USB dedicated charging port (DCP) controller BL2513A

DESCRIPTION

The BL2513A is USB dedicated charging port (DCP) controllers. Applications include vehicle power charger, wall adapters with USB DCP and other USB chargers. The BL2513A 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 BL2513A support five of the most common protocols:

- Divider 3 (DCP Applying 2.7V on D+ Line and 2.7V 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

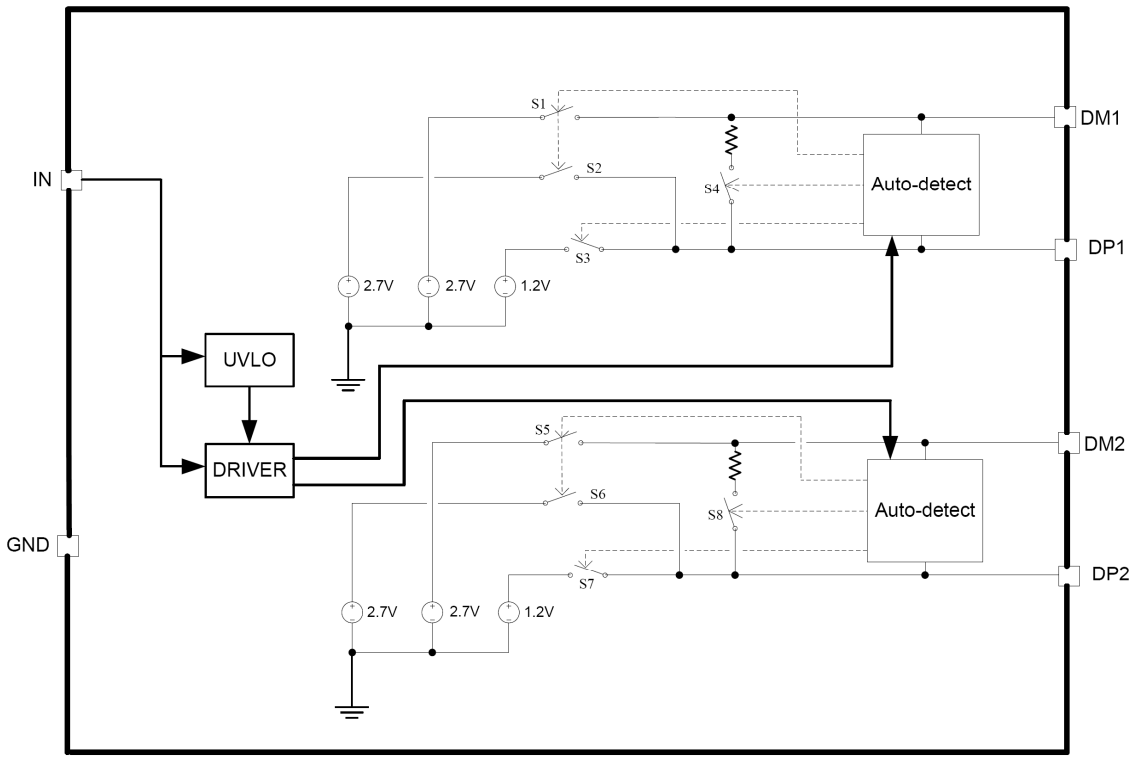
FEATURES

- 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 2.7 V on D+ Line and 2.7 V 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

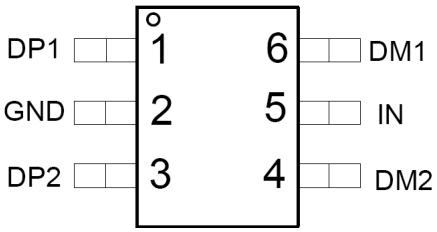
APPLICATIONS

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

BLOCK DIAGRAM



PIN CONFIGURATION



PIN DESCRIPTION

No.	Name	Type	description
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-μF 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)

Characteristic	Conditions	Min.	Max.	Unit
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
Operating junction temperature	T_J	-40	125	℃
Storage temperature range	Tstg	-65	150	℃
ESD (human body mode)		8000		V

*Stresses beyond those listed under Absolute Maximum Ratings 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.

THERMAL INFORMATION

Thermal metrc	Symbol	DBV	Unit
Junction-to-ambient thermal resistance	θ_{JA}	179.9	℃ /W
Junction-to-case (top) thermal resistance	θ_{JCtop}	117.5	
Junction-to-board thermal resistance	θ_{JB}	41.9	
Junction-to-top characterization parameter	ψ_{JT}	17.2	
Junction-to-board characterization parameter	ψ_{JB}	41.5	
Junction-to-case (bottom) thermal resistance	θ_{JCbot}	N/A	

RECOMMENDED OPERATING CONDITIONS

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

Characteristic	Symbol	Min.	Max.	Unit
Input voltage of IN	V_{IN}	4.5	5.5	V
DP1 data line input voltage	V_{DP1}	0	5.5	V
DM1 data line input voltage	V_{DM1}	0	5.5	V
Continuous sink or source current	I_{DP1}		±10	mA
Continuous sink or source current	I_{DM1}		±10	mA
DP2 data line input voltage	V_{DP2}	0	5.5	V
DM2 data line input voltage	V_{DM2}	0	5.5	V
Continuous sink or source current	I_{DP2}		±10	mA
Continuous sink or source current	I_{DM2}		±10	mA
Operating junction temperature	T_J	-40	125	℃

ELECTRICAL CHARACTERISTICS

Conditions are –40°C ≤ (T_J= T_A) ≤ 125°C, 4.5V ≤ V_{IN} ≤ 5.5V. Positive current are into pins. Typical values are at 25°C. All voltages are with respect to GND (unless otherwise noted).

Characteristic	Symbol	Conditions	Min.	Typ.	Max	Unit
Undervoltage Lockout						
IN rising UVLO threshold voltage	V_{UVLO}		3.89	4.15	4.38	V
Hysteresis				100		mV
Supply Current						
IN supply current	I_{IN}	4.5 V ≤ V_{IN} ≤ 5.5 V		155	231	μA
BC 1.2 DCP Mode(Short Mode)						
DP1 and DM1 shorting resistance	R_{DPM_SHORT1}	V_{DP1}=0.8V, I_{DM1}= 1mA		157	200	Ω
Resistance between DP1/DM1 and GND	R_{DCHG_SHORT1}	V_{DP1}=0.8V	350	656	1150	kΩ
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}=0.8V, I_{DM2}= 1mA		157	200	Ω
Resistance between DP2/DM2 and GND	R_{DCHG_SHORT2}	V_{DP2}=0.8V	350	656	1150	kΩ
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
Divider Mode						
DP1 output voltage	$V_{DP1_2.7V}$	V_{IN}=5V	2.56	2.7	2.87	V
DM1 output voltage	$V_{DM1_2。7V}$	V_{IN}=5V	2.56	2.7	2.87	V
DP1 output impedance	R_{DP1_PAD1}	I_{DP1}=-5μA	23.9	30	36.1	kΩ
DM1 output impedance	R_{DM1_PAD1}	I_{DM1}=-5μA	23.9	30	36.1	kΩ
DP2 output voltage	$V_{DP2_2.7V}$	V_{IN}=5V	2.56	2.7	2.87	V
DM2 output voltage	$V_{DM2_2.7V}$	V_{IN}=5V	2.56	2.7	2.87	V
DP2output impedance	R_{DP2_PAD1}	I_{DP2}=-5μA	23.9	30	36.1	kΩ
DM2output impedance	R_{DM2_PAD1}	I_{DM2}=-5μA	23.9	30	36.1	kΩ
1.2V/1.2V Mode						
DP1 output voltage	V_{DP1}	V_{IN}=5V	1.11	1.2	1.29	V
DM1 output voltage	V_{DM1}	V_{IN}=5V	1.11	1.2	1.29	V
DP1 output impedance	R_{DP1_PAD1}	I_{DP1}=-5μA	79.9	102	130.1	kΩ

DM1 output impedance	R_{DM1_PAD1}	I_{DM1}=-5μA	79.9	102	130.1	kΩ
DP2 output voltage	V_{DP2}	V_{IN}=5V	1.11	1.2	1.29	V
DM2 output voltage	V_{DM2}	V_{IN}=5V	1.11	1.2	1.29	V
DP2output impedance	R_{DP2_PAD1}	I_{DP2}=-5μA	79.9	102	130.1	kΩ
DM2output impedance	R_{DM2_PAD1}	I_{DM2}=-5μA	79.9	102	130.1	kΩ

* Specified by design. Not production tested.

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 500 mA 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 500 mA. In general, each USB device can subsequently request more current, which is granted in steps of 100 mA up 500 mA 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 900 mA 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 500 mA or 900 mA 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 500 mA (defined in the USB 2.0 Specification) or 900 mA (defined in the USB 3.0 Specification) minimum while using a single

micro-USB input connector.

The BL2513A 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 Typt	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 0.6 Voutput 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 0.3 V. 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 0.8 V. 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 0.6 V 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 0.3 V. 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 0.3 V and less than 0.8 V.

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 200 Ω. This is shown in Figure1.

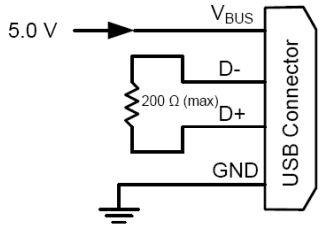


Fig 1. DCP Short Mode

Divider 3 (DCP Applying 2.7 V on D+ Line and 2.7 V on D– Line)

There is one charging scheme for divider DCP. The Divider 3 charging scheme is used for 12-W adapters, and applies 2.7V on D+ and D- lines.

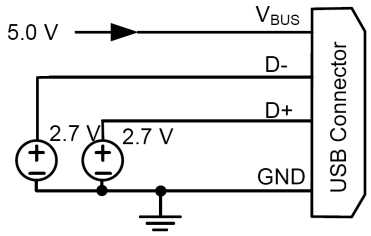


Fig 2. Divider 3 DCP

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DCP Auto-Detect

The BL2513A integrate an auto-detect feature to support divider mode, short mode and 1.2V / 1.2Vmodes. If a divider device is attached, 2.7V is applied to the DP pin and 2.7V is applied to the DM pin.

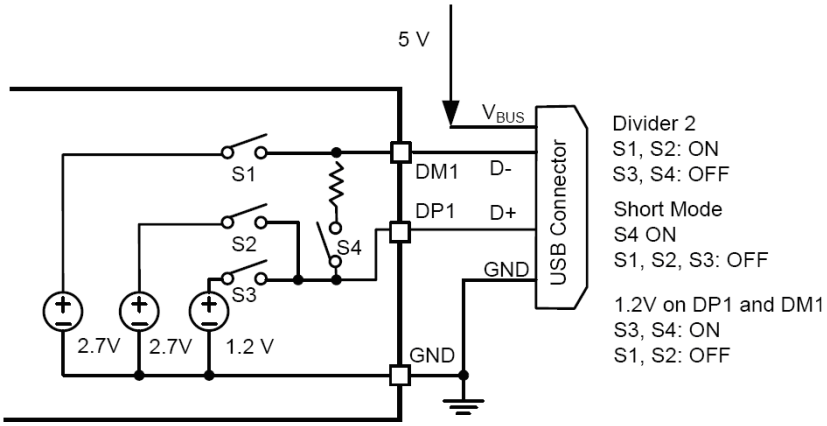


Fig 3. DCP Auto-Detect Functional Diagram

Undervoltage Lockout (UVLO)

The undervoltage lockout (UVLO) circuit disables DP1and 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 BL2513A only provide the correct electrical signatures on the data line of USB charger portand do not provide any power for the VBUS.

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

The BL2513A provide one type 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 12-W

Table2 Charging Scheme for 12-W USB Chargers

USB Charger Type	Containing Charging Schemes		
12-W	Divider 3	2.7V on both D+ and D- Lines	BC1.2DCP

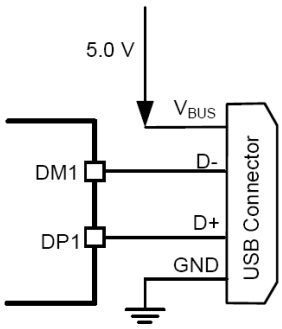
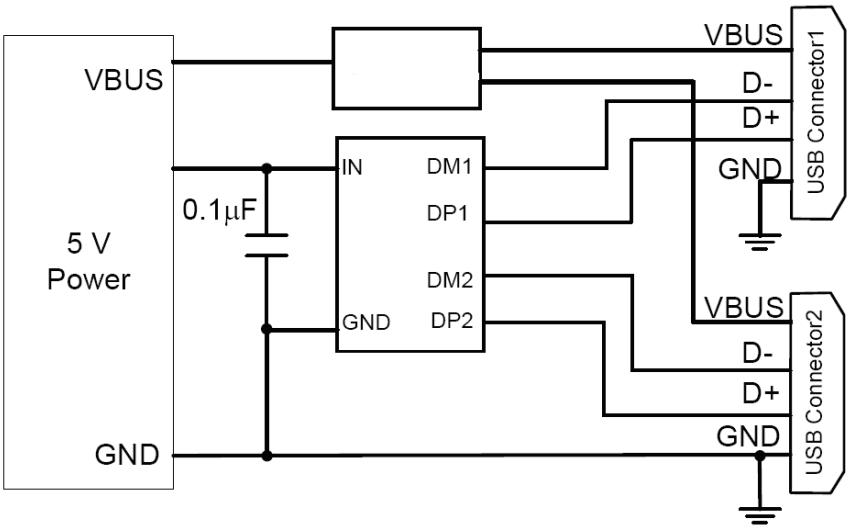


Fig 4. 12-w USB Charge Application

Layout Guidelines

Place the BL2513A near the USB output connector and place the 0.1-μF bypass capacitor near the IN pin.

APPLICATION CIRCUIT



CHARACTERISTICS CURVES

TYPICAL CHARACTERISTICS (continued)

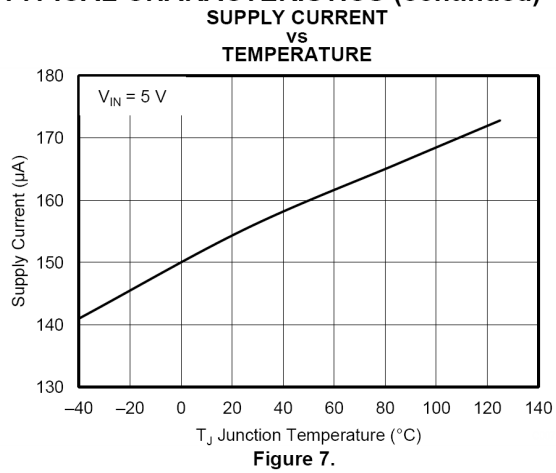
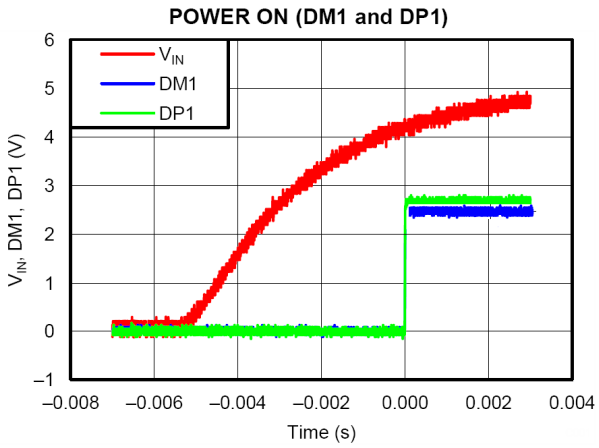
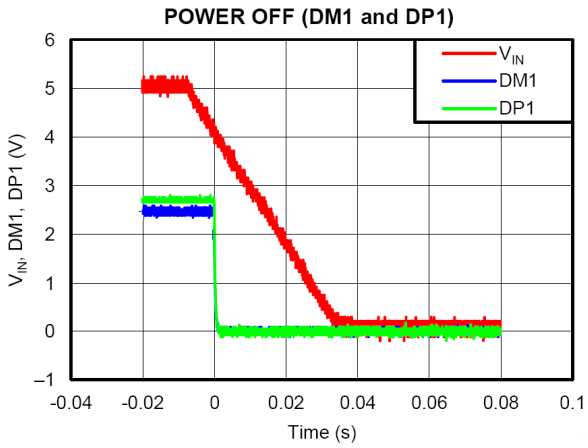
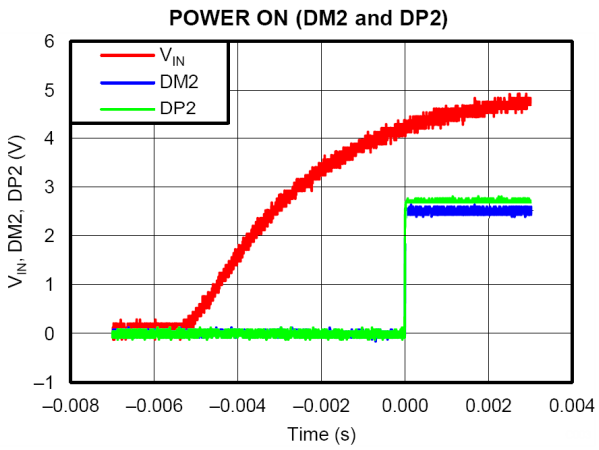
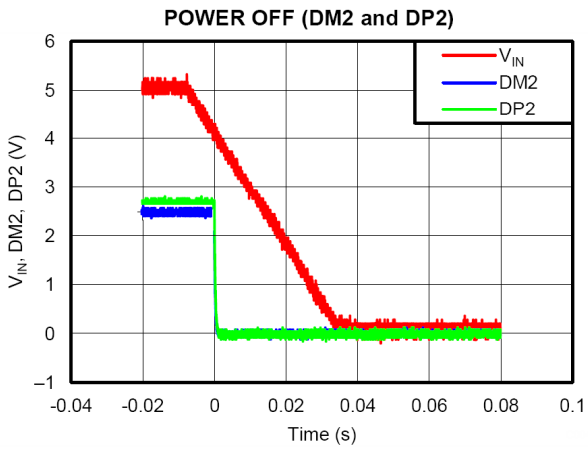


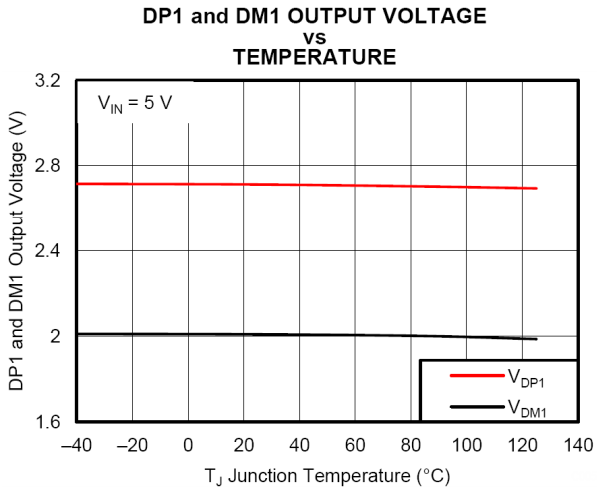
Figure 7.

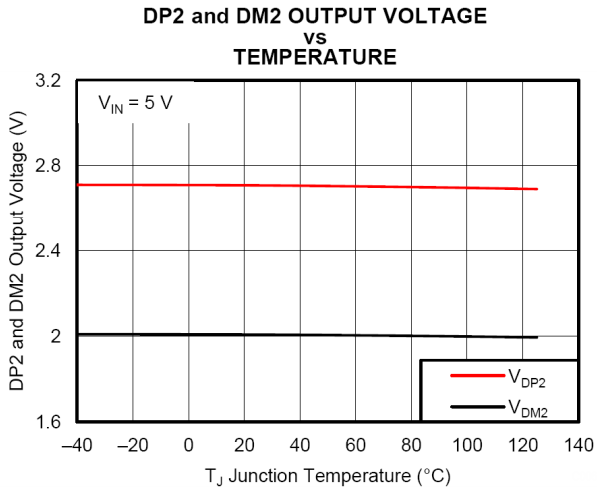

POWER ON (DM1 and DP1)
VIN
DM1
DP1
VIN, DM1, DP1 (V)
Time (s)


POWER OFF (DM1 and DP1)
VIN
DM1
DP1
VIN, DM1, DP1 (V)
Time (s)


POWER ON (DM2 and DP2)
VIN
DM2
DP2
VIN, DM2, DP2 (V)
Time (s)


POWER OFF (DM2 and DP2)
VIN
DM2
DP2
VIN, DM2, DP2 (V)
Time (s)


DP1 and DM1 OUTPUT VOLTAGE
vs
TEMPERATURE
VIN = 5 V
VDP1
VDM1
DP1 and DM1 Output Voltage (V)
TJ Junction Temperature (°C)


DP2 and DM2 OUTPUT VOLTAGE
vs
TEMPERATURE
VIN = 5 V
VDP2
VDM2
DP2 and DM2 Output Voltage (V)
TJ Junction Temperature (°C)

OUTLINE DRAWING

SOT-23-6 Unit: mm

