USER GUIDE

UG530: Si82Ax-Cx Isolated Gate Driver EVB User Guide

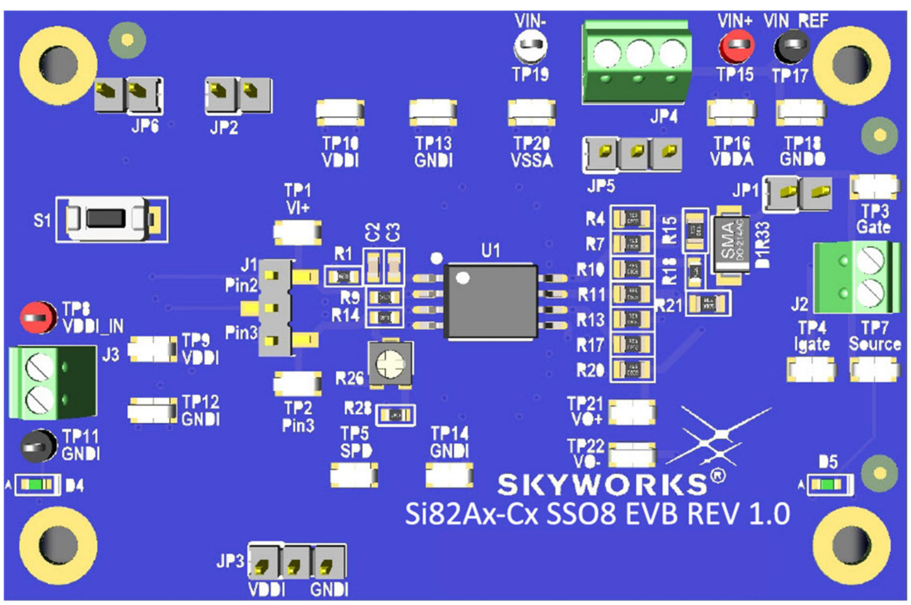
This user guide covers a range of evaluation boards (EVBs) for Skyworks' Si82Ax, Si82Bx, and Si82Cx isolated gate drivers. These EVBs are designed to evaluate and test the functionality and performance of these gate drivers. They can be used in standalone mode with an oscilloscope and the onboard dummy capacitive load or connected to a switched mode power supply (SMPS) controller and an external power MOSFET for system-level evaluation.

These single-channel isolated gate drivers are available in SSO-8 (6 kV_{RMS} isolation) and NB SOIC-8 (3.75 kV_{RMS} isolation) packages. The EVBs cover a wide variety of Si82Ax-Cx series devices. However, some features are only available on certain EVBs, depending on the driver IC on the board. EVBs with Si82Ax and Si82Bx devices allow for independent control of output rise and fall times. Another EVB version with the Si82Bx features a separate Miller clamp pin.

The Si82Cx EVB option includes Selectable Variable Current Drive (SelVCD™), which allows for dynamic adjustment of the rising/falling edge driving strength, eliminating the need for external gate resistors. For detailed information, please refer to the data sheets.

Features

- VI single-ended input or VI+/VI– complementary input
- Selectable Variable Current Drive (SelVCD™) eliminates external gate resistors
- 200 kV/µs common mode transient immunity (CMTI) performance
- Reverse polarity protection
- Various power supply schemes support unipolar and bipolar gate output voltages



1. Description

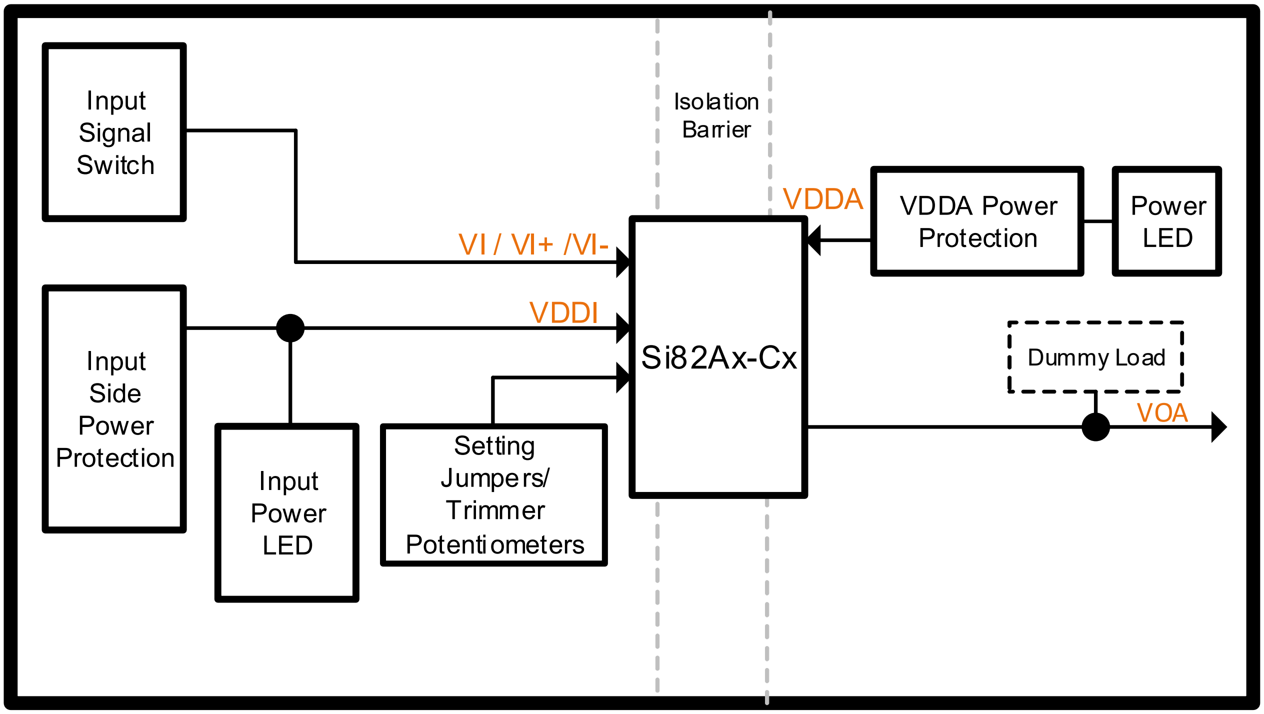


Figure 1. Si82Ax-Cx EVB Block Diagram

The EVB contains the Si82Ax-Cx chip, two power connectors, input signal connectors and switch, power supply circuit, dummy capacitive load, driver output connector, setting jumper headers, setting trim potentiometer, test points, and LED indicators.

The Si82Ax-Cx EVB requires two to three bench power supplies and one dual-trace oscilloscope to operate in standalone mode. No software is required to operate the board.

The EVB can also be connected to an SMPS controller and the external MOSFET for system-level evaluations.

Several different power schemes are supported. Based on the selected power scheme, the driver output voltage with respect to the MOSFET source terminal can be unipolar or bipolar. Unipolar output means that the V_{GS} gate drive output toggles between 0 V and the VDDA level. In bipolar output, V_{GS} toggles between positive and negative voltages.

A capacitive dummy load is included at the driver output to demonstrate more realistic waveforms. The dummy load can be disabled by the jumper shunt when the driver is connected to an actual MOSFET load.

2. Identify the Proper EVB Ordering Part Number (OPN)

Table 1 lists the evaluation board ordering part number (OPN) options.

Table 1. Si82Ax-Cx EVB Ordering Part Number Selection Guide (EVB Labels)

Ordering Part Number	Label	IC Part Number	Package	UVLO	SelVCD™ Outputs	Input Type
Si82C50ABE-KIT	Si82C50ABE-EVB	Si82C50ABE-IS4	SSO-8	8 V	Yes	Single-ended
Si82B41ACE-KIT	Si82B41ACE-EVB	Si82B41ACE-IS4	SSO-8	12 V	No	Complementary
Si82B30ABC-KIT	Si82B30ABC-EVB	Si82B30ABC-IS	NB SOIC-8	8 V	No	Single-ended
Si82A30ACE-KIT	Si82A30ACE-EVB	Si82A30ACE-IS4	SSO-8	12 V	No	Single-ended

Figure 2. EVP OPN Label Example

It is recommended to identify the EVB OPN before using the EVB. In Figure 2 above, the label shows "Si82B41ACE-EVB", and the driver part number is Si82B41ACE-IS4 in the Stretched Small Outline SSO-8 package, according to Table 1 above.

3. Connectors, Status LEDs, and Jumper Settings

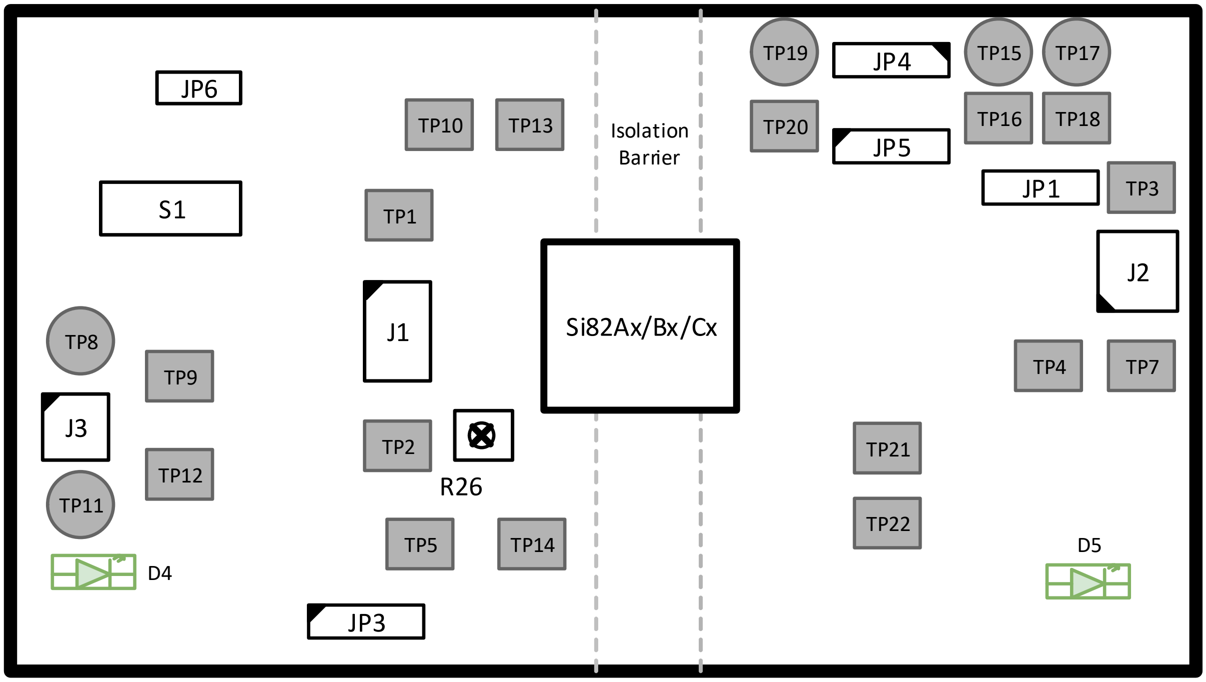


Figure 3. EVB Parts Placement, Pin 1 Positions are Marked

Table 2. Si82Ax-Cx EVB Connector Descriptions

Connector	Pin Number	Name	Description
J2	1	SOURCE	Driver output for the extremal FET Gate and Source terminals.
	2	GATE	
J3	1	VDDI_IN	Input side power supply connector (from 3.3 V to 5.5 V).
	2	GNDI	
JP4	1	VIN+	Driver output power supply connector (ranging from UVLO voltage to 30 V). See “4. Powering Up the EVB” on page 7 for connection details for the three power schemes.
	2	VIN_REF	
	3	VIN–	

Table 3. LED Indicators

LED	Color	Description
D4	Green	Lit when the input side power supply VDDI is present
D5	Green	Lit when the output side power supply VDDA is present

Table 4. Switches, Jumpers, and Trimmer Potentiometer Settings

Jumper Setting	Default Setting	Description
JP1	Short	Capacitive dummy load enable jumper. Shorting JP1 connects the capacitive dummy load (1 nF) to the driver output. Remove the jumper shunt to disable the capacitive dummy load when the external FET is connected to the EVB.
JP3	Pin 1–2	JP3 shunt position determines EN (enable)/DIS (disable) pin logic level. Pin 1–2 position: Logic High at EN/DIS pin. Pin 2–3 position: Logic Low at EN/DIS pin. Open: The EN/DIS pin signal is determined by on-board R25/R27 resistor or the external control signal connected to TP2. No jumper shunt for Si82B41ACE and Si82C50ABE EVBs.
JP5	Pin 1–2	JP5 shunt position determines the Si82Ax-Cx EVB power supply connection scheme on the output side. Pin 1–2 position: Single supply unipolar voltage scheme. Pin 2–3 position: Single supply bipolar voltage scheme. Open: Dual supply bipolar voltage scheme.
JP6	Short	Shorting JP6 to enable the debounce circuit for the on-board push button S1.
J1	Pin 1–2	J1 selects the signal direction of the on-board push-button S1. Pin 1–2 position: the push-button signal is routed to Si82Ax-Cx Pin 2. Pin 2–3 position: the push-button signal is routed to Si82Ax-Cx Pin 3.
S1	Tactile switches	S1 manually toggles Si82Ax-Cx input. See J1 settings. When pressed, S1 sends a logic High signal. When released, S1 sends a logic Low signal.
R26	Trimmer Potentiometer	Rising and/or falling edge drive strength adjustment R26 is only available for Si82Cx EVB

Table 5. Test Points

Test Point	Label	Description
TP1	VI+	VI or VI+ input signal. It can be also used to feed an external controller signal to the Si82Ax-Cx input pin with J1 jumper shunt removed.
TP2	Pin3	The test point for IC Pin 3 which could be EN/DIS, VI-, or SPD function, depending on driver IC OPN.
TP3	Gate	Driver output voltage at the load. Connect to the external FET Gate when the external FET is used.
TP4	Igate	Test point to probe the voltage across the 0.1 Ω current sense shunt resistor.
TP5	SPD	Test point reserved for external SPD control signal connection. Only available on Si82Cx.
TP7	Source	Reference point of driver output voltage. Connect to the external FET Source when the external FET is used.
TP8	VDDI_IN	Input side power supply positive terminal.
TP9	VDDI	Input side VDDI power supply voltage.
TP10		
TP11	GNDI	Input side power supply reference point.
TP12		
TP13		
TP14		
TP15	VIN+	Connect to output side positive supply output terminal.
TP16	VDDA	Output side positive power supply voltage VDDA.
TP17	VIN_REF	Connect to output side power supply reference point.

Table 5. Test Points (Continued)

Test Point	Label	Description
TP18	GNDO	Output side power supply reference point.
TP19	VIN–	Connect to output side negative supply output terminal.
TP20	VSSA	Output side negative power supply voltage VSSA.
TP21	VO+	Driver VO+ pin.
TP22	VO–	Driver VO– pin.

4. Powering Up the EVB

Two isolated voltage power supplies (VDDI and VDDA) are required to power the Si82Ax-Cx EVB. VDDI accepts 3 V to 5.5 V. VDDA can accept up to 30 V (referenced to VSSA). The lowest value of VDDA is limited by the Si82Ax-Cx UVLO threshold, which is a chip-dependent specification. (See Table 1, "Si82Ax-Cx EVB Ordering Part Number Selection Guide (EVB Labels)," on page 3.)

For normal operation, set VDDA to at least 2 V greater than the UVLO threshold. The current consumption for each supply should be less than 100 mA.

A voltage polarity protection circuit is included for each power supply connector. Power LEDs will light when the correct polarity power supplies are present.

The input-side power supply should be connected to the EVB through J3. The pin definition and direction can be found in Table 2 and Figure 3 on page 4.

The EVB supports various output-side power supply connections, depending on the output voltage polarity (V_{GS}) requirement. By configuring the power supply connection, the drivers can output unipolar or bipolar gate drive voltages. Negative V_{GS} usually results in shorter turn-off time. Turning off the MOSFET with the negative V_{GS} also provides better noise margin to avoid accidental MOSFET turn-on in harsh environments.

4.1. Single-Supply Unipolar Output

This is the most straightforward power supply scheme for the output side. The driver is powered by one positive voltage power supply and the V_{GS} output is unipolar, as shown in Figure 4 below.

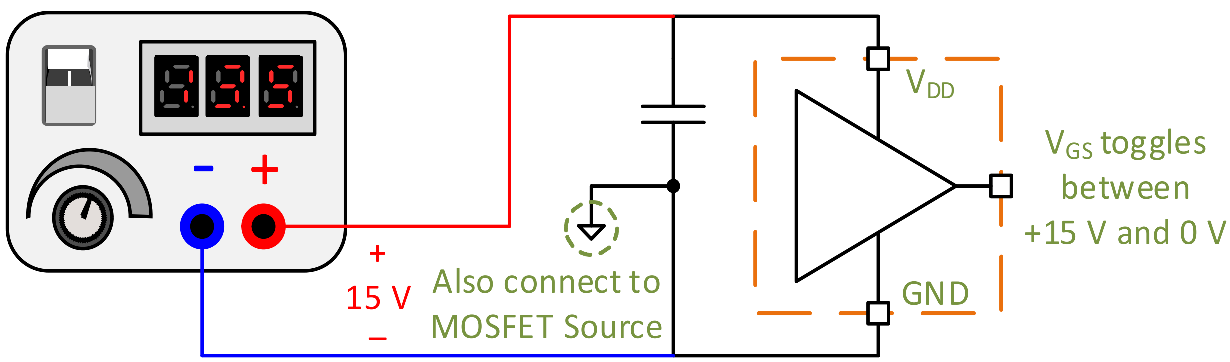


Figure 4. Single Supply, Unipolar V_{GS} Output

Table 6. Configuring for Unipolar Output

JP5 Jumper	Short 1–2.
JP4 Connector	Pin 1: Connect to the power supply positive output terminal. Pin 2: Connect to the power supply reference/return (negative) terminal. Pin 3: Open.
Output Side Voltage Supply Range	(UVLO + 2 V) to 30 V

4.2. Dual Supply Bipolar Output

The EVB supports bipolar V_{GS} output. This requires a power supply with positive and negative voltage outputs. Figure 5 shows an example using two power supplies with +15 V and +5 V outputs, respectively, which determine the turn-on and turn-off V_{GS} voltages. Note that the common point of the +15 V and +5 V supplies (the black trace between the red and blue traces below) should also be connected to the MOSFET Source pin.

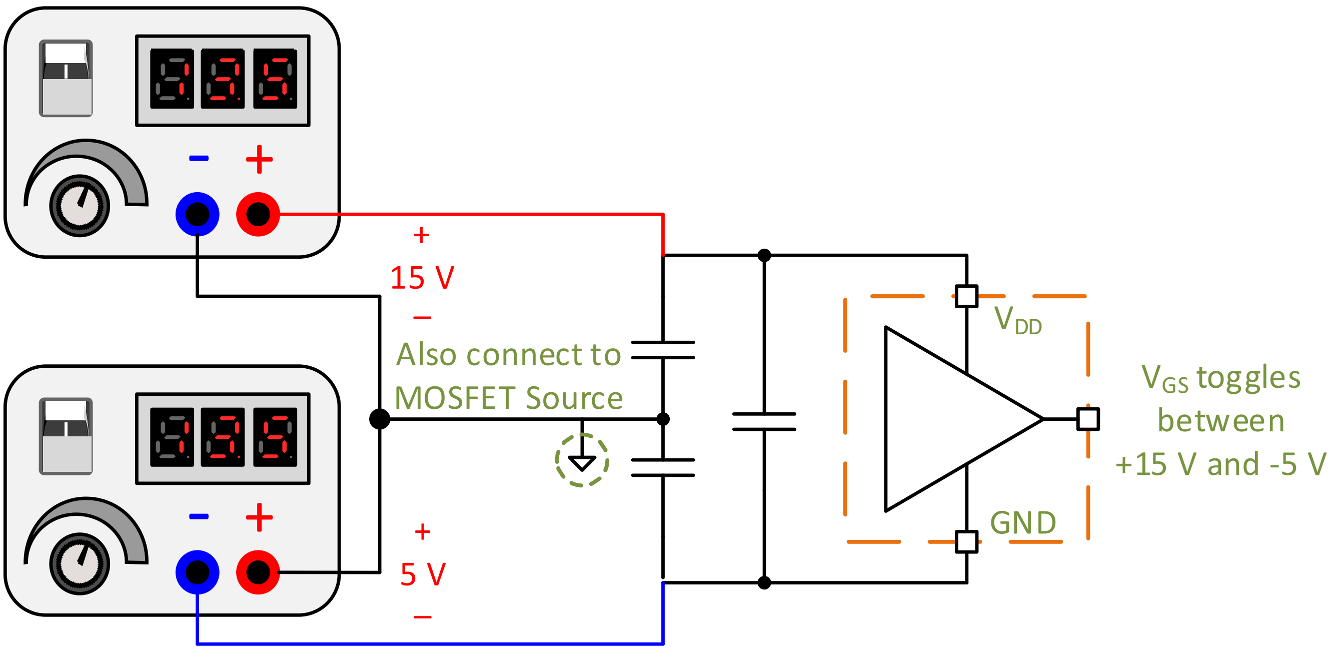


Figure 5. Dual Supply Bipolar V_{GS} Output

Table 7. Configuring for Dual Supply Bipolar Output

JP5 Jumper	Open. No jumper shunts.
JP4 Connector	Pin 1: Connect to the positive power supply output terminal. Pin 2: Connect to the reference/return terminals of both voltage sources. Pin 3: Connect to the negative power supply output terminal.
Output Side Voltage Supply Range	|Positive supply voltage| + |negative voltage supply| between (UVLO + 2 V) to 30 V.

4.3. Single Supply Bipolar Output

When bipolar output is desired but the bench power supply only has a single voltage output, the EVB includes a simple voltage splitter circuit to provide positive and negative voltages to the chip. The positive voltage level is fixed and determined by D6 Zener diodes (typically 10 V—see Table 9, "Si82Ax-Cx Bill of Materials," on page 19 for more details) on the evaluation board.

The resulting negative voltage is the difference between the bench power supply and the D6 Zener voltage. In the example below, the +15 V power supply is split into +10 V and –5 V to produce the bipolar V_{GS} output.

The MOSFET Source pin should be connected to the common point of the positive and negative voltage supplies.

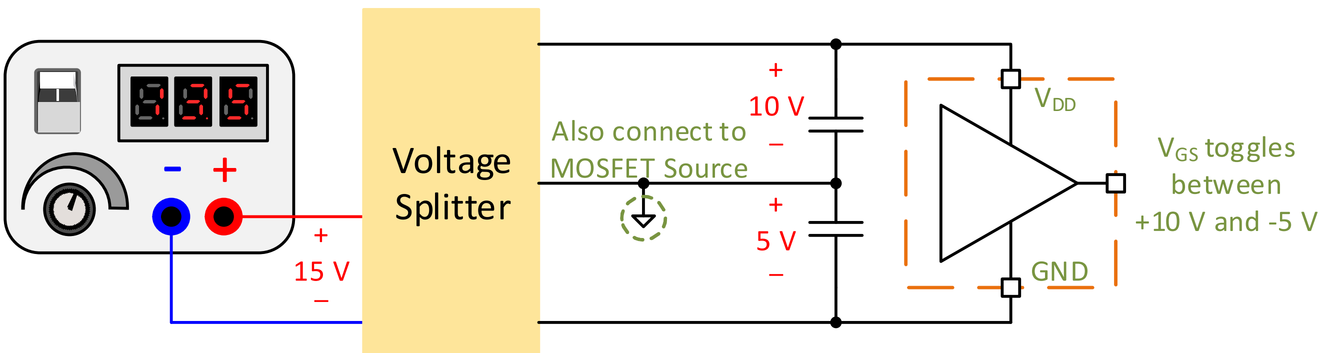


Figure 6. Single Supply Bipolar Output

Table 8. Configuring for Single Supply Bipolar Output

JP5 Jumper Head	Short 2–3.
JP4 Connector	Pin 1: Connect to the positive power supply output terminal. Pin 2: Open. Pin 3: Connect to the reference/return (negative) power supply terminal.
Output Side Voltage Supply Range	10 V to 30 V.

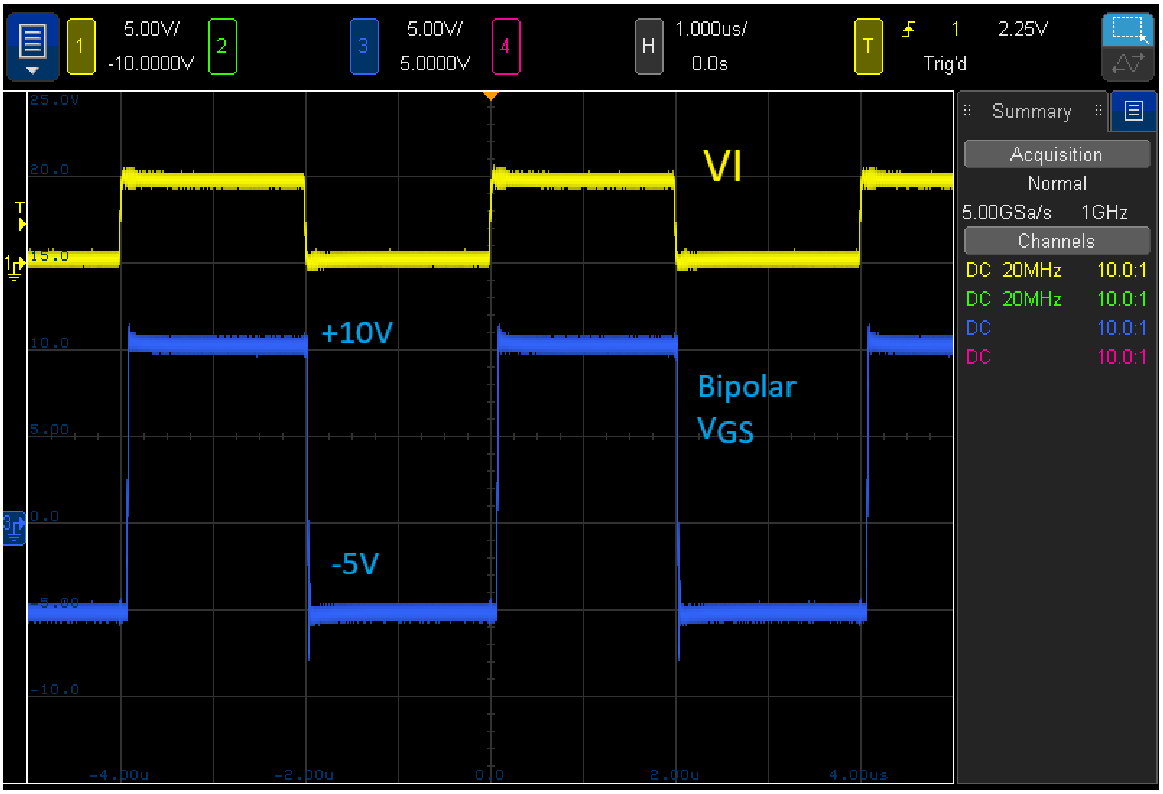


Figure 7. Single Supply Bipolar V_{GS} Output

5. Input Signal Interface

5.1. VI, VI+, and VI– Input Signals

Tactile switch S1 generates a slow-changing VI signal for demonstration purposes. A debounce filter consisting of a Schmitt trigger (U2) removes the unwanted tactile switch edge noise. The generated signal can be routed to the Si82Ax-Cx Pin 2 or Pin 3 by selecting the jumper shunt position on J1.

When an external control signal is applied through TP1, the jumper shunt on J1 should be removed to avoid conflicts with the debounce Schmitt trigger.

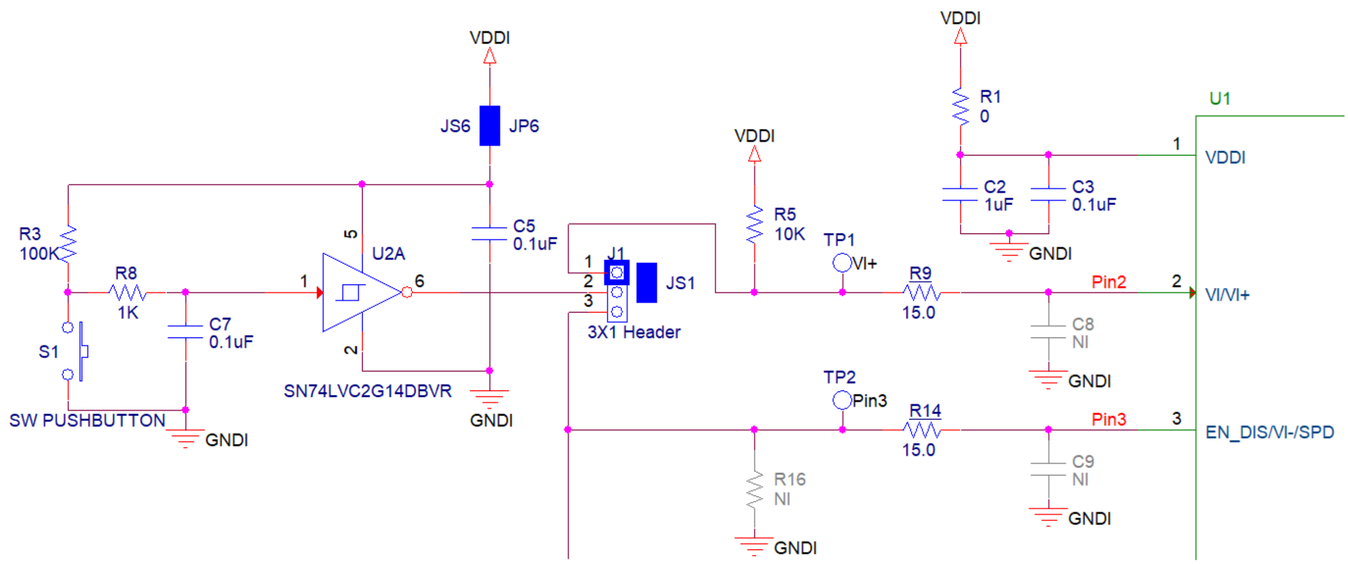


Figure 8. VI Input Signal Connections

5.2. Enable/Disable (EN/DIS) Signal

The EN/DIS (Enable/Disable) pin has global control to turn off the driver regardless of the input signal. The jumper shunt position on JP3 determines the logic level at the EN/DIS pin (see Table 4, "Switches, Jumpers, and Trimmer Potentiometer Settings," on page 5). Changing the jumper shunt positions on JP3 can be used to demonstrate the EN/DIS feature. For OPNs with EN/DIS pins, either R25 or R27 is populated to ensure that the driver is still active, even when the JP3 jumper shunt is temporarily removed during position changes.

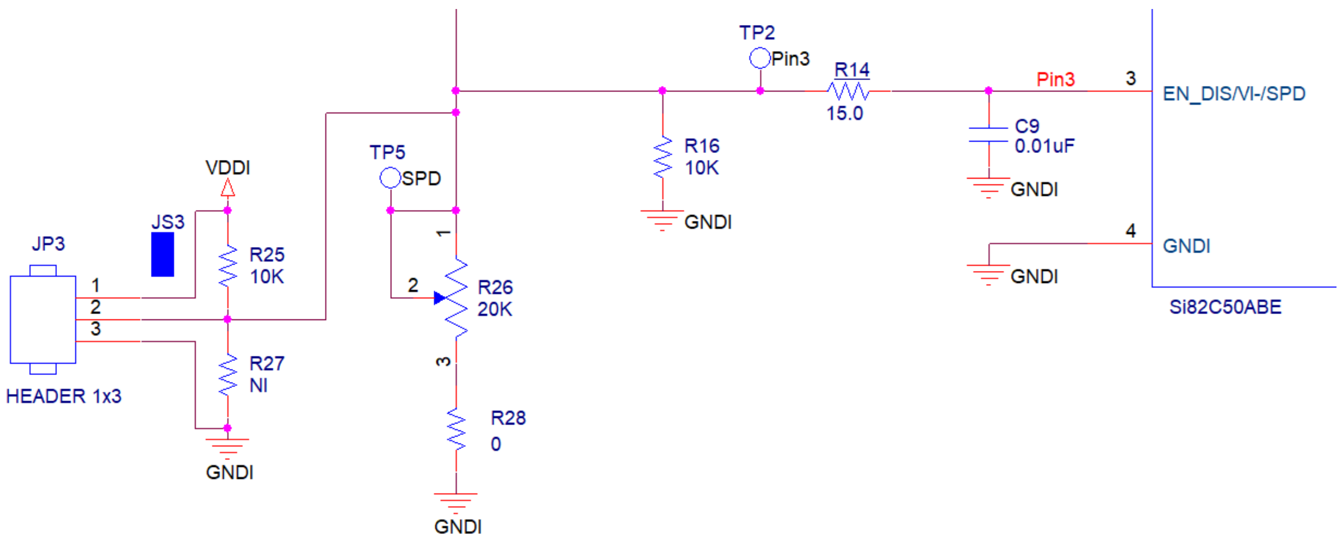


Figure 9. EN/DIS and SPD± Input Signal Connections

5.3. SPD+ and SPD– Signals

The Si82Cx features Selectable Variable Current Drive (SelVCD™) on its output. By changing the R26 pull-down resistor value at SPD+ (rising edge speed), SPD– (falling edge speed), or SPD± pin, the drive strength of the gate drive signals is adjusted to eliminate the need for conventional external gate resistors. Further, there is a Miller clamp feature built into the SelVCD™. For additional details on these features, refer to the data sheet. Turning R26 clockwise increases its resistance and thus increases output drive strength. When R26 is turned fully clockwise, the resulting resistance is greater than the SPD0 ~ SPD7 settings and will be recognized as the disable signal to turn off the driver.

If it is desired to evaluate SelVCD™ performance or variation for a given pull-down resistance, the EVB can be reworked by replacing R28 with the desired value and turning the trimmer potentiometer fully counterclockwise to nullify R26.

6. Output Signal Interface

The Si82Ax-Cx output signal can be monitored at test points on the EVB. The 1 nF capacitive dummy load, C12, simulates the MOSFET gate charge. When an actual MOSFET is connected to the EVB, C12 can be disabled by removing the jumper shunt on JP1. The Gate and Source terminals of the MOSFET can be connected to J2. Refer to Table 2 on page 4 for more connection details. Use short, heavy-gauge wires to connect the external MOSFET to the EVB.

For the Si82Ax-Bx, which do not support the SelVCD™ feature, gate resistors are still employed for edge slew rate tuning. On EVBs populated with Si82Bx devices, R15 (default 4.7 Ω) is used for rising-edge slew rate adjustment while R21 (default 1.2 Ω) is used for the falling-edge slew rate adjustment. On EVBs populated with Si82Ax devices, R15 (default 6.8 Ω) is used for rising-edge slew rate adjustment while R21 (default 3.3 Ω) is used for falling-edge slew rate adjustment. The gate resistors may be replaced to fine-tune desired slew rates.

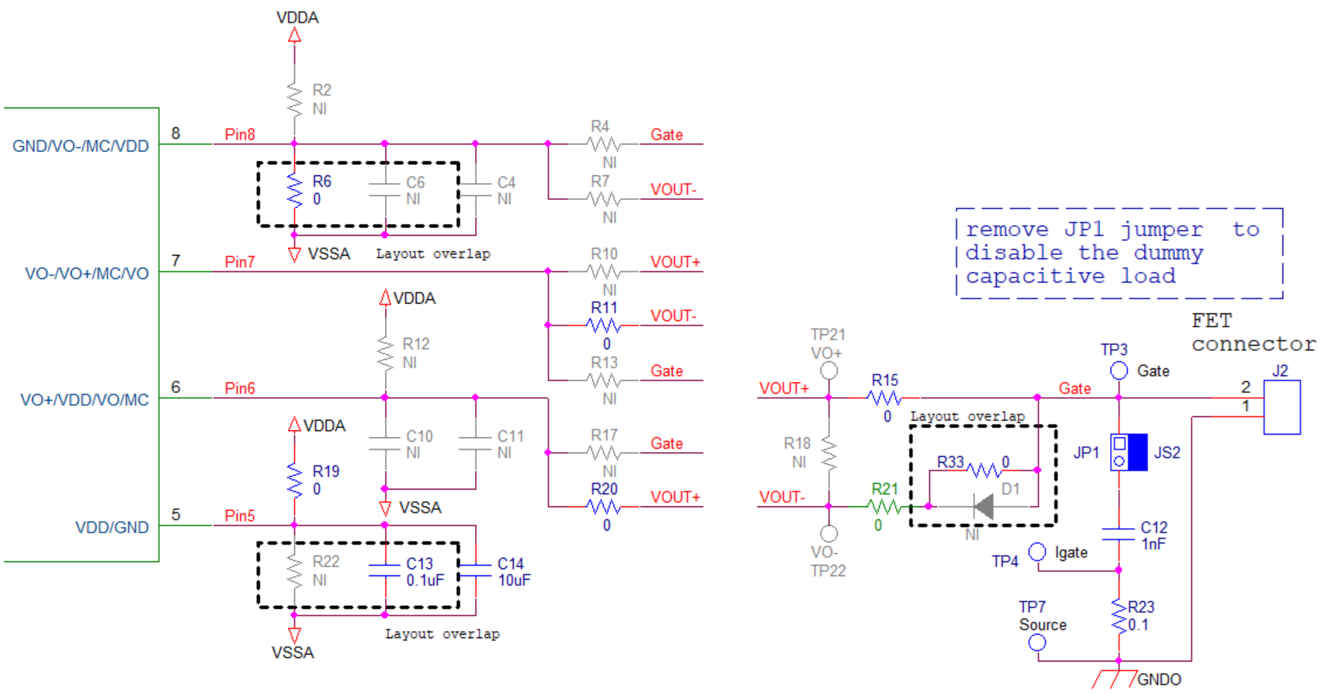


Figure 10. Output Signal Connections

7. Feature Demonstrations

7.1. Enable/Disable Pin

The EN/DIS pin is available on some OPNs of the Si82Ax-Cx to turn the output low regardless of the VI input signal level. This feature is useful for shutting down the driver when a system fault is detected.

Procedure

1. Make sure the driver IC has the EN/DIS function.
2. Power up the EVB.
3. Press the S1 tactile switch once at a time to send a High signal to the Si82Ax-Cx input pin. Monitor the VO waveform (TP3) on an auto-trigger oscilloscope to confirm that the output signal follows the S1 switch. If not, ensure that the JP3 jumper shunt is in the correct position.
4. While pressing S1, change the JP3 jumper shunt position. The output waveform should turn low.

7.2. Driver Output Current Control

The Si82Cx has an output current control that is adjustable with an external resistor. The variable output current results in different edge slew rates for a given capacitive load. The R26 trimmer potentiometer on the EVB is used to demonstrate this feature.

Procedure

1. Install a jumper shunt on JP1 to enable the capacitive dummy load, and power up the EVB.
2. Set the oscilloscope to normal trigger mode on the VO waveform rising edge. The suggested time base is 100 ns per division.
3. Press S1 to generate VO output. The oscilloscope should capture the rising-edge waveform.
4. Adjust the R26 trimmer potentiometer for a different value. Repeat Step 3 to see the slew rate change.
5. Note that Si82Cx output is disabled when the R26 trimmer potentiometer is turned fully clockwise.

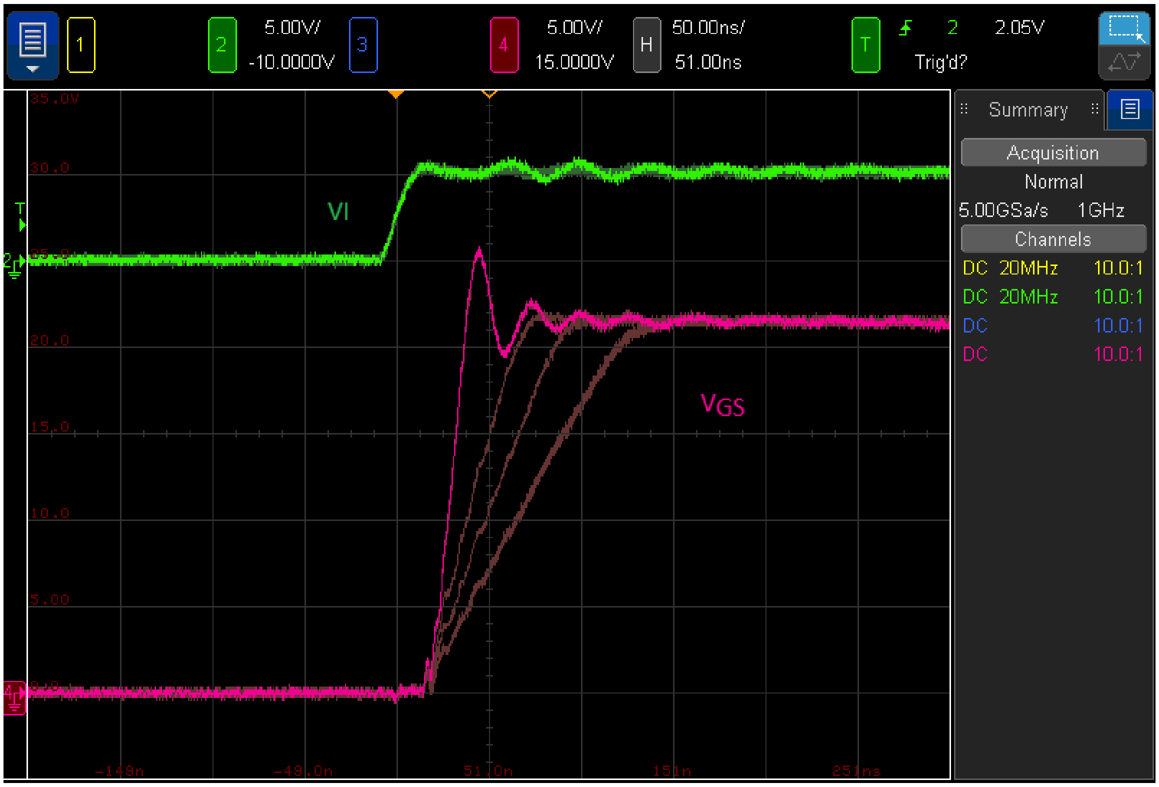


Figure 11. Rising Edge Slew Rate Adjustment

8. Si82Ax-Cx EVB Schematics

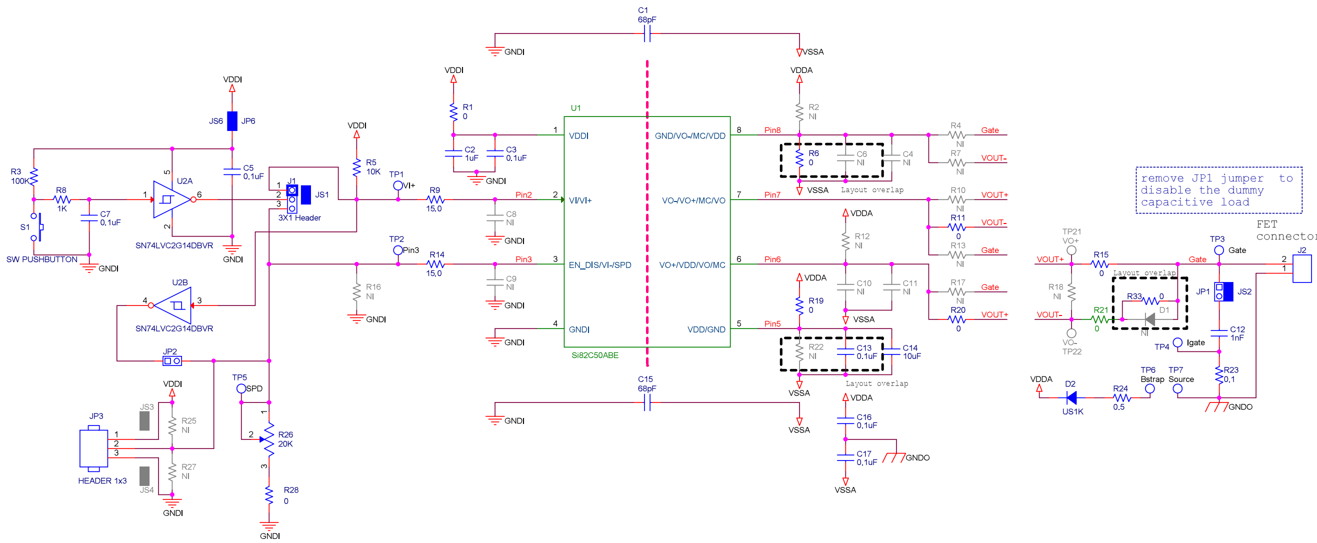


Figure 12. Si82C50ABE Driver

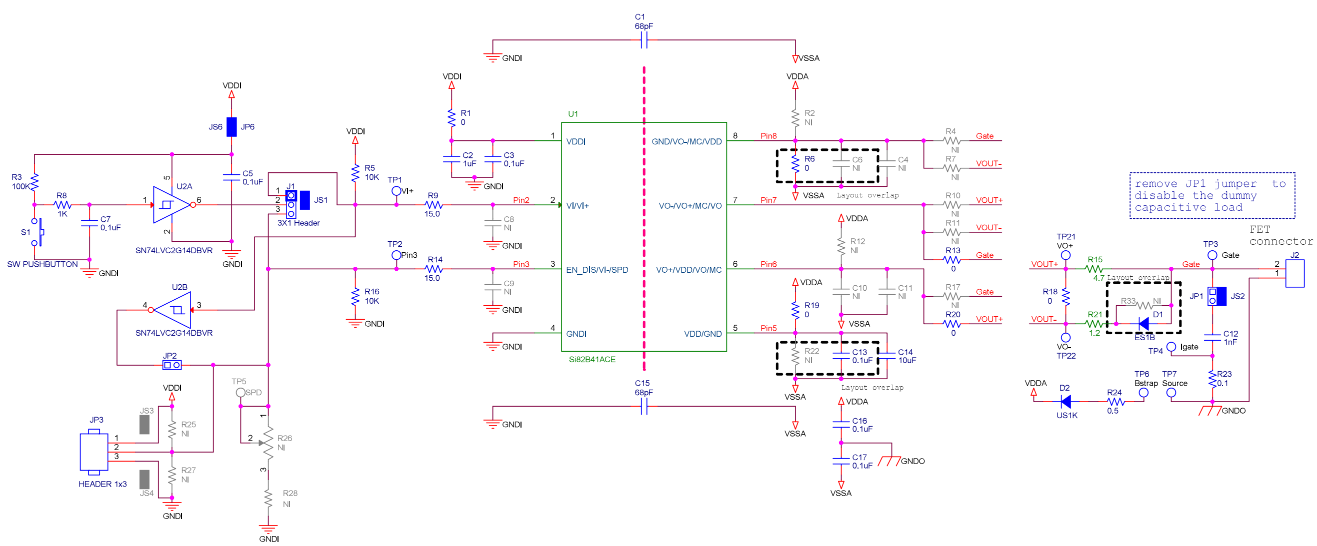


Figure 13. Si82B41ACE Driver

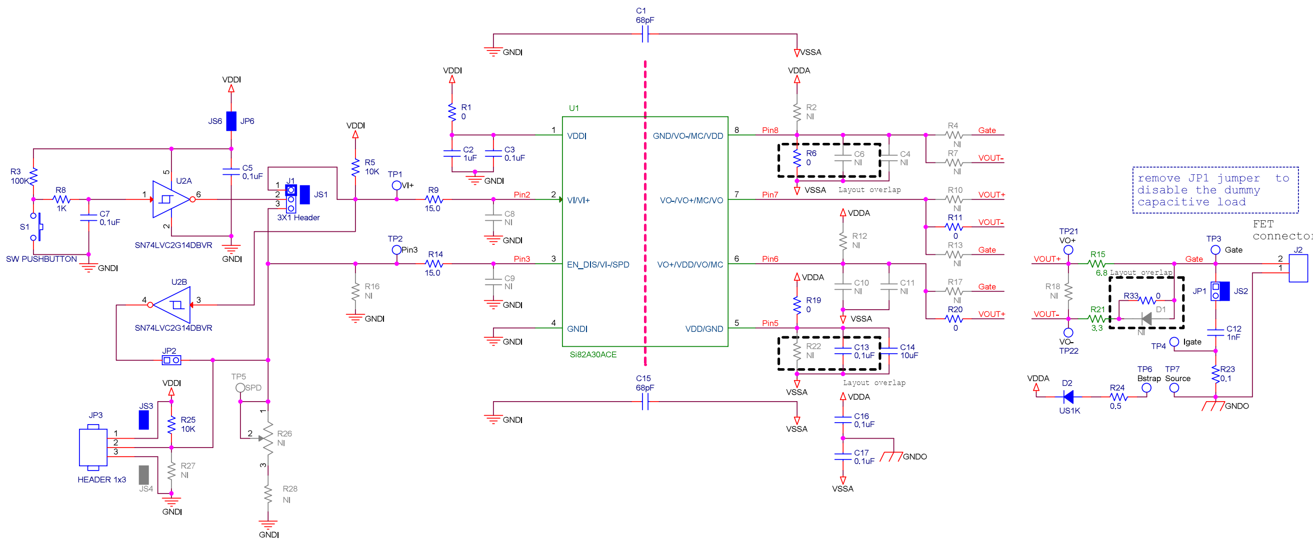


Figure 14. Si82A30ACE Driver

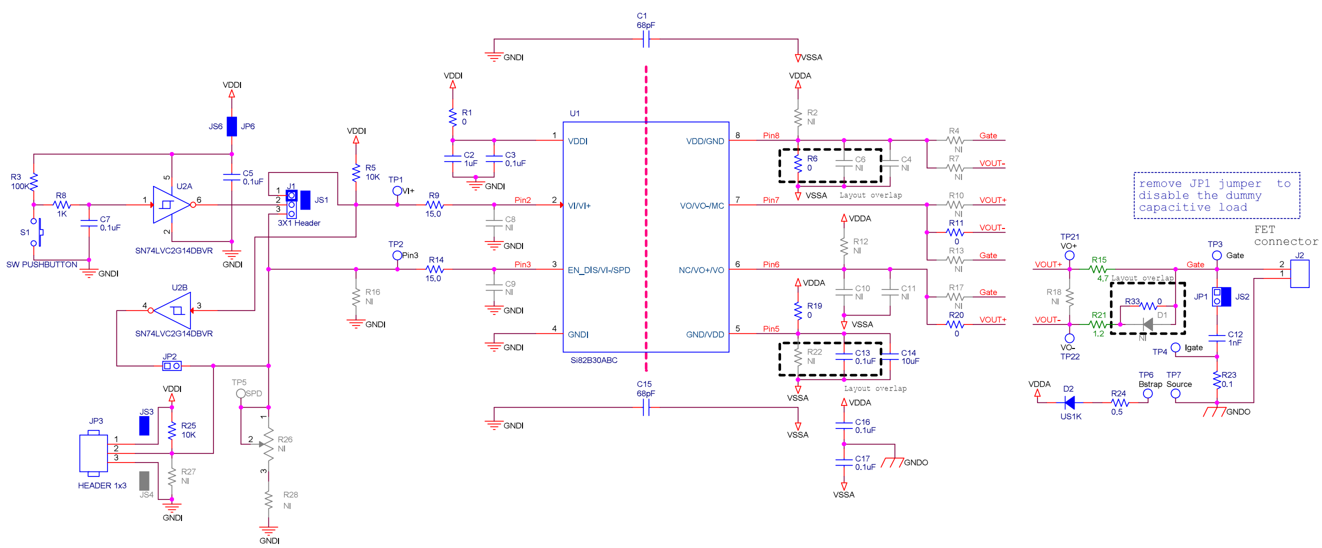


Figure 15. Si82B30ABC Driver

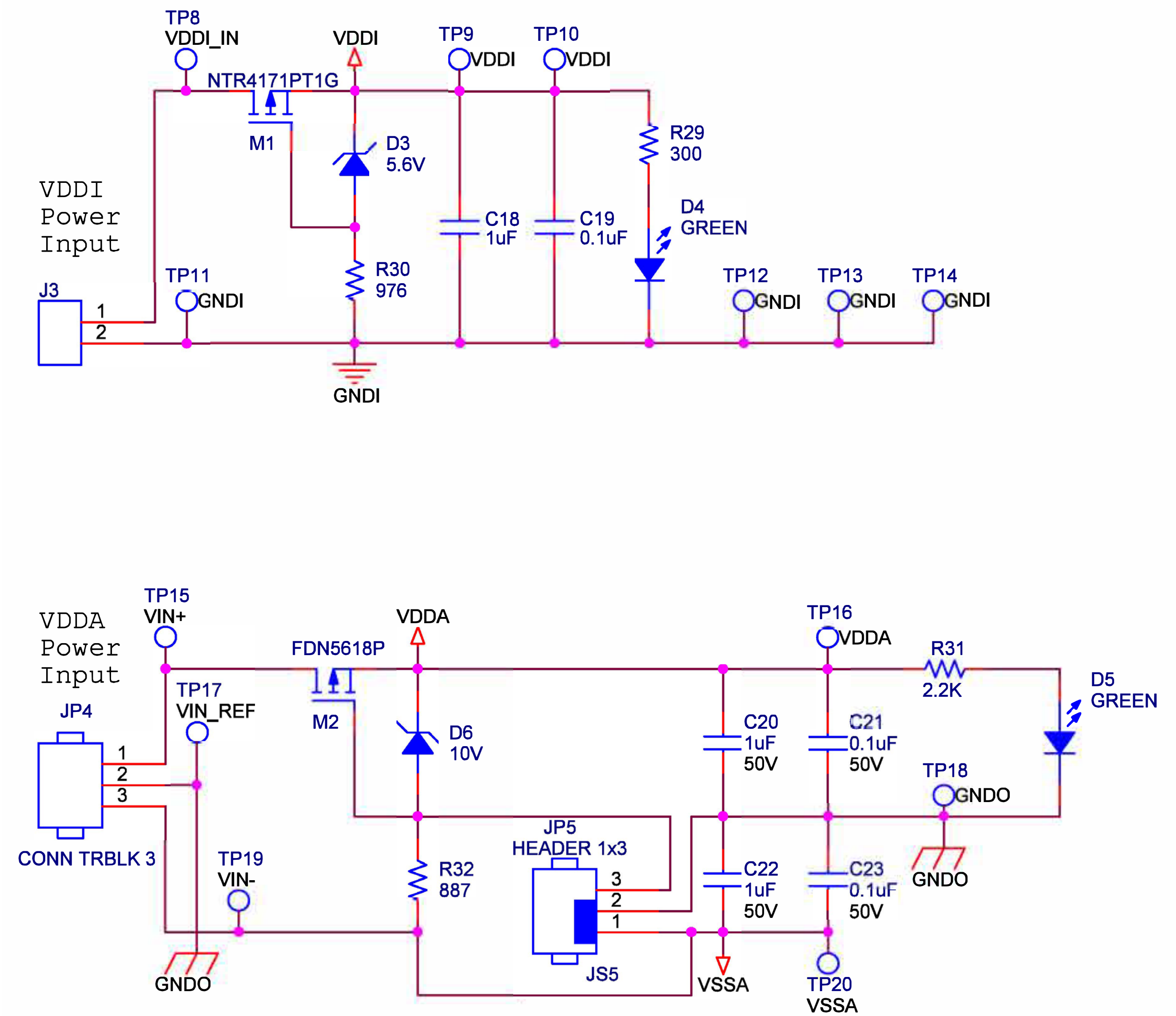


Figure 16. EVB Power Circuit

9. Bill of Materials

Table 9. Si82Ax-Cx Bill of Materials

Reference	Value	Rating	Manufacturer Part Number	Manufacturer
C1,C15	68 pF	Y2	GA342D1XGF680JY02L	MuRata
C2	1 µF	25 V	GCM188R71E105KA49	MuRata
C3,C5,C7	0.1 µF	25 V	C0603X7R250-104K	Venkel
C4,C11,C14	10 µF	50 V	GRM21BR61H106KE43L	Murata
C6,C10,C13,C16,C17,C21,C23	0.1 µF	50 V	C0603X7R500-104K	Venkel
C12	1 nF	50 V	C0805C0G500-102F	Venkel
C18	1 µF	10 V	C0603X7R100-105K	Venkel
C19	0.1 µF	10 V	C0402X7R100-104K	Venkel
C20,C22	1 µF	50 V	CL21B105KBFNNNE	Samsung
D1	ES1B	1.0 A	ES1B	Diodes Inc.
D3	5.6 V	500 mW	SZMMSZ5232BT1G	On Semi
D6	10 V	500 mW	MMSZ4697T1G	On Semi
M1	NTR4171PT1G	–3.5 A	NTR4171PT1G	On Semi
M2	FDN5618P	1.25 A	FDN5618P	Fairchild
R1,R2,R6,R12,R18,R19,R22,R28	0 Ω	1 A	CR0603-16W-000	Venkel
R3	100 kΩ	1/10 W	CR0603-10W-104J	Venkel
R4,R7,R10,R11,R13,R15[1], R17,R20,R33	0 Ω	2 A	CR0805-10W-000	Venkel
R5,R16,R25,R27	10 kΩ	1/16 W	CR0603-16W-1002F	Venkel
R8	1 kΩ	1/10 W	CR0603-10W-1001J	Venkel
R9,R14	15 Ω	1/16 W	CR0603-16W-15R0F	Venkel
R21[2]	1.2 Ω	1/10 W	CR0805-10W-1R2J	Venkel
R23	0.1 Ω	1/8 W	LCR0603-R100F	Venkel
R26	20 kΩ	1/4 W	PVG3A203C01R00	MuRata
R29	300 Ω	1/16 W	CR0603-16W-301J	Venkel
R30	976 Ω	1/4 W	CR1206-4W-9760F	Venkel
R31	2.2 kΩ	1/4 W	CR1206-4W-222JT	Venkel
R32	887 Ω	1 W	ERJ-1TNF8870U	Panasonic
S1	SW Pushbutton	50 mA	TL3302AF180QJ	E-Switch
U2	SN74LVC2G14DBVR		SN74LVC2G14DBV	TI

1. R15 = 0 Ω for Si82C50ABE EVB, R15 = 4.7 Ω for Si82B41ACE and Si82B30ABC EVB, and R15 = 6.8 Ω for Si82C50ABE EVB.
2. R21 = 0 Ω for Si82C50ABE EVB, R21 = 1.2 Ω for Si82B41ACE and Si82B30ABC EVB, and R21 = 3.3 Ω for Si82C50ABE EVB.