



# 16-Channel (Two Banks of 8-Channel), High-Voltage Analog Switches

MAX14805/MAX14806

## General Description

The MAX14805/MAX14806 provide high-voltage switching on 16 channels for ultrasonic imaging. Both devices are ideal for the following applications: banks selection in biplane or triplane ultrasound probes and relays replacement. The devices utilize 200V process technology to provide sixteen high-voltage, low-charge injection SPST switches, controlled by a digital interface.

The MAX14805/MAX14806's output switches are configured as two sets of eight SPST analog switches. The switches are controlled by two input logic controls, DIN1 and DIN2 (respectively for switch 0 to 7 and switch 8 to 15). The MAX14806 features integrated 40k $\Omega$  bleed resistors on each switch terminal, which help to reduce voltage buildup in capacitive loads such as piezoelectric elements.

The MAX14805/MAX14806 operate with a wide range of high-voltage supplies, including  $V_{PP}/V_{NN} = +100V/-100V$ ,  $+200V/0V$ , and  $+40V/-160V$ . The digital interface operates from a separate  $V_{DD}$  supply from +2.7V to +5.5V. Digital inputs DIN1, DIN2, and  $\overline{LE}$  operate on the  $V_{DD}$  supply voltage.

The MAX14805CCM+ is a drop-in replacement for the Supertex HV2631. The MAX14806CCM+ is a drop-in replacement for the Supertex HV2731. Both devices are available in the 48-pin, TQFP package and are specified for the extended -40°C to +85°C temperature range.

## Features

- ◆ HVCMOS Technology for High Performance
- ◆ Two Sets of 8-Channel SPST High-Voltage Analog Switches
- ◆ DC to 20MHz Low-Voltage Analog Signal Frequency Range
- ◆ +2.7V to +5.5V Logic Supply Voltage
- ◆ Ultra-Low (0.1 $\mu$ A) (typ) Quiescent Current
- ◆ Low-Charge Injection, Low-Capacitance 20 $\Omega$  Switches
- ◆ -77dB (typ) Off-Isolation at 5MHz (50 $\Omega$ )
- ◆ Flexible, High-Voltage Supplies ( $V_{PP} - V_{NN} = 230V$ )

## Applications

Medical Ultrasound Imaging  
Nondestructive Test (NDT)

## Ordering Information/Selector Guide

PART	SWITCH CHANNELS	BLEED RESISTOR	SECOND SOURCE	PIN-PACKAGE
MAX14805CCM+	2 x 8	No	HV2631	48 TQFP
MAX14806CCM+	2 x 8	Yes	HV2731	48 TQFP

**Note:** All devices are specified over the extended -40°C to +85°C operating temperature range.  
+Denotes a lead(Pb)-free/RoHS-compliant package.

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## ABSOLUTE MAXIMUM RATINGS

(All voltages referenced to GND.)

VDD Logic Supply Voltage	-0.3V to +7V	Junction-to-Ambient Thermal Resistance	
VPP - VNN Supply Voltage	230V	$\theta_{JA}$ (Note 1)	44°C/W
VPP Positive Supply Voltage	-0.3V to +220V	Junction-to-Case Thermal Resistance	
VNN Negative Supply Voltage	+0.3V to -220V	$\theta_{JC}$ (Note 1)	10°C/W
Logic Inputs Voltage ( $\overline{LE}$ , DIN1, DIN2)	-0.3V to +7V	Operating Temperature Range	-40°C to +85°C
Analog Signal Range (SW_)	(-0.3V + VNN) to (VNN + 200V)	Storage Temperature Range	-65°C to +150°C
Peak Analog Signal Current per Channel	3A	Junction Temperature	+150°C
Continuous Power Dissipation (TA = +70°C)		Lead Temperature (soldering, 10s)	+300°C
48-Pin TQFP (derate 22.7mW/°C above +70°C)	1818mW	Soldering Temperature (reflow)	+260°C

**Note 1:** Package thermal resistances were obtained using the method described in JEDEC specification JESD51-7, using a four-layer board. For detailed information on package thermal considerations, refer to [www.maxim-ic.com/thermal-tutorial](http://www.maxim-ic.com/thermal-tutorial).

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions 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.

## ELECTRICAL CHARACTERISTICS

(VDD = +2.7V to +5.5V, VPP = +40V to (VNN + 200V), VNN = -40V to -160V, TA = TMIN to TMAX, unless otherwise noted. Typical values are at TA = +25°C.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
<b>POWER SUPPLIES</b>						
VDD Supply Voltage	VDD		2.7		5.5	V
VPP Supply Voltage	VPP		40	100	VNN + 220	V
VNN Supply Voltage	VNN		-160	-100	-15	V
VDD Supply Quiescent Current	IDDDQ				5	μA
VDD Supply Dynamic Current	IDDD	VDD = +5V, $\overline{LE}$ = GND, fDIN1 = fDIN2 = 5MHz			2	mA
VPP Supply Quiescent Current	I PPQ				10	μA
VPP Supply Dynamic Current (All Channel Switching Simultaneously)	I PPD	VPP = +40V, VNN = -160V, fSW_ = 50kHz, fDIN1 = fDIN2 = 50kHz, $\overline{LE}$ = GND			5	mA
		VPP = +100V, VNN = -100V, fSW_ = 50kHz, fDIN1 = fDIN2 = 50kHz, $\overline{LE}$ = GND			6	
		VPP = +160V, VNN = -40V, fSW_ = 50kHz, fDIN1 = fDIN2 = 50kHz, $\overline{LE}$ = GND			7	
VNN Supply Quiescent Current	I NNQ				10	μA
VNN Supply Dynamic Current (All Channel Switching Simultaneously)	I NND	VPP = +40V, VNN = -160V, fSW_ = 50kHz, fDIN1 = fDIN2 = 50kHz, $\overline{LE}$ = GND			5.5	mA
		VPP = +100V, VNN = -100V, fSW_ = 50kHz, fDIN1 = fDIN2 = 50kHz, $\overline{LE}$ = GND			5	
		VPP = +160V, VNN = -40V, fSW_ = 50kHz, fDIN1 = fDIN2 = 50kHz, $\overline{LE}$ = GND			4.5	

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## ELECTRICAL CHARACTERISTICS (continued)

(V<sub>DD</sub> = +2.7V to +5.5V, V<sub>PP</sub> = +40V to (V<sub>NN</sub> + 200V), V<sub>NN</sub> = -40V to -160V, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise noted. Typical values are at T<sub>A</sub> = +25°C.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
<b>SWITCH CHARACTERISTICS</b>						
Analog Signal Range	V <sub>SW_</sub>	(Note 3)	V <sub>NN</sub>		V <sub>PP</sub> - 10	V
Small-Signal On-Resistance	R <sub>ONS</sub>	V <sub>PP</sub> = +40V, V <sub>NN</sub> = -160V, V <sub>SW_</sub> = 0V	I <sub>SW_</sub> = 5mA	28	52	Ω
			I <sub>SW_</sub> = 200mA	22	37	
		V <sub>PP</sub> = +100V, V <sub>NN</sub> = -100V, V <sub>SW_</sub> = 0V	I <sub>SW_</sub> = 5mA	22	34	
			I <sub>SW_</sub> = 200mA	18	27	
		V <sub>PP</sub> = +160V, V <sub>NN</sub> = -40V, V <sub>SW_</sub> = 0V	I <sub>SW_</sub> = 5mA	20	30	
			I <sub>SW_</sub> = 200mA	16	23	
Small-Signal On-Resistance Matching	ΔR <sub>ONS</sub>	V <sub>PP</sub> = +100V, V <sub>NN</sub> = -100V, I <sub>SW_</sub> = 5mA		5		%
Large-Signal Switch On-Resistance	R <sub>ONL</sub>	V <sub>SW_</sub> = V <sub>PP</sub> - 10V, I <sub>SW_</sub> = 1A		15		Ω
Shunt Resistance	R <sub>INT</sub>	MAX14806 only	27	40	53	kΩ
Switch-Off Leakage	I <sub>SW_(OFF)</sub>	V <sub>SW_</sub> = V <sub>PP</sub> - 10V or unconnected (MAX14805 only) (Figure 1)		0	2.5	μA
Switch-Off DC Offset		R <sub>L</sub> = 100kΩ (Figure 1)	-30		+30	mV
Switch Output Peak Current		100ns pulse width, 0.1% duty cycle		3		A
Switch Output Isolation Diode Current		300ns pulse width, 2% duty cycle (Figure 1)		2		A
<b>SWITCH DYNAMIC CHARACTERISTICS</b>						
Turn-On Time	t <sub>ON</sub>	V <sub>SW_</sub> = V <sub>PP</sub> - 10V, R <sub>L</sub> = 10kΩ, V <sub>NN</sub> = -40V to -160V (Figure 1)			5	μs
Turn-Off Time	t <sub>OFF</sub>	V <sub>SW_</sub> = V <sub>PP</sub> - 10V, R <sub>L</sub> = 10kΩ, V <sub>NN</sub> = -40V to -160V (Figure 1)			5	μs
Output Switching Frequency	f <sub>SW</sub>	Duty cycle = 50%			50	kHz
Off-Isolation	V <sub>ISO</sub>	f = 5MHz, R <sub>L</sub> = 1kΩ, C <sub>L</sub> = 15pF (Figure 1)		-50		dB
		f = 5MHz, R <sub>L</sub> = 50Ω (Figure 1)		-77		
Crosstalk	V <sub>CT</sub>	f = 5MHz, R <sub>L</sub> = 50Ω (Figure 1)		-80		dB
Switch Off-Capacitance (Note 4)	C <sub>SW_(OFF)</sub>	V <sub>SW_</sub> = 0V, f = 1MHz	4	11	18	pF
Switch On-Capacitance (Note 4)	C <sub>SW_(ON)</sub>	V <sub>SW_</sub> = 0V, f = 1MHz	20	36	56	pF
Output Voltage Spike (Note 4)	V <sub>SPK</sub>	R <sub>L</sub> = 50Ω (Figure 1)	-500		+250	mV
Small-Signal Analog Bandwidth	f <sub>BW</sub>	V <sub>PP</sub> = +100V, V <sub>NN</sub> = -100V, C <sub>L</sub> = 200pF		20		MHz

# 16-Channel (Two Banks of 8-Channel), High-Voltage Analog Switches

## ELECTRICAL CHARACTERISTICS (continued)

( $V_{DD} = +2.7V$  to  $+5.5V$ ,  $V_{PP} = +40V$  to  $(V_{NN} + 200V)$ ,  $V_{NN} = -40V$  to  $-160V$ ,  $T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise noted. Typical values are at  $T_A = +25^\circ C$ .) (Note 2)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Charge Injection	Q	$V_{PP} = +40V$ , $V_{NN} = -160V$ , $V_{SW\_} = 0V$ (Figure 1)		650		pC
		$V_{PP} = +100V$ , $V_{NN} = -100V$ , $V_{SW\_} = 0V$ (Figure 1)		450		
		$V_{PP} = +160V$ , $V_{NN} = -40V$ , $V_{SW\_} = 0V$ (Figure 1)		250		
<b>LOGIC LEVELS (DIN1, DIN2, <math>\overline{LE}</math>)</b>						
Logic-Input Low Voltage	$V_{IL}$				0.75	V
Logic-Input High Voltage	$V_{IH}$		$V_{DD} - 0.75$			V
Logic-Input Capacitance	$C_{IN}$				10	pF
Logic-Input Leakage Current	$I_{IN}$		-1		+1	$\mu A$
<b>LOGIC TIMING (See Timing Diagram, Figure 2)</b>						
Setup Time	$t_{SD}$		30			ns
Hold Time	$t_{HOLD}$				30	ns
Time Width of $\overline{LE}$	$t_{WLE}$		30			ns

**Note 2:** All devices are 100% tested at  $T_A = +85^\circ C$ . Limits over the operating temperature range are guaranteed by design and characterization.

**Note 3:** The analog signal input  $V_{SW\_}$  must satisfy  $V_{NN} \leq V_{SW\_} \leq V_{PP}$  or remain unconnected during power-up.

**Note 4:** Guaranteed by characterization; not production tested.

# 16-Channel (Two Banks of 8-Channel), High-Voltage Analog Switches

**MAX14805/MAX14806**

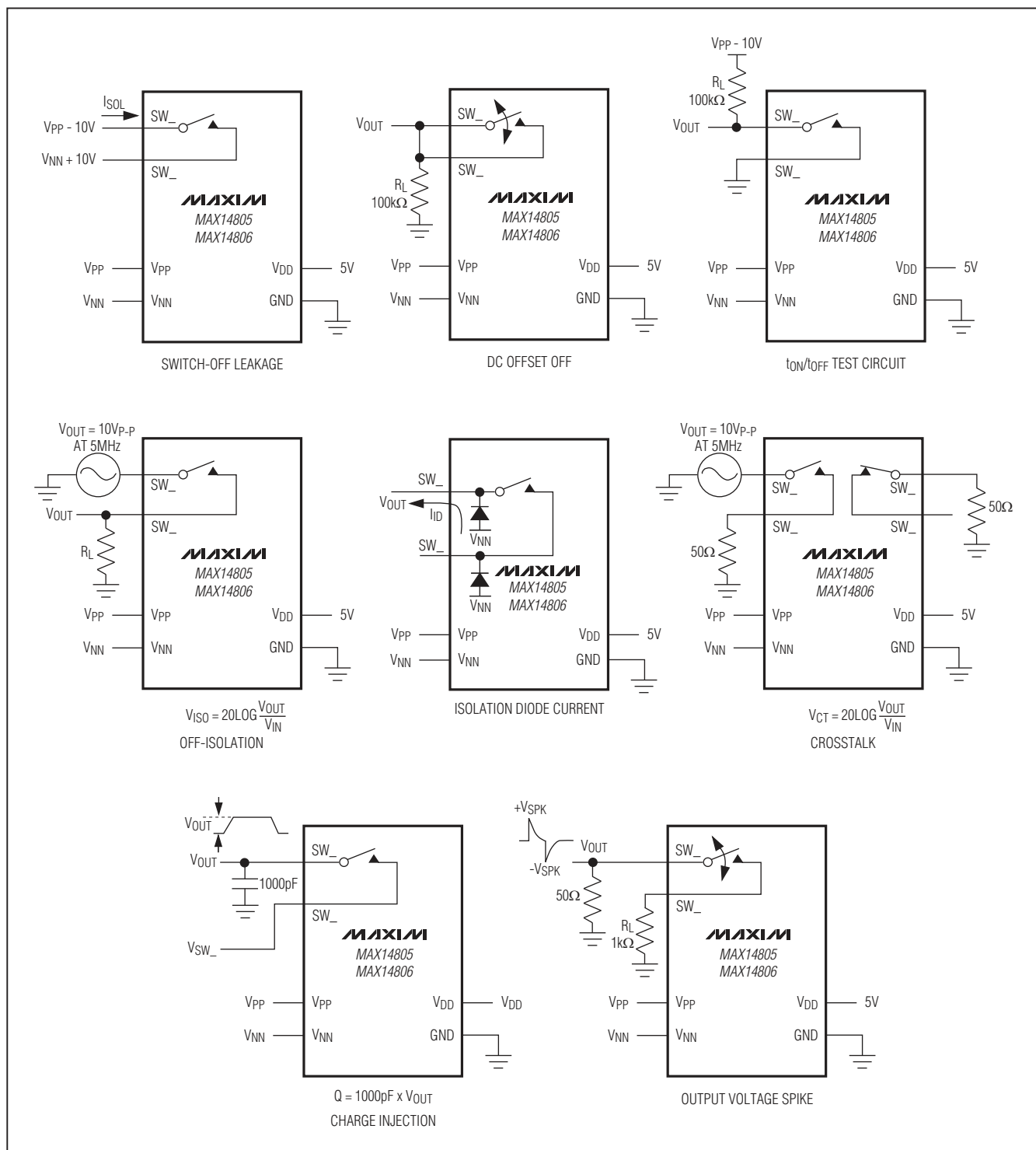
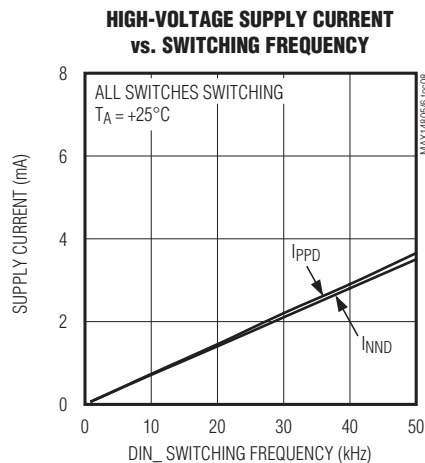
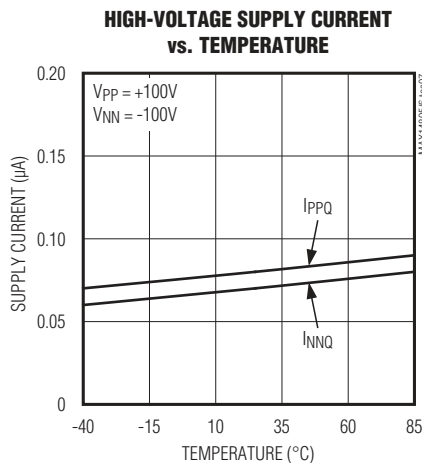
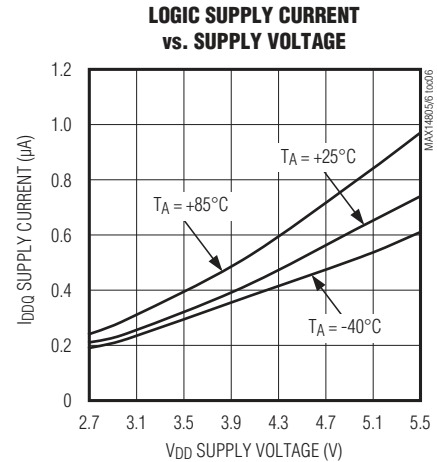
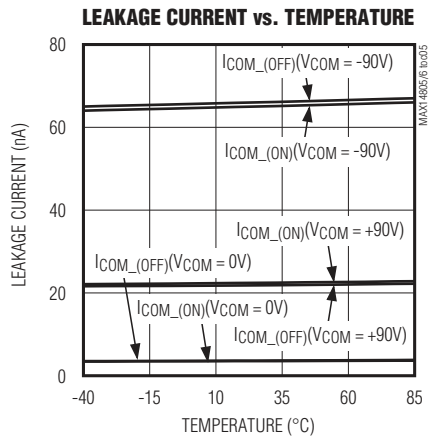
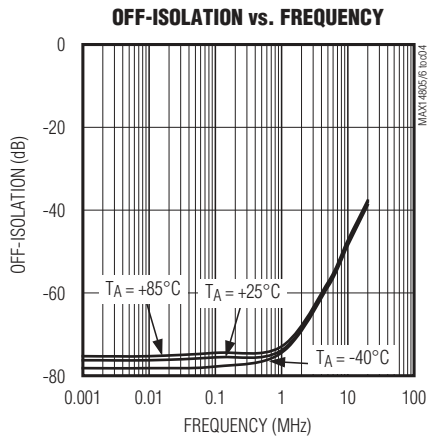
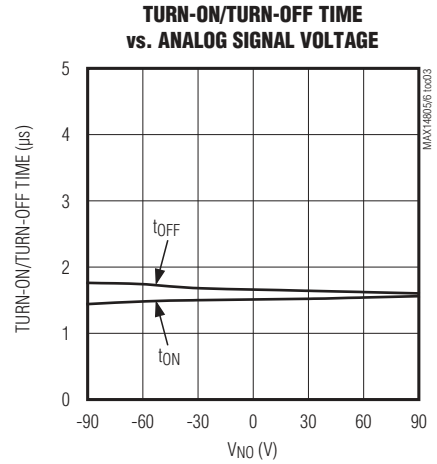
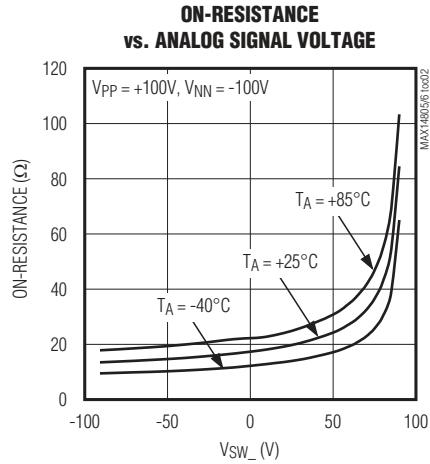
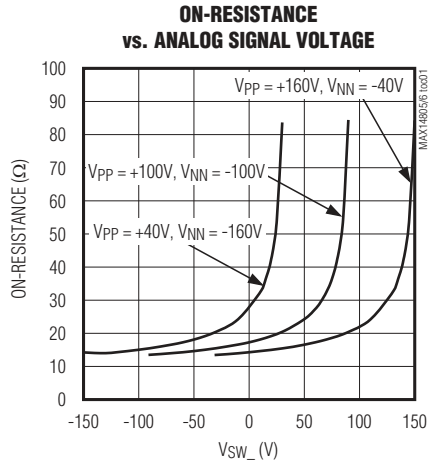


Figure 1. Test Circuits

# 16-Channel (Two Banks of 8-Channel), High-Voltage Analog Switches

## Typical Operating Characteristics

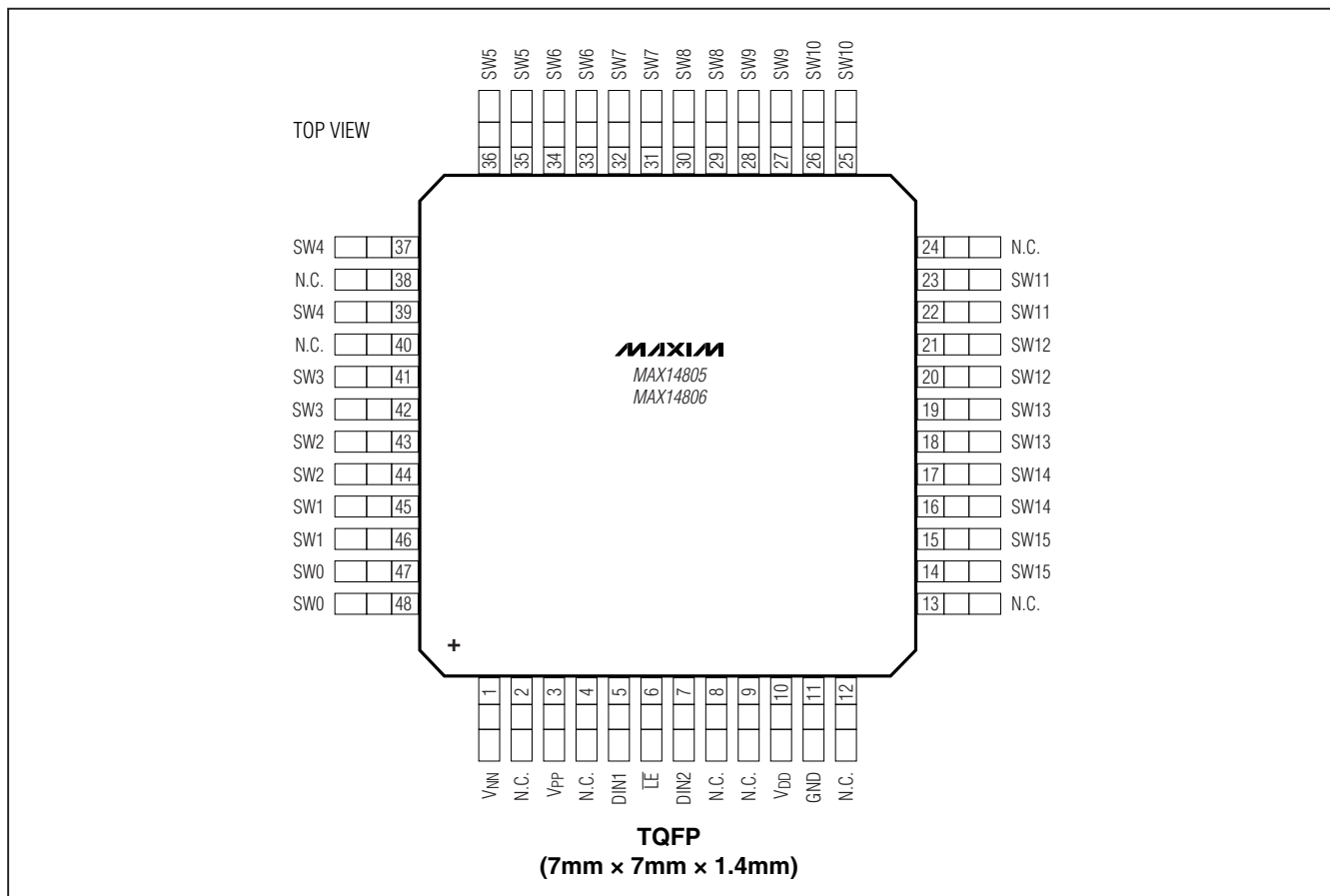
( $V_{DD} = +3V$ ,  $V_{PP} = +100V$ ,  $V_{NN} = -100V$ ,  $T_A = +25^\circ C$ , unless otherwise noted.)



# 16-Channel (Two Banks of 8-Channel), High-Voltage Analog Switches

## Pin Configuration

**MAX14805/MAX14806**



## Pin Description

PIN	NAME	FUNCTION
1	V <sub>NN</sub>	Negative High-Voltage Power Supply. Bypass V <sub>NN</sub> to GND with a 0.1μF or greater ceramic capacitor as close as possible to the device.
2, 4, 8, 9, 12, 13, 24, 38, 40	N.C.	No Connection. Not internally connected.
3	V <sub>PP</sub>	Positive High-Voltage Power Supply. Bypass V <sub>PP</sub> to GND with a 0.1μF or greater ceramic capacitor as close as possible to the device.
5	DIN1	Data Input 1
6	$\overline{LE}$	Active-Low Latch Enable Input. Drive $\overline{LE}$ low to latch data input. Drive $\overline{LE}$ high to hold data.
7	DIN2	Data Input 2
10	V <sub>DD</sub>	Digital Power Supply. Bypass V <sub>DD</sub> to GND with a 0.1μF or greater ceramic capacitor as close as possible to the device.
11	GND	Ground
14, 15	SW15	Analog Switch Terminal 15

## 16-Channel (Two Banks of 8-Channel), High-Voltage Analog Switches

### Pin Description (continued)

PIN	NAME	FUNCTION
16, 17	SW14	Analog Switch Terminal 14
18, 19	SW13	Analog Switch Terminal 13
20, 21	SW12	Analog Switch Terminal 12
22, 23	SW11	Analog Switch Terminal 11
25, 26	SW10	Analog Switch Terminal 10
27, 28	SW9	Analog Switch Terminal 9
29, 30	SW8	Analog Switch Terminal 8
31, 32	SW7	Analog Switch Terminal 7
33, 34	SW6	Analog Switch Terminal 6
35, 36	SW5	Analog Switch Terminal 5
37, 39	SW4	Analog Switch Terminal 4
41, 42	SW3	Analog Switch Terminal 3
43, 44	SW2	Analog Switch Terminal 2
45, 46	SW1	Analog Switch Terminal 1
47, 48	SW0	Analog Switch Terminal 0



# 16-Channel (Two Banks of 8-Channel), High-Voltage Analog Switches

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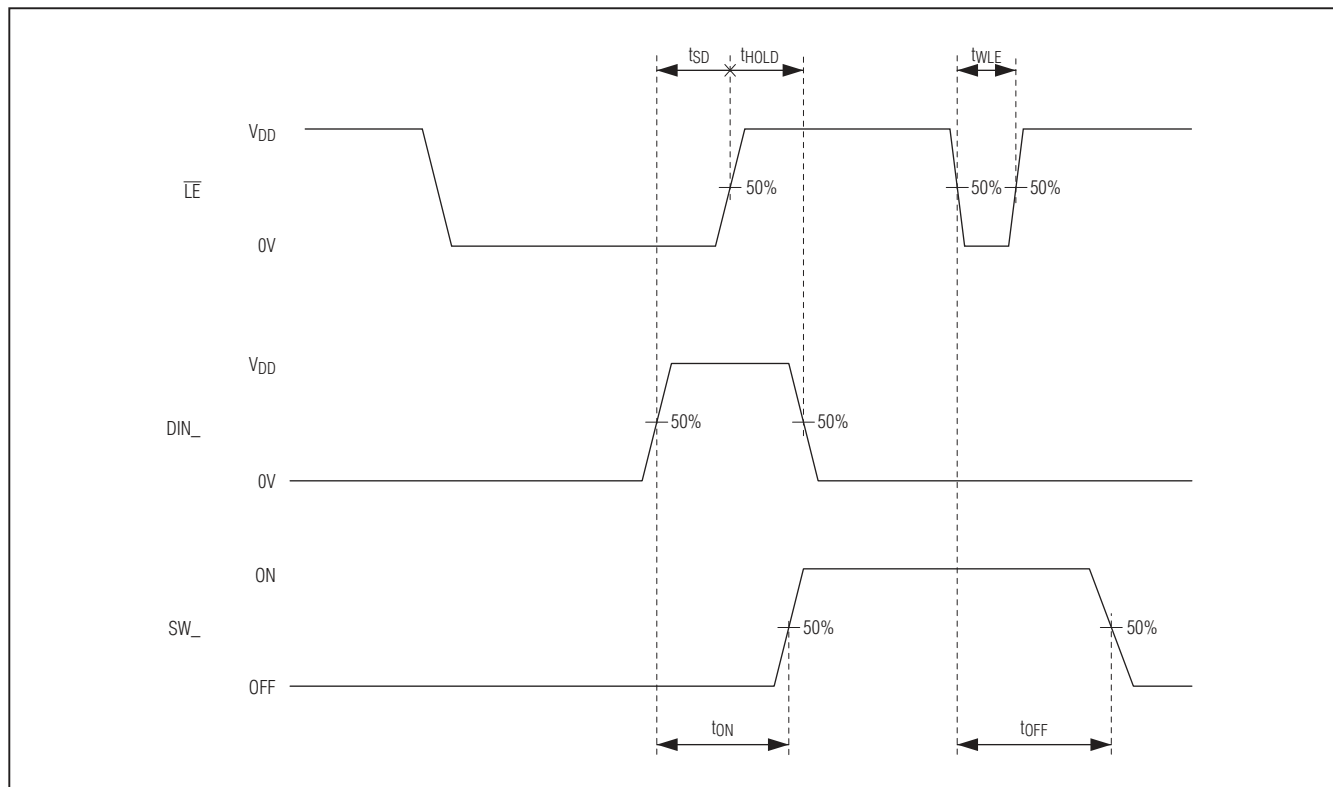


Figure 2. Digital Control (DIN1/DIN2/ $\overline{LE}$ ) Timing

Table 1. Truth Table

CONTROL			ANALOG SWITCH	
DIN1	DIN2	$\overline{LE}$	SW0–SW7	SW8–SW15
Low	Low	Low	Off	Off
High	Low	Low	On	Off
Low	High	Low	Off	On
High	High	Low	On	On
X	X	High	Hold Previous State	

X = Don't care.

# 16-Channel (Two Banks of 8-Channel), High-Voltage Analog Switches

## Detailed Description

The MAX14805/MAX14806 provide high-voltage switching on 16 channels for ultrasonic imaging. Both devices are ideal for the following applications: bank selection in biplane or triplane ultrasound probes and relays replacement in medical ultrasound systems. The devices utilize 200V process technology to provide 16 high-voltage, low-charge injection SPST switches, controlled by a digital interface.

The MAX14805/MAX14806's output switches are configured as two sets of eight SPST analog switches. The switches are controlled by two input logic controls, DIN1 and DIN2 (respectively for switch 0 to 7 and switch 8 to 15). The MAX14806 features integrated 40k $\Omega$  bleed resistors on each switch terminal that help to reduce voltage buildup in capacitive loads such as piezoelectric elements.

The MAX14805/MAX14806 operate with a wide range of high-voltage supplies, including  $V_{PP}/V_{NN} = +100V/-100V$ ,  $+200V/0V$ , and  $+40V/-160V$ . The digital interface operates from a separate  $V_{DD}$  supply from +2.7V to +5.5V. Digital inputs DIN1, DIN2, and  $\overline{LE}$  operate on the  $V_{DD}$  supply voltage.

The MAX14805CCM+ is a drop-in replacement for the Supertex HV2631. The MAX14806CCM+ is a drop-in replacement for the Supertex HV2731.

### Analog Switch

The MAX14805/MAX14806 allow a peak-to-peak analog signal range from  $V_{NN}$  to  $(V_{PP} - 10V)$ . During power-up and power-down, all analog switch inputs ( $SW_{\_}$ ) must be unconnected or satisfy  $V_{NN} \leq V_{SW_{\_}} \leq V_{PP}$ .

### High-Voltage Supplies

The MAX14805/MAX14806 allow a wide range of high-voltage supplies. The devices operate with  $V_{NN}$  from -160V to 0V and  $V_{PP}$  from +40V to  $(V_{NN} + 220V)$ . When  $V_{NN}$  is connected to GND (single-supply applications), the devices operate with  $V_{PP}$  up to +200V. The  $V_{PP}$  and  $V_{NN}$  high-voltage supplies are not required to be symmetrical, but the voltage difference ( $V_{PP} - V_{NN}$ ) must not exceed 230V.

### Bleed Resistors (MAX14806)

The MAX14806 features integrated 40k $\Omega$  bleed resistors to discharge capacitive loads such as piezoelectric transducers. Each analog switch terminal is connected to GND with a bleed resistor.

### Data Input (DIN1/DIN2)

DIN1/DIN2 control the on/off state of the analog switches. DIN1 controls SW0–SW7 and DIN2 controls SW8–SW15 (see Table 1 and Figure 2). DIN1 and DIN2 operate on the  $V_{DD}$  supply voltage.

### Latch Enable ( $\overline{LE}$ )

Drive  $\overline{LE}$  logic-low to latch DIN1/DIN2 data input (see Figure 2). Drive  $\overline{LE}$  logic-high to hold data. The  $\overline{LE}$  input operates on the  $V_{DD}$  supply voltage.

## Applications Information

For medical ultrasound applications, see Figures 3 and 4.

### Supply Sequencing and Bypassing

The MAX14805/MAX14806 do not require special sequencing of the  $V_{DD}$ ,  $V_{PP}$ , and  $V_{NN}$  supply voltages; however, analog switch inputs must be unconnected or satisfy  $V_{NN} \leq V_{SW_{\_}} \leq V_{PP}$  during power-up and power-down. Bypass  $V_{DD}$ ,  $V_{PP}$ , and  $V_{NN}$  to GND with a 0.1 $\mu$ F ceramic capacitor as close as possible to the device.

# 16-Channel (Two Banks of 8-Channel), High-Voltage Analog Switches

## Application Diagram

**MAX14805/MAX14806**

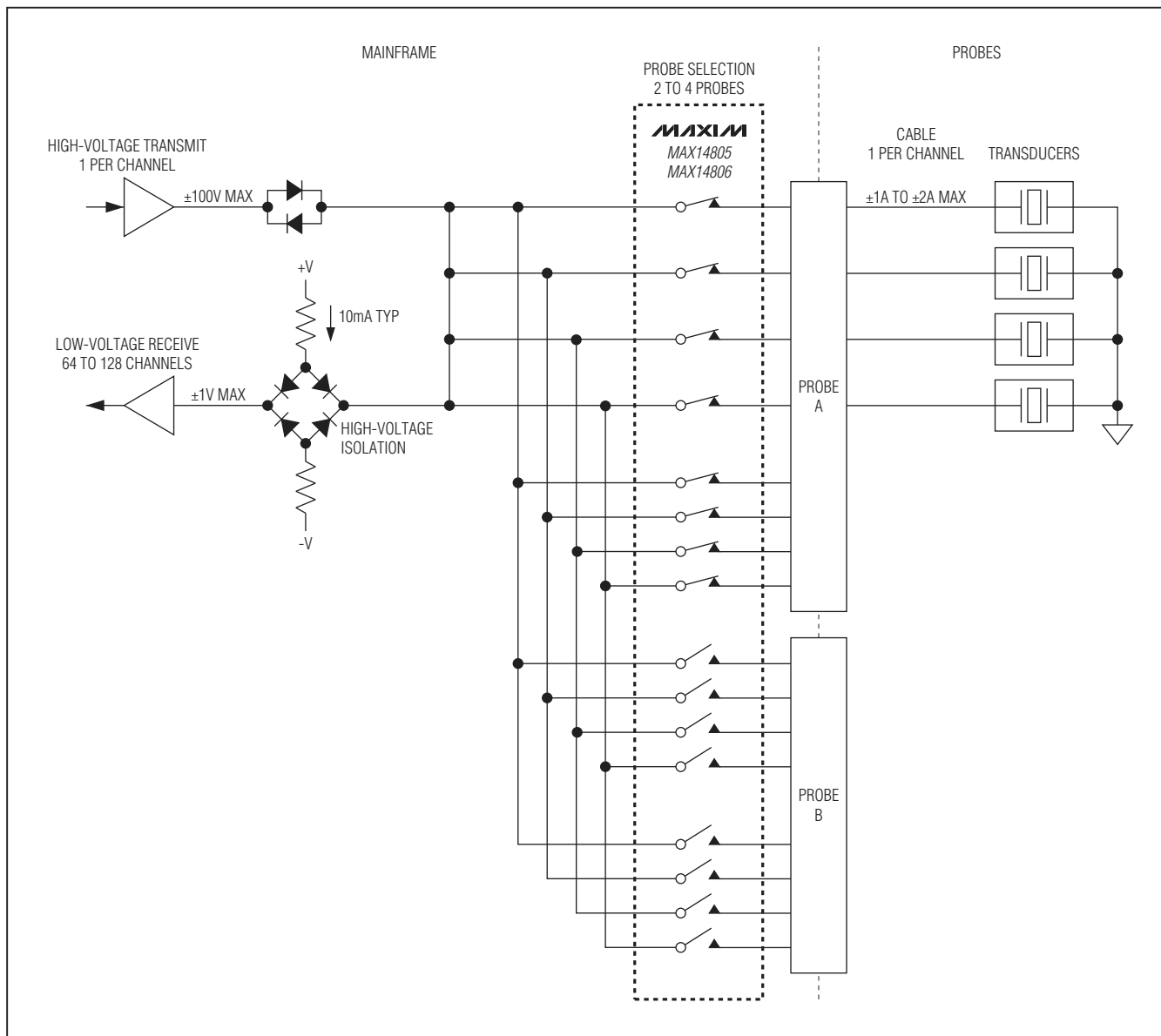


Figure 3. Relay Replacement Application in Medical System

# 16-Channel (Two Banks of 8-Channel), High-Voltage Analog Switches

## Application Diagram (continued)

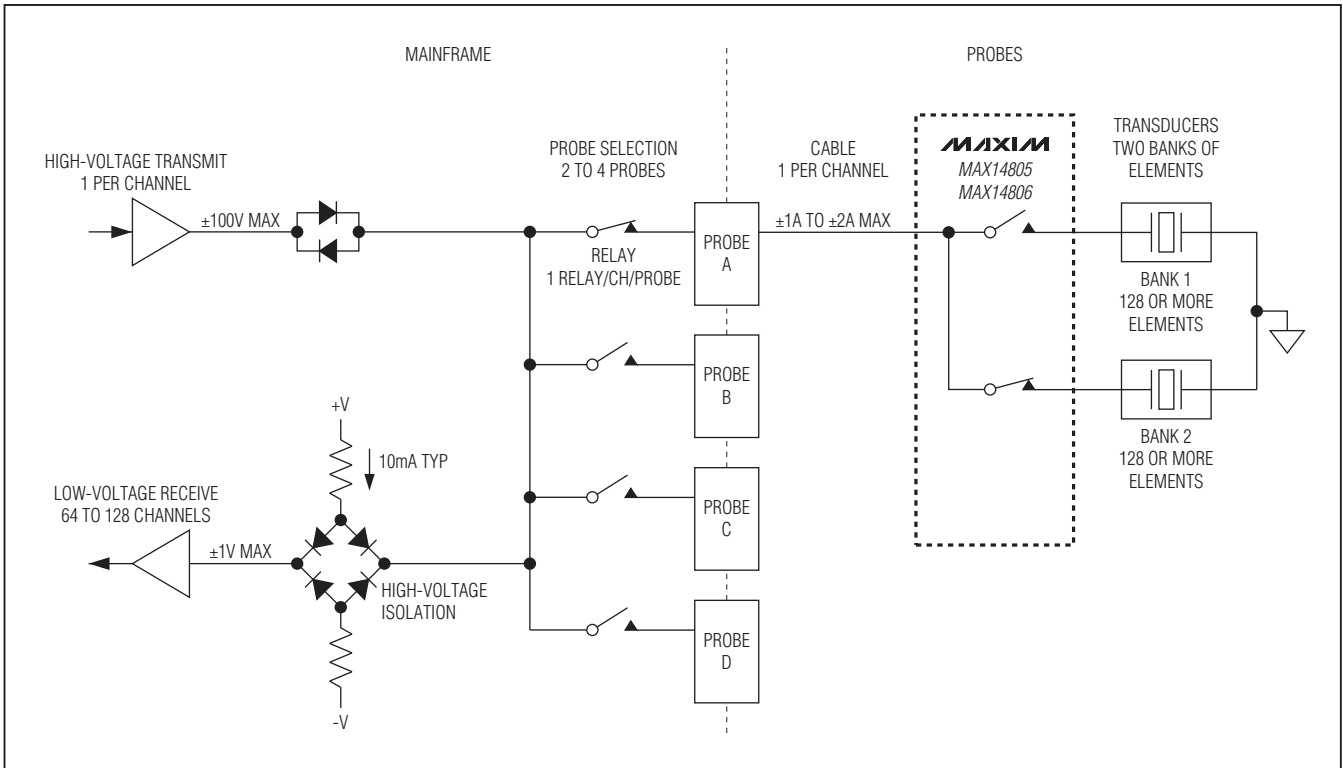
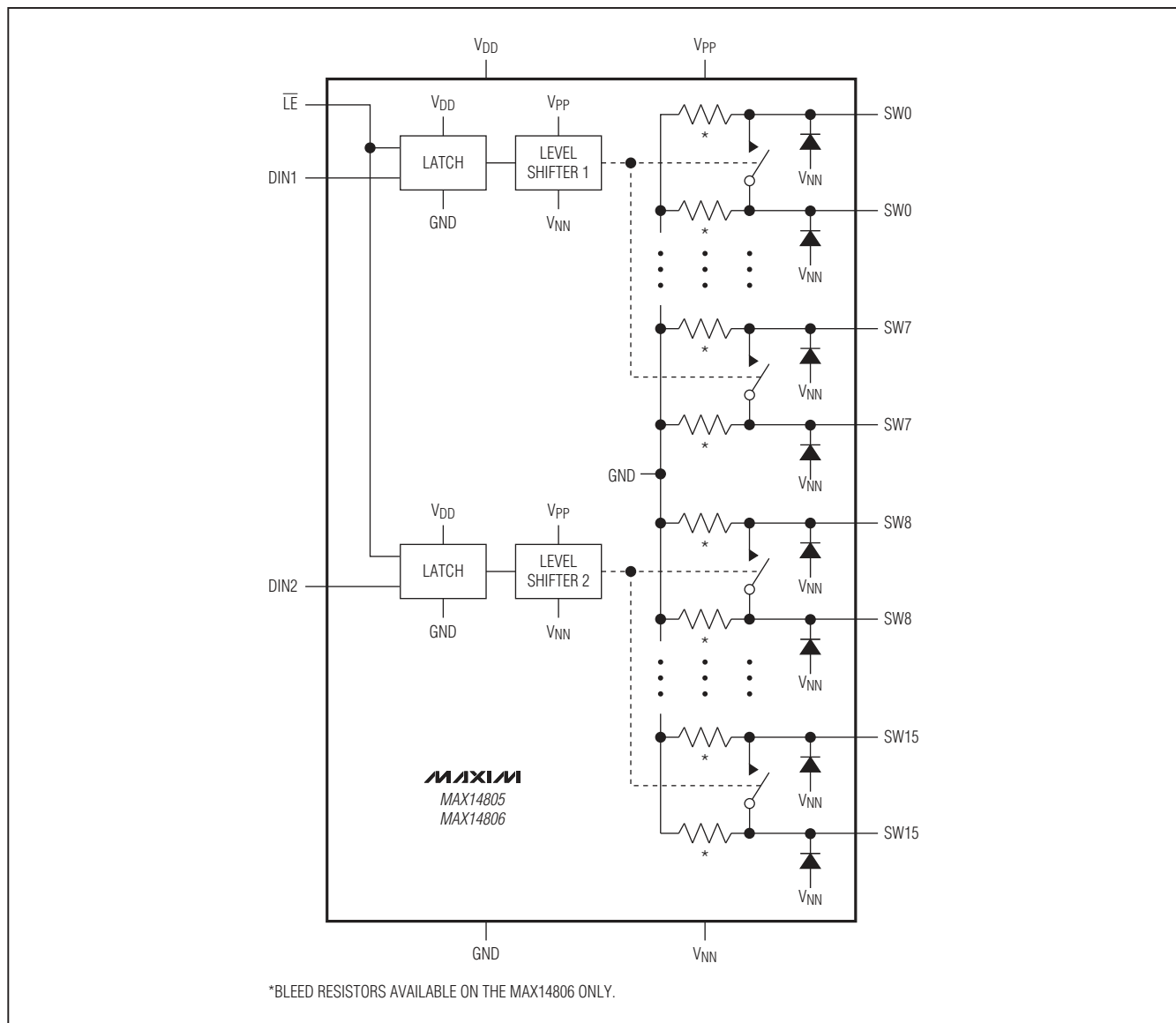


Figure 4. Probe Banks Selection in Biplane or Triplane Probe

# 16-Channel (Two Banks of 8-Channel), High-Voltage Analog Switches

## Functional Diagram

**MAX14805/MAX14806**



### Chip Information

PROCESS: BiCMOS

### Package Information

For the latest package outline information and land patterns, go to [www.maxim-ic.com/packages](http://www.maxim-ic.com/packages). Note that a "+", "#", or "-" in the package code indicates RoHS status only. Package drawings may show a different suffix character, but the drawing pertains to the package regardless of RoHS status.

PACKAGE TYPE	PACKAGE CODE	DOCUMENT NO.
48 TQFP	C48-6	<a href="#">21-0054</a>

# **16-Channel (Two Banks of 8-Channel), High-Voltage Analog Switches**

## **Revision History**

<b>REVISION NUMBER</b>	<b>REVISION DATE</b>	<b>DESCRIPTION</b>	<b>PAGES CHANGED</b>
0	4/10	Initial release	—

*Maxim cannot assume responsibility for use of any circuitry other than circuitry entirely embodied in a Maxim product. No circuit patent licenses are implied. Maxim reserves the right to change the circuitry and specifications without notice at any time.*

**14** \_\_\_\_\_ **Maxim Integrated Products, 120 San Gabriel Drive, Sunnyvale, CA 94086 408-737-7600**