Thermoeye Inc.

THERMOEYE

ThermoCam160B

User Manual

Contact help@thermoeye.co.kr

Technical Support https://github.com/ThermoEye

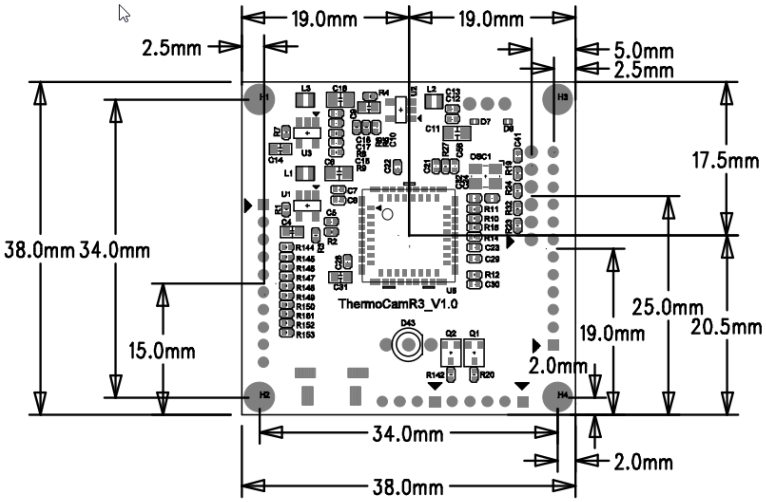
서울특별시 동작구 서달로 14 길 32 새마을금고 4 층

Revision

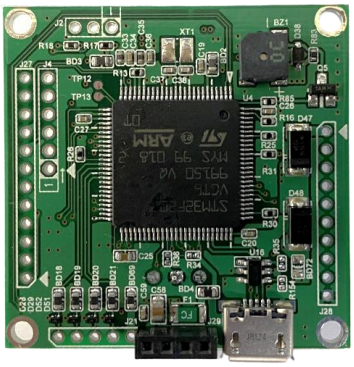
Version	Date	Contents
0.1	DEC.01.2020	Draft
1.0	DEC.22.2020	Initial
1.1	SEP.29.2022	Added Gain mode, Flux parameter command.

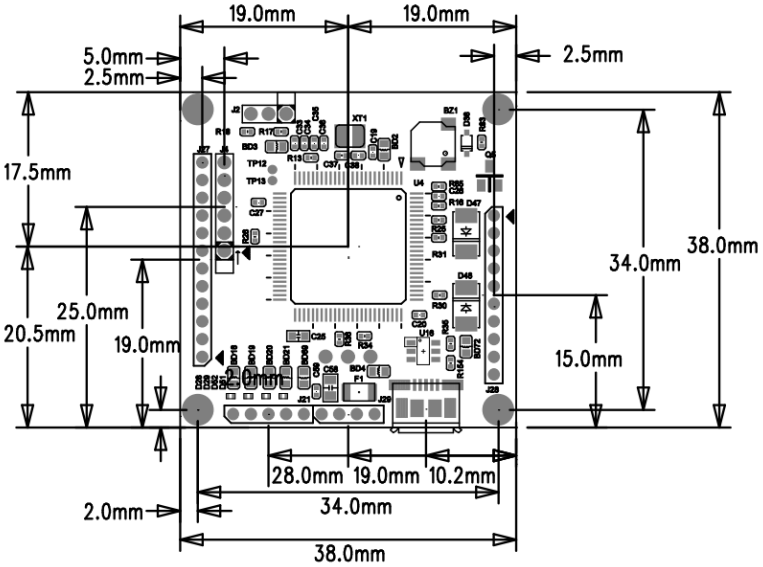
1. 하드웨어

- Top 배치도

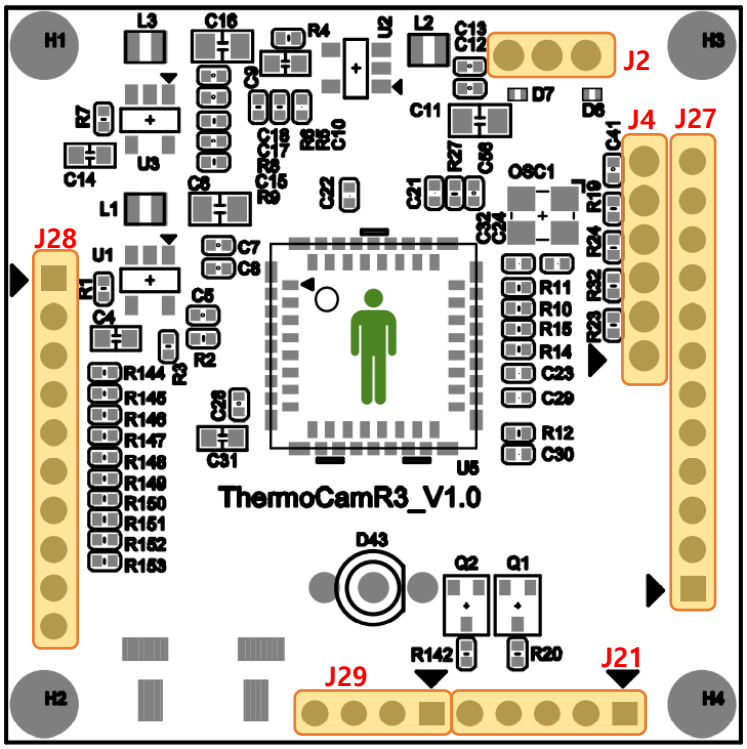


- Bottom 배치도





- Header Description



J2 – Debug UART : 460800 N-8-1		
1	DBG_UART_TX	Debug UART Transmit
2	GND	Ground
3	DBG_UART_RX	Debug UART Receive

J4 – JTAG/ST-LINK		
1	VCC	Power
2	JTMS-SWIO	JTMS / SWIO
3	JTCK-SWCLK	JTCK / SWCLK
4	JTDO-SWO	JTDO / SWO
5	NRST	Negative Reset
6	GND	Ground

J21 – External I/O		
1	EXT_OUT1	Out Pin1
2	EXT_OUT2	Out Pin2
3	EXT_IN1	In Pin1

4	EXT_IN2	In Pin2

J27 – Ethernet & External UART		
1	ETH_TX_EN	Transmit Enable
2	ETH_TXD0	Transmit Data Bit 0
3	ETH_TXD1	Transmit Data Bit 1
4	ETH_RXD0	Receive Data Bit 0
5	ETH_RXD1	Receive Data Bit 1
6	ETH_CRS_DV	Carrier Sense and RX_DATA Valid
7	ETH_MDC	Management Data Clock
8	ETH_MDIO	Management Data
9	ETH_REF_CLK	Continuous Reference Clock
10	ETH_NRST	Negative Reset
11	EXT_UART_TX	UART Transmit
12	EXT_UART_RX	UART Receive

J28 – External Communication		
1	VCC (5V)	Power +5V
2	GND	Ground
3	EXT_CAN_SLEEP	CAN Bus Sleep
4	EXT_CAN_TX/EXT_I2C_SDA	CAN Transmit / I2C SDA
5	EXT_CAN_RX/EXT_I2C_SCL	CAN Receive / I2C SCL
6	EXT_RS485_TX/EXT_PWM_OUT	RS485 Transmit / PWM Out
7	EXT_RS485_DE/EXT_ADC_IN	RS485 Data Enable / ADC In
8	EXT_RS485_RX/EXT_DAC_OUT	RS485 Receive / DAC Out
9	VCC (3.3V)	Power +3.3V
10	GND	Ground

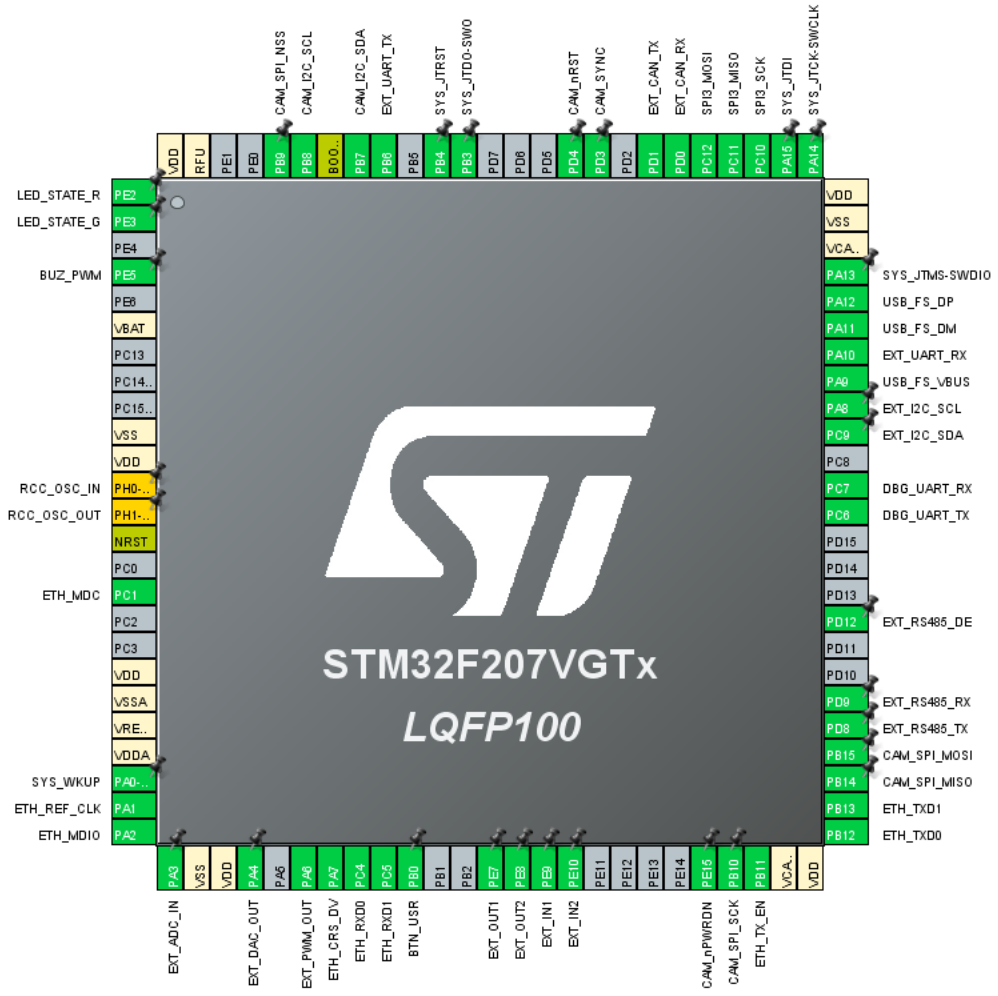
J29 - USB		
1	USB_VBUS	USB VBUS
2	USB_DM	Data Minus (D-)
3	USB_DP	Data Plus (D+)
4	GND	Ground

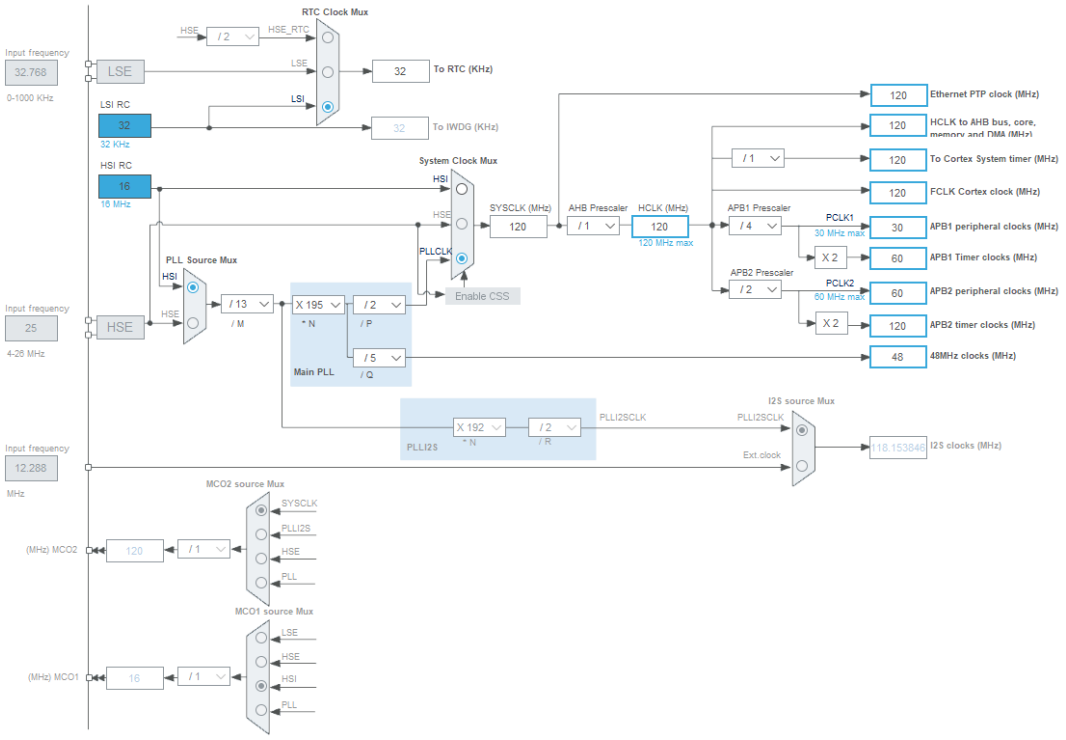
- Pin Configuration

Pin #	Pin Name	Alternate Function	Label
1	PE2	GPIO_Output	LED_STATE_R
2	PE3	GPIO_Output	LED_STATE_G
4	PE5	TIM9_CH1	BUZ_PWM
12	PH0-OSC_IN*	RCC_OSC_IN	
13	PH1-OSC_OUT*	RCC_OSC_OUT	
16	PC1	ETH_MDC	
23	PA0-WKUP	SYS_WKUP	

24	PA1	ETH_REF_CLK	
25	PA2	ETH_MDIO	
26	PA3	ADC1_IN3	EXT_ADC_IN
29	PA4	DAC_OUT1	EXT_DAC_OUT
31	PA6	TIM3_CH1	EXT_PWM_OUT
32	PA7	ETH_CRS_DV	
33	PC4	ETH_RXD0	
34	PC5	ETH_RXD1	
35	PB0	GPIO_EXTI0	BTN_USR
38	PE7	GPIO_Output	EXT_OUT1
39	PE8	GPIO_Output	EXT_OUT2
40	PE9	GPIO_Input	EXT_IN1
41	PE10	GPIO_Input	EXT_IN2
46	PE15	GPIO_Output	CAM_nPWRDN
47	PB10	SPI2_SCK	CAM_SPI_SCK
48	PB11	ETH_TX_EN	
51	PB12	ETH_TXD0	
52	PB13	ETH_TXD1	
53	PB14	SPI2_MISO	CAM_SPI_MISO
54	PB15	SPI2_MOSI	CAM_SPI_MOSI
55	PD8	USART3_TX	EXT_RS485_TX
56	PD9	USART3_RX	EXT_RS485_RX
59	PD12	USART3_RTS	EXT_RS485_DE
63	PC6	USART6_TX	DBG_UART_TX
64	PC7	USART6_RX	DBG_UART_RX
66	PC9	I2C3_SDA	EXT_I2C_SDA
67	PA8	I2C3_SCL	EXT_I2C_SCL
68	PA9	USB_OTG_FS_VBUS	USB_FS_VBUS
69	PA10	USART1_RX	EXT_UART_RX
70	PA11	USB_OTG_FS_DM	USB_FS_DM
71	PA12	USB_OTG_FS_DP	USB_FS_DP
72	PA13	SYS_JTMS-SWDIO	
76	PA14	SYS_JTCK-SWCLK	
77	PA15	SYS_JTDI	
78	PC10	SPI3_SCK	
79	PC11	SPI3_MISO	
80	PC12	SPI3_MOSI	
81	PD0	CAN1_RX	EXT_CAN_RX
82	PD1	CAN1_TX	EXT_CAN_TX
84	PD3	GPIO_EXTI3	CAM_SYNC
85	PD4	GPIO_Output	CAM_nRST
89	PB3	SYS_JTDO-SWO	
90	PB4	SYS_JTRST	
92	PB6	USART1_TX	EXT_UART_TX
93	PB7	I2C1_SDA	CAM_I2C_SDA
95	PB8	I2C1_SCL	CAM_I2C_SCL
96	PB9	SPI2_NSS	CAM_SPI_NSS

- Pinout & Clock Configuration

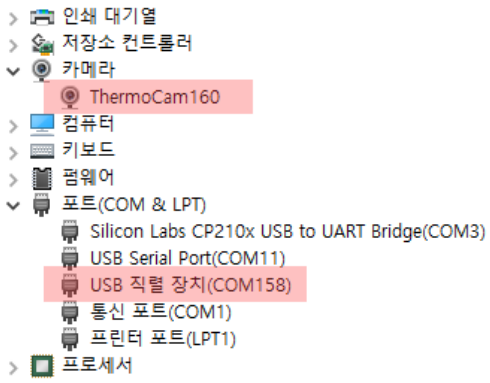




2. 설치

카메라 장치를 윈도우 PC 에 연결하면 장치 관리자에서 아래의 예시와 같이 인식 됩니다.

USB 직렬 장치 번호는 장치 연결 상태에 따라 번호는 달라집니다.



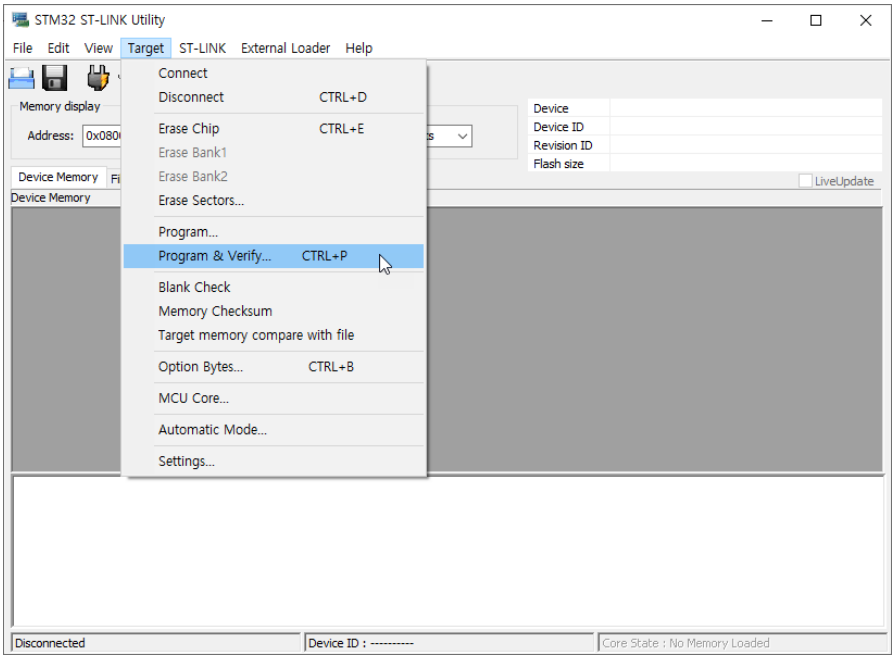
[그림] 구성 화면

3. 펌웨어

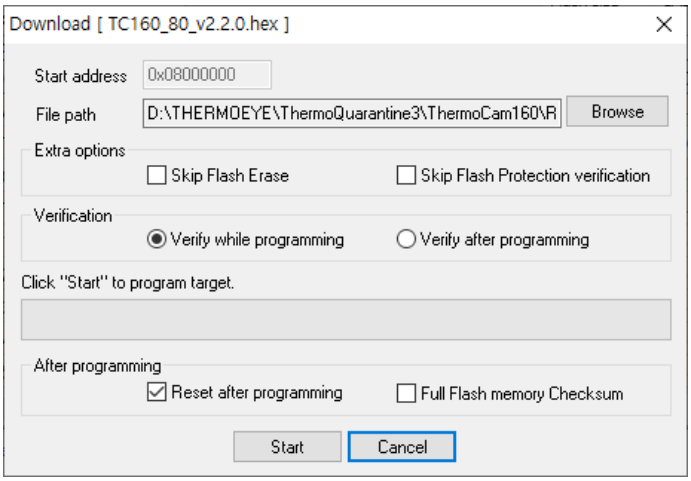
본 제품은 펌웨어가 프로그램된 상태로 출하되지만 고객사가 별도의 펌웨어 개발 혹은 수정이 된 후 다시 원래의 펌웨어를 사용하기 위해서는 제조사가 제공하는 펌웨어로 다시 프로그램 가능 합니다.

펌웨어 프로그램은 J-Link/ST-Link로 펌웨어 업데이트 가능합니다.

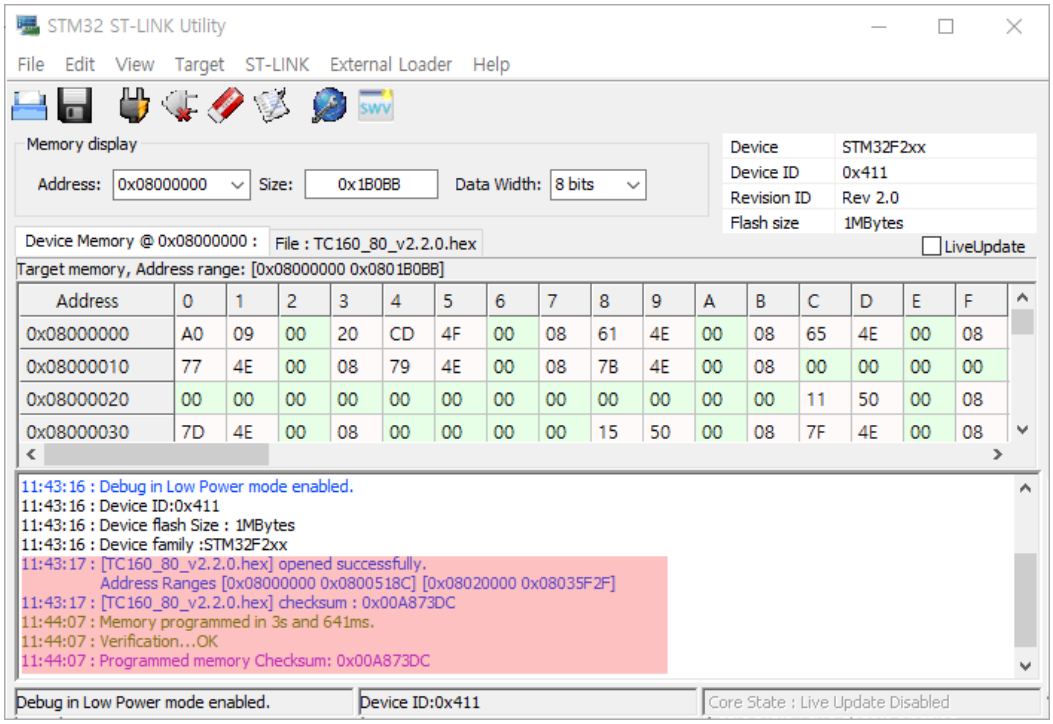
- HEX BIN 제공/ 업데이트 방법



ST Micro에서 제공하는 "STM32 ST-Link Utility" 프로그램을 실행 후 "Target-Program & Verify" 메뉴를 제조사가 제공하는 HEX 혹은 BIN 파일을 선택합니다.



펌웨어를 선택 후 "Start" 버튼을 클릭하여 업데이트 합니다.



펌웨어가 정상적으로 프로그램 되었는지 상기와 같이 확인합니다.

제조사에서 제공하는 펌웨어에서 추가적인 기능 및 변경을 목적으로 Firmware SDK 요청은 기술지원 메일로 요청 바랍니다.

4. LED 동작 상태 표시

표시	동작	상태
●○●○	적색 LED가 깜박거림	카메라 센서 모듈이 소켓과 연결이 양호하지 않거나 분리되어 있습니다. 센서 모듈을 소켓 방향으로 눌러 줍니다.
●	녹색 LED가 켜짐	정상 동작 상태입니다.
●○●○	녹색 LED가 깜박거림	정상적인 UVC 연결 및 동작 상태

5. 프로토콜

보드의 다양한 기능을 제공하기 위해 제조사 제공하는 기능 프로토콜을 아래와 같이 정의되어 있습니다.

5.1 Packet Format

Field	SOH[0]	STX[1]	ID[2]	CMD[3]	SIZE_L[4]	SIZE_H[5]	DATA[6]	CS	ETX
Bytes	1	1	1	1	1	1	n	1	1

- Field Description

Symbol	Value	Description
SOH	0x01	Start of Header
STX	0x02	Start of Text
ETX	0x03	End of Text
ID	0x00 ~ 0xFE : Specified 0xFF : Unspecified	Identification in RS485
CMD	0xXX	Packet Command
CS	0xXX	Checksum = ID ^ CMD ^ SIZE ^ DATA
DATA	N Length	Packet Payload

- Response Error Codes

Command	Data	Description
ACK[0xXX]	0x00	Command value is same as request command
NACK[0xFF]	0x01	Unknown Command
	0x02	Wrong Packet or Broken Packet
	0x03	Incorrect Checksum
	0x04	Zero Payload
	0x10	Invalid Argument
	0x20	Error In operation

5.2 Packet Commands

■ CMD_IMAGE_XXX

- CMD_IMAGE_FRAME : 0x10

Request Command		
CMD	DATA	Description
0x10	0x00	Full-size frame image (60x 80)
	0x01	Half-size frame image (30 x 40)
	0x02	Quarter-size frame image (15 x 20)
Response Command		
CMD	DATA	Description
0x10	Image data	N Length
0xFF	ErrorCode	NACK with error code

- CMD_TEMP_ROI : 0x21

Request Command		
CMD	DATA	Description
0x21	[xSTART][xEND][ySTART][yEND]	xSTART : x start position xEND : x end position ySTART : y start position yEND : y end position
Response Command		
CMD	DATA	Description
0x21	[minL][minH] [avgL][avgH] [maxL][maxH]	minTemp : minimum kelvin temperature in ROI (kelvin * 100) avgTemp : average kelvin temperature in ROI (kelvin * 100) maxTemp : maximum kelvin temperature in ROI (kelvin * 100)
0xFF	ErrorCode	NACK with error code

- CMD_CTRL_XXX

  - CMD_CTRL_RESET : 0x31

Request Command		
CMD	DATA	Description
0x31	0x00	Normal
	0x01	Reset (soft reset)
Response Command		
CMD	DATA	Description
0x31	0x00	
0xFF	ErrorCode	NACK with error code

  - CMD_CTRL_BUZZER : 0x33

Request Command		
CMD	DATA	Description
0x33	[<Octave><Note>] [BuzCtrl]	Octave<b7:b4> : 0x01 ~ 0x08 0x0 : Invalid 0x01 : Octave 1 0x02 : Octave 2 0x03 : Octave 3 0x04 : Octave 4 0x05 : Octave 5 0x06 : Octave 6 0x07 : Octave 7 0x08 : Octave 8 0x09 ~ 0x0F : Invalid Note<b3:b0> : 0x0 ~ 0x6 0x0 : C 0x1 : D 0x2 : E 0x3 : F 0x4: G 0x5 : A

		0x6 : B 0x7 ~ 0xF : Invalid BuzCtrl : 0x00 ~ 0xFF 0x00 : Stop Buzzer(Off) 0x01 ~ 0xFE : Buzzing Time (n * 100ms) 0xFF : Start Buzzer (On)
Response Command		
CMD	DATA	Description
0x33	0x00	
0xFF	ErrorCode	NACK with error code

- CMD_CAM_XXX

  - CMD_CAM_INFO : 0xC1

Request Command		
CMD	DATA	Description
0xC1	0x00	Sensor Type
	0x01	Sensor Module Serial Number
Response Command		
CMD	DATA	Description
0xC1		Internal Used
0xFF	ErrorCode	NACK with error code

  - CMD_CAM_GAIN : 0x7

Request Command		
CMD	DATA	Description
0xC7	0x00	Get gain mode
	[0x01][GainMode]	Set gain mode [GainMode] 0x00 = HIGH 0x01 = LOW 0x02 = AUTO
Response Command		
CMD	DATA	Description
0xC7	[0x00][GainMode]	[GainMode] 0x00 = HIGH 0x01 = LOW 0x02 = AUTO
0xC7	0x00	Set gain mode success
0xFF	ErrorCode	NACK with error code

- CMD_CAM_FLUX_PARAM : 0x8

Request Command		
CMD	DATA	Description
0xC8	0x00	Get Flux Linear Parameters
0xC8	0x01	Set Flux linear Parameters
Response Command		
CMD	DATA	Description
0xC8	[0x00][FLUX_LINEAR_PARAMS_T]	[FLUX_LINEAR_PARAMS_T]
0xC8	0x01	Set Flux Linear Parameters success
0xFF	ErrorCode	NACK with error code

[FLUX_LINEAR_PARAMS_T] : RAD Flux Linear Parameters

	Minimum Value	Maximum Value	Default Setting	Radiometric Releases Factory Default	Units	Scale factor
sceneEmissivity	82	8192	8192	8192	Percent	8192/100 (8192 = 100%)
TBkgK	0	65535	30000	29515	Kelvin	100 (29515 = 295.15K)
tauWindow	82	8192	8192	8192	Percent	8192/100 (8192 = 100%)
TWindowK	0	65535	30000	29515	Kelvin	100 (29515 = 295.15K)
tauAtm	82	8192	8192	8192	Percent	8192/100 (8192 = 100%)
TAtmK	0	65535	30000	29515	Kelvin	100 (29515 = 295.15K)
reflWindow	0	8192– tauWindow	0	0	Percent	8192/100 (8192 = 100%)
TReflK	0	65535	30000	29515	Kelvin	100 (29515 = 295.15K)

```
typedef struct FLUX_LINEAR_PARAMS_T_TAG
{
    uint16_t sceneEmissivity;
    uint16_t TBkgK;
    uint16_t tauWindow;
    uint16_t TWindowK;
    uint16_t tauAtm;
    uint16_t TAtmK;
    uint16_t reflWindow;
    uint16_t TReflK;
}FLUX_LINEAR_PARAMS_T, *FLUX_LINEAR_PARAMS_T_PTR;
```

- CMD_CFG_XXX
- CMD_SYS_XXX
  - CMD_SYS_GET_VERSION : 0xE1

Request Command		
CMD	DATA	Description
0xE1	0x00	Bootloader version
	0x01	Main application version
Response Command		
CMD	DATA	Description
0xE1	[RC][Minor][Major]['B']	'B' : Bootloader ID Major : Major Version Minor : Minor Version RC : Release Candidate
	[RC][Minor][Major]['M']	'M' : Main Application ID Major : Major Version Minor : Minor Version RC : Release Candidate
0xFF	ErrorCode	NACK with error code

  - CMD_SYS_GET_STATE : 0xE2

Request Command		
CMD	DATA	Description
0xE2	0x00	Invalid
	0x01	Get Camera Status
Response Command		
CMD	DATA	Description
0xE2	[CamState]	<b0> sensor module connection 0 : sensor module is not connected 1 : sensor module is connected well <b1> camera stability 0 : not stabilized yet 1: stabilized
0xFF	ErrorCode	NACK with error code

- CMD_FLASH_XXX
  - CMD_FLASH_START – 0xF1
  - CMD_FLASH_ING – 0xF2
  - CMD_FLASH_END – 0xF3

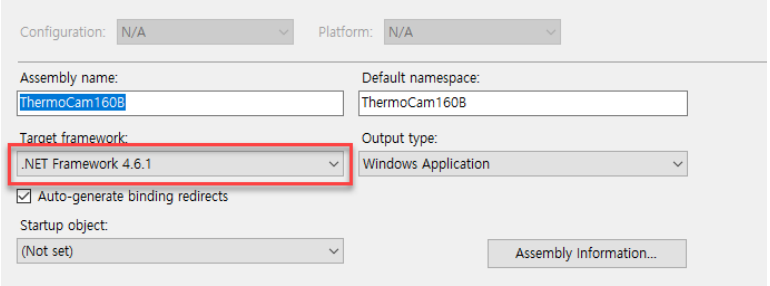
6. SDK Samples

6.1 Windows

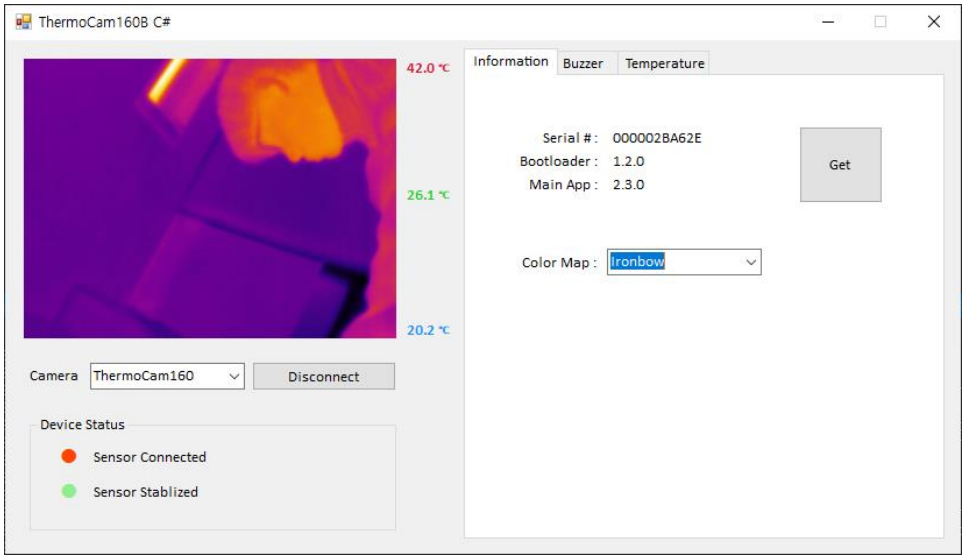
윈도우 프로젝트는 Microsoft Visual Studio 2019 Community를 기준으로 작성되었습니다.

A. Microsoft .NET C#

- .NET Framework 6.4.1 이상 버전에만 지원합니다.



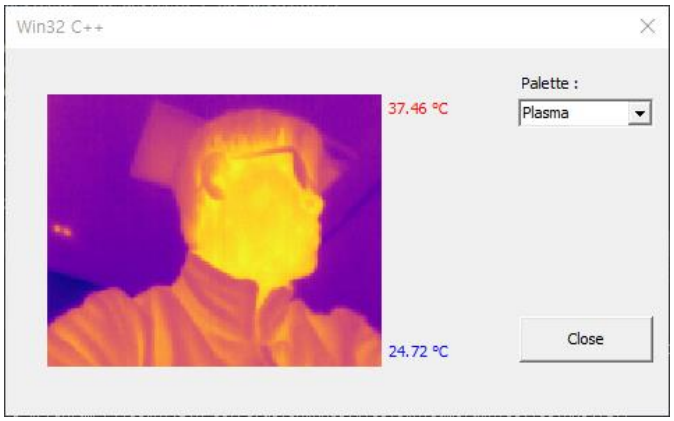
- 메인 화면



1) "Camera" 리스트에서 "ThermoCam160" 카메라 선택

2) "Connection"버튼을 클릭하여 연결

B. Win32 C++ 프로젝트



6.2 Python

윈도우 및 리눅스 환경하에서 실행 가능합니다.

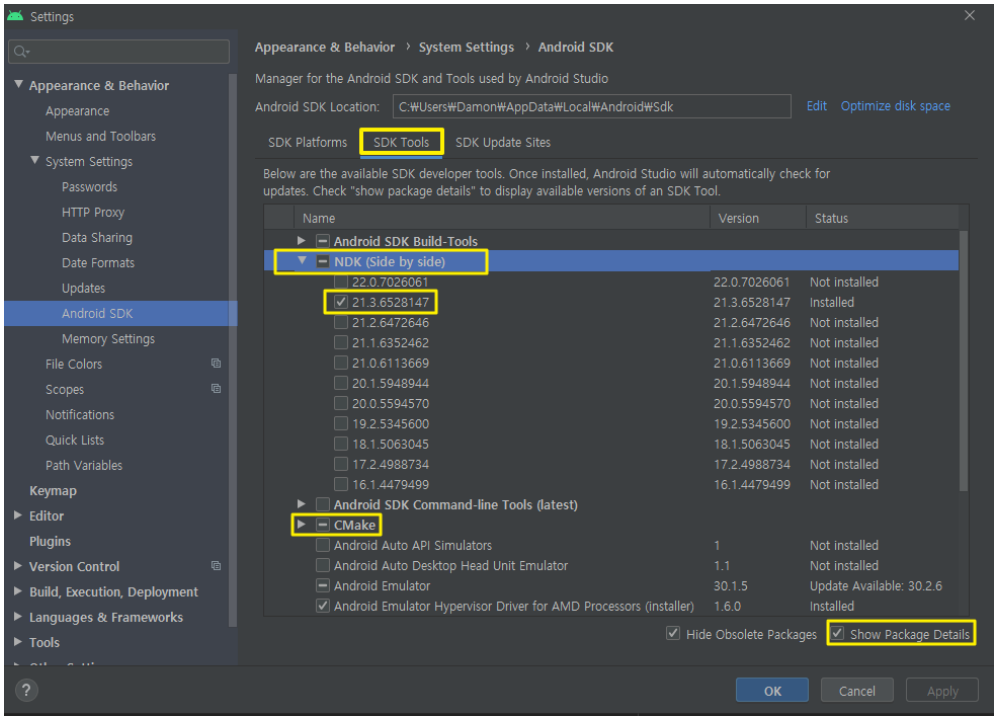
리눅스 환경하에서는 아래와 같이 uvcvideo 드라이버를 동적 로딩하셔야 합니다.

```
$ sudo rmmod uvcvideo
$ sudo modprobe uvcvideo nodrop=1 timeout=5000
```

6.3 Android

- Android Project 초기 설정

a. 안드로이드 스튜디오에서 Open an existing Android Studio Project를 선택하여 프로젝트 폴더를 선택한다.



b. NDK 및 CMake 설정

File-Settings 메뉴의 "Appearance & Behavior – Systems Settings-Android SDK-SDK Tools" 설정에서 NDK와 CMake를 설치한다.

NDK는 21.3.652847 버전을 선택.

c. 프로젝트를 불러오면 local.properties 파일이 자동 생성되며, 이 파일의 끝부분에 아래의 예시와 같이 설치된 NDK 설치 경로를 설정한다.