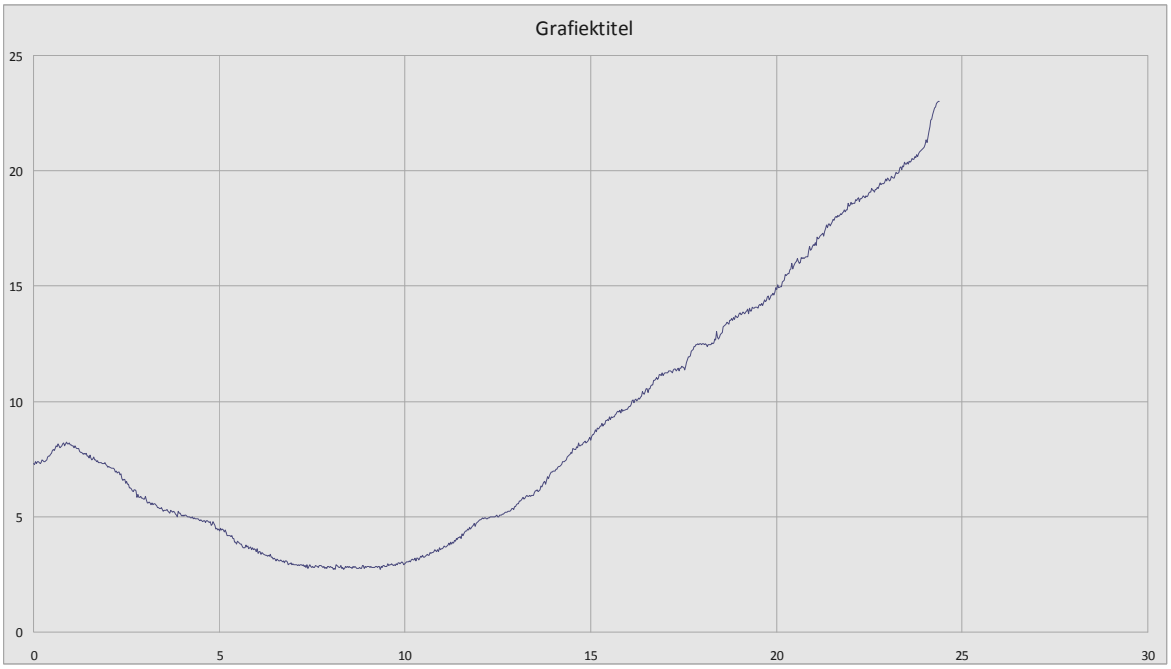
# IR_Reflection_distance_sensor

## The sensor system:

The sensor system makes use of an IR LED and a 38 kHz IR remote control receiver TSOP2138 arranged in a reflection setup. The signal is processed in a software routine running on an Arduino Uno.
The reflection distance signal is calculated from the values of a tuned IR LED output pulse frequency. In a timer interrupt routine, the IR LED output frequency is continuously adjusted in a range of about 20 discrete frequency settings on the edge of detection of the signal by the 38 kHz IR receiver. The IR receiver border of signal detection is in part depending on the actual signal frequency and the band filter characteristics of the remote receiver. If there is no signal detection, the IR LED output frequency is lowered in discrete steps towards the centre frequency of the 38 kHz band pass filter until the signal is detected by the IR remote control receiver. On detection, after a brief pause, the frequency is again raised in steps until the signal is no longer detected. Then after a brief pause the frequency is again lowered, and so on. The resulting IR LED output signal frequency continuously jumps around the border of detection. The differences of the used output frequencies from the centre or resonant frequency of the 38 kHz band filter are sampled in an Infinite Impulse Response filter. The resulting value relates to the actual distance of reflection of the IR signal. The second order response of the 38 kHz band filter in the IR remote control receiver allows for the interpolation of the relative position in relation to the discrete IR LED output frequency settings. The transmission characteristic of the 38 kHz band filter has a square relation to the frequency difference from the centre frequency, also the intensity of the reflected infra red signal has a square relation to the distance of reflection. As a result of these relations the proposed IR reflection sensor arrangement has a more or less linear characteristic in the range of practical use. The actual signal span and offset correction needed can be calculated in the distance() function in the software routine.

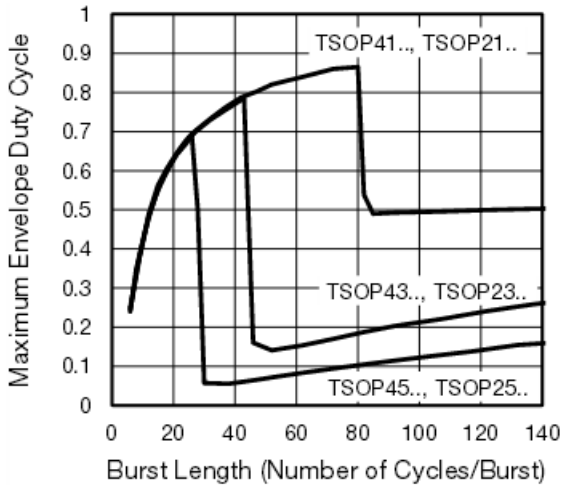
A test has been made, driving the IR LED with about 30 mA current. Reflection off a square foot of chip wood board:




Characteristic of the reflection sensor setup: Horizontal axle, reflection distance in cm. Vertical axle, resulting sensor values (no span or zero correction applied) recorded in the serial monitor from the Arduino Uno.

# The practical characteristics of the TSOP2138 (VISHAY):

An important feature of the TSOP2138 IR receiver is its envelope duty cycle of (more than) 50%.

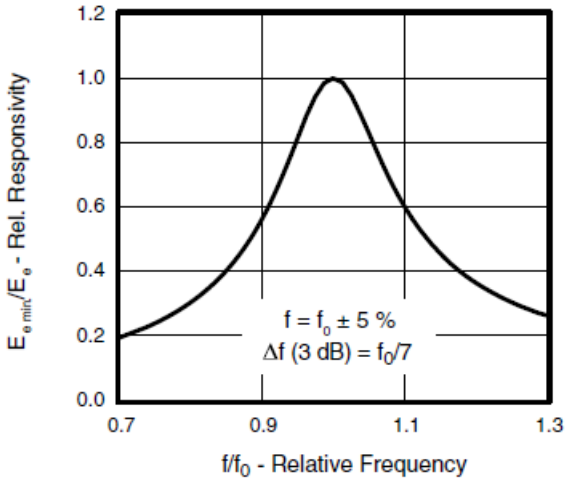



Max. Envelope Duty Cycle vs. Burst Length

The IR distance ranging routine of the distance sensor setup is continuously adjusting the IR emitting pulse frequency on the border of detection by the IR receiver. This results in a continuously on and off switching of the IR receiver output, hence an average envelope duty cycle of 50% results. The TSOP2138 sensor meets this requirement to handle 50% duty cycle at infinite burst length. Note, some 38 kHz IR receiver types do not meet this requirement. The shortest burst length is 18 cycles.

The linearity of the resulting reflection sensor distance signal is depending on the shape of the transmission characteristic of the 38kHz band filter in the IR receiver.

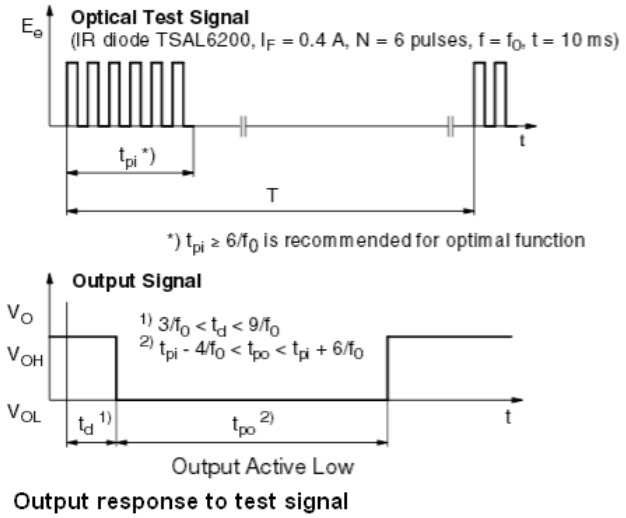
Relative Spectral Sensitivity vs. Wavelength




Frequency Dependence of Responsivity

The right hand side of the band filter curve is used. The inverted parabolic shape compensates for the quadratic relation between distance of reflection and the strength of the received IR light signal. The centre frequency $f_0$ of the used 38 kHz band filter of the IR receiver lays around 36 kHz. In the test setup, the used range in the program routine is $f_{min}$ = 35.9 kHz at most sensitive setting (corresponding to the max. reflection distance of 24 cm) and $f_{max}$ = 40 kHz the minimal used relative responsivity of 40% (corresponding to the shortest practical reflection distance of 10 cm).

The dynamic response of the 38kHz IR receiver depends on the characteristics of the 2nd order band filter. The excitation- respectively decay- time of the IR receiver band filter is approximately $6/f_0$ = 166 us:




**Output response to test signal**

The IR Distance Sensor Test Setup: