MT-0003

Determining Infrared Carrier Frequency for a Remote Control

Purpose

The purpose of this document is to clarify the operation of commercial infrared remote controls and to instruct on determining the carrier frequency for a typical remote.

Parts Required

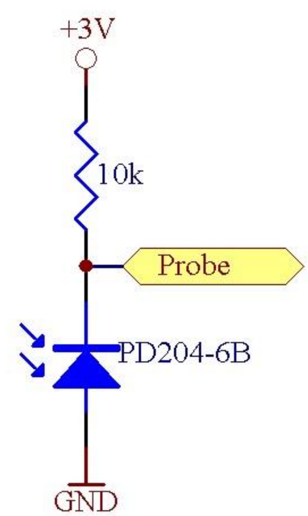
- Commercial remote control.
- Infrared photodiode e.g. PD204-6B from Everlight.
- 10 kOhm resistor.

Tools Required

- Multi-meter.
- Oscilloscope.
- (Variable) Power Supply.

Hardware Setup

It is important to understand that an infrared photodiode will detect the IR light and based on the intensity allow reverse current. For the purpose of this test, the photodiode will have to be reverse biased. The reverse current will have to be limited by a resistor. Determine the cathode of the photodiode using the multi-meter and set up the circuit as seen below.



The oscilloscope probe will be set between the resistor and the photodiode in order to determine the change in current through the photodiode. When the remote is pointed at the photodiode and a button is pressed, the scope should record a variation in voltage. This variation may be small so it is recommended to switch the measuring channel to an AC coupling and also the vertical scale should be reduced to about 500mV/div. Some trigger adjustment may be necessary as the pulses will most likely be below the level of the channel. Use the RUN/STOP button to capture a snapshot of a few milliseconds. Use the horizontal scaling to capture several pulse trains.

The resulting waveform should look similar to the image below:

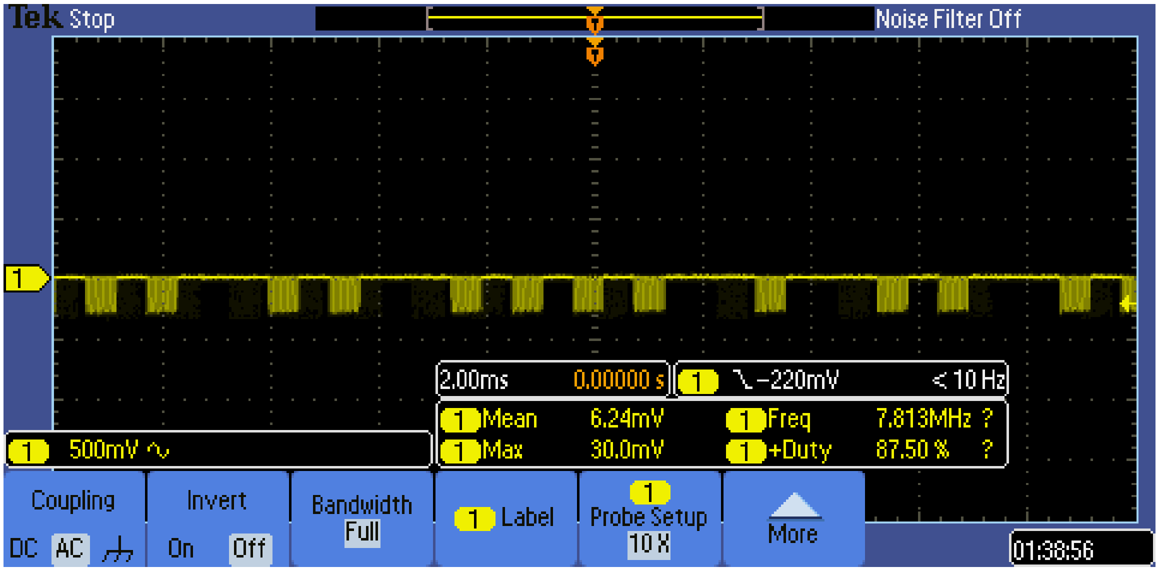


Figure 1 - Capture of IR data stream

Determining Carrier Frequency

To determine carrier frequency, zoom into one of the pulse trains from above. If the oscilloscope has poor resolution, recapture part of a pulse train again while zoomed in horizontally. As one zooms in, the periodicity will be very obvious.

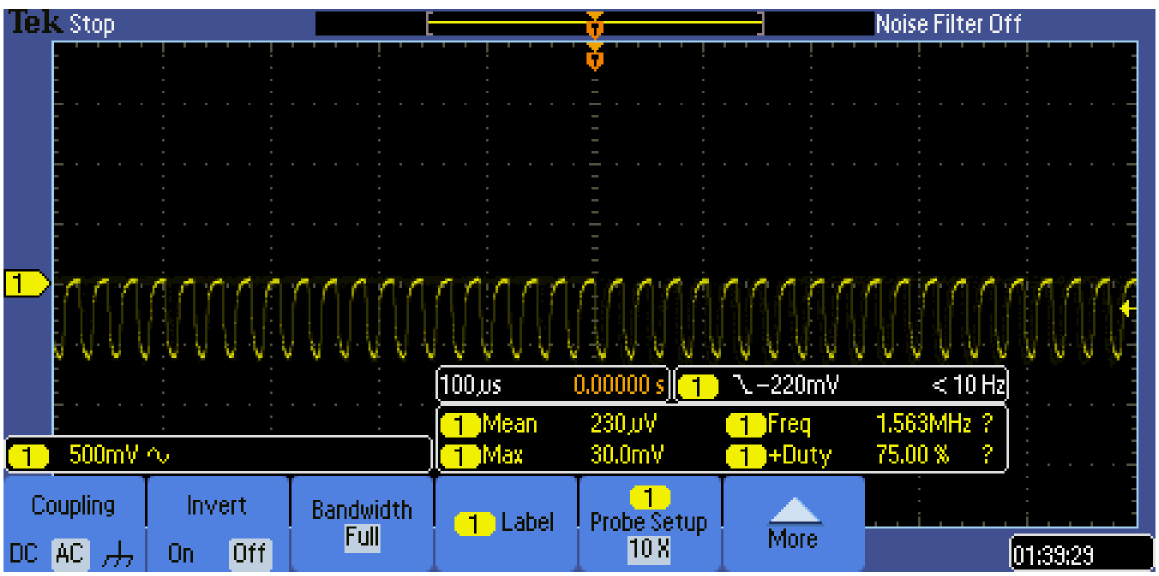


Figure 2 - Zoom-in of section

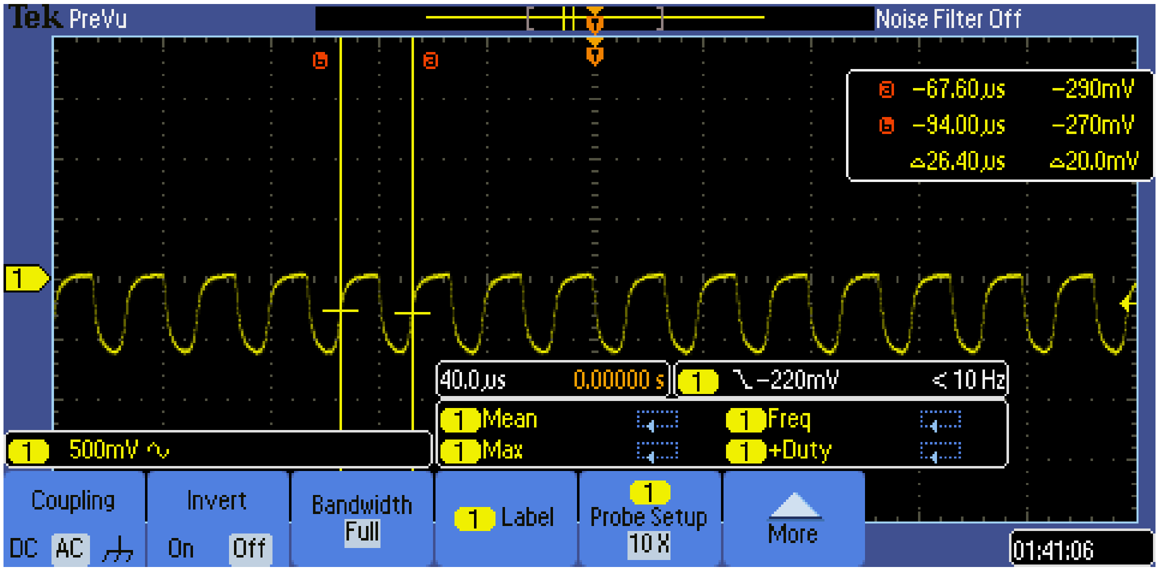


Figure 3 - Measurement of Carrier Frequency

As seen above, use the oscilloscope's cursor functions to determine the period of the waveform. Some oscilloscopes have a frequency measuring function directly built into the cursor functions. Other oscilloscopes do not have a cursor function at all. If this is the case, use the scale on the screen to estimate the period. In this last case, further zooming in might be necessary.

In the example above, it is clear that the period is approximately 26.4 us. The frequency can be calculated:

$$\mathrm{F} = \frac{1}{T} = \frac{1}{0.0000264} = 37{,}878\ Hz = 37.9\ kHz$$

In this particular example, it is obvious now that the carrier frequency is 38 kHz. Most IR transmissions have a carrier between 30 kHz up to 56 kHz with the most common commercial carrier frequencies being: **30 kHz, 33 kHz, 36 kHz, 38 kHz, 40 kHz, and 56 kHz**.

Interpretation

An IR receiver that matches the carrier frequency of the remote has to be selected. In this particular case, a 38 kHz receiver should be selected. Looking back at **Figure 1**, every part of the waveform that has the carrier frequency visible will be interpreted as a high level and every other part as a low level. The output of a 38 kHz receiver can be approximated by the red super-imposed trace below.

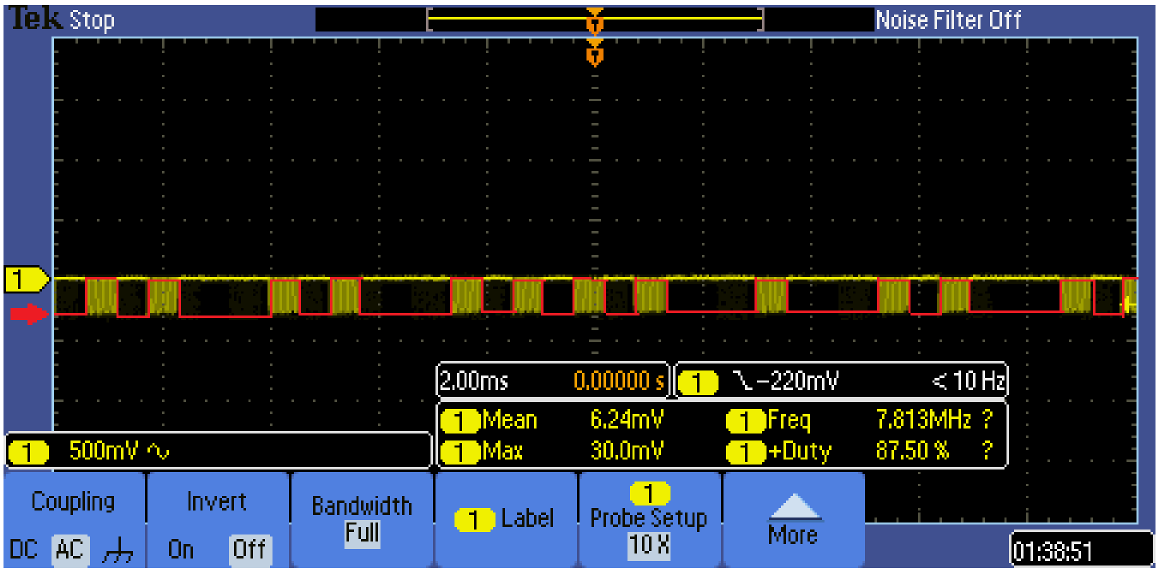


Figure 4 - IR Receiver Output

This signal still cannot be interpreted as-is. Looking at the signals above, it is obvious that the "high" levels are always the same length, but the "low" levels are not. This indicates a further coding of the data – in this case it is formatted as ***Pulse Distance Coding***.

Exploring this coding is beyond the scope of this document. More information can be found in document number *80071 from Vishay Semiconductors*.

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