

# MLX90640-D110 Thermal Camera

## *Instruction*

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This is a 32×24 pixels, 55° field of view, IR array thermal imaging camera, communicating via I2C interface. It is compatible with 3.3V/5V operating voltage, supports host platforms such as Raspberry Pi/Arduino(ESP32)/STM32, etc.

## **Features**

- Adopts MLX90640 far-infrared thermal sensor array, 32×24 pixels
- Communicating via I2C interface, configurable to fast mode (up to 1MHz data rate)
- Noise Equivalent Temperature Difference (NETD) 0.1K RMS @1Hz refresh rate
- Onboard voltage translator, compatible with 3.3V/5V operating voltage
- Comes with development resources and manual (examples for Raspberry Pi/Arduino(ESP32)/STM32)

## **Specification**

Operating voltage: 3.3V/5V Operating current: <23mA Communication interface: I2C (address 0x33) Field of view (Horizontal×Vertical):

- **MLX90640-D55 Thermal Camera:** 55°×35° (narrow angle FOV, suit for long range measuring)
- **MLX90640-D110 Thermal Camera:** 110°×75° (wide angle FOV, suit for short range measuring)
- Operating temperature: -40°C~85°C
- Target temperature: -40°C~300°C
- Resolution: ±1°C
- Refresh rate: 0.5Hz~64Hz (programmable)
- Dimensions: 28mm×16 mm
- Mounting hole size: 2.0mm

## **Interface**

- Vcc: Connect to 3,3V (MCU)
- GND: Connect to GND (MCU)
- SDA: Connect to SDA pin of I2C interface (MCU)
- SCL: Connect to SCL pin of I2C interface (MCU)

## **I2C**

This camera use the I2C interface supports High-speed mode. The default I2C address is 0x33.

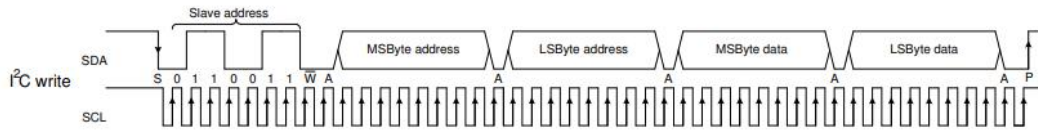


Figure 4 I<sup>2</sup>C write command format (default SA=0x33 is used)

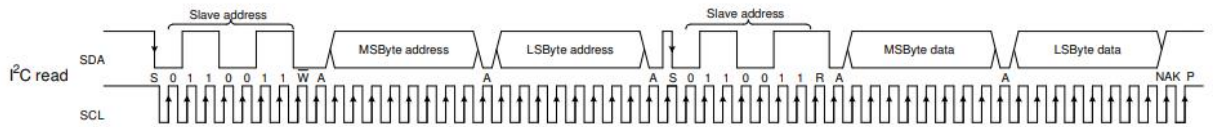
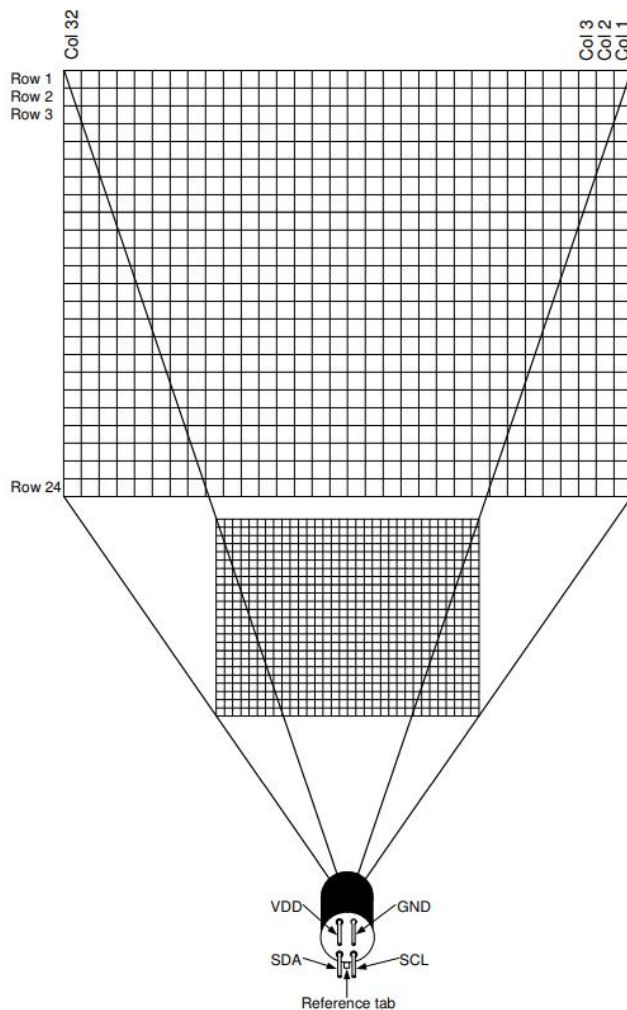


Figure 5 I<sup>2</sup>C read command format (default SA=0x33 is used)

## Pixel position

MLX90640 consists of 768 IR sensors (also called pixels). Each pixel is identified with its row and column position as Pix(i, j) where i is its row number (from 1 to 24) and j is its column number (from 1 to 32)



It is normal that the sensor may have less than four bad pixels. Every bad pixel is marked in EEPROM table. So the module you get may have bad pixels, it is normal and not covered by warranty. If the module you get has bad pixels, you can use the average value of the neighboring pixels.

### Address map

0x0000	ROM
0x03FF	
0x0400	RAM
0x07FF	
0x2400	EEPROM
0x273F	
0x8000	Registers (MLX reserved)
0x800C	
0x800D	Registers
0x8010	
0x8011	Registers (MLX reserved)
0x8016	

*Figure 10 MXL90640 memory map*

### RAM



EEPROM address	Access	Meaning
0x2400	Melexis	Melexis reserved
0x2401	Melexis	Melexis reserved
0x2402	Melexis	Melexis reserved
0x2403	Melexis	Configuration register
0x2404	Melexis	Melexis reserved
0x2405	Melexis	Melexis reserved
0x2406	Melexis	Melexis reserved
0x2407	Melexis	Device ID1
0x2408	Melexis	Device ID2
0x2409	Melexis	Device ID3
0x240A	Melexis	Device Options
0x240B	Melexis	Melexis reserved
0x240C	Customer	Control register_1
0x240D	Customer	Control register_2
0x240E	Customer	I2CConfReg
0x240F	Customer	Melexis reserved / I2C_Address

*Table 7 Configuration parameters memory*

## Refresh rate

This module support 8 kinds of refresh rate, up to 64Hz. The refresh rate is configured by registers 1-0x800D

B15	B14	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0	
Melexis reserved															<div style="border: 1px solid red; padding: 5px; display: inline-block;">Control register 1 - 0x800D</div>	
Reading pattern			Resolution control			Refresh rate control			Select subpage			Enable subpages: repeat	Enable data hold	Melexis reserved		Enable subpages mode
0 No subpages, only one page will be measured 1 Subpage mode is activated (default)																
0 Keep this bit = "0" (default) 1 Transfer the data into storage RAM at each measured frame (default) 1 Transfer the data into storage RAM only if en_overwrite = 1 (check 0x8000)																
0 Toggles between subpage "0" and subpage "1" if Enable subpages mode = "1" (default) 1 Select subpage determines which subpage to be measured if Enable subpages mode = "1"																
0 0 0 Subpage 0 is selected (default) 0 0 1 Subpage 1 is selected 0 1 0 Not Applicable 0 1 1 Not Applicable 1 0 0 Not Applicable 1 0 1 Not Applicable 1 1 0 Not Applicable 1 1 1 Not Applicable																
<div style="border: 1px solid red; padding: 5px;">           0 0 0 IR refresh rate = 0.5Hz            0 0 1 IR refresh rate = 1Hz            0 1 0 IR refresh rate = 2Hz (default)            0 1 1 IR refresh rate = 4Hz            1 0 0 IR refresh rate = 8Hz            1 0 1 IR refresh rate = 16Hz            1 1 0 IR refresh rate = 32Hz            1 1 1 IR refresh rate = 64Hz         </div>																
0 0 ADC set to 16 bit resolution 0 1 ADC set to 17 bit resolution 1 0 ADC set to 18 bit resolution (default) 1 1 ADC set to 19 bit resolution																
0 Interleaved (TV) mode 1 Chess pattern (default)																
Melexis reserved																

The refresh rate is defined by Bit 7, Bit 8 and Bit 9 of control registers 1-0x800D.

## Reading patterns

Chess pattern mode (factory default)

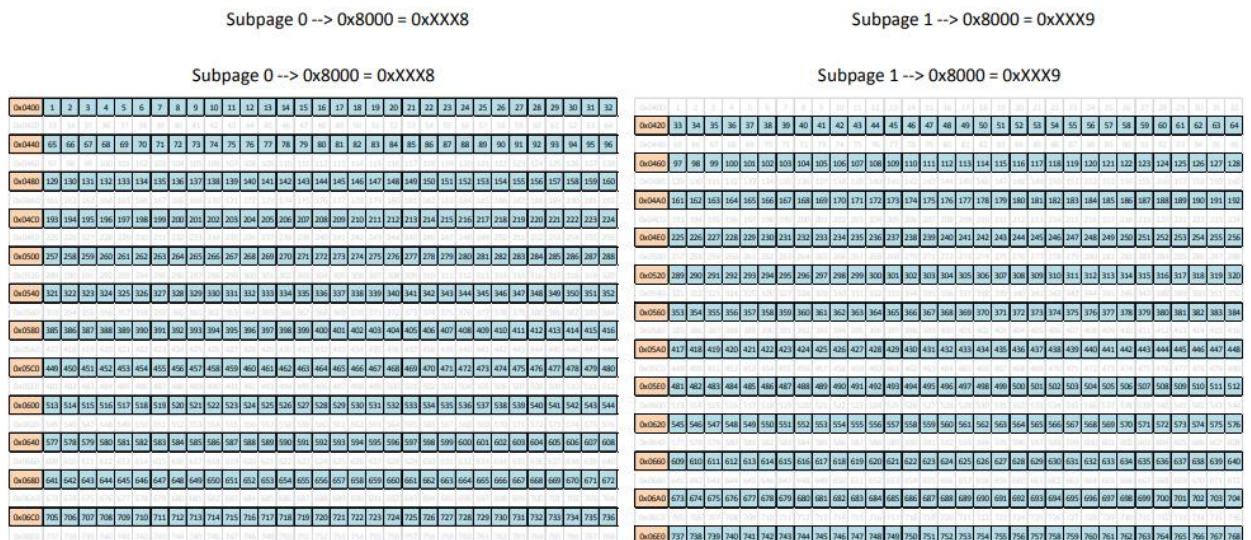


Figure 8 TV mode reading pattern (only highlighted cells are updated)

TV interleave mode

Subpage 0 --> 0x8000 = 0xXXX8																															Subpage 1 --> 0x8000 = 0xXXX9																														
0x0400	1	3	5	7	9	11	13	15	17	19	21	23	25	27	29	31	0x0400	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32																												
0x0402	34	36	38	40	42	44	46	48	50	52	54	56	58	60	62	64	0x0402	33	35	37	39	41	43	45	47	49	51	53	55	57	59	61	63																												
0x0404	65	67	69	71	73	75	77	79	81	83	85	87	89	91	93	95	0x0404	66	68	70	72	74	76	78	80	82	84	86	88	90	92	94	96																												
0x0406	96	100	102	104	106	108	110	112	114	116	118	120	122	124	126	128	0x0406	97	99	101	103	105	107	109	111	113	115	117	119	121	123	125	127																												
0x0408	129	131	133	135	137	139	141	143	145	147	149	151	153	155	157	159	0x0408	130	132	134	136	138	140	142	144	146	148	150	152	154	156	158	160																												
0x040A	162	164	166	168	170	172	174	176	178	180	182	184	186	188	190	192	0x040A	163	165	167	169	171	173	175	177	179	181	183	185	187	189	191	193																												
0x040C	193	195	197	199	201	203	205	207	209	211	213	215	217	219	221	223	0x040C	194	196	198	200	202	204	206	208	210	212	214	216	218	220	222	224																												
0x040E	226	228	230	232	234	236	238	240	242	244	246	248	250	252	254	256	0x040E	225	227	229	231	233	235	237	239	241	243	245	247	249	251	253	255																												
0x0410	257	259	261	263	265	267	269	271	273	275	277	279	281	283	285	287	0x0410	258	260	262	264	266	268	270	272	274	276	278	280	282	284	286	288																												
0x0412	290	292	294	296	298	300	302	304	306	308	310	312	314	316	318	320	0x0412	289	291	293	295	297	299	301	303	305	307	309	311	313	315	317	319																												
0x0414	321	323	325	327	329	331	333	335	337	339	341	343	345	347	349	351	0x0414	322	324	326	328	330	332	334	336	338	340	342	344	346	348	350	352																												
0x0416	354	356	358	360	362	364	366	368	370	372	374	376	378	380	382	384	0x0416	353	355	357	359	361	363	365	367	369	371	373	375	377	379	381	383																												
0x0418	385	387	389	391	393	395	397	399	401	403	405	407	409	411	413	415	0x0418	386	388	390	392	394	396	398	400	402	404	406	408	410	412	414	416																												
0x041A	418	420	422	424	426	428	430	432	434	436	438	440	442	444	446	448	0x041A	417	419	421	423	425	427	429	431	433	435	437	439	441	443	445	447																												
0x041C	449	451	453	455	457	459	461	463	465	467	469	471	473	475	477	479	0x041C	450	452	454	456	458	460	462	464	466	468	470	472	474	476	478	480																												
0x041E	482	484	486	488	490	492	494	496	498	500	502	504	506	508	510	512	0x041E	483	485	487	489	491	493	495	497	499	501	503	505	507	509	511	513																												
0x0420	513	515	517	519	521	523	525	527	529	531	533	535	537	539	541	543	0x0420	514	516	518	520	522	524	526	528	530	532	534	536	538	540	542	544																												
0x0422	546	548	550	552	554	556	558	560	562	564	566	568	570	572	574	576	0x0422	545	547	549	551	553	555	557	559	561	563	565	567	569	571	573	575																												
0x0424	577	579	581	583	585	587	589	591	593	595	597	599	601	603	605	607	0x0424	578	580	582	584	586	588	590	592	594	596	598	600	602	604	606	608																												
0x0426	610	612	614	616	618	620	622	624	626	628	630	632	634	636	638	640	0x0426	609	611	613	615	617	619	621	623	625	627	629	631	633	635	637	639																												
0x0428	641	643	645	647	649	651	653	655	657	659	661	663	665	667	669	671	0x0428	642	644	646	648	650	652	654	656	658	660	662	664	666	668	670	672																												
0x042A	674	676	678	680	682	684	686	688	690	692	694	696	698	700	702	704	0x042A	673	675	677	679	681	683	685	687	689	691	693	695	697	699	701	703																												
0x042C	705	707	709	711	713	715	717	719	721	723	725	727	729	731	733	735	0x042C	706	708	710	712	714	716	718	720	722	724	726	728	730	732	734	736																												
0x042E	738	740	742	744	746	748	750	752	754	756	758	760	762	764	766	768	0x042E	737	739	741	743	745	747	749	751	753	755	757	759	761	763	765	767																												

Figure 9 Chess reading pattern (only highlighted cells are updated)

The array frame is divided into two subpages and depending on bit 12 in "Control register 1" (0x800D). As a standard the MLX90640 is calibrated in Chess pattern mode, this results in better-fixed pattern noise behavior of the sensor when in chess pattern mode. For best results, we advise to use chess pattern mode.

## Measure principle

The FOV of this module is determined by 50% radiation signal which is received by the thermopile, it is also influenced by the main axis of the sensor. The temperature measured is the weighted average of the detected object's temperature in FOV. To improve the accuracy, you should make sure that the detected object is in the FOV totally.

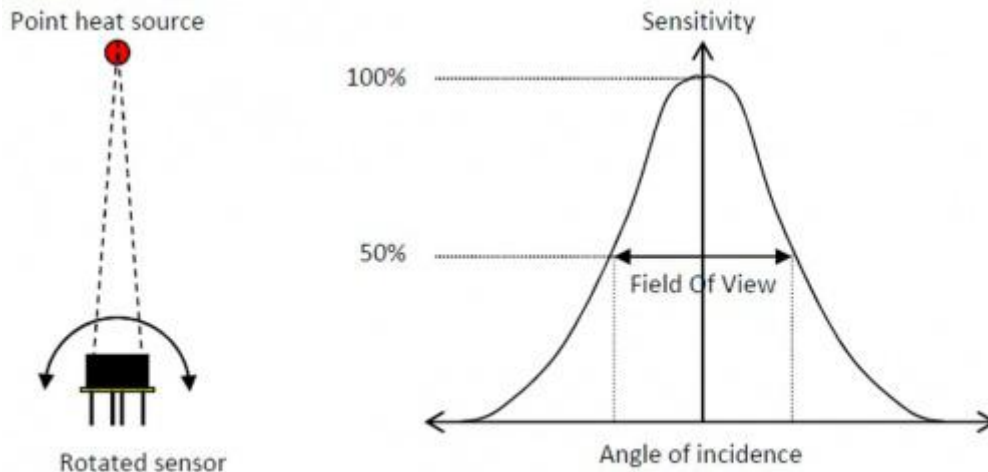
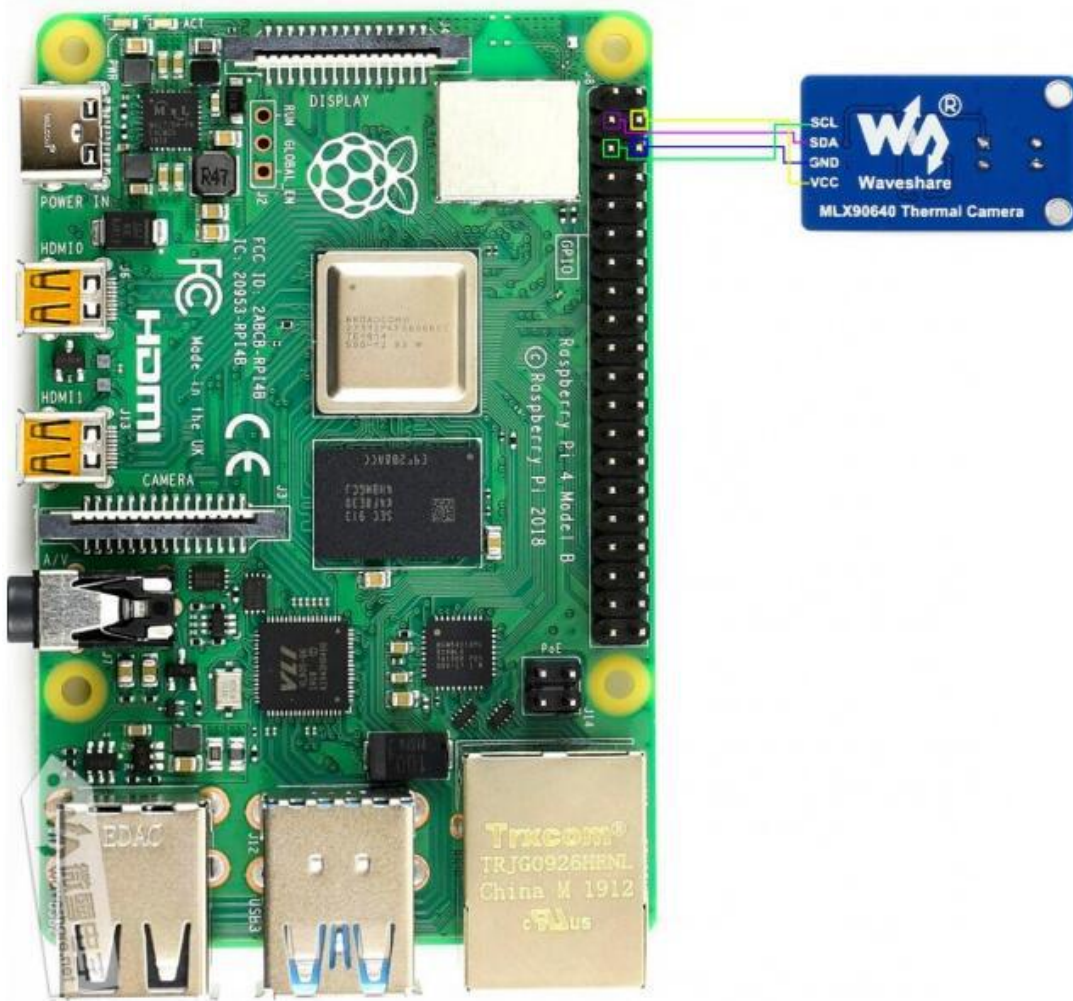


Figure 24: Field Of View measurement

Examples

Raspberry Pi

## Hardware connection



Raspberry Pi	MLX90640 Thermal Camera
5V	5V
GND	GND
SDA(BCM2)	SDA
SCL(BCM3)	SCL

Download the demo codes and use it.

```
cd ~  
wget http://www.waveshare.net/w/upload/5/56/MLX90640_Thermal_Camera_Code.7z  
sudo apt-get install p7zip  
p7zip --uncompress MLX90640_Thermal_Camera_Code.7z  
cd Raspberrypi/C++display shows/  
tar -xvf MLX90640_Thermal_Camera_SDL2.tar.gz  
cd MLX90640_Thermal_Camera_SDL2/  
sudo ./install.sh  
make
```



```
sudo ./main
```

If the detecting has delay, you can try to modify the i2c speed in config.txt file

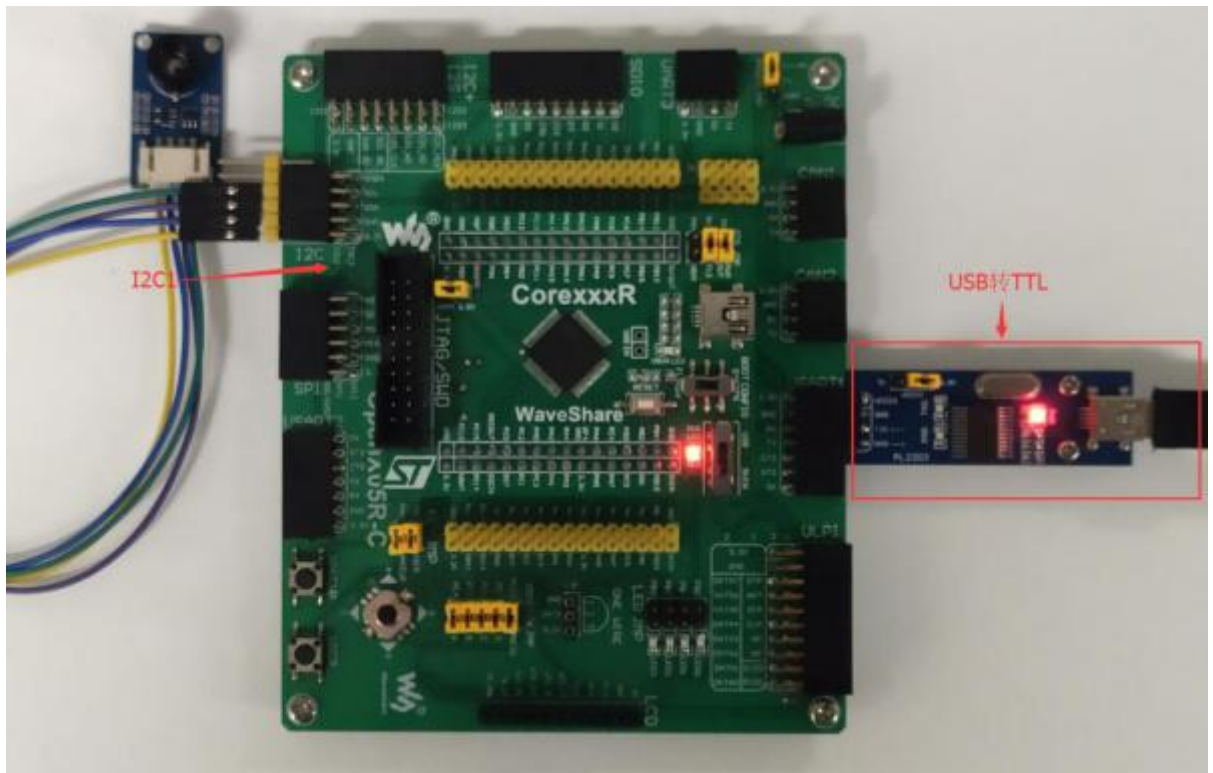
```
sudo nano /boot/config.txt
```

Add the line below to the config.txt file, reboot and check it again

```
dtoverlay=i2c1_baudrate=1000000
```

## STM32

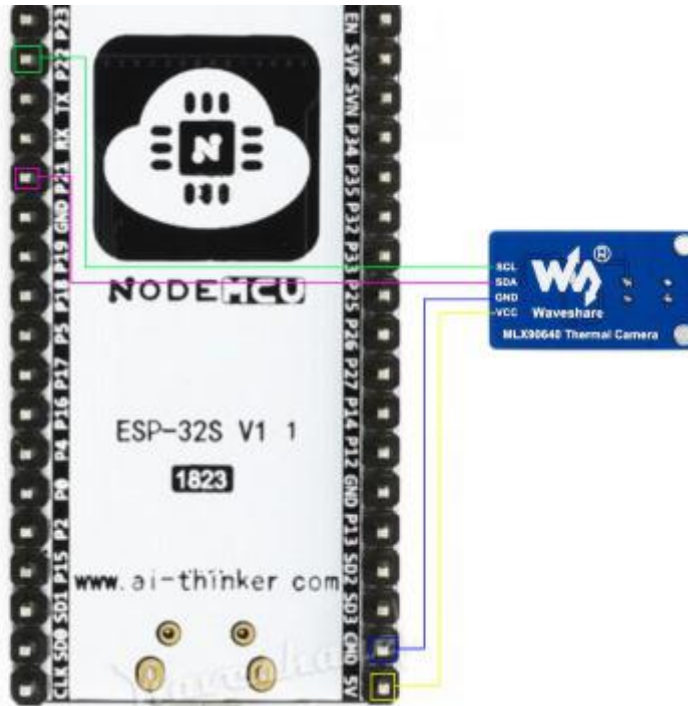
Hardware connection



STM32	MLX90640 Thermal Camera
5V	5V
GND	GND
SDA(PB11)	SDA
SCL(PB10)	SCL

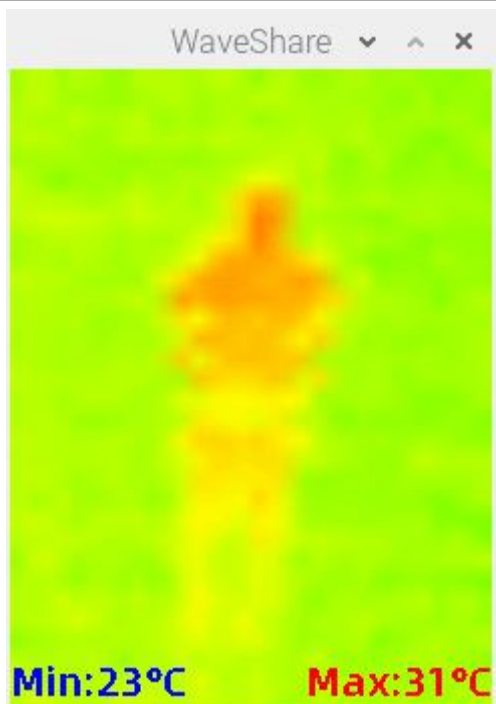
## ESP32

Hardware connection



ESP32	MLX90640 Thermal Camera
5V	5V
GND	GND
SDA(P21)	SDA
SCL(P22)	SCL

## Test result



## FAQ

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### Question:

What is the measurement distance of the MLX90640-D110, and what is the max frame rate?

### [\[Collapse\]](#) Answer:

A tester is 178cm tall, stands in 1M far, shake his hand backward. The focus disappears when the tester is farer than 9M. When the test away to 2M far, the camera loses the body contour. The Camera supports Maximum 64Hz.