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 there is only a short period of data transmitting at each keypress there is no necessity for regulation of the coding in the frequency band between 30 kHz and 60 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. The three commonly used represent–ations 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 center of each time chip (Figure 4). 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 5). In the ”Pulse Length Code” there are two kind of burst lengths depending on the bit value (Figure 6).

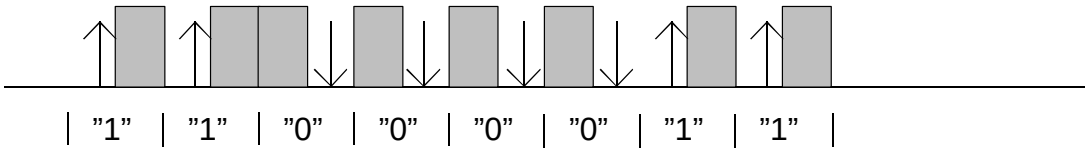

Figure 4. Bi–phase coding (a rising edge within a time window is equivalent to a ”1”, a falling edge represents a ”0”)

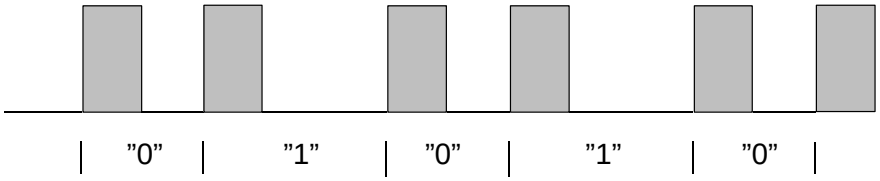

Figure 5. Pulse–distance modulation

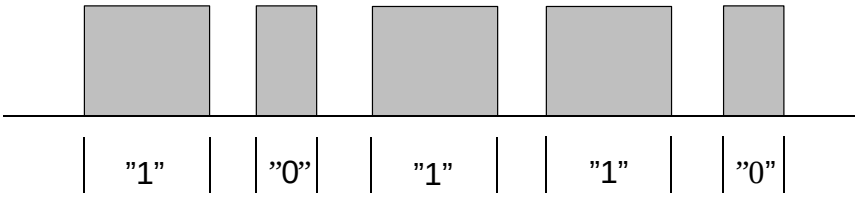

Figure 6. Pulse–length code

The Vishay Telefunken IR receiver modules are developed and optimized for the use in such carrier frequency burst transmission. Special types for different operating frequencies are available in the range from 30 kHz to 60 kHz. Standard types are available for the frequencies 30 kHz, 33 kHz, 36 kHz, 36,7 kHz, 38 kHz, 40 kHz and 56 kHz. Other frequencies in this range can be realized on request.

Beside the different kinds of coding and the different carrier frequencies there are also data formats with and without preburst, with different number of bits in a command and with different bitlength.

Almost all codes have addressbits and databits. For safety reasons some codes send the data twice (inverted and noninverted). There are different ways to overcome the difficulty to distinguish a multiple key pressing from an interruption of the transmission link (e.g. at the TV channel ”1” or channel ”11”). Some codes use a toggle bit which change the value at each keypress, some codes send an indication for start and stop before and after each command and some codes send the data only once at each keypress.

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

The RC5 Code

In the RC 5 standard, a bi–phase coding is applied (see Figure 7). 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 a data word consists of a burst of 32 cycles with a repetition rate of 36 kHz. The equivalent times are shown in the pulse diagrams.

All Vishay Telefunken photomodules can receive the RC5 Code correctly.

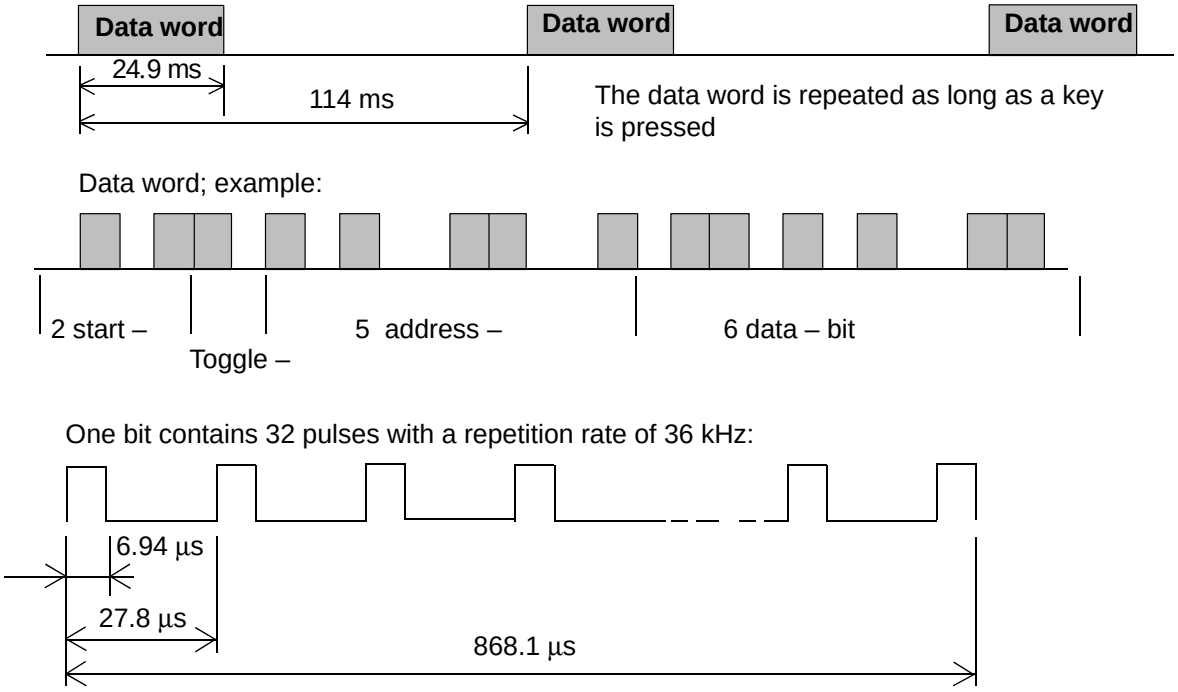

Figure 7. RC 5 transmission code

The NEC Code

The NEC code also works with bursts of a defined carrier frequency which is 38 kHz. All Vishay Telefunken receiver photomodules 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 Telefunken 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 a pulse–distance modulation. Both address and command bit are transmitted twice, first as the normal byte followed by the inverted byte. This is shown in Figures 8 and 9. 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 ”00011010” 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 the whole data is repeated as long as the key is pressed.

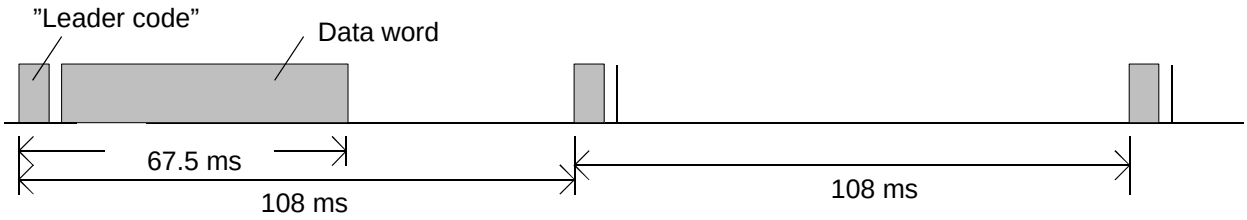

Figure 8. NEC transmission code (the leader code followed by a single bit is transmitted as long as a key is pressed)

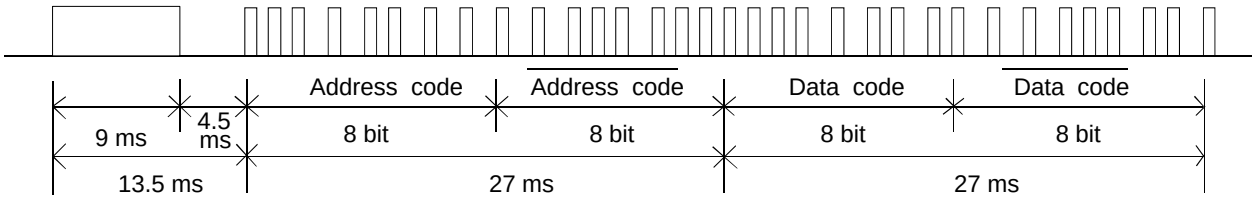

Figure 9. NEC transmission code (data word from figure 8)

Data transmission with the TSOP Receiver Modules:
Although the TSOP receiver modules are mainly used for IR remote control, some of them can also be used for continuous data transmission. For this purpose we recommend the TSOP11xx and the TSOP21xx series because they can receive short bursts (>= 6 cycles).

If a lower data rate can be accepted also the TSOP17 series will receive the signals correctly (burst length >=10 cycles). Two examples for such a continuous data transmission are shown in Figure 10 and 11:

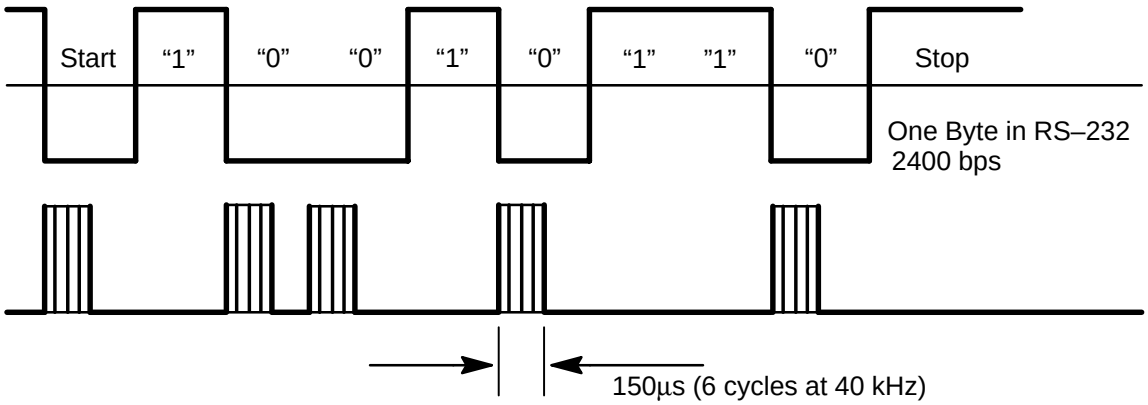

Figure 10. Example of a Data transmission at 2400 bps with TSOP1140

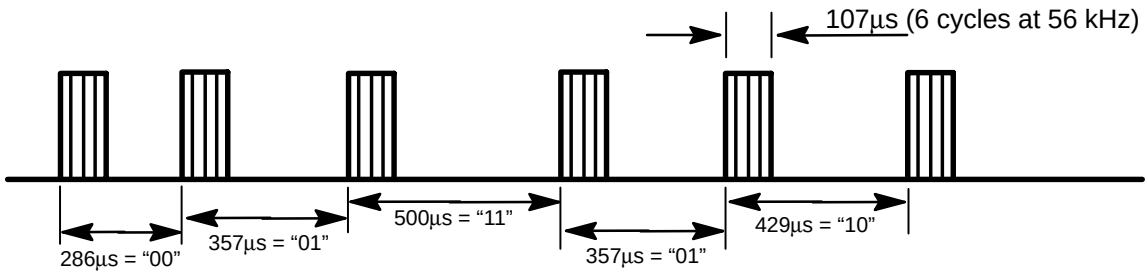

Figure 11. Example of a data transmission at > 4000 bps with the TSOP1156

Vishay Telefunken offers different IR receiver series in order to have an optimized solution for each application. The main differences are the following values:

Table 2. Data Signal Limitations for the Vishay Telefunken Photomodules

	TSOP11xx TSOP21xx	TSOP12xx TSOP15xx TSOP22xx TSOP48xx	TSOP 13xx	TSOP 17xx	TSOP18xx TSOP28xx	TSOP18 xxSS3V	TFMM 5xx0
Minimum Burst Length (number of cycles of carrier)	6 cycles	10 cycles	6 cycles	10 cycles	6 cycles	6 cycles	300 µs
Minimum Gap Time between the bursts (carrier cycles)	10 cycles	14 cycles	10 cycles	14 cycles	10 cycles	9 cycles	400 µs
Minimum Gap Time between the data commands	No limit	No limit	No limit	No limit	15ms	25ms	No limit
Minimum Gap Time in the data command if a burst is longer than 1.8ms	Burst length	4 x burst length	5.5x burst length	Burst length	No limit	No limit	1.3 x burst length

The following table gives some examples of possible formats:

Table 3. Suitable TSOP Types for standard transmission code

	TSOP11xx TSOP21xx	TSOP12xx TSOP15xx TSOP22xx TSOP48xx	TSOP 13xx	TSOP 17xx	TSOP18xx TSOP28xx	TSOP18 xxSS3V	TFMM 5xx0
NEC Code	+	++	+	+	+	+	+
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	+	–	++	–	+	+	–
R–2000Code (33kHz)	+	++	+	+	+	+	+
TCE RCA Code (56.7 kHz)	+	++	+	+	–	–	+
Toshiba Micom Format (similar NEC)	+	++	+	+	+	+	+
Grundig Code (30.3kHz)	+	++	+	+	+	+	+
Sony 12 Bit Code	+	++	+	+	+	–	+
Sony 15 Bit Code	+	+	–	++	+	–	+
Sony 20 Bit Code	+	–	–	++	–	–	–
Sharp Code	+	++	+	+	+	+	–
Kaseikyo Matsushita Code (36.7kHz)	+	++	+	+	+	+	+
Misubishi Code (33kHz)	+	++	+	+	+	+	–
Daewoo VCR Code (38kHz)	+	–	–	++	+	–	+
Zenith Trackball Code (40kHz)	+	++	+	+	+	–	+
Continuous transmission 4000bps	+	–	–	–	–	–	–
Continuous transmission 1200bps	+	+	–	++	–	–	+

+: data format is suitable; ++: optimum receiver for this data format; –: not recommended