

# Efficient Calibration

## ETAS INCA-FLOW helps users standardize calibration tasks

Calibrating gasoline and diesel engine management systems is a challenging task that is largely repetitive with regard to specific customer projects. Using INCA-FLOW, the calibration process can be set up for one ECU variant and then reused for others, which can significantly increase calibration efficiency. In addition, measurements can be easily reproduced, leading to clear improvements in calibration quality.

### AUTHORS

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### Bosch base calibration with INCA-FLOW

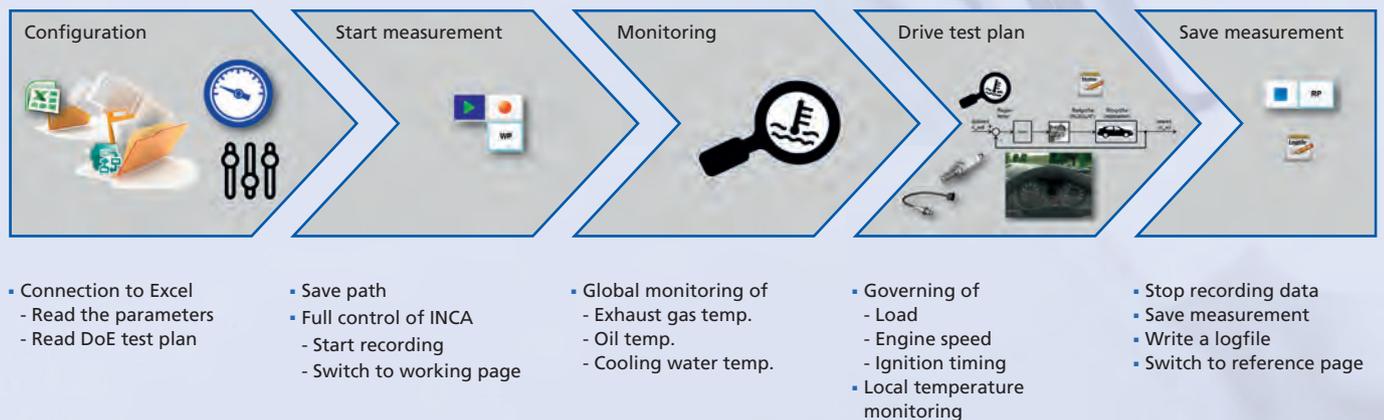
In the course of the base calibration of engine management systems at Robert Bosch GmbH, a Design of Experiment (DoE) plan is automatically carried out in the vehicle using INCA-FLOW.

This is analogous to the procedure used in engine test beds. The first step, which is done on a computer,

involves creation of the DoE plan and measurement configuration in the tool. In the vehicle, the plan is then automatically put through its paces using INCA-FLOW and INCA. To do this, the user first imports the files containing the DoE plan and measurement configurations, which define parameters such as the limits for operation and monitoring. During testing, the values

of the observed loads and other relevant calibration parameters are then set automatically. At the same time, INCA-FLOW monitors system limit values using specific methods. In this way, each operating point of the DoE plan is set, stabilized, and then measured.

Automation is used to check the calibration quality of the volumetric analysis, fuel pre-control, and torque



Sample INCA-FLOW sequence.



model in the vehicle. The same process is used for calibrating the exhaust-gas temperature model and component protection.

For the last two work packages, automatic calibration of the ignition angle is carried out based on each operating point in the DoE plan. The same calibration process can be used for different ECU variants once the DoE plan and the measurement configuration have been adapted using the INCA-FLOW standalone configurator.

**INCA-FLOW standalone configurator for adapting calibration processes to different ECU variants**

INCA-FLOW's runtime license allows scripts generated using INCA-FLOW Developer to be executed on a standalone basis, in other words without the developer license. The standalone configurator enables users to configure independently executable INCA-FLOW scripts for user-specific INCA environments.

At the same time, calibration, measurement, and user-defined variables can be assigned according to user-specific application cases. In this way, the calibration process algorithm can be retained independently of specific boundary conditions, such as different names for calibration and measurement variables and/or other values for specific variables.

Users of the INCA-FLOW standalone configurator are able to configure general information such as project name, process name, comments, soft and hard bounds, etc. The "project" uses as default

Reference name	Description	Original assignment	New assignment
ExperimentElement_...		APP_CharETKC:1	
ExperimentElement_...		ACCompr_RunMode_Pla...	
ExperimentElement_...		DrvInput_Trq_Req	
ExperimentElement_...		RngMoid_trqLosETKC:1	
ExperimentElement_KickDown		SW_KD_ModeETKC:1	
ExperimentElement_r...		Eng_SpdETKC:1	
ExperimentElement_...		Veh_SpdETKC:1	

In the "References" view, users can define "global references" for their calibration process based on existing measurement and calibration variables. The view shows the name of the global reference and, if available, a definition of the variable. The "Original Assignment" column shows the name of the measurement and calibration variable based on the existing process, while the "New Assignment" column allows users to reassign measurement and calibration variables. An existing A2L file or an existing LAB file can be used for the assignment. The "My" view permits users to define different values for certain user-defined variables. With the standalone tool, existing configurations can be loaded and modified configurations can be saved or reset to the old values. The tool allows users to use the same process for the calibration of several ECU variants. In this way, INCA-FLOW facilitates major improvements in the efficiency and quality of calibration.

the data that was defined in the project configuration of the executed process. Configurator users can adapt these settings to their specific INCA environment.

In addition, interfaces can be assigned for the individual measurement and calibration variables of the calibration process. A mapping function allows users to change interface assignments and the names of variables.

**Outlook**  
In the future, INCA-FLOW will also be used for other calibration tasks

such as knock control, engine warm-up, lambda closed-loop control, oxygen probe heating, dew point threshold, fuel tank ventilation, transient compensation, driving behavior, idle control, and camshaft control.



Automated base calibration with INCA-FLOW.