

# Genuine Signal Reports with Copyability and Strength

## Bruce Prior N7RR

When calibrated S-meters and well-filtered power supplies came into common use in Amateur Radio, the old Readability, Strength, Tone (RST) signal reporting system became obsolete. With one fun exception, the time is well past for putting RST behind us. As we shall see, RST is not accurate and it is also too complicated to remember in detail. Tune across CW and digital frequencies. Bogus 599 signal reports rule the bands. Very few people take RST seriously for signal reporting

Signal reporting is pretty much of a ritual in Amateur Radio. Even a short, friendly QSO often includes a signal report early in the exchange. They can be useful if they are real, even if informal, like "You're down in the noise." or "You're blasting my ears off." A number of contests – but not all of them by any means – include so-called "signal reports" as part of a required exchange. Radio amateurs are experimenters. We might be trying out a new mode, a new antenna, a new transceiver, and we often play around with different power levels. Genuine signal reports are much easier with the new **CS** or **Copyability and Strength** system than with the familiar RST system. RST is purely descriptive: it includes no quantitative information except for ranked categories.

### Signal Readability in RST

The **R** part of RST consists of five numbers denoting different degrees of readability. All of the distinctions are meaningful but still not adequate. There are significant differences among those five levels. On the low end, the difference between "unreadable" and "barely readable, occasional words distinguishable" is helpful. At the top end, the distinction in RST **R** levels 4 and 5 conveys a minor difference between "readable with practically no difficulty" and "perfectly readable."

Nevertheless, most of us get uncomfortable if we receive an **R** report of 4 rather than 5. We should not. That is, we should not worry if we know that the other operator really understands RST and is actually telling us that our signals are "readable with practically no difficulty." If so, we do not need to adjust the beam. We do not need to increase the output power. We do not need to speak closer to the microphone or enunciate more clearly or use wider word spacing in Morse code. The other operator is experiencing "practically no difficulty" in understanding us. We tend to hand out RST R-5 reports more often than we should. "Perfectly readable" signals are common enough, but signals which are "readable with practically no difficulty" occur more frequently.

If we receive an R report of 3, however, we need to take note. Our transmissions are "readable with considerable difficulty." There is a huge gulf between level 3, "readable with considerable difficulty" and level 4, "readable with practically no difficulty."

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The five levels of readability in RST are not enough to give us an accurate picture of the readability of our signals. I am not seriously suggesting that we set out to improve RST. Its problems are too significant for that, but if we were going to continue using RST, at least one more level between 3 and 4 would improve the R parameter:

- 1 - Unreadable
- 2 - Barely readable, occasional words distinguishable
- 3 - Readable with considerable difficulty
- 4 - Readable with some difficulty
- 5 - Readable with practically no difficulty
- 6 - Perfectly readable

Even a modified version of the R parameter is much less useful than a real quantitative expression, like percentage copyability.

## Signal Strength in Official RST

- 1 - Faint signals, barely perceptible
- 2 - Very weak signals
- 3 - Weak signals
- 4 - Fair signals
- 5 - Fairly good signals
- 6 - Good signals
- 7 - Moderately strong signals
- 8 - Strong signals
- 9 - Extremely strong signals

These are handwaving descriptions, which only made sense before we had S-meters. Indeed, RST is older than S-meters! The nine levels of the RST Signal Strength scale make a reasonable list if we want to limit ourselves to verbal descriptions.<sup>1</sup> Some people may quibble about the language of S-4, S-5 and S-6, but the progression is clear and it does

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<sup>1</sup>The list is already expanded. In 1934 the RST Signal Strength scale included only five levels:

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

[QST](#) November 1934, p. 72

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give scope for useful **S** reports. RST has three levels in the "strong signal" category: moderately strong, strong and extremely strong. Let's think about that "extremely strong signals" level, 9 on the RST signal strength scale. Extremely loud is the welcome cry of a healthy new-born baby or the scream of a mountain lion (*Puma concolor*)!

Alternatively, in order to grasp the meaning of "extremely" take a look at the ITU Radio Bands classification system:

### International Telecommunications Union (ITU) Radio Bands

3 Hz to 30 Hz = <b>Extremely Low Frequency</b>	<b>ELF</b>	
30 Hz to 300 Hz = Super Low Frequency	<b>SLF</b>	
300 Hz to 3 kHz = Ultra Low Frequency	<b>ULF</b>	
3 kHz to 30 kHz = Very Low Frequency	<b>VLF</b>	
30 kHz to 300 kHz = Low Frequency	<b>LF</b>	1 Amateur Radio band
300 kHz to 3 MHz = Middle Frequency	<b>MF</b>	2 Amateur Radio bands
3 MHz to 30 MHz = High Frequency	<b>HF</b>	9 Amateur Radio bands
30 MHz to 300 MHz = Very High Frequency	<b>VHF</b>	3 Amateur Radio bands
300 MHz to 3 GHz = Ultra High Frequency	<b>UHF</b>	5 Amateur Radio bands
3 GHz to 30 GHz = Super High Frequency	<b>SHF</b>	4 Amateur Radio bands
30 GHz to 300 GHz = <b>Extremely High Frequency</b>	<b>EHF</b>	5 (or 6) Amateur Radio bands <sup>2</sup>

Our lowest Amateur Radio allocation is the new 2200 m band, which ranges from 135.7 kHz to 137.8 kHz in the **Low Frequency (LF)** spectrum. **Middle Frequency (MF)** is in the middle of a set of bands graded on a geometric scale by orders of magnitude. For many years radio amateurs have had one **Middle Frequency** band, on 158 meters.<sup>3</sup> A new **MF** band called 630 meters has been added recently with only 7 kHz of spectrum. **High Frequency (HF)** is just above the middle, including our most important skywave bands. The bands above and below those three categories are designated by four different levels of superlatives: Very, Ultra, Super and Extremely. Those descriptors are the same going down and going up. **Extremely Low Frequency** and **Extremely High Frequency** are just that: **extreme**. They are outliers. They are beyond ordinary experience. Radio Amateur have no spectrum below LF, the SHF and EHF bands are rarely used.

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<sup>2</sup> The frequencies above 275 GHz are designated for Amateur Radio use. We could also call the unlimited spectrum a "band" if we wished.

<sup>3</sup> The 1.8 MHz to 2.0 MHz band is often called 160 m, but the bottom of the band is about 166 m and the top is about 150 m; middle of the band, 1.9 MHz, rounds closer to 158 m, using the *speed of light c* parameter: 299.792 458 Mm/s.

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Likewise, we should interpret "extremely strong signals" as outliers. They are beyond our ordinary experience. If we are giving signal reports according to the official RST system, S-9 should be given "extremely" rarely.

Many Amateur Radio operators equate 9 on the RST S scale with the approximate equivalent of S-9 on the S-meter. Look at S-meter(s) on your transceiver(s). Where is S-9? Is it as high as half-way up the S-meter scale, which is also geometric? Maybe S-9 is below half-scale. Different S-meters are calibrated differently, but a generally-agreed standard promulgated by the International Amateur Radio Union Region 1<sup>4</sup> is to calibrate an S-meter so that a 50  $\mu$ V signal at 50  $\Omega$  impedance reads S-9. That is certainly not "extremely strong." The official language of RST says that a strength report of 9 for RST is extremely strong. Based on the standard wording of RST, an S-9 report in RST should be reserved for that next-block kilowatt station whose beam is pointed toward our antenna. If our S-meter reads only S-9, our RST signal strength report should be 5, or maybe 6 on a good day, never more than that, according to official RST. If we are trying to use RST as it is published, we certainly should not give strength reports of 9 routinely for every QSO.

The actual language of the signal strength portion of RST is ignored by many operators, even when they are trying to give "honest" reports. For DXing and contesting? That's a whole different can of worms. Stereotyped signal reports serve no useful communications purpose whatsoever. This practice contravenes FCC regulations in the USA:

## **§97.113 Prohibited transmissions.**

(a) *No amateur station shall transmit*

(4) . . . *false or deceptive messages, signals or identification.*

Contest sponsors do not require 599 or 5NN signal reports on CW and digital modes, or five-nine on voice modes.

Contesters could instead use 55N or five-five routinely, and occasionally give 45N or 44N or even 33N reports on CW and digital modes and five-five, four-five, four-four or three-three reports during voice contests which require signal reports and for DX contacts.

## **Signal Strength Scale in Unofficial RST**

The official RST signal strength scale is complicated and difficult to remember. When RST was invented, S-meters did not exist in amateur stations. When calibrated S-meters arrived, they were game-changers:

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<sup>4</sup> The IARU Region 1 covers countries in Africa, Europe, the Middle East and Northern Asia.

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Collins KWM-2 S-meter

The analog S-meter on the Collins KWM-2 transceiver is simple and elegant. S-9 is exactly mid-scale, and the maximum strength reading shown is a whopping 60 decibels over S-9. Most modern amateur transceivers are equipped with analog or digital S-meters. Some go as high as 60 dB over S-9. Others top out a bit lower. Here is what those values in decibels over S-9 actually mean:

- 10 dB over S-9 is 10 ( $10^1$ ) times more powerful than an already-respectable S-9 signal.
- 20 dB over S-9 is 100 ( $10^2$ ) times more powerful.
- 30 dB over S-9 is 1000 ( $10^3$ ) times more powerful.
- 40 dB over S-9 is 10000 ( $10^4$ ) times more powerful.
- 50 dB over S-9 is 100000 ( $10^5$ ) times more powerful.
- 60 dB over S-9 is 1000000 ( $10^6$ ) times more powerful.

S-meters are helpful, since with an AGC (automatic gain control) commonly used on Amateur Radio receivers, very loud signals and moderately-loud signals sound about the same. Most S-meters are governed by the AGC control voltages. Since the lower part of the S-meter measures S-units 1 through 9, many operators began to ignore the official verbiage of the RST strength scale and substituted those S-units, like this:

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## Unofficial RST Strength Scale

**S-1 = S-meter S-1**

**S-2 = S-meter S-2**

**S-3 = S-meter S-3**

**S-4 = S-meter S-4**

**S-5 = S-meter S-5**

**S-6 = S-meter S-6**

**S-7 = S-meter S-7**

**S-8 = S-meter S-8**

**S-9 = S-meter S-9**

**S-9 plus = more than S-meter S-9**

Although never sanctioned by any Amateur Radio organization, this unofficial strength scale rules the bands now when operators are actually trying to send real RST signal reports. This system works fine as far as it goes, but since it does not take into account the number of decibels over S-9 which real S-meters indicate, the unofficial scale is not accurate. Most portable and QRP operators who use RST try to give real reports. Their task would be easier if they used a simpler system.

## Tone in RST

The tone part of RST is a whole different story. Look at the nine-level description:

**T-1 - Sixty-cycle ac or less, very rough and broad**

**T-2 - Very rough ac, very harsh and broad**

**T-3 - Rough ac tone, rectified but not filtered**

**T-4 - Rough note, some trace of filtering**

**T-5 - Filtered rectified ac but strongly ripple-modulated**

**T-6 - Filtered tone, definite trace of ripple modulation**

**T-7 - Near pure tone, trace of ripple modulation**

**T-8 - Near perfect tone, slight trace of modulation**

**T-9 - Perfect tone, no trace of ripple or modulation of any kind**

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Talk about a solution looking for a problem! Tone in RST is all about power supply problems. Back in the day of the transition from spark to CW, amateurs often had to build their own power supplies from scratch. Because of inadequate filtering, AC products in transmitted signals were a significant problem then. When was the last time you heard a signal with a "rough note, some trace of filtering" or some such description? A sign of how little attention is actually paid to the tone part of RST is the fact that T-1 is still defined as **<Sixty-cycle ac or less, very rough and broad>**. The terminology has not even been updated to read 60 hertz!<sup>5</sup>

Signals with AC products are not completely unknown today, but they certainly are not common enough to merit a nine-level scale in every CW or other text-mode signal report. That fact was implicitly recognized when by the time that voice modes became common in Amateur Radio, the T part of RST was dropped for those modes. Other quality problems for voice modes, like **overmodulation** for amplitude-modulated signals and **overdeviation** for frequency-modulated signals, were not addressed by the RS(T) system. Most three-character RST reports end properly with a T-9 tone report.

## Optional Suffixes in RST

The suffixes which are listed for RST do address the quality of signals. Chirpy signals and key clicks are still heard from some CW stations. The C and K suffixes telegraph those problems for CW, but the RST suffixes do not treat quality problems in digital and voice modes. The optional X suffix is a fine kudo. Its absence implies the same thing: there are no quality problems to report.

## Genuine Signal Reporting

**In order to leave RST in the past, we need largely to abandon it. We should not try to perpetuate RST by requiring it for contest exchanges, or using it routinely for DX communications. The ARRL and RSGB and JARL and CQ and other Amateur Radio groups should stop requiring RST or any other signal reporting system for all sponsored contests.**

Signal reporting is useful for traffic nets and for fun activities like Summits on the Air (SOTA).

If we want to exchange accurate reports for our radio signals, we need answers to three simple questions:

- 1) How much of our transmission can the other operator copy?
- 2) How strong is our transmission?
- 3) What quality problems, if any, are present?

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<sup>5</sup> In some parts of the world, commercial power is delivered at a frequency of 50 hertz.

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The **CS** or **Copyability and Strength** signal reporting system with optional suffixes answers those three questions. It was first published in the February 2012 issue of the American monthly Amateur Radio journal *QST* (page 77).

## Copyability and Strength or CS

### C or Copyability Scale

N = no recoverable signal\*

0 = discernible but not copyable\*

1 = 10 percent copy

2 = 20 percent copy

3 = 30 percent copy

4 = 40 percent copy

5 = 50 percent copy

6 = 60 percent copy

7 = 70 percent copy

8 = 80 percent copy

9 = 90 percent copy

G = Good 100 percent copy, but short of perfect

P = Perfect 100 percent copy or FM full-quieting

### S or Signal Strength Scale

0 = no S-meter reading

1 = S-1

2 = S-2

3 = S-3

4 = S-4

5 = S-5

6 = S-6

7 = S-7

8 = S-8

9 = S-9

A = 10 dB over S-9

B = 20 dB over S-9

C = 30 dB over S-9

D = 40 dB over S-9

E = 50 dB over S-9

F = 60 dB or more over S-9

### Optional Quality Suffixes

C = Chirp or tail on make and/or break

K = key clicKs or other Keying transients

O = Overmodulation or Overdeviation in voice or digital modes

R = AC Ripple or buzz in transmission

X = characteristic steadiness of crystal (Xtal) control or eXcellent quality

\* For Copyability reports of N or 0, no Signal Strength report is needed.

The CS system does a better job than RS(T) of telling the real story about our signals in a very brief format, normally consisting of just two characters:

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- On voice: "**Your CS is papa alpha [PA].**" That is a perfectly-copyable 10 dB over S-9 signal. Excellent quality is implied by adding no suffix. The suffix X could be added, just as in the case of RS(T). That same report could be sent informally in a voice mode as, "You're perfect armchair copy and 10 over 9 this morning."
- On CW: "**CS G5K**" for good 100 percent copyability but not perfect armchair copy at S-5 signal strength with key clicks or "**CS 53**" for 50 percent copy and S-3.
- On PSK31: "**CS G30**" for good 100 percent but less than armchair copy at S-3, and overdeviated.

## Signal Copyability in CS

Way back in 1925, when signal reporting was in its infancy, the American *QST* magazine reported a percentage "readability" proposal:

*E. G. Watts of 4FM makes a very good suggestion regarding an addition to the present R system of stating audibilities. The present "R9" signal only indicates a very loud signal---it may be audible all over the shack but if there is any great amount of QRN or streetcar QRM or induction the readability may be way down. Why not add to the signal strength "R" signal to indicate percent readability, thusly: 9 is 100%, 8-80%, 7-70%, 6-60%, and so on.<sup>6</sup>*

E. G. Watts' proposal did not catch on then. Maybe that was because designating 100 percent with a 9 and then skipping to 80 percent with an 8 is awkward. CS borrows E. G. Watts' idea, but fixes that glitch.

At the lower end, CS makes a distinction between "no recoverable signal" (N) and "discernible but not copyable" (Ø). The numerical digits from 1 through 9 designate 10 percent through 90 percent copyability. That is straightforward and easy to remember. In practice, operators often distinguish between a signal which is just 100 percent copyable and one which is not only 100 percent copyable, but at an "armchair" or "full-quieting" level. CS calls the first "G" for **Good**. Copyability of "G" in CS is the equivalent of R-4 in RST. The second is "P" for **Perfect**, the exact equivalent of R-5 in RST. The five levels of readability in RST, as we've seen, are too sparse for useful characterization, and since in RST that parameter consists of non-quantitative verbiage, it is difficult to remember the details.

With manually-operated stations, it may be difficult to estimate the percentage of copyability within a resolution of 10 percent, but as computer-aided operation becomes more common, we should be able to obtain accurate copyability measurements at even finer than a 10-percent resolution. The Copyability parameter of CS may thereby become automated.

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<sup>6</sup> *QST* October 1925, p. 36

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## C in CS Compared to R in RST

C-N = no recoverable signal  $\equiv$  R-1 - Unreadable

C-Ø = discernible but not copyable  $\equiv$  R-2 - Barely readable, occasional words distinguishable

C-1 to C-9 = 10 percent to 90 percent copy  $\approx$  R-3 - Readable with considerable difficulty

C-G = Good 100 percent copy, but short of perfect  $\equiv$  R-4 - Readable with practically no difficulty

C-P = Perfect armchair 100 percent copy or full-quieting on FM  $\equiv$  R-5 - Perfectly readable

**Note:**  $\equiv$  means <is comparable to>;  $\approx$  means <is approximately equal to>.

## Signal Strength in CS

To report signal strength, CS uses calibrated S-meter readings. We know all about S-meter variations. We are radio amateurs with practical communications equipment. Most of us do not have fine-tolerance laboratory equipment in our stations. Although a 50  $\mu$ V signal with a 50  $\Omega$  input impedance is an emerging standard for S-9 on HF S-meters, not all S-meters are calibrated that way. There is variation in receiver sensitivity, and of course our antennas differ considerably.

Nevertheless, this is no longer the early 20th century when S-meters did not exist, and S-meters, no matter how they are calibrated, cover many orders of magnitude of signal strengths, so the differences among S-meters are not significant. Most of us now operate transceivers equipped with S-meters. Using them is the reasonable way for most radio amateurs to report signal strength.

Unlike with RST, we can properly use the numbers 1 through 9 with CS to designate S-1 through S-9 signal strength. For signals stronger than S-9, we can report so many decibels above S-9 using the letters A through F. At the very top of the scale, a signal which is at least 60 decibels over S-9 is indicated by the letter F, actually the number fifteen in hexadecimal notation. Remember that the 60-decibel level is 1 000 000 times more powerful than S-9. We will report signal-strength values at that magnitude very rarely, indeed. To send the maximum CS report of PF routinely for every contact is absurd, like many radio amateurs erroneously do with RST 599 or RS 59.

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## Optional Quality Suffixes in CS

CS borrows three optional suffixes directly from RST: C, K and X. The quality-reporting system in RST has two major flaws: there is no way within RST to report **overmodulation** or **overdeviation** in non-CW modes. CS remedies that by employing a single letter **O** to alert an operator about those problems. Similarly, the **tone** parameter in RST has been eliminated in CS, since with modern power supplies, it is mostly irrelevant. For those rare cases when AC power-supply products appear in the signals, the optional **R** suffix can be used to flag that issue, but not to characterize it with the nine levels of the tone report in RST.

## CS in Operation

CS is far simpler than RST. Unless optional suffixes are added, CS requires only two characters to make a complete report, yet it can apply to the most common Amateur Radio modes when the operators are actively controlling their stations. For signals with no quality problems, we only have to think about two items: **percentage copyability** and **S-meter reading**.

When should CS be used? **CS, or any signal reporting system including RST, should be used only for routine contacts.** CS works great for Summits on the Air, where signal reports are required, but their format is not specified. CS would enhance traffic net operation since net control operators routinely use signal copyability and strength to make judgements about assigning message relaying tasks to net members. Signal reporting, even if done accurately, does not enhance fast-paced operations like contests and DX pileups. Contest sponsors should re-evaluate exchanges which require signal reports. What purpose do they serve when they are often given in stereotyped forms? Both contesters and DXers need to send exchanges which are always the same in a given contest or DXpedition operation, or at least predictable in the case of contests with serial-number exchanges. How about substituting other things like two-character Maidenhead Field or operator name or output power or antenna type or year first licensed or whatever for signal-report contest exchanges? In some cases, the signal-report contest requirement can simply be dropped. It will not be missed and QSO rates will increase.

Some amateurs believe that signal reports are a necessary component for a contact to be valid for Amateur Radio awards. That is not true. ARRL and CQ Amateur Radio staff have confirmed that there is no such requirement for any awards which either entity administers.

Here is a partial list of contests which do not require signal reports in their exchanges:

- **all VHF/UHF contests**

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- ARRL November Sweepstakes
- ARRL Field Day
- International CW Council Medium Speed Contest
- The Lightbulb QSO Party
- Stu Perry (W1BB) Top-Band Challenge
- ARRL Rookie Roundup
- ARRL International Digital Contest
- all ten 10-10 International QSO parties
- North American Sprint (National Contest Journal)
- Winter Field Day
- North American QSO Party two times/year, CW, RTTY, SSB
- CW Mini-CWT Contests (CW Operators' Club)
- Northern California DX Club Mini-Sprints
- State QSO Parties for AZ, CA, CO, MD-DC, MI, MN, MT, NM, NC, OH, PA, SC, VA & WI
- Phone Fray (NW2K)
- RTTY OPS Weekend Sprint

The same holds for DXpedition operations. Since bogus signal reports convey no useful information, they actually take up time and decrease QSO rates. Some DXpeditions may prefer to use only call sign exchanges. Should DXpeditioners wish to add information beyond call signs, two-character Maidenhead Fields would be much more appropriate as DXpedition exchanges, since they can flag propagation changes and enable beam adjustments. Exchanging Maidenhead Fields can open up a whole new aspect of DXing, which has been formalized through the CQ DX Field Award. During 2018 the ARRL sponsored the ARRL International Grid Chase <http://www.arrl.org/international-grid-chase-2018>, which used four Maidenhead Grid characters and did not require signal reports for valid contacts.

The following is an abbreviated summary of the CS Copyability & Strength system which is suitable for mounting at the station position or for portable operators to include in an outdoor kit:

# Genuine Signal Reports with Copyability and Strength

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## CS Compact Summary

### C or Copyability Scale

**N** = no recoverable signal\*

**Ø** = discernible but not copyable\*

**1 ~ 9** = 10 percent to 90 percent copy

**G** = Good 100 percent copy, but short of perfect

**P** = Perfect 100 percent copy or FM full-quieting

### S or Signal Strength Scale

**Ø** = no S-meter reading

**1 ~ 9** = S-1 to S-9

**A** = 10 dB over S-9

**B** = 20 dB over S-9

**C** = 30 dB over S-9

**D** = 40 dB over S-9

**E** = 50 dB over S-9

**F** = 60 dB or more over S-9

### Optional Quality Suffixes

**C** = Chirp or tail on make and/or break

**K** = key clicKs or other Keying transients

**O** = Overmodulation or Overdeviation in voice or digital modes

**R** = AC Ripple or buzz in transmission

**X** = characteristic steadiness of crystal (Xtal) control or eXcellent quality

\* For Copyability reports of N or Ø, no Signal Strength report is needed.

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