AU6256

USB2.0 Hub Controller

Technical Reference Manual

AU6256

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Revision History

Date	Revision	Description
Jan 2008	0.9	Preliminary Release.
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1. Introduction

1.1 Description

AU6256 is a fully compliant with the USB 2.0 hub specification and is designed to work with USB host as a high-speed hub. Its built-in TT (Transaction Translator) allows system to benefit combinational performance under the unbalanced traffic condition.
AU6256 supports four USB downstream ports and one upstream port. Each downstream port could be a device of high-speed, full-speed or low-speed traffic, while the upstream port supports both high-speed and full-speed traffic. For each downstream port it has individual power switch control built-in as over-current sensing control.
In addition to the application as a stand-alone hub, AU6256 is also very suitable for using in notebook and motherboard design to provide additional USB port. All these product advantages should be attributed to its compliance to standards, performance and low power consumption.

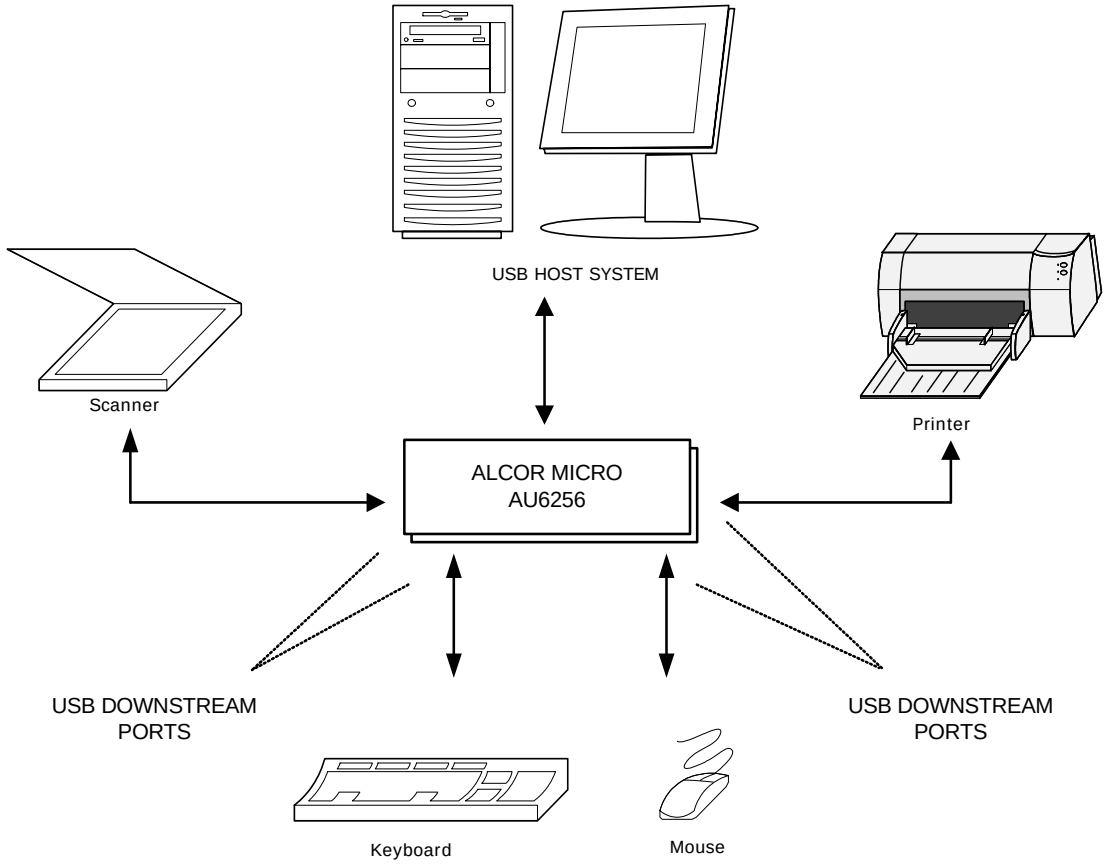
1.2 Features

- Fully compliant with USB Hub Specification version 2.0 and is also backward compatible with USB Hub specification 1.1.
- Single chip USB 2.0 hub controller.
- Supports four bus-powered/self-powered downstream ports.
- Supports automatic switching between bus- and self-powered modes.
- Cost effective design using one transaction translator for all downstream ports.
- Two-color LED controls available for each downstream port to indicate the status of each device port.
- Extra low power consumption.
- On chip internal pull-up and meets USB bus power regain emend pull down resistors for all data line.
- Built-in USB 2.0 transceiver.
- Supports individual and gang modes of power management.
- Built-in power switch control for over current sensing control.
- Built-in 1.8V regulator for core logic.
- Embedded in PLL (Phase Lock Loop) circuit for 12MHz operation precision
- Supports external EEPROM interface for customized PID and VID
- 5→3.3 regulators built in
- Available in 48-pin LQFP package

2. Application Block Diagram

AU6256 is a single chip 4-port USB hub controller. Its upstream port is connected to a USB Host system. The downstream ports can be used for a mouse, joystick, scanner, printer or other devices.

Figure 2.1 Block Diagram



3. Pin Assignment

AU6254 is available in 48-pin LQFP package. Below diagram shows signal name of each pin and table in the following page describes each pin in detail.

Figure 3.1 48 LQFP Pin Assignment Diagram

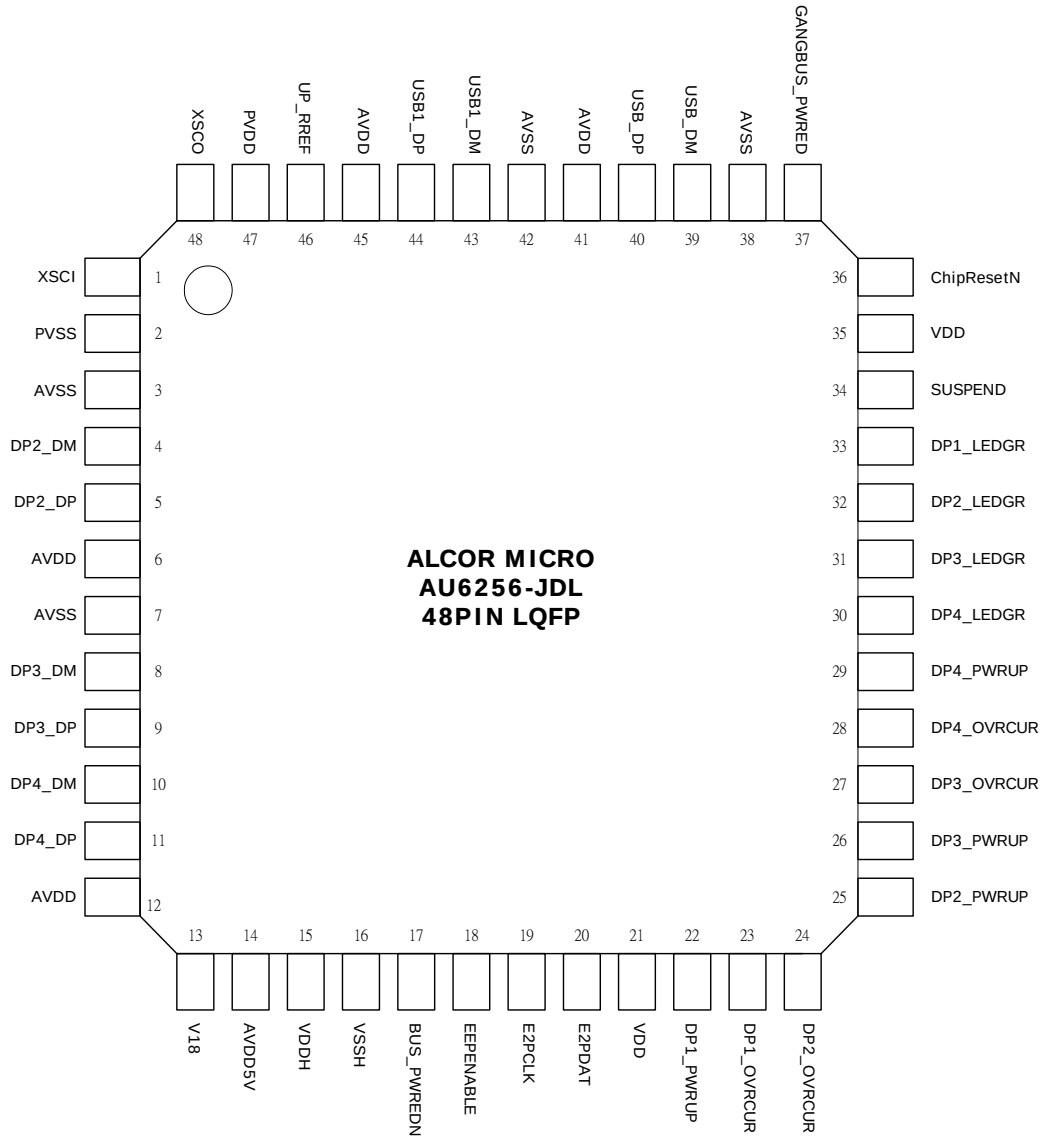


Table 3.1 48 LQFP Pin Descriptions

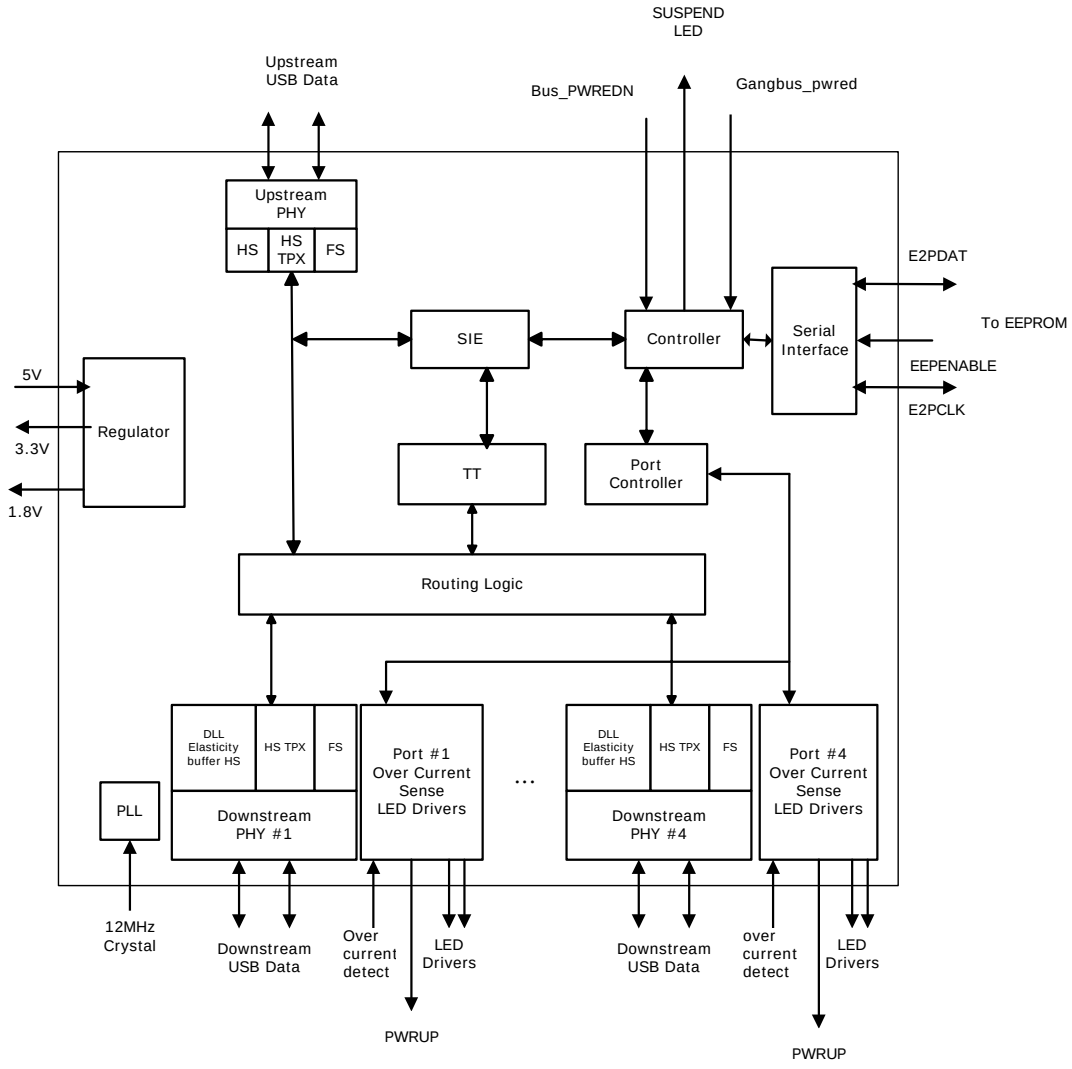
Pin #	Pin Name	I/O	Description
1	XSCI	UTMI	12MHz Crystal oscillator input
2	PVSS	UTMI	OSC GND
3	AVSS	UTMI	UTMI GND
4	DP2_DM	UTMI	Port2 USB bus
5	DP2_DP	UTMI	Port2 USB bus
6	AVDD	UTMI	UTMI Power
7	AVSS	UTMI	UTMI GND
8	DP3_DM	UTMI	Port3 USB bus
9	DP3_DP	UTMI	Port3 USB bus
10	DP4_DM	UTMI	Port4 USB bus
11	DP4_DP	UTMI	Port4 USB bus
12	AVDD	UTMI	UTMI Power
13	V18	Power	Voltage regulator output 1.8V
14	AVDD5V	Power	Voltage regulator input 5V
15	VDDH	Power	IO power input 3.3V
16	VSSH	Power	IO GND
17	BUS_PWREDN	O	1' = Self Powered '0' = Bus Powered
18	EEPENABLE	I	EEPControl '0' = Use internal ROM '1' = Use EEP contents
19	E2PCLK	I/O	EEP Clock
20	E2PDAT	I/O	EEP Data
21	VDD	Power	Care Power
22	DP1_PWRUP	O	Port1 PowerEnable '0' = power on '1' = power off
23	DP1_OVRCUR	I	Port 1 Overcurrent '0' = overcurrent '1' = not overcurrent
24	DP2_OVRCUR	I	Port 2 Overcurrent '0' = overcurrent '1' = not overcurrent
25	DP2_PWRUP	O	Port2 PowerEnable '0' = power on '1' = power off
26	DP3_PWRUP	O	Port3 PowerEnable '0' = power on '1' = power off

Pin #	Pin Name	I/O	Description
27	DP3_OVRCUR	I	Port3 Overcurrent '0' = overcurrent '1' = not overcurrent
28	DP4_OVRCUR	I	Port4 Overcurrent '0' = overcurrent '1' = not overcurrent
29	DP4_PWRUP	O	Port4 PowerEnable '0' = power on '1' = power off
30	DP4_LEDGR	O	Port4 Green LED indicator '0' = LED on (Fully operational) '1/Z' = LED off
31	DP3_LEDGR	O	Port3 Green LED indicator '0' = LED on (Fully operational) '1' = LED off
32	DP2_LEDGR	O	Port2 Green LED '0' = LED on (Fully operational) '1' = LED off
33	DP1_LEDGR	O	Port1 Green LED indicator '0' = LED on (Fully operational) '1' = LED off
34	SUSPEND	O	0' = Not Suspended '1' = Suspended
35	VDD	Power	Care Power
36	ChipResetN	I	0' = Reset '1' = Run
37	GANGBUS_PWRED	I	1' = Individual Power '0' = Gang powered
38	AVSS	UTMI	UTMI GND
39	USB_DM	UTMI	Upstream port USB bus
40	USB_DP	UTMI	Upstream port USB bus
41	AVDD	UTMI	UTMI Power
42	AVSS	UTMI	UTMI GND
43	USB1_DM	UTMI	Port1 USB bus
44	USB1_DP	UTMI	Port1 USB bus
45	AVDD	UTMI	UTMI Power
46	UP_RREF	UTMI	Reference resistor
47	PVDD	UTMI	OSC VDD
48	XSCO	UTMI	12MHz Crystal oscillator output

4. System Architecture and Reference Design

4.1 AU6256 Block Diagram

Figure 4.1 AU6256 Block Diagram



4.2 USB 2.0 Hub Descriptor

Table 4.1 Hub EEPROM Sample Value

OFFSET (BYTE, HEX)	LENGTH (BYTE, HEX)	VALUES (HEX)	DESCRIPTION
0	2	01,00	Configuration Byte 1 bit 0 : EnablePortError
2	2	1A,2C	LoByte : Pointer to Hub FS device descriptor 000h ROM address HiByte : Xfer end address + 1
4	2	2C,45	LoByte : Pointer to Hub FS configuration descriptor HiByte : Xfer end address + 1 (config+interface+endpoint) 000h ROM address
6	2	45,4F	LoByte : Pointer to Hub FS Device Qualifier descriptor HiByte : Xfer end address + 1 000h ROM address
8	2	4F,68	LoByte : Pointer to Hub FS Other Speed Configuration descriptor HiByte : Xfer end address + 1 (config+interface+endpoint) 000h ROM address
A	2	78,8A	LoByte : Pointer to Hub HS device descriptor 000h ROM address HiByte : Xfer end address + 1
C	2	8A,A3	LoByte : Pointer to Hub HS configuration descriptor HiByte : Xfer end address + 1 (config+interface+endpoint) 000h ROM address
E	2	B3,BD	LoByte : Pointer to Hub HS Device Qualifier descriptor HiByte : Xfer end address + 1 000h ROM address
10	2	BD,D6	LoByte : Pointer to Hub HS Other Speed Configuration descriptor HiByte : Xfer end address + 1 (config+interface+endpoint) 000h ROM address
12	2	D6,DF	LoByte : Pointer to HUB Class descriptor (0x29) 000h ROM address HiByte : Xfer end address + 1 Individual power
14	2	DF,E8	LoByte : Pointer to HUB Class descriptor (0x29) 000h ROM address HiByte : Xfer end address + 1 Gang Power
16	2	18,1A	LoByte : Pointer to Special Command Data 000h ROM address HiByte : Xfer end address + 1
18	2	01,00	
1A	12	12,01,00,02,09,00,00,40,8F,05,54,62,00,01,00,00,00,01	Hub FS device descriptor, version 2.0, 12 Descriptor length 01 Device Descriptor 00 02 USB Version 2.0 09 Hub class 00 Sub-class 00 Device Protocol 40h Maximum packet size 8F 05 Vender ID – Alcor 54 62 Product ID - 6254 01 00 Device release number 00 Index of Manufacturer string descriptor 00 Index of Product string descriptor 00 Index of serial number string descriptor – no serial number 01 Number of configuration
2C	9	09,02,19,00,01,01,00,E0,FA	Hub FS Config Desc. 1 interface, self powered, remote wakeup,500 mA Total bytes returned : 0x19
35	9	09,04,00,00,01,09,00,00,00	Hub FS interface descriptor, interface 0. Class code 0x9
3E	7	07,05,81,03,01,00,FF	Hub FS endpoint descriptor
45	A	0A,06,00,02,09,00,01,40,01,00	Hub FS Device Qualifier descriptor - USB 2.00,
4F	9	09,07,19,00,01,01,00,E0,FA	Hub FS Other Speed Config Desc. 1 interface, self powered, remote wakeup, 500 mA Total bytes returned : 0x19

OFFSET (BYTE, HEX)	LENGTH (BYTE, HEX)	VALUES (HEX)	DESCRIPTION
58	9	09,04,00,00,01 ,09,00,00,00	Hub FS Other speed interface descriptor, interface 0. Class code 0x9, single TT
61	7	07,05,81,03,01 ,00,0C	Hub FS Other speed endpoint descriptor
68	9	09,04,00,01,01 ,09,00,02,00	Hub FS Other speed interface descriptor, interface 0. Class code 0x9, single TT
71	7	07,05,81,03,01 ,00,0C	Hub FS Other speed endpoint descriptor
78	12	12,01,00,02,09 ,00,01,40,8F,0 5,54,62,00,01, 00,00,00,01	Hub HS device descriptor, version 2.0, 12 Descriptor length 01 Device Descriptor 00 02 USB Version 2.0 09 Hub class 01 Sub-class – (single TTs) 00 Device Protocol 40h Maximum packet size 8F 05 Vender ID – Alcor 54 62 Product ID - 6254 01 00 Device release number 00 Index of Manufacturer string descriptor 00 Index of Product string descriptor 00 Index of serial number string descriptor – no serial number 01 Number of configuration
8A	9	09,02,19,00,01 ,01,00,E0,FA	Hub HS Config Desc. 1 interface, self powered, remote wakeup, 500 mA Total bytes returned : 0x19
93	9	09,04,00,00,01 ,09,00,00,00	Hub HS interface descriptor, interface 0. Class code 0x9, single TT
9C	7	07,05,81,03,01 ,00,0C	Hub HS endpoint descriptor
A3	9	09,04,00,01,01 ,09,00,02,00	Hub HS interface descriptor, interface 0. Class code 0x9, formultipleTT
AC	7	07,05,81,03,01 ,00,0C	Hub HS endpoint descriptor
B3	A	0A,06,00,02,09 ,00,00,40,01,0 0	Hub HS Device Qualifier descriptor - USB 2.00,
BD	9	09,07,19,00,01 ,01,00,E0,FA	Hub HS Other speed Config Desc. 1 interface, self powered, remote wakeup, 500 mA Total bytes returned : 0x19
C6	9	09,04,00,00,01 ,09,00,00,00	Hub HS Other speed interface descriptor, interface 0. Class code 0x9
CF	7	07,05,81,03,01 ,00,FF	Hub HS Other speed endpoint descriptor
D6	9	09,29,04,89,00 ,32,64,00,FF	Hub class descriptor. 09 Descriptor length 29 Hub Descriptor 04 Number of downstream port –4 external ports A9 00 Individual Over-current sensing, individual power switch, 8 FS bit TT think time, port indicators supported 32 Power good wait time 32hx2 mS (=100ms) 64 Maximum current required (=100mA) 00 No ports are not removable FF Port power control mask
DF	9	09,29,04,80,00 ,32,64,00,FF	Hub class descriptor. 09 Descriptor length 29 Hub Descriptor 04 Number of downstream port – 4 external ports A0 00 Global Over-current sensing, gang power switch, 8 FS bit TT think time, port indicators supported 32 Power good wait time 32hx2 mS (=100ms) 64 Maximum current required (=100mA)

OFFSET (BYTE, HEX)	LENGTH (BYTE, HEX)	VALUES (HEX)	DESCRIPTION
			00 No ports are not removable FF Port power control mask
E8	18	00,00,00,00,00,00,00,00, 00,00,00,00,00,00,00,00, 00,00,00,00,00,00,00,00,	Spare bytes
100	2	01,00	Configuration Byte 1 bit 0 : EnablePortError Byte 1 bit 1 :
102	2	1A,2C	LoByte : Pointer to Hub FS device descriptor 000h ROM address HiByte : Xfer end address + 1
104	2	2C,45	LoByte : Pointer to Hub FS configuration descriptor HiByte : Xfer end address + 1 (config+interface+endpoint) 000h ROM address
106	2	45,4F	LoByte : Pointer to Hub FS Device Qualifier descriptor HiByte : Xfer end address + 1 000h ROM address
108	2	4F,68	LoByte : Pointer to Hub FS Other Speed Configuration descriptor HiByte : Xfer end address + 1 (config+interface+endpoint) 000h ROM address
10A	2	78,8A	LoByte : Pointer to Hub HS device descriptor 000h ROM address HiByte : Xfer end address + 1
10C	2	8A,A3	LoByte : Pointer to Hub HS configuration descriptor HiByte : Xfer end address + 1 (config+interface+endpoint) 000h ROM address
10E	2	B3,BD	LoByte : Pointer to Hub HS Device Qualifier descriptor HiByte : Xfer end address + 1 000h ROM address
110	2	BD,D6	LoByte : Pointer to Hub HS Other Speed Configuration descriptor HiByte : Xfer end address + 1 (config+interface+endpoint) 000h ROM address
112	2	D6,DF	LoByte : Pointer to HUB Class descriptor (0x29) 000h ROM address HiByte : Xfer end address + 1 Individual power
114	2	DF,E8	LoByte : Pointer to HUB Class descriptor (0x29) 000h ROM address HiByte : Xfer end address + 1 Gang Power
116	2	18,1A	LoByte : Pointer to Special Command Data 000h ROM address HiByte : Xfer end address + 1
118	2	01,00	
11A	12	12,01,00,02,09,00,00,40,8F,05,54,62,00,01, 00,00,00,01	Hub FS device descriptor, version 2.0, 12 Descriptor length 01 Device Descriptor 00 02 USB Version 2.0 09 Hub class 00 Sub-class 00 Device Protocol 40h Maximum packet size 8F 05 Vender ID – Alcor 54 62 Product ID - 6254 01 00 Device release number 00 Index of Manufacturer string descriptor 00 Index of Product string descriptor 00 Index of serial number string descriptor – no serial number 01 Number of configuration
12C	9	09,02,19,00,01,01,00,E0,32	Hub FS Config Desc. 1 interface, self powered, remote wakeup,100 mA Total bytes returned : 0x19
135	9	09,04,00,00,01,09,00,00,00	Hub FS interface descriptor, interface 0. Class code 0x9
13E	7	07,05,81,03,01,00,FF	Hub FS endpoint descriptor
145	A	0A,06,00,02,09,00,01,40,01,00	Hub FS Device Qualifier descriptor - USB 2.00,
14F	9	09,07,19,00,01,01,00,E0,32	Hub FS Other Speed Config Desc. 1 interface, self powered, remote wakeup, 100 mA

OFFSET (BYTE, HEX)	LENGTH (BYTE, HEX)	VALUES (HEX)	DESCRIPTION
			Total bytes returned : 0x19
158	9	09,04,00,00,01 ,09,00,00,00	Hub FS Other speed interface descriptor, interface 0. Class code 0x9, single TT
161	7	07,05,81,03,01 ,00,0C	Hub FS Other speed endpoint descriptor
168	9	09,04,00,01,01 ,09,00,02,00	Hub FS Other speed interface descriptor, interface 0. Class code 0x9, single TT
171	7	07,05,81,03,01 ,00,0C	Hub FS Other speed endpoint descriptor
178	12	12,01,00,02,09 ,00,01,40,8F,0 5,54,62,00,01, 00,00,00,01	Hub HS device descriptor, version 2.0, 12 Descriptor length 01 Device Descriptor 00 02 USB Version 2.0 09 Hub class 01 Sub-class – (single TTs) 00 Device Protocol 40h Maximum packet size 8F 05 Vender ID – Alcor 54 62 Product ID - 6254 01 00 Device release number 00 Index of Manufacturer string descriptor 00 Index of Product string descriptor 00 Index of serial number string descriptor – no serial number 01 Number of configuration
18A	9	09,02,19,00,01 ,01,00,E0,32	Hub HS Config Desc. 1 interface, self powered, remote wakeup, 100 mA Total bytes returned : 0x19
193	9	09,04,00,00,01 ,09,00,00,00	Hub HS interface descriptor, interface 0. Class code 0x9, single TT
19C	7	07,05,81,03,01 ,00,0C	Hub HS endpoint descriptor
1A3	9	09,04,00,01,01 ,09,00,02,00	Hub HS interface descriptor, interface 0. Class code 0x9, formultipleTT
1AC	7	07,05,81,03,01 ,00,0C	Hub HS endpoint descriptor
1B3	A	0A,06,00,02,09 ,00,00,40,01,0 0	Hub HS Device Qualifier descriptor - USB 2.00,
1BD	9	09,07,19,00,01 ,01,00,E0,32	Hub HS Other speed Config Desc. 1 interface, self powered, remote wakeup, 100 mA Total bytes returned : 0x19
1C6	9	09,04,00,00,01 ,09,00,00,00	Hub HS Other speed interface descriptor, interface 0. Class code 0x9
1CF	7	07,05,81,03,01 ,00,FF	Hub HS Other speed endpoint descriptor
1D6	9	09,29,04,89,00 ,32,64,00,FF	Hub class descriptor. 09 Descriptor length 29 Hub Descriptor 04 Number of downstream port –4 external ports A9 00 Individual Over-current sensing, individual power switch, 8 FS bit TT think time, port indicators supported 32 Power good wait time 32hx2 mS (=100ms) 64 Maximum current required (=100mA) 00 No ports are not removable FF Port power control mask
1DF	9	09,29,04,80,00 ,32,64,00,FF	Hub class descriptor. 09 Descriptor length 29 Hub Descriptor 04 Number of downstream port – 4 external ports A0 00 Global Over-current sensing, gang power switch, 8 FS bit TT think time, port indicators supported

OFFSET (BYTE, HEX)	LENGTH (BYTE, HEX)	VALUES (HEX)	DESCRIPTION
			32 Power good wait time 32hx2 mS (=100ms) 64 Maximum current required (=100mA) 00 No ports are not removable FF Port power control mask
1E8	18	00,00,00,00,00 ,00,00,00, 00,00,00,00,00 ,00,00,00, 00,00,00,00,00 ,00,00,00,	Spare bytes

5. Electrical Characteristics

5.1 Absolute Maximum Ratings

Table 5.1 Absolute Maximum Ratings

SYMBOL	PARAMETER	RATING	UNITS
V_{5IN}	Power Supply	-0.3 to 5.25	V
V_{DDH}	Power Supply	-0.3 to 3.6	V
V_{IN}	Input 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
V_{5IN}	Power Supply	4.75	5.0	5.25	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		V_{DDH} +0.3	V
T_{OPR}	Operating Temperature	0		85	^{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

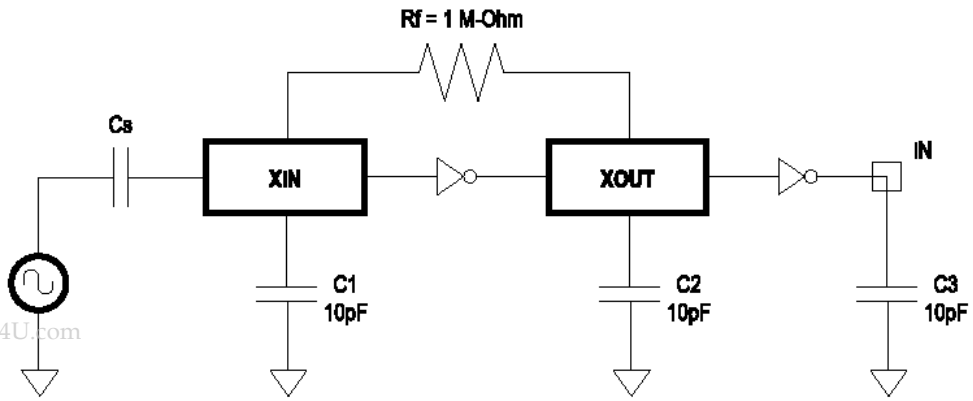
Table 5.4 DC Electrical Characteristics of 3.3V I/O Cells

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 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, Cs, is much larger than C1 and C2.

Figure 5.1 Crystal Oscillator Circuit Setup for Characterization



5.6 Bus Timing / Electrical Characteristics

Table 5.5 DC Electrical Characteristics

Input Levels for Low-/Full –speed:

SYMBOL	PARAMETER	LIMITS		UNIT
		MIN	MAX	
V_{IH}	High (Driven)	2.0		V
V_{IHZ}	High (floating)	2.7	3.6	V
V_{IL}	Low		0.8	V
V_{DI}	Differential Input Sensitivity	0.2		V
V_{CM}	Differential Common Mode Range	0.8	2.5	V

Input Levels for High –speed:

SYMBOL	PARAMETER	LIMITS		UNIT
		MIN	MAX	
V_{HHSSQ}	High-speed squelch detection threshold (differential signal amplitude)	100	150	mV
V_{HSDSC}	High speed disconnect detection threshold (differential signal amplitude)	525	625	mV

Output Levels for Low-/Full-speed:

SYMBOL	PARAMETER	LIMITS		UNIT
		MIN	MAX	
V_{OL}	Low	0.0	0.3	V
V_{OH}	High (driven)	2.8	3.6	V
V_{OSE1}	SE1	0.8		V
V_{CRS}	Output Signal Crossover Voltage	1.3	2.0	V

Output Levels for High –speed:

SYMBOL	PARAMETER	LIMITS		UNIT
		MIN	MAX	
V_{HSOI}	High-speed idle level	-10	10	mV
V_{HSOH}	High-speed data signaling high	360	440	mV
V_{HSOL}	High-speed data signaling low	-10	10	mV
V_{CHIRPJ}	Chirp J level (differential voltage)	700	1100	mV
V_{CHIRPK}	Chirp K level (differential voltage)	-900	-500	mV

Terminations:

SYMBOL	PARAMETER	LIMITS		UNIT
		MIN	MAX	
R_{PU}	Bus Pull-up Resistor on Upstream Facing Port	1.425	1.575	kΩ
R_{PD}	Bus Pull-down Resistor on Upstream Facing Port	14.25	15.75	kΩ
Z_{INP}	Input impedance exclusive of pull-up/pull-down (for low-/full-speed)	300		kΩ
V_{TERM}	Termination voltage for upstream facing port pull-up (R_{PU})	3.0	3.6	V

Terminations in High-speed:

SYMBOL	PARAMETER	LIMITS		UNIT
		MIN	MAX	
V_{HSTERM}	Termination voltage in high-speed	-10	10	mV

Table 5.6 High-speed Source Electrical Characteristics

Driver Characteristics:

SYMBOL	PARAMETER	LIMITS		UNIT
		MIN	MAX	
T_{HSR}	Rise Time (10%-90%)	500		ps
T_{HSF}	Fall Time (10%-90%)	500		ps
Z_{HSDRV}	Driver Output Resistance (which also serves as high-speed termination)	40.5	49.5	Ω

Clock Timings:

SYMBOL	PARAMETER	LIMITS		UNIT
		MIN	MAX	
T_{HSDRAT}	High-speed Data Rate	479.76	480.24	Mb/s
T_{HSFRAM}	Micorframe Interval	124.9375	125.0625	μs
T_{HSRFI}	Consecutive Microframe Interval Difference		4 high-speed bit times	

Table 5.7 Full-speed Source Electrical Characteristics

Driver Characteristics:

SYMBOL	PARAMETER	LIMITS		UNIT
		MIN	MAX	
T_{FR}	Rise Time	4	20	ns
T_{FF}	Fall Time	4	20	ns
T_{FRFM}	Differential Rise and Fall Time Matching	90	111.11	%
Z_{ZRV}	Driver Output Resistance for driver which is not high-speed capable	28	44	Ω

Clock Timings:

SYMBOL	PARAMETER	LIMITS		UNIT
		MIN	MAX	
$T_{FDRATHS}$	Full-speed Data Rate for hubs and devices which are high-speed capable	11.994	12.006	Mb/s
T_{FDRATE}	Full-speed Data Rate for devices which are not high-speed capable	11.970	12.030	Mb/s
T_{FRAME}	Frame interval	0.9995	1.0005	Ms
T_{RFI}	Consecutive Frame Interval Jitter		42	ns

Full-speed Data Timings:

SYMBOL	PARAMETER	LIMITS		UNIT
		MIN	MAX	
	Source Jitter Total(including frequency tolerance):			
T_{DJ1}	To Next Transition	-3.5	-3.5	ns
T_{DJ2}	For Paired Transitions	-4	-4	ns
T_{FDEOP}	Source Jitter for Differential Transition to SE0 Transition	-2	5	ns
	Receiver Jitter:			
T_{JR1}	To Next Transition	-18.5	-18.5	ns
T_{JR2}	For Paired Transitions	-9	-9	ns
T_{FEPPT}	Source SE0 interval of EOP	160	175	ns
T_{FEOPR}	Receiver SE0 interval of EOP	82		ns
T_{FST}	Width of SE0 interval during differential transition		14	ns

Table 5.8 Low-speed Source Electrical Characteristics

Driver Characteristics:

SYMBOL	PARAMETER	LIMITS		UNIT
		MIN	MAX	
T_{LR}	Rise Time	75	300	ns
T_{LF}	Fall Time	75	300	ns
T_{LRFM}	Differential Rise and Fall Time Matching	80	125	%
C_{LINUA}	Upstream Facing Port (w/cable, low-speed only)	200	450	pF

Clock Timings:

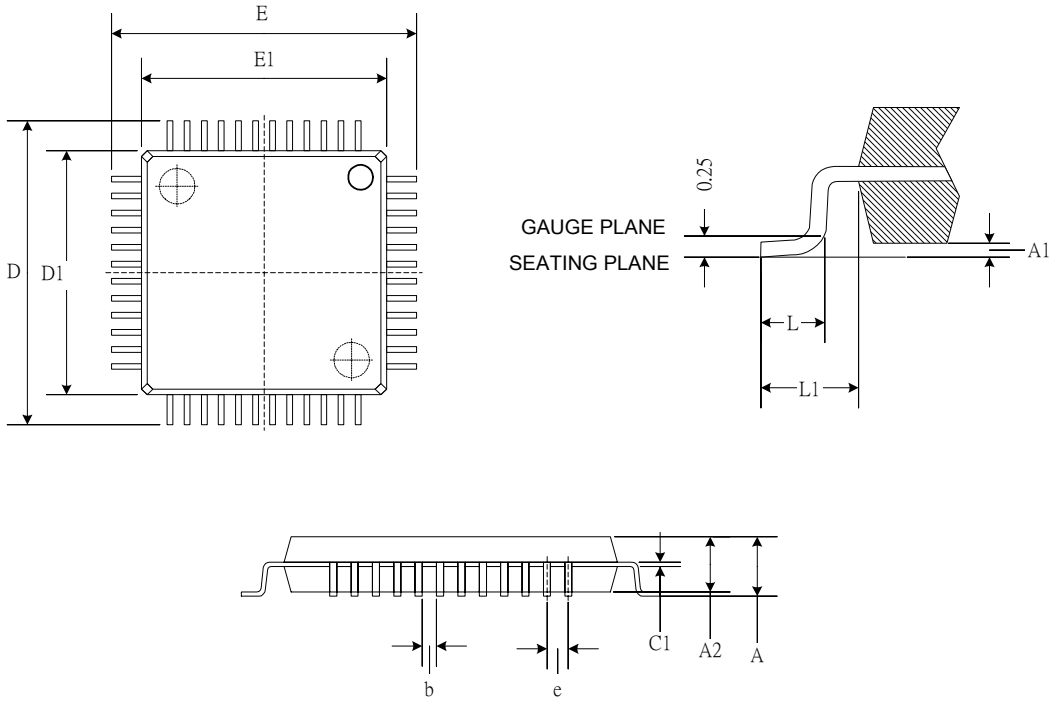
SYMBOL	PARAMETER	LIMITS		UNIT
		MIN	MAX	
$T_{LDRATHS}$	Low-speed Data Rate for hubs and devices which are high-speed capable	1.49925	1.50075	Mb/s
T_{LDRATE}	Low-speed Data Rate for devices which are not high-speed capable	1.4775	1.5225	Mb/s

Low-speed Data Timings:

SYMBOL	PARAMETER	LIMITS		UNIT
		MIN	MAX	
	Upstream facing port source Jitter Total(including frequency tolerance):			
T_{UDJ1}	To Next Transition	-95	95	ns
T_{UDJ2}	For Paired Transitions	-150	150	ns
T_{LDEOP}	Upstream facing port source Jitter for Differential Transition to SE0 Transition	-40	100	ns
	Upstream facing port differential Receiver Jitter:			
T_{DJR1}	To Next Transition	-75	75	ns
T_{DJR2}	For Paired Transitions	-45	45	ns
	Upstream facing port differential Receiver Jitter:			
T_{DDJ1}	To Next Transition	-25	25	ns
T_{DDJ2}	For Paired Transitions	-14	14	ns
	Downstream facing port Differential Receiver Jitter:			
T_{UJR1}	To Next Transition	-152	152	ns
T_{UJR2}	For Paired Transitions	-200	200	ns
T_{LEOPT}	Source SE0 interval of EOP	1.25	1.50	μs
T_{LEOPR}	Receiver SE0 interval of EOP	670		ns
T_{LST}	Width of SE0 interval during differential transition		210	ns

6. Mechanical Information

Figure 6.1 48LQFP Mechanical Information Diagram



SYMBOLS	MIN.	MAX.
A	--	1.6
A1	0.05	0.15
A2	1.35	1.45
c1	0.09	0.16
D	9.00 BSC	
D1	7.00 BSC	
E	9.00 BSC	
E1	7.00 BSC	
e	0.5 BSC	
b	0.17	0.27
L	0.45	0.75
L1	1 REF	

1. JEDEC OUTLINE: MS-026 BBC
2. DIMENSIONS D1 AND E1 DO NOT INCLUDE MOLD PROTRUSION. ALLOWABLE PROTRUSION IS 0.25mm PER SIDE. D1 AND E1 ARE MAXIMUM PLASTIC BODY SIZE DIMENSIONS IMCLUDING MOLD MISMATCH.
3. DIMENSION b DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL NOT CAUSE THE LEAD WIDTH TO EXCEED THE MAXIMUM b DIMENSION BY MORE THAN 0.08mm

7. Abbreviations

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

SIE	Serial Interface Engine
UTMI	USB Transceiver Macrocell Interface

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.