
I. Overview

This ambient light sensor provides I2C digital output and is ideal for agricultural, instrumentation, industrial sensors and more. Low power ambient light sensor with device operating current less than 0.8mA; 32-bit light value register and 112-byte EEPROM data storage unit measuring 0–200000 lumen light intensity values.

The spectral response of the on-chip photodiode is optimized for the human eye's response to ambient light, integrating infrared and ultraviolet shielding. The adaptive gain circuit automatically selects the correct lumen range optimization test (counts/lumens).

The sensor is designed to operate in the 2.7V to 6V supply voltage range and consumes 0.7mA at full load.

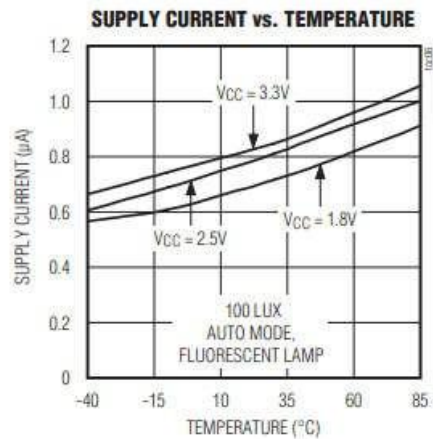
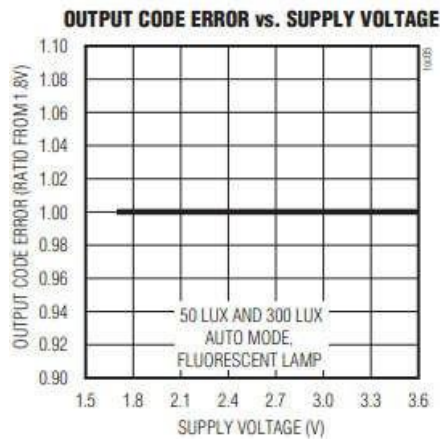
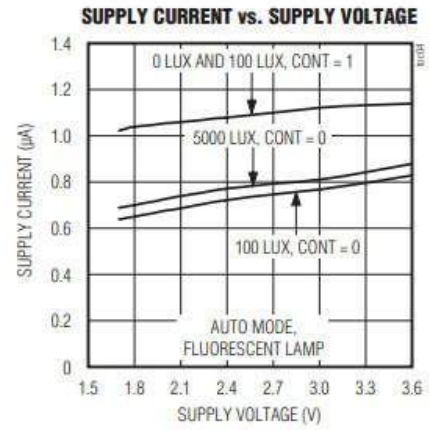
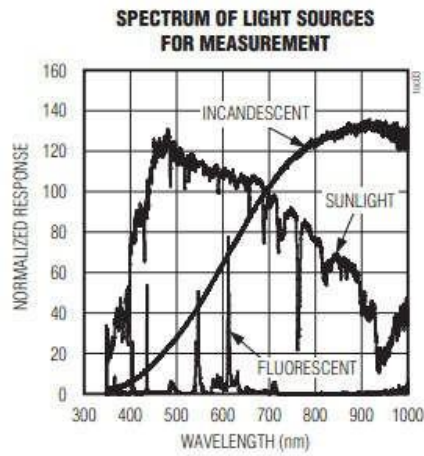
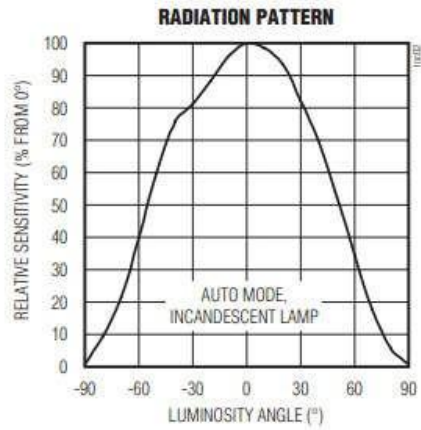
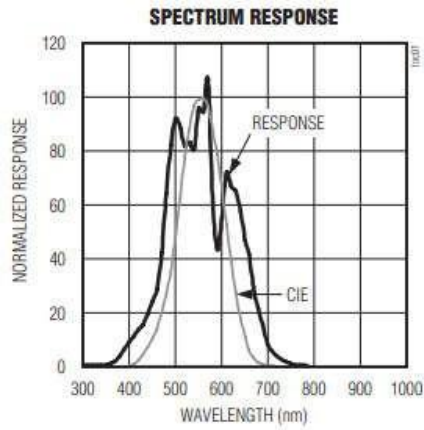
II. Characteristics

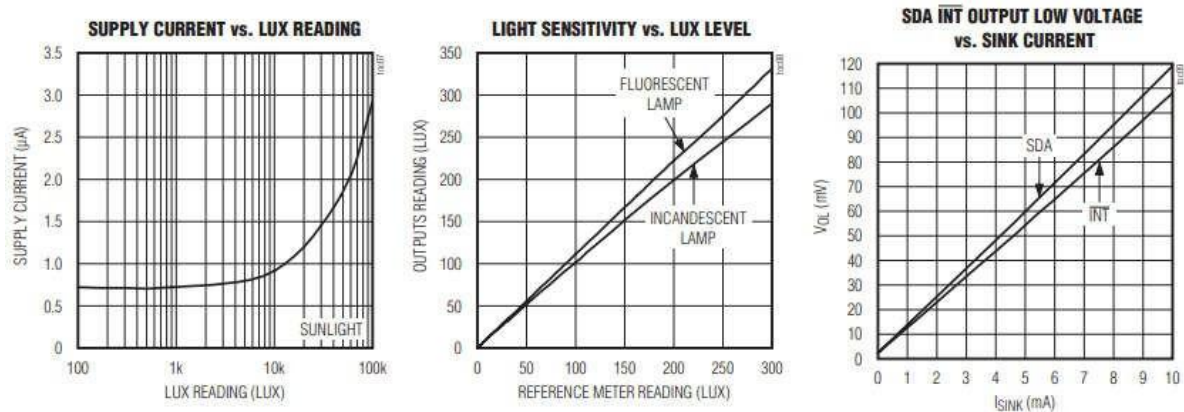
- 0 lumens to 200,000lumens wide detection range, low light accuracy 0.054Lux
- size: inside diameter22mm, outside diameter 26mm, large rim diameter 28.5 mm, height 18mmhemispherical package
- VCC= 2.7Vto 6V
- Operating current ICC= 0.7mA
- Operating temperature range-40 ° C to +85 ° C.
- Device address: 1001 0100 (0x94) write data address, 10010101

(0x95) read data address**III, pin definition**

pin	name	func tion
1	VCC	Power supply2.7V–6V.
2	SCL	I2C clock bus.
3	SDA	I2C data bus.
4	GND	Earth.
5	EN	EN sensor chip select enable terminal, H high active, L close sensor.

IV. Typical working characteristics





V. Detailed Description

This is an integrated photodiode and ADC ambient light sensor with an I2C digital interface. A photodiode inside the sensor converts the light intensity into a current, which is then processed into a digital bit stream by low-power circuitry. This bit stream is digitally processed and stored in an output register and read via the I2C interface.

On-chip filters prevent ultraviolet and infrared light from entering the photodiode, and the optical response is designed to match the spectral response of the human eye. The second photodiode array is primarily sensitive to the infrared spectrum and is used to match the optical signal response of fluorescent and incandescent lamps.

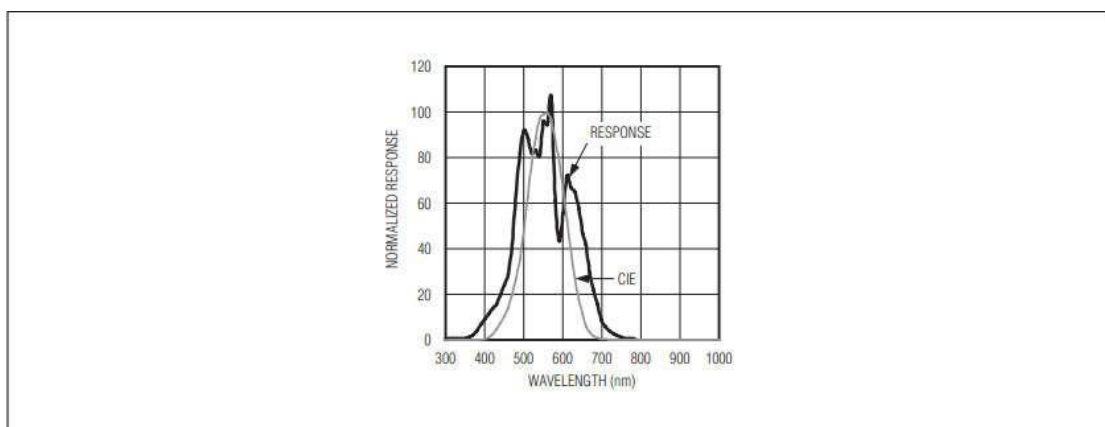
Two key features of the sensor analog design are the low current loss (typically 700 μA) and the extremely wide optical dynamic range, from 0.054 lumens to 200000 lumens—a range exceeding 4,000,000:1. The on-chip auto-ranging mechanism eliminates the need for user interference with gain range settings.

Sensors can be customized to enhance sensitivity for applications that require operation in darker environments. The ADC has a default integration time of 100ms and has inherent 50Hz and 60Hz ripple rejection for general purpose lighting supplies.

CIE curves of human eyes and different illuminants

The sensor detects brightness in the same way as the human eye. To achieve this, the spectral sensitivity of the sensor needs to be close to that of the human eye. Figure 1 shows the spectral sensitivity (CIE) curves for IC and human eyes.

As can be seen from the figure, the human eye is most sensitive to light at 555nm (green) and much less sensitive to blue light (about 470nm) and red light (about 630nm). In addition, the human eye cannot see infrared (>700nm) and ultraviolet (400nm)



radiation. Light sources can have the same visual brightness (lumens), but their IR radiation components are different (because they are invisible to the human eye). Spectral differences affect brightness measurements because silicon photodiodes can detect part of the infrared radiation. For example, a light source with a higher IR component, such as incandescent lamps or sunlight, measures a much brighter intensity than perceived by the human eye. Other light sources (e. g. fluorescent lamps and LED systems) have a low infrared component. The IC has strong IR rejection and an internal IR compensation mechanism that minimizes the effects of infrared light and provides accurate lumen response.

Figure1. Spectral sensitivity of sensor and human eye

VI. Register and bit description

register	7	6	5	4	3	2	1	0	site
read register	read-only register								
32bit illumination value	D07	D06	D05	D04	D03	D02	D01	D00	0x00
32bit illumination value	D15	D14	D13	D12	D11	D10	D09	D08	0x01
32bit illumination value	D23	D22	D21	D20	D19	D18	D17	D16	0x02
32bit illumination value	D31	D30	D29	D28	D27	D26	D25	D24	0x03
write register	read-writable registers								
configuration register	00	MANUAL	00	00	CDR	TIM[2:0]			0x04
stand-by register	00	00	00	00	00	00	00	00	0x05
stand-by register	00	00	00	00	00	00	00	00	...
stand-by register	00	00	00	00	00	00	00	00	0x0F
EEPROMdata storage	112 bytes EEPROM								
0x10	xx	xx	xx	xx	xx	xx	xx	xx	0x10
...	xx	xx	xx	xx	xx	xx	xx	xx	...
0x80	xx	xx	xx	xx	xx	xx	xx	xx	0x80

register descriptions

Light Value Storage Register (0x00 - 0x03)

register	7	6	5	4	3	2	1	0	site
32bit illumination value	D07	D06	D05	D04	D03	D02	D01	D00	0x00
32bit illumination value	D15	D14	D13	D12	D11	D10	D09	D08	0x01
32bit illumination value	D23	D22	D21	D20	D19	D18	D17	D16	0x02

0x00~ 0x03 are illumination value storage registers,

which store 32-bit illumination values.

Configuration register (0x04)

register	7	6	5	4	3	2	1	0	site
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configuration register	00	MANUAL	00	00	CDR	TIM[2:0]	0x04
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MANUAL Manual Configuration Register

MANUAL	parameter specific ation
0	Default auto mode. In this mode, CDR, TIM[2:0] bits are automatically assigned, and illumination values are collected internally by the IC. circuit autorange
1	Configure manual mode. In this mode, the CDR and TIM[2:0] bits can be set by the user.

CDRShunt Ratio Register

CDR	parameter specific ation
0	Default not divided. All photodiode current transitions to ADC
1	Dividedby8, as long as 1/8 of the photodiode currentchanges to ADC. This pattern is used in High brightness conditions.

Integration timeTIM[2:0]

TIM[2:0]	Time (ms)	parameter r specific ation
000	800	Preferred mode in low light.
001	400	--
010	200	--
011	100	Select mode first in bright light environment.
100	50	Manual mode only.
101	25	Manual mode only.
110	12.5	Manual mode only.
111	6.25	Manual mode only.

Spare register (0x05 - 0x07)

register	7	6	5	4	3	2	1	0	site
standby application	00	00	00	00	00	00	00	00	0x05
standby application	00	00	00	00	00	00	00	00	0x06
standby application	00	00	00	00	00	00	00	00	0x07

Application information:

automatic and manual modes

In automatic mode configuration (default setting), CDR and TIM bits are generated internally. The automatic range adjustment circuit uses two methods to change its sensitivity. When the light intensity exceeds 700 lumens, the shunt reduces the photodiode current by dividing by a factor of 8. By default, as described above, the shunt ratio is 1 and the current is fed directly into the I-to-F converter. When the light intensity decreases, the automatic range adjustment circuit increases the integration time from 100ms to 200ms, 400ms, or 800 ms. The combination of shunt and different integration times can increase the A/D conversion range by 8 times or reduce it by 8 times than its 16-bit nominal range. This results in a dynamic range of 22 bits or slightly more than 4,000,000:1.

In manual mode, the user can control the 4-bit (CDR and TIM[2:0]) values to mask the auto range circuit, which affects the integration time and shunt ratio of the A/D conversion. Refer to

the register description for details on manual configuration mode (0x02, bit 6).

Light Accuracy Table in Auto Mode

Minimum illumination value (min)	Maximum illumination value (max)	precision
0.0	11.5	0.054
11.5	23.0	0.09
23.0	46.1	0.18
46.1	92.2	0.36

92.2	184.3	0.72
184.3	368.6	1.44
368.6	737.3	2.88
737.3	1474.6	5.76
1474.6	2949.1	11.52
2949.1	5898.2	23.04
5898.2	11796.5	46.08
11796.5	23593.0	92.16
23593.0	47185.9	184.32
47185.9	94371.8	368.64
94371.8	200000.0	737.28

Manual Mode Setting Register (0x02)

light condition			Integration time and split ratio		
precision	illumination maximum	Acquisition time (ms)	TIM	CDR	
0.054	2938	800	000	0	
0.09	5875	400	001	0	
0.18	11750	200	010	0	
0.36	23501	100	011	0	
		800	000	1	
0.72	47002	50	100	0	
		400	001	1	
1.44	94003	25	101	0	
		200	010	1	
2.88	200000	12.5	110	0	
		100	011	1	
5.76	200000	6.25	111	0	
		50	100	1	
11.52	200000	25	101	1	
23.04	200000	12.5	110	1	
46.08	200000	6.25	111	1	

VII. I2Cserial interface

The sensor uses an I2C/SMBus™ compatible 2-wire serial interface consisting of a serial data line (SDA) and a serial clock line (SCL). Clock rates of up to 400kHz for SDA and SCL facilitate communication between IC and host. Figure 3 shows the timing diagram for the 2-wire interface. The host generates SCL on the bus and initiates data transfer. The master sends the corresponding

slave address, followed by the register address, followed by a data word to write data to the sensor. Each transmission sequence is packaged into frames by START(S) or REPEATED START(Sr) conditions and STOP(P) conditions. Each word length sent to the sensor is 8 bits, followed by a response clock pulse. When the master reads data from the sensor, it sends the corresponding slave address, followed by nine SCL pulses. The sensor sends data via SDA, synchronized with SCL pulses generated by the host. The host receives each byte of data

To respond to it. Each read sequence is framed by START or REPEATED_START conditions, non-acknowledge and STOP conditions. SDA is both an input and an open-drain output, and the SDA bus has pulled up 10K resistors. SCL is only used as input. If there are multiple masters on the bus, or if a master in a single-master system has an open-drain SCL output, the SCL clock has been pulled up by 10K. Optional series resistors on the SDA and SCL lines help protect the sensor's digital inputs from high-voltage glitches on the bus and minimize crosstalk and undershoot in bus signals. **bit transmission**

Each SCL cycle transmits one bit of data. The data on SDA must remain stable during the high of the SCL pulse. When SCL is high, the change on SDA represents the control signal (see the START and STOP Conditions section). When the I2C bus is idle, the idle states of SDA and SCL are high.

START and STOP conditions

When the bus is idle, the idle state of SDA and SCL is high. The host initiates communication by sending a START condition, which is a high-to-low transition of SDA when SCL is high. The STOP condition is a low to high transition of SDA when SCL is high (Figure 4). A START condition from the host notifies the sensor to start transmitting. The host terminates the transmission and releases the bus by sending a STOP condition. If a REPEATED START condition is generated instead of a STOP condition, the bus remains active.

Early STOP condition

The IC recognizes a STOP condition at any time during data transmission unless the STOP condition appears at the same high pulse as the START condition. For proper operation, do not send a STOP condition during the same SCL high pulse as the START condition.

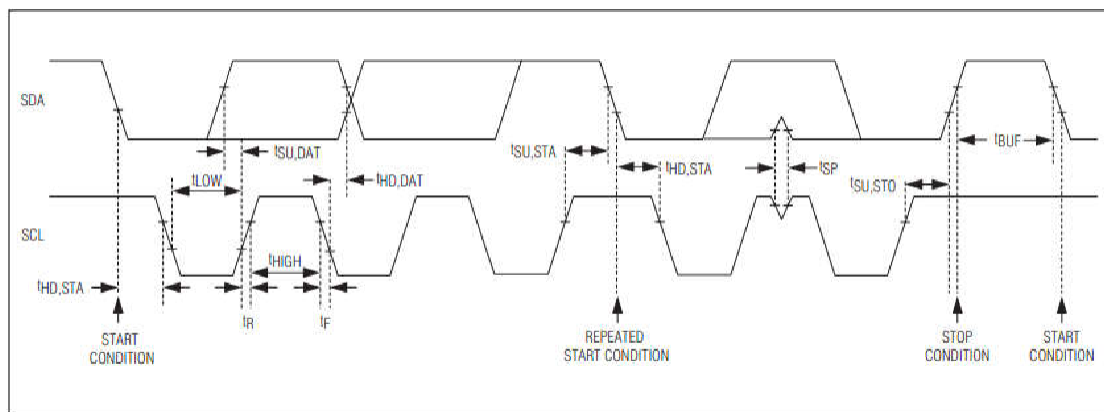


Figure 3. 2-wire interface timing diagram

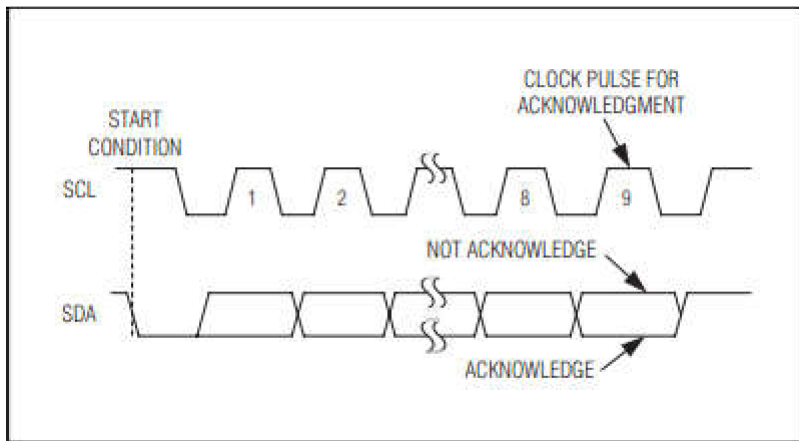


Figure 5. response

from the address

Table 10 lists the sensor addresses provided.

Table 10 Slave address

slave address write	slave address read
1001 0100 (0x94)	1001 0101 (0x95)

response

In write mode of operation, the acknowledge bit (ACK) is the 9th clock bit and is the handshake signal for each data byte received by the sensor (see Figure

5). If the previous byte was successfully received, the sensor pulls SDA low during the 9th clock pulse generated by the host. Monitoring ACKs can detect failed data transmissions. If the receiving device is busy or the system fails, a failed data transmission occurs. If the data transmission fails, the bus host will retry communication. When the sensor is in read mode, during the 9th clock pulse, the master pulls SDA low to acknowledge the received data. After each byte is read, the host sends a reply signal to allow the data to continue to be transmitted. When the host reads the last byte of data from the sensor, a non-acknowledge is sent, followed by a STOP condition.

write data format

A sensor write operation consists of a START condition, a slave address and R/W bit (set to 0), a data byte to configure the internal register address pointer, one or more data bytes, and a STOP condition. Figure 6 shows the correct frame format when writing 1 byte of data to the sensor.

A slave address with the R/W bit set to 0 indicates that the master is writing data to the sensor. The address byte that the sensor should have received during the 9th SCL pulse generated by the host.

The second byte sent by the host configures the sensor's internal register address pointer, which tells the sensor where to write the next data byte. After receiving the address pointer data, the sensor sends an acknowledge pulse.

The third byte sent to the sensor is the data written to the specified register. The host terminates the transmission by sending a STOP condition. **read data format**

To read a data byte, the register pointer must first be set by a write operation (Figure 7). Send the slave address and set the R/W bit to 0, followed by the address of the register to be read. After the REPEATED_START condition, the read operation is initiated by sending the slave address and setting the R/W bit to 1. The sensor then sends an acknowledge pulse followed by the register contents to be read. The transmit data is valid on the rising edge of the host-generated serial clock (SCL).

Figure 8 shows the frame format for reading two registers in succession without asserting a STOP condition during the read. Use only when lumendata registers 0x03 and 0x04 are read continuously.

sensor position

The photosensitive area of the sensor is 0.37mmx0.37mm, which is much smaller than the device itself, and the photosensitive area is located in the center of the sensor. Place the device in the light guide

In the rear, only the brightness of the photosensitive area is included in the light intensity calculation data.

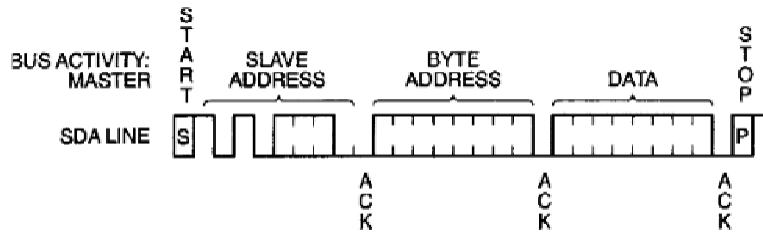


Figure6. 1. Single-byte writing

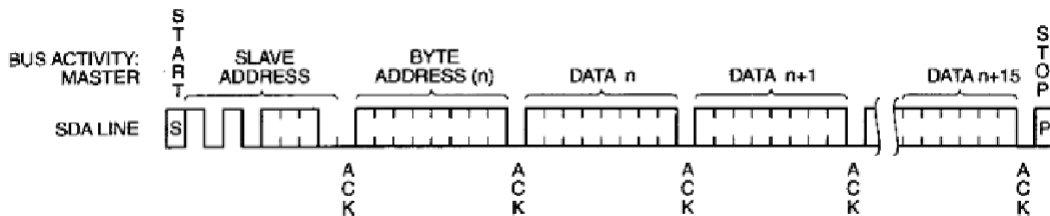


Figure6. 2. Multi-byte sequential writing

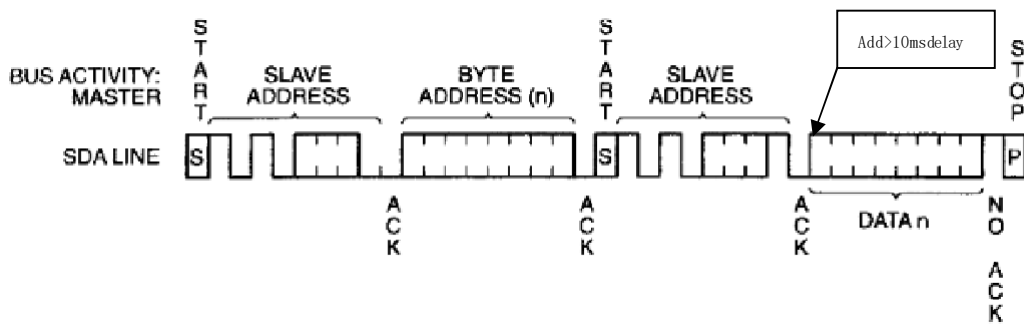


Figure7. 1. Single-byte read.

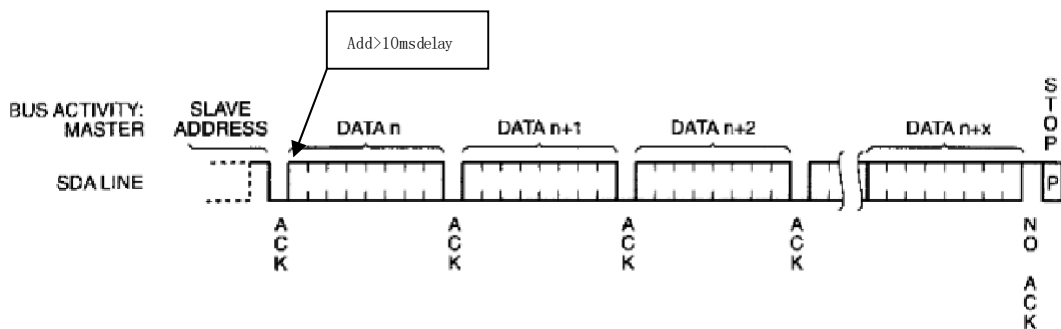


Figure 7. 2. Multibyte
Continuous Reading