UM0839
User manual

ST L9942 evaluation board

1 Introduction

The L9942 demonstration board is a board designed to provide the user with a platform for the evaluation of the L9942. The board provides all the main input/output capabilities necessary to correctly drive a bipolar stepper motor and supply also diagnostic functionalities.

The L9942 evaluation board is a standalone evaluation board for the L9942 devices.

The L9942 is a stepper motor driver for bipolar stepper motors in automotive applications like Throttle control, light levelling and bending light.

Contents

List of tables

List of figures

2 System description

Figure 1. System connection

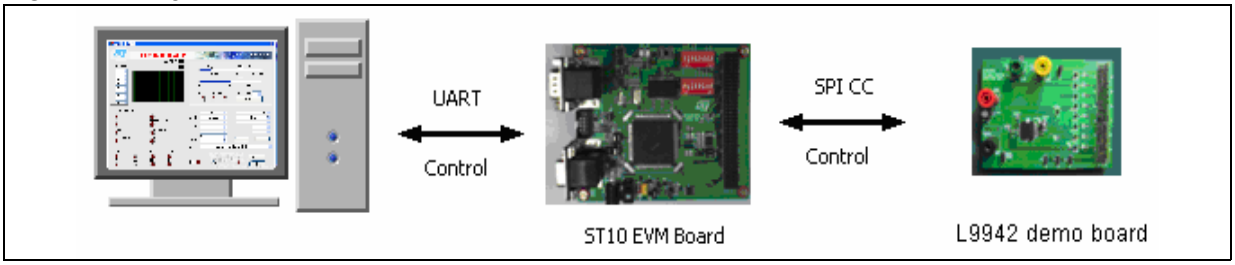
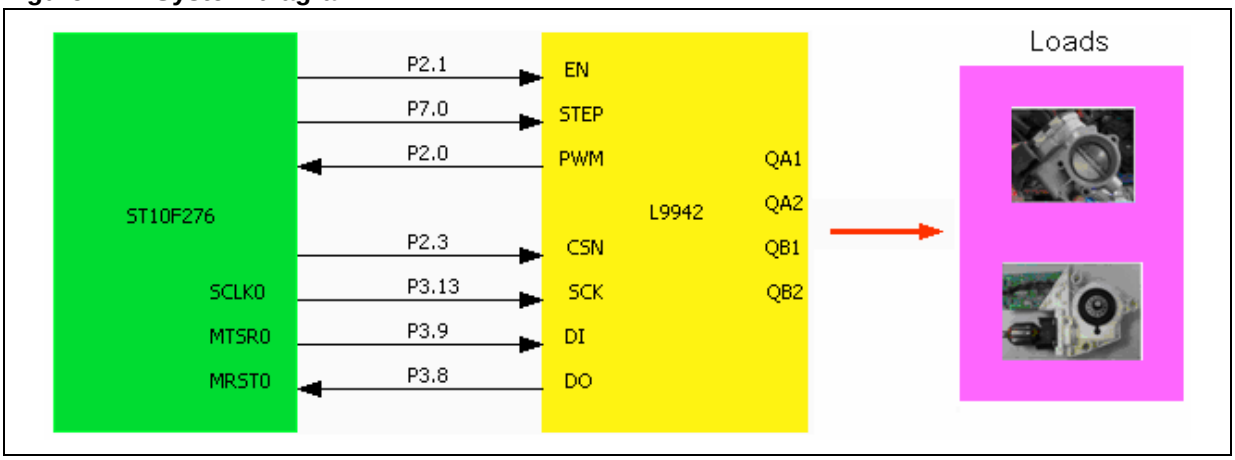


Figure 2. System diagram



The ST10F276 is configured as 64M Hz CPU clock as indicated in *Table 1.* and *Table 2.*

Table 1. ST10F276 S3 configuration

S3 configuration							
B1	B2	B3	B4	B5	B6	B7	B8
off	off	off	off	off	off	on	off

Table 2. ST10F276 S4 configuration

S4 configuration							
B1	B2	B3	B4	B5	B6	B7	B8
on	off	off	on	on	off	on	off

Connect PC COM port to ST10 UART0 as it can be configured by graphic user interface.

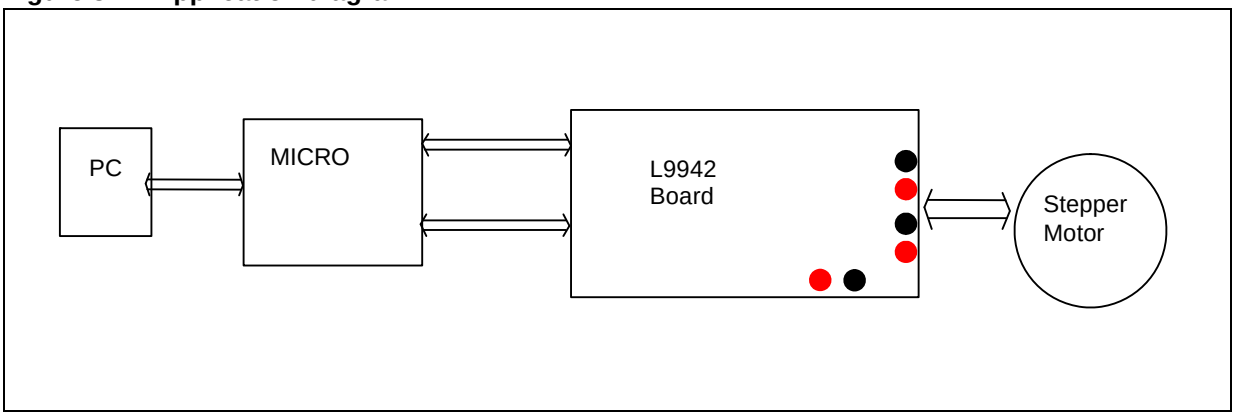
3 Hardware description

The L9942 demonstration board provides all the main input/output capabilities necessary to correctly drive a DC motor and supply also diagnostic functionalities.

- DI, CS, SCK, SO, SI, EN, PWM accessibility by test point.
- EN and VS LED indicator.

3.1 Block diagram

Figure 3. Application diagram

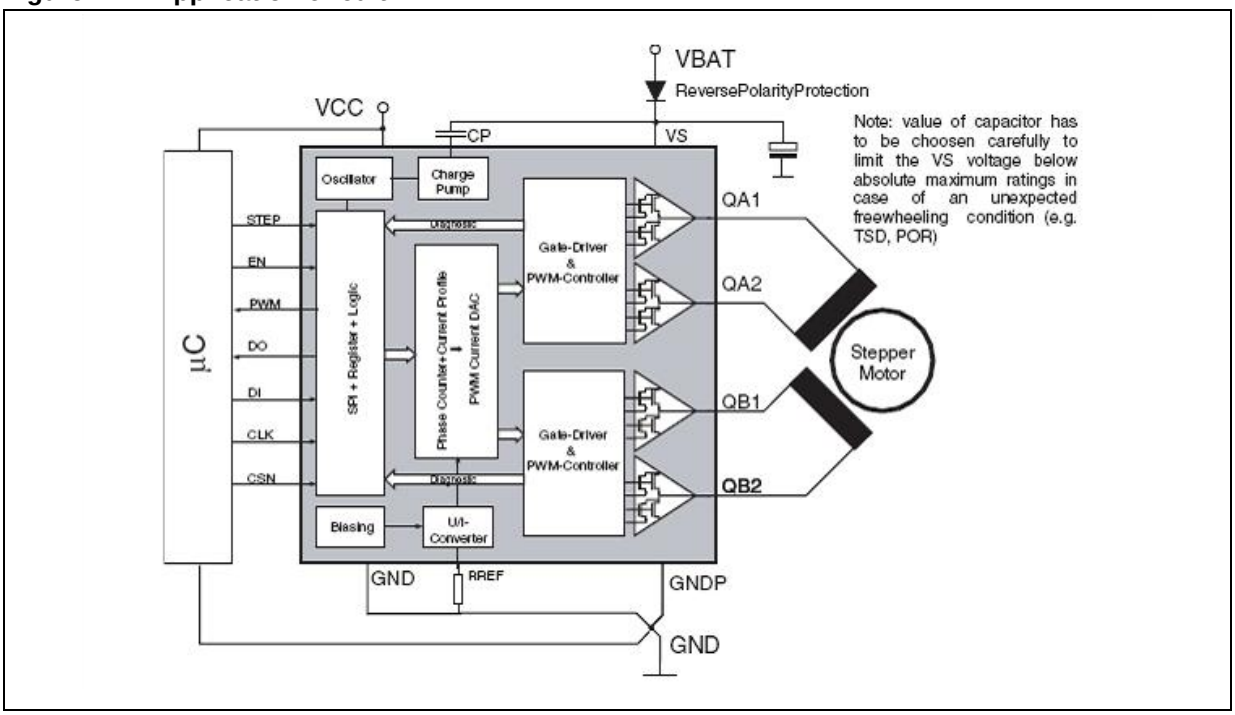


3.1.1 Microcontroller

- Standard connector for ST10xx family.
- PWM input
- Configuration and Diagnostic of L9942 via SPI
- Possibility to connect to others micros by wire adaptor

4 L9942 application circuit

Figure 4. Application circuit



5 L9942 pin description

Figure 5. L9942 pinout

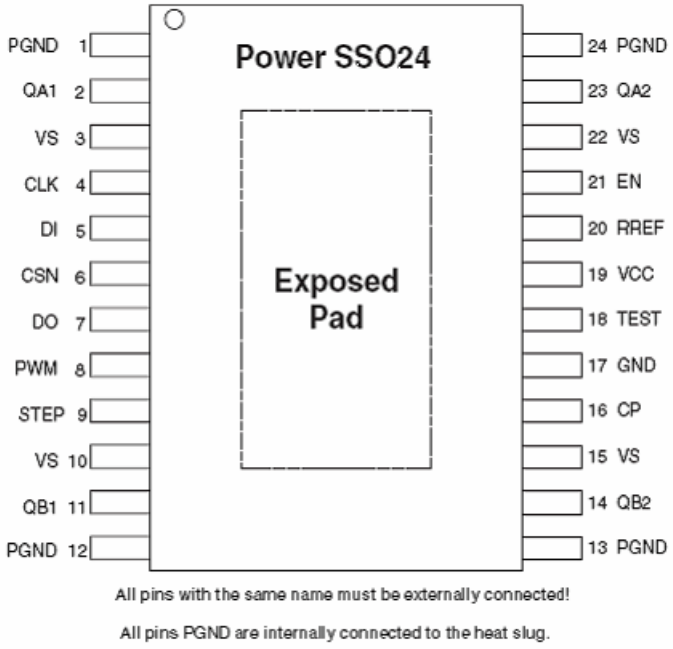


Table 3. L9942 pin descriptions

Pin	Symbol	Function
1, 12, 13, 24	PGND	Power ground.
3, 10,15 ,22	VS	Power supply voltage.
2, 23	QA1,QA2	Fullbridge outputs An.
11, 14	QB1, QB2	Fullbridge outputs Bn.
4	CLK	SPI clock input.
5	DI	Serial data input.
6	CSN	Chip select not input.
7	DO	SPI data output.
8	PWM	PMW output.
9	STEP	Step clock input.
16	CP	Charge pump output.
17	GND	Ground.
18	TEST	Test input.
19	VCC	Logic supply voltage.

Table 3. L9942 pin descriptions (continued)

Pin	Symbol	Function
20	RREF	Reference resistor.
21 EN	EN	Enable input.

6 Board layout, views and images

Figure 6. Board front layout

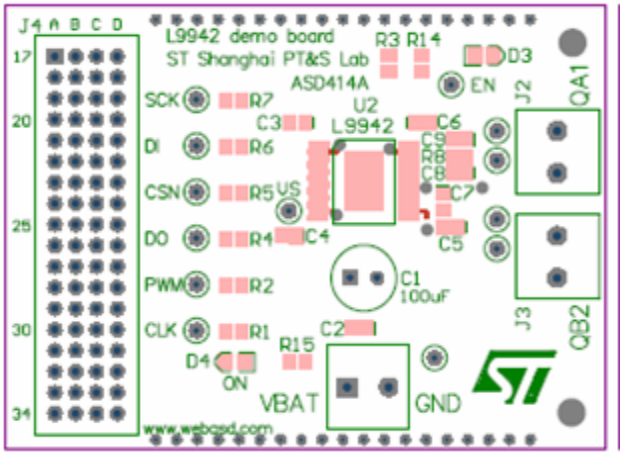


Figure 7. Board back layout

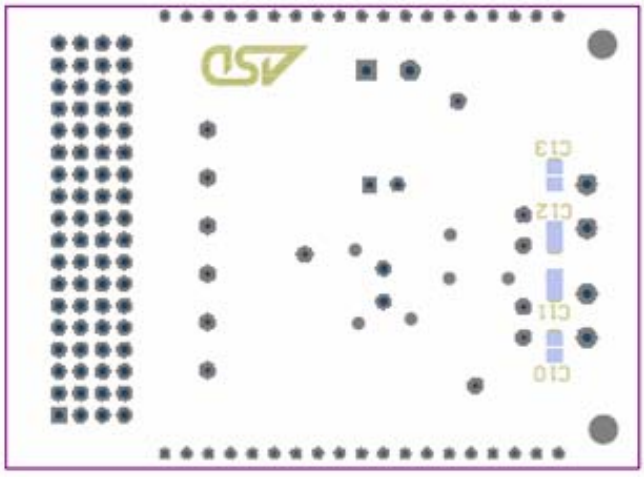


Figure 8. Board front view

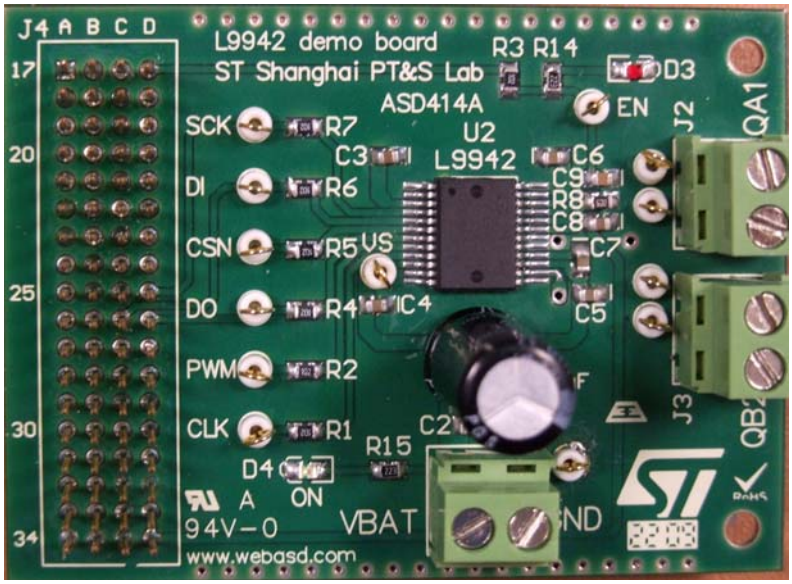
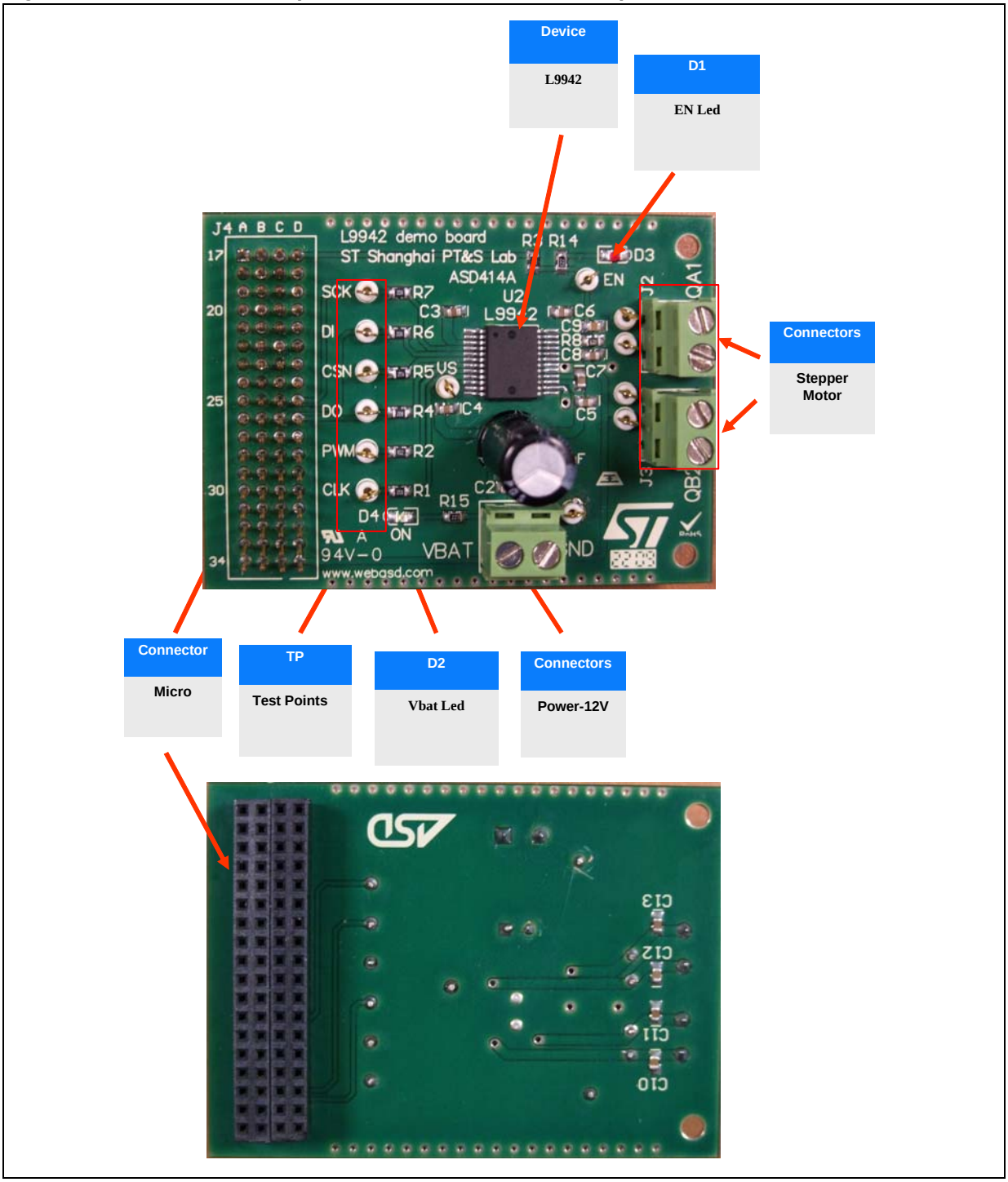


Figure 9. Board back view

7 Board main components and connectors description

Figure 10. Board main components and connectors description



8 Connectors descriptions

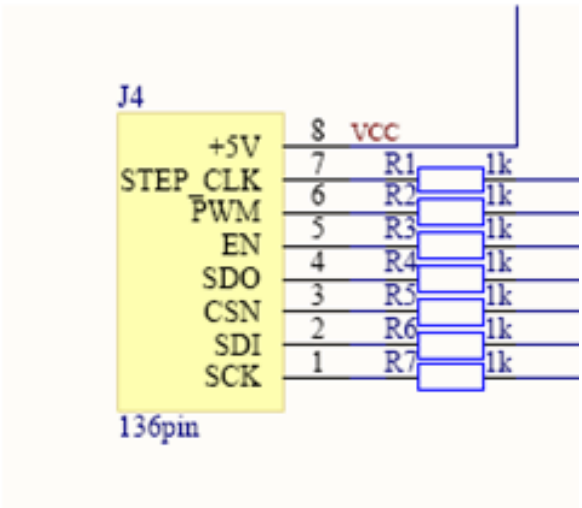
Table 4. Connectors description

Name	Description	Type
J2	Stepper Motor connector	Screw
J3	Stepper Motor connector	Screw
GND	Supply voltage GND connector	Screw
VBAT	+12V Supply voltage connector (VS)	Screw
J4	Microcontroller connector	Multipin

Table 5. Microcontroller connectors

Name	Description	Type
D34	Vcc	Pin
A,C,C34	GND	Pin
D17	EN	Pin
A22	PWM	Pin
D18	CSN	Pin
D25	SCK	Pin
C26	SDI	Pin
D26	SDO	Pin

Figure 11. Microcontroller connectors



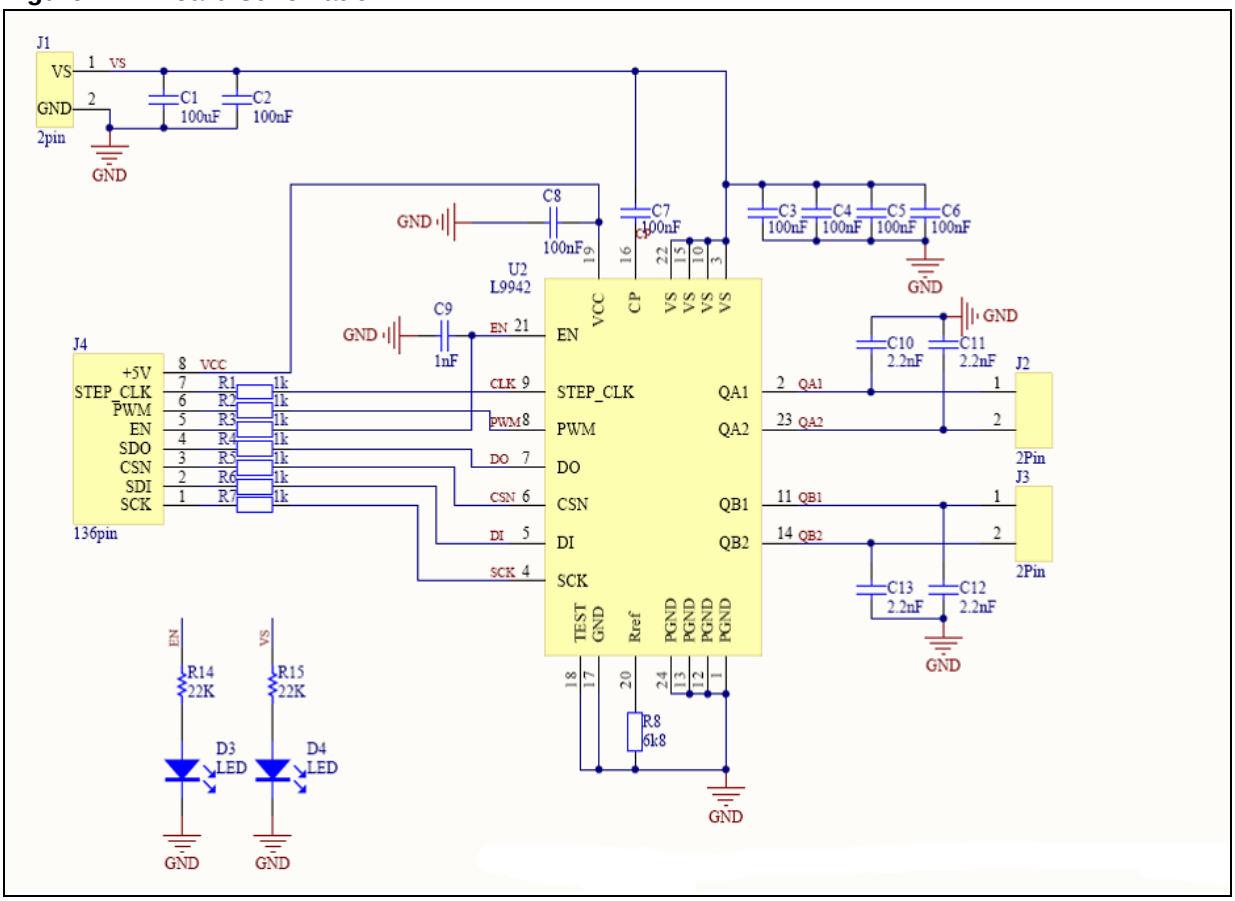
8.1 Test points description

Table 6. Test points description

TP Name	Pin Name	Description	I/O Type
T1	SCK	SPI clock test point	I
T2	DI	Serial in test point	I
T3	CSN	Chip select test point	I
T4	DO	Serial out test point	O
T5	PWM	PWM input test point	I
T6	CLK	Step clock input	I
T7	EN	Enable test point	I
T8	QA1	Fullbridge output A1	O
T9	QA2	Fullbridge output A2	O
T10	QB1	Fullbridge output B1	O
T11	QB2	Fullbridge output B2	O

8.2 Board schematiic

Figure 12. Board schematic

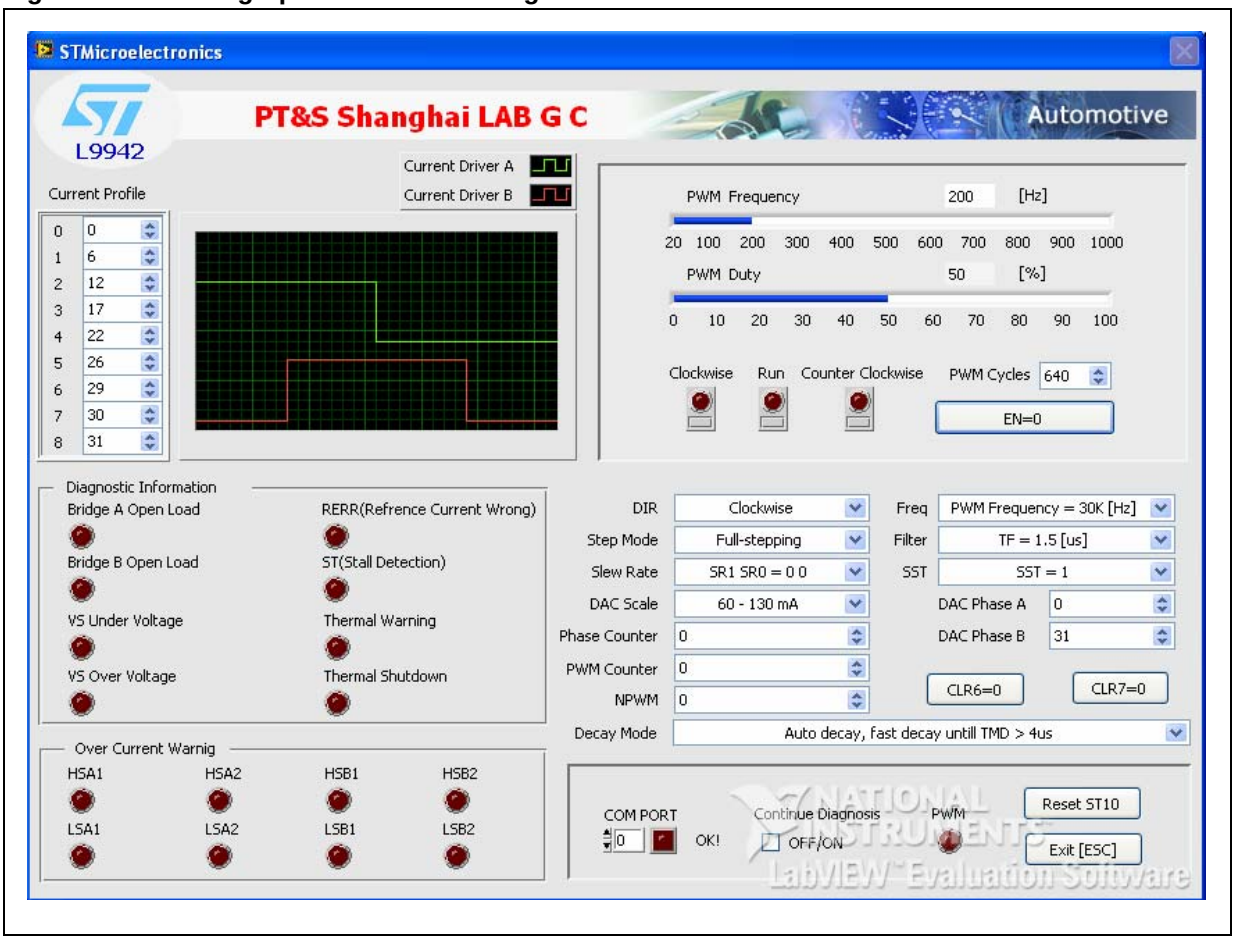


9 Grafic user interface general description

The L9942 graphic user interface consists of five fields:

1. motor control command field
2. SPI menu select field
3. current profile set
4. diagnostic status display
5. port configuration field

Figure 13. L9942 graphic user interface general view and default value



10 Run and stop L9942 graphic user interface

The L9942 graphic user interface is automatically running when it is opened.[a]

User can stop and exit the graphic user interface via click “exit” key or press “ESC” key on keypad.

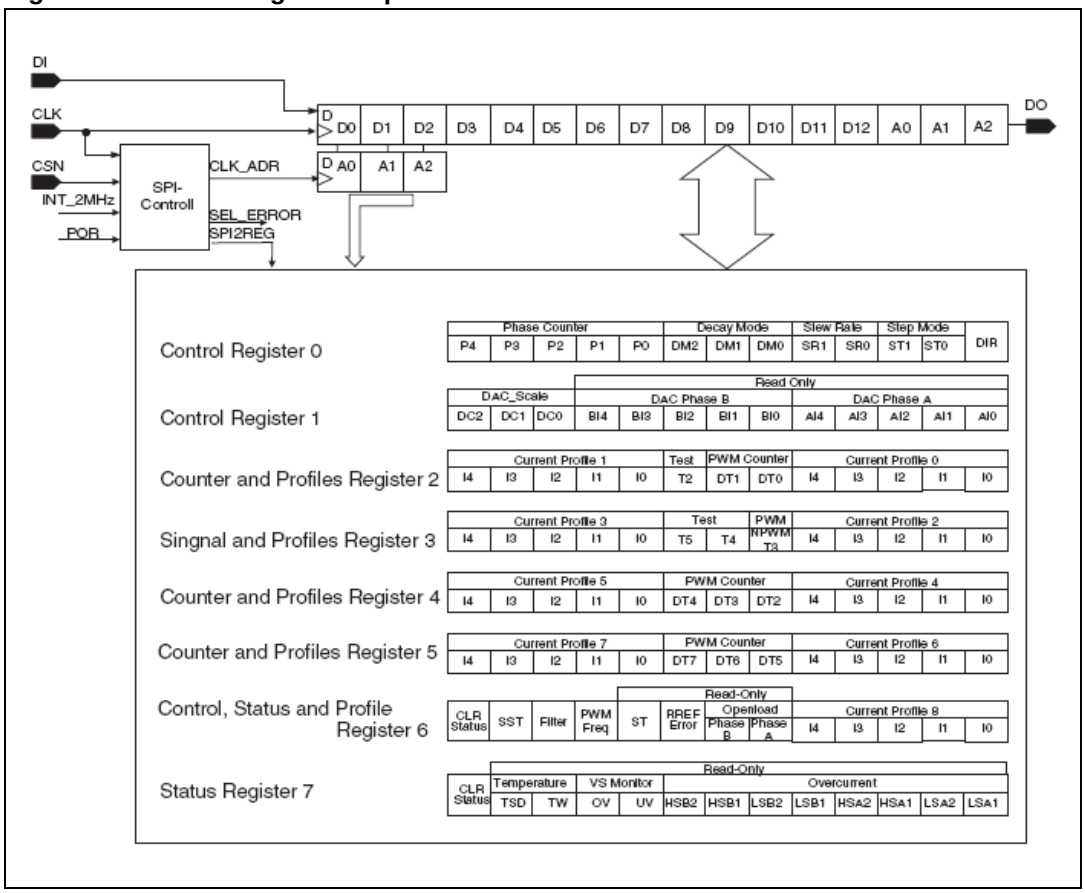
a. The default value was shown in *Figure 3.*

11 Configure L9942 graphic user interface

11.1 SPI menu select field

This field is used to set the value of registers 0~6. The values are sent to L9942 by ST10 via SPI. The *Figure 14.* shows the SPI and 8 registers, the first three bits at the DI-input are used to select one of the input registers.

Figure 14. SPI configuration protocol



11.1.1 Dir

Description: this bit controls direction of motor movement. DIR=1 clockwise, DIR=0 counter clockwise.

Value: Counter clockwise → 0

Default: → 0

SPI-DIN Bit: register 0, bit 0.

11.1.2 Step mode (ST1, ST0)

Description: these bits controls step mode of motor movement.

Value: Micro-stepping → 00

Mini-stepping → 01

Half-stepping → 10

Full-stepping → 11

Default: 11

SPI-DIN Bit: register 0,bits 2 and 1

11.1.3 Slew rate (SR1, SR0)

Description: These bits controls slew rate of bridge switches.(1)

Default: 00

SPI-DIN Bit: register 0,bits 4 and 3

1. For more details, please refer to *Table 12.* in L9942 data sheet.

11.1.4 Decay mode (DM2, DM1, DM0)

Description: These bits controls decay mode of output current.(1)

Value: Slow decay Æ 000

Mixed decay, fast decay until TMD>4us Æ 001

Mixed decay, fast decay until TMD>8us Æ 010

Mixed decay, fast decay until current undershoot Tmc=TFT+TCC Æ 011

Auto decay, fast decay without delay time Æ 100

Auto decay, fast decay until TMD>4us Æ 101

Auto decay, fast decay until TMD>8us Æ 110

Auto decay, fast decay until current undershoot Tmc Æ 111

Default: Æ 101

SPI-DIN Bit: Register 0, bits 7, 6 and 5

1. For more details, pleaser refer to figure 4 in L9942 datasheet.

11.1.5 Phase counter (P4~P0)

Description: These bits control position of motor

Default: 00000

SPI-DIN Bit: Register 0, bits 12~8.

11.1.6 DAC scale (DC2, DC1, DC0)

Description: These bits set full scale range of limit.

Value: 95mA → 000

140mA → 001

230mA→ 010

360mA → 011

550mA → 100

810mA → 101

1150mA → 110

1350mA → 111

Default: 000

SPI-DIN Bit: Register 1, bits 12, 11 and 10.

11.1.7 NPWM

Description: This bit switches internal PWM signal of bridge A to pin PWM if set to 0.

Value: Internal PWM signal of bridge A switch to pin PWM → 0

Pin PWM is in high resistance status → 1

Default: 0

SPI-DIN Bit: Register 3, bit 5.

11.1.8 PWM counter (D7~D0)

Description: These bits are for threshold value in counter of active time during signal PWM.

Value: 0~255

Default: 0

SPI-DIN Bit: Register 3, bits 7 and 6; Register 4, bits 7, 6 and 5; Register 5, bits 7, 6 and 5

11.1.9 FRE

Description: This bit sets frequency of PWM cycle.

Value: PWM frequency 30 kHz → 0

PWM frequency 20 kHz → 1

Default: 0

SPI-DIN Bit: Register 6, bit 9

11.1.10 Filter time (FT)

Description This bit set filter time in glitch filter.

Value: TF=1.5us → 0

TF=2.5us → 1

Default: 0

SPI-DIN Bit Register 6, bit 10

11.1.11 SST

Description his bit specifies output PWM to reflect same logical level like bit ST

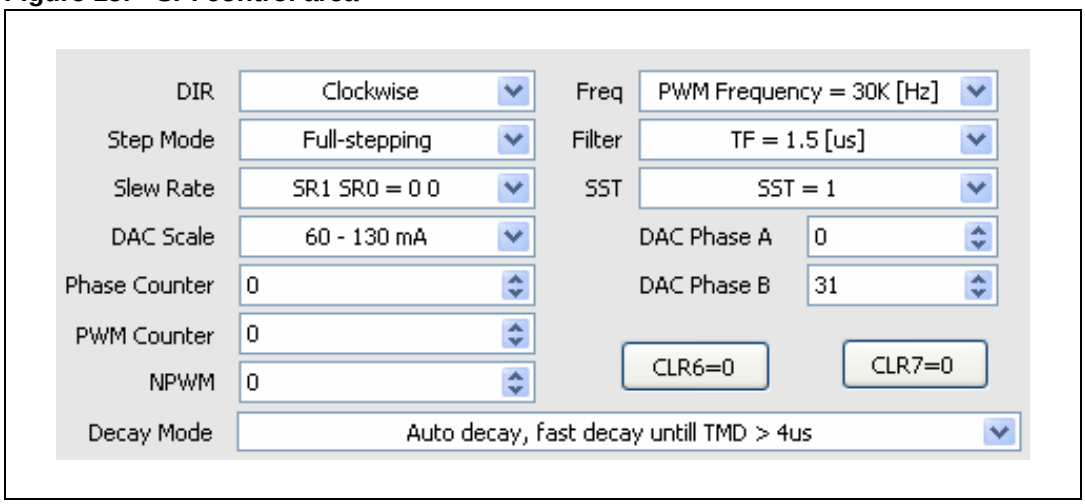
Value: Output PWM not reflect bit ST → 0

Output PWM reflect bit ST → 1

Default: 0

SPI-DIN Bit Register 6, bit 11.

Figure 15. SPI control area

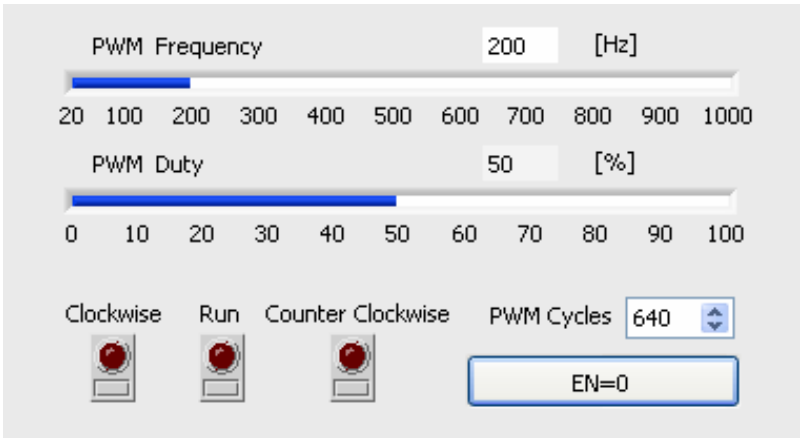


After configuring SPI menu, the configured SPI command will be automatically sent to L9942.

11.2 Motor control command field

This field is purposed to control motor command: motor enable, PWM frequency, PWM duty-cycle, PWM cycles, motor direction control.

Figure 16. Motor control command field



11.2.1 EN switch

This switch controls EN input signal of L9942 to make the device in standby mode or active mode.

11.2.2 PWM duty-cycle and frequency control

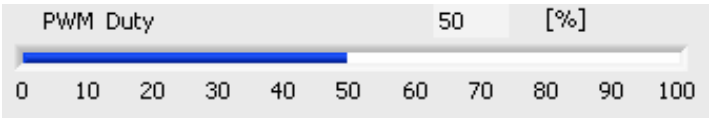
- PWM duty-cycle control

Range [0, 100] %

Step 1

Default 50%

Figure 17. Example of PWM cycle control



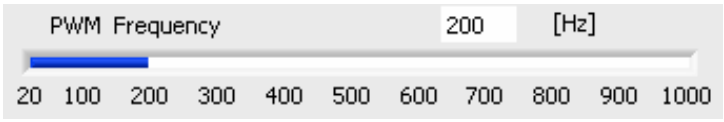
- PWM frequency control

Range [20,1000] Hz

Step 1

Default 200Hz

Figure 18. Example of frequency control



To adjust PWM control bars will change the duty-cycle and frequency of L9942's PWM input signal. Be careful do not change the PWM status if the motor is running, as the motor will run incorrectly.

11.2.3 Motor direction control key

These keys control the running of stepper motor. Click to run and unclick to stop. After running a finite step (PWM cycles), the key will unclick automatically when the motor stop. At any time, only one key can be clicked, when a key is clicked, the other 2 keys are disabled and can't be clicked.

11.3 Function configuration field

The function configuration field consists of 5 parts: Port Configuration, Rx Error, Continue Diagnosis switch, PWM output indication, Reset ST10 button and Exit button as shown in the *Figure 19.*.

Figure 19. Function configure field

11.3.1 Port configuration field

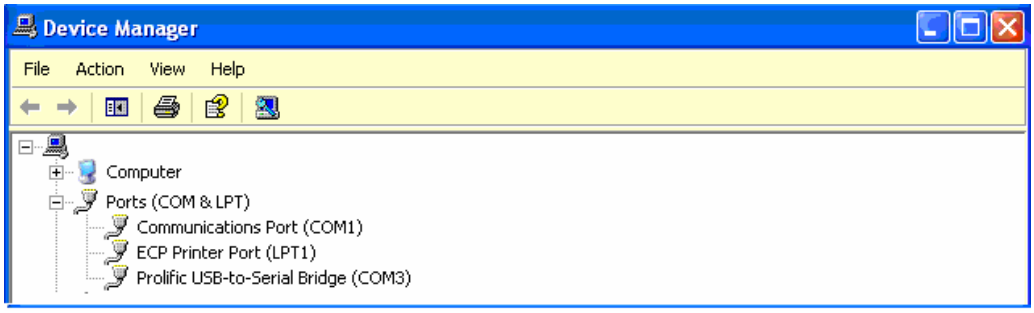
Com port (0) can be changed by user, according the used COM port number of PC.

After modified the com port number, user must click the reset key to reset and configure the ST10 evaluation board.

Port number: (COM Number – 1)

Baud rate: 38400 (default)

Figure 20. COM number map on pc



Example:

For COM1: “0” port number should be selected COM port 0

For COM3: “2” port number should be selected COM port 2

If the port configuration failed, when select ON/OFF, Com port 0 error happened:

Notes: when this error appeared, please do below actions:

- Configure the Port number correctly
- Click the reset ST10 button to reset the L9942 graphic user interface and ST10 configuration

11.3.2 Reset ST10 button

Reset ST10 and configure ST10 DIO, SPI and CC.

11.3.3 Rx error

The rx error turned red, indicate below receive error:

- Receive timeout
- Receive error
- Received frame incorrect

11.3.4 Exit button

The exit button was only used to stop and exit the L9942 graphic user interface.

11.3.5 Continue diagnosis switch

If the continue diagnosis is clicked , the L9942 graphic user interface enters automatic in diagnosis mode. The current SPI menu configuration will be sent to L9942 to do the continuous diagnosis.

11.3.6 PWM output indication

This part indicates the status of PWM pin of L9942.

11.4 SPI diagnosis indication

This field indicates the diagnosis status. SPI diagnosis word will display at SPI diagnosis indication field. The diagnosis protocol is referred in

Table 7. Control, status and profile register

	CLR	ST (PWM)	Filter	Freq	ST	REF ERR	Openload		Current profile 8				
Bit	12	11	10	9	8	7	6	5	4	3	2	1	0
Access	rw	rw	rw	rw	r	r	r	r	rw	rw	rw	rw	rw
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0
Name	CLR6	SST	FT	FRE	ST	RERR	OB	OA	I4	I3	I2	I1	I0

Table 8. Bits description

Bit	Description
OB OA	These bits indicate openland at bridges
RERR	This bit indicates if reference current is ok (15uA<I_{ref} current 250uA>t
ST	This bit indicates stall decision

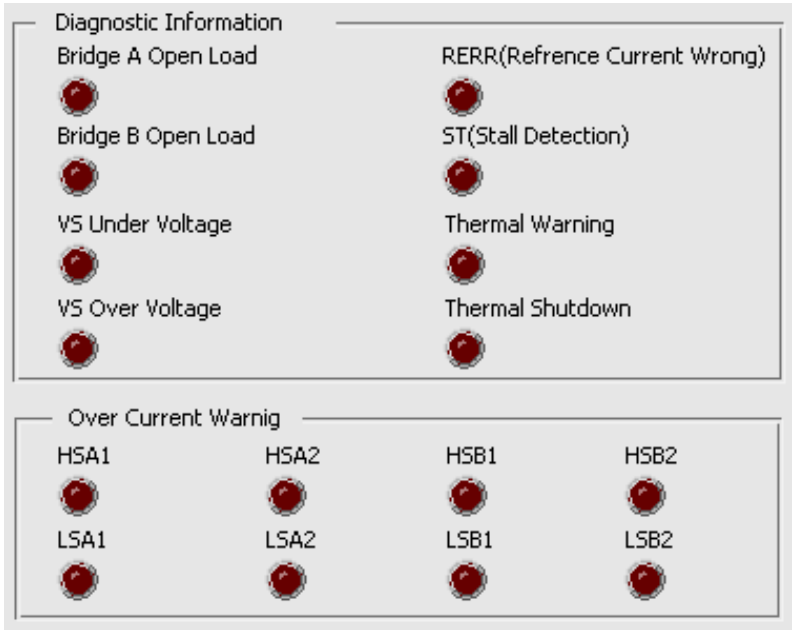
Table 9. Status register

Bit	CLR	Temperature		Vs monitor		Overcurrent								
Access	rw	r	r	r	r	r	r	r	r	r	r	r		r
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Name	CLR7	TSD	TW	OV	UV	HSB 2	HSB 1	LSB2	LSB1	HSA 2	HSA 1	LSA2		LSA1

Table 10. Bit description

Bits	Descriptions
bit 7 bit 0	These bits indicate overcurrent in each lowside or highside power transitstor
1	Over current failure I>2A
OV UV	These bits indicate failure at VS
01	Voltage at pin VS is too low
10	Voltage at pin VS is too high
TSD TW	These bits indicate temperature failure
01	Only for information set at temperature warning threshold
10	In case of thermal shutdown all bridges are switched off. It has to reset by bit CLR7

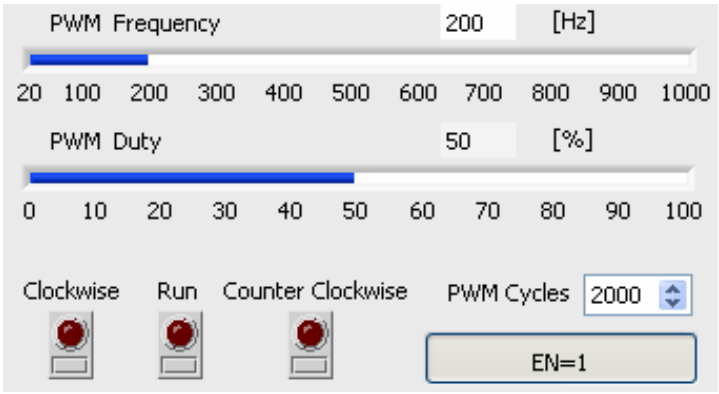
Figure 21. SPI diagnostic information



12 Test result

12.1 Test condition

Figure 22. Test condition



12.2 SPI result

Table 11. SPI result

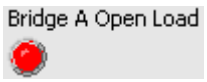
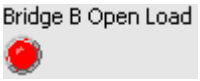
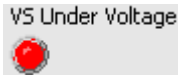
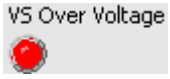
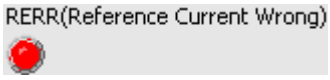
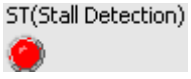
Item	Operation	SPI status register bit	Diagnostic information	Result
Bridge A open load	Open load	Register 6 bit 5		Pass
Bridge B open load	Open load	Register 6 bit 6		Pass
High side A1 over current	Connect QA1 and GND	Register 7 bit 2		Pass
Low side A1 over current	Connect QA1 and VS	Register 7 bit 0		Pass
High side A2 over current	Connect QA2 and GND	Register 7 bit 3		Pass
Low side A2 over current	Connect QA2 and VS	Register 7 bit 1		Pass
High side B1 over current	Connect QB1 and GND	Register 7 bit 6		Pass

Table 11. SPI result (continued)

Item	Operation	SPI status register bit	Diagnostic information	Result
Low side B1 over current	Connect QB1 and VS	Register 7 bit 4		Pass
High side B2 over current	Connect QB2 and GND	Register 7 bit 7		Pass
Low side B2 over current	Connect QB2 and VS	Register 7 bit 5		Pass
VS under voltage	VS < 6V	Register 7 bit 8		Pass
VS over voltage	VS > 20V	Register 7 bit 9		Pass
Reference current wrong	R_{REF} < 5k	Register 6 bit 7		Pass
Stall detection	Set large PWM counter value	Register 6 bit 8		Pass
Thermal warning		Register 7 bit 10		
Thermal shutdown		Register 7 bit 11		

Appendix A

A.1 ST10 configuration

CPU frequency: 64MHz

1) ASC

For ST10F276, either ASC0 or ASC1 can be initialized;

Baud rate: 38400, 8 bit data asynchronous, 1 stop bit

2) SSC

Frequency: 1MHz, 16 bit data width, MSB first, low level at idle, and transmit at rising edge

CS line: 2.3

A.2 Pinout

Pin connection between ST10F27x evaluation board and L9942 demonstration board.

Table 12. ST10F276 pinout for L9942 board

Function	Name	GPIO	PIN	F27x_SH*	F27x _FS*	Remark
EN	EN	P2.1	Pin48–GPIO	D17	D16	
Step frequency	PWM	P7.0	Pin 19 – POUT0	A22	A21	
SPI Signals	CSN	P2.3	Pin50–GPIO	D18	D17	
	SCK	P3.13	Pin80-SCLK0	D25	D24	
	SDI	P3.9	Pin76-MTSR0	C26	C25	
	SDO	P3.8	Pin75-MRST0	D26	D25	
UART signals	TxD0	P3.10	Pin 77-TxD0	C11	C10	
	RxD0	P3.11	Pin 78-RxD0	D11	D10	

1) F276_SH* is the board made by Shanghai PT&S lab APG China. (ST10F27X EVA v1.0)

2) F276_FS* is the board made by FORTH-SYSTEME. (EVA27X_0)

Revision history

Table 13. Document revision history

Date	Revision	Changes
26-Nov-2009	1	Initial release.
19-Sep-2013	2	Updated disclaimer.

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