# The RST Standard of Reporting

**L. B. Cebik, W4RNL**

## Part 1: The RST System Itself

The RST (Readability-Strength-Tone) system of reporting with which we are all familiar (or are we?) goes back to 1934. The S-meter name was derived from the S in RST. Before (and for some time after) that, receiver meters were sometimes called R-meters (and sometimes just "signal" meters) after an earlier system proposed for amateur use and terminated at either 5 or 9. The difference in the 2 scales results directly from the change brought about in the standard RST report system between 1925 and 1936. These vacuum-tube voltmeters inside the receiver were used as much to align the receiver as to determine the strength of incoming signals.

Most S-meters were and are still a derivative function of AGC (called AVC by many in those days) and thus cannot exactly parallel the RST system. Few S-meter circuits are able to meet the proposed standard of S9=50 microvolts, with each S-unit equaling a 6 dB reduction from that level. The more signal processing we insert before the detection of a voltage roughly corresponding to signal strength, the more troubles we encounter with the accuracy of the system. Moreover, receiver gain distribution tends to vary from band to band (which is why *QST* product reviews rate sensitivity on various bands). Hence, the standard proposed in the early 1940s was never adopted by manufacturer's, even though S-meters are given printed scales as if the system were universal.

Between S1 and S9, a well-calibrated meter can provide a reasonable indication of signal strength that parallels the original RST system. In contrast, S9+40 is a sort of meaningless extra in conversation relative to the system. It is extraneous precision for the term "extremely strong signals" on an electronic system (the receiver) that has been shown time and time again to be quite imprecise. Hence, S9+40 is almost the SSB equivalent of Dave's World talk--and of a world where the thing rules the operator rather than the operator ruling the thing (the meter).

Unfortunately, few if any transceivers have well-calibrated S-meters. For a review of the performance of some recent transceivers, see the website of Greg Ordy, W8WWV (http://www.seed-solutions.com/gregordy) and look at two special items: "S Meter Blues" and "S Meter Lite." The latter is an attempt to overcome transceiver S-meter limitations with better-calibrated software.

The only way for the meter to be precisely in tune with the RST reporting system at the low end is to have S1 as the left needle rest marking. Then, you give S1 if you can hear the non-needle mover and give nothing if you cannot hear him. If S1=a certain number of microvolts of signal strength, the needle does not move until there is that number +1 (or +.001, etc.). Everything else that is lower is still S1. Or it is silence, since a person cannot give a report to a station he does not hear (nets and contests not included). This means of meter calibration would make the meter again partially track the RST standard.

If we turn the question around and require that the reporting system parallel the action of meters, then we need a new standard by which to report. The RST system of reporting is a standard and was developed to be a standard. It is not and was never intended to be a large collection of individual interpretations and inventions. Rather, it is a standard agreed upon and promulgated to everyone for standard use, in essence, an ITU standard paralleling all those used in physics and electronics that have been agreed upon by recognized bodies representative of all users.

Until a new standard exists, the current standard places the RST system ahead of meter readings and "S" runs from 1 to 9. Those who insist upon putting their own revisions into practice--however widespread--only create confusion--like inventing a new set of meanings for voltage, current, and resistance such that E=2IR: quite possible, but confusing to casual readers.

A following notes may form some historical background to my comments concerning RST as a standard.

The earliest system of signal reporting emerged from the Q-signal system and included QSA (signal strength). In the May, 1925, issue of *QSI*, we find in the back pages (specifically, page 63, following correspondence) the following note.

> It has been suggested that the R system of indicating audibility be used instead of the ineffective QSA-QRZ-QRK arrangement in practice now. This has been suggested by a number of correspondents and isundoubtedly an improvement so the list is given below. Hang it by your set and make use of it.
> R1--Faint signals, just audible.
> R2--Weak signals, barely readable.
> R3--Weak signals, but readable.
> R4--Fair signals, easily readable.
> R5--Moderately strong signals.
> R6--Strong signals.
> R7--Good strong signals. Would be readable through heavy QRN and QRM.
> R8--Very strong signals. Several feel-from-phones stuff.
> R9--Extremely strong signals.

From the *QST* text, it is clear that the R-system existed informally and for some time before this mention by ARRL. From this system emetged the ealiest reference to signal strengh meters as R-meters. The system is not the full RST system that was soon to emerge.

In the 1930 *ARRL Handbook*, there is no mention of RST. Rather, the standard log page shows reference to QSA (Strength of signals on a scale of 1 to 5) and tone, given as a set of remarks (pp. 195-96). An alternative to the word "tone" was QRI? ("Is my tone bad?" as if the expected reply would be "yes.") Q-signals were the universal means of conveying complex questions and information quickly in early radio, augmented by the Phillips code, Navy signals, and a few other sources.

The 1936 *ARRL Handbook* (the next in my collection) reports (p. 323) that the basic version of the modern (?) RST system was proposed in 1934 by W2BSR. (See Arthur M. Braaten, W2BSR, "A New Standard System of Reporting signals," *QST*, (October, 1934), pages 18, 19, 106, 108.) Braaten's article followed a piece in August, 1934, by D. C. Redgrave, KA1NA, that emphasized the need for a change in the reporting of signals due to inconsistencies of usage.

His proposal ("FRAME") was far more complicated than the W2BSR proposal. The original RST system used a 559 scale to preserve the QSA range. "T" was very detailed, since the achievement of a "Purest d.c. note" was a function of many factors, including poor or nonexistent power supply filtration and what was then known as musical modulation and whistle. A recent article in *Funkamateur* shows a pair of QSL cards from W2BSR, a 1934 version using QSA and a 1935 update using RST. See Wolf Harrath, OE1WHC, "Wie gut, wie stark, wie rein? 72 Jahre RST-System," *Funkamateur*, (November, 2006), pages 1260-1262.) Braaten's original set of signal strength categories were as follows (from page 19 of the *QST* article). Compare the categories to those appearing in the tables later in these note.

Signal Strength
1. Faint--signals barely perceptible
2. Weak signals
3. Fairly good signals
4. Good signals
5. Very strong signals

ARRL enthusiatically adopted the RST system of signal reporting as "logical and brief," not to mention "increasingly satisfying as you keep using it" (from the prologue to the Braaten article by ARRL's Communication Manager).

"Some time later," W2BSR made a second proposal to expand the strength scale to 1 to 9 to accommodate finer gradations of perceived signal strength. (This step must have occurred either late in 1934 or early in 1935, since the copyright date of the '36 *Handbook* is October, 1935.) In 1936, an RST followed by "X" for the appearance of crystal control (for frequency stability) already existed, but there is no mention of "K" for key clicks is given. The 1947 *Handbook* adds "C" for chirp (p. 466), while retaining the 1936 meaning for the T-numbers. By 1952 the "K" appears, but the RST system had become such a standard part of amateur operations, that the editors moved the chart to the "Miscellaneous Data" chapter without any accompanying textual comment (p. 547).

To receive a report in 1936, one sent "RST?" or "QRK?" ("Are you receiving me well?") RST was an evolving standard, and reports were not yet sent by everyone as part of the first exchange. The '36 *Handbook* refers to the RST system as "the present standard recommended for your use" (p. 323).

Between 1936 and 1995, the meanings of the 5 R-numbers and the 9 S-numbers did not change. Sometime between 1970 and 1978 (the space between *Handbooks* in my collection), the T-numbers took on their current meanings. The T-scale was altered in wording to reflect changing problems in achieving pure CW. In the 30s, T represented what the ham constructor had achieved. In modern times, it largely indicates a malfunction of some stage in a transmitter. T-6 now means "Filtered tone, definite trace of ripple modulation." Between 1934 and the early 70s, it was interpreted as "Modulated note, slight trace of whistle." See the accompanying table for further details on "T" and a reminder of the meanings of the rest of the numbers.

**Table. 1. The RST system in 1936 and in 1995.**

| R: Same in '36 and '95 | S: Same in '36 and '95 |
| --- | --- |
| 1 Unreadable | 1 Faint signals, barely perceptible |
| 2 Barely readable, occasional words distinguishable | 2 Very weak signals |
| 3 Readable with considerably difficulty | 3 Weak signals |
| 4 Readable with practically no difficulty | 4 Fair signals |
| 5 Perfectly readable | 5 Fairly good signals |
| | 6 Good signals |
| | 7 Moderately strong signals |
| | 8 Strong signals |
| | 9 Extremely strong signals |

| T: 1936 | T: 1995 |
| --- | --- |
| 1 Extremely rough hissing note | 1 Sixty-cycle ac or less, very rough and broad |
| 2 Very rough a.c. note, no trace of musicality; broad | 2 Very rough ac, very harsh |
| 3 Rough, low-pitched a.c. note, slightly musical | 3 Rough ac tone, rectified but not filtered |
| 4 Rather rough a.c. note; moderately musical | 4 Rough note, some trace of filtering |
| 5 Musically modulated note | 5 Filtered rectified ac, but strongly ripple-modulated |
| 6 Modulated note, slight trace of whistle | 6 Filtered tone, definite trace of ripple modulation |
| 7 Near d.c. note, smooth ripple | 7 Near pure tone, trace of ripple modulation |

| | |
|---|---|
| 8 Good d.c. note, just a trace of ripple | 8 Near perfect tone, slight trace of modulation |
| 9 Purest d.c. note | 9 Perfect tone, no trace of ripple or modulation of any kind |

---

Does the RST standard system of reporting need change? Perhaps "R" is not to be changed, since it represents a measure of readability to the receiving operator. Is "S" a strict measure (a standardized meter reading), a relative measure (based on how signals sound compared to each other on a given occasion with given band conditions), or a subjective measure (of how the receiving operator feels about the incoming signal)? What can "S" be as a standard for the next century? Does "T" need revision, omission, or mention only when the note is other than purest d.c.? Perhaps QRP operators are in the best position to contribute to a revised standard applicable to them or to everyone since they work at power levels where the report is most meaningful.

If good QRP practice does require a new standard for RST, then let there be a deliberative body representative of all the QRP organizations, and let this body study the problem, receive input from all interested operators, consider all the aspects of the problem, and develop a new standard. Further, let all QRP organizations making studies, issuing awards, and publishing operating accomplishments formally adopt the new standard and insist that all data input to them be in accord with the new standard. At that time, deviant input must be rejected or revised to meet the new standard.

Until then, the *de facto* standard is that which appears in handbooks and which takes precedence over meters. Until we go through the process of creating a better standard, we can either report in accord with the standard to the best of our operating skill or we can be deviant (or "cool"). If the latter, we owe it to other QRP operators to let them know which we are doing so that operator may discount our report. If the former, then we are committed to applying our best efforts and skills to master the art of reporting uniformly with others who are also committed to the standard. The uniformity cannot be perfect, but it can be reliable.

"R" reports may improve as we better master the art of copying CW (or SSB). Recognizing CW signal faults may require much practice in this day and age when almost all rigs produce clean CW. Strength reporting may be the most controversial part of the process. If the RST system is the standard, then the use of meters is an aid to reporting signal strength, but it is not as the standard itself. Should anyone report my signal as S0, I shall stop transmitting, since that is--by the standard--evidence of non-contact, and except for CQ and QST (no, not the magazines), non-contact transmissions except for brief tests and known beacons are not regulatorily approved. If someone gives me an S9+anything, then that is only a cue to reduce power. Only the S9 goes in the logbook/disk.

Of course, virtually all BIG contest reports and dx pile-up reports are meaningless. But that fact does not say that QRP operators must adopt the meaningless. They can still adhere to the operative standard for maximum information transferral until such time as a better standard is adopted--if there is one.

Anyone care to lead the effort to form an international body to study the question and develop a new standard for the 21st century?

Whatever may transpire, I recommend that we always keep the other operator in mind as we use the present RST system for the transferal of the most precise information permitted by the standard. We can always add notes in our own logs for impressions of the band conditions, etc. But as the 1936 *Handbook* notes, the RST system is a complete and efficient report in its own right to the other operator.

**The S-Meter System**

Although derived from the "S" in "RST" and its preceding Q-signals, the S-meter system of reporting signal strength has taken on a life of its own. Because the system is mathematically derived from a base signal level of S9 that corresponds to a received signal strength that can be measured in micro-volts or in dBm, the S-meter system can give meaning to a report that S is zero--or even below zero.

When originally proposed, the S-meter system would use 6-dB increments below the base level for each S-level lower than 9. As noted earlier, difficulties in setting band-to-band receiver response led to the proposal falling into a limbo in which receiver manufacturers adhered to a general sense of the system, but S-units varied considerably (by up to a full dB) in increments between S-levels as we move from one receiver maker to another (using the same frequency for testing).

More recent events have renewed interest in standardizing the S-meter system. Reports of interfering signals and noise from amateurs to regulatory agencies have become common and provide a source of data for at least some of these agencies. However, most such agencies are more familiar with signal levels registered in micro-volts or in dB(uV)/dBm than in amateur S-levels. Hence, a reliable conversion scheme is once more in order. What the future of DSP and similar receiver developments may hold in store for overcoming the once insurmountable problem of variable receiver response (especially as related to the AGC system from which S-meter readings were derived), I cannot say.

A precise system of conversion requires--if it is to handle both signal and noise sources--a bandwidth for measurement as well as a signal strength reading. I am indebted to Hans-Joachim Brandt, DJ1ZB, leader of the study group of DARC (Deutscher Amateur Radio Club) for providing the table that they are submitting to the German national standards organization. Once fully accepted in Germany, the table may well be distributed widely among national government agencies and (hopefully) among receiver makers.

The following graphic presents the table exactly as I received it, including the European convention of using a "," instead of the U.S. "." to represent a decimal. I have not wished to change anything in the table. However, I shall update the table should I receive a revision from DARC or any U.S. regulatory source accepting a similar standard. An alternative version (from IARU Region 1 Recommendation R1, 1990) appears in Tabelle 4 and Tabelle 5 of the 2006 *Funkamateur* article referenced earlier in these notes. The differences are small, mostly representing a rounding of values. However, Tabelle 5 is interesting since it presents an alternative set of values for frequencies above 30 MHz. Values for the upper range are 0.1 times the received voltages for HF, a change of 20 dB. A second difference is that the magazine tables omit S0.

## S-numbers in Amateur Radio converted to µV, dB(µV) und dBm

| <<<<br>>>> | formulal 6<br>formula 1 | formula 2<br>formula 5 | dBµV=dBm+107<br>dBm=dB(µV) -107 |
|---|---|---|---|
| S | µV | dB(µV) | dBm |
| 0 | 0,0997 | -20 | -127 |
| 1 | 0,199 | -14 | -121 |
| 2 | o,397 | -8 | -115 |
| 3 | 0,792 | -2 | -109 |
| 4 | 1,581 | 4 | -103 |
| 5 | 3,155 | 10 | -97 |
| 6 | 6,295 | 16 | -91 |
| 7 | 12,56 | 22 | -85 |
| 8 | 25,06 | 28 | -79 |
| 9 | 50 | 34 | -73 |
| dB über S9 | | | |
| 6 | 99,76 | 40 | -67 |
| 10 | 158 | 44 | -63 |
| 12 | 199 | 46 | -61 |
| 18 | 397 | 52 | -55 |
| 20 | 500 | 54 | -53 |
| 24 | 792 | 58 | -49 |
| 30 | 1581 | 64 | -43 |
| 36 | 3155 | 70 | -37 |
| 40 | 5000 | 74 | -33 |
| 42 | 6295 | 76 | -31 |
| 48 | 12560 | 82 | -25 |
| 50 | 15810 | 84 | -23 |
| 54 | 25060 | 88 | -19 |
| 60 | 50000 | 94 | -13 |
| >>><br><<< | formula 3<br>formula 4 | formula 7<br>formula 8 | dBm=dB(µV) -107<br>dBµV=dBm+107 |

Usually radio amateurs will measure signals in the HF range in SSB bandwidth (ca 2,5 kHz, RMS value). For a correct evaluation of broadband signals according to CISPR such measurements have to be converted to a bandwidth of 9 kHz: 10*log(9/2,5) = 5,563 dB oder linear Faktor 1,9.

**Page 2: Conversion formulas 1 - 8**

Formula 1, S numbers up to S9 into µV:

$$\mu V = \frac{50}{10^{((9-S)*6/20)}}$$

---

Formula 2, µV levels into S numbers up to S9:

$$S = 9 + 20/6 * Log(\mu V/50)$$

---

Formula 3, S numbers above S9 into µV:

$$\mu V = 50 * 10^{dB/20}$$

---

Formula 4, µV levels into dB-levels above S9:

$$dB = 20 * Log(\mu V / 50)$$

---

Formula 5, S numbers up to S9 into dB(µV):

$$dB(\mu V) = 34 + (S-9) * 6$$

---

Formula 6, dB(µV) levels up to 34 dB into S numbers:

$$S = 9 - \frac{dB(\mu V) - 34}{6}$$

---

Formula 7, S reports above S9 into dB(µV):
dB(µV) = 34 + (dB-level above S9)

---

Formula 8, dB(µV) levels above 34 dB into dB-levels above S9:
dB above S9 = dB(µV) -34

DJ1ZB, Easter 2004

For careful reporting involving the strength of signals in a variety of circumstances, the proposed S-meter system--or a reasonable variant of it--makes eminent sense. The relevant activities include not only reporting to interfering signals and noise to regulatory agencies, but also matters such as equipment and antenna system tuning, antenna comparisons, etc.

Nevertheless, one should not confuse the S-meter system and its functions from the use of the RST system in report exchanges between amateurs communicating with each other. Where the other operator's signal is in question, the RST system--rightly used--provides a very compact way of reporting a wealth of information. However, it has relied and always will rely on the training and experience of the receiving operator to set the information into the proper alpha-numeric characters to provide maximum useful information to the sender.

*This item first appeared in* QRP Quarterly*, October, 1995. Updated 12-10-2001. Part 2 was added April 19, 2004, with further additions on September, 24, 2006 and November 29, 2006.*


Return to Amateur Radio Page