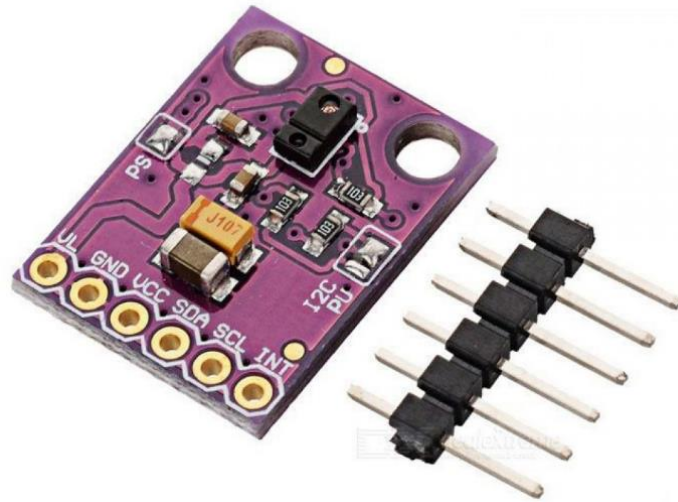## APDS-9960 Gesture Sensor

This is an RGB and Gesture Sensor, a small breakout board with a built-in APDS-9960 sensor that offers ambient light and color measuring, proximity detection, and touchless gesture sensing. With this RGB and Gesture Sensor it will be able to control a computer, microcontroller, robot, and more with a simple swipe of your hand! This is, in fact, the same sensor that the Samsung Galaxy S5 uses and is probably one of the best gesture sensors on the market for the price.
The APDS-9960 is a serious little piece of hardware with built-in UV and IR blocking filters, four separate diodes sensitive to different directions, and an I2C compatible interface. For your convenience, we have broken out the following pins: VL (optional power to IR LED), GND (Ground), VCC (power to APDS-9960 sensor), SDA (I2C data), SCL (I2C clock), and INT (interrupt). Each APDS-9960 also has a detection range of 4 to 8 inches (10 to 20 cm).

FEATURES:

- Ambient Light and RGB Color Sensing, Proximity Sensing, and Gesture Detection in an Optical Module
- Ambient Light and RGB Color Sensing

- UV and IR blocking filters

- Programmable gain and integration time

- Very high sensitivity

- Ideally suited for operation behind dark glass

- Proximity Sensing

  - Trimmed to provide consistent reading

  - Ambient light rejection - Offset compensation

  - Programmable driver for IR LED current

  - Saturation indicator bit

- Complex Gesture Sensing

  - Four separate diodes sensitive to different directions

  - Ambient light rejection

  - Offset compensation

  - Programmable driver for IR LED current

  - 32 dataset storage FIFO

  - Interrupt driven I2C communication

- I2C

  - bus Fast Mode Compatible Interface

  - Data Rates up to 400 kHz

  - Dedicated Interrupt Pin

- Small Package L $3.94 \times$ W $2.36 \times$ H 1.35 mm

SPECIFICATIONS:

- **Absolute maximum ratings**

Parameter	Symbol	Min	Max	Unit
Power supply voltage	VDD		3.8	V
Input voltage range	VIN	-0.5	3.8	V
Output voltage range	VOUT	-0.3	3.8	V
Storage temperature range	Tstg	-40	85	°C

Recommended operating conditions:

Parameter	Symbol	Min	Typ	Max	Units
Operating ambient temperature	TA	-30	-	85	°C
Power supply voltage	VDD	2.4	3.0	3.6	V
Supply voltage accuracy, VDD total error including transients	-	-3	-	+3	%
LED supply voltage	VLEDA	3.0		4.5	V

FUNCTIONAL DESCRIPTION:
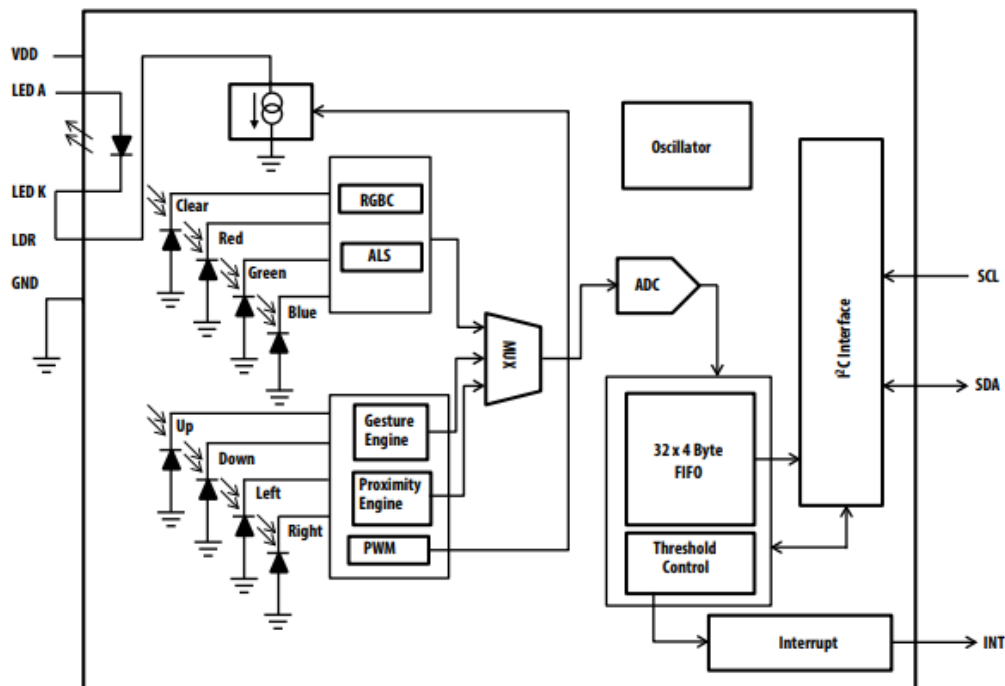
- The APDS-9960 device features advanced Gesture detection, Proximity detection, Digital Ambient Light Sense (ALS) and Color Sense (RGBC). The slim modular package, L 3.94 x W 2.36 x H 1.35 mm, incorporates an IR LED and factory calibrated LED driver for drop-in compatibility with existing footprints.

- **Gesture detection:** Gesture detection utilizes four directional photodiodes to sense reflected IR energy (sourced by the integrated LED) to convert physical motion information (i.e. velocity, direction and distance) to a digital information. The architecture of the gesture engine features automatic activation (based on Proximity engine results), ambient light subtraction, cross-talk cancelation, dual 8-bit data converters, power saving inter-conversion delay, 32-dataset FIFO, and interrupt driven I2C communication. The gesture engine accommodates a wide range of mobile device gesturing requirements: simple UP-DOWN-RIGHT-LEFT gestures or more complex gestures can be accurately sensed. Power consumption and noise are minimized with adjustable IR LED timing.

- **Proximity detection:** The Proximity detection feature provides distance measurement (E.g. mobile device screen to user's ear) by photodiode detection of reflected IR energy (sourced by the integrated LED). Detect/release events are interrupt driven, and occur whenever proximity result crosses upper and/ or lower threshold settings. The proximity engine features offset adjustment registers to compensate for system offset caused by unwanted IR energy reflections appearing at the sensor. The IR LED intensity is factory trimmed to eliminate the need for end-equipment calibration due to component variations. Proximity results are further improved by automatic ambient light subtraction.

- **Color and ALS detection:** The Color and ALS detection feature provides red, green, blue and clear light intensity data. Each of the R, G, B, C channels have a UV and IR blocking filter and a dedicated data converter producing16-bit data simultaneously. This architecture allows applications to accurately measure ambient light and sense color which enables devices to calculate color temperature and control display backlight.

Gesture, Proximity
Color/ALS
State Machine

Operational States
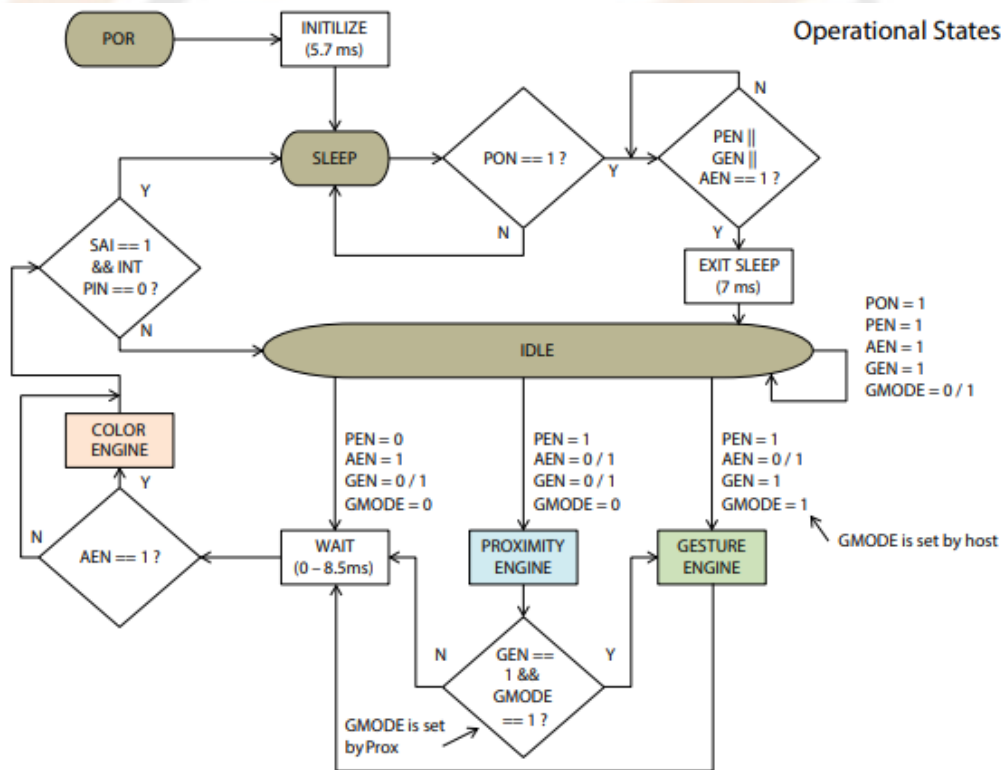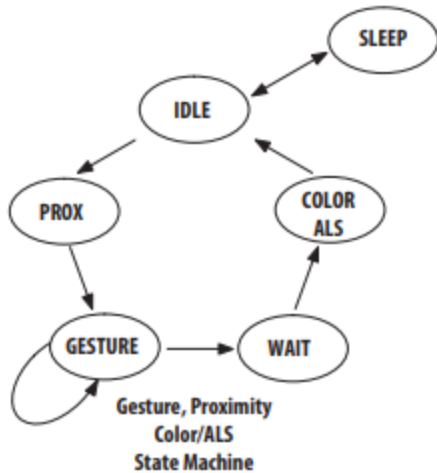
- Gesture detection, proximity detection, and RGBC color sense/ambient light sense functionality is controlled by a state machine, as depicted in Figure 12, which reconfigures on-chip analog resources when each functional engine is entered. Functional states/engines can be individually included or excluded from the progression of state machine flow. Each functional engine contains controls (E.g. Gain, ADC integration time, wait time, persistence, thresholds, etc.) that govern operation. Control of the Led Drive pin, LDR, is shared between Proximity and Gesture functionality. The color/ALS

engine does not use the IR LED, but cross talk from IR LED emissions during an optical pattern transmission may affect results.

- The operational cycle of the device for Gesture/Proximity/ Color is as depicted in Figures

- Upon power-up, POR, the device initializes and immediately enters the low power SLEEP state. In this operational state the internal oscillator and other circuitry are not active, resulting in ultra-low power consumption. If I²C transaction occurs during this state, the oscillator and I²C core wakeup temporarily to service the communication. Once the Power ON bit, PON, is enabled, the internal oscillator and attendant circuitry are active, but power consumption remains low until one of the functional engine blocks are entered. The first time the SLEEP state is exited and any of the analog engines are enabled (PEN, GEN, AEN =1) an EXIT SLEEP pause occurs; followed by an immediate entry into the selected engine. If multiple engines are enabled, then the operational flow progresses in the following order: idle, proximity, gesture (if GMODE = 1), wait, color/ALS, and sleep (if SAI = 1 and INT pin is asserted). The wait operational state functions to reduce the power consumption and data collection rate. If wait is enabled, WEN=1, the delay is adjustable from 2.78ms to 8.54s, as set by the value in the WTIME register and WLONG control bit.

- Sleep After Interrupt Operation: After all the enabled engines/operational states have executed, causing a hardware interrupt, the state machine returns to either IDLE or SLEEP, as selected by the Sleep After Interrupt bit, SAI. SLEEP is entered when two conditions are met: SAI = 1, and the INT pin has been asserted. Entering SLEEP does not automatically change any of the register settings (E.g. PON bit is still high, but the normal operational state is over-ridden by SLEEP state). SLEEP state is terminated by an I²C clear of the INT pin or if SAI bit is cleared.

PIN FUNCTION:

Pin	Name	Type	Description
1	SDA	I/O	I 2C serial data I/O terminal - serial data I/O for I2C-bus
2	INT	O	Interrupt - open drain (active low)
3	LDR		LED driver input for proximity IR LED, constant current source LED driver
4	LEDK		LED Cathode, connect to LDR pin when using internal LED

			driver circuit
5	LED		LED Anode, connect to VLEDA on PCB
6	GND		Power supply ground. All voltages are referenced to GND
7	SCL	I	I 2C serial clock input terminal - clock signal for I2C serial data
8	VDD		Power supply voltage

DIMENSION:

PINOUT
1 - SDA
2 - INT
3 - LDR
4 - LEDK
5 - LEDA
6 - GND
7 - SCL
8 - VDD
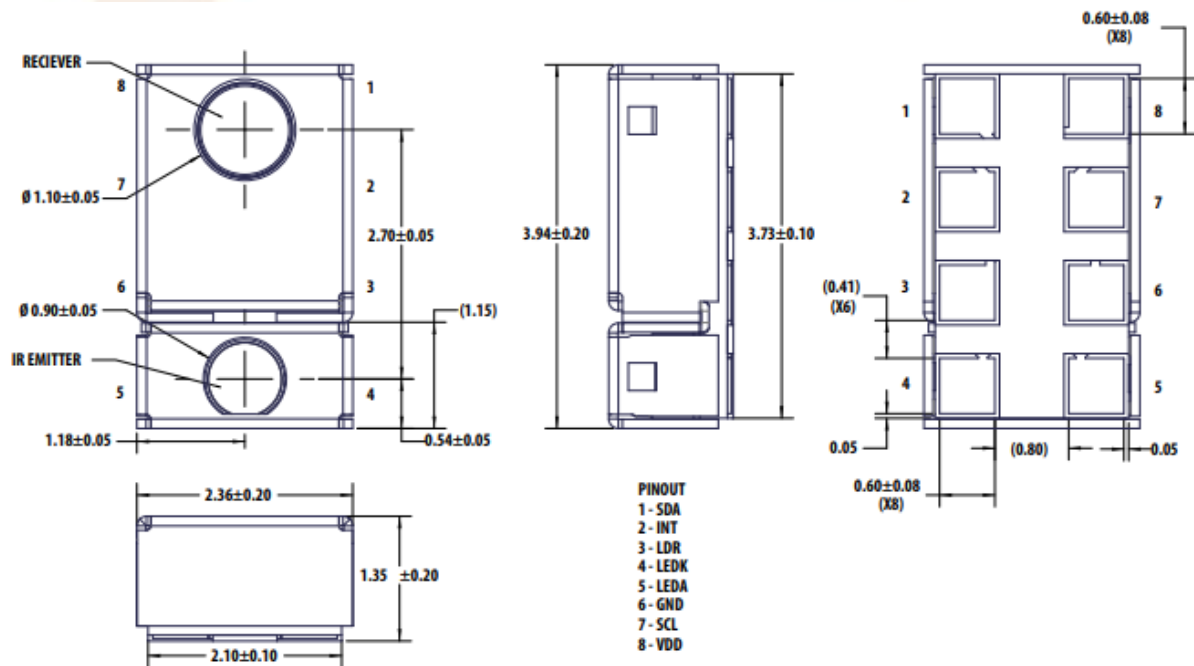
APPLICATIONS:

- Gesture Detection
- Color Sense
- Ambient Light Sensing
- Cell Phone Touch Screen Disable
- Mechanical Switch Replacement