# UG367: Si823Hx/8252x-EVB User's Guide

The Si823Hx/8252x isolated gate drivers are ideal for driving power switches used in a wide variety of power supplies, inverters, and motor control applications offering longer service life and dramatically higher reliability compared to opto-coupled gate drivers. The Si823Hx/8252x isolated gate drivers utilize Skyworks' proprietary silicon isolation technology that supports up to 5 kVRMS withstand voltage per UL1577. This technology enables industry-leading, common-mode transient immunity (CMTI), tight timing specifications, reduced variation with temperature and age, better part-to-part matching, and extremely high reliability. It also offers unique features, such as separate pull-up/down outputs, driver shutdown on UVLO fault, and precise dead time programmability. Driver outputs can be grounded to the same or separate grounds or connected to a positive or negative voltage. TTL level compatible inputs with 800 mV hysteresis are available in individual control input (Si823H1/2/3/5/6/7 and Si82520) or PWM input (Si823H4/8) configurations. High integration, low propagation delay, small installed size, flexibility, and cost-effectiveness make this family ideal for a wide range of isolated MOSFET/IGBT/SiC/GaN gate drive applications.

The Si823Hx/8252x evaluation board allows designers to evaluate Skyworks' Si823Hx/8252x family of high CMTI performance ISOdrivers. The board includes screw terminals for quick evaluation of key device parameters and includes test points on each device's pins to accommodate direct connection to the designer's end system. For more ISOdriver information, visit the Skyworks web site at www.skyworksinc.com//products/isolation. The product data sheet and numerous application notes can be referenced to help facilitate designs.

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• Si823Hx/8252x-based evaluation board (Si823Hx/8252x-EVB) populated with one of the following configurations:
  • One Si823H2 WB SOIC-14 ISOdriver
  • One Si82520 WB SOIC-14 ISOdriver
  • Two Si823H9 SSO-8 ISOdrivers
  • One Si823H1 DFN-14 ISOdriver
  • One Si823H2 NB SOIC-16 ISOdriver
  • Two Si823H9 NB SOIC-8 ISOdrivers
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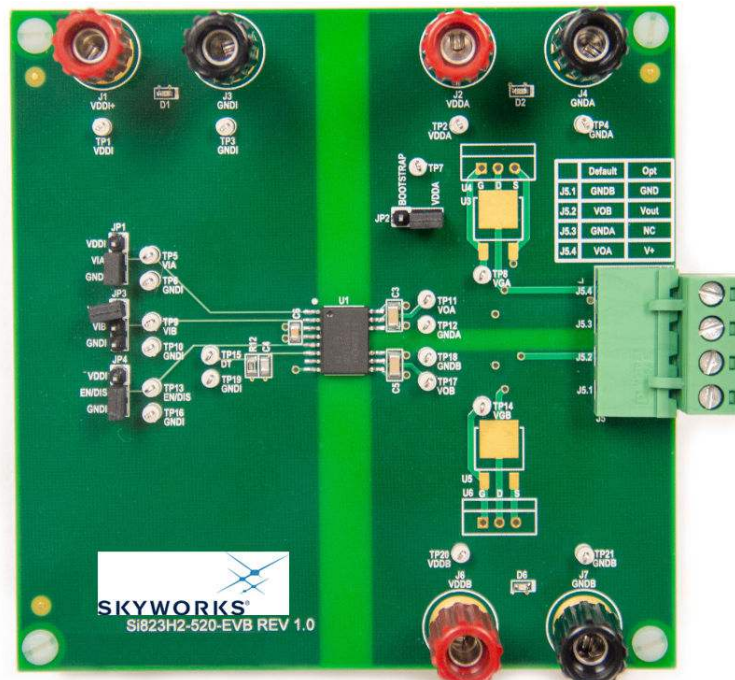
1. Ordering Guide

Table 1.1. Si823Hx/8252x Evaluation Board Ordering Guide

Ordering Part Number (OPN)	Description
Si823H2-KIT	Si823Hx WB SOIC-14 Isolated Gate Driver Evaluation Kit
Si82520-KIT	Si8252x WB SOIC-14 Isolated Gate Driver Evaluation Kit
Si823H9-KIT	Si823H9 SSO-8 Isolated Gate Driver Evaluation Kit
Si823Hx-DFN14-KIT	Si823Hx DFN-14 Isolated Gate Driver Evaluation Kit
Si823Hx-NB16-KIT	Si823Hx NB SOIC-16 Isolated Gate Driver Evaluation Kit
Si823H9-NB8-KIT	Si823H9 NB SOIC-8 Isolated Gate Driver Evaluation Kit

2. Required Equipment

The following equipment is required to demonstrate the evaluation board:

- One signal generator
- One dual dc power supply: 0–5 V and 0–15 V (or two single supplies)
- 1 oscilloscope (at least two channels)
- Assorted cables, leads and probes as necessary to connect equipment to EVB
- Si823Hx evaluation board (board under test)
- Si823Hx evaluation board user's guide (this document)

2.1 DC Supply Configuration

1. Set one supply to output 5 VDC.
2. Turn OFF the supply and connect the positive lead to VDDI (J1 pin1 or TP1).
3. Connect the negative lead to GNDI (J3 or TP3).
4. Turn ON the dc power supply.
5. Ensure that LED D1 turns on.
6. Ensure that the current draw is less than 25 mA. If it is larger, this indicates that either the board or Si823Hx has been damaged or the supply is connected backwards.
7. Set the other supply to output 15 VDC.
8. Turn OFF the supply and connect the positive lead to VDDA (J2 or TP2).
9. Connect the negative lead to GNDA (J4 or TP4).
10. Turn ON the supply.
11. Ensure that LED D2 turns on.
12. Ensure that the current draw is less than 100 mA. If it is larger, this indicates that either the board or Si823Hx has been damaged or the supply is connected backwards.

2.2 Function Generator

1. Turn ON the function generator with the output disabled.
2. Adjust its output to provide a 500 kHz, 0 to 5 V peak square wave (50 percent duty cycle) to its output.
3. Connect the output of the generator to VIA (TP5, ground on TP6).
4. Ensure a shunt is placed on JP3 between Pins 2 and 3 (connects VIB to GND).
5. If the board has an EN pin, ensure that a shunt is placed on JP4 between Pins 1 and 2 to enable the device. If the board has a DIS pin, ensure that the shunt is placed between Pins 2 and 3 to enable the device.
6. Enable the output of the waveform generator.

2.3 Oscilloscope Setup

To set up the oscilloscope, perform the following steps:
1. Set the scope to Trigger on CH1 and adjust the trigger level to approximately 2 V.
2. Set CH1 to 2 V per division and CH2 to 5 V per division
3. Adjust the seconds/division setting to 500 ns/division
4. Connect the scope channel 1 probe to VIA (TP5). Ground the probe to GNDI (TP6)
5. Connect Channel 2 probe to VOA (J5 Pin 4 or TP11). Ground the probe to GNDA (J5 Pin 3 or TP12)
6. Adjust the vertical position of each channel to properly view each channel as shown in the figure below

A 500 kHz square wave should display on Channel 1 of the scope for the input and a 15 V version should display on Channel 2, as shown in the following figure.
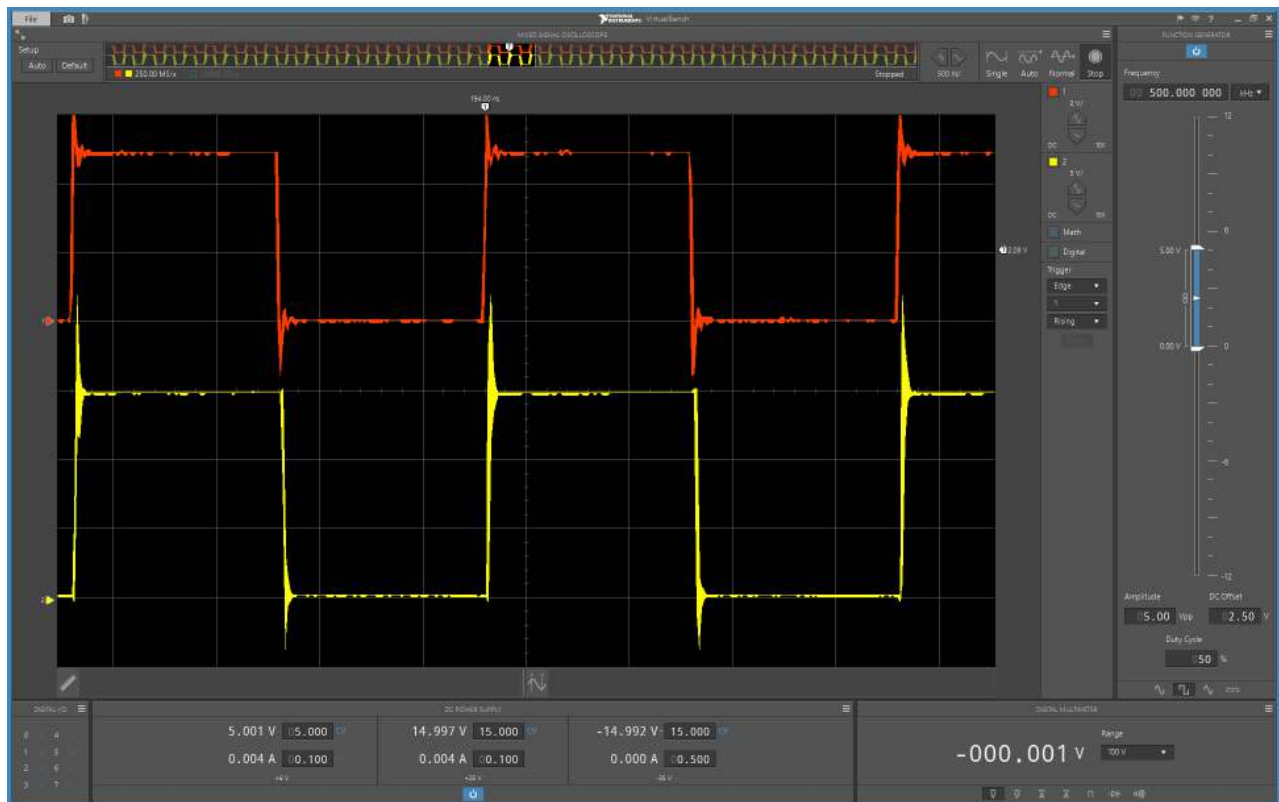
Figure 2.1. 500 kHz Square Wave

2.4 Repeat for Second Channel

1. Disable the function generator output.
2. Turn OFF the 15 V supply.
3. Disconnect 15 V supply from VDDA/GNDA.
4. Connect the 15 V supply to VDDB (J6 or TP20) and GNDB (J7 or TP21).
5. Move the Channel 2 scope probe to VOB (J5 pin 2 or TP17) and GNDB (J5 pin 1 or TP18).
6. Remove the shunt on JP3.
7. Move the function generator to VIB (TP9) and GNDI (TP10).
8. Place shunt on JP1 between Pins 2 and 3 (connects VIA to GNDI).
9. Turn ON the dc supply.
10. Ensure that LED D6 turns on.
11. Ensure that the current draw is less than 100 mA. If it is larger, this indicates that either the board or Si823Hx has been damaged or the supply is connected backwards.
12. Enable the function generator output.
13. The scope display should show both the input and output waveforms as before.

3. Built-In Options

The Si823H2, Si82520, and Si823Hx evaluation boards are populated with dual drivers with high-side/low-side (HS/LS) operation. If VIA and VIB inputs are driven high, the devices' overlap protection will force VOA and VOB to a low state. However, both versions of the Si823H9 EVBs are built with two single-channel drivers, which results in no overlap protection. If the customer populates the half-bridge components, they must ensure that both inputs are never driven high at the same time. Doing so will cause both FETs to turn on simultaneously and short circuit the bridge supply, damaging the FETs and the Si823H9 devices.

3.1 Device Swap

The six EVBs come installed with the OPNs and package types listed in the table below. These six boards cover all the package variations of the Si823Hx/8252x products, and the ICs on each panel can easily be swapped for another of the same package type using soldering tools. Check to ensure that pinout differences, such as EN/DIS pins and NC pins, are accounted for when powering up the new circuit.

Table 3.1. Evaluation Board Ordering Part Numbers and Package Types

Kit Name	Device OPN	Device Package Type
Si823H2-KIT	Si823H2BD-IS3	WB SOIC-14
Si82520-KIT	Si82520BD-IS3	WB SOIC-14
Si823H9-KIT	Si823H9BD-IS4	SSO-8
Si823Hx-DFN14-KIT	Si823H1BB-IM1	DFN-14
Si823Hx-NB16-KIT	Si823H2AB-IS1	NB SOIC-16
Si823H9-NB8-KIT	Si823H9AC-IS	NB SOIC-8

3.2 Half-Bridge Gate Driver Implementation

The Si823Hx/Si8252x EVBs come from the factory configured to provide VOA, GNDA, VOB, and GNDB signals to the connector J5. The transistors at U3/U4 and U5/U6 are missing, which allows the evaluation of the Si823Hx drivers on their own. Adding the transistors and modifying several other components enable the customer to build a half-bridge gate driver and test its application on the same EVB.

To configure the board for a half-bridge gate driver circuit, the following components must be removed:
- R3
- R9
- R11

Components for the following reference designators must be soldered to the board:
- R7
- U3 or U4
- U5 or U6

The positions for U3 / U4 allow the customer to place a high-side FET of either a TO-220 or D-PAK package. These two components are wired in parallel and should not be populated at the same time. The same is true for U5 / U6 for a low-side FET.

If this half-bridge gate driver is implemented, the pinout of connector J5 will be as follows:
- Pin 1 (GND) remains connected to GNDB but now also functions as the half-bridge supply ground.
- Pin 2 (V_{out}) is now the output of the half-bridge gate driver.
- Pin 3 (NC) is now disconnected from the circuit and floating.
- Pin 4 (V+) is now the half-bridge positive supply.

3.3 Optimizing FET Gate Drive

Diode and resistor combinations D4 & R4 and D5 & R8 provide an option to optimize turn-on and turn-off currents for the FETs. This modification would offer improvements to a customer that has implemented the half-bridge gate driver described above.

It should be noted that these diodes do not exist on the Si823H9-EVB and Si823H9-NB8-EVB, which provide separate pull-up and pull-down output lines.

Furthermore, adding pull-down resistors R6 and R13 can ensure the FETs default to an OFF state should the VOA and VOB outputs fail to pull the gates low.

3.4 Deadtime Modification

The deadtime resistor R12 can be swapped with another resistor to achieve a different deadtime setting. The data sheet provides the expected output behavior and the equation for dead time based on the resistor value.

3.5 Bootstrapping

Another option on the evaluation board is the setting of JP2. If Pins 2 and 3 of JP2 are jumped, drivers A and B will be powered with independent supplies. For a bootstrap option, remove the jumper between Pins 2 and 3 and place the jumper between Pins 1 and 2. The VDDA pin is now connected to diode D3, and a single power supply will drive both drivers via a bootstrap configuration. In this configuration, capacitor C3 becomes the bootstrap capacitor.

It may be necessary to modify the value of R6 and C3 to optimize the performance of the bootstrap supply. A 100 kΩ resistor is recommended for R6 when bootstrapping because C3 can only provide a limited amount of current to drive VOA. Furthermore, for faster switching applications, we recommend swapping D3 for a US1J diode, which has faster reverse recovery than the existing US1K diode. For even quicker applications, a SiC diode should be investigated. To help determine the bootstrap circuit components, Skyworks provides a bootstrap calculator. "AN486 High-Side Bootstrap Design Using ISODrivers in Power Delivery Systems" offers more detailed information on bootstrap design.

4. Evaluation Board Schematics

The 14-pin and 16-pin devices have identical circuits, with the only difference being two additional NC (No Connect) pins on the 16-pin devices. To reduce the number of schematics included in the user's guide, a 16-pin and an 8-pin schematic are shown. To see the schematic, layout, and BOM for each individual EVB, refer to "Schematics and Layouts" on the product webpage.
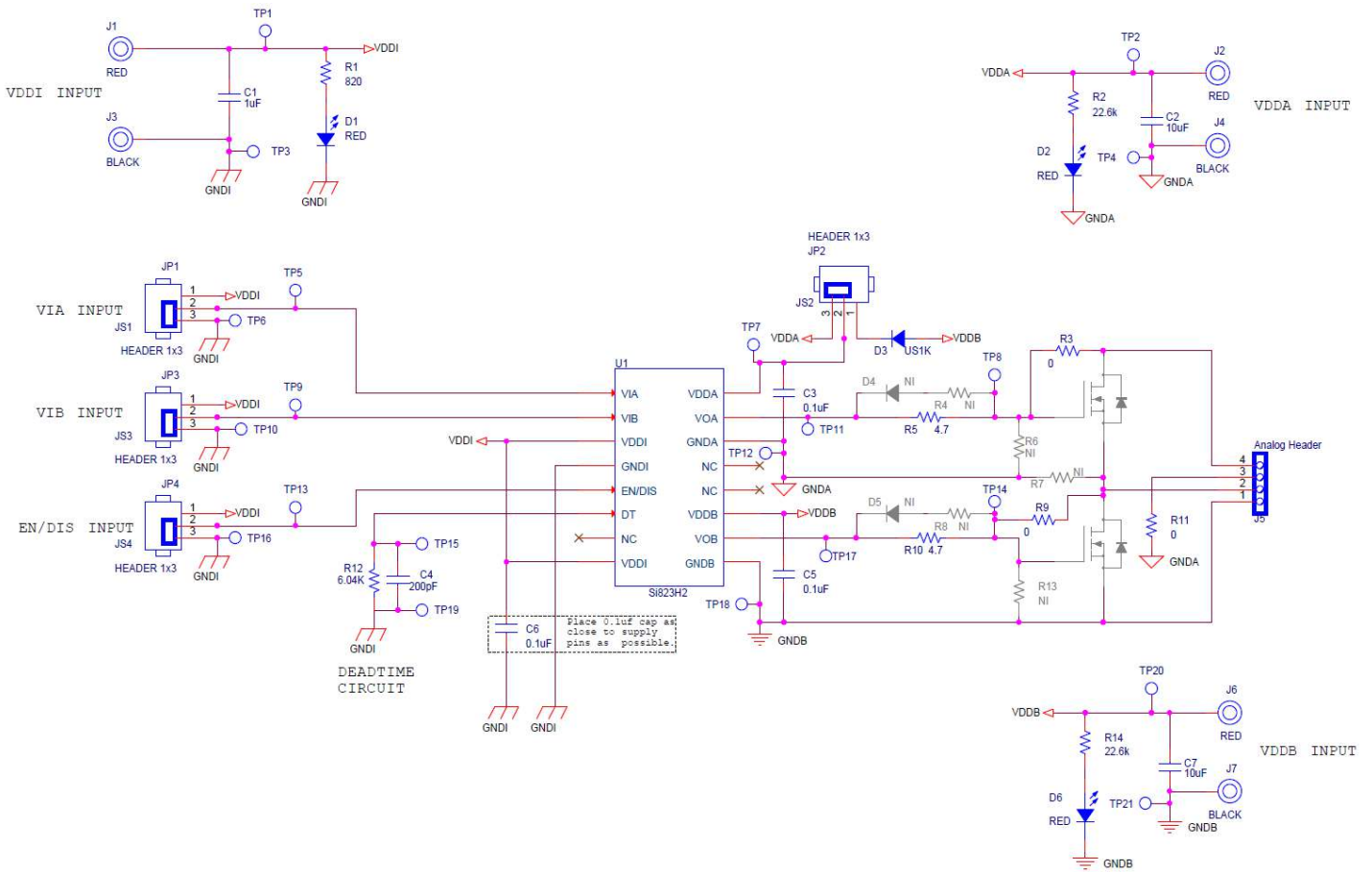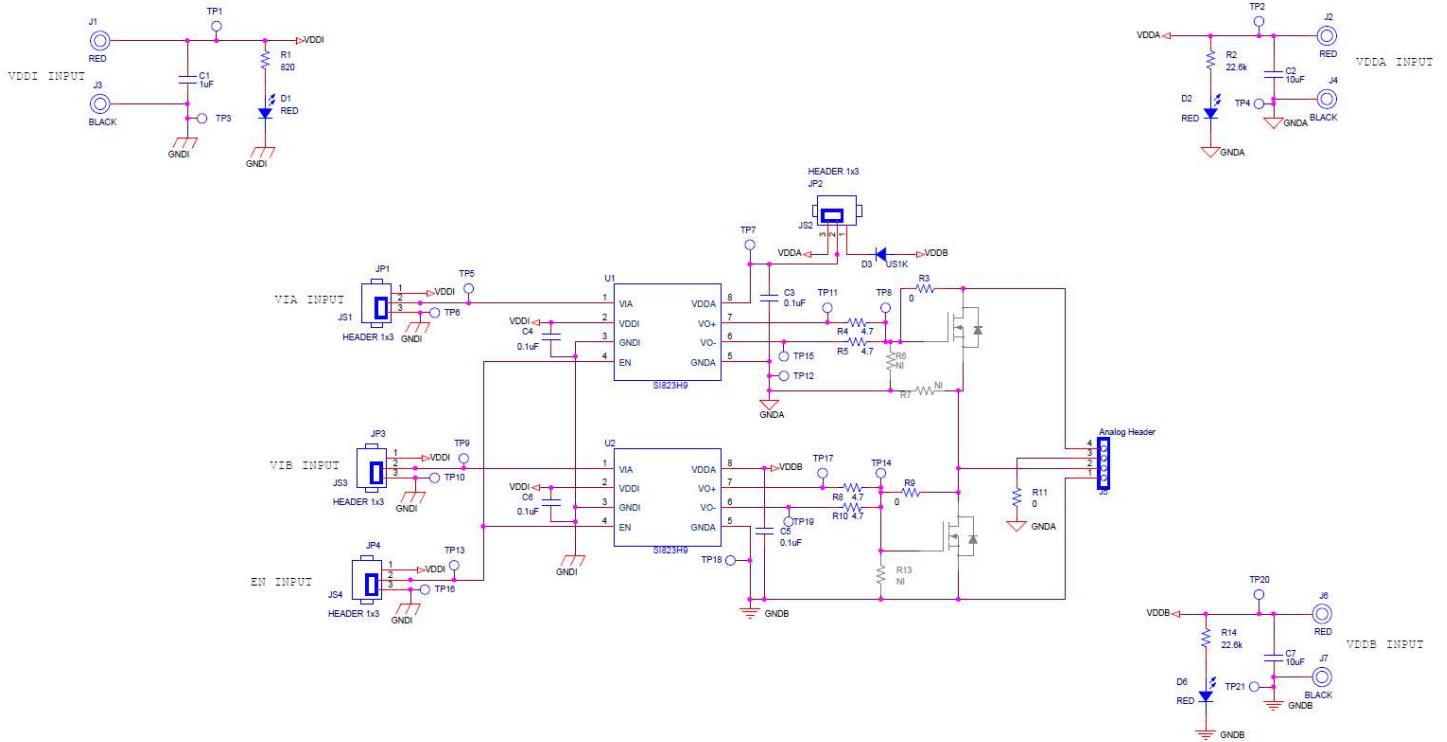

Figure 4.1. Si823Hx-NB16 Evaluation Board Schematic

Figure 4.2. Si823H9-NB8 Evaluation Board Schematic

5. Bill of Materials

This Bill of Materials shows the components that come installed on the board. To reduce the number of BOMs included in the user's guide, only the Si823Hx_NB16 BOM is shown. The BOM for each EVB can be found in the "Schematics and Layouts" file on the product webpage.

Table 5.1. Si823Hx-NB16 Evaluation Board Bill of Materials

Reference	Description	Manufacturer	Manufacturer Part Number
C1	1 μF ±10% 50 V Ceramic Capacitor, X7R, 0805, RoHS	Samsung	CL21B105KBFNNNE
C2, C7	10 μF ±20% 50 V Ceramic Capacitor, X7R, 1210, RoHS	Venkel	C1210X7R500-106M
C3, C5	0.1 μF ±20% 100 V Ceramic Capacitor, X7R, 1206, RoHS	Venkel	C1206X7R101-104M
C4	200 pF ±10% 50 V Ceramic Capacitor, X7R, 0805, RoHS	Venkel	C0805C0G500-201K
C6	0.1 μF ±10% 50 V Ceramic Capacitor, X7R, 0805, RoHS	Venkel	C0805X7R500-104K
D1, D2, D6	2 V Red 631 nm LED, 0603, RoHS	Lite-On Inc.	LTST-C190KRKT
D3	800 V 1A US1K Diode, Surface Mount, RoHS	Diodes Inc.	US1K-13-F
J1, J2, J6	Red Binding Post Connector, RoHS	Cinch Connectivity Solutions Johnson	111-0702-001
J3, J4, J7	Black Binding Post Connector, RoHS	Cinch Connectivity Solutions Johnson	111-0703-001
J5	4POS Terminal Block Header, Male Pins, Right Angle Through Hole, RoHS	Phoenix Contact	1757268
JP1, JP2, JP3, JP4	3POS Header Connector, RoHS	Samtec	TSW-103-07-T-S
JP5	4POS Terminal Block Plug, Female Sockets, Free Hanging, RoHS	Phoenix Contact	1757035
JS1, JS2, JS3, JS4	2POS Shunt Connector, RoHS	Samtec	SNT-100-BK-T
PCB1	Bare Si823Hx_NB16_EVB PCB, RoHS	Skyworks	Si823Hx_NB16_EVB
R1	820 Ω ±1% 1/16 W Chip Resistor, 0402, Thick Film, RoHS	Venkel	CR0402-16W-8200FT
R12	6.04 kΩ ±1% 1/10 W Chip Resistor, 0805, Thick Film, RoHS	Venkel	CR0805-10W-6041F
R2, R14	22.6 kΩ ±1% 1/16 W Chip Resistor, 0402, Thick Film, RoHS	Venkel	CR0402-16W-2262F
R3, R9, R11	0 Ω ±1% 1/10 W Chip Resistor, 0805, Thick Film, RoHS	Venkel	CR0805-10W-000
R5, R10	4.7 Ω ±5% 1/10 W Chip Resistor, 0805, Thick Film, RoHS	Venkel	CR0805-10W-4R7JT
TP1 – TP21	Loop Test Point, RoHS	Kobiconn	151-201-RC
U1	2.5 kVrms 4 A IsoDriver, NB SOIC-16, RoHS	Skyworks	Si823H2AB-IS1

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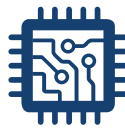
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