BBD Memo #035

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To: Broadband Development Group

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Subject: Temperature coefficient of optical fiber

The temperature coefficient of delay through the optical fiber used for conveying the RF from the LNA on the antenna to the rack in control room was measured. This is "standard" multimode fiber. The measurements were made using two methods. In the first method a 9.1 GHz signal was sent through the fiber transmitter and fiber cable to the fiber receiver, amplifier and power splitter in the "ORCA" box and then into a UDC. The phase of the downconverted signal out of the UDC set at 7750 MHz was further downconverted to 5 MHz by mixing with 595 MHz. In the second method the 9 GHz signal was split into 2 paths. One path through the fiber optic transmitter, fiber, receiver, amplifier and power splitter to a spectrum analyzer and the other directly to the analyzer. In this method the signal levels for each path were adjusted with an attenuator to be equal so that a sharp null is produced when the signal are out of phase. The 9 GHz frequency is then scanned to find the nulls. The separation of the nulls is the inverse of the fiber delay and the temperature coefficient is measured by measuring the change in the null frequency with temperature. The second method is more accurate because it avoids the synthesizers and the UDC. Figure 1 shows the block diagram for each method.

Measurement results

The portion of fiber under test was 200' long (by looping through 2 fibers in a 100' bundle) with a measured delay of about 300 ns. Most of the error being due to estimating the amount to subtract in order to remove connecting cables etc whose temperature was changed.

Method A

Time	Phase (deg)	Temp (°C)
11:39	0	25
12:00	45	33
1:30	90	45

Method B

Time	Null frequency (GHz)	Temp (°C)
7:24	9.100340	24
7:47	9.099670	36
8:12	9.099240	41

8:35	9.099000	44
9:24	9.098790	47
9:49	9.098740	48
10:36	9.098680	49
13:00	9.100110	28

Both methods result in a temperature coefficient of 3±1 ps/°C for 200' of fiber or 10±3 ppm of the fiber delay. This is slightly higher than the temperature coefficient of 9 ppm for the LMR-400 UF when the higher velocity factor of coax cable at 0.85 compared with the velocity factor of 0.67 for fiber is considered. The best option for the phase cal would be to use standard LMR-400 for the bulk of the cable run with LMR-400 UF in the cable wrap assuming that the extremely low temperature coefficient for the standard LMR-400 is (see MK5 memo #69) repeatable.

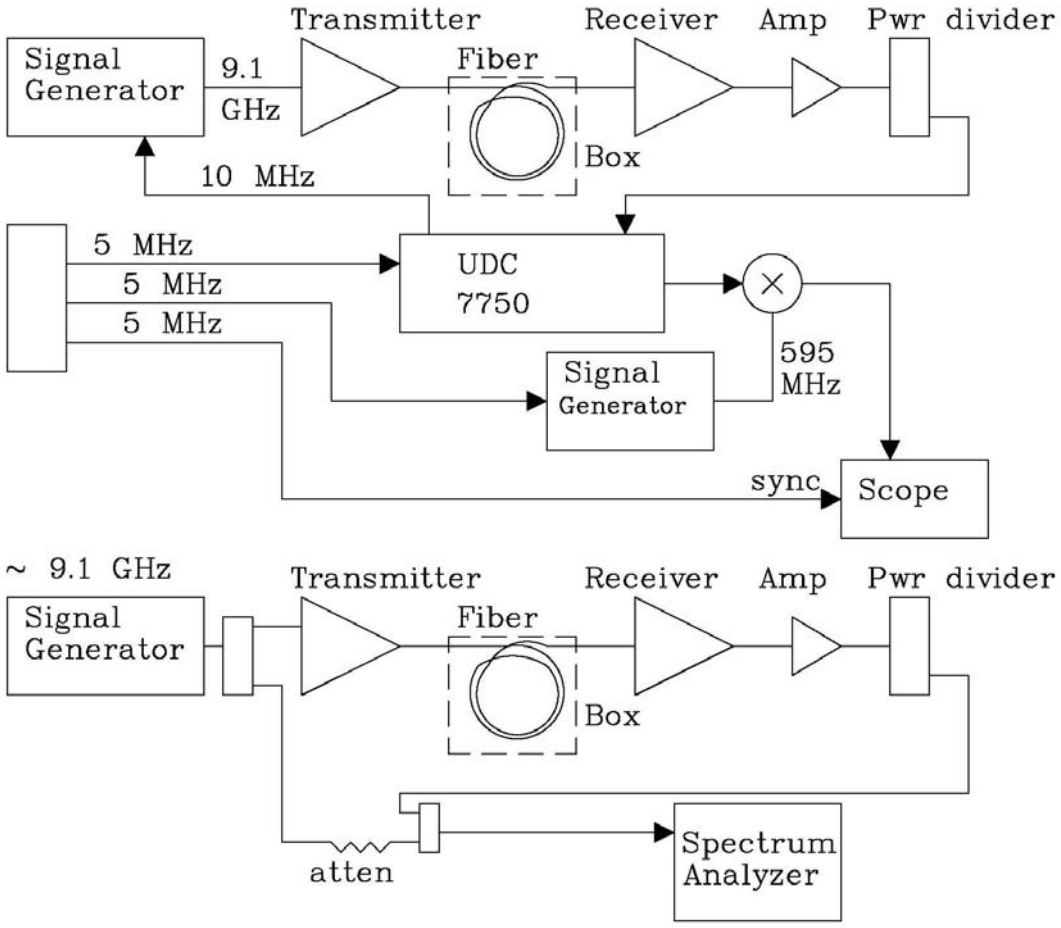

Fig1. Block diagrams of 2 methods used to measure fiber tempCo