IF Downconverter

Travis Newton
LO/IF Engineer

IF Downconverter

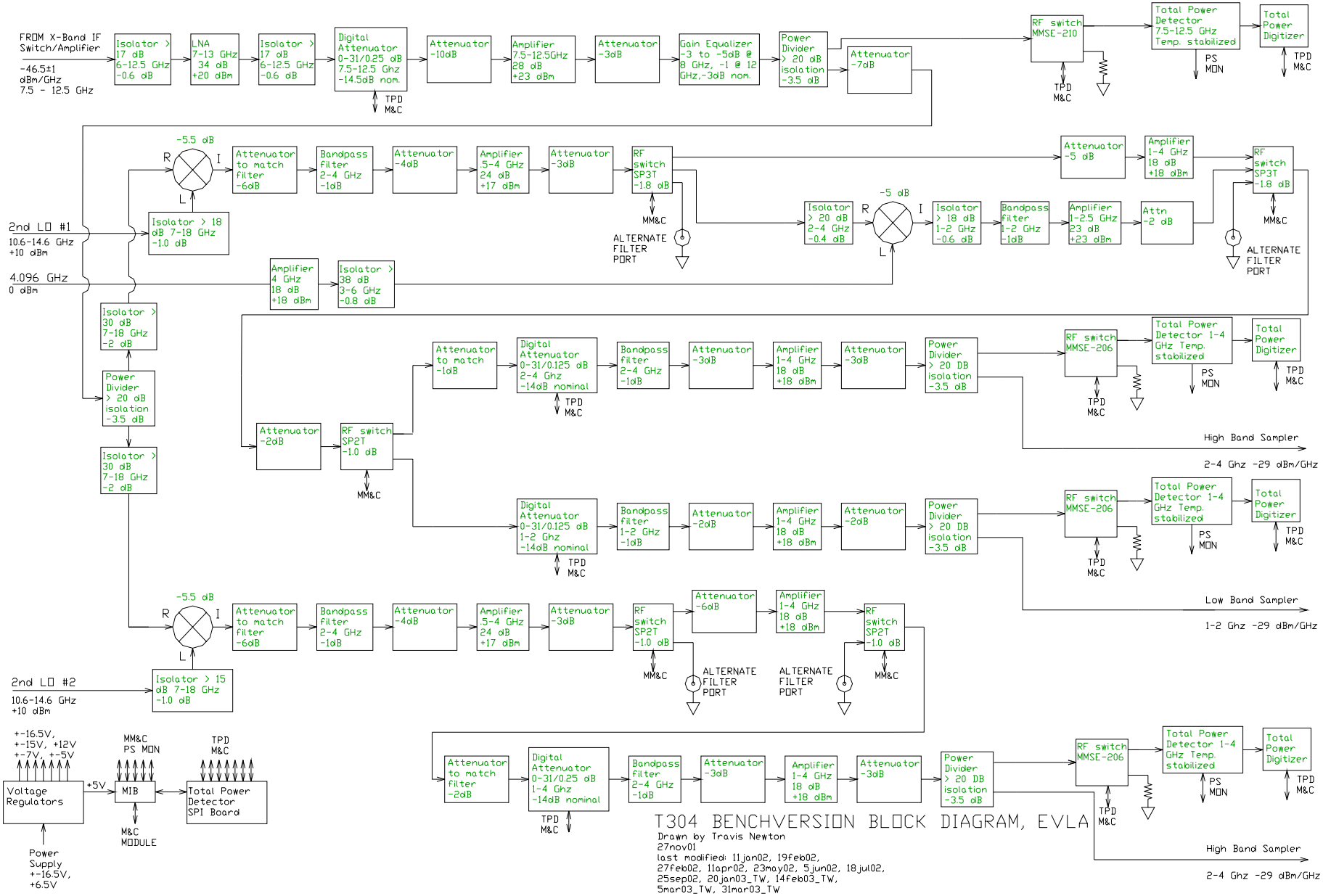
- -Converts 8-12 GHz IF to two 2-4 GHz baseband IF's for 3-bit, 4GHz sampling
- -Converts 8-12 GHz IF to one 1-2 GHz baseband IF's for 8-bit, 2GHz sampling

IF Downconverter

- Connectorized Version: Bench Unit, First Light Unit, First Test Antenna Units (Antenna 13). ~$32,000/ea
- Integrated Version: Surface Mount design reducing size, cost, power, heat load. ~$9000/ea

IF Downconverter

- Connectorized Version

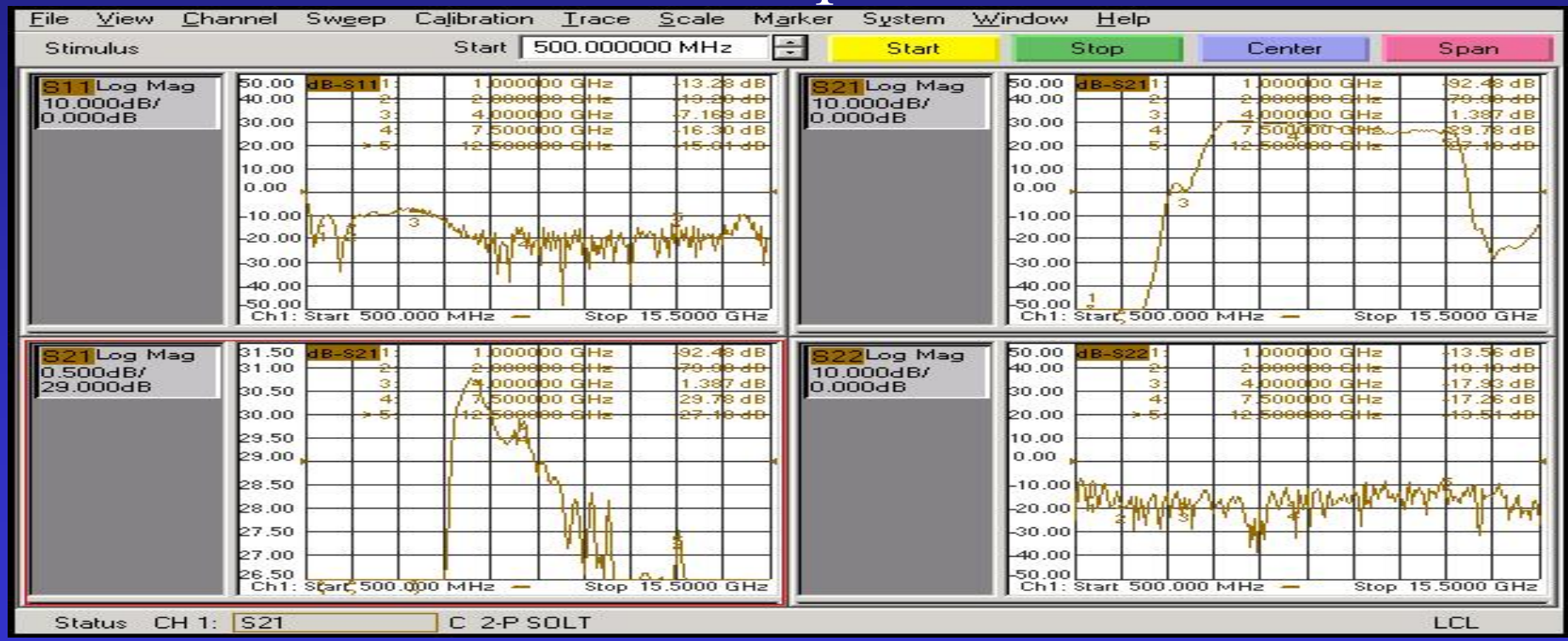

FROM X-Band IF Switch/Amplifier
-46.5±1 dBm/GHz 7.5 - 12.5 GHz
Isolator > 17 dB 6-12.5 GHz -0.6 dB
LNA 7-13 GHz 34 dB +20 dBm
Isolator > 17 dB 6-12.5 GHz -0.6 dB
Digital Attenuator 0-31/0.25 dB 7.5-12.5 Ghz -14.5dB nom.
TPD M&C
Attenuator -10dB
Amplifier 7.5-12.5GHz 28 dB +23 dBm
Attenuator -3dB
Gain Equalizer -3 to -5dB @ 8 GHz, -1 @ 12 GHz,-3dB nom.
Power Divider > 20 dB isolation -3.5 dB
Attenuator -7dB
RF switch MMSE-210
TPD M&C
Total Power Detector 7.5-12.5 GHz Temp. stabilized
PS MON
Total Power Digitizer
TPD M&C
-5.5 dB
R
I
L
Attenuator to match Filter -6dB
Bandpass filter 2-4 GHz -1dB
Attenuator -4dB
Amplifier 5-4 GHz 24 dB +17 dBm
Attenuator -3dB
RF switch SP3T -1.8 dB
MM&C
ALTERNATE FILTER PORT
Attenuator -5 dB
Amplifier 1-4 GHz 18 dB +18 dBm
RF switch SP3T -1.8 dB
MM&C
ALTERNATE FILTER PORT
2nd LO #1
10.6-14.6 GHz +10 dBm
Isolator > 18 dB 7-18 GHz -1.0 dB
-5 dB
Isolator > 20 dB 2-4 GHz -0.4 dB
Isolator > 18 dB 1-2 GHz -0.6 dB
Bandpass filter 1-2 GHz -1dB
Amplifier 1-2.5 GHz 23 dB +23 dBm
Attn -2 dB
4.096 GHz
0 dBm
Amplifier 4 GHz 18 dB +18 dBm
Isolator > 38 dB 3-6 GHz -0.8 dB
Isolator > 30 dB 7-18 GHz -2 dB
Power Divider > 20 dB isolation -3.5 dB
Isolator > 30 dB 7-18 GHz -2 dB
Attenuator to match -1dB
Digital Attenuator 0-31/0.125 dB 2-4 Ghz -14dB nominal
TPD M&C
Bandpass filter 2-4 GHz -1dB
Attenuator -3dB
Amplifier 1-4 GHz 18 dB +18 dBm
Attenuator -3dB
Power Divider > 20 DB isolation -3.5 dB
RF switch MMSE-206
TPD M&C
Total Power Detector 1-4 GHz Temp. stabilized
PS MON
Total Power Digitizer
TPD M&C
High Band Sampler
2-4 Ghz -29 dBm/GHz
Attenuator -2dB
RF switch SP2T -1.0 dB
MM&C
Digital Attenuator 0-31/0.125 dB 1-2 Ghz -14dB nominal
TPD M&C
Bandpass filter 1-2 GHz -1dB
Attenuator -2dB
Amplifier 1-4 GHz 18 dB +18 dBm
Attenuator -2dB
Power Divider > 20 DB isolation -3.5 dB
RF switch MMSE-206
TPD M&C
Total Power Detector 1-4 GHz Temp. stabilized
PS MON
Total Power Digitizer
TPD M&C
Low Band Sampler
1-2 Ghz -29 dBm/GHz
-5.5 dB
R
I
L
Attenuator to match Filter -6dB
Bandpass filter 2-4 GHz -1dB
Attenuator -4dB
Amplifier 5-4 GHz 24 dB +17 dBm
Attenuator -3dB
RF switch SP2T -1.0 dB
MM&C
Attenuator -6dB
ALTERNATE FILTER PORT
Amplifier 1-4 GHz 18 dB +18 dBm
RF switch SP2T -1.0 dB
ALTERNATE FILTER PORT
MM&C
2nd LO #2
10.6-14.6 GHz +10 dBm
Isolator > 15 dB 7-18 GHz -1.0 dB
+-16.5V, +-15V, +12V +-7V, +-5V
Voltage Regulators
+5V
MM&C PS MON
MIB
M&C MODULE
TPD M&C
Total Power Detector SPI Board
Power Supply +-16.5V, +6.5V
Attenuator to match Filter -2dB
Digital Attenuator 0-31/0.25 dB 1-4 Ghz -14dB nominal
TPD M&C
Bandpass filter 2-4 GHz -1dB
Attenuator -3dB
Amplifier 1-4 GHz 18 dB +18 dBm
Attenuator -3dB
Power Divider > 20 DB isolation -3.5 dB
RF switch MMSE-206
TPD M&C
Total Power Detector 1-4 GHz Temp. stabilized
PS MON
Total Power Digitizer
TPD M&C
High Band Sampler
2-4 Ghz -29 dBm/GHz
T304 BENCHVERSION BLOCK DIAGRAM, EVLA
Drawn by Travis Newton
27nov01
last modified: 11jan02, 19feb02, 27feb02, 11apr02, 23may02, 5jun02, 18jul02, 25sep02, 20jan03_TW, 14feb03_TW, 5mar03_TW, 31mar03_TW

IF Downconverter

- Connectorized: Variable Attenuators
- .125 dB LSB, 32.875 dB max
- +/- 6° phase shift with attenuation
- 13° phase shift with temp. change (10° - 30°C) (2 GHz)
- (.162 ° shift over .25 °C, .333 ° allowed)
- $1800 ea. X 4/module

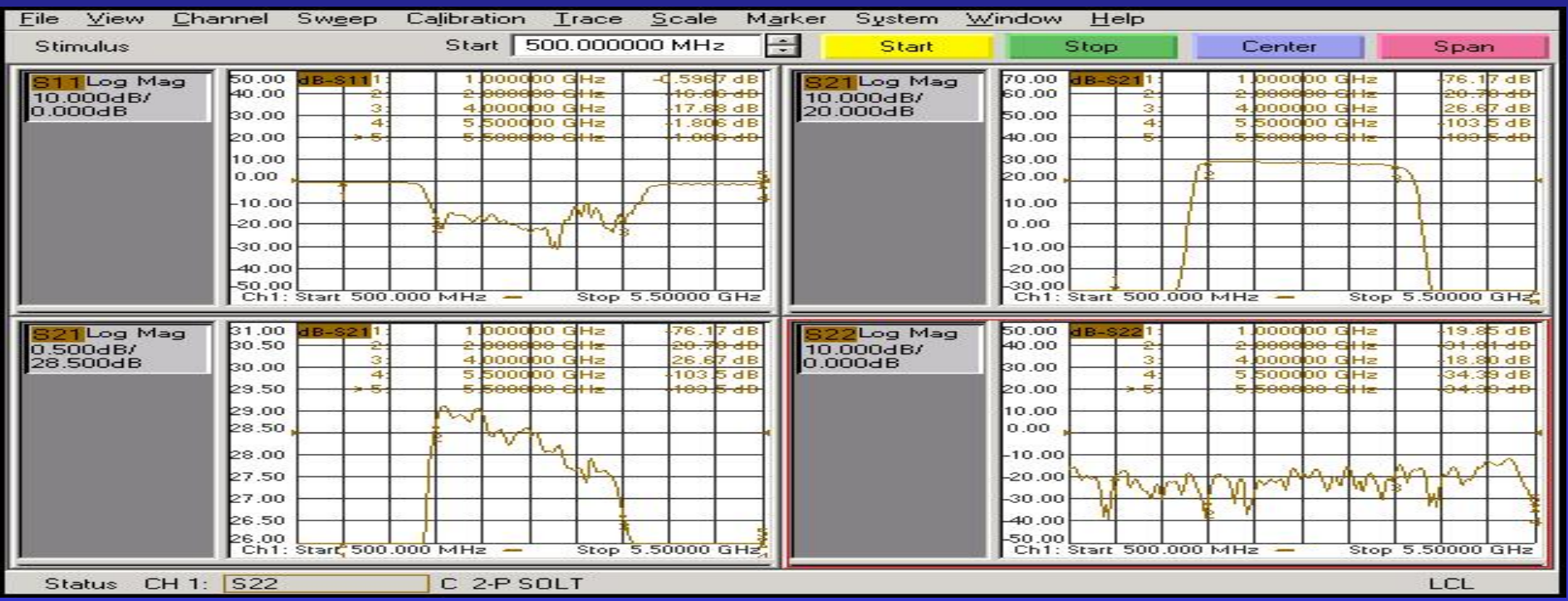
IF Downconverter

- Connectorized: RF Response



IF Downconverter

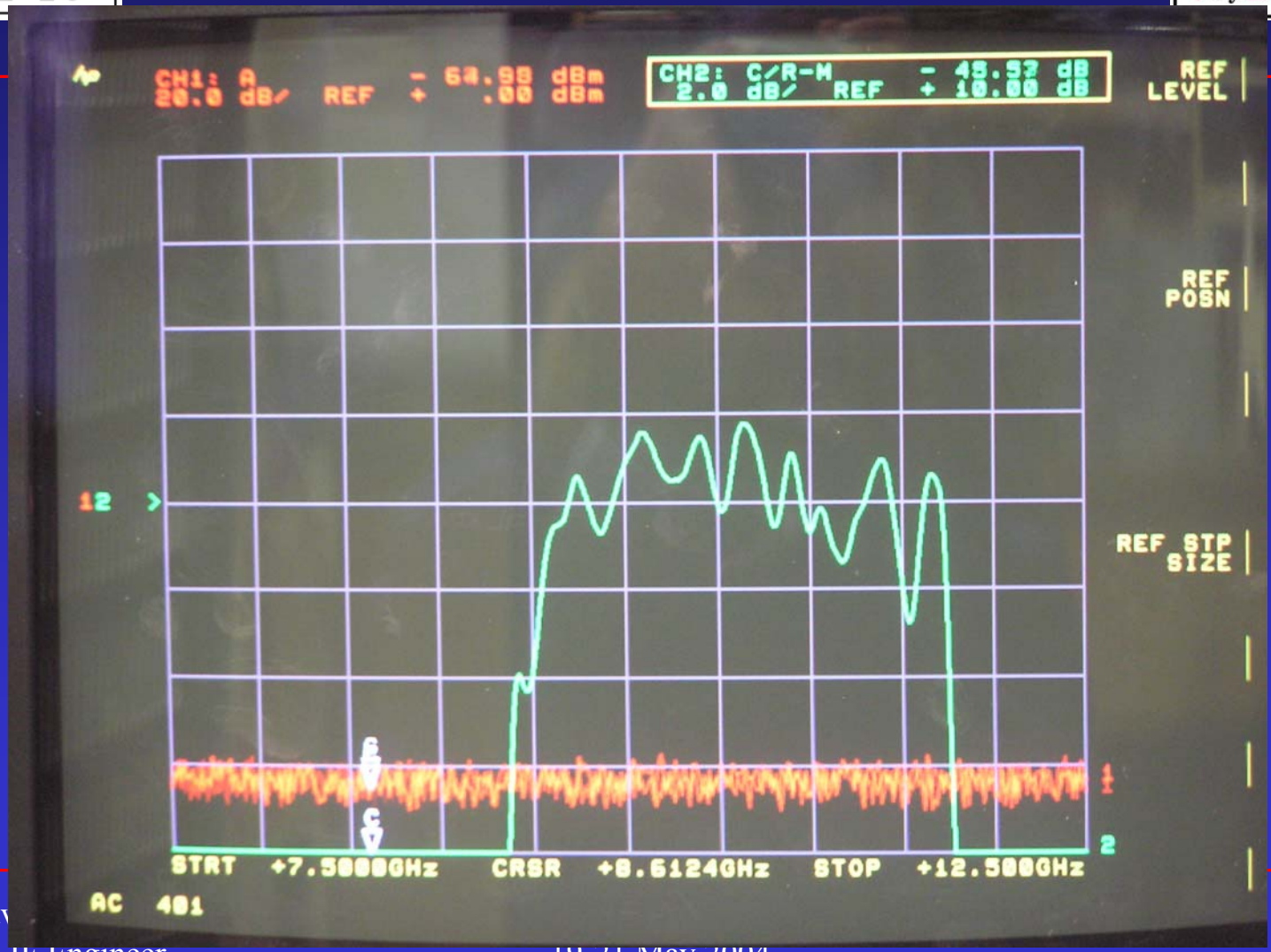
- Connectorized: IF Response



IF Downconverter

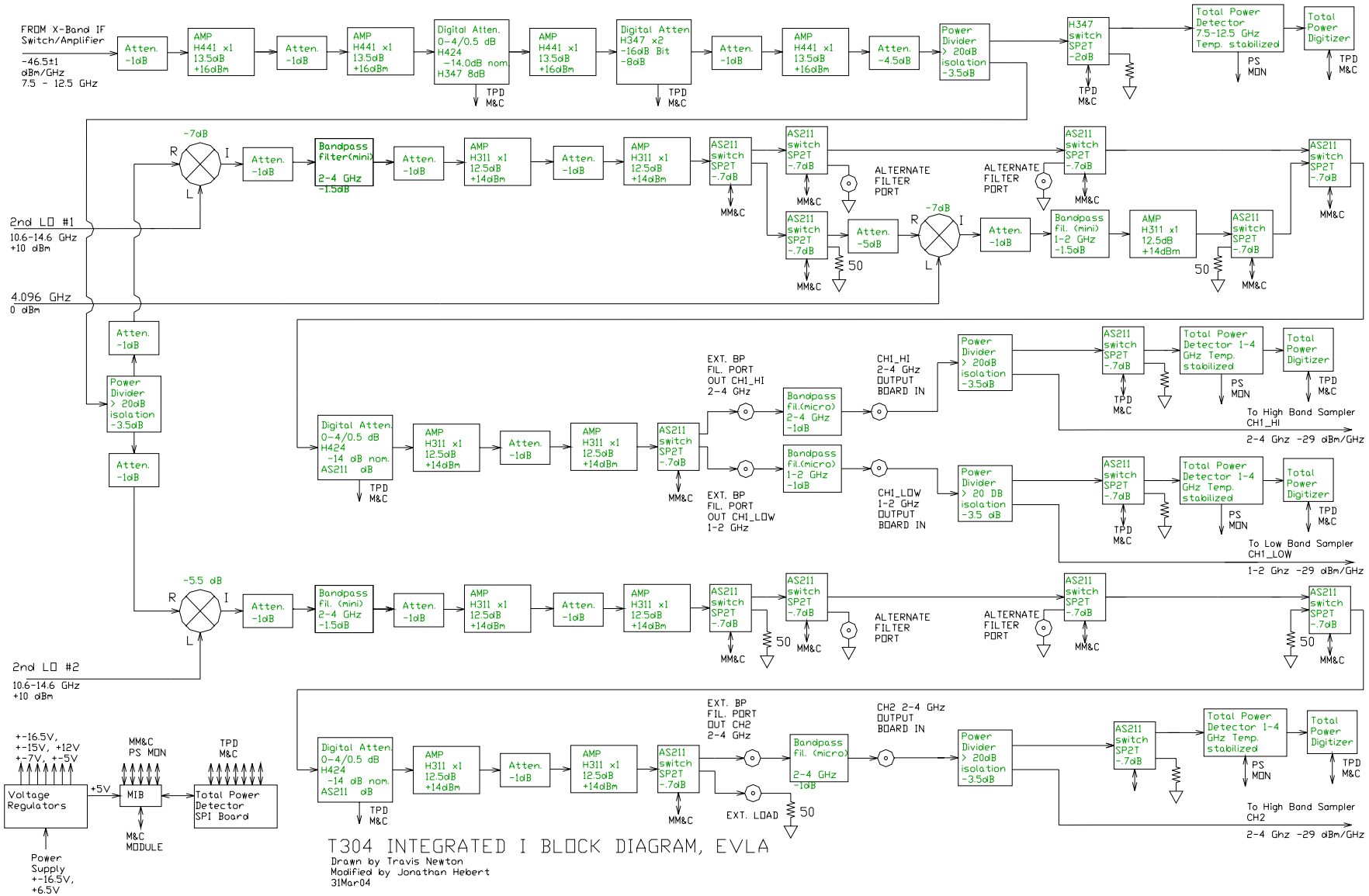
- Connectorized
- Full System, Frequency Translated Response

IF Downconverter



IF Downconverter

- Integrated Version


FROM X-Band IF Switch/Amplifier
-46.5±1 dBm/GHz 7.5 - 12.5 GHz
Atten. -1dB
AMP H441 x1 13.5dB +16dBm
Digital Atten. 0-4/0.5 dB H424 -14.0dB nom H347 8dB
Digital Atten H347 x2 -16dB Bit -8dB
Power Divider > 20dB isolation -3.5dB
H347 switch SP2T -2dB
Total Power Detector 7.5-12.5 GHz Temp. stabilized
Total Power Digitizer
TPD M&C
PS MON
2nd LO #1
10.6-14.6 GHz +10 dBm
4.096 GHz
0 dBm
-7dB
Bandpass filter(mini) 2-4 GHz -1.5dB
AS211 switch SP2T -.7dB
MM&C
ALTERNATE FILTER PORT
Atten. -5dB
50
Bandpass fil. (mini) 1-2 GHz -1.5dB
AMP H311 x1 12.5dB +14dBm
Digital Atten. 0-4/0.5 dB H424 -14 dB nom. AS211 dB
EXT. BP FIL. PORT OUT CH1_HI 2-4 GHz
Bandpass fil.(micro) 2-4 GHz -1dB
CH1_HI 2-4 GHz OUTPUT BOARD IN
To High Band Sampler CH1_HI
2-4 Ghz -29 dBm/GHz
EXT. BP FIL. PORT OUT CH1_LOW 1-2 GHz
Bandpass fil.(micro) 1-2 GHz -1dB
CH1_LOW 1-2 GHz OUTPUT BOARD IN
Power Divider > 20 DB isolation -3.5 dB
Total Power Detector 1-4 GHz Temp. stabilized
To Low Band Sampler CH1_LOW
1-2 Ghz -29 dBm/GHz
-5.5 dB
2nd LO #2
10.6-14.6 GHz +10 dBm
EXT. BP FIL. PORT OUT CH2 2-4 GHz
CH2 2-4 GHz OUTPUT BOARD IN
EXT. LOAD
To High Band Sampler CH2
2-4 Ghz -29 dBm/GHz
+-16.5V, +-15V, +12V +-7V, +-5V
Voltage Regulators
+5V
MIB
M&C MODULE
Total Power Detector SPI Board
Power Supply +-16.5V, +6.5V
T304 INTEGRATED I BLOCK DIAGRAM, EVLA
Drawn by Travis Newton
Modified by Jonathan Hebert
31Mar04

IF Downconverter

- Rogers 4003
- 3.38 Er, +40 ppm/°C
- Tan δ 0.0022
- CTEz 46 ppm/°C CTEx,y 14 ppm/°C
- Standard FR-4 PCB processing/soldering

IF Downconverter

- Integrated
- Hittite Microwave Corp. Surface Mount Digital Attenuators, Switches, Amplifiers
- Skyworks Inc. Surface Mount Switches
- Miteq Surface Mount Mixers
- Southwest Microwave connectors

IF Downconverter

- Integrated: Variable Attenuators
- 1 dB LSB, 31 dB max
- +/- 6° phase shift with attenuation
- 0.5° phase shift with temp. change (10° - 30°C) (2 GHz)
- (.0062 ° shift over .25 °C, .333 ° allowed)
- < $200 ea. X 3/module

IF Downconverter

- Integrated: Filters (Microtronics)
- Integrated ceramic for mixer IF output
- Packaged 2-4 GHz output and TPD with 40 dB, 60 dB rejection at BW+/- 32 MHz, +/-64 MHz
- Delay matched: < 10° across 80% centered BW
- Phase Linearity: < +/- 40° across any 2 GHz
- Phase Δ w/ Temp: <20° across BW

IF Downconverter

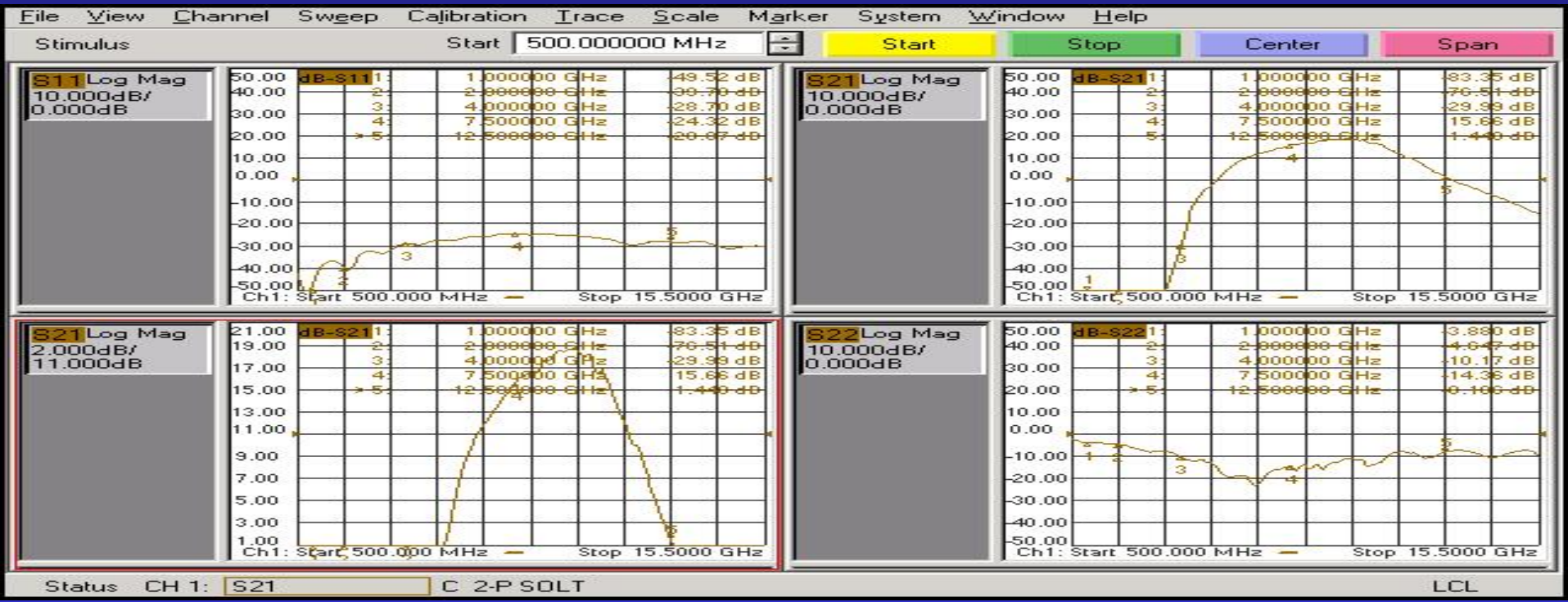
- Integrated: Filters (Microtronics)
- Integrated ceramic for mixer IF output
- Packaged 1-2 GHz output and TPD with 40 dB, 60 dB rejection at BW+/- 64 MHz, +/-128 MHz
- Delay matched: < 10° across 80% centered BW
- Phase Linearity: < +/- 40° across BW
- Phase Δ w/ Temp: <20° across BW

IF Downconverter

- Integrated: Total Power Detector
- Integrated Detector Diode and amplifier (NRAO, ACC Tunnel Diode Detector)
- 2ms sampled
- Servo Attenuators closed or open loop
- Total Power Digitizer: 4 channel, 4 chip selects from MIB

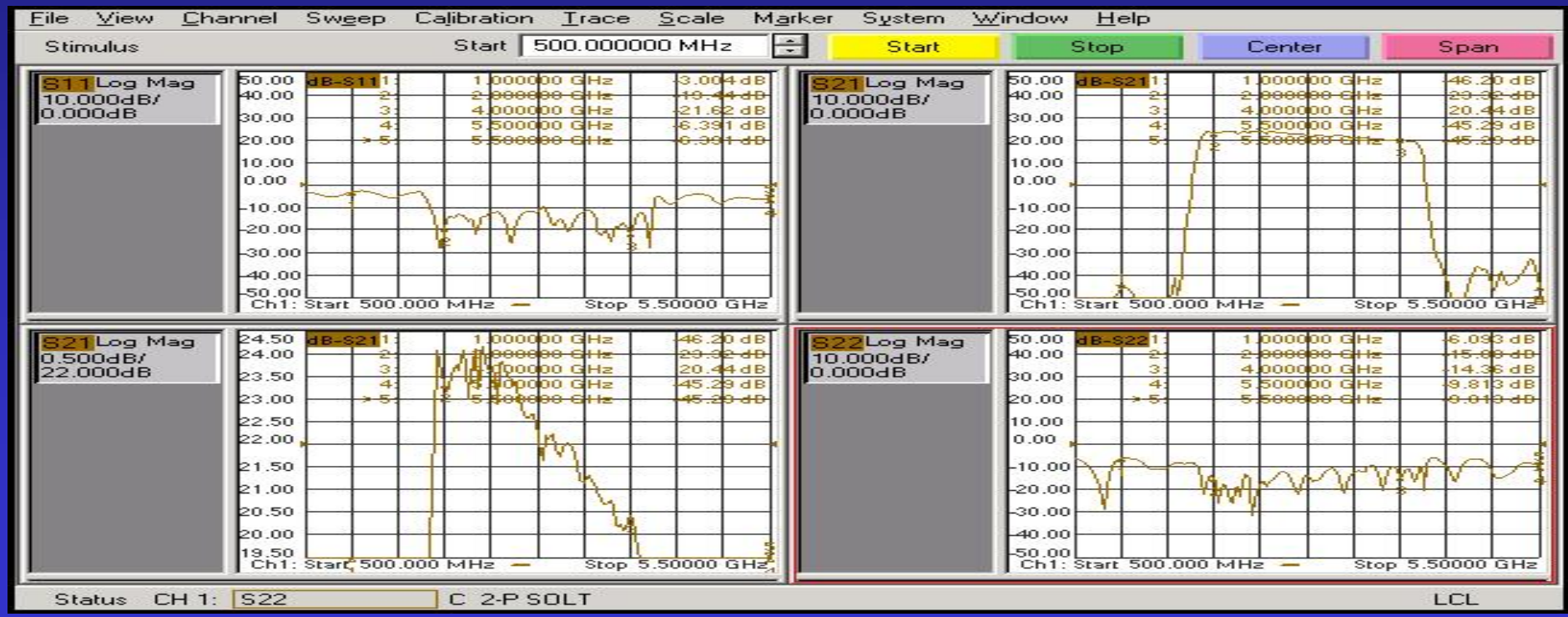
IF Downconverter

- Integrated Prototype: RF Response



IF Downconverter

- Integrated Prototype: IF Response



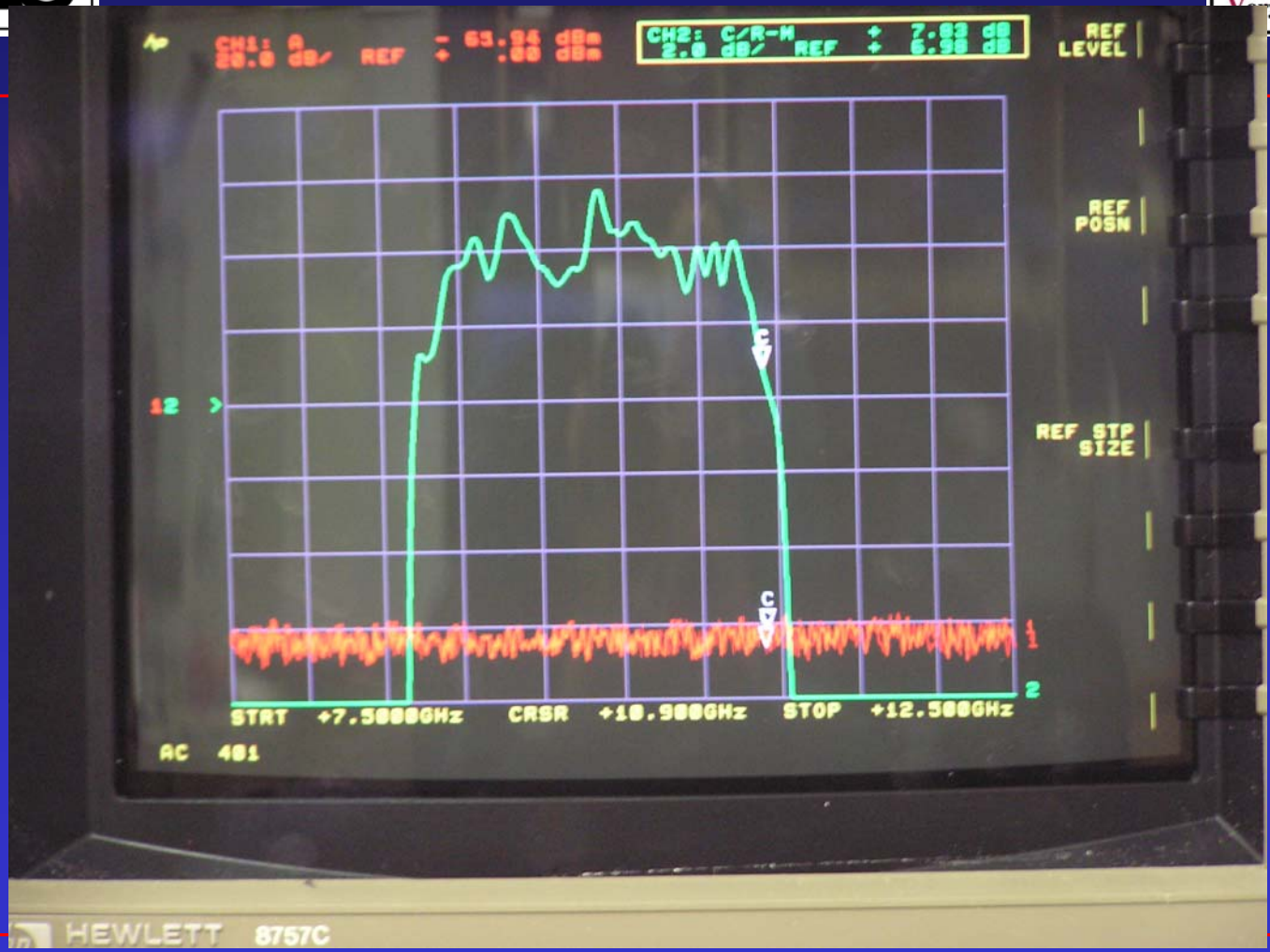
IF Downconverter

- Integrated: Passband Slope
- Physically long circuit (24”) due to printed filters, new version < 8”
- Investigation of RF amplifier with sloped gain response
- Surface mount equalizer chips

IF Downconverter

- Integrated
- Full System, Frequency Translated Response

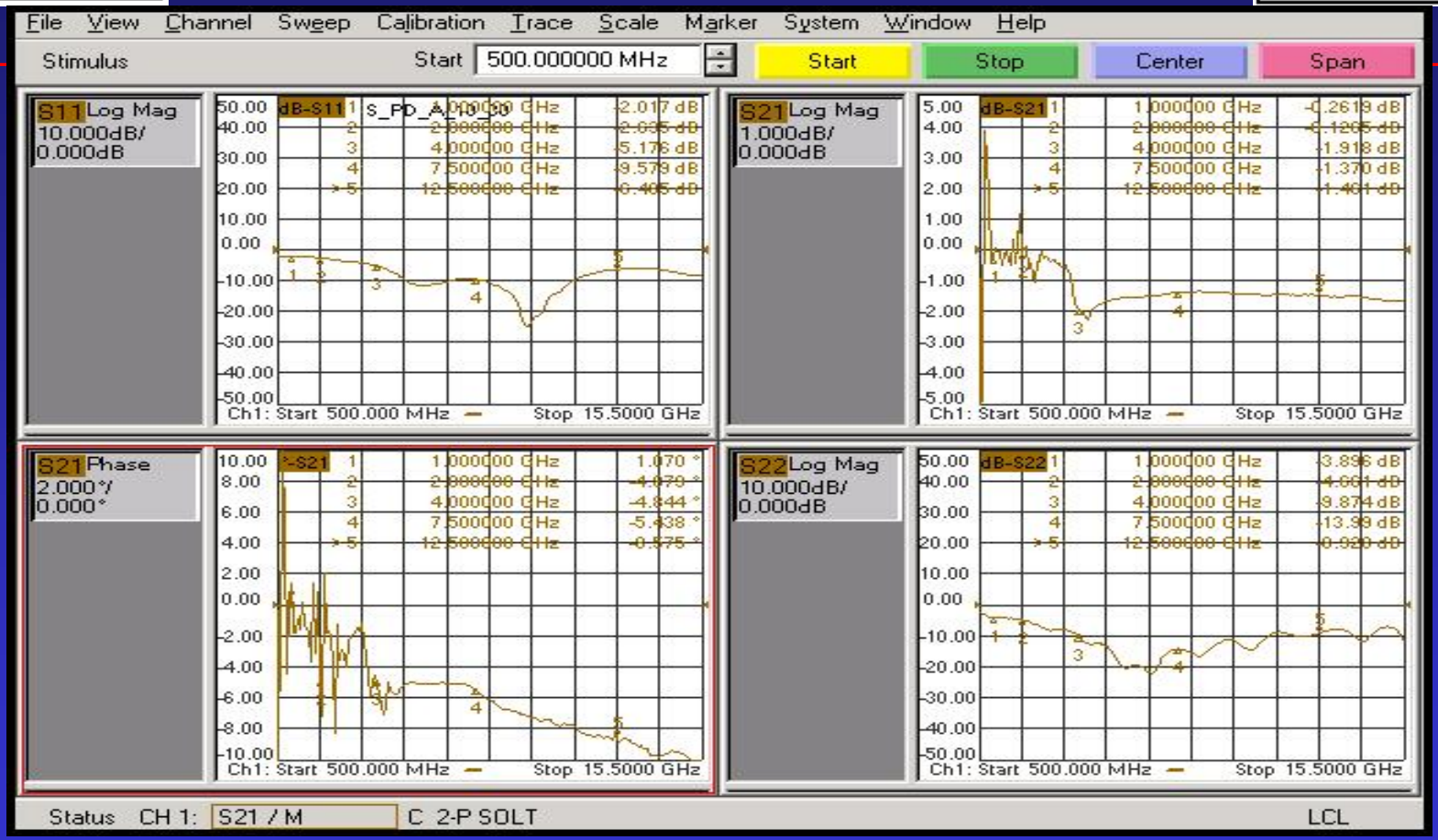
IF Downconverter



IF Downconverter

- Integrated
- RF X-Band Section, Phase and Amplitude change with Temperature (10°C – 30 ° C)

IF Downconverter



IF Downconverter

- 1/3 ° phase change vs .25 ° C temp. change in 30 min allowed for T304 (2 GHz)
- 2 ° phase change vs .25 ° C temp. change in 30 min allowed for T304 (12 GHz)
- RF section shows .1 ° phase change over this delta at 12 GHz, IF expected similar.