

# Projet SOC

## **Camera Infra Red FLIR Lepton**

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# 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

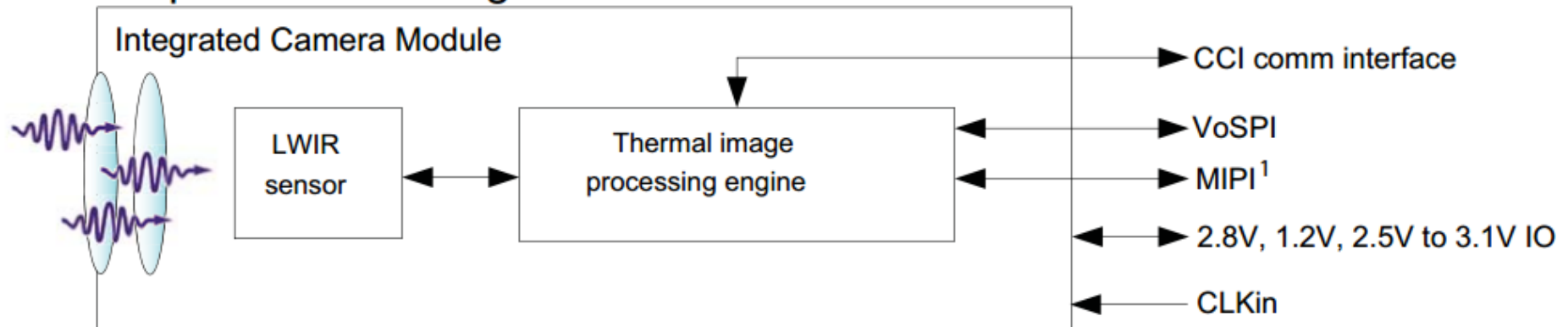
- Since 2014, low resolution camera as **80x60 pixels** are available for “public domain application” with some restriction in characteristics
- Ex.: **9Hz** max refresh cycle
- Ex.: ***FLIR Lepton camera***
- ***i2c*** for configuration
- ***SPI*** for data acquisition



# IR Camera: Global Bloc diagram

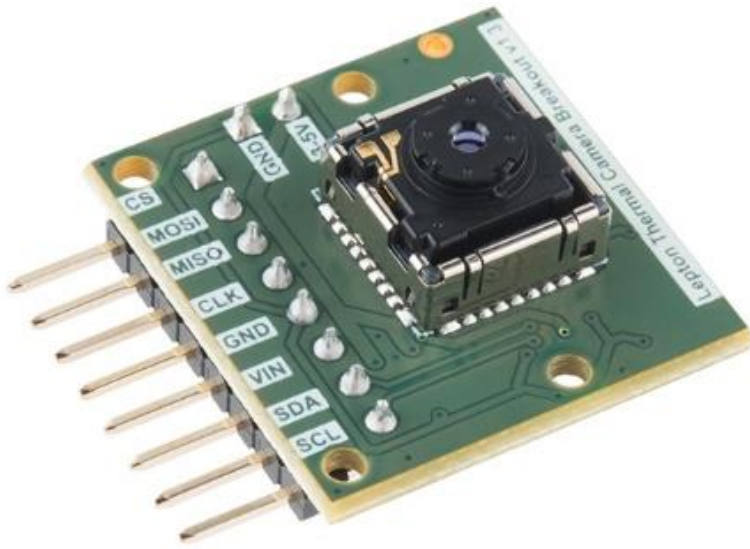
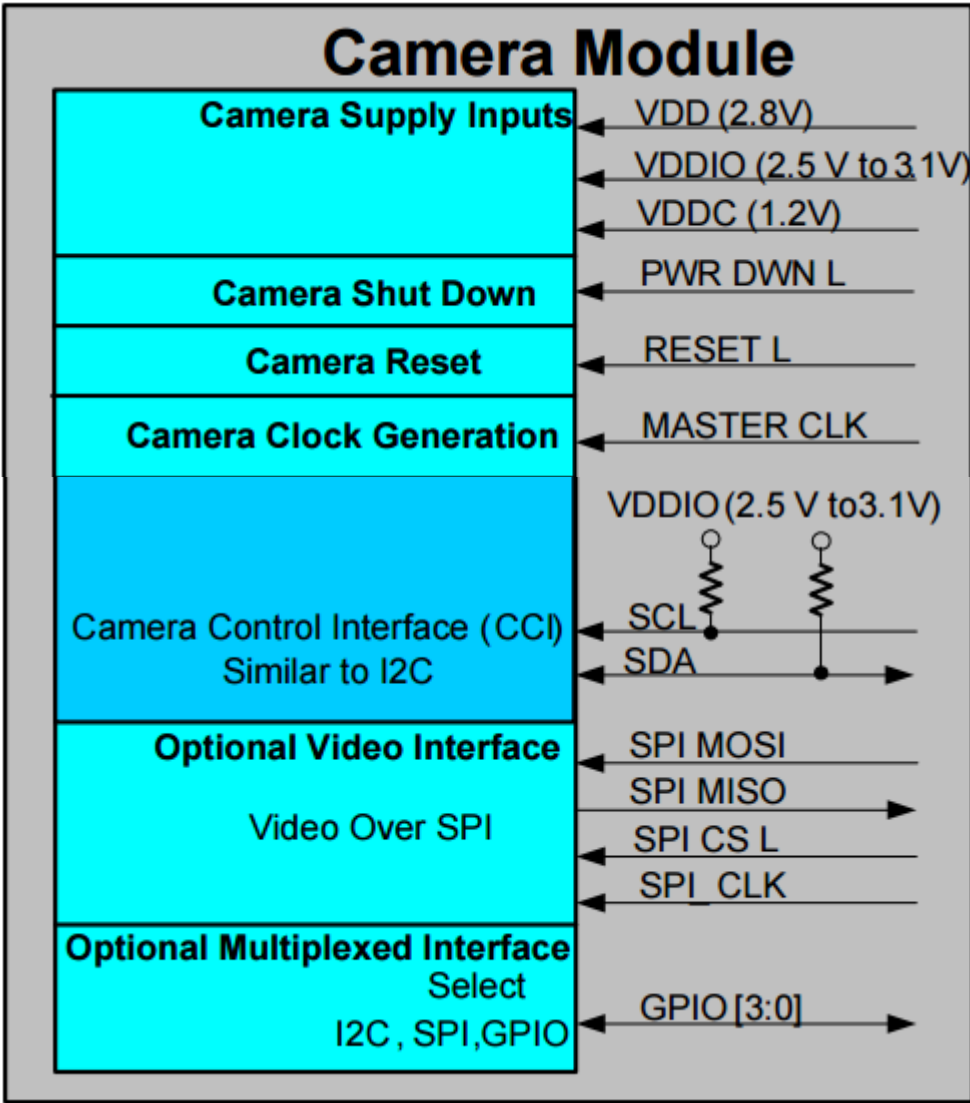
- Long-Wave InfraRed (LWIR) camera module, 8~14 $\mu\text{m}$

## Simplified Block Diagram



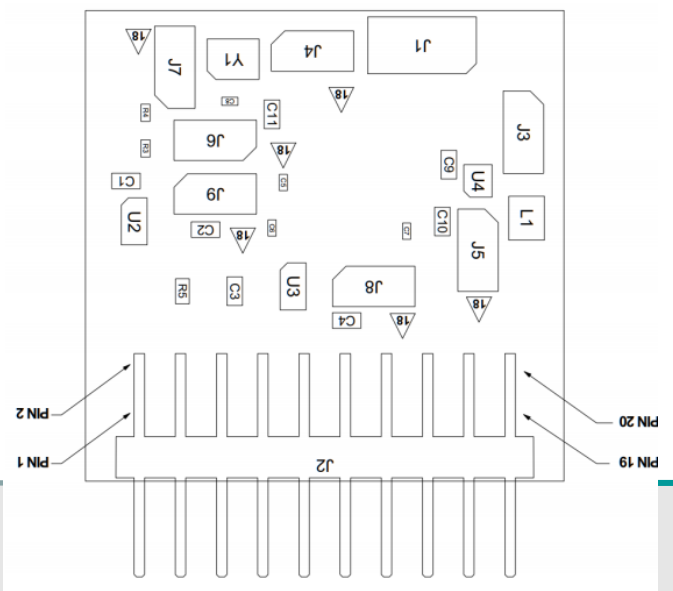
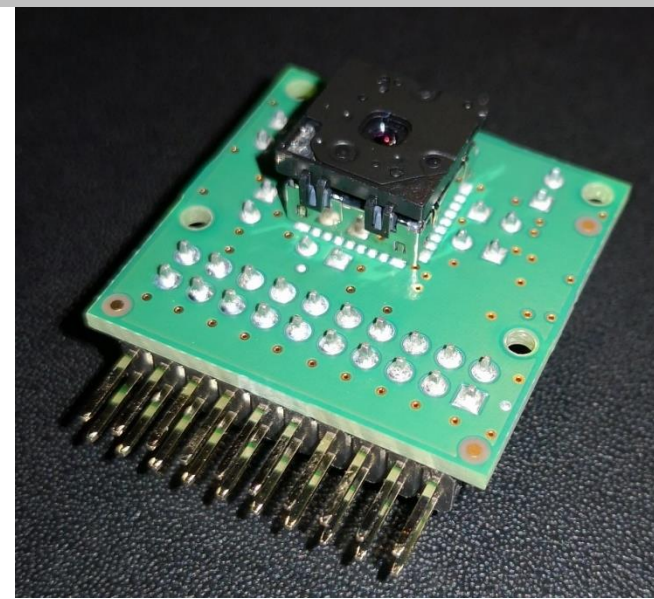
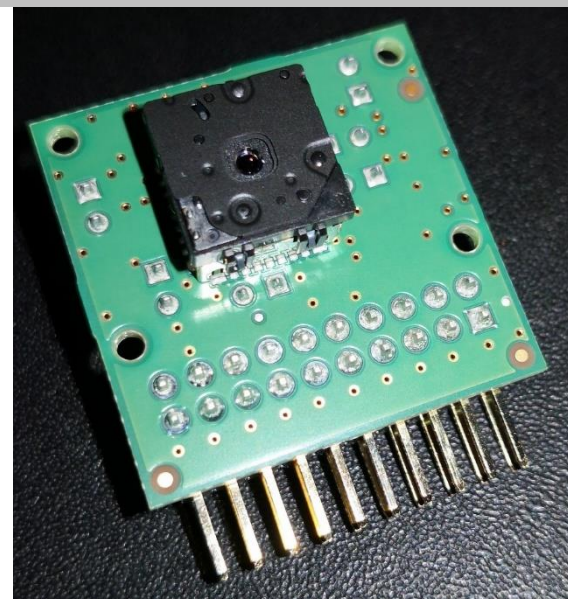
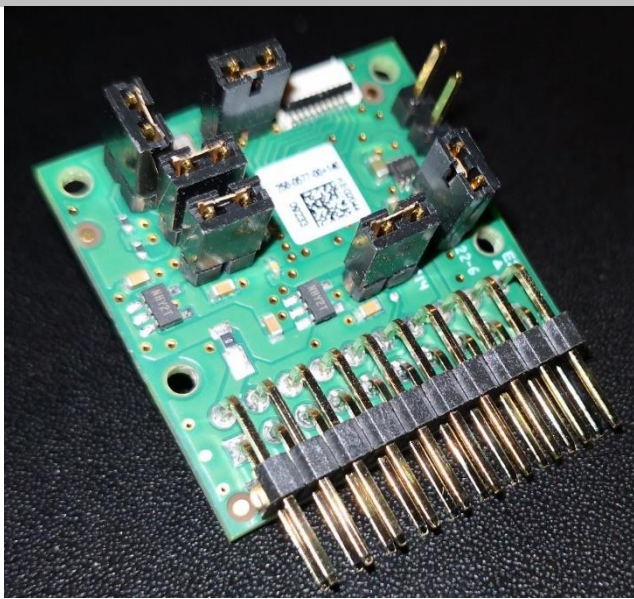
Source: FLIR\_Lepton\_Data\_Brief

# IR Camera module



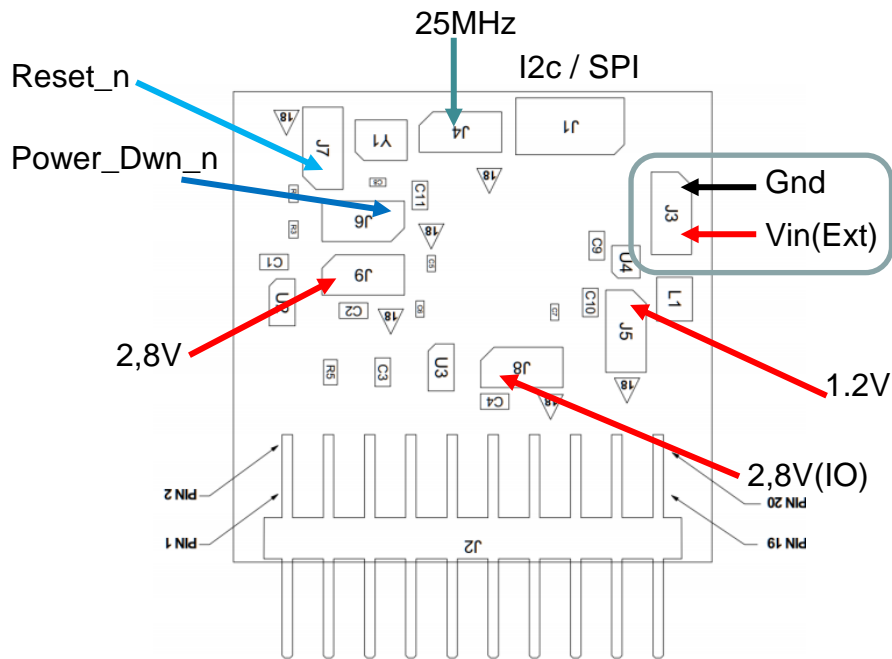
Source: FLIR\_Lepton\_Data\_Brief

# FLIR Lepton® Camera Breakout Board v2.0



## Pin-Out

Pin #	Function	Pin #	Function
Pin 1	GND	Pin 2	Power in 3–5.5V
Pin 3	VPROG	Pin 4	VCC28
Pin 5	SDA	Pin 6	VCC28_IO
Pin 7	SPI_CLK	Pin 8	SCL
Pin 9	SPI_MOSI	Pin 10	SPI_CS
Pin 11	GPIO0	Pin 12	SPI_MISO
Pin 13	GPIO2	Pin 14	GPIO1
Pin 15	GPIO3 / VSYNC	Pin 16	VCC12
Pin 17	RESET_L	Pin 18	MASTER_CLK
Pin 19	GND	Pin 20	PW_DWN_L



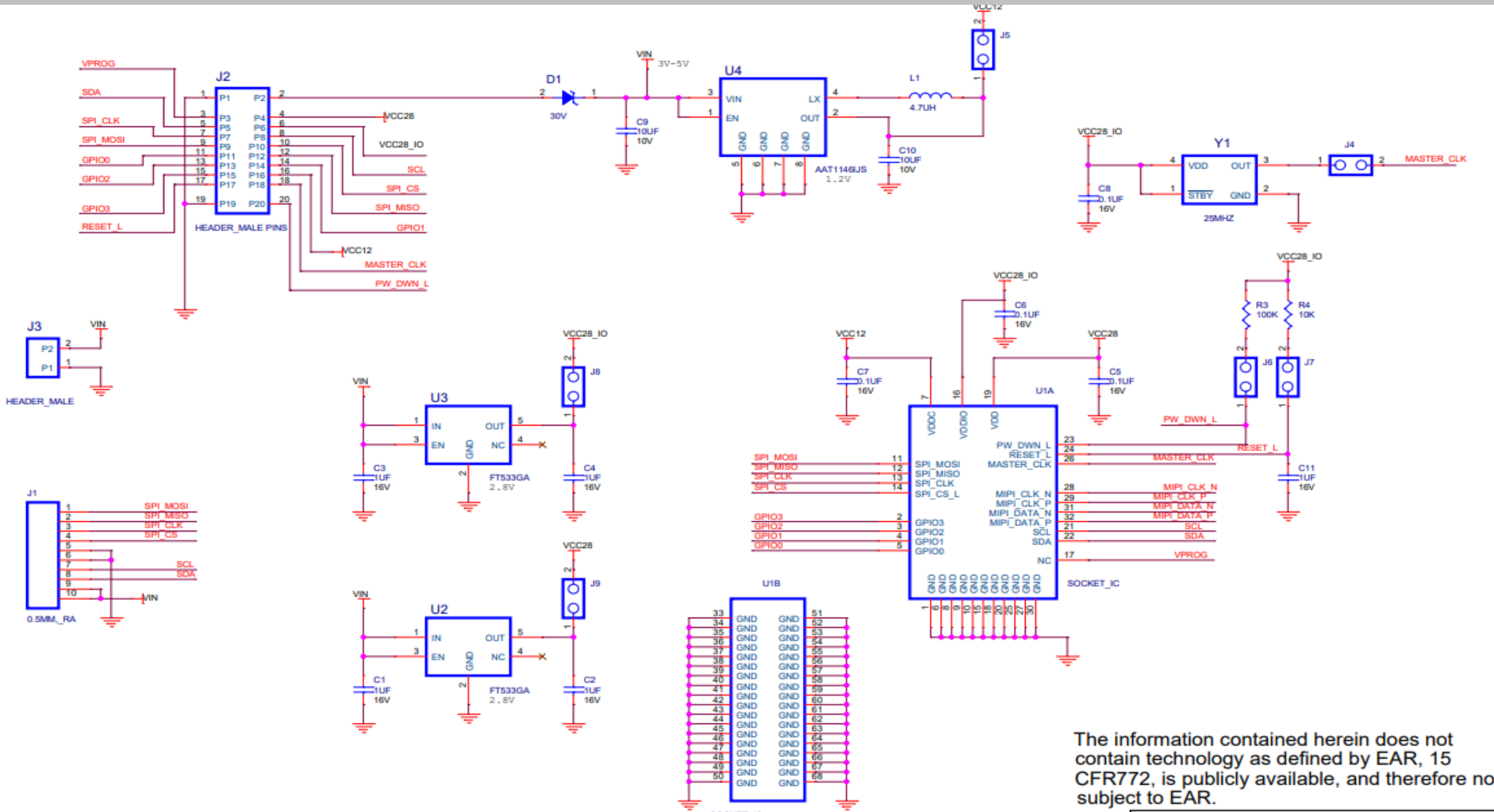
**!! VCC IO → 2.8V !!**

**Pin-Out**

Pin #	Function	Pin #	Function
Pin 1	GND	Pin 2	Power in 3–5.5V
Pin 3	VPROG	Pin 4	VCC28
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Pin 17	RESET_L	Pin 18	MASTER_CLK
Pin 19	GND	Pin 20	PW_DWN_L



# BreakOut module Schematic



The information contained herein does not contain technology as defined by EAR, 15 CFR772, is publicly available, and therefore not subject to EAR.

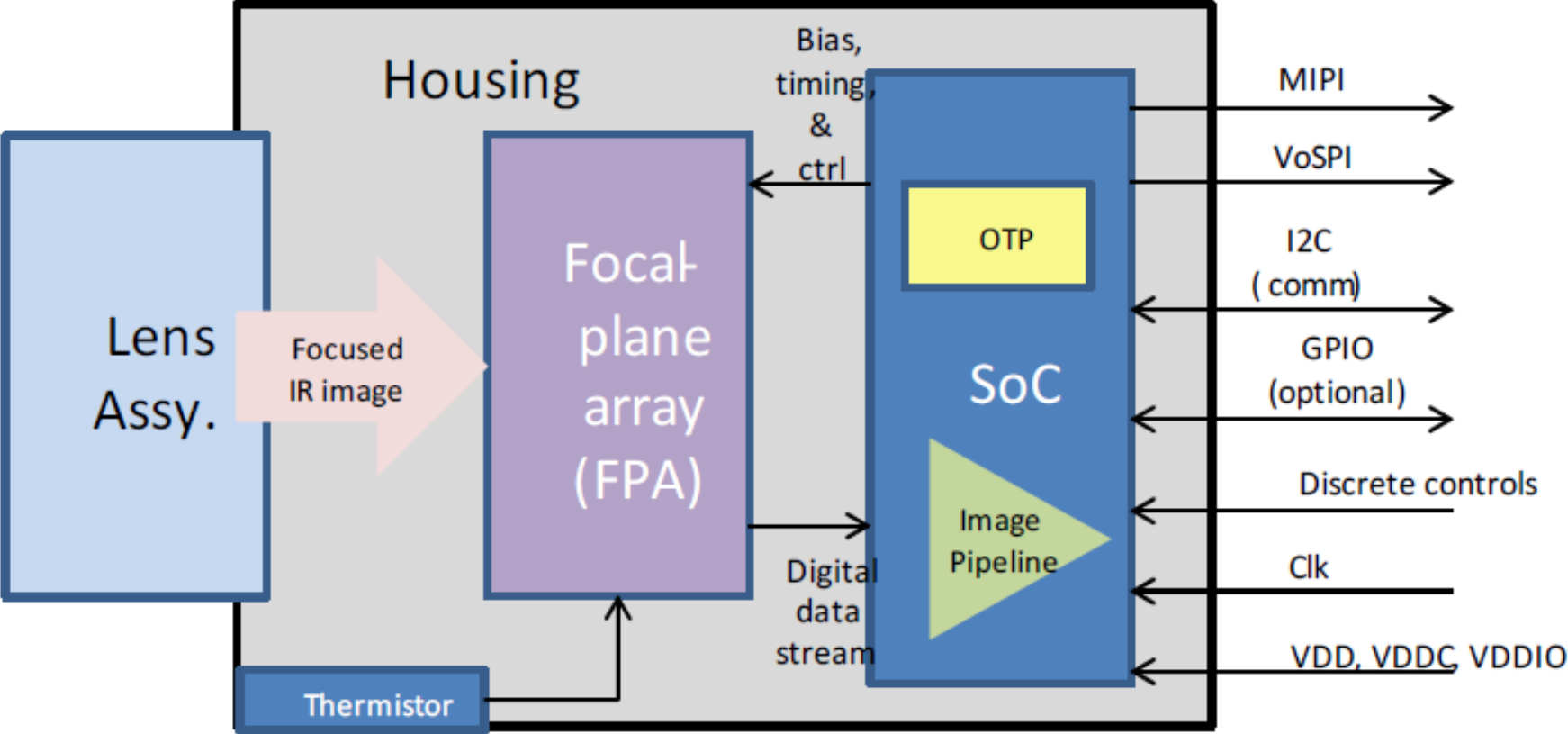
Title		
LEPTON THERMAL CAMERA BREAKOUT		
Size B	Document Number	Rev
	250-0577-24	110
Date:	Tuesday, October 09, 2018	Sheet 1 of 1

"PROPRIETARY - FLIR Systems Inc."



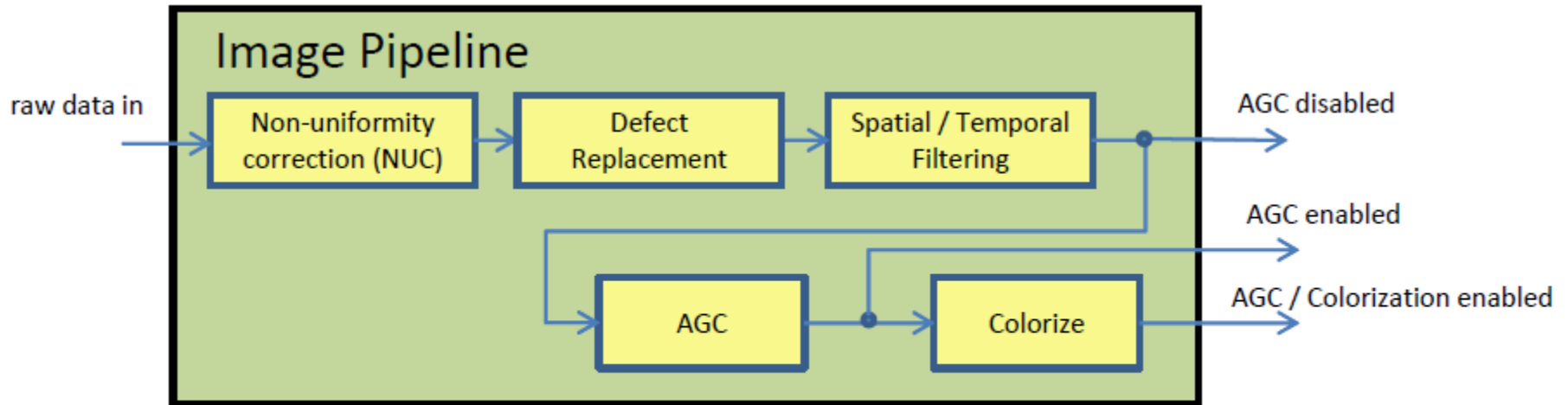


# Lepton FLIR System Architecture



Source: FLIR\_Lepton\_Data\_Brief

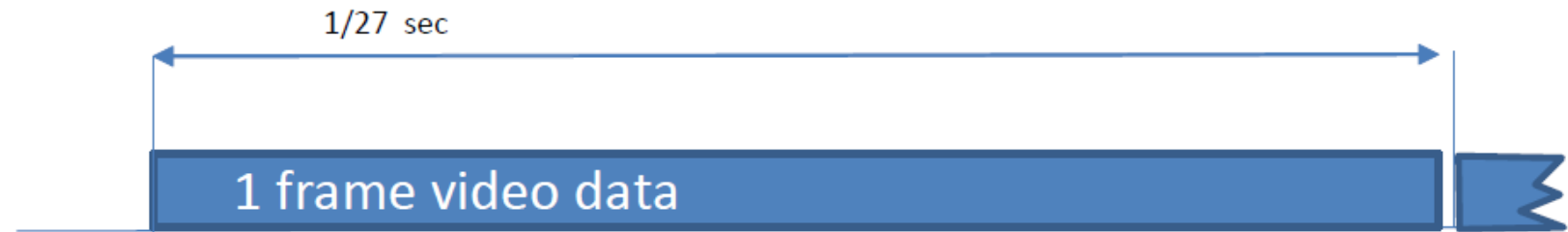
# Lepton FLIR System Architecture



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)  $F_{SCLK} \sim 2.2$  MHz

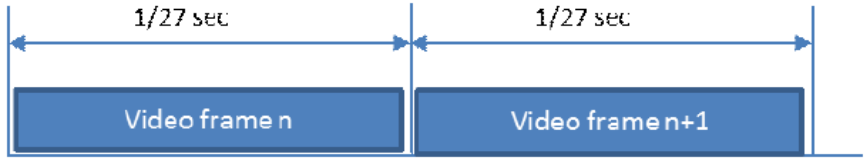


(a)  $F_{SCLK} \sim 20$  MHz

Source: FLIR\_Lepton\_Data\_Brief

# FLIR Lepton Video Frame with problems

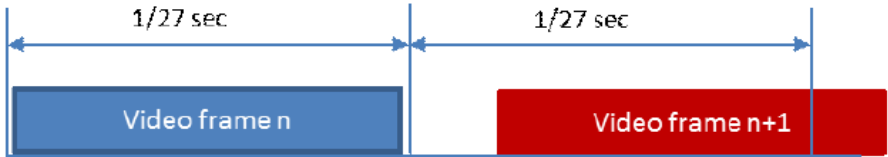
Valid Frame Timing (no loss of synchronization)



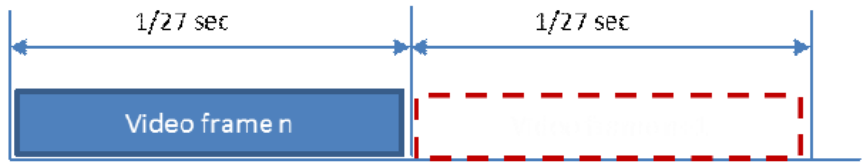
Clock Too Slow - Failure to Read an Entire Frame Within the Frame Period



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

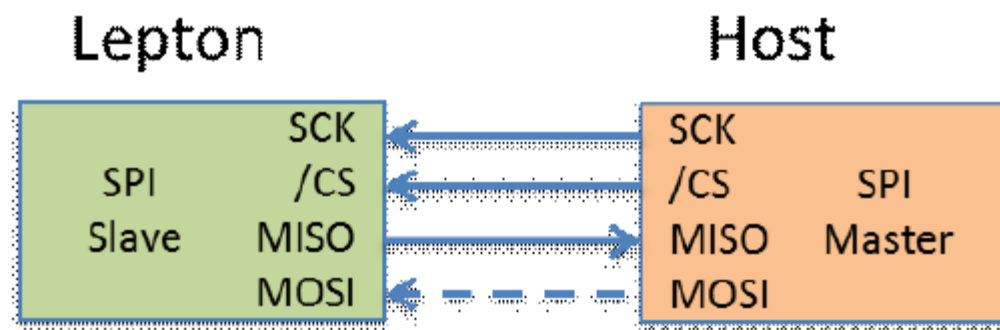


Failure to Read Out an Available Frame

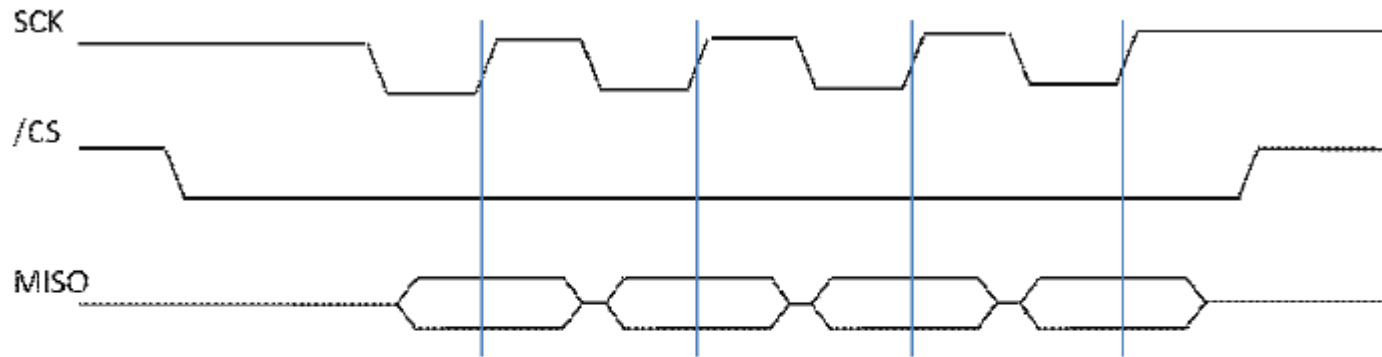


Source: FLIR\_Lepton\_Data\_Brief

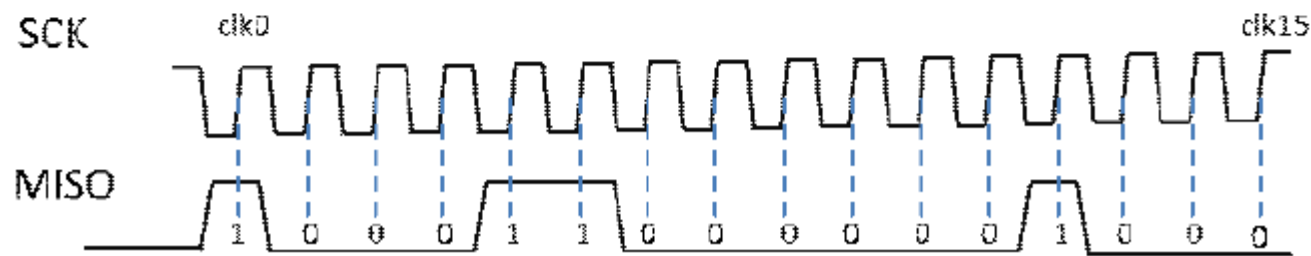
# SPI connection & protocol



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:

	Configuration		
Telemetry Mode	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



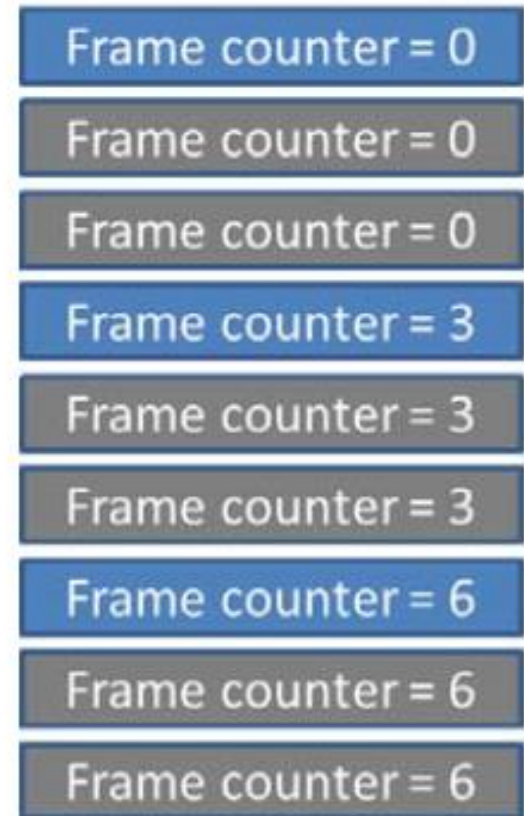
# Packet information (2)

- 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 !

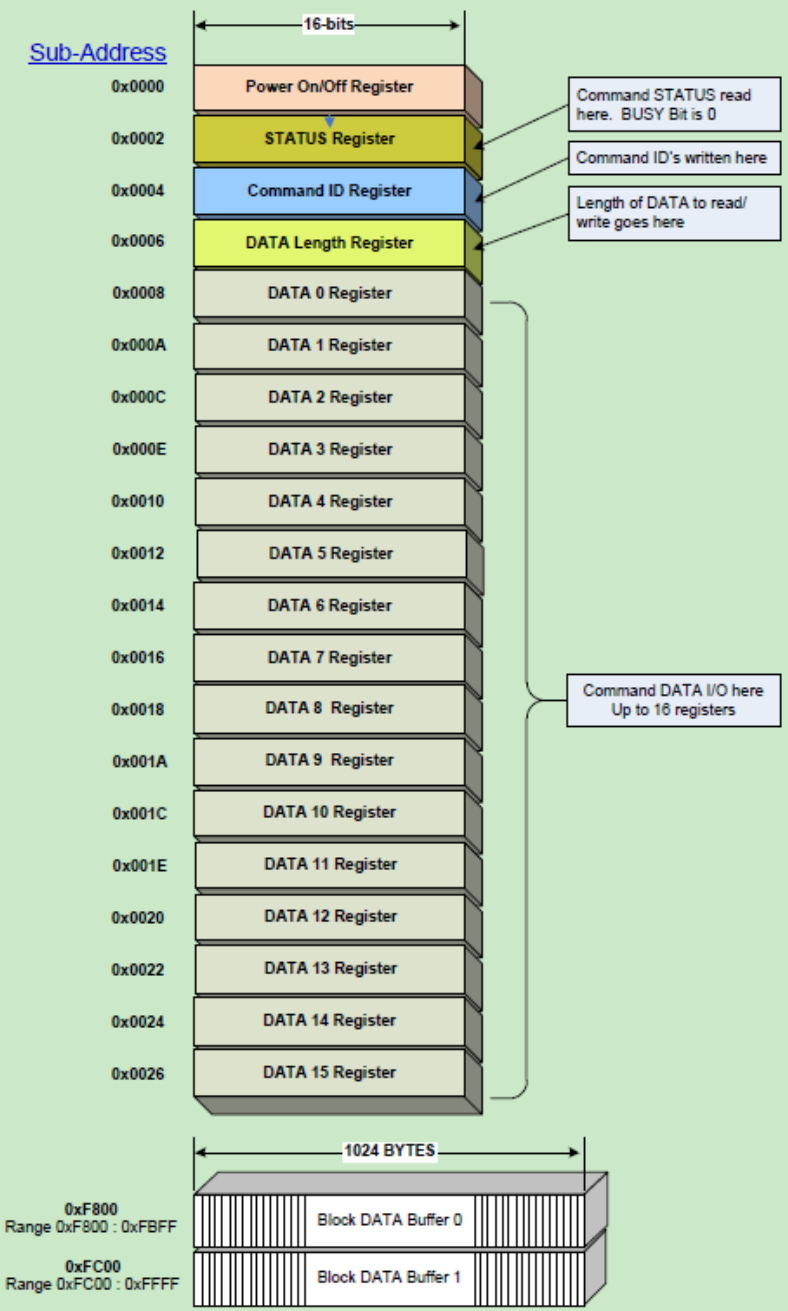


# Command to Camera

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

# Lepton Interface view

## Lepton CCI / TWI Interface



Source: FLIR Software Interface Description Document (IDD)

2016/03



