# Optical Telecom Sensors and Controls

I spent a few years in the fascinating world of optical telecommunications designing and building in-system an in-spectrum analyzer, tunable filter controller, and an InGaAs (indium gallium arsenide) pixel-array power monitor.

This work offered many unique challenges and experiences with fascinating equipment, instrumentation, control system design, and DSP techniques incorporating phased-lock loops, sensor interface FPGA logic design, and micro-electromechanical (MEM) mirror interfacing.

In-system spectrum monitors, tunable optical filters, and MEMS

Patent Granted:
Spectral power monitors with active alignment compensation
US 6504976 B1
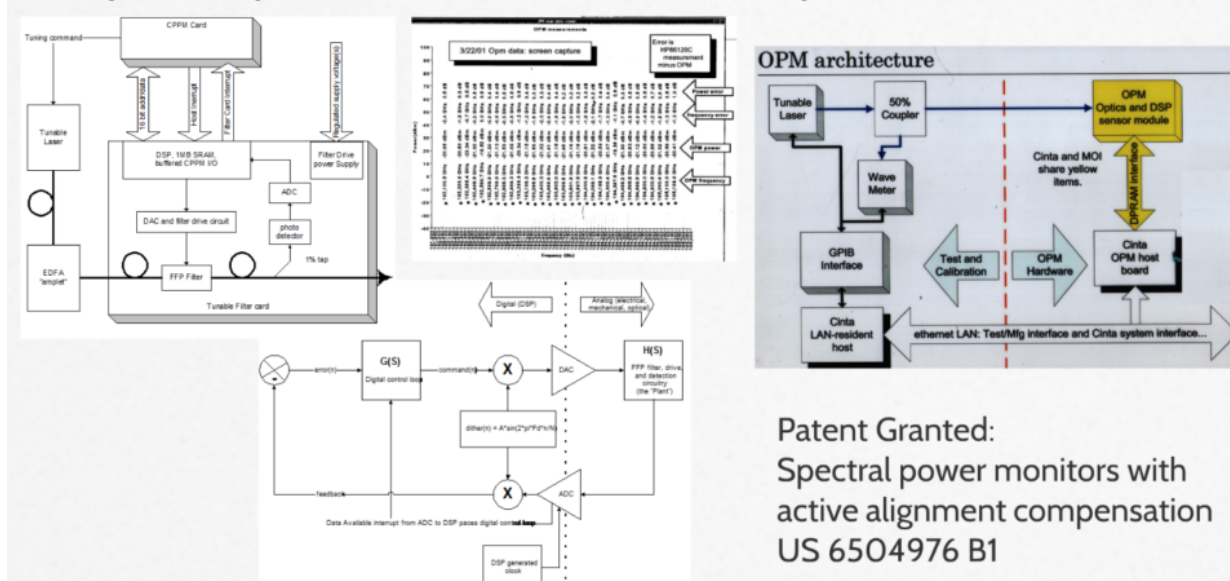
Tunable Optical Filter Module Description

The following PDF describes a Tunable optical filter control system to open-loop find, and thereafter closed-loop track OC48 and OC192 optical carrier frequencies.

The application involves tunable laser output to optics that

combine into wavelength-division-multiplexed (WDM) transmission fiber. Problem: each carrier laser noise floor is too high and must be bandpass filtered before combining.

However, the lasers are tunable, so fixed-filters won't suffice. A tunable Fabry Perot filter is used. It's basically a gap filter whereby the faces of input and output fibers are jacketed by a piezo-electric actuator that effectively squeezes the assembly to alter the gap length.

For example, OC-192 optical carrier wavelengths range 1310nm to 1550nm, halve that for an equivalent ideal passband gap, and imagine the piezo drive actuating the filter over the carrier range of interest.

Phase-Locked Loop Tracking Scheme

The distinguishing characteristic of this carrier tracking control system is the phase-locked loop approach. The piezo drive voltage is dithered, and resultant filter output power is mixed with this dither frequency to produce an error signal relative to the peak in a roughly linear region near the peak.

Tunable Filter Module Description (Design Description Document Draft)

This document describes the state of the design near completion, with notes indicating to-do items. IT describes a filter state machine for a fast open-loop carrier peak acquisition mode and closed-loop operation once near the linear region of the phase-lock, within which the filter can, "pull-in" to the carrier peak.

TFCmoduleDescription

Reference Material

Study, "lock-in Amplifiers" generally. The following textbook is also a great reference. I have the 2nd edition. If you're interested in carrier carrier tracking and communications transmitter and receiver schemes this is a good read.