Smart USB Charging Port Controller

General Description

The NT6008D is a smart USB interface IC specifically designed for high voltage dedicated charging port applications (HVDCP) that complies with Qualcomm® Quick Charge™ 2.0/3.0 Class A specification and HiSilicon Fast Charging Protocol (FCP). The NT6008D accurately adjusts HVDCP output voltage according to request of the handheld devices so that the charging time can be 75% faster.

The NT6008D automatically identifies the handheld devices attached to the USB port. Then it emulates the original chargers accordingly so that the attached device can draw maximum current from the charging port.

The NT6008D supports Apple iPad, Apple iPhone, BC1.2 or YD/T 1591 compliant devices, and majority of modern portable devices.

The NT6008D is available in TSOT23-8L and MSOP-10L packages.

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Note: *Apple, iPad and iPhone are trademarks belonging to their respective owners.*

Applications

- **CLA Car Chargers**
- **Computer Peripherals**
- **Wall Adaptors**
- **USB Power Plugs**
- **Portable Power Banks**

Features

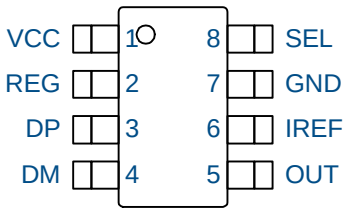
- **3.4V ~ 13.4V Single Supply Operation**
- **Smart USB Charger Identification Circuit**
  - **Compliant with Quick Charge™ 2.0/3.0 Class A**
  - **Support HiSilicon FCP Protocol**
  - **Support Apple 2.4A Application**
  - **Support BC1.2 & YD/T 1591 Battery Charging Specifications**
- **Output Voltage Discharge Function**
- **Output Over Voltage Protection**
- **8kV High ESD**
- **-40°C ~ +125°C Operating Ambient Temperature**
- **TSOT23-8L or MSOP-10L Package**
- **RoHS Compliant and Halogen-Free**

Ordering Information

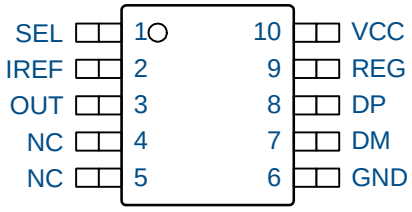
Order Number	Package	Top Marking
NT6008DMT8	TSOT23-8L	N06
NT6008DRAA	MSOP-10L	NT6008D

Note: EOSMEM products are compatible with the current IPC/JEDEC J-STD-020 requirement. They are halogen-free, RoHS compliant and 100% matte tin (Sn) plating that are suitable for use in SnPb or Pb-free soldering processes.

Pin Configuration

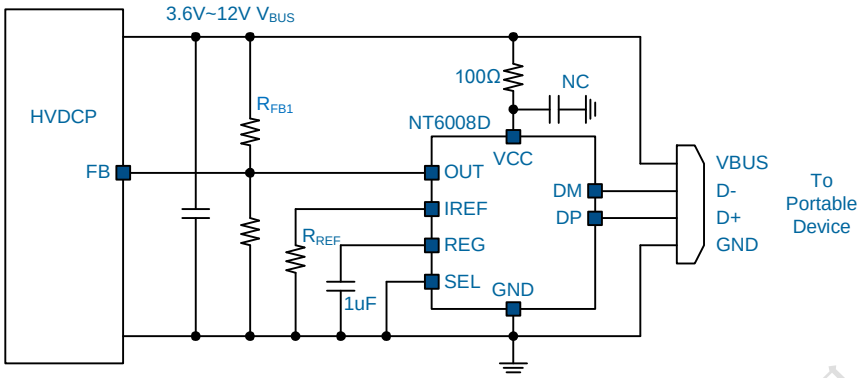


TSOT23-8



MSOP-10L

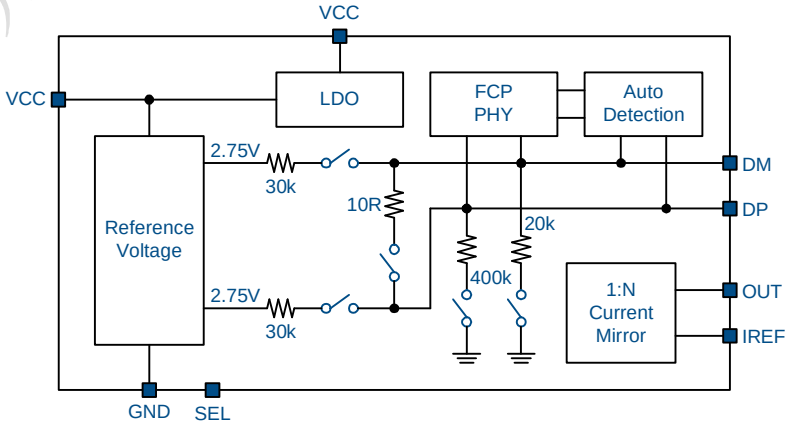
Typical Application Circuit



Functional Pin Description

Pin No.		Pin Name	Pin Function
MSOP-10L	SOT23-8L		
1	8	SEL	Connect this pin to GND directly. Do not let this pin open.
2	6	IREF	Reference Current Setting
3	5	OUT	Current Sink/Source Output
4, 5	NA	NC	Not Internally Connected
6	7	GND	Ground
7	4	DM	Negative Data Line
8	3	DP	Positive Data Line
9	2	REG	Bypass for Internal LDO Output.
10	1	VCC	Supply Input

Functional Block Diagram



Functional Description

The NT6008D is a smart USB interface IC specifically designed for high-voltage dedicated charging port applications. The NT6008D automatically identifies the handheld devices attached to the USB port. Then it emulates the genuine chargers accordingly so that the attached device can draw maximum current from the charging port with demanded output voltage.

DM/DP Configuration

The DM/DP have four configurations, mode 1 ~ mode 4, as shown in Figure 1 ~ Figure 4. The NT6008D automatically selects configurations according to the DP/DM status and pre-defined timing so that the attached portable devices can be quickly charged.

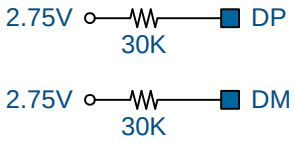


Figure 1. Mode 1 Configuration.

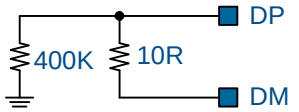


Figure 2. Mode 2 Configuration.

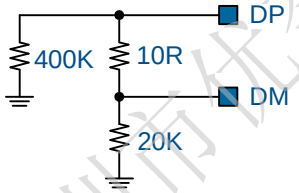


Figure 3. Mode 3 Configuration.

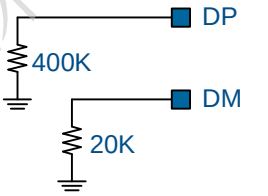


Figure 4. Mode 4 Configuration.

Mode 1 Configuration

Mode 1 is the default configuration when supply input is above the power on reset (POR) level. The NT6008D leaves mode 1 and enters mode 2 if one of the three conditions is true: 1.) $V_{DP} > V_{DP-0}$ for 2ms; 2.) $V_{DM} < V_{DM-1}$ for 10ms or 3.) $V_{DP} < V_{DP-1}$ for 10ms.

When entering mode 2, the NT6008D resets the internal 2-second counter.

Mode 2 Configuration

The NT6008D leaves mode 2 under two conditions:

1.) enters mode 3 if $V_{DP-3} < V_{DP} < V_{DP-2}$ for one second.

2.) otherwise enters mode 1 when the 2-second counter expires.

Mode 3 Configuration

The NT6008D leaves mode 3 under three conditions:

1.) enters mode 4 if $V_{DP-3} < V_{DP} < V_{DP-2}$ for 0.2s.

2.) otherwise enters mode 1 when the 2-second counter expires.

Mode 4 Configuration

When entering mode 4, the NT6008D starts internal 10-second counter. The NT6008D leaves mode 4 if $V_{DP} < V_{DP3}$ for 20ms or VCC overvoltage protection is triggered. Then the NT6008D enters mode 2 if the 10-second counter does not expire yet or enters mode 1 if the 10-second counter expires.

At mode 4, the NT6008D keeps monitoring V_{DM} voltage. Once $V_{DM} < V_{DM-3}$ for longer than 20ms, the NT6008D is ready to receive Quick Charge™ 2.0/3.0 commands or HiSilicon FCP protocols. The OUT pin will sink or source a current I_{OUT} according to DP/DM voltages and the reference current I_{REF} set by the resistor connected to IREF pin. Table 1 illustrates the relationship between I_{OUT} and DP/DM voltages according to Quick Charge™ 2.0/3.0 specification.

Table 1. I_{OUT} vs. DP/DM voltages relationship

V_{DP}	V_{DM}	I_{OUT}
$V_{DP} < V_{DP-3}$	X	Enter mode 1
$V_{DP-3} < V_{DP}$	$V_{DM} < V_{DM-3}$	0A
$V_{DP-3} < V_{DP} < V_{DP-1}$	$V_{DM-3} < V_{DM} < V_{DM-1}$	7 * I_{REF}
$V_{DP-3} < V_{DP} < V_{DP-1}$	$V_{DM} > V_{DM-1}$	Continuous mode
$V_{DP} > V_{DP-1}$	$V_{DM-3} < V_{DM} < V_{DM-1}$	4 * I_{REF}
$V_{DP} > V_{DP-1}$	$V_{DM} > V_{DM-1}$	Keep last state

Reference Current & Current Sink

Use a resistor R_{IREF} connected to IREF pin to set the reference current as:

$$I_{REF} = \frac{1.0V}{R_{REF}}$$

When selected by V_{DM}/V_{DM}, the OUT pin will ramp up/down the sinking/sourcing current to its target level with steps of 0.1 x I_{REF} incremental, 50us per step.

Incremental I_{OUT}

When $V_{DP-3} < V_{DP} < V_{DP-1}$ and $V_{DM} > V_{DM-1}$, the NT6008D enters continuous mode. Upon each DP positive pulse with 150us delay time, the NT6008D increases output sinking current by 0.2 x I_{REF} as shown in Figure 5. Pulsewidth (both t_L and t_H) shorter than 150us will be skipped. The maximum output sinking current is limited at 7.0 x I_{REF} that will set the HVDCP output voltage 7V higher than nominal level.

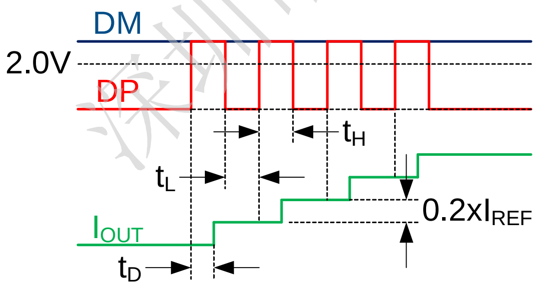


Figure 5. Incremental I_{OUT}.

Decremental I_{OUT}

Upon each DM negative pulse with 150us delay time, the NT6008D decreases output sinking current (increases output sourcing current) by 0.2 x I_{REF} as shown in Figure 6. Pulsewidth (both t_L and t_H) shorter than 150us will be skipped. The minimum output sinking current is limited at -1.4 x I_{REF} (1.4 x I_{REF} sourcing) that will set the HVDCP output voltage 1.4V lower than nominal level.

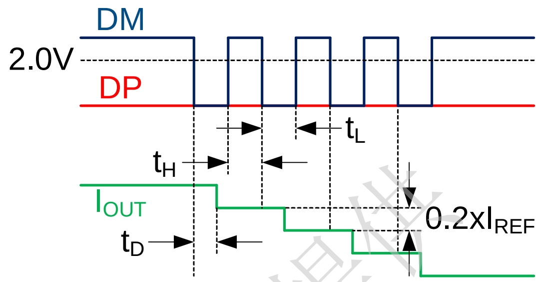


Figure 6. Decremental I_{OUT}.

Over Voltage Protection

If VCC is higher than 13.5V for 100us, over voltage protection (OVP) is triggered. OVP turns off the current sink and resets the DP/DM to mode 1 configuration.

Output Voltage Discharge

When the current sink decreases, the NT6008D sinks a 10mA current from the VCC pin for 500ms to discharge the output voltage of HVDCP to a safe level.

Absolute Maximum Rating

(Note1)

Supply Input Voltage, V_{CC} ---------- -0.3V to +15V

Other Pins ---------- +0.3V to 7V

Storage Temperature Range ---------- -55°C to +150°C

Operation Temperature Range ---------- -40°C to +125°C

Lead Temperature Range (Soldering 10sec) ---------- 260°C

ESD Rating (Note2)

- MM (Machine Mode), DP and DM ---------- 800V
- MM (Machine Mode), other pins ---------- 200V
- HBM (Human Body Mode), DP and DM ---------- 8kV
- HBM (Human Body Mode), other pins ---------- 2kV

Thermal Information

Package Thermal Resistance (Note3)

- TSOT23-8L q_{JA} ---------- 250°C/W
- MSOP-10L q_{JA} ---------- 160°C/W
- TSOT23-8L q_{JC} ---------- 100°C/W
- MSOP-10L q_{JC} ---------- 45°C/W

Power Dissipation, P_D @ T_A = 25°C

- TSOT23-8L ---------- 0.4W
- MSOP-10L ---------- 0.625W

Recommended Operating Conditions

Operating Junction Temperature Range (Note4) ---------- -40°C to +125°C

Operating Ambient Temperature Range ---------- -40°C to +125°C

Note 1. Stresses listed as the above "Absolute Maximum Ratings" may cause permanent damage to the device. These are for stress ratings. Functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may remain possibility to affect device reliability.

Note 2. Devices are ESD sensitive. Handling precaution recommended.

Note 3. q_{JA} is measured in the natural convection at T_A = 25°C on a high effective thermal conductivity test board of JEDEC 51-7 thermal measurement standard.

Note 4. The device is not guaranteed to function outside its operating conditions.

Electrical Characteristics

(V_{CC} = 5V, T_A = +25°C unless otherwise specified.)

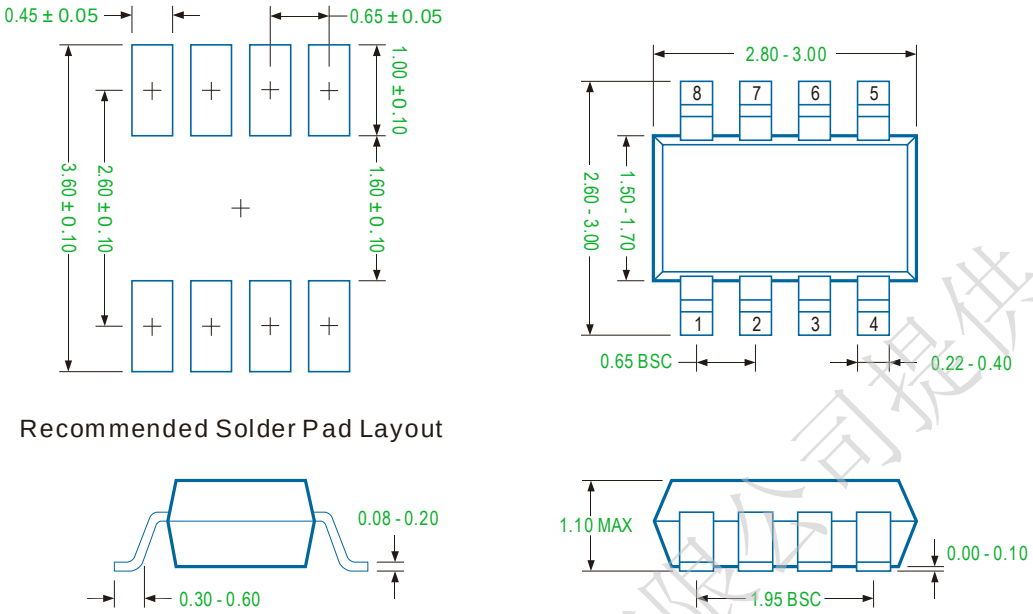
Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Supply Input						
Supply Voltage Range	V_{CC}		3.4	--	13.4	V
Input Over Voltage Protection	V_{OVP}		--	13.5	--	V
Quiescent Current	I_{CC}		--	0.26	0.5	mA
DP/DM Threshold Voltages						
0th DP Threshold Voltage	V_{DP-0}	Delta from initial V_{DP}	100	125	150	mV
Hysteresis for 0th DP Threshold			--	50	--	mV
1st DP/DM Threshold Voltage	V_{DP-1}/V_{DM-1}	V_{DP}/V_{DM} rising	1.95	2.05	2.15	V
Hysteresis for 1st DP/DM Threshold		V_{DP}/V_{DM} falling	--	100	--	mV
2nd DP/DM Threshold Voltage	V_{DP-2}/V_{DM-2}	V_{DP}/V_{DM} rising	1.25	1.35	1.45	V
Hysteresis for 2nd DP/DM Threshold		V_{DP}/V_{DM} falling	--	200	--	mV
3rd DP Threshold Voltage	V_{DP-3}	V_{DP} rising	0.325	0.35	0.375	V
Hysteresis for 3rd DP Threshold		V_{DP} falling	--	50	--	mV
3rd DM Threshold Voltage	V_{DM-3}	V_{DM} rising	0.4	0.425	0.45	V
Hysteresis for 3rd DM Threshold		V_{DM} falling	--	50	--	mV
DP/DM at Mode 1						
DP Floating Voltage	V_{DP}		2.70	2.75	2.80	V
DM Floating Voltage	V_{DM}		2.70	2.75	2.80	V
DP Pin Output Impedance	Z_{DP}		24	30	36	kW
DM Pin Output Impedance	Z_{DM}		24	30	36	kW
Debounce Time for Exiting Mode 1		$V_{DP} > V_{DP-0}$	1.5	2.0	2.5	ms
		$V_{DM} < V_{DM-1}$ or $V_{DP} < V_{DP-1}$	8	10	12	ms
DP/DM at Mode 2						
DP and DM Short Circuit Switch			5	10	20	W
DP Pull Low Resistance			360	400	480	kW
Recycle Time for Entering Mode 1			1.6	2.0	2.4	s
Debounce Time for Entering Mode 3			0.8	1.0	1.2	s
DP/DM at Mode 3						
DP and DM Short Circuit Switch			5	10	20	W
DM Pull Low Resistance			16	20	24	kW
DP Pull Low Resistance			320	400	480	kW
Debounce Time for Entering Mode 4			0.16	0.20	0.24	s

Electrical Characteristics

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
DP/DM at Mode 4						
DP Pull Low Resistance			320	400	480	kW
DM Pull Low Resistance			16	20	24	kW
Debounce Time for DM Low			16	20	24	ms
Debounce Time for DP Low			16	20	24	ms
Current Sink						
IREF Pin Voltage		R_{IREF} = 100kW	--	1.00	--	V
Output Current Accuracy R_{IREF} = 100kW		$V_{DP-3} < V_{DP} < V_{DP-1}$ $V_{DM-3} < V_{DM} < V_{DM-1}$	69	70	71	uA
		$V_{DP} > V_{DP-1}$; $V_{DM-3} < V_{DM} < V_{DM-1}$	39	40	41	uA
Glitch Time for V_{DP}/V_{DM} Change		Quick Charge 2.0 Mode	32	40	48	ms
		Quick Charge 3.0 (Continuous) Mode	120	150	180	us
Duration for Current Step		Quick Charge 2.0 Mode	40	50	60	us
Output Current Incremental or Decremental with R_{IREF} = 100kW		Quick Charge 2.0 Mode	--	1	--	uA
		Quick Charge 3.0 (Continuous) Mode	--	2	--	
Output Voltage Discharge						
Discharge Current			--	10	--	mA
Discharge Duration			--	500	--	ms

Package Information

TSOT23-8L

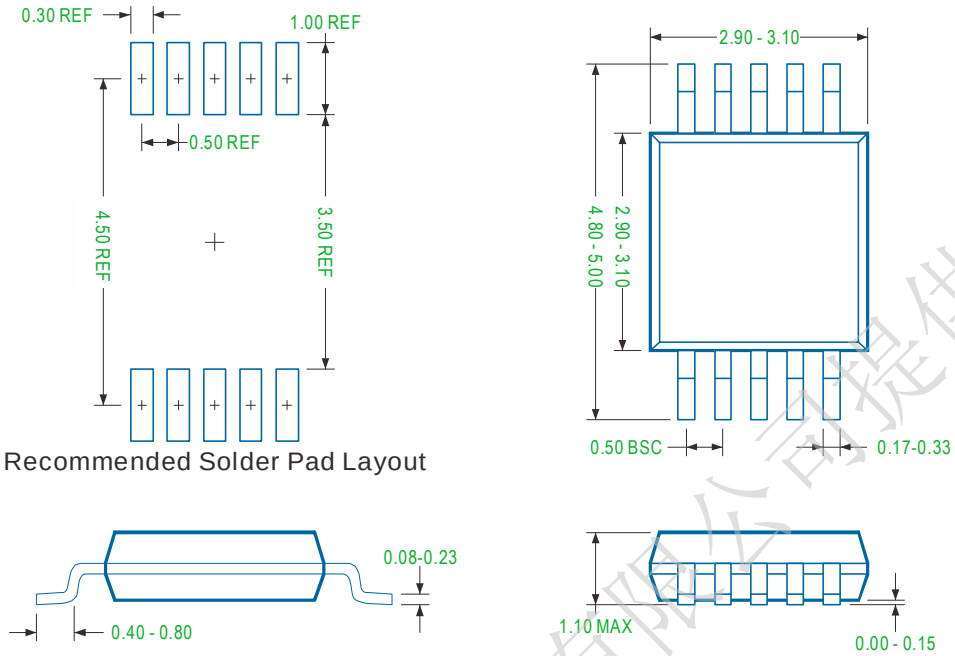


Note

1. Package Outline Unit Description:
   BSC: Basic. Represents theoretical exact dimension or dimension target
   MIN: Minimum dimension specified.
   MAX: Maximum dimension specified.
   REF: Reference. Represents dimension for reference use only. This value is not a device specification.
   TYP. Typical. Provided as a general value. This value is not a device specification.
2. Dimensions in Millimeters.
3. Drawing not to scale.
4. These dimensions do not include mold flash or protrusions. Mold flash or protrusions shall not exceed 0.15mm.

Package Information

MSOP-10L



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