- English -

DTS
Manual

Revision History

Revision	Description	Release Date	Author
0	Initial Release	2020-11-25	TS

Content

1 Notes and symbols used in this Manual

These paragraphs contain tips and practical advice for working with the DTS

In the paragraphs highlighted with this symbol, you will find additional information and it is very important that you follow the instructions given.

Documentation reference

- A user manual reference number is provided so the user can seek further assistance

"`Software Parameter`"	Monospaced text in quotation marks designates a software parameter, pages, tabs or tables in the WinIt Software
"`#Channel`"	Monospaced text in quotation marks with a leading hash mark designates a channel in the WinIt Software
- cross-reference -	Italic, dotted underlined text designates a cross-reference to a different chapter of the manual

2 The 2D Dynamic Test System

2.1 Introduction

The 2D DTS (Dynamic Test System) is a GPS based small and powerful, fully integrated vehicle dynamics test system. It can perform brake, acceleration and “Elk or slalom” test. Furthermore, it can be used to perform government homologation tests regarding fuel consumption and/or speedometer accuracy.

2.2 Features

The DTS Dash offers full recording functionality with up to 200Hz sampling rate including the GPS Information which is up sampled and corrected to 200Hz achieved through multi sensor data fusion interpolation.

To achieve a high data quality all channels are synchronized and delayed to match the GPS data therefore for example you will get the exact speed and GPS position when the brake trigger was engaged.

Also, the GPS Module online sends speed accuracy data which is recorded and used to decide whether the measurement was valid

Configurable close to 0 speed interpolation see chapter *- 3.5.1- DTS standstill speed & ACC/DCC value -* for more information.

2.3 Tests

2.3.1 Test validation Parameters

For all preprogrammed test you can select which criteria is has to be fulfilled to accept a test as valid, for example a minimum MFDD or acceleration / deceleration

2.3.2 Brake Tests

You can define up to 4 different brake tests where you can define the initial speed and the stop speed of each test individually. For each test you can choose between 2 different start conditions for each test: A speed-based test will use the decreasing speed signal to start the measurement or a trigger signal for example from the brake switch.

If needed, the start speed for a test can be changed easily by pushing the button while testing

2.3.3 Acceleration Tests

You can define up to 4 different acceleration tests where you can choose between a speed and distance-based measurement for any of the 4 tests individually.

If needed, the start speed for a test can be changed easily by pushing the button while testing

2.3.4 Elk or Slalom Test

For the slalom test, the time needed to pass through a slalom course (set up between two speed traps) is measured. It is possible to measure lap times with the ELX function by just using one lap trigger

2.4 Recording

The test cycle information (for example valid test number/time/distance/MFDD/a(t)[1] and a(s)[2]) is recorded in the DTS Dash. This information can be put on the DTS Dash´s info page and can be checked directly on the DTS Dash. After the testing you can download the test results directly from the DTS Dash as a CSV table and also get the detailed measurement data via the 2D Analyzer. For detailed information see chapter *- 8 - Test results -* .

2.5 Different System Configurations

The DTS can be used in different configurations depending on your needs.

DTS Basic → All tests are GPS based no external sensors possible.

DTS Standard → As above plus 1 frequency Input for the vehicle speed or fuel consumption and 1 frequency output for the GPS speed signal is provided

DTS Full → As above plus the **included DTS SensorBox** provides inputs for:
break pressure (analog)
brake force (analog)
brake pedal travel (analog)
vehicle speed (frequency up to 10kHz)
fuel consumption (frequency up to 50kHz)

DTS R&D → The **included DTS SensorBox** provides inputs for:
break pressure (analog)
brake force (analog)
brake pedal travel (analog)
vehicle speed (frequency up to 10kHz)
fuel consumption (frequency up to 50kHz)
The **included DTS Logger** provides:
- 4 additional Analog inputs with up to 16kHz sampling rate
- 1 Frequency input (f up to 50kHz)
- 64 CAN Inputs with up to 1000Hz sampling rate
- 1 additional CAN Line for vehicle communication
- all 2D CAN Extension Interfaces can be connected

System Layouts

For further Information please refer to our DTS Overview & Layout Diagrams

Cables and Accessories

The connection to the vehicle´s CAN and/or power supply can be done by wide range of available connection cables and connectors.

[1] Acc calculated via $a(t) = v/t$
[2] Acc calculated via $a(s) = 1/2 * (v * v/s)$

3 First Use

This chapter will guide you through your first measurement with the DTS. For this Guide we assume that you want to perform a brake test from 100 km/h to 0 km/h (standstill) with a normal passenger car.

Mandatory Settings

All Steps described in the First Use chapter are mandatory to use the DTS

3.1 Parameters

Here is an overview of all modifiable parameters of the DTS.

Table 3.1 – DTS Setup Parameters

Parameter	Description	Mandatory
`#DTS_Speed`	Source of the speed input	yes
`DTS standstill speed`	Lower speed threshold to identify “vehicle is stopped”	yes
`DTS ACC/DCC Value`	Low speed correction parameter	yes
`Acceleration/Deceleration`	Acceleration/Deceleration valid value	yes
`minimum MFDD for valid`	minimum MFDD for brake tests	yes
`#GPS_Speed_ok`	GPS Speed signal quality acceptance criteria	yes, default set
`#DTS_BrakeSwitch`	Source of the brake switch input	yes, default set
`#Fuel`	Source of the fuel consumption input	no
`#DTS_Value`	Source of the Channel displayed during the brake and acceleration tests	no
`Laptrigger`	Source of the Lap trigger input	only for ELX
`Start Page`	Preselected test after startup	default set

Table 3.2 – Brake Test Parameters

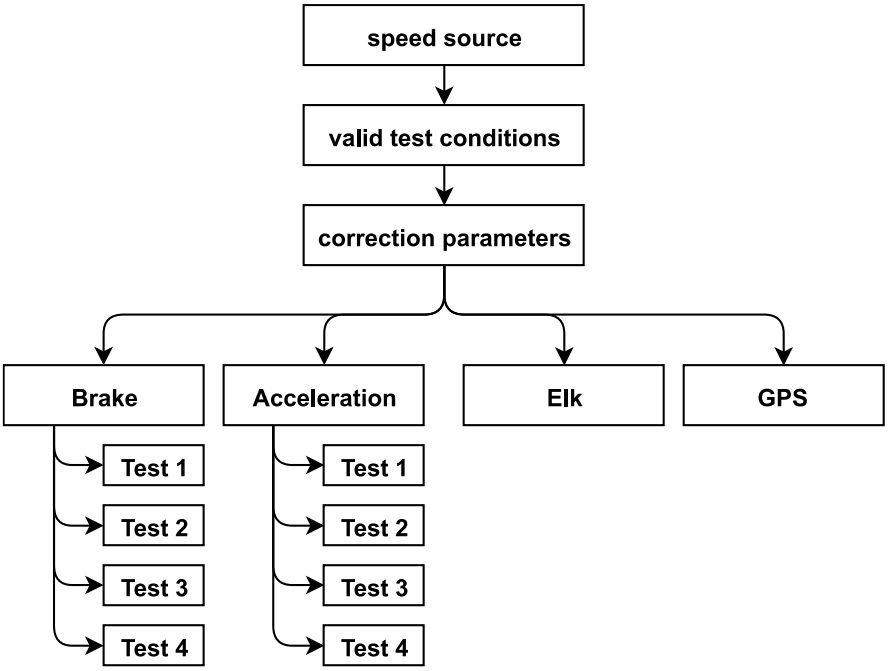
Parameter	Description	Mandatory
`Start Condition`	start conditions for each test individually	yes
`Thresholds`	start and end speed for each test individually	yes
`Test Preselection`	Preselected test in Menu	no

Table 3.3 – Acceleration Test Parameters

Parameter	Description	Mandatory
`Mode`	Test mode (speed or distance based) for each test individually	yes
`Thresholds`	start and end speed for each test individually	yes
`Test Preselection`	Preselected test in Menu	no

3.2 Parameter Dependencies

Those are the Basic Parameters you have to set to use the DTS, all steps will be described in this chapter:



For more detailed information please refer to chapter *- 9.2 - DTS Parameter Dependencies -*.

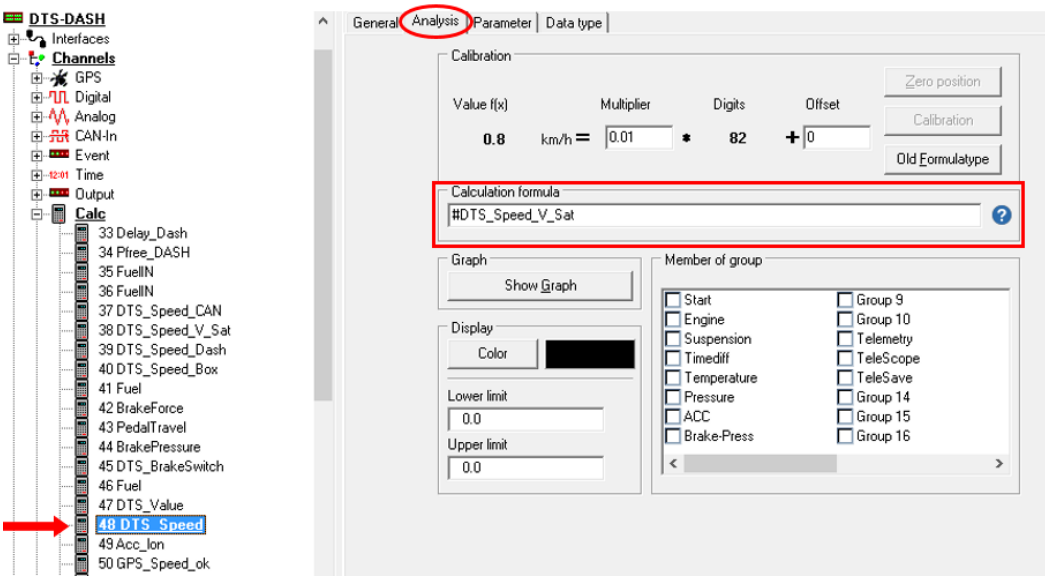
3.3 Speed source

The speed channel is the most important channel inside the DTS as it controls most of the testing – it can define the start and the end of a test and therefore also the behavior in between.

By default, the system is set to work with the GPS speed signal. If you connect the system to the vehicle´s CAN bus, you can also use the vehicle´s speed signal or use an additional speed sensor.

To change the speed source, navigate to the calc channel "`#DTS_Speed`". Replace "`#DTS_Speed_V_Sat`" with the appropriate channel for your setup.

For possible options please refer to *- Table 3.4 - Speed Inputs -*.



Confirm your changes with <**Apply**>.

Table 3.4 - Speed Inputs

Channel	Source	Comment
"`#DTS_Speed_CAN`"	Vehicle CAN Bus via DTS Logger	see[3] - only DTS R&D
"`#DTS_Speed_V_Sat`"	DTS GPS	← default setting
"`#DTS_Speed_Dash`"	Frequency Input of the DTS Dash	
"`#DTS_Speed_Box`"	Frequency Input of the DTS SensorBox	

[3] Please refer to the general logger manual on how to program CAN-In channels.
The manual can be downloaded from: 2d-datarecording.com/en/downloads/manuals ⇒ General Logger Manual

3.4 Valid Test Conditions

To ensure all measurements are valid in the defined scope you need to setup the following conditions.

3.4.1 GPS Speed OK

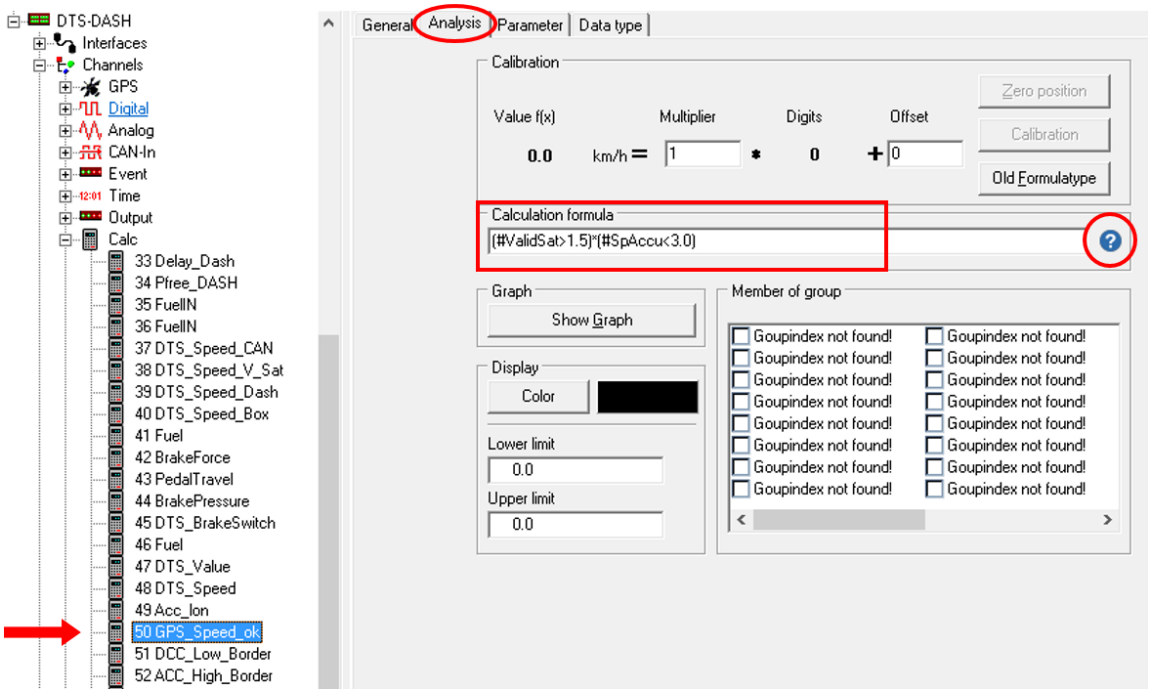
The channel "`#GPS_Speed_ok`" defines whether the speed information from the GPS module is accurate enough to consider the test valid.

If before a test the criteria are not fulfilled, a message in the bottom of the DTS Dash "`GPS not valid`" will be shown and test will not be started.

If during a test the criteria are not fulfilled, a message in the bottom of the DTS Dash "`GPS was invalid`" will be shown and test will be aborted and marked not valid

By default, this channel is set up that we need at least 5 visible GPS satellites and the GPS speed accuracy has to be better or equal than ±3.0km/h

To change it, navigate to the calc-channel "`#GPS_Speed_ok`". In tab "`Analysis`" can you´ll find the calculation formula, where you can modify the values to your needs also add filtering. Please have a look at the online calculation channel manual[4] or use the blue question mark for the online help function.



Confirm your changes with <**Apply**>.

GPS Speed Accuracy

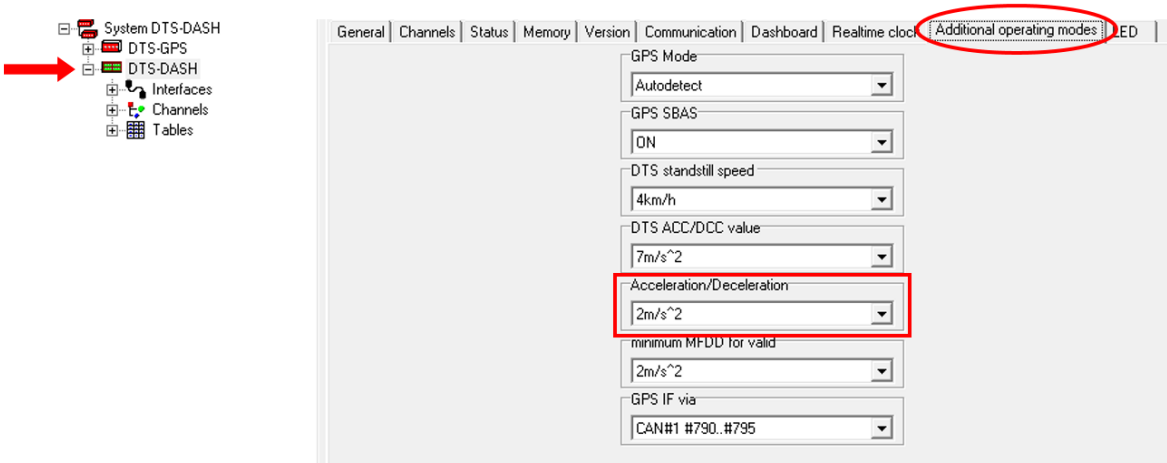
The DTS GPS Module has a separate output channel "`#SpAccu`" were the current absolute speed accuracy in ± x km/h of the module is sent. This Channel will also be recorded.

[4] Please refer to the online calculation channel manual on how to program calc channels.
The manual can be downloaded from: 2d-datarecording.com/en/downloads/manuals ⇒ Online Calculation Channels Manual

3.4.2 Acceleration/Deceleration valid

In addition to the "`DTS standstill speed`" and "`DTS ACC/DCC Value`", you can also decide on an acceleration and deceleration value, which is used to identify an acceleration or deceleration in all tests.

In tab "`Additional operating modes`" you can define the "`Acceleration/Deceleration`". The selected value is used as a symmetric constant speed window.



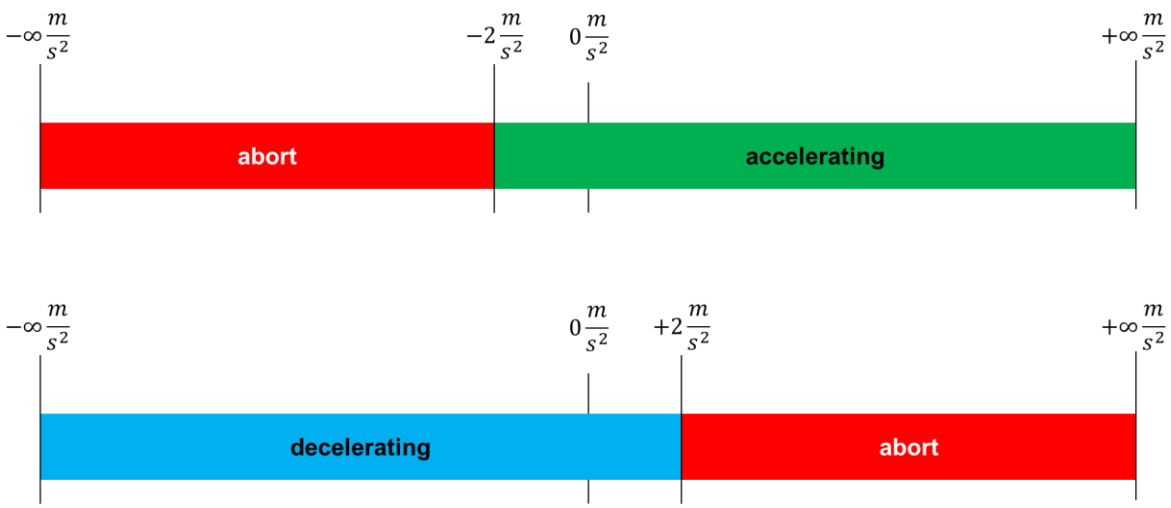
Confirm your changes with <**Apply**>.

Valid acceleration / deceleration

In this example ±2m/s² is selected. That means decelerations with a value > + 2m/s² are detected as "deceleration" and accelerations with a value > -2m/s² are detected as "acceleration".

If during the tests the acceleration/deceleration will get below the limit of ±2m/s², for instance due to wheel spin or slippage, the test will be aborted and marked not valid.

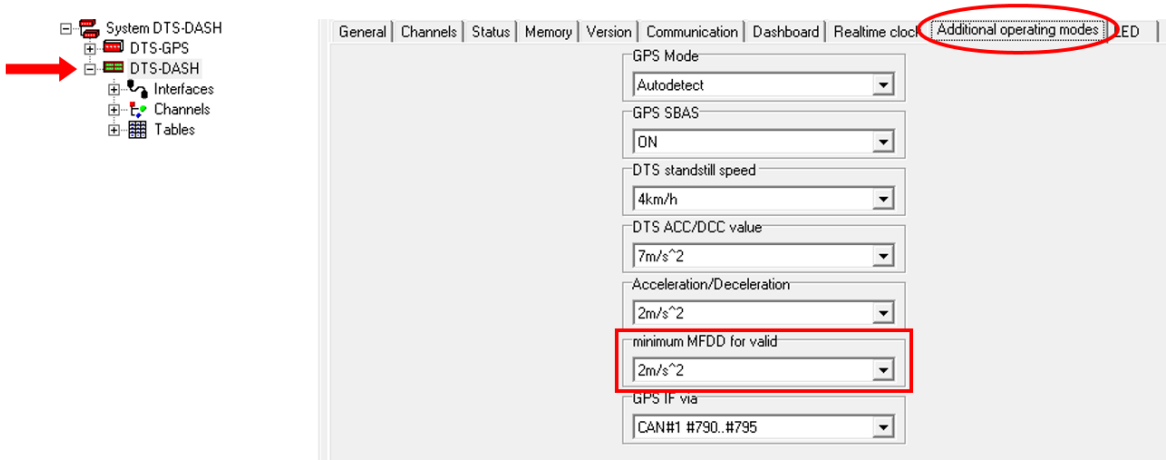
Example: A fast gear change will therefore not interrupt the acceleration measurement.



3.4.3 Minimum MFDD valid value

For the break test it is necessary to define a minimum MFDD valid value to ensure that only tests with a better/higher deceleration are accepted as valid.

In tab "`Additional operating modes`" you can define the "`minimum MFDD for valid`". Parameter:



Confirm your changes with <**Apply**>.

MFDD - mean fully developed deceleration

Is a braking test that is defined by the following formula:

$$MFDD = \frac{v_{08}^2 - v_{01}^2}{25.92 * (s_{01} - s_{08})} \qquad v_{01} = 0.1 * v_{start} \qquad s_{01} = s(v_{01})$$

$$v_{08} = 0.8 * v_{start} \qquad s_{08} = s(v_{08})$$

3.5 Correction Parameters

Brake / Acceleration Performance

Different kinds of vehicles can have very different acceleration and brake capabilities, for example a tractor vs a high-performance sports car. You need to adjust the "`ACC/DCC Value`" according to the capabilities of the vehicle you are testing.

3.5.1 DTS standstill speed & ACC/DCC value

Low Speed Accuracy

GPS

Depending upon external conditions, e.g. tree cover, limited vertical visibility in urban environments or the satellite constellation, GPS can only be accurate down to 1..3 km/h.

To identify the GPS speed signal quality, the DTS has a special channel "`#SpAccu`", which is also recorded in the measurements, to check the actual accuracy of the GPS speed signal.

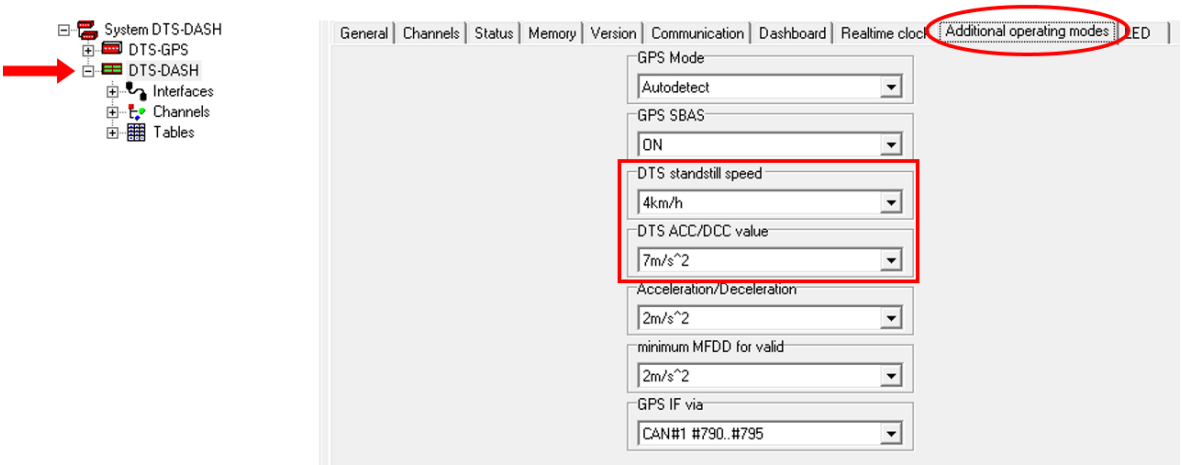
Wheel Speed Sensors

Depending on the trigger wheel and used sensor conventional pulse-based speed signals can also have an insufficient low speed accuracy

The DTS extrapolates the speed, acceleration and distance down to a standstill with configurable parameters.

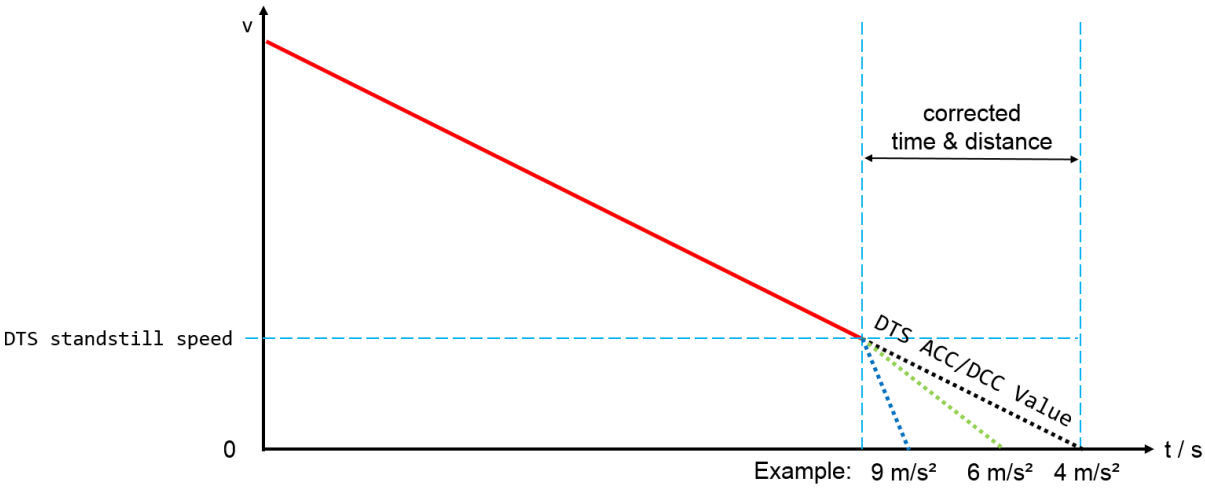
To correct the measurement, you can setup it to your application. You can define where the correction will start and also the acceleration / deceleration rate for it.

In tab "`Additional operating modes`" you can define the "`DTS standstill speed`" and "`DTS ACC/DCC Value`".



Select the appropriate values from the corresponding drop-down lists and confirm them with <**Apply**>.

Depending on the values you select, the DTS Dash will correct the corresponding time and distance for the test:



See calculation example in *- Table 3.5 - DTS standstill speed & ACC/DCC examples –*

Table 3.5 - DTS standstill speed & ACC/DCC examples

selected DTS standstill speed [km/h]	selected DTS ACC/DCC value [m/s²]	→	Time added [s]	Distance added [m]
1	7		0,040	0,006
2	9		0,062	0,017
3	7		0,119	0,050
3	8		0,104	0,043
5	8		0,174	0,121
5	9		0,175	0,107

Example: Test: 100 km/h to 0 km/h

- DTS standstill speed = 3 km/h
- DTS ACC/DCC value = 8 m/s²

→0,104s

→0,043m

3.6 Test Setup

Now, that you have test up all prerequisites for the tests you can define your first test.

Please refer to chapter *- 4 - Test Setup -* .

4 Test Setup

4.1 Brake Tests

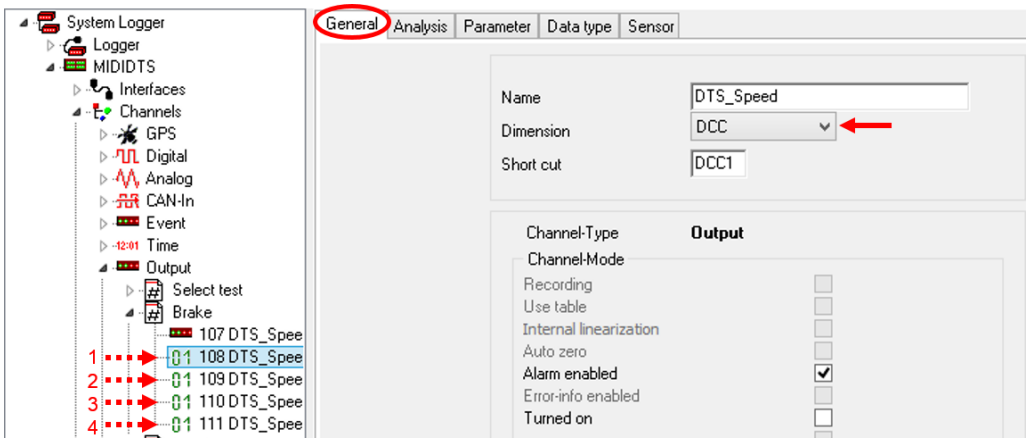
You can define up to four different brake tests where you can define the initial speed and the stop speed of the test. For example, 100 km/h to 0 km/h or from 100 km/h to 50 km/h.

4.1.1 Start Conditions

You can select between 2 different start conditions, speed or trigger based, for each of the 4 tests:

1. Speed (“`DCC`”) will use the decreasing speed signal to start the measurement
2. Trigger (“`TRIG`”) will use the trigger signal of channel “`#DTS_BrakeSwitch`”. Please refer to chapter *- 5.2 - Brake Switch Source -* how to set up it.

To change it, select the output channels of page “`Brake`”. In tab “`General`” you select the trigger source from the “`Dimension`” drop-down list:



Confirm your changes with <**Apply**>.

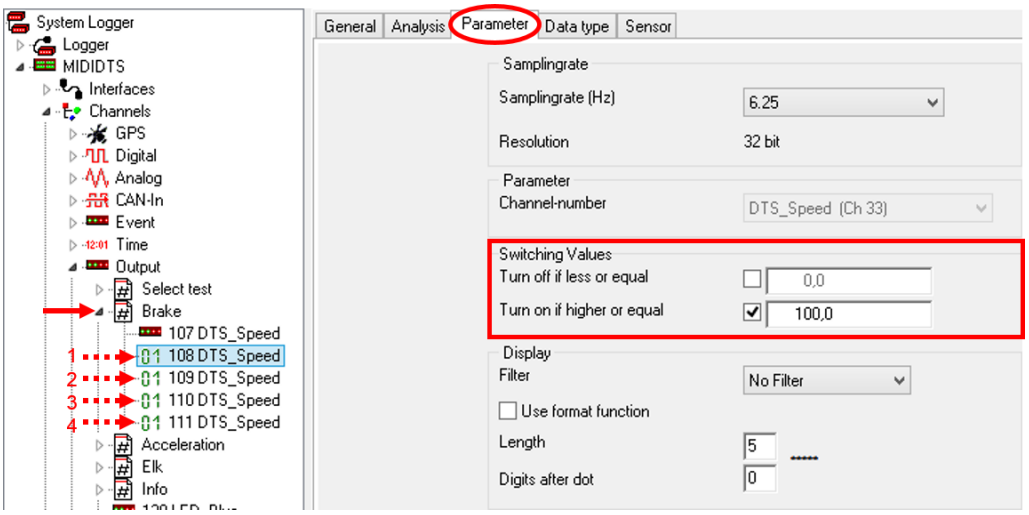
4.1.2 Thresholds

On tab "`Parameter`", you can set the speed threshold in group "`Switching Values`".

Dimension "`DCC`": The value of "`Turn on if higher or equal`" is used to start the test, the value of "`Turn off if less or equal`" is used to end the test.

Dimension "`TRIG`": The test is started with the trigger signal of channel "`#DTS_BrakeSwitch`" and the value of "`Turn off if less or equal`" is used to end the test.

The value of "`Turn on if higher or equal`" is used to reset the test. Therefore, it should be greater than the targeted starting speed.

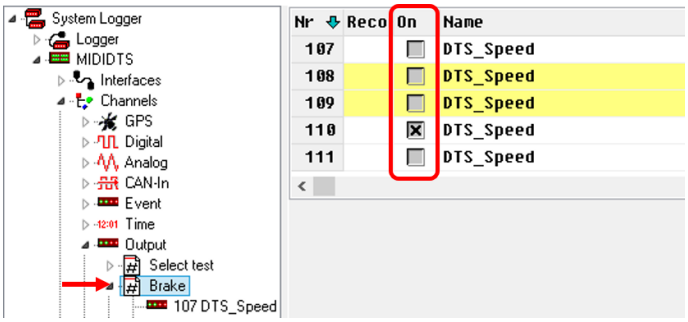


Confirm your changes with <**Apply**>.

4.1.3 Test Preselection

You can choose which test is preselected when you switch on the brake test page

To setup the test preselection, select the output page "`Brake`". Turning on one channel inside the grid is used to preselect a test. For example, if you turn on the channel of the third test setting, the dash automatically jumps to the third test profile, as soon as you select the brake tests:



Confirm your changes with <**Apply**>.

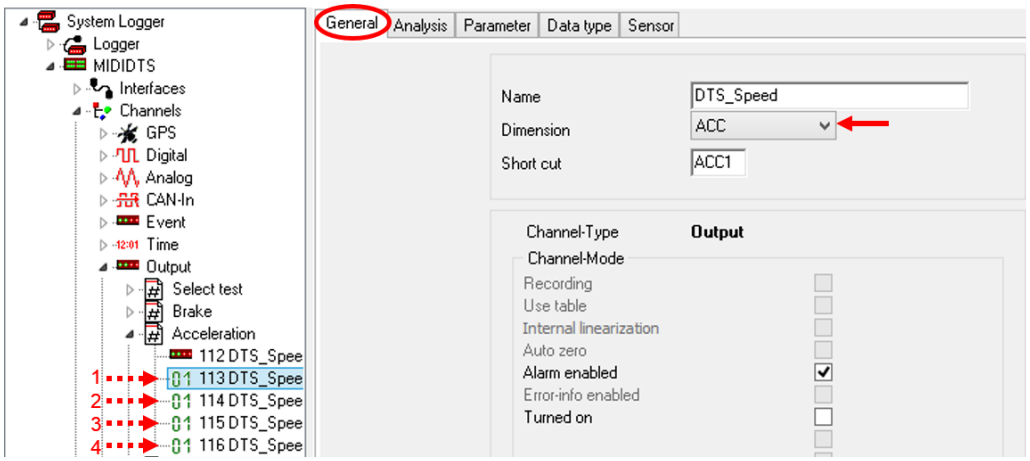
4.2 Acceleration Tests

You can define up to four different acceleration tests where you can choose between a speed and distance-based test for any of the 4 tests individually. For example, 0 km/h to 100 km/h, 80 km/h to 120 km/h or from 0m to 400m.

4.2.1 Modes

To change the mode of the acceleration test, select the output channels of the page "`Acceleration`". In tab "`General`" select the test type from the "`Dimension`" drop-down list:

1. "`ACC`" for the speed-based test, which will stop the measurement as soon as you reach the entered top speed
2. "`DIST`" for the distance-based test, will stop the measurement according to the entered distance



Confirm your changes with <**Apply**>.

Measurements which are a subset of the selected measurement are also recorded

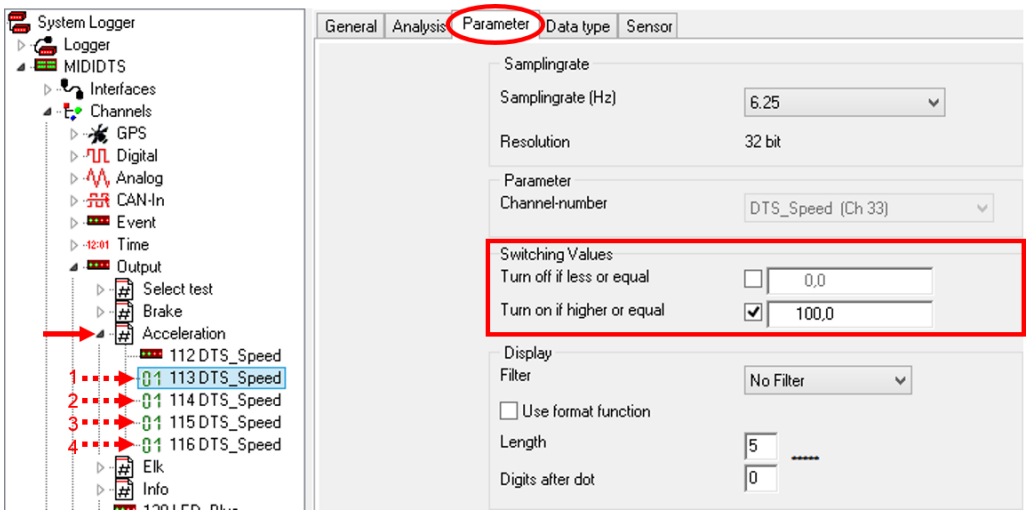
Example: If you've defined a 0m to 1000m test. All defined test that can be included in measurement will also be recorded → e.g. 0m to 100m, 0 to 400m, 0km/h to 60km/h, and 0km/h to 100km/h

4.2.2 Thresholds

On tab "`Parameter`" you can set the speed or distance values in group "`Switching Values`":

Dimension "`ACC`": The value of "`Turn on if higher or equal`" is the initial speed to start the test, the value of "`Turn off if less or equal`" is the top speed to end the test.

Dimension "`DIST`": Distance based test are always measured from the standstill[5]. The value of "`Turn on if higher or equal`" is the target distance of the measurement. ⓘ The value of "`Turn off if less or equal`" is not used in the distance-based test.

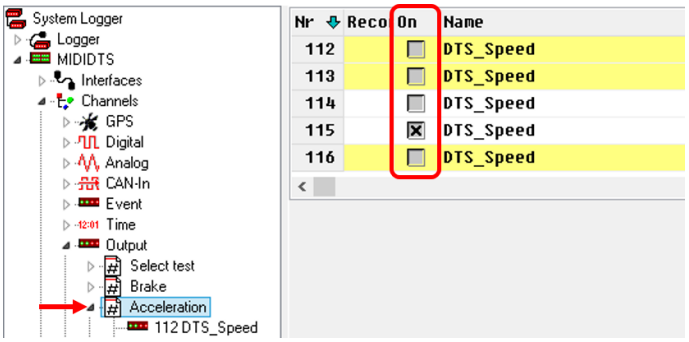


Confirm your changes with <**Apply**>.

4.2.3 Test Preselection

You can choose which test is preselected when you switch on the acceleration test page

To setup the test preselection, select the output page "`Acceleration`". Turning on one channel inside the grid is used to preselect a test. For example, if you turn on the channel of the third test setting, the dash automatically jumps to the third test profile, as soon as you select the acceleration tests:



Confirm your changes with <**Apply**>.

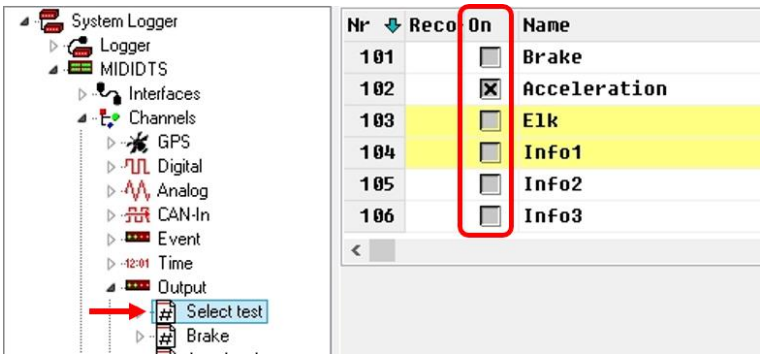
5 ⓘ see chapter - 3.5.1 DTS standstill speed - for further information

5 General Setup

5.1 Start page setup

You can choose which test is preselected when the DTS Dash is turned on. This might be helpful, for example, if you always want to start with an info page to check the sensor values, or if you only want to do acceleration tests.

To setup the start page, select the output page "`Select test`". Turning on one channel inside the grid is used to preselect a test. For example, if you turn on the channel "`Acceleration`", the dash automatically jumps to the acceleration selection when it´s turned on:



Confirm your changes with <**Apply**>.

5.2 Brake Switch Source

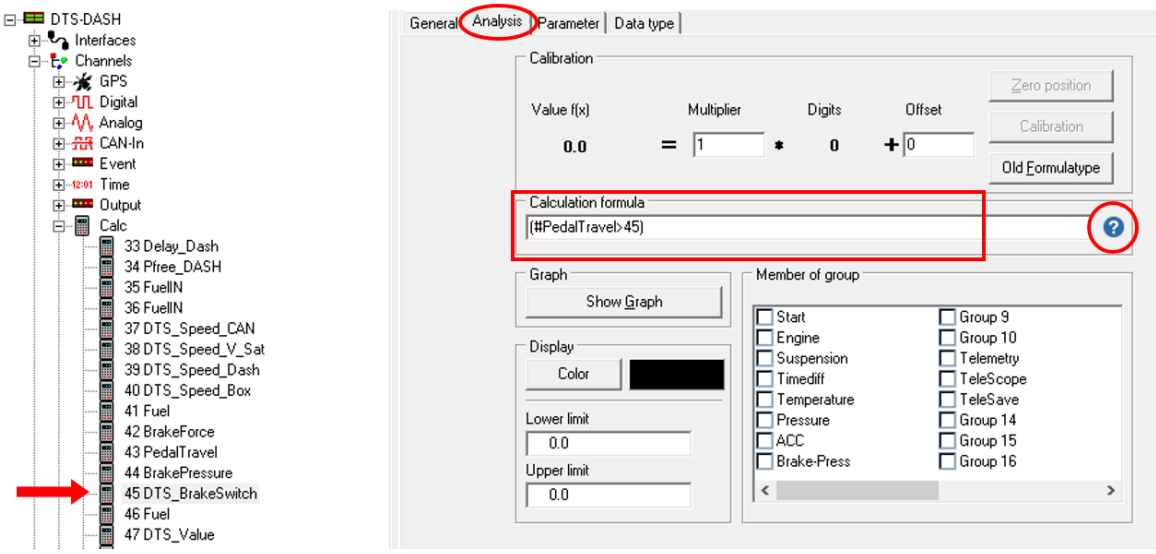
The channel "`#DTS_BrakeSwitch`" generates a trigger signal which can be used to start the braking test.

The DTS does not need an external trigger input, but is able to use one. Any proportional input can be used to create a trigger condition.

By default, the tests are set to work with the speed signal the Dimension of the test is set to "`DCC`". But if you want to start the tests with the brake switch you have to set the Dimension of the test to "`TRIG`", then the calc channel "`#DTS_BrakeSwitch`" is used as the trigger signal.

In tab "`Analysis`" of the calc channel "`#DTS_BrakeSwitch`" you´ll find the calculation formula "`#PedalTravel > 45`". If this condition is true, the channel value will be 1, otherwise 0.

Please adapt this calculation formula to your needs. If you´re using a different signal input, please change the channel name, in this example "`#PedalTravel`", for possible options please refer to Table 5.1 – Brake switch Inputs. Depending on your signal input, you may also adapt the trigger value. In this example it is the condition ">" in combination with the value "`45`". Make sure that the calc channel triggers, when the brake is used. Please have a look at the online calculation channel manual[6] or use the blue question mark for the online help function.



Confirm your changes with <**Apply**>.

Table 5.1 – Brake switch Inputs

Channel	Source	Comment
`#BrakeForce`	Analog input of DTS SensorBox	
`#PedalTravel`	Analog input of DTS SensorBox	← default setting
`#BrakePressure`	Analog input of DTS SensorBox	

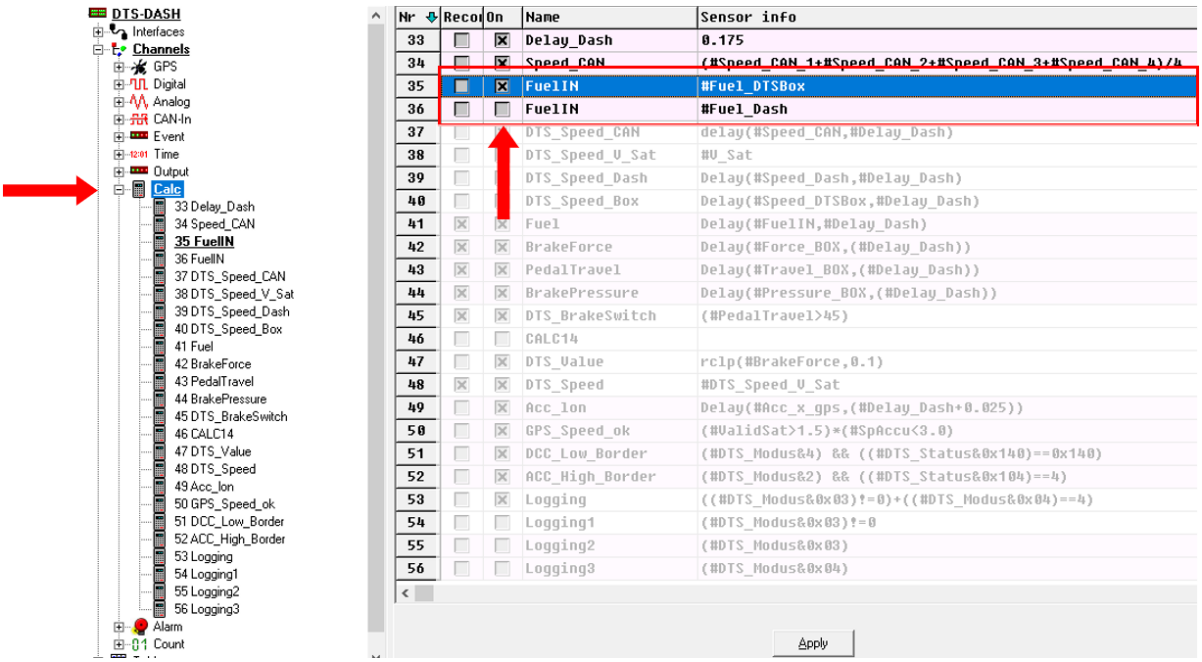
[6] Please refer to the online calculation channel manual on how to program calc channels.
The manual can be downloaded from: 2d-datarecording.com/en/downloads/manuals ⇒ Online Calculation Channels Manual

5.3 Fuel source

The fuel information will be shown on the first info page.

To change the Fuel source, navigate to the calc-channel overview and activate the **"`#FuelIN`"**. Channel appropriate for your setup.

For possible options please refer to Table 5.2 – Fuel Inputs.



Confirm your changes with <**Apply**>.

Only activate one of the channels!

Table 5.2 – Fuel Inputs

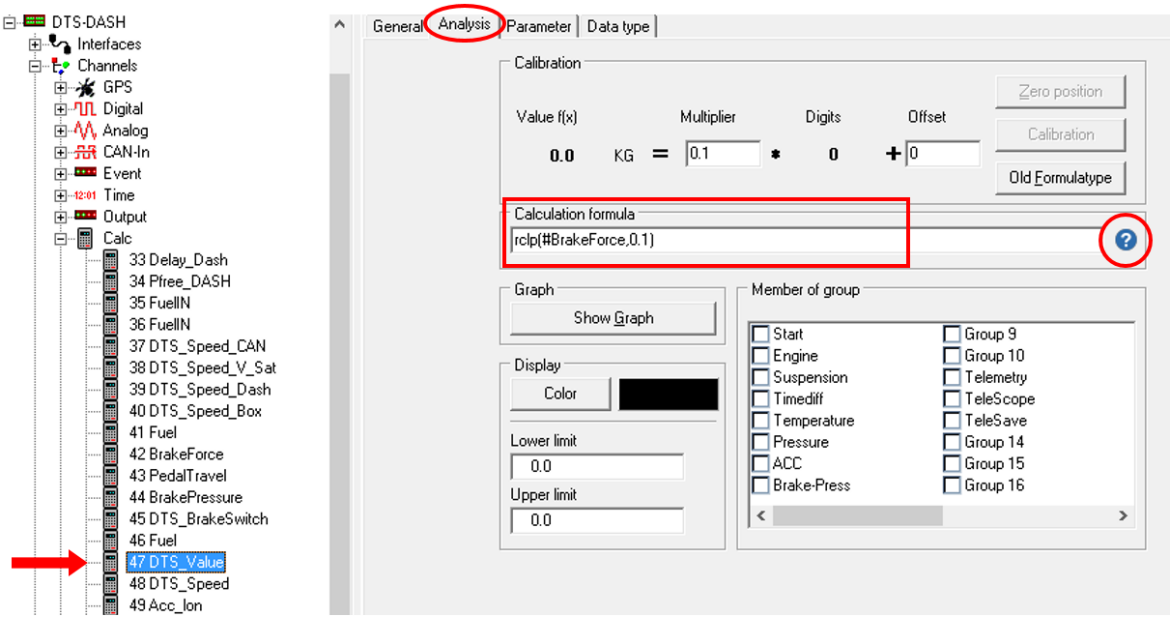
Input Channel	Description	Comment
`#Fuel_DTSBox`	Frequency input of the DTS SensorBox	← default setting
`#Speed_Dash`	Frequency input of the DTS Dash	Speed Input needs to be reconfigured

5.4 DTS_Value source

DTS_Value

The "`#DTS_Value`" channel, is designated channel to be displayed in the brake or accerleration test pages during the measurements. It can be customized to your needs.

By default, this channel is set up to show the brake force. To change it, navigate to the calc-channel "`#DTS_Value`". In tab "`Analysis`" can you´ll find the calculation formula, where you can modify the source channel and also do calculations and filtering. Please have a look at the online calculation channel manual[7] or use the blue question mark for the online help function.



Confirm your changes with <**Apply**>.

[7] Please refer to the online calculation channel manual on how to program calc channels.
The manual can be downloaded from: 2d-datarecording.com/en/downloads/manuals ⇒ Online Calculation Channels Manual

5.5 Speed Input

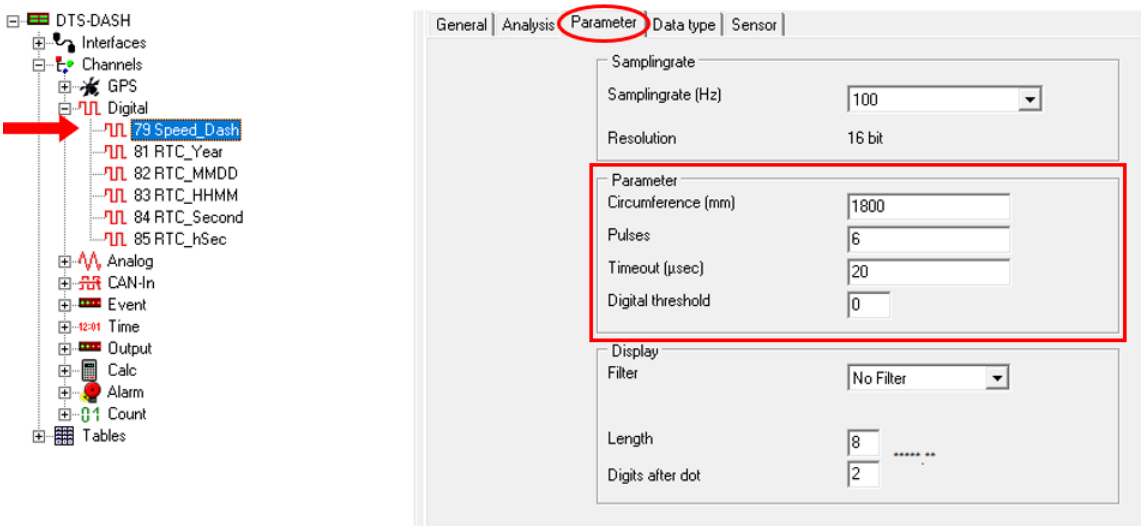
The frequency input of the DTS Dash "`#Speed_Dash`" is configured to be used as a wheel speed input with following example parameters:

- Trigger on rising edge
- Wheel circumference 1800mm (approx. 17" Bike Tire)
- Pulses per revolution: 6

Mandatory Settings

You need to adapt those parameters to your vehicle. The system will not work correctly with improper parameters!

To change the them go to the tab "`Parameters`" and set them accordingly



Metric speed dimension

The DTS is mend to be used with km/h as the speed dimension. The system will not work correctly with another dimension.

Confirm your changes with <**Apply**>.

Frequency Input Setup

For further Information please refer to chapter *- 9.4 - Frequency Input Setup -*

5.6 Lap trigger source

For the “Elk test” or slalom the system needs to receive lap triggers.

By default, the DTS is set to work with the GPS lap trigger.

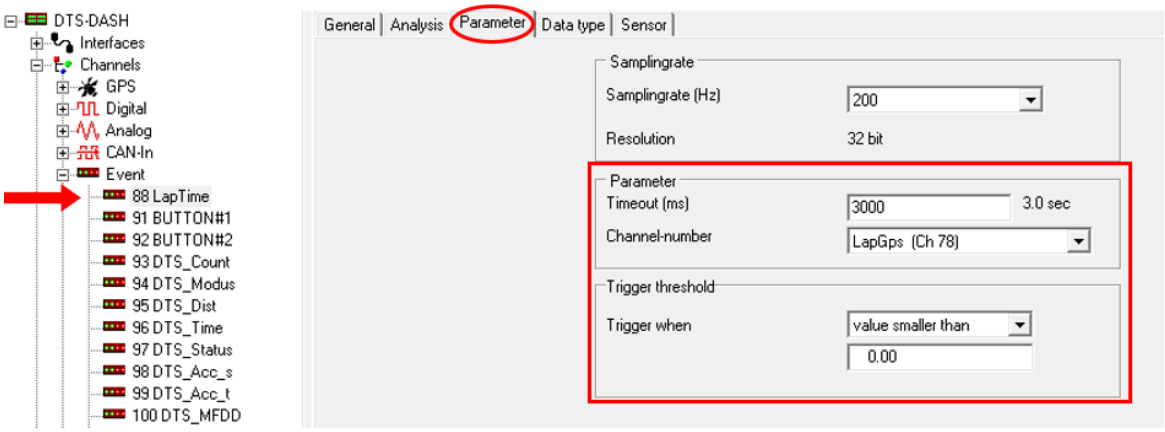
5.6.1 Using an external lap trigger

If you want to use an infrared lap trigger, you need to connect a corresponding lap trigger receiver to the trigger input of the DTS Dash.

Necessary Accessories

To connect an external lap trigger to the DTS Dash you the either the DTS Speed/Trigger Input Cable or the DTS Micro IO Box

To set up the DTS Dash to use an external trigger, you need to set up the “`#LapTime`” channel correctly:



On tab “`Parameter`” you can set the timeout. The timeout is used to suppress multiple lap triggers all at once. The parameter “`Channel-number`” defines the source channel to create a lap trigger. For the external trigger use the channel “`#Speed_Dash`”. In the field “`Trigger threshold`” you set the condition on when to trigger.

Recommended trigger threshold

We recommend the following values:
“`Trigger when`” → “`value smaller than`” → “`500`”

Confirm your changes with <**Apply**>.

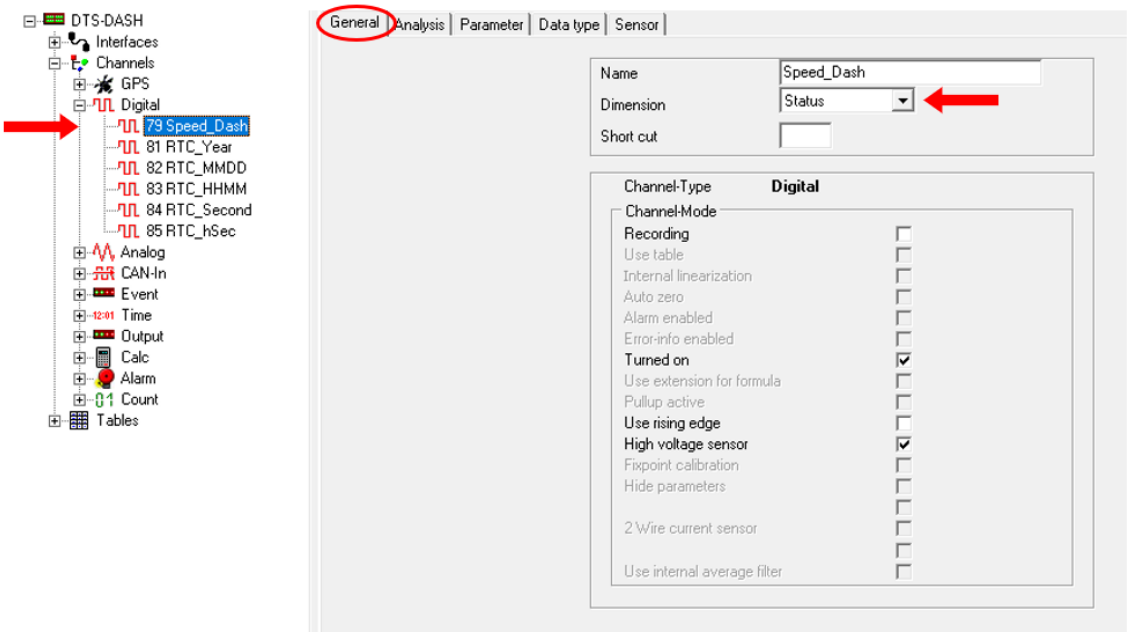
You also need to set up the trigger input

please refer to chapter *- 5.6.2 - Trigger Input Setup -*

5.6.2 Trigger Input Setup

By default, the frequency input of the DTS Dash is configured to be used as a wheel speed input.

To change it, to be used as a trigger input. In tab "`General`" need to set the "`Dimension`" of the channel "`#Speed_Dash`" to "`Status`"



Confirm your changes with <**Apply**>.

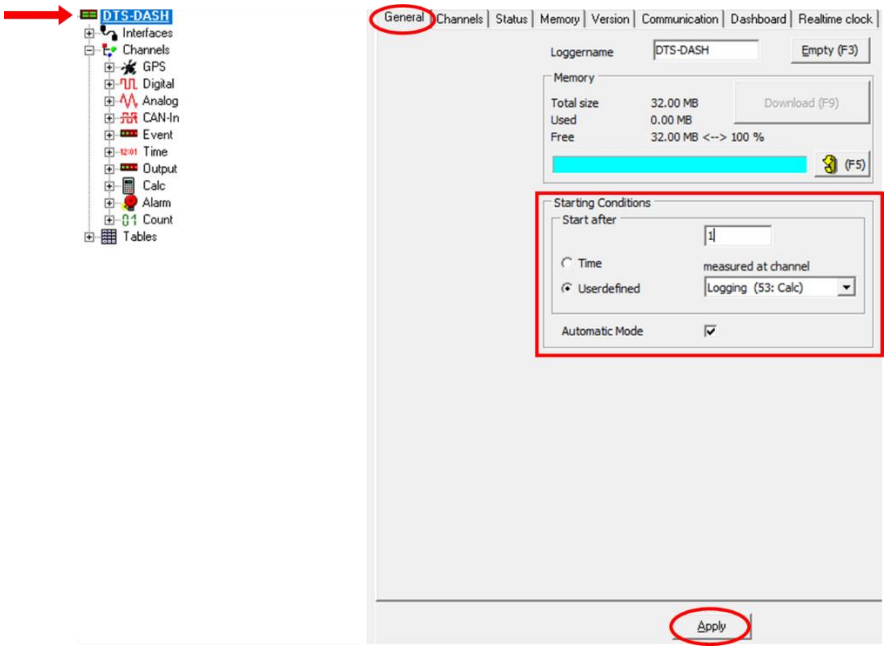
5.7 Recording Start Conditions

You can define the start condition when the DTS Dash will start recording to its internal memory.

By default, the DTS Dash will start to record when a test or the GPS Info page is selected. The condition is defined with the "`#Logging`" calc-channel.

There two predefined, non-changeable options: "`#Logging`" and "`#Logging_OFF`" and also two configurable options: "`#Logging_Custom1`" and "`#Logging_Custom2`" which can be customized to your needs

To change the them go to the tab "`General`" and set them accordingly



Confirm your changes with <**Apply**>.

DTS R&D – deactivate recording in DTS Dash

When you are using the DTS R&D please deactivate the recording function of the DTS Dash. Your data will be recorded by the DTS Logger.
→ Select the channel "`Logging_OFF`" in "`measured at channel`".

6 Operation of the DTS

As the DTS Dash can be fully operated with one button, it´s functionality is based on short or long button presses.

In the main menu:

- short press: switch to the next option
- long press (at least 3s): enter the test menu

In a test menu:

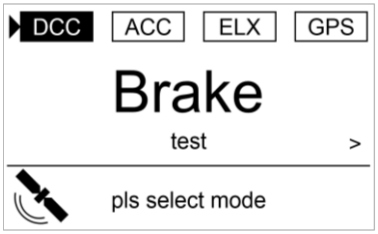
- short press: operate inside the test menu or select switch to the next sub-test
- long press (at least 3s): enter the sub-test menu or back to main menu

On the left side in the bottom corner, there is a signal which indicates the GPS availability:

If there is no GPS symbol, there was no GPS connected when the dash was turned on.	 GPS connected, signal is not valid	 GPS connected, signal is valid

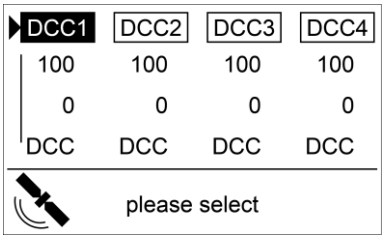
6.1 Brake Test (DCC)

Select the DCC menu and press the button long to enter the menu.



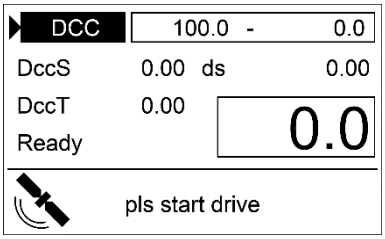
You will see the sub-menu of the brake test next. In here you switch to the next test profile with a short button press.

If you´ve turned on one channel, it will start with that profile, otherwise it starts with the first profile. Select a profile with a long button press.



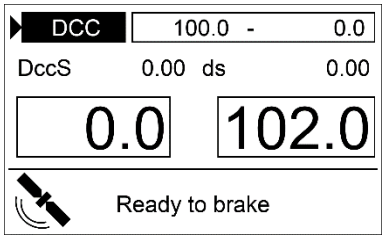
At the top you´ll see the test profile, in this example 100 km/h to 0 km/h. The DTS Dash will also show you the information on deceleration depending on distance and time as well as the distance while measuring and the current speed (in km/h).

At the bottom of the dash you see an info line which indicates what to do next, in this example the dash prompts you to start driving.



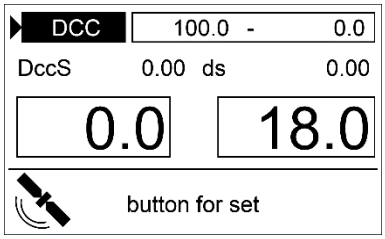
As long as you are in the test profile, the blue LED will light up

As soon as you´re faster than the end speed of your test, the dash will display the channel **"`#DTS_Value`"** on the right side. If you directly accelerate until you reach the speed you want to start the test, the dash will indicate "Ready to brake" at the bottom.
If you´re faster than the starting speed, the upper LEDs will turn on, depending on the current speed (one LED per km/h).

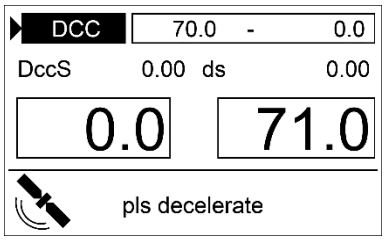


In the first test profile (`DCC1`) you can change the start speed directly in the DTS Dash: While accelerating, the dash gives you the option to define a new starting speed by pushing the button shortly. (The end speed is only programmable in WinIt.)

The starting speed set by the button is depending on the speed while pushing the button. It will round the value down to the last ten. For example: pressing the button while driving 72km/h will set the value to 70km/h.

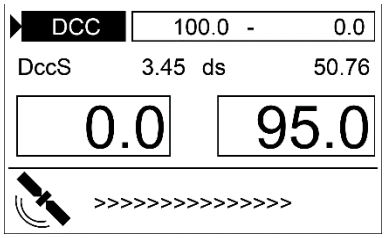


After pressing the button, the dash asks you to decelerate.

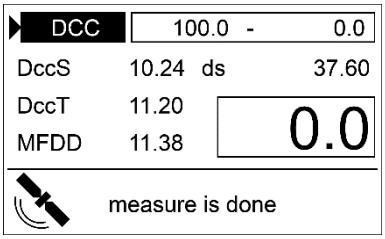


While braking, the measurement starts with passing the entered speed value.

While the measurement is active, the red LED will light up.



Passing the lower speed level will end the measuring. The dash will show you additionally the MFDD result and the green LED will light up, if the result is valid.



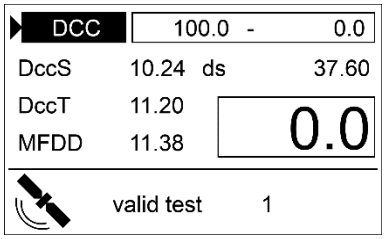
The mean fully developed deceleration (MFDD) is a braking test that is defined by the following formula:

$$MFDD = \frac{v_{08}^2 - v_{01}^2}{25.92 * (s_{01} - s_{08})}$$

$$v_{01} = 0.1 * v_{start} \qquad s_{01} = s(v_{01})$$

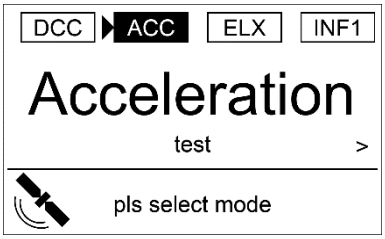
$$v_{08} = 0.8 * v_{start} \qquad s_{08} = s(v_{08})$$

After the measurement is done, it also indicates how many valid tests (overall) you´ve already done.



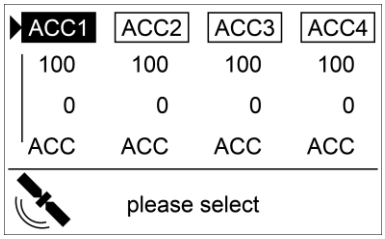
6.2 Acceleration test (ACC)

Select the ACC menu and press the button for longer than 3s to enter the menu.



You will see the sub-menu of the acceleration test next. In here you switch to the next test profile with a short button press.

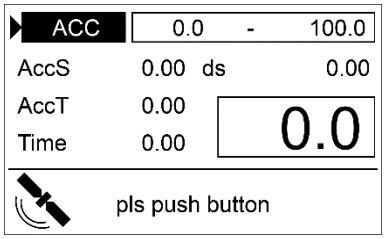
If you´ve turned on one channel, it will start with that profile, otherwise it starts with the first profile. Select a profile with a long button press.



At the top you´ll see the test profile, in this example 0 km/h to 100 km/h. The DTS Dash will also show you the information on acceleration depending on distance and time as well as the distance and time while measuring and the speed. (All speeds in km/h.)

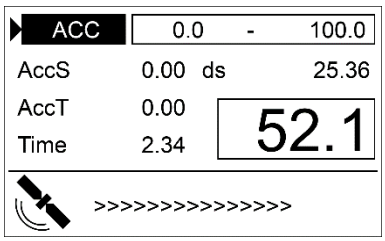
At the bottom of the dash it indicates what to do next, in this example push the button, but you could also just start the test by accelerating.

As long as you are in the test profile, the blue LED will light up

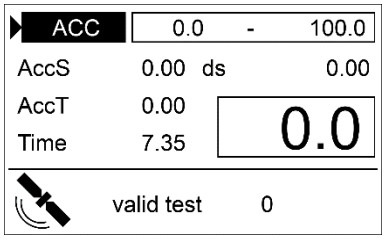


While accelerating, the measuring starts with passing the entered speed value or pressing the button.

While the measuring is active, the red LED will light up.



After the measurement is done, it also indicates how many valid tests (overall) you´ve already done.



6.3 The “Elk test”, Slalom and Lap Times (ELX)

Elk test

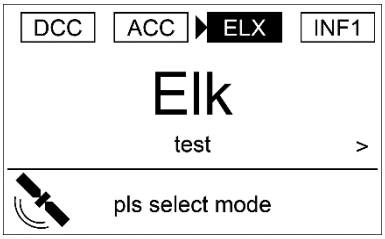
The “Elk test” is a maneuver to avoid contact with an obstacle on the road, where speed is measured directly before and after the maneuver.

For the slalom test, the time needed to pass through a slalom course (set up between two speed traps) is measured.

In addition, it is possible to measure lap times with the ELX function.

Select the ELX menu and press the button for longer than 3s to enter the menu.

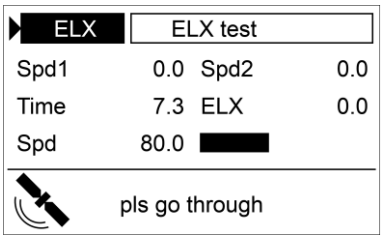
As long as you are in this menu, the blue LED will light up



The dash will show you the speed (in km/h) at the first speed trap, the speed (in km/h) at the second speed trap, the elapsed time (in seconds), the ELX value and the current speed (in km/h) – in digits and as a bar.

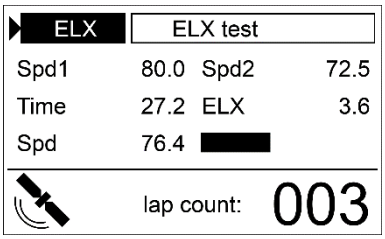
At the bottom of the dash it indicates what to do next, in this example go through/pass the first speed trap.

If you are between the first and second speed trap, the red LED will light up to indicate the active measurement.



With passing the second speed trap (or the single speed trap for the second time), the display changes and the dash will show you also the lap count.

Passing the second speed trap will also light up the green LED, which indicates the measurement result is valid and available.



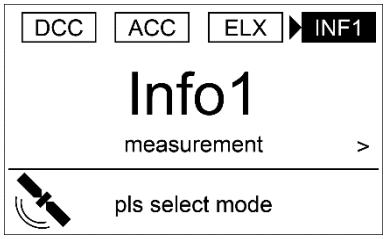
The procedure of the “Elk test” and the slalom measurement are the same. The “Elk test” measures the speeds at the first and second speed trap (before and after the maneuver), while the slalom measurement counts the elapsed time between the two speed traps.

In addition to the above functions, the ELX mode can be used to measure lap times. For this you only need one Lap trigger transmitter, set up at the start-finish line. When passing this point every lap, the DTS Dash counts the laps and shows the according lap time

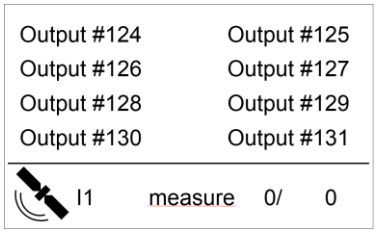
6.4 INFO Pages

There are two info pages available to show channel values or test results directly on the Dash.

Select page Info1 with a long button press.



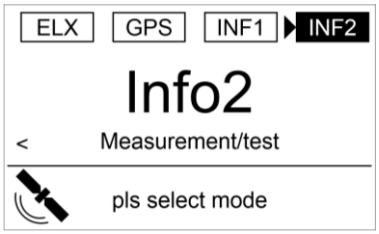
If you put some special event channels onto the page, the Result View Option is activated. → For further information see the info box below.



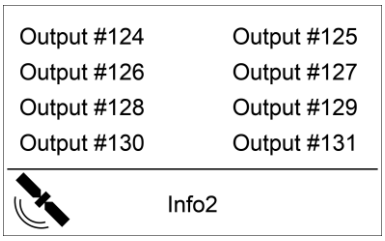
"Output #xyz" is just a placeholder, but this way you can easily see, where the information is put on the DTS Dash while programming it.

- On the bottom of the dash you can see to which valid test the results belong to and the total number of valid tests. Switch from one test result to the next with a short button push.

Select page Info2 with a long button press.



If the Info page is programmed only with "normal" channels, in this example Info2, it will look like this.



"Output #xyz" is just a placeholder, but this way you can easily see, where the information is put on the DTS Dash while programming it.

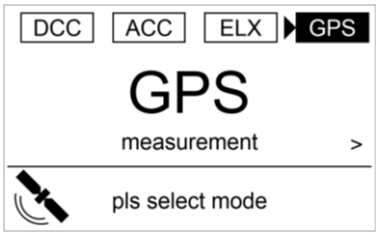
Result View Option

The DTS Dash's Info page differs from those of a normal 2D dash, as you can switch inside this page from one valid test result to the next valid test result. This option is only available if at least one of the following Event channels is put into an output line: `#DTS_Modus`, `#DTS_Count`, `#DTS_Dist`, `#DTS_Time`, `#DTS_ELX`, `#DTS_Acc_s`, `#DTS_Acc_t`, `#DTS_MFDD`, `#TopSpeed`, `#MaxSpeed`, `#LastSpeed` and `#FirstSpeed`. All other channels will show their current values.

6.5 GPS

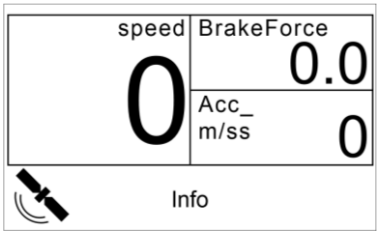
The GPS Page will show you the Vehicle Speed, Braking Force and longitudinal Acceleration of the Vehicle

Select page GPS with a long button press.



This is a fixed page. The displayed channels are:

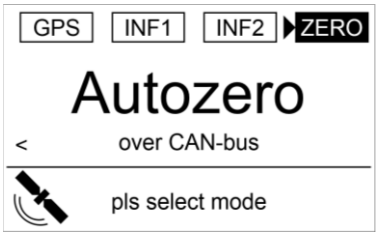
- Speed → "`#DTS_Speed`"
- BrakeForce → "`#BrakeForce`"
- Acc_m/ss → "`#Acc_lon`"



6.6 Auto Zero

The Auto Zero Page will send the 2D Auto Zero Command via CAN to all connected DTS Components

Select page Auto Zero with a long button.



Auto Zero

Some channels need to be set to zero before the measuring can begin. It is possible to send a command over the CAN Bus to set channels zero. In the moment when the command is sent from the Dash all channels with this flag set will change the offset of their formula to set the current value of the channel to zero.

7 Advanced Setup

7.1 Status Channel "#DTS_Status"

The status channel "`#DTS_Status`" is a bit coded channel which contains information regarding the current test status:

Table 7.1 - #DTS_Status Bits

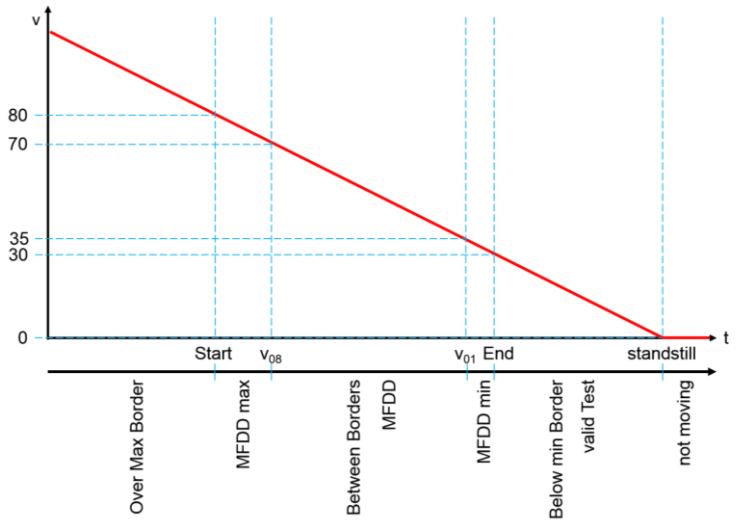
Bit		Status	Bit		Status
0	→	not accelerating	8	→	decelerating
1	→	not decelerating	9	→	accelerating
2	→	over max border	10	→	trigger signal
3	→	MFDD max	11	→	not used
4	→	between borders	12	→	not used
5	→	MFDD min	13	→	not used
6	→	below min border	14	→	not used
7	→	not moving / standstill	15	→	valid test

With these bits you can easily check the test´s state. Bits 0, 1, 8 and 9 are depending on the ACC/DCC values you set in the DTS Dash's "`additional operation modes`". Bit 7 depends on the stand still speed you set there as well.

Example: You´ve done a braking test from 80km/h to 30km/h.

The difference between 80km/h and 30km/h is 50km/h. Therefore the 80%-starting speed is 70km/h[8] and the 10%-starting speed limit is 35km/h[9].

All speeds greater than 80km/h are marked with bit 2 (over max border). Then you cross the 80km/h limit and it changes to bit 3 (MFDD max), as it marks the part of the testing where the values are above the upper MFDD limit are. Then it crosses the 70km/h limit, which means the values are now considered to calculate the MFDD value (marked with bit 4, between borders). As soon as you reach the 35km/h limit it changes to bit 5 (MFDD min), as it is now below the lower MFDD limit. By reaching the 30km/h limit the test ends. The bit 6 (below min border) is now set as the speed is below the lower test speed limit. Depending on your test´s result, the dash also sets the bit 15 to indicate the result is valid.



[8] 80% of 50km/h = 40km/h ⇒ 30km/h end speed + 40km/h = 70km/h
[9] 10% of 50km/h = 5km/h ⇒ 30km/h end speed + 5km/h = 35km/h

7.2 Status Channel "#DTS_Modus"

The status channel "`#DTS_Modus`" is a bit coded channel which contains information regarding the current mode of the DTS Dash and Test:

Table 7.2 - #DTS_Modus Bits

Bit		Status
0	→	Page Bit 0
1	→	Page Bit 1
2	→	Page Bit 2
3	→	not used
4	→	selected Test Lo
5	→	selected Test Hi
6	→	ACC/DIST or DCC/TRIG
7	→	Selection (Main) Menu

With these bits you can easily check the DTS Dash's Mode:

- ➔ Bits 0, 1 and 2 indicate which Menu is currently shown.
  Please refer to *- Table 7.3 - #DTS_Modus: Page* Bits -
- ➔ Bits 4 and 5 designate the currently selected test 0..3 → Test 1..4
- ➔ Bit 6 indicates depending on the selected test (Brake or Acceleration), which start condition (Brake) of the test (DCC or Trigger) or which mode (Acceleration) of the test (ACC or DIST) is defined
- ➔ Bit 7 indicates the Selection (Main) Menu is currently shown.

Table 7.3 - #DTS_Modus: Page Bits

Dec #		Page
1	→	Brake
2	→	Acceleration
3	→	ELX
4	→	GPS

7.3 Sensor Calibration

Analog & Frequency Channel Setup

Please refer to the general logger manual.
The manual can be downloaded from:
2d-datarecording.com/en/downloads/manuals ⇒ General Logger Manual.

8 Test results

There are different options how to view and save test results:

- Displaying them on the Info Page
- Viewing the recorded table "`DTS_Test`" of the DTS display when connected to the DTS Dash with the WinIt Software and storing the Data with Excel on your PC
- Downloading the Data with WinARace or WinIt.

8.1 Info Page

Display the test results is described in the chapter *- 6.4 - INFO Pages -*. It´s the easiest way to simply check the results.

8.2 Viewing the recorded Table

Connect the DTS Dash to your computer. Start WinIt and select the DTS Dash.
Go to "`Tables`" ⇒ "`Recorded`" ⇒ "`DTS_Test`":

Click on the button <**Show**>. The software will automatically start Excel (or whichever program is linked to open csv-files).

The table contains all information which is also available in the Event channels regarding the DTS tests.

Automatic Data Reset

If you change any setting of the DTS Dash, the "`DTS_Test`" table will be reset.

→ Please save the information while shown with Excel.

8.2.1 The DTS_Test table

The table will look like the following example table. You can easily identify the test number, the mode, the settings of the test profile (first speed, last speed) and the results – time, distance, ACC/DCC by distance, ACC/DCC by time, MFDD and the test distance.

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Test nr	Mode	State	Time[s]	Distance[m]	ACC/DCC by s[m/s²]	ACC/DCC by t[m/s²]	MFDD [m/s²]	Top speed [km/h]	Max speed [km/h]	Last speed [km/h]	First speed [km/h]	Distance_c[m]
2	1	ACC	8007	4,21	20,434	1,921	1,915	0	56,63	32,04	32,04	3,01	20,549
3	2	ACC	8007	7,775	38,955	1,006	1,036	0	56,63	32,02	32,02	3	39,07
4	3	ACC	8206	6,3	56,134	2,468	2,512	0	84,25	60,01	60,01	3,02	56,249
5	4	DCC	8141	1,845	21,627	3,786	3,763	3,84	59,71	59,71	29,95	54,95	21,627
6	5	DCC	8181	2,7	19,207	4,931	5,111	4,939	77,22	91,33	3,6	49,68	19,207
7	6	DCC	8141	1,96	20,335	4,963	5,033	4,962	68,23	180	19,44	54,72	20,335
8													

The State is the decimal encoded value of the channel **"`#DTS_Status`"** as explained in chapter *- 7.1 Status Channel "#DTS_Status" –* and is mainly used for debugging

8.3 2D Download

The DTS can also be used like any other 2D System to download the measurements

(Auto-)Download with WinARace

Please refer to the WinARace manual, it can be downloaded from:
2d-datarecording.com/en/downloads/manuals ⇒ WinARace

Download with WinIt

Please refer to the WinIt manual, it can be downloaded from:
2d-datarecording.com/en/downloads/manuals ⇒ WinIt

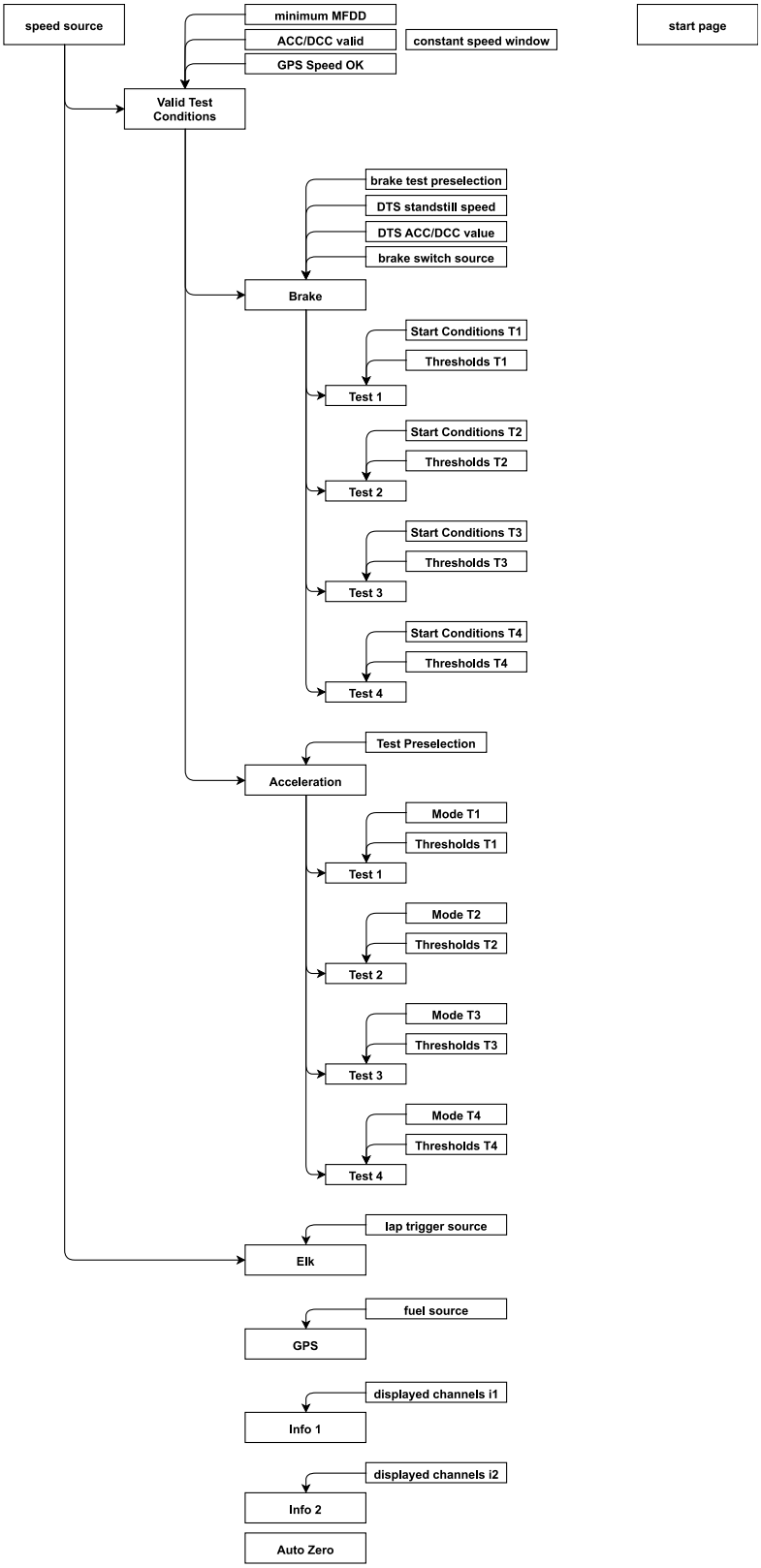
9 Annex

9.1 Channel Index

Channel Name	Description	Dimension
"#Distance_Box"	Distance from DTS SensorBox	m
"#FuelConsumed_Box"	Consumed Fuel from DTS SensorBox	ml
"#DTS_Speed_CAN"	Speed from CAN Bus (via DTS Logger)	km/h
"#DTS_Speed_V_Sat"	Speed from GPS Module	km/h
"#DTS_Speed_Dash"	Speed from DTS Dash Speed Input	km/h
"#DTS_Speed_Box"	Speed from DTS SensorBox Speed Input	km/h
"#BrakeForce"	Force applied on the Brake Pedal/Lever	N
"#PedalTravel"	Travel of the Brake Pedal/Lever	mm
"#BrakePressure"	Pressure in the Brake System	bar
"#DTS_BrakeSwitch"	User configurable Trigger	-
"#DTS_Value"	User configurable	-
"#DTS_Speed"	Speed which is used for Measurements	km/h
"#Acc_lon"	Longitudinal acceleration of the Vehicle	m/s²
"#GPS_Speed_ok"	User configurable criteria	-
"#ValidSat"	Visible satellites	-
"#SSHH"	Seconds:Hundredth (UTC)	
"#Course"	Driving direction	deg
"#Lat_dez"	Position in dezimal degree	deg
"#Lon_dez"	Position in dezimal degree	deg
"#Altitude"	Altitude above sea level	m
"#MMDD"	Month:Day (UTC)	
"#HHMM"	Hour:Minute (UTC)	
"#SpAccu"	accuracy of speed	± km/h
"#CourAccu"	accuracy of course	± deg
"#DTS_Count"	counter of valid tests	-
"#DTS_Modus"	Bits Channel	-
"#DTS_Dist"	Distance for last test	m
"#DTS_Time"	Time for last test	s
"#DTS_Status"	Bits Channel	-
"#DTS_Acc_s"	Acceleration / Deceleration based on Distance	m/s²
"#DTS_Acc_t"	Acceleration / Deceleration based on Time	m/s²
"#DTS_MFDD"	MFDD of last Valid test	m/s²
"#TopSpeed"	Max Driven Speed since Power on	km/h
"#MaxSpeed"	Max Speed in last Test cycle	km/h
"#LastSpeed"	Speed at End of last Valid test	km/h
"#FirstSpeed"	Speed at Start of last Valid test	km/h
"#DTS_DistC"	Corrected Distance for last test	m

9.2 DTS Parameter Dependencies

This a complete overview of the DTS parameter dependencies



9.3 Pre-Test Checklist

Here is a check list you can use before every usage of the DTS to ensure a trouble-free test session:

- ☐ DTS and sensors securely mounted on vehicle
- ☐ All connections checked
- ☐ Mandatory parameters set
- ☐ Tests defined
- ☐ Sensors calibrated
- ☐ Sensors zeroed
- ☐ "`DTS_Test`" table empty
- ☐ DTS Dash memory empty
- ☐ R&D only: DTS Logger memory empty
- ☐ ELX only: Lap trigger source set
- ☐ ELX only: Lap trigger(s) correctly positioned and powered

9.4 Frequency Input Setup

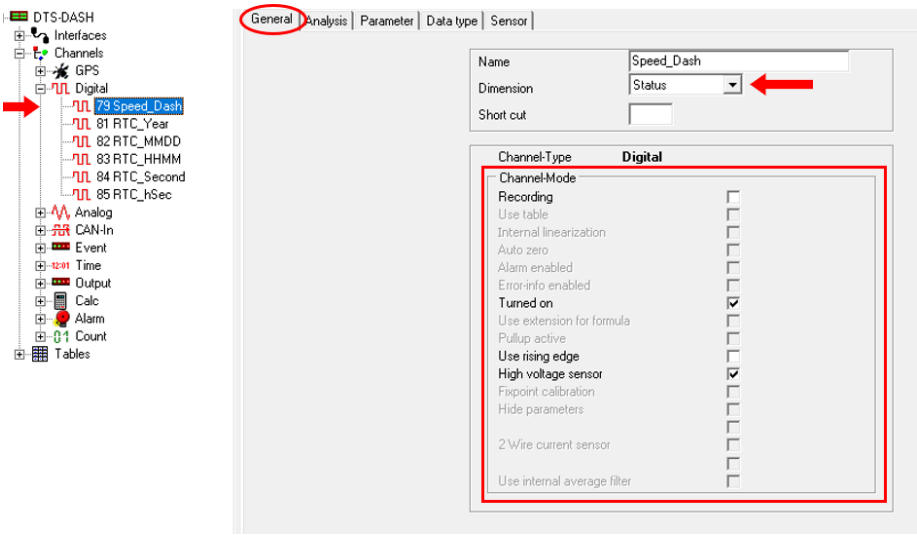
9.4.1 Introduction

Frequency inputs are channels which count the digital pulses and convert them into a signal, considering the selected channel settings, such as circumference, pulses, timeout, digital threshold and the selected dimension.

The internal sampling rate of the 2D Systems is much higher than the sampling rate you can select within the channel. This way it is possible to recognize all pulses. The sampling rate you can select on tab “Parameter” is used to send the data out on the CAN bus and for recording

9.4.2 General

In tab “`General`” of the frequency channels change the following settings:



- Dimension: select a dimension from the drop-down list
  - Hz – impulses per revs, time factor 1 s
  - rpm – impulses per revs, time factor 60 s
  - km/h – time gap between two impulses, converted into km/h, average value while using smaller sampling rates
  - mph – time gap between two impulses, converted into mph, average value while using smaller sampling rates
  - m/s – time gap between two impulses, converted into m/s, average value while using smaller sampling rates
  - 1/s – impulses per time factor 1 s
  - Status – can only be low or high
  - 1/min – impulses per time factor 60 s
- Recording: enable or disable the recording of the channel
- Turned on: turn this channel on or off
- Use rising edge: activate to use the rising edge of the signal, otherwise the falling edge is used
- High voltage sensor

9.4.3 Pull-Down

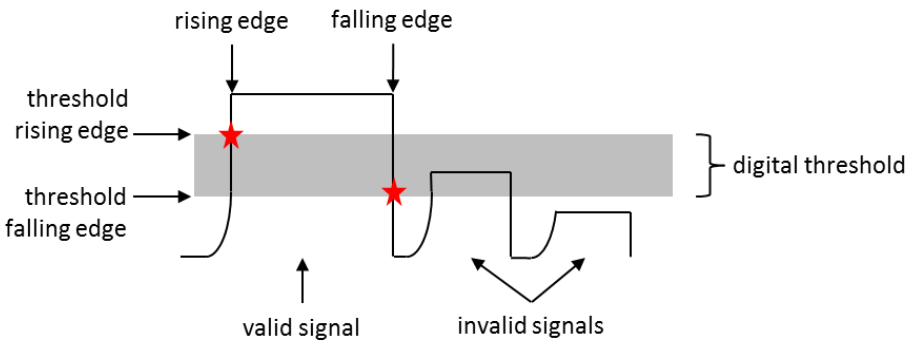
All frequency channels have an internal pull down of 100 kΩ.

9.4.4 Edge / Threshold

To trigger the channel through the signals rising edge enable the checkbox “Use rising edge”.

If this option is not activated the logger will automatically use the falling edge of the signal. The meaning of rising and falling edge is also explained in the figure further down.

A threshold needs to be set so that the trigger level at which the signal is supposed to be low or zero can be recognized. This can be the case if an open collector sensor is connected. The sensor is not powerful enough to lower the voltage down to 0 Volt. The voltage is merely lowered down to 3 Volt. But with a threshold of 4 Volt the logger can still differ between the high- and the low-level signal. Therefore, you have to specify the threshold for the rising edge of the signals and the threshold of the falling edge. If the edges of the signal pass both thresholds the signals are recognized as a valid frequency input signal. (see figure below, the red stars indicate the situation where the signals crosses thresholds)



To change the threshold, navigate to tab “`Parameter`”:

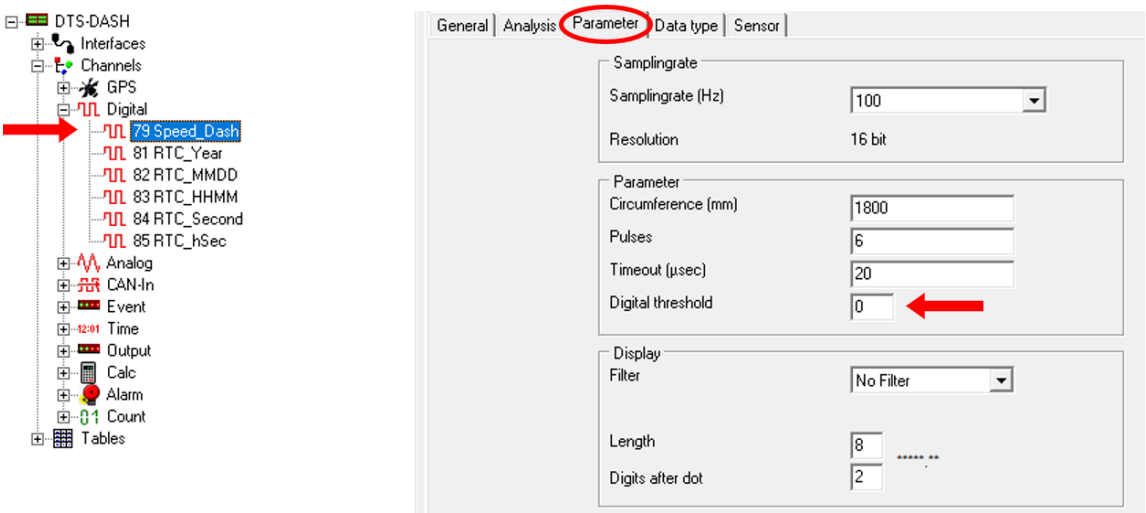
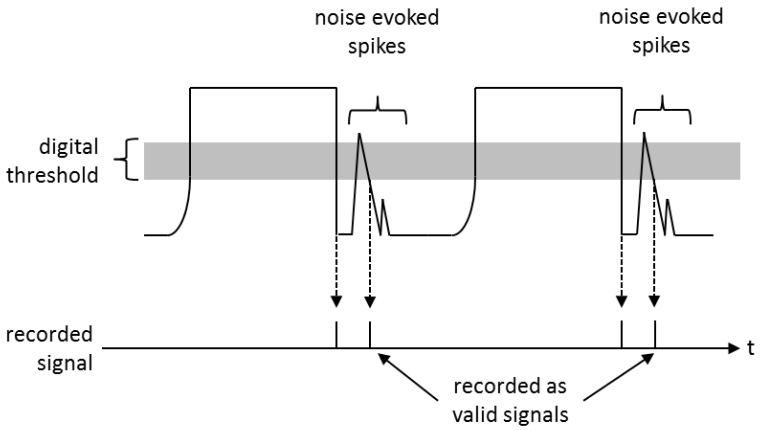


Table 9.1 – Threshold Values

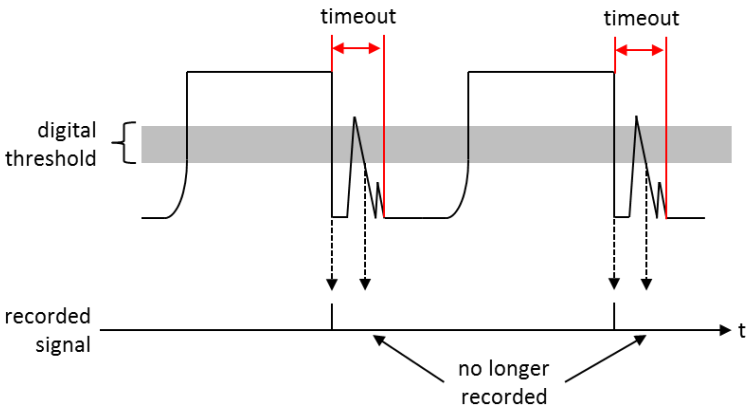
Threshold Value	Threshold rising edge [V]	Threshold falling edge [V]
1	0.04	0.00
10	0.42	0.31
20	0.84	0.64
30	1.24	0.94
40	1.63	1.26
50	2.00	1.55
60	2.36	1.84
70	2.71	2.11
80	3.05	2.38
90	3.38	2.64
100	3.70	2.89
110	4.01	3.13
120	4.31	3.37
130	4.60	3.59
140	4.88	3.82
150	5.15	4.03
160	5.42	4.24
170	5.68	4.44
180	5.93	4.64
190	6.17	4.84
200	6.41	5.02
210	6.64	5.20
220	6.87	5.38
230	7.09	5.55
240	7.30	5.72
250	7.51	5.89
255	7.61	5.97

9.4.5 Timeout

At higher frequencies the noise evoked spikes tend to increase. This means that they might rise above the trigger level and cause interference (see figure below).



To counter this effect, it is possible to define a timeout period for the input signal. The timeout period starts as soon as the falling edge of a signal crosses the falling edge threshold. During the timeout period, the logger ignores pulses on this input. It does not react on incoming signals.



The timeout needs to be set that the noise spikes are completely masked out of the measurement. Be careful not to specify a too long timeout period because that might mask out valid signals.

Set the timeout, navigate to tab "`Parameter`":