

Capacitance Level Measurement *Electronic insert FEC 12*

**Smart electronic inserts for Multicap probes
DC..TE/TA and DC..E/A
with HART protocol
and integrated linearisation curve**



Applications

The FEC 12 electronic insert is a 4...20 mA Smart transmitter for capacitive level measurement. Its compact form means that it can be installed in the housings of the Multicap probes DC..TE/TA and DC..E/A.

Features and Benefits

- Simple and easy operation:
 - Basic functions set locally at the press of a key
 - via intelligent data protocol (HART)
 - connection to a Rackbus or PC via interface boards
- Settings can be locked as required
- Linearisation curve for horizontally mounted cylindrical vessels
- Simple replacement of electronic inserts with downloading of parameters

Endress + Hauser

The Power of Know How



Measuring System

The FEC 12 electronic insert is a compact transmitter with the complete measuring system for the basic version consisting of just:

- the FEC 12 electronic insert
- a Multicap probe DC..TE/TA or DC..E/A
- a transmitter power supply unit and
- a display unit (e.g. ammeter)

This simple but complete measuring point allows access to the basic functions of the instrument.

Basic settings can be carried out locally using the four keys on the instrument without any other tools.

The instrument can be operated using a loop powered 4...20 mA (Smart) circuit with a handheld terminal (HART protocol) or by connecting to a Commubox (RS-232C interface). It can also be operated and measured values called up using the Rackbus FXN 672 interface card or a PLC.

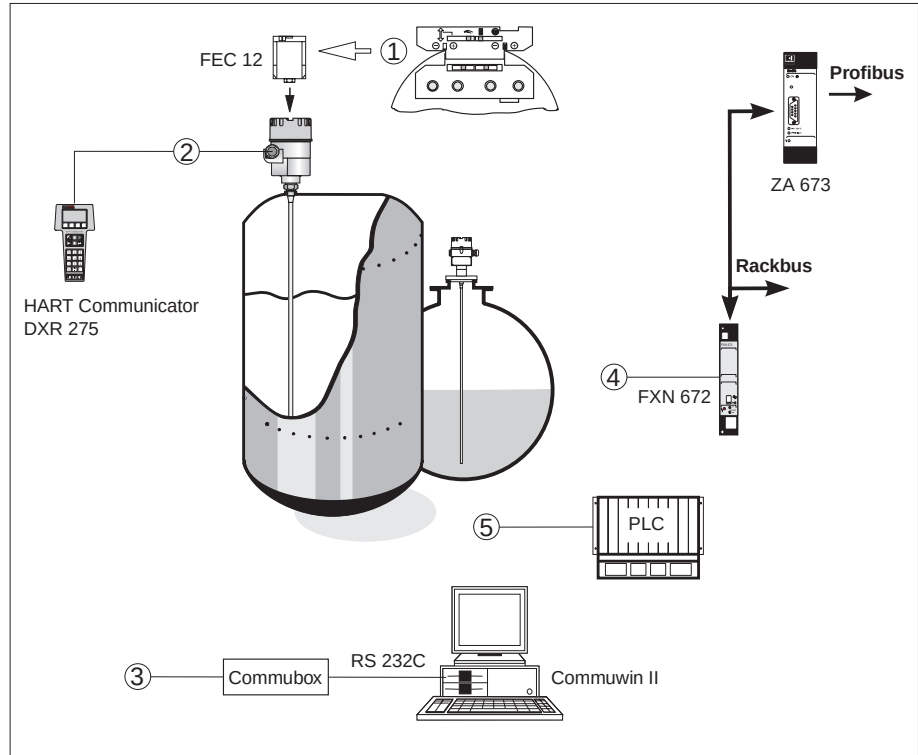
All types of operating the FEC 12 electronic insert are shown in this summary:

Local operation:

- ① Basic functions are set using four keys

Remote operation via:

- ② HART communicator handheld terminal DXR 275 (HART protocol)
 ③ Commubox FXA 191 (HART protocol)
 ④ Rackbus FXN 672 interface board (HART protocol)
 ⑤ Programmable logic controllers or a process control system



Operating Principle

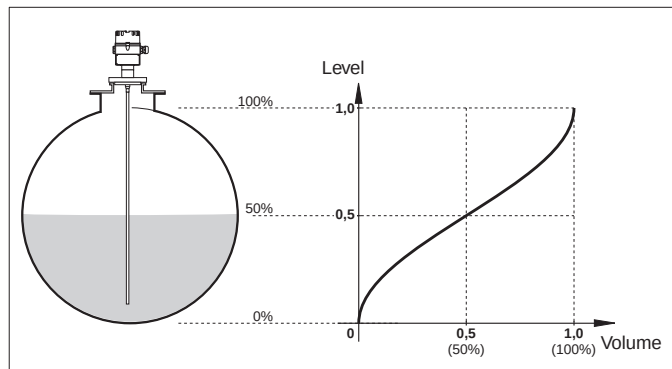
Measuring Principle

Capacitance measurement is based on the principle of the probe and vessel wall together forming a capacitor. The space between the probe and vessel wall is either filled with air (empty) or material (full), depending on the level inside the vessel. A specific impedance is then measured.

The FEC 12 Electronic Insert

The microprocessor in the FEC 12 electronic insert evaluates the impedance measurement which is carried out at high frequency ($f = 500 \text{ kHz}$). There is thus a standard 4...20 mA signal at the output of the electronic insert that is proportional to the level, if the vessel has a constant cross-sectional area. A linearisation can be carried out for those vessels which do not have a constant cross-sectional area. A digital communication signal is superposed on the current output to allow bi-directional data exchange between the FEC 12 electronic insert and the handheld terminal or transmitter. Additional digital information is transmitted using the HART protocol.

Relationship of level
to volume for a
horizontal cylinder



Linearisation

A preprogrammed linearisation curve can be activated when the probe with the FEC 12 is mounted in a horizontal cylinder.

Further settings can be made using a handheld terminal or transmitter.

Calibration

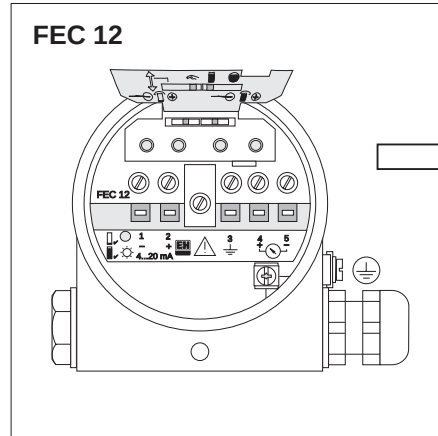
Calibration is carried out at start-up either locally on the electronic insert itself or remotely using a handheld terminal or Rackbus transmitter. Local calibration is done by simply pressing a key on the electronic insert. The output signal is set at 4 mA for empty vessels (= 0 %) and 20 mA for full vessels (= 100 %). Values between the 0 % and 100 % level can also be set locally using the four keys.

Recalibration is only required if the complete probe is replaced. However, if only the electronic insert is to be replaced, then the parameter settings are first read out and then entered into the new electronic insert using a handheld terminal or a transmitter.

Operation

The FEC 12 electronic insert mounted in the probe housing offers:

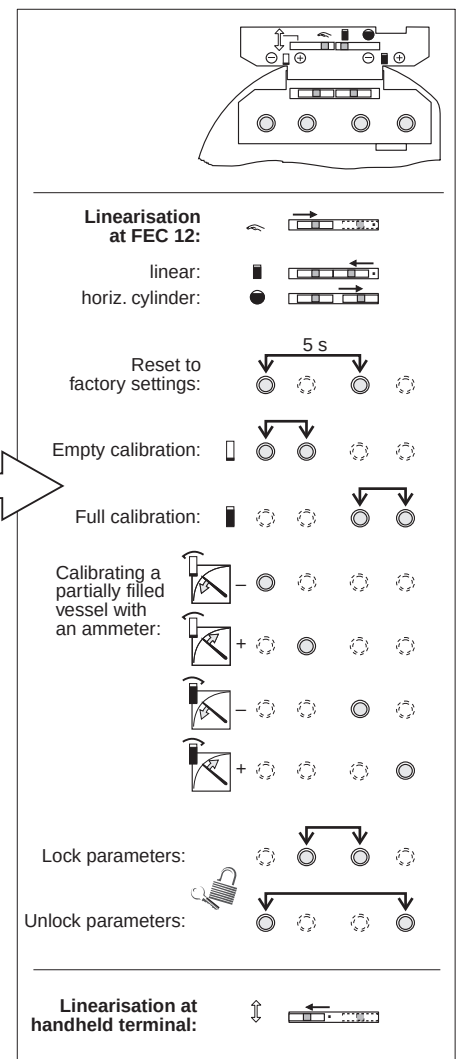
- Local empty and full calibration by simply pressing a key or
- Access to the E+H user matrix
 - via a handheld terminal,
 - via Rackbus FXN 672 interface card, Commubox FXA 191 and PC or PLC, PCS ...



Local Key Operation

The basic functions of the instrument can be called up by using the four keys on the operating interface of the FEC 12 electronic insert:

- Factory settings reset
- Empty and full calibration
- Settings protected by locking
- Partially-filled vessels calibrated by connecting an ammeter.



Local operation
via four keys

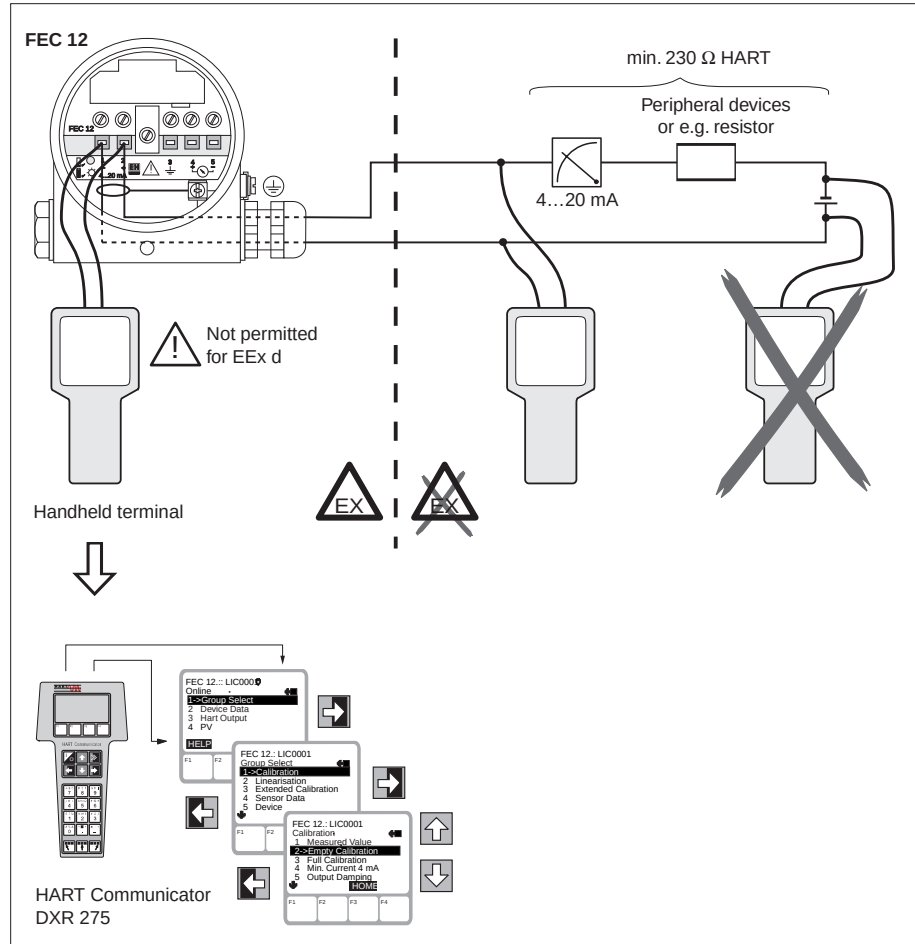
Handheld Terminal

A handheld terminal can be connected at any point along the 4...20 mA line to check, monitor and call up additional functions.

- HART Communicator DXR 275: HART protocol.

Matrix Operation

Operating with the uniform E+H matrix always remains identical and comprehensive whether calibrating with the handheld terminal or Rackbus transmitter.



Connecting a handheld terminal:
- HART Communicator DXR 275 with HART protocol

Operation Using the Transmitter

The electric insert can be connected to the following:

- Rackbus FXN 672 interface card, a 19" plug-in card for connecting Smart sensors with the HART protocol

Operation Using the Commubox

The Commubox FXA 191 connects intrinsically safe Smart transmitters with a HART protocol to the RS-232 C serial interface of a personal computer. This enables the FEC 12 electronic insert to be remotely operated with the Endress+Hauser Commuwin II operating program.

Operation Using PLC, PCS ...

Parameters can be changed, measured values called up or errors identified by connecting the FEC 12 electronic insert to a process control system (PCS) or else to programmable control systems (PLCs).

Technical Data

General Information

Manufacturer	Endress+Hauser
Instrument designation	FEC 12 electronic insert

Application

Continuous level measurement

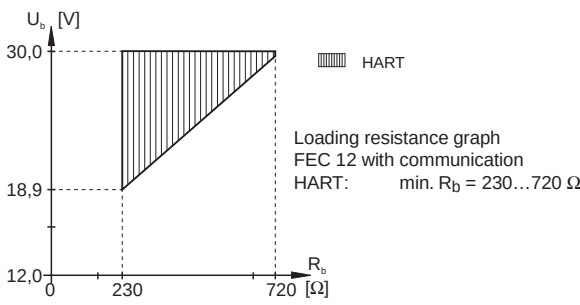
Operation and System Design

Measuring principle	Capacitance
Mechanical construction	Compact unit
Signal transmission	2-wire, 4...20 mA (Smart)

Input

Variable	Level (continuous level measurement)
Measuring ranges	Initial capacitance: $C_A = 0 \text{ pF} \dots 367.5 \text{ pF}$ Change in capacitance: $\Delta C = 10 \text{ pF} \dots 2000 \text{ pF}$ Final capacitance: $C_E = \text{max. } 2100 \text{ pF}$ Conductive media limit the measuring length.

Output

Output signal	4...20 mA
Transmitters	See appropriate Technical Information brochure
Load	 Loading resistance graph FEC 12 with communication HART: min. $R_b = 230 \dots 720 \Omega$
Overrange signal	22 mA
Integration time	1 s default, 4...40 s, adjustable

Accuracy

Measured error	$\leq 1 \%$ of full scale value, range: 0...2000 pF
Repeatability	0.25 % of full scale value, range: 0... 100 pF
Effects of ambient temperature	$T_K 0 \dots 70 \text{ }^\circ\text{C}$, $\leq 0.02 \%$ /K of full scale value, range: 0...100 pF

Application conditions

Installation conditions

Mounting	In any position
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Ambient conditions

Normal operating temperature	0 °C...+ 70 °C
Temperature limits	0 °C...+ 80 °C
Storage temperature	-40 °C...+ 85 °C
Protection	IP 20
Electromagnetic compatibility	Interference Emission to EN 61326; Electrical Equipment Class B Interference Immunity to EN 61326; Annex A (Industrial) and NAMUR Recommendation EMC (NE 21)

Medium conditions

Medium temperature	Dependent on the probe used, see supplementary documentation for probes.
Medium temperature limits	
Medium pressure limits	

Mechanical Construction

Design	Compact unit
Dimensions	See dimensional sketch
Weight	0.17 kg
Material	Plastic
Electrical connection	See section "Electrical Connection"

User Interface

Outside the cover

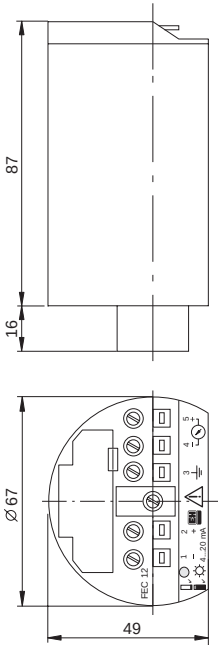
Green LED	Acknowledge successful calibration
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Under the cover

2 switches	Left switch: Linearisation on the handheld terminal or locally. Right switch: Selects type of linearisation (vessel linear or horizontal cylinder).
4 keys	Key combination for reset, empty calibration, full calibration, locking, unlocking, calibration with partially filled vessel using an ammeter.

Communication interfaces

HART Communicator DXR 275	Handheld terminal with HART protocol
FXN 672	Rackbus interface card with HART protocol
Commubox FXA 191	Connecting a Smart transmitter with a HART protocol to the RS 232C serial interface of a personal computer.



Dimensions of the
FEC 12 electronic insert

Power supply

Version HART	without interlock diode: 13 VDC...30 VDC with interlock diode: 13,8 VDC...30 VDC
Ripple with Smart transmitters	HART max. Ripple (measured on 500 Ω) 47...125 Hz: $U_{PP} = 200$ mV max. Noise (measured on 500 Ω) 500 Hz...10 kHz: $U_{eff} = 2.2$ mV

Certificates and Approvals

Certificates	Certificate of Conformity KEMA Ex-95.D.9021 X, EC Type Approval Test Certificate KEMA 97 ATEX 4493
CE Mark	By attaching the CE Mark, Endress+Hauser confirms that the instrument fulfils all the requirements of the relevant EC directives.

Ordering

Order No.: 942261-0000	FEC 12 with HART protocol
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Standards, Guidelines

Supplementary documentation	Safety Instructions (ATEX) Certificate of Conformity Multicap T DC .. TE. probe, Multicap T DC .. TA. probe, Multicap DC .. E. probe, Multicap DC .. A. probe, Hart Communicator DXR 275, Operating instructions FXN 672 transmitter power supply unit, Commubox FXA 191, EMC test documentation,	XA 042F-A/00/a3 ZE 149F/00/en TI 240F/00/en TI 239F/00/en TI 242F/00/en TI 243F/00/en TI 295F/00/en TI 237F/00/en TI 241F/00/en
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