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Sometimes I Hear It And Sometimes I Don't...

How Come?

OPERATIONAL RANGE is an often discussed, yet poorly understood topic in biotelemetry. This article is the first in a series which attempts to explain those factors influencing range performance.

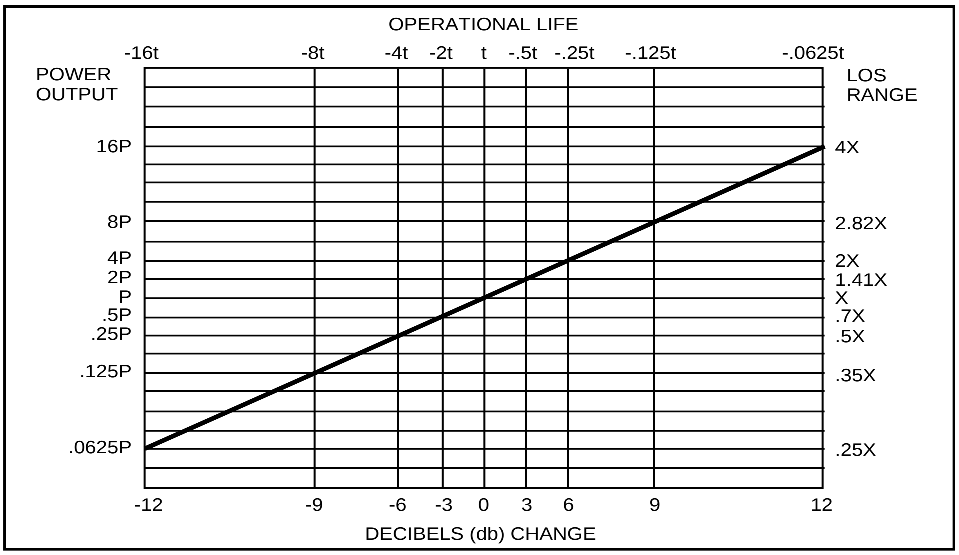
Often the term "range" refers to Line of Site (LOS) range, which is how far away from a transmitter you can be and still receive an adequate signal, assuming there are no obstructions between transmitting and receiving antennas. Of course, "adequate" signal is a subjective opinion. In the field, the operational range performance is often dramatically influenced by many additional factors including environmental and geographical factors. Range is a system-level characteristic where the system is composed of two distinct subsystem components — the transmitting subsystem and the receiving subsystem.

In the case of the transmitting subsystem, the battery capacity, operational life, and duty cycle requirements determine the amount of Radio Frequency (RF) energy the transmitter circuitry can "afford" to generate and deliver to the antenna. The transmitting antenna radiates RF energy in a largely omni-directional manner to assure that the receiving antenna has a reasonable probability of intercepting a usable portion of the radiated energy.

As the transmitted signal passes through the environment, its intensity is reduced as a function of the square of the distance traversed. LOS propagation losses increase as humidity increases and range is further reduced during periods of heavy mist, heavy rain, or wet snowfall. Some amount of radiated energy is also absorbed by intervening vegetation. Other losses result from phase cancellation due to the summation of radio waves reflecting from rock outcroppings (especially wet, rocky, or mineral-laden earth faces, bodies of water, or other surfaces).

Further losses are due to polarization effects as the electromagnetic radio waves emanating from the transmitting system encounter reflecting surfaces. These reflections impart a spiraling action to the electromagnetic wave fronts, causing them to actually rotate their characteristic polarization as they travel from one point to another. Losses result from the difference in polarization of the wave front and the polarization of the receiving antenna at the instant in time that the wave reaches the antenna.

In the case of the receiving subsystem, an antenna is required to collect the RF energy, transform the energy, and present it to the receiver. If, for the moment, we assume the receiver to be a state-of-the-art device with good noise discrimination and amplification characteristics, we can proceed to discuss range performance in more detail.



The relationship illustrated above addresses the issue of increasing LOS range by increasing power output of the transmitter. From the graph, it is clear that doubling the power of the transmitter does not double the range. In fact, the transmitter power output must be increased by a factor of four to double the LOS range performance of the system. This may be surprising because the common thought is that the "transmitter" is responsible for wide variations in range performance. Notice that such a 4X increase in the power output of the transmitter also carries the penalty of reducing battery life of the unit by 4X. If you increase the output of a "20-month" transmitting subsystem enough to be really noticeable (twice the range), its operational life will be reduced to only 5 months.

For this and future articles, it is useful to assign a unit of relative measure in order to compare the relative magnitude to the principal sources of propagation loss. Since the decibel is a logarithmic unit of measure for relative power relationships, decibels can be conveniently added and subtracted. As shown, a 2X increase in signal strength (RF power) corresponds to an increase of three (3) decibels (dB), which results in a corresponding improvement in LOS operational range of only 41%. A 4X increase in signal strength (6 dB) corresponds to a 2X increase in operational range. A 16X increase (12 dB) represents a 4X increase in range. Reductions in power can be treated in a similar fashion. For example, a .5X power output level (a loss of 3 dB) reduces range to .70X.

Continuing, we can place the decibel relationship in perspective to the human ear. For example, a change of 6 dB is quite noticeable, but not "night-to-day". A change of 10 to 12 dB is quite dramatic— or fairly loud versus soft. A change of 15-20 dB is definitely significant — the difference between soft as opposed to loud. A change of 30 dB corresponds to the difference between a barely perceptible signal and a loud signal.

Knowing these relationships, we can assign losses to various effects and relate them to field performance. For example, multi-path phase cancellation can cause varying degrees of effect, ranging from 2-3 to 10-15 dB (but generally 3 to 7 dB), or from "little effect" to "quite noticeable". Polarization shifts are generally more dramatic, ranging from 6-8 dB to as much as 20 dB. In short, they can make a signal simply disappear in worst case instances.

Losses due to vegetation (tropical overstory, high salt grass, wet forest and tall vegetation, etc.) can also be very significant. As compared to good conditions of propagation over a Kansas wheat field, the same telemetry system operated in a 100 meter high tropical rain forest can suffer relative losses of from 15 to 30 dB. It is not uncommon under such conditions for a system capable of 10 km under "good" conditions to be reduced to a maximum range of 100 meters in a wet forest. Generally speaking (and at risk of over simplification), all other vegetative types fall somewhere between the wet rain forest and dry, flat Southwest desert areas.

It is clear that when we speak of the "OPERATIONAL RANGE" of a given transmitter, we are actually referring to the overall operational range of a given radio telemetry SYSTEM which, as we now know, is determined by many more factors than the transmitter alone. These factors will be discussed extensively in a series of articles on range performance in future issues of the Quarterly.

Dave Beaty

Asynchronous PTT or RF Module

How to decide!

Since its introduction during the Spring of 1988, the ST-5 has filled a wide range of applications in both oceanography and meteorology. The past two years have demonstrated that this small, lightweight, and cost effective ARGOS satellite PTT is not only very reliable, but also adaptable.

The ST-5 hardware consists of two distinct functional areas: the Radio Frequency (RF) transmitter module and the separate digital control section. The RF module can be purchased separately for those researchers who prefer to provide their own digital control logic. In such a case, we supply an RF module which becomes a component part of your "new" PTT design. In effect, you become the manufacturer of a new PTT which you must then certify with Service ARGOS prior to deployment. Although there are currently no direct charges for certification of a PTT from ARGOS, the effort does take time to accomplish. Further, if you choose to personally accompany the PTT while it is going through the certification process, it can also be expensive. (Note: this certification requirement applies regardless of who provides your RF module. In fact, if you change manufacturers, you must recertify the "new" design!)

Changing either the digital control or the RF module will necessitate going through the certification process again. The reason ARGOS requires certification, even if the RF module has been previously certified with another controller, is to assure system performance. For example, certified PTT's must contain a feature to prevent or mitigate failures resulting in a continuous transmission condition. This condition must be detected by the digital controller, and the controller must automatically shut down the RF transmitter. If a runaway is not detected, it will jam the satellite and prevent other transmitters from being received.

There is an alternative for researchers who require control over their own sensor data collection and processing but who don't wish to certify their own PTT. By using the ST-5 with the asynchronous communication protocol, the original certification secured by Telonics remains in effect. In this application, the ST-5 can be used with software that allows the user to control the data stream via a serial data communications interface. Your microcomputer talks to our microcomputer. You control the data collection and the ST-5 digital control section provides RF transmitter control, timing functions, and support for the bi-directional asynchronous serial communication port.

Much of the usefulness of the ST-5 is directly related to the serial port. The serial port permits the researcher to deal with the ST-5 in a "master/slave" relationship. The researcher's computer becomes the master and the ST-5 is the slave. The host transmits commands and data to the ST-5 which responds in an expeditious manner.

Configuring the system in this way allows the researcher to acquire and format data externally and then send it to the ST-5 for uplinking. Commands are used to transport from 4 to 32 bytes of data from the host to the ST-5, select 1 of 8 pre-stored ARGOS user identification codes to be used in uplinking the data, and specify which of two ST-5 internal buffers will receive the data. The data can be transmitted immediately or delayed until a transmit command is issued.

Once a transmission is initiated, it is possible to re-transmit in accordance with a cyclic schedule. The schedule can be stored in the ST-5 as a default set or it can be supplied dynamically from the host via the serial link. Once initiated, a cyclic transmission operation is terminated either by command from the host or by satisfying the number of specified transmissions.

All commands received by the ST-5 are acknowledged either positively (ACK), if understood, or negatively (NAK), if not understood. This simple protocol assures the host that the communication link is functioning and affords the opportunity to retransmit a command, if necessary.

One of the commands available to the researcher is a "null" command which is used to check the ST-5 and serial communication link. The "null" command does not cause any action in the ST-5 other than to respond with a positive response code (ACK), if understood or a negative response (NAK), if not. By periodically issuing a "null" command, the host is able to monitor the viability of the ST-5 and serial communication link.

The Failsafe feature is another capability. The ST-5 can be optionally set up to monitor communication from the host. If the ST-5 does not detect any communication during a prescribed time period, it automatically begins transmitting a message on a regular time basis, as specified by the researcher. This feature is useful in locating and recovering a system when the rest of the interface has failed.

In addition, the ST-5 has a feature that is very useful in providing insight regarding the interface with the host, both during integration and following deployment of the system. The ST-5 can be commanded via the serial link to report 4-bit error codes in the uplink message. These codes define certain error and status conditions that can occur, although they are quite rare. Examples are serial communication overrun, line noise, framing error, illegal command, and Failsafe timeout.

ST-5 default values are programmed either at Telonics or by the researcher prior to deployment. It is possible for the researcher to program numerous ST-5 configuration parameters via TIPS (Telonics Interactive Programming System). The TIPS capability makes it possible for the researcher to respond to short lead time requirements by custom configuration of "off the shelf" ST-5's. TIPS consists of special software and hardware for an IBM PC or compatible. TIPS is available from Telonics as an optional package.

If the standard ST-5 described here doesn't sound like it will satisfy your requirements, give us the chance to discuss a custom version. Quite often, minor software changes can be made to solve a unique problem.

Paul Beaumont

Selecting The Right Antenna for ARGOS PTT's

A Few Guidelines

Antennas are often the most misunderstood aspect of communication systems—the ARGOS satellite system is no exception. Since ARGOS and NOAA control the antenna configuration on the satellite, we will deal specifically with the selection of antennas to be used on ARGOS Platform Transmitter Terminals (PTT's) in non wildlife applications. The antennas described in this article are omnidirectional. (That is, their radiating pattern is omnidirectional.)

FACTORS WHICH SHOULD BE CONSIDERED WHEN SELECTING AN ANTENNA ARE:

1. The physical configuration of the deployment. (This may include balloons, buoys, yachts and ships.)
2. The proximity of the antenna to metal. (If the antenna is too close to surrounding metal objects, the tuning and radiation pattern of the antenna will be adversely affected.)
3. A variety of environmental factors. (e.g. salt air exposure, high humidity, high winds, and perhaps excess traffic on a boat or ship where the antenna and/or cable could suffer physical damage.)
4. The presence or absence of ground plane beneath the antenna.

Telonics produces many specialized antennas which can be deployed in a variety of applications. The following products are representative:

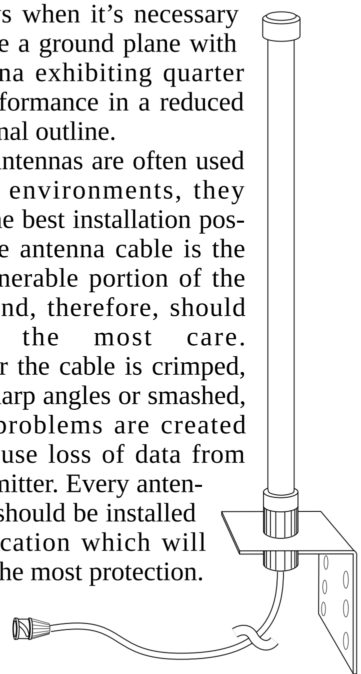
• The CM000398-401 is a half wave ground plane independent antenna suitable for applications where there is no ground plane available. The antenna must be protected from the elements by a waterproof housing that is transparent to RF. Antenna gain is 0 dBd.

• The CM001968-401 is a ground plane independent antenna that is designed to withstand the rigors of the shipboard environment. This antenna comes with an attached mounting bracket and a choice of connectors, BNC or TNC, on RG-58 cable with a maximum length of 17 feet. Antenna gain is 0 dBd.

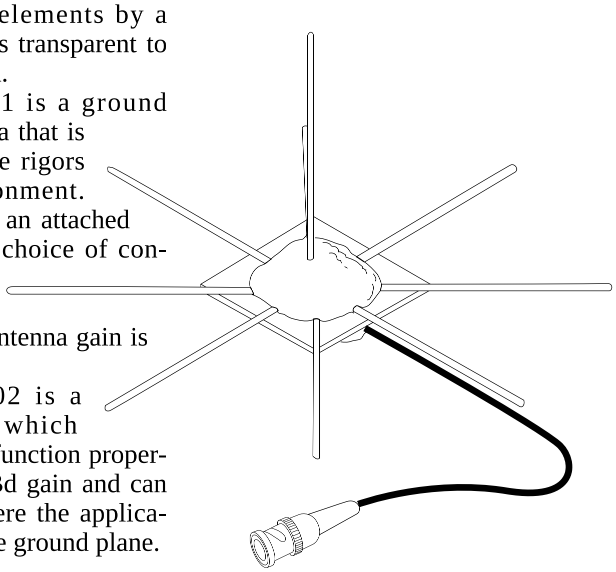
• The CM000849-002 is a quarter wave antenna which requires ground plane to function properly. This antenna has 0 dBd gain and can be used in situations where the application will provide a suitable ground plane.

• The CM001331-001 supplies its own ground plane with a foreshortened quarter wave radiating element. This type of antenna was designed for spherical buoys when it's necessary to provide a ground plane with an antenna exhibiting quarter wave performance in a reduced dimensional outline.

Since antennas are often used in harsh environments, they require the best installation possible. The antenna cable is the most vulnerable portion of the system and, therefore, should receive the most care. Whenever the cable is crimped, bent at sharp angles or smashed, serious problems are created which cause loss of data from the transmitter. Every antenna cable should be installed in the location which will afford it the most protection.



Your antenna choice for a given project will be influenced by many factors. In some cases, only one type of antenna will meet the requirements of a particular application. In another case, there might be two or three antennas that will do the job. Please be sure and talk with us about all the factors involved in your particular deployment. The right antenna is critical to system performance. Your choices are certainly not limited to the antennas listed above. Sometimes a custom antenna is required, and we have the expertise at Telonics to provide you with custom design services. *Gary Jones*



New Catalog Available

Several New Products!

The new Telonics VHF product catalog is off the presses and we're excited about getting it distributed. If you haven't yet received your copy, please give us a call and we'll be happy to send it to you.

One significant change in the new catalog is that it includes a greatly increased number of transmitting subsystems. Over the years we've developed a variety of new configurations and each was designed in response to specific requirements submitted from the field.

The MOD-225 and MOD-315 are good examples. Developed from the MOD-200 and MOD-300, the new subsystems are designed to provide longer operational life. In both instances, the needs of a particular study required that we increase the operational life of a given transmitter size without compromising pulse rate, pulse width or output power. The MOD-225 has already been used successfully on desert tortoises; the MOD-315 on bobcats, mountain lion kittens and juvenile deer. In addition, a variety of subsystems weighing under 20 grams have been included for the first time. While we have offered lightweight subsystems for a number of years, the number has been steadily increasing.

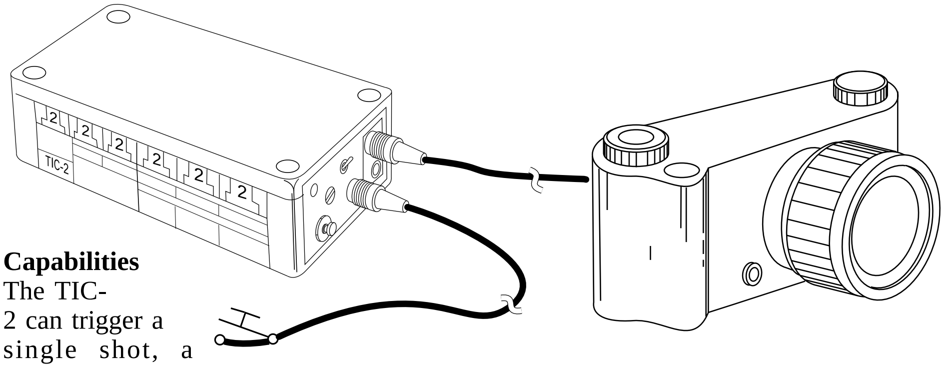
The TVR-1 Test Receiver is a new product and an article describing its capabilities appeared in our last issue of the Quarterly. The TVR-1 can be used to verify that a transmitter is operating properly at the time of deployment or when "exercising" transmitters during extended storage periods. It's small, easy to operate and, best of all, inexpensive! (i.e. $98)

While it's true that many of our products can now be listed in a catalog, we are still essentially producing custom equipment. That's not going to change. If you can't find what you want in our new catalog, don't hesitate to call 602-892-4444. We'll work with you on whatever your study requires, or we may be able to tell you about something new!

For example, our TR-4 Receiver is just completing prototype testing and we plan to test units in the field within 3-6 months. The TR-4 is a microprocessor controlled, fully synthesized receiver that will sell for about $600. (No, that's not a typo. It's the underfunded project's dream!) We'll publish more information about it just as soon as it becomes available.

In conclusion, we hope the new catalog helps you define your requirements more easily. Please don't hesitate to call with any questions or comments.

What is an Intervalometer?



The TIC-2 Precision Intervalometer Camera Control System is a highly flexible timing and control instrument. When combined with a 35mm, Super 8 or video camera, the TIC-2 allows the user to document events without the need for constant human observation.

Applications
The TIC-2 can be used for
. externally triggered photographic sequences,
. photographic documentation of presence or absence,
. time-lapse photography,
. remote triggering,
. or as a sequencer for aerial photography.

Camera Requirements
The TIC-2 can control cameras with an electronic shutter which can be triggered by the closure of the TIC-2's relay.
35mm cameras must have an autowinder to advance the film.

Capabilities
The TIC-2 can trigger a single shot, a programmable sequence of shots, a programmable number of sequences, or a specified run-time of either motion film or video tape. The unit operates continuously when you turn it on, or it can be activated via input from various types of sensors.
In the latter case, the sensor will detect the presence of the subject and trigger the TIC-2. In addition, the TIC-2 incorporates an "available light" sensor. This prevents the unit from exposing film when it is too dark for acceptable pictures.

Triggering Sensors
External triggering of the TIC-2 is easily accomplished by any switch closure. Some of the common types of sensors with switch closures include passive infrared detectors, pressure mats, and radar detectors.

Timing Options, Still
. 1 to 9 picture sequences, or continuous sequences following activation.
. 1 second to 9 hour timing interval between sequences.
. 1 to 9 picture frames in each sequence.
. 1/4 second to 90 seconds between picture frames.

Timing Options, Motion or Video
When used in conjunction with a movie or video camera, the TIC-2 allows for the control of burst modes ranging from 1/4 second to 810 seconds.
(Note: Burst mode is defined as the programmed timing period the relay in the TIC-2 remains closed.) *Jim Carter*

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