MAX5486

Stereo Volume Control with Pushbutton Interface

General Description

The MAX5486 dual 40kΩ logarithmic taper volume control features a debounced pushbutton up/down interface that controls volume and balance in audio applications. Each potentiometer has 32 log-spaced tap points with a buffered wiper output to replace mechanical potentiometers. An integrated bias generator provides the required $((V_{DD} + V_{SS})/2)$ bias voltage, eliminating the need for costly external op-amp circuits in unipolar audio applications. A mode-indicator LED output indicates volume or balance control. Five integrated LED drivers indicate volume level or balance settings, depending on the status of the mode indicator.

Use the MAX5486 digital inputs with momentary contact single-pole/single-throw (SPST) pushbutton switches. Each input includes internal debounced circuitry and a pullup resistor to V_{LOGIC}.

The MAX5486 advances the wiper setting once per button push. Maxim's proprietary SmartWiper™ control eliminates the need for a microcomputer to increase the wiper transition rate. The accelerated auto-advance feature provides a wiper-changing rate at 4Hz for holding the control input low for more than 250ms and at 8Hz after 500ms and then at 11Hz after 1000ms (see Table 2).

All of the MAX5486's pushbutton inputs are debounced. The mute input allows a single pushbutton to change between volume control and the -90dB (typ) mute setting. The mode input toggles between volume and balance control. The click-and-pop suppression feature minimizes the audible noise generated by wiper transitions. The typical total harmonic distortion plus noise (THD+N) for the device is 0.003%. The MAX5486 provides a nominal temperature coefficient of 35ppm/°C end-to-end and 5ppm/°C ratiometrically and a nominal resistance of 40kΩ per potentiometer. The MAX5486 is available in a 24-pin TSSOP package and is specified for operation over the -40°C to +85°C extended temperature range.

Applications

- Home-Theater Speakers
- Desktop Speakers
- Portable Media Players
- Docking Stations

SmartWiper is a trademark of Maxim Integrated Products, Inc.

Features

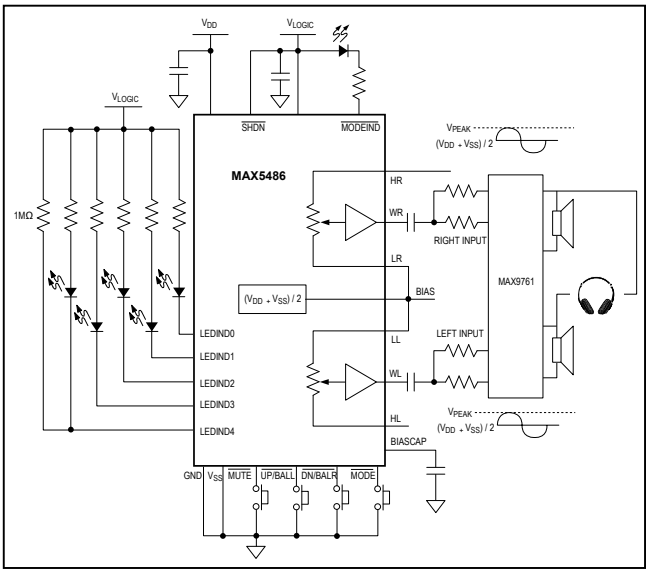
- Debounced Pushbutton Interface
- SmartWiper Control Advances Wiper Rate
- Low-Power Wiper Buffers Provide 0.003% THD+N
- Bias Generator Eliminates External Op Amps
- Five-Segment LED Volume/Balance Indicator
- Clickless Switching
- Logarithmic Taper Volume Control with (31) 2dB Steps
- Single +2.7V to +5.5V or Dual ±2.7V Supply Voltage Operation
- Power-On Reset to -12dBFS Wiper Position
- $\overline{\text{MUTE}}$ Function Toggles to 90dB (typ)
- Low 1µA Shutdown Supply Current
- 40kΩ End-to-End Fixed Resistance Value
- Small, 24-Pin TSSOP Package

Ordering Information

PART	TEMP RANGE	PIN-PACKAGE
MAX5486EUG+	-40°C to +125°C	24 TSSOP

+Denotes a lead(Pb)-free/RoHS-compliant package.

Typical Operating Circuit



maxim integrated™

Absolute Maximum Ratings

$\overline{SHDN}$, $\overline{MODE}$, $\overline{MUTE}$, $\overline{UP}/\overline{BALL}$, and $\overline{DN}/\overline{BALR}$ to GND ..... -0.3V to the lower of (V_{LOGIC} + 0.3V and +6V)
H_, L_, W_, BIASCAP, BIAS to GND .....-0.3V to the lower of (V_{DD} + 0.3V and +6V)
LEDIND_, $\overline{MODEIND}$ to GND .....-0.3V to +6V
V_{LOGIC} to GND .....-0.3V to +6V
V_{DD} to GND .....-0.3V to +6V
V_{DD} to V_{LOGIC} .....-6V to +6V
G_{ND} to V_{SS} .....-0.3V to +6V
V_{DD} to V_{SS}.....-0.3V to +6V

Average Current into H_, L_, and W_.....±1mA
Maximum Continuous Current into H_, L_.....±4mA
Input and Output Latchup Immunity.....±200mA
Continuous Power Dissipation (T_A = +70°C)
24-Pin TSSOP (derate 8.3mW/°C above +70°C).....657mW
Operating Temperature Range..... -40°C to +85°C
Storage Temperature Range..... -60°C to +150°C
Maximum Junction Temperature .....+150°C
Lead Temperature (soldering, 10s) .....+300°C

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_{SS} = GND = 0V, 2.7V ≤ (V_{DD} - V_{SS}) ≤ 5.5V, $C_{BIASCAP}$ = 1µF, BIAS = 3kΩ to GND, V_{LOGIC} = +2.7V to V_{DD}, $V_{H_}$ = V_{DD} - 0.15V, $V_{L_}$ = (V_{DD} - V_{SS})/2, $\overline{SHDN}$ = $\overline{MUTE}$ = V_{LOGIC}, all LED outputs open, pushbutton interface inactive, V_H = V_{BIAS} + $1V_{RMS}$, VBIAS = (V_{DD} - V_{SS})/2, T_A = T_{MIN} to T_{MAX}, unless otherwise specified. Typical values are at T_A = +25°C.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
RESISTOR LADDER						
End-to-End Resistance	R			40		kΩ
Absolute Tolerance				±0.25		dB
Tap-to-Tap Tolerance		(Note 2)		±0.1		dB
VOLUME CONTROL						
Total Harmonic Distortion Plus Noise	THD+N	V_{DD} = 5V, V_{SS} = 0V, V_H = (V_{DD}/2) + $1V_{RMS}$, V_L = V_{DD}/2, 1kHz, tap at top, R_L = 10kΩ to V_L = V_{DD}/2, 20Hz to 20kHz		0.003		%
		V_{DD} = 5V, V_{SS} = 0V, V_H = (V_{DD}/2) + $1V_{RMS}$, V_L = V_{DD}/2, 1kHz, tap at top, R_L = Ω to V_L = V_{DD}/2, 20Hz to 20kHz		0.001		
		V_{DD} = 5V, V_{SS} = 0V, V_H = (V_{DD}/2) + $1.5V_{RMS}$, VL = V_{DD}/2, 1kHz, tap at top, R_L = 10kΩ to V_L = V_{DD}/2, 20Hz to 20kHz		0.012		
Channel Isolation		V_{DD} = +2.7V, V_{SS} = -2.7V, V_{BIAS} = GND		100		dB
Interchannel Matching				±0.5		dB
Mute Attenuation		$\overline{SHDN}$ = V_{DD}		90		dB
Power-Supply Rejection Ratio	PSRR	Input referred, 217Hz, $100mV_{P-P}$ on V_{DD}		72		dB
H Terminal Capacitance	C_H			5		pF
L Terminal Capacitance	C_L			7		pF
End-to-End Resistance Temperature Coefficient				35		ppm/°C
Ratiometric Resistance Temperature Coefficient				5		ppm/°C
Bandwidth, -3dB	f_{CUTOFF}	C_W = 50pF		100		kHz

Electrical Characteristics (continued)

(V_{DD} = +2.7V to +5.5V, V_{SS} = GND = 0V, 2.7V ≤ (V_{DD} - V_{SS}) ≤ 5.5V, $C_{BIASCAP}$ = 1µF, BIAS = 3kΩ to GND, V_{LOGIC} = +2.7V to V_{DD}, $V_{H_}$ = V_{DD} - 0.15V, $V_{L_}$ = (V_{DD} - V_{SS})/2, $\overline{SHDN}$ = $\overline{MUTE}$ = V_{LOGIC}, all LED outputs open, pushbutton interface inactive, V_H = V_{BIAS} + 1V_{RMS}, VBIAS = (V_{DD} - V_{SS})/2, T_A = T_{MIN} to T_{MAX}, unless otherwise specified. Typical values are at T_A = +25°C.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Output Noise	e_N	20Hz to 20kHz, V_H = V_L = V_{DD}/2 = AC ground, tap = -6dB		2.2		μV_{RMS}
WIPER BUFFER						
Output Voltage Swing	V_O	R_L = 3kΩ to V_{BIAS}		V_{DD} - 0.3V		V
Output Current			3			mA
Output Current	R_{OWB}			1	10	Ω
DC Offset	V_{OS}			±2	±14	mV
INTEGRATED BIAS GENERATOR						
Output Voltage		R_L > 100kΩ	(V_{DD} + V_{SS})/2 - 20mV	(V_{DD} + V_{SS})/2	(V_{DD} + V_{SS})/2 + 20mV	V
Power-Supply Rejection Ratio		At 1kHz, 100mV_{P-P} on V_{DD}		60		dB
Minimum Load Resistance				3		kΩ
Maximum Load Capacitance				100		pF
Output Resistance	R_{OBR}			6		Ω
Noise Voltage		20Hz to 20kHz		2.2		μV_{RMS}
Minimum Output Current				2		mA
CONTACT INPUTS ($\overline{MUTE}$, $\overline{MODE}$, $\overline{UP}$/BALL, $\overline{DN}$/$\overline{BALR}$)						
Internal Pullup Resistor	R_{PU}			42		kΩ
Single-Pulse Input Low Time	t_{CPW}	Time required for a single pulse to cause an increment/decrement	16			ms
Repetitive Input Pulse Separation Time	t_{IPWS}		1			ms
Timeout Period	t_{WS}	Click-and-pop suppression inactive		126		ms
Debounce Corner Frequency		Internal analog filter		10		kHz
DIGITAL INPUTS (V_{LOGIC} > 4.5V)						
Input High Voltage	V_{IH}	V_{LOGIC} > 4.5V	2.4			V
		V_{LOGIC} < 4.5V	0.7 x V_{LOGIC}			
Input Low Voltage	V_{IL}	V_{LOGIC} > 4.5V			0.8	V
		V_{LOGIC} < 4.5V			0.3 x V_{LOGIC}	
Input Leakage Current		To GND for inputs with internal pullup resistors			±1	µA
Input Capacitance				5		pF
Digital Clock Feedthrough		f_{CLK} = 1Hz to 40Hz, tap = -6dB		-90		dB

Electrical Characteristics (continued)

(V_{DD} = +2.7V to +5.5V, V_{SS} = GND = 0V, 2.7V ≤ (V_{DD} - V_{SS}) ≤ 5.5V, $C_{BIASCAP}$ = 1µF, BIAS = 3kΩ to GND, V_{LOGIC} = +2.7V to V_{DD}, $V_{H_}$ = V_{DD} - 0.15V, $V_{L_}$ = (V_{DD} - V_{SS})/2, $\overline{SHDN}$ = $\overline{MUTE}$ = V_{LOGIC}, all LED outputs open, pushbutton interface inactive, V_H = V_{BIAS} + 1V_{RMS}, VBIAS = (V_{DD} - V_{SS})/2, T_A = T_{MIN} to T_{MAX}, unless otherwise specified. Typical values are at T_A = +25°C.) (Note 1)

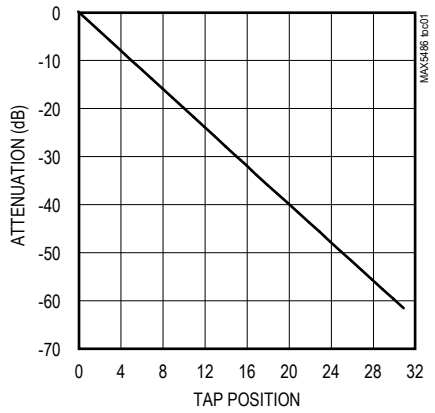
PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
POWER SUPPLIES						
Positive Power Supply	V_{DD}	V_{SS} = 0V	2.7		5.5	V
Negative Power Supply	V_{SS}	V_{DD} = +2.7V	-2.7		0	V
Supply-Voltage Difference		V_{DD} - V_{SS}			5.5	V
Analog Supply Current	I_{DD}	(Note 3)			1.4	mA
Power-Up Time	t_{PU}			126		ms
Logic Supply Voltage	V_{LOGIC}	V_{SS} = 0V	27		V_{DD}	V
Logic Active Supply Current	I_{LOGIC}	V_{LOGIC} = V_{DD} (Note 4)			200	µA
Logic Standby Supply Current (Note 3)	$I_{LOGICSTBY}$	V_{DD} = +5V, V_{SS} = 0V			1	µA
		V_{DD} = +2.7V, V_{SS} = -2.7V			1	
Shutdown Current	I_{SHDN}	$V_{\overline{SHDN}}$ = 0V, total of all supplies		1		µA
Shutdown Time/Return from Shutdown	t_{SHDN}	After 1st zero crossing		1		ms
LED INDICATORS (LEDIND0–LEDIND4, $\overline{MODEIND}$)						
Output Low Voltage	V_{OL}	V_{LOGIC} = 2.7V, I_{SINK} = 10mA			0.4	V
		V_{LOGIC} = 5V, I_{SINK} = 10mA			0.2	
Maximum Output Leakage Current				10		µA
Output Capacitance				3		pF

Note 1: Parameters are 100% production tested at +85°C and limits through the temperature range are guaranteed by design.
Note 2: Tap-to-tap tolerance is the error in voltage change between successive tap positions.
Note 3: Supply current measured while wiper position is fixed.
Note 4: One button pressed.

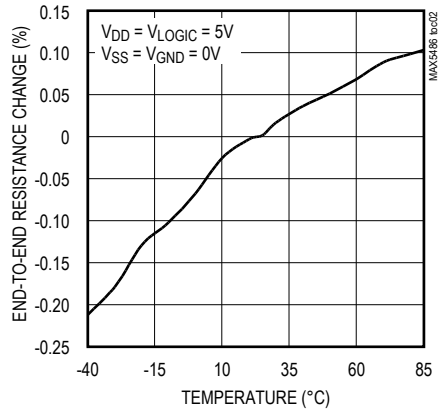
Typical Operating Characteristics

(V_{DD} = +5.0V, V_{SS} = GND = 0V, V_{LOGIC} = +5.0V, $V_{H_}$ = V_{DD} - 0.15V, $V_{L_}$ = V_{DD}/2, $C_{BIASCAP}$ = 1µF.)

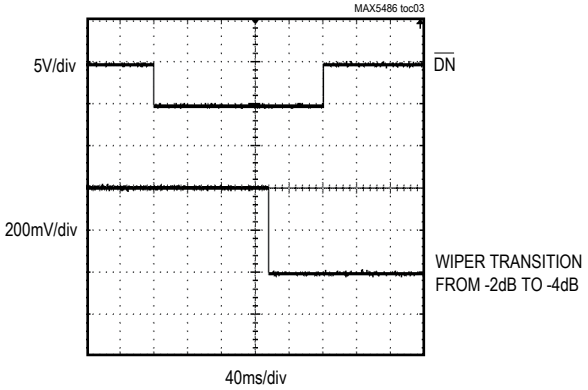
ATTENUATION vs. TAP POSITION



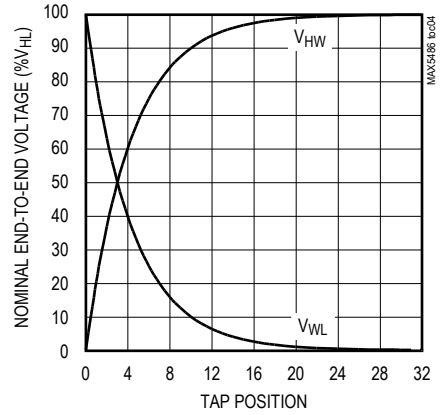
END-TO-END RESISTANCE % CHANGE vs. TEMPERATURE



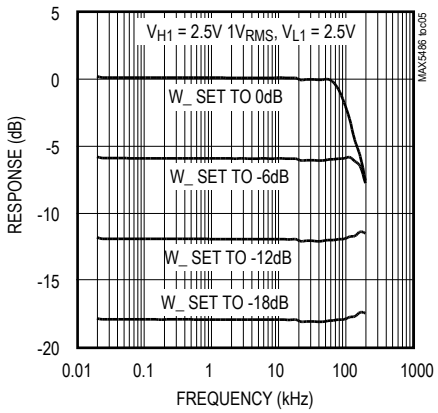
WIPER SWITCHING TRANSIENT



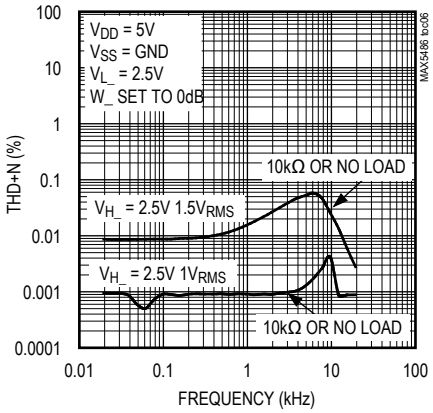
WIPER-TO-END TERMINAL VOLTAGE vs. TAP POSITION



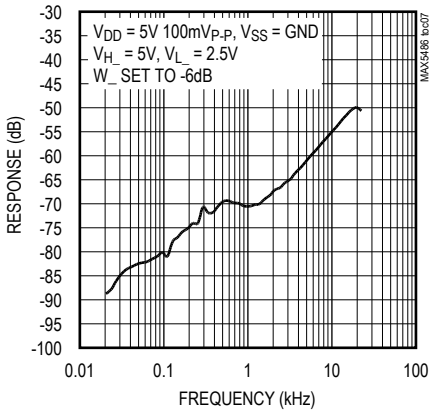
FREQUENCY RESPONSE



TOTAL HARMONIC DISTORTION PLUS NOISE vs. FREQUENCY



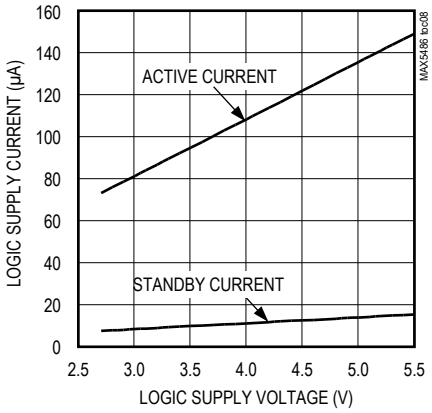
POWER-SUPPLY REJECTION RATIO



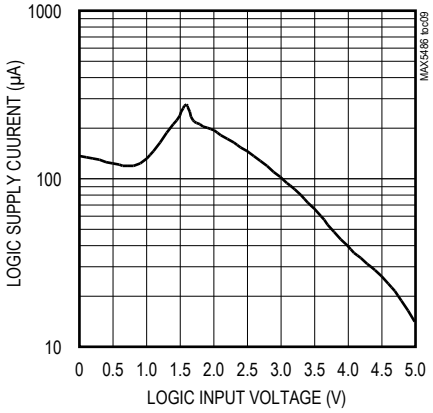
Typical Operating Characteristics (continued)

(V_{DD} = +5.0V, V_{SS} = GND = 0V, V_{LOGIC} = +5.0V, $V_{H_}$ = V_{DD} - 0.15V, $V_{L_}$ = V_{DD}/2, $C_{BIASCAP}$ = 1µF.)

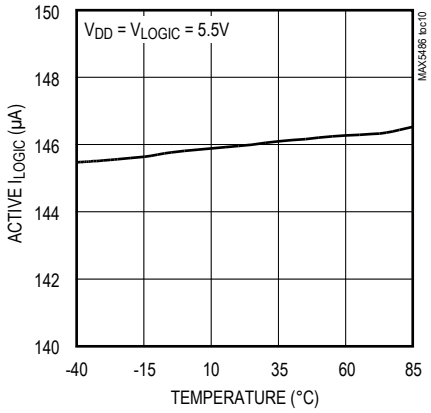
LOGIC SUPPLY CURRENT vs. LOGIC SUPPLY VOLTAGE



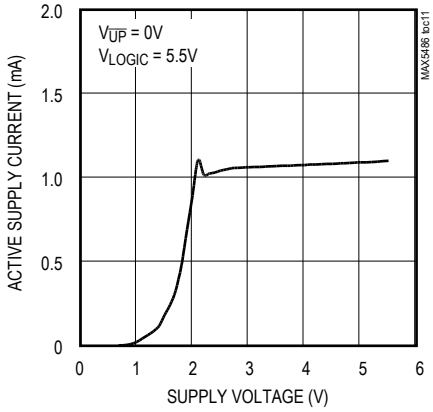
LOGIC SUPPLY CURRENT vs. LOGIC INPUT VOLTAGE



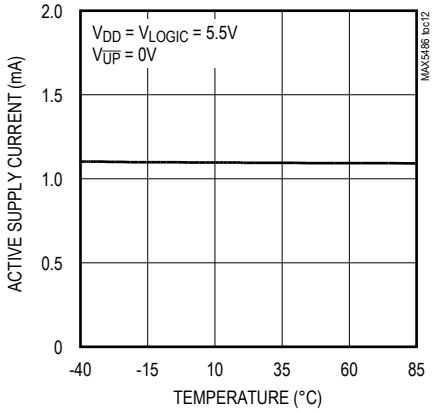
ACTIVE LOGIC SUPPLY CURRENT vs. TEMPERATURE



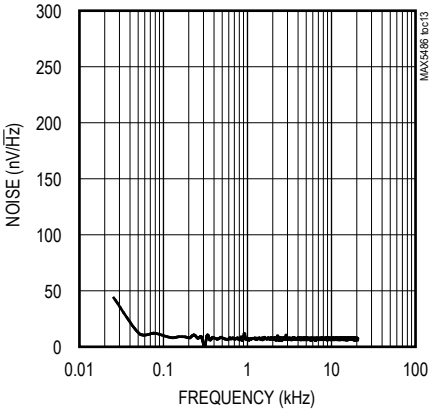
ACTIVE SUPPLY CURRENT vs. SUPPLY VOLTAGE



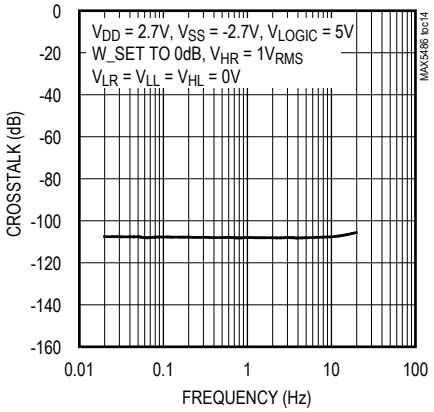
ACTIVE SUPPLY CURRENT vs. TEMPERATURE



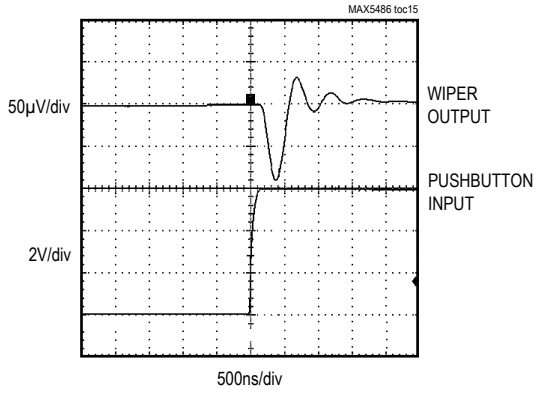
SPECTRAL NOISE DENSITY



CROSSTALK vs. FREQUENCY



DIGITAL FEEDTHROUGH



Pin Description

PIN	NAME	FUNCTION
1	V_{LOGIC}	Digital Logic Power Supply. Bypass V_{LOGIC} to ground with a 0.1µF capacitor as close as possible to the device.
2	$\overline{DN}/\overline{BALR}$	Active-Low Downward Volume/Balance Control. Press $\overline{DN}/\overline{BALR}$ to decrease the volume in volume mode and move balance to the right in balance mode. $\overline{DN}/\overline{BALR}$ is internally pulled high with a resistor to V_{LOGIC}.
3	$\overline{UP}/\overline{BALL}$	Active-Low Upward Volume/Balance Control. Press $\overline{UP}/\overline{BALL}$ to increase the volume in volume mode and move balance to the left in balance mode. $\overline{UP}/\overline{BALL}$ is internally pulled high with a resistor to V_{LOGIC}.
4	$\overline{MUTE}$	Active-Low Mute Input. Pull $\overline{MUTE}$ low to toggle the wiper between the mute setting (see Table 1) and the current setting. $\overline{MUTE}$ is internally pulled up to V_{LOGIC} with a resistor.
5	$\overline{MODE}$	Active-Low Volume/Balance Control Input. Each high-to-low transition on $\overline{MODE}$ toggles between the volume and balance modes. MODE is pulled high internally with a resistor to V_{LOGIC}. On power-up, the MAX5486 is in volume control mode.
6	$\overline{SHDN}$	Active-Low Shutdown Input. Drive $\overline{SHDN}$ low to place the device in shutdown mode. In shutdown mode, the MAX5486 stores the last wiper settings. The wipers move to the L_ end of the resistor string. Terminating the shutdown mode restores the wipers to the previous settings.
7	N.C.	Internally connected. Leave unconnected.
8	HR	Potentiometer R High Terminal
9	LR	Potentiometer R Low Terminal
10	WR	Potentiometer R Wiper Buffered Output
11	BIAS	Midbias Voltage Output. $V_{BIAS} = (V_{DD} + V_{SS})/2$; connect a 100pF capacitor from BIAS to V_{SS}.
12	BIASCAP	Bias Generator Bypass. Connect a 1µF filter capacitor from BIASCAP to V_{SS}.
13	V_{DD}	Analog Power Supply. Bypass V_{DD} to ground with a 0.1µF capacitor as close as possible to the device.
14	V_{SS}	Negative Power Supply. Bypass V_{SS} to ground with a 0.1µF capacitor as close as possible to the device. Connect to GND for single-supply operation.
15	WL	Potentiometer L Wiper Buffered Output
16	LL	Potentiometer L Low Terminal
17	HL	Potentiometer L High Terminal
18–22	LEDIND0–LEDIND4	LED Indicator Open-Drain Output 0–LED Indicator Open-Drain Output 4. Connect a 1MΩ resistor from LEDIND4 to V_{LOGIC} to enable these LED inductor drivers. LEDIND0–LEDIND4 form a bar graph indication of the current volume or balance. In volume mode, all LEDs off indicate mute and all LEDs on indicate maximum volume. In balanced mode, LED2 on indicates centered or balanced. Connect LEDIND0–LEDIND4 to GND when LED indicator drivers are not used.
23	$\overline{MODEIND}$	Active-Low Volume-Control/Balance-Control Mode-Indicator Open-Drain Output. Connect to an LED through a resistor to V_{LOGIC}. When the LED is on, the MAX5486 is in balance-control mode. When the LED is off, the MAX5486 is in volume-control mode.
24	GND	Ground

Detailed Description

The MAX5486 dual 40kΩ logarithmic taper digital volume control features a debounced pushbutton interface that controls volume and balance in audio applications. Each potentiometer has 32 log-spaced tap points with a buffered wiper output and replaces mechanical potentiometers.

Mode Control ($\overline{MODE}$)

The MAX5486 $\overline{MODE}$ input toggles between volume and balance modes. Each time $\overline{MODE}$ is forced low, the device switches between volume and balance modes. For example, driving $\overline{MODE}$ low once while in volume-control mode switches the MAX5486 to balance mode. Driving $\overline{MODE}$ low again switches the MAX5486 back to volume mode. $\overline{MODE}$ is internally pulled high with a resistor to V_{LOGIC}. The MAX5486 powers up in volume-control mode. Leave unconnected or connect to V_{LOGIC} if balance mode is not required.

Up-and-Down Interface

The MAX5486 interfaces with momentary contact SPST switches. All switch inputs are internally debounced and pulled up to V_{LOGIC} through resistors. The wiper setting advances once per button press up to 250ms. Maxim's SmartWiper control circuitry allows the wiper to advance at a 4Hz rate after holding the button for approximately 250ms. After 500ms, the wiper moves at an 8Hz rate. After 1s, the rate increases to 11Hz (see Table 2). The SmartWiper control eliminates the need for a microcomputer to increase the wiper transition rate.

The MAX5486 $\overline{MODE}$ input toggles the part between volume and balance-control modes. The $\overline{UP}$/$\overline{BALL}$ and $\overline{DN}$/$\overline{BALR}$ inputs control the wiper according to the selected mode. $\overline{MODE}$ is internally pulled high with a resistor to V_{LOGIC}.

Volume Control

In volume-control mode, the MAX5486's wipers move simultaneously, maintaining the balance separation between each wiper (Figure 2a).

When either wiper reaches the maximum tap position (position closest to H_), further commands to increase the volume are ignored. Balance separation is maintained in the maximum volume configuration (Figure 2b).

When either wiper reaches the minimum tap position (position closest to L_), further commands to decrease the volume adjust the other wiper until it also reaches the minimum tap position (Figure 2c). Increasing the volume from this minimum position restores the original balance separation of the wipers (Figure 2d).

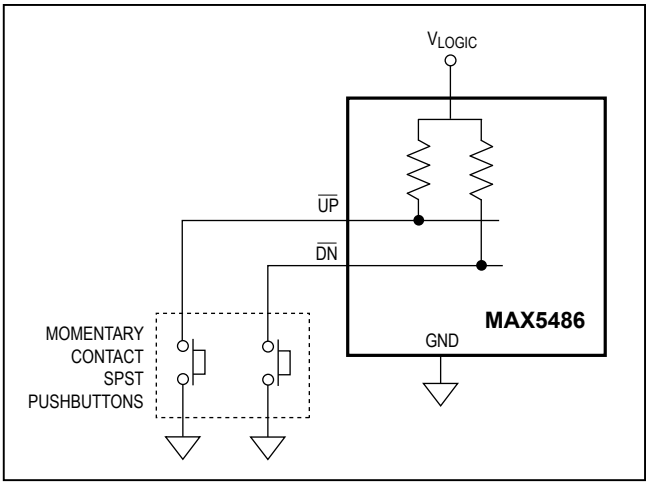


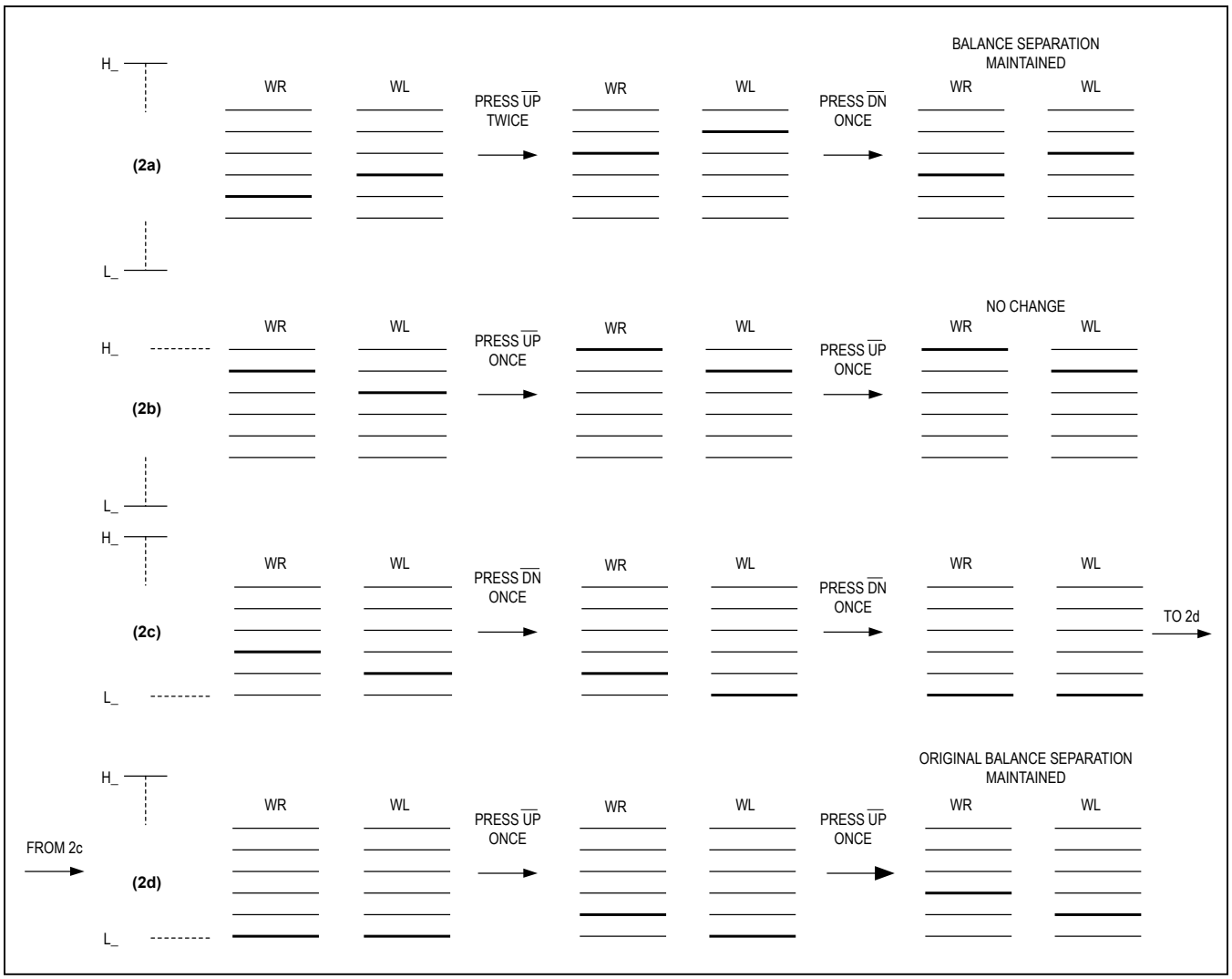
Figure 1. Pushbutton Interface

Table 1. Wiper Position and Attenuation

POSITION	ATTENUATION (dB)
0	0
1	2
2	4
3	6
4	8
...	...
30	60
31	62
32 (mute)	> 90

Table 2. Wiper Action vs. Pushbutton Contact Duration

CONTACT DURATION	WIPER ACTION
t ≤ 16ms	No motion.
16ms < t ≤ 250ms	Wiper changes position once.
250ms < t ≤ 500ms	SmartWiper begins. Wiper changes position at a rate of 4Hz.
500ms < t ≤ 1000ms	Wiper changes position at a rate of 8Hz.
t > 1000 ms	Wiper changes position at a rate of 11Hz.



Figures 2a–2d. Volume-Control Operation

When both wipers are in the tap 31 position (-62dB attenuation), further commands to $\overline{DN}/\overline{BALR}$ place the wipers in the mute position (see Table 1). $\overline{UP}/\overline{BALL}$ or $\overline{MUTE}$ pulses return the wipers to tap 31.

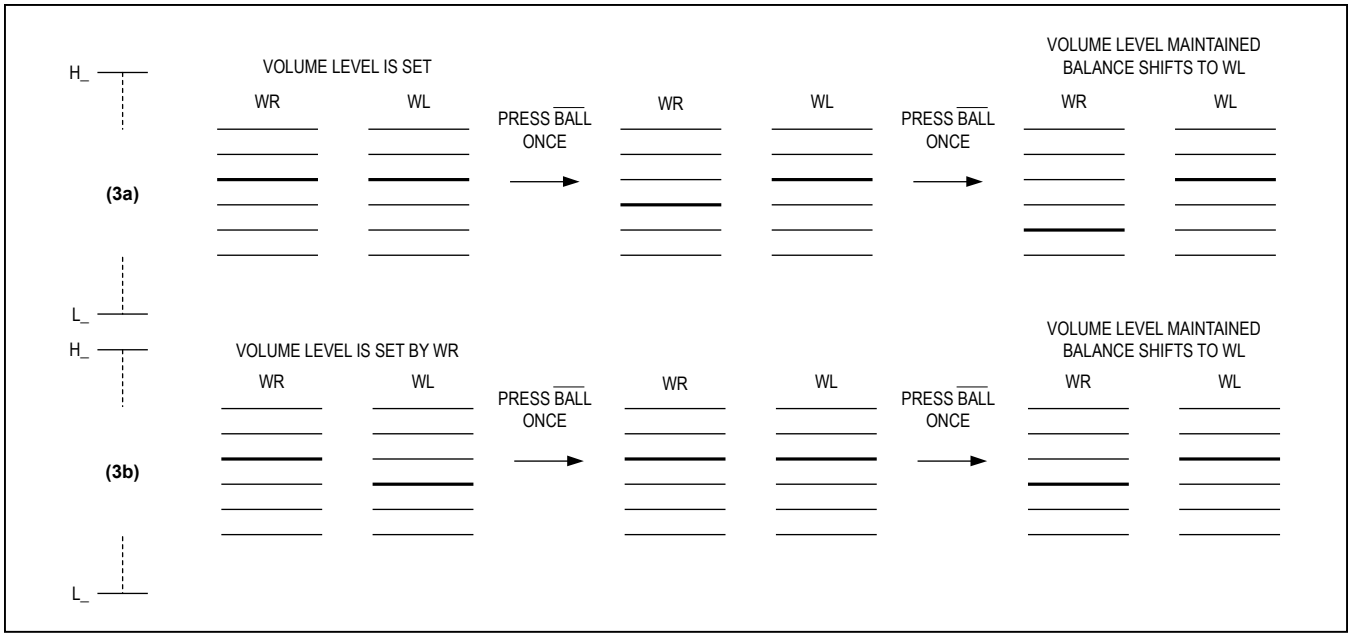
Balance Control

In balance-control mode, the MAX5486 adjusts the balance between the right and left channels while maintaining the set volume. For example, if the volume of the right channel equals the volume of the left channel, forcing the balance towards the left channel increases the attenuation of the right channel (Figure 3a). If the left channel is at a higher attenuation than the right channel, adjusting the balance to the left channel moves the left channel's wiper up to the same wiper position as the right channel before it was attenuated (Figure 3b).

Click-and-Pop Suppression

The click-and-pop suppression feature reduces the audible noise (clicks and pops) that results from wiper transitions. The MAX5486 minimizes this noise by allowing the wiper to change position only when $V_H = V_L$ (zero crossing) or after the zero crossing timeout (126ms). Each wiper has its own suppression and timeout circuitry. The MAX5486 changes wiper position when $V_H = V_L$, or after 32ms, whichever occurs first (see Figures 4a and 4b).

The suppression circuitry monitors left and right channels separately. In volume-control mode, when the first wiper



Figures 3a and 3b. Balance-Control Operation

changes position, the second wiper has 126ms to change or it changes automatically.

Power-On Reset

The power-on comparators monitor (V_{DD} - V_{SS}) and (V_{LOGIC} - GND). A power-on reset is initiated when either of the supplies is brought back to the normal operating voltage. The power-on reset feature sets both wipers to -12dB. The wipers initially wake up in mute mode (-90dB) and move to the -12dB position when V_H = V_L to eliminate clicks and pops during power-up. With DC inputs at V_H and V_L, the wipers move after exceeding the timeout period. A power-on reset places the MAX5486 in volume-control mode.

Shutdown ($\overline{SHDN}$)

Upon entering shutdown, the MAX5486 stores the last wiper settings. The wipers move to the L_ end of the resistor string when V_H = V_L to eliminate clicks and pops during shutdown. With DC inputs at V_H and V_L, the wipers move after exceeding the timeout period. Exiting shutdown restores the wipers to their previous settings. Shutdown also turns off all the LED indicators to save power.

Mute Function ($\overline{MUTE}$)

The MAX5486 features a mute function input, $\overline{MUTE}$. Successive low pulses on $\overline{MUTE}$ toggle its setting. Activating the mute function forces both wipers to maximum attenuation (-90dB typ). Deactivating the mute function returns the wipers to their previous settings. $\overline{MUTE}$ is internally pulled high with a resistor to V_{LOGIC}. When both wipers are in the tap 31 position (-62dB attenuation) further commands to lower the volume place the wipers in the mute position (see Table 1).

Mode Indicator ($\overline{MODEIND}$)

The open-drain $\overline{MODEIND}$ indicates volume-control mode or balance-control mode for the MAX5486. Connect $\overline{MODEIND}$ to an LED with a series resistor to V_{LOGIC}. When the LED is on, the MAX5486 is in balance-control mode. When the LED is off, the MAX5486 is in volume-control mode. See the *Mode Control ($\overline{MODE}$)* section for more detail on switching between modes.

Level Indicator LEDs

The MAX5486 includes five indicator LED drivers to display the current wiper settings in either volume or balance mode. The LED indicators are enabled by connecting a 1MΩ resistor between LEDIND4 and V_{LOGIC}. Connect the LEDIND_ outputs to the LEDs and to V_{LOGIC} through a series resistor as shown in the *Typical Operating Circuit*. Connect LEDIND_ outputs to GND when LED indicator drivers are not used.

In volume-control mode, all LEDs are off when the wipers reach the highest attenuation levels (mute). All LEDs are on at the lowest attenuation levels (0dB).

Table 3. LED Settings in Volume Mode

VOLUME POSITION	WIPER ACTION				
	LED0	LED1	LED2	LED3	LED4
0dB to -8dB	1	1	1	1	1
-10dB to -18dB	1	1	1	1	0
-20dB to -28dB	1	1	1	0	0
-30dB to -38dB	1	1	0	0	0
-40dB to -52dB	1	0	0	0	0
-54dB to mute (-90dB)	0	0	0	0	0

Table 3 shows the LED display as the wipers transition through various attenuation levels.

A PWM circuit interpolates the high-resolution 32 steps between the five LEDs over the volume range from 0dB to -54dB. This feature provides visible indication for the attenuation levels from 0dB to -54dB. For example, LED4 brightness level decreases progressively with each -2dB step from 0dB to -8dB. PWM is disabled in the range -56dB to mute.

In balance-control mode, only one LED is on at a time to indicate the current balance setting. Figure 5 shows the LEDs display for the current balance setting. When LED2 is on, the display indicates that the channels are centered or balanced at a set volume level. When LED4 turns on, the balance shifts completely toward the right channel and the left channel becomes fully attenuated.

Multiple Button Pushes

The MAX5486 does not respond to simultaneous button pushes. Additionally, a 16ms blocking period affects all other inputs when releasing any input that was forced low. The MAX5486 does not respond to any logic input until the blocking period ends. If multiple-control buttons are pressed, all wiper-control connections must be released before the device responds to further commands.

Applications Information

The *Typical Operating Circuit* shows a typical volume/balance application circuit using the MAX5486 in a single-supply configuration. The internally generated BIAS voltage eliminates the need for external op amps, and the wipers have internal low-power buffers for low distortion. Connect the W_ outputs of the MAX5486 to the left and right inputs of a stereo audio amplifier, such as the MAX9761. The pushbutton potentiometers attenuate the input signals. Use the $\overline{\text{MODE}}$ input to switch between volume-control and balance-control modes.

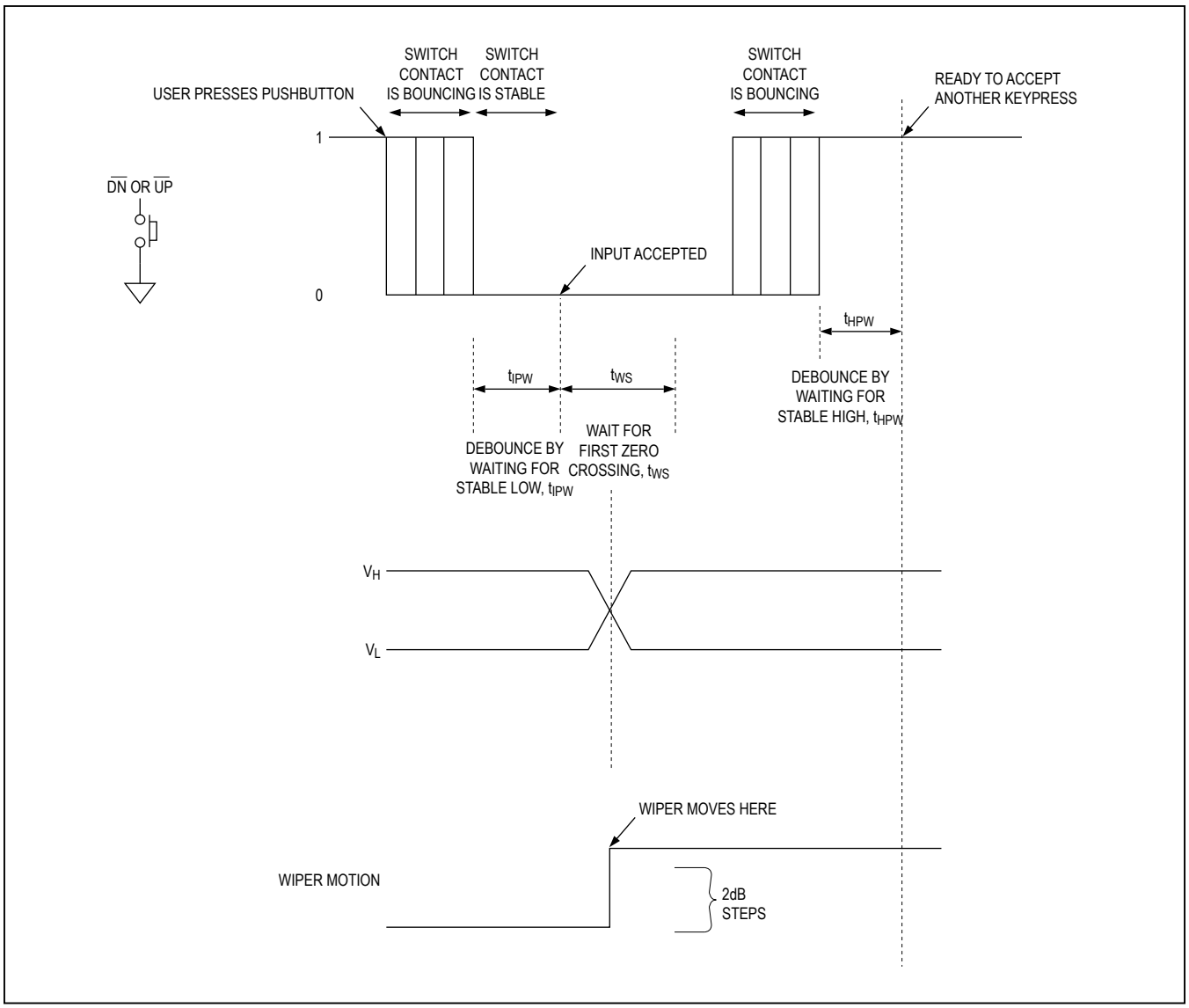


Figure 4a. Wiper Transition Timing Diagram—Suppression Circuitry Active

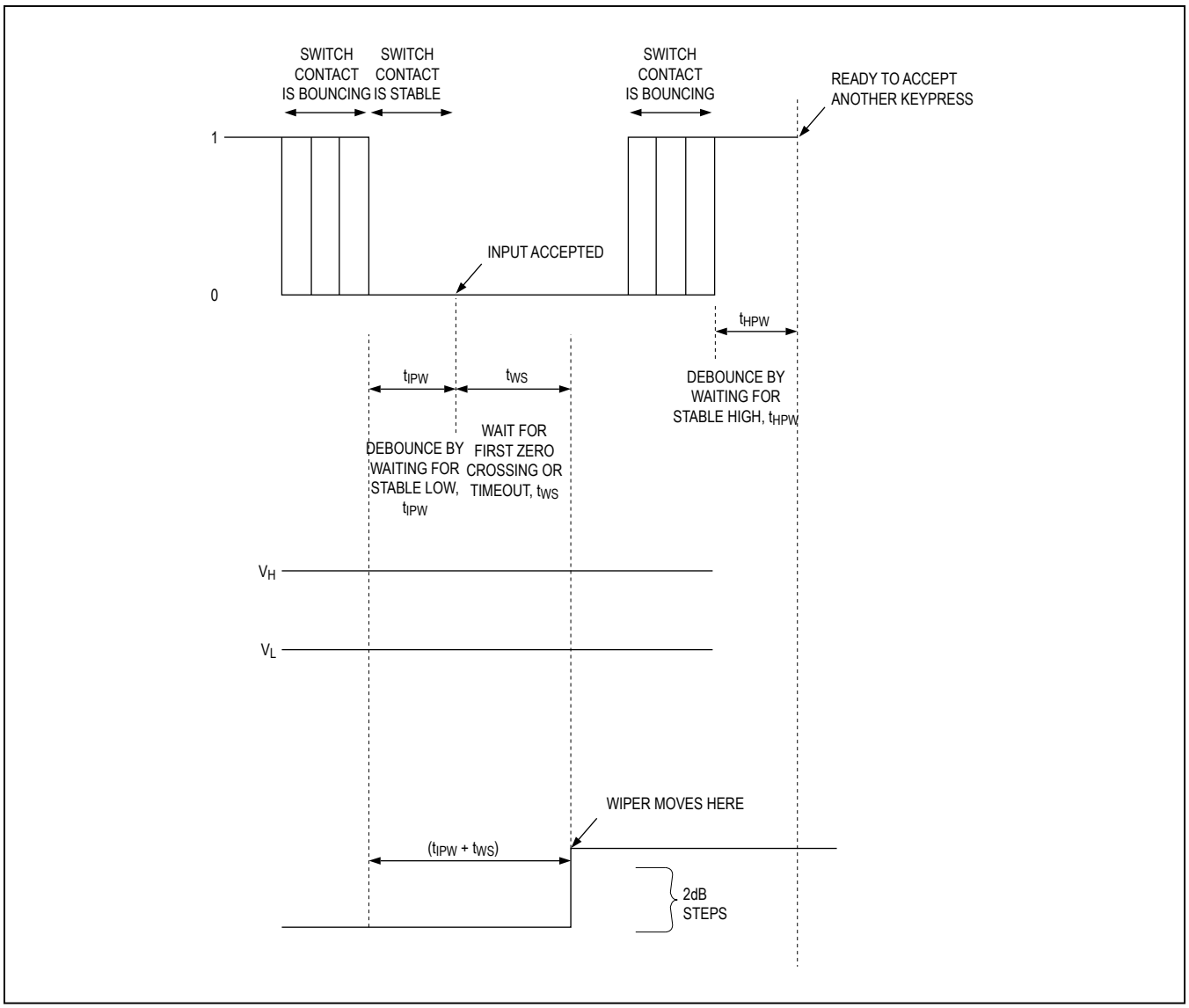


Figure 4a. Wiper Transition Timing Diagram—Suppression Circuitry Active

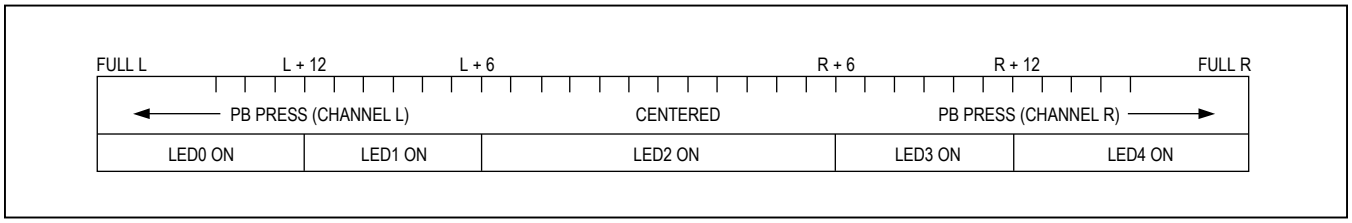
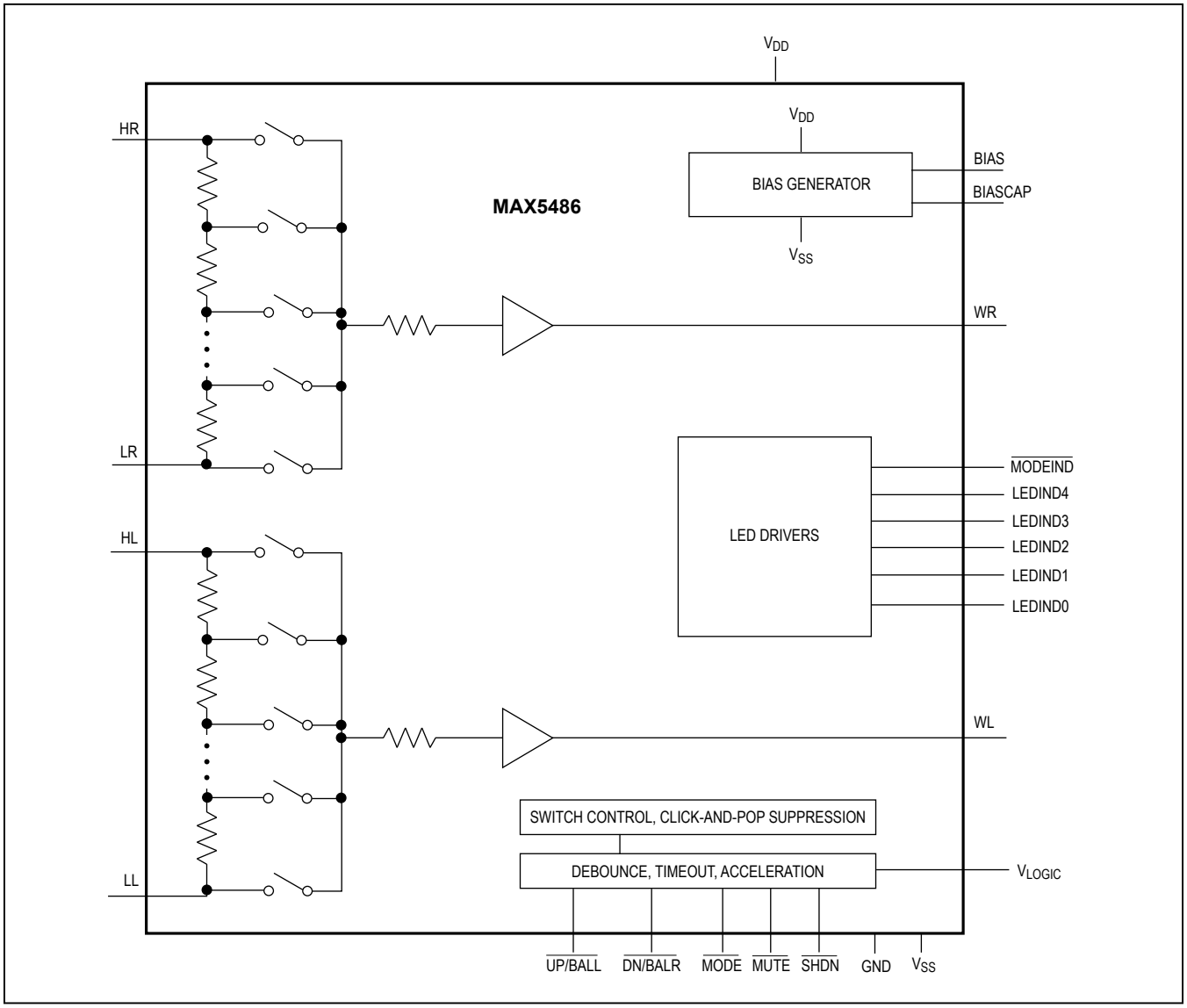
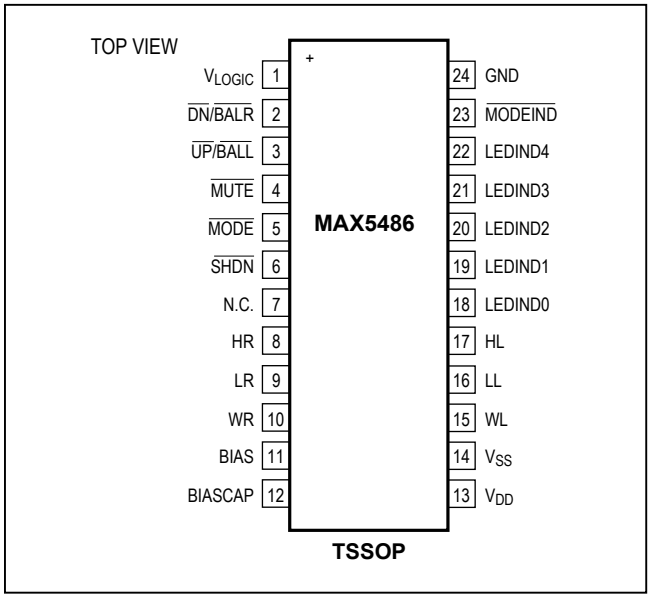


Figure 5. LED Settings in Balance Mode

Functional Diagram



Functional Diagram



Chip Information

PROCESS: BiCMOS

Package Information

For the latest package outline information and land patterns (footprints), go to www.maximintegrated.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	OUTLINE NO.	LAND PATTERN NO.
24 TSSOP	U24+1	**21-0066**	**90-0118**

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	11/06	Initial Release	—
1	4/14	Updated *Applications*	1

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

Maxim Integrated cannot assume responsibility for use of any circuitry other than circuitry entirely embodied in a Maxim Integrated product. No circuit patent licenses are implied. Maxim Integrated reserves the right to change the circuitry and specifications without notice at any time. The parametric values (min and max limits) shown in the Electrical Characteristics table are guaranteed. Other parametric values quoted in this data sheet are provided for guidance.

Maxim Integrated and the Maxim Integrated logo are trademarks of Maxim Integrated Products, Inc. © 2014 Maxim Integrated Products, Inc.