

# User Manual

TE – Q1 Development Kit

TE – V1 Development Kit



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## Contents

<b>1. Product Introduction</b> .....	<b>3</b>
<b>2. Product Specification</b> .....	<b>4</b>
2.1 TE - Q1 Deveopment Kit Specification.....	4
2.2 TE - V1 Deveopment Kit Specification .....	5
<b>3. Communication Interface</b> .....	<b>6</b>
3.1 Command Interface .....	6
3.2 Preparaion.....	6
3.3 Windows DLL.....	7
3.3.1 Windows Test Program.....	8
3.4 Linux SO.....	13
3.4.1 Linux Test Program.....	14
3.5 Android SDK.....	18
3.5.1 Android Test Program.....	20

## 1. Product Introduction

The Thermal Expert Development Kit has basic functions such as detector control, A/D conversion, USB 2.0 communication and calibration data storage (in flash memory). The algorithm is used to stabilize the output characteristics of the detector against the ambient temperature. Also The Thermal Expert Development Kit provides the calculation such as detector non-uniformity correction, dead correction and temperature calculation in user system. The android SDK, Windows DLL and Linux SO are available. Also, it is available in compact PC like Raspberry Pi, Odroid. It provides the output of thermal data and temperature data. And User can use the test program provided.



 RaspberryPi 2



**ODROID**



*i3system* i3system, Inc.

Intelligent Image & Information System

## 2. Product Specification

### 2.1 TE - Q1 Development Kit Specification

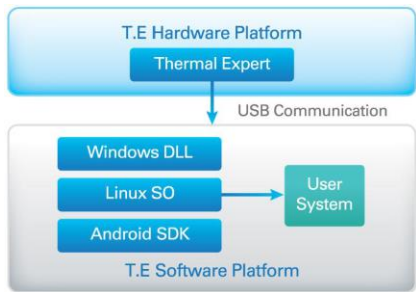
<b>Detector type</b>	micro-Bolometer(uncooled)
<b>Array format</b>	384x288
<b>Pitch</b>	17 $\mu$ m
<b>Sensitivity</b>	0.05°C @ f/1.0 (6.8mm lens) 0.08°C @ f/1.3 (13mm lens)
<b>Wavelength Band</b>	8 to 14 $\mu$ m
<b>Power consumption</b>	≤ 500mV
<b>Frame rate</b>	< 9Hz
<b>Interface</b>	Micro USB OTG
<b>Dimensions(W x H x D)</b>	47mm x 25mm x 16mm (Without Lens)
<b>Weight</b>	< 27g (with Wide FOV Lens)
<b>Operation temperature</b>	-10°C ~ 50°C
<b>Scene range temperature</b>	-10°C ~ 150°C (@ f/1.3)
<b>FOV</b>	<b>Wide FOV(default) :</b> 56.3°(H) x 41.8°(V) – 71.4°(diagonal) <b>Narrow FOV(option) :</b> 28.7°(H) x 21.7°(V) – 35.3°(diagonal)
<b>Focus range</b>	<b>Wide FOV :</b> 0.2m to infinity with 0.19 mm refocus <b>Narrow FOV :</b> 0.4m to infinity with 0.39mm refocus

## 2.2 TE – V1 Development Kit Specification

<b>Detector type</b>	micro-Bolometer(uncooled)
<b>Array format</b>	640x480
<b>Pitch</b>	17 $\mu$ m
<b>NETD</b>	<50mK
<b>Wavelength Band</b>	8 to 14 $\mu$ m
<b>Scene range temperature</b>	-10°C ~ 120°C
<b>Interface</b>	USB 2.0, Micro USB
<b>Compatibility</b>	Android, Windows, Linux
<b>Dimensions(W x H x D)</b>	50mm x 32mm x 30mm (Without Lens)
<b>Weight</b>	< 60g (with Wide FOV Lens)
<b>Lens</b>	FL8.5mm f/1.2 FL19mm f/1.0 FL 25mm f/1.2

### 3. Communication Interface

#### 3.1 Command Interface



<Thermal Expert Development Kit Relation Structure>

#### 3.2 Preparation

Refer to the table below, Check the appropriate files for your platform (OS). Include provided files in the folder.

Platform(OS)	File Name
Windows	i3system_te_dll.h, i3system_USB_V2.1.h, i3system_te_dll.dll, i3system_USB_V2.1.dll i3system_te_dll.lib, i3system_USB_V2.1.lib
Android	ThermalExpert.jar
Linux	i3system_TE.h libi3system_TE.so, libi3system_TE.so.1 libi3system_TE.so.1.0, libi3system_TE.so.1.0.0

### 3.3 Windows DLL

See the table below for the function used. Please refer to  
"i3system\_te\_dll.h" file for details

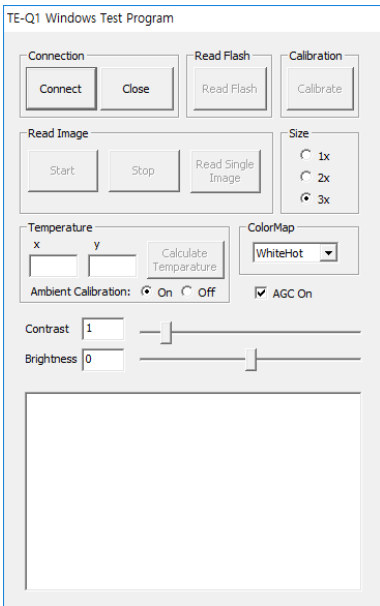
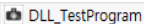
Function	Instruction
RecvImage	Receive the image from the USB
RecvImageWithinTempRange	In the temperature range, receive the image from the USB
SetTempRange	Set minimum and maximum temperature
CalcEntireTemp	Calculate temperature for all pixel
CalcTemp	Calculate temperature for particular pixel
CalcMin	Return minimum temperature in image
CalcMax	Return maximum temperature in image
ReadFlashData	Read flash data and Return success or failure
ShutterCalibrationOn	Recalculate offset data for calibration

Using test program, you can experience "Thermal Expert"

### 3.3.1 Windows Test Program

#### ① Run test program

Run DLL\_TestProgram.exe file.





## ② Connect

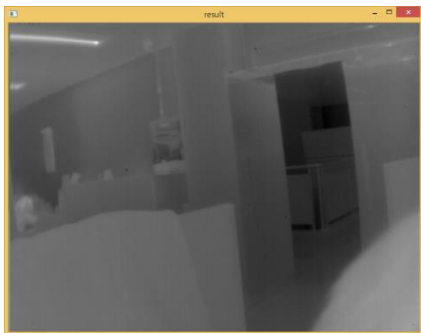
- 1) Connect Thermal Expert through USB connector
- 2) Click "Connect" Button
- 3) If USB connection succeed, "Connection completed" message is displayed.

## ③ Read Flash Data

- 1) Click "Read Flash" button to read flash data()
- 2) If succeed in reading flash data, "Flash read completed" message is displayed

## ④ Read Image

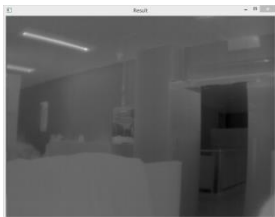
- 1) After reading flash data, you can receive image data (first few frames will show trash data)
- 2) To receive one frame image, press "Read Single Image" button. Then, image will be displayed in Result window and "Image read completed" message will appear
- 3) To receive image successively, press "Start" button
- 4) To stop receiving image, press "Stop" button



<Example>

⑤ Applying color map

If you change color map and read image, you can get image which color map is applied to.



Before applying color map



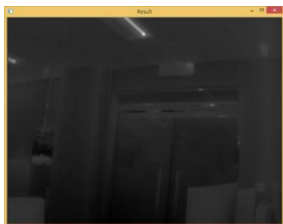
After applying color map(Hot)

## ⑥ Change contrast & brightness

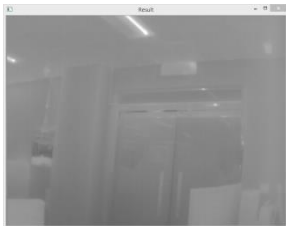
- 1) At the bottom of the program, you can change contrast and brightness condition  
(default setting is contrast = 1.0, brightness = 0)



- 2) Contrast and brightness can be set from 0 to 10.0 and -255 to 255 respectively



Before change brightness

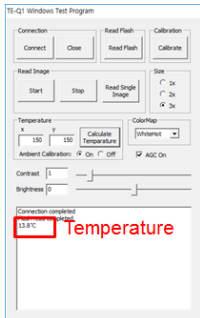


After change brightness

## ⑦ Get temperature

- 1) You can get temperature from received image. Type x, y pixel in Temperature box and press "Calculate Temperature" button. Then temperature at that point will show up.
- 2) Pixel value must be 0~383 for x, and 0 ~ 287 for y. If Pixel value is out of those range, "Out of Range" message appear.

- 3) Temperature calibration depending on ambient temperature is provided. It considers ambient temperature and calibrate shifted output depending on that temperature. If you want to get calibrated temperature, check "On" radio button. If not, check "Off" radio button. ("On" is checked as default)



## ⑧ Calibration

You can do calibration on your own, if you want.

To do that

- 1) Set thermal expert to see an image of which temperature is uniformly distributed.
- 2) Press "Calibrate" button.
- 3) Calibration will be done to produce uniform output.
- 4) After complete calibration, "Shutter Calibration completed" message will be displayed.

- 5) This calibration data will be used afterwards.
- 6) Calibration data is not stored permanently and removed when thermal expert is disconnected.

⑨ Close Program

To quit program, press "Close" button.

### 3.4 Linux SO

See the table below for the function used. Please refer to "i3system\_TE.h" file for details.

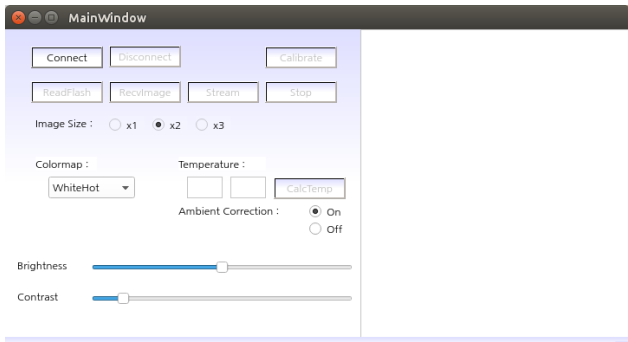
Function	Instruction
RecvImage	Receive the image from the USB
RecvImageWithinTempRange	In the temperature range, receive the image from the USB
SetTempRange	Set minimum and maximum temperature
CalcEntireTemp	Calculate temperature for all pixel
CalcTemp	Calculate temperature for particular pixel
CalcMin	Return minimum temperature in image
CalcMax	Return maximum temperature in image
ReadFlashData	Read flash data and Return success or failure
ShutterCalibrationOn	Recalculate offset data for calibration

Using test program, you can experience "Thermal Expert"

### 3.4.1 Linux Test Program

#### ① Run test Program

- 1) OS : Ubuntu 14.04
- 2) Add library path.
- 3) Run Library Test Program executable file.



#### ② Connect Thermal Expert

- 1) Connect Thermal Expert via USB connector
- 2) Click "Connect" button
- 3) If USB connection succeed, "Connected" message is displayed

#### ③ Read Flash Data

- 1) Click "ReadFlash" button to read flash data.
- 2) If succeed in reading flash data, "Flash read completed"

message is displayed

- 3) Certification Number will be checked while flash data is read. If Certification Number is incorrect, connection will be closed.

#### ④ Read Image

- 1) After reading flash data, you can receive image data (first few frames will show trash data)
- 2) To receive one frame image, press "RecvImage" button. Then, image will be displayed in Image window and "Image read completed" message will appear
- 3) To receive image successively, press "Stream" button
- 4) To stop receiving image, press "Stop" button

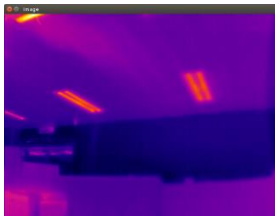


### ⑤ Applying color map

If you change color map and read image, you can get image which color map is applied to.



Before applying color map



After applying color map (Iron)

### ⑥ Change contrast & brightness

- 1) At the bottom of the program, you can change contrast and brightness condition (default setting is contrast = 1.0, brightness = 0)



- 2) Contrast and brightness can be set from 0 to 10.0 and -255 to 255 respectively



Before change brightness

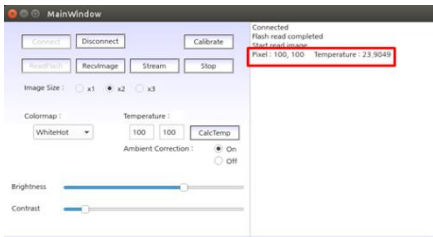


After change brightness



## ⑦ Get temperature

- 1) You can get temperature from received image. Type x, y pixel in Temperature box and press "CalcTemp" button. Then temperature at that point will show up.
- 2) Pixel value must be 0~383 for x, and 0 ~ 287 for y.
- 3) Temperature calibration depending on ambient temperature is provided. It considers ambient temperature and calibrate shifted output depending on that temperature. If you want to get calibrated temperature, check "On" radio button. If not, check "Off" radio button. ("On" is checked as default)



### ⑧ Calibration

You can do calibration on your own, if you want.

To do that

- 1) Set thermal expert to see an image of which temperature is uniformly distributed.
- 2) Press "Calibrate" button.
- 3) Calibration will be done to produce uniform output.
- 4) After complete calibration, "Calibration completed" message will be displayed.
- 5) This calibration data will be used afterwards.
- 6) Calibration data is not stored permanently and removed when thermal expert is disconnected.

### ⑨ Disconnect Thermal Expert

To disconnect Thermal Expert, press "Disconnect" button.

### ⑩ Hot plug

If Thermal Expert is removed and reconnected after doing connect, it will automatically reconnected. So, you don't have to do connect again.

## 3.5 Android SDK

See the table below for the function used. Please refer to "Android SDK Manual" file for details

- ThermalExpert Class

Function	Instruction
ThermalExpert	Constructor
Initail	Class Initailize
StartReceive	Start to receive images
StopReceive	Stop to receive images
GetImage	Get bitmap of a corrected image
GetData	Get a raw data
SetColorMap	Set Colormap
CalibrationImage	Recalculate offset data for calibration
GetARGBData	Get a ARGB(8888) data, 32bit
GetYUV420	Get a YUV420(planar) data, 8bit
FlashReload	Get Flash Data

- ThermalExpertListener Class (This class should be implemented in your project)

Function	Instruction
OnUsbConnected	When thermal expert is connected with usb, this function called.
onUsbDisconnected	When thermal expert is disconnected with usb, this function called
onFlashReadFinished	When reading flash data is finished, this function is called
onOneFrameFinished	Whenever a frame data is received, this function

	is called
onCalibrationFinished	When the image calibration is finished, this function is called

Using test program, you can experience “Thermal Expert”

### 3.5.1 Android Test Program

#### ① Connect Thermal Expert

- 1) Connect Thermal Expert through USB connector
- 2) Then Test Application is executed automatically

#### ② Read Flash Data

- 1) USB is connected successfully, then flash data is going to be read automatically  
(cf. It takes a few seconds to read flash data)
- 2) If succeed in reading flash data, “Flash read completed” message is displayed

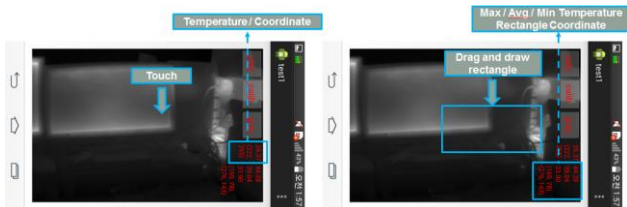
#### ③ Read Image

- 1) After reading flash data, you can receive image data (first few frames will show trash data)
- 2) The function, StartReceive(), is used to continuously receive and correct data.
- 3) The function, GetBitmap(), is used to get a bitmap of a



## ⑤ Get temperature

- 1) You can get temperature by touching screen
- 2) If you touch screen with a point, then the temperature of the point is displayed on the screen
- 3) If you draw a rectangle on the screen, then the maximum, average and minimum temperatures in the rectangle is displayed on the screen
- 4) Temperature calibration depending on ambient temperature is provided. It considers ambient temperature and calibrate shifted output depending on that temperature.



## ⑥ Calibration

You can do calibration on your own, if you want.

To do that

- 1) Set thermal expert to see an image of which temperature is uniformly distributed.
- 2) Press "Calib." button on the screen.

- 3) Calibration will be done to produce uniform output.
- 4) This calibration data will be used afterwards.
- 5) Calibration data is not stored permanently and removed when thermal expert is disconnected.

#### ⑦ Close Program

Thermal expert is disconnected with the smartphone, then the test application is automatically closed.