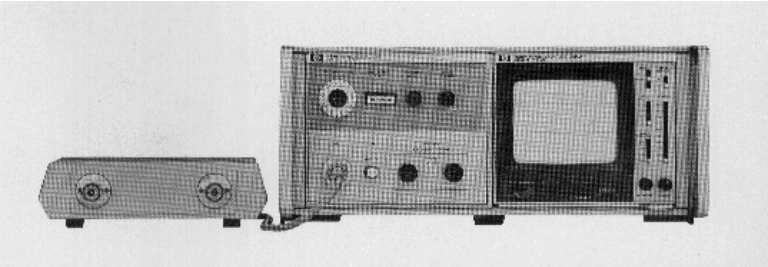
Owning and Operating the HP 8410



Network Analyzer

Mark Kahrs, KB2VSQ
9 Everitt Place
Maplewood, NJ 07040
(kahrs@caip.rutgers.edu)
http://www.caip.rutgers.edu/~kahrs

Outline

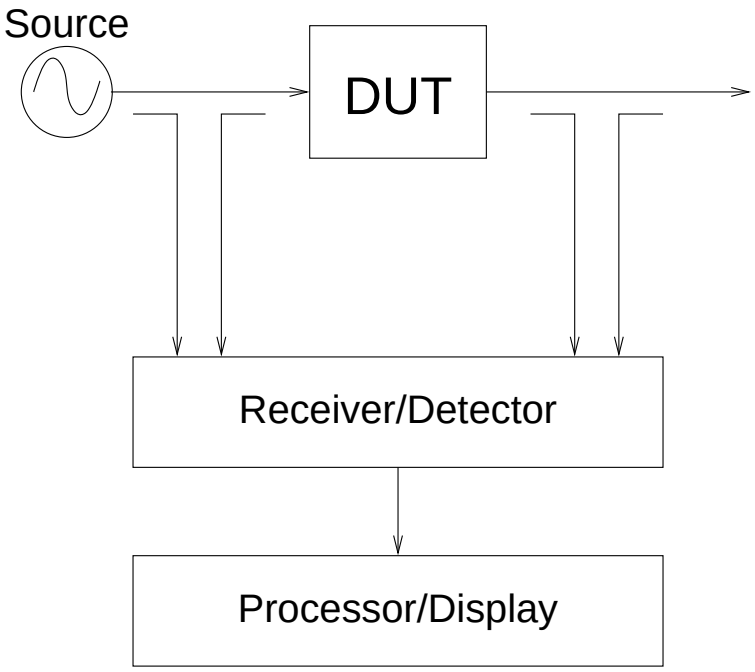
1. Introduction
2. Principles of operation
3. The 8410 receiver
4. The 8411A harmonic converter
5. The display units
6. The test sets
7. Auxiliary & Historical units
8. Automation
9. Errors & Calibration
10. Extensions
11. Conclusion

Introduction

- Why network analysis?
  - Measure *ratioed* amplitude and phase
  - Derive S-parameters
- Why the 8410?
  - Cheap
  - Only choice above 6 GHz

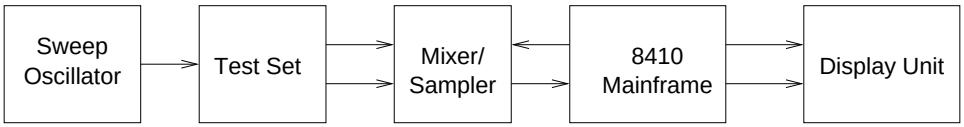
Model	Freq. Range	Std. Source	
8407A	0.001-0.110	8601A	Uses 8410 plugins
8410ABC	.11-18	8620C	
8505A	0.0005-1.3	internal	8501A normalizer
8510ABC	0.045-26	8341A	The gold standard
8712ABC	0.0003-3	internal	production use
8720ABCD	0.045-26	internal	"Improved" version of 8510A
8753ABCD	0.003-3	internal	
8754A	0.004-1.3	internal	

Principles of operation



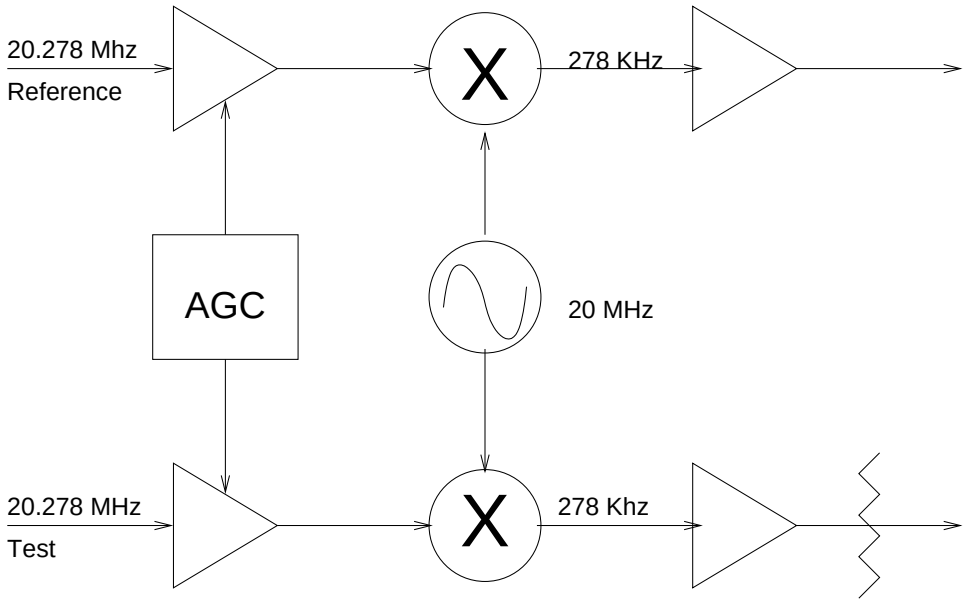
- Broadband swept source
- Signal separation
- Receiver / Detector
- Processor / Display

The 8410 System



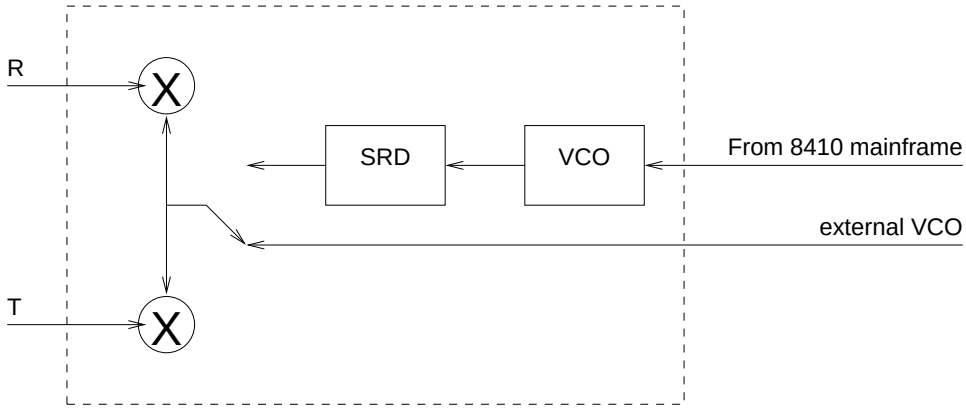
- External sweep oscillator (like 8620)
- Test set
  - Divides power: Test and Ref
  - Test goes thru DUT
  - Two channels to 8411
- 8411A (or mixer) downconverts to 1st IF
- 8410 downconverts again to 2nd IF
- Display Units detect

The 8410 Receiver



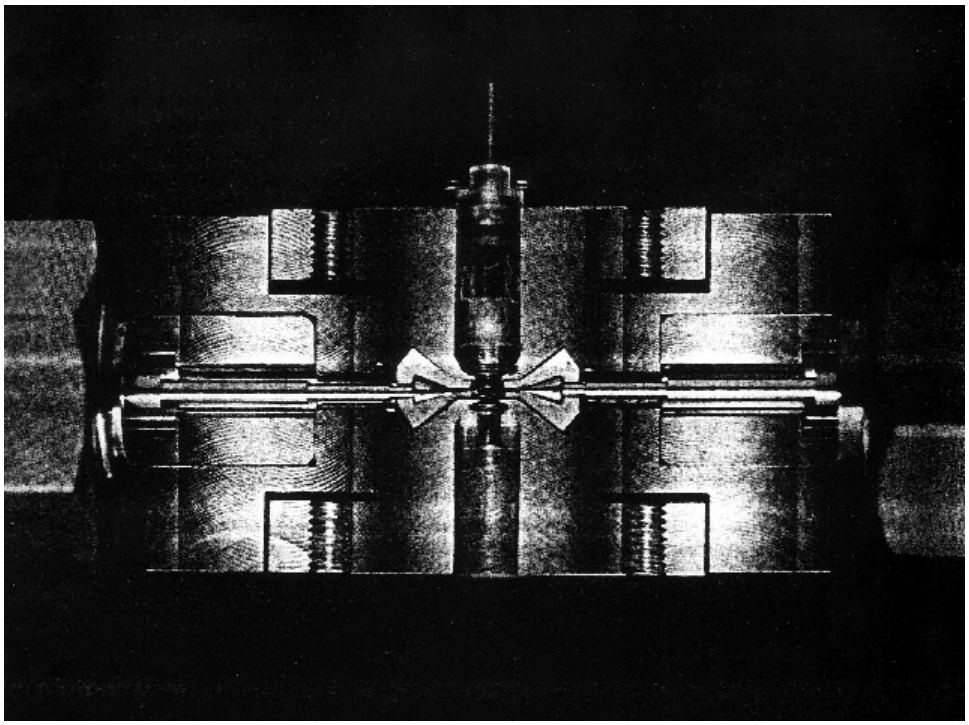
- AGC controls gain on reference channel
- 2nd mixer downconverts to 278 KHz
- 20 KHz postfilter

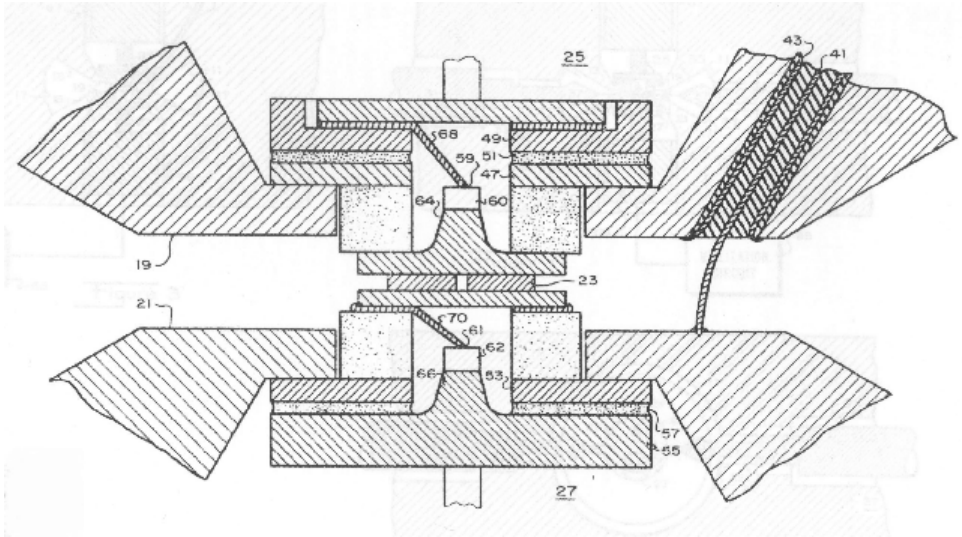
The 8411 Harmonic Converter



- Driven by SRD
- Internal VCO drives SRD
- Switch and VCO controlled by 8410
- Earlier versions lack external VCO input
- Later versions have option 18

Grove's sampler





Display Units

- 8412A/B Phase-Magnitude display
  - Synchronous detection for Magnitude
  - Rectangular display
  - B option connects to 8750A
- 8413A Phase-Magnitude indicator
- 8414A/B Polar Display
  - cos/sin detectors
  - Smith chart overlays

Reflection/Transmission Test sets

- Power out of one port *only*
- One directional coupler
- Coaxial one direction:
  - Reflection: 8740A
  - Transmission: 8741A,8742A
- Coaxial two directions: 8743A/B, 85040A
- Waveguide: 8747A
  - Four versions: X,P,R,K
  - R and K require external CW oscillator
  - V band also described

S parameter test sets

- Power out of either port
- Two directional couplers
- 8745A
  - Low frequency (0.11 to 2 GHz)
  - Matches 11600A,11601A transistor fixtures
- 8746A
  - Higher frequency (2 to 12.4/18 GHz)
  - Matches 11608A transistor fixture

Auxilary & Historical Units

- 8418A auxiliary power unit
  - Has 70 dB attenuator and power supply
- 8419A,B,C interface
  - Early A/D converter for HP 2100 computer
- 8709A synchronizer
  - Duplicates 8410 phase lock loop
  - Locks sweep osc. to ext. IF
- 8717A bias power supply
  - Used for biasing active devices

- 8750A storage normalizer
  - Connects to 8412B
- 8327A switch
  - Switch between 8745A and 8746A
  - Band control of 8690A sweeper
- 8705A multiplexor and 8707A RF unit holder
  - 8690A BWO plugins
- 8710A tracking “filter”
  - Tracks 5105A synthesizer output

Automation

- Why automate?
  - CAD
  - Eliminate fixtures and test sets ("de-embedding")
  - Redisplay output
  - Store calibration
- How to automate
  - Use 8419ABC
  - Use a 59313A A/D converter
  - PC interface

De-embedding & Error correction

- Instrument errors
- Test set/Connection errors
  - Directivity
  - Source match
  - Frequency tracking
- 8 term/12 term error model
- n equations — n unknowns

Operating: 8410 problems

- Harmonic skipping

  Ex: 5GHz is 40*125 Mhz or 50*100 Mhz

  - Use an *external* IF synthesizer (60 to 150 MHz)

  - Use 8709A to lock sweeper to synth

- Control of sweep oscillator (8510 has complete control over 488)

Calibration

- Manual lists 37 items
- Need many coaxial adaptors
- Need specialized components
  (short, load, sliding load, attenuators,
  airline)

Extensions: External mixer
(instead of 8411A)

- Changes
  - Requires external CW oscillator
  - Mixers should be matched
  - Direct connection to 8410
- Advantages
  - Sensitive to -110 dBm
  - Can have lower conversion loss
  - Any band covered by CW source

Conclusions

- What choice do we have?
- Many parts, many lessons
- Versatile, comprehendable
- Cheap!

The End.