Analyzing Serial FPDP Communications for Optimum Performance

by
Paul Davis and Mike Holl
Curtiss-Wright Controls Embedded Computing
Data Communications
4126 Linden Avenue
Dayton, OH 45432-3068 USA
Phone: 800-252-5601 or FAX: 937-258-2729
E-mail: info@systran.com
WWW: www.cwcembedded.com/

Abstract

Serial Front Panel Data Port (FPDP) has become a popular data transport technology in the Sensor-To-DSP (STD) market since it is a fast, efficient method of moving large quantities of data from Point A to Point B. Examples of systems using Serial FPDP include both military applications (radar, sonar, and infrared imaging systems) and medical imaging applications (MRI machines and PET scanners). Time and cost constraints demand that custom design and application issues be dealt with quickly so that the system can be operational as soon as possible. This paper will examine Serial FPDP, explore the various troubleshooting needs of the user, and discuss how Protocol Analyzers can be used to quickly and effectively resolve these issues.

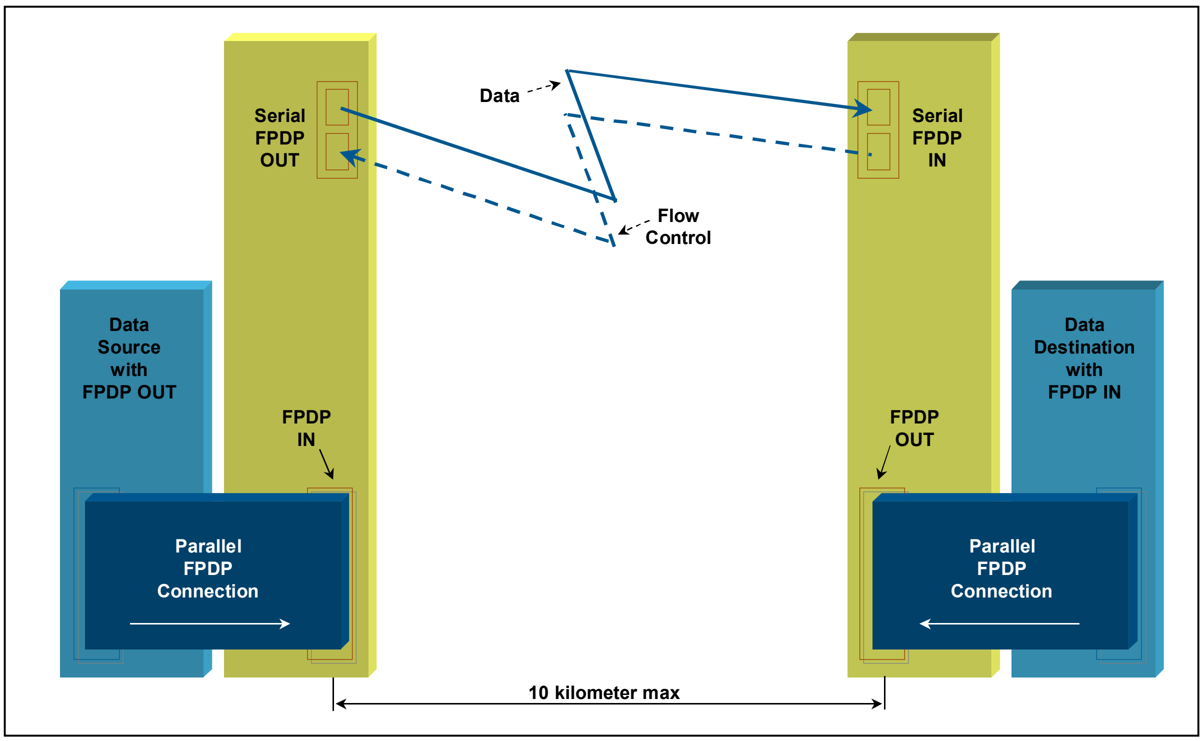
Introduction to Serial FPDP

The ANSI/VITA 17 Parallel Front Panel Data Port (FPDP) provides a high-speed connection between the A/D converter of a front-end data generating system (such as a radar antenna) and the digital signal processors (DSP) that are used to process the incoming data stream. While FPDP provides good real-time performance, it has a major limitation: The front-end data generation system must be located within one to five meters of FPDP cable length of the DSP system, depending on the FPDP configuration. This distance limitation represents a problem in many real-world applications in which greater distances between sensors and processors are necessary.

Serial FPDP (ANSI/VITA 17.1) was developed as an extension of FPDP to overcome this distance limitation. It presents a straightforward approach to serializing the FPDP data stream and transmitting it over extended distances. This protocol was originally developed at Systran Corporation in 1997. Since that time, a group of industry leaders has carried the technology forward, and in early 2003, they finalized the Serial FPDP specification. The ANSI/VITA 17.1 specification supports 1Gb/s, 2Gb/s, and 2.5Gb/s link speeds. It also supports various topologies including point-to-point, copy mode, and loop mode. All the topologies still maintain the simplicity and robustness that makes Serial FPDP so attractive.

Serial FPDP extends the maximum distance of FPDP connections up to 2 km by serializing the FPDP data stream and transmitting it over an extended distance using fiber optic cable (10m-30m with copper). On the transmit side, the parallel FPDP data is converted to Serial FPDP. On the receive side, the Serial FPDP data is converted back into the parallel FPDP data stream.

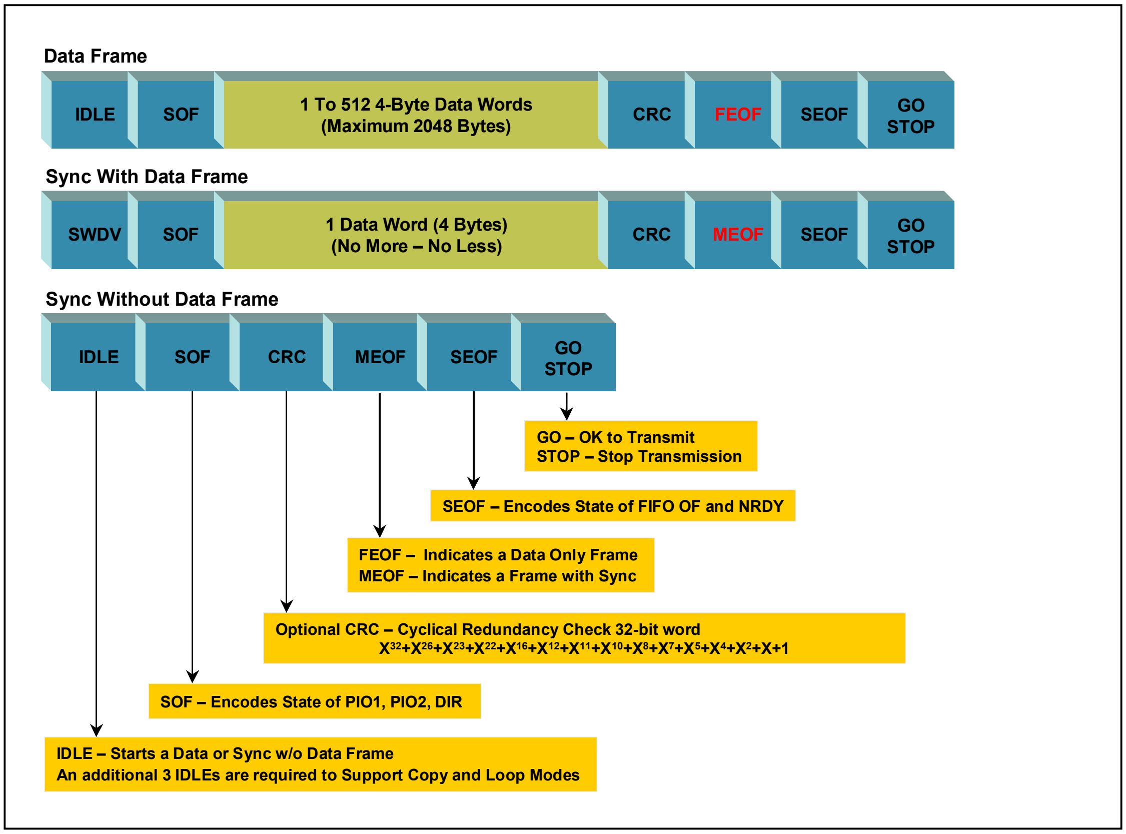
Serial FPDP provides solutions for many types of real time data streaming scenarios--many of which are not FPDP applications. Serial FPDP has evolved into a "general-purpose" high performance data link, providing high-speed, bi-directional data flow (with flow control) across multiple platforms. Figure 1 illustrates the Serial FPDP concept.



(Figure 1 – The Serial FPDP Concept)

Serial FPDP Framing

In addition to transferring FPDP standard 32-bit data words, Serial FPDP also transmits the control signals used by FPDP. These signals are encoded as part of a series of special characters that are used to frame the data for transmission across the link. Three FPDP signals (DIR, DVALID, SYNC) are set by the FPDP (and Serial FPDP) transmit operation, and two FPDP signals (NRDY, SUSPEND) are set by the receive operation. There are two user definable FPDP signals, (PIO1 and PIO2), that are available to be set/read from either side of the link.



(Figure 2 – Serial FPDP Framing Protocol)

Serial FPDP uses a series of frames to structure the data flow. Ordered sets (primitives) are used as part of this framing structure. Serial FPDP has three basic frame types: A data frame, a SYNC without data frame, and a SYNC with data frame. The data per frame is variable, with a maximum data buffer size of 512, 32-bit words (2048 bytes) in a single frame. SYNC is used to delimit data streams and maintain host program synchronization. Whenever a SYNC is recognized, the current frame is terminated and the proper SYNC frame (SYNC w/data or SYNC w/o data) is sent. Figure 2 shows the Serial FPDP framing protocol with and without a SYNC.

The Need for Efficient Serial FPDP Troubleshooting

Troubleshooting the protocol transmitted on the link can become an issue, especially when users implement their own version of Serial FPDP.

As the pace of business increases and Serial FPDP systems become more pervasive, it is unacceptable to take a time- and cost-intensive approach to troubleshooting a new design. Problems must be identified and corrected quickly. Once the link is running properly, then the more important task of developing the real application (Radar, Sonar, MRI, etc.) can be tackled.

A dedicated, special-purpose protocol analyzer can significantly streamline the troubleshooting process. Potential problems with new host interface designs, applications, and fiber optic cabling can be quickly pinpointed.

Troubleshooting The Application

System developers often use the features of Serial FPDP to support unique requirements of the system architecture. One such application is the use of SYNC frames to delineate groups of data so the receiving node can re-align the data appropriately. Transmission of video data is one such example.

The 'SYNC without data' and 'SYNC with data' both have their origins in parallel FPDP. 'SYNC with data' frames are often used at the end of a small frame of data. Such a small frame might be the end of one line of a video display being transmitted. 'SYNC with data' is used at the end of an epoch of data. Such an epoch of data might mean the end of the one screen (page) of video display.

A Serial FPDP Protocol Analyzer can be used to troubleshoot the software or hardware that generates such a repeating stream of data. If the transmitter does not frame the data properly, then the receiver doesn't have the chance of re-displaying the data on the remote end.

Troubleshooting A Custom Hardware Design Interface

While there are Serial FPDP solutions for the various PCI bus types, Race++ and VME carrier boards, not all systems can use such COTS solutions. The Common Mezzanine Card (CMC) version of the Serial FPDP card provides an interface through a simple unidirectional parallel port. This port can be connected to existing FPDP equipment or can be integrated into new products. This variation interoperates completely on the link interface, providing seamless integration between diverse platforms.

To support special requirements of a system, hardware engineers may need to design their own custom interface board that incorporates a Serial FPDP COTS product. This allows for custom configuration of the hardware while taking advantage of a ready-to-go Serial FPDP interface. The Serial FPDP CMC card lends itself to such a design interface.

The custom design is based on the Serial FPDP interface specifications of data, SYNC, clocks, flow control, data valid, and so on. Once the design is complete and a prototype is developed, testing must be done. A Serial FPDP Protocol Analyzer is the most efficient way to determine if the design criteria have been met. The analyzer will be able to display the protocol framing and data on the link. With this type of view into the serial FPDP stream, custom hardware debugging can be done quickly and efficiently.

Fiber Optic Cabling

While the implementation of a Serial FPDP system to send data from point A to point B may seem simple in theory, in the real world, it might be necessary for the cable to go through multiple bulkheads on an airplane or ship. Each connector pair can cause the loss of 0.5db to 1.0db of optical signal. If three or more connector pairs are involved, the total loss in optical energy can be excessive.

To avoid this type of problem with optical cable, a 'power budget' must be established. Looking at the differences between transmit power and receive sensitivity, how much light loss is acceptable across the link which joins the transmitter and receiver? If the transmit power drops too low, the receive sensitivity degrades to an unacceptable level, or there is too much light loss across the link, then a link error can occur.

A Serial FPDP Protocol Analyzer will pinpoint insufficient optical power levels through a link quickly. It would then be a simple matter to change the cable and then observe whether the error still occurs.

Basic Analyzer Operation

A Serial FPDP protocol analyzer includes three basic functional blocks: A pre-filter, a triggering system, and a post-filter.

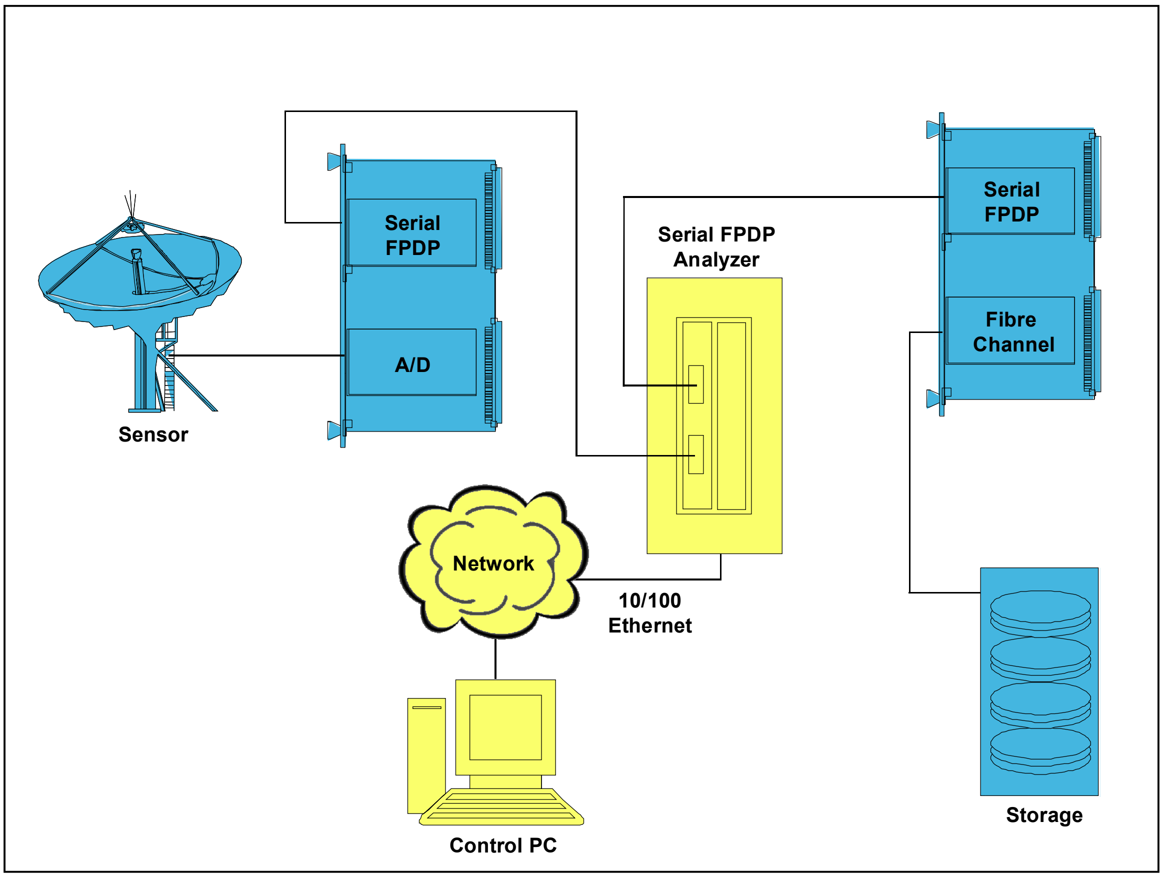
Pre-Filter. As the user starts to analyze/troubleshoot a link, the pre-filter is set according to what data the user wishes to examine. For example, the pre-filter can be set by the user to filter out all idle frames, or to limit the amount of data captured per frame.

Triggering System. The triggering system starts and stops the capturing of test data. Triggering criteria are determined by the user, and could include parameters such as what primitive or data pattern are being investigated, quantity of data to be captured, etc.

Post Filter. After the data has been captured, the post-filter is used to remove any unnecessary information or parts of the data stream which are not relevant to the analysis being conducted.

Other useful protocol analyzer capabilities include:

- Intelligent built-in controls, for performing complex multi-level triggers, filtering, and complex decision-making.
- Menus and dialogs to assist in set-up, configuration, defining a data capture strategy, and performing analysis functions.
- Ability to perform extensive searches across data channels, for frames, errors, etc.
- Ability to monitor and graph a wide range of performance statistics.



(Figure 3 – Example of a System Configuration w/ Protocol Analyzer)

Figure 3 depicts an example of a system configuration using a Serial FPDP Protocol Analyzer. The analyzer is interjected into the link between Point A and Point B. The serial stream sent by either node is captured by the analyzer, as prescribed by the user configuration. The fiber frames can then be examined.

(Photo 1 – Serial FPDP Protocol Analyzer)

One such analyzer is the FibreXtreme Serial FPDP Protocol Analyzer from Curtiss-Wright Controls Embedded Computing (see Photo 1). An analyzer like this allows the user to view and control Serial FPDP data transfers at 1.0625 Gbps, 2.125 Gbps, and 2.5 Gbps, via a Windows-based interface. The unit provides two-channel analysis with independent filtering logic and trace control processors for each channel. Data filters can be set based on frame type, source and destination of frame activity, and payload size. Data filtering is performed in real-time and is fully configurable, allowing the user to limit the amount of data being captured.

Intelligent trace control processors are capable of multilevel triggering, filtering, and performance monitoring. Searches can be performed on full-sized trace for frames, primitives, or errors, and post-filtering capabilities allow the user to continue to add filters to further refine captured data.

The analyzer is controlled through an Ethernet 10/100 Base-T host interface connection, and can be accessed remotely by multiple users. Two short wavelength transceivers and one 3-meter LC-LC multi-mode 50/125µm fiber optic cable allow physical integration into the system being analyzed.

The Serial FPDP Analyzer Advantage

A special-purpose analyzer is not required to troubleshoot Serial FPDP. An experienced engineer can perform troubleshooting with intuition about what the problem may be, a large quantity of test instrumentation, and a significant amount of time to track down the cause of the errors. But this clearly is not a practical alternative.

A Serial FPDP protocol analyzer will reduce costs by reducing the number of hours an engineer must spend, and by eliminating the need to invest in a wide range of general-purpose test gear. In the case of troubleshooting an engineering or production prototype, reduced troubleshooting time means a reduced time-to-market. In the case of troubleshooting a customer system or installation, reduced troubleshooting time means a more satisfied customer.

Given the sophistication of current Serial FPDP systems, and the need to minimize the time and cost to design and/or fix these systems, a special purpose protocol analyzer must now be considered a necessity in today's environment.

CURTISS WRIGHT Controls, Inc.
Embedded Computing