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| The New York City college of technology    DEPARTMENT OF ELECTRICAL & TELECOMMUNICATIONS ENGINEERING TECHNOLOGY |
| **Transmission Systems** |
| **Applications of Load-Pull Systems in Transmission Lines** |
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In a transmission system, load-pull system is the process of systematically varying the impedance presented to a device under the test. A load-pull system can be used anywhere in a transmission line. In other words it can be used at any port for the device under the test. It can help one improves the transmission on a transmission line (TL) by balancing the system when linearity breaks down, a situation which occurs, for example, under large-signal operating conditions associated with substantial harmonic generation or other manifestations of non-linearity. In the context of this course one can see this paper very useful because it connects the theory of the course with the practicality aspect of it.

The Smith Chart is a graphical aid that is used mostly in transmission system in order to solve problems in transmission lines and matching circuits. It’s one of the less complicated way of calculate the input impedance, the admittance, the voltage standard wave ratio (VSWR) and the load impedance of a transmission line. The article shows the relationship between the load-pull and the Smith Chart. Active and passive load-pull systems are two common load-pull techniques. The main differences between active and passive load-pull systems are the inability of the latter to synthesize reflection coefficients near the boundary of the Smith Chart. Therefore active tuner load-pull can be used for application requiring high coefficient reflection. On the other hand, passive tuner load is used for application requiring high speed measurement. The main advantages of the passive technique are: rapid impedance synthesis, low maintenance cost, low implementation cost, ease of usage and absence of any oscillation. Most load-pull systems are based on passive distributed networks using either a slab transmission line in its TEM mode or rectangular waveguide. The presence of oscillation in the closed loop structure can be explained as the reflected travelling input wave. It is a modified form of the device under the test (UDT) output. In order to overcome the oscillation, an amplifier with a high gain and high linearity in the feedback loop can be used. When you combine the passive and the active tuning in the same system, it results in what is called a hybrid load-pull. The quarter wave transformer technique is the approach that incorporates the quarter impedance transformer between the device under the test and the tuner. In order to overcome some of the shortcomings of the quarter wave transformer, it was replaced by a broadband impedance transformer named Klopfenstein. It reduces Smith Chart coverage with increasing impedance transformation ratios. Its bandwidth covers from 100 MHz to 12GHz. Passive and active load-pull techniques have been advanced over the years; one of the advancements is called enhanced loop passive load-pull technique. It is a combination of a passive loop and impedance tuner cascaded together. The impedance tuner is a standard low-loss passive tuner, whereas the passive loop is built using a high directivity circulator and a coupler.

This article discussed the load-pull concept and how it can be used in transmission system most importantly power amplifiers and wireless communication. This system has been in used for more than four decades and is still one of the best methods for measuring the optimal transistor parameters used in power amplifiers. It explained the two common load-pull techniques and setups. It talks about the two latest developments in load pull configurations and the advancement in both passive and active load-pull techniques.

References

Introduction to Load pull systems and their applications by M .H. Hashmi and F. M Ghannouchi

http://en.wikipedia.org/wiki/Smith\_chart