Dual Polarization Calibration
L3 – Baron Services Design for the WSR-88D

NEXRAD TAC Meeting
November 2009

Rich Ice

Overview

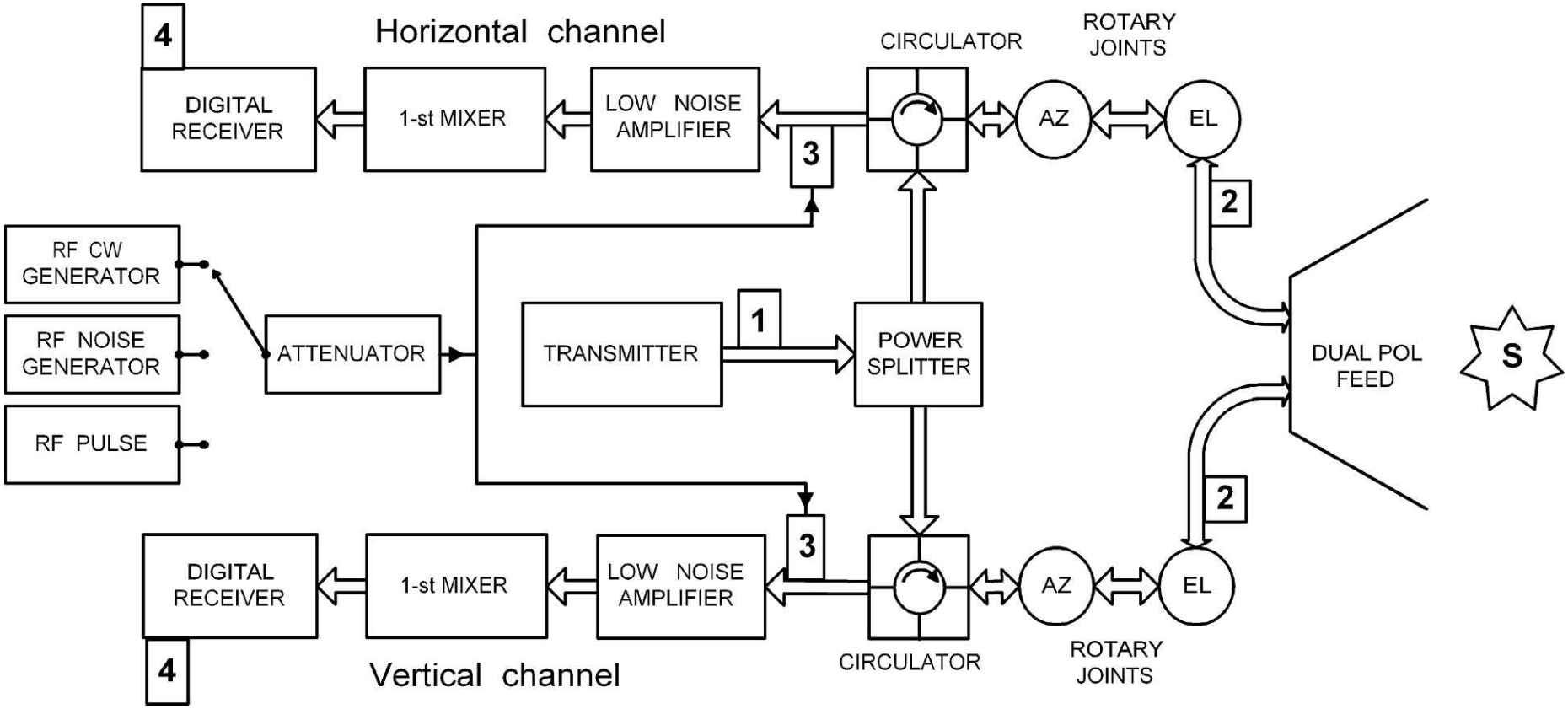
- Review Calibration System Approach
  - Based on PDR, CDR, and Contractor Documents
  - Baron Services Calibration and Uncertainty Analysis revised 9/11/2009
- Changes Since CDR
  - remove vertex feed
  - added low noise amplifiers to RF Pallet
- Calibration Functions
  - Z calibration, ZDR calibration, System Initial Phase
- Today's Approach
  - Present Functional Diagrams

Basic Concepts

Calibrating Differential Reflectivity on the WSR-88D

DUSAN S. ZRNIC
NOAA/National Severe Storms Laboratory, Norman, Oklahoma
VALERY M. MELNIKOV AND JOHN K. CARTER
Cooperative Institute for Mesoscale Meteorological Studies, University of Oklahoma, and NOAA/OAR/National Severe Storms Laboratory, Norman, Oklahoma

JOURNAL OF ATMOSPHERIC AND OCEANIC TECHNOLOGY VOLUME 23



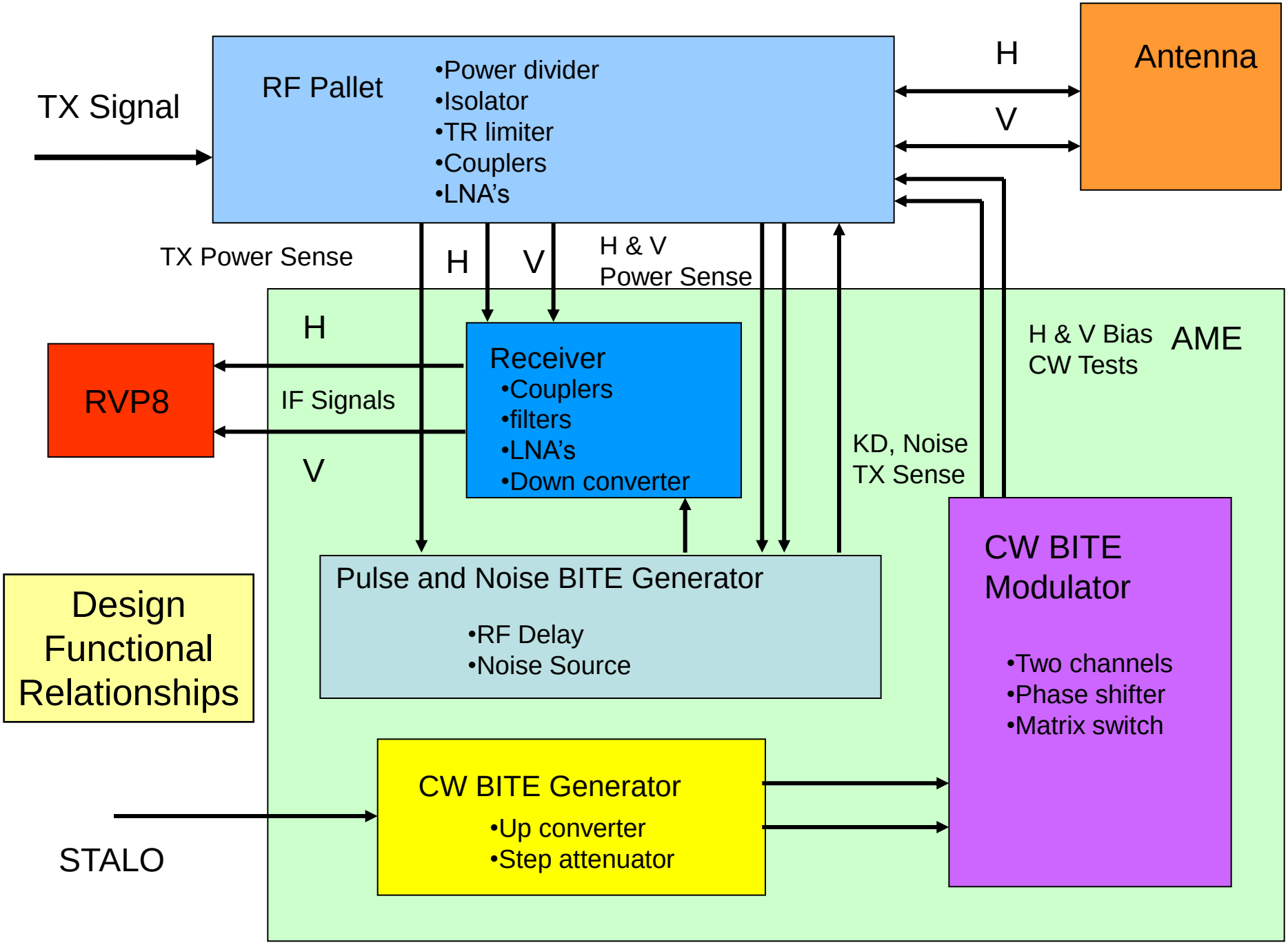
Approach is considered an “Engineering Calibration” supplemented by solar scans

Similar to methods used by NSSL on the KOUN Radar, but highly automated

Some highlights: Test signal switching, including a matrix switch, phase shifting, ‘ZDR Control’, Variable Phase power divider, TX input and divided power sensing

From L3 – Baron PDR Material

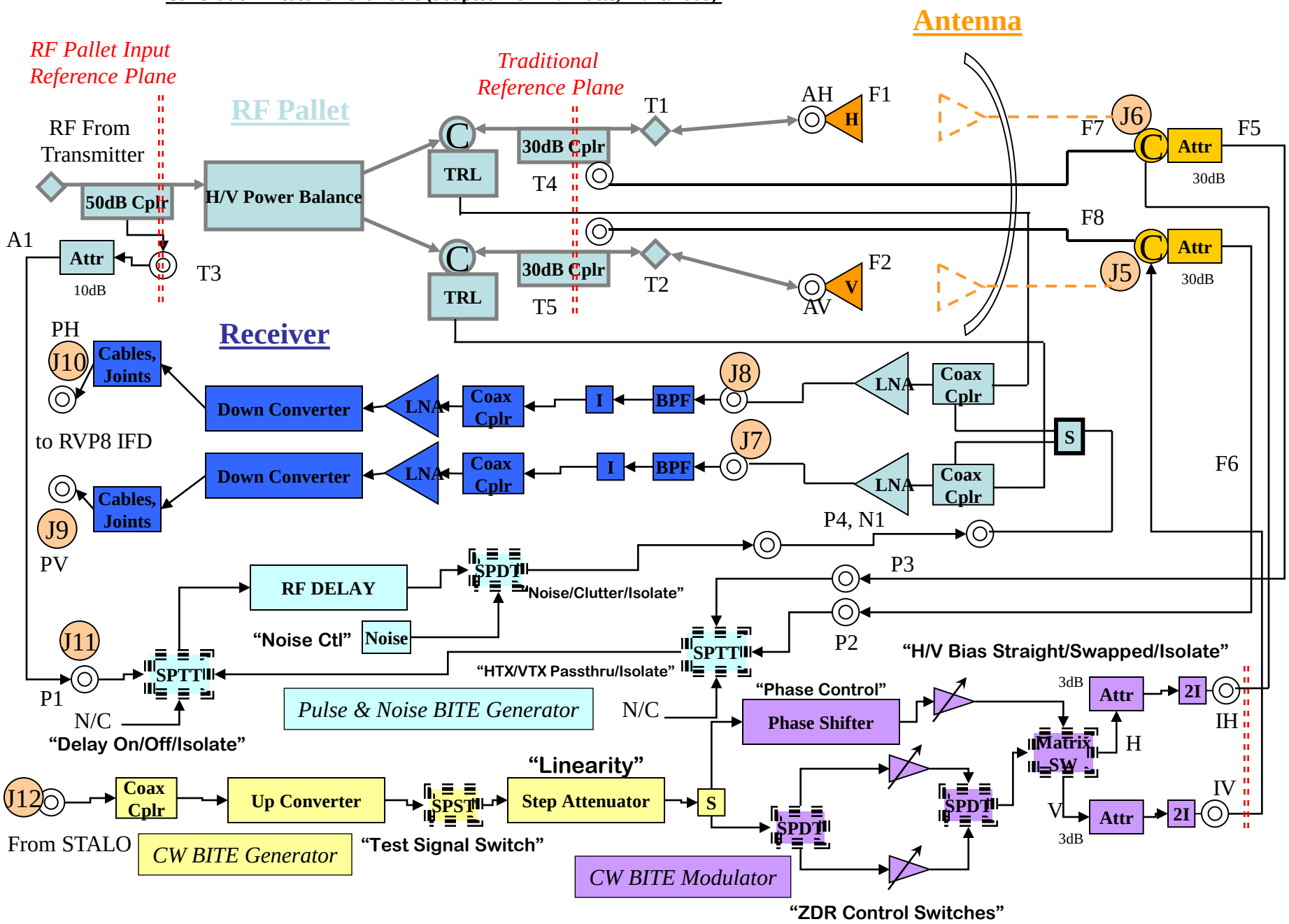
- NEXRAD Calibrations
  - The initial Dual Pol calibrations are sun check and test signal bias check to determine the imbalance in the test signal.
- Sun Check
  - Used to check initial receiver imbalance
    - This is used for the test signal bias check.
  - Performance Check
- Test Signal Bias
  - Used to calculate imbalance in CW test signal
  - First, read both H and V channels at IFD and calculate difference
  - Reverse test signal, and take another reading.
  - Using previous two readings, calculate imbalance in the CW test signal.

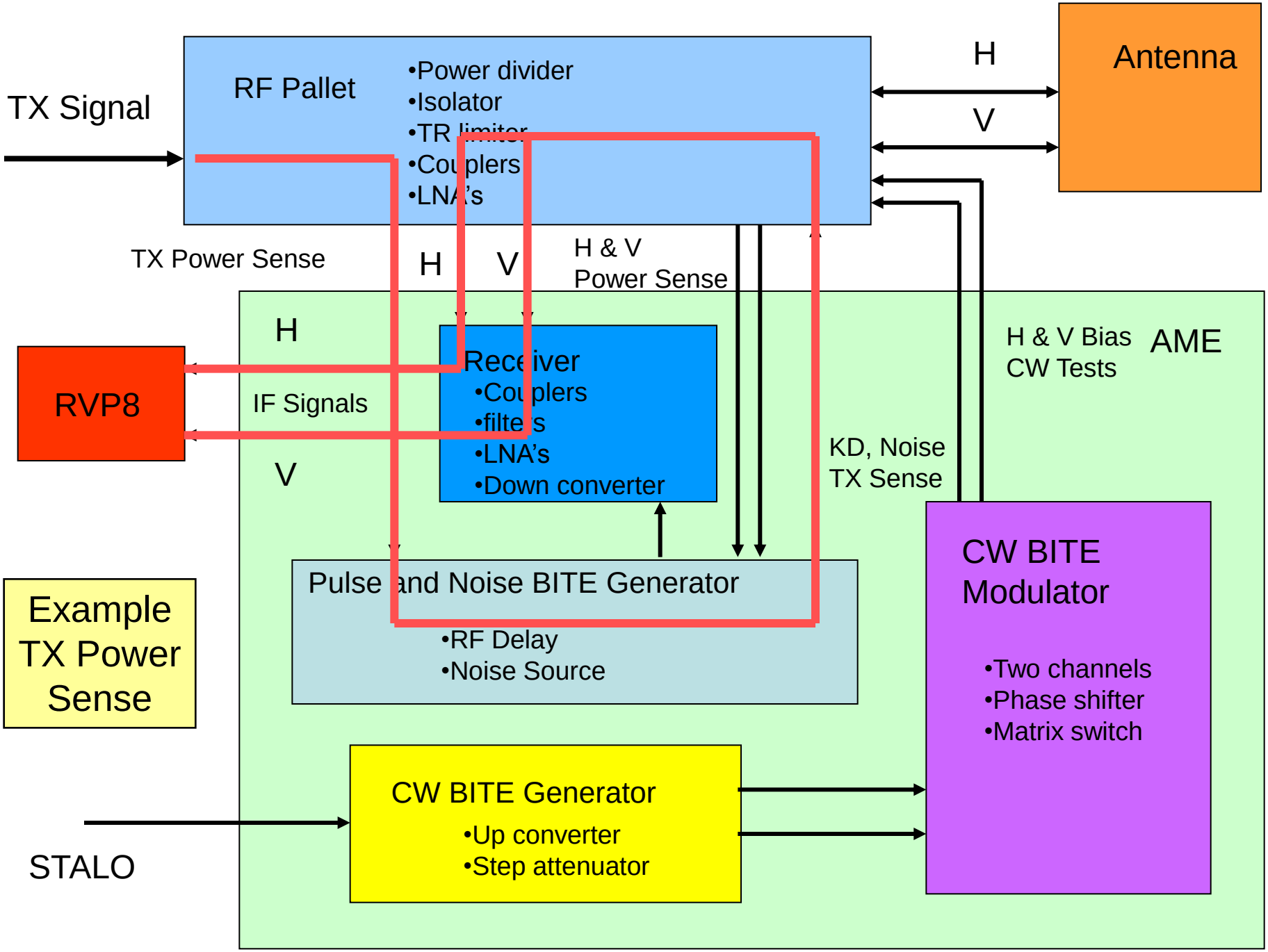

TX Signal
RF Pallet
•Power divider
•Isolator
•TR limiter
•Couplers
•LNA's
H
V
Antenna
TX Power Sense
H
V
H & V
Power Sense
H
RVP8
IF Signals
V
Receiver
•Couplers
•filters
•LNA's
•Down converter
H & V Bias
CW Tests
AME
KD, Noise
TX Sense
Pulse and Noise BITE Generator
•RF Delay
•Noise Source
CW BITE
Modulator
•Two channels
•Phase shifter
•Matrix switch
Design
Functional
Relationships
CW BITE Generator
•Up converter
•Step attenuator
STALO

From L3 – Baron PDR Material:

- AME Essential Element for:
  - Noise Level Calibration
  - Noise Temperature Check
  - Fast linearity Calibration
  - Dynamic Range
  - Clutter Suppression Test
  - Full linearity Calibration
  - Complex Spectrum
  - Spectrum Width and Velocity Check
  - Existing Receiver tests
    - Klystron RF
    - RF Driver
    - STALO RF

- ZDR Calibration
  - Measure H vs V transmitter imbalance using the AME transmit power sense.
  - Inject CW test signal into test feed.
  - Measure Zdr at signal processor and correct for test signal imbalance
    - Result is receiver imbalance
  - Add transmitter imbalance to receiver imbalance to get ZDR Offset.


Calibration Measurement Paths (adapted from F. Pratte, 12/16/2008)
Antenna
RF Pallet Input Reference Plane
Traditional Reference Plane
RF Pallet
RF From Transmitter
50dB Cplr
H/V Power Balance
TRL
30dB Cplr
T1
T4
T2
T5
T3
AH
H
F1
AV
V
F2
F7
J6
Attr
30dB
F5
F8
J5
A1
Attr
10dB
Receiver
PH
J10
Cables, Joints
Down Converter
LNA
Coax Cplr
I
BPF
J8
J7
to RVP8 IFD
PV
J9
F6
P4, N1
S
P3
P2
RF DELAY
SPDT
"Noise/Clutter/Isolate"
"Noise Ctl"
Noise
J11
SPTT
"HTX/VTX Passthru/Isolate"
"H/V Bias Straight/Swapped/Isolate"
P1
N/C
"Delay On/Off/Isolate"
Pulse & Noise BITE Generator
"Phase Control"
Phase Shifter
3dB
2I
IH
Matrix SW
H
IV
V
"Linearity"
J12
From STALO
Up Converter
SPST
Step Attenuator
CW BITE Generator
"Test Signal Switch"
CW BITE Modulator
"ZDR Control Switches"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•Couplers
•LNA's
H
V
Antenna
TX Power Sense
H
V
H & V
Power Sense
H
RVP8
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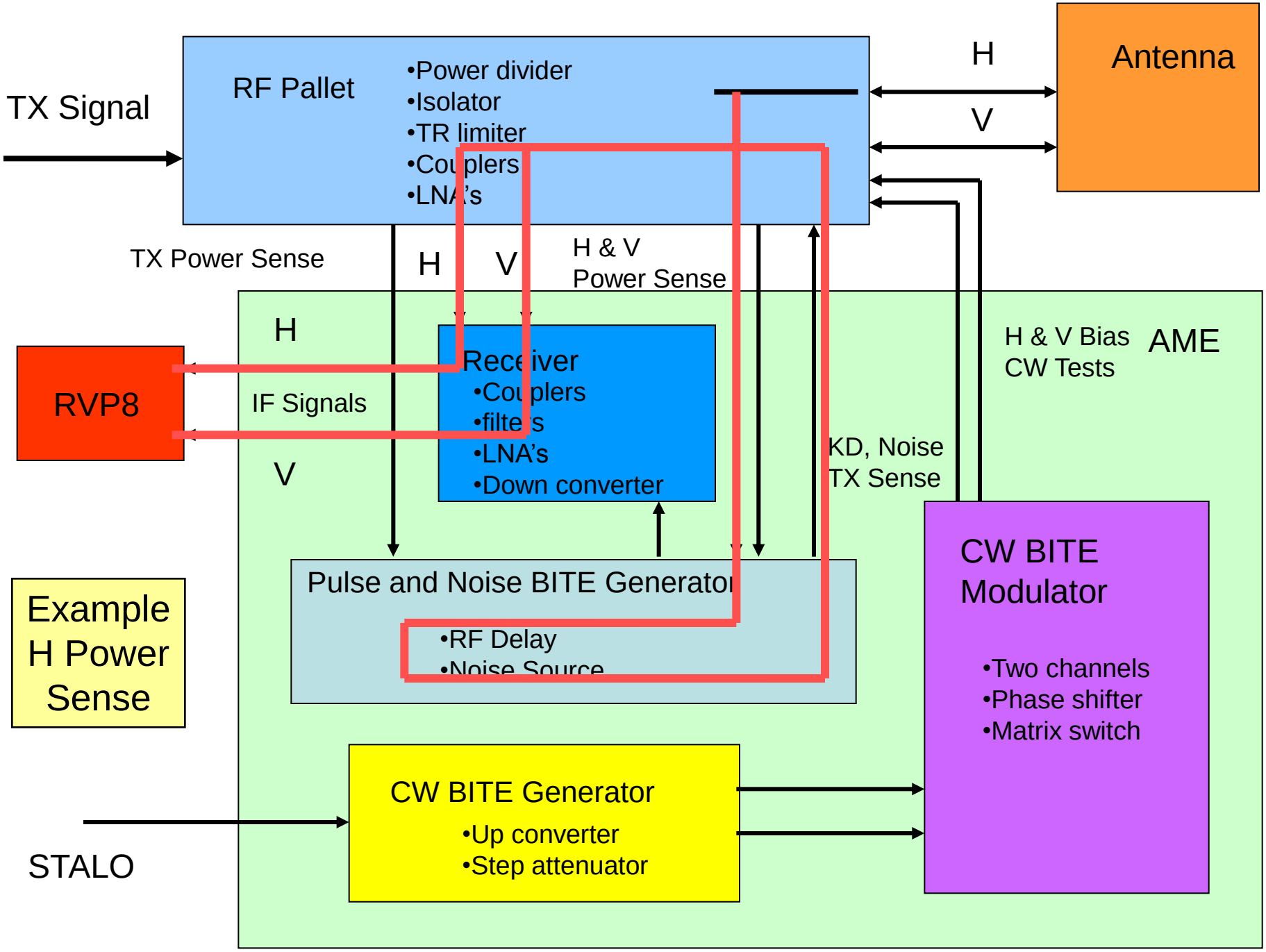
•Down converter
H & V Bias
CW Tests
AME
KD, Noise
TX Sense
Pulse and Noise BITE Generator
•RF Delay
•Noise Source
CW BITE
Modulator
•Two channels
•Phase shifter
•Matrix switch
Example
TX Power
Sense
CW BITE Generator
•Up converter
•Step attenuator
STALO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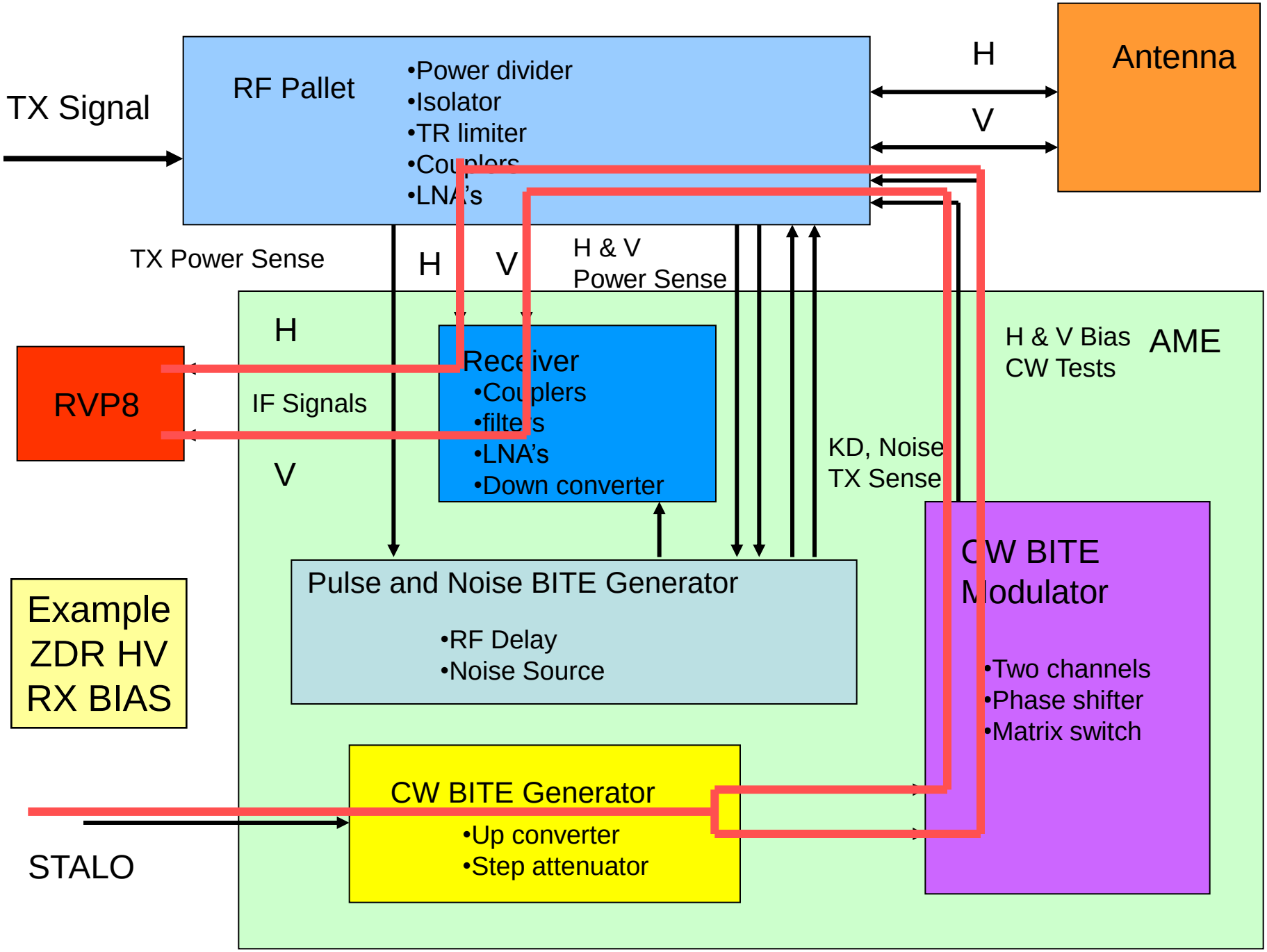
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Example
ZDR HV
RX BIAS
CW BITE Generator
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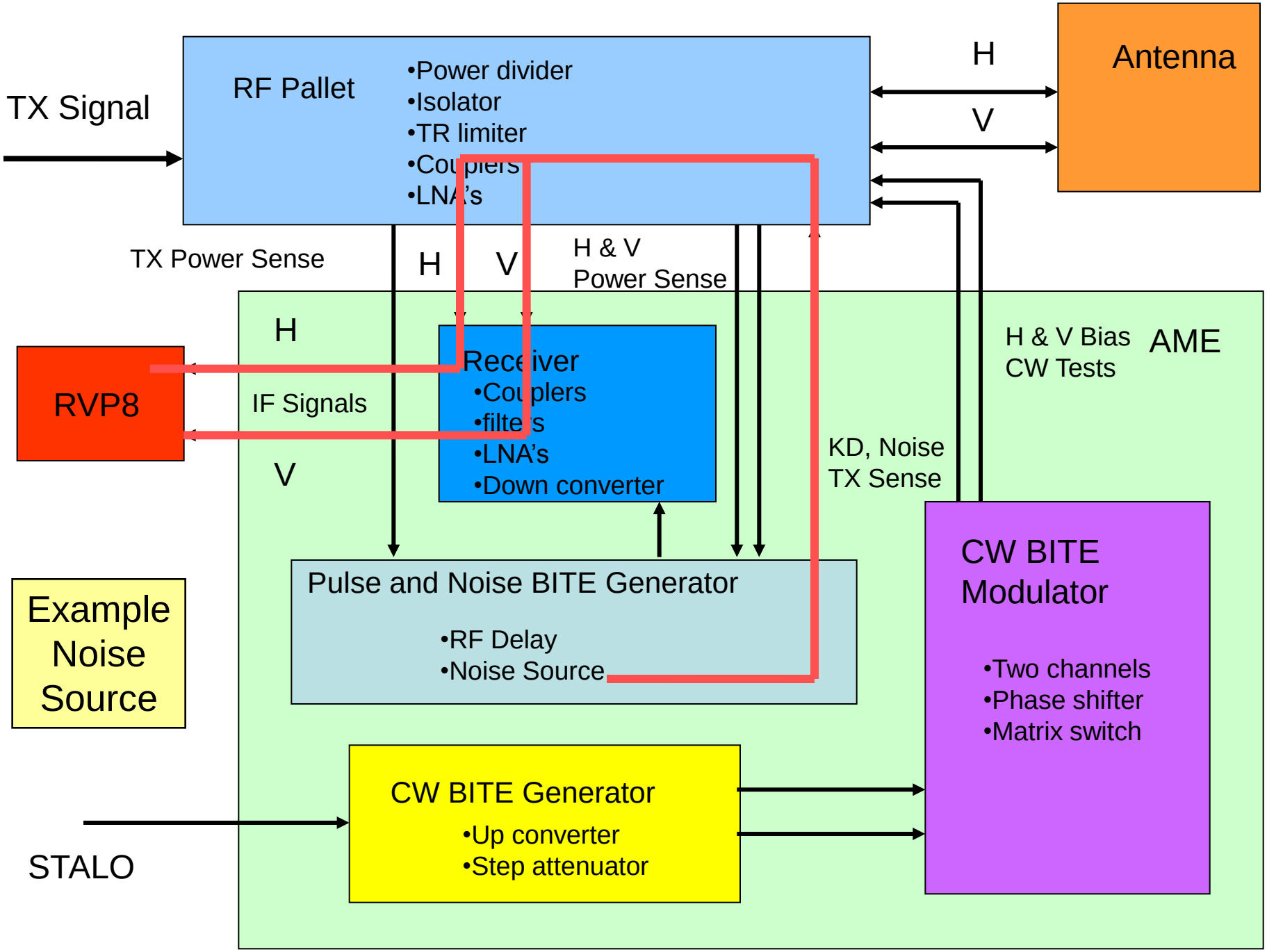
•Step attenuator
STALO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Example
Noise
Source
CW BITE Generator
•Up converter
•Step attenuator
STALO

Summary of L3 - Baron Approach

- Some elements “Factory Calibrated”, meaning paths measured with calibrated power meters
- Some paths calibrated using a noise source (tracable to NIST)
- Z calibration essentially same as WSR-88D, determine dBZo and ensure the receiver is linear
- ZDR calibration accomplished via combination of solar scans, power sense path difference measurements, test path calibrations, and through use of a matrix switch to cross connect CW test signals
- All basic WSR-88D calibration and fault monitoring functions are integrated into the design
- System Initial Phase Determination based on ground clutter targets