

# **Power System Stabilizer Test and Measurement**

**Application Note 052**



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## Power System Stabilizer Test and Measurement

Power System Stabilizer testing consists mainly of frequency analysis of power generator systems. The stability characteristics of power generators can be determined through frequency analysis, with the main goal being to improve small-signal stability. The CoCo-80X dynamic signal analyzer can be used to evaluate the performance and stability of power generator systems. By determining the phase-frequency characteristics of the excitation control system, the PSS can be tuned to provide optimal performance. Standard PSS tests measure parameters such as active power, reactive power, and generator terminal voltage fluctuation. The CoCo-80X's portable form factor provides flexibility for many PSS testing applications. (Figure 1.1)

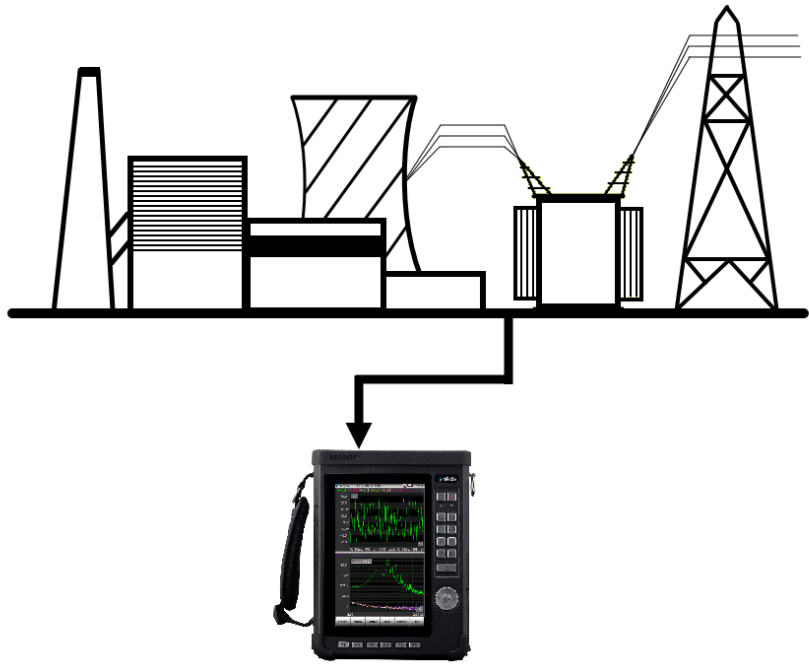


Figure 1.1

Traditional power systems are subjected to low frequency modes caused by groups of generators swinging against each other in an interconnected system. Oscillation modes in power systems can be divided into two groups: *local modes* and *interarea modes*. These modes are present in all interconnected systems and they can result in a loss of synchronization. Power system disturbances demand significant costs from the power industry and ensuring stability has always been a priority. (Figure 1.2)

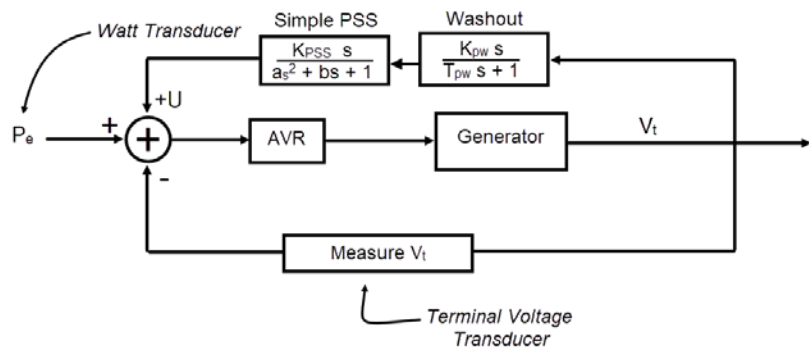


Figure 1.2

These control devices can be attached to power generation systems to help improve stability.

## Types of Measurements for PSS Performance Evaluation

PSS tunings must be performed whenever an excitation system is put into operation or periodically during system operation. PSS tunings must also be performed when PSS parameters need to be reset (except when gain is adjusted). If the power system undergoes a major repair, a step test should be performed on the

system under load – with or without a PSS attached. (Figure 2.1)

The PSS tuning process involves several FRF measurements:

- Establish inter-area modes of oscillation
- Establish local modes of oscillation
- Measure frequency response of PSS
- Verify local mode damping has improved

## Establish Inter-area Modes of Oscillation

The inter-area modes of oscillation

must first be identified by measuring the phase delay of the exciter-generator system. The interarea modes of oscillation are associated with power flow between generator groups in different areas. A frequency response of the terminal voltage ( $V_t$ ) vs.  $V_{\text{signal}}$  must be performed with the unit at full load, and with the PSS disconnected. The generator's frequency response is used to determine the correct settings for the PSS. (Figure 2.2)

The power system stabilizers typically utilize phase compensation to compensate for phase lags throughout the system. The PSS and excitation system modify the torque angle of the shaft to increase damping. The PSS provides damping and oscillation stability at the expense of the AVR. The phase-frequency characteristics of the excitation control system should be determined with a signal analyzer. This information is used to configure the PSS settings. The PSS shall be tuned to provide as close to 0 degrees of phase shift as possible at the inter-area frequency or frequencies. (Figure 2.3)

### Establish Local Mode Oscillations

The frequency response of  $P_e$  vs.  $V_{\text{signal}}$  indicates the frequency of local mode oscillations. The local mode oscillations must be determined to configure the PSS correctly. Using a modeling program or equivalent mathematical program to verify PSS settings will result in the proper phase in the inter-area (0.1 Hz to 1.0 Hz) and provide indication of the local mode damping. (Figure 2.4)

### Measure Frequency Response of PSS

The CoCo-80X analyzer can also be used to measure and verify the frequency response function of the PSS device. PSS settings should be applied with the gain turned down.

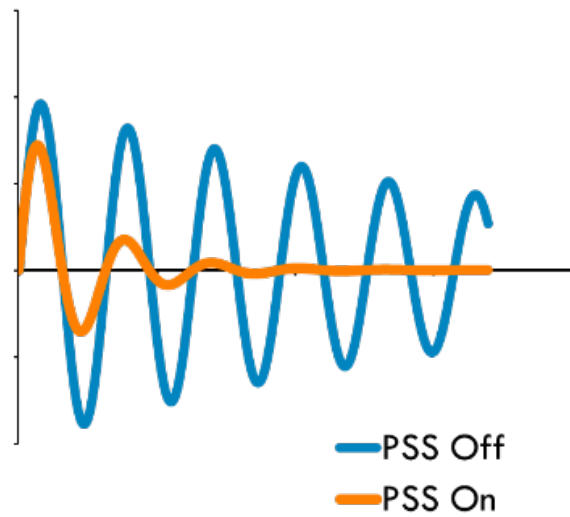


Figure 2.1

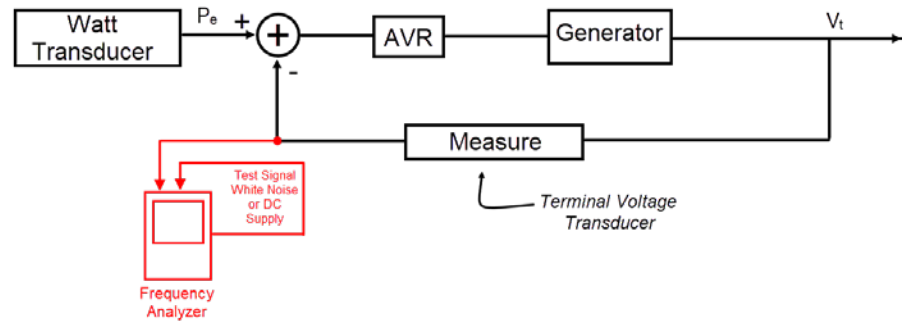


Figure 2.2

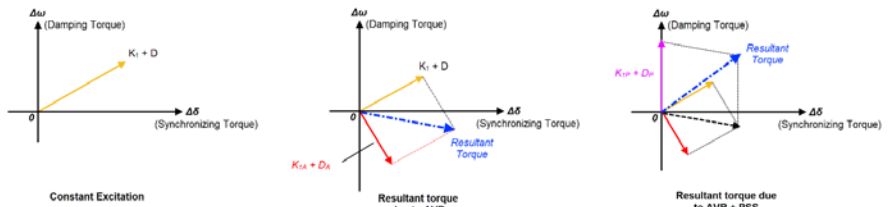


Figure 2.3

Connect the analyzer to the PSS as shown in figure 6. The CoCo-80X's output channel provides a test signal to excite the PSS device, so that the frequency-response characteristics of the PSS device can be determined. The frequency response of the PSS must be determined to verify that the PSS will result in the proper phase in the inter-area frequencies. The frequency-response characteristics should be verified before attaching

the PSS to the power generator system. (Figure 2.5)

### Commissioning Test

Once the PSS has been installed, the power generation system stability must be tested. An impulse response should be performed by injecting a large signal into the AVR. It should be verified that the system's local mode oscillation damping has improved. (Figure 2.6)

Reconnect the watt transducer to the PSS and connect the PSS to the rest of the system. Slowly increase the PSS gain until  $P_e$  begins to oscillate. Turn the gain down to 1/3 of that value. Now a step response should be performed on the PSS. Connect the analyzer's output to the test system and configure the DC signal to provide a step in  $V_t$  equivalent to 0.5% change. Close the test switch and monitor  $P_e$ . (Figure 2.7)

## PSS Measurements with the CoCo-80X

The CoCo-80X now supports a new software application dedicated to power system stabilizer measurements. This software application provides an intuitive interface for PSS applications. The signal analysis parameters are preconfigured to acquire data across a narrow frequency range for PSS measurements. These measurements provide stability results for various components of power generation systems. Due to its strong signal measurement and analysis capabilities, the CoCo-80X serves as an excellent tool for PSS tuning. (Figure 3.1)

### Capabilities of CoCo-80X

- Measure and optionally record 1 to 4 analog dynamic response channels simultaneously
- Acquire, display, and save FFT measurements (including FRF and coherence)
- Generate test signal output
- Generate PSS reports

### Connecting the CoCo-80X in a PSS Testing System

The CoCo-80X input channels should be connected to the power system's sensors. The first two input channels of the CoCo-80X should be used to acquire FRF measurements. The output channel is a LEMO connector and should be used to supply the

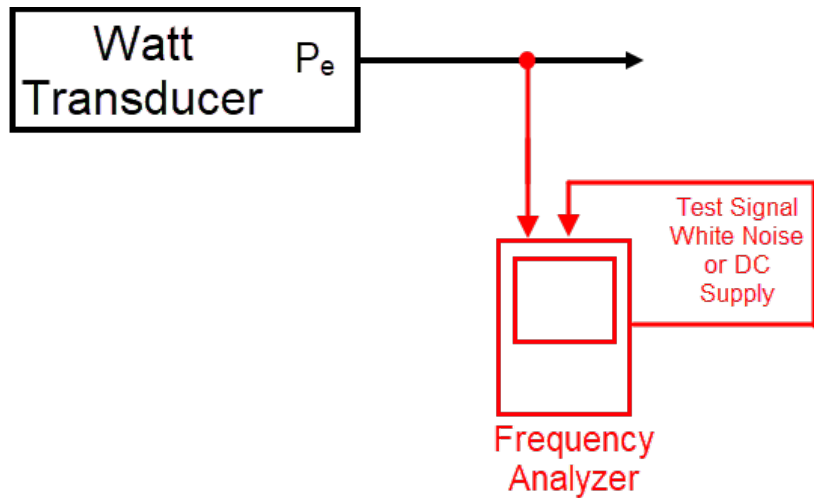


Figure 2.4

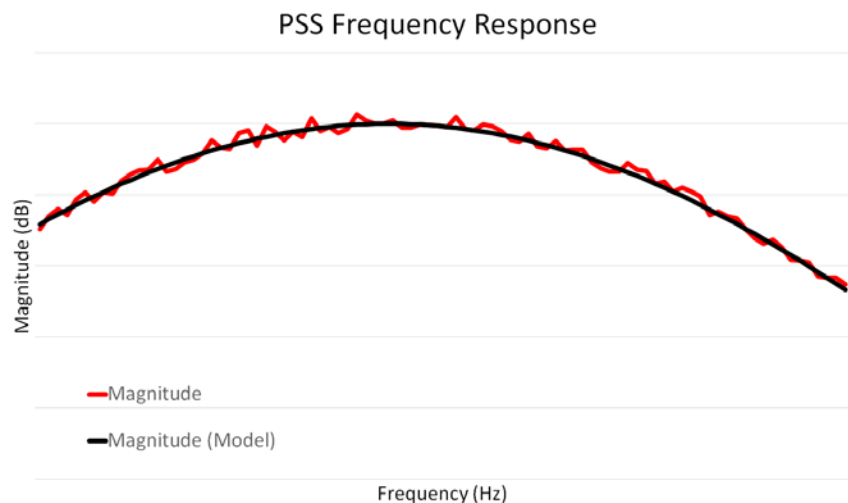
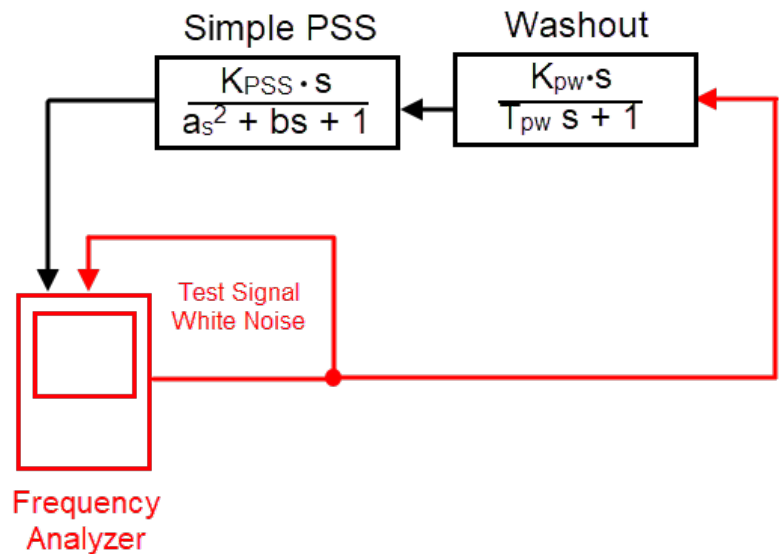


Figure 2.5

test signal for certain measurement. (Figure 3.2)

### Setup CoCo-80X Software for PSS Testing

The CoCo-80X's PSS software can be accessed from the main Analysis Groups screen. Select the PSS software and configure the system parameters for testing. The user-interface for live signal displays is very consistent across all software on the CoCo-80X. It is a highly-configurable signal analysis interface, and the user has much flexibility in the appearance of the display. (Figure 3.3)

Testing reports can be generated on the CoCo-80X as well as the PC. The report function provides a display of the FRF signals and provides a table of measurement values. The CoCo-80X's report viewer allows users to modify the maximum frequency range and delta frequency. Testing reports can be generated directly into Word doc format, including signal plots with cursors and markers. (Figure 3.4)

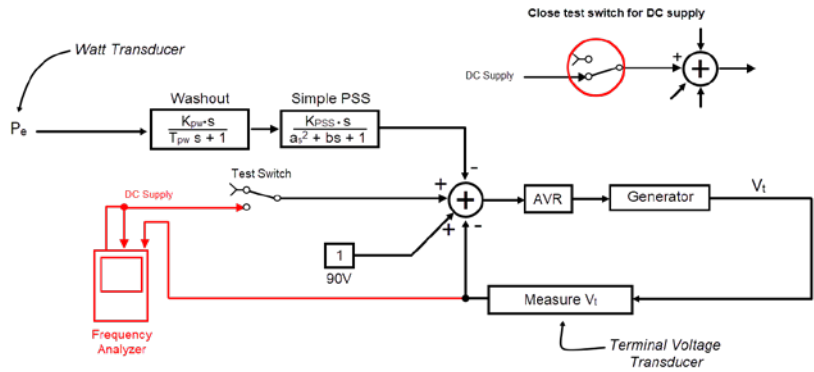


Figure 2.6

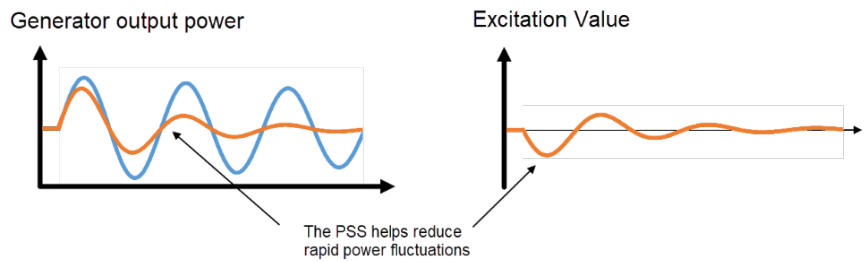


Figure 2.7

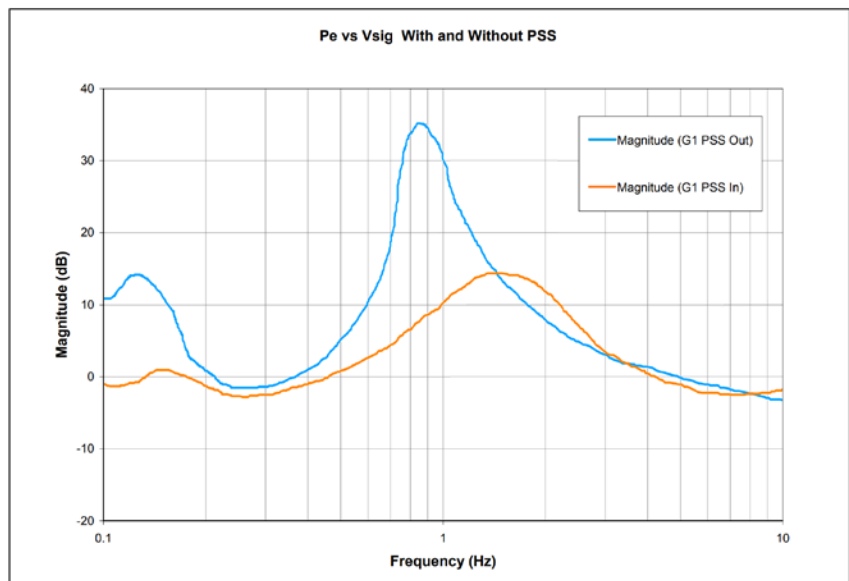


Figure 3.1

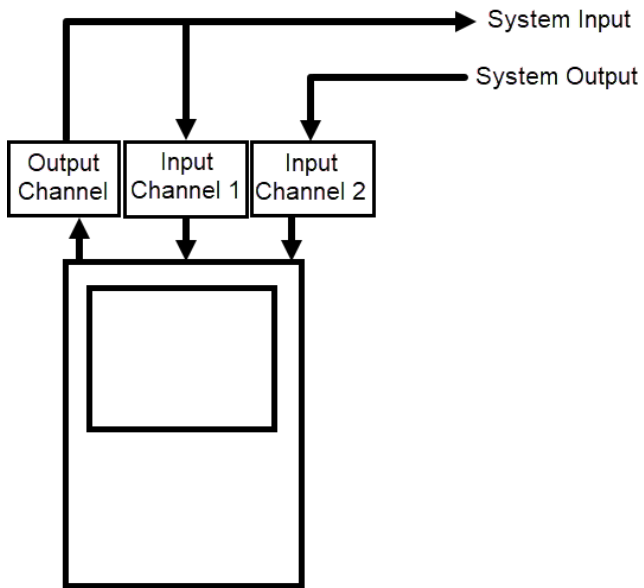


Figure 3.2

CoCo-80X Live Signal display



PSS testing report



Figure 3.3

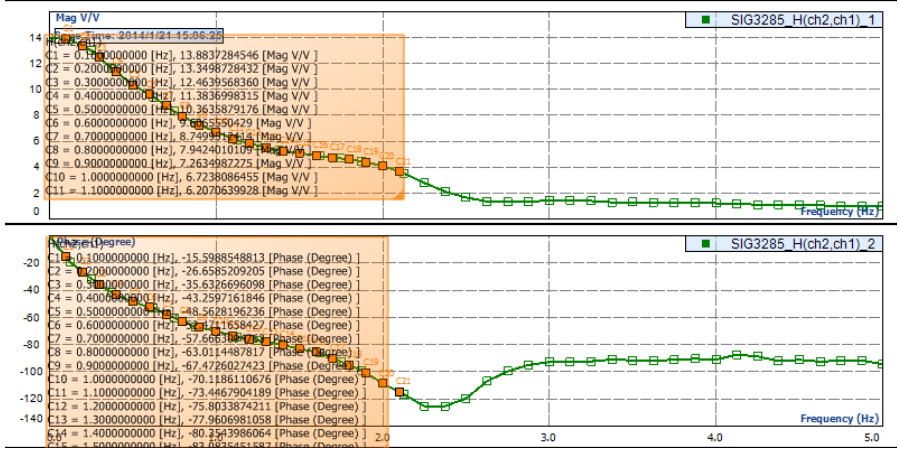


Figure 3.4

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