



Foundation Fieldbus End Users Council Australia Inc.

9 Corcoran St Duncraig, WA 6023

P.O. Box Z5546 Perth, WA 6831

FF Commissioning Practices

Ian Verhappen

Director, ICE-Pros Inc.

Abstract: The digital communications capability of Fieldbus networks and their associated “plug and play” feature enable changes to be made to the traditional way in which field device commissioning is performed. This paper discusses how these differences can be used to reduce the field commissioning time on a typical project.

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1. Controls in the Critical Path

The instrumentation and controls discipline because of its requirement of having pipes and vessels to “hold on to” is always one of the last parts of a project to be installed and therefore becomes “critical path” in the commissioning and start-up plan. Being on the critical path means that if the time required for this work can be reduced or placed off / outside the critical path it will be possible to start the plant or facility sooner and hence begin making products and profits earlier. Fieldbus because of its digital communications capabilities provides a number of opportunities to reduce the commissioning and start-up process through changes in work practices and the timing of other activities.

2. Commissioning Activities

To begin let's review the typical items that are part of the loop commissioning activity.

2.1. Cable Checks

To insure that the field devices can connect to the control system with a high quality signal, all the wiring and devices between the field and control system/host need to be verified to make sure that one or more of the wires in the cable have not been damaged during installation.

Cable testing normally consists of “Meggering” the cables to check their end-to-end resistance. Short circuit checks are also made between the wire pairs of a twisted pair, pairs and ground, and overall cable to ground.

Though the frequency of damaged cables is rare it is still considered good practise on longer cable runs and multiconductor cables to specify extra “spare pairs” as insurance against damage and to provide future expansion capacity. A general rule of thumb is to include 10-25% spares, leaning towards the upper end for analogue signals and the low end for Fieldbus installations, or a minimum of a single spare pair in all home run cable.¹

2.2. Terminal Boxes

Field junction boxes (JB's) and rack or interface room Marshalling Cabinets are used to terminate the many individual device signals and connect them to the appropriate wire pair on the home run cable. Traditional analogue signals require two “cross wiring” terminations; one in a field junction box to connect the field device to an assigned terminal and wire pair and the second to insure the same signal is connected to the correct single wire pair terminating on the host Input/Output card.

Since entire cables are normally terminated at a time, there is room for error in this step of process and diligent checking against the drawings can be the control used to minimise the number of errors in this labour intensive activity.

2.3. Bench Test / Calibration

Most facilities “test” their instruments in a maintenance shop environment prior to installing them in the field. Testing is used to verify the device is calibrated for the correct range indicated on the data sheet and documentation and in the case of HART devices that the tag number etc. is also properly entered. Analogue output devices such as valves are also normally “stroked” to have their positioners and actuator calibrated, mechanical linkages verified/tightened, accessories such as limit switches installed/calibrated and perhaps a valve signature taken.

It should be noted that measurement devices are normally not calibrated in this process but rather “reference checked” to verify the correct range has been entered

¹ In most cases, the purchase price of the cable itself is a fraction of the total installed cost and adding the spare cable pair to the cable price (10-15%) will require a minimal (<<10%) increase in the installed price of the cable itself.

and that it is verified against a known input of pressure, temperature, frequency of voltage as appropriate.

Once these procedures are complete the device is then placed back on its pallet for installation in the field.

2.4. Instrument Field Installation

Devices are installed in the field against the appropriate data sheet, Piping and Instrumentation Diagram, and Instrument or Electrical location plan. There are few errors made in this part of the process since the device will not fit in other than the nozzle/process connection for which it was specified.

Instrument installation also includes terminating the single wire pair from the device on the correct terminal in the field junction box and then again in the marshalling cabinet.

This step in the process is occasionally prone to error as the wires land on the incorrect terminals in either the junction box or marshalling cabinet and hence the requirements for the laborious exercise of “loop checking.”

2.5. Loop Check

The loop check itself requires that a change made at the measurement device is displayed and if required stored in the appropriate history/archive file in the host and HMI, and then the appropriate action is made by the control system to actuate the correct output to return the process to the desired condition.

All these activities require at least 2 people (panel operator and maintenance technician), and normally 3 (a second maintenance technician or process operator) each with the following roles:

- Panel operator to verify the changes to the signal are seen on the HMI
- Maintenance technician one to introduce a signal at the measuring device input that can be propagated through to the host.
- Technician two who is at either the marshalling cabinet to create or verify the analogue signal with their calibrator or multimeter; or in the field near the device to watch it change.

It is normally during this stage of the process that some or all of the following items are identified:

Incorrect Terminations – one or more wires have been connected to the incorrect terminal. Depending on the error this finding can propagate to affect additional loops as they may be occupying the correct terminal(s).

Tag mismatch – The tag in the host does not match the tag in the field, either because the wires are incorrectly terminated or the point is incorrectly defined in the host system.

Range mismatch – The range of the device in the field when converted to engineering units is different between the host and the field device. This can occur in any device but is more difficult to find for orifice flow meters where a range of 0-100” water is entered in the field device versus 0-150” water in the host.

Another hard to catch error is the square root function being applied in the field device and/or the host. For this reason most projects using analogue devices require that all signal linearization be done in the host.

One of the most insidious and hard to find problems in analogue control systems is the situation in which a loop is “under powered” so that even though a signal is presented on the HMI, it is not correct because the device is receiving less than the minimum required power. For example, a device should be reading 12 mA but because there is insufficient power it is sending 10 mA with the result that the operator and process continue to respond to a false reading.

Each of these items requires troubleshooting and field changes and then a repeat of at least this stage of the process to verify that the change repaired the problem.

2.6. Tuning

Once a signal loop has been verified as being correct, some degree of tuning is required to insure that when the process is started up the basic regulatory control will not result in unstable unit operations when switched to automatic.

In many cases, default values that are very conservative (Gain of 1.5, Integral of 1) or based on experience in similar installations are used and thus will not cause rapid oscillations in the process.

Improving these parameters is then planned for after the start-up when the process is in steady state with time available to improve process control.

2.7. “As Built”

When all is said and done, all the changes in the field necessary to actually make the process work must be documented via the “As Built” process. As Building is almost always done outside the critical path and regrettably in some cases is not done at all as a cost saving measure. This cost saving will be to the project, certainly not the operation where it will instead be a very large expense spread over the life of the facility.

3. Fieldbus Commissioning

Fieldbus systems and hence commissioning have many of the same requirements as traditional analogue systems in that the field devices must have a high quality signal between the field and control system/host. One significant part of the process that can change is to alter the cycle of when specific tasks are performed, thus removing them from the critical path of project start-up.

3.1 Cable checks

This task must also be done for Fieldbus systems though it can be simplified through the use of dedicated testing tools such as Relcom Inc.'s FBT-5 and FBT-3 combination. The FBT-5 generates a Manchester signal on the cable and the FBT-3 verifies the signal integrity along with a number of other parameters. The information recorded on the FBT-3 should be captured in a project database or similar system to record the baseline conditions for the installation.

Since many Fieldbus system "faults" arise from the Physical Layer it is important that this check-out be completed to include the terminators as a minimum. Suggested connection points for the FBT-3 and FBT-5 are at the Host I/O port and on one of the spare spurs of the field termination assembly.

These cable checks can be performed before the field devices are connected to the field termination assemblies and therefore will be outside the start-up critical path.

3.2 Terminal Boxes

Because each Fieldbus device is "Plug and Play" the extra checking of matching cable sets is not as critical. As long as the device is connected to the correct termination assembly, it will be part of the proper segment and hence I/O port.

The end result is that there are time savings available here though they are slightly offset by the training required of the installation technicians on the different requirements of Fieldbus versus traditional analogue wiring.

3.3 Bench Test / Calibration

Because Fieldbus is "plug and play" and has the benefit of bi-directional communication the bench test/calibration process is not required for analogue input devices though installation of the positioner on the valve and calibration of these connections will still be required.

Note, that this will require installation of a Fieldbus network in the maintenance area for the technicians to communicate with the field device. This network can be as simple as a power supply/conditioner, two terminators, and a laptop containing an H1 card or a complete computerized maintenance system with local industrially hardened workstations.

Because Fieldbus devices retain their configuration information in memory, this work can be done prior to final installation in the field and in fact may be included as part of the original purchase specification so that the field devices are “preconfigured” with partial or full information on their final installation details. This therefore once again moves the work outside the critical timeline for process start-up, thus minimizing the impact of field device installation on the project.

3.4 Instrument Field Installation

This process is not different than for a traditional instrument, though as discussed in earlier papers it is possible to install multi-parameter devices and reduce the total number of devices required.

Secondly, because Fieldbus is a multi-drop environment there will be fewer terminations required per field device with the result that field construction will be shorter and the potential to reduce the overall project duration could be possible.

3.5 Loop Check

This is where Fieldbus truly differentiates itself from analogue based systems. With its “plug-and-play” abilities, Fieldbus devices become “live” when connected to the host system, then once the device is “connected” to the associated configuration in the host the two virtual devices synchronize. Part of this synchronization process includes the comparison of such things as tag name, ranges, and status. Any mismatches are flagged and are therefore easily and rapidly corrected.

The process is very rapid, with some cases showing a reduction of six times versus other systems and it only requires two people: one at the HMI, and the other in the field connecting the devices to the segment. The author has seen devices in close proximity being added to the network in less than one minute per device.

To achieve this quick recognition of devices does require some pre-work, again outside the critical path timeline. The Capabilities or CFF file, allows the host system to be preconfigured prior to the addition of devices so that when the device is connected all the information necessary for control and the device can be downloaded from the Host to the field. In many cases, the devices are purchased with only the tag number information entered into its memory so that the configuration team can more easily match the device to its HMI tag.

The key to success here is planning, not just at the tail-end of the project when commissioning plans are being made but from the outset so that devices can be ordered with a minimum set of information included in their “factory shipped settings²”.

² Device Project Factory Settings that include the tag number will be lost if the device is reset to Factory Settings because the true default settings use the device serial number as part of its unique identifier, not the plant tag name.

Loop checking is always on the critical path, so time saved here will result in faster unit start-up.

3.6 Tuning

Tuning of Fieldbus systems is dependent on whether control is being done in the field or in the host. If host based the procedure is the same as for an analogue system. If Field based, the user must again wait for the process to be operating, and keep the following points in mind:

- PID algorithm should reside in the AO device to minimize cycle time.
- Not all PID algorithms by all manufacturers are necessarily the same though most manufacturers do include the “Ideal” or “ISA” PID algorithm as one PID option in their device.
- The default PID settings for a device need to be included in the configuration download included as part of the “loop check” process.

3.7 As Built

The As Built process for Fieldbus contains similar steps to that of a conventional system, though some of the information will be captured “automatically” by the host system as part of the regular system database back-ups.

4. Conclusion

Fieldbus represents a step change in the way control systems are designed and operated. They also represent an opportunity to introduce a step change in the way that control systems are configured. The challenge is one of capturing and redefining “best practices’ in a new area and it is only by sharing our experiences that we can all learn and develop the new Standards of Excellence.

5. References

Fieldbus Foundation AG-181 Engineering Guidelines