
TUNING RISE/FALL TIME: APPLICATION NOTE

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1 General Consideration

The ITFLabs uDPSK demodulator is based on a all fiber Mach-Zehnder interferometer. The optical structure is composed of two wide band couplers and a fiber delay line. The device comprises a fiber heater used to tune the phase through the thermo-optic effect. A thermistor is also provided, but is mounted to the device case, not the fiber.

To be sure to properly use the demodulator, the user should read the application note “DPSK Demodulator” for electrical driving instructions.

2 Time Constant definition

The goal is to characterize the spectral response in function of time. It is equivalent to tracking a transmission maximum after having changed the voltage bias on the fiber heater. It is known that the temperature changes seen by the fiber varies exponentially with time:

$$f = (f_i - f_f)e^{-\frac{t}{\tau}} + f_f$$

Where t is time, f if the tracked frequency, f_i is the initial frequency, f_f is the asymptotic frequency and τ is the time constant.

3 Experimental determination of the Time Constant

The demodulator is connected electrically and one of the optical port is monitored. A bias voltage is temporarily applied on the fiber heater. The optical transmission is measured through the experiment. Figure 1 shows a typical result. An algorithm is used to extract the maxima of the optical response versus time for the rise period (from 0V to 0.9 V_{max}) and the fall period (from 0.9 V_{max} to 0V). Since the rise/fall time is known to be exponential, a curve is fitted on the data points (Figure 2) and the time constant τ is calculated.

On one experiment, the number of data points is somewhat limited (around 5-6). Therefore, the experiment is repeated 5 times to get a proper level of confidence on the measurement.

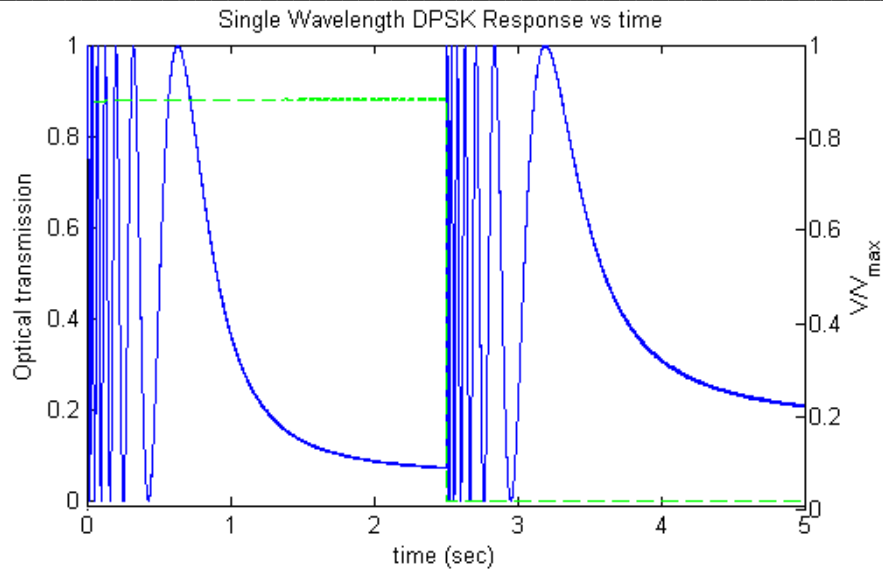


Figure 1 : In green : A bias voltage is temporarily applied on the fiber heater. In blue: The optical transmission of one of the output port.

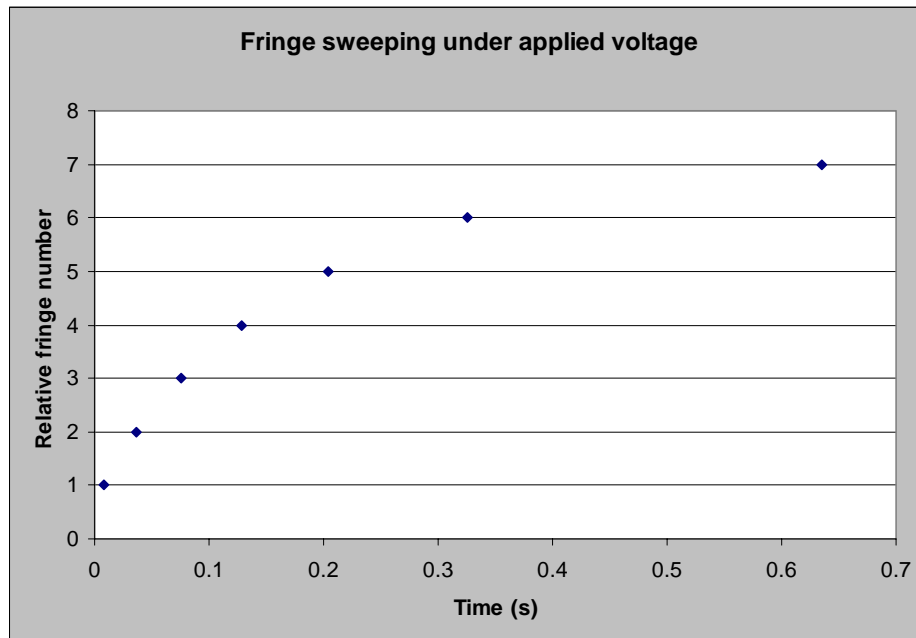


Figure 2 : Maximum swept during rising experiment. Successive frequency maxima are spectrally separated by one FSR.

4 Computation of equivalent time constants

Several definitions are possible for the rise/fall time constant:

Time constant τ :

The time constant is equivalent to measure time at which the fringe number has changed to 63% (1/e) of the total travel from initial to asymptotic state.

50% time constant $t_{1/2}$:

The 50% time constant is equivalent to measure time at which the fringe number has changed to 50% of the total travel from initial to asymptotic state. It can be calculated as: $t_{1/2} = \tau \ln 2$.

10%-90 % time constant t_{10-90} :

The 10%-90% time constant is equivalent to measure time at which the fringe number has changed from 10% to 90% of the total travel from initial to asymptotic state. It can be calculated as: $t_{10-90} = \tau \ln 9$.

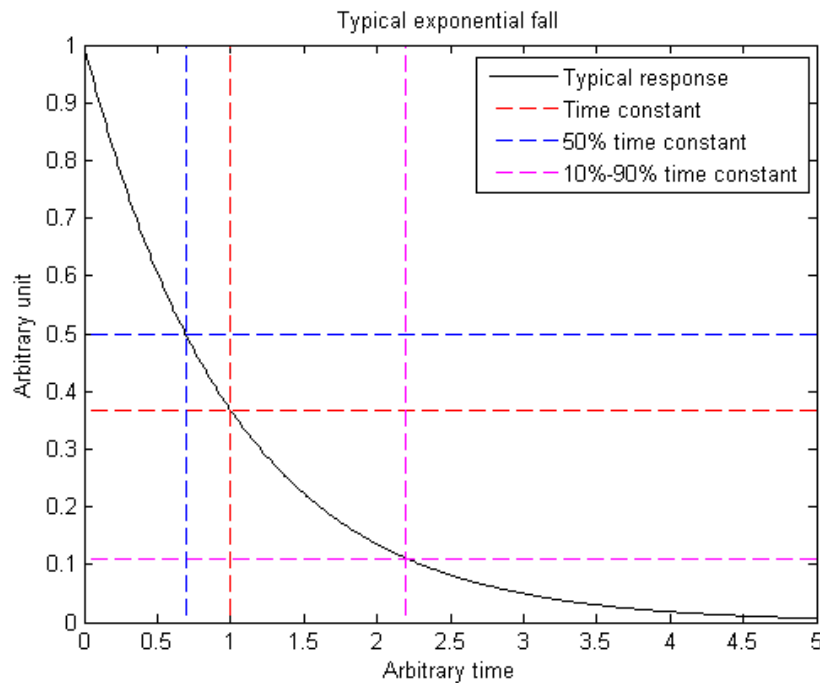


Figure 3 : Different time constant definitions put on graphic.