Field Communication Troubleshooting

When intelligent devices are not communicating or show abnormal status for any reason the DD file often get blamed first. However, the DD file is usually not the problem so time is lost. Indeed an EDDL file cannot fail. If the problem is a missing DD file, the system will display an error message saying the DD file is missing. If there is no such error message, the problem is something else. This guide provides hints to troubleshoot HART, FOUNDATION fieldbus, PROFIBUS, and other digital communication.

Causes

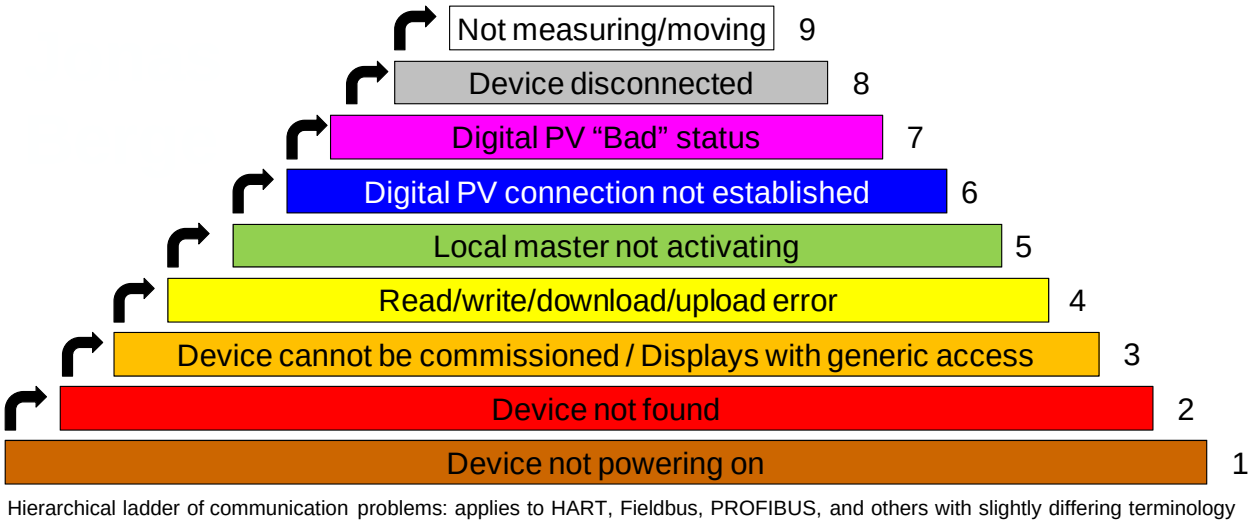
There are many possible root causes for communication error or device not behaving as expected:

Main Category	Subcategory	Root Cause
Configuration	Network	Polling range
		HART interface COM port
	Device	Address setting
		Fieldbus not downloaded
		HART burst setting
		Other invalid setting
	System	Fieldbus control strategy
		Fieldbus macrocycle
Installation	Connections	HART shunt resistor / fieldbus terminator
		Interface in the working place
		Device polarity/terminals
		HART master/slave jumper
	EMI/RFI (noise)	Wrong grounding
		Shielding / cable type
	Moisture, corrosion, and contamination	Poor sealing
	Loose connection	Vibration
	Loop/network resistance	
	Open circuit	
	Insufficient supply voltage	
Component failure	Safety barrier	
	Fieldbus power supply (“conditioner”/”impedance”) / HART line conditioner	
	HART filter	
	System HART I/O card / Fieldbus interface card	
	Device	Internal fuse
		Internal connector
		Excessive memory write cycles
	Sensor	Wiring
		Burnout
Integration	HART protocol version mismatch	
	Standard DD files	Missing
	Other host specific files	Missing
Operating conditions	Device	Temperature
	Sensor	Temperature

Key:
- Common to all protocols
- 4-20 mA/HART
- FOUNDATION fieldbus

Triage

Troubleshoot from the ground up, starting with power supply, then communication, and lastly system integration, and application configuration. Look for patterns: is it affecting only a single device, many, or all devices connected to the same field junction box?



Hierarchical ladder of communication problems: applies to HART, Fieldbus, PROFIBUS, and others with slightly differing terminology

Figure 1 Berge Hierarchical Ladder of Communication Problems

Device Not Powering On

Possible Cause	Inspect	Measure
General	• Local display is on	
System HART I/O card failure	• System I/O card LEDs • Terminal fuse • DC bulk power LEDs	• System I/O card voltage • Fuse integrity • DC bulk power voltage
Fieldbus power supply ("conditioner"/"impedance") failure	• Power supply LEDs • Terminal fuse • DC bulk power LEDs	• Power supply voltage • Fuse integrity • DC bulk power voltage
HART line conditioner failure		• Input and output voltage
Safety barrier failure	• LEDs	• Input and output voltage • Supply voltage
Excessive loop/network resistance	• Corroded terminals • Damaged terminals	
Open circuit	• Burnt HART shunt resistor • Other series 4-20 mA device failure • Disconnected or loose wires	• Voltage drop across HART shunt resistor • HART shunt resistance • Voltage on device terminals • Voltage at junction box terminals

Possible Cause	Inspect	Measure
Insufficient supply voltage	• Too many devices in series in the current loop / in parallel on the bus	• Voltage on device terminals meeting device requirements (for HART at 20 mA) • Auxiliary power voltage (separately powered devices)
Short circuit	• Stray wire strands • Stray shield foil/braid	
Connections	• Device connection (incorrect terminals, polarity, auxiliary power etc.) • System connection (incorrect terminals etc.) • Internal connection from terminal block to main PCB	
Device failure	• Internal connector between terminal block and PCB • Internal fuse	

Device Not Found

This refers to the device not being detected and not appearing in the host 'live list'

Possible Cause	Inspect	Measure
Not a HART-enabled device	• HART-enabled device	
Device communication settings	• Device address in the probed/polled range • Device tag matching system tag	• Use a handheld field communicator to probe/poll all device addresses to discover the device address
System HART I/O card or fieldbus interface card failure	• LEDs	
Computer interface (laptop port)	• HART interface COM port used by other software • HART interface COM port disabled in computer low power state • Driver software installed • HART interface COM port number mismatch	• Use Windows Device Manager in Windows Control Panel to discover the COM port number for the HART interface
Network configuration (host)	• HART not enabled for I/O channel • Poll address range • Configured as same HART master class as other master on the network • Number of HART preambles	

Possible Cause	Inspect	Measure
Connections	• HART master/slave jumper • HART interface/handheld field communicator connected in wrong place on the wires (transmitters only) • Missing HART shunt resistor, or wrong value (transmitters only) • Device connection (connected to wrong terminals etc.) • Non-current controlling HART device (i.e. non-transmitter) powered directly by DC power supply	• Loop current exceeding 22 mA
Noise/ripple	• Refer to separate section on EMI/RFI noise	• Measure noise level using fieldbus tester. Best to connect tester on unused spur. • HART tester not available but a HART "Audio Monitor" can be used to hear noise
Moisture, contamination, or corrosion in device terminal compartment or field junction box	• Device covers and junction box doors are tight • Sealing of cable gland threads, and between gland and cable	
Loose connections	• Connections at device, field junction box, and marshalling panel • Transmission of vibration • Missing spring washers	
Component selection	• Incorrect barrier type (not HART/fieldbus compatible) • Incorrect cable type (not meeting HART/fieldbus requirements)	
Signal level	• Missing HART shunt resistor / fieldbus terminators • HART shunt resistor value too low • Capacitance	• Measure signal level using fieldbus tester. Best to connect tester on unused spur. • HART tester not available but a HART "Audio Monitor" can be used to hear communication
Device failure	• Internal connector between main PCB and communication PCB	

Possible Cause	Inspect	Measure
HART signal short circuit	• Low AO card impedance, HART analog output filter missing	

Displays with Generic Access / Cannot be Commissioned

This refers to when a HART device cannot be displayed with all its internal variables, configuration settings, and diagnostics, or when a fieldbus device cannot be commissioned.

Possible Cause	Inspect	Measure
HART protocol version mismatch	• HART version 7 device is not recognized by a HART version 5 host	
EDDL files missing	• The standard files matching the device type and revision (version) have been loaded	• See the Device Library to discover if EDDL files for the device type and revision have been loaded • The system will display an error message like "EDDL not loaded" or "Template not loaded"
Other system files missing	• Any additional host-specific files matching the device type and revision (version) which the system may require have been loaded	

Read / Write / Download / Upload Error

This refers to when a single parameter cannot be changed, configuration download or upload is unsuccessful, or functions such as loop test (simulation), and sensor calibration trim etc. cannot be performed. If download is only successful on second or subsequent attempt this is due to internal parameter dependencies – problem common in older device versions but not in new devices and systems supporting "error free download" feature.

Possible Cause	Inspect	Measure
Write protection jumper	• Write protection jumper set to enable configuration changes	
Noise/ripple	• Refer to separate section on EMI/RFI noise	• Measure noise level using fieldbus tester. Best to connect tester on unused spur. • HART tester not available but a HART "Audio Monitor" can be used to hear noise

Local Master Not Activating

This refers to when a field device is a HART master polling other HART field devices for information, or a Fieldbus device is a backup Link Master (backup LAS). Use another host to test the device.

Possible Cause	Inspect	

Possible Cause	Inspect	
HART master device configuration	• Configured as same HART master class as other master on the network • Slave device tag mismatch	
HART slave device configuration	• Tag mismatch • HART PV, SV, TV, and QV selection and units	
Fieldbus backup link master (backup LAS) configuration	• Backup link master configured • Set to lowest address • More than one backup link master is not required	

Digital PV Connection Not Established

This refers to problems establishing an individual signal link such as PV while the overall device communication is OK. For HART this applies to use of the digital PV (not 4-20 mA) and includes both burst communication and continuous polling between a slave device and a smart signal conditioner or a control system (e.g. in multi-drop topology). For fieldbus this applies to publishing function block links.

Possible Cause	Inspect	
Device configuration (slave)	• HART burst communication enabled • HART burst communication command selection • HART slave engineering unit matching master unit selection • Fieldbus device configuration downloaded	

Digital PV Has 'Bad' / 'Uncertain' Status

This refers to when a digital PV connection is established but the status is 'Bad'. Make sure to use the Intelligent Device Management (IDM) software to verify the device configuration and diagnostics etc. For HART this applies to use of the digital PV (not 4-20 mA) and includes both burst communication and continuous polling between a slave device and a smart signal conditioner or a control system (e.g. in multi-drop topology). For fieldbus this applies to publishing function block links.

Possible Cause	Inspect	Measure
Device configuration (sensor)	• Configuration setting such as sensor type, range, unit, product properties etc. are valid	
Sensor failure	• Sensor burnout • Sensor wires • Sensor connection terminal numbers	• Sensor wire integrity • Sensor integrity
Device failure	• Non-volatile memory failure • Other failure	

Possible Cause	Inspect	Measure
Intermittent communication error due to emergent installation issues: Moisture in device compartment or field junction box, Noise/ripple, Loose connections	• Refer to section “Device Not Found”	• Refer to section “Device Not Found”
HART master conflict	• Another HART master with the same master class configuration has been connected	

Device ‘Disconnected’

This refers to when a device has been communicating but stops communicating, “drops off”, either permanently or intermittently. The system will display and log an error message. This happens when the system has tried unsuccessfully three times in a row to communicate with the device. Communication statistics in the host diagnostics is a good way to quantify the severity of the problem. If not built into the system, use external bus analyzer software.

Possible Cause	Inspect	Measure
Power supply: System HART I/O card failure, fieldbus power supply failure, safety barrier failure, increased loop/network resistance, open circuit, increased loading, short circuit, connection damage, device failure	• Follow the checklist for “device not powering on”	
Communication: System HART I/O card or fieldbus interface card failure, noise/ripple, moisture, loose connections, device failure	• Follow the checklist for “device not found”	• HART Requests, Responses, and Burst responses • Fieldbus Live list appearances, Retries, and Token pass timeouts

Device Not Measuring / Moving Correctly

The device is communicating, but is not performing its function such as measuring or actuating correctly. For instance, the wrong value may be produced or valve movement is not correct.

Possible Cause	Inspect	Measure
Setpoint source (mode of operation)	• Set to receive setpoint over HART/fieldbus as opposed to local, 4-20 mA, or other bus	
Fault state (ESD override)	• Active ESD input overriding the setpoint	
HART device variable mapping	• PV, SV, TV, or QV dynamic variable setting in device mapped to the wrong device variable	

Possible Cause	Inspect	Measure
Device configuration	• Correct settings like direct/reverse action, linear/rotary, square root/linear, engineering units, channel • HART multi-drop topology address • Parameter having invalid value • Device configuration has been downloaded	• These fieldbus parameters may provide hints to the problem o MODE_BLK o BLOCK_ERR o SIMULATE:: TransducerStatus o XD_ERROR o BLOCK_ALM o PV:: Status • HART command #48 'More Diagnostics Available' may provide hints to the problem
System configuration	• Square root extraction configured in both DP transmitter and system	
Calibration error	• Sensor drift • Range setting • Current trim mismatch	
Operation	• Loop test mode • Hold/freeze (calibration mode)	

EMI/RFI Noise and Ripple

Excessive noise can interfere with digital communications. The interference may prevent a field device from "hearing" a request from the host system or prevent the host system from "hearing" the response from the field device. Missed messages can cause alarms in the host system and if they persist can lead the system to believe that the device is no longer connected. Similarly, multiple missed publications can lead a subscribing peer field device to believe the measurement is no longer available.

Intermittent problems are those most difficult to troubleshoot. If problems come and go, refer to system error logs and note the time and duration of the errors. Try to correlate the times of these errors with other events such as start and stop of a pump motor or other heavy electric equipment. A fieldbus tester with "peak noise" function can also be used to capture intermittent noise. Signal tester for HART communication is not available but bus analyzer software can be used to capture intermittent communication errors.

Avoid sources of noise

Check that the installation is avoiding sources of noise

Possible Cause	Inspect	Measure
Multiple grounds (ground loop)	• Cable drain wire is not connected to the ground screw inside the device housing • Shield does not touch transmitter housing or junction box • Shield only be grounded in the marshalling cabinet	• Measure current flowing through drain wire using clamp meter. Should be zero. • Disconnect shield to measure that no other ground points exist

Possible Cause	Inspect	Measure
Bad safety barrier		• Measure AC voltage on safety barrier output
Bad power supply		• Measure AC voltage on I/O card terminals
Noisy ground		• Measure ground wire against structural steel etc. to see if ground is noisy or clean. Shall be zero and shall not change as motors start and stop
Adjacent AC cables	Inspect signal cable routing: • Signal cables must be routed away from AC power cables in separate cable trays. If signal cables and power cables must cross, they should do so only at right angles. • Pay particular attention to AC powered devices such as flowmeters and electric actuators, to ensure that long AC power cables and signal wires have not been coiled-up together inside the terminal compartment. • Variable Frequency Drives (VFD) / Variable Speed Drives (VSD) are notorious for generating noise if not installed correctly • Adjacent arc welding generates serious noise	

Ensure rejection of noise

Check that the installation ensures rejection of noise

Possible Cause	Inspect	Measure
Shield damage	Ensure shield integrity at installation: • Observe bending radius • Do not cut too deep when removing cable jacket • Maintain shield and jacket on as close to terminal block as possible	

Possible Cause	Inspect	Measure
Use shielded twisted pair cable	Inspect the cables used: • The single pair cable from the device to the field junction box shall be shielded twisted pair • The multi-pair cable from the field junction box to the marshalling cabinet shall have twisted pairs with individual shields as well as an overall shield.	
Shield continuity	• Inspect connections in the field junction box; the shield of the single pair cable from the device connects to the individual shield for the pair in the multi-core home-run cable to the marshalling cabinet.	
Housing grounded	• The device housing shall be connected to ground through a large cross-section conductor	
Field junction box shall be grounded	• The field junction box enclosure shall be connected to ground through a large cross-section conductor.	

Conclusion

When intelligent devices are not communicating or show abnormal status the EDDL is usually not the problem.