

# XL2803A SOP18

## 1 Features

- 500-mA-Rated Collector Current (Single Output)
- High-Voltage Outputs: 50 V
- Output Clamp Diodes
- Inputs Compatible With Various Types of Logic

## 2 Applications

- Relay Drivers
- Hammer Drivers
- Lamp Drivers
- Display Drivers (LED and Gas Discharge)
- Line Drivers
- Logic Buffers
- Stepper Motors
- IP Camera
- HVAC Valve and LED Dot Matrix

## 3 Description

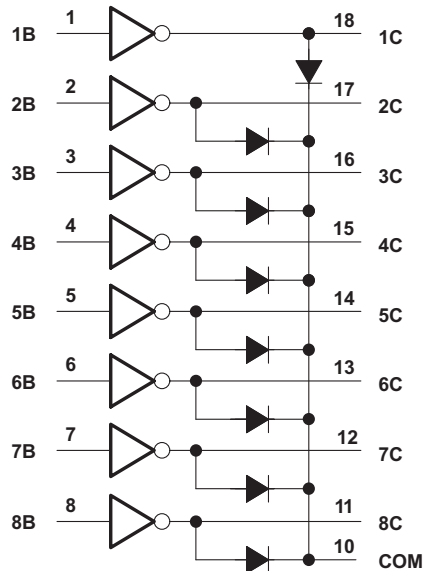
The XL2803A device is a 50 V, 500 mA Darlington transistor array. The device consists of eight NPN Darlington pairs that feature high-voltage outputs with common-cathode clamp diodes for switching inductive loads. The collector-current rating of each Darlington pair is 500 mA. The Darlington pairs may be connected in parallel for higher current capability.

Applications include relay drivers, hammer drivers, lamp drivers, display drivers (LED and gas discharge), line drivers, and logic buffers. The XL2803A device has a 2.7-kΩ series base resistor for each Darlington pair for operation directly with TTL or 5-V CMOS devices.

## 4 Device Information<sup>(1)</sup>

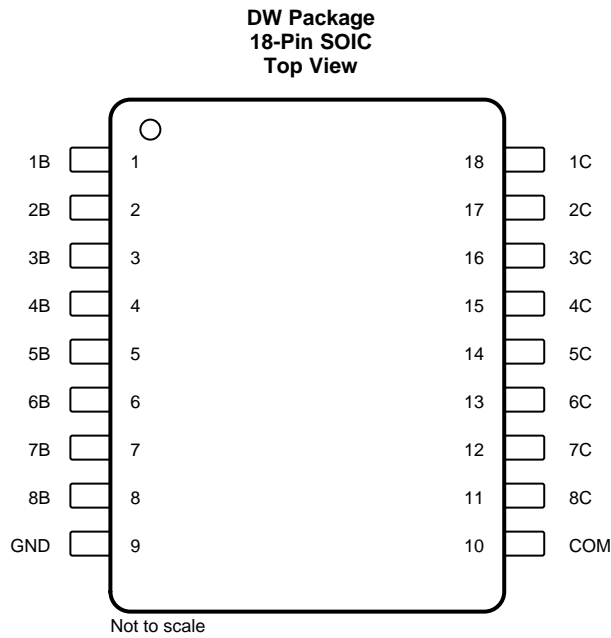
PART NUMBER	PACKAGE	BODY SIZE (NOM)
XL2803A	SOIC (18)	11.55 mm × 7.50 mm

Logic Diagram



# XL2803A SOP18

## 5 Pin Configuration and Functions



### Pin Functions

PIN		TYPE	DESCRIPTION
NAME	NO.		
1B	1	I	Channel 1 through 8 Darlington base input
2B	2		
3B	3		
4B	4		
5B	5		
6B	6		
7B	7		
8B	8		
1C	18	O	Channel 1 through 8 Darlington collector output
2C	17		
3C	16		
4C	15		
5C	14		
6C	13		
7C	12		
8C	11		
GND	9	—	Common emitter shared by all channels (typically tied to ground)
COM	10	I/O	Common cathode node for flyback diodes (required for inductive loads)

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## 6 Specifications

### 6.1 Absolute Maximum Ratings

at 25°C free-air temperature (unless otherwise noted)<sup>(1)</sup>

		MIN	MAX	UNIT
V <sub>CE</sub>	Collector-emitter voltage		50	V
V <sub>I</sub>	Input voltage <sup>(2)</sup>		30	V
	Peak collector current		500	mA
I(clamp)	Output clamp current		500	mA
	Total substrate-terminal current		-2.5	A
T <sub>J</sub>	Junction temperature	-65	150	°C
T <sub>stg</sub>	Storage temperature	-65	150	°C

- (1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- (2) All voltage values, unless otherwise noted, are with respect to the emitter/substrate terminal GND.

### 6.2 ESD Ratings

		VALUE	UNIT
V <sub>(ESD)</sub>	Electrostatic discharge	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001 <sup>(1)</sup>	V
		Charged device model (CDM), per JEDEC specification JESD22-C101 <sup>(2)</sup>	

- (1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
- (2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

### 6.3 Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted)

		MIN	MAX	UNIT
V <sub>CE</sub>	Collector-emitter voltage	0	50	V
T <sub>A</sub>	Ambient temperature	-40	85	°C

### 6.4 Thermal Information

THERMAL METRIC <sup>(1)</sup>		XL2803A	UNIT
		DW (SOIC)	
		18 PINS	
R <sub>θJA</sub>	Junction-to-ambient thermal resistance	66.4	°C/W
R <sub>θJC(top)</sub>	Junction-to-case (top) thermal resistance	29.5	°C/W
R <sub>θJB</sub>	Junction-to-board thermal resistance	33.0	°C/W
ψ <sub>JT</sub>	Junction-to-top characterization parameter	6.0	°C/W
ψ <sub>JB</sub>	Junction-to-board characterization parameter	32.5	°C/W
R <sub>θJC(bot)</sub>	Junction-to-case (bottom) thermal resistance	N/A	°C/W

- (1) For more information about traditional and new thermal metrics, see the *Semiconductor and IC Package Thermal Metrics* application report.

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## 6.5 Electrical Characteristics

at  $T_A = 25^\circ\text{C}$  free-air temperature (unless otherwise noted)

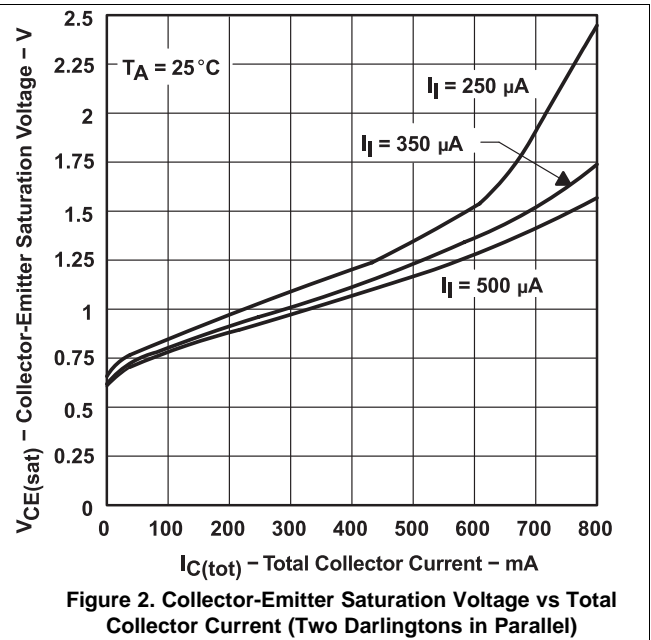
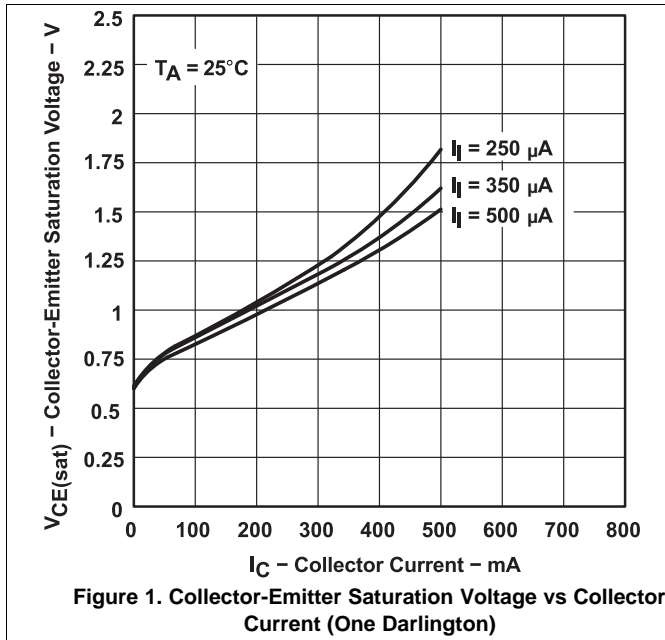
PARAMETER	TEST CONDITIONS	XL2803A			UNIT
		MIN	TYP	MAX	
$I_{CEX}$ Collector cutoff current	$V_{CE} = 50\text{ V}$ , see Figure 3 $I_I = 0$			50	$\mu\text{A}$
$I_{I(off)}$ Off-state input current	$V_{CE} = 50\text{ V}$ , $T_A = 70^\circ\text{C}$ $I_C = 500\ \mu\text{A}$ , see Figure 4	50	65		$\mu\text{A}$
$I_{I(on)}$ Input current	$V_I = 3.85\text{ V}$ , See Figure 5		0.93	1.35	mA
$V_{I(on)}$ On-state input voltage	$V_{CE} = 2\text{ V}$ , see Figure 6			$I_C = 200\text{ mA}$	2.4
				$I_C = 250\text{ mA}$	2.7
				$I_C = 300\text{ mA}$	3
$V_{CE(sat)}$ Collector-emitter saturation voltage	$I_I = 250\ \mu\text{A}$ , see Figure 7	$I_C = 100\text{ mA}$	0.9	1.1	V
		$I_C = 200\text{ mA}$	1	1.3	
		$I_C = 350\text{ mA}$	1.3	1.6	
$I_R$ Clamp diode reverse current	$V_R = 50\text{ V}$ , see Figure 8			50	$\mu\text{A}$
$V_F$ Clamp diode forward voltage	$I_F = 350\text{ mA}$ see Figure 9		1.7	2	V
$C_i$ Input capacitance	$V_I = 0$ , $f = 1\text{ MHz}$		15	25	pF

## 6.6 Switching Characteristics

$T_A = 25^\circ\text{C}$

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
$t_{PLH}$ Propagation delay time, low- to high-level output	$V_S = 50\text{ V}$ , $C_L = 15\text{ pF}$ , $R_L = 163\ \Omega$ , See Figure 10		130		ns
$t_{PHL}$ Propagation delay time, high- to low-level output			20		
$V_{OH}$ High-level output voltage after switching	$V_S = 50\text{ V}$ , $I_O = 300\text{ mA}$ , see Figure 11	$V_S - 20$			mV

## 6.7 Typical Characteristics



## 7 Parameter Measurement Information

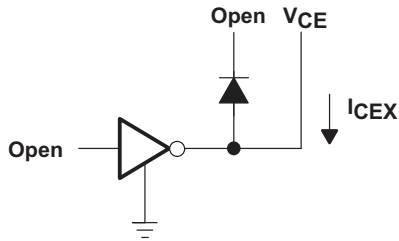


Figure 3.  $I_{CEX}$  Test Circuit

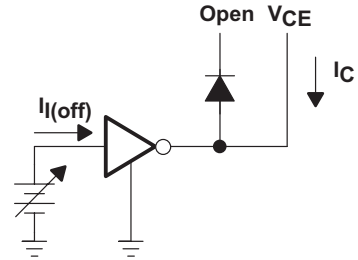


Figure 4.  $I_{I(off)}$  Test Circuit

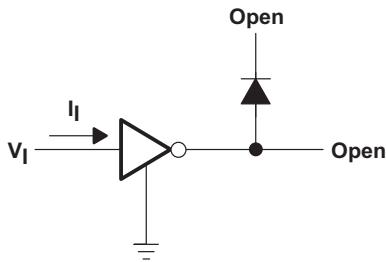


Figure 5.  $I_{I(on)}$  Test Circuit

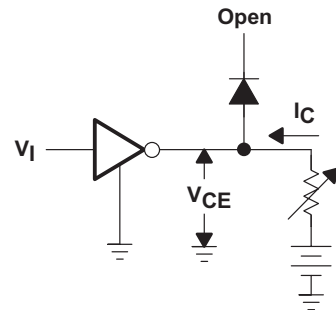


Figure 6.  $V_{I(on)}$  Test Circuit

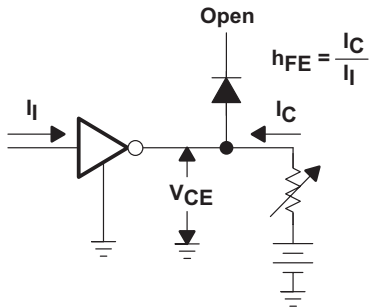


Figure 7.  $h_{FE}$ ,  $V_{CE(sat)}$  Test Circuit

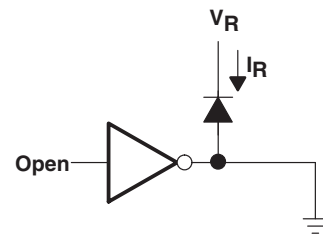


Figure 8.  $I_R$  Test Circuit

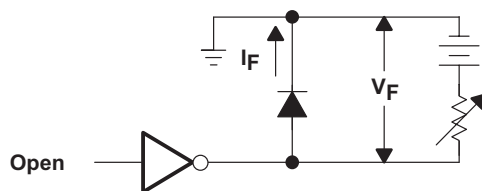
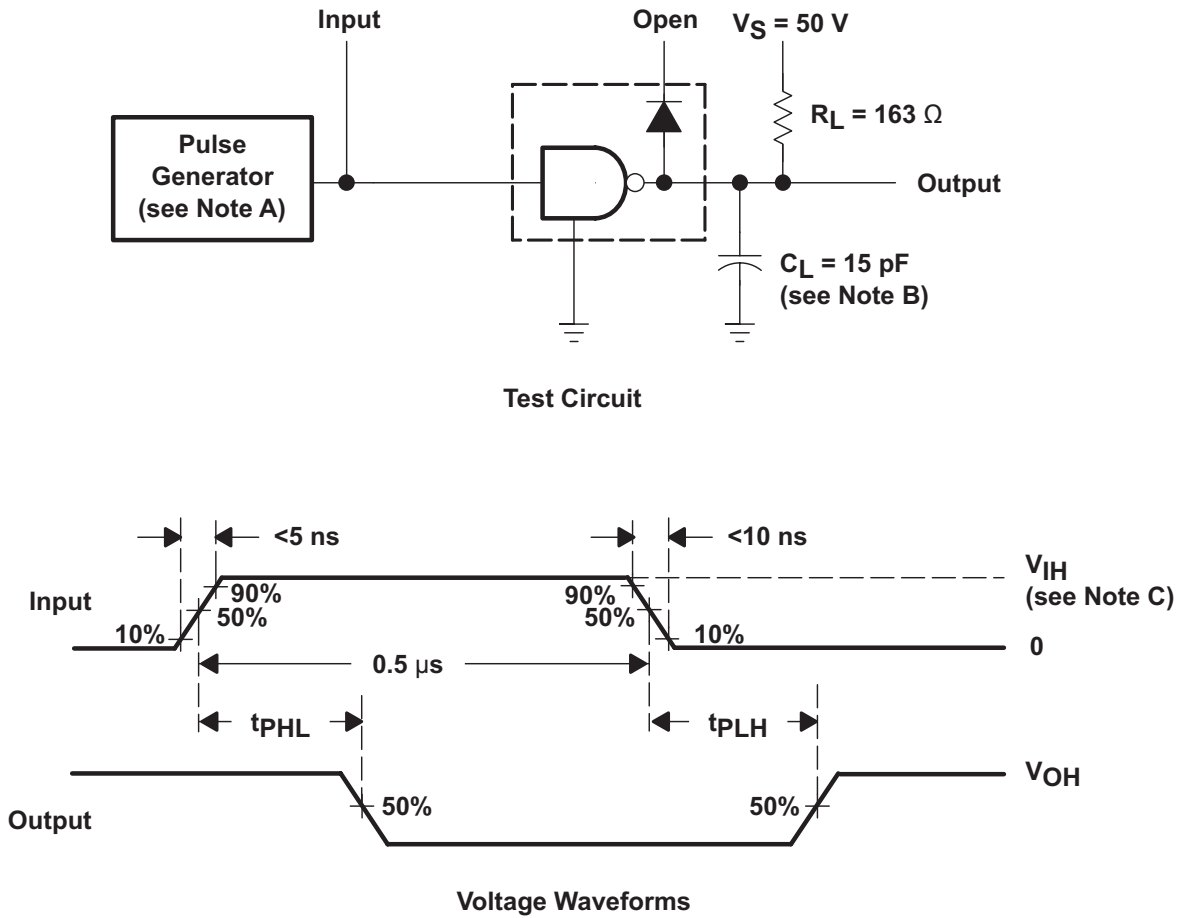


Figure 9.  $V_F$  Test Circuit

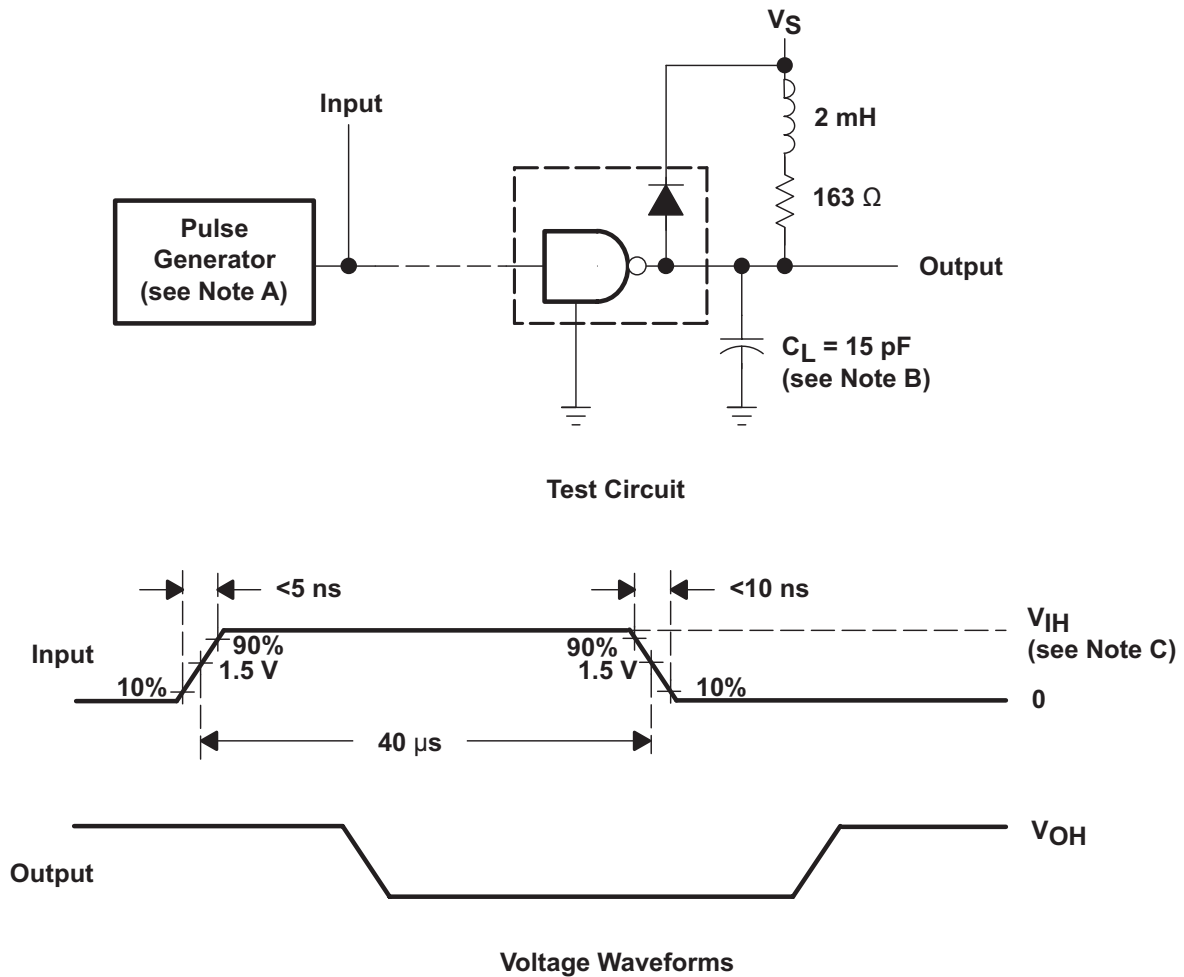
## Parameter Measurement Information (continued)



- A. The pulse generator has the following characteristics:  $\text{PRR} = 12.5 \text{ kHz}$ ,  $Z_O = 50 \Omega$ .
- B.  $C_L$  includes probe and jig capacitance.
- C.  $V_{IH} = 3 \text{ V}$

**Figure 10. Propagation Delay Times**

## Parameter Measurement Information (continued)



- A. The pulse generator has the following characteristics: PRR = 12.5 kHz,  $Z_O = 50 \Omega$ .
- B.  $C_L$  includes probe and jig capacitance.
- C.  $V_{IH} = 3$  V

**Figure 11. Latch-Up Test**

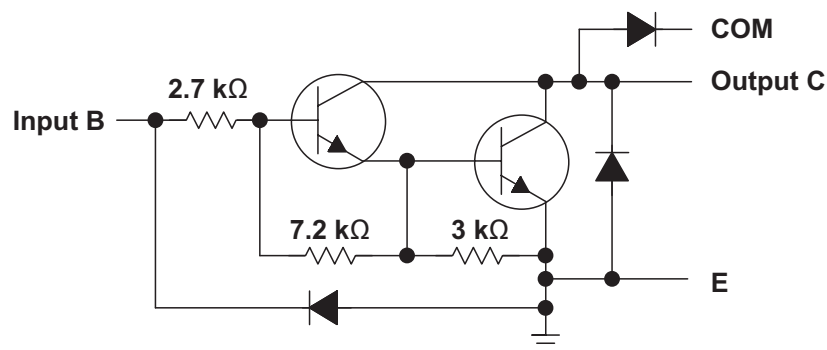
## 8 Detailed Description

### 8.1 Overview

This standard device has proven ubiquity and versatility across a wide range of applications. This is due to its integration of 8 Darlington transistors that are capable of sinking up to 500 mA and wide GPIO range capability.

The XL2803A is comprised of eight high voltage, high current NPN Darlington transistor pairs. All units feature a common emitter and open collector outputs. To maximize their effectiveness, these units contain suppression diodes for inductive loads. The XL2803A has a series base resistor to each Darlington pair, thus allowing operation directly with TTL or CMOS operating at supply voltages of 5 V or 3.3 V. The XL2803A offers solutions to a great many interface needs, including solenoids, relays, lamps, small motors, and LEDs. Applications requiring sink currents beyond the capability of a single output may be accommodated by paralleling the outputs.

### 8.2 Functional Block Diagram



### 8.3 Feature Description

Each channel of XL2803A consists of Darlington connected NPN transistors. This connection creates the effect of a single transistor with a very-high current gain. The very high  $\beta$  allows for high output current drive with a very-low input current, essentially equating to operation with low GPIO voltages.

The GPIO voltage is converted to base current through the 2.7-k $\Omega$  resistor connected between the input and base of the predriver Darlington NPN.

The diodes connected between the output and COM pin are used to suppress the kick-back voltage from an inductive load that is excited when the NPN drivers are turned off (stop sinking) and the stored energy in the coils causes a reverse current to flow into the coil supply through the kick-back diode.

In normal operation, the diodes on base and collector pins to emitter will be reverse biased. If these diodes are forward biased, internal parasitic NPN transistors will draw (a nearly equal) current from other (nearby) device pins.

### 8.4 Device Functional Modes

#### 8.4.1 Inductive Load Drive

When the COM pin is tied to the coil supply voltage, XL2803A is able to drive inductive loads and suppress the kick-back voltage through the internal free wheeling diodes.

#### 8.4.2 Resistive Load Drive

When driving resistive loads, COM can be left unconnected or connected to the load voltage supply. If multiple supplies are used, connect to the highest voltage supply.



## 9 Application and Implementation

### 9.1 Application Information

XL2803A will typically be used to drive a high voltage and/or current peripheral from an MCU or logic device that cannot tolerate these conditions. The following design is a common application of XL2803A, driving inductive loads. This includes motors, solenoids, and relays. Each load type can be modeled by what is seen in Figure 12.

### 9.2 Typical Application

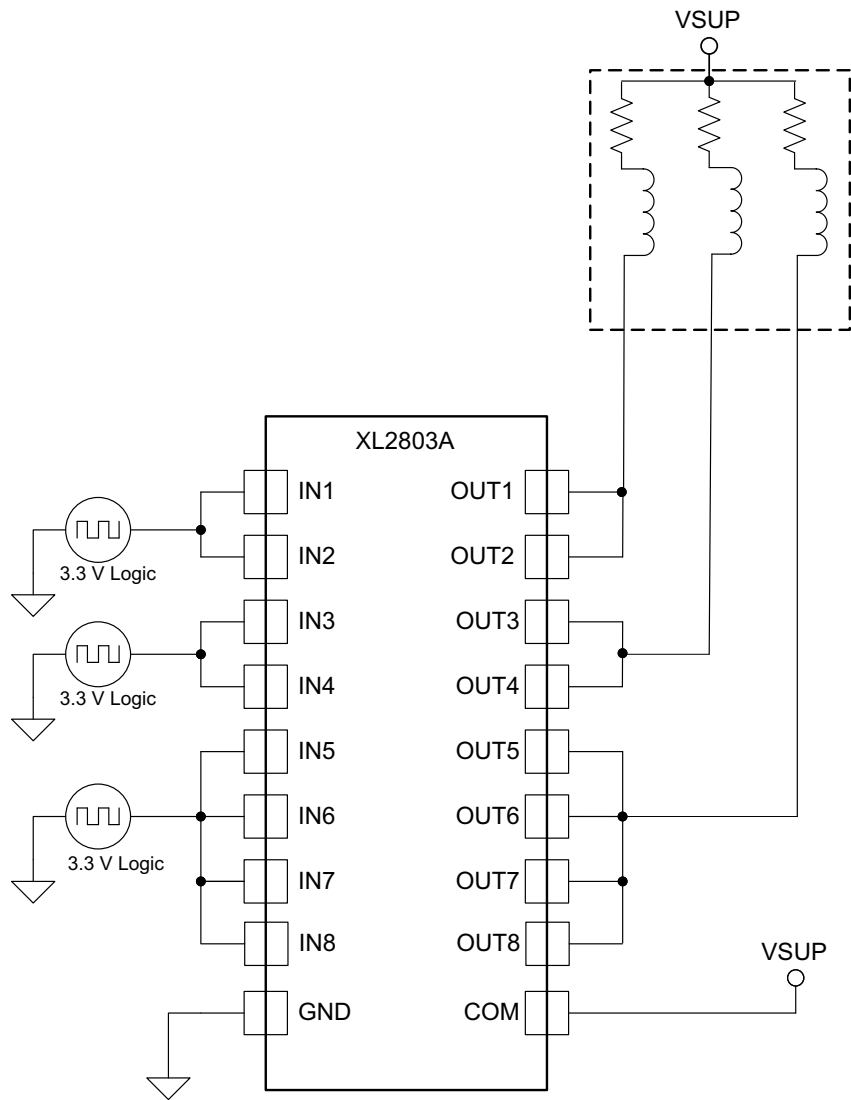


Figure 12. XL2803A as Inductive Load Driver

## Typical Application (continued)

### 9.2.1 Design Requirements

For this design example, use the parameters listed in Table 1 as the input parameters.

**Table 1. Design Parameters**

DESIGN PARAMETER	EXAMPLE VALUE
GPIO voltage	3.3 or 5 V
Coil supply voltage	12 to 50 V
Number of channels	8
Output current ( $R_{COIL}$ )	20 to 300 mA per channel
Duty cycle	100%

### 9.2.2 Detailed Design Procedure

When using XL2803A in a coil driving application, determine the following:

- Input voltage range
- Temperature range
- Output and drive current
- Power dissipation

#### 9.2.2.1 Drive Current

The coil current is determined by the coil voltage ( $V_{SUP}$ ), coil resistance, and output low voltage ( $V_{OL}$  or  $V_{CE(SAT)}$ ).

$$I_{COIL} = (V_{SUP} - V_{CE(SAT)}) / R_{COIL} \quad (1)$$

#### 9.2.2.2 Output Low Voltage

The output low voltage ( $V_{OL}$ ) is the same thing as  $V_{CE(SAT)}$  and can be determined by Figure 1, Figure 2, or *Electrical Characteristics*.

#### 9.2.2.3 Power Dissipation and Temperature

The number of coils driven is dependent on the coil current and on-chip power dissipation. To determine the number of coils possible, use Equation 2 to calculate XL2803A on-chip power dissipation  $P_D$ .

$$P_D = \sum_{i=1}^N V_{OLi} \times I_{Li}$$

where

- $N$  is the number of channels active together.
- $V_{OLi}$  is the  $OUT_i$  pin voltage for the load current  $I_{Li}$ . This is the same as  $V_{CE(SAT)}$

To ensure the reliability of XL2803A and the system, the on-chip power dissipation must be lower than or equal to the maximum allowable power dissipation ( $P_D$ ) dictated by Equation 3.

$$PD_{(MAX)} = \frac{(T_{J(MAX)} - T_A)}{\theta_{JA}}$$

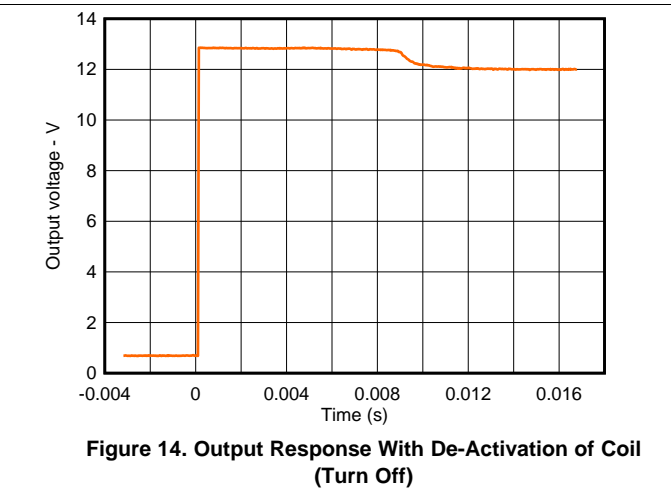
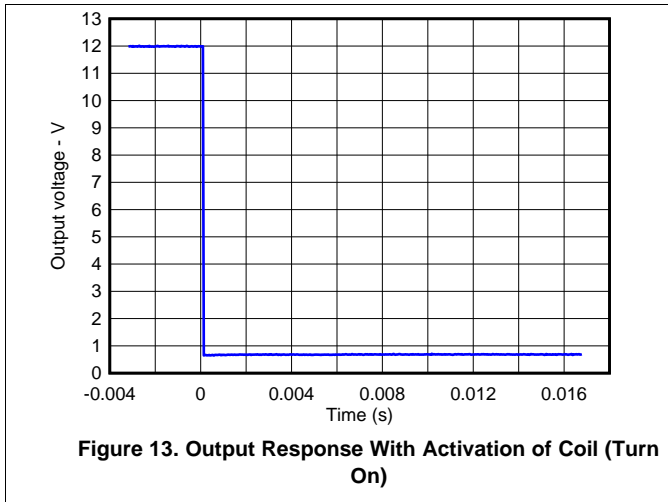
where

- $T_{J(MAX)}$  is the target maximum junction temperature.
- $T_A$  is the operating ambient temperature.
- $\theta_{JA}$  is the package junction to ambient thermal resistance.

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## 9.2.3 Application Curves

The following curves were generated with XL2803A driving an OMRON G5NB relay –  $V_{in} = 5.0\text{ V}$ ;  $V_{sup} = 12\text{ V}$  and  $R_{COIL} = 2.8\text{ k}\Omega$



## 10 Power Supply Recommendations

This part does not need a power supply; however, the COM pin is typically tied to the system power supply. When this is the case, make sure that the output voltage does not heavily exceed the COM pin voltage. This will heavily forward bias the flyback diodes and cause a large current to flow into COM, potentially damaging the on-chip metal or overheating the part.

## 11 Layout

### 11.1 Layout Guidelines

Thin traces can be used on the input due to the low current logic that is typically used to drive XL2803A. Take care to separate the input channels as much as possible, as to eliminate crosstalk. TI recommends thick traces for the output, in order to drive high currents as desired. Wire thickness can be determined by the trace material's current density and desired drive current.

Because all of the channels currents return to a common emitter, it is best to size that trace width to be very wide. Some applications require up to 2.5 A.

### 11.2 Layout Example

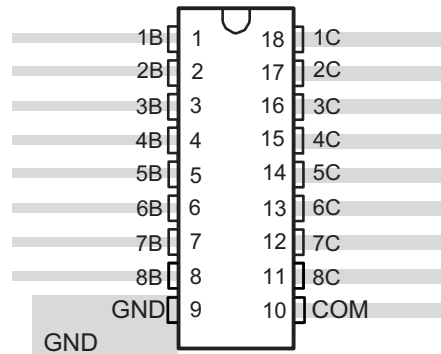


Figure 15. Package Layout



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