

# Application Note

## Bidirectional I2C to SPI Bridge

### AN-CM-334

#### **Abstract**

*This application note describes how to use the SLG46811 IC to design a converter between the I2C and SPI data transmission protocols.*

*This application note comes with the design file, which can be found in the Reference section.*

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## Bidirectional I2C to SPI Bridge

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## Bidirectional I2C to SPI Bridge

### 1 Terms and Definitions

CNT	Counter
DFF	D flip flop
EPG	Extended pattern generator
I2C	Inter-integrated circuit (bus)
IC	Integrated circuit
OE	Output Enable
SHR	Shift register
SPI	Serial peripheral interface
SRFF	SR flip flop

### 2 References

For related documents and software, please visit:

<https://www.dialog-semiconductor.com/greenpak>

Download our free **GreenPAK™** Designer software [1] to open the .gp files [2] and view the proposed circuit design. Use the **GreenPAK** development tools [3] to freeze the design into your own customized IC in a matter of minutes. Find out more in complete library of application notes [4] featuring design examples as well as explanations of features and blocks within the **GreenPAK** IC.

[1] [GreenPAK Designer Software](#), Software Download and User Guide

[2] [AN-CM-334 Bidirectional I2C to SPI bridge.gp](#) file, GreenPAK Design File

[3] [GreenPAK Development Tools](#), GreenPAK Development Tools Webpage

[4] [GreenPAK Application Notes](#), GreenPAK Application Notes Webpage

[5] [SLG46811](#), Datasheet

[6] [Technique: Building a Shift Register](#), The GreenPAK Cookbook

[7] [Technique: OE PIN](#), The GreenPAK Cookbook

[8] [Technique: Reading Serial Protocols with a Shift Register](#), The GreenPAK Cookbook

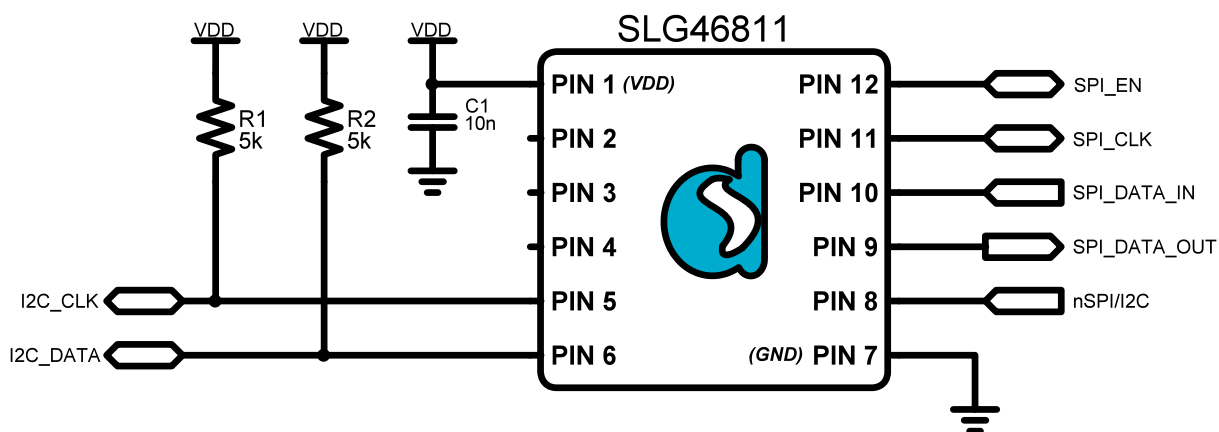
## Bidirectional I2C to SPI Bridge

### 3 Introduction

Many devices interact via the I2C and SPI data protocols. In this app note, we'll show how to convert between these two protocols using the SLG46811 integrated circuit (IC), a good option for this application due to its small size and high functionality combined with low cost and current.

### 4 How Does the Conversion Work?

The SLG46811V can convert in both directions, from I2C to SPI and vice versa.



**Figure 1: Application Circuit**

Figure 1 shows a typical schematic for the converter. The I2C bus is connected to PIN5 and PIN6, and the SPI bus is connected to PIN9, PIN10, PIN11 and PIN12. PIN8 is used to control the transmission direction. The I2C bus must be pulled up to VDD.

The conversion direction is selected by the nSPI/I2C signal. This circuit provides the transmission of four bytes, one of which is the I2C control byte.

Bidirectional I2C to SPI Bridge

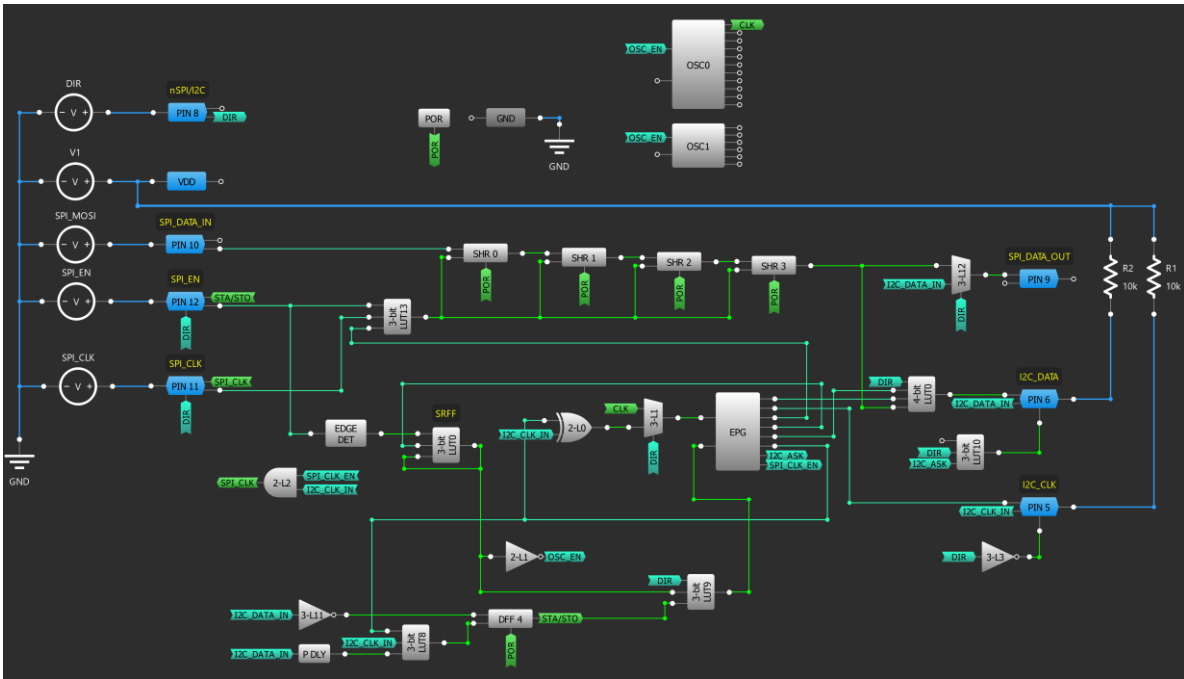


Figure 2: Design Implementation

4.1 SPI Data Reception and I2C Data Transmission

When the nSPI/I2C signal is low, the IC receives SPI commands and transmits I2C commands.

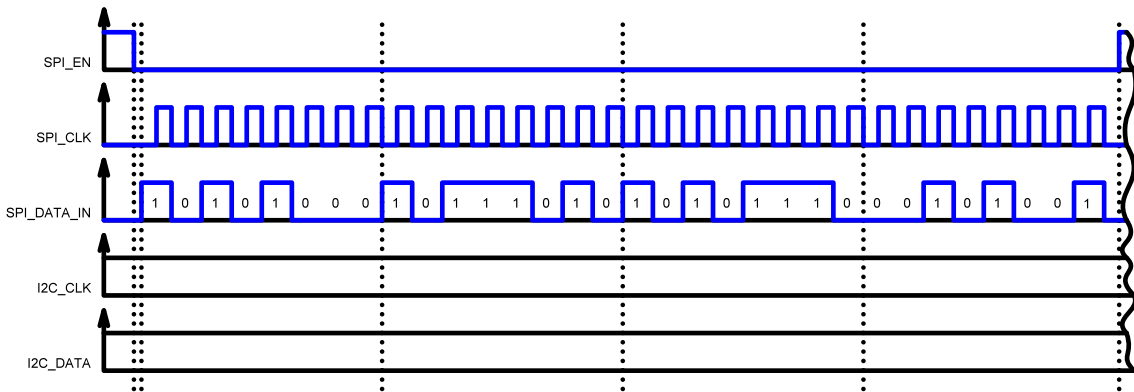


Figure 3: SPI Data Reception

The SPI\_EN signal determines the start and stop of SPI data reception. When the signal SPI\_EN changes from high to low, the IC reads from the input SPI\_DATA\_IN. In synch with the clock signal SPI\_CLK, the IC reads the data in the shift registers SHR 0 – SHR 3.

Bidirectional I2C to SPI Bridge

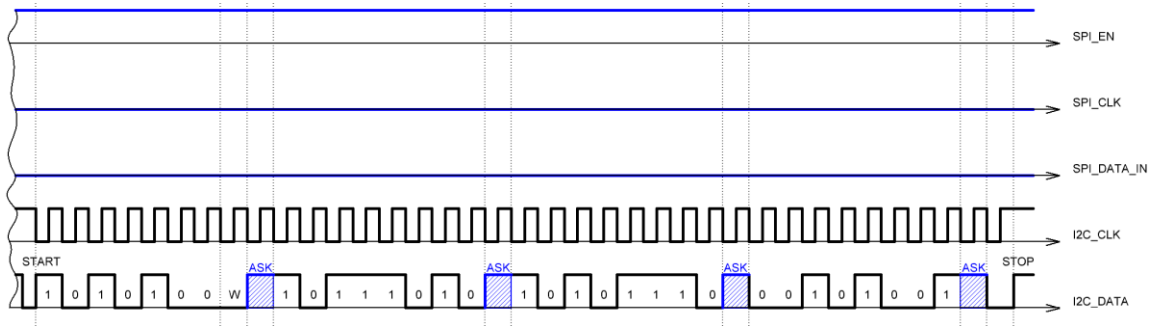


Figure 4: I2C Data Transmission

When the data is fully received, the signal SPI\_EN goes to high and the IC begins forming I2C packets. EDGE DET detects when the data is received, which translates the output of the SRFF trigger to 1. This allows the operation of the extended pattern generator (EPG) and the clock generator. The EPG unit deals with the formation of the I2C packets and controls the data issuance process.

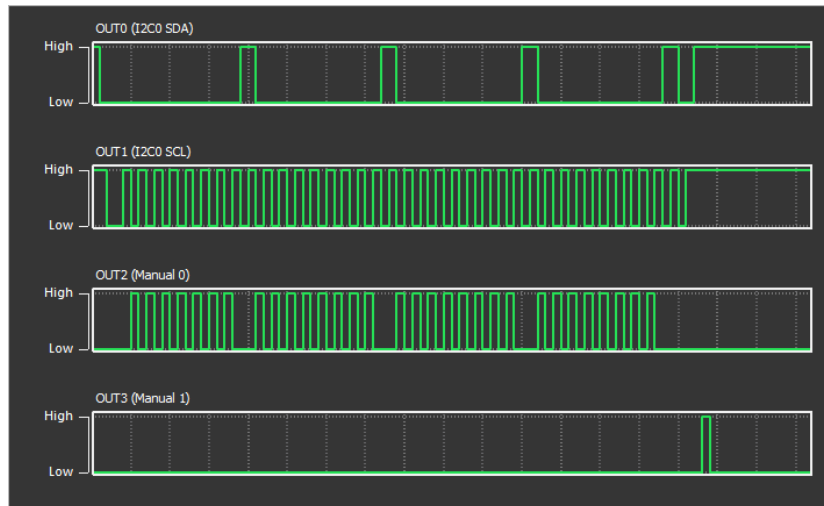


Figure 5: EPG Waveform

The EPG unit records a set of patterns for generating I2C operation signals. Output OUT0 is used to form the Start, Stop and ASK bits. Output OUT1 generates a clock signal for I2C\_CLK. The OUT2 signal provides a data offset in the SHR registers. Upon completion of I2C transmission, the OUT3 signal converts the SRFF trigger to 0, after which the system enters the initial state.

For example, we will try to change the counter data CNT0 in the SLG46826 using the SPI/I2C bridge.

Bidirectional I2C to SPI Bridge

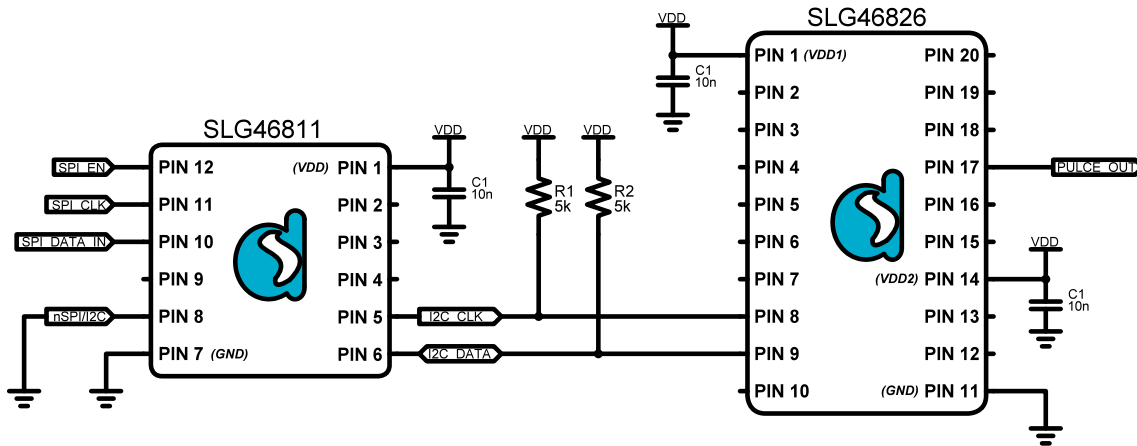


Figure 6: Test Schematic

Figure 6 shows a test connection diagram of the SPI/I2C bridge built on the SLG46811 and the generator built on the SLG46826. The SLG46826 has PIN8 and PIN9 for the I2C bus connection and PIN17 for the pulse output.

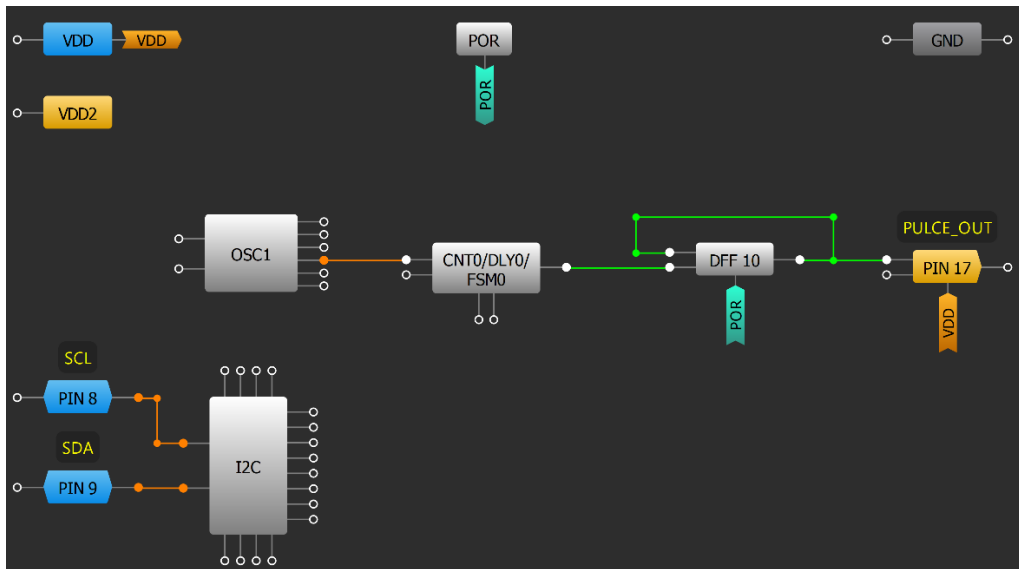


Figure 7: SLG46826 Internal Schematic

The following is a legend for Figure 8:

SLG46811

Channel 1 (yellow/top line) – PIN5 (I2C\_CLK) with external 5kΩ pull up resistor

Channel 2 (light blue/2nd line) – PIN6 (I2C\_DATA) with external 5kΩ pull up resistor

B1 – I2C data decoding

B2 – SPI data decoding

D0 – PIN12 (SPI\_EN)

D1 – PIN11 (SPI\_CLK)

D2 – PIN10 (SPI\_DATA\_IN)

Bidirectional I2C to SPI Bridge

SLG46826

D5 – PIN17 (PULSE\_OUT)

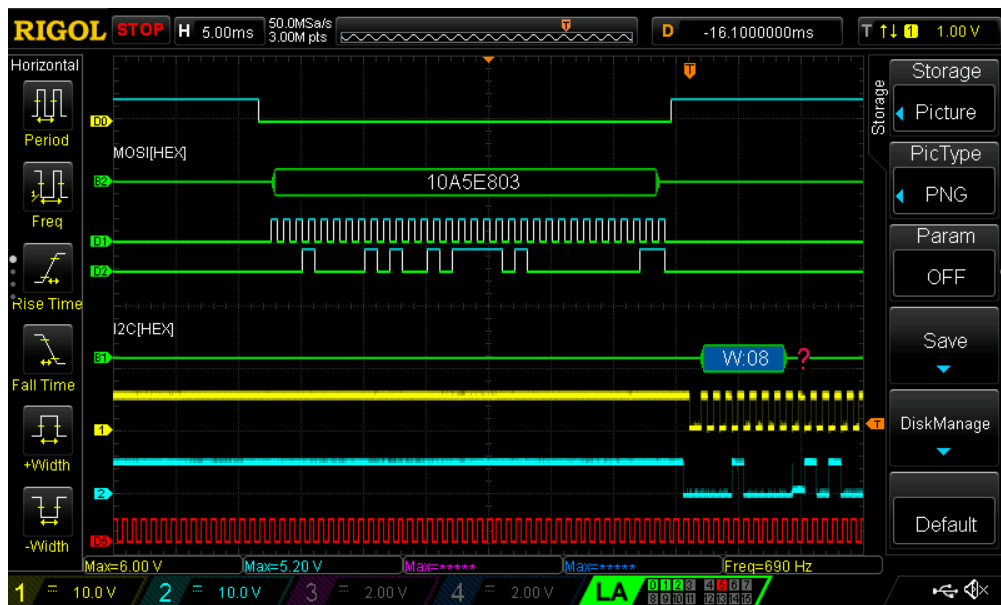


Figure 8: SPI Data Reception

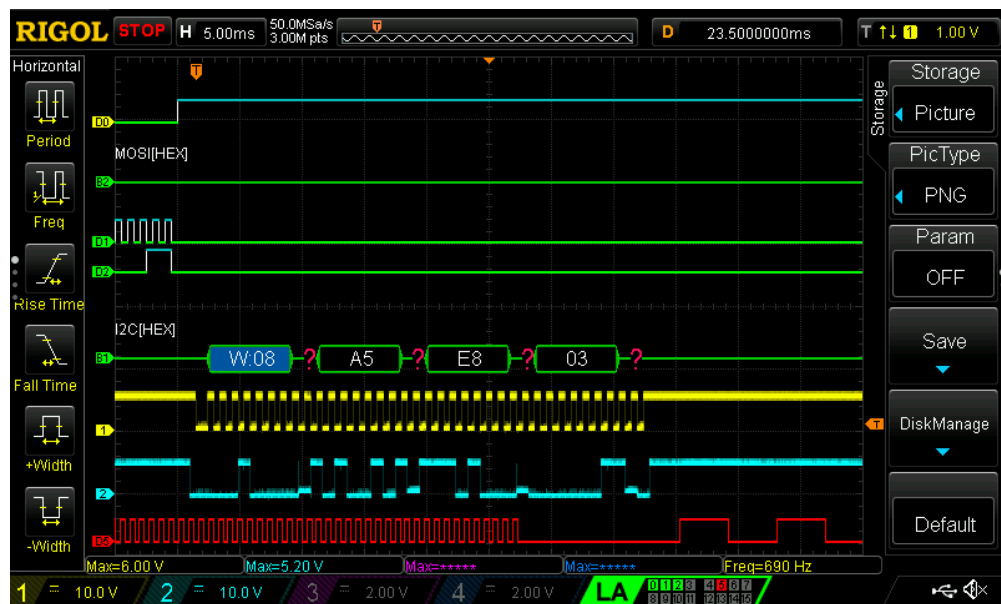


Figure 9: I2C Data Transmission



Bidirectional I2C to SPI Bridge

4.2 I2C Data Reception / SPI Data Transmission

When the nSPI/I2C signal is high, the IC operates in I2C slave / SPI master mode.

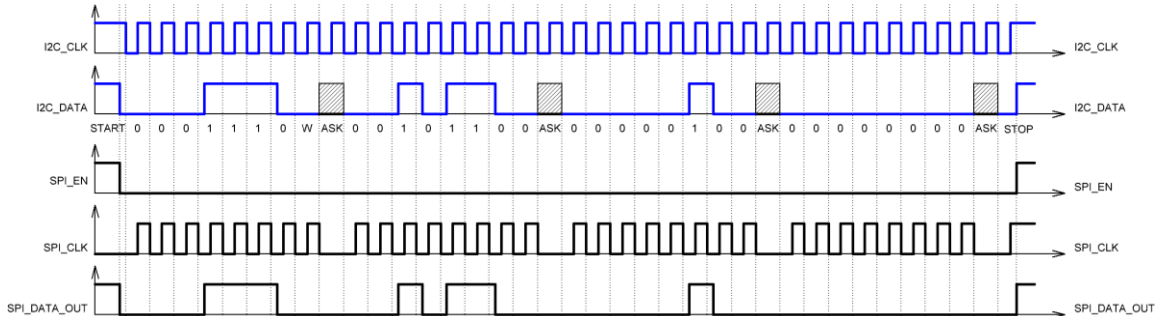


Figure 10: I2C Data Reception / SPI Data Transmission

In this mode, I2C data reception and SPI data transmission occur simultaneously. The following components are used to detect the I2C start / stop combination: P DLY in the EDGE mode of the detector, 3-bit LUT8, 3-L11 and DFF4. When the start combination arrives, the output of the trigger DFF4 goes to 0, which allows the EPG to operate and also activates the SPI\_EN signal. The second part of the EPG generates signals for processing data coming from the I2C, and also generates an ASK response signal. Data from I2C is transmitted immediately to the output SPI\_DATA\_OUT. SPI\_CLK is clocked with I2C\_CLK only for the time of service combinations such as Start, Stop and ASK, when SPI\_CLK clocking is suspended. When the Stop combination arrives, the output of the trigger DFF4 goes to 1, which puts the EPG in the initial state and signals the SPI bus signal SPI\_EN to complete the data transmission. To change the direction of operation, some IC outputs have an output enable (OE) signal.

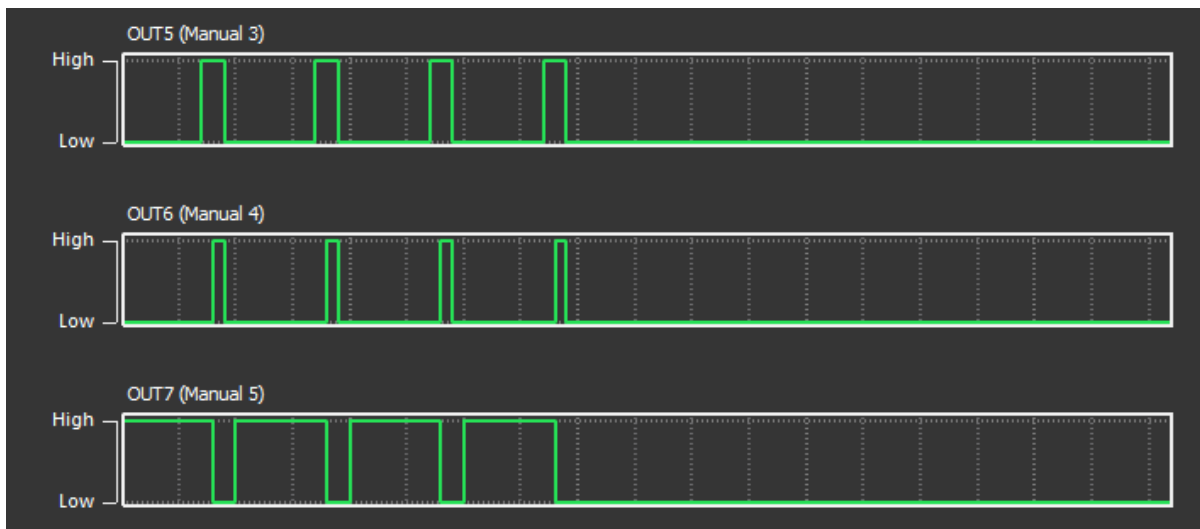


Figure 11: EPG Waveform

For receiving I2C commands and transmitting SPI commands we use EPG signals:

OUT5 – blocks the operation of the detector Start / Stop and inverts the CLK signal of the EPG unit when forming the ASK signal.

OUT6 – generates an ASK signal.

OUT7 – controls the SPI clock.

## Bidirectional I2C to SPI Bridge

The following is a legend for Figure 12:

Channel 1 (yellow/top line) – PIN5 (I2C\_CLK) with external 5kΩ pull up resistor

Channel 2 (light blue/2nd line) – PIN6 (I2C\_DATA) with external 5kΩ pull up resistor

B1 – I2C data decoding

B2 – SPI data decoding

D0 – PIN12 (SPI\_EN)

D1 – PIN11 (SPI\_CLK)

D2 – PIN10 (SPI\_DATA\_OUT)

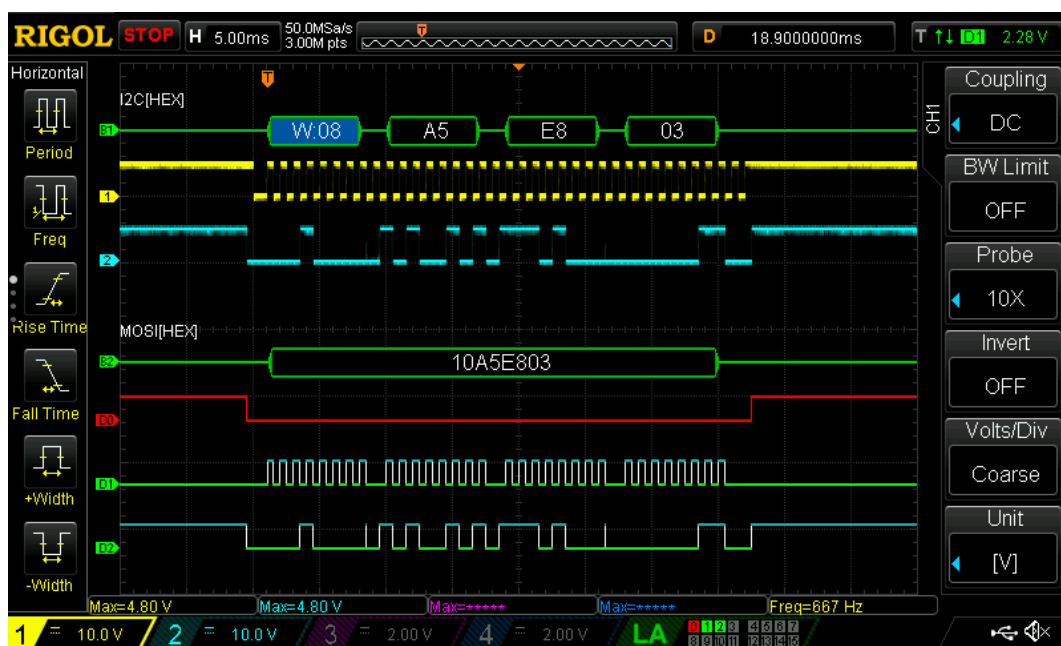


Figure 12: Testing Result

## 5 Conclusion

In this application note, we implemented an I2C/SPI converter using the GreenPAK SLG46811 IC. GreenPAK ICs offer a large number of functional elements to implement a variety of circuit designs. There are more than 50 ICs in the GreenPAK product family, and each has its own special features and functions. They allow for a significant reduction in the number of external circuit elements, and the ability to develop systems with highly specific requirements. Additionally, GreenPAK products enable very rapid design time and provide low power consumption, small board area, and low cost.

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**Bidirectional I2C to SPI Bridge****Revision History**

Revision	Date	Description
1.0	19-Apr-2022	Initial Version

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