

ASM1543 Data Sheet

SuperSpeedPlus USB switch with Configuration
Channel Logic using for USB3.1 Type-C

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Environmentally hazardous materials are not used in this product.

Revision History

Rev.	Date	Description
0.1	June 26, 2015	Initial Release
0.2	September 9, 2015	Update pinout Update the general description and feature list Remove internal PWM regulator Add some electrical spec Add Package Information
0.3	October 16, 2015	Update the strapping table of I_SEL0/1 Update the electrical spec of CCs
0.4	December 31, 2015	Update the pin description
0.5	January 12, 2016	Add the chapter 6 for the application description
0.6	January 25, 2016	Add Figure 3 & 4 for AC/DC-coupling design description Update the description of section 2 Feature Update the description of VCONN in section 6 Update electrical characteristics spec Add the waveform of Figure 10.
0.7	Feb. 25, 2016	Correct the typo on page 10
0.8	April 14, 2016	Add the system power design requirement description and VCONN current requirement in chapter 6
1.0	June 28, 2016	Modify the general/feature description from Rp to Ip current Update the pin function description in Section 5 Update the description of VCONN current in Section 6 Add top marking and ordering number information
1.1	March 14, 2017	Update the power consumption table and thermal spec
1.2	August 10, 2017	Correct typo of section 7.3.2
1.3	August 30, 2017	Update the spec description of USB type-C Spec Remove dead battery support Add V_{DC-CMD} Electrical spec

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1. General Description

ASM1543 is a one Four to two differential channels mux switch with integrated Type-C Configuration Channel Logic Circuitry, using for USB3.1 type-C mux and CC detection application. The signal performance of mux switch is up to 10Gbps SuperSpeedPlus USB bus with low insertion loss and return loss, and it also supports USB plug orientation, configurable as DFP role or UFP role through the setting of strapping pins, and implementing the strapping for the setting/detection of Type-C current mode, following USB3.1 Revision 1.0 and USB Type-C Connector and Cable Revision 1.3 standard specification. ASM1543 also integrates CC bus voltage detector, and internal Ip current/Rd resistors and internal power switch with overcurrent protection to support VCONN 5V supply, using an industry standard 32 pins QFN Green package, compliant with RoHS, operating at 3.3V supply voltage for chip and 5V voltage for VCONN supply on e-mark cable.

2. Features

- ◇ USB3.1 type-C Swith with integrated CC Logic
- ◇ Compliant with Universal Serial Bus 3.1 Specification Revision 1.0
- ◇ Compliant with USB Type-C Cable and Connector Specification Release 1.3
- ◇ Four to two Differential Signal mux switch
- ◇ 10Gbps SuperSpeedPlus USB Bus Signal
- ◇ Low insertion loss: -1.78dB @5GHz
- ◇ Low return loss: -17.52dB @5GHz
- ◇ Low Off Isolation: -22.39dB@5GHz
- ◇ Low crosstalk: -31.6dB@5GHz
- ◇ -3dB bandwidth: 7.559GHz
- ◇ Low Bit-to-Bit Skew
- ◇ Integrated the function of CC Logic control
- ◇ Support USB type-C plug orientation
- ◇ Internal Ip current/Rd resistors, configurable to perform DFP or UFP role
- ◇ Capability to support different type-C current mode
- ◇ Control VBUS power enable/disable
- ◇ Support VCONN with internal power switch
- ◇ Support Overcurrent Protection on VCONN supply
- ◇ 3.3V power supply

Package Type

- ◇ Green Package 4x4 mm² QFN 32 (Pb-free)
- ◇ RoHS Compliance

3. Functional Diagram

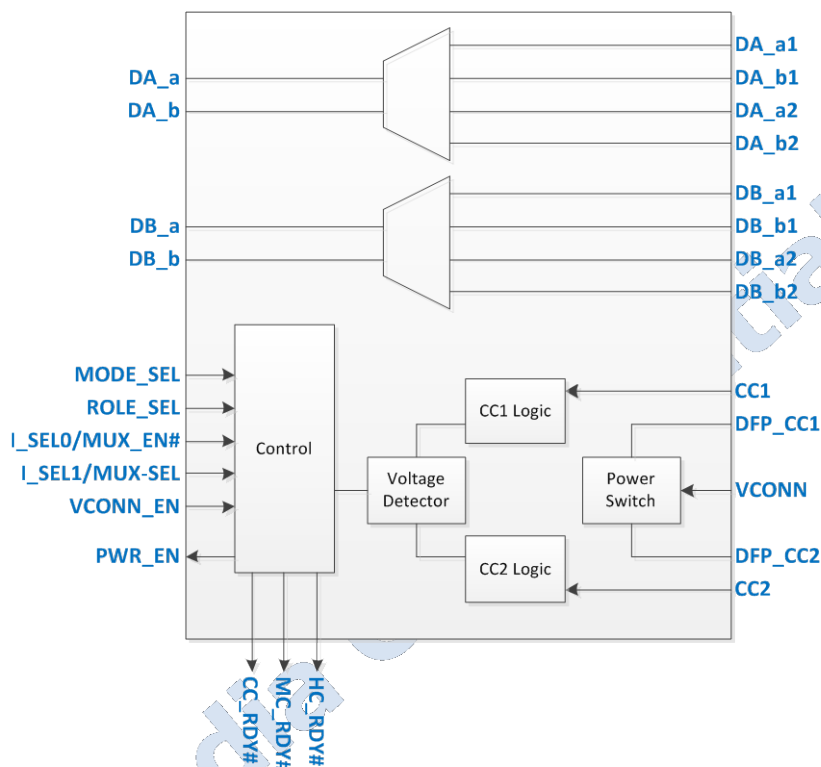


Figure 1: Functional Diagram of ASM1543

4. Pinout Diagrams

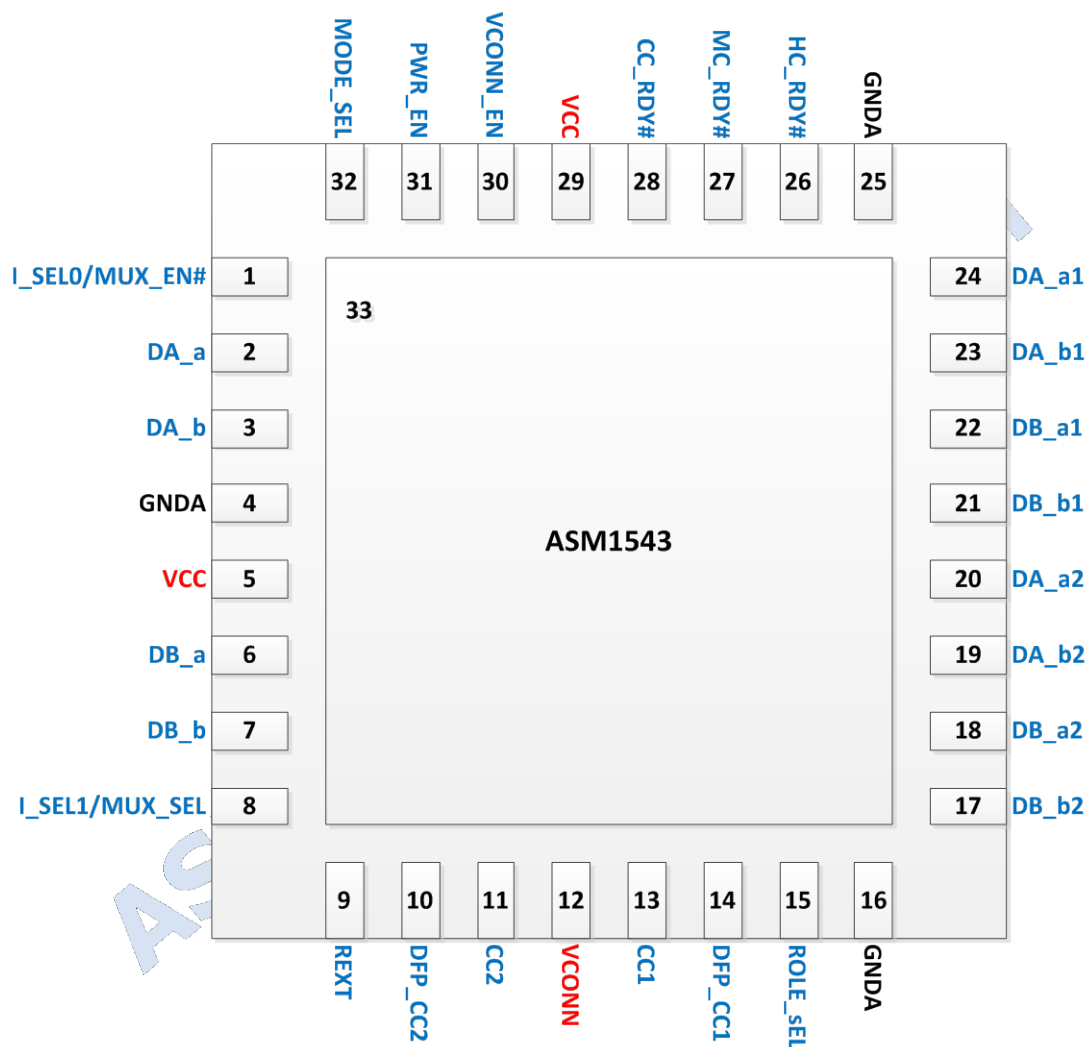


Figure 2: ASM1543 pinout

5. Pin Descriptions

This section provides a detailed description of each signal. The following notations are used to describe the signal type.

I/O Type	Definition
I	Input pin
O	Output pin
P	Power pin
G	Ground pin
OD	Open Drain

Pin name	Pin NO.	TYPE	Descriptions
DA_a	2	IO	Differential Channel connects to device controller for channel A
DA_b	3	IO	
DB_a	6	IO	Differential Channel connects to device controller for channel B
DB_b	7	IO	
DA_a1	24	IO	Differential Channel Lane 1 connects to type-C connector for channel A
DA_b1	23	IO	
DB_a1	22	IO	Differential Channel Lane 1 connects to type-C connector for channel B
DB_b1	21	IO	
DA_a2	20	IO	Differential Channel Lane 2 connects to type-C connector for channel A
DA_b2	19	IO	
DB_a2	18	IO	Differential Channel Lane 2 connects to type-C connector for channel B
DB_b2	17	IO	
CC1	13	I	Configuration Channel 1
CC2	11	I	Configuration Channel 2
DFF_CC1	14	O	Connect to CC1 when DFF mode; if UFP mode, not connected
DFF_CC2	10	O	Connect to CC2 when DFF mode; if UFP mode, not connected
MODE_SEL	32	I	As strapping pin to select as mux mode or CCL mode
ROLE_SEL	15	I	DFF or UFP Role select pins
VCONN_EN	30	I	Strapping for internal VCONN power switch enabling when DFF mode. When as 1, enable internal VCONN power switch When as 0, disable internal VCONN power switch
I_SEL0/MUX_EN#	1	I	As strapping pin for Type-C current mode when CCL mode, as Mux enable pin when MUX mode Refer to the below function table
I_SEL1/MUX_SEL	8	I	As strapping pin for Type-C current mode when CCL mode, as Mux Select pin when MUX mode Refer to the below function table
PWR_EN	31	OD	VBUS power enable pin
CC_RDY#	28	O	LED indicator when CC detect attached device Without device attached, default output high after power on
HC_RDY#	26	O	LED indicator In DFF mode, when I_SEL0/1 set up as 3A type-C current mode In UFP mode, when CC detect DFF support 3A type-C current Without device attached, default output high after power on
MC_RDY#	27	O	LED indicator In DFF mode, when I_SEL0/1 set up as 1.5A type-C current mode In UFP mode, when CC detect DFF support 1.5A type-C current Without device attached, default output high after power on
REXT	9	I	External 12.1Kohm resistor
VCONN	12	P	When DFF mode, 5V, 200mA VCONN suspend power supply input and internal LDO input When UFP mode, as internal LDO input only
VCC	5, 29	P	3.3V power input

GNDA	4, 16, 25	G	Analog ground
GND	33	G	Common ground

Strapping Table

MODE_SEL	Descriptions	Note
1	CCL mode, chip perform Mux with CC Logic	Default
0	Mux mode, chip perform as Mux only	

ROLE_SEL	Descriptions	Note
1	DFP role, remind to connect CCx and DFP_CCx and supply 5V suspend power	Default
0	UFP role Remind to open CCx and DFP_CCx	

Function Table

I_SEL1	I_SEL0	Descriptions	Note
1	1	When DFP, report as 3A VBUS capable When UFP, strapping as 3A VBUS required	Default
1	0	When DFP, report as 1.5A VBUS capable When UFP, strapping as 1.5A VBUS required	
0	1	When DFP, report as 900mA VBUS capable When UFP, strapping as 900mA VBUS required	
0	0	CC1 and CC2 will be High-Z, no matter DFP or UFP	

MUX_EN#	MUX_SEL	Descriptions	Note
1	X	DX_x1 & DX_x2 as Hi-Z state	Default
0	1	DX_x output to DX_x2	
0	0	DX_x output to DX_x1	

6. Function Description

ASM1543 is a mux switch chip, integrating the 10Gbps mux and Configuration Channel Controller, supporting up to 10Gbps high speed signals for USB Type-C application.

USB Plug Orientation support

For type-C application, there are two lanes of USB on connector to support USB plug flipping, in which a USB mux is required to perform such application. The direction of internal 10Gbps mux switch signal, selected by the strapping pin32 MODE_SEL, can be direct control by integrated Configuration Channel Controller, or the mux also can be controlled by external glue Logic or Power Delivery Controller. Once the function of MODE_SEL is selected, do not change it after the chip is power on.

USB Data Role select

ASM1543 can be configured as host mode (DFP role) or device mode (UFP role) through the select pin15 ROLE_SEL. It does not support Audio mode and Debug mode defined in updated Type-C specification. When ASM1543 perform as DFP role, it can detect cable or USB device plug-in. When cable attached without device, the VCONN and VBUS still stop to supply, until attached device detected. Once device detached, the VCONN and VBUS will stop to supply and VCONN bus will be discharged. It is default as DFP role when power on and is configured as UFP role when the ROLE_SEL pin drive to low externally. For dead battery supporting, when ASM1543 performs as DFP role with VCONN supply supporting, the CC1/CC2 should be connected with DFP_CC1/DFP_CC2, and both of VCC and VCONN should be suspend-powered. Otherwise, the connection can be ignored.

USB Type-C current mode select

According USB Type-C specification, there are three levels for USB Type-C current mode, ranging from 900mA, 1.5A and 3A high current mode. The different resistor value or different current mirror level indicates those three levels. ASM1543 implements precise current mirror and selectable through two GPIOs, I_SEL0 and I_SEL1. When ASM1543 performs as DFP role and I_SEL0/I_SEL1 is configured, the internal current mirror of CC Logic drives out a suitable current on CC bus. When it performs as UFP role, the I_SEL0/I_SEL1 configuration is used for the threshold level setup of internal voltage detector.

AC-Coupling design

ASM1543 can support 0V to 2V common mode on 10Gbps high speed mux. According to the specification, The SuperSpeed USB should be AC-coupling Signals and AC couple capacitors are requested on Transmitter signals. For the compatibility requirement, it is strongly recommended to put the capacitors between connector and ASM1543. Once the the common mode level of USB controller is over range of 0V to 2V, the extra capacitors on both Receiver and Transmitter bus are required between controller and ASM1543, and the external pull-down resistors to ground on both Receiver and Transmitter bus between connector and ASM1543 are necessary.

- 1.) When USB controller drives the DC common mode within the range of ASM1543's spec, it uses the DC coupling circuit between USB host and ASM1543. Other buses of ASM1543 must be AC coupling circuit.

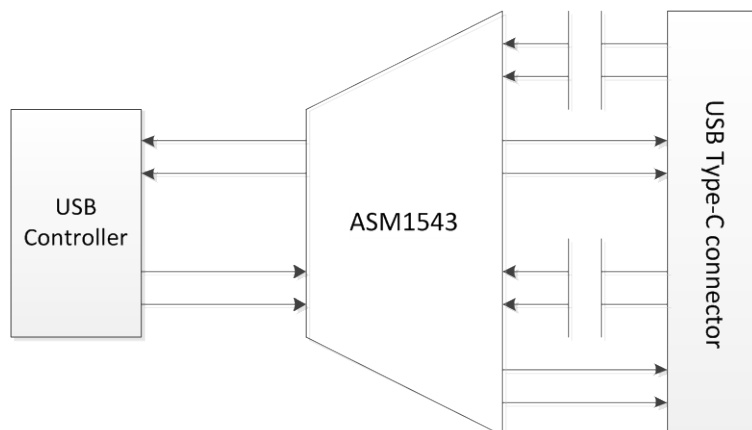


Figure 3: Example 1, USB controller DC common mode level within ASM1543 range

- 2.) When USB Controller drives the DC common mode level over the range of ASM1543's spec, it uses the AC coupling on all buses of ASM1543 with pull down resistors.

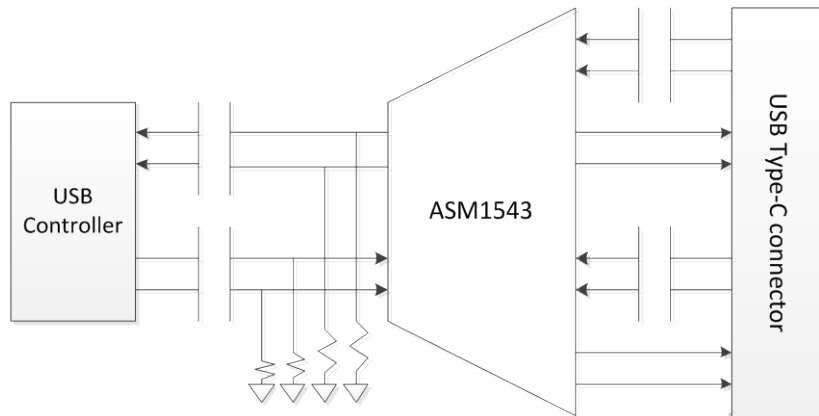


Figure 4: Example 2, USB controller DC common mode level out of ASM1543 range

VCONN supply

ASM1543 supports VCONN supply when it is as DFP role and it can be disabled when pin30 VCONN_EN drive to low. When ASM1543 is configured as DFP role with VCONN function, the additional power is supplied on power pin12 VCONN. There is an internal power switch for VCONN supply on CC bus. Once CC1 or CC2 detect a Ra exist, the VCONN will supply 5V on this CC bus. This internal power switch supports minimum 200mA over current protection. It is strongly recommend at least 600mA source current capability for VCONN supply.

VBUS Power Control

The pin31 PWR_EN could be used for VBUS power control. When ASM1543 is configured as DFP role, the PWR_EN will drive out high after CC1 or CC2 detects the device plug-in. It will drive low when device plug-out. For UFP role, the PWR_EN will drive high when CC1 or CC2 detect the DFP host plug-in and the USB type-C current level of DFP host meets the I_SELO/I_SEL1 of ASM1543 configuration requirement.

System Power design

ASM1543 operates by 3.3V supply for IO and Logic control, but it also requests 5V supply input on pin12 for VCONN supporting. Due to the feature of dead battery, suspend power is necessary for ASM1543. But, to avoid the leakage into 5V supply from 3.3V suspend power supply, it is strongly recommend having the same power design for 3.3V and 5V supply in. If 3.3V power turns on, 5V VCONN power turns on. Once 3.3V turns off, 5V VCONN must turn off, too.

LED behavior

There are three LED pins on ASM1543.

- 1.) The pin28 CC_RDY# drives low when CC1 or CC2 detects device/host plug-in.
- 2.) The pin27 MC_RDY# is used to indicate the status for USB Type-C current 1.5A mode. When ASM1543 is used as DFP role, it will drive low after I_SELO/I_SEL1 configures as USB Type-C current 1.5A capability mode. When ASM1543 is used for UFP role, it also drives low after it detects that host DFP can support USB Type-C current 1.5A or above capability.
- 3.) The pin26 HC_RDY# is used to indicate the status for USB Type-C current 3A mode. When ASM1543 is used as DFP role, it will drive low after I_SELO/I_SEL1 configures as USB Type-C current 3A capability mode. When ASM1543 is used for UFP role, it also drives low after it detects that host DFP can support USB Type-C current 3A capability.

The following diagrams show the basic application for host mode (DFP role) and device mode (UFP role) and mux mode (with Power Delivery Controller)

While ASM1543 performs as DFP mode, it is strongly recommend to use suspend power as supply of ASM1543.

Figure 5: ASM1543 perform DFP role with CCL mode

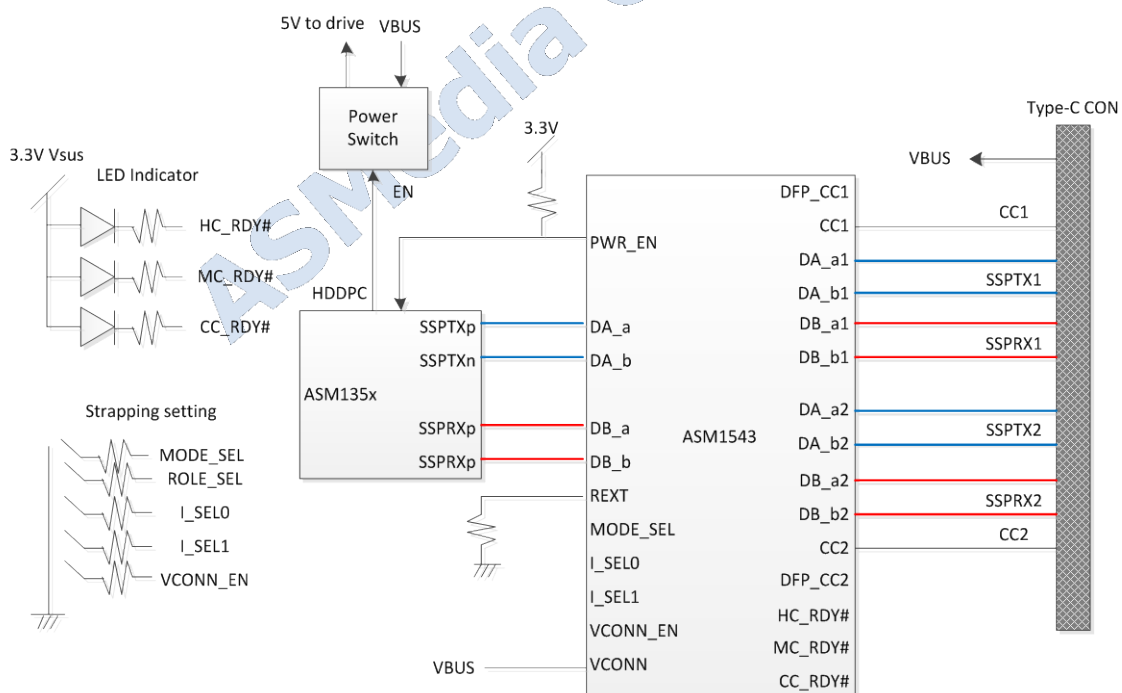


Figure 6: ASM1543 perform UFP role with CCL mode

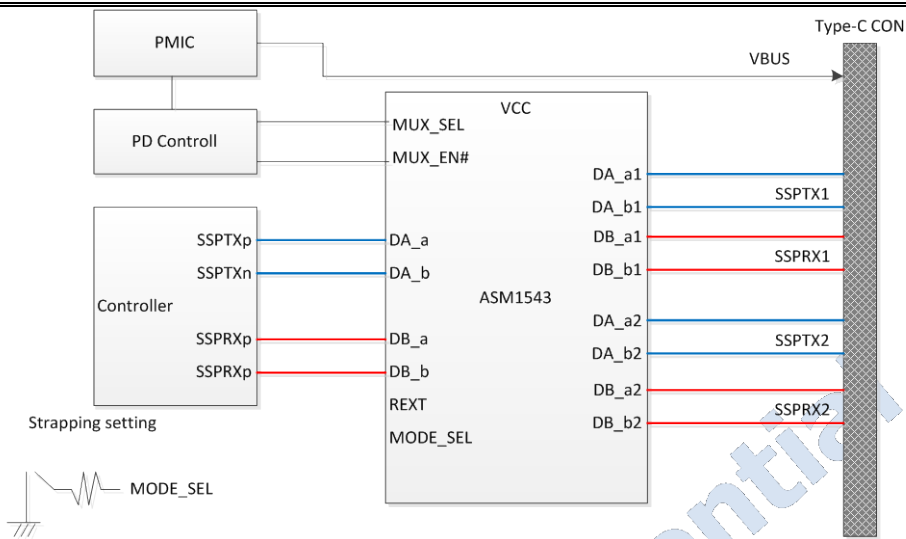


Figure 7: ASM1543 perform with Mux mode

7. Electrical Characteristics

7.1 Absolute Maximum Ratings

Stresses the below parameter listed under absolute maximum rating may cause the device permanent damage. This is a stress rating only, and the function operating of the device at these or any other conditions over those parameter in the recommended operating condition is not implied. It is recommended to have a clamp circuit to protect the device with abnormal exhibit voltage spikes while power is switched on or off.

Parameter	Range	Unit
Power Supply	-0.5 ~ VCONN+0.5	V
DC Input Voltage	-0.5 ~ VCC+0.5	V
Output Voltage	-0.5 ~ VCC+0.5	V
Storage Temperature	JEDEC J-STD-033B MSL 3	

7.2 Recommended Operating Conditions

Symbols	Parameter	Min.	Typ.	Max.	Units	Remark
V _{CONN}	VCONN Suspend Power Supply	4.5	5	5.5	V	
V _{CC}	VCC power supply from internal linear regulator	3.0	3.3	3.6	V	
I _{CC}	VCC current consumption @DFP mode	0.8	1.30	1.8	mA	
	VCC current consumption @UFP mode	0.55	0.95	1.35	mA	
	VCC current consumption @Mux mode	0.32	0.62	0.92	mA	
P _{VCC_ACT}	Total Power consumption @DFP mode (non-device)	3.3	4.9	6.5	mW	w/ VCONN power switch
	Total Power consumption @UFP mode (non-device)	2.7	4.1	5.5	mW	
	Total Power consumption @Mux mode	1	2	3	mW	
P _{VCC_IDLE}	Total power consumption @DFP (device detached)	4.8	7.4	10	mW	
	Total power consumption @UFP (device detached)	2.5	4	5.5	mW	
T _J	Operating Junction Temperature	0	25	120	°C	
T _C	Operating Case Temperature	0	25	85	°C	
HBM	Human Body mode	1.5K			V	
MM	Machine mode	100			V	

Chip Temperature (T_J, T_C) Calculation

Symbols	Parameter	How to get?
T _A	Ambient temperature	Measure temperature around chip
T _J	Operating junction temperature	$T_J = \Theta_{JA} * \text{Power} + T_A$
T _C	Operating case temperature	$T_C = T_J - \Psi_{JT} * \text{Power}$
R _{JA}	Junction to Ambient thermal resistance	47.8 (data from package vender)
R _{Jc}	Junction to case thermal resistance	27.2 (data from package vender)
Ψ _{JT}	Junction to top thermal characterization	0.69 (data from package vender)
Power	Chip power consumption	Measure chip power consumption

- Thermal test board condition, please refer to JEDEC JESD51-5
- Thermal test method environmental conditions refer to JESD51-2
- Example: If chip power consumption is 10mW; T_A=84.5°C
 $T_J = 47.8 * 0.01 + 84.5 = 84.98^\circ\text{C}$
 $T_C = 84.98 - 0.69 * 0.01 = 84.97^\circ\text{C}$

7.3 AC/DC Characteristics

7.3.1 Digital Signals Electrical Characteristics

(Including the pins of MODE_SEL, ROLE_SEL, VCONN_EN, I_SELO, and I_SEL1)

Symbols	Parameter	Min	Typ	Max	Unit	Remark
V _{IH}	High level input voltage	0.7*VCC		VCC+0.1	V	
V _{IL}	Low level input voltage	-0.5		0.3*VCC	V	
I _{IH}	High level input leakage			10	uA	
I _{IL}	Low level input leakage			10	uA	

7.3.2 CC Analog Signals Electrical Characteristics

(Including the pins of CC1 and CC2)

Symbols	Parameter	Condition	Min	Typ	Max	Unit	Remark
I _{CC_DFP}	Current Source of DFP CC Termination	ROLE_SEL=1, I_SEL[1:0]=01	64	80	96	uA	
		ROLE_SEL=1, I_SEL[1:0]=10	165.6	180	194.4	uA	
		ROLE_SEL=1, I_SEL[1:0]=11	303.6	330	356.4	uA	
R _{CC_UFP}	UFP CC Termination	ROLE_SEL=0,		5.1		kohm	
zOPEN		ROLE_SEL=1, Disable State	126			kohm	
	Impedance on CC		53		93	ohm	

7.3.3 VCONN Supply Electrical Characteristics

Symbols	Parameter	Condition	Min	Typ	Max	Unit	Remark
VCONN	VCONN supply from platfrom	VCONN_EN=1	4.75	5	5.5	V	
I _{oc_max}	Maximum current on VCONN bus	VCONN_EN=1	200			mA	

7.3.4 Dynamic Electrical Characteristics (DA_ax, DA_bx, DB_ax, DB_bx)

Symbols	Parameter	Condition	Min	Typ	Max	Unit	Remark
V _{DC-CMD}	DC common mode range		0		2	V	
C _{ON}	Ouput On capacitance			2		pF	
C _{OFF}	Output Off capacitance			2		pF	
R _{ON}	On resistance	VCC=3V, VCM=2V, IO=-8mA		11		Ohm	
IL	Differential Insertion Loss	f=2.5GHz		-1.05		dB	
		f=5GHz		-1.78		dB	
BW	-3dB bandwidth			7.559		GHz	
RL	Differential Return Loss	f=2.5GHz		-33.06		dB	
		f=5GHz		-17.52		dB	
OIRR	Differential OFF Isolation	f=2.5GHz		-32.12		dB	
		f=5GHz		-22.39		dB	
XTALK	Crosstalk	f=5GHz		-31.6		dB	

7.3.5 Switch Characteristics

Symbols	Parameter	Min	Typ	Max	Unit	Remark
tCCDebounce	Delay time for Debounce on CC bus while device	100		200	ms	

Symbols	Parameter	Min	Typ	Max	Unit	Remark
	attached					
tPD	Switch propagation delay		0.1		ps	
tSK_INTRA	Intra-pair output skew			5	ps	
tSK_INTER	Inter-pair output skew			5	ps	

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8. Electrical Test Condition

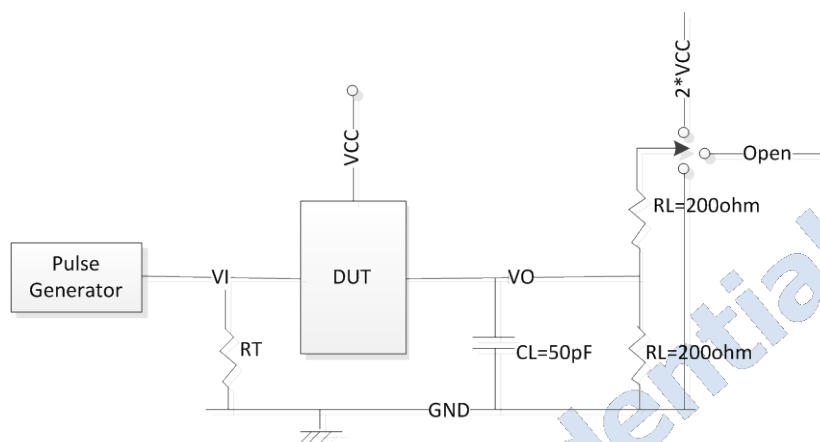


Figure 8: Test Circuit for Timing Characteristics

Notes:

1. CL is the load capacitance: Includes jig and probe capacitance.
2. RT is the termination resistance: should be equal to ZOUT of the pulse generator

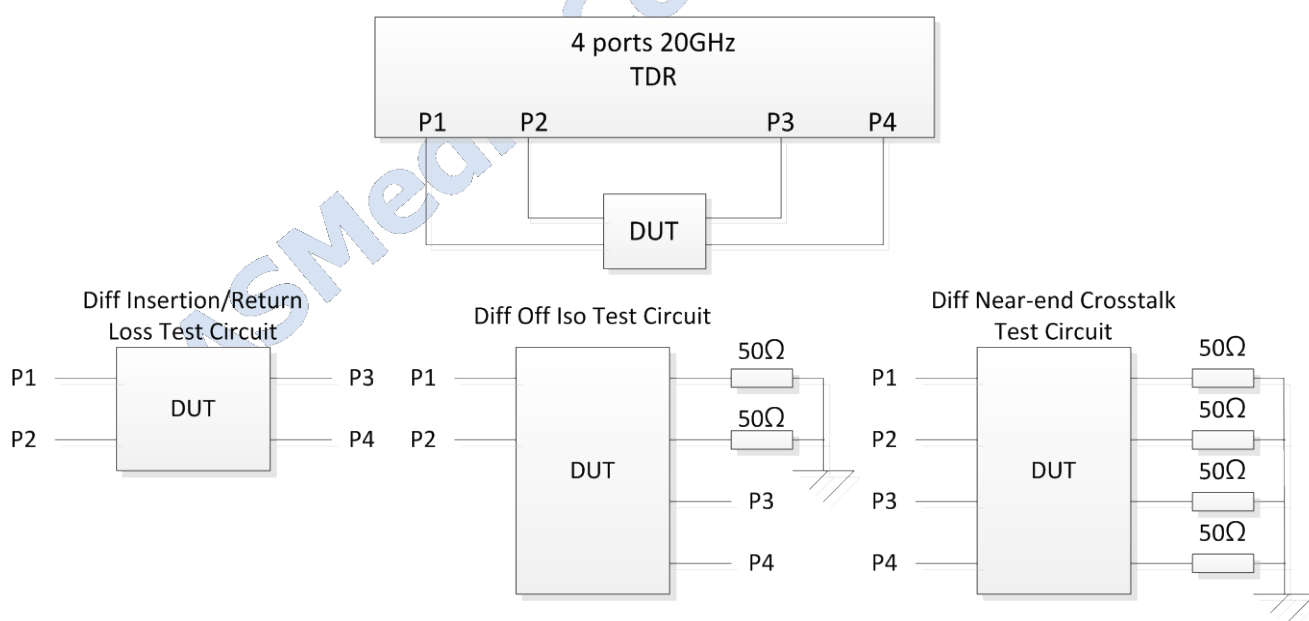
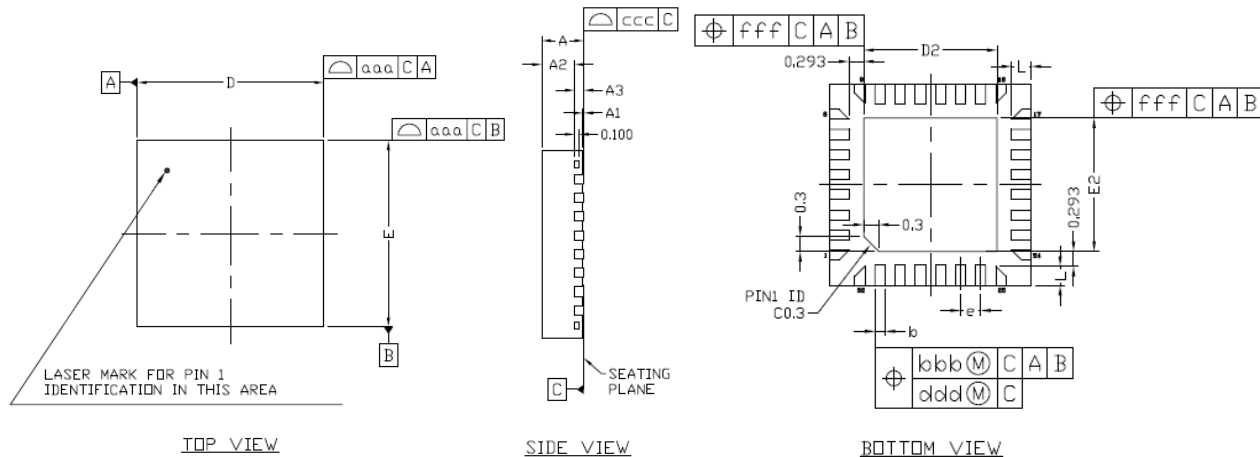


Figure 9: Test Circuit for Electrical Characteristics



Figure 10: Test Waveform for the Insertion Loss and Return Loss

9. Package Information



* CONTROLLING DIMENSION : MM

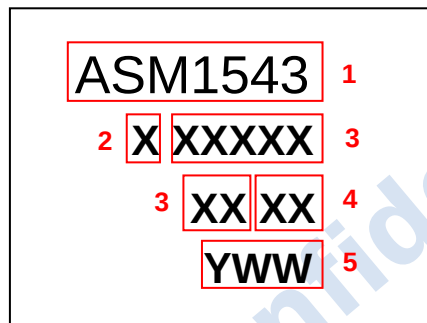
SYMBOL	MILLIMETER			INCH		
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A	---	---	0.80	---	---	0.031
A1	---	---	0.05	---	---	0.002
A2	---	0.53	0.58	---	0.021	0.023
A3	0.20 REF,			0.008 REF,		
b	0.15	0.20	0.25	0.006	0.008	0.010
D	4.00 bsc			0.157 BSC		
D2	2.55	2.65	2.75	0.100	0.104	0.108
E	4.00 bsc			0.157 BSC		
E2	2.55	2.65	2.75	0.100	0.104	0.108
L	0.35	0.40	0.45	0.014	0.016	0.018
e	0.40 bsc			0.016 bsc		
TOLERANCES OF FORM AND POSITION						
aaa	0.10			0.004		
bbb	0.07			0.003		
ccc	0.08			0.003		
ddd	0.05			0.002		
fff	0.10			0.004		

NOTES :

- 1.ALL DIMENSIONS ARE IN MILLIMETERS.
- 2.DIE THICKNESS ALLOWABLE IS 0.305 mm MAXIMUM(0.012 INCHES MAXIMUM)
- 3.DIMENSIONING & TOLERANCES CONFORM TO ASME Y14.5M, -1994.
- 4.THE PIN #1 IDENTIFIER MUST BE PLACED ON THE TOP SURFACE OF THE PACKAGE BY USING INDENTATION MARK OR OTHER FEATURE OF PACKAGE BODY.
- 5.EXACT SHAPE AND SIZE OF THIS FEATURE IS OPTIONAL.
- 6.PACKAGE WARPAGE MAX 0.08 mm.
- 7.APPLIED FOR EXPOSED PAD AND TERMINALS. EXCLUDE EMBEDDING PART OF EXPOSED PAD FROM MEASURING.
- 8.APPLIED ONLY TO TERMINALS.

Figure 11: Mechanical Specification

10. Top Marking Information



1. ASM1543: Product Name
2. X: Version of Marking Rule
3. XXXXXXXX: Serial No. reserved for vendor
4. XX: Version code
5. YWW: Date Code

11. Ordering Part Number

- ◆ ASM1543, 32pin QFN

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