AU9254 A21
USB Hub Controller
Technical Reference Manual

Revision 1.1

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1.0 Introduction

1.1. Description

The AU9254A21 is an integrated single chip USB hub controller designed for the emerging industry-standard Universal Serial Bus (USB). The AU9254A21 supports four USB downstream ports. Each downstream port has power switch control, and over-current sensing.
Single chip integration makes the AU9254A21 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.
- 28-pin SSOP package, both normal size (body size 209 mil) and smaller size (body size 150 mil) are available.

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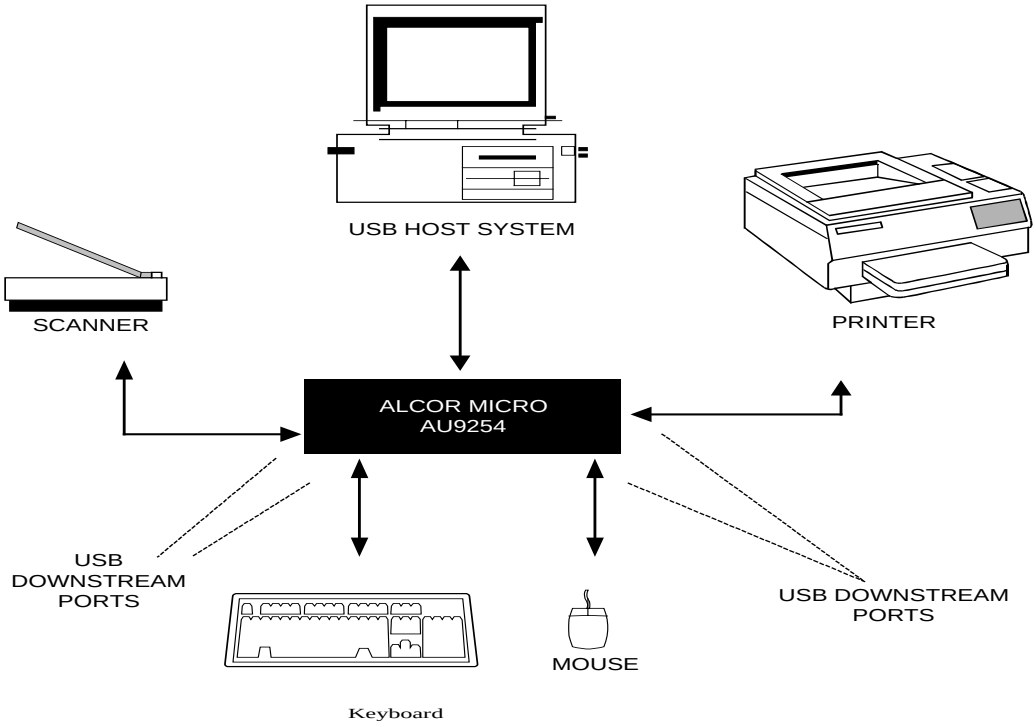
2.0 Application Block Diagram

The AU9254A21 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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3.0 Pin Assignment

The AU9254A21 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.

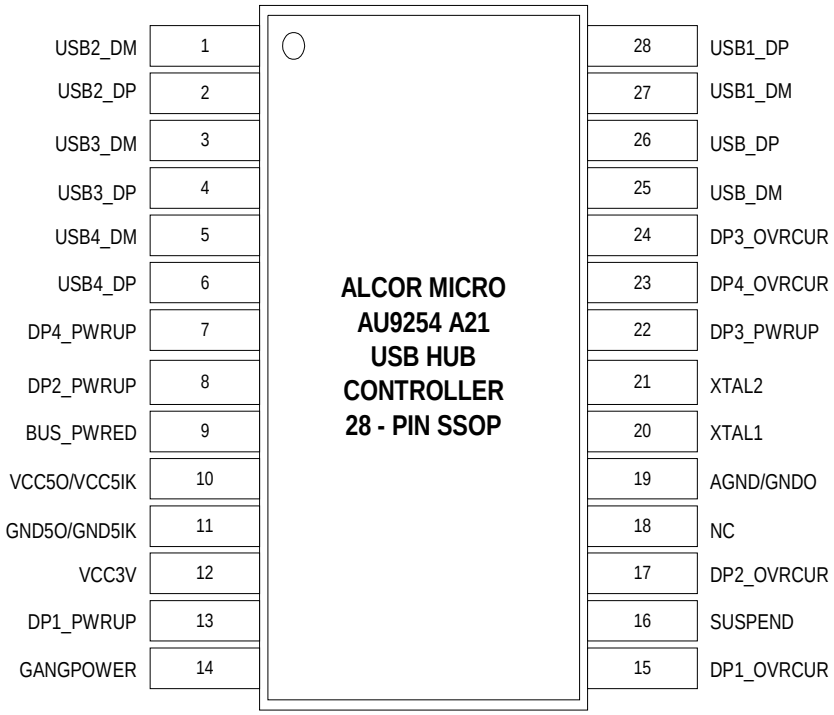

Table 3-1. Pin Descriptions of Au9254A21, 28-pin SSOP

Pin No	Pin Name	Input/Output	Description
1	USB_DM	Input/Output	USB D- for downstream port 2; add 15KΩ pull-down to ground.
2	USB2_DP	Input/Output	USB D+ for downstream port 2; add 15KΩ pull-down to ground.
3	USB3_DM	Input/Output	USB D- for downstream port 3; add 15KΩ pull-down to ground.
4	USB3_DP	Input/Output	USB D+ for downstream port 3; add 15KΩ pull-down to ground.
5	USB4_DM	Input/Output	USB D- for downstream port 4; add 15KΩ pull-down to ground.
6	USB4_DP	Input/Output	USB D+ for downstream port 4; add 15KΩ pull-down to ground.
7	DP4_PWRUP	Output	Downstream port 4 power switch control. Active low.
8	DP2_PWRUP	Output	Downstream port 2 power switch control. Active low.
9	BUS_PWRED	Input	Bus power. Low indicates bus-powered.
10	VCC5O/VCC5IK	Power	+5 V power supply.
11	GND5O/GND5IK	Power	Ground.
12	VCC3V	Power	3.3V output for upstream D+ pull-up.
13	DP1_PWRUP	Output	Downstream port 1 power switch control. Active low.
14	GANGPOWER	Input	Ganged or individual port power selection. Add a 10k pull down for ganged power. 10k pull up for individual power.
15	DP1_OVRCUR	Input	Downstream port 1 over-current indicator. Active low.

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

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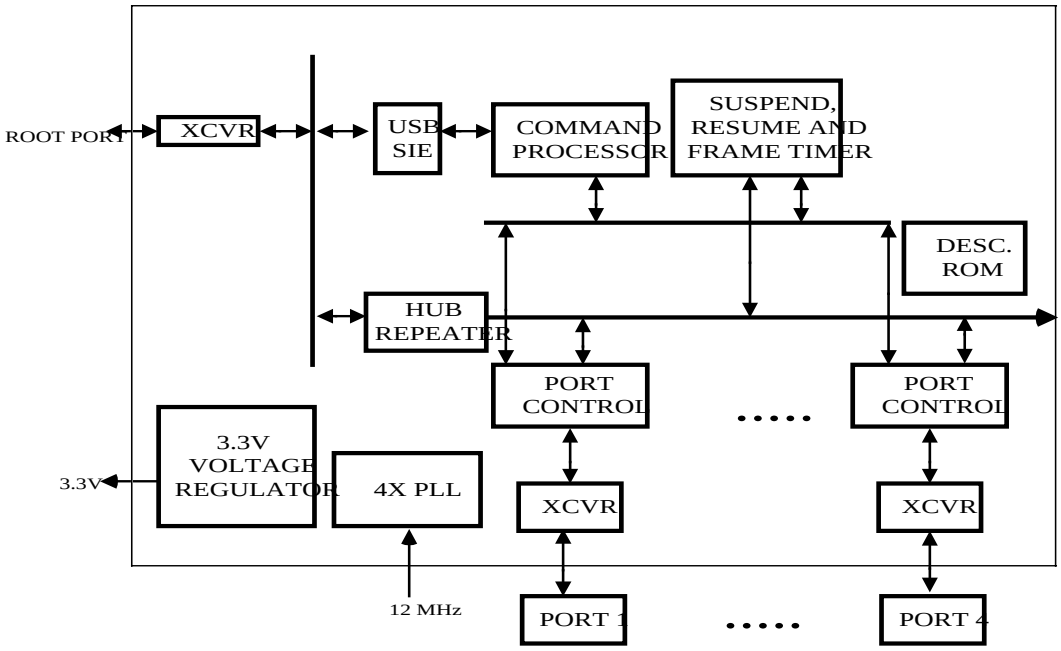
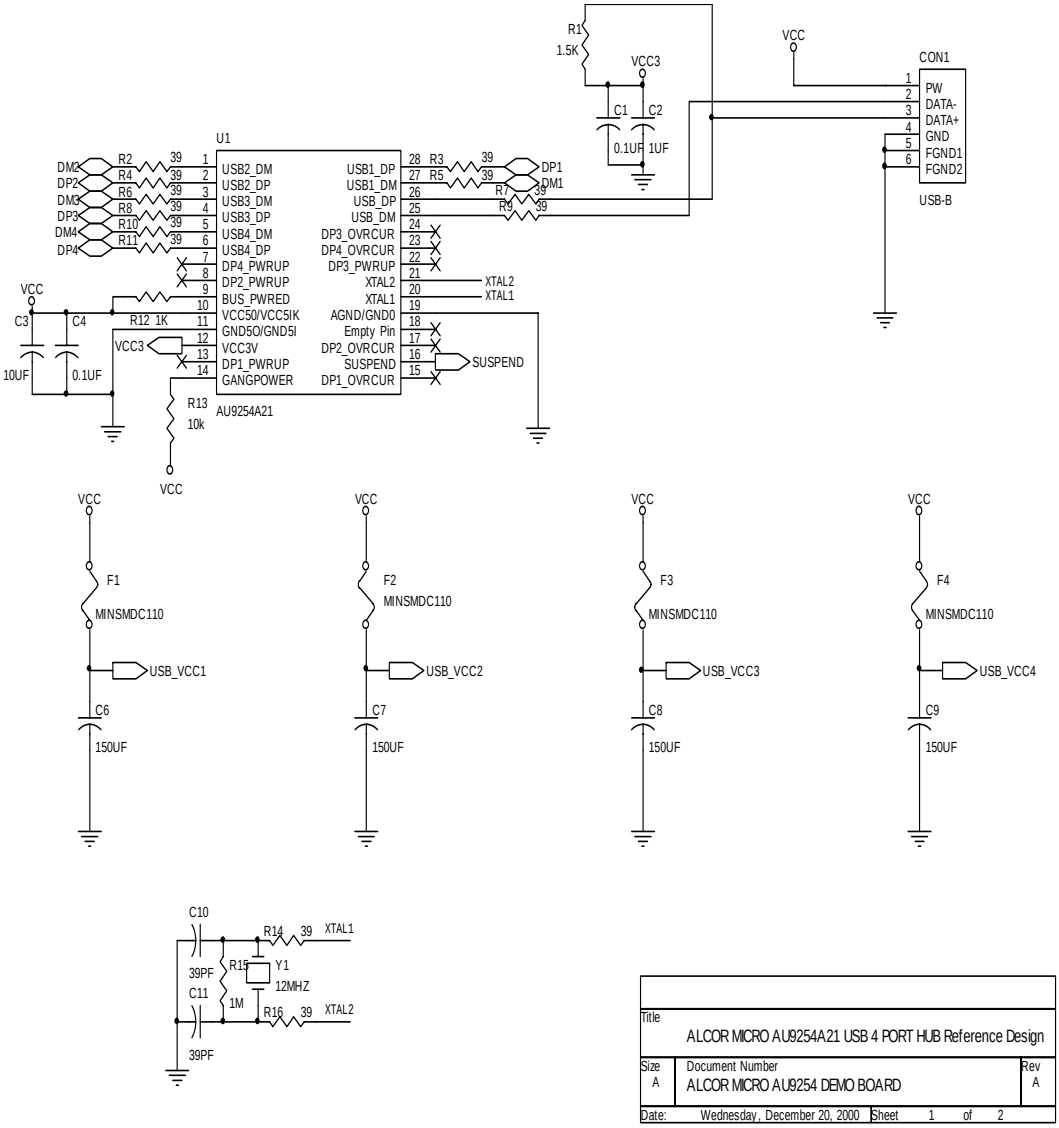
4.0 System Architecture and Reference Design

4.1. AU9254A21 Block Diagram



4.2 Sample Schematics



Title	ALCOR MICRO AU9254A21 USB 4 PORT HUB Reference Design	
Size A	Document Number ALCOR MICRO AU9254 DEMO BOARD	Rev A
Date: Wednesday, December 20, 2000	Sheet 1 of 2	

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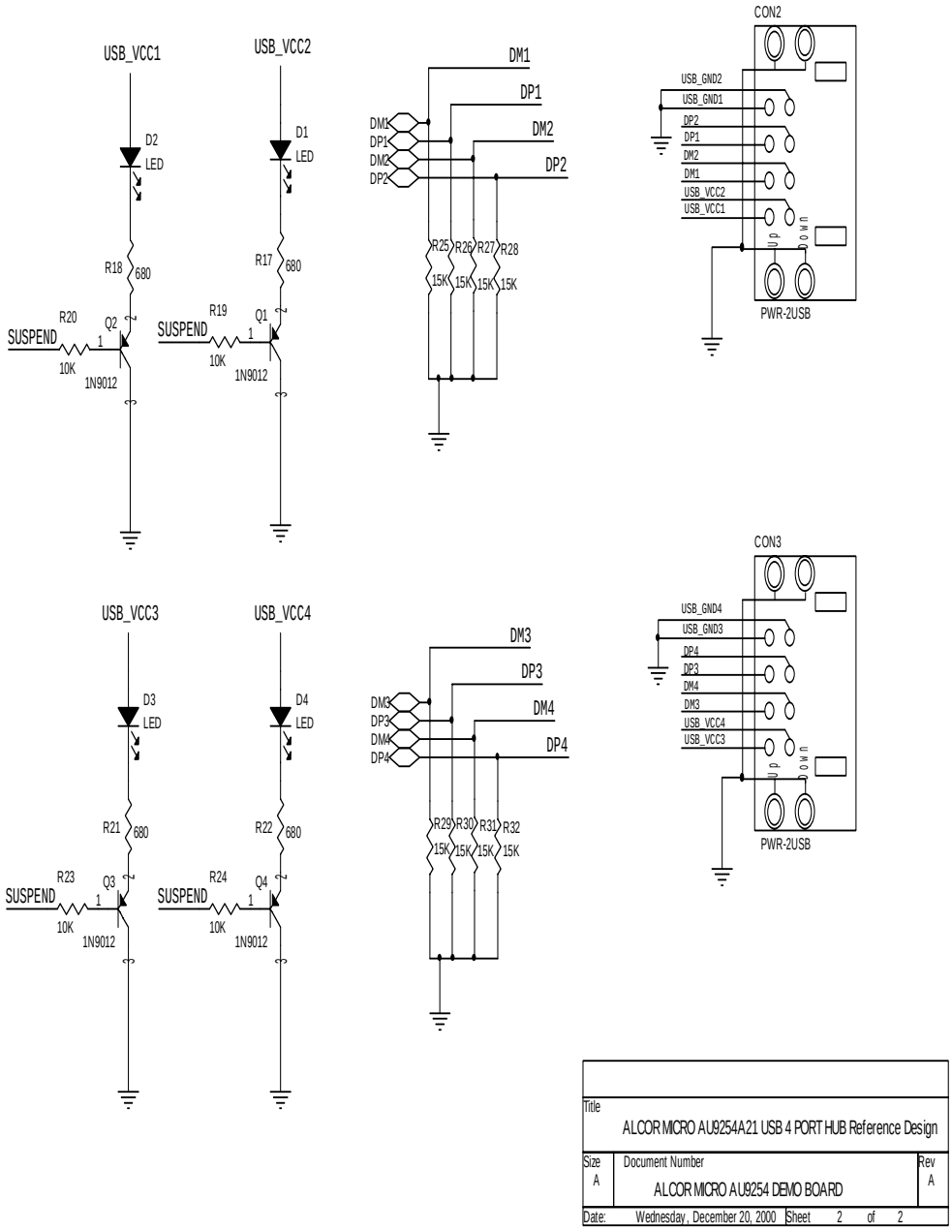

Title	ALCOR MICRO AU9254A21 USB 4 PORT HUB Reference Design	
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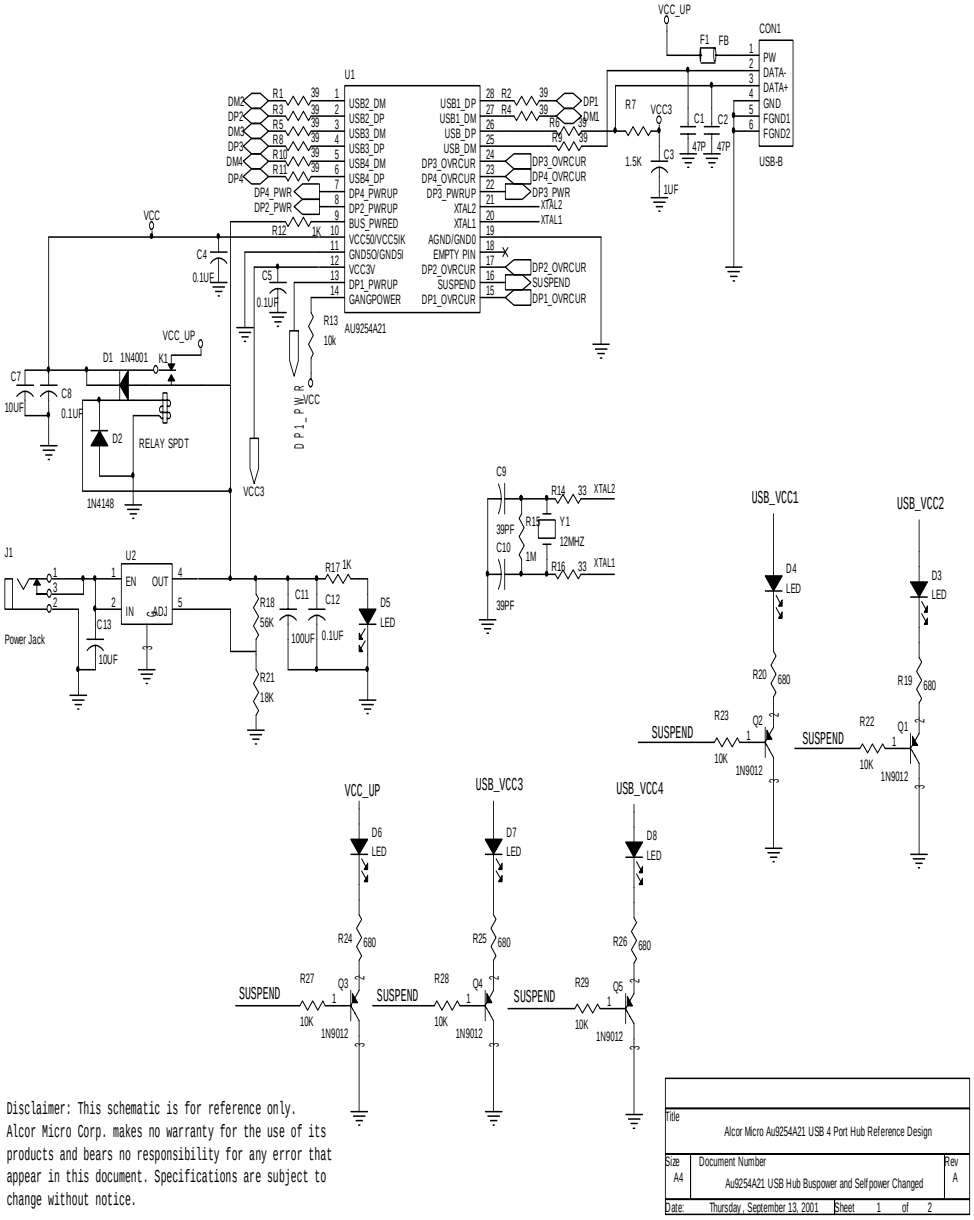
VCC_UP
F1 FB
CON1
PW
DATA-
DATA+
GND
FGND1
FGND2
USB-B
U1
AU9254A21
USB2_DM
USB2_DP
USB3_DM
USB3_DP
USB4_DM
USB4_DP
DP4_PWRUP
DP2_PWRUP
BUS_PWRED
VCC5O/VCC5IK
GND5O/GND5I
VCC3V
DP1_PWRUP
GANGPOWER
USB1_DP
USB1_DM
USB_DP
USB_DM
DP3_OVRCUR
DP4_OVRCUR
DP3_PWRUP
XTAL2
XTAL1
AGND/GND0
EMPTY PIN
DP2_OVRCUR
SUSPEND
DP1_OVRCUR
DP4_PWR
DP2_PWR
DP1_PWR
VCC
VCC3
1N4001
RELAY SPDT
1N4148
Power Jack
USB_VCC1
USB_VCC2
USB_VCC3
USB_VCC4
LED
SUSPEND
1N9012
12MHZ
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Title
Alcor Micro Au9254A21 USB 4 Port Hub Reference Design
Size
A4
Document Number
Au9254A21 USB Hub Buspower and Selfpower Changed
Rev
A
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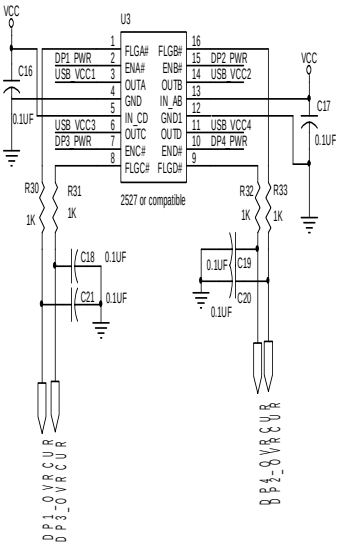

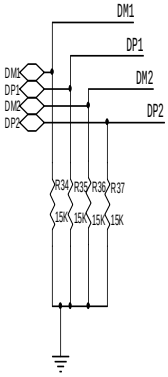

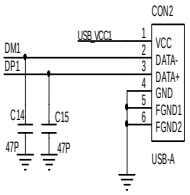

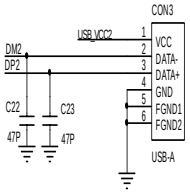

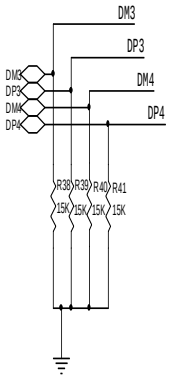

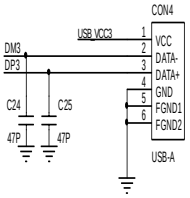

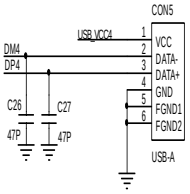

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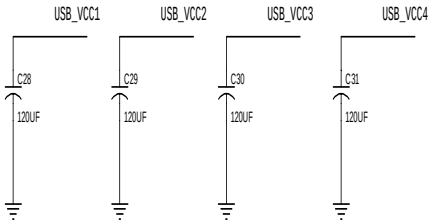

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Size A4	Document Number Au9254A21 USB Hub Buspower Selfpower Changed	Rev A
Date: Thursday, September 13, 2001	Sheet 2 of 2	

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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 VCC+0.3	V
V_{OUT}	Output Voltage	-0.3 to VCC+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		ρF
C_{OUT}	Output capacitance			4		ρF
C_{BID}	Bi-directional buffer capacitance			4		ρF

5.4. DC Electrical Characteristics for 5 volts operation

(Under Recommended Operating Conditions and V_{CC}=4.5v ~ 5.5v , Tj= -40^{O}C to + 85^{O}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*V_{CC}	V
V_{IL}	Schmitt input Low Voltage	TTL		1.10		V
V_{IL}	Schmitt input Low V oltage	CMOS		1.84		V
V_{IH}	Input High Voltage	TTL	2.2			V
V_{IH}	Input Hight Voltage	CMOS	0.7*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 mA			0.4	V
V_{OH}	Output high voltage	I_{OH}=2, 4, 8, 12, 16, 24 mA	3.5			V
R_I	Input Pull-up/down resistance	Vil=0_V or Vih=V_{CC}		50		KΩ

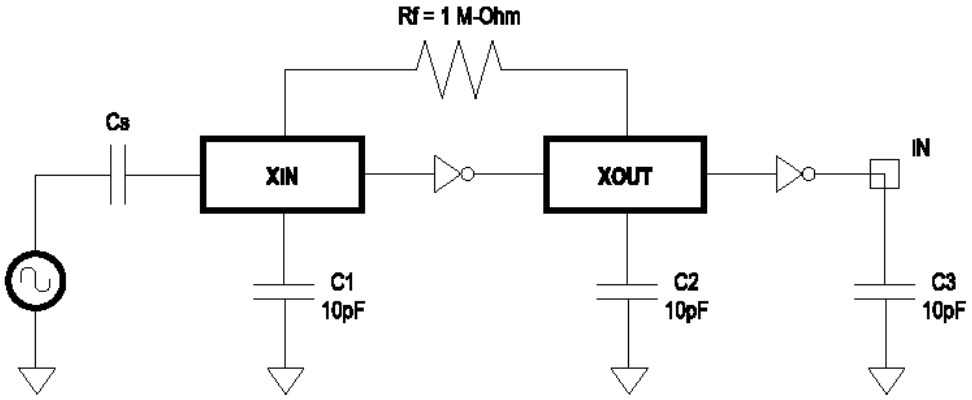
5.5. DC Electrical Characteristics for 3.3 volts operation

(Under Recommended Operating Conditions and V_{CC}=3.0v ~ 3.6v , Tj = -40^{O}C to +85^{O}C)

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
V_{IL}	Input Low Voltage	CMOS			0.3*V_{CC}	V
V_{IL}	Schmitt input Low Voltage	CMOS		1.22		V
V_{IH}	Input Hight Voltage	CMOS	0.7*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 mA			0.4	V
V_{OH}	Output high voltage	I_{OH}=2, 4, 8, 12, 16, 24 mA	2.3			V
R_I	Input Pull-up/down resistance	Vil=0_V or Vih=V_{CC}		75		KΩ

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 MIN	LIMITS MAX	UNIT
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 MIN	LIMITS MAX	UNIT
V_{CC}	DC supply voltage		-0.5	+6.5	V
I_{IK}	DC input diode current	Vi<0		-50	mA
V_I	DC input voltage	Note 3	-0.5	+5.5	V
$V_{I/O}$	DC input voltage range for I/Os		-0.5	Vcc +0.5	V
I_{OK}	DC output diode current	Vo> Vcc or Vo<0		+/-50	mA
V_O	DC output voltage	Note 3	-0.5	Vcc +0.5	V
I_O	DC output source sink current for VP/VM and RCV pins	Vo=0 to Vcc		+/-15	mA
I_O	DC output source or sink current for D+/D- pins	Vo= 0 to Vcc		+/-50	mA
I_{CC}, I_{GND}	DC Vcc 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 -40°C to +85°C			UNIT
			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-.

AC ELECTRICAL CHARACTERISTICS

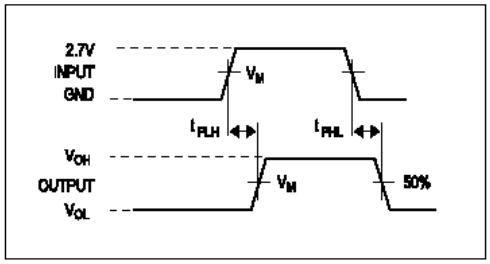
GND=0V, $t_R = t_F$ =3.0 ns; C_L =50 pF; RL=500 Ohms

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- RL = 500ohm	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

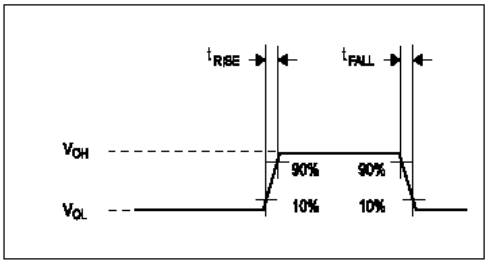
NOTES:

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

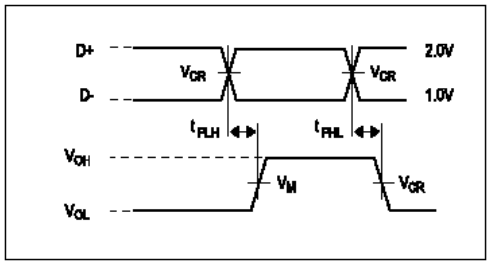
AC WAVEFORM 1.
D+/D- TO VP/VM OR VPO/VMO TO D+/D-



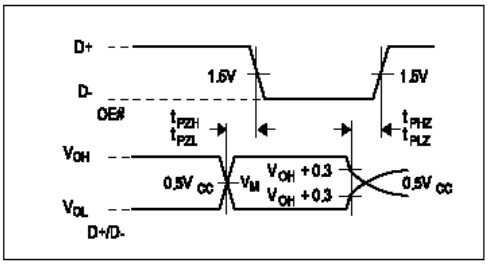
AC WAVEFORM 2.
RISE AND FALL TIMES



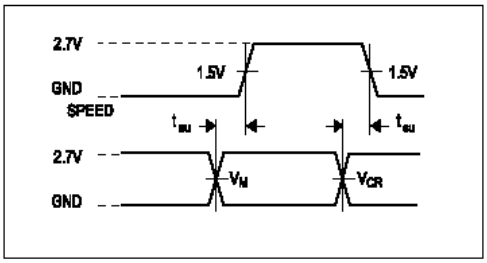
AC WAVEFORM 3.
D+/D- TO RCV



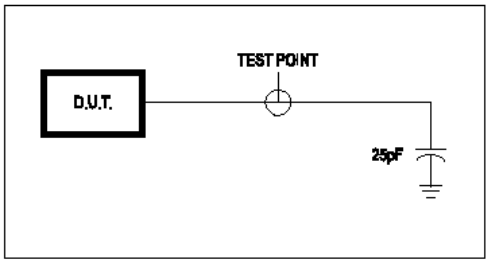
AC WAVEFORM 4.
OE# TO D/+/D-



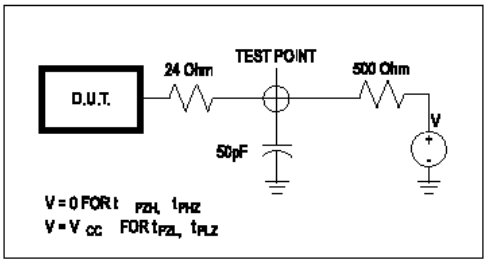
AC WAVEFORM 5.
SETUP FOR SPEED



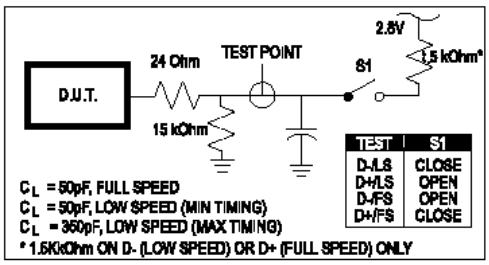
TEST CIRCUIT 1.
LOAD FOR VM/VP AND RCV



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

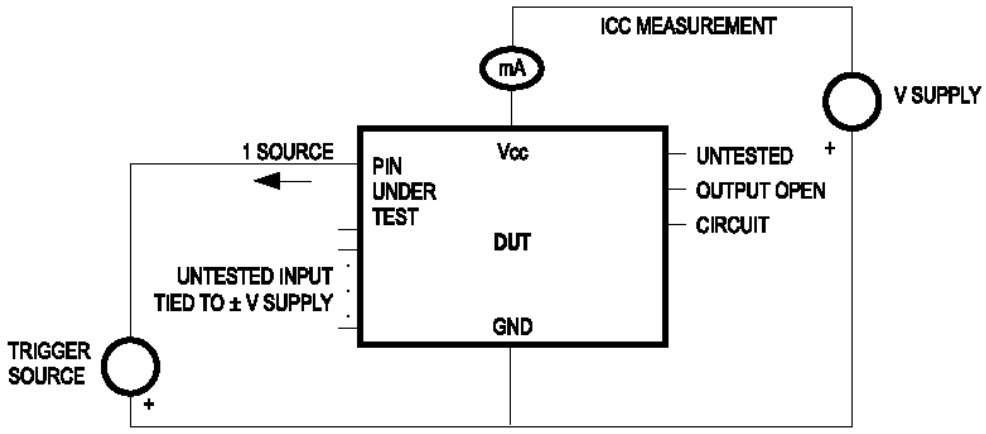
Test Description: Latch-Up testing was performed at room ambient using an IMCS-4600 system which applies a stepped voltage to one pin per device with all other pins open except Vdd and Vss which were biased to 5Volts and ground respectively.

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

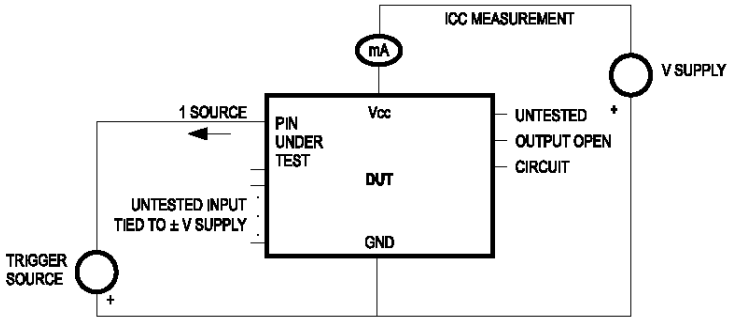
If neither the PUT current supply nor the device current supply reached the predefined limit (DUT=00mA, Icc=100mA), then the voltage was increased by 0.1Volts and the pin was tested again.

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

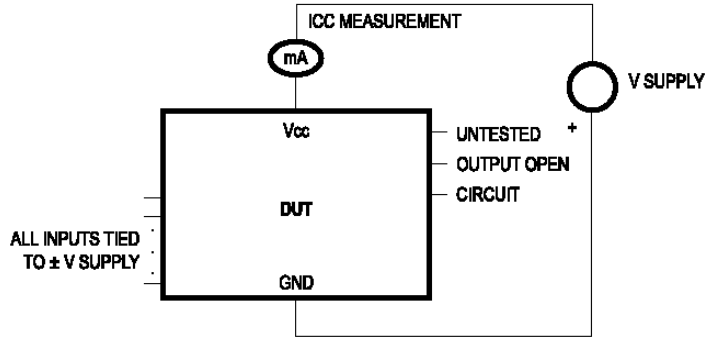
Notes:
1. DUT: The device under test.
2. PUT: The pin under test.



Test Circuit: Positive Input/Output Overvoltage/Overcurrent



Test Circuit: Negative Input/Output Overvoltage/Overcurrent



Supply Overvoltage Test

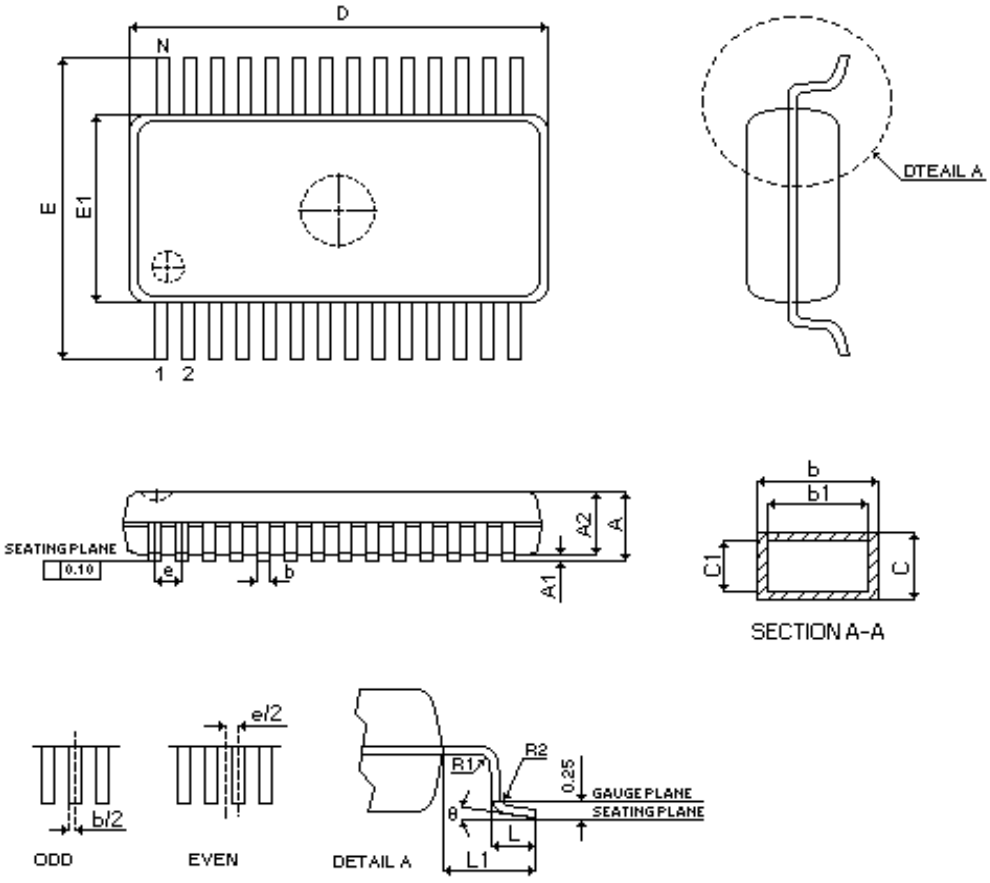
Latch-Up Data

Mode		Voltage (V) CUITENT(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

6.1. Normal Size Package (Body Size 209 mil)

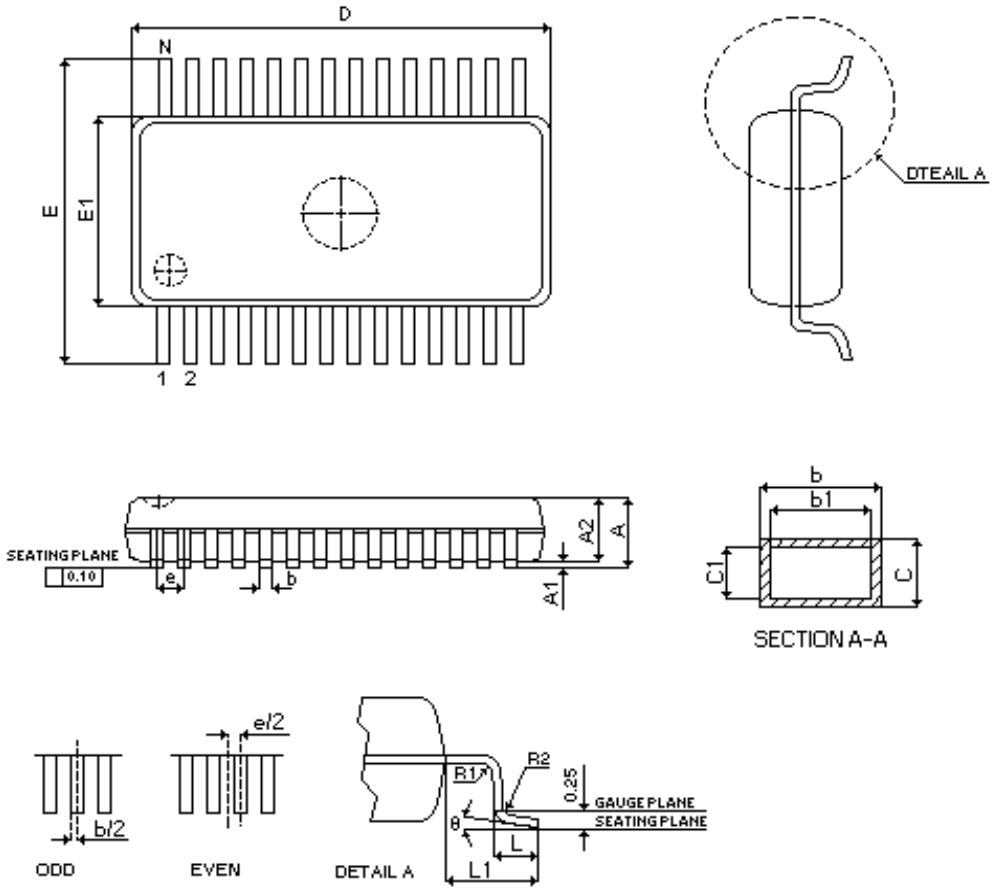
Following diagrams show the dimensions of the normal size 28-pin SSOP package. Measurements are in inches. Dimensions do not include mold flash and dambar protrusion; allowable mold flash is 0.010 inch.



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
D	9.9	10.2	10.5	0.390	0.402	0.413
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	0^0	4^0	8^0	0^0	4^0	8^0

6.2. Small Size Package (Body Size 150 mil)

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



SYMBOL	COMMON DIMENSION MILLIMETERS			COMMON DIMENSION INCH		
	MIN.	**NOM.**	**MAX.**	**MIN.**	**NOM.**	**MAX.**
A	1.35	1.63	1.75	0.053	0.064	0.069
A1	0.10	0.15	0.25	0.004	0.006	0.010
A2			1.50			0.059
b	0.20		0.30	0.008		0.012
b1	0.20	0.25	0.27	0.008	0.010	0.011
c	0.18		0.25	0.007		0.010
D	9.8	9.91	10.01	0.386	0.390	0.394
E	5.79	5.99	6.20	0.0228	0.236	0.244
E1	3.81	3.91	3.99	0.150	0.154	0.157
e	0.635 BSC			0.025 BSC		
L	0.41	0.635	1.27	0.016	0.025	0.050
L1	0.838 REF.			0.033 REF.		
R1	0.20			0.008		
θ	0^0		8^0	0^0		8^0