

Description

The AS025-HVPAK DC Motor Driver Pmod™ board combines a highly integrated HVPAK™ IC, Current monitor, and protection function. The board can provide a quick configuration of PMDC motor and Stepper motor. The board will be configured with one of the Quick connect boards on PMOD6A architecture. The motors like DC motor with direction and speed control as well as Stepper motor with micro-steps are easily configurable. This will reduce the development and turnaround time of any customer.

Kit Contents

- AS025-HVPAK DCM CONTROL BOARD

Features

- It will be suitable for a quick connect platform using the Pmod™ architecture.
- The same can be used as standalone development solution for HVPAK™ motor driver.
- The system solution can be extended for up to 2 DC Motor drivers or 1 Stepper motor driver.
- External current protection circuit provided using ISL28025 for additional system level hard reset and protection.
- I2C gives options for multiple dynamic configurations like Speed, Direction, Steps, Mode etc.

Evaluation Board

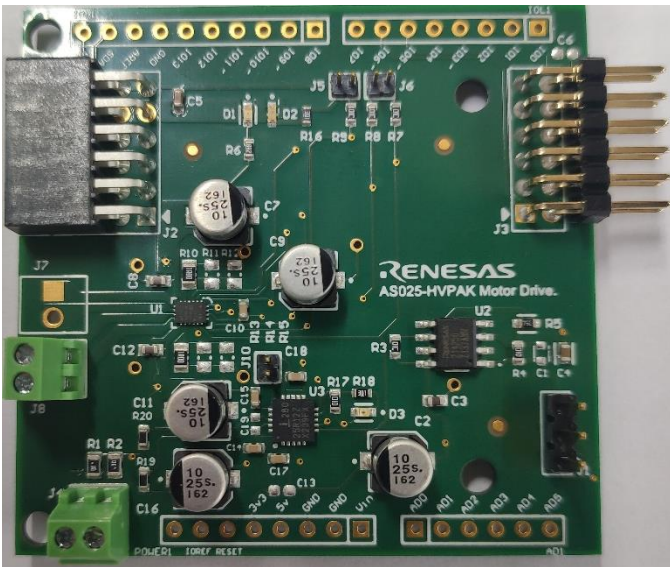


Figure 1: AS025-HVPAK

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AS025-HVPAK Overview

The AS025-HVPAK DC Motor Driver Pmod™ board combines a highly integrated HVPAK™ IC. This design can provide Quick configuration with Dc motor. This solution can be extended for 2 DC Motor drivers. ISL28025 is used to provide external current and voltage protection for the circuit. Design has low idle current consumption in combination with a compact size. Speed, direction control options provided using I2C.

The block diagram below highlights the main parts of the system:

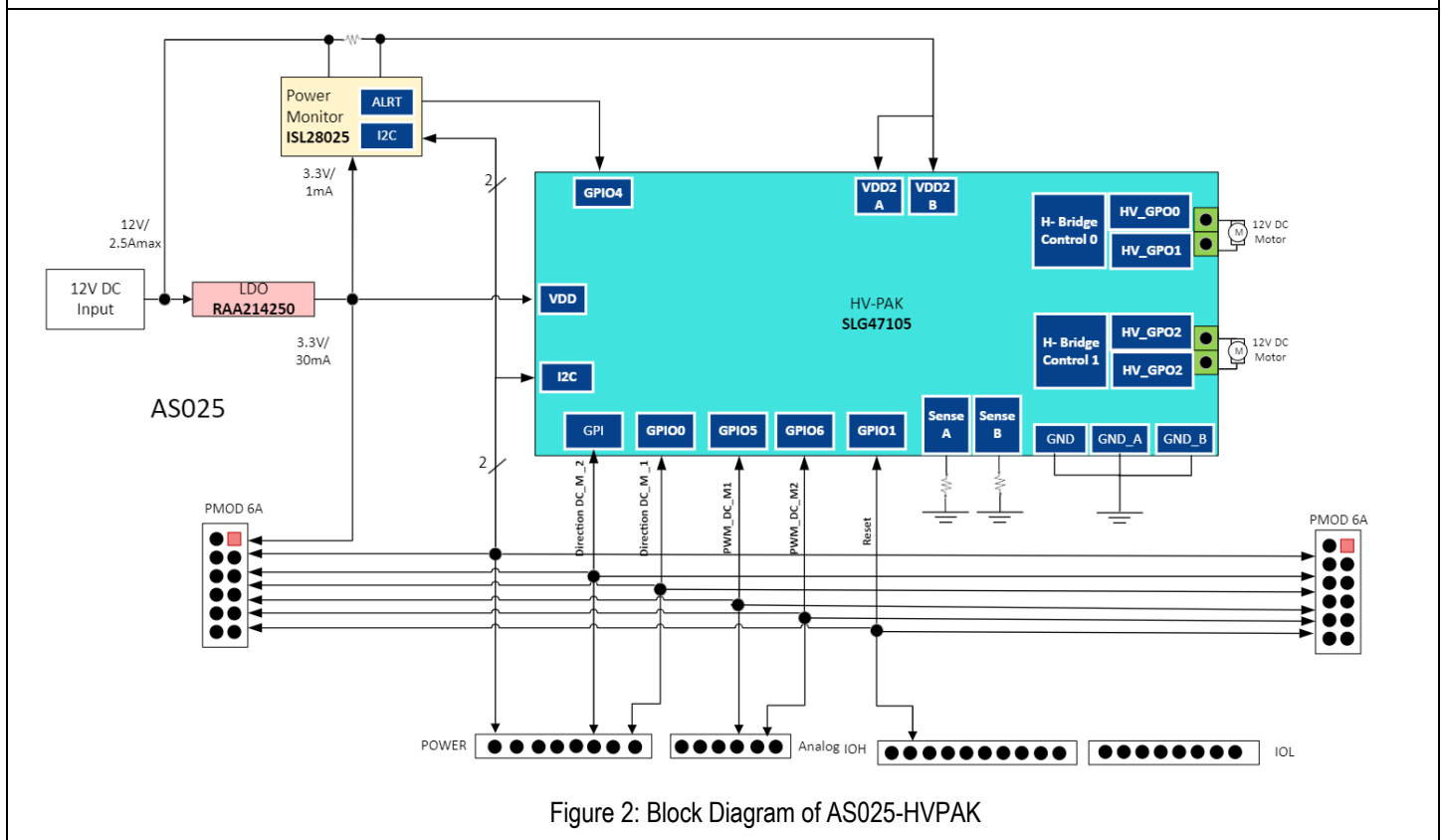


Figure 2: Block Diagram of AS025-HVPAK

The building blocks of the AS025-HVPAK and their functionality are listed below:

1. [SLG47105](#): HVPAK™ Programmable Mixed-Signal Matrix with Four Outputs with Operating Voltage up to 13.2 V and up to 2 A Current per Output. SLG47105 has Full H-Bridge and Independent Half-Bridge Control.
2. [RAA214250](#): The RAA214250 is a low-dropout linear voltage regulator that operates from 2.5V to 20V and provide up to 500mA of output current with a typical dropout of 269mV. The output voltage is adjustable with external feedback resistors anywhere from 1.224V to 18V.
3. [ISL28025](#): Precision Digital Power Monitor with Real Time Alerts. The ISL28025 is a bidirectional high-side and low-side digital current sense and voltage monitor with a serial interface. The device monitors power supply current and voltage, which provides digital results along with calculated power.

Hardware Overview

The following block diagrams have specific applications explained below.

1. Power monitor Alert

The internal comparators of the ISL28025 can be configured to monitor the input supply voltage for undervoltage and overvoltage conditions. The comparator can signal the microcontroller to perform an action. A sense resistor, R1 & R2, is used to monitor the current delivered to the circuit load. The sense resistor is connected between the FB (feedback) and the VOUT pin of the ISL28025.

Power Monitor Section:

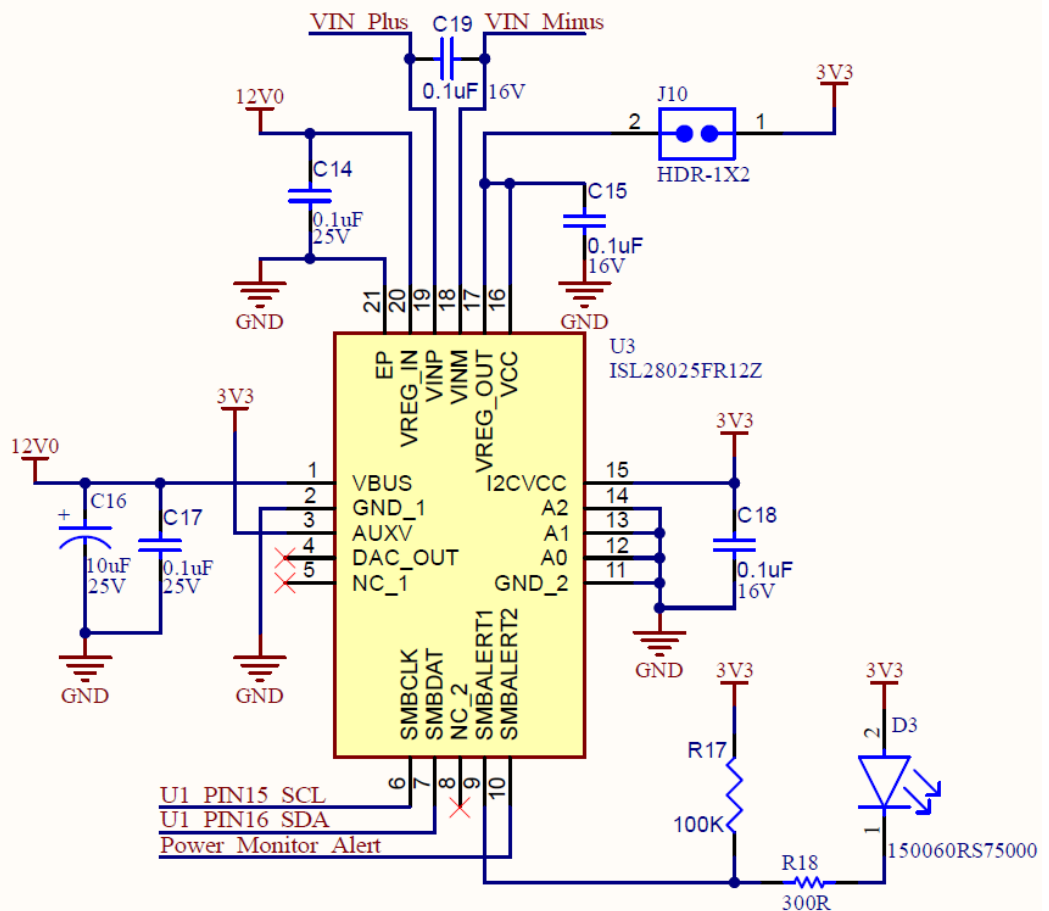
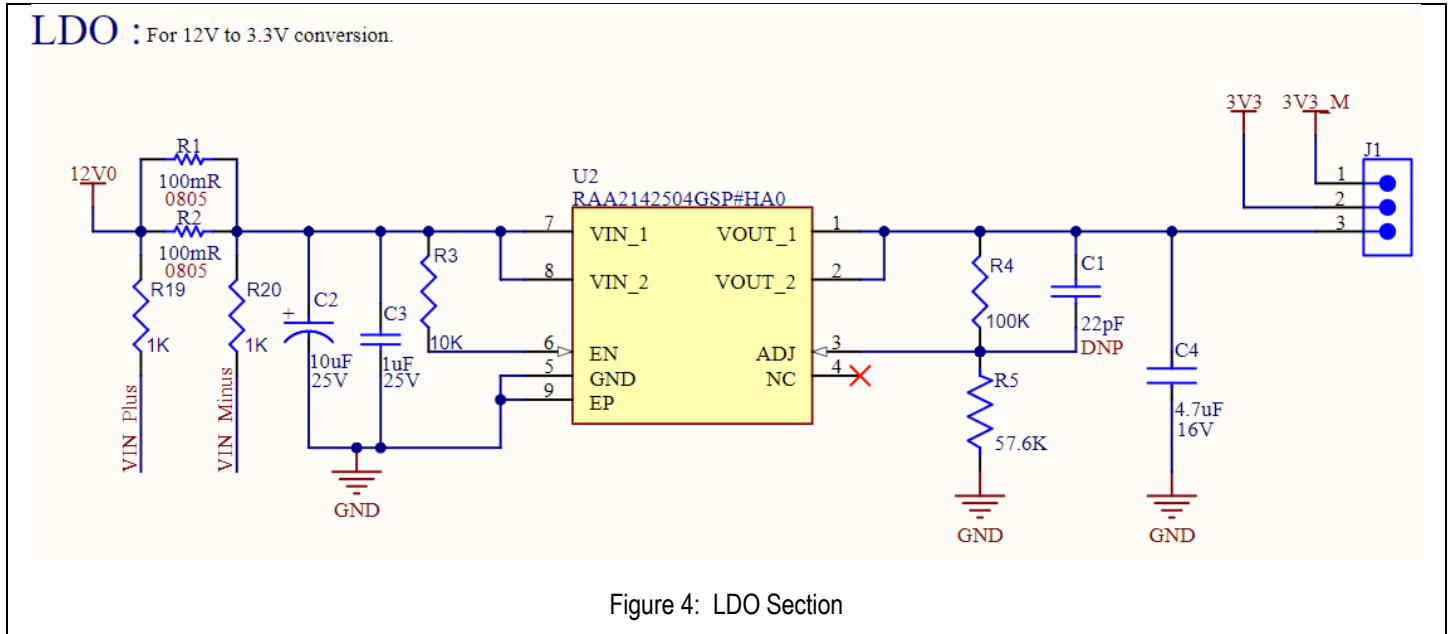


Figure 3: Power monitor section ISL28025FR12Z

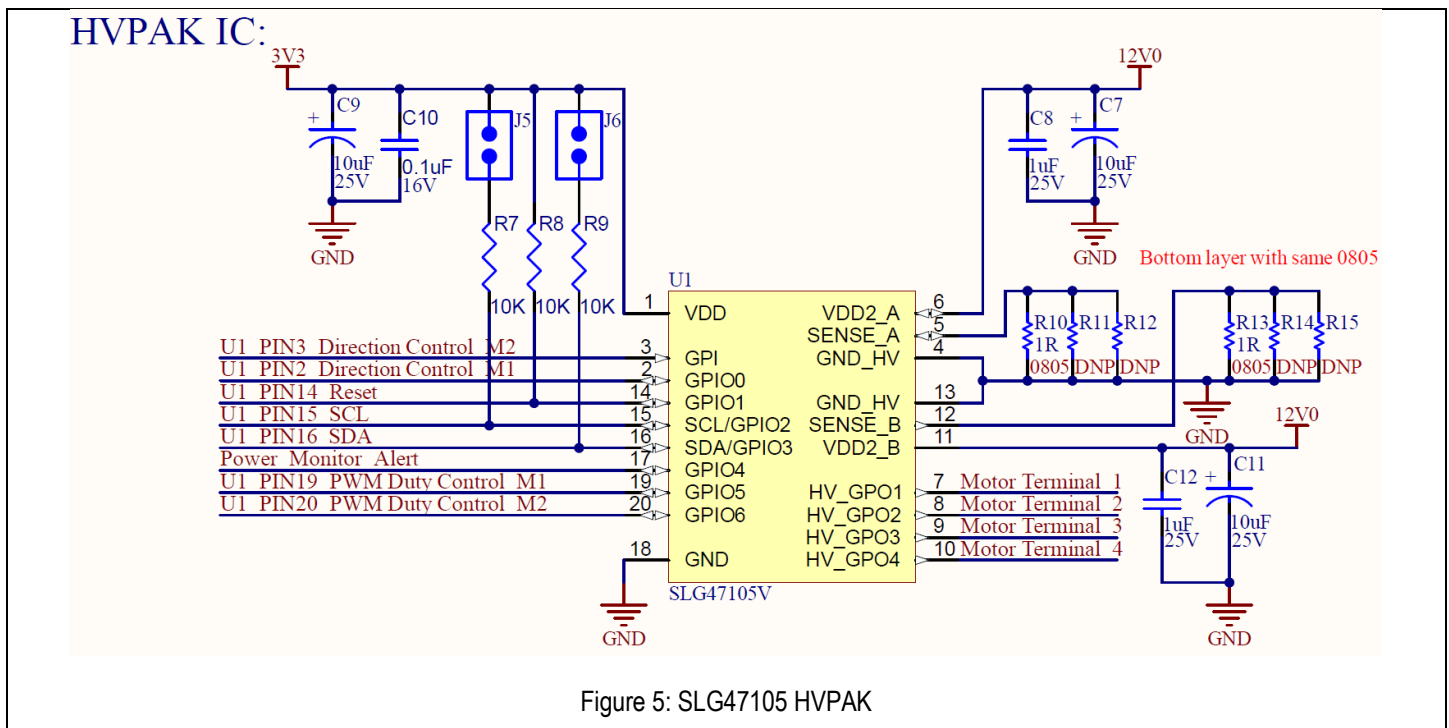
2. LDO:

The RAA214250 output voltage (VOUT) used to programmed down to 3.3 V from 12 v input using the feedback (FB) resistors, R4 and R5 and Low Dropout of 269mV at 500mA. RAA21450 has feature as short circuit current limit protection with fold-back at higher input voltage.



3. SLG47105V (HVPAK IC):

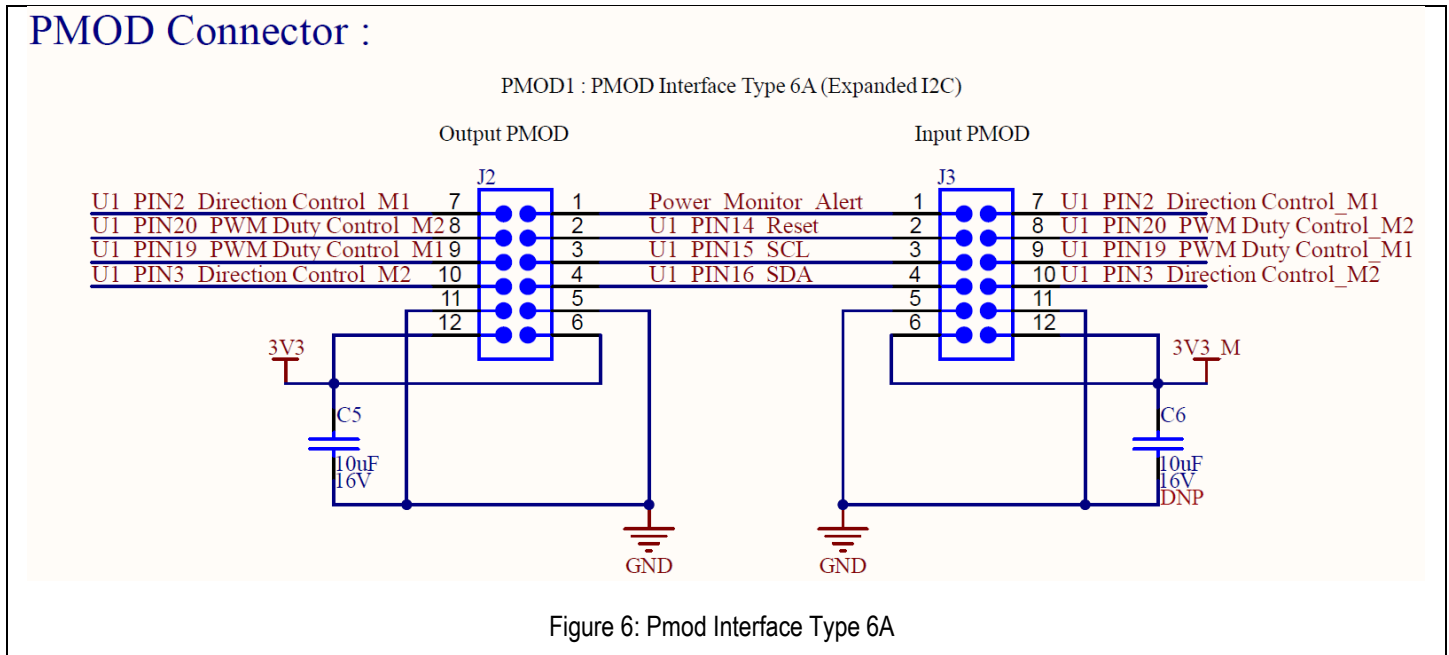
SLG47105 V provides Independent half-bridge control allows dual bidirectional DC motor operations. Build-in overcurrent and over-temperature protection reduces design complexity and enables higher system reliability, Flexible motor control with a programmable current sense comparator for current limiting or programmable overcurrent protection and R10, R13 used to limit the current. 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 Vin.



4. Pmod:

This interface conforms to the I2C specification, with an optional interrupt and reset pin plus some optional control signals. If these optional pins are not used, they will be no connects. The pull-up resistors used to provide the logic high level for SCL and SDA are provided on the modules and can be attached to or detached from the bus via onboard jumpers. Pull-ups on INT and RESET, if used, are also provided on the module, and can be attached or detached from the bus via onboard jumpers to enable daisy chaining.

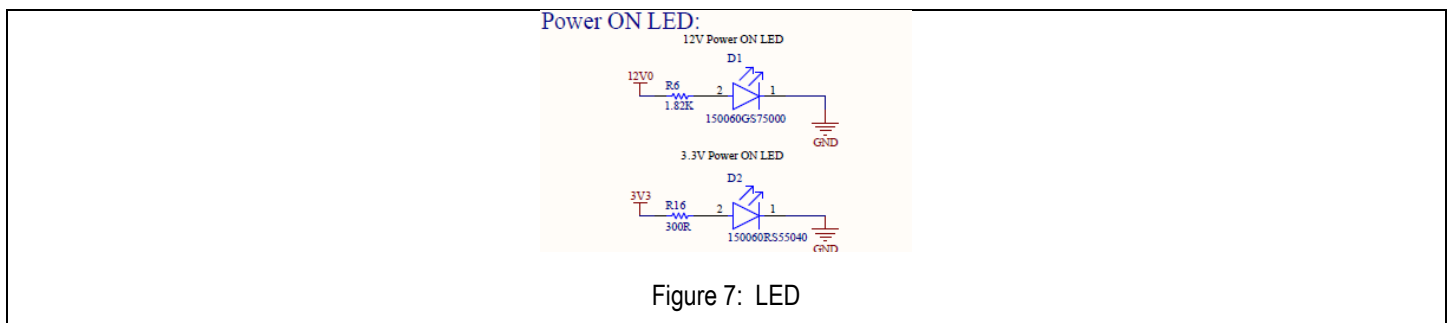
An optional passthrough female Pmod connector may be added to the Pmod opposite to the side with the male connector. This connector may be a six-pin or 12-pin connector, though it should be considered that extra control signals, such as those on the lower row on a 12-pin connector, may not be appropriate for a pass-through connector due to the potential signal conflict if other modules in a daisy chain also used these control signal pins.



5. LED: LEDs are used for power on indication and 3.3 v output indication.

Description of LEDs:

LED Color	Reference Designator	Function
Green	D1	Power up
Yellow	D2	3.3 v output indication



6. Arduino connectors:

Near the center of the system control and ecosystem access is an Arduino uno R3 compatible connector interface.

Connector	Pin No.	Arduino Connection description
IOH	J-24-1	IO8/GPIO/CLKOUT
	J-24-2	IO9/GPIO/PWM(GTIOC7B)
	J-24-3	IO10/SSLA0/CTS_RTS9/PWM(GTIOC4A)
	J-24-4	IO11/MOSIA/TXD9/PWM(GPIOC5A)
	J-24-5	IO12/MISOA/RXD9/PWM(GTIOC5B)
	J-24-6	IO13/RSPCKA/SCK9/PWM(GTIOC4B)
	J-24-7	GND
	J-24-8	AREF
	J-24-9	SDA1
	J-24-10	SCL
IOL	J-23-1	IO0/RXD7
	J-23-2	IO1/TXD7
	J-23-3	IO2/IRQ13-DS/AN009
	J-23-4	IO3/IRQ3/PWM/(GTIOC3A)
	J-23-5	IO4/GPIO/PWM/(GTIOC2A)
	J-23-6	IO5/GPIO/PWM/(GTIOC2B)
	J-23-7	IO6/GPIO/PWM/(GTIOC6B)
	J-23-8	IO7/GPIO/PWM/(GTIOC7A)
POWER (J18)	J_18-1	VIN
	J_18-2	GND
	J_18-3	GND
	J_18-4	5v
	J_18-5	3.3V
	J_18-6	RESET
	J_18-7	IOREF
	J_18-8	NC
AD (J19)	J_19_1	AD0/AN000
	J_19_2	AD1/AN001
	J_19_3	AD2/AN003
	J_19_4	AD3/AN007
	J_19_5	AD4/DAC/AN012
	J_19_6	AD5/DAC/AN013

Arduino Shield:

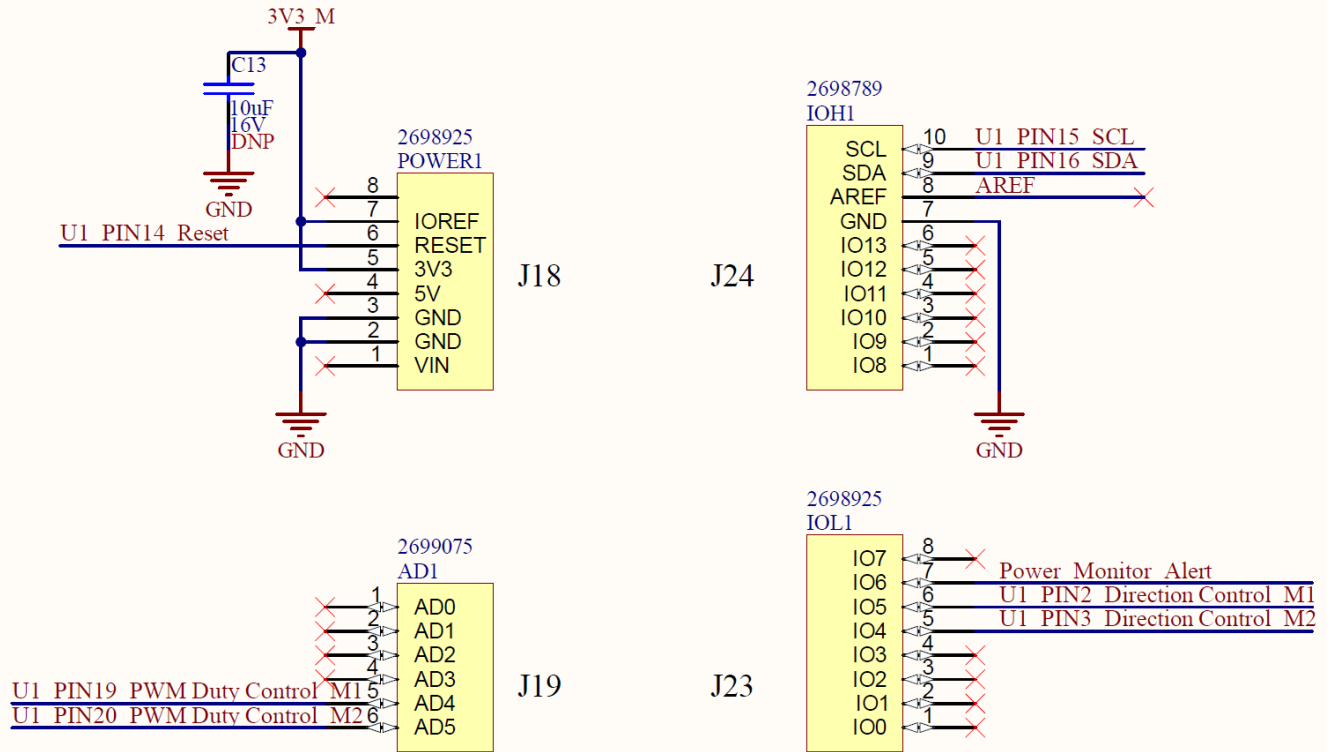


Figure 8: Arduino shield

Software Overview

1. Debugging/Building the Project: Use Renesas E1 Emulator to build and debug the program. Connect the E1 emulator to RL78/F14 board and PC and proceed with the build and debug of the project.

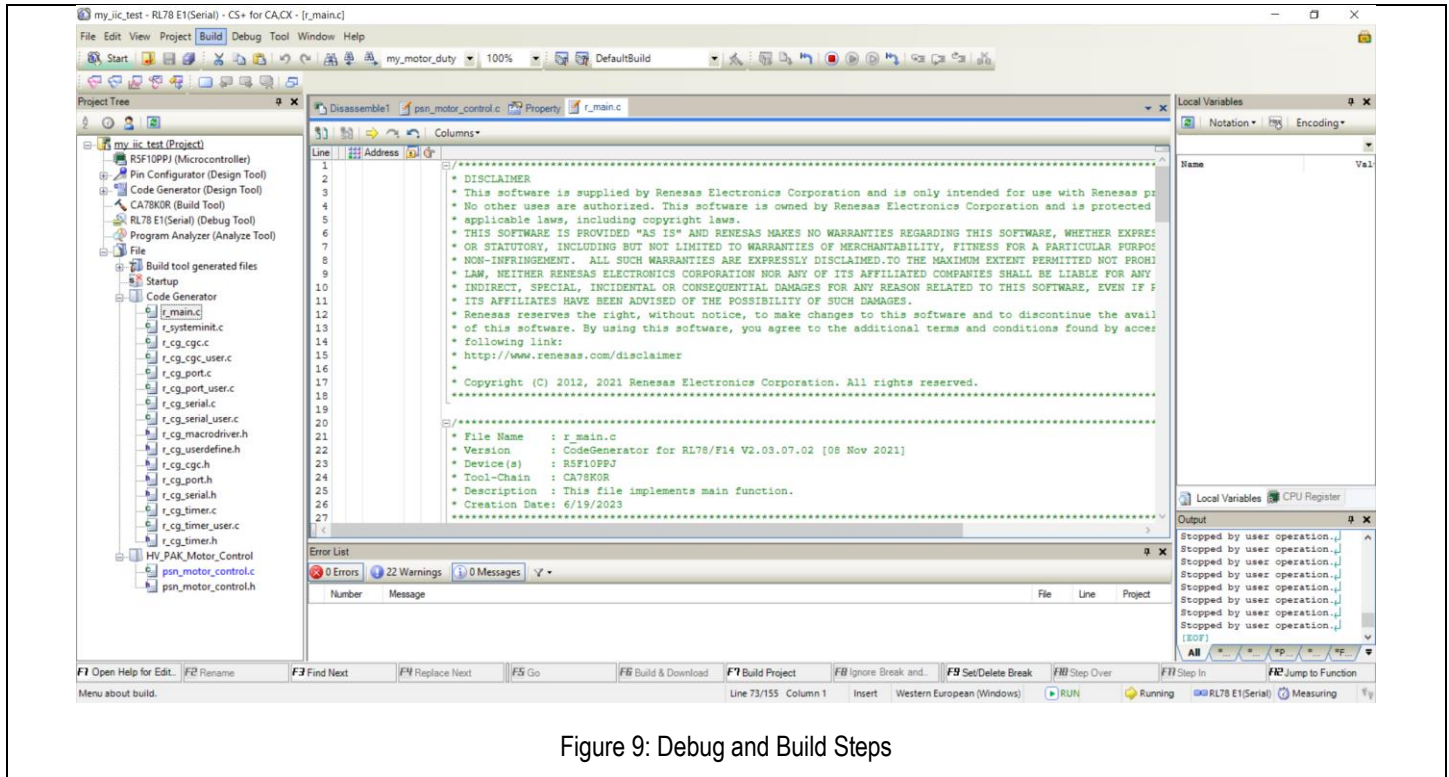


Figure 9: Debug and Build Steps

2. Pin Configurations:

Table 1: Motor 1 control mode:

I2C_Control_M1, <reg<608>	Control MODE
0	PINs Control: PWM_M1 Direction_M1
1	I2C Control: PWM0 Duty I2C_Direction_M1

Table 2: Motor 1 Pins Control Mode:

Alert	Reset	I2C Reset	PWM_M1	Direction_M1	M1_1 (HV_OUT0)	M1_2 (HV_OUT1)	Function
X	0	0	X	X	Hi-Z	Hi-Z	Sleep, (H-Bridge Hi-Z)
0	1	X	X	X	Hi-Z	Hi-Z	Coast, (H-Bridge Hi-Z)
1	1	X	0	X	LOW	LOW	Brake, (Low-Side Slow Decay)
1	1	X	1	0	HIGH	LOW	Forward (OUT0 → OUT1)
1	1	X	1	1	LOW	HIGH	Reverse (OUT1 → OUT0)

Table 3: Motor 1 I2C Control Mode:

Alert	Reset	I2C Reset	PWM0 Duty	I2C_Direction_M1	M1_1 (HV_OUT0)	M1_2 (HV_OUT1)	Function
X	0	0	X	X	Hi-Z	Hi-Z	Sleep, (H-Bridge Hi-Z)
0	X	1	X	X	Hi-Z	Hi-Z	Coast, (H-Bridge Hi-Z)
1	X	1	0	X	LOW	LOW	Brake, (Low-Side Slow Decay)
1	X	1	1	0	HIGH	LOW	Forward (OUT0 → OUT1)
1	X	1	1	1	LOW	HIGH	Reverse (OUT1 → OUT0)

Table 4: Motor 2 Control Mode:

I2C_Control_M2, <reg<611>	Control MODE
0	PINs Control: PWM_M2 Direction_M2
1	I2C Control: PWM1 Duly I2C_Direction_M2

Table 5: Motor 2 Pins Control Mode:

Alert	Reset	I2C Reset	PWM_M2	Direction_M2	M2_1 (HV_OUT2)	M2_2 (HV_OUT3)	Function
X	0	0	X	X	Hi-Z	Hi-Z	Sleep, (H-Bridge Hi-Z)
0	1	X	X	X	Hi-Z	Hi-Z	Coast, (H-Bridge Hi-Z)
1	1	X	0	X	LOW	LOW	Brake, (Low-Side Slow Decay)
1	1	X	1	0	HIGH	LOW	Forward (OUT2 → OUT3)
1	1	X	1	1	LOW	HIGH	Reverse (OUT3 → OUT2)

Table 6: Motor 2 I2C Control Mode:

Alert	Reset	I2C Reset	PWM1 Duty	I2C_Direction_M2	M2_1 (HV_OUT0)	M2_2 (HV_OUT1)	Function
X	0	0	X	X	Hi-Z	Hi-Z	Sleep, (H-Bridge Hi-Z)
0	X	1	X	X	Hi-Z	Hi-Z	Coast, (H-Bridge Hi-Z)
1	X	1	0	X	LOW	LOW	Brake, (Low-Side Slow Decay)
1	X	1	1	0	HIGH	LOW	Forward (OUT2 → OUT3)
1	X	1	1	1	LOW	HIGH	Reverse (OUT3 → OUT2)

Table 7: Chip I2C Address

HEX	BIN	DEC
0x08	0001000	8

Table 8: I2C Control Registers

The CONTROL register is used to set the MOTOR Control MODE, Reset, PWM Duty, Direction, Current Comparator settings. The register is defined as follows:

Address Byte	Register Bit	Block	Function	Default
0x4C	reg<608>	Virtual Input <0>	I2C_Reset	0
	reg<609>	Virtual Input <1>	I2C_Control_M1	0
	reg<610>	Virtual Input <2>	I2C_Direction_M1	0
	reg<611>	Virtual Input <3>	I2C_Control_M2	0
	reg<612>	Virtual Input <4>	I2C_Direction_M2	0
	reg<615:613>	Virtual Inputs <5..7>	X	000
0xA1	reg<1295:1288>	Initial PWM0 Duty Cycle value	PWM0 Duty MOTOR1	0x80
0xA2	reg<1296>	I2C Trigger for PWM0	0: Don't update duty cycle value 1: Update duty cycle value	0
	reg<1297>	I2C Trigger for PWM1	0: Don't update duty cycle value 1: Update duty cycle value	0
	reg<1303:1298>		Do not change!	010000
0xA3	reg<1311:1304>	Initial PWM1 Duty Cycle value	PWM1 Duty MOTOR2	0x80
0x57	reg<701:696>	Current Sense CMP0 Vref select for MOTOR1	000000: 32 mV ~ 111110: 2016mV step = 32 mV. 111111: External Vref, (Default: 800mV)	011000
	reg<703:702>		Do not change!	00
0x58	reg<709:704>	Current Sense CMP1 Vref select for MOTOR2	000000: 32 mV ~ 111110: 2016mV step = 32 mV. 111111: External Vref, (Default: 800mV)	011000
	reg<711:710>		Do not change!	00

3. Serial COM Port settings: Use TTL to USB Adapter and Tera-term terminal software to give serial commands to the device. COM port Connection settings. Specify the baud rate setting as 19200.

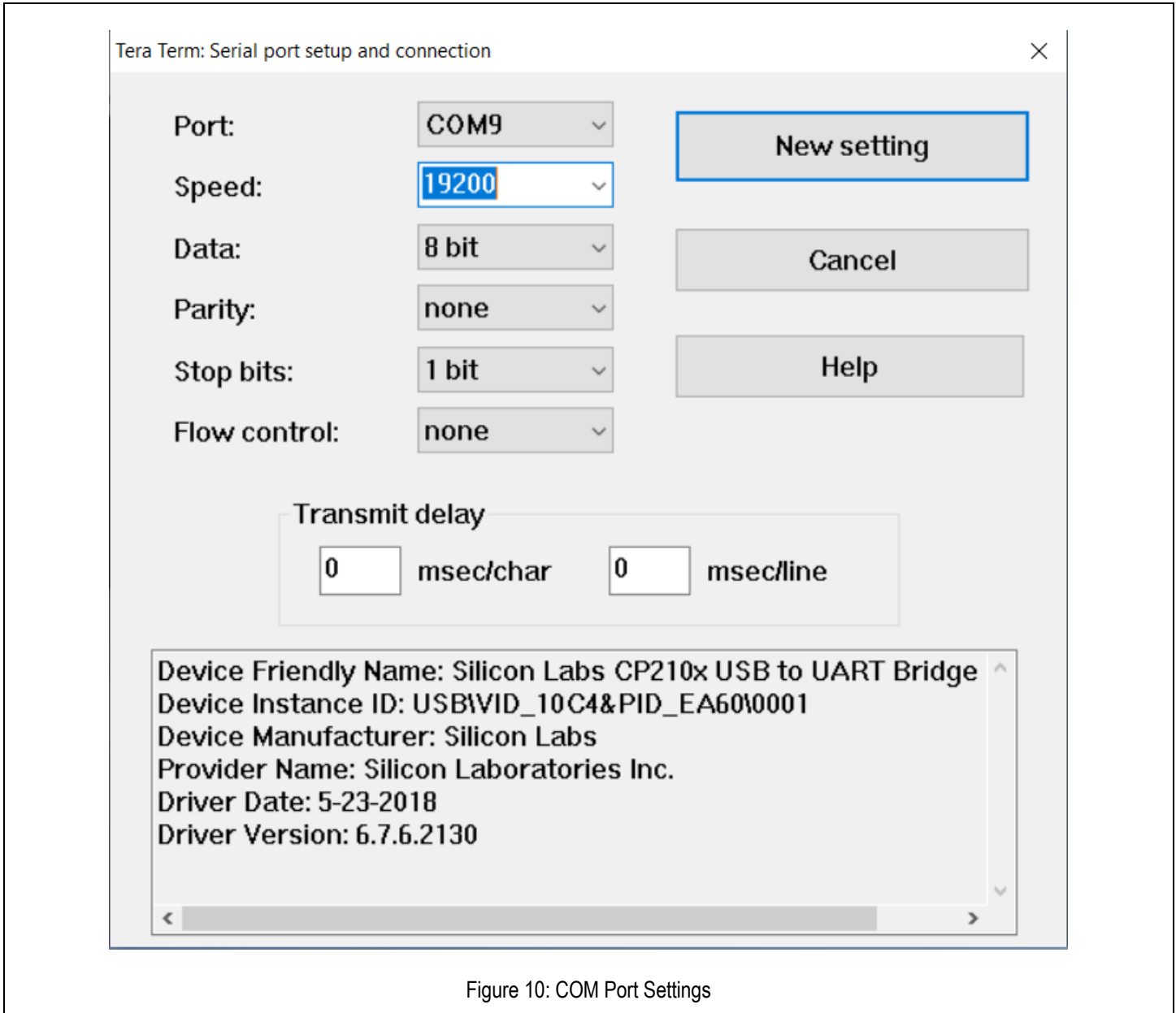


Figure 10: COM Port Settings

Go Configuration Block Design and Firmware Flashing Steps

Connect SLG47105 chip using socket to programming board and design block using go configure GUI and flash firmware to us as DC motor controller.

1. Design block for DC motor –
 1. Open GO configure GUI to design block.
 2. Add PWM block for duty control.
 3. Add Enable disable function block for reset functionality.
 4. Add Direction control block for motor rotation direction control.

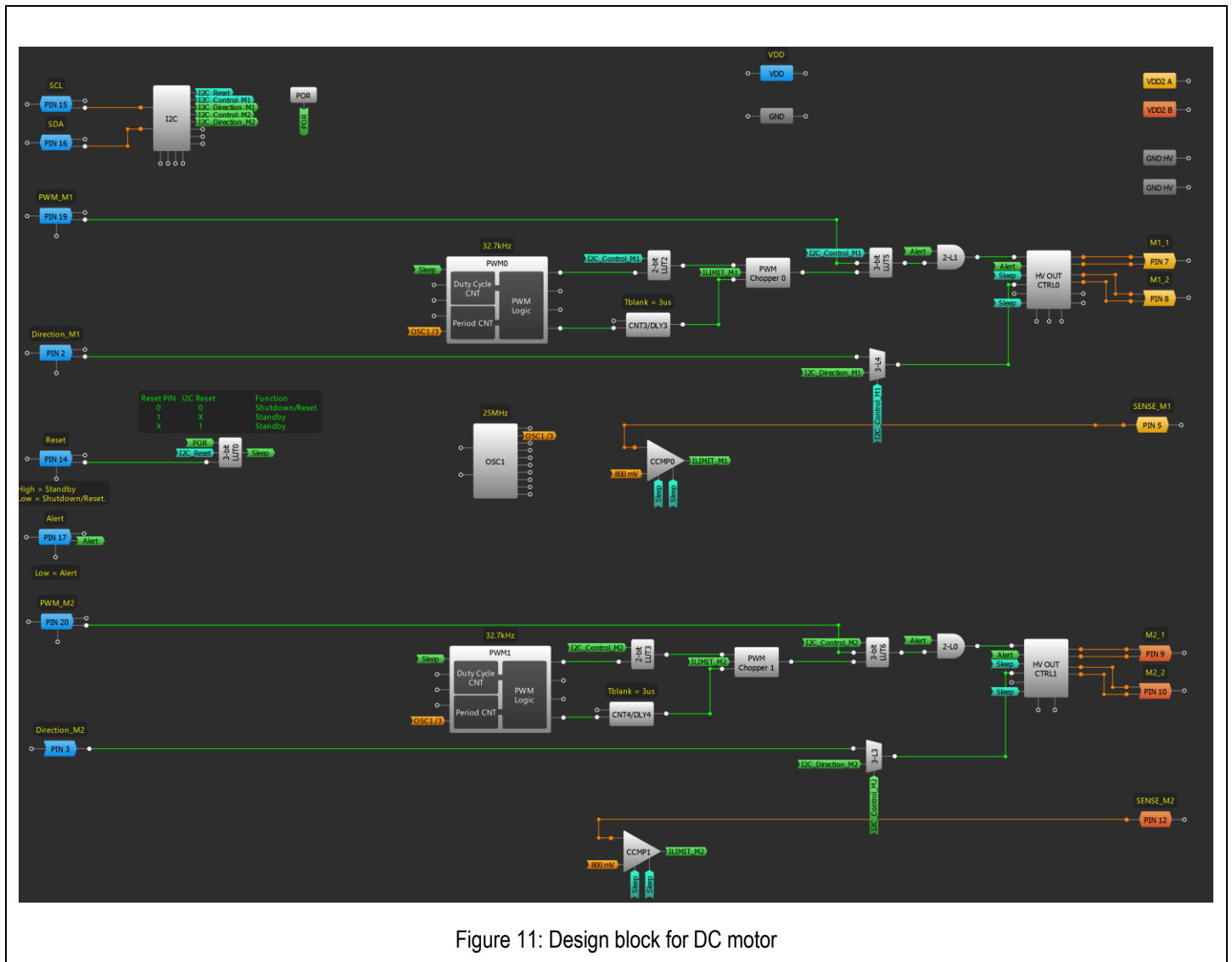
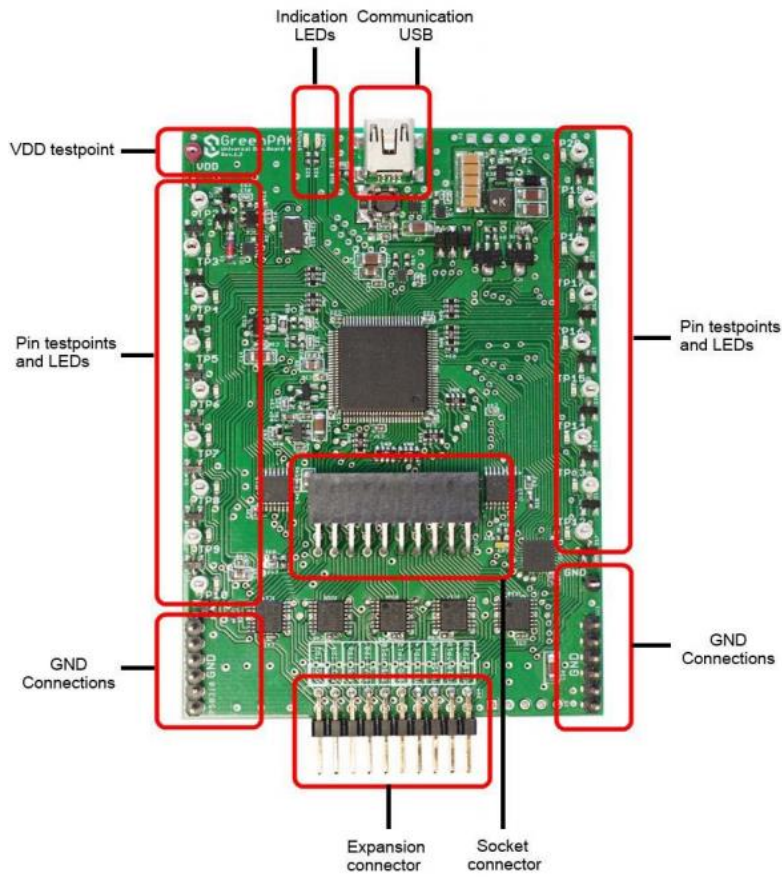


Figure 11: Design block for DC motor

2. Follow below settings for configure HVPAK (SLG47105) as DC motor controller.
 1. Place Unprogrammed SLG47105 chip into socket.
 2. Connect Board and socket using USB & power up the board.
 3. Design blocks using go configure GUI.
 4. Press debug button to run program.
 5. Press program from debugging control panel.
 6. Confirm Configuration.



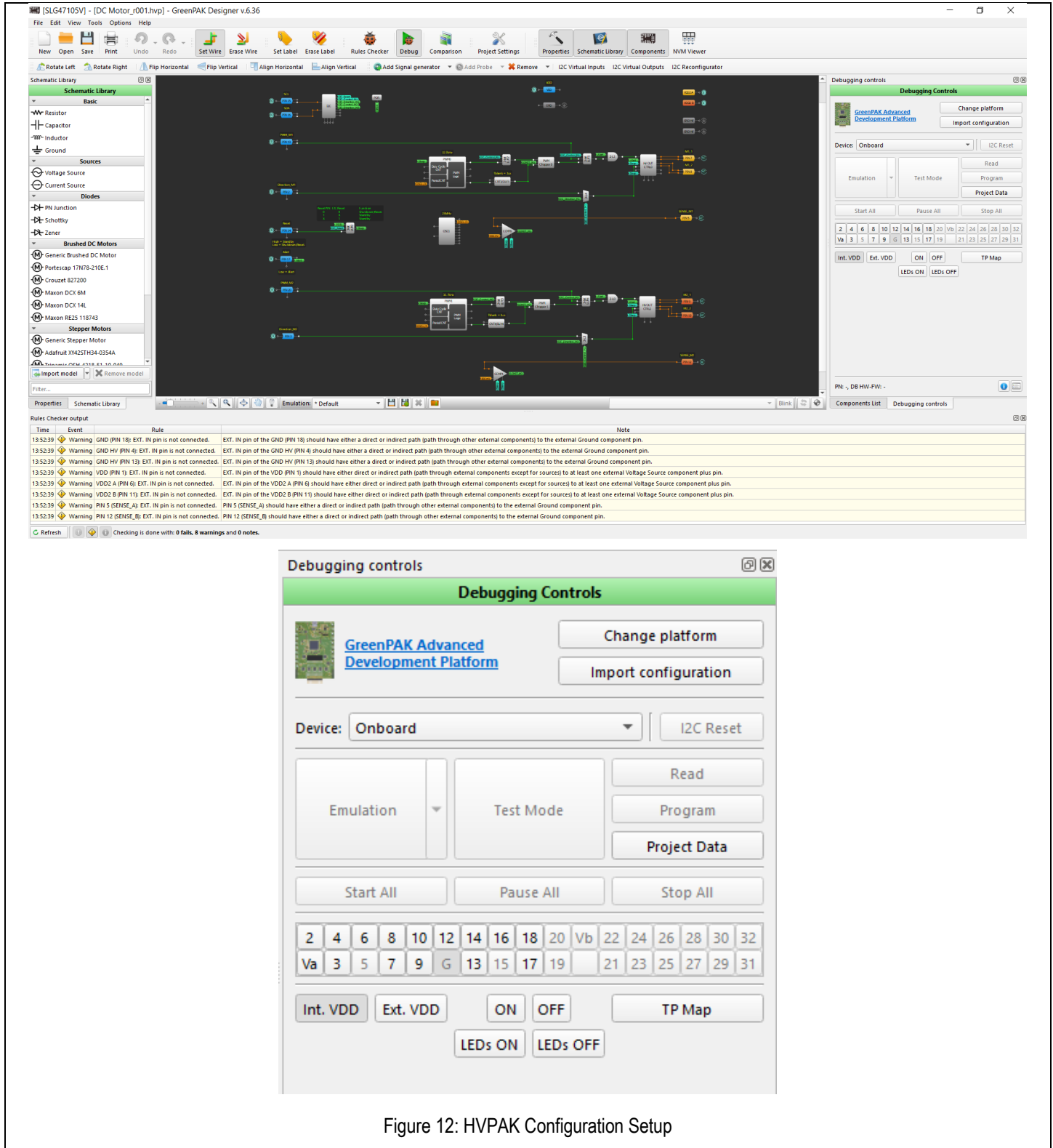


Figure 12: HVPAK Configuration Setup

Test Setup

Method 1: I2C Configuration (In this method the board is fully functional using software mode.)

Follow these procedures to set up the kit as shown in Figure 13

1. Connect AS025-HVPAK board with the RL78/F14 EVK board. The RL78/F14 and AS025-HVPAK board are communicated by I2C communication.
2. Connect 12V DC supply to jumper J4 of AS025-HVPAK board.
3. Connect the E1 emulator to build and debug the project.
4. Connect the USB to TTL converter to give the user commands. Connect RXD pin of TTL board to Pin 5: TXD pin and TXD pin to Pin 7: RXD pin of RL78/F14 board.
5. Open the Tera term software and give the commands for number of motors, Duty of motor, direction of motor and Motor enable and disable.
6. After the user specifies the commands, the motor runs with the specified commands given to it.
7. The serial commands are shown in the figure:13

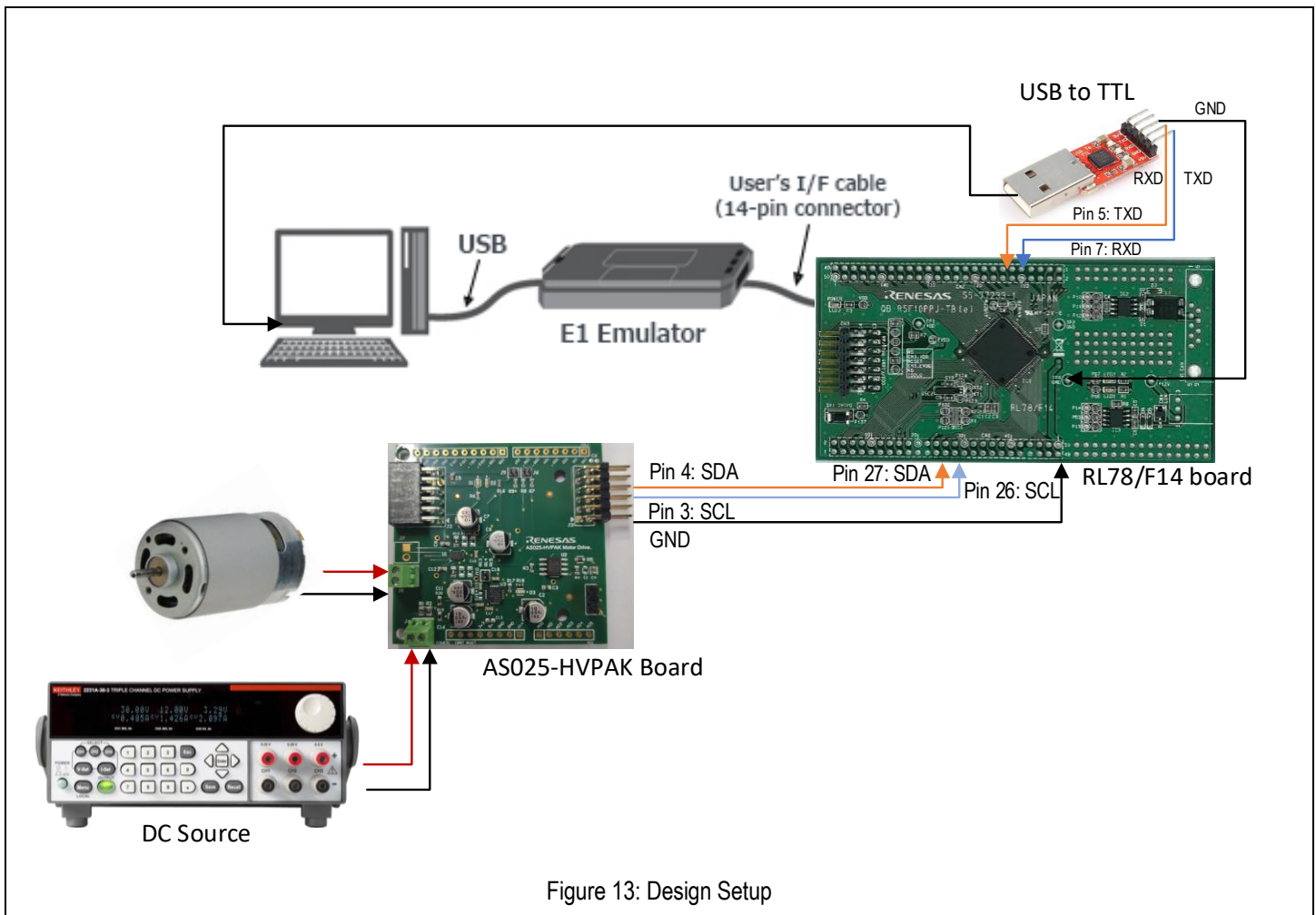


Figure 13: Design Setup


```

COM9 - Tera Term VT
File Edit Setup Control Window Help
/*---- Welcome to HUPAK Demo ----*/
/*---- 2 DC Motor Control -----*/
/*----- Motor 1 or 2 or Both(3)? -----*/
Selected Motor is : 1
- Enter Duty Cycle Motor_1<0 to 99> -
Duty Entered is : 50
- Enter Motor_1 Direction <1=CCW, 0=CCW> -
Selected Direction is : 1
----- Enable Motor? Y/N -----
Motor is ENABLED
-----Motor_1_IS_RUNNING!!!-----
/*---- Welcome to HUPAK Demo ----*/
/*---- 2 DC Motor Control -----*/
/*----- Motor 1 or 2 or Both(3)? -----*/
    
```

Figure 14: Motor 1 Serial Data

```

COM9 - Tera Term VT
File Edit Setup Control Window Help
/*---- Welcome to HUPAK Demo ----*/
/*---- 2 DC Motor Control -----*/
/*----- Motor 1 or 2 or Both(3)? -----*/
Selected Motor is : 2
- Enter Duty Cycle Motor_2<0 to 99> -
Duty Entered is : 40
- Enter Motor_2 Direction <1=CCW, 0=CCW> -
Selected Direction is : 1
----- Enable Motor? Y/N -----
Motor is ENABLED
-----Motor_2_IS_RUNNING!!!-----
/*---- Welcome to HUPAK Demo ----*/
/*---- 2 DC Motor Control -----*/
/*----- Motor 1 or 2 or Both(3)? -----*/
    
```

Figure 15: Motor 2 Serial Data

```

COM9 - Tera Term VT
File Edit Setup Control Window Help
/*---- Welcome to HUPAK Demo ----*/
/*---- 2 DC Motor Control ----*/
/*----- Motor 1 or 2 or Both(3)? -----*/
You have selected option 3: Both Motors

- Enter Duty Cycle Motor_1(0 to 99) -
Duty Entered is : 50
- Enter Duty Cycle Motor_2(0 to 99) -
Duty Entered is : 60
- Enter Motor_1 Direction (1=CW, 0=CCW) -
Selected Direction is : 1
- Enter Motor_2 Direction (1=CW, 0=CCW) -
Selected Direction is : 0
----- Enable Motor? Y/N -----
Motors are ENABLED
-----Motor_1_and_2_ARE_RUNNING!!!-----
/*---- Welcome to HUPAK Demo ----*/
/*---- 2 DC Motor Control ----*/
/*----- Motor 1 or 2 or Both(3)? -----*/

```

Figure 16: Motor 1 and 2 Serial Data

Method 2: Pin Configuration Method: (In this method the board is fully functional using external input without software. External Inputs: Function Generator and DC Source)

Follow these procedures to set up the kit as shown in Figure 17.

1. Connect 12V DC supply to jumper J4 of AS025-HVPAK board.
2. Connect motors to connectors J7 and J8.
3. Connect Waveform generator and provide the PWM signal to Pin 8 and 9 of Pmod connector, i.e., J3 connector. Pins 8 and 9 of Pmod Interface are used for PWM duty control of the motor.
4. Pin 7 and 10 of Pmod interface connector J3 are used for Direction control of motors.
5. For Motor 1 PWM control, provide PWM signal to Pin 9 and for direction control use Pin 7 of Pmod Interface connector J3.
6. For Motor 2 PWM control, provide PWM signal to Pin 8 and for direction control use Pin 10 of Pmod Interface connector J3.

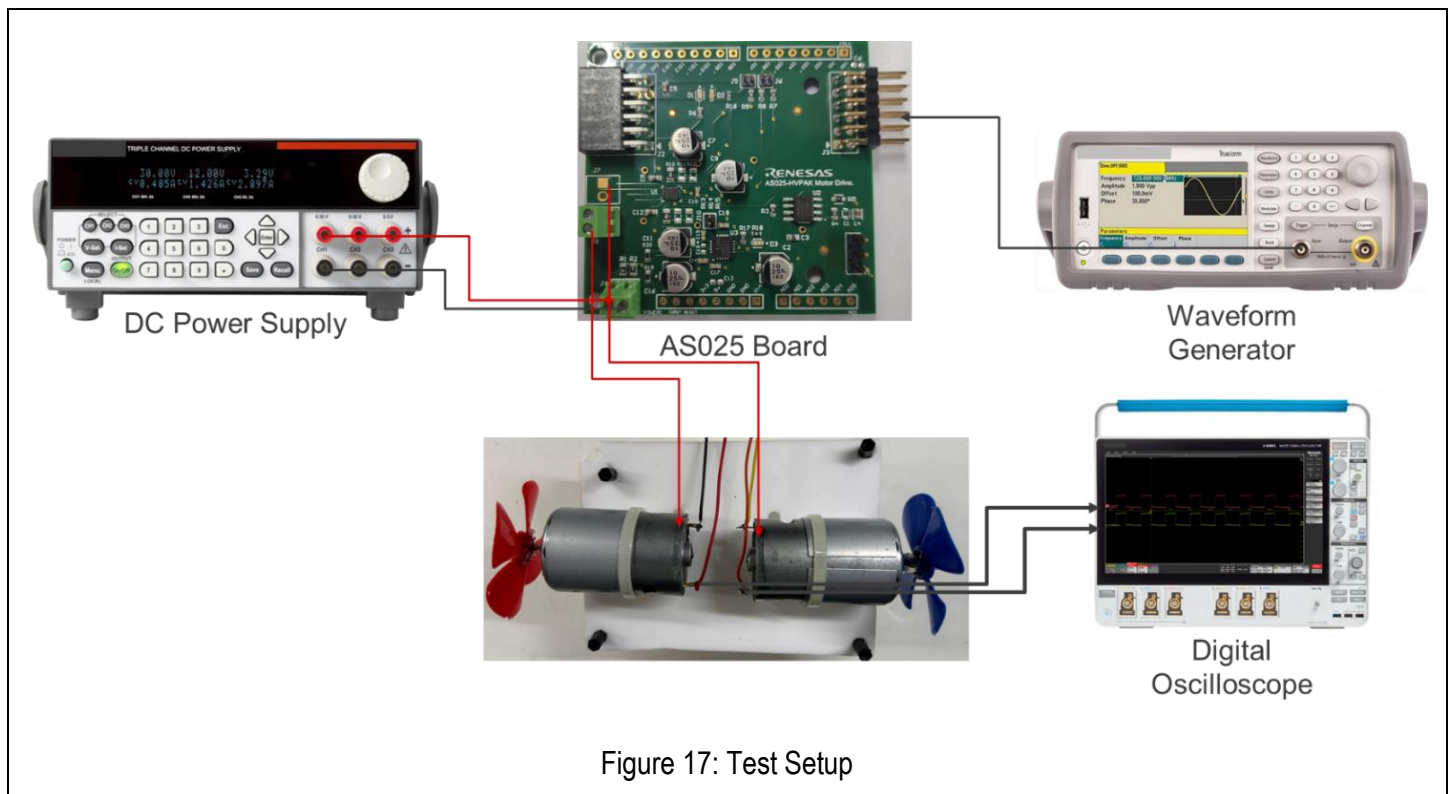


Figure 17: Test Setup

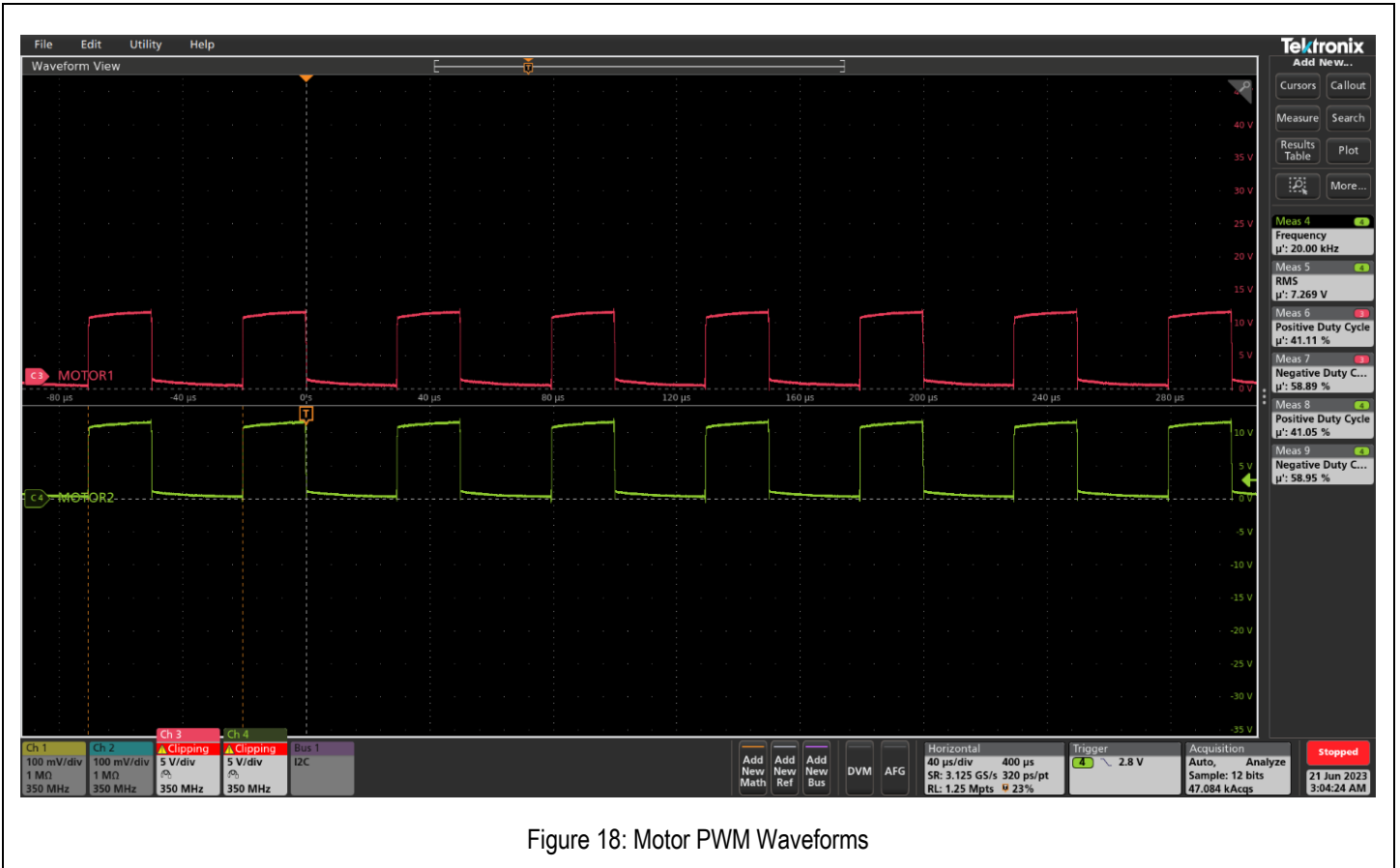


Figure 18: Motor PWM Waveforms

AS025-HVPAK Application Schematic

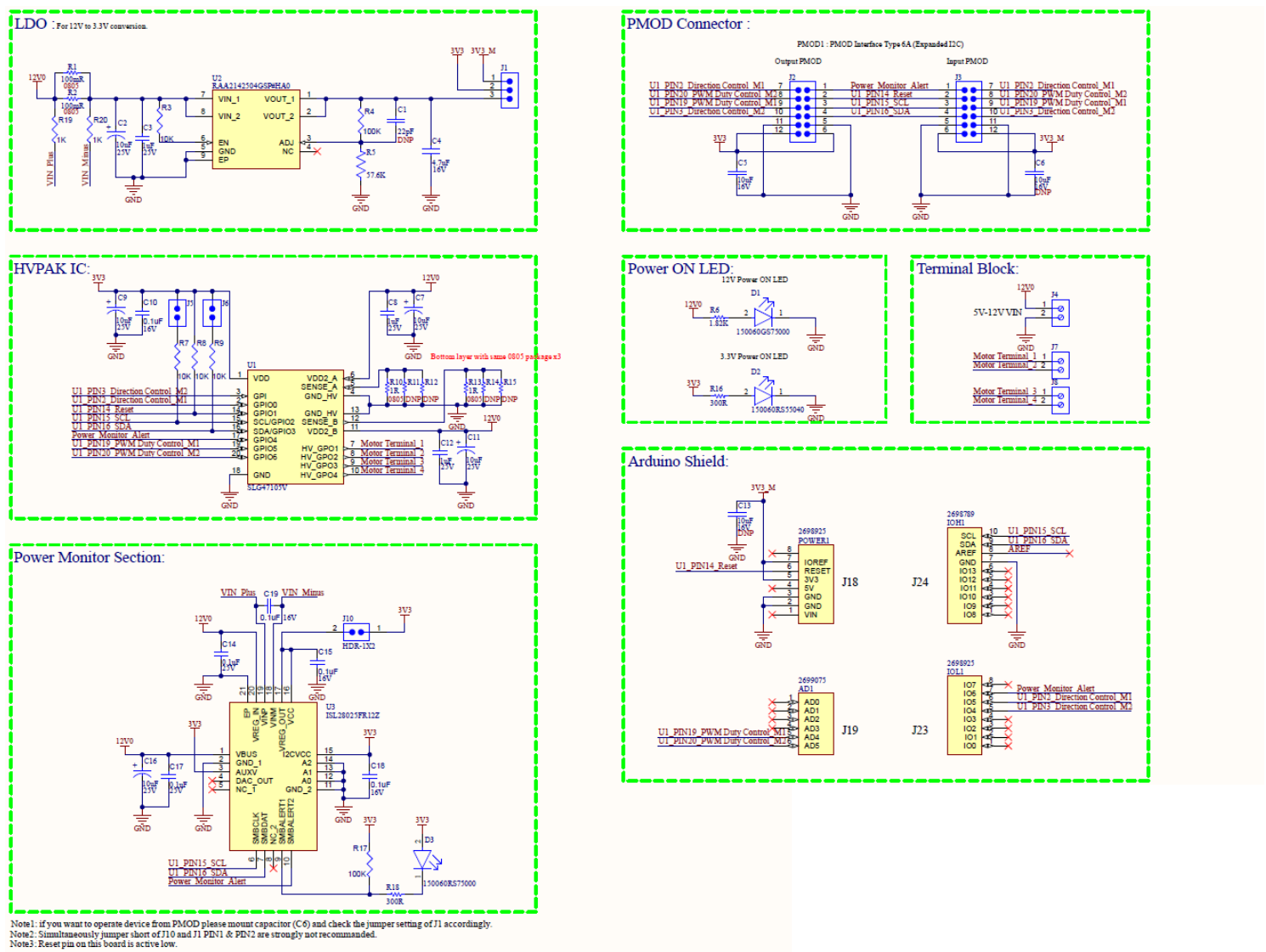


Figure 19: Schematic

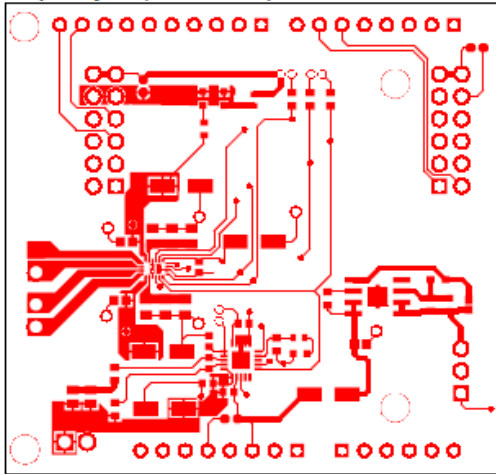
Bill of Materials (BOM)

Table 9. AS025-HVPAK BOM

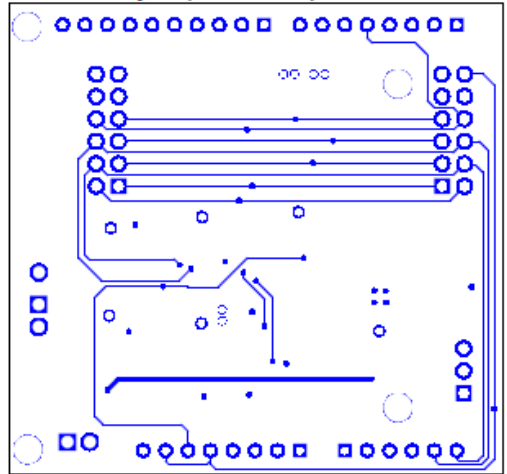
Quantity	Designator	Description	Manufacturer	Manufacturer Part #
1	AD1	6 Position Receptacle Connector 0.100" (2.54mm) Through Hole Gold	Samtec	SSQ-106-03-G-S
0	C1	Capacitor, 22pF, 25V, SM 0603	Kemet	C0603C220K3GACTU
5	C2, C7, C9, C11, C16	CAP ALUM 10UF 20% 25V SMD	Panasonic	EEE-1EA100SR
3	C3, C8, C12	1 $\mu\text{F} \pm 10\%$ 25V Ceramic Capacitor X7R 0603 (1608 Metric)	Yageo	CC0603KRX7R8BB105
1	C4	Multilayer Ceramic Capacitors 4.7 $\mu\text{F} \pm 10\%$ 16V X5R SMD 0603	TDK Corporation	C1608X5R1C475K080AC
1	C5	10 $\mu\text{F} \pm 10\%$ 16V Ceramic Capacitor X5R 0603 (1608 Metric)	Yageo	CC0603KRX5R7BB106
0	C6, C13	10 $\mu\text{F} \pm 10\%$ 16V Ceramic Capacitor X5R 0603 (1608 Metric)	Yageo	CC0603KRX5R7BB106
3	C10, C15, C18	0.1 $\mu\text{F} \pm 10\%$ 16V Ceramic Capacitor X7R 0603 (1608 Metric)	YAGEO	CC0603KPX7R7BB104
2	C14, C17	0.1 $\mu\text{F} \pm 10\%$ 25V Ceramic Capacitor X7R 0603 (1608 Metric)	YAGEO	CC0603KPX7R8BB104
1	D1	LED GREEN CLEAR 0603 SMD	Würth Electronics	150060GS75000
1	D2	LED RED DIFFUSED 0603 SMD	Würth Elektronik	150060YS55040
1	D3	LED RED CLEAR 0603 SMD	Würth Electronics	150060RS75000
1	IC1	Digital Power Monitors Precision Digital Power Monitor with Real Time Alerts	Renesas Electronics	ISL28025FR12Z
1	IOH1	10 Position Receptacle Connector 0.100" (2.54mm) Through Hole Gold	Samtec	SSQ-110-03-G-S
1	IOL1	8 Position Receptacle Connector 0.100" (2.54mm) Through Hole Gold	Samtec	SSQ-108-03-G-S
1	J1	Connector Header Through Hole 3 position 0.100" (2.54mm)	FCI	77311-818-03LF
1	J2	12 Position Receptacle Connector 0.100" (2.54mm) Through Hole, Right Angle Gold	Würth Elektronik	SSW-106-02-F-D-RA
1	J3	Connector Header Through Hole, Right Angle 12 position 0.100" (2.54mm)	Würth Elektronik	61301221021
3	J4, J7, J8	Series 101 - 5.00 mm Horizontal Entry Modular with Pressure Clamp WR-TBL, 2 pin	Würth Elektronik	691101710002
4	J5, J6, J9, J10	CONN HEADER VERT 2POS 1.27 MM	Samtec Inc.	FTS-102-01-L-S
1	POWER1	8 Position Receptacle Connector 0.100" (2.54mm) Through Hole Gold	Samtec	SSQ-108-03-G-S
2	R1, R2	220 mOhms $\pm 1\%$ 0.333W, 1/3W Chip Resistor 0805 (2012 Metric) Automotive AEC-Q200, Current Sense Thick Film	Panasonic	ERJ-6DSFR10V
4	R3, R7, R8, R9	Chip Resistor, 10 KOhm, +/- 1%, 01 W, -55 to 155 degC, 0603 (1608 Metric)	Yageo	RC0603FR-0710KL
2	R4, R17	Chip Resistor, 100 KOhm, +/- 1%, 0.1 W, -55 to 155 degC, 0603 (1608 Metric)	Yageo	RC0603FR-07100KL
1	R5	RES SMD 57.6K OHM 1% 1/10W 0603	Yageo	RT0603FRE0759KL
1	R6	1.82 kOhms $\pm 1\%$ 0.1W, 1/10W Chip Resistor 0603 (1608 Metric) Moisture Resistant Thick Film	YAGEO	RC0603FR-071K82L
2	R10, R13	Chip Resistor, 1 Ohm, +/- 1%, 125 mW, -55 to 155 degC, 0805 (2012 Metric), RoHS, Tape and Reel	Yageo	RC0805FR-071RL
0	R11, R12, R14, R15	Chip Resistor, 1 Ohm, +/- 1%, 125 mW, -55 to 155 degC, 0805 (2012 Metric), RoHS, Tape and Reel	Yageo	RC0805FR-071RL
2	R16, R18	300 Ohms $\pm 1\%$ 0.1W, 1/10W Chip Resistor 0603 (1608 Metric) Moisture Resistant Thick Film	Yageo	RC0603FR-07300RL
1	U1	GreenPAK Programmable Mixed-Signal Matrix	Renesas Electronics	SLG47105V
1	U2	500mA 20V Wide Input Voltage Range LDO Linear Regulator	Renesas Electronics	RAA2142504GSP#HA0

Board Layout

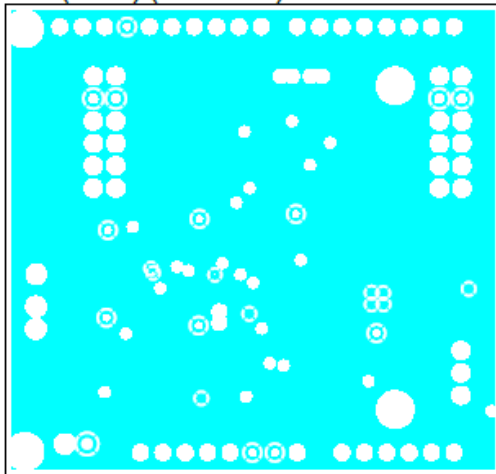
Top Layer (Scale 1:1)



Bottom Layer (Scale 1:1)



Int1 (GND) (Scale 1:1)



Int2 (PWR) (Scale 1:1)

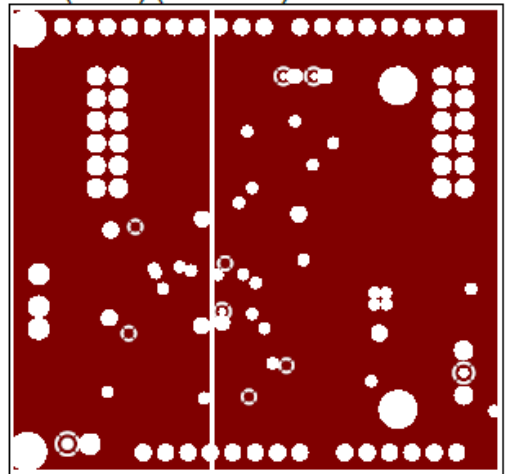


Figure 20: Board Layout- 2 Layer

Ordering Information

Orderable Part Number[a]	Description
AS025HVPAKDCM-POCZ	AS025-HVPAK: DC Motor Driver Pmod™

Revision History

Revision Date	Description of Change
June 31, 2023	Initial release.