3. Applications

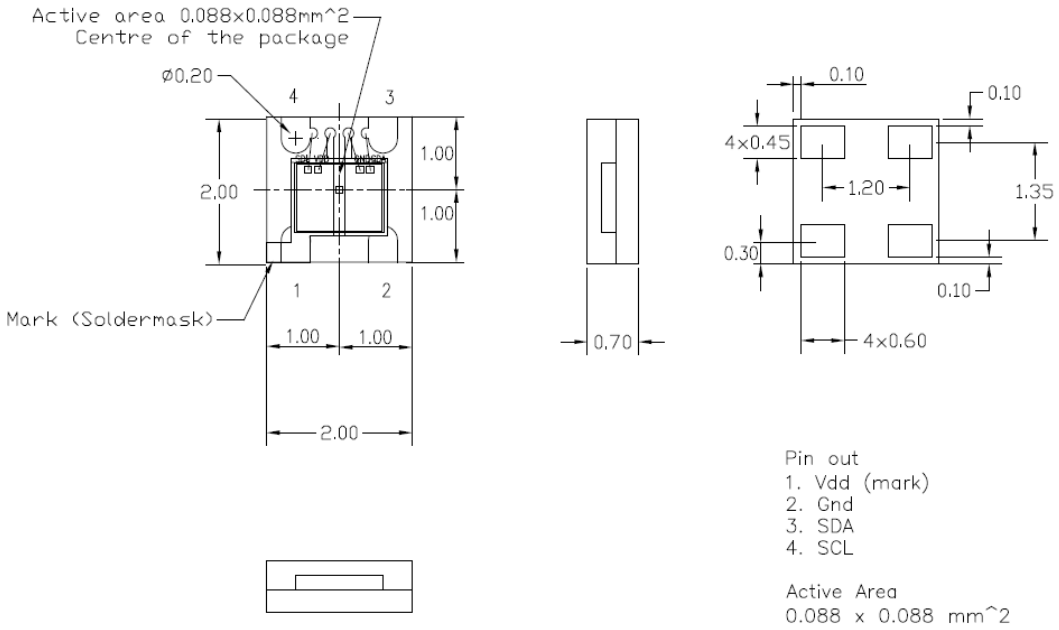
To control display backlight in

- Mobile Devices: Mobile phone, PDA
- Computing Devices: Notebook PC, Desktop Monitor
- Consumer Devices: LCD/PDP TV backlight systems, Cameras, Personal Navigation Device, Digital Photo Frame
- Dashboard

4. Ordering Information

Part Number	Packaging Type	Package	Quantity
LTR-328ALS-01	Tape and Reel	4-pins chipled package	2500

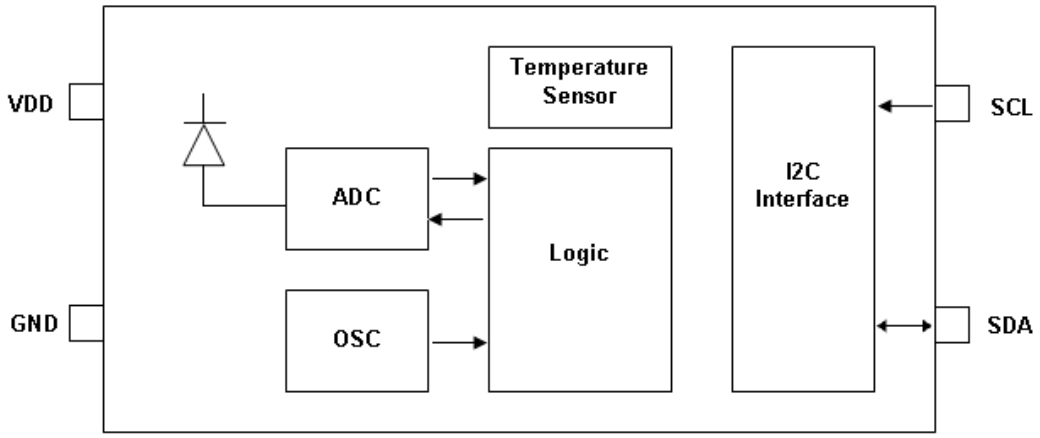
5. Outline Dimensions



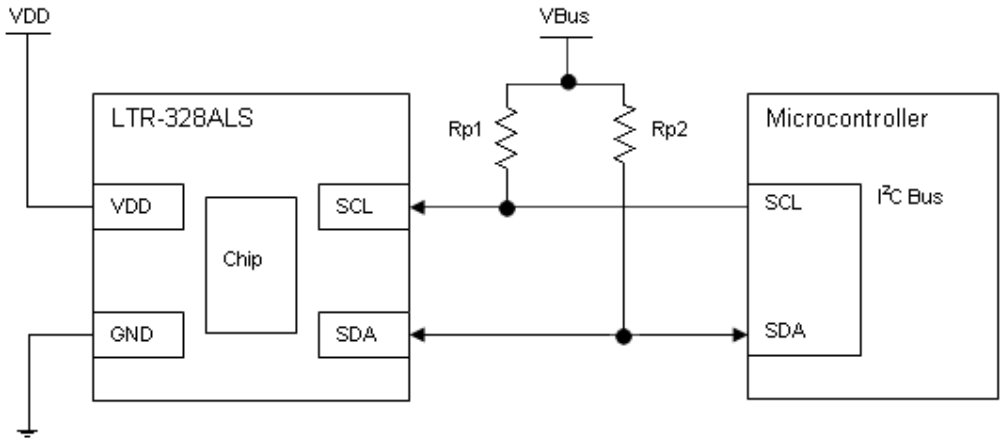
Notes:

1. All dimensions are in millimeters
2. Tolerances: ±0.1mm

6. Functional Block Diagram



7. Application Circuit



I/O Pins Configuration Table

Pin	I/O Type	Symbol	Description
1		VDD	Supply Voltage
2		GND	Ground
3	I/O	SDA	I^2C serial data
4	I	SCL	I^2C serial clock

Recommended Application Circuit Components

Component	Recommended Value	Condition
Rp1, Rp2 [1]	1 kΩ	

[1] Selection of pull-up resistors value is dependent on bus capacitance values. For more details, please refer to I2C Specifications: http://www.nxp.com/documents/user_manual/UM10204.pdf

8. Rating and Specification

Absolute Maximum Ratings at Ta = 25°C

Parameter	Symbol	Rating	Unit
Supply Voltage	VDD	3.8	V
I^2C Bus Pin Current	SCL, SDA	±5	mA
Storage Temperature	T_{stg}	-40 to +85	°C

Note: Exceeding these ratings could cause damage to the device. All voltages are with respect to ground. Currents are positive into, negative out of the specified terminal.

Recommended Operating Conditions

Description	Symbol	Min.	Typ.	Max.	Unit	Condition
Supply Voltage	VDD	2.3		3.0	V	
V_{Bus} Voltage	V_{Bus}		1.8	VDD	V	
Operating Temperature	T_{ope}	-25		70	°C	
I^2C Bus Input Pin High Voltage	Vih _SCL, Vih_SDA	0.9*V_{Bus}			V	
I^2C Bus Input Pin Low Voltage	Vil _SCL, Vil_SDA			0.25	V	

Electrical & Optical Specifications

All specifications are at VDD = 2.5V, T_{ope} = 25°C, unless otherwise noted.

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Active Supply Current	IDD1		120	200	uA	(Note 1)
Shutdown Current	IDD2			2.5	uA	SDA,SCL ≥ Vih, Lux = 0
Light Sensor						
Peak Sensitivity	λ_{peak}		530		nm	Figure1
Full Scale ADC Count	DATA0			65280	count	
Dark ADC Count	DATA1	0		3	count	Lux = 0 (Note 1)
ADC Count	DATA3	680	850	1020	count	Lux = 1000 (Note 1)
Measurement Accuracy	$M_{Accuracy}$		0.85			Lux = 1000 (Note1, 2)
Light Ratio	L_1	0.8	1.28	1.4		Lux = 1000 (Note 3)
Integration Time	T_{INT}		100		ms	
Response Time	$T_{RESPONSE}$		500		ms	

Notes:
1. White LED is used as light source.

2. $M_{Accuracy}$ = Sensor ADC Count / Actual Lux

3. L_1 = Y(Incandescent) / Y(Fluorescent)
   Y(Incandescent) = output signal under Incandescent light
   Y(Fluorescent) = output signal under fluorescent light

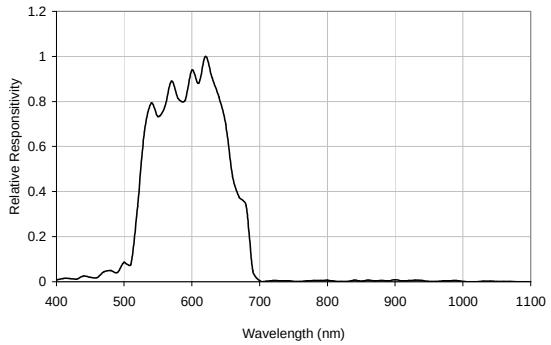


Figure1. Spectral Response of DLS

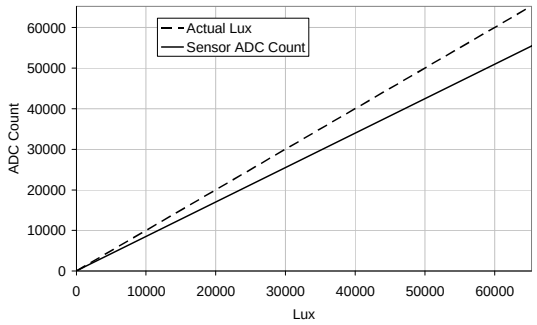


Figure2. Output Response for DLS

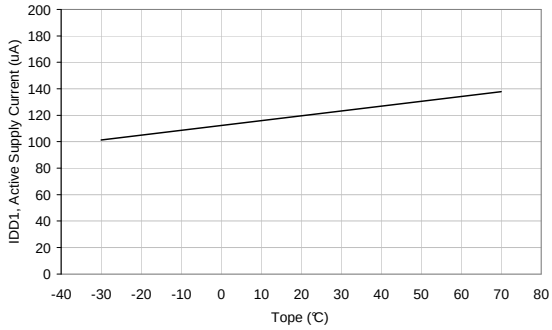


Figure3. Active Supply Current vs Operating Temperature
(VDD = 2.5V, Lux = 1000)

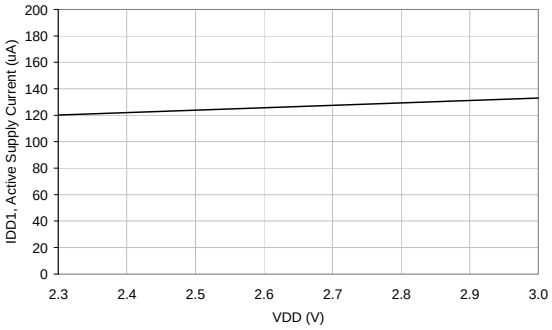


Figure4. Active Supply Current vs VDD
(T_{ope} = 25°C, Lux = 1000)

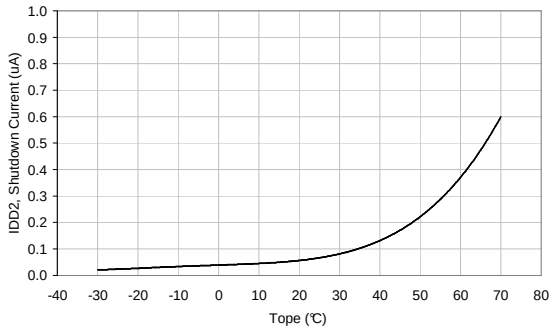


Figure5. Shutdown Current vs Operating Temperature
(VDD = 2.5V, Lux = 0)

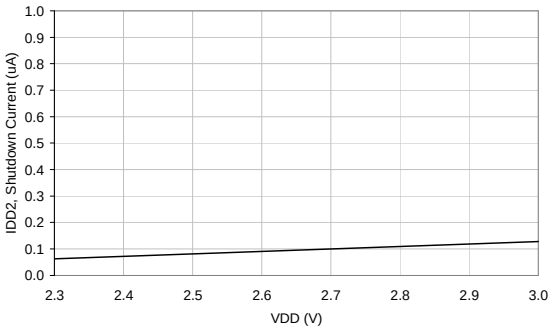


Figure6. Shutdown Current vs VDD
(T_{ope} = 25°C, Lux = 0)

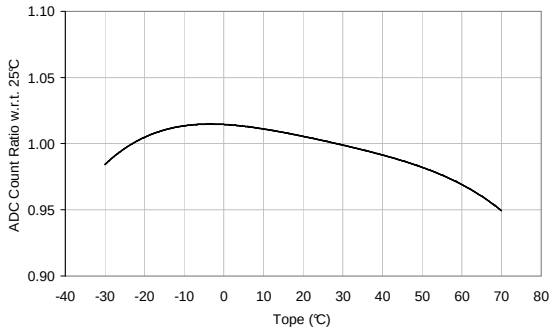


Figure7. ADC Count Ratio vs Operating Temperature

(VDD = 2.5V, Lux = 1000)

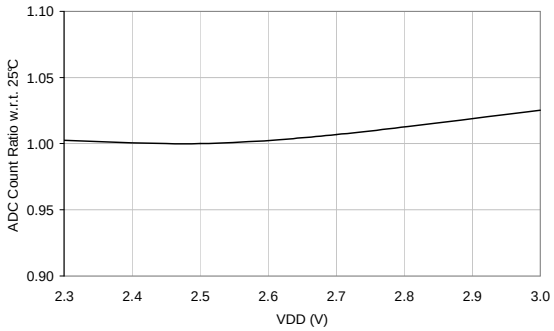


Figure8. ADC Count Ratio vs VDD

(T_{ope} = 25°C, Lux = 1000)

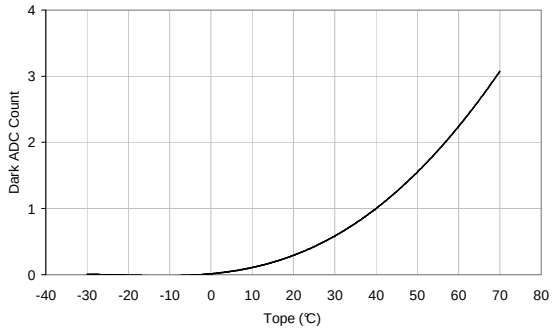


Figure9. Dark ADC Count vs Operating Temperature

(VDD = 2.5V, Lux = 0)

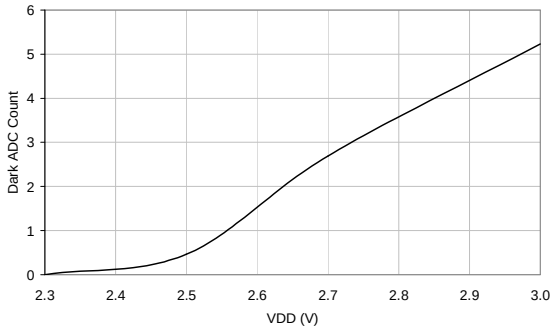


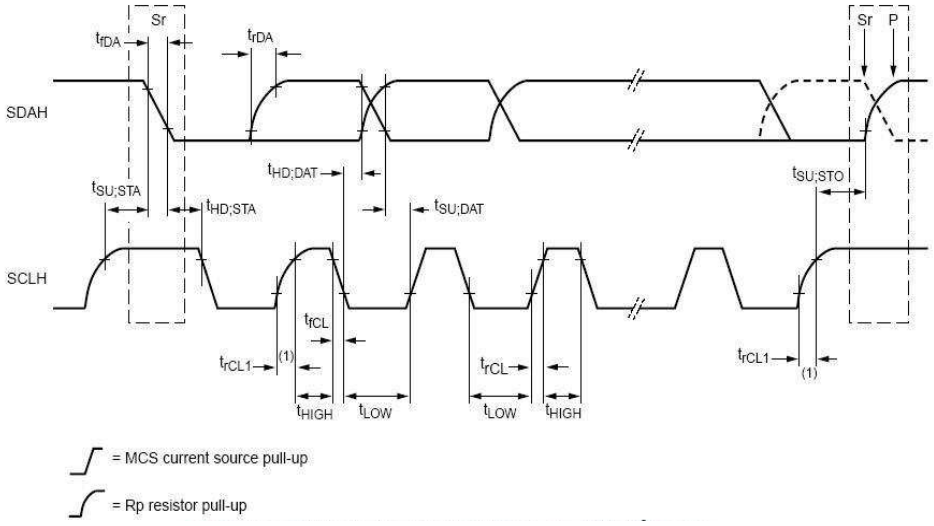
Figure10. Dark ADC Count vs VDD

(T_{ope} = 25°C, Lux = 0)

AC Electrical Characteristics

All specifications are at VBus = 1.8V, T_{ope} = 25°C, unless otherwise noted.

Parameter	Symbol	Min.	Max.	Unit
SCLH clock frequency	f_{SCLH}	0.001	3.4	MHz
Set-up time for a repeated START condition	$t_{SU;STA}$	160	--	ns
Hold time (repeated) START condition	$t_{HD;STA}$	160	--	ns
LOW period of the SCL clock	t_{LOW}	160	--	ns
HIGH period of the SCL clock	t_{HIGH}	60	--	ns
Data setup time	$t_{SU;DAT}$	10		ns
Data hold time	$t_{HD;DAT}$	0	70	ns
Rise time of SCLH signal	t_{rCL}	10	40	ns
Rise time of SCLH signal after a repeated START condition and after an acknowledge bit	t_{rCL1}	10	80	ns
Fall time of SCLH signal	t_{fCL}	10	40	ns
Rise time of SDAH signal	t_{rDA}	10	80	ns
Fall time of SDAH signal	t_{fDA}	10	80	ns
Set-up time for STOP condition	$t_{SU;STO}$	160	--	ns
Capacitive load for each bus line (SDAH and SCLH line)	C_b	20	100	pF



Definition of timing for I^2C bus

9. Principles of Operation

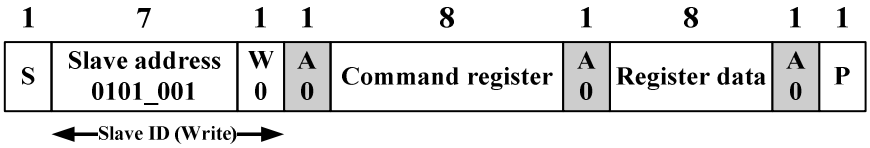
I2C Features

I2C Feature	
START condition	Support
STOP condition	Support
Acknowledge	Support
7-bit slave address	Support

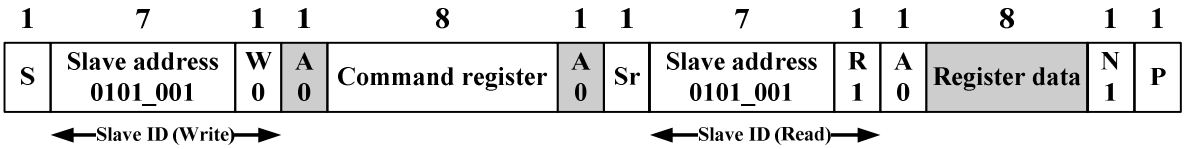
I2C Protocols

The first byte is the 7-bits slave address. The second byte is the command register. This is followed by the register data such as 0h, Ch or Dh.

I2C writing:



I2C reading (Combined mode):



A	Acknowledge (0 for an ACK)	**N**	Non-Acknowledge(1 for a NACK)
S	Start condition	**Sr**	Repeated Start condition
P	Stop condition		
W	Write (0 for writing)	**R**	Read (1 for read)
▦	Slave-to-master	□	Master-to-Slave

I2C Slave Address

The 7 bits slave address for this device is 0x29H. A read/write bit should be appended to the slave address by the master device to properly communicate with the device.

I2C Slave Address									
Command Type	(0x29H)							W/R	value
	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	
Write	0	1	0	1	0	0	1	0	0x52H
Read	0	1	0	1	0	0	1	1	0x53H

Register Set

ADDR (HEX)	REGISTER NAME	DESCRIPTION
--	COMMAND	Specifies Register Address
0h	CONTROL	Control of Basic Functions
Ah	Reserved	
Bh	Reserved	
Ch (Read only)	DATALOW	ADC Channel Lower Byte
Dh (Read only)	DATAHIGH	ADC Channel Upper Byte

COMMAND Register

The COMMAND register specifies the address of the target register for subsequent read and write operations.

	COMMAND							
	B7	**B6**	**B5**	**B4**	**B3**	**B2**	**B1**	**B0**
	CMD	***Reserved***			***Address***			

Field	BITS	Description
CMD	7	Select command register. Must write as 1. 0: This command data is invalid. It shows that the current I2C writing command will not update the command register. 1: The command data is valid. It shows that the current I2C writing command will update the command register.
Reserved	6:4	Don't care. Device operation will not change regardless of the bit values.
Address	3:0	Register Address. This field selects the specific control or status register for following write and read commands according to Register Set table.

CONTROL Register (00H)

The CONTROL register contains two bits and is used to power up or to power down the device.

00H	CONTROL (default = 0x00)							
	B7	**B6**	**B5**	**B4**	**B3**	**B2**	**B1**	**B0**
	Reserved						***Power***	

Field	BITS	Description
Reserved	7:2	Write as 0.
Power	1:0	Power up or power down the device. The device is powered down: 0x00H. The device is powered up: 0x03H.

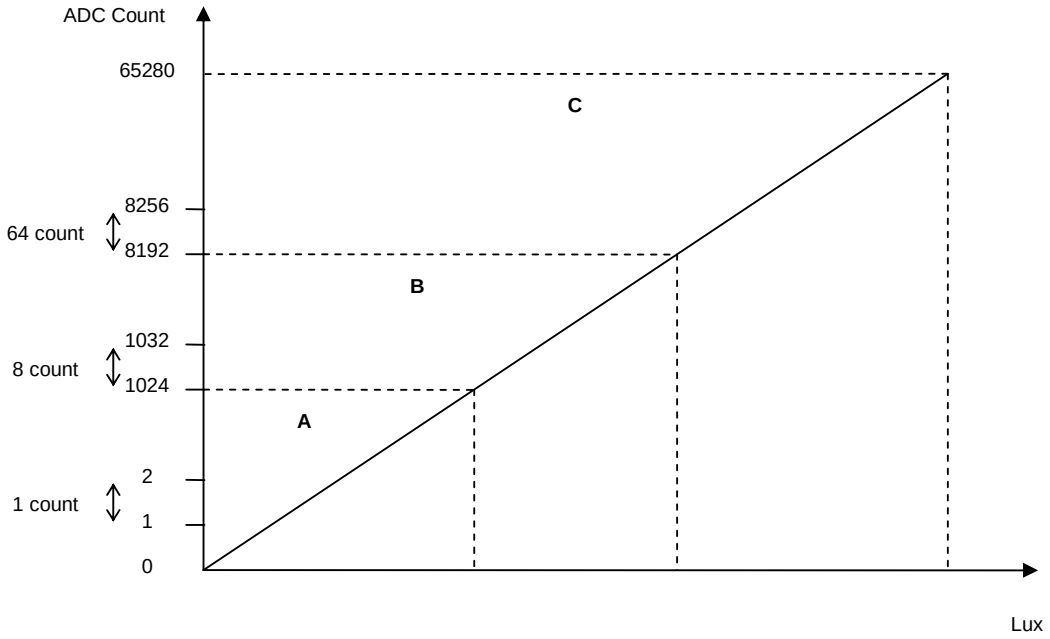
DATA Register (0CH - 0DH) (Read Only)

The ADC channel data are expressed as 16-bit data spread across two registers. The ADC channel data registers, DATALOW and DATAHIGH, provide the lower and upper bytes of the ADC value respectively. All DATA registers are read-only.

0CH / 0DH	DATA							
	B7	B6	B5	B4	B3	B2	B1	B0
	DATALOW / DATAHIGH							

Field	Address	BITS	Description
DATALOW	0CH	7:0	ADC Channel Lower Byte Data.
DATAHIGH	0DH	7:0	ADC Channel Upper Byte Data.

The upper byte data registers can only be read following a read to the corresponding lower byte register. When the lower byte register is read, the upper bits are stored in a temporary register, which is read by a subsequent read to the upper byte. The upper register will read the correct value even if additional integration cycles end between the reading of the lower and upper registers.



Register	Address	BITS	Description
DATALOW	0CH	L7:L0	ADC Channel Lower Byte
DATAHIGH	0DH	H7:H0	ADC Channel Upper Byte

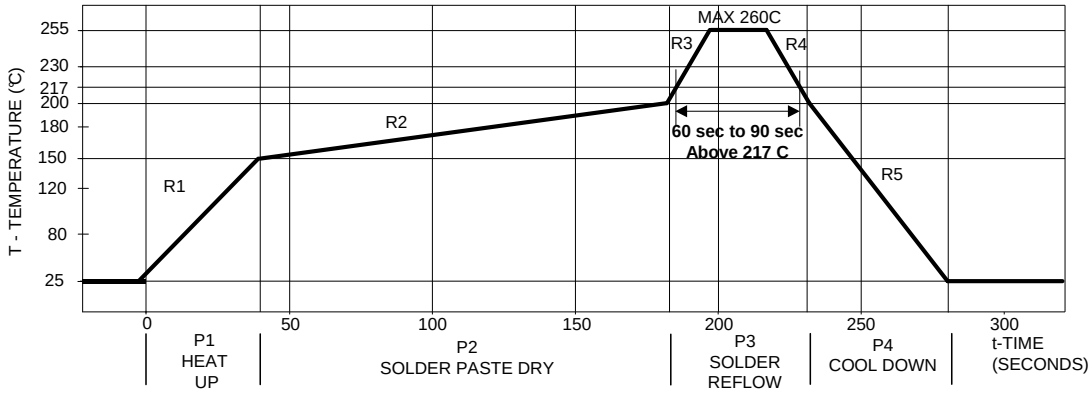
LUX vs ADC Count formula:

Region A: Lux = [(Data H7:H0)*256+(Data L7:L0)] / $M_{Accuracy}$

Region B: Lux = [(Data H7:H0)*256+(Data L7:L3)] / $M_{Accuracy}$

Region C: Lux = [(Data H7:H0)*256+(Data L7:L6)] / $M_{Accuracy}$

10. Recommended Leadfree Reflow Profile



Process Zone	Symbol	ΔT	Maximum ΔT/Δtime or Duration
Heat Up	P1, R1	25°C to 150°C	3°C/s
Solder Paste Dry	P2, R2	150°C to 200°C	100s to 180s
Solder Reflow	P3, R3 P3, R4	200°C to 260°C 260°C to 200°C	3°C/s -6°C/s
Cool Down	P4, R5	200°C to 25°C	-6°C/s
Time maintained above liquidus point , 217°C		> 217°C	60s to 90s
Peak Temperature		260°C	-
Time within 5°C of actual Peak Temperature		> 255°C	20s
Time 25°C to Peak Temperature		25°C to 260°C	8mins

11. Moisture Proof Packaging

All LTR-328ALS-01 are shipped in moisture proof package. Once opened, moisture absorption begins. This part is compliant to JEDEC Level 3.

Time from Unsealing to Soldering

After removal from the moisture barrier bag, the parts should be stored at the recommended storage conditions and soldered within seven days. When the moisture barrier bag is opened and the parts are exposed to the recommended storage conditions for more than seven days, the parts must be baked before reflow to prevent damage to the parts.

Recommended Storage Conditions

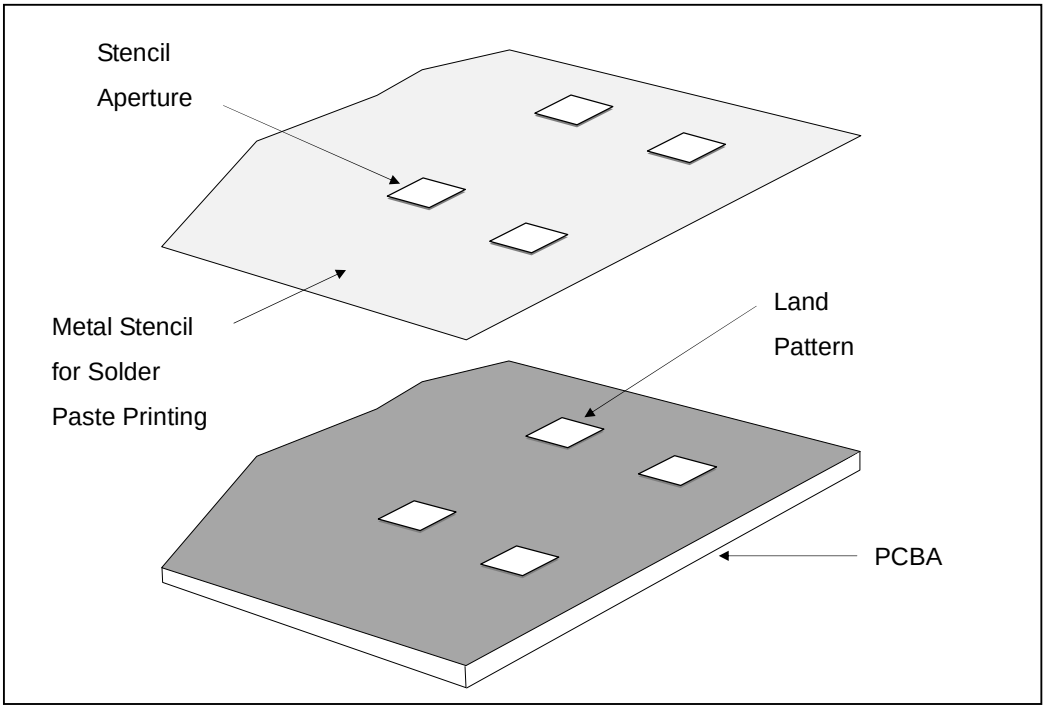
Storage Temperature	10°C to 30°C
Relative Humidity	Below 60% RH

Baking Conditions

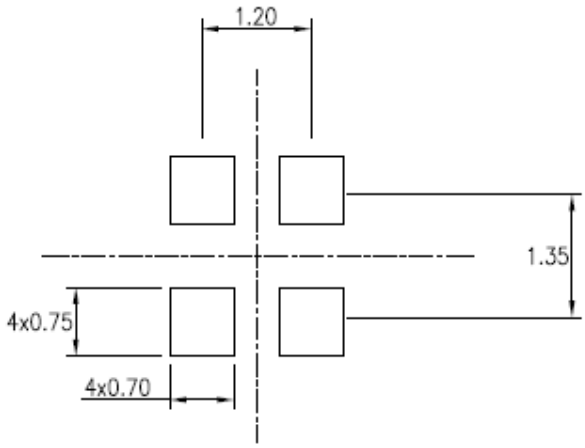
Package	Temperature	Time
In Reels	60°C	48 hours
In Bulk	100°C	4 hours

Baking should only be done once.

12. Recommended Land Pattern and Metal Stencil Aperture



Recommended Land Pattern



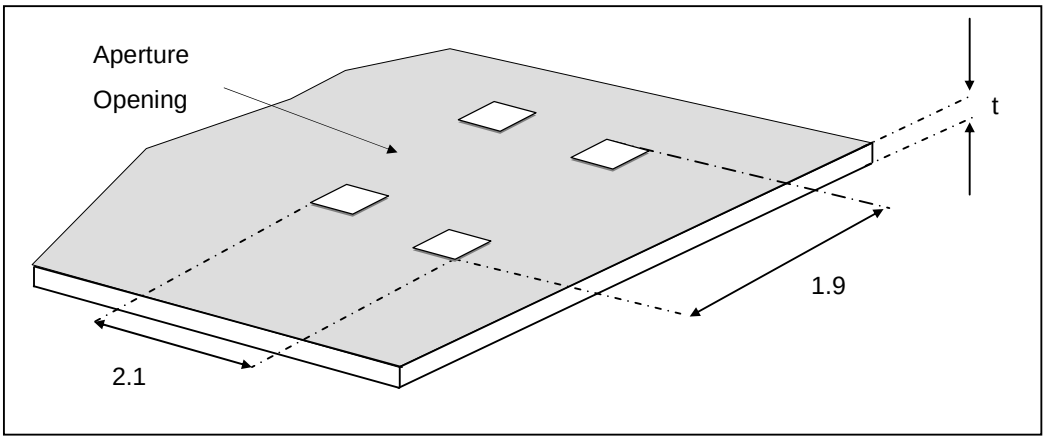
Note:

1. All dimensions are in millimeters

Recommended Metal Stencil Aperture

It is recommended that the metal stencil used for solder paste printing has a thickness (t) of 0.11mm (0.004 inches / 4 mils) or 0.127mm (0.005 inches / 5 mils).

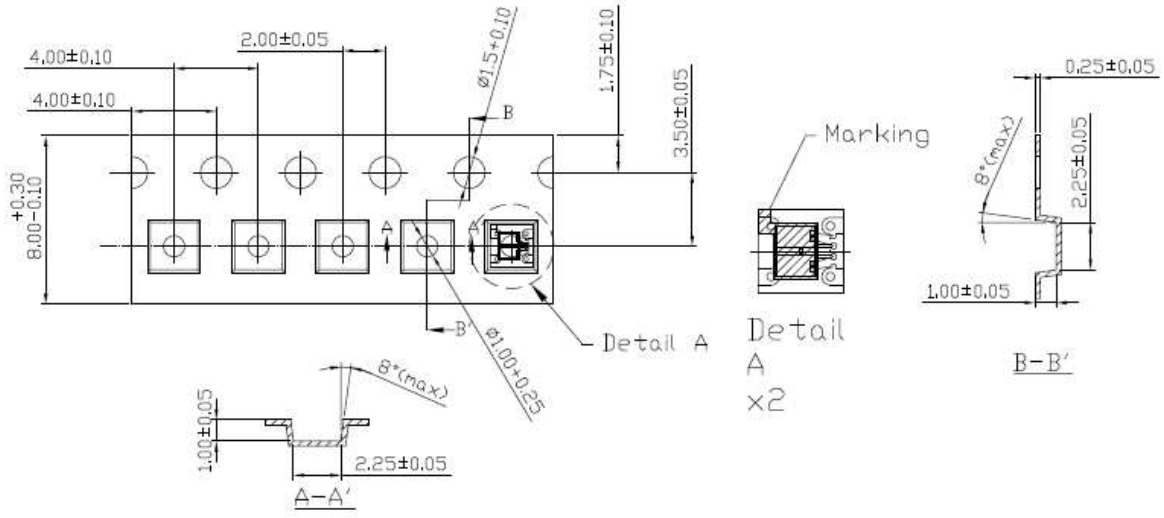
The stencil aperture opening is recommended to be 0.75mm x 0.70mm which has the same dimension as the land pattern. This is to ensure adequate printed solder paste volume and yet no shorting.



Note:

1. All dimensions are in millimeters

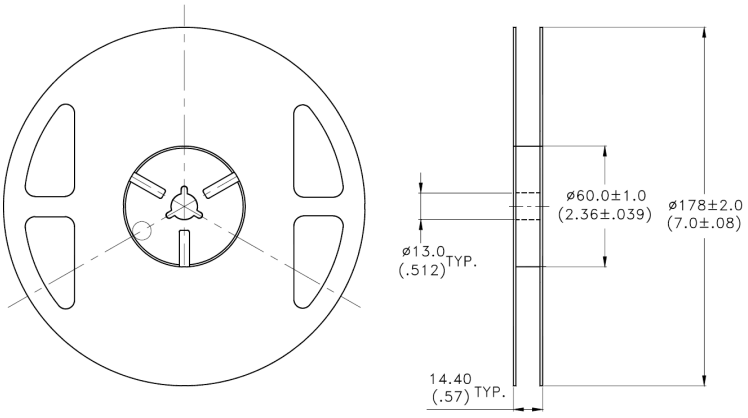
13. Package Dimension for Tape and Reel



Note:

1. All dimensions are in millimeters

Package Dimension of Reel:



Notes:

1. All dimensions are in millimeters (inches)
2. Empty component pockets sealed with top cover tape
3. 7 inch reel - 2500 pieces per reel

4. In accordance with ANSI/EIA 481-1-A-1994 specifications