

Waveshare Thermal Camera MLX90640-D110 User Manual

[Home](#) » [WAVESHARE](#) » Waveshare Thermal Camera MLX90640-D110 User Manual 

MLX90640-D110 Thermal Camera

Contents

- [1 Instruction](#)
- [2 Features](#)
- [3 Specification](#)
- [4 Interface](#)
- [5 I2C](#)
- [6 PIXEL POSITION](#)
- [7 Address map](#)
- [8 REM](#)
- [9 EEPROM](#)
- [10 Refresh rate](#)
- [11 Reading patterns](#)
- [12 Measure principle](#)
- [13 Examples](#)
- [14 Raspberry Pi](#)
- [15 STM32](#)
- [16 ESP32](#)
- [17 Test result](#)
- [18 FAQ](#)
- [19 Documents / Resources](#)
- [20 Related Posts](#)

Instruction

This is a 32×24 pixel, 55° field of view, IR array thermal imaging camera, communicating via the 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: ~ 4085
- Target temperature: ~ 40300
- Resolution: ±1
- 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 uses the I2C interface that supports High-speed mode. The default I2C address is 0x33.

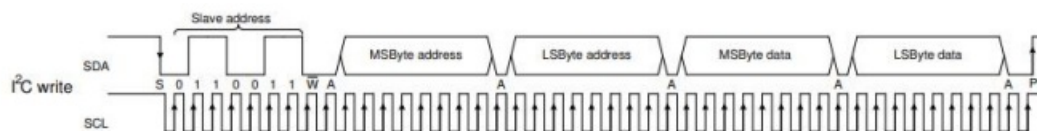


Figure 4 I²C write command format (default SA=0x33 is used)

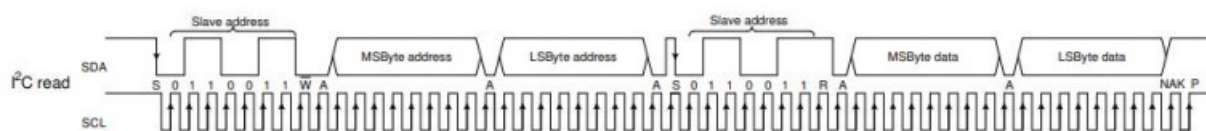
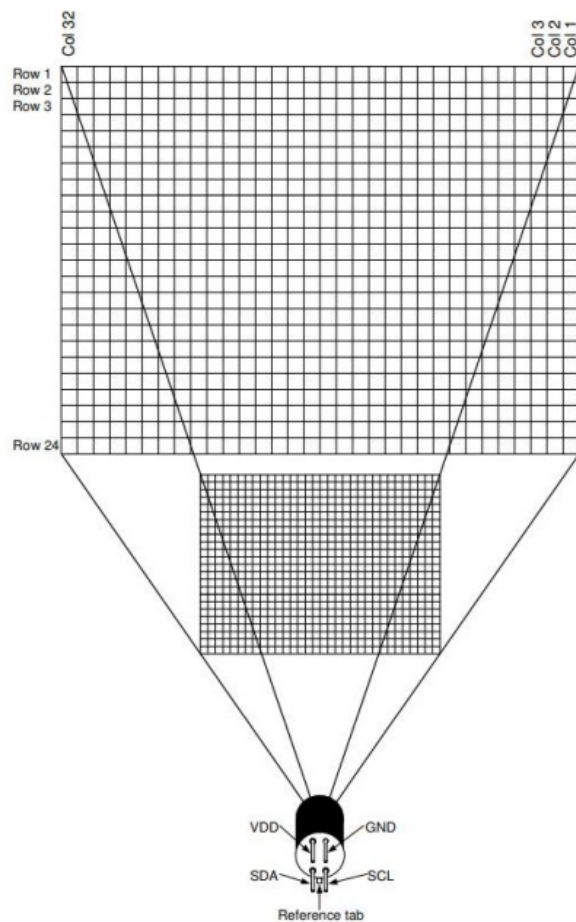


Figure 5 I²C read command format (default SA=0x33 is used)

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

Figure 10 MXL90640 memory map

REM

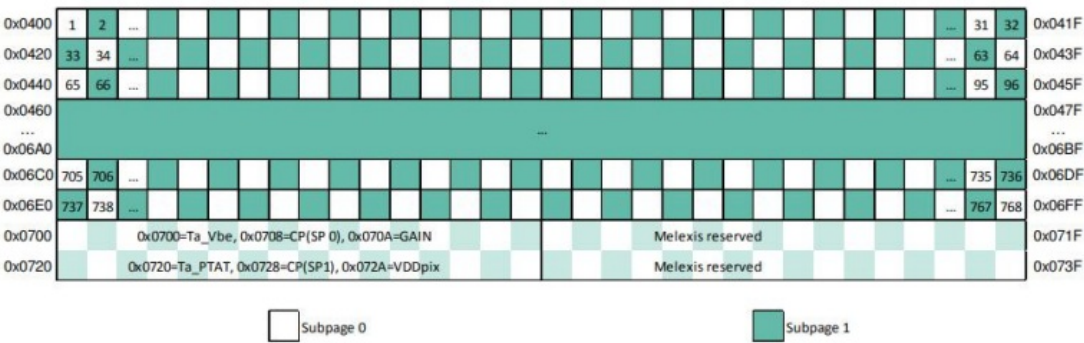


Figure 14 RAM memory map (Chess pattern mode) – factory default mode

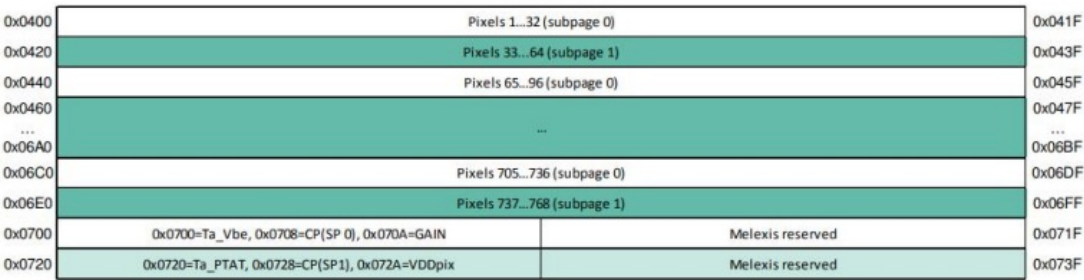


Figure 15 RAM memory map (Interleaved mode)

EEPROM

The EEPROM is used to store the calibration constants and the configuration parameters of the device

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 102
0x2409	Melexis	Device 1D3
0x240A	Melexis	Device Options
0x240B	Melexis	Melexis reserved
0x240C	Customer	Control register_1
0x240D	Customer	Control register _2
0x240E	Customer	12CConf Reg
0x240F	Customer	Melexis reserved / 12C 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			Reading pattern	Resolution control		Refresh rate control		Select subpage			Enable subpages repeat	Enable data hold	Melexis reserved	Enable subpages mode	Control register 1 - 0x800D			
															0	No subpages, only one page will be measured		
															1	Subpage mode is activated (default)		
															0	Keep this bit = "0" (default)		
															0	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
															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
															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)

Subpage 0 --> 0x8000 = 0xFFFF																																Subpage 1 --> 0x8000 = 0xFFFF																																
0x0000	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64
0x0400	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128
0x0800	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192
0x0C00	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256
0x0000	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320
0x0400	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360	361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380	381	382	383	384
0x0800	385	386	387	388	389	390	391	392	393	394	395	396	397	398	399	400	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416	417	418	419	420	421	422	423	424	425	426	427	428	429	430	431	432	433	434	435	436	437	438	439	440	441	442	443	444	445	446	447	448
0x0C00	449	450	451	452	453	454	455	456	457	458	459	460	461	462	463	464	465	466	467	468	469	470	471	472	473	474	475	476	477	478	479	480	481	482	483	484	485	486	487	488	489	490	491	492	493	494	495	496	497	498	499	500	501	502	503	504	505	506	507	508	509	510	511	512
0x0000	513	514	515	516	517	518	519	520	521	522	523	524	525	526	527	528	529	530	531	532	533	534	535	536	537	538	539	540	541	542	543	544	545	546	547	548	549	550	551	552	553	554	555	556	557	558	559	560	561	562	563	564	565	566	567	568	569	570	571	572	573	574	575	576
0x0400	577	578	579	580	581	582	583	584	585	586	587	588	589	590	591	592	593	594	595	596	597	598	599	600	601	602	603	604	605	606	607	608	609	610	611	612	613	614	615	616	617	618	619	620	621	622	623	624	625	626	627	628	629	630	631	632	633	634	635	636	637	638	639	640
0x0800	641	642	643	644	645	646	647	648	649	650	651	652	653	654	655	656	657	658	659	660	661	662	663	664	665	666	667	668	669	670	671	672	673	674	675	676	677	678	679	680	681	682	683	684	685	686	687	688	689	690	691	692	693	694	695	696	697	698	699	700	701	702	703	704
0x0C00	705	706	707	708	709	710	711	712	713	714	715	716	717	718	719	720	721	722	723	724	725	726	727	728	729	730	731	732	733	734	735	736	737	738	739	740	741	742	743	744	745	746	747	748	749	750	751	752	753	754	755	756	757	758	759	760	761	762	763	764	765	766	767	768

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

TV interleave mode

Subpage 0 --> 0x8000 = 0xXXX8																															
0x0000	1	5	9	13	17	21	25	29	33	37	41	45	49	53	57	61	65	69	73	77	81	85	89	93	97	101	105	109	113	117	121
0x0020	35	39	43	47	51	55	59	63	67	71	75	79	83	87	91	95	99	103	107	111	115	119	123	127	131	135	139	143	147	151	155
0x0040	119	123	127	131	135	139	143	147	151	155	159	163	167	171	175	179	183	187	191	195	199	203	207	211	215	219	223	227	231	235	239
0x0060	287	291	295	299	303	307	311	315	319	323	327	331	335	339	343	347	351	355	359	363	367	371	375	379	383	387	391	395	399	403	407
0x0080	455	459	463	467	471	475	479	483	487	491	495	499	503	507	511	515	519	523	527	531	535	539	543	547	551	555	559	563	567	571	575
0x00A0	623	627	631	635	639	643	647	651	655	659	663	667	671	675	679	683	687	691	695	699	703	707	711	715	719	723	727	731	735	739	743
0x00C0	791	795	799	803	807	811	815	819	823	827	831	835	839	843	847	851	855	859	863	867	871	875	879	883	887	891	895	899	903	907	911
0x00E0	959	963	967	971	975	979	983	987	991	995	999	1003	1007	1011	1015	1019	1023	1027	1031	1035	1039	1043	1047	1051	1055	1059	1063	1067	1071	1075	1079
0x0100	1127	1131	1135	1139	1143	1147	1151	1155	1159	1163	1167	1171	1175	1179	1183	1187	1191	1195	1199	1203	1207	1211	1215	1219	1223	1227	1231	1235	1239	1243	1247
0x0120	1295	1299	1303	1307	1311	1315	1319	1323	1327	1331	1335	1339	1343	1347	1351	1355	1359	1363	1367	1371	1375	1379	1383	1387	1391	1395	1399	1403	1407	1411	1415
0x0140	1463	1467	1471	1475	1479	1483	1487	1491	1495	1499	1503	1507	1511	1515	1519	1523	1527	1531	1535	1539	1543	1547	1551	1555	1559	1563	1567	1571	1575	1579	1583
0x0160	1631	1635	1639	1643	1647	1651	1655	1659	1663	1667	1671	1675	1679	1683	1687	1691	1695	1699	1703	1707	1711	1715	1719	1723	1727	1731	1735	1739	1743	1747	1751
0x0180	1799	1803	1807	1811	1815	1819	1823	1827	1831	1835	1839	1843	1847	1851	1855	1859	1863	1867	1871	1875	1879	1883	1887	1891	1895	1899	1903	1907	1911	1915	1919
0x01A0	1987	1991	1995	1999	2003	2007	2011	2015	2019	2023	2027	2031	2035	2039	2043	2047	2051	2055	2059	2063	2067	2071	2075	2079	2083	2087	2091	2095	2099	2103	2107
0x01C0	2155	2159	2163	2167	2171	2175	2179	2183	2187	2191	2195	2199	2203	2207	2211	2215	2219	2223	2227	2231	2235	2239	2243	2247	2251	2255	2259	2263	2267	2271	2275
0x01E0	2343	2347	2351	2355	2359	2363	2367	2371	2375	2379	2383	2387	2391	2395	2399	2403	2407	2411	2415	2419	2423	2427	2431	2435	2439	2443	2447	2451	2455	2459	2463
0x0200	2511	2515	2519	2523	2527	2531	2535	2539	2543	2547	2551	2555	2559	2563	2567	2571	2575	2579	2583	2587	2591	2595	2599	2603	2607	2611	2615	2619	2623	2627	2631
0x0220	2679	2683	2687	2691	2695	2699	2703	2707	2711	2715	2719	2723	2727	2731	2735	2739	2743	2747	2751	2755	2759	2763	2767	2771	2775	2779	2783	2787	2791	2795	2799
0x0240	2847	2851	2855	2859	2863	2867	2871	2875	2879	2883	2887	2891	2895	2899	2903	2907	2911	2915	2919	2923	2927	2931	2935	2939	2943	2947	2951	2955	2959	2963	2967
0x0260	2915	2919	2923	2927	2931	2935	2939	2943	2947	2951	2955	2959	2963	2967	2971	2975	2979	2983	2987	2991	2995	2999	3003	3007	3011	3015	3019	3023	3027	3031	3035
0x0280	3103	3107	3111	3115	3119	3123	3127	3131	3135	3139	3143	3147	3151	3155	3159	3163	3167	3171	3175	3179	3183	3187	3191	3195	3199	3203	3207	3211	3215	3219	3223
0x02A0	3271	3275	3279	3283	3287	3291	3295	3299	3303	3307	3311	3315	3319	3323	3327	3331	3335	3339	3343	3347	3351	3355	3359	3363	3367	3371	3375	3379	3383	3387	3391
0x02C0	3439	3443	3447	3451	3455	3459	3463	3467	3471	3475	3479	3483	3487	3491	3495	3499	3503	3507	3511	3515	3519	3523	3527	3531	3535	3539	3543	3547	3551	3555	3559
0x02E0	3607	3611	3615	3619	3623	3627	3631	3635	3639	3643	3647	3651	3655	3659	3663	3667	3671	3675	3679	3683	3687	3691	3695	3699	3703	3707	3711	3715	3719	3723	3727
0x0300	3795	3799	3803	3807	3811	3815	3819	3823	3827	3831	3835	3839	3843	3847	3851	3855	3859	3863	3867	3871	3875	3879	3883	3887	3891	3895	3899	3903	3907	3911	3915
0x0320	3983	3987	3991	3995	3999	4003	4007	4011	4015	4019	4023	4027	4031	4035	4039	4043	4047	4051	4055	4059	4063	4067	4071	4075	4079	4083	4087	4091	4095	4099	4103
0x0340	4151	4155	4159	4163	4167	4171	4175	4179	4183	4187	4191	4195	4199	4203	4207	4211	4215	4219	4223	4227	4231	4235	4239	4243	4247	4251	4255	4259	4263	4267	4271
0x0360	4319	4323	4327	4331	4335	4339	4343	4347	4351	4355	4359	4363	4367	4371	4375	4379	4383	4387	4391	4395	4399	4403	4407	4411	4415	4419	4423	4427	4431	4435	4439
0x0380	4487	4491	4495	4499	4503	4507	4511	4515	4519	4523	4527	4531	4535	4539	4543	4547	4551	4555	4559	4563	4567	4571	4575	4579	4583	4587	4591	4595	4599	4603	4607
0x03A0	4675	4679	4683	4687	4691	4695	4699	4703	4707	4711	4715	4719	4723	4727	4731	4735	4739	4743	4747	4751	4755	4759	4763	4767	4771	4775	4779	4783	4787	4791	4795
0x03C0	4863	4867	4871	4875	4879	4883	4887	4891	4895	4899	4903	4907	4911	4915	4919	4923	4927	4931	4935	4939	4943	4947	4951	4955	4959	4963	4967	4971	4975	4979	4983
0x03E0	4995	4999	5003	5007	5011	5015	5019	5023	5027	5031	5035	5039	5043	5047	5051	5055	5059	5063	5067	5071	5075	5079	5083	5087	5091	5095	5099	5103	5107	5111	5115
0x0400	5183	5187	5191	5195	5199	5203	5207	5211	5215	5219	5223	5227	5231	5235	5239	5243	5247	5251	5255	5259	5263	5267	5271	5275	5279	5283	5287	5291	5295	5299	5303
0x0420	5371	5375	5379	5383	5387	5391	5395	5399	5403	5407	5411	5415	5419	5423	5427	5431	5435	5439	5443	5447	5451	5455	5459	5463	5467	5471	5475	5479	5483	5487	5491
0x0440	5559	5563	5567	5571	5575	5579	5583	5587	5591	5595	5599	5603	5607	5611	5615	5619	5623	5627	5631	5635	5639	5643	5647	5651	5655	5659	5663	5667	5671	5675	5679
0x0460	5747	5751	5755	5759	5763	5767	5771	5775	5779	5783	5787	5791	5795	5799	5803	5807	5811	5815	5819	5823	5827	5831	5835	5839	5843	5847	5851	5855	5859	5863	5867
0x0480	5935	5939	5943	5947	5951	5955	5959	5963	5967	5971	5975	5979	5983	5987	5991	5995	5999	6003	6007	6011	6015	6019	6023	6027	6031	6035	6039	6043	6047	6051	6055
0x04A0	6123	6127	6131	6135	6139	6143	6147	6151	6155	6159	6163	6167	6171	6175	6179	6183	6187	6191	6195	6199	6203	6207	6211	6215	6219	6223	6227	6231	6235	6239	6243
0x04C0	6311	6315	6319	6323	6327	6331	6335	6339	6343	6347	6351	6355	6359	6363	6367	6371	6375	6379	6383	6387	6391	6395	6399	6403	6407	6411	6415	6419	6423	6427	6431
0x04E0	6503	6507	6511	6515	6519	6523	6527	6531	6535	6539	6543	6547	6551	6555	6559	6563	6567	6571	6575	6579	6583	6587	6591	6595	6599	6603	6607	6611	6615	6619	6623
0x0500	6695	6699	6703	6707	6711	6715	6719	6723	6727	6731	6735	6739	6743	6747	6751	6755	6759	6763	6767	6771	6775	6779	6783	6787	6791	6795	6799	6803	6807	6811	6815
0x0520	6883	6887	6891	6895	6899	6903	6907	6911	6915	6919	6923	6927	6931	6935																	



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
```

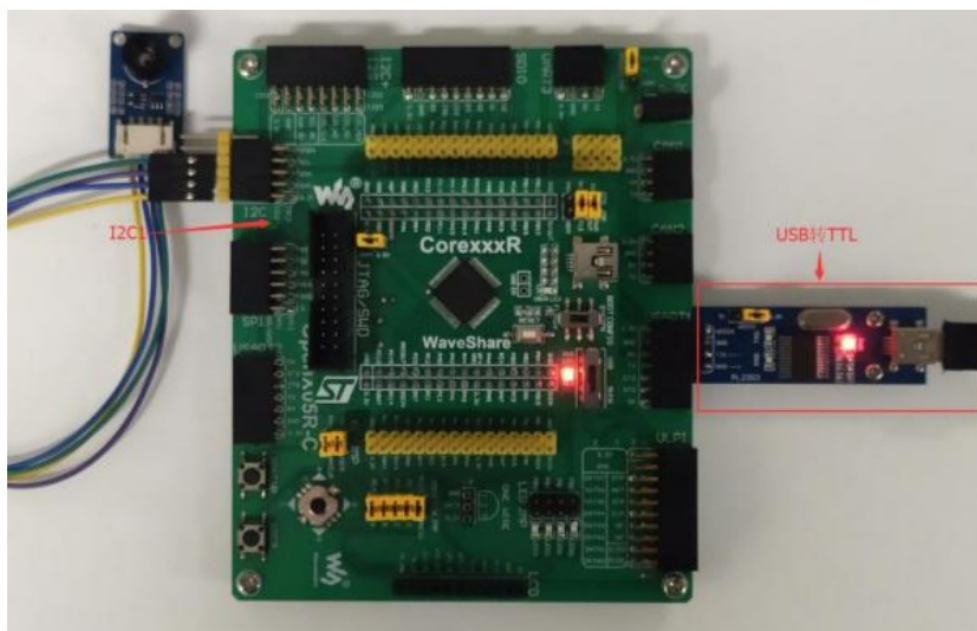
Add the line below to the config.txt file, reboot and check it again

```
dtoverlay=i2c1_baudrate=1000000
```

STM32

Hardware connection

STM32 MLX90640 Thermal Camera



STM32	MLX90640 Thermal Camera
5V	5V
GND	GND
SDA(BCM2)	SDA
SCL(BCM3)	SCL

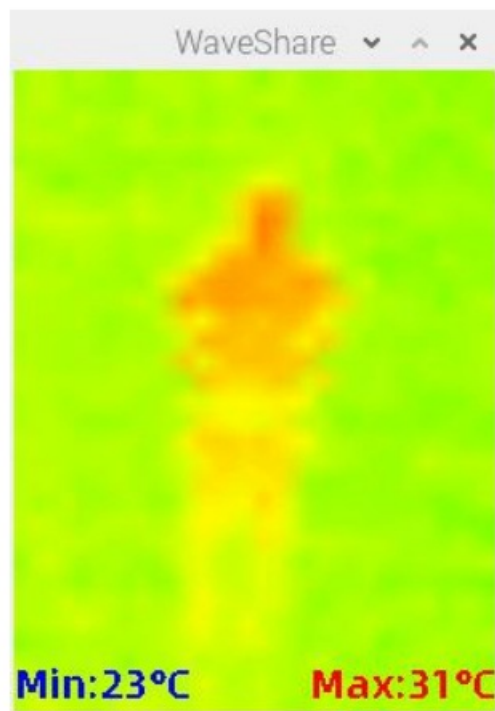
ESP32

Hardware connection



STM32	MLX90640 Thermal Camera
5V	5V
GND	GND
SDA(BCM2)	SDA
SCL(BCM3)	SCL

Test result



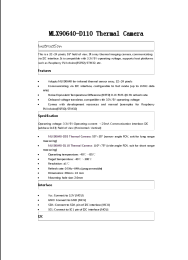
FAQ

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 1M far, shakes his hand backward. The focus disappears when the tester is farther than 9M. When the test away to 2M far, the camera loses the body contour. The Camera supports a Maximum 64Hz.

Documents / Resources

	<p>Waveshare Thermal Camera MLX90640-D110 [pdf] User Manual Waveshare, Thermal Camera, MLX90640</p>
-------------------------------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------