



## DESCRIPTION

The A2513 is USB dedicated charging port (DCP) controllers. Applications include vehicle power charger, wall adapters with USB DCP and other USB chargers. The A2513 controller has the auto-detect feature that monitors the D+ and D- line voltages of the USB connector, providing the correct electrical signatures on the DP and DM pins for the correct detections of compliant portable devices to fast charge.

These portable devices include smart phones, 5-V tablets and personal media players.

The A2513 support five of the most common protocols:

- Divider 1 (DCP Applying 2V on D+ Line and 2.7V on D- Line)
- Divider 2 (DCP Applying 2.7V on D+ Line and 2V on D- Line)
- USB Battery Charging Specification, Revision 1.2 (BC1.2)
- Chinese Telecommunications Industry Standard YD/T 1591-2009
- 1.2V on both D+ and D- lines

The A2513 is available in SOT-26 package.

## ORDERING INFORMATION

Package Type	Part Number	
SOT-26	E6	A2513E6R
		A2513E6VR
Note	V: Halogen free Package R: Tape & Reel	
AiT provides all RoHS products Suffix " V " means Halogen free Package		

## FEATURES

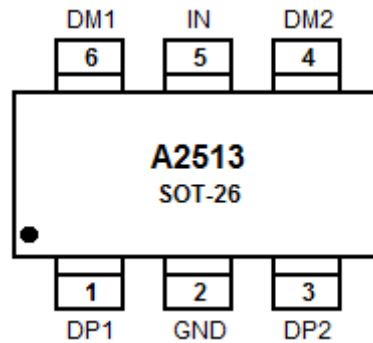
- In accordance with USB Battery Charging Specification, Revision 1.2 (BC1.2), support USB DCP D+ line shorted to D- line.
- In accordance with Chinese Telecommunications Industry Standard YD/T 1591-2009, support Short mode. ( support D+ line shorted to D- line)
- Support DCP applying 2V on D+ Line and 2.7V on D- Line, (or DCP applying 2.7V on D+ Line and 2V on D- Line)
- Support DCP applying 1.2V to the D+ Line and 1.2V to the D- Line
- Automatic switching D+ Line and D- Line for connected devices.
- Double USB port controller.
- Operation voltage range from 4.5V to 5.5V
- Available in SOT-26 Package

## APPLICATION

- USB car charger
- AC-DC adapter with USB port
- Other USB charger



## PIN DESCRIPTION



Top View

Pin #	Symbol	Type	Function
1	DP1	I/O	Connected to the D+ or D- line of USB connector, provide the correct voltage with attached portable equipment for DCP detection.
2	GND	G	Ground connection
3	DP2	I/O	Connected to the D+ or D- line of USB connector, provide the correct voltage with attached portable equipment for DCP detection.
4	DM2	I/O	Connected to the D+ or D- line of USB connector, provide the correct voltage with attached portable equipment for DCP detection.
5	IN	P	Power supply. Connect a ceramic capacitor with a value of 0.1- $\mu$ F or greater from the IN pin to GND as close to the device as possible.
6	DM1	I/O	Connected to the D+ or D- line of USB connector, provide the correct voltage with attached portable equipment for DCP detection.



## ABSOLUTE MAXIMUM RATINGS

Over recommended junction temperature range, voltages are referenced to GND (unless otherwise noted)

Parameter	Conditions	MIN	MAX	Units
Voltage Range	IN	-0.3	7	V
	DP1,DP2 output voltage, DM1,DM2 output voltage	-0.3	5.8	
	DP1,DP2 input voltage, DM1,DM2 input voltage	-0.3	5.8	
Continuous Output Sink Current	DP1,DP2 input voltage, DM1,DM2 input voltage		35	mA
Continuous Output Source Current	DP1,DP2 output voltage, DM1,DM2 output voltage		35	mA
ESD Rating	Human body model (HBM)	IN	2	kV
		DP1,DP2,DM1,DM2	6	
	Charging device model (CDM)		500	V
Operating Junction Temperature	T <sub>J</sub>	-40	125	°C
Storage Temperature Range	T <sub>STG</sub>	-65	150	°C

Stress beyond above listed "Absolute Maximum Ratings" may lead permanent damage to the device. These are stress ratings only and operations of the device at these or any other conditions beyond those indicated in the operational sections of the specifications are not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

## THERMAL INFORMATION

Thermal metrc	Symbol	DBV	Unit
Junction- to-Ambient Thermal Resistance	$\theta_{JA}$	179.9	°C/W
Junction- to-Case ( Top) Thermal Resistance	$\theta_{JcTop}$	117.5	
Junction- to-Board Thermal Resistance	$\theta_{JB}$	41.9	
Junction- to-Top Characterization Parameter	$\psi_{JT}$	17.2	
Junction- to-Board Characterization Parameter	$\psi_{JB}$	41.5	
Junction- to-Case (Bottom) Thermal Resistance	$\theta_{Jcbot}$	N/A	

## RECOMMENDED OPERATING CONDITIONS

Voltages are referenced to GND (unless otherwise noted), positive current are into pins.

Parameter	Symbol	MIN	MAX	Units
Input Voltage of IN	V <sub>IN</sub>	4.5	5.5	V
DP1 Data Line Input Voltage	V <sub>DP1</sub>	0	5.5	V
DM1 Data Line Input Voltage	V <sub>DM1</sub>	0	5.5	V
Continuous Sink or Source Current	I <sub>DP1</sub>		±10	mA
Continuous Sink or Source Current	I <sub>DM1</sub>		±10	mA
Operating Junction Temperature	T <sub>J</sub>	-40	125	°C



## ELECTRICAL CHARACTERISTICS

Conditions are  $-40^{\circ}\text{C} \leq (T_J = T_A) \leq 125^{\circ}\text{C}$ ,  $4.5\text{V} \leq V_{IN} \leq 5.5\text{V}$ . Positive current are into pins. Typical values are at  $25^{\circ}\text{C}$ . All voltages are with respect to GND (unless otherwise noted).

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
<b>Undervoltage Lockout</b>						
IN rising UVLO Threshold Voltage	$V_{UVLO}$		3.89	4.1	4.31	V
Hysteresis				100		mV
<b>Supply Current</b>						
IN Supply Current	$I_{IN}$	$4.5\text{V} \leq V_{IN} \leq 5.5\text{V}$		155	231	$\mu\text{A}$
<b>BC 1.2 DCP Mode(Short Mode)</b>						
DP1 and DM1 Shorting Resistance	$R_{DPM\_SHORT1}$	$V_{DP1}=0.8\text{V}$ , $I_{DM1}=1\text{mA}$		157	200	$\Omega$
Resistance between DP1/DM1 and GND	$R_{DCHG\_SHORT1}$	$V_{DP1}=0.8\text{V}$	350	656	1150	k $\Omega$
Voltage Threshold on DP1 Under Which The Device Goes Back to Divider Mode	$V_{DPL\_TH\_DETACH1}$		310	330	350	mV
Hysteresis	$V_{DPL\_TH\_DETACH\_HYS1}$			50		mV
DP2 and DM2 Shorting Resistance	$R_{DPM\_SHORT2}$	$V_{DP2}=0.8\text{V}$ , $I_{DM2}=1\text{mA}$		157	200	$\Omega$
Resistance between DP2/DM2 and GND	$R_{DCHG\_SHORT2}$	$V_{DP2}=0.8\text{V}$	350	656	1150	k $\Omega$
Voltage Threshold on DP2 Under Which The Device Goes Back to Divider Mode	$V_{DPL\_TH\_DETACH2}$		310	330	350	mV
Hysteresis	$V_{DPL\_TH\_DETACH\_HYS2}$			50		mV
<b>Divider Mode</b>						
DP1 Output Voltage	$V_{DP1\_2.7V}$	$V_{IN}=5\text{V}$	2.56	2.7	2.87	V
DM1 Output Voltage	$V_{DM1\_2V}$	$V_{IN}=5\text{V}$	1.89	2	2.14	V
DP1 Output Impedance	$R_{DP1\_PAD1}$	$I_{DP1}=-5\mu\text{A}$	23.9	30	36.1	k $\Omega$
DM1 Output Impedance	$R_{DM1\_PAD1}$	$I_{DM1}=-5\mu\text{A}$	23.9	30	36.1	k $\Omega$
DP2 Output Voltage	$V_{DP2\_2.7V}$	$V_{IN}=5\text{V}$	2.56	2.7	2.87	V
DM2 Output Voltage	$V_{DM2\_2V}$	$V_{IN}=5\text{V}$	1.89	2	2.14	V
DP2 Output Impedance	$R_{DP2\_PAD1}$	$I_{DP2}=-5\mu\text{A}$	23.9	30	36.1	k $\Omega$
DM2 Output Impedance	$R_{DM2\_PAD1}$	$I_{DM2}=-5\mu\text{A}$	23.9	30	36.1	k $\Omega$



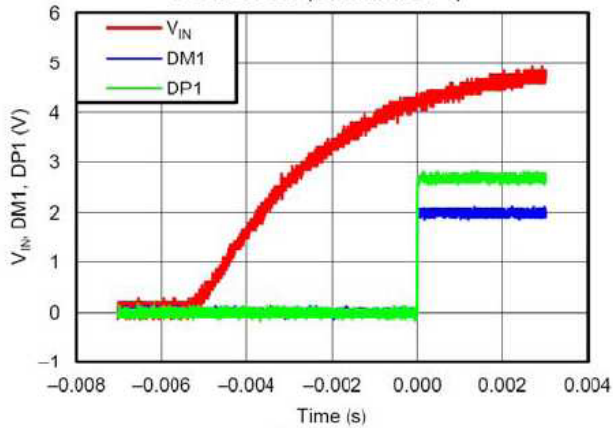
Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
<b>1.2V/1.2V Mode</b>						
DP1 Output Voltage	$V_{DP1\_2.7V}$	$V_{IN}=5V$	1.11	1.2	1.29	V
DM1 Output Voltage	$V_{DM1\_2V}$	$V_{IN}=5V$	1.11	1.2	1.29	V
DP1 Output Impedance	$R_{DP1\_PAD1}$	$I_{DP1}=-5\mu A$	79.9	102	130.1	k $\Omega$
DM1 Output Impedance	$R_{DM1\_PAD1}$	$I_{DM1}=-5\mu A$	79.9	102	130.1	k $\Omega$
DP2 Output Voltage	$V_{DP2\_2.7V}$	$V_{IN}=5V$	1.11	1.2	1.29	V
DM2 Output Voltage	$V_{DM2\_2V}$	$V_{IN}=5V$	1.11	1.2	1.29	V
DP2 Output Impedance	$R_{DP2\_PAD1}$	$I_{DP2}=-5\mu A$	79.9	102	130.1	k $\Omega$
DM2 Output Impedance	$R_{DM2\_PAD1}$	$I_{DM2}=-5\mu A$	79.9	102	130.1	k $\Omega$

\* Specified by design. Not production tested.

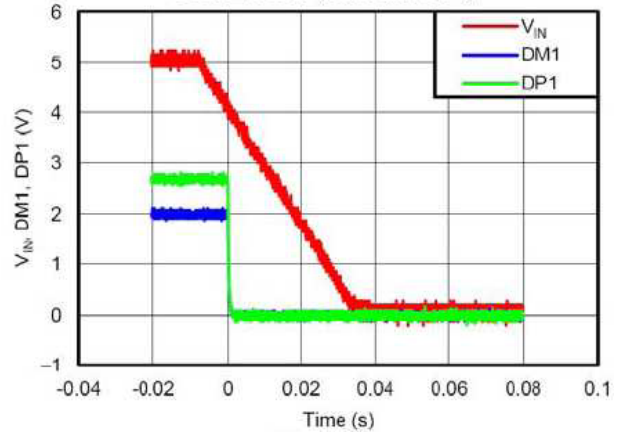


## TYPICAL PERFORMANCE CHARACTERISTICS

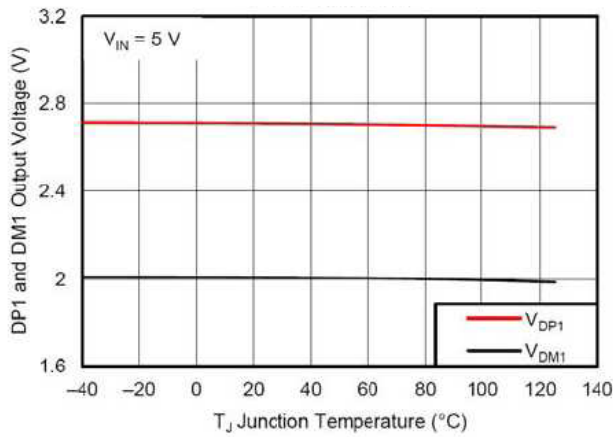
1. Power On (DM1 and DP1)



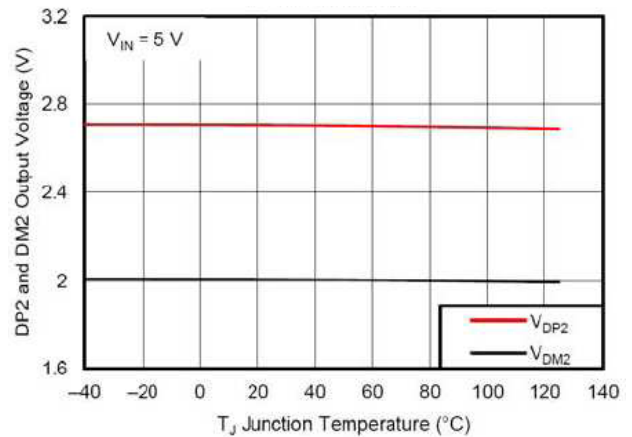
2. Power Off (DM1 and DP1)



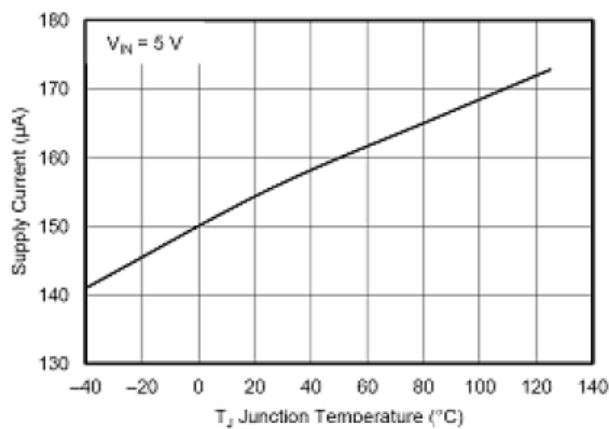
3. DP1 and DM1 Output Voltage vs. Temperature



4. DP2 and DM2 Output Voltage vs. Temperature

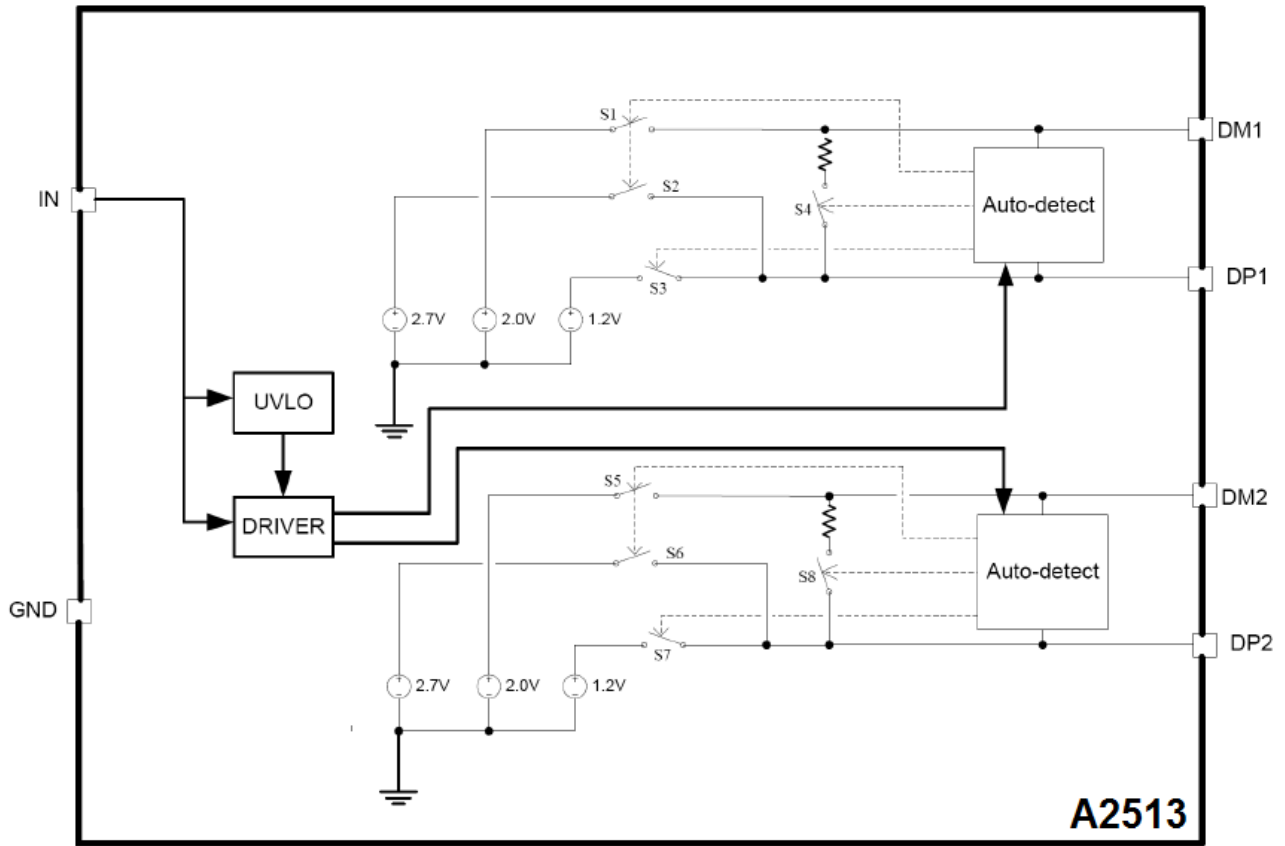


5. Supply Current vs. Temperature





**BLOCK DIAGRAM**





## DETAILED INFORMATION

### APPLICATION SUMMARY

#### OVERVIEW

The following overview references various industry standards. It is always recommended to consult the latest standard to ensure the most recent and accurate information.

Rechargeable portable equipment requires an external power source to charge its batteries. USB ports are convenient locations for charging because of an available 5-V power source. Universally accepted standards are required to ensure host and client-side devices meet the power management requirements. Traditionally, USB host ports following the USB 2.0 Specification must provide at least 500mA to downstream client-side devices. Because multiple USB devices can be attached to a single USB port through a bus-powered hub, it is the responsibility of the client-side device to negotiate the power allotment from the host to guarantee the total current draw does not exceed 500mA. In general, each USB device can subsequently request more current, which is granted in steps of 100mA up 500mA total. The host may grant or deny the request based on the available current.

Additionally, the success of the USB technology makes the micro-USB connector a popular choice for wall adapter cables. This allows a portable device to charge from both a wall adapter and USB port with only one connector.

One common difficulty has resulted from this. As USB charging has gained popularity, the 500-mA minimum defined by the USB 2.0 Specification or 900mA defined in the USB 3.0 Specification, has become insufficient for many handsets, tablets and personal media players (PMP) which have a higher rated charging current. Wall adapters and car chargers can provide much more current than 500mA or 900mA to fast charge portable devices. Several new standards have been introduced defining protocol handshaking methods that allow host and client devices to acknowledge and draw additional current beyond the 500mA (defined in the USB 2.0 Specification) or 900mA (defined in the USB 3.0 Specification) minimum while using a single micro-USB input connector.

The A2513 support four of the most common protocols:

- USB Battery Charging Specification, Revision 1.2 (BC1.2)
- Chinese Telecommunications Industry Standard YD/T 1591-2009
- Divider mode
- 1.2 Von both D+ and D- lines





YD/T 1591-2009 is a subset of the BC1.2 specification supported by the vast majority of devices that implement USB charging. Divider and 1.2-V charging schemes are supported in devices from specific yet popular device makers. BC1.2 has three different port types, listed as follows.

- Standard downstream port (SDP)
- Charging downstream port (CDP)
- Dedicated charging port (DCP)

The BC1.2 Specification defines a charging port as a downstream facing USB port that provides power for charging portable equipment.

Table 1 shows different port operating modes according to the BC1.2 Specification.

Table1. Operating Modes Table

Port Type	Supports USB2.0 Communication	Maximum Allowable Current Drawn by Portable Equipment (A)
SDP(USB2.0)	Yes	0.5
SDP(USB3.0)	Yes	0.9
CDP	Yes	1.5
DCP	No	1.5

The BC1.2 Specification defines the protocol necessary to allow portable equipment to determine what type of port it is connected to so that it can allot its maximum allowable current drawn. The hand-shaking process is two steps. During step one, the primary detection, the portable equipment outputs a nominal 0.6V output on its D+ line and reads the voltage input on its D- line. The portable device concludes it is connected to a SDP if the voltage is less than the nominal data detect voltage of 0.3V. The portable device concludes that it is connected to a Charging Port if the D- voltage is greater than the nominal data detect voltage of 0.3V and less than 0.8V. The second step, the secondary detection, is necessary for portable equipment to determine between a CDP and a DCP. The portable device outputs a nominal 0.6V output on its D- line and reads the voltage input on its D+ line. The portable device concludes it is connected to a CDP if the data line being remains is less than the nominal data detect voltage of 0.3V. The portable device concludes it is connected to a DCP if the data line being read is greater than the nominal data detect voltage of 0.3V and less than 0.8V.

### Dedicated Charging Port (DCP)

A dedicated charging port (DCP) is a downstream port on a device that outputs power through a USB connector, but is not capable of enumerating a downstream device, which generally allows portable devices to fast charge at their maximum rated current. A USB charger is a device with a DCP, such as a wall adapter or car power adapter. A DCP is identified by the electrical characteristics of its data lines. The following DCP identification circuits are usually used to meet the handshaking detections of different portable devices.



### Short the D+ Line to the D- Line

The USB BC1.2 Specification and the Chinese Telecommunications Industry Standard YD/T 1591-2009 define that the D+ and D- data lines should be shorted together with a maximum series impedance of 200Ω. This is shown in Figure1.

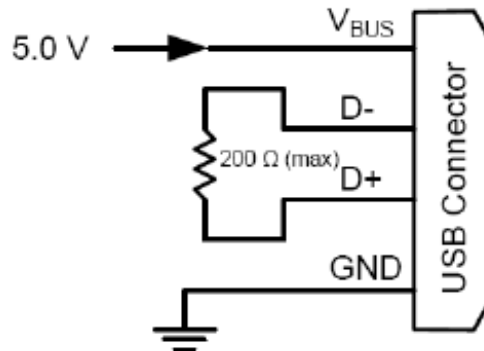


Figure1. DCP Short Mode

Divider 1 (DCP Applying 2V on D+ Line and 2.7V on D- Line) or Divider 2 (DCP Applying 2.7V on D+ Line and 2V on D- Line)

There are two charging schemes for divider DCP. They are named after Divider 1 and Divider 2 DCPs that are shown in Figure2 and Figure3. The Divider 1 charging scheme is used for 5-W adapters, and applies 2V to the D+ line and 2.7V to the D- data line. The Divider 2 charging scheme is used for 10-W adapters, and applies 2.7V on the D+ line and 2V is applied on the D- line.

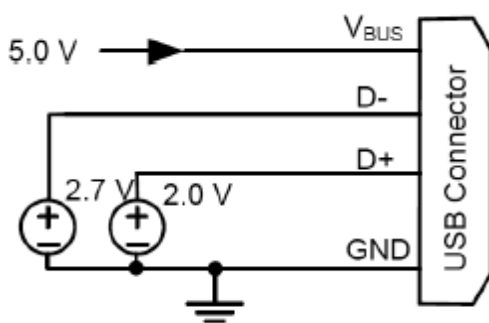


Figure 2. Divider 1 DCP

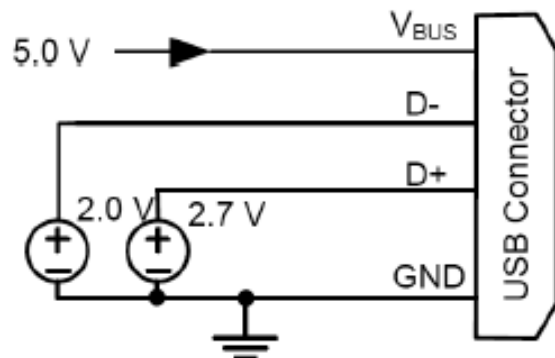


Figure 3. Divider 2 DCP



### Applying 1.2V to the D+ Line and 1.2V to the D- Line

As shown in Figure 4, some tablet USB chargers require 1.2V on the shorted data lines of the USB connector. The maximum resistance between the D+ line and the D- line is 200Ω.

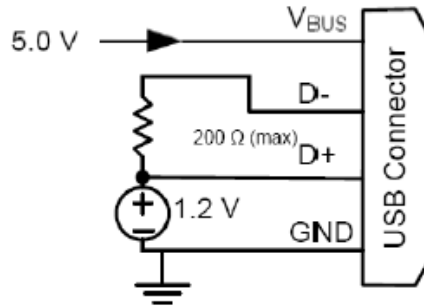


Figure 4. DCP Applying 1.2V to the D+ Line and 1.2V to the D-Line

The A2513 is USB dedicated charging port (DCP) controllers. Applications include vehicle power charger, wall adapters with USB DCP and other USB chargers. The A2513 controllers has the auto-detect feature that monitors the D+ and D- line voltages of the USB connector, providing the correct electrical signatures on the DP and DM pins for the correct detections of compliant portable devices to fast charge. These portable devices include smart phones, 5-V tablets and personal media players.

### DCP Auto-Detect

The A2513 integrate an auto-detect feature to support divider mode, short mode and 1.2V / 1.2V modes. If a divider device is attached, 2.7V is applied to the DP pin and 2V is applied to the DM pin. If a BC1.2-compliant device is attached, the A2513 automatically switches into short mode. If a device compliant with the 1.2V / 1.2V charging scheme is attached, 1.2V is applied on both the DP pin and the DM pin. The functional diagram of DCP auto-detect feature (DM1 and DP1) is shown in Figure 5. below. DCP autodetect feature has the same functional configuration.

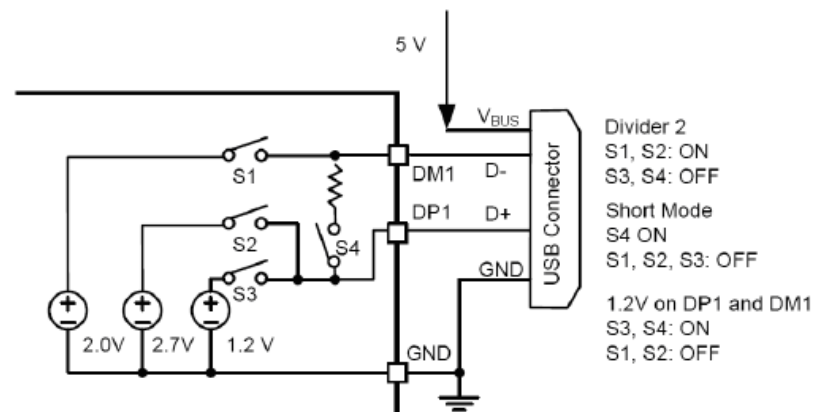


Figure 5. DCP Auto-Detect Functional Diagram



### Undervoltage Lockout (UVLO)

The undervoltage lockout (UVLO) circuit disables DP1 and DM1 output voltage until the input voltage reaches the UVLO turn-on threshold. Built-in hysteresis prevents unwanted oscillations due to input voltage drop from large current surges. The device only provides the correct electrical signatures on the data line of the USB charger port and does not provide any power for the VBUS.

### Divide Mode Selection of 5-W and 10-W USB Chargers

The A2513 provides two types of connections between the DP pin and the DM pin and between the D+ data line and the D- data line of the USB connector for a 5-W USB charger and a 10-W USB charger with a single USB port. For a 5-W USB charger, the DP1 pin is connected to the D- line and the DM1 pin is connected to the D+ line. This is shown in Figure 6, 7. For a 10-W USB charger, the DP1 pin is connected to the D+ line and the DM1 pin is connected to the D- line. This is shown in Figure 6, 7. Table 2 shows different charging schemes for both 5-W and 10-W USB charger solutions.

Table 2. Charging Schemes for 5-W and 10-W USB Chargers

USB Charger Type	Containing Charging Schemes		
5-W	Divider 1	1.2V on both D+ and D- Lines	BC1.2DCP
10-W	Divider 2	1.2V on both D+ and D- Lines	BC1.2DCP

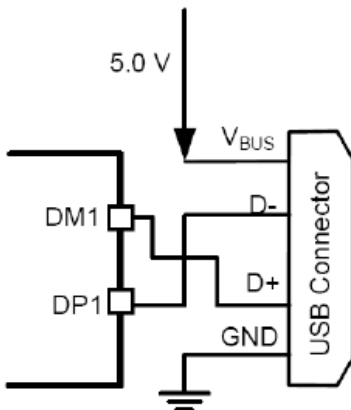


Figure 6. 5-W USB Charge Application

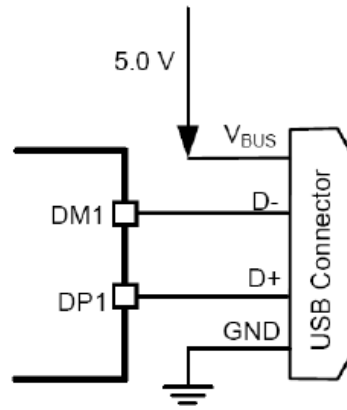


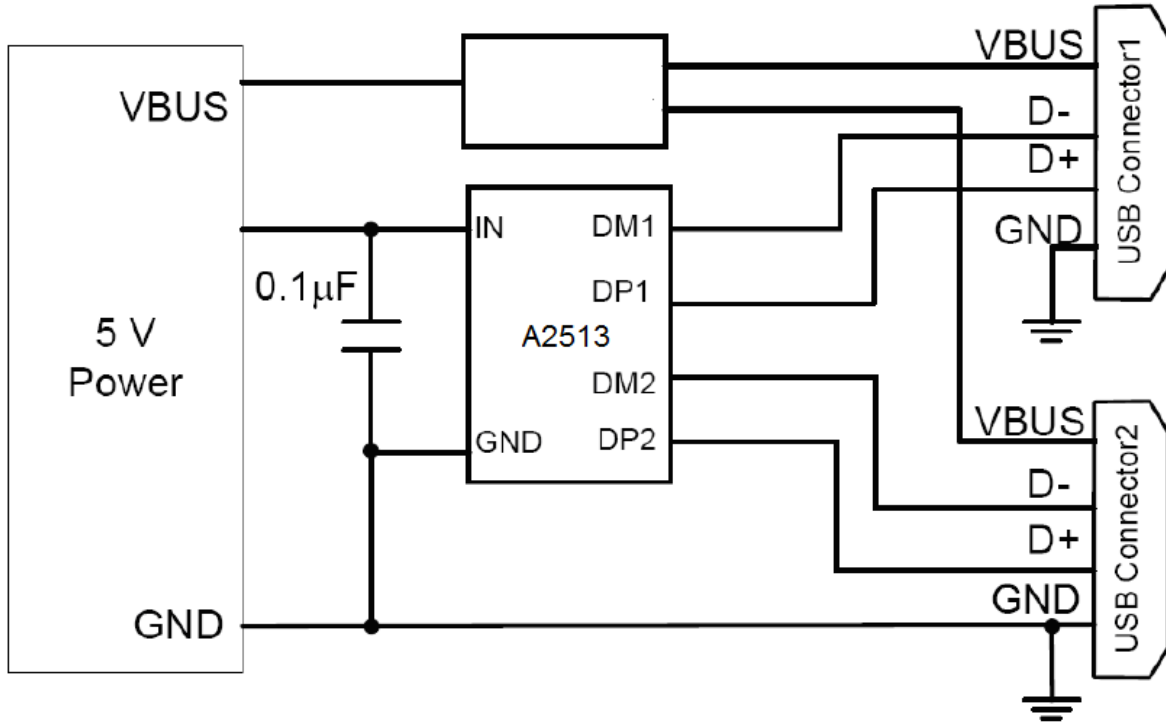
Figure 7. 10-W USB Charge

### Layout Guidelines

Place the A2513 near the USB output connector and place the 0.1- $\mu$ F bypass capacitor near the IN pin.



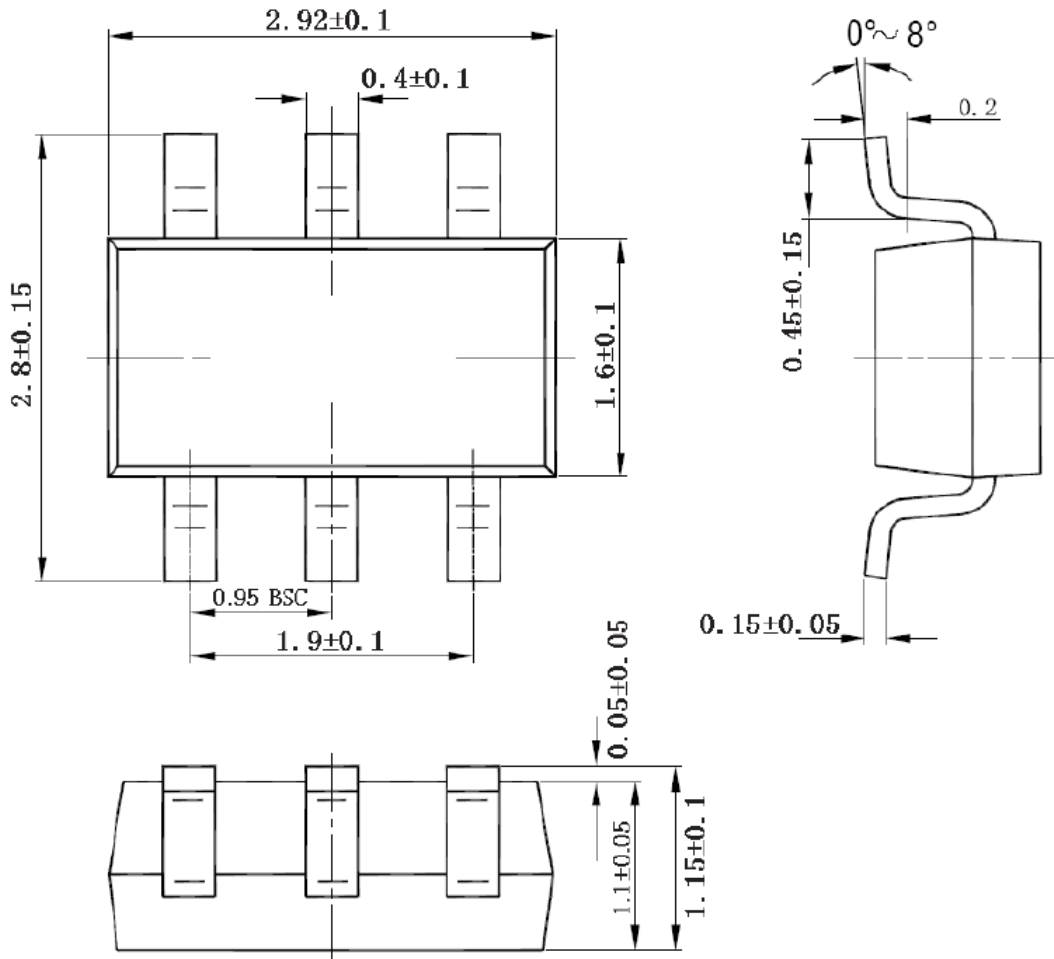
**APPLICATION CIRCUIT**





## PACKAGE INFORMATION

Dimension in SOT-26 (Unit: mm)





## IMPORTANT NOTICE

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