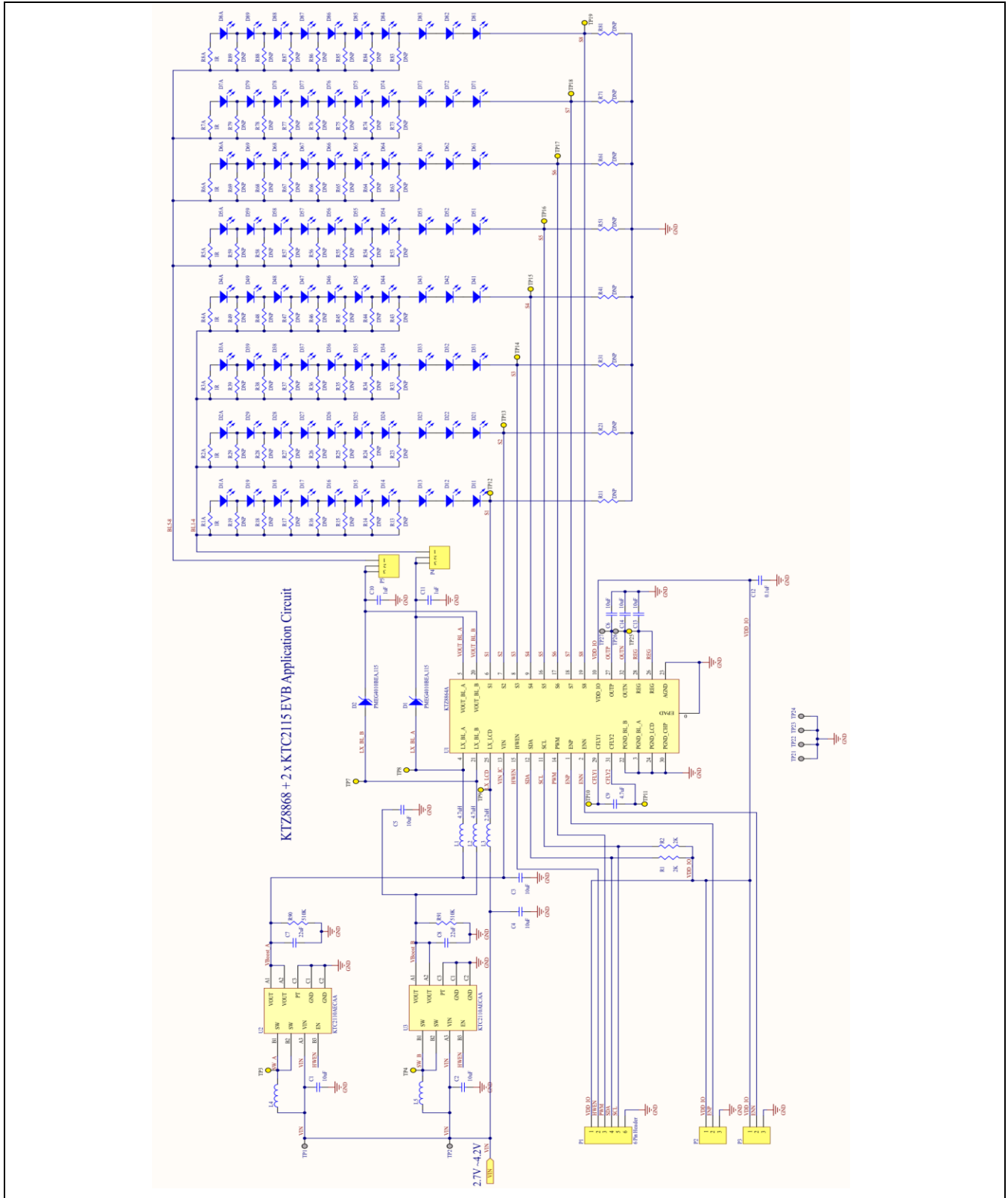
I2C Frequency set to 100.00 kHz
 VDD_IO ON
 HWEN ON

Reset GUI Only Clear

USB Device Attached - MC Rev 3.32

Diagram: GND, SCL, SDA, ENP, ENN, HWEN, VDD_IO

Electrical Schematic



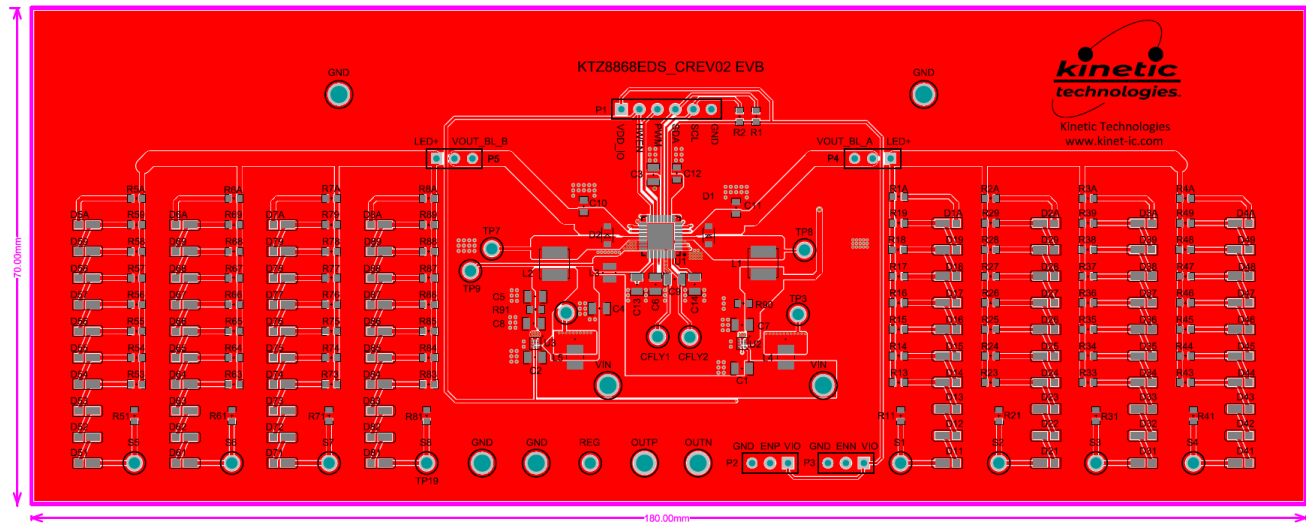


Bill of Materials (BOM)

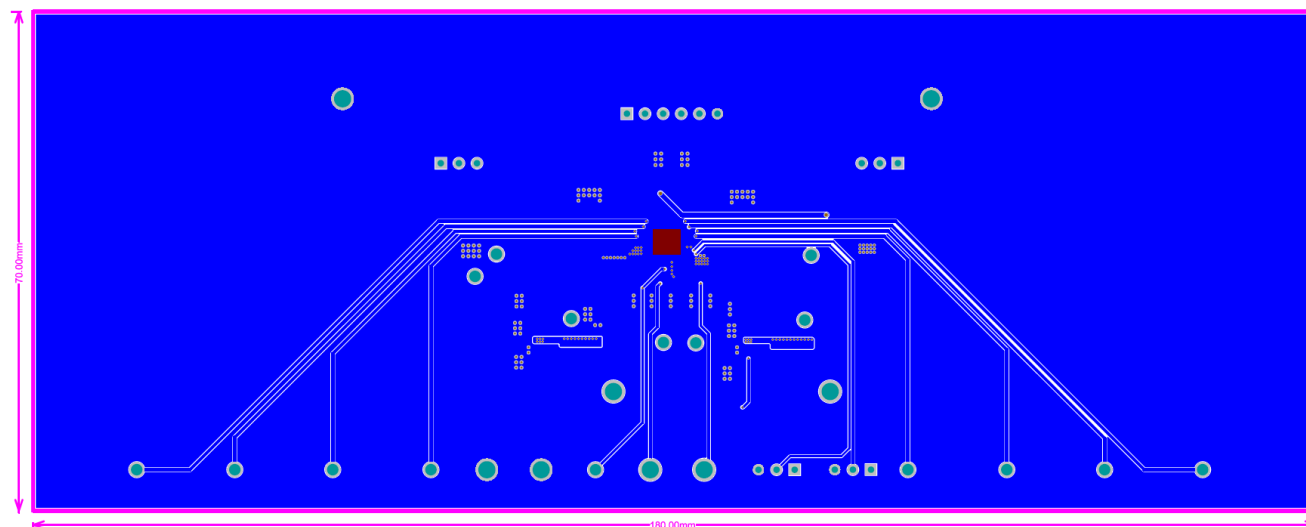
Item	Quantity	Designator	Description	Value	Package	Manufacturer	Manufacturer Part Number	Digikey Part Number	Mouser Part Number
1	8	C1, C2, C3, C4, C5, C6, C13, C14	CAP CER 10uF 25V X5R 0805	10uF	0805	Samsung	CL21A106KAYNNNE	1276-2891-1-ND	187-CL21A106KAYNNNE
2	2	C7, C8	CAP CER 22uF 16V X5R 0805	22uF	0805	Samsung	CL21A226MOQNNNE	1276-2909-1-ND	187-CL21A226MOQNNNE
3	1	C9	CAP CER 4.7uF 50V X5R 0805	4.7uF	0805	Samsung	CL21A475KBQNNNE	1276-1248-1-ND	187-CL21A475KBQNNNE
4	2	C10, C11	CAP CER 1.0uF 50V X5R 0603	1uF	0603	Samsung	CL10A105KB8NNNC	1276-1860-1-ND	187-CL10A105KB8NNNC
5	1	C12	CAP CER 0.1uF 50V X7R 0603	0.1uF	0603	Samsung	CL10B104KB8NNNC	1276-1000-1-ND	187-CL10B104KB8NNNC
6	2	D1, D2	DIODE SCHOTTKY 40V 1A SOD323		SOD323	Nexperia USA Inc.	PMEG4010BEA,115	1727-5211-1-ND	771-PMEG4010BEAT/R
7	80	D1A, D2A, D3A, D4A, D5A, D6A, D7A, D8A, D11, D12, D13, D14, D15, D16, D17, D18, D19, D21, D22, D23, D24, D25, D26, D27, D28, D29, D31, D32, D33, D34, D35, D36, D37, D38, D39, D41, D42, D43, D44, D45, D46, D47, D48, D49, D51, D52, D53, D54, D55, D56, D57, D58, D59, D61, D62, D63, D64, D65, D66, D67, D68, D69, D71, D72, D73, D74, D75, D76, D77, D78, D79, D81, D82, D83, D84, D85, D86, D87, D88, D89	6500K Positive post White light 132mW		SMD3014	HONGLITRONIC	HL-A-3014H421W-S1-08HL-HR3		
8	2	L1, L2	FIXED IND 4.7uH 1.9A 166MOHM SMD	4.7uH	SMD	Shenzhen Sunlord Electronics Co.	WPN4012H4R7MT	3442-WPN4012H4R7MTTR-ND	
9	1	L3	FIXED IND 2.2uH 2.1A 144 mOHM SMD	2.2uH	0806	Murata	DFE201612P-2R2M=P2	490-10620-1-ND	81-DFE201612P-2R2MP2
10	2	L4, L5	FIXED IND 470NH 4.9A 23MOHM SMD			Murata Electronics	DFE252012F-R47M=P2	490-13049-1-ND	81-DFE252012F-R47MP2
11	1	P1	CONN HEADER VERT 6POS 2.54MM		TH	Sullins Connector Solutions	PREC006SAAN-RC	S1012EC-06-ND	N/A
12	4	P2, P3, P4, P5	CONN HEADER VERT 3POS 2.54MM		TH	Sullins	PREC003SAAN-RC	S1012EC-03-ND	
13	2	R1, R2	RES 2.0k OHM 1% 1/10W 0603	2K	0603	Yageo	RC0603FR-072KL	311-2.00KHRCT-ND	603-RC0603FR-072KL
14	56	R11, R13, R14, R15, R16, R17, R18, R19, R21, R23, R24, R25, R26, R27, R28, R29, R31, R33, R34, R35, R36, R37, R38, R39, R41, R43, R44, R45, R46, R47, R48, R49, R51, R53, R54, R55, R56, R57, R58, R59, R61, R63, R64, R65, R66, R67, R68, R69, R71, R73, R74, R75, R76, R77, R78, R79, R81, R83, R84, R85, R86, R87, R88, R89	RES 1 OHM 1% 1/10W 0603	DNP	0603	Yageo	RC0603FR-071RL	311-1.00HRCT-N	603-RC0603FR-071RL
15	16	R1A, R2A, R3A, R4A, R5A, R6A, R7A, R8A	RES 1 OHM 1% 1/10W 0603	1	0603	Yageo	RC0603FR-071RL	311-1.00HRCT-N	603-RC0603FR-071RL
16	2	R90, R91	RES 510K OHM 1% 1/10W 0603	510K	0603	Yageo	RC0603FR-07510KL	311-510KHRCT-ND	603-RC0603FR-07510KL
17	6	TP1, TP2, TP21, TP22, TP23, TP24	TERM TURRET SINGLE L=5.56MM TIN		TH	Keystone	1502-2	36-1502-2-ND	534-1502-2
18	16	TP3, TP4, TP7, TP8, TP9, TP10, TP11, TP12, TP13, TP14, TP15, TP16, TP17, TP18, TP19, TP25	PC TEST POINT MULTIPURPOSE YELLOW		TH	Keystone	5014	36-5014-ND	534-5014
19	2	TP26, TP27	PC TEST POINT MULTIPURPOSE RED		TH	Keystone	5010	36-5010-ND	534-5010
20	1	U1	High Efficiency 8-CH LED Backlight Driver with Dual LCD Bias Power		WQFN55-32	Kinetic Technologies	KTZ8868EUAD-TB		
21	2	U2, U3	2.5MHz 1.5A High Efficiency Low IQ Synchronous Boost		WLCSP33-9	Kinetic Technologies	KTC2115ECAB-TA		389-KTC2115ECAB-TA

Printed Circuit Board (PCB)

Top Layer



Bottom Layer



Troubleshooting

Symptom	Root Cause	Solution
GUI display on bottom left "USB Device Detached"	I2C adapter not connected to the computer USB connector.	Connect the USB cable between I2C adapter and the computer.
Device is not responding to I2C command	VIN supply is not powered.	Make sure the VIN supply (for example 3.6V) is connected to EVB.
Device is not responding to I2C command	I2C adapter cable wires VDD_IO, HWEN, SDA, SCL or GND are not plugged into the EVB.	Connect the I2C adapter cable wires VDD_IO, HWEN, SDA, SCL and GND to the EVB header P1.
Device is not responding to I2C command	The GUI Slave address does not match the KTZ8868 device address on the EVB	Make sure the GUI Slave Address is correct.
LEDs are not turning on in backlight mode	The jumpers on P4 & P5 are missing or not at the right positions.	Mount the jumpers on P4 & P5 at the proper location on the board. Then enable Backlight again.
The number of LEDs per channel need to be changed.	Rxx 1-ohm resistors next to the LEDs are not mounted at the desired location.	Reposition the Rxx 1-ohm resistors in order to connect to the desired number LEDs for each channel.

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