



AU9540

USB Smart Card Reader Controller

Technical Reference Manual

Rev. 1.6
June, 2010



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Revision History

Date	Revision	Description
March, 2010	1.0	Official Release
March, 2010	1.1	Adding description of selective suspend
April, 2010	1.2	Adding power current under suspend mode
April, 2010	1.3	1. Modification on Table 5.2 2. Adding Appendix for BatteryMark test
April, 2010	1.4	1. Modifying description in 1.4 Features
May, 2010	1.5	
June, 2010	1.6	1. Modifying description of Pin19

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1. Introduction

1.1 Description

AU9540 is a highly integrated single chip USB Smart Card reader controller. Highly integration enables the lowest BOM cost of smart card reader. The AU9540 supports multiple international standards including ISO7816 for IC card standard, PC/SC 2.0 for windows smart card standard, Microsoft WHQL, EMV for Europay MasterCard Visa standard and USB-IF CCID standard. The application of AU9540 can be generally applied to Smart Card read/write terminal device, such as ATM, POS terminal, Public telephone, E-Commerce, personal consumption on Internet, personal certification, prepay system, loyalty system...etc.

1.4 Features

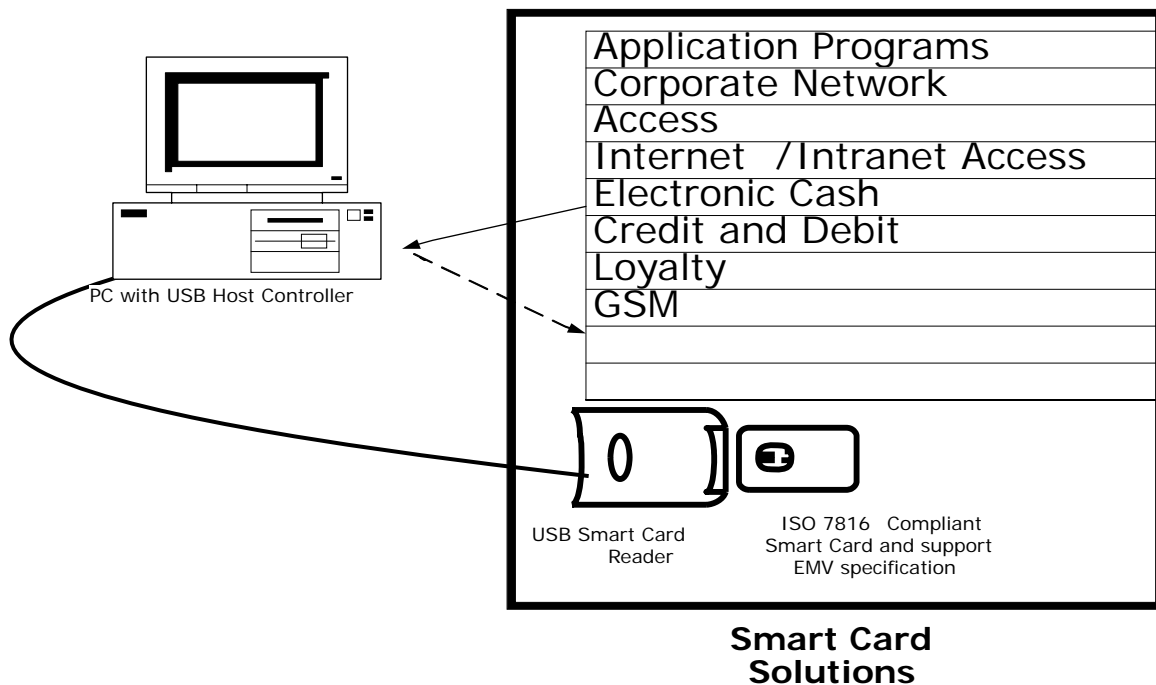
- Package
 - 28 SSOP
- Standard Compliance
 - Support EMV Level 1 specification
 - Support USB 2.0 full speed
 - Based on ISO7816 implementation
 - Support PC Smart Card industry standard – PC/SC 2.0
 - Support Microsoft Smart Card for Windows
 - Meet Microsoft WHQL USB Smart Card Reader requirements
 - Meet US Federal Information Processing Standards (FIPS) Publication 201 requirements on smart card reader interoperability
- Features
 - Support single slot
 - Support T0, T1 protocol
 - Support I2C memory card, SLE4418, SLE4428, SLE4432, SLE4442, SLE4436, SLE5536, SLE6636, AT88SC1608, AT45D041 card and AT45DB041 card via external EEPROM
 - Support ISO7816 Class A, B and C (5V/3V/1.8V) card
 - Implemented as an USB full speed device with bulk transfer endpoint, Mass Storage endpoint
 - Built-in PLL for USB and Smart Card clocks requirement
 - Support EEPROM for USB descriptors customization (PID/VID/ iManufacturer/ iProduct/Serial Number), Direct Web Page Link, and accessing memory card module.
 - EEPROM programmable via USB interface
 - Support software update for memory card module
 - Support Direct Web Page Link via configuration in external EEPROM
 - Support short APDU and extended APDU
 - Compatible with Microsoft USB-CCID driver
 - Support remote wake up through inserting card/removing card
 - Support USB selective suspend
 - Support Power Saving Mode (Using one pin to select between Normal/PWR Saving Mode)



2. Application Block Diagram

AU9540 is a highly integrated single chip, which is used as USB Smart Card reader or in an embedded USB device through the downstream port of an USB hub. Following is the application diagram of a typical card reader product with AU9540 by connecting the card reader to an ATM or E-Commerce. AU9540 can also be used in STB, embedded system, POS...etc.

Figure 2.1 Block Diagram



3. Pin Assignment

The AU9540 is packed in 28-SSOP-form factor. The following figure shows signal name for each pin and the table in the following page describes each pin in detail.

Figure 3.1 AU9540 Pin Assignment Diagram

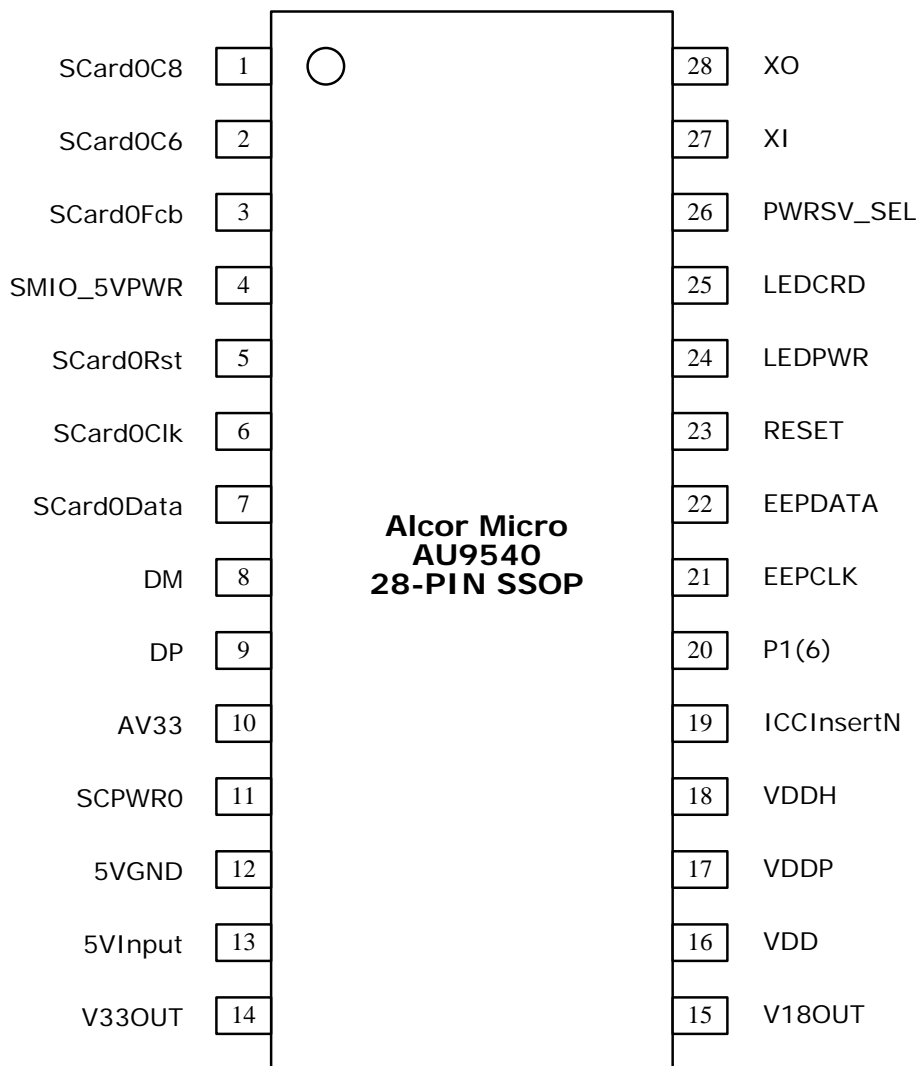




Table 3.1 AU9540 Pin Descriptions

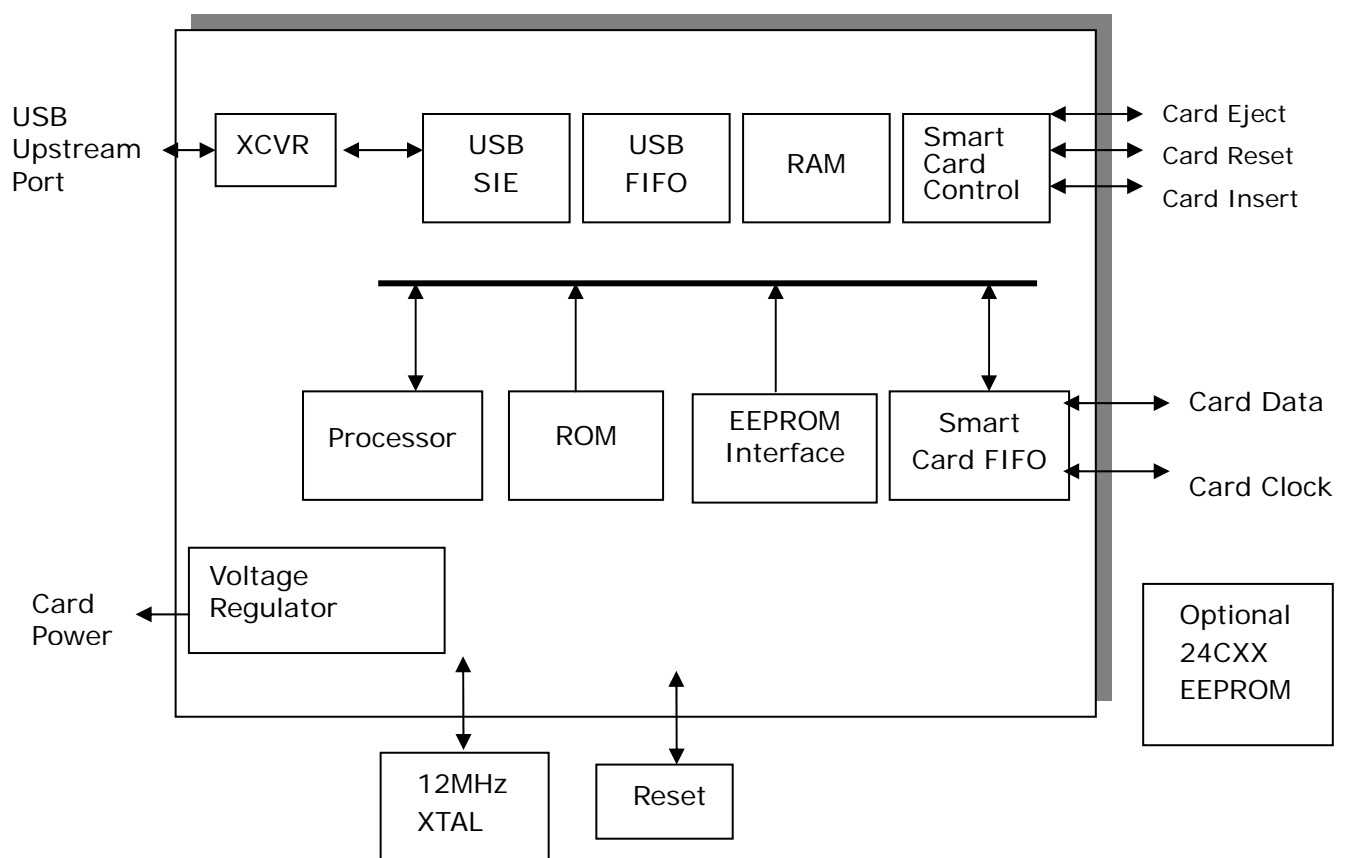
Pin #	Pin Name	I/O	Description
1	SCard0C8	IO	Smart card GPIO_2
2	SCard0C6	IO	Smart card GPIO_1
3	SCard0Fcb	IO	Smart card GPIO_0
4	SMIO_5VPWR	PWR	Smart Card IO pad power
5	SCard0Rst	O	Smart card reset
6	SCard0Clk	O	Smart card clock
7	SCard0Data	IO	Smart card serial data
8	DM	IO	USB D-
9	DP	IO	USB D+
10	AV33	PWR	USB PHY power
11	SCPWR0	PWR	Smart card Power
12	5VGND	PWR	AGND5V
13	5VInput	PWR	5VInput
14	V33OUT	PWR	3.3V OUT
15	V18OUT	PWR	1.8V OUT
16	VDD	PWR	Core Power
17	VDDP	PWR	PLL Power
18	VDDH	PWR	Pad Power
19	ICCIInsertN	I	Smart card insert detection (Low active) (internal pull high)
20	P1(6)	I	EEPROM Write Protect
21	EEPCLK	O	EEPROM Clock (need pull high)
22	EEPDATA	IO	EEPROM Data (need pull high)
23	RESET	I	Chip Reset
24	LEDPWR	O	Chip Power LED
25	LEDCRD	O	Card Slot LED
26	PWRSV_SEL	I	PWRSV_SEL (Default high) (High: Normal mode, Low: Power Saving Mode)
27	XI	I	Crystal Oscillator Input (12MHz)
28	XO	O	Crystal Oscillator Output (12MHz)



4. System Architecture and Reference Design

4.1 AU9540 Block Diagram

Figure 4.1 AU9540 Block Diagram





5. Electrical Characteristics

5.1 Recommended Operating Conditions

Table 5.1 Recommended Operating Conditions

SYMBOL	PARAMETER	MIN	TYP	MAX	UNITS
V _{5IN}	5V Power Supply	4.75	5.0	5.25	V
V ₃₃	3.3V Power Supply	3.0	3.3	3.6	V
V _{IN}	Input Signal Voltage	V _{DDH} -0.3		V _{DDH} +0.3	V
V _{DDH}	Power Supply	3.0	3.3	3.6	V
V _{DD}	Digital Supply	1.62	1.8	1.98	V
T _{OPR}	Operating Temperature	0		85	°C

5.2 General DC Characteristics

Table 5.2 General DC Characteristics

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
I _{IN}	Input current	No pull-up or pull-down	-10	±1	10	μA
I _{OZ}	Tri-state leakage current		-10	±1	10	μA
C _{IN}	Input capacitance	Pad Limit		2.8		ρF
C _{OUT}	Output capacitance	Pad Limit		2.8		ρF
C _{BID}	Bi-directional buffer capacitance	Pad Limit		2.8		ρF
I _{CC}	Operating supply current	Without Memory Card			0.2	mA



5.3 DC Electrical Characteristics of 3.3V I/O Cells

Table 5.3 DC Electrical Characteristics of 3.3V I/O Cells

SYMBOL	PARAMETER	CONDITIONS	Limits			UNIT
			MIN	TYP	MAX	
V_{D33P}	Power supply	3.3V I/O	3.0	3.3	3.6	V
V_{il}	Input low voltage	LVTTL			0.8	V
V_{ih}	Input high voltage		2.0			V
V_{ol}	Output low voltage	$ I_{ol} = 2\sim 16\text{mA}$			0.4	V
V_{oh}	Output high voltage	$ I_{oh} = 2\sim 16\text{mA}$	2.4			V
R_{pu}	Input pull-up resistance	PU=high, PD=low	55	75	110	$K\Omega$
R_{pd}	Input pull-down resistance	PU=low, PD=high	40	75	150	$K\Omega$
I_{in}	Input leakage current	$V_{in} = V_{D33P}$ or 0	-10	± 1	10	μA
I_{oz}	Tri-state output leakage current		-10	± 1	10	μA

5.4 Power Consumption

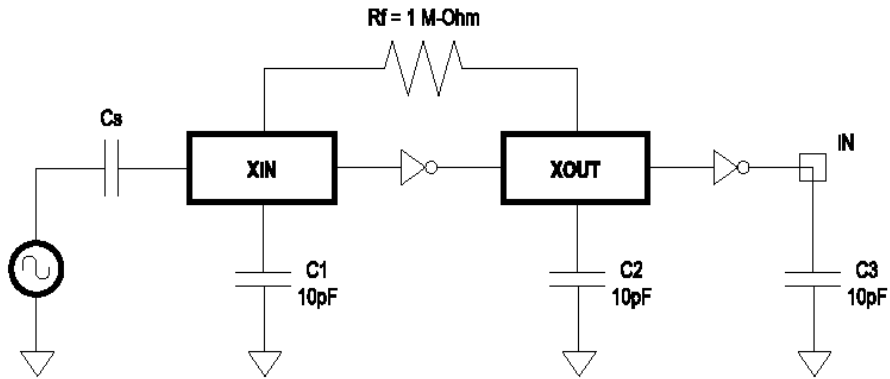
Table 5.4 Power Consumption

Status	Mode	Power Current	Note
With card present, before being suspended.	Normal Mode	27.9 mA	This value may vary with different card.
Without card present, before being suspended.	Normal Mode	19.2 mA	
After being suspended with smart card present	Normal Mode	390 μA	This value may vary with different card.
After being suspended without smart card present	Normal Mode	350 μA	
With card present, before being suspended.	Power Saving Mode	27.9 mA	This value may vary with different card.
Without card present	Power Saving Mode	240 μA	This value may vary with different card.
After being suspended with smart card present	Power Saving Mode	390 μA	

5.5 Crystal Oscillator Circuit Setup for Characterization

The following setup was used to measure the open loop voltage gain for crystal oscillator circuits. The feedback resistor serves to bias the circuit at its quiescent operating point and the AC coupling capacitor, C_s , is much larger than C_1 and C_2 .

Figure 5.1 Crystal Oscillator Circuit Setup for Characterization



5.6 Behaviors of power saving mode

Table 5.5 Behavior Description

Power Saving Mode	Test item	Expected Behavior
Under power saving mode, when the card is removed, the USB connection of AU9540 will be disconnected from host. If the card is inserted, then AU9540 will be connected to the host.	1. Host is in normal mode. While there is no card inserted, plug AU9540 into host.	AU9540 will be in suspending mode. Host will not detect AU9540.
	2. Host is in normal mode. While there is card inserted, plug AU9540 into host.	AU9540 will be detected by the host and ready to operate smart card.
	3. Host is in normal mode. When AU9540 is connected to the host and there is card inserted in the slot, plug off the card and plug in it again.	When the card is removed, AU9540 will be forced into suspend mode. Host will detect that AU9540 is removed. When the card is inserted again, AU9540 will be detected by the host again.
	4. When AU9540 is not inserted into the host and host is in suspend mode, make sure there is no card inserted into AU9540 and plug	Host will not detect AU9540. And host will not be woken up.



	AU9540 into the host.	
	5. When AU9540 is not inserted into the host and the host is in suspend mode. Plug AU9540 into the host with smart card inserted in advance.	Host will be woken up and detect AU9540. After the host is woken up, AU9540 is ready to operate card now.
	6. When AU9540 is inserted into the host, insert a smart card into AU9540. Then get host into suspend mode. After that, remove the smart card from AU9540. Then plug in the smart card again.	When user removes the card, it will not wake up the host from suspend mode. Then insert a card. It will wake up the host. After the host is woken up, AU9540 will be ready to operate the card.
	7. When there is no card inserted into AU9540 and the host is in suspend mode, plug AU9540 into the host. Then, insert a smart card into AU9540.	When AU9540 is plugged into the host without card inserted, the host will not be woken up. However, if user inserts a card now, the host will be woken up. This feature must work with host system that supports remote-wake up.

6. USB Selective Suspend Feature

The driver determines whether it should enter selective suspend state by the following requirements.

1. The card is in power off state or there is no card in the reader.
2. The reader is idle at least for a given time (30 seconds by default). It means during the period there is no command issuing to reader and there is no card inserting/removing event occurs.

When the driver detects both the two requirements above are met, it starts processing the following tasks,

1. Send standard USB command to the reader to enable remote wake function.
2. Start selective-suspend procedure to ask the system to suspend the reader.

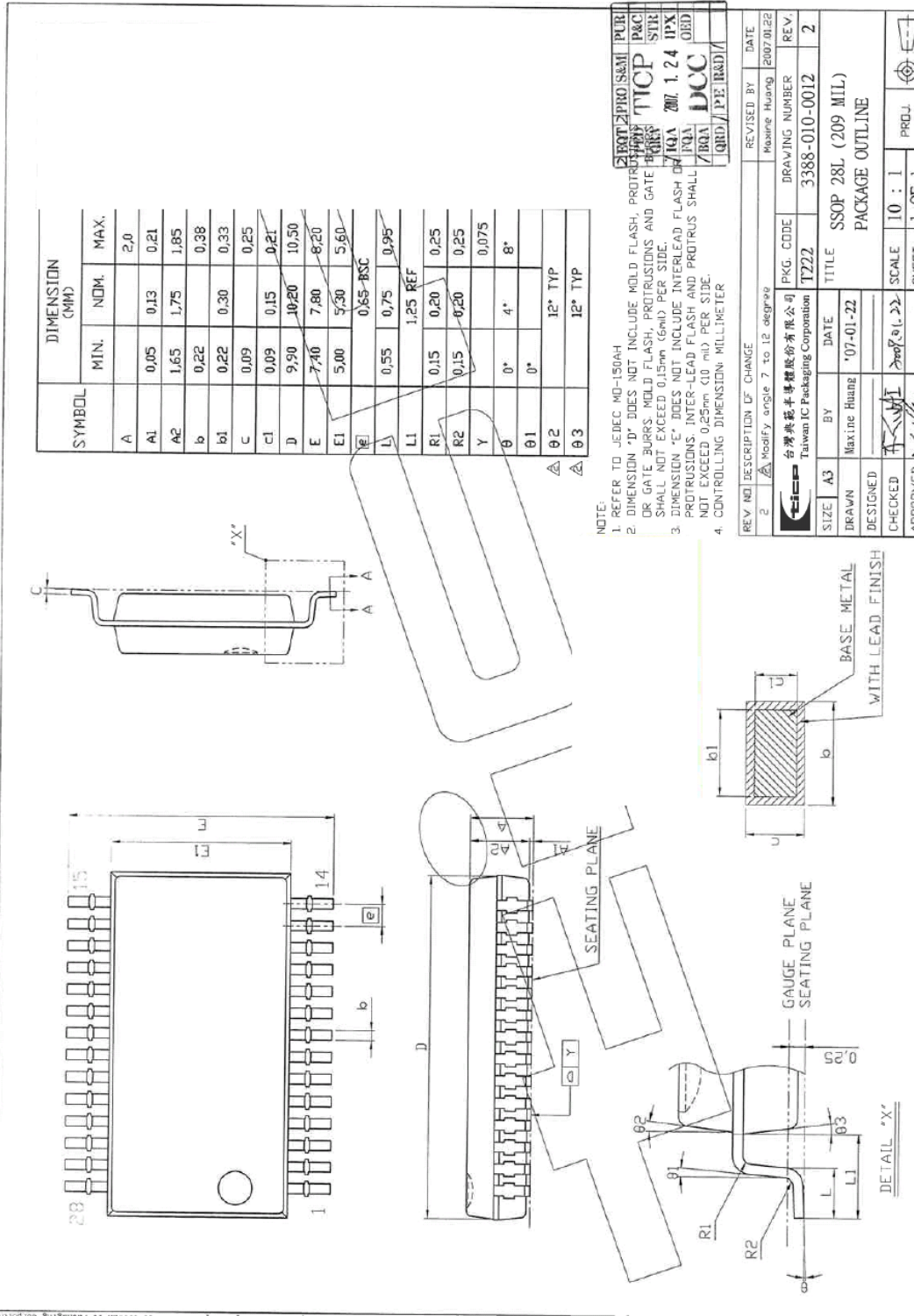
After entering the selective suspend state, the driver determines whether it should exit selective suspend state when one of the following conditions occurs,

1. There is any command which intend to communicate with the reader.
2. When card inserting/removing event occurs, the reader issues resume signal to the host. Then the system will inform the driver to exit selective suspend state.



7. Mechanical Information

Figure 7.1 Mechanical Information Diagram





8. Abbreviations

In this chapter some of the terms and abbreviations used throughout the technical reference manual are listed as follows.

WHQL	Windows Hardware Quality Labs
EMV	Europay MasterCard Visa
ATM	Automatic Teller Machine
BOM	Bill of Material
PC/SC	This is association name. (http://www.pcscworkgroup.com/)
VID	Vendor ID
PID	Product ID
PLL	Phase Lock Loop
GSM	Globe System for Mobile Communication
ESD	Electrostatic Sensitive Device

About Alcor Micro, Corp.

Alcor Micro, Corp. designs, develops and markets highly integrated and advanced peripheral semiconductor, and software driver solutions for the personal computer and consumer electronics markets worldwide. We specialize in USB solutions and focus on emerging technology such as USB and IEEE 1394. The company offers a range of semiconductors including controllers for USB hub, integrated keyboard/USB hub and USB Flash memory card reader...etc. Alcor Micro, Corp. is based in Taipei, Taiwan, with sales offices in Taipei, Japan, Korea and California. Alcor Micro is distinguished by its ability to provide innovative solutions for spec-driven products. Innovations like single chip solutions for traditional multiple chip products and on-board voltage regulators enable the company to provide cost-efficiency solutions for the computer peripheral device OEM customers worldwide.



9. Appendix: BatteryMark Test

Test Condition	With AU9540: Card Present	Without AU9540
BatteryMark Test Result: Condition Run	2:02	2:02
Version	BatteryMark 4.01	
Model Name	COMPAQ Presario CQ40	
CPU Name	Intel(R) Pentium(R) III or Pentium(R) III Xeon(TM)	
CPU Clock Speed	1900	
System BIOS Version	HPOEM - 1	
Display Mode	1280 x 800 32 bits/pixel	
Display Refresh Rate (Hz)	60	