Real Time
Passive Load / Source Pull Systems
RTLP-0810B

The PAF Dragon series passive Real Time Load / Source Pull systems, model RTLP-0810B, is the first commercially available Passive Real Time Load Pull Measurement System Family based on mechanical tuners.

**KEY FEATURES**

- No calibration of tuners or components in the measurement set-up is required.
- Fully compatible with all commercially available mechanical tuners.
- Easily be integrated into existing Passive Load Pull Systems for both fundamental and harmonics measurements.

**SYSTEM DESCRIPTION**

The PAF Dragon RTLP-0810B Real Time Load Pull System is derived from the long experience of PAF with active real time system transferred to the world of passive tuners. The system incorporates a Network Analyser, an input amplifier (if required), 2-Bias Tees (if required – i.e. for package devices in Test Fixture), Input Tuner (Input Load), an Output Tuner (Output Load) and two NEW PAF Ultra Low Loss Heads (for input and output sides of the DUT).
The advantage of using RTLP measurement system compared to the standard commercially available mechanical tuner systems is that it uses VNA for measurements and hence the accuracy and repeatability of the measurement system does not dependent on the tuners repeatability or the accuracy of their calibrations nor on any other components de-embedding procedure.

The most critical element of the system is the new Ultra Low Loss Head (ULLH-0810) with less than 0.05dB insertion loss at 2GHz. The two ULLH-0810 are inserted on either side of the DUT in the case of DUT in Test Fixtures and in the case of on-wafer measurements the two Heads are connected via low loss cable & probes to the DUT. The heads physically measure only 10 cm by 3 cm by 3 cm, which makes them ideal for on-wafer device characterisation providing a very easy access to the DUT via probe.

Ultra Low Loss Head

Ultra Low Loss Heads on Wafer Prober

The heads acts as an ultra low loss directional couplers and are connected to the Dragon Switch Unit.

**DRAGON SWITCH UNIT**

This unit controls the Input Power, the Network Analyser, system configuration for measuring [S] parameters, Load Pull and Source Pull.

It also controls the tuners as well as extra active loops (if required as options)

**CALIBRATION**

The Calibration of the system is very simple and takes a fraction of the time when compared with standard passive load pull systems. With the Dragon system, the calibration is based on inserting standards at DUT reference plane and can be SOLT, TRL, LRM etc. All standard calibration techniques are fully supported and can easily be selected in the software. The accuracy of the system depends on how good are your standards, how they are well connected and is similar to ordinary S parameter measurements. Furthermore the Calibration does not rely on tuner mechanical repeatability or perfect knowledge of all the external components S parameters.
SOFTWARE

Software is used to take all device measurements and the control of instrumentation in the measurement set-up. The software supports all the most commercially available tuner system as well as the most common VNAs and many other instruments like Voltmeters, Power Supplies, Spectrum Analyzer and so on. All the measurement data are automatically exported into Excel© as well as in the most common file format.

INTEGRATED TUNER & ULLH UNIT

To keep the overall dimensions minimum of the ‘Front-end’ part, PAF has engineered an integrated ULLH and mechanical tuner unit. The integrated Unit is especially suited for on-wafer application and also the overall loss is slightly reduced if compared with the two units connected separately. This new tuner promises to have better performance, more speed and better accuracy.

MEASUREMENT

With respect to traditional passive load pull system the PAF Dragon measures the following Large Signal Performances for each output load (fundamental and harmonics) in real time without any pre-characterization of the Load or of the other external components:

- Input Reflection Coefficient
- Load and Source Reflection Coefficients (at all the harmonics)
- Power level delivered to the loads (at all the harmonics)
- Available Input Power Level
- Net Input Power Level
- Actual Compression Level;
- Transistor bias point (input and output voltages and currents);
- Device Efficiency (i.e. power added efficiency).
- AM/AM and AM/PM conversion

Additional Measurement are available with an external spectrum analyzer used
- Inter-modulation Distortion
- ACPR
- Time Domain Waveforms (optionally with Time Domain Receiver).

**MEASURED DATA**

Examples of Load Pull Data using RTLP software and RTLP0810B

<table>
<thead>
<tr>
<th>Output power [dBm] @ 1dB gain compression</th>
<th>Power Added Efficiency (PAE) [%] @ 2dB gain compression</th>
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Inter-modulation Distortion Measurements
ADVANTAGES

In addition to RTLP’s advantages in terms of: Performance; Versatility; Simplicity; Compatibility with Existing Hardware and Cost & Availability it has numerous technical advantages:

- **Real Time Measurements**
  Measurements are instantaneous unlike in a traditional system where many measurements & calibrations have to be done in advance and cumbersome de-embedding procedure has to be applied.

- **RTLP measures DUT Input Reflection Coefficient in Real Time.**
  It is very important to know the change of DUT input impedance vs. Load or Input Power. This information is not available in traditional systems

- **There is No Affect on System Calibration** by connecting or disconnecting any components before the input Head or after the Output head (i.e. outside the reflectometer plane. So one can add or change any of the components outside the reflectometer plane like a different bias tee, input amplifier or spectrum analyzer.

- **Full Vector Error Correction**
  System accuracy is as in the same as [S] parameter measurements since they are both based on the same receiver.

- **Absolute Power Accuracy**
  Measurements are made using VNA and hence it measures true power. Traditional systems use power meter which integrates also the harmonic power content.

- **RTLP has Increased Dynamic Range** (only limited by VNA) over traditional available systems as they incorporate power meters
• Higher Measurement Speed (based on VNA as receiver)

• Higher Tuning Resolution
  is available as the tuner probe can physically be positioned anywhere on the
  Smith Chart © within the tuner VSWR range and is under the control of
  Dragon Unit and hence measures Real Impedance via VNA. In comparison the
  traditional systems provide impedances based on tuners that are pre-calibrated
  and only the pre-calibrated tuner positions are available and intermediate
  positions have to be interpolated with lack of accuracy.

**SPECIFICATION**

The RTLP-0810B is the basic system of the PAF Dragon Family design for
passive tuners and has the following specifications.

- Frequency Range: 0.8GHz–10GHz
- Power Capability: Only limited by the connector on tuners (3.5mm, APC-7, N-type, 7/16) or Probes for on-wafer application.

**ORDERING INFORMATION**

Typical system configuration for a Basic RTLP System:
- Dragon Switch Unit
- Ultra Low Loss Heads (ULLH) – customer specified connectors
- Four Cables with 3.5mm connectors for connecting ULLH to Dragon
- Power Cord for Dragon Unit
- System Software
- Programmable Mechanical Tuners or Manual Tuners
  (No additional tuner controller required)

**System Options:**
- Opt F-01SH: Focus Microwave tuner control software and control card for two tuners.
- Opt M-01SH: Maury Microwave tuner control software
- Opt TD-01SH-MT: Time Domain control software
- Opt P: Pulsed RF option of the switch unit, allow to pulse the RF to the DUT.
- Opt S: S-parameter measurement configurator including switches for automatic switch between S-parameter and load-pull measurement.

**System Expansion Capability:**
- Time Domain Waveform Load-pull
- Active Load-pull

**SYSTEM EXTENDIBILITY**

PAF Dragon system can be extended to make time-domain measurements with the addition of MTA or sampling Scopes.

*Time domain waveform load-pull*
Low Impedance Device Measurements and Harmonics Control

The basis RTLP0810B can be extended using Dual Ultra Low Loss Heads, Mechanical Tuner and Active Loop to achieve high VSWR for low impedance devices or harmonics load pull.