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Configuring a Reference Distribution System

Configuring a distribution system isn't an easy task as there are always conflicting requirements which have to be satisfied or overcome with a suitable compromise.

The most important consideration is whether the reference has to be phase coherent at all locations. Fortunately this is usually not required and only the stability has to be equal.

If phase coherence is a must the only possible option is to distribute the reference frequency directly either electrically or optically. The conventional way is to use coaxial cables and power splitters/amplifiers to usually distribute a stable 10MHz reference signal. RF-SUISSE provides several building blocks for such a system. The major problem with this type of distribution is that coaxial cables will radiate the signal even if well shielded and thus difficult to bend and will also act as an antenna for EMI signals. Over longer distances they also have significant losses thus limiting their coverage range.

To avoid these EMI problems the signal can also be distributed via fibre-optic cables. For medium distances up to about 300m polymer fibres are an ideal solution. For larger distances up to 2km real glass fibres can be used. RF-SUISSE provides several building blocks for both types of fibres to enable the construction even of mixed mode distribution systems. As discussed below for the 1PPS distribution an optical transmission for the reference should also be strongly considered if the connection has to be made outdoors and above the ground to prevent problems with lightning and static charges.

If phase coherence isn't required which is for most reference systems a much easier solution is to distribute a 1PPS signal from a GPS receiver mounted close to the antenna either electrically via simple twisted telephone cables or even better via fibre-optic transmission. As the frequency is low an ideal solution for this are plastic fibres used with connector-less adapters. RF-SUISSE provides such GPS receivers with either electrical or optical outputs as well as the matching receivers and distribution units.

An ideal solution for small to large-sized set-ups is to use a GPS receiver with optical plastic fibre output to feed one of the GPS guided references from RF-SUISSE. The fibre only has 2.2mm diameter and as there is no connector required it can be fed via tiny 3 mm holes from the receiver to the reference unit. If the distance between receiver and reference unit is more than ~75m one can switch to a Versatile Link style fibre or for longest distance to a glass fibre. From the reference unit itself the 10MHz signal can then be distributed electrically for short distances or via fibre-optic cables for up to 2km.
One of the major advantages of using a GPS receiver mounted under the roof but close to the antenna with a fibre-optic 1PPS output is lightning protection. The GPS antenna has to be outdoors to get the best possible reception and is therefore endangered to be hit by lightning. The flash will follow the cable to the GPS receiver and if a wired distribution is chosen will find its way into the laboratory! With a fibre-optic connection the fibre will completely isolate the path and one only has to take care of the power supply for the GPS receiver which is a much simpler task.

Phase noise also has to be taken into account. An electrical distribution with RF-SUISSE components will not degrade the close-in phase noise of the source. Only the noise floor is limited to ~-160dBc. Optical distributions usually deteriorate the phase-noise. If good phase noise is required in multiple places together with excellent frequency stability and low interference problems the best solution is the distribution of the 10MHz (either optically or electrically) feeding a receiver unit with clean-up crystal oscillator like the RS-FOR10 or RS-FOC10-10 for 10MHz or the RS-FOR100 for a 100MHz output frequency.

Another consideration is the required stability for the reference system. In many cases even the 10^{-9} stability of our standard TCXO based GPS Guided References is sufficient and they have the advantage of low current consumption and only a few minutes after turn-on for lock. For more stringent requirements in the $1*10^{-10}$ and better range either the special TCXO versions or OCXO based solutions are available in multiple configurations and in desktop/wall-mount configurations as well as 19" rack-mount enclosures and a flexible 19" cassette system. The advantage of these GPS Guided References is that they will always be on frequency (calibrated) as long as there is a GPS reception. One should be aware that a non GPS locked, free running Rubidium standard will have less accuracy than our OCXO based systems after only 3-4 months of operation.

Only in very rare cases all the disadvantages of Rubidium standards may be tolerated if the highest possible long term stability is really required. In this case the RF-SUISSE GPS receivers and distribution units can be used to complement such a system by locking them to GPS as well (Rubidium standards are not available from RF-SUISSE as we concentrate on frequency and not timing references) and to distribute the reference signal. Please see our application note “What frequency stability is required for a laboratory reference” for more details.

The ideal configuration for a reference system is the following:

- roof mounted GPS antenna (i.e. RS-GPSANT70)
- Under the roof mounted GPS timing receiver with fibre-optic 1PPS output (i.e. RS-GPSPPS4) to achieve good lightning protection and immunity from interferers.
- 1PPS fibre-cable to the frequency reference (we recommend the connectorless 1.0/2.2mm plastic type if the distance is short enough for cost and ease of wiring)
- frequency reference with optical 1PPS input (i.e. RS-GGRS series). Please see our “What Stability is Required” application note to make the right decision.
- distribution of the reference frequency as desired via electrical or optical distribution systems depending on the distances to be covered.

In case an existing GPS set-up shall be used an RS-PPSOT can be used to convert the electrical 1PPS into an optical signal and RS-PPSD or RS-PPSFR can be used as a receiver close to the frequency reference. Naturally system can be mixed and matched with an RS-GPSPPS4 as the GPS receiver and RS-PPSD or RS-PPSFR as the optical receivers. This is the desired set-up for existing Rubidium standards to have better lightning protection.

For datasheets of all the product and further information please see or website at http://www.rf-suisse.ch or contact our representative for your region.

All RF-SUISSE product is manufactured in the INWAVE AG owned assembly line in Switzerland.

RF-SUISSE provides the following product types to enable the design of small and large scale reference distribution systems:

Electrical		**Optical**	
10MHz electrical distribution:		10+MHz optical distribution:	
RS-CDGF10-D	10MHz ground free amp/splitter	RS-FOT50 RS-FOD100 RS-FOC25 RS-FOC10-10	Single channel optical transmitter 8 outputs optical transmitter optical receiver optical receiver with clean-up XO
1PPS electrical reception:		1PPS optical reception:	
RS-GPSPPS1 RS-GPSPPS2 RS-GPSPPS3	GPS timing receiver GPS timing receiver GPS timing receiver	RS-GPSPPS4	GPS timing receiver
1PPS electrical distribution:		1PPS optical distribution:	
RS-PPSD	8x 1PPS distribution	RS-PPSOT-xx RS-PPSD RS-PPSFR	Electrical to optical 1PPS transmitter optical receiver and 8x electrical distribution optical receiver/converter
GPS Guided References:			
RS-CGGO10-T RS-CGGO10-O-xxxx-yyy RS-MRGGT10-xxx-yyy	GPSDO TCXO based GPSDO OCXO based GPSDO TCXO based		