# TELONICS QUARTERLY™

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## Data Acquisition

*Early systems*

The moment the first transmission was received from a radio collar deployed on a wild animal, excitement began to build over the possible applications of radio telemetry. However, the research biologist was then obliged to either spend the night shivering in his truck with head phones, or tracking the animal on foot while stumbling over cactus, logs, etc., and falling down embankments into streams. His next question was entirely predictable, "You mean I have to stay out here all night?" Thus, the notion of remote, unmanned data acquisition was born immediately on the heals of the first telemetry transmitter. Automatic data acquisition continues as a high priority to the research community.

The first systems available were analog data acquisition systems. Most of us are familiar with the "chart recorders" employed. Initially, the detected audio output from the receiver was virtually "pumped" into a chart recorder. The baseline signal looked like "grass" and every once in a while a strong deviation would occur as the transmitter pulsed (see Figure 1). Later, you could look at the chart recorder, count the number of pulses and even measure the time interval between pulses. If any noise was present, this system was marginal because noise bursts appeared just like a received signal from a transmitter, making data interpretation difficult if not impossible under certain conditions. By adding a signal conditioner and processor with signal-to-noise threshold control between the receiver and the chart recorder, much of the unwanted background noise could be eliminated. With the development of data processors (i.e. TDP-1 or TDP-2), analog data acquisition reached its zenith. These processors could output a signal proportional to the signal amplitude on one channel and the interpulse period on a second channel (Figure 2). These outputs eliminated searching through the "grass" and simplified reading the charts. This approach provided an easy way to distinguish between two transmitters on two different animals having two different pulse rates operating on the same "channel" or frequency. Further, it allowed distinguishing between various pulse rates of a single transmitter (i.e. active versus inactive pulse rate).

The next step in analog data acquisition involved adding a frequency scanning capability to the receiving system. The ability to automatically switch from channel to channel (frequency to frequency) was accomplished by scanning receivers such as the TS-1/TR-2. Often, a "marker" beacon transmitter with a unique pulse rate (usually a very short pulse interval) was placed on a particular frequency. After scanning through several transmitters, this unique pulse rate occurred, thus "marking" the scan sequence on the chart. Since "scanners" switch from channel to channel in a predetermined sequence, the marker transmitter could be considered channel 1. On a chart recorder, the dwell time on a given channel was translated to linear distance. Thus, the marker transmitter provided a time base for distinguishing among several transmitters being recorded on the same chart recorder.

Chart recorders in general provided vast amounts of data. These early devices were reasonably priced and quite durable under field conditions. However, in recent years they have gotten expensive — it is difficult to obtain even a "cheap" dual channel recorder for less than $1,000. But the main problem was the volume of paper generated. Someone had to analyze that paper — reams, and reams, and reams of paper. In fact, as you read this article, somewhere in your office are boxes and boxes of chart recording paper, and probably only a third of it has been analyzed. I am certain, however, that there is the commitment to go back through those vast reams to recover the data as soon as the graduate students return from the field...

*Stan Tomkiewicz*

*Note: This is the first in a series of articles describing the historical development of data acquisition systems.*

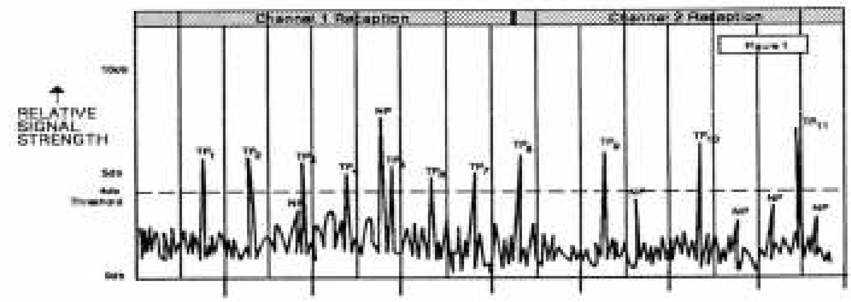



Chart record of early analog data acquisition system. Transmitter pulses are labeled $TP_X$. The pulse interval can be obtained by measuring the distance between consecutive pulses and converting to time by relating distance on the paper to chart speed (cm/sec). Note the confusion created by noise pulses (NP) intermixed with transmitter pulses. Further, recordings of this type are usually not practical in the field because they require a continuous and very fast recorder to obtain the kind of traces shown in the figure.

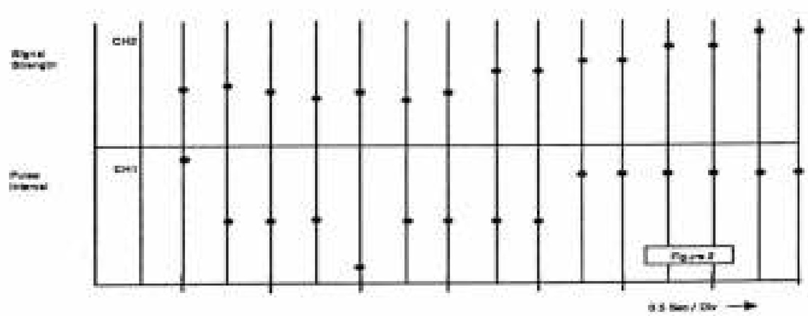



Chart record with processing and noise threshold setting at 4 db. Using the data from Figure 1, notice the subthreshold noise pulses (<4 db above the noise floor) are eliminated and the y-axis is proportional to pulse interval. A second channel records signal strength. Further, the "snapping pen recorder" used to obtain this chart was more practical in the field (low power). However, the timing of the "pen snapping" is independent of the incoming data. Therefore, it required sample-hold circuitry in the processor to present the data to the chart recorder when the pen was actually ready to "snap".

# Telonics Interactive Programming System

*Introducing TIPS*

ARGOS system users have long sought ways to have more direct control over the final software configuration of their PTT's (Platform Transmitter Terminals). In the past, this has been attempted by employing banks of DIP switches to control ID code and transmission repetition rate. Switches had several limitations, however, including the ability to modify only a few parameters. Some microprocessor driven PTT's allowed users to modify parameters in RAM (Random Access Memory). The disadvantage was that RAM is volatile and loses content, including user parameters, if power is interrupted. Recent advances in microprocessors have provided a new kind of memory known as EEPROM. An acronym for Electrically Erasable Programmable Read Only Memory, EEPROM has the advantage of remaining unaltered when power is removed. This makes it ideal for storing parameters in microcomputer based systems that may be susceptible to power interruptions.

This new technology is now available in a system called TIPS. The Telonics Interactive Programming System consists of special software and hardware interfaces that run on any IBM compatible PC. The capability allows researchers to modify previously programmed transmitters, helping them to respond quickly to new projects or new requirements. With TIPS, an inventory of transmitters containing a skeletal program can be sitting on a shelf waiting for an application. Researchers can adjust existing software parameters for themselves rather than submitting requirements to the factory. The new system is cost effective and easy to use.

To modify the skeletal program, a transmitter is connected to an IBM PC via a special interface unit called TPI (TIPS Programming Interface). A communications program and configuration file are loaded into the PC and the user proceeds to program the desired parameters. TIPS allows researchers to "tweak" parameters both during and after testing.

TIPS was first developed for the ST-5 ARGOS certified PTT, but other types of transmitters and receivers are utilizing the interface. It should be noted that different PTT hardware configurations are required to support certain software features. For instance, one ST-5 factory option is the installation of hardware for monitoring sea temperatures in oceanographic applications. Even though TIPS supports the modification of software parameters associated with the option, it is pointless (and could cause problems) if temperature monitoring hardware (i.e. internal circuitry/ external sensors) has not been installed.

The TIPS package (under $500) consists of the TPI, a diskette, and cables. The diskette contains the TIPS communications program and configuration file appropriate to the firmware being used. TIPS is compatible with all ST-5 transmitters incorporating the external programming option 102. Thus, as future ST-5's are added to the researcher's inventory, the necessary configuration files of user changeable parameters can be provided on an "as needed" basis.

TIPS runs on any IBM compatible computer, including lap tops. Using MSDOS Version 3.1 or later, the TPI connects to the PC using serial port COM 1 and a DB25 connector. The minimum memory requirement is 256K bytes.

TIPS operates by displaying one page of user changeable parameters at a time, and the initial display shows the parameters that were installed at the factory. The cursor is initially positioned on the first parameter at the top of the screen. When the researcher has modified the displayed parameter, the cursor moves to the next parameter and so on until all parameters have been examined or modified. When the researcher has finished modifying one page, the next page is displayed and so on. Normally, most PTT configurations can be supported using only two or three pages.

Parameters that can be modified include ARGOS identification code and transmission repetition rate. In addition, all researcher modifiable parameters associated with each PTT software type can be altered. For example, if temperature monitoring hardware has been installed, the user has full control over the number of thermistor ports being monitored, the number of samples taken, the time between samples and other associated parameters of the sampling regime. After all modifications, the researcher can direct TIPS to produce a printed copy of the current set of parameters.

While TIPS allows great control over the final programmed PTT parameters, the capability should be exercised with much care. An exhaustive test procedure should be applied to each PTT after it is programmed and before it is deployed. If testing is based upon actual data transmission through ARGOS and the comparisons have been made with predicted values, users can be assured that PTT's will operate successfully.

*Paul Beaumont*

# Transmitter Attachment Collars

*What's best?*

A wide variety of collar types have been developed over telemetry's brief history. This article focuses on what many consider to be "standard" (a misnomer) collars for attachment to mammals.

Each of the attachment collars that we deliver is handmade to the specifications provided for a particular application. Our "belting type" collars are provided with adjustment holes over the range of neck circumferences specified by the user. (Our collar designations CSM, CMM, and CLM simply denote general size classes of collars.) Custom attachment hardware is also provided. This allows easy fitting and attachment of the collar in the field.

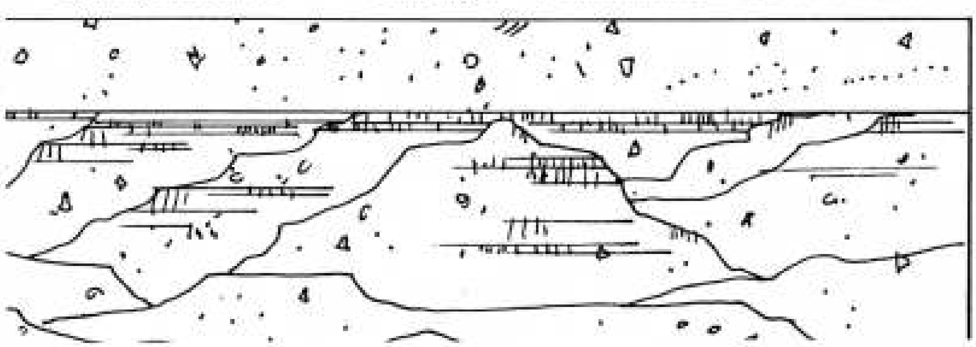
Butyl belting has been found to be a very good material for many applications. Butyl is durable, withstands extreme environmental conditions, does not absorb moisture, and remains relatively flexible in cold temperatures. Urethane belting, flat nylon webbing, tubular materials, and metal ball-chains are preferred materials in other applications.

Our records provide collar adjustment ranges used previously on numerous species in different areas. This is useful for users who are unsure of the range of neck circumferences which may be encountered in their study animals. It is important to realize, however, that there can be considerable variation in appropriate collar circumferences even within a species. Consider the differences between males and females of many species, or differences in size between certain subspecies or populations. The more precisely the range of neck circumferences can be established, the better we can design the collar for a good fit. If there are questions regarding the proper circumference, it's normally considered better to overestimate than to underestimate; however, requesting excessively large adjustment ranges can result in a less than optimal fit. For example, if collars were requested with a range of 12-40 inches (30-101 cm), but actual neck sizes were all within the 14-20 inch (35-50 cm) range, the collars would work but

probably not fit as well as they could. The positioning of the transmitter and the shaping of the collar at the transmitter attachment point are normally based on the assumption that average neck size will be near the middle of the specified adjustment range.

In addition to collar material and circumference, the thickness and width of collars can vary. Smaller animals carrying smaller transmitter packages normally use thinner collars than those used on larger animals. Collar thickness can influence flexibility and durability. Collar width also influences these parameters and is considered important in how the collar "rides" on the animal. Two inch (5 cm) wide collars are frequently used for many large mammals. However, 3 or 4 inch (7.5 or 10 cm) collars are also used. Some biologists working with Black Bears prefer 1.5 inch (3.8 cm) collars, while others prefer 2 inch (5 cm) collars. Some researchers think a narrow collar is preferable because it presents less surface area in contact with the animal. Others think a wider collar is preferable because it distributes weight more evenly. Wider collars may also be more visible, which may be desirable in some applications but not in others.

Instead of simply being an old leather belt with a transmitter riveted to it, attachment collars are an important part of the transmitting subsystem. The collars should have minimal influence on the animal, securely support the transmitter package and antenna, and be easily attached in the field. Collars for large animals are typically expected to remain functional for years, despite often severe weather and physical abuse. Much thought has gone into our attachment collars. Optimizing them for each application requires input from researchers and field personnel. What neck sizes are required for your work? Perhaps measurements can be obtained from animals previously collared in your area or from captive animals. Thought should also be given to where and how tight the collar is fitted. Many animals have tapered necks and potential movement of the collar should be considered. Are there any specific considerations you know of relative to your study area or study animals? We want to work with you to perfect the design of your collars. *Bill Burger*



# Wildlife Satellite Telemetry

*A Progress Report*

In 1982, Telonics began developing a series of platform transmitter terminals (PTT's) designed to provide the wildlife field with satellite tracking technology. Since the ARGOS system provided us with our first cost-effective alternative to conventional VHF tracking, our interest was more than casual. The availability of the polar orbiting satellite allowed tracking animal movements over a wider area, acquiring data and positioning information on a more regular basis.

By 1985, satellite telemetry had graduated from the experimental to the operational. The pilot studies had established the feasibility of using ARGOS and the necessary systems developed at a remarkable rate. From our point of view as a research facility, it's been an exciting decade and we offer the following notes as a progress report.

**Wildlife Studies:** The original pilot studies on caribou and polar bears have expanded. With additional deployments in Alaska, Canada, and Norway, the relationships between large subpopulations scattered over wide geographic ranges can be assessed with high data recovery rates. Other studies have included grizzly bears, wolves, elk, bighorn, dall sheep, moose, deer, feral camels, elephants, ibex, sea turtles, several species of whales and seals, manatees, and dugongs. Most recently, experimental units have been developed for avian species. In total, wildlife tracking accounts for some 10-15% of total ARGOS utilization.

**Associated Technologies:** The growth in power source technology, software regimes for data collection, antenna design, and attachment proceedures has also been rapid. Low power, low current microprocessors allow PTT's to interface with new sensor technologies. The data sets, transmitted in both raw and processed formats, represent an area of tremendous growth. Sophisticated software regimes are available which allow long term data to be collected, processed and uplinked, or stored and uplinked at a later time.

**Location Capability:** Wildlife tracking uses varying degrees of position accuracy. Close cooperation with ARGOS Data Processing Centers, and information provided by local user terminals (LUT's), now permits researchers to relax or restrict criteria per individual study needs.

**Package Size:** The electronics package continues to decrease in size without any sacrifice in capabilities. Currently measuring 3.75 x 2.20 x 0.40 inches, it greatly increases the number of species which can be instrumented. The new ST-6 package, now entering production, measures 4.0 x 1.5 x 0.5 inches. The combination of small surface mount configurations and very advanced packaging opens the door to avian species and medium sized mammals.

**Battery Technology:** Transmitters are exposed to temperatures as low as -50° C, pushing the operation of the power supply to the limit. By working closely with manufacturers, cells are built to our own specifications. Packs are then assembled in our own lab to ensure reliability. The size, weight and performance of both primary and secondary battery systems, however, is still the factor that most limits our ability to deploy PTT's on smaller animals.

**Packaging and Attachment:** Our involvement with satellite telemetry arose from 20 years experience with VHF systems. While we draw on that experience in satellite work, we also have to accommodate new technology. In general, satellite PTT's are larger and heavier than VHF packages. Thus the attachment considerations are more critical as every attempt is made to minimize impact on the animal.

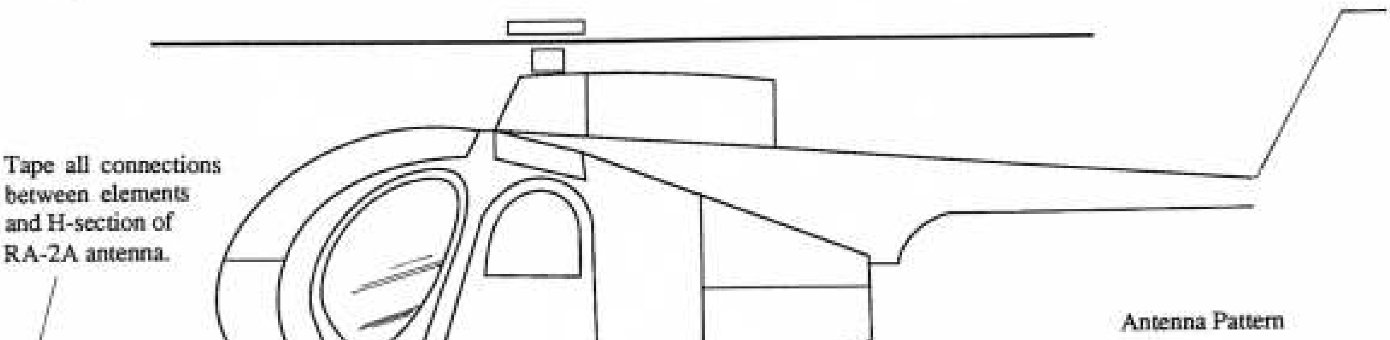
**Public Relations:** Wildlife instrumentation is a sensitive public issue. The various interfaces include the scientific community, funding agencies, native peoples, and the public in general. Everyone involved is concerned about the safety of the animal and the personnel who install the units. Consequently, we have always tried to emphasize that wildlife tracking is a partnership. The people who build transmitters, the people who deploy transmitters, and the people who recover data have to work in close cooperation if we're to achieve the success necessary to justify the work.

# Happy Holidays

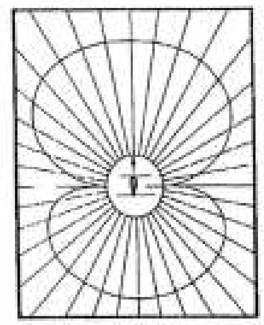
As we enter the holiday season, we would like to thank you for your continued support. We send our best wishes and our hopes for a safe, prosperous and happy New Year. The holidays are a time for families and friends. Telonics will close December 22 and reopen January 2, 1990. Until then, have a wonderful time!

# Helicopter Mounting Brackets

Although instrumentation of helicopters for radio tracking is often required during tracking and capture operations, mounting brackets have been custom made by researchers for each study and not readily available. The THB-1 bracket designed for the Hughes 500 series helicopters is simple to install and requires no permanent modification to the helicopter.




Antenna Pattern



The bracket attaches to either skid, and secures the RA-2A antenna into a forward looking position. This positioning results in a pattern which is easy to learn. The strongest signal obtained is directly in front of the helicopter and the pilot simply flies toward peak signal strength to find the transmitter.

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