Automotive Power and Motor Drive

Evaluation Kit for Automotive 2-Channel Half-Bridge Gate Driver IC

BD16951EFV-EVK-001

The ROHM BD16951EFV-M is an AEC-Q100 automotive qualified 2-channel Half-Bridge Gate Driver IC, suitable for DC motor drive in Automotive applications such as Power Window Lifter, Sunroof Module, Wiper, Seat belt tensioner, Seat positioning, 2H motors etc. This EVK enables the performance evaluation of this IC in research and development laboratories.

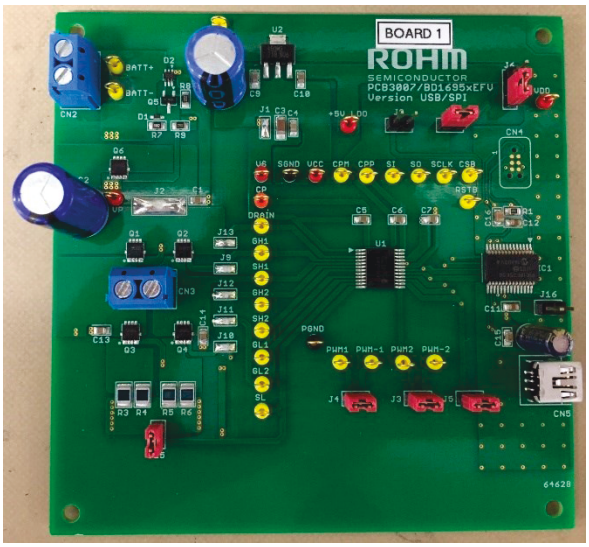
- Description

This EVK consists of an evaluation board for the Automotive 2-channel Half-Bridge Driver IC and USB cable. Also a GUI can be provided by ROHM for easy SPI register configuration.

The key component of the evaluation board is the ROHM BD16951EFV-M which is an AEC-Q100 automotive qualified 2-channel Half-Bridge Gate Driver, controlled by an external MCU through a 16-bit Serial Peripheral Interface (SPI). Independent control of low-side and high-side N-MOSFETS allows for several MCU controlled modes. A programmable drive current is available to adjust slew-rates, in order to meet EMI and power dissipation requirements. Diagnostics can be read and reset by an external MCU.

Besides this motor driver IC the evaluation board contains all external components necessary for operation including a full bridge created by discrete FETs, an LDO for logic supply, SPI interface and various test points for signal monitoring.

- BD16951EFV-M Key Specifications
  - Wide Input voltage range……...5.5 to 40V
  - Gate Drive Voltage (Half Bridge) …..……..……11V
  - VS quiescent supply current.....0 μA
  - VCC quiescent supply current ……..……..2 μA
  - Integrated Charge Pump Frequency ……..…500 kHz
  - Programmable Parameters…...…..…SPI (7 MHz max)



- EVK Features
  - Plug & Play DC Motor Evaluation Kit
  - No need for driver installation due to GUI design as Human Interface Device
  - Single Power Supply with Reverse Polarity Protection
  - On Board Logic Supply by LDO or USB
  - Discrete H-Bridge FETs with high current capability
  - Test pins for easy signal monitoring

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2023.11

Contents

1. Introduction

This evaluation kit (EVK) manual describes the usage of ROHM's BD16951EFV-EVK-001. The purpose of the EVK is to allow the test and evaluation of the motor driver IC BD16951EFV-M in professional research and development environments. This document provides guidelines to quickly setup the hardware and software for fast and easy motor driver IC performance evaluation.

- BD16951EFV-M evaluation board
- USB cable

For operation of the EVK the following additional items will be required:

- BD16951EFV-M GUI control software (MS Windows)
- PC with operating system Windows 7 or higher
- Laboratory DC power supply
- Load (e.g. Brush DC motor)
- Connecting cables

For receiving the BD16951EFV-M GUI control software please get in touch with your local ROHM sales office or use the general ROHM customer support system.

2. Safety Instructions

2.1 Warnings

- This evaluation kit must only be operated by trained professionals.
- This evaluation kit should be operated in a well ventilated environment and, if used inside a case, the case should not be covered.
- This evaluation kit should be placed on a stable, flat, non-conductive surface in use and should not be contacted by conductive items.
- All peripherals used with the evaluation kit should comply with relevant standards for the country of use and be marked accordingly to ensure that safety and performance requirements are met.
- Where peripherals are connected that do not include the cable or connector, the cable or connector used must offer adequate insulation and operation in order that the requirements of the relevant performance and safety are met.
- The connection of incompatible devices to the evaluation kit may affect compliance or result in damage to the unit and invalidate the warranty.

2.2 Instructions for Safe Use

- Do not expose the evaluation kit to water, moisture or place on a conductive surface whilst in operation.
- Take care whilst handling to avoid mechanical or electrical damage to the printed circuit board and components.
- Avoid handling the printed circuit board while it is powered. Only handle by the edges to minimize the risk of electrostatic discharge damage.
- Do not short any outputs to each other, to the supply or to GND.
- Do not operate the evaluation kit outside its specified ratings.
- Take care to monitor the PCB and IC temperatures in particular when operating with high power loads and do not exceed the absolute maximum ratings of all components.

3. Hardware Description

3.1 Schematic

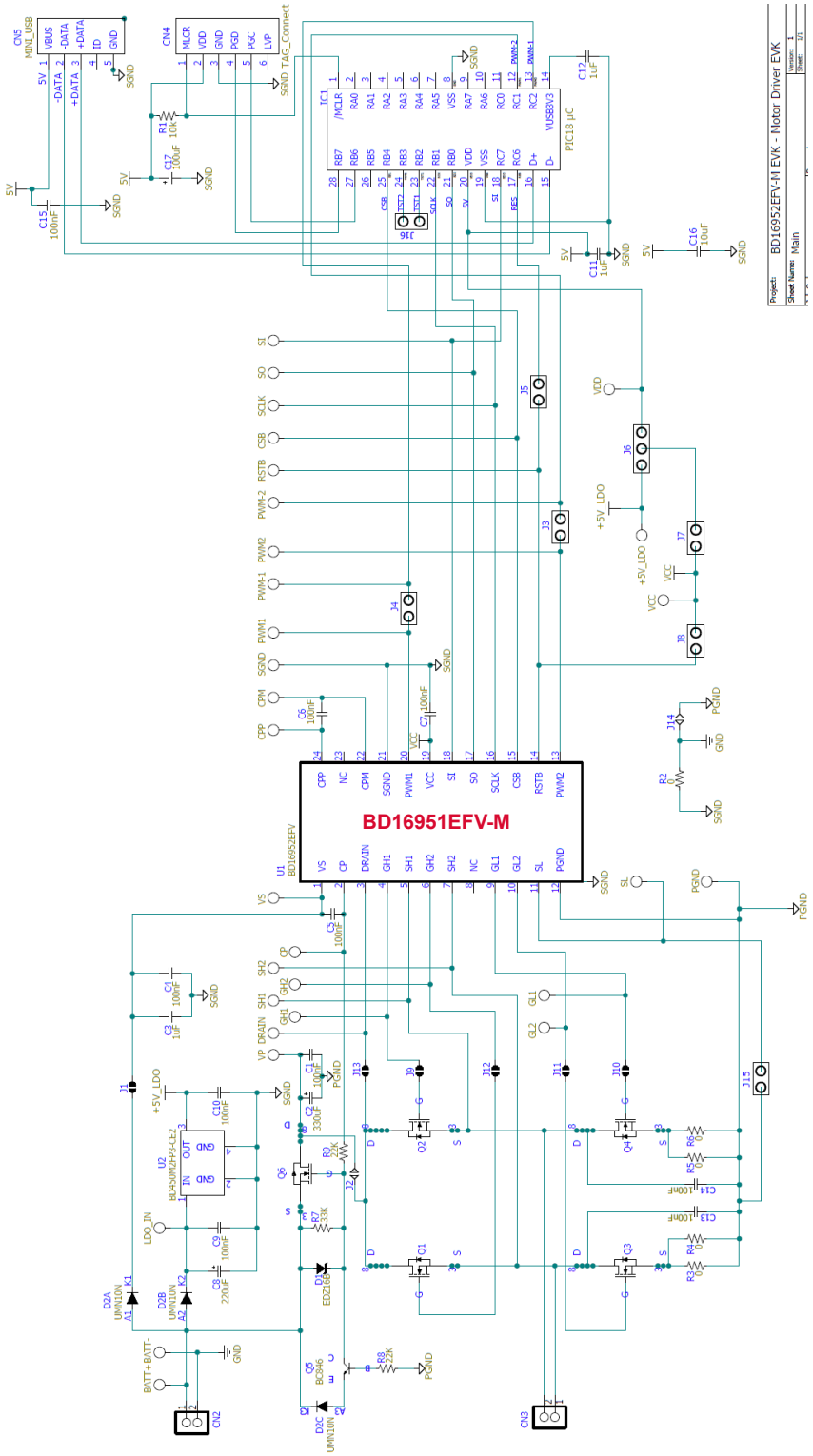

Figure 1: Evaluation Board Schematic

3.2 PCB Layout and Component Placement

Please note that the layout of this EVK is not optimized in terms of thermal performance or signal routing.

The focus is more on enabling easy test by adding test points to each signal.

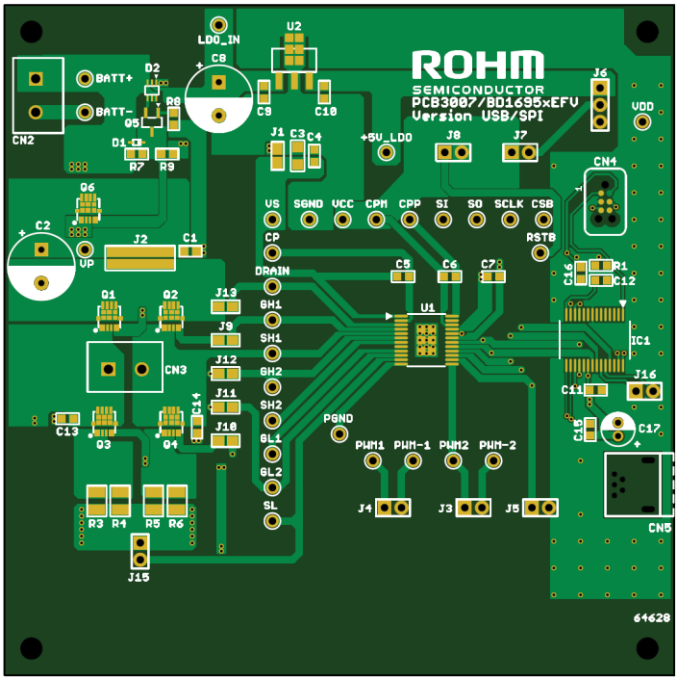

Figure 2: TOP side PCB layout pattern

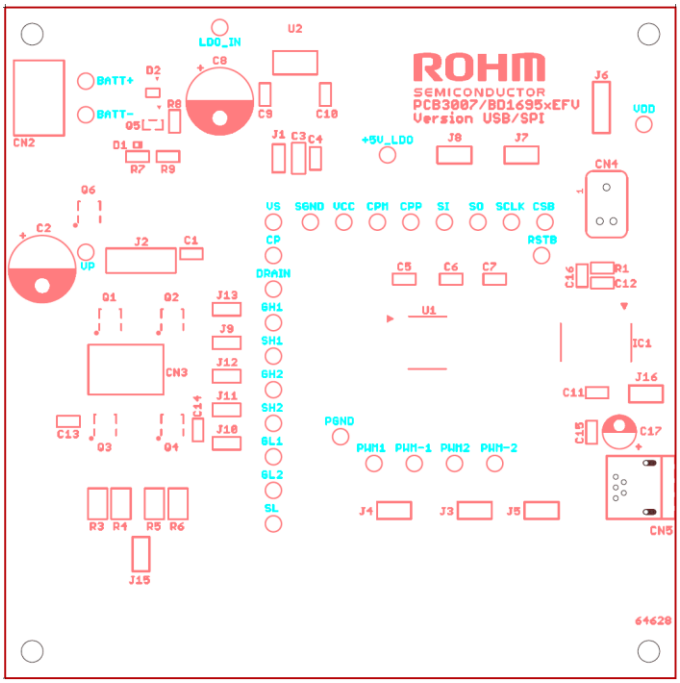

Figure 3: TOP side component placement

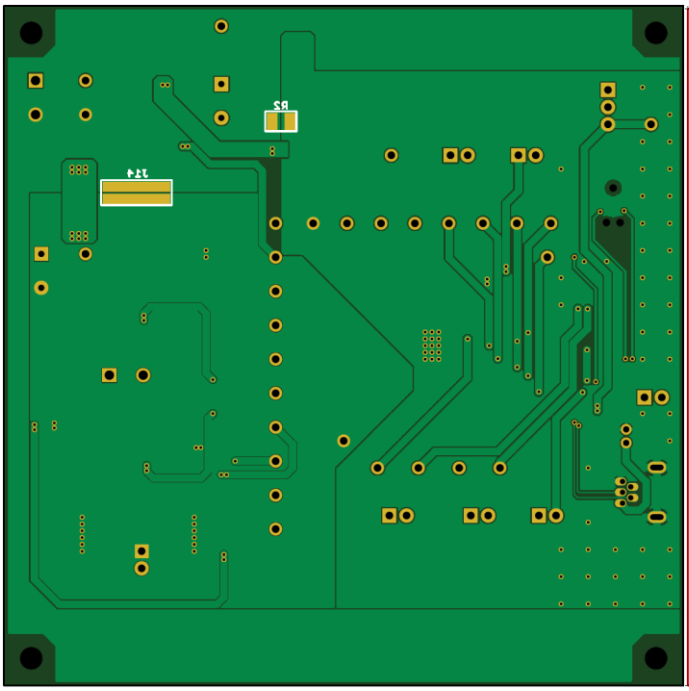

Figure 4: BOTTOM side PCB layout pattern
(as seen from TOP side)

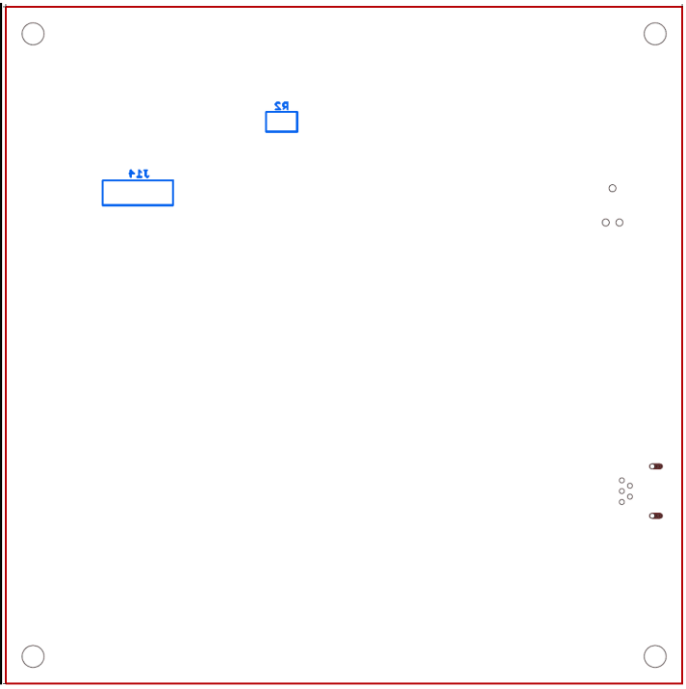

Figure 5: BOTTOM side component placement
(as seen from TOP side)

3.3 Bill of Materials

Comp. Name	Description	Type	Quantity
C1, C4, C5, C6, C7, C9, C10, C13, C14, C15	100 nF, 50 V 0805 X7R	Capacitor, Surface Mount	10
C2	330 µF, 50 V 5x10	Aluminum Electrolytic Capacitor	1
C3	1 µF, 50V 1206 X7R	Capacitor, Surface Mount	1
C8	220 µF, 50 V 10x16	Aluminum Electrolytic Capacitor	1
C11, C12	1 µF	Capacitor, Surface Mount	2
C16	10 µF	Capacitor, Surface Mount	1
C17	100 µF	Capacitor, Surface Mount	1
CN2, CN3	Blue Connector	Connector	2
CN4	TAG_Connect	Connector	1
CN5	MINI_USB	Connector	1
D1	EDZ16B/ROHM, SOD-523 16V,150 mW	Diode, Surface Mount	1
D2	BAS16VV/NXP, SOT-666 100 V, 200 mA	Diode, Surface Mount	1
J1, J9, J10, J11, J12, J13	Solder Connection, closed	Jumper, Surface Mount	6
J2, J14	Solder Connection, closed	Jumper, Surface Mount	2
J3, J4, J5, J7, J8, J15, J16	1x2 Pin Header, Through Hole	1x2 Pin Header, Through Hole	7
J6	1x3 Pin Header, Through Hole	1x3 Pin Header, Through Hole	1
Q1, Q2, Q3, Q4, Q6	RQ3G270BL	Nch MOSFET	5
Q5	BC846 NXP, SOT23	Transistor, Surface Mount	1
R1	10 kΩ, 0805	Chip Resistor, Surface Mount	1
R2, R3, R4, R5, R6	0 Ω, 1210	Chip Resistor, Surface Mount	5
R7	33 kΩ, 0805	Chip Resistor, Surface Mount	1
R8, R9	22 kΩ, 0805	Chip Resistor, Surface Mount	2
All Testpins	Probe Ring	Test Pin, Through Hole	30
U1	BD16951EFV-M	ROHM Motor Driver	1
U2	BD450M2FP3-C	ROHM LDO Regulator IC	1

Table 1: Evaluation Board Bill of Materials

4. Operating Instructions

4.1 Hardware

Please connect a DC laboratory source to the connector CN2 of the evaluation board. The pins are labelled with "BATT+" and "BATT-". Although reverse battery protection is included on the evaluation board please take care about the proper polarity in order not to stress the components. Since in final application the IC is operated by a car battery the typical supply voltage of this EVK is 13.5V.
Although the maximum operating supply voltage of the motor driver IC BD16951EFV-M is 40V it is also the absolute maximum value of the IC and external MOSFETs. So if you use higher supply voltage than typical please make sure to include enough margin for fluctuation or voltage spikes to never exceed the absolute maximum ratings.
Please operate the EVK at room temperature only.
The maximum load current is limited by thermal performance of the components. For example with the typical SPI register settings (see chapter 4.2, Table 3) and a load current of 4.5A the transistor Q4 surface temperature was 50°C.
Please take care to measure the temperature of the EV board components when applying your desired settings and load.

The EVK has some Jumpers for signal configuration. By default the Jumpers should be in the position as described below and typically do not need to be changed.

Name	Typical Position	Description
J1, J2, J9-14	closed (hard wired)	These power and signal lines are hard connected by solder and should only be opened for test purposes.
J3, J4, J5	closed	Must be closed to connect PWM1, PWM2 and RSTB to the SPI controller
J6	closed middle pin to bottom pin	Selects USB 5V instead of LDO 5V supply as logic supply
J7	closed	Connects logic supply to BD16951EFV-M
J8	open	Can hardwire the RSTB pin to VCC. Typically not required
J15	closed	Feedback of low side transistors source to BD16951EFV-M
J16	closed	Don't care. Different GND signals are hard-connected anyway.

Table 2: Typical Jumper configuration

4.2 Software

The BD16951EFV-M software user interface consists of an .exe and .dll file, which have to be copied in one folder of your Windows PC. Please check with your local ROHM sales office or ROHM customer support system to have the latest software version.
Since the GUI is designed as Human Interface Device (HID), no driver installation will be required.
After plugging in the evaluation board with the USB cable to the PC it will automatically be recognized by Windows and show as "GHOST USB Interface" in "Devices and Printers".

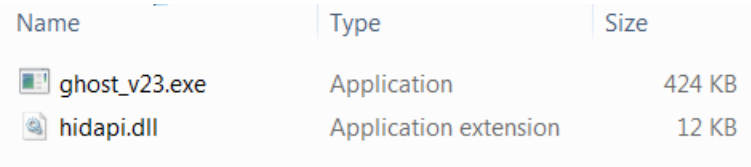

Figure 6: User Interface Software Files

NOTE: The evaluation board should be connected by USB cable to the PC before starting the software.

Then the software can be started by double clicking the ".exe" file.
In case the USB Cable is not connected or recognized by Windows, the GUI will report so (Figure 8).
In case the USB Cable is connected but not recognized, disconnect the USB cable and reconnect after 5-6 seconds.

GUI Description:

- **PWM sliders:** Set the duty cycle of the two PWM input signals which connect to BD16951EFV-M.
- **RESET button:** RES(H): High pin level, RES(L): Low pin level. Typically not required to change.
- **SEL button:** SEL(H): High pin level. Will only switch to low when SPI Read / Write. SEL(L): Constantly low.
- **SET pull-down menu:** Can select some pre-defined register settings. (Table 4, Table 5)
  When the menu is selected, reset chip and set registers on table 4. Then enable "Enable Register" to drive motor.
- **CMD pull-**down menu: Select the register by address and name to apply your desired settings. Only BD16951EFV-M specific commands can be sent. OR use "raw" mode to send/receive general commands to the SPI interface.
- **WR button:** Write the configured Bits to the selected register.
- **RD button:** Read the selected register.

Use the buttons to the left of the "WR" button to set the individual Bits of the selected register. The resulting binary word is shown as HEX value.

The following procedure is recommended in particular when operating the first time in a new application:

1. Set PWM1 slider to 100 and PWM2 slider to 0
   (PWM1:"100" is PWM duty 0 %, PWM2:"0" is PWM duty 0 %)
2. Configure registers 02h-08h according to your application.
3. Enable the IC, charge pump and output drivers in register 01h
4. Increase PWM duty cycle (only applicable if your configured mode of operation uses PWM) and monitor load current and EVK temperature.

Typical register settings which are suitable for operating this EVK are summarized in Table 3.

Address	Value	Description
04h	0Ah	Source current = 10 mA
05h	1Eh	Sink current = 30 mA
06h	10h	CCPT = 5 µs
07h	02h	OCP = 400 mV
08h	09h	OCP Filter = 10 µs
02h	18h	Ch1 = Mode 9, CH2 = Mode 3
01h	04h	EN = High (note 1)
01h	06h	EN + CP = High (note 2)
01h	07h	EN + CP + DRVEN = High (note 3)

Table 3: Typical register settings

(note 1)MCU sends the EN='1' command. State is changed to Normal state.

(note 2)MCU sends the CPEN='1' command. Charge pump circuit is activated. Charge time is 0.2ms(Max).

(note 3)MCU sends the DRVEN='1' command. GH1, GL1, GH2 and GL2 outputs are active(Constant current driving).

Each register setting is set before DRVEN='1'.

Resister (Addr.: Description)	SET (Mode Setting)				
	v1 OFF	v1 Basic CW	v1 Basic CCW	v1 PWM1 CW	v1 PWM2 CCW
0x02: Mode Setting Ch2, Ch1	00	18	81	18	81
0x03: Protection Mode Setting	FC	FC	FC	FC	FC
0x04: Half-br Motor Op. set 1 Curr_Src[ ]	1F	1F	1F	1F	1F
0x05: Half-br Motor Op. set 2 Curr_SINK[ ]	1F	1F	1F	1F	1F
0x06: Half-br Motor Op. set 1 CCPT[ ]	07	07	07	07	07
0x07: OCP setting OCPHD[ ], OCPLD[ ]	0B	0B	0A	0B	0B
0x08: OCP Filter time setting OCP-FILT[]	09	09	09	09	09

Table 4: (**SET pull-down menu)** Pre-defined register setting value v1 [hex]

Resister (Addr.: Description)	SET (Mode Setting)				
	v2 OFF	v2 Basic CW	v2 Basic CCW	v2 PWM1 CW	v2 PWM2 CCW
0x02: Mode Setting Ch2, Ch1	00	18	81	18	81
0x03: Protection Mode Setting	FC	FC	FC	FC	FC
0x04: Half-br Motor Op. set 1 Curr_Src[ ]	10	10	10	10	10
0x05: Half-br Motor Op. set 2 Curr_SINK[ ]	1E	1E	1E	1E	1E
0x06: Half-br Motor Op. set 1 CCPT[ ]	07	07	07	07	07
0x07: OCP setting OCPHD[ ], OCPLD[ ]	0B	0B	0B	0A	0B
0x08: OCP Filter time setting OCP-FILT[]	09	09	09	09	09

Table 5: (**SET pull-down menu)** Pre-defined register setting value v2 [hex]

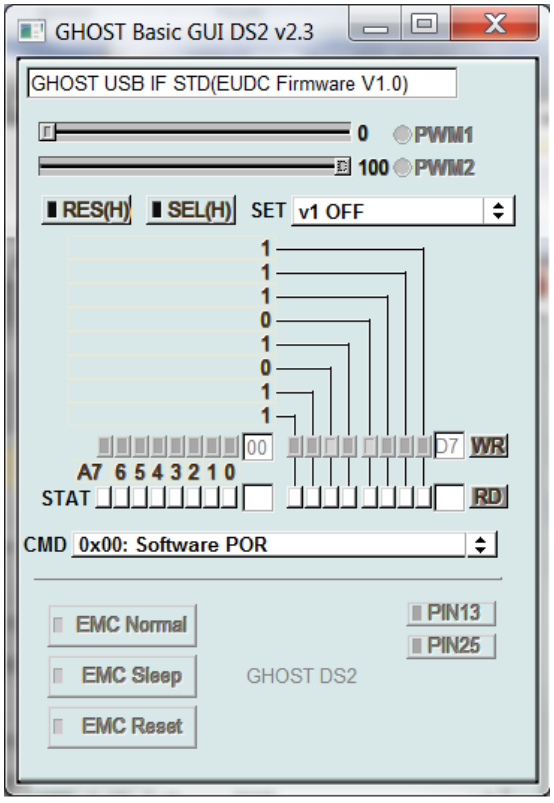

Figure 7: GUI after successful start-up

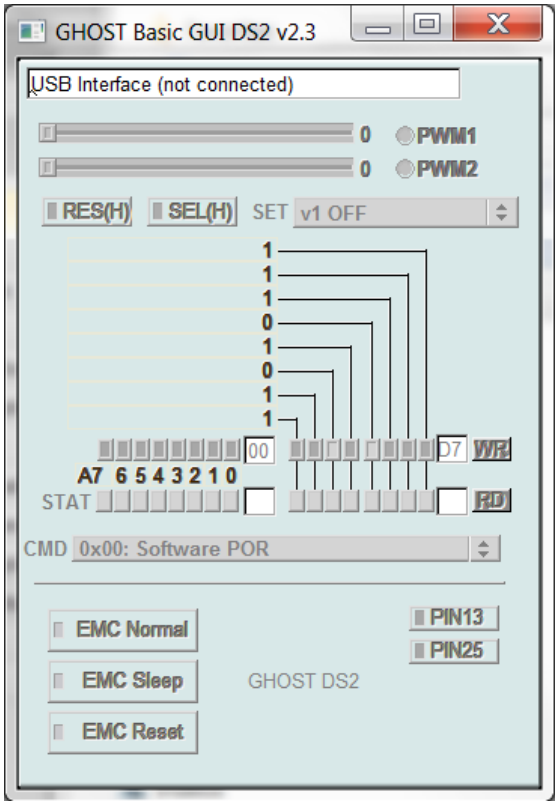

Figure 8: USB Cable not detected

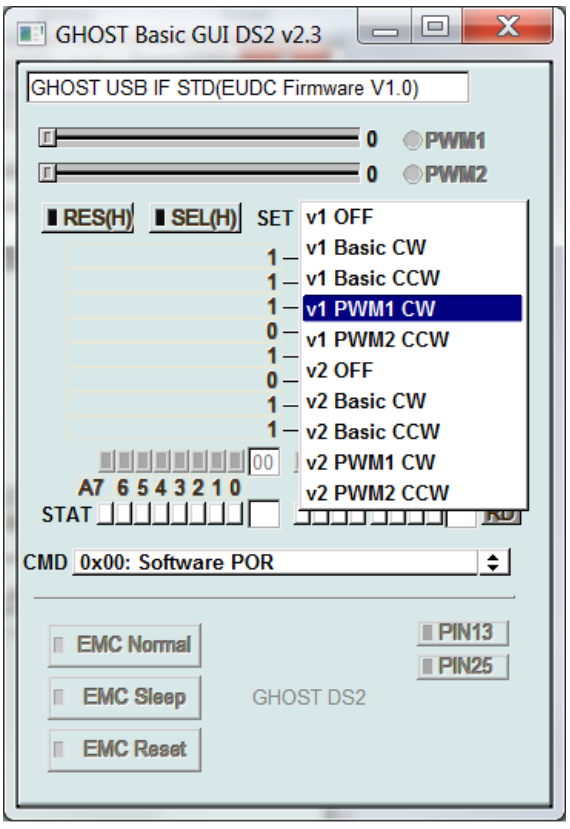

Figure 9: Recall pre-defined register settings

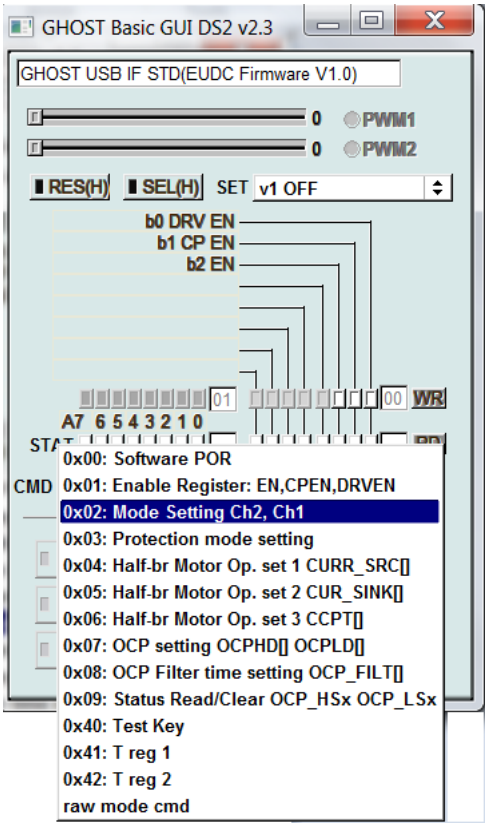

Figure 10: Selecting SPI register to read or write

Revision History

Date	Revision Number	Description
2023.11	001	New Release

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