

User Manual

SLG47105 Demo Board UM-GP-003

Abstract

This user manual provides basic guidelines for developers to get familiar with the Demo Board for SLG47105. It consists of the functional descriptions of that board and the preprogrammed project.

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1 Terms and Definitions

ACMPxH	Analog Comparator High Speed
DC	Direct Current
DFF	D Flip-Flop
EMF	Electromotive Force
HV _{DD}	High Voltage
HV_GPO	High Voltage General Purpose Output
IC	Integrated Circuit
LED	Light Emitting Diode
PGen	Pattern Generator
PWM	Pulse-Width Modulation
PWR	Power
STS	Status
SW	Switch
USB	Universal Serial Bus
Vref	Voltage Reference

2 References

- [1] SLG47105, Datasheet - <https://www.renesas.com/SLG47105#documents>.

3 Introduction

SLG47105 Demo Board (see Figure 1) allows the User to get acquainted with SLG47105's functionality, especially the H-Bridge and Half-Bridge functions, and demonstrates the power part of the chip.

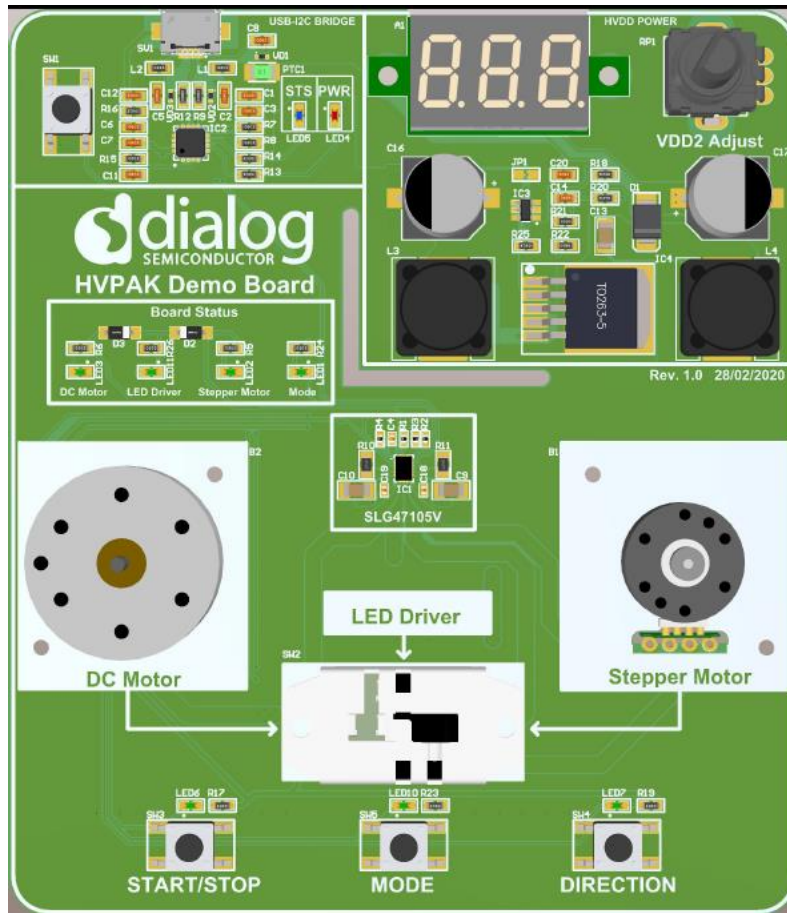


Figure 1: SLG47105 Demo Board General View

The Board is designed for hands-on and visually shows the SLG47105 chip's capability to handle both DC and Stepper Motors, as well as LEDs. The chip on the Board is already programmed with a versatile project, allowing the User to control different loads and switch between modes.

4 Functional Description

4.1 USB Connector

There is a micro-USB connector on the Board, which is used both to power all components and to emulate customer projects using the GreenPAK Designer. SW1 serves to reset the connection. The Demo Board can be powered from different power sources, such as smartphone OTG, power bank, and others, which can provide at least 500 mA.

4.2 Power Supply

The Board is powered entirely from the USB port. There is also a regulated DC-DC converter to power the high voltage part (HV_{DD}). The converter is designed to deliver a variable voltage in a range from 3.3 to 12 V, which can be adjusted using the potentiometer RP1. The indicator A1 serves to display the selected voltage, see [Figure 2](#).

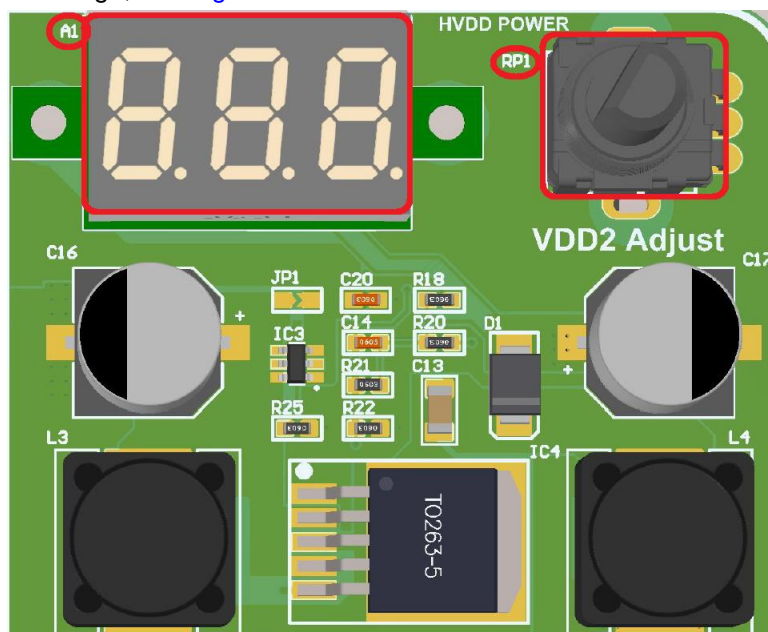


Figure 2: HV_{DD} Voltage Indicator and Regulator

4.3 LED Indicators

There are several LED indicators installed on the Board. For their location see from [Figure 3](#) to [Figure 6](#), and for their functions and description refer to [Table 1](#).

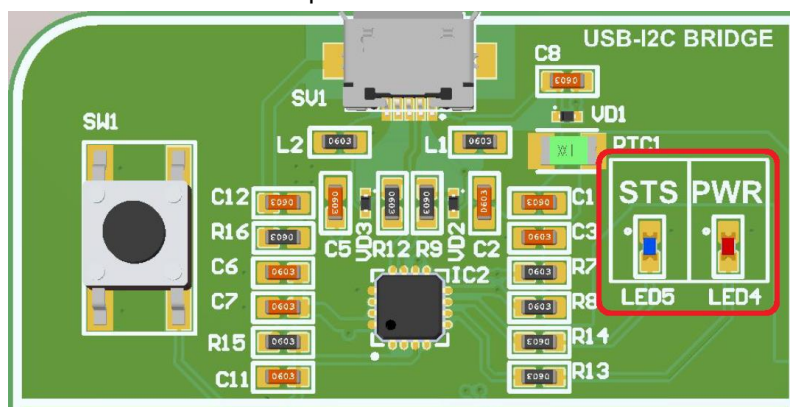


Figure 3: Connection Status and Power LEDs

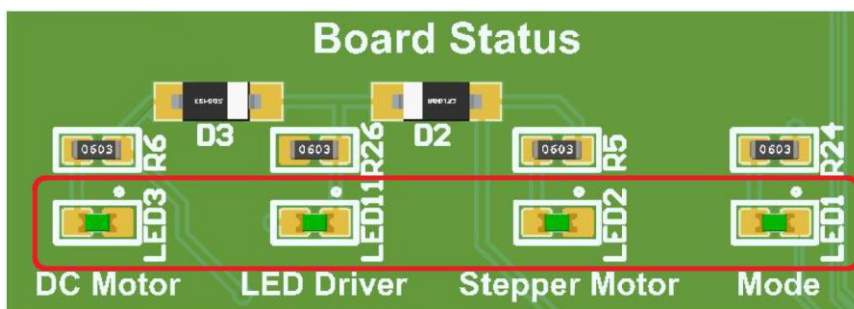


Figure 4: Board Status LEDs

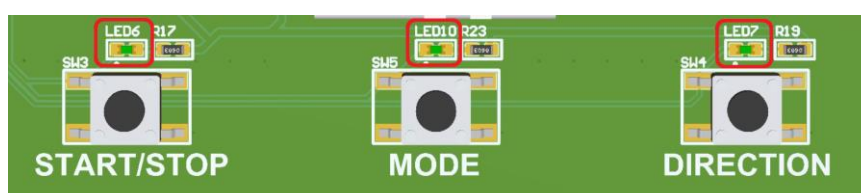


Figure 5: Button LEDs

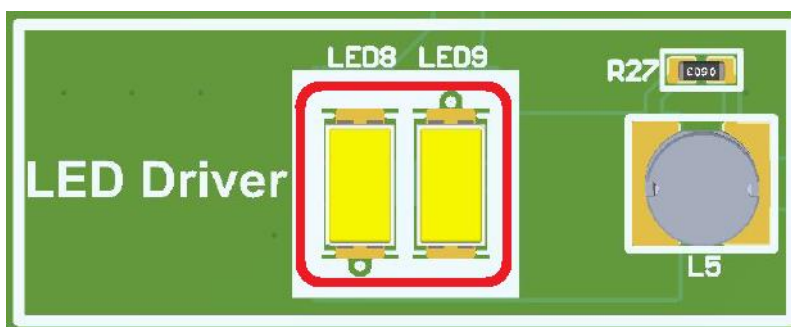


Figure 6: Load LEDs

Table 1: LED Functions

Designator	Function	Description	Notes
LED1	Mode	Stepper Motor mode indicator for preprogrammed design. Mode 1 - LED is off. Stepper Motor rotates constantly step-by-step after the button "START/STOP" is pressed, and stops after the button is pressed again. Mode 2 - LED flashes. Stepper Motor rotates one step each time the button "START/STOP" is pressed.	LED1 is connected to GPIO4.
LED2	Stepper Motor	Indicates the Stepper Motor is selected as load according to SW2 position.	
LED3	DC Motor	Indicates the DC Motor is selected as load according to SW2 position.	
LED4	PWR	USB power indicator. Flashes once when USB is connected.	
LED5	STS	Connection status indicator. LED is on when connection established via USB.	

Designator	Function	Description	Notes
LED6	START/STOP (button indicator)	LED is on while the button "START/STOP" is being pressed.	
LED7	DIRECTION (button indicator)	LED is on while the button "DIRECTION" is being pressed.	
LED8	LED Load 1	SLG47105 LED load 1. Cold white.	
LED9	LED Load 2	SLG47105 LED load 2. Warm white.	
LED10	MODE (button indicator)	LED is on while the button "MODE" is being pressed.	
LED11	LED Driver	Indicates the LED load is selected.	

4.4 Load Selector and Control Buttons

There are three types of load installed on the Board: DC Motor, Stepper Motor, and LED, see [Figure 7](#). Switch SW2 serves to select between loads. There are also three control buttons: START/STOP, MODE, and DIRECTION, see [Figure 8](#). The control buttons are named according to the preprogrammed design functionality, but they are general purpose buttons, which can be used for any other function in custom design.

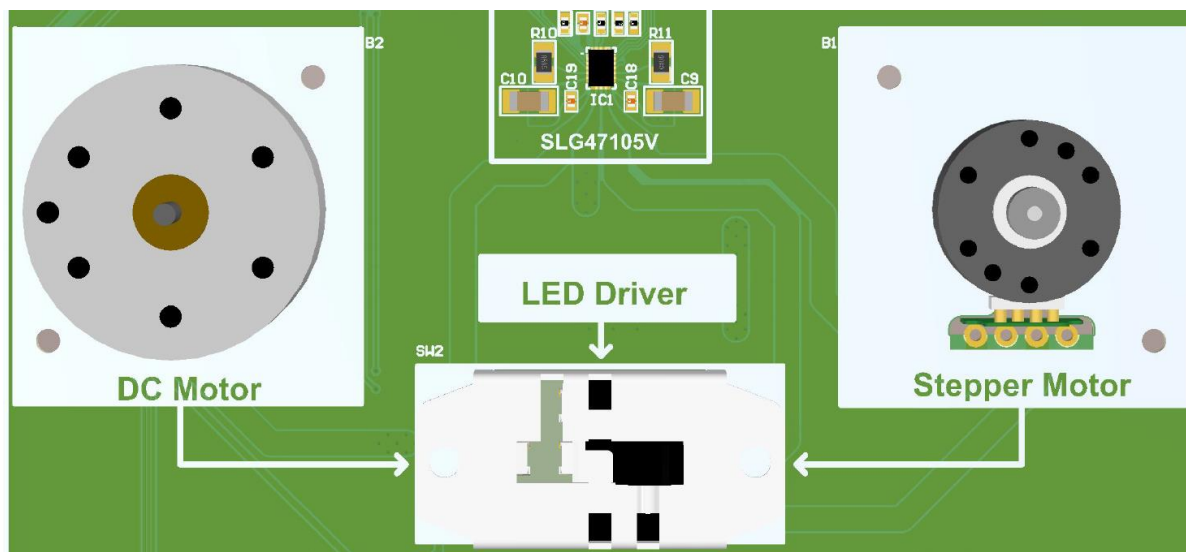


Figure 7: DC Motor, Stepper Motor, and Load Selector

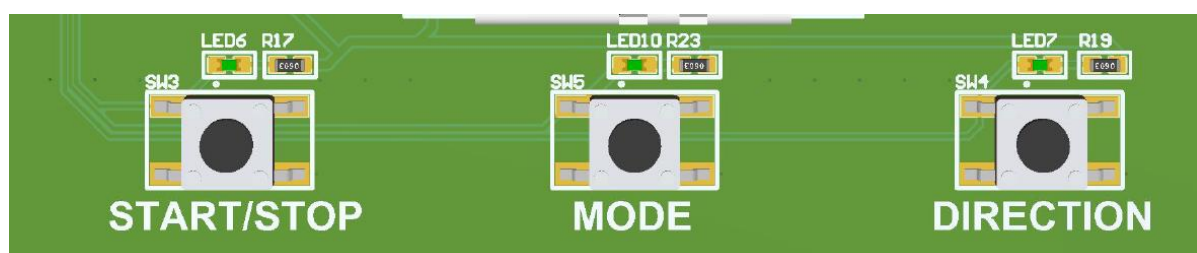


Figure 8: Control Buttons

For the control buttons functions refer to [Table 2](#).

Table 2: Control Buttons Functions

Designator	Name	Load Selected		
		DC Motor	LED	Stepper Motor
SW3	START/STOP	Start and stop the DC Motor	Soft turn-on and soft turn-off the LED	Start and stop the Stepper Motor
SW5	MODE	N/A	N/A	Mode select Mode 1 - Stepper Motor rotates constantly step-by-step after the button "START/STOP" is pressed, and stops after the button "START/STOP" is pressed again. Mode 2 - Stepper Motor rotates one step each time the button "START/STOP" is pressed.
SW4	DIRECTION	Change rotation direction by reversing output polarity	Change LED color by reversing output polarity	Change rotation direction by reversing output polarity

4.5 Additional Features

4.5.1 PWM

The SLG47105 has a capability of driving loads with PWM voltage. In case of the preprogrammed project, PWM is used to stabilize the rotating speed of the motors, as well as the brightness of the load LEDs. This means that trimming HV_{DD} voltage from 3.3 to 12 V will not affect the load (neither motor speed nor LED brightness).

4.5.2 Overcurrent Protection

The SLG47105 has an overcurrent protection feature. In case of the preprogrammed project, it is used to protect the GreenPAK outputs from the load short circuit or overcurrent.

4.5.3 "Push-to-start " and "Push-to-stop"

In case when DC Motor is selected as load, functions "Push-to-start " and "Push-to-stop" are implemented. To start the motor the User can push the shaft in any direction. If the motor's shaft is forced to stop for 0.5 seconds, it will be powered off, and after a 2-second pause it can be re-started manually or by pressing the START/STOP button.

5 SLG47105 Preprogrammed Design Description

The HV PAK Demo Board can drive DC Motor, Stepper Motor, and LED load using SLG47105. This is a small, low power component for commonly used Mixed-Signal and H-Bridge functions, that allows integrating motor driver solution for battery-powered toys, printers, and other low-voltage or battery-powered motion control applications. Also, due to SLG47105 flexibility it can be used as the LED driver.

5.1 Benefits of HV PAK

- Independent half-bridge control allows dual bidirectional or four unidirectional motor operations;
- Build-in overcurrent and over-temperature protection reduces design complexity and enables higher system reliability;
- Flexible motor control with a programmable current sense comparator for current limiting or programmable overcurrent protection, or Customer defined/Sine current regulation;
- Low power sleep mode extends battery life;
- Low power consumption of Analog and Digital allows doing more in one IC;
- Smaller board space/smaller form factors;
- Constant motor speed with the variable V_{in} .

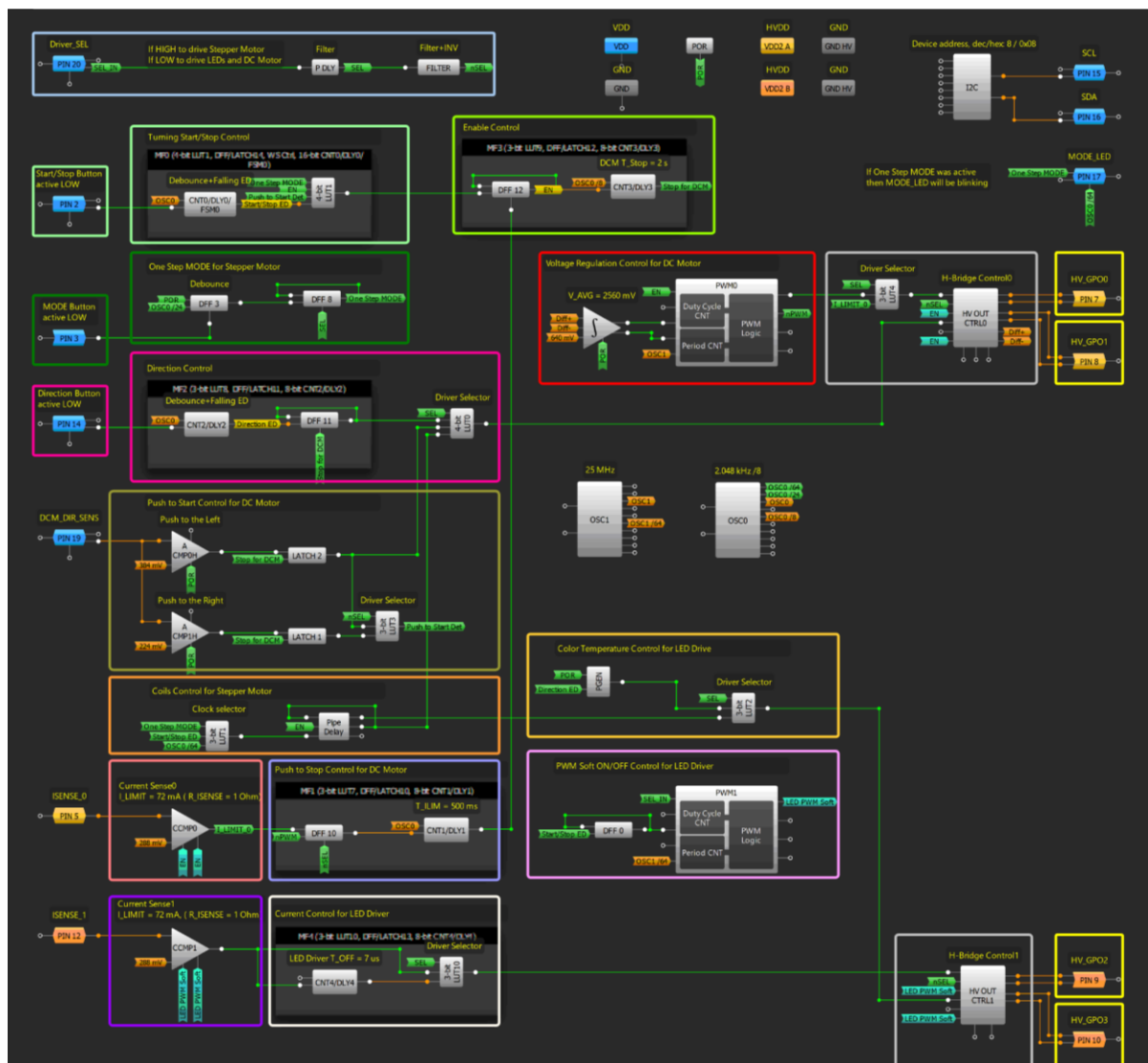


Figure 9: Design Block Diagram

5.2 Design Overview

The flexibility of the preprogrammed design using SLG47105 enables to control motors or LEDs depending on the Driver Switch Selector (SW2) position, which selects and gives the control signal to the appropriate parts (either DC Motor, LEDs, or Stepper Motor) of the board. Some parts of the design intended to create the specific functions (like constant voltage control, PWM soft ON/OFF, and others), some are shared and used to control the drive parts in different modes. Let's briefly consider their purposes.

General Blocks:

- Driver Switch Selector – is used to select the control modes (either DC Motor, LED Driver, or Stepper Motor);
- Turning Start/Stop Control – is used to detect the START/STOP button pressing and turning control;
- Enable Control – is used to enable the driver;
- Direction Control – is used to detect the DIRECTION button pressing and direction control;
- Current Sensor0 and 1 – are used to sense the current by measuring the voltage drop on the external current sense resistor;

- H-Bridge Control0 and 1 – are used to drive motors and LEDs, with the ability to change the voltage polarity;
- HV_GPOx – is used as a power PIN, which can pass the current up to 2 A each.

5.2.1 DC Motor Driver Blocks

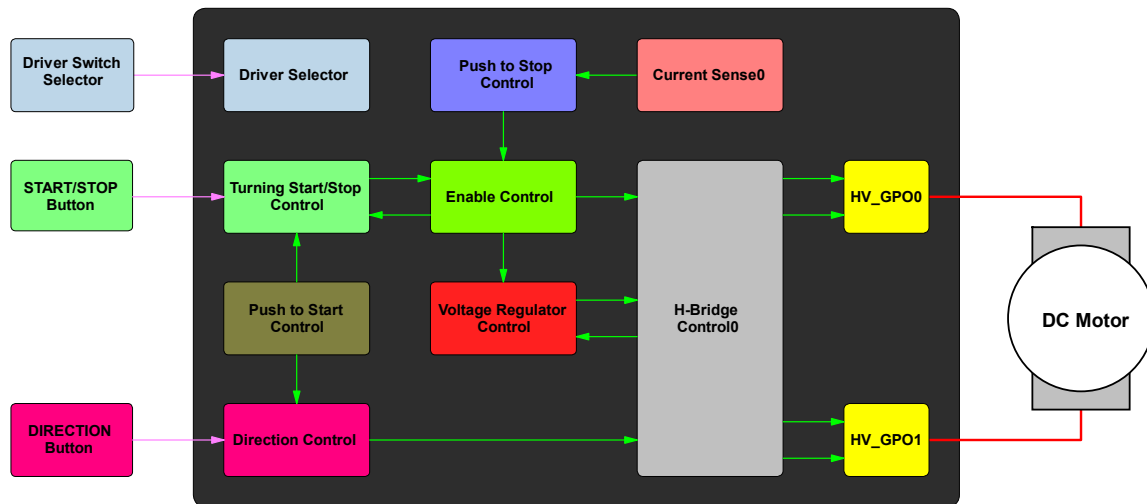


Figure 10: DC Motor Driver Functional Block Diagram

To drive the DC Motor, the Load Selector Switch must be set to the leftmost position. The START/STOP button starts or stops the motor, the DIRECTION button changes the rotation direction.

Control blocks

Voltage Regulator Control is useful when the constant voltage at the H-Bridge load is required. The circuit monitors the voltage difference between the HV_GPO0 and HV_GPO1 output pins and integrates it to get an average DC voltage value. This voltage is divided by 4 and compared to the output voltage of the Integrator Vref. Average output voltage level is $640\text{ mV} * 4 = 2560\text{ mV}$. If the averaged output voltage (divided by 4) is lower than Vref, the duty cycle of the PWM0 output is increased; if the averaged output voltage (divided by 4) is higher than Vref, the duty cycle is decreased. When integrated voltage is equal to Vref, the duty cycle remains unchanged.

Push-to-Start Control

When the shaft of the DC Motor rotates, an electromotive force (EMF) is induced in the coil according to the electromagnetic induction law. The direction of EMF depends on the shaft rotation direction. ACMP0H detects the CCW (Left) rotation, ACMP1H detects CW (Right) rotation. The direction signals enable the DC Motor drive by setting LATCH2. This function is inactive for 2 seconds after the driver was disabled.

Push-to-Stop Control

When the shaft of the DC Motor pushed to stop and Current Limit0 is detected during 500 ms, the DC Motor will be stopped.

5.2.2 Stepper Motor Driver Blocks

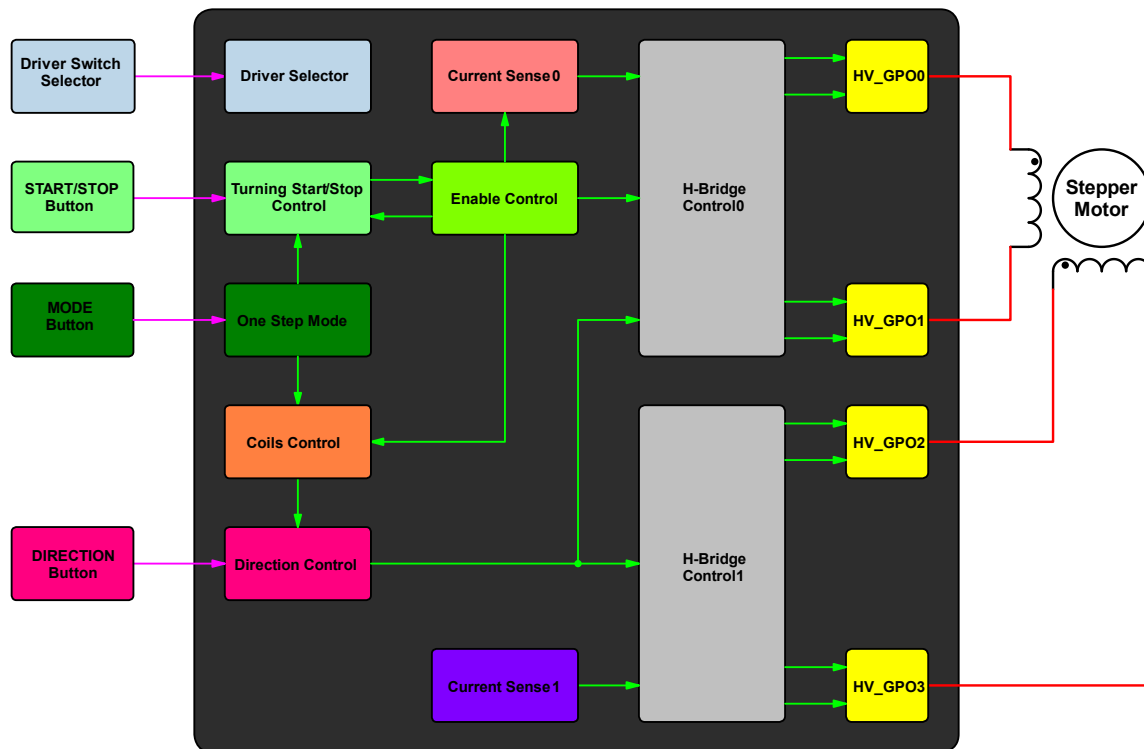


Figure 11: Stepper Motor Driver Functional Block Diagram

To drive the Stepper Motor the Load Selector Switch must be set to the rightmost position. The START/STOP button can start or stop the motor, the DIRECTION button changes the rotation direction. Also, pressing the MODE button enables One Step MODE.

Control blocks

Coils Control: In this case a full step drive is used. It always has two of the electromagnets "turned on". To rotate the central shaft, one of the electromagnets gets turned off and the next electromagnet gets turned on, causing the shaft to rotate 1/4 of a tooth (at least for hybrid Stepper Motors).

One Step MODE: When One Step MODE is disabled, the Clock source for speed rotation of the motor is taken from OSC1/64. When One Step MODE is enabled, the Clock source for speed rotation of the motor is taken from the START/STOP button, simultaneously LED "Mode" starts blinking.

Current Sensor0 and 1 are used to limit the current through the Stepper Motor coils.

5.2.3 LED Driver Blocks

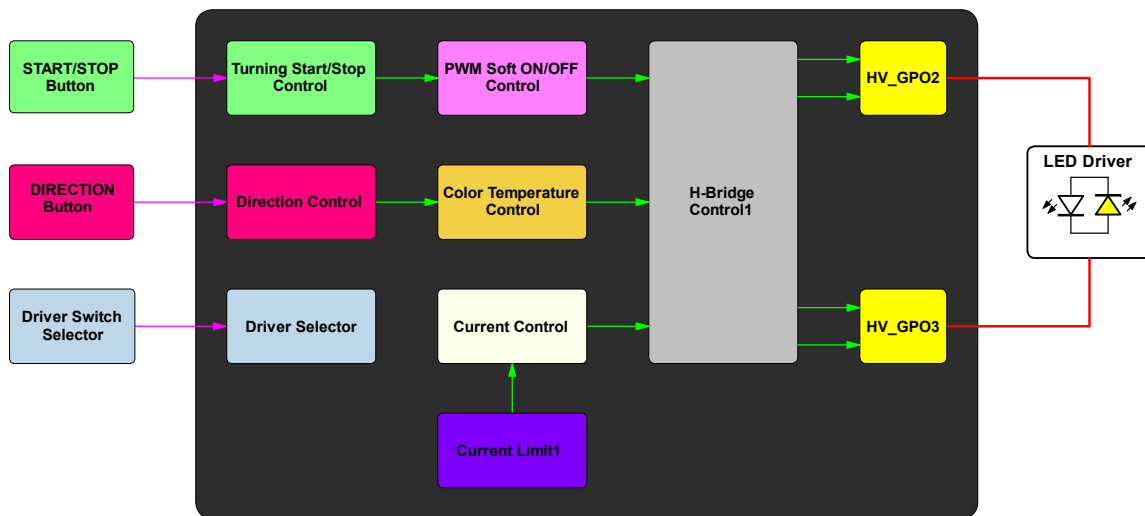


Figure 12: LED Driver Functional Block Diagram

To control the LED Driver, the Load Selector Switch must be set to the central position. The START/STOP button can switch ON or switch OFF the LED Driver, and the DIRECTION button changes the color of the LED, hence the polarity.

Control blocks

LED Driver Current Control: When voltage drop on the current sense resistor is higher than V_{ref} , the current limiter is triggered, the LED T_OFF Time Delay is started, and the Slow Decay sequence is performed. The Slow Decay sequence starts turning ON all the LOW sides of the H-Bridge. After the OFF time, the system returns to the ON state.

PWM Soft ON/OFF Control: When DFF0 OUT goes LOW, the PWM0 output is decreased and H-Bridge Control1 turns on the LED Driver softly. When DFF0 OUT goes HIGH, the PWM0 output is increased and H-Bridge Control1 turns off the LED Driver softly.

LED Color Control: When PGen OUT is LOW, the “Cold LED” is ON. When PGen OUT is High, the “Warm LED” is ON.

6 Conclusions

The Demo Board has been designed as a high power demonstrating platform for SLG47105. It is a convenient tool that allows the customers to get acquainted with SLG47105's functionality, especially the H-Bridge functions.

Appendix A Board Dimensions

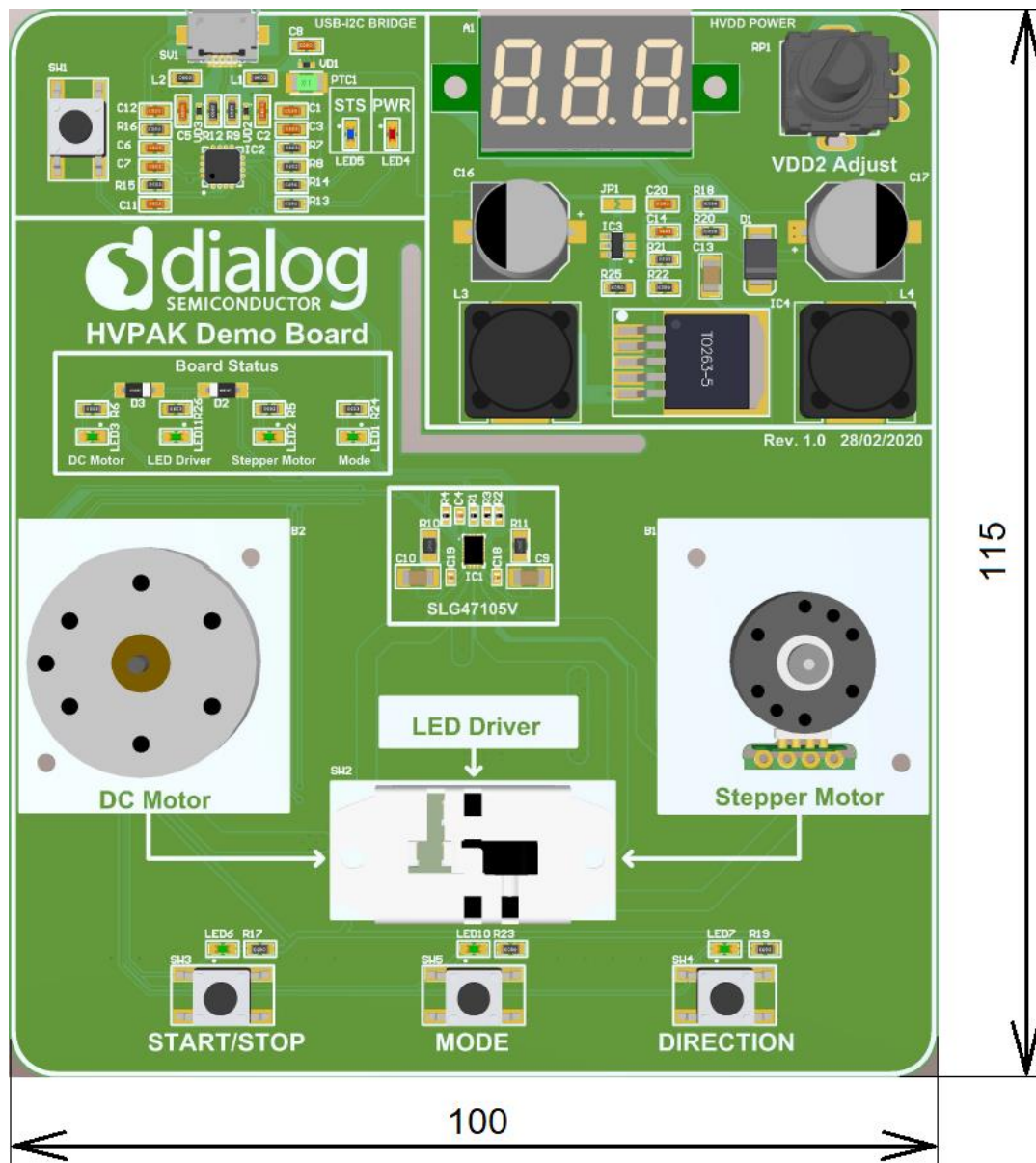


Figure 13: SLG47105 Demo Board Dimensions

Appendix B Top View

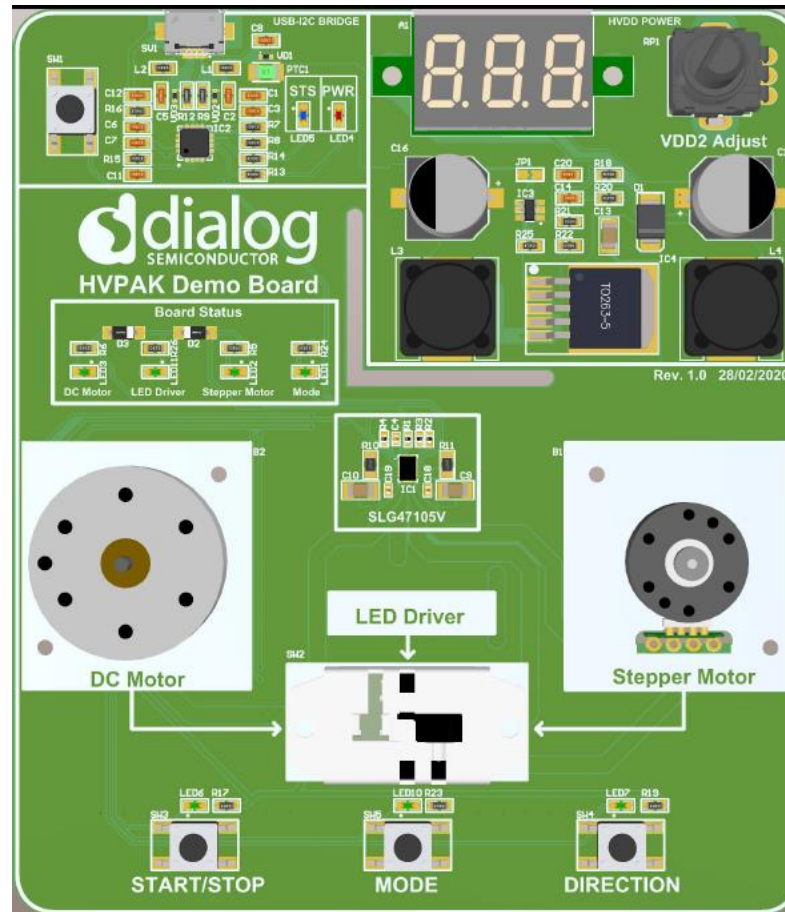


Figure 14: SLG47105 Demo Board, Top View

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SLG47105 Demo Board

Appendix C Board Schematic

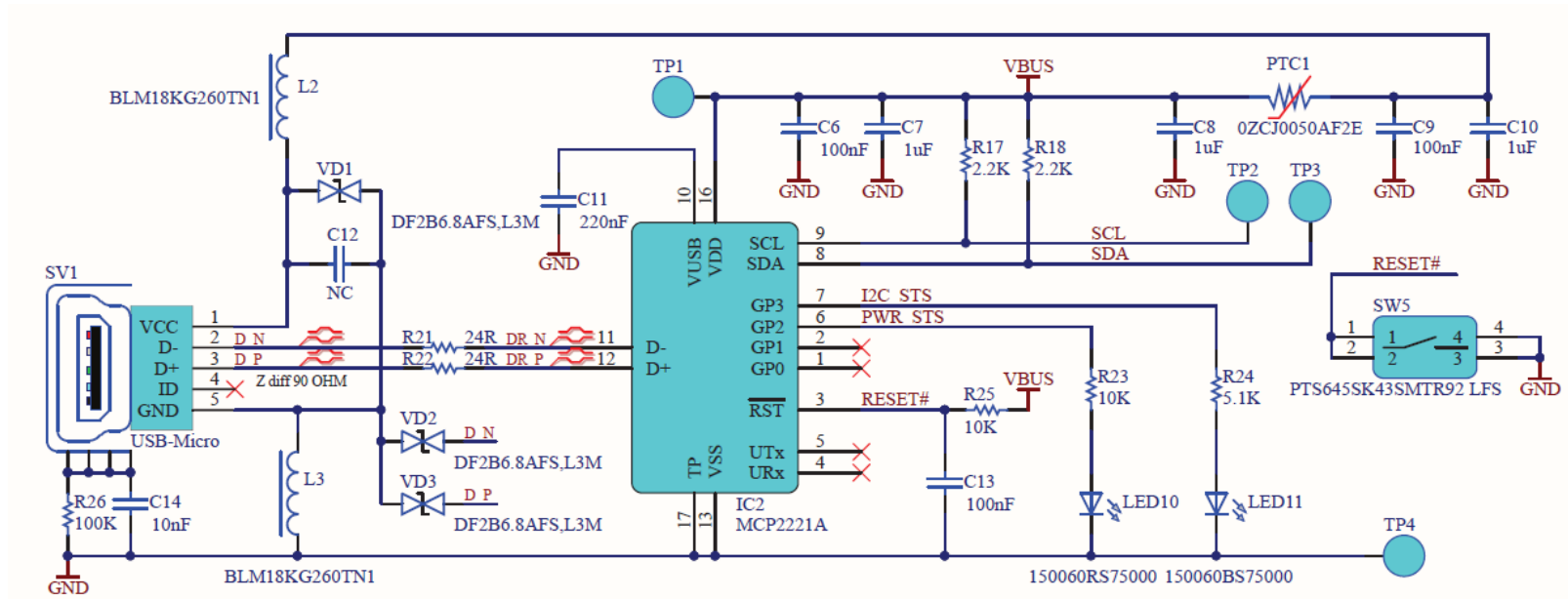


Figure 15: USB-I²C Bridge

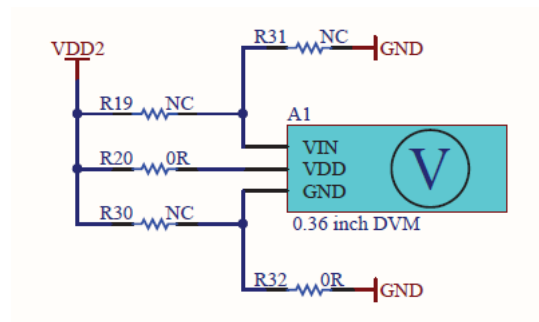


Figure 16: Digital Voltmeter

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SLG47105 Demo Board

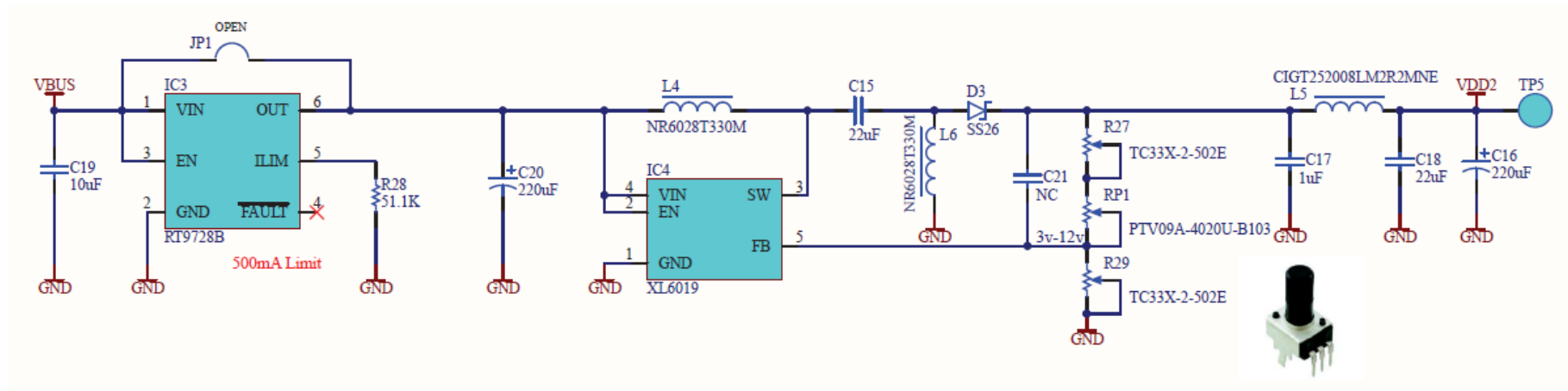


Figure 17: HV_{DD} Power Supply

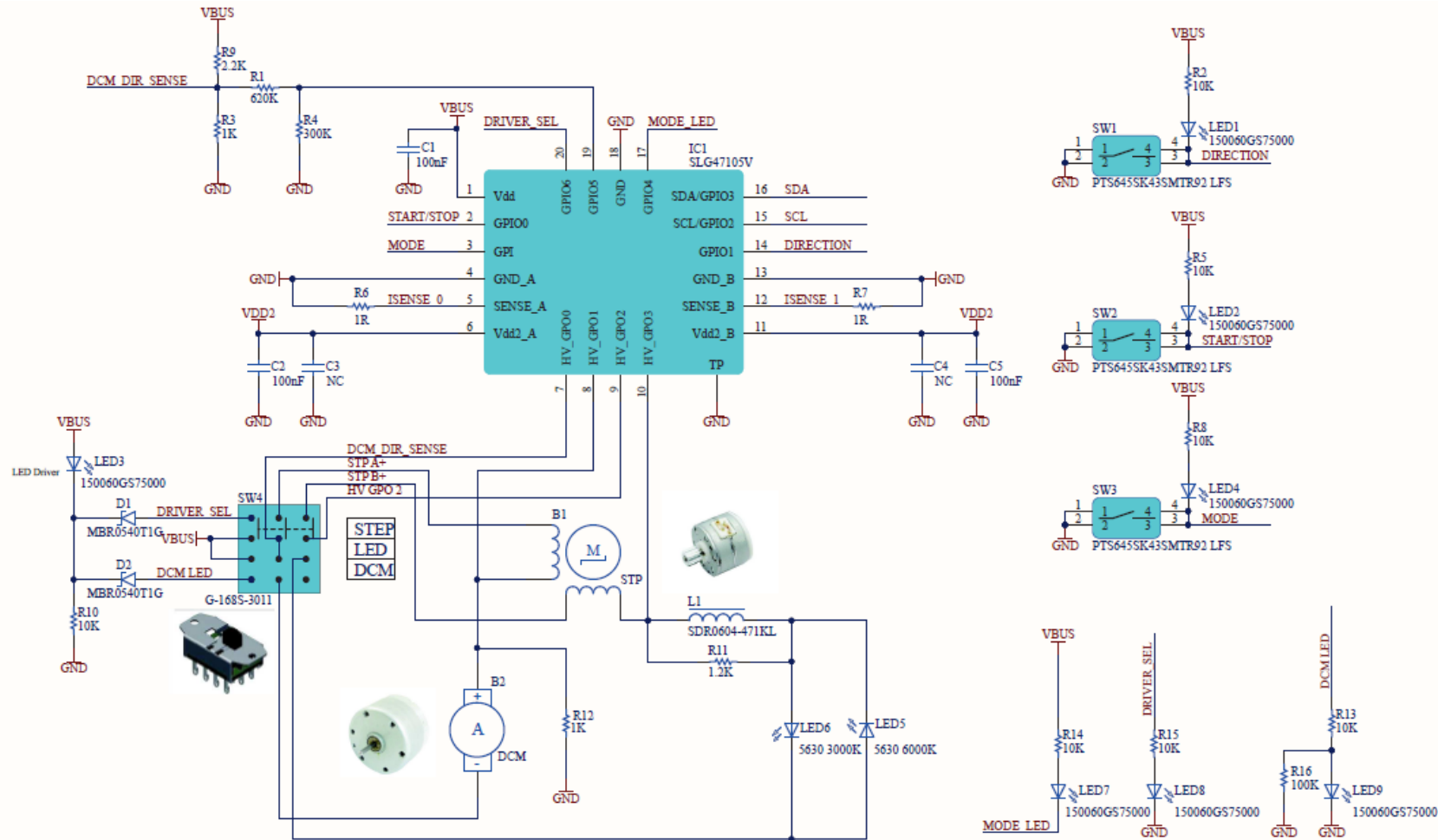


Figure 18: HV PAK Main Circuit

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SLG47105 Demo Board

Appendix D BOM

#	Designator	Name	Manufacturer Part Number 1	Quantity	Footprint
1	A1	0.36 inch DVM	--	1	dvm
2	B1	STP	PM15S-020	1	stp_motor
3	B2	DCM	LB0192	1	dc_motor
4	BP1, BP2, BP3, BP4	SJ61A6	SJ61A6	4	bumper
5	C1, C2, C5	100nF	GRM155R71C104KA88D	3	C0402
6	C3, C4	NC	--	2	C1206
7	C6, C9, C13	100nF	CGA3E2X7R1H104K080AA	3	C0603
8	C7, C8, C10, C17	1uF	C0603C105K3PACTU	4	C0603
9	C11	220nF	GRM188R71E224KA88D	1	C0603
10	C12, C21	NC	--	2	C0603
11	C14	10nF	CC0603KRX7R9BB103	1	C0603
12	C15, C18	22uF	GRM32ER61C226KE20L	2	C1210
13	C16, C20	220uF	UWT1C221MCL1GS	2	0.260" L x 0.260" W (6.60 mm x 6.60 mm)
14	C19	10uF	C1210C106Z4VACTU	1	C1210
15	D1, D2	MBR0540T1G	MBR0540T1G	2	SOD123
16	D3	SS26	SS26T3G	1	DO-214AA, SMB
17	IC1	SLG47105	SLG47105	1	STQFN-20-2.0X3.0-C
18	IC2	MCP2221A	MCP2221A-I/ML	1	MCP2221
19	IC3	RT9728B	RT9728BHGE	1	SOT23-6
20	IC4	XL6019	XL6019	1	TO263-5L
21	JP1	Solder Jumper	--	1	JP_0603

SLG47105 Demo Board

#	Designator	Name	Manufacturer Part Number 1	Quantity	Footprint
22	L1	SDR0604-471KL	SDR0604-471KL	1	sdr0604
23	L2, L3	BLM18KG260TN1	BLM18KG260TN1D	2	R0603
24	L4, L6	NR6028T330M	NR6028T330M	2	CHOKE 6X6MM
25	L5	CIGT252008LM2R2MNE	CIGT252008LM2R2MNE	1	CHOKE 1008
26	LED1, LED2, LED3, LED4, LED7, LED8, LED9	150060GS75000	150060GS75000	7	LED0603-G
27	LED5	5630 6000K	SPMWHT541MP5WAPKS4	1	LED5630
28	LED6	5630 3000K	LTW-5630AZL30	1	LED5630
29	LED10	150060RS75000	150060RS75000	1	LED0603-R
30	LED11	150060BS75000	150060BS75000	1	LED0603-B
31	PTC1	0ZCJ0050AF2E	0ZCG0030FF2C	1	PTC-1206
32	R1	620K	ERJ-2RKF6203X	1	R0402
33	R2, R5, R8, R10, R13, R14, R15, R23, R25	10K	CRCW060310K0FKEA	9	R0603
34	R3, R12	1K	ERJ-2RKF1001X	2	R0402
35	R4	300K	ERJ-2RKF3003X	1	R0402
36	R6, R7	1R	CRCW08051R00FNEA	2	R0805
37	R9, R17, R18	2.2K	CRCW06032K20FKEA	3	R0603
38	R11	1.2K	CRCW06031K20FKEA	1	R0603
39	R16, R26	100K	ERJ3EKF1003V	2	R0603
40	R19, R30, R31	NC	--	3	R0603
41	R20, R32	0R	RC0603JR-070RL	2	R0603
42	R21, R22	24R	CRCW060324R0FKEA	2	R0603
43	R24	5.1K	CRCW06035K10FKEA	1	R0603
44	R27, R29	TC33X-2-502E	TC33X-2-502E	2	pot_TC33X

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#	Designator	Name	Manufacturer Part Number 1	Quantity	Footprint
45	R28	51.1K	CRCW060351K1FKEA	1	R0603
46	RP1	PTV09A-4020U-B103	PTV09A-4020U-B103	1	pot
47	SV1	USB-Micro	10118192-0001LF	1	m_USB
48	SW1, SW2, SW3, SW5	PTS645SK43SMTR92 LFS	PTS645SK43SMTR92LFS	4	TACKTILE-SWITCH-6 mm
49	SW4	G-168S-3011	G-168S-3011	1	G-168S-3011
50	TP1, TP2, TP3, TP4, TP5	Testpoint	--	5	TP_WHITE
51	VD1, VD2, VD3	DF2B6.8AFS	DF2B6.8AFS,L3M	3	SOD-923
52	Z1	Dialog_LOGO	--	1	LOGO_9.1x30.2
53	Z2, Z3	709940300	709940300	2	
54	Z4, Z5	97791003111	97791003111	2	

Revision History

Revision	Date	Description
1.3	21-Mar-2022	Renesas rebranding
1.2	7-Sep-2021	Updated hyperlinks
1.1	3-Sep-2020	Updated figures Fixed typos Updated Board Schematic Updated BOM
1.0	9-Jun-2020	Initial version