NESS RF PROTOCOL

INTRODUCTION

This document defines the data transmission protocol, as developed by Ness, for short range, low power applications for nurse call and security system requirements. The RF carrier is modulated using on/off keying (ASK), and the state of each data bit is represented by a pulse width modulated (PWM) sequence.

A Ness codeword is comprised of a “start” bit followed by twenty-four (24) serially transmitted data bits, as defined below. The most significant bit (bit-1) of each codeword is transmitted first. A transmission batch consists of first sending a codeword, and then repeating the same codeword, with an “interword” gap between successive codewords. The usual interword gap is nominally 2 milliseconds, however, Smart-Caller has also utilised 5 millisecond interword gap in the past. New equipment should use a 2 milliseconds gap.

The duration of each transmission burst is not specified, however, a timed duration in the region 800-1000 milliseconds should suffice, i.e. 30-40 codeword repeats. The usual decoding process requires that a received codeword is not valid until three consecutive codewords within the same batch are received as identical codewords. A reduced burst length may degrade the decode sensitivity near the range limit, or with the presence of other on-channel transmissions of longer duration.

The Smart-Caller decoding devices associated with the HP2, HP3 and Safe-T-Net products are capable of detecting three different code formats, of which the Ness format is one. When a code is successfully received, the data is translated to a “standardised” 24-bit output format, before the result is stored in a buffer – this output format is quite different from the incoming Ness format. When the decoder buffer is interrogated by the equipment, the originating format is actually unknown. There may have been some past confusion on this issue.

RF MODULATION PROTOCOL

For the Ness format, the RF carrier is modulated using on/off keying (ASK), and the state of each data bit is represented by a pulse width modulated (PWM) sequence. A codeword consists of a “start” bit, followed by the twenty-four "data bit" sequences. Each new codeword is separated from the previous codeword by an “interword gap” period. For a transmitter device, the tolerance for all timing parameters is ±2 percent or ±20 microseconds, whichever is greater.

Start bit duration:	330 microseconds carrier <u>on</u> period
Data bit sequence:	Each data bit of a codeword is represented by a carrier <u>off</u> period, followed by a carrier <u>on</u> period.
Logic zero:	330 microsecond off period; 670 microsecond on period
Logic one:	670 microsecond off period; 330 microsecond on period
Total data bit duration:	1.0 millisecond
Interword gap period:	2.0 milliseconds

The time interval between the end of a transmission batch and the start of the next transmission batch should not be less than 100 milliseconds. The timing details associated with the modulation envelope are defined below.

Fig. 1: Data bit timing

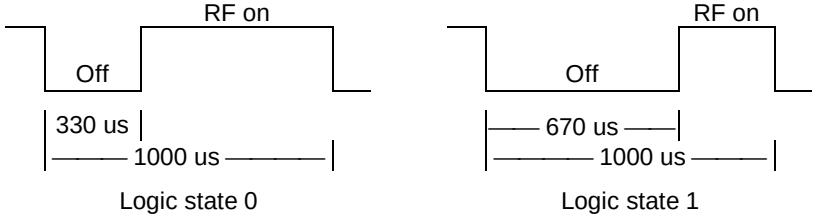
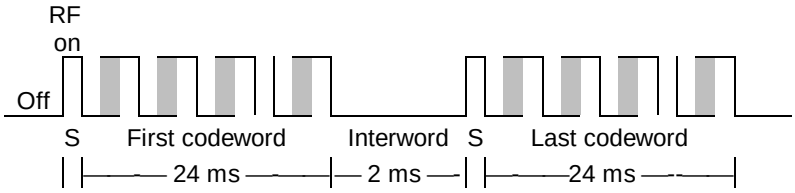


Fig. 2: Transmission batch format



NESS CODEWORD STRUCTURE

Each Ness codeword consists of twenty-four (24) data bits transmitted MSB first. There are actually two slightly different structures – the "traditional" Ness structure, and a modified Ness structure, used by many existing Smart-Caller products. The modified structure is a legacy requirement, originally introduced by Clift Electronics to provide a means of generating a "staff assist" alarm event for an early wireless callpoint product. The documented Ness protocol does not specifically allow for staff assist events.

The decoding devices associated with the HP2, HP3 and Safe-T-Net products utilise the modified codeword structure. There is further discussion below on compatibility issues when used in conjunction with transmitter devices originating from Ness.

Other Smart-Caller products that directly decode Ness format (and that do not have a need to respond to staff assist or alarm restoral events) will be totally compatible with Ness supplied transmitters. This includes recent hard-wired callpoint products capable of wireless actuation.

The format for each Ness codeword structure is shown in Figures 3 and 4. As can be seen, the role of Bit-16 differs between the two structures. The traditional structure has sixteen address bits to uniquely identify the wireless device, whereas the modified structure has only fifteen address bits.

Fig. 3: Traditional Ness codeword structure:

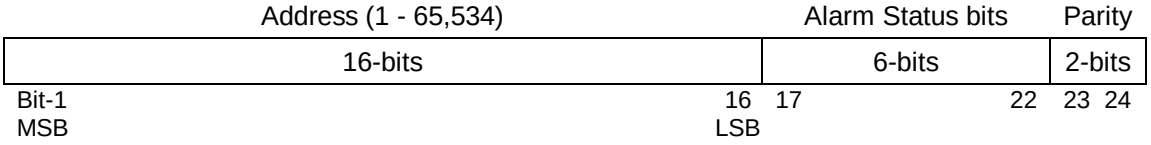
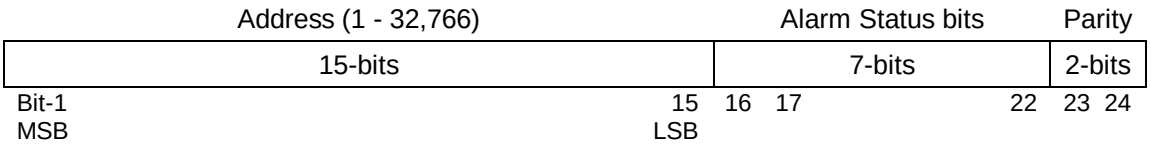


Fig. 4: Modified Ness codeword structure:



Traditional Ness structure:

Bits 1 through 16: Address field:

This field is expressed as a 16-bit binary number with an allowable decimal range 1 to 65,534. Bit-1 is the most significant bit. For reliable decoding, address values of 0 (all bits = 0) and 65,535 (all bits = 1) are usually invalid.

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Modified Ness structure:

Bits 1 through 15: Address field:

This field is expressed as a 15-bit binary number with an allowable decimal range 1 to 32,766. Bit-1 is the most significant bit. For reliable decoding, address values of 0 (all bits = 0) and 65,535 (all bits = 1) are invalid. For some decoding processes, bits 1 through 5 may also represent a "group" identification (31 groups available) to optionally provide a more selective decoding process.

Bit 16: Alarm status bit - staff assist alarm

This bit is available only for the modified Ness structure, to provide *staff assist* alarm status.

0 = no staff assist alarm event, 1 = staff assist alarm event active.

Note that this has opposite polarity to the other six alarm status bits 17- 22, where the active state is low.

For the decoders currently in use, a staff assist event will not be detected unless all other alarm status bits are also inactive high, with the exception of bit-20 for low battery.

Bit	16	17	18	19	20	21	22	Decoder O/P event byte
Battery OK	1	1	1	1	1	1	1	$09
Low battery	1	1	1	1	0	1	1	$29

Alarm restoral (cancel):

An alarm restoral (cancel) is another event that is available only with the modified Ness structure, so is appropriate to include at this point. For the decoders currently in use, a restoral event is assumed when all alarm status bits are inactive, with the exception of bit-20 for low battery.

Bit	16	17	18	19	20	21	22	Decoder O/P event byte
Battery OK	0	1	1	1	1	1	1	$03
Low battery	0	1	1	1	0	1	1	$23

The following description applies to both the traditional and modified Ness structures.

Bit 17: Alarm status bit - standard (nurse call) alarm

This bit usually provides for *standard* (nurse call) alarm status.

1 = no standard alarm event, 0 = standard alarm event active.

For the decoders currently in use, when this bit is active, all other alarm status bits are ignored, with the exception of bit-20 for low battery.

Bit	16	17	18	19	20	21	22	Decoder O/P event byte
Battery OK	X	0	X	X	1	X	1	$01
Low battery	X	0	X	X	0	X	1	$21

X = Don't care

This assumes a pendant device with bit-22 set to 1. For a Ness PIR device, with bit-22 set to 0, a different status bit is used as the alarm bit (see below). For the HP3 decoder only, if bit-17 *and* bit-22 are both clear, no alarm event will be output.

Bit 18: Alarm status bit - close (arm) command

This bit generally provides for a *close* (arm) command.

1 = no close event, 0 = close command active.

For the decoders currently in use, when this bit is active, all later alarm status bits are ignored, with the exception of bit-20 for low battery.

Bit	16	17	18	19	20	21	22	Decoder O/P event byte
Battery OK	X	1	0	X	1	X	1	$02
Low battery	X	1	0	X	0	X	1	$22

X = Don't care

This assumes a pendant device with bit-22 set to 1. For a Ness PIR device, with bit-22 set to 0, this status bit is used as the alarm bit for a *standard* alarm. At the present time, only the HP3 decoder will recognise this alternative bit usage.

Bit	16	17	18	19	20	21	22	Decoder O/P event byte
Battery OK	X	1	0	X	1	X	0	$01
Low battery	X	1	0	X	0	X	0	$21

X = Don't care

Bit 19: Alarm status bit - open (disarm) command

This bit provides for an *open* (disarm) command.

1 = no open event, 0 = open command active.

For the decoders currently in use, when this bit is active, all later alarm status bits are ignored, with the exception of bit-20 for low battery.

Bit	16	17	18	19	20	21	22	Decoder O/P event byte
Battery OK	X	1	1	0	1	X	1	$04
Low battery	X	1	1	0	0	X	1	$24

X = Don't care

This assumes a pendant device with bit-22 set to 1. For the HP3 decoder only, if bit-19 *and* bit-22 are both clear, no alarm event will be output.

Bit 20: Alarm status bit - low battery

This bit provides the current *low battery* status for the transmitting device, when applicable.

1 = battery OK, 0 = low battery.

The status of this bit is interrogated for all types of alarm event. For the decoder output event byte, bit-5 is set whenever low battery is detected.

Bit 21: Alarm status bit - unused

This undocumented bit is currently not used by any Smart-Caller application, and should remain at inactive high state.

Bit 22: Alarm status bit – device type

This bit provides for selection of *device type*, and is currently used for this purpose by Ness sourced equipment only.

1 = Pendant device, 0 = PIR device.

For the decoders currently in use, activation of this bit may also be used to generate a *test* event.

Bit	16	17	18	19	20	21	22	Decoder O/P event byte
Battery OK	X	1	1	1	1	1	0	$05
Low battery	X	1	1	1	0	1	0	$25

X = Don't care

Bit 23 & 24: Parity:

It is doubtful whether these bits were ever used by Ness. All Smart-Caller decoders ignore the status of these bits.

ALARM DECODE PRIORITIES

When the Ness format is decoded, it is theoretically possible for more than one alarm event to be active in a single codeword. With the exception of low battery status, this does not actually occur in practice, and would not be meaningful were it to do so. Hence, the general assumption is that each codeword shall represent only a single alarm event, plus low battery status. This means that the Ness translation process within the decoder should incorporate event prioritisation, with the first active event encountered representing the current alarm event.

For the HP2 and Safe-T-Net decoders, bit-20 is first examined to determine low battery status, and then the following bit sequence occurs – 17, 18, 19, 21, 22 and 16. Then if all bits are found inactive, a restoral event is assumed.

For the HP3 decoder, bit-20 is first examined, as above. Next, bit-22 is examined to determine the device type, and then the following bit sequence – 17, 18, 19, 21 and 16. Then if all bits are found inactive, a restoral event is assumed.

Note that the examination of bit-16 does not occur if any of the other alarm status bits are active. This allows compatibility of Ness sourced transmitters with the modified codeword structure. The only limitation in the conversion of a 16-bit address to 15 bits is that a pendant with an odd-numbered 16-bit address must not be used on the same system as a pendant with the next lower even-numbered address, since the two devices cannot be differentiated.

DECODER OUTPUT EVENTS:

The decoder devices for HP3, HP2 or Safe-T-Net equipments provide a 24-bit serial output, either as a synchronously clocked output, or in PWM format (2 ms per bit). The output format is independent of the received wireless format.

Fig. 5: Decoder output format:

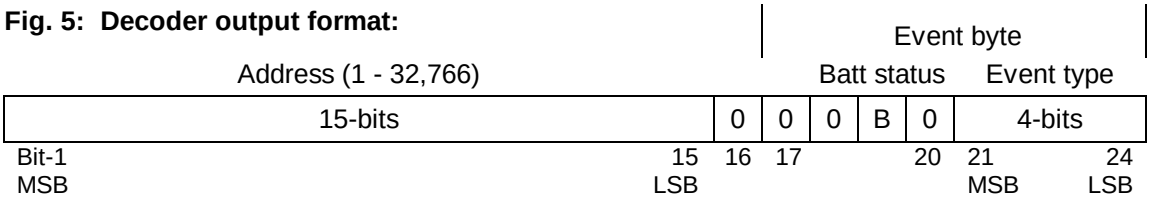

Table 1: Available event types:

Event type:		*Event description:*	
Decimal	*Hex*	*Medical application:*	*Security application:*
0	0	No event	No event
1	**1**	**Standard alarm**	**Standard alarm (panic)**
2	**2**	-	**Disarm (open) command**
3	**3**	**Alarm restoral**	**Alarm restoral**
4	**4**	-	**Arm (close) command**
5	**5**	**Test event**	**Test event**
6	6	Tamper or battery alarm	Tamper or battery alarm
7	7	Repeat alarm	-
8	8	Not allocated	Not allocated
9	**9**	**Staff assist alarm**	-
10	A	Nurse presence	-
11	B	-	Duress alarm
12	C	Power fail	Power fail
13	D	Power restoral	Power restoral
14	E	-	Man-down alarm
15	F	Not allocated	Not allocated

Highlighted event types show those that are available when decoding and translating modified Ness format.

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