MLX90255-BC

Linear Optical Array

Features and Benefits

- 128 x 1 Sensor-Element Organization (1 Not Connected, 1 dummy, 128 real, 1 dummy and 1 Dark Pixel)
- 385 Dots-Per-Inch (DPI) Sensor Pitch
- High Linearity and Uniformity for 256 Gray-Scale (8-Bit) Applications
- High Sensitivity: 2.0V @ 10µW/cm² @ 0.7ms integration time for open cavity devices
  1.7V @ 10µW/cm² @ 0.7ms integration time for glass lid devices
- Special Gain Compensation for use with single LED light source
- Output Referenced to Ground
- Low Image Lag
- Single 5V Supply
- Replacement for TAOS, Inc. TSL1301 & TSL1401 and MLX90255BA
- Operation to 800kHz

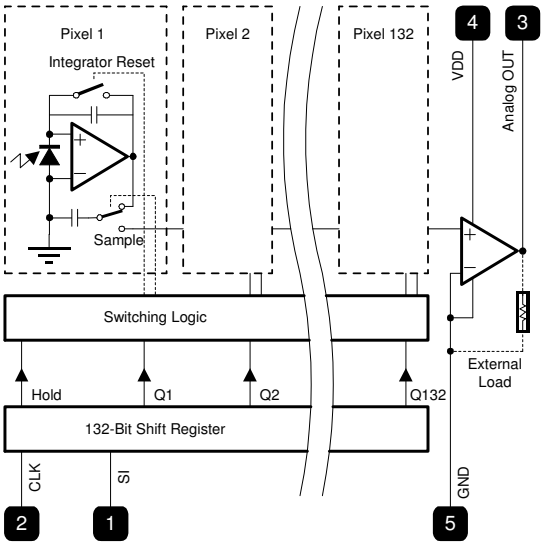
Applications

- Linear Position Encoder
- Rotary Position Encoder
- Steering Torque and Angle Sensing (EPAS, ESP)
- Spectrometer Applications
- Bio-metrical Applications
- OCR and Barcode Applications

Ordering Information

Part No.	Temperature Suffix	Package Code	Option code
MLX90255	K (-40°C to 125°C)	XA (SOIC-24 without glass)	-BCR
MLX90255	K (-40°C to 125°C)	UC (Die on wafer (un-sawn))	-BCV

1. Functional Diagram



2. Description

The MLX90255BC linear sensor array consists of a 128 x 1 array of photodiodes, associated charge amplifier circuitry and a pixel data-hold function that provides simultaneous-integration start and stop times for all pixels. The pixels measure 200µm (H) by 66 µm (W). Operation is simplified by internal control logic that requires only a serial-input (SI) signal and a clock.

The sensor consists of 128 photodiodes arranged in a linear array. Light energy falling on a photodiode generates photocurrent, which is integrated by the active integration circuitry associated with that pixel. During the integration period, a sampling capacitor connects to the output of the integrator through an analog switch. The amount of charge accumulated at each pixel is directly proportional to the light intensity and the integration time. The output and reset of the integrators is controlled by a 132-bit shift register and reset logic. An output cycle is initiated by clocking in a logic 1 on SI.

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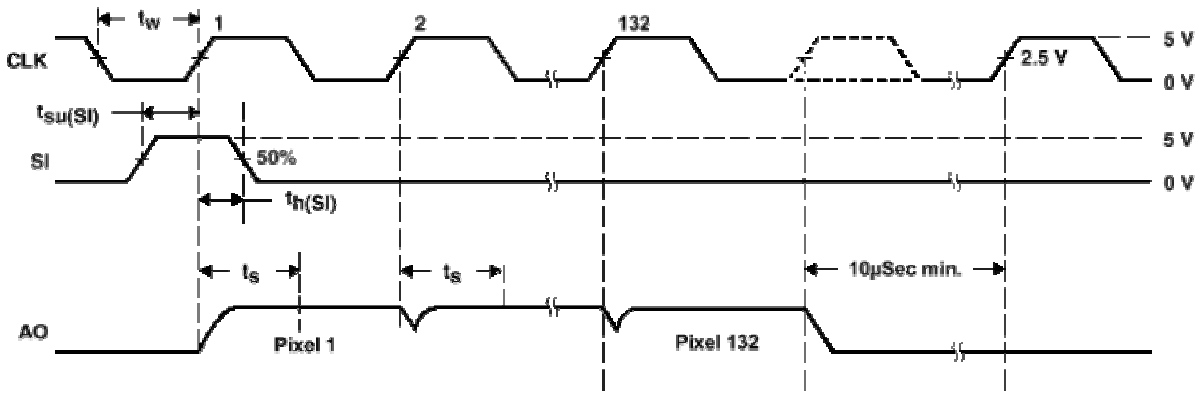
3. MLX90255BC Electrical Specifications

DC Operating Parameters T_A = -40°C to 125°C, V_{DD} = 4.5V to 5.5V (unless otherwise specified)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Supply voltage	Vdd		4.5	5	5.5	V
Input voltage	Vi		0		Vdd	V
High-level input voltage	Vih		Vdd*0.7		Vdd	V
Low-level input voltage	Vil		0		Vdd*0.3	V
Hysteresis on SI and CLK			0.2	0.4	0.8	V
Wavelength of light source			400		1000	nm
Clock frequency	Fclock		64		800	kHz
Sensor integration time below 60°C (1)	Tint		0.125		100	ms
Sensor integration time (full temperature range) (2)	Tint		0.125		2	ms
Pixel charge transfer time (full temp range)	Tqt		8			µs
Setup time, serial input	Tsu(SI)		350			ns
Hold time, serial input (3)	Th(SI)		160			ns
Operating free-air temperature	Ta		-40		125	°C
Clock pulse duration (high)	Tw(H)		625			ns
Clock pulse duration (low)	Tw(L)		625			ns

Notes:

(1) Reset until clock pulse 18 (on declining flank).
Minimum integration time = (133-18) * CLK period + 10µs (this is the time the S&H cap needs to follow).
At 1MHz clock speed, the minimum integration time becomes 0.125ms.
(2) At 125°C, the integration time should be limited to 2ms.
(3) The SI pulse must go low before the rising edge of the next clock pulse.



MLX90255BC Electrical specifications

All tests are made with 0.7ms integration time at 25°C at 880nm and with a clock speed of 500kHz in, 250kHz out, and 500kHz, unless otherwise specified in the Test Conditions. 100% light under Test Conditions means that the light is set in such a way that there is 2.4V at the output of the chip.

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Sensitivity for devices with glas lid Sensitvity for open devices Polyimide Wafer	Sensitivity	At 25°C	0.135 0.14 0.14	0.151 0.16 0.176	0.179 0.19 0.21	V/µW/ cm2
Illumination (1)	Illum100	At 25°C, 2.4V at output		14		µW/cm²
Average analog output (1)	VaoLight	At 25°C, 100% light		2.4		V
Average analog output	Initial offset	At 25°C, 0% light	0	0.15	0.3	V
Average analog output	VaoDark	At 125°C, 0% light	0	0.40	1.4	V
Highest Dark Pixel	Vaodarkmax	At 125°C, 0.25ms integration time			0.8	V
Non Linearity	Nlao1	All Temp		±0.5%	±1.2%	FS
Pixel Response Non Uniformity (2)	PRNU	All Temp, 100% light		±4.0%	±8.5%	FS
Pixel Interaction Test (3)	PIT	AT 25°C		5%		FS
Noise Level (4)	Vn	All Temp		3	6	mV (RMS)
Hold spec, same as PRNU	PRNUH	All Temp, 100% light, 62.5kHz		±4.0%	±8.5%	FS
Output Settling Time	Ts	All Temp		450	750	ns
Array Lag (5)	Alag	At 25°C		0.5%		FS
Dark Signal Non Uniformity (6)	DSNU	At 25°C At 125°C		80 140	120 440	mV mV
Analog Output Saturation		All Temp	3.0			V
Change in sensitivity with Temperature at 880nm (7)				0.3		%/°C
Operating Free Temp			-40		125	°C
Supply Current (8)	Idd		2	5	8	mA

(0) After power on, the first integration scan is not guaranteed correct. This scan is needed for initializing digital levels on chip. After a SI and 133 proper CLK signals, the system is fully initialized and all further scans are valid. The next SI will provide a valid scan.

(1) Absolute Light measurements are very test-setup dependent and should be regarded with caution. Relative measurements are possible with ±1% accuracy.

(2) PRNU is defined as the worst case deviation of any PixelValue (pixel 3 till 130) to the average light value. PixelValue = (Vout of a pixel at 100% light – Vout of same pixel at 0% light) The MLX90255BC has a cosine shaped gain: external pixels have 15% more gain than middle pixels.

(3) PIT = (Vout of pixel 132 @ 10µW – Vout of pixel 132 @0µW) / (Vaverage @10µW – Vaverage @10µW)

(4) Noise: We compare 5 different measurements, normalize them and then take the RMS value.

(5) Array Lag is defined as: (Vaverage 0µW1 Vaverage 0µW2) / ((Vaverage 10µW Vaverage 0µW2). Where 0µW1 is a 0% light level, 1ms after a 100% light level. (there can still be some light effects). 0µW2 is a 0% light level, 10ms after a 100% light level, which should be a true dark reference.

(6) DSNU is defined as: (max Vout of pixel I @ 0% light) - (min Vout of pixel j @ 0% light) for pixels 3 thru 130

(7) Sensitivity always increases with rising temperature.
(8) Idd is measured with Rload disconnected from the output pin.

4. General Description

(continued from page 1)

This causes all 132 sampling capacitors to be disconnected from their respective integrators and starts an integrator reset period. As the SI pulse is clocked through the shift register, the charge stored on the sampling capacitors is sequentially connected to a charge-coupled output amplifier that generates a voltage on the analog output AO. Two dummy pixel values are shifted out first, then the 128 actual pixel bits, followed by two additional dummy pixel bits, for a total of 132 data bits. Although there are only 132 pixels, 133 clock pulses are necessary for a complete shift out. The final pulse is used to re-initialize the shift register.
The integrator reset period ends 18 clock cycles after the SI pulse is clocked in. So the light-integration starts after the 18th CLK pulse. The light-integration ends at the next SI pulse. Between the end of the 133th clock pulse and the next SI pulse, a minimum time of 10µs is necessary for an effective S&H function. So the minimum integration time of the MLX90255BC is (133 -18) * Ts + 10µs and thus dependent on clock speed. (Ts = clock period) After the 132 data bits are clocked out, the output becomes high impedance. (see figure) The AO is driven by a source follower that requires an external pulldown resistor. (typically 330Ω) The output is nominally 125mV for no light input and 2.4V for a nominal full-scale output. The pixel gain is 15% bigger at the edges than in the middle (cosine correction) in order to get a flat output when illuminating the device with a single LED light source (see also Section 6).

The MLX90255BC is intended for use in a wide variety of applications, including: image scanning, mark and code reading, optical character recognition (OCR) and contact imaging, edge detection and positioning, and optical linear and rotary encoding. The MLX90255BC is a replacement for the Texas Instruments' TSL1301 and TSL1401 parts.

5. Absolute Maximum Ratings

Supply Voltage, Vdd	+7V
Digital Input Current Range	-20 to 20 mA
Operating Free-Air temperature range, Ta	-40°C to 125°C (automotive compliant optical package)
Storage temperature range, Tstg	-40°C to 125°C
ESD Sensitivity (Human Body Model according to CDF-AEC-Q100-002)	2kV

Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device.
These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied.
Exposure to absolute-maximum -rated conditions for extended periods may affect device reliability.

6. Cosine Correction

When using a single LED light source, which is placed above the middle of the die, the light intensity that falls onto the outer pixels is lower than the light intensity that falls onto the middle pixels (due to the distance die-LED, the shape of the LED light emission and the sensitivity of pixels vs. angle of incident light). To compensate for these effects, each pixel in the array has a slightly different gain correction with respect to the centre of the array. For a light source to photodiode array distance of 15mm the relative pixels sensitivities are shown in the table below.

Pixel number		Relative Pixel Sensitivity
1	132	1.1703
2	131	1.1649
3	130	1.1596
4	129	1.1544
5	128	1.1493
6	127	1.1442
7	126	1.1393
8	125	1.1345
9	124	1.1298
10	123	1.1251
11	122	1.1206
12	121	1.1161
13	120	1.1117
14	119	1.1074
15	118	1.1032
16	117	1.0991
17	116	1.0951

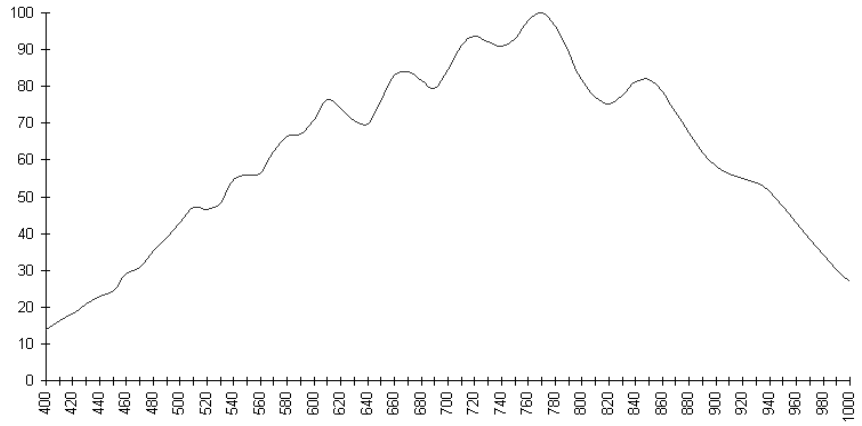
Pixel number		Relative Pixel Sensitivity
18	115	1.0912
19	114	1.0874
20	113	1.0836
21	112	1.0799
22	111	1.0764
23	110	1.0729
24	109	1.0695
25	108	1.0661
26	107	1.0629
27	106	1.0598
28	105	1.0567
29	104	1.0537
30	103	1.0508
31	102	1.0480
32	101	1.0453
33	100	1.0426
34	99	1.0400

Pixel number		Relative Pixel Sensitivity
35	98	1.0376
36	97	1.0352
37	96	1.0328
38	95	1.0306
39	94	1.0284
40	93	1.0263
41	92	1.0243
42	91	1.0224
43	90	1.0206
44	89	1.0188
45	88	1.0171
46	87	1.0155
47	86	1.0140
48	85	1.0126
49	84	1.0112
50	83	1.0099
51	82	1.0087

Pixel number		Relative Pixel Sensitivity
52	81	1.0076
53	80	1.0066
54	79	1.0056
55	78	1.0047
56	77	1.0039
57	76	1.0031
58	75	1.0025
59	74	1.0019
60	73	1.0014
61	72	1.0010
62	71	1.0006
63	70	1.0003
64	69	1.0002
65	68	1.0000
66	67	1.0000

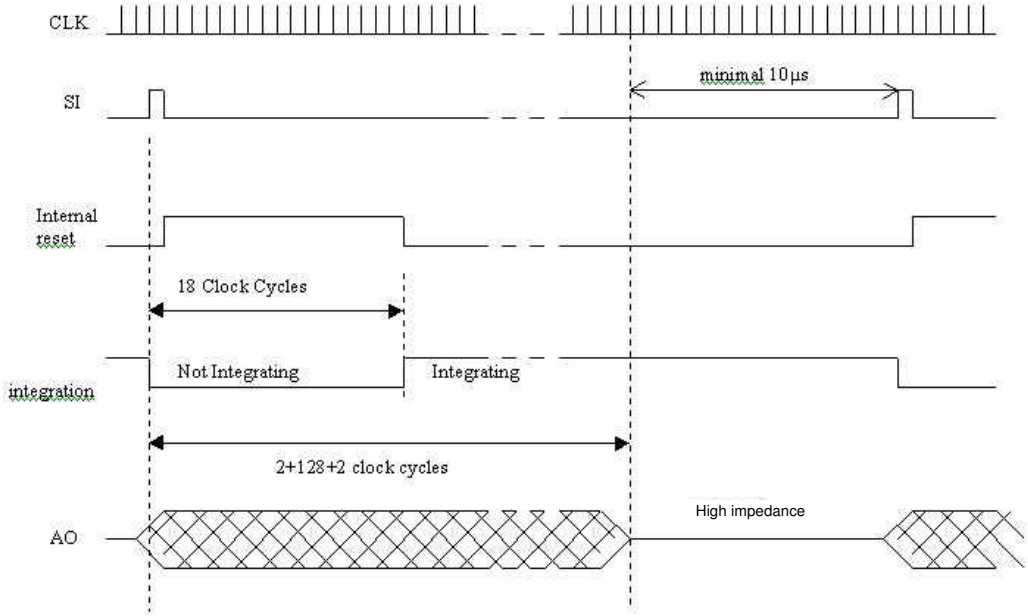
7. Performance Graphs

Typical Photodiode Spectral Response Curve (%), without Anti Reflection Coating*



*There is also an option for an **Anti Reflection Coating**. This will remove the interference ripples in the figure above. With this special Anti Reflection Coating, the sensitivity curve in function of wavelength will be somewhat lower (typically 4%) but will no longer display interference ripples.

MLX90255 Timing Diagram



8. Standard information regarding manufacturability of Melexis products with different soldering processes

Our products are classified and qualified regarding soldering technology, solderability and moisture sensitivity level according to following test methods:

Reflow Soldering SMD's (Surface Mount Devices)

- IPC/JEDEC J-STD-020
  Moisture/Reflow Sensitivity Classification for Nonhermetic Solid State Surface Mount Devices
  (classification reflow profiles according to table 5-2)
- EIA/JEDEC JESD22-A113
  Preconditioning of Nonhermetic Surface Mount Devices Prior to Reliability Testing
  (reflow profiles according to table 2)

Wave Soldering SMD's (Surface Mount Devices) and THD's (Through Hole Devices)

- EN60749-20
  Resistance of plastic- encapsulated SMD's to combined effect of moisture and soldering heat
- EIA/JEDEC JESD22-B106 and EN60749-15
  Resistance to soldering temperature for through-hole mounted devices

Iron Soldering THD's (Through Hole Devices)

- EN60749-15
  Resistance to soldering temperature for through-hole mounted devices

Solderability SMD's (Surface Mount Devices) and THD's (Through Hole Devices)

- EIA/JEDEC JESD22-B102 and EN60749-21
  Solderability

For all soldering technologies deviating from above mentioned standard conditions (regarding peak temperature, temperature gradient, temperature profile etc) additional classification and qualification tests have to be agreed upon with Melexis.

The application of Wave Soldering for SMD's is allowed only after consulting Melexis regarding assurance of adhesive strength between device and board.

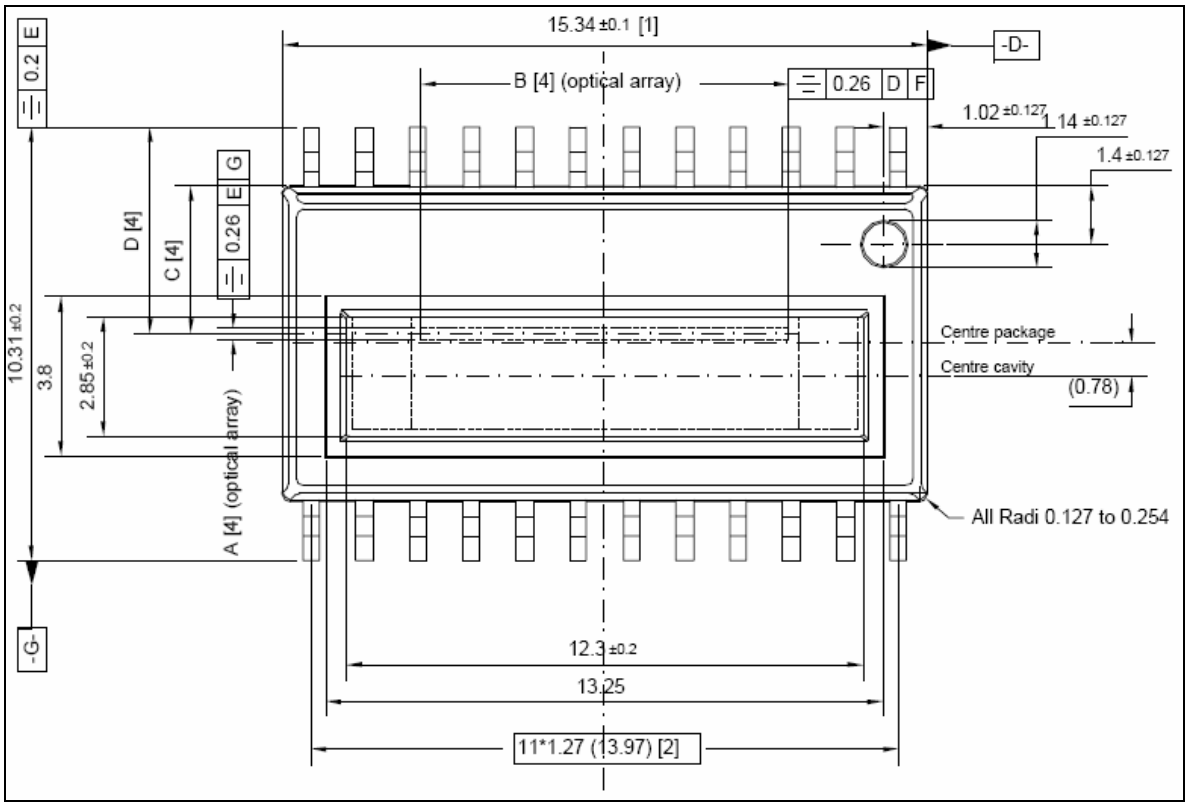
Melexis is contributing to global environmental conservation by promoting **lead free** solutions. For more information on qualifications of **RoHS** compliant products (RoHS = European directive on the Restriction Of the use of certain Hazardous Substances) please visit the quality page on our website:
http://www.melexis.com/quality.asp

9. ESD Precautions

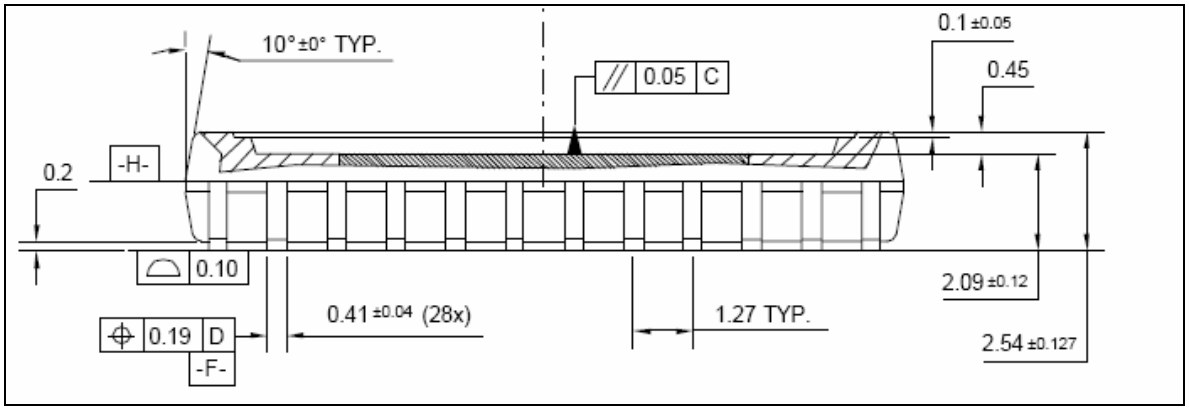
Electronic semiconductor products are sensitive to Electro Static Discharge (ESD).
Always observe Electro Static Discharge control procedures whenever handling semiconductor products.

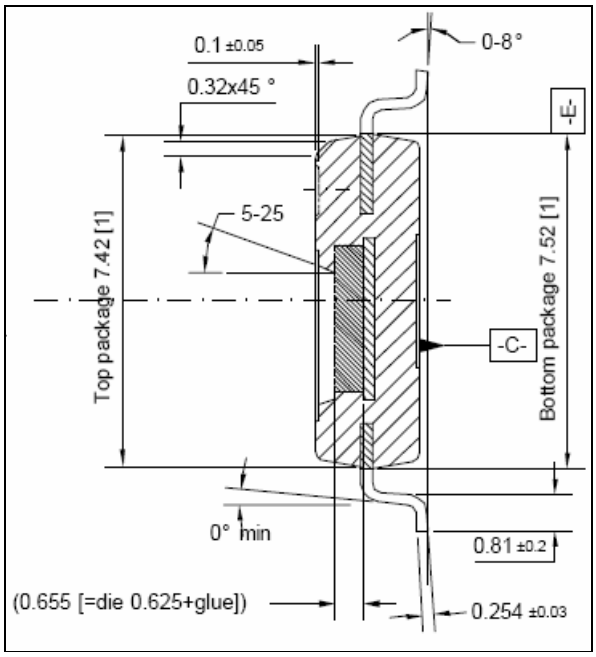
10. Package Information

10.1. MLX90255KXA-BCR (SOIC-24 without glass) package dimensions



A = 200um pixel height
B = 132 x 66um = 8712um, mid 128 pixels are usefull pixels
C = 3.53 +/- 0.13 (tolerance is indicated on the drawing as 0.26 in absolute deviation)
D = 4.92 +/- 0.13 (tolerance in again indicated on the drawing as 0.26 in absolute deviation)





10.2. XA (SOIC-24 without glass) Pin Description

Pin	Symbol	Description
5	SI	Serial Input. Si defines the start of the data-out sequence
6	CLK	Clock. CLK controls the charge transfer, pixel output and reset (together with SI)
7	A0	Analog Output
8	Vdd	Supply voltage, for both analog and digital circuits
3,4,9,10, 15,16,21,22	Vss	Ground (substrate). All Vss Pins are referenced to the substrate.

10.3. MLX90255KUC-BCV (Wafer Polyimide)

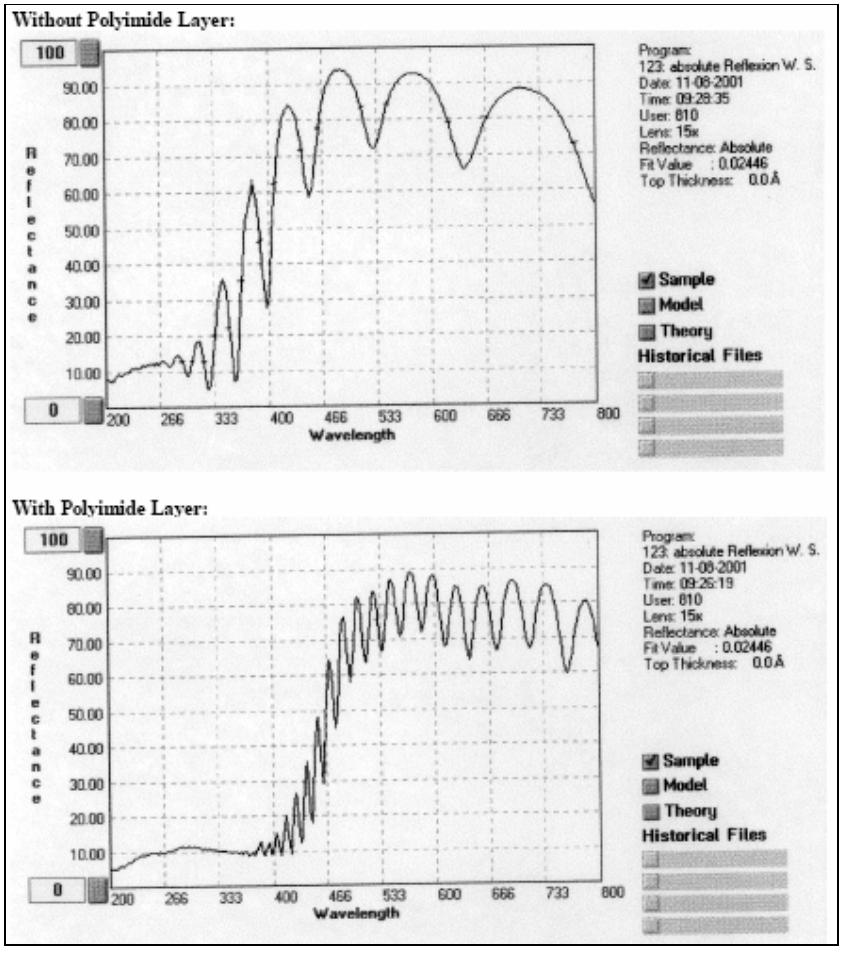
Die on wafer (unsawn) with polyimide passivation.

- Advantages: Extra adhesion by polyimide layer
- Disadvantages: The sensitivity of a wafer with polyimide layer is ~20% less than on a normal wafer without this layer

Light Transmission Properties of Polyimide Layer

Method of Measurement:

- Testwafer with AlSiCu + Passivation Layer
- Measure of absolute Reflectance with NANOSPEC about maximal wavelength area



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