Data Formats for IR Remote Control

In most remote control transmission systems, only small data rates are required for transmitting the control functions of home entertainment equipment. The reliability of the transmission is essential as an incorrect interpretation of a transmitted code is not permissible. Corrupted signals must be ignored. In most coding schemes, commands are repeated until the remote controlled device reacts as desired. The operator can directly observe the result of pressing a key by means of visual feedback.

Because IR signals are confined within a room and because there is only a short period of data transmission with each key press, there are no legal restrictions for IR transmission in the frequency band between 30 kHz and 56 kHz.

Several methods of modulation have become well established. A reliable and power saving transmission method in which bursts of the carrier frequency are transmitted is called “Pulse Code Modulation” (PCM). There are three commonly used representations of one bit in remote control systems which are described in the following diagrams.

The “Bi Phase Coding” has one rising or falling edge in the centre of each time slot (figure 1). In the “Pulse Distance Coding”, all bursts have the same length but the time between the bursts is different depending on the value of the bit (figure 2). In the “Pulse Length Code”, there are two kinds of burst lengths depending on the bit value (figure 3).

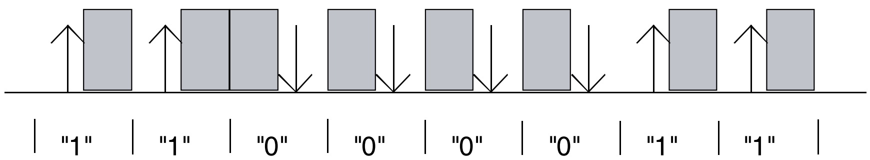

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Fig. 1 - BI Phase Coding (a rising edge within a time window is equivalent to a “1“, a falling edge represents a “0“)

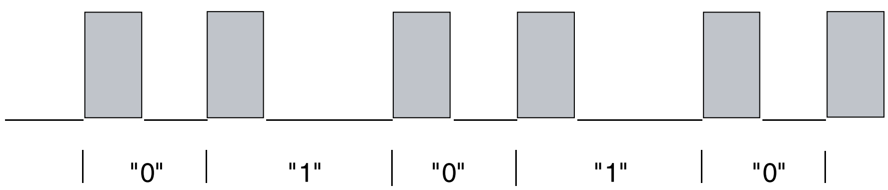

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Fig. 2 - Pulse Distance Coding

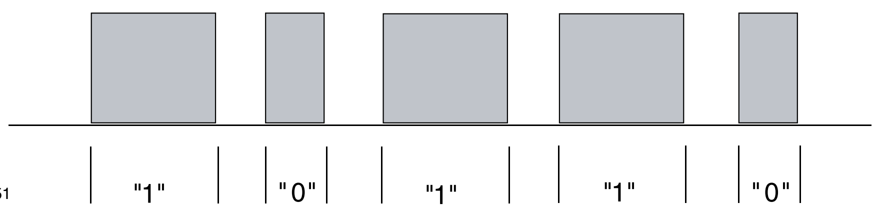

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Fig. 3 - Pulse Length Coding

The Vishay IR receiver modules were developed and optimised for use in all such carrier frequency burst transmission systems. Standard types are available for the frequencies **30 kHz, 33 kHz, 36 kHz, 36.7 kHz, 38 kHz, 40 kHz, and 56 kHz**.

In addition to different kinds of coding and different carrier frequencies, there are further variations in the data formats; with and without pre-burst, with different numbers of bits in a command, and with different bit lengths.

Almost all codes have address bits and data bits. For reliability reasons, some codes send the data twice, once inverted and once non-inverted. Usually the data command is repeatedly sent as long as the key is being pressed. There are different ways to distinguish between a multiple key press and an interruption of the transmission link (e.g. to avoid the TV selecting channel “11” when channel “1” was intended). Some codes use a toggle bit, which changes its value at each key-press. Some codes send a pre- or post-burst at the beginning and/or at the end of each key press. And some codes send the data only once for each key-press.

Two common data formats, the RC5 code and the NEC code, are described in more detail here.

THE RC 5 CODE

The RC 5 standard uses a bi-phase coding (see figure 4) the carrier frequency fixed at 36 kHz.
The transmission of a data word begins with two start bits followed by a toggle bit. The toggle bit changes its value at each new key-press. The five address bits represent the address of the device to be controlled. The six command bits contain the information to be transmitted.

Each bit in the data word consists of half a bit period with no transmission and half a bit period with a burst of 32 pulses at 36 kHz. The timing is shown in the pulse diagrams.
The most suitable IR receivers for receiving the RC5 code are those with the "AGC2" setting and a bandpass frequency of 36 kHz. Some examples are: TSOP1236, TSOP4836, TSOP34836, TSOP39236, TSOP36236.

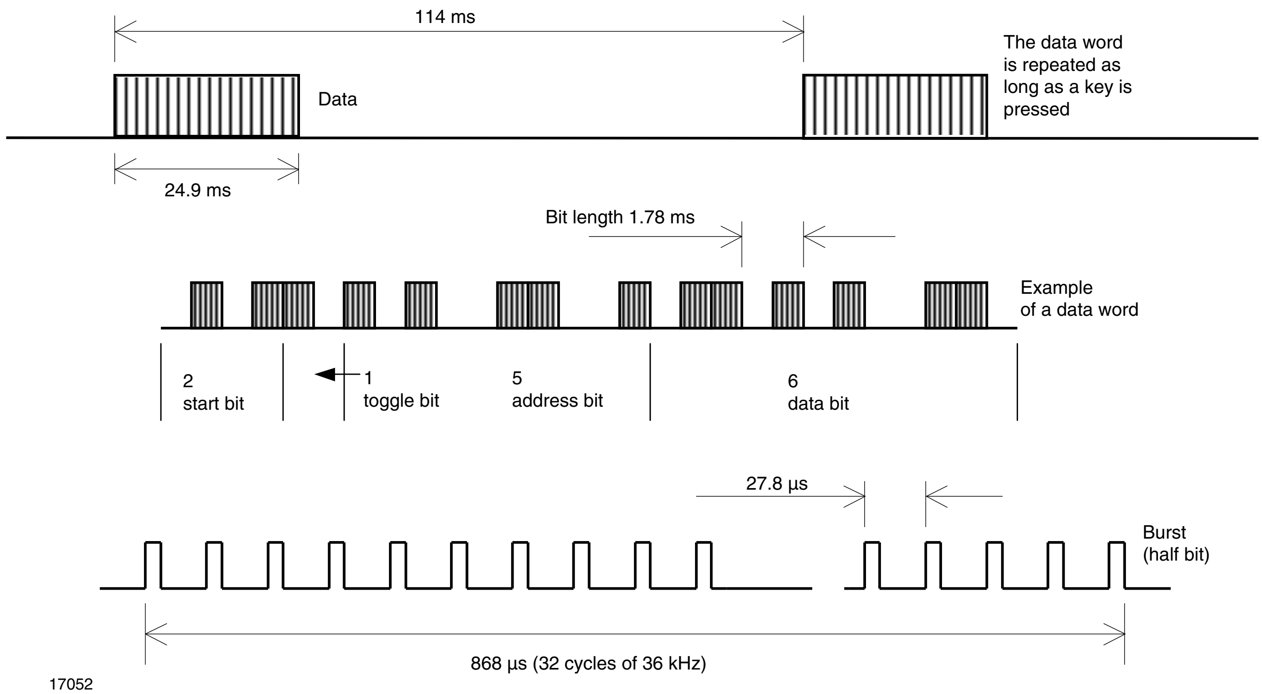

Fig. 4 - RC 5 Transmission Code

THE NEC CODE

The NEC code uses bursts at a carrier frequency of 38 kHz. All Vishay receiver modules operate well with this coding scheme, but those types with the AGC4 setting (e.g. TSOP4438, TSOP58438 or TSOP75438) have the best noise suppression while still supporting this data format.
The NEC code starts the transmission using a so called leader code, a burst with a length of 9 ms, followed by a pause of 4.5 ms and then the data word. The original purpose of this leader code was to let the internal control loops in the receiver modules settle. But such a pre-burst is not necessary for the Vishay receivers to function correctly. After transmitting the data word, only the leader code and a single bit are transmitted repeatedly for as long as a key is pressed. A special property of this code is a constant word length in combination with pulse distance modulation. Both the address and the data bits are transmitted twice, first as a normal byte followed by an inverted byte. This is shown in figure 5. The half period burst portion of each bit contains 22 pulses, each with a width of 8.77 µs and a period of 26.3 µs. A "0" is represented by a pulse distance of 1.125 ms and a "1" by a pulse distance of 2.25 ms. 8 address bits are used to identify the device to be controlled. A further 8 bits are used for the transmission of the command data. As mentioned above, the words are always followed, without a pause, by the inverted words. E.g., the transmission of the address word "00110111" and the command data word "000110" is performed by sending the bits:
"00110111'11001000'00011010'11100101".
In a special version of the NEC code, the pre-burst, including all of the address and data bits, is repeated in each 108 ms time slot for as long as the key is pressed.

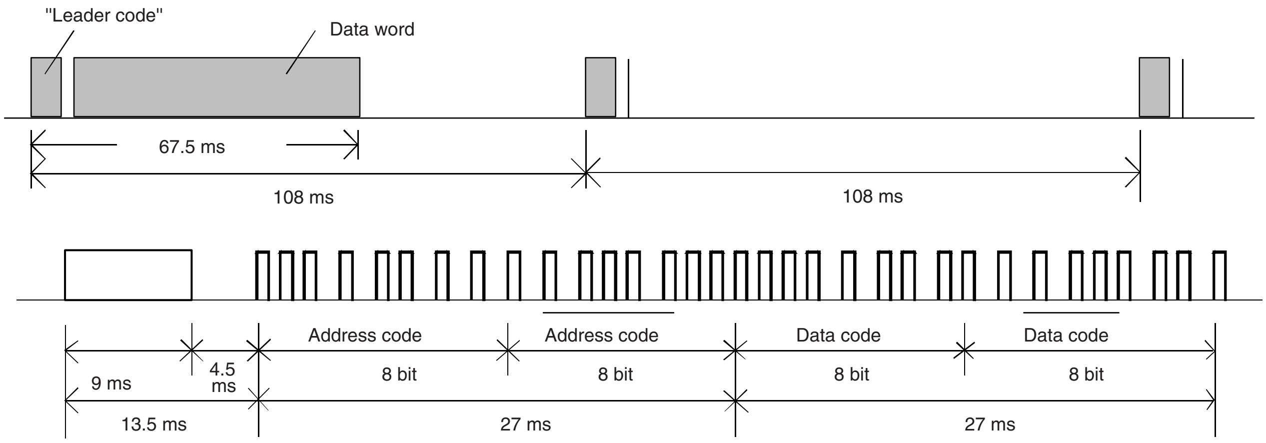

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Fig. 5 - NEC Transmission Code

DATA TRANSMISSION WITH THE TSOP RECEIVER MODULES

Although the TSOP receiver modules are mainly used for IR remote control, some of them are suitable for continuous data transmission as well.

For this purpose, we recommend those IR receiver types with the AGC1 setting, such as TSOP4140, TSOP38156 or TSOP36138. These receivers are suitable for continuous transmission and short bursts. Two examples for such continuous data transmission are shown in figures 6 and 7:

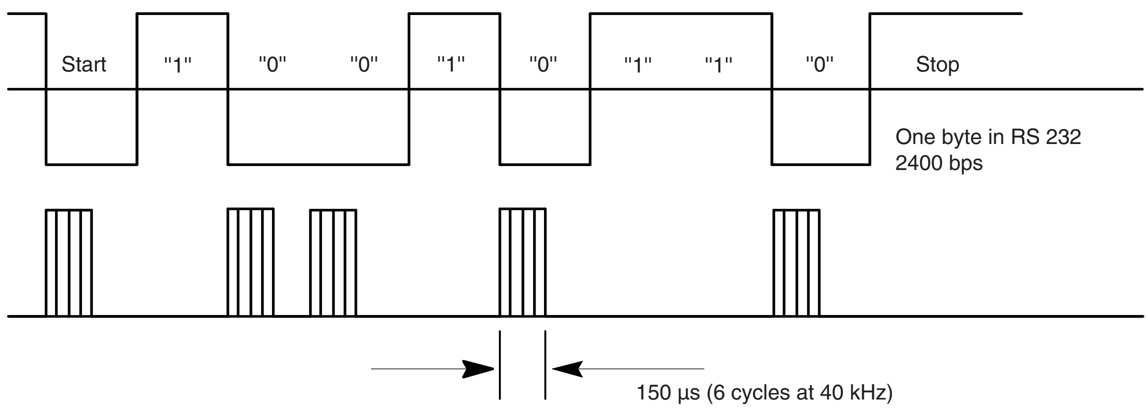

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Fig. 6 - Example of a Data Transmission at 2400 bps with TSOP4140

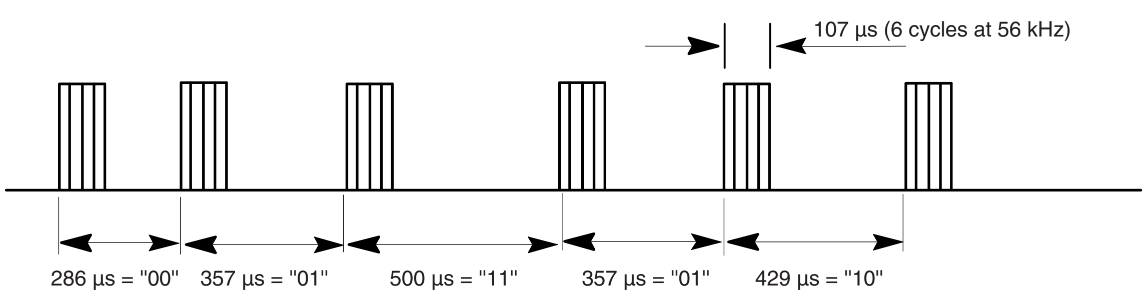

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Fig. 7 - Example of a Data Transmission at about 4000 bps with the TSOP83156

COMPATIBILITY OF THE TSOP RECEIVER MODULES WITH DATA FORMATS

Vishay offers a variety of IR receiver series in order to supply an optimised solution for each application. Guidelines for selecting the best part for each data format is given here.

Basically there are four categories of IR receiver settings regarding noise suppression and data format compatibility. The summary of the features of these AGC types is listed here:

AGC1 is compatible with any coding scheme, it is optimized for continuous data transmission.
AGC2 is optimized for most common remote control standard applications with typical long burst data formats.

AGC3 is optimized for short burst data formats in noisy environments.
AGC4 is optimized for most common remote control standard applications in very noisy environments (including dimmed LCD backlightings).
AGC5 is optimized for short burst data formats in very noisy environments.

Table 1 provides an overview of which IR receiver type can be used for the various data formats.

TABLE 1 - COMPATIBILITY FOR DATA FORMATS

	AGC1	AGC2	AGC3	AGC4	AGC5	BEST CHOISE
NEC continuous data frames	yes	yes	yes	yes	yes	AGC4
RC5 code	yes	yes	yes	yes	yes	AGC4
RC6 code	yes	yes	yes	yes	yes	AGC4
RCMM	yes	no	yes	no	yes	AGC5
Mitsubishi code 38 kHz	yes	yes	yes	no	yes	AGC5
Sony code SIRCS 12 bit	yes	yes	no	no	no	AGC2
Sony code SIRCS 15 bit	yes	yes	no	no	no	AGC2
Sony code SIRCS 20 bit	yes	yes	no	no	no	AGC2
r-map data format 38 kHz	yes	no	yes	no	yes	AGC5
r-step data format 38 kHz	yes	yes	yes	yes	yes	AGC4
r-step data format for keyboards 56 kHz	yes	yes	yes	yes	yes	AGC4
XMP-1	yes	no	yes	no	yes	AGC5
XMP-2	yes	no	yes	no	yes	AGC5
Low latency protocol - worst case frame 16 bit	yes	yes	yes	no	no	AGC3
Low latency protocol - extended frame 24 bit	yes	yes	no	no	no	AGC2
MCIR code keyboard package timing	yes	yes	yes	no	yes	AGC5
MCIR code pointing device timing	yes	yes	yes	no	yes	AGC5
MCIR code remote control timing	yes	yes	yes	yes	yes	AGC5
Konka TV data format	yes	yes	yes	yes	yes	AGC4
Panasonic/Matsushita command	yes	yes	yes	yes	yes	AGC4
Sharp data format	yes	yes	yes	yes	yes	AGC4

Document Number: 80071
Rev. 1.8, 28-Jul-10