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ADNS-9500

LaserStream™ Gaming Sensor



Preliminary Datasheet



ADNS-9500 Datasheet Revision Log

The revision log is to be filled out for each revision of the document.

Revision	Date	Modified by	Notes
0.04	25-Mar-08	CM, Teo	-
1.0	07-Jul-08	Wei-Ye,Saw	- Page 1: Add in Revision Log - Page 3: Features - o Changed max speed 150ips from 100ips - o Changed max resolution to 5000cpi from 4200cpi - o Deleted "Minimal number of passive components" & "832-865 nm wavelength" - Page 3: Deleted bundle part number - Page 4: Pinout Table Deleted PadA and PadB rows - Page 4: Updated Figure 1. Package Pinout drawing - Page 5: Updated Figure 2. Package Outline drawing - Page 6: Updated Figure 3. Assembly drawing - Page 7: Updated Figure 4. Isometric drawing & Figure 5. Recommended PCB Mechanical Cutout and Spacing drawing - Page 8: Updated Figure 6a. Schematic Diagram for 5V Corded Mouse - Page 10: Deleted Laser Drive Mode section - Page 10: Rephrase Eye Safety section - Page 11: Updated Figure 7. Single Fault Detection and Eye Safety Feature Block Diagram & Figure 8. Block Diagram of ADNS-9500 - Page 12: Regulatory Requirements - Changed ESD discharge level to TBD and added IEC/EN 60825-1 eye safety class 1 regulatory - Page 12: Absolute Maximum Ratings - o Deleted parameters: Latchup Current, VCSEL Power Dissipation and VCSEL Junction Temperature - o Added parameter: Laser Output Power - Page 12: Recommended Operating Conditions - o Changed Min and Max of Z parameter to TBD. - o Changed Speed Max to 150ips - o Added Laser Output Power Max to 506uW - o Added Frame Rate parameter - Page 12: Removed VCSEL's Optical/Electrical Characteristics section - Page 16: Deleted VCSEL's Typical Characteristics Section - Page 17: Motion Pin - Changed from "The motion pin is lowered whenever the motion bit is set;..... will put the motion pin high." to "The motion pin is high whenever the motion bit is set;..... will put the motion pin low." - Page 21: Added Figure 20. SROM Download Burst Mode diagram

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			- Page 22: Added Figure 21. Frame Capture Burst Mode and Figure 22. Pixel Map - Page 23: Shutdown - Added step 8: Reload SROM to sensor - Page 26-44: Added Data Type to all registers - Page 26: Motion register - Renamed Pix_First (Bit0) to FRAME_Pix_First. - Page 28: SQUAL register - Updated USAGE section. - Page 29: Pixel_Sum register - Updated USAGE section. - Page 30: Shutter_Lower & Upper registers - Updated USAGE section. - Page 31: Configuration_I register - Updated USAGE section. - Page 32: Configuration_II register - Updated USAGE section. - Page 33: Frame_Capture, SROM_Enable & Run_Downshift registers - Updated USAGE section respectively. - Page 34: Rest1_Rate, Rest1_Downshift & Rest2_Rate registers - Updated USAGE section. - Page 35: Rest2_Downshift & Rest3_Rate registers - Updated USAGE section. - Page 36: Frame_Period_Max_Bound_Lower & Upper registers - Updated USAGE section. - Page 37: Frame_Period_Min_Bound_Lower & Upper registers - Updated USAGE section. - Page 39: LASER_CTRL0 register – Added VCSEL Current Range description. - Page 39: LASER_CTRL1 register – Deleted Field Name Description Table - Page 40: LP_CFG0 register - Updated Relative Laser Current description. - Page 41: Observation register - Added Field Name Description Table - Page 41: Data_Out_Lower & Data_Out_Upper registers – Added CRC result for SROM test - Page 42: Lift_Detection_Thr & Configuration_V registers - Updated USAGE section. - Page 43: Motion_Burst & SROM_Load_Burst registers - Updated USAGE section. - Page 44: Pixel_Burst register - Updated USAGE section.
1.1	8-Jul-08	Wei-Ye,Saw	- Page 5: Updated Figure 2. Package Outline drawing - Page 6: Updated Figure 3. Assembly drawing - Page 7: Updated Figure 4. Isometric drawing
2.0	3-Oct-08	Wei-Ye,Saw	- Page 5: Features- Changed VDDIO range from 1.65-3.60V to 1.65 – 3.3V - Page 5: Features- Changed resolution step from ~100cpi to ~90cpi - Page 6: Updated Device Pinout Table - Page 11: Updated schematics diagram for 5V mode corded mouse in Figure 7a with C17 and C23 caps value changed from 3.3uF to 10uF - Page 12: Updated new schematics diagram for 3V mode cordless mouse in Figure 7b. - Page 13: - o Deleted 2nd paragraph of "If mouse manufacturer section "Single Fault Detection"." in Eye Safety Section. - o Deleted LASER Power Adjustment Procedure Section - o Added LASER Drive Mode Section - o Added LOP measurement steps in LASER Output Power Section - Page 14: Absolute Maximum Ratings - o Changed VDD3 Max from 3.7V to 3.4V - o Changed VDDIO Max from 3.7V to 3.4V - o Added Figure 10: Soldering Profile - Page 15: Recommended Operating Conditions - o Changed VDD3's Max from 3.6V to 3.3V - o Changed VDDIO's Max from 3.6V to 3.3V - o Updated Z's Min = 2.18mm and Max = 2.62mm, results in +/-0.22mm DOF - o Added Figure 10: Distance of lens reference plane to surface., Z - Page 16: AC Electrical Specifications - o Updated t_{WAKEUP}'s to 50ms Min - Page 17: DC Electrical Specifications

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			○ Updated I_{DD_RUN3} = 32.0mA typical ○ Updated I_{DD_REST1} = 0.26mA typical ○ Updated I_{DD_REST2} = 0.12mA typical ○ Updated I_{DD_REST3} = 0.08mA typical ○ Updated I_{DD_RUN5} = 32.0mA typical ○ Updated I_{DDSTDWN} = 1uA typical ○ Changed I_{DDSTDWN}'s Notes from MISO, MOSI = Hi-Z to MOSI = VDDIO and MISO = GND - Page 18: Sensor's Typical Performance Characteristics ○ Updated Mean Resolution Vs Z graph in Figure 11 ○ Updated Average Error Vs Z graph in Figure 12 - Page 19: Added new Wavelength Responsivity graph in Figure 13 - Page 20: Motion Pin - Changed from "The motion pin is a level-sensitive output.....The motion pin is high whenever the motion bit is set;..... will put the motion pin low." to "The motion pin is an active low output.....The motion pin is lowered whenever the motion bit is set;..... will put the motion pin high." - Page 22: Motion Burst Read ○ Added "Lower NCS" as step 1 in Procedure to start motion burst ○ Changed "Note: In rest mode, motion burst.....data can be read any time after sending in address." to "Note: In rest mode, motion burstmotion burst data can be read from Motion_Burst register even in rest modes." - Page 23: SROM Download ○ Changed "This function is used only 1.5K bytes of SROM will be used." to "This function is used 3K bytes of SROM will be used." - Page 24: Updated Figure 24 of Pixel Map with 1st pixel output from lower left - Page 25: Shutdown – Updated *2 foot note with "Depends on last state. MISO should be configured to drive LOW during shutdown to meet the low current consumption as specified in the datasheet. This can be achieved by reading Inverse_Product_ID register (address 0x3f) since the return value (0xcc) on MISO line ends in a 0 (low state)". - Page 26: Registers ○ Changed Default Value of Configuration_I register from 0x11 to 0x12 ○ Changed Default Value of Rest2_Downshift register from 0x2f to 0xbc ○ Changed Default Value of LASER_CTRL0 register from 0x00 to 0x01 ○ Deleted LASER_CTRL1, LP_CFG0 and LC_CFG1 registers - Page29: Updated Figure 25 of SQUAL Values and Figure 26 of Mean SQUAL Vs Z graphs - Page 31: Updated Figure 27 of Shutter Values and Figure 28 of Mean Shutter Vs Z graphs - Page 32: Configuration_I ○ Changed Reset Value from 0x11 to 0x12 ○ Changed Resolution step changed from ~100cpi to ~90cpi ○ Changed resolution calculation formula to Resolution value (counts per inch, cpi) = RES [5:0] x 90 - Page 33: Configuration_II – Changed Bit-0 from Sys_Test to Reserved - Page 36: Rest2_Downshift ○ Changed Reset Value from 0x2f to 0xbc ○ Changed Rest2_Downshift calculation formula from R2D[7:0] x 128 x Rest2_Rate to R2D[7:0] x 32 x Rest2_Rate. - Page 40 : ○ LASER_CTRL0 – Changed Bit-7 from Range to Reserved and Reset Value to 0x01 ○ Removed LASER_CTRL1, LP_CFG0 and LP_CFG1 registers - Page 40: Observation

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			○ Changed “wait for appropriate delay” to “wait for one frame” ○ Updated OB₆ bit field description: from “0 = chip is running SROM code and 1 = chip is not running SROM code” to “0 = chip is not running SROM code and 1 = chip is running SROM code” ○ Changed OB[7,5:0] field name to OB[5:] - Page 41: Removed System Self test and SROM CRC test description from Data_Out_Lower and Upper registers
3.0	29-Dec-08	Wei-Ye,Saw	- Page 7: Features ○ Added “Advanced technology 832-865nm wavelength VCSEL” & “Single mode lasing” ○ Enhanced Programmability - Changed “Frame rate up to 10,000fps” to “Frame rate up to 12,000fps” - Page 8: Device Pinout – Rephrase description for pin 8, 9, 10 and 11. - Page 9: Changed package width and length dimensions’ tolerance in Figure 2. - Page 13: Removed 1.8V voltage regulator circuitry in Figure 6b. - Page 14: ○ Regulatory Requirements – Updated “Provides sufficient ESD creepage/clearance distance to withstand discharge up to 15KV when assembled into a mouse according to usage instructions above” ○ Laser Drive Mode – Added description on laser setting in 2nd paragraph. - Page 16: Absolute Maximum Rating ○ Changed ESD (Human body model MIL 883 Method 3015) to “ESD (Human body model)” ○ Changed VCSEL DC Forward Current’s Max from 12mA to 11mA with notes added ○ Removed VCSEL Peak Pulsing Current - Page 17: Recommended Operating Conditions – Updated Frame Rate’s Max = 12,000fps - Page 18: AC Electrical Specifications ○ Updated t_{MOT-RST} – Min = 30ms ○ Updated t_{WAKEUP} – Max = 500us ○ Changed t_{WAKEUP} – Min from 50ms to 30ms ○ Updated t_{REST_EN} – Max = 1s ○ Updated t_{REST_DIS} – Max = 1s ○ Changed t_{r_MISO} – Typical from 40ns to 50ns ○ Changed t_{f_MISO} – Typical from 40ns to 50ns ○ Changed t_{hold-MISO} – Min from 250ns to 200ns ○ Changed t_{r_MOTION} – Typical from 150ns to 50ns & Max from 300ns to 200ns ○ Changed t_{f_MOTION} – Typical from 150ns to 50ns & Max from 300ns to 200ns ○ Updated I_{DDT5} – Max = 85mA ○ Updated I_{DDT3} – Max = 50mA - Page 19: DC Electrical Specifications ○ Updated I_{DD_RUN3} – Typical from 32mA to 33mA & Max = 45mA ○ Updated I_{DD_REST1} – Max = 0.4mA ○ Updated I_{DD_REST2} – Max = 0.2mA ○ Updated I_{DD_REST3} – Max = 0.15mA ○ Updated I_{DD_RUN5} – Max = 50mA ○ Updated I_{DD_P3} – Max = 60mA ○ Updated I_{DD_P5} – Max = 65mA ○ Updated I_{DD_STDW} – Typical from 1μA to 45μA & Max = 85mA ○ Removed I_{LAS} & I_{LAS_FAULT} ○ Updated Notes for V_{OL} and V_{OH} - Page 24: Motion Burst – Added step 6

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			- Page 25: - o SROM Download – Changed Soonest time to read SROM_ID after SROM download from ≥100μs to ≥160μs in Figure 24 - o Frame Capture – Added step 2 - Page 27: - o Power up – Added step 6 & 7 - o Shutdown – Removed “Apply power to VDD5.VDD3 and VDDIO in any order” & “Reload SROM to the sensor” steps and added step 7 - Page 28: Registers Table - o Shutter_Lower register – Changed Reset Default from 0x15 to 0x20 - o Shutter_Upper register – Changed Reset Default from 0x20 to 0x4e - o Frame_Period_Lower register – Changed Default Value from 0x36 to 0xc0 - o Frame_Period_Upper register – Changed Default Value from 0x10 to 0x5d - o Frame_Period_Max_Bound_Lower register – Changed Default Value from 0x3c to 0xc0 - o Frame_Period_Max_Bound_Upper register – Changed Default Value from 0x5a to 0x5d - o Frame_Period_Min_Bound_Lower register – Changed Default Value from 0x6c to 0xa0 - o Frame_Period_Min_Bound_Upper register – Changed Default Value from 0x07 to 0x0f - o LASER_CTRL0 register – Changed Default Value from 0x00 to 0x10 - o Configuration_V register – Changed Default Value from 0x40 to 0x12 - o Power_Up_Reset register – Changed Default Value from Undefined to NA - Page 30: Motion register – Added OP_Mode_[1:0] for Bit[2:1] and field description - Page 34: - o Shutter_Lower register – Changed Reset Value from 0x15 to 0x20 - o Shutter_Upper register – Changed Reset Value from 0x20 to 0x4e - Page 35: - o Frame_Period_Lower register – Changed Reset Value from 0x36 to 0xc0 - o Frame_Period_Upper register – Changed Reset Value from 0x10 to 0x5d - Page 36: Configuration_II register - o Changed Rpt_Mod = 1 setting's description from “CPI setting while Configuration_IV register resolution” to “CPI setting while Configuration_V register..... resolution” - o Changed BIT[1:0] setting from “Reserved” to “Must be set to 00” - Page 37: Run_Downshift register – Changed “All the above...base on 100Hz Hibernate clock,have 40% tolerance.” to “All the above...base on system clock,have 20% tolerance.” - Page 40: - o Frame_Period_Max_Bound_Lower register – Changed Reset Value from 0x3c to 0xc0 - o Frame_Period_Max_Bound_Upper register – Changed Reset Value from 0x5a to 0x5d - o Frame_Period_Max_Bound_Lower & Upper registers' USAGE - Updated Frame Period example table - Page 41: - o Frame_Period_Min_Bound_Lower register – Changed Reset Value from 0x0a to 0xa0 - o Frame_Period_Max_Bound_Lower & Upper registers' USAGE - Changed the minimum allowed write value from TBD to 0fa0 and the maximum from 5a3c to 61a8. - Page 43: LASER_CTRL0 Register – Changed Force_Disable reset setting to “1 = LASER_NEN force disabled”. - Page 44: Data_Out_Lower & Upper register – Added “The SROM CRC test is initiated by writing 0x15 to SROM_Enable register”. - Page 45: Configuration_V register

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			○ Changed Reset Value from 0x40 to 0x12 ○ USAGE - Added description of “The approximate resolution value for each register setting can be calculated using the following formula. Each bit change is~90cpi. The minimum write value is 0x01 and maximum is 0x37” and resolution calculation formula. ○ Power_Up_Reset register – Changed from “Reset is required after recovering from shutdown mode “to “Reset is required after recovering from shutdown mode and restore normal operation after Frame Capture”. ○ Shutdown register – Added with “Refer to Shutdown section for more details”.

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Description

The ADNS-9500 LaserStream gaming sensor comprises of sensor and VCSEL in a single chip-on-board (COB) package. ADNS-9500 provides enhanced features like programmable frame rate, programmable resolution, configurable sleep and wake up time to suit various PC gamers' preferences.

The advanced class of VCSEL was engineered by Avago Technologies to provide a laser diode with a single longitudinal and a single transverse mode.

This LaserStream gaming sensor is in 16-pin integrated chip-on-board (COB) package. It is designed to be used with ADNS-6190-002 small form factor (SFF) gaming laser lens to achieve the optimum performance featured in this document. These parts provide a complete and compact navigation system without moving part and laser calibration process is NOT required in the complete mouse form, thus facilitating high volume assembly.

Theory of Operation

The sensor is based on LaserStream technology, which measures changes in position by optically acquiring sequential surface images (frames) and mathematically determining the direction and magnitude of movement. It contains an Image Acquisition System (IAS), a Digital Signal Processor (DSP), and a four wire serial port. The IAS acquires microscopic surface images via the lens and illumination system. These images are processed by the DSP to determine the direction and distance of motion. The DSP calculates the Δx and Δy relative displacement values. An external microcontroller reads the Δx and Δy information from the sensor serial port. The microcontroller then translates the data into PS2, USB, or RF signals before sending them to the host PC or game console.

Features

- Small form factor chip-on-board package
- Dual power supply selections, 3V or 5V
- VDDIO range: 1.65 – 3.3V
- 16-bits motion data registers
- High speed motion detection up to 150ips and acceleration up to 30g
- Advanced technology 832-865nm wavelength VCSEL
- Single mode lasing
- No laser power calibration needed
- Compliance to IEC/EN 60825-1 Eye Safety
 - Class 1 laser power output level
 - On-chip laser fault detect circuitry
- Self-adjusting frame rate for optimum performance
- Motion detect pin output
- Internal oscillator – no external clock input needed
- Enhanced Programmability
 - Frame rate up to 12,000fps
 - 1 to 5 mm lift detection
 - Resolution up to 5000cpi with ~90cpi step
 - X and Y axes independent resolution setting
 - Register enabled Rest Modes
 - Sleep and wake up times

Applications

- Corded and cordless gaming laser mice
- Optical trackballs
- Motion input devices

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Pinout of ADNS-9500 Optical Mouse Sensor

Pin No	Pin Name for 5V mode	Pin Name for 3V mode	Description
1	+VCSEL	+VCSEL	Positive Terminal Of VCSEL
2	LASER_NEN	LASER_NEN	LASER Enable (Active Low Output)
3	NCS	NCS	Chip Select (Active Low Input)
4	MISO	MISO	Serial Data Output (Master In/Slave Out)
5	SCLK	SCLK	Serial Clock Input
6	MOSI	MOSI	Serial Data Input (Master Out/Slave In)
7	MOTION	MOTION	Motion Detect (Active Low Output)
8	XYLASER	XYLASER	Laser Current Output Control
9	VDD5	VDD3	5V input for 5V mode 3V Input for 3V mode
10	PWR_OPT (GND)	PWR_OPT (VDD3)	Power Option: Connect to GND for 5V Mode Connect to VDD3 for 3V Mode
11	GND	GND	Analog Ground
12	REFB	VDD3	3V Regulator Output for 5V Mode 3V Input for 3V Mode
13	REFA	REFA	1.8V Regulator Output
14	DGND	DGND	Digital Ground
15	VDDIO	VDDIO	IO Voltage Input (1.65 - 3.3V)
16	-VCSEL	-VCSEL	Negative Terminal Of VCSEL

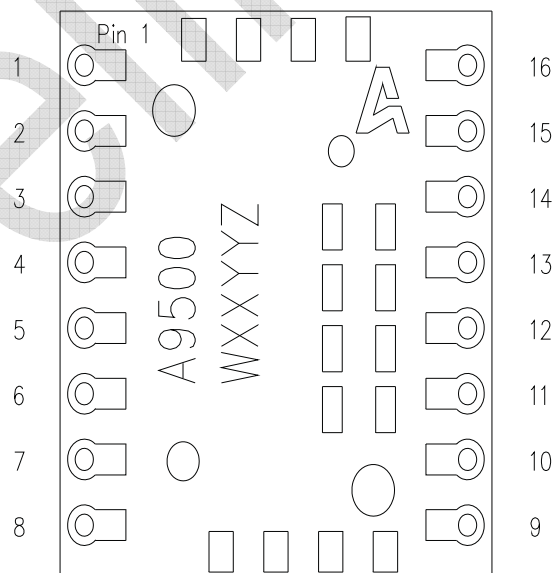


Figure 1. Package Pinout