Description of EFABUS Decode Option

Lahniss, December 2011-April 2019

Contents

Introduction

The EFAbus is a dual bus (HS/LS), with:

- a high speed part (HS) data bus operating at 20Mbits/sec, also known as STANAG 3910.
- a low speed part is a MIL-1553 at 1Mbit/sec dual redundant Low Speed (LS) bus.

The LS bus provides the command and control of the HS bus by use of “Action Words” sent over the LS bus. The HS bus is used only for Data Transfers under the control of these “Action Words”.

In other words, the **HS bus is subordinated to the LS bus**, but allows the transfer of bulk data, which is not possible on the MIL-1553 bus, because it is too slow for this amount of data.

The design of the EFAbus Decoder was conducted with this situation in mind. The Decoder can execute standalone on the HS bus, but a second Decoder can be used for the LS bus. When both decoders execute at the same time, the timing relationship between both buses can be observed in detail. This is important since both buses are tightly correlated.

Correspondence with Serial Operators Manual

This document often refers to the Teledyne LeCroy Serial_Debug_OM_e.pdf, which explains several other buses and contains valuable information about the decoding Framework. The Framework supports the buttons on the left part of the dialog, such as Measure, Search, Configure Table and Export Table.

Using the EFAbus Decoder (HS part)

The High Speed (HS) Frame length is a minimum of 624 bits up to a maximum of 65,648 bits depending on the type of HS message transfer taking place. It contains a Preamble, Start Delimiter (SD), Headers (2 addresses), Word Count (WC), Information Field, Error Detection (CRC) and an End Delimiter (ED).

The information is Manchester encoded, and can be transmitted over wires (STANAG 3910) or fiber-optic cables (EFAbus).

HS Frames are completely independent of one another and can be decoded and validated one by one. This contrasts with the complex handshaking between BC and RTs on the MIL-1553 bus.

User Interface Access

In the Serial Decode dialog, select EFAbus, and associate a source to it. Four channels might be decoded at the same time. This feature is used to decode the HS part and the LS part at the same time, using 2 distinct decoders. When decoding the EFAbus, there are still 2 other decoder slots available, that can be used to monitor other buses, for example I2C or SPI on a circuit board.

Figure 1: The Serial Decode Dialog is the entry point to the Decoders. It allows the setting of the sources as well as turning the Decoders on and off.

Decoder Settings

All of the EFAbus HS Decoder settings reside in 2 tabs, on the right-hand side dialog. The tabs are called “Basic” and “Levels” and will be explained below.

Figure 2: The Basic tab for the EFAbus HS Decoder.

The “Basic” tab Controls.

The “Bitrate” control.

The EFAbus HS operates at 20 Mb/s. Therefore, the default value for this control is 20 Mb/s. However, as in all other Decoders, the user is allowed to set non-standard values. This is particularly useful during development phases when one or more actors of the bus might not be operating at the specified speed. If an actor is using the wrong speed, inadvertently or on purpose, its data can still be decoded on the oscilloscope by selecting the appropriate speed.

There are also cases when a system is in operation, where one or more actors are malfunctioning and transmitting at the wrong speed. Most other tools will flag errors and refuse to decode, therefore not identifying the malfunctioning node. The Decoder can simply be tuned to the (wrong) speed of the malfunctioning node, and the node’s information will decode, therefore allowing its identification. Afterwards the Decoder can be returned to the nominal bit rate.

The “Table Mode” control

The “Table Mode” control offers 3 choices:

Figure 3: The 3 Table Modes.

In **EFAbus Mode**, the Frames are completely decoded, as shown throughout the examples in this document. This is the preferred mode when working on a well functioning system.

In **Manchester** mode the signal is decoded as 0 or 1, with exceptional voluntary violations for the Start and End Delimiters. This decoding yields an image that shows the actual logical bits, with the transition in the middle.

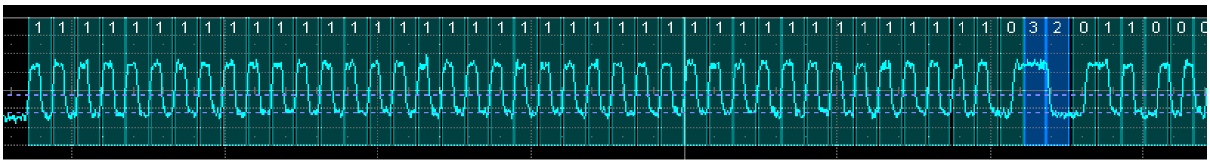

Figure 4: Example of decoding in Manchester mode, on Preamble and Start Delimiter.

In Burst Mode, only the bursts of activities are decoded.

Both the Manchester and the Burst Modes are used for low level debug purposes, especially when there are errors at the Frame Level. Please refer to Appendix B for a search methodology for low level errors.

The “Data Viewing” control

This control allows toggles the Data viewing between hexadecimal and decimal formats. The default setting is Hexadecimal.

The “Annotated Data” control

For performance reasons, due to the potentially very long payload of 65 Kbits, a control is provided in the dialog to avoid decoding the Data words. When unchecked, the payload is neither loaded into the table nor annotated, but still used to verify the Cyclic Redundancy Check (CRC). This will increase the throughput when decoding long records. The image below shows a Frame decoded without its data annotated.

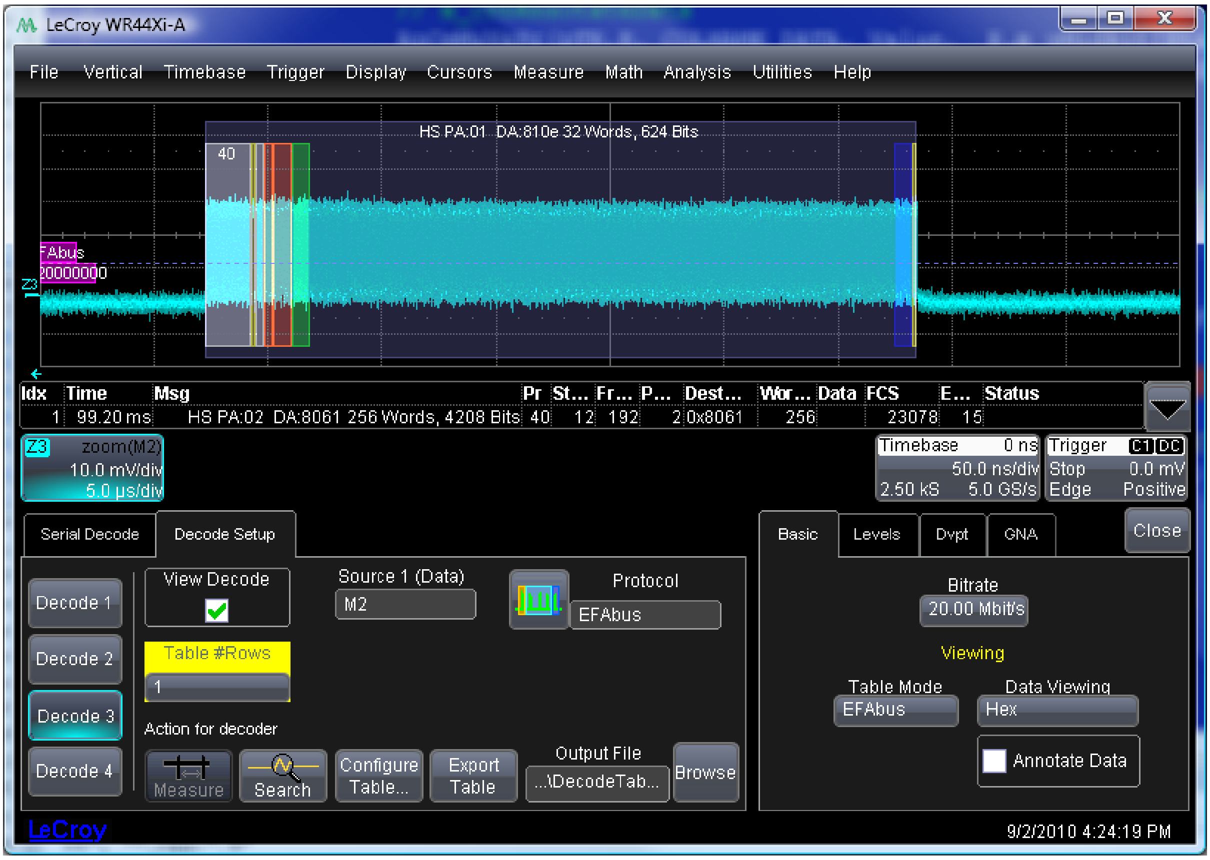

Figure 5: Same Frame as Figure 2, but without Data annotation.

The “Level” Tab Controls

The Level tab contains 2 controls, The Level Type and the Level. Both of these settings are important for correct decoding, and they can be adjusted when encountering non-standard waveforms.

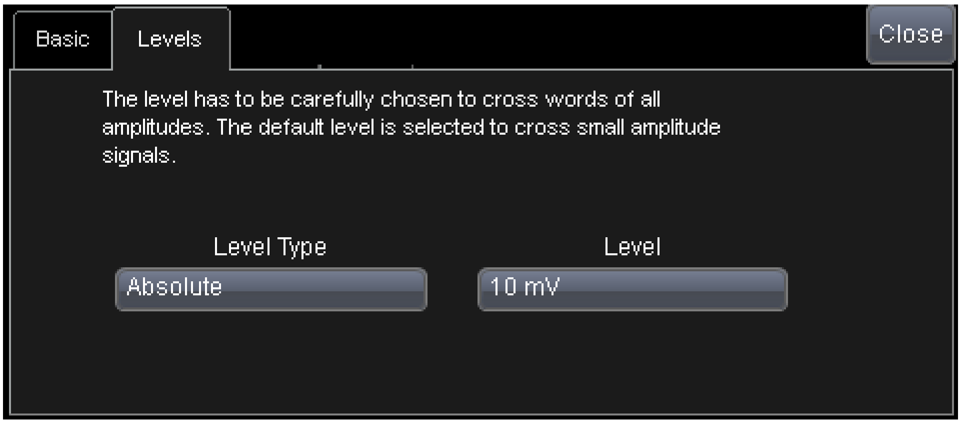

Figure 6: The Level Tab Dialog

The "Level Type" control

This control has 2 settings, Absolute or Relative. When in Absolute Mode, the user can set the threshold level in Volts. This threshold determines which bits will be Zeroes and which bits will be Ones. In Absolute Mode the level remains constant from one acquisition to the next.

When in Relative Mode, the user can select a percentage value of the total signal amplitude to be the level. The computational chain will automatically determine the level to be used, based on the data in the record. In relative mode, the threshold level can change from one acquisition to the next.

Both methods have pros and cons. On a stable bi-modal signal, the Percent Mode is easy to set, usually at or around 50%. (This is also the default value). A classical case is a system where measurements are taken in different positions. For example, when the measurement is made near the emitter, it could have a peak to peak amplitude value of 12 Volts, whereas when the same signal is measured 50 meters away, near the receiver, it could only have an amplitude of 2 Volts. The Relative mode set at 50% would automatically determine the threshold to be at 6 Volts and 1 Volts respectively.

Conversely, a classical case for using the absolute mode is the following. Let's assume that when observing a multiplexed bus, all the actors (nodes) have message amplitudes of i.e. 8 to 12 Volts. However, one actor on the bus emits with an amplitude of only 500 mV. The messages generated by this actor can still be decoded by setting the Level Mode to Absolute and the Level to 250 mV. This would let the engineer identify the faulty node, correct the error and return to Relative Mode.

The "Level" control

The level control appears either as value either in percent or in Volts, depending upon the setting of the Level Type controls on its left.

Errors Checking

Several Error detection mechanisms are built in: The Word Count in the Frame should match the number of transmitted words. The CRC in the Frame should match the computed CRC from the data transmitted. There should be no gap between the words within a Frame. There should be 40 pulses in the PR.

When any of these conditions occur, it will be flagged in red on the corresponding line of the table, as well as in the annotations.

Other mechanisms might be built-in upon request.

Search and Export

The Search and Export functions work comparably to the MIL-1553 equivalent functions and allow searching on any of the items embedded in the HS Frame.

After clicking the Search button from the Decode dialog, the Zoom dialog is shown along with the EFAbus Search right-hand dialog.

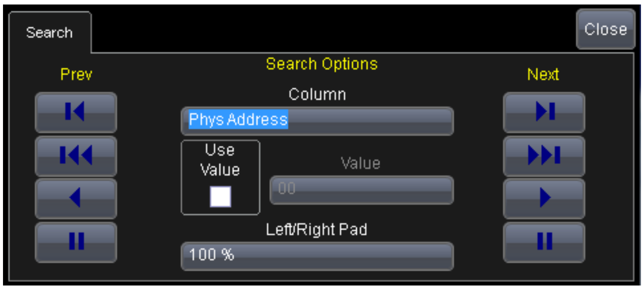

Figure 7: The Search Dialog.

Navigation Fields

On either side of the dialog there are four Previous and Next buttons for navigating through each occurrence, jump to the last or first occurrence, play in either direction, and pause.

Search Options Fields

Search Options fields in the center of the dialog allow to restrict the search based on parameter values for Column, Left/Right Pad and Value. Value may be included or excluded from the search parameters using the Use Value checkbox. A percentage value in the Left/Right Pad field can be provided if desired.

The following Column field values are available for your searches.

Figure 8: Searchable columns.

Using the MIL-1553 Decoder (LS part)

The EFAbus LS portion consists of an extended MIL-1553 Decoder. The extension supports the HS Action Words (Data Transfer and Mode Code) used to drive the HS RTs on the HS bus.

Using the MIL-1553 as part of EFAbus

When the EFABUS option key is present, the MIL-1553 dialog has an additional “Table mode”, called Transfer EFAbus.

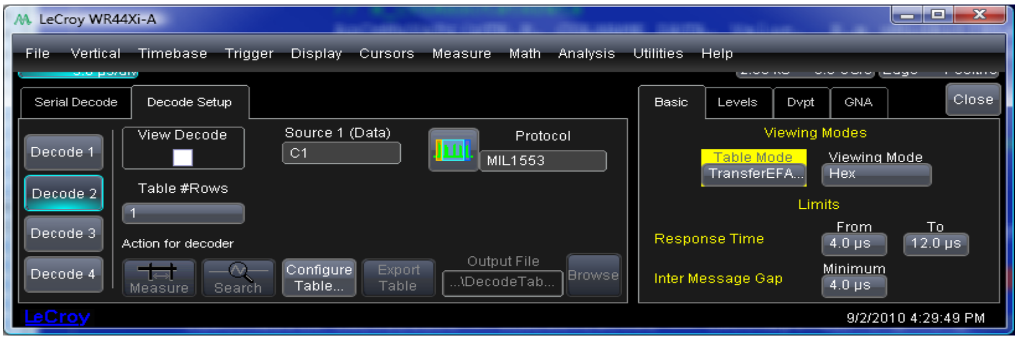

Figure 9: Activating the EFAbus extended decode on the LS bus.

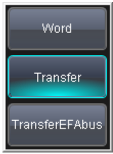

Figure 10: The choices of Decode Flavors on the LS bus.

This additional “Table Mode” dynamically adds several columns to the standard MIL-1553 decoder, to allow full decode and annotation of the HS Action words. When not used, the normal MIL-1553 decode scheme is applied. This allows normal MIL-1553 decode even if EFABUS option is present. Each decoder has its own “Table mode”, so one decoder could be used in normal MIL-1553 and another one in EFAbus mode.

Decoding of the HS Words

The spirit of the extension is in line with all other Decode & Annotation packages in the sense that every bit or group of bits is delineated by a translucent rectangle.

Note the differences in the table and in the annotation when decoding the LS bus in command mode of the HS bus.

Figure 11: Examining the HS Action Word.

When zoomed some more, the Lane and Transmit bits can be fully seen.

The Decode table will be expanded to support the HS control syntax, bearing in mind that all columns can never be shown at the same time because of the width limitation of the DSO screen. The user can select the most useful columns for the task at hand by pushing the “Configure Table” button to reach the “View Columns” pop-up dialog.

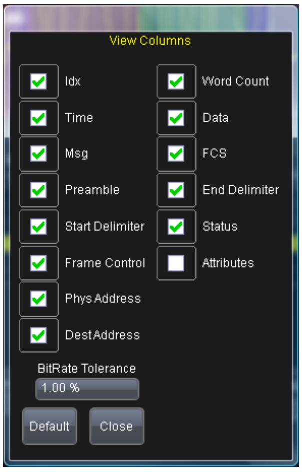

Figure 12: The Column selection pop-up dialog.

Search and Export

The Search and Export functions work comparably to the MIL-1553 equivalent functions. For more information on the Search and Export, see also the general Teledyne LeCroy Serial Manual.

Using the MIL-1553 Trigger (LS part)

This matches the MIL-1553 trigger. Triggering on action words requires configuring the sub address as an Action Word structure.

Appendix A, the HS Frame structure

The pictures below show the Frame Structure, with the bit width of each individual field. When used on real signals, the algorithm yields the following images. The beginning of the packet looks like Figure 16.

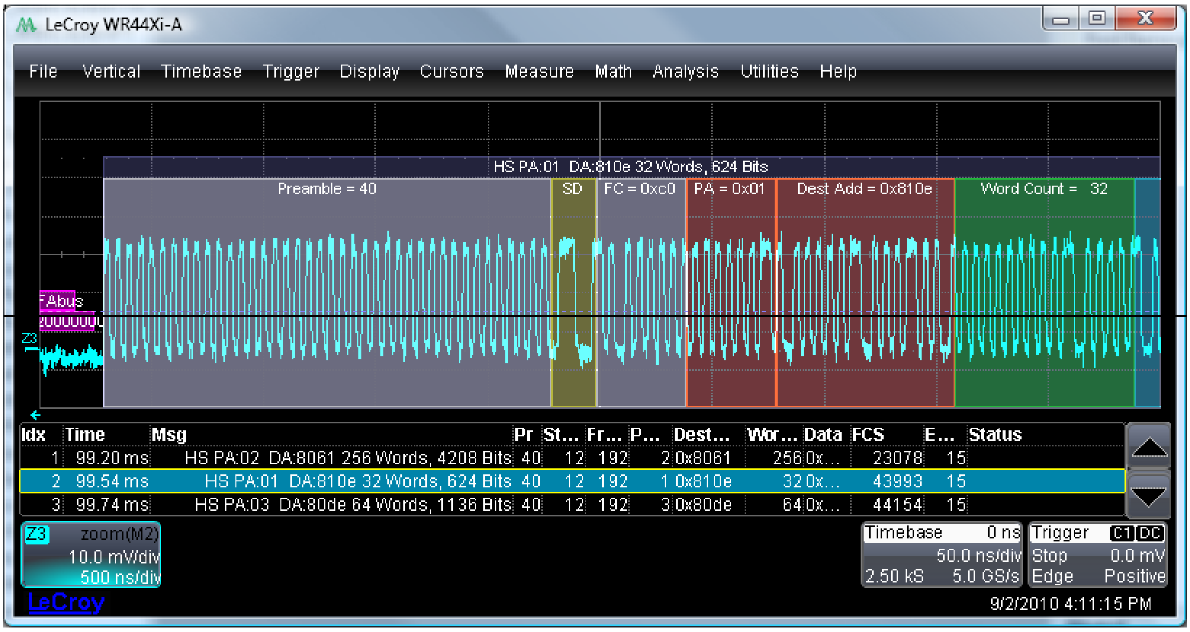

Figure 13: Beginning of a HS transaction

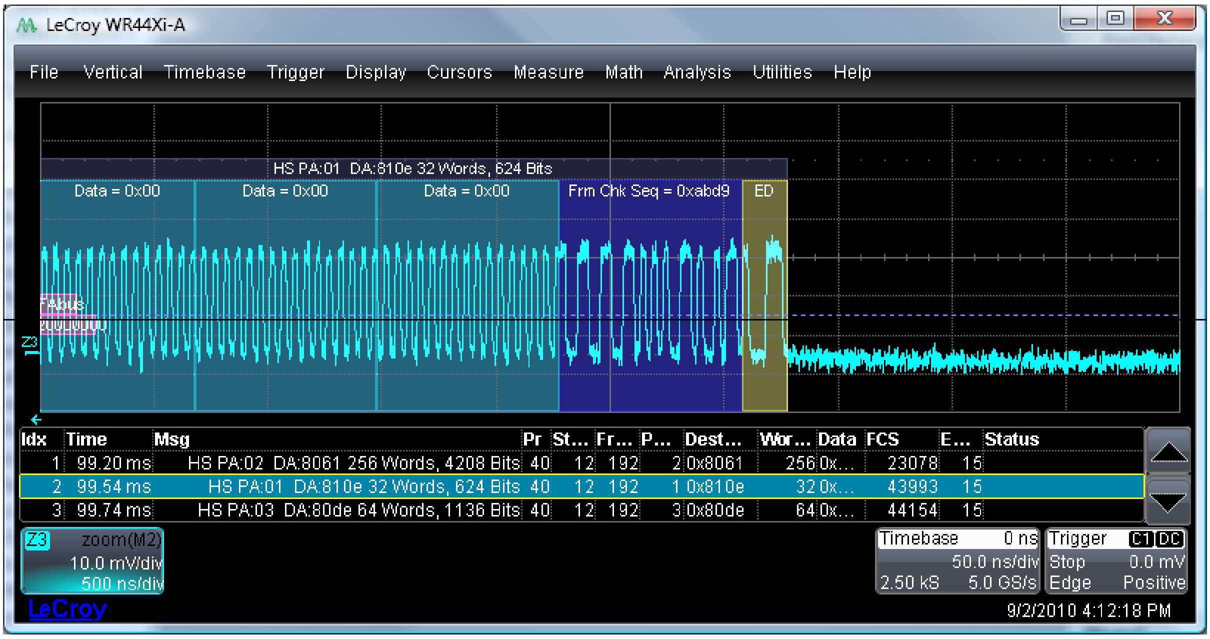

Figure 14: End of the same transaction.

While the images above only show beginning and end of a packet, the entire payload can be viewed by scrolling through the packet.

Appendix B: What to do when a Frame has errors

When decoding a high-level Frame, many different types or errors can occur, such as FRC errors, mismatched number of words, parity errors, etc. Many of these errors can be caused by a poor physical layer, inducing high level errors, however it can be tricky to understand the root cause of the problems when observing the Frame level.

The first approach is to verify the integrity of the physical layer. This is best done by using the Manchester decode mode mentioned above, in the listing of the controls.

In this mode, the beginning and the end of the Frame should look like the following images.

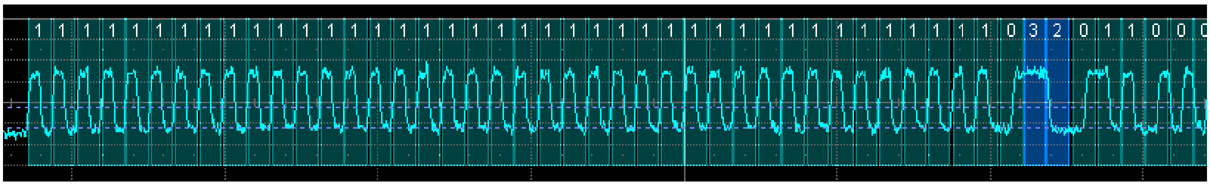

Figure 15: Decoding in Manchester mode, on Preamble and Start Delimiter.

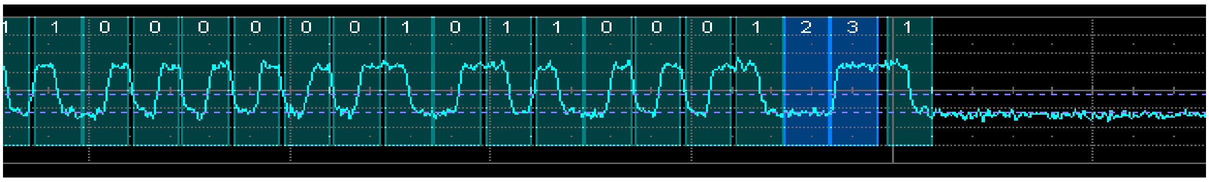

Figure 16: Decoding the End of Frame in Manchester Mode, with the End Delimiter in blue.

In order to rapidly visually scan a Frame, the scale can be reduced to have a zoom on the entire Frame. A healthy Frame will show in turquoise, with the Start and End Delimiters in blue. Any other appearance of blue would indicate illegal Manchester bits.

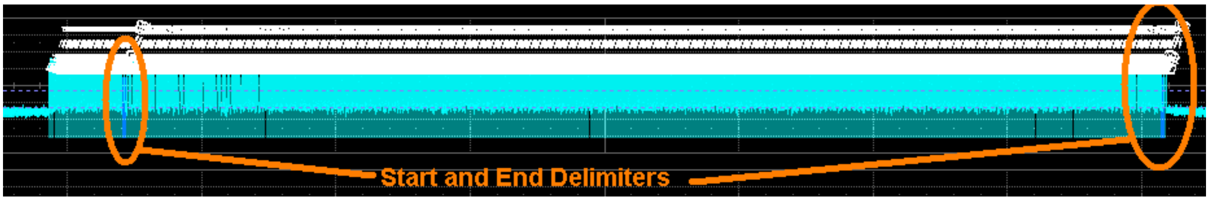

Figure 17: Correct HS Frame, with only 4 blue bits.

The following screen dump shows a suspicious Frame, in which many wrong bits appear.

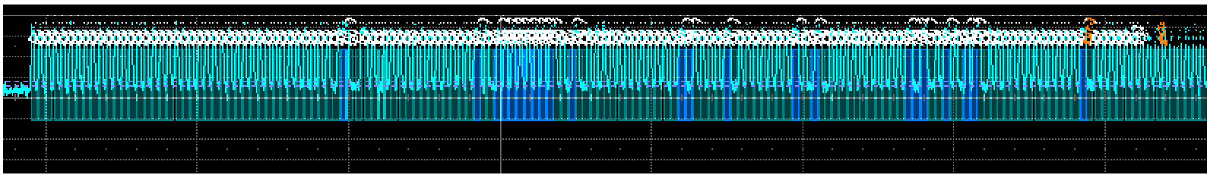

Figure 18: Incorrect HS Frame with many blue bits, indicating violations of the Manchester protocol.

When these types of errors appear, it is then easy to start examining the wrong bits to see if they have incorrect amplitude, incorrect span, or any other pathologies.

Appendix C: Using the Multi-Zoom on the HS and LS buses

Common Zoom on both Decoder

When examining the behavior of the double bus, the user is likely to resort to the Common Zoom function. The Common Zoom/Multi Zoom allows the close examination of the time aligned interactions between the commands on the LS bus and the induced data transfers on the HS bus.

The Multi Zoom is turned on in the corresponding dialog and is a very powerful feature of the oscilloscope tool-box.

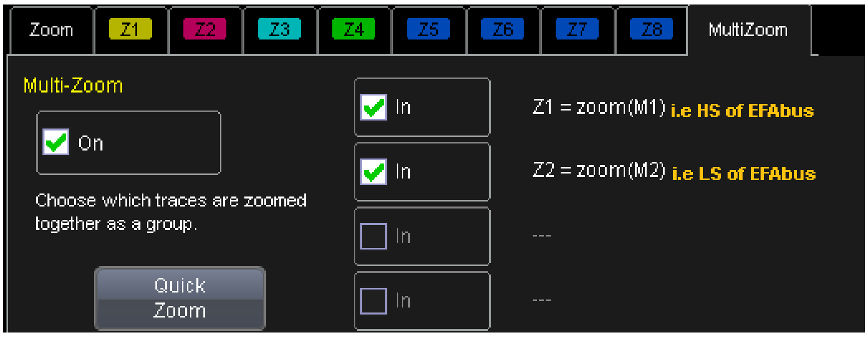

Figure 19: The Multi-Zoom Dialog-

Once the Multi-zoom is turned on, using Z1 and Z2 for example, both zooms will stay locked, regardless of which one is expanded, translated or shrunk. This behavior is very valuable when examining signals that are interdependent and governed by strict timing relationships. For example, in the image below we see that the latency between the end of the LS Frame and the beginning of the HS Frame is 22.756 micro-seconds. This value is measured using the cursors. Note that due to the time alignment of the zooms, the cursors are also time aligned.

Figure 20: Measurement of Latency on locked zooms.

Several practical points can be discussed here also. As the speed ratio between both buses is 1:20, the annotations on the HS bus are too compact when using the proper scale for the LS bus. If it is desired to observe both buses at the right scale, the Multi-zoom can be turned off, and the zoom factors selected individually, whilst retaining the correct cursor read out.

Figure 21: Measurement of Latency on unlocked zooms.

In this example, a precise measurement is performed between the mid-bit of the Parity bit on the LS bus and the beginning of the Start Delimiter on the HS bus. The value read out in this case is 25.484 micro-seconds.

Note that after unlocking the zooms, it is easy to re-lock the zooms and realign them. Using the cursors helps in that task.