

# FLIR Boson External Sync

## APPLICATION NOTE

Official Publication Date: 6/27/2019

Official Expiration Date: N/A



Document Number: 102-2013-100-04 Rev 200

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### 1 Introduction

#### 1.1 Revision History

Version	Date	Comments
100	08/14/2017	Initial Release
110	09/19/2017	Added command info and I/O details
120	05/23/2018	Sync feature updates, ADK VPC board
130	6/13/2018	Rollover and input frequency notes
140	12/18/2018	Documentation on External Sync Board
150	2/19/2019	Sync Signal changes, BNC specification
200	10/3/2019	External Sync Official release

#### 1.2 Reference Documents

Ref Number	Document number	Comments
1	102-2013-43	Boson datasheet also 102-2013-40
2	102-2013-44	Boson Software IDD
3	N/A	Boson Latency and Timing App note
4	N/A	Boson Development board App note

#### 1.3 SCOPE

This document describes the external synchronization feature on FLIR Boson camera modules. Note that this feature only applies to fast Boson configurations. Slow configurations (<9Hz output rate) do not provide any of the capabilities described herein. \*Customers using earlier versions of the software may not have complete functionality as described herein\*

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## 2 External Sync

### 2.1 OVERVIEW

The intended use of Boson's external-synchronization feature is to synchronize the Boson frame capture timing to that of a different camera or device, with the Boson as either the master device or slave device. When operated as a master, Boson will output a pulse corresponding to the start of each frame's readout from the sensor, with nominal frequency of 60.0Hz. When operated as a slave device, Boson will synchronize the start of its sensor readout to a pulse received.

### 2.2 SLAVE MODE

When External Sync Mode is set to *Slave*, the Boson camera will generate a new frame for each pulse received on the EXT\_SYNC pin. (If no pulses are received, the camera will not output a video signal.) Figure 1 illustrates the relationship between the pulse received on EXT\_SYNC, the start of frame readout from the camera's sensor, and the start of video output. As shown, the first row of frame  $n$  is read out from the sensor 0.5 msec after the rising edge of the associated pulse is received on EXT\_SYNC. Each subsequent row is automatically read out at a regular interval of  $r$  after the previous, where  $r$  is approximately 55.6  $\mu$ sec for the 320 configuration and 27.8  $\mu$ sec for the 640 configuration. Note that the camera begins outputting frame  $n$  at some later time after readout from the sensor, as described in the Boson Latency and Timing App note.

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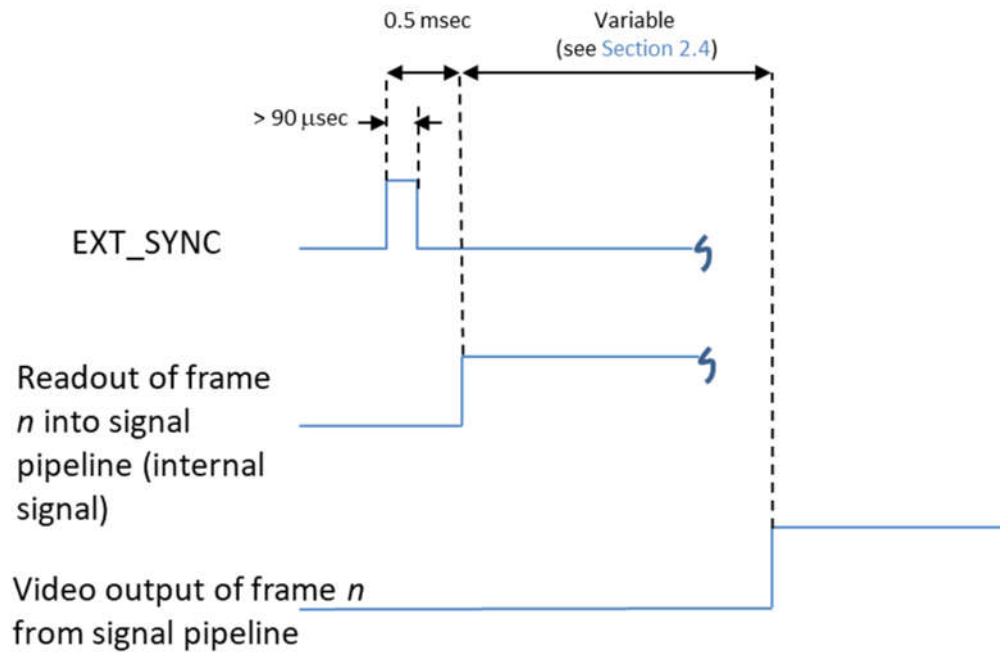


Figure 1: External-sync Slave Timing

For best imaging performance, the input sync-pulse rate should closely match the frame rate at which the sensor was factory calibrated, approximately 60.0 Hz. Pulse frequencies in the range 59.75Hz to 60.25Hz have been validated to produce comparable image quality to performance using internal frame timing (sync mode = disabled or master).

- External-sync frequencies much lower than 59.75Hz are possible; however, performance is expected to be significantly compromised as frame rate is reduced outside the recommended range, particularly non-uniformity as camera temperature is varied. More frequent FFC is recommended when operating in this manner. It is also worth noting that if EXT\_SYNC is provided in “bursts” (e.g. a nominal frequency near 60Hz but with occasional long gaps between pulses), image quality may be compromised for several seconds after the pulse train resumes while the sensor returns to its steady-state temperature.

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- The highest supported sync frequency is 60.4Hz. Any EXT\_SYNC pulse sent <16.56 msec after a previous pulse will be ignored. For example, if a pulse train is sent at a rate of 60.5 Hz (= 16.53 msec between pulses), every other pulse will be ignored, resulting in readout rate of 30.25Hz (= 33.06 msec between output frames).

It is possible to utilize Boson's averager feature in conjunction with slave mode. The averager feature combines data from pairs of frames. Consequently, if a sync-pulse frequency of 60.0Hz is provided on EXT\_SYNC (when the camera is in slave mode), the video channel will output imagery at 30.0Hz because every 2 sensor frames will be used to generate one video-output frame.

Boson provides two CMOS output modes – continuous and one-shot. For operation in slave sync mode, one-shot CMOS-output mode is highly recommended. Continuous mode is intended for interfacing to display systems which require video frames at a regular 60.0Hz interval, regardless of sensor frame rate. Boson accomplishes a 60.0Hz output frame rate by duplicating or dropping sensor frames as necessary. For example, if Boson is configured to slave mode and provided with a sync-pulse train of 50Hz, a video output rate of 60Hz will be accomplished in continuous CMOS-output mode by duplicating 1 out every 5 sensor frames, as conceptually illustrated in Figure 2. Notice in the figure that frame 5 (f5) has not yet been triggered by the time an output frame must be provided on the video output channel. Consequently, the video channel outputs frame 4 a second time. Also notice the variable latency between sync pulses and the corresponding output frames, which is a major obstacle for synchronizing Boson video to a master video channel. This obstacle is avoided in one-shot CMOS-output mode because each sync pulse generates a *single* output video frame with *fixed* latency, as illustrated in Figure 3.

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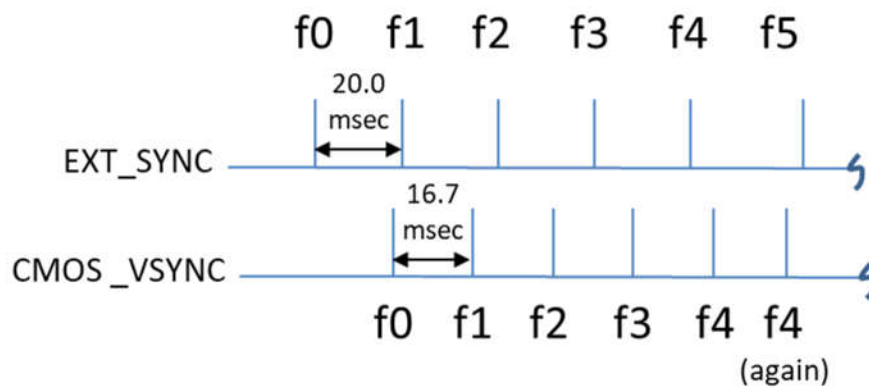


Figure 2: Conceptual Illustration of Sync Timing vs. Output-Frame Timing in Continuous CMOS-Output Mode.  
Notice variable latency between sync pulses and output frames, as well as possibility of duplicated output frames.

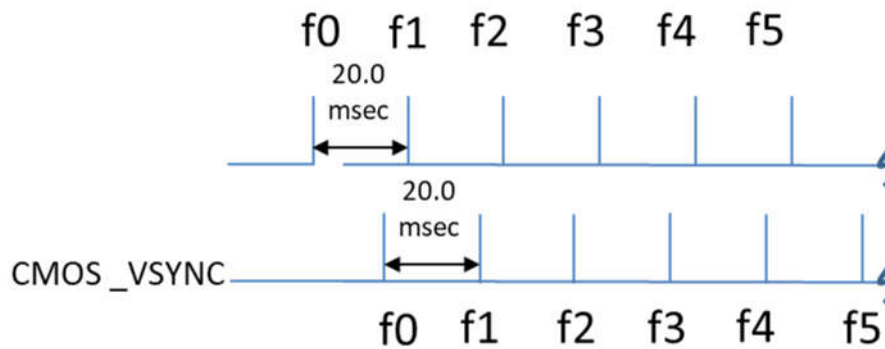


Figure 3: Conceptual Illustration of Sync Timing vs. Output-Frame Timing in One-Shot CMOS-Output Mode (preferred mode)  
Notice fixed latency between sync pulses and output frames and no duplication.

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### 2.3 MASTER MODE

When the External Sync Mode is set to *Master*, the Boson camera will generate an output pulse on EXT-SYNC for each new frame. Figure 4 illustrates the relationship between the output pulse, the start of frame readout from the camera's sensor, and the start of video output. As shown, the first row of frame  $n$  is read out from the sensor 0.5 msec after the rising edge of the output pulse provided on EXT\_SYNC. Each subsequent row is automatically read out at a regular interval of  $r$  after the previous, where  $r$  is approximately 55.6  $\mu\text{sec}$  for the 320 configuration and 27.8  $\mu\text{sec}$  for the 640 configuration. Note that the camera begins outputting frame  $n$  at some later time after read out from the sensor, as described in the section of this application note called "Latency" (Section 2.4).

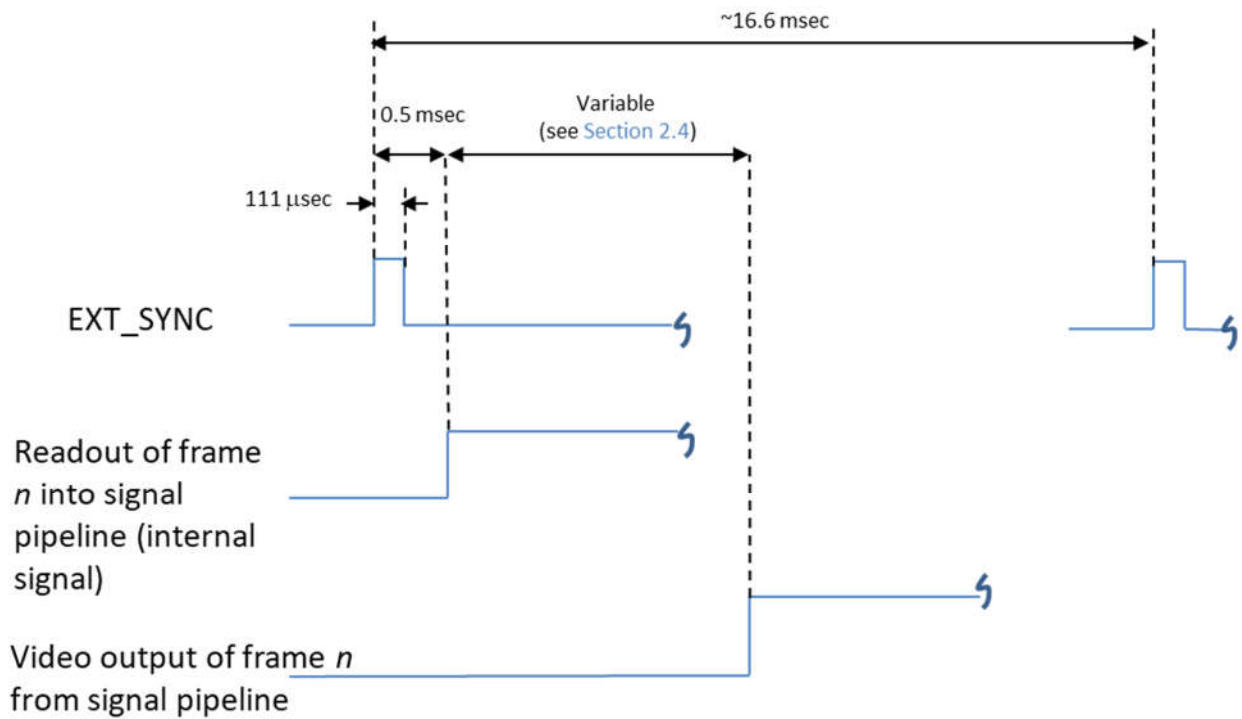


Figure 4: External-sync Master Timing

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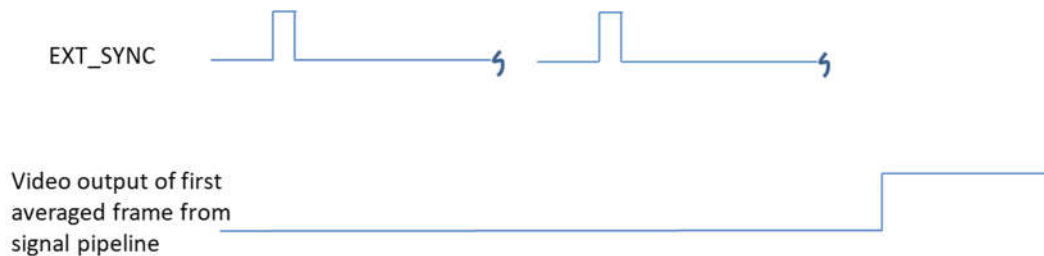
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It is possible to utilize Boson's averager feature in conjunction with master mode. The averager feature combines data from pairs of frames. Consequently, the sync-pulse frequency on EXT\_SYNC will remain at 60.0Hz (when the camera is in master mode) even though the video channel outputs imagery at 30.0Hz. That is because every 2 sensor frames will be used to generate one video-output frame. Figure 5 illustrates this scenario for the first video frame output from the camera.



*Figure 5: Illustration of Pulse Timing in Master Mode with Frame-Averager Enabled (2 output pulses for each video frame)*

Boson provides two CMOS output modes – continuous and one-shot. For operation in master sync mode, one-shot CMOS-output mode is highly recommended. Continuous mode is intended for interfacing to display systems which require video frames at a regular 60.0Hz interval, regardless of sensor frame rate, which may be very slightly faster or slower than 60.0Hz in master mode due to differences in Boson's front-end and back-end timing. When the sensor frame rate is slightly less than 60.0Hz, the output channel must occasionally duplicate a frame in continuous mode. Conversely, if the sensor frame rate is slightly greater than 60.0Hz, the output channel must occasionally drop a frame in continuous mode. Consequently, there is no guaranteed correspondence between each external-sync pulse and each output frame when in continuous mode. That is, a pulse on EXT\_SYNC might represent a sensor frame which was dropped (never provided on the video output channel) or which duplicated (appears twice on the video output channel). This ambiguity is eliminated by operating in one-shot CMOS-output mode. In one-shot mode, the output video frame rate exactly matches the sensor frame rate, and therefore each sync pulse corresponds to exactly one video output frame.

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### 2.4 LATENCY

There is latency associated with the Boson Video pipeline, and pixels/frames that are captured corresponding to the individual sync pulses take >25ms to be available over any video output. The latency associated with the Boson video pipeline can be found in the Boson datasheet and the Boson Latency and Timing App note.

### 2.5 VIDEO CHANNEL

For best synchronization results, FLIR recommends using the CMOS channel rather than the USB channel. USB data transfer is subject to bandwidth and timing factors outside of the Boson camera. Timing of USB video data may not be consistent, and frames may be dropped if there is insufficient bandwidth available in the complete USB system. Consequently, in either master or slave mode, a sync pulse may not necessarily correspond to a received USB frame.

The Boson External Sync feature should not be used in BT.656 CMOS or Analog video output mode, both of which require continuous CMOS-video mode.

## 3 Electrical Interface

### 3.1 General

There are a couple of boards that FLIR provides for customers that enable use of the external sync feature of the camera. The Boson USB External Sync board and the Development Board both offer a quick connection to the designated external sync pin, but the USB variant only allows Slave mode functionality.

The Boson External Sync feature is implemented with a single I/O signal, EXT\_SYNC (pin 72 on Boson's primary I/O connector). Digital ground should be used for the ground pin of the pulse. This signal becomes an output in *Master* mode, and an input in *Slave* mode. The factory-default sync mode is 'disabled', in which case EXT\_SYNC must be enabled via software commands listed in Section 4.

The external sync signal is an unbuffered high-speed logic signal, intended to be sourced or terminated on a circuit board mated directly to the Boson camera main board-to-board connector. High-speed logic best design practices should be used to prevent EMC issues or circuit damage.

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### 3.2 Using the USB-C External Sync board pn 250-0681-00

The Boson has a USB board interface that looks like the picture below when assembled. The two USB boards are nearly identical, but the BNC connector shown is connected to the External Sync pin on board 250-0681-00.

The BNC cable should have the center conductor pin designated as P+ and the outer shield designated as GND. The USB/BNC Y-cable supplied with the Boson USB board kits will work with both the analog USB board and the External Sync board. The External Sync board requires a 3-12 volt input signal, and will be active on the low-going pulse edge. The Boson USB external sync board will not provide MASTER mode functionality.

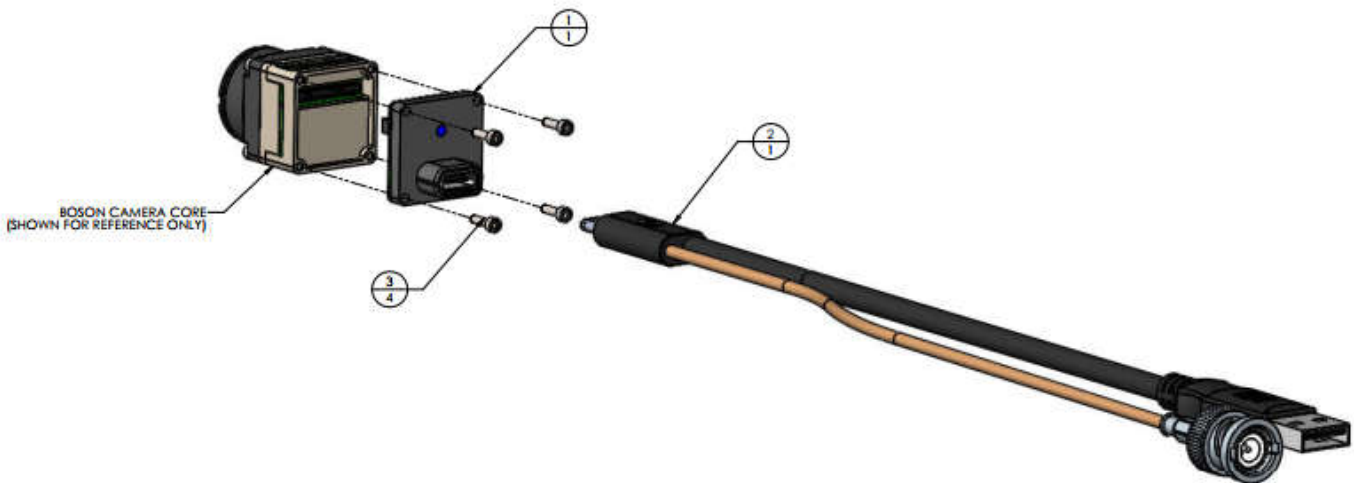


Figure 6: Boson USB Assembly with Y-cable suitable for SLAVE sync signal

Boson USB External Sync Board 250-0681-00  
SLAVE MODE ONLY



Boson USB/Analog VPC Board 250-0618-00  
(Does not allow External Sync)

Figure 7: Boson USB Boards (P/N is printed on back side of board)

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**Table 1: External Sync VPC USB Board 250-0681-00 Signals Electrical Parameters**

Parameter	Value	Units	Notes
BNC Cable amplitude – Operational Range	± 3-12	Vdc	Do not exceed absolute limits for input
BNC Cable voltage range – absolute limits	-12 to 12	Vdc	Do not exceed this range.
BNC Cable frequency input	< 60.25	Hz	Please see Guidelines for Frequency
Input Pulse Width	100ns & < 8ms	time	Triggered by low-going pulse edge
Output pulse width	> 90 & < 9e+6	nS	Active high
Output frequency	60	Hz	Synchronized to camera acquisition.

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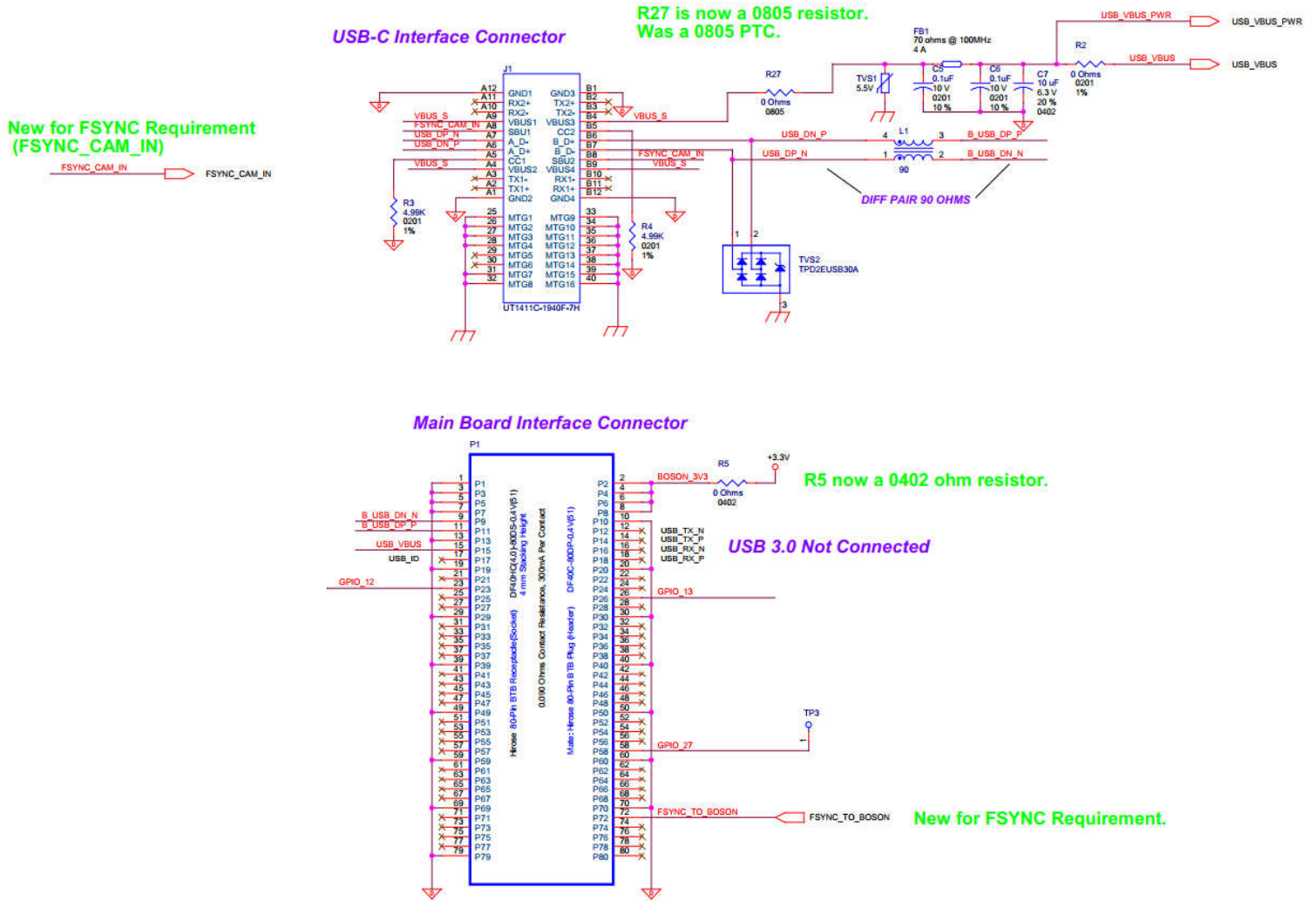


Figure 8: External Sync Board 250-0681-00 Connector Layout

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### 3.3 Boson Development Board

There are two revisions of the Boson Development board. The newer version is 250-0705-00. The key distinction is that the new board supports both SLAVE and MASTER modes. The old board 250-0593-00 only has capability to use SLAVE mode without modifications. By changing the jumper position on the J28 header, you can enable Master mode in jumper position 2-3 and SLAVE mode in jumper position 1-2.

The input and output of External Sync is buffered and can accept up to 3.3V.

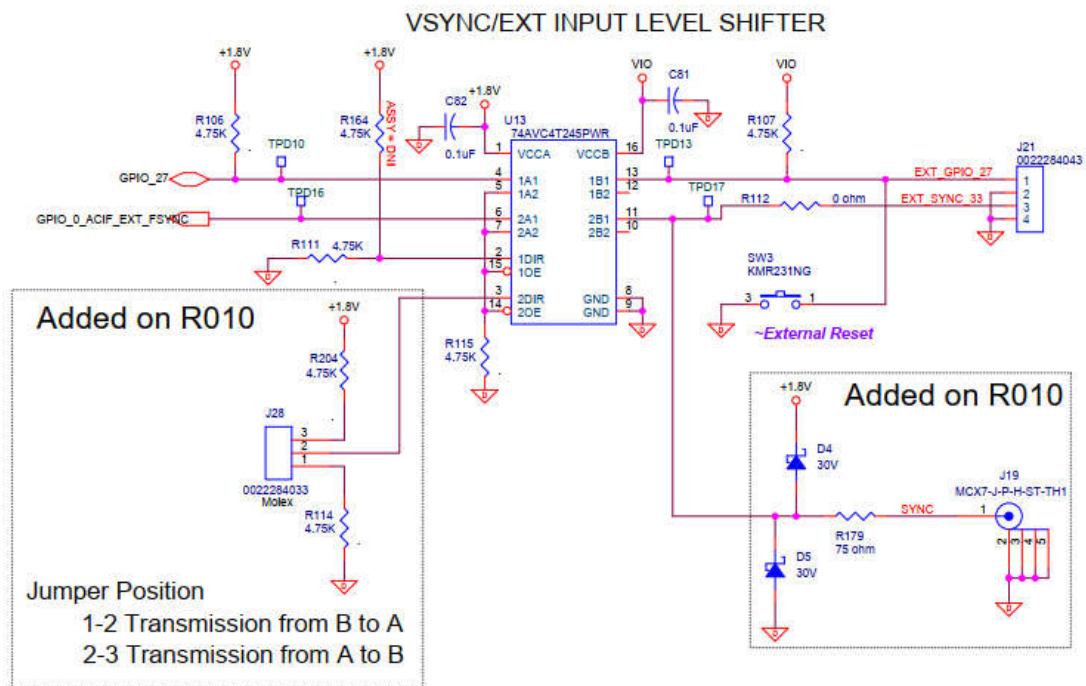


Figure 9: Boson Development Board 250-0705-00 External Sync

#### 3.3.1 Using the 250-0593-00 Boson Development Board

The 250-0593-00 Boson development board is configured to support External Sync Slave mode operation only. The board does allow a direct connection to the Boson external sync pin at J20 pins -3 and -4. This is the unprotected 1.8 volt processor input/output and must be used with due care to avoid camera damage. The buffered input at J21-3 is preferred, which is only intended for ext\_sync as an input to the boson. This uses a level shifter

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located on the Development Board and will use the signal levels determined by the I/O supply of the board.

The development board needs to be modified if it is to be used in External Sync Master mode, as the Boson pin is driven by the level shifter output U13-6. See the level shifter schematic Figure 1 and location Figure 2. This pin must be lifted or otherwise disabled for the camera to output master sync pulses.

For prototyping, the Boson Development Board FLIR P/N 250-0593-00 has a flexible level shifted input for *Slave* External Sync mode.

**Table 2: Development Board 250-0593-00 Ext. Sync Signals Electrical Parameters**

Parameter	Value	Units	Notes
External sync GPIO pin number	72	N/A	See the Boson datasheet for details.
I/O voltage range – absolute limits	-0.25 to 1.92	Vdc	Do not exceed this range.
Output pulse width	50 to 100	nS	Active high
Output frequency	60	Hz	Synchronized to camera acquisition.
Output voltage high	1.28	Vdc	Maximum - Load dependent
Output voltage low	0.56	Vdc	Minimum - Load dependent
Input threshold voltage high	1.92	Vdc	Maximum
Input threshold voltage low	0.56	Vdc	Minimum

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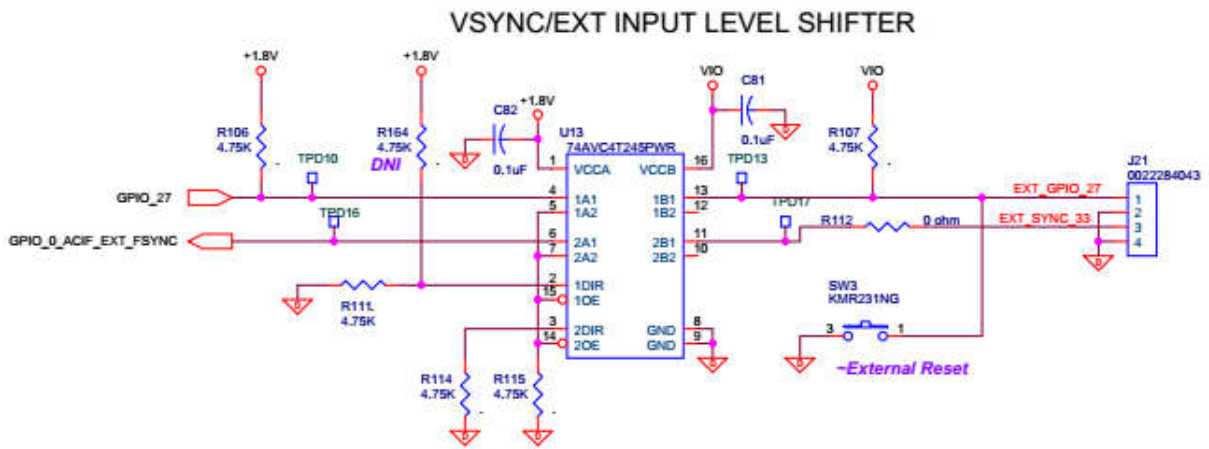


Figure 1: Dev Board Level Shifter Schematic.

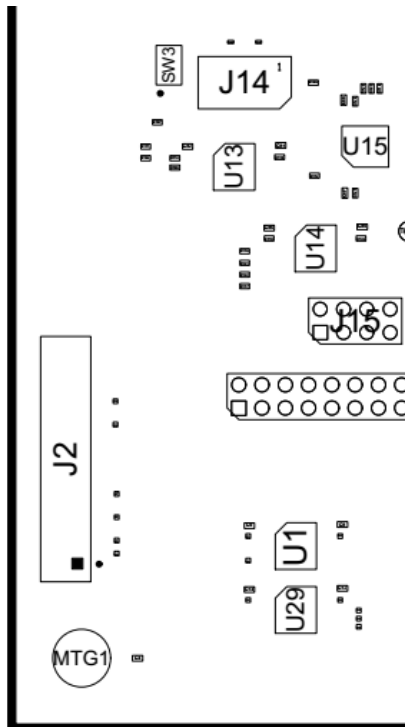


Figure 2: Dev Board Level Shifter U13 Location

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### 4 Software Interface

- External Sync can be enabled via the Boson Application GUI v1.5.0 or via the SDK
- External Sync can be enabled via the SDK via command `bosonSetExtSyncMode()`.

The commands to set the External Sync mode are defined in the Boson Software IDD. For the current 2.1 release of Boson software, see function `bosonSetExtSyncMode()`.

For further information see the Software IDD and the datasheet. Both C sharp and Python can also be used as an SDK with the same functionality.

The commands to set the External Sync mode are defined in the Boson Software IDD. For Boson software versions 2.0.10715 and previous, see the function `roicSetExtSyncMode()` and the related datatypes. For later Boson software versions, see function `bosonSetExtSyncMode()`. Also, for the Boson to use external sync at bootup, use the `bosonWriteDynamicHeaderToFlash()` command after external sync is enabled. **In Boson software released before v2.1.0: Make sure the external sync signal is present when booting up the camera, otherwise it will get stuck in a reset loop, effectively making the camera unable to communicate or display video. If the camera does not have SLAVE mode written the dynamics headers, the camera may need to be rebooted if the signal is not provided initially.**

For example, to set the External Sync state to *Slave* mode the command function ID 0x00020027 would be used with data 0x0002. For later software versions, the command function ID would be 0x00050098 with data 0x0002.

Compile the ClientFiles\_C folder within the SDK. Open the ReadMe and follow the instructions. Tiny C Compiler or GCC can be used to compile the code.

Inside the `do_build` batch file, make sure the file paths are defined to the appropriate locations. By default, `tcc` (tiny C compiler) is used. Open the `do_build` batch file with a code or text editor to change the paths and the compiler used.

The `Example.c` file provided is a template on how to send commands to the Boson. To communicate with the Boson, you must know what COM port it is connected to. This info can be found in device manager under COM ports.

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Inside the Example.c file:

```
{  
Edit the: result = Initialize(5, 921600); //COM6, 921600 baud (port_number=5 for COM6)  
(COM port -1) = first parameter in the Initialize function.  
To change what commands are sent to the Boson, you can edit the: result = bosonRunFFC();  
line of code. bosonRunFFC() can be replaced with any command in the Software IDD/SDK.  
For example to enable external sync: result = bosonSetExtSyncMode(2). Notice the 2, it  
defines that external sync is in slave mode. For the python SDK, use the enum rather than  
the integer as the parameter to command ext. sync mode. For Example, the command used  
is:  
bosonSetExtSyncMode(FLR_BOSON_EXT_SYNC_MODE_E.FLR_BOSON_EXT_SYNC_SLAVE_MODE)  
EXT_SYNC_DISABLE_MODE = 0  
EXT_SYNC_MASTER_MODE = 1  
EXT_SYNC_SLAVE_MODE = 2  
EXT_SYNC_END = 3  
}
```

Once the correct and desired COM port and commands are saved in Example.c, run the do\_build batch file via the command prompt. After this has compiled without error, run Example\_64.exe. The executable will then open communications with the Boson and pass the command.

Contact us via the online portal at [flir.custhelp.com](http://flir.custhelp.com) for technical support.

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