mTrigger™: Trigger Signal Board

User Manual

2020. 7.

WITHROBOT Inc.

Revision History

Rev	Date	Description	Author
1.0	2019. 4	1st Release	PD
1.1	2020. 7	External Trigger Polarity Change	PD

Note

This product is for indoor use only. Severe electrostatic stress can damage the product.

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1. INTRODUCTION

Features

mTrigger is a user programmable trigger signal generating board which can be used for any applications that require external trigger source. mTrigger is fully compatible with the external trigger cameras from WITHROBOT Inc., such as oCam-1CGN-U-T and oCam-1MGN-U-T.

mTrigger supports 4 trigger modes as follows.

Reference	Time Synch.	Modes	Details
Internal	Synchronous	Internal Synchronous	Provides 8 time-synchronized autonomous trigger signals.
	Asynchronous	Internal Asynchronous	Provides 8 time sequential autonomous trigger signals.
External	Synchronous	External Synchronous	Provides 8 time-synchronized trigger signals driven by an external signal source.
	Asynchronous	External Asynchronous	Provides 8 time sequential trigger signals driven by an external signal source.

Multiple mTriggers can be connected in a cascade manner to provide unlimited number of trigger signals as follows.

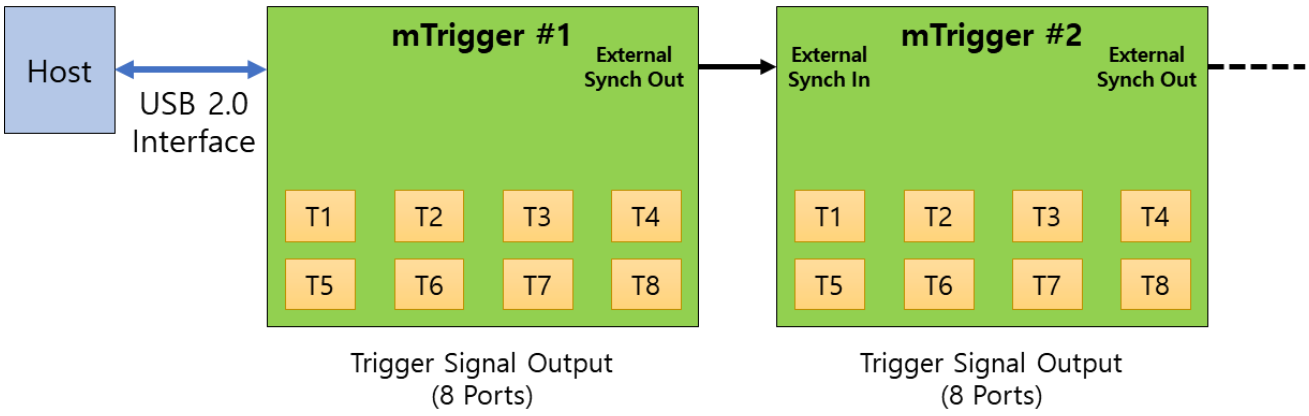


Figure 1. Cascade connection of multiple mTrigger boards

The major specifications of the mTrigger are as follows.

Item	Value
Number of Outputs	8 for each mTrigger board
Output Level	Low Level: 0V / High Level: 5V
External Source Input Level	Low Level: 0V / High Level: 5V
Deviation between Time-synchronized Trigger Signal Outputs	3 μsec or less
Range of Trigger Pulse Period(user programmable)	5 msec ~ 30,000 msec
Range of Interval between Trigger Pulse(user programmable)	0 msec ~ 30,000 msec
Range of Asynchronous Trigger Pulse Width(user programmable)	5 msec ~ 30,000 msec
Range of Number of Trigger Pulses(user programmable)	0 ~ 30,000 pulses

The internal structure of the mTrigger is as follows.

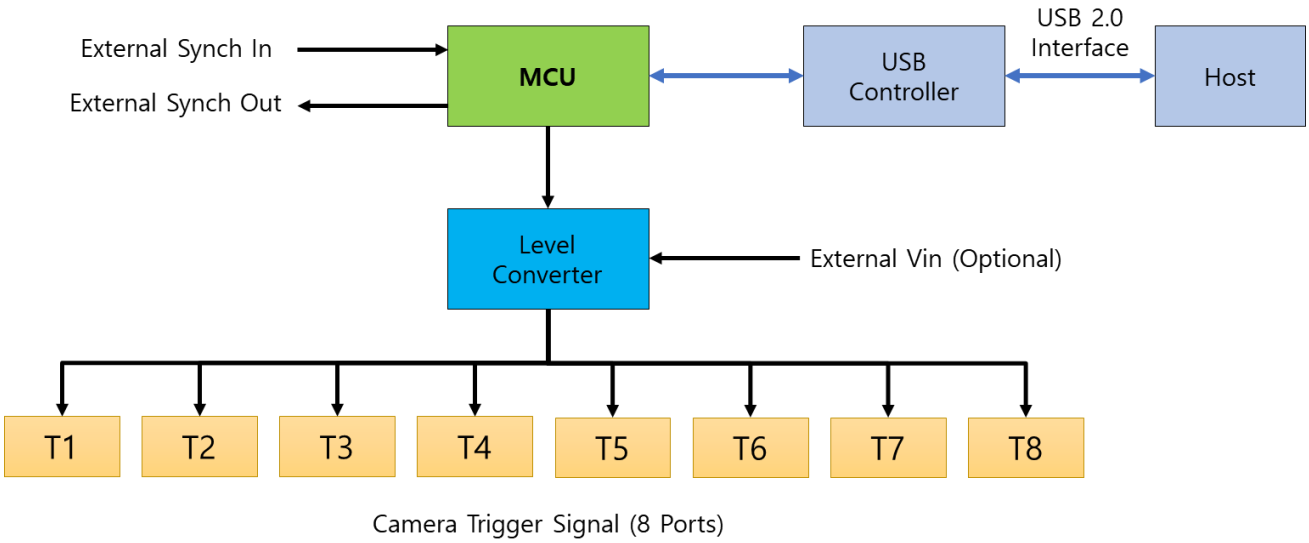


Figure 2. Internal structure of mTrigger

2. HARDWARE DESCRIPTION

Input / Output / Selection

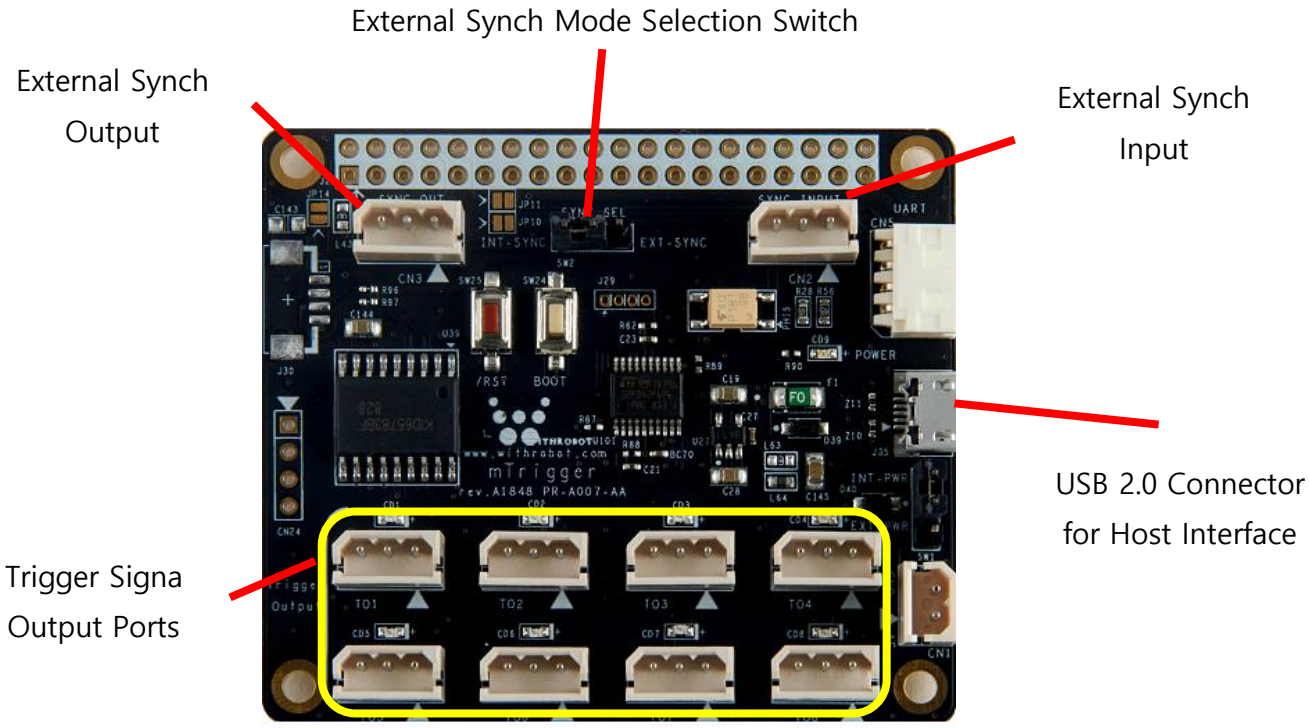


Figure 3. Input / Output / Selection of mTrigger

Pin Description

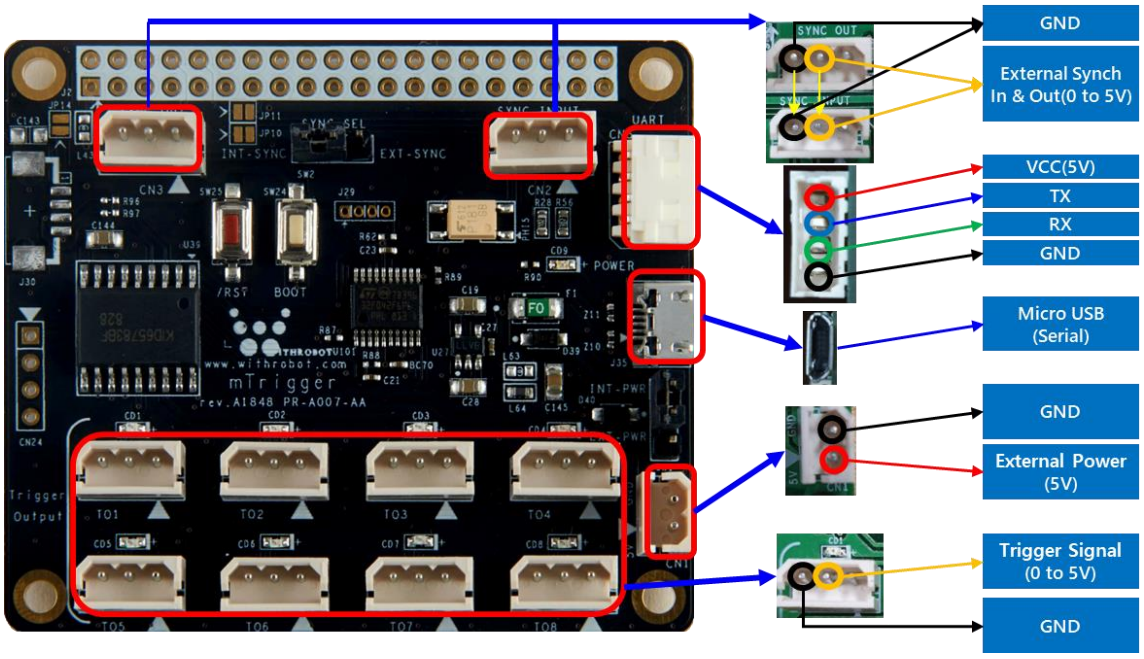


Figure 4. Pin description

Board(PCB) Dimension

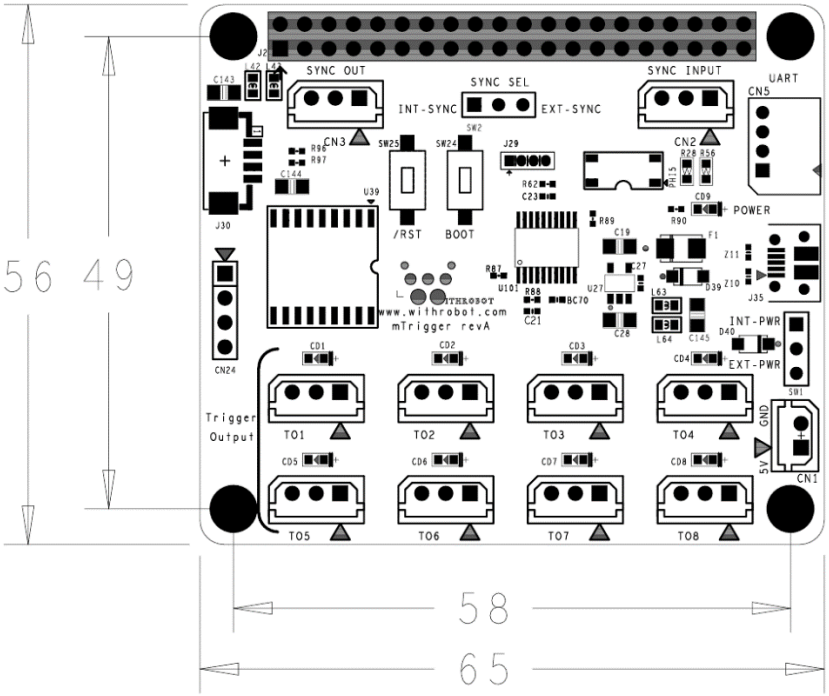


Figure 5. Board dimension (Unit: mm)

3. TRIGGER MODES DESCRIPTION

Reference Signal: Internal / External

The mTrigger supports both of the internal reference mode and the external reference mode. In the internal reference mode, mTrigger generates trigger signals based on the parameters set by a user. In the external reference mode, mTrigger generates trigger signals based on an external reference signal.

The "S1" (synchronous) or "S2" (asynchronous) command starts the trigger signal generation in the internal reference mode. To stop the trigger signal, use "S3" command.

The "M1" (synchronous) or "M2" (asynchronous) command starts the trigger signal generation in the external reference mode. For this mode, the trigger signal is stopped when the external reference signal stops to come in.

With an external synch signal, the mTrigger generates the trigger signal with the same polarity as the external reference signal as shown in the next diagram.

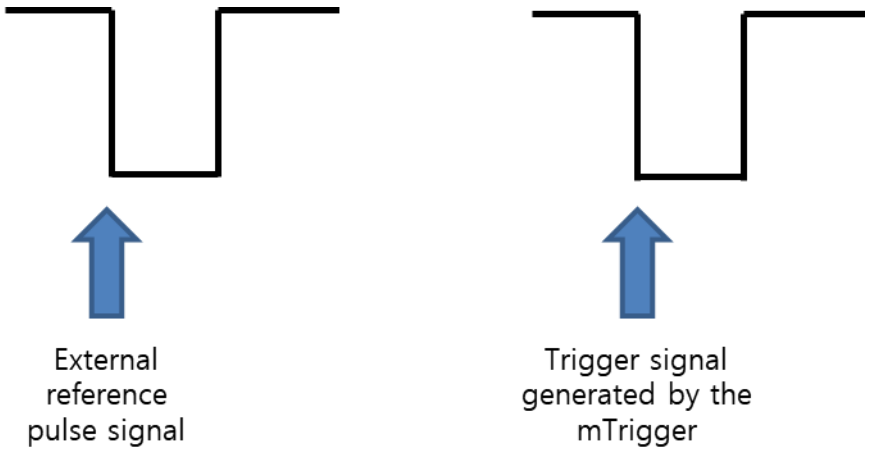


Figure 6. Timing and polarity relationship between the external reference signal and the trigger signal of mTrigger

Time Alignment of Trigger Signal: Synchronous / Asynchronous

The mTrigger supports the synchronous mode in which the trigger pulses are generated at the same time and the asynchronous mode in which the trigger pulses are generated sequentially.

(1) Synchronous Trigger Mode

The mTrigger provides 8 trigger signals at the same time where the detailed parameters can be set by a user.

- Pulse Frequency(F): Period of pulses, 5 ~ 30,000 msec

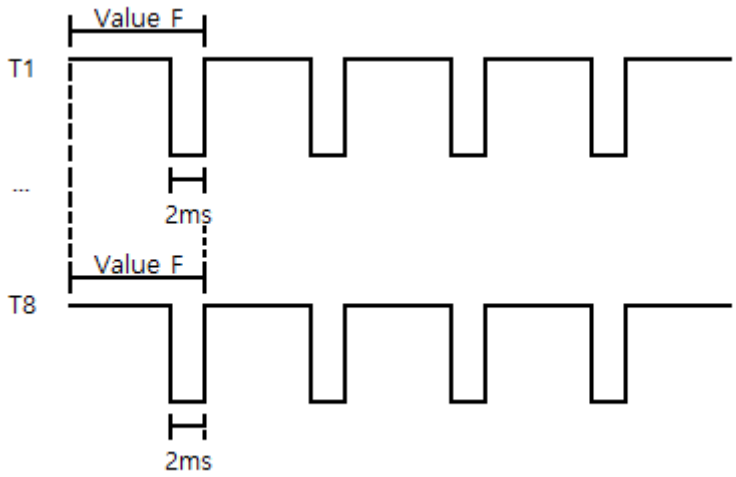


Figure 7. Pulse timing diagram in the synchronous mode

(2) Asynchronous Trigger Mode

The mTrigger provides 8 trigger signals sequentially where the detailed parameters can be set by a user.

- Pulse Width(W): Duration of a trigger pulse. This corresponds to the time between the start command and the rising edge of the trigger signal, 5 ~ 30,000 msec
- Pulse Interval Time(T): The time interval between the adjacent trigger pulses, 0 ~ 30,000 msec
- Number of Pulses(N): Number of pulses generated on one start command, 0 ~ 30,000

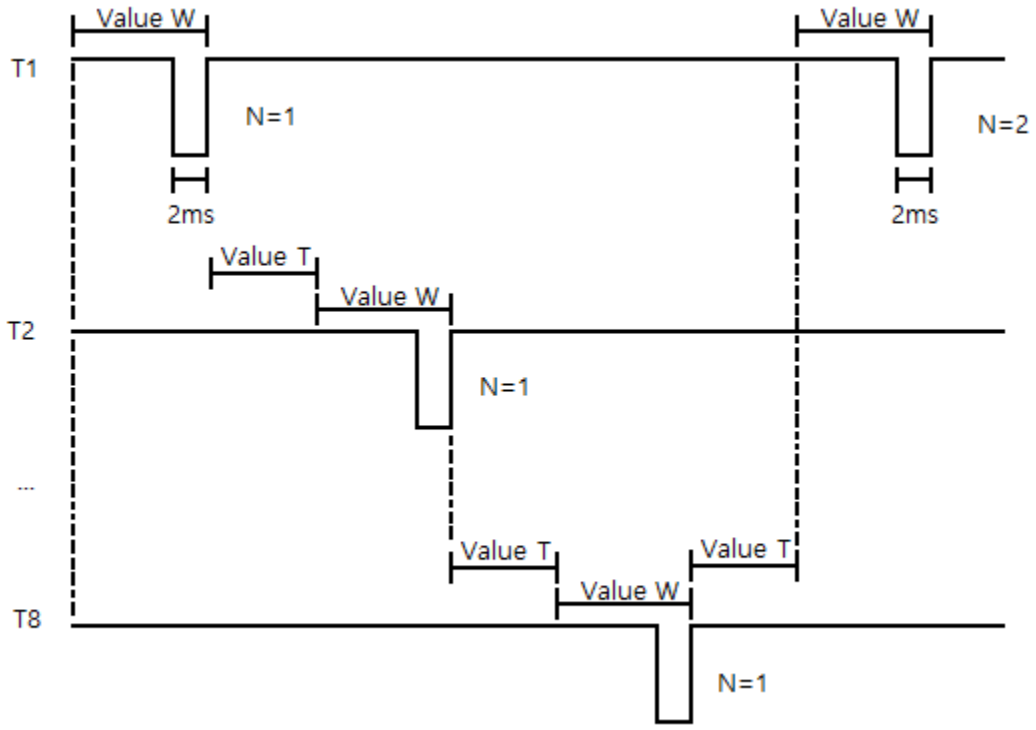


Figure 8. Pulse timing diagram in the asynchronous mode

For example, with N = 2, all of the 8 output ports will provide trigger pulses in sequential mode two times, to make the total number of pulses to be 8 x 2 = 16.

The length of the low level of trigger signal is set to be 2 msec, therefore the length of high level of each trigger pulse signal will be W – 2 msec. For example, with W = 100, the trigger signal will be maintained to be high for 100 – 2 = 98 msec.

The parameters should be saved by "S4" command before pressing the reset button to start the asynchronous mode.

Transfer of External Reference Signal: Direct and Indirect

In the cascade connection of multiple mTrigger boards, the reference signal can be transferred to the next mTrigger board either in direct mode or in indirect mode.

The selection is made by inserting the jumper pin to the desired pair of pins of the mTrigger board. When the jumper pin is inserted to connect the two pins on "EXT-SYNC", the reference

signal will be transferred directly to the next mTrigger board, while with the "INT-SYNC" selection, the reference signal will be transferred to the next mTrigger board indirectly.

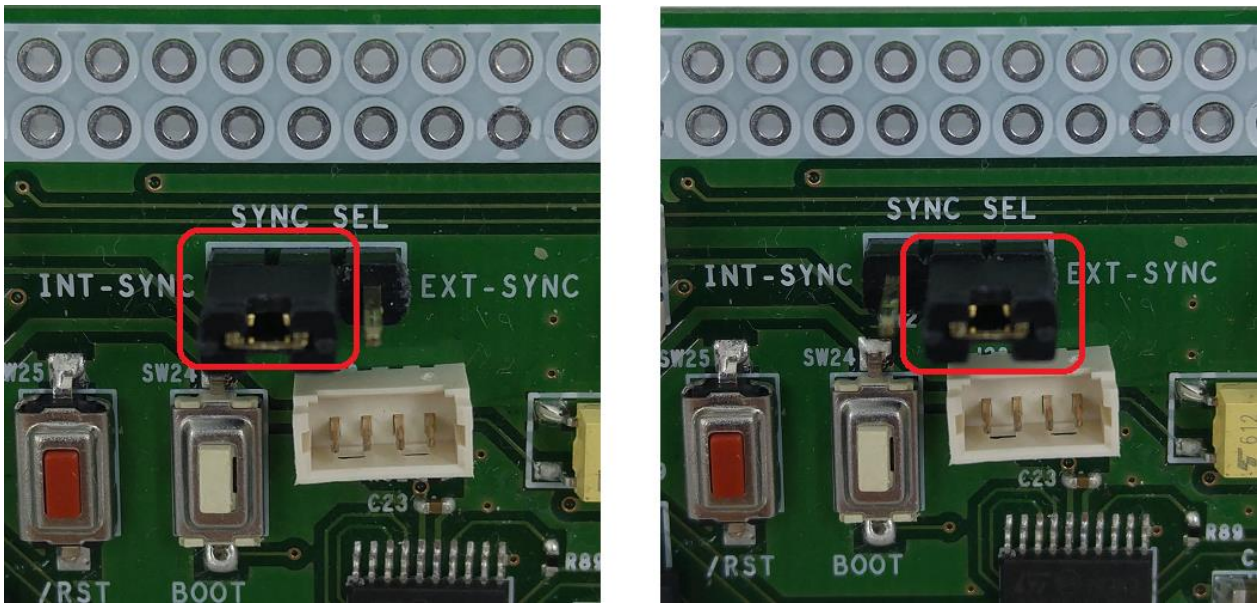


Figure 9. Selection of reference signal transfer mode: indirect(left) and direct(right)

(1) Indirect Transfer Mode

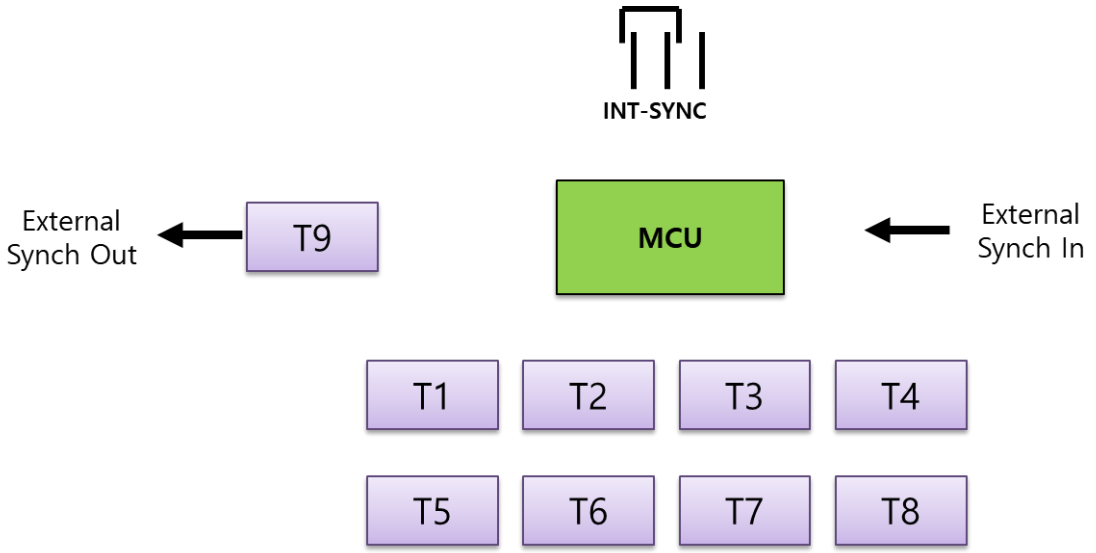


Figure 10. Transfer of reference signal in indirect mode (INT-SYNC)

In the indirect transfer mode, the "External Synch Out" port provides a trigger signal just like a 9th pulse by the processor of the mTrigger board. Therefore, in the asynchronous mode, the signal transferred to the next mTrigger board will be generated sometime later after the 8th trigger pulse from the T8 port. In this way, all of the trigger pulses from the multiple mTrigger

boards connected in cascade mode will be generated in sequential mode. On the contrary, in the synchronous mode, all the 9 ports will generate the trigger pulses at the same time

(2) Direct Transfer Mode

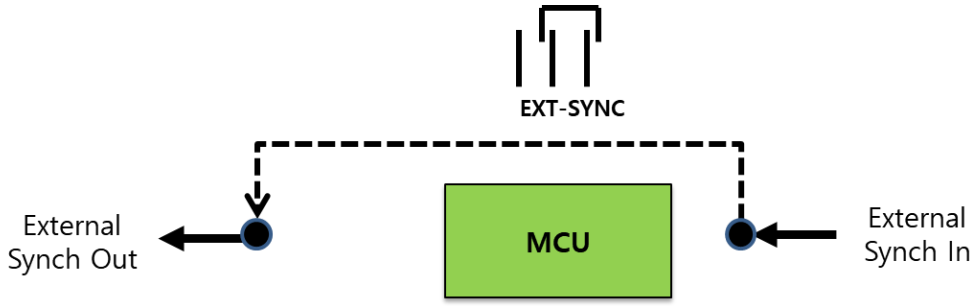


Figure 11. Transfer of reference signal in direct mode (EXT-SYNC)

In the direct transfer mode, the signal coming out from the "External Synch Out" port will be driven by the signal coming in the "External Synch In" port, without the intervention of the processor of the mTrigger board.

Parameter of Each Mode

(1) Internal Synchronous Trigger Mode

The mTrigger provides time synchronous 8 pulses controlled by the onboard processor.

- Reference Source: Autonomous operation controlled by the onboard processor
- Pulse Counts: Infinite number of pulses until the stop command is issued
- Mode Setup: S1 command
- Start of Operation: On S1 command
- Parameters:
  - Pulse Period(F), 5 ~ 30,000 msec

(2) External Synchronous Trigger Mode

The mTrigger provides time synchronous 8 pulses based on external reference signal.

- Reference Source: External reference signal coming in the “SYNC INPUT” port.
- Pulse Counts: 8 synchronized pulses to each one external reference pulse input.
- Mode Setup: M1 command.
- Start of Operation: On external signal reception.
- Parameters:
  - Pulse Period(F), 5 ~ 30,000 msec

(3) Internal Asynchronous Trigger Mode

The mTrigger provides time sequential 8 pulses controlled by the onboard processor.

- Reference Source: Autonomous operation controlled by the onboard processor
- Pulse Counts: Infinite number of pulses until the stop command is issued
- Mode Setup: S2 command
- Start of Operation: On S2 command
- Parameters:
  - Pulse Width(W), 5 ~ 30,000 msec
  - Pulse Interval Time(T), 0 ~ 30,000 msec
  - Number of Pulses(N), 0 ~ 30,000

(4) External Asynchronous Trigger Mode

The mTrigger provides time sequential 8 pulses based on external reference signal.

- Reference Source: External reference signal coming in the “SYNC INPUT” port.
- Pulse Counts: 8 sequential pulses to each one external reference pulse input.
- Mode Setup: M2 command.
- Start of Operation: On external signal reception.

- Parameters:
  - Pulse Width(W), 5 ~ 30,000 msec
  - Pulse Interval Time(T), 0 ~ 30,000 msec
  - Number of Pulses(N), 0 ~ 30,000

4. COMMANDS DESCRIPTION

General Specification

The mTrigger is set and controlled through the USB 2.0 interface from the host system. The commands are in ASCII format with "1 character command" + "Variable length parameters" + "End of message of CR(0x0D)LF(0x0A)" structure.

Parameter Setup Commands

Command	Description	Example
F	Set pulse period in synchronous mode.	F100: To set pulse period of 100 msec
W	Set pulse width in asynchronous mode.	W200: To set pulse width of 200 msec
T	Set pulse interval in asynchronous mode	T500: To set pulse interval of 500 msec
M	Set synchronous or asynchronous mode in external reference mode	M1: To set synchronous mode for external reference mode M2: To set asynchronous mode for external reference mode
N	Set number of pulses in asynchronous mode	N10: To set 10 counts for external reference mode

Action Commands

Command	Description
S1	Start the internal synchronous mode
S2	Start the internal asynchronous mode
S3	Stop the internal reference mode, synchronous and asynchronous
S4	Save the parameters for external reference mode

Error Codes

Code	Name	Description
E101	New line error	Linefeed(LF, 0x0A) is missing in command
E102	Value error	Parameter is out of valid range
E103	Start error	Command is issued without necessary parameters set
E104	Save error	Save command is issued without setting parameters
E105	Command error	Invalid command
EXXX	Unknown Error	Unknown error

Use Cases

Mode	Example Procedure
Internal Synchronous	● Check if no cable is connected to the external synch input connector (SYNC INPUT) ● Connect USB 2.0 cable between the mTrigger and a host system ● Connect trigger signal cable between the mTrigger and the external trigger cameras (Ex. oCam-1CGN-U-T) ● Issue "F" command with pulse period value. Ex. F100 ● Issue "S1" command to start the pulse output ● Issue "S3" command to stop the pulse output
Internal Asynchronous	● Check if no cable is connected to the external synch input connector (SYNC INPUT) ● Connect USB 2.0 cable between the mTrigger and a host system ● Connect trigger signal cable between the mTrigger and the external trigger cameras (Ex. oCam-1CGN-U-T) ● Issue "W" command with pulse width value. Ex. W200 = 200 msec ● Issue "T" command with pulse interval value. Ex. T300 = 300 msec ● Issue "N" command with pulse count value. Ex. N10 = 10 times ● Issue "S4" command to save the parameters. ● Press the reset button to restart the mTrigger ● Issue "S2" command to start the pulse output. ● Issue "S3" command to stop the pulse output

Mode	Example Procedure
External Synchronous	● Check if a cable is connected between the external synch input connector (SYNC INPUT) and a signal source (Ex. another mTrigger) ● Connect USB 2.0 cable between the mTrigger and a host system ● Connect trigger signal cable between the mTrigger and the external trigger cameras (Ex. oCam-1CGN-U-T) ● Issue "M1" command to set the external reference synchronous mode. ● Issue "S4" command to save the parameters. ● Press the reset button to restart the mTrigger ● Apply external signal to mTrigger.
External Asynchronous	● Check if a cable is connected between the external synch input connector (SYNC INPUT) and a signal source (Ex. another mTrigger) ● Connect USB 2.0 cable between the mTrigger and a host system ● Connect trigger signal cable between the mTrigger and the external trigger cameras (Ex. oCam-1CGN-U-T) ● Issue "W" command with pulse width value. Ex. W200 = 200 msec ● Issue "T" command with pulse interval value. Ex. T300 = 300 msec ● Issue "N" command with pulse count value. Ex. N10 = 10 times ● Issue "M2" command to set the external reference asynchronous mode. ● Issue "S4" command to save the parameters. ● Press the reset button to restart the mTrigger ● Apply external signal to mTrigger.

5. HOW TO USE ON WINDOWS SYSTEM

Connection to Windows PC

Connect USB 2.0 cable between the micro USB connector (J35) of the mTrigger board and a Windows PC. The mTrigger should be recognized without installing any device driver. This can be checked under the Ports (COM & LPT) in the Device Manager as shown below.

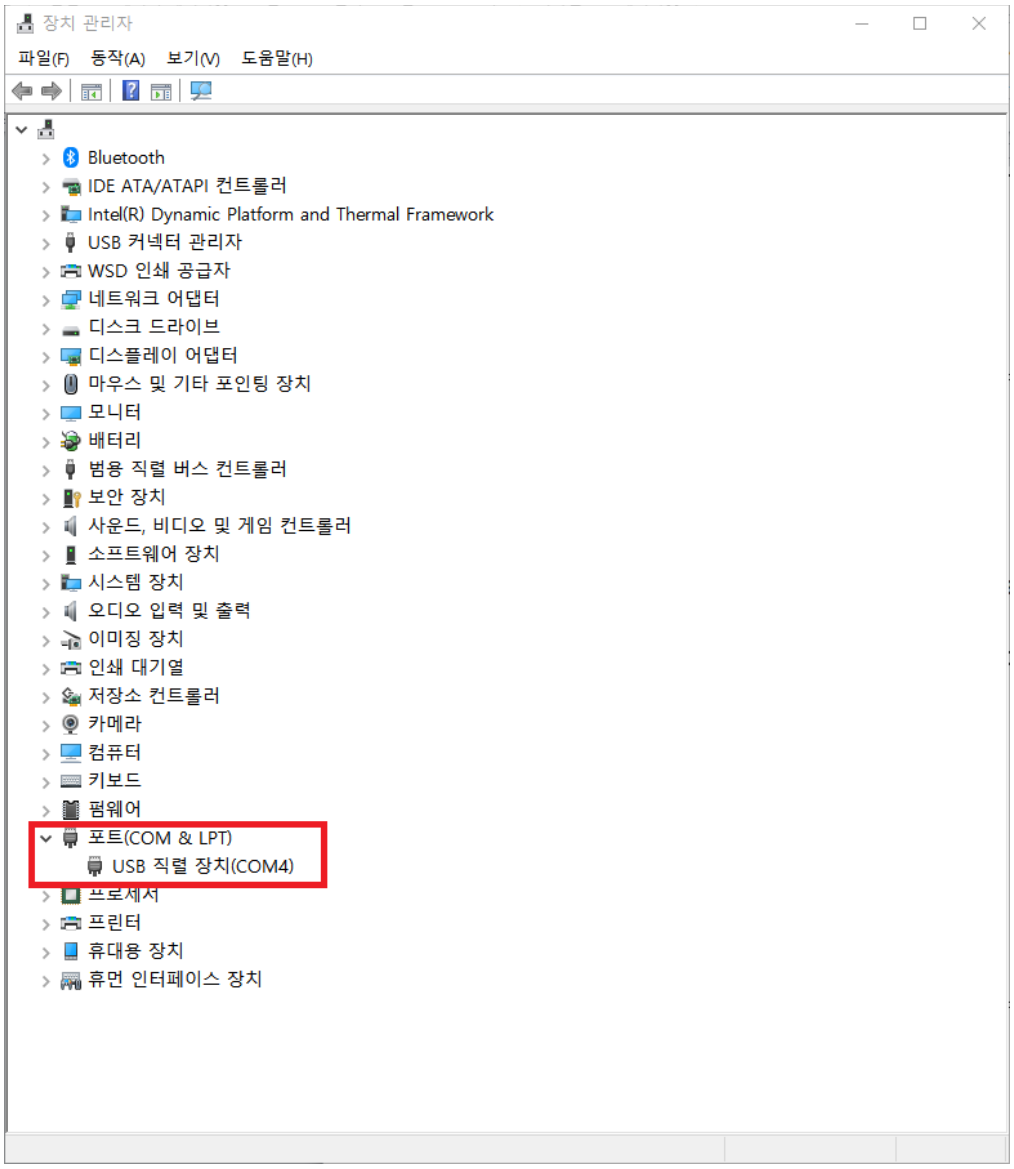


Figure 12. Connection check in the Device Manager (example of Windows 10)

How to Send Commands

Any terminal programs can be used to issue commands to the mTrigger. Here, the ComPortMaster program from WITHROBOT Inc. is used for explanation.

- The ComPortMaster can be downloaded from the following site.
  - http://withrobot.com/en/technical-data/?uid=23&mod=document&pageid=1

(1) COM Port Setup

Select the COM port identified in the Device Manager and set the Baudrate to be 115,200.

(2) Command Transmission

- Check the ASCII mode and Auto CR/LF mode.
- After compose a command, click [Send] button to send the command.
- Check the "Recv" window to monitor the return message from the mTrigger..

Use Examples

(1) 8 Synchronous Trigger Pulses with Single mTrigger Board

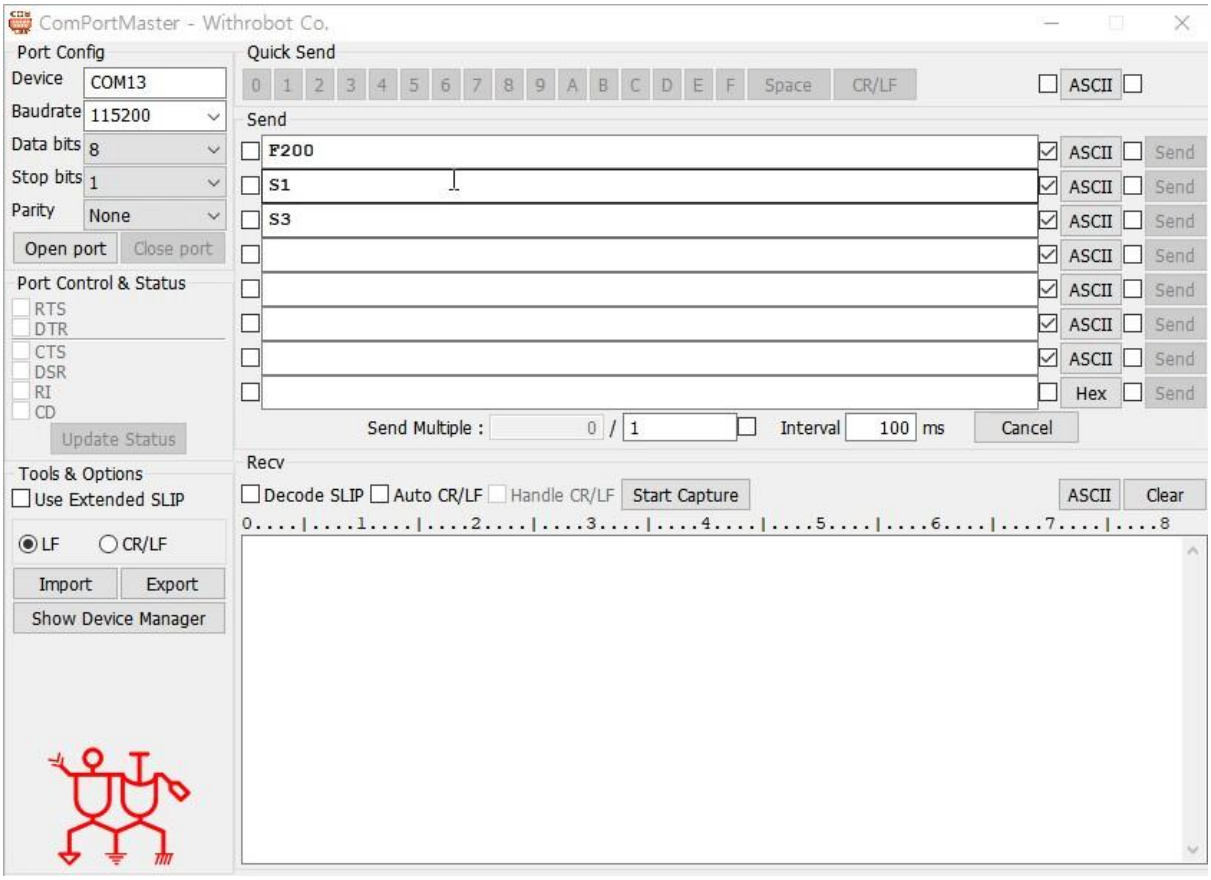


Figure 13. Setup for the internal reference synchronous mode with one mTrigger

- F200: To set trigger pulse of 200 msec pulse period.
- S1: To set and start mTrigger to generate 8 synchronous pulse signals.
- S3: To stop the trigger pulse signals.

(2) 8 Sequential Trigger Pulses with Single mTrigger Board

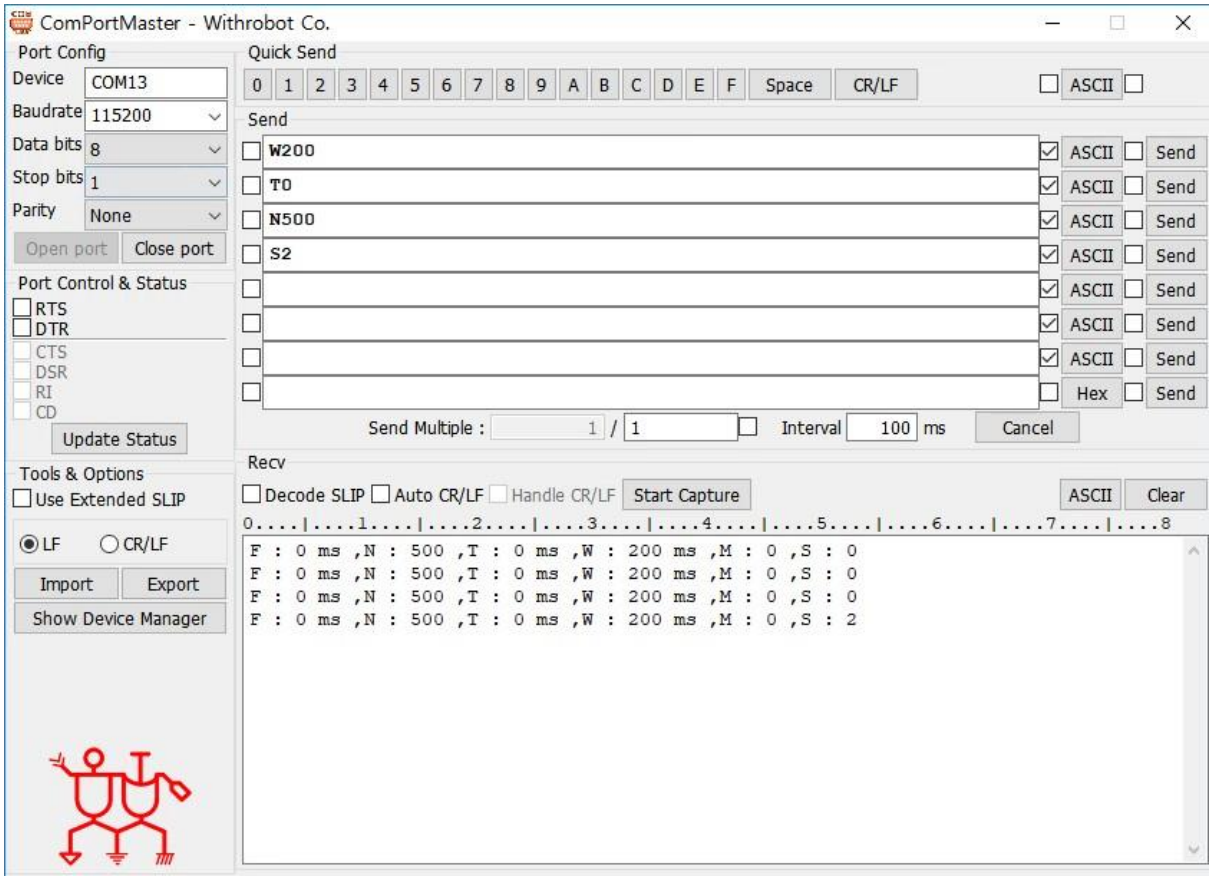


Figure 14. Setup for the internal reference asynchronous mode with one mTrigger

- W200: To set trigger pulse width of 200 msec
- T0: To set trigger pulse interval of 0 msec
- N500: To set pulse count of 500.
- S2: To set and start mTrigger to generate 8 sequential pulse signal pulses.

(3) 16 Synchronous Trigger Pulses with Two mTrigger Boards

In this example, the master board is set for internal synchronous mode and the connected slave board is set for external reference synchronous mode.

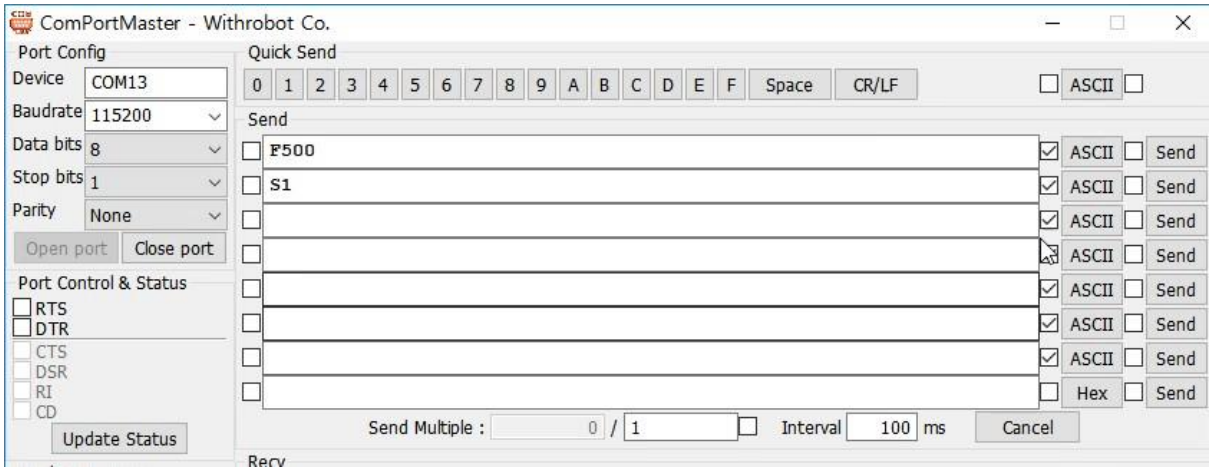


Figure 15. Setup for the internal reference synchronous mode for the master mTrigger board

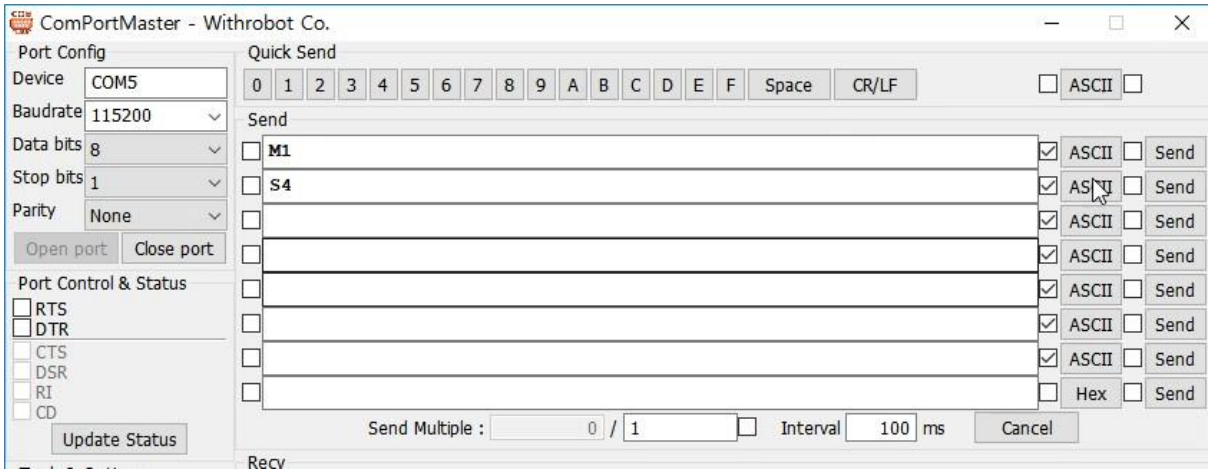
- F500: To set trigger pulse of 500 msec pulse period.
- S1: To set and start mTrigger to generate 8 synchronous pulse signals.
- 

Figure 16. Setup for the external reference synchronous mode for the slave mTrigger board.

- M1: To set for external reference synchronous mode.
- S4: To save the parameters.
- Press the reset button to restart the mTrigger.

(4) 8 Synchronous Trigger Pulses and 8 Asynchronous Trigger Pulses with Two mTrigger Boards

In this example, the master board is set for internal synchronous mode and the connected slave board is set for external reference asynchronous mode.

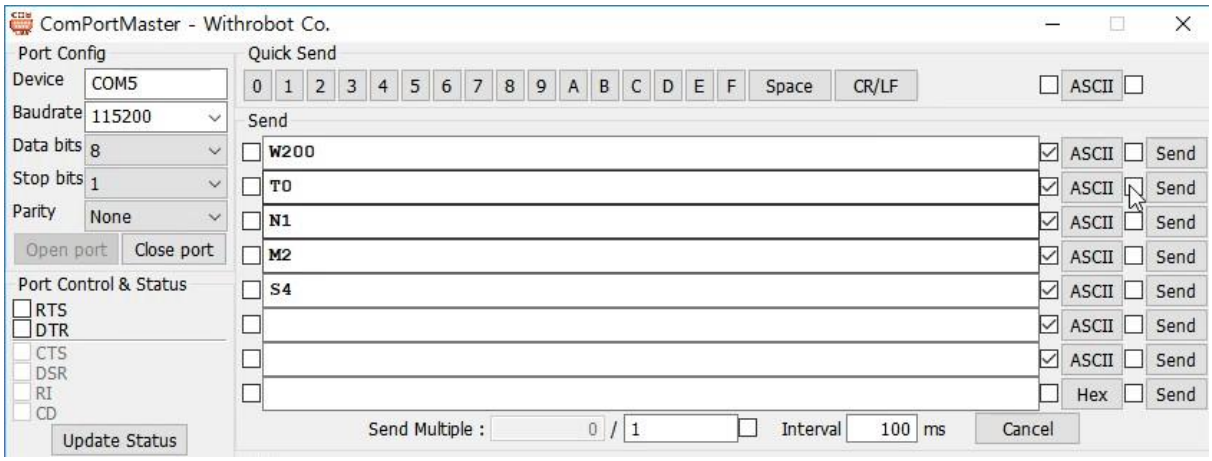


Figure 17. Setup for the external reference asynchronous mode for the slave mTrigger board

- W200: To set trigger pulse of 200 msec pulse width.
- T0: To set trigger pulse of 0 msec pulse interval.
- N1: To set pulse count of 1.
- M2: To set for external reference asynchronous mode.
- S4: To save the parameters.
- Press the reset button to restart the mTrigger.

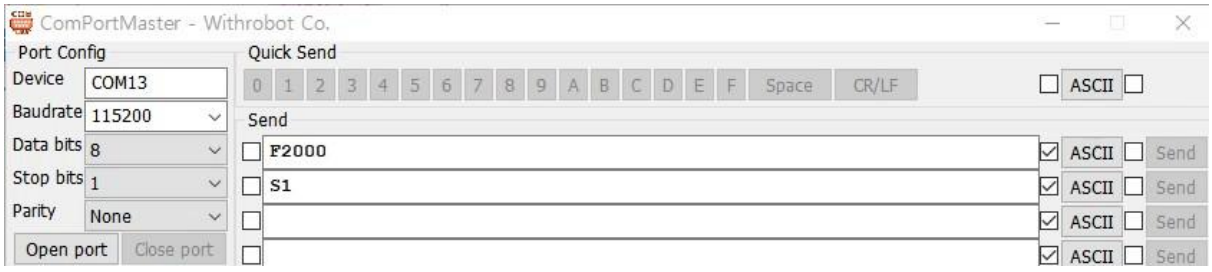


Figure 18. Setup for the internal reference synchronous mode for the master mTrigger board

- F2000: To set trigger pulse of 2,000 msec pulse period.
- S1: To set and start mTrigger to generate 8 synchronous pulse signals

6. HOW TO USE ON LINUX SYSTEM

Connection to Linux PC

Connect USB 2.0 cable between the micro USB connector (J35) of the mTrigger board and a Linux PC.

How to Send Commands

Any terminal programs can be used to issue commands to the mTrigger. Here, two terminal windows are used for explanation, one for sending command and the other for checking the reply from the mTrigger.

(1) Command Terminal

Open a terminal window and send the commands using the "echo" command to the "ttyACM0" device as follows.

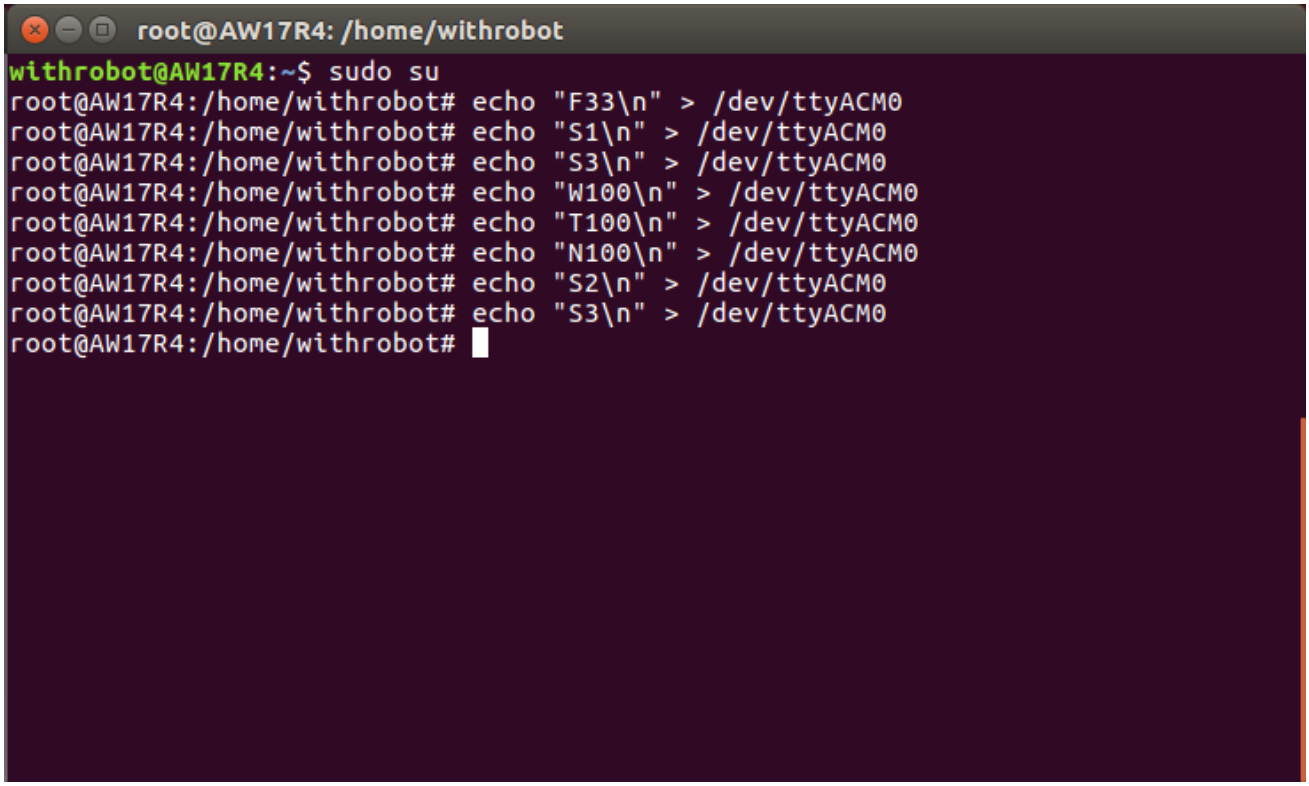


Figure 19. Terminal window to send commands

(2) Reply Monitor Terminal

Open a terminal window and check the reply messages coming from the mTrigger as follows

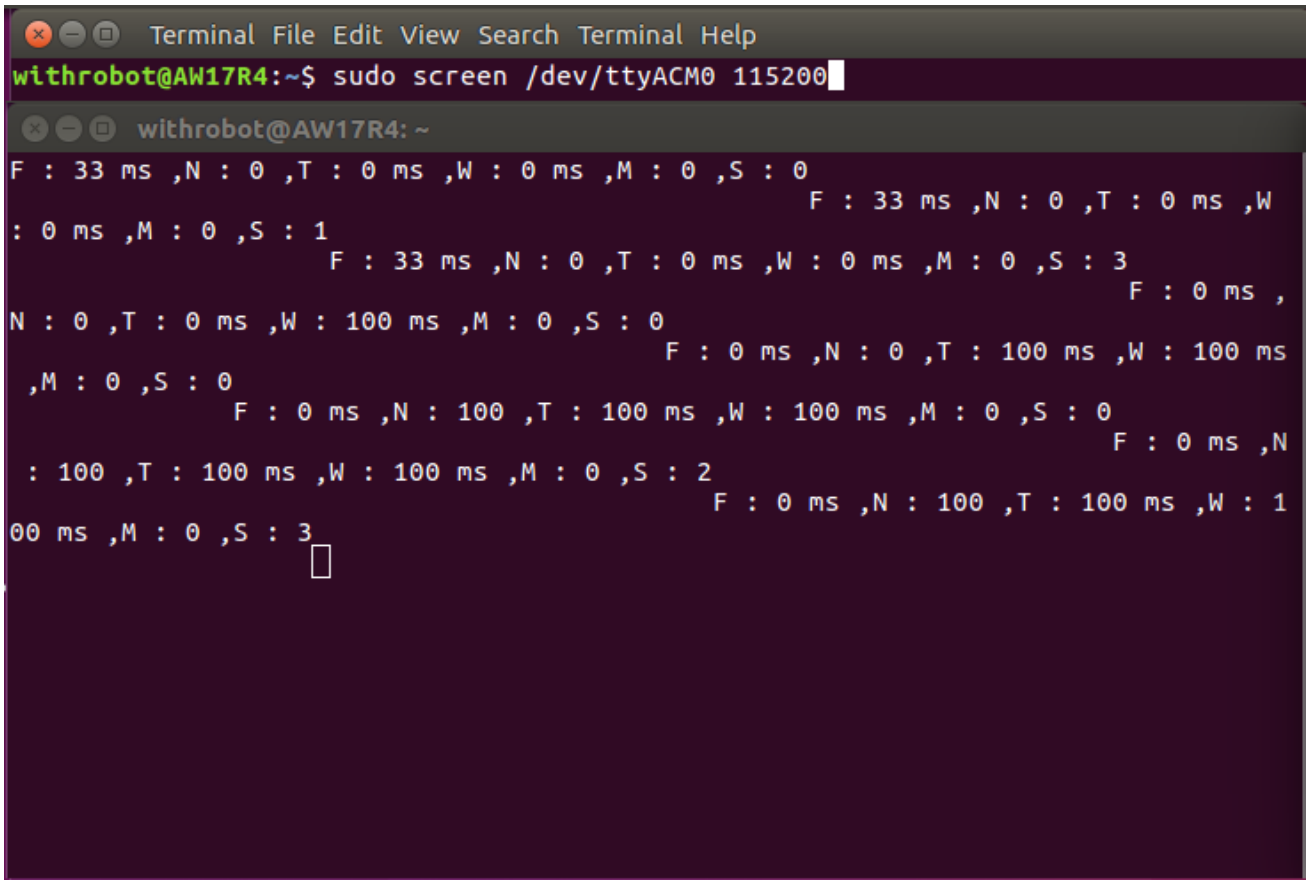


Figure 20. Terminal window to monitor the reply messages

7. ACTUAL SIGNAL WAVEFORMS

Synchronous Trigger Signal

The waveform shown below is an example of synchronous trigger signals generated by the mTrigger.

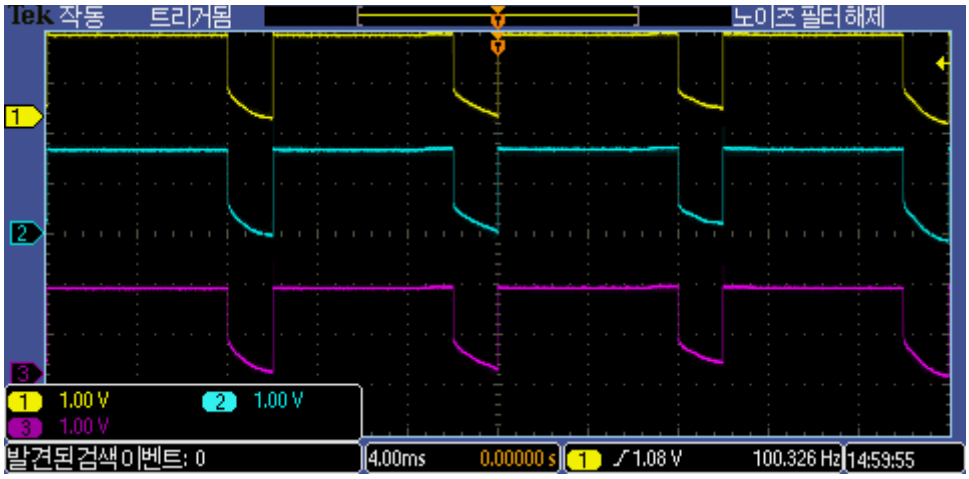


Figure 21. Actual waveform of synchronous trigger signals of mTrigger

The following is the zoom-in waveform of the rising edges of the synchronous trigger signals. In this example, the time difference between the trigger channel 1 and the trigger channel 2 is about 2 μsec. In the synchronous mode, the deviation between two adjacent trigger signals is within 3 μsec and for all the trigger signals, the total deviation is within 21 μsec.

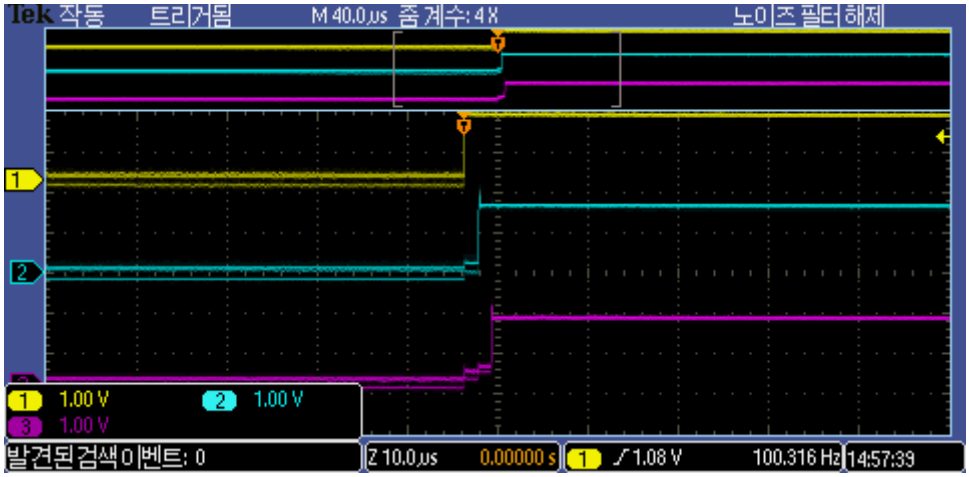


Figure 22. Zoom-in waveform of rising edges of synchronous trigger signals

The waveform shown below is an example of asynchronous trigger signals generated by the mTrigger which is set for trigger pulse interval of 5 msec and the trigger pulse width of 10 msec.

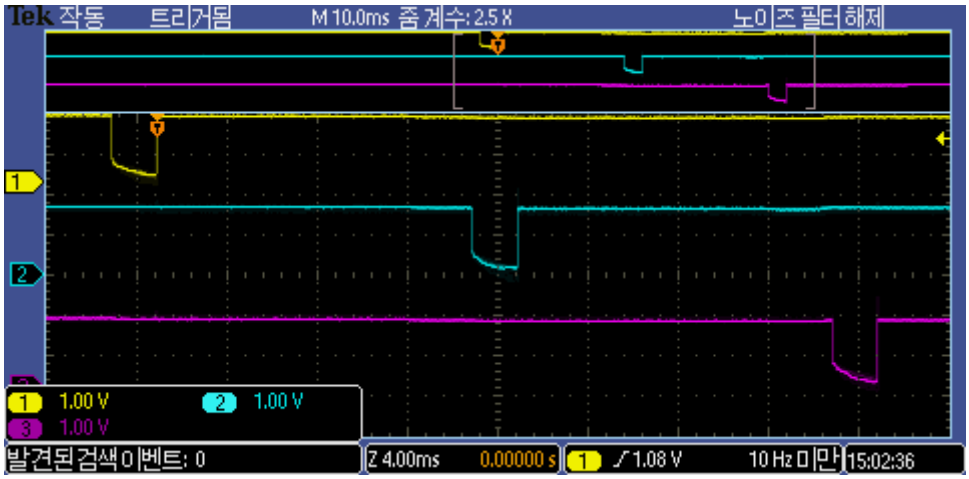


Figure 23. Actual waveform of asynchronous trigger signals of mTrigger

8. NOTES

Limit of Save Counts

The command “S4” is used to save the parameters to the flash memory of the mTrigger. Therefore, the number of stable saving will be limited to about 10,000 times due to the flash memory characteristics.

9. HOW TO UPDATE THE FIRMWARE

Preparation of Downloading Program

The downloading program, Dfuse Demo, is available at the following site.

https://www.st.com/en/development-tools/stsw-stm32080.html#getsoftware-scroll

Preparation of Firmware

The latest firmware is available at the following site.

https://github.com/withrobot/oCam/tree/master/Firmware/mTrigger

Cable Connection

Connect the mTrigger with a host with a USB 2.0 cable. On successful connection, the mTrigger should appear as a device under the Port (COM & LPT) as shown in the Figure 12.

Download the Firmware

- When the "Dfuse Demo" starts, there will be no device in the "Available DFU Devices" as shown in the below.

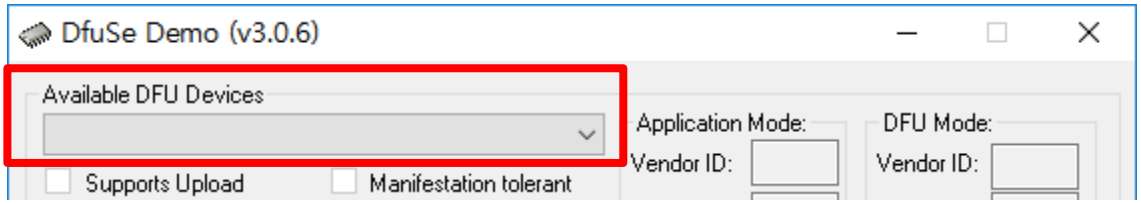


Figure 24. Initial look of the Dfuse Demo program

- While pressing the "Boot" button of the mTrigger, press the "Reset" button simultaneously.

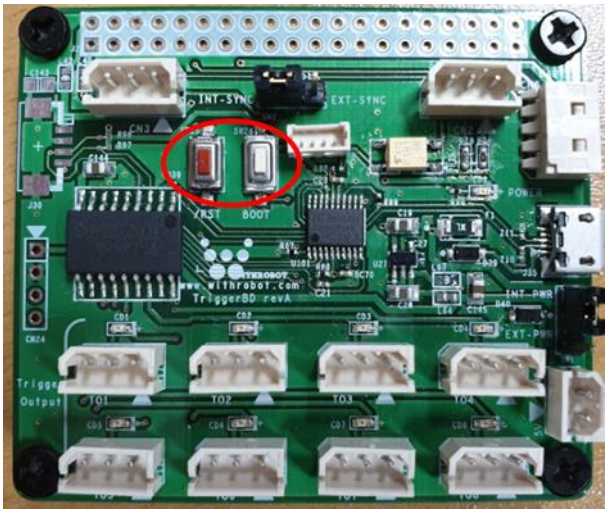


Figure 25. "Boot" button and "Reset" button

- On successful connection of the mTrigger, "STM Device in DFU Mode" should appear under "Available DFU Devices".

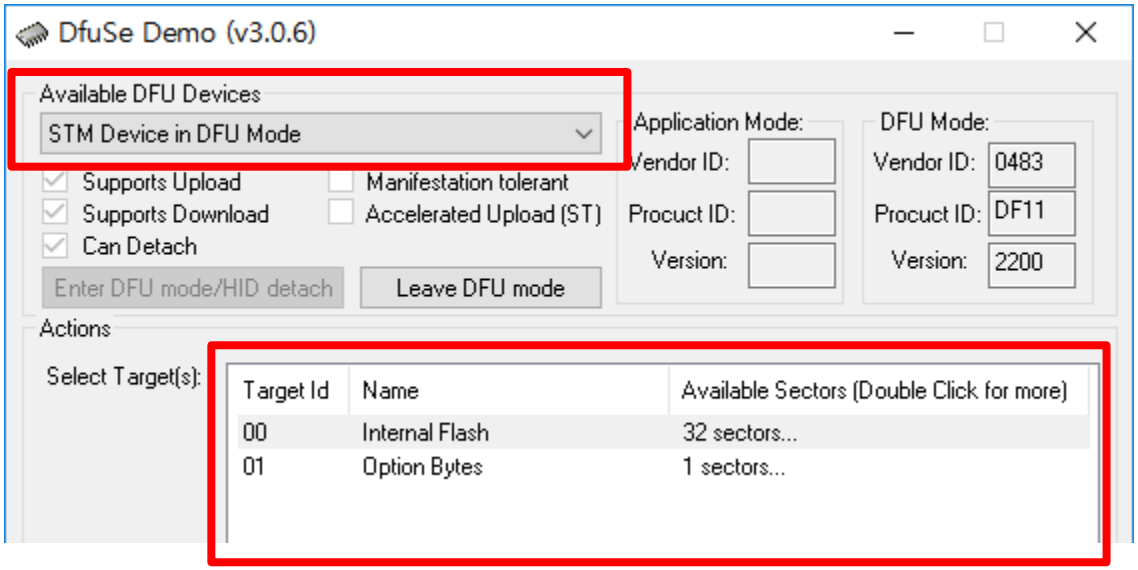


Figure 26. On successful connection of mTrigger

- Click [Choose] button to select a firmware.

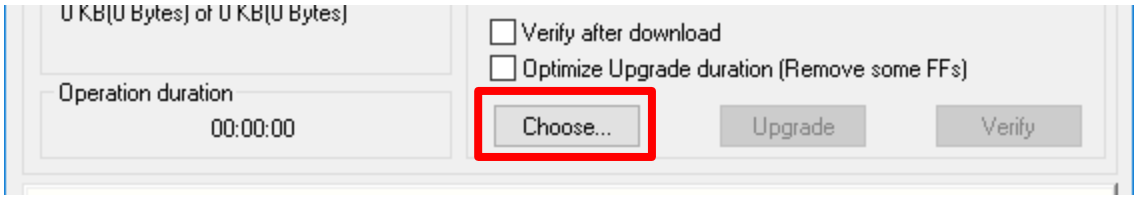


Figure 27. Firmware selection

- Click [Upgrade] button to start the update process. On successful completion, a notify window will appear as shown below.

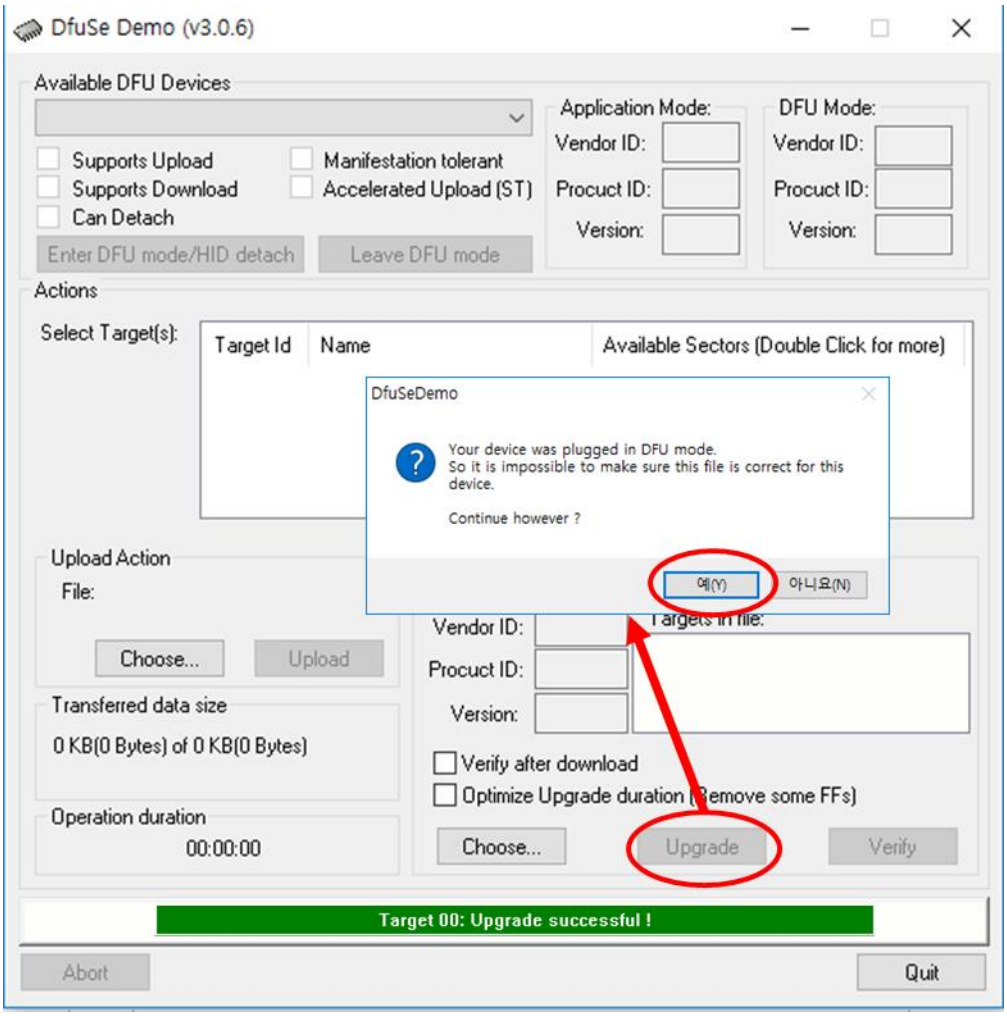


Figure 28. Successful update notify window

APPENDIX: OCAM CAMERA EXTERNAL TRIGGER SIGNAL

Trigger Signal Specifications

The external trigger cameras of WITHROBOT Inc., oCam-1CGN-U-T and oCam-1MGN-U-T, capture the image on the falling edge of the external trigger signal pulse and it is required to maintain the low level at least 1 msec. Therefore the mTrigger is implemented to maintain the low trigger level for 2 msec.

Trigger Signal Connector Specifications

The oCam trigger cameras accept the external trigger signal through the 3-pin connector on the back side of the camera. The pin descriptions are as follows:

- Pin 1: Signal ground
- Pin 2: For trigger signals in the range of 3V ~ 5V DC
- Pint 3: For trigger signals in the range of 5V ~ 24V DC

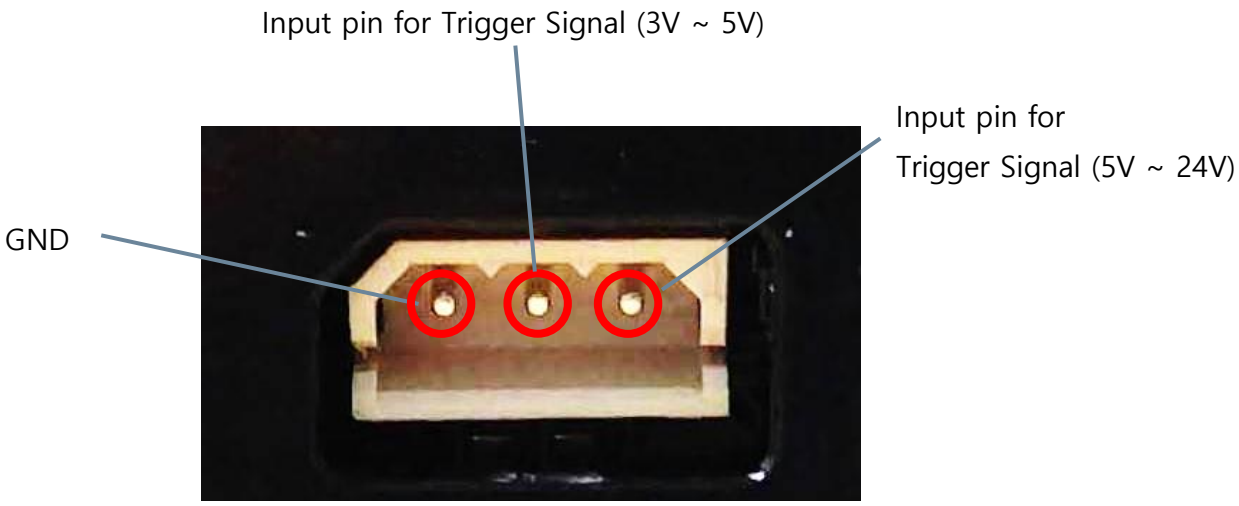


Figure 29. Pin description of the external trigger input signal connector

The circuit diagram of external trigger input is shown in the next figure. The input pins and the internal circuit are isolated with a photo coupler. Therefore, the external input trigger signal needs to supply more than 2 mA current to activate properly the trigger.

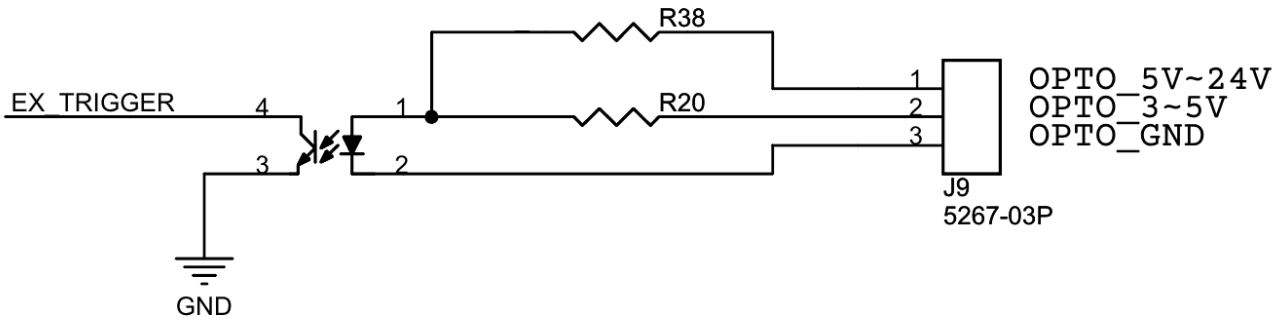


Figure 30. Trigger input circuit

Camera Trigger Modes

The oCam cameras support the following 3 trigger modes.

One Shot Mode

With this mode, the camera acquires one frame of image. The trigger signal should maintain the low level at least 1 msec(T1).

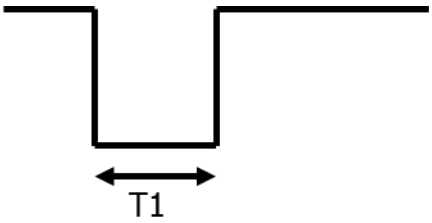


Figure 31. One shot mode

Multi Shot Mode

With this mode, the camera acquires multiple frames of images. The interval between the two adjacent trigger pulses should be at least 2 msec (T2). To get images as specified by the trigger signal frequency, it is needed to set the camera speed at least twice the trigger signal frequency. If the camera speed is set below this, the trigger signal will be applied while the previously acquired image frame is being transmitted. For example, to apply 30 Hz trigger signal, the camera should be set at least 60 fps.

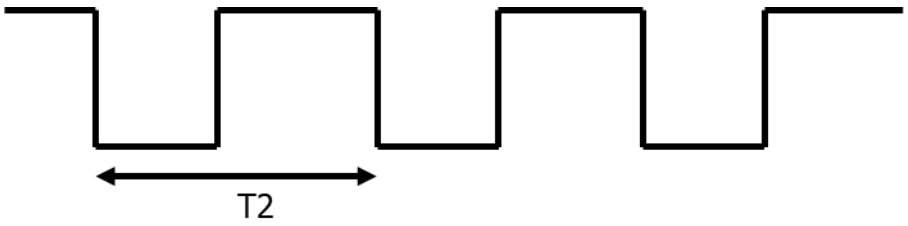


Figure 32. Multi shot mode

Continuous Mode

With this mode, the camera acquires images continuously at the interval set as camera speed. For example, in the following figure, the camera starts to acquire the image after the trigger signal goes low and acquires the images at the interval of T3 set as the camera fps. When the trigger signal goes high, the camera stops to acquire the images.

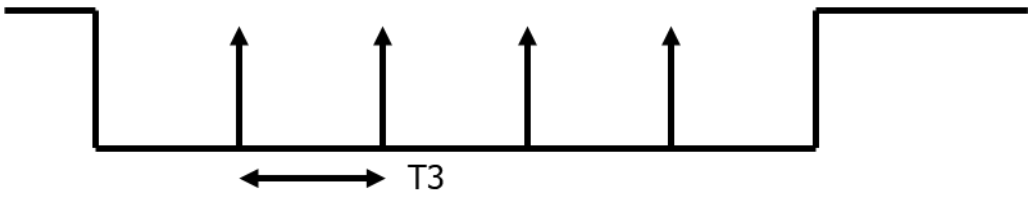


Figure 33. Continuous mode

Technical Support

- E-Mail: withrobot@withrobot.com

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