



Serially Controlled, Clickless Audio/Video Switches

MAX4571-MAX4574

General Description

The MAX4571-MAX4574 serial-interface controlled switches are ideal for multimedia applications. Each device features 35Ω max on-resistance, -90dB audio off-isolation at 20kHz, -60dB video off-isolation at 1.0MHz, and "clickless" mode operation for audio applications.

The MAX4571/MAX4573 contain eleven SPST switches, while the MAX4572/MAX4574 contain two SPST switches and six SPDT switches. The MAX4571/MAX4572 feature a 2-wire, I²C™-compatible serial interface. The MAX4573/MAX4574 feature a 3-wire, SPI™/QSPI™/MICROWIRE™-compatible serial interface. All four parts are available in 28-pin QSOP, SSOP, and wide SO packages and operate over the commercial and extended temperature ranges.

Applications

Set-Top Boxes Audio Systems
 PC Multimedia Boards Video Conferencing Systems

Pin Configurations



Features

- ◆ Selectable Soft Switching Mode for "Clickless" Audio Operation
- ◆ 35Ω max On-Resistance
- ◆ -90dB Audio Off-Isolation at 20kHz
-50dB Video Off-Isolation at 10MHz
- ◆ -90dB Audio Crosstalk at 20kHz
-52dB Video Crosstalk at 10MHz
- ◆ Serial Interface
 - 2-Wire, Fast-Mode, I²C-Compatible (MAX4571/72)
 - 3-Wire, SPI/QSPI/MICROWIRE-Compatible (MAX4573/74)
- ◆ Single-Supply Operation from +2.7V to +5.25V

Ordering Information

| PART | TEMP. RANGE | PIN-PACKAGE |
|------------|----------------|-------------|
| MAX4571CEI | 0°C to +70°C | 28 QSOP |
| MAX4571CAI | 0°C to +70°C | 28 SSOP |
| MAX4571CWI | 0°C to +70°C | 28 Wide SO |
| MAX4571EEI | -40°C to +85°C | 28 QSOP |
| MAX4571EAI | -40°C to +85°C | 28 SSOP |
| MAX4571EWI | -40°C to +85°C | 28 Wide SO |
| MAX4572CEI | 0°C to +70°C | 28 QSOP |
| MAX4572CAI | 0°C to +70°C | 28 SSOP |
| MAX4572CWI | 0°C to +70°C | 28 Wide SO |
| MAX4572EEI | -40°C to +85°C | 28 QSOP |
| MAX4572EAI | -40°C to +85°C | 28 SSOP |
| MAX4572EWI | -40°C to +85°C | 28 Wide SO |
| MAX4573CEI | 0°C to +70°C | 28 QSOP |
| MAX4573CAI | 0°C to +70°C | 28 SSOP |
| MAX4573CWI | 0°C to +70°C | 28 Wide SO |
| MAX4573EEI | -40°C to +85°C | 28 QSOP |
| MAX4573EAI | -40°C to +85°C | 28 SSOP |
| MAX4573EWI | -40°C to +85°C | 28 Wide SO |
| MAX4574CEI | 0°C to +70°C | 28 QSOP |
| MAX4574CAI | 0°C to +70°C | 28 SSOP |
| MAX4574CWI | 0°C to +70°C | 28 Wide SO |
| MAX4574EEI | -40°C to +85°C | 28 QSOP |
| MAX4574EAI | -40°C to +85°C | 28 SSOP |
| MAX4574EWI | -40°C to +85°C | 28 Wide SO |

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SPI/QSPI are trademarks of Motorola, Inc.

MICROWIRE is a trademark of National Semiconductor Corp.



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ABSOLUTE MAXIMUM RATINGS

V+ to GND-0.3V to +6V
 NO_-, COM_-, DOUT to GND (Note 1)-0.3V to (V+ + 0.3V)
 SCL, SDA, CS, SCLK, DIN, A0, A1 to GND.....-0.3V to +6V
 Continuous Current into Any Terminal.....±10mA
 Peak Current (pulsed at 1ms, 10% duty cycle).....±50mA
 Continuous Power Dissipation (T_A = +70°C)
 QSOP (derate 10.8mW/°C above +70°C)860mW

SSOP (derate 9.5mW/°C above +70°C)762mW
 Wide SO (derate 12.5mW/°C above +70°C).....1000mW
 Operating Temperature Ranges
 MAX457_C_.....0°C to +70°C
 MAX457_E_.....-40°C to +85°C
 Storage Temperature Range-65°C to +160°C
 Lead Temperature (soldering, 10sec)+300°C

Note 1: Signals on NO_ or COM_ exceeding V+ or V- are clamped by internal diodes. Limit forward-diode current to maximum current rating.

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—Single +5V Supply

(V+ = +5V ±5%, 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 | |
|--|---|--|---|------|------|-------|----|
| ANALOG SWITCHES | | | | | | | |
| Analog Signal Range (Note 3) | V _{NO_-} , V _{COM_-} | | 0 | | V+ | V | |
| On-Resistance | R _{ON} | I _{COM_-} = 4mA, V _{NO_-} = 3V, V+ = 4.75V | T _A = +25°C | 25 | 35 | Ω | |
| | | | T _A = T _{MIN} to T _{MAX} | | 45 | | |
| On-Resistance Match Between Channels (Note 4) | ΔR _{ON} | I _{COM_-} = 4mA, V _{NO_-} = 3V, V+ = 4.75V | T _A = +25°C | 0.8 | 3 | Ω | |
| | | | T _A = T _{MIN} to T _{MAX} | | 3 | | |
| On-Resistance Flatness (Note 5) | R _{FLAT} | I _{COM_-} = 4mA; V+ = 4.75V; V _{NO_-} = 1V, 2V, 3V | T _A = +25°C | 2 | 6 | Ω | |
| | | | T _A = T _{MIN} to T _{MAX} | | 6 | | |
| NO_ Off-Leakage Current (Note 6) | I _{NO_-} (OFF) | V _{NO_-} = 4.5V, 1V; V _{COM_-} = 1V, 4.5V; V+ = 5.25V | T _A = +25°C | -0.2 | 0.01 | 0.2 | nA |
| | | | T _A = T _{MIN} to T _{MAX} | -10 | | 10 | |
| COM_ Off-Leakage Current (Note 6) | I _{COM_-} (OFF) | V _{NO_-} = 4.5V, 1V; V _{COM_-} = 1V, 4.5V; V+ = 5.25V | T _A = +25°C | -0.2 | 0.01 | 0.2 | nA |
| | | | T _A = T _{MIN} to T _{MAX} | -10 | | 10 | |
| COM_ On-Leakage Current (Note 6) | I _{COM_-} (ON) | V _{COM_-} = 4.5V, 1V; V _{NO_-} = 4.5V, 1V, or floating; V+ = 5.25V | T _A = +25°C | -0.2 | 0.01 | 0.2 | nA |
| | | | T _A = T _{MIN} to T _{MAX} | -10 | | 10 | |
| AUDIO PERFORMANCE | | | | | | | |
| Total Harmonic Distortion plus Noise | THD+N | f _{IN} = 1kHz, R _L = 600Ω, V _{NO_-} = 1V _{RMS} , V _{NO_-} = 2.5V | | 0.07 | | % | |
| Off-Isolation (Note 7) | V _{ISO(A)} | V _{NO_-} = 1V _{RMS} , f _{IN} = 20kHz, R _L = 600Ω, Figure 1 | | -90 | | dB | |
| Channel-to-Channel Crosstalk | V _{CT(A)} | V _{NO_-} = 1V _{RMS} , f _{IN} = 20kHz, R _S = 600Ω, Figure 1 | | -90 | | dB | |

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ELECTRICAL CHARACTERISTICS—Single +5V Supply (continued)

(V+ = 5V ±5%, 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 |
|---|----------------------|--|---|------|-------|-------|
| VIDEO PERFORMANCE | | | | | | |
| Off-Isolation (Note 7) | V _{ISO(V)} | V _{NO--} = 1V _{RMS} , f _{IN} = 1.0MHz, R _L = 50Ω, Figure 1 | | -50 | | dB |
| Channel-to-Channel Crosstalk | V _{CT(V)} | V _{NO--} = 1V _{RMS} , f _{IN} = 1.0MHz, R _S = 50Ω, Figure 1 | | -52 | | dB |
| -3dB Bandwidth | BW | R _{SOURCE} = 50Ω, R _L = 50Ω | | >150 | | MHz |
| Off-Capacitance | C _{OFF(NO)} | f _{IN} = 1MHz | | 9 | | pF |
| DYNAMIC TIMING WITH CLICKLESS MODE DISABLED (Notes 8 and 12, Figure 2) | | | | | | |
| Turn-On Time | t _{ONSD} | V _{NO--} = 1.5V, R _L = 5kΩ, C _L = 35pF | T _A = +25°C | 200 | 500 | ns |
| | | | T _A = T _{MIN} to T _{MAX} | | | |
| Turn-Off Time | t _{OFFSD} | V _{NO--} = 1.5V, R _L = 300Ω, C _L = 35pF | T _A = +25°C | 75 | 300 | ns |
| | | | T _A = T _{MIN} to T _{MAX} | | | |
| Break-Before-Make Time | t _{BBM} | MAX4572/MAX4574, V _{NO--} = 1.5V, T _A = T _{MIN} to T _{MAX} | 10 | 125 | | ns |
| DYNAMIC TIMING WITH CLICKLESS MODE ENABLED (Note 8, Figure 2) | | | | | | |
| Turn-On Time | t _{ONSE} | V _{NO--} = 1.5V, R _L = 5kΩ, C _L = 35pF, T _A = +25°C | | 8 | | ms |
| Turn-Off Time | t _{OFFSE} | V _{NO--} or = 1.5V, R _L = 300Ω, C _L = 35pF, T _A = +25°C | | 3 | | ms |
| POWER SUPPLY | | | | | | |
| Supply Voltage Range | V+ | T _A = T _{MIN} to T _{MAX} | +2.7 | | +5.25 | V |
| Supply Current (Note 9) | I+ | All logic inputs = 0 or V+, T _A = T _{MIN} to T _{MAX} | | 6 | 10 | μA |

ELECTRICAL CHARACTERISTICS—Single +3V Supply

(V+ = 3V ±10%, 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 |
|--|---|---|---|-----|-----|-------|
| ANALOG SWITCHES | | | | | | |
| Analog Signal Range (Note 3) | V _{NO--} , V _{COM--} | | 0 | | V+ | V |
| On-Resistance | R _{ON} | I _{COM--} = 4mA, V _{NO--} = 2V, V+ = 2.7V | T _A = +25°C | 43 | 90 | Ω |
| | | | T _A = T _{MIN} to T _{MAX} | | | |
| On-Resistance Match Between Channels (Note 4) | ΔR _{ON} | I _{COM--} = 4mA, V _{NO--} = 2V, V+ = 2.7V | T _A = +25°C | 1 | 5 | Ω |
| | | | T _A = T _{MIN} to T _{MAX} | | | |

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ELECTRICAL CHARACTERISTICS—Single +3V Supply (continued)

(V+ = +3V ±10%, 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 |
|---|-------------------------|--|---|------|------|------|-------|
| On-Resistance Flatness (Note 5) | R _{FLAT} | I _{COM_} = 4mA; V+ = 2.7V; V _{NO_} = 1V, 5V, 2V | T _A = +25°C | | 4 | 10 | Ω |
| | | | T _A = T _{MIN} to T _{MAX} | | | 10 | |
| NO_ Off-Leakage Current (Notes 6 and 10) | I _{NO_} (OFF) | V _{NO_} = 3V, 0.5V; V _{COM_} = 0.5V, 3V; V+ = 3.6V | T _A = +25°C | -0.2 | 0.01 | 0.2 | nA |
| | | | T _A = T _{MIN} to T _{MAX} | -10 | | 10 | |
| COM_ Off-Leakage Current (Notes 6 and 10) | I _{COM_} (OFF) | V _{NO_} = 3V, 0.5V; V _{COM_} = 0.5V, 3V; V+ = 3.6V | T _A = +25°C | -0.2 | 0.01 | 0.2 | nA |
| | | | T _A = T _{MIN} to T _{MAX} | -10 | | 10 | |
| COM_ On-Leakage Current (Notes 6 and 10) | I _{COM_} (ON) | V _{COM_} = 3V, 0.5V; V _{NO_} = 3V, 0.5V, or floating; V+ = 3.6V | T _A = +25°C | -0.2 | 0.01 | 0.2 | nA |
| | | | T _A = T _{MIN} to T _{MAX} | -10 | | 10 | |
| AUDIO PERFORMANCE | | | | | | | |
| Total Harmonic Distortion plus Noise | THD+N | f _{IN} = 1kHz, R _L = 600Ω, V _{NO_} = 0.5V _{RMS} , V _{NO_} = 1.5V | | | 0.07 | | % |
| Off-Isolation (Note 7) | V _{ISO(A)} | V _{NO_} = 0.5V _{RMS} , f _{IN} = 20kHz, R _L = 600Ω, Figure 1 | | | -90 | | dB |
| Channel-to-Channel Crosstalk | V _{CT(A)} | V _{NO_} = 0.5V _{RMS} , f _{IN} = 20kHz, R _S = 600Ω, Figure 1 | | | -90 | | dB |
| VIDEO PERFORMANCE | | | | | | | |
| Off-Isolation (Note 7) | V _{ISO(V)} | V _{NO_} = 0.5V _{RMS} , f _{IN} = 10MHz, R _L = 50Ω, Figure 1 | | | -50 | | dB |
| Channel-to-Channel Crosstalk | V _{CT(V)} | V _{NO_} = 0.5V _{RMS} , f _{IN} = 10MHz, R _S = 50Ω, Figure 1 | | | -52 | | dB |
| -3dB Bandwidth | BW | R _{SOURCE} = 50Ω, R _L = 50Ω, C _L = 35pF | | | >150 | | MHz |
| Off Capacitance | C _{OFF(NO)} | f _{IN} = 1MHz | | | 9 | | pF |
| DYNAMIC TIMING WITH CLICKLESS MODE DISABLED (Notes 8 and 12, Figure 2) | | | | | | | |
| Turn-On Time | t _{ONSD} | V _{NO_} = 1.5V, R _L = 5kΩ, C _L = 35pF | T _A = +25°C | | 300 | 900 | ns |
| | | | T _A = T _{MIN} to T _{MAX} | | | 1000 | |
| Turn-Off Time | t _{OFFSD} | V _{NO_} = 1.5V, R _L = 300Ω, C _L = 35pF | T _A = +25°C | | 100 | 300 | ns |
| | | | T _A = T _{MIN} to T _{MAX} | | | 400 | |
| Break-Before-Make Time | t _{BBM} | V _{NO_} = 1.5V, T _A = T _{MIN} to T _{MAX} | | 10 | 200 | | ns |
| DYNAMIC TIMING WITH CLICKLESS MODE ENABLED (Notes 8 and 12, Figure 2) | | | | | | | |
| Turn-On Time | t _{ONSE} | V _{NO_} = 1.5V, R _L = 5kΩ, C _L = 35pF, T _A = +25°C | | | 8 | | ms |
| Turn-Off Time | t _{OFFSE} | V _{NO_} = 1.5V, R _L = 300Ω, C _L = 35pF, T _A = +25°C | | | 3 | | ms |

Serially Controlled, Clickless Audio/Video Switches

MAX4571-MAX4574

I/O INTERFACE CHARACTERISTICS

(V+ = +2.7V to +5.25V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---------------------|-----------------------------|---------------------------|------|------|-------|
| DIGITAL INPUTS (SCLK, DIN, CS, SCL, SDA, A0, A1) | | | | | | |
| Input Low Voltage | V _{IL} | V+ = 5V | | | 0.8 | V |
| | | V+ = 3V | | | 0.6 | |
| Input High Voltage | V _{IH} | V+ = 5V | 3 | | | V |
| | | V+ = 3V | 2 | | | |
| Input Hysteresis | V _{HYST} | | | 0.2 | | V |
| Input Leakage Current | I _{LEAK} | Digital inputs = 0 or V+ | -1 | 0.01 | 1 | μA |
| Input Capacitance | C _{IN} | | | 5 | | pF |
| DIGITAL OUTPUTS (DOUT, SDA) | | | | | | |
| Output Low Voltage | V _{OL} | I _{SINK} = 6mA | | | 0.4 | V |
| DOUT Output High Voltage | V _{OH} | I _{SOURCE} = 0.5mA | V+ | | -0.5 | V |
| 2-WIRE INTERFACE TIMING (Figure 3) | | | | | | |
| SCL Clock Frequency | f _{SCL} | | DC | | 400 | kHz |
| Bus Free Time between Stop and Start Condition | t _{BUF} | | 1.3 | | | μs |
| START Condition Hold Time | t _{HD:STA} | | 0.6 | | | μs |
| STOP Condition Setup Time | t _{SU:STO} | | 0.6 | | | μs |
| Data Hold Time | t _{HD:DAT} | | 0 | | 0.9 | μs |
| Data Setup Time | t _{SU:DAT} | | 100 | | | ns |
| Clock Low Period | t _{LOW} | | 1.3 | | | μs |
| Clock High Period | t _{HIGH} | | 0.6 | | | μs |
| SCL/SDA Rise Time | t _R | (Note 11) | 20 + 0.1C _b | | 300 | ns |
| SCL/SDA Fall Time | t _F | (Note 11) | 20 + 0.1C _b | | 300 | ns |
| 3-WIRE TIMING (Figure 5) | | | | | | |
| Operating Frequency | f _{OP} | | DC | | 2.1 | MHz |
| DIN to SCLK Setup | t _{DS} | | 100 | | | ns |
| DIN to SCLK Hold | t _{DH} | | | | 0 | ns |
| SCLK Fall to Output Data Valid | t _{DO} | C _{LOAD} = 50pF | 20 | | 200 | ns |
| $\overline{\text{CS}}$ to SCLK Rise Setup | t _{CSS} | | 100 | | | ns |
| $\overline{\text{CS}}$ to SCLK Rise Hold | t _{CSh} | | 0 | | | ns |
| $\overline{\text{CS}}$ High Pulse Width | t _{Csw} | | 200 | | | ns |
| SCLK Pulse Width Low | t _{CL} | | 200 | | | ns |
| SCLK Pulse Width High | t _{CH} | | 200 | | | ns |
| Rise Time (SCLK, DIN, $\overline{\text{CS}}$) | t _R | | | | 2 | μs |
| Fall Time (SCLK, DIN, $\overline{\text{CS}}$) | t _F | | | | 2 | μs |

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- Note 2:** The algebraic convention is used in this data sheet; the most negative value is shown in the minimum column.
- Note 3:** Guaranteed by design. Not subject to production testing.
- Note 4:** $\Delta R_{ON} = R_{ON(MAX)} - R_{ON(MIN)}$.
- Note 5:** Resistance flatness is defined as the difference between the maximum and minimum on-resistance values, as measured over the specified analog signal range.
- Note 6:** Leakage parameters are 100% tested at maximum rated temperature, and guaranteed by correlation at $T_A = +25^\circ\text{C}$.
- Note 7:** Off-isolation = $20 \log [V_{COM_} / V_{NO_}]$, $V_{COM_}$ = output, $V_{NO_}$ = input to off switch.
- Note 8:** All timing is measured from the rising clock edge of the ACK bit for 2-wire, and from the rising edge of \overline{CS} for 3-wire. Turn-off time is defined at the output of the switch for a 0.5V change, tested with a 300Ω load to ground. Turn-on time is measured with a $5k\Omega$ load resistor to GND. All timing is shown with respect to 20% V_+ and 70% V_+ , unless otherwise noted.
- Note 9:** Supply current can be as high as 2mA per switch during switch transitions in the clickless mode, corresponding to a 28mA total supply transient current requirement.
- Note 10:** Leakage testing for single-supply operation is guaranteed by testing with a single +5.25V supply.
- Note 11:** C_b = capacitance of one bus line in pF. Tested with $C_b = 400\text{pF}$.
- Note 12:** Typical values are for MAX4573/MAX4574 devices.

Typical Operating Characteristics

($V_+ = +5\text{V}$, $T_A = +25^\circ\text{C}$, unless otherwise noted.)



Serially Controlled, Clickless Audio/Video Switches

Typical Operating Characteristics (continued)

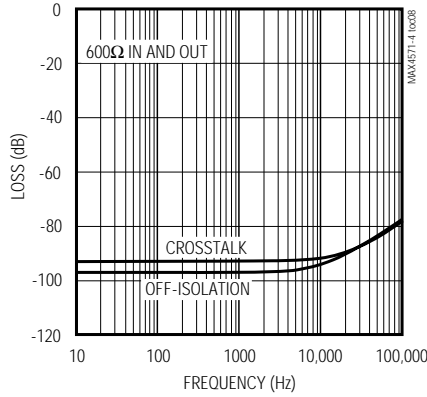
($V_+ = 5V, T_A = +25^\circ C$, unless otherwise noted.)

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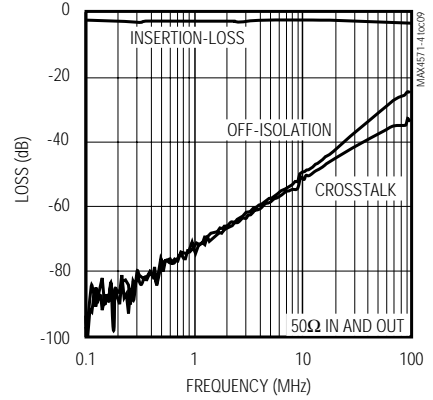
TOTAL HARMONIC DISTORTION + NOISE vs. FREQUENCY



AUDIO FREQUENCY RESPONSE



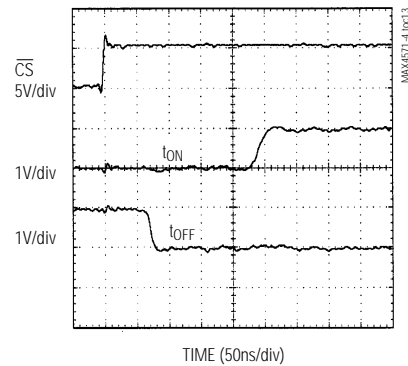
VIDEO FREQUENCY RESPONSE



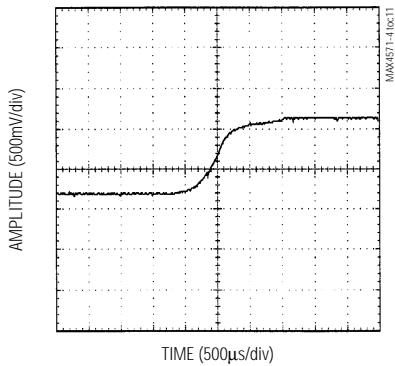
ON/OFF TIMES (SOFT MODE)



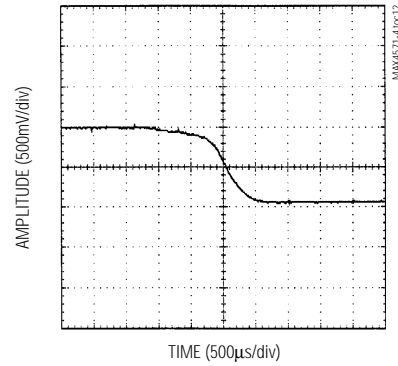
ON/OFF TIMES (HARD MODE)



SOFT MODE RISE TIME



SOFT MODE FALL TIME



Serially Controlled, Clickless Audio/Video Switches

Pin Descriptions

| PIN | | NAME | | FUNCTION |
|--|--------------------------------|------------|---------------------------|--|
| MAX4571 | MAX4572 | MAX4571 | MAX4572 | |
| 1, 3, 5, 7, 9, 11, 13, 22, 20, 18, 16 | - | NO1-NO11 | - | Normally Open Terminals |
| - | 1, 4, 7, 10 | - | NO1A-NO4A | Normally Open Terminals |
| - | 3, 6, 9, 12 | - | NO1B-NO4B | Normally Open Terminals |
| - | 13, 16 | - | NO5, NO8 | Normally Open Terminals |
| - | 22, 19, 20, 17 | - | NO6A, NO7A, NO6B, NO7B | Normally Open Terminals |
| 2, 4, 6, 8, 10, 12, 14, 21, 19, 17, 15 | 2, 5, 8, 11, 14, 21, 18, 15 | COM1-COM11 | COM1-COM8 | Common Terminals |
| 23 | 23 | GND | GND | Ground |
| 24 | 24 | A0 | A0 | LSB + 1 of 2-Wire Serial Interface Address Field |
| 25 | 25 | A1 | A1 | LSB + 2 of 2-Wire Serial Interface Address Field |
| 26 | 26 | SCL | SCL | Clock Input of 2-Wire Serial Interface |
| 27 | 27 | SDA | SDA | Data Input of 2-Wire Serial Interface |
| 28 | 28 | V+ | V+ | Positive Supply Voltage |

| PIN | | NAME | | FUNCTION |
|--|--------------------------------|-----------------|---------------------------|--|
| MAX4573 | MAX4574 | MAX4573 | MAX4574 | |
| 1, 3, 5, 7, 9, 11, 13, 22, 20, 18, 16 | - | NO1-NO11 | - | Normally Open Terminals |
| - | 1, 4, 7, 10 | - | NO1A-NO4A | Normally Open Terminals |
| - | 3, 6, 9, 12 | - | NO1B-NO4B | Normally Open Terminals |
| - | 13, 16 | - | NO5, NO8 | Normally Open Terminals |
| - | 22, 19, 20, 17 | - | NO6A, NO7A, NO6B, NO7B | Normally Open Terminals |
| 2, 4, 6, 8, 10, 12, 14, 21, 19, 17, 15 | 2, 5, 8, 11, 14, 21, 18, 15 | COM1-COM11 | COM1-COM8 | Common Terminals |
| 23 | 23 | GND | GND | Ground |
| 24 | 24 | \overline{CS} | \overline{CS} | Chip Select of 3-Wire Serial Interface |
| 25 | 25 | SCLK | SCLK | Clock Input of 3-Wire Serial Interface |
| 26 | 26 | DIN | DIN | Clock Input of 3-Wire Serial Interface |
| 27 | 27 | DOOUT | DOOUT | Data Output of 3-Wire Serial Interface |
| 28 | 28 | V+ | V+ | Positive Supply Voltage |

Serially Controlled, Clickless Audio/Video Switches

MAX4571-MAX4574



Figure 1. Off-Isolation and Crosstalk



Figure 2. Switching Time

Serially Controlled, Clickless Audio/Video Switches

Detailed Description

The MAX4571-MAX4574 are serial-interface controlled switches with soft-mode “clickless” and hard-mode operating capability. The MAX4571/MAX4573 contain 11 SPST switches, while the MAX4572/MAX4574 contain two SPST switches and six SPDT switches. The SPDT switches are actually 2-to-1 multiplexers, in that each SPDT is really two independent SPST switches with a common node, as shown in the *Pin Configurations*. Each switch is controlled independently by either the SPI or I²C interface.

Audio off-isolation is -90dB at 20kHz, crosstalk is at least -90dB at 20kHz, and video off-isolation is at least -50dB at 10MHz.

Each switch of any device may be set to operate in either soft or hard mode. In soft mode, the switching transition is slowed to avoid the audible “clicking” that can occur when switches are used to route audio signals. In hard mode, the switches are not slowed down, making this mode useful when a faster response is required. If a new command is issued while any soft-mode switch is transitioning, the switch transition time is decreased so it reaches its final state before the new command is executed. Soft mode is the power-up default state for all switches. Switches in the same mode are guaranteed to be break-before-make relative to each other. Break-before-make does not apply between switches operating in different modes.

These devices operate from a single supply of +2.7V to +5.25V. The MAX4571/MAX4572 feature a 2-wire, I²C-compatible serial interface, and the MAX4573/MAX4574 feature a 3-wire, SPI/QSPI/MICROWIRE-compatible serial interface.

Applications Information

Switch Control

The MAX4571-MAX4574 have a common command and control-bit structure, the differences being only in the interface type (2-wire or 3-wire) and in the switch configurations.

The SWITCHSET command controls the open/closed states of the various switches. MODESET controls soft/hard-mode states of the switches. There are also NO_OP and RESET commands. The NO_OP command is useful for daisy-chaining multiple 3-wire parts. The RESET command places a device in a state identical to its power-up state, with all switches open and in soft switching mode.

Table 1 shows the configuration of the command bits and their related commands. Table 2 shows the configuration of the command bits and their related commands. *SendByte* and *WriteWord* are trademarks of Philips Corp.

uration of the data bits and their related switches. The arrangement of the command bits and the data bits depends on the interface type (2-wire or 3-wire). After a SWITCHSET command is issued, a logic 1 in any data-bit location closes the associated switch, while a logic 0 opens it. After a MODESET command, a logic 1 in any data-bit location sets the associated switch into hard mode, while a logic 0 sets it into soft mode.

2-Wire Serial Interface

The MAX4571/MAX4572 use a 2-wire, I²C-compatible serial interface requiring only two I/O lines of a standard microprocessor port for communication. These devices use the *SendByte*[™] and *WriteWord*[™] protocols. The *SendByte* protocol is used only for the RESET command. The *WriteWord* protocol is used for the MODESET and SWITCHSET commands.

The first byte of any 2-wire serial-interface transaction is always the address byte. To address a given chip, the A0 and A1 bits in the address byte (Table 3) must duplicate the values present at the A0 and A1 pins of that chip, and the rest of the address bits must be configured as shown in Table 3. Connect the A0 and A1 pins to V+ or to GND, or drive them with CMOS logic levels.

The second byte is the command byte. The possible commands are RESET, MODESET, and SWITCHSET. RESET sets all switches to the initial power-up state (open and in soft switching mode). The RESET command is executed on the rising clock edge of the acknowledge bit after the command byte. The MODESET and SWITCHSET commands are each followed by two data bytes. The first data byte is buffered so all the data latches switch together. MODESET and SWITCHSET are executed on the rising clock edge of the acknowledge bit after the second data byte. Table 3 details the 2-wire interface data structure. Figures 3 and 4 and the *I/O Interface Characteristics* detail the timing of the 2-wire serial-interface protocol. All bytes of the transmission, whether address, command, or data, are sent MSB first.

The MAX4571/MAX4572 are receive-only devices and must be controlled by a bus master device. A bus master signals the beginning of a transmission with a start condition by transitioning SDA from high to low while SCL is high. The slave devices monitor the serial bus continuously, waiting for a start condition followed by an address byte. When a device recognizes its address byte, it acknowledges by pulling the SDA line low for one clock period; it is then ready to accept command and data bytes. The device then issues a similar acknowledgment after the command byte, and again after each data byte. When the master has finished

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Table 1. Command Bit Mapping

| MSB | MSB - 1 | COMMAND | DESCRIPTION |
|-----|---------|-----------|--|
| 0 | 0 | RESET | Sets all switches open and in soft switching mode. |
| 0 | 1 | MODESET | Sets specified switches to soft or hard mode. |
| 1 | 0 | NO_OP | No Operation. |
| 1 | 1 | SWITCHSET | Sets specified switches open or closed. |

Table 2. Data-Bit Switch Control

| DATA BIT | MAX4571/MAX4573 | | MAX4572/MAX4574 | |
|----------|-----------------|------------------|-----------------|------------------|
| | SWITCH | SWITCH TERMINALS | SWITCH | SWITCH TERMINALS |
| D13 | X | X | SW8 | 15, 16 |
| D12 | X | X | SW5 | 13, 14 |
| D11 | X | X | SW7B | 17, 18 |
| D10 | SW11 | 15, 16 | SW7A | 18, 19 |
| D9 | SW10 | 17, 18 | SW6B | 20, 21 |
| D8 | SW9 | 19, 20 | SW6A | 21, 22 |
| D7 | SW8 | 21, 22 | SW4B | 11, 12 |
| D6 | SW7 | 13, 14 | SW4A | 10, 11 |
| D5 | SW6 | 11, 12 | SW3B | 8, 9 |
| D4 | SW5 | 9, 10 | SW3A | 7, 8 |
| D3 | SW4 | 7, 8 | SW2B | 5, 6 |
| D2 | SW3 | 5, 6 | SW2A | 4, 5 |
| D1 | SW2 | 3, 4 | SW1B | 2, 3 |
| D0 (LSB) | SW1 | 1, 2 | SW1A | 1, 2 |

X = Don't care

communicating with the slave, it issues a stop condition by transitioning SDA from low to high while SCL is high. The bus is then free for another transmission.

3-Wire Serial Interface

The MAX4573/MAX4574 use a 3-wire SPI/QSPI/MICROWIRE-compatible serial interface. An active-low chip-select pin, \overline{CS} , enables the device to receive data from the serial input pin, DIN. Command and data information are clocked in on the rising edge of the serial-clock signal (SCLK) MSB first. A total of 16 bits are needed in each write cycle. The write cycle allows two 8-bit-wide transfers if \overline{CS} remains low for the entire 16 bits. The command code is contained in the two MSBs of the 16-bit word. The remaining bits control the switches as shown in Table 4. While shifting in the serial data, the device remains in its original configuration. A rising edge on \overline{CS} latches the data into the MAX4573/MAX4574 internal registers, initiating the device's change of state. Table 4 shows the details of the 3-wire interface data structure.

Figures 5 and 6 and the *I/O Interface Characteristics* show the timing details of the 3-wire interface. If the two command bits initiate a SWITCHSET command, a logic 1 in a switch control location closes the associated switch, while a logic 0 opens it. If the command bits initiate a MODESET command, a logic 1 in a switch control location sets the associated switch into hard mode, while a logic 0 sets it into soft, "clickless" mode. For command-bit configurations, see Table 1.

Using Multiple Devices

There are two ways to connect multiple devices to the same 3-wire serial interface. The first involves using the DOUT pin. DOUT presents a copy of the last bit of the internal shift register, useful for daisy-chaining multiple devices. Data at DOUT are simply the input data delayed by 16 clock cycles, appearing synchronous with SCLK's falling edge. After \overline{CS} goes high, DOUT holds the last bit in the shift register until new data are shifted into DIN. For a simple interface using several MAX4573/MAX4574 devices, daisy-chain the shift reg-

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Table 3. 2-Wire Serial-Interface Data Format

RESET Command

| Address Byte | | | | | | | | | | Command Byte (RESET) | | | | | | | | | |
|--------------|---|---|---|---|-----|---|---|---|---|----------------------|---|---|---|---|-----|---|---|---|---|
| MSB | | | | | LSB | | | | | MSB | | | | | LSB | | | | |
| S | 0 | 1 | 1 | 0 | 1 | A | A | 0 | A | 0 | 0 | X | X | X | X | X | X | A | S |
| R | | | | | 1 | 0 | 0 | A | 0 | 0 | X | X | X | X | X | X | C | T | |
| T | | | | | | | | C | 0 | 0 | X | X | X | X | X | X | K | P | |

SWITCHSET Command

| Address Byte | | | | | | | | | | Command Byte (SWITCHSET) | | | | | | | | | |
|--------------|---|---|---|---|-----|---|---|---|---|--------------------------|---|---|---|---|-----|---|---|---|---|
| MSB | | | | | LSB | | | | | MSB | | | | | LSB | | | | |
| S | 0 | 1 | 1 | 0 | 1 | A | A | 0 | A | 1 | 1 | X | X | X | X | X | X | A | S |
| R | | | | | 1 | 0 | 0 | A | 1 | 1 | X | X | X | X | X | X | X | C | T |
| T | | | | | | | | C | 1 | 1 | X | X | X | X | X | X | X | K | P |

MAX4571

| First Data Byte | | | | | | | | | | Second Data Byte | | | | | | | | | |
|-----------------|---|---|---|---|-----|----|----|---|----|------------------|----|----|----|----|-----|----|---|---|--|
| MSB | | | | | LSB | | | | | MSB | | | | | LSB | | | | |
| X | X | X | X | X | SW | SW | SW | A | SW | SW | SW | SW | SW | SW | SW | SW | A | S | |
| | | | | | 11 | 10 | 9 | C | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | C | T | |
| | | | | | | | | K | | | | | | | | | K | P | |

MAX4572

| First Data Byte | | | | | | | | | | Second Data Byte | | | | | | | | | |
|-----------------|---|----|----|----|-----|----|----|---|----|------------------|----|----|----|----|-----|----|---|---|--|
| MSB | | | | | LSB | | | | | MSB | | | | | LSB | | | | |
| X | X | SW | SW | SW | SW | SW | SW | A | SW | SW | SW | SW | SW | SW | SW | SW | A | S | |
| | | 8 | 5 | 7B | 7A | 6B | 6A | C | 4B | 4A | 3B | 3A | 2B | 2A | 1B | 1A | C | T | |
| | | | | | | | | K | | | | | | | | | K | P | |

MODESET Command

| Address Byte | | | | | | | | | | Command Byte (MODESET) | | | | | | | | | |
|--------------|---|---|---|---|-----|---|---|---|---|------------------------|---|---|---|---|-----|---|---|---|---|
| MSB | | | | | LSB | | | | | MSB | | | | | LSB | | | | |
| S | 0 | 1 | 1 | 0 | 1 | A | A | 0 | A | 0 | 1 | X | X | X | X | X | X | A | S |
| R | | | | | 1 | 0 | 0 | A | 0 | 1 | X | X | X | X | X | X | X | C | T |
| T | | | | | | | | C | 0 | 1 | X | X | X | X | X | X | X | K | P |

MAX4571

| First Data Byte | | | | | | | | | | Second Data Byte | | | | | | | | | |
|-----------------|---|---|---|---|-----|----|----|---|----|------------------|----|----|----|----|-----|----|---|---|--|
| MSB | | | | | LSB | | | | | MSB | | | | | LSB | | | | |
| X | X | X | X | X | SW | SW | SW | A | SW | SW | SW | SW | SW | SW | SW | SW | A | S | |
| | | | | | 11 | 10 | 9 | C | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | C | T | |
| | | | | | | | | K | | | | | | | | | K | P | |

MAX4572

| First Data Byte | | | | | | | | | | Second Data Byte | | | | | | | | | |
|-----------------|---|----|----|----|-----|----|----|---|----|------------------|----|----|----|----|-----|----|---|---|--|
| MSB | | | | | LSB | | | | | MSB | | | | | LSB | | | | |
| X | X | SW | SW | SW | SW | SW | SW | A | SW | SW | SW | SW | SW | SW | SW | SW | A | S | |
| | | 8 | 5 | 7B | 7A | 6B | 6A | C | 4B | 4A | 3B | 3A | 2B | 2A | 1B | 1A | C | T | |
| | | | | | | | | K | | | | | | | | | K | P | |

X = Don't Care
 SRT = Start Condition
 ACK = Acknowledge Condition

STP = Stop Condition
 Logic "0" in any data bit location places the associated switch open or in soft (clickless) switching mode.
 Logic "1" in any data bit location places the associated switch closed or in hard switching mode.
 For command bit configuration see Table 1.

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MAX4571-MAX4574

Table 4. 3-Wire Serial-Interface Data Format

| MAX4573 (11 SPST) | | | | | | | | | | | | | | | |
|-------------------|-----|----------------|-----|-----|------|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| MSB | | | | | | | | | | | | | | | LSB |
| COMMAND | | SWITCH CONTROL | | | | | | | | | | | | | |
| D15 | D14 | D13 | D12 | D11 | D10 | D9 | D8 | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
| C1 | C0 | X | X | X | SW11 | SW10 | SW9 | SW8 | SW7 | SW6 | SW5 | SW4 | SW3 | SW2 | SW1 |

| MAX4574 (6 SPDT + 2 SPST) | | | | | | | | | | | | | | | |
|---------------------------|-----|----------------|-----|------|------|------|------|------|------|------|------|------|------|------|------|
| MSB | | | | | | | | | | | | | | | LSB |
| COMMAND | | SWITCH CONTROL | | | | | | | | | | | | | |
| D15 | D14 | D13 | D12 | D11 | D10 | D9 | D8 | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
| C1 | C0 | SW8 | SW5 | SW7B | SW7A | SW6B | SW6A | SW4B | SW4A | SW3B | SW3A | SW2B | SW2A | SW1B | SW1A |

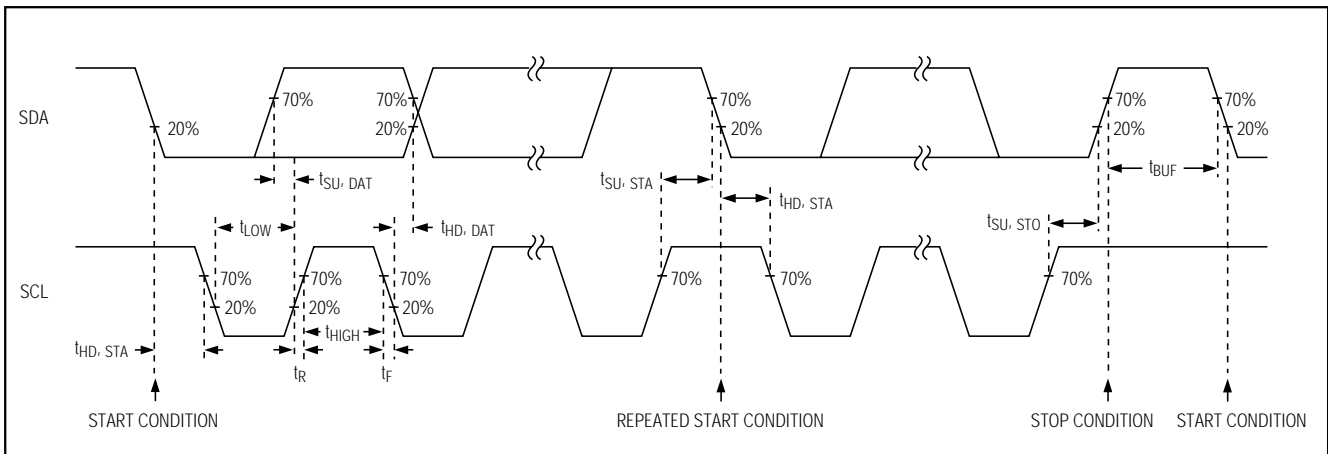


Figure 3. 2-Wire Serial-Interface Timing Diagram



Figure 4. A Complete 2-Wire Serial-Interface Transmission

Serially Controlled, Clickless Audio/Video Switches

istors by connecting DOUT of the first device to DIN of the second, etc. Connect the \overline{CS} pins of all devices together. Data are shifted through the MAX4573/MAX4574s in series. When \overline{CS} is brought high, all devices are updated simultaneously. If any of the devices in the chain are to be left unchanged, use a NO_OP command for that device, as shown in Table 1.

An alternate way of connecting multiple devices is to decode the \overline{CS} line. In this case the DOUT pin is not used and the DIN pins of all devices are connected together. Address decode logic individually controls the \overline{CS} line of each device. When a device is to be selected its \overline{CS} line is brought low, data are shifted in, and its \overline{CS} is then brought high to execute the command.



Figure 5. 3-Wire Serial-Interface Timing Diagram

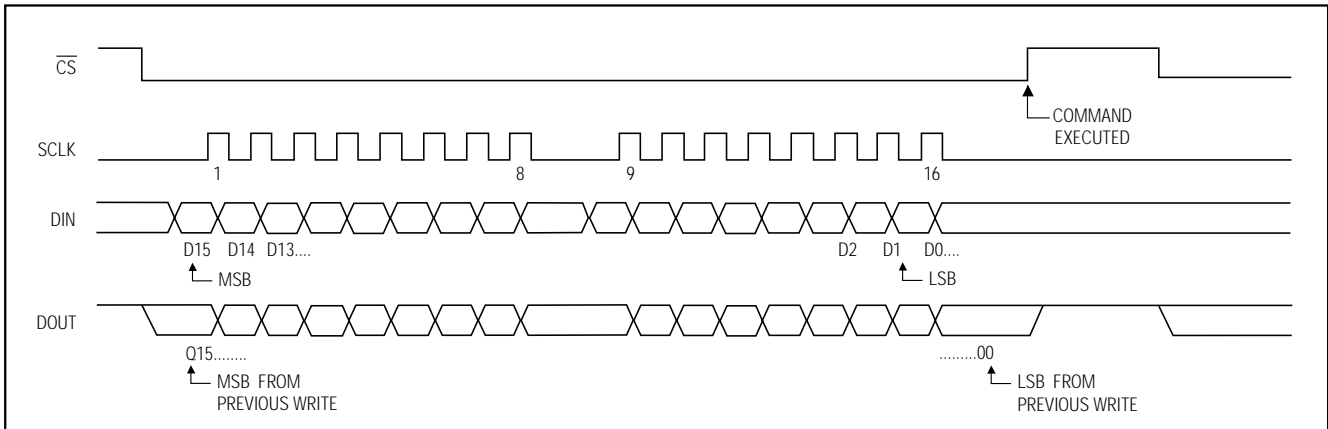


Figure 6. A Complete 3-Wire Serial-Interface Transmission

Serially Controlled, Clickless Audio/Video Switches

Pin Configurations (continued)

Chip Information

TRANSISTOR COUNT: 5397

MAX4571-MAX4574

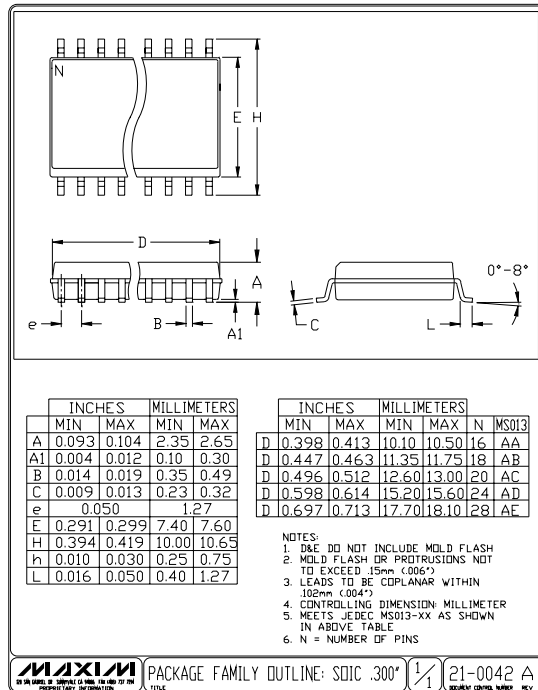
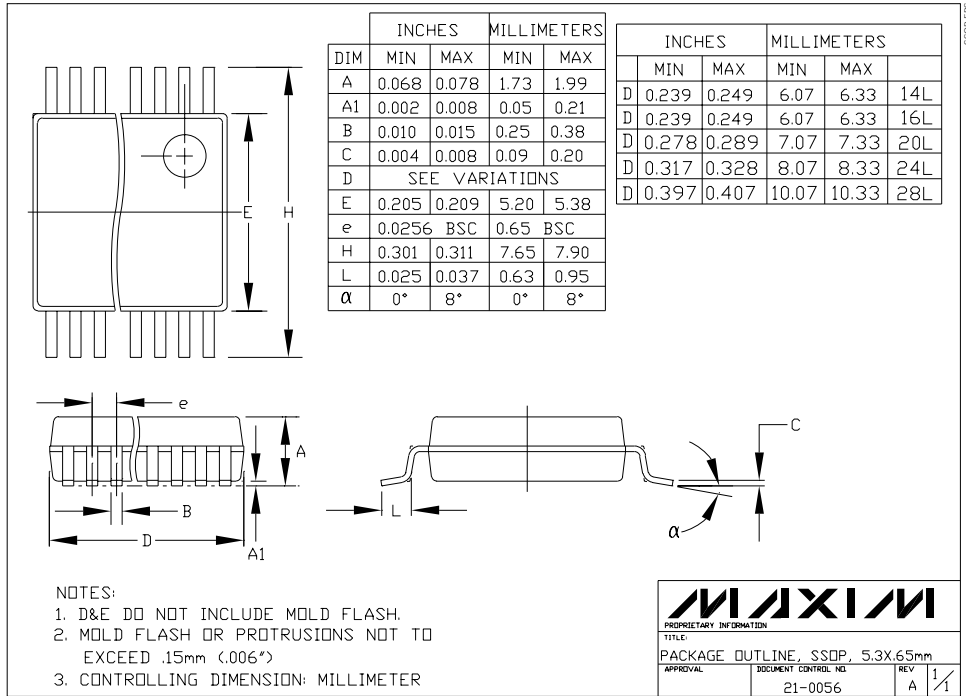


Package Information



Serially Controlled, Clickless Audio/Video Switches

Package Information (continued)



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16 Maxim Integrated Products, 120 San Gabriel Drive, Sunnyvale, CA 94086 408-737-7600



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Как с нами связаться

Телефон: 8 (812) 309 58 32 (многоканальный)

Факс: 8 (812) 320-02-42

Электронная почта: org@eplast1.ru

Адрес: 198099, г. Санкт-Петербург, ул. Калинина, дом 2, корпус 4, литера А.