STRAIGHTENING MACHINE

DESIGN DOCUMENT

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1. INTRODUCTION

The purpose of this design document is to provide detailed information on the design of the **"Straightening machine's HMI screens"**.

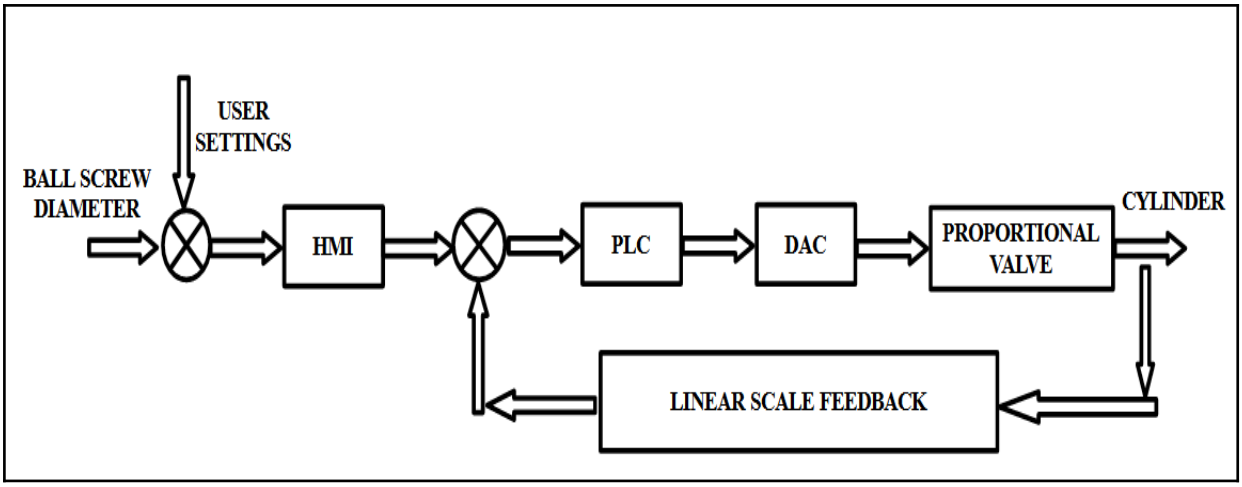
This design document will help in understanding the design of the HMI screens and also to troubleshoot any errors in further screen developments.

The software used for the screen development was DOPSoft software. There are 6 screens created including the pop up screens.

Suitable and necessary macro commands are also programmed in this screen development software so as to help us in ease of operation.

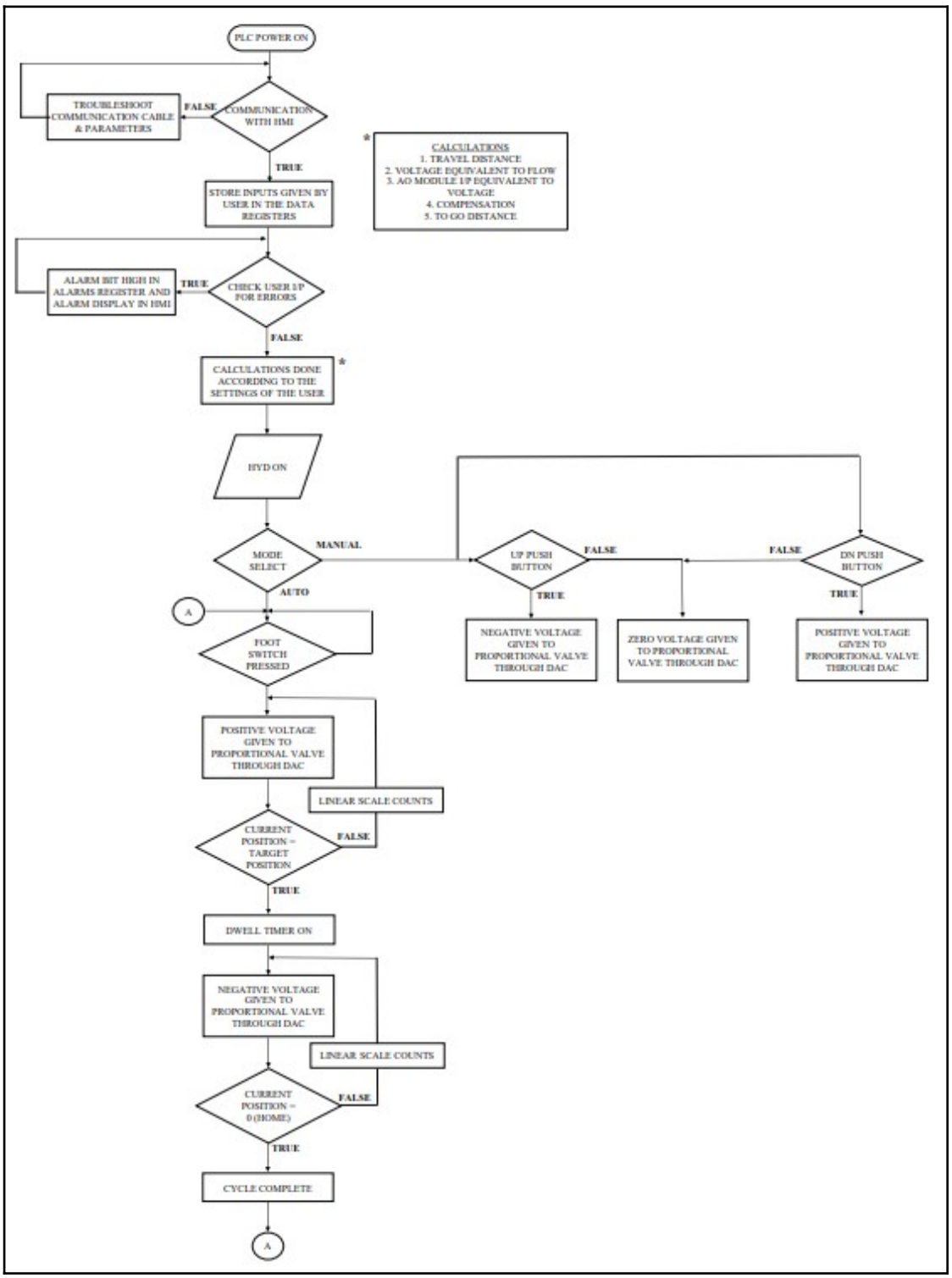
Further details are enclosed below.

2. BLOCK DIAGRAM

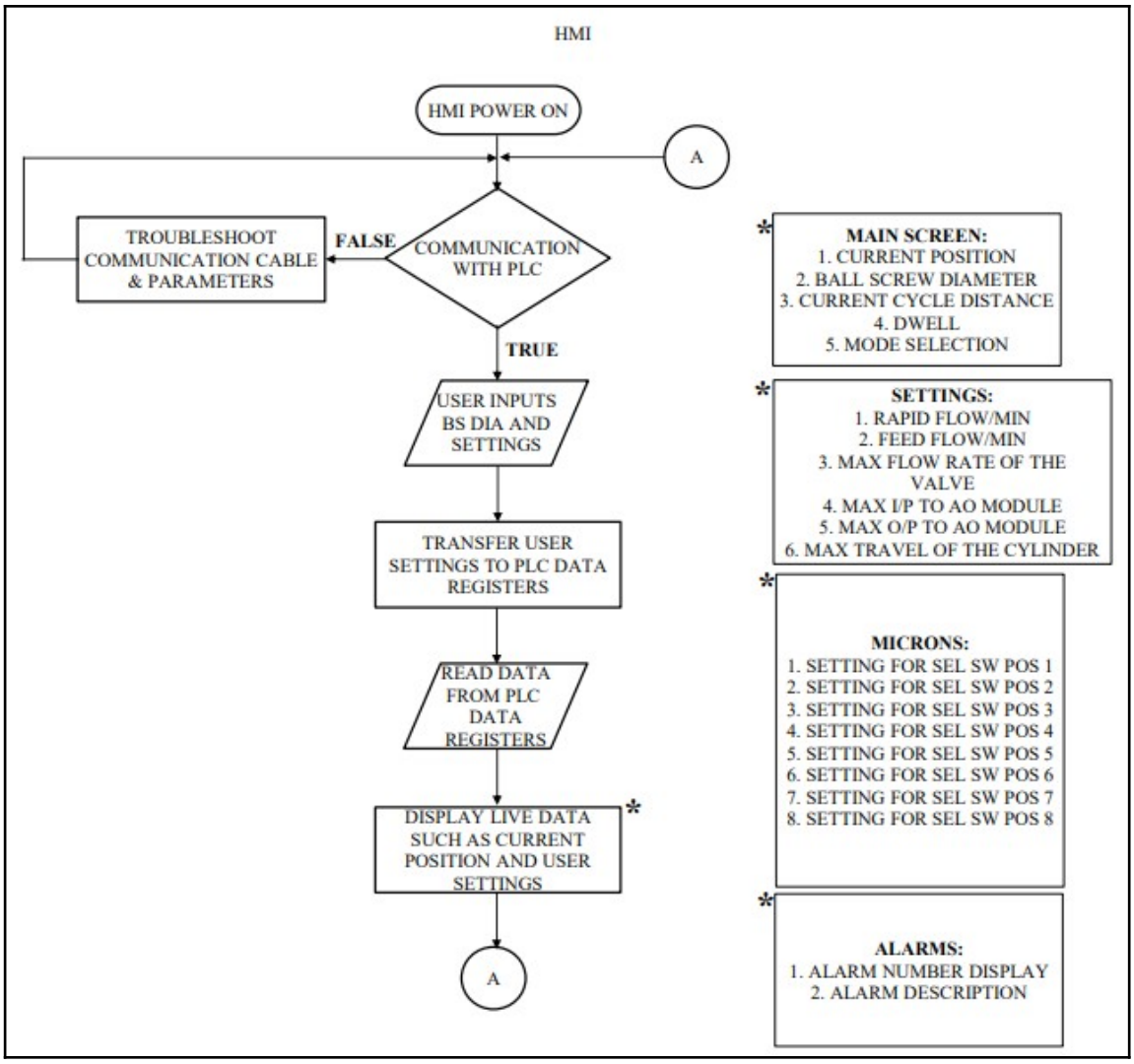


3. FLOWCHARTS

3.1 PLC FLOW



3.2 HMI FLOW

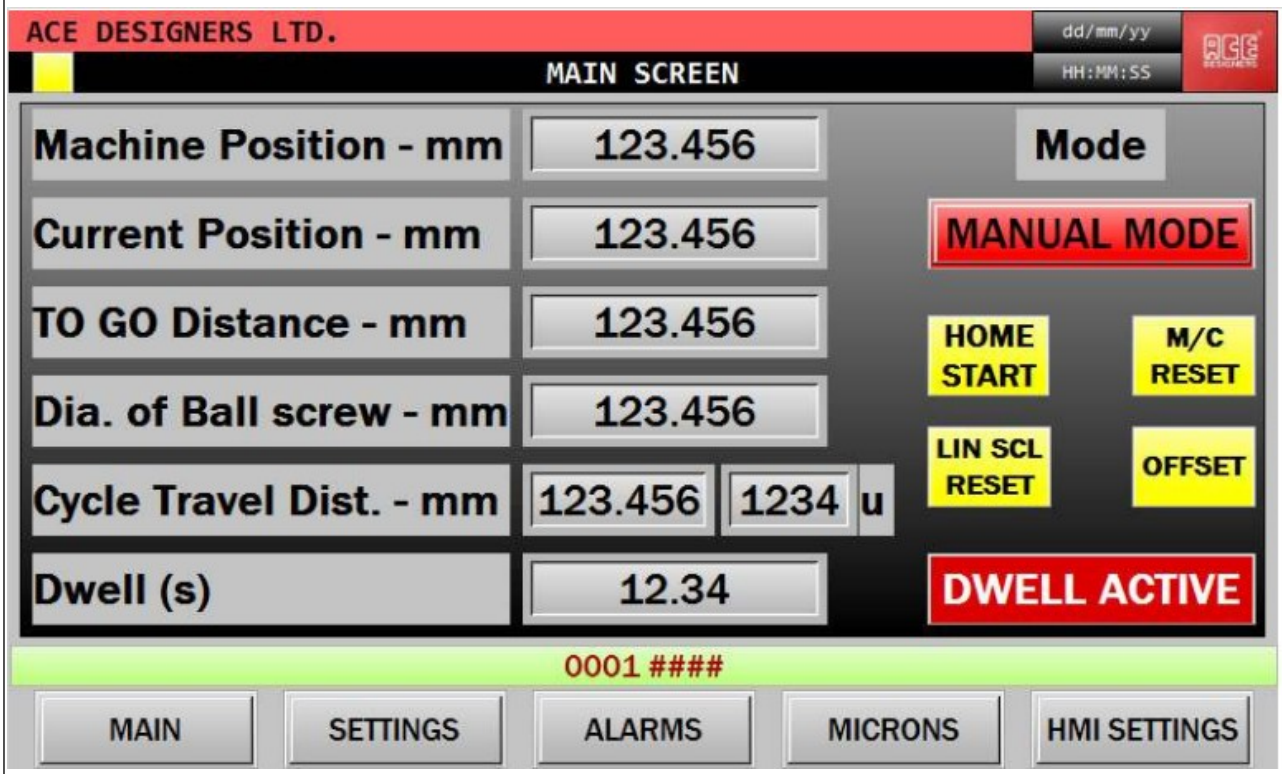

HMI
HMI POWER ON
A
TROUBLESHOOT COMMUNICATION CABLE & PARAMETERS
FALSE
COMMUNICATION WITH PLC
TRUE
USER INPUTS BS DIA AND SETTINGS
TRANSFER USER SETTINGS TO PLC DATA REGISTERS
READ DATA FROM PLC DATA REGISTERS
DISPLAY LIVE DATA SUCH AS CURRENT POSITION AND USER SETTINGS
A
MAIN SCREEN:
1. CURRENT POSITION
2. BALL SCREW DIAMETER
3. CURRENT CYCLE DISTANCE
4. DWELL
5. MODE SELECTION
SETTINGS:
1. RAPID FLOW/MIN
2. FEED FLOW/MIN
3. MAX FLOW RATE OF THE VALVE
4. MAX I/P TO AO MODULE
5. MAX O/P TO AO MODULE
6. MAX TRAVEL OF THE CYLINDER
MICRONS:
1. SETTING FOR SEL SW POS 1
2. SETTING FOR SEL SW POS 2
3. SETTING FOR SEL SW POS 3
4. SETTING FOR SEL SW POS 4
5. SETTING FOR SEL SW POS 5
6. SETTING FOR SEL SW POS 6
7. SETTING FOR SEL SW POS 7
8. SETTING FOR SEL SW POS 8
ALARMS:
1. ALARM NUMBER DISPLAY
2. ALARM DESCRIPTION

4. SCREEN DESIGN

There are 6 screens designed in the software. Their names and their screen numbers are given below.

1. MAIN
2. SETTINGS
3. ALARMS
4. POP UP CONFIRMATION
5. RE ENTER POP UP
6. MICRONS

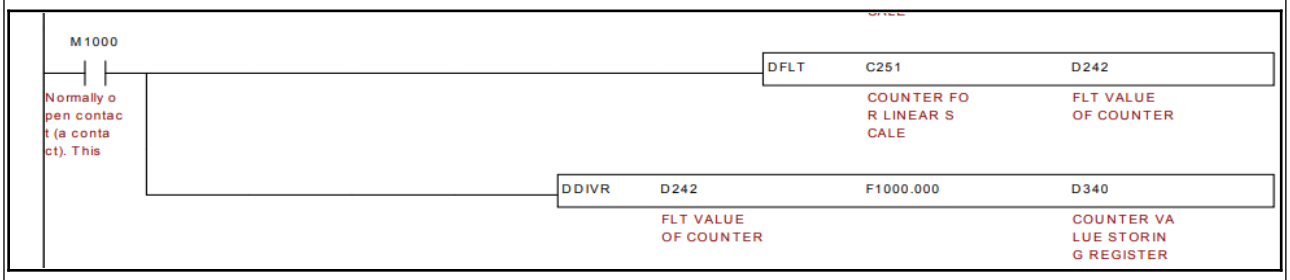
4.1.MAIN



4.1.1 Machine position

Machine position is a numeric display element. Its read address is **D340**. The Data type of the element is double word and the data format is floating. The Machine position is displayed by converting the linear scale counts form microns to millimetres in the PLC and stored in the data register D340.

As the display value is a floating point value, the linear scale counts are converted to the float value first and is divided by 1000 to obtain the millimetres value.

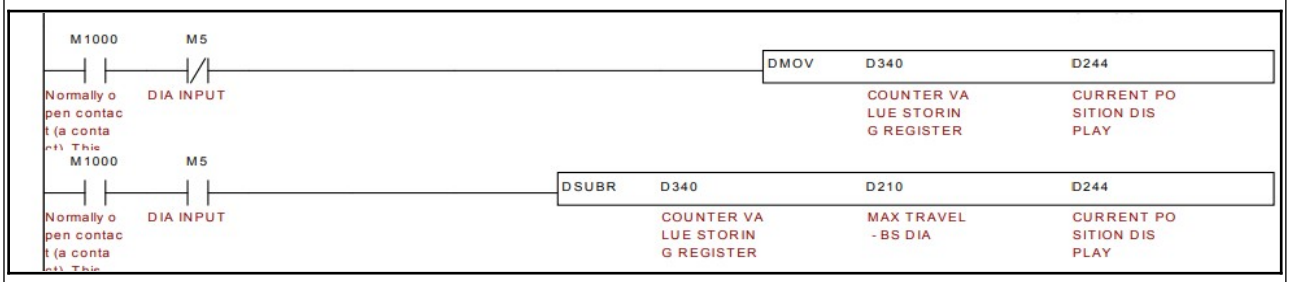


4.1.2 Current position

Current position is a numeric display element and its read address is **D244**. The Data type of the element is double word and the data format is floating. The current position is calculated by the following formula.

Current pos. = Machine pos. – (Max travel of cylinder – Ball screw diameter)

Until the ball screw diameter is entered, the machine position will be the current position, as soon as the ball screw diameter is entered, then the above formula will be calculated.

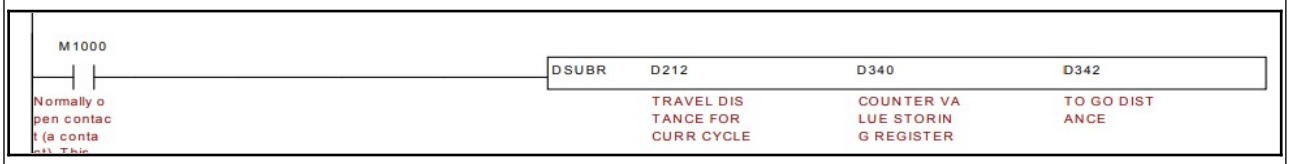


4.1.3 TO GO distance

The TO GO distance is a numeric display element and its read address is **D342**. The Data type of the element is double word and the data format is floating.

The TO GO distance is calculated by the following formula.

TO GO distance = (Travel distance for the current cycle – Machine position)



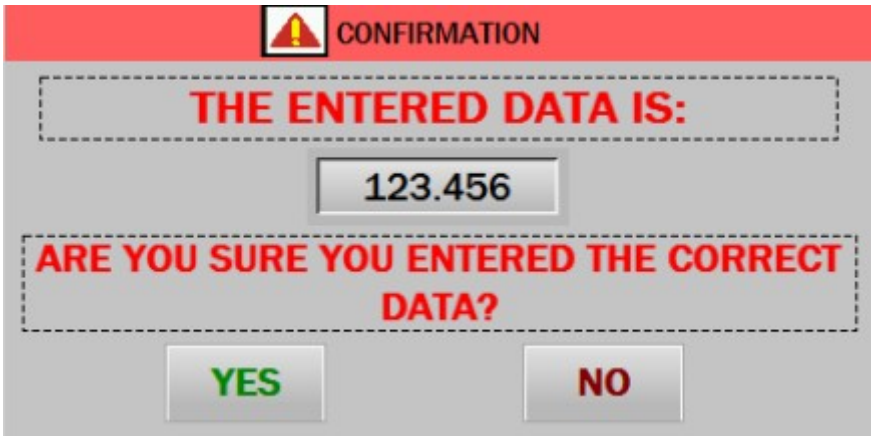
4.1.4 Dia of ball screw

The Dia of ball screw is a numeric entry element. Its write address is **$10** i.e. the internal memory of the HMI. The Data type of the element is double word and the data format is floating. Its read address is **D0** of PLC.

An after execute macro is written for this element. The macro is as follows:

- OPENSCREEN (4)
- END

The openscreen command opens the screen number 4 as soon as the user enters a number in the element. The screen 4 is shown below.



Here there is a numeric display element whose read address is $10. When the entered value is correct the user selects the YES button. The YES button is a set to constant element whose write address is $1.

An after execute macro is written for this element. The macro is as follows.

- IF $1==1
- CLOSESUBSCREEN(4)
- {Link2} 1@D0 = FMOV($10) (Signed DW)
- ENDIF
- END

If the contents of the **$1** is 1 then the contents of the **$10** is moved to the PLC data register **D0**.

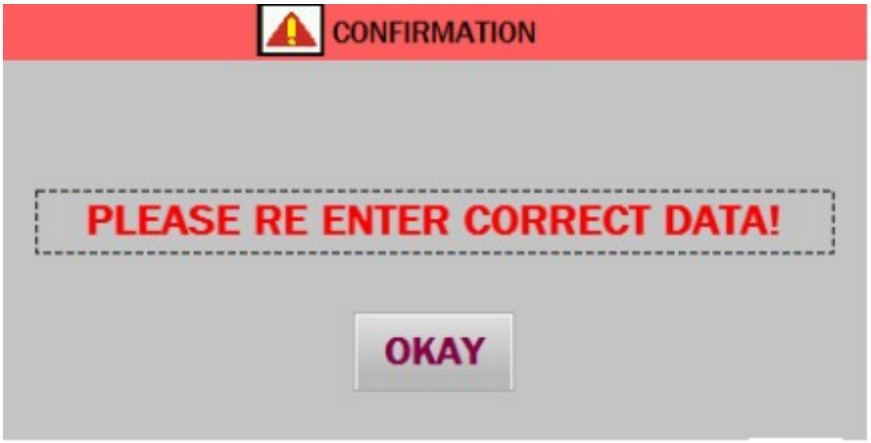
The NO button has to be selected when the user enters a wrong value in the Dia of ball screw element. The element is a decrement element and the write address is $1.

After execute macro for the same is as below.

- OPENSCREEN(5)
- $10 = FMOV(0.0) (Signed DW)
- {Link 2} 1@D0 = FMOV($10) (Signed DW)

As soon as the NO button is pressed the screen number 5 is opened and the $10 is made 0.0 and the data to the D0 is also made 0.0.

Screen 5:



As soon as the user selects okay, all the pop ups are closed and the main screen is opened again.

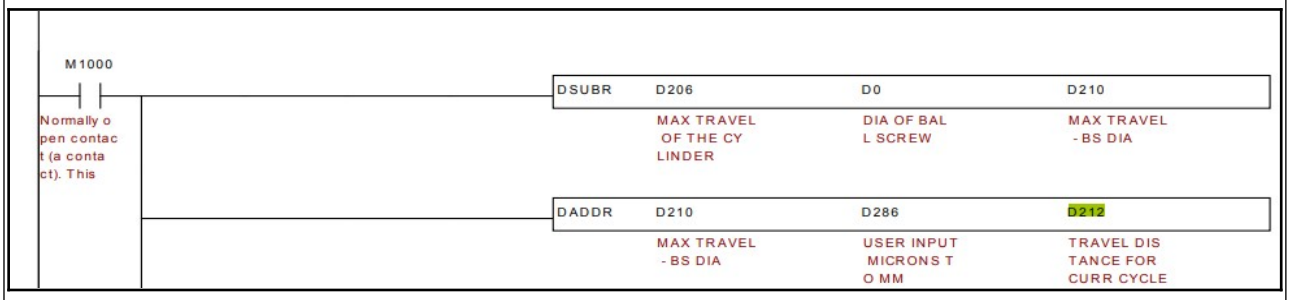
4.1.5 Cycle travel distance

The cycle travel distance is a numeric display element and the read address of the same is **D212**. The data type is double word and the data format is floating.

The cycle travel distance is calculated as shown below.

Cycle travel = (Max travel of cyl – Ball screw dia) + User selected microns.

Beside the display element is another display element which shows the microns selected by the user through the selector switch. The read address for the same is D208.



4.1.6 Dwell

The dwell element is a numeric entry element and the write address is **D310**. The units is in seconds.

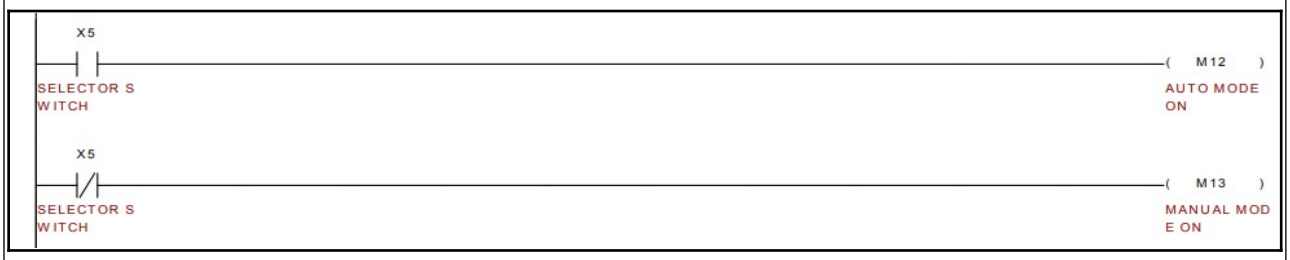
Maximum of 20 seconds can be given as dwell. Data type is double word and the format is floating.

4.1.7 Mode

There are two modes – Auto and Manual. The element is a multistate indicator and the read address is M12.

When M12 is 0 – the mode is Manual mode

When M12 is 1 – the mode is Auto mode.



4.1.8 Home start

The home start button is used to start the homing of the cylinder. The element is a set to on element and the write address is M16.

4.1.9 M/C Reset

Machine reset is used to reset the functions of the machine. The Write address is M31 and the element is Momentary.

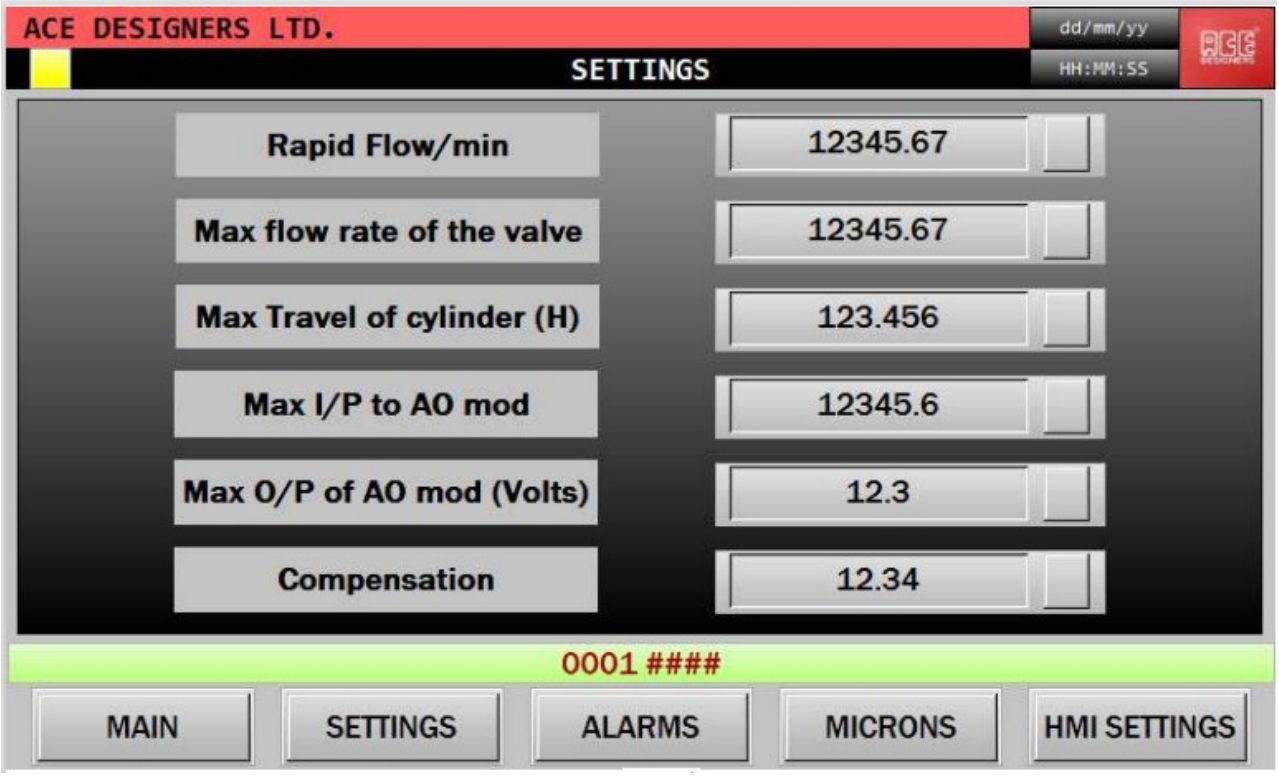
4.1.10 Lin Scl Reset

Linear scale reset is used to reset the machine position or shift the home position of the cylinder. The write address is M26 and the element is Momentary.

4.1.11 Offset

Offset button is used to enter the offset value from the home position to the surface of the ball screw.

4.2 SETTINGS



4.2.1 Rapid Flow/min

Rapid flow/min refers to the amount of oil flow to the cylinder. Max value of this parameter is set in the Max flow rate of valve.

4.2.2 Max flow rate of the valve

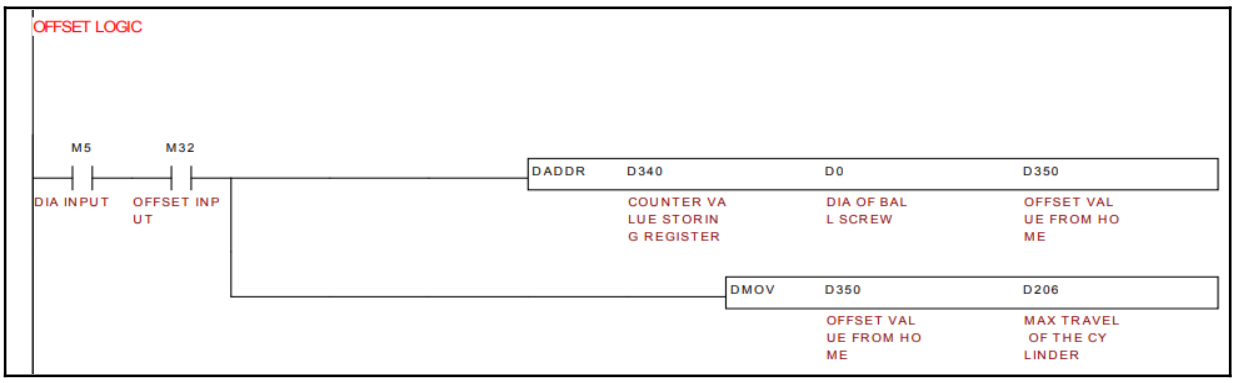
Sets the maximum limit for the flow rate of the valve.

4.2.3 Max Travel of the cylinder

Used to set the maximum stroke of the cylinder. Units is in mm. The maximum travel of the cylinder can be set manually by the user or also can be set by the offset button in the main screen.

The calculations for the offset is as shown below.

Max travel = (Pos. of machine in contact with ball screw + Dia of ball screw)



Offset logic:

- The Diameter has to be input by the user so as to use the offset input function.
- Homing has to be done before using the offset function.

4.2.4 Max I/P to AO mod

This parameter sets the maximum input to the DAC. The maximum I/P to the DAC according to the data sheet is **32000**.

4.2.5 Max O/P of AO mod

This parameter sets the maximum output of the DAC. The maximum output of the DAC is 10 volts.

4.2.6 Compensation

This sets the compensatory value for the error in positions.

The calculations according to the above parameters are described below.

5. CALCULATIONS

Scaling of the user input to get the desired output is done in the PLC. The following calculations are done in the PLC.

5.1.Travel distance

Travel distance is calculated according to the diameter of the ball screw and the max travel distance. The formula for the same is as follows.

Travel distance = (Max travel of cyl – Dia of ballscrew) + Microns selected

5.2. Voltage

Voltage scaling is done in the PLC to provide input to the DAC which in turn gives input to the proportional valve.

Formula:

(Max I/P to valve / Max flow rate of valve) * Rapid flow / min

Example:

- Max input to valve is **10 volts.**
- Max flow rate of valve is 10000 ml/min**.**

Let Rapid flow / min be 5000 ml/min.

Now according to the formula (10/10000)*5000 = 5 volts.

To get **5000 ml/min** flow from the valve, the DAC has to provide **5 volts** to the proportional valve.

5.3. DAC input

For getting the analog voltage 5 volts from the DAC, we have to provide the corresponding input to the DAC. The formula for the same is

(Max I/P to AO module / Max O/P of AO module) * Voltage.

Example:

- Max I/P to AO module is 32000.

- Max O/P of AO module is 10 volts.
- The voltage calculated according to the flow above is 5 volts.

Now the input to DAC to obtain 5 volts output is (32000/10)*5 = **16000**.

The data value 16000 has to be given to the DAC to obtain 5v output from the DAC.

5.4. Compensation

Compensation is calculated so as to obtain precise positioning of the cylinder. The formula is as follows:

Compensation = Travel distance – (Compensation * feed / 1000)

5.5. TO GO distance

The TO GO distance is calculated according to the travel distance. The formula is as follows:

TO GO dist = (Travel distance for curr cycle – Machine position).

6. CURRENT CALCULATIONS

Power supply chosen for the machine is Meanwell NDR 240-24 VDC. This provides 24VDC and the rated power is 240W. It also has an overload protection of over 105-130% of rated power.

The current utilisation of the components are as follows:

COMPONENTS	CURRENT IN A
1. DELTA DVP14SS211R	7.54
2. LINEAR SCALE GVS215 T1E	0.1
3. DAC DVP04DA-SL	0.145
4. PROPORTIONAL VALVE ELDFG 01 EH 3C2L XY C D 10	3
5. DELTA HMI DOP 107CV	0.7
TOTAL	**11.485**

Overall current utilisation is within the power supply's output power.