



HOW-TO

How-to Use DBW Tuner in EMU PRO

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1. Introduction

The DBW Tuner in EMU PRO is designed to calibrate the throttle position sensor (TPS) and H-Bridge control parameters, including PID coefficients, in Drive-By-Wire (DBW) Systems.

2. Requirements

Before starting the DBW tuner, the following parameters should be configured:

1. Set *Throttles type* to **DBW Throttles**

In *Sensors / Accelerator position / Throttle type*

If the vehicle is equipped with dual throttles, the following parameters should be configured for both throttles indicated by the # symbol in the settings path. In this path, the # symbol is replaced with:

- 1 for vehicles with a single throttle body
- 1 and 2 for vehicles with dual throttle bodies

2. Choose the analog input and voltage reference for the *Main signal* from the **Throttle # position** sensor.

In *Sensors / Throttle # position / Main signal / Input*

Sensors / Throttle # position / Main signal / Voltage reference

3. Choose the analog input and voltage reference for the *Check signal* from the **Throttle # position** sensor.

In *Sensors / Throttle # position / Check signal / Input*

Sensors / Throttle # position / Check signal / Voltage reference

If there is no second signal for the sensor (no physical *Check signal*), select the same input as for *Main signal*.

**Warning:**

It is highly recommended to use two independent position sensors for the accelerator pedal. Using only one sensor increases the risk of not detecting possible failure.

4. Choose the output for **Throttle #**

In *DBW / Throttle # / Setup / Output*

5. Set the output frequency for **Throttle #**

In *DBW / Throttle # / Setup / Output frequency*

according to the throttle manufacturer's recommendations.

6. Set the current limit for **Throttle #**

In *DBW / Throttle # / Setup / Output / Current limit*

according to the throttle manufacturer's recommendations.

3. Using the DBW Tuner

To access DBW Tuner, navigate to the main menu, and select *Tools / DBW Tuner*.

1 Choose throttle: Throttle 1

2 Position sensor: Resource: **3** Voltage: 0,702 [V]

Main signal: Analog 15

Check signal: Analog 13

5 Position: 4,6 [%]

6 Status: OK

4 Graph showing Main signal (blue line) and Check signal (orange line) voltages vs. Throttle position (0% to 100%).

8 Throttle: Resource: Duty cycle: 0,0 [%]

7 Output: H-bridge 1

9 DBW Target: 0,0 [%]

10 Calibration SUCCESSFUL

11 START AGAIN

12 1. Calibrating Throttle position sensor Main signal:
Main signal voltage at limp position: 0,753 V
Main signal voltage at 0%: 0,510 V at 100%: 4,659 V
Invert motor: Yes

2. Calibrating throttle:
Duty cycle base A: 20,8 %DC, B: 26,0 %DC, C: 7,0 %DC,
Duty cycle base reverse A': -15,6 %DC, B: -22,4 %DC, C: -4,6 %DC,
Duty cycle ABOVE limp ref start: 11,3 %DC ref max: 16,5 %DC friction: 9,5 %DC
Duty cycle BELOW limp ref start: -6,7 %DC ref max: -13,5 %DC friction: 8,9 %DC

3. Calibrating PID:
Throttle oscillation center position: 52,9 %
tU: 0,074 s kU: 11,072
kP: 2,214 kI: 59,849 kD: 0,055

4. Calibrating Throttle position sensor Check signal:
Check signal voltage min: 0,338 V max: 4,481 V
Check signal voltage at 0,0%: 4,476 V at 100,0%: 0,336 V

13 Apply **14** Cancel

The DBW Tuner window description:

1. Choosing a throttle for calibration
2. Assigned resources for TPS - Analog Input for *Main* and *Check signal*

3. Voltage of each used resource
4. Plot with voltage progression for each TPS position of the *Main signal* (blue) and the *Check signal* (orange).
5. TPS position channel value. Not visible during calibration or if calibration fails.
6. TPS Diagnostics. Not visible during calibration or if calibration fails.
7. Control resource in use (H-Bridge or BMW S65)
8. Current duty cycle of the H-Bridge
9. Current DBW target of the throttle
10. Calibration result
11. Button to start or abort the auto-calibration
12. Calibration report window
13. Apply button: Saves parameters calculated by auto-calibration and closes the window
14. Cancel button: Discards parameters calculated by auto-calibration and closes the window

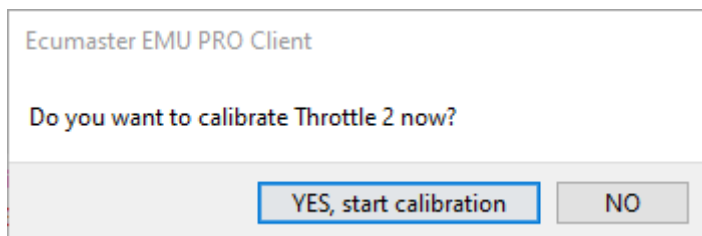
Calibration Procedure for DBW Tuner:

- Ensure the ignition is switched on while the engine is turned off.
- Choose desired Throttle (1 or 2).
- If there are no 'Missing configurations' messages, start the calibration process.
- Process of autocalibration should take about 1-2 minutes.

Calibration process:

1. Disabling the H-Bridge to check the limp position
2. Verifying the throttle's extreme positions by setting 100% duty cycle (max throttle opening) and -100% duty cycle (max throttle closure)
3. If necessary, reversing the H-Bridge direction (to ensure 100% duty cycle opens the throttle)
4. Determining the minimum duty cycle for which the throttle can reach 100% position
5. Establishing the duty cycle hysteresis while maintaining the throttle position at 100% (calibration of the static throttle friction above the limp position)
6. Determining the minimum duty cycle for which the throttle can reach 0% position
7. Establishing the duty cycle hysteresis while maintaining the throttle position at 0% (calibration of the static throttle friction below the limp position)
8. Determining the frequency and amplitude of oscillations at half of the throttle's operating range to determine coefficients for PID control
9. Determining the voltage progression for individual throttle positions.

- The DBW Tuner assumes that the TPS Main Signal voltage is linear between 0% and 100%, but the TPS Check Signal voltage progression may not be linear. The voltage for the 100% position must be equal to either the minimum or maximum voltage.
- Calibration will only proceed if both the Main signal and Check signal change by a minimum of 1V.
- If both throttles have been configured, after completing the calibration of the first one, a window will appear, asking whether to proceed with the calibration of the second one.



- To save the calibration in the project, click Apply.
- To discard the calibration, click Cancel.
- After completing the calibration, configure the following parameters:
Sensors / Throttle # position / Rate calculation interval
DBW / Throttle # / Setup / Output / Disable when no RPM

Parameters not set by the DBW Tuner:

Sensors / Throttle # position / Rate calculation interval

DBW / Throttle # / Setup / Output / Disable when no RPM

For the ITB (Individual Throttle bodies) from the BMW S65 (V8), only TPS1 and TPS2 are calibrated. H-Bridge control parameters are not calibrated, as the throttle controller is responsible for them.

The detailed description of the configuration and calibration for the BMW S65 is in chapter: [Configuration of ITB for BMW S65 \(on page 10\)](#).

4. Possible errors

"Stop the engine during the calibration!"

The engine must be turned off throughout the entire calibration process.

"Select 'DBW throttles' in 'Sensors / Accelerator position / Throttles type' to use DBW tuner."

The throttle type must be chosen as DBW throttles. Change the setting of accelerator position sensor. The DBW is not present in cable operated throttles.

"Sensors / Throttle position # sensor / Main signal / Input - not defined."

Main signal Input must be configured before starting the calibration process.

"Sensors / Throttle position # sensor / Check signal / Input" - not defined. If 'Check signal' is not required, select same Input as for 'Main signal'."

Both the Main signal Input and Check signal Input must be configured before starting the calibration process. If only one analog input is used, assigning the same analog input for Main signal and Check signal is possible. WARNING: It is highly recommended to use two independent position sensors for the accelerator pedal. Using only one sensor increases the risk of not detecting possible failure.

"DBW / Throttle # / Output" - resource is duplicated."

The selected H-Bridge is assigned to two functions in the project. Navigate to *Tools / Assigned outputs* to check the H-Bridge's assignments.

"DBW / Throttle # / Output" - not defined."

The H-Bridge's must be assigned before starting the calibration process.

"Both 'Main signal' and 'Check signal' voltages do not change enough (only ... V and ... V of change, should be more than 1.000 V). Motor control problem or voltage measurement problem on both signals."

The minimum voltage change for both Main Signal and Check Signal is 1V. Any change less than 1V during calibration is considered improper sensor behavior.

"Main signal voltage does not change enough (only ... V of change, should be more than 1.000 V). Main signal voltage measurement problem."

The minimum voltage change for both Main Signal and Check Signal is 1V. Any change less than 1V during calibration is considered improper sensor behavior.

"Check signal voltage does not change enough (only ... V of change, should be more than 1.000 V). Check signal voltage measurement problem."

The minimum voltage change for both Main Signal and Check Signal is 1V. Any change less than 1V during calibration is considered improper sensor behavior.

"Main signal inverted. Swap the sensor SGND with +5V or swap 'Main signal / Input' with 'Check signal / Input'."

The main signal must be increasing. Voltage for 0% position (throttle closed) should be lower than the voltage for 100% position (throttle open).

"Voltage for 0% position of the main sensor is less than 0,125V - signal range too close to GND."

The minimum accepted voltage for 0% position is 0.125V to allow error detection.

"Voltage for 100% position of the main sensor is greater than 4.9V - signal range too close to 5.000V."

The maximum accepted voltage for 100% position is 4.9V to allow error detection.

"Min voltage of main sensor is less than 0.125V - signal range too close to GND."

The minimum accepted voltage for the main signal is 0.125V to allow error detection.

"Max voltage of main sensor is greater than 4.75V - signal range too close to 5.000V."

The maximum accepted voltage for the main signal is 4.75V to allow error detection.

"Not enough free table memory for Check signal Expected voltage."

There is insufficient free memory to correctly fill the table *Sensors / Throttle X Position / Check Signal / Expected voltage*. Free up memory by reducing the size of any other table or removing objects from the project tree.

"Throttle did NOT reach back the limp position. There may be the problem with the return spring."

Mechanical inspection of the throttle body is necessary.

"Throttle does NOT open from limp position."

Mechanical inspection of the throttle body is necessary.

"Throttle starts to open but does NOT reach max open position."

Mechanical inspection of the throttle body is necessary.

"Throttle did NOT close automatically. There may be the problem with the return spring."

Mechanical inspection of the throttle body is necessary.

"Throttle did NOT reach back the limp position. There may be the problem with the return spring."

Mechanical inspection of the throttle body is necessary.

"Could not reach DBW Target (Throttle at ... position)."

During calibration check, the throttle must reach the specified target (+/- 0.5%) within 1 second. Failure to reach the target may be due to incorrect PID calibration or throttle malfunction (e.g., high resistance). In the case of ITB throttles, improper adjustment of individual blades (small single throttle bodies) between them.

"Check signal voltage for 100% position is not equal to minimum neither maximum sensor reachable voltage. Swap the 'Main signal / Input' with 'Check signal / Input'."

The Check signal voltage for 100% position must be equal to either the minimum or maximum reachable sensor voltage.

"Check signal voltage for 0% position is not equal to minimum neither maximum sensor reachable voltage. Swap the 'Main signal / Input' with 'Check signal / Input'."

The voltage for the Check position at 0% must be equal to the minimum or maximum reachable voltage.

"Throttle in limp position is too wide open. In BMW S65 DBW limp position must be close to 0.0%."
Applicable only to BMW S65.

"Lost connection with the device. Tuner will be closed."

If the connection with EMU is lost, the tuner will close. Restore the connection with the EMU and try again.

"Sensors / Throttle position # sensor / Main signal / Input' - must be 'BMW S65 CAN'."
Only for BMW S65, configuration error.

"DBW / BMW S65 / Clutch output' - must not be 'None'."
Only for BMW S65, configuration error.

"DBW / BMW S65 / Clutch output 2' - must not be 'None', or 'DBW / BMW S65 / Use two clutch outputs' - must be disabled."
Only for BMW S65, configuration error.

"Timeout while waiting for the power cycle of the EMU PRO. Tuner will be closed. EMU PRO - DBW Tuner"
Only for BMW S65, the user did not perform the power cycle or EMU could not reconnect with the client.

"No CAN communication with the S65 DBW module. Check 'DBW / BMW S65 / Diagnostic' channel."
Only for BMW S65, communication error.

"General error' received from the S65 DBW module. Check 'DBW / BMW S65 / Diagnostic' channel."
Only for BMW S65, error reported by the throttle controller.

"No movement at startup error" received from the S65 DBW module. Check 'DBW / BMW S65 / Diagnostic' channel."

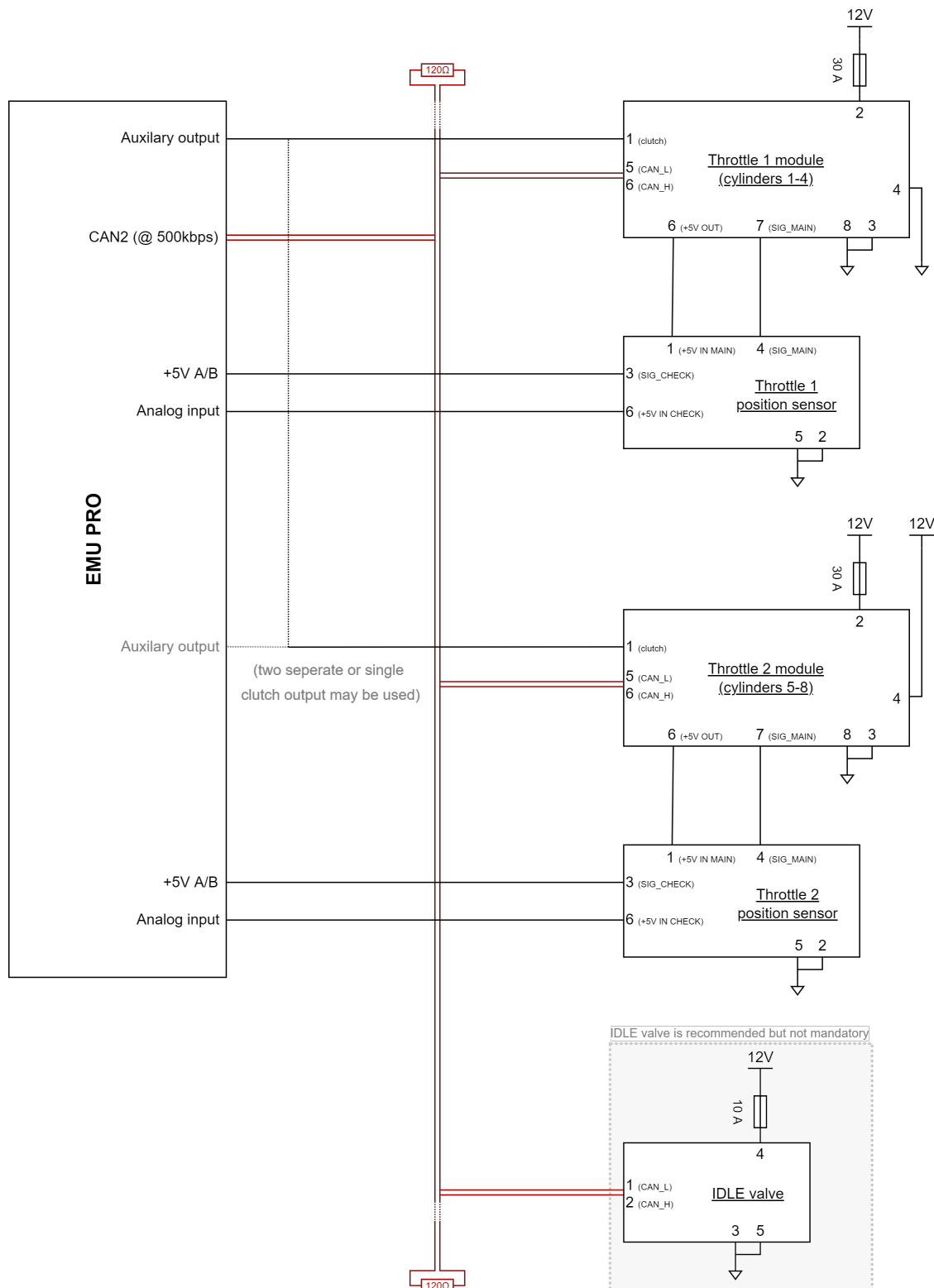
Only for BMW S65, the throttle should perform an auto-check during startup. If it doesn't, it is interpreted as an error.

"Upgrade firmware to version 83.0 or higher to use DBW tuner with Client in this version."

Calibration is possible from version 83 onwards.

5. Configuration of ITB for BMW S65

5.1. Wiring harness



Schematic description:

- Throttle 1 (for cylinders 1-4) has pin 4 connected to GND
- Throttle 2 (for cylinders 5-8) has pin 4 connected to power supply +12V
- All modules (*Throttle 1 module*, *Throttle 2 module* and *IDLE valve*) have to be connected to the same CAN bus – in the EMU PRO it is CAN2 set to 500kbps.

For modules *Throttle 1* and *Throttle 2* pin 5 is connected to CAN_L and pin 6 is connected to CAN_H. IDLE valve on pin 1 to CAN_L and on pin 2 to CAN_H.

- Aim of pin 1 (clutch) in modules *Throttle 1* and *Throttle 2* is to connect clutch between electric engine and the throttle body itself. In the EMU PRO should be connected to any Auxiliary, Injector or H-Bridge output.
 - clutch inputs for modules *Throttle 1* and *Throttle 2* can be connected separately for each of the modules (parameter *use two clutch output* should be enabled) or can be connected to one output in EMU PRO and activated simultaneously (parameter *use two clutch output* should NOT be enabled). Connection method does not affect how the strategy works. Only wiring harness may be more simple to manufacture.
- On output 6 of the Throttle position sensor it is *Check signal* of the sensor. It is analog signal in range 0-5V. Should be connected to any analog input in EMU PRO.
 - Reference (+5V) should be connected to 5V A or 5V B output in EMU PRO and to output 6 in each Throttle position sensor.
- IDLE valve is recommended to be used, but is not mandatory for the system to work.
- In modules *Throttle 1* and *Throttle 2* inputs 3 and 8 (by OEM) are connected to the GND, and output 2 is connected to the power supply (12V) with fuse 30A.
- On output 4 of the Throttle position sensor there is a main signal of the Throttle position sensor. It is analog signal in range 0-5V. It is connected to input 7 in each of the *Throttle 1* and *Throttle 2* modules.
 - *Main signal* reference (+5V) is connected to output 6 in the *Throttle 1* or *Throttle 2* and input 1 in each of the throttle position sensor.

5.2. DBW settings

DBW	
Target	0,0 %
Target unlimited	0,0 %
Target source	Accelerator translati...
Target source components	
Accelerator translation	
Accelerator translation	0,0 %
Speed limit	#
Throttle 1	
Setup	
Output	BMW S65 CAN
Target spring position	0,0 %
Error	0,0 %
Absolute error	0,0 %
Delta error	0,0 %/s
Throttle 2	
Setup	
Output	BMW S65 CAN
Target spring position	0,0 %
Error	0,0 %
Absolute error	0,0 %
Delta error	0,0 %/s
Safety	
Disable brake check	[]
State	
BMW S65	
Use two clutch outputs	[X]
Clutch output	Auxiliary 7
Current	0,00 A
Testing	[]
Clutch output 2	Auxiliary 8
Current	0,00 A
Testing	[]
Diagnostic	
Throttle A no CAN communication	1
Throttle A no movement at startup	0
Throttle A general error	0
Throttle B no CAN communication	1
Throttle B no movement at startup	0
Throttle B general error	0
Throttle A,B enable line state	1
Idle throttle no CAN communication	1
Idle throttle general error	0

In **DBW** category must be configured:

Throttle 1 / Setup / Output on BMW S65 CAN

Throttle 2 / Setup / Output on BMW S65 CAN

BMW S65:

- enabled **use two clutch outputs** if two separate clutch outputs are used for Throttle 1 and Throttle 2
- **Clutch output**

- when **use two clutch outputs** is NOT enabled – clutch output (common for two throttles) must be chosen
- when **use two clutch outputs** is enabled – clutch output for Throttle 1 must be chosen
- **Clutch output 2** (visible only when **use two clutch outputs** is enabled)
 - when **use two clutch outputs** is enabled (true) - clutch output for Throttle 2 must be chosen

5.3. Sensors / Throttle # position configuration

Throttle 1 position	
Value	25,6 %
Main signal	
Input	BMW S65 CAN
Value	25,6 %
Check signal	
Input	Analog input #4
Pullup / pulldown	1M Pulldown
Voltage	3,453 V
Voltage	3,453 V
Expected voltage	3,442 V
4,212 1,204	
0,0 100,0	
Throttle 1 position Main signal Value[%]	
Voltage reference	5V output A
Error tolerance	10,0 %
Error	0,3 %
Min valid voltage	1,004 V
Max valid voltage	4,414 V
Rate calculation interval	50 ms
Rate	0,0 %/s
Status	OK (1)
Throttle 2 position	
Value	25,6 %
Main signal	
Input	BMW S65 CAN
Value	25,6 %
Check signal	
Input	Analog input #2
Pullup / pulldown	1M Pulldown
Voltage	3,441 V
Voltage	3,453 V
Expected voltage	3,453 V
4,223 1,219	
0,0 100,0	
Throttle 2 position Main signal Value[%]	
Voltage reference	5V output B
Error tolerance	10,0 %
Error	0,0 %
Min valid voltage	1,018 V
Max valid voltage	4,424 V
Rate calculation interval	50 ms
Rate	0,0 %/s
Status	OK (1)

In **Sensors** category must be configured:

Throttle 1 position:

- **Main signal / Input** to **BMW S65 CAN**
- **Check signal / Input** as Throttle 1 position sensor analog input
 - **Pullup / pulldown** to **1M Pulldown**
 - **Voltage reference** to used reference +5V output (**5V output A** or **5V output B**)

Throttle 2 position:

- **Main signal / Input** to **BMW S65 CAN**
- **Check signal / Input** as Throttle 2 position sensor analog input
 - **Pullup / pulldown** to **1M Pulldown**
 - **Voltage reference** to used reference +5V output (**5V output A** or **5V output B**)

Next autocalibration should be performed. To do so choose Tools / DBW tuner, next push Start button and follow instruction on the screen


DBW throttle and throttle position calibration

Choose **Throttle 1**

Position sensor:

	Resource:	Position / Voltage:
Main signal:	BMW S65 CAN	0,0 [%]
Check signal:	Analog input #4	4,195

Position: 0,0 [%]
Status: Error: BMW S65 Error



Throttle:

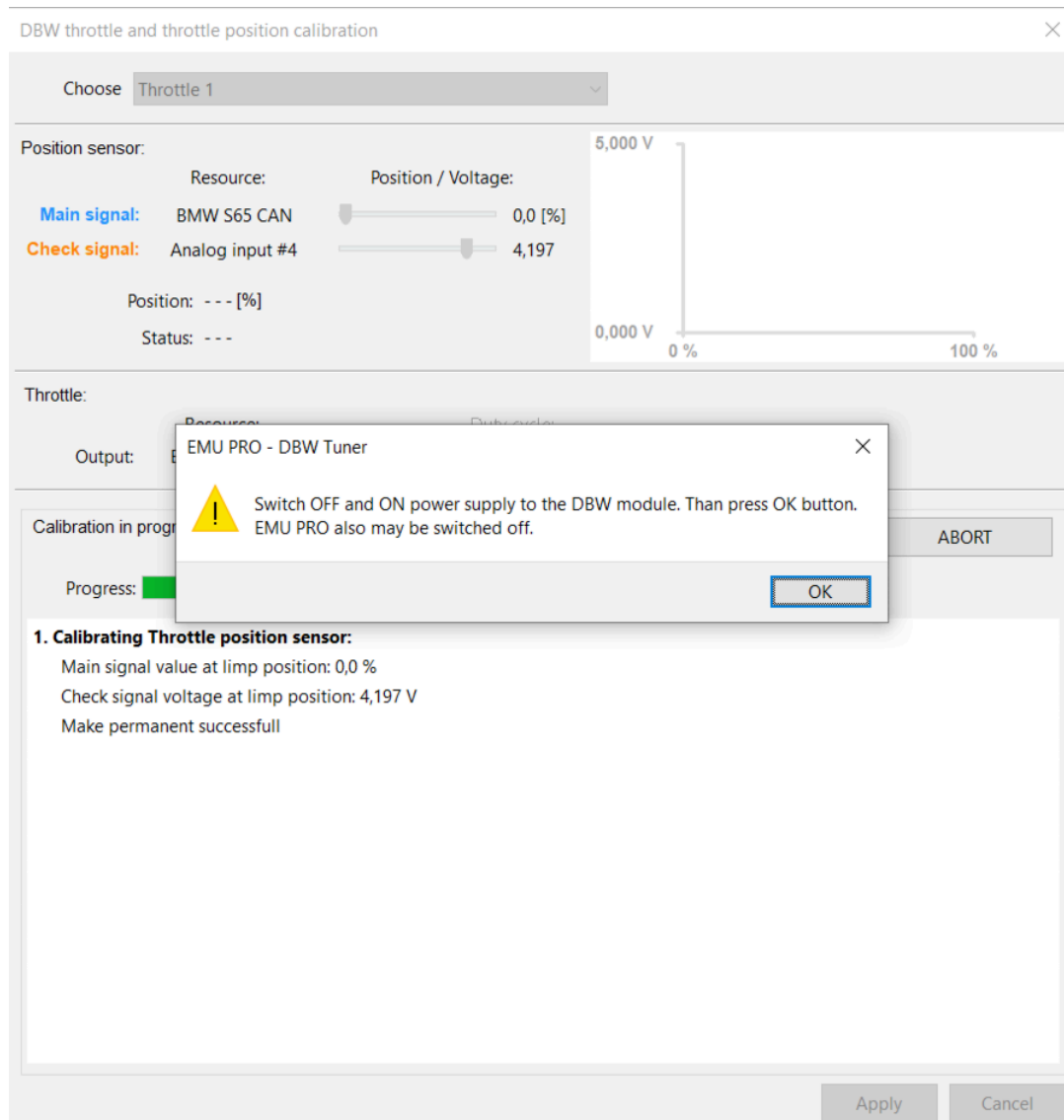
	Resource:	Duty cycle:
Output:	BMW S65 CAN	0,0 [%]

Press the START button to begin the calibration process...

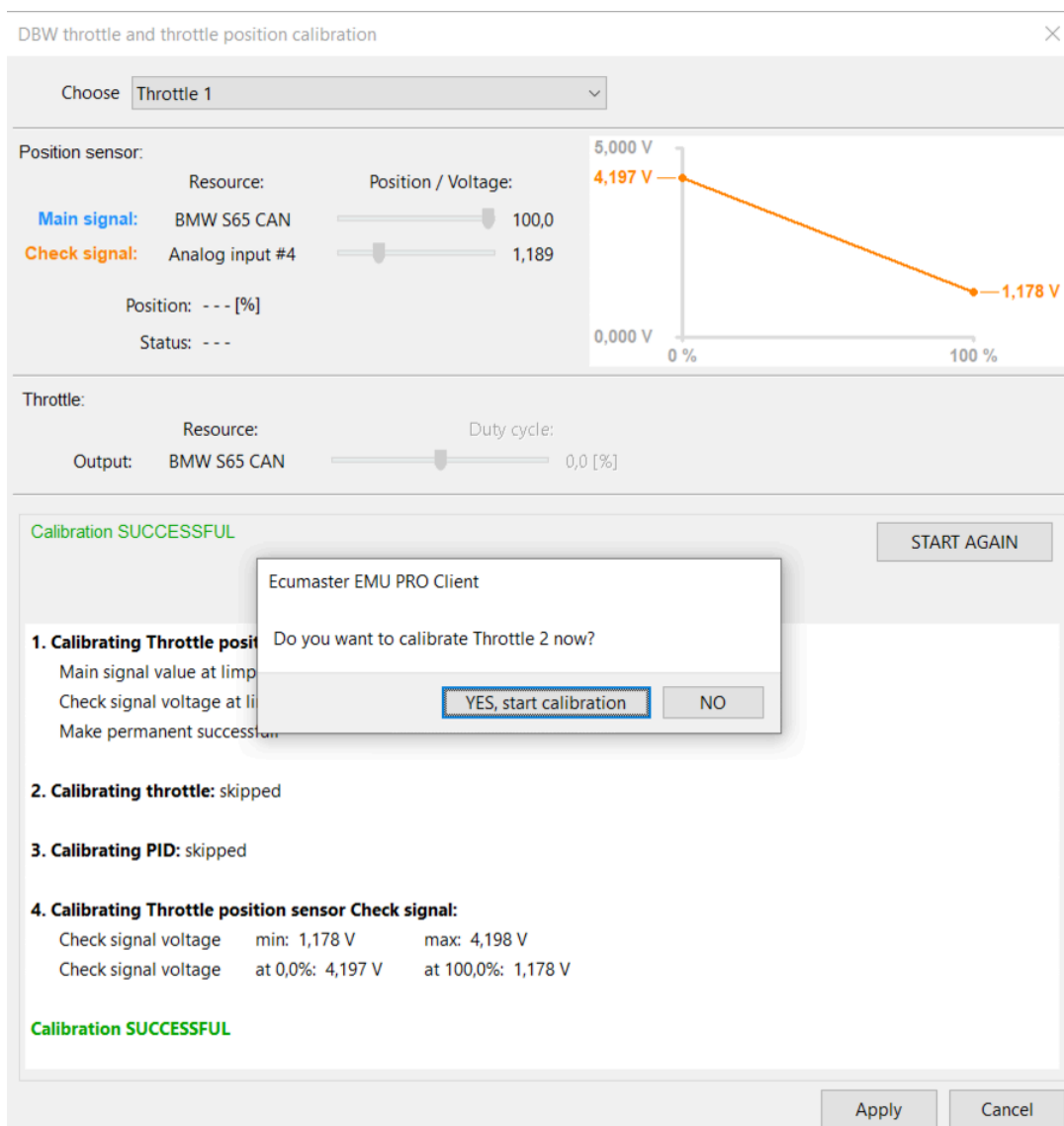
START

Apply Cancel

When pop-up asking for restarting the DBW module will be shown – switch off and on the power supply for the throttle bodies. It can be done by switching off and on for the main power supply (EMU PRO is allowed to restart).



After finishifg calibration of the Throttle 1 pop-up asking for calibration Throttle 2 will show up. Push **Yes, start calibration**.



After finishing the calibration push the **Apply** Button. Pushing Cancel will reject whole calibration process.

DBW throttle and throttle position calibration

Choose **Throttle 2**

Position sensor:

Resource: Position / Voltage:

Main signal: BMW S65 CAN 0,0 [%]

Check signal: Analog input #12 4,205

Position: 0,0 [%]

Status: Error: BMW S65 Error

5,000 V
4,207 V
0,000 V
0 % 100 %

Throttle:

Resource: Duty cycle:

Output: BMW S65 CAN 0,0 [%]

Calibration **SUCCESSFUL** **START AGAIN**

1. Calibrating Throttle position sensor:
Main signal value at limp position: 0,0 %
Check signal voltage at limp position: 4,197 V
Make permanent successfull

2. Calibrating throttle: skipped

3. Calibrating PID: skipped

4. Calibrating Throttle position sensor Check signal:
Check signal voltage min: 1,211 V max: 4,205 V
Check signal voltage at 0,0%: 4,207 V at 100,0%: 1,211 V

Calibration **SUCCESSFUL**

Apply Cancel

After calibration switch off and on the Throttle controller. It can be done by switching off and on for the main power supply (EMU PRO may restart).

6. Document history

Version	Date	Changes
1.0	2024.03.06	Initial release