

Using the TLK2711-SP With Minimal Protocol

Wade Vonbergen

ABSTRACT

The TLK2711-SP can be implemented using a minimal protocol with various levels of additional complexity for added features. This can run the range of streaming raw data with occasional comma character for transmission to packetizing data with checksum transmission and link level commands.

Contents

1	Introduction	2
2	8B/10B Primer:	2
3	Quick Experiment to Obtain Byte-Alignment With TLK2711-SP EVM	3
4	Defining a Simple Protocol	4
5	References:	5

List of Figures

1	EVM Jumper Settings	4
---	---------------------------	---

List of Tables

1	5B/6B Table Lookup	2
2	3B/4B Table Lookup	3
3	Control Code Lookup	3

1 Introduction

The TLK2711-SP is a 1.6-Gbps to 2.5-Gbps Class V SERDES transceiver capable of approximately 1.28-Gbps to 2-Gbps of data payload. It has a 16-bit parallel interface with built in 8B/10B encoding.

In order to successfully implement a TLK2711 transceiver, one must have a working knowledge of 8B/10B encoding.

2 8B/10B Primer:

8B/10B is an encoding scheme that takes an 8-bit word, and converts it to a 10-bit value for transmission. The encoding scheme was developed by IBM, and has several advantages over transmitting raw data without encoding.

1. DC balance. The running disparity will always be bounded between +2 and -2. The running disparity is defined as the difference in the number of 1 s and 0 s transmitted.
2. Maximum run length is bounded. The encoding scheme ensures that no more than 5 consecutive 1 s or 0 s will occur. This insures that a minimum transition density exists for proper clock recovery.
3. Defined control codes, and specifically the "comma" character to align 8-bit boundary at receiver. The comma character is contained in a K28.5, that gets decoded to a (0011111)010 or 110000101. The () indicates the comma value that the TLK2711 needs for alignment.

8B/10B uses tables to encode the transmitted word, and to decode it at the receiver. It actually uses two sets of codes. 8B/10B is defined by a 5B/6B and a 3B/4B code. The common convention used to describe the 8B/10B values is to utilize upper case for 8B, and lower case for the 10B. For example an 8-bit word is defined as ABCDEFGH with A being the least significant bit. This gets broken down as EDCBA HGF. This is commonly referred to as Dx.y. Where X is 0-31, and Y is 0-7 and represents the 5b and 3b bit values. An 8-bit value of 0xBC breaks down as 101 1100 and is D28.5. Encoding tables for 5B/6B and 3B/4B shown below.

A full table of all 8B/10B values is published within the IEEE 802.3.2000 specification. Within the tables, many of the 5B, and 3B codes have multiple encodings. The appropriate coding is selected based on the current running disparity.

Table 1. 5B/6B Table Lookup

INPUT	EDCBA	RD = -1	RD = +1	INPUT	EDCBA	RD = -1	RD = +1
	EDCBA	abcdei			EDCBA	abcdei	
D.00	00000	100111	011000	D.16	10000	011011	100100
D.01	00001	011101	100010	D.17	10001	100011	
D.02	00010	101101	010010	D.18	10010	010011	
D.03	00011	110001		D.19	10011	110010	
D.04	00100	110101	001010	D.20	10100	001011	
D.05	00101	101001		D.21	10101	101010	
D.06	00110	011001		D.22	10110	011010	
D.07	00111	111000	000111	D.23	10111	111010	000101
D.08	01000	111001	000110	D.24	11000	110011	001100
D.09	01001	100101		D.25	11001	100110	
D.10	01010	010101		D.26	11010	010110	
D.11	01011	110100		D.27	11011	110110	001001
D.12	01100	001101		D.28	11100	001110	
D.13	01101	101100		D.29	11101	101110	010001
D.14	01110	011100		D.30	11110	011110	100001
D.15	01111	010111	101000	D.31	11111	101011	010100

Table 2. 3B/4B Table Lookup

INPUT		RD = -1	RD = +1
	HGF		fgjh
D.x.0	000	1011	0100
D.x.1	001		1001
D.x.2	010		0101
D.x.3	011	1100	0011
D.x.4	100	1101	0010
D.x.5	101		1010
D.x.6	110		0110
D.x.P7	111	1110	0001
D.x.A7	111	0111	1000

Table 3. Control Code Lookup

INPUT		RD = -1	RD = +1
	HGF EDCBA	abcdei fgjh	abcdei fgjh
K.28.0	000 11100	001111 0100	110000 1011
K.28.1	001 11100	001111 1001	110000 0110
K.28.2	010 11100	001111 0101	110000 1010
K.28.3	011 11100	001111 0011	110000 1100
K.28.4	100 11100	001111 0010	110000 1101
K.28.5	101 11100	001111 1010	110000 0101
K.28.6	110 11100	001111 0110	110000 1001
K.28.7	111 11100	001111 1000	110000 0111
K.23.7	111 10111	111010 1000	000101 0111
K.27.7	111 11011	110110 1000	001001 0111
K.29.7	111 11101	101110 1000	010001 0111
K.30.7	111 11110	011110 1000	100001 0111

Within the 8B/10B encoding, there are special symbols defined for control information. These are commonly referred to as K characters. These characters are used for higher level control such as start of frame (SOF), end of frame (EOF), retransmit, errors, etc. The single most important K character is the comma. The TLK2711 uses the comma for byte alignment of the parallel data at the receiver. The comma is contained in multiple K characters, but for practical purposes it is defined as the K28.5. From [Table 3](#), K28.5 is decoded as a 001111 1010 or a 1100000101 depending on current running disparity. Note, the TLK2711 only achieves alignment on the 001111 1010 comma. Specifically it is looking for the 0011111. This has a significant implication. This implies that the user must send the 0011111 comma. However, a single K28.5 may not generate this comma, as the current running disparity is not deterministic. This is solved by sending two inverting (or correcting) idles back to back. An inverting IDLE is two words that taken as a whole will cause the running disparity to flip. So two back-to-back inverting idles will ensure that one of them will be the correct decoding of the K28.5. The inverting idle is defined as a /K28.5/D5.6/. There are other data values that will cause an inversion when paired with the K28.5. However, this symbol pair is the standard.

3 Quick Experiment to Obtain Byte-Alignment With TLK2711-SP EVM

This is a trivial example, to help visually explain the minimum requirements to achieve byte-alignment utilizing the TLK2711-SP EVM. With TXCLK being driven at a clock frequency within the operational range of 80 Mhz to 125 Mhz, the comma character can be sent by configuring jumper pins on the TXD interface.

Start with a configuration that is only sending data with internal loopback.

The jumper settings show a D28.5/D5.6 being transmitted on the TX bus. Note, that this does not include the comma, as it is coded as data with TKLSB set to low.

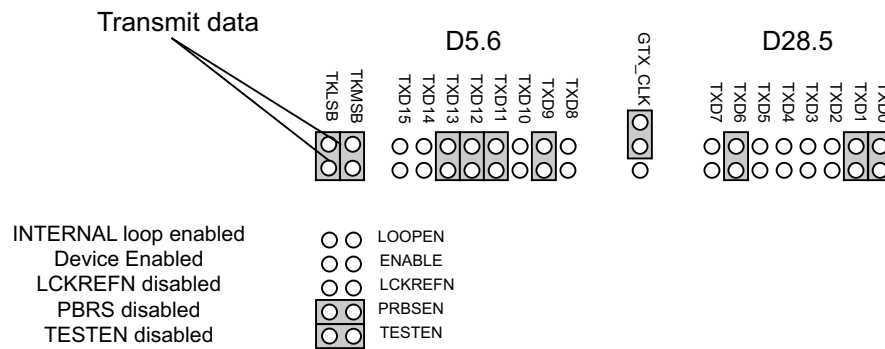


Figure 1. EVM Jumper Settings

Internal LOOPEN may be disabled (add jumper), if external loopback is used. Connect TXP to RXP and TXN to RXN via SMA cables. With LOOPEN enabled, the transmitted signal is routed internally to receiver.

Next, supply power and TXCLK to board.

The user can now probe the received signals on the RXD buss. When probing signals, notice that the data does not represent what is on the transmit buss. It is possible, but unlikely that device will happen to align to proper boundary.

Now, remove and replace the TKLSB jumper.

This will cause many inverting idles to be sent on the buss, and will give the TLK2711 the necessary comma character to achieve byte alignment. Now probe the RXD bus. Signals should now match the D28.5/D5.6 mirroring the TXD buss.

4 Defining a Simple Protocol

The simplest protocol would be transmitting raw data, with a periodic transmission of 2 inverting idles, then resume transmitting raw data. A step beyond this would be the inclusion of framing or packetizing the data. Sending periodic commas in the stream is necessary, as an error in the bit stream could cause false byte-alignment on receiver.

A simple and effective protocol can be implemented as follows.

- K28.5 D5.6
- K28.5 D5.6
- K28.5 D11.5 (SOF optional and user definable)
- Dxx Dxx (Transmitted packet. Repeat for packet depth.)
- Dxx Dxx (Packet CRC if desired)
- K28.5 D5.6
- K28.5 D5.6
- K28.5 D11.5 (SOF optional)

Repeat with next packet.

Note, that a packet begins with 2 inverting idles. This will achieve byte alignment on the receiver, and provide for re-alignment if a bit error causes a mis-alignment at some point during operation.

The (SOF) sequence is not necessary, but can be used by receiving link layer to manage capturing the data.

The use of a CRC is also optional, but depending on source of the data, this is a convenient means to detect if an error occurred in the data. A more elaborate scheme could include a bidirectional control path. On receipt of a data error, the receiving link could transmit back to request a retransmit of the erroneous packet. This is beyond the scope of this document.

5 References:

A.X. Widmer, Peter A. Franaszek (1983). "[A DC-Balanced, Partitioned-Block, 8B/10B Transmission Code](#)" *IBM Journal of Research and Development* **27**(5): 440.

Texas Instruments TLK2711-SP Data sheet ([SGLS307D](#))

Texas Instruments TLK2711-SP EVM manual ([SGLU001](#))

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

Products

Audio	www.ti.com/audio
Amplifiers	amplifier.ti.com
Data Converters	dataconverter.ti.com
DLP® Products	www.dlp.com
DSP	dsp.ti.com
Clocks and Timers	www.ti.com/clocks
Interface	interface.ti.com
Logic	logic.ti.com
Power Mgmt	power.ti.com
Microcontrollers	microcontroller.ti.com
RFID	www.ti-rfid.com
RF/IF and ZigBee® Solutions	www.ti.com/lprf

Applications

Communications and Telecom	www.ti.com/communications
Computers and Peripherals	www.ti.com/computers
Consumer Electronics	www.ti.com/consumer-apps
Energy and Lighting	www.ti.com/energy
Industrial	www.ti.com/industrial
Medical	www.ti.com/medical
Security	www.ti.com/security
Space, Avionics and Defense	www.ti.com/space-avionics-defense
Transportation and Automotive	www.ti.com/automotive
Video and Imaging	www.ti.com/video
Wireless	www.ti.com/wireless-apps

TI E2E Community Home Page

e2e.ti.com

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2011, Texas Instruments Incorporated