

# MAX9240

## 6.25MHz to 100MHz, 25-Bit GMSL Deserializer for Coax or STP Cable With Line Fault Detect

### General Description

The MAX9240 compact deserializer is designed to interface with a GMSL serializer over 50Ω coax or 100Ω shielded twisted-pair (STP) cable. The device pairs with the MAX9271 or MAX9273 serializers.

The parallel output is programmable for single or double output. Double output strobes out half of a parallel word on each pixel clock cycle. Double output can be used with GMSL serializers that have the double-input feature.

The device features an embedded control channel that operates at 9.6kbps to 1Mbps. Using the control channel, a microcontroller (μC) can program the serializer/deserializer and peripheral device registers at any time, independent of video timing. Two programmable GPIO ports and a continuously sampled GPI input are available.

For use with longer cables, the device has a programmable equalizer. Programmable spread spectrum is available on the parallel output. The serial input meets ISO 10605 and IEC 61000-4-2 ESD standards. The core supply range is 1.7V to 1.9V and the I/O supply range is 1.7V to 3.6V. The device is available in a 48-pin (7mm x 7mm) TQFN-EP package with 0.5mm lead pitch and operates over the -40°C to +105°C temperature range.

### Applications

Automotive Camera Systems

**Ordering Information** appears at end of data sheet.

**Typical Application Circuit** appears at end of data sheet.

For related parts and recommended products to use with this part, refer to [www.maximintegrated.com/MAX9240.related](http://www.maximintegrated.com/MAX9240.related).

### Benefits and Features

- ◆ **Ideal for Camera Applications**
  - ◇ Works with Low-Cost 50Ω Coax Cable and FAKRA Connectors or 100Ω STP
  - ◇ Error Detection/Correction
  - ◇ 9.6kbps to 1Mbps Control Channel in I<sup>2</sup>C-to-I<sup>2</sup>C Mode with Clock Stretch Capability
  - ◇ Best-in-Class Supply Current: 90mA (max)
  - ◇ Double-Rate Clock for Megapixel Cameras
  - ◇ Cable Equalization Allows 15m Cable at Full Speed
  - ◇ 48-Pin (7mm x 7mm) TQFN-EP Package with 0.5mm Lead Pitch
- ◆ **High-Speed Data Deserialization for Megapixel Cameras**
  - ◇ Up to 1.5Gbps Serial-Bit Rate with Single or Double Output: 6.25MHz to 100MHz Clock
- ◆ **Multiple Control-Channel Modes for System Flexibility**
  - ◇ 9.6kbps to 1Mbps Control Channel in UART-to-UART or UART-to-I<sup>2</sup>C Modes
- ◆ **Reduces EMI and Shielding Requirements**
  - ◇ Input Programmable for 100mV to 500mV Single-Ended or 50mV to 400mV Differential
  - ◇ Programmable Spread Spectrum on the Parallel Output Reduces EMI
  - ◇ Tracks Spread Spectrum on Serial Input
- ◆ **Peripheral Features for Camera Power-Up and Verification**
  - ◇ Built-In PRBS Checker for BER Testing of the Serial Link
  - ◇ Fault Detection of Serial Link Shorted Together, to Ground, to Battery, or Open
  - ◇ Two GPIO Ports
  - ◇ Dedicated “Up/Down” GPI for Camera Frame Sync Trigger and Other Uses
  - ◇ Remote/Local Wake-Up from Sleep Mode
- ◆ **Meets Rigorous Automotive and Industrial Requirements**
  - ◇ -40°C to +105°C Operating Temperature
  - ◇ ±10kV Contact and ±15kV Air IEC 61000-4-2 ESD Protection
  - ◇ ±10kV Contact and ±30kV Air ISO 10605 ESD Protection

# MAX9240

## 6.25MHz to 100MHz, 25-Bit GMSL Deserializer for Coax or STP Cable With Line Fault Detect

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### TABLE OF CONTENTS

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|  |    |
|--|----|
| General Description . . . . .  | 1  |
| Applications . . . . .   | 1  |
| Benefits and Features . . . . .  | 1  |
| Absolute Maximum Ratings* . . . . .  | 6  |
| Package Thermal Characteristics . . . . .                                  | 6  |
| DC Electrical Characteristics . . . . .                                    | 6  |
| AC ELECTRICAL CHARACTERISTICS . . . . .                                    | 9  |
| Typical Operating Characteristics . . . . .                                | 11 |
| Pin Configuration . . . . .  | 13 |
| Pin Description . . . . .  | 13 |
| Functional Diagram . . . . .   | 16 |
| Detailed Description . . . . .   | 21 |
| Register Mapping . . . . .   | 21 |
| Bit Map . . . . .  | 21 |
| Serial Link Signaling and Data Format . . . . .                            | 27 |
| Reverse Control Channel . . . . .  | 27 |
| Data-Rate Selection . . . . .  | 27 |
| Control Channel and Register Programming . . . . .                         | 28 |
| UART Interface . . . . .   | 28 |
| Interfacing Command-Byte-Only I <sup>2</sup> C Devices with UART . . . . . | 29 |
| UART Bypass Mode . . . . .   | 29 |
| I <sup>2</sup> C Interface . . . . .                                       | 29 |
| START and STOP Conditions . . . . .  | 31 |
| Bit Transfer . . . . .   | 31 |
| Acknowledge . . . . .  | 31 |
| Slave Address . . . . .  | 32 |
| Bus Reset . . . . .  | 32 |
| Format for Writing . . . . .   | 32 |
| Format for Reading . . . . .   | 32 |
| I <sup>2</sup> C Communication with Remote-Side Devices . . . . .          | 33 |
| I <sup>2</sup> C Address Translation . . . . .                             | 33 |
| Control-Channel Broadcast Mode . . . . .                                   | 33 |
| GPO/GPI Control . . . . .  | 33 |

# MAX9240

## 6.25MHz to 100MHz, 25-Bit GMSL Deserializer for Coax or STP Cable With Line Fault Detect

---

### TABLE OF CONTENTS (continued)

---

|  |    |
|--|----|
| PRBS Test . . . . .  | 34 |
| Line Equalizer . . . . .                                       | 34 |
| Spread Spectrum . . . . .                                      | 34 |
| Manual Programming<br>of the Spread-Spectrum Divider . . . . . | 34 |
| Additional Error Detection and Correction . . . . .            | 35 |
| Cyclic Redundancy Check (CRC) . . . . .                        | 35 |
| Hamming Code . . . . .   | 35 |
| HS/VS Encoding and/or Tracking. . . . .                        | 35 |
| Serial Input . . . . .   | 35 |
| Coax-Mode Splitter . . . . .                                   | 35 |
| Cable Type Configuration Input (CX/TP). . . . .                | 36 |
| Sleep Mode. . . . .  | 36 |
| Power-Down Mode . . . . .                                      | 36 |
| Configuration Link . . . . .                                   | 36 |
| Link Startup Procedure. . . . .                                | 37 |
| Applications Information. . . . .                              | 39 |
| Error Checking . . . . .                                       | 39 |
| ERR Output . . . . .   | 39 |
| Autoerror Reset . . . . .                                      | 39 |
| Dual $\mu$ C Control. . . . .                                  | 39 |
| Changing the Clock Frequency . . . . .                         | 39 |
| Fast Detection of<br>Loss-of-Synchronization . . . . .         | 39 |
| Providing a Frame Sync<br>(Camera Applications). . . . .       | 40 |
| Software Programming<br>of the Device Addresses. . . . .       | 40 |
| Three-Level Configuration Inputs . . . . .                     | 40 |
| Configuration Blocking . . . . .                               | 40 |
| Compatibility with other GMSL Devices . . . . .                | 40 |
| GPIOs . . . . .  | 40 |
| Staggered Parallel Outputs . . . . .                           | 40 |
| Local Control-Channel Enable (LCCEN). . . . .                  | 41 |
| Line-Fault Detection . . . . .                                 | 41 |

**6.25MHz to 100MHz, 25-Bit GMSL Deserializer for Coax or STP Cable With Line Fault Detect****TABLE OF CONTENTS (continued)**

|   |    |
|---|----|
| Internal Input Pulldowns . . . . .                        | 42 |
| Choosing I <sup>2</sup> C/UART Pullup Resistors . . . . . | 42 |
| AC-Coupling . . . . .                                     | 42 |
| Selection of AC-Coupling Capacitors . . . . .             | 42 |
| Power-Supply Circuits and Bypassing . . . . .             | 42 |
| Power-Supply Table. . . . .                               | 42 |
| Cables and Connectors . . . . .                           | 42 |
| ESD Protection . . . . .                                  | 43 |
| Typical Application Circuit . . . . .                     | 50 |
| Ordering Information . . . . .                            | 50 |
| Chip Information. . . . .                                 | 50 |
| Package Information. . . . .                              | 50 |
| Revision History . . . . .                                | 51 |

**LIST OF FIGURES**

|   |    |
|---|----|
| Figure 1. Reverse Control-Channel Output Parameters. . . . .  | 17 |
| Figure 2. Test Circuit for Differential Input Measurement. . . . .  | 18 |
| Figure 2a. Line Fault. . . . .  | 18 |
| Figure 3. Worst-Case Pattern Output. . . . .  | 19 |
| Figure 4. Parallel Clock Output High and Low Times . . . . .  | 19 |
| Figure 5. I <sup>2</sup> C Timing Parameters . . . . .  | 19 |
| Figure 6. Output Rise-and-Fall Times . . . . .  | 20 |
| Figure 7. Deserializer Delay . . . . .  | 20 |
| Figure 8. GPI-to-GPO Delay. . . . .   | 20 |
| Figure 9. Lock Time . . . . .   | 21 |
| Figure 10. Power-Up Delay . . . . .   | 21 |
| Figure 11. Single-Output Waveform (Serializer Using Single Input) . . . . .   | 22 |
| Figure 12. Single-Output Waveform (Serializer Using Double Input) . . . . .   | 22 |
| Figure 13. Double-Output Waveform (Serializer Using Single Input) . . . . .   | 23 |
| Figure 14. Double-Output Waveform (Serializer Using Double Input) . . . . .   | 23 |
| Figure 15. Serial-Data Format . . . . .   | 27 |
| Figure 16. GMSL UART Protocol for Base Mode. . . . .  | 28 |
| Figure 17. GMSL UART Data Format for Base Mode. . . . .   | 29 |
| Figure 18. SYNC Byte (0x79) . . . . .   | 29 |
| Figure 19. ACK Byte (0xC3). . . . .   | 29 |
| Figure 20. Format Conversion Between GMSL UART and I <sup>2</sup> C with Register Address (I2CMETHOD = 0) . . . . . | 30 |

**6.25MHz to 100MHz, 25-Bit GMSL Deserializer for Coax or STP Cable With Line Fault Detect****LIST OF FIGURES (continued)**

|   |    |
|---|----|
| Figure 21. Format Conversion Between GMSL UART and I <sup>2</sup> C with Register Address (I2CMETHOD = 1) . . . . . | 30 |
| Figure 22. START and STOP Conditions . . . . .  | 31 |
| Figure 23. Bit Transfer . . . . .   | 31 |
| Figure 24. Acknowledge . . . . .  | 31 |
| Figure 25. Slave Address . . . . .  | 32 |
| Figure 26. Format for I <sup>2</sup> C Write . . . . .  | 32 |
| Figure 27. Format for Write to Multiple Registers . . . . .   | 32 |
| Figure 28. Format for I <sup>2</sup> C Read . . . . .   | 33 |
| Figure 29. 2:1 Coax-Mode Splitter Connection Diagram . . . . .  | 36 |
| Figure 30. Coax-Mode Connection Diagram . . . . .   | 36 |
| Figure 31. State Diagram, Remote Microcontroller Application . . . . .  | 38 |
| Figure 32. Human Body Model ESD Test Circuit . . . . .  | 43 |
| Figure 33. IEC 61000-4-2 Contact Discharge ESD Test Circuit . . . . .   | 43 |
| Figure 34. ISO 10605 Contact Discharge ESD Test Circuit . . . . .   | 43 |

**LIST OF TABLES**

|  |    |
|--|----|
| Table 1. Power-Up Default Register Map (see <a href="#">Table 16</a> ) . . . . .   | 24 |
| Table 2. Output Map . . . . .  | 26 |
| Table 3. Data-Rate Selection Table . . . . .                                       | 27 |
| Table 4. I <sup>2</sup> C Bit-Rate Ranges . . . . .                                | 33 |
| Table 5. Cable Equalizer Boost Levels . . . . .                                    | 34 |
| Table 6. Parallel Output Spread . . . . .  | 34 |
| Table 7. Modulation Coefficients and Maximum SDIV Settings . . . . .               | 34 |
| Table 8. Configuration Input Map . . . . .   | 36 |
| Table 9. Startup Procedure for Video-Display Applications . . . . .                | 37 |
| Table 10. Startup Procedure for Image-Sensing Applications . . . . .               | 38 |
| Table 11. MAX9240 Feature Compatibility . . . . .                                  | 40 |
| Table 12. Staggered Output Delay . . . . .   | 41 |
| Table 13. Double-Function Configuration . . . . .                                  | 41 |
| Table 13a. Line Fault Mapping . . . . .  | 41 |
| Table 14. Typical Power-Supply Currents (Using Worst-Case Input Pattern) . . . . . | 42 |
| Table 15. Suggested Connectors and Cables for GMSL . . . . .                       | 42 |
| Table 16. Register Table (see <a href="#">Table 1</a> ) . . . . .                  | 44 |

# MAX9240

## 6.25MHz to 100MHz, 25-Bit GMSL Deserializer for Coax or STP Cable With Line Fault Detect

### ABSOLUTE MAXIMUM RATINGS\*

|   |                                      |   |                 |
|---|--------------------------------------|---|-----------------|
| AVDD to EP .....                                      | -0.5V to +1.9V                       | TQFN (derate 40mW/°C above +70°C) ..... | 3200mW          |
| DVDD to EP .....                                      | -0.5V to +1.9V                       | Junction Temperature .....              | +150°C          |
| IOVDD to EP .....                                     | -0.5V to +3.9V                       | Operating Temperature Range .....       | -40°C to +105°C |
| IN+, IN- to EP .....                                  | -0.5V to +1.9V                       | Storage Temperature Range .....         | -65°C to +150°C |
| LMN_ TO EP (15mA current limit) .....                 | -0.5V to +3.9V                       | Lead Temperature (soldering, 10s) ..... | +300°C          |
| All other pins to EP .....                            | -0.5V to (V <sub>IOVDD</sub> + 0.5V) | Soldering Temperature (reflow) .....    | +260°C          |
| IN+, IN- short circuit to ground or supply .....      | Continuous                           | *EP is connected to PCB ground.         |                 |
| Continuous Power Dissipation (T <sub>A</sub> = +70°C) |                                      |   |                 |

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

### PACKAGE THERMAL CHARACTERISTICS (Note 1)

TQFN

|   |        |  |       |
|---|--------|--|-------|
| Junction-to-Ambient Thermal Resistance (θ <sub>JA</sub> ) ..... | 25°C/W | Junction-to-Case Thermal Resistance (θ <sub>JC</sub> ) ..... | 1°C/W |
|---|--------|--|-------|

**Note 1:** Package thermal resistances were obtained using the method described in JEDEC specification JESD51-7, using a four-layer board. For detailed information on package thermal considerations, refer to [www.maximintegrated.com/thermal-tutorial](http://www.maximintegrated.com/thermal-tutorial).

### DC ELECTRICAL CHARACTERISTICS

(V<sub>AVDD</sub> = V<sub>DVDD</sub> = 1.7V to 1.9V, V<sub>IOVDD</sub> = 1.7V to 3.6V, R<sub>L</sub> = 100Ω ±1% (differential), EP connected to PCB ground, T<sub>A</sub> = -40°C to +105°C, unless otherwise noted. Typical values are at V<sub>AVDD</sub> = V<sub>DVDD</sub> = V<sub>IOVDD</sub> = 1.8V, T<sub>A</sub> = +25°C.) (Note 2)

| PARAMETER  | SYMBOL           | CONDITIONS                                 | MIN                       | TYP                       | MAX  | UNITS |
|--|------------------|--|---------------------------|---------------------------|------|-------|
| <b>SINGLE-ENDED INPUTS (I2CSEL, LCCEN, GPI, PWDN, MS/HVEN)</b> |                  |  |                           |                           |      |       |
| High-Level Input Voltage                                       | V <sub>IH1</sub> |  | 0.65 x V <sub>IOVDD</sub> |                           |      | V     |
| Low-Level Input Voltage  | V <sub>IL1</sub> |  |                           | 0.35 x V <sub>IOVDD</sub> |      | V     |
| Input Current  | I <sub>IN1</sub> | V <sub>IN</sub> = 0V to V <sub>IOVDD</sub> | -10                       |                           | +20  | μA    |
| <b>THREE-LEVEL LOGIC INPUTS (CX/TP)</b>                        |                  |  |                           |                           |      |       |
| High-Level Input Voltage                                       | V <sub>IH</sub>  |  | 0.7 x V <sub>IOVDD</sub>  |                           |      | V     |
| Low-Level Input Voltage  | V <sub>IL</sub>  |  |                           | 0.3 x V <sub>IOVDD</sub>  |      | V     |
| Mid-Level Input Current  | I <sub>INM</sub> | (Note 3)                                   | -10                       |                           | +10  | μA    |
| Input Current  | I <sub>IN</sub>  |  | -150                      |                           | +150 | μA    |
| <b>SINGLE-ENDED OUTPUTS (DOUT_, PCLKOUT)</b>                   |                  |  |                           |                           |      |       |
| High-Level Output Voltage                                      | V <sub>OH1</sub> | I <sub>OUT</sub> = -2mA                    | DCS = 0                   | V <sub>IOVDD</sub> - 0.3  |      | V     |
|  |                  |  | DCS = 1                   | V <sub>IOVDD</sub> - 0.2  |      |       |
| Low-Level Output Voltage                                       | V <sub>OL1</sub> | I <sub>OUT</sub> = 2mA                     | DCS = 0                   |                           | 0.3  | V     |
|  |                  |  | DCS = 1                   |                           | 0.2  |       |

# MAX9240

## 6.25MHz to 100MHz, 25-Bit GMSL Deserializer for Coax or STP Cable With Line Fault Detect

### DC ELECTRICAL CHARACTERISTICS (continued)

( $V_{AVDD} = V_{DVDD} = 1.7V$  to  $1.9V$ ,  $V_{IOVDD} = 1.7V$  to  $3.6V$ ,  $R_L = 100\Omega \pm 1\%$  (differential), EP connected to PCB ground,  $T_A = -40^\circ C$  to  $+105^\circ C$ , unless otherwise noted. Typical values are at  $V_{AVDD} = V_{DVDD} = V_{IOVDD} = 1.8V$ ,  $T_A = +25^\circ C$ .) (Note 2)

| PARAMETER   | SYMBOL                       | CONDITIONS                                 |  | MIN                          | TYP | MAX                    | UNITS    |    |
|---|------------------------------|--|--|------------------------------|-----|------------------------|----------|----|
| Output Short-Circuit Current  | $I_{OS}$                     | DOUT_                                      | $V_O = 0V$ ,<br>DCS = 0                                | $V_{IOVDD} = 3.0V$ to $3.6V$ | 15  | 25                     | 39       | mA |
|   |                              |  | $V_{IOVDD} = 1.7V$ to $1.9V$                           | 3                            | 7   | 13                     |          |    |
|   |                              | PCLKOUT                                    | $V_O = 0V$ ,<br>DCS = 1                                | $V_{IOVDD} = 3.0V$ to $3.6V$ | 20  | 35                     | 63       |    |
|   |                              |  |  | $V_{IOVDD} = 1.7V$ to $1.9V$ | 5   | 10                     | 21       |    |
|   |                              |  | $V_O = 0V$ ,<br>DCS = 0                                | $V_{IOVDD} = 3.0V$ to $3.6V$ | 15  | 33                     | 50       |    |
|   |                              |  |  | $V_{IOVDD} = 1.7V$ to $1.9V$ | 5   | 10                     | 17       |    |
| $V_O = 0V$ ,<br>DCS = 1   | $V_{IOVDD} = 3.0V$ to $3.6V$ | 30   | 54   | 97                           |     |                        |          |    |
| $V_{IOVDD} = 1.7V$ to $1.9V$  | 9                            | 16   | 32   |                              |     |                        |          |    |
| <b>OPEN-DRAIN INPUTS/OUTPUTS (GPIO0/DBL, GPIO1/BWS, RX/SDA/EDC, TX/SCL/ES, ERR, LOCK, LFLT)</b> |                              |  |  |                              |     |                        |          |    |
| High-Level Input Voltage  | $V_{IH2}$                    |  |  | $0.7 \times V_{IOVDD}$       |     |                        | V        |    |
| Low-Level Input Voltage   | $V_{IL2}$                    |  |  |                              |     | $0.3 \times V_{IOVDD}$ | V        |    |
| Input Current   | $I_{IN2}$                    | (Note 4)                                   | RX/SDA, TX/SCL   | -110                         | +5  |                        | $\mu A$  |    |
|   |                              |  | LOCK, ERR, GPIO_, LFLT                                 | -80                          | +5  |                        |          |    |
|   |                              |  | DBL, BWS, EDC, ES                                      | -10                          | +20 |                        |          |    |
| Low-Level Output Voltage  | $V_{OL2}$                    | $I_{OUT} = 3mA$                            | $V_{IOVDD} = 1.7V$ to $1.9V$                           |                              |     | 0.4                    | V        |    |
|   |                              |  | $V_{IOVDD} = 3.0V$ to $3.6V$                           |                              |     | 0.3                    |          |    |
| <b>OUTPUT FOR REVERSE CONTROL CHANNEL (IN+, IN-)</b>  |                              |  |  |                              |     |                        |          |    |
| Differential High Output Peak Voltage, $(V_{IN+}) - (V_{IN-})$                                  | $V_{ROH}$                    | No high-speed data transmission (Figure 1) |  | 30                           | 60  |                        | mV       |    |
| Differential Low Output Peak Voltage, $(V_{IN+}) - (V_{IN-})$                                   | $V_{ROL}$                    | No high-speed data transmission (Figure 1) |  | -60                          | -30 |                        | mV       |    |
| <b>DIFFERENTIAL INPUTS (IN+, IN-)</b>   |                              |  |  |                              |     |                        |          |    |
| Differential High Input Threshold (Peak) Voltage, $(V_{IN+}) - (V_{IN-})$                       | $V_{IDH(P)}$                 | (Figure 2)                                 | Activity detector, medium threshold (0x22 D[6:5] = 01) |                              |     | 60                     | mV       |    |
|   |                              |  | Activity detector, low threshold (0x22 D[6:5] = 00)    |                              |     | 45                     |          |    |
| Differential Low Input Threshold (Peak) Voltage, $(V_{IN+}) - (V_{IN-})$                        | $V_{IDL(P)}$                 | (Figure 2)                                 | Activity detector, medium threshold (0x22 D[6:5] = 01) |                              |     | -60                    | mV       |    |
|   |                              |  | Activity detector, medium threshold (0x22 D[6:5] = 00) |                              |     | -45                    |          |    |
| Input Common-Mode Voltage $((V_{IN+}) + (V_{IN-}))/2$   | $V_{CMR}$                    |  |  | 1                            | 1.3 | 1.6                    | V        |    |
| Differential Input Resistance (Internal)  | $R_I$                        |  |  | 80                           | 105 | 130                    | $\Omega$ |    |

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### DC ELECTRICAL CHARACTERISTICS (continued)

( $V_{AVDD} = V_{DVDD} = 1.7V$  to  $1.9V$ ,  $V_{IOVDD} = 1.7V$  to  $3.6V$ ,  $R_L = 100\Omega \pm 1\%$  (differential), EP connected to PCB ground,  $T_A = -40^\circ C$  to  $+105^\circ C$ , unless otherwise noted. Typical values are at  $V_{AVDD} = V_{DVDD} = V_{IOVDD} = 1.8V$ ,  $T_A = +25^\circ C$ .) (Note 2)

| PARAMETER   | SYMBOL       | CONDITIONS   | MIN                    | TYP      | MAX             | UNITS    |          |
|---|--------------|--|------------------------|----------|-----------------|----------|----------|
| <b>SINGLE-ENDED INPUTS (IN+, IN-)</b>   |              |  |                        |          |                 |          |          |
| Single-Ended High Input Threshold (Peak) Voltage, ( $V_{IN+}$ ) - ( $V_{IN-}$ ) | $V_{IDH(P)}$ | Activity detector, medium threshold (0x22 D[6:5] = 01) |                        |          | 43              | mV       |          |
|   |              | Activity detector, low threshold (0x22 D[6:5] = 00)    |                        |          | 33              |          |          |
| Single-Ended Low Input Threshold (Peak) Voltage, ( $V_{IN+}$ ) - ( $V_{IN-}$ )  | $V_{IDL(P)}$ | Activity detector, medium threshold (0x22 D[6:5] = 01) | -43                    |          |                 | mV       |          |
|   |              | Activity detector, medium threshold (0x22 D[6:5] = 00) | -33                    |          |                 |          |          |
| Input Resistance (Internal)   | $R_I$        |  | 40                     | 52.5     | 65              | $\Omega$ |          |
| <b>LINE FAULT DETECTION INPUT (LMN0, LMN1)</b>                                  |              |  |                        |          |                 |          |          |
| Short-to-GND Threshold  | $V_{TG}$     | Figure 2A  |                        |          | 0.3             | V        |          |
| Normal Threshold  | $V_{TN}$     | Figure 2A  | 0.57                   |          | 1.07            | V        |          |
| Open Threshold  | $V_{TO}$     | Figure 2A  | 1.45                   |          | $V_{IO} + 0.06$ | V        |          |
| Open Input Threshold  | $V_{IO}$     | Figure 2A  | 1.49                   |          | 1.75            | V        |          |
| Short-to-Battery Threshold  | $V_{TE}$     | Figure 2A  | 2.47                   |          |                 | V        |          |
| <b>POWER SUPPLY</b>   |              |  |                        |          |                 |          |          |
| Worst-Case Supply Current (Figure 3)  | $I_{WCS}$    | BWS = 0, single output, EQ off                         | $f_{PCLKOUT} = 25MHz$  | 42       | 65              | mA       |          |
|   |              |  | $f_{PCLKOUT} = 50MHz$  | 61       | 90              |          |          |
|   |              | BWS = 0, double output, EQ off                         | $f_{PCLKOUT} = 50MHz$  | 42       | 70              |          |          |
|   |              |  | $f_{PCLKOUT} = 100MHz$ | 62       | 90              |          |          |
| Sleep Mode Supply Current   | $I_{CCS}$    |  | 50                     | 100      |                 | $\mu A$  |          |
| Power-Down Current  | $I_{CCZ}$    | $\overline{PWDN} = EP$                                 | 15                     | 70       |                 | $\mu A$  |          |
| <b>ESD PROTECTION</b>   |              |  |                        |          |                 |          |          |
| IN+, IN- (Note 5)   | $V_{ESD}$    | Human Body Model, $R_D = 1.5k\Omega$ , $C_S = 100pF$   |                        |          | $\pm 8$         | kV       |          |
|   |              | IEC 61000-4-2, $R_D = 330\Omega$ , $C_S = 150pF$       | Contact discharge      |          |                 |          | $\pm 10$ |
|   |              |  | Air discharge          |          |                 |          | $\pm 15$ |
|   |              | ISO 10605, $R_D = 2k\Omega$ , $C_S = 330pF$            | Contact discharge      |          |                 |          | $\pm 10$ |
| Air discharge   |              |  |                        | $\pm 30$ |                 |          |          |
| All Other Pins (Note 6)   | $V_{ESD}$    | Human Body Model, $R_D = 1.5k\Omega$ , $C_S = 100pF$   |                        |          | $\pm 4$         | kV       |          |



# MAX9240

## 6.25MHz to 100MHz, 25-Bit GMSL Deserializer for Coax or STP Cable With Line Fault Detect

### AC ELECTRICAL CHARACTERISTICS

( $V_{AVDD} = V_{DVDD} = 1.7V$  to  $1.9V$ ,  $V_{IOVDD} = 1.7V$  to  $3.6V$ ,  $R_L = 100\Omega \pm 1\%$  (differential), EP connected to PCB ground,  $T_A = -40^\circ C$  to  $+105^\circ C$ , unless otherwise noted. Typical values are at  $V_{AVDD} = V_{DVDD} = V_{IOVDD} = 1.8V$ ,  $T_A = +25^\circ C$ .) (Note 2)

| PARAMETER                                   | SYMBOL        | CONDITIONS  | MIN                      | TYP  | MAX   | UNITS |      |
|---|---------------|---|--------------------------|------|-------|-------|------|
| <b>PARALLEL CLOCK OUTPUT (PCLKOUT)</b>      |               |   |                          |      |       |       |      |
| Clock Frequency                             | $f_{PCLKOUT}$ | BWS = 0, DRS = 1  | 8.33                     |      | 16.66 | MHz   |      |
|   |               | BWS = 0, DRS = 0  | 16.66                    |      | 50    |       |      |
|   |               | BWS = 1, DRS = 1  | 6.25                     |      | 12.5  |       |      |
|   |               | BWS = 1, DRS = 0  | 12.5                     |      | 37.5  |       |      |
|   |               | BWS = 1, DRS = 0, 15-bit double input   | 25                       |      | 75    |       |      |
|   |               | BWS = 0, DRS = 0, 11-bit double input   | 33.33                    |      | 100   |       |      |
| Clock Duty Cycle                            | DC            | $t_{HIGH}/t_T$ or $t_{LOW}/t_T$ (Figure 4, Note 7)  | 40                       | 50   | 60    | %     |      |
| Clock Jitter                                | $t_J$         | Period jitter, peak to peak, spread off, 1.5Gbps, PRBS pattern, UI = $1/f_{PCLKOUT}$ (Note 7) |                          | 0.05 |       | UI    |      |
| <b>I<sup>2</sup>C/UART PORT TIMING</b>      |               |   |                          |      |       |       |      |
| I <sup>2</sup> C/UART Bit Rate              |               |   | 9.6                      |      | 1000  | kbps  |      |
| Output Rise Time                            | $t_R$         | 30% to 70%, $C_L = 10pF$ to $100pF$ , $1k\Omega$ pullup to $V_{IOVDD}$                        | 20                       |      | 120   | ns    |      |
| Output Fall Time                            | $t_F$         | 70% to 30%, $C_L = 10pF$ to $100pF$ , $1k\Omega$ pullup to $V_{IOVDD}$                        | 20                       |      | 120   | ns    |      |
| Input Setup Time                            | $t_{SET}$     | I <sup>2</sup> C only (Figure 5, Note 7)  | 100                      |      |       | ns    |      |
| Input Hold Time                             | $t_{HOLD}$    | I <sup>2</sup> C only (Figure 5, Note 7)  | 0                        |      |       | ns    |      |
| <b>SWITCHING CHARACTERISTICS</b>            |               |   |                          |      |       |       |      |
| PCLKOUT Rise-and-Fall Time                  | $t_R, t_F$    | 20% to 80%, $V_{IOVDD} = 1.7V$ to $1.9V$ (Note 7)   | DCS = 1, $C_L = 10pF$    | 0.4  |       | 2.2   | ns   |
|   |               |   | DCS = 0, $C_L = 5pF$     | 0.5  |       | 2.8   |      |
|   |               | 20% to 80%, $V_{IOVDD} = 3.0V$ to $3.6V$ (Note 7)   | DCS = 1, $C_L = 10pF$    | 0.25 |       | 1.7   |      |
|   |               |   | DCS = 0, $C_L = 5pF$     | 0.3  |       | 2.0   |      |
| Parallel Data Rise-and-Fall Time (Figure 6) | $t_R, t_F$    | 20% to 80%, $V_{IOVDD} = 1.7V$ to $1.9V$ (Note 7)   | DCS = 1, $C_L = 10pF$    | 0.5  |       | 3.1   | ns   |
|   |               |   | DCS = 0, $C_L = 5pF$     | 0.6  |       | 3.8   |      |
|   |               | 20% to 80%, $V_{IOVDD} = 3.0V$ to $3.6V$ (Note 7)   | DCS = 1, $C_L = 10pF$    | 0.3  |       | 2.2   |      |
|   |               |   | DCS = 0, $C_L = 5pF$     | 0.4  |       | 2.4   |      |
| Deserializer Delay                          | $t_{SD}$      | (Figure 7, Notes 7, 8)  | Spread spectrum enabled  |      |       | 6960  | Bits |
|   |               |   | Spread spectrum disabled |      |       | 2160  |      |
| Reverse Control-Channel Output Rise Time    | $t_R$         | No forward-channel data transmission (Figure 1, Note 7)                                       | 180                      |      | 400   | ns    |      |
| Reverse Control-Channel Output Fall Time    | $t_F$         | No forward-channel data transmission (Figure 1, Note 7)                                       | 180                      |      | 400   | ns    |      |

# MAX9240

## 6.25MHz to 100MHz, 25-Bit GMSL Deserializer for Coax or STP Cable With Line Fault Detect

### AC ELECTRICAL CHARACTERISTICS (continued)

( $V_{AVDD} = V_{DVDD} = 1.7V$  to  $1.9V$ ,  $V_{IOVDD} = 1.7V$  to  $3.6V$ ,  $R_L = 100\Omega \pm 1\%$  (differential), EP connected to PCB ground,  $T_A = -40^\circ C$  to  $+105^\circ C$ , unless otherwise noted. Typical values are at  $V_{AVDD} = V_{DVDD} = V_{IOVDD} = 1.8V$ ,  $T_A = +25^\circ C$ .) (Note 2)

| PARAMETER        | SYMBOL     | CONDITIONS   | MIN                      | TYP | MAX | UNITS   |
|------------------|------------|--|--------------------------|-----|-----|---------|
| GPI-to-GPO Delay | $t_{GPIO}$ | Deserializer GPI to serializer GPO (cable delay not included) (Figure 8) |                          |     | 350 | $\mu s$ |
| Lock Time        | $t_{LOCK}$ | (Figure 9, Note 7)   | Spread spectrum enabled  |     | 1.5 | ms      |
|                  |            |  | Spread spectrum disabled |     | 1   |         |
| Power-Up Time    | $t_{PU}$   | (Figure 10)  |                          |     | 6   | ms      |

**Note 2:** Limits are 100% production tested at  $T_A = +105^\circ C$ . Limits over the operating temperature range and relevant supply voltage range are guaranteed by design and characterization.

**Note 3:** To provide a midlevel, leave the input open, or, if driven, put driver in high impedance. High-impedance leakage current must be less than  $\pm 10\mu A$ .

**Note 4:**  $I_{IN}$  min due to voltage drop across the internal pullup resistor.

**Note 5:** Specified pin to ground.

**Note 6:** Specified pin to all supply/ground.

**Note 7:** Guaranteed by design and not production tested.

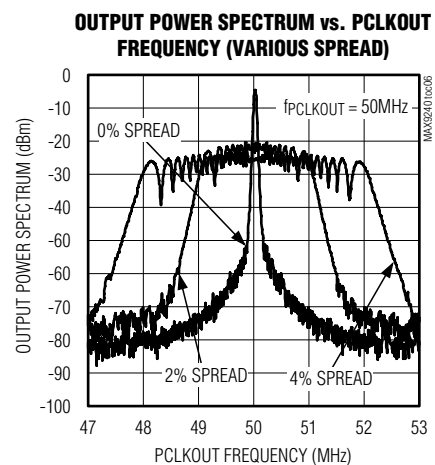
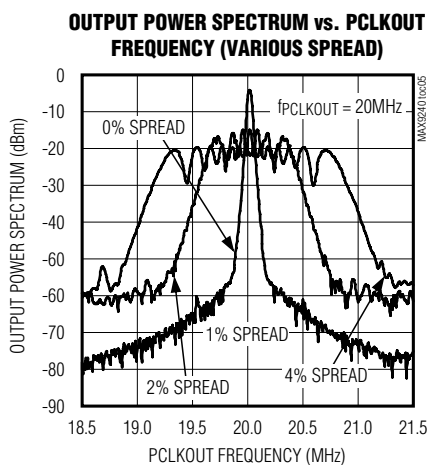
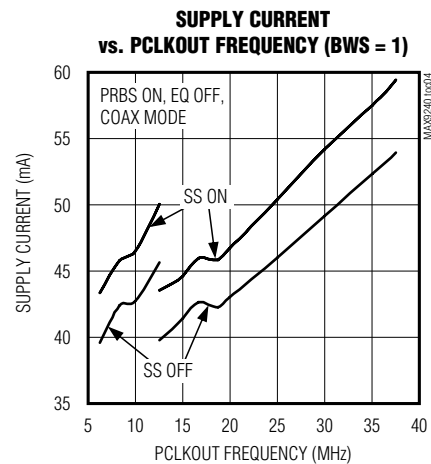
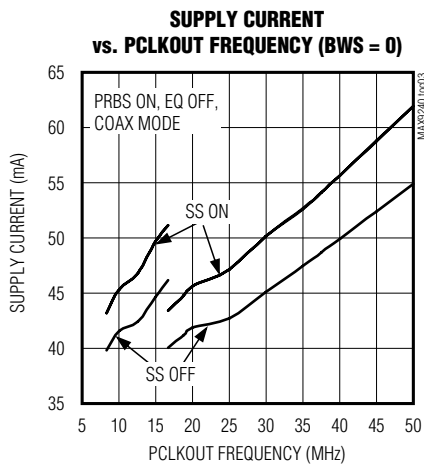
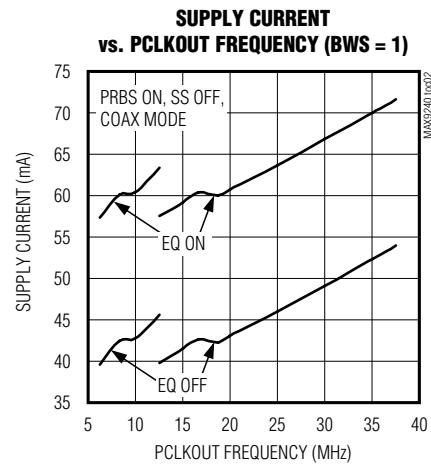
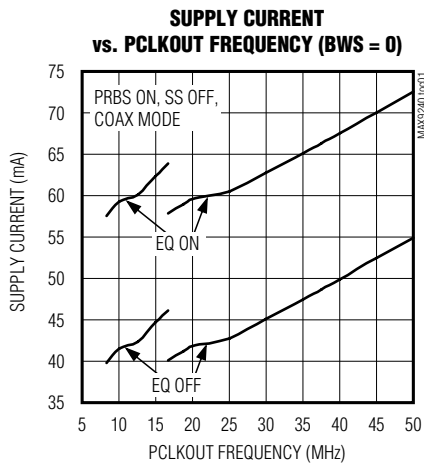
**Note 8:** Measured in serial link bit times. Bit time =  $1/(30 \times f_{PCLKOUT})$  for BWS = GND. Bit time =  $1/(40 \times f_{PCLKOUT})$  for BWS = 1.

# MAX9240

## 6.25MHz to 100MHz, 25-Bit GMSL Deserializer for Coax or STP Cable With Line Fault Detect

### Typical Operating Characteristics

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



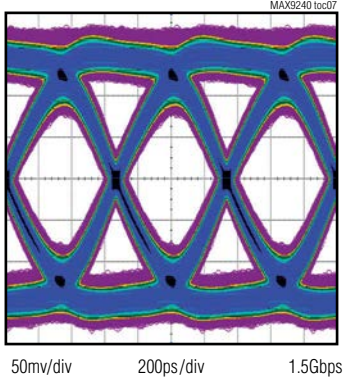
# MAX9240

## 6.25MHz to 100MHz, 25-Bit GMSL Deserializer for Coax or STP Cable With Line Fault Detect

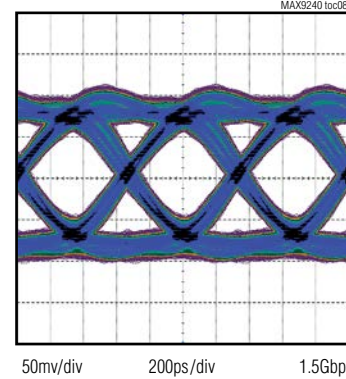
### Typical Operating Characteristics (continued)

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

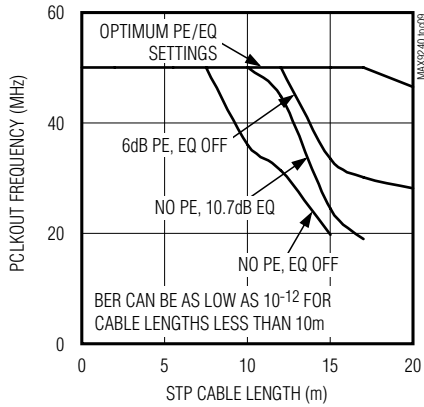
**SERIAL LINK SWITCHING PATTERN WITH 6dB PREEMPHASIS (PARALLEL BIT RATE = 50MHz, 10m STP CABLE)**



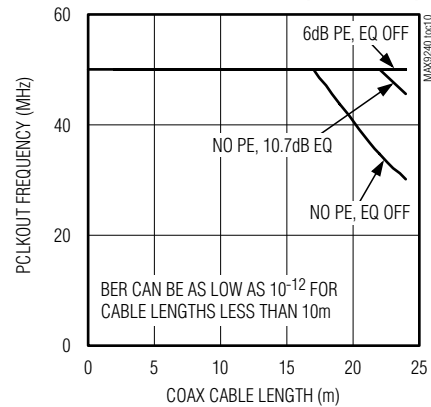
**SERIAL LINK SWITCHING PATTERN WITH 6dB PREEMPHASIS (PARALLEL BIT RATE = 50MHz, 20m COAX CABLE)**



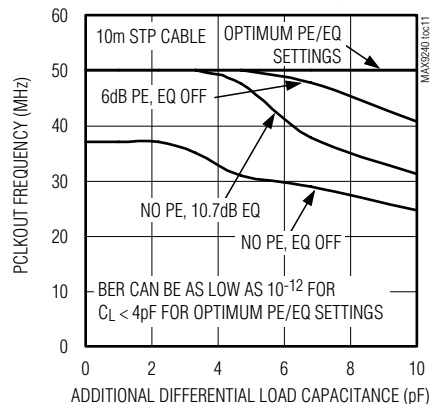
**MAXIMUM PCLKOUT FREQUENCY vs. STP CABLE LENGTH (BER ≤ 10<sup>-10</sup>)**



**MAXIMUM PCLKOUT FREQUENCY vs. COAX CABLE LENGTH (BER ≤ 10<sup>-10</sup>)**



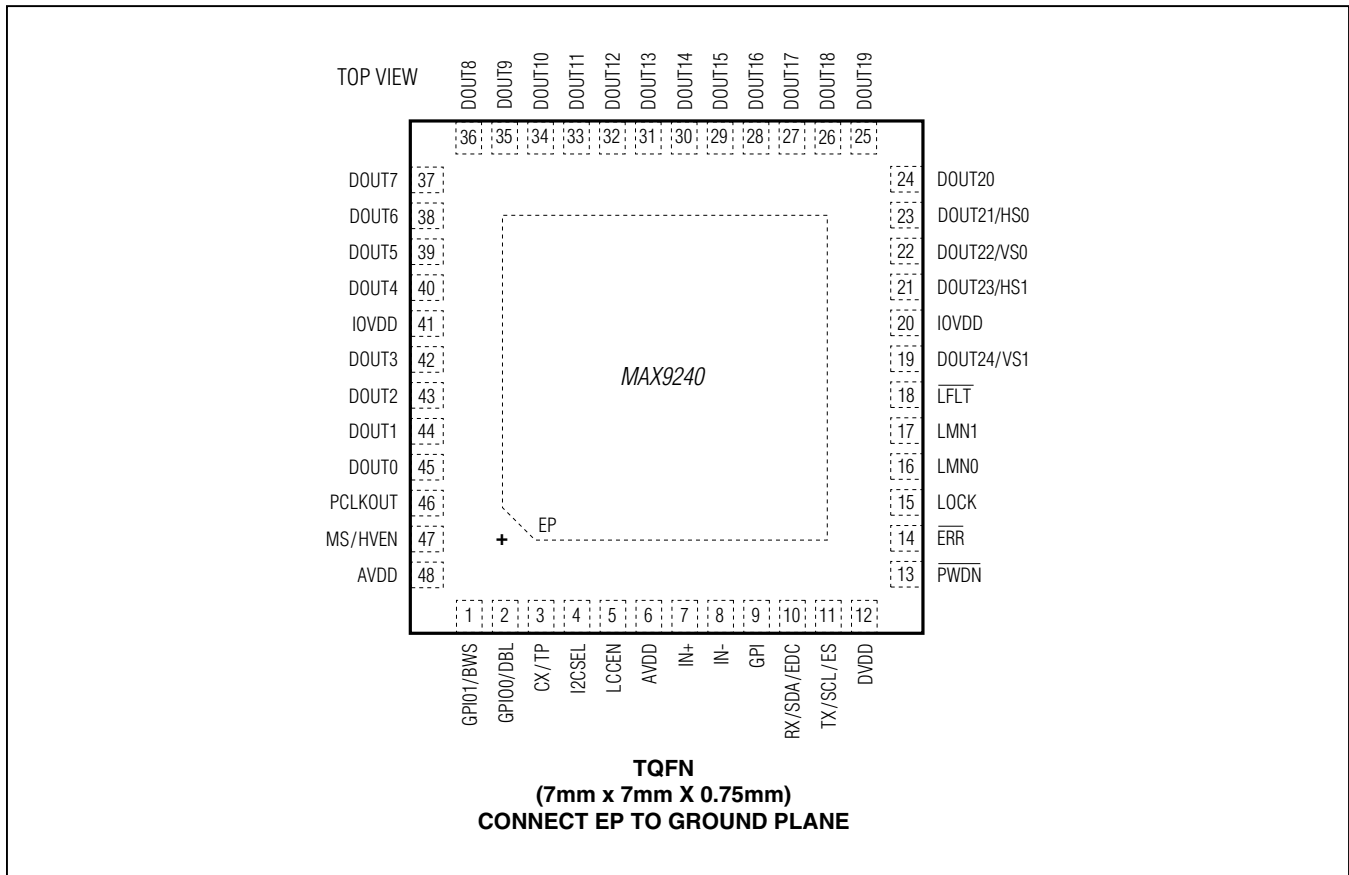
**MAXIMUM PCLKOUT FREQUENCY vs. ADDITIONAL DIFFERENTIAL C<sub>L</sub> (BER ≤ 10<sup>-10</sup>)**



# MAX9240

## 6.25MHz to 100MHz, 25-Bit GMSL Deserializer for Coax or STP Cable With Line Fault Detect

### Pin Configuration



### Pin Description

| PIN | NAME      | FUNCTION   |
|-----|-----------|--|
| 1   | GPIO1/BWS | GPIO/Bus Width Select Input. Function is determined by the state of LCCEN (Table 13).<br>GPIO1 (LCCEN = high): Open-drain, general-purpose input/output with internal 60kΩ pullup to IOVDD.<br>BWS (LCCEN = low): Input with internal pulldown to EP. Set BWS = low for 22-bit input latch. Set BWS = high for 30-bit input latch.   |
| 2   | GPIO0/DBL | GPIO/Double-Mode Input. Function is determined by the state of LCCEN (Table 13).<br>GPIO0 (LCCEN = high): Open-drain, general-purpose input/output with internal 60kΩ pullup to IOVDD.<br>DBL (LCCEN = low): Input with internal pulldown to EP. Set DBL = high to use double-input mode.<br>Set DBL = low to use single-input mode. |
| 3   | CX/TP     | Coax/Twisted-Pair Three-Level Configuration Input (Table 8)  |
| 4   | I2CSEL    | I <sup>2</sup> C Select. Control-channel interface protocol select input with internal pulldown to EP.<br>Set I2CSEL = high to select I <sup>2</sup> C slave interface. Set I2CSEL = low to select UART interface.   |

# MAX9240

## 6.25MHz to 100MHz, 25-Bit GMSL Deserializer for Coax or STP Cable With Line Fault Detect

### Pin Description (continued)

| PIN   | NAME                     | FUNCTION   |
|-------|--------------------------|--|
| 5     | LCCEN                    | Local Control-Channel Enable Input with Internal Pulldown to EP. LCCEN = high enables the control-channel interface pins. LCCEN = low disables the control-channel interface pins and selects an alternate function on the indicated pins (Table 13).  |
| 6, 48 | AVDD                     | 1.8V Analog Power Supply. Bypass AVDD to EP with 0.1 $\mu$ F and 0.001 $\mu$ F capacitors as close as possible to the device with the smaller capacitor closest to AVDD.   |
| 7     | IN+                      | Noninverting Coax/Twisted-Pair Serial Input  |
| 8     | IN-                      | Inverting Coax/Twisted-Pair Serial Input   |
| 9     | GPI                      | General-Purpose Input. The GMSL deserializer GPI (or INT) input follows GPI.   |
| 10    | RX/SDA/EDC               | Receive/Serial Data/Error Detection Correction. Function is determined by the state of LCCEN (Table 13).<br>RX/SDA (LCCEN = high): Input/output with internal 30k $\Omega$ pullup to IOVDD. In UART mode, RX/SDA is the Rx input of the MAX9240's UART. In the I <sup>2</sup> C mode, RX/SDA is the SDA input/output of the MAX9240's I <sup>2</sup> C master/slave. RX/SDA has an open-drain driver and requires a pullup resistor.<br>EDC (LCCEN = low): Input with internal pulldown to EP. Set EDC = high to enable error detection correction. Set EDC = low to disable error detection correction.   |
| 11    | TX/SCL/ES                | Transmit/Serial Clock/Edge Select. Function is determined by the state of LCCEN (Table 13).<br>TX/SCL (LCCEN = high). Input/output with internal 30k $\Omega$ pullup to IOVDD. In UART mode, TX/SCL is the Tx output of the MAX9240's UART. In the I <sup>2</sup> C mode, TX/SCL is the SCL input/output of the MAX9240's I <sup>2</sup> C master/slave. TX/SCL has an open-drain driver and requires a pullup resistor.<br>ES (LCCEN = low): Input with internal pulldown to EP. When ES is high, PCLKOUT indicates valid data on the falling edge of PCLKOUT. When ES is low, PCLKOUT indicates valid data on the rising edge of PCLKOUT. Do not change the ES input while the pixel clock is running. |
| 12    | DVDD                     | 1.8V Digital Power Supply. Bypass DVDD to EP with 0.1 $\mu$ F and 0.001 $\mu$ F capacitors as close as possible to the device with the smaller value capacitor closest to DVDD.  |
| 13    | $\overline{\text{PWDN}}$ | Active-Low Power-Down Input with Internal Pulldown to EP. Set $\overline{\text{PWDN}}$ low to enter power-down mode to reduce power consumption.   |
| 14    | $\overline{\text{ERR}}$  | Error Output. Open-drain data error detection and/or correction indication output with internal 60k $\Omega$ pullup to IOVDD. $\overline{\text{ERR}}$ is an open-drain driver and requires a pullup resistor.  |
| 15    | LOCK                     | Open-Drain Lock Output with Internal 60k $\Omega$ Pullup to IOVDD. LOCK = high indicates that PLLs are locked with correct serial-word-boundary alignment. LOCK = low indicates that PLLs are not locked or an incorrect serial-word-boundary alignment. LOCK remains low when the configuration link is active or during PRBS test. LOCK is high impedance when $\overline{\text{PWDN}}$ = low. LOCK is an open-drain driver and requires a pullup resistor.  |

# MAX9240

## 6.25MHz to 100MHz, 25-Bit GMSL Deserializer for Coax or STP Cable With Line Fault Detect

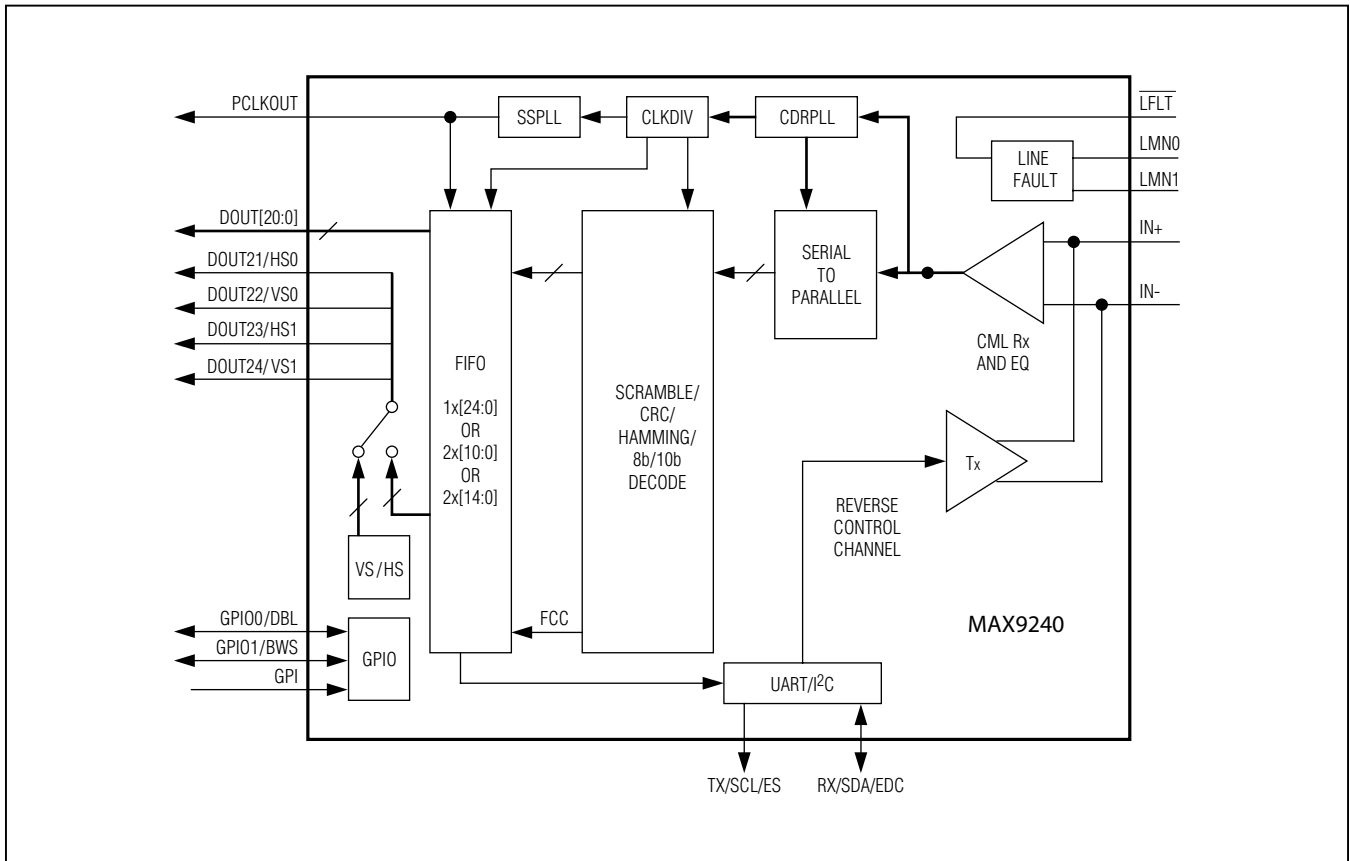
### Pin Description (continued)

| PIN             | NAME                     | FUNCTION   |
|-----------------|--------------------------|--|
| 16              | LMN0                     | Line Fault Monitor Input 0 (see Figure 2A)   |
| 17              | LMN1                     | Line Fault Monitor Input 1 (see Figure 2A)   |
| 18              | $\overline{\text{LFLT}}$ | Active-Low Open-Drain Line Fault Output. $\overline{\text{LFLT}}$ has a 60k $\Omega$ internal pullup to IOVDD. LFLT = low indicates a line fault. $\overline{\text{LFLT}}$ is high impedance when PWDN = low.  |
| 19              | DOUT24/VS1               | Parallel Data/Vertical Sync 1 Output. Defaults to parallel data output on power-up.<br>Parallel data output when VS/HS encoding is disabled.<br>Decoded vertical sync for upper half of single-output when VS/HS encoding is enabled (Table 2).  |
| 20, 41          | IOVDD                    | I/O Supply Voltage. 1.8V to 3.3V logic I/O power supply. Bypass IOVDD to EP with 0.1 $\mu$ F and 0.001 $\mu$ F capacitors as close as possible to the device with the smallest value capacitor closest to IOVDD.   |
| 21              | DOUT23/HS1               | Parallel Data/Horizontal Sync 1 Output. Defaults to parallel data output on power-up.<br>Parallel data output when VS/HS encoding is disabled.<br>Decoded horizontal sync for upper half of single-output when VS/HS encoding is enabled (Table 2).  |
| 22              | DOUT22/VS0               | Parallel Data/Vertical Sync 0 Output. Defaults to parallel data output on power-up.<br>Parallel data output when VS/HS encoding is disabled.<br>Decoded vertical sync for lower half of single-output when VS/HS encoding is enabled (Table 2).  |
| 23              | DOUT21/HS0               | Parallel Data/Horizontal Sync 0 Output. Defaults to parallel data input on power-up.<br>Parallel data output when VS/HS encoding is disabled.<br>Decoded horizontal sync for lower half of single-output when VS/HS encoding is enabled (Table 2).   |
| 24–40,<br>42–45 | DOUT20–<br>DOUT0         | Parallel Data Outputs  |
| 46              | PCLKOUT                  | Parallel Clock Output. Latches parallel data into the input of another device.   |
| 47              | MS/HVEN                  | Mode Select/HS and VS Encoding Enable with Internal Pulldown to EP. Function is determined by the state of LCCEN (Table 13).<br>MS (LCCEN = high): Set MS = low to select base mode. Set MS = high to select the bypass mode.<br>HVEN (LCCEN = low): Set HVEN = high to enable HS/VS encoding on DOUT_/HS_ and DOUT_/VS_.<br>Set HVEN = low to use DOUT_/HS_ and DOUT_/VS_ as parallel data outputs. |
| —               | EP                       | Exposed Pad. EP is internally connected to device ground. <b>MUST</b> connect EP to the PCB ground plane through an array of vias for proper thermal and electrical performance.   |

# MAX9240

## 6.25MHz to 100MHz, 25-Bit GMSL Deserializer for Coax or STP Cable With Line Fault Detect

**Functional Diagram**





# MAX9240

## 6.25MHz to 100MHz, 25-Bit GMSL Deserializer for Coax or STP Cable With Line Fault Detect

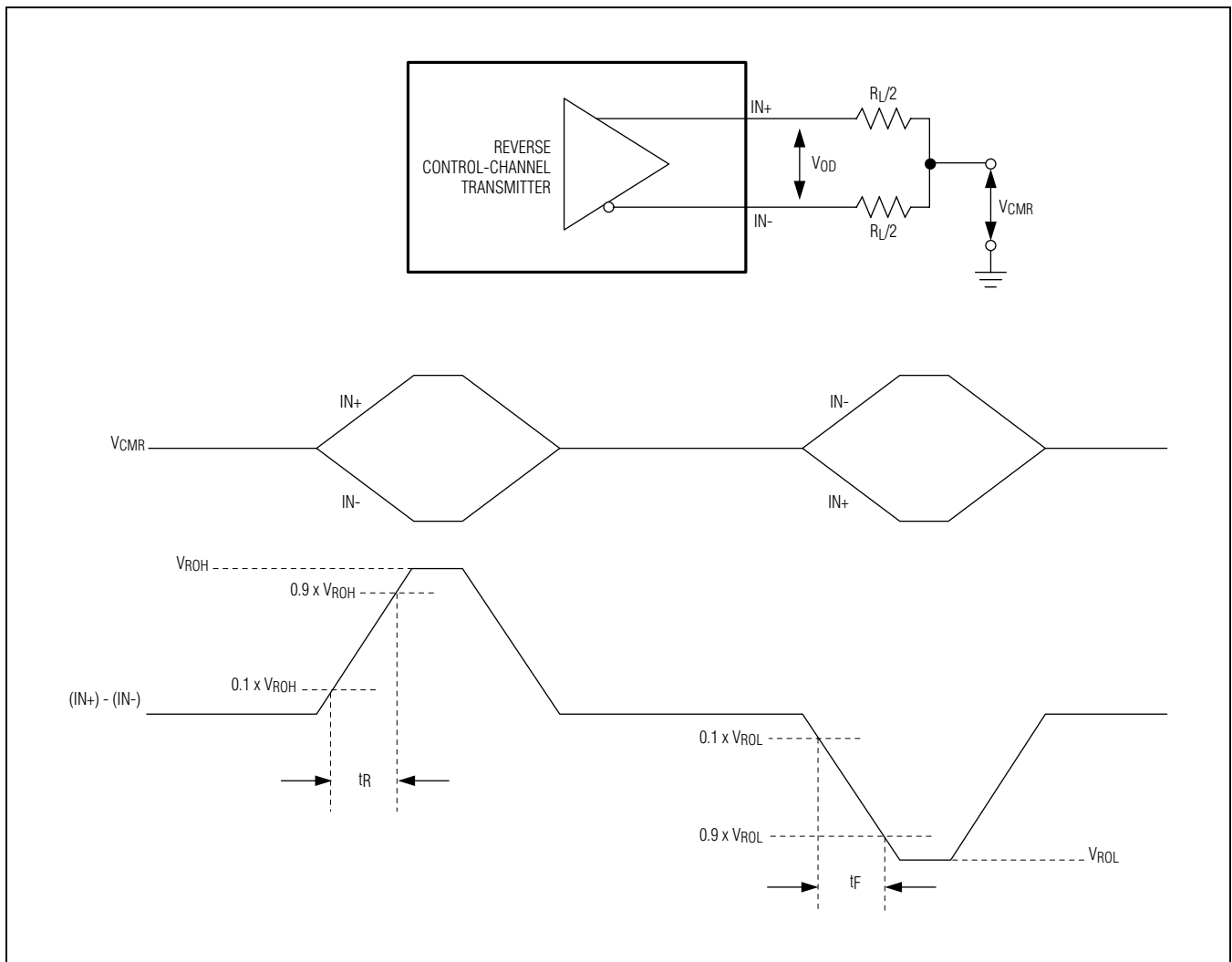


Figure 1. Reverse Control-Channel Output Parameters

# MAX9240

## 6.25MHz to 100MHz, 25-Bit GMSL Deserializer for Coax or STP Cable With Line Fault Detect

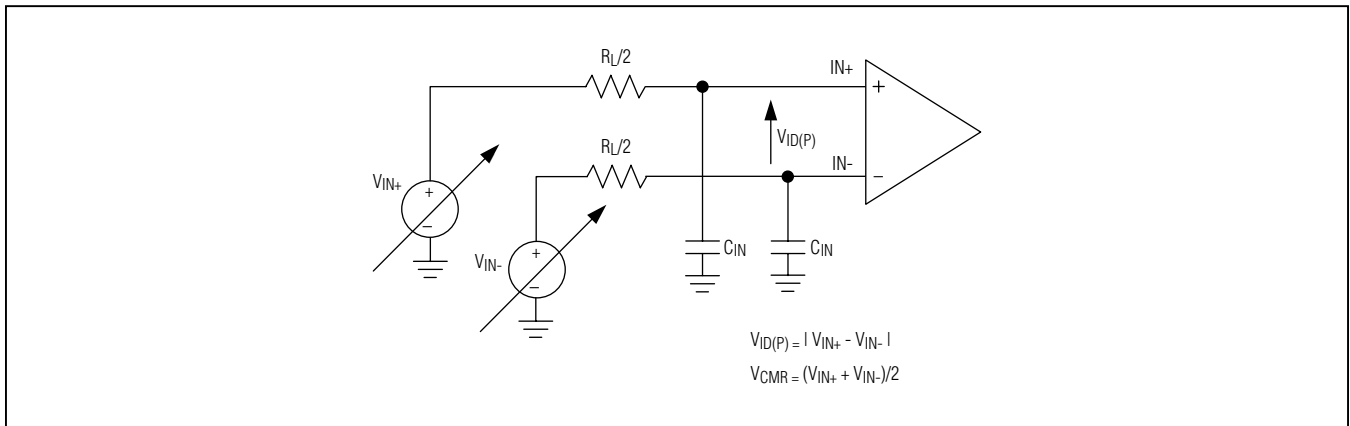


Figure 2. Test Circuit for Differential Input Measurement

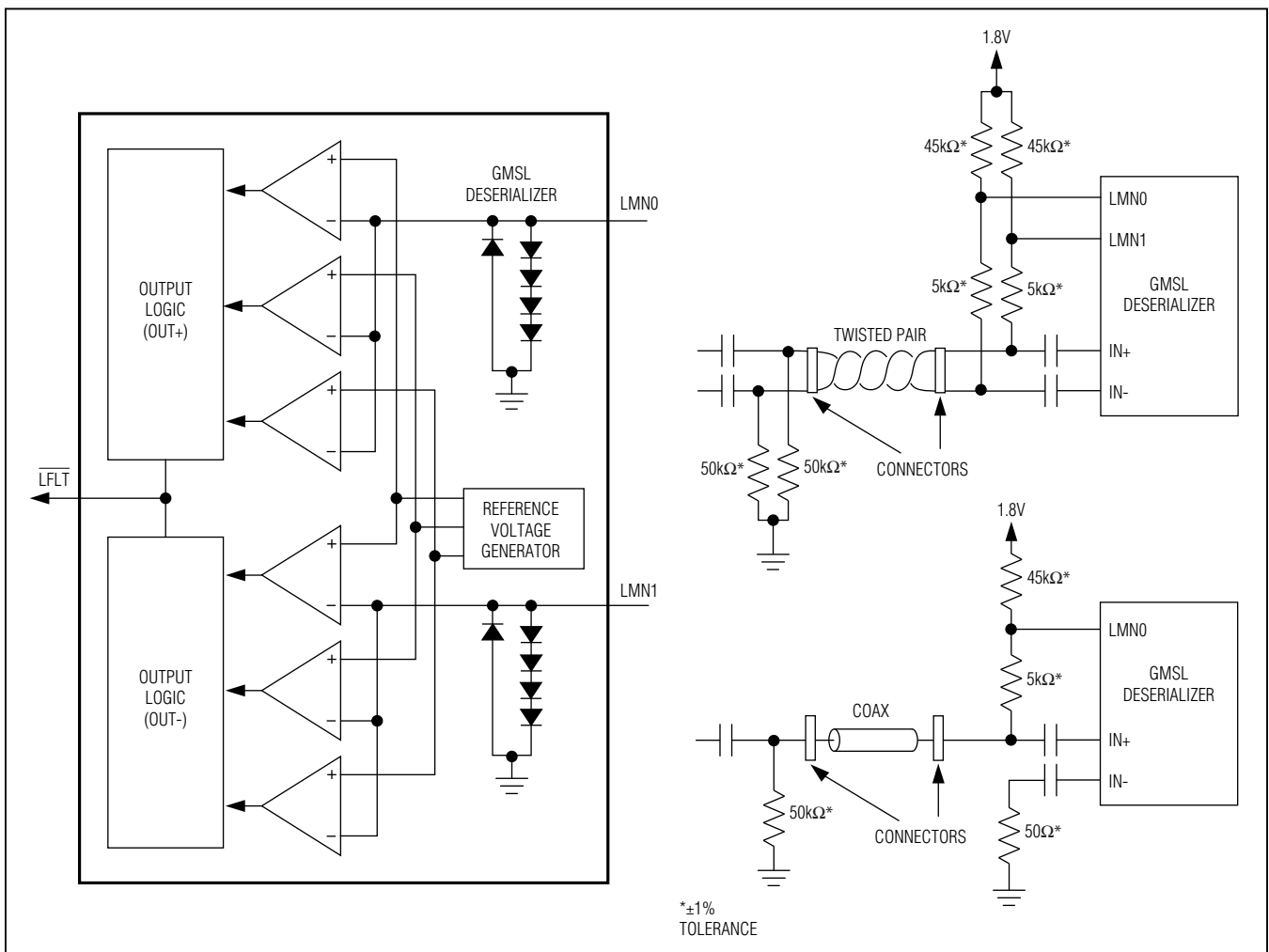


Figure 2a. Line Fault

# MAX9240

## 6.25MHz to 100MHz, 25-Bit GMSL Deserializer for Coax or STP Cable With Line Fault Detect

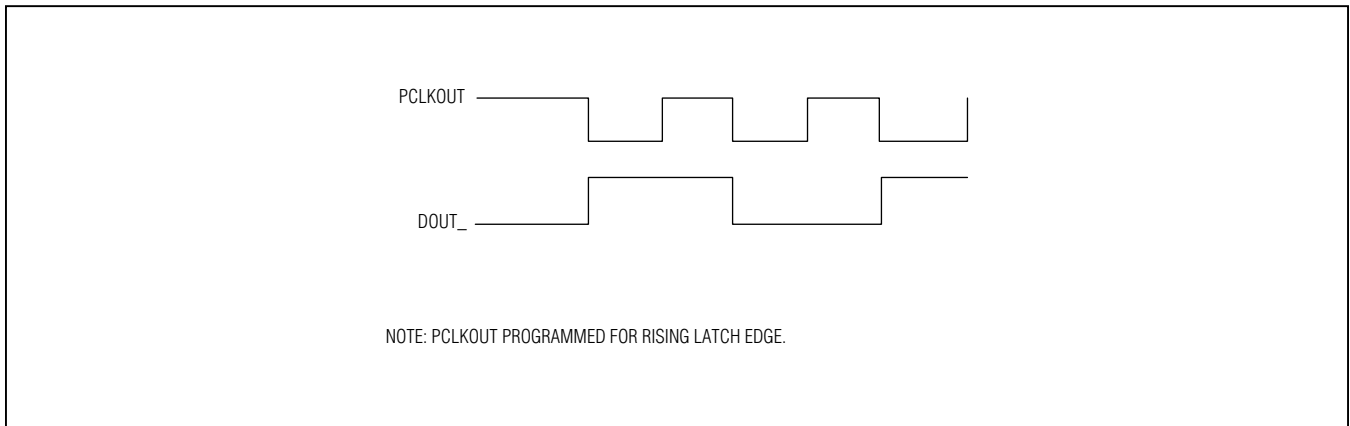


Figure 3. Worst-Case Pattern Output

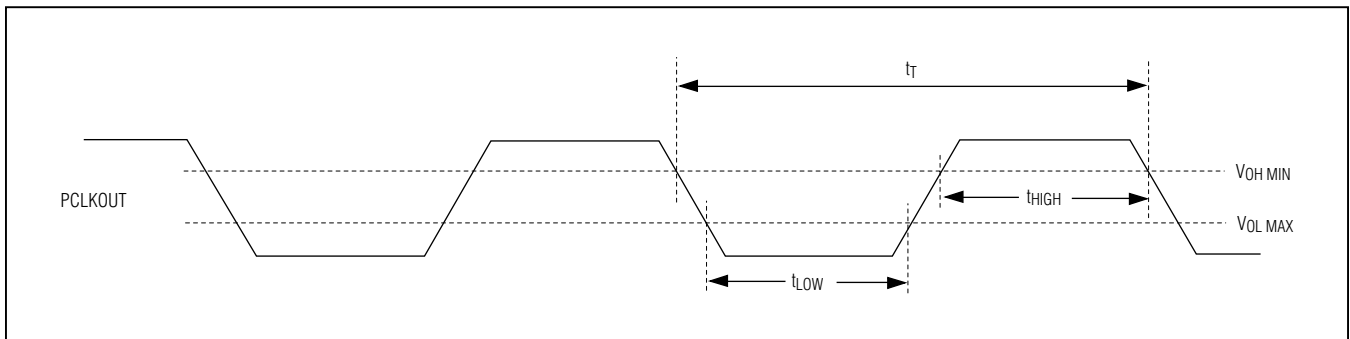


Figure 4. Parallel Clock Output High and Low Times

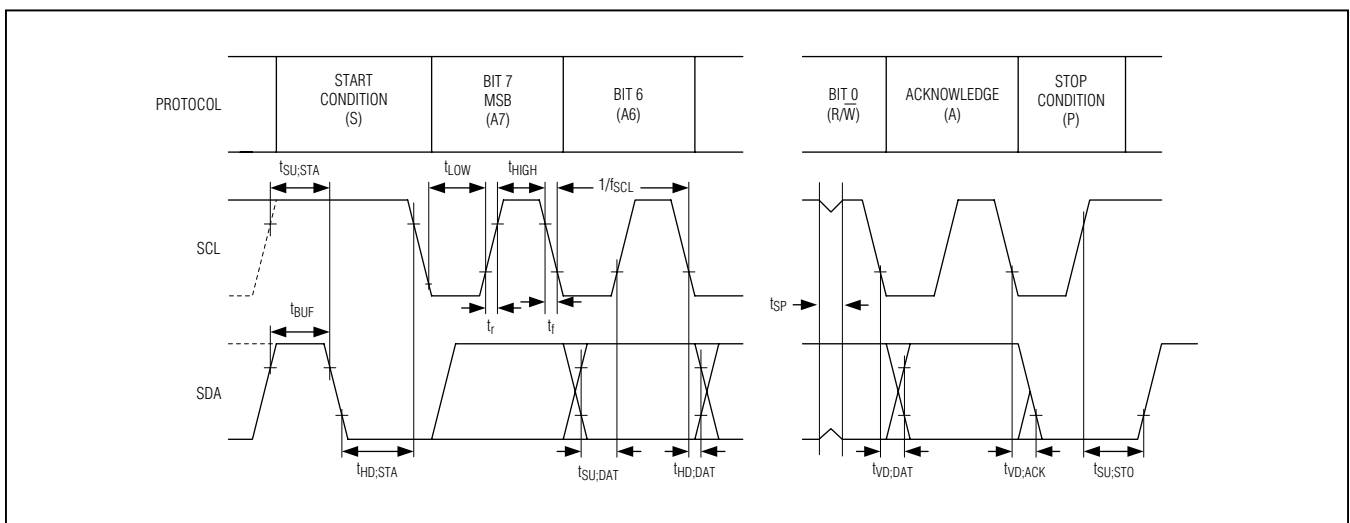


Figure 5. I<sup>2</sup>C Timing Parameters

# MAX9240

## 6.25MHz to 100MHz, 25-Bit GMSL Deserializer for Coax or STP Cable With Line Fault Detect

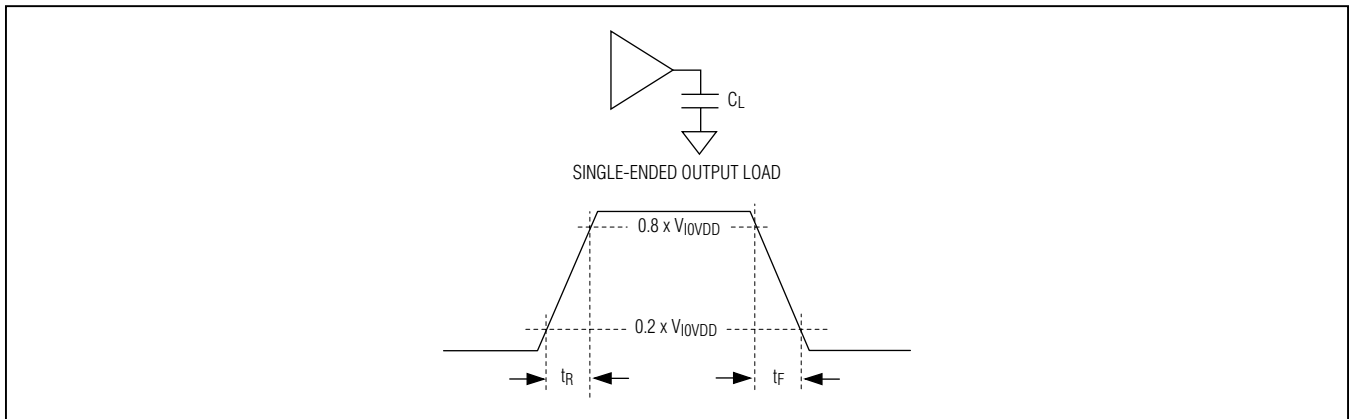


Figure 6. Output Rise-and-Fall Times

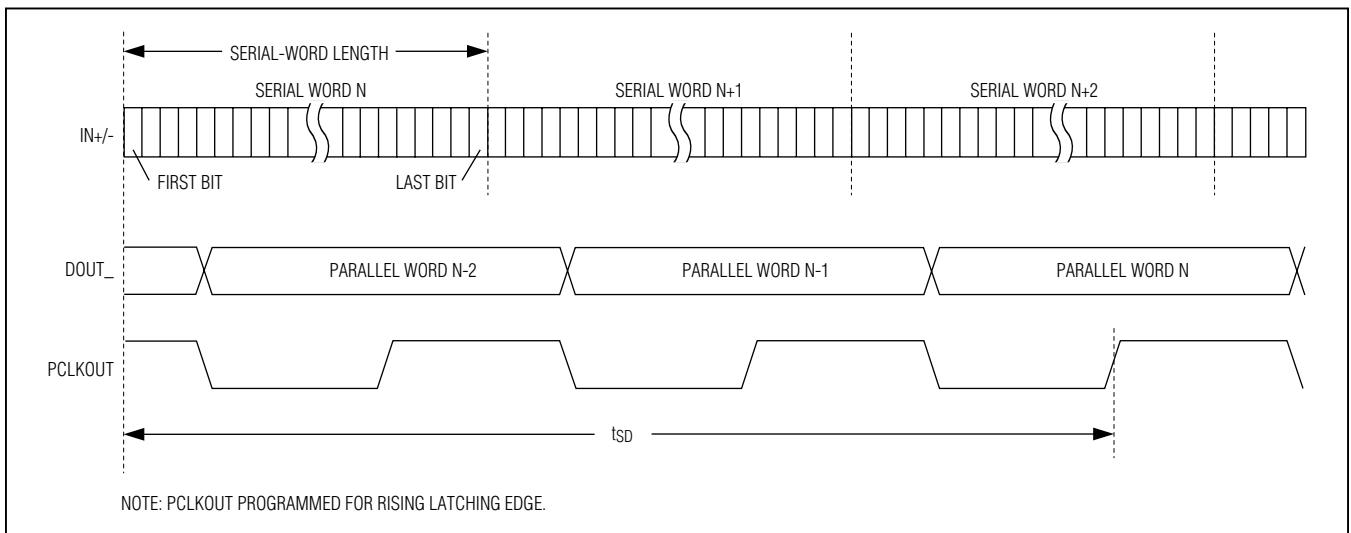


Figure 7. Deserializer Delay

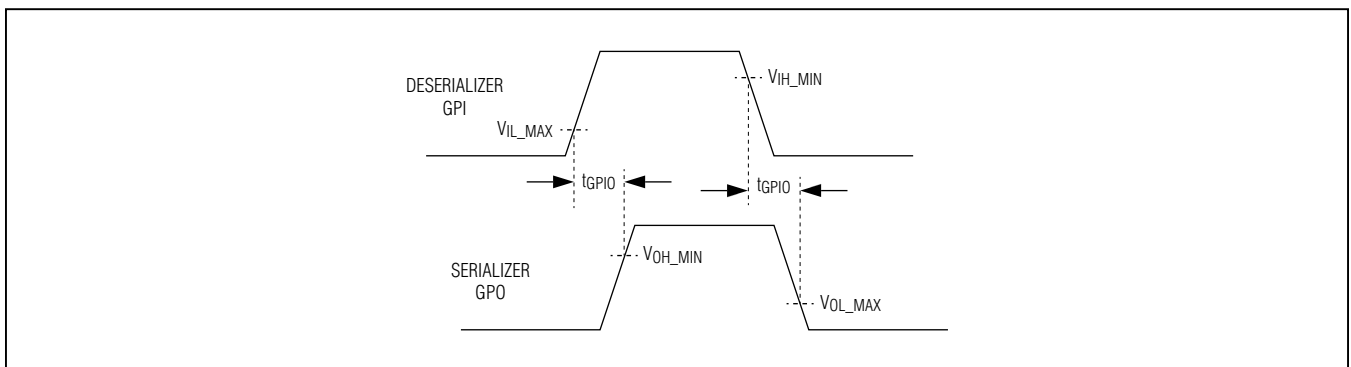


Figure 8. GPI-to-GPO Delay

# MAX9240

## 6.25MHz to 100MHz, 25-Bit GMSL Deserializer for Coax or STP Cable With Line Fault Detect

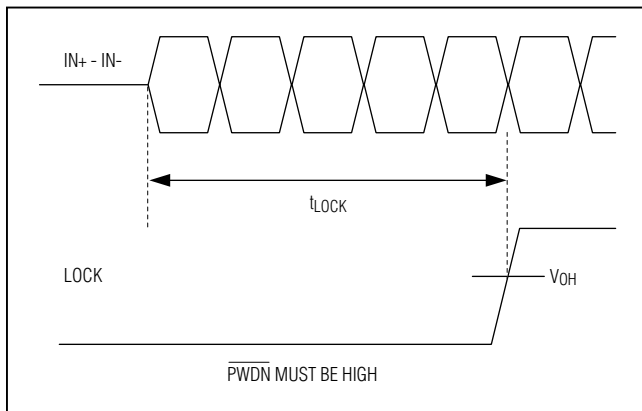


Figure 9. Lock Time

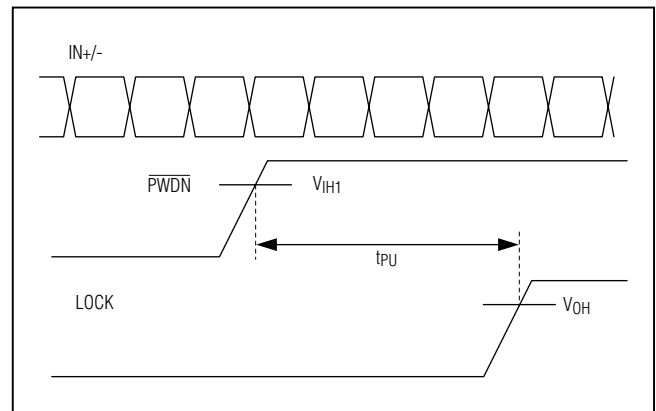


Figure 10. Power-Up Delay

### Detailed Description

The MAX9240 deserializer, when paired with the MAX9271 or MAX9273 serializer, provides the full set of operating features, but offers basic functionality when paired with any GMSL serializer.

The deserializer has a maximum serial-bit rate of 1.5Gbps for 15m or more of cable and operates up to a maximum output clock of 50MHz in 25-bit, single-output mode, or 75MHz to 100MHz in 15-bit/11-bit, double-output mode, respectively. This bit rate and output flexibility support a wide range of displays, from QVGA (320 x 240) to WVGA (800 x 480) and higher with 18-bit color, as well as megapixel image sensors. Input equalization, combined with GMSL serializer pre/deemphasis, extends the cable length and enhances link reliability.

The control channel enables a  $\mu$ C to program the serializer and deserializer registers and program registers on peripherals. The control channel is also used to configure and access the GPIO. The  $\mu$ C can be located at either end of the link, or when using two  $\mu$ Cs, at both ends. Two modes of control-channel operation are available. Base mode uses either I<sup>2</sup>C or GMSL UART protocol, while bypass mode uses a user-defined UART protocol. UART protocol allows full-duplex communication, while I<sup>2</sup>C allows half-duplex communication.

Spread spectrum is available to reduce EMI on the parallel output. The serial input complies with ISO 10605 and IEC 61000-4-2 ESD protection standards.

### Register Mapping

Registers set the operating conditions of the deserializer and are programmed using the control channel in base mode. The deserializer holds its device address and the device address of the serializer it is paired with. Similarly, the serializer holds its device address and the address of the deserializer. Whenever a device address is changed, the new address should be written to both devices. The default device address of the deserializer is set by the CX/TP input and the default device address of any GMSL serializer is 0x80 (see [Table 1](#) and [Table 8](#)). Registers 0x00 and 0x01 in both devices hold the device addresses.

### Bit Map

The parallel output functioning and width depend on settings of the double-/single-output mode (DBL), HS/VS encoding (HVEN), error correction used (EDC), and bus width (BWS) pins. [Table 2](#) lists the bit map for the control pin settings. Unused output bits are pulled low.

The parallel output has two output modes: single and double output. In single-output mode, the deserialized parallel data is clocked out every PCLKOUT cycle. The device accepts pixel clocks from 6.25MHz to 50MHz ([Figures 11](#) and [12](#)).

In double-output mode, the device splits deserialized data into two half-sized words that are output at twice the serial-word rate ([Figures 13](#) and [14](#)). The serializer/deserializer use pixel clock rates from 33.3MHz to 100MHz for 11-bit, double-output mode and 25MHz to 75MHz for 15-bit, double-output mode.

# MAX9240

## 6.25MHz to 100MHz, 25-Bit GMSL Deserializer for Coax or STP Cable With Line Fault Detect

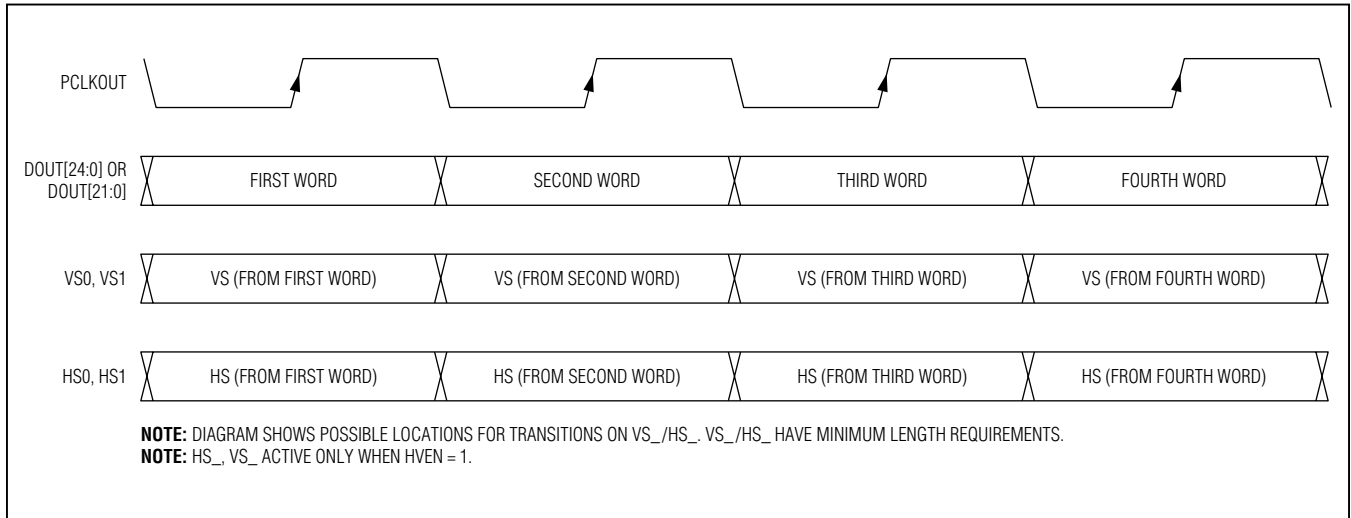


Figure 11. Single-Output Waveform (Serializer Using Single Input)

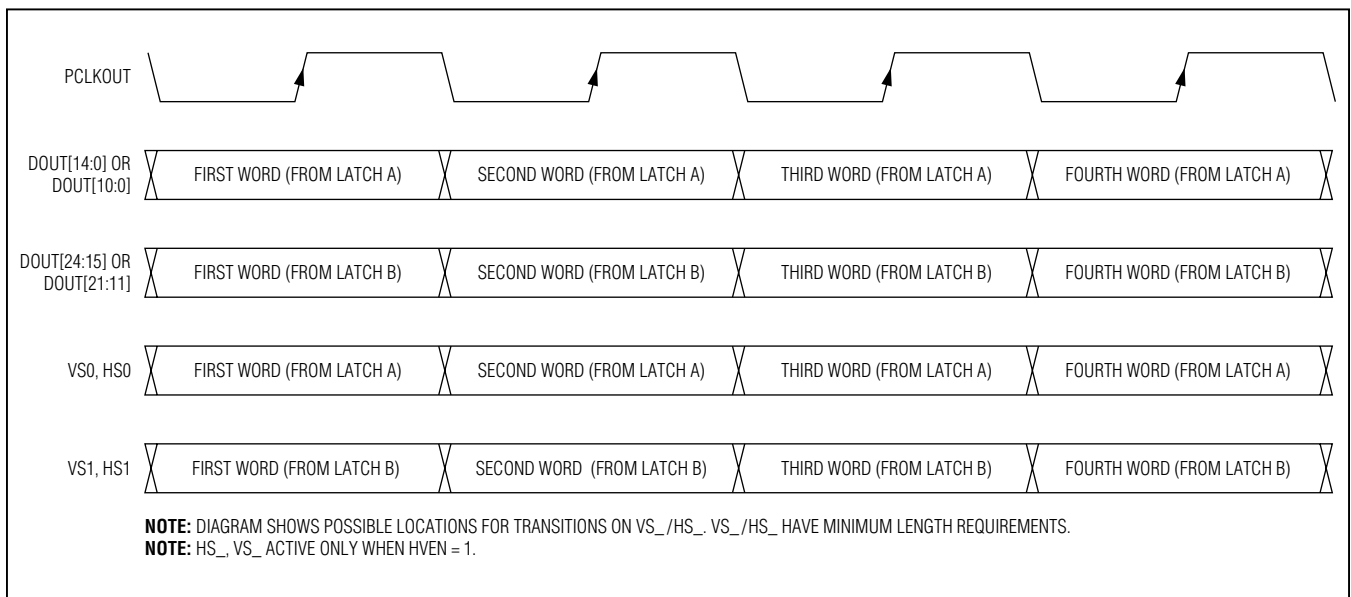


Figure 12. Single-Output Waveform (Serializer Using Double Input)

# MAX9240

## 6.25MHz to 100MHz, 25-Bit GMSL Deserializer for Coax or STP Cable With Line Fault Detect

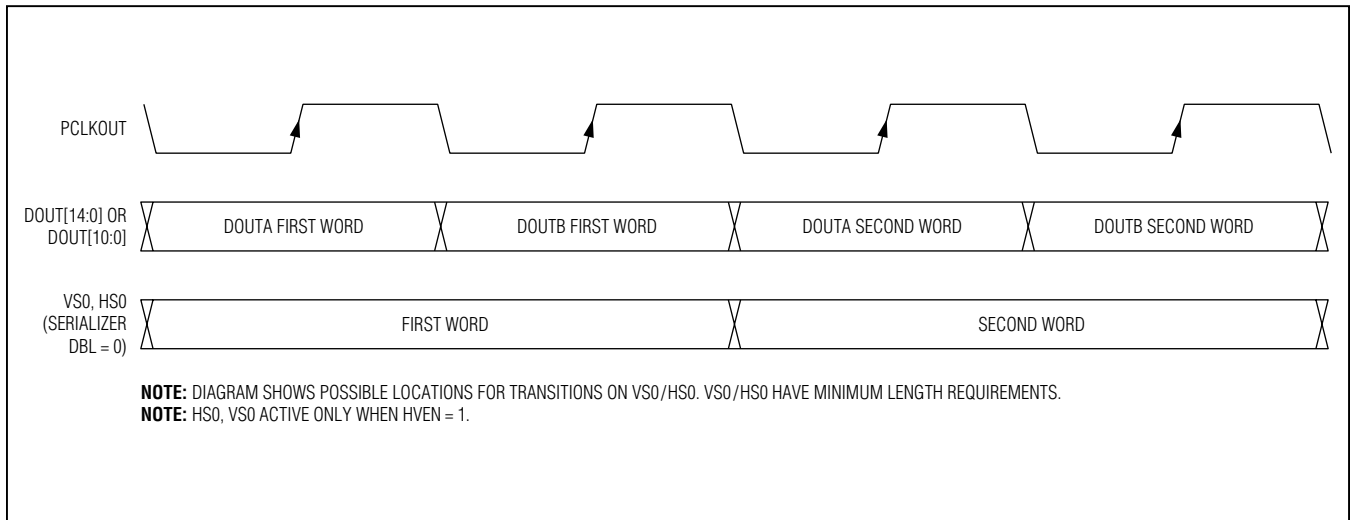


Figure 13. Double-Output Waveform (Serializer Using Single Input)

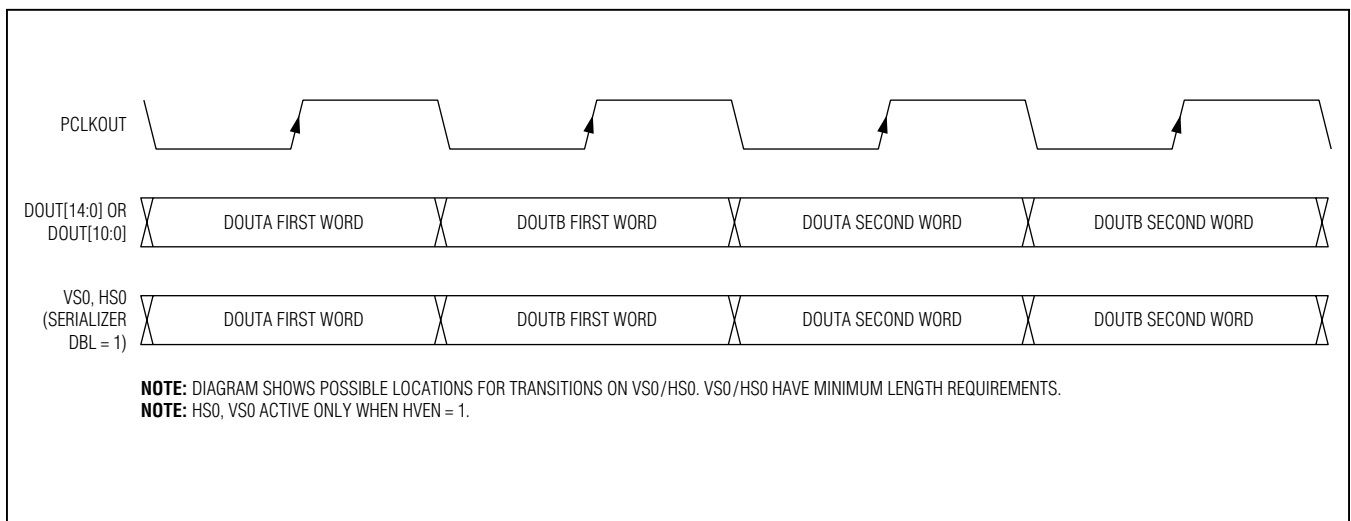


Figure 14. Double-Output Waveform (Serializer Using Double Input)

# MAX9240

## 6.25MHz to 100MHz, 25-Bit GMSL Deserializer for Coax or STP Cable With Line Fault Detect

Table 1. Power-Up Default Register Map (see [Table 16](#))

| REGISTER ADDRESS (hex) | POWER-UP DEFAULT (hex) | POWER-UP DEFAULT SETTINGS (MSB FIRST)   |
|------------------------|------------------------|---|
| 0x00                   | 0x80                   | SERID = 1000000, serializer device address<br>RESERVED = 0  |
| 0x01                   | 0x90 or 0x92           | DESID = 1001000 (CX/TP = high or low), DESID = 1001001 (CX/TP = midlevel), deserializer device address is determined by the state of the CX/TP input at power-up<br>CFGBLOCK = 0, registers 0x00 to 0x1F are read/write   |
| 0x02                   | 0x1F                   | SS = 00, spread spectrum disabled<br>RESERVED = 01<br>PRNG = 11, automatically detect the pixel clock range<br>SRNG = 11, automatically detect serial-data rate   |
| 0x03                   | 0x00                   | AUTOFM = 00, calibrate spread-modulation rate only once after locking<br>RESERVED = 0<br>SDIV = 00000, autocalibrate sawtooth divider   |
| 0x04                   | 0x07                   | LOCKED = 0, LOCK output is low (read only)<br>OUTENB = 0, output enabled<br>PRBSEN = 0, PRBS test disabled<br>SLEEP = 0, sleep mode deactivated (see the <i>Link Startup Procedure</i> section)<br>INTTYPE = 01, base mode uses UART<br>REVCEN = 1, reverse control channel active (sending)<br>FWDCCEN = 1, forward control channel active (receiving)   |
| 0x05                   | 0x24                   | I2CMETHOD = 0, I <sup>2</sup> C master sends the register address<br>DCS = 0, normal parallel output driver current<br>HVTRMODE = 1, full periodic HS/VS tracking<br>ENEQ = 0, equalizer disabled<br>EQTUNE = 1001, 10.7dB equalization   |
| 0x06                   | 0x02 or 0x22           | RESERVED = 00X00010   |
| 0x07                   | 0xXX                   | DBL = 0 or 1, single-/double-input mode setting determined by the state of LCCEN and GPIO0/DBL at startup<br>DRS = 0, high data-rate mode<br>BWS = 0 or 1, bit width setting determined by the state of LCCEN and GPIO1/BWS at startup<br>ES = 0 or 1, edge-select input setting determined by the state of LCCEN and TX/SCL/ES at startup<br>HVTRACK = 0 or 1, HS/VS tracking setting determined by the state of LCCEN and MS/HVEN at startup<br>HVEN = 0 or 1, HS/VS tracking encoding setting determined by the state of LCCEN and MS/HVEN at startup<br>EDC = 00 or 10, error-detection/correction setting determined by the state of LCCEN and RX/SDA/EDC at startup |



# MAX9240

## 6.25MHz to 100MHz, 25-Bit GMSL Deserializer for Coax or STP Cable With Line Fault Detect

Table 1. Power-Up Default Register Map (see [Table 16](#)) (continued)

| REGISTER ADDRESS (hex) | POWER-UP DEFAULT (hex) | POWER-UP DEFAULT SETTINGS (MSB FIRST)  |
|------------------------|------------------------|--|
| 0x08                   | 0x00                   | INVVS = 0, deserializer does not invert VSYNC<br>INVHS = 0, deserializer does not invert HSYNC<br>RESERVED = 0<br>UNEQDBL = 0, serializer DBL is not the same as deserializer<br>DISSTAG = 0, outputs are staggered<br>AUTORST = 0, error registers/output autoreset disabled<br>ERRSEL = 00, detected errors trigger $\overline{ERR}$     |
| 0x09                   | 0x00                   | I2CSCRA = 0000000, I <sup>2</sup> C address translator source A is 0x00<br>RESERVED = 0  |
| 0x0A                   | 0x00                   | I2CDSTA = 0000000, I <sup>2</sup> C address translator destination A is 0x00<br>RESERVED = 0   |
| 0x0B                   | 0x00                   | I2CSCRB = 0000000, I <sup>2</sup> C address translator source B is 0x00<br>RESERVED = 0  |
| 0x0C                   | 0x00                   | I2CDSTB = 0000000, I <sup>2</sup> C address translator destination B is 0x00<br>RESERVED = 0   |
| 0x0D                   | 0x36                   | I2CLOCACK = 0, acknowledge not generated when forward channel is not available<br>I2CSLVSH = 01, 469ns/234ns I <sup>2</sup> C setup/hold time<br>I2CMSTBT = 101, 339kbps (typ) I <sup>2</sup> C-to-I <sup>2</sup> C master bit-rate setting<br>I2CSLVTO = 10, 1024 $\mu$ s (typ) I <sup>2</sup> C-to-I <sup>2</sup> C slave remote timeout |
| 0x0E                   | 0x6A                   | RESERVED = 01<br>GPIEN = 1, enable GPI-to-GPO signal transmission to serializer<br>GPIIN = 0, GPI input is low (read only)<br>GPIO1OUT = 1, set GPIO1 to high<br>GPIO1IN = 0, GPIO1 input is low (read only)<br>GPIO0OUT = 1, set GPIO0 to high<br>GPIO0IN = 0, GPIO0 input is low (read only)   |
| 0x0F                   | 0x00                   | DETTNR = 00000000, error threshold set to zero for detected errors   |
| 0x10                   | 0x00<br>(read only)    | DETERR = 00000000, zero errors detected  |
| 0x11                   | 0x00                   | CORRTHR = 00000000, error threshold set to zero for corrected errors   |
| 0x12                   | 0x00<br>(read only)    | CORRERR = 00000000, zero errors corrected  |
| 0x13                   | 0x00<br>(read only)    | PRBSERR = 00000000, zero PRBS errors detected  |
| 0x14                   | 0x0A<br>(read only)    | PRBSOK = 0, PRBS test not completed<br>RESERVED = 000<br>LFNEG = 10, no faults detected<br>LFPOS = 10, no faults detected  |
| 0x15                   | 0x2X                   | RESERVED = 00100XXX  |
| 0x16                   | 0x30                   | RESERVED = 00110000  |
| 0x17                   | 0x54                   | RESERVED = 01010100  |
| 0x18                   | 0x30                   | RESERVED = 00110000  |
| 0x19                   | 0xC8                   | RESERVED = 11001000  |

# MAX9240

## 6.25MHz to 100MHz, 25-Bit GMSL Deserializer for Coax or STP Cable With Line Fault Detect

**Table 1. Power-Up Default Register Map (see [Table 16](#)) (continued)**

| REGISTER ADDRESS (hex) | POWER-UP DEFAULT (hex) | POWER-UP DEFAULT SETTINGS (MSB FIRST)   |
|------------------------|------------------------|---|
| 0x1A                   | 0xXX<br>(read only)    | RESERVED = XXXXXXXX   |
| 0x1B                   | 0xXX<br>(read only)    | RESERVED = XXXXXXXX   |
| 0x1C                   | 0xXX<br>(read only)    | RESERVED = XXXXXXXX   |
| 0x1D                   | 0x0X<br>(read only)    | CXTP = 0, twisted-pair input<br>CXSEL = 0, noninverting input<br>I2CSEL = 0, UART input<br>LCCEN = 0, local control channel disabled<br>RESERVED = XXXX |
| 0x1E                   | 0x0A<br>(read only)    | ID = 00001011, device ID is 0x0C  |
| 0x1F                   | 0x0X<br>(read only)    | RESERVED = 000<br>CAPS = 0, not HDCP capable<br>REVISION = XXXX   |

X = Indeterminate.

**Table 2. Output Map**

| EDC | BWS | DBL | HVEN | OUTPUT* (PAIRED WITH MAX9271) | OUTPUT* (PAIRED WITH MAX9273) | PCLK RANGE** (MHz) |
|-----|-----|-----|------|-------------------------------|-------------------------------|--------------------|
| 0   | 0   | 0   | 0    | DOUT0:15                      | DOUT0:21                      | 16.66 to 50        |
| 0   | 0   | 0   | 1    | DOUT0:13, HS, VS              | DOUT0:20, HS, VS              | 16.66 to 50        |
| 0   | 0   | 1   | 0    | DOUT0:10                      | DOUT0:10                      | 33.33 to 100       |
| 0   | 0   | 1   | 1    | DOUT0:10, HS, VS              | DOUT0:10, HS, VS              | 33.33 to 100       |
| 0   | 1   | 0   | 0    | DOUT0:15                      | DOUT0:21                      | 12.5 to 37.5       |
| 0   | 1   | 0   | 1    | DOUT0:13, HS, VS              | DOUT0:20, HS, VS              | 12.5 to 37.5       |
| 0   | 1   | 1   | 0    | DOUT0:14                      | DOUT0:14                      | 25 to 75           |
| 0   | 1   | 1   | 1    | DOUT0:13, HS, VS              | DOUT0:14, HS, VS              | 25 to 75           |
| 1   | 0   | 0   | 0    | DOUT0:15                      | DOUT0:15                      | 16.66 to 50        |
| 1   | 0   | 0   | 1    | DOUT0:13, HS, VS              | DOUT0:15, HS, VS              | 16.66 to 50        |
| 1   | 0   | 1   | 0    | DOUT0:7                       | DOUT0:7                       | 33.33 to 100       |
| 1   | 0   | 1   | 1    | DOUT0:7, HS, VS               | DOUT0:7, HS, VS               | 33.33 to 100       |
| 1   | 1   | 0   | 0    | DOUT0:15                      | DOUT0:21                      | 12.5 to 37.5       |
| 1   | 1   | 0   | 1    | DOUT0:13, HS, VS              | DOUT0:20, HS, VS              | 12.5 to 37.5       |
| 1   | 1   | 1   | 0    | DOUT0:14                      | DOUT0:14                      | 25 to 75           |
| 1   | 1   | 1   | 1    | DOUT0:13, HS, VS              | DOUT0:14, HS, VS              | 25 to 75           |

\*\*The number of available outputs depends on the serializer attached to the MAX9240.

\*\*Device is in high-speed mode (DRS = LOW). See Table 3 for PCLK ranges in low-speed mode (DRS = high).

# MAX9240

## 6.25MHz to 100MHz, 25-Bit GMSL Deserializer for Coax or STP Cable With Line Fault Detect

### Serial Link Signaling and Data Format

The serializer uses differential CML signaling to drive twisted-pair cable and single-ended CML to drive coax cable with programmable pre/deemphasis and AC-coupling. The deserializer uses AC-coupling and programmable channel equalization.

Input data is scrambled and then 8b/10b coded. The deserializer recovers the embedded serial clock, then samples, decodes, and descrambles the data. In 24-bit or 32-bit mode, 22 or 30 bits contain the video data and/or error-correction bits, if used. The 23rd or 31st bit carries the forward control-channel data. The last bit is the parity bit of the previous 23 or 31 bits (Figure 15).

### Reverse Control Channel

The serializer uses the reverse control channel to receive I<sup>2</sup>C/UART and GPO signals from the deserializer in the

opposite direction of the video stream. The reverse control channel and forward video data coexist on the same serial cable, forming a bidirectional link. The reverse control channel operates independently from the forward control channel. The reverse control channel is available 2ms after power-up. The serializer temporarily disables the reverse control channel for 350μs after starting/stopping the forward serial link.

### Data-Rate Selection

The serializer/deserializer use DRS, DBL, and BWS to set the PCLKOUT frequency range (Table 3). Set DRS = 1 for a PCLKOUT frequency range of 6.25MHz to 12.5MHz (32-bit, single-output mode) or 8.33MHz to 16.66MHz (24-bit, single-output mode). Set DRS = 0 for normal operation. It is not recommended to use double-output mode when DRS = 1.

**Table 3. Data-Rate Selection Table**

| DRS SETTING | DBL SETTING      | BWS SETTING     | PCLKOUT RANGE (MHz) |
|-------------|------------------|-----------------|---------------------|
| 0           | 0 (single input) | 0 (24-bit mode) | 16.66 to 50         |
| 0           | 0                | 1 (32-bit mode) | 12.5 to 35          |
| 0           | 1 (double input) | 0               | 33.3 to 100         |
| 0           | 1                | 1               | 25 to 75            |
| 1           | 0                | 0               | 8.33 to 16.66       |
| 1           | 0                | 1               | 6.25 to 12.5        |
| 1           | 1                | 0               | Do Not Use          |
| 1           | 1                | 1               | Do Not Use          |

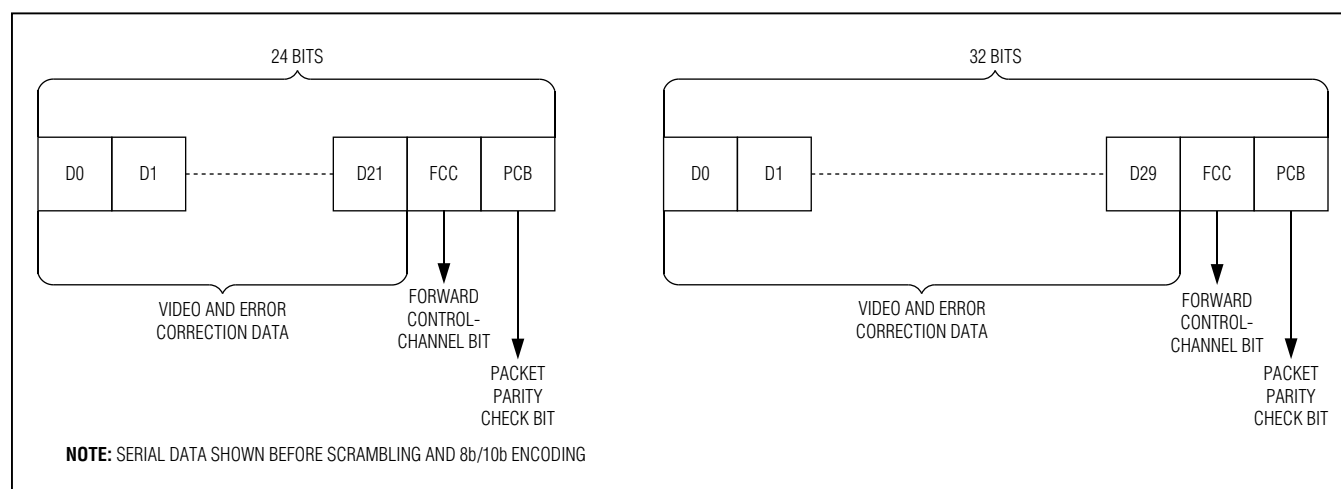


Figure 15. Serial-Data Format

## 6.25MHz to 100MHz, 25-Bit GMSL Deserializer for Coax or STP Cable With Line Fault Detect

### Control Channel and Register Programming

The control channel is available for the  $\mu\text{C}$  to send and receive control data over the serial link simultaneously with the high-speed data. The  $\mu\text{C}$  controls the link from either the serializer or the deserializer side to support video-display or image-sensing applications. The control channel between the  $\mu\text{C}$  and serializer or deserializer runs in base mode or bypass mode, according to the mode selection (MS/HVEN) input of the device connected to the  $\mu\text{C}$ . Base mode is a half-duplex control channel and bypass mode is a full-duplex control channel.

### UART Interface

In base mode, the  $\mu\text{C}$  is the host and can access the registers of both the serializer and deserializer from either side of the link using the GMSL UART protocol. The  $\mu\text{C}$  can also program the peripherals on the remote side by sending the UART packets to the serializer or deserializer, with the UART packets converted to I<sup>2</sup>C by the device on the remote side of the link. The  $\mu\text{C}$  communicates with a UART peripheral in base mode (through INTTYPE register settings), using the half-duplex default GMSL UART protocol of the serializer/deserializer. The device addresses of the serializer/deserializer in base mode are programmable. The default value is 0x80 for the serializer and is determined by the CX/TP input for the deserializer (Table 8).

When the peripheral interface is I<sup>2</sup>C, the serializer/deserializer convert UART packets to I<sup>2</sup>C that have device addresses different from those of the serializer or deserializer. The converted I<sup>2</sup>C bit rate is the same as the original UART bit rate.

The deserializer uses differential line coding to send signals over the reverse channel to the serializer. The bit rate of the control channel is 9.6kbps to 1Mbps in both directions. The serializer/deserializer automatically detect the control-channel bit rate in base mode. Packet bit-rate changes can be made in steps of up to 3.5 times higher or lower than the previous bit rate. See the [Changing the Clock Frequency](#) section for more information on changing the control-channel bit rate.

Figure 16 shows the UART protocol for writing and reading in base mode between the  $\mu\text{C}$  and the serializer/deserializer.

Figure 17 shows the UART data format. Figure 18 and Figure 19 detail the formats of the SYNC byte (0x79) and the ACK byte (0xC3). The  $\mu\text{C}$  and the connected slave chip generate the SYNC byte and ACK byte, respectively. Events such as device wake-up and GPI generate transitions on the control channel that can be ignored by the  $\mu\text{C}$ . Data written to the serializer/deserializer registers do not take effect until after the ACK byte is sent. This allows the  $\mu\text{C}$  to verify that write commands are received without error, even if the result of the write command directly affects the serial link. The slave uses the SYNC byte to synchronize with the host UART's data rate. If the GPI or MS/HVEN inputs of the deserializer toggle while there is control-channel communication, or if a line fault occurs, the control-channel communication is corrupted. In the event of a missed or delayed acknowledge (~1ms due to control-channel timeout), the  $\mu\text{C}$  should assume there was an error in the packet when the slave device received it, or that an error occurred during the response from the slave device. In base mode, the  $\mu\text{C}$  must keep the UART Tx/Rx lines high for 16 bit times before starting to send a new packet.

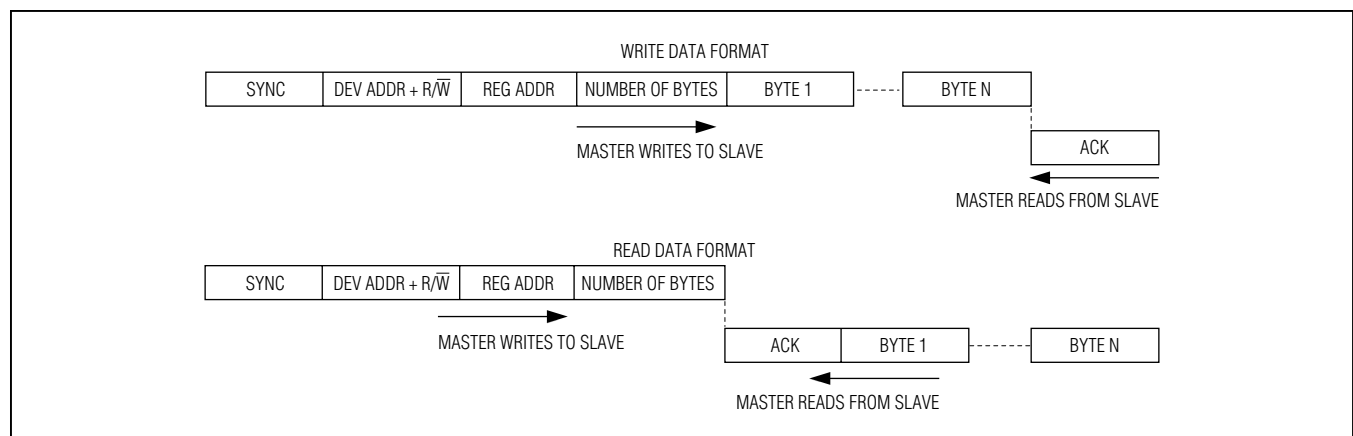


Figure 16. GMSL UART Protocol for Base Mode

## 6.25MHz to 100MHz, 25-Bit GMSL Deserializer for Coax or STP Cable With Line Fault Detect

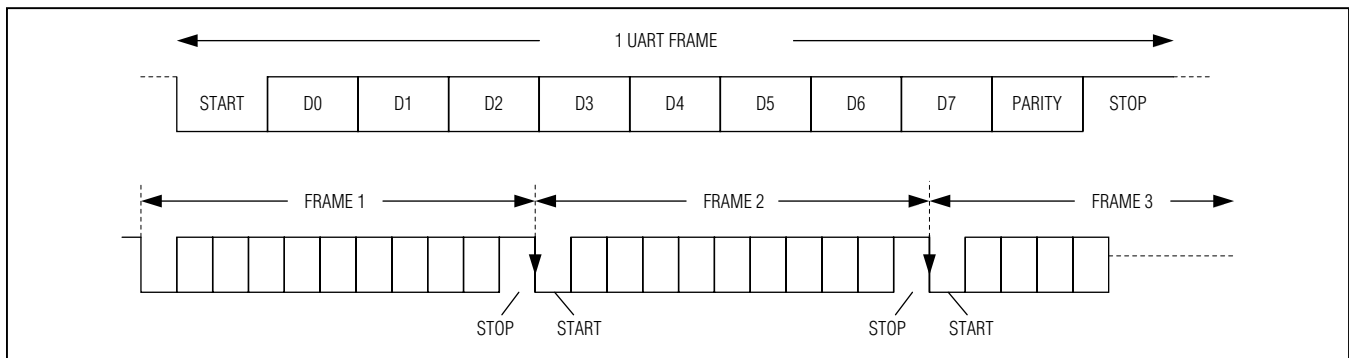


Figure 17. GMSL UART Data Format for Base Mode

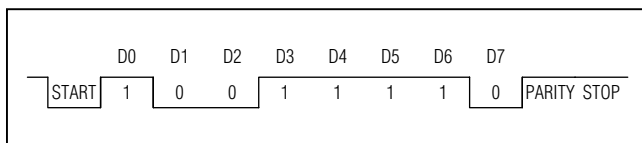


Figure 18. SYNC Byte (0x79)

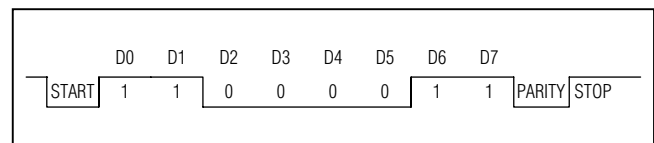


Figure 19. ACK Byte (0xC3)

As shown in [Figure 20](#), the remote-side device converts packets going to or coming from the peripherals from UART format to I<sup>2</sup>C format and vice versa. The remote device removes the byte number count and adds or receives the ACK between the data bytes of I<sup>2</sup>C. The I<sup>2</sup>C bit rate is the same as the UART bit rate.

### Interfacing Command-Byte-Only I<sup>2</sup>C Devices with UART

The serializer/deserializer UART-to-I<sup>2</sup>C conversion can interface with devices that do not require register addresses, such as the MAX7324 GPIO expander. In this mode, the I<sup>2</sup>C master ignores the register address byte and directly reads/writes the subsequent data bytes ([Figure 21](#)). Change the communication method of the I<sup>2</sup>C master using the I2CMETHOD bit. I2CMETHOD = 1 sets command-byte-only mode, while I2CMETHOD = 0 sets normal mode where the first byte in the data stream is the register address.

### UART Bypass Mode

In bypass mode, the serializer/deserializer ignore UART commands from the  $\mu$ C and the  $\mu$ C communicates with the peripherals directly using its own defined UART protocol. The  $\mu$ C cannot access the serializer/deserializer registers in this mode. Peripherals accessed through the forward control channel using the UART interface need to handle at least one PCLKOUT period  $\pm$  10ns of jitter due to the asynchronous sampling of the UART signal by PCLKOUT. Set MS/HVEN = high to put the control channel into bypass mode. For applications with the  $\mu$ C

connected to the deserializer, there is a 1ms wait time between setting MS/HVEN high and the bypass control channel being active. There is no delay time when switching to bypass mode when the  $\mu$ C is connected to the serializer. Do not send a logic-low value longer than 100 $\mu$ s to ensure proper GPO functionality. Bypass mode accepts bit rates down to 10kbps in either direction. See the [GPO/GPI Control](#) section for GPI functionality limitations. The control-channel data pattern should not be held low longer than 100 $\mu$ s if GPI control is used.

### I<sup>2</sup>C Interface

In I<sup>2</sup>C-to-I<sup>2</sup>C mode, the deserializer's control-channel interface sends and receives data through an I<sup>2</sup>C-compatible 2-wire interface. The interface uses a serial-data line (SDA) and a serial-clock line (SCL) to achieve bidirectional communication between master and slave(s). A  $\mu$ C master initiates all data transfers to and from the device and generates the SCL clock that synchronizes the data transfer. When an I<sup>2</sup>C transaction starts on the local-side device's control-channel port, the remote-side device's control-channel port becomes an I<sup>2</sup>C master that interfaces with remote-side I<sup>2</sup>C peripherals. The I<sup>2</sup>C master must accept clock stretching, which is imposed by the deserializer (holding SCL low). The SDA and SCL lines operate as both an input and an open-drain output. Pullup resistors are required on SDA and SCL. Each transmission consists of a START condition ([Figure 5](#)) sent by a master, followed by the device's 7-bit slave address plus a R/W bit, a register address byte, one or more data bytes, and finally a STOP condition.

# MAX9240

## 6.25MHz to 100MHz, 25-Bit GMSL Deserializer for Coax or STP Cable With Line Fault Detect

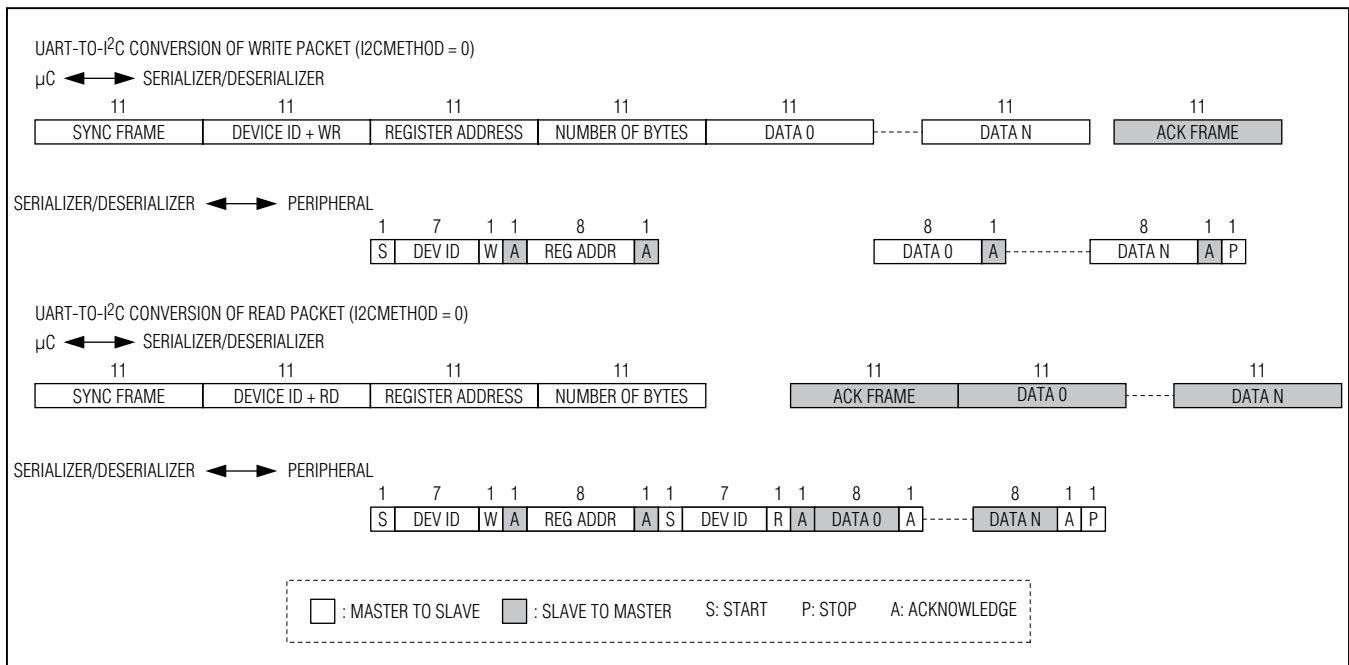


Figure 20. Format Conversion Between GMSL UART and I<sup>2</sup>C with Register Address (I2CMETHOD = 0)

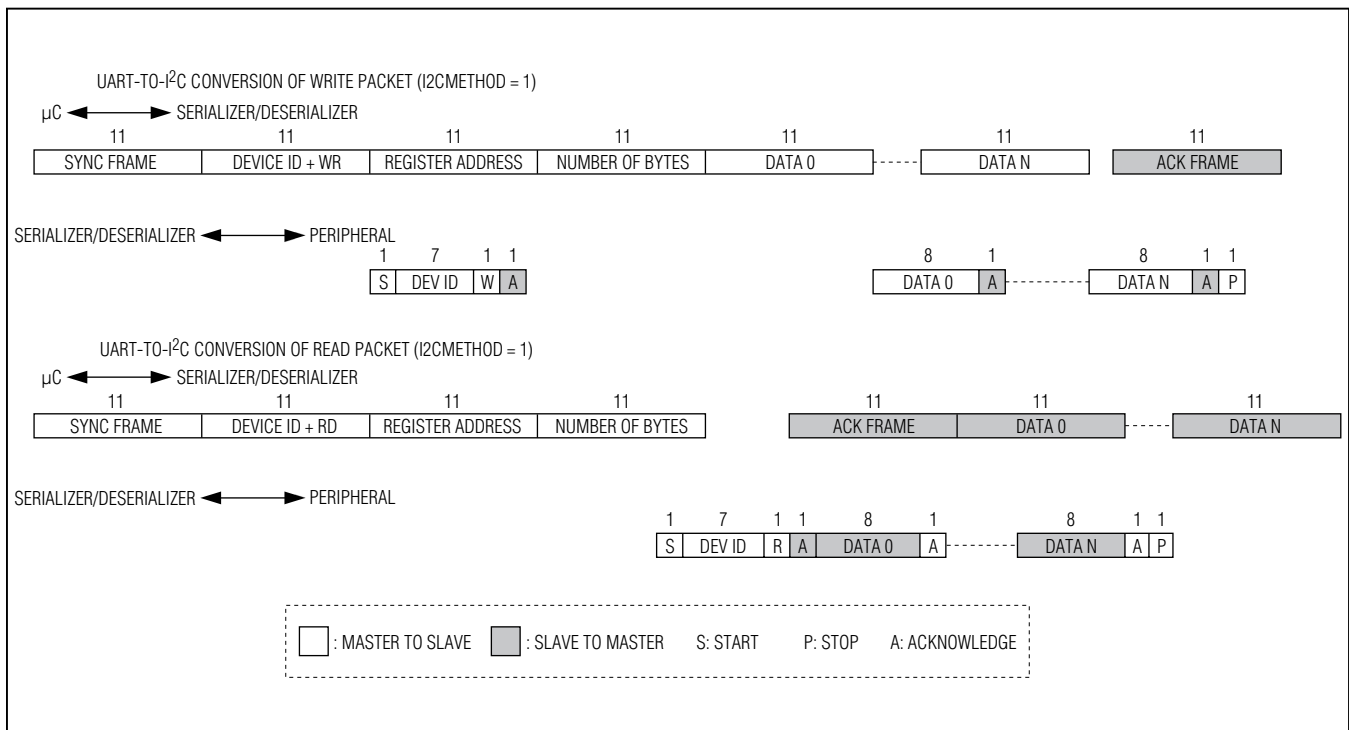


Figure 21. Format Conversion Between GMSL UART and I<sup>2</sup>C with Register Address (I2CMETHOD = 1)

## 6.25MHz to 100MHz, 25-Bit GMSL Deserializer for Coax or STP Cable With Line Fault Detect

### START and STOP Conditions

Both SCL and SDA remain high when the interface is not busy. A master signals the beginning of a transmission with a START (S) condition by transitioning SDA from high to low while SCL is high (Figure 22). When the master has finished communicating with the slave, it issues a STOP (P) condition by transitioning SDA from low to high while SCL is high. The bus is then free for another transmission.

### Bit Transfer

One data bit is transferred during each clock pulse (Figure 23). The data on SDA must remain stable while SCL is high.

### Acknowledge

The acknowledge bit is a clocked 9th bit that the recipient uses to handshake receipt of each byte of data (Figure 24). Thus, each byte transferred effectively requires 9 bits. The master generates the 9th clock pulse, and the recipient pulls down SDA during the acknowledge clock pulse. The SDA line is stable low during the high period of the clock pulse. When the master is transmitting to the slave device, the slave device generates the acknowledge bit because the slave device is the recipient. When the slave device is transmitting to the master, the master generates the acknowledge bit because the master is the recipient. The device generates an acknowledge even when the forward control channel is not active (not locked). To prevent acknowledge generation when the forward control channel is not active, set the I2CLOCKACK bit low.

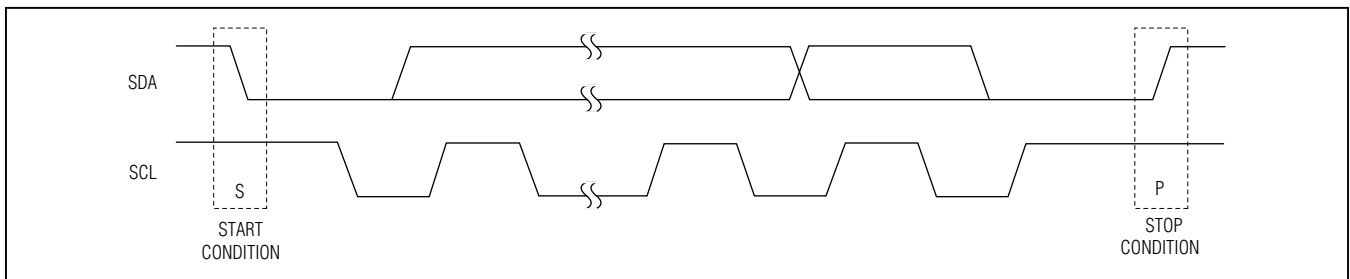


Figure 22. START and STOP Conditions

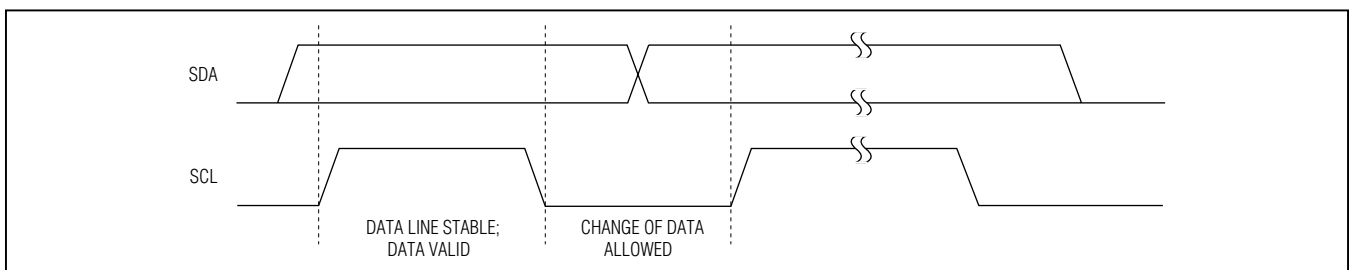


Figure 23. Bit Transfer

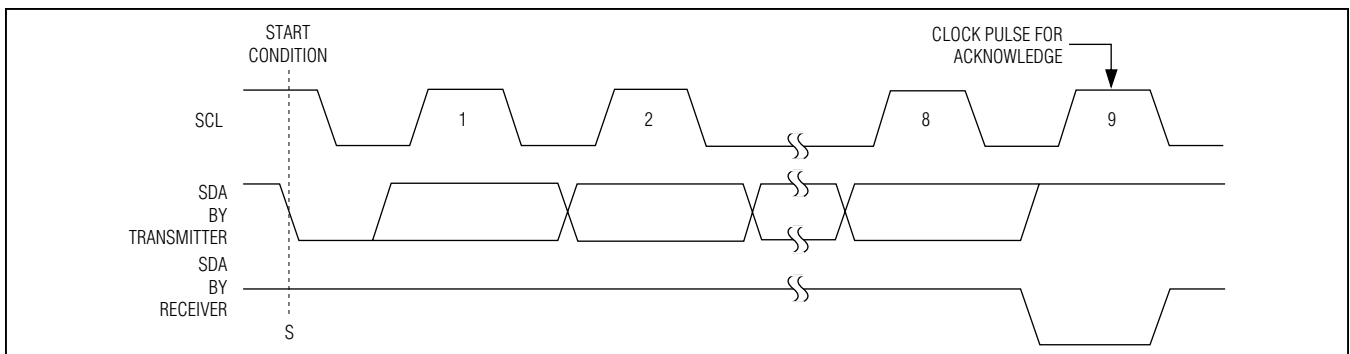


Figure 24. Acknowledge

## 6.25MHz to 100MHz, 25-Bit GMSL Deserializer for Coax or STP Cable With Line Fault Detect

### Slave Address

The serializer/deserializer have a 7-bit-long slave address. 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 slave address is 100100X1 for read commands and 100100X0 for write commands. See [Figure 25](#).

### Bus Reset

The device resets the bus with the I<sup>2</sup>C START condition for reads. When the R/W bit is set to 1, the serializer/deserializer transmit data to the master, thus the master is reading from the device.

### Format for Writing

A write to the serializer/deserializer comprises the transmission of the slave address with the R/W bit set to zero, followed by at least one byte of information. The first byte of information is the register address or command byte. The register address determines which register of the device is to be written by the next byte, if received. If a STOP (P) condition is detected after the register address is received, the device takes no further action

beyond storing the register address ([Figure 26](#)). Any bytes received after the register address are data bytes. The first data byte goes into the register selected by the register address, and subsequent data bytes go into subsequent registers ([Figure 27](#)). If multiple data bytes are transmitted before a STOP condition, these bytes are stored in subsequent registers because the register addresses autoincrement.

### Format for Reading

The serializer/deserializer are read using the internally stored register address as an address pointer, the same way the stored register address is used as an address pointer for a write. The pointer autoincrements after each data byte is read using the same rules as for a write. Thus, a read is initiated by first configuring the register address by performing a write ([Figure 28](#)). The master can now read consecutive bytes from the device, with the first data byte being read from the register address pointed by the previously written register address. Once the master sends a NACK, the device stops sending valid data.

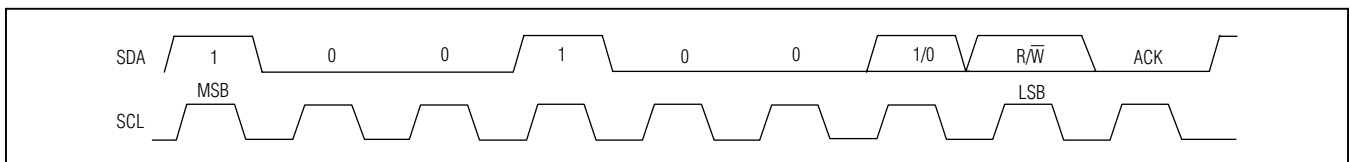


Figure 25. Slave Address

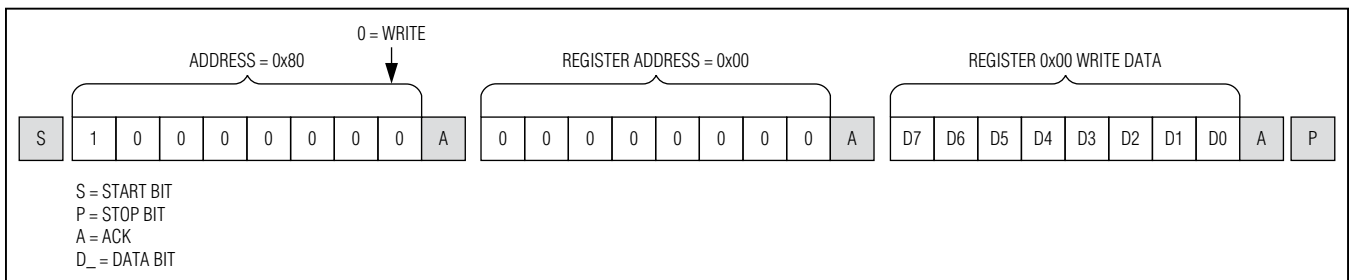


Figure 26. Format for I<sup>2</sup>C Write

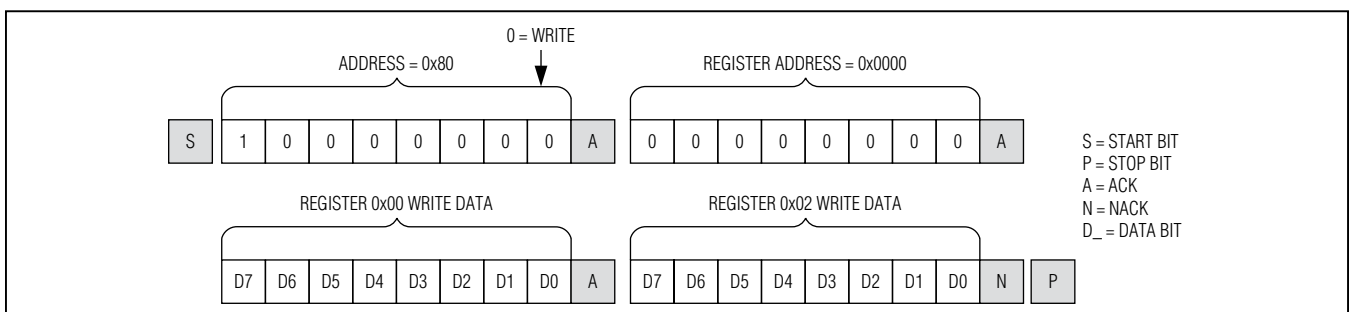


Figure 27. Format for Write to Multiple Registers



# MAX9240

## 6.25MHz to 100MHz, 25-Bit GMSL Deserializer for Coax or STP Cable With Line Fault Detect

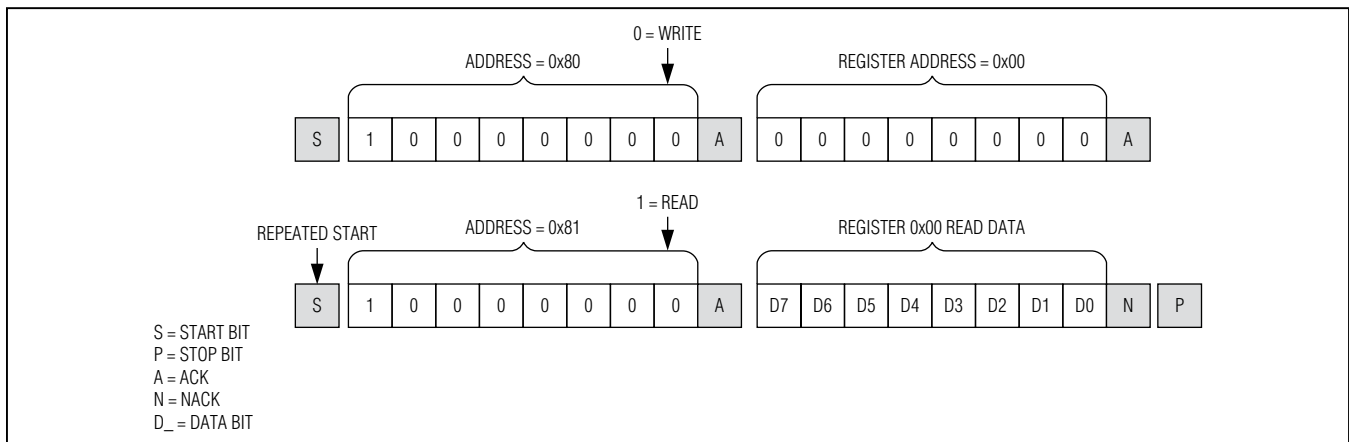


Figure 28. Format for I<sup>2</sup>C Read

**Table 4. I<sup>2</sup>C Bit-Rate Ranges**

| LOCAL BIT RATE                      | REMOTE BIT-RATE RANGE | I2CMSTBT SETTING |
|-------------------------------------|-----------------------|------------------|
| $f > 50\text{kbps}$                 | Up to 1Mbps           | Any              |
| $20\text{kbps} > f > 50\text{kbps}$ | Up to 400kbps         | Up to 110        |
| $f < 20\text{kbps}$                 | Up to 10kbps          | 000              |

### I<sup>2</sup>C Communication with Remote-Side Devices

The deserializer supports I<sup>2</sup>C communication with a peripheral on the remote side of the communication link using SCL clock stretching. While multiple masters can reside on either side of the communication link, arbitration is not provided. The connected masters need to support SCL clock stretching. The remote-side I<sup>2</sup>C bit-rate range must be set according to the local-side I<sup>2</sup>C bit rate. Supported remote-side bit rates can be found in [Table 4](#). Set the I2CMSTBT (register 0x0D) to set the remote I<sup>2</sup>C bit rate. If using a bit rate different than 400kbps, local- and remote-side I<sup>2</sup>C setup and hold times should be adjusted by setting the SLV\_SH register settings on both sides.

### I<sup>2</sup>C Address Translation

The deserializer supports I<sup>2</sup>C address translation for up to two device addresses. Use address translation to assign unique device addresses to peripherals with limited I<sup>2</sup>C 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.

### Control-Channel Broadcast Mode

The deserializer supports broadcast commands to control multiple peripheral devices. Select an unused device address to use as a broadcast device address. Program the remote-side GMSL device to translate the broadcast device address (source address stored in registers 0x09, 0x0B) to the peripheral device address (destination address stored in registers 0x0A, 0x0C). Any commands sent to the broadcast address are sent to all designated peripherals, while commands sent to a peripheral's unique device address are sent to that particular device only.

### 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 frame sync in a surround-view camera system. The GPI-to-GPO delay is 0.35ms (max). Keep the time between GPI transitions to a minimum 0.35ms. This includes transitions from the other deserializer in coax-splitter mode. Bit D4 of register 0x0E in the deserializer stores the GPI input state. GPO is low after power-up. The  $\mu\text{C}$  can set GPO by writing to the serializer SET\_GPO register bit. Do not send a logic-low value on the deserializer RX/SDA input (UART mode) longer than 100 $\mu\text{s}$  in either base or bypass mode to ensure proper GPO/GPI functionality.

## 6.25MHz to 100MHz, 25-Bit GMSL Deserializer for Coax or STP Cable With Line Fault Detect

### PRBS Test

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 and then in the serializer. To exit the PRBS test, set PRBSEN = 0 (0x04, D5) in the serializer.

### Line Equalizer

The deserializer includes an adjustable line equalizer to further compensate cable attenuation at high frequencies. The cable equalizer has 11 selectable levels of compensation from 2.1dB to 13dB (Table 5). **The device powers up with the equalizer disabled.** To select other equalization levels, set the corresponding register bits in the deserializer (0x05 D[3:0]). Use equalization in the deserializer, together with preemphasis in the serializer, to create the most reliable link for a given cable.

### Spread Spectrum

To reduce the EMI generated by transitions, the deserializer output is programmable for spread spectrum. If the serializer driving the deserializer has programmable spread spectrum, do not enable spread for both at the same time or their interaction will cancel benefits. The programmable spread-spectrum amplitudes are ±2% and ±4% (Table 6).

The deserializer includes a sawtooth divider to control the spread-modulation rate. Autodetection of the PCLKOUT 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 according to the PCLKOUT frequency. When ranges are manually selected, program the SDIV value for a fixed modulation frequency around 20kHz.

### Manual Programming of the Spread-Spectrum Divider

The modulation rate for the deserializer relates to the PCLKOUT frequency as follows:

$$f_M = (1 + DRS) \frac{f_{PCLKOUT}}{MOD \times SDIV}$$

where:

$f_M$  = Modulation frequency

DRS = DRS value (0 or 1)

$f_{PCLKOUT}$  = PCLKOUT frequency

MOD = Modulation coefficient given in Table 7

SDIV = 5-bit SDIV setting, manually programmed by the  $\mu C$

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 7, set SDIV to the maximum value.

**Table 5. Cable Equalizer Boost Levels**

| BOOST SETTING<br>(0x05 D[3:0]) | TYPICAL BOOST GAIN<br>(dB) |
|--------------------------------|----------------------------|
| 0000                           | 2.1                        |
| 0001                           | 2.8                        |
| 0010                           | 3.4                        |
| 0011                           | 4.2                        |
| 0100                           | 5.2                        |
| 0101                           | 6.2                        |
| 0110                           | 7                          |
| 0111                           | 8.2                        |
| 1000                           | 9.4                        |
| <b>1001</b>                    | <b>10.7<br/>Default*</b>   |
| 1010                           | 11.7                       |
| 1011                           | 13                         |

\*The equalizer is disabled at power-up.

**Table 6. Parallel Output Spread**

| SS | SPREAD (%)                                   |
|----|--|
| 00 | No spread spectrum. <b>Power-up default.</b> |
| 01 | ±2% spread spectrum.                         |
| 10 | No spread spectrum.                          |
| 11 | ±4% spread spectrum.                         |

**Table 7. Modulation Coefficients and Maximum SDIV Settings**

| SPREAD-SPECTRUM SETTING (%) | MODULATION COEFFICIENT (dec) | SDIV UPPER LIMIT (dec) |
|-----------------------------|------------------------------|------------------------|
| 4                           | 208                          | 15                     |
| 2                           | 208                          | 30                     |

## 6.25MHz to 100MHz, 25-Bit GMSL Deserializer for Coax or STP Cable With Line Fault Detect

### **Additional Error Detection and Correction**

In default mode (additional error detection and correction disabled), data encoding/decoding is the same as in previous GMSL serializers/deserializers (parity only). At the serializer, the parallel input word is scrambled and a parity bit is added. The scrambled word is divided into 3 or 4 bytes (depending on the BWS setting), 8b/10b encoded, and then transmitted serially. At the deserializer, the same operations are performed in reverse order. The parity bit is used by the deserializer to find the word boundary and for error detection. Errors are counted in an error counter register and an error pin indicates errors. The deserializer can use one of two additional error-detection/correction methods (selectable by register setting):

- 1) 6-bit cyclic redundancy check
- 2) 6-bit hamming code with 16-word interleaving

### **Cyclic Redundancy Check (CRC)**

When CRC is enabled, the serializer adds 6 bits of CRC to the input data. This reduces the available bits in the input data word by 6, compared to the non-CRC case (see [Table 2](#) for details). For example, 16 bits are available for input data instead of 22 bits when BWS = 0, and 24 bits instead of 30 bits when BWS = 1.

The CRC generator polynomial is  $x^6 + x + 1$  (as used in the ITU-T G704 telecommunication standard).

The parity bit is still added when CRC is enabled, because it is used for word-boundary detection. When CRC is enabled, each data word is scrambled and then the 6-bit CRC and 1-bit parity are added before the 8b/10b encoding.

At the deserializer, the CRC code is recalculated. If the recalculated CRC code does not match the received CRC code, an error is flagged. This CRC error is reported to the error counter.

### **Hamming Code**

Hamming code is a simple and effective error-correction code to detect and/or correct errors. The MAX9240 deserializer (when used with the MAX9271/MAX9273 GMSL serializers) uses a single-error correction/double-error detection per pixel hamming-code scheme.

The deserializer uses data interleaving for burst error tolerance. Burst errors up to 11 consecutive bits on the serial link are corrected and burst errors up to 31 consecutive bits are detected.

Hamming code adds overhead similar to CRC. See [Table 2](#) for details regarding the available input word size.

### **HS/VS Encoding and/or Tracking**

HS/VS encoding by a GMSL serializer allows horizontal and vertical synchronization signals to be transmitted while conserving pixel data bandwidth. With HS/VS encoding enabled, 10-bit pixel data with a clock up to 100MHz can be transmitted using one video pixel of data per HS/VS transition versus 8-bit data with a clock up to 100MHz without HS/VS encoding. The deserializer performs HS/VS decoding, tracks the period of the HS/VS signals, and uses voting to filter HS/VS bit errors. When using HS/VS encoding, use a minimum HS/VS low-pulse duration of two PCLKOUT cycles when DBL = 0 on the deserializer. When DBL = 1, use a minimum HS/VS low-pulse duration of five PCLKOUT cycles and a minimum high-pulse duration of two PCLKOUT cycles. When using hamming code with HS/VS encoding, do not send more than two transitions every 16 PCLKOUT cycles.

When the serializer uses double-input mode (DBL = 1), the active duration, plus the blanking duration of HS or VS signals, should be an even number of PCLKOUT cycles. When DBL = 1 in the serializer and DBL = 0 in the deserializer, two pixel clock cycles of HS/VS at the serializer input are output at the HS0/VS0 and HS1/VS1 output of the deserializer in one cycle. The first cycle of HS/VS goes out of HS0/VS0 and the second cycle goes out of HS1/VS1. HS1 and VS1 are not used when HVEN = 0.

If HS/VS tracking is used without HS/VS encoding, use DOUT0 for HSYNC and DOUT1 for VSYNC. In this case, if DBL values on the serializer/deserializer are different, set the UNEQDBL register bit in the deserializer to 1. If the serializer and deserializer have unequal DBL settings and HVEN = 0, then HS/VS inversion should only be used on the side that has DBL = 1. HS/VS encoding sends packets when HSYNC or VSYNC is low; use HS/VS inversion register bits if input HSYNC and VSYNC signals use an active-low convention in order to send data packets during the inactive pixel clock periods.

### **Serial Input**

The device can receive serial data from two kinds of cables: 100Ω twisted pair and 50Ω coax (contact the factory for devices compatible with 75Ω cables).

### **Coax-Mode Splitter**

In coax mode, OUT+ and OUT- of the serializer are active. This enables use as a 1:2 splitter ([Figure 29](#)). In coax mode, connect OUT+ to IN+ of the deserializer.

# MAX9240

## 6.25MHz to 100MHz, 25-Bit GMSL Deserializer for Coax or STP Cable With Line Fault Detect

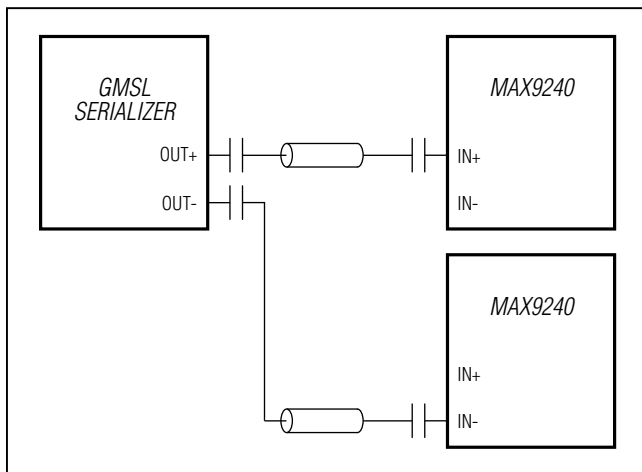


Figure 29. 2:1 Coax-Mode Splitter Connection Diagram

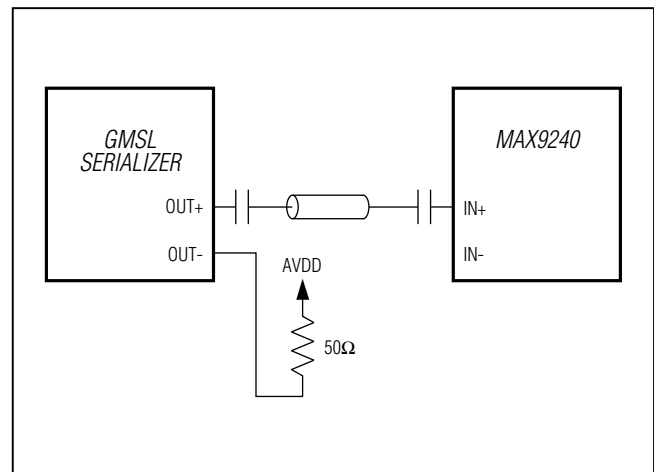


Figure 30. Coax-Mode Connection Diagram

Connect OUT- to IN- of the second deserializer. Control-channel data is broadcast from the serializer to both deserializers and their attached peripherals. Assign a unique address to send control data to one deserializer. Leave all unused IN\_ pins unconnected, or connect them to ground through  $50\Omega$  and a capacitor for increased power-supply rejection. If OUT- is not used, connect OUT- to AVDD through a  $50\Omega$  resistor (Figure 30). When there are  $\mu$ Cs at the serializer, and at each deserializer, only one  $\mu$ C can communicate at a time. Disable one splitter control-channel link to prevent contention. Use the DIS\_REV\_P or DIS\_REV\_N register bits to disable a control-channel link.

### Cable Type Configuration Input (CX/TP)

CX/TP determines the power-up state of the serial input. In coax mode, CX/TP also determines which coax input is active, along with the default device address (Table 8). These functions can be changed after power-up by writing to the appropriate register bits.

### Sleep Mode

The deserializer includes a sleep mode to reduce power consumption. The device enters or exits sleep mode by a command from a local  $\mu$ C or a remote  $\mu$ C using the control channel. Set the SLEEP bit to 1 to initiate sleep mode. The serializer sleeps immediately after setting its SLEEP = 1. The deserializer sleeps after serial link inactivity or 8ms (whichever arrives first) after setting its SLEEP = 1. To wake up from the local side, send an arbitrary control-channel command to the deserializer, wait 5ms for the chip to power up, and then write 0 to the SLEEP register bit to make the wake-up permanent. To wake up from the

### Table 8. Configuration Input Map

| CX/TP | FUNCTION                                 |
|-------|--|
| High  | Coax+ input. Device address 0x90.        |
| Mid   | Coax- input. Device address 0x92.        |
| Low   | Twisted-pair input. Device address 0x90. |

remote side, enable serialization. To deserializer detects the activity on the serial link and then when it locks, it automatically sets its SLEEP register bit to 0.

### Power-Down Mode

The deserializer has a power-down mode that further reduces power consumption compared to sleep mode. Set PWDN low to enter power-down mode. In power-down mode, the outputs of the device remain in high impedance. Entering power-down resets the device's registers. Upon exiting power-down, the state of external pins GPIO1/BWS, GPIO0/DBL, CX/TP, I2CSEL, LCCEN, RX/SDA/EDC, TX/SCL/ES, and MS/HVEN are latched.

### Configuration Link

The control channel can operate in a low-speed mode called configuration link in the absence of a clock input. This allows a microprocessor to program configuration registers before starting the video link. An internal oscillator provides the clock for the configuration link. Set CLINKEN = 1 on the serializer to enable the configuration link. The configuration link is active until the video link is enabled. The video link overrides the configuration link and attempts to lock when SEREN = 1.

## 6.25MHz to 100MHz, 25-Bit GMSL Deserializer for Coax or STP Cable With Line Fault Detect

### Link Startup Procedure

Table 9 lists the startup procedure for video-display applications. Table 10 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 9. Startup Procedure for Video-Display Applications**

| NO. | μC   | SERIALIZER  | DESERIALIZER  |
|-----|--|---|---|
| —   | μC connected to serializer.  | Sets all configuration inputs. If any configuration inputs are available on one end of the link but not on the other, always connects that configuration input low. | Sets all configuration inputs. If any configuration inputs are available on one end of the link but not on the other, always connects that configuration input low. |
| 1   | Powers up.   | Powers up and loads default settings.   | Powers up and loads default settings.   |
| 2   | Enables configuration link by setting CLINKEN = 1 (if not enabled automatically) and gets an acknowledge. Waits for link to be established (~3ms). | Establishes configuration link.   | Locks to configuration link signal.   |
| 3   | Writes one link configuration bit (DRS, BWS, or EDC) in the deserializer and gets an acknowledge.  | —   | Configuration changed from default settings (loss-of-lock can occur when BWS or EDC changes).   |
| 4   | Writes corresponding serializer link configuration bit and gets an acknowledge.  | Configuration changed from default settings.  | Relocks to configuration link signal.   |
| 5   | Waits for link to be established (~3ms) and then repeats steps 3 and 4 until all serial link bits are configured.                                  | —   | —   |
| 6   | Writes remaining configuration bits in the serializer/deserializer and gets an acknowledge.  | Configuration changed from default settings.  | Configuration changed from default settings.  |
| 7   | Enables video link by setting SEREN = 1 and gets an acknowledge. Waits for link to be established (~3ms).  | Begins serializing data.  | Locks to serial link signal and begins deserializing data.  |

# MAX9240

## 6.25MHz to 100MHz, 25-Bit GMSL Deserializer for Coax or STP Cable With Line Fault Detect

Table 10. Startup Procedure for Image-Sensing Applications

| NO. | μC   | SERIALIZER  | DESERIALIZER  |
|-----|--|---|---|
| —   | μC connected to deserializer.  | Sets all configuration inputs. If any configuration inputs are available on one end of the link but not on the other, always connects that configuration input low. | Sets all configuration inputs. If any configuration inputs are available on one end of the link but not on the other, always connects that configuration input low. |
| 1   | Powers up.   | Powers up and loads default settings. Establishes serial link.  | Powers up and loads default settings. Locks to serial link signal.  |
| 3   | Writes deserializer configuration bits and gets an acknowledge.  | —   | Configuration changed from default settings (loss-of-lock can occur).   |
| 4   | Writes serializer configuration bits. Cannot get an acknowledge (or gets a dummy acknowledge) if loss-of-lock occurred.  | Configuration changed from default settings.  | Relocks the serial link signal.   |
| 5   | Enables video link by setting SEREN = 1 (if not enabled automatically). Cannot get an acknowledge (or gets a dummy acknowledge) if loss-of-lock occurred. Waits for link to be established (~3ms). | Begins serializing data.  | Locks to serial link signal and begins deserializing data.  |

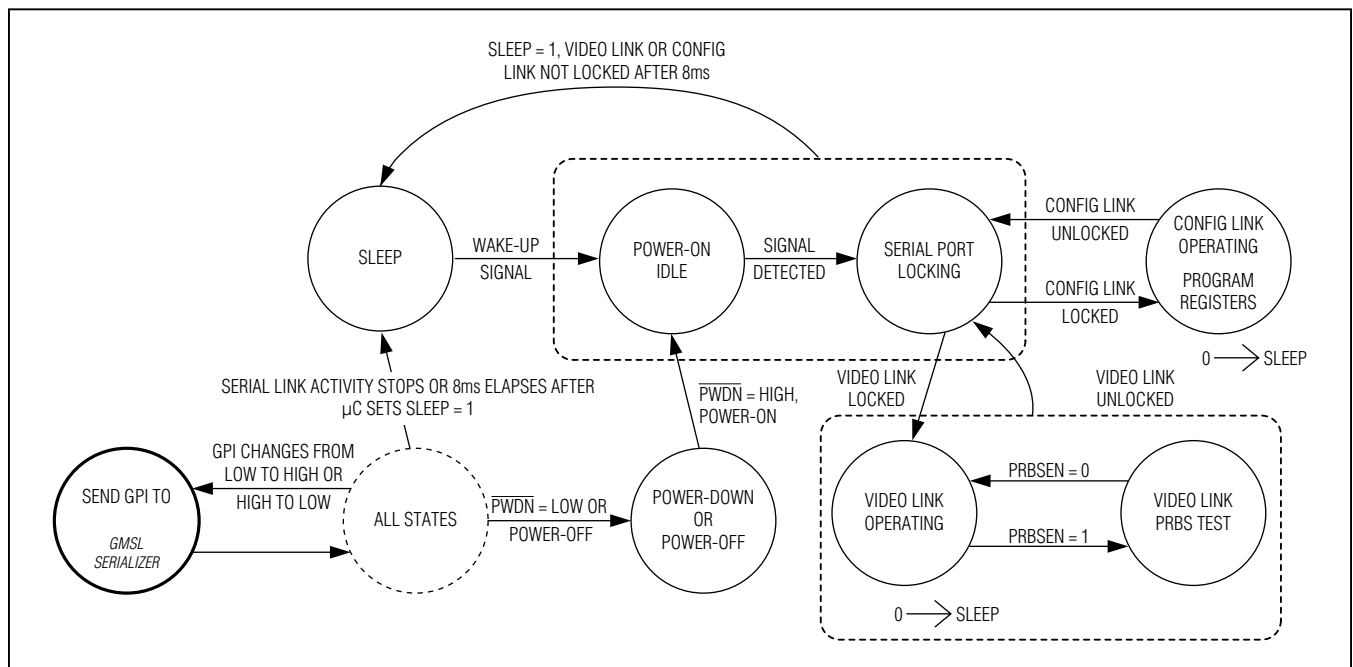


Figure 31. State Diagram, Remote Microcontroller Application

## **6.25MHz to 100MHz, 25-Bit GMSL Deserializer for Coax or STP Cable With Line Fault Detect**

### ***Applications Information***

#### ***Error Checking***

The deserializer checks the serial link for errors and stores the number of detected and corrected errors in the 8-bit registers, DETERR (0x10) and CORRERR (0x12). If a large number of 8b/10b errors are detected within a short duration (error rate  $\geq 1/4$ ), the deserializer loses lock and stops the error counter. The deserializer then attempts to relock to the serial data. DETERR and CORRERR reset upon successful video link lock, successful readout of their respective registers (through  $\mu\text{C}$ ), or whenever autoerror reset is enabled. The deserializer uses a separate PRBS register during the internal PRBS test, and DETERR and CORRERR are reset to 0x00.

#### ***ERR Output***

The deserializer has an open-drain  $\overline{\text{ERR}}$  output. This output asserts low whenever the number of detected/corrected errors exceeds their respective error thresholds during normal operation, or when at least one PRBS error is detected during PRBS test.  $\overline{\text{ERR}}$  reasserts high whenever DETERR and CORRERR reset, due to DETERR/CORRERR readout, video link lock, or autoerror reset.

#### ***Autoerror Reset***

The default method to reset errors is to read the respective error registers in the deserializer (0x10, 0x12, and 0x13). Autoerror reset clears the error counters DETERR/CORRERR and the  $\overline{\text{ERR}}$  output  $\sim 1\mu\text{s}$  after  $\overline{\text{ERR}}$  goes low. Autoerror reset is disabled on power-up. Enable autoerror reset through AUTORST (0x08, D2). Autoerror reset does not run when the device is in PRBS test mode.

#### ***Dual $\mu\text{C}$ Control***

Usually systems have one  $\mu\text{C}$  to run the control channel, located on the serializer side for video-display applications or on the deserializer side for image-sensing applications. However, a  $\mu\text{C}$  can reside on each side simultaneously and trade off running the control channel. In this case, each  $\mu\text{C}$  can communicate with the serializer and deserializer and any peripheral devices.

Contention occurs if both  $\mu\text{C}$ s 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 I<sup>2</sup>C 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  $\mu\text{C}$ s 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  $\mu\text{C}$ s cannot occur.

As an example of dual  $\mu\text{C}$  use in an image-sensing application, the serializer can be in sleep mode and waiting for wake-up by the  $\mu\text{C}$  on the deserializer side. After wake-up, the serializer-side  $\mu\text{C}$  assumes master control of the serializer's registers.

#### ***Changing the Clock Frequency***

It is recommended that the serial link be enabled after the video clock (fPCLKOUT) and the control-channel clock (fUART/fI2C) are stable. When changing the clock frequency, stop the video clock for 5 $\mu\text{s}$ , apply the clock at the new frequency, then restart the serial link or toggle SEREN. On-the-fly changes in clock frequency are possible if the new frequency is immediately stable and without glitches. The reverse control channel remains unavailable for 350 $\mu\text{s}$  after serial link start or stop. When using the UART interface, limit on-the-fly changes in fUART to factors of less than 3.5 at a time to ensure that the device recognizes the UART sync pattern. For example, when lowering the UART frequency from 1Mbps to 100kbps, first send data at 333kbps then at 100kbps for reduction ratios of 3 and 3.333, respectively.

#### ***Fast Detection of Loss-of-Synchronization***

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. If other sources use the GPI input, such as a touch-screen controller, the  $\mu\text{C}$  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.

# MAX9240

## 6.25MHz to 100MHz, 25-Bit GMSL Deserializer for Coax or STP Cable With Line Fault Detect

### **Providing a Frame Sync (Camera Applications)**

The GPI/GPO provides 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 $\mu$ s. Skew between multiple GPI/GPO channels is 115 $\mu$ s (max). If a lower skew signal is required, connect the camera's frame sync input to one of the GMSL deserializer's GPIOs and use an I<sup>2</sup>C broadcast write command to change the GPIO output state. This has a maximum skew of 1.5 $\mu$ s.

### **Software Programming of the Device Addresses**

Both the serializer and the deserializer have programmable device addresses. This allows multiple GMSL devices, along with I<sup>2</sup>C 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).

### **Three-Level Configuration Inputs**

CX/TP is a three-level input that controls the serial-interface configuration and power-up defaults. Connect

CX/TP through a pullup resistor to IOVDD to set a high level, a pulldown resistor to GND to set a low level, or IOVDD/2 or open to set a midlevel. For digital control, use three-state logic to drive the three-level logic input.

### **Configuration Blocking**

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

### **Compatibility with other GMSL Devices**

The MAX9240 deserializer is designed to pair with the MAX9271/MAX9273 serializers, but interoperate with any GMSL serializers. See the [Table 11](#) for operating limitations.

### **GPIOs**

The deserializer has two open-drain GPIOs available when not used as configuration inputs. GPIO1OUT and GPIO0OUT (0x0E, D3 and D1) set the output state of the GPIOs. Setting the GPIO output bits to 0 pulls the output low, while setting the bits to 1 leaves the output undriven and pulled high through internal/external pullup resistors. The GPIO input buffers are always enabled. The input states are stored in GPIO1 and GPIO0 (0x0E, D2 and D0). Set GPIO1OUT/GPIO0OUT to 1 when using GPIO1/GPIO0 as an input.

### **Staggered Parallel Outputs**

The deserializer staggers the parallel data outputs to reduce EMI and noise. Staggering outputs also reduces the power-supply transient requirements. By default, the deserializer staggers outputs according to [Table 12](#). Disable output staggering through the DISSTAG bit (0x08, D3).

**Table 11. MAX9240 Feature Compatibility**

| MAX9240 FEATURE                      | GMSL DESERIALIZER   |
|--------------------------------------|---|
| HSYNC/VSYNC encoding                 | If feature not supported in the serializer, must be turned off in the deserializer.   |
| Hamming-code error correction        | If feature not supported in the serializer, must be turned off in the deserializer.   |
| I <sup>2</sup> C-to-I <sup>2</sup> C | If feature not supported in the serializer, must use UART-to-I <sup>2</sup> C or UART-to-UART.  |
| CRC error detection                  | If feature not supported in the serializer, must be turned off in the deserializer.   |
| Double output                        | If feature not supported in the serializer, the data is inputted as a single word at 1/2 the output frequency.  |
| Coax                                 | If feature not supported in the deserializer, must connect unused serial output through 200nF and 50 $\Omega$ in series to AVDD and set the reverse control-channel amplitude to 100mV. |
| I <sup>2</sup> S encoding            | If feature is supported in the serializer, must disable I <sup>2</sup> S in the serializer.   |



# MAX9240

## 6.25MHz to 100MHz, 25-Bit GMSL Deserializer for Coax or STP Cable With Line Fault Detect

**Table 12. Staggered Output Delay**

| OUTPUT                       | OUTPUT DELAY RELATIVE TO DOUT0 (ns) |             |
|------------------------------|-------------------------------------|-------------|
|                              | DISSTAG = 0                         | DISSTAG = 1 |
| DOUT0–DOUT5, DOUT21, DOUT22  | 0                                   | 0           |
| DOUT6–DOUT10, DOUT23, DOUT24 | 0.5                                 | 0           |
| DOUT11–DOUT15                | 1                                   | 0           |
| DOUT16–DOUT20                | 1.5                                 | 0           |
| PCLKOUT                      | 0.75                                | 0           |

**Table 13. Double-Function Configuration**

| LCCEN | GPIO0/DBL FUNCTION  | GPIO1/BWS FUNCTION  | MS/HVEN FUNCTION  | RX/SDA/EDC FUNCTION  | TX/SCL/ES FUNCTION  |
|-------|---|---|---|--|---|
| High  | Functions as GPIO   | Functions as GPIO   | MS input<br>(low = base mode,<br>high = bypass mode)                                  | UART/I <sup>2</sup> C input/output   | UART/I <sup>2</sup> C input/output  |
| Low   | DBL input<br>(low = single<br>input,<br>high = double<br>input) | BWS input<br>(low = 24-bit<br>mode,<br>high = 32-bit<br>mode) | HVEN input<br>(low = HS/VS<br>encoding disabled,<br>high = HS/VS<br>encoding enabled) | EDC input<br>(low = error detection/<br>correction disabled,<br>high = error detection/<br>correction enabled) | ES input<br>(low = valid DOUT_ on<br>rising edge of PCLKOUT,<br>high = valid DOUT_ on<br>falling edge of PCLKOUT) |

**Table 13a. Line Fault Mapping**

| REGISTER ADDRESS | BITS   | NAME  | VALUE | LINE FAULT TYPE                               |
|------------------|--------|-------|-------|---|
| 0x14             | D[3:2] | LFNEG | 00    | Negative cable wire shorted to supply voltage |
|                  |        |       | 01    | Negative cable wire shorted to ground         |
|                  |        |       | 10    | Normal operation                              |
|                  |        |       | 11    | Negative cable wire disconnected              |
|                  | D[1:0] | LFPOS | 00    | Positive cable wire shorted to supply voltage |
|                  |        |       | 01    | Positive cable wire shorted to ground         |
|                  |        |       | 10    | Normal operation                              |
|                  |        |       | 11    | Positive cable wire disconnected              |

### Local Control-Channel Enable (LCCEN)

The deserializer provides inputs for limited configuration of the device when a  $\mu\text{C}$  is not connected. Connect LCCEN = low upon power-up to disable the local control channel and enable the double-function configuration inputs (Table 13). All input configuration states are latched at power-up.

### Line-Fault Detection

The line-fault detector in the deserializer monitors for line failures such as short to ground, short to battery, and open link for system fault diagnosis. Figure 2a shows the

required external resistor connections.  $\overline{\text{LFLT}}$  goes low when a line fault is detected and  $\overline{\text{LFLT}}$  goes high when the line returns to normal. The line-fault failure type is stored in 0x14 D[3:0] of the deserializer. Filter  $\overline{\text{LFLT}}$  with the  $\mu\text{C}$  to reduce the detector's susceptibility to temporary ground shifts. The fault detector threshold voltages are referenced to the deserializer ground. Additional passive components set the DC level of the cable (Figure 2a). If the serializer and GMSL deserializer grounds are different, the link DC voltage during normal operation can vary and cross one of the fault detection thresholds.

# MAX9240

## 6.25MHz to 100MHz, 25-Bit GMSL Deserializer for Coax or STP Cable With Line Fault Detect

For the fault detection circuit, select the resistor's power rating to handle a short to the battery. In coax mode, leave the unused line-fault inputs unconnected. To detect the short-together case, refer to *Application Note 4709: GMSL Line-Fault Detection*. Table 13A lists the mapping for line-fault types.

### Internal Input Pulldowns

The control and configuration inputs, except three-level inputs, include a pulldown resistor to GND. External pulldown resistors are not needed.

### Choosing I<sup>2</sup>C/UART Pullup Resistors

The I<sup>2</sup>C and UART 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. I<sup>2</sup>C specifies 300ns rise times (30% to 70%) for fast mode, which is defined for data rates up to 400kbps (see the I<sup>2</sup>C specifications in the *AC Electrical Characteristics* table for details). To meet the fast-mode rise-time requirement, choose the pullup resistors so that rise time  $t_R = 0.85 \times R_{PULLUP} \times C_{BUS} < 300\text{ns}$ . The waveforms are not recognized if the transition time becomes too slow. The deserializer supports I<sup>2</sup>C/UART rates up to 1Mbps (UART-to-I<sup>2</sup>C mode) and 400kbps (I<sup>2</sup>C-to-I<sup>2</sup>C mode).

### AC-Coupling

AC-coupling isolates the receiver from DC voltages up to the voltage rating of the capacitor. Capacitors at the serializer output and at the deserializer input are needed for proper link operation and to provide protection if either end of the cable is shorted to a battery. AC-coupling blocks low-frequency ground shifts and low-frequency common-mode noise.

### Selection of 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 trans-

mission line impedance (usually 100 $\Omega$  differential and 50 $\Omega$  single-ended). This leaves the capacitor selection to change the system time constant. Use 0.2 $\mu\text{F}$  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.

### Power-Supply Circuits and Bypassing

The deserializer uses an AVDD and DVDD of 1.7V to 1.9V. All inputs and outputs, except for the serial input, derive power from an IOVDD of 1.7V to 3.6V that scales with IOVDD. Proper voltage-supply bypassing is essential for high-frequency circuit stability. The GPI-to-GPO delay is 0.35ms (max). Keep the time between GPI transmissions to a minimum 0.35ms.

### Power-Supply Table

Power-supply currents shown in the *Electrical Characteristics* table are the sum of the currents from AVDD, DVDD, and IOVDD. Typical currents from the individual power supplies are shown in [Table 14](#).

### Cables and Connectors

Interconnect for CML typically has a differential impedance of 100 $\Omega$ . Use cables and connectors that have matched differential impedance to minimize impedance discontinuities. Coax cables typically have a characteristic impedance of 50 $\Omega$  (contact the factory for 75 $\Omega$  operation). [Table 15](#) lists the suggested cables and connectors used in the GMSL link.

**Table 14. Typical Power-Supply Currents (Using Worst-Case Input Pattern)**

| PCLK (MHz) | AVDD (mA) | DVDD (mA) | IOVDD (mA) |
|------------|-----------|-----------|------------|
| 25         | 25.1      | 9.2       | 10.3       |
| 50         | 33.3      | 13.7      | 13.3       |

**Table 15. Suggested Connectors and Cables for GMSL**

| SUPPLIER    | CONNECTOR      | CABLE           | TYPE |
|-------------|----------------|-----------------|------|
| Rosenberger | 59S2AX-400A5-Y | RG174           | Coax |
| JAE         | MX38-FF        | A-BW-Lxxxxx     | STP  |
| Nissei      | GT11L-2S       | F-2WME<br>AWG28 | STP  |
| Rosenberger | D4S10A-40ML5-Z | Dacar 538       | STP  |

## 6.25MHz to 100MHz, 25-Bit GMSL Deserializer for Coax or STP Cable With Line Fault Detect

### Board Layout

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 PCB traces close to each other for a  $100\Omega$  differential characteristic impedance. The trace dimensions depend on the type of trace used (microstrip or stripline). Note that two  $50\Omega$  PCB traces do not have  $100\Omega$  differential impedance when brought close together—the impedance goes down when the traces are brought closer. Use a  $50\Omega$  trace for the single-ended output when driving coax.

Route the PCB traces for differential CML channel in parallel to maintain the differential characteristic impedance. Avoid vias. Keep PCB traces that make up a differential pair equal length to avoid skew within the differential pair.

### 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 link inputs 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  $C_S = 100\text{pF}$  and  $R_D = 1.5\text{k}\Omega$  (Figure 32). The IEC 61000-4-2 discharge components are  $C_S = 150\text{pF}$  and  $R_D = 330\Omega$  (Figure 33). The ISO 10605 discharge components are  $C_S = 330\text{pF}$  and  $R_D = 2\text{k}\Omega$  (Figure 34).

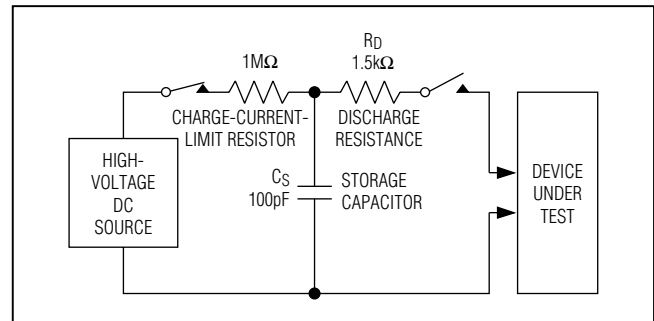


Figure 32. Human Body Model ESD Test Circuit

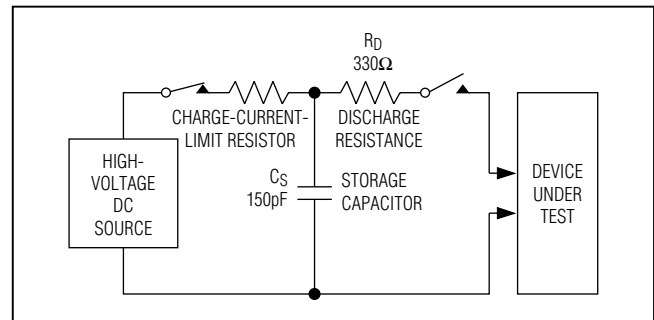


Figure 33. IEC 61000-4-2 Contact Discharge ESD Test Circuit

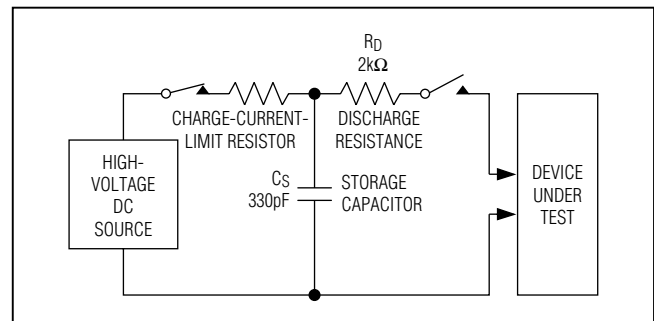


Figure 34. ISO 10605 Contact Discharge ESD Test Circuit

# MAX9240

## 6.25MHz to 100MHz, 25-Bit GMSL Deserializer for Coax or STP Cable With Line Fault Detect

Table 16. Register Table (see [Table 1](#))

| REGISTER ADDRESS | BITS   | NAME     | VALUE  | FUNCTION  | DEFAULT VALUE       |
|------------------|--------|----------|--|---|---------------------|
| 0x00             | D[7:1] | SERID    | XXXXXXX  | Serializer device address.  | 1000000             |
|                  | D0     | —        | 0  | Reserved.   | 0                   |
| 0x01             | D[7:1] | DESID    | XXXXXXX  | Deserializer device address. Default address is determined by the state of the CX/TP input (Table 8). | 1001000,<br>1001001 |
|                  | D0     | CFGBLOCK | 0<br>1   | Normal operation.<br>Registers 0x00 to 0x1F are read only.  | 0                   |
| 0x02             | D[7:6] | SS       | 00   | No spread spectrum.   | 00                  |
|                  |        |          | 01   | ±2% spread spectrum.  |                     |
|                  |        |          | 10   | No spread spectrum.   |                     |
|                  |        |          | 11   | ±4% spread spectrum.  |                     |
|                  | D[5:4] | —        | 01   | Reserved.   | 01                  |
|                  | D[3:2] | PRNG     | 00   | 12.5MHz to 25MHz pixel clock.   | 11                  |
|                  |        |          | 01   | 25MHz to 50MHz pixel clock.   |                     |
|                  |        |          | 10   | Do not use.   |                     |
|                  |        |          | 11   | Automatically detect the pixel clock range.   |                     |
|                  | D[1:0] | SRNG     | 00   | 0.5Gbps to 1Gbps serial-data rate.  | 11                  |
| 01               |        |          | 1Gps to 2Gps serial-data rate.   |   |                     |
| 10               |        |          | Automatically detect serial-data rate.   |   |                     |
| 11               |        |          | Automatically detect serial-data rate.   |   |                     |
| 0x03             | D[7:6] | AUTOFM   | 00   | Calibrate spread-modulation rate only once after locking.   | 00                  |
|                  |        |          | 01   | Calibrate spread-modulation rate every 2ms after locking.   |                     |
|                  |        |          | 10   | Calibrate spread-modulation rate every 16ms after locking.  |                     |
|                  |        |          | 11   | Calibrate spread-modulation rate every 256ms after locking.   |                     |
|                  | D5     | —        | 0  | Reserved.   | 0                   |
|                  | D[4:0] | SDIV     | 00000  | Autocalibrate sawtooth divider.   | 00000               |
| XXXXX            |        |          | Manual SDIV setting. See the <i>Manual Programming of the Spread-Spectrum Divider</i> section. |   |                     |

# MAX9240

## 6.25MHz to 100MHz, 25-Bit GMSL Deserializer for Coax or STP Cable With Line Fault Detect

Table 16. Register Table (see [Table 1](#)) (continued)

| REGISTER ADDRESS | BITS   | NAME      | VALUE   | FUNCTION  | DEFAULT VALUE    |
|------------------|--------|-----------|---|---|------------------|
| 0x04             | D7     | LOCKED    | 0   | LOCK output is low.   | 0<br>(read only) |
|                  |        |           | 1   | LOCK output is high.  |                  |
|                  | D6     | OUTENB    | 0   | Enable outputs.   | 0                |
|                  |        |           | 1   | Disable outputs.  |                  |
|                  | D5     | PRBSEN    | 0   | Disable PRBS test.  | 0                |
|                  |        |           | 1   | Enable PRBS test.   |                  |
|                  | D4     | SLEEP     | 0   | Normal mode.  | 0                |
|                  |        |           | 1   | Activate sleep mode.  |                  |
|                  | D[3:2] | INTTYPE   | 00  | Local control channel uses I <sup>2</sup> C when I2CSEL = 0.  | 01               |
|                  |        |           | 01  | Local control channel uses UART when I2CSEL = 0.  |                  |
|                  |        |           | 10, 11  | Local control channel disabled.   |                  |
|                  | D1     | REVCCEN   | 0   | Disable reverse control channel to serializer (sending).  | 1                |
|                  |        |           | 1   | Enable reverse control channel to serializer (sending).   |                  |
|                  | D0     | FWDCEN    | 0   | Disable forward control channel from serializer (receiving).  | 1                |
| 1                |        |           | Enable forward control channel from serializer (receiving). |   |                  |
| 0x05             | D7     | I2CMETHOD | 0   | I <sup>2</sup> C conversion sends the register address when converting UART to I <sup>2</sup> C.                        | 0                |
|                  |        |           | 1   | Disable sending of I <sup>2</sup> C register address when converting UART to I <sup>2</sup> C (command-byte-only mode). |                  |
|                  | D6     | DCS       | 0   | Normal parallel output driver current.  | 0                |
|                  |        |           | 1   | Boosted parallel output driver current.   |                  |
|                  | D5     | HVTRMODE  | 0   | Partial periodic HS/VS tracking.  | 1                |
|                  |        |           | 1   | Full periodic HS/VS tracking.   |                  |
|                  | D4     | ENEQ      | 0   | <b>Equalizer disabled. Power-up default.</b>  | 0                |
|                  |        |           | 1   | Equalizer enabled.  |                  |
|                  | D[3:0] | EQTUNE    | 0000  | 2.1dB equalizer-boost gain.   | 1001             |
|                  |        |           | 0001  | 2.8dB equalizer-boost gain.   |                  |
|                  |        |           | 0010  | 3.4dB equalizer-boost gain.   |                  |
|                  |        |           | 0011  | 4.2dB equalizer-boost gain.   |                  |
|                  |        |           | 0100  | 5.2dB equalizer-boost gain.   |                  |
|                  |        |           | 0101  | 6.2dB equalizer-boost gain.   |                  |
|                  |        |           | 0110  | 7dB equalizer-boost gain.   |                  |
|                  |        |           | 0111  | 8.2dB equalizer-boost gain.   |                  |
|                  |        |           | 1000  | 9.4dB equalizer-boost gain.   |                  |
|                  |        |           | 1001  | 10.7dB equalizer-boost gain. <b>Power-up default.</b>   |                  |
| 1010             |        |           | 11.7dB equalizer-boost gain.                                |   |                  |
| 1011             |        |           | 13dB equalizer-boost gain.                                  |   |                  |
| 11XX             |        |           | Do not use.   |   |                  |

# MAX9240

## 6.25MHz to 100MHz, 25-Bit GMSL Deserializer for Coax or STP Cable With Line Fault Detect

Table 16. Register Table (see [Table 1](#)) (continued)

| REGISTER ADDRESS | BITS   | NAME    | VALUE    | FUNCTION   | DEFAULT VALUE |
|------------------|--------|---------|----------|--|---------------|
| 0x06             | D[7:0] | —       | 00000010 | Reserved.  | 00000010      |
| 0x07             | D7     | DBL     | 0        | Single-input mode. <b>Power-up default when LCCEN = high or GPIO0/DBL = low.</b>   | 0, 1          |
|                  |        |         | 1        | Double-input mode. <b>Power-up default when LCCEN = low and GPIO0/DBL = high.</b>  |               |
|                  | D6     | DRS     | 0        | High data-rate mode.   | 0             |
|                  |        |         | 1        | Low data-rate mode.  |               |
|                  | D5     | BWS     | 0        | 24-bit mode. <b>Power-up default when LCCEN = high or GPIO1/BWS = low.</b>   | 0, 1          |
|                  |        |         | 1        | 32-bit mode. <b>Power-up default when LCCEN = low and GPIO1/BWS = high.</b>  |               |
|                  | D4     | ES      | 0        | Output data valid on rising edge of PCLKOUT. <b>Power-up default when LCCEN = high or TX/SCL/ES = low.</b> Do not change this value while the pixel clock is running.  | 0, 1          |
|                  |        |         | 1        | Output data valid on rising edge of PCLKOUT. <b>Power-up default when LCCEN = low and TX/SCL/ES = high.</b> Do not change this value while the pixel clock is running. |               |
|                  | D3     | HVTRACK | 0        | HS/VS tracking disabled. <b>Power-up default when LCCEN = high or MS/HVEN = low.</b>   | 0, 1          |
|                  |        |         | 1        | HS/VS tracking enabled. <b>Power-up default when LCCEN = low and MS/HVEN = high.</b>   |               |
|                  | D2     | HVEN    | 0        | HS/VS encoding disabled. <b>Power-up default when LCCEN = high or MS/HVEN = low.</b>   | 0, 1          |
|                  |        |         | 1        | HS/VS encoding enabled. <b>Power-up default when LCCEN = low and MS/HVEN = high.</b>   |               |
|                  | D[1:0] | EDC     | 00       | 1-bit parity error detection (GMSL compatible). <b>Power-up default when LCCEN = high or RX/SDA/EDC = low.</b>   | 00, 10        |
|                  |        |         | 01       | 6-bit CRC error detection.   |               |
|                  |        |         | 10       | 6-bit hamming code (single-bit error correct, double-bit error detect) and 16-word interleaving. <b>Power-up default when LCCEN = low and RX/SDA/EDC = high.</b>       |               |
|                  |        |         | 11       | Do not use.  |               |

# MAX9240

## 6.25MHz to 100MHz, 25-Bit GMSL Deserializer for Coax or STP Cable With Line Fault Detect

Table 16. Register Table (see [Table 1](#)) (continued)

| REGISTER ADDRESS | BITS   | NAME    | VALUE  | FUNCTION  | DEFAULT VALUE |
|------------------|--------|---------|--|---|---------------|
| 0x08             | D7     | INVVS   | 0  | No VS or DOUT0 inversion.   | 0             |
|                  |        |         | 1  | Invert VS when HVEN = 1. Invert DOUT0 when HVEN = 0. Do not use if DBL = 0 in the deserializer and DBL = 1 in the serializer. |               |
|                  | D6     | INVHS   | 0  | No HS or DOUT1 inversion.   | 0             |
|                  |        |         | 1  | Invert HS when HVEN = 1. Invert DOUT1 when HVEN = 0. Do not use if DBL = 0 in the deserializer and DBL = 1 in the serializer. |               |
|                  | D5     | —       | 0  | Reserved.   | 0             |
|                  | D4     | UNEQDBL | 0  | Serializer DBL is not the same as deserializer.   | 0             |
|                  |        |         | 1  | Serializer DBL same as deserializer (set to 1 only when HVEN = 0 and HVTRACK = 1).  |               |
|                  | D3     | DISSTAG | 0  | Enable staggered outputs.   | 0             |
|                  |        |         | 1  | Disable staggered outputs.  |               |
|                  | D2     | AUTORST | 0  | Do not automatically reset error registers and outputs.   | 0             |
| 1                |        |         | Automatically reset DETERR and CORRERR registers 1μs after ERR asserts.                              |   |               |
| D[1:0]           | ERRSEL | 00      | $\overline{\text{ERR}}$ asserts when DETERR is larger than DETTHR.                                   | 00  |               |
|                  |        | 01      | $\overline{\text{ERR}}$ asserts when CORRERR is larger than CORRTHR.                                 |   |               |
|                  |        | 10, 11  | $\overline{\text{ERR}}$ asserts when DETERR is larger than DETTHR or CORRERR is larger than CORRTHR. |   |               |
| 0x09             | D[7:1] | I2CSRCA | XXXXXXX  | I <sup>2</sup> C address translator source A.   | 0000000       |
|                  | D0     | —       | 0  | Reserved.   | 0             |
| 0x0A             | D[7:1] | I2CDSTA | XXXXXXX  | I <sup>2</sup> C address translator destination A.  | 0000000       |
|                  | D0     | —       | 0  | Reserved.   | 0             |
| 0x0B             | D[7:1] | I2CSRCA | XXXXXXX  | I <sup>2</sup> C address translator source B.   | 0000000       |
|                  | D0     | —       | 0  | Reserved.   | 0             |
| 0x0C             | D[7:1] | I2CDSTB | XXXXXXX  | I <sup>2</sup> C address translator destination B.  | 0000000       |
|                  | D0     | —       | 0  | Reserved.   | 0             |

# MAX9240

## 6.25MHz to 100MHz, 25-Bit GMSL Deserializer for Coax or STP Cable With Line Fault Detect

Table 16. Register Table (see [Table 1](#)) (continued)

| REGISTER ADDRESS | BITS     | NAME      | VALUE   | FUNCTION  | DEFAULT VALUE           |
|------------------|----------|-----------|---|---|-------------------------|
| 0x0D             | D7       | I2CLOCACK | 0   | Acknowledge not generated when forward channel is not available.  | 0                       |
|                  |          |           | 1   | I <sup>2</sup> C-to-I <sup>2</sup> C slave generates local acknowledge when forward channel is not available. |                         |
|                  | D[6:5]   | I2CSLVSH  | 00  | 352ns/117ns I <sup>2</sup> C setup/hold time.   | 01                      |
|                  |          |           | 01  | 469ns/234ns I <sup>2</sup> C setup/hold time.   |                         |
|                  |          |           | 10  | 938ns/352ns I <sup>2</sup> C setup/hold time.   |                         |
|                  |          |           | 11  | 1046ns/469ns I <sup>2</sup> C setup/hold time.  |                         |
|                  | D[4:2]   | I2CMSTBT  | 000   | 8.47kbps (typ) I <sup>2</sup> C-to-I <sup>2</sup> C master bit-rate setting.                                  | 101                     |
|                  |          |           | 001   | 28.3kbps (typ) I <sup>2</sup> C-to-I <sup>2</sup> C master bit-rate setting.                                  |                         |
|                  |          |           | 010   | 84.7kbps (typ) I <sup>2</sup> C-to-I <sup>2</sup> C master bit-rate setting.                                  |                         |
|                  |          |           | 011   | 105kbps (typ) I <sup>2</sup> C-to-I <sup>2</sup> C master bit-rate setting.                                   |                         |
|                  |          |           | 100   | 173kbps (typ) I <sup>2</sup> C-to-I <sup>2</sup> C master bit-rate setting.                                   |                         |
|                  |          |           | 101   | 339kbps (typ) I <sup>2</sup> C-to-I <sup>2</sup> C master bit-rate setting.                                   |                         |
|                  |          |           | 110   | 533kbps (typ) I <sup>2</sup> C-to-I <sup>2</sup> C master bit-rate setting.                                   |                         |
|                  |          |           | 111   | 837kbps (typ) I <sup>2</sup> C-to-I <sup>2</sup> C master bit-rate setting.                                   |                         |
| D[1:0]           | I2CSLVTO | 00        | 64μs (typ) I <sup>2</sup> C-to-I <sup>2</sup> C slave remote timeout.   | 10  |                         |
|                  |          | 01        | 256μs (typ) I <sup>2</sup> C-to-I <sup>2</sup> C slave remote timeout.  |   |                         |
|                  |          | 10        | 1024μs (typ) I <sup>2</sup> C-to-I <sup>2</sup> C slave remote timeout. |   |                         |
|                  |          | 11        | No I <sup>2</sup> C-to-I <sup>2</sup> C slave remote timeout.           |   |                         |
| 0x0E             | D[7:6]   | —         | 01  | Reserved.   | 01                      |
|                  | D5       | GPIEN     | 0   | Disable GPI-to-GPO signal transmission to serializer.   | 1                       |
|                  |          |           | 1   | Enable GPI-to-GPO signal transmission to serializer.  |                         |
|                  | D4       | GPIIN     | 0   | GPI input is low.   | 0<br>(read only)        |
|                  |          |           | 1   | GPI input is high.  |                         |
|                  | D3       | GPIO1OUT  | 0   | Set GPIO1 to low.   | 1                       |
|                  |          |           | 1   | Set GPIO1 to high.  |                         |
|                  | D2       | GPIO1IN   | 0   | GPIO1 input is low.   | 0<br>(read only)        |
|                  |          |           | 1   | GPIO1 input is high.  |                         |
|                  | D1       | GPIO0OUT  | 0   | Set GPIO0 to low.   | 1                       |
|                  |          |           | 1   | Set GPIO0 to high.  |                         |
|                  | D0       | GPIO0IN   | 0   | GPIO0 input is low.   | 0<br>(read only)        |
| 1                |          |           | GPIO0 input is high.  |   |                         |
| 0x0F             | D[7:0]   | DETHR     | XXXXXXXX  | Error threshold for detected errors.  | 00000000                |
| 0x10             | D[7:0]   | DETRR     | XXXXXXXX  | Detected error counter.   | 00000000<br>(read only) |
| 0x11             | D[7:0]   | CORRTHR   | XXXXXXXX  | Error threshold for corrected errors.   | 00000000                |
| 0x12             | D[7:0]   | CORRERR   | XXXXXXXX  | Corrected error counter.  | 00000000<br>(read only) |
| 0x13             | D[7:0]   | PRBSERR   | XXXXXXXX  | PRBS error counter.   | 00000000<br>(read only) |



# MAX9240

## 6.25MHz to 100MHz, 25-Bit GMSL Deserializer for Coax or STP Cable With Line Fault Detect

Table 16. Register Table (see [Table 1](#)) (continued)

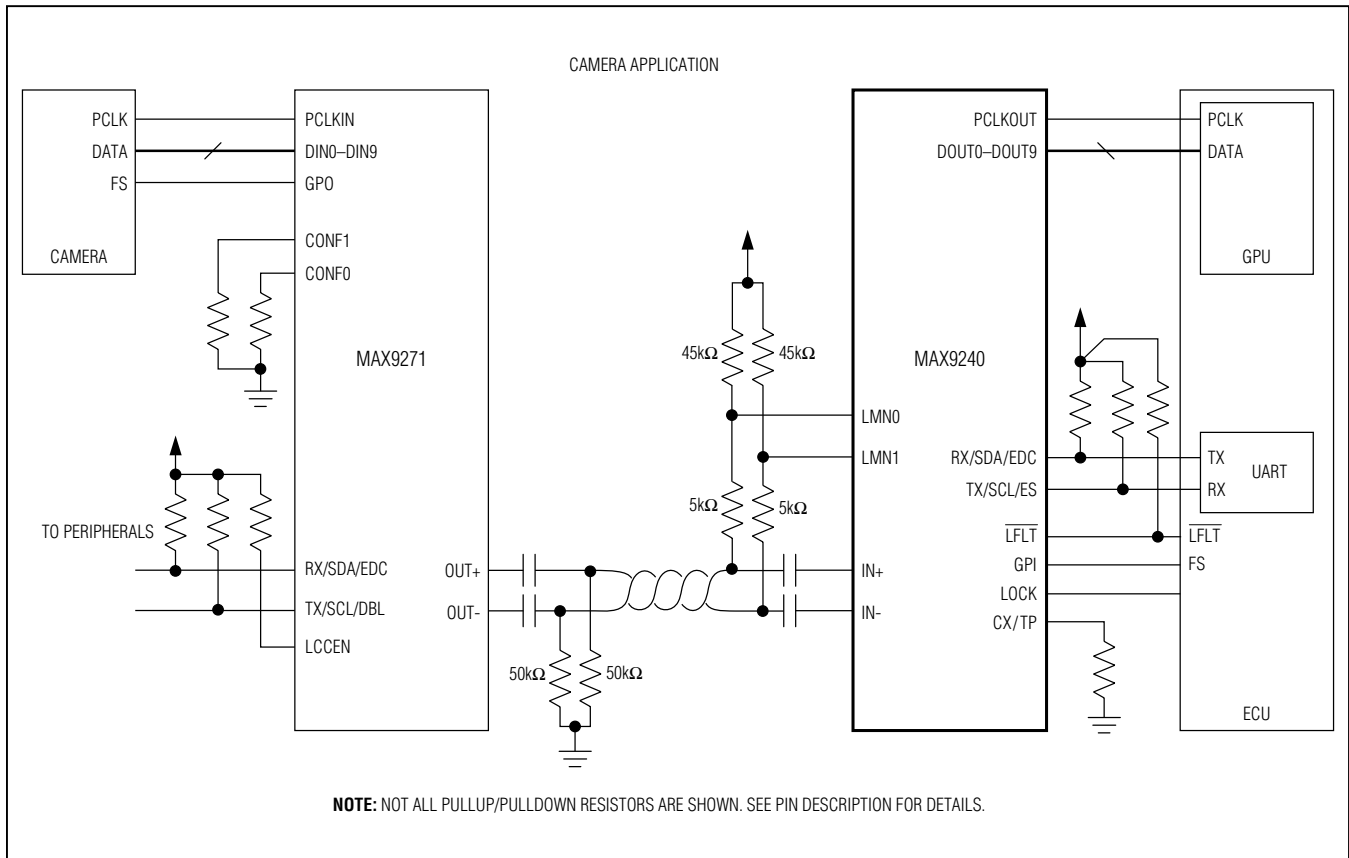
| REGISTER ADDRESS | BITS     | NAME   | VALUE                            | FUNCTION                                      | DEFAULT VALUE                       |
|------------------|----------|--------|----------------------------------|---|-------------------------------------|
| 0x14             | D7       | PRBSOK | 0                                | PRBS test not completed.                      | 0<br>(read only)                    |
|                  |          |        | 1                                | PRBS test completed with success.             |                                     |
|                  | D[6:4]   | —      | 000                              | Reserved.                                     | 000<br>(read only)                  |
|                  | D[3:2]   | LFNEG  | 00                               | Negative cable wire shorted to supply voltage | 10<br>(read only)                   |
|                  |          |        | 01                               | Negative cable wire shorted to ground         |                                     |
|                  |          |        | 10                               | Normal operation                              |                                     |
|                  |          |        | 11                               | Negative cable wire disconnected              |                                     |
|                  | D[1:0]   | LFPOS  | 00                               | Positive cable wire shorted to supply voltage | 10<br>(read only)                   |
|                  |          |        | 01                               | Positive cable wire shorted to ground         |                                     |
|                  |          |        | 10                               | Normal operation                              |                                     |
| 11               |          |        | Positive cable wire disconnected |   |                                     |
| 0x15             | D[7:0]   | —      | 00100XXX                         | Reserved.                                     | 00100XXX                            |
| 0x16             | D[7:0]   | —      | 00110000                         | Reserved.                                     | 00110000                            |
| 0x17             | D[7:0]   | —      | 01010100                         | Reserved.                                     | 01010100                            |
| 0x18             | D[7:0]   | —      | 00110000                         | Reserved.                                     | 00110000                            |
| 0x19             | D[7:0]   | —      | 11001000                         | Reserved.                                     | 11001000                            |
| 0x1A             | D[7:0]   | —      | XXXXXXXX                         | Reserved.                                     | 00000000<br>(read only)             |
| 0x1B             | D[7:0]   | —      | XXXXXXXX                         | Reserved.                                     | 00000000<br>(read only)             |
| 0x1C             | D[7:0]   | —      | XXXXXXXX                         | Reserved.                                     | 00000000<br>(read only)             |
| 0x1D             | D7       | CXTP   | 0                                | CX/TP input is low.                           | 0<br>(read only)                    |
|                  |          |        | 1                                | CX/TP input is high.                          |                                     |
|                  | D6       | CXSEL  | 0                                | CXSEL is 0.                                   | 0<br>(read only)                    |
|                  |          |        | 1                                | CXSEL is 1.                                   |                                     |
|                  | D5       | I2CSEL | 0                                | Input is low.                                 | 0<br>(read only)                    |
|                  |          |        | 1                                | Input is high.                                |                                     |
|                  | D4       | LCCEN  | 0                                | Input is low.                                 | 0<br>(read only)                    |
|                  |          |        | 1                                | Input is high.                                |                                     |
|                  | D[3:0]   | —      | XXXX                             | Reserved.                                     | 0000<br>(read only)                 |
|                  | 0x1E     | D[7:0] | ID                               | 00001011                                      | Device identifier (MAX9240 = 0x0C). |
| 0x1F             | D[7:5]   | —      | 000                              | Reserved.                                     | 000<br>(read only)                  |
|                  | D4       | CAPS   | 0                                | Not HDCP capable.                             | 0<br>(read only)                    |
|                  |          |        | 1                                | HDCP capable.                                 |                                     |
| D[3:0]           | REVISION | XXXX   | Device revision.                 | (read only)                                   |                                     |

X = Don't care.

# MAX9240

## 6.25MHz to 100MHz, 25-Bit GMSL Deserializer for Coax or STP Cable With Line Fault Detect

### Typical Application Circuit



### Ordering Information

| PART            | TEMP RANGE      | PIN-PACKAGE |
|-----------------|-----------------|-------------|
| MAX9240GTM+     | -40°C to +105°C | 48 TQFN-EP* |
| MAX9240GTM/V+** | -40°C to +105°C | 48 TQFN-EP* |

*V* denotes an automotive qualified part.

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

\*EP = Exposed pad.

\*\*Future product—contact factory for availability.

### Chip Information

PROCESS: CMOS

### Package Information

For the latest package outline information and land patterns (footprints), go to [www.maximintegrated.com/packages](http://www.maximintegrated.com/packages). Note that a "+", "#", or "-" in the package code indicates RoHS status only. Package drawings may show a different suffix character, but the drawing pertains to the package regardless of RoHS status.

| PACKAGE TYPE | PACKAGE CODE | OUTLINE NO.             | LAND PATTERN NO.        |
|--------------|--------------|-------------------------|-------------------------|
| 48 TQFN-EP   | T4877+4      | <a href="#">21-0144</a> | <a href="#">90-0130</a> |

# MAX9240

## 6.25MHz to 100MHz, 25-Bit GMSL Deserializer for Coax or STP Cable With Line Fault Detect

### *Revision History*

| REVISION NUMBER | REVISION DATE | DESCRIPTION     | PAGES CHANGED |
|-----------------|---------------|-----------------|---------------|
| 0               | 3/13          | Initial release | —             |



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

**Maxim Integrated 160 Rio Robles, San Jose, CA 95134 USA 1-408-601-1000**

51