



## ULTRA- LOW ON RESISTANCE, 6-A DUAL LOAD SWITCH WITH CONTROLLED TURN-ON

### FEATURES

- Integrated dual channel load switch
- Input Voltage Range: 0.8V to 5.5V
- Ultra-low ON-Resistance,  $R_{ON} = 20m\Omega$  per channel
- 6A Maximum Continuous Current per channel
- Low Threshold Control Input
- Adjustable Rise Time
- Quick Output Discharge Transistor
- RoHS Compliant and Halogen Free Product

### APPLICATIONS

- Telecom Systems
- Industrial Systems
- Set-Top-Box
- Consumer Electronics
- Notebooks / Netbooks

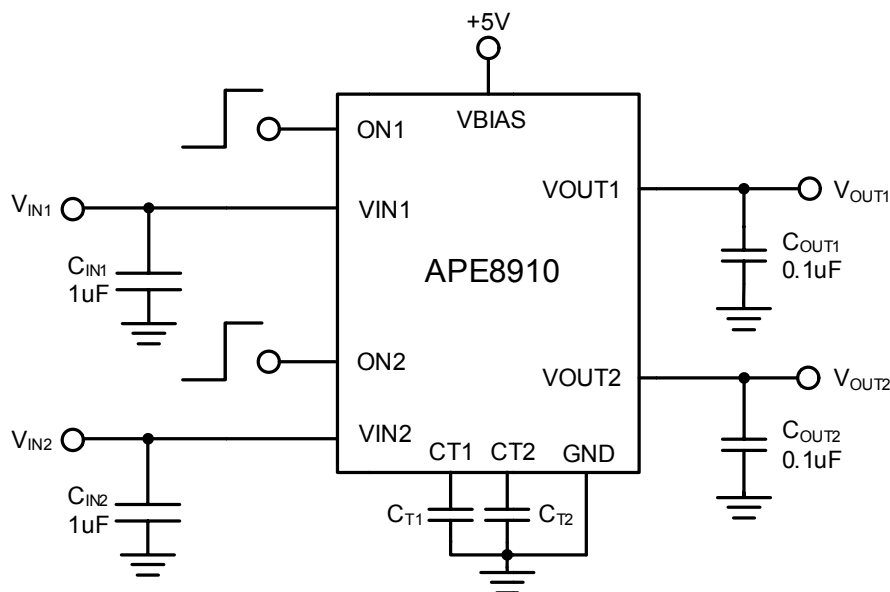
### DESCRIPTION

The APE8910 is a small, ultra-low  $R_{ON}$  dual load switch with controlled turn on. It contains two N-channel MOSFETs that can operate over an input voltage range of 0.8V to 5.5V and support maximum continuous current up to 6A each. Each load switch is controlled by an on/off input (ON), which is capable of interfacing directly with low-voltage control signals.

Additional features include a  $250\Omega$  on-chip load resistor for output quick discharge when switch is turned off, in order to avoid inrush current, the rise time is adjustable by an external ceramic capacitor on the CTx pin.

The APE8910 is available in an ultra-small, space saving 3mmx2mm 14-pin DFN package with thermal pad.

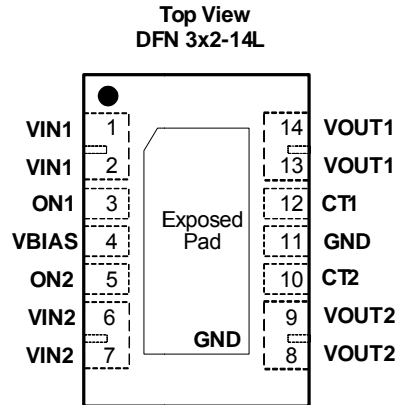
### TYPICAL APPLICATION





ORDERING / PACKAGE INFORMATION

APE8910X Package Type GN3B: DFN 3x2-14L



ABSOLUTE MAXIMUM RATINGS (at TA=25°C)

Table of absolute maximum ratings including VIN1, VOUT1, VON1, VBIAS, I\_MAX, Storage Temperature Range, Junction Temperature, Lead Temperature, Thermal Resistance, and ESD Electrostatic Discharge Capability.

RECOMMENDED OPERATING CONDITIONS

Table of recommended operating conditions including VIN1,2, VBIAS, VON1,2, VOUT1,2, CIN1,2, Junction Temperature, Operating Temperature Range, and Power Dissipation.



**ELECTRICAL SPECIFICATIONS**

(VIN1, 2=0.8 to 5.5V, VBIAS=5V, TA =25°C, unless otherwise specified)

PARAMETER	SYM	TEST CONDITION	MIN	TYP	MAX	UNIT
Quiescent Current	I <sub>BIAS</sub>	VIN1=VIN2=VON1=VON2=5V IOUT1=IOUT2=0A		80	120	uA
Shutdown Current	I <sub>SD</sub>	VON1=VON2=GND, VOU1=VOU2=0			1	uA
ON Resistance (each switch)	R <sub>ON</sub>	VINx=5V, VBIAS=5V, IOUTx=-200mA, TA=25°C		20	28	mΩ
		VINx=5V, VBIAS=5V, IOUTx=-200mA, -40°C < TA < 85°C			35	mΩ
		VINx=3.3V, VBIAS=5V, IOUTx=-200mA, TA=25°C		20	28	mΩ
		VINx=3.3V, VBIAS=5V, IOUTx=-200mA, -40°C < TA < 85°C			35	mΩ
		VINx=1.8V, VBIAS=5V, IOUTx=-200mA, TA=25°C		20	28	mΩ
		VINx=1.8V, VBIAS=5V, IOUTx=-200mA, -40°C < TA < 85°C			35	mΩ
		VINx=1.5V, VBIAS=5V, IOUTx=-200mA, TA=25°C		20	28	mΩ
		VINx=1.5V, VBIAS=5V, IOUTx=-200mA, -40°C < TA < 85°C			35	mΩ
		VINx=1.2V, VBIAS=5V, IOUTx=-200mA, TA=25°C		20	28	mΩ
		VINx=1.2V, VBIAS=5V, IOUTx=-200mA, -40°C < TA < 85°C			35	mΩ
		VINx=0.8V, VBIAS=5V, IOUTx=-200mA, TA=25°C		20	28	mΩ
		VINx=0.8V, VBIAS=5V, IOUTx=-200mA, -40°C < TA < 85°C			35	mΩ
Output Pull Down Resistance	R <sub>OPD</sub>	VBIAS=5V, VONx=0V		250	350	Ω
ONx Input Leakage Current	I <sub>ON</sub>	VONx=5V or GND			1	uA
ONx Logic High	V <sub>IH</sub>	VBIAS= 2.5V to 5.5V		1.2	5.5	V
ONx Logic Low	V <sub>IL</sub>	VBIAS= 2.5V to 5.5V		0	0.4	V



**SWITCHING CHARACTERISTICS**

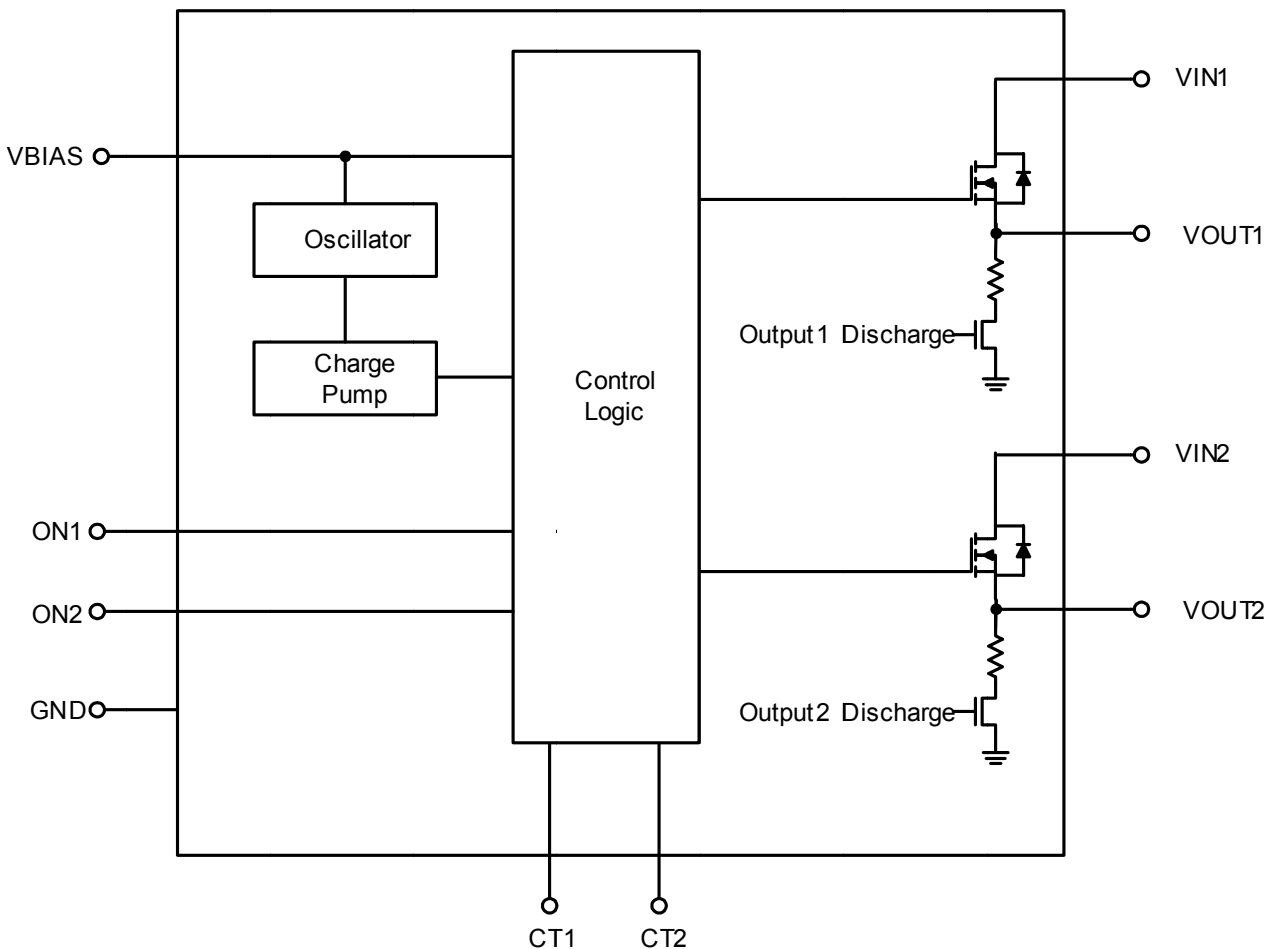
PARAMETER	SYM	TEST CONDITION	MIN	TYP	MAX	UNIT
$V_{IN}=V_{ON}=V_{BIAS}=5V, T_A=25^{\circ}C$ (unless otherwise noted)						
Turn on Time	$t_{ON}$	$R_L=10\ \Omega, C_L=0.1\ \mu F, C_T=1000\ pF$		1870		us
Turn off Time	$t_{OFF}$	$R_L=10\ \Omega, C_L=0.1\ \mu F, C_T=1000\ pF$		1		us
$V_{OUT}$ Rise Time	$t_R$	$R_L=10\ \Omega, C_L=0.1\ \mu F, C_T=1000\ pF$		1440		us
$V_{OUT}$ Fall Time	$t_F$	$R_L=10\ \Omega, C_L=0.1\ \mu F, C_T=1000\ pF$		2		us
ON Delay Time	$t_D$	$R_L=10\ \Omega, C_L=0.1\ \mu F, C_T=1000\ pF$		230		us
$V_{IN}=0.8V, V_{ON}=V_{BIAS}=5V, T_A=25^{\circ}C$ (unless otherwise noted)						
Turn on Time	$t_{ON}$	$R_L=10\ \Omega, C_L=0.1\ \mu F, C_T=1000\ pF$		420		us
Turn off Time	$t_{OFF}$	$R_L=10\ \Omega, C_L=0.1\ \mu F, C_T=1000\ pF$		1		us
$V_{OUT}$ Rise Time	$t_R$	$R_L=10\ \Omega, C_L=0.1\ \mu F, C_T=1000\ pF$		280		us
$V_{OUT}$ Fall Time	$t_F$	$R_L=10\ \Omega, C_L=0.1\ \mu F, C_T=1000\ pF$		2		us
ON Delay Time	$t_D$	$R_L=10\ \Omega, C_L=0.1\ \mu F, C_T=1000\ pF$		230		us
$V_{IN}=V_{BIAS}=3.3V, V_{ON}=5V, T_A=25^{\circ}C$ (unless otherwise noted)						
Turn on Time	$t_{ON}$	$R_L=10\ \Omega, C_L=0.1\ \mu F, C_T=1000\ pF$		1040		us
Turn off Time	$t_{OFF}$	$R_L=10\ \Omega, C_L=0.1\ \mu F, C_T=1000\ pF$		2		us
$V_{OUT}$ Rise Time	$t_R$	$R_L=10\ \Omega, C_L=0.1\ \mu F, C_T=1000\ pF$		1320		us
$V_{OUT}$ Fall Time	$t_F$	$R_L=10\ \Omega, C_L=0.1\ \mu F, C_T=1000\ pF$		2		us
ON Delay Time	$t_D$	$R_L=10\ \Omega, C_L=0.1\ \mu F, C_T=1000\ pF$		250		us
$V_{IN}=0.8V, V_{BIAS}=3.3V, V_{ON}=5V, T_A=25^{\circ}C$ (unless otherwise noted)						
Turn on Time	$t_{ON}$	$R_L=10\ \Omega, C_L=0.1\ \mu F, C_T=1000\ pF$		460		us
Turn off Time	$t_{OFF}$	$R_L=10\ \Omega, C_L=0.1\ \mu F, C_T=1000\ pF$		2		us
$V_{OUT}$ Rise Time	$t_R$	$R_L=10\ \Omega, C_L=0.1\ \mu F, C_T=1000\ pF$		300		us
$V_{OUT}$ Fall Time	$t_F$	$R_L=10\ \Omega, C_L=0.1\ \mu F, C_T=1000\ pF$		2		us
ON Delay Time	$t_D$	$R_L=10\ \Omega, C_L=0.1\ \mu F, C_T=1000\ pF$		250		us



## PIN DESCRIPTIONS

PIN No.	PIN SYMBOL	PIN DESCRIPTION
1, 2	VIN1	Channel 1 input, bypass this input with a ceramic capacitor to ground.
3	ON1	Channel 1 enable control input, active high. Do not leave floating.
4	VBIAS	5V bias voltage.
5	ON2	Channel 2 enable control input, active high. Do not leave floating.
6,7	VIN2	Channel 2 input, bypass this input with a ceramic capacitor to ground.
8,9	VOUT2	Channel 2 output.
10	CT2	A capacitor to ground set the rise time of VOUT2.
11	GND	Ground.
12	CT1	A capacitor to ground set the rise time of VOUT1.
13,14	VOUT1	Channel 1 output.

## BLOCK DIAGRAM





## TYPICAL PERFORMANCE CHARACTERISTICS

VBIAS=5V, VIN1=VIN2, ON1=ON2, IOUTX=0A, CTX=1nF, CINX=1μF, COUTX=0.1μF,

ch1:ONx, ch2:VOUT1, ch3: VOUT2

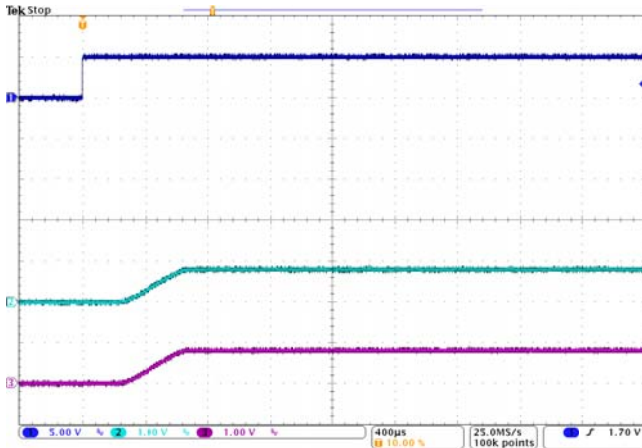


Fig.1 Turn-on Response, VINx=0.8V

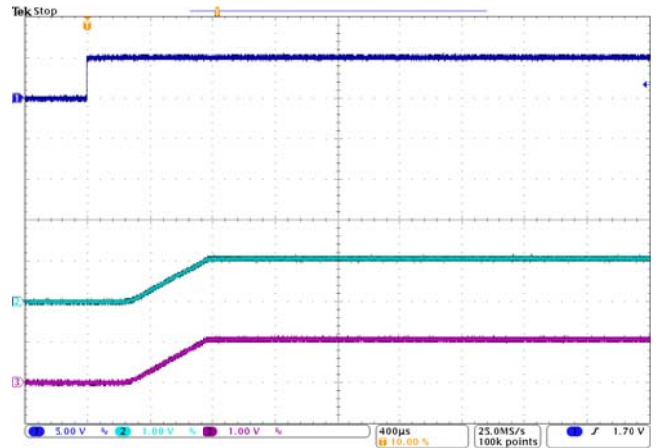


Fig.2 Turn-on Response, VINx=1.05V

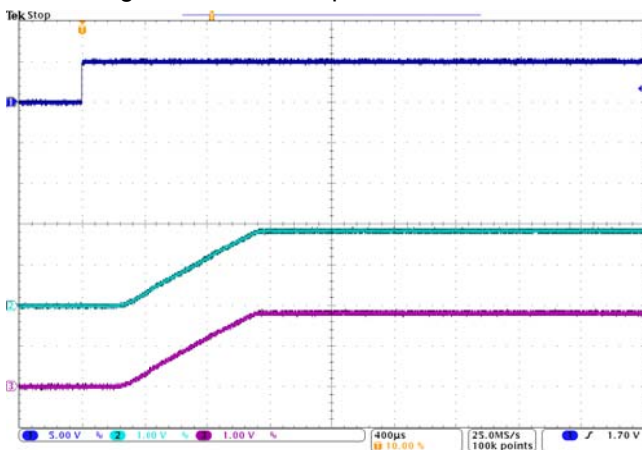


Fig.3 Turn-on Response, VINx=1.8V

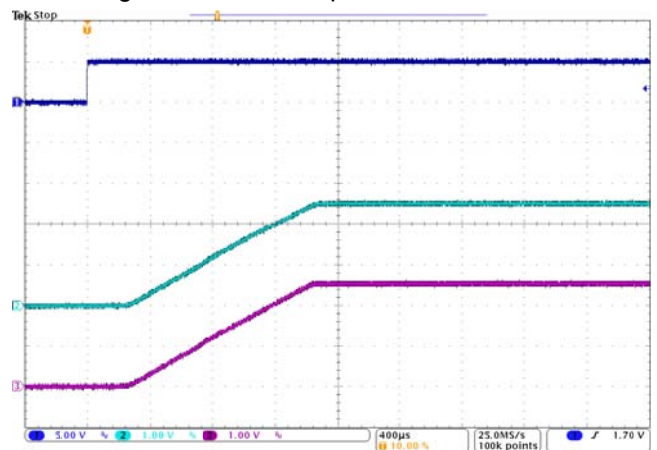


Fig.4 Turn-on Response, VINx=2.5V

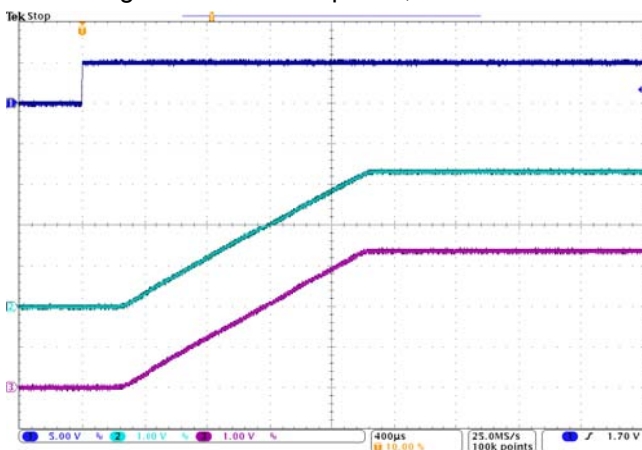


Fig.5 Turn-on Response, VINx=3.3V

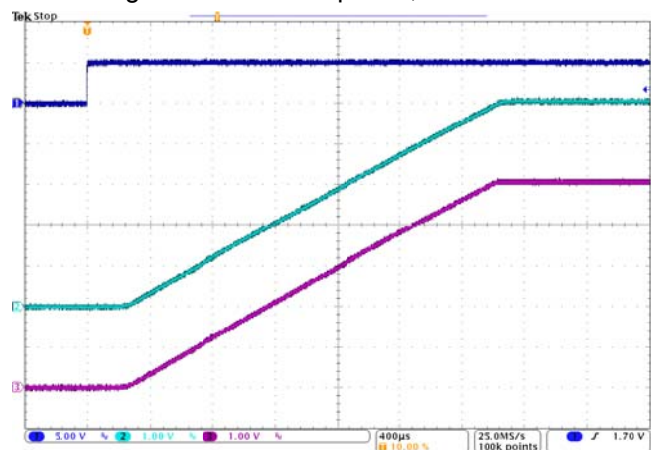


Fig.6 Turn-on Response, VINx=5.0V



### TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

VBIAS=5V, VIN1=VIN2, ON1=ON2, I<sub>OUTX</sub>=0A, C<sub>TX</sub>=1nF, C<sub>INX</sub>=1μF, C<sub>OUTX</sub>=0.1μF,

ch1:ONx, ch2:VOUT1, ch3: VOUT2

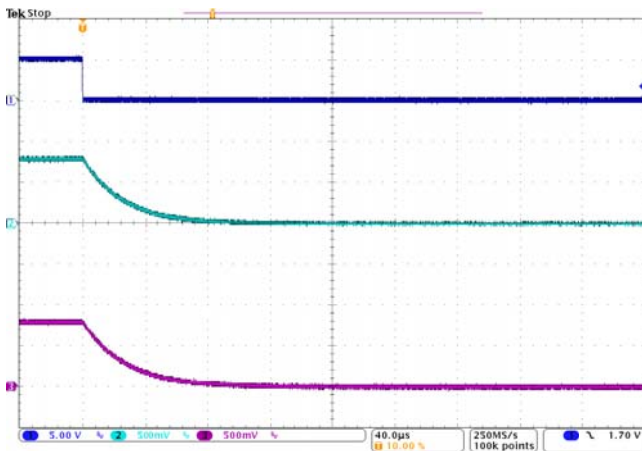


Fig.7 Turn-off Response, VIN=0.8V

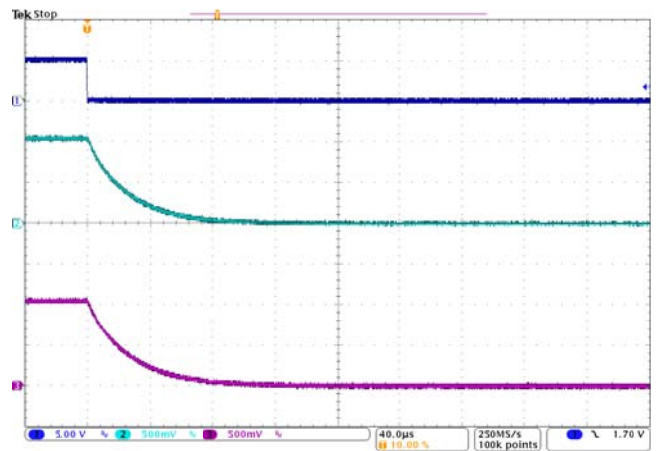


Fig.8 Turn-off Response, VIN=1.05V

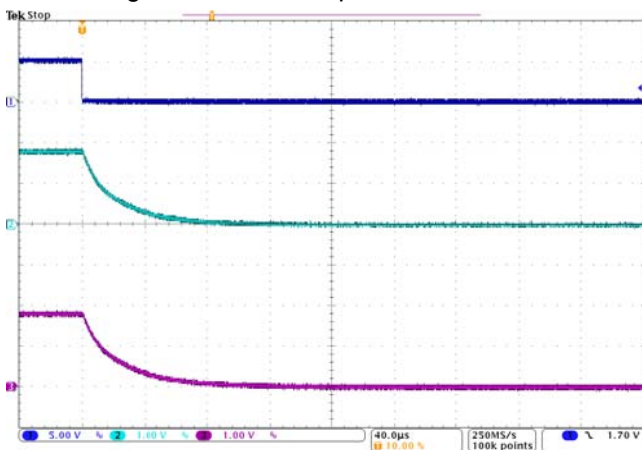


Fig.9 Turn-off Response, VIN=1.8V

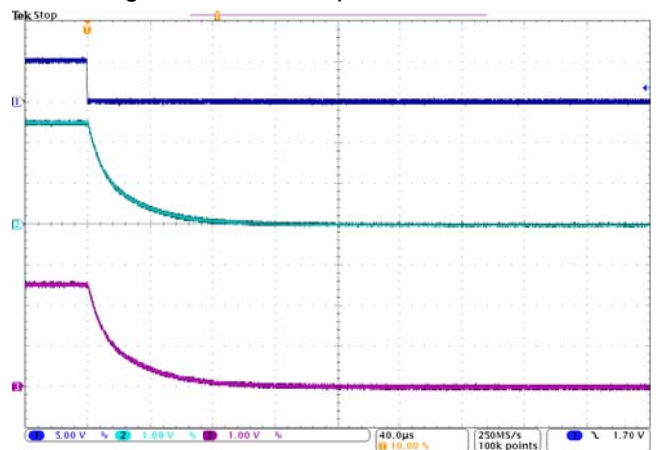


Fig.10 Turn-off Response, VIN=2.5V

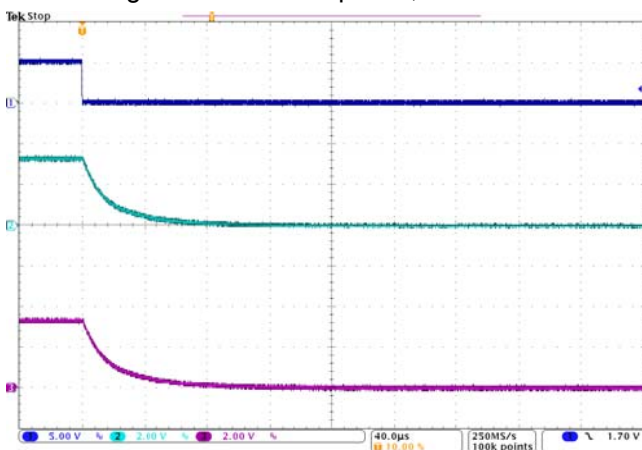


Fig.11 Turn-off Response, VIN=3.3V

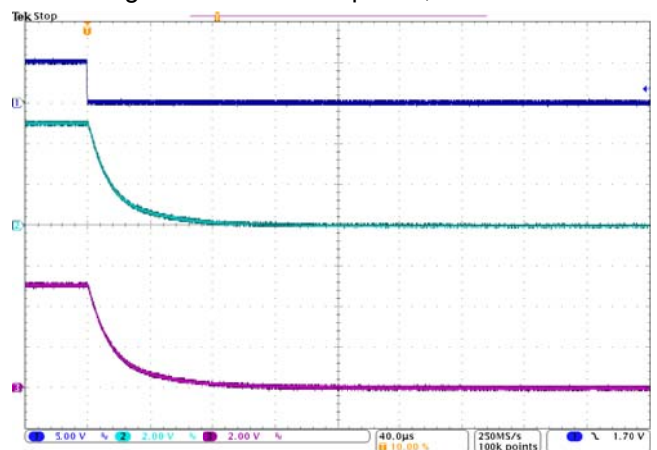


Fig.12 Turn-off Response, VIN=5.0V



TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

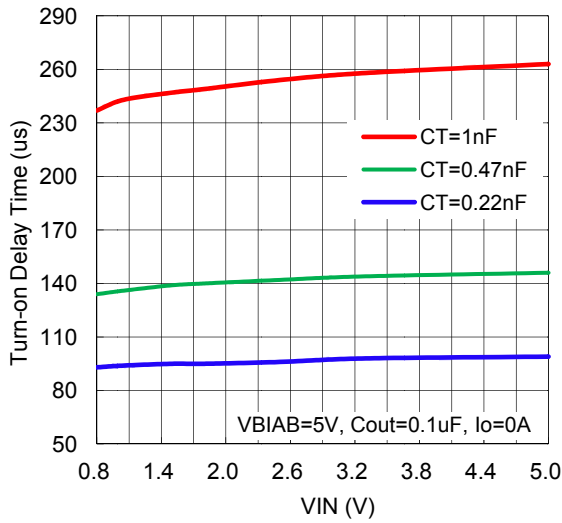


Fig. 13  $t_{D-ON}$  vs. VIN

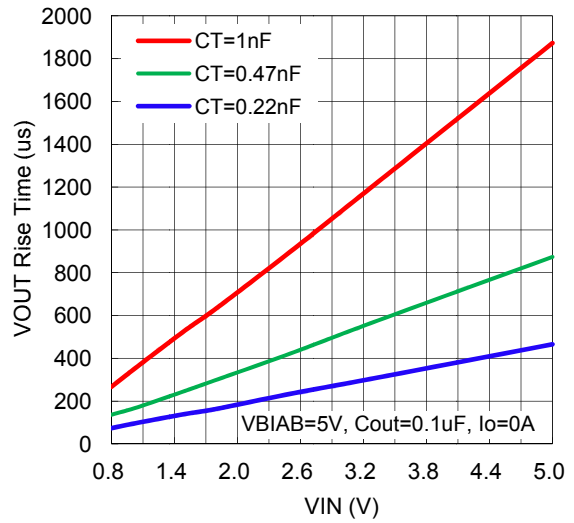


Fig. 14  $t_R$  vs. VIN

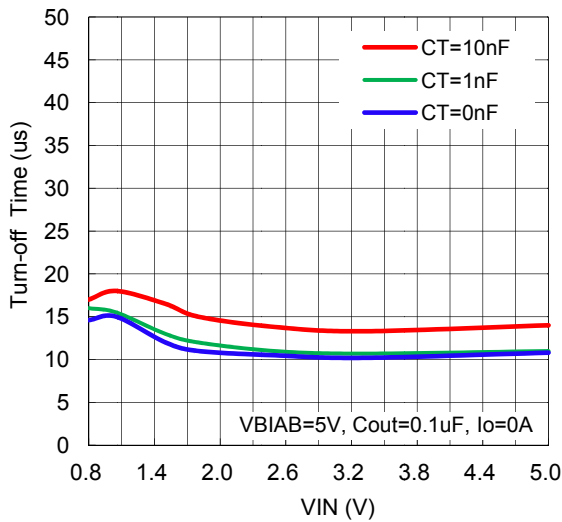


Fig. 15  $t_{OFF}$  vs. VIN

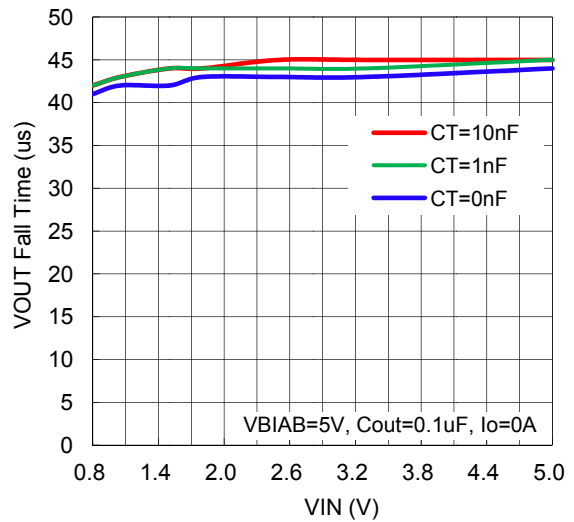


Fig. 16  $t_F$  vs. VIN

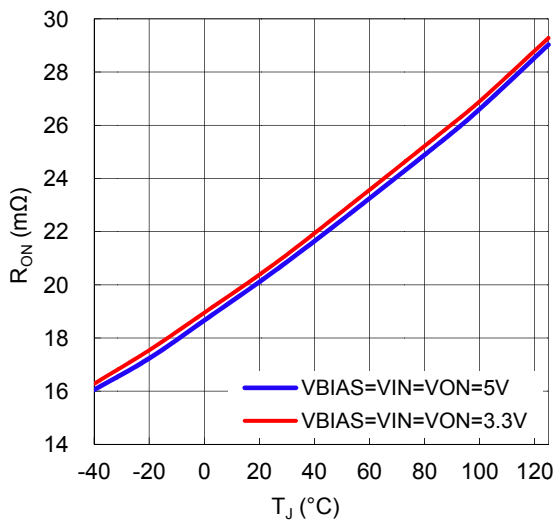


Fig. 17  $R_{ON}$  vs. Temperature

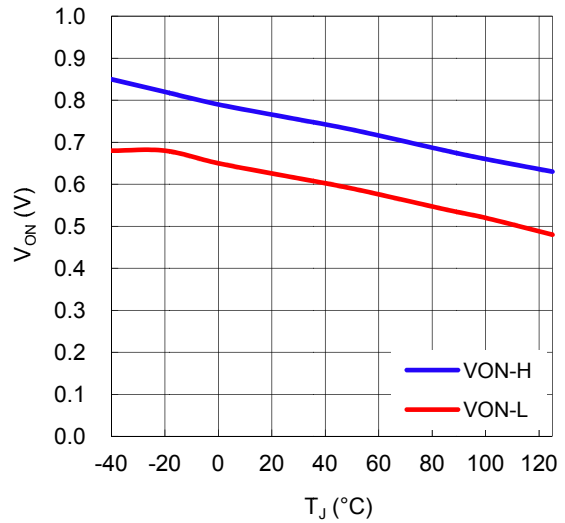


Fig. 18 ON Threshold vs. Temperature





TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

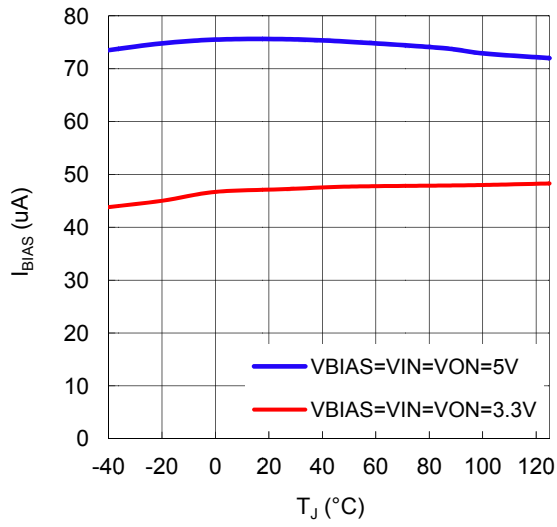


Fig.19 Quiescent Current (VBIAS) vs. Temperature

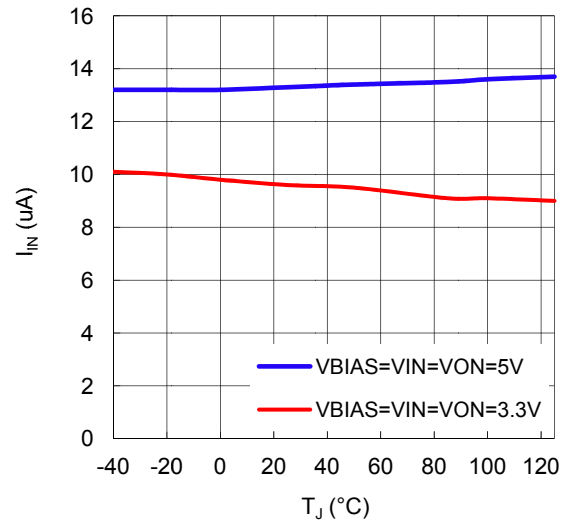


Fig.20 Quiescent Current (VIN) vs. Temperature



### APPLICATION INFORMATION

#### On/Off Control

The load switch is controlled by the ON pin. The ONx pin is active high and has a low threshold making it capable of interfacing with low voltage signals. The ONx pin can be used with standard 1.2V, 1.8V, 2.5V or 3.3V GPIO logic threshold. Do not leave the ONx pin float.

The Figure 21 show the VOUTx turn-on/off waveform.

t<sub>D</sub>: VOUT Turn On Delay Time

t<sub>ON</sub>: VOUT Turn On Time

t<sub>R</sub>: VOUT Rise Time

t<sub>OFF</sub>: VOUT Turn Off Time

t<sub>F</sub>: VOUT Fall Time

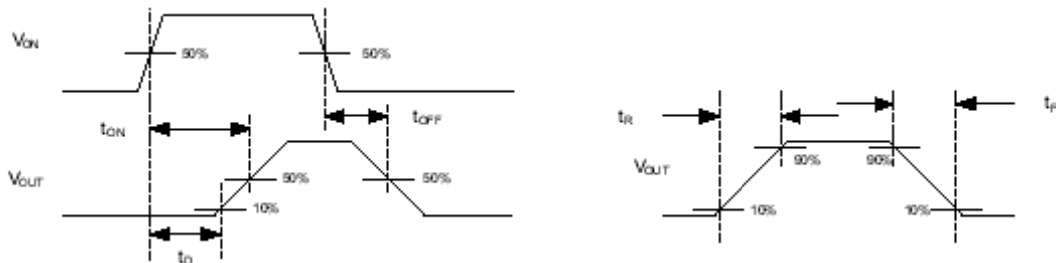


Fig.21 ON/OFF Waveform

#### Output Rise Time Control

The rise time of each VOUTx is adjustable by an external capacitor on the CTx pin. The rise time shows on below Table 1 are typical measured value. Please refer it for determined rise time.

CT (nF)	Rise Time, t <sub>R</sub> (μs), 10%~90%, C <sub>OUT</sub> =0.1μF, C <sub>IN</sub> =1uF							
	VIN=0.8V	VIN=1.05V	VIN=1.2V	VIN=1.5V	VIN=1.8V	VIN=2.5V	VIN=3.3V	VIN=5V
0	27	31	34	38	40	48	59	75
0.22	72	93	107	131	158	220	284	418
0.47	126	159	178	233	280	400	520	776
1	250	327	378	485	584	780	1045	1657
2.2	509	725	827	1027	1235	1777	2391	3593
4.7	1012	1387	1699	1898	2269	3451	4670	7418
10	2008	2865	3425	4328	5203	7491	10142	15409

<Table 1>



## APPLICATION INFORMATION (Continued)

### Input Capacitor

An input capacitor is recommended to be placed between VINx and GND to limit the voltage drop on the input supply during high current application.

### Output Capacitor

Setting a  $C_{IN}$  greater than the  $C_{OUT}$  is highly recommended. Since the internal body diode is in the NMOS switch, this prevents the current flows through the body diode from VOUTx to VINx when the system supply is removed.

### Layout Considerations

The Figure 22 shows the reference layout for APE8910. Below lists help start layout.

1. The current loop of two load switch should be separated and symmetrized to each other.
2. Keep the high current paths (VIN, VOUT and GND; blue circle) wide and short to obtain the best effect.
3. The input and output capacitors should be close to the device as possible to minimize the parasitic trace inductances.
4. Place the thermal vias under the exposed pad of the device (green circle). This help for thermal diffusion away from the device.

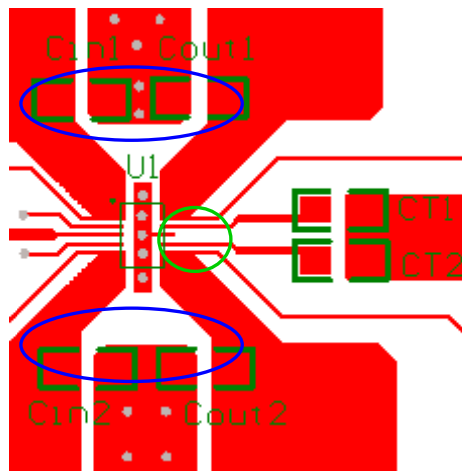


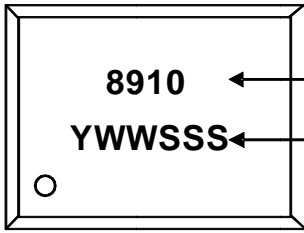
Fig.22 APE8910 Reference Layout



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**MARKING INFORMATION**

DFN 3x2-14L



Part Number

Date Code (YWWSSS)

Y : Year

WW : Week

SSS : Sequence