EntréPad AES2501B FINGERPRINT SENSOR
USB Interface Applications

Hardware Specification

3063 Rev 1.2
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Hardware Specification for the AES2501B Fingerprint Sensor

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1. Introducing the EntréPad AES2501B Slide Sensor

1.1 Feature Summary

- ✓ Patented TruePrint Technology for best Ability To Acquire (ATA)
- ✓ High Definition 192 X 16 TruePrint Technology Based Pixel Array
  - o 500 pixels per inch (ppi) native
  - o 9.75mm X 0.81mm array area
- ✓ Compact 48 BGA eXtendaBall Package
  - o 13.8mm X 5mm X 1.3mm
- ✓ USB Operating Voltage Range
  - o 3.0V to 3.6V single supply
- ✓ 0°C to +70°C operating temperature range
- ✓ Easy to Integrate USB 2.0 Full Speed
- ✓ Operation with Crystal, Resonator, or with external clock input
- ✓ Ultra-hard scratch resistance surface coating
  - o > 10 Million rubs w/o degradation
- ✓ IEC 61000-4-2 Level 4 ESD Capability (+/- 15KV)
- ✓ Built-in low power Finger Detection w/system interrupt capability
- ✓ Multiple battery-friendly operating modes @ 3.3V
  - o Imaging @ 50mA typical.
  - o Scroll Navigation @ 25mA typical.

1.2 Operational Description

The Sensor begins operation in the 'idle' state after a reset. In the idle state, array power is turned off and clocking is disabled (except to support interface activity). In this state it is necessary for the system SW to program the sensor for the desired operation (Imaging or Navigation). If imaging is selected, the sensor enters finger detect mode and checks for a finger present.

During an imaging event, the RF TruePrint Signal is conducted via the drive ring to the users' finger. The TruePrint Signal is them conducted through and modulated by the "live layer" of the finger where the true fingerprint originates. The imaging array (center strip region of the chip) measures the TruePrint signal; the strength of which corresponds to either a ridge or valley region.

The image array of the AES2501B sensor is composed of 192x16 pixels. During the imaging process, 16 pixels in a column are powered up, sampled, and converted to 4-bit or 2-bit values.

A powerful utility contained within TruePrint Technology™ is Dynamic Optimization™. This tool analyzes each image, controlling up to 15 parameters real-time to optimize the fingerprint image slices, regardless of unusual skin conditions or surface contamination. This functionality is built right into the sensor hardware or you can perform these functions in software for total control and upgrade-ability.

After finger detection, the sensor will begin the programmed operation and will enter Imaging mode until the finger is removed. Once the finger is removed, the sensor returns to the low power finger detect mode. When no activity is detected on the system interface bus for approximately 200uS, power is reduced by disabling the internal clocks and the array power is once again turned off.

The array consists of 192 columns of 16 pixels each. During imaging, the columns are powered up and the signals from each of the 16 pixels/column are sampled, digitized and returned to the host computer over the selected interface sequentially in order on a per-column basis.

The sensor has the capability to utilize only the center 128 columns during imaging mode to facilitate faster finger slide speeds. During fingerprint enrollment, a 192-pixel wide template is created. After enrollment, either a 192-pixel wide or 128-pixel wide image can be used to verify the user. This mode is entirely controlled via software.

If the finger detect is not active at the end of an image, the array is powered down and the sensor reverts back to low power finger detect mode.

AuthenTec has application notes to support the integration of the AES2501B for all available interface options. Contact AuthenTec for availability.

1.3 Internal Chip Block Diagram

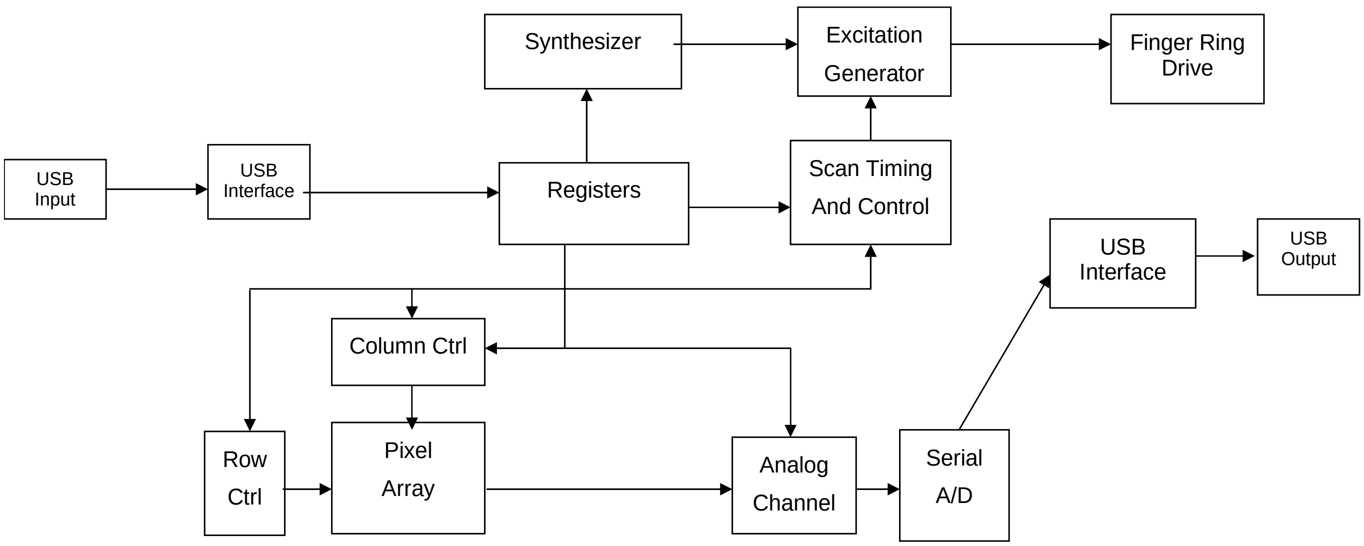


Figure 1-1 Internal Chip Block Diagram

1.4 Navigation

The navigation use model is a button replacement system. The typical Left / Right / Up / Down button functionality can be easily emulated on the sensor by statically touching the sensor to indicate desired left or right direction and by sliding the finger at normal finger speeds in the up or down direction to indicate up or down.

When operations are enabled and Navigation mode is selected, the sensor will provide constant, periodic indications of direction and finger presence by sending a 2-byte message to the selected interface.

After NAV mode is enabled, the sensor takes 10 samples of the center column approximately every 100 us. After producing an output message, the sensor then enters a low power state for a programmable amount of time, and then repeats the above sequence.

2. DC ELECTRICAL CHARACTERISTICS

2.1 Absolute Maximum Ratings

An absolute maximum rating is the maximum value guaranteed by the AuthenTec. The use of a product in violation of these ratings can result in significant loss of device reliability or cause damage to the sensor.

Symbol	Parameter	Min.	Max.	Units
V_{DD}	Supply Voltage	-0.5	4.3	V
V_I	Input Voltage	-0.5	V_{DD}+0.5	V
V_O	Output Voltage	-0.5	V_{DD}+0.5	V
I_{IK}	Input Clamp Current $V_I < V_{SS}$ of $V_I > V_{DD}$		±20	mA
I_{OK}	Output Clamp Current $V_O < V_{SS}$ of $V_O > V_{DD}$		±20	mA
T_{STG}	Storage Temperature	-65	150	°C
Latch-Up	Latch-Up Immunity JEDEC JESD78	±100		mA
T_{SOL}	Soldering Temperature		+240	°C
ESD_{PIN}	Pin-level ESD Immunity JESD22 Method A114-B	-2000	+2000	V
$ESD_{PACKAGE}$	Package-level ESD Immunity IEC61000-4-2 Level 4 Air Discharge method using AuthenTec approved reference design	-15	+15	KV

Table 2-1 Absolute Maximum Ratings

2.2 Recommended Operating Conditions

Symbol	Parameter	Min.	Typ	Max.	Units
V_{DD}	Supply Voltage	3.0	3.3	3.6	V
$V_{DDACp\text{-}p}$	Power Supply Ripple	-50	0	+50	mV
V_I	Input Voltage	0		V_{DD}	V
V_O	Output Voltage	0		V_{DD}	V
V_{IH}	High Level Input Voltage	70% V_{DD}		V_{DD}	V
V_{IL}	Low Level Input Voltage	0		30% V_{DD}	V
t_t	Clock Input Transition (Rise and Fall) Time	3nS		10%	
T_A	Ambient operating temperature	0		70*	°C

Table 2-2 Recommended Operating Conditions

***Advisory**

The AES2501B remains fully operational at temperatures that are high enough to be uncomfortable for the user.

For reasons of safety and protection, AuthenTec reference designs include circuitry that serves to manage the junction temperature by controlling the supply current. If the hardware developer elects not to use the AuthenTec-provided control circuit design, it will then be essential that an equivalent design be developed and implemented.

2.3 DC Characteristics @ Recommended Operating Conditions

Typical: V_{DD} = 3.3V, V_I = V_{DD} or $V_{SS,}$ $T_{Ambient}$ = 25°C, Maximum: V_{DD} = 3.6V, $T_{Ambient}$ = 70°C

Symbol	Parameter	Conditions	Min.	Typ	Max.	Units
V_{OH}	High Level Output Voltage	I_{OH}=2mA	V_{dd}-0.3			V
V_{OL}	Low Level Output Voltage	I_{OL}=2mA			0.3	V
I_{IL}	Low Level Input Current	V_I=V_{IL}(min.)			±1	µA
I_{IH}	High Level Input Current	V_I=V_{IH}(max.)			±1	µA
I_{OZ}	High Impedance State Output Current				±20	µA
USB Interface Supply Currents						
I_{DDQ}	Supply Current Imaging mode; USB			50	70	mA
I_{DDQ}	Supply Current Scroll Wheel Navigation			25	45	mA
I_{DDQ}	Supply Current SW-based Finger Detect			15	25	mA
I_{DDQ}	Supply Current Suspend mode; USB				395	uA

Table 2-3 DC Characteristics

All I_{DDQ} Currents measured RMS using standard AuthenTec software and drivers. Use of other software or customized register settings may effect actual power consumption.

3. Packaging & Pin Definitions

3.1 Packaging Information

The AES2501B sensor is housed in a plastic molded 48 Ball Grid Array eXtendaBall package using lead-free solder balls. The eXtendBall package (designator code “MF”) is shown in figure 3-1.

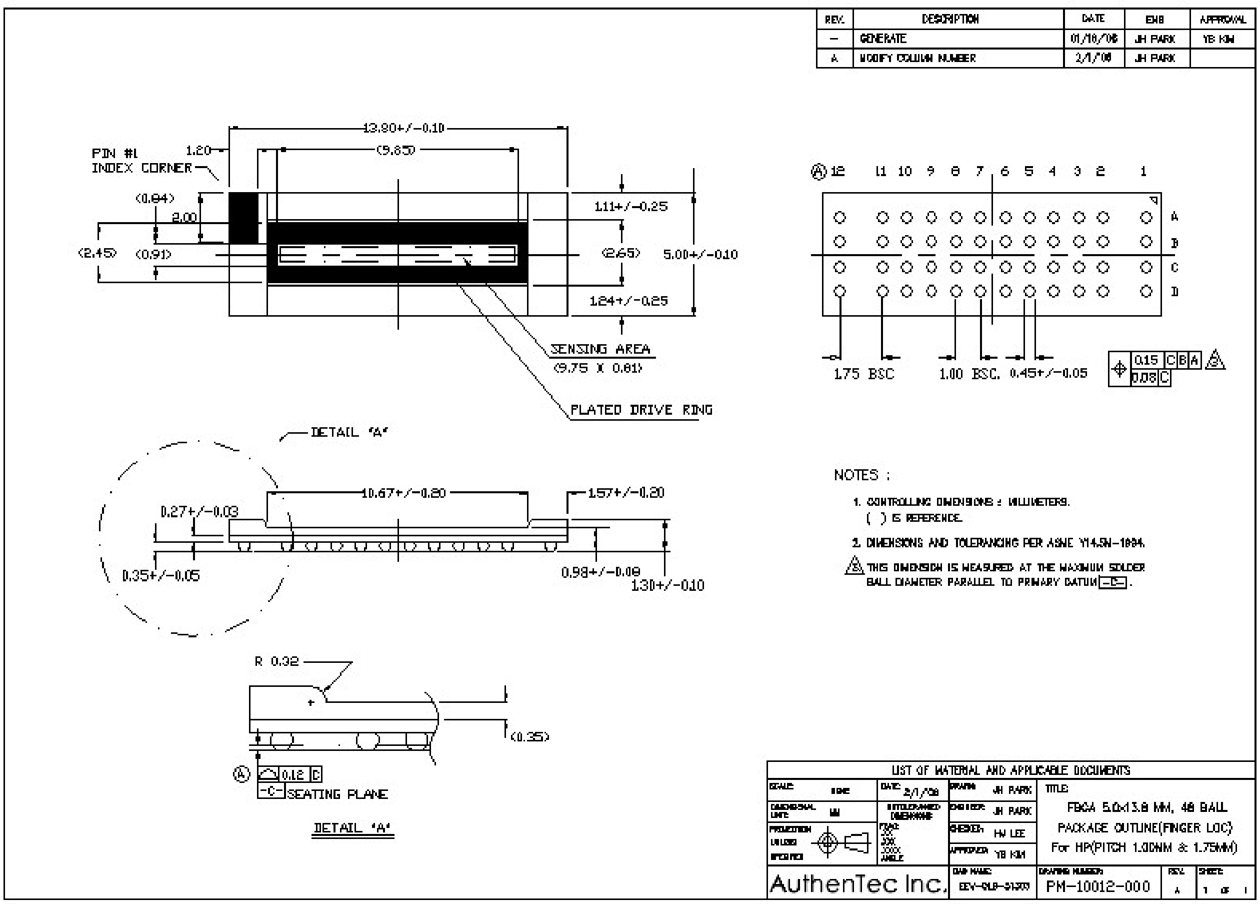


Figure 3-1 48 BGA eXtendaBall Package

3.2 Recommended PCB Footprint

The PCB BGA pad sizes for the AES2501B which uses 0.45mm BGA balls, as shown on the package drawing, shall be 0.40 mm round pads with a 0.40 mm square solder mask and solder paste opening. The use of a >0.40 mm circular solder mask is authorized, but the square shape is preferred.

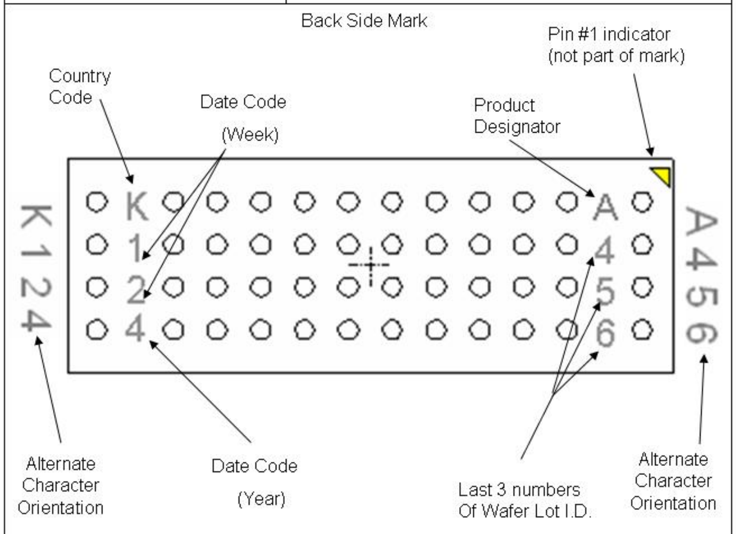
The package drawing shows both the mechanical dimensions of the package as well as recommended housing "keep-out" areas and angles of approach to and from the slide surface.

The bottom side Pin 1 indicator is a gold triangle located in the corner of the package adjacent to pin one. Post-assembly top-side inspection can be performed visually using the topside Pin 1 laser mark etched into the top left corner of the package when viewed from the front. The hatched rectangle indicates the general area of the laser mark (small dot). In addition, the drive bars are of different thickness. When the thicker drive bar is located at the top of the device from the inspection viewpoint, pin one is located top left from the same perspective. For additional information, contact AuthenTec Applications Engineering for more details.

Other Information:

	Gold Ring	Nickel Ring
Package Mass:	0.1183g ±0.000388g	0.1159g±0.000877

Labeling Diagram Document	Specification # PD-10006-000 Date: 03/01/2006 Package Type: Exposed Die 48 BGA Revision



Date Code Legend:
K = Country Code (U=USA,K=Korea, T=Taiwan, S=Singapore, C= China)
124 = Mold Week & Year (week 12, year 2004)
A = Product Designator :
F: AES2501B Pb-Free

AA1456.5 = Wafer Lot I.D.

Font Size: ~1 mm height
Ink Color: Laser Marking

3.3 Pin List

Pin assignments and pin function descriptions of the AES2501B sensor are given below. Shared pin definitions for SIO[8:0] are selected by the state of the IOSEL[1:0] pins. Refer to section 4.1 for the interface-specific SIO definitions. The following pin lists match AuthenTec certified reference designs. Certain pin functions will be required to change for other implementations.

Pin	Type	Digital Activity	Signal Name (USB)
A1	Passive	Static	VREF
A2	Passive	Static	CT2
A3	Passive	Static	CT1
A4	Output	Active	FINGERDRIVE
A5	Input	Static	RESET*
A6	Reserved		N/C
A7	Reserved		N/C
A8	Power		VDD
A9	Power		GND
A10	Passive	Static	PLL_FILTER
A11	Input	Active	SYS_CLK
A12	Output	Active	DRIVE_RING
B1	Input	Static	CLKSEL2
B2	Power		GND
B3	Power		VDD
B4	Input	Static	VDDL
B5	Input	Static	VDDL
B6	Input	Static	CLKSEL1
B7	I/O	Active	SUSPEND
B8	I/O	Active	USB_OE*
B9	I/O	Active	D+
B10	I/O	Active	D-
B11	I/O	Active	PID3
B12	I/O	Active	PID2
C1	Reserved		N/C
C2	Power		VSS
C3	Power		VDDA
C4	Input	Static	VSSL
C5	Input	Static	CLKSEL0
C6	Input	Static	VSSL
C7	I/O	Active	PID0
C8	I/O	Active	PID1
C9	I/O	Active	ENUM
C10	Output	Active	VDDA_ON*
C11	Power		VSS
C12	Power		VDDA

Pin	Type	Digital Activity	Signal Name (USB)
D1	Output	Active	DRIVE_RING
D2	Reserved		N/C
D3	Reserved		N/C
D4	Reserved		N/C
D5	Reserved		N/C
D6	Reserved		N/C
D7	Reserved		N/C
D8	Power		OVC_VDD
D9	Output	Static	OVC_DET
D10	Power		OVC_VDDA
D11	Input	Static	OVC_SENSE
D12	Power		VSS

Table 3-1 Pin List by Interface

3.3.1 Pin Type and Activity Definitions

Power:	Power Supply Connections
Passive:	Connections to passive components (ex: Filter caps, etc)
Input:	Active Inputs to the sensor
Output:	Active Outputs from the sensor
I/O:	Active I/O's from the sensor (state / configuration dependent)
Reserved:	Do Not Connect anything to these pins
Static:	DC or slowly changing voltages
Active:	Active Signals, Digital or Analog
VDDL:	Fixed Active High Logic Level
VSSL:	Fixed Active Low Logic Level
VDDA:	Pixel Array Power supply pin

3.4 Pin Descriptions

Pin	Signal Name	Function Description
		For pins D8-D12, Refer to the appropriate AuthenTec Reference Design for connection details
C5	**CLKSEL0**	Clock input option selection. Refer to section 3.5
B6	**CLKSEL1**	Clock input option selection. Refer to section 3.5
B1	**CLKSEL2**	Clock input option selection. Refer to section 3.5
A3	**CT1**	Filter Capacitor - connect to pin A2 through a 0.1uF capacitor, standard bypass type
A2	**CT2**	Filter Capacitor - connect to pin A3 through a 0.1uF capacitor, standard bypass type
D1	**DRIVERING**	DriveRing - connection to the metal ring on the sensor surface. No other connections made.
A12	**DRIVERING**	DriveRing - connection to the metal ring on the sensor surface. No other connections made.
A4	**FINGERDRIVE**	TruePrint Signal output used to drive radio frequency signal through external circuitry to finger ring pins (A12 and D1). Controlled by internal excitation generator.
D9	**OVC_DET**	Over Current Detect Power Off output - Active low for power on. Refer to reference design schematics for connection details.
D11	**OVC_SENSE**	Load side of current sense resistor input for over current control. Refer to Ref. Design
D8	**OVC_VDD**	Over Current Detect Circuit Digital Power Supply Pin (V) Refer to Ref. Design
D10	**OVC_VDDA**	Over Current Detect Circuit Analog Power Supply Pin (V) Refer to Ref. Design
A5	**RESET***	Reset input - 2/3 threshold voltage with hysteretic input. Approximately 57 Kohm pull-up resistor internal, with tolerance of 30%. See section 4.3 for additional definition of a proper reset.
B8	**SIO0**	Refer to Figure 5.1
B7	**SIO1**	Refer to Figure 5.1
C7	**SIO2**	Refer to Figure 5.1
C8	**SIO3**	Refer to Figure 5.1
B12	**SIO4**	Refer to Figure 5.1
B11	**SIO5**	Refer to Figure 5.1
B10	**SIO6**	Refer to Figure 5.1
B9	**SIO7**	Refer to Figure 5.1
C9	**SIO8**	Refer to Figure 5.1
A11	**SYS_CLK**	Clock input pin - input clock used for all chip functions. See **Error! Reference source not found.** and Section 3.5 for input characteristics and requirements.
C12	**VDDA**	Pixel Array Power Connection
C3	**VDDA**	Pixel Array Power Connection
C10	**VDDA_ON***	External Array Power FET control - If used this pin may drive a high side P-channel FET. See AuthenTec Reference Designs for connection details.
A1, A2, A3		These are N/C pins.
D12	**VSSOD**	Over Current Detect Circuit Return Supply pin (GND)
A10	**PLL_FILTER**	Refer to USB Reference Design Schematic for appropriate filter components / connection

Table 3-2 AES2501B Active Pin Functional Description

3.5 Clock Select Control

AES2501B can support a variety of clock sources, ranging in frequency from 6MHz up through 48MHz. The AES2501B uses a single pin crystal/resonator oscillator circuit that can also be overdriven with an external clock source. Clock frequency selection [including clocks driven into the SYS_CLK pin] is done via the CLKSEL[2:0] input pins. The following table shows the CLKSEL[2:0] pin configurations:

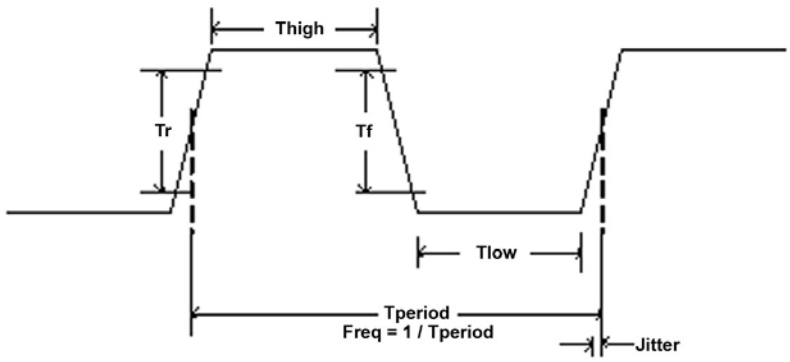
CLKSEL2 Pin B1	CLKSEL1 Pin B6	CLKSEL0 Pin C5	Crystal/Resonator or Clock Frequency
0	0	0	6 MHz
0	0	1	Reserved
0	1	0	12 MHz
0	1	1	18 MHz
1	0	0	24 MHz
1	0	1	Reserved
1	1	0	Reserved
1	1	1	48 MHz (PLL Bypass, clock only)

Table 3-3 CLKSEL[2:0] Decode

For USB applications, Crystal/Resonator frequency options include 6, 12, 18, and 24MHz.

3.5.1 Clock Specification

For the AES2501B, there are several different clocking options available: Crystal connection, ceramic resonator connection, and external clock driven. Appropriate application of clock sources is driven the desired circuit application (interface type) and reference design. This section addresses the specification requirements for an externally driven clock. All electrical and environmental conditions from the device specification apply as well. When driving an external clock into the SYSCLK device pin, the following timing diagram applies:



[1]	Parameter	[1]	Minimum	[1]	Maximum
[2]	Freq. (USB Interface)	[2]	12MHz – 0.25%	[2]	12MHz + 0.25%
[3]	Jitter (USB Interface)	[3]		[3]	0.2ns
[4]	Tr	[4]	3nS	[4]	10%[Tperiod]
[5]	Tf	[5]	3nS	[5]	10%[Tperiod]
[6]	Thigh	[6]	45%[Tperiod]	[6]	55%[Tperiod]
[7]	Tlow	[7]	45%[Tperiod]	[7]	55%[Tperiod]

Table 3-4 External Clock Specifications

3.6 Timing Information

3.6.1 Image Scan Timing

The fastest scan time available is 32us per sixteen pixels and will limit image frame rates to less than [16x192 pixels * 32us/16 pixels = 6.144 ms] or ~162.7 fps maximum. Transferring register data, histogram data, and authentication data will reduce this frame rate.

3.6.2 USB Interface

The AES2501B fingerprint sensor is as a USB low power device. This requires that the total current consumption be less than 100 mA and suspend current be less than 500uA. For all timing diagrams, please refer to the Universal Serial Bus Specification, Version 2.0. The AES2501B fully supports the USB selective suspend mode (C3 power state).

3.6.3 Finger Detect Auto-calibration

When using Finger Detect [delay method], the device is automatically calibrated once on power up. Sending a master reset to the device does not affect the setting of the reference delay value used for the finger detect calculation.

4. System Interface Descriptions

4.1 Interface Select Control

For the USB interface, the following pin assignments apply:

SIO / Pin	USB (See section)	DIR
SIO0 / B8	USB_OE*	O
SIO1 / B7	SUSPEND	O
SIO2 / C7	PID0	I/O
SIO3 / C8	PID1	I/O
SIO4 / B12	PID2	I/O
SIO5 / B11	PID3	I/O
SIO6 / B10	D-	I/O
SIO7 / B9	D+	I/O
SIO8 / C9	ENUM	O

Table 4-1 SIO Pin Definitions for the USB Interface

AuthenTec Vendor ID = 08FFh, Product ID= 258xh

4.2 USB Interface

The USB interface is compliant with version 2.0 of the USB specification for full speed interfaces. The AES2501B sensor is designed as a USB low power device.

The on-chip USB implementation utilizes 3 endpoints in one interface (endpoint 0, 1, and 2).

Endpoint 0 supports control read and write transactions, including String Descriptor support for the device identification function in Windows.

Endpoint 1 is a BULKIN endpoint for data going from the Sensor to the Host.

Endpoint 2 is a BULKOUT endpoint for Sensor commands from the Host.

The following Descriptor Tables are included to show the enumeration information for all USB configurations.

Field	Index	Value	Meaning
bLength	0	12h	Length of this descriptor = 18 bytes
bDescriptorType	1	01h	Descriptor Type = Device
bcdUSB(L)	2	10	USB spec. version 1.10 (L)
bcdUSB(H)	3	01	USB spec. version 1.10 (H)
bDeviceClass	4	FFh	Device class (FF is vendor specific)
bDeviceSubClass	5	FFh	Device sub-class (FF is vendor specific)
bDeviceProtocol	6	FFh	Device Protocol (FF is vendor specific)
bMaxPacketSize0	7	08h	Max Packet size for EP0 = 8 bytes
idVendor(L)	8	FFh	Vendor ID (L)
idVendor(H)	9	08h	Vendor ID (H)
idProduct(L)	10	8Xh	Product ID low byte programmed via PID[3:0]
idProduct(H)	11	25h	Product ID high byte
bcdDevice(L)	12	Device ID	Device ID (L)
bcdDevice(H)	13	Device ID	Device ID (H)
iManufacturer	14	00h	None
iProduct	15	01h	Product String – "Fingerprint Sensor"
iSerialNumber	16	00h	None
bNumConfigurations	17	01h	One configuration in this interface

Table 4-2 Device Descriptor

Field	Index	Value	Meaning
bLength	0	09h	Length of this descriptor = 9 bytes
bDescriptorType	1	02h	Type = Configuration
wTotalLength(L)	2	20h	Total Length(L) including Interface and Endpoint descriptors
wTotalLength(H)	3	00h	
bNumInterfaces	4	01h	Number of interfaces in this configuration
bConfigurationValue	5	01h	Configuration value used by Set_Configuration to select this interface
iConfiguration	6	00h	00h = no string reference
bmAttributes	7	A0h	A0h, Attributes: bus-powered, remote wake-up supported
MaxPower	8	32h	Max current =100mA

Table 4-3 Default Configuration Descriptor

Field	Index	Value	Meaning
bLength	0	09h	Length of the Interface descriptor = 9 bytes
bDescriptorType	1	04h	Descriptor type = interface
bInterfaceNumber	2	00h	Zero based index of this interface = 0
bAlternateSetting	3	00h	Alternate setting =0
bNumEndpoints	4	02h	Number of endpoints in this interface (not counting endpoint0)
bInterfaceClass	5	FFh	Interface Class = vendor specific
bInterfaceSubClass	6	FFh	Interface Sub Class = vendor specific
bInterfaceProtocol	7	FFh	Interface Protocol = vendor specific
Interface	8	00h	Index to string descriptor = none

Table 4-4 Default Interface 0, Alternate Setting 0 Descriptor

Field	Index	Value	Meaning
bLength	0	07h	Descriptor length = 7 bytes long
bDescriptorType	1	05h	ENDPOINT descriptor
bEndpointAddress	2	81h	In endpoint, endpoint #1
bmAttributes	3	02	xfr type = Bulk
wMaxPacketSize(L)	4	20h	Max Packet Size = 32 bytes
wMaxPacketSize(H)	5	00h	
bInterval	6	00h	Polling interval in milliseconds
Field		Value	Meaning
bLength	0	07h	Descriptor length = 7 bytes long
bDescriptorType	1	05h	ENDPOINT descriptor
bEndpointAddress	2	02h	Out endpoint, endpoint #2
bmAttributes	3	02h	xfr type = Bulk
wMaxPacketSize(L)	4	08h	Max Packet Size = 8 bytes
wMaxPacketSize(H)	5	00h	
bInterval	6	00h	Polling interval in milliseconds

Table 4-5 Default Interface 0, Alternate Setting 0, Bulk Endpoint Descriptors

Field	Index	Value	Meaning
bLength	0	04h	String Index 0
bDescriptorType	1	03h	String descriptor type
wLANGID(0)(L)	2	09h	Language ID for English (L)
wLANGID(1)(H)	3	04h	Language ID for English (H)

Table 4-6 String 0 Descriptor

Field	Index	Value	Meaning
bLength	0	26h	String Index 1
bDescriptorType	1	03h	String descriptor type
bString	2	4600h	“Fingerprint Sensor” – in UNICODE format “F”
	4	6900h	“i”, 00
	6	6E00h	“n”, 00
	8	6700h	“g”, 00
	10	6500h	“e”, 00
	12	7200h	“r”, 00
	14	7000h	“p”, 00
	16	7200h	“r”, 00
	18	6900h	“i”, 00
	20	6E00h	“n”, 00
	22	7400h	“t”, 00
	24	2000h	“ “, 00
	26	5300h	“S”, 00
	28	6500h	“e”, 00
	30	6E00h	“n”, 00
	32	7300h	“s”, 00
	34	6F00h	“o”, 00
	36	7200h	“r”, 00

Table 4-7 String 1 Descriptor

A remote wakeup feature supports finger detect while the host has the sensor in the Suspend state. For finger detect wakeup, an internal low power, low frequency oscillator is used to cycle the 12 MHz oscillator on and off, with finger detect attempted whenever the 12 MHz oscillator is enabled. Sending a “master reset” command to the sensor will cause a data buffer flush action to occur so any unsent data is made available to the host.

4.3 Reset

The reset input has an internal pull-up of 57K ohm with a tolerance of 30%.
A nominal value of 47nF may be used to provide a proper reset to the device.
A valid reset is achieved if the reset is still active (less than 2/3 of the VDD rail voltage) for 3 mS after the Vdd voltage has reached the specification limits.

5. Data Formats

5.1 Overview

The sensor communicates with the host via data packets. A one-byte header that identifies the message precedes each data packet type. Note that since the pixel data formats use all 8-bits per byte, the header bytes are not unique in the data stream. Software can use the header bytes to verify that it is synchronized with the data stream. They cannot be used as a mechanism to synchronize with the data. If software gets out of synch with the data, it should disable image scanning and issue a scan reset. This will cause the data stream to stop. The following table shows the header byte definitions for each message type.

5.1.1 Registers Message Format

When a request to read registers is received, all of the register values are returned preceded by the header for that register. Registers are written to by writing the register ID followed by the data byte.

5.1.2 Image Data Format – Grey Scale 500 ppi

The header for the row is sent first, followed by each column vector sent as eight bytes. After all of the data for the selected number of rows is sent, the authentication word is sent preceded by the header byte for the authentication message. The authentication data is sent lower byte first. The register values are then returned, with each register preceded by the command byte for the register. The register values are the ones that were in effect during the image.

5.1.3 Image Data Format – 250 ppi

The header for the row is sent first, followed by each 2-column vector sent as eight bytes. The difference between this mode and 500 PPI mode is that four adjacent pixels are summed together and returned as a single 4-bit value. After all data for the selected number of columns is sent, the authentication word is sent preceded by the header byte for the authentication message. The authentication data is sent lower byte first. The register values are then returned, with each register preceded by the command byte for the register. The register values are the ones that were in effect during the image.

5.1.4 Image Data Format – Monochrome

The packed monochrome data format sends only a 1-bit value per pixel but packs the data so all eight bits are used. The header for the row is sent first, followed by each column sent as two bytes. The 64-bit value from four columns updates the authentication word in the same manner as for normal data. After all data for the selected number of rows is sent, the authentication word and register data are sent as in normal mode.

5.1.5 Histogram Message Format

When the histogram message is enabled, it is sent once per image. When sent once per image, it will be sent after the image data and before the authentication word. The header is followed by the counts for each of the bins representing possible pixel values. Bin 0 (the number of pixels whose value is 0) is sent first as two bytes. The first byte has the lower seven bits and the second byte has the upper seven bits. This is followed by the counts for the remaining bins.

5.1.6 Authentication Word Message Format

The authentication word is sent after an image is complete. The authentication word is used to validate that the transaction is authentic (i.e. that the image data isn't being provided from some storage device containing a valid fingerprint image).

6. Ordering Information

AES2501B – I – PP – CC – DDEF

<u>I = Temperature Range</u>
C = Commercial temperature range = 0C to + 70C

<u>PP = Packaging Options</u>
MF = 48 BGA eXtendaBall package with Pb-free Balls
SB = 10 unit sample packs (gold and nickel)

<u>CC = Carrier Options</u>
CA = Plastic Carrier Trays 245 sensors per tray
TR = Tape & Reel w/ 3500 sensors per reel

<u>DD = Drive Ring Options:</u>
GO = Gold
NI = Nickel

<u>EF = Options</u>
E:
0 = No Topside Pin 1 mark (for older product)
1 = Topside Pin 1 mark (standard option)

F:
C = Silicon revision code in 2501B series*

* Contact AuthenTec Sales for current revision code.

Example: AES2501B with Gold ring, Lead-free solder balls, shipped as tape reels with topside pin 1 mark:
AES2501B-C-MF-TR-GO1C

7. Hazardous Material Compliance

The AuthenTec AES2501B is manufactured to be in compliance with various world wide standards specifying the elimination of hazardous substances.

The silicon IC and the physical packaging are Lead (Pb) free and do not contain any of the hazardous substances currently being eliminated within the semiconductor industry.

The AES2501B is EU RoHS compliant. The full list of industry hazardous materials compliance will be included in future updates of this product specification.

8. Revision History

Version	Date	Person	Reason
1.0	05/22/06	Hicks	Initial version
1.1	06/06/06	Hicks	Updated the 48 BGA eXtendaBall package drawing
1.2	07/12/06	Hicks	Added recommended PCB footprint