## 32x32 Video Crosspoint with Differential Inputs

The ISL59533 is a 32x32 integrated video crosspoint switch matrix with input and output buffers and On-Screen Display (OSD) insertion. The ISL59533 is ideal for routing video signals in security and video-on-demand systems. This device operates from a single +5V supply. Any output can be switched to any of the 32 input video signal sources and OSD information through an internal, dedicated fast 2:1 mux (15ns switching times) located before the output buffer. Also, any one input can be broadcast to all 32 outputs.

The ISL59533 offers a -3dB signal bandwidth of 300MHz. The differential gain and phase at 0.01% and 0.03° respectively, along with 0.1dB flatness out to 35MHz, make the ISL59533 suitable for many video applications.

The switch matrix configuration and output buffer gain are programmed through an SPI/QSPI™-compatible, three-wire serial interface. The ISL59533 interface is set up to facilitate both fast updates and initialization. On power-up, all outputs are initialized in the disabled state to avoid output conflicts within the user system.

The ISL59533 is available in a 356-pin BGA package and specified over an extended -40°C to +85°C temperature range.

The ISL59533 has single-supply signal operation. It can accommodate input and output voltages from ground to >3.5V. It also has fully differential inputs. The differential input span is ±1.5V. The output offset is applied via a group reference input.

## Features

- 32x32 non-blocking switch with buffered inputs and outputs
- Differential inputs
- Operates from a single +5V supply
- Output gain switchable +1 or +2
- Tri-state output
- -80dB Isolation at 6MHz
- 0.01%/0.03° dG/dP
- Pb-Free plus anneal available (RoHS compliant)

## Applications

- Security camera switching
- RGB routing
- HDTV routing

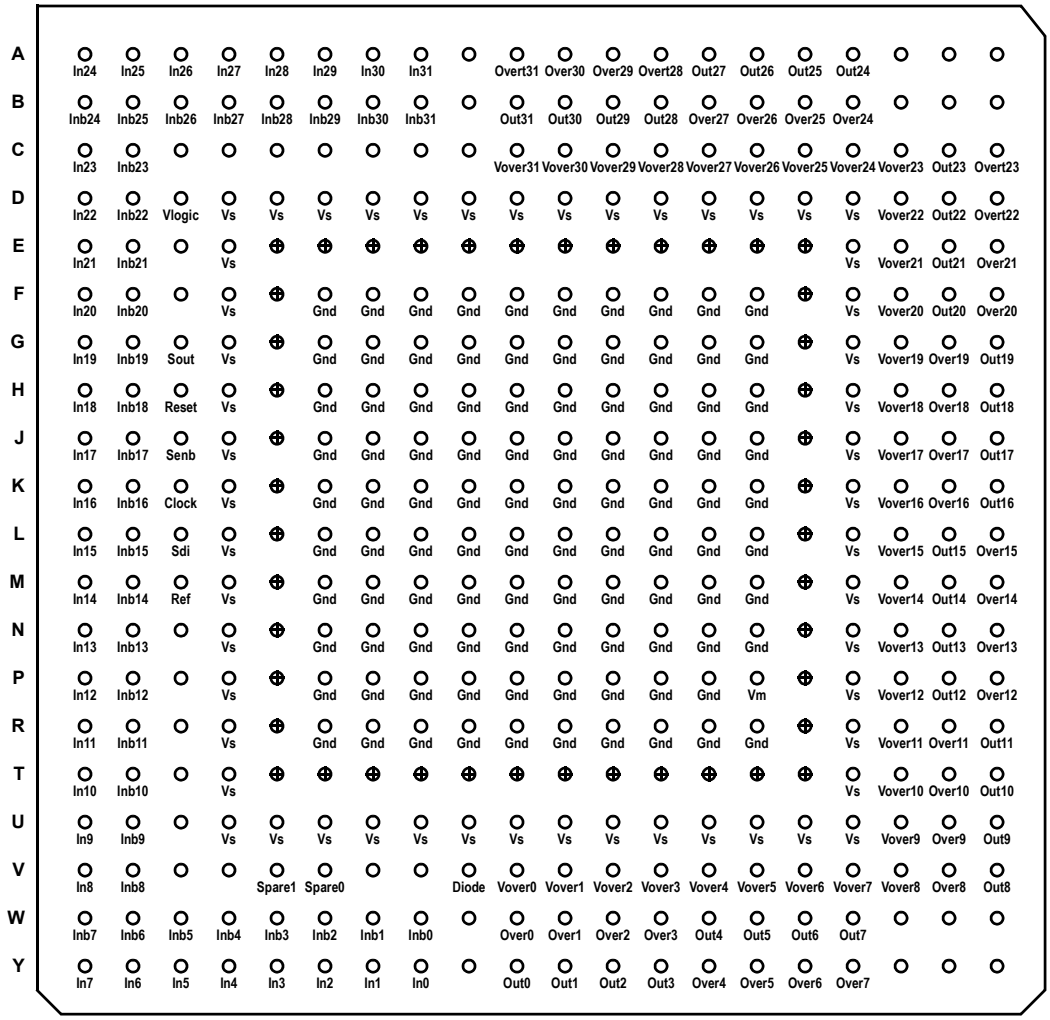
## Ordering Information

| PART NUMBER | TAPE & REEL | PACKAGE | PKG. DWG. # |
|---|---|---|---|
| ISL59533IKEZ (See Note) | - | 356-Pin BGA (Pb-Free) | V356.27x27A |

NOTE: Intersil Pb-free plus anneal products employ special Pb-free material sets; molding compounds/die attach materials and 100% matte tin plate termination finish, which are RoHS compliant and compatible with both SnPb and Pb-free soldering operations. Intersil Pb-free products are MSL classified at Pb-free peak reflow temperatures that meet or exceed the Pb-free requirements of IPC/JEDEC J STD-020.

## Pinout

**ISL59533**
**(356-PIN BGA)**
TOP VIEW




⊕ = NO BALLS

PAD NAME "GND" IS THE SAME AS PACKAGE OR BALL NAME "GROUND" OR "G"
PAD NAME "VS" IS THE SAME AS PACKAGE OR BALL NAME "POWER" OR "P"
ALL PADS ARE 70µ x 70µ

## Absolute Maximum Ratings ($T_A$ = 25°C)

Supply Voltage between $V_S$ and GND . . . . . .6V
Maximum Continuous Output Current . . . . . 40mA
Ambient Operating Temperature . . . . . -TBD°C to +TBD°C
Maximum Die Temperature . . . . . +125°C
Storage Temperature . . . . . -TBD°C to +TBD°C

*CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.*

*IMPORTANT NOTE: All parameters having Min/Max specifications are guaranteed. Typical values are for information purposes only. Unless otherwise noted, all tests are at the specified temperature and are pulsed tests, therefore: $T_J = T_C = T_A$*

## DC Electrical Specifications $V_S$ = 5V

| PARAMETER | DESCRIPTION | CONDITION | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| $V_S$ | Supply Range | | 4.5 | | 5.5 | V |
| $V_D$ | Digital Supply | Establishes serial output high level | 1.2 | | 5.5 | V |
| G | Gain | G = 1, $R_L$ = 500Ω | 0.97 | 1 | 1.03 | V/V |
| | | G = 2, $R_L$ = 150Ω | 1.94 | 2 | 2.06 | % |
| GM | Gain Matching (to average of all other outputs) | G = 1 | -1.5 | 1 | 1.5 | % |
| | | G = 2 | | 0.5 | 1.0 | % |
| $V_{IN}$ | Input Voltage Range | G = 1 | 0 | | 3.5 | V |
| $V_{OUT}$ | Output Voltage Range | G = 2, $R_L$ = 150Ω | 0 | | 4.0 | V |
| $I_B$ | Input Bias Current | | | 7 | 15 | µA |
| $V_{OS}$ | Output Offset Voltage | $A_V$ = 1 | -25 | 0 | 25 | mV |
| | | $A_V$ = 2 | -70 | 0 | 70 | mV |
| $I_{OUT}$ | Output Current | Sourcing, $R_L$ = 10Ω to GND | 60 | 100 | | mA |
| | | Sinking, $R_L$ to 2.5V | 25 | 35 | | mA |
| PSRR | Power Supply Rejection Ratio | | | | | dB |
| $I_S$ | Supply Current | Enabled, all outputs enable, no load current | | 600 | 700 | mA |
| | | Enable, all outputs disable, no load current | | 245 | | mA |
| | | Disabled | | 1.6 | 2.2 | mA |
| | | Supply current per output channel | | 9.5 | | mA |

## AC Electrical Specifications

| PARAMETER | DESCRIPTION | CONDITION | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| BW -3dB | 3dB Bandwidth | $V_{OUT}$ = 200m$V_{P-P}$, $A_V$ = 2 | | 320 | | MHz |
| BW 0.1dB | 0.1dB Bandwidth | $V_{OUT}$ = 200m$V_{P-P}$, $A_V$ = 2 | | 50 | | MHz |
| SR | Slew Rate | $V_{OUT}$ = 2$V_{P-P}$, $A_V$ = 2 | 360 | 470 | | V/µs |
| $T_S$ | Settling Time to 0.1% | $V_{OUT}$ = 2$V_{P-P}$, $A_V$ = 2 | | 12 | | ns |
| Glitch | Switching Glitch, Peak | $A_V$ = 1 | | 40 | | mV |
| $T_{over}$ | Overlay Delay Time | Beginning of output transition | | 6 | | ns |
| dG/dP | Diff Gain | $A_V$ = 2, $R_L$ = 150Ω | | 0.01 | | % |
| | Diff Phase | $A_V$ = 2, $R_L$ = 150Ω | | 0.03 | | % |
| Xt | Hostile Crosstalk | 6MHz | | 80 | | dB |
| $V_N$ | Input Noise Voltage | | | 42 | | nV/√Hz |

## Pin Descriptions

| NAME | NUMBER | DESCRIPTION |
|---|---|---|
| INB4 | W4 | Complementary input |
| IN4 | Y4 | Input |
| INB5 | W3 | Complementary input |
| IN5 | Y3 | Input |
| INB6 | W2 | Complementary input |
| IN6 | Y2 | Input |
| INB7 | W1 | Complementary input |
| IN7 | Y1 | Input |
| REF | M3 | Output reference |
| GND | GND | Ground |
| SDI | L3 | Serial data input |
| VS | VS | Power supply |
| INB8 | V2 | Complementary input |
| IN8 | V1 | Input |
| INB9 | U2 | Complementary input |
| IN9 | U1 | Input |
| INB10 | T2 | Complementary input |
| IN10 | T1 | Input |
| INB11 | R2 | Complementary input |
| IN11 | R1 | Input |
| VS | VS | Power supply |
| GND | GND | Ground |
| INB12 | P2 | Complementary input |
| IN12 | P1 | Input |
| INB13 | N2 | Complementary input |
| IN13 | N1 | Input |
| INB14 | M2 | Complementary input |
| IN14 | M1 | Input |
| INB15 | L2 | Complementary input |
| IN15 | L1 | Input |
| CLOCK | K3 | Serial data clock |
| VS | VS | Power supply |
| SENB | J3 | Serial enable-inverted |
| GND | GND | Ground |
| INB16 | K2 | Complementary input |
| IN16 | K1 | Input |
| INB17 | J2 | Complementary input |
| IN17 | J1 | Input |
| INB18 | H2 | Complementary input |

## Pin Descriptions (Continued)

| NAME | NUMBER | DESCRIPTION |
|---|---|---|
| IN18 | H1 | Input |
| INB19 | G2 | Complementary input |
| IN19 | G1 | Input |
| VS | VS | Power supply |
| GND | GND | Ground |
| INB20 | F2 | Complementary input |
| IN20 | F1 | Input |
| INB21 | E2 | Complementary input |
| IN21 | E1 | Input |
| INB22 | D2 | Complementary input |
| IN22 | D1 | Input |
| INB23 | C2 | Complementary input |
| IN23 | C1 | Input |
| RESET | H3 | Reset input |
| VS | VS | Power supply |
| SOUT | G3 | Serial data output |
| GND | GND | Ground |
| INB24 | B1 | Complementary input |
| IN24 | A1 | Input |
| INB25 | B2 | Complementary input |
| IN25 | A2 | Input |
| INB26 | B3 | Complementary input |
| IN26 | A3 | Input |
| INB27 | B4 | Complementary input |
| IN27 | A4 | Input |
| $\overline{\text{INPUTTEST}}$ | NONE | Manufacturing test pin - leave open |
| GND | GND | Ground |
| GND | GND | Ground |
| VS | VS | Power supply |
| VS | VS | Power supply |
| VLOGIC | D3 | Logic power supply for serial output driver |
| INB28 | B5 | Complementary input |
| IN28 | A5 | Input |
| INB29 | B6 | Complementary input |
| IN29 | A6 | Input |
| INB30 | B7 | Complementary input |
| IN30 | A7 | Input |
| INB31 | B8 | Complementary input |
| IN31 | A8 | Input |

## Pin Descriptions (Continued)

| NAME | NUMBER | DESCRIPTION |
|---|---|---|
| VSL | VS | Power supply |
| VGL | GND | Ground |
| VS | VS | Power supply |
| GND | GND | Ground |
| OVER31 | A10 | Overlay logic control |
| VOVER31 | C10 | Overlay analog input |
| OUT31 | B10 | Output |
| OVER30 | A11 | Overlay logic control |
| VOVER30 | C11 | Overlay analog input |
| OUT30 | B11 | Output |
| OVER29 | A12 | Overlay logic control |
| VOVER29 | C12 | Overlay analog input |
| OUT29 | B12 | Output |
| OVER28 | A13 | Overlay logic control |
| VOVER28 | C13 | Overlay analog input |
| OUT28 | B13 | Output |
| GND | GND | Ground |
| VS | VS | Power supply |
| OUT27 | A14 | Output |
| VOVER27 | C14 | Overlay analog input |
| OVER27 | B14 | Overlay logic control |
| OUT26 | A15 | Output |
| VOVER26 | C15 | Overlay analog input |
| OVER26 | B15 | Overlay logic control |
| OUT25 | A16 | Output |
| VOVER25 | C16 | Overlay analog input |
| OVER25 | B16 | Overlay logic control |
| OUT24 | A17 | Output |
| VOVER24 | C17 | Overlay analog input |
| OVER24 | B17 | Overlay logic control |
| GND | GND | Ground |
| OUTTEST3 | NONE | Manufacturing test pin-leave open |
| VS | VS | Power supply |
| OVER23 | C20 | Overlay logic control |
| VOVER23 | C18 | Overlay analog input |
| OUT23 | C19 | Output |
| OVER22 | D20 | Overlay logic control |
| VOVER22 | D18 | Overlay analog input |
| OUT22 | D19 | Output |
| OVER21 | E20 | Overlay logic control |

## Pin Descriptions (Continued)

| NAME | NUMBER | DESCRIPTION |
|---|---|---|
| VOVER21 | E18 | Overlay analog input |
| OUT21 | E19 | Output |
| OVER20 | F20 | Overlay logic control |
| VOVER20 | F18 | Overlay analog input |
| OUT20 | F19 | Output |
| GND | GND | Ground |
| VS | VS | Power supply |
| OUT19 | G20 | Output |
| VOVER19 | G18 | Overlay analog input |
| OVER19 | G19 | Overlay logic control |
| OUT18 | H20 | Output |
| VOVER18 | H18 | Overlay analog input |
| OVER18 | H19 | Overlay logic control |
| OUT17 | J20 | Output |
| VOVER17 | J18 | Overlay analog input |
| OVER17 | J19 | Overlay logic control |
| OUT16 | K20 | Output |
| VOVER16 | K18 | Overlay analog input |
| OVER16 | K19 | Overlay logic control |
| OUTTEST2 | NONE | Manufacturing test pin-leave open |
| GND | GND | Ground |
| VS | VS | Power supply |
| OVER15 | L20 | Overlay logic control |
| VOVER15 | L18 | Overlay analog input |
| OUT15 | L19 | Output |
| OVER14 | M20 | Overlay logic control |
| VOVER14 | M18 | Overlay analog input |
| OUT14 | M19 | Output |
| OVER13 | N20 | Overlay logic control |
| VOVER13 | N18 | Overlay analog input |
| OUT13 | N19 | Output |
| OVER12 | P20 | Overlay logic control |
| VOVER12 | P18 | Overlay analog input |
| OUT12 | P19 | Output |
| GND | GND | Ground |
| VS | VS | Power supply |
| OUT11 | R20 | Output |
| VOVER11 | R18 | Overlay analog input |
| OVER11 | R19 | Overlay logic control |
| OUT10 | T20 | Output |

## Pin Descriptions (Continued)

| NAME | NUMBER | DESCRIPTION |
|---|---|---|
| VOVER10 | T18 | Overlay analog input |
| OVER10 | T19 | Overlay logic control |
| OUT9 | U20 | Output |
| VOVER9 | U18 | Overlay analog input |
| OVER9 | U19 | Overlay logic control |
| OUT8 | V20 | Output |
| VOVER8 | V18 | Overlay analog input |
| OVER8 | V19 | Overlay logic control |
| VS | VS | Power supply |
| OUTTEST1 | NONE | Manufacturing test pin-leave open |
| GND | GND | Ground |
| OVER7 | Y17 | Overlay logic control |
| VOVER7 | V17 | Overlay analog input |
| OUT7 | W17 | Output |
| OVER6 | Y16 | Overlay logic control |
| VOVER6 | V16 | Overlay analog input |
| OUT6 | W16 | Output |
| OVER5 | Y15 | Overlay logic control |
| VOVER5 | V15 | Overlay analog input |
| OUT5 | W15 | Output |
| OVER4 | Y14 | Overlay logic control |
| VOVER4 | V14 | Overlay analog input |
| OUT4 | W14 | Output |
| VS | VS | Power supply |
| GND | GND | Ground |
| OUT3 | Y13 | Output |
| VOVER3 | V13 | Overlay analog input |
| OVER3 | W13 | Overlay logic control |
| OUT2 | Y12 | Output |
| VOVER2 | V12 | Overlay analog input |
| OVER2 | W12 | Overlay logic control |
| OUT1 | Y11 | Output |
| VOVER1 | V11 | Overlay analog input |
| OVER1 | W11 | Overlay logic control |
| OUT0 | Y10 | Output |
| VOVER0 | V10 | Overlay analog input |
| OVER0 | W10 | Overlay logic control |
| VS | VS | Power supply |
| OUTTEST0 | NONE | Manufacturing test pin-leave open |
| GND | GND | Ground |

## Pin Descriptions (Continued)

| NAME | NUMBER | DESCRIPTION |
|---|---|---|
| IN0 | Y8 | Input |
| INB0 | W8 | Complementary input |
| IN1 | Y7 | Input |
| INB1 | W7 | Complementary input |
| IN2 | Y6 | Input |
| INB2 | W6 | Complementary input |
| IN3 | Y5 | Input |
| INB3 | W5 | Complementary input |
| DIODE | V9 | Anode of a ground-connected diode: useful for measuring die temperature |
| VS | VS | Power supply |
| GND | GND | Ground |
| VS | VS | Power supply |
| GND | GND | Ground |
| SPARE0 | V6 | Not assigned-do not connect |
| SPARE1 | V5 | Not assigned-do not connect |
| INPUTTEST BUS | NONE | Manufacturing test pin-leave open |

## Typical Performance Curve

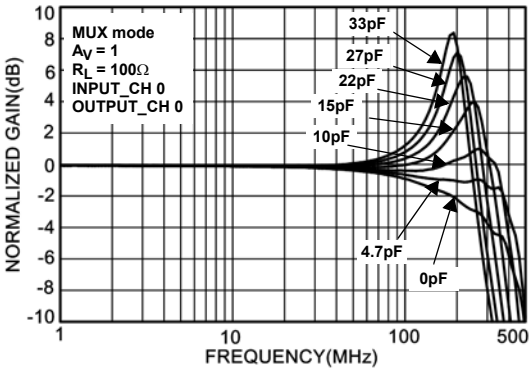



FIGURE 1. FREQUENCY RESPONSE - VARIOUS $C_L$, $A_V$ = 1, MUX MODE

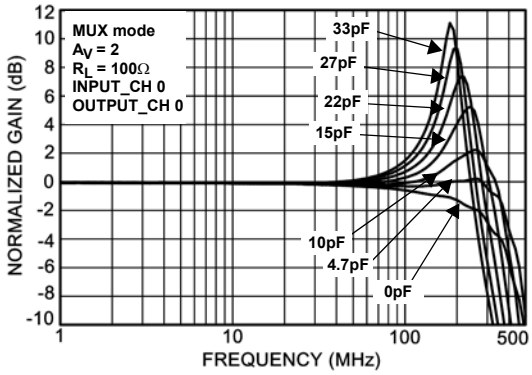



FIGURE 2. FREQUENCY RESPONSE - VARIOUS $C_L$, $A_V$ = 2, MUX MODE

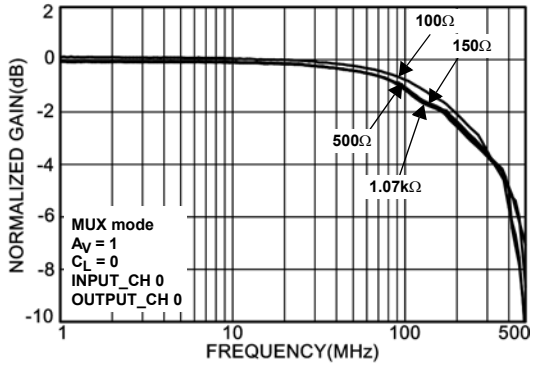



FIGURE 3. FREQUENCY RESPONSE - VARIOUS $R_L$, $A_V$ = 1, MUX MODE

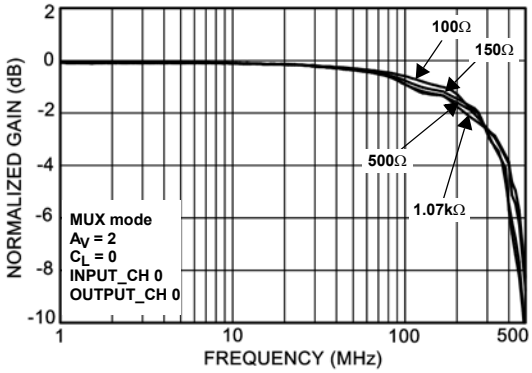



FIGURE 4. FREQUENCY RESPONSE - VARIOUS $R_L$, $A_V$ = 2, MUX MODE

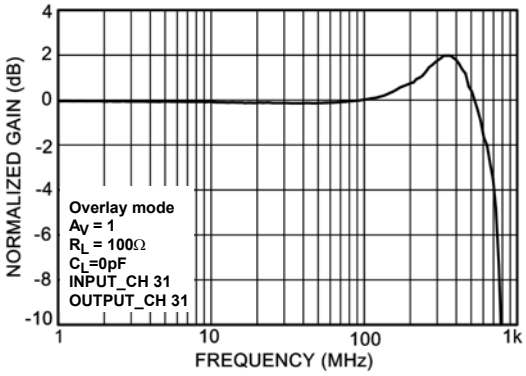



FIGURE 5. FREQUENCY RESPONSE - OVERLAY INPUT, $A_V$ = 1

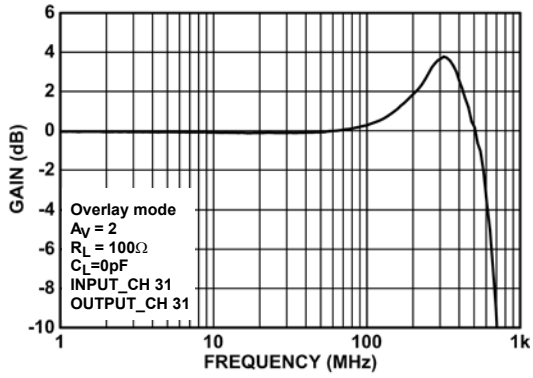



FIGURE 6. FREQUENCY RESPONSE - OVERLAY INPUT, $A_V$ = 2

## Typical Performance Curve (Continued)

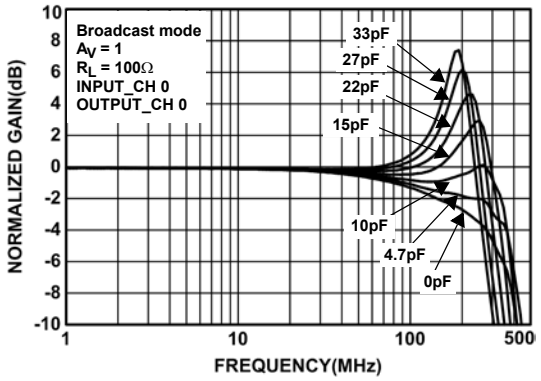



FIGURE 7. FREQUENCY RESPONSE - VARIOUS $C_L$, $A_V$ = 1, BROADCAST MODE

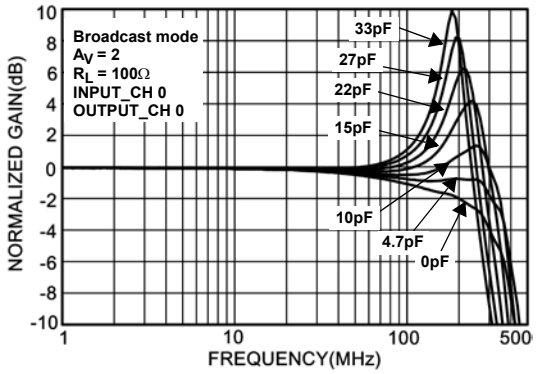



FIGURE 8. FREQUENCY RESPONSE - VARIOUS $C_L$, $A_V$ = 2, BROADCAST MODE

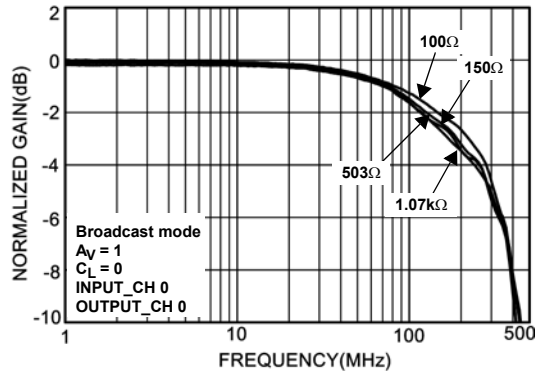



FIGURE 9A. FREQUENCY RESPONSE - VARIOUS $R_L$, $A_V$ = 1, BROADCAST MODE

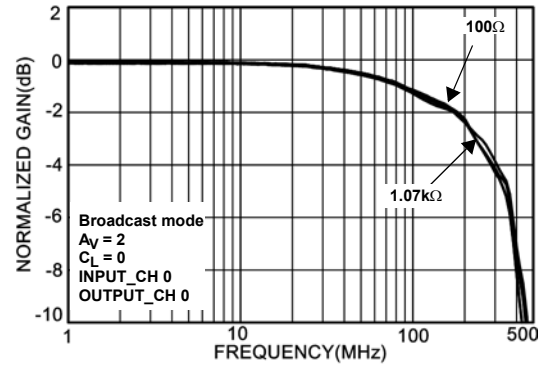



FIGURE 10. FREQUENCY RESPONSE - VARIOUS $R_L$, $A_V$ = 2, BROADCAST MODE

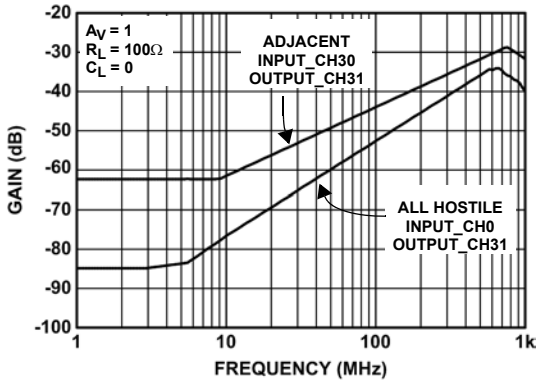



FIGURE 11. CROSSTALK - $A_V$ = 1

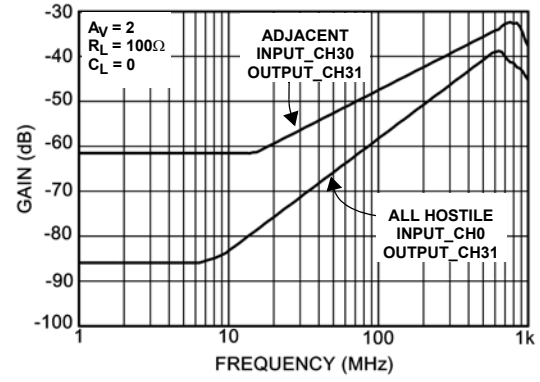



FIGURE 12. CROSSTALK - $A_V$ = 2

## Typical Performance Curve (Continued)

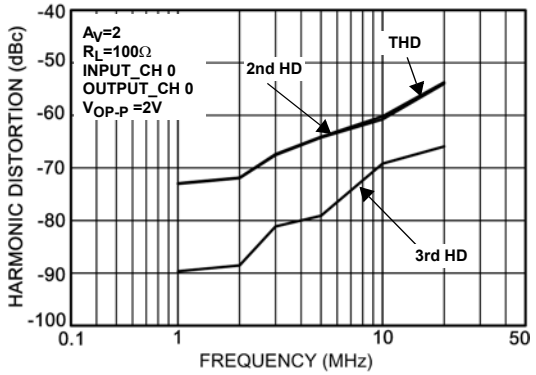



FIGURE 13. HARMONIC DISTORTION vs FREQUENCY

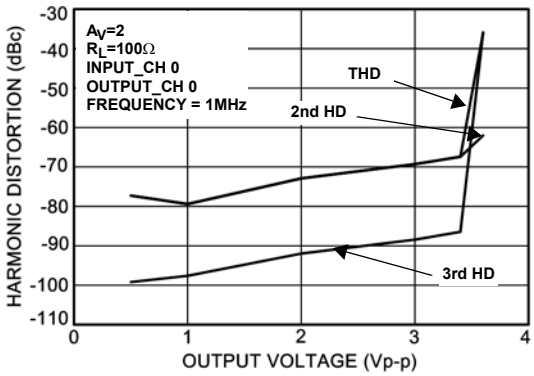



FIGURE 14. HARMONIC DISTORTION vs $V_{OUT\_P-P}$

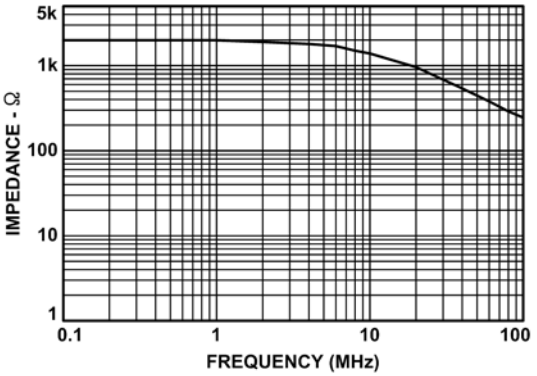



FIGURE 15. DISABLE OUTPUT IMPEDANCE

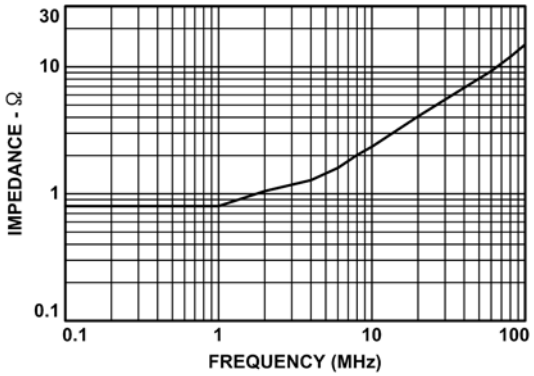



FIGURE 16. ENABLE OUTPUT IMPEDANCE

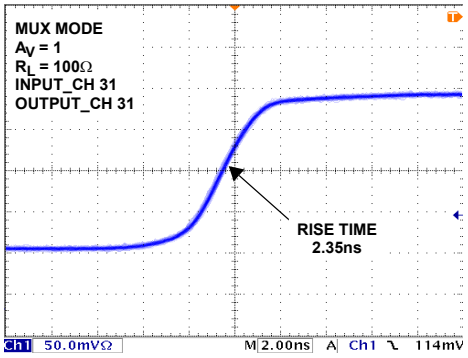



FIGURE 17. RISE TIME - $A_V$ = 1

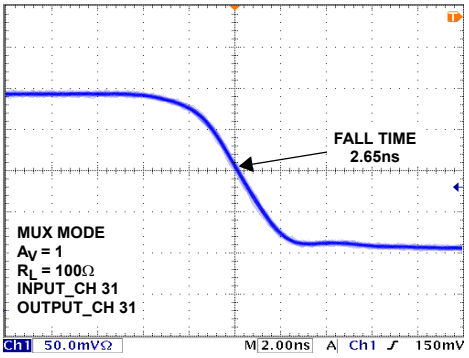



FIGURE 18. FALL TIME - $A_V$ = 1

## Typical Performance Curve (Continued)

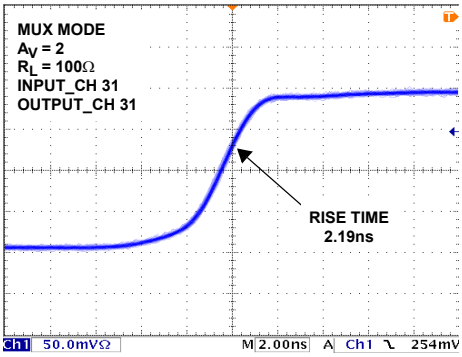



FIGURE 19. RISE TIME - $A_V$ = 2

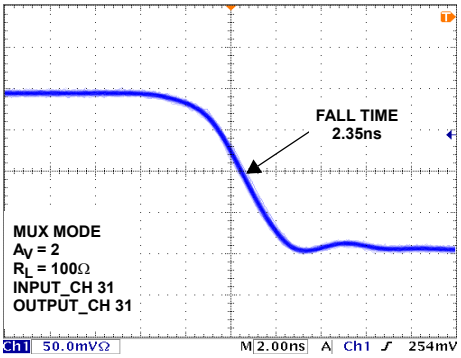



FIGURE 20. FALL TIME - $A_V$ = 2

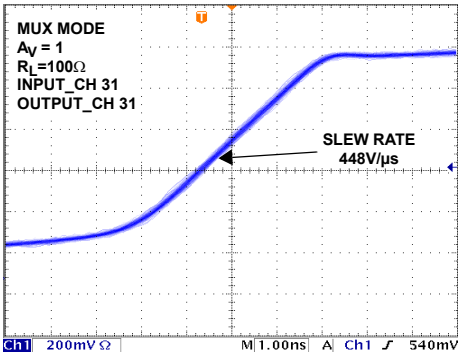



FIGURE 21. RISING SLEW RATE - $A_V$ = 1

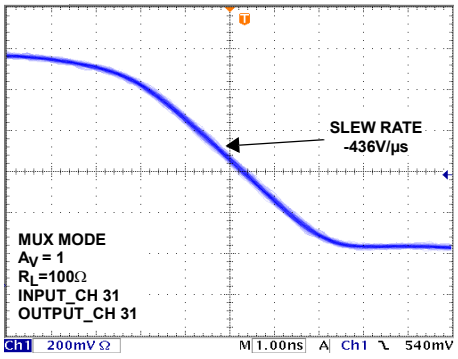



FIGURE 22. FALLING SLEW RATE - $A_V$ = 1

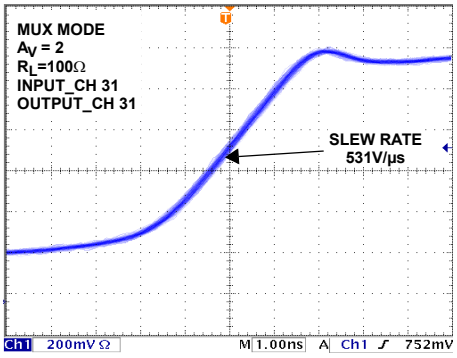



FIGURE 23. RISING SLEW RATE - $A_V$ = 2

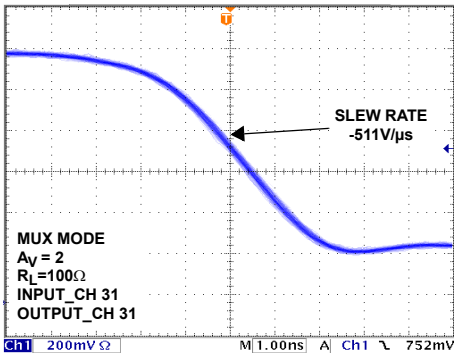



FIGURE 24. FALLING SLEW RATE - $A_V$ = 2

## Typical Performance Curve (Continued)

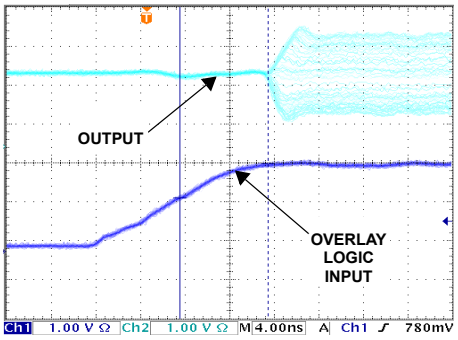



FIGURE 25. OVERLAY SWITCH TURN-ON DELAY TIME

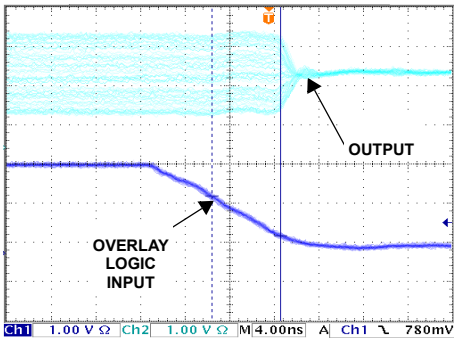



FIGURE 26. OVERLAY SWITCH TURN-OFF DELAY TIME

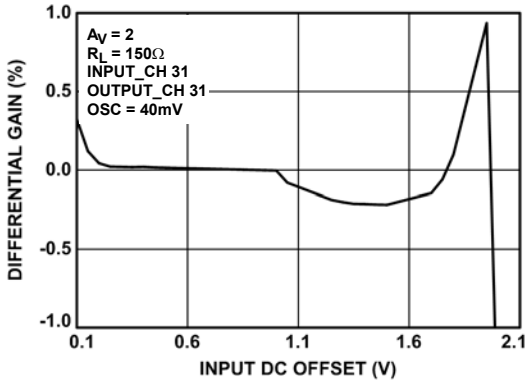



FIGURE 27. DIFFERENTIAL GAIN, $A_V$ = 2

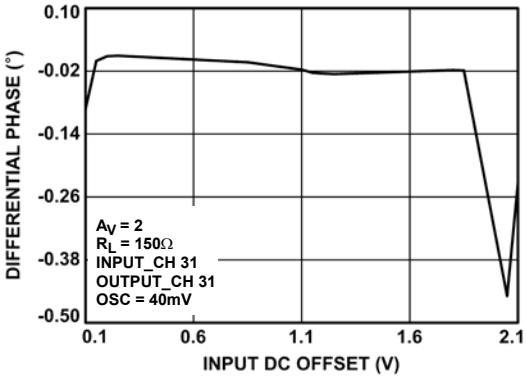



FIGURE 28. DIFFERENTIAL PHASE, $A_V$ = 2

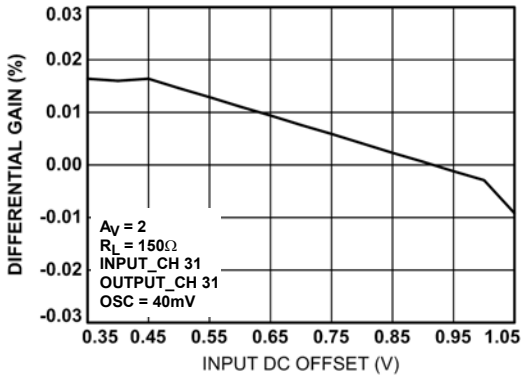



FIGURE 29. DIFFERENTIAL GAIN, $A_V$ = 2

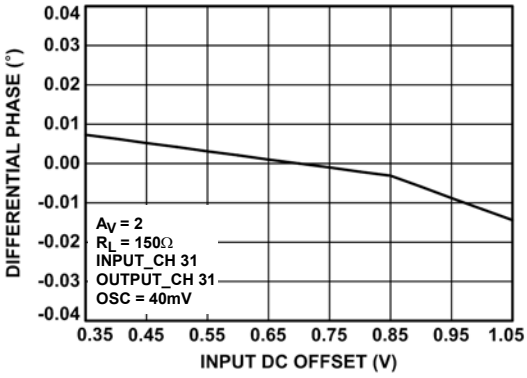



FIGURE 30. DIFFERENTIAL PHASE, $A_V$ = 2

## Typical Performance Curve (Continued)

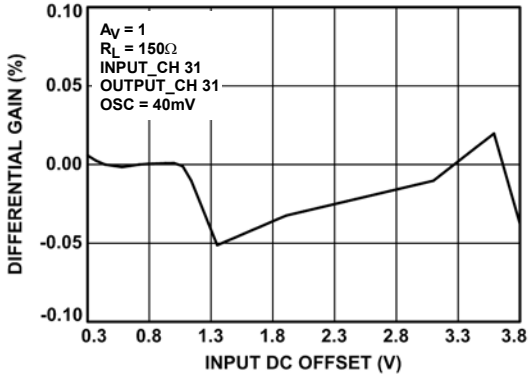



FIGURE 31. DIFFERENTIAL GAIN, $A_V$ = 1

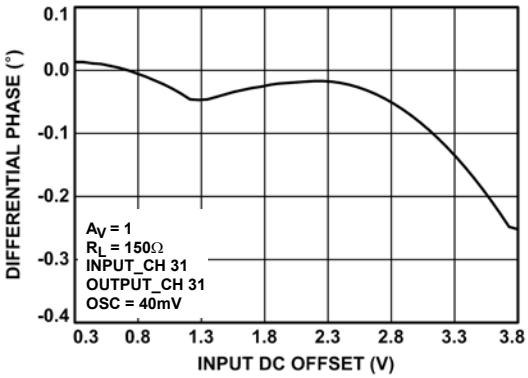



FIGURE 32. DIFFERENTIAL PHASE, $A_V$ = 1

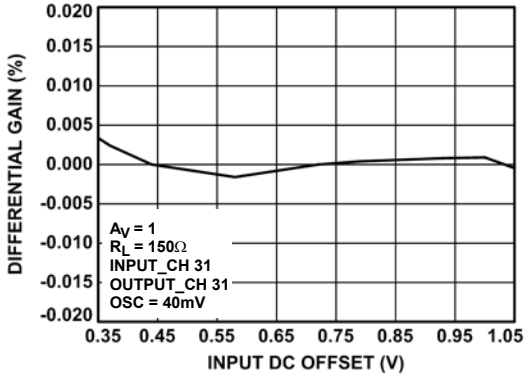



FIGURE 33. DIFFERENTIAL GAIN, $A_V$ = 1

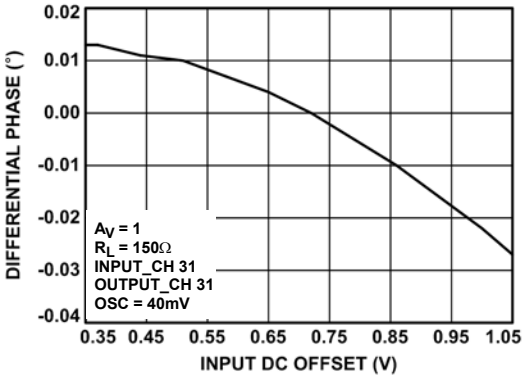



FIGURE 34. DIFFERENTIAL GAIN, $A_V$ = 1

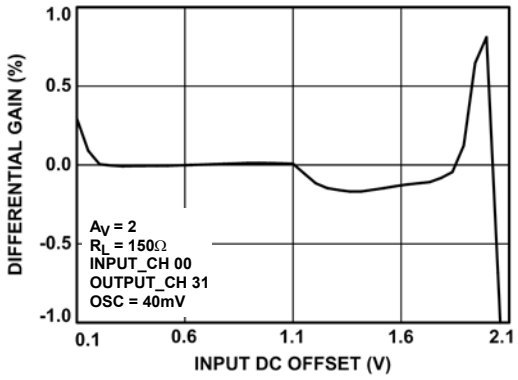



FIGURE 35. DIFFERENTIAL GAIN, $A_V$ = 2

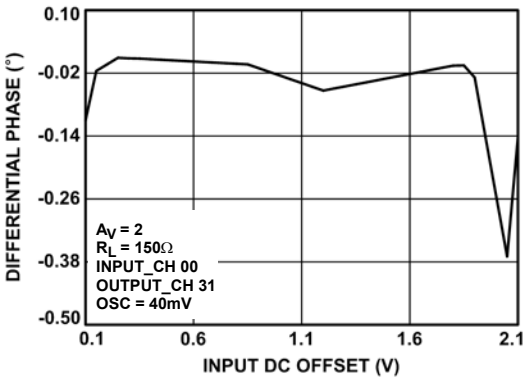



FIGURE 36. DIFFERENTIAL PHASE, $A_V$ = 2

## Typical Performance Curve (Continued)

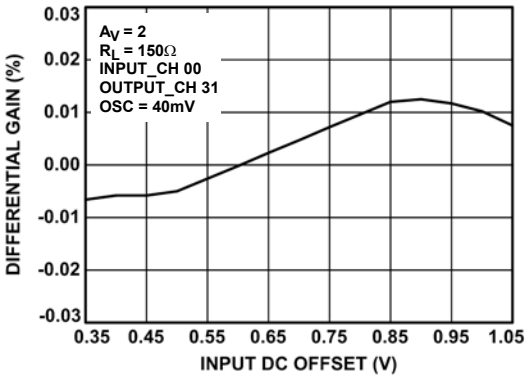



FIGURE 37. DIFFERENTIAL GAIN, $A_V$ = 2

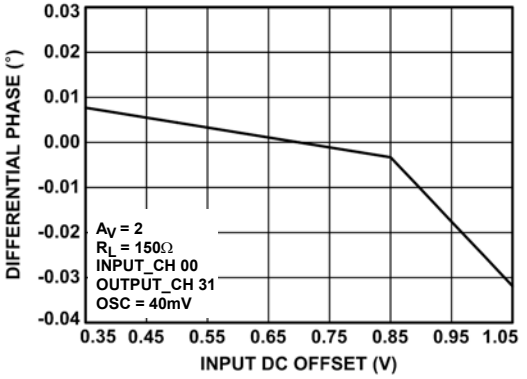



FIGURE 38. DIFFERENTIAL PHASE, $A_V$ = 2

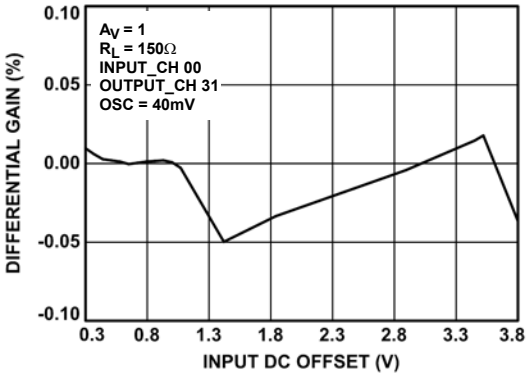



FIGURE 39. DIFFERENTIAL GAIN, $A_V$ = 1

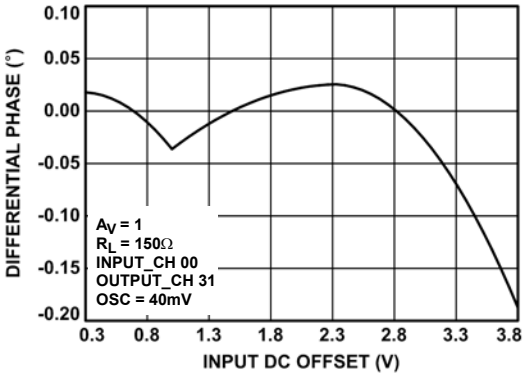



FIGURE 40. DIFFERENTIAL PHASE, $A_V$ = 1

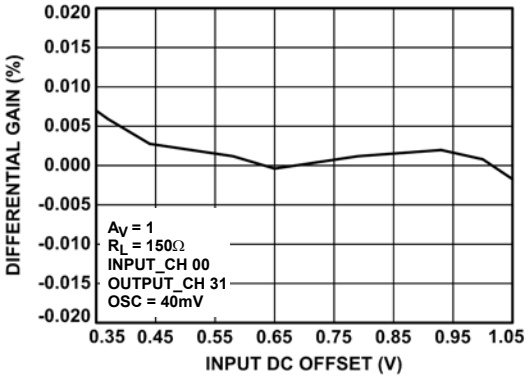



FIGURE 41. DIFFERENTIAL GAIN, $A_V$ = 1

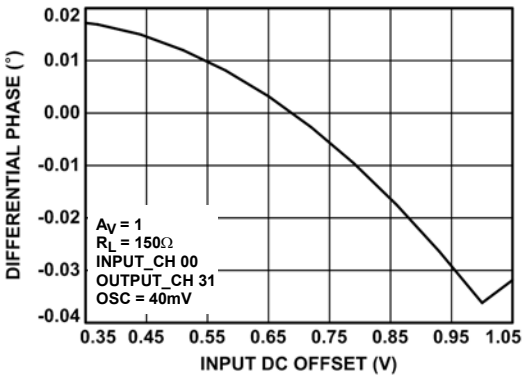



FIGURE 42. DIFFERENTIAL PHASE, $A_V$ = 1

## Typical Performance Curve (Continued)

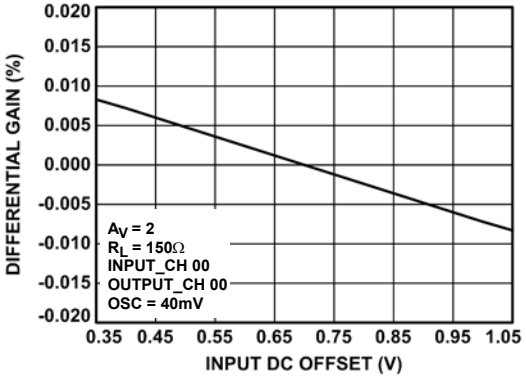



FIGURE 43. DIFFERENTIAL GAIN, OVERLAY, $A_V$ = 2

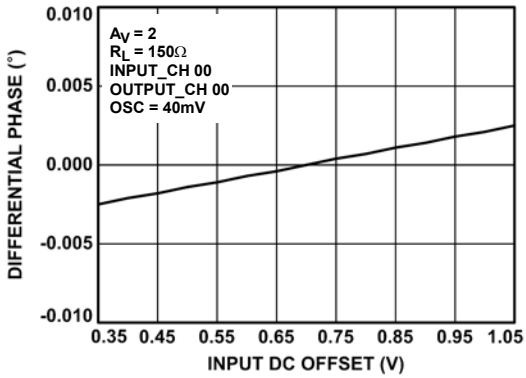



FIGURE 44. DIFFERENTIAL PHASE, OVERLAY, $A_V$ = 2

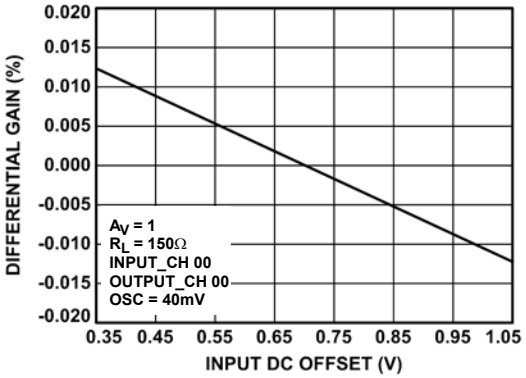



FIGURE 45. DIFFERENTIAL GAIN, OVERLAY, $A_V$ = 1

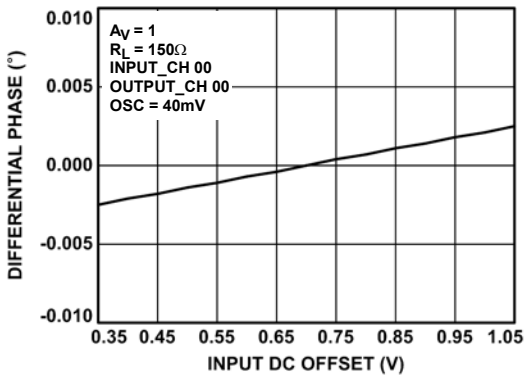



FIGURE 46. DIFFERENTIAL PHASE, OVERLAY, $A_V$ = 1

## 3dB Bandwidth, MUX Mode, $A_V$ = 1, $R_L$ = 100Ω [MHz]

| OUTPUT CHANNELS | INPUT CHANNELS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 |
| | 0 | 262 | | | | | 270 | | | | | 268 | | | | | 235 | | | | | 236 | | | | | 235 | | | | | | 236 |
| | 1 | | 224 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 214 | |
| | 2 | | | 217 | | | | | | | | | | | | | | | | | | | | | | | | | | | 214 | | |
| | 3 | | | | 211 | | | | | | | | | | | | | | | | | | | | | | | | | 203 | | | |
| | 4 | | | | | 277 | | | | | | | | | | | | | | | | | | | | | | | 272 | | | | |
| | 5 | 267 | | | | | 268 | | | | | | | | | | 247 | | | | | | | | | | | 268 | | | | | 259 |
| | 6 | | | | | | | 288 | | | | | | | | | | | | | | | | | | 290 | | | | | | | |
| | 7 | | | | | | | | 271 | | | | | | | | | | | | | | | | | 278 | | | | | | | |
| | 8 | | | | | | | | | 269 | | | | | | | | | | | | | | | 271 | | | | | | | | |
| | 9 | | | | | | | | | | 277 | | | | | | | | | | | | | 275 | | | | | | | | | |
| | 10 | 273 | | | | | | | | | | 274 | | | | | 256 | | | | | | 272 | | | | | | | | | | 267 |
| | 11 | | | | | | | | | | | | 274 | | | | | | | | | 272 | | | | | | | | | | | |
| | 12 | | | | | | | | | | | | | 255 | | | | | | | 258 | | | | | | | | | | | | |
| | 13 | | | | | | | | | | | | | | 264 | | | | | 271 | | | | | | | | | | | | | |
| | 14 | | | | | | | | | | | | | | | 268 | | | 274 | | | | | | | | | | | | | | |
| | 15 | 298 | 292 | 289 | 290 | 304 | 299 | 307 | 304 | 198 | 309 | 299 | 300 | 292 | 290 | 286 | 283 | 290 | 292 | 299 | 296 | 298 | 308 | 326 | 311 | 221 | 309 | 313 | 311 | 293 | 297 | 294 | 283 |
| | 16 | | | | | | | | | | | | | | | | 278 | 286 | | | | | | | | | | | | | | | |
| | 17 | | | | | | | | | | | | | | | 268 | | | 276 | | | | | | | | | | | | | | |
| | 18 | | | | | | | | | | | | | | 265 | | | | | 277 | | | | | | | | | | | | | |
| | 19 | | | | | | | | | | | | | 255 | | | | | | | 264 | | | | | | | | | | | | |
| | 20 | 281 | | | | | | | | | | | 282 | | | | 265 | | | | | 288 | | | | | | | | | | | 283 |
| | 21 | | | | | | | | | | | 266 | | | | | | | | | | | 275 | | | | | | | | | | |
| | 22 | | | | | | | | | | 285 | | | | | | | | | | | | | 350 | | | | | | | | | |
| | 23 | | | | | | | | | 268 | | | | | | | | | | | | | | | 336 | | | | | | | | |
| | 24 | | | | | | | | 196 | | | | | | | | | | | | | | | | | 216 | | | | | | | |
| | 25 | 264 | | | | | | 271 | | | | | | | | | 247 | | | | | | | | | | 277 | | | | | | 272 |
| | 26 | | | | | | 269 | | | | | | | | | | | | | | | | | | | | | 285 | | | | | |
| | 27 | | | | | 267 | | | | | | | | | | | | | | | | | | | | | | | 283 | | | | |
| | 28 | | | | 199 | | | | | | | | | | | | | | | | | | | | | | | | | 281 | | | |
| | 29 | | | 206 | | | | | | | | | | | | | | | | | | | | | | | | | | | 252 | | |
| | 30 | | 214 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 252 | |
| | 31 | 238 | | | | | 230 | | | | | 238 | | | | | 220 | | | | | 280 | | | | | 287 | | | | | | 274 |

## 3dB Bandwidth, MUX Mode, $A_V$ = 2, $R_L$ = 100Ω [MHz]

| | | INPUT CHANNELS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 |
| OUTPUT CHANNELS | 0 | 262 | | | | | 270 | | | | | 268 | | | | | 235 | | | | | 236 | | | | | 235 | | | | | | 236 |
| | 1 | | 224 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 214 | |
| | 2 | | | 217 | | | | | | | | | | | | | | | | | | | | | | | | | | | 214 | | |
| | 3 | | | | 211 | | | | | | | | | | | | | | | | | | | | | | | | | 203 | | | |
| | 4 | | | | | 277 | | | | | | | | | | | | | | | | | | | | | | | 272 | | | | |
| | 5 | 267 | | | | | 268 | | | | | | | | | | 247 | | | | | | | | | | | 268 | | | | | 259 |
| | 6 | | | | | | | 288 | | | | | | | | | | | | | | | | | | | 290 | | | | | | |
| | 7 | | | | | | | | 271 | | | | | | | | | | | | | | | | | 278 | | | | | | | |
| | 8 | | | | | | | | | 269 | | | | | | | | | | | | | | | 271 | | | | | | | | |
| | 9 | | | | | | | | | | 277 | | | | | | | | | | | | | 275 | | | | | | | | | |
| | 10 | 273 | | | | | | | | | | 274 | | | | | 256 | | | | | | 272 | | | | | | | | | | 267 |
| | 11 | | | | | | | | | | | | 274 | | | | | | | | | 272 | | | | | | | | | | | |
| | 12 | | | | | | | | | | | | | 255 | | | | | | | 258 | | | | | | | | | | | | |
| | 13 | | | | | | | | | | | | | | 264 | | | | | 271 | | | | | | | | | | | | | |
| | 14 | | | | | | | | | | | | | | | 268 | | | 274 | | | | | | | | | | | | | | |
| | 15 | 298 | 292 | 289 | 290 | 304 | 299 | 307 | 304 | 198 | 309 | 299 | 300 | 292 | 290 | 286 | 283 | 290 | 292 | 299 | 296 | 298 | 308 | 326 | 311 | 221 | 309 | 313 | 311 | 293 | 297 | 294 | 283 |
| | 16 | | | | | | | | | | | | | | | | 278 | 286 | | | | | | | | | | | | | | | |
| | 17 | | | | | | | | | | | | | | | 268 | | | 276 | | | | | | | | | | | | | | |
| | 18 | | | | | | | | | | | | | | 265 | | | | | 277 | | | | | | | | | | | | | |
| | 19 | | | | | | | | | | | | | 255 | | | | | | | 264 | | | | | | | | | | | | |
| | 20 | 281 | | | | | | | | | | | 282 | | | | 265 | | | | | 288 | | | | | | | | | | | 283 |
| | 21 | | | | | | | | | | | 266 | | | | | | | | | | | 275 | | | | | | | | | | |
| | 22 | | | | | | | | | | 285 | | | | | | | | | | | | | 350 | | | | | | | | | |
| | 23 | | | | | | | | | 268 | | | | | | | | | | | | | | | 336 | | | | | | | | |
| | 24 | | | | | | | | 196 | | | | | | | | | | | | | | | | | 216 | | | | | | | |
| | 25 | 264 | | | | | | 271 | | | | | | | | | 247 | | | | | | | | | | 277 | | | | | | 272 |
| | 26 | | | | | | 269 | | | | | | | | | | | | | | | | | | | | | 285 | | | | | |
| | 27 | | | | | 267 | | | | | | | | | | | | | | | | | | | | | | | 283 | | | | |
| | 28 | | | | 199 | | | | | | | | | | | | | | | | | | | | | | | | | 281 | | | |
| | 29 | | | 206 | | | | | | | | | | | | | | | | | | | | | | | | | | | 252 | | |
| | 30 | | 214 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 252 | |
| | 31 | 238 | | | | | 230 | | | | | 238 | | | | | 220 | | | | | 280 | | | | | 287 | | | | | | 274 |

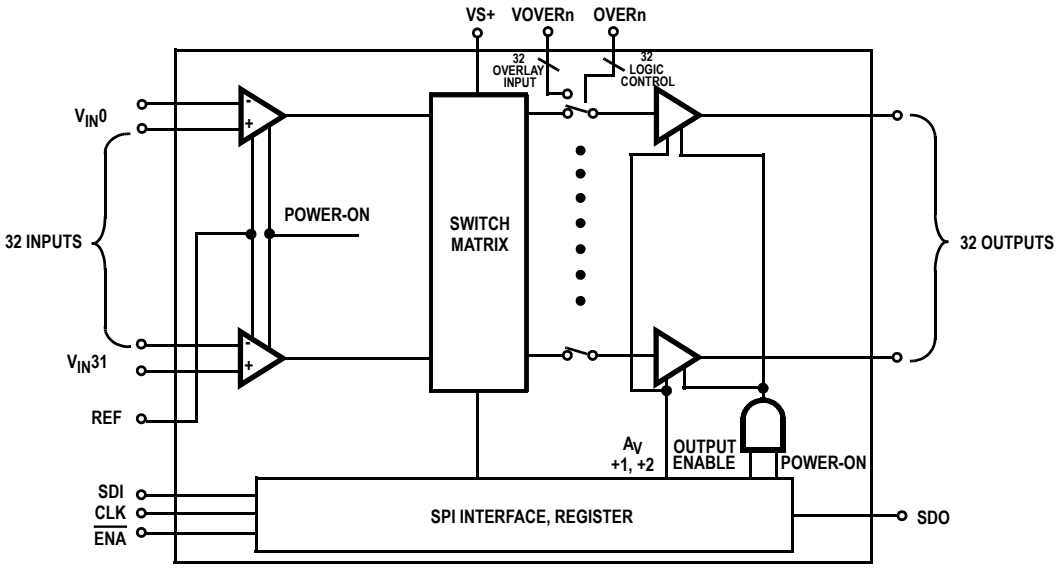
## 3dB Bandwidth, Broadcast Mode, $A_V$ = 1, $R_L$ = 100Ω [MHz]

| | INPUT CHANNELS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 |
| OUTPUT CHANNELS | 0 | 196 | 204 | 193 | 175 | 154 | 154 | 158 | 161 | 169 | 157 | 155 | 146 | 125 | 121 | 115 | 109 | 81 | 81 | 79 | 80 | 85 | 85 | 86 | 86 | 83 | 82 | 82 | 77 | 80 | 82 | 85 | 86 |
| | 1 | 185 | 189 | | | | | | | | | | | | | | 104 | | | | | | | | | | | | | | | 85 | 87 |
| | 2 | 172 | | 163 | | | | | | | | | | | | | 104 | | | | | | | | | | | | | | 85 | | 87 |
| | 3 | 161 | | | 138 | | | | | | | | | | | | 99 | | | | | | | | | | | | | 81 | | | 87 |
| | 4 | 165 | | | | 128 | | | | | | | | | | | 99 | | | | | | | | | | | | 79 | | | | 89 |
| | 5 | 160 | | | | | 126 | | | | | | | | | | 97 | | | | | | | | | | | 82 | | | | | 89 |
| | 6 | 152 | | | | | | 123 | | | | | | | | | 95 | | | | | | | | | | 81 | | | | | | 89 |
| | 7 | 141 | | | | | | | 119 | | | | | | | | 91 | | | | | | | | | 84 | | | | | | | 89 |
| | 8 | 133 | | | | | | | | 113 | | | | | | | 86 | | | | | | | | 82 | | | | | | | | 89 |
| | 9 | 133 | | | | | | | | | 113 | | | | | | 90 | | | | | | | 85 | | | | | | | | | 90 |
| | 10 | 132 | | | | | | | | | | 113 | | | | | 91 | | | | | | 88 | | | | | | | | | | 92 |
| | 11 | 130 | | | | | | | | | | | 107 | | | | 90 | | | | | 90 | | | | | | | | | | | 93 |
| | 12 | 125 | | | | | | | | | | | | 94 | | | 87 | | | | 81 | | | | | | | | | | | | 92 |
| | 13 | 125 | | | | | | | | | | | | | 91 | | 88 | | | 84 | | | | | | | | | | | | | 95 |
| | 14 | 127 | | | | | | | | | | | | | | 90 | 88 | | 85 | | | | | | | | | | | | | | 97 |
| | 15 | 125 | 129 | 124 | 118 | 109 | 109 | 110 | 112 | 113 | 110 | 107 | 106 | 95 | 93 | 91 | 89 | 88 | 88 | 88 | 88 | 95 | 94 | 96 | 97 | 93 | 92 | 89 | 86 | 91 | 93 | 95 | 98 |
| | 16 | 124 | | | | | | | | | | | | | | | 89 | 88 | | | | | | | | | | | | | | | 100 |
| | 17 | 119 | | | | | | | | | | | | | | 85 | 85 | | 86 | | | | | | | | | | | | | | | 100 |
| | 18 | 116 | | | | | | | | | | | | | 88 | | 84 | | | 87 | | | | | | | | | | | | | 100 |
| | 19 | 113 | | | | | | | | | | | | 89 | | | 82 | | | | 88 | | | | | | | | | | | | 100 |
| | 20 | 114 | | | | | | | | | | | 97 | | | | 84 | | | | | 98 | | | | | | | | | | | 102 |
| | 21 | 112 | | | | | | | | | | 99 | | | | | 82 | | | | | | 98 | | | | | | | | | | 103 |
| | 22 | 108 | | | | | | | | | 94 | | | | | | 80 | | | | | | | 100 | | | | | | | | | 102 |
| | 23 | 107 | | | | | | | | 96 | | | | | | | 78 | | | | | | | | 100 | | | | | | | | 104 |
| | 24 | 106 | | | | | | | 96 | | | | | | | | 79 | | | | | | | | | 99 | | | | | | | 106 |
| | 25 | 107 | | | | | | 96 | | | | | | | | | 80 | | | | | | | | | | 99 | | | | | | 110 |
| | 26 | 108 | | | | | 96 | | | | | | | | | | 81 | | | | | | | | | | | 98 | | | | | 114 |
| | 27 | 107 | | | | 97 | | | | | | | | | | | 81 | | | | | | | | | | | | 99 | | | | 123 |
| | 28 | 104 | | | 98 | | | | | | | | | | | | 78 | | | | | | | | | | | | | 105 | | | 115 |
| | 29 | 104 | | 102 | | | | | | | | | | | | | 80 | | | | | | | | | | | | | | 106 | | 119 |
| | 30 | 105 | 106 | | | | | | | | | | | | | | 80 | | | | | | | | | | | | | | | 118 | 125 |
| | 31 | 107 | 110 | 108 | 103 | 98 | 98 | 98 | 99 | 101 | 99 | 97 | 95 | 87 | 86 | 84 | 81 | 113 | 112 | 112 | 114 | 126 | 126 | 128 | 129 | 124 | 118 | 114 | 111 | 120 | 122 | 129 | 131 |

## 3dB Bandwidth, Broadcast Mode, $A_V$ = 2, $R_L$ = 100Ω [MHz]

| | INPUT CHANNELS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 |
| OUTPUT CHANNELS | 0 | 270 | 277 | 268 | 247 | 213 | 216 | 227 | 244 | 258 | 223 | 208 | 196 | 147 | 142 | 132 | 123 | 85 | 85 | 85 | 86 | 91 | 91 | 92 | 93 | 90 | 88 | 86 | 85 | 89 | 90 | 92 | 94 |
| | 1 | 256 | 261 | | | | | | | | | | | | | | 117 | | | | | | | | | | | | | | | 93 | 93 |
| | 2 | 240 | | 223 | | | | | | | | | | | | | 112 | | | | | | | | | | | | | | 88 | | 92 |
| | 3 | 219 | | | 189 | | | | | | | | | | | | 106 | | | | | | | | | | | | | 86 | | | 92 |
| | 4 | 233 | | | | 158 | | | | | | | | | | | 108 | | | | | | | | | | | | 83 | | | | 95 |
| | 5 | 225 | | | | | 152 | | | | | | | | | | 106 | | | | | | | | | | | 86 | | | | | 95 |
| | 6 | 204 | | | | | | 146 | | | | | | | | | 105 | | | | | | | | | | 88 | | | | | | 95 |
| | 7 | 187 | | | | | | | 137 | | | | | | | | 99 | | | | | | | | 89 | | | | | | | | 94 |
| | 8 | 172 | | | | | | | | 128 | | | | | | | 92 | | | | | | | 85 | | | | | | | | | 94 |
| | 9 | 171 | | | | | | | | | 128 | | | | | | 96 | | | | | | 93 | | | | | | | | | | 96 |
| | 10 | 170 | | | | | | | | | | 126 | | | | | 97 | | | | | 94 | | | | | | | | | | | 98 |
| | 11 | 167 | | | | | | | | | | | 119 | | | | 97 | | | | | 96 | | | | | | | | | | | 101 |
| | 12 | 152 | | | | | | | | | | | | 103 | | | 93 | | | | 89 | | | | | | | | | | | | 99 |
| | 13 | 153 | | | | | | | | | | | | | 99 | | 93 | | | 88 | | | | | | | | | | | | | 103 |
| | 14 | 155 | | | | | | | | | | | | | | 96 | 94 | | 89 | | | | | | | | | | | | | | 105 |
| | 15 | 151 | 155 | 146 | 134 | 123 | 125 | 126 | 126 | 128 | 123 | 123 | 114 | 103 | 99 | 97 | 94 | 94 | 92 | 92 | 93 | 102 | 102 | 102 | 102 | 99 | 99 | 93 | 93 | 98 | 99 | 102 | 104 |
| | 16 | 146 | | | | | | | | | | | | | | | 93 | 94 | | | | | | | | | | | | | | | 109 |
| | 17 | 138 | | | | | | | | | | | | | | 91 | 91 | | 92 | | | | | | | | | | | | | | | 109 |
| | 18 | 133 | | | | | | | | | | | | | 94 | | 90 | | | 93 | | | | | | | | | | | | | 109 |
| | 19 | 127 | | | | | | | | | | | | 95 | | | 90 | | | | 94 | | | | | | | | | | | | 109 |
| | 20 | 129 | | | | | | | | | | | 106 | | | | 89 | | | | | 106 | | | | | | | | | | | | 113 |
| | 21 | 126 | | | | | | | | | | 106 | | | | | 86 | | | | | | 105 | | | | | | | | | | | 114 |
| | 22 | 119 | | | | | | | | | 102 | | | | | | 84 | | | | | | | 107 | | | | | | | | | | 112 |
| | 23 | 118 | | | | | | | | 105 | | | | | | | 83 | | | | | | | | 106 | | | | | | | | | 114 |
| | 24 | 116 | | | | | | | 103 | | | | | | | | 83 | | | | | | | | | 107 | | | | | | | | 117 |
| | 25 | 118 | | | | | | 103 | | | | | | | | | 84 | | | | | | | | | | 107 | | | | | | | 125 |
| | 26 | 120 | | | | | 103 | | | | | | | | | | 84 | | | | | | | | | | | 108 | | | | | | 135 |
| | 27 | 118 | | | | 103 | | | | | | | | | | | 85 | | | | | | | | | | | | 108 | | | | | 142 |
| | 28 | 113 | | | 106 | | | | | | | | | | | | 82 | | | | | | | | | | | | | 113 | | | | 133 |
| | 29 | 114 | | 110 | | | | | | | | | | | | | 81 | | | | | | | | | | | | | | 123 | | | 143 |
| | 30 | 115 | 116 | | | | | | | | | | | | | | 82 | | | | | | | | | | | | | | | 138 | | 155 |
| | 31 | 117 | 121 | 118 | 112 | 105 | 105 | 106 | 108 | 110 | 107 | 104 | 101 | 93 | 91 | 88 | 85 | 130 | 127 | 127 | 130 | 153 | 150 | 158 | 163 | 149 | 140 | 133 | 126 | 140 | 146 | 161 | 164 |

## Block Diagram




## General Description

The ISL59533 is a 32x32 integrated video crosspoint switch matrix with differential input and output buffers and On-Screen Display (OSD) insertion. This device operates from a single +5V supply. Any output can be switched to any of the 32 input video signal sources and OSD information through an internal, dedicated fast 2:1 mux located before the output buffer. Also, any one input can be broadcast to all 32 outputs.

Each output X is defined as:

Voutx = Avx*(INx-INBx+REF)

Where Avx = 1, or Avx = 2. Note that all REF's are common between channels and must be externally well buffered and/or bypassed.

The ISL59533 offers a -3dB signal bandwidth of 300MHz. The differential gain and phase at 0.01% and 0.03° respectively, along with 0.1dB flatness out to 35MHz. The switch matrix configuration and output buffer gain are programmed through an SPI/QSPI™-compatible, three-wire serial interface. The ISL59533 interface is set up to facilitate both fast updates and initialization. On power-up, all facilities are initialized in the disabled state to avoid output conflicts within the user system.

### Digital Interface

The ISL59533 uses a simple 3-wire SPI compliant digital interface to program the outputs. The ISL59533 can support the clock rate up to 5MHz.

### Serial Interface

The ISL59533 is programmed through a three-wire serial interface. The start and stop conditions are defined by the $\overline{ENA}$ signal. While the $\overline{ENA}$ is low, the data on the SDI (serial data input) pin is shifted into the 16-bit shift register on the positive edge of the SCLK (serial clock) signal. The LSB (bit 0) is loaded first and the MSB (bit 15) is loaded last (see Table 1). After the full 16-bit data has been loaded, the $\overline{ENA}$ is pulled high and the addressed output channel is updated. The SCLK is disabled internally when the $\overline{ENA}$ is high. The SCLK must be low before the $\overline{ENA}$ is pulled low.

The Serial Timing Diagram and parameters table show the timing requirements for three-wire signals.

## Serial Timing Diagram

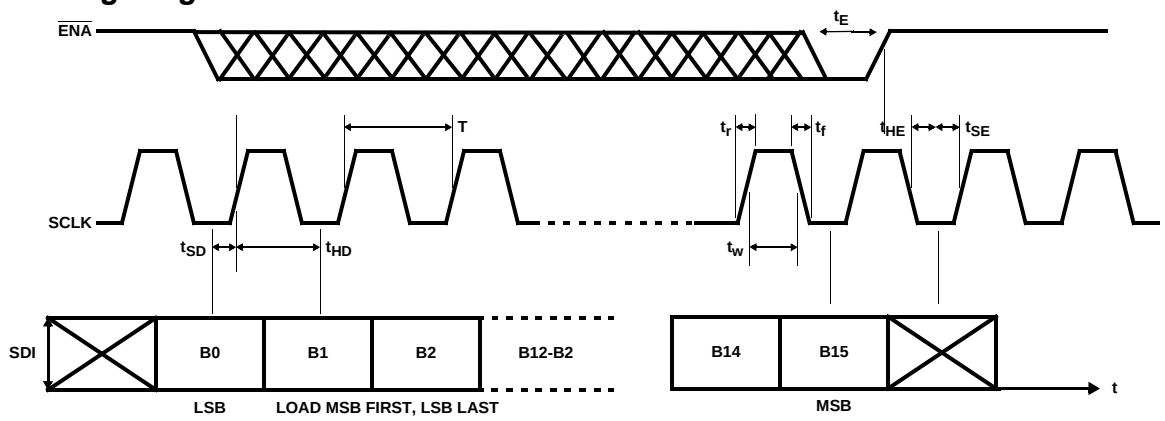



**TABLE 1. SERIAL TIMING PARAMETERS**

| PARAMETER | RECOMMENDED OPERATING RANGE | DESCRIPTION |
|---|---|---|
| T | ≥200ns | Clock Period |
| $t_{HE}$ | ≥20ns | $\overline{ENA}$ Hold Time |
| $t_{SE}$ | ≥20ns | $\overline{ENA}$ Setup Time |
| $t_{HD}$ | ≥20ns | Data Hold Time |
| $t_{SD}$ | ≥20ns | Data Setup Time |
| $t_W$ | 0.50 * T | Clock Pulse Width |

### Programming Model

The device has power-on reset that disables outputs, disables test mode, and turns off analog currents. To start up the device the control word is sent:

**TABLE 2. CONTROL WORD FORMAT**

| B15 | B14 | B13 | B12 | B11 | B10 | B9 | B8 | B7 | B6 | B5 | B4 | B3 | B2 | B1 | B0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 1 | - | - | - | - | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Power on | Common output enable |

It is important to always program control bits 2-8 as zeros to avoid activating test modes designed for device manufacturing. The clamp bit activates the input clamp and bleed current sink and works only in the single-ended version.

To enable individual outputs, the output enable control word is sent. There are 32 enables to set; this is done with serial words controlling eight at a time. The output enable control word format is:

**TABLE 3. OUTPUT ENABLE FORMAT**

| B15 | B14 | B13 | B12 | B11 | B10 | B9 | B8 | B7 | B6 | B5 | B4 | B3 | B2 | B1 | B0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 1 | - | - | - | N1 | N0 | $O_{n+7}$ | $O_{n+6}$ | $O_{n+5}$ | $O_{n+4}$ | $O_{n+3}$ | $O_{n+2}$ | $O_{n+1}$ | $O_n$ |

The $O_X$ bits represent output enables of eight individual registers. The N1N0 bits represent a two bit binary number which is used in setting $n = 2^{N1N0}$. For instance, to access the control bit of the 11th output enable, we send the word:

**TABLE 4. OUTPUT ENABLE WORD OF 2ND GROUP OF OUTPUTS**

| B15 | B14 | B13 | B12 | B11 | B10 | B9 | B8 | B7 | B6 | B5 | B4 | B3 | B2 | B1 | B0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 1 | - | - | - | 0 | 1 | $O_{15}$ | $O_{14}$ | $O_{13}$ | $O_{12}$ | $O_{11}$ | $O_{10}$ | $O_9$ | $O_8$ |

Individual output enables are ended with the control register's common output enable bit and the power on bit.

### Gain Setting

The gain of each output may be set to 1 or 2 using the gain set word. It is in the same format as the output enable control word:

**TABLE 5. GAIN SET FORMAT**

| B15 | B14 | B13 | B12 | B11 | B10 | B9 | B8 | B7 | B6 | B5 | B4 | B3 | B2 | B1 | B0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 0 | - | - | - | N1 | N0 | $G_{n+7}$ | $G_{n+6}$ | $G_{n+5}$ | $G_{n+4}$ | $G_{n+3}$ | $G_{n+2}$ | $G_{n+1}$ | $G_n$ |

### Input to Output Selection

Individual outputs receive their input selection choice using the input/output control word. Its format is:

**TABLE 6. INPUT/OUTPUT WORD**

| B15 | B14 | B13 | B12 | B11 | B10 | B9 | B8 | B7 | B6 | B5 | B4 | B3 | B2 | B1 | B0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | $I_4$ | $I_3$ | $I_2$ | $I_1$ | $I_0$ | - | - | - | $O_4$ | $O_3$ | $O_2$ | $O_1$ | $O_0$ |

For a given binarily selected output, as specified by the O's, an input channel is assigned by the binarily selected I's. Thirty-two transmissions of the input/output control words will be required to set up all outputs.

### Broadcast Mode

The broadcast mode routs one input to all 32 outputs. It has a memory bit that remembers its state. The configuration of input/output assignments that existed before setting broadcast mode is kept in memory and when broadcast mode is disabled the previous configuration is restored. The broadcast control word format is:

**TABLE 7. BROADCAST WORD**

| B15 | B14 | B13 | B12 | B11 | B10 | B9 | B8 | B7 | B6 | B5 | B4 | B3 | B2 | B1 | B0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 1 | $I_4$ | $I_3$ | $I_2$ | $I_1$ | $I_0$ | - | - | - | - | - | - | - | EB |

EB sets or resets the broadcast mode memory bit. The I's binarily select the input channel to be broadcast to all outputs.

Note: Going from broadcast mode to normal crosspoint mode can alter the input/output configuration. All input/output selections currently must be re-sent after a broadcast-to-non-broadcast transition.

## *Bandwidth Considerations*

Wide frequency response (high bandwidth) in a video system means better video resolution. Four sets of frequency response curves are shown in Figure 47. Depending on the switch configurations, one can get between 250MHz to 350MHz bandwidth. A short discussion of the trade-offs follows—including matrix configuration, output buffer gain selection, channel selection, and loading.

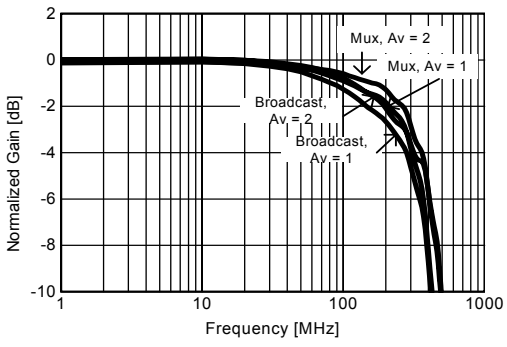



**FIGURE 47. FREQUENCY RESPONSE FOR VARIOUS MODES**

In multiplexer mode, the input only drives one output channel, while in broadcast mode the same input drives all 32 outputs. The parasitic capacitance of all 32 channels loads down the input and reduces bandwidth in broadcast mode. In addition, output buffer gain of +2 has higher bandwidth than gain of +1 due to internal device compensation. Therefore, the highest bandwidth set-up is multiplexer mode and output buffer gain of +2.

The relative location of the input and output channel also has significant impact on the device bandwidth. Again this is due to the layout of the device. When the input and output channels are further away, there are additional parasitics as a result of the distance and lower bandwidth results.

The bandwidth does not change significantly with resistive loading as shown in Figure 3 in the typical performance curves. However, it does change greatly with capacitance loading, Figure 4 in typical performance curves. This is most significant when laying out the PCB. If the PCB trace between the output of the crosspoint switch and the back termination resistor is not minimized, additional parasitic capacitance severely distorts the frequency response.

To emphasize how critical the PCB layout is to performance, let's compare the two boards presented in Figures 48 and 49. Figure 48 shows a larger engineering evaluation board where the termination resistor is far away from the device because of the use of a socket. The board in Figure 48 is a

demoboard without the socket. The parasitic capacitance of the demoboard is about 2.7pF less.

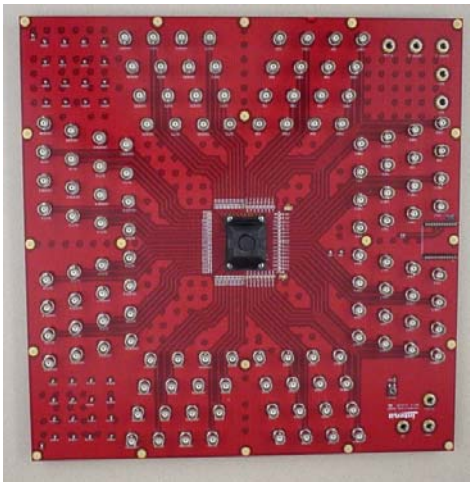


FIGURE 48. ENGINEERING EVALUATION BOARD

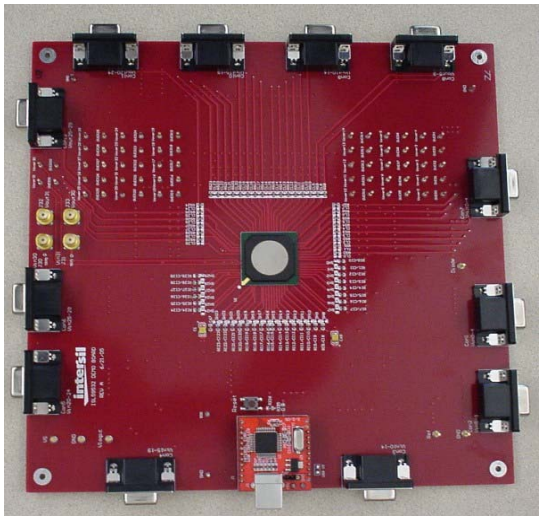


FIGURE 49. CUSTOMER DEMOBOARD

To prove that the parasitic capacitance is the largest contributor to the difference in bandwidth of the two boards, we added 2.7pF at the output of the demoboard. Figure 50 shows the similarity in frequency response of the engineering evaluation board alongside the demoboard piggybacked with 2.7pF.

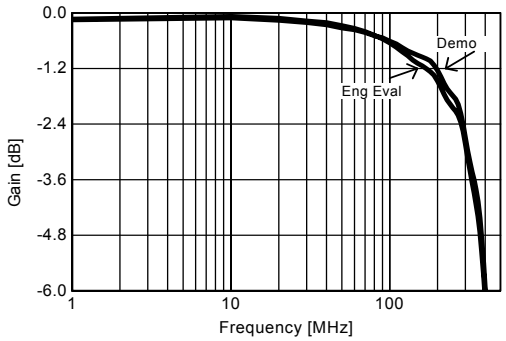



FIGURE 50. FREQUENCY RESPONSE - ENG EVAL BOARD vs DEMO

### *Linear Operating Region*

In addition to bandwidth, one must also be very careful with operating the device at its linear operating region. Figure 51 shows differential gain curve. The ISL59533 is a single supply 5V device with its linear region is between 0.1 and 2V. The signal range is fine for most video signals whose nominal signal amplitude is 1V. Both inputs should be maintained at 0.3V or above for best operation. A DC restore circuit is required to put the video signal within the linear operating region of the crosspoint switch.

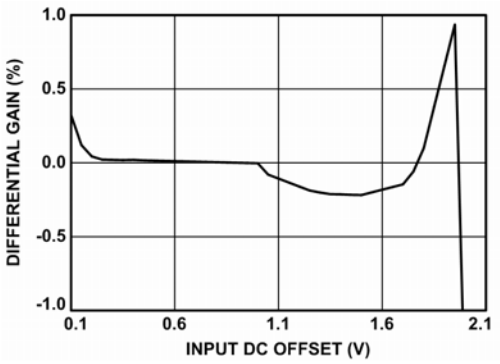



FIGURE 51. DIFFERENTIAL GAIN RESPONSE

### Power Dissipation and Thermal Resistance

With a large number of switches, it is possible to exceed the 150°C absolute maximum junction temperature under certain load current conditions. Therefore, it is important to calculate the maximum junction temperature for an application to determine if load conditions or package types need to be modified to assure operation of the crosspoint switch in a safe operating area.

The maximum power dissipation allowed in a package is determined according to:

$$PD_{MAX} = \frac{T_{JMAX} - T_{AMAX}}{\Theta_{JA}}$$

Where:

- $T_{JMAX}$ = Maximum junction temperature = 125°C
- $T_{AMAX}$ = Maximum ambient temperature = 85°C
- $\theta_{JA}$ = Thermal resistance of the package

The maximum power dissipation actually produced by an IC is the total quiescent supply current times the total power supply voltage, plus the power in the IC due to the load, or:

$$PD_{MAX} = V_S \times I_{SMAX} + \sum_{i=1}^{n} (V_S - V_{OUTi}) \times \frac{V_{OUTi}}{R_{Li}}$$

Where:

- $V_S$ = Supply voltage = 5V
- $I_{SMAX}$ = Maximum quiescent supply current = 700mA
- $V_{OUT}$ = Maximum output voltage of the application = 2V
- $R_{LOAD}$ = Load resistance tied to ground = 150
- n = 1 to 32 channels

$$PD_{MAX} = V_S \times I_{SMAX} + \sum_{i=1}^{n} (V_S - V_{OUTi}) \times \frac{V_{OUTi}}{R_{Li}} = 4.8W$$

The reqired $\theta_{JA}$ to dissipate 4.8W is:

$$\Theta_{JA} = \frac{T_{JMAX} - T_{AMAX}}{PD_{MAX}} = 8.33(°C/W)$$

Table 8 shows $\theta_{JA}$ thermal resistance results with a Wakefield heatsink and without heatsink and various airflow. At the thermal resistance equation shows, the required thermal resistance depends on the maximum ambient temperature.

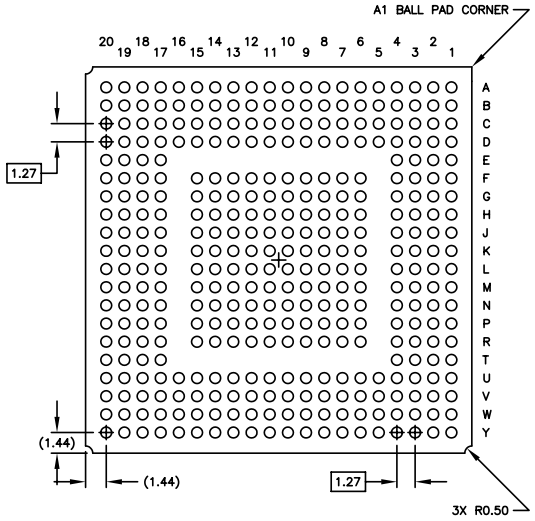
**TABLE 8. $\theta_{JA}$ THERMAL RESISTANCE [°C/W]**

| Airflow [LFM] | 0 | 250 | 500 | 750 |
|---|---|---|---|---|
| No Heatsink | 18 | 14.3 | 13.0 | 12.6 |
| Wakefield 658-25AB | 16.0 | 7.0 | 6.0 | 4.7 |

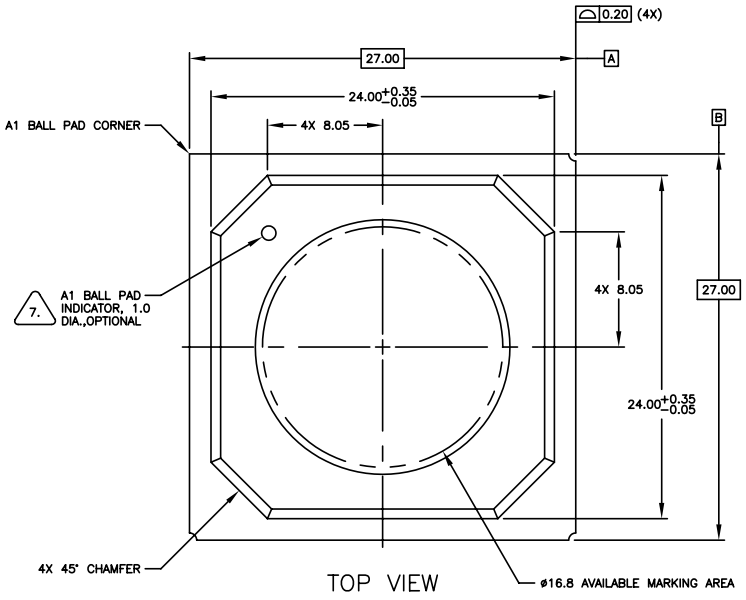
# 356 Ld HBGA Package

NOTES: UNLESS OTHERWISE SPECIFIED

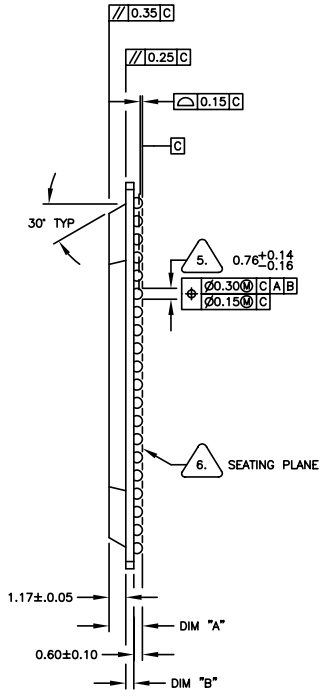
1. ALL DIMENSIONS AND TOLERANCES CONFORM TO ASME Y14.5M–1994.
2. THE BASIC SOLDER BALL GRID PITCH IS 1.27mm.
3. THE MAXIMUM SOLDER BALL MATRIX SIZE IS 20 X 20.
4. THE MAXIMUM ALLOWABLE NUMBER OF SOLDER BALLS IS 400.
5. DIMENSION IS MEASURED AT THE MAXIMUM SOLDER BALL DIAMETER, PARALLEL TO PRIMARY DATUM C.
6. PRIMARY DATUM C AND SEATING PLANE ARE DEFINED BY THE SPHERICAL CROWNS OF THE SOLDER BALLS.
7. A1 BALL PAD CORNER I.D. FOR PLATE MOLD: TO BE MARKED BY INK. AUTO MOLD: DIMPLE TO BE FORMED BY MOLD CAP.
8. REFERENCE SPECIFICATIONS:
   A. THIS DRAWING CONFORMS TO THE JEDEC REGISTERED OUTLINE MS-034/A VARIATION BAL-2.




BOTTOM VIEW
356 SOLDER BALLS




TOP VIEW




SIDE VIEW

| | |
|---|---|
| Drawing#: | V356.27x27A |
| Rev: | 0 |
| Date: | 2/28/06 |
| Units: | mm |

PACKAGE OUTLINE DRAWING – 356 HPBGA
27 x 27 mm x 1.17 mm MOLD CAP
1.27 mm PITCH SUBSTRATE

| NO. LAYERS | DIM "A" | DIM "B" | NOTES |
|---|---|---|---|
| 4 | 2.38±0.21 | 0.61±0.06 | STANDARD |

HPBGA THICKNESS SCHEDULE