elements.

supply voltage.



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

### **General Description**

The MAX14805/MAX14806 provide high-voltage switch-

ing on 16 channels for ultrasonic imaging. Both devices

are ideal for the following applications: banks selection in

biplane or triplane ultrasound probes and relays replace-

ment. The devices utilize 200V process technology to

provide sixteen high-voltage, low-charge injection SPST

The MAX14805/MAX14806's output switches are con-

figured 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

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 oper-

ates from a separate V<sub>DD</sub> supply from +2.7V to +5.5V. Digital inputs DIN1, DIN2, and  $\overline{LE}$  operate on the V<sub>DD</sub>

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.

switches, controlled by a digital interface.

**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 (0.1µA) (typ) Quiescent Current
- Low-Charge Injection, Low-Capacitance 20Ω Switches
- -77dB (typ) Off-Isolation at 5MHz (50Ω)
- Flexible, High-Voltage Supplies (VPP VNN = 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.

Maxim Integrated Products 1

For pricing, delivery, and ordering information, please contact Maxim Direct at 1-888-629-4642, or visit Maxim's website at www.maxim-ic.com.

### **ABSOLUTE MAXIMUM RATINGS**

(All voltages referenced to GND.)

VDD Logic Supply Voltage	-0.3V to +7V
VPP - VNN Supply Voltage	230V
VPP Positive Supply Voltage	0.3V to +220V
VNN Negative Supply Voltage	+0.3V to -220V
Logic Inputs Voltage (IE, DIN1, DIN2)	-0.3V to +7V
Analog Signal Range (SW_)(-0.3V +	V <sub>NN</sub> ) to (V <sub>NN</sub> + 200V)
Peak Analog Signal Current per Channe	I3A
Continuous Power Dissipation (TA = +70	°С)
48-Pin TQFP (derate 22.7mW/°C above	e +70°C) 1818mW

Junction-to-Ambient Thermal Resistance	
θJA (Note 1)	44°C/W
Junction-to-Case Thermal Resistance	
θJC (Note 1)	10°C/W
Operating Temperature Range	40°C to +85°C
Storage Temperature Range	65°C to +150°C
Junction Temperature	+150°C
Lead Temperature (soldering, 10s)	+300°C
Soldering Temperature (reflow)	+260°C

Note 1: Package thermal resistances were obtained using the method described in JEDEC specification JESD51-7, using a fourlayer board. For detailed information on package thermal considerations, refer to <u>www.maxim-ic.com/thermal-tutorial</u>.

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**

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

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
POWER SUPPLIES						
V <sub>DD</sub> Supply Voltage	VDD		2.7		5.5	V
Vpp Supply Voltage	Vpp		40	100	V <sub>NN</sub> + 220	V
V <sub>NN</sub> Supply Voltage	V <sub>NN</sub>		-160	-100	-15	V
VDD Supply Quiescent Current	IDDQ				5	μΑ
VDD Supply Dynamic Current	IDDD	$V_{DD} = +5V, \overline{LE} = GND, f_{DIN1} = f_{DIN2} = 5MHz$			2	mA
VPP Supply Quiescent Current	IPPQ				10	μΑ
	IPPD	$\label{eq:VPP} \begin{array}{l} V_{PP} = +40V, \ V_{NN} = -160V, \ f_{SW} = 50kHz, \\ f_{DIN1} = f_{DIN2} = 50kHz, \ \overline{LE} = GND \end{array}$			5	
VPP Supply Dynamic Current (All Channel Switching Simultaneously)		$\label{eq:VPP} \begin{array}{l} V_{PP}=+100V, \ V_{NN}=-100V, \ f_{SW}=50kHz, \\ f_{DIN1}=f_{DIN2}=50kHz, \ \overline{LE}=GND \end{array}$			6	mA
Simulaticously)		$\label{eq:VPP} \begin{array}{l} V_{PP}=+160V, \ V_{NN}=-40V, \ f_{SW}=50kHz, \\ f_{DIN1}=f_{DIN2}=50kHz, \ \overline{LE}=GND \end{array}$			7	
V <sub>NN</sub> Supply Quiescent Current	I <sub>NNQ</sub>				10	μΑ
	<u> </u>	$\label{eq:VPP} \begin{array}{l} V_{PP} = +40V, \ V_{NN} = -160V, \ f_{SW\_} = 50kHz, \\ f_{DIN1} = f_{DIN2} = 50kHz, \ \overline{LE} = GND \end{array}$			5.5	
V <sub>NN</sub> Supply Dynamic Current (All Channel Switching Simultaneously)		$\label{eq:VPP} \begin{array}{l} V_{PP}=+100V, \ V_{NN}=-100V, \ f_{SW}=50kHz, \\ f_{DIN1}=f_{DIN2}=50kHz, \ \overline{LE}=GND \end{array}$			5	mA
		$\label{eq:VPP} \begin{array}{l} V_{PP}=+160V, \ V_{NN}=-40V, \ f_{SW}=50kHz, \\ f_{DIN1}=f_{DIN2}=50kHz, \ \overline{LE}=GND \end{array}$			4.5	

### **ELECTRICAL CHARACTERISTICS (continued)**

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

PARAMETER	SYMBOL	C	ONDITIONS	MIN	TYP	MAX	UNITS
SWITCH CHARACTERISTICS	·						
Analog Signal Range	V <sub>SW</sub> _	(Note 3)		V <sub>NN</sub>		V <sub>PP</sub> - 10	V
		VPP = +40V, V <sub>NN</sub> = -160V,	I <sub>SW</sub> _ = 5mA		28	52	
		$V_{SW} = 0V$	I <sub>SW</sub> _ = 200mA		22	37	
Small-Signal	Rons	VPP = +100V, V <sub>NN</sub> = -100V,	I <sub>SW</sub> _ = 5mA		22	34	Ω
On-Resistance		$V_{SW} = 0V$	I <sub>SW</sub> _ = 200mA		18	27	22
		VPP = +160V, V <sub>NN</sub> = -40V,	I <sub>SW</sub> _ = 5mA		20	30	
		$V_{SW} = 0V$	I <sub>SW</sub> _ = 200mA		16	23	
Small-Signal On-Resistance Matching	ΔRons	VPP = +100V, Vr	NN = -100V, I <sub>SW</sub> _ = 5mA		5		%
Large-Signal Switch On-Resistance	Ronl	VSW_ = VPP - 10	V, ISW_ = 1A		15		Ω
Shunt Resistance	RINT	MAX14806 only		27	40	53	kΩ
Switch-Off Leakage	ISW_(OFF)	V <sub>SW</sub> _ = V <sub>PP</sub> - 10 (MAX14805 only	V or unconnected ) (Figure 1)		0	2.5	μA
Switch-Off DC Offset		$R_L = 100k\Omega$ (Figure 1)		-30		+30	mV
Switch Output Peak Current		100ns pulse wid	th, 0.1% duty cycle		3		А
Switch Output Isolation Diode Current		300ns pulse wid (Figure 1)	th, 2% duty cycle		2		А
SWITCH DYNAMIC CHARACTE	RISTICS						
Turn-On Time	ton	V <sub>SW</sub> = V <sub>PP</sub> - 10' V <sub>NN</sub> = -40V to -1				5	μs
Turn-Off Time	tOFF	V <sub>SW</sub> = V <sub>PP</sub> - 10' V <sub>NN</sub> = -40V to -1				5	μs
Output Switching Frequency	fsw	Duty cycle = 509	%			50	kHz
Off-Isolation	VISO	$f = 5MHz$ , $R_L = 1k\Omega$ , $C_L = 15pF$ (Figure 1) $f = 5MHz$ , $R_L = 50\Omega$ (Figure 1)			-50 -77		dB
Crosstalk	VCT	f = 5MHz, RL = 5			-80		dB
Switch Off-Capacitance (Note 4)	C <sub>SW_(OFF)</sub>	V <sub>SW</sub> = 0V, f = 1		4	11	18	pF
Switch On-Capacitance (Note 4)	C <sub>SW_(ON)</sub>	$V_{SW}$ = 0V, f = 1MHz		20	36	56	pF
Output Voltage Spike (Note 4)	VSPK	$R_L = 50\Omega$ (Figure	e 1)	-500		+250	mV
Small-Signal Analog Bandwidth	fBW	VPP = +100V, VN	N = -100V, CL = 200pF		20		MHz

#### **ELECTRICAL CHARACTERISTICS (continued)**

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

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
		VPP = +40V, V <sub>NN</sub> = -160V, V <sub>SW</sub> = 0V (Figure 1)		650		
Charge Injection	Q	VPP = +100V, V <sub>NN</sub> = -100V, V <sub>SW</sub> = 0V (Figure 1)		450		рС
		VPP = +160V, V <sub>NN</sub> = -40V, V <sub>SW</sub> = 0V (Figure 1)		250		
LOGIC LEVELS (DIN1, DIN2, L	E)					
Logic-Input Low Voltage	VIL				0.75	V
Logic-Input High Voltage	VIH		V <sub>DD</sub> - 0.75			V
Logic-Input Capacitance	CIN				10	рF
Logic-Input Leakage Current	lin		-1		+1	μA
LOGIC TIMING (See Timing Dia	agram, Figure	2)				
Setup Time	tsD		30			ns
Hold Time	thold				30	ns
Time Width of $\overline{\text{LE}}$	twle		30			ns

Note 2: All devices are 100% tested at TA = +85°C. Limits over the operating temperature range are guaranteed by design and characterization.

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

Note 4: Guaranteed by characterization; not production tested.

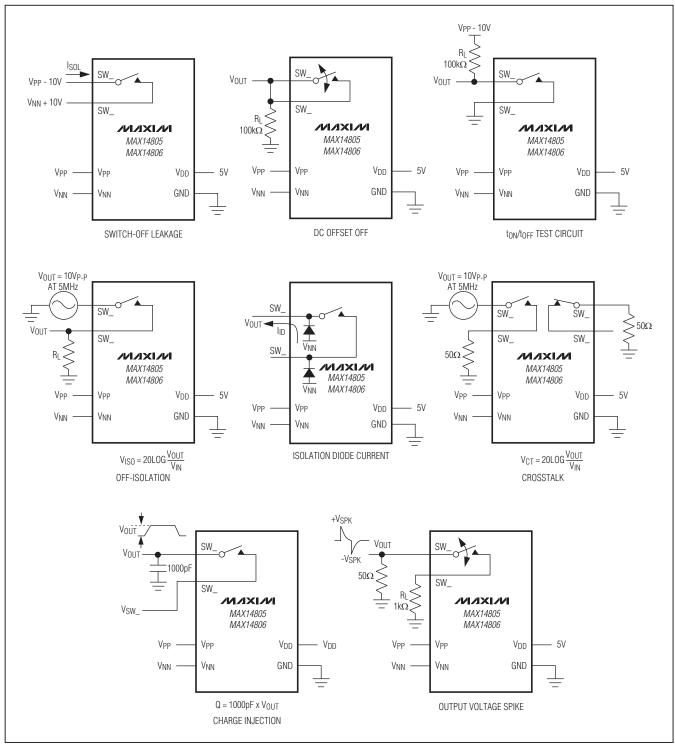


Figure 1. Test Circuits

MAX14805/MAX14806

# (V<sub>DD</sub> = +3V, V<sub>PP</sub> = +100V, V<sub>NN</sub> = -100V, T<sub>A</sub> = +25°C, unless otherwise noted.)

**ON-RESISTANCE ON-RESISTANCE TURN-ON/TURN-OFF TIME** vs. ANALOG SIGNAL VOLTAGE vs. ANALOG SIGNAL VOLTAGE vs. ANALOG SIGNAL VOLTAGE 100 5 120 V<sub>PP</sub> = +160V, V<sub>NN</sub> = -40V V<sub>PP</sub> = +100V, V<sub>NN</sub> = -100V 90 100 80 **FURN-ON/TURN-OFF TIME (µs)** 4 70 ON-RESISTANCE (Ω) ON-RESISTANCE (Q) VPP = +100V, V<sub>NN</sub> = -100V 80  $T_A = +85^{\circ}C$ 60 3 toff VPP = +40V, VNN = -160V 50 60  $T_A = +25^{\circ}C$ 2 40 40 30  $T_A = -40^{\circ}C$ 20 1 20 ton 10 0 0 0 -100 -50 -60 -30 -150 -50 0 50 100 150 -100 0 50 100 -90 0 30 60 90 Vsw\_(V) Vsw\_(V) V<sub>NO</sub> (V) LOGIC SUPPLY CURRENT **OFF-ISOLATION vs. FREQUENCY LEAKAGE CURRENT vs. TEMPERATURE** vs. SUPPLY VOLTAGE 0 80 1.2 ICOM (OFF)(VCOM = -90V) 1.0 4 DDQ SUPPLY CURRENT (µA) -20 60 EAKAGE CURRENT (nA)  $T_A = +25^{\circ}C$ ICOM\_(ON)(VCOM = -90V) OFF-ISOLATION (dB) 0.8  $T_A = +85^{\circ}C$ -40 40 0.6  $I_{COM}(ON)(V_{COM} = +90V)$ ICOM\_(OFF)(VCOM = 0V) 0.4 -60 20  $T_A = -40^{\circ}C$ ICOM (ON)(VCOM = 0V)0.2 ICOM\_(OFF)(VCOM = +90V) -40°C TA = 0 -80 0 -15 35 85 0.01 0.1 10 100 -40 10 60 3.1 3.5 3.9 4.3 0.001 1 2.7 4.7 5.1 5.5 FREQUENCY (MHz) TEMPERATURE (°C) VDD SUPPLY VOLTAGE (V) **HIGH-VOLTAGE SUPPLY CURRENT HIGH-VOLTAGE SUPPLY CURRENT** vs. TEMPERATURE vs. SWITCHING FREQUENCY 0.20 8 VPP = +100V ALL SWITCHES SWITCHING  $V_{NN} = -100V$  $T_A = +25^{\circ}C$ 0.15 6 SUPPLY CURRENT (mA) SUPPLY CURRENT (µA) IPP0 0.10 4 IPPD 0.05 2 INNO INND

0

0

10

20

DIN\_ SWITCHING FREQUENCY (kHz)

30

40

50



0

-40

-15

10

TEMPERATURE (°C)

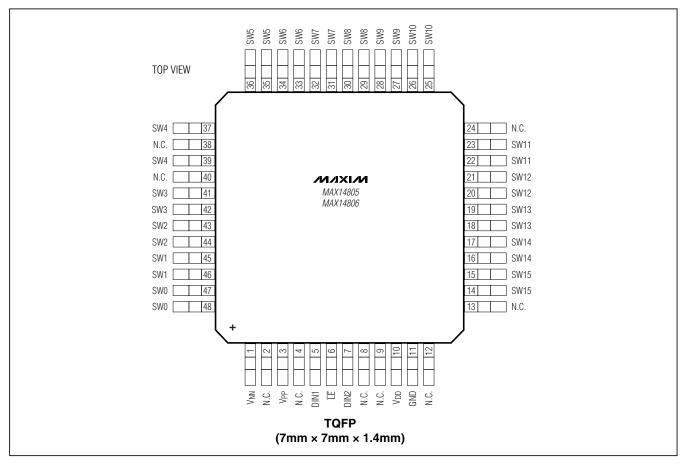
35

60

85

### **\_Pin Configuration**

MAX14805/MAX14806



### Pin Description

PIN	NAME	FUNCTION
1	Vnn	Negative High-Voltage Power Supply. Bypass $V_{NN}$ 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	Vpp	Positive High-Voltage Power Supply. Bypass Vpp to GND with a 0.1µF or greater ceramic capac- itor as close as possible to the device.
5	DIN1	Data Input 1
6	LE	Active-Low Latch Enable Input. Drive $\overline{\text{LE}}$ low to latch data input. Drive $\overline{\text{LE}}$ high to hold data.
7	DIN2	Data Input 2
10	V <sub>DD</sub>	Digital Power Supply. Bypass $V_{DD}$ 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

### 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

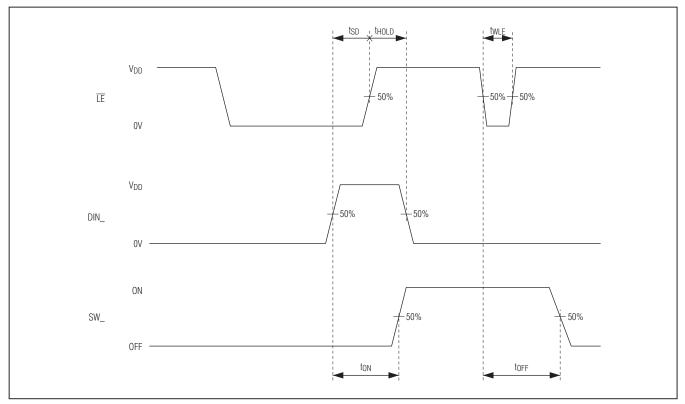


Figure 2. Digital Control (DIN1/DIN2/LE) Timing

#### Table 1. Truth Table

	CONTROL		ANALOG SWITCH		
DIN1	DIN2	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	
Х	Х	High	Hold Previous State		

X = Don't care.

9

MAX14805/MAX14806

### **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 VPP/VNN = +100V/-100V, +200V/0V, and +40V/-160V. The digital interface operates from a separate V<sub>DD</sub> supply from +2.7V to +5.5V. Digital inputs DIN1, DIN2, and  $\overline{\text{LE}}$  operate on the V<sub>DD</sub> supply voltage.

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

 $\label{eq:signal} \begin{array}{l} \textbf{Analog Switch} \\ \textbf{The MAX14805/MAX14806 allow a peak-to-peak analog} \\ \textbf{signal range from V_{NN} to (V_{PP} - 10V). During power-up} \\ \textbf{and power-down, all analog switch inputs (SW_) must be} \\ \textbf{unconnected or satisfy V_{NN} \leq V_{SW_{-}} \leq V_{PP}. \end{array}$ 

#### **High-Voltage Supplies**

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

#### Latch Enable (*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<sub>DD</sub> 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 VDD, VPP, and VNN supply voltages; however, analog switch inputs must be unconnected or satisfy VNN  $\leq$  VSW\_  $\leq$  VPP during power-up and power-down. Bypass VDD, VPP, and VNN to GND with a 0.1µF ceramic capacitor as close as possible to the device.

### \_Application Diagram

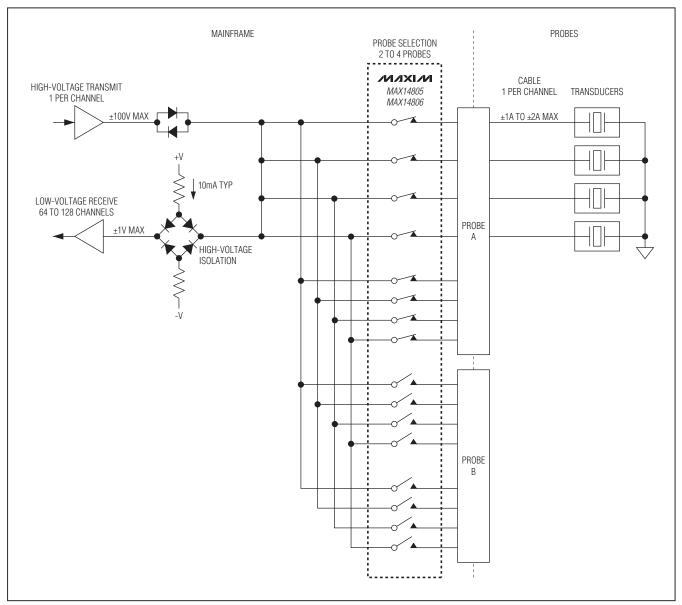


Figure 3. Relay Replacement Application in Medical System

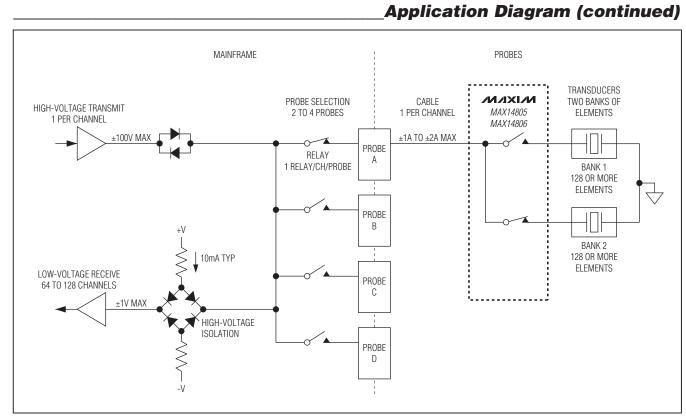
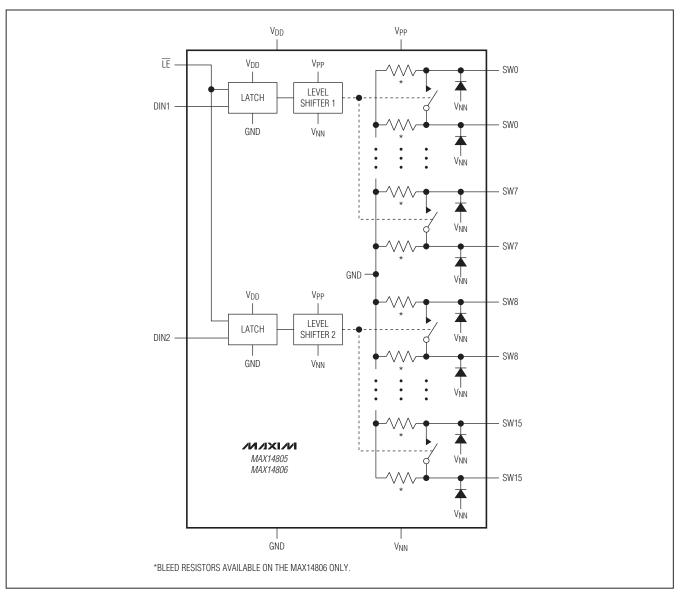


Figure 4. Probe Banks Selection in Biplane or Triplane Probe

MAX14805/MAX14806

### \_Functional Diagram



### Chip Information

PROCESS: BICMOS

### **Package Information**

For the latest package outline information and land patterns, go to **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	<u>21-0054</u>

#### **Revision History**

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
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.

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