Digital Proximity Sensor with Ambient Light Sensor and Interrupt

Description

The NOA3302 combines an advanced digital proximity sensor and LED driver with an ambient light sensor (ALS) and tri-mode I^2C interface with interrupt capability in an integrated monolithic device. Multiple power management features and very low active sensing power consumption directly address the power requirements of battery operated mobile phones and mobile internet devices.

The proximity sensor measures reflected light intensity with a high degree of precision and excellent ambient light rejection. The

Additional Features

- Programmable interrupt function including independent upper and lower threshold detection or threshold based hysteresis for proximity and or ALS
- Proximity persistence feature reduces interrupts by providing hysteresis to filter fast transients such as camera flash
- Automatic power down after single measurement or continuous measurements with programmable interval time for both ALS and PS function
- Wide operating voltage range (2.3 V to 3.6 V)
- Wide operating temperature range (-40°C to 80°C)
- I²C serial communication port
 - ◆ Standard mode 100 kHz

- Fast mode 400 kHz
- ♦ High speed mode 3.4 MHz
- No external components required except the IR LED and power supply Decoupling Caps
- 8-lead CUDFN 2.0 x 2.0 x 0.6 mm clear package
- These Devices are Pb–Free, Halogen Free/BFR Free and are RoHS Compliant

Applications

- Senses human presence in terms of distance and senses ambient light conditions, saving display power in applications such as:
 - Smart phones, mobile internet devices, MP3 players, GPS
 - Mobile device displays and backlit keypads

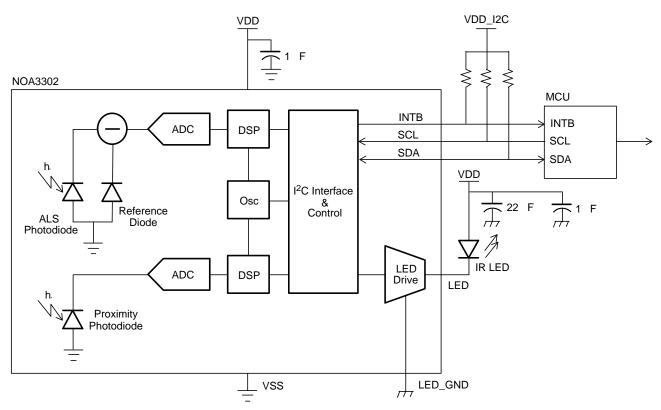


Figure 1. NOA3302 Application Block Diagram

Table 1. PIN FUNCTION DESCRIPTION

Pin	Pin Name	Description			
1	VDD	Power pin.			
2	VSS	Ground pin.			
3	LED_GND	Ground pin for IR LED driver.			
4	LED	IR LED output pin.			
5	INT	Interrupt output pin, open-drain.			
6	NC	Not connected.			
7	SDA	Bi-directional data signal for communications with the I ² C master.			
8	SCL	External I ² C clock supplied by the I ² C master.			

Table 2. ABSOLUTE MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Input power supply	VDD	4.0	V
Input voltage range	V _{in}	-0.3 to VDD + 0.2	V
Output voltage range	V _{out}	-0.3 to VDD + 0.2	V
Maximum Junction Temperature	T _{J(max)}	100	°C
Storage Temperature	T _{STG}	-	-

 $\textbf{Table 4. ELECTRICAL CHARACTERISTICS} \text{ (Unless otherwise specified, these specifications apply over } 2.3 \text{ V} < \text{VDD} < 3.3 \text{ V}, \\ 1.7 \text{ V} < \text{VDD_I2C} < 1.9 \text{ V}, \\ -40^{\circ}\text{C} < \text{T}_{A} < 80^{\circ}\text{C}, \\ 10 \text{ pF} < \text{Cb} < 100 \text{ pF)} \text{ (See Note 4)}$

Parameter	Symbol	Min	Тур	Max	Unit
LED pulse current	I _{LED_pulse}	5		160	mA
LED pulse current step size	I _{LED_pulse_step}		5		mA
LED pulse current accuracy	I _{LED_acc}	-20		+20	%
Interval Timer Tolerance	Tol _{f_timer}	-35		+35	%
SCL clock frequency	f _{SCL_std}	10		100	kHz
	f _{SCL_fast}	100		400	
	f _{SCL_hs}	100		3400	
Hold time for START condition. After this period,	T _{HD;STA_std}	4.0		-	S
the first clock pulse is generated.	t _{HD;STA_fast}	0.6		-	
	t _{HD;STA_hs}	0.160		-	
Low period of SCL clock	t _{LOW_std}	4.7		_	

Table 4. ELECTRICAL CHARACTERISTICS (Unless otherwise specified, these specifications apply over 2.3 V < VDD < 3.3 V, $1.7 \text{ V} < \text{VDD_I2C} < 1.9 \text{ V}, -40^{\circ}\text{C} < \text{T}_{\text{A}} < 80^{\circ}\text{C}, 10 \text{ pF} < \text{Cb} < 100 \text{ pF})$ (See Note 4) (continued)

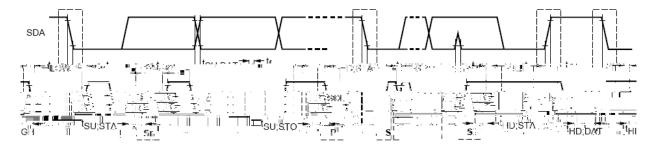


Figure 2. AC Characteristics, Standard and Fast Modes

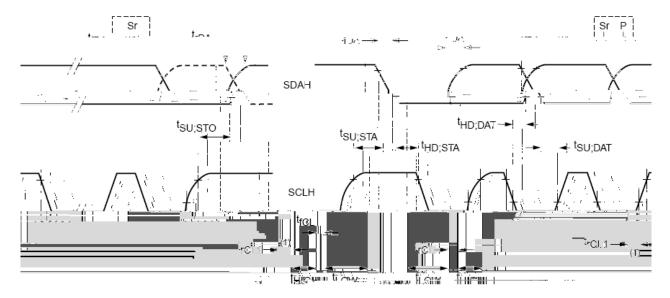
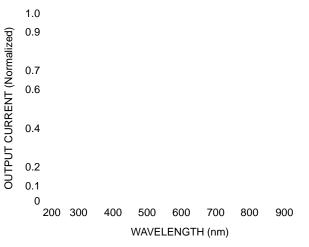


Figure 3. AC Characteristics, High Speed Mode

TYPICAL CHARACTERISTICS



0 0.5 1.0 1.5 2.0 RATIO

Figure 4. ALS Spectral Response (Normalized)

Figure 5. ALS Light Source Dependency (Normalized to Fluorescent Light)

Figure 6. ALS Response to White Light vs. Angle

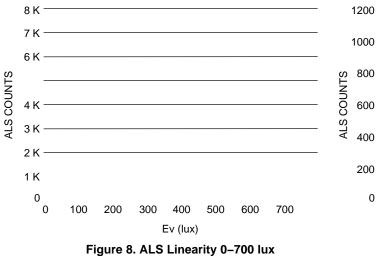


Figure 7. ALS Response to IR vs. Angle

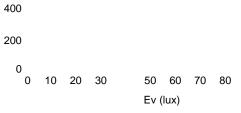


Figure 9. ALS Linearity 0–100 lux

TYPICAL CHARACTERISTICS

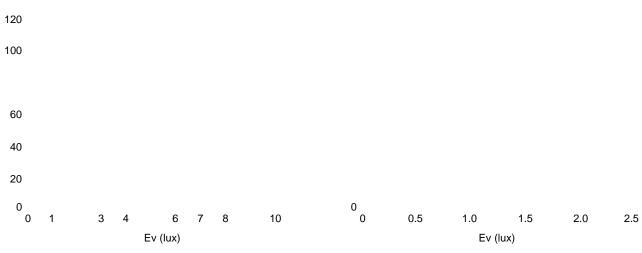


Figure 10. ALS Linearity 0–10 lux

Figure 11. ALS Linearity 0-2 lux

TYPICAL CHARACTERISTICS

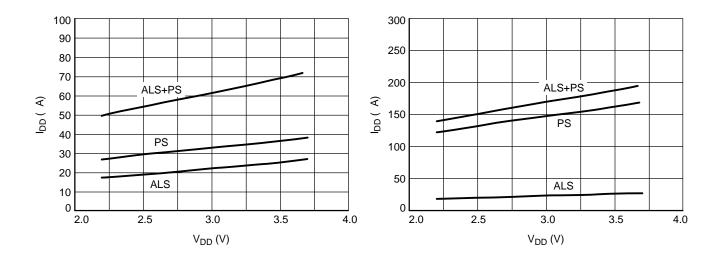


Figure 22 shows an I^2C read command sent by the master to the slave device. Read transactions begin in much manner as the write transactions in that the slave address must be sent with a write(0) command bit.	ch the same

NOA3302 Data Registers

NOA3302 operation is observed and controlled by internal data registers read from and written to via the external I²C interface. Registers are listed in Table 6. Default values are set on initial power up or via a software reset command (register 0x01).

The I²C slave address of the NOA3302 is 0x37.

Table 6. NOA3302 DATA REGISTERS

Address	Туре	Name	Description	
0x00	R	PART_ID	NOA3302 part number and revision IDs	
0x01	RW	RESET	Software reset control	
0x02	RW	INT_C:5 refBT8dG0.8	4 612.36 .85.36 ref59.76 6112.36 .84 2 .833997 refBT8 0 0 8 266.04 617.76 Tm.01	72 Tc(R00TjETI)

RESET Register (0x01)

Software reset is controlled by this register. Setting this register followed by an I2C_STOP sequence will immediately reset the NOA3302 to the default startup

standby state. Triggering the software reset has virtually the same effect as cycling the power supply tripping the internal Power on Reset (POR) circuitry.

Table 8. RESET REGISTER (0x01)

Bit	7	6	5	4	3	2	1	0
Field			NA					

Field	Bit	Default	Description
NA	7:1	XXXXXXX	Don't care
SW_reset	0	0	Software reset to startup state

INT_CONFIG Register (0x02)

INT_CONFIG register controls the external interrupt pin function.

Table 9. INT_CONFIG REGISTER (0x02)

Table 11. PS_TH_UP REGISTERS (0x10 - 0x11)

	Bit	7	6	5	4	3	2	1	0
Ī	Field		PS_TH_UP_MSB(0x10), PS_TH_UP_LSB(0x11)						

Field	Bit	Default	Description
PS_TH_UP_MSB			

PS	INTER	2/ΔΙ	Register	(0x16)
гυ_		/ VML	Register	(UXIU)

The PS_INTERVAL register sets the wait time between consecutive proximity measurements in PS_Repeat mode. The register is binary weighted times 5 in milliseconds with

Table 18. ALS_TH_LO REGISTERS (0x22 - 0x23)

	Bit	7	6	5	4	3	2	1	0			
Fie	d		ALS_TH_LO_MSB(0x22), ALS_TH_LO_LSB(0x23)									

Field	Bit	Default	Description
ALS_TH_LO_MSB	7:0	0x00	Lower threshold for ALS detection, MSB
ALS_TH_LO_LSB	7:0	0x00	Lower threshold for ALS detection, LSB

ALS_CONFIG Register (0x25)

The ALS_CONFIG register controls the ambient light measurement sensitivity by specifying the integration time. Hyst_enable and hyst_trigger work with the ALS_TH (threshold) settings to provide jitter control of the INT function.

Integration times below 50 ms are not recommended for normal operation as 50/60 Hz rejection will be impacted. They may be used in testing or if 50/60 Hz rejection is not a concern.

Table 19. ALS_CONFIG REGISTER (0x25)

Bit 7		6	5	4	3	2	1	0
Field	NA		hyst_enable	hyst_trigger	reserved	inte	egration_tii	me

Field	Bit	Default	Description			
NA	7:6	XX	Don't Care			
hyst_enable	5	0	0	Disables hysteresis		
			1	Enables hysteresis		
hyst_trigger	4	0	0	Lower threshold with hysteresis		
			1	Upper threshold with hysteresis		
reserved	3	0	Must b	e set to 0		
integration_time	2:0	2:0 100	000	6.25 ms integration time		
			001	12.5 ms integration time		
			010	25 ms integration time		
			011	50 ms integration time		
			100	100 ms integration time		
			101	200 ms integration time		
			110	400 ms integration time		
			111	800 ms integration time		

ALS_INTERVAL Register (0x26)

The ALS_INTERVAL register sets the interval between consecutive ALS measurements in ALS_Repeat mode. The register is binary weighted times 50 in milliseconds. The

range is 0 ms to 3.15 s. The register value 0x00 and 0 ms translates into a continuous loop measurement mode at any integration time. The default startup value is 0x0A (500 ms).

Table 20. ALS_INTERVAL REGISTER (0x26)

Bit	7	6	5	4	3	2	1	0
Field	N.	A			inte	rval		

Field	Bit	Default	Description
interval	5:0	0x0A	Interval time between ALS measurement cycles

ALS_CONTROL Register (0x27)

The ALS_CONTROL register is used to control the functional mode and commencement of ambient light sensor measurements. The ambient light sensor can be operated in either a single shot mode or consecutive measurements taken at programmable intervals.

Both single shot and repeat modes consume a minimum of power by immediately turning off sensor circuitry after

each measurement. In both cases the quiescent current is less than the IDD_{STBY} parameter. These automatic power management features eliminate the need for power down pins or special power down instructions.

For accurate measurements

ALS_DATA Registers (0x43 - 0x44)

The ALS_DATA registers store results from completed ALS measurements. When an I²C read operation begins, the current ALS_DATA registers are locked until the operation

is complete (I2C_STOP received) to prevent possible data corruption from a concurrent measurement cycle.

Table 24. ALS_DATA REGISTERS (0x43 - 0x44)

	Bit	7	6	5	4	3	2	1	0			
ſ	Field		ALS_DATA_MSB(0x43), ALS_DATA_LSB(0x44)									

Field	Bit	Default	Description
ALS_DATA_MSB	7:0	0x00	ALS measurement data, MSB
ALS_DATA_LSB	7:0	0x00	ALS measurement data, LSB

Proximity Sensor Operation

NOA3302 operation is divided into three phases: power up, configuration and operation. On power up the device initiates a reset which initializes the configuration registers to their default values and puts the device in the standby state. At any time, the host system may initiate a software reset by writing 0x01 to register 0x01. A software reset performs the same function as a power-on-reset.

The configuration phase may be skipped if the default register values are acceptable, but typically it is desirable to change some or all of the configuration register values. Configuration is accomplished by writing the desired configuration values to registers 0x02 through 0x17. Writing to configuration registers can be done with either individual I²C byte-write commands or with one or more I²C block write commands. Block write commands specify the first register address and then write multiple bytes of data in sequence. The NOA3302 automatically increments the register address as it acknowledges each byte transfer.

Proximity sensor measurement is initiated by writing appropriate values to the CONTROL register (0x17).

Sending an I2C STOP sequence at the end of the write signals the internal state machines to wake up and begin the next measurement cycle. Figures 23 and 24 illustrate the activity of key signals during a proximity sensor measurement cycle. The cycle begins by starting the precision oscillator and powering up and calibrating the proximity sensor receiver. Next, the IR LED current is modulated according to the LED current setting at the chosen LED frequency and the values during both the on and off times of the LED are stored (illuminated and ambient values). Finally, the proximity reading is calculated by subtracting the ambient value from the illuminated value and storing the result in the 16 bit PS_Data register. In One-shot mode, the PS receiver is then powered down and the oscillator is stopped (unless there is an active ALS measurement). If Repeat mode is set, the PS receiver is powered down for the specified interval and the process is repeated. With default configuration values (receiver integration time = 300 s), the total measurement cycle will be less than 2 ms.

Ambient Light Sensor Operation	

Example Programming Sequence

The following pseudo code configures the NOA3302 proximity sensor in repeat mode with 50 ms wait time between each measurement and then runs it in an interrupt driven mode. When the controller receives an interrupt, the interrupt determines if the interrupts was caused by the proximity sensor and if so, reads the PS_Data from the device, sets a flag and then waits for the main polling loop to respond to the proximity change.

```
external subroutine I2C_Read_Byte (I2C_Address, Data_Address);
external subroutine I2C_Read_Block (I2C_Address, Data_Start_Address, Count, Memory_Map);
external subroutine I2C_Write_Byte (I2C_Address, Data_Address, Data);
external subroutine I2C_Write_Block (I2C_Address, Data_Start_Address, Count, Memory_Map);
subroutine Initialize_PS () {
MemBuf[0x02] = 0x02; // INT_CONFIG assert interrupt until cleared
MemBuf[0x0F] = 0x09; // PS_LED_CURRENT 50mA
MemBuf[0x10] = 0x8F; // PS_TH_UP_MSB
MemBuf[0x11] = 0xFF; // PS_TH_UP_LSB
MemBuf[0x12] = 0x70; // PS_TH_LO_MSB
MemBuf[0x13] = 0x00; // PS_TH_LO_LSB
MemBuf[0x14] = 0x11; // PS_FILTER_CONFIG turn off filtering
MemBuf[0x15] = 0x01; // PS_CONFIG 300us integration time
MemBuf[0x16] = 0x0A; // PS_INTERVAL 50ms wait
MemBuf[0x17] = 0x02; // PS_CONTROL enable continuous PS measurements
MemBuf[0x20] = 0xFF; // ALS_TH_UP_MSB
MemBuf[0x21] = 0xFF; // ALS_TH_UP_LSB
MemBuf[0x22] = 0x00; // ALS_TH_LO_MSB
MemBuf[0x23] = 0x00; // ALS_TH_LO_LSB
MemBuf[0x25] = 0x04; // ALS_CONFIG 100ms integration time
MemBuf[0x26] = 0x00; // ALS_INTERVAL continuous measurement mode
MemBuf[0x27] = 0x02; // ALS_CONTROL enable continuous ALS measurements
I2C_Write_Block (I2CAddr, 0x02, 37, MemBuf);
subroutine I2C Interupt Handler () {
// Verify this is a PS interrupt
INT = I2C_Read_Byte (I2CAddr, 0x40);
if (INT == 0x11 \mid \mid INT == 0x12) {
 // Retrieve and store the PS data
 PS_Data_MSB = I2C_Read_Byte (I2CAddr, 0x41);
 PS_Data_LSB = I2C_Read_Byte (I2CAddr, 0x42);
 NewPS = 0 \times 01;
 }
subroutine main_loop () {
I2CAddr = 0x37;
NewPS = 0x00;
Initialize PS ();
 // Do some other polling operations
 if (NewPS == 0 \times 01) {
  NewPS = 0 \times 00;
  // Do some operations with PS_Data
  }
```

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Physical Location of The physical locat	of Photodiode S ions of the NOA	Sensors A3302 proxim	ity sensor and	ambient light se	ensor photodiod	es are shown in	Figure 27.

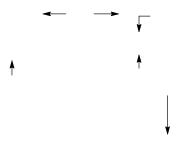
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PACKAGE DIMENSIONS

CWDFN8, 2x2, 0.5P CASE 505AJ ISSUE O



MOUNTING FOOTPRINT*



DIMENSIONS: MILLIMETERS

*For