The Legend Lives On

By Lynn Strube
Bird Technologies Group Applications Engineer

Introduction

The evolution in public, military and emergency communication is growing at an explosive rate. This reality necessitates the essential need for transmitting equipment to function at its full potential. Confidence in the equipment means knowing that on the operating frequency, the power specified by the transmitter manufacturer, is being achieved, delivered to the antenna and being broadcasted. A Bird THRULINE® Wattmeter was the best selection in the past for measuring RF power and is still a trusted selection today.

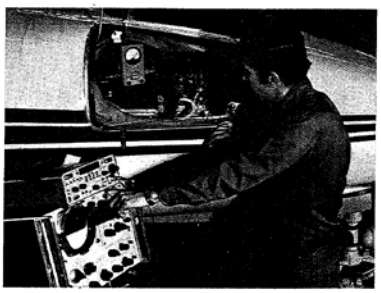
The Bird THRULINE® Wattmeter model 43 was created, and first produced, in the 50's. The self-contained instrument used microwatts of energy from the transmission it measured. Its precision reference line section made it economical and provided build-in reference accuracy that remained consistent with age.

In the 1960's the mobile radio had the majority of its components stored in the trunk of a car and was comparable in size to a microwave oven. A Bird 43 THRULINE® Wattmeter was used to test the power output of the two-way mobile radio transmitter and to match it to the antenna most commonly mounted on the trunk. The transmission line to the antenna was very short. This provided easy access to the equipment which in turn made measuring the equipment convenient. Additionally, the same wattmeter was used to measure the RF power in the operational base station.

In the 1970's, the mobile radio had advanced from the trunk of the car to the car's front interior. The Bird 43 was still used in the same capacity of testing the RF output and matching the transmitter to the antenna.

However, the new interior position of the mobile radio, and the existing rear antenna position required a longer transition line. This still provided easy access to test and measure the system.

The versatile Bird 43 was also used in the aviation industry to accomplish identical results. Measure the power from the transmitter and match the antenna to the system. In the aviation industry today, the Bird 43 remains in use.



How was the dual function of forward output power and reflected power actually accomplished? Once the correct element for frequency and rated RF power is selected, the Bird 43 is placed in the transmission path (in-line) and the forward power out of the transmitter is set. One of the outstanding features of the THRULINE® Wattmeter is that it can be left in the transmission line for continuous monitoring of the forward transmitter output power or reflected power from the antenna. By rotating the element in the wattmeter 180 degrees, the meter then displays reflected power, and all that needs to be done is to nullify the reflected power to the smallest reading by

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adjusting the length of the antenna. This explanation may over simplify the procedure, but in effect, it worked and worked well for over fifty years. In 2008, the legend lives on and is still working for a multitude of applications.

In an attempt to gain current information and a greater perspective about existing emergency communication equipment used across the state of Ohio, I spent, a few hours with the Ohio State Patrol Communication Service Department located in Columbus. The communication equipment is installed and maintained in all state highway patrol cars at this location. Charles Morrison, the Technology/Communications Services MARCS Technical Manager, generously allowed me to view the process and to ask questions regarding the vehicle equipment installations. The majority of my questions naturally revolved around the RF equipment installed in the cars, and the test equipment used to ensure the consistency of a quality working system. Specifics regarding radios, coaxial line, and antennas motivated my series of questions. Eric DeVoe, the Electronic Technician Lead Worker of their Central Installation Facility, escorted me on a grand tour of the facility.

Before touring the facility, I assumed that the vehicle manufacturer installed the cable bundle to facilitate the multiple radios needed. The installation crew would then simply bolt the radio in the car, plug in the cable, and bolt on an antenna. My assumptions were entirely incorrect. Upon entering the service area, there were multiple vehicles in various stages of the installation process. A fleet of vehicles in almost every stage of the installation process were present. Some vehicles were absolutely bare except for the person installing the cables. Cables were routed from the console area to the trunk and from the rooftop to the multiple antenna locations.

Cable Bundle in Process of Installation

Others were installing practically every piece of equipment from PC's to cameras, and naturally that pesky radar equipment. Due to the massive amount of electronic equipment needed in the state-of-the-art patrol vehicle, the trunk now serves as an electronic mounting compartment. This is a return of the 60's era where the equipment was originally mounted.

Communication Equipment in Trunk

One vehicle was being equipped with newly innovative voice activated controls. Technology has significantly increased from the humble beginnings of a simple car radio used for emergency service. I finally asked the question gnawing at my engineering mind. How do you prove the patrol car radio is working, when the installation is complete? Eric showed me a lot of test equipment which they use for test and measurement purposes and among this equipment is a Bird 43.

Ohio State Patrol Car with Voice Activation System

The Bird 43 THRULINE® Wattmeter, which was developed in the middle of the last century, was so versatile and highly respected in the industry that it is still used today. The question is, "Does it continue to be the best choice?" The answer is a resounding "Yes." Although time and technology have

dramatically changed, the Bird 43 THRULINE® Wattmeter may continue to fit your needs with its satisfying performance and easy operation.

Troubleshooting systems can also be accomplished using the Bird 43.

For example:

A transmitter is working, but the signal is not being received. A Bird 43 can isolate the problem easily with the use of a 50 Ω load, which is capable of handling the transmitter power. By connecting the wattmeter to the transmitter and terminating the meter into a 50 Ω load, the transmitter operates into a perfect termination, and the meter will show the forward power. This confirms that the transmitter is working, so the problem could be in one of two areas: the transmission line or antenna. By reconnecting the coax to the transmitter and moving the terminated THRULINE® Wattmeter to the coax end where it attaches to the antenna, a transmitter and coax terminated into a perfect load is created. Powering the transmitter again at the same power level isolates the problem to the antenna. If there is a large difference in power then a coax problem exists. Now that really begins to open up a COW (can of worms). Merely checking the operating system in a vehicle with easy access to the coax and the antenna is a relatively small COW. The solution is to just change the coax cable, or tune the antenna. However, we have progressed from the past and are now living in the 21st century, and the COW regarding a coax problem has significantly increased.

Not only are the air waves getting crowded, but the space on the support towers is also a massive entangled sea of coaxial line. If tower space is shared on a building rooftop, following a cable from the transmitter could easily become the proverbial needle in a haystack. So in this instance, is the Bird 43 still the preferred choice? With enough time and patience, it can still isolate the problem.

The problems related to RF power measurement multiply rapidly when distance between the transmitter and antenna is extended, or by having several transmitters working on different frequencies, while sharing a single transmission line. Coaxial line can provide transmission pathways to accommodate multiple transmitters working on countless frequencies through different antennas. Cable selection brings with it a whole new set of problems such as, velocity factor (RF Speed reduction due to containment in coax as compared to RF's energy traveling at the speed of light in space), cable loss (Problems related to cable length, dielectric properties, and frequency), and environmental factors (water or moisture introduced though openings in insulation). Any time a transmission system containing a transmitter, coax cable, system connectors, and an antenna transmits, a small amount of energy is reflected back. VSWR or reflected power causes transmitter components to create unwanted heat, which over time may damage the system.

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Problem

A transmitter appears to be working, but the signal is not being received. A Bird 43 can isolate the problem easily with the use of a 50 Ω load, which is capable of handling the transmitter power.

By connecting the wattmeter to the transmitter and terminating the meter into a 50 Ω load, the transmitter operates into a perfect termination, and the meter will show the transmitter power.

If the meter indicates **no power** or **less than expected,** then the transmitter is faulty.

Transmitter repair will be necessary.

If the meter shows the expected transmission power, this confirms that the transmitter is working.

By reconnecting the coaxial line to the transmitter and moving the terminated Bird 43 THRULINE® Wattmeter to the coaxial end where it attaches to the antenna, a transmitter and coaxial terminated into a perfect load is created.

If significantly less power is indicated on the Bird 43, then the problem is isolated to the coaxial line.

Replacing the line should solve the problem.

When the transmitter is powered again, and the same power is indicated on the Bird 43, then the problem is isolated to the antenna.

If the VSWR is low, indicating no antenna problem, then the problem is isolated to the receivers.

Reversing the Bird 43 element by 180º displays the reflected power. If the measurement is too high, the antenna can then be tuned to minimize the VSWR.

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Is it really necessary to know the cable loss, physical and electrical length of the cable? That really depends on each specific installation. It is beneficial to minimize the reflected power, if the installation is a simple mobile radio in a vehicle. If the installation is a base station with an antenna hundreds of feet away/or involves a combiner where multiple

Transmitters are in the system along with reject loads, then the answer is “yes.” It is essential to know the cable loss along with the physical and electrical length of the cable. Using a calculator to compute the formulas for finding cable loss, velocity factor, and electrical cable length can be a time consuming activity. Bird Electronic Corporation makes your life much easier by using their website. Simply go to www.bird-electronic.com and select the support tab, click on Technical Support, then scroll down to the RF calculator. All of the needed formulas are provided and Microsoft Excel is required to view the calculator. After a few moments of becoming familiar with the calculator, it is easy to utilize all of its options.

System installation can be simplified, and time saved, by specifying coaxial cables with the connectors already installed. If possible buy the cable with the correct connectors which will eliminate the use of any adapter, therefore reducing VSWR. The use of any adapter can also create additional signal loss. Still many will purchase cable and connectors and personally complete the interface. This action can drive the need for new test equipment to verify not only RF power output, but coax verification.

So now it comes down to the real question, is the 43 still the best selection? The answer: It is still a trusted selection. However, with today’s digital modulation formats and the necessity of verifying coax and locating actual problem areas in coax or rapidly tuning antennas there are other choices. Accurately measuring digital modulation with the 43 will result in power measurement errors. With the ultimate goal of 100% reliable full time operation, there are a few other equipment options, and valid reasons to use other test equipment each with their specific application.

With the intent of using a rugged easy to use RF wattmeter every day in many different environments and applications, a Bird 43 THRULINE® Wattmeter is still a great choice and will be a great choice for decades to come.