Advanced Power Electronics Corp. **APS8922A**

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} = 20mΩ 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

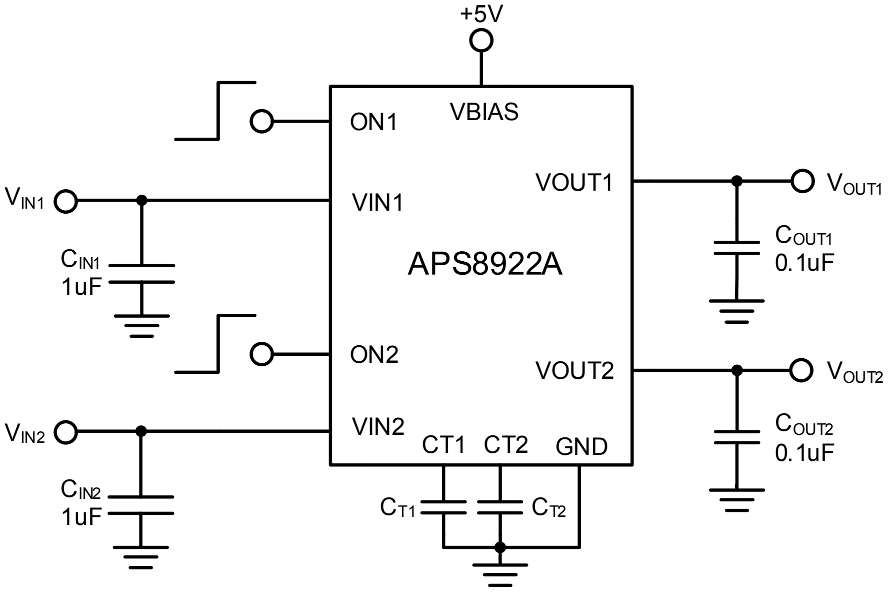
DESCRIPTION

The APS8922A 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 250Ω 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 APS8922A is available in an ultra-small, space saving 3mmx2mm 14-pin DFN package with thermal pad.

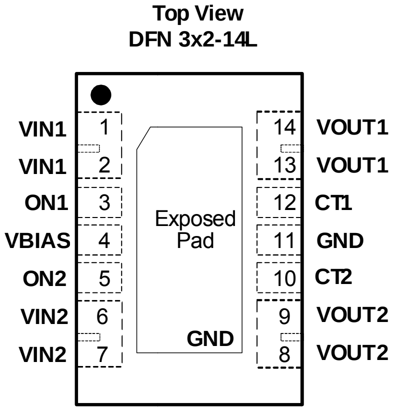
TYPICAL APPLICATION



ORDERING / PACKAGE INFORMATION

APS8922 AX

Package Type
GN3B: DFN 3x2-14L



ABSOLUTE MAXIMUM RATINGS (at T_A=25°C)

VIN1, VIN2	-0.3V to 6V
VOUT1, VOUT2	VIN+0.3V
VON1, VON2	-0.3V to 6V
VBIAS	-0.3+6V
I_{MAX}	6A
Storage Temperature Range (T_{ST})	-65 to +150°C
Junction Temperature (T_J)	150°C
Lead Temperature (Soldering, 10sec.)	260°C
Thermal Resistance from Junction to Ambient ($R\theta_{JA}$)	
DFN-14L (3mmX2mm)	65°C/W
ESD Electrostatic Discharge Capability	
Human Body Model, MIL-STD-883G Method 3015.7	2KV
Machine Model, JESD 22	200V
Charged Device Model, JESD 22	1KV

RECOMMENDED OPERATING CONDITIONS

VIN1,2	0.8V to 5.5V
VBIAS	2.5V to 5.5V (VBIAS ≧ VIN)
VON1,2	0V to 5.5V
VOUT1,2	VIN1,2
CIN1,2	≧0.1uF
Junction Temperature (T_J)	125°C
Operating Temperature Range	-40°C to 85°C
Power Dissipation (P_D) @T_A=25°C	1.53W

ELECTRICAL SPECIFICATIONS

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

PARAMETER	SYM	TEST CONDITION	MIN	TYP	MAX	UNIT
Quiescent Current	I_{BIAS}	VIN1=VIN2=VON1=VON2=5V IOUT1=IOUT2=0A		130	170	uA
Shutdown Current	I_{SD}	VON1=VON2=GND, VOUT1=VOUT2=0			1	uA
ON Resistance (each switch)	R_{ON}	VINx=5V, VBIAS=5V, IOUTx=-200mA, T_A=25°C		20	25	mΩ
		VINx=3.3V, VBIAS=5V, IOUTx=-200mA, T_A=25°C		20	25	mΩ
		VINx=1.8V, VBIAS=5V, IOUTx=-200mA, T_A=25°C		20	25	mΩ
		VINx=1.5V, VBIAS=5V, IOUTx=-200mA, T_A=25°C		20	25	mΩ
		VINx=1.2V, VBIAS=5V, IOUTx=-200mA, T_A=25°C		20	25	mΩ
		VINx=0.8V, VBIAS=5V, IOUTx=-200mA, T_A=25°C		20	25	mΩ
Output Pull Down Resistance	R_{OPD}	VBIAS=5V, VONx=0V		250	350	Ω
ONx Input Leakage Current	I_{ON}	VONx=5V or GND			1	uA
ONx Logic High	V_{IH}	VBIAS= 2.5V to 5.5V	1			V
ONx Logic Low	V_{IL}	VBIAS= 2.5V to 5.5V			0.4	V

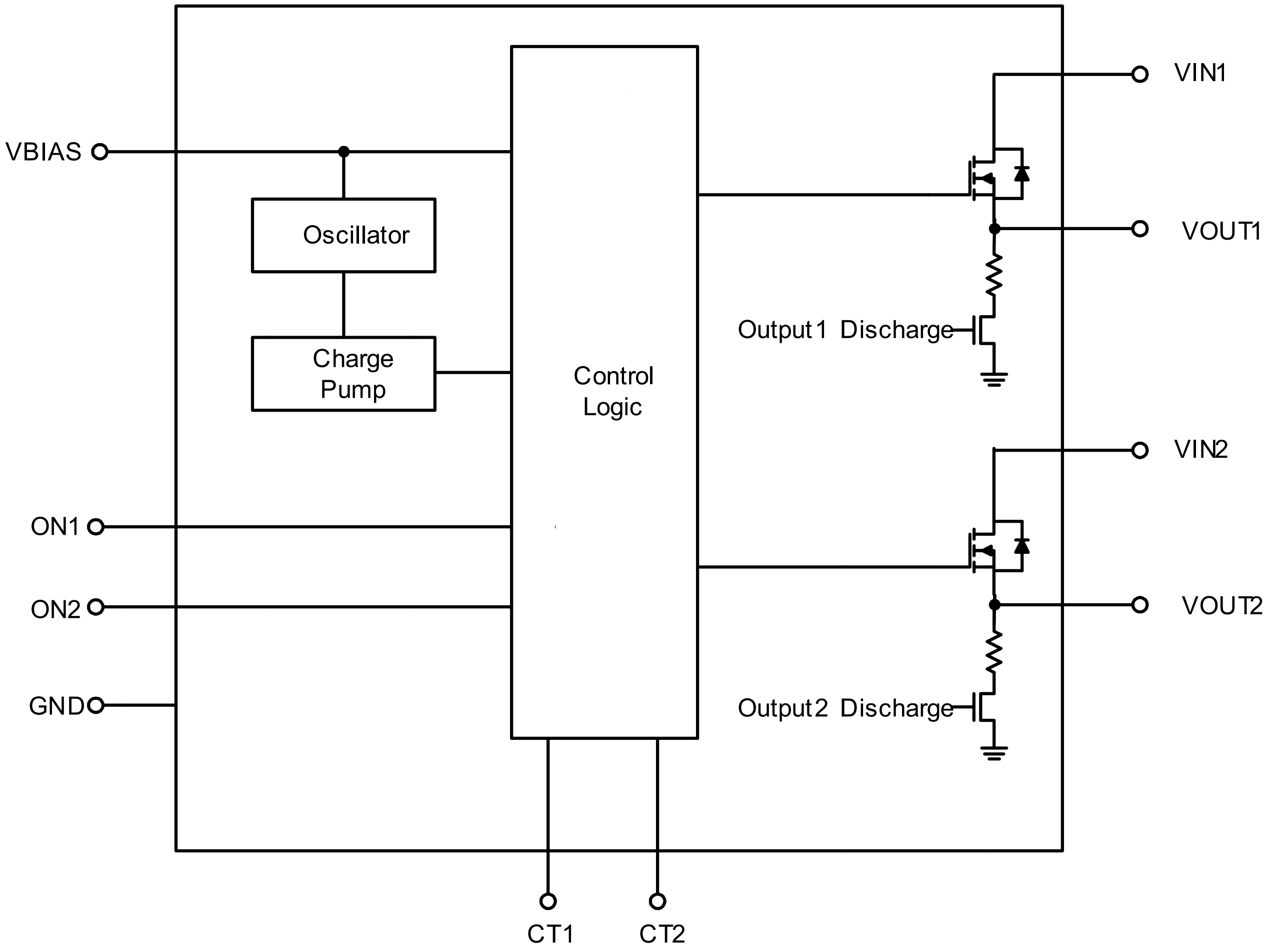
SWITCHING CHARACTERISTICS

PARAMETER	SYM	TEST CONDITION	MIN	TYP	MAX	UNIT
$V_{IN}=V_{ON}=V_{BIAS}=5V$, $T_A=25^oC$ (unless otherwise noted)						
Turn on Time	t_{ON}	$R_L=10\Omega$, $C_L=0.1uF$, $C_T=1000pF$		1400		us
Turn off Time	t_{OFF}	$R_L=10\Omega$, $C_L=0.1uF$, $C_T=1000pF$		1		us
V_{OUT} Rise Time	t_R	$R_L=10\Omega$, $C_L=0.1uF$, $C_T=1000pF$		1700		us
V_{OUT} Fall Time	t_F	$R_L=10\Omega$, $C_L=0.1uF$, $C_T=1000pF$		1.7		us
ON Delay Time	t_D	$R_L=10\Omega$, $C_L=0.1uF$, $C_T=1000pF$		300		us
$V_{IN}=0.8V$, $V_{ON}=V_{BIAS}=5V$, $T_A=25^oC$ (unless otherwise noted)						
Turn on Time	t_{ON}	$R_L=10\Omega$, $C_L=0.1uF$, $C_T=1000pF$		500		us
Turn off Time	t_{OFF}	$R_L=10\Omega$, $C_L=0.1uF$, $C_T=1000pF$		1		us
V_{OUT} Rise Time	t_R	$R_L=10\Omega$, $C_L=0.1uF$, $C_T=1000pF$		320		us
V_{OUT} Fall Time	t_F	$R_L=10\Omega$, $C_L=0.1uF$, $C_T=1000pF$		1.5		us
ON Delay Time	t_D	$R_L=10\Omega$, $C_L=0.1uF$, $C_T=1000pF$		250		us
$V_{IN}=V_{BIAS}=3.3V$, $V_{ON}=5V$, $T_A=25^oC$ (unless otherwise noted)						
Turn on Time	t_{ON}	$R_L=10\Omega$, $C_L=0.1uF$, $C_T=1000pF$		1200		us
Turn off Time	t_{OFF}	$R_L=10\Omega$, $C_L=0.1uF$, $C_T=1000pF$		1.3		us
V_{OUT} Rise Time	t_R	$R_L=10\Omega$, $C_L=0.1uF$, $C_T=1000pF$		1330		us
V_{OUT} Fall Time	t_F	$R_L=10\Omega$, $C_L=0.1uF$, $C_T=1000pF$		1.8		us
ON Delay Time	t_D	$R_L=10\Omega$, $C_L=0.1uF$, $C_T=1000pF$		300		us
$V_{IN}=0.8V$, $V_{BIAS}=3.3V$, $V_{ON}=5V$, $T_A=25^oC$ (unless otherwise noted)						
Turn on Time	t_{ON}	$R_L=10\Omega$, $C_L=0.1uF$, $C_T=1000pF$		600		us
Turn off Time	t_{OFF}	$R_L=10\Omega$, $C_L=0.1uF$, $C_T=1000pF$		1.4		us
V_{OUT} Rise Time	t_R	$R_L=10\Omega$, $C_L=0.1uF$, $C_T=1000pF$		360		us
V_{OUT} Fall Time	t_F	$R_L=10\Omega$, $C_L=0.1uF$, $C_T=1000pF$		1.6		us
ON Delay Time	t_D	$R_L=10\Omega$, $C_L=0.1uF$, $C_T=1000pF$		330		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, I_{OUTX}=0A, CTx=1nF, C_{INX}=1μF, C_{OUTX}=0.1μF,

ch1:ONx, ch2:VOUT1, ch3: VOUT2

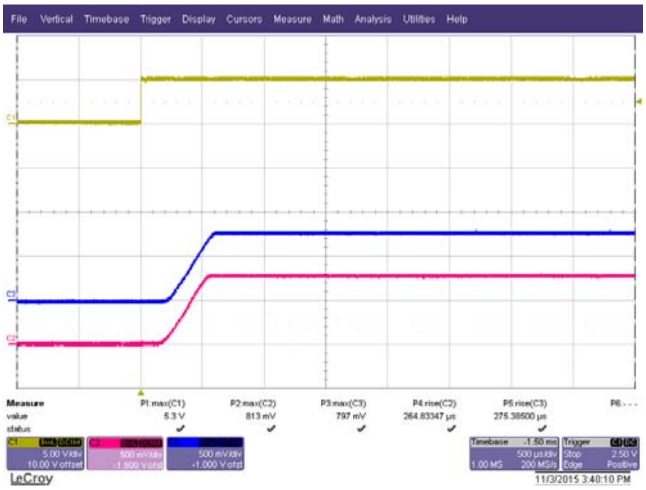


Fig.1 Turn-on Response, VINx=0.8V

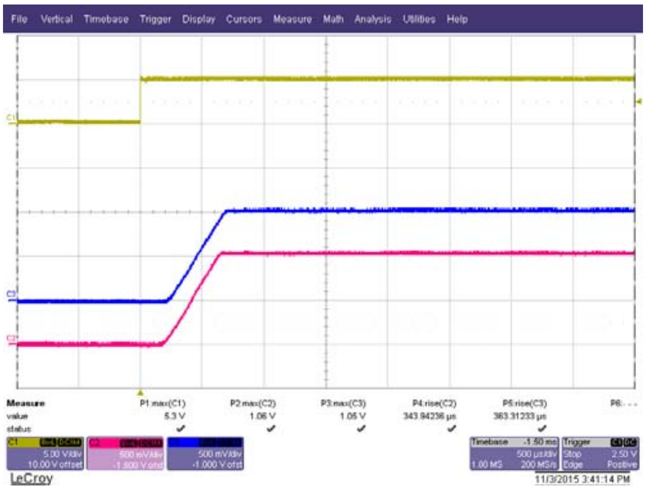


Fig.2 Turn-on Response, VINx=1.05V

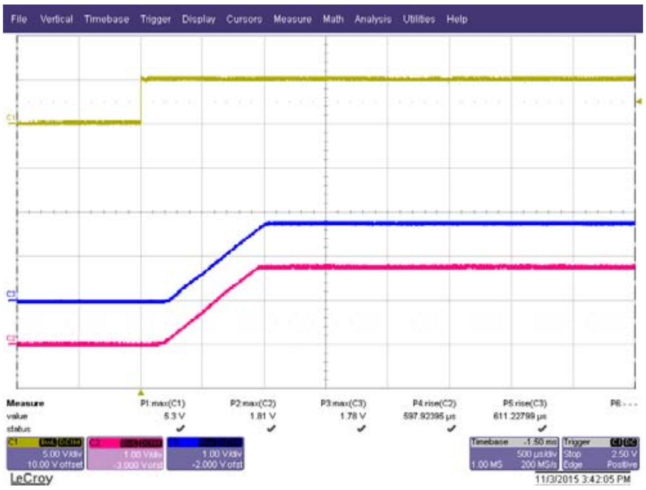


Fig.3 Turn-on Response, VINx=1.8V

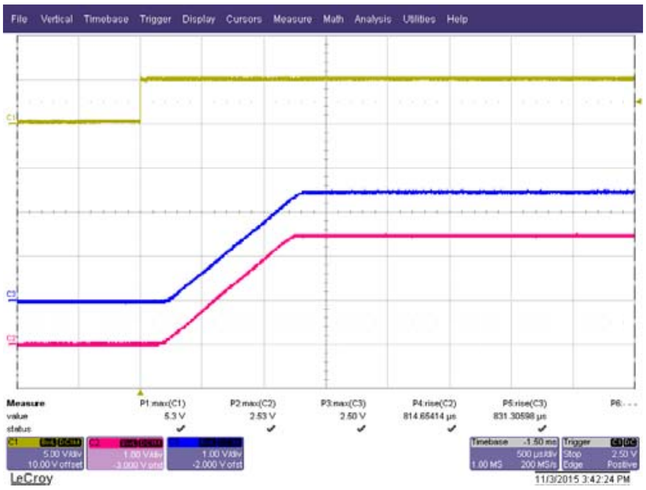


Fig.4 Turn-on Response, VINx=2.5V

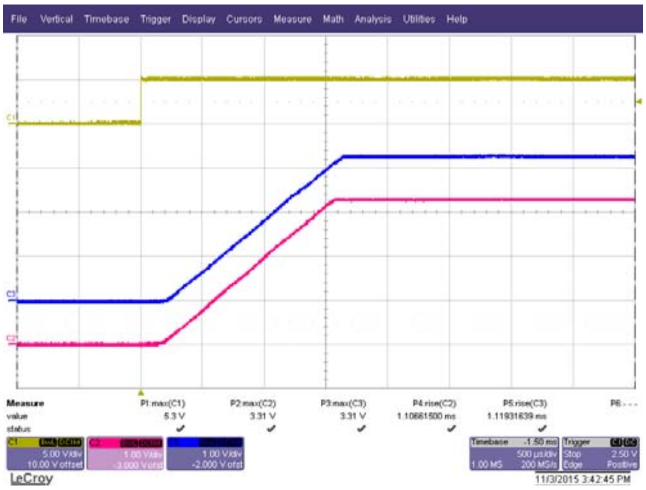


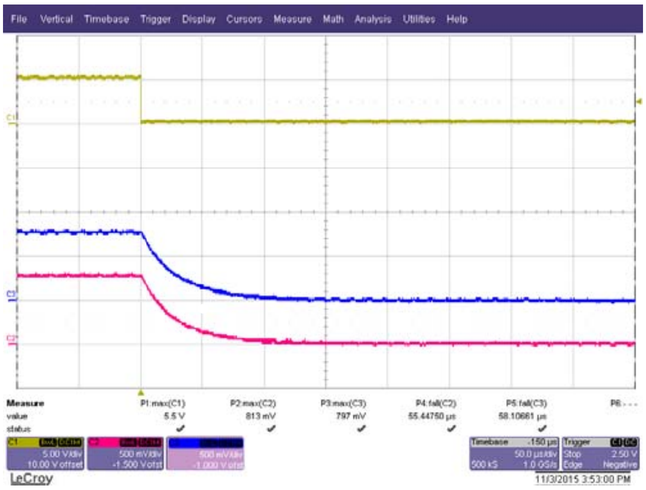
Fig.5 Turn-on Response, VINx=3.3V

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

TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

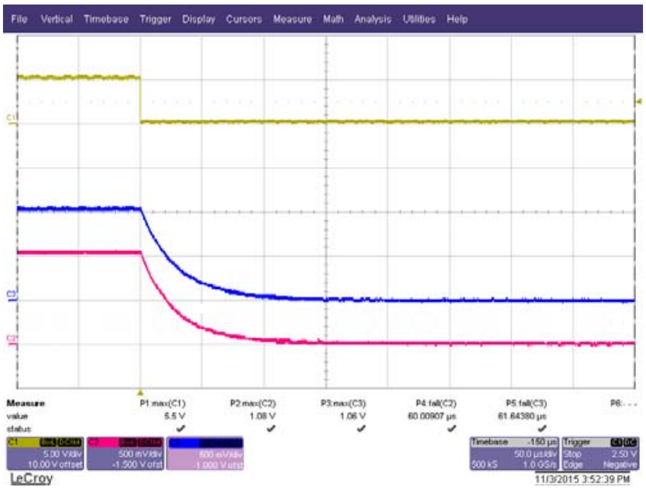
VBIAS=5V, VIN1=VIN2, ON1=ON2, I_{OUTX}=0A, CTx=1nF, C_{INX}=1μF, C_{OUTX}=0.1μF,

ch1:ONx, ch2:VOUT1, ch3: VOUT2



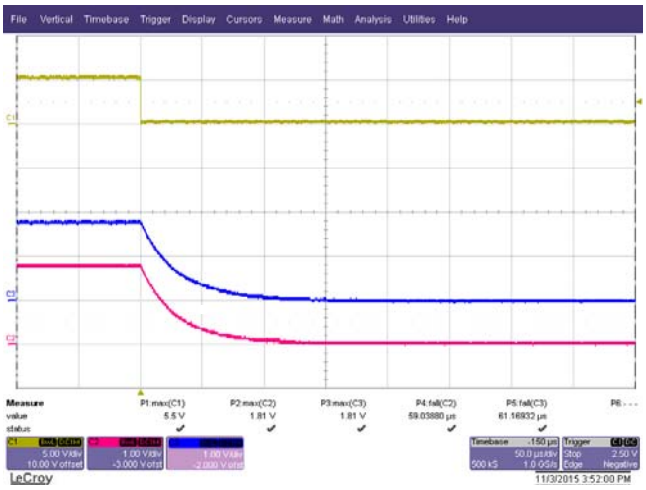
Measure	P1:max(C1)	P2:max(C2)	P3:max(C3)	P4:fall(C2)	P5:fall(C3)	P6:- - -
value	5.5 V	813 mV	797 mV	55.44750 μs	58.10661 μs	
status	✓	✓	✓	✓	✓	

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



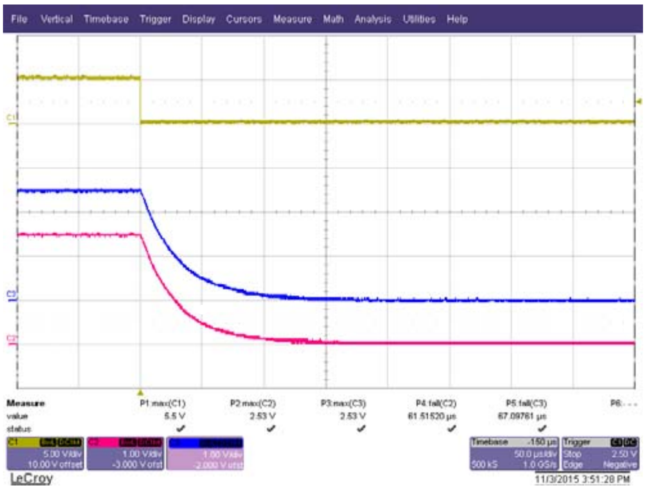
Measure	P1:max(C1)	P2:max(C2)	P3:max(C3)	P4:fall(C2)	P5:fall(C3)	P6:- - -
value	5.5 V	1.08 V	1.06 V	60.00907 μs	61.64380 μs	
status	✓	✓	✓	✓	✓	

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



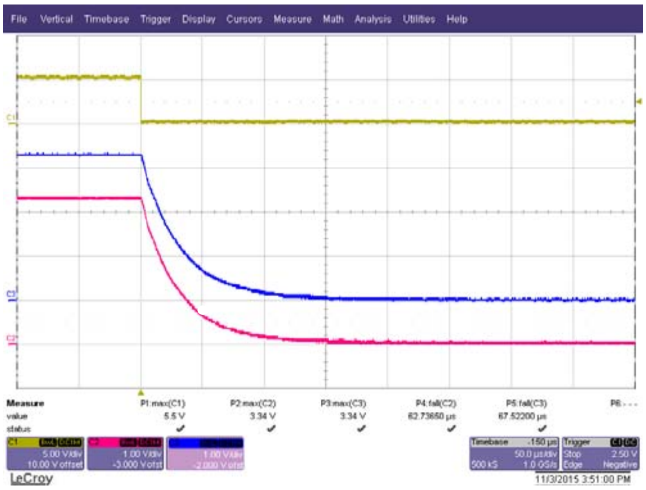
Measure	P1:max(C1)	P2:max(C2)	P3:max(C3)	P4:fall(C2)	P5:fall(C3)	P6:- - -
value	5.5 V	1.81 V	1.81 V	59.03880 μs	61.16932 μs	
status	✓	✓	✓	✓	✓	

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



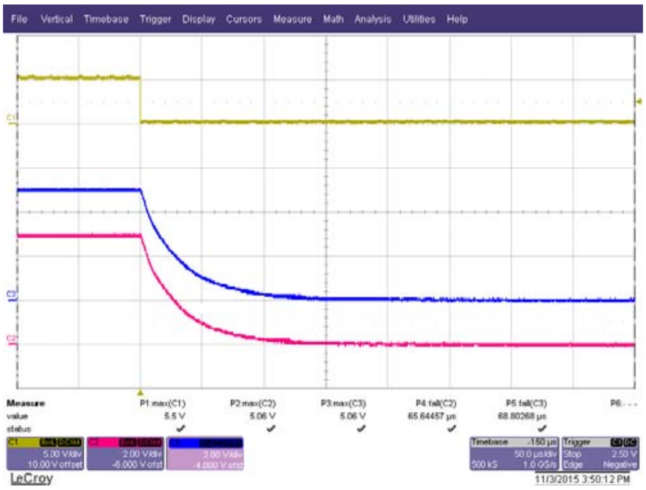
Measure	P1:max(C1)	P2:max(C2)	P3:max(C3)	P4:fall(C2)	P5:fall(C3)	P6:- - -
value	5.5 V	2.53 V	2.53 V	61.51520 μs	67.09761 μs	
status	✓	✓	✓	✓	✓	

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



Measure	P1:max(C1)	P2:max(C2)	P3:max(C3)	P4:fall(C2)	P5:fall(C3)	P6:- - -
value	5.5 V	3.34 V	3.34 V	62.73650 μs	67.52200 μs	
status	✓	✓	✓	✓	✓	

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



Measure	P1:max(C1)	P2:max(C2)	P3:max(C3)	P4:fall(C2)	P5:fall(C3)	P6:- - -
value	5.5 V	5.06 V	5.06 V	65.64457 μs	68.80268 μs	
status	✓	✓	✓	✓	✓	

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

TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

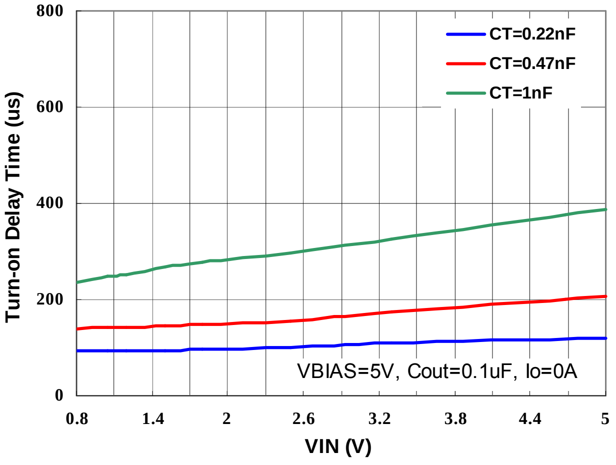


Fig.13 $t_{D\text{-}ON}$ vs. VIN

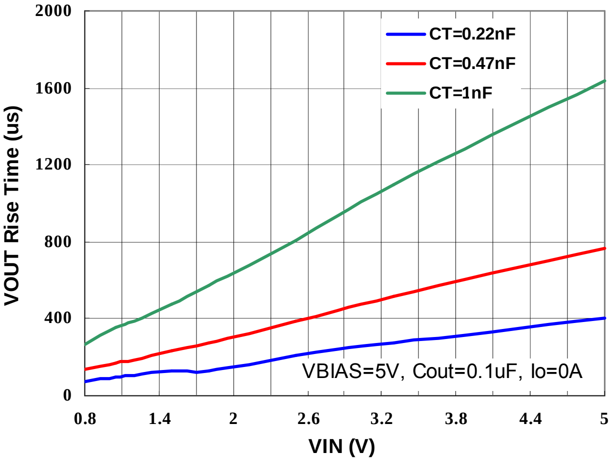


Fig.14 t_R vs. VIN

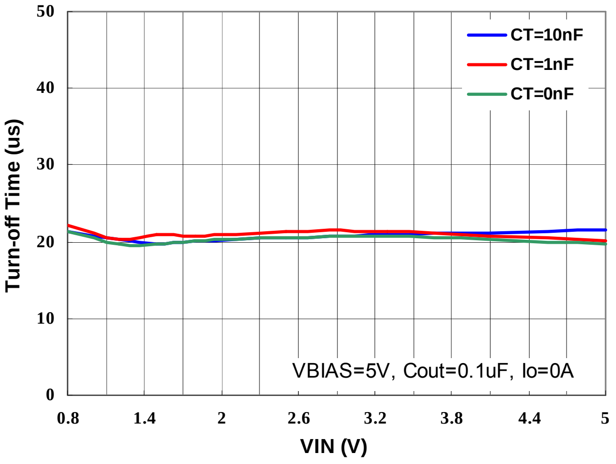


Fig.15 t_{OFF} vs. VIN

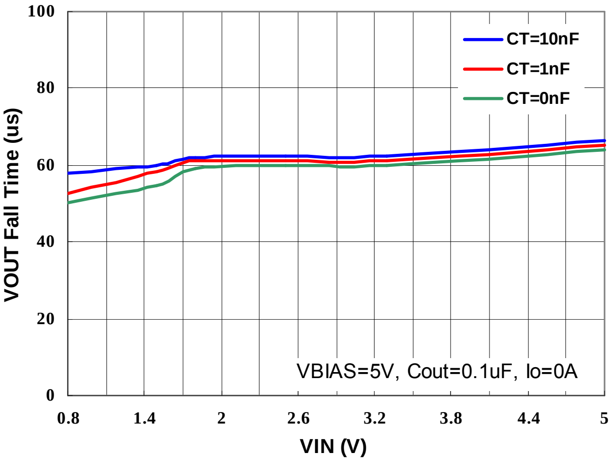


Fig.16 t_F vs. VIN

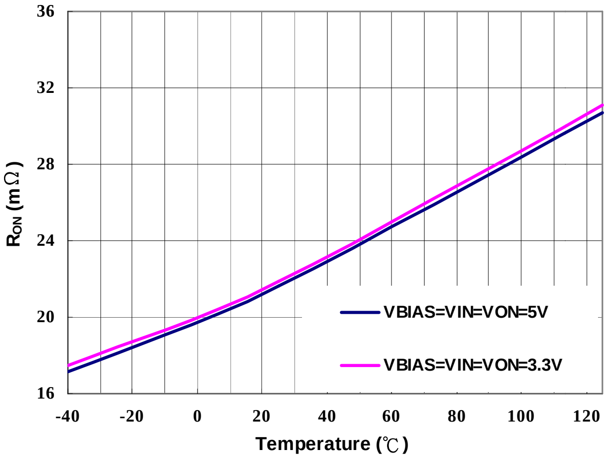


Fig.17 R_{ON} vs. Temperature

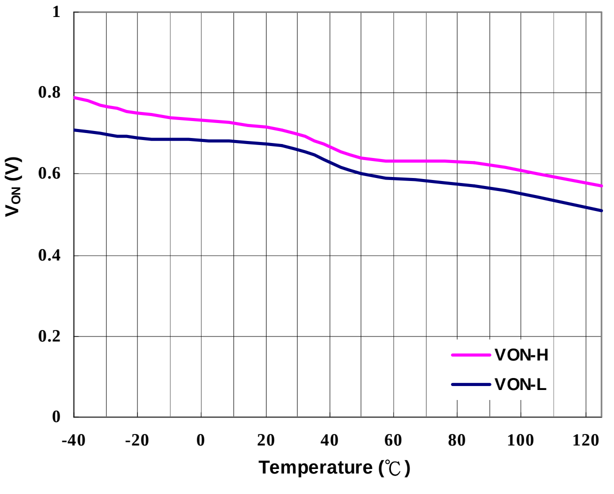


Fig.18 ON Threshold vs. Temperature

TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

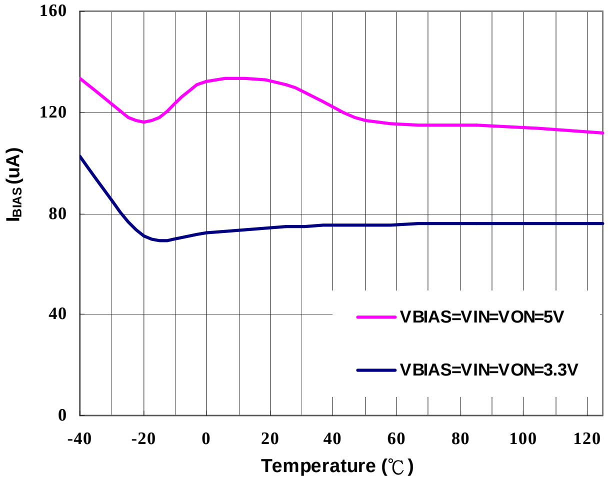


Fig.19 Quiescent Current (VBIAS) vs. Temperature

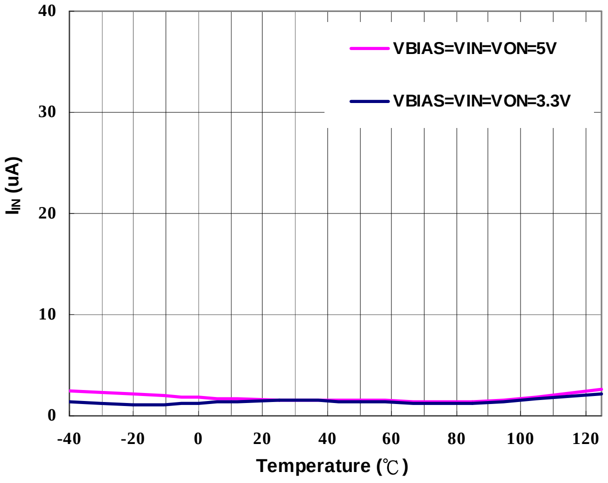


Fig.20 Quiescent Current (VIN) vs. Temperature

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_D: VOUT Turn On Delay Time

ton: VOUT Turn On Time

t_R: VOUT Rise Time

t_{OFF}: VOUT Turn Off Time

t_F: VOUT Fall Time

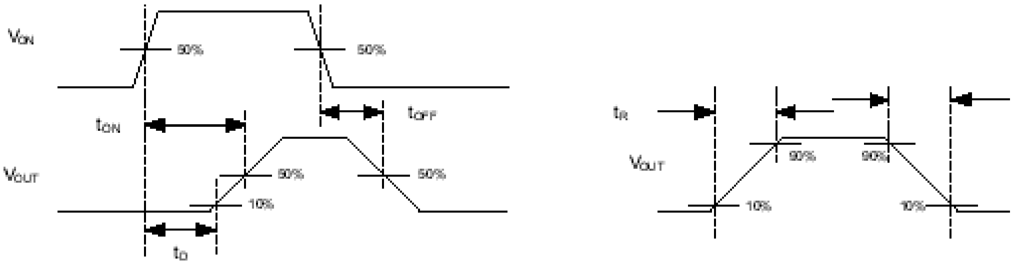


Fig.21 ON/OFF Waveform

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_R (μs),10%~90%, C_{OUT}=0.1μF,C_{IN}=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	21	26	28	32	36	42	50	66
0.22	76	99	114	140	165	225	300	445
0.47	128	173	193	240	285	390	515	776
1	262	344	398	492	584	811	1104	1657
2.2	561	734	831	1084	1246	1757	2403	3631
4.7	1257	1607	1773	2252	2719	3828	5217	7912
10	2562	3372	3692	4672	5669	8045	10971	16612

<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 APS8922A. 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.

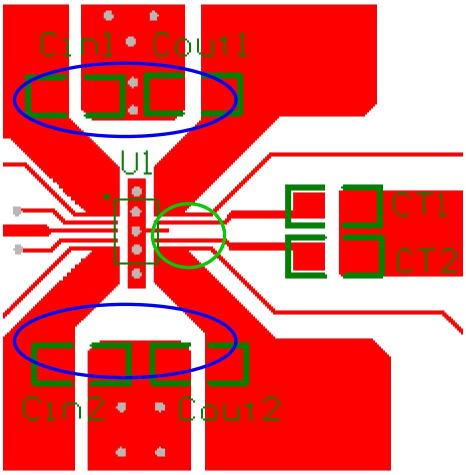


Fig.22 APS8922A Reference Layout

MARKING INFORMATION

DFN 3x2-14L