

# Projet SOC

## Camera Infra Red FLIR Lepton

René Beuchat  
Laboratoire d'Architecture des  
Processeurs

*rene.beuchat@epfl.ch*

# IR Camera: main characteristics

- For thermal capture, a camera module is a way to acquire the information
- Low resolution as a single point of measurement are available, ex: PIR detectors
- Medium/High resolution and expensive IR captors exists but available with restriction, mainly for military reason

# IR Camera: main characteristics

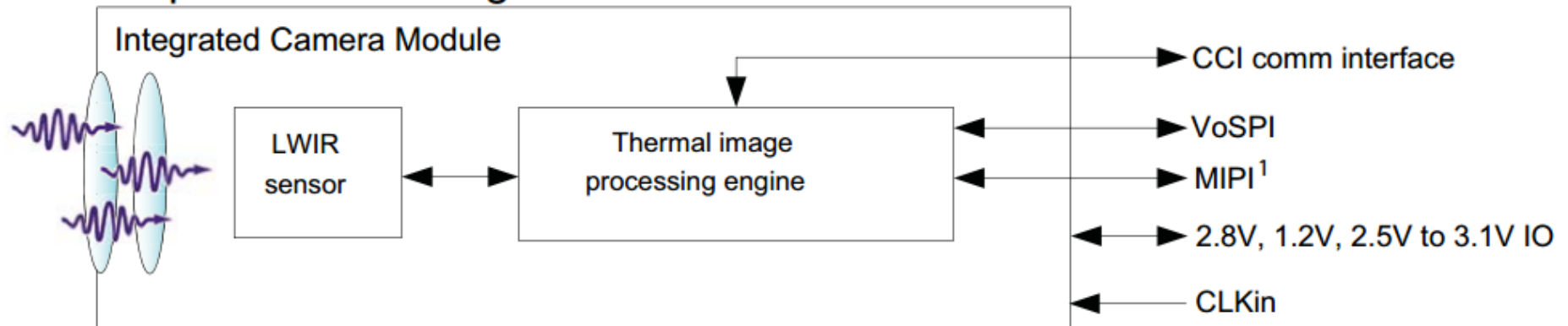
- Since 2014, low resolution camera as **80x60 pixels** are available for “public domain application” with some restriction in characteristics
- Ex.: **9Hz** max refresh cycle
- Ex.: **FLIR Lepton camera**
- **i2c** for configuration
- **SPI** for data acquisition



# IR Camera: Global Bloc diagram

- Long-Wave InfraRed (LWIR) camera module, 8~14 $\mu\text{m}$

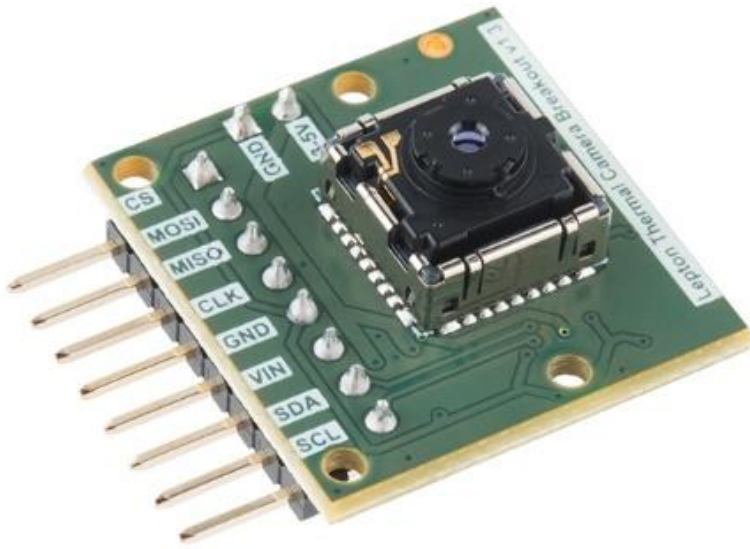
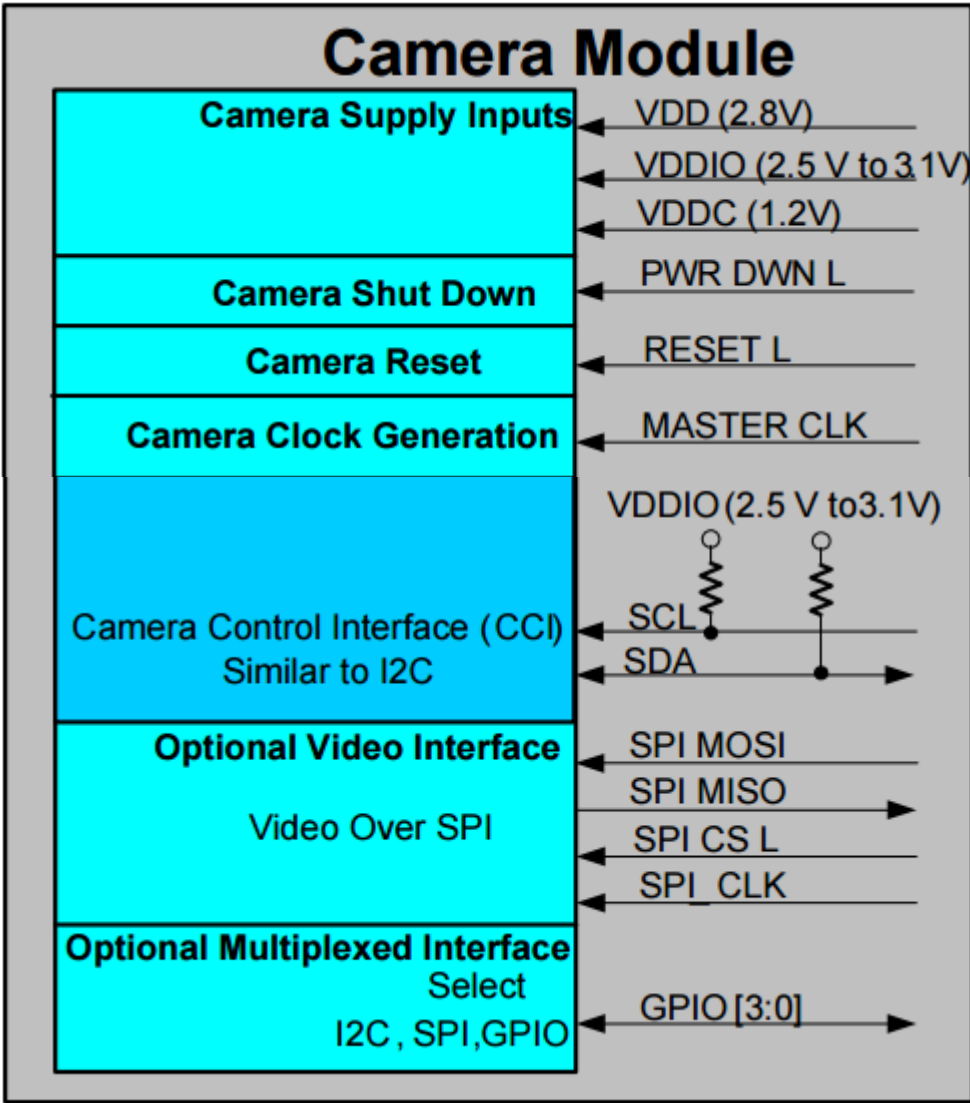
## Simplified Block Diagram



1. Feature anticipated in a future product release

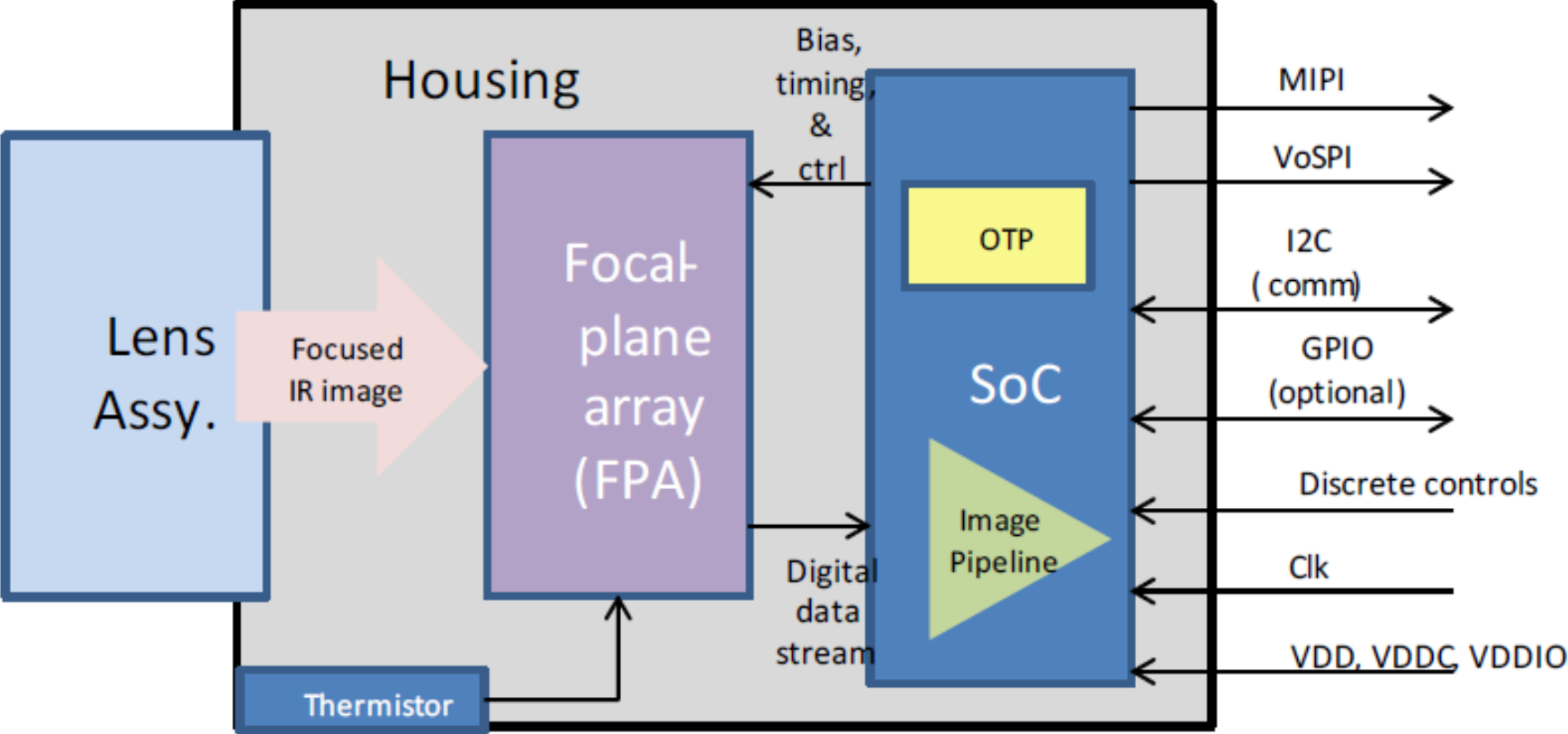
Source: FLIR\_Lepton\_Data\_Brief

# IR Camera module



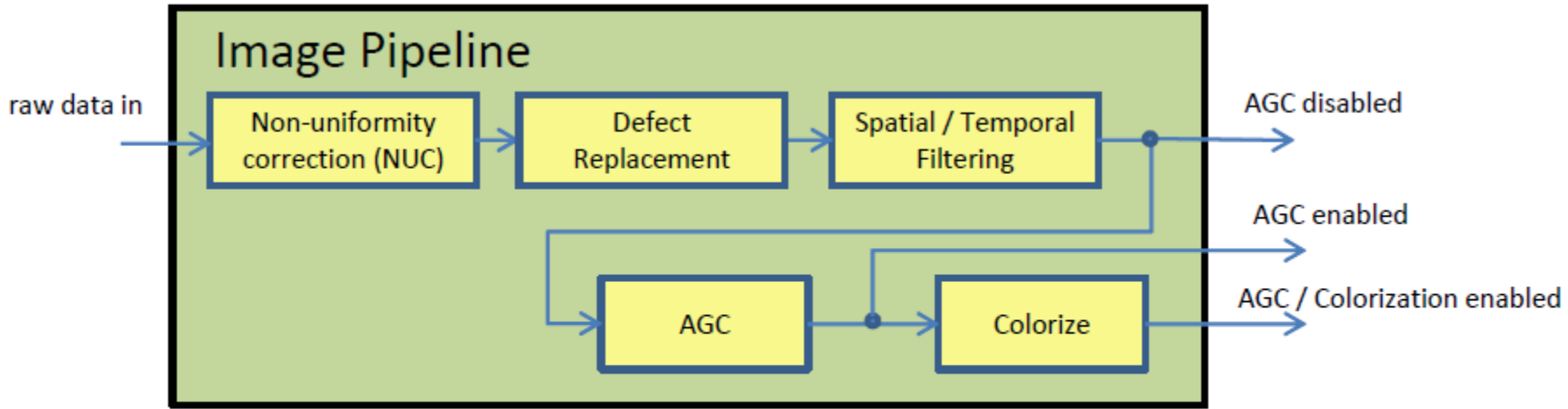
Source: FLIR\_Lepton\_Data\_Brief

# Lepton FLIR System Architecture



Source: FLIR\_Lepton\_Data\_Brief

# Lepton FLIR System Architecture



The video pipeline includes non-uniformity correction (NUC), defect replacement, spatial and temporal filtering, automatic gain correction (AGC), and colorization.

Source: FLIR\_Lepton\_Data\_Brief

# FLIR Lepton Video Frame



(a)  $F_{SCLK} \sim 2.2 \text{ MHz}$



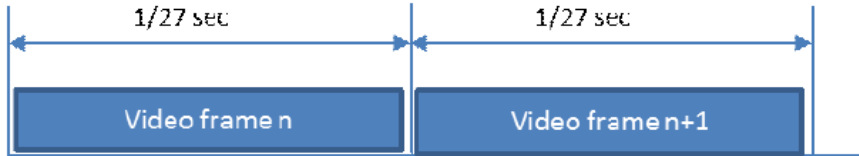
(a)  $F_{SCLK} \sim 20 \text{ MHz}$

Source: FLIR\_Lepton\_Data\_Brief



# FLIR Lepton Video Frame with problems

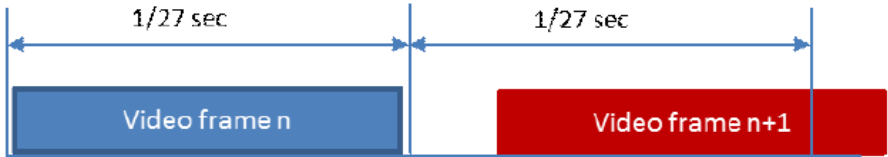
Valid Frame Timing (no loss of synchronization)



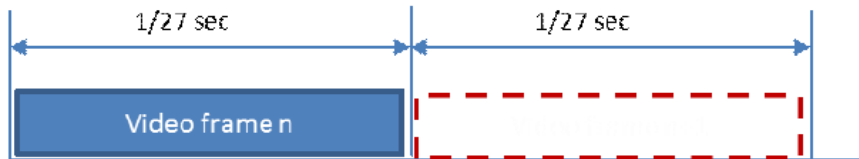
Clock Too Slow - Failure to Read an Entire Frame Within the Frame Period



Intra-frame Delay Too Long - Failure to Read Out an Entire Frame Before the Next is Available

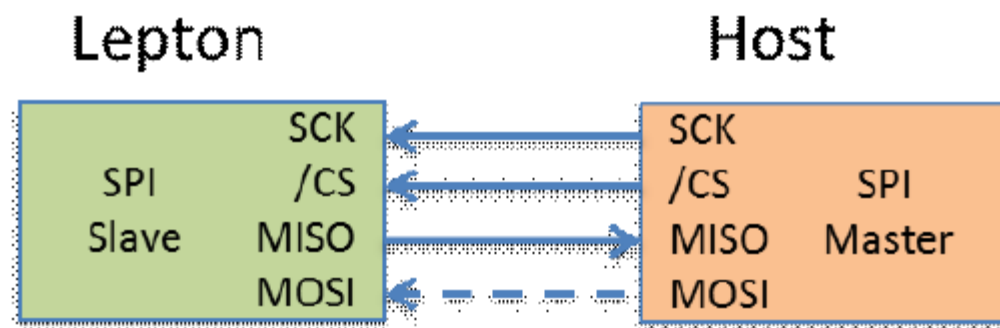


Failure to Read Out an Available Frame

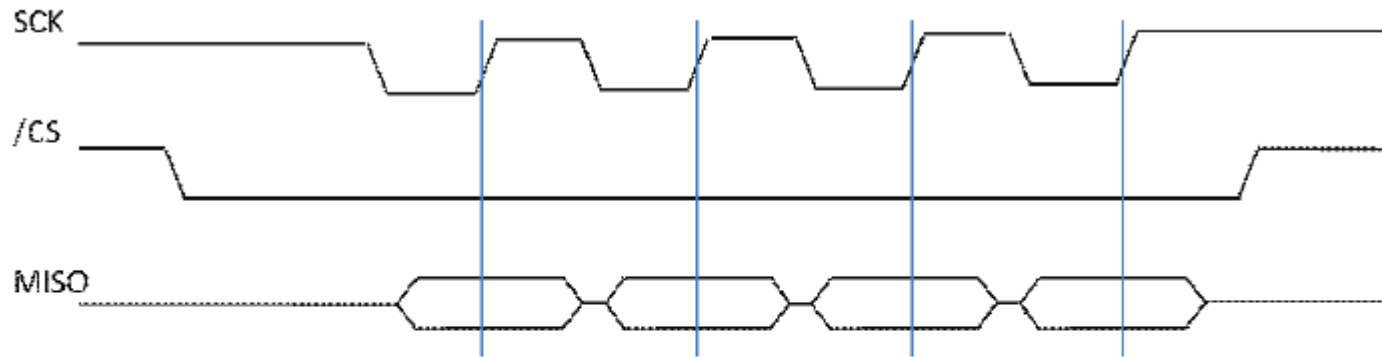


Source: FLIR\_Lepton\_Data\_Brief

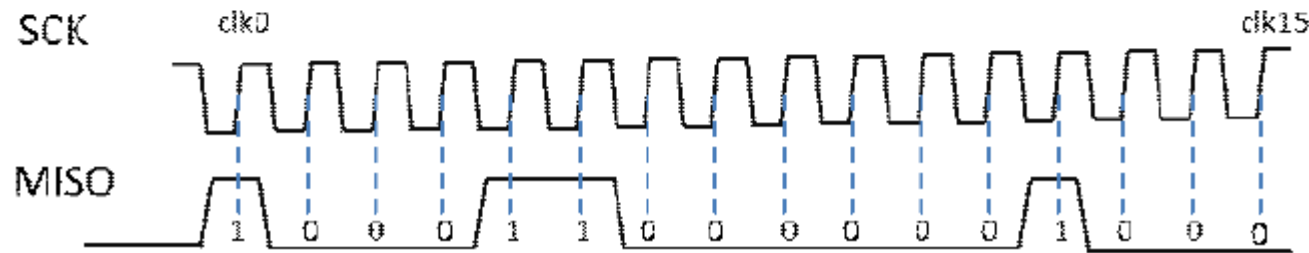
# SPI connection & protocol



SPI Mode 3 (CPOL=1, CPHA=1)



SPI Bit Order (transmission of 0x8C08)



# Video Packet

ID	CRC	Payload
xNNN (16 bits)	CRC (16 bits)	Video pixels for one video line

## Discard Packet

ID	CRC	Payload
xFxx	xxxx	Discard data (same number of bytes as video packets)

Source: FLIR\_Lepton\_Data\_Brief

# Packet information (1)

- Start of Frame packets:

Telemetry Mode	Configuration		
	As header	As footer	Disabled
Packet 0	Telemetry line A	FPA Row 0	FPA Row 0
Packet 1	Telemetry line B	FPA Row 1	FPA Row 1
Packet 2	Telemetry line C	FPA Row 2	FPA Row 2
Packet 3	FPA Row 0	FPA Row 3	FPA Row 3
...	...	...	...
Packet 29	FPA Row 26	FPA Row 29	FPA Row 29
Packet 30	FPA Row 27	FPA Row 30	FPA Row 30
Packet 31	FPA Row 28	FPA Row 31	FPA Row 31
Packet 32	FPA Row 29	FPA Row 32	FPA Row 32

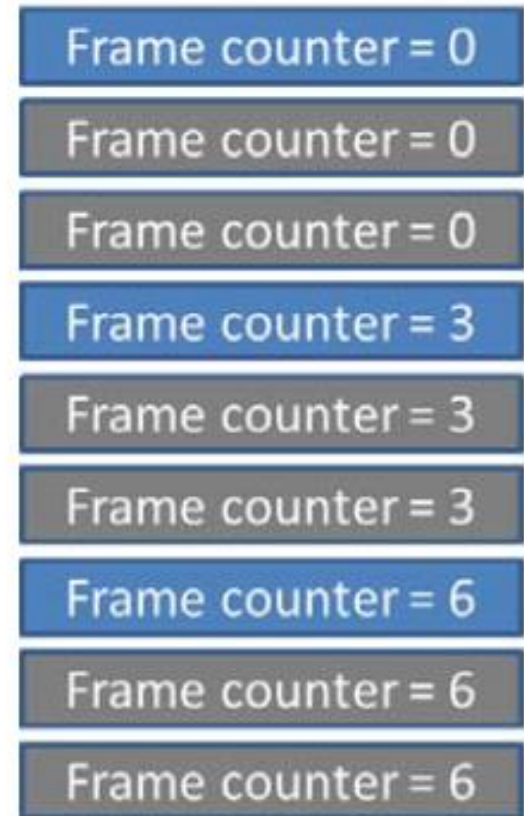
## Packet information (2)

- End of frame packets:

	Configuration		
...	...	...	...
Packet 59	FPA Row 56	FPA Row 59	FPA Row 59
Packet 60	FPA Row 57	Telemetry line A	n/a
Packet 61	FPA Row 58	Telemetry line B	n/a
Packet 63	FPA Row 59	Telemetry line C	n/a

# Frame Counter for fast transfert

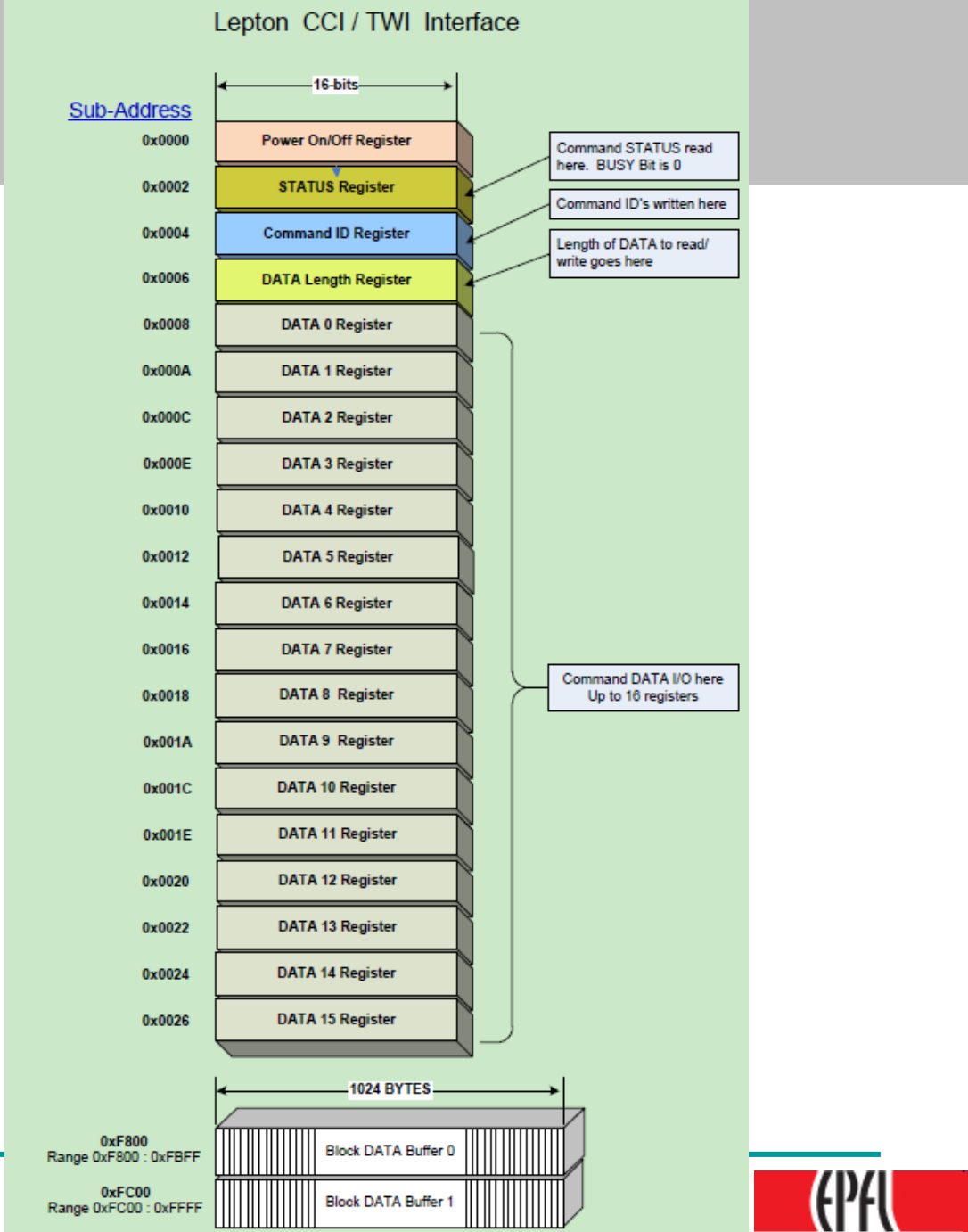
- Due to legislation, frame rate is limited to 9Hz !
- The same packet could be send more than 1 time
- Packet with xFxx counter have to be discarded !



# Command to Camera

- Commands have to be send by i2c like interface
- Data part is always **2 Bytes** for 16 bits transfers

# Lepton Interface view



Source: FLIR Software Interface Description Document (IDD)

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