**MEASURING SIGNAL STRENGTH AT THE RECEIVER** by VK2ACD

Most amateur radios have a meter of some kind to indicate the received signal strength, commonly referred to as the 'S-meter'. These typically indicate a range from S0 to S9, then increments above S9 at 10 or 20dB intervals, up to around +60dB. Why stop at S9? Because this would make the standard RST signal report difficult since the 'S' figure could potentially have 2 digits!

Ideally, the meter input would measure the incoming signal right at the input, where the feedline is connected. However this is impractical since the meter would be indicating the total strength of signals across all bands. Of course, the operator only wants an indication of the signal that is being tuned.

Therefore the signal is measured usually after the IF stage (or direct conversion stage in a simple receiver), so that only the tuned signal is indicated. It is commonly taken by a feed from the AGC voltage, which responds to signal strength.

The IARU standard for S meter readings on MF and HF frequencies, is that a signal of 50µV at a 50Ω input (at the 'antenna' socket) should indicate S9, and each 'S-point' lower is 6dB weaker (half the voltage and one quarter the power).

However, there is no guarantee that the meter in any particular radio will be calibrated to this. Likewise, there is no guarantee that the S-unit divisions will be exactly 6dB apart. S-meter readings are best considered as a relative, rather than an absolute measurement. They are very useful nevertheless because they give a simple indication of logarithmic variation in signal strength on an approximately linear scale.

If we want an absolute value of signal strength at the input to the receiver, the standard unit is the 'dBm' which stands for 'decibel-milliwatts'.

With these units, 0 dBm is taken as a power of 1mW present at the input.

0 dBm or 1mW is a very strong signal, and most signals are in the micro-watt to pico-watt range. For example, a strong S9 signal at the standard 50µV into 50Ω, works out at minus 73dBm. A weak S1 signal will be minus 121dBm. That’s a difference of 38dB!

To see how this figure of -73dBm for S9 is arrived at -

An S9 signal is defined as 50µV into 50Ω.

50µV = $\frac{50}{1000000}$ = 0.00005 volt

Using the power equation P = EI = $\frac{E}{R}^{2}$

therefore power at S9 = $\frac{0.00005 x 0.00005}{50} $ = 0.0000000005 W

We will call this P2. P1 will be the 0 dBm reference of 1mW = 0.001 W

To find S9 in dBm we compare P2 with P1 , using the standard dB formula for power, thus

dB = 10 log $\frac{P1}{P2}$ = 10 log ($\frac{0.001}{0.00000000005}$ ) = 10 x 7.3 = 73 dB

Thus S9 is 73 dB down from the reference of 0dBm, that is minus 73dBm (phew!)

For a really good explanation of signal metering see the article by Larry Gugle [at this address](http://www.rfcec.com/RFCEC/Section-3%20-%20Fundamentals%20of%20RF%20Communication-Electronics/33%20-%20TRANSCEIVER/Transceiver%20-%20S-Meter%20Calibration%20%26%20IARU%20Standards%20%28By%20Larry%20E.%20Gugle%20K4RFE%29.pdf).