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19-5253; Rev 0; 4/10

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

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 40kΩ 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 (0.1µA) (typ) Quiescent Current**
- **Low-Charge Injection, Low-Capacitance 20Ω Switches**
- **-77dB (typ) Off-Isolation at 5MHz (50Ω)**
- **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.

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

ABSOLUTE MAXIMUM RATINGS

(All voltages referenced to GND.)

V_{DD} Logic Supply Voltage .....-0.3V to +7V
V_{PP} - V_{NN} Supply Voltage 230V
V_{PP} Positive Supply Voltage .....-0.3V to +220V
V_{NN} Negative Supply Voltage .....+0.3V to -220V
Logic Inputs Voltage ($\overline{LE}$, DIN1, DIN2) .....-0.3V to +7V
Analog Signal Range (SW_).....(-0.3V + V_{NN}) to (V_{NN} + 200V)
Peak Analog Signal Current per Channel 3A
Continuous Power Dissipation (T_A = +70°C)
48-Pin TQFP (derate 22.7mW/°C above +70°C) 1818mW

Junction-to-Ambient Thermal Resistance
θ_{JA} (Note 1) .....44°C/W
Junction-to-Case Thermal Resistance
θ_{JC} (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 four-layer board. For detailed information on package thermal considerations, refer to **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

(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°C.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
POWER SUPPLIES						
V_{DD} Supply Voltage	V_{DD}		2.7		5.5	V
V_{PP} Supply Voltage	V_{PP}		40	100	V_{NN} + 220	V
V_{NN} Supply Voltage	V_{NN}		-160	-100	-15	V
V_{DD} Supply Quiescent Current	I_{DDQ}				5	µA
V_{DD} Supply Dynamic Current	I_{DDD}	V_{DD} = +5V, $\overline{LE}$ = GND, f_{DIN1} = f_{DIN2} = 5MHz			2	mA
V_{PP} Supply Quiescent Current	I_{PPQ}				10	µA
V_{PP} Supply Dynamic Current (All Channel Switching Simultaneously)	I_{PPD}	V_{PP} = +40V, V_{NN} = -160V, $f_{SW\_}$ = 50kHz, f_{DIN1} = f_{DIN2} = 50kHz, $\overline{LE}$ = GND			5	mA
		V_{PP} = +100V, V_{NN} = -100V, $f_{SW\_}$ = 50kHz, f_{DIN1} = f_{DIN2} = 50kHz, $\overline{LE}$ = GND			6	
		V_{PP} = +160V, V_{NN} = -40V, $f_{SW\_}$ = 50kHz, f_{DIN1} = f_{DIN2} = 50kHz, $\overline{LE}$ = GND			7	
V_{NN} Supply Quiescent Current	I_{NNQ}				10	µA
V_{NN} Supply Dynamic Current (All Channel Switching Simultaneously)	I_{NND}	V_{PP} = +40V, V_{NN} = -160V, $f_{SW\_}$ = 50kHz, f_{DIN1} = f_{DIN2} = 50kHz, $\overline{LE}$ = GND			5.5	mA
		V_{PP} = +100V, V_{NN} = -100V, $f_{SW\_}$ = 50kHz, f_{DIN1} = f_{DIN2} = 50kHz, $\overline{LE}$ = GND			5	
		V_{PP} = +160V, V_{NN} = -40V, $f_{SW\_}$ = 50kHz, f_{DIN1} = f_{DIN2} = 50kHz, $\overline{LE}$ = GND			4.5	

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°C.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
SWITCH CHARACTERISTICS							
Analog Signal Range	$V_{SW\_}$	(Note 3)		V_{NN}		V_{PP} - 10	V
Small-Signal On-Resistance	R_{ONS}	V_{PP} = +40V, V_{NN} = -160V, $V_{SW\_}$ = 0V	$I_{SW\_}$ = 5mA		28	52	Ω
			$I_{SW\_}$ = 200mA		22	37	
		V_{PP} = +100V, V_{NN} = -100V, $V_{SW\_}$ = 0V	$I_{SW\_}$ = 5mA		22	34	
			$I_{SW\_}$ = 200mA		18	27	
		V_{PP} = +160V, V_{NN} = -40V, $V_{SW\_}$ = 0V	$I_{SW\_}$ = 5mA		20	30	
			$I_{SW\_}$ = 200mA		16	23	
Small-Signal On-Resistance Matching	ΔR_{ONS}	V_{PP} = +100V, V_{NN} = -100V, $I_{SW\_}$ = 5mA			5		%
Large-Signal Switch On-Resistance	R_{ONL}	$V_{SW\_}$ = V_{PP} - 10V, $I_{SW\_}$ = 1A			15		Ω
Shunt Resistance	R_{INT}	MAX14806 only		27	40	53	kΩ
Switch-Off Leakage	$I_{SW\_(OFF)}$	$V_{SW\_}$ = V_{PP} - 10V or unconnected (MAX14805 only) (Figure 1)			0	2.5	µA
Switch-Off DC Offset		R_L = 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
SWITCH DYNAMIC CHARACTERISTICS							
Turn-On Time	t_{ON}	$V_{SW\_}$ = V_{PP} - 10V, R_L = 10kΩ, V_{NN} = -40V to -160V (Figure 1)				5	µs
Turn-Off Time	t_{OFF}	$V_{SW\_}$ = V_{PP} - 10V, R_L = 10kΩ, V_{NN} = -40V to -160V (Figure 1)				5	µs
Output Switching Frequency	f_{SW}	Duty cycle = 50%				50	kHz
Off-Isolation	V_{ISO}	f = 5MHz, R_L = 1kΩ, C_L = 15pF (Figure 1)			-50		dB
		f = 5MHz, R_L = 50Ω (Figure 1)			-77		
Crosstalk	V_{CT}	f = 5MHz, R_L = 50Ω (Figure 1)			-80		dB
Switch Off-Capacitance (Note 4)	$C_{SW\_(OFF)}$	$V_{SW\_}$ = 0V, f = 1MHz		4	11	18	pF
Switch On-Capacitance (Note 4)	$C_{SW\_(ON)}$	$V_{SW\_}$ = 0V, f = 1MHz		20	36	56	pF
Output Voltage Spike (Note 4)	V_{SPK}	R_L = 50Ω (Figure 1)		-500		+250	mV
Small-Signal Analog Bandwidth	f_{BW}	V_{PP} = +100V, V_{NN} = -100V, C_L = 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°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		
LOGIC LEVELS (DIN1, DIN2, $\overline{LE}$)						
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	µA
LOGIC TIMING (See Timing Diagram, Figure 2)						
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°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.

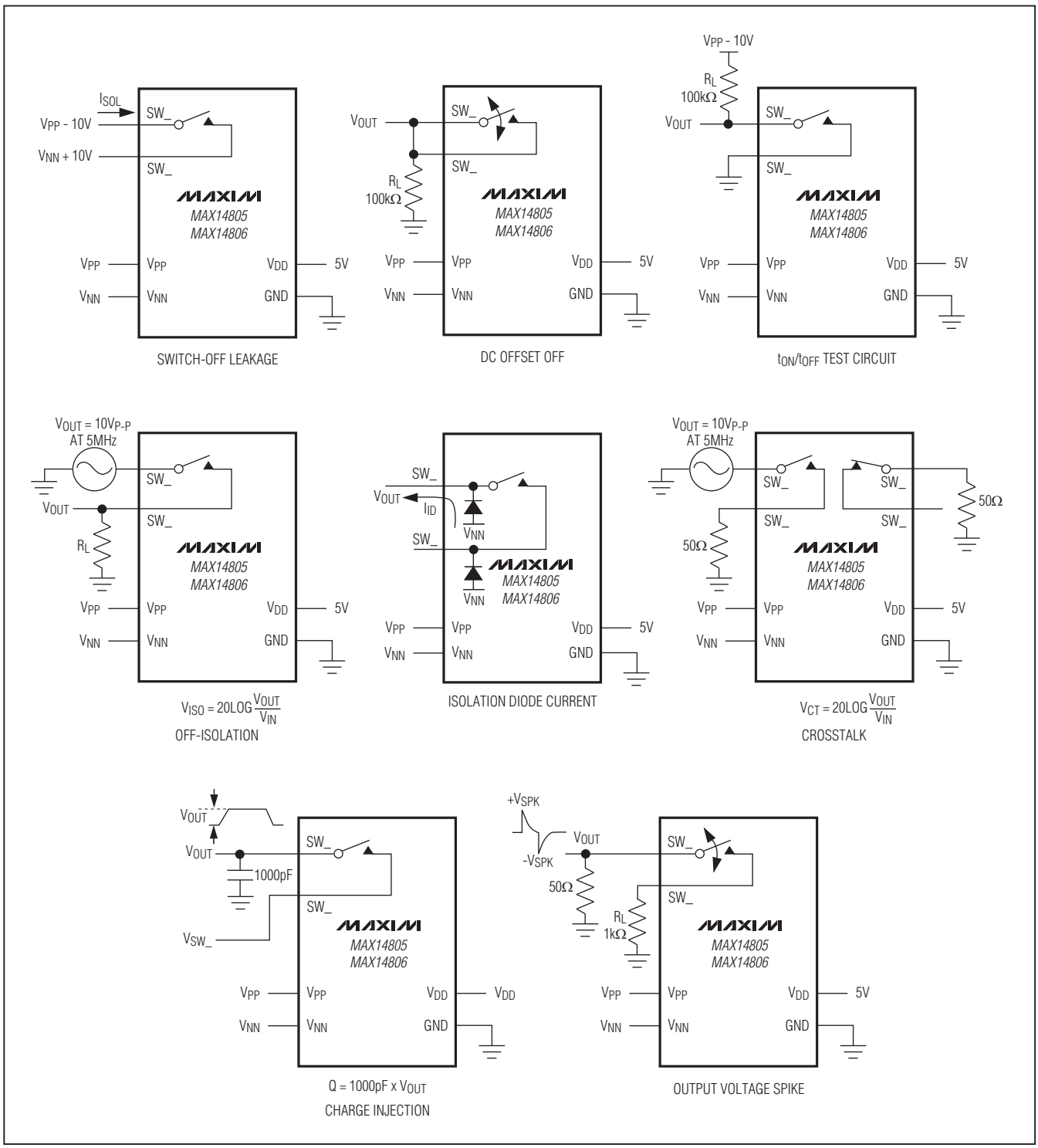


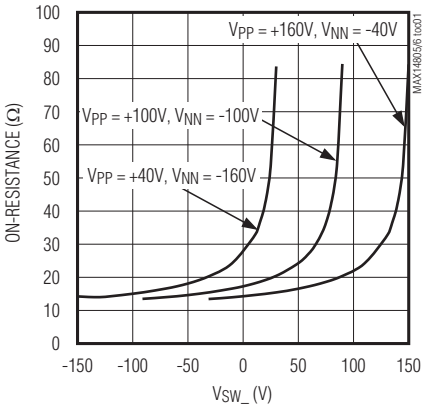
Figure 1. Test Circuits

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

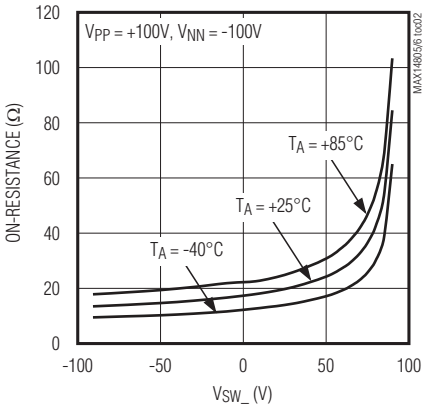
Typical Operating Characteristics

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

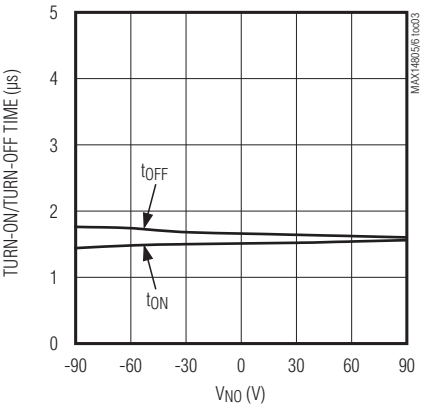
ON-RESISTANCE vs. ANALOG SIGNAL VOLTAGE



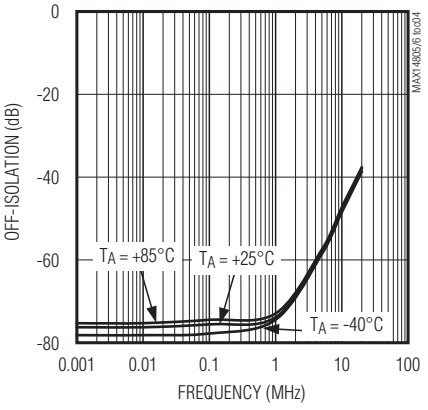
ON-RESISTANCE vs. ANALOG SIGNAL VOLTAGE



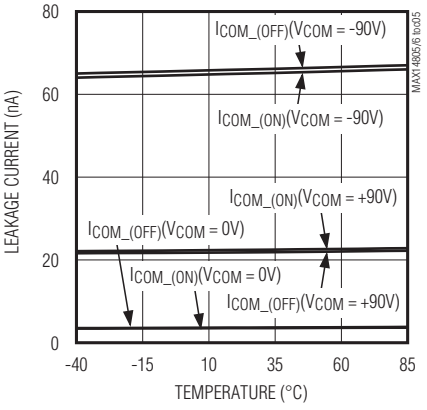
TURN-ON/TURN-OFF TIME vs. ANALOG SIGNAL VOLTAGE



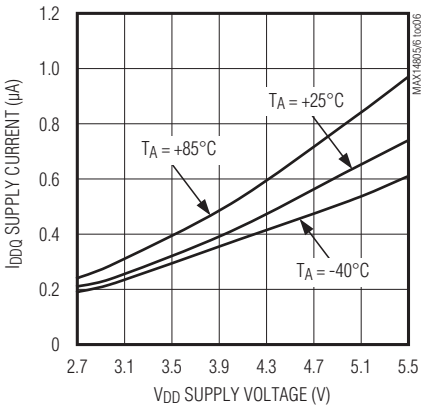
OFF-ISOLATION vs. FREQUENCY



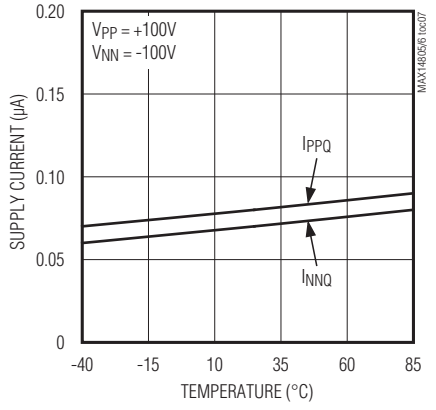
LEAKAGE CURRENT vs. TEMPERATURE



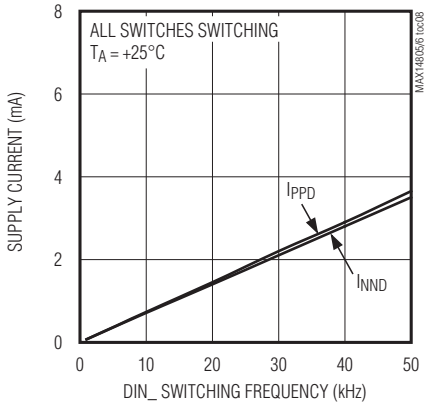
LOGIC SUPPLY CURRENT vs. SUPPLY VOLTAGE



HIGH-VOLTAGE SUPPLY CURRENT vs. TEMPERATURE

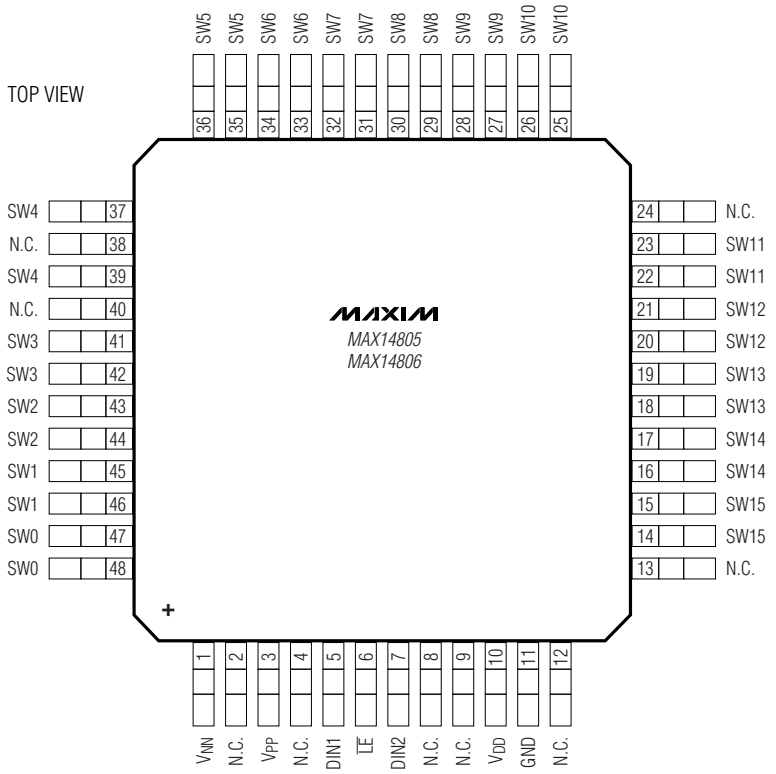


HIGH-VOLTAGE SUPPLY CURRENT vs. SWITCHING FREQUENCY



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

Pin Configuration



TQFP
(7mm × 7mm × 1.4mm)

Pin Description

PIN	NAME	FUNCTION
1	V_{NN}	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	V_{PP}	Positive High-Voltage Power Supply. Bypass V_{PP} 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_{DD}	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

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

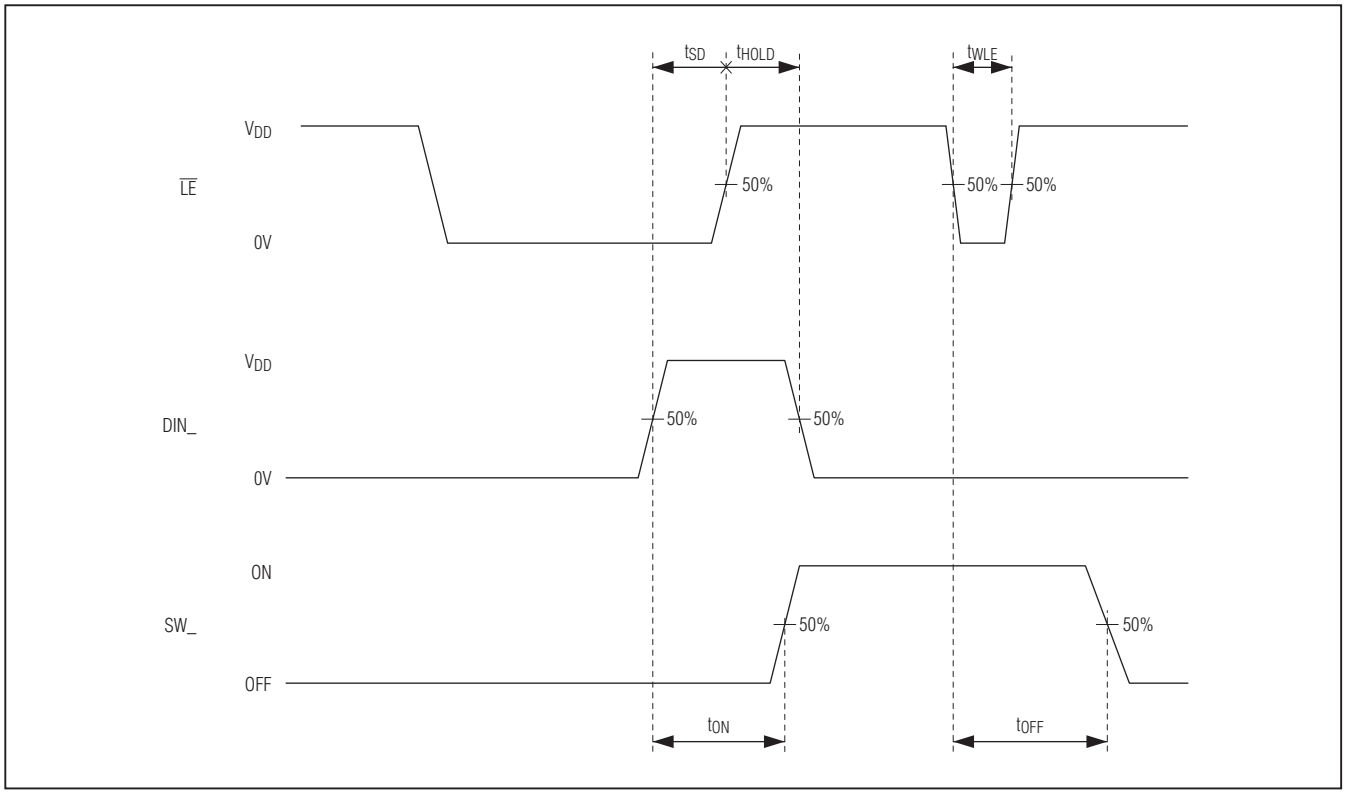


Figure 2. Digital Control (DIN1/DIN2/$\overline{LE}$) Timing

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 40kΩ 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 $V_{NN} \le V_{SW\_} \le V_{PP}$.

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 40kΩ 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 $V_{NN} \le V_{SW\_} \le V_{PP}$ during power-up and power-down. Bypass V_{DD}, V_{PP}, and V_{NN} to GND with a 0.1µF ceramic capacitor as close as possible to the device.

Application Diagram

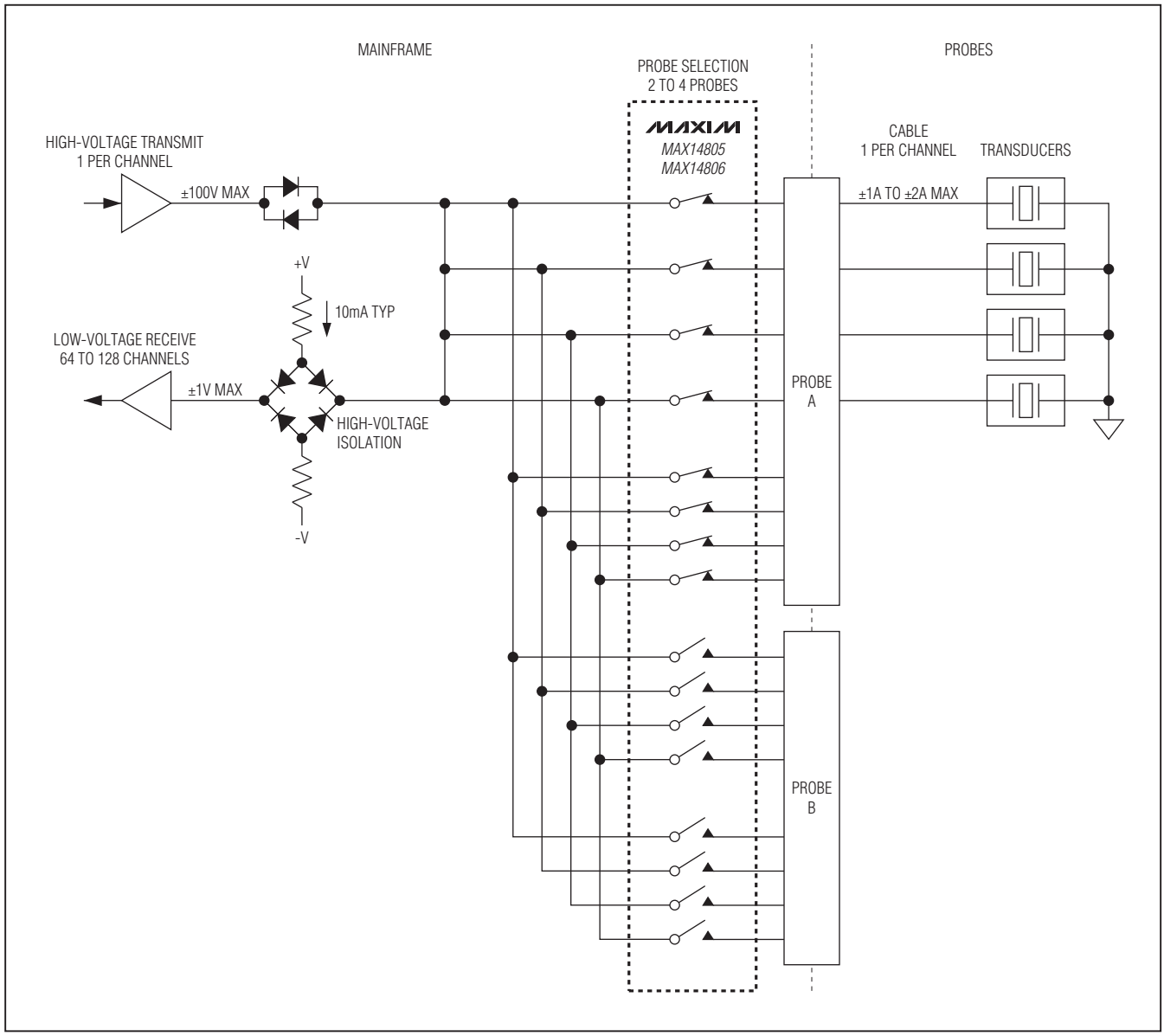


Figure 3. Relay Replacement Application in Medical System

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

Application Diagram (continued)

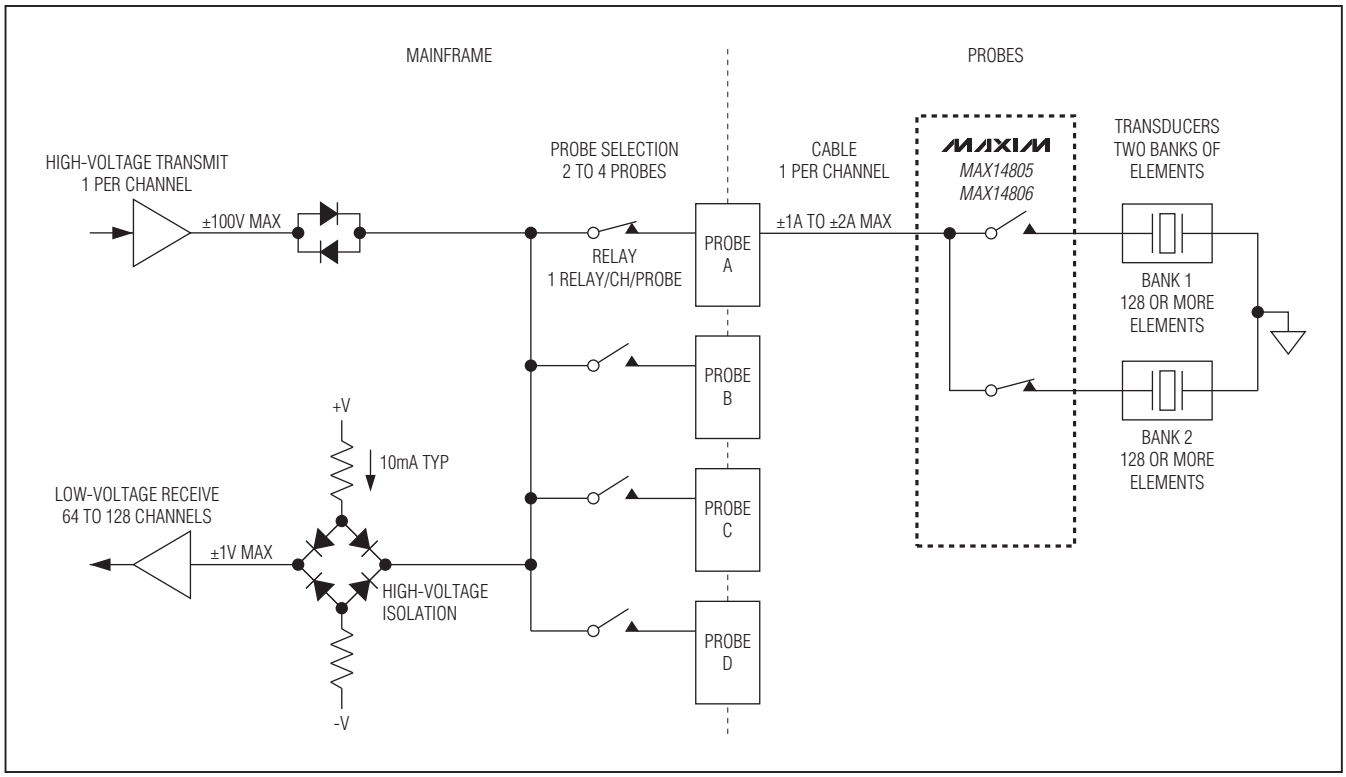
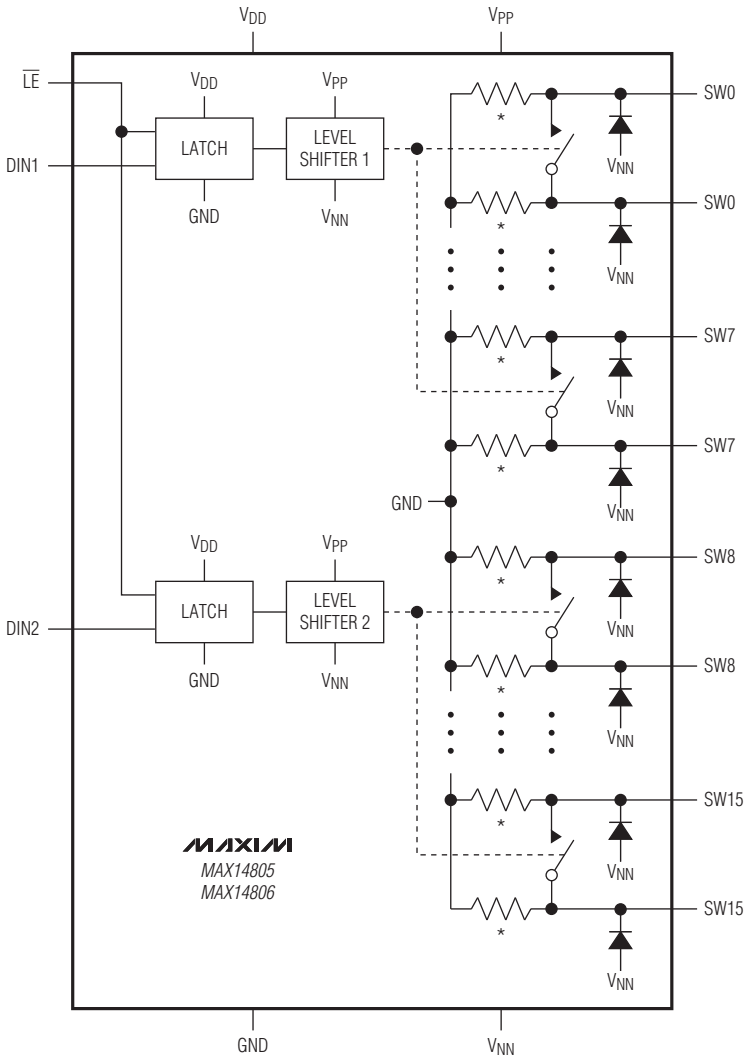


Figure 4. Probe Banks Selection in Biplane or Triplane Probe

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

Functional Diagram



*BLEED RESISTORS AVAILABLE ON THE MAX14806 ONLY.

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	21-0054

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

Revision History

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