

# UCC5870-Q1 EVM Quick Start Demo

Texas Instruments

APP-HVP-HPD



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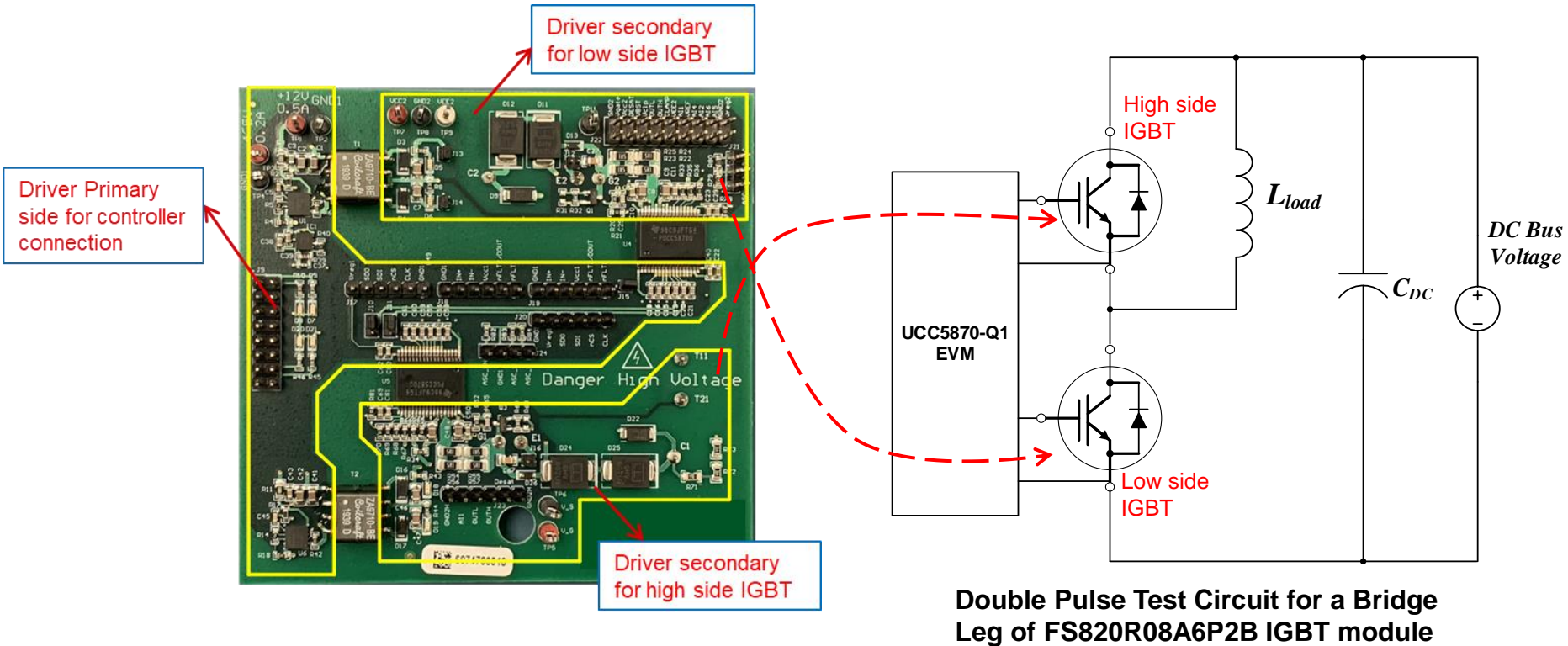
# Outline

- ❑ EVM hardware introduction and test system setup
- ❑ Initial programming the driver:
  - ❑ Power up, start GUI software, build up connection
  - ❑ Reset → Configuration 1 → Configuration 2 → Active
- ❑ PWM generation examples in active state
  - ❑ Generate continuous PWM
  - ❑ Generate double pulses
  - ❑ Generate desat fault and then clear the fault
- ❑ Summary and live GUI demo

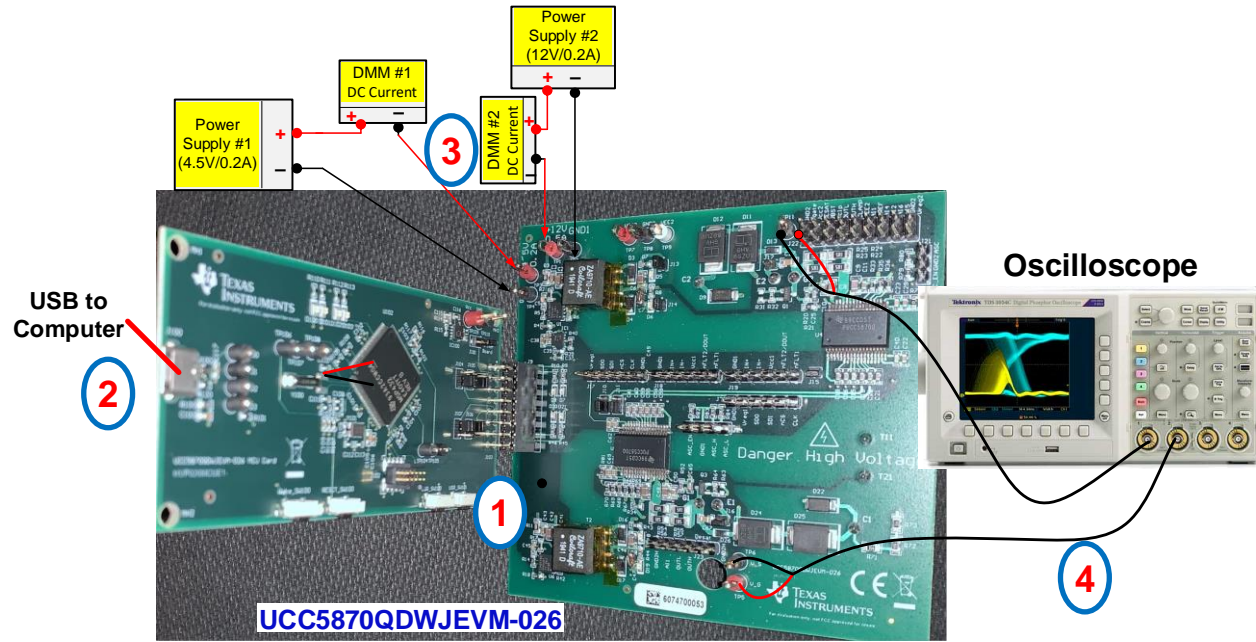
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# EVM Board (designed to fit FS820R08A6P2B IGBT module)



# Test System Setup



1. Plug in the MCU board, *make sure the side with components is facing the EVM board;*
2. Connect the MCU board to computer with the USB cable;
3. Connect 12V and 4.5V or 5V power supplies;
4. Connect oscilloscope probes, for example, to measure both high side and low side driver Vout.

Test system setup for low power test (without connecting IGBT)

# Outline

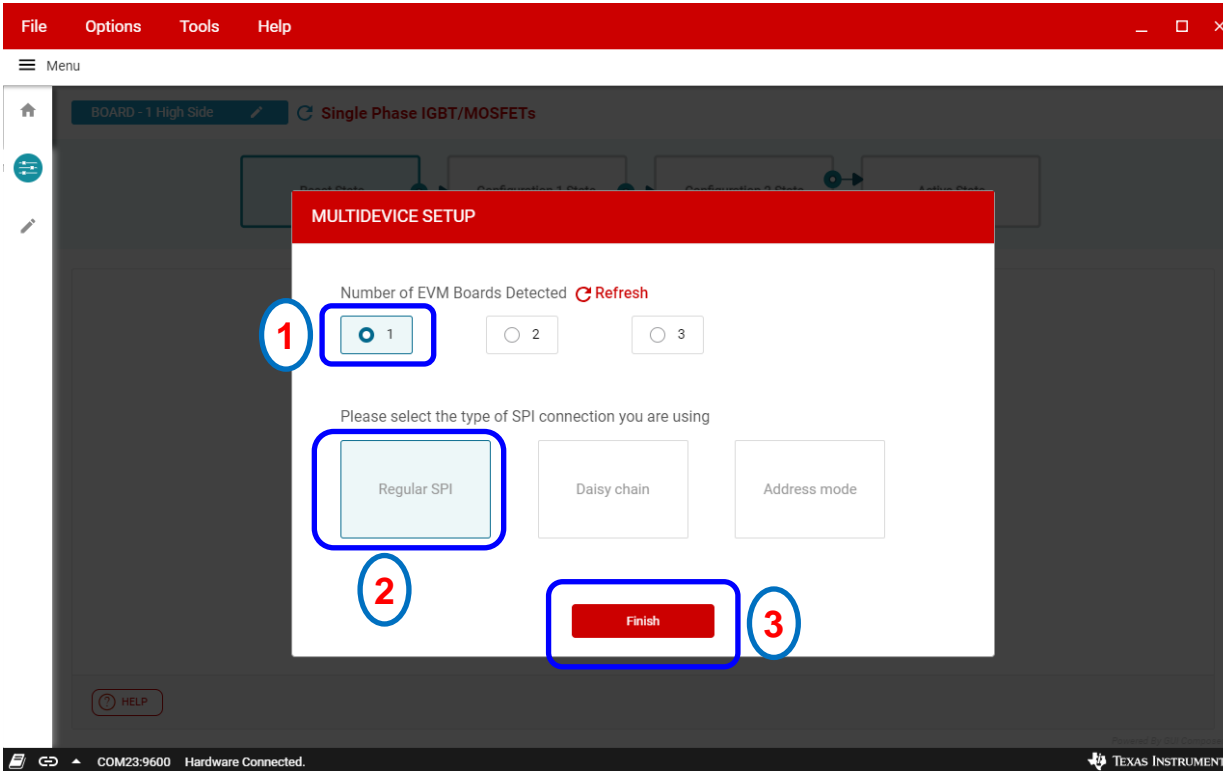
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# Driver Initial Programming (Power up, start GUI and connection)

The screenshot displays the UCC5870 GUI software interface. The top menu bar includes 'File', 'Options', 'Tools', and 'Help'. The 'Options' menu is highlighted with a blue box and a red circle containing the number '3'. Below the menu bar, the 'Device Connected' section shows 'UCC5870 - Q1 EVM' and '15A Isolated IGBT/SIC MOSFET Gate Driver'. A red box highlights the 'Explore Device Modes' button, with a red circle containing the number '4' next to it. The 'Register Map' button is also visible. A central image shows a blue car being charged at a red charging station. To the right, the 'Protection Features' section lists six features: 1. Active Miller Clamp, 2. DESAT detection, 3. Shunt current sensing support, 4. Soft turn-off, 5. Overvoltage and undervoltage protection, and 6. Temperature monitoring. At the bottom, there are 'User Guide' and 'Datasheet' buttons. The status bar at the bottom shows 'COM90:9600 Hardware Connected.' and the Texas Instruments logo.

1. Turn on both 4.5V and 12V power supplies;
2. Start the GUI software;
3. If the connection is failed, click Options and select a different port;
4. After “Hardware Connected”, click “Explore Device Modes”.

# Driver Initial Programming (Driver in RESET state)



1. Number of EVM boards will be detected as one automatically which may take a few seconds;
2. With default MCU board jumper setting, select “Regular SPI”;
3. Then click “Finish”;

# Driver Initial Programming (Driver in configuration 1 state)

File Options Tools Help

Menu

SELECT DEVICE x Single Phase IGBT/MOSFETs

Choose the device you want to configure

Reset State Configuration 1 State Configuration 2 State Active State

BOARD 1

LS GATE UCC5870 LS GATE UCC5870

Regular SPI Configuration

Slave Address 0x00

Proceed

COM23:9600 Hardware Connected. TEXAS INSTRUMENTS

1. Select which driver to program; For example, select “LS GATE”;
2. then click “Proceed” or click “Configuration 2” directly.

# Driver Initial Programming (Driver in configuration 2 state)

BOARD - 1 Low Side Single Phase IGBT/MOSFETs

Reset Registers

Reset State → Configuration 1 State → **Configuration 2 State** ↔ Active State

**1**

**Two Level/Soft Turn-off**

ADC Configuration

UVLO/OVLO

SCP/OCF

Active Miller Clamp

DESAT

OTP/OTW

Report to nFAULT

Gate Voltage Monitor

Manual BIST

Other Configurations

**Two Level Turn-off/Soft Turn Off**

STO/2LTOFF is Enabled For  
STO:Disabled(0x0)

**Two Level Turn-off settings**

Plateau Voltage:(V2 LOFF)  
6V

Plateau Voltage Duration:(t2 LOFF)  
150ns

Gate Discharge Current:(I2 LOFF)  
0.3A

Second Turn-off Current

HELP Confirm

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COM23:9600 Hardware Connected.

1. LS driver moves to Configuration 2 state;

# Driver Initial Programming (Driver in configuration 2 state)

The screenshot displays the TI Configurator software interface. The top menu bar includes 'File', 'Options', 'Tools', and 'Help'. Below the menu, there are buttons for 'READ REGISTER', 'READ ALL REGISTERS', 'WRITE REGISTER', 'WRITE ALL REGISTERS', and 'Immediate Write'. A search bar is present for finding registers by name or address. The main area is divided into two sections: 'Register Map' and 'FIELD VIEW'.

**Register Map**

Register Name	Address	Value	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
<b>Configuration Register</b>																		
Configuration Register 1	0x00	0xFFFF	1	1	1	1	1	1	-	1	1	1	1	1	1	1	1	1
Configuration Register 2	0x01	0xFFFF	1	1	1	1	1	1	1	1	1	1	1	-	-	1	-	1
Configuration Register 3	0x02	0xFFFF	1	1	1	1	1	-	1	1	1	1	1	1	1	1	1	1
Configuration Register 4	0x03	0xFFFF	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Configuration Register 5	0x04	0xFFFF	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Configuration Register 6	0x05	0xFFFF	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Configuration Register 7	0x06	0xFFFF	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Configuration Register 8	0x07	0xFFFF	1	1	1	1	1	1	1	-	1	1	1	1	1	1	1	1
Configuration Register 9	0x08	0xFFFF	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-	1
Configuration Register 10	0x09	0xFFFF	1	1	1	1	1	-	1	1	1	1	1	1	1	1	1	1
Configuration Register 11	0x0A	0xFFFF	1	1	1	1	1	1	1	1	1	1	1	1	-	-	1	1
<b>ADC Data Registers</b>																		
ADCDATA1 Register (AI1)	0x0B	0xFFFF	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
ADCDATA2 Register (AI3)	0x0C	0xFFFF	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
ADCDATA3 Register (AI5)	0x0D	0xFFFF	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
ADCDATA4 Register (AI2)	0x0E	0xFFFF	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
ADCDATA5 Register (AI4)	0x0F	0xFFFF	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
ADCDATA6 Register (AI6)	0x10	0xFFFF	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
ADCDATA7 Register (die temp)	0x11	0xFFFF	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

**FIELD VIEW**

Configuration Register 1

Configuration Register / Configuration Register 1 / TDEAD[5:0]  
0x3F

Configuration Register / Configuration Register 1 / NFLT2\_DOUT\_MUX[6]  
NFLT2\_DOUT\_MUX  
DOUT

Configuration Register / Configuration Register 1 / RESERVED[7]  
RESERVED b1

Configuration Register / Configuration Register 1 / OV1\_DIS[8]  
 OV1\_DIS

Configuration Register / Configuration Register 1 / RESERVED\_2[9]  
RESERVED\_2 b1

Configuration Register / Configuration Register 1 / GD\_OTW\_PRI\_DIS[10]  
 GD\_OTW\_PRI\_DIS

1. Click "Register Maps", all values are shown as 1;
2. Then click "READ ALL REGISTERS", default values of all the driver registers will be read back by the GUI program.

# Driver Initial Programming (Driver in configuration 2 state)

File Options Tools Help

Menu

BOARD - 1 Low Side Single Phase IGBT/MOSFETs Reset Registers

1

Reset State Configuration 1 State Configuration 2 State Active State

Two Level/Soft Turn-off  
ADC Configuration  
UVLO/OVLO  
SCP/OCF  
Active Miller Clamp  
OTF/OTW  
Report to nFAULT  
Gate Voltage Monitor  
Manual BIST  
Other Configurations

DESAT

DESAT SCP Protection

DESAT Detection Enable  
DESAT Current Enable

DESAT Detection Threshold:(VDESATth)  
9.5V

Blanking Cap Charging Current:(ICHG)  
1mA

Default State for DESAT/SCP Fault  
PL

HELP Confirm

COM23:9600 Hardware Connected. TEXAS INSTRUMENTS

1. Click “Basic Settings”;
2. Click “DESAT” section;
3. Change “DESAT Detection Enable” and “DESAT Current Enable” to Disable;

Note: The purpose of this step is to disable the desat function as the driver Desat pin is not connected to an IGBT collector pin.

# Driver Initial Programming (Driver in configuration 2 state)

1. Click “Gate Voltage Monitor” section;
2. Disable Gate Voltage Monitor Function; Otherwise gate voltage monitor fault may trigger when the driver output switches with 100nF load and 5.1ohm gate resistor on the EVM board;

# Driver Initial Programming (Driver in active state)

File Options Tools Help

Menu

BOARD - 1 Low Side Single Phase IGBT/MOSFETs Register Functions Test Functions Software Reset

Reset State Configuration 1 State Configuration 2 State Active State

PWM Duty Cycle(%) 0 25 50 75 100

PWM Frequency(kHz) 1 10 20 30 40 50

Start PWM

ADC Data Monitoring

Analog pins need to be configured to monitor the ADC results

Configure

Warning Status

Fault Status

Clear Fault

HELP

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1. Click “Active State”, then this Low Side driver will move to active stage where it can output PWM which follows the IN+/IN-
2. The next step is to program High Side driver, click “BOARD-1 Low Side”

# Driver Initial Programming (High side driver programming)

File Options Tools Help

Menu

SELECT DEVICE x Single Phase IGBT/MOSFETs

Choose the device you want to configure

Reset State → Configuration 1 State → Configuration 2 State ↔ Active State

BOARD 1

HS GATE UCC5870 LS GATE UCC5870

1

Regular SPI Configuration

Slave Address  
0x00

Proceed

COM23:9600 Hardware Connected. TEXAS INSTRUMENTS

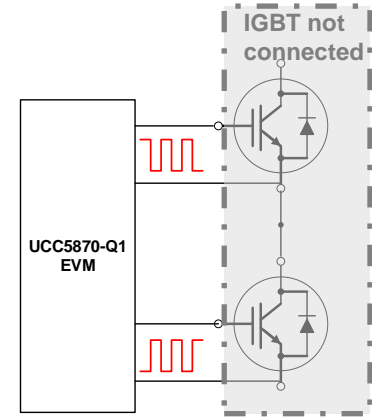
1. select “HS Gate”, then program the high side driver similarly as the low side driver until it enters active state.

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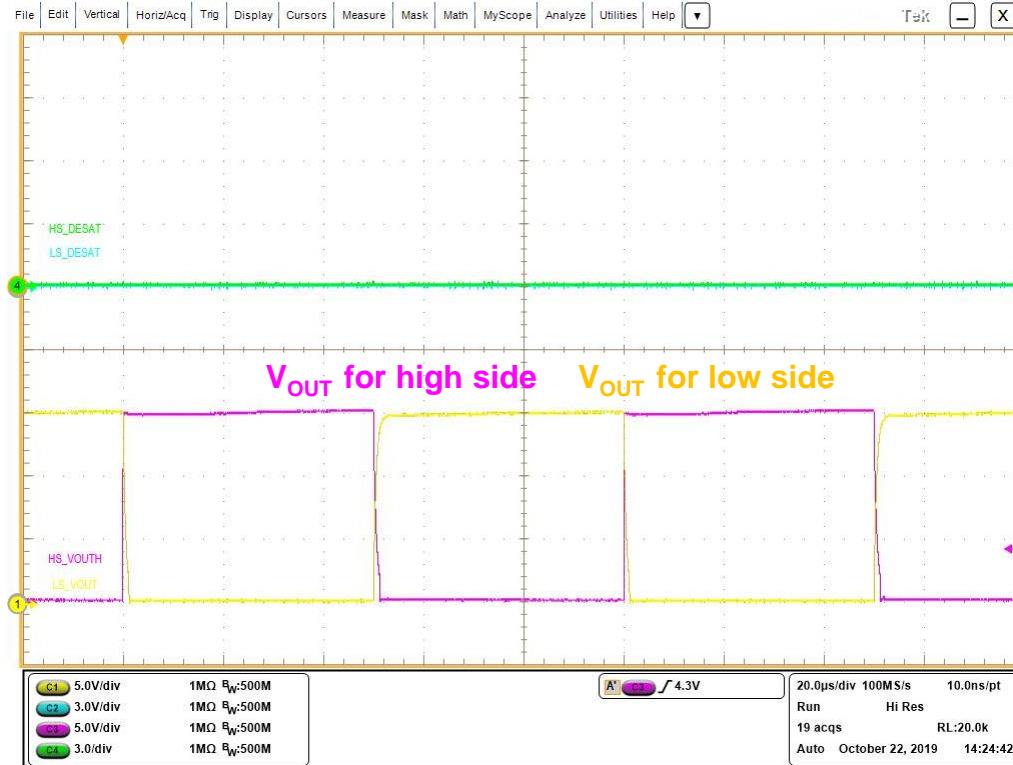
# PWM Generation Examples: Continuous PWM

The screenshot displays the software interface for the UCC5870-Q1 EVM. At the top, there is a red header with 'File', 'Options', 'Tools', and 'Help' menus. Below this is a 'Menu' bar. The main area shows a state transition diagram with 'Reset State', 'Configuration 1 State', 'Configuration 2 State', and 'Active State'. On the left, there are two sliders: 'PWM Duty Cycle(%)' set to 50 and 'PWM Frequency(kHz)' set to 10. A red 'Start PWM' button is highlighted with a blue circle and the number '2'. A red circle with the number '1' is placed over the ADC Data Monitoring section, which contains the text 'Analog pins need to be configured to monitor the ADC results' and a 'Configure' button. At the bottom, there are 'Warning Status' and 'Fault Status' indicators, a 'Clear Fault' button, and a 'HELP' button. The status bar at the very bottom shows 'COM23:9600 Hardware Connected.' and the Texas Instruments logo.



1. When both high side and low side driver are in active stage, set PWM duty cycle 50%, and frequency 10kHz as an example;
2. Click “Start PWM”.

# PWM Generation Examples: Continuous PWM



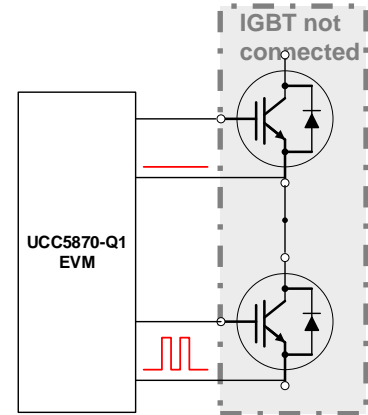
Duty Cycle = 50%

Frequency = 10kHz

Oscilloscope Waveforms

# PWM Generation Examples: Double Pulses

The screenshot displays the control software for the UCC5870-Q1 EVM. The top navigation bar includes 'File', 'Options', 'Tools', and 'Help'. The main interface shows a state machine with four states: 'Reset State', 'Configuration 1 State', 'Configuration 2 State', and 'Active State'. The 'Active State' is highlighted with a blue box and a red circle containing the number '1'. Below the state machine, there are two sliders: 'PWM Duty Cycle(%)' set to 50 and 'PWM Frequency(kHz)' set to 10. A 'Start PWM' button is located below the sliders. To the right, the 'ADC Data Monitoring' section contains the text 'Analog pins need to be configured to monitor the ADC results' and a 'Configure' button. At the bottom, there are 'Warning Status' and 'Fault Status' indicators, a 'Clear Fault' button, and a 'HELP' button. The bottom status bar shows 'COM23:9600 Hardware Connected.' and the Texas Instruments logo.



1. Click "Test Functions"

# PWM Generation Examples: Double Pulses

File Options Tools Help

Menu

BOARD - 1 Low Side Single Phase IGBT/MOSFETs Register Functions Test Functions Software Reset

Double Pulse And Short Circuit Test

Double Pulse Test Short Circuit Test

Double Pulse Test

Selected EVM Board: U

Selected Driver: Low Side 1

t1: 20 μs

t2: 20 μs 2

t3: 20 μs

Test 3

HELP

PWM Duty Cycle(%)

0 25 50

PWM Frequency(kHz)

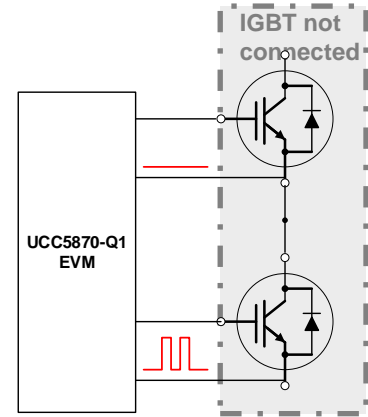
1 10 20 3

Start PWM

Warning Status

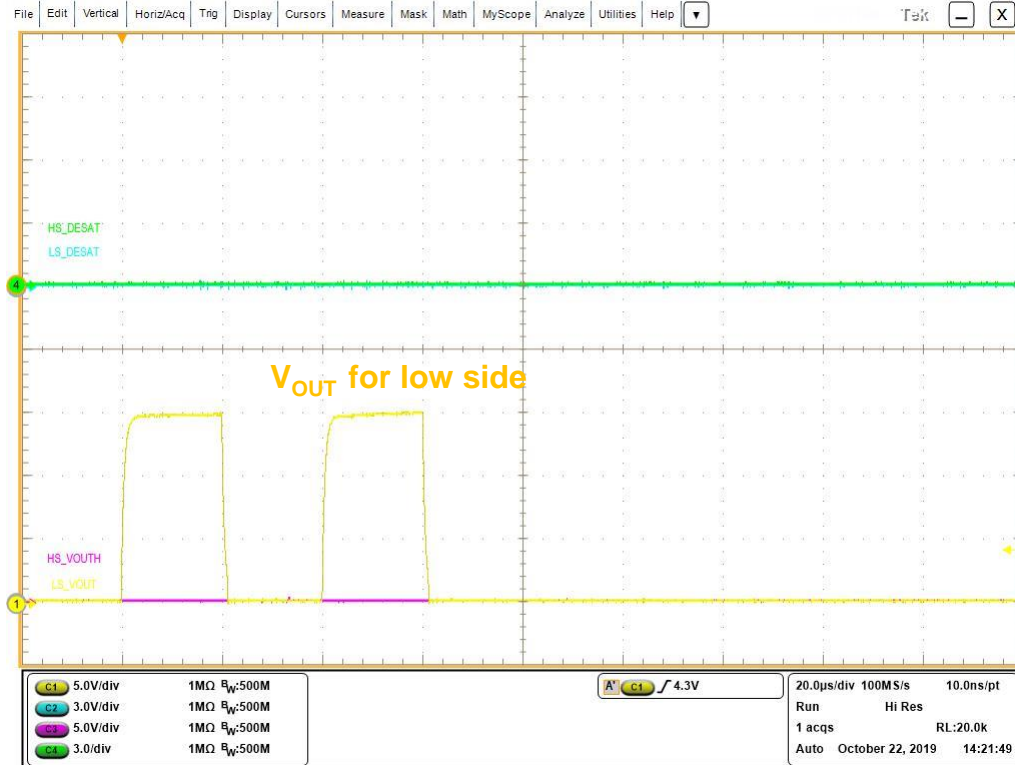
Fault Status

COM23:9600 Hardware Connected. TEXAS INSTRUMENTS



1. Select Driver: Low Side;
2. set t1, t2, t3 values for double pulses, for example 20us for each;
3. Click "Test", a double pulses PWM will be generated by the controller and sent to the low side driver.

# PWM Generation Examples: Double Pulses



$t_1 = 20\mu\text{s}$

$t_2 = 20\mu\text{s}$

$t_3 = 20\mu\text{s}$

Oscilloscope Waveforms

# PWM Generation Examples: Generate Fault

File Options Tools Help

Menu

BOARD - 1 Low Side Single Phase IGBT/MOSFETs Reset Registers

Reset State Configuration 1 State Configuration 2 State Active State

DESAT SCP Protection

DESAT Detection Enable

DESAT Current Enable

DESAT Detection Threshold:(VDESATth)

9.5V

Blanking Cap Charging Current:(ICHG)

1mA

Default State for DESAT/SCP Fault

PL

HELP Confirm

COM90:9600 Hardware Connected. TEXAS INSTRUMENTS

1. Move to “Configuration 2 “ state for low side driver;
2. Enable DESAT Protection;
3. Then move to Active State and generate a double pulse.

# PWM Generation Examples: Generate Fault



Desat fault triggers at ~4us

## Oscilloscope Waveforms

# PWM Generation Examples: Generate Fault

The screenshot displays the Texas Instruments GUI for PWM generation. At the top, there is a red header with 'File', 'Options', 'Tools', and 'Help' menus. Below this, a 'Menu' icon is visible. The main interface is titled 'BOARD - 1 Low Side' and 'Single Phase IGBT/MOSFETs'. It features three buttons: 'Register Functions', 'Test Functions', and 'Software Reset'. A state machine diagram shows four states: 'Reset State', 'Configuration 1 State', 'Configuration 2 State', and 'Active State', connected by arrows. Below the diagram, there are two sliders: 'PWM Duty Cycle(%)' set to 50 and 'PWM Frequency(kHz)' set to 10. A 'Start PWM' button is present. The 'ADC Data Monitoring' section contains a message: 'Analog pins need to be configured to monitor the ADC results' and a 'Configure' button. At the bottom, there is a 'Warning Status' indicator (off) and a 'Fault Status' indicator (on, highlighted with a red circle and the number '1'). A 'Clear Fault' button and a 'HELP' button are also visible. The bottom status bar shows 'COM90:9600 Hardware Connected.' and the Texas Instruments logo.

1. The Fault Status indicator becomes red which means nFLT1 pin is low, the Warning Status is for nFLT2 status; There are also red LEDs on the EVM board to show nFLT1 and nFLT2 status

# PWM Generation Examples: Read Fault

The screenshot shows the Register Map tool interface. The 'Register Map' table is visible, with the 'STATUS3 Register' selected. The 'FIELD VIEW' pane on the right shows the 'STATUS3 Register' fields, with 'DESAT\_FAULT[0]' highlighted in red, indicating a fault. The 'READ ALL REGISTERS' button is highlighted in blue. The 'STATUS3 Register' is also highlighted in blue. The 'DESAT\_FAULT[0]' field is highlighted in red. The 'STATUS3 Register' is also highlighted in blue. The 'DESAT\_FAULT[0]' field is highlighted in red.

Register Name	Address	Value	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
CRC Data Register	0x13	0x7BF2	0	1	1	1	0	1	1	1	1	1	1	0	0	1	0	
SPITEST Register	0x14	0x0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GD Address Register	0x15	0x0000	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0
STATUS1 Register	0x16	0x00C0	0	0	-	-	0	-	-	0	1	1	0	0	-	-	-	0
STATUS2 Register	0x17	0x4004	-	1	0	0	0	-	0	0	0	0	0	0	0	0	1	0
STATUS3 Register	0x18	0x0801	0	0	0	0	1	0	0	0	0	0	0	0	-	-	0	1
STATUS4 Register	0x19	0x0401	-	0	0	0	-	1	0	0	0	0	0	-	-	-	-	1
STATUS5 Register	0x1A	0x8000	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CONTROL1 Register	0x1B	0x0000	0	-	-	-	-	-	0	0	-	0	-	-	-	-	-	0
CONTROL2 Register	0x1C	0x0000	0	-	0	0	0	-	0	0	-	0	-	0	0	0	0	-
ADCCFG Register	0x1D	0x0000	-	0	0	0	0	0	0	0	-	0	0	0	0	0	0	0
DOUTCFG Register	0x1E	0x1800	0	0	0	1	1	0	0	0	-	0	0	0	0	0	0	0

1. Go to Register Map;
2. Click “READ ALL REGISGTERS”;
3. Click each STATUS register and find out which fault is triggered on the right;
4. In this example, Desat fault is triggered and the indicator changes to red.

# PWM Generation Examples: Clear Fault

File Options Tools Help

Menu

BOARD - 1 Low Side Single Phase IGBT/MOSFETs Register Functions Test Functions Software Reset

Reset State Configuration 1 State Configuration 2 State Active State

PWM Duty Cycle(%) 50

PWM Frequency(kHz) 10

Start PWM

ADC Data Monitoring

Analog pins need to be configured to monitor the ADC results

Configure

Warning Status

Fault Status

Clear Fault 1

HELP

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1. The fault can be cleared by clicking “Clear Fault” which is writing a “1” to CONTROL2 register bit 15.

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