

AU9254 R2

USB Hub Controller

Technical Reference Manual

Revision 1.0



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1.0 Introduction

1.1. Description

The AU9254 is an integrated single chip USB hub controller designed for the emerging industry-standard Universal Serial Bus (USB). The AU9254 supports four USB downstream ports. Each downstream port has power switch control, and over-current sensing.

Single chip integration makes the AU9254 the most cost effective stand-alone USB hub solution available in the market. Downstream ports can be used to connect various USB peripheral devices, such as USB printers, modems, scanners, cameras, mice, or joysticks to the system without adding external glue logic.

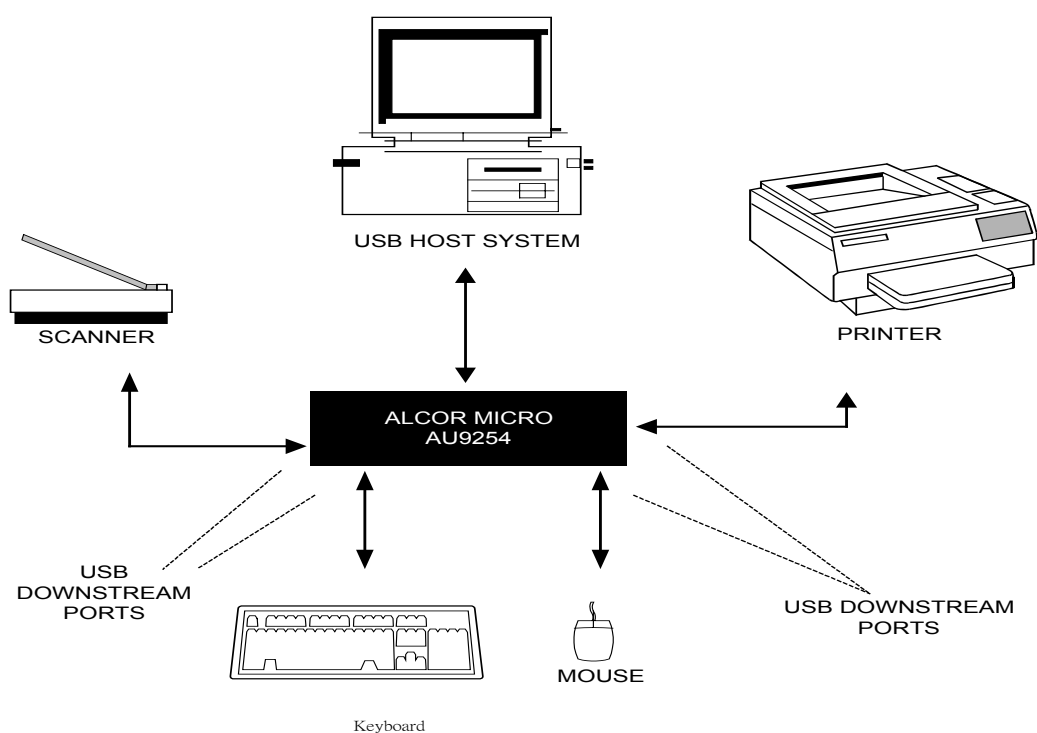
1.2. Features

- Fully compliant with the Universal Serial Bus Specification, version 1.1.
- USB hub design is compliant with Universal Serial Bus Hub Specification, revision 1.1.
- Single chip integrated USB hub controller with embedded proprietary processor.
- Supports four bus-powered/self-powered downstream ports.
- Built-in 3.3v voltage regulator allows single +5V operating voltage, resulting in reduced overall system cost.
- Runs at 12Mhz frequency.
- Available in 28-pin SSOP.

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2.0 Application Block Diagram

The AU9254 is a single chip 4-port USB hub controller. The upstream port is connected to the USB system. The downstream ports can be used for a mouse, joystick, scanner, printer or other device.



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APPLICATION BLOCK DIAGRAM **4**

3.0 Pin Assignment

The AU9254 is packaged as a 28-pin shrink small outline plastic package (SSOP). The figure on the following page shows the signal names for each of the pins on the chip. Accompanying the figure is the table that describes each of the pin signals.

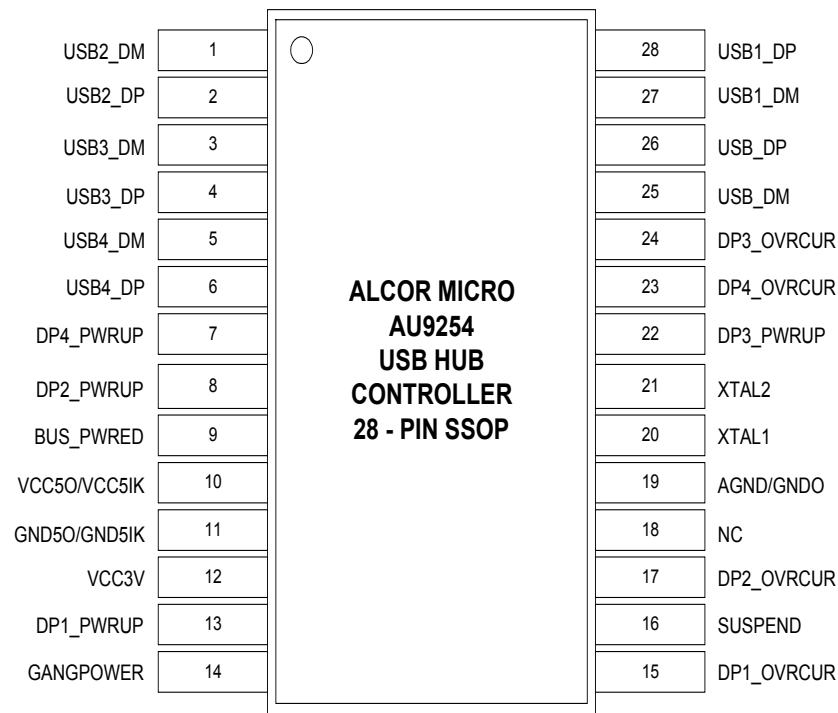


Table 3-1. Pin Descriptions for the 28-pin SSOP

Pin #	Pin Name	I/O	Description
1	USB_DM	I/O	USB D- for downstream port 2; add 15K Ω pull-down to ground.
2	USB2_DP	I/O	USB D+ for downstream port 2; add 15K Ω pull-down to ground.
3	USB3_DM	I/O	USB D- for downstream port 3; add 15K Ω pull-down to ground.
4	USB3_DP	I/O	USB D+ for downstream port 3; add 15K Ω pull-down to ground.
5	USB4_DM	I/O	USB D- for downstream port 4; add 15K Ω pull-down to ground.
6	USB4_DP	I/O	USB D+ for downstream port 4; add 15K Ω pull-down to ground.
7	DP4_PWRUP	O	Downstream port 4 power switch control. Active low.
8	DP2_PWRUP	O	Downstream port 2 power switch control. Active low.
9	BUS_PWRED	I	Bus power. Low indicates bus-powered.
10	VCC50/VCC5IK	PWR	+5 V power supply.
11	GND50/GND5IK	PWR	Ground.
12	VCC3V	PWR	3.3V output for upstream D+ pull-up.
13	DP1_PWRUP	O	Downstream port 1 power switch control. Active low.
14	GANGPOWER	I	Ganged or individual port power selection. Add a 10k pull down for ganged power. a 10k pull up for individual power.

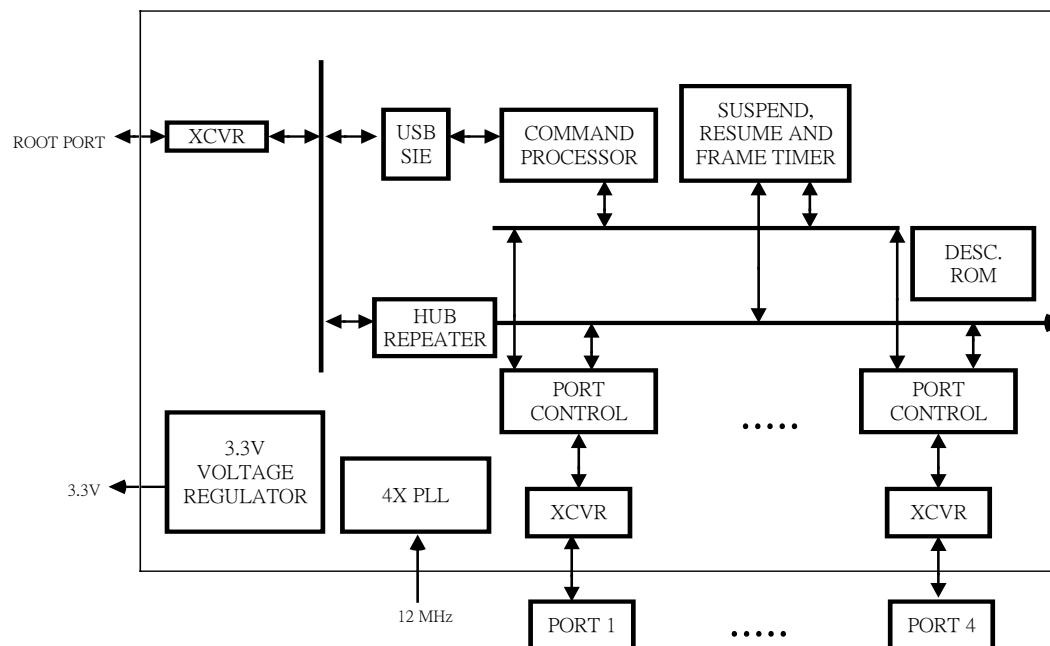
Table 3-1 (continued). Pin Description for the 28-pin SSOP

Pin #	Pin Name	I/O	Description
15	DP1_OVRCUR	I	Downstream port 1 over-current indicator. Active low.
16	SUSPEND	O	Device is in suspended state: Active high.
17	DP2_OVRCUR	I	Downstream port 2 over-current indicator. Active low.
18	NC		
19	AGND/GNDO	PWR	+5 V power supply.
20	XTAL_1	I	Crystal in.
21	XTAL_2	O	Crystal out.
22	DP3_PWRUP	O	Downstream port 3 power switch control. Active low.
23	DP4_OVRCUR	I	Downstream port 4 over-current indicator. Active low.
24	DP3_OVRCUR	I	Downstream port 3 over-current indicator. Active low.
25	USB_DM	I/O	USB D- for upstream.
26	USB_DP	I/O	USB D+ for upstream port. Need external 1.5K Ω pull-up to 3.3V.
27	USB1_DM	I/O	USB D- for downstream port 1; add 15K Ω pull-down to ground.
28	USB1_DP	I/O	USB D+ for downstream port 1; add 15K Ω pull-down to ground.

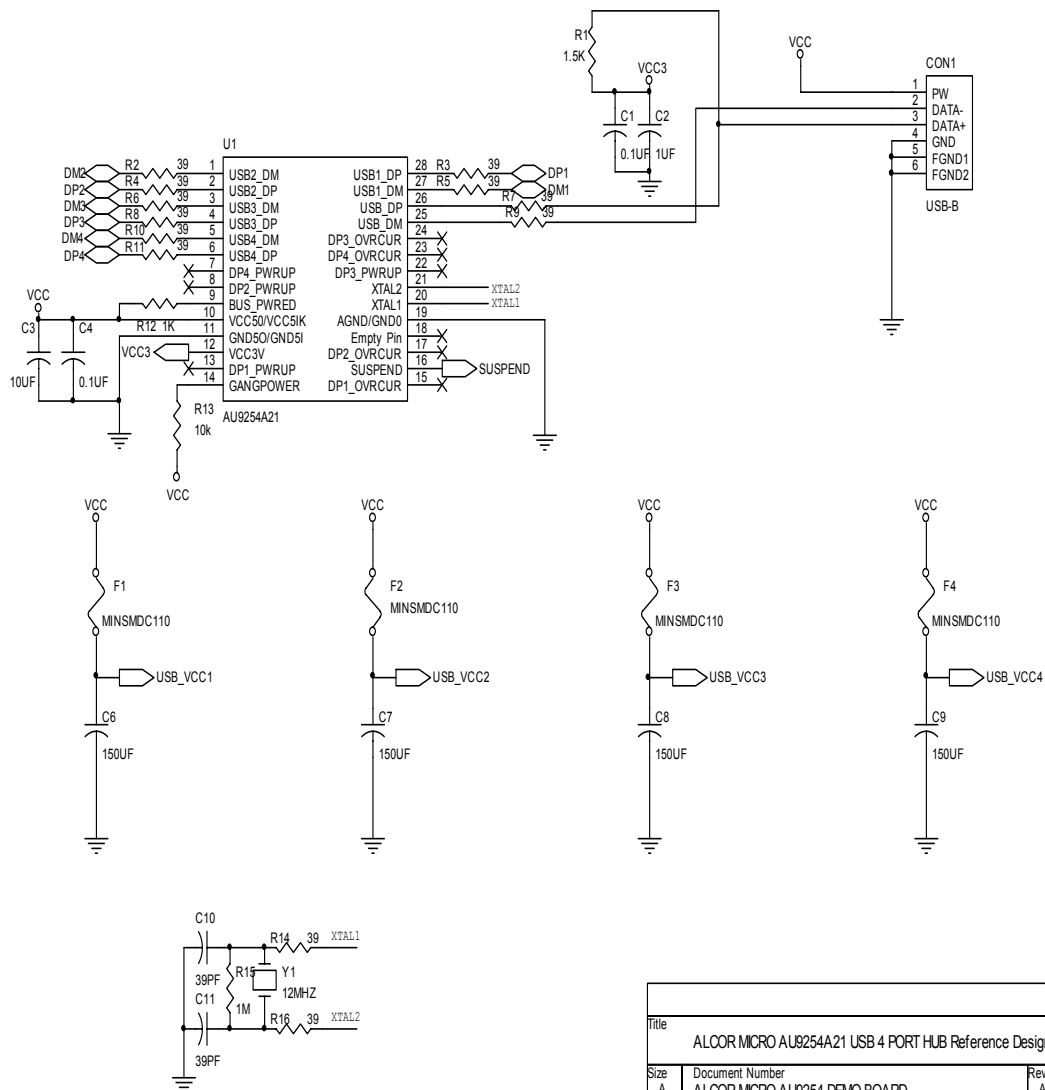
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4.0 System Architecture and Reference Design

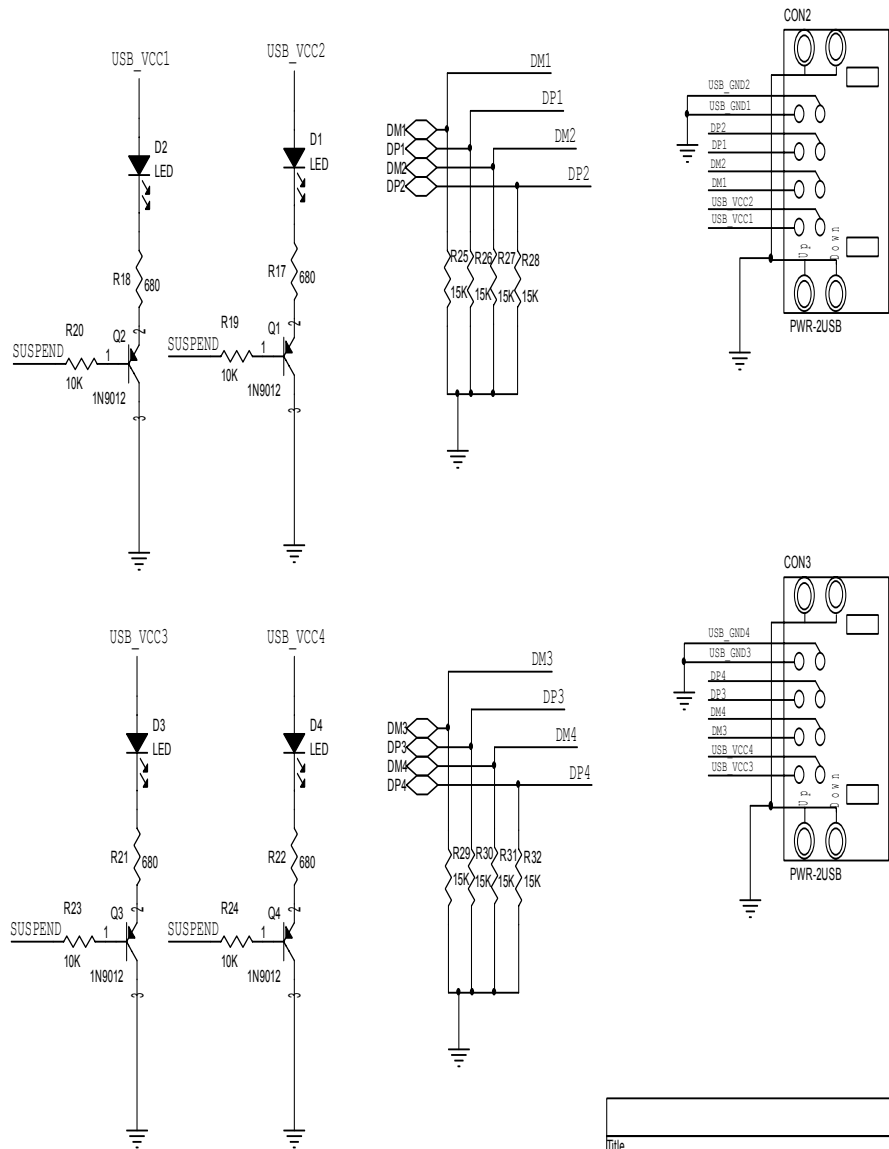
4.1. AU9254 Block Diagram



4.2 Sample Schematics

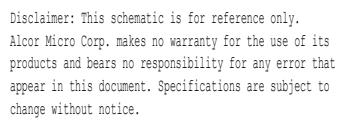


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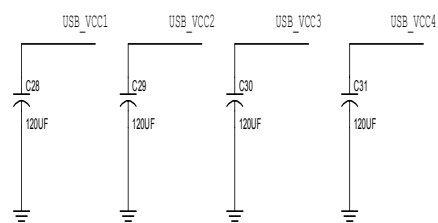
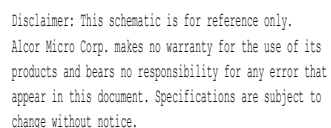


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Title		
ALCOR MICRO AU8254A21 USB 4 PORT HUB Reference Design		
Size	Document Number	Rev
A	ALCOR MICRO AU8254 DEMO BOARD	A
Date:	Wednesday, December 20, 2000	Sheet 2 of 2



Title			Alcor Micro Au254A21 USB 4 Port Hub Reference Design		
Size	Document Number				Rev
A4	Au254A21 USB Hub Buspower and Selfpower Changed				A
Date:	Thursday, September 13, 2001	Sheet	1	of	2



Title			
Alcor Micro Au254A21 USB 4 Port Hub Reference Design			
Size	Document Number		Rev
A4	Au254A21 USB Hub Buspower Selfpower Changed		A
Date:	Thursday, September 13, 2001	Sheet	2 of 2

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5.0 Electrical Characteristics

5.1. Absolute Maximum Ratings

SYMBOL	PARAMETER	RATING	UNITS
V _{CC}	Power Supply	-0.3 to 6.0	V
V _{IN}	Input Voltage	-0.3 to V _{CC} +0.3	V
V _{OUT}	Output Voltage	-0.3 to V _{CC} +0.3	V
T _{STG}	Storage Temperature	-40 to 125	°C

5.2. Recommended Operating Conditions

SYMBOL	PARAMETER	MIN	TYP	MAX	UNITS
V _{CC}	Power Supply	4.5	5.0	5.5	V
V _{IN}	Input Voltage	0		V _{CC}	V
T _{OPR}	Operating Temperature	-5		85	°C

5.3. General DC Characteristics

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
I _{IL}	Input low current	no pull-up or pull-down	-1		1	μA
I _{IH}	Input high current	no pull-up or pull-down	-1		1	μA
I _{OZ}	Tri-state leakage current		-10		10	μA
C _{IN}	Input capacitance			4		pF
C _{OUT}	Output capacitance			4		pF
C _{BID}	Bi-directional buffer capacitance			4		pF

5.4. DC Electrical Characteristics for 5 volts operation

(Under Recommended Operating Conditions and $V_{CC}=4.5\text{v} \sim 5.5\text{v}$, $T_j = -40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$)

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
V_{IL}	Input Low Voltage	TTL			0.8	V
V_{IL}	Input Low Voltage	CMOS			$0.3 \cdot V_{CC}$	V
V_{IL}	Schmitt input Low Voltage	TTL		1.10		V
V_{IL}	Schmitt input Low Voltage	CMOS		1.84		V
V_{IH}	Input High Voltage	TTL	2.2			V
V_{IH}	Input High Voltage	CMOS	$0.7 \cdot V_{CC}$			V
V_{IH}	Schmitt input High Voltage	TTL		1.87		V
V_{IH}	Schmitt input High Voltage	CMOS		3.22		V
V_{OL}	Output low voltage	$I_{OL}=2, 4, 8, 12, 16, 24 \text{ mA}$			0.4	V
V_{OH}	Output high voltage	$I_{OH}=2, 4, 8, 12, 16, 24 \text{ mA}$	3.5			V
R_I	Input Pull-up/down resistance	$V_{il}=0_V$ or $V_{ih}=V_{CC}$		50		$K\Omega$

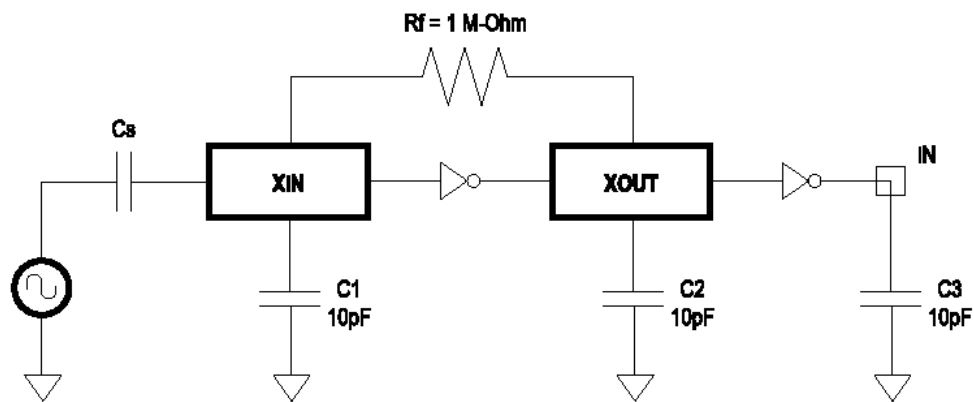
5.5. DC Electrical Characteristics for 3.3 volts operation

(Under Recommended Operating Conditions and $V_{CC}=3.0\text{v} \sim 3.6\text{v}$, $T_j = -40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$)

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
V_{IL}	Input Low Voltage	CMOS			$0.3 \cdot V_{CC}$	V
V_{IL}	Schmitt input Low Voltage	CMOS		1.22		V
V_{IH}	Input High Voltage	CMOS	$0.7 \cdot V_{CC}$			V
V_{IH}	Schmitt input High Voltage	CMOS		2.08		V
V_{OL}	Output low voltage	$I_{OL}=2, 4, 8, 12, 16, 24 \text{ mA}$			0.4	V
V_{OH}	Output high voltage	$I_{OH}=2, 4, 8, 12, 16, 24 \text{ mA}$	2.3			V
R_I	Input Pull-up/down resistance	$V_{il}=0_V$ or $V_{ih}=V_{CC}$		75		$K\Omega$

5.6. 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.



5.7. USB Transceiver Characteristics

RECOMMENDED OPERATING CONDITIONS

SYMBOL	PARAMETER	CONDITIONS	LIMITS		UNIT
			MIN	MAX	
V _{CC}	DC supply voltage		3.0	3.6	V
V _I	DC input voltage range		0	5.5	V
V _{I/O}	DC input range for I/Os		0	V _{CC}	V
V _O	DC output voltage range		0	V _{CC}	V
T _{AMB}	Operating ambient temperature range in free air	See DC and AC characteristics for individual device	0	70	C

ABSOLUTE MAXIMUM RATINGS (Notes 1 and 2)

In accordance with the Absolute Maximum Rating System, Voltages are referenced to GND (Ground=0v)

SYMBOL	PARAMETER	CONDITIONS	LIMITS		UNIT
			MIN	MAX	
V_{CC}	DC supply voltage		-0.5	+6.5	V
I_{IK}	DC input diode current	$V_i < 0$		-50	mA
V_i	DC input voltage	Note 3	-0.5	+5.5	V
V_{IO}	DC input voltage range for I/Os		-0.5	$V_{CC} + 0.5$	V
I_{OK}	DC output diode current	$V_o > V_{CC}$ or $V_o < 0$		+/-50	mA
V_o	DC output voltage	Note 3	-0.5	$V_{CC} + 0.5$	V
I_o	DC output source sink current for VP/VM and RCV pins	$V_o = 0$ to V_{CC}		+/-15	mA
I_o	DC output source or sink current for D+/D- pins	$V_o = 0$ to V_{CC}		+/-50	mA
I_{CC}, I_{GND}	DC V_{CC} or GND current			+/-100	mA
T_{STO}	Storage temperature range		-60	+150	C
P_{TOT}	Power dissipation per package				mW

NOTES:

1. Stresses beyond those listed may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated under "Recommended Operating Conditions" is not implied. Exposure to absolute maximum rated conditions for extended periods may affect device reliability.
2. The performance capability of a high performance integrated circuit in conjunction with its thermal environment can create junction temperatures which are detrimental to reliability. The maximum junction temperature of this integrated circuit should not exceed 150 C.
3. The input and output voltage ratings may be exceeded if the input and output clamp current ratings are observed.

DC ELECTRICAL CHARACTERISTICS

Over recommended operating conditions. Voltages are referenced to GND (Ground=0V).

SYMBOL PARAMETER		TEST CONDITIONS	LIMITS			UNIT
			-40 C to +85 C			
			MIN	TYP	MAX	
VHYS	Hysteresis on inputs	Vcc=3.0V to 3.6V (Note 3)	0.3	0.4	0.5	V
VIH	HIGH level input	Vcc=3.0V to 3.6V (Note 3)		1.5	2.0	V
VIL	LOW level input	Vcc=3.0V to 3.6V (Note 3)	0.8	1.1		V
RoH	Output impedance (HIGH state)	Note 2	28	34	43	ohm
RoL	Output impedance (LOW state)	Note 2	28	35	43	ohm
VOH	HIGH level output (Note 3)	Vcc=3.0V Io=6mA Vcc=3.0V Io=4mA Vcc=3.0V Io=100μA	2.2 2.4 2.8	2.7		V
VOL	LOW level output (Note 3)	Vcc=3.0V Io=6mA Vcc=3.0V Io=4mA Vcc=3.0V Io=100μA		0.3	0.7 0.4 0.2	V
IQ	Quiescent supply current	Vcc=3.6V VI=Vcc or GND Io=0		330	600	μA
Isup	Supply current in suspend	Vcc=3.6V VI=Vcc or GND Io=0			70	μA
IFS	Active supply current (Full Speed)	Vcc=3.3V		9	14	mA
ILS	Active supply current (Low Speed)	Vcc=3.3V		2		mA
ILeak	Imput leakage current	Vcc=3.6V VI=5.5V or GND, not for I/O Pins		+/- 0.1	+/- 0.5	μA
IOFF	3-state output OFF-state current	Vi=Vih or ViL; Vo=Vcc or GND			+/-10	μA

NOTES:

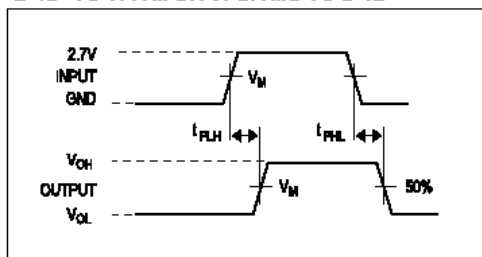
1. All typical values are at Vcc=3.3V and Tamb=25°C.
2. This value includes an external resistor of 24 ohm +/-1%. See "Load D+ and D-" diagram for testing details.
3. All signals except D+ and D-.

SYMBOL	PARAMETER	WAVEFORM	LIMITS (T_{AMB})					
			0 C to +25 C			0 C to +70 C		UNIT
			MIN	TYP	MAX	MIN	MAX	
tpLH tpHL	VMO/VPO to D+/D- Full Speed	1	0 0		12 12	0 0	14 14	ns
trise tfall	Rise and Fall Times Full Speed	2	4 4	9 9	20 20	4 4	20 20	ns
tRFM	Rise and Fall Time Matching Full Speed		90		110	90	110	%
tpLH tpHL	VMO/VPO to D+/D- Low Speed	1		120 120	300 300		300 300	ns
trise tfall	Rise and Fall Times Low Speed	2	75 75		300 200	75 75	300 200	ns
tRFM	Rise and Fall Time Matching Low Speed		70		130	70	130	%
tpLH tpHL	D+/D- to RCV	3		9 9	16 16		16 16	ns
tpLH tpHL	D+/D- to VP/VM	1		4 4	8 8		8 8	ns
tpHZ tpZH tpLZ tpZL	OE# to D+/D- $R_L = 500\Omega$	4			12 12 10 10		12 12 10 10	ns
tsu	Setup for SPEED	5	0					ns
Vcr	Crossover point ¹	3	1.3		2.0	1.3	2.0	V

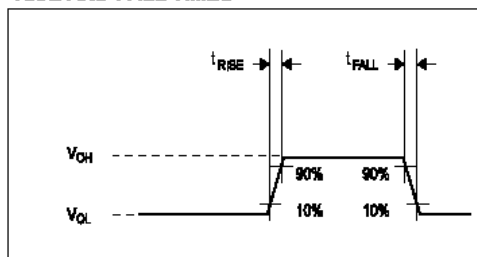
NOTES:

- The crossover point is in the range of 1.3V to 2.5V for the low speed mode with a 50 pF capacitance.

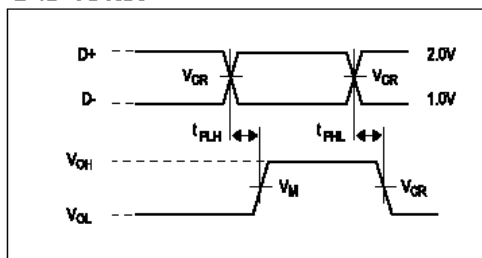
AC WAVEFORM 1.
D+/D- TO VP/VM OR VPO/VMO TO D+/D-



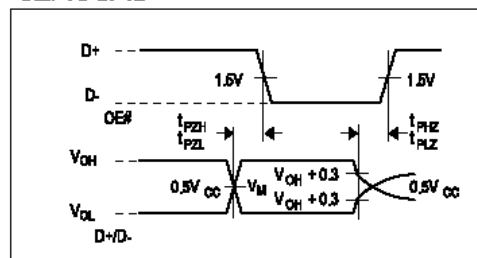
AC WAVEFORM 2.
RISE AND FALL TIMES



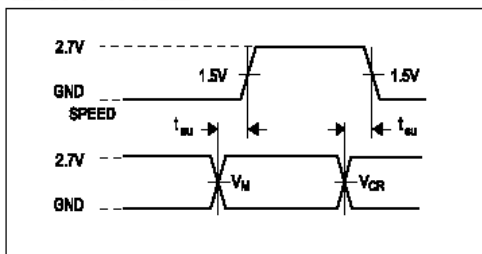
AC WAVEFORM 3.
D+/D- TO RCV



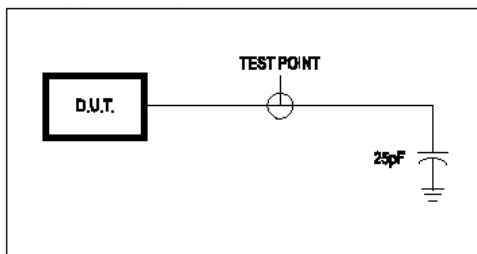
AC WAVEFORM 4.
OE# TO D+/D-



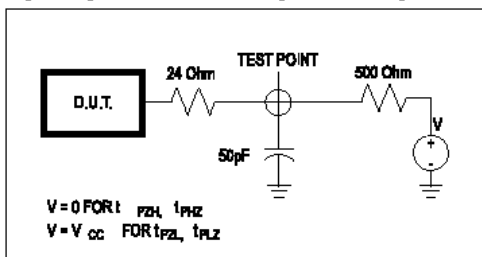
AC WAVEFORM 5.
SETUP FOR SPEED



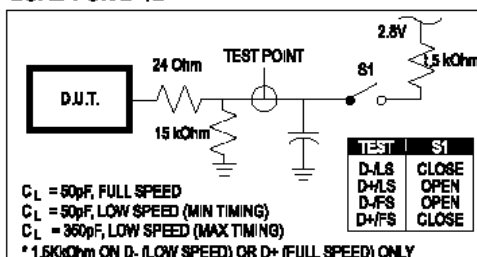
TEST CIRCUIT 1.
LOAD FOR VM/VP AND RCV



TEST CIRCUIT 2.
LOAD FOR ENABLE AND DISABLE TIMES



TEST CIRCUIT 3.
LOAD FOR D+/D-



5.8.ESD Test Results

Test Description: ESD Testing was performed on a Zapmaster system using the Human-Body-Model (HBM) and Machine-Model (MM), according to MIL-STD 883 and EIAJ IC-121 respectively.

- Human-Body-Model stresses devices by sudden application of a high voltage supplied by a 100pF capacitor through 1.5k-ohm resistance.
- Machine-Model stresses devices by sudden application of a high voltage supplied by a 200pF capacitor through very low (0 ohm) resistance.

Test Circuit & Condition

- Zap Interval: 1 second
- Number of Zaps: 3 positive and 3 negative at room temperature
- Criteria: I-V Curve Tracing

ESD Data

Model	Mode	S/S	Target	Results
HBM	Vdd, Vss, I/C	15	6000V	PASS
MM	Vdd, Vss, I/C	15	200V	PASS

5.9. Latch-Up Test Results

Test Description: Latch-Up testing was performed at room ambient using an IMCS-4600 system which applies a stepped voltage to one pin per device with all other pins open except Vdd and Vss which were biased to 5Volts and ground respectively.

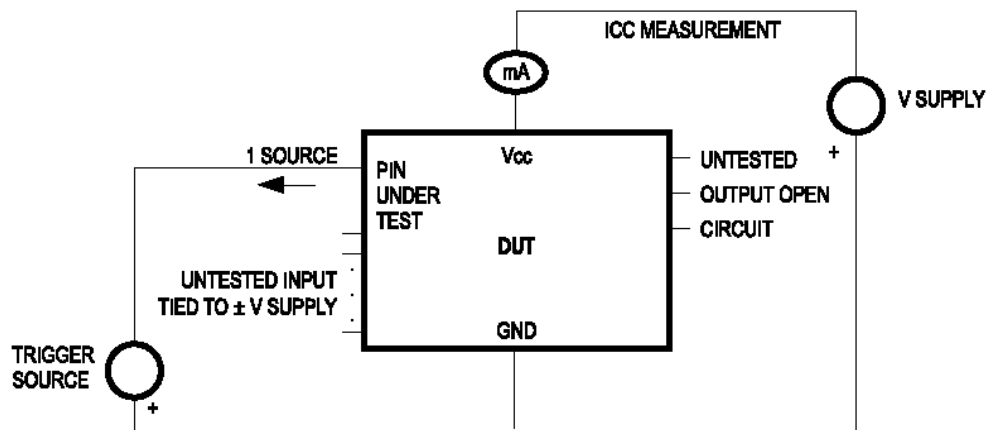
Testing was started at 5.0V (Positive) or 0V (Negative), and the DUT was biased for 0.5 seconds.

If neither the PUT current supply nor the device current supply reached the predefined limit (DUT=00mA, Icc=100mA), then the voltage was increased by 0.1Volts and the pin was tested again.

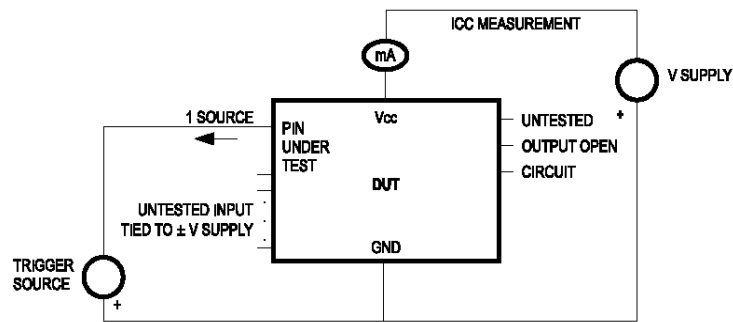
This procedure was recommended by the JEDEC JC-40.2 CMOS Logic standardization committee.

Notes:

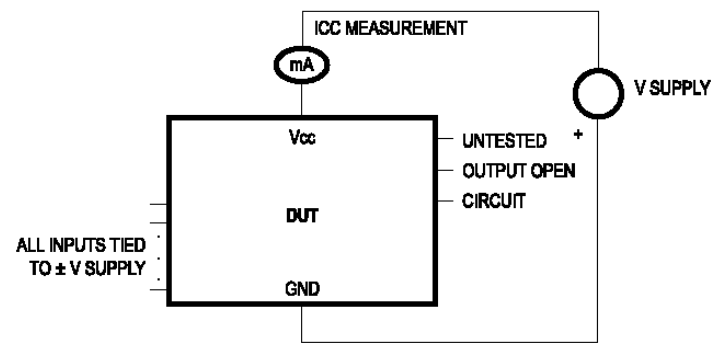
1. DUT: The device under test.
2. PUT: The pin under test.



Test Circuit: Positive Input/Output Overvoltage/Overcurrent



Test Circuit: Negative Input/Output Overvoltage/Overcurrent



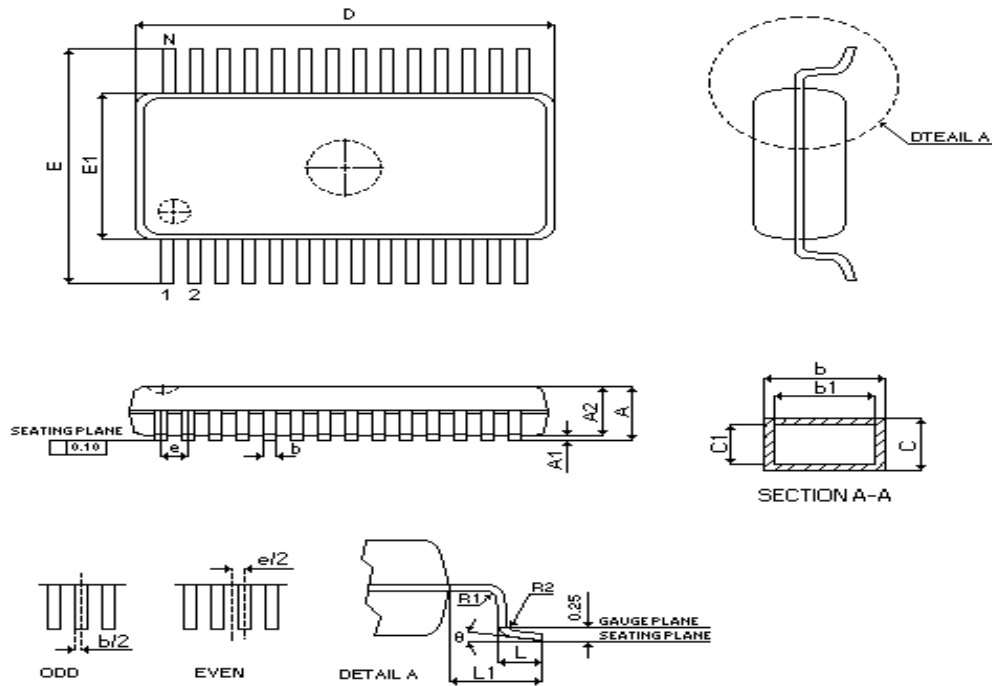
Supply Overvoltage Test

Latch-Up Data

Mode		Voltage (V)/CUI TENT(ma)	S/S	Results
Voltage	+	11.0	5	Pass
	-	11.0	5	Pass
Current	+	200	5	Pass
	-	200	5	Pass
Vdd - Vxx		9.0	5	Pass

6.0 Mechanical Information

Following diagrams show the dimensions of the AU9254 28-pin SSOP. Measurements are in inches. Dimensions do not include mold flash and dambar protrusion; allowable mold flash is 0.010 inch.



REV.	DESCRIPTION	BY	DATE
ORIG.	1. REGENERATED FROM PO-P402 VERSION"A"	JIMMY	97.04.21
	2. ADD GAUGE PLANE		
①	ADD CROSS SECTIONA-A" DRAWING	STEVEN	97.07.31
②	MODIFY 0.020 TO 0.002	IRIS	97.08.21
③	ADD E-PIN	IRIS	98.06.10
	CHANGE PIN "I" DOT DIMENSION		

SYMBOL	COMMON DIMENSION MILLIMETERS			COMMON DIMENSION INCH		
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A			2.00			0.079
A1	0.05			0.002		
A2	1.65	1.75	1.85	0.065	0.069	0.073
b	0.22		0.38	0.009		0.015
b1	0.22	0.30	0.33	0.009	0.012	0.013
c	0.09		0.25	0.004		0.010
c1	0.09	0.15	0.21	0.004	0.006	0.008
E	7.40	7.80	8.20	0.291	0.307	0.323
E1	5.00	5.30	5.60	0.197	0.209	0.220
e	0.65 BSC			0.0256 BSC		
L	0.55	0.75	0.95	0.021	0.030	0.037
L1	0.25 REF.			0.050 REF.		
R1	0.09			0.004		
θ	0°	4°	8°	0°	4°	8°

N	14	16	18	20	24	28
0 ± 0.30	6.20	6.20	7.20	7.20	8.20	10.20
JEDEC NO.	MO-150	MO-150	MO-150	MO-150	MO-150	MO-150
	AB	AC	AD	AE	AG	AH

UNLESS OTHERWISE SPECIFIED	DECMAL X $\pm$ XX ± 10 XXX $\pm .05$	ANGULAR $\pm 3^{\circ}$	ORENT SEMCONOUCTOR ELECTRONICS	UNIT	MM	SCALE : 10:1
DRAWN	IRIS 98.06.10		TITLE	SHEET:1 OF1		
CHECKED			SSOP 14/16/20/21/28L (209 MIL)	FILE: PD-P503C		A3
APPROVED			PACKAGE OUTLINE	DWG. NO. : PD-P503C		