# Data Formats for IR Remote Control

In most remote control transmission systems, only small data rates are transmitted to control the functions of home entertainment equipment. Most important is the safety of transmission where an incorrect interpretation of the transmitted code is not permissible. Unintelligible signals must be ignored. Usually, commands are repeated until the remote controlled device reacts as desired. The operator can directly observe the result of pressing a key by visual feedback.

Because IR signals do not exit a room and because there is only a short period of data transmitting at each keypress there is no necessity for legal guidelines of the coding in the frequency band between 30 kHz and 56 kHz and also at 455 kHz.

Some methods of modulation have been established. In order to achieve reliable and battery power saving, transmission bursts of the carrier frequency are transmitted. This is called "Pulse Code Modulation" (PCM). The three commonly used representations of one bit in remote control systems are described in the following diagrams.

The "Bi Phase Coding" has one rising or falling edge in the centre of each time chip (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).

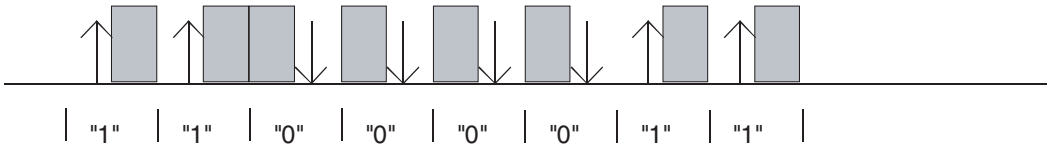


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Figure 1. BI phase coding ( a rising edge within a time window is equivalent to a “1“, a falling edge represents a “0“)

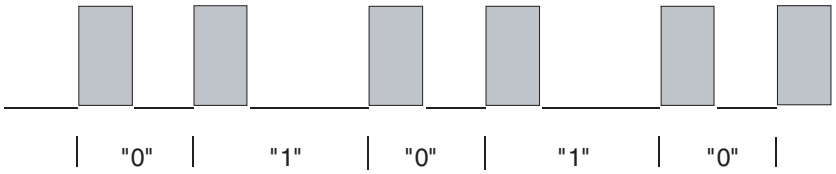


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Figure 2. Pulse distance coding

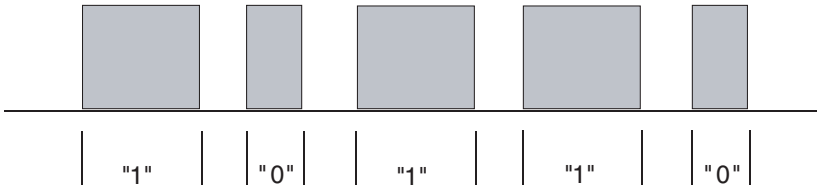


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Figure 3. Pulse length coding

The Vishay IR receiver modules are developed and optimized for use in such carrier frequency burst transmission. Standard types are available for the frequencies **30 kHz, 33 kHz, 36 kHz, 36.7 kHz, 38 kHz, 40 kHz, 56 kHz and 455 kHz**. Other frequencies in this range can be realized on request.

Beside the different kinds of coding and the different carrier frequencies there are further variations of data formats with and without preburst, with different numbers of bits in a command and with different bit lengths.

Almost all codes have address bits and data bits. For safety reasons some codes send the data twice (inverted and noninverted). Usually the data command is sent (repeated) as long as the key is pressed. There are different ways to overcome the difficulty of distinguishing between a multiple key pressing and an interruption of the transmission link (e.g. to avoid the TV selecting channel "11" when channel "1" is expected). Some codes use a toggle bit which change the value at each keypress, some codes send an indication for start and stop at the beginning and at the end of each keypress and some codes send the data only once at each keypress.

Two common data formats are described more in detail here: the RC5 Code and the NEC Code.

## The RC 5 Code:

In the RC 5 standard, a bi-phase coding is applied (see Figure 4). The carrier frequency is fixed at 36 kHz.

The transmission of a word begins with two start bits, followed by a toggle bit. The toggle bit changes its value at each key operation. 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 includes a burst of 32 cycles with a repetition rate of 36 kHz. The equivalent times are shown in the pulse diagrams.

The most suitable Vishay IR receivers for receiving the RC5 Code are: TSOP1236, TSOP2236, TSOP4836 and TSOP6236.

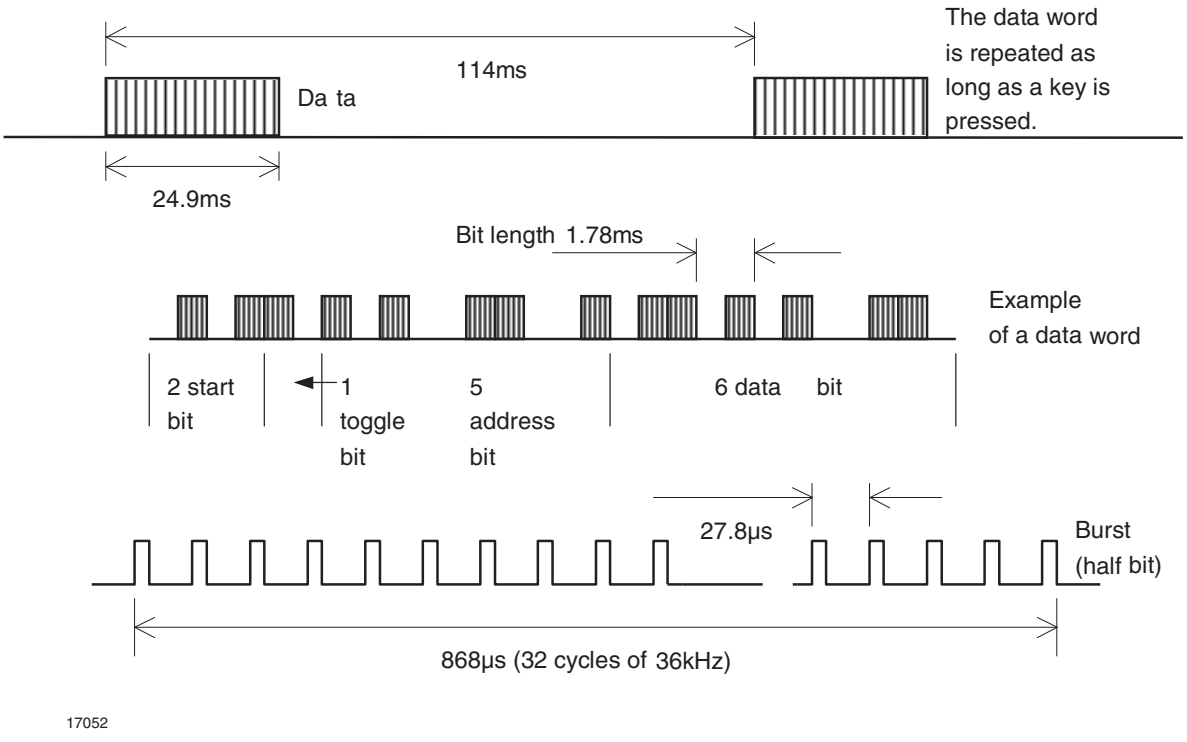


Figure 4. RC 5 transmission code

## The NEC Code:

The NEC code also works with bursts of a defined carrier frequency, which is 38 kHz. All Vishay receiver modules operate well with this system.

The NEC code starts the transmission using a so-called leader code, a burst of a length of 9 ms, followed by the data word after a pause of 4.5 ms. The initial idea of this leader code is to settle the internal control loops in the receiver modules. But for the Vishay receiver such a preburst is not necessary.

As long as a key is pressed, only the leader code is repeatedly transmitted, followed by a single bit. A specialty of this code is the property of constant word length in connection with pulse distance modulation. Both address and command bits are transmitted twice, first as the normal byte followed by the inverted byte. This is shown in Figure 5. The burst defining a bit contains 22 pulses each of a length of 8.77 µs with a period of 26.3 µs. A ”0” is represented by a pulse distance of 1.125 ms, the ”1” with 2.25 ms, respectively. 8 address bits are used to identify the device to be controlled. A further 8 bits are used for the transmission of the command. As mentioned above, the words are always followed, without a pause, by the inverted words, e.g. the transmission of the address ”00110111” and the command ”0001101” is performed by sending the word: ”00110111'11001000'00011010'11100101”.

A special version of the NEC code is with repetitive data. That means that each 108 ms the preburst including all the data is repeated as long as the key is pressed.

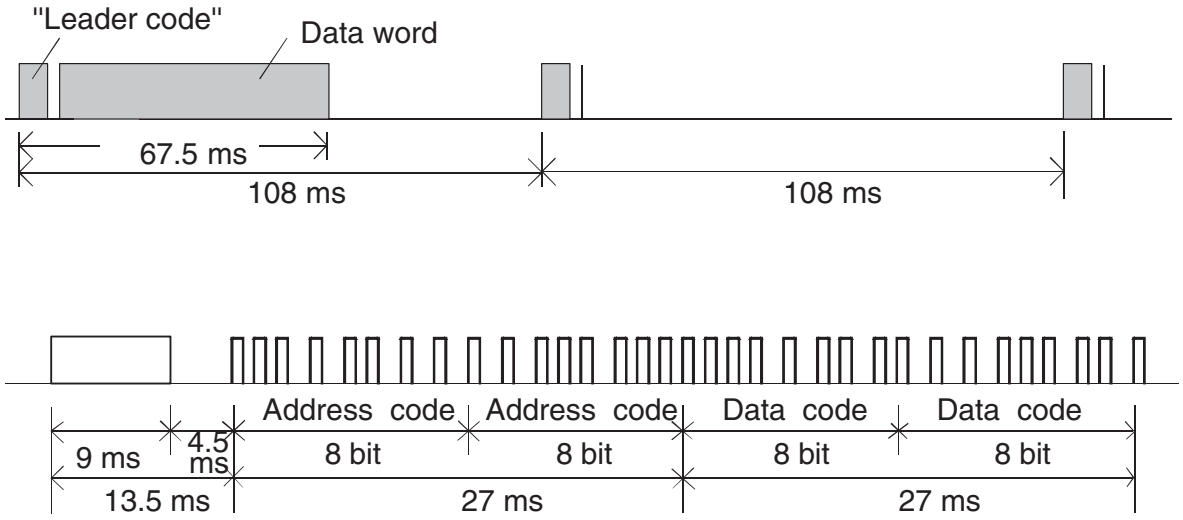


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Figure 5. NEC transmission code

## Data transmission with the TSOP Receiver Modules:

Although the TSOP receiver modules are mainly used for IR remote control, some of them can be used for continuous data transmission as well. For this purpose we recommend either the TSOP11xx, TSOP21xx, TSOP41xx, TSOP61xx series (data rate below 4 kbit/s) or the TSOP7000 and TSOP5700 (data rate up to 20 kbit/s). These receivers are suitable for continuous transmission and short bursts. Two examples for such a continuous data transmission are shown in Figure 6 and 7:

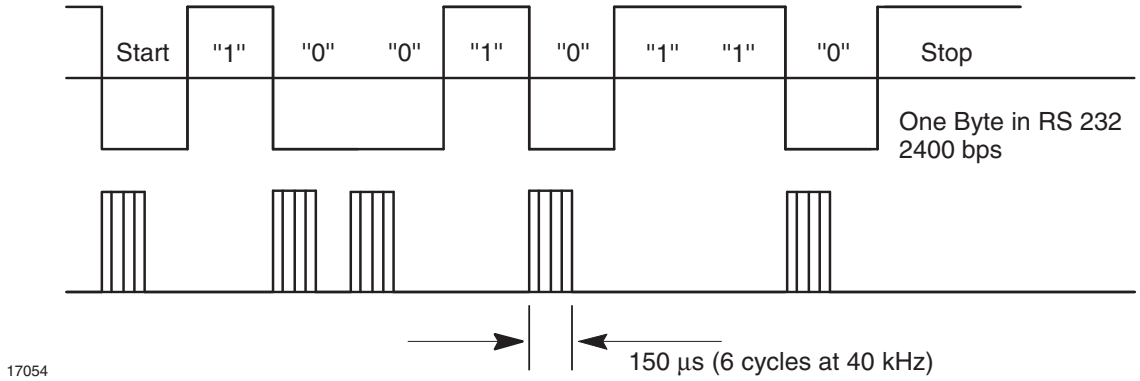


Figure 6. Example of a Data transmission at 2400 bps with TSOP4140

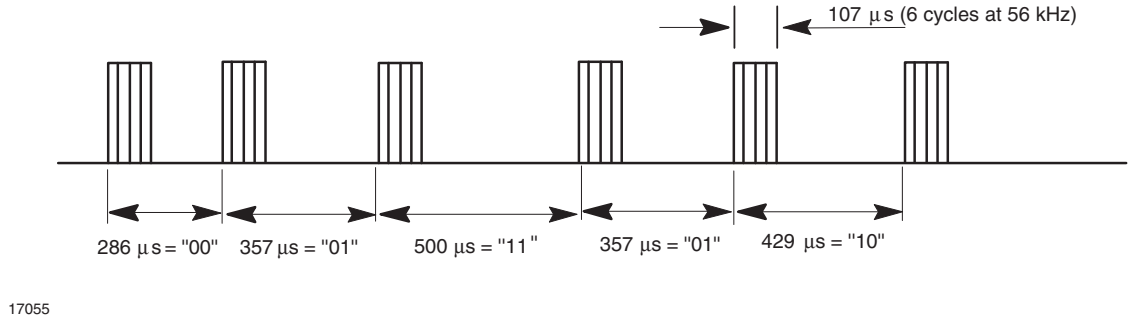


Figure 7. Example of a data transmission at about 4000 bps with the TSOP1156

## Compatibility of the TSOP Receiver Modules with Data Formats

Vishay can offer a variety of different IR receiver series in order to be able to supply the optimized solution for each application. Help in selecting the right part with respect to each data format is given here.

In case of an application for data transmission with a data rate above 4 kbit/s or in case of a carrier frequency of 455 kHz the selection is TSOP7000 or TSOP5700.

If the application is a normal IR remote control application (30 kHz to 56 kHz) or if it is operating at a lower data rate, then the customer has the choice among 3 categories of IR receivers:

1. For short bursts or continuous data transmission (e.g. TSOP11xx or TSOP21xx),
2. For standard remote control applications (e.g. TSOP12xx or TSOP48xx),
3. For operation under extreme disturbance conditions (e.g.TSOP24xx or TSOP44xx).

In table 2 and table 3 there is an overview which IR receiver type can be used for what kind of data format.

| | TSOP11xx<br>TSOP21xx<br>TSOP321xx<br>TSOP41xx<br>TSOP341xx<br>TSOP61xx<br>TSOP361xx | TSOP12xx<br>TSOP22xx<br>TSOP322xx<br>TSOP48xx<br>TSOP348xx<br>TSOP62xx<br>TSOP362xx | TSOP24xx<br>TSOP324xx<br>TSOP44xx<br>TSOP344xx | TSOP7000<br>TSOP5700 |
|---|---|---|---|---|
| Minimum Burst Length<br>(number of cycles of carrier) | 6 cycles | 10 cycles | 10 cycles | 10 cycles (22µs) |
| Minimum Gap Time between the bursts (carrier cycles) | 10 cycles | 14 cycles | 14 cycles | 12 cycles (26µs) |
| Maximum rate of data bursts | 2200 bursts/sec. | 800 bursts/sec. | 400 bursts/sec. | 20000 bursts/sec. |

Table 2: Data Signal Limitations for the Vishay IR Receiver Modules

The following table gives some examples of possible data formats:

| | TSOP11xx<br>TSOP21xx<br>TSOP321xx<br>TSOP41xx<br>TSOP341xx<br>TSOP61xx<br>TSOP361xx | TSOP12xx<br>TSOP22xx<br>TSOP322xx<br>TSOP48xx<br>TSOP348xx<br>TSOP62xx<br>TSOP362xx | TSOP24xx<br>TSOP324xx<br>TSOP44xx<br>TSOP344xx |
|---|---|---|---|
| NEC Code (repetitive pulse) | + | + | + |
| NEC Code (repetitive data) | + | + | - |
| RC5 Code | + | + | + |
| RC6 Code, Mode 0 | + | + | + |
| RC6 Code, Mode 1A | + | + | + |
| RC6 Code, Mode 1B (bi directional) | + | + | - |
| RC6 Code, Mode 2A | + | + | - |
| RCMM Code | + | - | - |
| RECS-80 Code | + | o | o |
| R-2000 Code (33 kHz) | + | + | + |
| Thomson RCA Code (56.7 kHz) | + | + | - |
| Toshiba Micom Format (similar NEC) | + | + | + |
| Grundig Code (30.3 kHz or 36 kHz) | + | + | + |
| Sony 12 Bit Code | + | + | - |
| Sony 15 Bit Code | + | + | - |
| Sony 20 Bit Code | + | + | - |
| Sharp Code | + | + | + |
| Kaseikyo Matsushita Code (36.7 kHz) | + | + | - |
| Mitsubishi Code (33 kHz, 16 bit) | + | + | + |
| Mitsubishi Code (38 kHz, preburst 8 ms, 16 bit) | + | + | - |
| Zenith Trackball Code (40 kHz) | + | + | o |
| Continuous transmission 4000 bps | + | - | - |
| Continuous transmission 1000 bps | + | + | - |

+: data format is suitable; o: data format is received with lower sensitivity -: not recommended

Table 3: Suitable TSOP Types for standard transmission codes