

Thermoeye Inc.



User Manual

ThermoCam160B, ThermoCam80B

Contact	help@thermoeye.co.kr
Technical Support	https://github.com/thermoeye/ThermoCam160B

서울특별시 동작구 서대로 14길 32 새마을금고 4층 (06979)

Revision

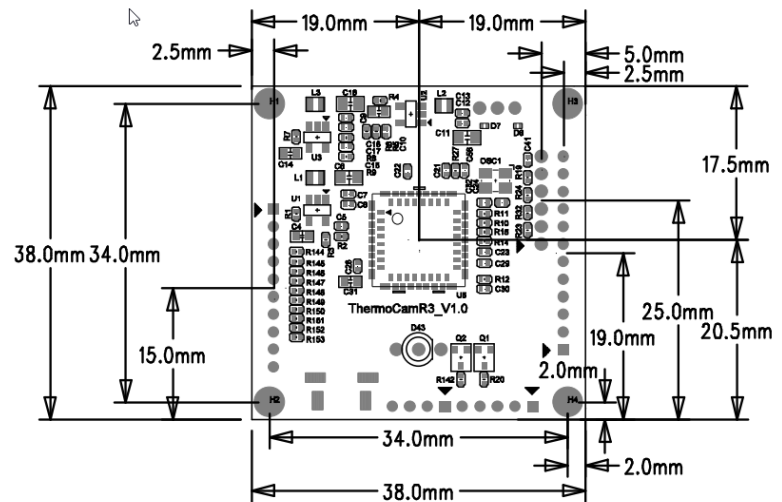
Version	Date	Contents
0.1	DEC.01.2020	Draft
1.0	DEC.22.2020	Initial
1.1	SEP.29.2022	Added Gain mode, Flux parameter command.

Specification

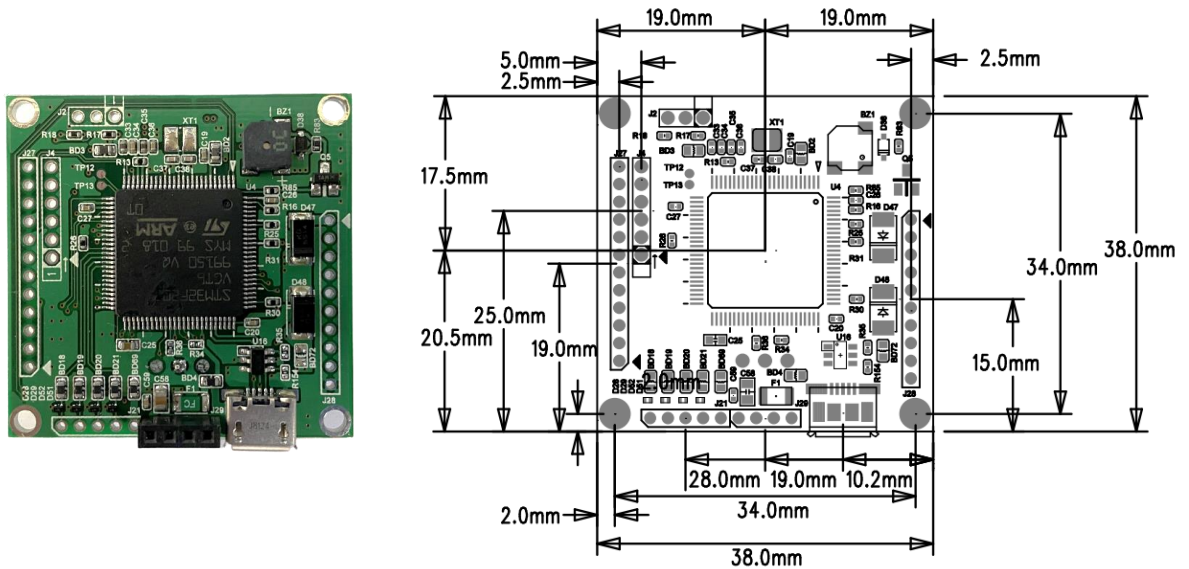
Model	Item	Description
Thermal Sensor	Sensor Technology	Uncooled VOx microbolometer
	Spectra Range	Longwave Infrared, 8 μ m to 14 μ m
	Video Scan	Progressive
	Effective Frame Rate	8.7 Hz
	Array Format (Resolution)	160x120 (ThermoCam160B) 80x60 (ThermoCam80B)
	Horizontal FOV	57 degree (ThermoCam160B) 50 degree (ThermoCam80B)
	Shutter	Yes
	Scene Dynamic Range	-10°C ~ +140°C
	Pixel Pitch	12 μ m (ThermoCam160B) 17 μ m (ThermoCam180B)
	Thermal Sensitivity	< 50 mK (0.050°C)
	Camera Operating Temperature	-10°C ~ +80°C
	Dimension	38mm x 38mm
MCU	Part	STM32F207VGT6
	Flash Memory	1024 KB
	SRAM	128 KB
	Maximum Frequency	120 MHz
	Operating Voltage	1.8 V to 3.6V
	Package	LQFP100 (14 x 14 mm)
Power	USB	5V
	DC Input	4.75 V ~ 28V
Interface	UVC	USB UVC 1.1
	RS485	115200 N-8-1
	RS232	115200 N-8-1

1. 하드웨어

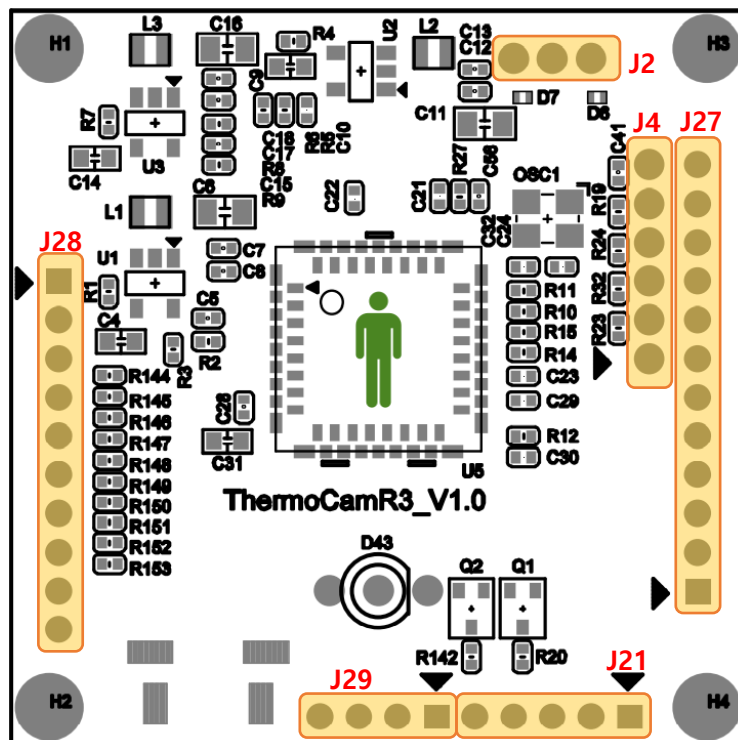
- Top 배치도



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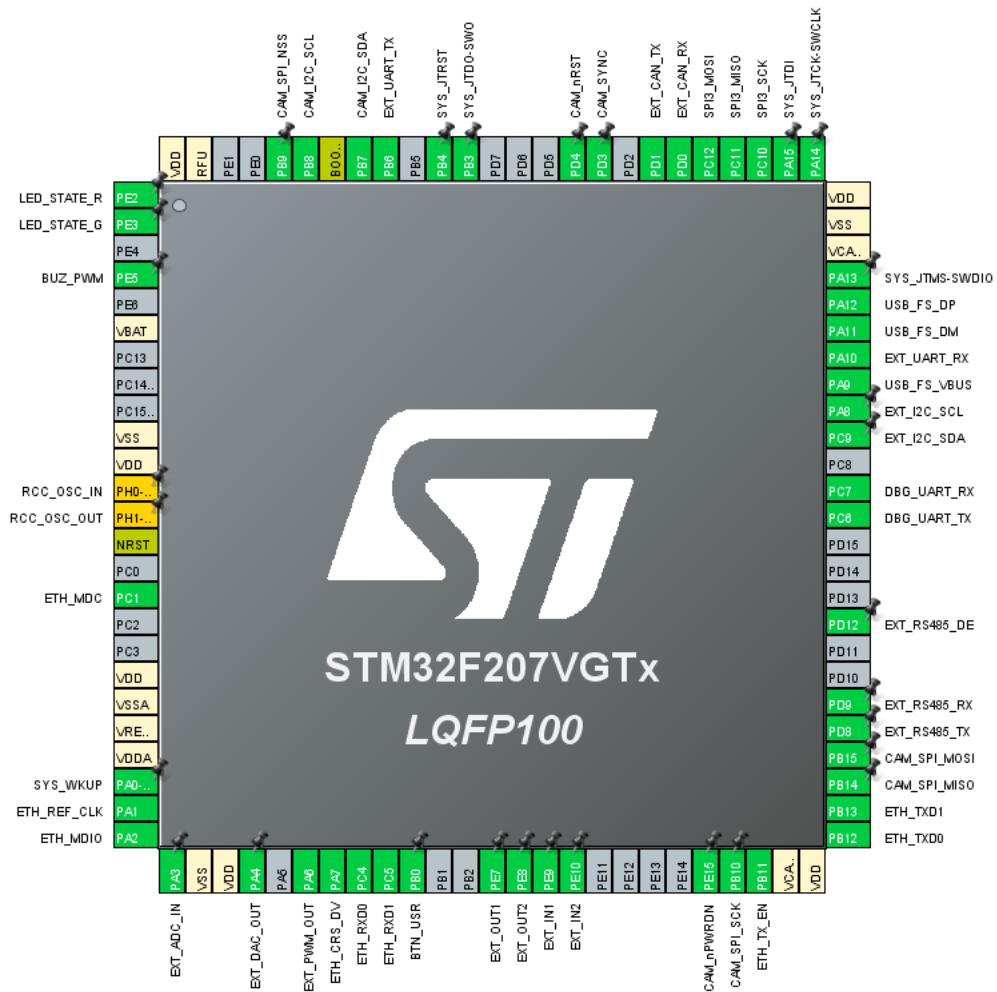
J29 - USB		
1	USB_VBUS	USB VBUS
2	USB_DM	Data Minus (D-)
3	USB_DP	Data Plus (D+)
4	GND	Ground

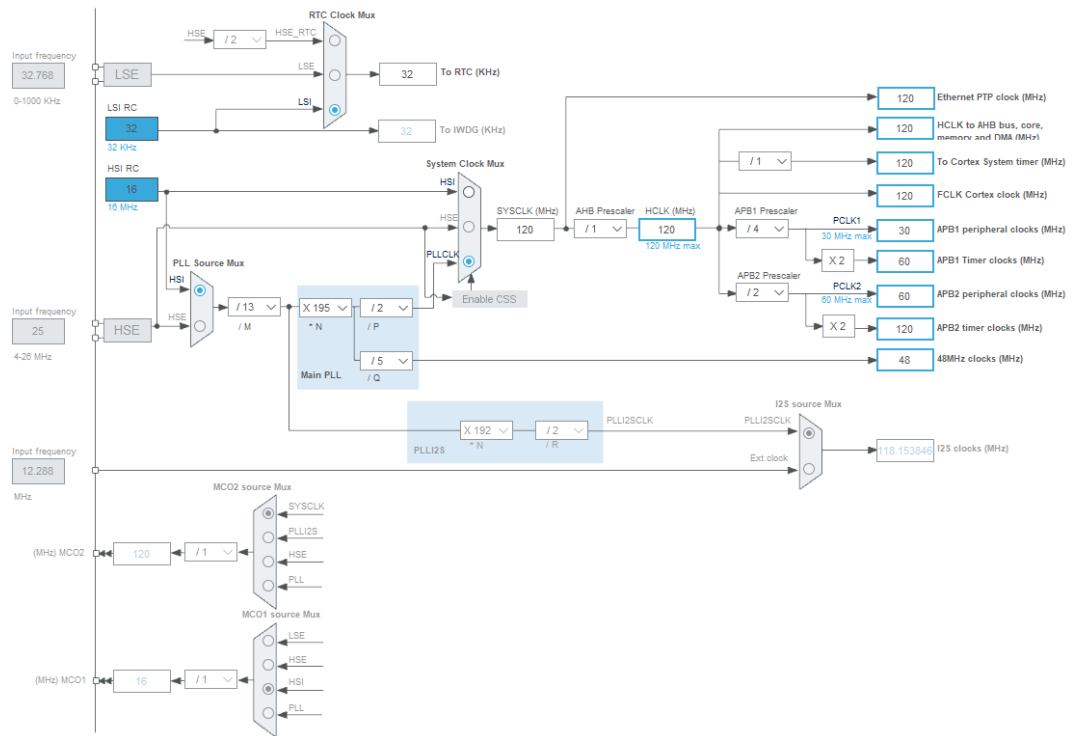
- Pin Configuration

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_CRSDV	
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_TXEN	
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

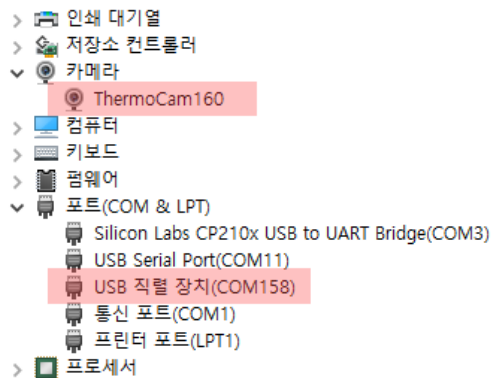




2. 설치

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

USB 직렬 장치 번호는 장치 연결 상태에 따라 번호는 달라집니다.



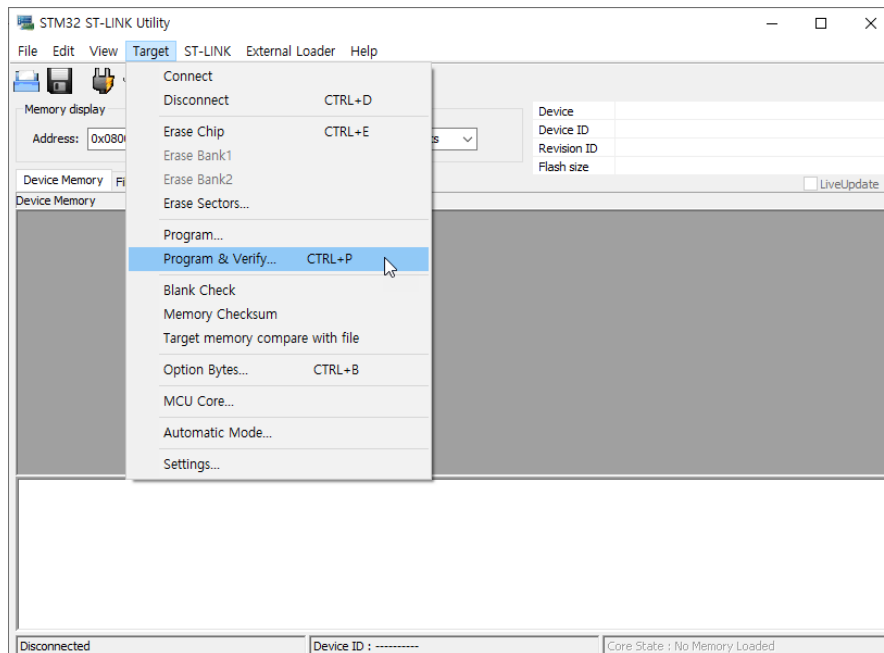
[그림] 구성 화면

3. 펌웨어

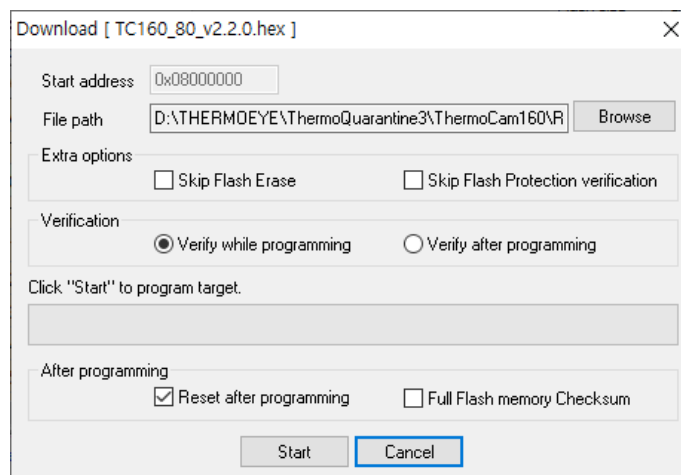
본 제품은 펌웨어가 프로그램된 상태로 출하되지만 고객사가 별도의 펌웨어 개발 혹은 수정이 된 후 다시 원래의 펌웨어를 사용하기 위해서는 제조사가 제공하는 펌웨어로 다시 프로그램 가능 합니다.

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

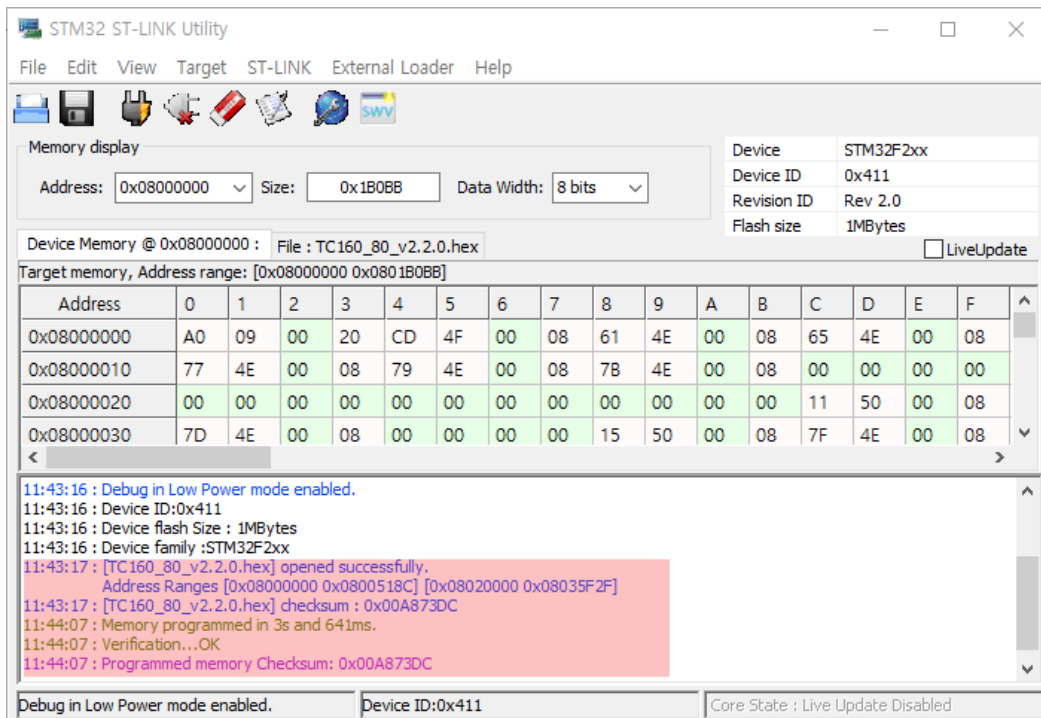
- HEX BIN 제공/ 업데이트 방법



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	0xFF	Packet Command
CS	0xFF	Checksum = ID ^ CMD ^ SIZE ^ DATA
DATA	N Length	Packet Payload

● Response Error Codes

Command	Data	Description
ACK[0xFF]	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 : 0xC7

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)

```

/* Radiometry Flux Linear Params
*/
typedef struct LEP_RAD_FLUX_LINEAR_PARAMS_T_TAG
{
    /* Type      Field name      format      comment */
    LEP_UINT16 sceneEmissivity; /* 3.13      */ /*
    LEP_UINT16 TBkgK;           /* 16.0      value in Kelvin 100x */
    LEP_UINT16 tauWindow;       /* 3.13      */ /*
    LEP_UINT16 TWindowK;        /* 16.0      value in Kelvin 100x */
    LEP_UINT16 tauAtm;          /* 3.13      */ /*
    LEP_UINT16 TAtmK;           /* 16.0      value in Kelvin 100x */
    LEP_UINT16 reflWindow;      /* 3.13      */ /*
    LEP_UINT16 TReflK;          /* 16.0      value in Kelvin 100x */
} LEP_RAD_FLUX_LINEAR_PARAMS_T, *LEP_RAD_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

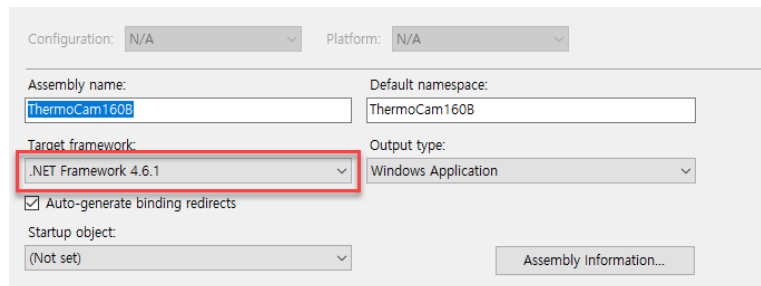
6. SDK Samples

6.1 Windows

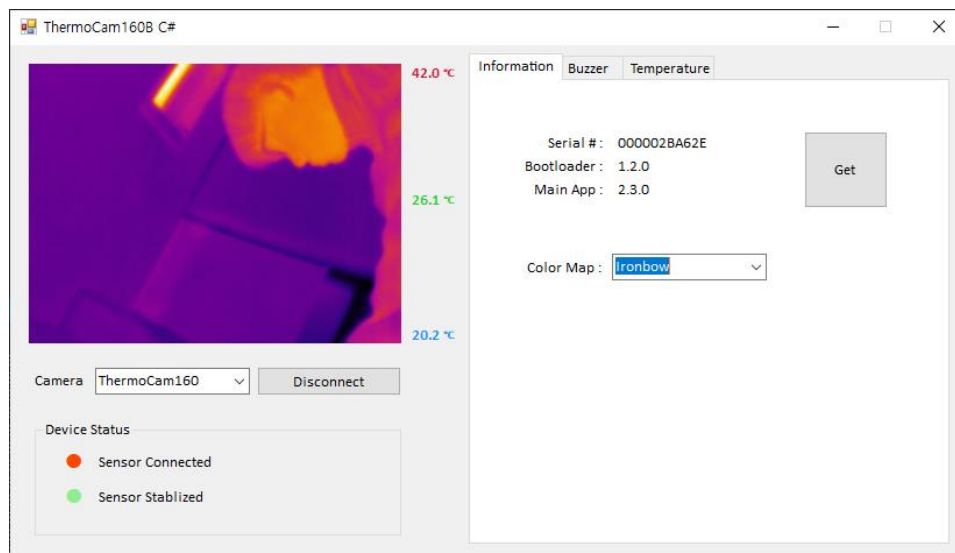
윈도우 프로젝트는 Microsoft Visual Studio 2019 Community를 기준으로 작성되었습니다.

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

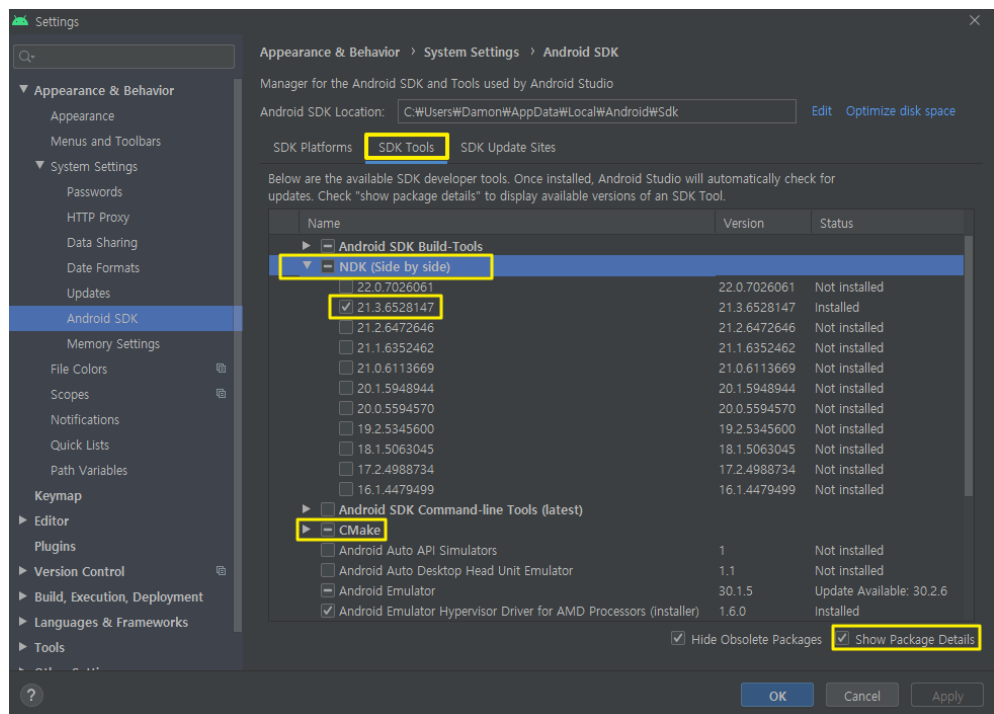
윈도우 및 리눅스 환경하에서 실행 가능합니다.

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.

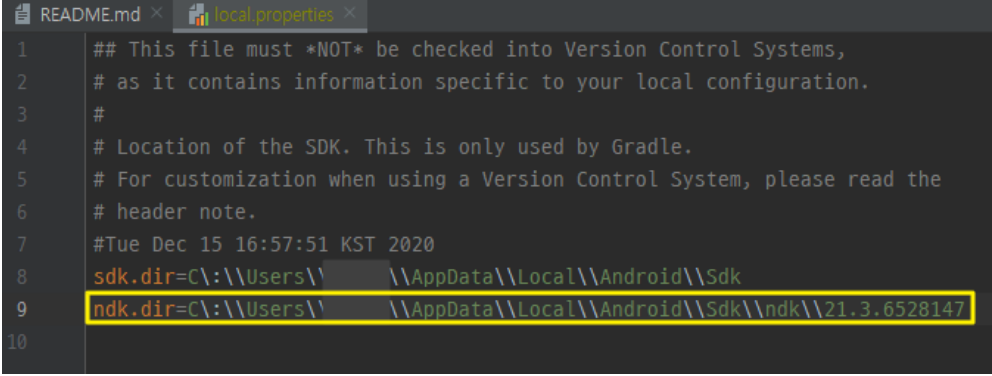


- b. NDK 및 CMake 설정

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.



```
1  ## This file must *NOT* be checked into Version Control Systems,
2  # as it contains information specific to your local configuration.
3  #
4  # Location of the SDK. This is only used by Gradle.
5  # For customization when using a Version Control System, please read the
6  # header note.
7  #Tue Dec 15 16:57:51 KST 2020
8  sdk.dir=C:\\Users\\...\\AppData\\Local\\Android\\Sdk
9  ndk.dir=C:\\Users\\...\\AppData\\Local\\Android\\Sdk\\ndk\\21.3.6528147
10
```