

Guide to Calibrating the TPM using the 7006A250

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Introduction

This guide is intended to give a step by step procedure for calibrating a TPM in-situ using the 7006A250 Transfer Standard Kit. The benefit of using the 7006A250 is that it can calibrate the TPM in the field while still providing accuracy traceable to NIST.

Contents of the 7006A250 Transfer Standard Kit:

5000-035 – Transit Case
5000-XT – Digital Power Meter
TS-TPM-1 – TPM Transfer Standard
6A340-ADJ – Calibration Adjustment Tool

Set-up

In order to begin calibration, you want to make sure you have everything you need to make the process as quick as possible. In addition to the TPM and the 7006A250 Transfer Standard kit, you will require some means to measure the voltage output of the TPM (Voltmeter or 3140A8 meter panel). When connecting a device to the DC output of the TPM, make sure you use a cable with jack screws instead of thumb screws, as thumb screws will block the TS-TPM-1 from fitting snugly on the forward coupling port on the TPM. Make sure you have access to the coupling ports on the TPM, and that the calibration card and loads are easily accessible.



Forward Power Calibration

Step 1: Start up the sensor

Connect the TS-TPM-1 to the 5000-XT using the RS232 cable included in the kit. After turning the 5000-XT on, you should be able to zero the sensor. [add steps to zero the sensor]

Step 2: Attach the sensor

Attach the TS-TPM-1 to the forward coupling port after removing the attached 50 ohm load.



Step 3: Enter Calibration Factors

On the TPM calibration card, find the frequency closest to your operating frequency. Press the offset button on the 5000-XT and enter the corresponding coupling value in dB.

| Frequency | Forward (dB) | Reflected (dB) |
|-----------|--------------|----------------|
| 174.0 | -22.63 | -22.64 |
| 177.0 | -22.63 | -22.64 |
| 180.0 | -22.63 | -22.64 |
| 183.0 | -22.63 | -22.64 |
| 186.0 | -22.63 | -22.63 |
| 189.0 | -22.63 | -22.63 |
| 192.0 | -22.64 | -22.63 |
| 195.0 | -22.64 | -22.63 |
| 198.0 | -22.65 | -22.63 |



Step 4: Take Power Readings on the TPM and the Transfer Standard Kit

With the TPM under standard Transmitting power output (TPO), record the power measurement on the 5000-XT. This is now the reference power level in the line.

Using either a voltmeter or a 3140A8 meter, measure the power coming from the DB9 connector on the TPM. When using the 3140A8, simply confirm that the power is on and read the power on the forward meter. When using the voltmeter,

you will need to set up the system using the 9 pin diagram below. Make sure that Vcc is supplied so that the TPM power light is on.



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Step 5: Tune the TPM Forward Calibration

Use the Calibration Adjustment tool to break the seal covering the forward calibration potentiometer. After seating the tool, adjust the calibration potentiometer so that the TPM (either Voltmeter or 3140A8) read identical to the reading recorded on the 5000-XT.



Step 6: Remove the reference

Once calibration is complete, turn off the 5000-XT and remove the TS-TPM-1 from the forward calibration port. Remember to reinstall the 50 ohm load to the forward coupling port. It's also suggested that a new seal is used to cover the forward calibration potentiometer.

Reflected Power Calibration

The accuracy of the reflected power measurement is not required by the FCC, as reflected power is normally used for trending and spotting large errors in a system. The drifting associated with the reflected power calibration should not be significant enough to cause failure to catch failures and see trending. For that reason, reflected calibration isn't necessary. However, if you still want to measure reflected power, there are two ways to perform the calibration.

Low Power Calibration

Low power calibration is performed using the current VSWR of the system. Since most transmission systems have some reflected power at any given time, the calibration can be done to that power. The benefit of this calibration is that it doesn't require turning off the transmitter. However, make sure that the TS-TPM-1 is within its dynamic power range of +10 dBm down to -20 dBm.

Simply perform the steps in the forward power calibration section, using the reflected coupling port and calibration potentiometer instead. Also note that reflected full scale power (4.0 Vdc) is 10% of the forward full scale power of the TPM.

High Power Calibration

High power calibration requires taking the TPM out of the line and flipping it in the reverse



direction. Then power down the transmitter to 10% of standard output power. While this provides a more accurate calibration point and overall linearity, it is more invasive and provides lower accuracy at very low reflected power. It also requires a transmitter that can drop in power significantly without detriment to signal quality

Turn the Transmitter off and turn the TPM around in line. Before turning the transmitter back on, lower the gain to 10% of TPO. Once done, perform the same steps as the forward power calibration, using the reflected coupling port and calibration potentiometer instead.

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FAQ

Q: Do I need to calibrate the TPM for both forward and reflected power?

A: In an ideal situation, calibrating both ports would be best. However, since the FCC only requires accurate forward power measurement, calibrating the reflected port is suggested but not necessary.

Q: What is the ideal power for TPM calibration?

A: For the greatest accuracy, calibration should be performed at standard operating power. This removes any issues with linearity on the TPM. In addition, calibration lower than 10% of full scale (for forward or reflected) is not suggested, as any error would be amplified at higher power levels.

Q: After calibration, I seem to be getting strange forward and reflected power readings. What happened?

A: Make sure the 50 ohm loads are reattached to the forward and reflected ports, and that during calibration the forward and reflected ports weren't left open. If the ports aren't terminated in 50 ohms, the reflections from the ports will inject noise into the detector.

Q: Can I use any reference for calibrating the TPM?

A: Yes, but the calibration may not be traceable to NIST. For operating powers and frequencies, the TS-TPM-1 has a NIST traceable accuracy of +/- 2%. If you use a less accurate reference or one that's not NIST traceable, the overall error budget will be worse than factory calibration.

Q: Do I need to terminate the sampler port?

A: No. Since the non-directional sampler port is independent, reflections will not affect readings in any way.

Q: Do I need to send the 7006A250 Calibration Kit in for recalibration?

A: Only the TS-TPM-1 Transfer Standard needs to be recalibrated. This should be done yearly, but since it is not integrated into the transmission system, this recalibration won't cause any downtime.