ROBOTIQ
eLearning

Communicate with your machine

There are dozens of CNC machines brands out there and within them, several machine models. It is almost impossible to have a universal communication system that allows us to do the handshake automatically. However, there are guidelines that can help you achieve communication between your robot and CNC.

Fig 1.1 Cobot Opening a CNC Machine Door

Industrial robots usually handshake with a CNC machine using a PLC or an external "robot ready" board. In fact, this requirement is usually due to the complexity of the cell. The robot and machine are talking to each other to manage safety sensors, complex tooling, and other external components. Since collaborative robots are easier and safer to use, there is a lot less communication required between the robot and the machine.

Most collaborative robots offer several communication options. Ethernet/IP is a complex communication protocol that can be joined to a PLC and manage different components of the CNC machine tending cell. However, what we see more often is simple I/O communication with a very limited number of signals. CNC machines use lines of M-code to trigger I/Os and send signals to external components. These I/O modules can take various shapes. In fact, some machines manufacturers will have I/Os directly available on the machine. Some others will sell I/O expansion packs that can be plugged into the machine. In particular cases, you will need to purchase the service from a CNC machine technician to get the signals you need from the machine. In all cases, the principles remain the same.

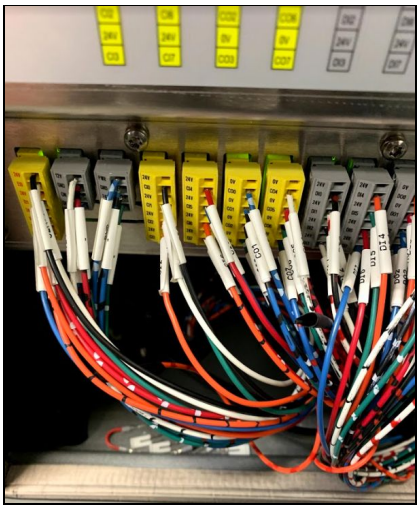

Fig.1.2 Cobot Controller I/O

The CNC will trigger M-code at some point in the program; these will trigger an electrical signal that will be sent to the robot controller to communicate the status of the machine. For example, at the end of the program, adding machine code line *M65* will trigger an I/O in the robot control box which will, in turn, trigger the robot for it to start its sequence.

In order to do so, some brands have published the best way to integrate a robot in front of a machine. One of the most detailed documents is from Haas Machinery.

The Robot Integration Aid from Haas machinery allows users to dive deep into the integration process of robots for machine tending. In fact, with its detailed diagrams and robot sequences, it gives you a good idea of how complex (or simple) a robot integration is.

Third parties are also doing a great job at developing communication modules to do the handshake between the robot and the CNC. Versabuilt is one of them. They are specialized in the Universal Robots communication between several CNC controller brands. The solution is pretty cheap and allows you to go into production a little faster than by doing it yourself.

A large number of signals can quickly become confusing. Here is a list of the essential signals that you should take into consideration.

Essential Signals

If we break down the simple signal that needs to be exchanged with the robot, it goes like this:

- Machine end cycle
- Robot pick up
- Robot out of the machine
- Machine ready to start

Only two I/Os are needed to operate the robot in front of the machine. What we've seen in the industry is a sub-program waiting for the state to change.

For example:

```
Sub_Program_CNC_HANDSHAKE
    Wait_CNC_M21Inp=TRUE
    Set Safety_signal=TRUE
```

The program is calling a sub-program which will first wait for M-code 21 to set an I/O called Safety_signal to True. This means that the robot will wait for the safety signal to be triggered before starting its program.

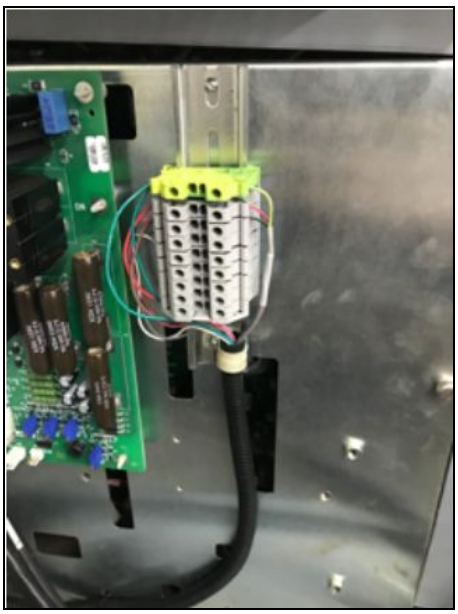

Fig.1.3 Relays Inside the CNC Controller

Once the steps inside the machine are done and the robot is out of the machine, another sub-program sets the Safety_signal to False and triggers back the state of the M-code 21 so the machine can go back in production.

```
Sub_Program_CNC_HANDSHAKE_BACK
    Set Safety_signal=False
    Set CNC_M21Inp=False
```

What we usually see is an M-code that changes the state of a relay, which is connected to a configurable I/O of the robot. Depending on the machine setup, a relay might need to be added to jump-start the machine start button.

Other Signals

You can exchange a few other signals between the robot and the machine; you just need to concentrate on the essential: your priority signals. If you are controlling the machine vise using the machine controller, for example, you will need to read the state of the vise. Another signal that can be relevant for you is the confirmation that the doors have been correctly opened or closed.

The connectivity shown earlier is also typically used for other equipment. Make sure that you are choosing a relay that can be triggered under 24V since it is the operating voltage of most collaborative robots.

Those are the basics. If you want to get into a more complex setup, there might be a need for I/O expansions for the machine or the robot. However, most of the installations are generally performed with the basic setup.

It is recommended to start using the robot I/Os outside of the machine and make sure you understand what you are doing before diving too deep into the machine signals configurations. Note that most machine manufacturers will have instructions regarding which M-code to use in order to trigger an external relay. Make sure to go through that documentation before plugging everything together.

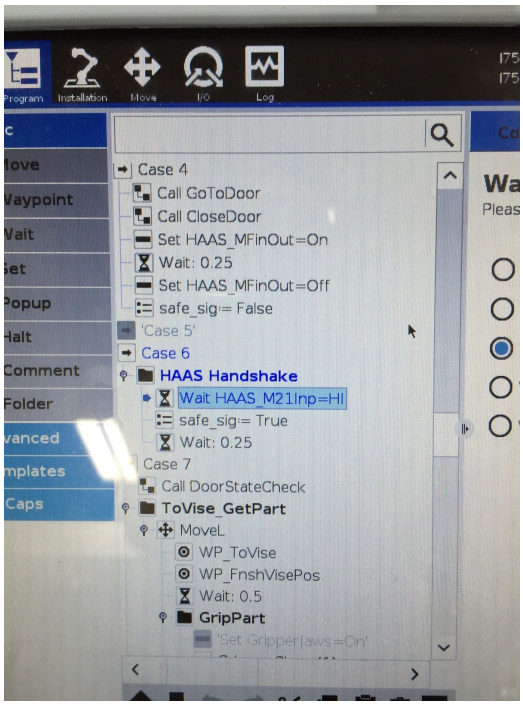

Fig.1.4 Cobot Interface

At the end of the day, it all comes down to what you want to do. Developing your own communication sequence and hardware provides a significant advantage; it allows to replicate your interfacing solution in your next cell. It is a long process at first but it pays off in the long run. If you are keen to learn how it is done, you can jump directly to the Integrate Lesson, which covers how to connect your robot to a CNC machine.