BOONTON

Application Note

High-speed Measurement of RF Power Sweeps

Boonton Model 4530 RF Power Meter now includes operating modes that save power readings into a memory buffer and this feature is especially useful for high-speed production test applications. These modes allow the user to store sequential power readings into an onboard memory buffer as they become available, and then read the complete buffer from the instrument into the control system after the acquisition is complete.

Wireless Power Sweep Test Application:

For testing of wireless devices such as cellular handsets, it is frequently necessary to verify the power control abilities of the transmitter over the full operating range of the product. Performing a power sweep and monitoring the power at each level can accomplish this. With traditional power meters, this test is performed by incrementing the transmitter power, taking a filtered measurement, and then querying the power meter to return the data to the host.

For maximum test throughput, this sweep should be as short as possible, while still containing each power level to be verified. Traditional methods usually require step dwell times of up to several hundred milliseconds to allow for the combined latencies of the power step command, device-under-test, power meter, data network, and host.

Programming the test device to perform a preset power sweep over a defined time interval is a faster solution, since it can eliminate two of these five latencies. Setting the power meter for a free-run mode and taking readings as fast as possible through the host as the sweep progresses will work only if the power meter, data network and host are fast enough to read the data in real time. If not, the dwell time at each step in the sweep will have to be increased until no readings are missed.

With many manufacturing test systems consisting of groups of instrumentation connected together through a data network (GPIB, LAN or other type), things can get very busy during high-speed, high-volume testing. In the case of fast instruments such as the Boonton 4530 series, the measurement rate of test instruments is usually more than sufficient to gather the test data in the required time, but often exceeds the ability of the data network to read and store the data in real time. When this happens, measurements may be lost, and the host controller will not record all readings taken by the instrument. Often the only choice is to increase the test time so the controller can keep up.

There are several ways to avoid these problems. First, the measurements may be processed by the instrument to yield a reduced number of values, which reduces the demands on the data network and host controller. A second technique is to save all the measurement values in onboard instrument memory, and read them back at whatever rate the data network can handle. These two methods may be combined to further reduce the amount of data to a manageable size.

For fastest testing, it is desirable to reduce dwell time at each step to the minimum required for the power meter to achieve a stable reading. Storing the readings onboard the instrument as the sweep occurs, then transferring an array of readings can do this. In this way, interruptions due to controller and data network latency will not affect the integrity of the sweep measurement. Optimum test throughput is achieved through combination of buffered measurements and peak power sensors inherently fast settling time.

High-speed Measurements in CW or Modulated Modes:

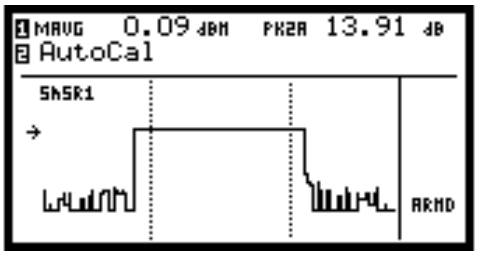
A capability of the 4530 Series allows free-run measurements in CW or modulated modes to be stored (“buffered”) at various pre-programmed rates up to 500 readings per second. Up to 4000 measurements per channel may be saved, and then read by the host. This allows the user to trade off between time resolution, measurement duration, and data set size. This mode is best for continuous modulation formats where the power is stepped at periodic time intervals.

In CW or modulated modes, the entry is placed into the buffer at periodic time intervals, as determined by SENS:MBUF:RATE. CW or modulated mode readings are free-running and, in contrast to measurements in the pulse triggered mode, not synchronized to any pulses in the signal.

High-speed Measurements in Pulse Triggered Mode:

Triggered pulse measurements may also be buffered to record power sweeps for discontinuous formats such as GSM or TDMA. When measurements are buffered in the pulse mode, the power meter saves one reading into the buffer each time a pulse triggers the meter. The 4530's powerful triggering features allow synchronization with most types of pulse and burst modulation formats. Each reading consists of the average power between the two on-screen time markers (cursors), so the buffer will contain a sequence of readings, which represent the average power of each individual pulse in a burst sequence.

4530 Series Display in Pulse Mode:



If the power is increased for each pulse, the buffered data array will contain one power reading for each power increment. This can be far faster than recording thousands of data points and analyzing the step increases offline.

Buffered measurements in the pulse mode can also be used with a continuous power sweep, rather than pulses, if an external trigger pulse is supplied for each power step. This is used to synchronize the acquisition with the steps, and ensure that each power reading takes place when the device's power is properly settled. Absolute timing of the synchronization pulses is not critical – they merely need to be repeatable.

Note that in pulse mode, each buffer entry corresponds to the power between markers for a single trigger event. If averaging is set to greater than one, or the timespan is set to faster than 50us, each reading will be a weighted average of the current pulse and past pulses. It is also important to consider that the power meter has a re-arm time of 2 to 3 milliseconds at the end of each sweep, or some pulses of the next sweep may be missed.

GSM timing generally have pulse repetition periods longer than 3 milliseconds should not present a problem, but signals with pulse periods less than about 3 to 4 milliseconds may skip pulses.

Quick Command Reference:

SENS:MBUF:SIZe set/return size (0 to 4095) of measurement buffer. When buffer has filled to this preset size, the measurement will be considered complete, and buffering will halt.

INIT:CONTinuous If INIT:CONTinuous is off, the measurement will stop when the buffer size is reached. If INIT:CONTinuous is on, new measurement data will overwrite the oldest data when the memory is full.

SENS:MBUF:RATe set/return the buffer write rate in measurements per second (1 - 1000, used for modulated or cw modes only). In continuous modes, the current measurement value is periodically placed into the buffer. Note that the internal reading rate is 500 meas/sec for modulated mode, and 300 meas/sec for cw mode. Although any value will operate, it is suggested that "rate" be set at, or to a sub-multiple of the measurement rate (500, 250, 125, 100, 50, etc for modulated) to avoid duplicate or skipped entries. Note that filtering should be set shorter than the buffer period (1/rate) if no overlap of information can be tolerated.

SENS:MBUF:POS? return the current position of the write index into the measurement buffer. If zero is returned, no measurements are in the buffer yet. If "size" is returned, the buffer is full, and no further measurements will be placed into it.

SENS:MBUF:IDX set/return index pointer for reading the measurement buffer over the bus (0 - 4095). After each read, the buffer index is incremented automatically to the next unread buffer entry unless MBUF:COUNt is set to zero, in which case the index remains unchanged.

SENS:MBUF:COUNt set/return the number of buffer entries that are returned each time the buffer is read over the bus (0 - 4096). A minimum of one reading is always returned if any are present, and the index will be incremented by this number after each read.

SENS:MBUF:DATA? returns "count" measurement buffer entries, beginning at "index" (1 - 4096). Entries are returned separated by commas.

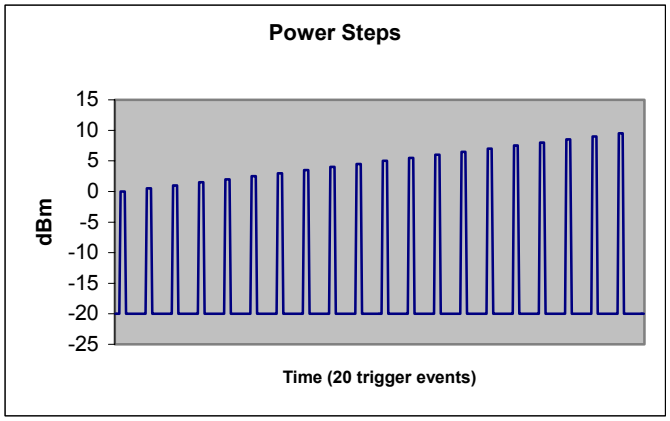
CALC1:MOD CW sets channel 1 to CW mode. CALC2:MOD CW sets channel 2 to CW mode. If CW mode is selected for a meter using a peak power sensor, it will automatically be forced to MODULATED mode.

CALC1:MOD PULSE sets channel 1 to pulse mode. CALC2:MOD PULSE sets channel 2 to pulse mode.

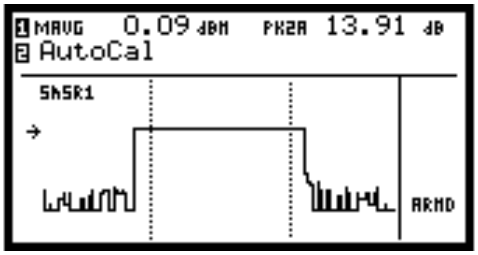
Power Step Measurement (Pulse Mode) Example:

The 4530 series peak power meter was set to pulse mode and the markers were placed on the top of the pulse. The RS232 utility program Hyper-Terminal was used to setup the high-speed measurement for buffered memory operation and read back the results. In this example, averaging was set to 1 and the measurement of the average power between the cursors was added to the 4530 series internal buffer for a total of 20 measurements. All 20 measurements were read out at once.

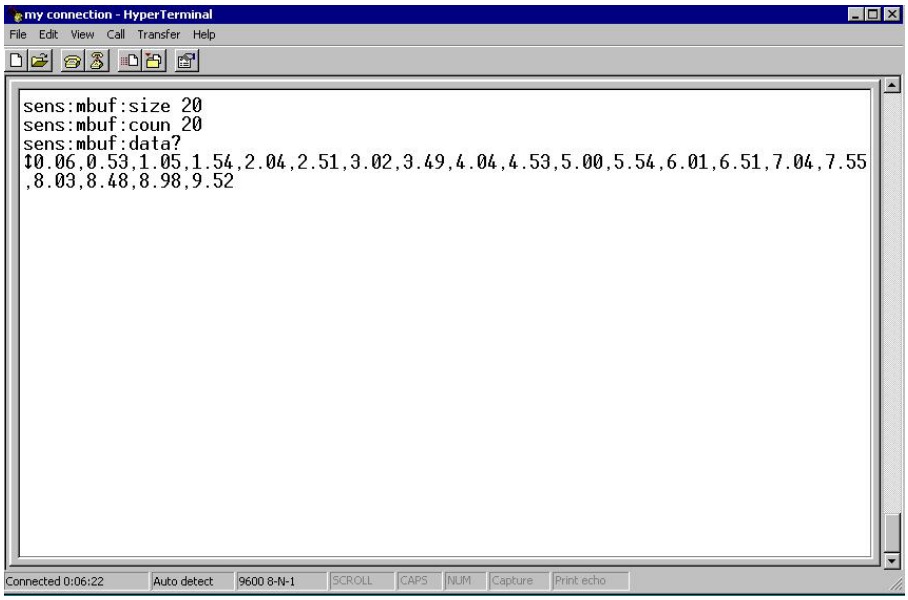
Measurement Setup:



4530 Series Display in Pulse Mode:



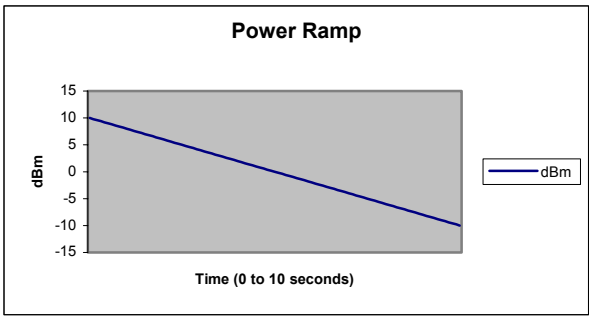
High-speed Measurement Commands, Queries and Results:



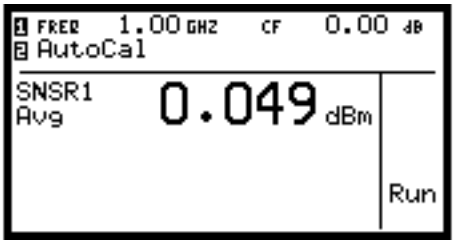
Power Ramp Measurement (CW and Modulated Modes) Example:

The 4530 series was set to CW mode (or modulated mode if a peak power sensor is used) and the power of a signal decreasing linearly over ten seconds from +10 dBm to –10 dBm was monitored. The measurement rate was set to 10 readings/second and a total of 100 measurements fill the buffer in this example. The buffer was read out 10 measurements at a time starting at the beginning and stepping up by 10 with each additional read back. The first 30 measurements are shown below.

Measurement Setup:



4530 Series Display in CW and Modulated Modes:



High-speed Measurement Commands, Queries and Results: