Tracing The Signal

Ron Maddalena
July 2011
Typical Components

- Amplifiers
- Mixers
- Attenuators
- Power Detectors
- Synthesizers

- Splitters
- Couplers
- Filters
- Switches
- Multipliers
Types of Filters

Edges are smoother than illustrated
Types of Mixers

- $n$ 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: $f_{LO} < f$

$f_{IF} = n*f_{LO} + m*f$
Example Switches

HIGH

LOW

CM1 Output
- All Pass
- 0.5-1.0 GHz
- All Pass
- LPF 550 MHz

J3: SamplerFilter1:J1
J4: VLBA_DAR:C
J9: Unk
J5: Spare

CFFilter
- 50-100 MHz
- 25-37.5 MHz
- Spare
- External

SI
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 Room
Typical Receiver

1.15 - 1.75 GHz
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

Diagram showing the relationship between Power In and Power Out, with a linear and a non-linear region.
Converter and Analog Filter Racks, Spectrometer
Converter Rack – Receivers for Optical Fibers, LO2 and LO3, Power Balancing Attenuators, Output Switches to Backends and AFR
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.
<table>
<thead>
<tr>
<th>L.O. 1</th>
<th>RECEIVERS</th>
<th>SPLITTERS</th>
<th>I.F. ROUTER</th>
<th>OPT. DRIVERS</th>
<th>OPT. RECEIVERS</th>
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<tbody>
<tr>
<td>LO1A</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>LO1B</td>
<td></td>
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<tr>
<td>LO1Router</td>
<td></td>
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**Graphical representation of cabling between OBT devices. Click...**
**Spectrum**

<table>
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<tr>
<th>Sideband</th>
<th>lower</th>
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<tr>
<td>IF</td>
<td>1200</td>
</tr>
<tr>
<td>Sky</td>
<td>-2770</td>
</tr>
<tr>
<td>Bandwidth</td>
<td>0</td>
</tr>
<tr>
<td>Polarization</td>
<td>linear_y</td>
</tr>
<tr>
<td>Noise Diode</td>
<td>lowCal</td>
</tr>
</tbody>
</table>

**Sinusoid**

| IF       | 0     |
| At LO    | 0     |

**Feed:** RcvrPF_1:YRD_342
- Freq: 270 to 420 MHz
- Polarization: linear_y
- Poln: 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:FLYRD03
- Freq: 1040 to 1120 MHz

**Filter:** RcvrPF_1:FLYRD
- Freq: 960 to 1200 MHz

**Attenuator:** RcvrPF_1:FLYRD atten

**Output Port:** RcvrPF_1:J4

**Input Port:** PF_IF_Connector:J4

**Input Port:** IFRouter:J23

**Input Port:** IFRouter:J67

**Input Port:** OpticalDriver3:J1

**Attenuator:** OpticalDriver3:atten

**Output Port:** OpticalDriver3:J2

**Input Port:** OpticalReceiver3:J1

**Output Port:** OpticalReceiver3:J5

**Mixer:** ConverterModule8:MX2
- LO: 13500 MHz
  - Component -- LO2_04: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.....

```python
cfgLine = ""
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.