DIO7610

Ultra-Low On-Resistance, 6 A Load Switch with Soft Start

Features

- Wide input voltage range (V_{IN}): 0.6 V to 5.5 V
- Supply voltage range (V_{BIAS}): 2.5 V to 5.5 V
- R_{ON}: 13 mΩ (typ.)
- Continuous current: 6 A
- Soft start time programmable by external capacitor
- Quick output discharge
- Enable input of switch
  DIO7610A: logic high turns on switch
  DIO7610B: logic low turns on switch
- Over-temperature protection
- Package: DFN2*2-8

Applications

- Notebook
- Tablet PCs
- AIO PC
- Consumer electronics
- Set-top boxes
- Telecom systems
- Industrial systems

Descriptions

The family of DIO7610 is an ultra-low on-resistance, power-distribution switch equipped with external soft start control. It integrates a N-channel MOSFET that can each deliver 6 A continuous load current.

The device contains over-temperature protection. When the junction temperature rises above 160°C , the over-temperature protection function shuts down the N-channel MOSFET power switch and turns the power switch on automatically when temperature drops by 25°C.

The device is available in lead free DFN2*2-8 package

Ordering Information

Part Number	Top Marking	RoHS	T_A	Package	
DIO7610APN8	FAVA	Green	-40 to 85°C	DFN2*2-8	Tape & Reel, 3000
DIO7610BPN8	FAVB	Green	-40 to 85°C	DFN2*2-8	Tape & Reel, 3000

Pin Assignment

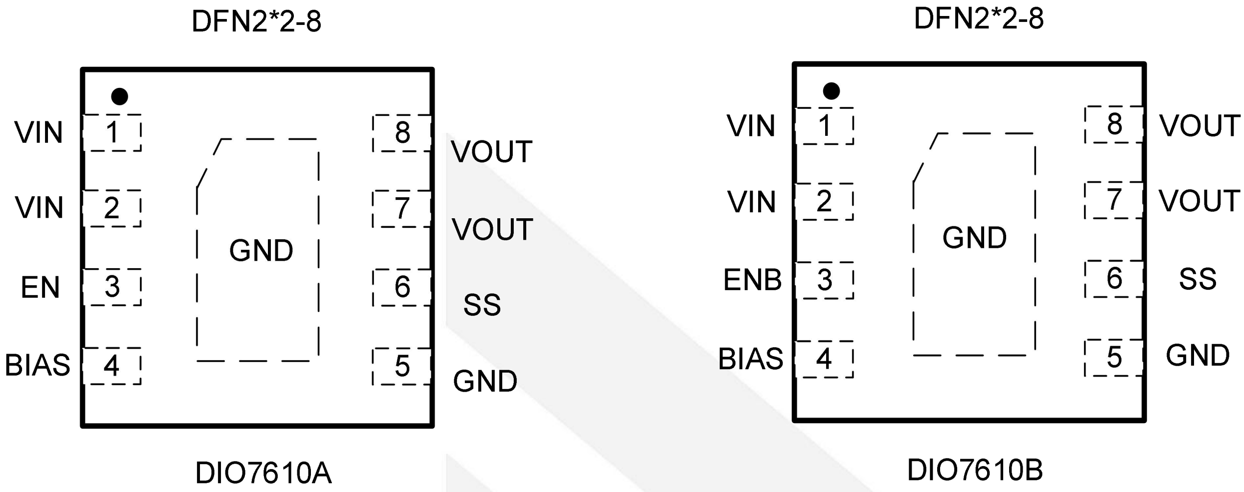


Figure 1. Pin assignment (Top view)

Pin Descriptions

Name	Description
VIN	Power supply input of switch. Connect this pin to an external DC supply.
EN / ENB	Enable input of switch. The pin cannot be left floating. EN: logic high turns on switch. ENB: logic low turns on switch.
BIAS	Bias voltage input pin for internal control circuitry.
GND	Ground pin of the circuitry. All voltage levels are measured with respect to this pin.
SS	Soft start control of switch. A capacitor (C_T) from this pin to ground sets the VOUT's rise slew rate.
VOUT	Switch output.
Exposed Pad	Connect this pad to system ground plane for good thermal conductivity.

Absolute Maximum Ratings

Stresses beyond those listed under "Absolute Maximum Rating" may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other condition beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Symbol	Parameter		Rating	Unit
V_{BIAS}	BIAS input voltage		-0.3 to 6	V
V_{IN}	VIN input voltage		-0.3 to 6	V
I_{OUT}	VOUT output current		-0.3 to 6	V
V_{EN}, V_{ENB}	EN or ENB to GND voltage		-0.3 to 6	V
$I_{OUT(max)}$	Maximum pulsed switch current, pulse < 300 μs, 1% duty cycle		8	A
T_J	Maximum junction temperature		-40 to 150	°C
T_{STG}	Storage temperature		-65 to 150	°C
T_{SDR}	Maximum lead soldering temperature (10s)		260	°C
ESD	Electrostatic discharge voltage	Human body model (HBM)	±7000	V
$θ_{JA}$	Package thermal resistance		TBD	°C/W
$θ_{JC}$			TBD	

Recommend Operating Conditions

The Recommended Operating Conditions table defines the conditions for actual device operation. Recommended Operating conditions are specified to ensure optimal performance to the datasheet specifications. DIOO does not Recommend exceeding them or designing to Absolute Maximum Ratings.

Symbol	Parameter	Rating	Unit
V_{BIAS}	BIAS input voltage	2.5 to 5.5	V
V_{IN}	VIN input voltage	0.6 to 5.5	V
I_{OUT}	VOUT output current	0 to 6	A
V_{EN} , V_{ENB}	Input logic high	1 to 5.5	V
	Input logic low	0 to 0.4	V
T_A	Ambient temperature	-40 to 85	°C
T_J	Junction temperature	-40 to 125	°C

Electrical Characteristics

Unless otherwise specified, these specifications apply over V_{IN} = 0.6 V to 5 V, V_{BIAS} = 5 V, V_{EN} = High or V_{ENB} = Low, T_A = 25ºC.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Supply current						
I_Q	BIAS supply current	No load		28	50	µA
$I_{SD,VBIAS}$	BIAS supply current at shutdown	No load, V_{EN} = 0 V		2.5	5	µA
		No load, V_{ENB} = 5 V		3.5	5	µA
$I_{SD,VIN}$	VIN off-state supply current	No load, V_{BIAS} = 5 V, V_{EN} = 0 V or V_{ENB} = 5 V, V_{IN} = 5 V		0.01	8	µA
		No load, V_{BIAS} = 5 V, V_{EN} = 0 V or V_{ENB} = 5 V, V_{IN} = 3.3 V		0.01	3	µA
		No load, V_{BIAS} = 5 V, V_{EN} = 0 V or V_{ENB} = 5 V, V_{IN} = 1.8 V		0.01	2	µA
		No load, V_{BIAS} = 5 V, V_{EN} = 0 V or V_{ENB} = 5 V, V_{IN} = 0.8 V		0.01	1	µA
Under-voltage lockout (UVLO)						
V_{UVLO}	Rising BIAS UVLO threshold	V_{BIAS} rising	1.9	2.1	2.3	V
$V_{UVLO, Hys}$	BIAS UVLO hysteresis			0.1		V
Power switch						
$R_{DS(ON)}$	Power switch on resistance	V_{BIAS} = 5 V, V_{IN} = 0.6 to 5 V, I_{OUT} = 1 A, T_J = 25ºC		13	18	mΩ
		V_{BIAS} = 2.5 V, V_{IN} = 0.6 to 2.5 V, I_{OUT} = 1 A, T_J = 25ºC		13	18	mΩ
	VOUT discharge resistance	V_{EN} = 0 V or V_{ENB} = 5 V, VOUT force 1 V		100		Ω
Soft-start control pin						
	SS discharge current	V_{SS} = 6 V, V_{EN} = 0 V or V_{ENB} = 5 V, measured at SS		1.5		mA
EN or ENB input pin						
V_{EN}, V_{ENB}	Input logic high		1			V
	Input logic low				0.4	V
	Input current				1	µA
Overt-temperature protection (OTP)						
	Over-temperature threshold	T_J rising		160		ºC
	Over-temperature threshold hysteresis	T_J falling		25		ºC

Note:

(1)Specifications subject to change without notice.

Switching Characteristics

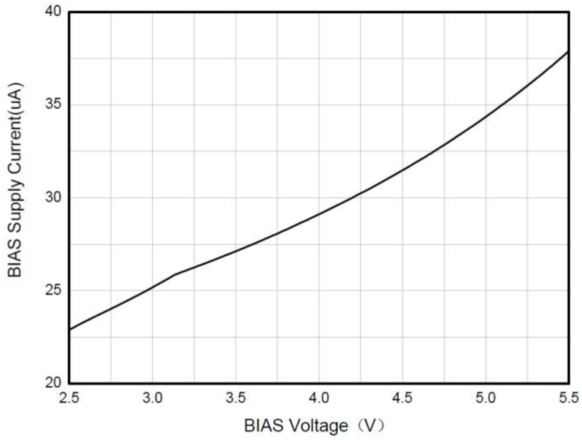
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$V_{IN} = V_{BIAS} = 5$ V, $T_A = 25$ºC (unless otherwise noted)						
t_{ON}	Turn on time	$R_L = 10\ \Omega$, $C_L = 0.1\ \mu F$, $C_{IN} = 1\ \mu F$, $C_T = 1$ nF, $V_{ON} = 5$ V		1200		
t_{OFF}	Turn off time	$R_L = 10\ \Omega$, $C_L = 0.1\ \mu F$, $C_{IN} = 1\ \mu F$, $C_T = 1$ nF, $V_{ON} = 5$ V		1		
t_R	V_{OUT} rise time	$R_L = 10\ \Omega$, $C_L = 0.1\ \mu F$, $C_{IN} = 1\ \mu F$, $C_T = 1$ nF, $V_{ON} = 5$ V		1800		μs
t_F	V_{OUT} fall time	$R_L = 10\ \Omega$, $C_L = 0.1\ \mu F$, $C_{IN} = 1\ \mu F$, $C_T = 1$ nF, $V_{ON} = 5$ V		2		
t_D	ON delay time	$R_L = 10\ \Omega$, $C_L = 0.1\ \mu F$, $C_{IN} = 1\ \mu F$, $C_T = 1$ nF, $V_{ON} = 5$ V		390		
$V_{IN} = 0.8$ V, $V_{BIAS} = 5$ V, $T_A = 25$ºC (unless otherwise noted)						
t_{ON}	Turnon time	$R_L = 10\ \Omega$, $C_L = 0.1\ \mu F$, $C_{IN} = 1\ \mu F$, $C_T = 1$ nF, $V_{ON} = 5$ V		430		
t_{OFF}	Turnoff time	$R_L = 10\ \Omega$, $C_L = 0.1\ \mu F$, $C_{IN} = 1\ \mu F$, $C_T = 1$ nF, $V_{ON} = 5$ V		1		
t_R	V_{OUT} rise time	$R_L = 10\ \Omega$, $C_L = 0.1\ \mu F$, $C_{IN} = 1\ \mu F$, $C_T = 1$ nF, $V_{ON} = 5$ V		320		μs
t_F	V_{OUT} fall time	$R_L = 10\ \Omega$, $C_L = 0.1\ \mu F$, $C_{IN} = 1\ \mu F$, $C_T = 1$ nF, $V_{ON} = 5$ V		1.9		
t_D	ON delay time	$R_L = 10\ \Omega$, $C_L = 0.1\ \mu F$, $C_{IN} = 1\ \mu F$, $C_T = 1$ nF, $V_{ON} = 5$ V		290		
$V_{IN} = 0.6$ V, $V_{BIAS} = 5$ V, $T_A = 25$ºC (unless otherwise noted)						
t_{ON}	Turnon time	$R_L = 10\ \Omega$, $C_L = 0.1\ \mu F$, $C_{IN} = 1\ \mu F$, $C_T = 1$ nF, $V_{ON} = 5$ V		450		
t_{OFF}	Turnoff time	$R_L = 10\ \Omega$, $C_L = 0.1\ \mu F$, $C_{IN} = 1\ \mu F$, $C_T = 1$ nF, $V_{ON} = 5$ V		1		
t_R	V_{OUT} rise time	$R_L = 10\ \Omega$, $C_L = 0.1\ \mu F$, $C_{IN} = 1\ \mu F$, $C_T = 1$ nF, $V_{ON} = 5$ V		260		μs
t_F	V_{OUT} fall time	$R_L = 10\ \Omega$, $C_L = 0.1\ \mu F$, $C_{IN} = 1\ \mu F$, $C_T = 1$ nF, $V_{ON} = 5$ V		1.4		
t_D	ON delay time	$R_L = 10\ \Omega$, $C_L = 0.1\ \mu F$, $C_{IN} = 1\ \mu F$, $C_T = 1$ nF, $V_{ON} = 5$ V		330		
$V_{IN} = V_{BIAS} = 2.5$ V, $T_A = 25$ºC (unless otherwise noted)						
t_{ON}	Turn on time	$R_L = 10\ \Omega$, $C_L = 0.1\ \mu F$, $C_{IN} = 1\ \mu F$, $C_T = 1$ nF, $V_{ON} = 5$ V		1000		μs
t_{OFF}	Turn off time	$R_L = 10\ \Omega$, $C_L = 0.1\ \mu F$, $C_{IN} = 1\ \mu F$, $C_T = 1$ nF, $V_{ON} = 5$ V		1.3		

t_R	V_{OUT} rise time	R_L = 10 Ω, C_L = 0.1 μF, C_{IN} = 1 μF, C_T = 1 nF, V_{ON} = 5 V		1450		
t_F	V_{OUT} fall time	R_L = 10 Ω, C_L = 0.1 μF, C_{IN} = 1 μF, C_T = 1 nF, V_{ON} = 5 V		2.2		
t_D	ON delay time	R_L = 10 Ω, C_L = 0.1 μF, C_{IN} = 1 μF, C_T = 1 nF, V_{ON} = 5 V		440		
V_{IN} = 0.8 V, V_{BIAS} = 2.5 V, T_A = 25°C (unless otherwise noted)						
t_{ON}	Turn on time	R_L = 10 Ω, C_L = 0.1 μF, C_{IN} = 1 μF, C_T = 1 nF, V_{ON} = 5 V		600		
t_{OFF}	Turn off time	R_L = 10 Ω, C_L = 0.1 μF, C_{IN} = 1 μF, C_T = 1 nF, V_{ON} = 5 V		1.3		
t_R	V_{OUT} rise time	R_L = 10 Ω, C_L = 0.1 μF, C_{IN} = 1 μF, C_T = 1 nF, V_{ON} = 5 V		480		μs
t_F	V_{OUT} fall time	R_L = 10 Ω, C_L = 0.1 μF, C_{IN} = 1 μF, C_T = 1 nF, V_{ON} = 5 V		2.3		
t_D	ON delay time	R_L = 10 Ω, C_L = 0.1 μF, C_{IN} = 1 μF, C_T = 1 nF, V_{ON} = 5 V		380		
V_{IN} = 0.6 V, V_{BIAS} = 2.5 V, T_A = 25°C (unless otherwise noted)						
t_{ON}	Turn on time	R_L = 10 Ω, C_L = 0.1 μF, C_{IN} = 1 μF, C_T = 1 nF, V_{ON} = 5 V		620		
t_{OFF}	Turn off time	R_L = 10 Ω, C_L = 0.1 μF, C_{IN} = 1 μF, C_T = 1 nF, V_{ON} = 5 V		1.2		
t_R	V_{OUT} rise time	R_L = 10 Ω, C_L = 0.1 μF, C_{IN} = 1 μF, C_T = 1 nF, V_{ON} = 5 V		380		μs
t_F	V_{OUT} fall time	R_L = 10 Ω, C_L = 0.1 μF, C_{IN} = 1 μF, C_T = 1 nF, V_{ON} = 5 V		1.5		
t_D	ON delay time	R_L = 10 Ω, C_L = 0.1 μF, C_{IN} = 1 μF, C_T = 1 nF, V_{ON} = 5 V		430		

Note:

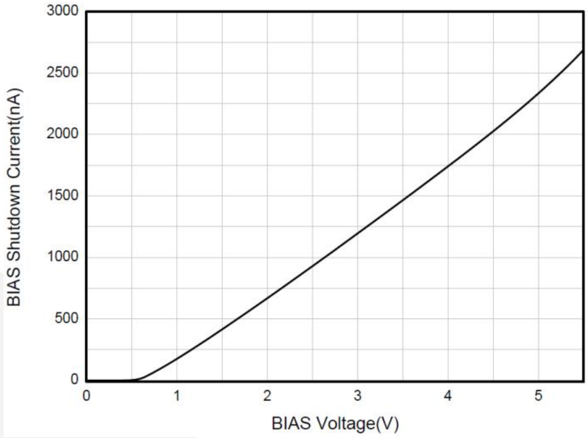
(1)Specifications subject to change without notice.

Typical Performance Characteristics



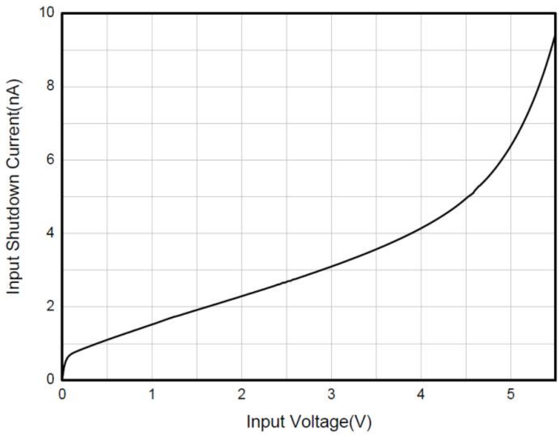
V_{IN} = V_{BIAS}, V_{ON} = 5 V, V_{OUT} = 0 V

Figure 2. BIAS supply current vs. BIAS voltage



V_{IN} = V_{BIAS}, V_{ON} = 0 V, V_{OUT} = 0 V

Figure 3. BIAS shutdown current vs. BIAS voltage



V_{BIAS} = 5.5 V, V_{ON} = 0 V, V_{OUT} = 0 V

Figure 4. Input shutdown current vs. Input voltage

Typical Performance Characteristics (continue)

R_L = 10 Ω, C_L = 0.1 μF, C_{IN} = 1 μF, C_T = 1 nF, V_{BIAS} = V_{IN} = 5 V

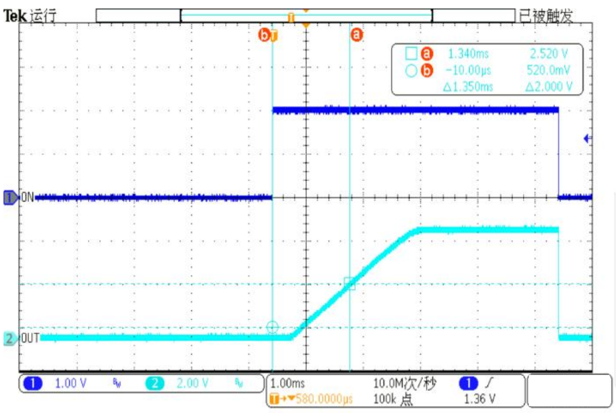


Figure 5. Turn on response time

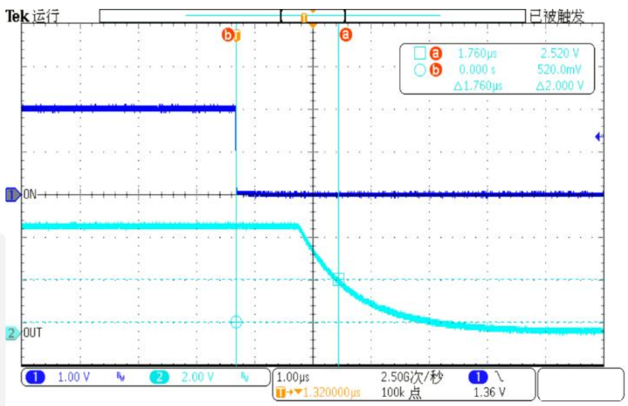


Figure 6. Turn off response time

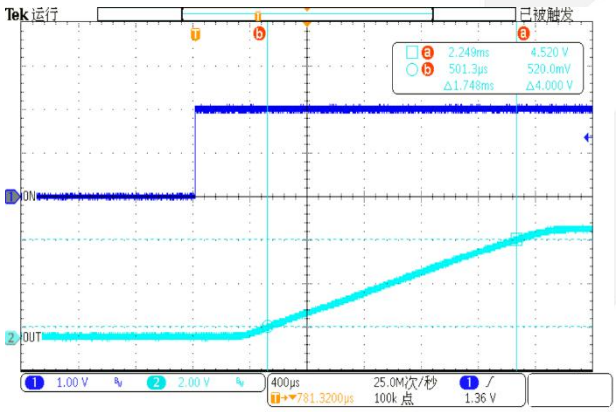


Figure 7. Rise time vs. Input voltage

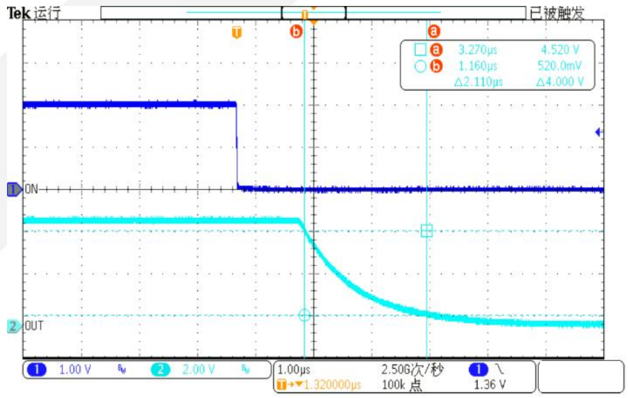


Figure 8. Fall time vs. Input voltage

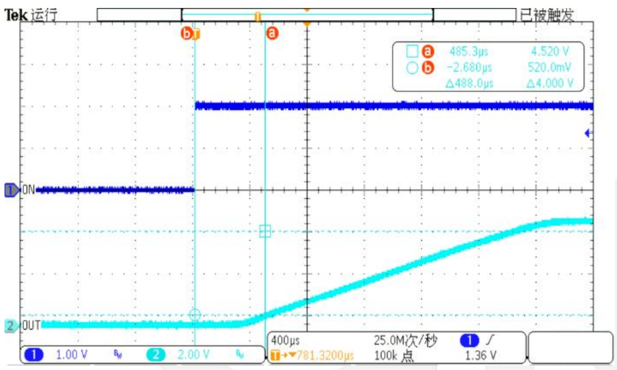


Figure 9. Delay time vs. Input voltage

Typical Performance Characteristics (continue)

R_L = 10 Ω, C_L = 0.1 μF, C_{IN} = 1 μF, C_T = 1 nF, V_{BIAS} = 2.5 V V_{IN} = 0.6 V

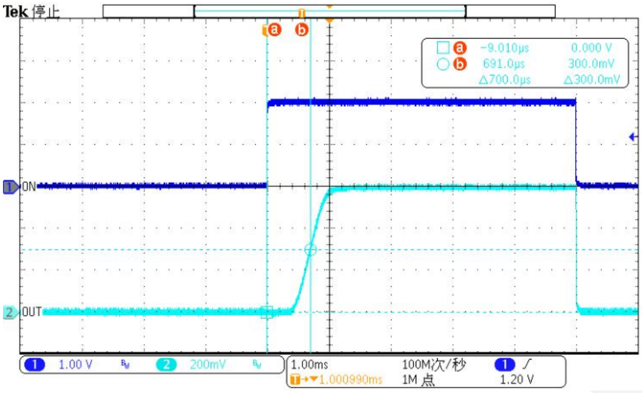


Figure 10. Turn on response time

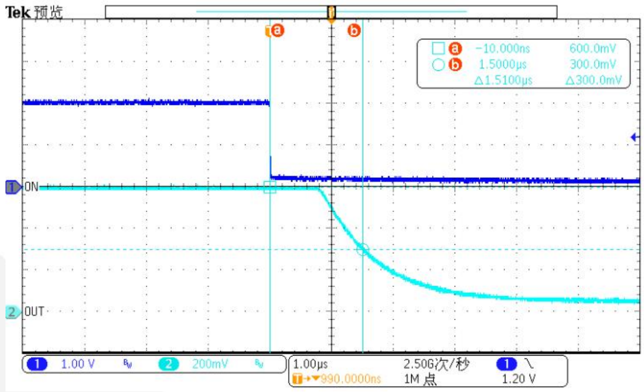


Figure 11. Turn off response time

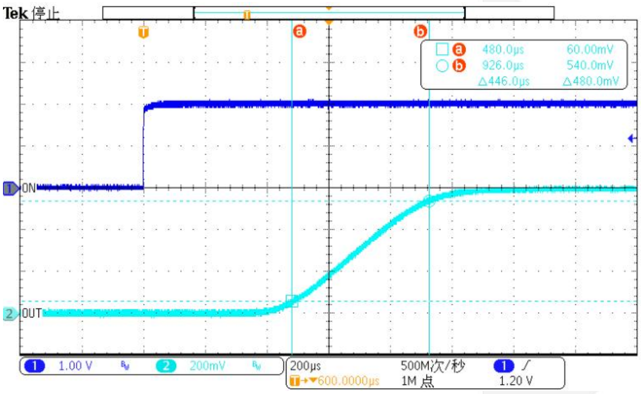


Figure 12. Rise time vs. Input voltage

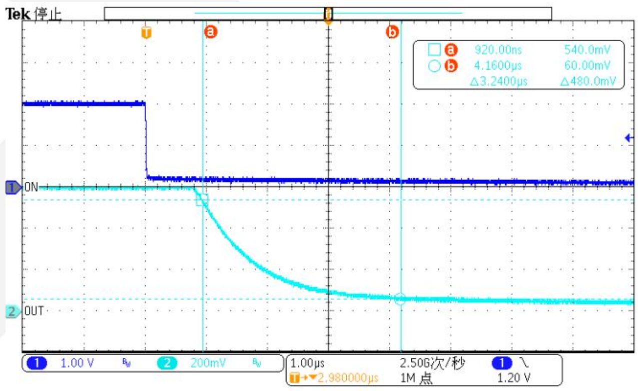


Figure 13. Fall time vs. Input voltage

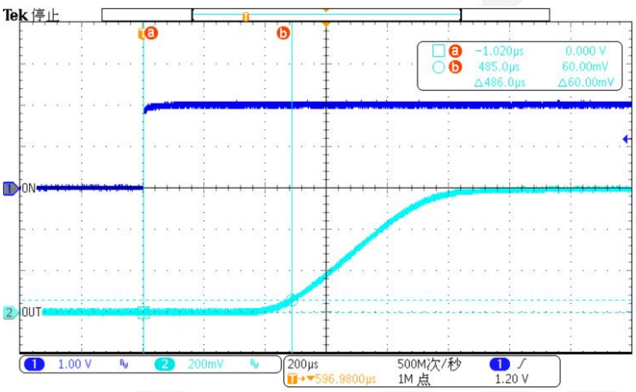


Figure 14. Delay time vs. Input voltage

Block Diagram

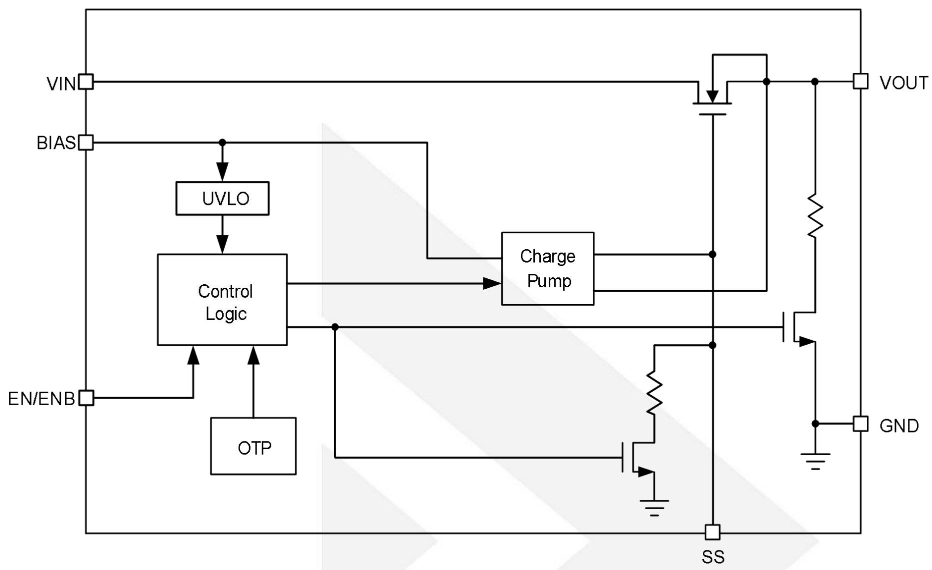


Figure 15. Block diagram

Typical Application

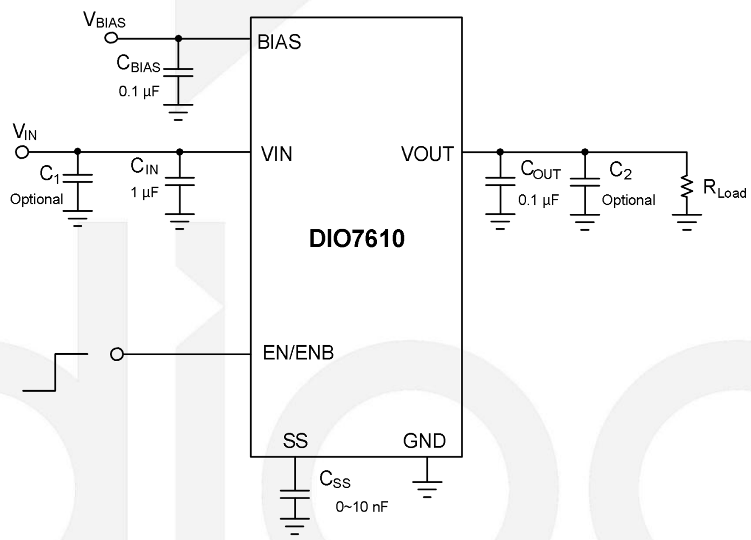


Figure 16. Typical application

Soft-Start-Time

C_{SS}(nF)	Soft-start time (μs) 10% to 90%, V_{BIAS} = 5 V, C_L = 0.1 μF, C_{IN} = 1 μF, R_L = 10 Ω, Typical values are at T_A = 25ºC.							
	V_{IN} = 5 V	V_{IN} = 3.3 V	V_{IN} = 1.8 V	V_{IN} = 1.5 V	V_{IN} = 1.2 V	V_{IN} = 1.05 V	V_{IN} = 0.8 V	V_{IN} = 0.6 V
0	220	170	130	110	95	85	70	65
1	1800	1200	680	570	460	410	320	260
10	16000	10500	5500	4550	3650	3200	2560	2350

Detailed Description

BIAS Under-voltage Lockout (UVLO)

Wrong logic controls are prevented by an under-voltage lockout (UVLO) circuit which monitors the BIAS pin's voltage. During powering on, the UVLO function initiates a soft-start process after the BIAS supply voltages exceed the rising UVLO voltage threshold.

Soft-start

An adjustable soft-start circuitry is provided by the family of DIO7610 to control the rising rate of the output voltage and limit the current surge during start-up. A capacitor connected from the SS pin to the ground controls the soft-start duration.

Enable control

Pulling the ENB pin above 1 V or the EN pin below 0.4 V will deactivate the device, while pulling the ENB pin above 1 V or the EN pin below 0.4 V will enable the device. It is not possible to let the EN/ENB pins float.

Quick-output discharge (QOD)

There is a QOD feature included in the family of DIO7610. An internal discharge resistance is connected between V_{OUT} and GND to remove the remaining charge from the output when the switch is disabled. This resistance has a typical value of 100 Ω and prevents the output from floating while the switch is disabled. It is recommended that the device gets disabled before V_{BIAS} falls below the minimum recommended voltage.

Over-temperature protection (OTP)

The internal thermal sense circuit turns off the power FET when the junction temperature exceeds 160°C to allow the device to cool down. The internal thermal sense circuit will enable the device when the device's junction temperature cools by 25°C, resulting in a pulsed output during continuous thermal protection. For normal operation, the junction temperature cannot exceed T_J = 135°C, and thermal protection is designed to protect the IC in the event of over temperature conditions.

Application Information

Power sequencing

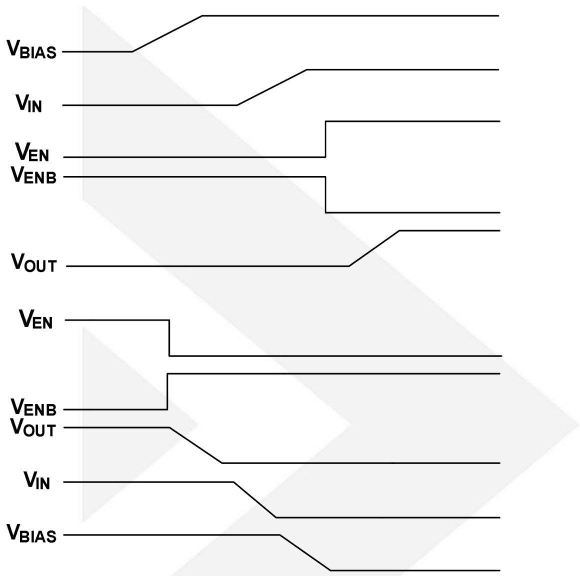


Figure 17. Power sequencing diagram

The internal parasitic diodes of the power switch connected from V_{OUT} to V_{IN} will be forward biased while I_C is in the UVLO state. The internal parasitic diodes connected from V_{OUT} to V_{BIAS} will be forward biased if V_{OUT} is higher than V_{BIAS}, and V_{BIAS} must be higher than the voltage of any other input pin.

Timing chart

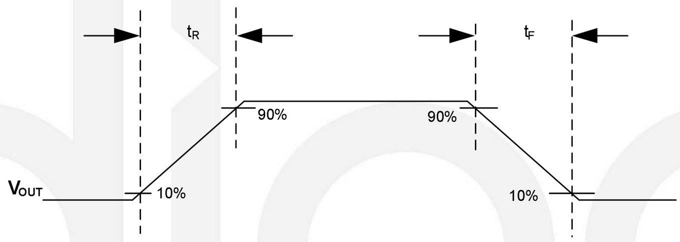


Figure 18. t_R/t_F wave forms

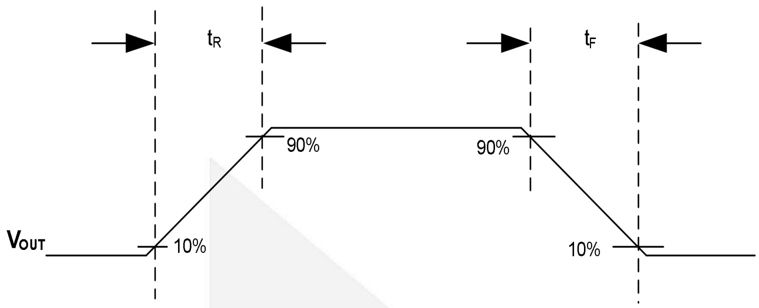


Figure 19. t_{ON}/t_{OFF} wave forms

Capacitor selection

Proper input capacitors are necessary for the family of DIO7610 to supply current surge during stepping load transients to prevent the input voltage rail from dropping. More input capacitance is required for higher parasitic inductance in order to reduce the slew rate of the surge currents coming from voltage sources or other bulk capacitors to the VIN pin.

Input capacitance of 1 μF is advised for VIN in all applications except OTP or output short circuits. To prevent voltage overshoot from exceeding the device's absolute maximum voltage during load transient situations, more input capacitance may be required.

It is advised that VOUT's output capacitance be no less than 0.1 μF. Please put the capacitors as close to the DIO7610 as possible. To sustain load transient current, it is advised to place a bulk output capacitor close to the load.

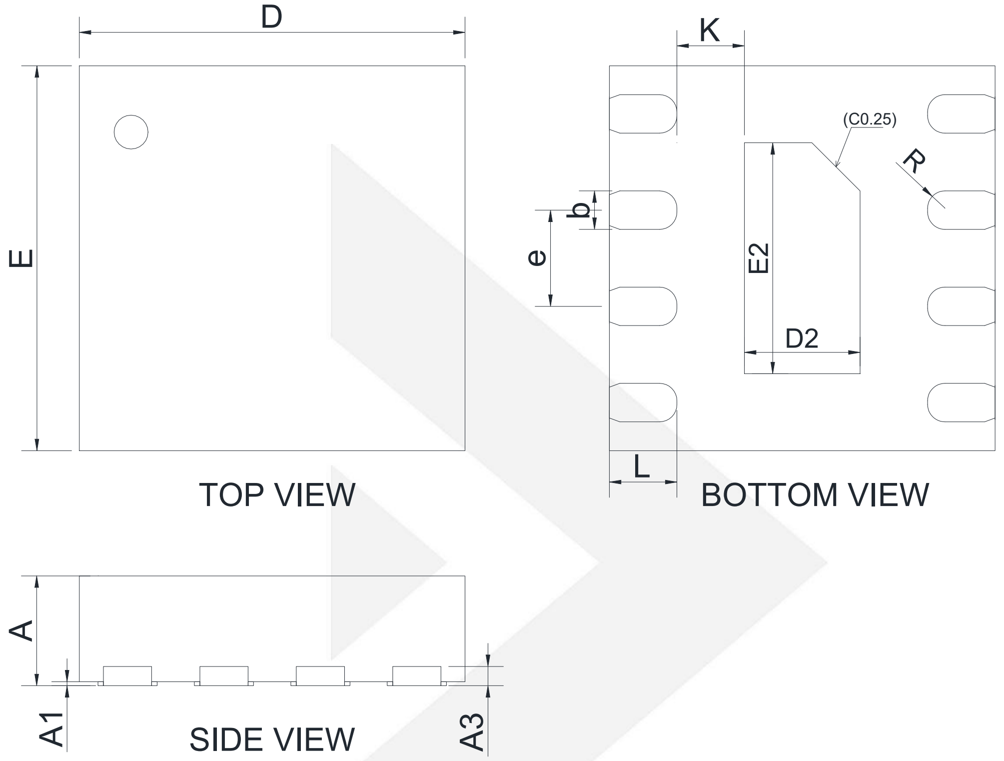
Soft-start capacitor

A capacitor that is connected from the SS pin to the ground and used to control the soft-start period might lessen output voltage overshoot and inrush current.

Layout consideration

In order to reduce EMI and increase heat dissipation, the PCB layout needs to be properly executed. Locate the DIO7610 and output capacitors close to the load to reduce parasitic resistance and inductance for excellent load transient performance. The input capacitors must be placed as close to the VIN pin as possible, the output decoupling capacitors for the load must be placed as close to the load as possible for decoupling high-frequency ripples.

Physical Dimensions: DFN2*2-8



Common Dimensions (Units of Measure = Millimeter)			
Symbol	Min	Nom	Max
A	0.70	0.75	0.80
A1	0.00	0.02	0.05
A3	0.20 REF		
b	0.15	0.20	0.25
D	1.90	2.00	2.10
E	1.90	2.00	2.10
D2	0.50	0.60	0.70
E2	1.10	1.20	1.30
e	0.40	0.50	0.60
K	0.20	-	-
L	0.30	0.35	0.40
R	0.09	-	-

CONTACT US

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