Doc No APTJ002-EN-01

Vertical Form Fill and Seal Machine

Automated with next Omron products

Model:

R88D-KN[][][]-ECT Servodrive

TJ2-MC64 Motion controller

MX2A[][][][]-E Inverter

APPLICATION NOTE

OMRON

CONTENTS

1. INTRODUCTION

The purpose of this document is to provide a description about how a typical intermittent motion vertical form fill and seal machine operates, to describe the main functional operations of the machine and the solution and its alternatives when there is more than one.

Later it is explained how Omron can meet the requirements and offer a solution that fits the application.

Every part of the machine is discussed in detail, it is explained the operation itself and how to program this operation with the Omron solution. Some example programs are provided too so, this document is a useful tool to help both, to select the suitable Omron products according to your machine, and to program the products as the main subroutines are pre-made.

2. MACHINE OVERVIEW

a. Which kind of goods is packaging.

The vertical form fill and seal machine is designed to pack:

- Liquid or other viscous products like juice, soap, toothpaste, beauty cream, and other.
- Powder products like washing powder, flour, etc.
- Small solid goods: Sweets, chips, etc.

The pack is a soft plastic bag made from a roll of plastic film. See some examples in the picture:

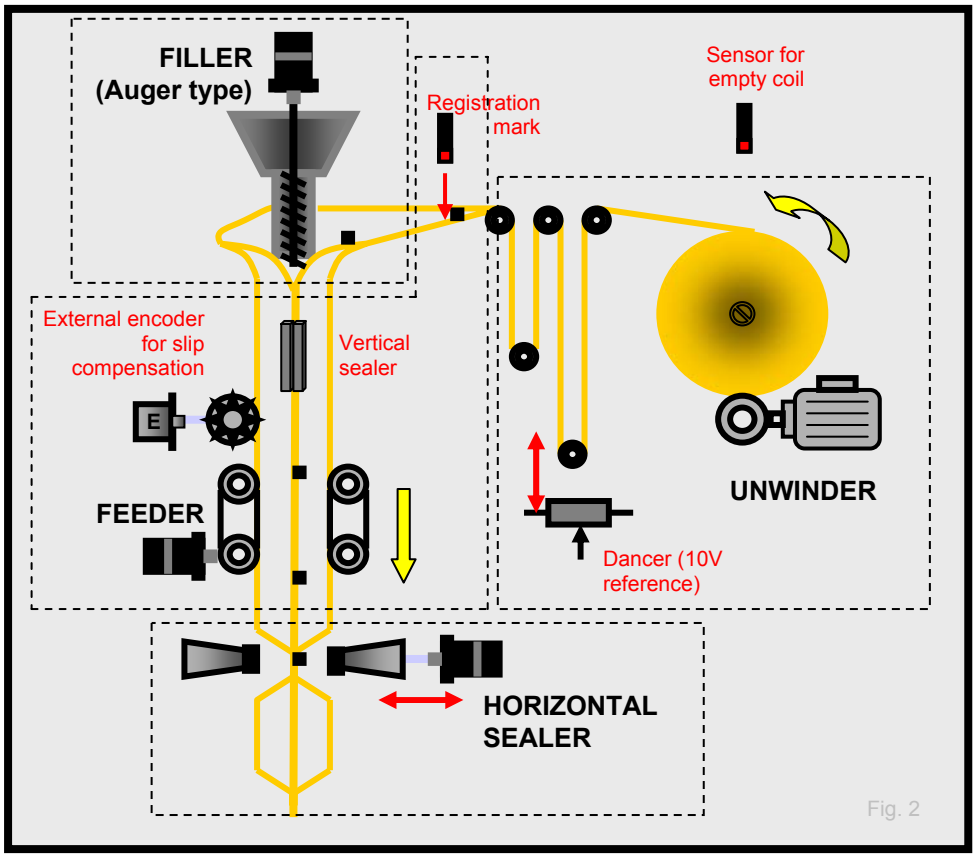
Fig. 1

Due to the nature of the goods to be packed, the machine is designed to fill the product in the vertical direction so the products are falling into the bag by gravity.

b. The machine general description.

Although there are many variations and every machine has differences from another one due to the OEM technology, the packaging material and the goods to be packed, we can say that the vertical form fill and seal is one of the most standard ones in the packaging market.

Here you can see a general diagram of a typical machine:



Some parts of the machine are a must; some other varies depending on the material used in the bags and on the goods to be packed.

BRIEF DESCRIPTION:

The bag material comes from a plastic film coil that is unwound. This plastic film is shaped into a tube by a mechanical mandrel while it is feed, at the same time, the plastic tube is sealed vertically.

The feed movement is intermittent and the feed length corresponds with the bag length. Once the bag is fed, the horizontal sealer closes the bag and it is filledw with the product. After that, the process starts again feeding a new bag.

* * *

THE FEEDER

The heart of the machine is the film feeder. This axis consists of a servomotor attached to some chain that feeds the plastic film to a certain length, that is the bag length. If the plastic bag is transparent or does not have a fixed printed pattern, the movement is just a simple point-to-point movement, but if the bag has a defined pattern that you must respect (and this is the most usual case), it is necessary to make the movement adding a correction based in a printed mark.

Without Mark **With Mark** **Detail of a Mark**

Fig. 3

Most of the machines have the option to work with mark and without mark.

Another important topic to consider regarding the feeder is the slip of the plastic film: In some conditions, the plastic film slips over the feeder belts so, the movement of the feeder is longer than the real plastic film movement (e.g. The feeder moves 200mm but the plastic just 190mm). If this slip is small can be neglected (or corrected if we are using registration) but if this slip is big it can create problems in the precision of the bag.

The slip depends on several factors as:

- The adherence to the material to be fed.
- The weight of the material to be feed (especially if the machine has no unwinder system).
- The speed and acceleration of the machine.

The solution to avoid the slip is to add an external encoder that measures the real movement of the plastic. This is an optional element that not all the machines have.

* * *

THE FORMING HEAD AND SIDE-SEAL

The bag material is a flat plastic sheet. To form the bag this flat sheet must be shaped into a tube and side-sealed.

The tube is formed while the material is feed because the film is driven through a mandrel with a specific shape.

The side sealing is done usually via two sealing heads heated at a certain temperature. While the material is feed the sides of the plastic tube passes through the sealer and makes the closed tube.

There is a mechanism that stops the sealing to avoid that the plastic burns when the feeder is stopped due to excessive heating. One of the systems is a small valve activated by a digital output

* * *

THE HORIZONTAL SEALER

The horizontal sealer consists on two heated jaws. Those jaws may be driven by a piston in the more simple machines or may be driven by a servomotor when more precise control of the movement and timings is required. This movement is performed after the feed movement, when the bag tube is stopped.

It is a simple “Open-close” point-to-point movement.

The same movement seals the top of the previous bag and the bottom of the current one and can, optionally, cut the bag. There is different physical construction of the seal jaws, but the principle of operation is always the same.

* * *

THE FILLER

The filler varies a lot depending on the material to fill. In fact, in some cases it is considered as a separate machine. For products consisting in small pieces like sweets or chips it is normal to weight and to dose, for liquid products is more common a valve and a caudalimeter and, for powder and viscous material it is used the so called “Auger filler”.

The Auger filler consist in a tool with screw-like shape driven by a servomotor. The volume of product is proportional to the movement of the screw.

In case of the Auger fillers, the movement is a point-to-point movement that is performed just after the jaw sealer has been closed.

* * *

THE UNWINDER

One optional device is the unwinder. For the smaller machines, the feeder movement is, at the same time, unwinding the plastic from the coil. But this system is valid if the plastic coil is not very big and the

plastic is rather rigid so, it is not deformed by excessive tension during the acceleration. Usually it exists some kind of accumulator system.

For bigger plastic coils and delicate material it is usual to have some kind of unwinding system and a material accumulator. Those unwinding systems tend to be very simple as no precision is required. Normally it uses an AC motor with a frequency inverter.

The most common way to unwind is with an inverter and a PID system where the reference is a fixed value and the feedback is an analogue signal coming from a dancer arm in the accumulator.

* * *

SPECIFICATION EXAMPLE:

A typical specification of a vertical form fill and seal machine can be as it is shown in the table below:

ITEM	VALUE
Bag Width	**50 mm minimum up to 380 mm maximum**
Bag Length	**100 mm minimum up to 550 mm maximum**
Machine Speed	**12 bag/min minimum up to 100 bags/min maximum**
Power Requirements	**220-240Vac single phase, 30 A**
Film Width	**800 mm**
Maximum Roll Diameter	**600 mm**
Machine Finish	**Stainless Steel**
Machine dimensions	**1950mm L x 1250 mm W x 1450 mm H**

c. The necessities and requirements for the motion control.

The machine consist basically in three axes driven by servomotors:

- The feeder.
- The side sealer
- The filler (considering an Auger-Type)

The unwinder, if it exists, is usually one inverter with an embedded PID. The PID is executed in the inv erter and the setpoint is set from Motion controller (although it tend to be a fixed value). In moderns systems, inverter are controlled in similar way to servos using a common motion bus.

The movements of the machine are basically point-to-point sequential movements, that is, every axis makes an independent movement but one movement in one axis cannot start until the previous movement in the sequence has not finished.

The next diagram shows the sequence of a complete cycle:

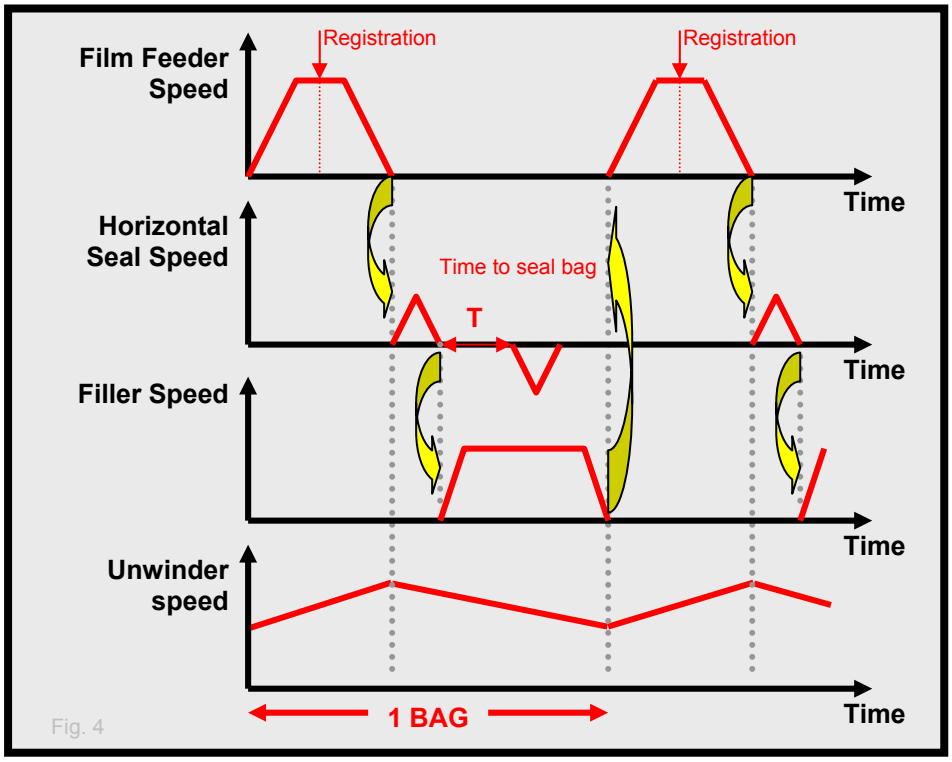


Fig. 4

The feeder needs a point to point position control with the possibility of a printed mark correction and the possibility to have an external encoder for the real positioning.

The horizontal sealer is just a point-to-point positioner with two absolute positions.

The Auger filler needs a point-to-point incremental positioner. The incremental position needs to be adjustable.

d. The Omron solution with TJ2-MC04

- General overview of the solution.

This is the proposed Omron solution for the vertical form fill and seal machines.

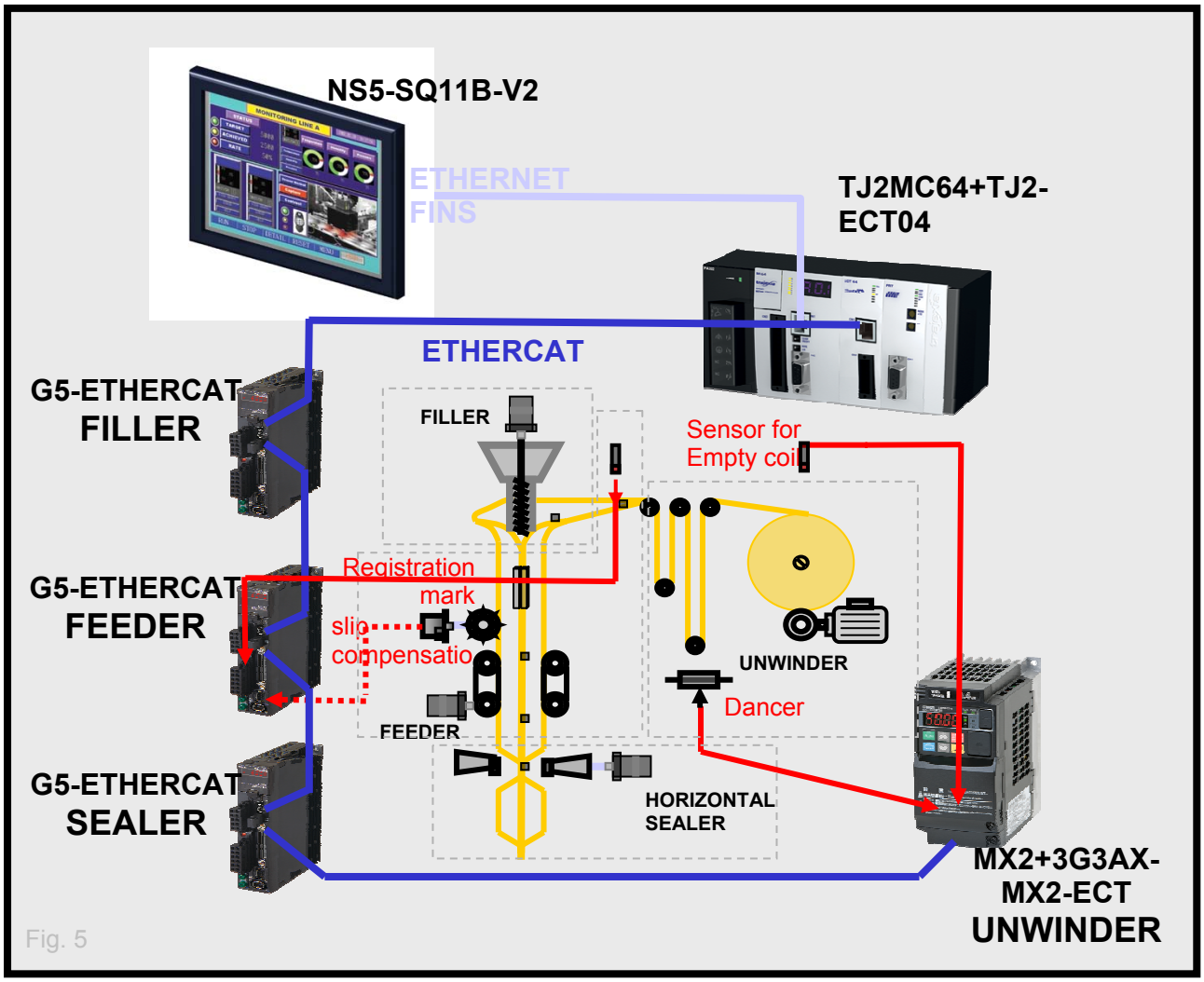


Fig. 5

The proposed solution is based on the TJ2-MC64 motion controller with the TJ2-ECT04 EtherCAT Master. The filler, feeder and sealer will be driven by G5 servodrives with EtherCAT interface and the unwinder will be a MX2 Inverter, also with EtherCAT option board.

For this document we will assume that the embedded digital inputs and outputs in the TJ2-MC04 are sufficient for the machine. If more inputs or outputs are necessary, those can be added to the EtherCAT network by using the Omron slice IO's and the EtherCAT interface (GRT1-ECT).

- How Omron solution match the machine requirements.

The solution based in TJ2-MC64 match perfectly the machine requirements.

Regarding the performance, the TJ2-MC64 can execute the necessary movements and supports registration correction (executed in the servodrive) and external encoder connection (also connected directly to the servodrive).

TJ2-MC64 can also handle the sequence of the machine. It is programmed in a dedicated multi-tasking basic-like programming language with advanced high-level motion commands.

The TJ2-MC64 controls the servomotors using the high performance EtherCAT motion bus. EtherCAT sends cyclicaly and deterministically the position reference to the servodrives. The system dramatically reduces the wiring of the machine because the connections to the servodrives is done by using cheap and widely available standard Ethernet cables (Category 5 or higher). That reduces cost of cables and installation manpower compared with the traditional pulse or analogue solutions. In addition, EtherCAT adds additional performance as you can access to all drive features from a single connection point, including read/write parameters, tuning, trace, diagnostics, etc.
The inverter also is connected to the same EtherCAT network and is handled in the same way than a servodrive (in speed control in this case), this simplifies also the wiring and the engineering hours.

If more I/O's are needed, they also can be connected to the EtherCAT network. For this we will use the Slice IO's and the EtherCAT coupler: GRT1-ECT.

The ACCURAX G5 servodrives with embedded EtherCAT interface (R88D-KNxxxx-ECT) controls the servomotor. The position loop is performed in the servodrive so, it is quick and independent on the number of axes. Besides, it has registration input and connection for the external encoder for the slip compensation. All this without additional boards.

ACCURAX G5 is the servo with the highest bandwidth (faster dynamic response) in the market (at January 2011).

The servodrives also have embedded Safety (STO) to match the safety regulations in a simple way. Up to 8 servodrives can be connected to a single safety relay.

The MX2 Inverter, with the EtherCAT interface module has an embedded PID that is used to control the unwinder so, the motion controller simply gives the PID reference and the sequence commands (run, stop, reset, …) via EtherCAT.

The user interface typically is an NS touch screen HMI that provides a friendly graphic and intuitive environment to the machine operator. Besides we can make all the necessary machine adjustments, have a complete diagnostics and make all the operations from this single point. The HMI is connected to the TJ2-MC64 via Ethernet (FINS protocol) or via serial (Hostlink protocol).

TJ2-MC04 also provides several Ethernet protocols that can be used for different purposes like, connectivity with an upper controller, remote programmability, etc. It is possible to connect Trajexia to a LAN or to the Internet to have worldwide access to it.

- Part list and details about the products:

MOTION CONTROLLER

1x	TJ2-MC64	Motion controller
1x	TJ2-ECT04	EtherCAT Master
1x	CJ1W-PA202	Power supply

SERVO SYSTEM

3x	R88M-K75030H-S2	750W, 3000rpm servomotor
3x	R88D-KN08H-ECT	800W, EtherCAT servodrive
3x	R88A-CAKA005SR-E	Motor power cable
3x	R88A-CRKA005CR-E	Motor encoder cable
3x	R88A-FIK107-RE	Filters
1x	R88A-CNW01C	IO connector (to connect the registration)
3x	R88A-CSK003S-E	Safety connector cable (3m)

INVERTER

1x	3G3MX2-AB007	MX2 Inverter 1.1KW
1x	3G3AX-MX2-ECT	EtherCAT interface

HMI

1x	N25-SQ11B-V2	HMI with EtherCAT

OTHER

1x	E3M-VG16	Fast photocell for registration
1x	G9SB-2002A-24V	Safety relay

3. MACHINE SECTIONS.

In this section it is described in detail the different sections of the machine and the way of solving it with the Omron products. It includes technical description of the different topics and references to the different program examples.

a. The filler:

We consider here Auger filler. The distance to move is proportional to the product volume to be feed. This data is a variable that the user enters via the HMI. To simplify the interface with the machine operator it is very convenient to use recipes in the HMI. The operator enters, for example “bag of 250g salt”, and the HMI sends to the PLC all the set of necessary data, not just for the filler but also for the complete machine.
The condition to start the movement is that the horizontal sealer has closed the bag.

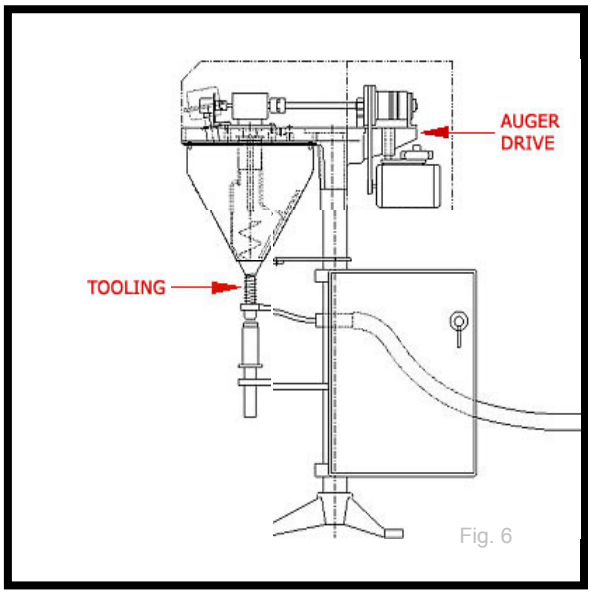


Fig. 6

When the movement has finished it must start the feeder movement to feed a new bag.

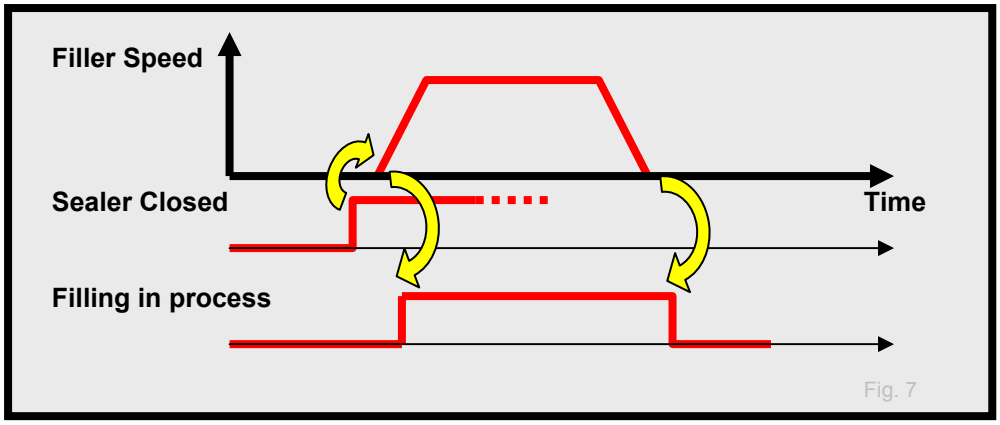


Fig. 7

Note: in this entire document we will draw the speed time curve because it is easier to visualize but the commands we give are POSITION. The position in this graph is the area below the speed curve.

With the TJ2-MC04 the program is as simple as a MOVE function (see the program example below).

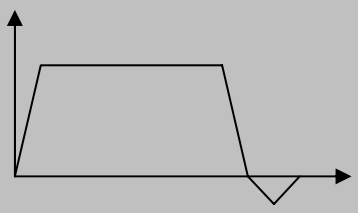
```
'...
IF VR(mode)=automatic THEN
    '...
    WAIT IDLE AXIS(sealer)
    MOVE(VR(fill_amount)) AXIS(filler)
    WAIT IDLE AXIS(filler)
    '...
ENDIF
'...
```

The variables grouped as *VR(name)* are global variables that may be changed via the HMI. Those variables can be changed and applied on the fly, depending on the way the program is written.

The command *IDLE AXIS(name)* indicates if one axis is in movement or not, this is used to control the sequence of the movements. No flags are necessary, simplifying the program.

TECHNICAL HINT

In some Auger fillers for viscous materials like toothpaste, they combine a fill movement and, after that, a small movement backwards to remove the last "drop" and avoid product accumulation in the dosifier.



b. The feeder and vertical sealer

The feeder has two working modes: Without registration mark and with registration mark.

Working without registration mark is a simple point-to-point incremental movement.

Working with registration mark, the motion controller executes a movement to a certain position. If during the positioning the registration mark is detected, the target position is changed on the fly in order to finish the movement at **a defined position after the mark**.

It is wise to order the movement to a position that is the theoretical bag length so the correction is very small during normal operation.

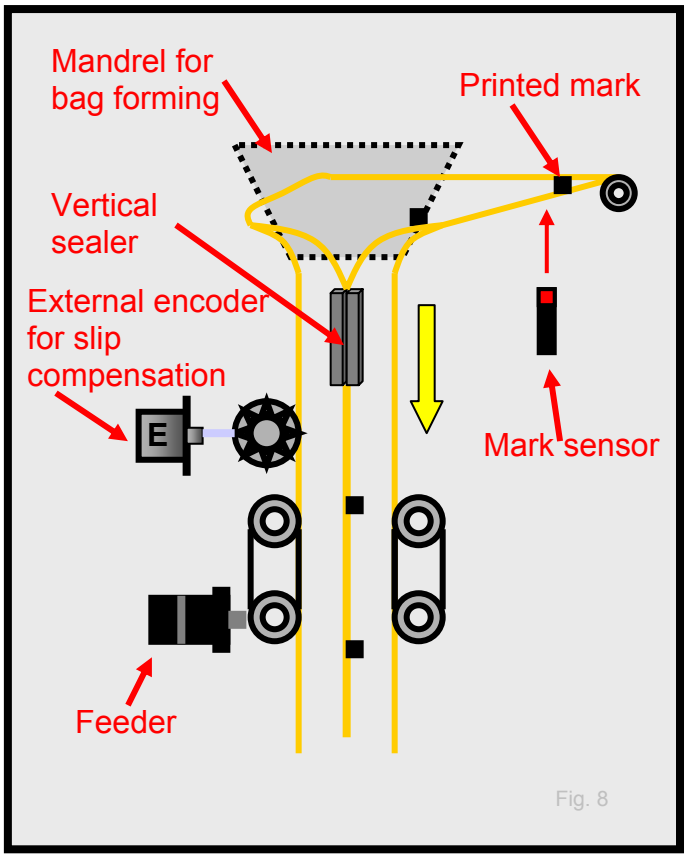


Fig. 8

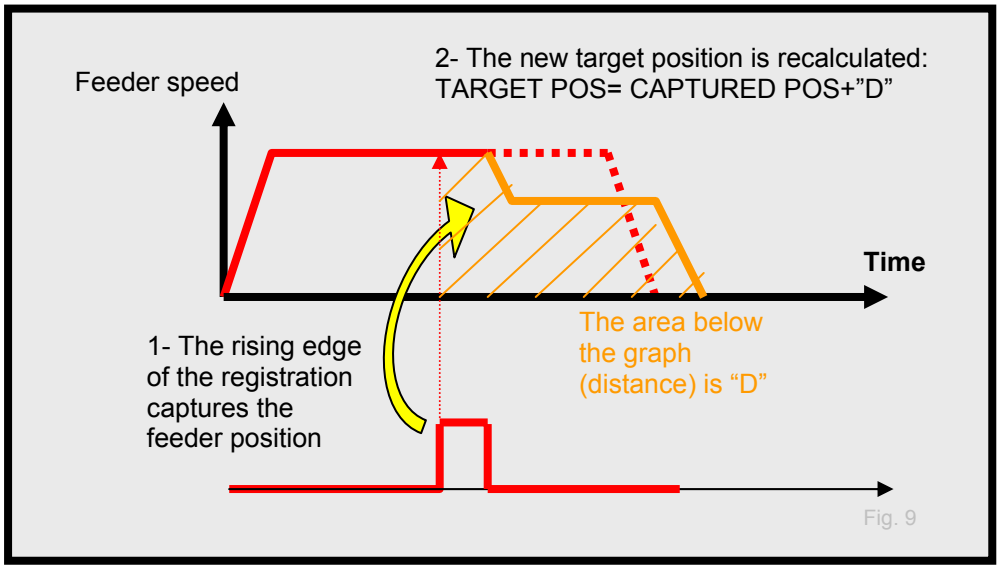


Fig. 9

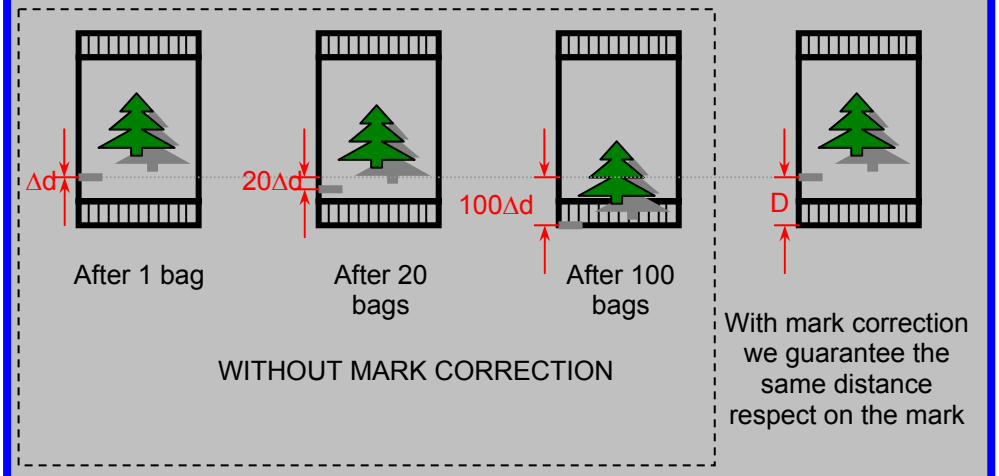
TECHNICAL HINT

Why the registration is needed?

When we have a design that must be centered in the bag, showing the brand logo, etc, we can never guarantee that we feed exactly the same distance that the design pattern. Of course, we feed a length that is nearly the print pattern length, but the precision is never infinite… And the error is accumulative!!

For example, if we have to feed a bag of 200mm but the real pattern is 200.1mm and we have no correction, we are accumulating an error of 0.1mm per bag. Of course, in a few bags we will not note the difference but, after 500 bags, we will have an error of 50 mm!!!

Using the mark, every bag we stop in a certain position respect on the printed pattern. The correction is very small and do not affect to the dynamics. And besides, if we loose one mark some other time, nothing happens, the error in one bag is very small and will be corrected in the next one.



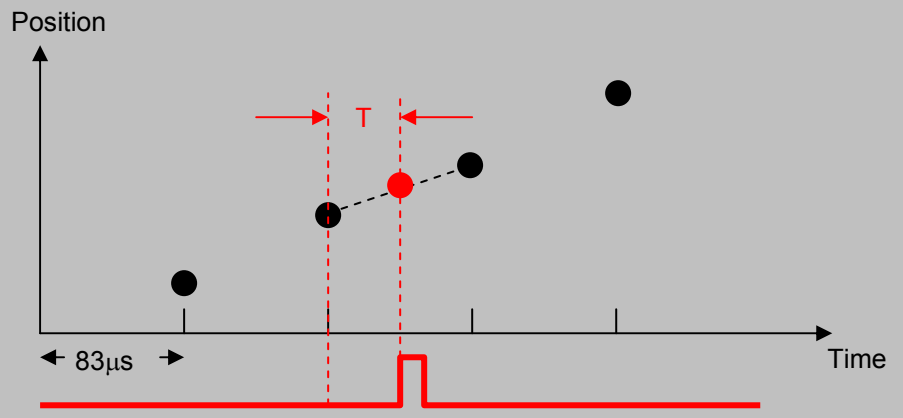
If the mark is in such a position that is detected just at the end of the bag, it may happen that sometimes is detected at the end of the current bag and sometimes at the beginning of the next one. It is better to avoid this situation, otherwise, it needs additional program code to distinguish between both situations and make the right processing:

TECHNICAL HINT

How the G5 captures the registration.

The G5 has three fast inputs (EXT1, EXT2 and EXT3) with a delay of around 7µs and two hardware latch circuits so, two registrations can be captured at the same time. In this machine we will need just one. This latch captures in real time the position of the motor in the moment that a rising edge appears in the selected input.
The encoder in the motor is a serial encoder that sends its position every 83 µs to the drive. The position of the motor in the precise moment in which the mark arrived is the result of the interpolation between two consecutive samples. The result is very accurate.

This value is sent to the motion controller via EtherCAT network to apply the correction in a transparent way for the user.



Once the sealer has sealed the bag and is opened and the product has been filled, the feeder can start the operation. The steps, assuming we work with mark are next:

- Prepare to detect the mark (Trigger).
- Move the theoretical bag length.
- During the movement check if we detect the mark.
- If the mark is detected, adjust the end position according to the mark.
- After finishing the movement, reset the bag position to zero.

It is quite common to keep a counter with the number of consecutive missed marks. If one mark is missed, the feeder simply moves the theoretical bag length. This is not a problem as the difference between the theoretical length and the real one is small. But if many consecutive marks are missed, something is wrong and the machine must be stopped.

This is an example of program making such operation:

```
'...
WAIT IDLE AXIS(sealer)
WAIT IDLE AXIS(filler)
BASE(feeder)
IF VR(with_mark)=1 THEN 'If we work with MARK
    IF MARK=-1 THEN 'If trigger not ready
        REGIST(1) 'Activate trigger
        WAIT UNTIL MARK=0 'Wait until trigger is ready
    ENDIF
ENDIF

MOVEABS(VR(bag_length))

IF VR(with_mark)=1 THEN
    WAIT UNTIL MARK=-1 OR IDLE
    IF MARK THEN
        MOVEMODIFY (REG_POS+VR(mark_offset))
        WAIT IDLE
        VR(missed_marks)=0
    ELSE
        VR(missed_marks)=VR(missed_marks)+1
    ENDIF
ELSE
    WAIT IDLE
ENDIF

'Reset the position to zero
OFFPOS=-DPOS
WAIT UNTIL OFFPOS=0
'...
```

Normally the registration mark is separated from the drawing of the bag design so, there is only one mark and no possibility of confusion.
But sometimes, the mark sensor not only detects the mark but also detects parts of the bag design. In this case, to distinguish between the correct mark and the bag design we use “inclusive windowing”, that is, we define two absolute positions where we start looking at marks (OPEN_WIN) and we stop looking at marks (CLOSE_WIN), every mark that arrives outside of this window will be ignored. Of course, those window positions are set via the HMI.

If the slip of the plastic film is very big (this happens in systems with big coils, small or no accumulator and slippery materials) sometimes you need to make the material feed based in a real measurement of the plastic, instead of trusting in the motor encoder position.
For doing this, you can connect an external encoder measuring the plastic directly to CN4 Connector in the G5 servodrive. The encoder has to be an A, B line driver quadrature encoder.

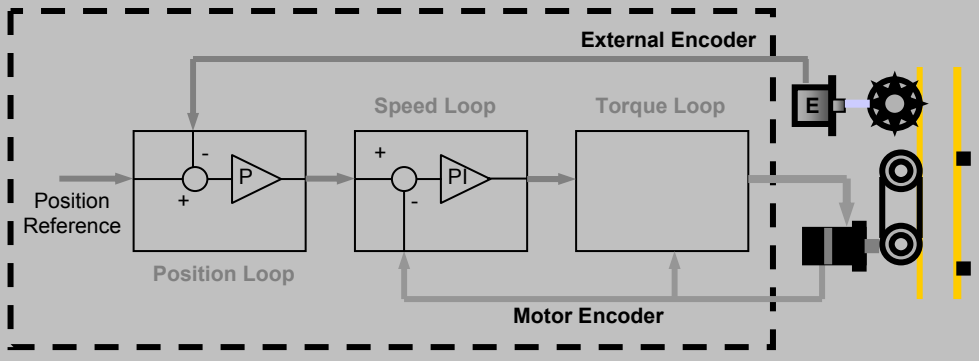
TECHNICAL HINT

How the Full closed encoder works?

In many application we have a servomotor that is moving the material via a mechanical transmission. Due to this mechanical transmission, the movement in the material do not corresponds with the movement in the motor so we want to put an external encoder that is measuring the real position of the material, and to make the positioning using this external encoder as feedback.

The position loop uses the external encoder, but the other loops (speed loop and torque loop) follow the motor encoder, as it is shown in the drawing.

As a recommendation, if the slip is quite big, it is recommended to decrease the gains in the position loop.



To activate the "Full closed encoder" in the G5, you have to change next parameters:

- Pn001 (Object 3001.00hex)=6 "Enable Full closed control"
- Pn323 to Pn328 for the external encoder setup

See the G5 manual for details.

There is no necessary to make changes in the application program.

Note, to change from/to Full closed control and other modes is necessary to power off-on the drive after changing PN001 parameter

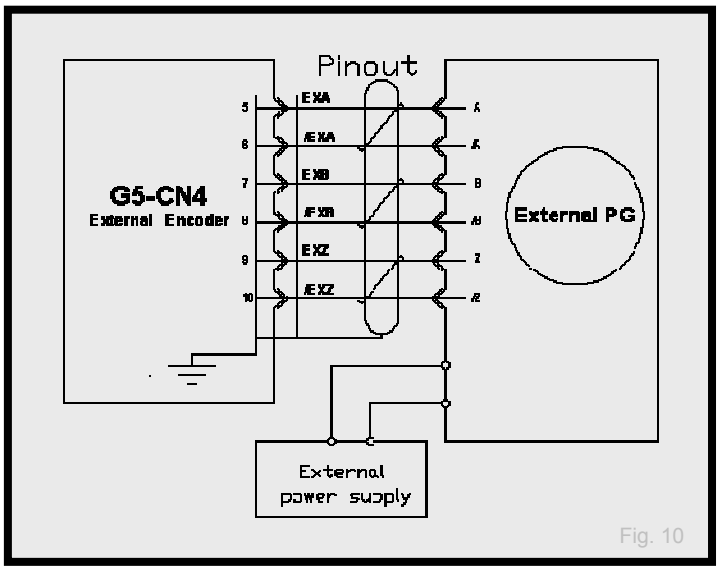


Fig. 10

c. The horizontal sealer.

The horizontal sealer is a simple point-to-point movement. Although there exists a lot of different mechanical shapes and configuration, from the motion point of view, the movement consists just in closing the jaws to seal the bags once the feed finishes and open them again after a certain time. This time depends on the material to seal and is part of the machine sets via the HMI. Normally the machine seals and cut the bags at the same time but there are different possibilities.

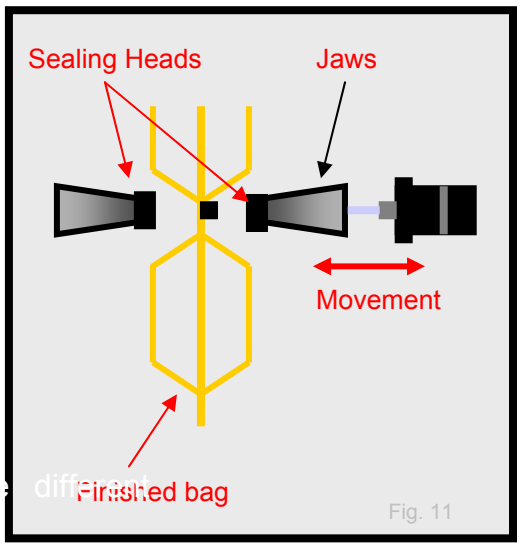


Fig. 11

The main difference of this axis respect the others are that the positions are absolute ones, not incremental so, a homing sequence after power on is required. As an alternative, it is possible to have a

motor with absolute encoder so the homing is no longer necessary. The program for the homing and the sealer positioning are as follows (including the coordination with the feeder axis).

```
'...
IF VR(mode)=automatic THEN
    '...
    WAIT IDLE AXIS(feeder)
    MOVEABS(VR(close_jaws)) AXIS(sealer)
    WAIT IDLE AXIS(sealer)
    MOVE(VR(fill_amount)) AXIS(filler)
    WA(VR(seal_time))
    MOVEABS(VR(open_jaws))
    WAIT IDLE AXIS(sealer)
    WAIT IDLE AXIS(filler)
    '...
ENDIF
'...
```

And for the homing

```
sealer homing:
    DATUM((3) AXIS(sealer)
    WAIT IDLE AXIS (sealer)
RETURN
```

NOTE: There are different pre-defined partterns in the TJ2-MC04 (check the manual for details). Nevertheless, if none of the patterns cover the application necessities, it is possible to create any other sequence via programming.

d. The unwinder.

Not all the machines have any unwinder device. In all cases it is any kind of simple solution with an inve rter and an AC motor, changing the speed and with some kind of accumulator system.

Some possible configurations are:

- Sending a speed reference that corresponds with the machine speed and having some limits in the accumulator to increase the speed if the accumulator is empty and stopping the motor if the accumulator is full.
- Connecting a potentiometer in the dancer arm in the accumulator giving maximum reference when the accumulator is empty and zero reference when the accumulator is full.
- PID with a dancer.

Here you can see a diagram showing this last configuration: Unwinding with a PID.

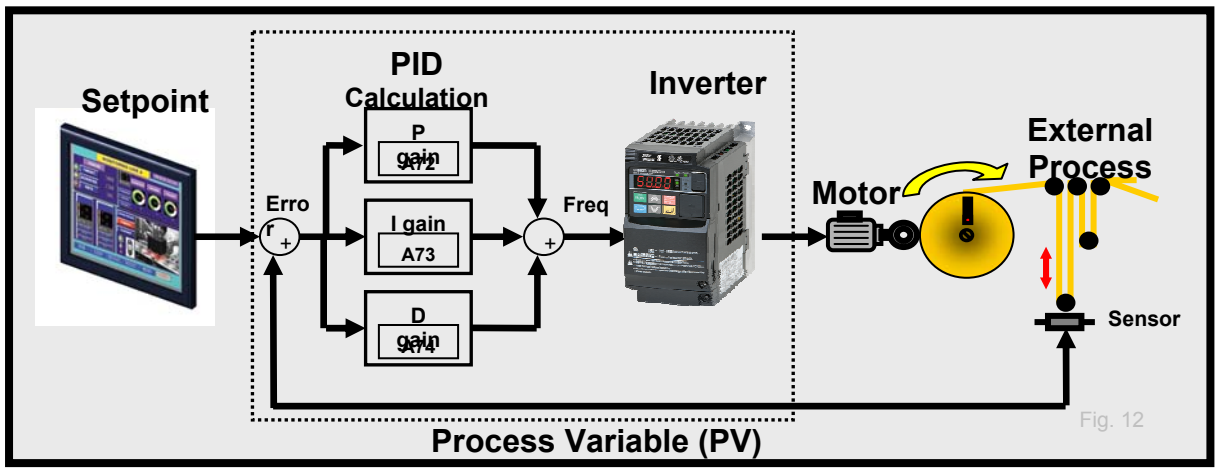


Fig. 12

PID diagram in MX2 drive

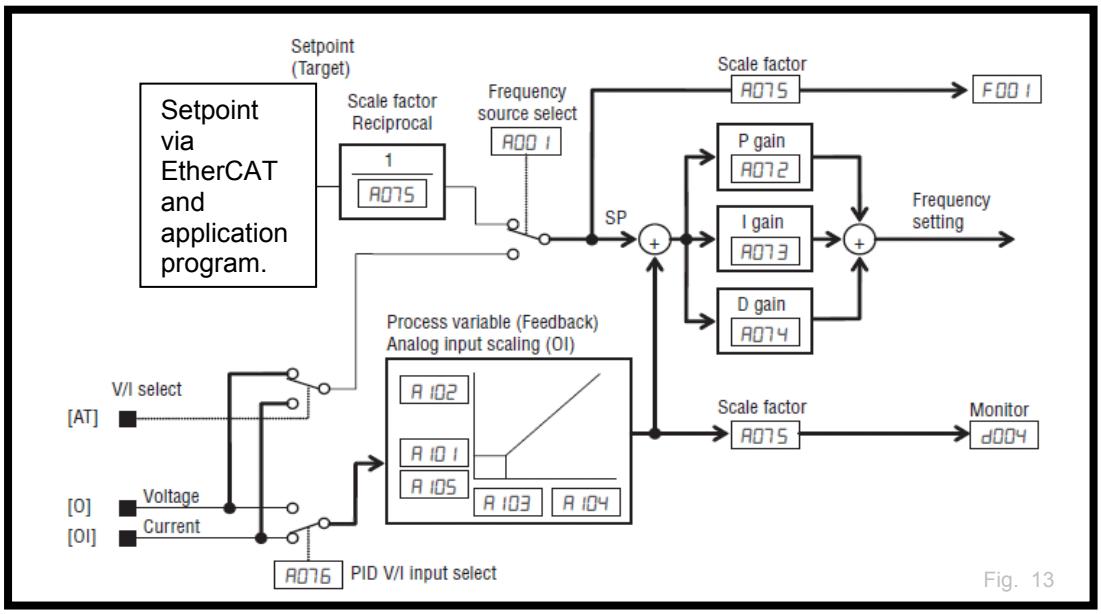


Fig. 13

The principle of operation is next:

- You adjust a potentiometer in the dancer arm in the accumulation in such a way that when the accumulator is empty (arm in the top in Fig. 12) the voltage is zero and when the accumulator is full (arm in the bottom in Fig. 12) it gives 10Vdc. We connect this input to an analogue input in the MX2 inverter and we configure it as PID feedback.
- We adjust the PID target to a fixed value, for example, 50%. If the potentiometer gives less than 5V, the accumulator is becoming full, the error is negative and that means that we have to decrease speed.
- If the potentiometer gives more than 5V, the accumulator is becoming empty, the error is positive and that means that we have to increase speed to fill it again.
- As that process uses to be slow, we will program small gains to have smooth movements without sudden speed changes.

The advantage of one configuration like this one is that the unwinder works independently of the rest of the machine.

In addition, all system, independently if they have unwinder system or not, have a sensor to detect if the coil is empty. The machine stops the operation if the coil finishes.

Apart from the cyclic movements (automatic), the machine has other working modes like the manual, where you can make Jog movements.

One possible solution for the machine that includes this is next:

```
WHILE TRUE
'...
IF VR(mode)=automatic THEN

    IF sealer_home=0 THEN GOSUB sealer_homing

    WAIT IDLE AXIS(feeder)
    MOVEABS(VR(close_jaws)) AXIS(sealer)
    WAIT IDLE AXIS(sealer)
    MOVE(VR(fill_amount)) AXIS(filler)
    WA(VR(seal_time))
    MOVEABS(VR(open_jaws))
    WAIT IDLE AXIS(sealer)
    WAIT IDLE AXIS(filler)

    BASE(feeder)
    'Reset the position to zero
    OFFPOS=-DPOS
    WAIT UNTIL OFFPOS=0
    IF VR(with_mark)=1 THEN 'If we work with MARK
        IF MARK=-1 THEN 'If trigger not ready
            REGIST(1) 'Activate trigger
            WAIT UNTIL MARK=0 'Wait until trigger is
ready
        ENDIF
    ENDIF
    MOVEABS(VR(bag_length))
    IF VR(with_mark)=1 THEN
        WAIT UNTIL MARK=-1 OR IDLE
        IF MARK THEN
            MOVEMODIFY (REG_POS+VR(mark_offset))
            WAIT IDLE
            VR(missed_marks)=0
        ELSE
            VR(missed_marks)=VR(missed_marks)+1
        ENDIF
    ELSE
        WAIT IDLE
    ENDIF
```

```
ELSE 'Mode manual

    IF READ_BIT(0,manual) THEN 'Move filler forward
        FORWARD AXIS(filler)
        WAIT UNTIL READ_BIT(0,manual)=0
        CANCEL AXIS(filler)
        WAIT IDLE AXIS(filler)
    ENDIF

    IF READ_BIT(1,manual) THEN 'Move filler reverse
        REVERSE AXIS(filler)
        WAIT UNTIL READ_BIT(1,manual)=0
        CANCEL AXIS(filler)
        WAIT IDLE AXIS(filler)
    ENDIF

    IF READ_BIT(2,manual) THEN 'Move feeder forward
        FORWARD AXIS(feeder)
        WAIT UNTIL READ_BIT(2,manual)=0
        CANCEL AXIS(feeder)
        WAIT IDLE AXIS(feeder)
    ENDIF

    IF READ_BIT(3,manual) THEN 'Move feeder reverse
        REVERSE AXIS(feeder)
        WAIT UNTIL READ_BIT(3,feeder)=0
        CANCEL AXIS(feeder)
        WAIT IDLE AXIS(feeder)
    ENDIF

    IF READ_BIT(4,manual) THEN 'Move open
        IF sealer_home=0 THEN
            GOSUB sealer_homing
        ELSE
            MOVEABS(VR(open_jaws)) AXIS(sealer)
        ENDIF
        WAIT UNTIL READ_BIT(4,manual)=0
        IF sealer_home=0 THEN
            CANCEL AXIS(sealer)
            WAIT IDLE AXIS(sealer)
            sealer_home=0
        ELSE
            CANCEL AXIS(sealer)
            WAIT IDLE AXIS(sealer)
        ENDIF
    ENDIF
```

```
IF READ_BIT(5,manual) AND sealer_home=1 THEN 'Move
close
        MOVEABS(VR(close_jaws)) AXIS(sealer)
        WAIT UNTIL READ_BIT(5,manual)=0
        CANCEL AXIS(sealer)
        WAIT IDLE AXIS(sealer)
    ENDIF

ENDIF

WEND
STOP

sealer_homing:
    DATUM(3) AXIS(sealer)
    WAIT IDLE AXIS (sealer)
    sealer_home=1
RETURN
```

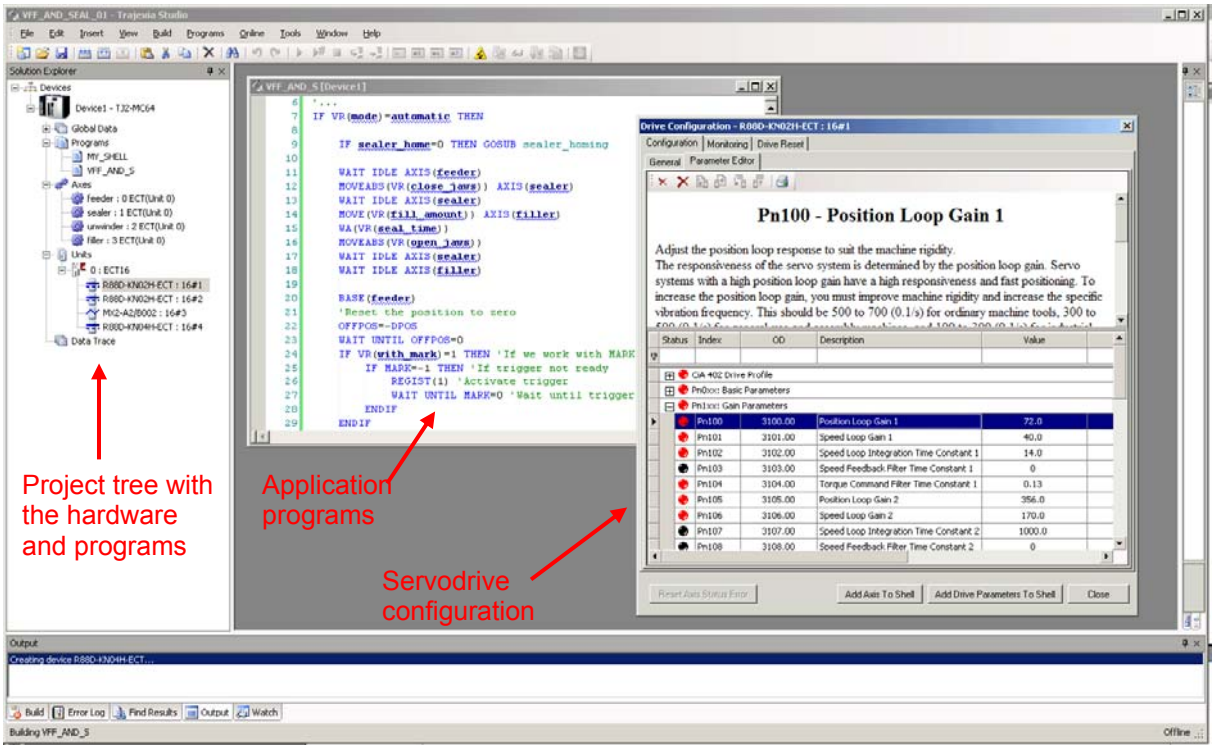
4. THE MACHINE OPERATION AND CONFIGURATION:

To program and configure the application you need to use Trajexia Studio version 1.3 or newer or CX-Motion-Pro (both are the same software).

With this software tool you can make your application programs and also you can access to the servodrives and inverter parameters from a single connection point. It is also possible to make tuning, traces and even frequency analysis in the servodrives.

We have EtherCAT connection for the servodrives, inverter and, if necessary, IO's and EtherNET connectionf for the HMI, software tool and possible upper controller.

All parameter in the appl ication like: oper ation speeds, lengths of the movements, wait times, photocell offsets, etc. are programmed as global variables that can be set and read from the HMI.



THE MACHINE OPERATION AND FLOW DIAGRAM.

The simplified operation flow of the machine follows the next sequence:

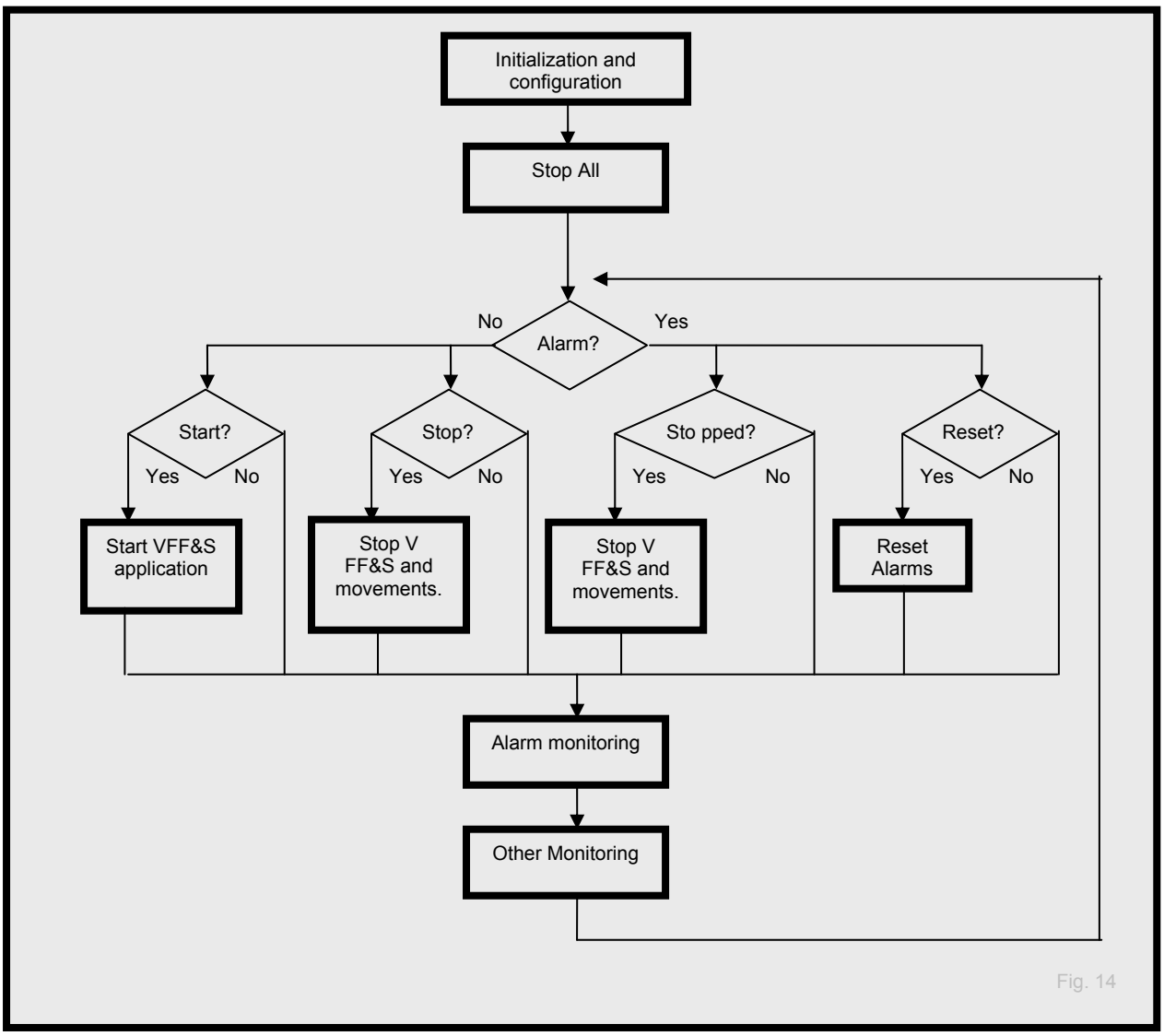


Fig. 14

As you can see from section 3, making an application program for the Vertical Form Fill and Seal is not complicated. Sometimes it is more time consuming to program all the sequence around the cyclic machine operation, that is:

- To make the necessary configuration after power-up.
- To take care of the fault handling: stop the machine in the right way and report alarms properly.
- Change from differentm modes smoothly (manual ← → automatic).

In order to simplify this operation it is necessary that the machine flow diagram is very clear. We propose next flow diagram that is integrated in the SHELL Program.

SHELL program is a template provided by the software tool that the user must modify to adapt to the particular machine operation. The flow diagram is next:

At startup, the SHELL checks that all the expected hardware is present (similar to the IO table in a PLC. If YES, it checks that all setting, drive parameter and variables have the right initial values and starts the main loop with the “Fault handling” sequence.

This loops takes care to

- Start the Application program if the system is healthy
- Stops the programs and movements if one error occurs
- Reset the possible alarms.
- Monitor, diagnostics and update of the variables set & visualized in the HMI.

Then, you can focus all your efforts in the machine operation itself.

In this particular example, the machine has two modes:

- Automatic: The machine starts the cyclic operation based in the data entered from the HMI.
- Manual: based in bits from the HMI you can jog forward-reverse all the axes
- There is no particular command for homing the sealer. If the homing has not been done, it will be executed in the first sequence.
- When you change from automatic to manual, the change is done after finishing the current cycle.
- The change from manual to automatic is after the current jog is cancelled.

Of course, the details change from one machine to another.

5. SUMMARY AND CONCLUSION

Omron is the right partner to support you in automating your Vertical Form Fill & Seal machine.

Omron has a deep knowledge and experience in the packaging industry and we will use this to support you.

The solution shown here is based on the latest, advanced technological solutions. There are other simpler solutions we can offer, but offers you reduced performance, more difficult maintenance or longer commissioning and development time. For example, a solution based in pulse train from a PLC.

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