NCV75215R1GEVK – Ultrasonic Parking Assist Kit

EVBUM2895/D

NCV75215R1GEVK is Ultrasonic Parking Assist Kit to present full performance of the chip. User−friendly Graphical User Interface (GUI) makes it possible to operate the evaluation kit in an easy way. Easy access to several signals makes debugging very easy and gives you the possibility to understand full set of features of the chip.

Figure 1. Ultrasonic Parking Assist Kit

Features

- Measurement Distance Range from 0.25 m to 4.5 m (Depends on External Parts)
- Acoustic Noise Monitoring
- Diagnosis of Transducer Performance
- Junction Temperature Monitoring and Thermal Shutdown
- Transducer Center Frequency Range from 35 to 90 kHz
- Direct and Indirect Measurement Modes
- EEPROM Memory for Configuration Setting and User Data
- Rx Gain Adjustable in 0.5 dB Steps in the Range from 50 to 110 dB
- Time−dependent Threshold Values for the Sensitivity Control
- Dynamic (Time−dependent) Gain Control
- Tx Current Range Adjustable from 50 mA to 350 mA
- Programmable Ultrasonic Burst Length
- On−chip Bidirectional I/O Line

Table 1. RECOMMENDED OPERATING CONDITIONS

Symbol	Parameter	Min	Typ	Max	Unit
VSUP	DC supply voltage	6	12	18	V
IO	I/O line voltage	0		VSUP	V
DRVA	Transmitter phase A output voltage	0		2xVSUP	V
DRVB	Transmitter phase B output voltage	0		2XVSUP	V
DRVC	Transmitter common output voltage	0		VSUP	V
TA	Ambient temperature under bias	−40		85	°C

Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

NCV75215GEVK works together with USB−LIN Interface.

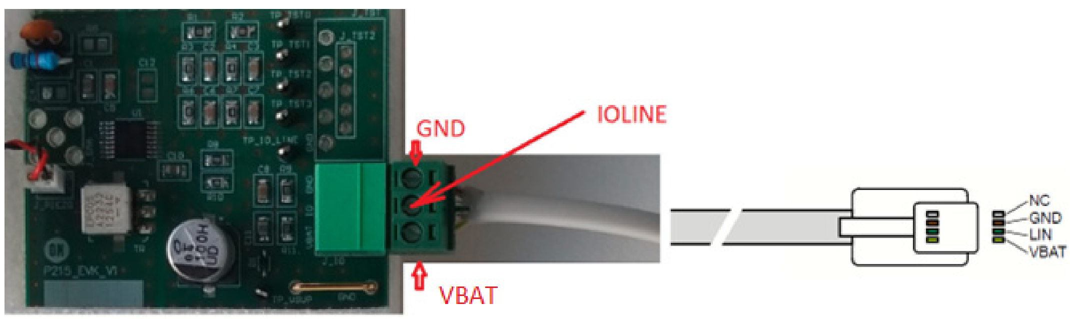

Figure 2. Connection of NCV75215GEVK to USB−LIN Interface

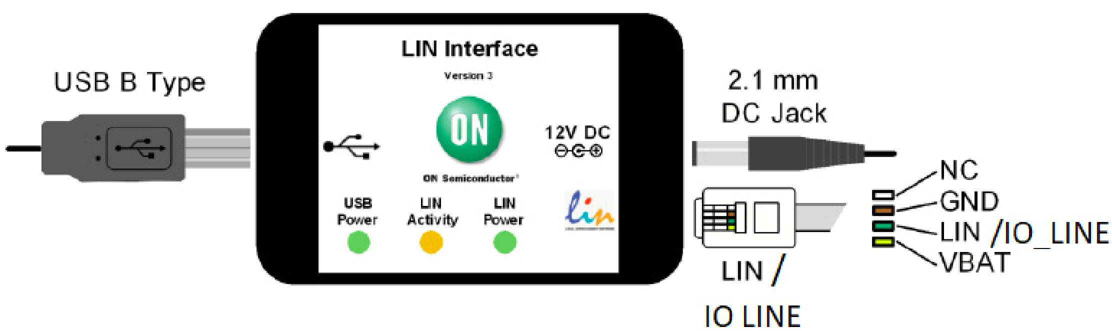

Figure 3. Connection of the USB−LIN to Power and PC

Getting Started

This section contains instructions for the NCV7430 setup configuration and first connection. Only a few steps need be proceeded to get fully working setup with NCV75215.

Please take the following steps to get a functional setup:

1. Install the NCV75215 Evaluation Software (see the NCV75215 Evaluation Software section for details). The USB drivers are included in the installation package. This installation requires administrator rights.
2. Connect LIN Interface to USB and wait until the device is installed. This step requires administrator rights.
3. Connect the boards according to figure below and run Evaluation software.

After running the file P215.exe, you will get following window – Figure 4:

Figure 4.

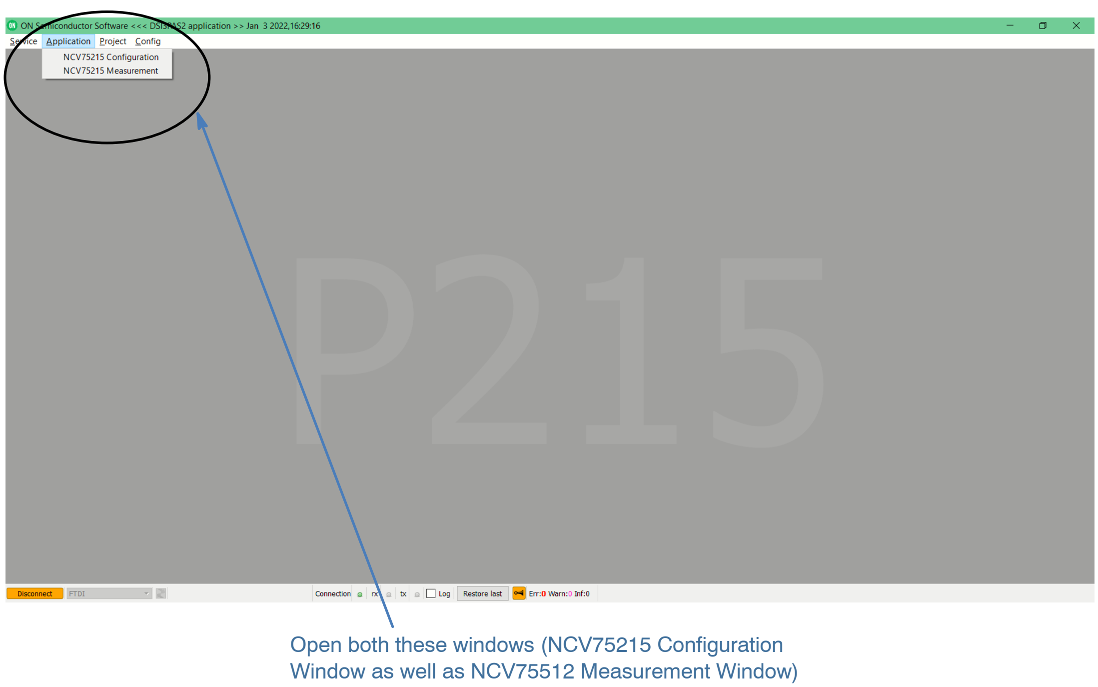

Figure 5.

You can use Configuration File provided together with this GUI – file name is P215_conf_v5.bench – Figure 6.

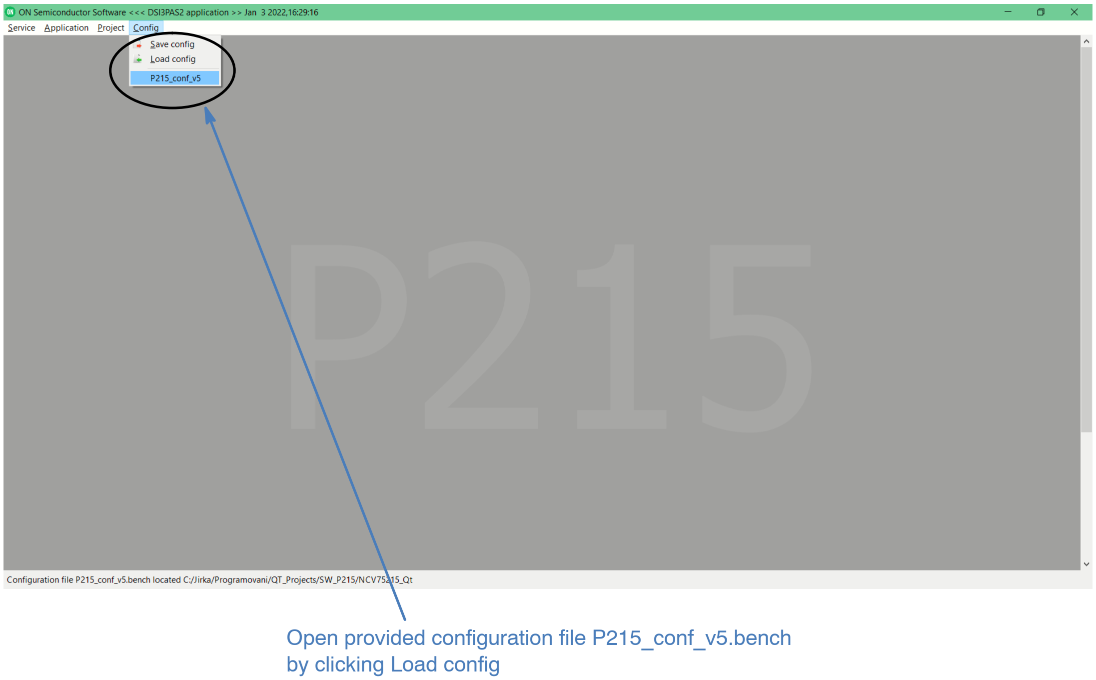

Figure 6.

Now you can configure NCV75215 GUI by opening NCV75215 Configuration window: – Figure 7.

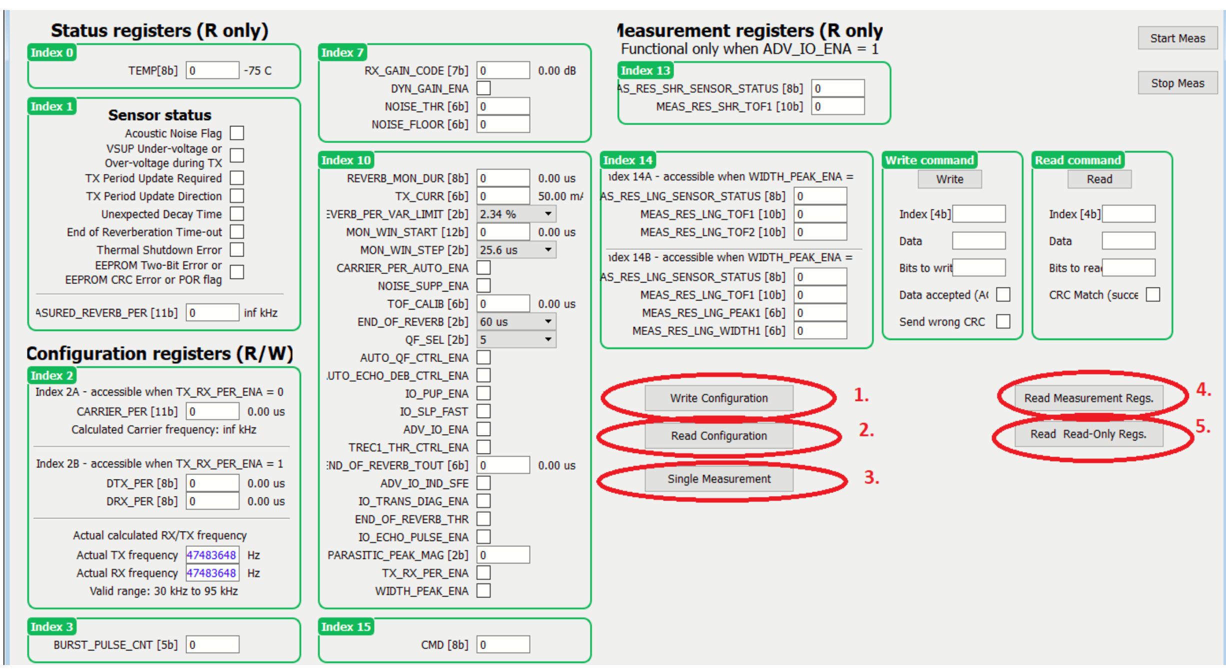

Figure 7.

In this window, you have access to all configuration registers. You can configure NCV75215 by clicking on button Write Configuration (*item 1* on the picture). You can read back configuration registers of NCV75215 by clicking on button Read Configuration (*item 2*). Then you can already start measurement by clicking on button Single

Measurement (*item 3*). When a measurement was performed, you can read Measurement registers (index 13 and 14) – by clicking on Read Measurement regs (*item 4*).

By clicking on Read Read−only regs (*item 5*), you can get chip’s junction temperature.

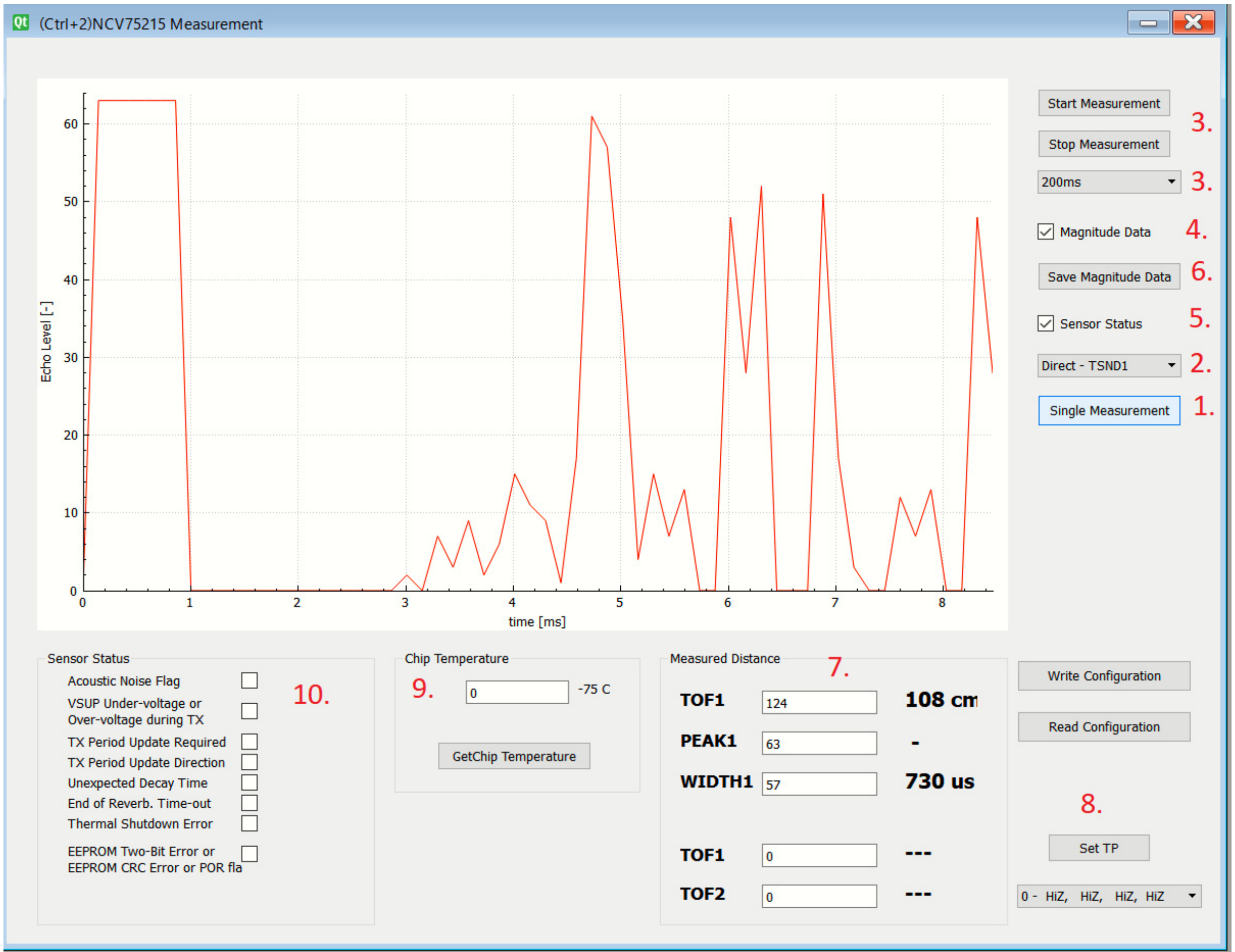

Figure 8.

Main Measurement window is present in Figure 8. You can perform single measurement by clicking on *Item1*. *Item 2* selects the direct / indirect measurement. *Item 3* starts periodic measurements with period 200, 500 or 1000 ms. *Item 4* enables Magnitude data at each measurement *Item 5* updates Sensor status at each measurement *Item 6* saves magnitude data into the csv file *Item 7* contains Measured distance *Item 8* selects Debugging output on TST0 to TST3 In *Item 9* you can read back chip’s temperature *Item 10* shows sensor status.

External ULS Components Basics

Key factor to get good ultrasonic performance is to select transducer, transformer and other components.

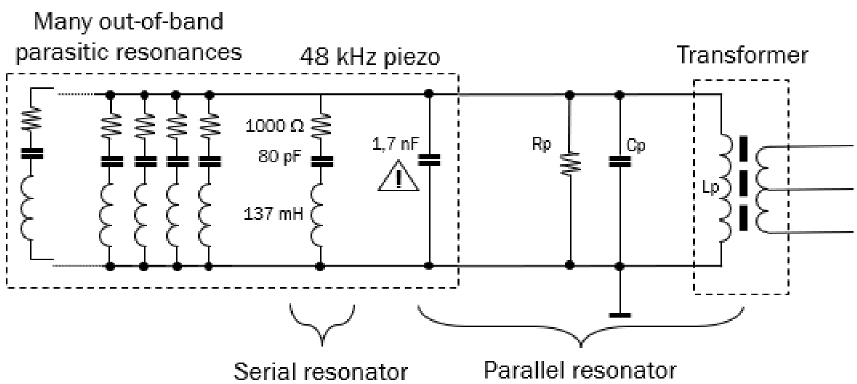

Figure 9.

You can find external components related to ultrasonic transducer in Figure 9. It is a coupled structure of 2 resonators. Parallel and serial resonators are tuned to the same frequency. The goal is to find Rp and CP value to get optimal tuning. It is discussed below.

There is replacement circuit in dashed rectangle – there is visible main serial resonator with frequency 48 kHz and many out of band parasitic resonances. There is also visible capacitor of the transducer – 1.7 nF.

How to Tune Parallel Resonator

In previous chapter we checked the external coupling structure (components around ultrasonic transducer) – transformer, Rp and Cp. Typically we select transducer, transformer and calculate Rp and Cp. Cp value affects the resonant frequency of the parallel resonator – it can be calculated by Thomson formula:

$$f_R = \frac{1}{2\pi\sqrt{LC}} \quad [Hz, H, F] \qquad \text{(eq. 1)}$$

Where

- L is the inductance of the secondary side of the transformer,
- C is sum of transducer capacity and value of external capacitor Cp.

Example:

Let's take the transducer from Figure 9, we know that it has capacity of 1.7 nF and resonant frequency 48 kHz. Let's assume that our inductance of the secondary side of the transformer is 4 mH.

Then we calculate the value of the Cp as 1 nF to get close to the 48 kHz (in this case 48.4 kHz, using formula above) which is sufficient.

Rp selects coupling between serial and parallel resonator. Typically this resistor is 5.6 kΩ.

Properly tuned coupling structure is reflected in shortest reverberation time and therefore minimum achievable distance detetcted by ultrasonic measurements.

It is recommended to check reverberation on the TP_TST0 pin on NCV75215EVK.

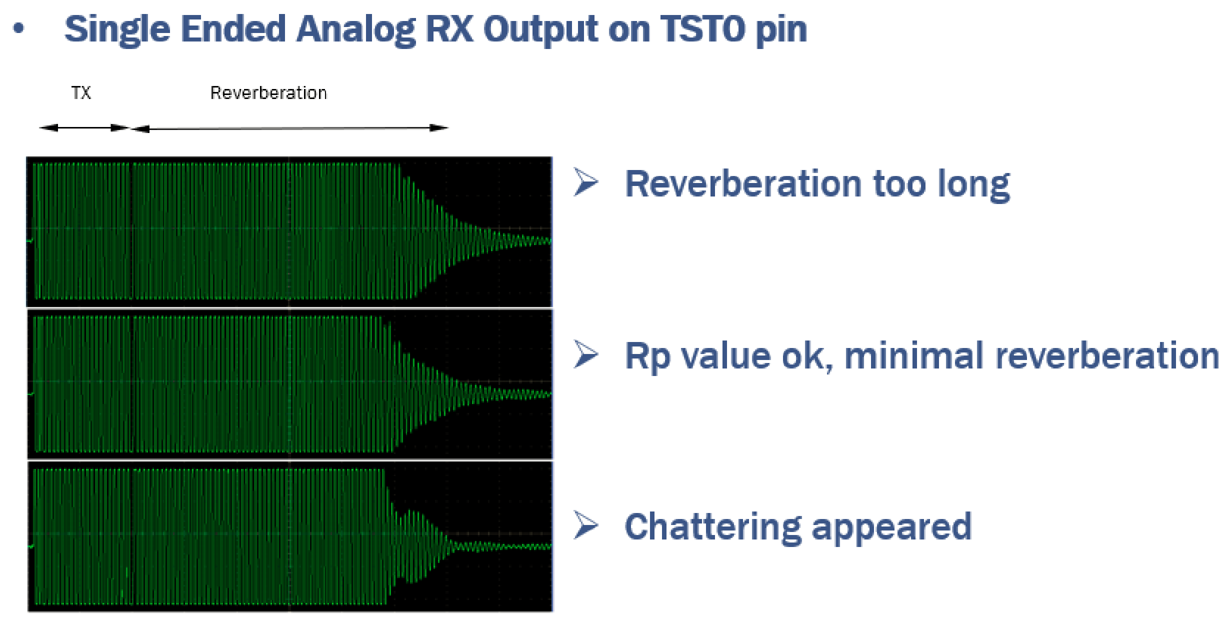

Figure 10.

Single ended Analog RX Output can be seen on TP_TST0 on NCV75215EVK.

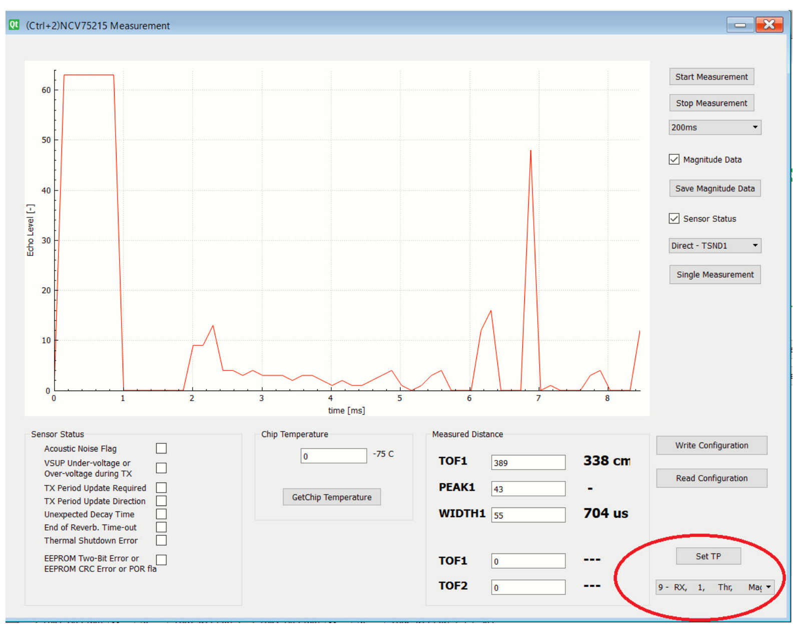

Figure 11.

Setting up Threshold Curve

Thresholds define a magnitude level of detectable echoes => Echo is ignored if it is below threshold. Main goal of the threshold curve is to detect the obstacle reliably and filter out noise .

Threshold curve consists of 12 sections. You can set threshold level and duration for each section.

Thresholds are linearly interpolated – you can find the example of the threshold curve in Figure 12.

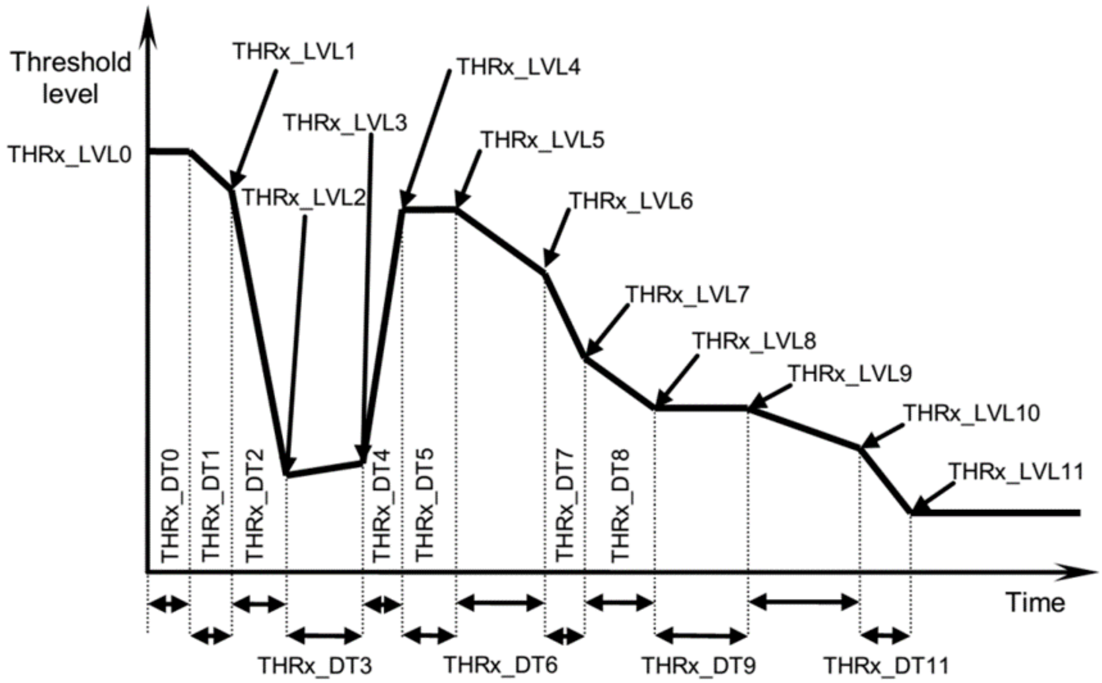

Figure 12.

y	0	1	2	3	4	5	6	7	8	9	10	11
THRx_LVLy	33	33	33	33	33	32	28	20	15	12	8	4
THRx_DTy	9	9	9	9	9	9	9	9	9	10	12	14

Figure 13. Example (1) of Setting the Threshold Curve

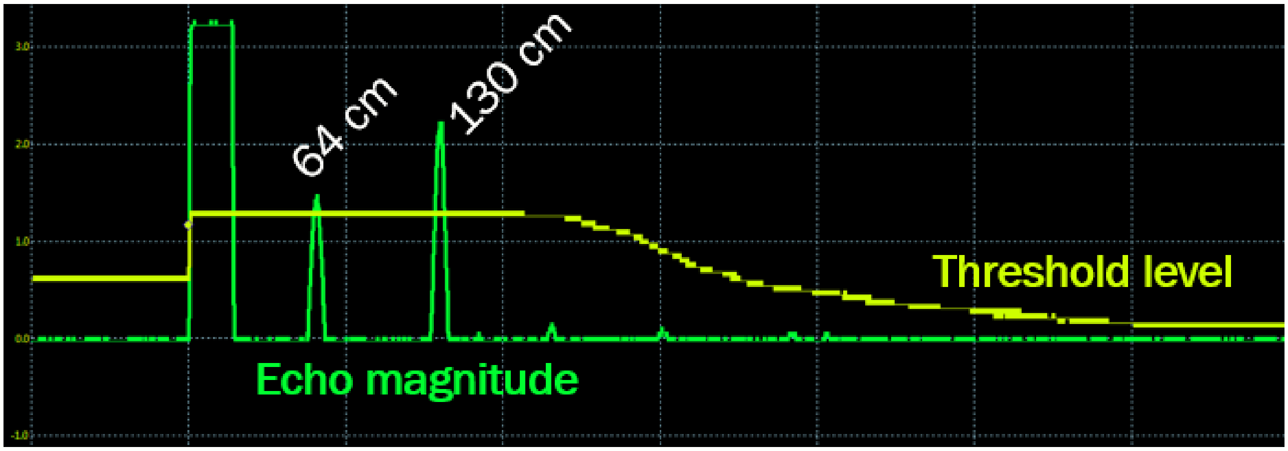

Figure 14.

In Figure 13 you can find example of setting the threshold curve (or level) and inf Figure 14 there is already a real measurement with 2 detected echoes – at 64 and 130 cm.

y	0	1	2	3	4	5	6	7	8	9	10	11
THRx_LVLy	33	45	45	33	33	10	28	20	15	12	8	4
THRx_DTy	10	6	6	6	6	9	9	9	9	10	12	14

Figure 15. Example (2) of Setting the Threshold Curve

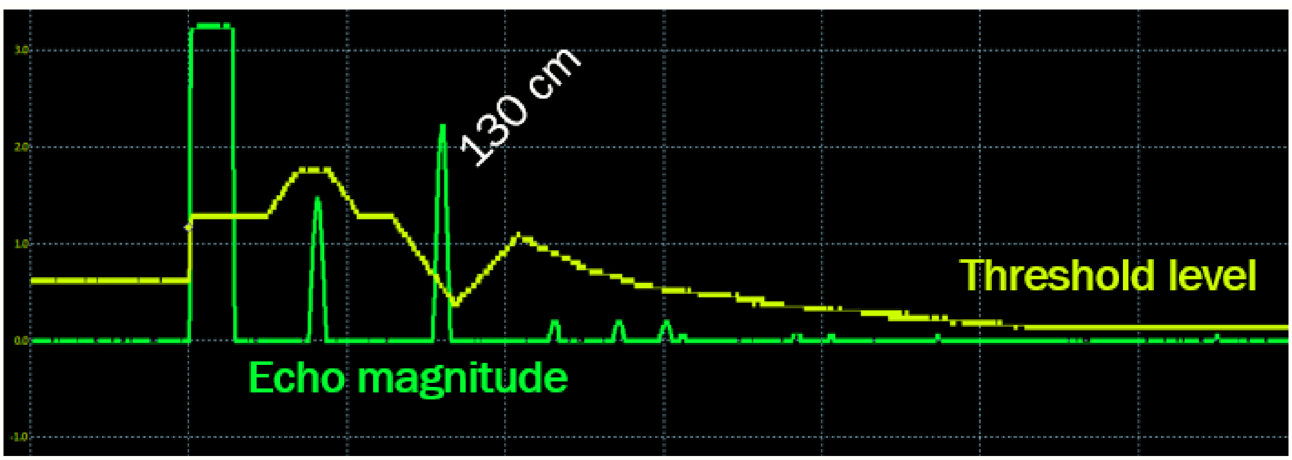

Figure 16.

In Figure 15 you can find example of setting the threshold curve (or level) and inf Figure 16 there is already a real measurement with just one detected echo – at 130 cm.

Dynamic gain is used to keep echo analog signal within dynamic range of digital processing. Main goal is to compensate for attenuation of the sound waves in the air. Dynamic gain consists of 5 sections. You can set the starting gain, gain delta and duration for each section as it is visible in the examples below.

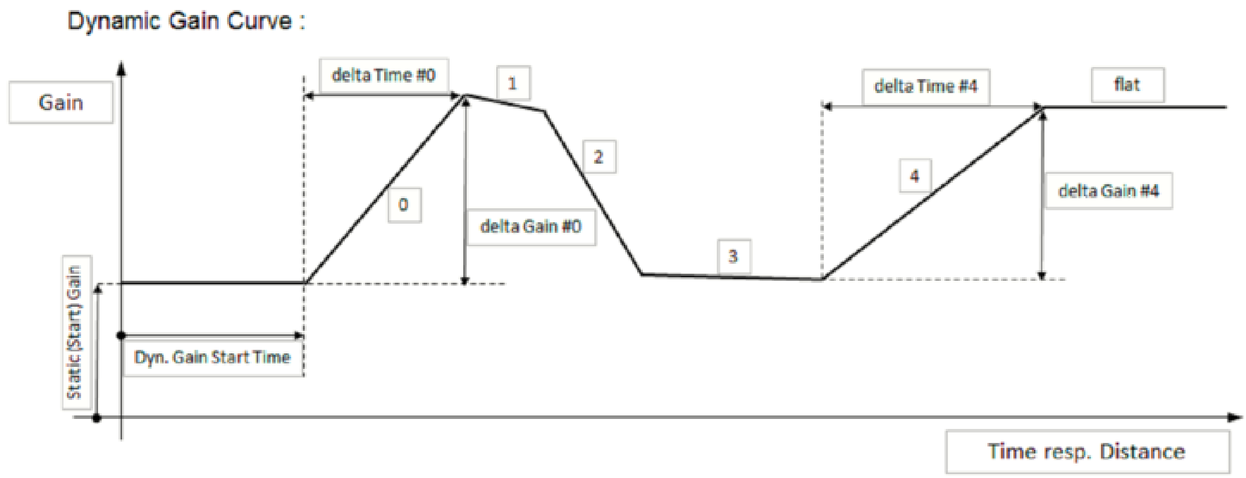

Figure 17.

	value
Static RX_GAIN_code	33
DYN_GAIN_start	10

X	0	1	2	3	4
DELTA_GAIN_x	33	45	45	33	33
DTx	8	8	8	8	12

Figure 18. Example (1) of Setting the Gain Curve

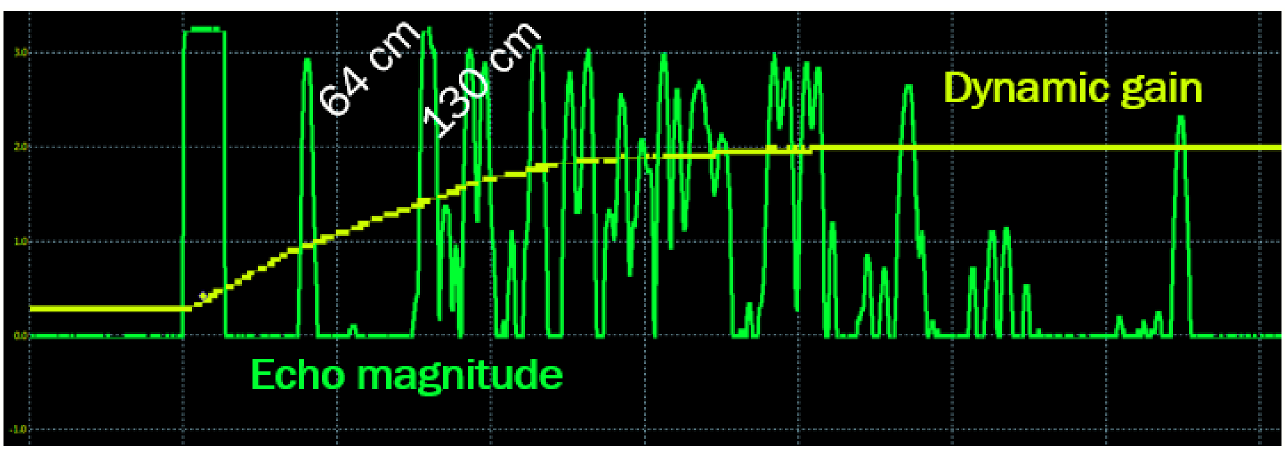

Figure 19.

In Figure 18 you can find example of setting the gain curve and in Figure 19 there is already a measurement with 2 detected echoes – at 64 and 130 cm.

	value
Static RX_GAIN_code	33
DYN_GAIN_start	10

X	0	1	2	3	4
DELTA_GAIN_x	30	-50	0	60	40
DTx	8	8	10	8	12

Figure 20. Example (2) of Setting the Threshold Curve

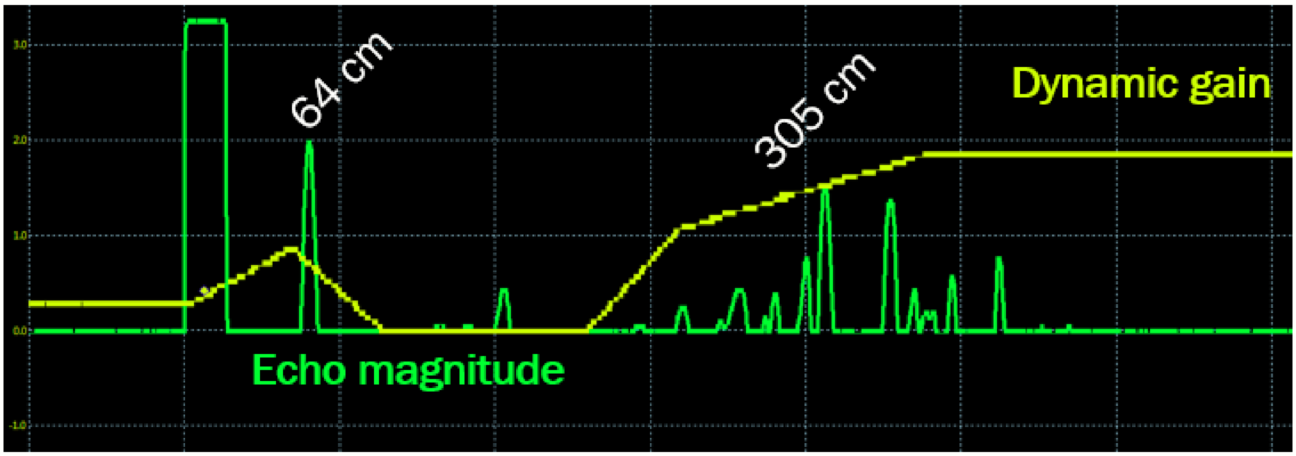

Figure 21.

In Figure 20 you can find example of setting the gain curve and in Figure 21 there is already a real measurement with only 1 detected echo – at 64 cm. Echo at 305 cm is below the threshold.

If you compare real measurements in Figures 19 and 21, you can find how much the signals differ – if the gain curve is set to low values (Figure 21), then you may miss the real obstacle. On the other hand if the gain curve is set to rather high values (Figure 19), then you may also get the noise (for instance gravel) as the valid echo. Remember that signal should be set within dynamic range of digital processing.

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