A COMPARISON OF THE
FREEDOM COMMUNICATION TECHNOLOGIES
MODEL 8100 TO THE
VIAVI MODEL 8800SX
COMMUNICATIONS SERVICE MONITOR
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EXECUTIVE SUMMARY

The land mobile radio (LMR) market has been using full-featured communication service monitors since the late 1970's when Motorola introduced the R2001A. Before that, a communications technician had to carry approximately 10 to 20 separate test instruments to a radio site to properly analyze and repair the equipment. Many times, this meant multiple trips up 2 or more flights of stairs to the floor above the elevator penthouse where the communications equipment was located.

In the middle 1970's, the advanced communications service monitors were born with more than 15 of the required test sets integral into one test set. These advanced test sets were heavy, large, and cumbersome to operate. As time moved forward, the test sets got more powerful; and included more different instruments, but the weight and size also increased, making them harder to climb stairs or able to carry on an airplane for remote field service.

The Freedom Communication Technologies (FCT) R8000 was one of the first advanced communications service monitors to combine the latest digital communications protocols into a lightweight, easy to transport, and high end specifications unit into one portable box. This was introduced in 2009. The only real competition for the digital radio test sets that were coming into the marketplace at the time was the IFR/Aeroflex/Cobham/VIAVI (VIAVI) 3902/3920 test sets. The VIAVI 39xx test sets were complete analyzers, but were heavy and cumbersome to use.

In order to compete with the R8000 test sets, VIAVI developed the 3550 digital test sets which were an upgrade to the 3500 analog only test sets. The 3550 has a color screen and is very comprehensive in its capabilities and operation. The small screen and size limited its abilities to contain more features, and the 8800 was born. That test set is more complete and has become the direct competition to the FCT R8000 series communications service monitors.

One area where the R8100 exceeds the 8800 is in the extended frequency range to 3 GHz. The VIAVI 3920B also has this same option, but it is a much higher priced test set than the R8100.

The short term timebase accuracy (stability) of the R8100 is 0.01 PPM. The same specification for the 8800 is 0.15 PPM. This parameter is important when measuring

frequency error on 700/800/900 MHz radios, simulcast radios, and will show up as problems on the narrowband radios as errors in their operation.

USER CONTROL COMPARISON

The FCT R8100 uses hard keys to allow the operator to decide which test and test instrument to emulate. The list of the main tests and modes is chosen using hard keys that are defined by screen options coupled to hard push-button switches.

The VIAVI 8800 uses touch screen icons to allow the user to determine and chose which mode and test instrument to use.

Most test functions and operations are very similar between the two units. It is the little nuances that separate the two units when used by competent LMR technicians in the field. This report details these nuances.

When switching between tests, modes, or instruments, it is instantaneous on the R8100, but can take anywhere from 30 seconds to over 4 minutes to load the requested feature into the 8800.

BASIC OPERATION

The first thing that the operator of the 8800 notices is the extremely long time it takes for the unit to go from off to on. There are many "engines" that have to be brought up in the correct sequence for the unit to work. This takes approximately 4 minutes to boot up and bring up the basic startup screen. The same time delay also applies to the 8800 when the operator switches between the analog and digital modes and back.

The FCT R8100 is up and running in under 1 minutes.

On both units, the operator chooses the mode of operation on the test set to make the desired measurements. The frequency of operation, the ports, levels, modulation mode, and other pertinent parameters are similar in the way that they are selected and enabled.

The R8100 uses hard keys, and then screen defined function keys to select the different options related to the tests being selected. The 8800 uses touchscreen technology such that all functions and selections are made by touching the screen directly over the selection that is desired. Both schemes work well and are intuitive to someone familiar with LMR testing.

Both the R8100 and the 8800 have a myriad of tests and selections, and many of the features and functions are only available after certain selections are made that require the operator to further define and select what options and tests are to be made next. This is where application notes and live training allows the users of both instruments to be more proficient in their testing of radios.

There is a large difference in how tests and screens are saved. The R8100 allows items to be saved as soon as a memory stick is installed into one of the USB ports on the unit. The 8800 allows the operator to save data and screens to a file on the main memory area of the unit's computer.

Both the R8100 and 8800 use firmware upgrades and software keys to enable and upgrade instruments within their respective units.

One of the features of the 8800 that the R8100 does not have is a SUSPEND mode to allow the 8800 to be powered down and resume at the exact same point when the unit is powered back up. Since the R8100 does boot up in under 1 minute, this is not needed.

The R8100 has a greater number of operating modes, especially in the digital modes, and has more features than the 8800. VIAVI has the 3920B as its top-of-the-line model. Many of the added modes and features of the R8100 are found on the 3920B, which is a much more expensive unit.

The 8800 has a battery that will last for 3 hours between charges versus the 1.5 hours that the R8100 has available. The 8800 battery is accessible but is a specially built pack and can only be purchased from VIAVI. The R8100 battery is a standard, commercial-off-the-shelf (COTS) battery pack that is used by computers and camcorders, besides the R8100. In addition, there is a rapid charger available so that a spare battery can be used, and a second battery can be charged independently from the R8100 at the same time.

Both test sets have saved preset configuration functionality. These presets are useful when the same test is repeated often, as all the normal operating parameters can be loaded into the correct fields and simplify the number of buttons that need to be pressed to complete these tasks and tests. The 8800 allow the operator to store 10 of these presets. The R8100 has no upper limit to the number of presets, which can be in the thousands of tests. In addition, specific channels and bandwidths can be stored as separate presets to even shorten the setup time on these tests.

The detailed listing of the differences between the R8100 and the 8800 are found in the next section of this report.

SPECIFIC TEST DIFFERENCES BETWEEN THE R8100 AND THE 8800

TRACKING GENERATOR

The most important difference between the R8100 and the 8800 is that the R8100 has a 0 to 62 dB front end attenuator, while the 8800 has none. Since a front-end attenuator is a critical part of using a spectrum analyzer, an external attenuator is required when using the 8800.

For the expert user of a spectrum analyzer, the number of measurement points and the resolution bandwidth are critical in most interference hunting techniques. The 8800 has fewer points and no resolution bandwidth controls.

For the casual user of a tracking generator, the similarities are such that they are the same in power and usefulness, but for the experience tracking generator user, the extra parameters that are found on the R8100 are essential for the easy resolution of the most complex problems being hunted or mitigated.

The tracking generators are very similar in their specifications and operation. Even though the 8800 has a maximum output level of -5 dBm and the R8100 has a maximum useful level of -13 dBm, the actual operating range of the 8800 is -5 dBm to -111 dBm which is 106 dB peak to minimum, while the R8100 operates from -13 dBm to -105 dBm, but when normalized, this becomes 0 dBm to -105 dBm on the tracking generator screen. This means that the 8800 only has a 1 dB advantage over the R8100, and that may be erroneous, as the 8800 accuracy of the generator is +/- 3 dB when the generator is below -100 dBm.

The R8100 has 4 markers, while the 8800 has 6 markers. In most situations, 4 markers is all that is needed.

A tracking generator must have a flat output so that any abnormalities or filter shape changes are in the filter or device being analyzed and not in the frequency response of the tracking generator. The 8800 forces the operator to NORMALIZE the output to the input port to give a flat response before it will operate. The R8100 allows the user to make measurements without normalizing the sweep, but these readings will not be accurate unless the R8100 is normalized. Once the R8100 is normalized, then the response is accurate, and the range is extended to 105 dB between the highest and lowest value that can be read.

The marker position on the 8800 can be pinpointed using the touch screen to where the operator wants it to be. The R8100 can get close to the exact frequency, but sometimes it is slightly off of the exact frequency where it is desired. The number of resolution points may need to be increased or an option where the peak or valley is automatically found with a soft-switch would correct this issue. The R8100 has a range of 100 to 600 measurement points in 1 unit steps between 100 and 600. The 8800 has 100, 200, or 400 measurement points available, with no intermediate steps other than those three fixed numbers.

The screen display on the R8100 can be normal, frozen, peak held, or averaged, whereas the 8800, only normal and peak hold are allowed.

A CENTER MARKER is available on the R8100, but not on the 8800.

SPECTRUM ANALYZER

The spectrum analyzers on the R8100 and 8800 are similar. The 8800 has a slightly higher sensitivity (-125 dBm vs. -120 dBm without the pre-amplifier and -145 dBm vs. -140 dBm with the pre-amplifier on), but in most situations, the two spectrum analyzers give identical results.

The vertical scales on the R8100 are: 1, 2, 5, and 10 dB per division; while the 8800 has vertical scale units in 2, 5, 10, 15, and 20 dB per division.

The R8100 has a feature where the 3 dB below peaks are calculated and displayed, which is used for working with bandpass filters. This feature is not available on the 8800.

The spectrum analyzer amplitude units on the R8100 are: VOLTS, WATTS, or DBM. The 8800 has its amplitude units in: DBM, MICROVOLTS, and DBuV.

CABLE FAULT ANALYZER

Both communications service monitor units will allow the operator to use a directional bridge in the tracking generator mode to see the RETURN LOSS vs. FREQUENCY. Both of these units appear to be work well in this mode.

The R8100 and the 8800 have a DISTANCE TO FAULT (DTF) mode. Neither unit works as well as the dedicated antenna analyzers that are on the market today.

The R8100 has a few cables that are included in the preset cable mode so that the VELOCITY FACTOR and DB PER FOOT losses are pre-loaded into the unit's memory to increase the accuracy of the DTF mode. Specific cables can be added and recalled as necessary.

SIGNAL GENERATOR

A signal generator is included as part of every Communications Service Monitor. The minor nuances between the R8100 and the 8800 are worth noting and the differences mainly come into play when troubleshooting a receiver that has a minor sensitivity issue. It is in this area where the differences are significant and critical for testing receivers.

The R8100 allows the operator to from +5 to -130 dBm in output level, while the 8800 forces the operator to change ports on these two ranges: -125 dBm to -50 dBm on the RF INPUT/OUTPUT port, and -5 dBm to -65 dBm on the RF Generator port. Many of the newer receivers can listen below the -125 dBm level, so the 8800 requires an external attenuator.

The output level accuracy of the R8100 is +/- 1dB to 1GHZ from the RF I/O port and +/- 2dB above 1GHz from the RF I/O port and across the full range of the Generate Port. *In the range between -100 dBm and -125 dBm, the accuracy of the 8800 is +/- 3dB. This might let bad receivers in the auto-test mode pass as a working receiver.*

The US government is advising all agencies at the local, state, and federal level to have High Frequency (HF – [3-30 MHz]) Single Sideband (SSB) backup radios for extreme emergencies. In addition, the same US government program is highly recommending that the infrastructure utilities also have connectivity via the same HF frequencies. The R8100 has LSB and USB operating modes. The 8800 does not have these modes in the unit.

POWER METER

The RF power level is an important parameter that helps determine the range of a radio or system. Most all new communications service monitors can read power is some manner.

The R8100 will measure from 0 to 150 Watts maximum. The 8800 will measure from 0 to 125 Watts maximum. The 8800S has an optional internal Bird directional coupler which allows the unit to read forward and reflected power up to 500 Watts.

The R8100 will display power units in Watts, dBm, and Volts, while the 8800 displays both Watts and dBm as its units.

The R8100 has a universal offset for cable loss that is part of the settings. The 8800 has an offset in each mode of the unit.

The R8100 has 4 ranges, while the 8800 has 11 ranges. In addition, the 8800 allows for auto-ranging to insure the readings are as accurate as possible.

Both units have direct reading display, and bar graphs.

MOTOTRBO SUBSCRIBER TESTING

Both the R8100 and the 8800 allow for testing of DMR digital radios. The testing of the receivers is done in the GENERATE mode of both units, and the testing of the transmitters is done in the MONITOR mode of both units.

The R8100 allows the operator to monitor a transmission, record it, and play back the audio to the same radio via the GENERATE mode of the R8100. The 8800 can also record or playback the transmission to a radio.

Both units allow for encoding and decoding the following parameters:
- COLOR CODE
- 1031 TEST PATTERN
- 0153
- SILENCE
- BS/BR
- FREQUENCY ERROR
- POWER LEVEL PER TIMESLOT
- SOURCE ID
- SYMBOL DEVIATION
- FSK ERROR
- MAGNITUDE ERROR
- BIT ERROR RATE
- TIME SLOT
- CALL ID

There are a few items that the 8800 has that the R8100 does not have, and visa-versa. The R8100 has other items that the 8800 does not.

Both units have displays to confirm that the transmission of the two time slots have the proper separation and what is the power level differences in the time slot power levels.

Finally, both units have a constellation diagram to confirm that the bits are at the proper amplitude and deviation off the center frequency, which is a critical parameter when testing this mode of operation.

CONCLUSION

As a test instrument to check analog and digital DMR radios, the Freedom Communication Technologies (FCT) R8100 and VIAVI 8800 are similar in operation and usefulness. The differences between the two units show up in the higher end testing and differing tests that reflect the product placement in the marketplace. The R8100 is the top of the line test set for FCT. This is the higher end of the field test set in the product catalog by FCT for testing P25, NXDN, TETRA, or other digital formats. VIAVI has other communications service monitors that complement the 8800 that have better specifications and features. VIAVI protects the more sophisticated units with the more features and options, but at a much high price to the end user.

DETAIL ADVANTAGES OF THE R8100

The R8100 has the following advantages over the 8800SX:

- Lighter in weight (14 lbs. vs. 17 lbs. for the 8800)
- More features are standard as opposed to extra options at an added cost
  - Tracking Generator
  - Cable Fault Analyzer
- Powers up faster by a factor of more than four times
- More accurate generated signal levels – crucial for receiver sensitivity testing.
- Option available to work up to 3 GHz
- Has a built-in front end attenuator
- Has higher and lower output levels from the RF signal generator
- Has SSB operating modes (USB and LSB)
- Has more digital modes
  - P25 Trunking
  - NXDN Trunking
- Higher power termination for measuring RF power
- Unlimited preset configurations as opposed to only 10 presets on the 8800
- The short term and long term stability of the time base in the R8100 is vastly superior than the one in the 8800
- The battery is easily removed and is available on the open market at most power / battery outlets.

The bottom line for comparing test sets between the R8100 and the VIAVI 8800SX is the R8100 has more features, better specifications, and at a lower price.