Notes about Alert Radio Messages

Information transmitted in the Alert system is formed by a series of high and low tones. Listening to an Alert message is something like listening to a two-noted tuba player who rapidly plays "Um pah, Um pah, Um pah pah" until he completes a forty note song. Each note or tone is transmitted for precisely 1/300th of a second. The sequence of forty tones, each lasting 1/300th of a second, requires .133 seconds to complete the Alert data transfer.

The tones are used to represent ones or zeros, the basic building blocks used by all computers to represent numbers. Each note, i.e. one or zero, is called a bit in computer parlance. It is the combination of the forty bits into different sequences which convey the sensor ID and accumulator or data value.

In order to insure that what is being heard is the Alert system, a substantial portion of each message must follow a pre-defined pattern of high and low notes, i.e. ones and zeros. These framing notes, or bits, help to assure that we are receiving a complete message from one source; that we are not confusing parts of two messages or interpreting radio static as an Alert message.

The rules which govern the pattern of pre-defined, as well as changeable, ones or zeroes are called the format. A number of formats have been used in the Alert system in an attempt to convey the maximum amount of information. The pattern of bits (the format) must utilize enough pre-defined bits in a recognizeable pattern to assure that the message is part of the Alert system. The format must also provide enough flexible bits to convey the numbers which represent the sensor address and the data value. Inasmuch as different types of data have different requirements, it should be recognized that the bits required for effective transmission of one type of data are not necessarily optimal for other purposes. That format or pattern of bits which is in most widespread use in Alert is the binary format (see enclosure one). The organization of ten bits into a "word" is a convenience to allow us to count bit positions. Although this convenience is in common use, even the computer processes the bits by words, the actual transmitted bit stream has no separation of the forty bits. Each bit occupies 1/300th of a second and is immediately followed by the next bit.

In the binary format, all bits identified on enclosure one as S, 1, 0, or E must be transmitted and received as pre-defined tones in the sequence indicated. The A bits are flexible, they can be either tone representing ones or zeros, allowing the sensor identifier to be encoded with binary arithmetic. The D bits provide a similiar capability for the data value.

Enhanced formats have the capability of making more effective use of the bit structure in Alert data transmissions. One such enhanced format is listed on enclosure one. Variations of the format which can be clearly distinguished from other formats allow additional features to be added to the Alert system. An example of how wind gusts might be included in the basic wind message is given in enclosure two. These formats and others are being studied as they represent one of the least expensive techniques for a compatible extension of Alert system capabilities.

Bob Burnash
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ALERT DATA RECOVERY FACTORS

There are numerous factors affecting the recovery of Alert data transmissions. These factors include radio path, extraneous signals or noise on the assigned frequency, antenna efficiency (both gain and filtering capability), cable run between the antenna and the receiver, selectivity of the receiver, induced signals on the line between the receiver and the decoder, the audio output level recieved by the decoder, the length of the cable between the decoder and the receiving computer, and the effectiveness of all shielding and connections. Experience has repeatedly demonstrated that only if all of these potential problems have been minimized can the carrying capacity of the Alert system be maximized.

Other important factors involved in maximizing Alert system throughput are the length of each data transmission, the amount of intelligence conveyed with each transmission, and the number of transmissions per hour. The length of each transmission is controlled by the warm up time of the transmitter, the baud rate used for communication, and the number of bits used to form the message. The warm up time should be as short as possible consistent with activating the number of relays required for a station's data to reach the desired data recovery site. The baud rate utilized by the Alert system was initially set at 300 baud as that capability was most cost effective at the time the Alert system was devised. If other factors are properly optimized, the 300 baud system still has substantially more capability than the size of any existing network requires. A 1200 baud message could, on a totally optimized system increase the message conveyance by approximately 70% over the capability of a 300 baud system. The 1200 baud approach would, however, require some stations (only experiment would determine which ones) to be relocated. This problem is due to the increased problem associated with reflected signals (i.e. multiple path transmissions). Such transmissions rarely generate timing errors with 300 baud data rates however as communication speeds are increased through higher baud rates, the potential for producing framing errors which confuse the decoder are increased.

Regardless of all of the factors discussed thus far, the form of the Alert message - i.e. it's format - provides a unique potential for upgrading Alert systems. An improved format would provide an improved noninterfering capability for the future with no changes in hardware at any base station which does not employ a pre-processor in delivering its intelligence to the base station micro computer. Such a change would allow current Alert equipment to operate conjunctively with new equipment with only a very simple software modification. A suggested Alert format which provides this enhanced capability is outlined on the accompanying sheets.

Enclosure Two

Enhanced Wind Reports - Gusts Included

All gust reporting wind gages in the Alert system will utilize the enhanced format with ID checking for all sensors other than wind. The enhanced wind reporting format shall include gust information with each wind transmission through the use of the format below. Transmitters not equipped for gust sampling will transmit zeroes in the gust position.

	Bits									
1	2	3	4	5	6	7	8	9	10	
S	A	A	A	A	A	A	0	A	E	Word One
S	A	A	A	A	A	D	0	D	E	Word Two
S	D	D	D	D	V	V	1	V	E	Word Three
S	V	V	G	G	G	G	1	G	E	Word Four

Character	Purpose	Range
S	Indicates start bit	---
A	Indicates sensor identifier	4095
1	Used to confirm message form	--
0	Used to confirm message form	--
E	Indicates stop bit	--
D	Used to form wind direction counter	63
V	Used to form velocity accumulation	31
G	Used to form relative gust speed	31

Relative gust speed is determined by subdividing a kilometer of wind run into 15 increments of travel - the transmitter stores the elapsed time for the fastest 15th of a kilometer of wind run (i.e. shortest time) - as well as the total time for all increments. When the appropriate number of kilometers has elapsed for keying a transmission the gust factor will be transmitted with the regular wind report. The gust factor will be encoded as:

$$(S15/TT)*(465*KS)+.5$$

where:

S15 = Elapsed time for the fastest 1/15th of a kilometer of wind travel since the previous transmission.

TT = Elapsed time for the total number of kilometers necessary to key a transmission.

KS = The number of kilometers of wind travel which have been set for keying a transmission.

Enclosure One

ADVANCED DATA FORMATS FOR THE ALERT SYSTEM

All Alert data transmissions are based on the use of four words, each word is 8 bits in length plus a start and a stop bit. Total transmission length is 40 bits.

Binary Format - Negative Logic

SAAAAAA10E	SAAAAAA10E	SADDDDD11E	SDDDDDD11E
word 1	word 2	word 3	word 4

Enhanced Format - Negative Logic

SAAAAAA0AE	SAAAAAC0CE	SCCDDDD1DE	SDDDDDD1DE (B)
word 1	word 2	word 3	word 4

Bits used in both formats

	Format limit Binary	Enhanced
S indicates start bit		
A bits indicate sensor identifier	8191	4095
1 used to confirm message form		
0 used to confirm message form		
E indicates stop bit		
D indicates data value	2047	4095

Unique bit uses in Enhanced Format

C provides check of sensor id by verifying the number of 1 bits utilized in forming the id.

B optional battery level bit which transforms the normal 1 bit to a 0 when battery voltage drops below 12 volts.

The Enhanced data format:

1) Reduces the number of valid sensor id's to more correctly reflect the physical limit on the number of sensors which can transmit data on a single radio frequency.
2) Doubles the range of the sensor data value to allow increased effectiveness in evaluating river stage and other parameters with an extended range.
3) Provides id checking which reduces the probability of an incorrectly identified transmission to less than one error in eight thousand transmissions.
4) Provides an option which assists in the early detection of imminent battery failure.