6V/1.5A, 90mΩ RON SWITCH WITH SHORT-CIRCUIT PROTECTION

Description

The AP22919Q is a single-channel load switch with controlled turn-on slew rate. It contains a p-channel MOSFET that can operate over an input voltage range of 1.6V to 5.5V and switch currents up to 1.5A.

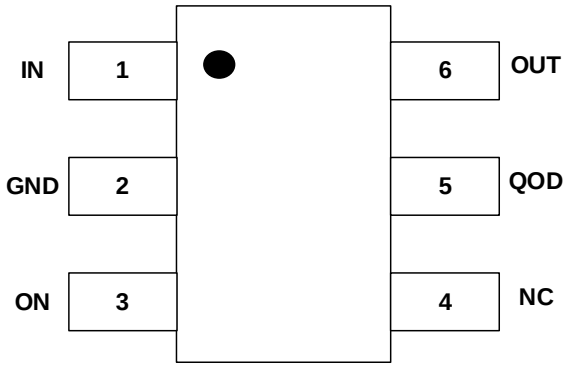
The AP22919Q ON state can be controlled by a digital input that is capable of interfacing directly with low-voltage control signals. When power is first applied, a Smart Pulldown is used to keep the ON pin from floating until system sequencing is complete. Once the pin is deliberately driven High (>V_{IH}), the Smart Pulldown will be disconnected to prevent unnecessary power loss.

The AP22919Q is also self-protected, meaning that it protects against short-circuit events on the output of the device. It also has thermal shutdown protection to prevent any damage from overheating.

The AP22919Q is available in a standard SOT363 (Standard) package.

Pin Assignments

(Top View)



SOT363 (Standard)

Features

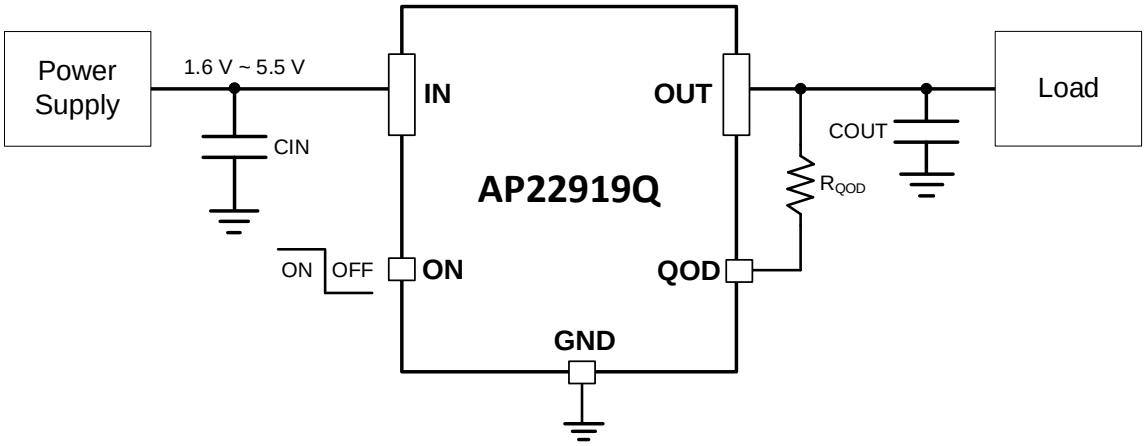
- AEC-Q100 Qualification Compliance with Device Temperature Grade 1 (-40°C to +125°C Ambient Operating Temperature Range)
- 1.6V to 5.5V Input Voltage Range
- 1.5A Maximum Continuous Current
- Low R_{ON}
  - Typ 90mΩ at V_{IN} = 5V
  - Typ 110mΩ at V_{IN} = 3.6V
  - Typ 180mΩ at V_{IN} = 1.8V
- Low Quiescent Current of typ 7µA
- Low Shutdown Current of typ 45nA
- Output Short Protection: typ 3A
- Slow Turn ON Timing to Limit Inrush Current
  - 5V Turn ON (t_{ON}): 2.3ms at 2.6mV/µs
  - 3.6V Turn ON (t_{ON}): 2.0ms at 2.4mV/µs
  - 1.8V Turn ON (t_{ON}): 1.4ms at 2.2mV/µs
- Adjustable Quick Output Discharge (QOD)
  - Internal QOD Resistance = typ 10Ω
- Smart ON Pin Pulldown:
  - ON ≥ V_{IH}: max 100nA of I_{ON}
  - ON ≤ V_{IL}: typ 530kΩ of R_{PD}
- Active HIGH Operation
- Thermal Shutdown
- Smaller Form Factor Package SOT363 (Standard)
- **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
- **Halogen and Antimony Free. "Green" Device (Note 3)**
- **The AP22919Q is suitable for automotive applications requiring specific change control; this part is AEC-Q100 qualified, PPAP capable, and manufactured in IATF 16949 certified facilities.**
  https://www.diodes.com/quality/product-definitions/

Applications

- Infotainment and cluster head units
- Automotive cluster displays
- ADAS surround view system ECU
- Body control modules and gateways

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.

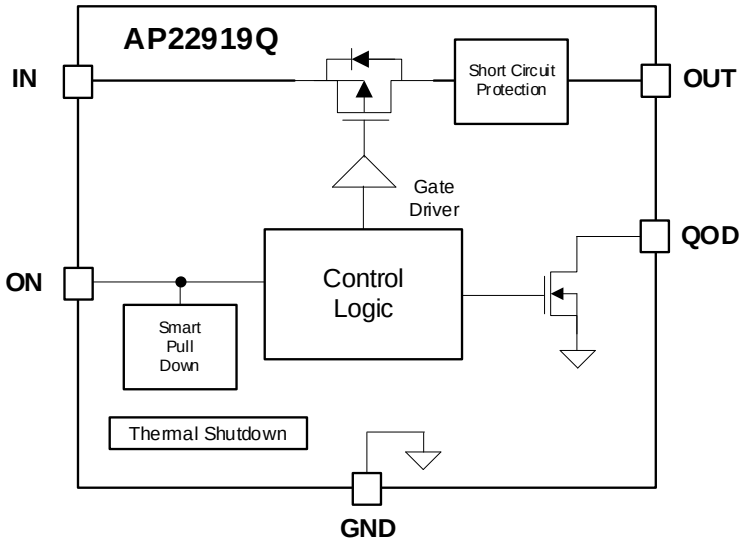
Typical Applications Circuit



Pin Descriptions

Pin Name	Pin Number	Function
IN	1	Power Switch Input. Place bypass capacitor to GND.
OUT	6	Power Switch Output. Place bypass capacitor to GND.
ON	3	Active HIGH enable input. Do not leave floating.
QOD	5	Quick Output Discharge pin. The functionality can be used in one of the three ways. (1) Placing an external resistor between OUT and QOD. (2) Tying QOD directly to OUT and using the internal resistor value of R_{PD}. (3) Disabling QOD by leaving the pin floating.
GND	2	Ground
NC	4	No connection pin. Leave floating.

Functional Block Diagram



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

Symbol	Parameter	Ratings	Unit
ESD HBM	Human Body ESD Protection	±2	kV
ESD CDM	Charged Device Model ESD Protection	±1	V
V_{IN}	Input Voltage at IN Pin	-0.3 to +6	V
V_{OUT}	Output Voltage at OUT Pin	-0.3 to +6	V
V_{ON}	Voltage at ON Pin	-0.3 to +6	V
V_{QOD}	Voltage at QOD Pin	-0.3 to +6	V
I_L	Load Current	1.5	A
I_{PLS}	Maximum Pulsed Switch Current, Pulse < 300µs, 2% Duty Cycle	2.5	A
$T_{J(max)}$	Maximum Junction Temperature	Internally Limited	°C
T_{STG}	Storage Temperature	-65 to +150	°C
$R_{\theta JA}$	Junction-to-Ambient Thermal Resistance (Notes 5 & 6)	199.7	°C/W
$R_{\theta JC(top)}$	Junction-to-Case (Top) Thermal Resistance (Notes 5 & 6)	148.1	°C/W
$R_{\theta JB}$	Junction-to-Board Thermal Resistance (Notes 5 & 6)	82.2	°C/W
ψ_{JT}	Junction-to-Top Characterization Parameter (Notes 5 & 6)	61.9	°C/W
ψ_{JB}	Junction-to-Board Characterization Parameter (Notes 5 & 6)	80.5	°C/W
$R_{\theta JC(bot)}$	Junction-to-Case(Bottom) Thermal Resistance (Notes 5 & 6)	106.3	°C/W

Note: 4. Stresses greater than 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 or any other conditions beyond those indicated under *Recommended Operating Conditions* is not implied. Exposure to *Absolute Maximum Ratings* for extended periods can affect device reliability.

5. $R_{\theta JA}$ and $R_{\theta JC}$ are measured at T_A = +25°C on a high effective thermal conductivity 2S2P layer PCB test board per JEDEC 51-7.

6. Device mounted on the JEDEC High-K board. 3 inch x 3 inch with 1oz. Internal power and ground planes and 2oz. copper traces on the top and bottom of the board.

Recommended Operating Conditions (@ T_A = +25°C, unless otherwise specified.) (Note 7)

Symbol	Parameter	Min	Max	Unit
V_{IN}	Input Voltage	1.6	5.5	V
V_{OUT}	Output Voltage	0	5.5	V
T_A	Operating Ambient Temperature	-40	+125	°C
V_{IH}	ON Input Logic HIGH Voltage	1	5.5	V
V_{IL}	ON Input Logic LOW Voltage	0	0.35	V

Note: 7. Refer to the *Typical Applications Circuit*.

Electrical Characteristics (Typical values are V_{IN} = 3.6V at T_A = +25°C, unless otherwise specified.).

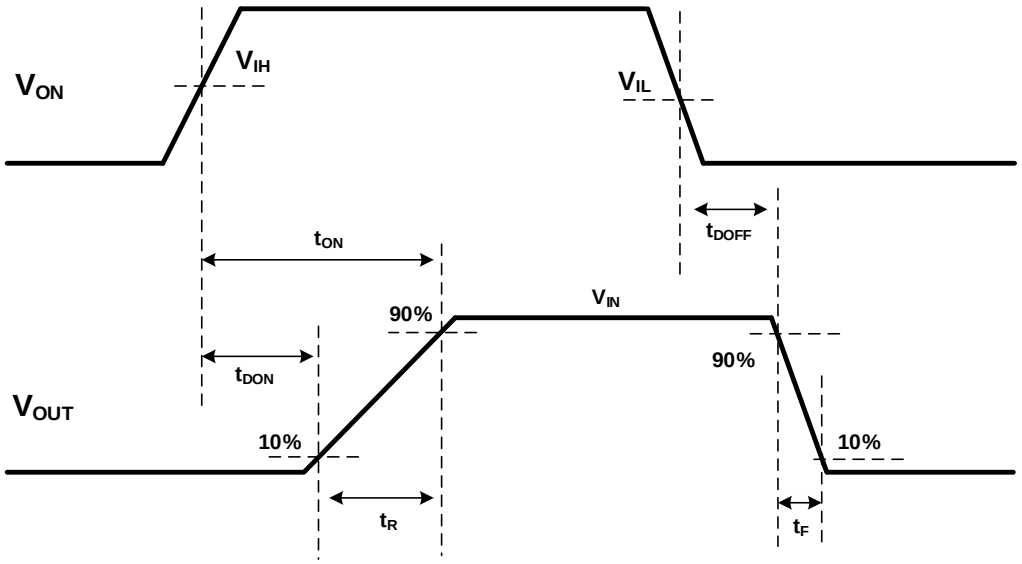
Symbol	Parameter	Test Conditions		Min	Typ	Max	Unit
Device							
I_Q	Quiescent Current	Switch enabled, V_{OUT} = Open	T_A = +25°C	—	7	15	µA
			T_A = -40°C to +125°C	—	—	20	
I_{SD}	Shutdown Current	Switch disabled, V_{OUT} = GND	T_A = +25°C	—	45	100	nA
			T_A = -40°C to +125°C	—	—	2500	
I_{ON}	ON Input Leakage	$V_{ON} \geq V_{IH}$, T_A = -40°C to +125°C		—	—	100	nA
R_{PD_ON}	Smart Pulldown Resistance	$V_{ON} \leq V_{IL}$, T_A = -40°C to +125°C		—	530	—	kΩ
R_{DIS}	QOD Internal Discharge Resistance	$V_{ON} \leq V_{IL}$, T_A = -40°C to +125°C		—	10	—	Ω
T_{SDN}	Thermal Shutdown	Threshold		—	+180	—	°C
		Hysteresis		—	+45	—	
Output Short-Circuit Protection (SCP)							
I_{SC}	Short-Circuit Current Limit (Note 8)	$V_{OUT} \leq V_{IN}$ -1.5V, T_A = -40°C to +125°C		—	3	—	A
		$V_{OUT} \leq V_{SC}$, T_A = -40°C to +125°C		30	500	900	mA
V_{SC}	Output Short Detection Threshold (Note 8)	V_{IN} - V_{OUT}	T_A = -40°C to +105°C	0.3	0.36	0.46	V
			T_A = -40°C to +125°C	0.22	0.36	0.57	V
t_{SC}	Output Short Response Time (Note 8)	V_{IN} = 1.6V to 5.5V, R_L = 10mΩ Short applied. T_A = -40°C to +125°C		—	2	—	µs
Power Switch							
R_{ON}	ON Resistance	I_{OUT} = 200mA T_A = +25°C	V_{IN} = 5V	—	90	125	mΩ
			V_{IN} = 3.6V	—	110	150	
			V_{IN} = 1.8V	—	180	250	
		I_{OUT} = 200mA T_A = -40°C to +85°C	V_{IN} = 5V	—	—	130	
			V_{IN} = 3.6V	—	—	160	
			V_{IN} = 1.8V	—	—	260	
		I_{OUT} = 200mA T_A = -40°C to +105°C	V_{IN} = 5V	—	—	140	
			V_{IN} = 3.6V	—	—	170	
			V_{IN} = 1.8V	—	—	270	
		I_{OUT} = 200mA T_A = -40°C to +125°C	V_{IN} = 5V	—	—	150	
			V_{IN} = 3.6V	—	—	180	
			V_{IN} = 1.8V	—	—	280	

Note: 8. Refer to the *Applications Information* and guaranteed by RD design.

Switching Characteristics (V_{IN} = 3.6V, C_{OUT} = 0.1µF, R_L = 100Ω, T_A = +25°C, unless otherwise noted)

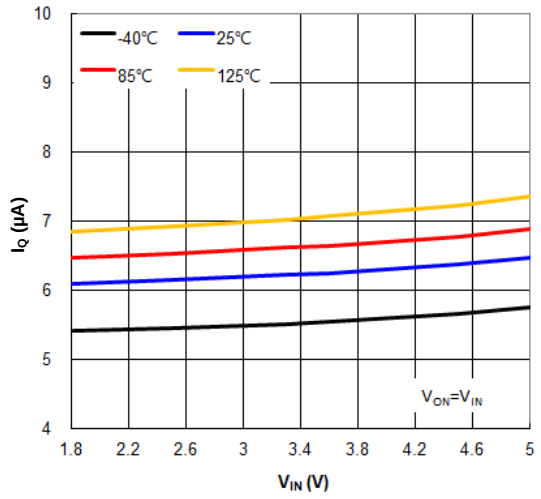
Symbol	Parameter	Test Conditions		Min	Typ	Max	Unit
t_{ON}	Output Turn ON Time	V_{IN} = 5V		—	2300	—	µs
		V_{IN} = 3.6V		—	2000	—	
		V_{IN} = 1.8V		—	1400	—	
t_R	Output Rise Time	V_{IN} = 5V		—	1280	—	
		V_{IN} = 3.6V		—	1100	—	
		V_{IN} = 1.8V		—	750	—	
SR_{ON}	Turn ON Slew Rate	V_{IN} = 5V		—	3.2	—	mV/µs
		V_{IN} = 3.6V		—	2.7	—	
		V_{IN} = 1.8V		—	1.8	—	
t_{DOFF}	Turn OFF Time	V_{IN} = 1.8V to 5V		—	6	—	µs
t_F	VOUT Fall Time	R_L = 100Ω	C_{OUT} = 0.1µF R_{QOD} = Short	—	20	—	µs
		R_L = Open	C_{OUT} = 10µF R_{QOD} = Short	—	0.4	—	ms
			C_{OUT} = 10µF R_{QOD} = 100Ω	—	3.5	—	ms
			C_{OUT} = 100µF R_{QOD} = Short	—	4	—	ms

Typical t_{ON}/t_{OFF} Waveforms

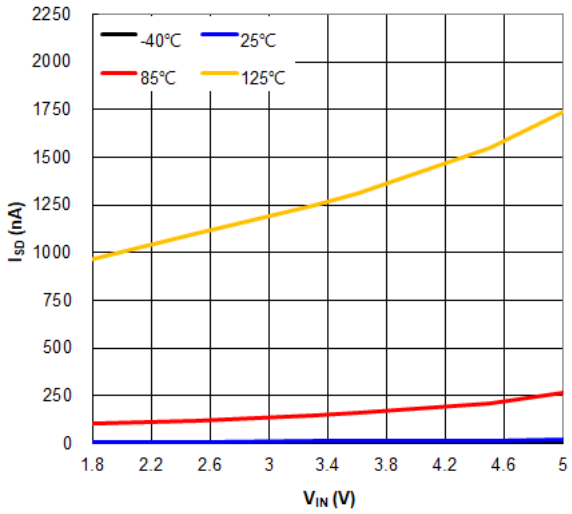


Typical Performance Characteristics

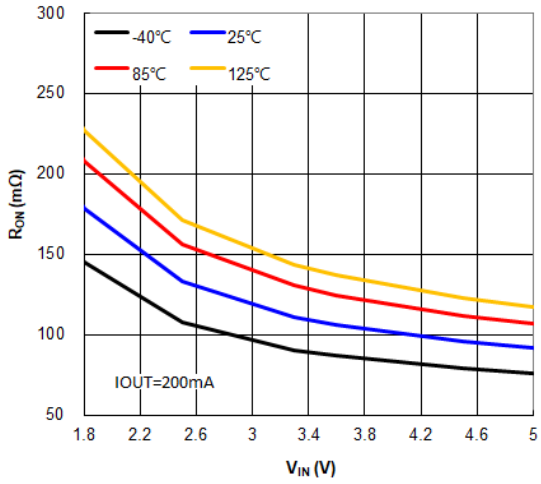
Quiescent Current vs. Input Voltage



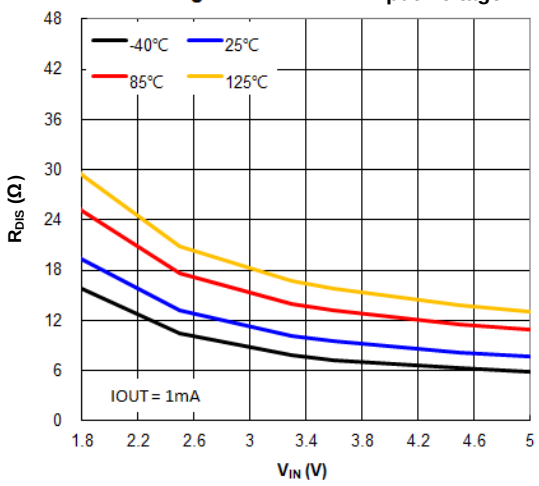
Shutdown Current Leakage vs. Input Voltage



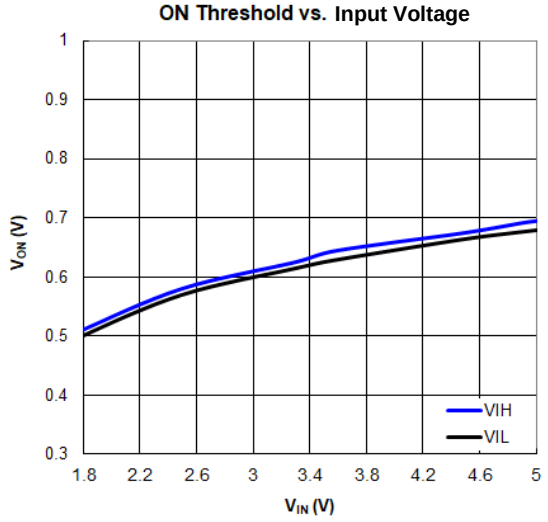
Switch On-Resistance vs. Input Voltage



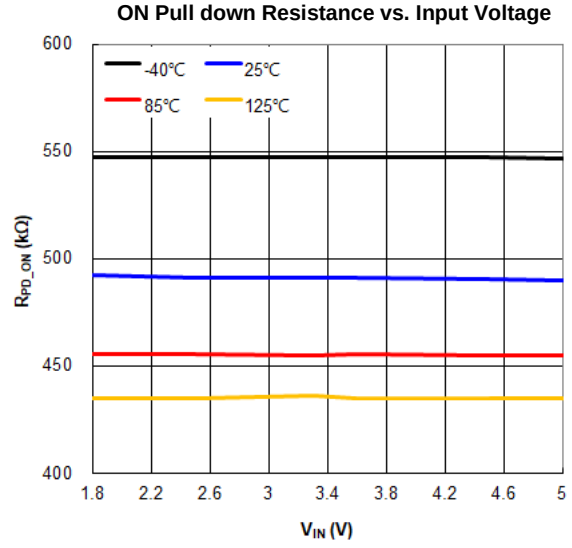
Discharge Resistance vs. Input Voltage



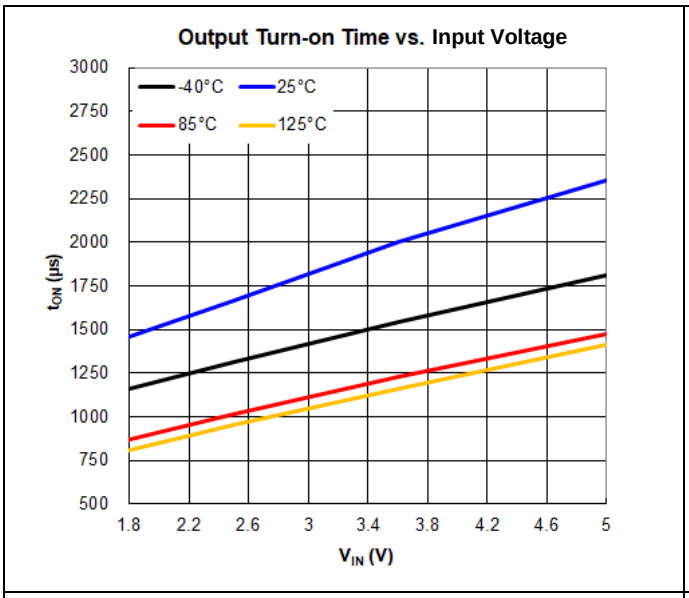
ON Threshold vs. Input Voltage

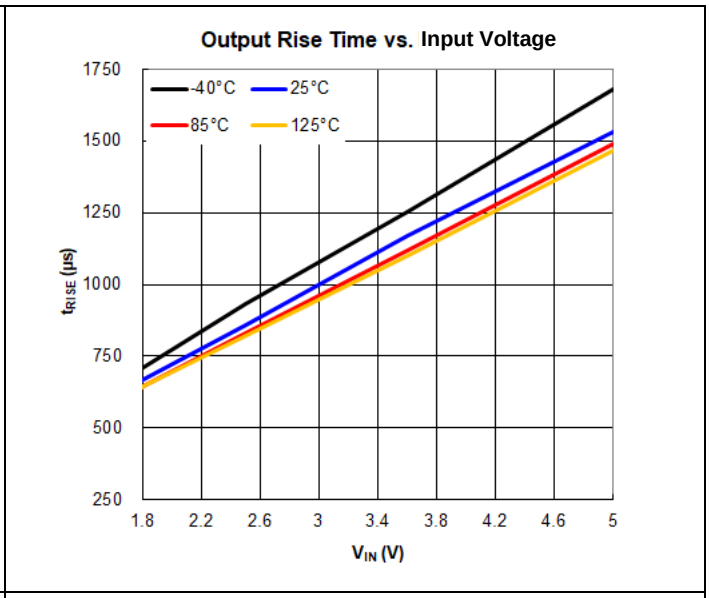


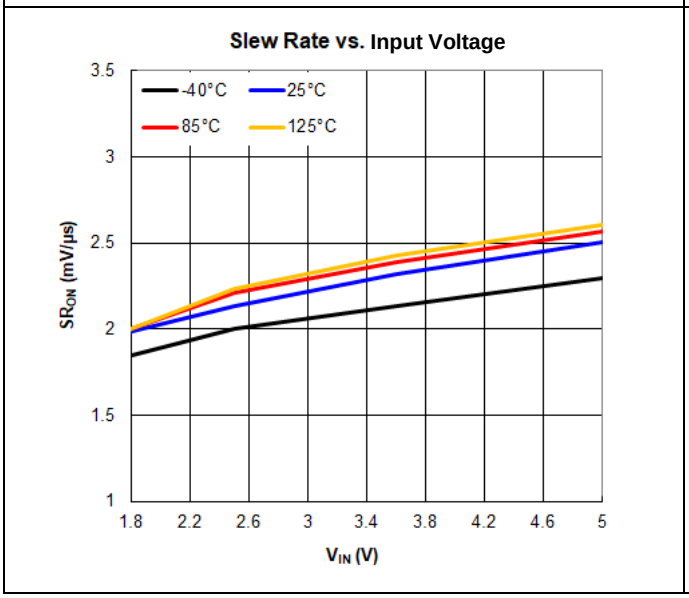
ON Pull down Resistance vs. Input Voltage

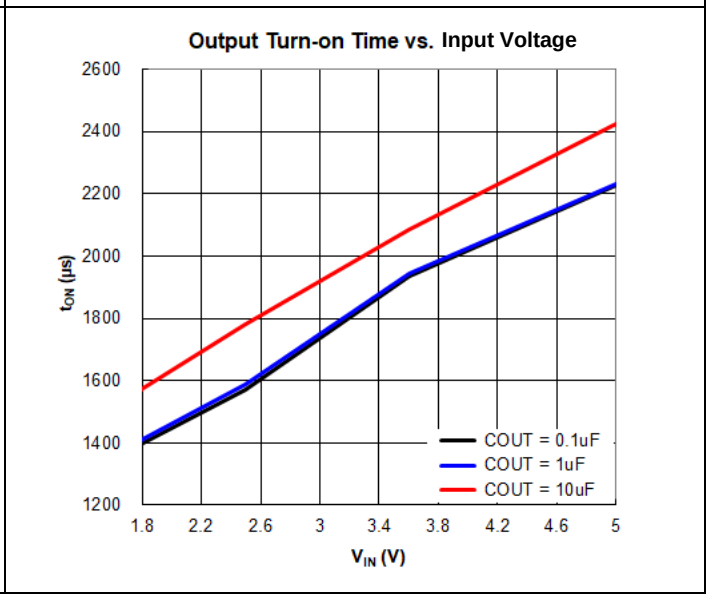


Typical Performance Characteristics (continued)

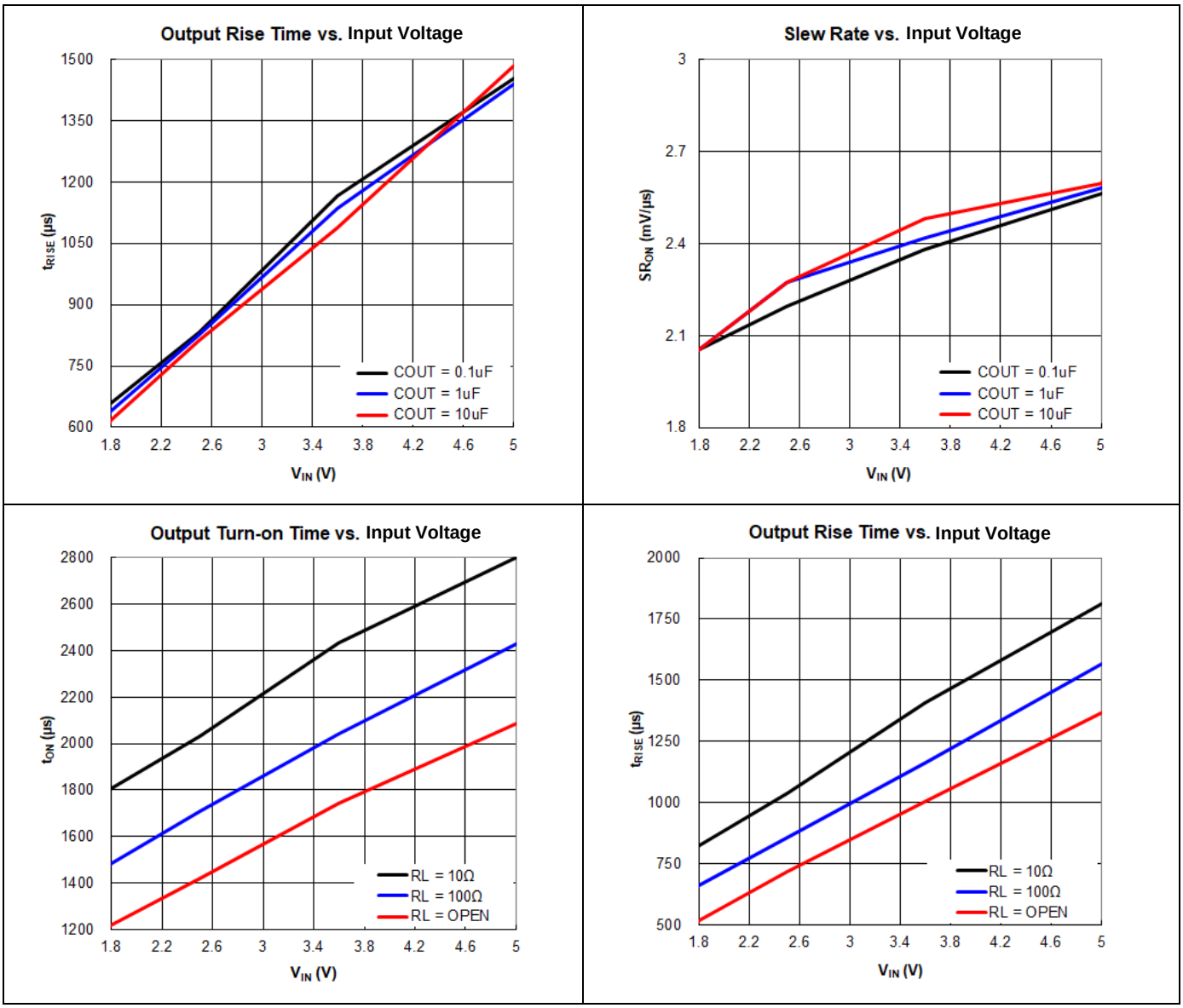




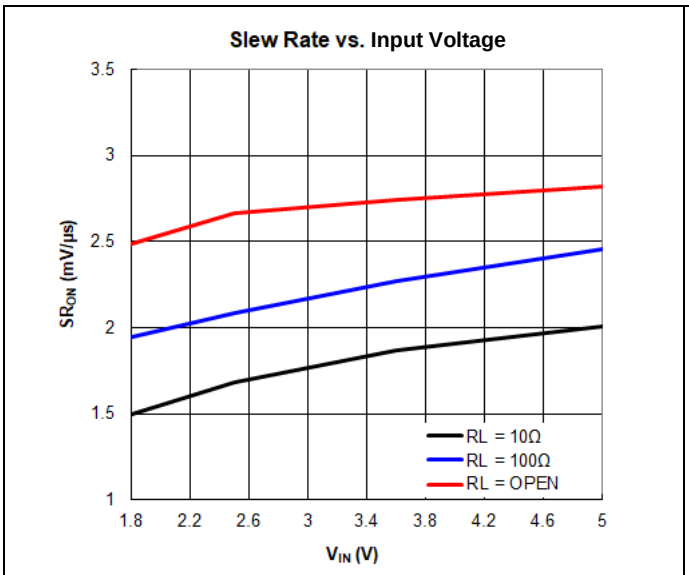


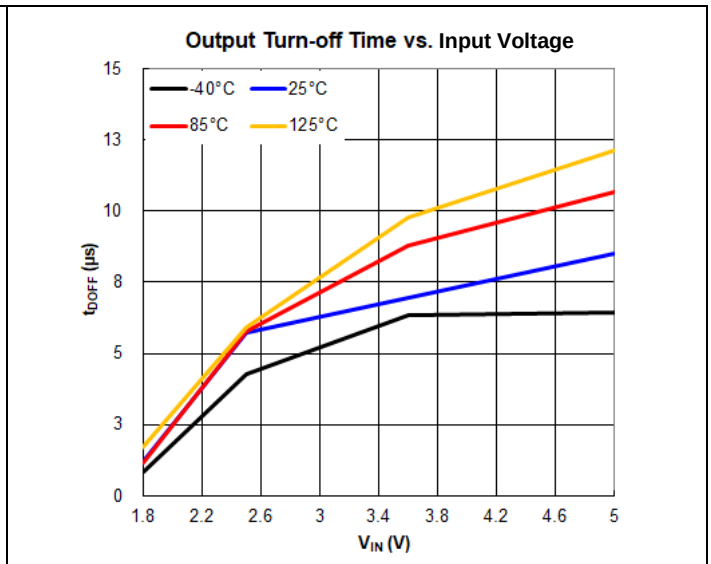


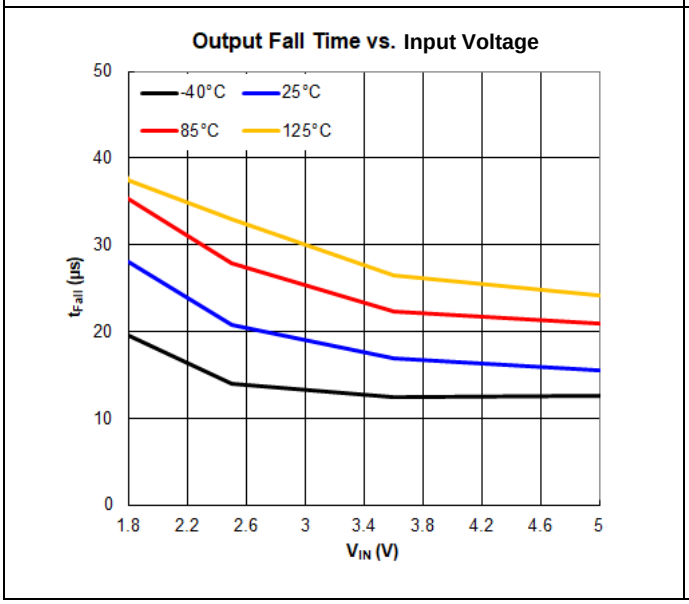
Typical Performance Characteristics (continued)

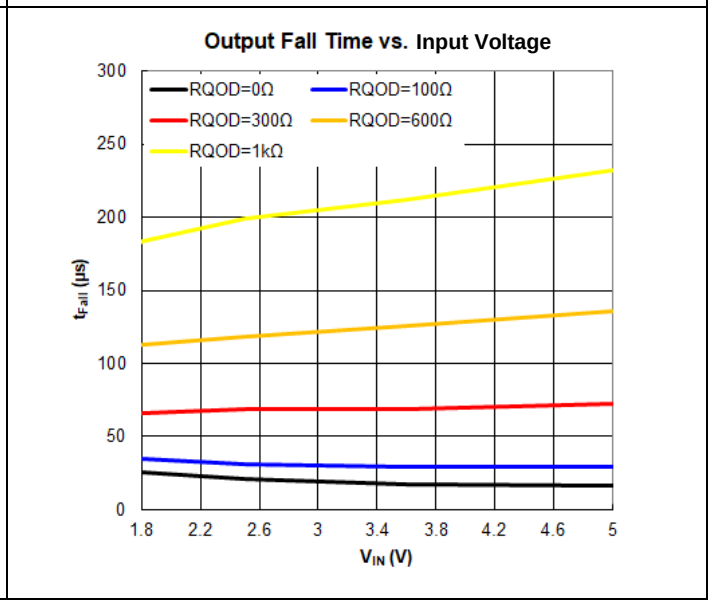


Typical Performance Characteristics (continued)





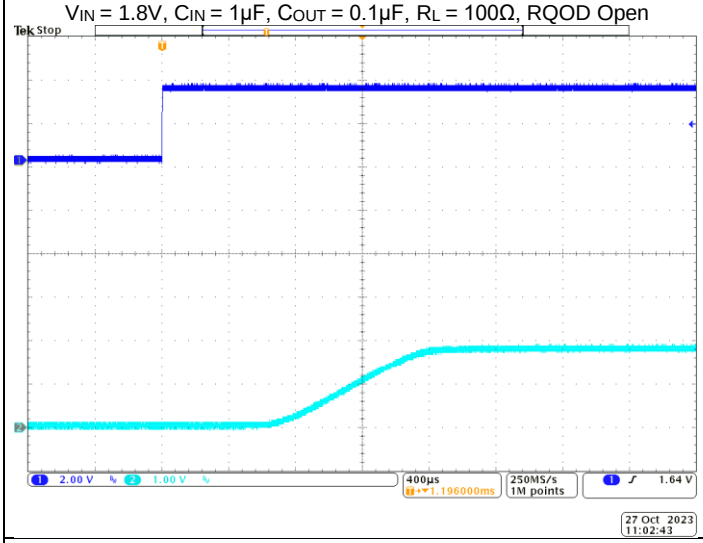




Typical Performance Characteristics (continued)

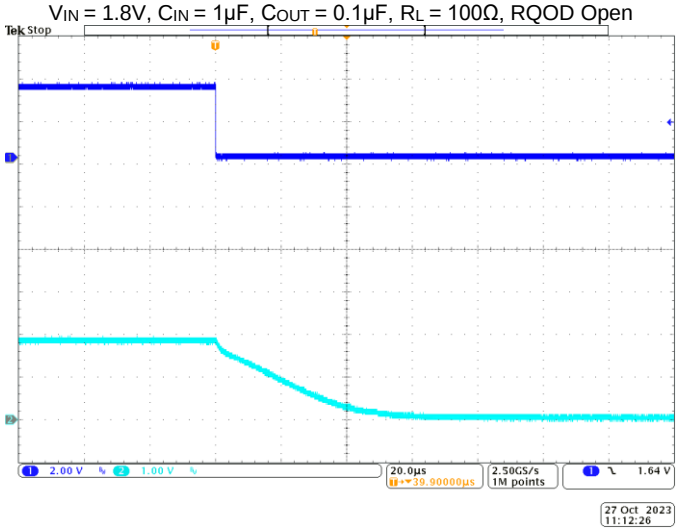
Output Turn On Response

V_{IN} = 1.8V, C_{IN} = 1µF, C_{OUT} = 0.1µF, R_L = 100Ω, RQOD Open



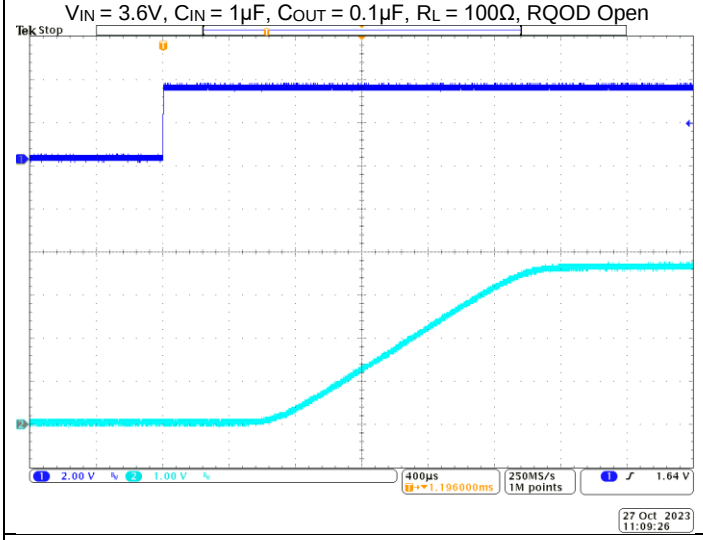
Output Turn Off Response

V_{IN} = 1.8V, C_{IN} = 1µF, C_{OUT} = 0.1µF, R_L = 100Ω, RQOD Open



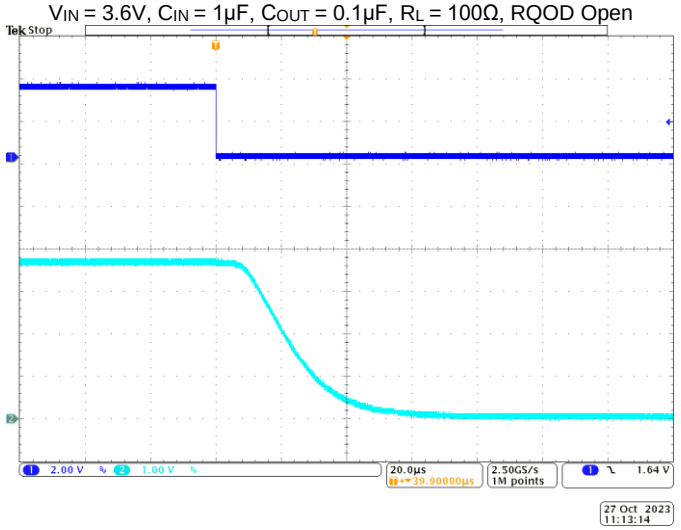
Output Turn On Response

V_{IN} = 3.6V, C_{IN} = 1µF, C_{OUT} = 0.1µF, R_L = 100Ω, RQOD Open



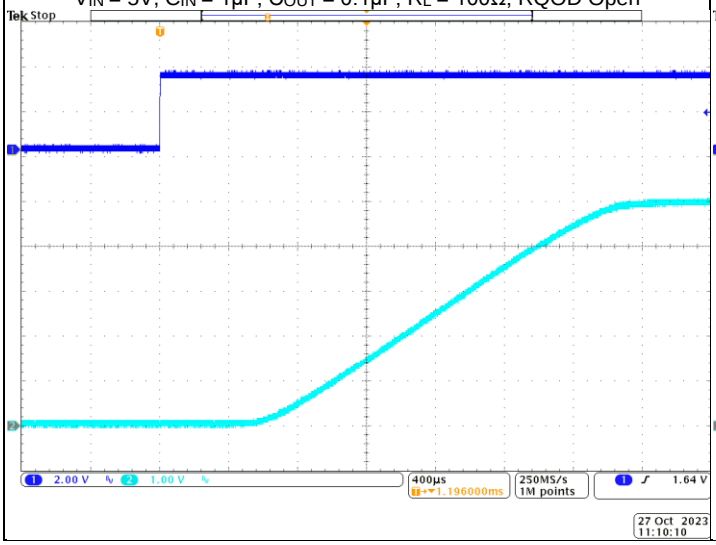
Output Turn Off Response

V_{IN} = 3.6V, C_{IN} = 1µF, C_{OUT} = 0.1µF, R_L = 100Ω, RQOD Open



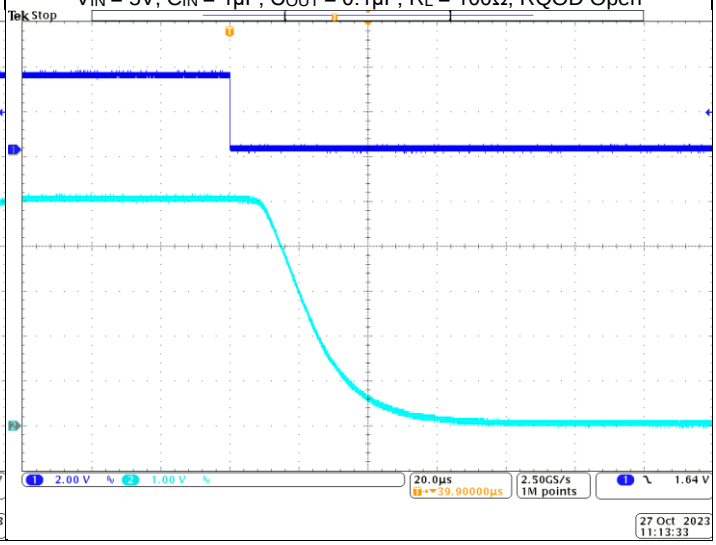
Output Turn On Response

V_{IN} = 5V, C_{IN} = 1µF, C_{OUT} = 0.1µF, R_L = 100Ω, RQOD Open



Output Turn Off Response

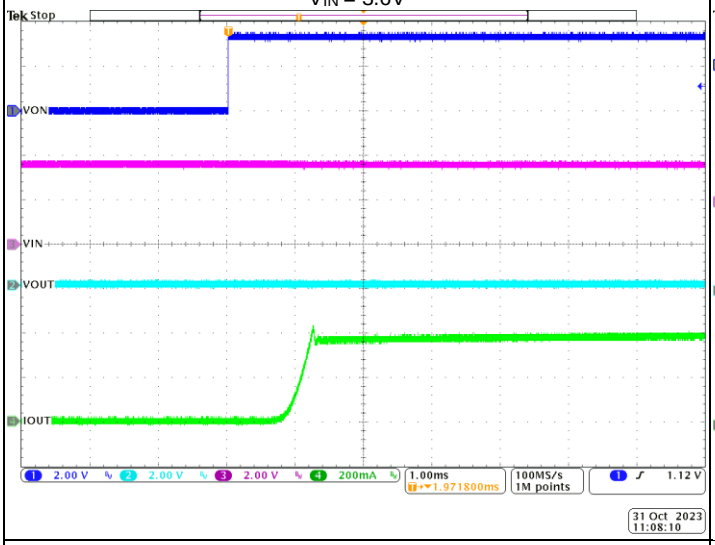
V_{IN} = 5V, C_{IN} = 1µF, C_{OUT} = 0.1µF, R_L = 100Ω, RQOD Open



Typical Performance Characteristics (continued)

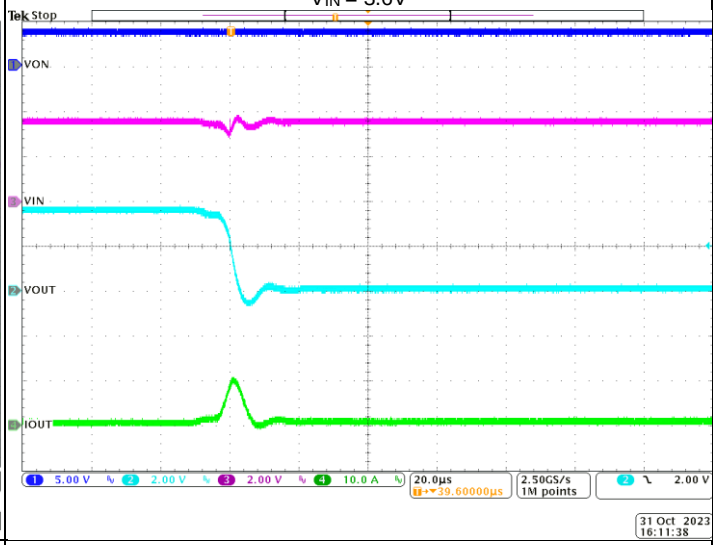
Turn On into an Output Short

V_{IN} = 3.6V



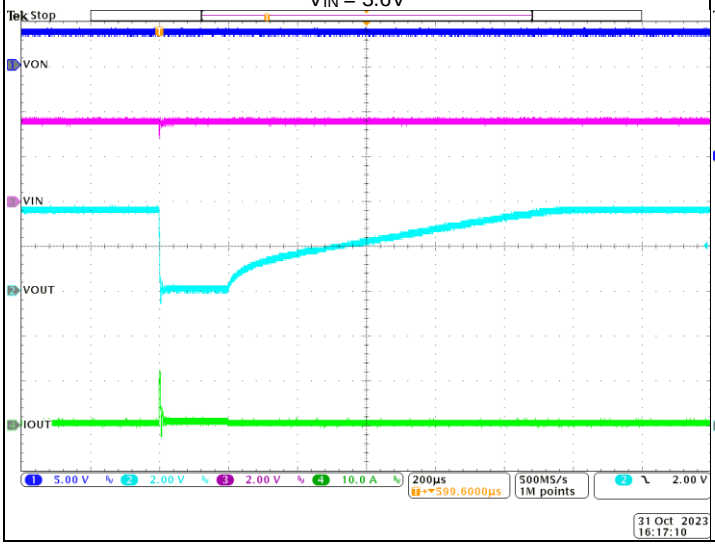
Hot Short Event when ON

V_{IN} = 3.6V



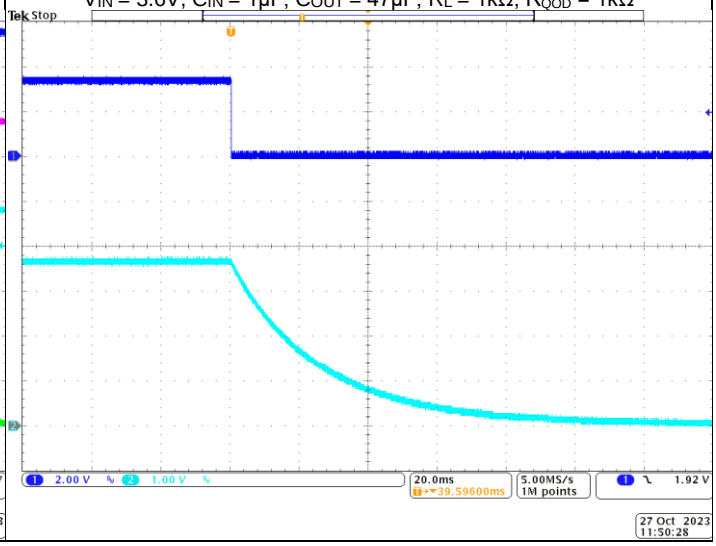
Hot Short Event when ON and Recovery

V_{IN} = 3.6V



Output Turn Off Response

V_{IN} = 3.6V, C_{IN} = 1µF, C_{OUT} = 47µF, R_L = 1kΩ, R_{QOD} = 1kΩ



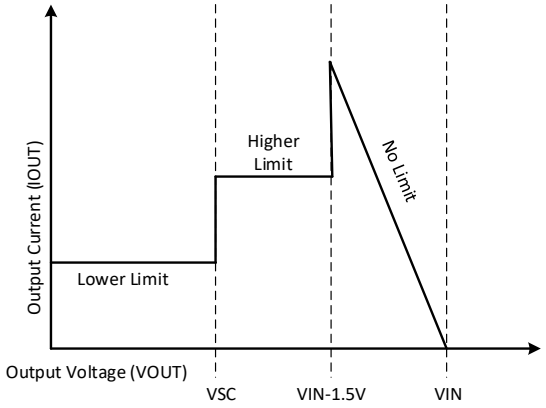
Application Information

Enable/Disable Control

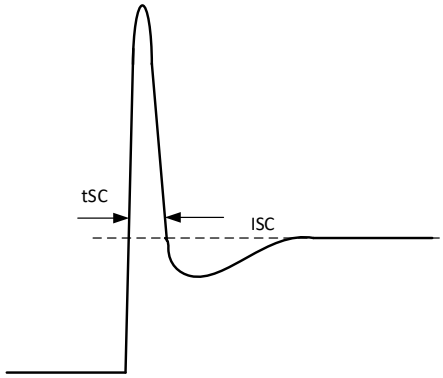
The ON pin controls the state of the power switch. AP22919Q is enabled when the ON pin is asserted high and the device is disabled when ON pin is asserted low. The ON input is compatible with both TTL and CMOS logic. This pin cannot be left floating and must be tied either high or low for proper functionality.

Output Short-Circuit Protection

The AP22919Q will limit current to the output in case of output shorts. When a short occurs, the large V_{IN} to V_{OUT} voltage drop causes the switch to limit the output current (I_{SC}) within (t_{SC}). When the output is below the hard short threshold (V_{SC}), a lower limit is used to minimize the power dissipation while the fault is present. The device will continue to limit the current until it reaches its thermal shutdown temperature. At this time, the device will turn off until its temperature has lowered by the thermal hysteresis (+35°C typical) before turning on again.



(Output Short-Circuit Current Limit)



(Output Short-Circuit Current Limit)

Fall Time (t_F) and Quick Output Discharge (QOD)

The AP22919Q includes a QOD pin that can be configured in one of three ways:

- QOD pin shorted to OUT pin. Using this method, the discharge rate after the switch becomes disabled is controlled with the value of the internal resistance QOD (RPD, QOD).
- QOD pin connected to OUT pin using an external resistor RQOD. After the switch becomes disabled, the discharge rate is controlled by the value of the total discharge resistance. To adjust the total discharge resistance following equation can be used.

  $R_{DIS} = R_{PD\_QOD} + R_{QOD}$

  where:

  R_{DIS} is the total output discharge resistance (Ω).

  R_{PD_QOD} is internal pulldown resistance (Ω).

  R_{QOD} is the external resistance placed between the OUT and QOD pins. (Ω).
- QOD pin is unused and floating. Using this method, there will be no quick output discharge functionality, and the output will remain after the switch is disabled.

The fall times of the device depends on total resistance (R_{DIS}) and the output capacitance (C_{OUT}). To calculate the approximate fall time of V_{OUT}, use the following equation of 20µs if t_{FALL} calculation is less than 20µs.

$t_{FALL} = 2.2 \times (R_{DIS} \parallel R_L) \times C_{OUT}$

where:

t_{FALL} is the output fall time from 90% to 10% (µs).

R_{DIS} is the total QOD + R_{QOD} resistance (Ω).

R_L is the output load resistance (Ω).

C_{OUT} is the output load capacitance (µF).

Application Information (continued)

Thermal Consideration

The maximum junction temperature should be restricted to +150°C under normal operating conditions. The maximum allowable power dissipation $P_{D(MAX)}$ can be calculated as:

$$P_{D(MAX)} = (T_{J(MAX)} - T_A) / \theta_{JA}$$

where,

$T_{J(MAX)}$ is the maximum operating junction temperature.

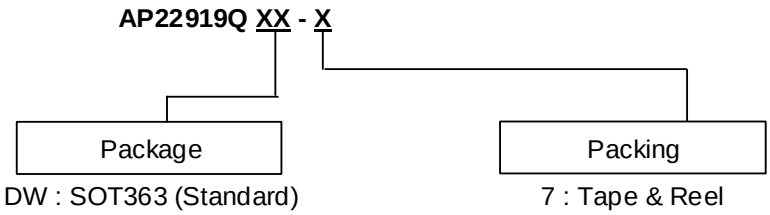
T_A is the ambient temperature of the device.

θ_{JA} is the junction-to-air thermal impedance.

Board Layout

Good PCB layout is important for improving the thermal performance of the device. All trace lengths should be kept as short as possible. Place input and output capacitors close to the device to minimize the effects of parasitic inductance. The input and output PCB traces should be as wide as possible.

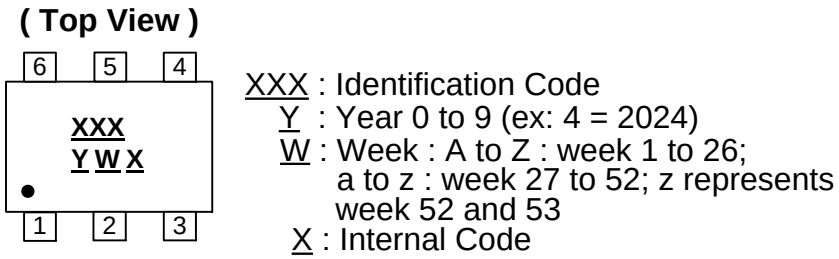
Ordering Information



Part Number	QOD	Package Code	Package	Packing	
				Qty.	Carrier
AP22919QDW-7	Yes	DW	SOT363 (Standard)	3000	Tape & Reel

Marking Information

SOT363 (Standard)

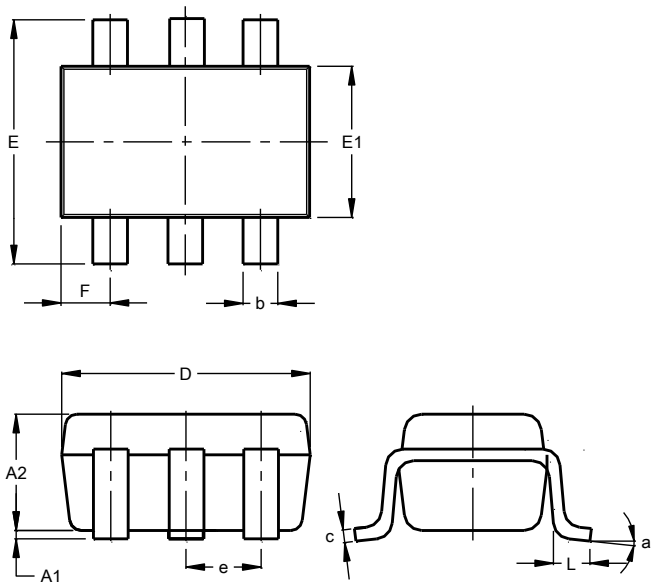


Part Number	Package	Identification Code
AP22919QDW-7	SOT363 (Standard)	X2Q

Package Outline Dimensions

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

SOT363 (Standard)

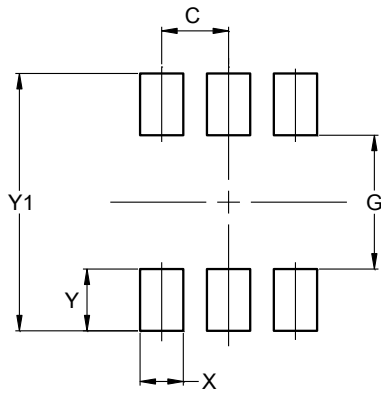


SOT363 (Standard)			
Dim	**Min**	**Max**	**Typ**
A1	0.00	0.10	0.05
A2	0.80	1.00	0.90
b	0.10	0.35	0.225
c	0.08	0.22	0.15
D	1.80	2.20	2.00
E	2.00	2.45	2.225
E1	1.15	1.35	1.25
e	--	--	0.65
F	0.25	0.45	0.35
L	0.25	0.46	0.355
a	0°	8°	--
All Dimensions in mm			

Suggested Pad Layout

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

SOT363 (Standard)



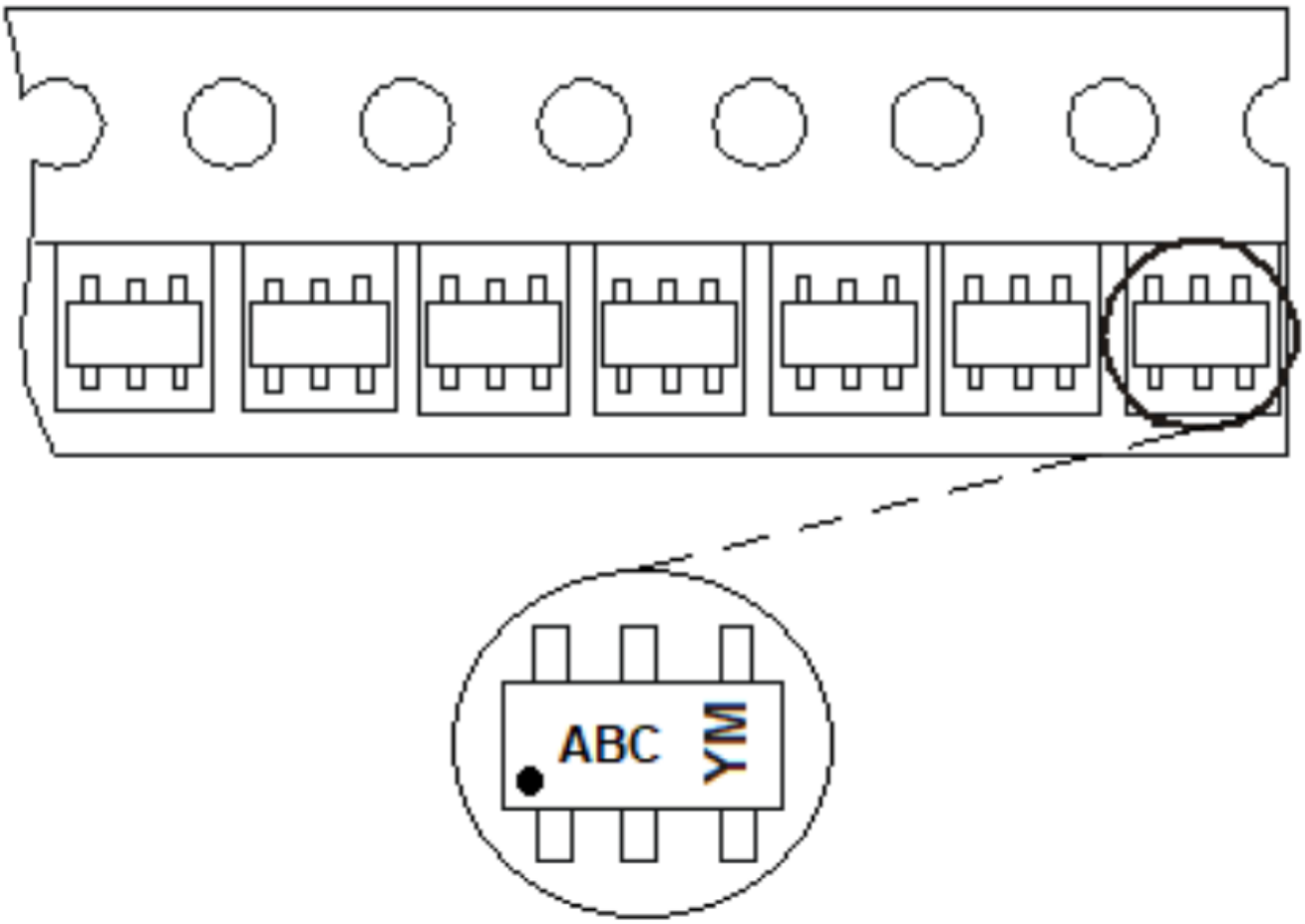
Dimensions	Value (in mm)
C	0.650
G	1.300
X	0.420
Y	0.600
Y1	2.500

Mechanical Data

- Moisture Sensitivity: Level 1 per J-STD-020
- Terminals: Finish – Matte Tin Plated Leads, Solderable per JESD22-A113 (e3)
- Weight: 0.00822 grams (Approximate)

Taping Orientation (Note 9)

Package Type: SOT363 (Standard)



Note: 9. The taping orientation of the other package type can be found on our website at https://www.diodes.com/assets/Packaging-Support-Docs/ap02007.pdf.

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