

Alarming on drift in DVB-T SFN networks

This technical note details a novel mechanism for detecting absolute timing offsets in Single Frequency Networks as found in DVB-T architectures. Timing offsets down to +/- 0.1 microseconds are registered. The functionality described is available in the BRIDGETECH VideoBRIDGE monitoring product family.

The mechanism has applications into SFN networks where a practical problem often is to ensure that the transmitters and modulators are kept in absolute and continuous synchronization across the network. Any drift between the transmitters will cause reception degradation in fringe areas covered by two or more SFN DVB-T transmitters.

The SFN drift alarming functionality is available on both the ASI input and COFDM input simultaneously.

Overview

The products of relevance are the VB120 and VB220 IP probe with one or two VB250 COFDM demodulator front-end modules.

Specifications of relevance are:

- ETSI TR 101 190 Digital Video Broadcasting (DVB) "Implementation guidelines for DVB terrestrial services"; Transmission aspects.
- ETSI TR 101 191 Digital Video Broadcasting (DVB) "DVB mega-frame for Single Frequency Network (SFN) synchronization"

The picture below shows the BRIDGETECH 1RU chassis equipped with one VB120 Broadcast IP probe and two VB250 COFDM front-end input modules.

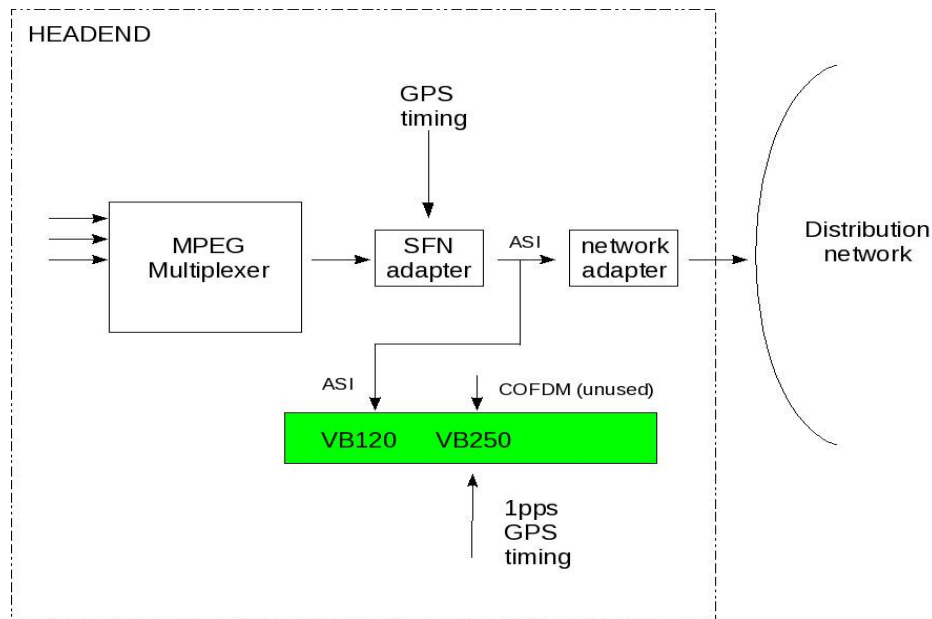


The connectors on the VB120 module are from left to right: USB Type-A connector for initial setup, 10/100/1G RJ-45 for video segment, alternative SFN port for video segment, ASI SMB connector for ASI INPUT, 10/100T RJ-45 for management and ASI SMB connector for ASI OUTPUT.

The connectors on the VB250 module are from left to right: RF input (F-connector), 1pps 50 ohm TTL GPS reference input, ASI output.

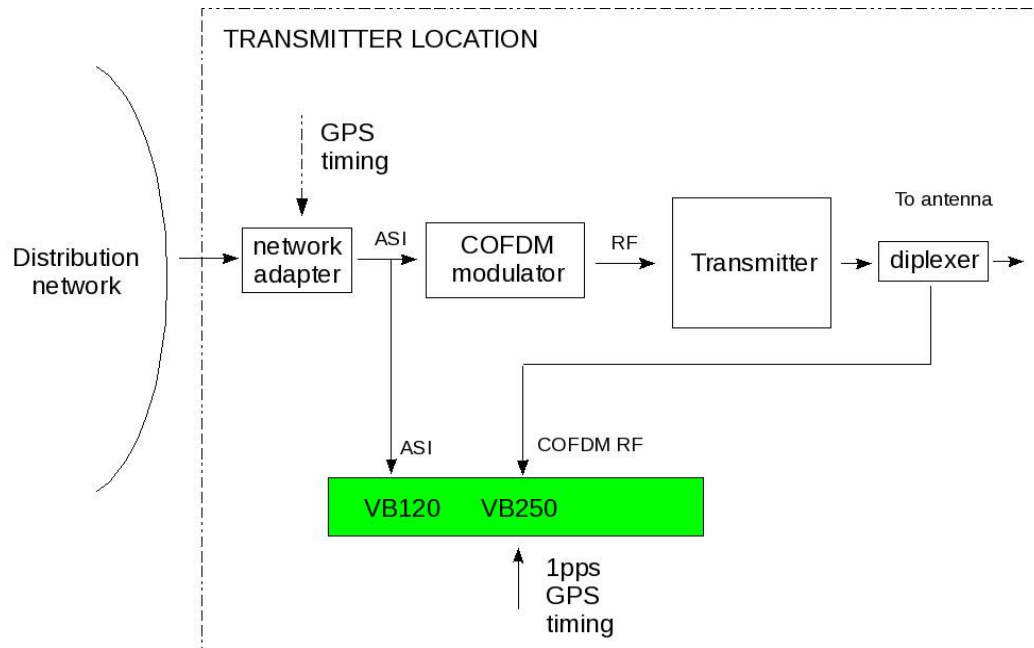
Applications

Application for verifying correct timing of ASI signal after SFN adaption at head-end:



The operator is alerted in case the SFN adapter at the head-end starts to drift outside user-configurable time window. Window is defined in units of 100 ns with an accuracy of +/- 100 ns. Drift can happen if the SFN adapter loses its local GPS reference and must default to its built-in timing reference instead.

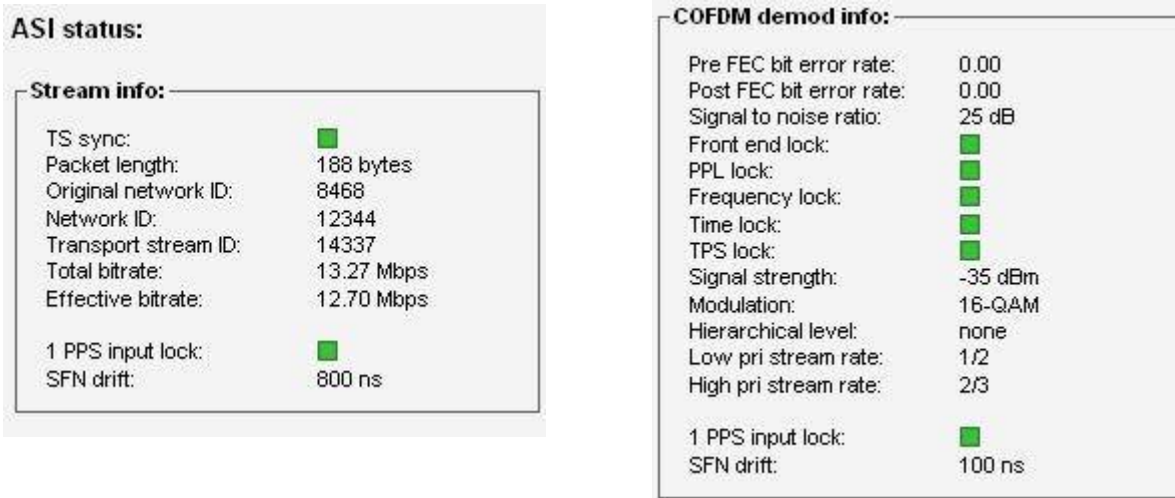
Verifying that the transmitters stay locked to GPS timing reference at transmitter towers on both ASI and COFDM level:



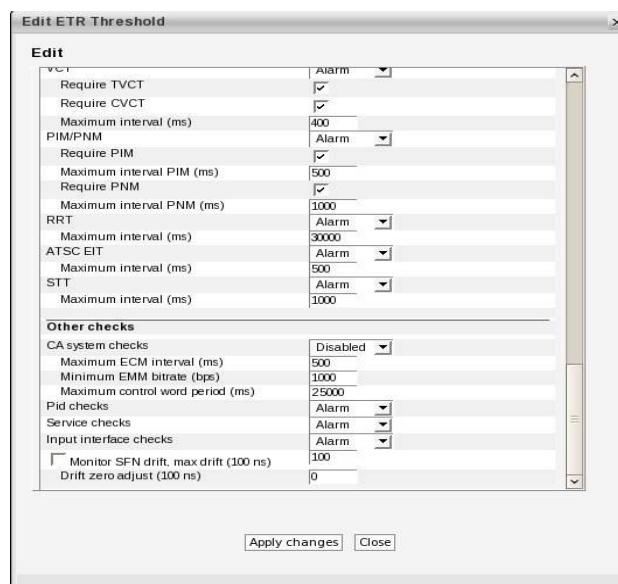
Advantages to this solution include:

- Alerts the operator in case the transmitted COFDM signal starts to drift outside user-configurable time window. Window is defined in units of 100 ns with an accuracy of +/- 100 ns. This can happen in cases where the transmitter defaults to its local oscillator reference instead of the incoming GPS reference. It can also happen as the transmitter power stage changes characteristics slowly over time.
- Alerts the operator in case the ASI signal prior to COFDM modulation is outside pre-configured time window. This can happen if distribution network has varying 'memory'. That is, the amount of bytes coming out of the network is varying slightly compared to the number of bytes going into it over time.

Functional detail



The GUI screenshots show maximum timing difference between the ideal and actual mega-frame transmission point since last readout. Values are measured for both the ASI and COFDM input interfaces simultaneously. The readout resolution is in 0.1 microseconds (=100 ns) with an accuracy of +/- 0.1 microseconds. Negative values signify negative delay. Negative values equal to the *maximum_delay* configuration setting are measured - and expected - on the ASI prior to modulation and transmission since the transmitter delays the signal by the same *maximum_delay* value.



The operator configures the TR 101 290 alarm template for the ASI and the COFDM transponder to measure on. The *Drift Zero Adjust* parameter is used to zero calibrate the drift reading and is subtracted from the SFN drift timing difference measured before presenting the result in the ASI or COFDM GUI screens described earlier. In this manner it is possible to calibrate away constant timing offsets introduced by over-air transmission delay and COFDM demodulator delay.

The parameter called *Max Drift* sets the criteria for SFN drift alarming. If the numerical value of the offset-compensated drift value - negative or positive - is larger than the value set in the template then an alarm is generated.

Units for both offset and drift are in 100 ns, or 0.1 microseconds.

Algorithm used - theory

Define T=0 as when 1 pps pulse goes high and reference all timestamps relative to this.

Use existing 27MHz clock to timestamp. This gives an accuracy of +/- 37 ns, which is better than the 10MHz reference normally used in GPS (+/- 100 ns).

Receive all MIP packets. Use the pointer field from the MIP to identify which packet is the start of the next (M+1) mega-frame.

Timestamp - using local 27Mhz oscillator - the reception of the first (M+1) mega-frame packet. The timestamp is relative to the T=0 point in time occurring as the 1pps pulse goes high. Call this value (*synchronisation_time_stamp+maximum_delay*)_ACTUAL

Extract the corresponding fields from the MIP packet M. Call the sum: (*synchronisation_time_stamp+maximum_delay*)_IDEAL.

This is a calculated value and represents the time from when the 1pps pulse goes high to when the start of the (M+1) mega-frame should be transmitted out of the antenna of each transmitter tower.

ACTUAL is larger than IDEAL in a real-life system due to the transmission delay from the transmitter antenna output to the COFDM demodulator antenna input. A second delay factor is the delay in the COFDM demodulator stage of the VB250 COFDM demodulator input card.

If the GPS sync of the transmitter is failing then the transmitter will slowly start to drift out. We will see this as a gradual change in (ACTUAL-IDEAL).

This is what is alarmed against.

Generate an alarm if the (ACTUAL – IDEAL) value is starting to drift. User specifies alarm criteria as a number (units: time) that the absolute value of (ACTUAL – IDEAL) difference should stay within.

For example: Generate alarm if $ABS(ACTUAL - IDEAL) > 10$ us.

The alarms are logged in the normal fashion inside the VB120 unit. The alarms can be forwarded as SNMP TRAPs using the existing VB120 framework or polled using XML over HTTP. Please refer to VB120 users manual for details on this framework.