

## Maxim > Design Support > Technical Documents > Application Notes > High-Speed Interconnect > APP 4254

Keywords: PRBS, pseudo-random bit sequence, serializer, deserializer, eye diagram, ECU, bit error rate tester, BERT, continuous PRBS, PRBS pattern length, JAE connector

## PRBS Mode Setup for the MAX9257/MAX9258 Evaluation Kit

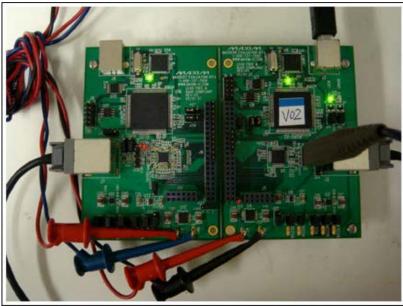
Jun 26, 2008

Abstract: The following application note details how to utilize the internal bit error-rate testing (BERT) feature of the MAX9257/MAX9258 serializer/deserializer (SerDes) in its pseudorandom bit sequence (PRBS) mode. This integrated feature of the SerDes chipset allows quick verification of full functionality of the link, and allows a first look at the quality of the signal transmission across the link without requiring the system engineer to design a BER/PRBS system.

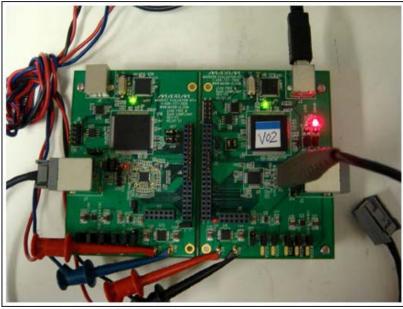
Applications that use a serializer/deserializer (SerDes) often require the designer to check the quality of the link by comparing the transmitted data with the received data. One way to analyze the quality of the link is by generating an eye diagram for the worst-case pattern pseudorandom bit sequence (PRBS). The eye diagram provides an abundance of information about potential problems in a SerDes system, such as excessive reflections, impedance mismatch, and nonideal termination of the differential link. However, it should always be checked for bit errors as well.

The MAX9257/MAX9258 SerDes chipset features an internal PRBS function that allows a user to check the quality of the link and determine if and especially how many bit errors have been logged for a given time, bit pattern, and data-transmission rate. This application note details how to set up the MAX9257/MAX9258 evaluation (EV) kit for this internal PRBS test with bit-error analysis, and compares test results for 0.5m and 2m shielded cables.

This application note assumes that the reader is familiar with and in possession of a MAX9257/MAX9258 EV kit (**Figure 1**). Data sheets for the chipset and the EV kit can be obtained through Maxim's website.



More detailed image (PDF, 2MB) Figure 1a. MAX9257/MAX9258 EV kit with JAE cable link locked.



More detailed image (PDF, 2MB) Figure 1b. MAX9257/MAX9258 EV kit with JAE cable link unlocked/in error (the link is severed).

To begin the testing procedure, follow these guidelines to power up the EV kit and start the software.

- 1. Verify that all the jumpers are set in their default positions. For default shunt positions, see Table 1 in the manual that came with the MAX9257/MAX9258 EV kit.
- 2. Connect a 5V power supply to the 5V and GND pads on both sides of the EV kit board. Keep the power turned off until all connections are made and all jumper positions have been verified.
- 3. Connect the JAE cable between J2 and J7.
- 4. Connect the USB cable between the PC and J3 (attention: not J8).
- 5. Download the most recent version of the MAX9257/MAX9258 EV kit software.
- 6. Install the MAX9257/MAX9258 EV kit software on your computer by running the INSTALL.EXE program. The

program files are copied and icons are created in the Windows® Start menu.

- 7. Start the MAX9257\_8 Evaluation Kit program by opening its icon in the Start menu.
- 8. Click the **Yes** button when asked if the ECU remotely wakes up the MAX9257. The software main window appears as shown in **Figure 2**.

💯 MAX9257_B Evaluation Kit
Elle Options Help
ECU Control Deserializer MAV9258 Serializer MAV9257 Camera Control
Select ECU UART Baud Rate
ECU Writes N Bytes to M4X9257/58/Camera     Format: [Dev Addr + W] (Reg Address) [Number of Bytes] (Byte 1) (Byte 1) (Byte 2) (Byte N) [ZXX (Dev Addr + W) (Reg Address) [Number of Bytes) (Byte 1) (Byte 2) (Byte N)]     All numbers are hexadecimal values.
The second command is optional.
Approximate time delay between two commands: (XX+3) microseconds.  Example: F8 00 01 85 204 FA 00 01 85
Vile
ECU Reads N Bytes from M4X9257/58/Camera      Format: (Dev Addr + R): (Reg Address): (Number of Bytes)         All numbers are hexadecimal values.
Example: F9 00 01
Read
ECU Wake: Up MAX9257
Prefix a SYNC frame everytime a read/write command is sent
Postfix an END frame everytime a read/write command is sent.
Reset the EVKIT
Hardware: Connected.

More detailed image (PDF, 4kB)

Figure 2. On the start-up screen, click on **ECU Wakes Up MAX9257** button to wake up the serializer. Ensure that your EV kit is connected by checking the comment in the lower left corner of the start-up screen.

- 9. Verify that the **Hardware Connected** message is displayed on the status bar (lower left corner) of the software's main window. This indicates the EV kit's proper connection.
- 10. Click the ECU Wakes Up MAX9257 button on the ECU Control tab sheet.
- 11. Next, click on the **Camera Control** tab to verify your EV kit's start-up clock frequency in default mode (PCLK = PRATE = 30MHz). (See **Figure 3**.)

Command to the Camera II the Camera has a UV	7 Camera Control ART Interface (M4X/9257/M4X/9258 in Bypass Mode)			
Turn On D4	Enable PCLK_IN/HSYNC_IN/VSYNC_IN	Change PCLK_IN/HSYNC_IN/VSYNC_IN C PCLK_IN = 5MHz C PCLK_IN = 40MHz		
Tum Off D4	Disable PCLK_IN/HSYNC_IN/VSYNC_IN	C PCLK_IN = 10MHz C PCLK_IN = 50MHz		
Fast Blink D4	Change Camera UART Baud Rate	C PCLK_IN = 20MHz C PCLK_IN = 60MHz PCLK_IN = 30MHz C PCLK_IN = 70MHz		
Slow Blink D4	C 100 Kbps C 2.0 Mbps C 8.0 Mbps	Onboard PCLK_IN, HSYNC_IN, VSYNC_IN Status		
xit UART Mode => Enter I2C Mode	C 200 Kbps C 3.0 Mbps C 9.0 Mbps F 400 Kbps C 4.0 Mbps C 10.0 Mbps C 500 Kbps C 4.25 Mbps	- Enabled (external clocks are not allowed) - PCLK_IN = 30MHz - HSYNC_IN = 30KHz - VSYNC_IN = 60Hz		
Command to the Camera if the Camera has an I.	2C Interface (MAX3257/MAX3258 in Base Mode)			
	Enable PCLK_IN/HSYNC_IN/VSYNC_IN	C PCLK_IN/HSYNC_IN/VSYNC_IN C PCLK_IN = 5MHz C PCLK_IN = 40MHz		
Tum On D 4				
	Disable PCLK. IN/HSYNC. IN/VSYNC. IN	C PCLK_IN = 10MHz C PCLK_IN = 50MHz		
Tum Off D4	Disable PCLK_IN/HSYNC_IN/VSYNC_IN	PCLK_JN = 10MHz     PCLK_JN = 50MHz     PCLK_JN = 60MHz		
	Disable PCLK_IN/HSYNC_IN/VSYNC_IN			

More detailed image (PDF, 6kB)

Figure 3. **Camera Control** tab sheet depicts the default clock frequency of 30MHz (the basis for this application note).

- 12. Click the **Enable PCLK\_IN/HSYNC\_IN/VSYNC\_IN** button, and verify that LOCK indicator LED (D1) turns on. If it lights up (green), this means that the system is locked (as in Figure 1b).
- 13. Once the clock frequency has been verified, click the **Deserializer MAX9258** tab to move to the **Deserializer MAX9258** tab sheet (Figure 4).

Elle Options	_8 Evaluation Kit Helo					
	Deserializer MAX9258 Serializer	MAX9257 Camera Control				
Reg00:	PRATE 10 (20MH2 - 40MH2)	SRATE 10 (200 · 400Mbps)	PAREN 0 (Disable)	PWIDTH 000 (10 bits)	Write Read	Write Both 92588-9257
Reg01:	SPREAD 00 (0#)	BANG 0 [Normal]	PDCUR 00 (6.3uA)		Write Read	
Reg02:	STODIV 1010 (1024)	STOCNT 0000 (0)			Write Read	<b>N</b>
Reg03:	ETODIV 1010 (1024)	ETOCNT 1001 (9)			Write Read	<b>v</b>
Reg04:	VEDGE HEDGE Falling V Falling V	CKEDGE CCSPRDIS Rising • Enable •	LKSHORT DISLEAK	TRN2× PRBSEN Nomal ▼ Enable ▼	Write Read	
Reg05:	DEVICEID 1111 100 Write	Read		Reg06: 1111 111	Write Read	
Reg07:	INTMODE INTEN	FAST 0 · 4Mbps	CT0 100 (64 bits)	BITRATE 00 (95 - 400Kbps)	Write Read	2
Reg08,	09 (Threshold for numbe	er of video parity errors)	): Decimal:	PATHRL0 PATHRHI 0x10 0x00	Write Read	
Reg10,	11 (Number of video pa	rity errors):	Decimal: 0	PAERRLO PAERRHI 0x00 0x00	Read	
Reg12 (	PRBS test number of bit	errors):	Decimal: 0	PRBSERR 0x00	Read	
Reg13:	DESPERR DESFERR	SERPERR SERFERR	No Read			
Reg14 (	Decimat Bit length): 37	BITLEN 0x25 Read				
Reset MA	X9258 GUI Read MAX9	258 & 9257 Write MAX9	258 & 9257 Read MAX92	258 Write MAX3258		
Hardware: Conr	nected.					

More detailed image (PDF, 6kB)

Figure 4. Deserializer MAX9258 tab sheet shows the MAX9258 register setup for continuous PRBS mode.

- 14. Click Read MAX9258 & 9257 button to read all of the MAX9258 and MAX9257 registers.
- 15. For this example, set register 00 for both the MAX9258 and the MAX9257. For the permanent PRBS and BER test, a 10-bit pattern width was selected. Set **PWIDTH** to **000** (10 bits) and click the **Write** button on the right side of **Reg00**.
- 16. With a 30MHz parallel data rate (**PRATE; serializer**), the serial data rate (**SRATE; deserializer**) needs to be changed to 200Mbps to 400Mbps in register 00. To make this change, set **SRATE** to **10** and click the **Write** button on the right side of **Reg00**.
- 17. Next, set **ETOCNT** in both MAX9258's register 03 and MAX9257's register 03 to **1001** by selecting the **ETOCNT** dropdown menu; then click the **Write** button on the right side of **Reg03**.
- 18. Set CTO in both MAX9258's register 07 and MAX9257's register 08 to **100** by selecting the **CTO** dropdown menu and click the **Write** button on the right side of **Reg07**.
- 19. Next, enable the PRBS mode by selecting **Enable** from the dropdown menu of **PRBSEN** in **Reg04**; then click the **Write** button on the right side of **Reg04**.
- 20. Click the Serializer MAX9257 tab to move to the Serializer MAX9257 tab sheet (shown in Figure 5).

Elle Options (	_B Evaluation Kit Help					
ECU Control	Deserializer MAX9258 Serializer	r MAX9257 Camera Control				
Reg00:	PRATE 10 (20MHz · 40MHz)	SRATE 10 (200 · 400Mbps)	PAREN 0 (Disable)	PWIDTH 000 (10 bits)	Write Read	Write Both 92588.9257
Reg01:	SPREAD 000 (0#)	SAWDV 11111			Write Read	」
Reg02:	STODIV 1010 (1024)	STOCNT 0000 (0)			Write Read	9
Reg03:	ETODIV 1010 (1024)	ETOCNT 1001 (9)			Write Read	
Reg04:	VEDGE HEDGE Faling V Faling V	CKEDGE PD Rising Power U	SEREN BYPFPLL Enable  Active	TRN2X PRBSEN	Write Read	
Reg05:	DEVICEID 1111 101 Write	Reg06: 11111	11 Write Read	MAX9258 ID Reg07: 1111 100	Write Read	」
Reg08:	INTMODE INTEN UART V Enable V	FAST 0 · 4Mbp:	CT0 100 (64 bits)	BITRATE 00 (95 - 400Kbps)	Write Read	9
Reg09:	PRBSLEN 1111 (Continuous)	GPI09DIR GPI08DIR	GPI09 GPI08 0		Write Read	]
Reg10:	GPI07DIR GPI06DIR	GPI05DIR GPI04DIR	GPI03DIR GPI02DIR Input • Input •	GPI01DIR GPI00DIR Input • Output •	Write Read	
Reg11:	GPI07 GPI06 0 • 0 •	GPI05 GPI04 0 •	GPI03 GPI02 0 •	GPI01 GPI00 0 • 1 •	Write Read	
Reg12:	PREEMP C	PCUR	Read Reg13:	12CFILT 00 (According to bit rate)	Write Read	
Reg14:	LOCKED Read		Reg15 (Bit length):	Decimat BITLEN	Read	
Reset MAX	X9257 GUI Read MAXS	3258 & 9257 Write MAX9	258 & 9257 Read MAX92	257 Write MAX9257		
Hardware: Conn	ected.					

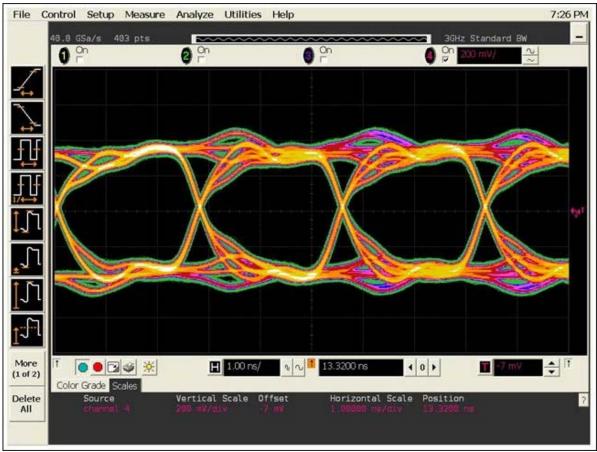
More detailed image (PDF, 6kB)

Figure 5. The **Serializer MAX9257** tab sheet provides the MAX9257 register setup for continuous PRBS mode.

- 21. Enable the PRBS mode by selecting **Enable** from the dropdown menu of **PRBSEN** in **Reg04**, then click the **Write** button on the right side of **Reg04**.
- 22. Select the desired **PRBS** length from **Reg09**. For this application note, continuous PRBS mode was selected. Set **PRBSLEN** to **1111** for permanent PRBS mode and click the **Write** button on the right side of **Reg09**. Note that this mode can only be exited by powering down the EV kit and resetting its software.
- 23. Enable the MAX9257 SEREN bit by selecting the **SEREN** dropdown menu and clicking the **Write** button to the right of **Reg04**.

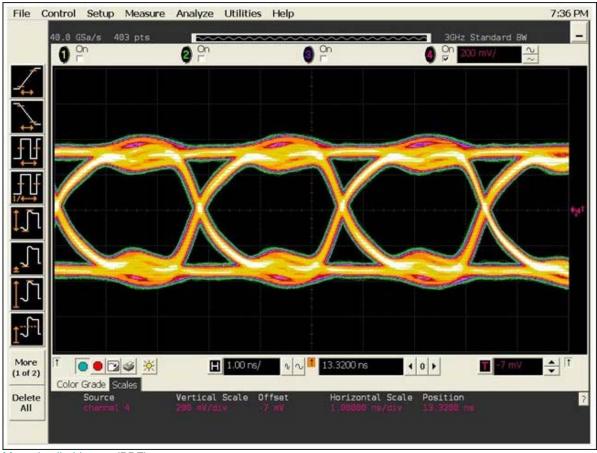
Use a multichannel oscilloscope to check the waveforms during the evaluation of this board. By setting the trigger accordingly, single transmit/receive sequences and data sent across the link can be observed.

For this application note, the BER test was conducted for cable lengths of 0.5m and 2m, as well as for two resolution rates (10 bit and 12 bit). In addition to these BER tests (with the MAX9257/MAX9258's integrated BER test configuration), the signal quality of the deserializer link was monitored and logged through eye diagram measurements (see **Figures 6** and **7** for continuous PRBS mode only).



More detailed image (PDF)

Figure 6. Permanent PRBS mode—eye diagram, JAE connector 0.5m.



More detailed image (PDF) Figure 7. Permanent PRBS mode—eye diagram, JAE connector 2m.

For the BER tests under the aforementioned cable and resolution conditions, the EV kit's internal BER tester was utilized with different PRBS pattern lengths. The contents of **Reg12** on the **Deserializer MAX9258** tab sheet can be polled (click on the **Read** button to the right of the **PRBSERR** cell) to check on the number of bit errors that have been logged during each run of the individually programmed PRBS pattern lengths.

**Tables 1** and **2** depict the BER test results for the 10-bit and 12-bit pattern lengths at a 30MHz transmit clock with shielded 0.5m and 2m JAE cables.

10-Bit Resolution			12-Bit Resolut	tion			
PRBS Pattern	Length (m)	Shielded	Errors	PRBS Pattern	Length (m)	Shielded	Errors
2 <sup>21</sup>	0.5	Yes	0	2 <sup>21</sup>	0.5	Yes	0
222	0.5	Yes	0	2 <sup>22</sup>	0.5	Yes	0
2 <sup>23</sup>	0.5	Yes	0	2 <sup>23</sup>	0.5	Yes	0
2 <sup>24</sup>	0.5	Yes	0	2 <sup>24</sup>	0.5	Yes	0
2 <sup>25</sup>	0.5	Yes	0	2 <sup>25</sup>	0.5	Yes	0
2 <sup>26</sup>	0.5	Yes	0	2 <sup>26</sup>	0.5	Yes	0
2 <sup>27</sup>	0.5	Yes	0	2 <sup>27</sup>	0.5	Yes	0
2 <sup>28</sup>	0.5	Yes	0	2 <sup>28</sup>	0.5	Yes	0

Table 1. 10- and 12-Bit Resolutions for 0.5m Cable

229	0.5	Yes	0	2 <sup>29</sup>	0.5	Yes	0
230	0.5	Yes	0	2 <sup>30</sup>	0.5	Yes	0
2 <sup>31</sup>	0.5	Yes	0	2 <sup>31</sup>	0.5	Yes	0
232	0.5	Yes	0	232	0.5	Yes	0
233	0.5	Yes	0	233	0.5	Yes	0
2 <sup>34</sup>	0.5	Yes	0	2 <sup>34</sup>	0.5	Yes	0
2 <sup>35</sup>	0.5	Yes	0	2 <sup>35</sup>	0.5	Yes	0

Table 2. 10- and 12-Bit Resolutions for 2m Cable

10-Bit Resolution				12-Bit Resolution			
<b>PRBS</b> Pattern	Length (m)	Shielded	Errors	PRBS Pattern	Length (m)	Shielded	Errors
2 <sup>21</sup>	2	Yes	0	2 <sup>21</sup>	2	Yes	0
2 <sup>22</sup>	2	Yes	0	2 <sup>22</sup>	2	Yes	0
2 <sup>23</sup>	2	Yes	0	2 <sup>23</sup>	2	Yes	0
2 <sup>24</sup>	2	Yes	0	2 <sup>24</sup>	2	Yes	0
2 <sup>25</sup>	2	Yes	0	2 <sup>25</sup>	2	Yes	0
2 <sup>26</sup>	2	Yes	0	2 <sup>26</sup>	2	Yes	0
2 <sup>27</sup>	2	Yes	0	227	2	Yes	0
2 <sup>28</sup>	2	Yes	0	2 <sup>28</sup>	2	Yes	0
2 <sup>29</sup>	2	Yes	0	2 <sup>29</sup>	2	Yes	0
2 <sup>30</sup>	2	Yes	0	2 <sup>30</sup>	2	Yes	0
2 <sup>31</sup>	2	Yes	0	2 <sup>31</sup>	2	Yes	0
2 <sup>32</sup>	2	Yes	0	2 <sup>32</sup>	2	Yes	0
2 <sup>33</sup>	2	Yes	0	2 <sup>33</sup>	2	Yes	0
2 <sup>34</sup>	2	Yes	0	2 <sup>34</sup>	2	Yes	0
2 <sup>35</sup>	2	Yes	0	2 <sup>35</sup>	2	Yes	0

Windows is a registered trademark and registered service mark of Microsoft Corporation.

<b>Related Parts</b>		
MAX9257	Programmable Serializer/Deserializer with UART/I <sup>2</sup> C Control Channel	Free Samples
MAX9258	Programmable Serializer/Deserializer with UART/I <sup>2</sup> C Control Channel	Free Samples

## More Information

For Technical Support: http://www.maximintegrated.com/support For Samples: http://www.maximintegrated.com/samples Other Questions and Comments: http://www.maximintegrated.com/contact

Application Note 4254: http://www.maximintegrated.com/an4254

APPLICATION NOTE 4254, AN4254, AN 4254, APP4254, Appnote4254, Appnote 4254 Copyright © by Maxim Integrated Products Additional Legal Notices: http://www.maximintegrated.com/legal