5.5V, 6A, 19mΩ Dual Channel Load Switch

■ General Description

The AME6206 is a small, low $R_{DS(ON)}$, dual-channel load switch with controlled turn on. The device contains two N-channel MOSFETs that can operate over an input voltage range of 0.8V to 5.5V and can offer a maximum continuous current of 6A per channel. Each switch is independently controlled by an on and off input (EN1 and EN2), which can be driven directly by low-voltage control signals. In AME6206, a 220Ω on-chip load resistor is added for quick-output discharge when switch is turned off. It's available in a small, space-saving DFN-14A (3 x 2 x 0.75mm) package with thermal pad allowing for high power dissipation.

■ Features

- Input Voltage Range: 0.8V to 5.5V
- Bias Voltage Supports: 2.5V to 5.5V
- Integrated Dual-Channel Load Switch
- Ultra low $R_{DS(ON)}$ 19mΩ Per Channel
- 6A Maximum Continuous Current Per Channel
- Low Quiescent Current (72μA)
- Thermal Protection
- Configurable Rise Time
- Quick Output Discharge (QOD)
- DFN-14A(3 x 2 x 0.75mm) Package with Thermal Pad

■ Application

- Ultrabook, Notebooks and Netbooks
- Tablet PCs
- Consumer Electronics
- Set-top Boxes and Residential Gateways
- Telecom Systems
- Solid-State Drives (SSD)

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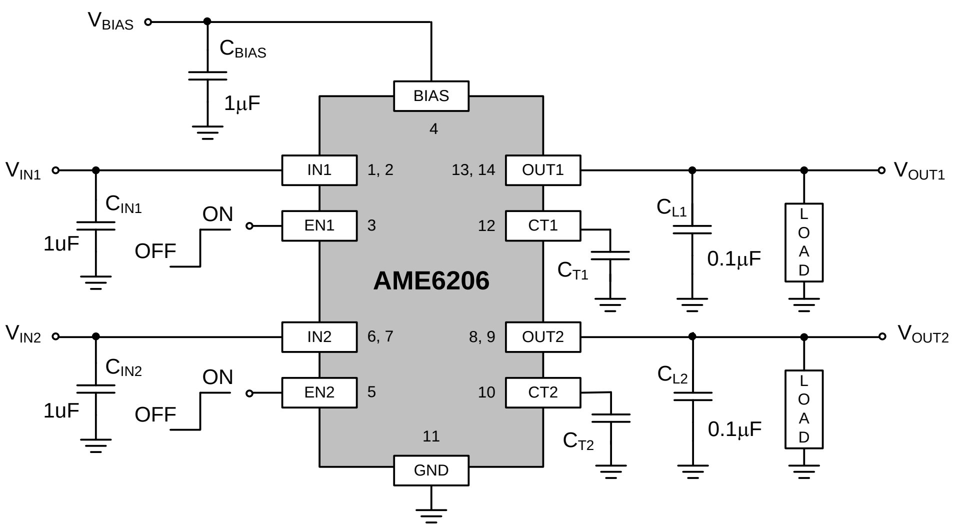
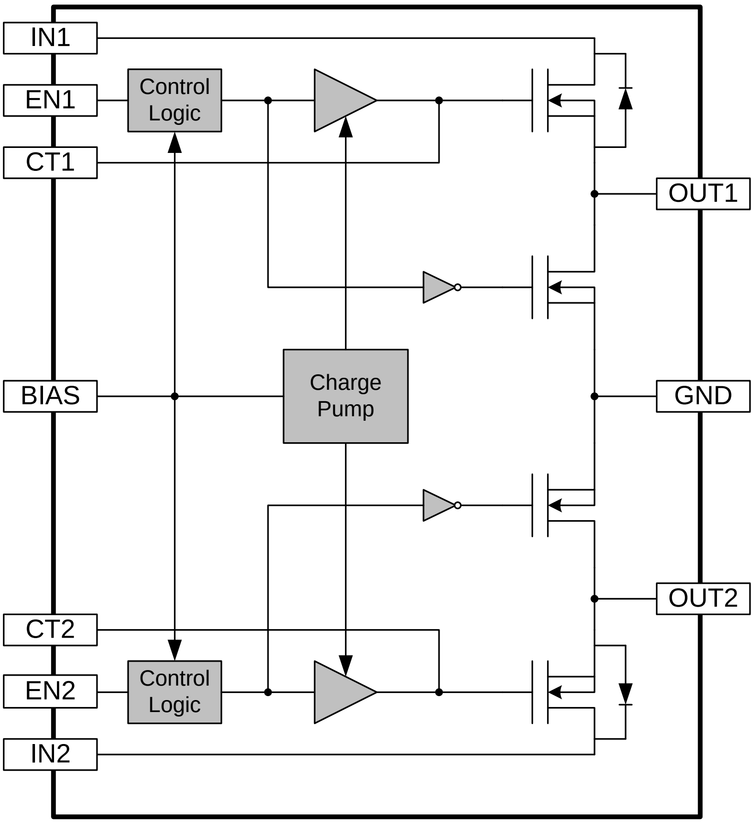
■ Typical Application Schematic

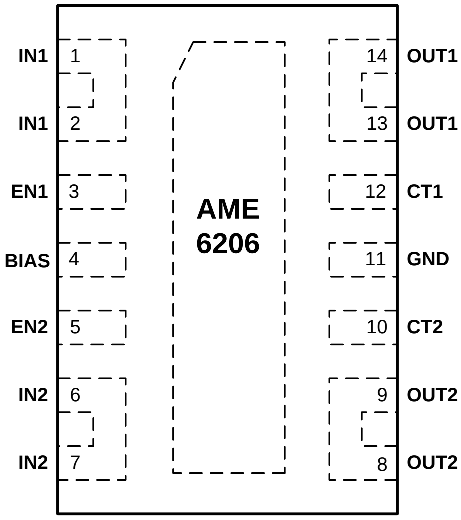


■ **Function Block Diagram**



■ Pin Configuration

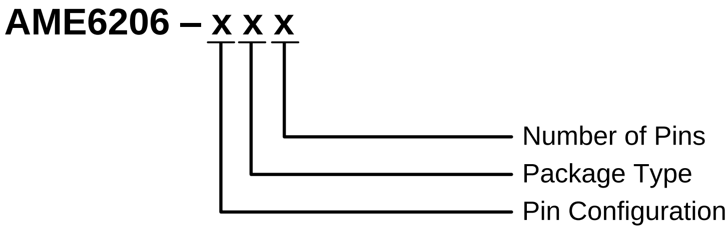
Top View
DFN-14A (3 x 2 x 0.75mm)



■ Pin Description

Pin Name	Pin No.	I/O	Description
IN1	1, 2	I	Power-switch 1 input. 0.8V to BIAS voltage range for optimal $R_{DS(ON)}$ is recommended. Place an optional decoupling capacitor between this pin and GND for reduce input voltage dip during turn on.
EN1	3	I	Power-switch 1 control input. Active high is turn-on. Do not leave floating.
BIAS	4	I	Bias voltage input. Recommend voltage range (2.5V to 5.5V) to supply the device.
EN2	5	I	Power-switch 2 control input. Active high is turn-on. Do not leave floating.
IN2	6, 7	I	Power-switch 2 input. 0.8V to BIAS voltage range for optimal $R_{DS(ON)}$ is recommended. Place an optional decoupling capacitor between this pin and GND for reduce input voltage dip during turn on.
OUT2	8, 9	O	Power-switch 2 output.
CT2	10	I	Power-switch 2 slew-rate control. Capacitor must be rated for a minimum of 25V for desired rise time performance. This pin can be left floating.
GND	11	-	Ground
CT1	12	I	Power-switch 1 slew-rate control. Capacitor must be rated for a minimum of 25V for desired rise time performance. This pin can be left floating.
OUT1	13, 14	O	Power-switch 1 output.

■ Ordering Information



Pin Configuration	Package Type	Number of Pins
A: 1. IN1 2. IN1 3. EN1 4. BIAS 5. EN2 6. IN2 7. IN2 8. OUT2 9. OUT2 10. CT2 11. GND 12. CT1 13. OUT1 14. OUT1	V:DFN	D:14

■ Absolute Maximum Ratings

Parameter		Value	Unit
Input Voltage (IN1, IN2)		-0.3 to +6	V
BIAS Voltage (BIAS)		-0.3 to +6	V
Output Voltage (OUT1, OUT2)		-0.3 to +6	V
Enable Voltage (EN1, EN2)		-0.3 to +6	V
Output Current (Continuous)		6	A
Output Current (Pulsed) (Note1)		8	A
ESD Ratings	HBM	±2000	V
	MM	±200	V
	CDM	±1000	V

Note1: Maximum pulsed current switch per channel, pulse < 300µs, 3% duty cycle.

■ Recommended Operation Conditions

Parameter	Symbol	Value	Unit
Input Voltage	V_{IN}	0.8 to V_{BIAS}	V
BIAS Voltage	V_{BIAS}	2.5 to 5.5	V
Enable Voltage	V_{EN}	0 to 5.5	V
Ambient Temperature Range	T_A	-40 to +85	^oC
Junction Temperature Range	T_J	-40 to +125	
Storage Temperature	T_{STG}	-65 to +150	

■ Thermal Information

Parameter	Package	Die Attach	Symbol	Maximum	Unit
Thermal Resistance* (Junction to Case)	DFN-14A	Conductive Epoxy	θ_{JC}	11	^oC / W
Thermal Resistance (Junction to Ambient)	DFN-14A	Conductive Epoxy	θ_{JA}	45	^oC / W
Internal Power Dissipation	DFN-14A	Conductive Epoxy	P_D	2200	mW
Lead Temperature (soldering 10 sec)**				300	^oC

* Measure θ_{JC} on backside center of Exposed Pad.

** MIL-STD-202G210F

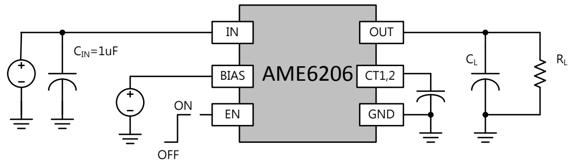
■ Electrical Specifications

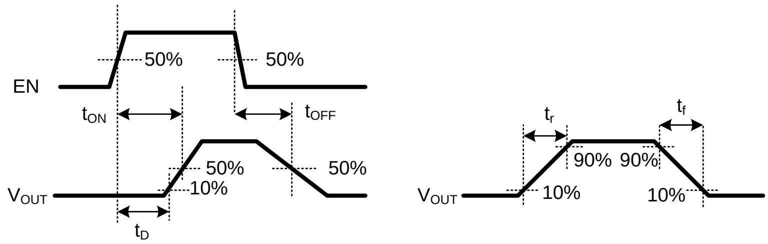
V_{BIAS} = 5V, $V_{IN1,2}$ = 5V, T_J = 25°C, unless otherwise specified.

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
BIAS Pin Quiescent Current (Both Channels)	I_Q	$I_{OUT1,2}$ = 0mA, V_{BIAS} = 5V, $V_{EN1,2}$ = 5V		72	96	µA
		$I_{OUT1,2}$ = 0mA, V_{BIAS} = 2.5V, $V_{EN1,2}$ = 2.5V		36	48	µA
BIAS Pin Quiescent Current (Single Channel)	I_Q	$I_{OUT1,2}$ = 0mA, V_{BIAS} = 5V, V_{EN1} = 5V, V_{EN2} = 0V		60		µA
		$I_{OUT1,2}$ = 0mA, V_{BIAS} = 2.5V, V_{EN1} = 2.5V, V_{EN2} = 0V		30		µA
BIAS Pin Shutdown Current	I_{SHDN_BIAS}	V_{EN1} = 0V, V_{EN2} = 0V		0.1	2	µA
IN1,IN2 Pin Shutdown Current	I_{SHDN_INX}	V_{EN1} = 0V, V_{EN2} = 0V, $V_{IN1,2}$ = 0.8V to 5V		0.1	2	µA
EN Pin Current	I_{EN}	$V_{EN1,2}$ = 5.5V		0.1	1	µA
ON Resistance	$R_{DS(ON)}$	I_{OUT} = 200mA, V_{BIAS} = 5V, V_{IN} = 0.8V to 5V		19	24	mΩ
		I_{OUT} = 200mA, V_{BIAS} = 2.5V, V_{IN} = 0.8V to 2.5V		20	25	mΩ
Output Discharge Resistance	R_{DSG}	V_{IN} = V_{BIAS} = 5V		220	290	Ω
		V_{IN} = V_{BIAS} = 2.5V		260	300	Ω
EN Pin High Level	V_{EN_H}		1.2			V
EN Pin Low Level	V_{EN_L}				0.6	V
Thermal Shutdown Temperature	T_{SD}			150		°C
Thermal Shutdown Hysteresis	T_{SDHY}			30		°C

■ Parameter Measurement Information

Single Channel Shown





Parameter	Symbol	Test Condition	Min	Typ	Max	Units
V_{IN} = 5V, V_{EN} = V_{BIAS} = 5V, T_A = 25°C						
Turn-on Time	T_{ON}	R_L = 10Ω, C_L = 0.1μF, C_T = 1nF		1210		μS
Turn-off Time	T_{OFF}	R_L = 10Ω, C_L = 0.1μF, C_T = 1nF		6		μS
V_{OUT} Rise Time	T_R	R_L = 10Ω, C_L = 0.1μF, C_T = 1nF		1710		μS
V_{OUT} Fall Time	T_F	R_L = 10Ω, C_L = 0.1μF, C_T = 1nF		7		μS
ON Delay Time	T_D	R_L = 10Ω, C_L = 0.1μF, C_T = 1nF		190		μS
V_{IN} = 0.8V, V_{EN} = V_{BIAS} = 5V, T_A = 25°C						
Turn-on Time	T_{ON}	R_L = 10Ω, C_L = 0.1μF, C_T = 1nF		370		μS
Turn-off Time	T_{OFF}	R_L = 10Ω, C_L = 0.1μF, C_T = 1nF		9		μS
V_{OUT} Rise Time	T_R	R_L = 10Ω, C_L = 0.1μF, C_T = 1nF		310		μS
V_{OUT} Fall Time	T_F	R_L = 10Ω, C_L = 0.1μF, C_T = 1nF		5		μS
ON Delay Time	T_D	R_L = 10Ω, C_L = 0.1μF, C_T = 1nF		190		μS
V_{IN} = 2.5V, V_{EN} = V_{BIAS} = 2.5V, T_A = 25°C						
Turn-on Time	T_{ON}	R_L = 10Ω, C_L = 0.1μF, C_T = 1nF		2600		μS
Turn-off Time	T_{OFF}	R_L = 10Ω, C_L = 0.1μF, C_T = 1nF		11		μS
V_{OUT} Rise Time	T_R	R_L = 10Ω, C_L = 0.1μF, C_T = 1nF		2600		μS
V_{OUT} Fall Time	T_F	R_L = 10Ω, C_L = 0.1μF, C_T = 1nF		7		μS
ON Delay Time	T_D	R_L = 10Ω, C_L = 0.1μF, C_T = 1nF		800		μS
V_{IN} = 0.8V, V_{EN} = V_{BIAS} = 2.5V, T_A = 25°C						
Turn-on Time	T_{ON}	R_L = 10Ω, C_L = 0.1μF, C_T = 1nF		900		μS
Turn-off Time	T_{OFF}	R_L = 10Ω, C_L = 0.1μF, C_T = 1nF		7		μS
V_{OUT} Rise Time	T_R	R_L = 10Ω, C_L = 0.1μF, C_T = 1nF		900		μS
V_{OUT} Fall Time	T_F	R_L = 10Ω, C_L = 0.1μF, C_T = 1nF		5		μS
ON Delay Time	T_D	R_L = 10Ω, C_L = 0.1μF, C_T = 1nF		750		μS

Application Information

Input Capacitor (Optional)

Place a 1μF ceramic capacitor, C_{IN} between IN and GND as close as possible to the pins to limit the voltage drop on the input supply caused by inrush current when the power switch turns on into a discharged load capacitor. Recommend to adopt an input capacitance about 10 times higher than output one to prevent from excessive voltage drop when switching heavy load.

Output Capacitor (Optional)

Because of the body diode in NMOS, it is recommended to use a C_{IN} greater than C_L. If a C_L is greater than C_{IN}, it will cause V_{OUT} to exceed V_{IN} while the system supply is removed. This could result in current flow through the body diode from V_{OUT} to V_{IN}.
A C_{IN} : C_L = 10:1 is recommended for minimizing V_{IN} dip caused by inrush currents during startup, however a 10:1 ratio for capacitance is not required for proper functionality of the device. If a ratio is smaller than 10 (such as 1), it will cause slightly more V_{IN} dip upon turn on due to inrush currents. This can be mitigated by increasing the capacitance on the CT pin for a longer rise time (see the **Adjustable Rise Time** section).

ON and OFF Control

The EN pins control the state of AME6206. Asserting EN pin high activates the switch. EN pin is active-high with a low threshold, making it capable of interfacing with low-voltage signals. The EN pin can be applied by standard GPIO logic threshold. It can be used with any microcontroller with 1.2 V or higher GPIO voltage. Do not make the pin floating and must be tied either high or low for proper functionality.

Quick Output Discharge (QOD)

When AME6206 is disabled, an internal discharge resistance is automatically connected between OUT and GND, thus discharge the remaining charge from the output. This resistance prevents the output from floating while the switch is disabled. For best results, it is recommended that AME6206 gets disabled before V_{BIAS} falls below the minimum recommended voltage.

Device Functional Modes

EN	IN to OUT	OUT to GND
H	ON	OFF
L	OFF	ON

Power Dissipation

The maximum IC junction temperature must be restricted to 125°C under normal operating conditions. To calculate the maximum allowable power dissipation

$$P_{D(max)} = \frac{T_{J(max)} - T_A}{\theta_{JA}}$$

where

- $P_{D(max)}$ is the maximum allowable power dissipation.
- $T_{J(max)}$ is the maximum allowable junction temperature.
- T_A is the ambient temperature of the device.
- θ_{JA} is the junction to air thermal impedance. This parameter is highly dependent upon board layout.

■ Application Information (Contd.)

Adjustable Rise Time

Place a capacitor between CT pin and GND to set the rise time for each channel. To ensure desired performance, a capacitor with a minimum voltage rating of 25V must be applied on either CT pins. An approximate formula for the relationship between CT and rise time is shown

Rise Time (µS) = $(C_T + 58) * V_{OUT} * 0.36 + 21$

It account for 10% to 90% measurement on V_{OUT} and do not apply for C_T < 100pF. Use Table 1 to determine rise times for when C_T = 0pF.

where C_T is the capacitance value on the CT pin (pF)

Rise time values measured on a typical device is shown as table. Rise times shown below are only valid for the power-up sequence where IN and BIAS are already in steady state condition, and the EN pin is asserted high.

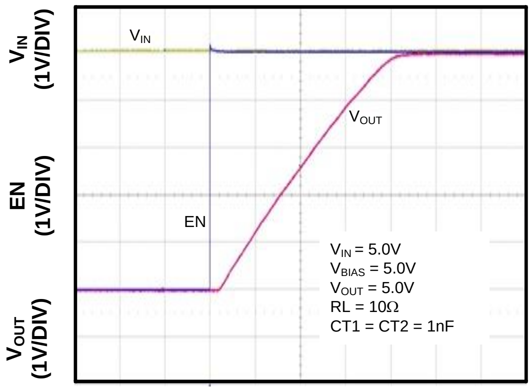
Table 1. Rise Time Values

C_T(pF)	Rise Time (µs) 10% ~ 90%, C_L=0.1µF, C_{IN}=1µF, R_L=10Ω(1)							
	5V	3.3V	2.5V	1.8V	1.5V	1.2V	1.05V	0.8V
0	126	97	79	66	59	50	44	37
220	498	341	268	182	167	131	121	100
470	971	641	482	345	291	236	201	162
1000	1869	1195	854	638	520	441	395	313
2200	4172	2643	1914	1405	1130	952	818	652
4700	8615	5534	4262	3032	2580	2107	1689	1366
10000	18003	11897	8911	6294	5278	4823	4640	3060

(1) Typical Values at 25°C, V_{BIAS} = 5V, 15V X7R 10% Ceramic Cap

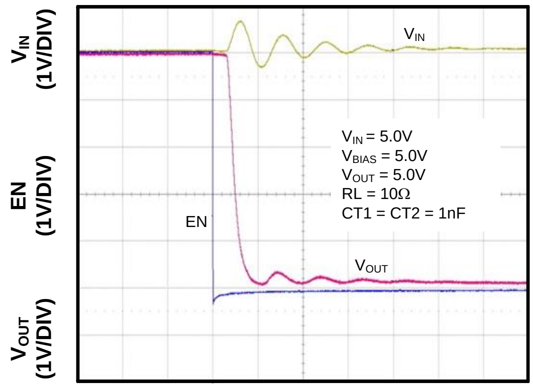
■ Characterization Curve

Turn On Response Time



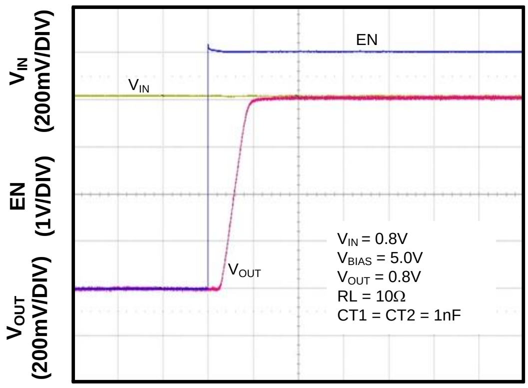
Time (500µs/DIV)

Turn Off Response Time



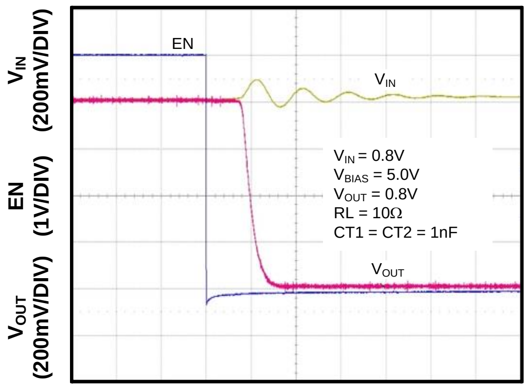
Time (5µs/DIV)

Turn On Response Time



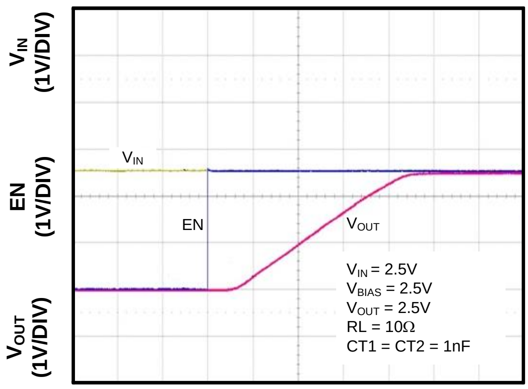
Time (500µs/DIV)

Turn Off Response Time



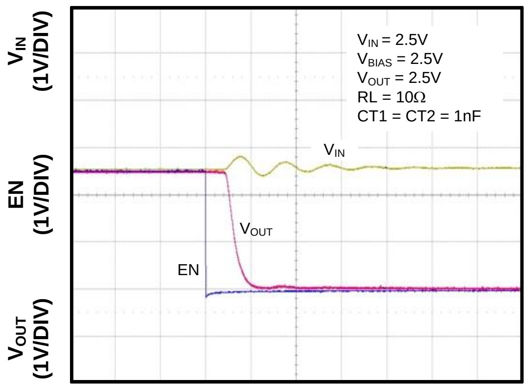
Time (5µs/DIV)

Turn On Response Time



Time (1ms/DIV)

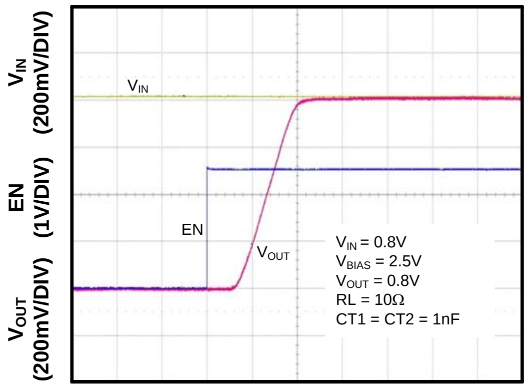
Turn Off Response Time



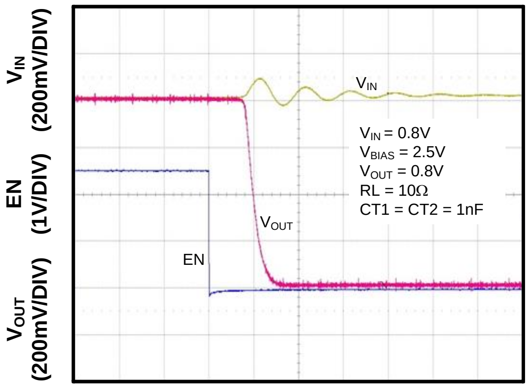
Time (5µs/DIV)

■ Characterization Curve (Contd.)

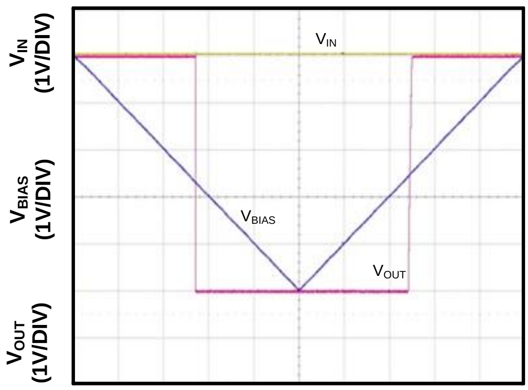
Turn On Response Time



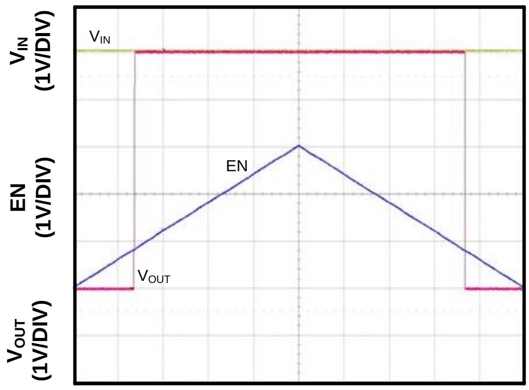
Turn Off Response Time



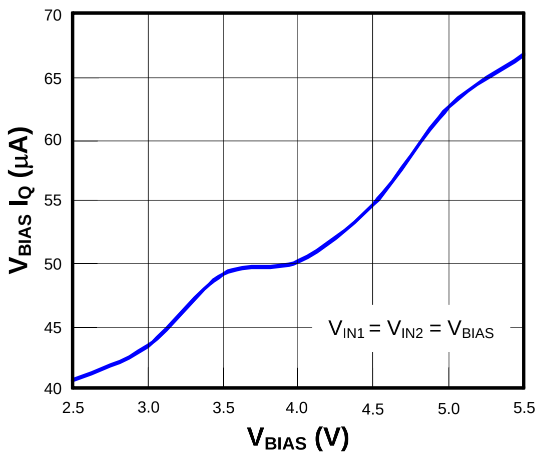
V_{BIAS} POR



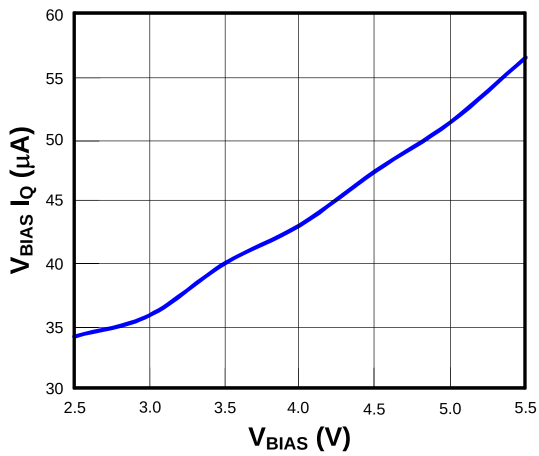
Enable ON/OFF Control



Dual Channel V_{BIAS} I_Q vs. V_{BIAS}

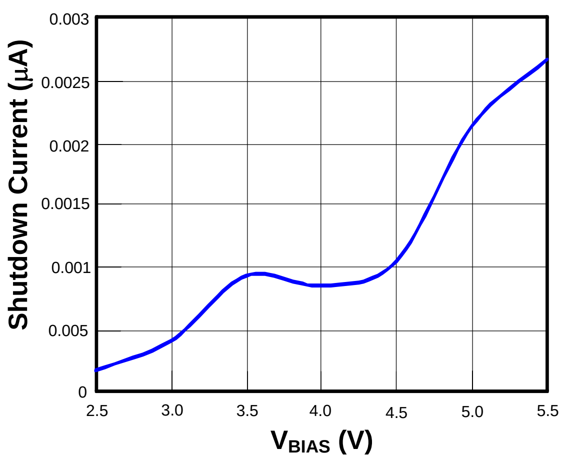


Single Channel I_Q

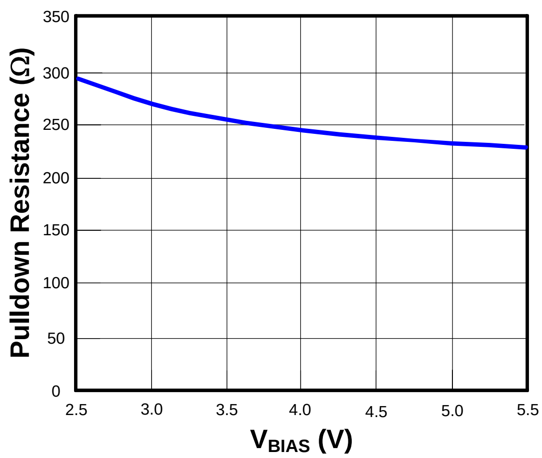


■ Characterization Curve (Contd.)

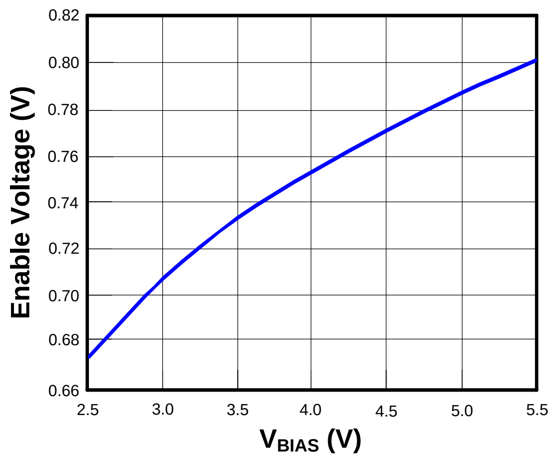
V_{BIAS} vs. Shutdown Current



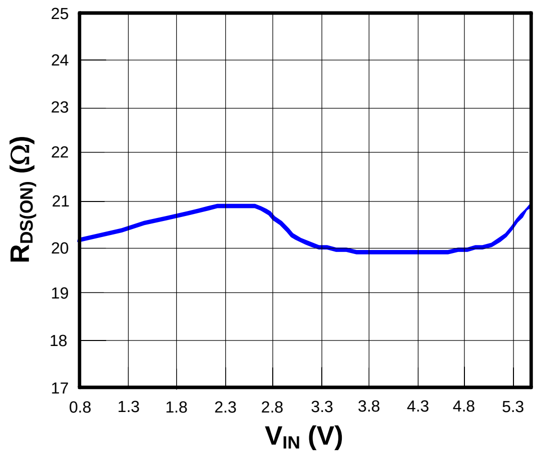
Pulldown Resistance vs. V_{BIAS}



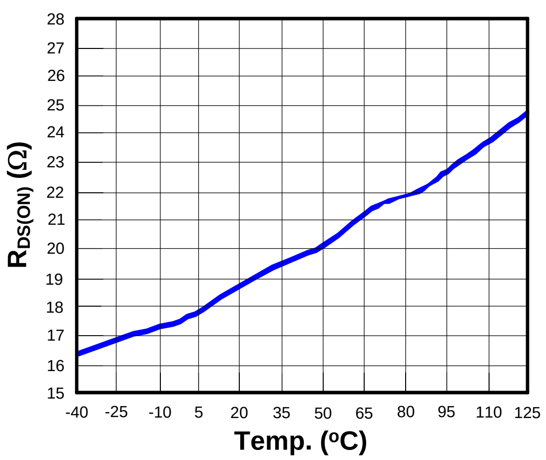
EN High vs. V_{BIAS}



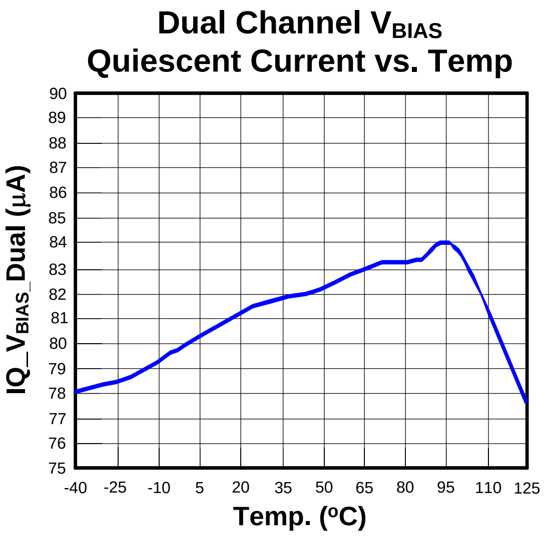
$R_{DS(ON)}$ vs. V_{IN}

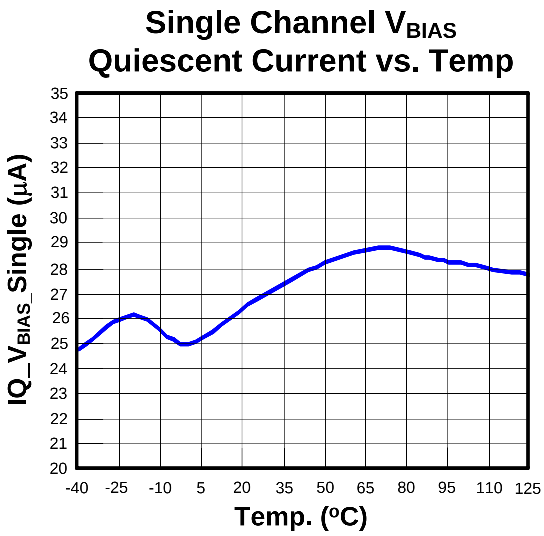


$R_{DS(ON)}$ vs. Temp



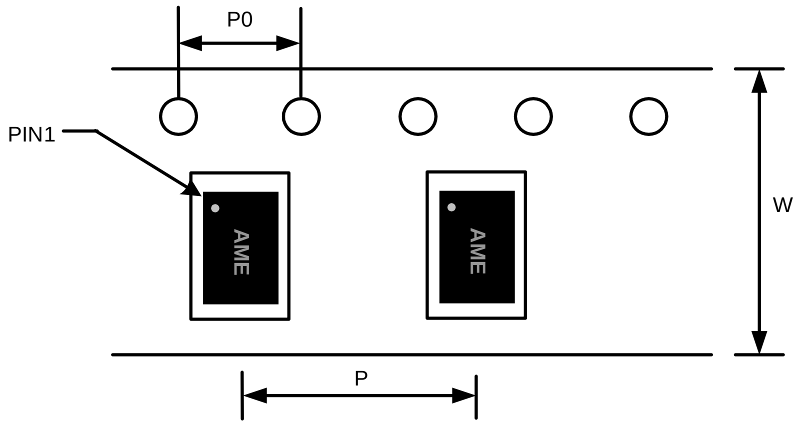
■ Characterization Curve (Contd.)





■ Tape and Reel Dimension

DFN-14A (3 x 2 x 0.75mm)

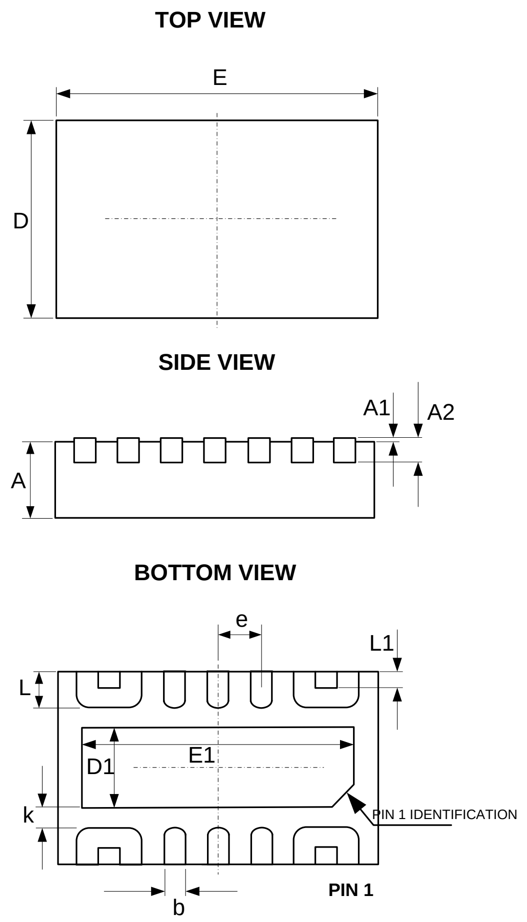


Carrier Tape, Number of Components Per Reel and Reel Size

Package	Carrier Width (W)	Pitch (P)	Pitch (P0)	Part Per Full Reel	Reel Size
DFN-14A	8.0±0.1 mm	4.0±0.1 mm	4.0±0.1 mm	3000pcs	180±1 mm

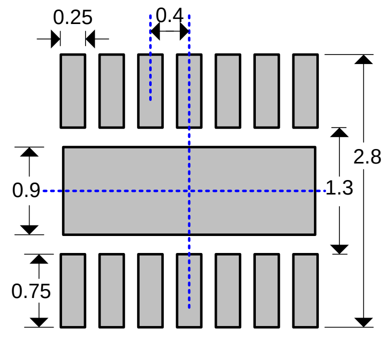
■ Package Dimension

DFN-14A (3 x 2 x 0.75mm)



SYMBOLS	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	0.700	0.800	0.028	0.031
A1	0.000	0.050	0.000	0.002
A2	0.203REF.		0.008REF.	
D	1.900	2.100	0.075	0.083
E	2.900	3.100	0.114	0.122
D1	0.700	1.000	0.028	0.039
E1	2.400	2.600	0.094	0.102
k	0.150MIN.		0.0059MIN.	
b	0.130	0.230	0.005	0.009
e	0.400TYP.		0.016TYP.	
L	0.224	0.400	0.009	0.016
L1	0.110REF.		0.004REF.	

■ Lead Pattern



Note:

1. Dimensions in Millimeters.
2. General tolerance ±0.05mm unless otherwise specified

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