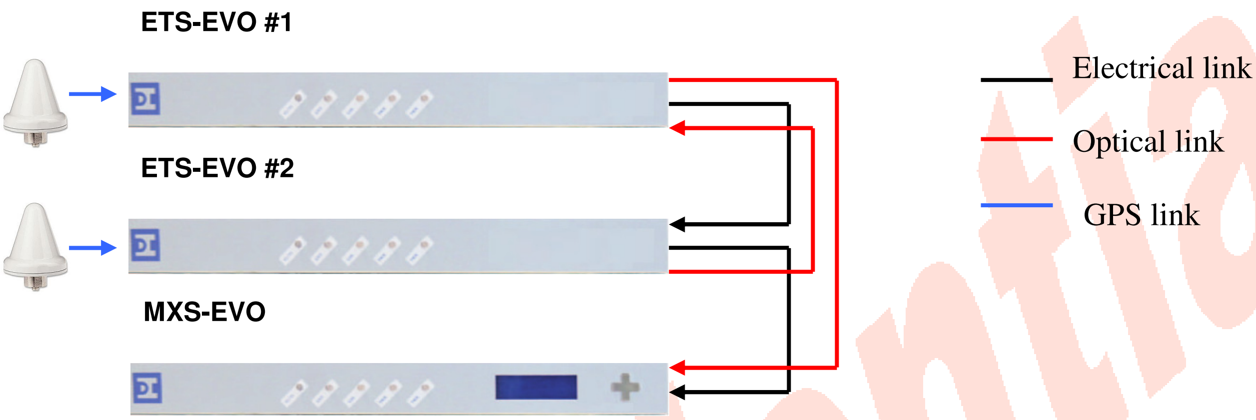
IRIG-B Redundancy

Goal

- to test the redundancy of the system thanks to the IRIG-B point-to-point distribution

Requirements

- 1x MXS-EVO
- 2x ETS-EVO
- Oscilloscope



Equipment

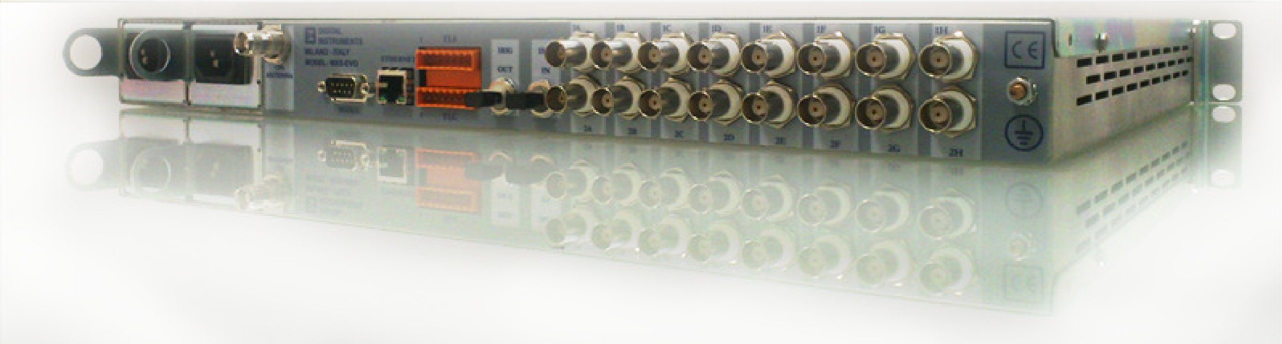
MXS-EVO

MXS-EVO is a multi-output generator for high stability Time & Frequency signals, aimed to synchronization of systems and devices in many areas like Broadcast, Defence, Space, Telecommunication etc.

The unit has 12 programmable outputs designed to make the equipment adaptable to di_erent situation and meet user's needs. Furthermore it has an Ethernet interface for Time Protocol Synchronization (NTP or PTPv2 Grandmaster Clock).

The unit is also capable of two (1 input and 1 output) optical ST connectors designed for IRIG B.

MXS-EVO can get external reference input from GPS receiver, E1/T1, PPS, 1 to 10 MHz analogue, IRIG-B Time code, PTPv2 IEEE 1588-2008, in order to have maximum reliability that is completed by dual independent Power Supply Unit.



Features

- Internal high stability OCXO aging rate of ± $1*10^{-10}$/day
- 12 channels GPS receiver with automatic tracking and timing error management
- New generation DPLL fast lock with holdover
- Multi reference inputs:
    - GPS
    - E1 (G.703/9) or T1
    - PPS
    - 1, 2, 2.048, 5, 10 MHz
    - IRIG-B Time Code
    - PTPv2 (IEEE 1588-2008)
- 1x Fast-Ethernet interface for NTP and/or PTP synchronization
- 1x Optical multimode I/O via ST connectors
- 12x programmable outputs configurable between:
    - PPS
    - IRIG B DCLS
    - IRIG B AM
    - E1 (G.703/9) / T1 with SSM
    - 2.048 MHz (G.703/13)
    - 10 MHz (Low Phase Noise)
- 2x PSU (AC or DC)

ETS-EVO

ETS-EVO is a very flexible solution to generate ultra-stable Time (PPS, Time Codes, NTP/PTP Serial Time Telegrams, etc…) and Frequency (10 MHz Low Noise and 2.048 MHz square wave output).

The unit is a multi reference input equipment that can accept various reference inputs from (GPS, NTP/PTP as well as IRIG B Time Code both Electrical and Optical).

ETS-EVO has Event Time input capability via Dry Contacts.

Furthermore the unit can be easily remotely managed via SNMP or a user friendly GUI on a web interface.

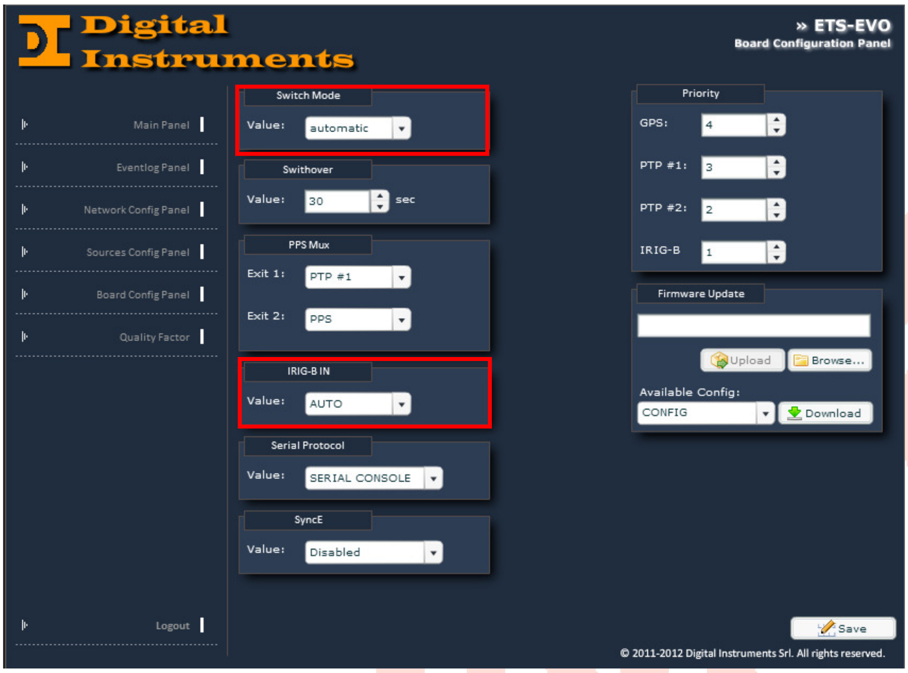
Features

- Internal high stability OCXO aging rate of ± $1*10^{-10}$/day
- 12 channels GPS receiver with automatic tracking and timing error management
- New generation DPLL fast lock with holdover
- Multi reference inputs:
    - GPS
    - IRIG-B Time Code
    - PTPv2 (IEEE 1588-2008)
- 2x Fast-Ethernet interface for NTP and/or PTP synchronization
- 1x Optical multimode I/O via ST connectors
- 2x PSU (AC or DC)

Test cases

The configuration of the equipment is really simple. It is just needed to put the various devices in

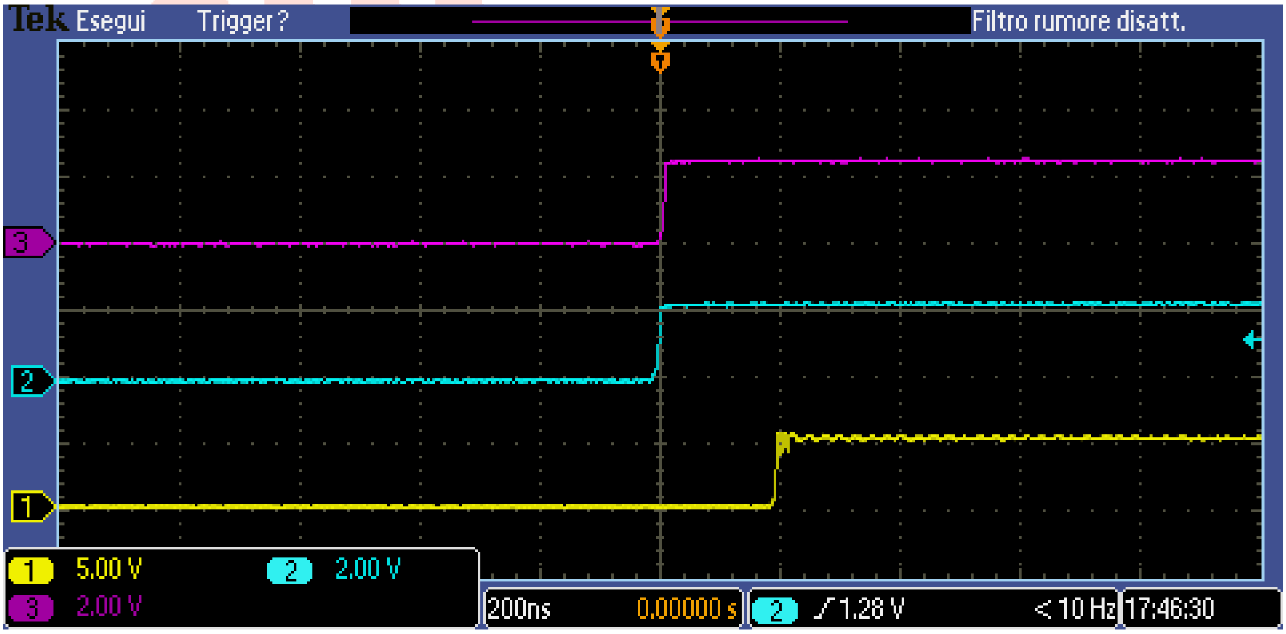
- automatic switch mode
- automatic IRIG-B input selection



In this way the default configuration makes the ETS-EVO to be directly disciplined by the GPS antennas and the MXS-EVO by the IRIG-B input (either electrical or optical) from the two ETS-EVO. In case of an antenna failure on a ETS-EVO the other ETS-EVO would still propagate the time via the IRIG-B link.
So the system is fully redundant and the time on the various devices is always synchronous.

Test #1

In this test we want to check the PPS accuracy and coherence on the three devices



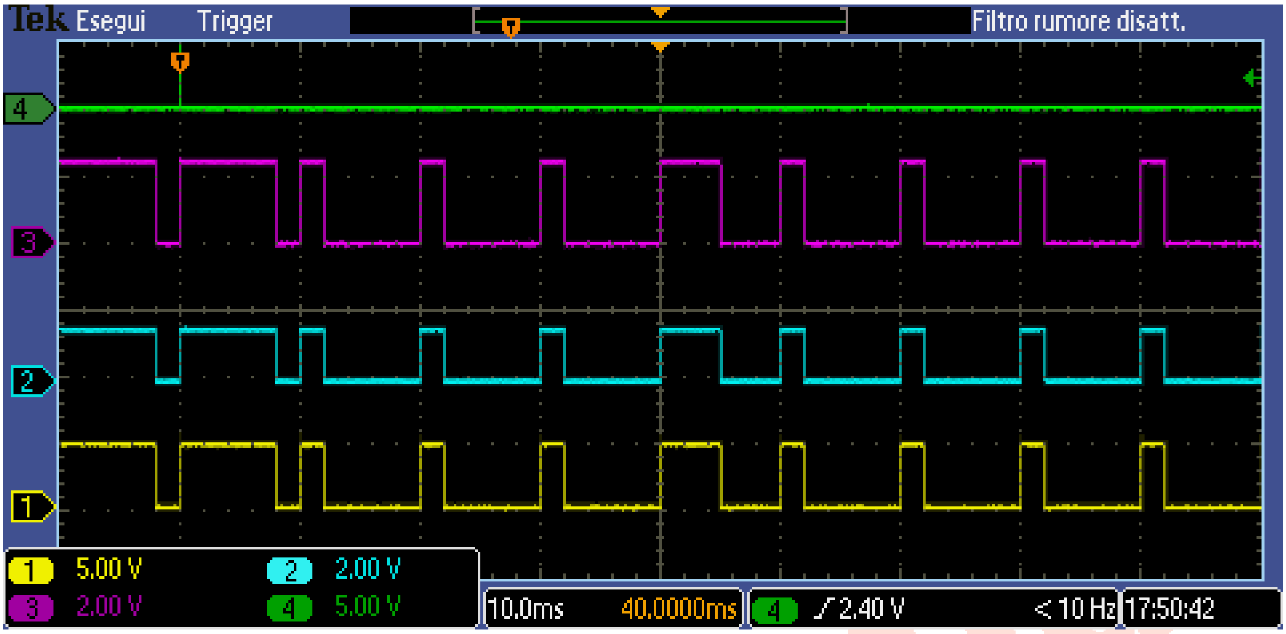
Test #2

In this test we want to check the IRIG-B accuracy and coherence on the three devices

With an oscilloscope is possible to compare the output signals from the three devices.
The IRIG-B signal carries information about date and time, as shown in the following table.

Bit position	Information transmitted
0	Position identifier P_R (seconds' boundary marker)
1–4	Units of seconds
6–8	Tens of seconds
9	Position identifier P_1
10–13	Units of minutes
15–17	Tens of minutes
19	Position identifier P_2
20–23	Units of hours
25–26	Tens of hours
29	Position identifier P_3
30–33	Units of days
35–38	Tens of days
39	Position identifier P_4
40–41	Hundreds of days
49	Position identifier P_5
50–53	Units of year or control function bits
55–58	Tens of year or control function bits
59	Position identifier P_6
60–68	Control function bits
69	Position identifier P_7
70–78	Control function bits
79	Position identifier P_8
80–88	Nine lowest significant bits of time of day in straight binary seconds (bit 80 –> 2^0 … bit 88 –> 2^8)
89	Position Identifier P_9
90–97	Eight most significant bits of time of day in straight binary seconds (bit 90 –> 2^9 … bit 97 –> 2^{16})
99	Position identifier P_0
Note: Bits not listed are index markers, and are sent as binary zeroes.	

It is quite easy to recognize the time passing by triggering a PPS and observing the first few bits indicating the seconds.



The above picture represents the time 8 seconds.

<u>Test #3</u>

In this test we want to check the NTP accuracy and coherence on the three devices

1. We need to setup a NTP daemon[1]
2. And add a line for every device (MXS-EVO and ETS-EVO). It is also a good idea to specify an external public NTP server in order to compare the time stamp with an external source.

```
## ntpd.conf
server ntp1.ien.it
server ntp2.ien.it
server 192.168.200.14
server 192.168.200.15
server 192.168.200.16
```

3. Ask the timing information with `ntpq -c peer`

```
     remote           refid      st t when poll reach   delay   offset  jitter
==============================================================================
+ntp1.inrim.it   .CTD.            1 u    4   64  377   73.870   -4.482   0.868
+ntp2.inrim.it   .CTD.            1 u   32   64  377   74.691   -3.401   1.008
+192.168.200.14  .GPS.            1 u   31   64  377  122.112   48.593  33.547
*192.168.200.15  .SHM.            1 u   21   64  377   20.853  -25.797   4.407
+192.168.200.16  .SHM.            1 u   21   64  377   34.259  +12.432   6.124
```

The time stamps should be coherent to each other and to the external servers.

[1] GNU/Linux version can be downloaded from http://www.ntp.org/downloads.html
Microsoft Windows version can be downloaded from http://norloff.org/ntp/ntp-4.2.6p3-RC8.zip

Conclusions

IRIG-B is just one of the many timing protocols implemented in our devices.

We have prepared other papers where we have presented a few methods for synchronizing remote devices via an Ethernet connection, both in frequency (**SyncE**) and time (**PTP**), with precision ranging from nanoseconds (**SyncE** and **PTP**) to milliseconds (**NTP**).

This paper is meant to be used as a starting point to implement a fully redundant system and to show how it can be done with a few simple point-to-point connections.

The overall achievable accuracy is ±100 ns and this precision is suited to most of the applications.

Digital Instruments is up-to-date on the topic and is manufacturing its very own solutions, by having full control over the hardware and software components involved in the process.

We are particularly willing to let our customers get used to these technologies and let them understand what is the best solution that fits their needs.

If you would like to test our solutions or ask some questions about these or other subjects please do not hesitate to contact us!

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