DEMO BGT60LTR11AIP software user manual

60 GHz-based radar applications

BGT60LTR11AIP shield V2.0

About this document

Scope and purpose

This user manual describes the firmware and the development recommendations required to build an application around Infineon's "DEMO BGT60LTR11AIP" board, based on the BGT60LTR11(B)AIP MMIC.

It provides guidelines for novice users on how to build and run BGT60LTR11AIP radar applications such as motion detection and direction of movement (approaching or retreating), and also to support ease-of-use and faster-to-market integration.

Intended audience

This document is intended for users of the "DEMO BGT60LTR11AIP" board who want to get started with Infineon's BGT60LTR11AIP firmware solution, test several sensing demonstrations, and implement custom radar applications in the 60 GHz industrial, scientific and medical (ISM) band.

Related documents

Additional information can be found in the supplementary documentation provided with the Radar BGT60LTR11AIP Kit in the Infineon Toolbox, or from **www.infineon.com/60GHz**:

- BGT60LTR11AIP Shield application note (AN608)
- Radar Baseboard MCU7 application note (AN599)
- User's guide to BGT60LTR11(B)AIP MMIC (AN625)
- BGT60LTR11(B)AIP datasheet

Table of contents

List of figures

1 Firmware

1.1 Overview

The radar baseboard MCU7 comes with a default firmware that is intended to serve as a bridge between a host (typically a PC) and the BGT60LTR11AIP RF shield, which is mounted on the sensor connectors. For this, the firmware implements logic to:

- communicate with the host via USB
- read and write sensor registers
- read sensor data via SPI
- check if a sensor board is plugged into one of the connectors
- read and write the EEPROM on the sensor board (for example, to identify the board)
- control some auxiliary peripherals such as status LEDs on the baseboard and RF shield.

The main communication between the radar baseboard MCU7, and the BGT60LTR11AIP RF shield board is a serial peripheral interface (SPI). This SPI interface allows applying configuration parameters to the sensor, and retrieving sensor measurement.

For more details, please refer to the AN599 - Radar Baseboard MCU7 application note.

1.2 SPI MISO arbitration

The BGT60LTR11(B)AIP MMIC V3.0 implements a new internal digital detector, using the internal ADC samples from I/Q signals. Thus, the internal access to the ADC values must be multiplexed with the external SPI access (from the radar baseboard MCU7) , in a process known as “SPI MISO arbitration”.

Note: The SPI MISO arbitration is already implemented on the RBB MCU7 Firmware V1.1.7 (RadarBaseboardMCU7_v117.bin) part of the Radar BGT60LTR11AIP package V2.7.0 (and above) available for download from Infineon Toolbox.

1.2.1 Use cases

The SPI MISO line arbitration is active when:

- BGT60LTR11AIP device is active after hard or soft reset and after boot-up time in any autonomous mode.
- After activation of Pulse mode in SPI Mode (set start_pm (Reg15[14]) bit to “1”)
- After activation of CW mode in SPI Mode (set start_pm (Reg15[14]) bit and start_cw (Reg15[12]) bit to “1”)

The SPI MISO line arbitration is by default in High-Z after reset, to avoid disturbance in Multi-Client SPI setup, and needs to be set explicitly into driving mode by setting miso_drv (Reg15[6]) bit to “1”, to be active outside SPI access.

So, the consequences are:

- If the BGT60LTR11(B)AIP registers needs only to be set once, before Pulse mode is activated, MISO arbitration could be ignored. Recommended to use Hard-Reset pin, instead of Soft-Reset via Reg15, to avoid SPI access.

- If the BGT60LTR11(B)AIP registers needs to updated when device is “running”, MISO line arbitration needs to respected.
- If a clear synchronization to the RF-Pulse is wanted, the MISO arbitration could be used. Synchronization could be setup, just before starting Pulse mode. (with raising edge of MISO indicates a good sampling point),
- If already “div-out”-RF-Pulse-sync is used or implemented, it could still be continued to be used.

For more details on the BGT60LTR11(B)AIP MMIC registers, please refer to the BGT60LTR11(B)AIP datasheet.

1.2.2 Implementation

In this section, we detail the MISO arbitration implementation, running on the RadarBaseboardMCU7_v117.bin Firmware, and then can be implemented in any other MCU, in order to support the BGT60LTR11(B)AIP MMIC.

If MISO arbitration is required to be implemented, then you need best a raising and falling edge IRQ on GPIO line. Multiplexing on MISO pin should be considered.

Also, the implementation of a GUARD timer is highly recommended, to prevent access some time before the next pulse is required. If only a **defined** sequence of SPI accesses is performed, and if it is ensured that the arbitration timing is ensured, the usage of a guard time might be neglected.

Here below the recommended procedure to synchronize the access with the pulsing.

After starting Pulse/CW Mode, register raising edge IRQ, to sync with pulse; block-out SPI access.

1. Wait for raising edge on MISO (via IRQ):
    a. Deactivate raising edge IRQ
    b. Start Guard timer with “pulse repletion rate – guard time”
    c. Activate falling edge IRQ
2. After falling edge:
    a. Deactivate falling edge IRQ
    b. MCU SPI communication allowed
    c. Start read-out of internal ADC registers (Reg40 and Reg41) if needed
    d. Perform other SPI register access
3. Guard Timer expires:
    a. Block SPI communication
    b. Activate raising edge IRQ

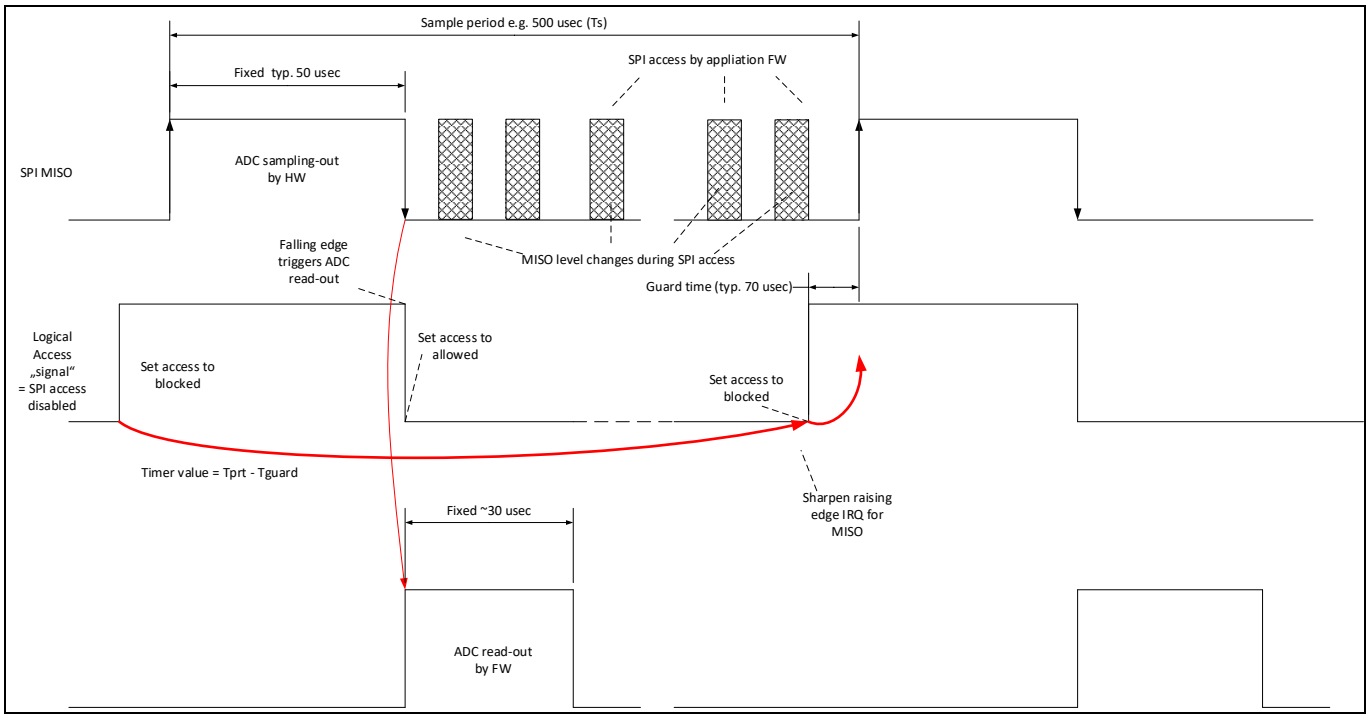

Figure 1 Time diagram – synchronized SPI access

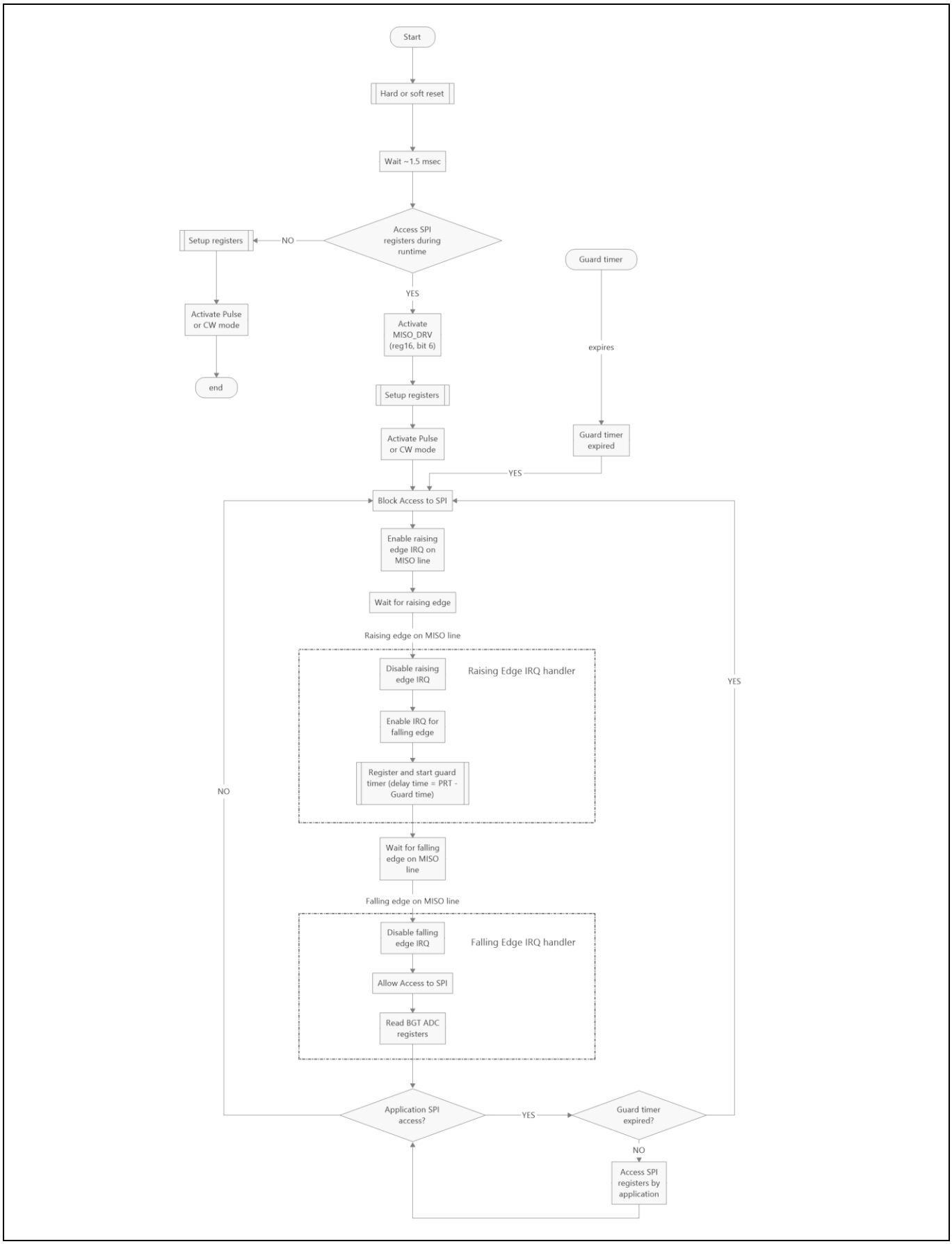

Figure 2 SPI arbitration flow diagram

Please note that:

- MISO line is high-Z if CS is inactive (default)
- MISO arbitration can be enabled via miso_drv (Reg15[6]) bit.
- Without respecting MISO arbitration device functionality is **NOT** ensured.
- Only I/Q channel (Reg40 and Reg41) is sampled via internal state machine. For other ADC channels explicit ADC conversion needs to be triggered manually.
- If external ADC is used for sampling, the best time for Sample&Hold activation would be at raising edge of MISO arbitration signal. Conversion could be done later.

Here below a typical access screenshot in Figure 2.

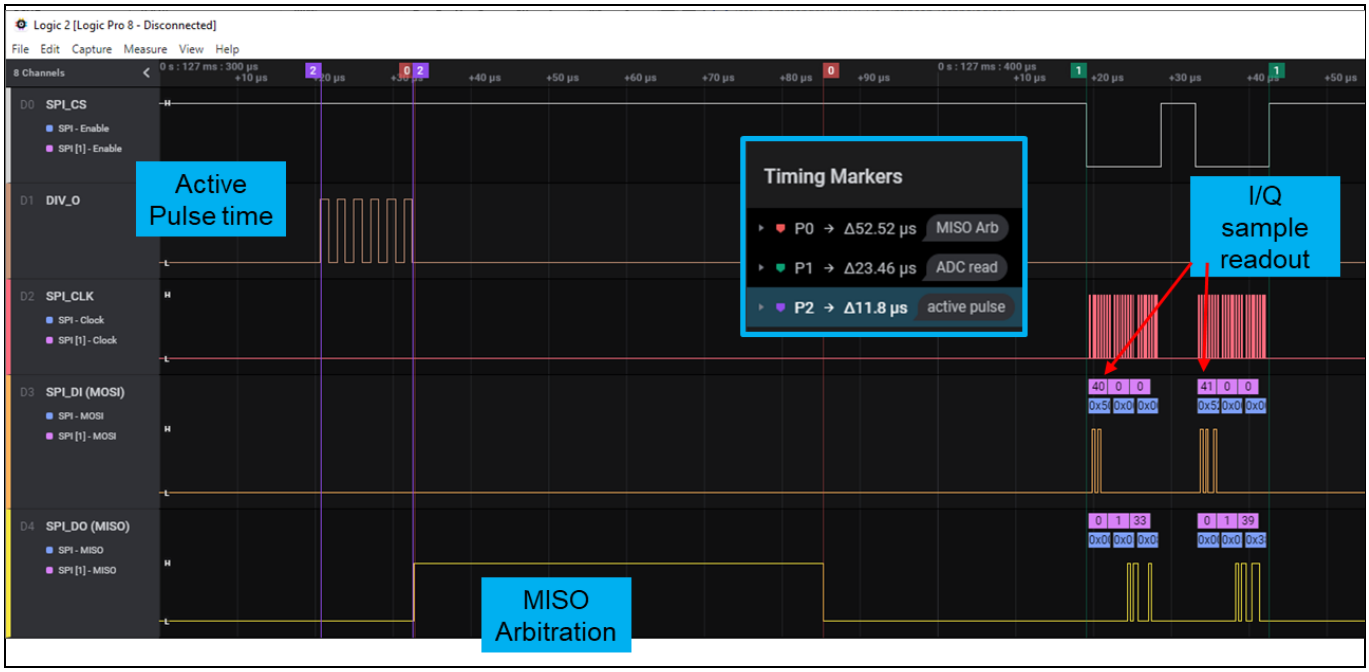

Figure 3 Typical SPI access

2 Python Wrapper

2.1 Overview

This Python module allows you to easily access the Infineon BGT60LTR11(B)AIP radar sensor, part of the “DEMO BGT60LTR11AIP” board. The main functionality includes:

- Configuring the BGT60LTR11(B)AIP and reading back the configuration.
- Fetching the IFI and IFQ signal.
- Reading the status of the internal motion detector.
- Reading and writing arbitrary registers of the BGT60LTR11(B)AIP.
- Performing a soft-reset.

2.2 Hardware setup

Please make sure that the BGT60LTR11AIP RF shield is plugged into the socket of the RadarBaseboardMCU7 board on the upper side (side 1; the side with the black Atmel microcontroller). For RF shield V2.0, it's also possible to connect it to the backside (side2). The white filled circle on the BGT60LTR11AIP shield should be next to the white filled circle on the RadarBaseboardMCU7 board.

Connect the RadarBaseboardMCU7 using a USB cable to your computer. On success, when motion is detected, the LED on the RadarBaseboardMCU7 will be red if the target is departing and green if the target is approaching (off if no target is detected).

The green LED on the BGT60LTR11AIP shield will be on if a target was detected.

The red LED of the BGT60LTR11AIP shiel will be on if the target is departing from the sensor.

2.3 Dependencies

This wrapper requires a 64bit version of Python and numpy. The wrapper works on Windows 10 and Ubuntu 20.04. You can install numpy either using pip

```
$ pip install numpy
```

or you can install the Anaconda Python distribution which includes among others

the numpy module: https://www.anaconda.com/products/individual

2.4 Documentation

You can view this documentation using pdoc:

```
$ pdoc -d numpy ./ltr11.py
```

3 Authors

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Revision history

Document version	Date of release	Description of changes
V1.0	2021-10-11	Initial version
V1.1	2021-11-17	Added support of BGT60LTR11BAIP MMIC version

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