Trust is good - but testing is better

HENQ 1100 - a new, mobile analyzer for incremental rotary encoders

Ralf Schenk, Axel Loharens

The operation of an electrically controlled drive is decisively affected by the quality of the measurement signal fed back by the rotary encoder. If drive tasks have to be implemented under arduous environmental conditions, then the selection of a robust rotary encoder has No. 1 priority. Furthermore, it is necessary to deal with any sources of interference that could affect the measurement signal between the encoder and the input to the controller. Not only that, but undetected installation errors may, in certain circumstances, lead to the encoder being erroneously interpreted as faulty by the controller during the subsequent commissioning, although the encoder is, in fact, operating correctly. A function monitoring facility that is only integrated into the encoder will therefore soon reach the limits of its capabilities, as only the checking of the measurement signal at *various* points in the transmission path will permit a proper analysis of the cause in the event of an error. The following article presents a mobile analyzer for incremental encoders that provides extensive monitoring and diagnosis options - from the initial stages of installation to full continuous operation.

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The **H**übner **EN**coder **Q**uality Measurement System **HENQ 1100** is a hand-held instrument for testing incremental encoders that produce HTL/TTL or sin/cos output signals. The instrument is operated through a built-in user-friendly keypad and a 4-line LC display with background lighting. This is used to show the signal measurements from the encoder and any error messages, in plain text. **Fig. 1** provides a detailed overview of the monitoring and diagnosis functions that have been implemented in the HENQ 1100. The trigger levels for error messages, such as the permissible phase deviation or the permissible mark-space ratio for the encoder signals, can be *individually* programmed. If the quality of a measurement signal that has been acquired under arduous conditions has deteriorated, then the cause can often be determined only through detailed diagnosis. It is often not

clear, at first, whether the *encoder* is faulty or the signal has suffered interference in the transmission path to the controller. In some applications, such as test beds at megawatt power levels, construction requirements make it inevitable that measurement signal cables have to be routed in the immediate vicinity of power cables. As a result, switching actions in the power circuitry can induce spikes in the signal cables, even if they are shielded. This has a negative effect on the control loop response of the drive, without any obvious cause, since the encoder itself does not indicate any error. Here, as in other situations where the measuring electronics has to be installed in a difficult environment, the HENQ 1100 comes into action, with its philosophy of providing options for connection to *various* positions in the control loop, for testing purposes (**Fig. 2**).

The HENQ 1100 simplifies the installation and commissioning of rotary encoders

Often there is no interference present, the encoder itself functions properly – but a mistake was made during installation. Maybe an encoder was built in with the wrong number of pulses per turn, or a connector was wired up incorrectly, or cables have been swapped. For such reasons, experience has shown that it is advisable to make a step-by-step check of the measurement signal path *during the installation phase*. To facilitate this, the HENQ 1100 is able to power a connected encoder from its own supply voltage (**Fig. 3**). So the encoder can be run on its own, even if the supervisory control system is not yet operational. It is also possible to temporarily disconnect a section of a system that is already operational, for testing purposes, and meanwhile to power the relevant encoder independently, using the supply from the HENQ 1100.

Instrument functions

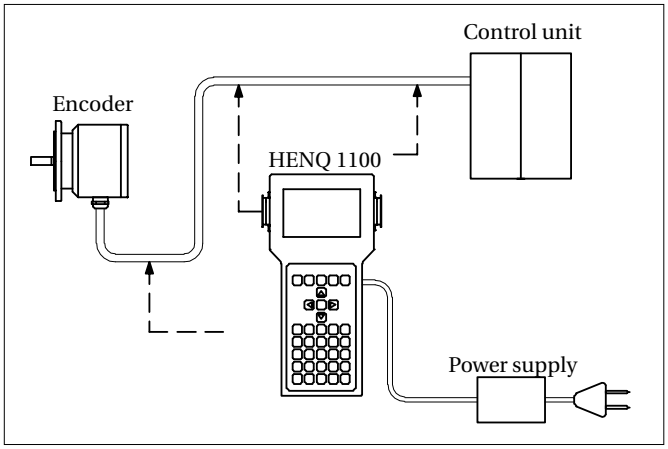
- Continuous **monitoring and display** of
  - the **speed**, **angular position**, and **position of the marker pulse**
  - the **phase angle** between K1 and K2 (or A and B)
  - the **mark space ration** of K1 and K2 (or A and B)
  - the **voltage range** of encoder output signals [1)]
  - the **supply voltage** and **current drawn** by the encoder, with the **power consumption** calculated from these values
- Continuous **error monitoring**
  - **elimination of signal disturbances** through adaptive filtering
  - **comparision of the nominal/actual number of pulses per turn** [2)]
  - errors in connection with the **marker pulse**
  - **check of quadrature coding** by evaluation of the track signals and the marker pulse
- **Individual error messages**
- **Windows applications software** for the PC, for **graphical display** and **statistical evaluation** of the measurements
- **Recording of measurements and error messages** in a logbook on the PC

[1)] not available for sine encoders
[2)] only if a marker pulse is available

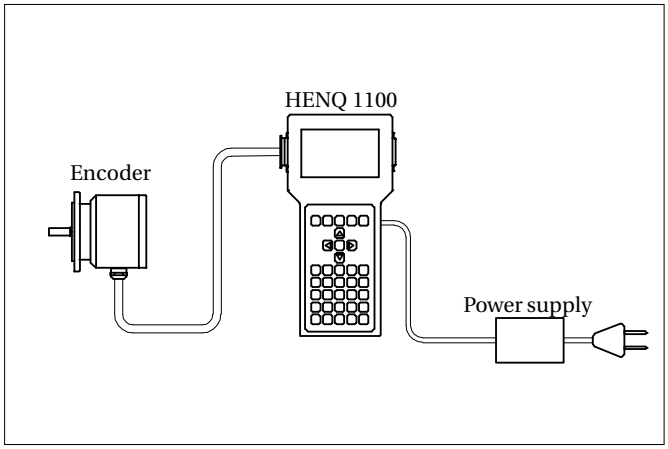
1: Instrument functions

The HENQ 1100 can be connected to rotary encoders from various manufacturers

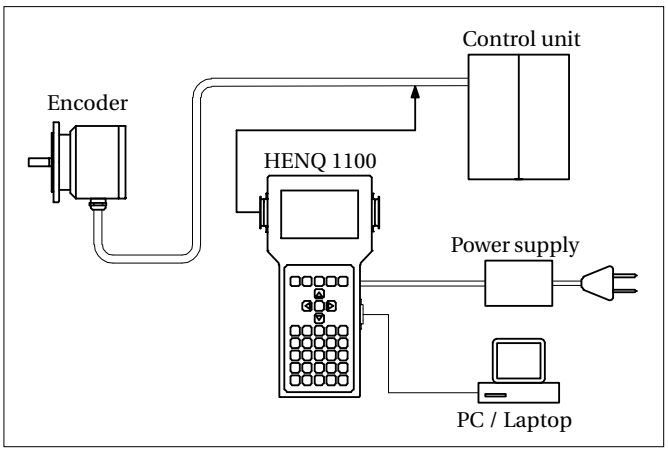
Adaptation to the specific encoder is very simple: an ex-factory pre-programmed database of standard Hübner types has been incorporated in the HENQ 1100. If the attached device is included in the database, then it can be set up with just a few keyboard commands. If not, then the parameters for the encoder that is to be connected can also be entered individually, by hand. There are two ways of achieving this: the user can either take the existing database as a starting point, and edit an existing data set, or make manual entries as a complete set for the encoder that is not yet available, thus adding an additional type to the database. On request, the data specified by the customer can already be added to the database as default entries at the factory. As a universal tester, the HENQ 1100 permits the connection of just about any rotary encoder – regardless of the manufacturer – that generates the appropriate HTL/TTL or sin/cos output signals.



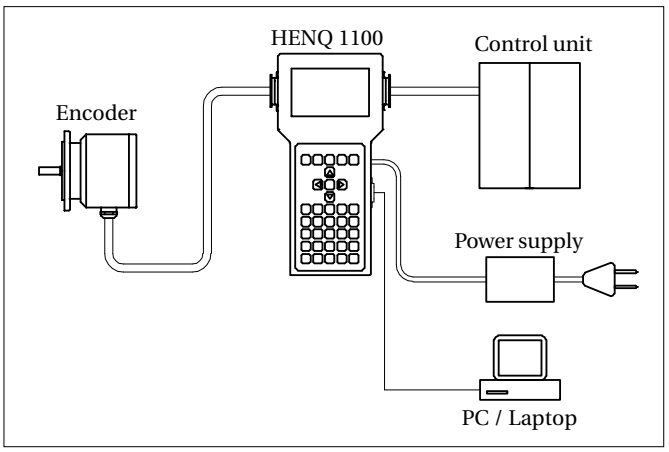
2: Error analysis through a step-by-step check of the test signal at various points in the signal path



3: Encoder supply from the HENQ 1100



4: Long-term monitoring by a PC to detect sporadic errors



5: Long-term monitoring with simultaneous filtering of the looped-through measuring signal

A logbook with long-term recording permits the analysis of rarely occurring sporadic errors

Measurement data and error messages can be read out via an integrated RS-485 interface and saved in a logbook on the PC, with a date stamp. The required Windows measurement application is included in the standard package. The hard disk capacity of a normal commercial laptop is sufficient to carry out on-site *long-term* recording. Such a record is required for the demonstrable proof and analysis of rarely occurring sporadic errors. Monitoring is normally conducted by "listening in" on the system, in other words, without disturbing normal running (**Fig. 4**). Fast signal processing in the HENQ 1100 also ensures the registration of even brief disturbances, such as those caused by short voltage drop-outs in the power supply. The logbook is in the format of a plain text file, so that there are no problems in importing it into other applications (such as the usual Office programs) for further processing. If the HENQ 1100 is wired into the signal path, as shown in **Fig. 5**, then it is also possible to filter out glitches in the signal, and in this way to test how the control system responds to an appropriately cleaned-up measurement signal.

In addition, the Windows measurement application for the PC permits continuous display of the measurement data on the screen – not only in plain text, but also to some extent in graphical form (**Fig. 6**). It thus complements the online representation on the hand-held display. The software also provides the possibility of storing the measurements and error messages from *several* encoders, and of performing statistical evaluations. This means that the HENQ 1100 is not only interesting for the measurement technician who looks after the system, but is a test instrument that serves as a useful tool for quality assurance and the documentation of measurement points in accordance with EN ISO 9001.

The hand-held device presented here offers the user comprehensive function monitoring. It saves time, because it speeds up fault-finding. And, since the HENQ 1100 can be used as a mobile instrument for monitoring *several* encoders, it is very attractive from the point of view of investment costs: the cost of purchasing the hand-held instrument, divided up to give the *calculated* cost per *individual* encoder, is very modest.

Trust is good, but testing is not only better – it is urgently recommended. To this end, the user can be greatly helped by the HENQ 1100 for incremental rotary encoders.

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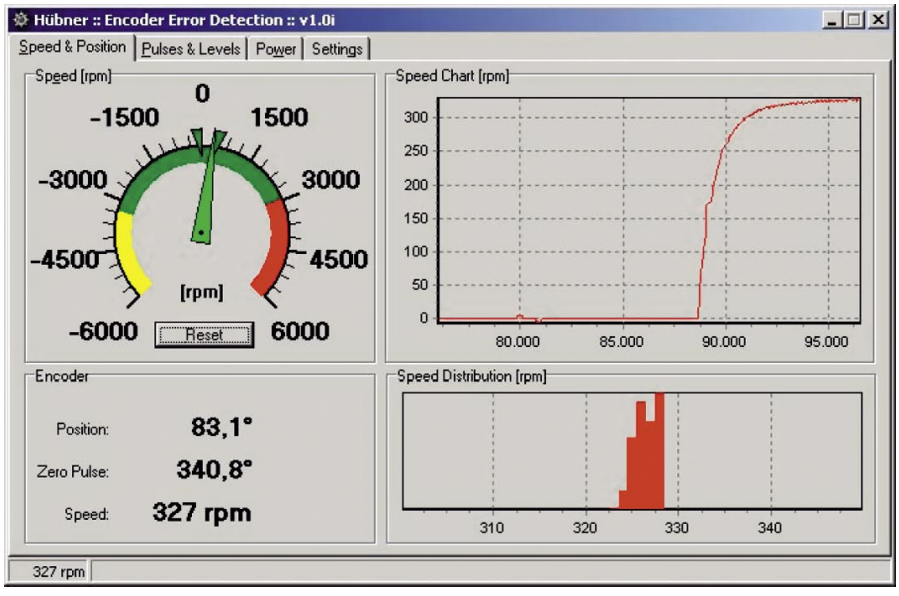

6: Display and evaluation of measurements by a PC program

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