

MAX96707

14-Bit GMSL Serializer with High-Immunity/ Bandwidth Mode and Coax/STP Cable Drive

General Description

The MAX96707 is a compact serializer in a 4mm x 4mm TQFN package especially suited for automotive camera applications. In high-bandwidth mode, the parallel-clock maximum is 116MHz for 12-bit linear or combined HDR data types.

The embedded control channel operates at 9.6kbps to 1Mbps in I²C mode, allowing programming of serializer, deserializer (SerDes), and camera registers independent of video timing.

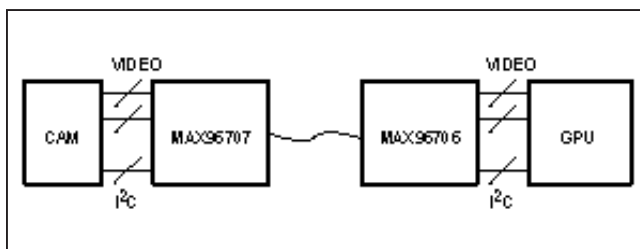
For driving longer cables, the IC has programmable pre/deemphasis. Programmable spread spectrum is available on the serial output. The serial output meets ISO 10605 and IEC 61000-4-2 ESD standards. The supply range is 1.7V to 1.9V.

The MAX96707 is available in a 24-pin TQFN package with 0.5mm lead pitch, and operates over the -40°C to +115°C temperature range.

Applications

- Automotive Camera Applications

Simplified Block Diagram



Ordering Information appears at end of data sheet.

Benefits and Features

- Ideal for Safety Camera Applications
 - Works with Low-Cost 50Ω Coax (100Ω STP) Cables
 - Error Detection of Video/Control Data
 - High-Immunity Mode for Robust Control-Channel EMC Tolerance
 - Retransmission of Control Data Upon Error Detection
 - Best-in-Class Supply Current: 88mA (max)
 - Pre/Deemphasis Allows 15m Cable at Full Speed
 - 24-Pin (4mm x 4mm) TQFN Package with 0.5mm Lead Pitch
- High-Speed Data Serialization for Megapixel Cameras
 - Up to 1.74Gbps Serial-Bit Rate
 - 12.5MHz to 87MHz x 12-Bit + H/V Data
 - 36.66MHz to 116MHz x 12-Bit + H/V Data (through Internal Encoding)
- Multiple Modes for System Flexibility
 - 9.6kbps to 1Mbps Control Channel in I²C Mode (with Clock Stretch)
 - Crosspoint Switch Accepts Any Input Bitmap
 - Modes for Encoded VSYNC and HSYNC
- Reduces EMI and Shielding Requirements
 - Programmable Output Spread Spectrum
 - Tracks Spread Spectrum Applied at the Parallel Input
 - 1.7V to 1.9V I/O Supply
- Peripheral Features for Camera Power-Up and Verification
 - Built-In PRBS Generator for BER Testing
 - Dedicated GPO for Camera Frame-Sync Trigger and Other Uses
 - Remote/Local Wake-Up from Sleep Mode
- Meets AEC-Q100 Automotive Specification
 - -40°C to +115°C Operating Temperature
 - ±8kV Contact and ±15kV Air IEC 61000-4-2 and ISO 10605 ESD Protection

TABLE OF CONTENTS

| | |
|---|----|
| General Description | 1 |
| Applications | 1 |
| Benefits and Features | 1 |
| Simplified Block Diagram | 1 |
| Absolute Maximum Ratings | 6 |
| Package Information | 6 |
| 24-Pin TQFN-EP | 6 |
| DC Electrical Characteristics | 7 |
| AC Electrical Characteristics | 10 |
| Typical Operating Characteristics | 13 |
| Pin Configuration | 15 |
| Pin Description | 15 |
| Functional Block Diagram | 17 |
| Detailed Description | 22 |
| Serial Link Signaling and Data Format | 22 |
| Operating Modes | 22 |
| Video/Configuration Link | 22 |
| Single/Double Mode | 23 |
| HS/VIS Encoding | 23 |
| Error Detection | 23 |
| Bus Widths | 23 |
| Control Channel and Register Programming | 27 |
| Forward Control Channel | 27 |
| Reverse Control Channel | 27 |
| I ² C Interface | 27 |
| Remote-End Operation | 27 |
| Clock-Stretch Timing | 27 |
| Packet-Based I ² C | 27 |
| Packet Protocol Summary | 28 |
| Control-Channel Error Detection and Packet Retransmission | 28 |
| GPO/GPI Control | 28 |
| Spread Spectrum | 28 |
| Cable Type Configuration | 28 |
| Crossbar Switch | 28 |
| Video Timing Generator | 28 |
| Shutdown/Sleep Modes | 30 |
| Configuration Link | 30 |

TABLE OF CONTENTS (CONTINUED)

| | |
|-----------------------------------|----|
| Serialization Disable | 30 |
| Sleep Mode | 30 |
| Link Startup Procedure | 31 |
| Register Map | 32 |
| GMSL Register Map | 32 |
| seraddr (0x00) | 36 |
| desaddr (0x01) | 36 |
| ss (0x02) | 37 |
| sdiv (0x03) | 37 |
| main_control (0x04) | 38 |
| prbs_len (0x05) | 38 |
| cmlvl_preemp (0x06) | 39 |
| config (0x07) | 40 |
| rsvd_8 (0x08) | 40 |
| i2c_source (0x09, 0x0B) | 41 |
| i2c_dest (0x0A, 0x0C) | 41 |
| i2c_config (0x0D) | 42 |
| gpio_en (0x0E) | 42 |
| gpio_out (0x0F) | 43 |
| gpio_in (0x10) | 43 |
| errg (0x11) | 44 |
| rsvd_12 (0x12) | 44 |
| pd (0x13) | 45 |
| pktcc_lock (0x14) | 45 |
| input_status (0x15) | 46 |
| max_rt_err (0x16) | 46 |
| rsvd_17 (0x17) | 47 |
| crc (0x18 to 0x1B) | 47 |
| cc_crc_errcnt (0x1C) | 47 |
| rsvd_1d (0x1D) | 47 |
| id (0x1E) | 48 |
| revision (0x1F) | 48 |
| crossbar (0x20 to 0x3E) | 48 |
| crossbar_hs (0x3F) | 49 |
| crossbar (0x40) | 49 |
| crossbar_de (0x41) | 50 |
| link_config (0x42) | 50 |

TABLE OF CONTENTS (CONTINUED)

| | |
|---|----|
| sync_gen_config (0x43) | 51 |
| vs_dly (0x44 to 0x46) | 51 |
| vs_h (0x47 to 0x49) | 52 |
| vs_l (0x4A to 0x4C) | 52 |
| cxtp (0x4D) | 52 |
| hs_dly (0x4E to 0x50) | 53 |
| rsvd (0x51 to 0x53, 0x5D to 0x5F) | 53 |
| hs_h (0x54, 0x55) | 53 |
| hs_l (0x56, 0x57) | 53 |
| hs_cnt (0x58, 0x59) | 54 |
| de_dly (0x5A to 0x5C) | 54 |
| de_h (0x60, 0x61) | 54 |
| de_l (0x62, 0x63) | 54 |
| de_cnt (0x64, 0x65) | 55 |
| prbs_type (0x66) | 55 |
| dbl_align_to (0x67) | 56 |
| cc_crc_length (0x68) | 56 |
| hi_lo (0x69) | 57 |
| rsvd_96 (0x96) | 57 |
| rsvd_97 (0x97) | 58 |
| rsvd_98 (0x98) | 58 |
| rsvd_99 (0x99) | 58 |
| pktcc_en (0x9A) | 59 |
| rsvd_C8 (0xC8) | 59 |
| rsvd_c9 (0xC9) | 59 |
| rsvd_fc (0xFC) | 60 |
| rsvd_fd (0xFD) | 60 |
| rsvd_fe (0xFE) | 61 |
| rsvd_ff (0xFF) | 61 |
| Applications Information | 62 |
| Parallel Interface | 62 |
| Bus Data Width | 62 |
| Bus Data Rates | 62 |
| Crossbar-Switch Programming | 63 |
| Recommended Crossbar-Switch Program Procedure | 63 |

TABLE OF CONTENTS (CONTINUED)

| | |
|---|----|
| Timing-Generator Programming | 66 |
| Double-Mode Alignment | 66 |
| External High/Low Signal | 66 |
| Align from HS or DE | 66 |
| I ² C Interface | 66 |
| I ² C Bit Rate | 66 |
| Software Programming of Device Addresses | 67 |
| I ² C Address Translation | 67 |
| Configuration Blocking | 67 |
| Cascaded/Parallel Devices | 67 |
| Dual μ C Control | 67 |
| Spread Spectrum | 68 |
| Manual Programming of the Spread-Spectrum Divider | 68 |
| Equation: | 68 |
| Board Layout | 69 |
| Power-Supply Circuits and Bypassing | 69 |
| High-Frequency Signals | 69 |
| ESD Protection | 69 |
| Compatibility with Other GMSL Devices | 70 |
| Device Configuration and Component Selection | 70 |
| Internal Input Pulldowns | 70 |
| I ² C Pullup Resistors | 71 |
| AC-Coupling Capacitors | 71 |
| Cables and Connectors | 71 |
| PRBS | 71 |
| GPI/GPO | 71 |
| Fast Detection of Loss-of-Lock | 72 |
| Providing a Frame Sync (Camera Applications) | 72 |
| Entering/Exiting Sleep Mode | 72 |
| Typical Application Circuits | 73 |
| Ordering Information | 73 |
| Revision History | 74 |

LIST OF FIGURES

| | |
|---|----|
| Figure 1. Serial-Output Parameters | 19 |
| Figure 2. Output Waveforms at OUT+, OUT- | 20 |
| Figure 3. Single-Ended Output Template | 20 |
| Figure 4. Worst-Case Pattern Input | 20 |
| Figure 5. Parallel Clock Input Requirements | 20 |
| Figure 6. I ² C Timing Parameters | 21 |
| Figure 7. Differential Output Template | 21 |
| Figure 8. Input Setup and Hold Times | 22 |
| Figure 9. GPI-to-GPO Delay | 22 |
| Figure 10. Serializer Delay | 23 |
| Figure 11. Link Startup Time | 23 |
| Figure 12. Power-Up Delay | 24 |
| Figure 13. 24-Bit Mode Serial-Data Format | 26 |
| Figure 14. 27-Bit High-Bandwidth Mode Serial-Data Format | 27 |
| Figure 15. 32-Bit Mode Serial-Data Format | 28 |
| Figure 16. Coax Connection | 30 |
| Figure 17. Crossbar-Switch Dataflow | 31 |
| Figure 18. Sync-Signal Format For Video-Timing Generation | 31 |
| Figure 19. State Diagram | 32 |
| Figure 20. Crossbar-Switch Default Mapping | 67 |
| Figure 21. Human Body Model ESD Test Circuit | 71 |
| Figure 22. IEC 61000-4-2 Contact Discharge ESD Test Circuit | 71 |
| Figure 23. ISO 10605 Contact Discharge ESD Test Circuit | 71 |

LIST OF TABLES

| | |
|--|----|
| Table 1. Reverse Control-Channel Modes | 29 |
| Table 2. Link-Startup Procedure | 33 |
| Table 3. Input Data-Width Selection | 64 |
| Table 4. Data-Rate Selection | 64 |
| Table 5. Crossbar Output to Serial Link Map (D23:0) | 65 |
| Table 6. Crossbar Output to Serial Link Map (D31:24 and Special Packets) | 66 |
| Table 7. Legend | 67 |
| Table 8. Timing-Generator Parameter Restrictions | 68 |
| Table 9. Output Spread | 70 |
| Table 10. Spread Limitations | 70 |
| Table 11. Modulation Coefficients and Maximum SDIV Settings | 71 |
| Table 12. Feature Compatibility | 72 |
| Table 13. Suggested Connectors and Cables for GMSL | 73 |

Absolute Maximum Ratings

| | | |
|--|------------------------|--|
| AVDD to GND* | -0.5V to +1.9V | Continuous Power Dissipation, T _A = +70°C |
| DVDD to GND* | -0.5V to +1.9V | TQFN (derate 27.8 mW/°C above +70°C) |
| OUT+, OUT- to GND* | -0.5V to +1.9V |2222.2mW |
| All Other Pins to GND* | -0.5V to (DVDD + 0.5V) | Operating Temperature Range |
| OUT+, OUT- Short Circuit to Ground or Supply | Continuous |-40°C to +115°C |
| | | Junction Temperature |
| | | +125°C |
| | | Storage Temperature Range |
| | | -40°C to +150°C |
| | | Soldering Temperature (reflow) |
| | | +260°C |

*EP externally connected to GND.

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.

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.

24-Pin TQFN-EP

| | |
|---|-------------------------|
| Package Code | T2444+4 |
| Outline Number | 21-0139 |
| Land Pattern Number | 90-0022 |
| Single-Layer Board: | |
| Junction-to-Ambient Thermal Resistance (θ _{JA}) | 48 |
| Junction-to-Case Thermal Resistance (θ _{JC}) | 3 |
| Four-Layer Board: | |
| Junction-to-Ambient Thermal Resistance (θ _{JA}) | 36 |
| Junction-to-Case Thermal Resistance (θ _{JC}) | 3 |

Package thermal resistances were obtained using the method described in JEDEC specification JESD51-7, using a four-layer board. For detailed information on package thermal considerations, refer to www.maximintegrated.com/thermal-tutorial.

DC Electrical Characteristics

($V_{DVDD} = V_{AVDD} = 1.7V$ to $1.9V$, $R_L = 100\Omega \pm 1\%$ (differential), $T_A = -40^\circ C$ to $+115^\circ C$, EP connected to GND, typical values are at $V_{DVDD} = V_{AVDD} = 1.8V$, $T_A = +25^\circ C$, unless otherwise noted.) (Note 1)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|--|----------|---|-------------------|-------------------|-----|---------|
| SINGLE-ENDED INPUTS (DIN_, PCLKIN, HS, VS, HIM, MS) | | | | | | |
| High-Level Input Voltage | V_{IH} | | 0.65 x V_{DVDD} | | | V |
| Low-Level Input Voltage | V_{IL} | | | 0.35 x V_{DVDD} | | V |
| Input Current | I_{IN} | $V_{IN} = 0$ to V_{DVDD} | -20 | | +20 | μA |
| SINGLE-ENDED OUTPUT (GPO) | | | | | | |
| High-Level Output Voltage | V_{OH} | $I_{OH} = -2mA$ | $V_{DVDD} - 0.2$ | | | V |
| Low-Level Output Voltage | V_{OL} | $I_{OL} = 2mA$ | | 0.2 | | V |
| Output Short-Circuit Current | I_{OS} | $V_O = 0V$ | 3 | 12 | 21 | mA |
| I²C and GENERAL-PURPOSE I/Os (SDA, SCL, GPIO_) with OPEN-DRAIN OUTPUTS | | | | | | |
| High-Level Input Voltage | V_{IH} | | 0.7 x V_{DVDD} | | | V |
| Low-Level Input Voltage | V_{IL} | | | 0.3 x V_{DVDD} | | V |
| Input Current | I_{IN} | $V_{IN} = 0$ to V_{DVDD} (Note 2), SDA, SCL | -110 | | +5 | μA |
| | | $V_{IN} = 0$ to V_{DVDD} (Note 2), GPIO_ | -80 | | +5 | |
| Low-Level Open-Drain Output Voltage | V_{OL} | $I_{OL} = 3mA$ | | 0.4 | | V |
| Input Capacitance | C_{IN} | Each pin (Note 3) | | 10 | | pF |

DC Electrical Characteristics (continued)

($V_{DVDD} = V_{AVDD} = 1.7V$ to $1.9V$, $R_L = 100\Omega \pm 1\%$ (differential), $T_A = -40^\circ C$ to $+115^\circ C$, EP connected to GND, typical values are at $V_{DVDD} = V_{AVDD} = 1.8V$, $T_A = +25^\circ C$, unless otherwise noted.) (Note 1)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|--|-----------------|--|-----|-----|------|----------|
| DIFFERENTIAL OUTPUTS (OUT+, OUT-) | | | | | | |
| Differential Output Voltage | V_{OD} | Preemphasis off, high drive (Figure 1) | 300 | 400 | 500 | mV |
| | | 3.3dB preemphasis, high drive (Figure 2) | 350 | | 610 | |
| | | 3.3dB deemphasis, high drive (Figure 2) | 240 | | 425 | |
| Change in V_{OD} Between Complementary Output States | ΔV_{OD} | | | | 25 | mV |
| Output Offset Voltage ($V_{OUT+} + V_{OUT-})/2 = V_{OS}$ | V_{OS} | Preemphasis off | 1.1 | 1.4 | 1.56 | V |
| Change in V_{OS} Between Complementary Output States | ΔV_{OS} | | | | 25 | mV |
| Output Short-Circuit Current | I_{OS} | V_{OUT+} or $V_{OUT-} = 0V$ | -60 | | | mA |
| | | V_{OUT+} or $V_{OUT-} = 1.9V$ | | | 25 | |
| Magnitude of Differential Output Short-Circuit Current | I_{OSD} | $V_{OD} = 0V$ | | | 25 | mA |
| Output-Termination Resistance (Internal) | R_O | From OUT+ or OUT- to AVDD | 45 | 54 | 63 | Ω |
| REVERSE CONTROL-CHANNEL RECEIVER OUTPUTS (OUT+, OUT-) | | | | | | |
| High-Switching Threshold | V_{CHR} | Legacy | | | 27 | mV |
| | | High immunity | | | 40 | |
| Low-Switching Threshold | V_{CLR} | Legacy | -27 | | | mV |
| | | High immunity | -40 | | | |
| SINGLE-ENDED SERIAL OUTPUTS (OUT+ or OUT-) | | | | | | |
| Single-Ended Output Voltage | V_O | Preemphasis off, high drive (Figure 3) | 375 | 500 | 625 | mV |
| | | 3.3dB preemphasis, high drive (Figure 2) | 435 | | 765 | |
| | | 3.3dB deemphasis, high drive (Figure 2) | 300 | | 535 | |
| Output Short-Circuit Current | I_{OS} | V_{OUT+} or $V_{OUT-} = 0V$ | -69 | | | mA |
| | | V_{OUT+} or $V_{OUT-} = 1.9V$ | | | 32 | |
| Output-Termination Resistance (Internal) | R_O | From OUT+ or OUT- to AVDD | 45 | 54 | 63 | Ω |

DC Electrical Characteristics (continued)

($V_{DVDD} = V_{AVDD} = 1.7V$ to $1.9V$, $R_L = 100\Omega \pm 1\%$ (differential), $T_A = -40^\circ C$ to $+115^\circ C$, EP connected to GND, typical values are at $V_{DVDD} = V_{AVDD} = 1.8V$, $T_A = +25^\circ C$, unless otherwise noted.) (Note 1)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|---|-----------|--|-----|----------|-----|---------|
| POWER SUPPLY | | | | | | |
| Supply Current, Worst-Case Pattern (Figure 4) | I_{WCS} | $f_{PCLKIN} = 116MHz$, HIBW = 0, BWS = 0, default register values, AVDD + DVDD (1.9V) | | 66 | 88 | mA |
| | | $f_{PCLKIN} = 116MHz$, HIBW = 1, BWS = 0, default register values, AVDD + DVDD (1.9V) | | 63 | 83 | |
| | | $f_{PCLKIN} = 87MHz$, BWS = 1, default register values, AVDD + DVDD (1.9V) | | 62 | 83 | |
| Sleep-Mode Supply Current | I_{CCS} | Wake-up receiver enabled | | 40 | 100 | μA |
| ESD PROTECTION | | | | | | |
| OUT+, OUT- (Note 4) | V_{ESD} | Human Body Model, $R_D = 1.5k\Omega$, $C_S = 100pF$ | | ± 8 | | kV |
| | | IEC 61000-4-2, $R_D = 330\Omega$, $C_S = 150pF$, Contact Discharge | | ± 8 | | |
| | | IEC 61000-4-2, $R_D = 330\Omega$, $C_S = 150pF$, Air Discharge | | ± 15 | | |
| | | ISO 10605, $R_D = 2k\Omega$, $C_S = 330pF$, Contact Discharge | | ± 8 | | |
| | | ISO 10605, $R_D = 2k\Omega$, $C_S = 330pF$, Air Discharge | | ± 15 | | |
| All Other Pins (Note 5) | V_{ESD} | Human Body Model, $R_D = 1.5k\Omega$, $C_S = 100pF$ | | ± 4 | | kV |

AC Electrical Characteristics

($V_{DVDD} = V_{AVDD} = 1.7V$ to $1.9V$, $R_L = 100\Omega \pm 1\%$ (differential), $T_A = -40^\circ C$ to $+115^\circ C$, EP connected to GND, typical values are at $V_{DVDD} = V_{AVDD} = 1.8V$, $T_A = +25^\circ C$, unless otherwise noted.) (Note 1)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|---|--------------|---|-------|-----|------|---------|
| PARALLEL CLOCK INPUT (PCLKIN) | | | | | | |
| Clock Frequency | f_{PCLKIN} | BWS = 0, HIBW = 0, single input | 16.66 | | 58 | MHz |
| | | BWS = 0, HIBW = 1, single input | 36.66 | | 58 | |
| | | BWS = 1, single input | 12.5 | | 43.5 | |
| | | BWS = 0, HIBW = 0, double input | 33.32 | | 116 | |
| | | BWS = 0, HIBW = 1, double input | 73.33 | | 116 | |
| | | BWS = 1, double input | 25 | | 87 | |
| Clock Duty Cycle | DC | t_{HIGH}/t_T or t_{LOW}/t_T (Note 3, Figure 5) | 35 | 50 | 65 | % |
| Clock Transition Time | t_R, t_F | (Note 3, Figure 5) | | | 4 | ns |
| Clock Jitter | t_J | 1.74Gbps bit rate, 300kHz sinusoidal jitter (Note 3) | | | 800 | ps |
| I²C PORT TIMING | | | | | | |
| I ² C Bit Rate | | | 9.6 | | 1000 | kbps |
| Output Rise Time | t_R | 30% to 70%, $C_L = 10pF$ to $100pF$, $1k\Omega$ pullup to DVDD | 20 | | 150 | ns |
| Output Fall Time | t_F | 70% to 30%, $C_L = 10pF$ to $100pF$, $1k\Omega$ pullup to DVDD | 20 | | 150 | ns |
| I²C TIMING (Figure 6) | | | | | | |
| SCL Clock Frequency | f_{SCL} | Low f_{SCL} range: (I2CMSTBT = 010, I2CSLVSH = 10) | 9.6 | | 100 | kHz |
| | | Mid f_{SCL} range: (I2CMSTBT 101, I2CSLVSH = 01) | > 100 | | 400 | |
| | | High f_{SCL} range: (I2CMSTBT = 111, I2CSLVSH = 00) | > 400 | | 1000 | |
| START Condition Hold Time | $t_{HD:STA}$ | f_{SCL} range, low | 4 | | | μs |
| | | f_{SCL} range, mid | 0.6 | | | |
| | | f_{SCL} range, high | 0.26 | | | |
| Low Period of SCL Clock | t_{LOW} | f_{SCL} range, low | 4.7 | | | μs |
| | | f_{SCL} range, mid | 1.3 | | | |
| | | f_{SCL} range, high | 0.5 | | | |
| High Period of SCL Clock | t_{HIGH} | f_{SCL} range, low | 4 | | | μs |
| | | f_{SCL} range, mid | 0.6 | | | |
| | | f_{SCL} range, high | 0.26 | | | |
| Repeated START Condition Setup Time | $t_{SU:STA}$ | f_{SCL} range, low | 4.7 | | | μs |
| | | f_{SCL} range, mid | 0.6 | | | |
| | | f_{SCL} range, high | 0.26 | | | |

AC Electrical Characteristics (continued)

($V_{DVDD} = V_{AVDD} = 1.7V$ to $1.9V$, $R_L = 100\Omega \pm 1\%$ (differential), $T_A = -40^\circ C$ to $+115^\circ C$, EP connected to GND, typical values are at $V_{DVDD} = V_{AVDD} = 1.8V$, $T_A = +25^\circ C$, unless otherwise noted.) (Note 1)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|--|--------------|--|------|------|------|-------|
| Data Hold Time | $t_{HD:DAT}$ | f _{SCL} range, low | 0 | | | ns |
| | | f _{SCL} range, mid | 0 | | | |
| | | f _{SCL} range, high | 0 | | | |
| Data Setup Time | $t_{SU:DAT}$ | f _{SCL} range, low | 250 | | | ns |
| | | f _{SCL} range, mid | 100 | | | |
| | | f _{SCL} range, high | 50 | | | |
| Setup Time for STOP Condition | $t_{SU:STO}$ | f _{SCL} range, low | 4 | | | μs |
| | | f _{SCL} range, mid | 0.6 | | | |
| | | f _{SCL} range, high | 0.26 | | | |
| Bus-Free Time | t_{BUF} | f _{SCL} range, low | 4.7 | | | μs |
| | | f _{SCL} range, mid | 1.3 | | | |
| | | f _{SCL} range, high | 0.5 | | | |
| Data Valid Time | $t_{VD:DAT}$ | f _{SCL} range, low | | | 3.45 | μs |
| | | f _{SCL} range, mid | | | 0.9 | |
| | | f _{SCL} range, high | | | 0.45 | |
| Data Valid-Acknowledge Time | $t_{VD:ACK}$ | f _{SCL} range, low | | | 3.45 | μs |
| | | f _{SCL} range, mid | | | 0.9 | |
| | | f _{SCL} range, high | | | 0.45 | |
| Pulse Width of Spikes Suppressed | t_{SP} | f _{SCL} range, low | | | 50 | ns |
| | | f _{SCL} range, mid | | | 50 | |
| | | f _{SCL} range, high | | | 50 | |
| Capacitive Load of Each Bus Line | C_B | (Note 3) | | | 100 | pF |
| SWITCHING CHARACTERISTICS (Note 3) | | | | | | |
| Differential/Single-Ended Output Rise/Fall Time | t_R, t_F | 20% to 80%, V_{OD} , 400mV differential $R_L = 100\Omega$, 500mV single-ended $R_L = 50\Omega$, serial bit rate = 1.74Gbps | | | 250 | ps |
| Total Serial-Output Jitter (Differential Output) | t_{TSOJ1} | 1.74Gbps PRBS, measured at $V_{OD} = 0V$ differential, preemphasis disabled (Figure 7) | | 0.25 | | UI |
| Deterministic Serial-Output Jitter (Differential Output) | t_{DSOJ2} | 1.74Gbps PRBS, measured at $V_{OD} = 0V$ differential, preemphasis disabled (Figure 7) | | 0.15 | | UI |
| Total Serial-Output Jitter (Single-Ended Output) | t_{TSOJ1} | 1.74Gbps PRBS, measured at $V_O/2$, preemphasis disabled (Figure 3) | | 0.25 | | UI |
| Deterministic Serial-Output Jitter (Single-Ended Output) | t_{DSOJ2} | 1.74Gbps PRBS, measured at $V_O/2$, preemphasis disabled (Figure 3) | | 0.15 | | UI |
| Parallel Data-Input Setup Time | t_{SET} | (Figure 8) | 2 | | | ns |

AC Electrical Characteristics (continued)

($V_{DVDD} = V_{AVDD} = 1.7V$ to $1.9V$, $R_L = 100\Omega \pm 1\%$ (differential), $T_A = -40^\circ C$ to $+115^\circ C$, EP connected to GND, typical values are at $V_{DVDD} = V_{AVDD} = 1.8V$, $T_A = +25^\circ C$, unless otherwise noted.) (Note 1)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|-------------------------------|------------|--|-----|-----|------|---------|
| Parallel Data Input Hold Time | t_{HOLD} | (Figure 8) (Note 3) | 1 | | | ns |
| GPI-to-GPO Delay | t_{GPIO} | Deserializer GPI to serializer GPO (Figure 9) | | | 350 | μs |
| Serializer Delay | t_{SD} | Spread spectrum enabled (Figure 10) (Notes 3, 6) | | | 2065 | Bits |
| | | Spread spectrum disabled (Figure 10) (Notes 3, 6) | | | 1095 | |
| Link Start Time | t_{LOCK} | (Figure 11) | | | 2 | ms |
| Power-Up Time | t_{PU} | (Figure 12) | | | 7 | ms |

Note 1: Limits are 100% production tested at $T_A = +115^\circ C$. Limits over the operating temperature range are guaranteed by design and characterization, unless otherwise noted.

Note 2: I_{IN} min is due to voltage drop across the internal pullup resistor.

Note 3: Not production tested. Guaranteed by design.

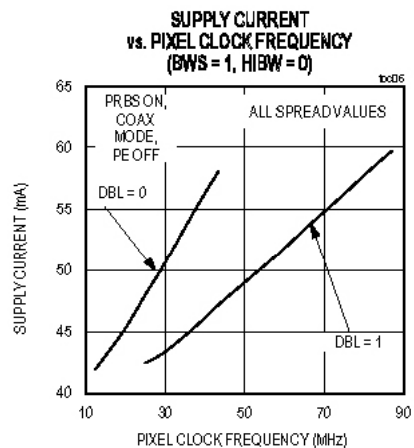
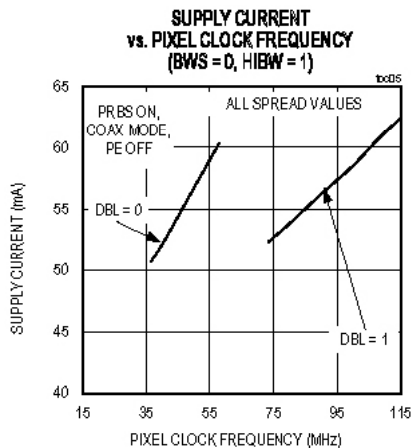
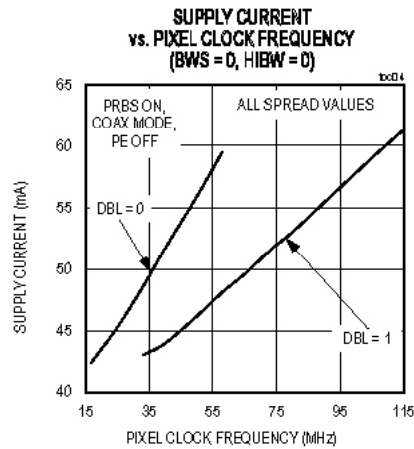
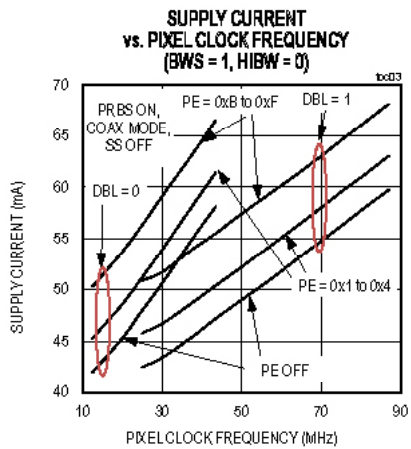
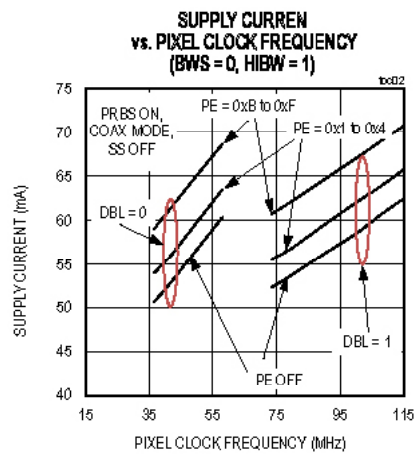
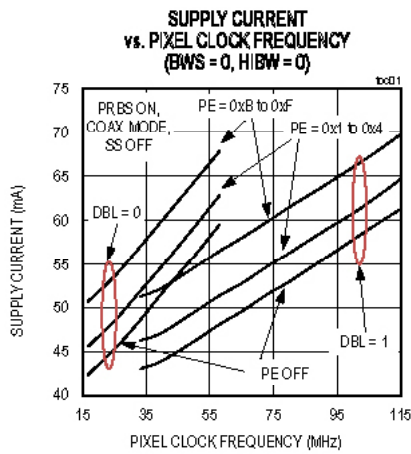
Note 4: Specified pin to ground.

Note 5: Specified pin to all supply/ground.

Note 6: Measured in serial link bit times. Bit time = $1/(30 \times f_{PCLKIN})$ for BWS = 0; bit time = $1/(40 \times f_{PCLKIN})$ for BWS = 1.

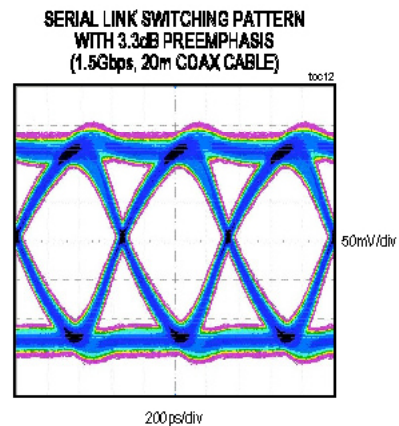
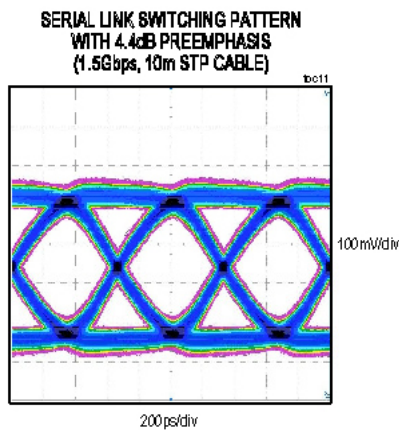
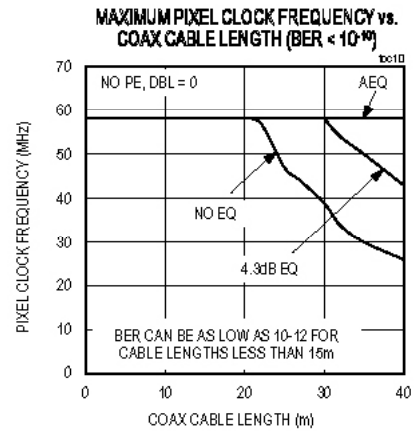
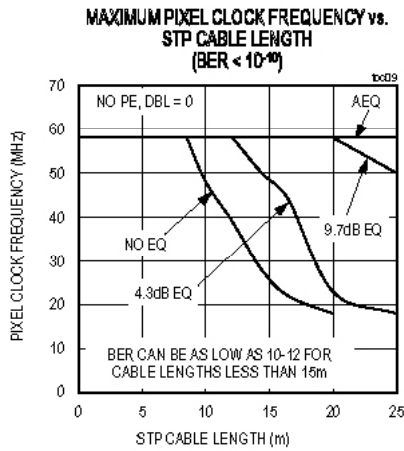
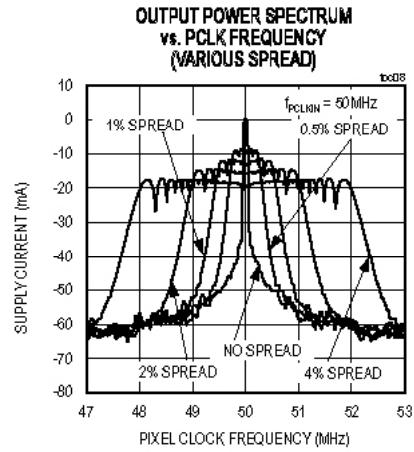
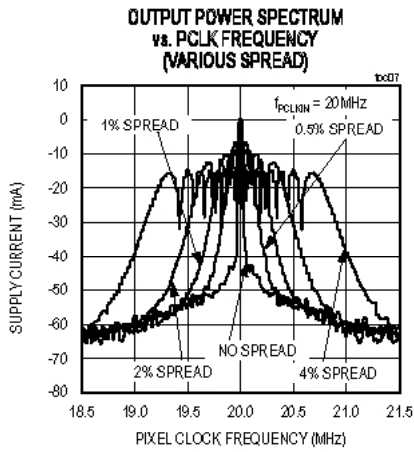
Typical Operating Characteristics

($V_{AVDD} = V_{DVDD} = 1.8V$, $T_A = +25^\circ C$, unless otherwise noted.)

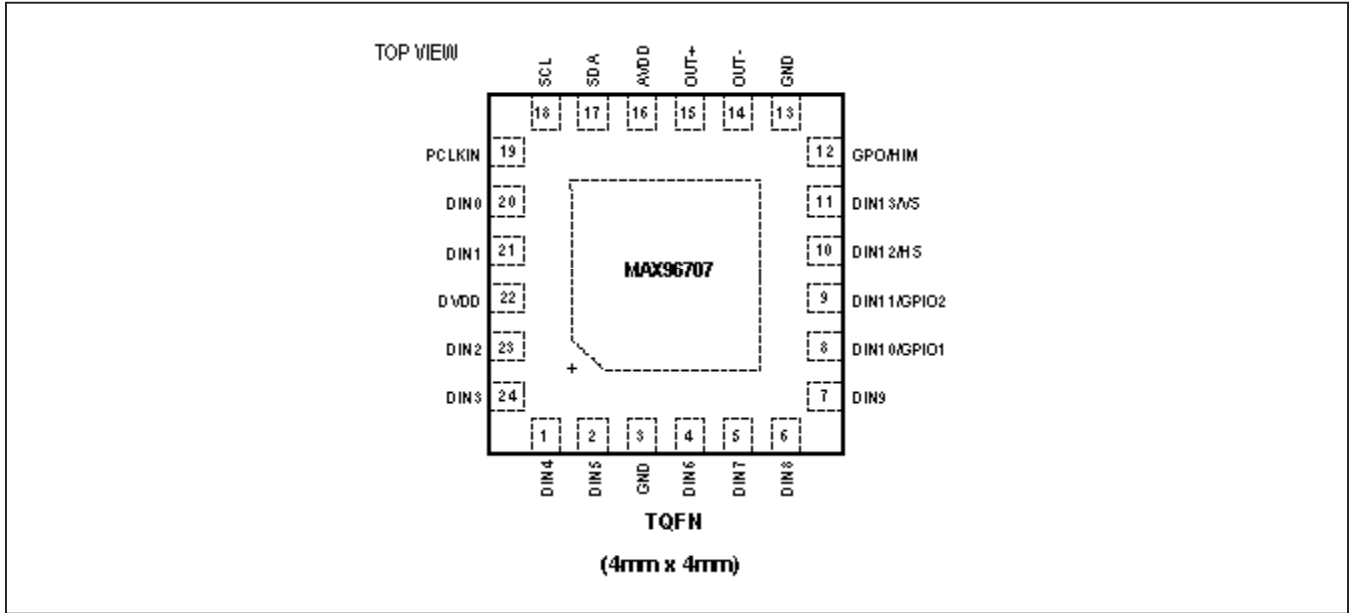


Typical Operating Characteristics (continued)

($V_{AVDD} = V_{DVDD} = 1.8V$, $T_A = +25^\circ C$, unless otherwise noted.)



Pin Configuration



Pin Description

| PIN | NAME | FUNCTION | REF SUPPLY | TYPE |
|---------------------------|--------|---|------------|---------|
| POWER | | | | |
| 3, 13 | GND | Analog and Digital Ground | | Power |
| 16 | AVDD | 1.8V Analog Power Supply. Bypass AVDD to GND with 0.1µF, and 0.001µF capacitors as close as possible to the device with the smaller value capacitor closest to AVDD. | | Power |
| 22 | DVDD | 1.8V Digital Power Supply. Bypass DVDD to GND with 0.1µF, and 0.001µF capacitors as close as possible to the device with the smaller value capacitor closest to DVDD. | | Power |
| EP | — | Exposed Pad. EP is internally connected to device ground. Must connect EP to the PCB ground plane through a via array for proper thermal and electrical performance. | | Power |
| HIGH-SPEED DIGITAL | | | | |
| Single Function | | | | |
| 1 | DIN4 | Parallel Data Input. Internal pulldown to GND. | DVDD | Digital |
| 2 | DIN5 | Parallel Data Input. Internal pulldown to GND. | DVDD | Digital |
| 4 | DIN6 | Parallel Data Input. Internal pulldown to GND. | DVDD | Digital |
| 5 | DIN7 | Parallel Data Input. Internal pulldown to GND. | DVDD | Digital |
| 6 | DIN8 | Parallel Data Input. Internal pulldown to GND. | DVDD | Digital |
| 7 | DIN9 | Parallel Data Input. Internal pulldown to GND. | DVDD | Digital |
| 19 | PCLKIN | Parallel Clock Input with Internal Pulldown to GND. Latches parallel data inputs and provides the PLL reference clock. | DVDD | Digital |
| 20 | DIN0 | Parallel Data Input. Internal pulldown to GND. | DVDD | Digital |

Pin Description (continued)

| PIN | NAME | FUNCTION | REF SUPPLY | TYPE |
|------------------------------------|-------------|---|------------|---------|
| 21 | DIN1 | Parallel Data Input. Internal pulldown to GND. | DVDD | Digital |
| 23 | DIN2 | Parallel Data Input. Internal pulldown to GND. | DVDD | Digital |
| 24 | DIN3 | Parallel Data Input. Internal pulldown to GND. | DVDD | Digital |
| Multifunction | | | | |
| 8 | DIN10/GPIO1 | Parallel Data Input/GPIO. Defaults to parallel data input on power-up. Parallel data input has internal pulldown to GND. GPIO1 has an open-drain input/output with internal 60kΩ pullup to DVDD. | DVDD | Digital |
| 9 | DIN11/GPIO2 | Parallel Data Input/GPIO. Defaults to parallel data input on power-up. Parallel data input has internal pulldown to GND. GPIO2 has an open-drain input/output with internal 60kΩ pullup to DVDD. | DVDD | Digital |
| 10 | DIN12/HS | Parallel Data Input/Horizontal Sync with Internal Pulldown to GND. Defaults to parallel data input on power-up. Defaults to horizontal-sync input when HS/VS encoding is enabled, or when in high-bandwidth mode. | DVDD | Digital |
| 11 | DIN13/VS | Parallel Data Input/Vertical Sync with Internal Pulldown to GND. Defaults to parallel data input on power-up. Defaults to vertical-sync input when HS/VS encoding is enabled, or when in high-bandwidth mode. | DVDD | Digital |
| Configuration and Interface | | | | |
| 12 | GPO/HIM | General-Purpose Output/High-Immunity Mode Input with internal Pulldown to GND. HIM is latched at power-up and switches to GPO output automatically after power-up. Connect HIM to DVDD with a 30kΩ resistor to set high, or leave open to set low. HIGHIMM can be programmed to a different value after power-up. HIGHIMM in the deserializer must be set to the same value. GPO output follows the state of the GPI (or INT) input on the GMSL deserializer. GPO is low upon power-up. | DVDD | Digital |
| 14 | OUT- | Inverting Coax/Twisted-Pair Serial Output | — | Digital |
| 15 | OUT+ | Noninverting Coax/Twisted-Pair Serial Output | — | Digital |
| 17 | SDA | Serial Data. Input/output with internal 30kΩ pullup to DVDD. SDA is the SDA input/output of the serializer's I ² C master/slave. SDA has an open-drain driver and requires a pullup resistor. | DVDD | Digital |
| 18 | SCL | Serial Clock. Input/output with internal 30kΩ pullup to DVDD. SCL is the SCL input/output of the serializer's I ² C master/slave. SCL has an open-drain driver and requires a pullup resistor. | DVDD | Digital |

Functional Block Diagram

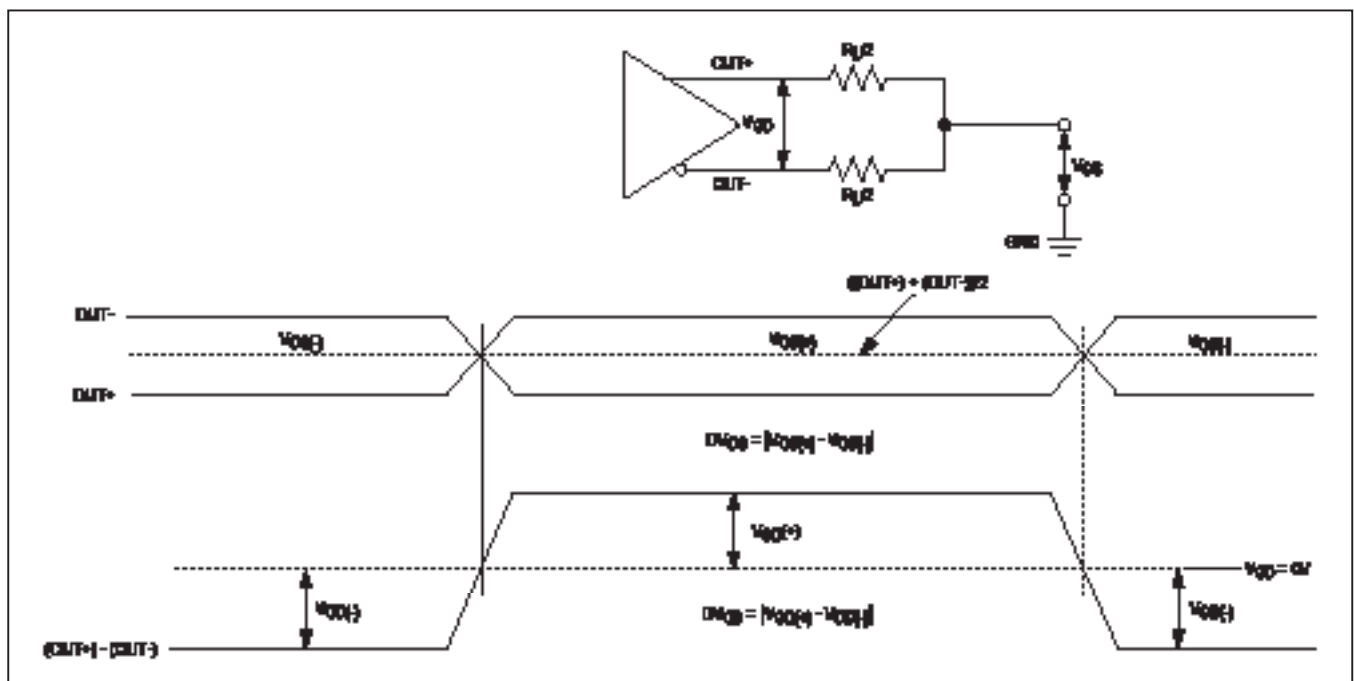
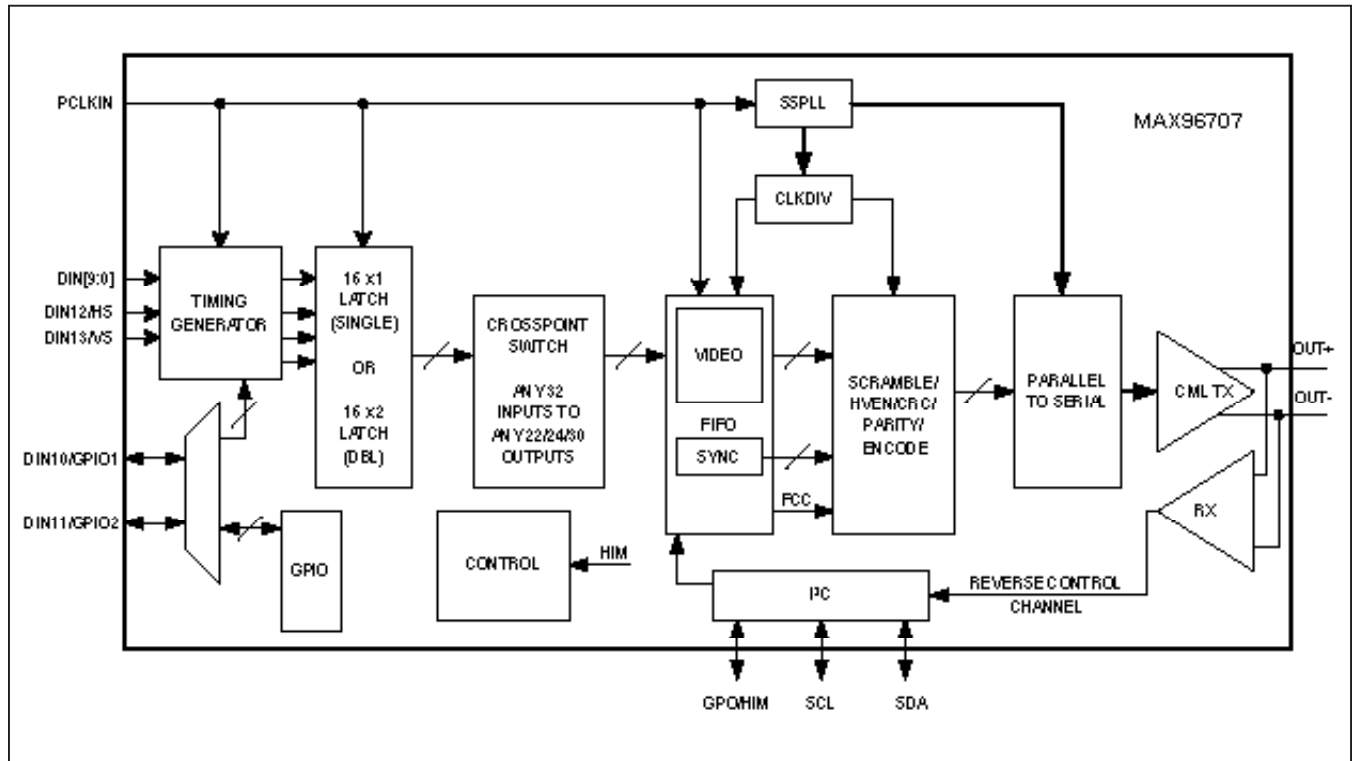


Figure 1. Serial-Output Parameters

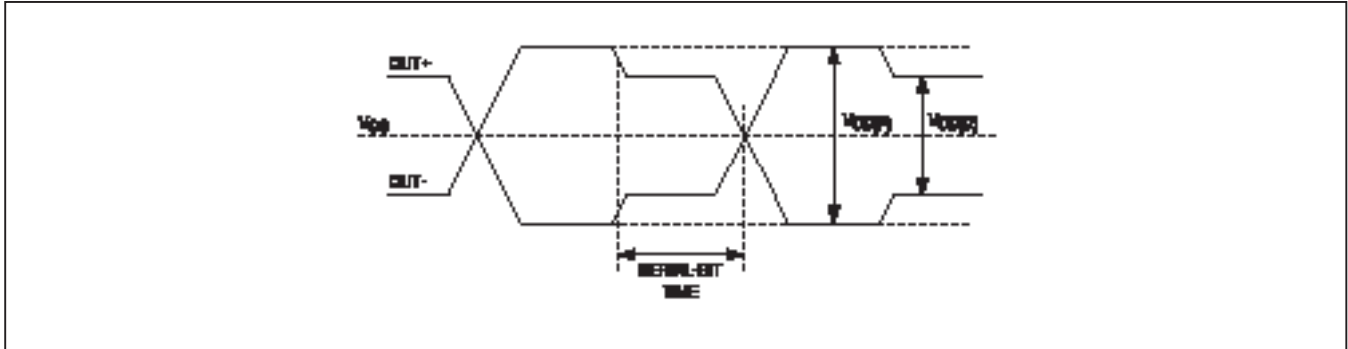


Figure 2. Output Waveforms at OUT+, OUT-

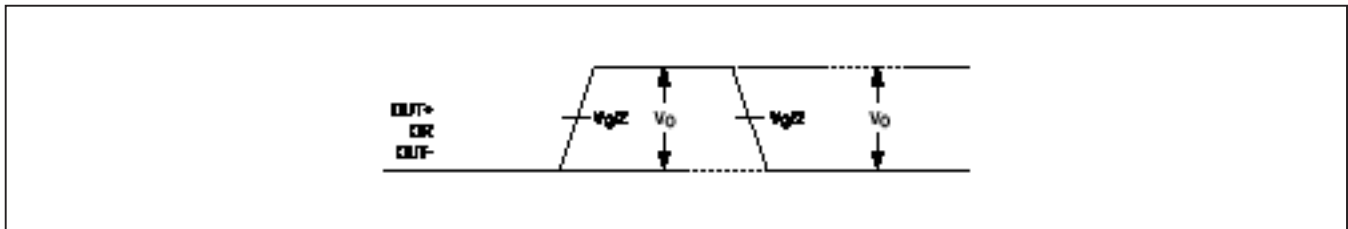


Figure 3. Single-Ended Output Template

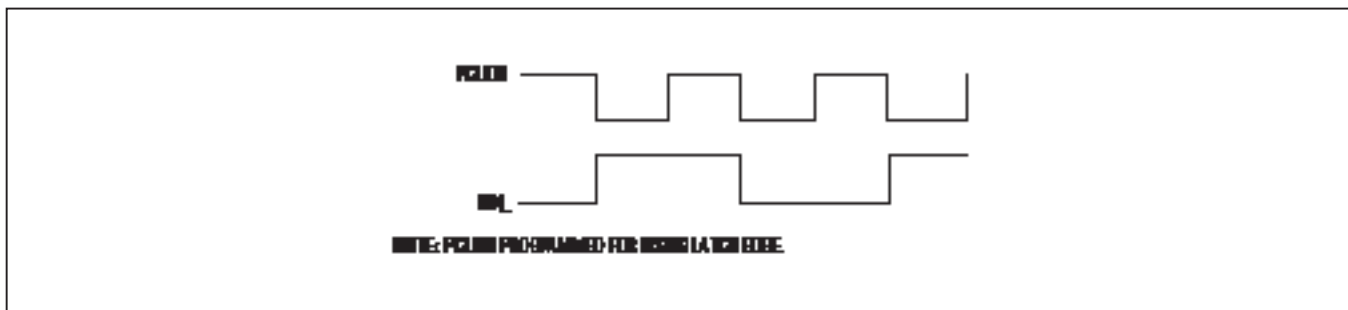


Figure 4. Worst-Case Pattern Input

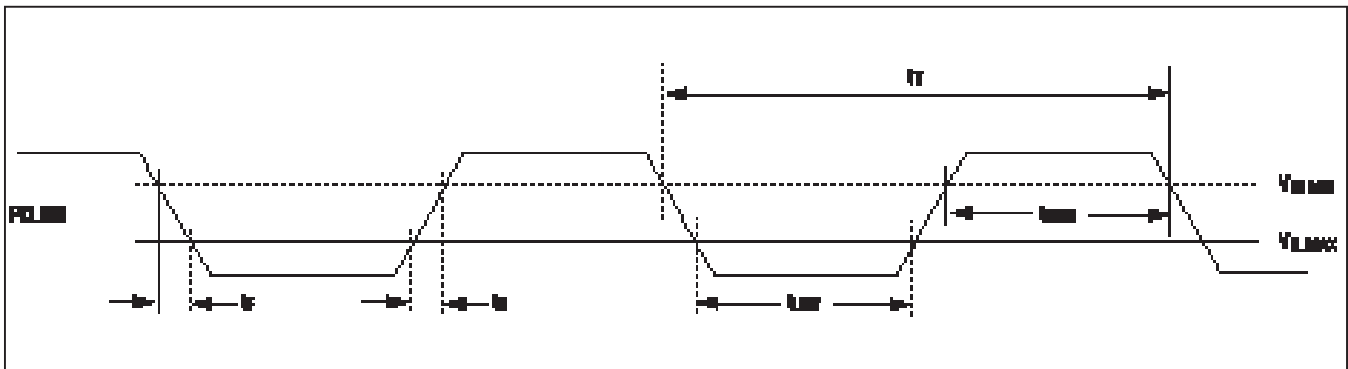


Figure 5. Parallel Clock Input Requirements

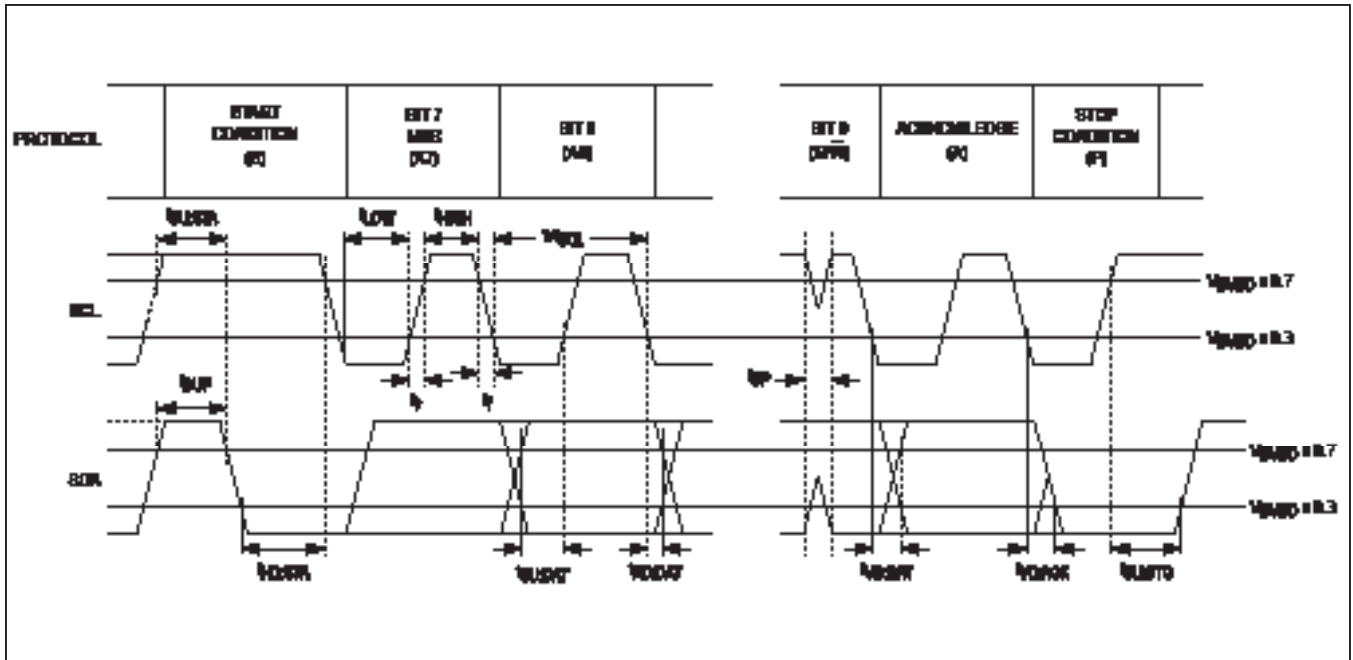


Figure 6. I²C Timing Parameters

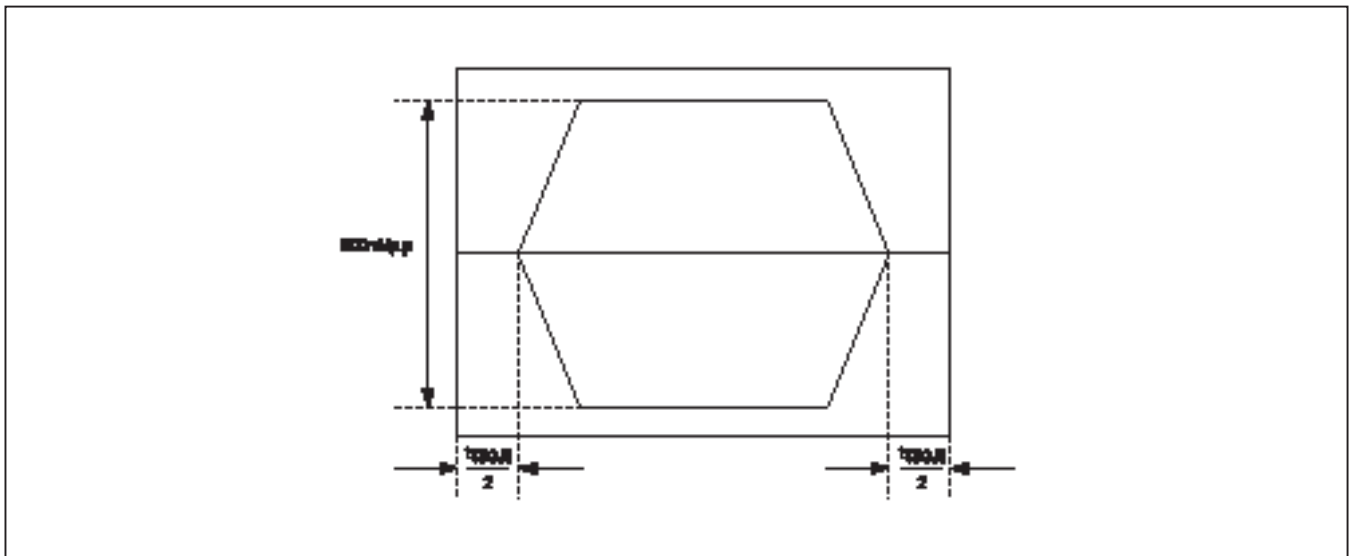


Figure 7. Differential Output Template

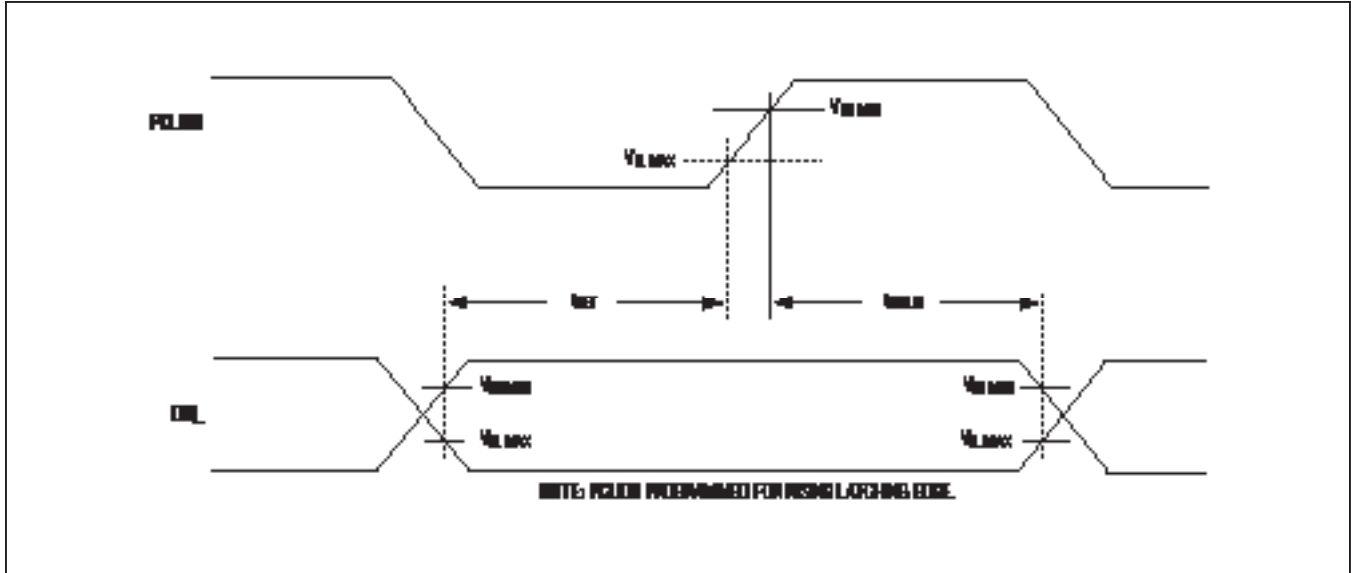


Figure 8. Input Setup and Hold Times

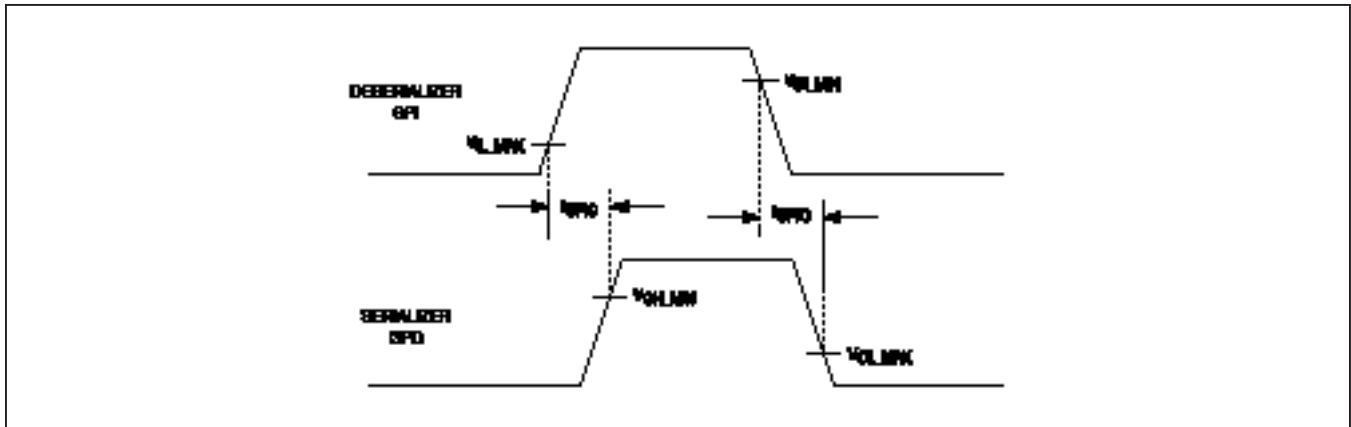


Figure 9. GPI-to-GPO Delay

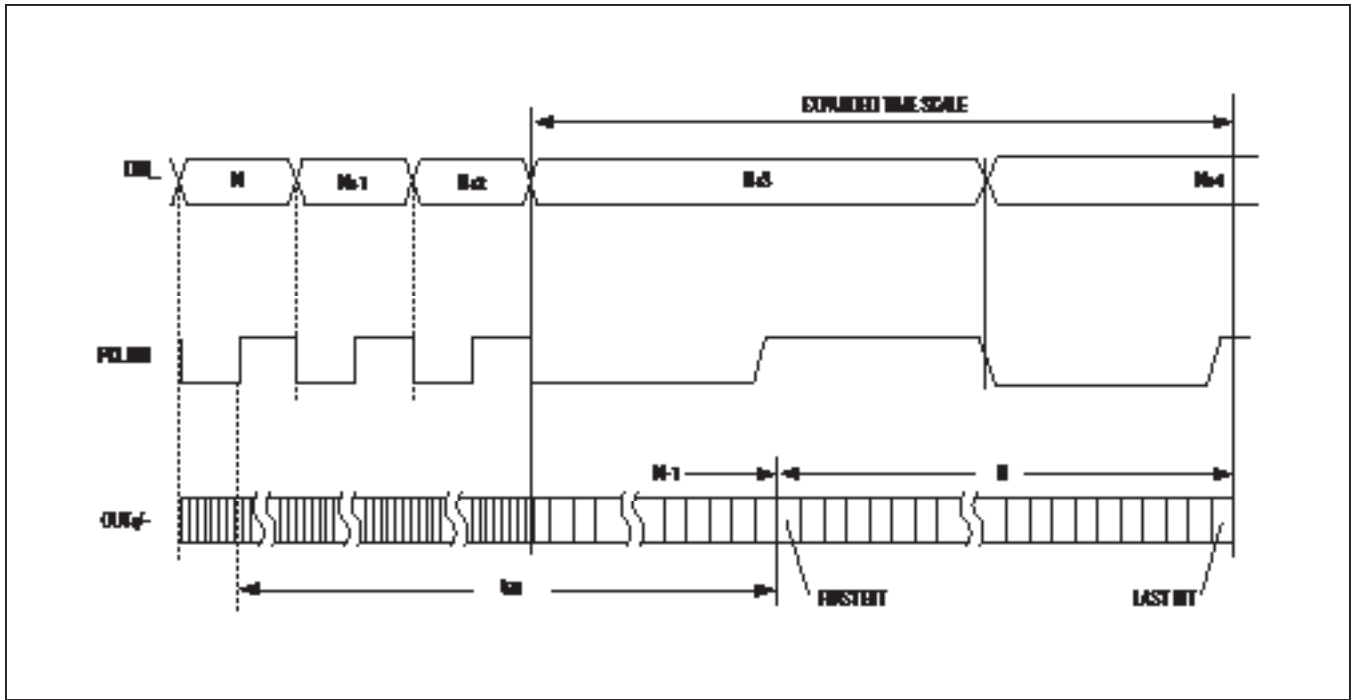


Figure 10. Serializer Delay

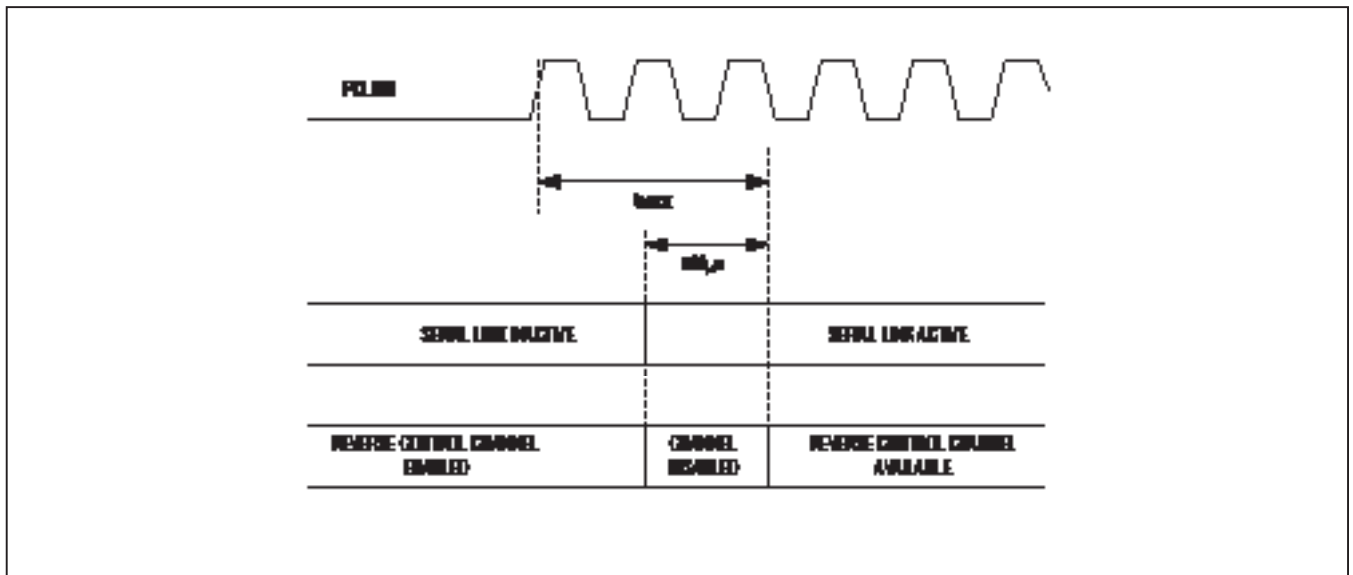


Figure 11. Link Startup Time

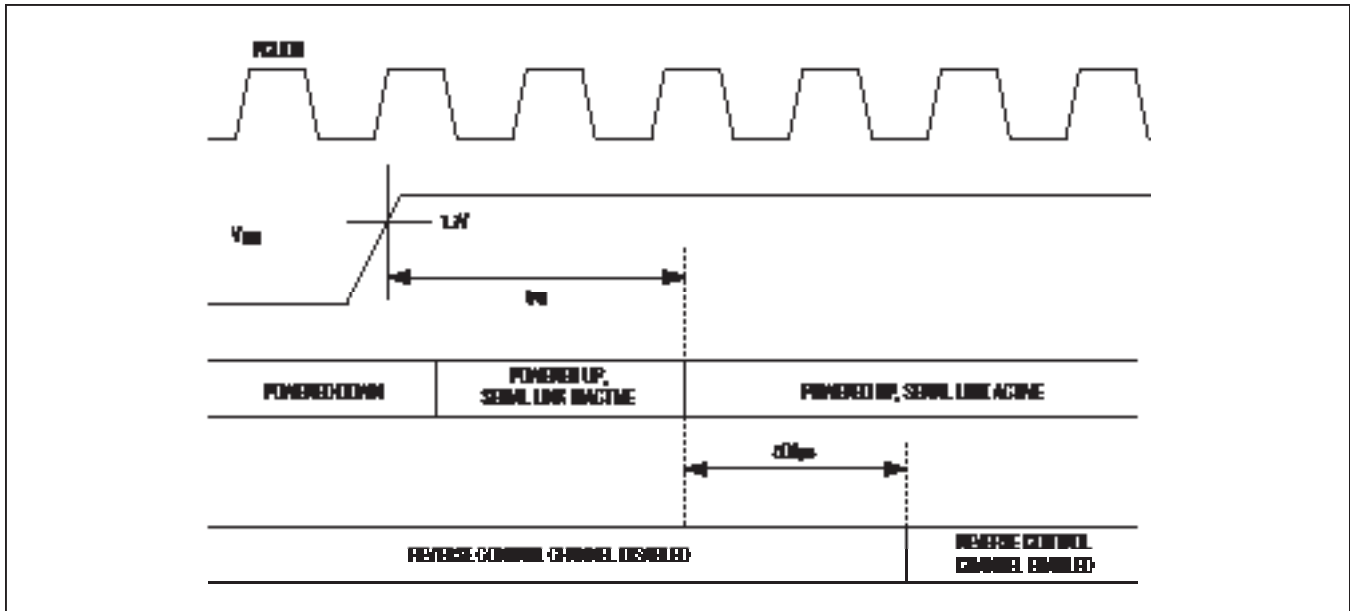


Figure 12. Power-Up Delay

Detailed Description

The MAX96707 is a compact device with features especially suited for automotive camera applications. The device operates at a variety of input widths and word rates up to a total serial-data rate up to 1.74Gbps. High-bandwidth mode offers a 116MHz parallel clock rate with 12 bits of video data and 2 bits of sync (HS/VS) data. An embedded 9.6kbps to 1Mbps control channel programs the serializer, deserializer, and any attached I²C peripherals.

To promote safety applications, the device features CRC protection of video and control data. In addition, control-channel retransmission and high-immunity modes reduce the effects of bit errors corrupting communication. Preemphasis and a PRBS tester allow for in-system evaluation and optimization of the link quality.

The MAX96707 operates over the -40°C to +115°C automotive temperature range.

Serial Link Signaling and Data Format

The serializer scrambles the input parallel data and combines this with the forward control data. The data is then encoded for transmission and output as a single-serialized bitstream at several times the input word rate (depending on bus width). The deserializer receives the serial data and recovers the clock signal. The data is then deserialized, decoded, and descrambled into parallel output data and forward control data.

Operating Modes

The GMSL devices are configurable to operate in many modes depending on the application. These modes allow for a more efficient use of serial bandwidth. Most of these settings are set during system design, and are configured through register bits.

Video/Configuration Link

In normal operation, the serializer runs in video link mode (serializer SEREN = 1) with video data and control data sent across the serial link. Set SEREN = 0 in the serializer to turn off serialization. The serializer powers up in video link mode and requires a valid PCLK for operation.

A configuration link is available to set up the serializer, deserializer, and peripherals when PCLK is not available. Set SEREN = 0 and CLINK = 1 in the serializer to enable the configuration link (SEREN = 1 forces the serializer into video link mode). Once PCLK has been established, turn on the video link (SEREN = 1).

By default, video link mode requires a valid PCLK for operation. Set AUTO_CLINK bit = 1 and SEREN = 1 in the serializer to have the device automatically switch between the video link and configuration link whenever PCLK is not present.

Single/Double Mode

Single-/double-mode operation configures the available 1.74Gbps bandwidth into a variety of widths and word rates. Single-mode operation is compatible with all GMSL devices and serializers, yielding one parallel word for each serial word. Double mode serializes two half-width parallel words for each serial word, resulting in a 2x increase in the parallel word rate range (compared to single mode). Set DBL = 0 for single-mode operation and DBL = 1 for double-mode operation.

HS/VS Encoding

By default, GMSL assigns a video bit slot to HSYNC, VSYNC, and DE (if used). With HS/VS encoding, the device instead encodes special packets to sync signals to free up additional video bit slots. HS/VS encoding is on by default when the device is in high-bandwidth mode (HIBW = 1). DE is encoded only when HIBW = 1 and DE_EN = 1. Set HVEN = 1 to turn on HS/VS encoding when HIBW = 0 (DE, if enabled, uses up a video bit). HS/VS encoding requires that HSYNC, VSYNC, and DE (if used) remain high during the active video and low during the blanking period. Use HS/VS inversion when using reverse-polarity sync signals.

Error Detection

The serial link's 8b/10b encoding/decoding and 1-bit parity detect bit errors that occur on the serial link. An optional 6-bit CRC check is available at the expense of 6 video bits (when HIBW = 0). To activate 6-bit CRC mode, set PXL_CRC = 1 in the remote-side device first, then in the local-side device. When using 6-bit CRC mode, the available internal bus width is reduced by 6 bits in single-input mode (DBL = 0) and 3 bits in double-input mode (DBL = 1). Note that the input bus width may already have been reduced due to pin availability of the serializer or deserializer; thus, the reduction of bandwidth from CRC may not be visible (see [Table 3](#)).

An additional 32-bit video line CRC is available by setting LINE_CRC_EN = 1. When enabled, the serializer calculates the 32-bit CRC of the video line and sends this information during the blanking period. The deserializer compares the received CRC with the video line data. The deserializer's LINE_CRC_ERR bit latches when a CRC error is detected. LINE_CRC_ERR clears when read.

Bus Widths

The serial link has multiple bus-width settings that determine the parallel bus width and the resulting parallel word rate. The serial link operates to a maximum serial bit rate of 1.74Gbps. The BWS bit determines if each serial packet is 30 or 40 bits long, which translates to a maximum serial packet rate (and resulting maximum parallel word rate) of 58MHz or 43.5MHz when BWS = 0 or 1 respectively. Encoding translates the 24, 27, or 32 parallel bits into 30- or 40-bit serial packets. One bit is used for parity, while a second is reserved for the control channel. An additional 6 bits are used during optional 6-bit CRC. In addition, double mode splits the remaining word size in half, if used. The remaining bits can be used for video bits (minus any sync bits if H/V encoding is not used)

The following modes list the internal bus widths. The number of available input and output pins may limit the actual bus width available.

- **24-Bit Mode** ([Figure 13](#))

When BWS = 0 and HIBW = 0, the 30-bit serial packet corresponds with three 8b/10b symbols representing 24 bits (24-bit mode). After the parity and control channel, this leaves 16/22 bits of video data if CRC is/ or is not used (single mode), or 8/11 bits of video data if CRC is/ or is not used (double mode).

- **27-Bit High-Bandwidth Mode** ([Figure 14](#))

When BWS = 0 and HIBW = 1 (high-bandwidth mode), the 30-bit serial packet represents three 9b/10b symbols representing 27 bits. After the parity and control channel, this leaves 19/25 bits of video data if CRC is/ or is not used (single mode), or 9/12 bits of video data if CRC is/ or is not used (double mode)

- **32-Bit Mode** ([Figure 15](#))

When BWS = 1, the 40-bit serial packet corresponds with four 8b/10b symbols representing 32 bits (32-bit mode). After parity and control channel, this leaves 24/30 bits of video data if CRC is/ or is not used (single mode), or 12/15 bits of video data if CRC is/ or is not used (double mode).

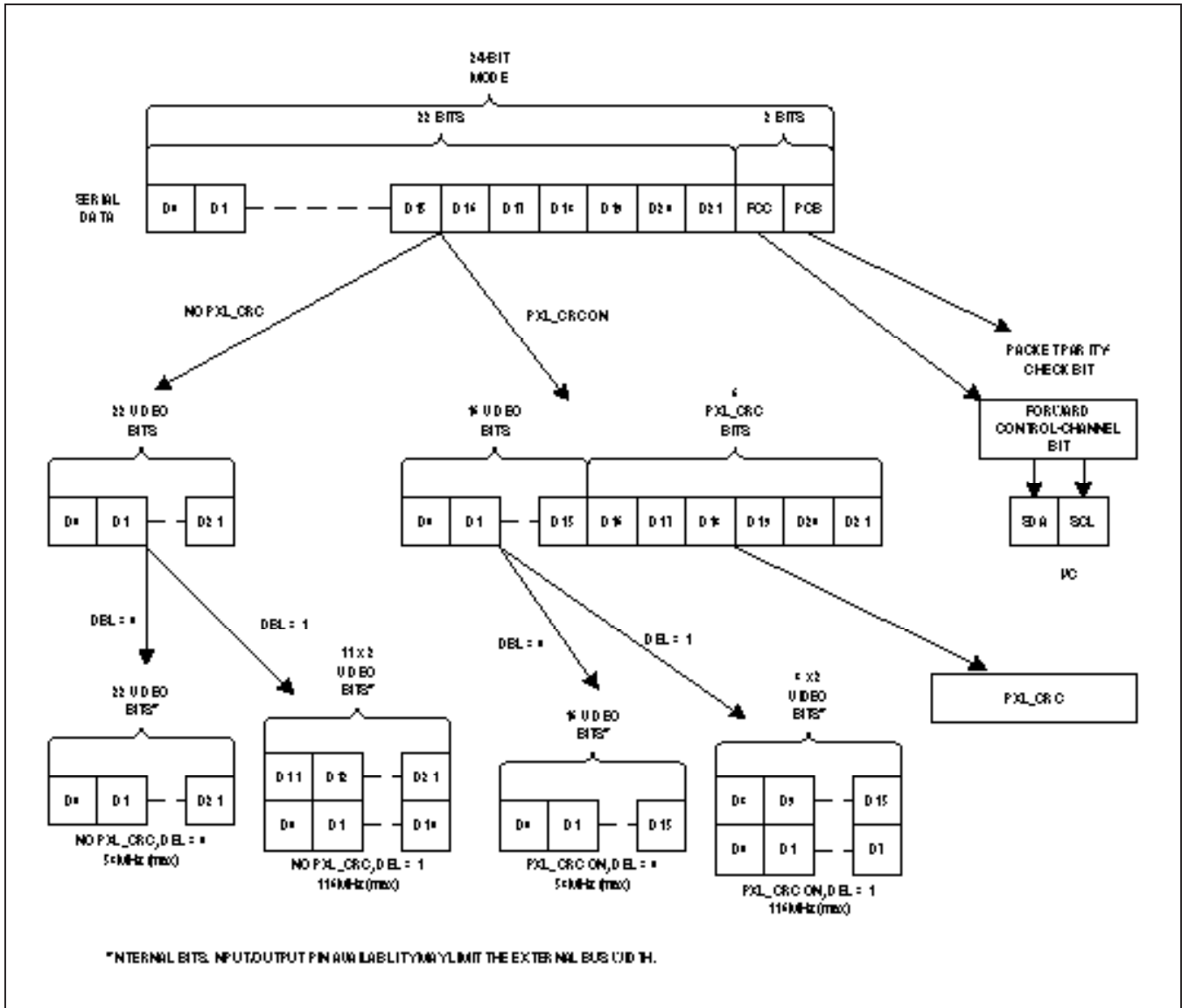


Figure 13. 24-Bit Mode Serial-Data Format

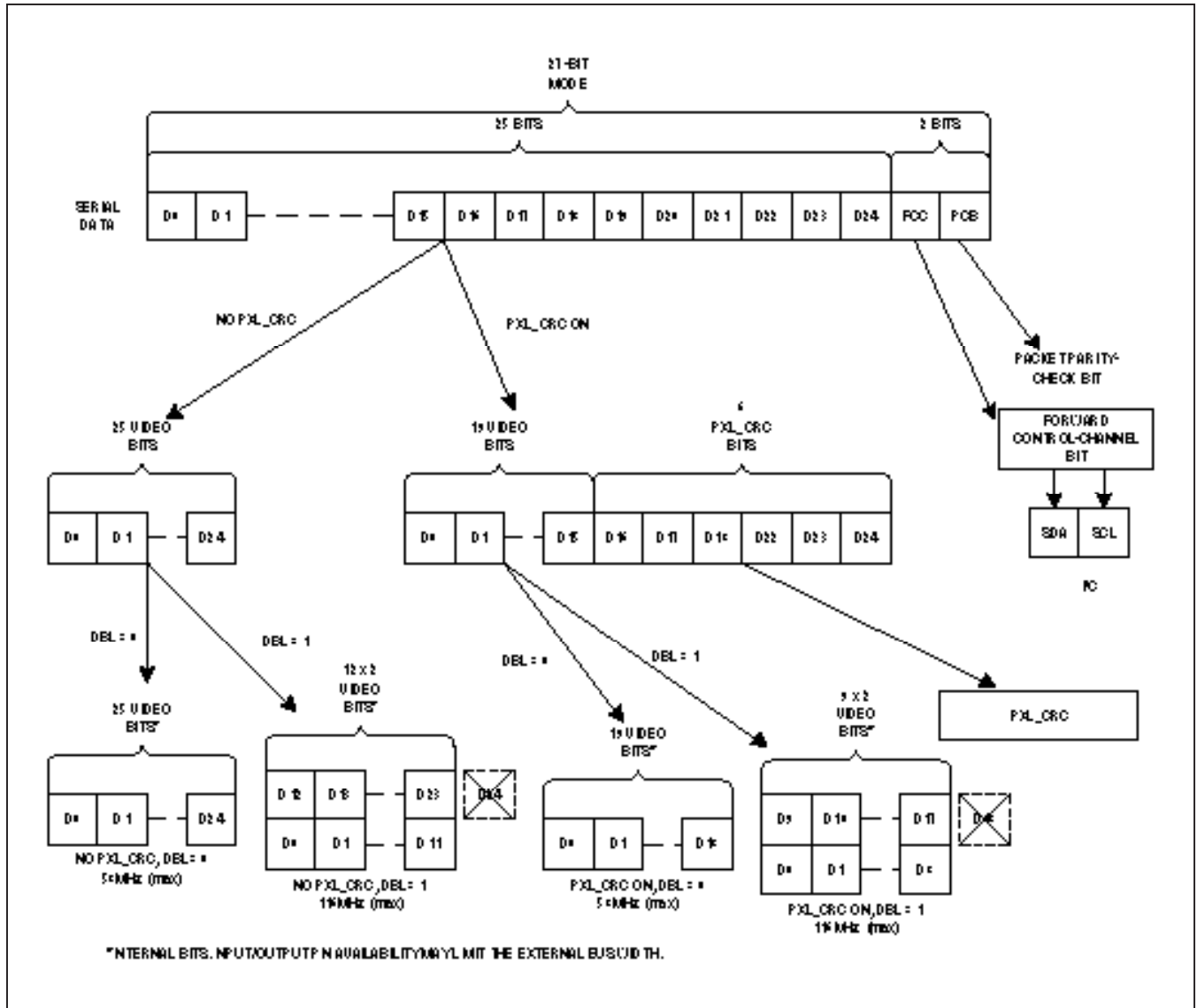


Figure 14. 27-Bit High-Bandwidth Mode Serial-Data Format

Control Channel and Register Programming

The control channel sends information across the serial link for control of the serializer, deserializer, and any attached peripherals. The control channel is multiplexed onto the serial link and is available with or without the video channel.

Forward Control Channel

Control data sent from the serializer to the deserializer is sent on the forward control channel. The data is encoded as one of the serial bits in the forward high-speed link. After deserialization, the forward control-channel data is extracted from the serial link. The forward control-channel bandwidth exceeds the maximum external control data rate, and all data sent on the forward control channel appears on the remote side after transmission delay of a few bit times.

Reverse Control Channel

Control data sent from the deserializer to the serializer is sent on the reverse control channel. The data is encoded as a series of 1 μ s pulses, with a maximum raw data rate of 1Mbps. High-immunity mode is available to increase the robustness of the reverse control channel at a reduced raw bit rate of 500kbps. In [Table 1](#), setting the REV_FAST bit = 1 increases this rate back to 1Mbps. When the input data rate (after encoding) exceeds the reverse data rate, the input clock is held through clock stretching to slow the external clock to match the internal bit rate.

I²C Interface

The serial link connects the serializer and deserializer I²C interfaces together through the control channel. When an I²C master sends a command to one side of the link (local side) the control channel forwards this information

to and from the other side of the link (remote side), allowing a single microcontroller to configure the serializer, deserializer, and peripherals. The microcontroller can be located on the serializer side (display applications) and the deserializer side (camera applications). Dual microcontroller operations are supported as long as a software-arbitration method is used. The serial link assumes that only one microcontroller is talking at any given time.

Remote-End Operation

When an I²C master initiates communication on the local slave device (the serializer/deserializer directly connected to the master), the remote-side device acts as a master device that sends data forwarded from the local-side device, and forwards any data received from peripherals attached to the remote-side device. This remote-side master device operates according to the timing settings in the I²C master setting register. Set the master settings to match the timing settings used by the external microcontroller.

Clock-Stretch Timing

The I²C interface uses clock stretching to allow time for data to be forwarded across the serial link. The master microcontroller, along with any attached peripherals, must accept clock stretching of the GMSL devices.

Packet-Based I²C

A packet-based control channel is available for enhanced error handling of the control channel. This control-channel method handles simultaneous GPI/GPO and I²C transmission, along with error detection and retransmission.

Table 1. Reverse Control-Channel Modes

| HIM PIN SETTING | REVFAST BIT | REVERSE CONTROL-CHANNEL MODE | MAXIMUM I ² C BIT RATE (KBPS) |
|-----------------|-------------|--|--|
| Low | X | Legacy reverse control-channel mode (compatible with all GMSL devices) | 1000 |
| High | 0 | High-immunity mode | 500 |
| | 1 | Fast high-immunity mode (requires HIBW = 0, serial-data rate > 1.25Gbps) | 1000 |

X = Don't care.

Packet Protocol Summary

The packet-based control channel uses a synchronous, symbol-based system to send data across the control channel. Data to be sent across the control channel is split into symbols and stored in a transmit queue and then sent across the link. If both GPI and I²C data needs to be sent (e.g., when GPI transitions during an I²C transmission), the symbols from both commands are combined in the queue. If the transmit queue is empty, idle packets are sent across the link to maintain control-channel lock. Received I²C packets are output as determined by the microcontroller SCL rate (local device) or the programmed master bit rate (remote device). The device holds SCL low (clock stretch) until data has been received from the remote-side device.

Control-Channel Error Detection and Packet Retransmission

When the packet-based control channel is used, all packets are checked for errors through CRC. Using 1, 5, or 8 bits, CRC detects 1, 3, or 4 random bit errors in a packet. The transmitter retransmits packets whenever an error is detected. The transmitter sets a flag if a number of retries exceed a programmed threshold. The receiver filters out packets with errors.

GPO/GPI Control

GPO on the serializer follows GPI transitions on the deserializer. This GPO/GPI function can be used to transmit signals such as a frame sync in a surround-view camera system (see the [Providing a Frame Sync \(Camera Applications\)](#) section). Optionally, GPO can be set directly by register bits.

Spread Spectrum

The serializer contains a programmable spread-spectrum output to lower emission levels by spreading the clock-frequency peaks across a frequency spectrum. In addition, the serializer and deserializer can track a spread input clock, eliminating the need for multiple spread clocks.

Cable Type Configuration

The driver output is programmable for two kinds of cable, 100Ω twisted pair and 50Ω coax (contact the factory for devices compatible with 75Ω cables). In coax mode, connect OUT+ to IN+ of the deserializer. Leave the unused IN₋ pin unconnected, or connect it to ground through 50Ω, and a capacitor for increased power-supply rejection. Connect OUT- to V_{DD} through a 50Ω resistor (Figure 16).

Crossbar Switch

The crossbar switch routes data between the parallel input/output and the SerDes. The anything-to-anything routing assures the mapping between the video source and destination. For each crossbar output (XBO₋) an input multiplexer selects from the available crossbar inputs (XBI₋) using the CROSSBAR₋ register bits (Figure 17). Multiple crossbar outputs can use the same crossbar input. By default, the sync signals share the same inputs as the MSBs of the video data.

Video Timing Generator

The serializer includes a programmable video timing generator to generate/retime the input sync signals. The timing generator can be used to modify a camera's input timing, filter out glitches in the sync signals, or to reduce the number of required input sync signals. Each sync signal can be individually retimed or left unmodified. Several registers determine the length of the timing parameters (in PCLK cycles) shown in Figure 18. Timing parameters include high/low period length, line count, and delay from the input VS signal.

The timing generator uses three different trigger modes, tracking, single trigger, and autorun. Tracking mode looks at the input VSYNC and locks once it receives three consecutive identical VSYNC signals. The tracker then continues to output the same identical signal, erasing any glitches that may appear on VSYNC. The tracker attempts to relock to a new signal if three consecutive input waveforms do not match the locked signal. Single trigger generates one generated frame for each input VSYNC edge. Autorun generates a new frame at the rate determined by the VSYNC high/low period. If a new VSYNC signal appears before a frame is complete in either single trigger or autorun modes, a new frame immediately starts, cutting the previous frame short.

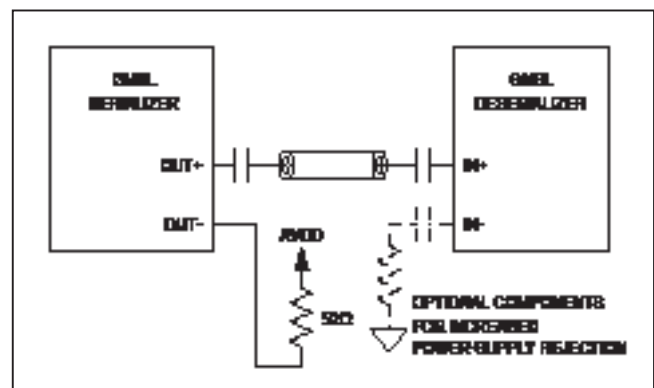


Figure 16. Coax Connection

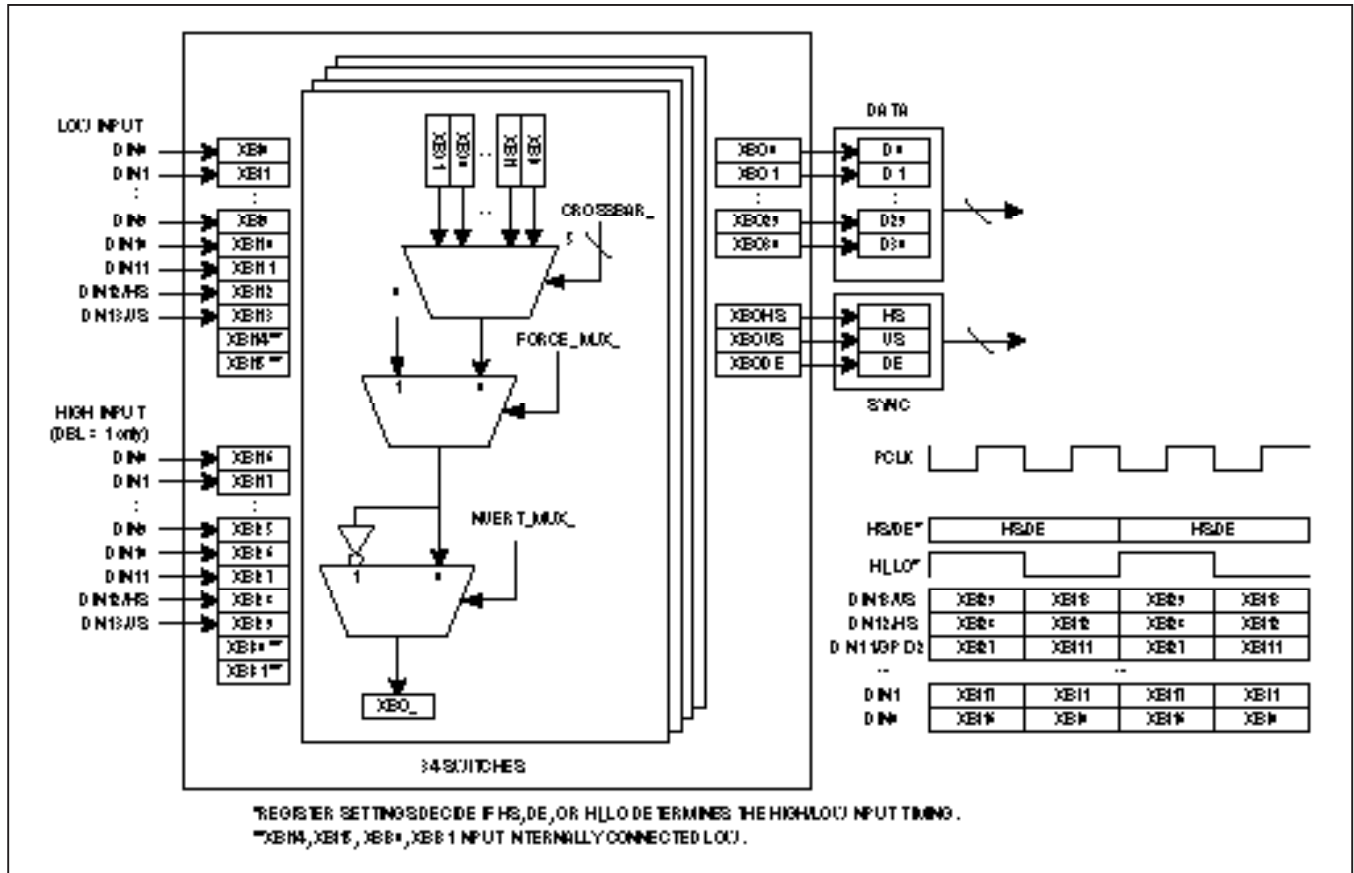


Figure 17. Crossbar Switch Dataflow

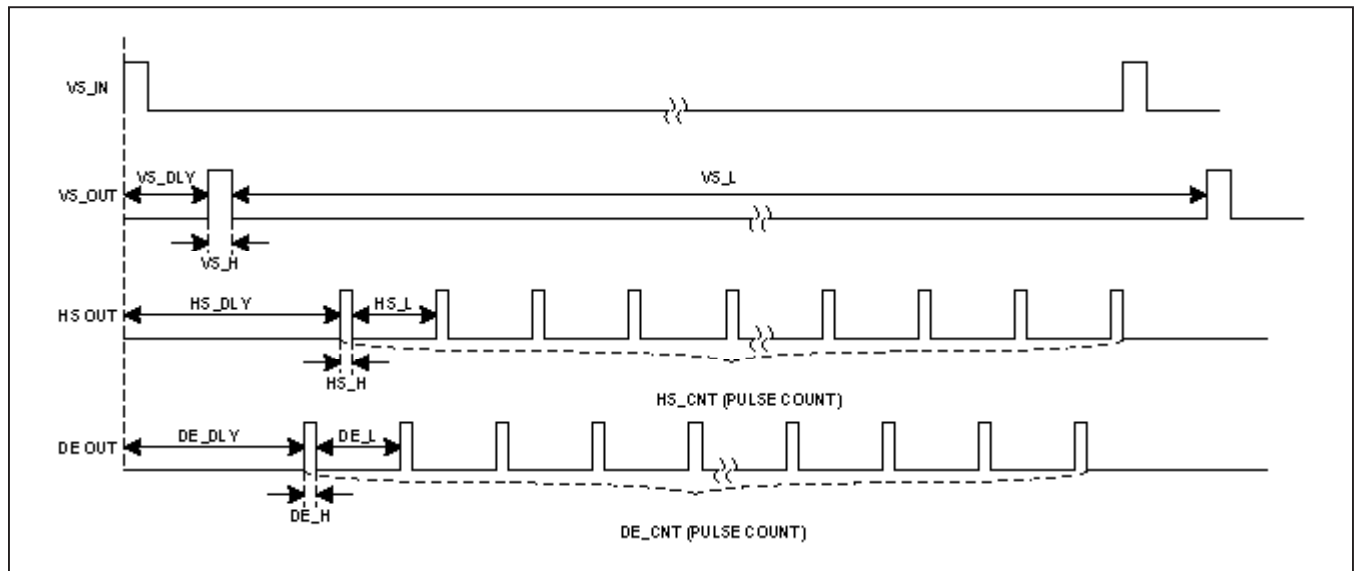


Figure 18. Sync Signal Format for Video-Timing Generation

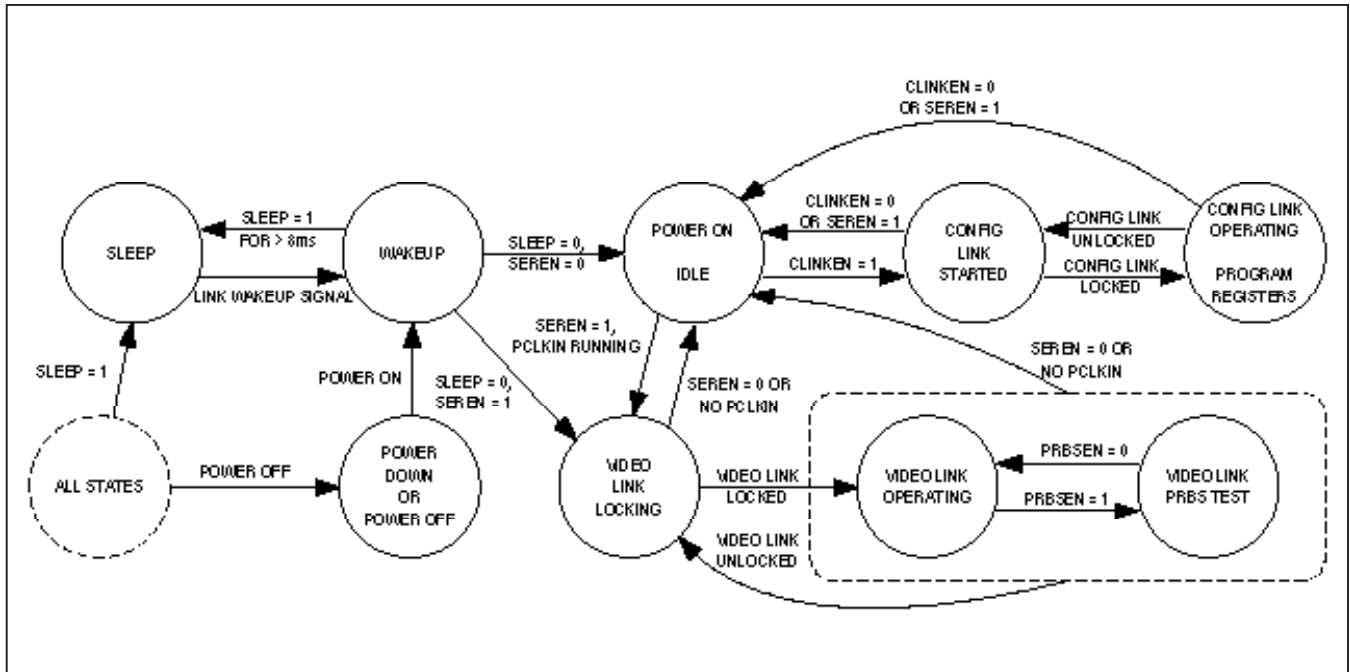


Figure 19. State Diagram

Shutdown/Sleep Modes

Several sleep and shutdown modes are available when full operation is not needed.

Configuration Link

When the high-speed video link is not needed, or unavailable, a configuration link can be used in its place. In configuration link mode, the parallel digital input/output is disabled, the LOCK pin remains low, and the serial link internally generates its own clock to allow full operation of the control channel (I2C and GPIO).

Serialization Disable

When the serial link is not needed, such as when downstream devices are powered off, the user can disable

serialization. In this mode, all forward communication is shut down. The user can reenale serialization either locally, or through the reverse channel.

Sleep Mode

To reduce power consumption further, the devices can be put into sleep mode. In this mode, all registers keep their programmed values, and all functions in the device are powered down except for the wake-up detectors on the local control interface, and the serial link. Any activity seen by the wake-up detectors temporarily turns on the control-channel interface. During this time, a microcontroller can command the device to exit sleep mode. See the *Shutdown/Sleep Modes* section.

Link Startup Procedure

[Table 2](#) lists the startup procedure for image-sensing applications. The control channel is available after the

video link or the configuration link is established. If the deserializer powers up after the serializer, the control channel becomes unavailable until 2ms after power-up.

Table 2. Link-Startup Procedure

| NO. | μ C | SERIALIZER | DESERIALIZER |
|-----|---|--|--|
| — | μC Connected to Deserializer | Set Configuration Inputs | Set Configuration Inputs |
| 1 | Powers up (wait t_{PU}). | Powers up and loads default settings. Establishes video link when valid PCLK is available. | Powers up and loads default settings. Locks to video link signal if available. |
| 1a | If no PCLK, programs CLINKEN, SEREN, and/or AUTOCLINK bits. Wait 5ms after each command. | Establishes configuration link. | Locks to configuration link if available. |
| 1b | If not locked, sets any additional configuration bits that are mismatched between the serializer and deserializer (e.g., BWS, CX/TP). Wait 5ms for lock after each command. | Configuration changed. Reestablishes configuration/video link if needed. | Configuration changed. Locks to configuration/video link. |
| 2 | Sets register 0x07 configuration bits in the serializer (DBL, BWS, HIBW, PXL_CRC, etc.). Wait 2ms. | Configuration changed. Reestablishes configuration/video link if needed. | Loss-of-lock may occur. |
| 3 | Sets register 0x07 configuration bits in the deserializer (DBL, BWS, HIBW, PXL_CRC, etc.). Wait 5ms for lock to reestablish. | — | Configuration changed. Locks to configuration/video link. |
| 4 | Writes rest of serializer/deserializer configuration bits. | Configuration changed. | Configuration changed. |
| 5 | Writes camera/peripheral configuration bits. | Forwards commands from μ C to serializer. | Forwards commands to camera/peripherals. |
| 5a | If in configuration link, when PCLK is available, set SEREN = 1. Wait 5ms for lock. | Enables video link. | Locks to video link. |

Register Map

GMSL Register Map

| OFFSET | NAME | MSB | | | | | | | LSB |
|--------|---------------|--------------------|-----------------|----------------|-----------------|---------------|------------|-----------------|------------|
| 0x00 | seraddr | SERADDR[6:0] | | | | | | | CFG-BLOCK |
| 0x01 | desaddr | DESADDR[6:0] | | | | | | | RSVD |
| 0x02 | ss | SS[2:0] | | | RSVD | PRNG[1:0] | | SRNG[1:0] | |
| 0x03 | sdiv | AUTOFM[1:0] | | | SDIV[5:0] | | | | |
| 0x04 | main_control | SEREN | CLINKEN | PRBSEN | SLEEP | RSVD[1:0] | | REVCEN | FWDCEN |
| 0x05 | prbs_len | RSVD | RSVD | PRBS_LEN[1:0] | | RSVD | RSVD | RSVD | RSVD |
| 0x06 | cmlvl_preemp | CMLLVL[3:0] | | | | PREEMP[3:0] | | | |
| 0x07 | config | DBL | HIBW | BWS | ES | RSVD | HVEN | RSVD | PXL_CRC |
| 0x08 | rsvd_8 | RSVD | RSVD | RSVD | RSVD | RSVD | RSVD | RSVD | RSVD |
| 0x09 | i2c_source A | I2C_SRC_A[6:0] | | | | | | | RSVD |
| 0x0A | i2c_dest A | I2C_DST_A[6:0] | | | | | | | RSVD |
| 0x0B | i2c_source B | I2C_SRC_B[6:0] | | | | | | | RSVD |
| 0x0C | i2c_dest B | I2C_DST_B[6:0] | | | | | | | RSVD |
| 0x0D | i2c_config | I2C_LOC_ACK | I2C_SLV_SH[1:0] | | I2C_MST_BT[2:0] | | | I2C_SLV_TO[1:0] | |
| 0x0E | gpio_en | RSVD | RSVD | RSVD | RSVD | RSVD | GPIO_EN_2 | GPIO_EN_1 | RSVD |
| 0x0F | gpio_out | EN_SET_GPO | RSVD | RSVD | RSVD | RSVD | GPIO_OUT_2 | GPIO_OUT_1 | SET_GPO |
| 0x10 | gpio_in | RSVD | RSVD | RSVD | RSVD | RSVD | GPIO_IN_2 | GPIO_IN_1 | GPO_L |
| 0x11 | errg | ERRG_RATE[1:0] | | ERRG_TYPE[1:0] | | ERRG_CNT[1:0] | | ERRG_PER | ERRG_EN |
| 0x12 | rsvd_12 | RSVD | RSVD | RSVD | RSVD[4:0] | | | | |
| 0x13 | pd | SOFT_PD | RSVD | RSVD | RSVD | RSVD | RSVD | RSVD[1:0] | |
| 0x14 | pktcc_lock | RSVD[1:0] | | RSVD | RSVD | RSVD | RSVD | CC_WBLOCK | REM_CCLOCK |
| 0x15 | input_status | RSVD | RSVD | RSVD | RSVD | RSVD | RSVD | OUT-PUTEN | PCLKDET |
| 0x16 | max_rt_err | RSVD | MAX_RT_ERR | RSVD[5:0] | | | | | |
| 0x17 | rsvd_17 | RSVD[7:0] | | | | | | | |
| 0x18 | crc 0 | CRC_VALUE_0[7:0] | | | | | | | |
| 0x19 | crc 1 | CRC_VALUE_1[7:0] | | | | | | | |
| 0x1A | crc 2 | CRC_VALUE_2[7:0] | | | | | | | |
| 0x1B | crc 3 | CRC_VALUE_3[7:0] | | | | | | | |
| 0x1C | cc_crc_errcnt | CC_CRC_ERRCNT[7:0] | | | | | | | |
| 0x1D | rsvd_1d | RSVD[7:0] | | | | | | | |

GMSL Register Map (continued)

| OFFSET | NAME | MSB | | | | | LSB |
|--------|-------------|---------|--------------|---------------|------------------|---------------|-----|
| 0x1E | id | ID[7:0] | | | | | |
| 0x1F | revision | RSVD | RSVD | RSVD | HDCPCAP | REVISION[3:0] | |
| 0x20 | crossbar 0 | RSVD | FORCE_MUX_0 | INVERT_MUX_0 | CROSSBAR_0[4:0] | | |
| 0x21 | crossbar 1 | RSVD | FORCE_MUX_1 | INVERT_MUX_1 | CROSSBAR_1[4:0] | | |
| 0x22 | crossbar 2 | RSVD | FORCE_MUX_2 | INVERT_MUX_2 | CROSSBAR_2[4:0] | | |
| 0x23 | crossbar 3 | RSVD | FORCE_MUX_3 | INVERT_MUX_3 | CROSSBAR_3[4:0] | | |
| 0x24 | crossbar 4 | RSVD | FORCE_MUX_4 | INVERT_MUX_4 | CROSSBAR_4[4:0] | | |
| 0x25 | crossbar 5 | RSVD | FORCE_MUX_5 | INVERT_MUX_5 | CROSSBAR_5[4:0] | | |
| 0x26 | crossbar 6 | RSVD | FORCE_MUX_6 | INVERT_MUX_6 | CROSSBAR_6[4:0] | | |
| 0x27 | crossbar 7 | RSVD | FORCE_MUX_7 | INVERT_MUX_7 | CROSSBAR_7[4:0] | | |
| 0x28 | crossbar 8 | RSVD | FORCE_MUX_8 | INVERT_MUX_8 | CROSSBAR_8[4:0] | | |
| 0x29 | crossbar 9 | RSVD | FORCE_MUX_9 | INVERT_MUX_9 | CROSSBAR_9[4:0] | | |
| 0x2A | crossbar 10 | RSVD | FORCE_MUX_10 | INVERT_MUX_10 | CROSSBAR_10[4:0] | | |
| 0x2B | crossbar 11 | RSVD | FORCE_MUX_11 | INVERT_MUX_11 | CROSSBAR_11[4:0] | | |
| 0x2C | crossbar 12 | RSVD | FORCE_MUX_12 | INVERT_MUX_12 | CROSSBAR_12[4:0] | | |
| 0x2D | crossbar 13 | RSVD | FORCE_MUX_13 | INVERT_MUX_13 | CROSSBAR_13[4:0] | | |
| 0x2E | crossbar 14 | RSVD | FORCE_MUX_14 | INVERT_MUX_14 | CROSSBAR_14[4:0] | | |
| 0x2F | crossbar 15 | RSVD | FORCE_MUX_15 | INVERT_MUX_15 | CROSSBAR_15[4:0] | | |
| 0x30 | crossbar 16 | RSVD | FORCE_MUX_16 | INVERT_MUX_16 | CROSSBAR_16[4:0] | | |
| 0x31 | crossbar 17 | RSVD | FORCE_MUX_17 | INVERT_MUX_17 | CROSSBAR_17[4:0] | | |
| 0x32 | crossbar 18 | RSVD | FORCE_MUX_18 | INVERT_MUX_18 | CROSSBAR_18[4:0] | | |
| 0x33 | crossbar 19 | RSVD | FORCE_MUX_19 | INVERT_MUX_19 | CROSSBAR_19[4:0] | | |
| 0x34 | crossbar 20 | RSVD | FORCE_MUX_20 | INVERT_MUX_20 | CROSSBAR_20[4:0] | | |

GMSL Register Map (continued)

| OFFSET | NAME | MSB | | | | | | | LSB |
|--------|-----------------|-------------------|--------------|---------------|------------------|-----------|-------------|---------------|--------|
| 0x35 | crossbar 21 | RSVD | FORCE_MUX_21 | INVERT_MUX_21 | CROSSBAR_21[4:0] | | | | |
| 0x36 | crossbar 22 | RSVD | FORCE_MUX_22 | INVERT_MUX_22 | CROSSBAR_22[4:0] | | | | |
| 0x37 | crossbar 23 | RSVD | FORCE_MUX_23 | INVERT_MUX_23 | CROSSBAR_23[4:0] | | | | |
| 0x38 | crossbar 24 | RSVD | FORCE_MUX_24 | INVERT_MUX_24 | CROSSBAR_24[4:0] | | | | |
| 0x39 | crossbar 25 | RSVD | FORCE_MUX_25 | INVERT_MUX_25 | CROSSBAR_25[4:0] | | | | |
| 0x3A | crossbar 26 | RSVD | FORCE_MUX_26 | INVERT_MUX_26 | CROSSBAR_26[4:0] | | | | |
| 0x3B | crossbar 27 | RSVD | FORCE_MUX_27 | INVERT_MUX_27 | CROSSBAR_27[4:0] | | | | |
| 0x3C | crossbar 28 | RSVD | FORCE_MUX_28 | INVERT_MUX_28 | CROSSBAR_28[4:0] | | | | |
| 0x3D | crossbar 29 | RSVD | FORCE_MUX_29 | INVERT_MUX_29 | CROSSBAR_29[4:0] | | | | |
| 0x3E | crossbar 30 | RSVD | FORCE_MUX_30 | INVERT_MUX_30 | CROSSBAR_30[4:0] | | | | |
| 0x3F | crossbar_hs | RSVD | FORCE_MUX_HS | INVERT_MUX_HS | CROSSBARHS[4:0] | | | | |
| 0x40 | crossbar_vs | RSVD | FORCE_MUX_VS | INVERT_MUX_VS | CROSSBARVS[4:0] | | | | |
| 0x41 | crossbar_de | RSVD | FORCE_MUX_DE | INVERT_MUX_DE | CROSSBARDE[4:0] | | | | |
| 0x42 | link_config | LINE_CRC_LOC[1:0] | | LINE_CRC_EN | MAX_RT_EN | RSVD | GPI_COMP_EN | GPI_RT_EN | GPO_EN |
| 0x43 | sync_gen_config | RSVD | RSVD | GEN_VS | GEN_HS | GEN_DE | VS_TRIG | VTG_MODE[1:0] | |
| 0x44 | vs_dly 2 | VS_DLY[7:0] | | | | | | | |
| 0x45 | vs_dly 1 | VS_DLY[7:0] | | | | | | | |
| 0x46 | vs_dly 0 | VS_DLY[7:0] | | | | | | | |
| 0x47 | vs_h 2 | VS_H[7:0] | | | | | | | |
| 0x48 | vs_h 1 | VS_H[7:0] | | | | | | | |
| 0x49 | vs_h 0 | VS_H[7:0] | | | | | | | |
| 0x4A | vs_l 2 | VS_L[7:0] | | | | | | | |
| 0x4B | vs_l 1 | VS_L[7:0] | | | | | | | |
| 0x4C | vs_l 0 | VS_L[7:0] | | | | | | | |
| 0x4D | cxtp | RSVD | CXTP | RSVD | RSVD | VSYNC_INV | HSYNC_INV | DE_INV | RSVD |
| 0x4E | hs_dly 2 | HS_DLY[7:0] | | | | | | | |

GMSL Register Map (continued)

| OFFSET | NAME | MSB | | | | | | | LSB |
|--------|---------------|---------------|------------|--------------|---------------------|-------------------|--------------------|-----------|------|
| 0x4F | hs_dly 1 | HS_DLY[7:0] | | | | | | | |
| 0x50 | hs_dly 0 | HS_DLY[7:0] | | | | | | | |
| 0x51 | rsvd_51 | RSVD[7:0] | | | | | | | |
| 0x52 | rsvd_52 | RSVD[7:0] | | | | | | | |
| 0x53 | rsvd_53 | RSVD[7:0] | | | | | | | |
| 0x54 | hs_h 1 | HS_H[7:0] | | | | | | | |
| 0x55 | hs_h 0 | HS_H[7:0] | | | | | | | |
| 0x56 | hs_l 1 | HS_L[7:0] | | | | | | | |
| 0x57 | hs_l 0 | HS_L[7:0] | | | | | | | |
| 0x58 | hs_cnt 1 | HS_CNT[7:0] | | | | | | | |
| 0x59 | hs_cnt 0 | HS_CNT[7:0] | | | | | | | |
| 0x5A | de_dly 2 | DE_DLY[7:0] | | | | | | | |
| 0x5B | de_dly 1 | DE_DLY[7:0] | | | | | | | |
| 0x5C | de_dly 0 | DE_DLY[7:0] | | | | | | | |
| 0x5D | rsvd_5D | RSVD[7:0] | | | | | | | |
| 0x5E | rsvd_5E | RSVD[7:0] | | | | | | | |
| 0x5F | rsvd_5F | RSVD[7:0] | | | | | | | |
| 0x60 | de_h 1 | DE_H[7:0] | | | | | | | |
| 0x61 | de_h 0 | DE_H[7:0] | | | | | | | |
| 0x62 | de_l 1 | DE_L[7:0] | | | | | | | |
| 0x63 | de_l 0 | DE_L[7:0] | | | | | | | |
| 0x64 | de_cnt 1 | DE_CNT_1[7:0] | | | | | | | |
| 0x65 | de_cnt 0 | DE_CNT_0[7:0] | | | | | | | |
| 0x66 | prbs_type | RSVD[1:0] | PRBS_TYPE | REV_FAST | DE_EN | DIS_WAKE | RSVD | CXSEL | |
| 0x67 | dbl_align_to | RSVD[1:0] | AUTO_CLINK | RSVD | RSVD | DBL_ALIGN_TO[2:0] | | | |
| 0x68 | cc_crc_length | RSVD | RSVD[2:0] | | RSVD[1:0] | | CC_CRC_LENGTH[1:0] | | |
| 0x69 | hi_lo | RSVD | EN_HI_LO | INVERT_HI_LO | CROSSBAR_HI_LO[4:0] | | | | |
| 0x96 | rsvd_96 | RSVD | RSVD | RSVD | RSVD | RSVD | RSVD | RSVD[1:0] | |
| 0x97 | rsvd_97 | RSVD | RSVD | RSVD | RSVD | RSVD | RSVD[2:0] | | |
| 0x98 | rsvd_98 | RSVD[1:0] | | RSVD[2:0] | | RSVD[2:0] | | | |
| 0x99 | rsvd_99 | RSVD | RSVD | RSVD | RSVD | RSVD | RSVD | RSVD[1:0] | |
| 0x9A | pktcc_en | RSVD[1:0] | | RSVD[1:0] | | PKTCC_EN | RSVD[1:0] | | RSVD |

GMSL Register Map (continued)

| OFFSET | NAME | MSB | | | | | | | LSB |
|--------|---------|-----------|------|------|------|-----------|------|------|------|
| 0xC8 | rsvd_c8 | RSVD | RSVD | RSVD | RSVD | RSVD | RSVD | RSVD | RSVD |
| 0xC9 | rsvd_c9 | RSVD[7:0] | | | | | | | |
| 0xFC | rsvd_fc | RSVD | RSVD | RSVD | RSVD | RSVD | RSVD | RSVD | RSVD |
| 0xFD | rsvd_fd | RSVD[7:0] | | | | | | | |
| 0xFE | rsvd_fe | RSVD[3:0] | | | | RSVD[3:0] | | | |
| 0xFF | rsvd_ff | RSVD | RSVD | RSVD | RSVD | RSVD[3:0] | | | |

seraddr (0x00)

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-------------|--------------|---|---|---|---|---|---|-------------|
| Field | SERADDR[6:0] | | | | | | | CFGBLOCK |
| Reset | 1000000b | | | | | | | 0b |
| Access Type | Write, Read | | | | | | | Write, Read |

| BITFIELD | BITS | DESCRIPTION | DECODE |
|-----------|------|---|---|
| SERADDR | 7:1 | Serializer Address: Serializer device address | 0000000: Write/read device address is 0x00/0x01 0000001: Write/read device address is 0x02/0x03 1111111: Write/read device address is 0xFE/0xFF |
| CFG-BLOCK | 0 | Configuration Block: Set to 1 to make all registers read-only. Power-on reset to clear this bit. | 0: Make all registers read/write 1: Make all registers read-only |

desaddr (0x01)

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-------------|--------------|---|---|---|---|---|---|-------------|
| Field | DESADDR[6:0] | | | | | | | RSVD |
| Reset | 1001000b | | | | | | | 0b |
| Access Type | Write, Read | | | | | | | Write, Read |

| BITFIELD | BITS | DESCRIPTION | DECODE |
|----------|------|--|---|
| DESADDR | 7:1 | Deserializer Address: Deserializer device address | 0000000: Write/read device address is 0x00/0x01 0000001: Write/read device address is 0x02/0x03 1111111: Write/read device address is 0xFE/0xFF |
| RSVD | 0 | Reserved: Do not change from default value | 0: Reserved |

ss (0x02)

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|--------------------|-------------|---|---|-------------|-------------|---|-------------|---|
| Field | SS[2:0] | | | RSVD | PRNG[1:0] | | SRNG[1:0] | |
| Reset | 000b | | | 1b | 11b | | 11b | |
| Access Type | Write, Read | | | Write, Read | Write, Read | | Write, Read | |

| BITFIELD | BITS | DESCRIPTION | DECODE |
|----------|------|--|--|
| SS | 7:5 | Spread Spectrum: Spread-spectrum setting | 000: Spread is off 001: 0.5% Spread setting 010: 1.5% Spread setting 011: 2% Spread setting 100: Spread is off 101: 1% Spread setting 110: 3% Spread setting 111: 4% Spread setting |
| RSVD | 4 | Reserved: Do not change from default value | 1: Reserved |
| PRNG | 3:2 | Pixel Clock Range: Pixel clock-range selection Stated ranges depend on DBL = setting | 00: Select 12.5MHz to 25MHz (DBL = 0) or 25MHz to 50MHz (DBL = 1) pixel clock range 01: Select 25MHz to 58MHz (DBL = 0) or 50MHz to 116MHz (DBL = 1) pixel clock range 10: Automatically detect pixel clock range 11: Automatically detect pixel clock range. |
| SRNG | 1:0 | Serial-Data Rate Range | 00: 0.5Gbps to 1Gbps serial-data range 01: 1Gbps to 1.74Gbps serial-data range 10: Automatically detect serial-data range 11: Automatically detect serial-data range |

sdiv (0x03)

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|--------------------|-------------|---|---|-------------|---|---|---|---|
| Field | AUTOFM[1:0] | | | SDIV[5:0] | | | | |
| Reset | 00b | | | 000000b | | | | |
| Access Type | Write, Read | | | Write, Read | | | | |

| BITFIELD | BITS | DESCRIPTION | DECODE |
|----------|------|---|--|
| AUTOFM | 7:6 | Automatic Frequency Modulation: Modulation-rate calibration interval | 00: Calibration occurs once 01: Calibration occurs every 2ms 10: Calibration occurs every 16ms 11: Calibration occurs every 256ms |
| SDIV | 5:0 | Sawtooth Divider: Sawtooth divider value 0x00 sets the sawtooth divider to autocalibrate mode | 000000: Sawtooth divider automatically calibrates the divider value 000001: Sawtooth divider set to 1 111111: Sawtooth divider set to 63 |

main_control (0x04)

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-------------|-------------|-------------|-------------|-------------|-------------|---|-------------|-------------|
| Field | SEREN | CLINKEN | PRBSEN | SLEEP | RSVD[3:2] | | REVCCEN | FWDCEN |
| Reset | 1b | 0b | 0b | 0b | 01b | | 1b | 1b |
| Access Type | Write, Read | Write, Read | Write, Read | Write, Read | Write, Read | | Write, Read | Write, Read |

| BITFIELD | BITS | DESCRIPTION | DECODE |
|----------|------|--|---|
| SEREN | 7 | Serialization Enable: Requires a valid PCLK for serialization | 0: Disable serialization 1: Enable serialization |
| CLINKEN | 6 | Configuration Link Enable: Configuration link enabled only when the video link is not enabled (SEREN = 1) | 0: Disable configuration link 1: Enable configuration link |
| PRBSEN | 5 | PRBS Test Enable: See the PRBS test section for more details | 0: Disable PRBS test 1: Enable PRBS test |
| SLEEP | 4 | Sleep Mode Enable: Activates sleep mode (see the Shutdown/Sleep Modes section for more information) | 0: Disable sleep mode 1: Enable sleep mode |
| RSVD | 3:2 | Reserved: Do not change from default value | 01: Reserved |
| REVCCEN | 1 | Reverse Control-Channel Enable: Enable reverse control-channel receiver (data from deserializer) | 0: Disable reverse control-channel receiver 1: Enable reverse control-channel receiver |
| FWDCEN | 0 | Forward Control Channel Enable: Enable forward control channel receiver (data to deserializer) | 0: Disable forward control channel transmitter 1: Enable forward control channel transmitter |

prbs_len (0x05)

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-------------|-------------|-------------|---------------|---|-------------|-------------|-------------|-------------|
| Field | RSVD | RSVD | PRBS_LEN[1:0] | | RSVD | RSVD | RSVD | RSVD |
| Reset | 0b | 0b | 00b | | 0b | 0b | 0b | 0b |
| Access Type | Write, Read | Write, Read | Write, Read | | Write, Read | Write, Read | Write, Read | Write, Read |

| BITFIELD | BITS | DESCRIPTION | DECODE |
|----------|------|---|---|
| RSVD | 7 | Reserved: Do not change from default value | 0: Reserved |
| RSVD | 6 | Reserved: Do not change from default value | 0: Reserved |
| PRBS_LEN | 5:4 | PRBS Length: PRBS test pattern length | 00: Continuous bit pattern (infinite length) 01: 9.8Mbit length 10: 167.1Mbit length 11: 1341.5Mbit length |
| RSVD | 3 | Reserved: Do not change from default value | 0: Reserved |
| RSVD | 2 | Reserved: Do not change from default value | 0: Reserved |
| RSVD | 1 | Reserved: Do not change from default value | 0: Reserved |
| RSVD | 0 | Reserved: Do not change from default value | 0: Reserved |

cmlvl_preemp (0x06)

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-------------|-------------|---|---|---|-------------|---|---|---|
| Field | CMLLVL[3:0] | | | | PREEMP[3:0] | | | |
| Reset | 10X0b | | | | 0000b | | | |
| Access Type | Write, Read | | | | Write, Read | | | |

| BITFIELD | BITS | DESCRIPTION | DECODE |
|----------|------|---|---|
| CMLLVL | 7:4 | CML Level: Output CML signal level = (register value) x 50mV Default level depends on cable type (COTP) | 0000: Do not use 0001: Do not use 0010: 100mV output 0011: 150mV output 0100: 200mV output 0101: 250mV output 0110: 300mV output 0111: 350mV output 1000: 400mV output (STP default) 1001: 450mV output 1010: 500mV output (coax default) 1011: Do not use 1100: Do not use 1101: Do not use 111X: Do not use |
| PREEMP | 3:0 | Preemphasis Level: Preemphasis setting | 0000: Preemphasis off 0001: 1.2dB deemphasis 0010: 2.5dB deemphasis 0011: 4.1dB deemphasis 0100: 6.0dB deemphasis 0101: Do not use 011X: Do not use 1000: 1.1dB preemphasis 1001: 2.2dB preemphasis 1010: 3.3dB preemphasis 1011: 4.4dB preemphasis 1100: 6.0dB preemphasis 1101: 8.0dB preemphasis 1110: 10.5dB preemphasis 1111: 14.0dB preemphasis |

config (0x07)

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Field | DBL | HIBW | BWS | ES | RSVD | HVEN | RSVD | PXL_CRC |
| Reset | 0b | 0b | 0b | 0b | 0b | 0b | 0b | 0b |
| Access Type | Write, Read | Write, Read | Write, Read | Write, Read | Write, Read | Write, Read | Write, Read | Write, Read |

| BITFIELD | BITS | DESCRIPTION | DECODE |
|----------|------|---|---|
| DBL | 7 | Double-Input Mode Enable: Set high to enable double-input mode | 0: Single-input mode 1: Double-input mode |
| HIBW | 6 | High-Bandwidth Mode Enable: High-bandwidth mode select (effective only when BWS = 0) | 0: Use 24-bit mode when BWS = 0 1: Use high-bandwidth mode when BWS = 0 |
| BWS | 5 | Bus-Width Select | 0: 24-bit and high-bandwidth mode 1: 32-bit mode |
| ES | 4 | Edge Select | 0: Parallel data clocked in on rising edge 1: Parallel data clocked in on falling edge |
| RSVD | 3 | Reserved: Do not change from default value | 0: Reserved |
| HVEN | 2 | HSYNC/VSNC Encoding Enable | 0: Disable HS/VS encoding 1: Enable HS/VS encoding |
| RSVD | 1 | Reserved: Do not change from default value | 0: Reserved |
| PXL_CRC | 0 | Pixel CRC Type: Pixel error-detection type | 0: Serial data uses 1-bit parity 1: Serial data uses 6-bit CRC |

rsvd_8 (0x08)

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Field | RSVD | RSVD | RSVD | RSVD | RSVD | RSVD | RSVD | RSVD |
| Reset | 0b | 0b | 0b | 0b | 0b | 0b | 0b | 0b |
| Access Type | Write, Read | Write, Read | Write, Read | Write, Read | Write, Read | Write, Read | Write, Read | Write, Read |

| BITFIELD | BITS | DESCRIPTION | DECODE |
|----------|------|---|-------------|
| RSVD | 7 | Reserved: Do not change from default value | 0: Reserved |
| RSVD | 6 | Reserved: Do not change from default value | 0: Reserved |
| RSVD | 5 | Reserved: Do not change from default value | 0: Reserved |
| RSVD | 4 | Reserved: Do not change from default value | 0: Reserved |
| RSVD | 3 | Reserved: Do not change from default value | 0: Reserved |
| RSVD | 2 | Reserved: Do not change from default value | 0: Reserved |
| RSVD | 1 | Reserved: Do not change from default value | 0: Reserved |
| RSVD | 0 | Reserved: Do not change from default value | 0: Reserved |

i2c_source (0x09, 0x0B)

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-------------|--------------|---|---|---|---|---|---|-------------|
| Field | I2C_SRC[6:0] | | | | | | | RSVD |
| Reset | 0000000b | | | | | | | 0b |
| Access Type | Write, Read | | | | | | | Write, Read |

| BITFIELD | BITS | DESCRIPTION | DECODE |
|----------|------|--|---|
| I2C_SRC | 7:1 | I²C Source: I ² C address translator source | 0000000: Write/read device address is 0x00/0x01 0000001: Write/read device address is 0x02/0x03 1111111: Write/read device address is 0xFE/0xFF |
| RSVD | 0 | Reserved: Do not change from default value | 0: Reserved |

i2c_dest (0x0A, 0x0C)

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-------------|--------------|---|---|---|---|---|---|-------------|
| Field | I2C_DST[6:0] | | | | | | | RSVD |
| Reset | 0000000b | | | | | | | 0b |
| Access Type | Write, Read | | | | | | | Write, Read |

| BITFIELD | BITS | DESCRIPTION | DECODE |
|----------|------|--|---|
| I2C_DST | 7:1 | I²C Destination: I ² C address translator destination | 0000000: Write/read device address is 0x00/0x01 0000001: Write/read device address is 0x02/0x03 1111111: Write/read device address is 0xFE/0xFF |
| RSVD | 0 | Reserved: Do not change from default value | 0: Reserved |

i2c_config (0x0D)

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|--------------------|-------------|-----------------|---|-----------------|---|---|-----------------|---|
| Field | I2C_LOC_ACK | I2C_SLV_SH[1:0] | | I2C_MST_BT[2:0] | | | I2C_SLV_TO[1:0] | |
| Reset | 1b | 01b | | 101b | | | 10b | |
| Access Type | Write, Read | Write, Read | | Write, Read | | | Write, Read | |

| BITFIELD | BITS | DESCRIPTION | DECODE |
|-------------|------|--|--|
| I2C_LOC_ACK | 7 | I2C Local Acknowledge: I2C-to-I2C slave generates local acknowledge when forward channel is not available | 0: Do not send local autoacknowledge when control channel is absent 1: Send local autoacknowledge when control channel is absent |
| I2C_SLV_SH | 6:5 | I2C Slave Setup/Hold Time: I2C-to-I2C slave setup and hold-time setting (setup, hold) (typ) | 00: (352ns, 117ns) setup/hold time 01: (469ns, 234ns) setup/hold time 10: (938ns, 352ns) setup/hold time 11: (1406ns, 469ns) setup/hold time |
| I2C_MST_BT | 4:2 | I2C Master Bit Rate: I2C-to-I2C master bit-rate setting (min, typ, max) | 000: (6.61, 8.47, 9.92) kbps 001: (22.1, 28.3, 33.2) kbps 010: (66.1, 84.7, 99.2) kbps 011: (82, 105, 123) kbps 100: (136, 173, 203) kbps 101: (265, 339, 397) kbps 110: (417, 533, 625) kbps 111: (654, 837, 980) kbps |
| I2C_SLV_TO | 1:0 | I2C Slave Timeout: I2C-to-I2C slave remote-side timeout setting (typ) | 00: 64µs slave timeout 01: 256µs slave timeout 10: 1024µs slave timeout 11: Slave timeout disabled |

gpio_en (0x0E)

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|--------------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Field | RSVD | RSVD | RSVD | RSVD | RSVD | GPIO_EN_2 | GPIO_EN_1 | RSVD |
| Reset | 0b | 0b | 0b | 0b | 0b | 0b | 0b | 0b |
| Access Type | Write, Read | Write, Read | Write, Read | Write, Read | Write, Read | Write, Read | Write, Read | Write, Read |

| BITFIELD | BITS | DESCRIPTION | DECODE |
|-----------|------|---|--|
| RSVD | 7 | Reserved: Do not change from default value | 0: Reserved |
| RSVD | 6 | Reserved: Do not change from default value | 0: Reserved |
| RSVD | 5 | Reserved: Do not change from default value | 0: Reserved |
| RSVD | 4 | Reserved: Do not change from default value | 0: Reserved |
| RSVD | 3 | Reserved: Do not change from default value | 0: Reserved |
| GPIO_EN_2 | 2 | GPIO Enable: Disabled by default | 0: Pin functions as a parallel input 1: Pin functions as a GPIO |
| GPIO_EN_1 | 1 | GPIO Enable: Disabled by default | 0: Pin functions as parallel input 1: Pin functions as GPIO |
| RSVD | 0 | Reserved: Do not change from default value | 0: Reserved |

gpio_out (0x0F)

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Field | EN_SET_GPO | RSVD | RSVD | RSVD | RSVD | GPIO_OUT_2 | GPIO_OUT_1 | SET_GPO |
| Reset | 0b | 0b | 1b | 1b | 1b | 1b | 1b | 0b |
| Access Type | Write, Read | Write, Read | Write, Read | Write, Read | Write, Read | Write, Read | Write, Read | Write, Read |

| BITFIELD | BITS | DESCRIPTION | DECODE |
|------------|------|--|---|
| EN_SET_GPO | 7 | Enable Set GPO: Set to 1 to enable setting of GPO from SET_GPO | 0: Disable setting of GPO through SET_GPO 1: Enable setting of GPO through SET_GPO |
| RSVD | 6 | Reserved: Do not change from default value | 0: Reserved |
| RSVD | 5 | Reserved: Do not change from default value | 1: Reserved |
| RSVD | 4 | Reserved: Do not change from default value | 1: Reserved |
| RSVD | 3 | Reserved: Do not change from default value | 1: Reserved |
| GPIO_OUT_2 | 2 | GPIO Output Level: Pull down GPIO when 0 | 0: Set GPIO output level low 1: Set GPIO output level high |
| GPIO_OUT_1 | 1 | GPIO Output Level: Pull down GPIO when 0 | 0: Set GPIO output level low 1: Set GPIO output level high |
| SET_GPO | 0 | Set GPO Level: Set GPO output high or low (when EN_SET_GPO = 1) | 0: Set GPO output low 1: Set GPO output high |

gpio_in (0x10)

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| Field | RSVD | RSVD | RSVD | RSVD | RSVD | GPIO_IN_2 | GPIO_IN_1 | GPO_L |
| Reset | 0b | 0b | 0b | 0b | 0b | Xb | Xb | 0b |
| Access Type | Read Only | Read Only | Read Only | Read Only | Read Only | Read Only | Read Only | Read Only |

| BITFIELD | BITS | DESCRIPTION | DECODE |
|-----------|------|--|---|
| RSVD | 7 | Reserved | 0: Reserved |
| RSVD | 6 | Reserved | 0: Reserved |
| RSVD | 5 | Reserved | X: Reserved |
| RSVD | 4 | Reserved | X: Reserved |
| RSVD | 3 | Reserved | X: Reserved |
| GPIO_IN_2 | 2 | GPIO Input Level: Input pin level of GPIO | 0: GPIO input is low 1: GPIO input is high |
| GPIO_IN_1 | 1 | GPIO Input Level: Input pin level of GPIO | 0: GPIO input is low 1: GPIO input is high |
| GPO_L | 0 | GPO Output Level | X: Reserved |

errg (0x11)

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-------------|----------------|---|----------------|---|---------------|---|-------------|-------------|
| Field | ERRG_RATE[1:0] | | ERRG_TYPE[1:0] | | ERRG_CNT[1:0] | | ERRG_PER | ERRG_EN |
| Reset | 0b | | 0b | | 0b | | 0b | 0b |
| Access Type | Write, Read | | Write, Read | | Write, Read | | Write, Read | Write, Read |

| BITFIELD | BITS | DESCRIPTION | DECODE |
|-----------|------|---|---|
| ERRG_RATE | 7:6 | Error-Generation Rate: Error-generation rate, on average | 00: Generate errors every 2560 bits 01: Generate errors every 40,960 bits 10: Generate errors every 655,360 bits 11: Generate errors every 10,485,760 bits |
| ERRG_TYPE | 5:4 | Error-Generation Type: Type of generated errors | 00: Single-bit errors 01: 2 8b/10b symbols 10: 3 8b/10b symbols 11: 4 8b/10b symbols |
| ERRG_CNT | 3:2 | Error-Generation Count: Number of generated errors | 00: Generate errors continuously 01: Generate 16 errors 10: Generate 128 errors 11: Generate 1024 errors |
| ERRG_PER | 1 | Periodic Error Generation Enable | 0: Generator creates errors randomly (based on error rate) 1: Generator creates errors periodically (based on error rate) |
| ERRG_EN | 0 | Error Generator Enable | 0: Disable error generator 1: Enable error generator |

rsvd_12 (0x12)

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-------------|-------------|-------------|-------------|-------------|---|---|---|---|
| Field | RSVD | RSVD | RSVD | RSVD[4:0] | | | | |
| Reset | 0b | 1b | 0b | 00000b | | | | |
| Access Type | Write, Read | Write, Read | Write, Read | Write, Read | | | | |

| BITFIELD | BITS | DESCRIPTION | DECODE |
|----------|------|---|-----------------|
| RSVD | 7 | Reserved: Do not change from default value | 0: Reserved |
| RSVD | 6 | Reserved: Do not change from default value | 1: Reserved |
| RSVD | 5 | Reserved: Do not change from default value | 0: Reserved |
| RSVD | 4:0 | Reserved: Do not change from default value | 00000: Reserved |

pd (0x13)

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-------------|----------------------|-------------|-------------|-------------|-------------|-------------|-------------|---|
| Field | SOFT_PD | RSVD | RSVD | RSVD | RSVD | RSVD | RSVD[1:0] | |
| Reset | 0b | 0b | 0b | 0b | 0b | 0b | 10b | |
| Access Type | Write 1 to Set, Read | Write, Read | Write, Read | Write, Read | Write, Read | Write, Read | Write, Read | |

| BITFIELD | BITS | DESCRIPTION | DECODE |
|----------|------|--|--|
| SOFT_PD | 7 | Soft Power Down: Set this bit to 1 to reset the device; this bit is cleared after the device resets | 0: Normal operation 1: Reset the device (bit clears itself) |
| RSVD | 6 | Reserved: Do not change from default value | 0: Reserved |
| RSVD | 5 | Reserved: Do not change from default value | 0: Reserved |
| RSVD | 4 | Reserved: Do not change from default value | 0: Reserved |
| RSVD | 3 | Reserved: Do not change from default value | 0: Reserved |
| RSVD | 2 | Reserved: Do not change from default value | 0: Reserved |
| RSVD | 1:0 | Reserved: Do not change from default value | 10: Reserved |

pktcc_lock (0x14)

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-------------|-----------|---|-----------|-----------|-----------------|-----------|-----------|------------|
| Field | RSVD[1:0] | | RSVD | RSVD | RSVD | RSVD | CC_WBLOCK | REM_CCLOCK |
| Reset | XXb | | Xb | Xb | Xb | Xb | Xb | Xb |
| Access Type | Read Only | | Read Only | Read Only | Read Clears All | Read Only | Read Only | Read Only |

| BITFIELD | BITS | DESCRIPTION | DECODE |
|------------|------|---|--|
| RSVD | 7:6 | Reserved | XX: Reserved |
| RSVD | 5 | Reserved | X: Reserved |
| RSVD | 4 | Reserved | X: Reserved |
| RSVD | 3 | Reserved | X: Reserved |
| RSVD | 2 | Reserved | X: Reserved |
| CC_WBLOCK | 1 | Control-Channel Word Boundary Locked | 0: Control-channel word boundary is not locked 1: Control-channel word boundary is locked |
| REM_CCLOCK | 0 | Remote-Side Control Channel Locked | 0: Remote side control channel is not locked 1: Remote side control channel is locked |

input_status (0x15)

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-------------|-----------|-----------|-------------|-----------|-----------|-----------|-----------|-----------|
| Field | RSVD | RSVD | RSVD | RSVD | RSVD | RSVD | OUTPUTEN | PCLKDET |
| Reset | Xb | Xb | Xb | 0b | 0b | 0b | Xb | Xb |
| Access Type | Read Only | Read Only | Write, Read | Read Only | Read Only | Read Only | Read Only | Read Only |

| BITFIELD | BITS | DESCRIPTION | DECODE |
|----------|------|---|---|
| RSVD | 7 | Reserved | X: Reserved |
| RSVD | 6 | Reserved | X: Reserved |
| RSVD | 5 | Reserved | X: Reserved |
| RSVD | 4 | Reserved | 0: Reserved |
| RSVD | 3 | Reserved | 0: Reserved |
| RSVD | 2 | Reserved | 0: Reserved |
| OUTPUTEN | 1 | Output Enabled | 0: Output disabled 1: Output enabled |
| PCLKDET | 0 | PCLK Detected: Valid PCLK detected | 0: No valid PCLK detected 1: Valid PCLK detected |

max_rt_err (0x16)

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-------------|-----------|-----------------|-----------|---|---|---|---|---|
| Field | RSVD | MAX_RT_ERR | RSVD[5:0] | | | | | |
| Reset | 0b | Xb | XXXXXXb | | | | | |
| Access Type | Read Only | Read Clears All | Read Only | | | | | |

| BITFIELD | BITS | DESCRIPTION | DECODE |
|------------|------|---|--|
| RSVD | 7 | Reserved | 0: Reserved |
| MAX_RT_ERR | 6 | Maximum Retransmission Error: maximum retransmission error bit Goes high if packet control channel hits maximum retransmission limit. Cleared when read | 0: Device has not reached maximum retransmission limit. 1: Device has reached maximum retransmission limit. |
| RSVD | 5:0 | Reserved | XXXXXX: Reserved |

rsvd_17 (0x17)

| | | | | | | | | |
|--------------------|-----------|----------|----------|----------|----------|----------|----------|----------|
| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Field | RSVD[7:0] | | | | | | | |
| Reset | XXXXXXXXb | | | | | | | |
| Access Type | Read Only | | | | | | | |

| BITFIELD | BITS | DESCRIPTION | DECODE |
|-----------------|-------------|--------------------|--------------------|
| RSVD | 7:0 | Reserved | XXXXXXXX: Reserved |

crc (0x18 to 0x1B)

| | | | | | | | | |
|--------------------|----------------|----------|----------|----------|----------|----------|----------|----------|
| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Field | CRC_VALUE[7:0] | | | | | | | |
| Reset | XXXXXXXXb | | | | | | | |
| Access Type | Read Only | | | | | | | |

| BITFIELD | BITS | DESCRIPTION | DECODE |
|-----------------|-------------|--|--|
| CRC_VALUE | 7:0 | CRC Value: CRC output for latest line CRC_VALUE_3 to CRC_VALUE_0 represents CRC[31:0] | 00000000: Value is 0 00000001: Value is 1 11111111: Value is 255 |

cc_crc_errcnt (0x1C)

| | | | | | | | | |
|--------------------|--------------------|----------|----------|----------|----------|----------|----------|----------|
| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Field | CC_CRC_ERRCNT[7:0] | | | | | | | |
| Reset | XXXXXXXXb | | | | | | | |
| Access Type | Read Only | | | | | | | |

| BITFIELD | BITS | DESCRIPTION | DECODE |
|-----------------|-------------|--|--|
| CC_CRC_ERRCNT | 7:0 | Control-Channel CRC Error Count: Packet-based control-channel CRC error counter | 00000000: Value is 0 00000001: Value is 1 11111111: Value is 255 |

rsvd_1d (0x1D)

| | | | | | | | | |
|--------------------|-----------|----------|----------|----------|----------|----------|----------|----------|
| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Field | RSVD[7:0] | | | | | | | |
| Reset | XXXXXXXXb | | | | | | | |
| Access Type | Read Only | | | | | | | |

| BITFIELD | BITS | DESCRIPTION | DECODE |
|-----------------|-------------|--------------------|--------------------|
| RSVD | 7:0 | Reserved | XXXXXXXX: Reserved |

id (0x1E)

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-------------|-----------|---|---|---|---|---|---|---|
| Field | ID[7:0] | | | | | | | |
| Reset | XXXXXXXXb | | | | | | | |
| Access Type | Read Only | | | | | | | |

| BITFIELD | BITS | DESCRIPTION | DECODE |
|----------|------|---|-------------------------------|
| ID | 7:0 | Device ID: 8-bit value depends on the GMSL device attached | 01000101 Device is a MAX96707 |

revision (0x1F)

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-------------|-----------|-----------|-----------|-----------|---------------|---|---|---|
| Field | RSVD | RSVD | RSVD | HDCPCAP | REVISION[3:0] | | | |
| Reset | 0b | 0b | 0b | Xb | XXXXb | | | |
| Access Type | Read Only | Read Only | Read Only | Read Only | Read Only | | | |

| BITFIELD | BITS | DESCRIPTION | DECODE |
|----------|------|--|---|
| RSVD | 7 | Reserved | 0: Reserved |
| RSVD | 6 | Reserved | 0: Reserved |
| RSVD | 5 | Reserved | 0: Reserved |
| HDCPCAP | 4 | HDCP Capability: 1 = HDCP capable | 0: Device does not have HDCP 1: Device is HDCP capable |
| REVISION | 3:0 | Device Revision | 0000: Value is 0 0001: Value is 1 1111: Value is 15 |

crossbar (0x20 to 0x3E)

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-------------|-------------|-------------|-------------|---------------|---|---|---|---|
| Field | RSVD | FORCE_MUX | INVERT_MUX | CROSSBAR[4:0] | | | | |
| Reset | 0b | 0b | 0b | XXXXXb | | | | |
| Access Type | Write, Read | Write, Read | Write, Read | Write, Read | | | | |

| BITFIELD | BITS | DESCRIPTION | DECODE |
|------------|------|--|---|
| RSVD | 7 | Reserved: Do not change from default value | 0: Reserved |
| FORCE_MUX | 6 | Force Mux Output | 0: Input mapped to mux output 1: Force mux output low |
| INVERT_MUX | 5 | Invert Mux Output | 0: Do not invert mux output 1: Invert mux output |
| CROSS-BAR | 4:0 | Crossbar Setting Select 1 of 32 input signals. Default values connect Mux N with input N for flow-through routing (i.e., DIN_ mapped to DOUT_) | 00000: Mux outputs data from input 0 00001: Mux outputs data from input 1 11111: Mux outputs data from input 31 |

crossbar_hs (0x3F)

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|--------------------|-------------|--------------|---------------|-----------------|---|---|---|---|
| Field | RSVD | FORCE_MUX_HS | INVERT_MUX_HS | CROSSBARHS[4:0] | | | | |
| Reset | 0b | 0b | 0b | 01100b | | | | |
| Access Type | Write, Read | Write, Read | Write, Read | Write, Read | | | | |

| BITFIELD | BITS | DESCRIPTION | DECODE |
|---------------|------|---|---|
| RSVD | 7 | Reserved: Do not change from default value | 0: Reserved |
| FORCE_MUX_HS | 6 | Force Mux Output | 0: Input mapped to mux output 1: Force mux output low |
| INVERT_MUX_HS | 5 | Invert Mux Output | 0: Do not invert mux output 1: Invert mux output |
| CROSS-BARHS | 4:0 | Crossbar Setting HS: Select 1 of 16 input pins for HS. Default values connect HS with the corresponding named input pin. Use unconnected inputs (DIN14, DIN15) when generating sync signals with the timing generator. | 00000: Mux sync signal from DIN0 00001: Mux sync signal from DIN1 01111: Mux sync signal from DIN15 1XXXX: Do Not Use |

crossbar (0x40)

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|--------------------|-------------|--------------|---------------|-----------------|---|---|---|---|
| Field | RSVD | FORCE_MUX_VS | INVERT_MUX_VS | CROSSBARVS[4:0] | | | | |
| Reset | 0b | 0b | 0b | 01101b | | | | |
| Access Type | Write, Read | Write, Read | Write, Read | Write, Read | | | | |

| BITFIELD | BITS | DESCRIPTION | DECODE |
|---------------|------|---|---|
| RSVD | 7 | Reserved: Do not change from default value | 0: Reserved |
| FORCE_MUX_VS | 6 | Force Mux Output | 0: Input mapped to mux output 1: Force mux output low |
| INVERT_MUX_VS | 5 | Invert Mux Output | 0: Do not invert mux output 1: Invert mux output |
| CROSS-BARVS | 4:0 | Crossbar Setting VS: Select 1 of 16 input pins for VS. Default values connect VS with the corresponding named input pin. Use unconnected inputs (DIN14, DIN15) when generating sync signals with the timing generator. | 00000: Mux sync signal from DIN0 00001: Mux sync signal from DIN1 01111: Mux sync signal from DIN15 1XXXX: Do Not Use |

crossbar_de (0x41)

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-------------|-------------|--------------|---------------|-----------------|---|---|---|---|
| Field | RSVD | FORCE_MUX_DE | INVERT_MUX_DE | CROSSBARDE[4:0] | | | | |
| Reset | 0b | 0b | 0b | 01011b | | | | |
| Access Type | Write, Read | Write, Read | Write, Read | Write, Read | | | | |

| BITFIELD | BITS | DESCRIPTION | DECODE |
|---------------|------|---|---|
| RSVD | 7 | Reserved: Do not change from default value | 0: Reserved |
| FORCE_MUX_DE | 6 | Force Mux Output | 0: Input mapped to mux output. 1: Force mux output low. |
| INVERT_MUX_DE | 5 | Invert Mux Output | 0: Do not invert mux output. 1: Invert mux output. |
| CROSSBARDE | 4:0 | Crossbar Setting DE: Select 1 of 16 input pins for DE. Default values connect DE with DIN11. Unconnected inputs (DIN14, DIN15) when generating sync signals with the timing generator. | 00000: Mux sync signal from DIN0 00001: Mux sync signal from DIN1 01111: Mux sync signal from DIN15 1XXXX: Do Not Use |

link_config (0x42)

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-------------|-------------------|---|-------------|-------------|-------------|-------------|-------------|-------------|
| Field | LINE_CRC_LOC[1:0] | | LINE_CRC_EN | MAX_RT_EN | RSVD | GPI_COMP_EN | GPI_RT_EN | GPO_EN |
| Reset | 01b | | 0b | 1b | 1b | 0b | 1b | 1b |
| Access Type | Write, Read | | Write, Read | Write, Read | Write, Read | Write, Read | Write, Read | Write, Read |

| BITFIELD | BITS | DESCRIPTION | DECODE |
|--------------|------|---|---|
| LINE_CRC_LOC | 7:6 | Line CRC Location: Video line CRC insertion location | 00: CRC insertion at [1..4] 01: CRC insertion at [5..8] 10: CRC insertion at [9..12] 11: CRC insertion at [13..16] |
| LINE_CRC_EN | 5 | Line CRC Enable: Video line CRC enable | 0: Disable CRC 1: Enable CRC |
| MAX_RT_EN | 4 | Maximum Retransmission Limit Enable | 0: Disable maximum retransmission limit 1: Enable maximum retransmission limit |
| RSVD | 3 | Reserved: Do not change from default value | 1: Reserved |
| GPI_COMP_EN | 2 | GPI Compensation Enable | 0: Disable GPI compensation 1: Enable GPI compensation |
| GPI_RT_EN | 1 | GPI Retransmission Enable | 0: Disable GPI retransmission 1: Enable GPI retransmission |
| GPO_EN | 0 | GPO Enable: Enable GPO pin | 0: Disable GPO pin 1: Enable GPO pin |

sync_gen_config (0x43)

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-------------|-------------|-------------|-------------|-------------|-------------|-------------|---------------|---|
| Field | RSVD | RSVD | GEN_VS | GEN_HS | GEN_DE | VS_TRIG | VTG_MODE[1:0] | |
| Reset | 0b | 0b | 0b | 0b | 0b | 1b | 01b | |
| Access Type | Write, Read | Write, Read | Write, Read | Write, Read | Write, Read | Write, Read | Write, Read | |

| BITFIELD | BITS | DESCRIPTION | DECODE |
|----------|------|--|--|
| RSVD | 7 | Reserved: Do not change from default value | 0: Reserved |
| RSVD | 6 | Reserved: Do not change from default value | 0: Reserved |
| GEN_VS | 5 | VSYNC Generation: Enable to generate VS output according to the timing definition | 0: Disable VS output generation (VS used from input) 1: Enable VS output generation (VS internally generated) |
| GEN_HS | 4 | HSYNC Generation: Enable to generate HS output according to the timing definition | 0: Disable HS output generation (HS used from input) 1: Enable HS output generation (HS internally generated) |
| GEN_DE | 3 | DE Generation: Enable to generate DE output according to the timing definition | 0: Disable DE output generation (DE used from input) 1: Enable DE output generation (DE internally generated) |
| VS_TRIG | 2 | VSYNC Trigger Edge Select | 0: VS trigger uses falling edge 1: VS trigger uses rising edge |
| VTG_MODE | 1:0 | Video Timing Generator Mode | 00: VS input is tracked and then locked after three consecutive matches (three consecutive mismatches unlock tracking) 01: VS edge triggers one VS frame (current frame is extended/cut short to adjust timing to next trigger) 10: VS edge triggers VS generation (current frame is extended/cut short to adjust timing to next trigger) 11: Same as above |

vs_dly (0x44 to 0x46)

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-------------|-------------|---|---|---|---|---|---|---|
| Field | VS_DLY[7:0] | | | | | | | |
| Reset | 0000000b | | | | | | | |
| Access Type | Write, Read | | | | | | | |

| BITFIELD | BITS | DESCRIPTION | DECODE |
|----------|------|--|--|
| VS_DLY | 7:0 | VSYNC Delay: VS delay in terms of PCLK cycles; the output VS delay by VS_DELAY cycles from the input VS | 00000000: Value is 0 00000001: Value is 1 11111111: Value is 255 |

vs_h (0x47 to 0x49)

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-------------|-------------|---|---|---|---|---|---|---|
| Field | VS_H[7:0] | | | | | | | |
| Reset | 00000000b | | | | | | | |
| Access Type | Write, Read | | | | | | | |

| BITFIELD | BITS | DESCRIPTION | DECODE |
|----------|------|---|--|
| VS_H | 7:0 | VSYNC High: VS high period in terms of PCLK cycles | 00000000: Value is 0 00000001: Value is 1 11111111: Value is 255 |

vs_l (0x4A to 0x4C)

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-------------|-------------|---|---|---|---|---|---|---|
| Field | VS_L[7:0] | | | | | | | |
| Reset | 00000000b | | | | | | | |
| Access Type | Write, Read | | | | | | | |

| BITFIELD | BITS | DESCRIPTION | DECODE |
|----------|------|---|--|
| VS_L | 7:0 | VSYNC Low: VS low period in terms of PCLK cycles | 00000000: Value is 0 00000001: Value is 1 11111111: Value is 255 |

cxtp (0x4D)

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Field | RSVD | CXTP | RSVD | RSVD | VSYNC_INV | HSYNC_INV | DE_INV | RSVD |
| Reset | Xb | 0b | 0b | 0b | 0b | 0b | 0b | 0b |
| Access Type | Write, Read | Write, Read | Write, Read | Write, Read | Write, Read | Write, Read | Write, Read | Write, Read |

| BITFIELD | BITS | DESCRIPTION | DECODE |
|-----------|------|---|--|
| RSVD | 7 | Reserved: Do not change from default value | X: Reserved |
| CXTP | 6 | Coax/Twisted Pair Select: Default to STP mode | 0: Use differential output (STP mode) 1: Use dual single ended outputs (coax) |
| RSVD | 5 | Reserved: Do not change from default value | 0: Reserved |
| RSVD | 4 | Reserved: Do not change from default value | 0: Reserved |
| VSYNC_INV | 3 | VSYNC Inversion: Invert output VSYNC in TIMING GEN | 0: Do not invert VS in timing generator 1: Invert VS in timing generator |
| HSYNC_INV | 2 | HSYNC Inversion: Invert output HSYNC in TIMING GEN | 0: Do not invert HS in timing generator 1: Invert HS in timing generator |
| DE_INV | 1 | DE Inversion: Invert output DE in TIMING GEN | 0: Do not invert DE in timing generator 1: Invert DE in timing generator |
| RSVD | 0 | Reserved: Do not change from default value | 0: Reserved |

hs_dly (0x4E to 0x50)

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-------------|-------------|---|---|---|---|---|---|---|
| Field | HS_DLY[7:0] | | | | | | | |
| Reset | 0000000b | | | | | | | |
| Access Type | Write, Read | | | | | | | |

| BITFIELD | BITS | DESCRIPTION | DECODE |
|----------|------|---|--|
| HS_DLY | 7:0 | VSYNC to HSYNC Delay: VS edge to the rising edge of the first HS in terms of PCLK cycles (bits [15:8]) | 00000000: Value is 0 00000001: Value is 1 11111111: Value is 255 |

rsvd (0x51 to 0x53, 0x5D to 0x5F)

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-------------|-------------|---|---|---|---|---|---|---|
| Field | RSVD[7:0] | | | | | | | |
| Reset | 0000000b | | | | | | | |
| Access Type | Write, Read | | | | | | | |

| BITFIELD | BITS | DESCRIPTION | DECODE |
|----------|------|---|--------------------|
| RSVD | 7:0 | Reserved: Do not change from default value | 00000000: Reserved |

hs_h (0x54, 0x55)

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-------------|-------------|---|---|---|---|---|---|---|
| Field | HS_H[7:0] | | | | | | | |
| Reset | 0000000b | | | | | | | |
| Access Type | Write, Read | | | | | | | |

| BITFIELD | BITS | DESCRIPTION | DECODE |
|----------|------|--|--|
| HS_H | 7:0 | HSYNC High Period: HS high period in terms of PCLK cycles | 00000000: Value is 0 00000001: Value is 1 11111111: Value is 255 |

hs_l (0x56, 0x57)

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-------------|-------------|---|---|---|---|---|---|---|
| Field | HS_L[7:0] | | | | | | | |
| Reset | 0000000b | | | | | | | |
| Access Type | Write, Read | | | | | | | |

| BITFIELD | BITS | DESCRIPTION | DECODE |
|----------|------|--|--|
| HS_L | 7:0 | HSYNC Low Period: HS low period in terms of PCLK cycles | 00000000: Value is 0 00000001: Value is 1 11111111: Value is 255 |

hs_cnt (0x58, 0x59)

| | | | | | | | | |
|--------------------|-------------|----------|----------|----------|----------|----------|----------|----------|
| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Field | HS_CNT[7:0] | | | | | | | |
| Reset | 00000000b | | | | | | | |
| Access Type | Write, Read | | | | | | | |

| BITFIELD | BITS | DESCRIPTION | DECODE |
|----------|------|---|--|
| HS_CNT | 7:0 | HSYNC Count: Lines per panel (bits [7:0]). | 00000000: Value is 0 00000001: Value is 1 11111111: Value is 255 |

de_dly (0x5A to 0x5C)

| | | | | | | | | |
|--------------------|-------------|----------|----------|----------|----------|----------|----------|----------|
| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Field | DE_DLY[7:0] | | | | | | | |
| Reset | 00000000b | | | | | | | |
| Access Type | Write, Read | | | | | | | |

| BITFIELD | BITS | DESCRIPTION | DECODE |
|----------|------|--|--|
| DE_DLY | 7:0 | VSYNC to DE: VS falling edge to the rising edge of the first DE in terms of PCLK cycles | 00000000: Value is 0 00000001: Value is 1 11111111: Value is 255 |

de_h (0x60, 0x61)

| | | | | | | | | |
|--------------------|-------------|----------|----------|----------|----------|----------|----------|----------|
| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Field | DE_H[7:0] | | | | | | | |
| Reset | 00000000b | | | | | | | |
| Access Type | Write, Read | | | | | | | |

| BITFIELD | BITS | DESCRIPTION | DECODE |
|----------|------|---|--|
| DE_H | 7:0 | DE High Period: DE high period in terms of PCLK cycles | 00000000: Value is 0 00000001: Value is 1 11111111: Value is 255 |

de_l (0x62, 0x63)

| | | | | | | | | |
|--------------------|-------------|----------|----------|----------|----------|----------|----------|----------|
| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Field | DE_L[7:0] | | | | | | | |
| Reset | 00000000b | | | | | | | |
| Access Type | Write, Read | | | | | | | |

| BITFIELD | BITS | DESCRIPTION | DECODE |
|----------|------|---|--|
| DE_L | 7:0 | DE Low Period: DE low period in terms of PCLK cycles | 00000000: Value is 0 00000001: Value is 1 11111111: Value is 255 |

de_cnt (0x64, 0x65)

| | | | | | | | | |
|--------------------|-------------|----------|----------|----------|----------|----------|----------|----------|
| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Field | DE_CNT[7:0] | | | | | | | |
| Reset | 00000000b | | | | | | | |
| Access Type | Write, Read | | | | | | | |

| BITFIELD | BITS | DESCRIPTION | DECODE |
|-----------------|-------------|---|--|
| DE_CNT | 7:0 | DE Count: Active lines per panel | 00000000: Value is 0 00000001: Value is 1 11111111: Value is 255 |

prbs_type (0x66)

| | | | | | | | | |
|--------------------|-------------|----------|-------------|-------------|-------------|-------------|-------------|-------------|
| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Field | RSVD[1:0] | | PRBS_TYPE | REV_FAST | DE_EN | DIS_RWAKE | RSVD | CXSEL |
| Reset | 01b | | 1b | 0b | 0b | 0b | 0b | 1b |
| Access Type | Write, Read | | Write, Read | Write, Read | Write, Read | Write, Read | Write, Read | Write, Read |

| BITFIELD | BITS | DESCRIPTION | DECODE |
|-----------------|-------------|--|---|
| RSVD | 7:6 | Reserved: Do not change from default value | 01: Reserved |
| PRBS_TYPE | 5 | PRBS Type: PRBS type select | 0: Select legacy PRBS mode 1: Select MAX9271–MAX9273 PRBS mode |
| REV_FAST | 4 | Reverse Channel Fast-Mode Enable | 0: Disable reverse channel fast mode 1: Enable reverse channel fast mode |
| DE_EN | 3 | DE Enable: Enable processing separate HS and DE signals | 0: Disable separate processing of HS and DE signals 1: Enable separate processing of HS and DE signals |
| DIS_RWAKE | 2 | Disable Remote Wake-Up: Disable wake-up receiver | 0: Do not disable remote wake-up receiver 1: Disable remote wake-up receiver |
| RSVD | 1 | Reserved: Do not change from default value | 0: Reserved |
| CXSEL | 0 | Coax Select | 0: Coax cable connected to inverting output 1: Coax cable connected to noninverting output |

dbl_align_to (0x67)

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-------------|-------------|---|-------------|-------------|-------------|-------------------|---|---|
| Field | RSVD[1:0] | | AUTO_CLINK | RSVD | RSVD | DBL_ALIGN_TO[2:0] | | |
| Reset | 11b | | 0b | 0b | 0b | 111b | | |
| Access Type | Write, Read | | Write, Read | Write, Read | Write, Read | Write, Read | | |

| BITFIELD | BITS | DESCRIPTION | DECODE |
|--------------|------|---|--|
| RSVD | 7:6 | Reserved: Do not change from default value | 11: Reserved |
| AUTO_CLINK | 5 | Auto Configuration Link: Automatic control of configuration link | 0: Enable configuration link only when CLINKEN = 1 and SEREN = 0 1: Automatically enable configuration link when SEREN = 1 and PCLKDET = 0 |
| RSVD | 4 | Reserved: Do not change from default value | 0: Reserved |
| RSVD | 3 | Reserved: Do not change from default value | 0: Reserved |
| DBL_ALIGN_TO | 2:0 | Double Alignment Mode: Sets the alignment mode when DBL = 1 in the serializer and DBL = 0 in the deserializer. Set DBL_ALIGN_TO = 000 when an external high-low signal is used (EN_HI_LO = 1). | 000: Align at each rising edge of HS. Turn off alignment after HS is low (MAX9286). Use this setting when an external high/low signal is used. 001: Do not use 010: Force align 011: Do not use 100: Align at each rising edge of HS 101: Align at each rising edge of DE 110: Force align 111: No alignment done while in DBL mode |

cc_crc_length (0x68)

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-------------|-------------|-------------|---|---|-------------|---|--------------------|---|
| Field | RSVD | RSVD[2:0] | | | RSVD[1:0] | | CC_CRC_LENGTH[1:0] | |
| Reset | 0b | 001b | | | 10b | | 01b | |
| Access Type | Write, Read | Write, Read | | | Write, Read | | Write, Read | |

| BITFIELD | BITS | DESCRIPTION | DECODE |
|---------------|------|---|--|
| RSVD | 7 | Reserved: Do not change from default value | 0: Reserved |
| RSVD | 6:4 | Reserved: Do not change from default value | 001: Reserved |
| RSVD | 3:2 | Reserved: Do not change from default value | 10: Reserved |
| CC_CRC_LENGTH | 1:0 | Control-Channel CRC Length | 00: 1-bit CC CRC length 01: 5-bit CC CRC length 10: 8-bit CC CRC length 11: Do not use |

hi_lo (0x69)

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-------------|-------------|-------------|--------------|---------------------|---|---|---|---|
| Field | RSVD | EN_HI_LO | INVERT_HI_LO | CROSSBAR_HI_LO[4:0] | | | | |
| Reset | 0b | 0b | 0b | 01101 | | | | |
| Access Type | Write, Read | Write, Read | Write, Read | Write, Read | | | | |

| BITFIELD | BITS | DESCRIPTION | DECODE |
|----------------|------|---|--|
| RSVD | 7 | Reserved: Do not change from default value | 0: Reserved |
| EN_HI_LO | 6 | Enable High/Low Signal Alignment | 0: Do not align using a Hi-Lo signal 1: Use a Hi-Lo signal to align input data |
| INVERT_HI_LO | 5 | Invert High/Low Signal Alignment | 0: Do not invert Hi-Lo signal 1: Invert Hi-Lo signal |
| CROSSBAR_HI_LO | 4:0 | Crossbar High Low: Select 1 of 16 input pins for the Hi-Lo signal. (effective when DBL_ALIGN_TO = 000) | 00000: Mux Hi-Lo signal from DIN0 00001: Mux Hi-Lo signal from DIN1 01111: Mux Hi-Lo signal from DIN15 1XXXX: Do Not Use |

rsvd_96 (0x96)

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|---|
| Field | RSVD | RSVD | RSVD | RSVD | RSVD | RSVD | RSVD[1:0] | |
| Reset | 0b | 0b | 0b | 0b | 0b | 1b | 10b | |
| Access Type | Write, Read | Write, Read | Write, Read | Write, Read | Write, Read | Write, Read | Write, Read | |

| BITFIELD | BITS | DESCRIPTION | DECODE |
|----------|------|---|--------------|
| RSVD | 7 | Reserved: Do not change from default value | 0: Reserved |
| RSVD | 6 | Reserved: Do not change from default value | 0: Reserved |
| RSVD | 5 | Reserved: Do not change from default value | 0: Reserved |
| RSVD | 4 | Reserved: Do not change from default value | 0: Reserved |
| RSVD | 3 | Reserved: Do not change from default value | 0: Reserved |
| RSVD | 2 | Reserved: Do not change from default value | 1b: Reserved |
| RSVD | 1:0 | Reserved: Do not change from default value | 10: Reserved |

rsvd_97 (0x97)

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-------------|-------------|-------------|-------------|-------------|-------------|-------------|---|---|
| Field | RSVD | RSVD | RSVD | RSVD | RSVD | RSVD[2:0] | | |
| Reset | 0b | 0b | 0b | 1b | 1b | 111b | | |
| Access Type | Write, Read | Write, Read | Write, Read | Write, Read | Write, Read | Write, Read | | |

| BITFIELD | BITS | DESCRIPTION | DECODE |
|----------|------|---|---------------|
| RSVD | 7 | Reserved: Do not change from default value | 0: Reserved |
| RSVD | 6 | Reserved: Do not change from default value | 0: Reserved |
| RSVD | 5 | Reserved: Do not change from default value | 0: Reserved |
| RSVD | 4 | Reserved: Do not change from default value | 1: Reserved |
| RSVD | 3 | Reserved: Do not change from default value | 1: Reserved |
| RSVD | 2:0 | Reserved: Do not change from default value | 111: Reserved |

rsvd_98 (0x98)

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-------------|-------------|---|-------------|---|---|-------------|---|---|
| Field | RSVD[1:0] | | RSVD[2:0] | | | RSVD[2:0] | | |
| Reset | 01b | | 001b | | | 010b | | |
| Access Type | Write, Read | | Write, Read | | | Write, Read | | |

| BITFIELD | BITS | DESCRIPTION | DECODE |
|----------|------|---|---------------|
| RSVD | 7:6 | Reserved: Do not change from default value | 01: Reserved |
| RSVD | 5:3 | Reserved: Do not change from default value | 001: Reserved |
| RSVD | 2:0 | Reserved: Do not change from default value | 010: Reserved |

rsvd_99 (0x99)

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|---|
| Field | RSVD | RSVD | RSVD | RSVD | RSVD | RSVD | RSVD[1:0] | |
| Reset | 0b | 0b | 0b | 0b | 1b | 1b | 01b | |
| Access Type | Write, Read | Write, Read | Write, Read | Write, Read | Write, Read | Write, Read | Write, Read | |

| BITFIELD | BITS | DESCRIPTION | DECODE |
|----------|------|---|--------------|
| RSVD | 7 | Reserved: Do not change from default value | 0: Reserved |
| RSVD | 6 | Reserved: Do not change from default value | 0: Reserved |
| RSVD | 5 | Reserved: Do not change from default value | 0: Reserved |
| RSVD | 4 | Reserved: Do not change from default value | 0: Reserved |
| RSVD | 3 | Reserved: Do not change from default value | 1: Reserved |
| RSVD | 2 | Reserved: Do not change from default value | 1: Reserved |
| RSVD | 1:0 | Reserved: Do not change from default value | 01: Reserved |

pktcc_en (0x9A)

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-------------|-------------|---|-------------|---|-------------|-------------|---|-------------|
| Field | RSVD[1:0] | | RSVD[1:0] | | PKTCC_EN | RSVD[1:0] | | RSVD |
| Reset | 00b | | 01b | | 0b | 00b | | 0b |
| Access Type | Write, Read | | Write, Read | | Write, Read | Write, Read | | Write, Read |

| BITFIELD | BITS | DESCRIPTION | DECODE |
|----------|------|---|---|
| RSVD | 7:6 | Reserved: Do not change from default value | 00: Reserved |
| RSVD | 5:4 | Reserved: Do not change from default value | 01: Reserved |
| PKTCC_EN | 3 | Packet-Based Control-Channel-Mode Enable | 0: Disable packet-based control-channel mode 1: Enable packet-based control-channel mode |
| RSVD | 2:1 | Reserved: Do not change from default value | 00: Reserved |
| RSVD | 0 | Reserved: Do not change from default value | 0: Reserved |

rsvd_C8 (0xC8)

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-------------|-----------|-----------|-----------|-----------|-----------|---|-----------|---|
| Field | RSVD | RSVD | RSVD | RSVD | RSVD[3:2] | | RSVD[1:0] | |
| Reset | 0b | Xb | Xb | Xb | 10b | | 10b | |
| Access Type | Read Only | Read Only | Read Only | Read Only | Read Only | | Read Only | |

| BITFIELD | BITS | DESCRIPTION | DECODE |
|----------|------|---|--------------|
| RSVD | 7 | Reserved: Do not change from default value | 0: Reserved |
| RSVD | 6 | Reserved | X: Reserved |
| RSVD | 5 | Reserved | X: Reserved |
| RSVD | 4 | Reserved | X: Reserved |
| RSVD | 3:2 | Reserved | 10: Reserved |
| RSVD | 1:0 | Reserved | 10: Reserved |

rsvd_c9 (0xC9)

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-------------|-----------|---|---|---|---|---|---|---|
| Field | RSVD[7:0] | | | | | | | |
| Reset | XXXXXXXXb | | | | | | | |
| Access Type | Read Only | | | | | | | |

| BITFIELD | BITS | DESCRIPTION | DECODE |
|----------|------|-----------------|--------------------|
| RSVD | 7:0 | Reserved | XXXXXXXX: Reserved |

rsvd_fc (0xFC)

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Field | RSVD | RSVD | RSVD | RSVD | RSVD | RSVD | RSVD | RSVD |
| Reset | 0b | 0b | 0b | 0b | 0b | 0b | 0b | 0b |
| Access Type | Write, Read | Write, Read | Write, Read | Write, Read | Write, Read | Write, Read | Write, Read | Write, Read |

| BITFIELD | BITS | DESCRIPTION | DECODE |
|----------|------|---|-------------|
| RSVD | 7 | Reserved: Do not change from default value | 0: Reserved |
| RSVD | 6 | Reserved: Do not change from default value | 0: Reserved |
| RSVD | 5 | Reserved: Do not change from default value | 0: Reserved |
| RSVD | 4 | Reserved: Do not change from default value | 0: Reserved |
| RSVD | 3 | Reserved: Do not change from default value | 0: Reserved |
| RSVD | 2 | Reserved: Do not change from default value | 0: Reserved |
| RSVD | 1 | Reserved: Do not change from default value | 0: Reserved |
| RSVD | 0 | Reserved: Do not change from default value | 0: Reserved |

rsvd_fd (0xFD)

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-------------|-------------|---|---|---|---|---|---|---|
| Field | RSVD[7:0] | | | | | | | |
| Reset | 00000000b | | | | | | | |
| Access Type | Write, Read | | | | | | | |

| BITFIELD | BITS | DESCRIPTION | DECODE |
|----------|------|---|--------------------|
| RSVD | 7:0 | Reserved: Do not change from default value | 00000000: Reserved |

rsvd_fe (0xFE)

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-------------|-------------|---|---|---|-------------|---|---|---|
| Field | RSVD[3:0] | | | | RSVD[3:0] | | | |
| Reset | 0000b | | | | 0000b | | | |
| Access Type | Write, Read | | | | Write, Read | | | |

| BITFIELD | BITS | DESCRIPTION | DECODE |
|----------|------|---|----------------|
| RSVD | 7:4 | Reserved: Do not change from default value | 0000: Reserved |
| RSVD | 3:0 | Reserved: Do not change from default value | 0000: Reserved |

rsvd_ff (0xFF)

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-------------|-------------|-------------|-------------|-------------|-----------|---|---|---|
| Field | RSVD | RSVD | RSVD | RSVD | RSVD[3:0] | | | |
| Reset | 0b | 0b | 0b | 0b | XXXXb | | | |
| Access Type | Write, Read | Write, Read | Write, Read | Write, Read | Read Only | | | |

| BITFIELD | BITS | DESCRIPTION | DECODE |
|----------|------|---|----------------|
| RSVD | 7 | Reserved: Do not change from default value | 0: Reserved |
| RSVD | 6 | Reserved: Do not change from default value | 0: Reserved |
| RSVD | 5 | Reserved: Do not change from default value | 0: Reserved |
| RSVD | 4 | Reserved: Do not change from default value | 0: Reserved |
| RSVD | 3:0 | Reserved | XXXX: Reserved |

Applications Information

Parallel Interface

The CMOS parallel interface-data width is programmable and depends on the application. Using a larger width (BWS = 1) results in a lower-pixel clock rate, while a smaller width (BWS = 0) allows a higher-pixel clock rate.

Bus Data Width

The bus data width depends on the selected modes. The available bus width is less when using error detection or

when in double mode (DBL = 1). [Table 3](#) shows the available bit widths and default mapping for various modes.

Bus Data Rates

The bus data rate depends on the settings for BWS and DBL. [Table 4](#) lists the available PCLK rates available for different bus-width settings. For lower PCLK rates, set DBL = 0 (if DBL = 1 in both the serializer and deserializer).

Table 3. Input Data-Width Selection

| REGISTER BIT SETTINGS | | | | | INPUT MAPPING |
|-----------------------|-----|------|---------|------|------------------|
| DBL | BWS | HIBW | PXL_CRC | HVEN | |
| 1 | 1 | — | 1 | 1 | DIN11:0, HS, VS |
| 1 | 1 | — | 1 | 0 | DIN11:0 |
| 1 | 1 | — | 0 | 1 | DIN11:0*, HS, VS |
| 1 | 1 | — | 0 | 0 | DIN13:0* |
| 1 | 0 | 1 | 1 | — | DIN8:0, HS, VS |
| 1 | 0 | 1 | 0 | — | DIN11:0, HS, VS |
| 1 | 0 | 0 | 1 | 1 | DIN7:0, HS, VS |
| 1 | 0 | 0 | 1 | 0 | DIN7:0 |
| 1 | 0 | 0 | 0 | 1 | DIN10:0, HS, VS |
| 1 | 0 | 0 | 0 | 0 | DIN10:0 |
| 0 | 1 | — | 1 | 1 | DIN11:0*, HS, VS |
| 0 | 1 | — | 1 | 0 | DIN13:0* |
| 0 | 1 | — | 0 | 1 | DIN11:0*, HS, VS |
| 0 | 1 | — | 0 | 0 | DIN13:0* |
| 0 | 0 | 1 | - | — | DIN11:0*, HS, VS |
| 0 | 0 | 0 | 1 | 1 | DIN11:0*, HS, VS |
| 0 | 0 | 0 | 1 | 0 | DIN13:0* |
| 0 | 0 | 0 | 0 | 1 | DIN11:0*, HS, VS |
| 0 | 0 | 0 | 0 | 0 | DIN13:0* |

*The input bit width is limited by the number of available inputs.

Table 4. Data-Rate Selection

| DBL | BWS | HIBW | PCLK RANGE (MHz) |
|-----|-----|------|------------------|
| 1 | 1 | 0 | 25 to 87 |
| 1 | 0 | 0 | 33.3 to 116 |
| 1 | 0 | 1 | 73.3 to 116 |
| 0 | 1 | 0 | 12.5 to 43.5 |
| 0 | 0 | 0 | 16.7 to 58 |
| 0 | 0 | 1 | 36.6 to 58 |

Crossbar Switch

By default, the crossbar switch connects the serializer input pins DIN_ and HS/VS (when HV encoding is used) to the corresponding deserializer output pins DOUT_ and HS/VS. Reprogram the crossbar switch when changing the input or output pin assignments, or when connecting to devices that do not have a DBL = 1 mode.

Crossbar-Switch Programming

Each crossbar-switch output can select any of the 14 DIN_ inputs for either high or low words (when DBL = 1) for a total of 32 possible inputs. Multiple outputs can share the same input. HS, VS, and DE remain the same for both word halves, and should be programmed to use the low-word input of the corresponding pin. To invert an input data bit, set the respective INVERT_MUX_ = 1. To force an output low, (and ignore the input) set the FORCE_MUX_ bit = 1. To force an output high set both INVERT_MUX_ and FORCE_MUX_ = 1.

Recommended Crossbar-Switch Program Procedure

The procedure to program the crossbar switch depends on the DBL settings on the serializer and deserializer. Devices without double mode can be assumed to have DBL = 0.

- Both Devices' DBL Set to the Same Value
1. For the crossbar-output equivalent of DIN0 (XBO0, XBO16) select which pin to map (e.g., DIN4 XBI4, XBI20).

2. Set the low- and high-input crossbar bits (CROSSBAR0, CROSSBAR 16) to the desired selected mapped input (e.g., CROSSBAR0 = 00100, CROSSBAR16 = 10100).
3. Repeat for the other crossbar outputs, making sure the set of high and low crossbar outputs are assigned to the same crossbar input set. In general, XBO[i] and XBO[i+16] should be assigned to XBI[j] and XBI[j+16].
4. For XBOHS, XBOVS, and XBODE, set crossbar to use the low-input pins (CROSSBAR_ = 00000 to 01111). Note that HS, VS, and DE use both the low and high input.

- Both Devices' DBL Do Not Match
1. Table 5, Table 6, and Table 7 list which crossbar output (XBO_) maps to each serial bit.
 2. For each crossbar output, select which pin and high/low clock cycle (if needed) to map (e.g., DIN4 low input).
 3. Set the crossbar bits (CROSSBAR_) to select the desired selected mapped input (e.g., CROSSBAR0 = 00100 maps DIN4 low input to XBO0).
 4. Repeat for the other crossbar outputs; any unused serial bits should have a force low mapped to the respective crossbar output.
 5. For XBOHS, XBOVS, and XBODE, set crossbar to use the low-input pins (CROSSBAR_ = 00000 to 01111). Note that HS, VS, and DE use both the low and high input.

Table 5. Crossbar Output to Serial Link Map (D23:0)

| BIT SETTING | | | | | | SERIAL BITS | | | | | | | | | | | | | | | | | | | | | | | | |
|-------------|----|----|----|----|----|-------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|---|
| DB | HV | BW | HB | CR | DE | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | |
| 0 | 0 | 0 | 0 | 0 | X | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | Z | Z | Z | Z | Z | Z | Z | F | P |
| 0 | 0 | 0 | 0 | 1 | X | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | F | E | E | E | E | E | E | E | P |
| 0 | 0 | 0 | 1 | 0 | X | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | Z | Z | Z | Z | Z | Z | F | P | |
| 0 | 0 | 0 | 1 | 1 | X | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | Z | Z | Z | F | E | E | E | P | |
| 0 | 0 | 1 | 0 | 0 | X | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | Z | Z | Z | Z | Z | Z | Z | Z | Z |
| 0 | 0 | 1 | 0 | 1 | X | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | Z | Z | Z | Z | Z | Z | Z | Z | Z |
| 0 | 1 | 0 | 0 | 0 | X | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | Z | Z | Z | Z | Z | Z | F | P | |
| 0 | 1 | 0 | 0 | 1 | X | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | F | E | E | E | E | E | E | E | P |
| 0 | 1 | 1 | 0 | 0 | X | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | Z | Z | Z | Z | Z | Z | Z | Z | Z |
| 0 | 1 | 1 | 0 | 1 | X | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | Z | Z | Z | Z | Z | Z | Z | Z | Z |
| 1 | 0 | 0 | 0 | 0 | X | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | F | P | |
| 1 | 0 | 0 | 0 | 1 | X | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | F | E | E | E | E | E | E | E | P |
| 1 | 0 | 0 | 1 | 0 | X | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Z | F | P | |

Table 5. Crossbar Output to Serial Link Map (D23:0) (continued)

| BIT SETTING | | | | | | SERIAL BITS | | | | | | | | | | | | | | | | | | | | | | | |
|-------------|----|----|----|----|----|-------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| DB | HV | BW | HB | CR | DE | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 |
| 1 | 0 | 0 | 1 | 1 | X | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Z | F | E | E | E | P |
| 1 | 0 | 1 | 0 | 0 | X | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 1 | 0 | 1 | 0 | 1 | 1 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | DH | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | DL |
| 1 | 0 | 1 | 0 | 1 | 0 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 1 | 1 | 0 | 0 | 0 | 1 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | DH | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | DL | F | P |
| 1 | 1 | 0 | 0 | 0 | 0 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | F | P |
| 1 | 1 | 0 | 0 | 1 | 1 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | DH | 0 | 1 | 2 | 3 | 4 | 5 | 6 | DL | F | E | E | E | E | E | E | P |
| 1 | 1 | 0 | 0 | 1 | 0 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | F | E | E | E | E | E | E | P |
| 1 | 1 | 1 | 0 | 0 | X | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 1 | 1 | 1 | 0 | 1 | 1 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | DH | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | DL |
| 1 | 1 | 1 | 0 | 1 | 0 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |

Table 6. Crossbar Output to Serial Link Map (D31:24 and Special Packets)

| BIT SETTING | | | | | | | | | | | | | | SPECIAL PACKETS | | | | | | | |
|-------------|----|----|----|----|----|----|----|----|----|----|----|----|----|-----------------|----|----|----|------|------|----|--|
| DB | HV | BW | HB | CR | DE | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | C0 | C1 | C2 | C3 | HS | VS | DE | |
| 0 | 0 | 0 | 0 | 0 | X | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | |
| 0 | 0 | 0 | 0 | 1 | X | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | |
| 0 | 0 | 0 | 1 | 0 | X | Z | Z | Z | — | — | — | — | — | Z | Z | Z | Z | H | V | D | |
| 0 | 0 | 0 | 1 | 1 | X | E | E | E | — | — | — | — | — | Z | Z | Z | Z | H | V | D | |
| 0 | 0 | 1 | 0 | 0 | X | Z | Z | Z | Z | Z | Z | F | P | — | — | — | — | — | — | — | |
| 0 | 0 | 1 | 0 | 1 | X | F | E | E | E | E | E | E | P | — | — | — | — | — | — | — | |
| 0 | 1 | 0 | 0 | 0 | X | — | — | — | — | — | — | — | — | — | — | — | — | H | V | — | |
| 0 | 1 | 0 | 0 | 1 | X | — | — | — | — | — | — | — | — | — | — | — | — | H | V | — | |
| 0 | 1 | 1 | 0 | 0 | X | Z | Z | Z | Z | Z | Z | F | P | — | — | — | — | H | V | — | |
| 0 | 1 | 1 | 0 | 1 | X | F | E | E | E | E | E | E | P | — | — | — | — | H | V | — | |
| 1 | 0 | 0 | 0 | 0 | X | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | |
| 1 | 0 | 0 | 0 | 1 | X | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | |
| 1 | 0 | 0 | 1 | 0 | X | 9 | 10 | 11 | — | — | — | — | — | A | Z | A | A | H | V | D | |
| 1 | 0 | 0 | 1 | 1 | X | E | E | E | — | — | — | — | — | A | Z | A | A | H | V | D | |
| 1 | 0 | 1 | 0 | 0 | X | 9 | 10 | 11 | 12 | 13 | 14 | F | P | — | — | — | — | — | — | — | |
| 1 | 0 | 1 | 0 | 1 | 1 | F | E | E | E | E | E | E | P | — | — | — | — | — | — | — | |
| 1 | 0 | 1 | 0 | 1 | 0 | F | E | E | E | E | E | E | P | — | — | — | — | — | — | — | |
| 1 | 1 | 0 | 0 | 0 | 1 | — | — | — | — | — | — | — | — | — | — | — | — | HH/L | VH/L | — | |
| 1 | 1 | 0 | 0 | 0 | 0 | — | — | — | — | — | — | — | — | — | — | — | — | HH/L | VH/L | — | |
| 1 | 1 | 0 | 0 | 1 | 1 | — | — | — | — | — | — | — | — | — | — | — | — | HH/L | VH/L | — | |
| 1 | 1 | 0 | 0 | 1 | 0 | — | — | — | — | — | — | — | — | — | — | — | — | HH/L | VH/L | — | |
| 1 | 1 | 1 | 0 | 0 | X | 9 | 10 | 11 | 12 | 13 | 14 | F | P | — | — | — | — | HH/L | VH/L | — | |
| 1 | 1 | 1 | 0 | 1 | 1 | F | E | E | E | E | E | E | P | — | — | — | — | HH/L | VH/L | — | |
| 1 | 1 | 1 | 0 | 1 | 0 | F | E | E | E | E | E | E | P | - | - | - | - | HH/L | VH/L | - | |

Table 7. Legend

| BIT SETTINGS | | MAP INPUTS | |
|------------------------|---|------------|---|
| DB | Double-mode bit DBL | H | HSYNC (when DBL = 0 or HIBW = 1) |
| HV | H/V Encoding bit HVEN | V | VSYNC (when DBL = 0 or HIBW = 1) |
| BW | BWS bit | D | DE (when DBL = 0 or HIBW = 1) |
| HB | HIBW bit | HH | HSYNC (high word, DBL = 1) |
| CR | PXL_CRC bit | VH | VSYNC (high word, DBL = 1) |
| DE | DE = 1 when DEEN = 1 and not processed in RGB888 mode | DH | DE (high word, DBL = 1) |
| X | 1 or 0 | HL | HSYNC (low word, DBL = 1) |
| SPECIAL PACKETS | | VL | VSYNC (low word, DBL = 1) |
| C0 | CNT_0 | DL | DE (low word, DBL = 1) |
| C1 | CNT_1 | # | XBO output from crossbar switch |
| C2 | CNT_2 | F | Internal forward control-channel bit |
| C3 | CNT_3 | E | Internal pixel CRC bit |
| BIT COLOR | | P | Internal pixel parity bit |
| | Output bits from crossbar | — | Serial bit not sent |
| | Internal bits | Z | Zero |
| | Other output bits | A | Internal alignment bit (used when HIBW=1) |
| | Output bits from sync | | |

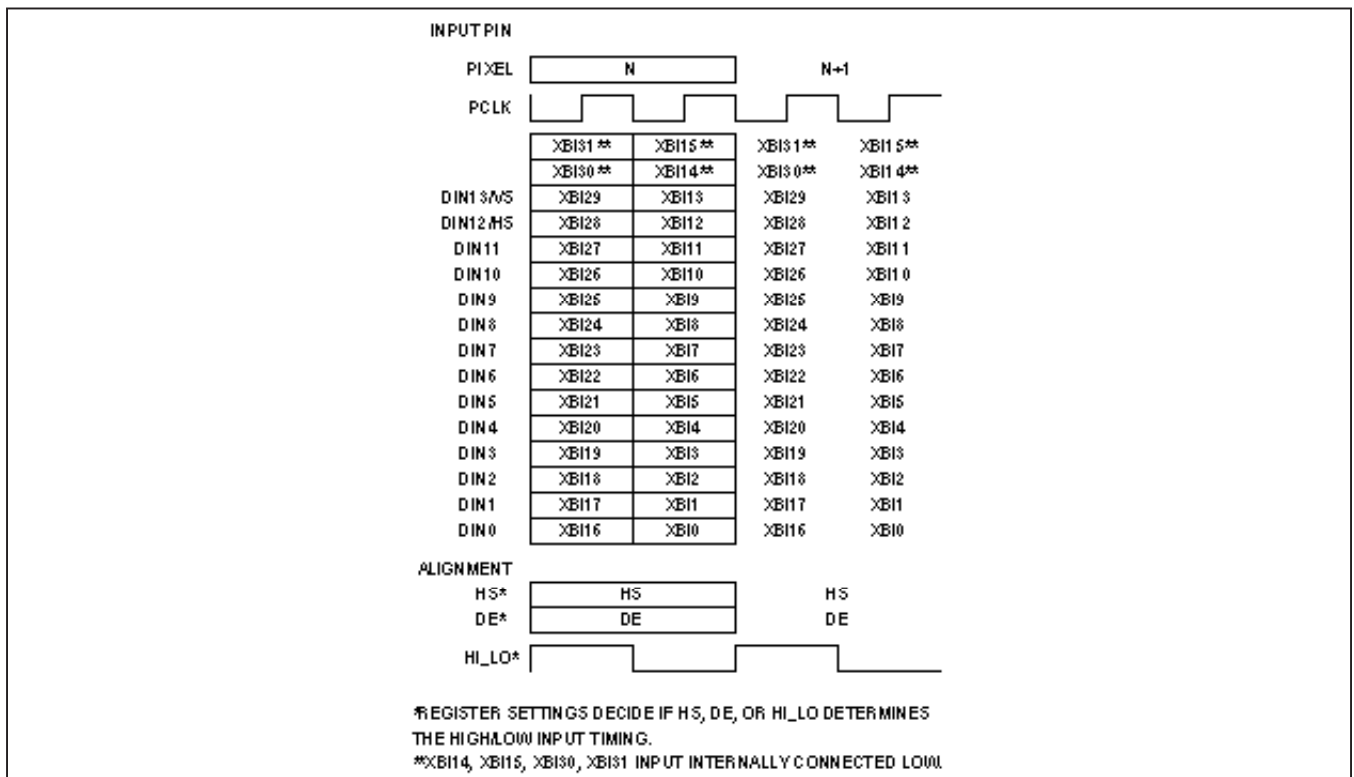


Figure 20. Crossbar-Switch Default Mapping

Timing-Generator Programming

Timing-generator parameters are stored in the registers as unsigned integers as PCLK periods. To prevent output glitches, program all timing-generator parameters while the device is in configuration-link mode, or when PCLK is not applied. By default, the timing generator is set to single trigger, and is disabled. Figure 18 show the timing waveforms under the default conditions with rising-edge trigger, and noninverted signals. Do not program the HSYNC or DE signals such that the total length exceeds the length of a VSYNC period (Table 8). All delay parameters are positive. To implement a negative delay, set the delay value subtracted from the VSYNC period (e.g., a delay value of VS_HIGH + VS_LOW - N creates a delay of -N PCLK cycles). Do not set any delay lengths larger than the VSYNC period.

Double-Mode Alignment

When DBL = 1 in both the serializer and deserializer, GMSL automatically keeps the pixels in order. Use double-mode alignment when DBL = 1 in the serializer and DBL = 0 (or is not supported) in the deserializer. Two different methods are available for double-mode alignment.

External High/Low Signal

To use an external alignment signal, set EN_HI_LO = 1, DBL_ALIGN_TO = 000, and select which input DIN_ pin to use by setting the CROSSBAR_HI_LO bits. The external signal designates whether the clocked word is the high or low word (e.g., for pixels [1H, 1L, 2H, 2L...] the high/low signal would be [1, 0, 1, 0...]).

Align from HS or DE

To align from a sync signal, set the DBL_ALIGN_TO to select the input signal. When using this mode, ensure that the signal used for alignment uses the same value for both the high and low word (e.g., for pixels [1H, 1L, 2H, 2L...], aligning on DE requires values of [DE1, DE1, DE2, DE2...]).

I²C Interface

The control channel forwards I²C commands from the microcontroller side to the other side of the GMSL link. The remote device acts as an I²C master to the other peripherals connected to the remote-side device. I²C-to-I²C mode uses clock stretching to hold the microcontroller until the data and an acknowledge or not acknowledge have been sent across the link.

I²C Bit Rate

The I²C interface accepts bit rates from 9.6kbps to 1Mbps. The local I²C rate is set by the microcontroller. The remote I²C rate is set by the remote device. By default, the control channel is set up for a 400kbps I²C bit rate. Program the I2C_MSTBT and SLV_SH bits (register 0x0D) to match the desired microcontroller I²C rate.

Table 8. Timing-Generator Parameter Restrictions

| SIGNAL | SIZE (BITS) | MIN VALUE (HEX) | MAXIMUM VALUE RESTRICTION (HEX) |
|---------|-------------|-----------------|--|
| VS_HIGH | 24 | 1 | VS_HIGH + VS_LOW < 0xFFFFFFFF |
| VS_LOW | 24 | 1 | VS_HIGH + VS_LOW < 0xFFFFFFFF |
| VS_DLY | 24 | 0 | VS_DLY < VS_HIGH + VS_LOW |
| HS_HIGH | 16 | 1 | (HS_HIGH + HS_LOW) x HS_CNT < VS_HIGH + VS_LOW |
| HS_LOW | 16 | 1 | (HS_HIGH + HS_LOW) x HS_CNT < VS_HIGH + VS_LOW |
| HS_CNT | 16 | 1 | (HS_HIGH + HS_LOW) x HS_CNT < VS_HIGH + VS_LOW |
| HS_DLY | 24 | 0 | HS_DLY < VS_HIGH + VS_LOW |
| DE_HIGH | 16 | 1 | (DE_HIGH + DE_LOW) x DE_CNT < VS_HIGH + VS_LOW |
| DE_LOW | 16 | 1 | (DE_HIGH + DE_LOW) x DE_CNT < VS_HIGH + VS_LOW |
| DE_CNT | 16 | 1 | (DE_HIGH + DE_LOW) x DE_CNT < VS_HIGH + VS_LOW |
| DE_DLY | 24 | 0 | DE_DLY < VS_HIGH + VS_LOW |

Software Programming of Device Addresses

The serializer and deserializer have programmable device addresses. This allows multiple GMSL devices, along with I²C peripherals, to coexist on the same control channel. The serializer device address is in register 0x00 of each device, while the deserializer device address is in register 0x01 of each device. To change a device address, first write to the device whose address changes (register 0x00 of the serializer for serializer device address change, or register 0x01 of the deserializer for deserializer device address change). Then, write the same address into the corresponding register on the other device (register 0x00 of the deserializer for serializer device address change, or register 0x01 of the serializer for deserializer device address change).

I²C Address Translation

The device supports I²C address translation for up to two device addresses. Use address translation to assign unique device addresses to peripherals with limited I²C addresses. Source addresses (address to translate from) are stored in registers 0x09 and 0x0B. Destination addresses (address to translate to) are stored in registers 0x0A and 0x0C.

Configuration Blocking

The device can block changes to its registers. Set CFGBLOCK to make all registers read-only. Once set, the registers remain blocked until the supplies are removed or until PWDNB is low.

Cascaded/Parallel Devices

GMSL supports both cascaded and parallel devices connected through I²C. When cascading or using parallel links, all I²C commands are forwarded to all links. Each link attempts to hold the control channel until it receives an acknowledge/not acknowledge from the remote-side device. It is important to keep the control channel active between links to prevent timeout. If a link is unused, keep the control channel clear by turning on the configuration link, disconnecting the I²C lines, or powering down the unused device.

Dual μ C Control

Most systems use a single microcontroller; however μ Cs can reside on each side simultaneously and trade off in running the control channel. Contention occurs if both μ Cs attempt to use the control channel at the same time. It is up to the user to prevent this contention by implementing a higher level protocol. In addition, the control channel does not provide arbitration between I²C masters on both sides of the link. An acknowledge frame is not generated when communication fails due to contention. If communication across the serial link is not required, the μ Cs can disable the forward and reverse control channel using the FWCCEN and REVCCEN bits (0x04, D[1:0]) in the serializer/deserializer. Communication across the serial link is stopped and contention between μ Cs cannot occur.

Device Address

The serializer/deserializer both have a 7-bit-long slave address stored in registers 0x00 and 0x01. The bit following a 7-bit slave address is the R/W bit, which is low for a write command and high for a read command. The default slave address is 0x80. After startup, a microcontroller can reprogram the slave address as needed.

Spread Spectrum

Program the SS bits in the serializer to turn on spread spectrum in the serializer ([Table 9](#)). If the deserializer driven by the serializer has programmable spread spectrum, do not enable spread for both at the same time or their interaction cancels benefits. The deserializer tracks the serializer's spread and passes the spread to the deserializer output. Some spread-spectrum amplitudes can only be used at lower PCLKIN frequencies ([Table 10](#)). When the spread spectrum is turned on or off, the serial link stops for several microseconds and then restarts in order for the deserializer to lose and relock to the new serial-data stream. Changing the spread-spectrum amplitude does not cause a loss of lock.

Manual Programming of the Spread-Spectrum Divider

By default, autodetection of the PCLKIN operation range guarantees a spread-spectrum modulation frequency within 20kHz to 40kHz. Additionally, manual configuration of the sawtooth divider (SDIV: 0x03,D[5:0]) allows the user to set a modulation frequency (typically 20kHz) according to the PCLKIN frequency.

Equation:

Relation of modulation rate to the PCLKIN frequency:

$$f_M = f_{PCLKIN} / (\text{MOD} \times \text{SDIV})$$

where:

f_M = Modulation frequency

f_{PCLKIN} = PCLKIN frequency

MOD = Modulation coefficient given in [Table 11](#)

SDIV = 6-bit SDIV setting, manually programmed by the μC

To program the SDIV setting, first look up the modulation coefficient according to the desired bus-width and spread-spectrum settings. Solve the above equation for SDIV using the desired pixel clock and modulation frequencies. If the calculated SDIV value is larger than the maximum allowed SDIV value in [Table 11](#), set SDIV to the maximum value.

Board Layout

Power-Supply Circuits and Bypassing

The serializer uses an AVDD and DVDD of 1.7V to 1.9V. All inputs and outputs, except for the serial output, derive power from DVDD. Proper voltage-supply bypassing is essential for high-frequency circuit stability.

High-Frequency Signals

Separate the LVCMOS logic signals and CML/coax high-speed signals to prevent crosstalk. Use a four-layer PCB with separate layers for power, ground, CML/coax, and LVCMOS logic signals. Layout STP-PCB traces close to each other for a 100 Ω differential characteristic impedance. The trace dimensions depend on the type of trace used (microstrip or stripline).

Note: Two 50 Ω PCB traces do not have 100 Ω differential impedance when brought close together; the impedance goes down when the traces are brought closer. Use a 50 Ω trace for the single-ended output when driving coax. Route the PCB traces for differential CML in parallel to maintain the differential characteristic impedance. Avoid via arrays. Keep PCB traces that make up a differential pair equal in length to avoid skew within the differential pair.

Table 9. Output Spread

| SS | SPREAD (%) |
|-----|---------------------------------------|
| 000 | Power-up default (no spread spectrum) |
| 001 | $\pm 0.5\%$ spread spectrum |
| 010 | $\pm 1.5\%$ spread spectrum |
| 011 | $\pm 2\%$ spread spectrum |
| 100 | No spread spectrum |
| 101 | $\pm 1\%$ spread spectrum |
| 110 | $\pm 3\%$ spread spectrum |
| 111 | $\pm 4\%$ spread spectrum |

Table 10. Spread Limitations

| BWS = 0 MODE, PCLKIN FREQUENCY (MHz) | BWS = 1 MODE, PCLKIN FREQUENCY (MHz) | SERIAL LINK BIT RATE (Mbps) | AVAILABLE SPREAD RATES |
|--------------------------------------|--------------------------------------|-----------------------------|------------------------|
| < 33.3 (DBL = 0) | < 25 (DBL = 0) | < 1000 | All rates available |
| < 66.6 (DBL = 1) | < 50 (DBL = 1) | | |
| 33.3 to 58 (DBL = 0) | 25 to 43.5 (DBL = 0) | ≥ 1000 | 1.5%, 1%, 0.5% |
| 66.6 to 116 (DBL = 1) | 50 to 87 (DBL = 1) | | |

Table 11. Modulation Coefficients and Maximum SDIV Settings

| BWS | SPREAD-SPECTRUM SETTING (%) | MODULATION COEFFICIENT (DEC) | SDIV UPPER LIMIT (DEC) |
|-----|-----------------------------|------------------------------|------------------------|
| 1 | 1 | 104 | 40 |
| | 0.5 | 104 | 63 |
| | 3 | 152 | 27 |
| | 1.5 | 152 | 54 |
| | 4 | 204 | 15 |
| 0 | 2 | 204 | 30 |
| | 1 | 80 | 52 |
| | 0.5 | 80 | 63 |
| | 3 | 112 | 37 |
| | 1.5 | 112 | 63 |
| 0 | 4 | 152 | 21 |
| | 2 | 152 | 42 |

ESD Protection

ESD tolerance is rated for Human Body Model, IEC 61000-4-2, and ISO 10605. The ISO 10605 and IEC 61000-4-2 standards specify ESD tolerance for electronic systems. The serial outputs are rated for ISO 10605 ESD protection and IEC 61000-4-2 ESD protection. All pins are tested for the Human Body Model. The Human Body Model discharge components are CS = 100pF and RD = 1.5kΩ (Figure 21). The IEC 61000-4-2 discharge components are CS = 150pF and RD = 330Ω (Figure 22). The ISO 10605 discharge components are CS = 330pF and RD = 2kΩ (Figure 23).

Compatibility with Other GMSL Devices

The device is designed to pair with the MAX96705–MAX96711 family of devices, but interoperates with any GMSL device. See Table 12 for operating limitations.

Device Configuration and Component Selection

Internal Input Pulldowns

The control and configuration inputs include a pulldown resistor to GND; external pulldown resistors are not needed.

Multifunction GPO/HIM

Functions as the GPO output, and as a configuration pin. On power-up, or when reverting from a power-down state, the pins act as the HIM input. After latching the input state, the pin becomes the GPO output. Connect a configuration input through a 30kΩ resistor to DVDD to

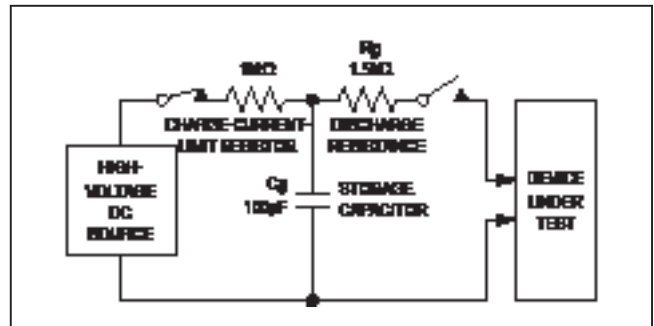


Figure 21. Human Body Model ESD Test Circuit

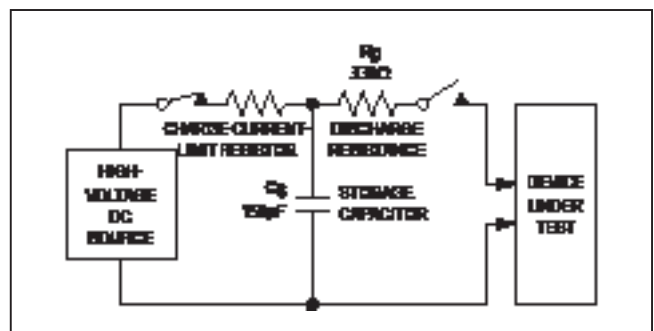


Figure 22. IEC 61000-4-2 Contact Discharge ESD Test Circuit

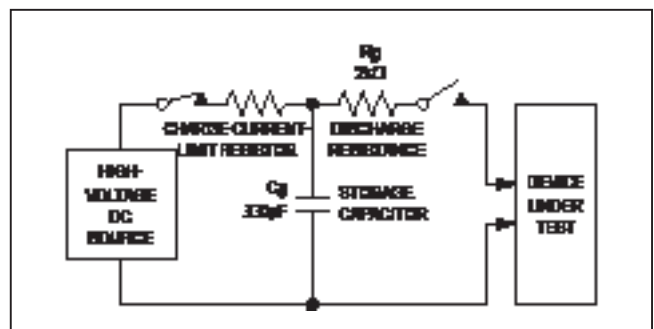


Figure 23. ISO 10605 Contact Discharge ESD Test Circuit

set a high level. Leave the configuration input open to set a low level.

I²C Pullup Resistors

The I²C open-drain lines require a pullup resistor to provide a logic-high level. There are tradeoffs between power dissipation and speed, and a compromise may be required when choosing pullup resistor values. Every device connected to the bus introduces some capacitance even when the device is not in operation. I²C specifies 300ns rise times (30% to 70%) for fast mode, which is defined for data rates up to 400kbps (see the I²C Port

Timing section in the [AC Electrical Characteristics](#) table for details). To meet the fast-mode rise-time requirement, choose the pullup resistors so that rise time $t_R = 0.85 \times R_{PULLUP} \times C_{BUS} < 300ns$. The waveforms are not recognized if the transition time becomes too slow. GMSL supports I²C rates up to 1Mbps.

AC-Coupling Capacitors

Voltage droop and the digital-sum variation (DSV) of transmitted symbols cause signal transitions to start from different voltage levels. Because the transition time is fixed, starting the signal transition from different voltage levels causes timing jitter. The time constant for an AC-coupled link needs to be chosen to reduce droop and jitter to an acceptable level. The RC network for an AC-coupled link consists of the CML/coax receiver termination resistor (R_{TR}), the CML/coax-driver termination resistor (R_{TD}), and the series AC-coupling capacitors (C). The RC time constant for four equal-value series capacitors is $(C \times (R_{TD} + R_{TR}))/4$. R_{TD} and R_{TR}

are required to match the transmission-line impedance (usually 100Ω differential, 50Ω single-ended). This leaves the capacitor selection to change the system time constant. Use 0.2μF or larger high-frequency, surface-mount ceramic capacitors with sufficient voltage rating to withstand a short to battery, to pass the lower speed reverse control-channel signal. Use capacitors with a case size less than 3.2mm x 1.6mm to have lower-parasitic effects to the high-speed signal.

Cables and Connectors

Interconnect for CML typically has a differential impedance of 100Ω. Use cables and connectors that have matched differential impedance to minimize impedance discontinuities. Coax cables typically have a characteristic impedance of 50Ω; contact the factory for 75Ω operation). [Table 13](#) lists the suggested cables and connectors used in the GMSL link.

Table 12. Feature Compatibility

| SERIALIZER FEATURE | GMSL DESERIALIZER |
|--------------------------------------|--|
| HSYNC/VSYNC Encoding | If feature not supported in the deserializer, turn off in the serializer. |
| I ² C to I ² C | If feature not supported in the deserializer, do not use control channel. |
| Packet Control Channel | If feature not supported in the deserializer, use legacy control channel. |
| CRC Error Detection | If feature not supported in the deserializer, turn off in the serializer. |
| Double Input | If feature not supported in the deserializer, data is output as a single word at half the input frequency. Use crossbar switch to correct input mapping. |
| Coax | If feature not supported in the deserializer, connect unused serial input through 200nF and 50Ω in series to AVDD, and set the reverse control-channel amplitude to 100mV. |
| I ² S Encoding | If supported in the deserializer, disable I ² S in the deserializer. |
| High-Bandwidth Mode | If feature not supported in the deserializer, turn off in the serializer. |
| High-Immunity Mode | If feature not supported in the deserializer, turn off in the serializer. |
| Low-Speed Mode | If supported in the deserializer, set DRS to 0 in the deserializer. |

Table 13. Suggested Connectors and Cables for GMSL

| VENDOR | CONNECTOR | CABLE | TYPE |
|-------------|----------------|--------------|------|
| Rosenberger | 59S2AX-400A5-Y | Dacar 302 | Coax |
| Rosenberger | D4S10A-40ML5-Z | Dacar 538 | STP |
| Nissei | GT11L-2S | F-2WME AWG28 | STP |
| JAE | MX38-FF | A-BW-Lxxxxx | STP |

PRBS

The serializer includes a PRBS pattern generator that works with bit-error verification in the deserializer. To run the PRBS test, set PRBSEN = 1 (0x04, D5) in the deserializer, then in the serializer. To exit the PRBS test, set PRBSEN = 0 (0x04, D5) in the serializer. The deserializer automatically ends PRBS checking and sets the PRBS_OK bit high. During PRBS mode, the forward control channel is not available except to exit PRBS mode if autoacknowledge is enabled in the deserializer; otherwise, the remote control channel is not available at all.

To run the PRBS with a 3Gbps SerDes, or when HIBW = 1, first set the PRBS_TYPE bit = 0 in the MAX967XX. Then set PRBSEN = 1 (0x04, D5) in the serializer and then in the deserializer. To exit the PRBS test, set PRBSEN = 0 (0x04, D5) in the deserializer, then in the serializer.

During PRBS test, ERRB function changes to reflect PRBS errors only. ERRB goes low when any PRBS errors occur. ERRB goes high when the PRBS error counter is reset when PRBS_ERR is read. Normal ERRB function resumes when exiting the PRBS test.

GPI/GPO

GPO on the serializer follows GPI transitions on the deserializer. By default, the GPI-to-GPO delay is 0.35ms (max). Keep the time between GPI transitions to a minimum 0.35ms. GPI_IN the deserializer stores the GPI input state. GPO is low after power-up. The μ C can set GPO by writing to the SET_GPO register bit.

Fast Detection of Loss-of-Lock

A measure of link quality is the recovery time from loss-of-synchronization. The host can be quickly notified of loss-of-lock by connecting the deserializer's LOCK output to the GPI input (when PKTCC_EN = 0). If other sources use the GPI input, such as a touch-screen controller, the μ C can implement a routine to distinguish between interrupts from loss-of-sync and normal interrupts. Reverse control-channel communication does not require an active forward link to operate and accurately tracks the LOCK status of the GMSL link. LOCK asserts for video link only and not for the configuration link.

Providing a Frame Sync (Camera Applications)

The GPI and GPO provide a simple solution for camera applications that require a frame-sync signal from the ECU (e.g., surround-view systems). Connect the ECU frame-sync signal to the GPI input and connect the GPO output to the camera frame-sync input. GPI/GPO have a typical delay of 275 μ s in legacy mode and 21 μ s in packet mode (with 5-bit CRC). Skew between multiple GPI/

GPO channels is 115 μ s (max) in legacy mode and 21 μ s (max) in packet mode. If a lower skew signal is required in legacy mode, connect the camera's frame-sync input to one of the serializer's GPIOs and use an I²C broadcast-write command to change the GPIO output state. This has a maximum skew of 1.5 μ s, independent from the used I²C bit rate. In packet-based control-channel mode, set GPI_COMP_EN = 1 in both the serializer and deserializer to turn on GPI/GPO compensation. This reduces the device-to-device skew to 0.35 μ s.

Entering/Exiting Sleep Mode

The procedure for entering and exiting sleep mode depends on the location of the microcontroller, and the type of control-channel interface used. If wake up from a remote (deserializer) side microcontroller is not needed or desired, set the DIS_RWAKE bit = 1 to shut down remote wake-up for further power savings.

Legacy Control Channel:

To enter sleep mode, set SLEEP = 1. The device sleeps after 8ms. To wake up the device, send an arbitrary control-channel command to the serializer (the serializer does not send an acknowledge), wait for 5ms for the chip to power up and then set SLEEP = 0 to make the wake-up permanent.

Packet-Based Control Channel:

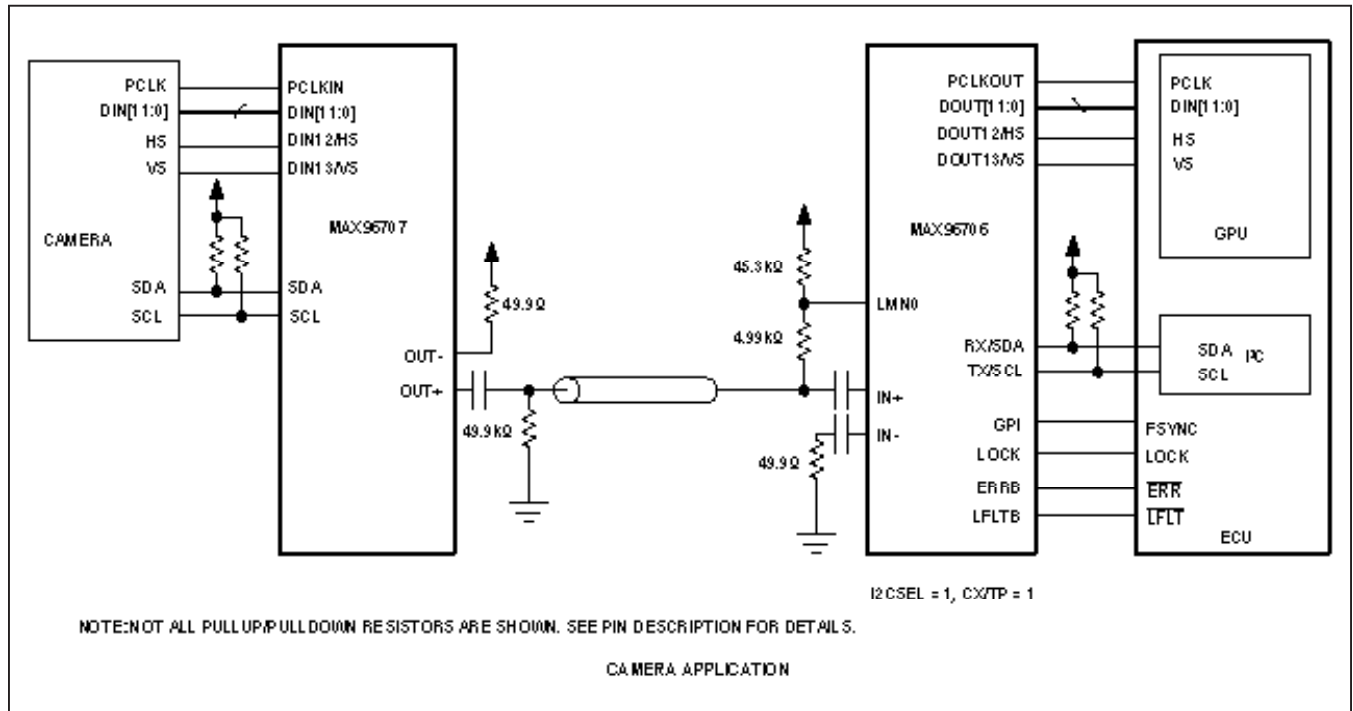
- When μ C is on the deserializer side, set SLEEP = 1 in serializer. Next set REVCCEN = 0 in the deserializer to stop reverse-control transmission to the serializer. The device sleeps after 8ms.

To wake up the serializer, first set REVCCEN = 1, wait 8ms for the device to wake up and then set SLEEP = 0 to exit sleep mode permanently.

- When μ C is on the serializer side, first set SLEEP = 1 in the deserializer. If the deserializer must remain awake, switch to legacy control-channel mode. Next, set SLEEP = 1 in the serializer. The device sleeps after 8ms.

To wake up the device, send an arbitrary control-channel command to the serializer (the serializer does not send an acknowledge). Wait for 5ms for the chip to power up and then set SLEEP = 0 to make the wake-up permanent. The deserializer wakes up and clears its SLEEP bit when serialization is enabled and it locks to the serializer.

Typical Application Circuits



Ordering Information

| PART NUMBER | TEMP RANGE | PIN-PACKAGE |
|-------------------|-----------------|-------------|
| MAX96707GTG+ | -40°C to +115°C | 24 TQFN-EP* |
| MAX96707GTG+T | -40°C to +115°C | 24 TQFN-EP* |
| MAX96707GTG/V+** | -40°C to +115°C | 24 TQFN-EP* |
| MAX96707GTG/V+T** | -40°C to +115°C | 24 TQFN-EP* |

V denotes an automotive qualified product.
 +Denotes a lead(Pb)-free/RoHS-compliant package.
 *EP = Exposed pad.
 **Future product—contact factory for availability.
 T = Tape and reel.

Revision History

| REVISION NUMBER | REVISION DATE | DESCRIPTION | PAGES CHANGED |
|-----------------|---------------|---|---------------|
| 0 | 2/16 | Initial release | — |
| 0.1 | | Corrected broken link In <i>Package Information</i> section | 8 |

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.

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