Introduction

GHS/Perception is designed to measure physical quantities with high accuracy. However, for various reasons, such as uncontrollable environmental conditions, even with the highest quality standards, it is impossible to measure a quantity exactly and without error. Therefore, it is essential to always state a measurement result together with the associated measurement uncertainty (MU). This Quick Start Guide describes the MU Estimation (Basic) sheet in Perception which allows estimating the MU of measured electrical and mechanical power values as well as the MU of efficiencies.

The MU Estimation (Basic) sheet is integrated in Perception but does not use the data and other information available in Perception. This means that the information required to calculate MU, such as type of acquisition card, the transducers used, value of measurands, etc., must be entered by the user. How this can be done is explained in this Quick Start Guide. Some basic ideas on how the MU is calculated are given in a white paper available from the HBM website.

Overview

The upper part ❶ of the Perception MU Estimation (Basic) sheet is shown in Figure 1 where the MU for DC power ❷, sinusoidal AC power ❸, and mechanical power ❹ can be calculated. If the sheet tab is not visible in Perception: From the menu bar select “Sheets” and then “MU Estimation (Basic)” ❺.

Figure 1: Overview of the upper part of the Perception MU sheet

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The upper part of every Power type area (see Figure 1) contains several input fields required to calculate the MU. When the name of an input field is red, the input field is not yet specified and therefore no MU calculation can be done (see below with **Setup…** for switching this Missing Information feature off).
When clicking the “Calculate” button (see Figure 1), the validity of the input will be checked. If required, an error message appears, and the area where the error occurred will be highlighted. The results of the calculations will be displayed in the bottom part of each of the three Power type areas. When hovering or selecting a results field, a higher accuracy number will be shown. The calculated results are also available in the Data Sources navigator panel under MU ❶ (see Figure 2).

Note: The calculated results in the bottom part of a Power type area and in the Data Sources navigator panel will be cleared when an entry in the upper part of that Power type area is changed**.**

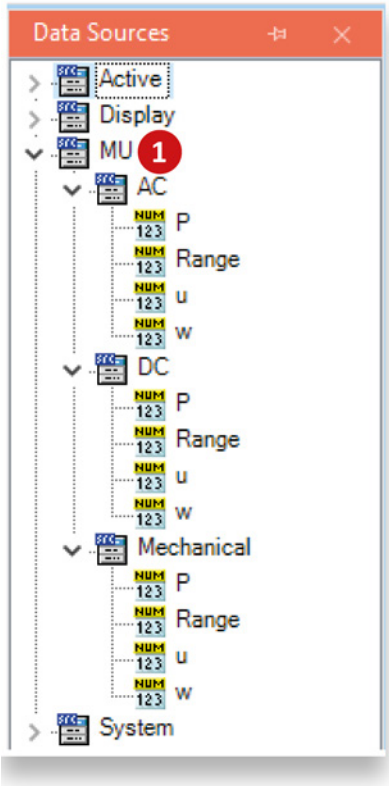

Figure 2: The calculated results in the Data Sources navigator panel

Right-clicking the MU Estimation (Basic) sheet tab or clicking the corresponding Perception menu item shows the context menu (see Figure 3) with the following options:

- Load data samples: load default inputs for all or any of the three Power type areas
- Clear and Restart: clear all inputs and results for all or any of the three Power
  type areas
- Data Sheets: show the names of the data sheets used for the MU calculations
  Quick Start Guide…: opens this Quick Start Guide
- Setup…:
  - select if missing information should be marked (red font)
  - select the unit for temperature
- About…: show information about the MU sheet
- Move Sheet ‘MU Estimation (Basic)’ to: move the mentioned sheet to a new Perception workbook
- Hide sheet ‘MU Estimation (Basic)’: hide (remove) the sheet ‘MU Estimation (Basic)’. It can be reopened by choosing from the menu bar Sheets → Manage Sheets… , selecting ‘MU Estimation (Basic)’ and clicking Load

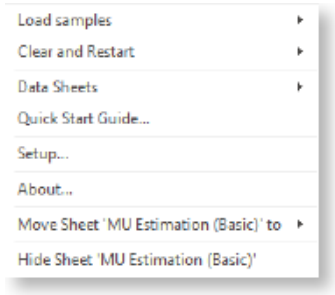

Figure 3: Context menu of the MU sheet tab

The inputs fields for a component (acquisition card or transducer) have a question mark symbol (see Figure 4). When a component is selected, the question mark ❶ symbol changes to blue and clicking it will open the data sheet of the selected component.
Most of the input and output names have a tooltip giving additional information. Hovering the mouse cursor over a name will show the additional information (see Figure 4 for an example).

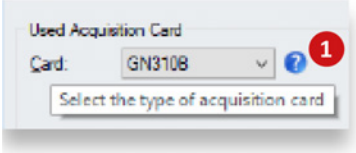

Figure 4: Question mark symbol, and showing a tooltip by hovering the cursor

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By clicking the dotted button ❶ “Show details...” (see Figure 5) at the bottom of the Perception MU sheet (see Figure 1), or choosing the “eta” symbol in the Perception toolbar, or by right-clicking the “MU Estimation (Basic)” tab and selecting “Show Efficiency Calculation Results”, the lower part of the MU Estimation (Basic) sheet becomes visible where the MU of efficiencies are shown. This will be further explained below in the chapter “MU of efficiencies“ on page 6.

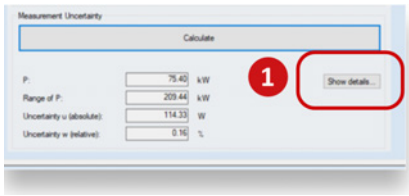

Figure 5: Show details button to show MU Efficiency

DC Power

The DC Power part of the MU Estimation (Basic) sheet (see Figure 6) contains the following entries:

- **Used Acquisition card** ❶
  - Card: select the used acquisition card
  - Measurement bandwidth: select the measurement bandwidth used by the card. Used to determine the noise contribution to the MU. Choose 500kHz in case wideband is selected on the card (see Perception, Settings → Input → Basic –Voltage/Current)
- **Voltage** ❷
  - Method: select how voltage is measured
  - Range selection: when Manual is selected, select a range using the Range drop-down menu. When Automatically is selected, the range will be determined based on the selected input voltage (see “Input Signals” below)
- **Current** ❸
  - Method: select how current is measured
  - Range selection: when Manual is selected, select a range using the Range drop-down menu. When Automatically is selected, the range will be determined based on the selected input current (see Input Signals below)
  - CT: when a Method is selected using a separate Current Transducer (CT), select the used CT.
  - Elapsed time since calibration: select the number of months since calibration
- **Ambient** ❹: select the ambient temperature range when measuring
- **Input signals** ❺: specify the DC voltage and DC current for which the MU must be calculated
- **Measurement Uncertainty** ❻:
  - Click the Calculate button to determine the MU for the given inputs
  - P: the total DC power given the Input Signals
  - Range of P: the range of the power given the ranges of the current and voltage
  - Uncertainty u (absolute): the absolute uncertainty in the DC power
  - Uncertainty w (relative): the relative uncertainty in the DC power

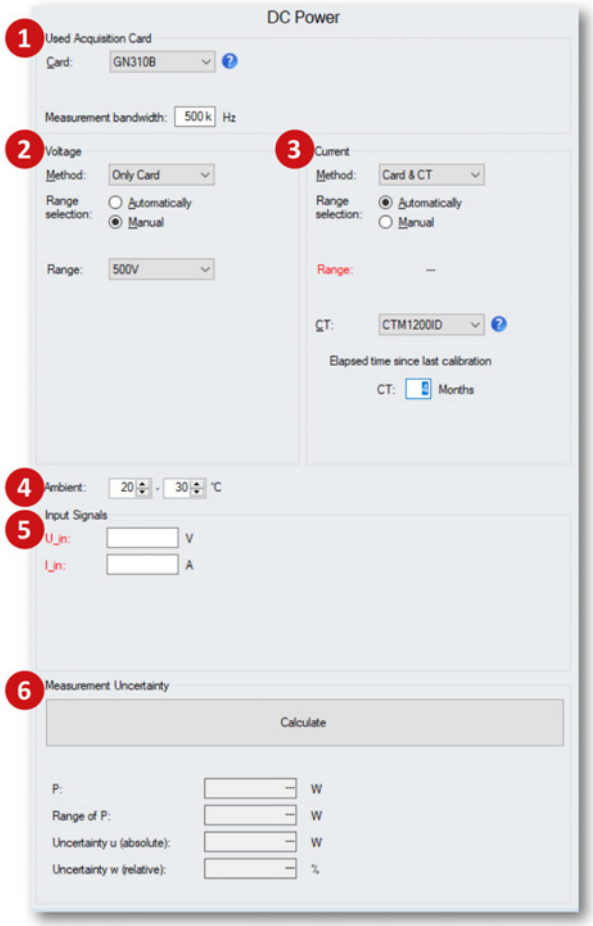

Figure 6: DC Power Measurement Uncertainty

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AC Power

The AC Power part of the MU Estimation (Basic) sheet (see Figure 7) contains the following entries:

- **Used Acquisition card** ❶
  - Card: select the used acquisition card
  - Calculate: select the number of electrical phases
  - Measurement bandwidth: select the measurement bandwidth used by the card. Used to determine the noise contribution to the MU. Choose 500kHz in case wideband is selected on the card (see Perception, Settings → Input → Basic – Voltage/Current)
- **Voltage** ❷
  - Method: select how voltage is measured
  - Range selection: when Manual is selected, select a range using the Range drop-down menu. When Automatically is selected, the range will be determined based on the selected input voltage (see Input Signals below)
- **Current** ❸
  - Method: select how current is measured
  - Range selection: when Manual is selected, select a range using the Range drop-down menu. When Automatically is selected, the range will be determined based on the selected input current (see Input Signals below)
  - CT: when a Method is selected using a separate Current Transducer (CT), select the used CT
  - Elapsed time since calibration: for a 1-phase system, select the number of months since calibration. For a 3-phase system, all three CTs should be of the same type but may have different calibration dates
  - Hide graph: toggle between hiding and showing the graph depicting the input signals
- **Ambient** ❹: select the ambient temperature range when measuring
- **Input signals** ❺: specify the AC RMS voltage (phase to star), AC RMS current, the AC frequency, and the phase between voltage and current for pure sinusoidal signals for which the MU must be calculated
- **Measurement Uncertainty** ❻:
  - Click the Calculate button to determine the MU for the given inputs
  - P: the total DC power given the Input Signals
  - Range of P: the range of the power given the ranges of the current and voltage
  - Uncertainty u (absolute): the absolute uncertainty in the DC power
  - Uncertainty w (relative): the relative uncertainty in the DC power

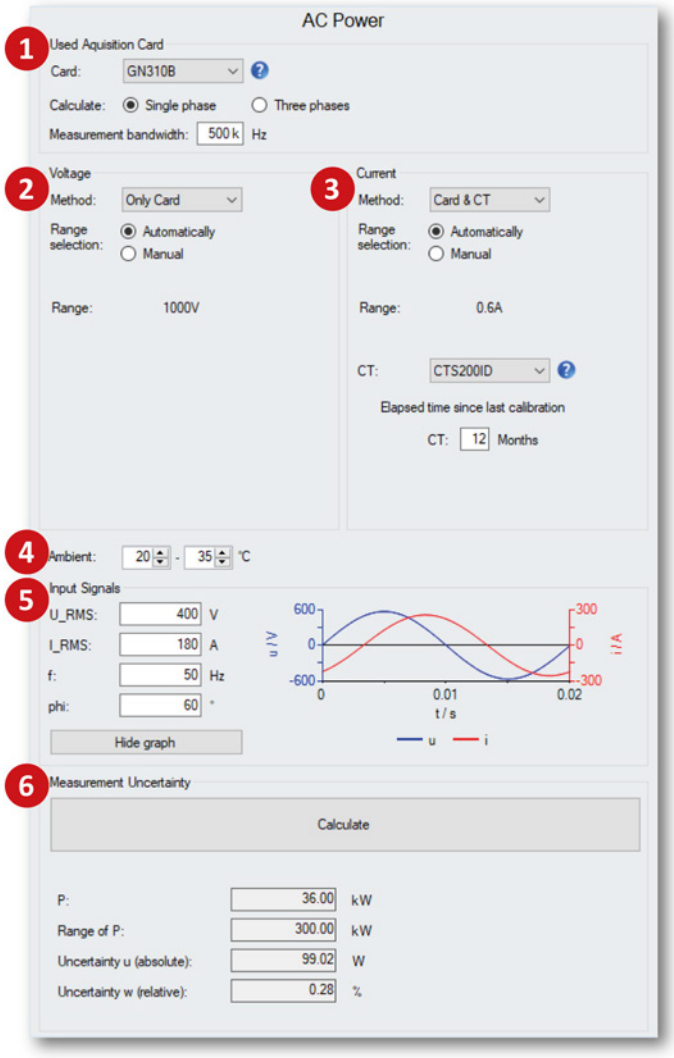

Figure 7: DC Power Measurement Uncertainty

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Mechanical Power

The Mechanical Power part of the MU Estimation (Basic) sheet (see Figure 8) contains the following entries:

- **Used Acquisition card** ❶
  - Card: select the used acquisition card
  - Torque Sensor with speed option / Torque Sensor + Speed Sensor: select if a single torque
  - sensor with speed option is used, or a separate torque and speed sensor
  - Measurement bandwidth: select the measurement bandwidth used by the card. Used to determine the noise contribution to the MU. Choose 500kHz in case wideband is selected on the card (see Perception, Settings → Input → Basic – Voltage/ Current)
  - t measure: specify the measurement time of the acquisition card used to measure the frequency of the torque and speed signals card (see Perception, Settings → Input → Timer - Counter
- **Torque** ❷
  - Sensor: select the sensor used to measure torque
  - M_nom: select the (rated) nominal torque
  - Working range: select the observed working range in terms of minimum and maximum torque
  - Frequency: select the zero-torque frequency
  - Influence of parasitic load: select the parasitic load as 10% of the total budget, or give detailed inputs to determine the parasitic load
- **Speed** ❸
  - Sensor: select the sensor to measure speed (if not combined with torque sensor)
  - M_nom: select the (rated) nominal torque (if not combined with torque sensor)
  - Pulses/rev: select the number of pulses generated per revolution
  - Speed(M/H): select the Standard or High speed options
- **Ambient** ❹: select the ambient temperature range when measuring
- **Input signals** ❺: specify the measured torque and speed values for which the MU must be calculated
- **Measurement Uncertainty** ❻:
  - Click the Calculate button to determine the MU for the given inputs
  - P: the total mechanical power given the Input Signals for torque and speed
  - Range of P: the range of the power given the nominal torque and nominal speed values
  - Uncertainty u (absolute): the absolute uncertainty in the mechanical power
  - Uncertainty w (relative): the relative uncertainty in the mechanical power
  - Show details…: show details on the various calculated values

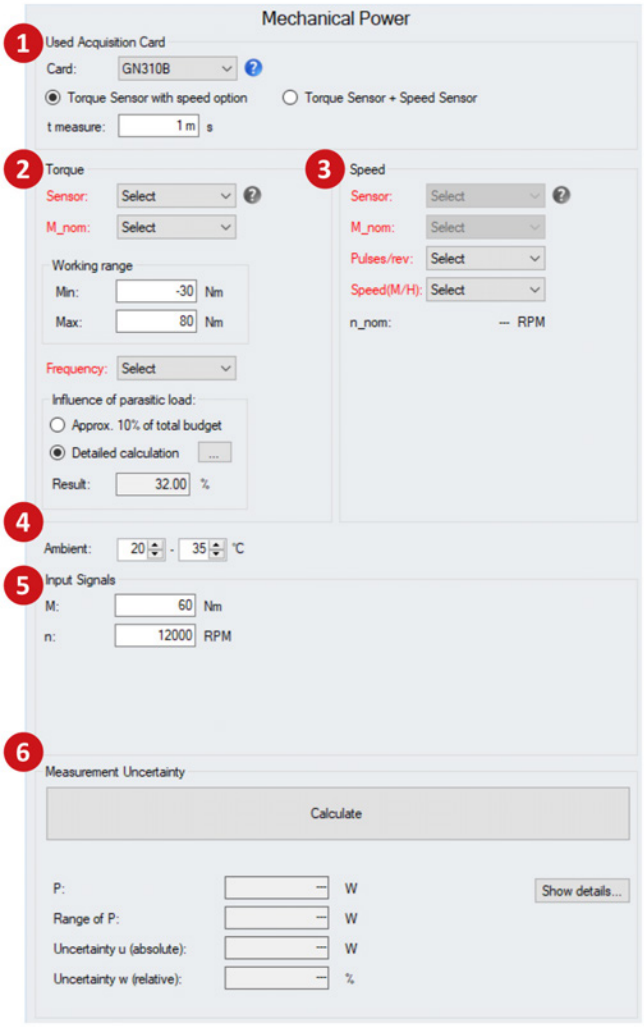

Figure 8: Mechanical Power Measurement Uncertainty

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MU of efficiencies

Based on the MU of the DC, AC and mechanical power, the lower part of the MU sheet gives the value and MU of three efficiencies (see Figure 9).
The **DC-AC Efficiency** ❶ is related to a measured DC power and a measured AC power, for example measured at the input and the output of an inverter, respectively.
The **AC-Mechanical Efficiency** ❷ is related to a measured AC and mechanical power (e.g., of a motor or generator).
The **DC-Mechanical Efficiency** ❸ is related to a measured DC and mechanical power (e.g., going from battery power to mechanical power of a drive train). The blue arrows indicate which of the powers is higher.

Note: In Figure 9, the absolute MU is given as a percentage. Due to the fact that the efficiency itself is given as a percentage and an absolute MU takes the unit of the measurand.
As an example for the relative MU, when the measured efficiency is 80% and the absolute MU is 5%, the relative MU is (5%/80%)*100%=(5/80)*100%=6.25% because the relative MU is given as 100 % * absolute MU / measured value.

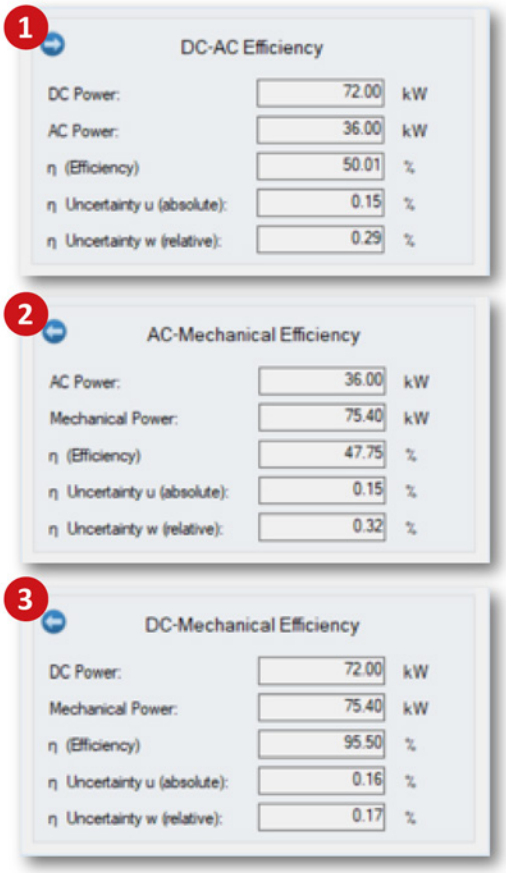

Figure 9: Overview of the lower part of the Perception MU sheet

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