WIDE INPUT VOLTAGE RANGE, 300mA ULDO REGULATOR WITH PG

Description

The DIODES™ AP7583Q/AQ series are 300mA LDO for automotive battery-powered applications. The AP7583Q features 2.5μA quiescent current at light loads. Therefore, the AP7583Q/AQ are suitable solution to supply always power-on components, such as microcontroller (MCUs) and controller area network (CAN) transceivers.

The AP7583Q/AQ have features of wide input-voltage range, high accuracy, low-dropout voltage, current limit and ultra-low quiescent current, which make it ideal for automotive applications. The AP7583AQ has power-good indicator.

The IC consists of a voltage reference, an error amplifier, a resistor network for setting output voltage, a current-limit circuit for current protection, and a chip-enable circuit.

The AP7583Q/AQ both have 3.3V and 5V fixed output-voltage version, and adjustable version.

The AP7583Q is available in space-saving W-DFN2020-6 (SWP) (Type A1) package, and AP7583AQ has good power dissipation packages of MSOP-8EP, W-DFN2020-6 (SWP) (Type A1), and TO252-4 (Type C).

Features

- Wide Input-Voltage Range: 3V to 42V
- Maximum Output Current: 300mA
- Low-Dropout Voltage: V_{DROP} = 320mV @I_{OUT} = 300mA (Typ)
- Low Quiescent Current:
  - AP7583Q is 2.5μA (Typ)
  - AP7583AQ is 3μA (Typ)
- High Output-Voltage Accuracy: ±1.5%
- Compatible with Low ESR Ceramic Capacitor
- Excellent Line/Load Regulation
- Thermal Shutdown Function
- Short Current Protection Function
- Output Current Limit
- AP7583AQ with Power-Good (PG) Output for Supply Monitoring and for Sequencing of Other Supplies
- **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
- **Halogen and Antimony Free. "Green" Device (Note 3)**
- **The AP7583Q/AQ are suitable for automotive applications requiring specific change control; these parts are AEC-Q100 qualified, PPAP capable, and manufactured in IATF16949 certified facilities.**
  https://www.diodes.com/quality/product-definitions/

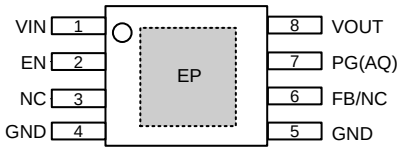
Applications

- Powering MCUs and CAN/LIN transceivers
- Automotive head units
- EV and HEV battery management systems
- Body control modules
- Transmission control units (TCU)

Pin Assignments

AP7583AQ

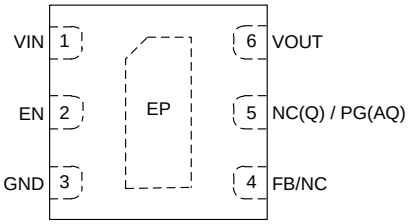
(Top View)



MSOP-8EP

AP7583Q/AQ

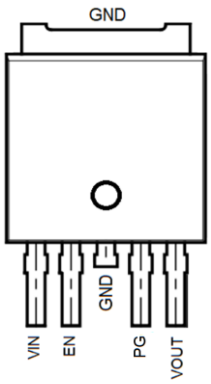
(Top View)



W-DFN2020-6 (SWP) (Type A1)

AP7583AQ

(Top View)

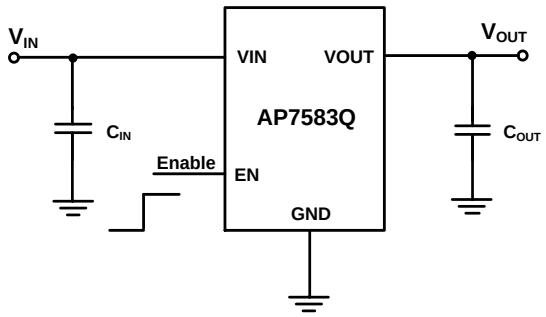


TO252-4 (Type C)

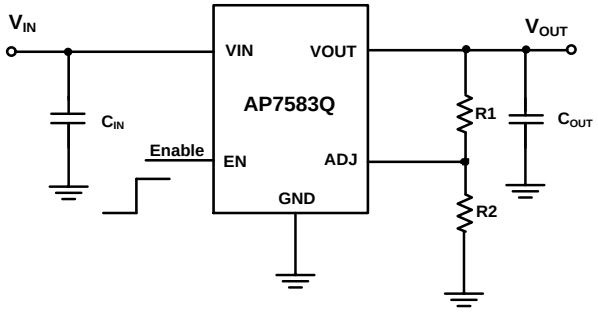
Future Product

Notes:
1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS), 2011/65/EU (RoHS 2) & 2015/863/EU (RoHS 3) compliant.
2. See https://www.diodes.com/quality/lead-free/ for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free.
3. Halogen- and Antimony-free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.

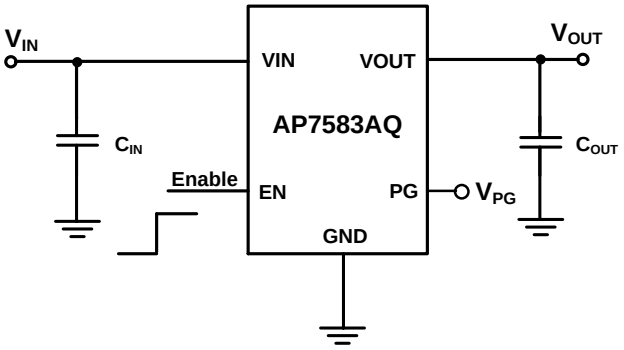
Typical Applications Circuit



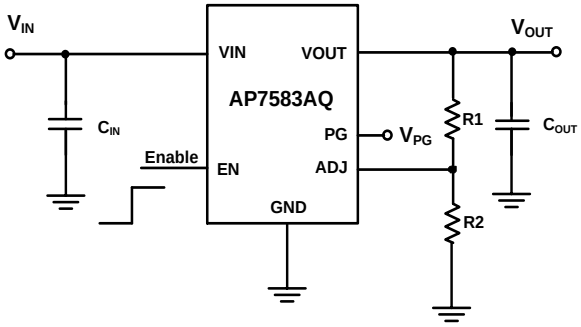
AP7583Q Fixed Version



AP7583Q Adjustable Output



AP7583AQ Fixed Version

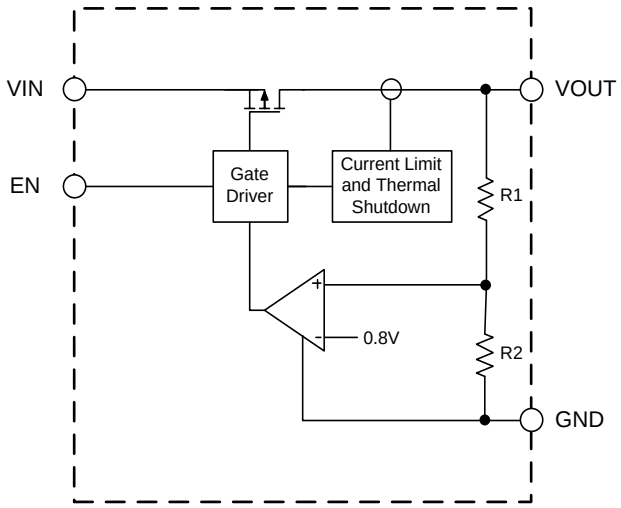


AP7583AQ Adjustable Output

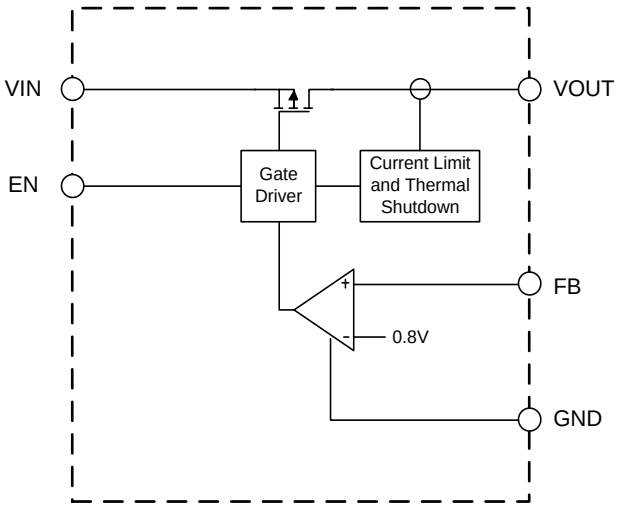
Pin Descriptions

Pin Number			Pin Name	Function
MSOP-8EP AP7583AQ	W-DFN2020-6 (SWP) (Type A1) AP7583Q/AQ	TO252-4 (Type C) AP7583AQ		
1	1	1	VIN	Input voltage
2	2	2	EN	Enable input, active high
3	5(Q)	—	NC	Not connected internally. Recommend connection to GND to maximize PCB copper for thermal dissipation.
7	5(AQ)	4	PG	Power-Good pin with one internal pull high resistor. When the V_{OUT} is below the PG threshold, the PG pin is driven low; when the V_{OUT} exceeds the threshold, the PG pin goes into a high-impedance state.
4, 5	3	3	GND	Ground
6	4	—	FB/NC	Adjustable voltage version only – a resistor divider from this pin to the OUT pin and ground sets the output voltage.
8	6	5	VOUT	Regulated output voltage
EP	EP	—	Exposed Pad	In PCB layout, prefer to use large copper area to cover this pad for better thermal dissipation, then connect this area to GND or leave it open. However, do not use it as GND electrode function alone.

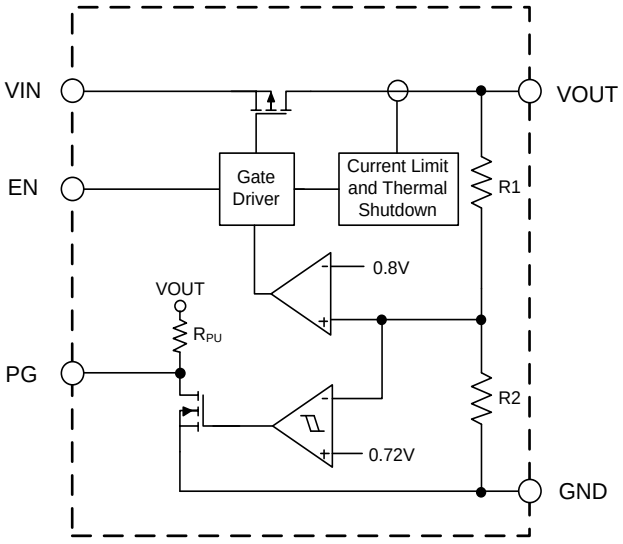
Functional Block Diagram



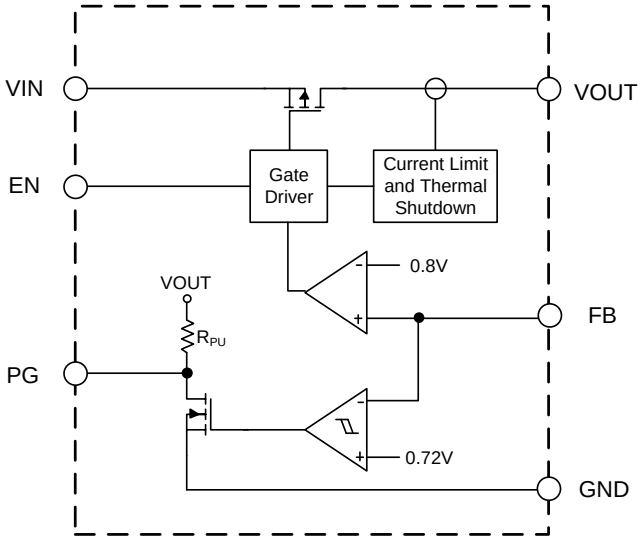
AP7583Q Fixed Version with EN



AP7583Q Adjustable Version



AP7583AQ Fixed Version



AP7583AQ Adjustable Version

Absolute Maximum Ratings (Note 4) (@T_A = +25°C, unless otherwise specified.)

Symbol	Parameter	Rating		Unit
V_{IN}	Supply Input Voltage	-0.3 to 45		V
V_{OUT}	Regulated Output Voltage	-0.3 to 7		V
I_{OUT}	Output Current	300		mA
T_{LEAD}	Lead Temperature (Soldering, 10sec)	+260		ºC
T_J	Operating Junction Temperature	+150		ºC
θ_{JA}	Thermal Resistance (Junction to Ambient)	MSOP-8EP	36.1	°C/W
		W-DFN2020-6 (SWP) (Type A1)	80.4	
		TO252-4 (Type C)	27.2	
θ_{JC}	Thermal Resistance (Junction to Case)	MSOP-8EP	6.532	°C/W
		W-DFN2020-6 (SWP) (Type A1)	26.4	
		TO252-4 (Type C)	7.5	
T_{STG}	Storage Temperature Range	-40 to +150		°C
CDM	ESD (Charged Device Model)	±1500		V
HBM	ESD (Human Body Model)	±2000		V

Notes: 4. a). Stresses beyond those listed under *Absolute Maximum Ratings* can cause permanent damage to the device. These are stress ratings only and functional operation of the device at these conditions is not implied. Exposure to absolute-maximum-rated conditions for extended period can affect device reliability.

b). Ratings apply to ambient temperature at +25°C. The JEDEC STD.51 High-K board design used to derive this data was a 3inch × 3inch multilayer board with 1oz. internal power and ground planes and 2oz. copper traces on the top and bottom of the board.

Recommended Operating Conditions

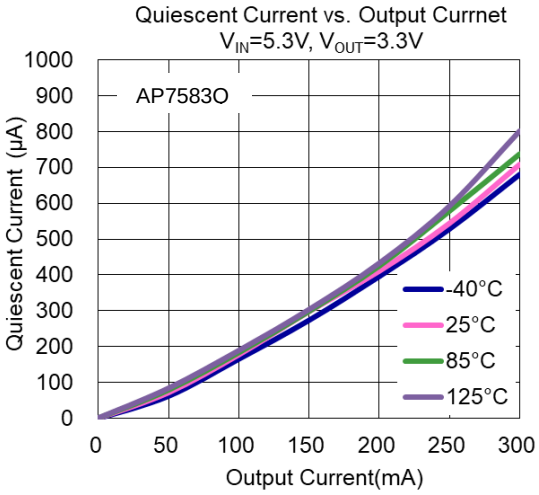
Symbol	Parameter	Min	Max	Unit
V_{IN}	Supply Input Voltage	3.0	42	V
V_{OUT}	Supply Output Voltage	1.2	5	V
T_J	Operating Junction Temperature	-40	+125	°C

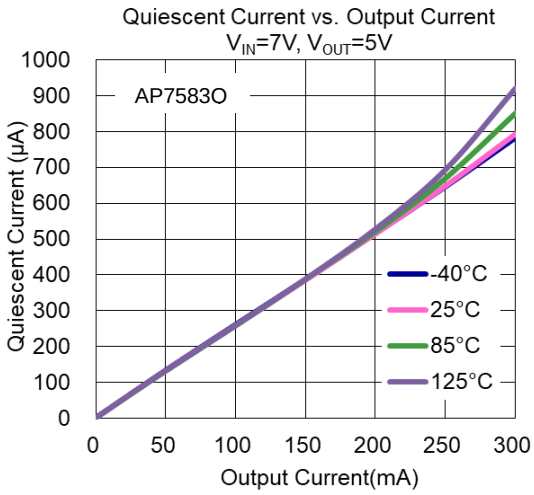
Electrical Characteristics (-40°C ≤ T_J ≤ +125°C, I_{OUT} = 1mA, C_{IN} = C_{OUT} = 10µF ceramic capacitor, V_{IN} = 14V)

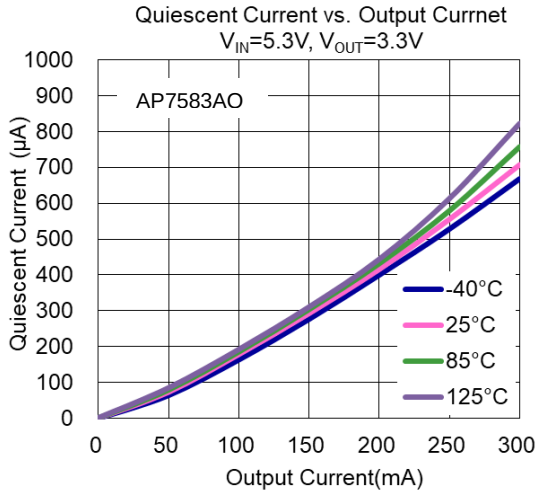
Symbol	Parameter		Test Conditions	Min	Typ	Max	Unit
V_{OUT}	Output Voltage		Variation from Specified V_{OUT}	V_{OUT}* 98.5%	—	V_{OUT}* 101.5%	V
V_{IN}	Input Voltage		—	3.0	—	42	V
V_{FB}	Feedback Reference Voltage		—	1.183	1.207	1.231	V
I_{LIMIT}	Current Limit		V_{OUT} Short to 90% x V_{OUT}	310	510	690	mA
$\Delta V_{OUT}/\Delta V_{IN}$	Line Regulation		V_{IN} = V_{OUT} + 1V to 40V, I_{OUT} = 1mA	-10	—	10	mV
$\Delta V_{OUT}/V_{OUT}$	Load Regulation		1mA ≤ I_{OUT} ≤ 300mA	-20	—	20	mV
V_{DROP}	Dropout Voltage (Note 5)		I_{OUT} = 300mA @V_{OUT} = 3.3V	—	450	700	mV
			I_{OUT} = 300mA @V_{OUT} = 5V	—	320	500	mV
I_Q	Quiescent Current	AP7583Q	I_{OUT} = 0A	—	2.5	4.0	µA
		AP7583AQ	I_{OUT} = 0A	—	3	6	µA
$I_{SHUTDOWN}$	Shutdown Current		EN = 0V	—	0.3	0.5	µA
V_{IL}	EN Input Logic-Low Voltage		—	0	—	0.3	V
V_{IH}	EN Input Logic-High Voltage		—	1.7	—	V_{IN}	V
$\Delta V_{OUT}/(V_{OUT}x\Delta T)$	Output Voltage Temperature Coefficient		I_{OUT} = 100µA, -40°C ≤ T_J ≤ +125°C	—	±100	—	ppm/°C
T_{OTSD}	Thermal Shutdown Temperature		—	—	+175	—	°C
T_{HYOTSD}	Thermal Shutdown Hysteresis		—	—	+20	—	°C
PSRR	Power Supply Rejection Ratio		$V_{(Ripple)}$ = 0.5V_{PP}, I_{OUT} = 10mA, frequency = 100Hz, C_{OUT} = 2.2µF	—	70	—	dB
UVLO	VIN Undervoltage Detection		Ramp VIN up until the Output Turns on	2.1	2.4	2.7	V
			Hysteresis	—	0.2	—	V
I_{FB}	FB Leakage Current		FB = 0V (Adjustable Version)	-10	—	20	nA
AP7583AQ							
t_D	Output-Voltage Turn-On Delay Time		V_{EN} High to V_{OUT} Rising 10%	—	0.8	—	ms
t_{SS}	Output-Voltage Ramp-Up Time		V_{OUT} Rising 10% to 90%	—	200	—	µs
t_{PG}	PG React Time		V_{OUT} 90% to PG Active	—	30	—	µs
t_{PGF}	PG Off Deglitch Time		V_{FB} Falling to PG Low	—	3	—	µs
			EN Goes Low to PG Low				
V_{PGR}	PG Rising Threshold		V_{FB} Rising	90	—	94	%
V_{PGF}	PG Falling Threshold		V_{FB} Falling	88	—	92	%
V_{PGS}	PG Sinking Voltage		Sinking Current = 5mA	—	—	0.4	V

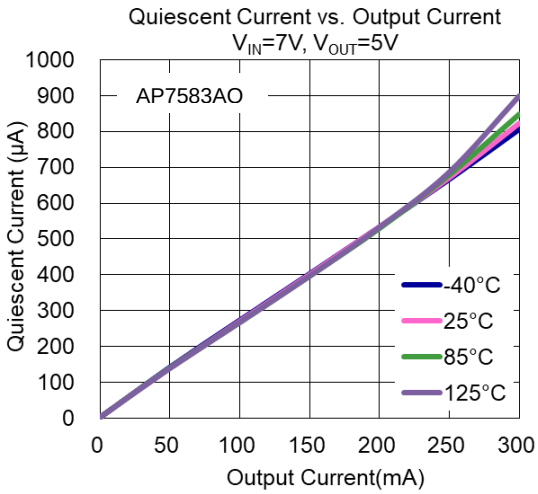
Note: 5. Dropout voltage is the voltage difference between the input and the output at which the output voltage drops 2% below its nominal value.

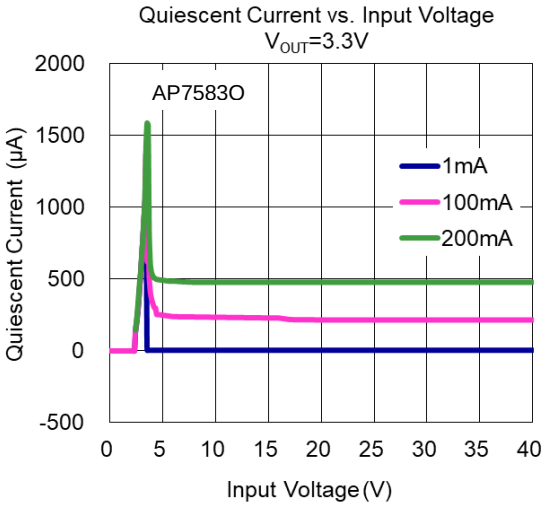
Typical Characteristics (C_{IN} = C_{OUT} = 10μF)

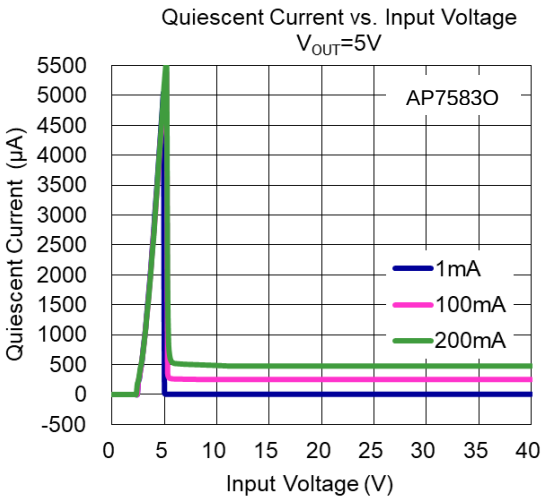




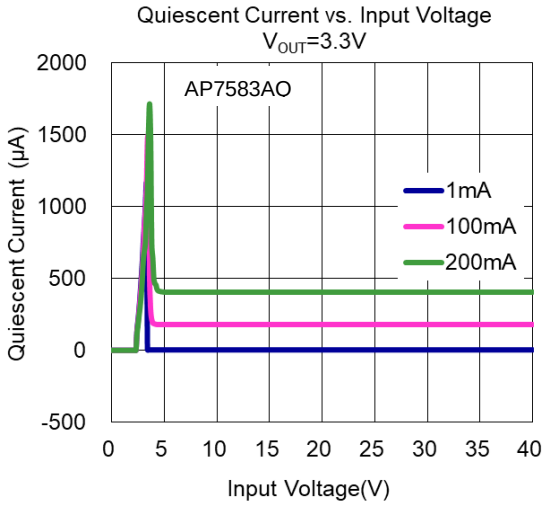


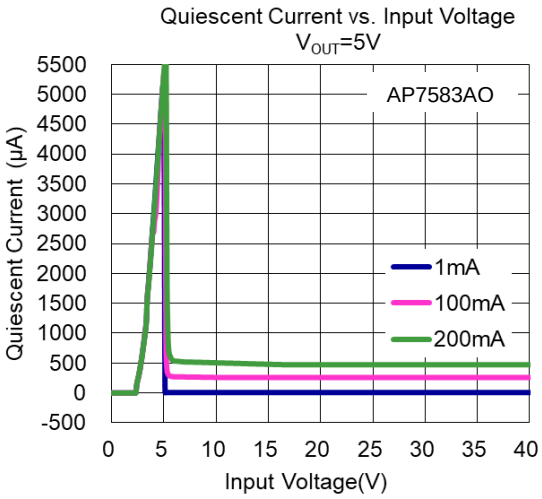


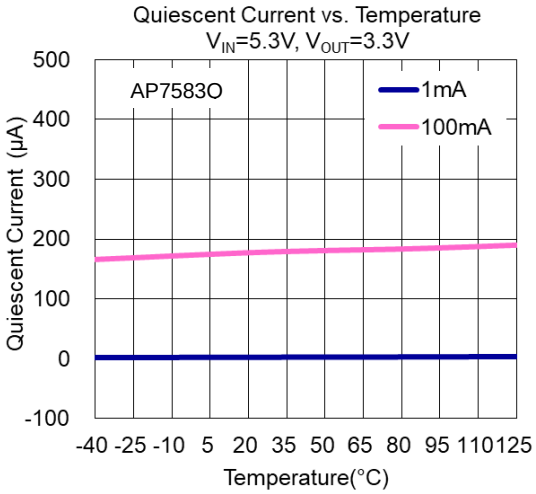


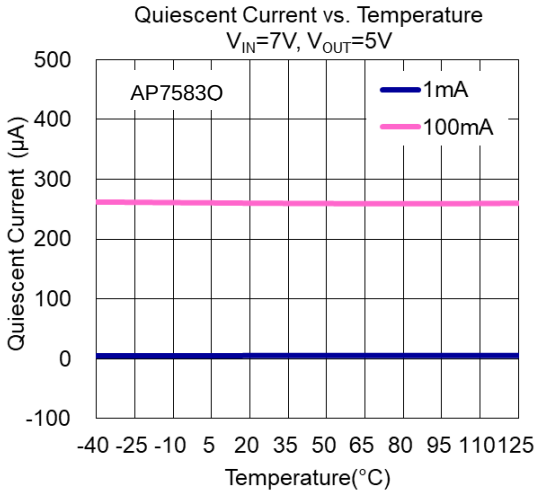


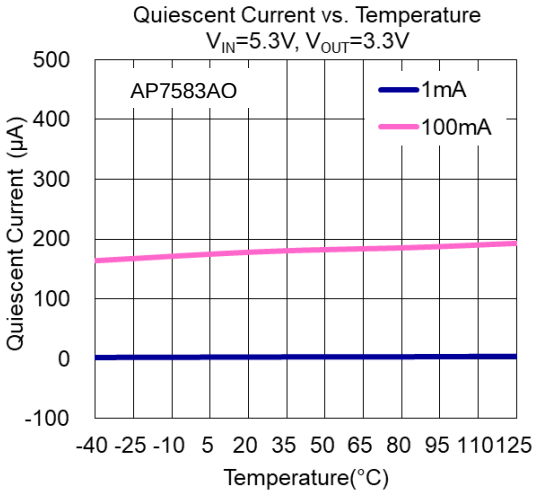
Typical Characteristics (C_{IN} = C_{OUT} = 10μF) (continued)

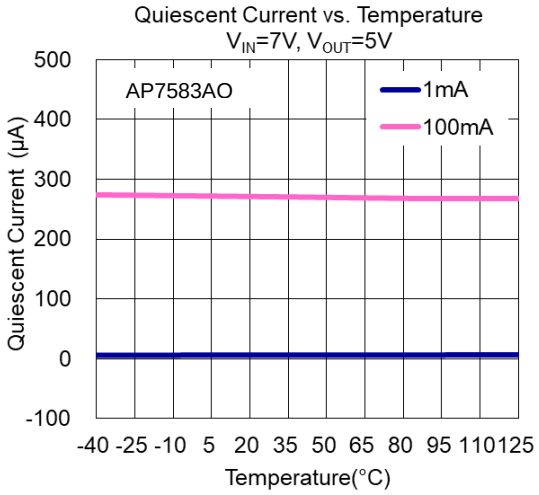






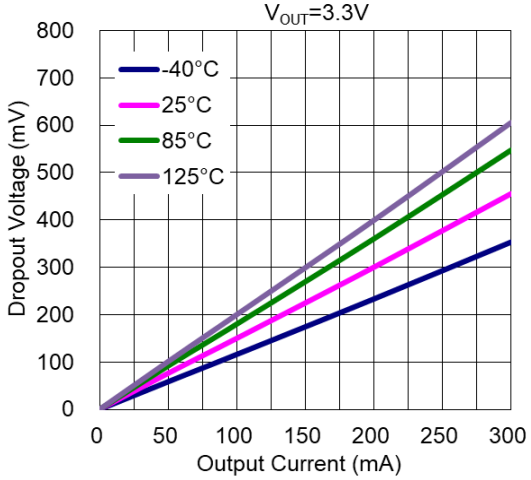




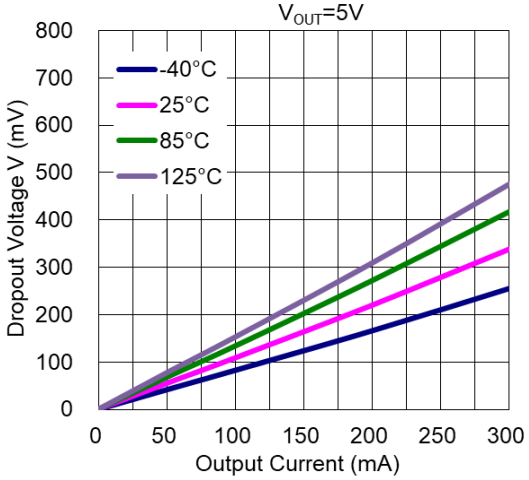


Typical Characteristics (C_{IN} = C_{OUT} = 10μF) (continued)

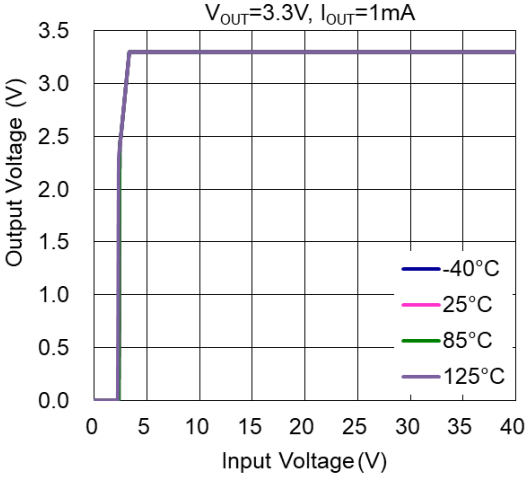
Dropout Voltage vs. Output Current
V_{OUT}=3.3V



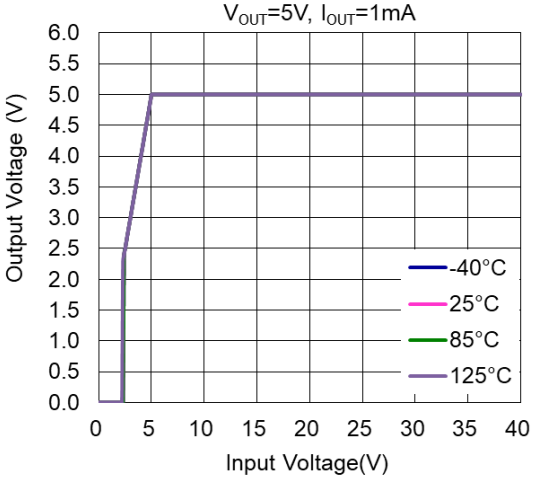
Dropout Voltage vs. Output Current,
V_{OUT}=5V



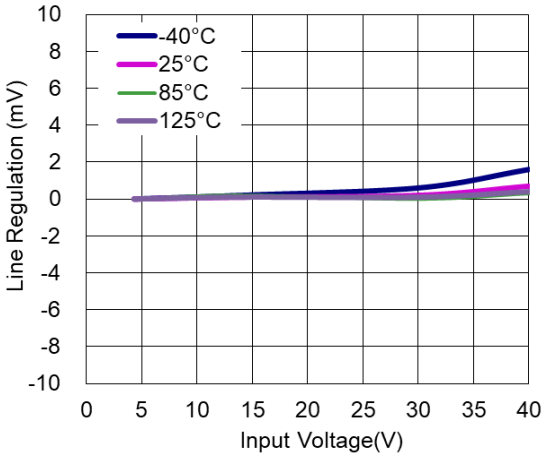
Output Voltage vs. Input Voltage
V_{OUT}=3.3V, I_{OUT}=1mA



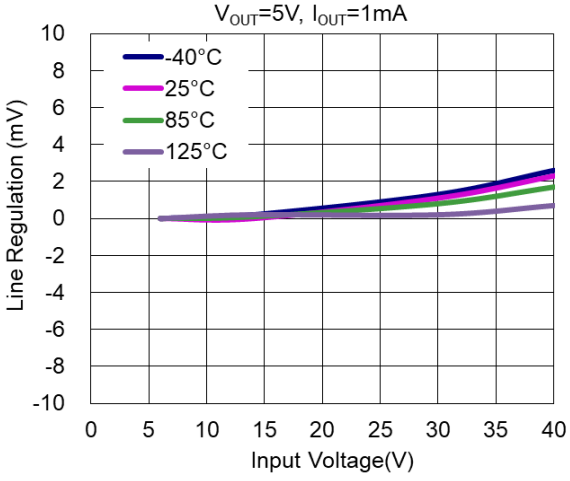
Output Voltage vs. Input Voltage
V_{OUT}=5V, I_{OUT}=1mA



Line Regulation vs. Input Voltage
V_{OUT}=3.3V, I_{OUT}=1mA

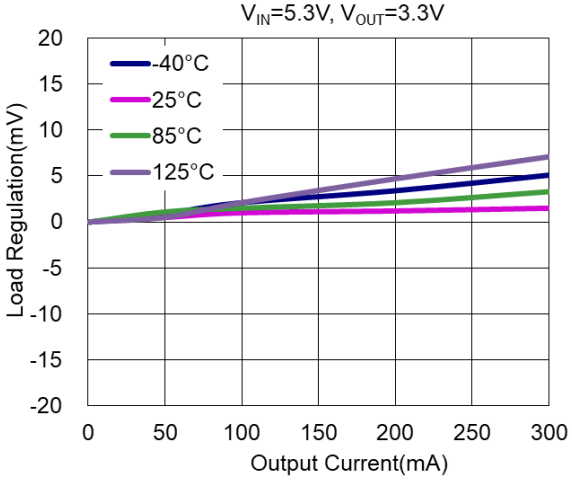


Line Regulation vs. Input Voltage
V_{OUT}=5V, I_{OUT}=1mA

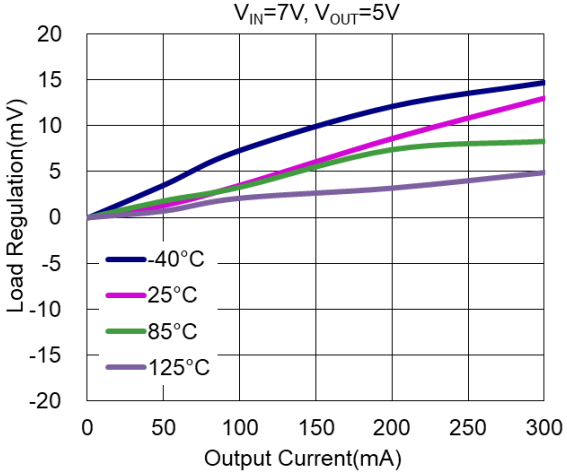


Typical Characteristics (C_{IN} = C_{OUT} = 10μF) (continued)

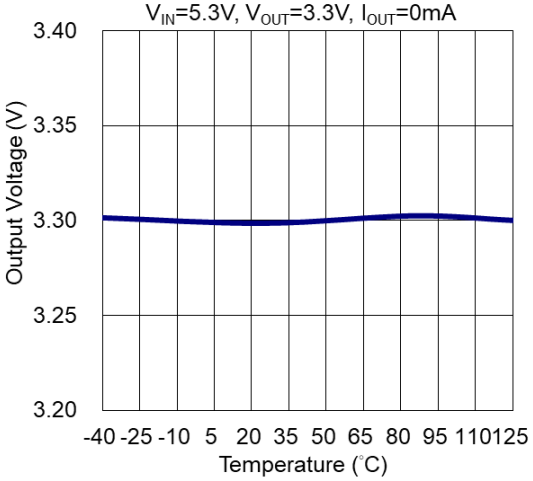
Load Regulation vs. Output Current
V_{IN}=5.3V, V_{OUT}=3.3V



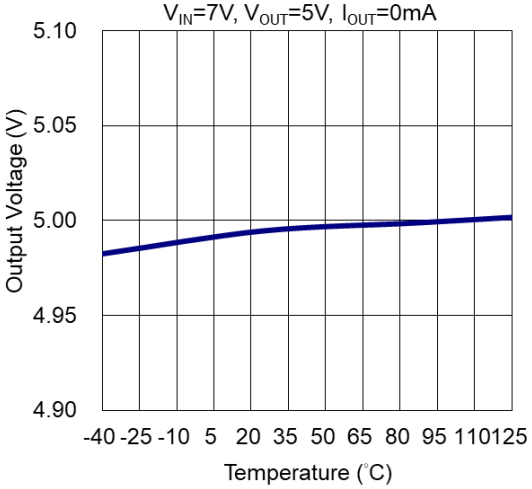
Load Regulation vs. Output Current
V_{IN}=7V, V_{OUT}=5V



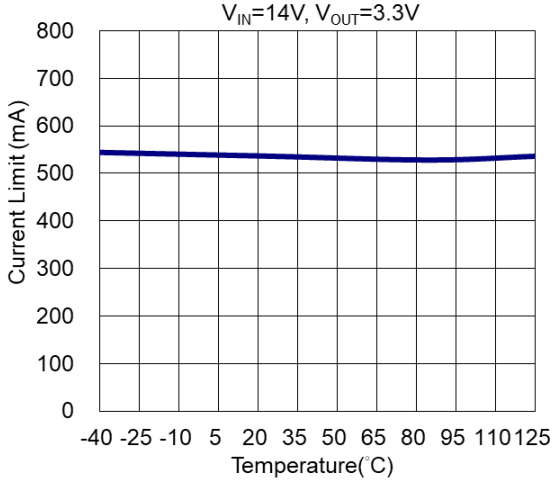
Output Voltage vs. Temperature
V_{IN}=5.3V, V_{OUT}=3.3V, I_{OUT}=0mA



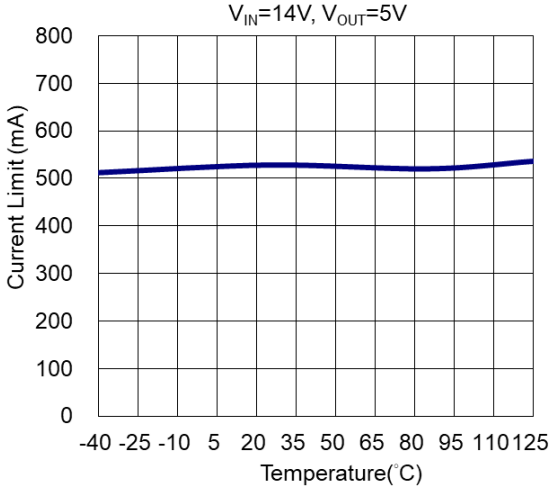
Output Voltage vs. Temperature
V_{IN}=7V, V_{OUT}=5V, I_{OUT}=0mA



Current Limit vs. Temperature
V_{IN}=14V, V_{OUT}=3.3V



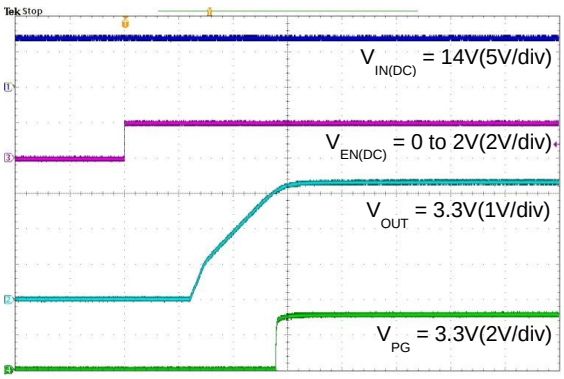
Current Limit vs. Temperature
V_{IN}=14V, V_{OUT}=5V



Typical Characteristics (C_{IN} = C_{OUT} = 10µF) (continued)

Enable Turn-on Response

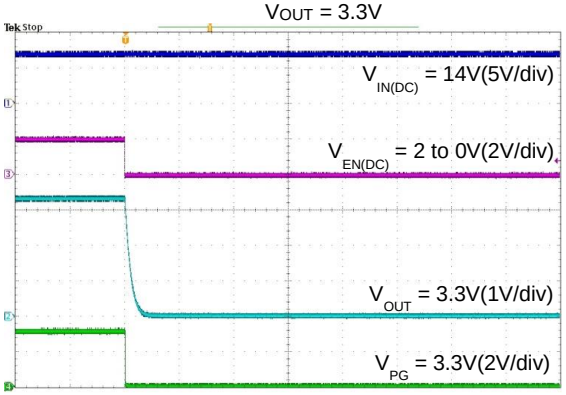
V_{OUT} = 3.3V



Time (1ms/div)

Enable Turn-off Response

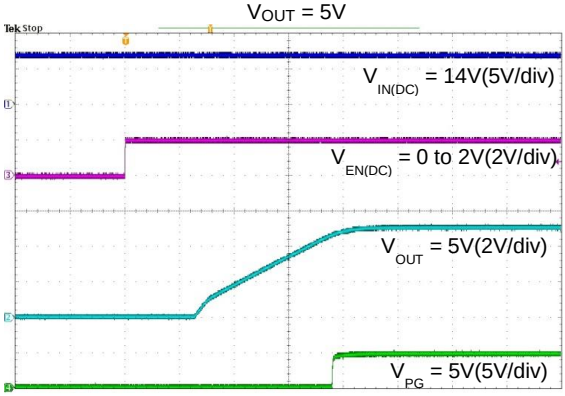
V_{OUT} = 3.3V



Time (1ms/div)

Enable Turn-on Response

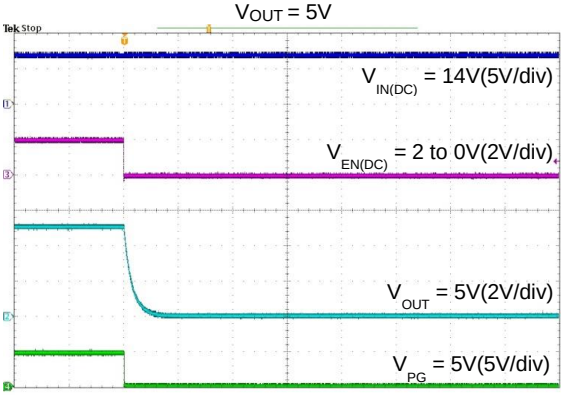
V_{OUT} = 5V



Time (1ms/div)

Enable Turn-off Response

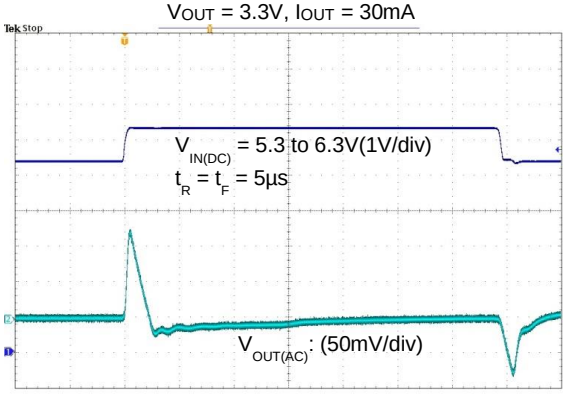
V_{OUT} = 5V



Time (1ms/div)

Line Transient Response

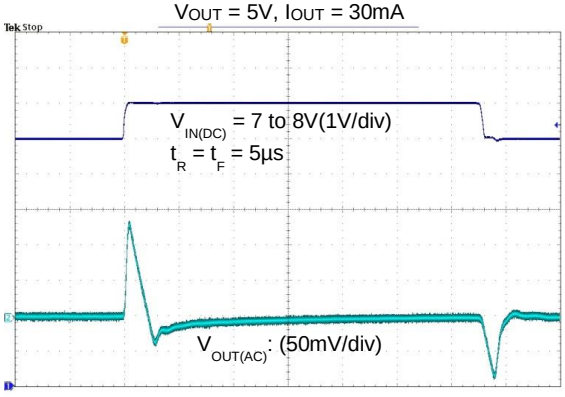
V_{OUT} = 3.3V, I_{OUT} = 30mA



Time (80µs/div)

Line Transient Response

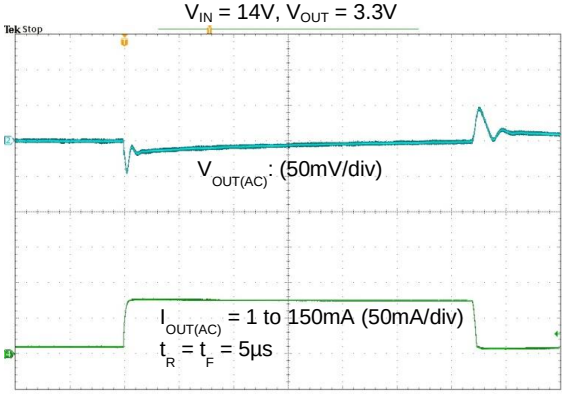
V_{OUT} = 5V, I_{OUT} = 30mA



Time (80µs/div)

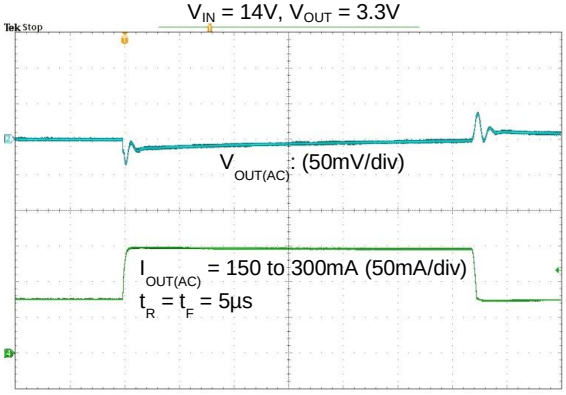
Typical Characteristics (C_{IN} = C_{OUT} = 10μF) (continued)

Load Transient Response
V_{IN} = 14V, V_{OUT} = 3.3V



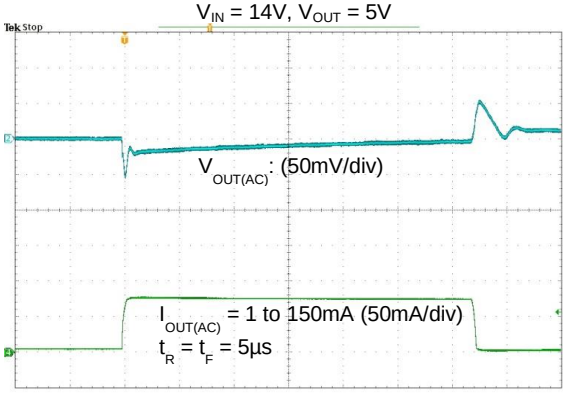
Time (80μs/div)

Load Transient Response
V_{IN} = 14V, V_{OUT} = 3.3V



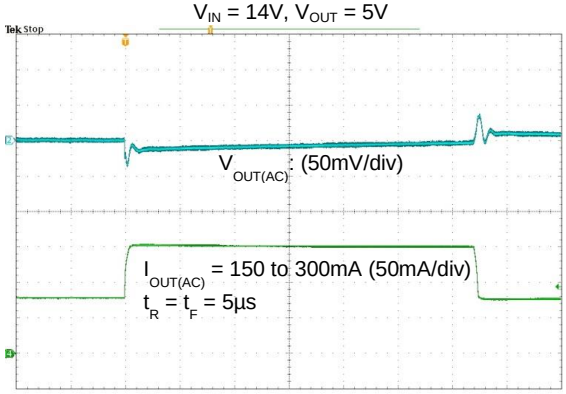
Time (80μs/div)

Load Transient Response
V_{IN} = 14V, V_{OUT} = 5V



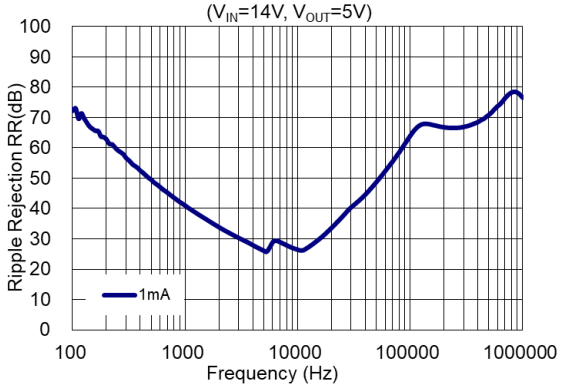
Time (80μs/div)

Load Transient Response
V_{IN} = 14V, V_{OUT} = 5V

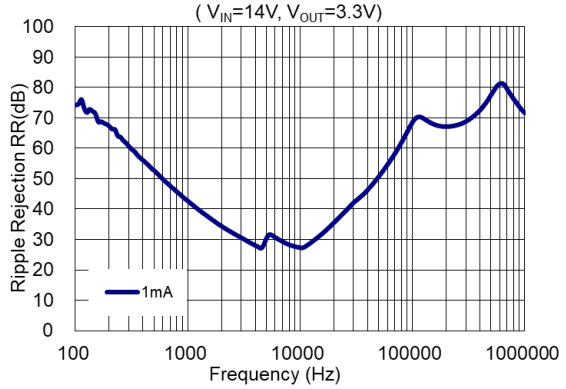


Time (80μs/div)

Ripple Rejection vs Frequency
(V_{IN}=14V, V_{OUT}=5V)



Ripple Rejection vs Frequency
(V_{IN}=14V, V_{OUT}=3.3V)



Application Information

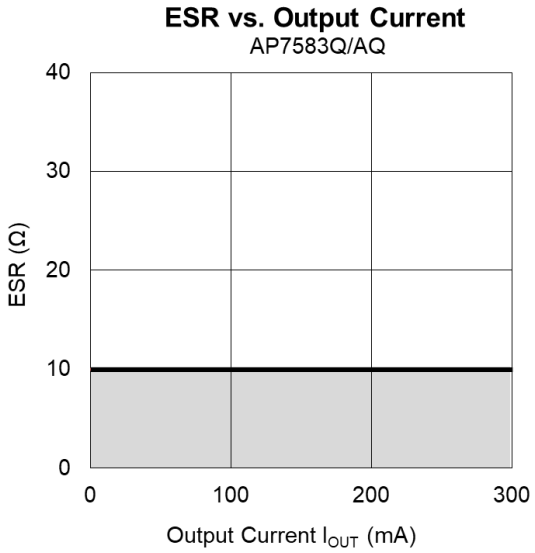
Input Capacitor

A 10μF ceramic capacitor is recommended between IN and GND pins to decouple input power-supply glitch and noise. The amount of the capacitance may be increased without limit. This input capacitor must be located as close as possible to the device to assure input stability and reduce noise. For PCB layout, a wide copper trace is required for both IN and GND pins. A lower ESR capacitor type allows the use of less capacitance, while higher ESR type requires more capacitance.

Output Capacitor

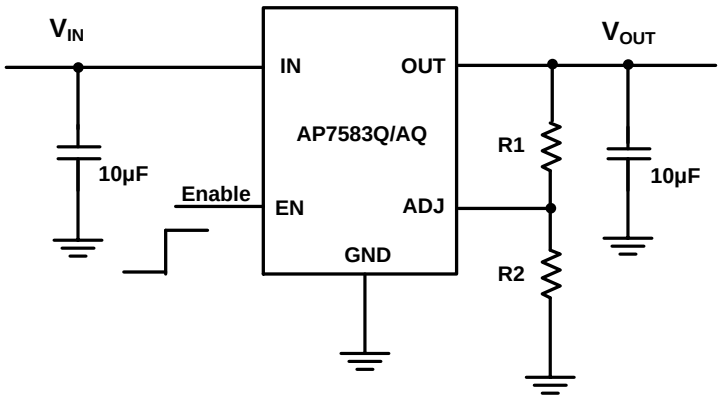
Ceramic type output capacitor is recommended for this series; however, the other output capacitors with low ESR also can be used. One 10μF output capacitor is suggested, the AP7583Q/AQ series LDO would have stable output capacitance range from 4.7μF to 100μF. The relations between I_{OUT} (Output Current) and ESR of an output capacitor are shown below. The stable region for the safety operating temperature (-40°C to +125°C) is marked as the gray area in the graph.

Measurement conditions: Frequency Band: 10Hz to 2MHz, Temperature: -40°C to +125°C.



Adjustable Operation

The AP7583Q/AQ provides output voltage from 1.2V to 5.0V through external resistor divider as shown below:



Adjustable Output

Application Information (continued)

The output voltage is calculated by:

$$V_{OUT} = V_{REF}\left(1+\frac{R_1}{R_2}\right)$$

Where V_{REF} = 1.2V (the internal reference voltage).

Rearranging the equation will give the following that is used for adjusting the output to a particular voltage:

$$R1 = R2\left(\frac{V_{OUT}}{V_{REF}}-1\right)$$

To maintain the stability of the internal reference voltage, R2 needs to be kept smaller than 80kΩ.

No Load Stability

Other than external resistor divider, no minimum load is required to keep the device stable. The device will remain stable and regulated in no load condition.

ON/OFF Input Operation

The AP7583Q/AQ is turned on by setting the EN pin high, and is turned off by pulling it low. If this feature is not used, the EN pin should be tied to IN pin to keep the regulator output on at all time. To ensure proper operation, the signal source used to drive the EN pin must be able to swing above and below the specified turn-on/off voltage thresholds listed in the *Electrical Characteristics* section under V_{IL} and V_{IH}.

Current Limit Protection

When output current at OUT pin is higher than current-limit threshold, the current-limit protection will be triggered and clamp the output current to prevent overcurrent and to protect the regulator from damage due to overheating.

Power Good

The power-good (PG) pin is an open-drain output with one internal resistor. When the $V_{OUT} \geq V_{PGR}$, the PG output is high-impedance; if the V_{OUT} drops to below V_{PGF}, or the device is disabled, the PG pin is pulled to low by an internal MOSFET.

Thermal Shutdown Protection

Thermal protection disables the output when the junction temperature rises to approximately +175°C, allowing the device to cool down. When the junction temperature reduces to approximately +155°C, the output circuitry is enabled again. Depending on power dissipation, thermal resistance, and ambient temperature, the thermal protection circuit may cycle on and off. This cycling limits the heat dissipation of the regulator, protecting it from damage due to overheating.

Power Dissipation

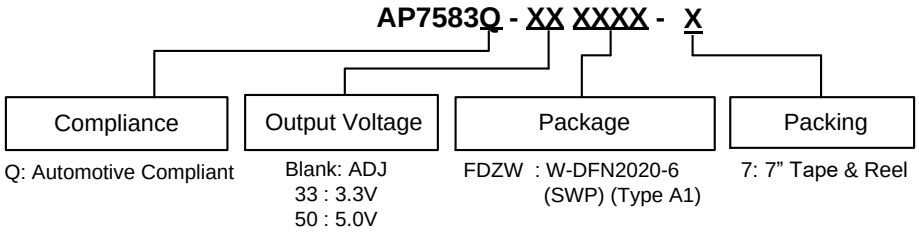
The device power dissipation and proper sizing of the thermal plane that is connected to the thermal pad is critical to avoid thermal shutdown and ensure reliable operation. Power dissipation of the device depends on input voltage and load conditions and can be calculated by:

$P_D = (V_{IN} - V_{OUT}) \times I_{OUT}$

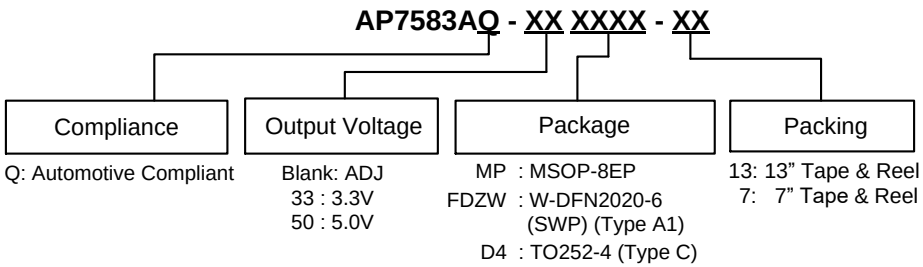
The maximum power dissipation, handled by the device, depends on the maximum junction to ambient thermal resistance, maximum ambient temperature, and maximum device junction temperature, which can be calculated by the equation in the following:

$$P_D(max@T_A) = \frac{(+150°C - T_A)}{R_{\theta JA}}$$

Ordering Information



Part Number	Package Code	Package	Packing	
			Qty.	Carrier
AP7583Q-XXFDZW-7	FDZW	W-DFN2020-6 (SWP) (Type A1)	3,000	7" Tape & Reel



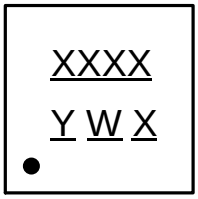
Part Number	Package Code	Package	Packing	
			Qty.	Carrier
AP7583AQ-XXMP-13	MP	MSOP-8EP	2,500	13" Tape & Reel
AP7583AQ-XXFDZW-7	FDZW	W-DFN2020-6 (SWP) (Type A1)	3,000	7" Tape & Reel
AP7583AQ-XXD4-13(*)	D4	TO252-4 (Type C)	2,500	13" Tape & Reel

*: Future Product

Marking Information (AP7583Q)

(1) W-DFN2020-6 (SWP) (Type A1)

(Top View)

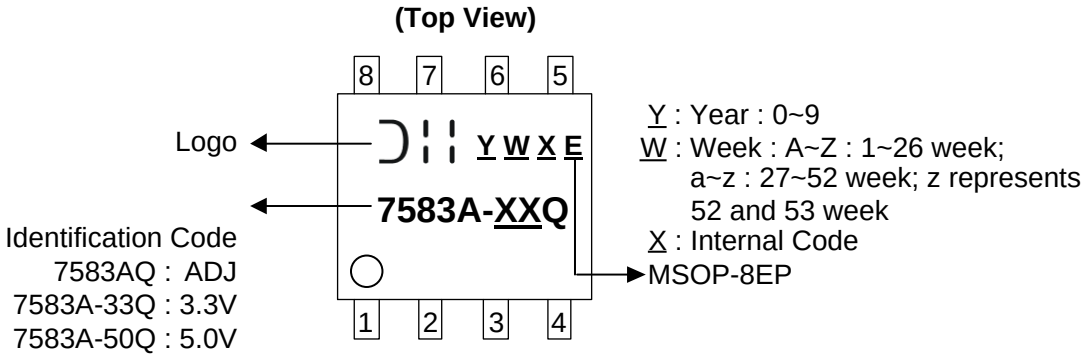


XXXX : Identification Code
Y : Year : 0~9
W : Week : A~Z : 1~26 week;
a~z : 27~52 week; z represents 52 and 53 week
X : Internal Code

Part Number	Package	Identification Code
AP7583Q-FDZW-7	W-DFN2020-6 (SWP) (Type A1)	F7AQ
AP7583Q-33FDZW-7	W-DFN2020-6 (SWP) (Type A1)	F7DQ
AP7583Q-50FDZW-7	W-DFN2020-6 (SWP) (Type A1)	F7EQ

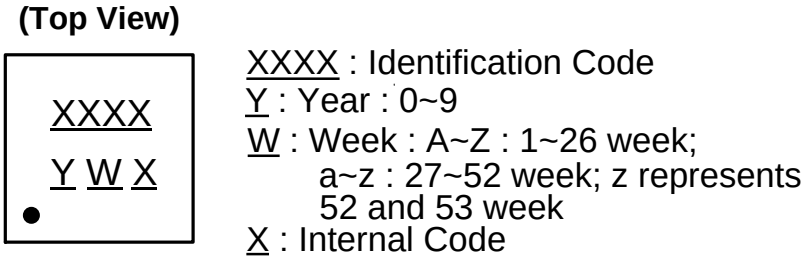
Marking Information (AP7583AQ)

(1) MSOP-8EP



Part Number	Package	Identification Code
AP7583AQ-MP-13	MSOP-8EP	7583AQ
AP7583AQ-33MP-13	MSOP-8EP	7583A-33Q
AP7583AQ-50MP-13	MSOP-8EP	7583A-50Q

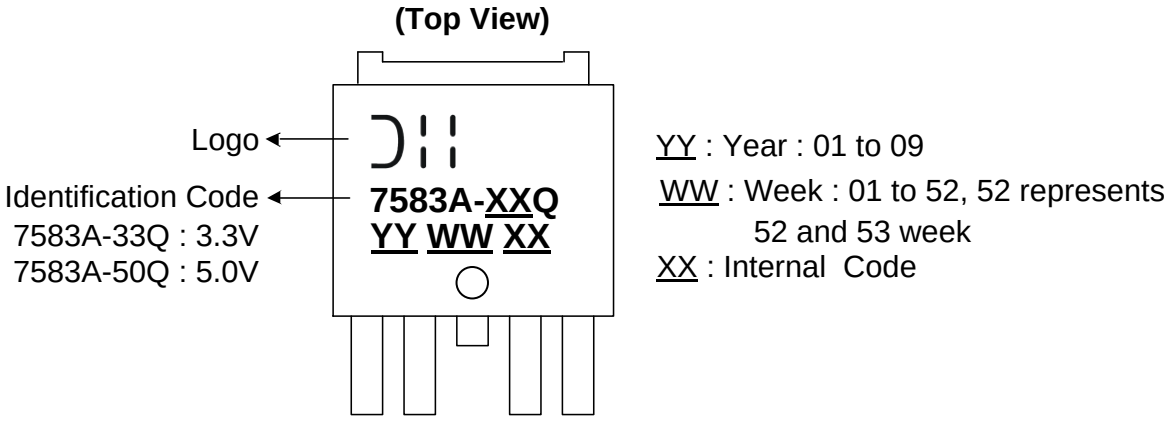
(2) W-DFN2020-6 (SWP) (Type A1)



Part Number	Package	Identification Code
AP7583AQ-FDZW-7	W-DFN2020-6 (SWP) (Type A1)	F8AQ
AP7583AQ-33FDZW -7	W-DFN2020-6 (SWP) (Type A1)	F8DQ
AP7583AQ-50FDZW -7	W-DFN2020-6 (SWP) (Type A1)	F8EQ

Marking Information (AP7583AQ) (continued)

(3) TO252-4 (Type C)

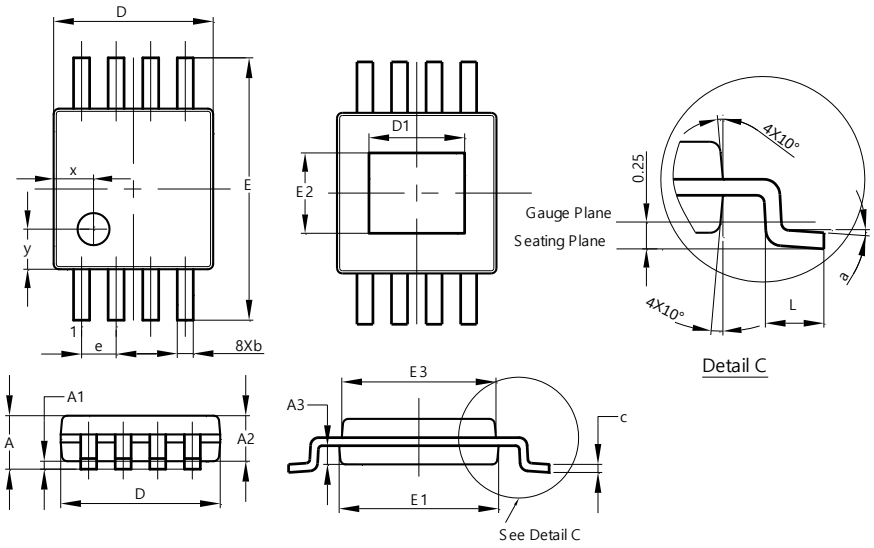


Part Number	Package	Identification Code
AP7583AQ-33D4-13	TO252-4 (Type C)	7583A-33Q
AP7583AQ-50D4-13	TO252-4 (Type C)	7583A-50Q

Package Outline Dimensions

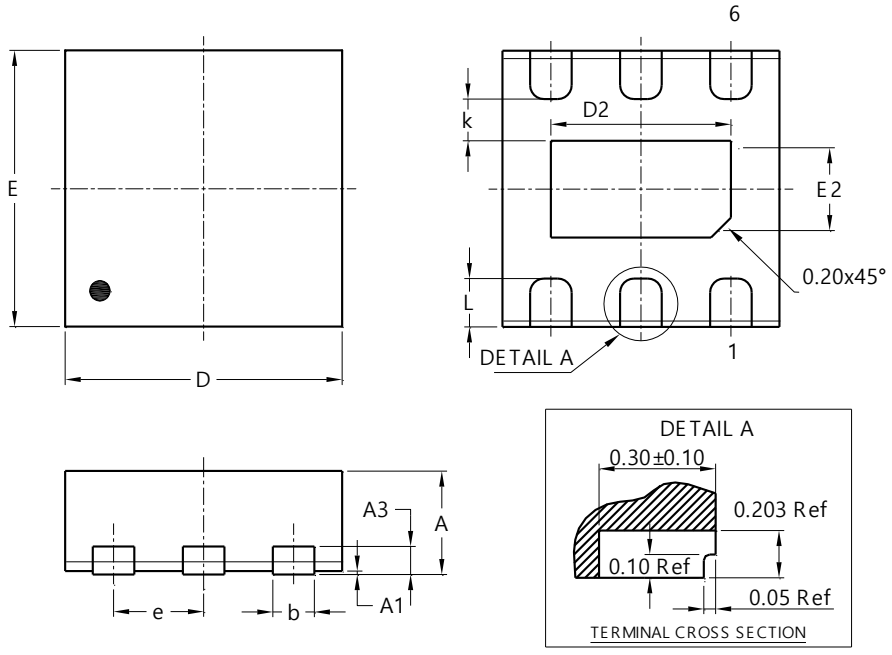
Please see http://www.diodes.com/package-outlines.html for the latest version.

(1) MSOP-8EP



MSOP-8EP			
Dim	**Min**	**Max**	**Typ**
A	-	1.10	-
A1	0.05	0.15	0.10
A2	0.75	0.95	0.86
A3	0.29	0.49	0.39
b	0.22	0.38	0.30
c	0.08	0.23	0.15
D	2.90	3.10	3.00
D1	1.60	2.00	1.80
E	4.70	5.10	4.90
E1	2.90	3.10	3.00
E2	1.30	1.70	1.50
E3	2.85	3.05	2.95
e	-	-	0.65
L	0.40	0.80	0.60
a	0°	8°	4°
x	-	-	0.750
y	-	-	0.750
All Dimensions in mm			

(2) W-DFN2020-6 (SWP) (Type A1)

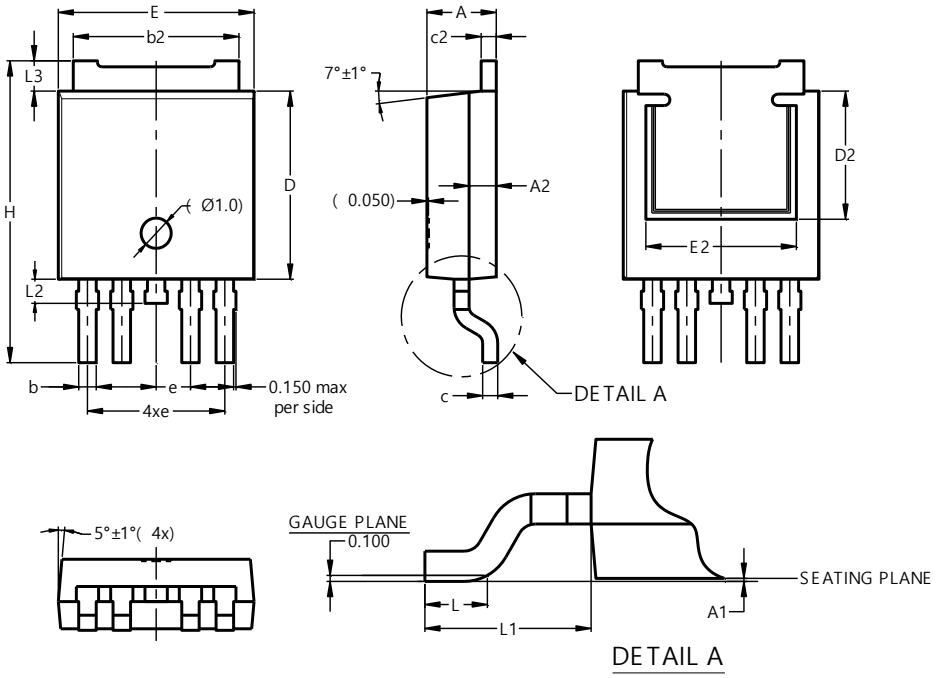


W-DFN2020-6 (SWP) (Type A1)			
Dim	**Min**	**Max**	**Typ**
A	0.70	0.80	0.75
A1	0.00	0.05	0.02
A3	0.203 REF		
b	0.25	0.35	0.30
D	2.00 BSC		
D2	1.35	1.45	1.40
E	2.00 BSC		
E2	0.55	0.65	0.60
e	0.65 BSC		
k	0.20	—	—
L	0.20	0.40	0.30
All Dimensions in mm			

Package Outline Dimensions (continued)

Please see http://www.diodes.com/package-outlines.html for the latest version.

(3) TO252-4 (Type C)

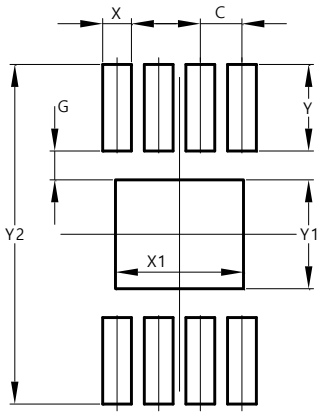


TO252-4 (Type C)			
Dim	**Min**	**Max**	**Typ**
A	2.20	2.35	--
A1	0.00	0.15	--
A2	0.80	1.00	--
b	0.50	0.70	0.60
b2	5.30	5.70	--
c	0.46	0.58	--
c2	0.46	0.58	--
D	6.02	6.22	--
D2	4.24REF		
e	1.14BSC		
E	6.45	6.65	--
E2	5.00REF		
H	9.48	10.48	9.98
L	0.60	--	--
L1	2.76REF		
L2	0.65	0.95	0.80
L3	0.90	1.10	1.00
All Dimensions in mm			

Suggested Pad Layout

Please see http://www.diodes.com/package-outlines.html for the latest version.

(1) MSOP-8EP

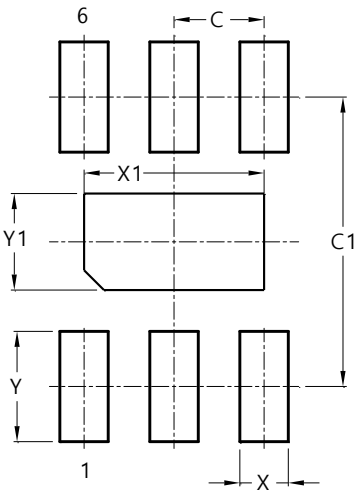


Dimensions	Value (in mm)
C	0.650
G	0.450
X	0.450
X1	2.000
Y	1.350
Y1	1.700
Y2	5.300

Suggested Pad Layout (continued)

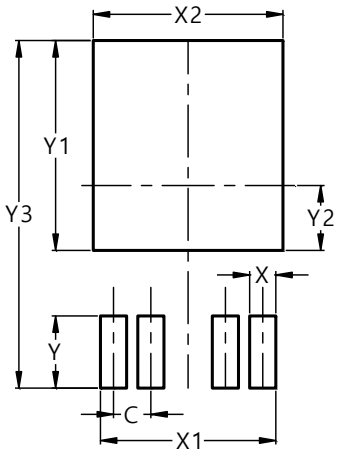
Please see http://www.diodes.com/package-outlines.html for the latest version.

(2) W-DFN2020-6 (SWP) (Type A1)



Dimensions	Value (in mm)
C	0.650
C1	2.100
X	0.350
X1	1.400
Y	0.800
Y1	0.600

(3) TO252-4 (Type C)



Dimensions	Value (in mm)
C	1.140
X	0.800
X1	5.360
X2	5.800
Y	2.200
Y1	6.400
Y2	1.980
Y3	10.600

Mechanical Data

- Moisture Sensitivity:
  - MSOP-8EP: Level 1 Per J-STD-020
  - W-DFN2020-6 (SWP) (Type A1): Level 1 Per J-STD-020
  - TO252-4 (Type C): Level 3 Per J-STD-020
- Terminals: Finish - Matte Tin Plated Leads, Solderable per MIL-STD-202, Method 208 e3
- Weight:
  - MSOP-8EP: 0.024 grams (Approximate)
  - W-DFN2020-6 (SWP) (Type A1): 0.01 grams (Approximate)
  - TO252-4 (Type C): 0.343 grams (Approximate)

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