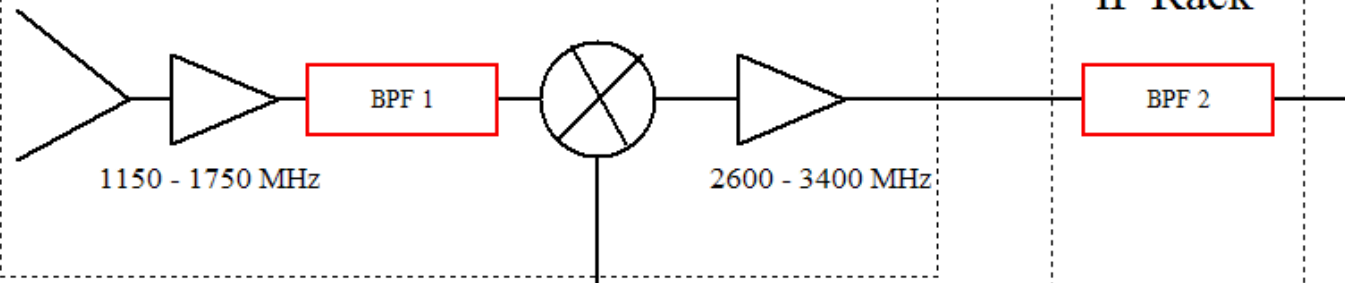




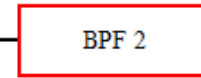
Tracing The Signal

Ron Maddalena
July 2011

Receiver



IF Rack

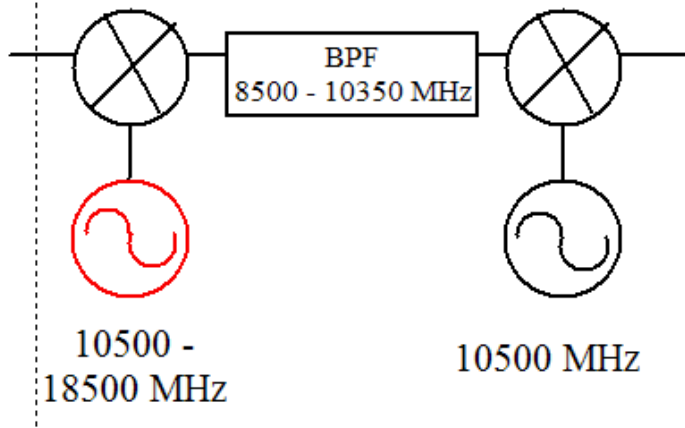


LO1

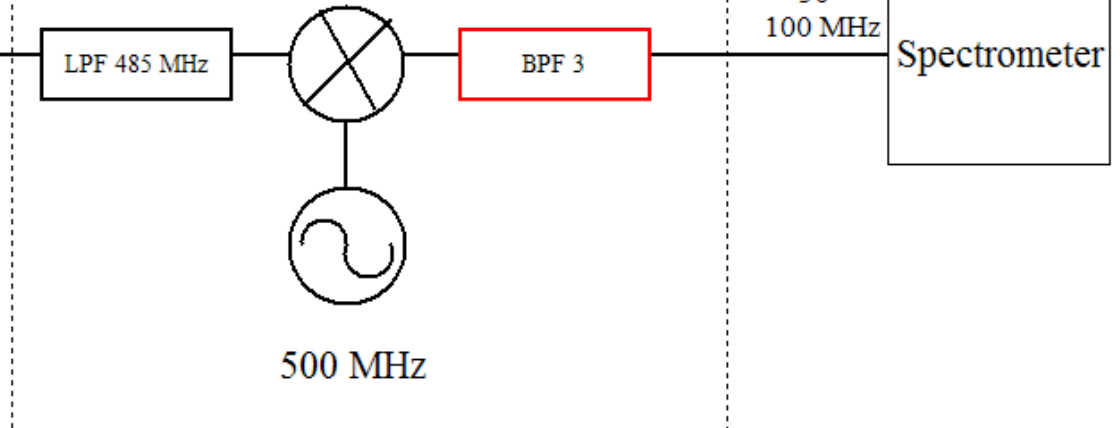


1000 - 10,000 MHz

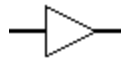
Converter Module



Analog Filter Module



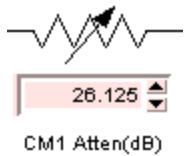
Typical Components



Amplifiers



Mixers



Attenuators



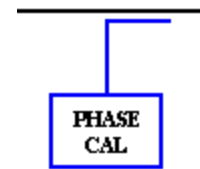
Power Detectors



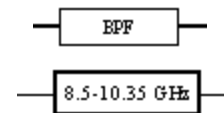
Synthesizers



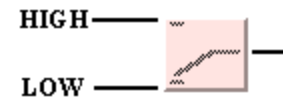
Splitters



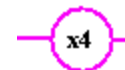
Couplers



Filters

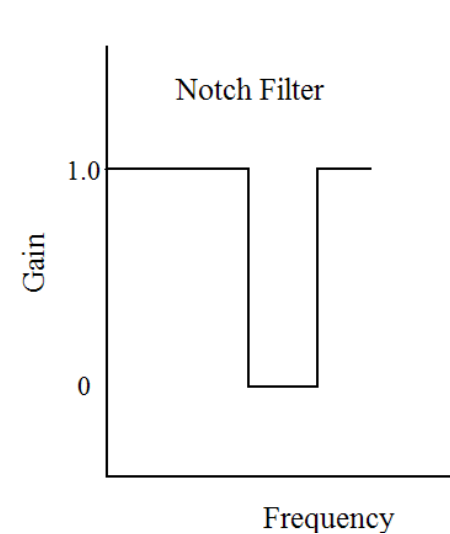
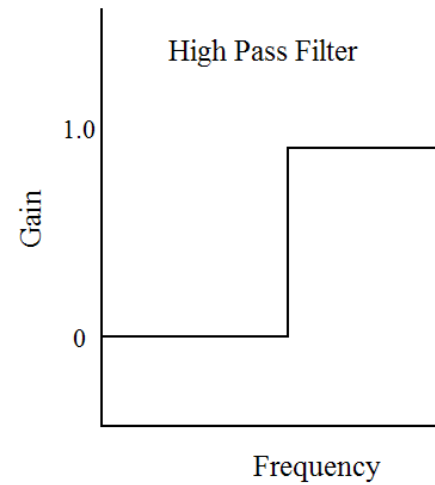
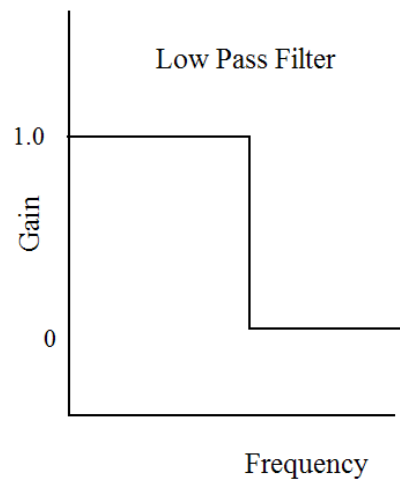
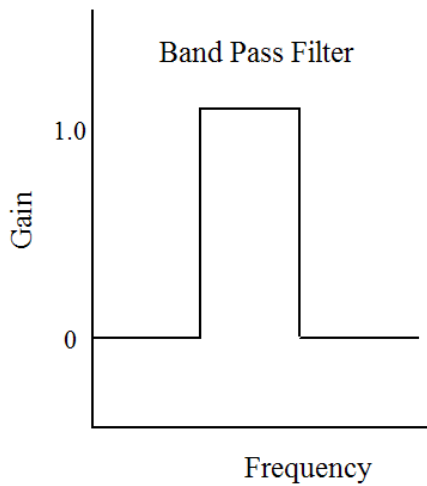


Switches



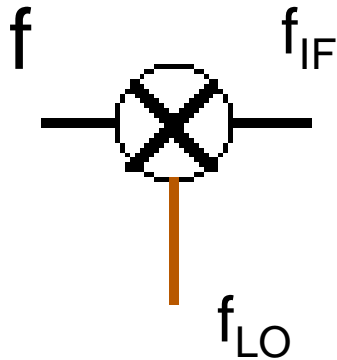
Multipliers

Types of Filters



Edges are smoother than illustrated

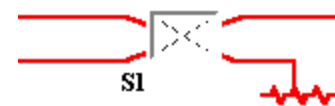
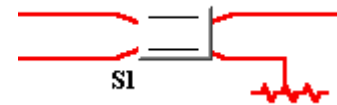
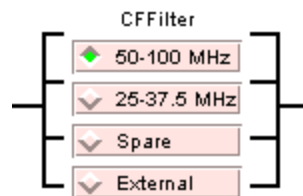
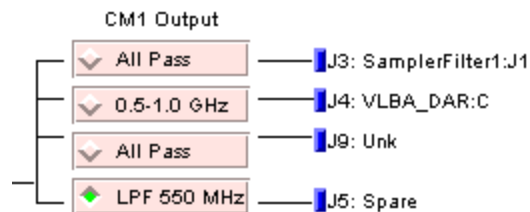
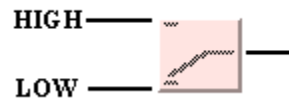
Types of Mixers



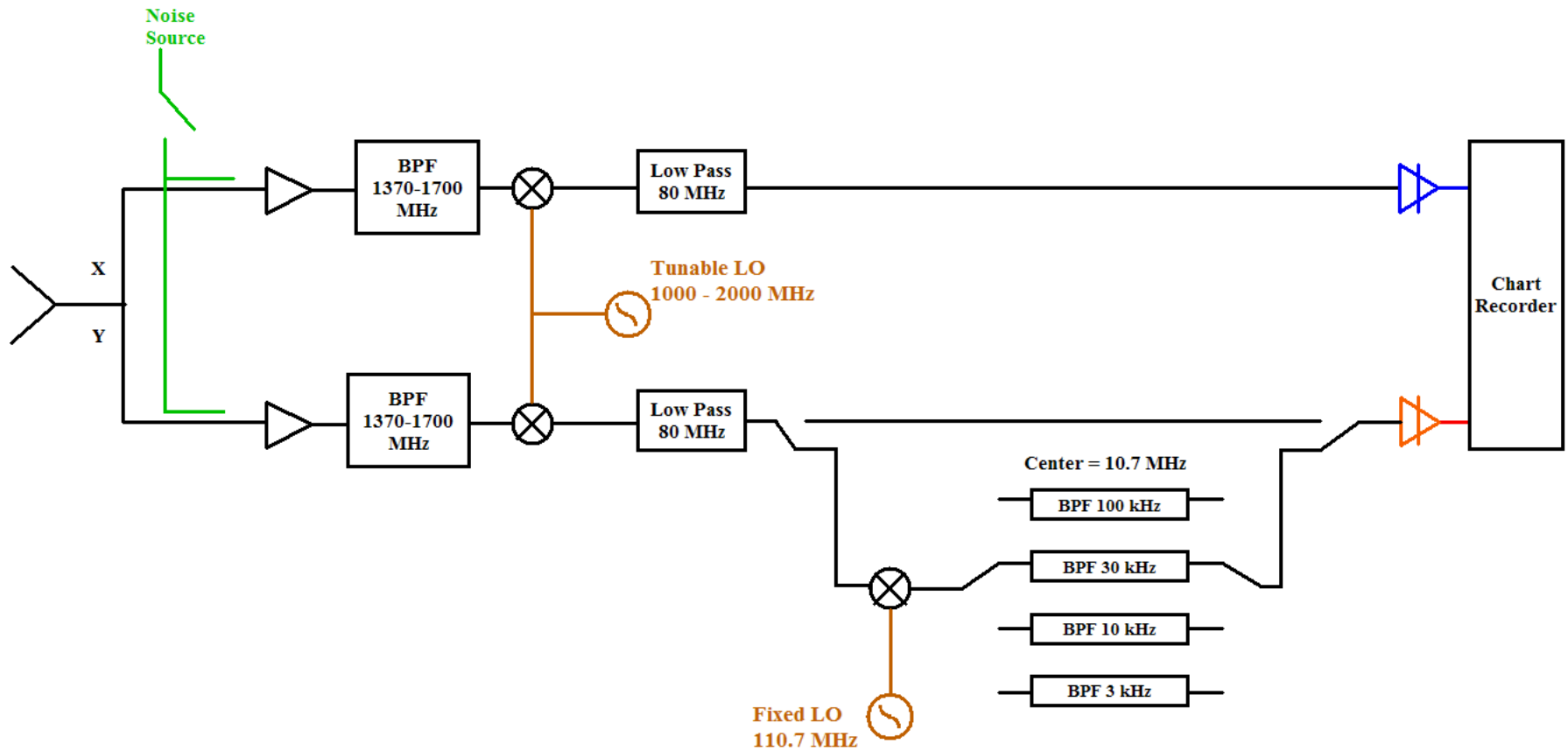
$$f_{IF} = n \cdot f_{LO} + m \cdot f$$

- n and m are positive or negative integers, usually 1 or -1
- Up Conversion : $f_{IF} > f$
- Down Conversion : $f_{IF} < f$
- Lower Side Band : $f_{LO} > f$
 - Sense of frequency flips
- Upper Side Band : $f_{LO} < f$

Example Switches



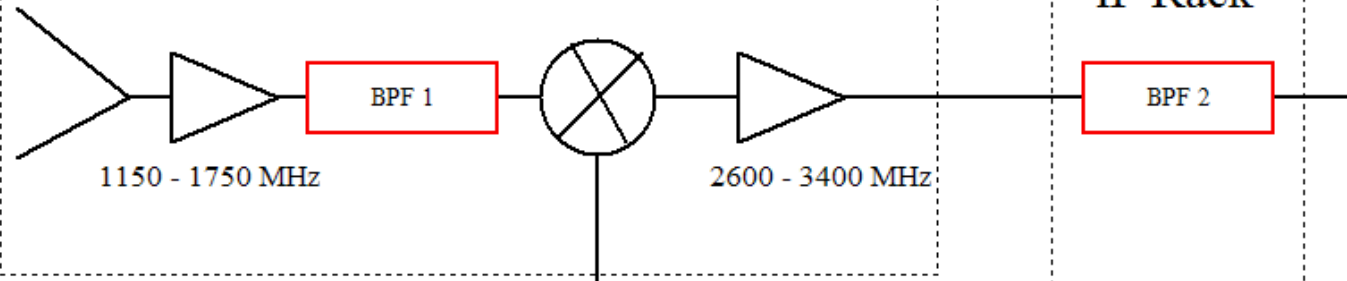
40-Ft System



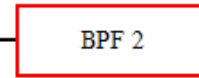
Quiz 1: Determine values for the first LO for the 40-ft when...

- Observing HI at 1420.41 MHz with a 30 kHz bandwidth
- Observing OH at 1665.6 MHz with a 10 kHz bandwidth

Receiver



IF Rack

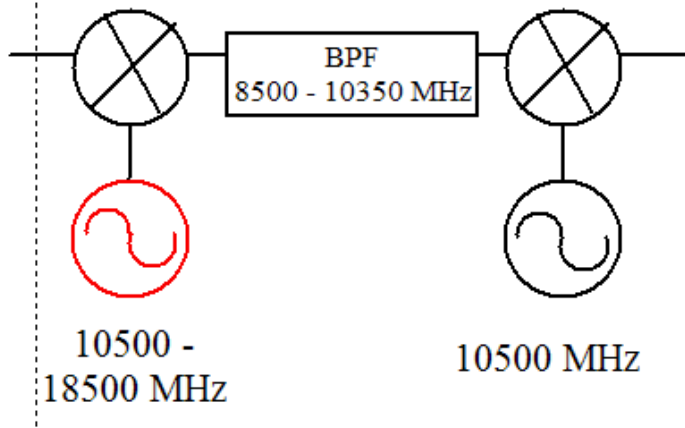


LO1

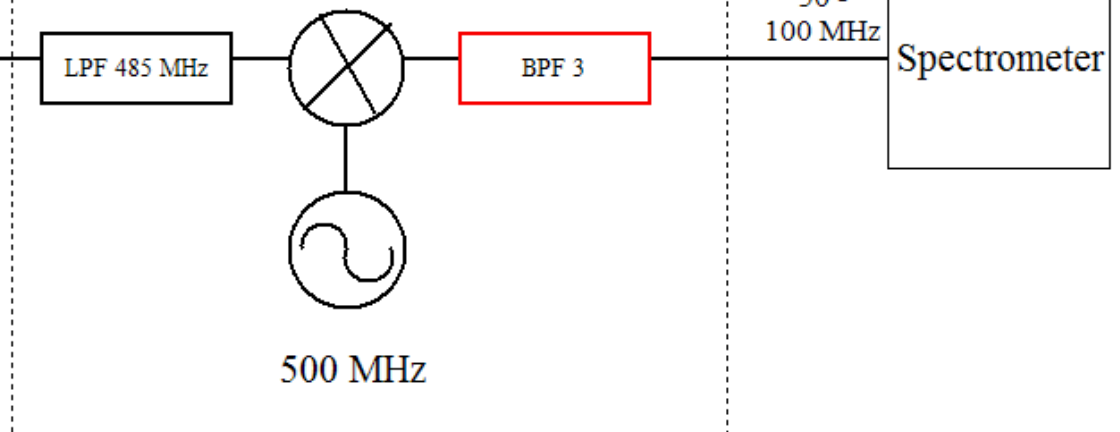


1000 - 10,000 MHz

Converter Module

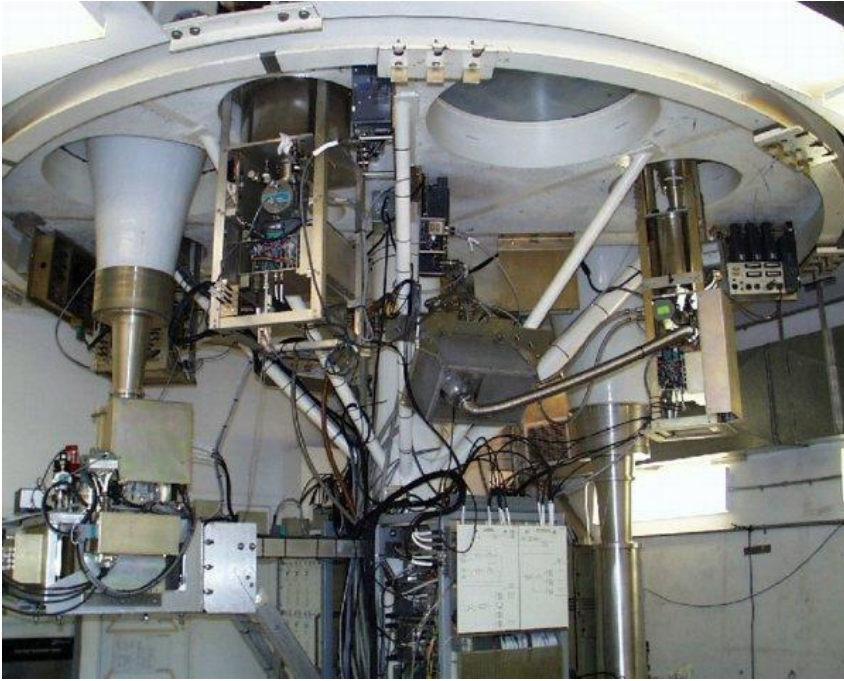


Analog Filter Module

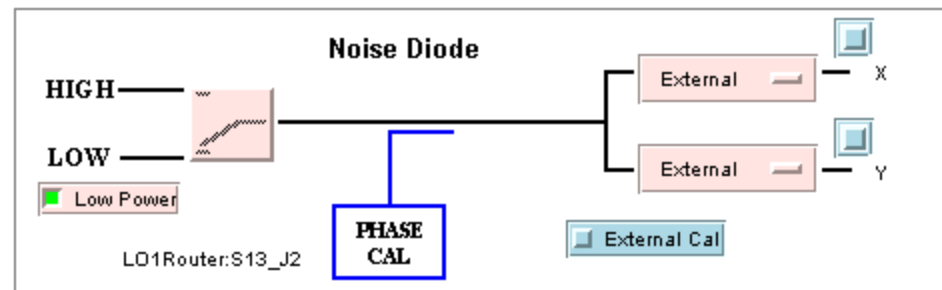
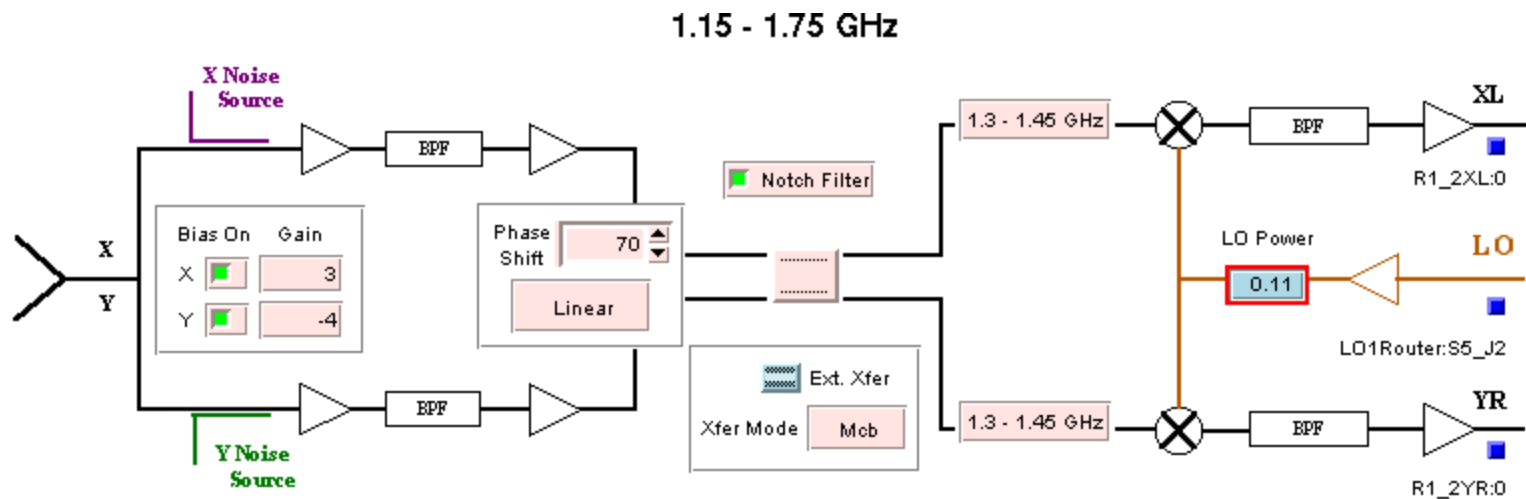


Spectrometer

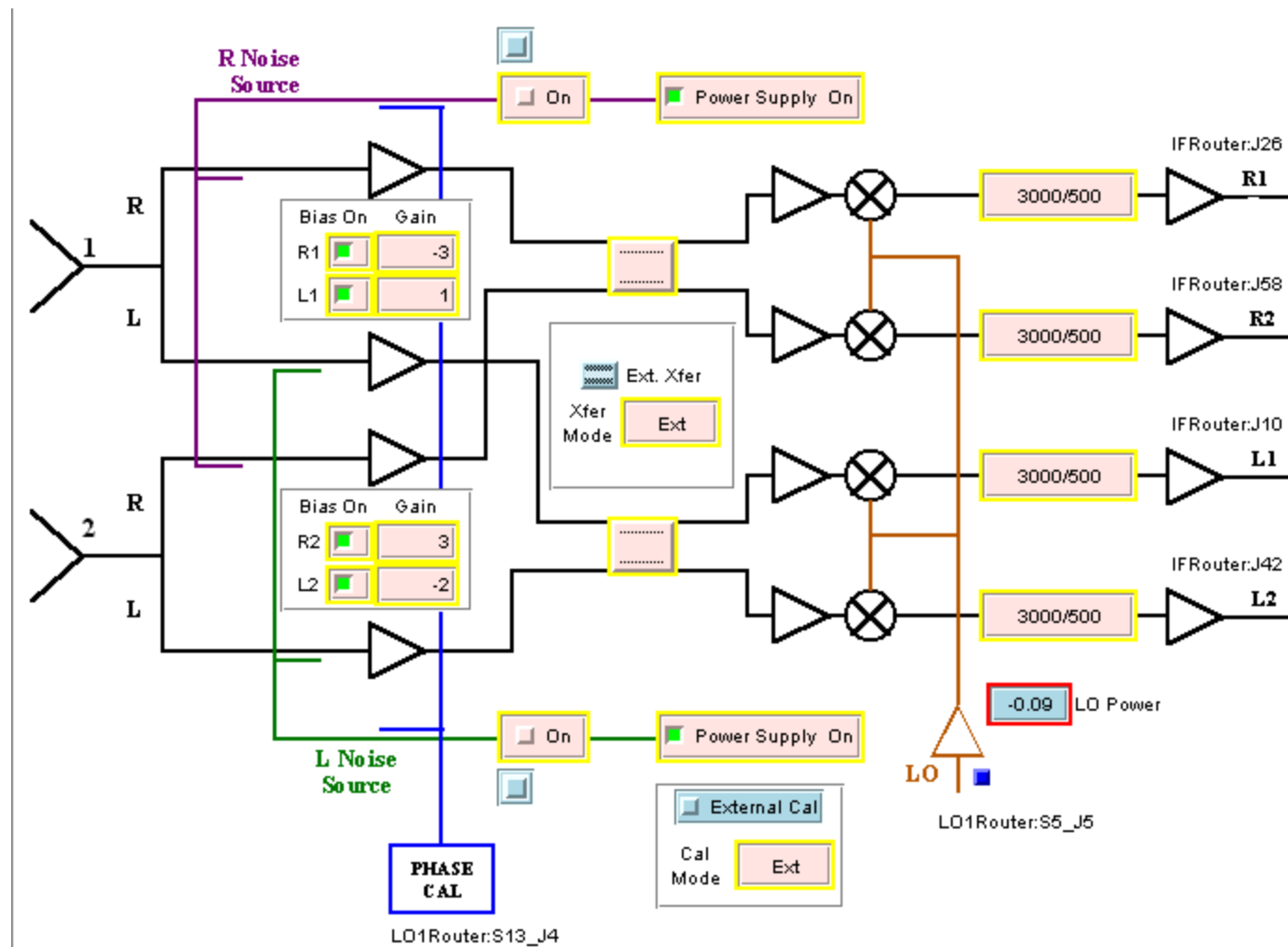
Receiver Room



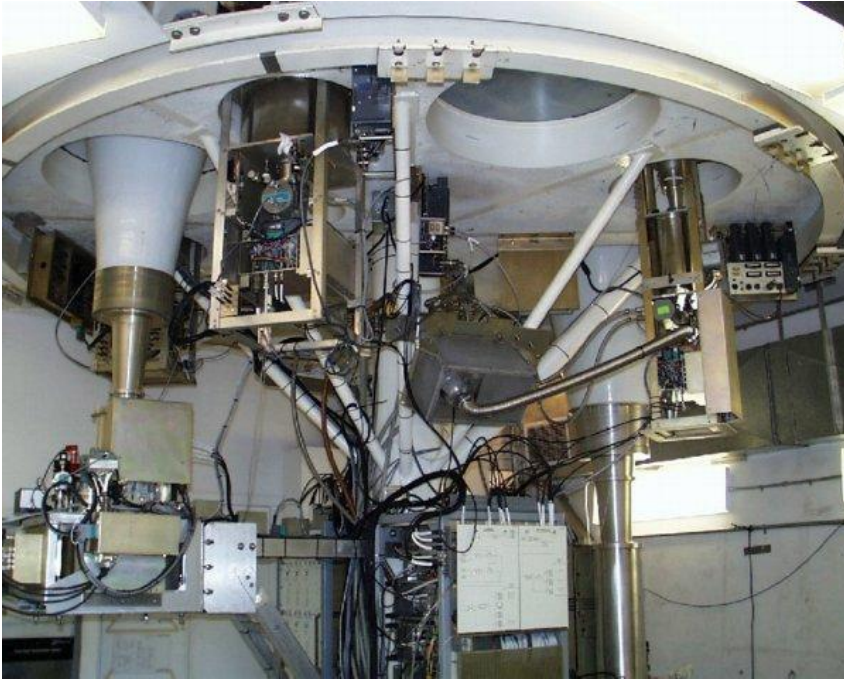
Typical Receiver

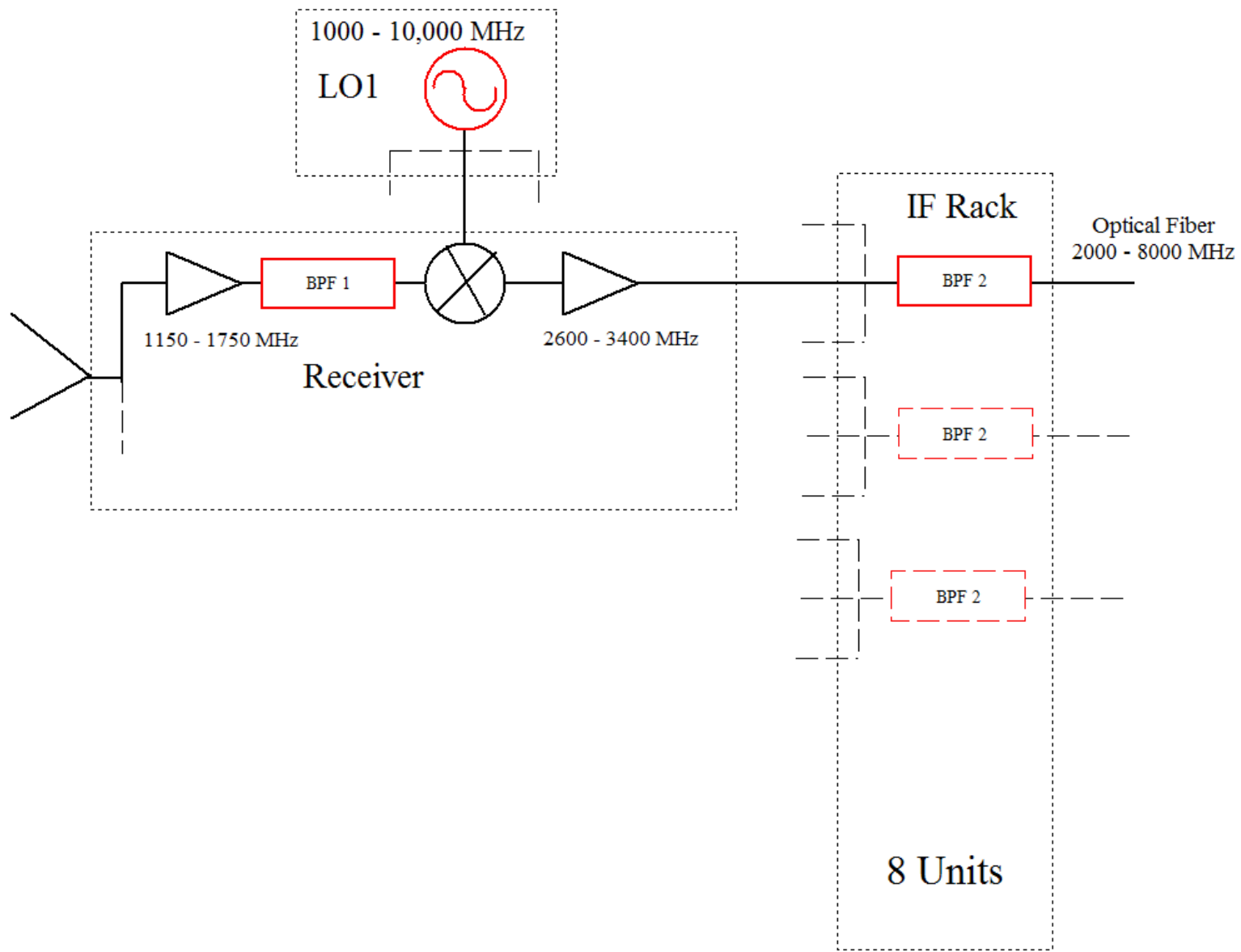


Multi-beam Receiver

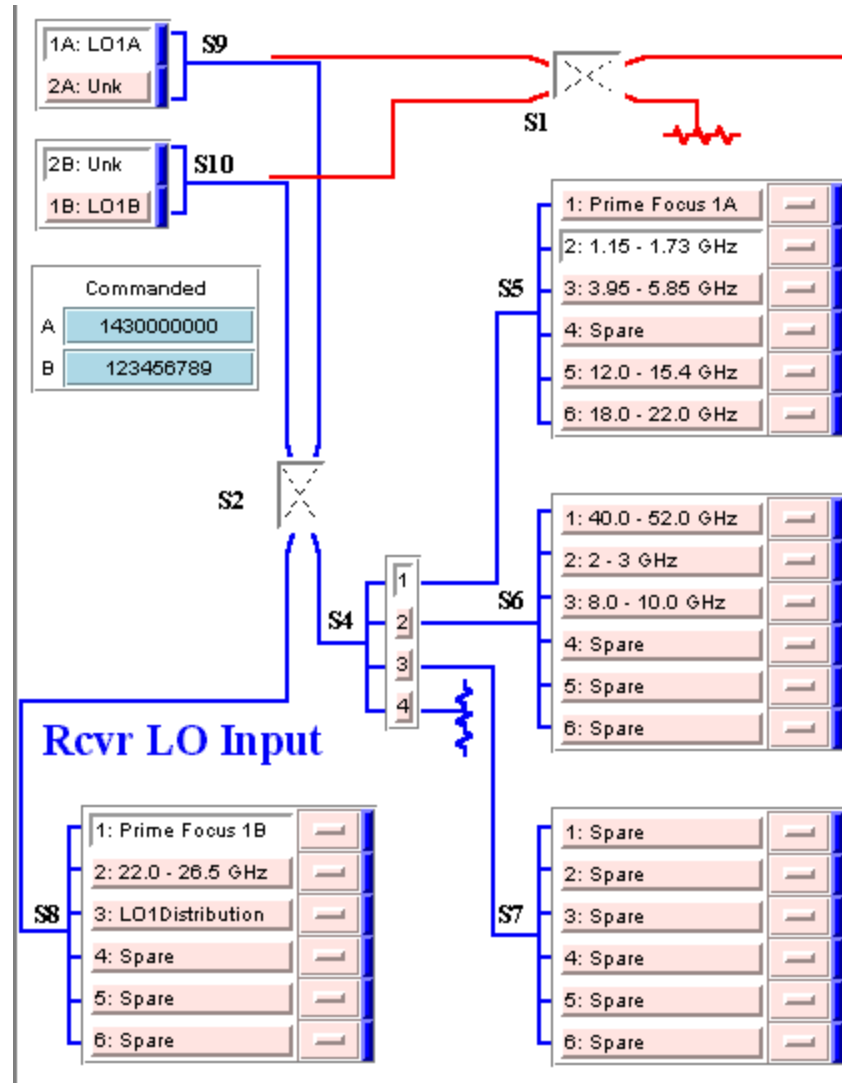


Receiver Room

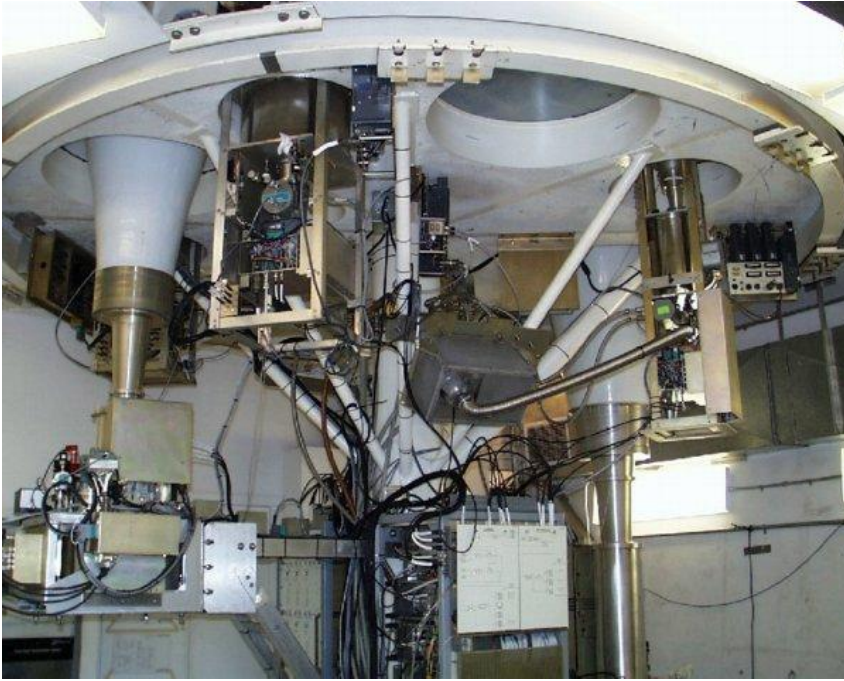




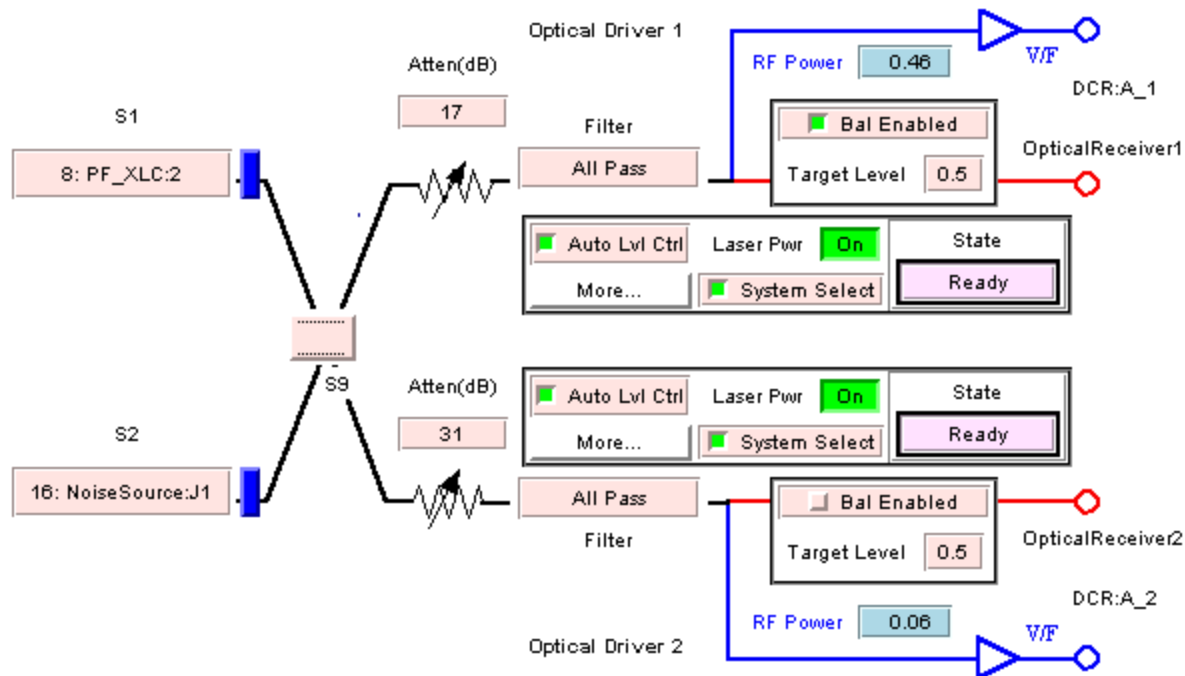
Local Oscillator and Switching Matrix



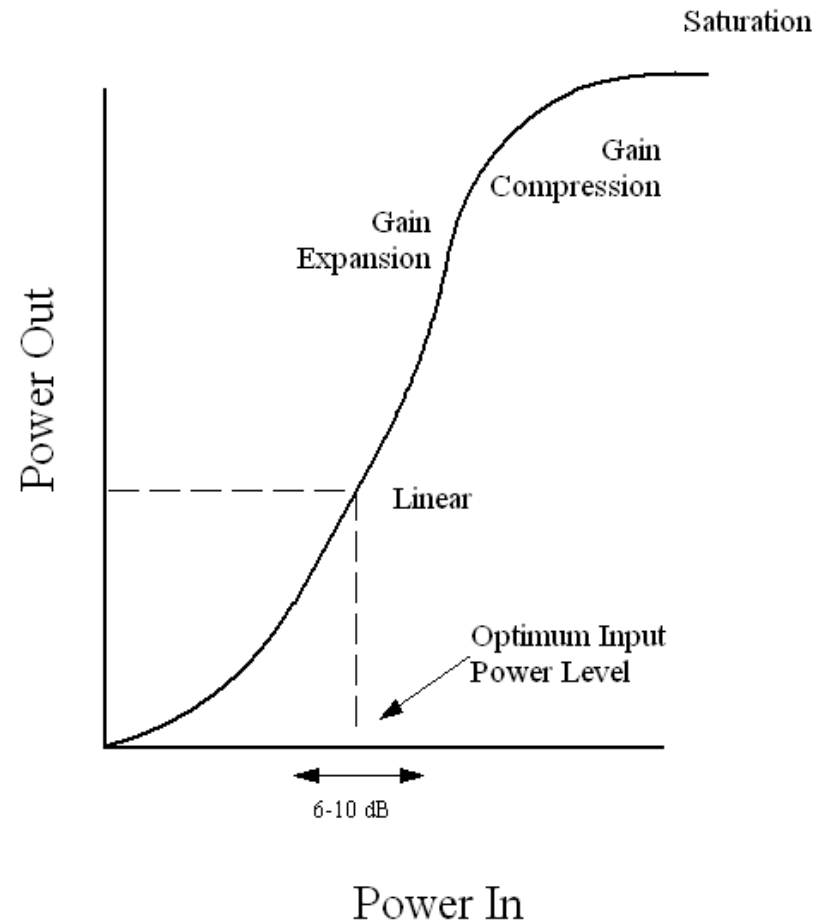
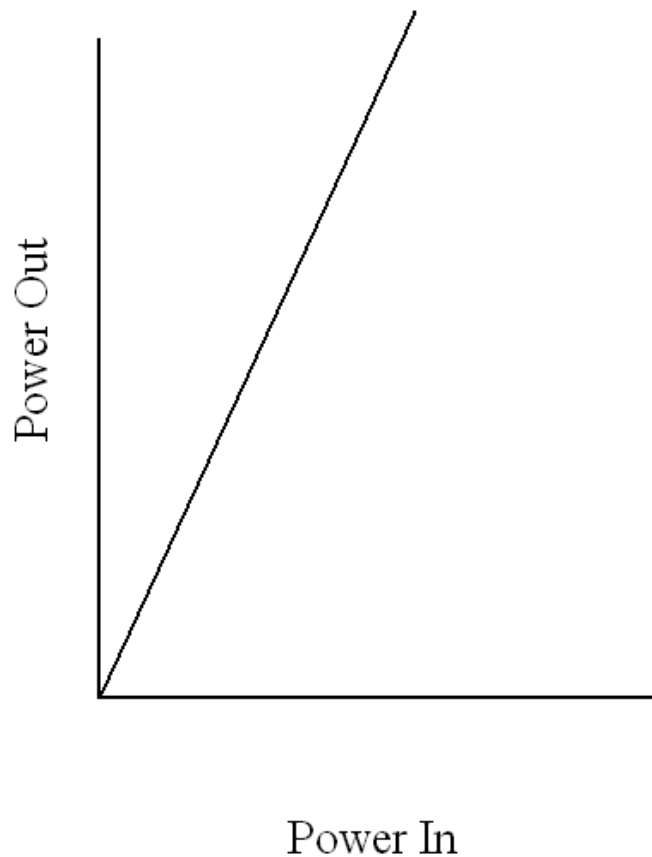
Receiver Room



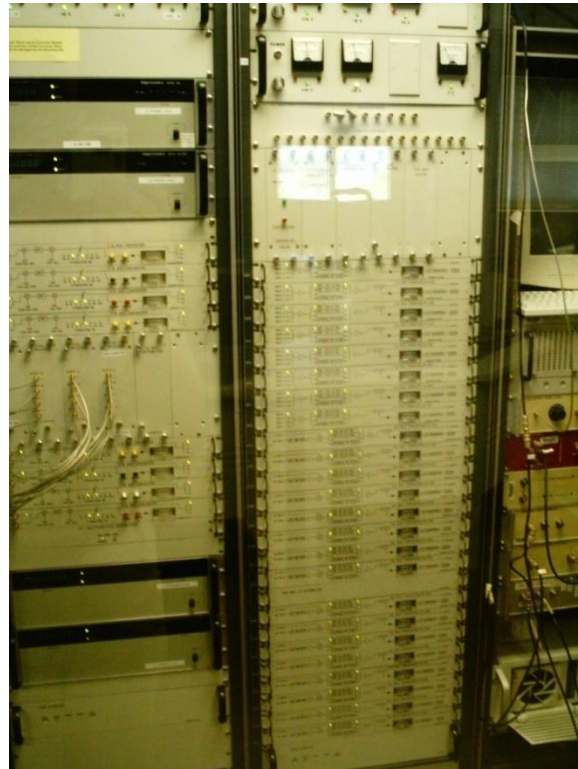
IF Rack – Input switching Matrix, IF Filters, Power Balancing Attenuators, and Drivers for 8 Optical Fibers



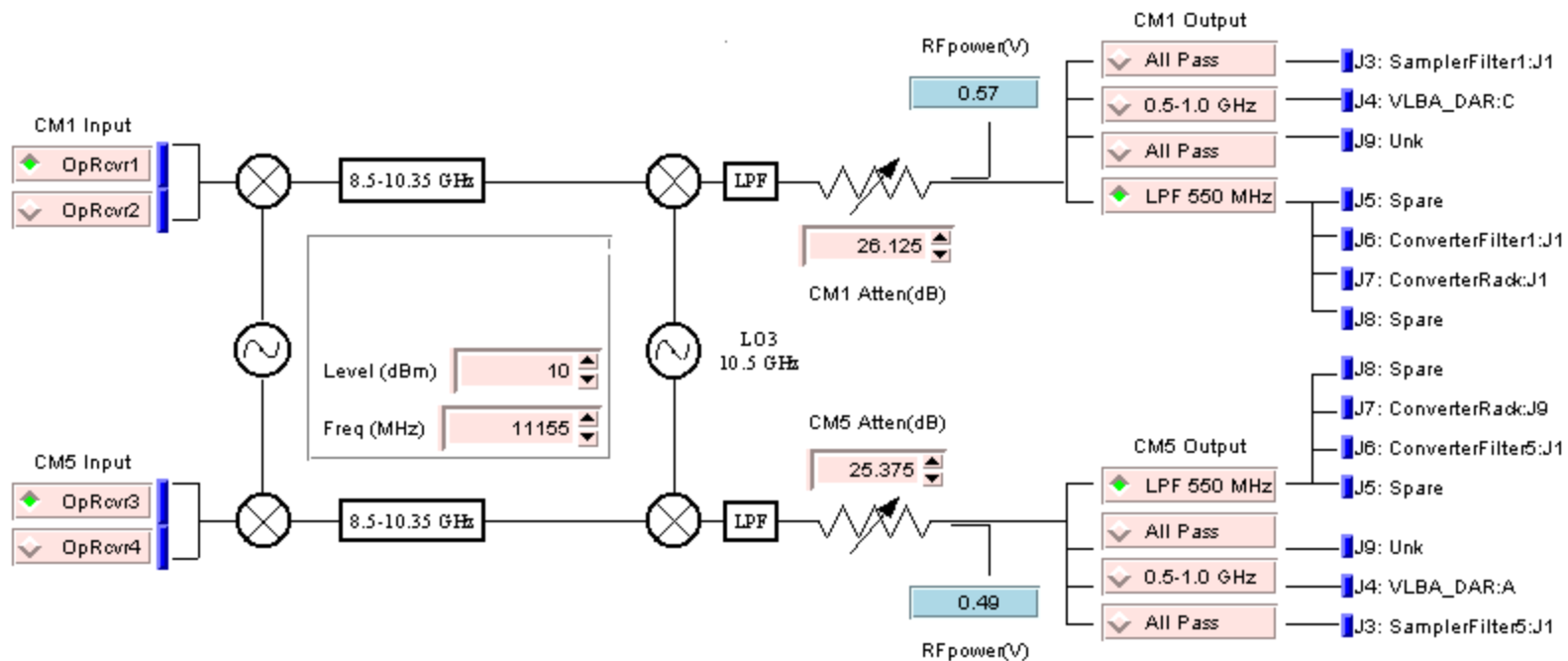
Power Balancing/Leveling and Non-Linearity



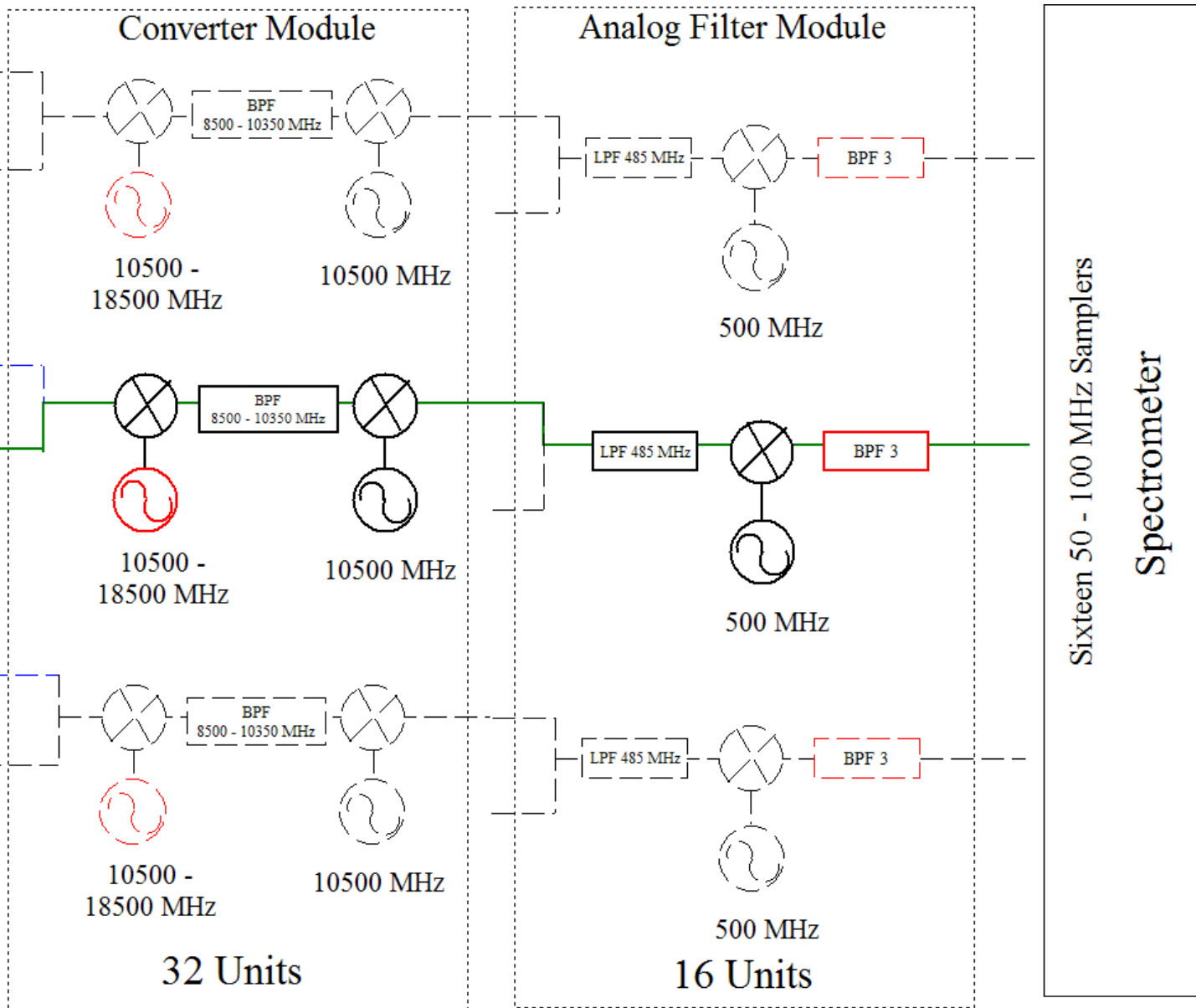
Converter and Analog Filter Racks, Spectrometer



Converter Rack – Receivers for Optical Fibers, LO2 and LO3, Power Balancing Attenuators, Output Switches to Backends and AFR

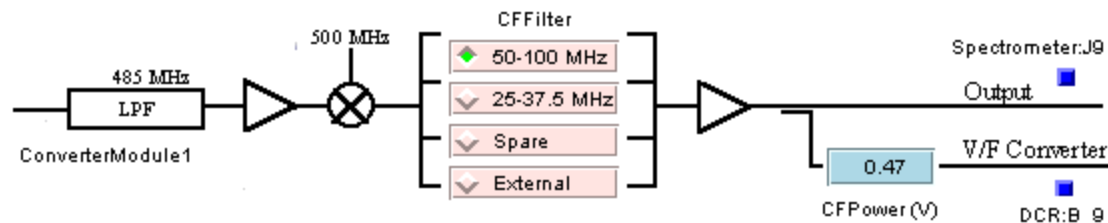


8 Fibers
Each Split 4x

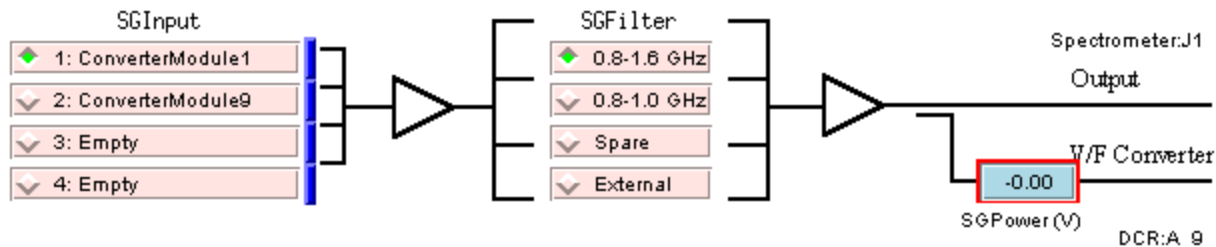


Analog Filter Rack

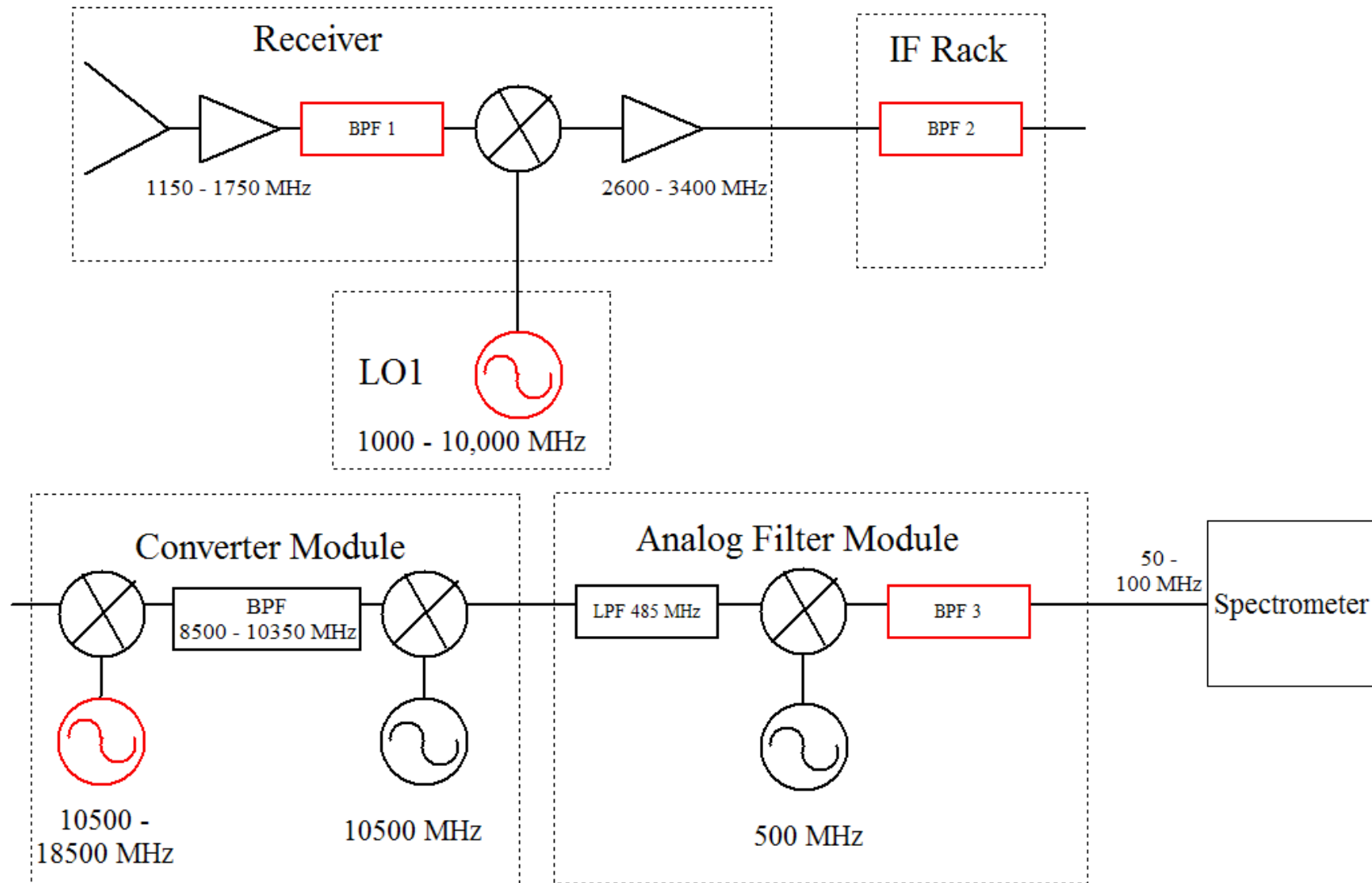
For 12.5 and 50 MHz Slow-Speed Spectrometer Samplers : LO4 and Filters



For 200 and 800 MHz High-Speed Spectrometer Samplers : Input Switches and Filters.



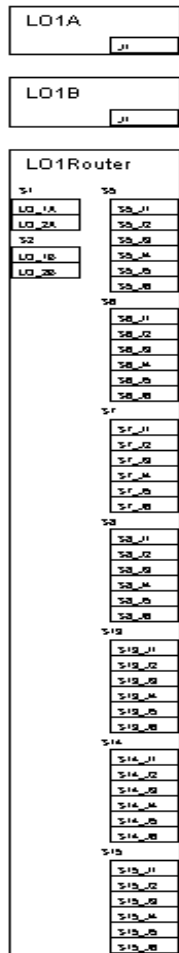
Quiz 2: Determine values for red components



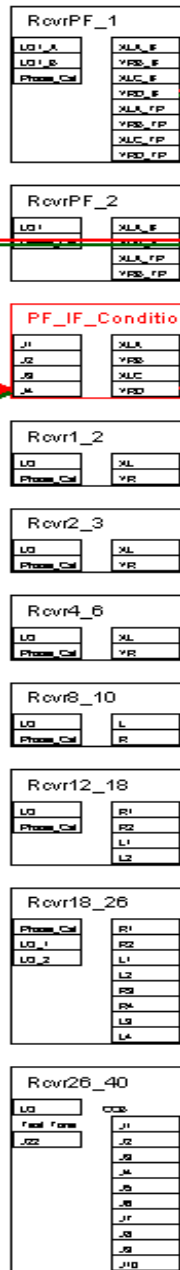
Quiz 2: Determine values for red components

- Goal : Observe 1420 MHz with the 50 MHz mode of the Spectrometer
- Parameters:
 - BPF1 can be: 1100–1800, 1600-1750, 1300-1450, or 1100-1450 MHz
 - All mixers are Lower Side Band. Hint: first two mixers up convert, the last two down convert.
 - BPF2 can be : 2990-3010, 2960-3040, 2840-3160, 2360-3640, 5960-6040, 5840-6160, or 5360-6640 MHz
 - BPF3 can be : 50-100 or 25-37.5 MHz
 - See block diagram for other parameters
- Hint: Work from the receiver down the chain until you get stuck, then from Spectrometer up
- Record values for LO1 and LO2; settings for BPF1, 2, and 3; and values for all Intermediate Frequencies.

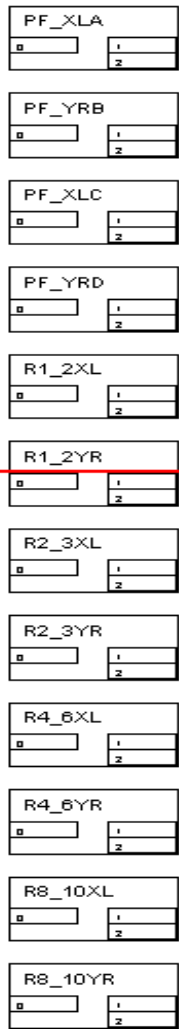
L.O. 1



RECEIVERS



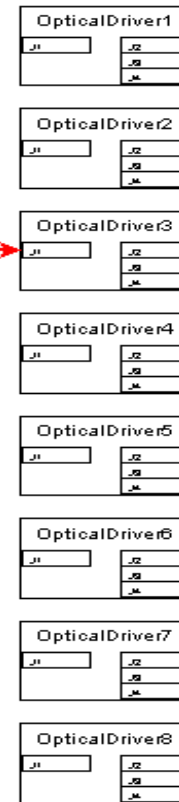
SPLITTERS



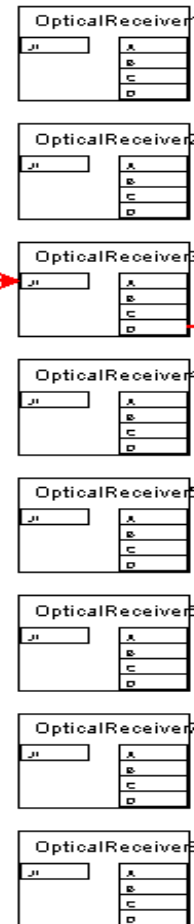
I.F. ROUTER

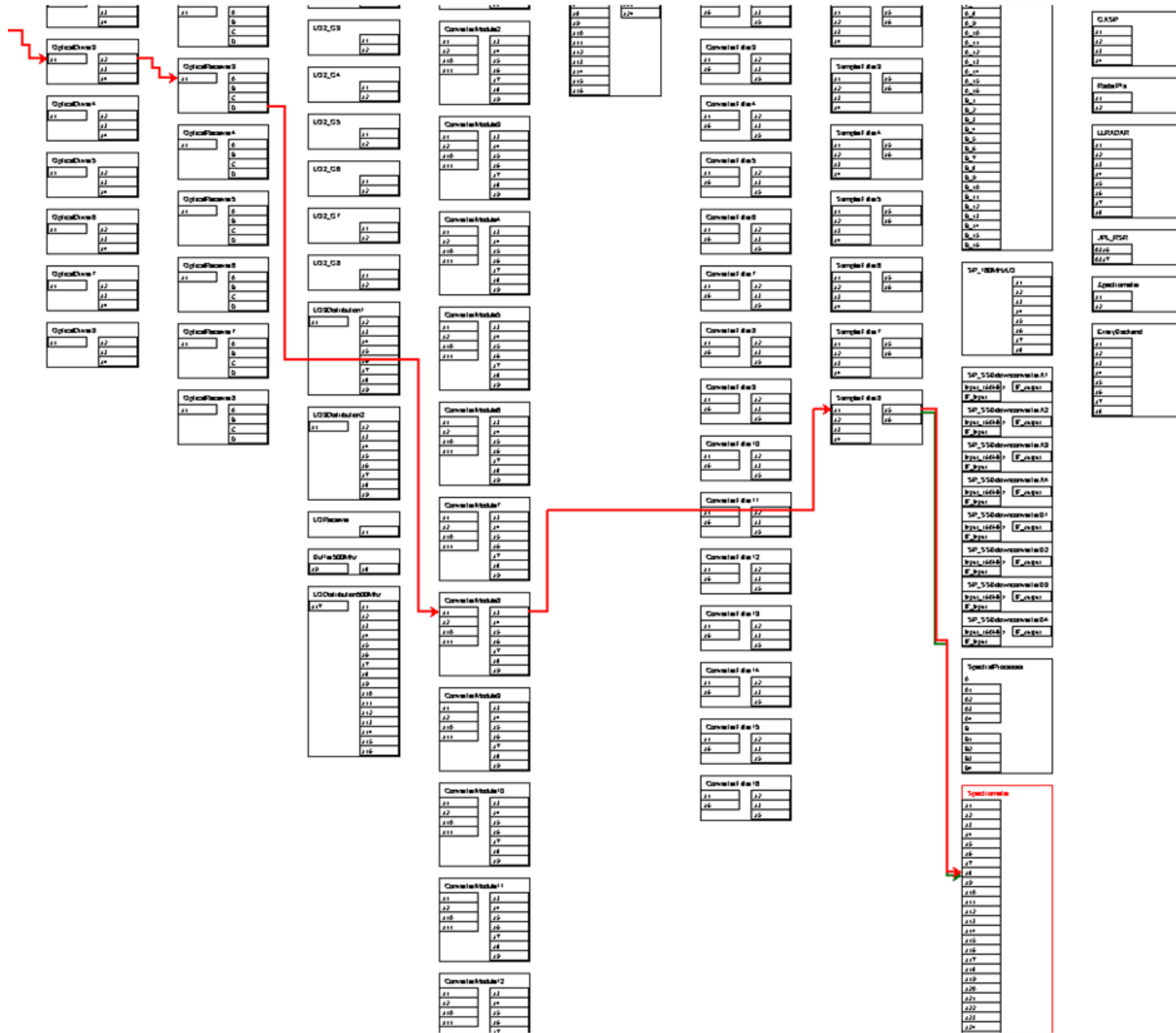


OPT. DRIVERS



OPT. RECEIVERS





Spectrum	
Sideband	lower
IF	1200
Sky	-2770
Bandwidth	0
Polarization	linear_y
Noise Diode	lowCal
Sinusoid	
IF	0
At LO	0
From: SamplerFilter8:J5	

```

Feed: RcvrPF_1:YRD_342
  Freq: 270 to 420 MHz
  Polarization: linear_y
  Horn: 1
Tone: RcvrPF_1:C342Y
  Freq: 0 MHz
Filter: RcvrPF_1:FL342_5Y
  Freq: 270 to 420 MHz
Mixer: RcvrPF_1:MXYRD
  LO: 1430 MHz
  Component -- LO1A:synthesizer
  Lower Sideband: IFo = 1430 - IFi
Filter: RcvrPF_1:FLYRD3
  Freq: 1040 to 1120 MHz
Filter: RcvrPF_1:FLYRD
  Freq: 960 to 1200 MHz
Attenuator: RcvrPF_1:ifChannelD
Output Port: RcvrPF_1:J4
Input Port: PF_IF_Conditioner:J4
Output Port: PF_IF_Conditioner:J8
Input Port: IFRouter:J23
Output Port: IFRouter:J67
Input Port: OpticalDriver3:J1
Attenuator: OpticalDriver3:attenuator
Output Port: OpticalDriver3:J2
Input Port: OpticalReceiver3:J1
Output Port: OpticalReceiver3:J5
Input Port: ConverterModule8:J1
Mixer: ConverterModule8:MX2
  LO: 13500 MHz
  Component -- LO2_G4:synthesizer
  Lower Sideband: IFo = 13500 - IFi
Filter: ConverterModule8:FL1
  Freq: 8500 to 10350 MHz
Mixer: ConverterModule8:MX3
  LO: 10500 MHz
  Component -- LO3Distribution1:synthesizer
  Lower Sideband: IFo = 10500 - IFi
Filter: ConverterModule8:FL2
  Freq: 0 to 2200 MHz

```

Spectrum	
Sideband	lower
IF	1200
Sky	-2770
Bandwidth	0
Polarization	linear_y
Noise Diode	lowCal
Sinusoid	
IF	0
At LO	0
From: SamplerFilter8:J5	

```

Mixer: RcvrPF_1:MXYRD
  LO: 1430 MHz
  Component -- LO1A:synthesizer
  Lower Sideband: IFo = 1430 - IFi
Filter: RcvrPF_1:FLYRD3
  Freq: 1040 to 1120 MHz
Filter: RcvrPF_1:FLYRD
  Freq: 960 to 1200 MHz
Attenuator: RcvrPF_1:ifChannelD
Output Port: RcvrPF_1:J4
Input Port: PF_IF_Conditioner:J4
Output Port: PF_IF_Conditioner:J8
Input Port: IFRouter:J23
Output Port: IFRouter:J67
Input Port: OpticalDriver3:J1
Attenuator: OpticalDriver3:attenuator
Output Port: OpticalDriver3:J2
Input Port: OpticalReceiver3:J1
Output Port: OpticalReceiver3:J5
Input Port: ConverterModule8:J1
Mixer: ConverterModule8:MX2
  LO: 13500 MHz
  Component -- LO2_G4:synthesizer
  Lower Sideband: IFo = 13500 - IFi
Filter: ConverterModule8:FL1
  Freq: 8500 to 10350 MHz
Mixer: ConverterModule8:MX3
  LO: 10500 MHz
  Component -- LO3Distribution1:synthesizer
  Lower Sideband: IFo = 10500 - IFi
Filter: ConverterModule8:FL2
  Freq: 0 to 2200 MHz
Attenuator: ConverterModule8:AT1
Output Port: ConverterModule8:J3
Input Port: SamplerFilter8:J1
Filter: SamplerFilter8:FL1
  Freq: 800 to 1600 MHz
Output Port: SamplerFilter8:J5
Input Port: Spectrometer:J8

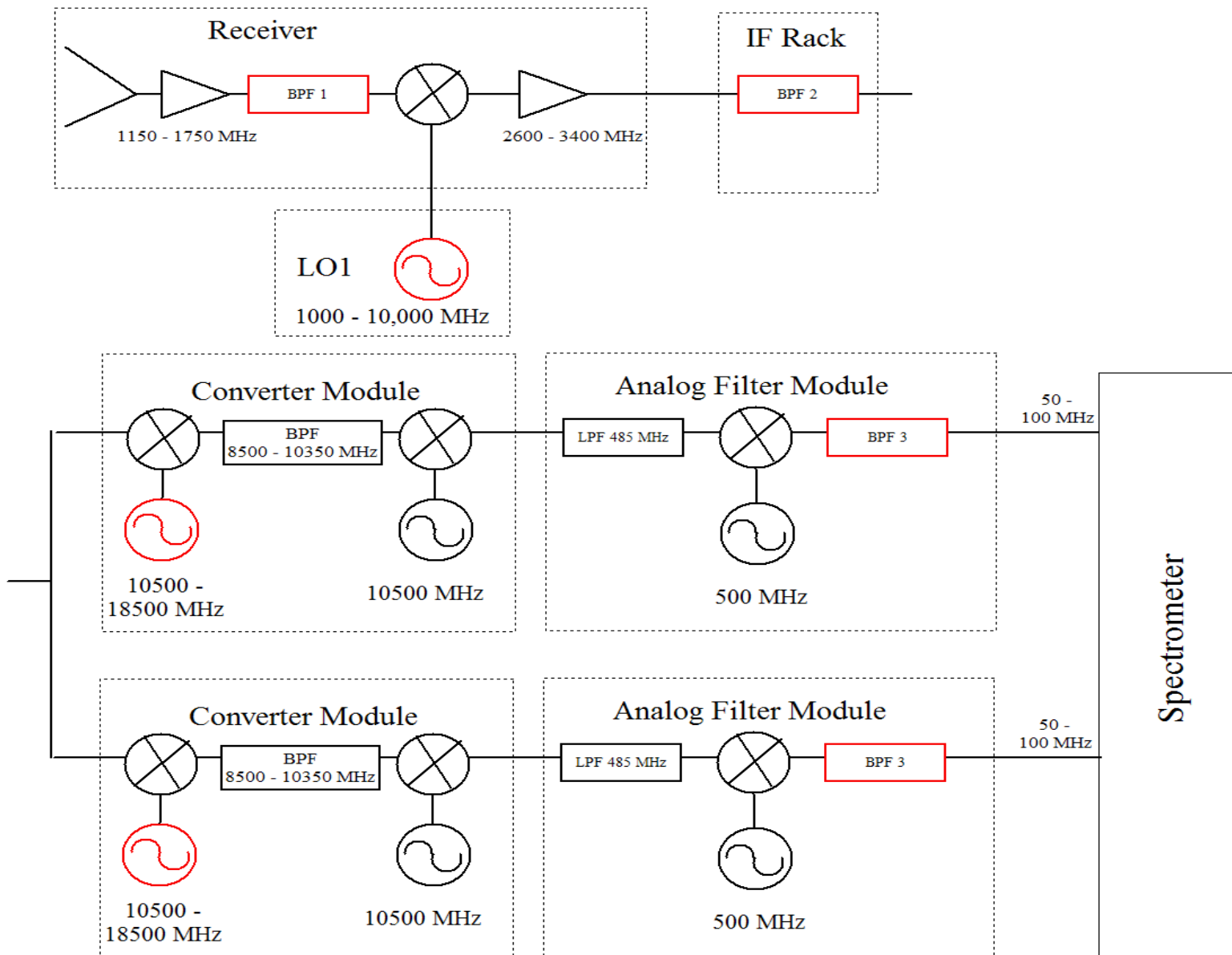
```

GBT – Astrid program does all the hard work for you.....

```
configLine = ""  
receiver = "Rcvr1_2"  
beam      = "B1"  
obstype  = "Spectroscopy"  
backend   = "Spectrometer"  
nwin     = 1  
restfreq  = 1420.4058  
deltafreq = 0  
bandwidth = 12.5  
swmode    = "tp"  
swtype    = "none"  
swper     = 1.0  
swfreq    = 0.0, 0.0  
tint      = 30
```

```
vlow      = 0  
vhigh     = 0  
vframe    = "lsrk"  
vdef      = "Radio"  
noisecal  = "lo"  
pol       = "Linear"  
nchan     = "low"  
spect.levels = 3  
""
```

Quiz 3: Determine values for red components



Quiz 3: Determine values for red components

- Goal : Observe simultaneously 1420 MHz and 1665 MHz with the 50 MHz mode of the Spectrometer
- Parameters:
 - BPF1 can be: 1100–1800, 1600-1750, 1300-1450, or 1100-1450 MHz
 - All mixers are LSB. Hint: first two mixers up convert, the last two down convert.
 - BPF2 can be : 2990-3010, 2960-3040, 2840-3160, 2360-3640, 5960-6040, 5840-6160, or 5360-6640 MHz
 - BPF3 can be : 50-100 or 25-37.5 MHz
 - See block diagram for other parameters
- Hint: Work from the receiver down the chain until you get stuck, then from Spectrometer up. Start with the results from Quiz 1.
- Record values for LO1 and both LO2's; settings for BPF1, 2, and 3; and values for all Intermediate Frequencies.