AU6981

USB2.0 Universal Flash Disk Controller

Technical Reference Manual

AU6981

USB2.0 Universal Flash Disk Controller

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Revision History

Date	Revision	Description
Oct 2006	1.00W	Official Release.
June 2007	1.01W	Modify 3.1 Pin Descriptions-P7(External 330 Resister to Ground) Modify 3.2 Pin Descriptions-P5(External 330 Resister to Ground)

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1. Introduction

1.1 Description

The AU6981 USB 2.0 Flash Disk Controller is one of the best solutions for all kinds of SLC (Single- Level Cell) and MLC (Multi-Level Cell) NAND and AG-AND with multiple dies data flashes. Its high-speed read and write access performance enable users to transfer and backup data effectively. Besides, AU6981 is certified by USB-IF (USB Implementers Forum), WHQL (Window Hardware Quality Labs) and EMI tests to guarantee the quality and reliability for end-users.

The multi-function single chip AU6981 integrates build-in regulator to save the cost of customers more. It provides dual channel access and ISP (In-System Programming) technologies, which are the most important features to allow manufacturers building high performance UFD easily. It has auto-run function to prompt the designed AP automatically when plug into PC. In addition to being a removable storage device, AU6981 can also be configured as a bootable disk for system recovery.

To enhance the usefulness and manageability of UFD further, Alcor Micro develops a smart application program iStar (Partition/Password Operation Tool) as a handy utility in managing partition, password and security. Having iStar as the companion of UFD, the data in a UFD could be protected from unauthorized access successfully.

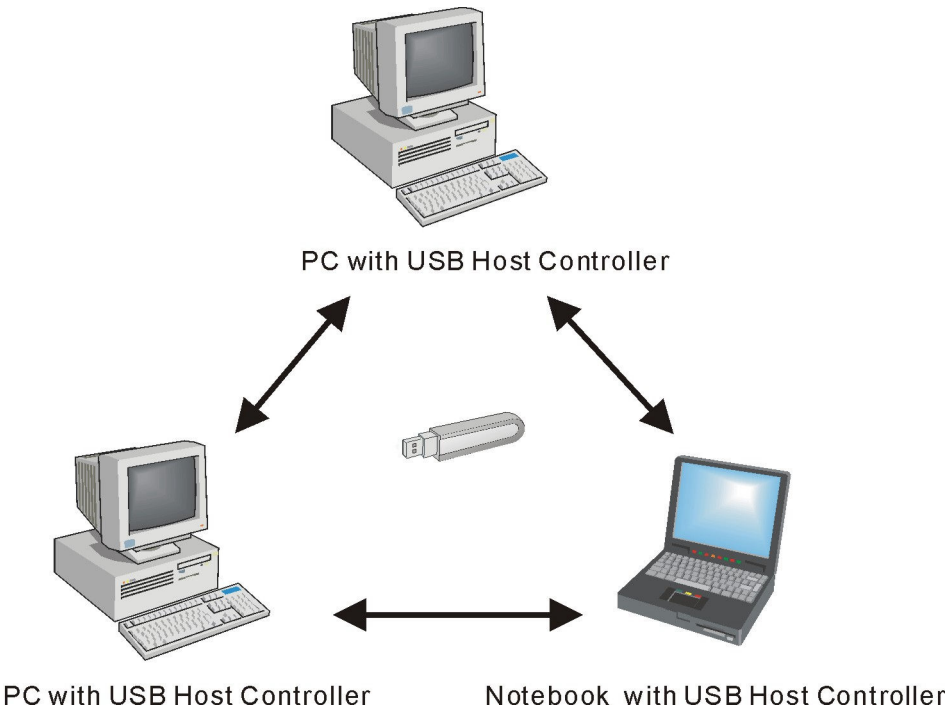
1.2 Features

- PCBs are pin compatible in AU6980, AU6981, AU6982.
- Integrate build-in regulator
- Supports dual channel mode for high-speed transfer
- Supports firmware upgrade mechanism (ISP, In-System Programming)
- Integrates hardware DMA engine to tune up the operation performance
- Integrates multi-bit ECC correction mechanism
- Complies with the standards defined in USB v2.0, USB Device Class Definition for Mass Storage and Bulk-Transport v1.0
- Works with default driver under the environments of Windows ME, Windows 2000, Windows XP, Mac 9.2, Mac OS X. Using Alcor Micro's vendor driver for the environment under Windows 98SE
- Concurrent bus operation using multiple FIFO for better performance
- Integrates into flash memory power control switch
- Supports bad block management
- Supports dynamic serial number modification via mass production software
- Supports software write protection
- Support Auto Run function
- Support erasable and read-only mode AP Disk
- Companion application program with UFD – iStar available for users
  - To have UFD partition management function
  - To do password protection for the security in data access
  - To guard data files with software write protection function
  - To lock up PC by UFD as the key
- Available in 48-pin LQFP 7x7mm package to support 4CE pin flash

2. Application Block Diagram

The following figure shows the application diagram of a typical flash disk product with AU6981. By connecting the flash disk to a desktop or notebook PC through USB bus, AU6981 is then turned into a bus-powered, high speed USB disk, which can be used as a bridge for data transfer between Desktop PC and Notebook PC.

Figure 2.1 Block Diagram



3. Pin Assignment

Depending on the application, the AU6981 is available in two different packages. Below figure shows signal name for each pin and the table in the page after describes each pin in detail.

Figure 3.1 AU6981-GDL Pin Assignment Diagram

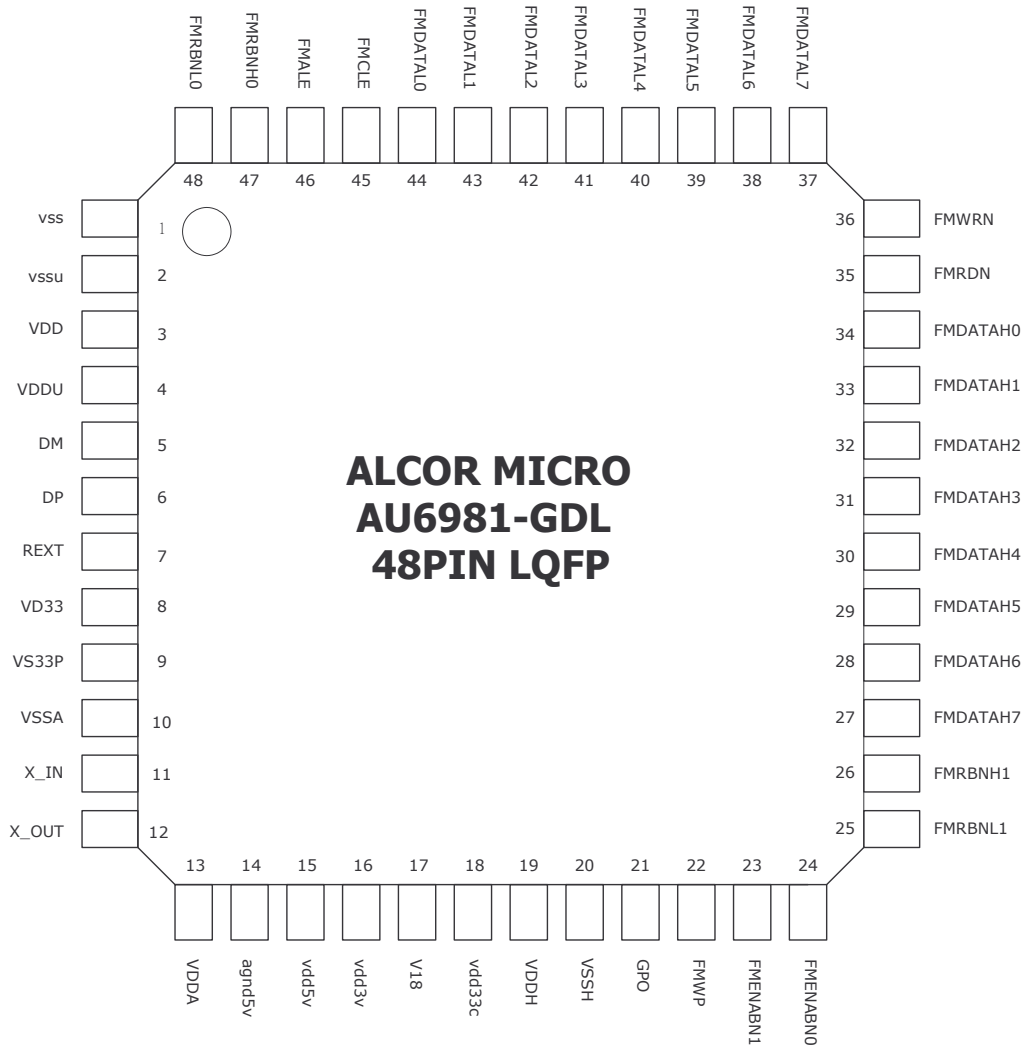


Table 3.1 AU6981-GDL Pin Descriptions

Pin #	Pin Name	I/O	Description
1	VSS	GND	Ground
2	VSSU	GND	Ground
3	VDD	I	1.8V Power Source for Core
4	VDDU	I	1.8V Power Source for UTMI
5	DM	I/O	USB DM
6	DP	I/O	USB DP
7	REXT	I	External 330 Resister to Ground
8	VD33	I	3.3V Power Source for UTMI
9	VS33P	GND	Ground
10	VSSA	GND	Ground
11	X_IN	I	12 MHz crystal input.
12	X_OUT	O	12 MHz crystal output.
13	VDDA	I	1.8V Power Source for PLL
14	AGND5V	GND	Ground
15	AVDD5V	I	5V Power Source
16	VDD3V	O	3.3 V Power Out
17	V18	O	1.8V Power Out for Core
18	VDD33C	O	3.3V Power Out for Flash Memory
19	VDDH	I	3.3V Power Source for IO pad
20	VSSH	GND	Ground
21	OPLED	O	General Purpose OutPut
22	FMWP	I	Flash Memory Write Protect; High Active
23	FMENABN1	I/O	Flash Memory #1 Enable; Low Active
24	FMENABN0	I/O	Flash Memory #0 Enable; Low Active
25	FMRBNL1	I	Flash Memory(L1) Ready and Busy Signal (1=Ready ; 0=Busy)
26	FMRBNH1	I	Flash Memory(H1) Ready and Busy Signal (1=Ready ; 0=Busy)
27	FMDATAH7	I/O	Flash Memory DataH[7]
28	FMDATAH6	I/O	Flash Memory DataH[6]

Pin #	Pin Name	I/O	Description
29	FMDATAH5	I/O	Flash Memory DataH[5]
30	FMDATAH4	I/O	Flash Memory DataH[4]
31	FMDATAH3	I/O	Flash Memory DataH[3]
32	FMDATAH2	I/O	Flash Memory DataH[2]
33	FMDATAH1	I/O	Flash Memory DataH[1]
34	FMDATAH0	I/O	Flash Memory DataH[0]
35	FMRDN	I/O	Flash Memory Read Enable; Low Active
36	FMWRN	I/O	Flash Memory Write Enable; Low Active
37	FMDATAL7	I/O	Flash Memory DataL[7]
38	FMDATAL6	I/O	Flash Memory DataL[6]
39	FMDATAL5	I/O	Flash Memory DataL[5]
40	FMDATAL4	I/O	Flash Memory DataL[4]
41	FMDATAL3	I/O	Flash Memory DataL[3]
42	FMDATAL2	I/O	Flash Memory DataL[2]
43	FMDATAL1	I/O	Flash Memory DataL[1]
44	FMDATAL0	I/O	Flash Memory DataL[0]
45	FMCLE	O	Flash Memory Command Latch Enable ;High Active
46	FMALE	O	Flash Memory Address Latch Enable; High Active;
47	FMRBNH0	I	Flash Memory(H0) Ready and Busy Signal (1=Ready ; 0=Busy)
48	FMRBNL0	I	Flash Memory(L0) Ready and Busy Signal (1=Ready ; 0=Busy)

The following figure shows signal name of each pin in 48-pin package and the table in the page after describes each pin in detail.

Figure 3.2 AU6981-GHL Pin Assignment Diagram

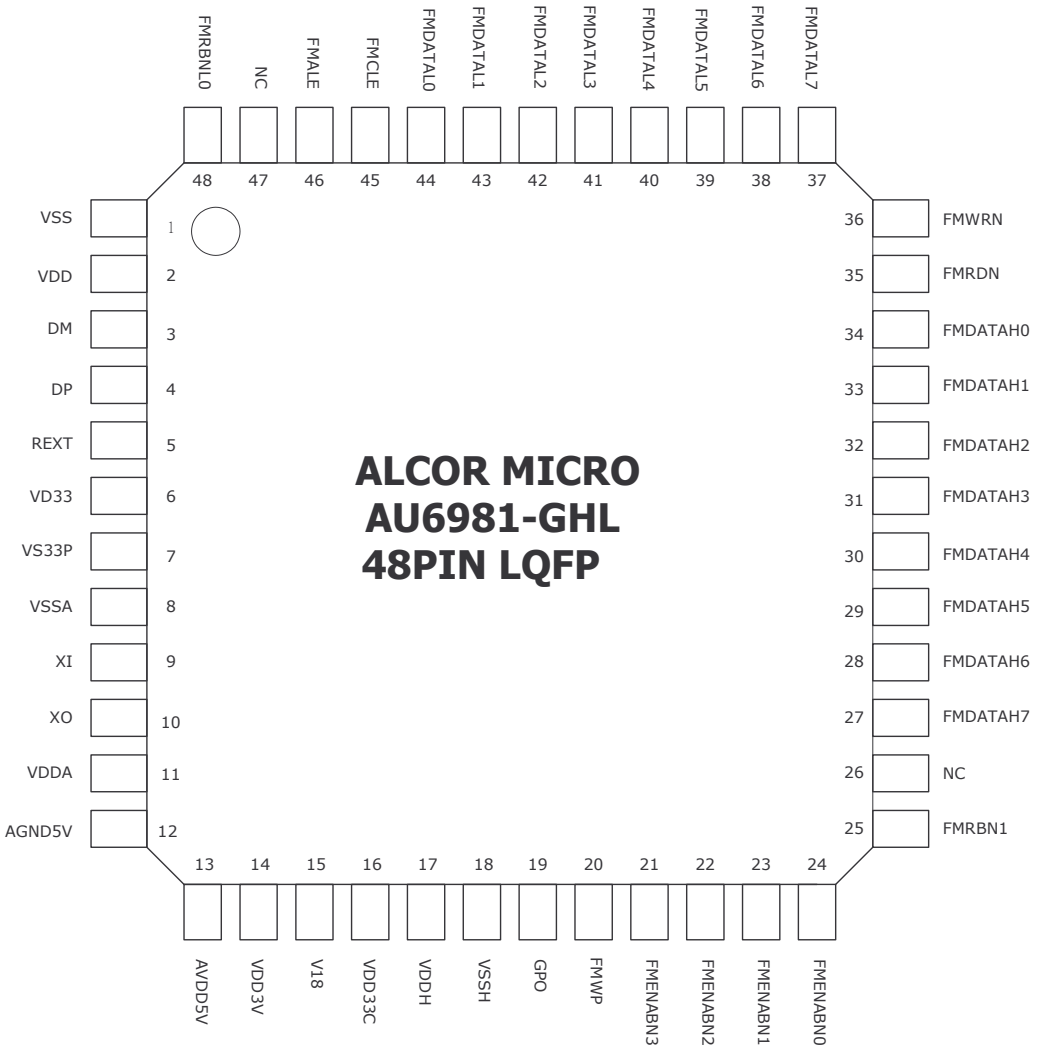


Table 3.2 AU6981-GHL Pin Descriptions

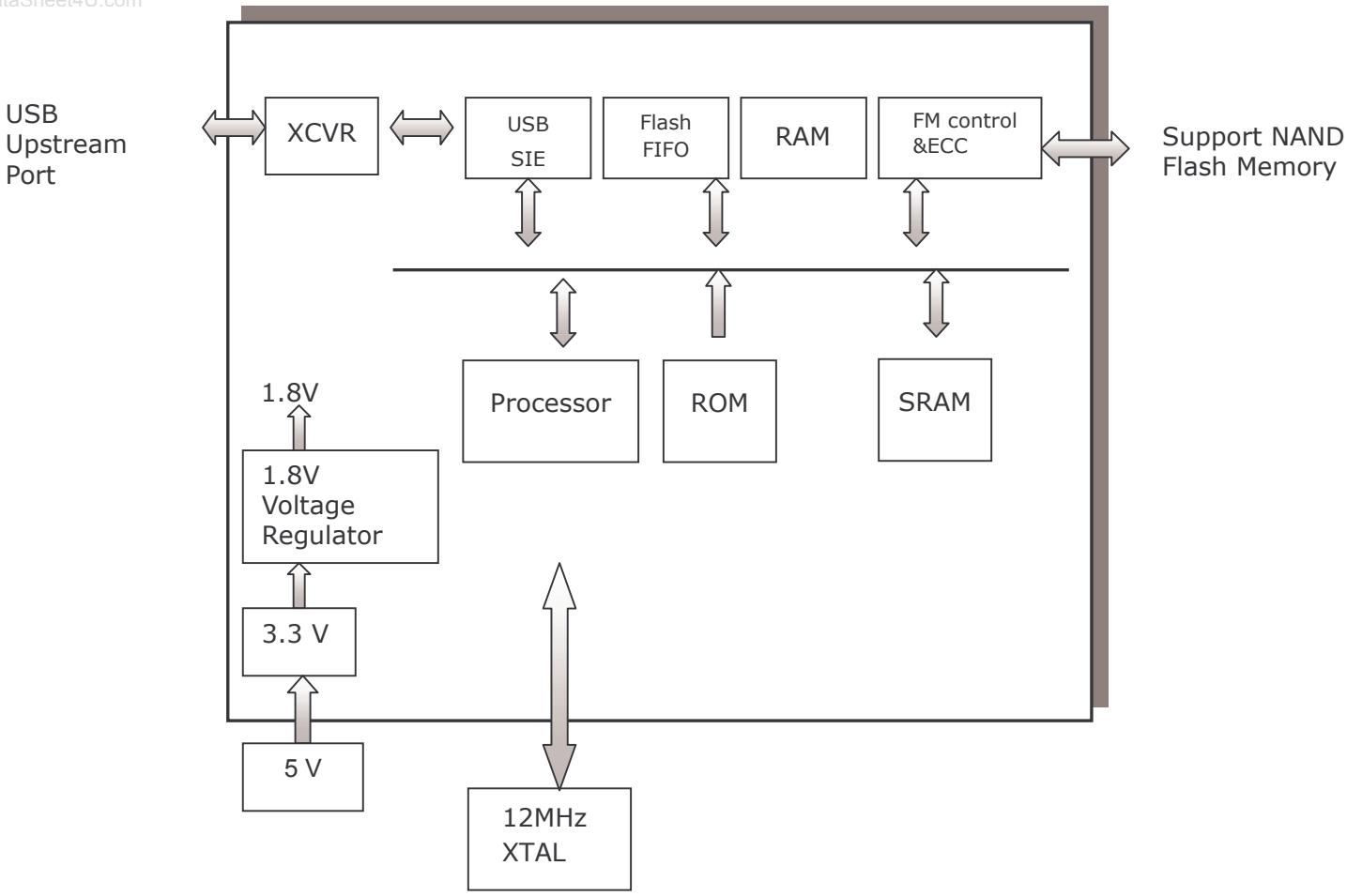
Pin #	Pin Name	I/O	Description
1	VSS	GND	Ground
2	VDD	I	1.8V Power Source for Core
3	DM	I/O	USB DM
4	DP	I/O	USB DP
5	REXT	I	External 330 Resister to Ground
6	VD33	I	3.3V Power Source for UTMI
7	VS33P	GND	Ground
8	VSSA	GND	Ground
9	XI	I	12 MHz crystal input.
10	XO	O	12 MHz crystal output.
11	VDDA	I	1.8V Power Source for PLL
12	AGND5V	GND	Ground
13	AVDD5V	I	5V Power Source
14	VDD3V	O	3.3 V Power Out
15	V18	O	1.8V Power Out for Core
16	VDD33C	O	3.3V Power Out for Flash Memory
17	VDDH	I	3.3V Power Source for IO pad
18	VSSH	GND	Ground
19	GPO	O	General Purpose OutPut
20	FMWP	I	Flash Memory Write Protect; High Active
21	FMENABN3	I/O	Flash Memory #3 Enable; Low Active
22	FMENABN2	I/O	Flash Memory #2 Enable; Low Active
23	FMENABN1	I/O	Flash Memory #1 Enable; Low Active
24	FMENABN0	I/O	Flash Memory #0 Enable; Low Active
25	FMRBN1	I	Flash Memory(L1) Ready and Busy Signal (1=Ready ; 0=Busy)
26	NC		
27	FMDATAH7	I/O	Flash Memory DataH[7]
28	FMDATAH6	I/O	Flash Memory DataH[6]
29	FMDATAH5	I/O	Flash Memory DataH[5]

Pin #	Pin Name	I/O	Description
30	FMDATAH4	I/O	Flash Memory DataH[4]
31	FMDATAH3	I/O	Flash Memory DataH[3]
32	FMDATAH2	I/O	Flash Memory DataH[2]
33	FMDATAH1	I/O	Flash Memory DataH[1]
34	FMDATAH0	I/O	Flash Memory DataH[0]
35	FMRDN	I/O	Flash Memory Read Enable; Low Active
36	FMWRN	I/O	Flash Memory Write Enable; Low Active
37	FMDATAL7	I/O	Flash Memory DataL[7]
38	FMDATAL6	I/O	Flash Memory DataL[6]
39	FMDATAL5	I/O	Flash Memory DataL[5]
40	FMDATAL4	I/O	Flash Memory DataL[4]
41	FMDATAL3	I/O	Flash Memory DataL[3]
42	FMDATAL2	I/O	Flash Memory DataL[2]
43	FMDATAL1	I/O	Flash Memory DataL[1]
44	FMDATAL0	I/O	Flash Memory DataL[0]
45	FMCLE	O	Flash Memory Command Latch Enable ;High Active
46	FMALE	O	Flash Memory Address Latch Enable; High Active;
47	NC		
48	FMRBN0	I	Flash Memory(L0) Ready and Busy Signal (1=Ready ; 0=Busy)

4. System Architecture and Reference Design

4.1 AU6981 Block Diagram

Figure 4.1 AU6981 Block Diagram



5. Electrical Characteristics

5.1 Absolute Maximum Ratings

Table 5.1 Absolute Maximum Ratings

Symbol	Parameter	Rating	Units
V_{DDH}	Power Supply	-0.3 to V_{DDH} +0.3	V
V_{IN}	Input Signal Voltage	-0.3 to 3.6	V
V_{OUT}	Output Signal Voltage	-0.3 to V_{DDH} +0.3	V
T_{STG}	Storage Temperature	-40 to 150	^{O}C

5.2 Recommended Operating Conditions

Table 5.2 Recommended Operating Conditions

Symbol	Parameter	Min.	Typ.	Max.	Units
A_{DD}	5V Power Supply	4.75	5.0	5.0	V
V_{DDH}	Power Supply	3.0	3.3	3.6	V
V_{DD}	Digital Supply	1.62	1.8	1.98	V
V_{IN}	Input Signal Voltage	0	3.3	3.6	V
T_{OPR}	Operating Temperature	0		70	^{O}C

5.3 General DC Characteristics

Table 5.3 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

5.4 DC Electrical Characteristics of 3.3V I/O Cells

Table 5.4 DC Electrical Characteristics of 3.3V I/O Cells

Symbol	Parameter	Conditions	Limits			Unit
			Min.	Typ.	Max.	
V_{DDH}	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	$\lvert I_{ol} \rvert$ =2~16mA			0.4	V
V_{oh}	Output high voltage	$\lvert I_{oh} \rvert$ =2~16mA	2.4			V
R_{pu}	Input pull-up resistance	PU=high, PD=low	55	75	110	KΩ
R_{pd}	Input pull-down resistance	PU=low, PD=high	40	75	150	KΩ
I_{in}	Input leakage current	V_{in}= V_{DDH} or 0	-10	±1	10	μA
I_{oz}	Tri-state output leakage current		-10	±1	10	μA

5.5 USB Transceiver Characteristics

Table 5.5 Electrical characteristics

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
VD33	Analog supply Voltage		3.0	3.3	3.6	V
VDDU VDDA	Digital supply Voltage		1.62	1.8	1.98	V
I_{CC}	Operating supply current	High speed operating at 480 MHz			55	mA
$I_{CC\ (susp)}$	Suspend supply current	In suspend mode, current with 1.5kΩ pull-up resistor on pin RPU disconnected			120	μA

Table 5.6 Static characteristic：Digital pin

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
Input levels						
V_{IL}	Low-level input voltage				0.8	V
V_{IH}	High-level input voltage		2.0			V
Output levels						
V_{OL}	Low-level output voltage				0.2	V
V_{OH}	High-level output voltage		VDDH-0.2			V

VD33=3.0V~3.6V；VDDU,VDDA=1.62V~1.98V；Temp=0℃~70℃

Table 5.7 Static characteristic：Analog I/O pins（DP/DM）

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
USB2.0 Transceiver（HS）						
Input Levels（differential receiver）						
V_{HSDIFF}	High speed differential input sensitivity	$\lvert V_{I(DP)}-V_{I(DM)} \rvert$ measured at the connection as application circuit	300			mV
V_{HSCM}	High speed data signaling common mode voltage range		-50		500	mV
V_{HSSQ}	High speed squelch detection threshold	Squelch detected			100	mV
		No squelch detected	150			mV
V_{HSDSC}	High speed disconnection detection threshold	Disconnection detected	625			mV
		Disconnection not detected			525	mV
Output Levels						
V_{HSOI}	High speed idle level output voltage(differential)		-10		10	mV
V_{HSOL}	High speed low level output voltage(differential)		-10		10	mV
V_{HSOH}	High speed high level output voltage(differential)		-360		400	mV
V_{CHIRPJ}	Chirp-J output voltage（differential）		700		1100	mV
V_{CHIRPK}	Chirp-K output voltage（differential）		-900		-500	mV
Resistance						

R_{DRV}	Driver output impedance	Equivalent resistance used as internal chip only	3	6	9	Ω
		Overall resistance including external resistor	40.5	45	49.5	
Termination						
V_{TERM}	Termination voltage for pull-up resistor on pin RPU		3.0		3.6	V
USB1.1 Transceiver（FS/LS）						
Input Levels（differential receiver）						
V_{DI}	Differential input sensitivity	$\lvert V_{I(DP)}-V_{I(DM)} \rvert$	0.2			V
V_{CM}	Differential common mode voltage		0.8		2.5	V
Input Levels（single-ended receivers）						
V_{SE}	Single ended receiver threshold		0.8		2.0	V
Output levels						
V_{OL}	Low-level output voltage		0		0.3	V
V_{OH}	High-level output voltage		2.8		3.6	V

VD33=3.0V~3.6V；VDDU,VDDA=1.62V~1.98V；Temp=0℃~70℃

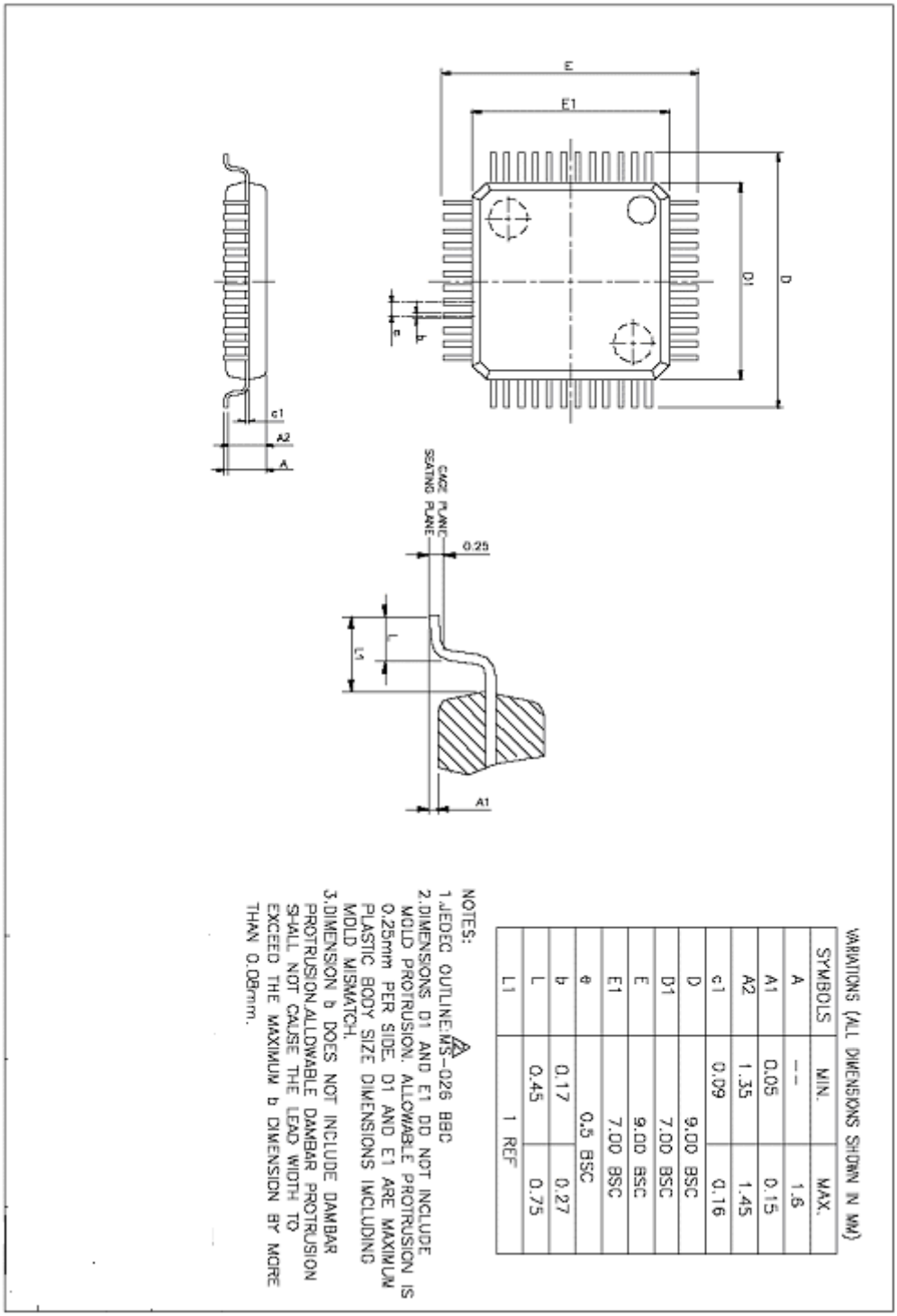
Table 5.8 Dynamic characteristic：Analog I/O pins（DP/DM）

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
Driver Characteristics						
High-Speed Mode						
t_{HSR}	High-speed differential rise time		500			ps
t_{HSF}	High-speed differential fall time		500			ps
Full-Speed Mode						
t_{FR}	Rise time	CL=50pF；10 to 90% of $\lvert V_{OH}-V_{OL} \rvert$；	4		20	ns
t_{FF}	Fall time	CL=50pF；90 to 10% of $\lvert V_{OH}-V_{OL} \rvert$；	4		20	ns
t_{FRMA}	Differential rise/fall time matching（t_{FR} / t_{FF}）	Excluding the first transition from idle mode	90		110	%
V_{CRS}	Output signal crossover voltage	Excluding the first transition from idle mode	1.3		2.0	V
Low-Speed Mode						
t_{LR}	Rise time	CL=200pF-600pF；10 to 90% of $\lvert V_{OH}-V_{OL} \rvert$；	75		300	ns

t_{LF}	Fall time	CL=200pF-600pF；90 to 10% of $\lvert V_{OH}-V_{OL} \rvert$ ；	75		300	ns
t_{LRMA}	Differential rise/fall time matching（t_{LR} / t_{LF}）	Excluding the first transition from idle mode	80		125	%
V_{CRS}	Output signal crossover voltage	Excluding the first transition from idle mode	1.3		2.0	V
V_{OH}	High-level output voltage		2.8		3.6	V

6. Mechanical Information

Figure 6.1 Mechanical Information Diagram



7. Abbreviations

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

DC Electrical	Direct Current Electrical
PLL	Phase Lock Loop, which is a closed-loop frequency control system.
ECC	Error Checking and Correcting
XTAL	Crystal
UFD	USB Flash Disk
iStar	Partition/Password Operation Tool - the smart application program developed by Alcor Micro as a companion handy tool for managing the UFD.

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.