SIGNAMI - Signal Analysis Guidelines using 7500 EXL

Example1: E3 signal with self synchronized PRN

Steps	Activity	Guide	Desired Response
1	**Recommended Settings in Front End receiver**		
1.1	Tune the receiver to the exact center frequency of the signal	Tune the signal to get a properly centered spectrum in 7500 EXL GUI. Go to the 'Analyze' mode in GUI and zoom in to have almost 2/3rd of the main band visible in the spectrum display Tuning resolution to be used is 10 KHz and 1 KHz preferably.	
1.2	Set the optimum filter bandwidth in the receiver	The IF spectrum to be observed in spectrum analyzer, to ensure that it is not over filtered or filters opened too wide	
1.3	Set AGC mode		

2	**Recommended Steps in 7500 EXL**		
2.1	Select the appropriate IF input (70/21.4/140/160 MHz) in 7500 EXL	Set DPSK as default modulation	The Signal level indicator should show presence of signal. The indicator is divided in to 15 dB segments ranging from –60 dBm to 0 dBm. PSK lock indicator should be 'IN' *Note: A flashing yellow indicates a too high signal from the receiver and a flashing red indicates an overload condition. In each case, the gain of the receiver should be reduced.*

2.2	1. Select E1 at level L1, E2 at level L2 & E3 at level L3. This will open up the filter appropriately in the unit. 2. The filters can be manually tuned using ‘tool’ menu.	Observe the Spectrum and constellation in the GUI.	1. For any PSK signal, the constellation will be a recognizable form 2. The XY constellation plot can be observed in a oscilloscope with using the analog I & Q videos 3. For a optimally filtered signal, the constellation will give an idea of the type of modulation

2.3	1. 'Analyze' the signal and determine the symbol rate using the analysis mode of the GUI. 2. Transfer to 'ABR Insert' and close the analysis window. 3. Observe the constellation and set the modulation as inferred. 4. Find the bit rate using 'Auto Bit Rate' search.	Adjust the spectrum display by zooming in or out until the main signal band is almost $2/3^{rd}$ of the spectrum display of the GUI	4. After the 'ABR' has completed it's search, the bit sync lock will be 'IN'.
2.4	1. De-select the 'Auto' button in the ambiguity-resolving field, and set PRN 'OFF'. 2. Capture the snapshot in 'Raster' at 'Decoder Output'. 3. Find the appropriate PRN format and frame length by using 'PRN Magic'. *Note: If the modulation is inferred as QPSK, first apply DQPSK and PRN magic. If PRN magic does not yield any result, used QPSK*	From the bit rate of the intended signal, a pre-assumption of frame length can be made. For example, if the bit rate found matches with E3 bit rate of 34 MBPS, the frame length range may be assigned as 1500 to 1600 (E3 frame length being 1536 bits) Note:	1. On successful completion, the PRN magic algorithm will display the detected PRN format, and the frame length. 2. The raster scan display will align as per the detected frame length.

2.5	1. Examine the raster scan for the Frame Alignment Synchronization (FAS) word. Compare with the pattern of a standard E3 signal. 2. Set the E3 standard library at L3. 3. Alternatively, perform ‘Higher order special’ programming and call the library in L3.	Due to unresolved ambiguity, the raster scan may display a FAS pattern other than the known pattern. In such cases, change the ambiguity settings and capture the raster until the known pattern is observed. Alternatively, select the E3 standard library at L3 level. Resolve the ambiguity automatically or manually to get a lock in L3 level.	For successful programming/appropriate call of E3 library, the L3 level will indicate a Lock. For a standard E3 signal, the FAS pattern is **‘1111010000’**
2.6	Select any of the tributary (1-4) of E3 at L3 level.		
2.7	1. Capture a raster sample at ‘Input L2’. 2. Find the FAS. 3. Set the E2 standard library at L2. 4. Alternatively, perform ‘Higher order special’ programming and call the library in L2.	Identify the standard E2 FAS pattern in the raster with frame length of 848 bits, before programming the L2 level.	For successful programming/appropriate call of E2 library, the L2 level will indicate a Lock. For a standard E2 signal, the FAS pattern is **‘1111010000’**

2.8	Capture a snapshot at ‘Input L1’ with frame length set to 512.	Observe raster with data captured at ‘Input L1’. By default, the frame length in the raster display will be 512. Also, frame length can be automatically found by using ‘Frame Length’ search.	With appropriate ambiguity applied to the signal, the FAS will be **‘X0011011’** for a standard E1 signal. The alternate FAS is at a location 257 to 264 and the pattern is ‘X1XXXXXX’.
2.9	Identify the Byte boundaries in raster scan display to ascertain whether the signal is 8 bit PCM or 4 bit ADPCM.	1. It is possible to observe the byte boundaries by distinguishing between LSBs and MSBs of a time slot. The MSBs tends to display a lower variation and LSBs the most. On the raster scan GUI, the LSB is the far right bit. Beginning of the time slot is indicated by activity by the sign bit, which is the first on the left of the time slot.	
2.10	Program L1 using E1 standard library format. Alternatively use ‘Lower order special’ programming GUI to program and set the library at L1.		For successful programming/appropriate call of E1 library, the L1 level will indicate a Lock.
2.11	For 8 bit PCM, select any of the channel (1-32) and listen to the voice output.	Select the PCM decoder (A-Law/μ-Law) to get the best voice quality. For standard E1 transmission, A-law is standard. To monitor all 31 voice grade channels, go to the ‘E1 Channel scan’ and select the voice grade channel number of interest for monitoring	

2.12	For 4 bit ADPCM, select 'ADPCM' 4 bit in channel decoder.	Select (A-Law/μ-Law) to get the best voice quality. To monitor all 62 voice grade channels, go to the 'E1 Channel scan' and select the voice grade channel number of interest for monitoring.	

Example2: Analysis of unknown signal

Steps	Activity	Guide	Desired Response
1	**Recommended Settings in Front End receiver**		
1.1	Tune the receiver to the exact center frequency of the signal	Tune the signal to get a properly centered spectrum in 7500 EXL GUI. Go to the 'Analyze' mode in GUI and zoom in to have almost 2/3rd of the main band visible in the spectrum display. Tuning resolution to be used is 10 KHz and 1 KHz preferably.	
1.2	Set the optimum filter bandwidth in the receiver	The IF spectrum to be observed in spectrum analyzer, to ensure that it is not over filtered or filters opened too wide	

1.3	Set AGC mode		
2	**Recommended Steps in 7500 EXL**		
2.1	Select the appropriate IF input (70/21.4/140/160 MHz) in 7500 EXL	Set DQPSK as default modulation	The Signal level indicator should show presence of signal. The indicator is divided in to 15 dB segments ranging from –60 dBm to 0 dBm. PSK lock indicator should be ‘IN’ Note: A flashing yellow indicates a too high signal from the receiver and a flashing red indicates an overload condition. In each case, the gain of the receiver should be reduced.

2.2	1. Select E1 at level L1, E2 at level L2 & E3 at level L3. This will open up the filter appropriately in the unit. 2. The filters can be manually tuned using ‘tool’ menu.	Observe the Spectrum and constellation in the GUI.	1. For any PSK signal, the constellation will be a recognizable form 2. The XY constellation plot can be observed in a oscilloscope with using the analog I & Q videos 3. For a optimally filtered signal, the constellation will give an idea of the type of modulation
2.3	1. ‘Analyze’ the signal and determine the symbol rate using the analysis mode of the GUI. 2. Transfer to ‘ABR Search’ and close the analysis window. 3. Observe the constellation and set the modulation as inferred. 4. Find the bit rate using ‘Auto Bit Rate’ search.	Adjust the spectrum display by zooming in or out until the main signal band is almost 2/3rd of the spectrum display of the GUI.	4. After the ‘ABR’ has completed it’s search, the bit sync lock will be ‘IN’.
2.4	Apply the FEC decoders Viterbi ½, Viterbi ¾ and Viterbi 7/8 in the Convolutional FEC field to see any recognizable bit rate format is detected.	On applying a particular FEC, the signal bit rate may be forced to a pre-calculated value. Type in the original bit rate and ensure that PSK and bit sync levels are locked ‘IN’.	For a matched FEC, the FEC layer will be locked ‘IN’.

2.5	After applying all the FECs available in the system, if the FEC lock is not achieved, switch the FEC level 'OFF'.		
2.6	1. De-select the 'Auto' button in the ambiguity-resolving field, and set PRN 'OFF'. 2. Capture the snapshot in 'Raster' at 'Decoder Output'. 3. Find the appropriate PRN format and frame length by using 'PRN Magic'. *Note: If the modulation is inferred as QPSK, first apply DQPSK and PRN magic. If PRN magic does not yield any result, used QPSK*.	Perform the PRN search with frame length range in steps of 100 bits. One can start with 100 bits to 200 bits, next 201 to 300 bits and so and so forth. From the bit rate of the intended signal, a pre-assumption of frame length can be made. For example, if the bit rate found matches with E3 bit rate of 34 MBPS, the frame length range may be assigned as 1500 to 1600 (E3 frame length being 1536 bits) However for non standard bit rate, it may be presumed that overhead bits are added to the standard multiplexer.	1. On successful completion, the PRN magic algorithm will display the detected PRN format, and the frame length. 2. The raster scan display will align as per the detected frame length.

2.7	If the PRN magic fails to detect the scrambler, PRN search with non standard taps to be carried out. This process is manual. Here, the frame length to be fixed to a presumed value, while the tap points to be programmed using 'preset' option in PRN layer. Next, raster sample to be captured to manually observe for any stable pattern. Start with 2 tap Maximum length sequences from the training manual. Apply non maximal length sequences for 2 taps next. Next, the common maximal length sequences for more than 2 tapes to be applies. However, there may be very very large number of non maximal length sequence with more than 2 taps.	It is necessary to arrive at the correct combination of scrambler and frame length to get a stable pattern in the raster scan display. For an unknown signal, large number of combinations may have to be tried out. *Note: Apply a particular scrambler using the manual PRN programming option and capture the raster snapshot. The expected range of frame length of an unknown signal can be presumed to be a 0.0003% of the bit rate for the lower expected frame length to a high of 3 times the value calculated for the lower end. Set the Start with frame length which is considered near to the presumed lower end of the frame length range, and use the up scroll button the keep changing the frame length. Each time the up scroll button is pressed, the raster display will be refreshed with new alignment. Observe the raster each time to detect any FAS pattern. Repeat the process with the next scrambler setting until the upper limit of the expected range is reached.*	For an appropriate de-scrambler and frame length selected, the raster will show stable patterns.

2.8	Investigate if the signal bit rate can be represented as below: S=O+ M S: Signal bit rate O: Overhead bit rate M: Nearest Std. Mux bit rate Use higher order special format programming GUI for removing the overhead bits. Call the program to the appropriate level (L3 or L2) Note:The decision for programming in L3 or L2 tobe made based on the data rate of the signal.	Try to locate stable bits other than the FAS. They may be OH bits. However, some of the OH bits may not be possible to distinguish. Presumption can be made for the position of the OH bits. The presumption may be from common formats or symmetry. Example: S=4256 KBPS O=32 KBPS M=4224 KBPS	On successful programming, the respective level will be locked 'IN'
2.9	1. Having resolved the previous level, the signal now to be analyzed in the next lower layer. 2. Capture a raster at the input of the level being analyzed.	If the bit rate of the current level matches with a standard mux, one can look for the known FAS patterns using the standard frame lengths.	
2.10	For a non standard signal, auto frame length search can be used for finding word interleaved FAS pattern.		The stable bits including the FAS pattern will be displayed in the raster at the end of the search.

2.11	If word interleaved FAS pattern is not found, one can investigate for bit interleaved pattern by manually observing waterfall display at various frame lengths.	For bit interleaved FAS, the repeating FAS pattern will appear in a vertical line.	
2.12	If the signal is found to be a multiplexed one with various tributaries, higher order special programming to be used at the current level. *Note: While analyzing the signal in different layers, the primary multiplexer should programmed at L1 level only.*		On successful programming, the current level will be locked 'IN'
2.13	After resolving the higher levels, Capture a snapshot at 'Input L1' with the default frame length set. Use auto frame length search to determine the primary frame length. *Note: For a bit interleaved mux format, the FAS pattern should be manually detected by observing the waterfall display with various frame lengths.*		After the end of the auto frame length search, the raster scan will show stable word interleaved patterns.

2.14	Identify the Byte boundaries in raster scan display to ascertain whether the signal is 8 bit PCM or 4 bit ADPCM. Other possibilities may the CVSD encoding with 1 bit per channel through 8 bit per channel.	It is possible to observe the byte boundaries by distinguishing between LSBs and MSBs of a time slot. The MSBs tends to display a lower variation and LSBs the most. On the raster scan GUI, the LSB is the far right bit. Beginning of the time slot is indicated by activity by the sign bit, which is the first on the left of the time slot.	
2.15	Program using ‘Lower order special’ programming GUI to program and set the library at L1.		For successful programming, the L1 level will indicate a Lock.
2.16	For 8 bit PCM, select any of the channel (1-N) and listen to the voice output. N: number of 8 bit voice grade channels. Example: Dividing the bit rate of 2048 kbps by the 64 kbps, which is the standard bit rate for primary time slot, one can infer that there may be 32 time slots in the frame. If the division result comes out to be a fraction, there is a chance that the signal is still having overhead bits or the time slot size is other than 8 bits.	Select the PCM decoder (A-Law/μ-Law) to get the best voice quality. To monitor all the voice grade channels, go to the ‘E1 Channel scan’ and select the voice grade channel number of interest for monitoring	

2.17	For 4 bit ADPCM, select ‘ADPCM’ 4 bit in channel decoder.	Select (A-Law/μ-Law) to get the best voice quality. To monitor all the voice grade channels, go to the ‘E1 Channel scan’ and select the voice grade channel number of interest for monitoring.	
2.18	For CVSD channels with channel time slot size less the 4 bits, use X1 and Y1 options for monitoring the possible channels.		