Palestine Polytechnic University

College of Engineering

Design and Implementation of Gypsum Mixing Machine

By

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Supervisor: Prof. Dr. Sameer Hana Khader

Submitted to the College of Engineering

in partial fulfillment of the requirements for the

Bachelor degree in Industrial Automation Engineering

Hebron, May 2018

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Supervisor Signature

……

Chair of the Department Signature

…….

May - 2018

إهداء

إلى معلمنا وقائدنا وحبيبنا وشفيعنا و قدوتنا محمد صلى الله عليه وسلم.

إلى من رسموا بدمائهم خارطة الوطن وطريق المستقبل وهندسوا بأجسادهم معاقل العزة والكرامة وإلى من هم أكرم منا جميعا شهداء الوطن الحبيب.

إلى الذين عشقوا الحرية التي تفوح منها رائحة الياسمين وتواروا خلف القضبان ليفسحوا لنا النور أسرانا البواسل.

إلى أبي الذي لم يبخل علي يوماً بشيء، وأمي التي زودتني بالحنان والمحبة أقول لهم:

أنتم وهبتموني الحياة والأمل والنشأة على شغف الإطلاع والمعرفة.

إلى إخوتي وأسرتي جميعا.

إلى كل من علمني حرفاً أصبح سنا برقه يضيء الطريق أمامي.

إلى من ضاقت السطور لذكرهم فوسعتهم قلوبنا أصدقاءنا الأعزاء.

إلي كل من أضاء بعلمه عقل غيره، أو هدى بالجواب الصحيح حيرة سائليه، فأظهر بسماحته تواضع العلماء، وبرحابته سماحة العارفين .

إلى من رسم معنا خطوات هذا النجاح الى من بذل جهده ووقتة وكان لنا مرشداً وناصحاً وأخاً مشرفنا الحبيب الأستاذ البروفيسور سمير خضر.

شكر وتقدير

نتقدم بجزيل الشكر والتقدير والإمتنان العظيم إلى المشرف الأستاذ الدكتور سمير حنا خضر لما منحه لنا من وقت وجهد وتوجيه وإرشاد وتشجيع. كما و نتقدم بجزيل الشكر إلى أساتذتنا الكرام .

وأيضا جزيل الشكر والإمتنان لمن سهر الليالي لنصل لما وصلنا إليه اليوم أهلنا الكرام.

كما ولا ننسى أن نشكر جامعتنا الموقره لما وفرته لنا طوال الفتره الدراسية.

ونشكر أصدقاءنا وزملاءنا الذين كانوا خير عون خلال سنين الدراسة, شكرا لكم جميعا.

الملخص

"تصميم وتنفيذ ماكينة لخلط الجبص"

يهدف هذا المشروع للخروج بماكينة تعمل على خلط الجبص المحضر يدويا, لتقليل الجهد اللازم لعملية تحضير خليط الجبص وايضا زيادة القدرة الانتاجية وتوفير بيئة عمل صحية مناسبة للعامل وكذلك الحصول على خليط ذو جودة عالية وذلك من خلال تصميم وبناء ماكينة مؤتمتة بشكل كامل.

تم دراسة آلية عمل الماكينات المستخدمة عالمياً لتوزين وتعبئة الجبص وكذلك اليات عملية خلط المزيج و شروطها وبعدها تم تحديد التصميم الميكانيكي و المعدات والأجهزة اللازمة لبناء هذا المشروع وتم بعدها تنفيذ الماكنة عمليا.

بعد تنفيذ الماكنه عمليا تم اجراء عدة اختبارات للماكينة لفحص جودة مخرجاتها وسلامة تصميمها حيث تم الخروج بماكينة و قد حققت اهداف المشروع كاملة متمثلة بانتاج خليط الجبص بوقت اقل ودقة اعلى من عملية الخلط اليدوية وزادت القدرة الانتاجية وحافظت على سلامة بيئة العمل من غبار الجبص الضار وقللت الفاقد في المادة الخام لذلك نعتبر مشروعنا ناجح من كل النواحي.

Abstract

"Design and Implementation of Weighing and Mixing Gypsum"

This project is intended to produce a full automatic machine that mix the gypsum with water, instead of being prepared manually. This leads to saving effort and time in preparing the mixture, from one hand this increases the capacity of production, allows healthy working conditions, comfortable to the worker and provides a mixture with high quality.

A study has been conducted on similar machines that are used worldwide to weight and pack gypsum, also the mechanism of mixing the ingredient (gypsum and water), and the ideal conditions for running the process. Accordingly, the mechanical designing and the equipment needed for the completing of the project have been determined, and implemented to form the mentioned machine.

After completely building the machine, several tests have been conducted to the quality of the product, and the safety of the machine components to ensure that the machine meets all the goals and conditions for accurate quality and healthy productions. So, the conducted tests and validation satisfy the project requirement and achieved results. So, we humbly consider our project a complete success.

APPENDIX:

List of Figures

List of Tables

List of Equations

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1

Chapter one

Introduction

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1.1 Introduction

One of common handmade industries in Palestine is production of Decorative Gypsum Pieces and bricks that is popular in Palestinian community as a Decorative product in building construction.

Till to now weighing gypsum and mixing with water is prepared manually, our project came to automate this process.

1.2 Literature review

After having viewed previous partially machines similar in this project with respect to filling procedure, the following were concluded:

Filling powder machine and similar materials comes in three main types:

1.2.1 Auger filler machine:

Auger fillers machine as illustrated on **figure 1.1** for all fine powders or any product that has consistent size particulates such as talcum powders, flour, cake mixes and more. Auger filling equipment consists of a main hopper, main hopper (stainless cone), agitator blade that driven by mixing motor, auger screw that driven by filling motor and stirring bar to keep the auger fed (even on powders that are not free flowing) closely. Most of auger fillers are volumetric machine which means that not actually weigh the product. [4]

Figure 1.1: Auger filler

`

- Advantages of Auger filler:

    - Relatively dust free, even on very fine powders that tend to get airborne easily. This is because of Auger fillers are closed corpus.
    - Simply and smoothly in powder flow inside the corpus.
    - Uses for fine and consistent size particulates powder.

- Disadvantages of auger filler:

    - Not reliably accurate for products with irregular shapes or densities.
    - Can damage products that cannot withstand compression.

1.2.2 Net weight filler:

Net weight filling machine as illustrated on **figure 1.2** are different from auger fillers and cup fillers that actually weighs the product before dispensing into container. A net weight filler moves product from a hopper via vibratory trays or belts depending on the type of product. The product streams directly into a bucket mounted on to a load cell. As the weight in the bucket reaches the target weight the feed system slow down the feeding rated until approaching the exact weight. [4]

Figure 1.2: Net weight filler

`

- Advantages of Net weight filler:

    - Accurate in weighting.
    - Gentle product handling capability - little compression.

- Disadvantages of net weight filler:

    - Relatively slow compared to augers and cup fillers.
    - Running very fine powders such as talcum and flour.

1.2.3 Cup filler:

Cup fillers as illustrated on **figure 1.3** are also volumetric fillers that work in a different way than Auger filler. Cup filler work well with any free-flowing product such as nuts, granules and powder. Hopper sits above the top of the cup and gravity feeds product in. Wipers remove excess product so that the cup is levelled. When the cup reaches the discharge chute it falls out of the bottom of the cup and into the container or bag. Cup fillers can be made for very high production rates compared to auger and net weight fillers. [4]

Figure 1.3: Cup filler

`

- Advantages of cup filler:

    - Can run virtually any free-flowing product (not recommended for fine powders).
    - Fast - Capable of speeds into the hundreds of fills per minute.

- Disadvantages of cup filler:

    - Cannot run products that are not very free flowing.
    - Does not run irregular shapes or densities.
    - Very limited fill range.

According of pervious applied methods for powder filling, the Auger filling method in chosen for completing present work due to:

- This method is a suitable way for filling gypsum.
- Can be locally easily designed and manufactured.
- Unlimited fill range without change any parts of the machine in contrast of cup and net weight filler machine.

1.3 Problem statement

The project idea came up from the status of preparing for casting Decorative Gypsum that has some drawbacks:

- Large quantity of wasted gypsum being lost during weighing process.
- Direct contact with gypsum dust that eventually causes a lot of lung diseases.
- Manually manufactured gypsum pieces lead to existing of air bubbles, which in turn causing mechanically weakness.

`

1.4 Objectives

- Applying and introducing new technology to Palestinian sector dealing with gypsum.
- Achieving better quality than manually made by extruding the air from gypsum, making it harder.
- Enhancing health condition by avoiding direct contact with gypsum dust that eventually causes a lot of lung diseases.
- Reducing the wasted materials of gypsum.

1.5 Solution methodology

Working on design full-automatic machine to do following:

- Preparing the gypsum mixture without any worker interference.
- To isolate the mixing procedure to protect the workers around the machine from the gypsum dust.
- Design a mechanical mixing system to remove all air bubble from the mixture.

All of these done according the following procedure:

- Conceptual design.
- 3D design for the machine on solid works platform.
- Selecting and sizing sensors and actuators.
- Designing the electrical control circuits.
- Programming the controllers.
- Start the machine implementation.
- machine testing and calibration.

`

1.6 Time table

1.6.1 First semester:

The following time table displays the project implementation-flow divided into fifteen weeks of the first semester as following. (**See table 1.2**)

Table 1.1: First semester time table

Weeks / Tasks	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Identification of Project Idea															
Drafting a Preliminary Project Proposal															
Introduction Chapter (1)															
Main Design Concepts Chapter (2)															
Mechanical Design Chapter (3)															
Electrical Design Chapter (4)															

`

1.6.2 Second semester:

The following time table displays the project implementation-flow divided into fifteen weeks of the second semester as following. (**See table 1.3**)

Table 1.2: Second semester time table

Weeks / Tasks	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Treatment and rectify the reviews command project	■	■	■												
Mechanical implementation			■	■	■	■									
Electrical implementation						■	■	■	■						
Calibration and adjustment									■	■	■				
Testing											■	■	■		
Report													■	■	■

`

2

Chapter two

Machine operation concepts

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2.1 Principles of machine operation:

The principle of machine operation is to weigh and mix gypsum according to following procedures:

- The worker pours the gypsum in a powder container.
- The quantities of mixing materials (Gypsum and Water) is determined through the HMI interfacing panel.
- The sent by HMI signals is processed by PLC logic, which in turn activates the liquid sensors and related motion systems.
- Having these commands together leads to produce the mixture and casting the gypsum.

2.2 Machine stages

2.2.1 Transfer gypsum stage

The powder conveyor as illustrated on **figure 2.1** having of three main components, powder container, extruder tunnel and screw located inside the tunnel which is driven by a motor gearbox combination.

The gypsum is poured in the container then raw gypsum enters extruder via container gate and the extruder move the materials to the next weighing stage.

Figure 2.1: Powder conveyer

`

2.2.2 Weighing stage

In this stage the weight of gypsum will be determined by auger filler machine. Auger filler as illustrated on **figure 2.2** consist of main hopper (stainless cone), agitator blade, that are used to move the gypsum to the mixing container.

After the main hopper filled by gypsum the mixing and filling motors run with specific time and speed, Consequently the output of this stage is the desired weight gypsum needed.

Figure 2.2: Auger filler machine

2.2.3 Mixing stage

In this stage the gypsum is mixed with water, this stage contains of the following components:

- Mixing tank as illustrated on **figure 2.3.**
- Mixing blade.
- Driving motor.

`

The gypsum must be mixed under the following conditions:

- The gypsum and water are mixed with certain ratio and time depending on the type of gypsum used in the process.[7]
- use a high speed direct drive propeller mixer with the mixing shaft set at an angle of 15 degrees from vertical.[7]
- The shaft should be about half way between the center and the side of the container, and about two inches from the bottom.[7]
- The propeller rotation should force the mix downward.[7]

The output of this stage is gypsum mixture ready for casting.

Figure 2.3: Mixing tank

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2.3 Function block diagram

Function block diagram as illustrated on figure 2.4 clarify machine stages.

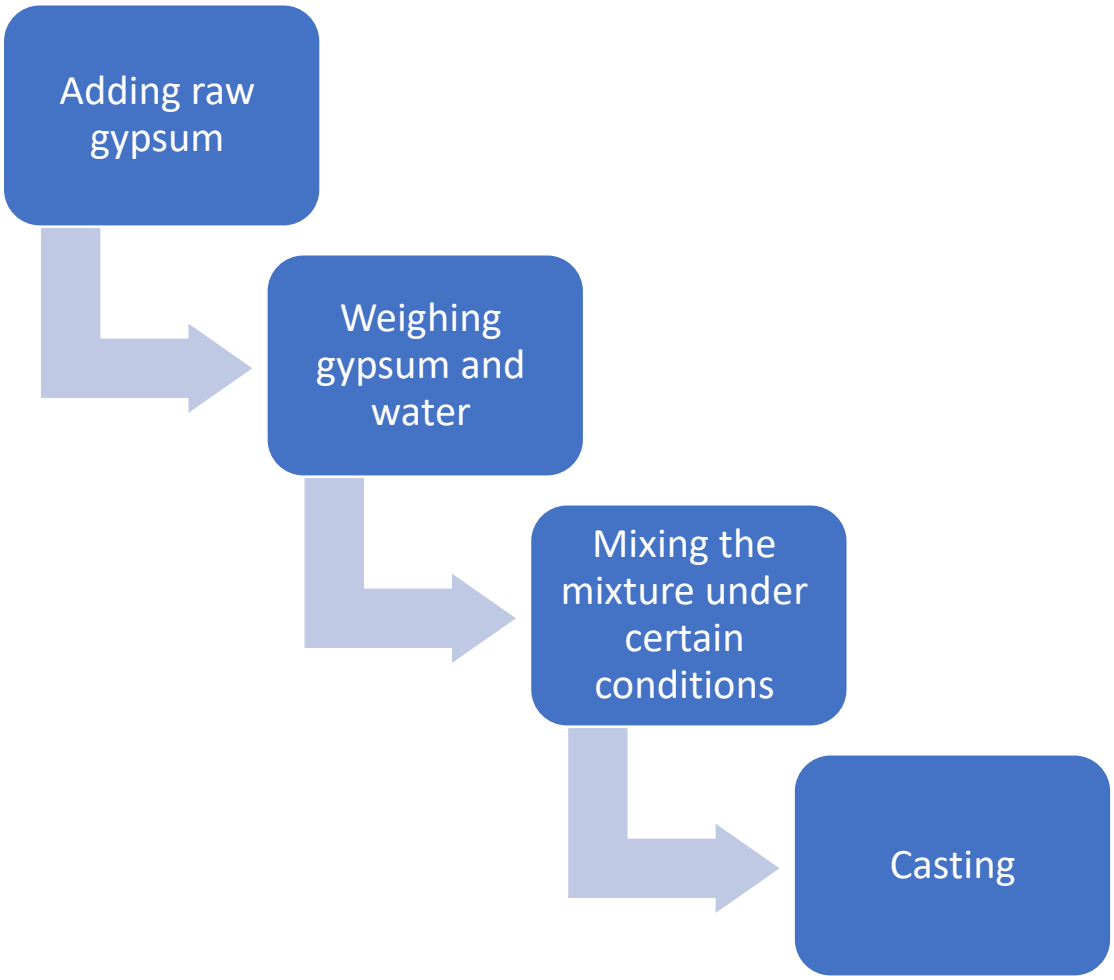

Figure 2.4: Function block diagram

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2.4 Process Flow chart

The following flow chart as illustrated on figure 2.5 shows the machine principle of operation.

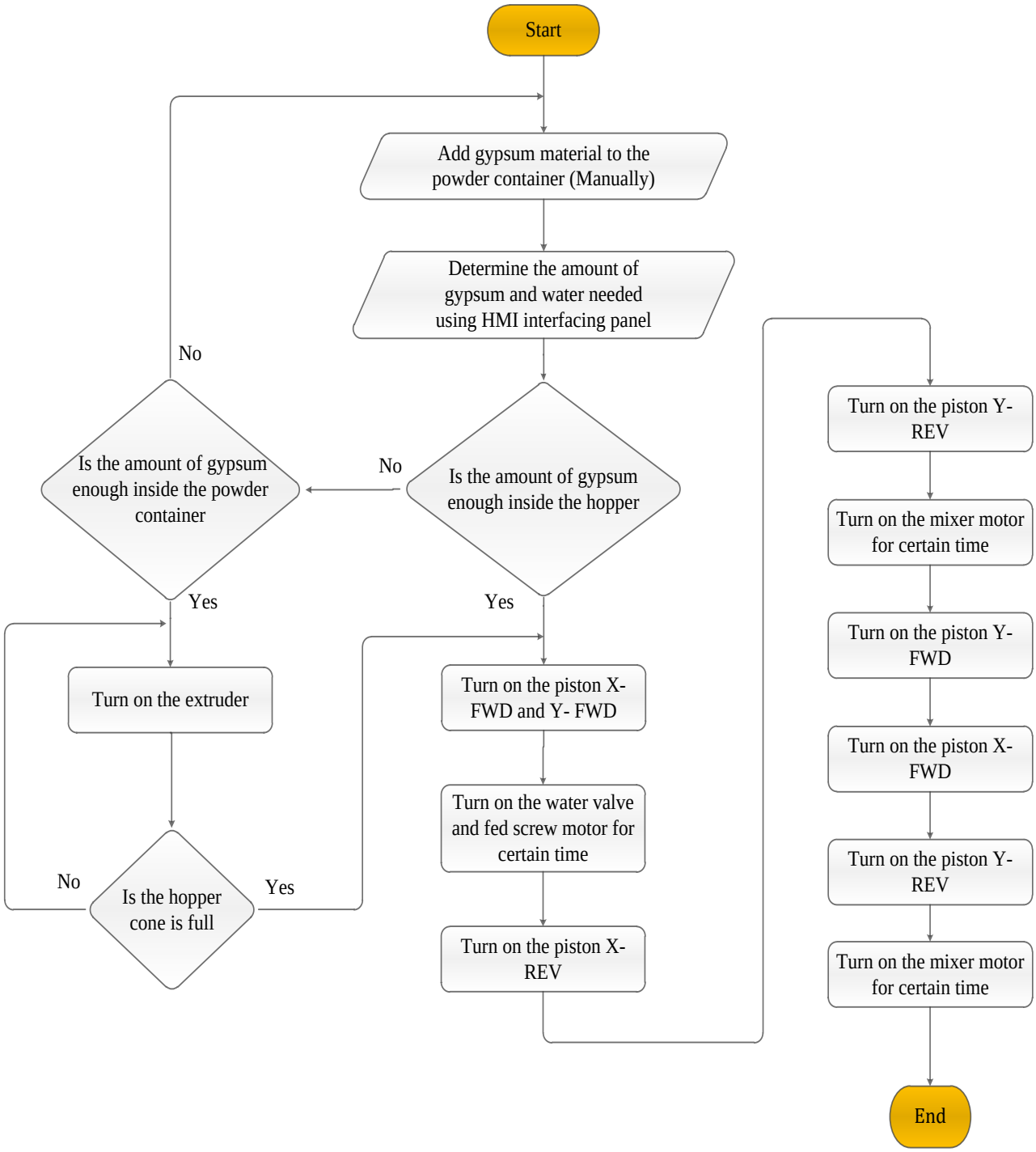

Figure 2.5: Process Flow Chart

`

2.5 Required components

The following are the needed components that should be selected after the connection diagrams in CH4.

2.5.1 Motors

The machine needs four three-phase squirrel cage induction motor, one for the mixer blades, one for the extruder screw, one for the agitator blade and one for the fed screw. They will move the mixer, agitator blade, fed screw and extruder via connected to the shaft of the motors. (See figure 2.6)

Figure 2.6: Motor-Gearbox Combination

Note: All the motors and gears sizing calculations will be shown in the following chapters.

2.5.2 Sensors

Magnetic sensor as illustrated on figure 2.7 is used to detect the start and end of the cylinder.

Figure 2.7: Magnetic sensor.

`

2.5.3 Variable frequency drive (VFD)

VFD as illustrated in figure 2.8 is a type of adjustable-speed drive used in electro-mechanical drive systems to control AC motor speed and torque by varying motor input frequency and voltage.

The machine has one VFD used to Control mixer speed.

Figure 2.8: VFD

2.5.4 Valves

Pneumatic valve as illustrated on figure 2.9 will be needed for filling the mixing tank with water.

Figure 2.9: Pneumatic valve.

`

2.5.5 Pneumatic Components

Two pneumatic cylinders will be needed for the mixer stage as mentioned .The pistons will need solenoid valve to be controlled by PLC, see figures below.

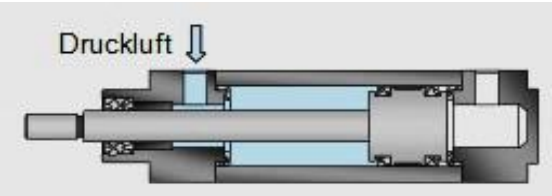

Figure 2.10: Double Acting Cylinder

Figure 2.11: Solenoid Valve

2.5.6 Protection & Switching Devices

Every motor and pump need an overload, three-phase circuit breaker that is used to protect the motors and their installations also, an earth leakage circuit breaker. In addition, they need a 24V contactor to control the motor ON/OFF operations. Emergency switch is also needed for emergency cases as illustrated on figure 2.12.

Figure 2.6: Protections & Switching Device

`

2.5.7 PLC (Programmable Logic Controller)

A programmable logic controller (PLC) as illustrated on figure 2.13 is a microprocessor-based piece of hardware that is specifically designed to operate in the industrial environment.

Generally, PLCs (as the name suggests) implement logic, determining outputs based on some logical combination of inputs. PLCs are programmable devices that are capable of taking inputs from sensors and activating actuators in order to control industrial equipment.

The PLC type that will be used is DELTA-DVP32ES2 that has 16 inputs and 16 outputs. We chose delta PLC because of its good quality, it is easy to be programmed, has accepted price and meet the required purpose.

The PLC DELTA-DVP32ES Datasheet is attached in the Appendix A.

Figure 2.7: PLC DELTA-DVP32ES

`

2.5.8 HMI (Human Machine Interface)

A Human Machine Interface (HMI) as illustrated in figure 2.14 is the user Interface that connects an operator to the controller for an industrial system.

HMIs are usually deployed on Windows based machines, communicating with programmable logic controllers (PLC) and other industrial controllers.

The HMI Datasheet is attached in the Appendix B.

Figure 2.8: HMI Screen**.**

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3

Chapter three

Mechanical Design

3.1 Proposed system description and specification

3.2 Introduction

3.3 Conceptual design

3.4 Mechanical design

3.1 Proposed System Description and Specification

The first step in mechanical design is to specify the whole operation of the system and to plan how the machine is being constructed as shown in figure 3.1.

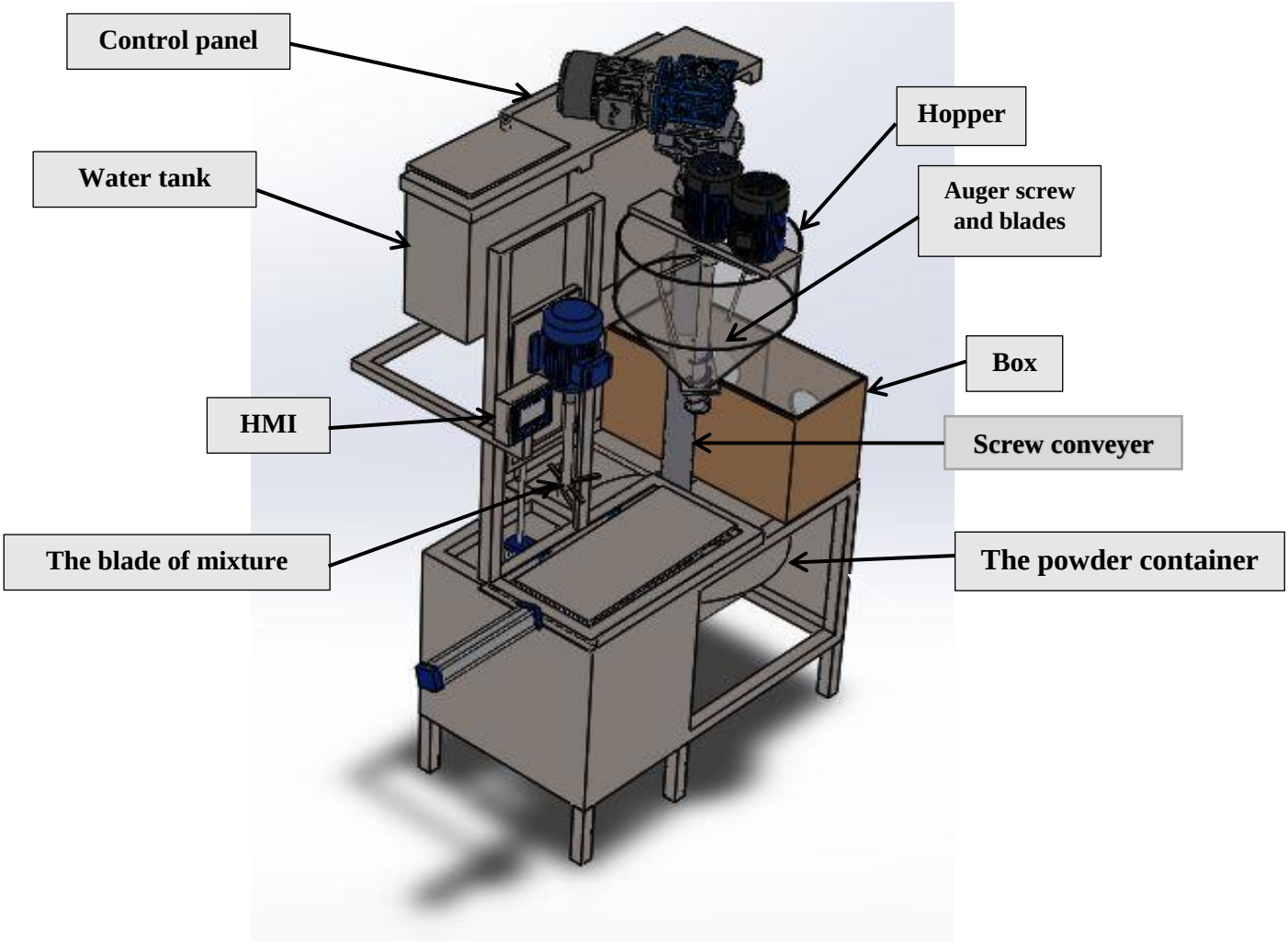


Figure 3.1: Overall machine view

3.2 Introduction

Refer to figure 3.1 has the following parts:

1. Container.
2. Screw conveyor.
3. Hopper.
4. Blades & Auger screw.
5. Mixer.
6. Machine corpus.

On the sideline of production of the gypsum mixture, there are a set of requirements should be into:

- Safety
- Easy to move
- Cost
- Design simplicity
- Work space
- Ease to maintenance

3.3 Conceptual Design

It is desired to design and produce a gypsum mixture machine fully automated.

The machine divided into four subsystems:

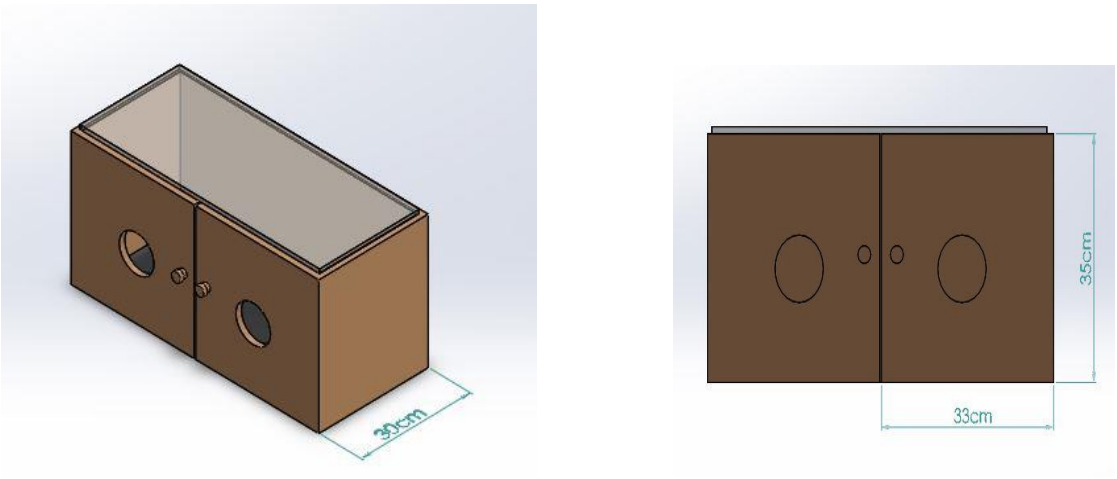
1. Loading system.
2. Transporting system.
3. Auger filler system.
4. Mixture and Casting system.

3.4 Mechanical Design

In this section each block should be explained in details, the used materials for parts in this machine are stainless steel, wood and glass.

3.4.1 The box

The box is used to isolate the worker from powder particular during the pouring powder.



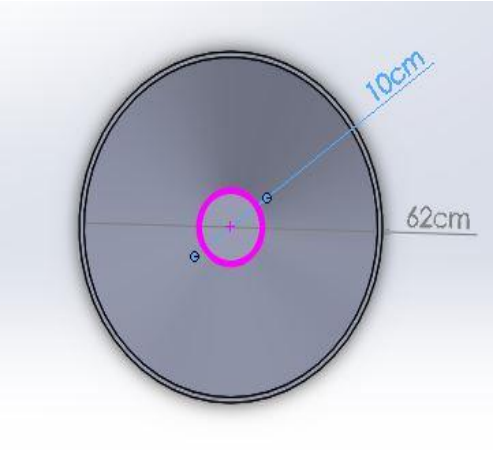
a. Overall view **b**. Side view

Figure 3.2: Box

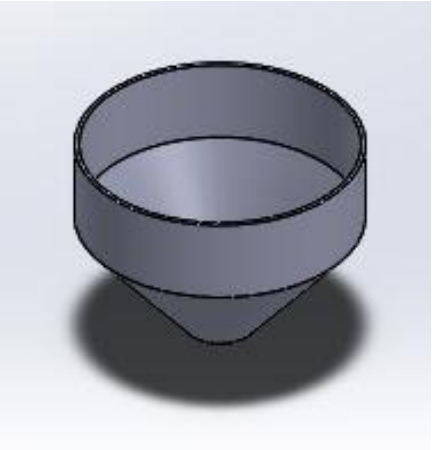
The box dimensions are determined according to machine capacity requirement.

3.4.2 The powder container

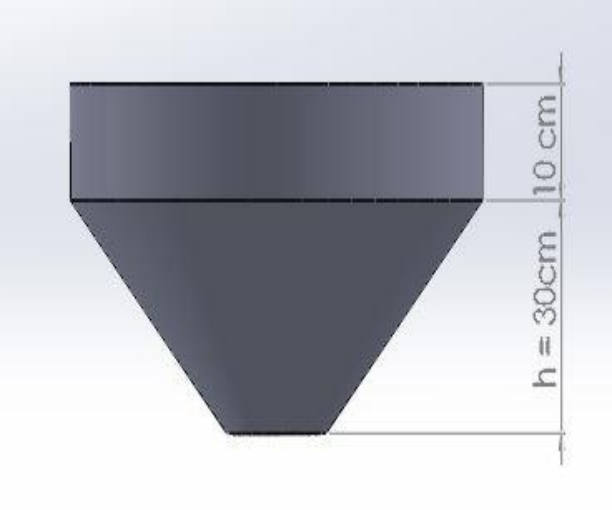
The container is design to handle 50kg gypsum- powder with shape and dimension as shown in figure 3.3.



a. Top view



b. Overall view



c. Side view

Figure 3.3: Powder container

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The container mass and volume can be determined based on the following expression:

$V = \frac{M}{\rho} = 0.0592\ m^3$ ..... **(3.1)[3]**

Where:

V: the total volume of powder container.

ρ = 1350 kg/m^3 the density of raw gypsum.

M = 80kg the mass of raw gypsum in container.

To find height of cone assume large radius and small radius

$V = V1 + V2$ **…… (3.2)**

$V1 = \pi * R^2 * 0.1 = 0.03m^3$ **…… (3.3)**

$V2 = V - V1 = 0.292m^3$ **…… (3.4)**

$h = V2 - \frac{3*V}{\pi*(R^2 + r^2 + R*r)} = 30cm$ **…… (3.5)**

Where

V1: the cylinder volume of powder container.

V2: the cone volume of powder container

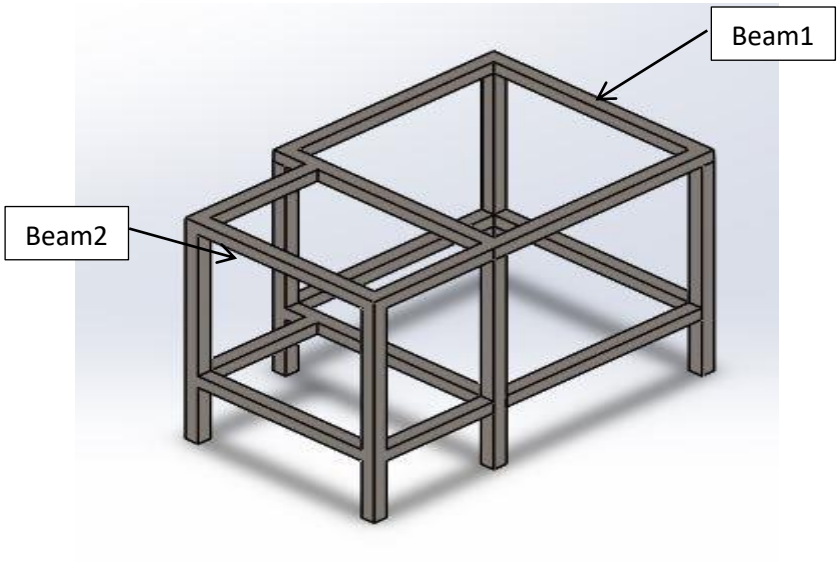
R = 31cm, large radius of powder container.

r = 5cm, small radius of powder container.

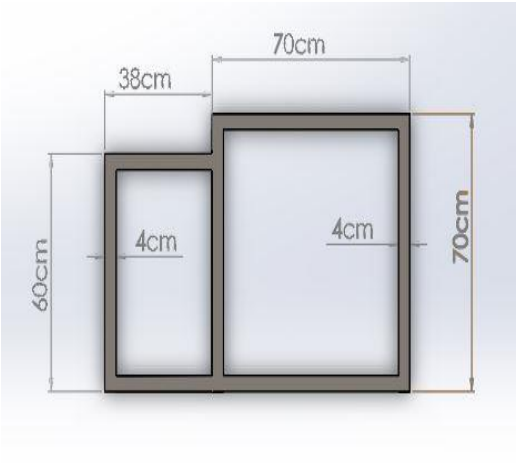
h: height of cone.

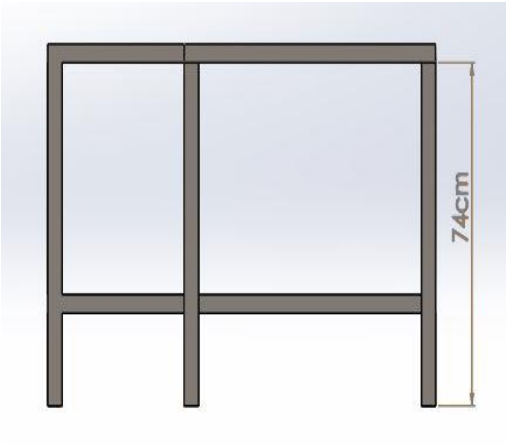
3.4.3 Stand of machine

Design the stand needs to calculate all the system forces that cause deflection according to figure 3.4.



a. Overall view



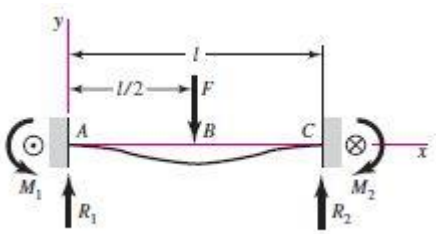


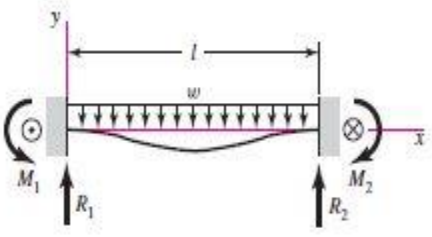
b. Top view

c. Side view

Figure 3.4: Stand of machine.

The maximum deflection on beam 1 and beam2:





a. the concentrate force

b. the distribute force

Figure 3.5: deflection of stand.

$Y_{max1} = Y1 + Y2$ **……..... (3.6)[7]**

$Y1 = -\frac{F1*L1^3}{192*E*I}$, the concentrate deflection on beam1 **…… (3.7)**

$Y2 = -\frac{w*L^2}{38*E*I}$, the distribute deflection on beam1 **…… (3.8)**

$Y_{max2} = \frac{F2*L2^3}{192*E*I}$, the deflection on beam2 …… **(3.9)**

Where:

Y_{max1}: The maximum deflection on the beam1.

Y_{max2}: The maximum deflection on the beam2.

F1: The concentrate force on the beam1.

F2: The concentrate force on the beam2.

w: The distribute force on the beam.

I: Moment of inertia.

L1 = 70cm, the length of the beam1.

L2 = 60cm, the length of the beam2.

E = 207GPa, modules of elasticity.

- Calculate the concentrate force on the beam1: -

  $F1 = \frac{Mc1 * 9.81}{4} = 490.5N$ **…… (3.10)**

  Where:

  Mc1 = 200kg, concentrate mass on beam1.

- Calculate the distribute force on the beam1: -

$$W = \frac{Mb * 9.81}{4} = 49N \text{ ..... (3.11)}$$

Where:

Mb = 20kg, mass of box.

- Calculate the concentrate force on the beam2: -

$$F2 = \frac{Mc2 * 9.81}{4} = 122.6N \text{ ..... (3.12)}$$

Where:

Mc2= 50kg, mass on beam1.

Calculate the moment of inertia:

$$I = \frac{0.04*0.04^3}{12} = 213*10^{-9}\ m^4 \text{ ..... (3.13)}$$

Refer into equations 3.4 and 3.5 the maximum deflection on the beam is:

$Y1 = 2*10^{-5}$ m

$Y2 = 1.5*10^{-5}$ m

$Ymax1 = 3.5*10^{-5}$ m

$Ymax2 = 3*10^{-6}$m

3.4.4 Screw conveyor

In this section the screw conveyer transfers the raw material from the powder container to the hopper (stainless cone) as show in figure 3.9.

Figure 3.6: Screw conveyor

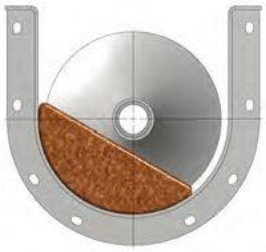
Table 3.1: Bulk Material

Bulk Material:	Gypsum (Powdered)
Maximum particle size:	No.100 Sieve (0.0059 in) And Ander
Bulk Density:	60-80 lbs. per cu.ft.
Trough Loading:	30A (30-percent)
Component Series:	A2
Abrasive:	Mildly Abrasive
Material factor:	2
Flowability:	Average Flowability
Bearing type	H

Table 3.2: Pitch capacity factor

Pitch	Description	CF
Standard	Pitch = Diameter of screw	1
Short	Pitch = 2/3 Diameter of screw	1.5
Half	Pitch = 0.5 Diameter of screw	2
long	Pitch = 1.5 Diameter of screw	0.67

Table 3.3: Capacity of screw conveyor

Capacity Table				
Trough Loading	Screw Dia. (in.)	Max. RPM *	Capacity in ft^3/hr	
			At Max. RPM	At 1 RPM
 30% A	4	139	57	0.4
	6	120	179	1.5
	9	100	545	5.5
	12	90	1,161	12.9
	14	85	1,768	20.8
	16	80	2,496	31.2
	18	75	3,375	45.0
	20	70	4,375	62.5
	24	65	7,085	109.0
	30	60	12,798	213.3
	36	50	18,440	368.8

*The diameter of screw conveyor in this machine is 4 inches then capacity at 1 RPM is 0.4ft^3/hr from table 3.4.

The speed of screw conveyor:

$$N = \frac{C*CF}{Capacity\ at\ 1\ RPM} = 70\ \text{RPM} \quad \textbf{..... (3.14)[6]}$$

Where:

N: Speed of screw conveyor (RPM).

C = 19 ft^3/ hr, required capacity.

CF = 1.5, Capacity factor from table 3.3.

Calculate the horsepower of screw conveyor:

$$\text{Total HP} = (HPf + HPm) * Fo \quad \textbf{..... (3.15)}$$

Where:

Fo = 3, overload factor from figure 3.7.

HPf: Horsepower to run an empty conveyor (hp).

HPm: Horsepower to move the material (hp).

Table 3.4 : Conveyor diameter factor

Screw Diameter (Inches)	Factor Fd
4	12
6	18
9	31
10	37

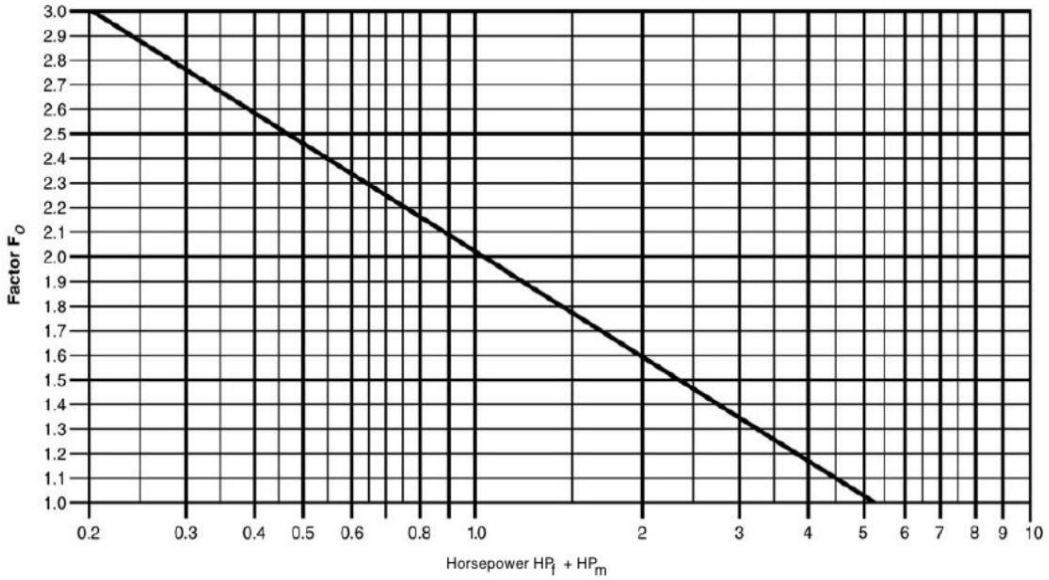


Figure 3.7: Overload factor (Fo)

Table 3.5: Hanger bearing factor

Bearing type		Hanger Bearing Factor Fb
B	Ball	1
L	Martin Bronze	2
S	Graphite Bronze Melamine	3.4
H	Hard Surfaced	4.4

	Satellite	

- The horsepower without load on screw conveyor: 4

HPf = $\frac{L*N*Fd*Fb}{1000000}$ = 0.036 hp **……(3.3)**

Where:

L = 9.84ft, Length of conveyor.

N = 70 RPM, Operating speed.

Fd = 12, conveyor diameter factor from table 3.4.

Fb = 4.4, hanger bearing factor from table 3.5.

- The horsepower with load on screw conveyor:

HPm = $\frac{C*L*W*Ff*Fm*Fo}{1000000}$ = 0.044 hp **…… (3.4)**

Where:

C = 19ft^3/ hr, required capacity.

L = 9.84ft, length of conveyor.

Ff = 1, flight factor from table 3.7.

Fm = 2, material factor from table 3.3.

Fo = 3, overload factor figure 3.10.

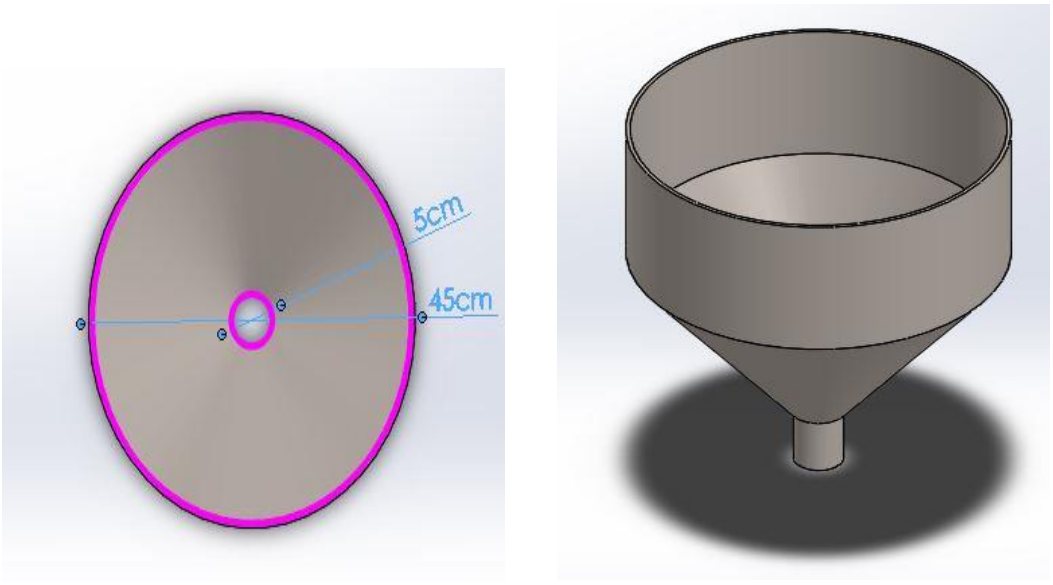
Table 3.6: Flight Factor (Ff)

Flight Type	Ff Factor for Percent Conveyor Loading		
	30%	45%	90%
Standard	1.0	1.0	1.0
Cut Flight	1.15	1.2	1.3
Cut & Folded Flight	1.5	1.7	2.2
Ribbon Flight	1.14	1.2	—

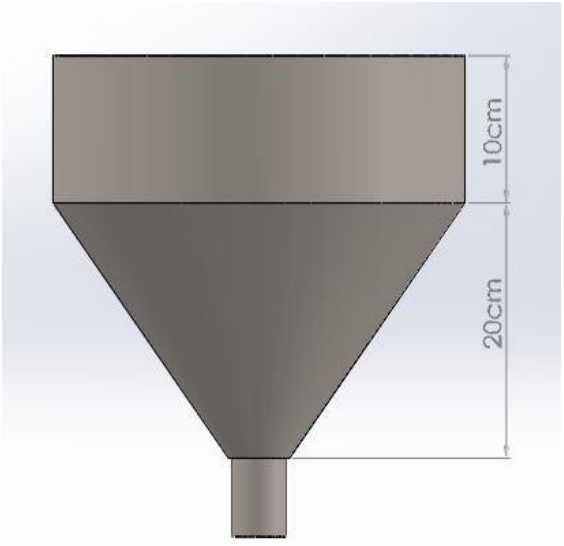
Total HP = 0.24hp.

3.4.5 The hopper

The maximum weight of the powder is 35 kg that can be filled into hopper in figure 3.9.



a. Top View b. overall view



c. Side view

Figure 3.9: Hopper

The container mass and volume can be determined based on the following expression:

$V = \frac{M}{\rho} = 0.026\ m^3$ **..... (3.18)**

Where:

V: the volume of powder container.

$\rho = 1350\ kg/m^3$ the density of raw gypsum.

M = 35kg the mass of raw gypsum in container.

To find height of cone assume large radius and small radius

$V = V1 - V2$ **…… (3.19)**

$V1 = \pi * R^2 * 0.1 = 0.015m^3$ **…… (3.20)**

$V2 = V - V1 = 0.011m^3$ **…… (3.21)**

$h = V2 - \frac{3*V}{\pi*(R^2 + r^2 + R*r)} = 20cm$ **…… (3.22)**

Where

V1: the cylinder volume of powder container.

V2: the cone volume of powder container

R = 22.5cm, large radius of powder container.

r = 2.5cm, small radius of powder container.

h: height of cone.

3.4.6 Blades with auger screw

The blades and auger screw are used to provide smooth mixture flow.

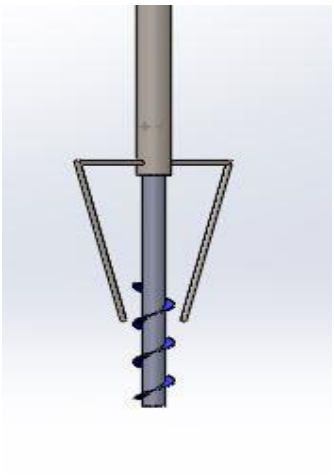


Figure 3.10: Blades with auger screw.

The speed of auger conveyor:

$$N = \frac{C*CF}{Capacity\ at\ 1\ RPM} = 70\ \text{RPM} \quad \textbf{.....} \quad \textbf{(3.5)}$$

Where:

N: Speed of l screw conveyor (RPM).

C = 19 ft^3/ hr, required capacity.

CF = 1.5, Capacity factor from table [3].

- The needed horsepower of screw conveyor:

$$\text{Total HP} = (HPf + HPm) * Fo * SF \quad \textbf{.....} \quad \textbf{(3.24)}$$

Where:

Fo = 3, overload factor from figure 3.5.

SF = 2, Safety factor.

HPf: Horsepower to run an empty conveyor (hp).

HPm: Horsepower to move the material (hp).

- The horsepower without load on screw conveyor:

$$HPf = \frac{L*N*Fd*Fb}{1000000} = 0.0025\ \text{hp} \quad \textbf{.....(3.25)}$$

Where:

L = 0.7ft, Length of conveyor.

N = 70 RPM, Operating speed.

Fd = 12, Conveyor diameter factor from table 3.

Fb = 4.4, Hanger bearing factor from table 3.

- The horsepower with load on screw conveyor:

$$HPm = \frac{C*L*W*Ff*Fm*Fo}{1000000} = 0.0032 \text{ hp} \quad \textbf{(3.26)}$$

Where:

C = 19ft^3/ hr, required capacity.

L = 0.74ft, length of conveyor.

Ff = 1, flight factor from table 3.

Fm = 2, material factor from table 3.

Fo = 3, overload factor from table 3.

Refer into equations 3.8 the horsepower of screw conveyor is:

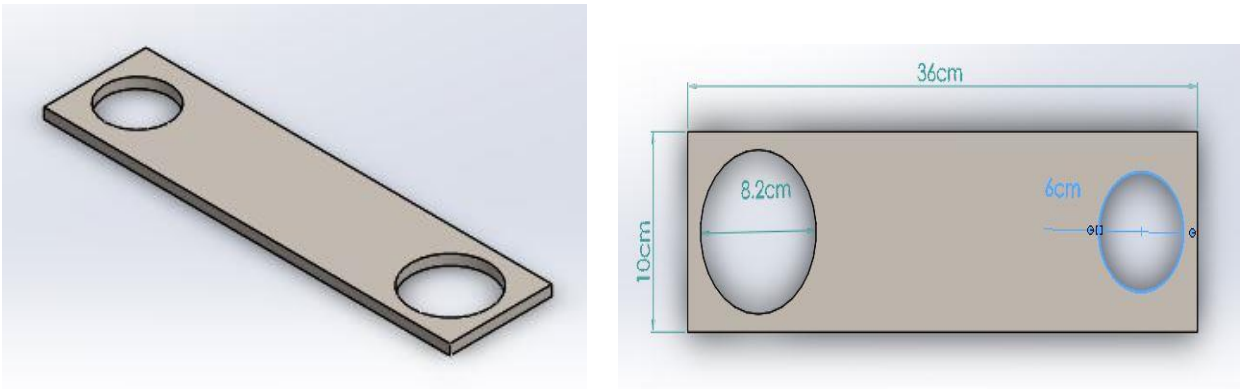
Total HP = 0.48hp.

- The horsepower of blades:

In this part cannot calculate the power of blade motor so we worked on scaling on the machine has the same dimension at factory in Hebron. The power of the motor was 0.5hp.

3.4.7 Design the ring of hopper

The ring used to carry the hopper container.



a. Overall view **b. Top view**

c. Side view

Figure 3.11: The ring.

3.4.8 Stress analysis:

The force as illustrated on figure 3.12 produced from the hopper has a shear effect on the rod that carry the container and to find it we make the following calculation:

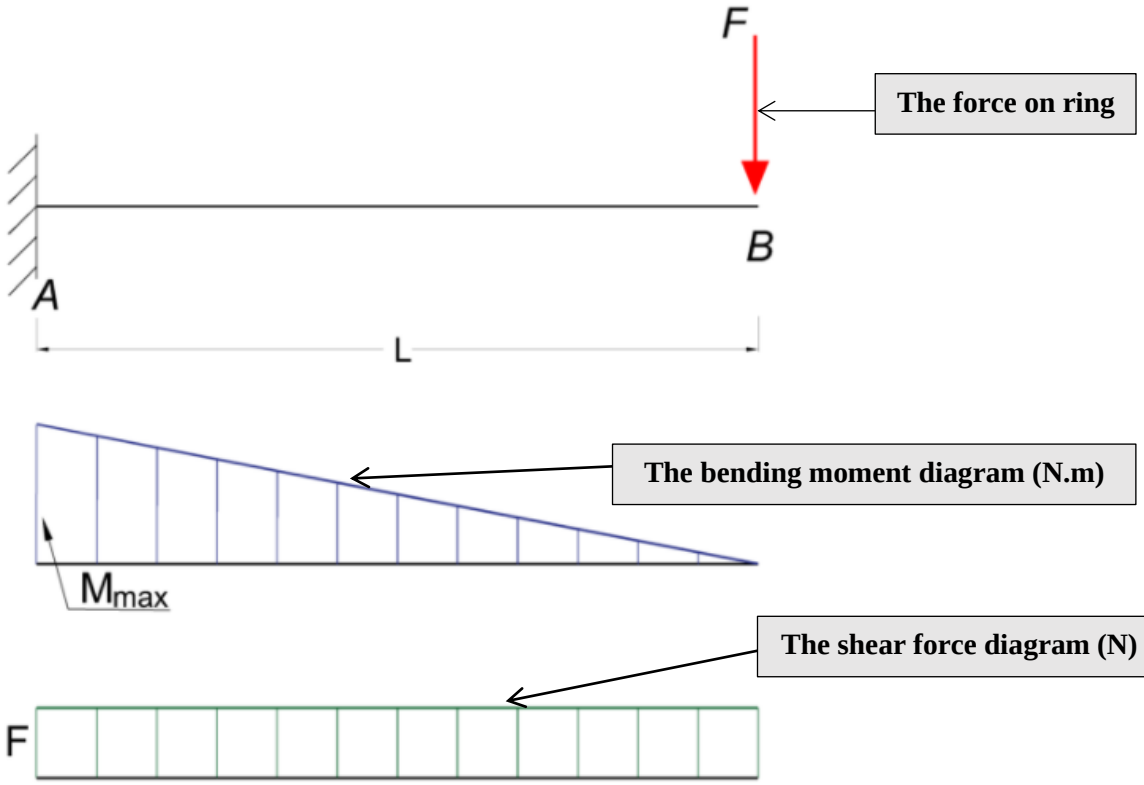


Figure 3.12: The shear force and Bending moment on the ring.

$\sum Fy=0$ ..... **(3.27)**

$R_A - F = 0$

$R_A = 490.5N$

Where:

R_A: the reaction force on point A.

F=490.5, the force on the ring

$\sum M_A=0$ ..... **(3.28)**

$M_A - 490.5*0.23 = 0$

$M_A = 112.8N.m$

$\sum M_B=0$ ..... **(3.29)**

$M_B = 0$

Where:

M_A: moment about point A.

M_B: moment about point B.

$M_{max} = M_A = 112.8$ N.m

$$\sigma_{req} = \frac{Mmax.C}{I} \quad \text{..... (3.30)}$$

$$I = \frac{1}{12} * b * h^3 \quad \text{..... (3.31)}$$

Where:

σ_{req}: required stress

M_{max} : the maximum moment on the cantilever beam.

$C = \frac{L}{2} = 13.5$cm.

b = , width of ring.

h: thickness of ring.

The chosen safety factor equal 2 and the chosen material of beam it a Chromium it has allowable stress equal 689 Mpa

$$n_f = \frac{\sigma all}{\sigma req} \quad \text{..... (3.32)}$$

$$\sigma_{req} = \frac{\sigma all}{nf} = 344.5 \text{ Mpa}$$

$\sigma_{req} = 344.5$MPa

Now by subtition Eq(29) , Eq(30) and Eq(31) we can found the required thickness of the ring.

$$I = \frac{112.8 * .135}{344.5 * 10^6} = 44.2 * 10^{-9} \text{ m}^4$$

$$h = \sqrt[3]{\frac{12 * I}{b}} = 17.5 \text{ mm}$$

The maximum deflection from figure 3.10:

$$Ymax = -\frac{F * L^3}{3 * E * I} \quad \text{..... (3.33)}$$

Where:

Y_{max}: The maximum deflection on the beam as shown in figure 3.11.

F: The concentrate force on the beam as shown in figure 3.13.

I: Moment of inertia.

L = 39cm, the length of the beam.

E = 207GPa, modules of elasticity.

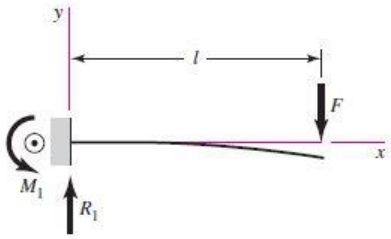


Figure 3.13: The force on the ring.

- Calculate the concentrate force on the beam:

F = M*g = 194.3N …… **(3.34)**

Where:

M = 30kg, mass of hopper.

g = 9.81m/s^2, gravity acceleration.

- Calculate the moment of inertia:

I = $\frac{0.1*0.018^3}{12}$ = 48*10^{-9} m^4 …… **(3.35)**

Refer into equations 3.32 the maximum deflection on the beam is:

Y_{max} = - 9*10^{-4} m.

3.4.9 The blade of mixer

The blade as illustrated on figure 3.14 is use to mix the powder with water.

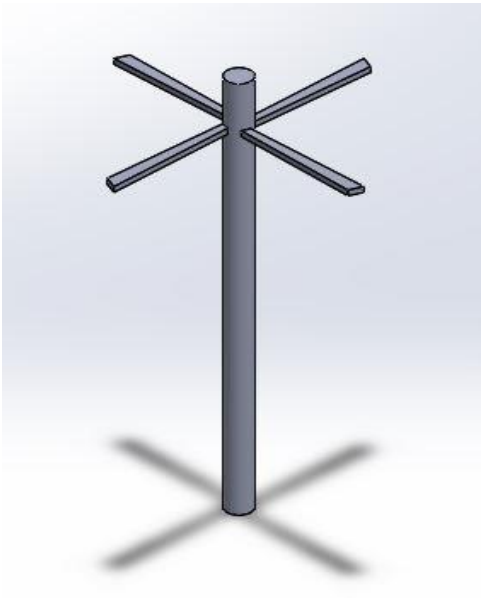


Figure 3.14 : Over all of the blade of mixer.

4

Chapter Four

Electrical Design

4.1 Introduction

Electrical design of the machine means:

- Motors sizing.
- Pneumatic circuit design.
- Power circuit design.
- Control circuit design.
- Contactor sizing.
- Protection circuit sizing.

4.2 Motors sizing

4.2.1 Extruder motor

According to the calculation in previous chapter the extruder motor is determined as following:

$Pm = {}^{Pc}/_{\eta m}$ = 1.14 hp ……**(4.1)[9]**

Where:

Pm: Input power to the motor (hp)

Pc: Mechanical power consumed by the extruder (hp) = 0.97 hp

ηm: Motor efficiency (%) = 85%

The selected extruder motor specification is display in table 4.1

Table 4.1: Specification of selected extruder motor

Parameter	Rated value
Voltage	400V/50Hz
Power	1.5 hp
current	2.7 A
Rotating speed	1420 rpm
Item no.	Z-627/5

4.2.2 Tank mixer motor

Power requirement to mix the materials is calculated as following:

$Pr = k * \rho * n^3 * D^5 = 192.2699$ Watt **…… (4.2)[8]**

Where:

Pr: Power Requirement (Watt)

k: Mixing Constant = 0.76 (See equation 4.4)

ρ: Fluid Mass Density (kg/m^3) = 2000 kg/m^3

n: speed of mixing (rev/s) = 23.3 rev/s

D: Impeller Diameter(m) = 0.2m

$Pm = Pr / \eta m = 225.8$ Watt = 0.3 hp**…… (4.1)**

Where:

Pm: Power of motor (watt).

ηm: Motor efficiency (%) = 85%.

$$k = \frac{D^3 * N}{D_t^2 * z} = 0.76$$ **…… (4.3)**

Where:

D: Impeller Diameter(m) = 0.2m

N: the agitator speed (rev/s) = 23.3rev/s

Dt: the tank diameter (m) = 0.34m

z: the height of mixture in tank (m) = 0.3m

The selected tank mixer motor specification is display in table 4.2

Table 4.2: Specification of selected mixer motor

Name	Rated value
Voltage	380V/50Hz
Power	0.5 hp
Current	1.2 A
Rotating speed	1420

4.2.3 Filling motor

According to the calculation in section 3.4.6:

the horsepower of screw conveyor is:

Total HP = 0.48hp.

The selected filling motor specification is display in table 4.3

Table 4.3: Specification of selected filling motor

Name	Rated value
Voltage	380V/50Hz
Power	0.5 hp
Current	1.2 A
Rotating speed	1420

4.2.4 Mixing motor

In this part cannot calculate the power of blade motor so we worked on scaling on the machine has the same dimension at factory in Hebron. The power of the motor was 0.5hp.

The selected tank mixing motor specification is display in table 4.4

Table 4.4: Specification of selected mixing motor

Name	Rated value
Voltage	380V/50Hz
Power	0.5 hp
Current	1.2 A
Rotating speed	1421

4.3 Protection circuit sizing

The following table describes selected motors specifications. (See table 4.5)

Table 4.5: Motors nameplate

Name	phase	P / kW	V	A	f/Hz
Extruder motor	3Φ	1.11	380	2.7	50
Mixing motor	3Φ	0.37	380	1.2	50
Filling motor	3Φ	0.37	380	1.2	50
Tank mixer motor	3Φ	0.37	380	1.2	50

4.3.1 Extruder motor protection circuit

- Overload

  OL = In = 2.7A **……...…… (4.4)[9]**

  Where In: nominal current.

- MCB (Miniature Circuit Breaker)

  MCB = 1.25In = 3.375 A **…...…… (4.5)**

- Contactor

  Contactor = 1.1*Pin = 1.221 kW **…...…… (4.6)**

  Where Pin: power input to motor.

4.3.2 Mixing motor protection circuit

- Overload

  OL = In = 1.2 A **……...…… (4.4)**

  Where In: nominal current

- MCB (Miniature Circuit Breaker)

  MCB = 1.25In = 1.5 A **…...…… (4.5)**

- Contactor

  Contactor = 1.1*Pin = 0.407 kW **…...…… (4.6)**

  Where Pin: power input to motor.

4.3.3 Filling motor protection circuit

- Overload

  OL = In = 1.2 A **……...…… (4.4)**

  Where In: nominal current.

- MCB (Miniature Circuit Breaker)

MCB = 1.25In = 1.5 A **…….…… (4.5)**

- Contactor

  Contactor = 1.1*Pin =0.407 Kw **…….…… (4.6)**

  Where Pin: power input to motor.

4.3.4 Tank mixer motor protection circuit

- Overload

  OL = In = 1.2A **……..…… (4.4)**

  Where In: nominal current.

- MCB (Miniature Circuit Breaker)

  MCB = 1.25In = 1.5A **…….…… (4.5)**

- Contactor

  Contactor = 1.1*Pin = 0.407 kW **…….…… (4.6)**

  Where Pin: power input to motor.

The following table shows the selected components ratings. (See table 4.6)

Table 4.6: Selected Protection Components Ratings

Name	Overload size	MCB size	Contactor size
Extruder Motor	6 A	6A	4KW – AC3
Mixing Motor	6 A	6A	4KW – AC3
Filling motor	6 A	6A	4KW – AC3
Tank mixer motor	6 A	6A	4KW – AC3

4.4 PLC Control Circuit

PLC Control Circuit, I/O Table and wiring diagram are attached in Appendix C.

4.5 Power Circuit

The power circuit is displayed on figure 4.1.

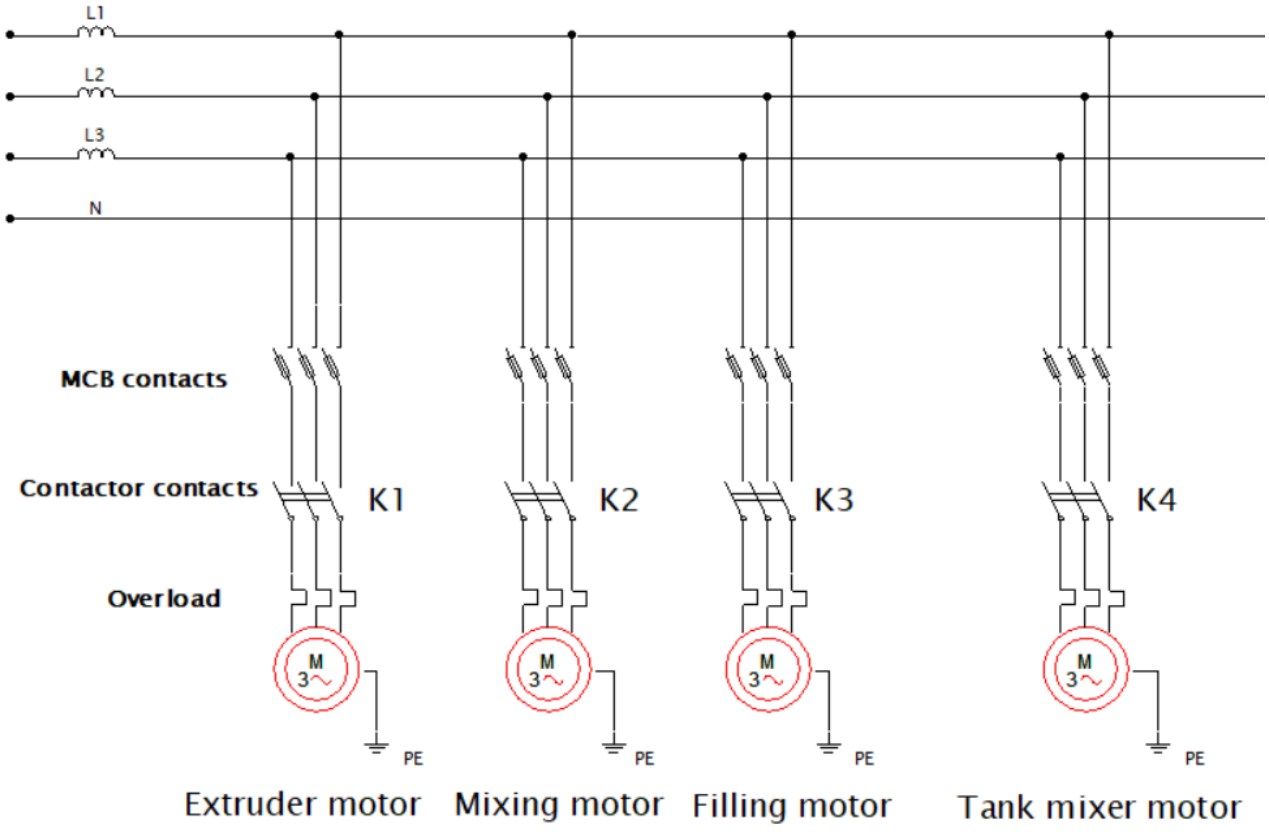


Figure 4.1: Power Circuit

4.6 Pneumatic circuit

The figure below shows the pneumatic power circuit.

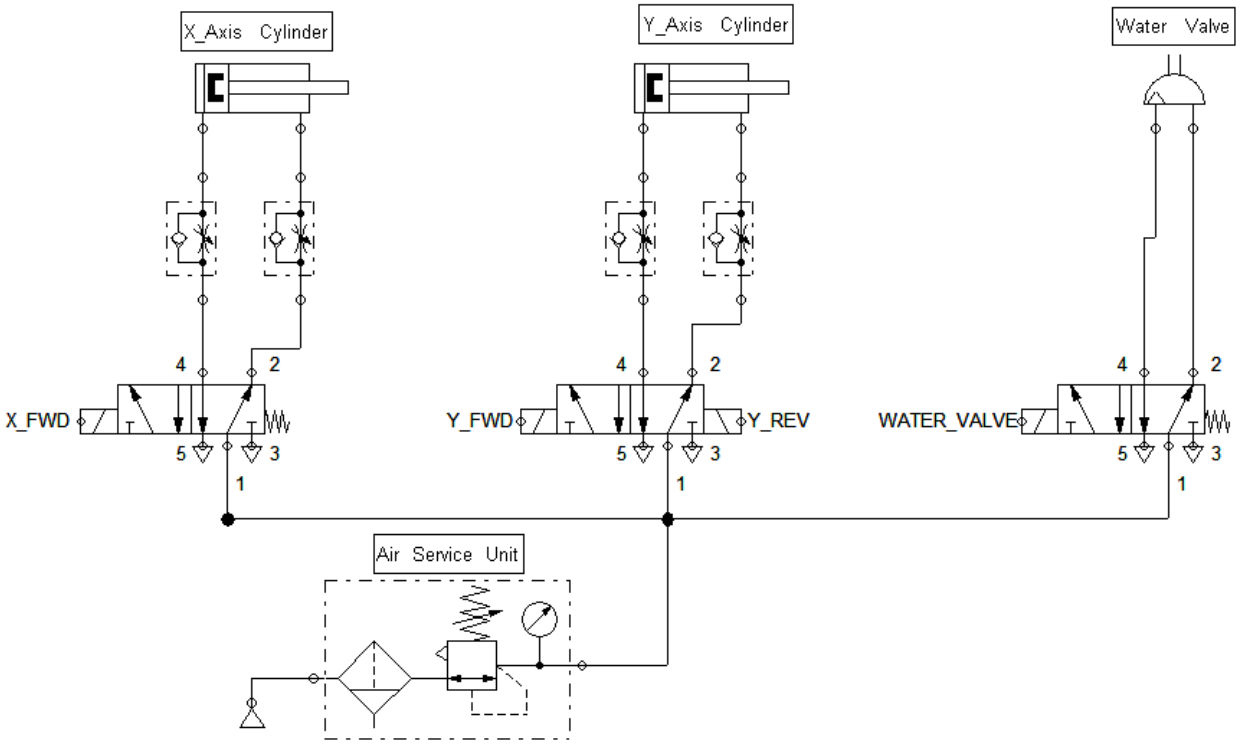


Figure 4.2: Pneumatic Circuit.

5

Chapter Five

Testing, Results and Recommendations

5.1 Introduction

This chapter provides experimental results and some recommendations for future work for this project. In this chapter we are listing some goals hope to be accomplished or to be considered for future project.

5.2 Machine Testing

In this part, several tests have been conducted in manual mode to verify the machine efficiency and to calibrate the Automatic PLC program.

- The first test aims to find the required time for filling the needed amount of gypsum in the mixer container.

Table 5.1: The Relation between gypsum feeding time and gypsum weight.

Reading No.	1	2	3	4	5
Time (sec.)	5	10	15	20	25
Weight (Kg)	1.01	2.03	3.03	4.01	5.02

According to the previous table we conclude that the feeding screw delivers approximately 0.2 Kg/sec., this value is added to PLC Automatic program so the user can specify the desired gypsum weight for the mixture.

- The second test tests the repeatability of the machine.

Table 5.2: Repeatability Test Measurements.

Reading No.	1	2	3	4	5
Time (sec.)	5	5	5	5	5
Weight (Kg)	1.01	1.02	1.00	1.02	1.00

- The Third test aims to find the required time for filling the needed amount of water in the mixer container.

Table 5.3: The Relation between Water feeding time and Water weight.

Reading No.	1	2	3	4	5
Time (sec.)	20	40	60	80	100
Weight (Kg)	1.25	2.51	3.76	4.02	5.25

According to the previous table we conclude that the feeding water valve delivers approximately 0.0625 Kg/sec., this value is added to PLC Automatic program so the user can specify the desired water ratio for the mixture.

- In the final test and after building the Automatic PLC program we run the machine for 5 operating cycles and the following points are the observed results.
    - The final mixture was homogenise, without air bubbles and within the user specified weight and water ratio.
    - During operation no material was lost.
    - Machine operation maintained a healthy working environment without any direct contact with gypsum dust.
    - The cycle time for the machine when the user selected 12 Kg of gypsum and 70% water ratio was 3.5 minutes.

5.3 Recommendations

This machine main purpose is to prepare a gypsum mixture for casting, in order to increase the machine readability in the factory we recommend the following.

- Design a machine extension stage to make the machine able to pour gypsum mixture directly into molds.
- Build a SCADA system to control and monitor the machine by a central computer.
- Add a temperature controller for the water tank to improve mixture chemical properties.
- Apply automatic feeding for raw materials in the main containers

Note: Final Machine Photos are presented in Appendix E.

5.4 Project Cost

The following table represent the final cost of the project.

Table 5.4: Cost Table

Item Name	No. of Items	Total Cost (NIS)
Selector Switch	**1**	**70**
Emergency Switch	**2**	**80**
Double Acting Cylinder	**2**	**800**
Pneumatic valve	**1**	**350**
Solenoid Valve	**3**	**200**
3 phase Induction Motor	**4**	**1200**
Gears	**2**	**400**
Contactor	**4**	**400**
MCB	**3**	**200**
Relay	**6**	**260**
PLC	**1**	**1400**
VFD	**1**	**650**
Magnetic Sensors	**4**	**150**
Rack	**1**	**250**
Overload	**3**	**300**
Overall Machine Body + Extruder and Mixer Lathing Cost	**1**	**6500**
Electric Panel	**1**	**500**
Wires	**-**	**300**
Power Supply	**1**	**150**
Total Cost		**14160 NIS**

References

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[9] 2013, م. الجيلاني, المرجع في التركيبات والتصميمات الكهربية, القاهره

Appendix A

“PLC Delta User Manual”

Appendix B

“HMI User Manual”

Appendix C

“Electrical Design”

Appendix D

“PLC Code”

Appendix E

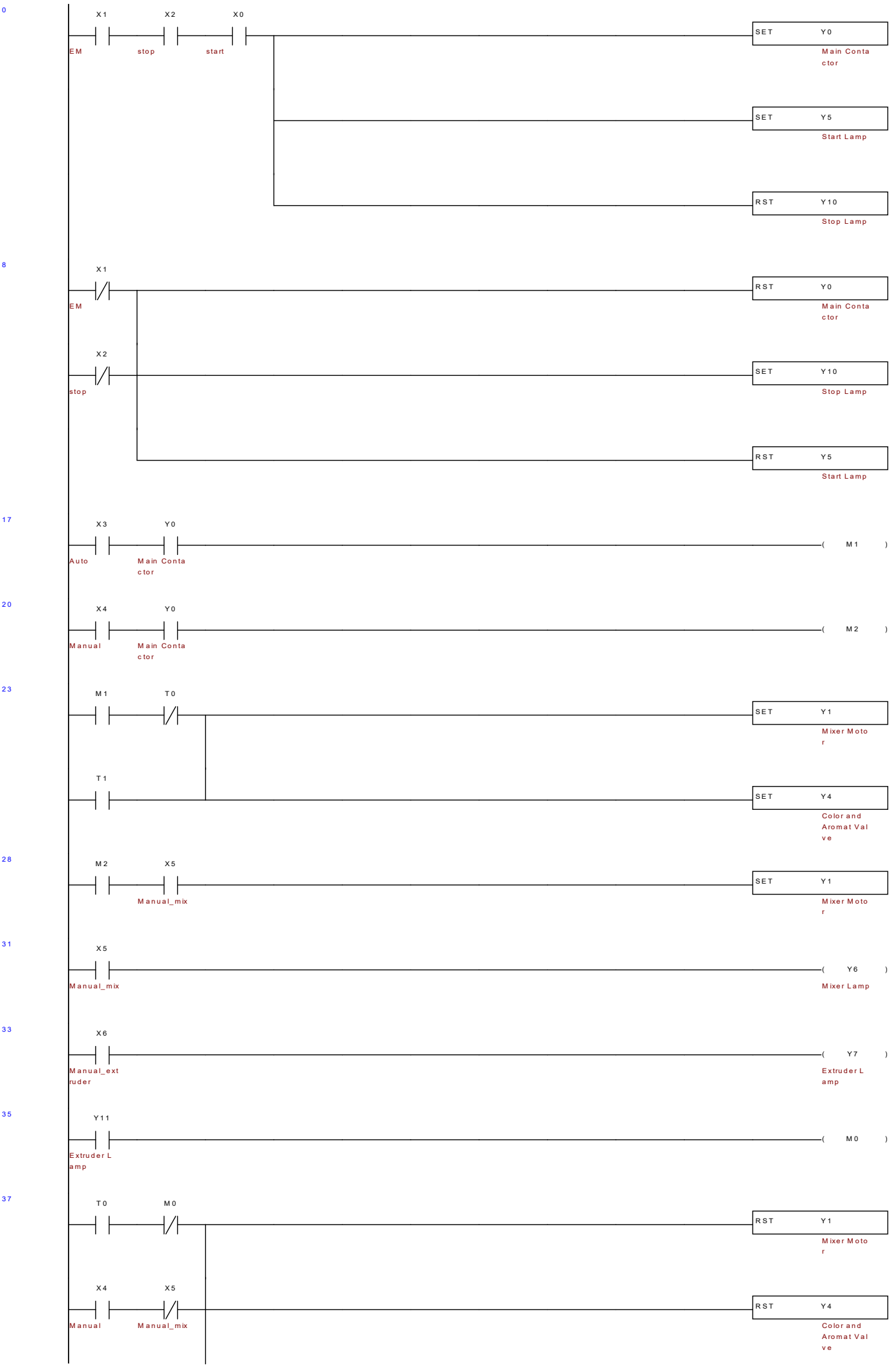
“Machine Photos”

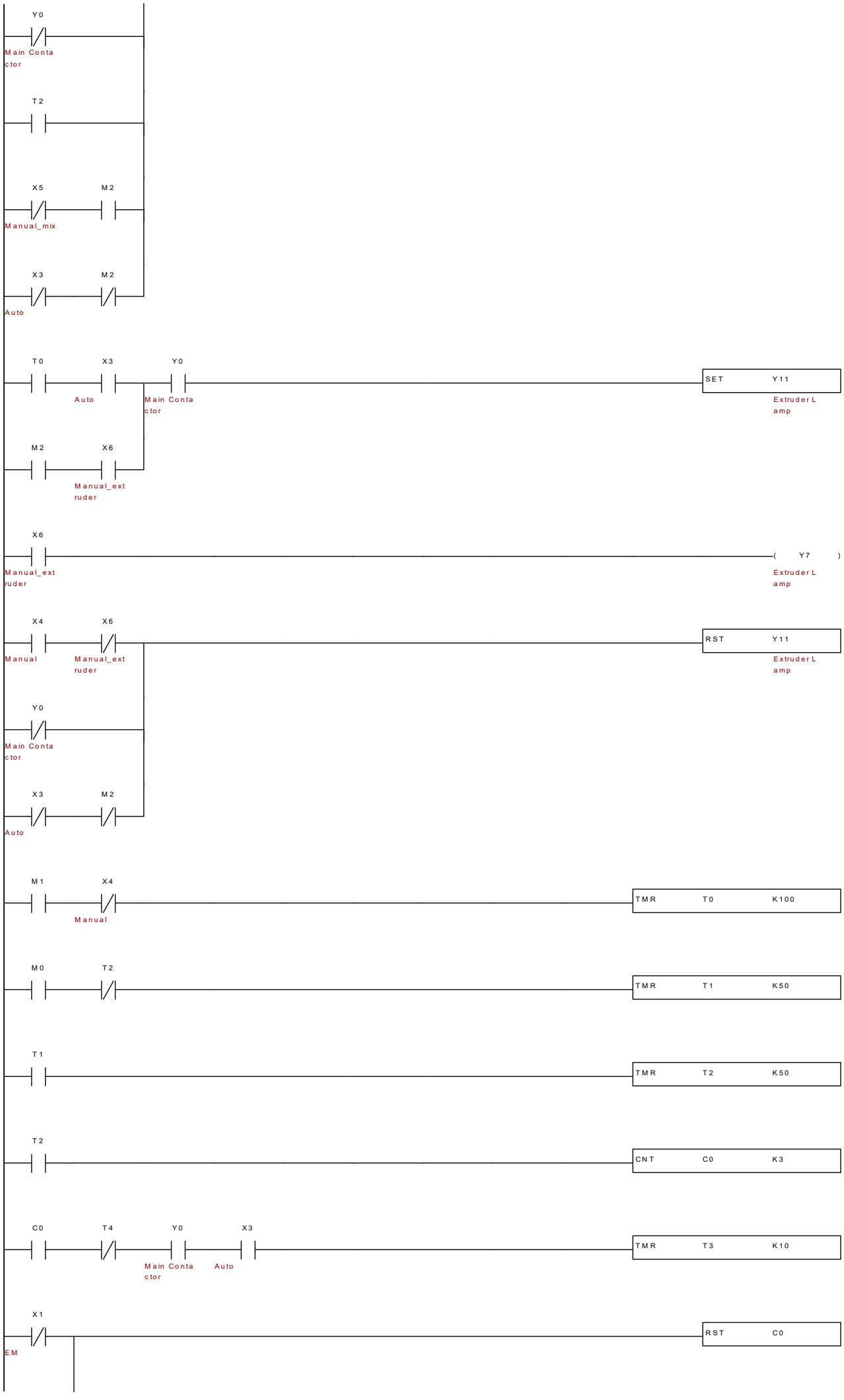
Program Title:

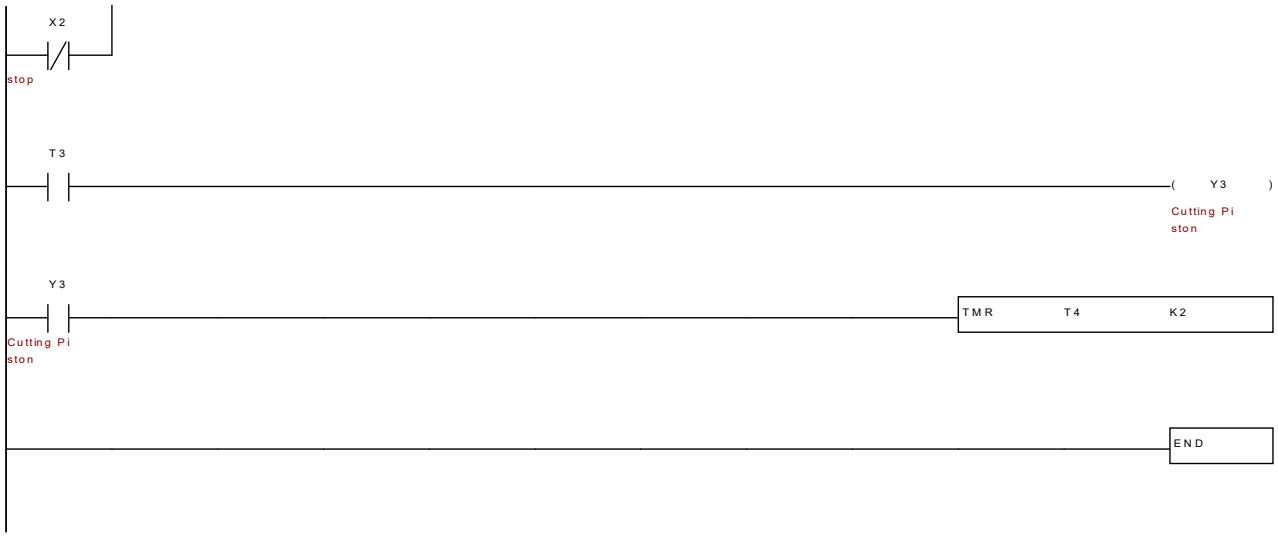
File Name:project final

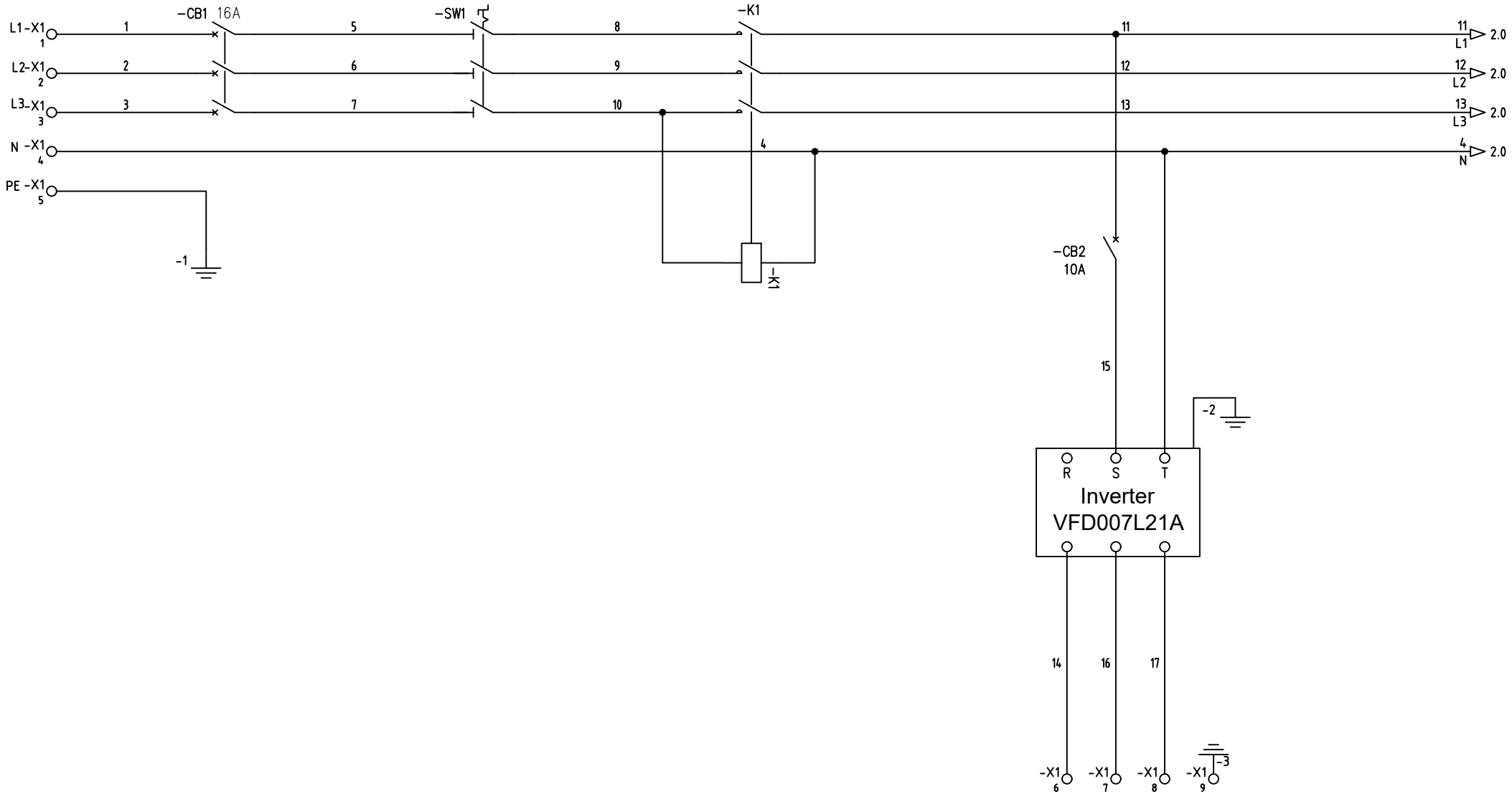
Company Name:

Designer:


0
X1
EM
X2
stop
X0
start
SET Y0
Main Contactor
SET Y5
Start Lamp
RST Y10
Stop Lamp
8
X1
EM
RST Y0
Main Contactor
X2
stop
SET Y10
Stop Lamp
RST Y5
Start Lamp
17
X3
Auto
Y0
Main Contactor
(M1)
20
X4
Manual
Y0
Main Contactor
(M2)
23
M1
T0
SET Y1
Mixer Motor
T1
SET Y4
Color and Aromat Valve
28
M2
Manual
X5
Manual_mix
SET Y1
Mixer Motor
31
X5
Manual_mix
(Y6)
Mixer Lamp
33
X6
Manual_extruder
(Y7)
Extruder Lamp
35
Y11
Extruder Lamp
(M0)
37
T0
M0
RST Y1
Mixer Motor
X4
Manual
X5
Manual_mix
RST Y4
Color and Aromat Valve


Y0
Main Contactor
T2
X5
M2
Manual_mix
X3
M2
Auto
56
T0
X3
Y0
Auto
Main Contactor
SET Y11
Extruder Lamp
M2
X6
Manual_extruder
63
X6
Manual_extruder
(Y7)
Extruder Lamp
65
X4
X6
Manual
Manual_extruder
RST Y11
Extruder Lamp
Y0
Main Contactor
X3
M2
Auto
74
M1
X4
Manual
TMR T0 K100
80
M0
T2
TMR T1 K50
86
T1
TMR T2 K50
91
T2
CNT C0 K3
96
C0
T4
Y0
X3
Main Contactor
Auto
TMR T3 K10
104
X1
EM
RST C0


X2
stop
109
T3
(Y3)
Cutting Pi
ston
111
Y3
Cutting Pi
ston
TMR T4 K2
116
END



Δ–Circuit 910rpm 3.66A
1Ph 230V 0.72KW
Main Motor

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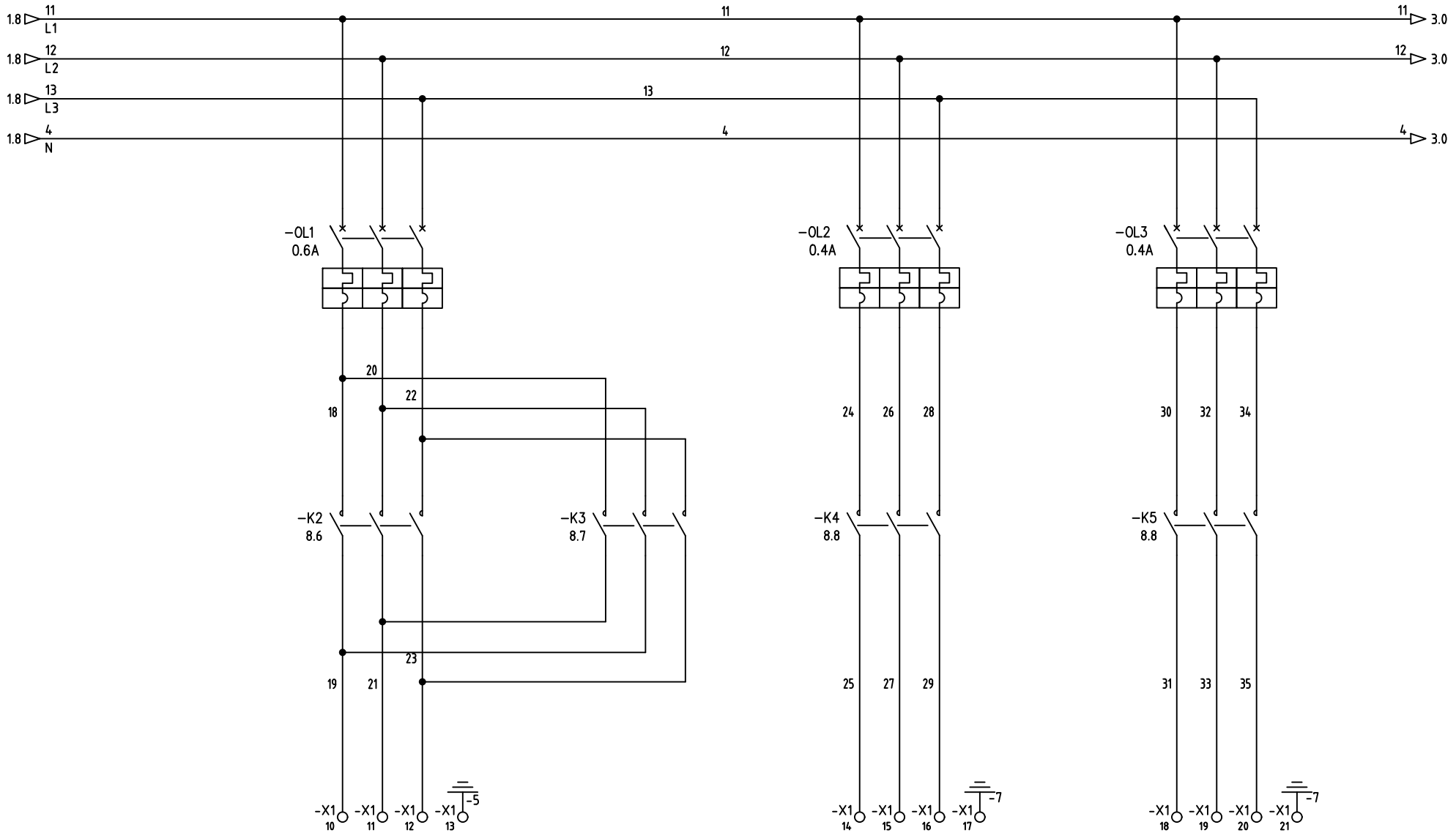

Y-Circuit 1310rpm 0.59A
3Ph 380V 0.18KW
Extruder Motor FWD/REV

Y-Circuit 1380rpm 0.4A
3Ph 380V 0.09KW
Mixer Motor 1

Y-Circuit 1380rpm 0.4A
3Ph 380V 0.09KW
Mixer Motor 2

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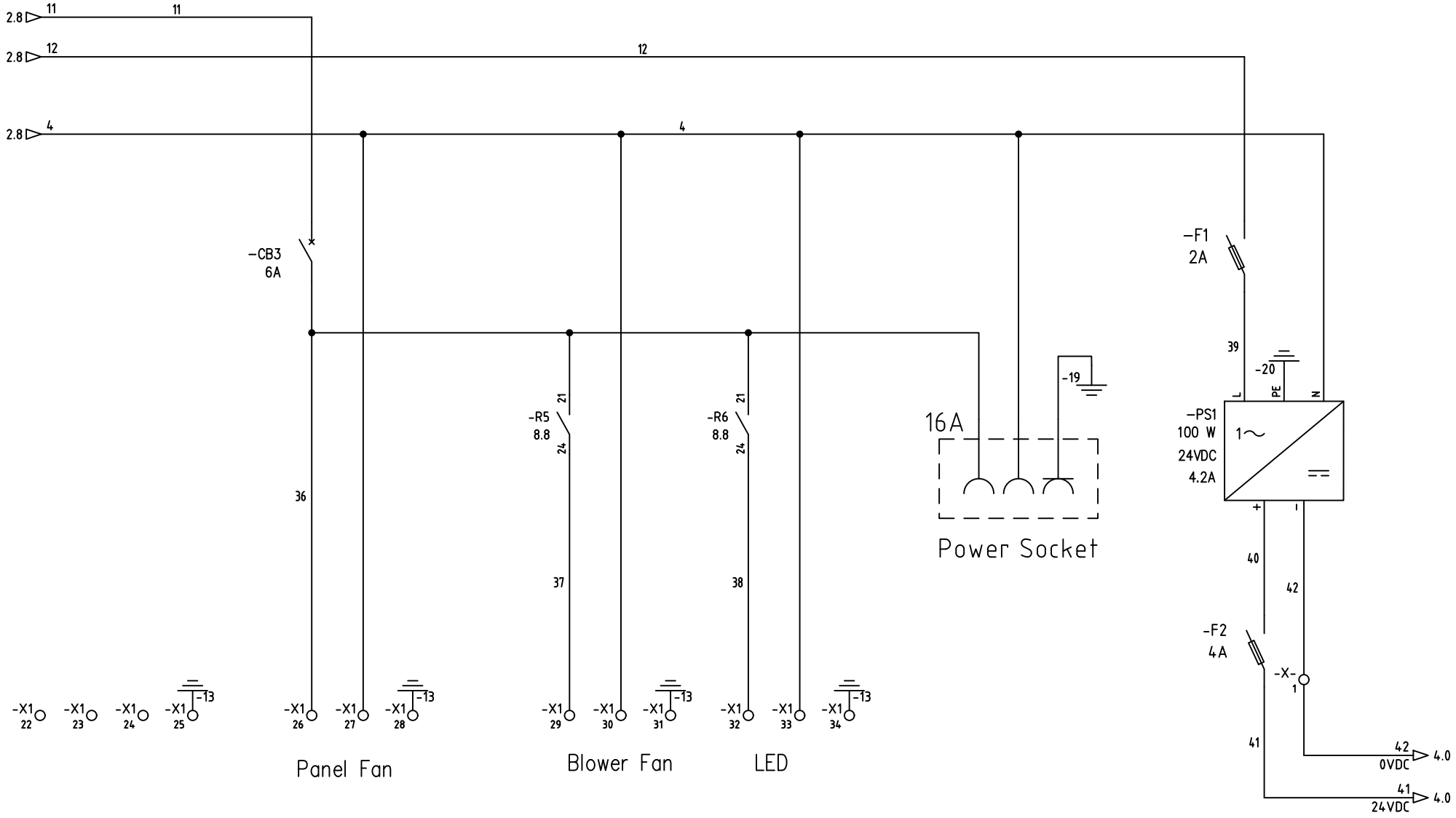

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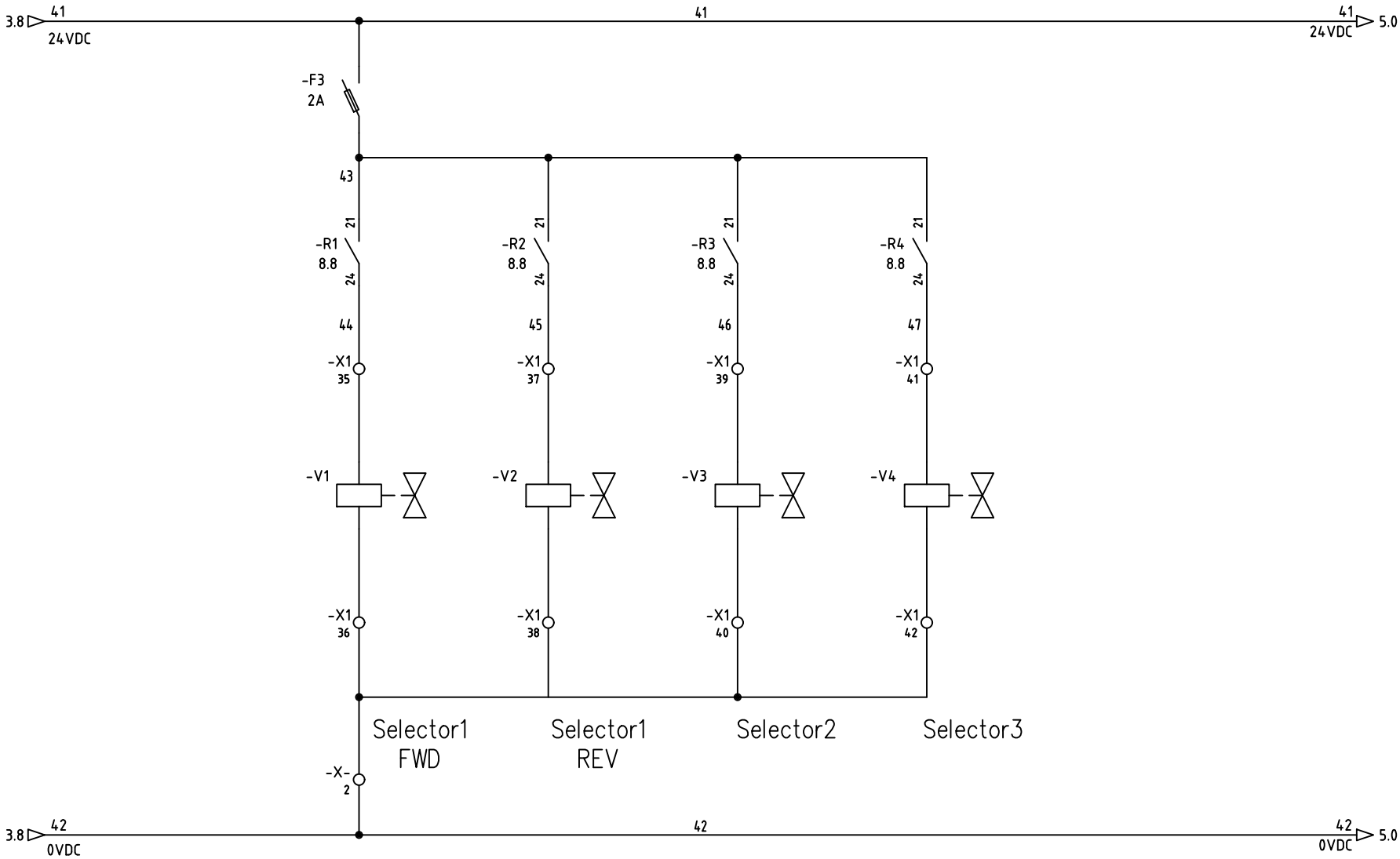

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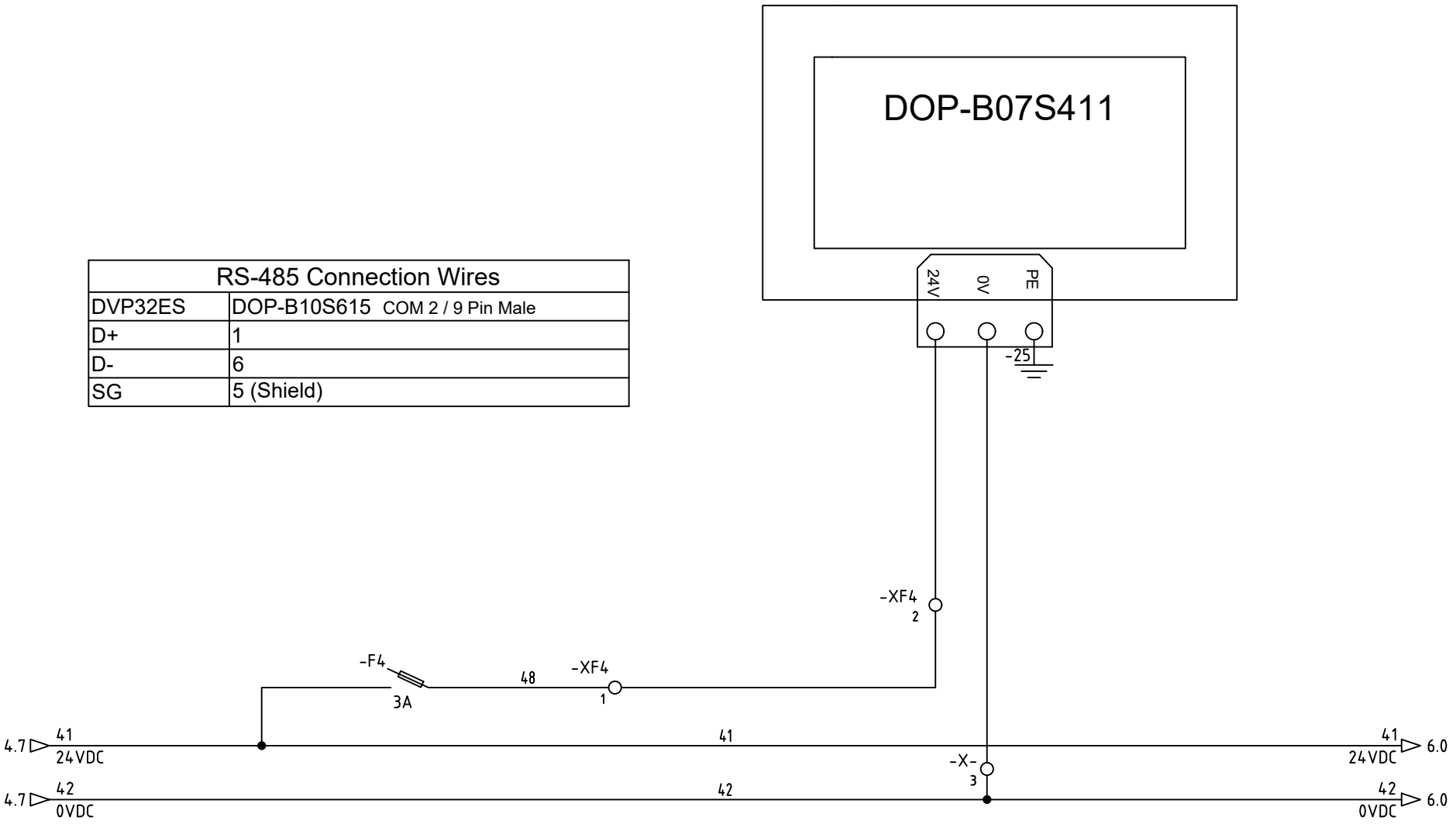
RS-485 Connection Wires	
DVP32ES	DOP-B10S615 COM 2 / 9 Pin Male
D+	1
D-	6
SG	5 (Shield)



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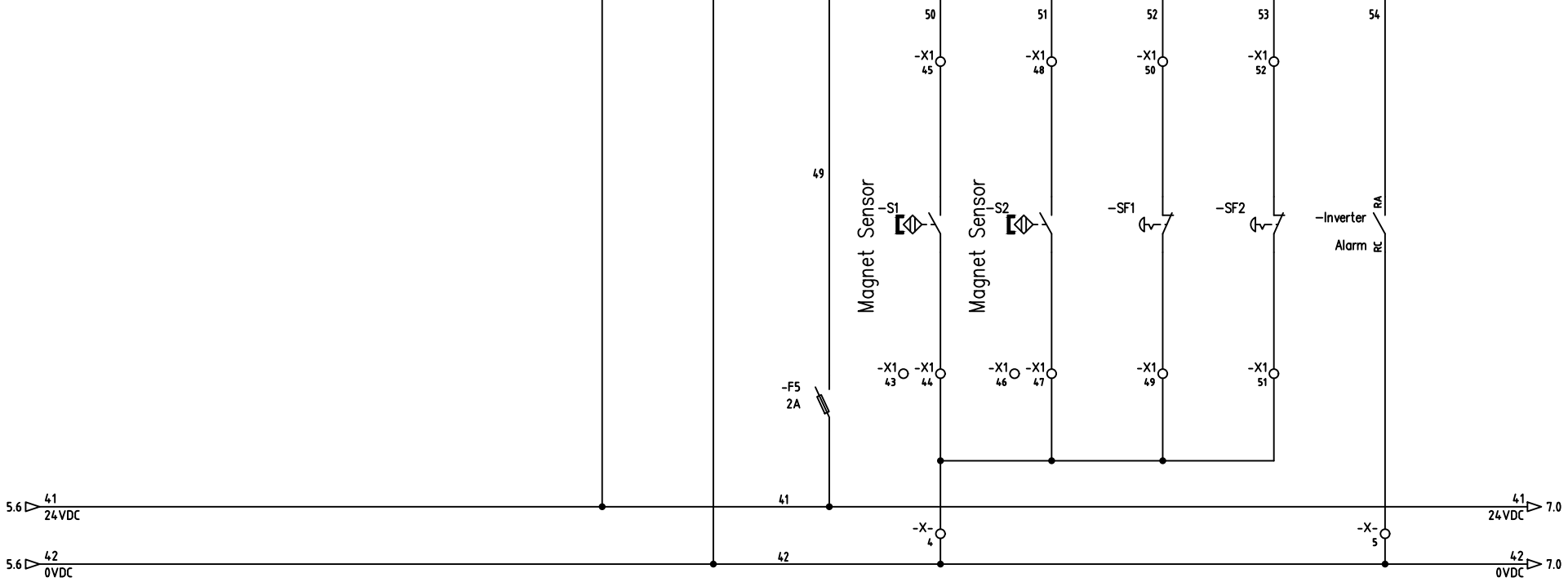
DVP32ES2
(16 DI)

L	N	PE	NC	+24V	24G	S/S	X0	X1	X2	X3	X4
1	2	3	4	5	6	7	8	9	10	11	12
○	○	○	○	○	○	○	○	○	○	○	○



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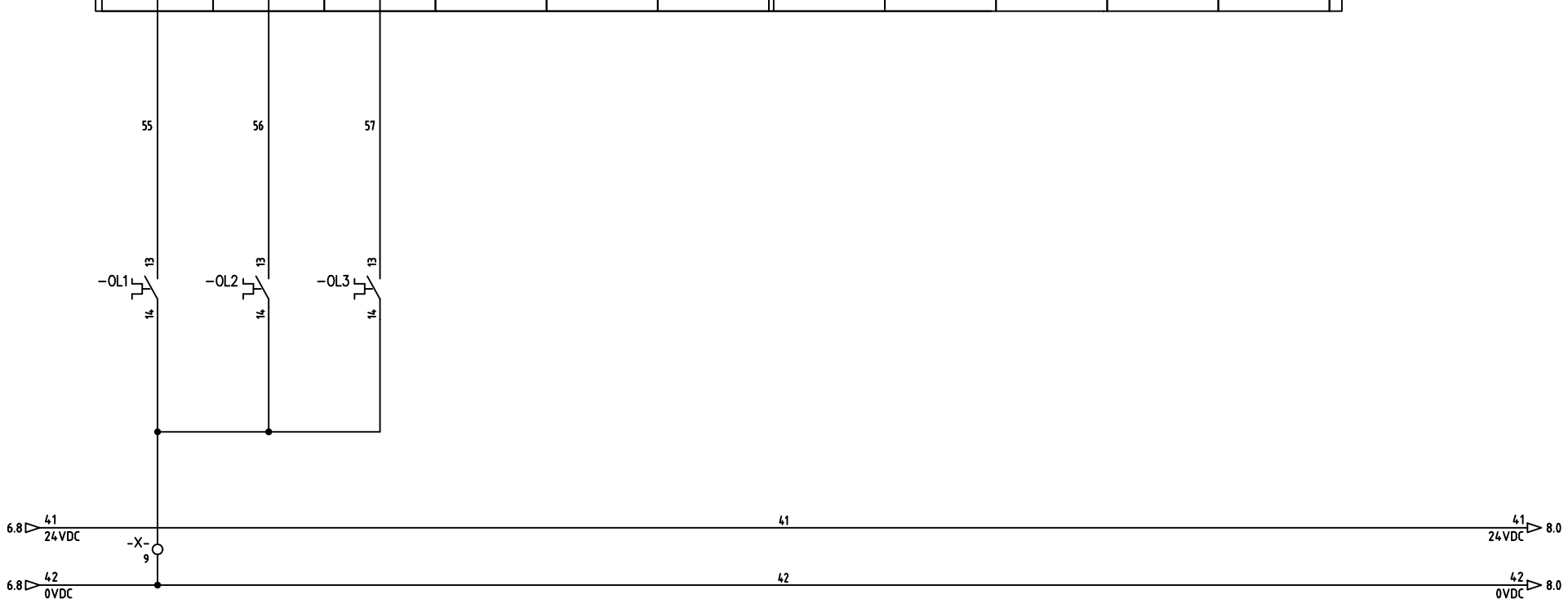
DVP32ES2
(16 DI)

X5	X6	X7	X10	X11	X12	X13	X14	X15	X16	X17
13	14	15	16	17	18	19	20	21	22	23



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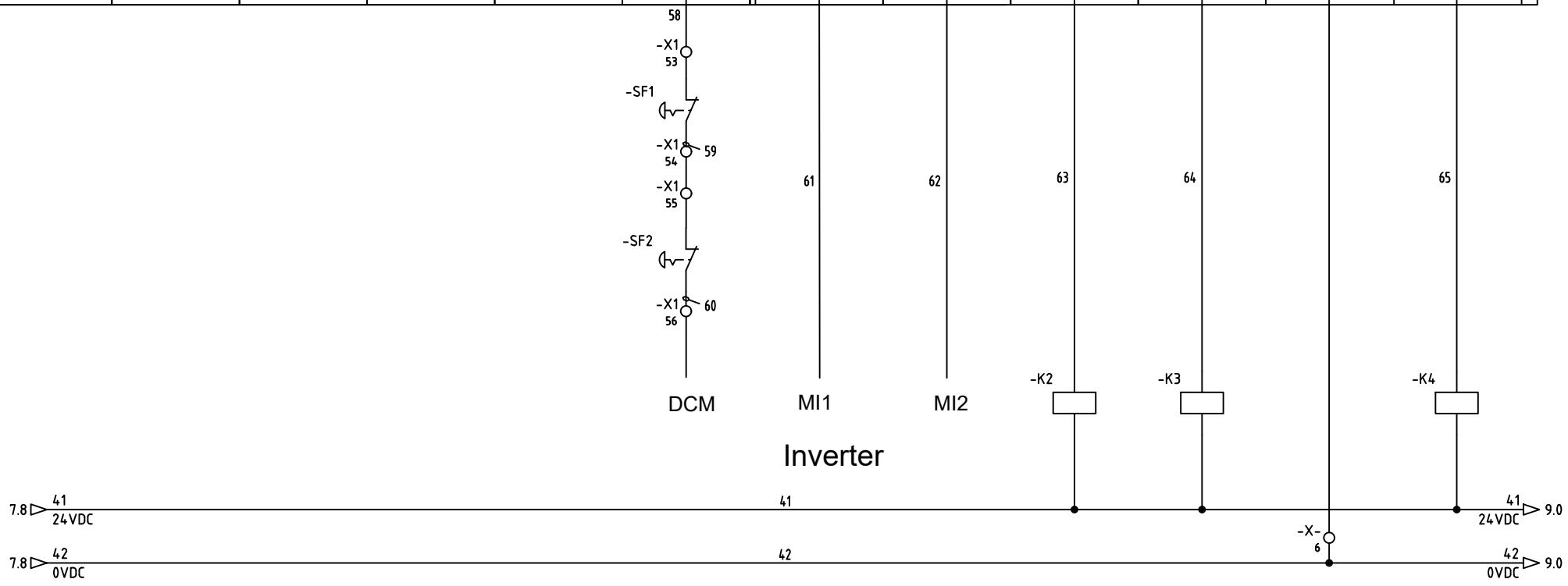
DVP32ES2
(16 DO)

CAN+	CAN-	SG	D+	D-	C0	Y0	Y1	Y2	Y3	C1	Y4
1	2	3	4	5	6	7	8	9	10	11	12
○	○	○	○	○	○	○	○	○	○	○	○



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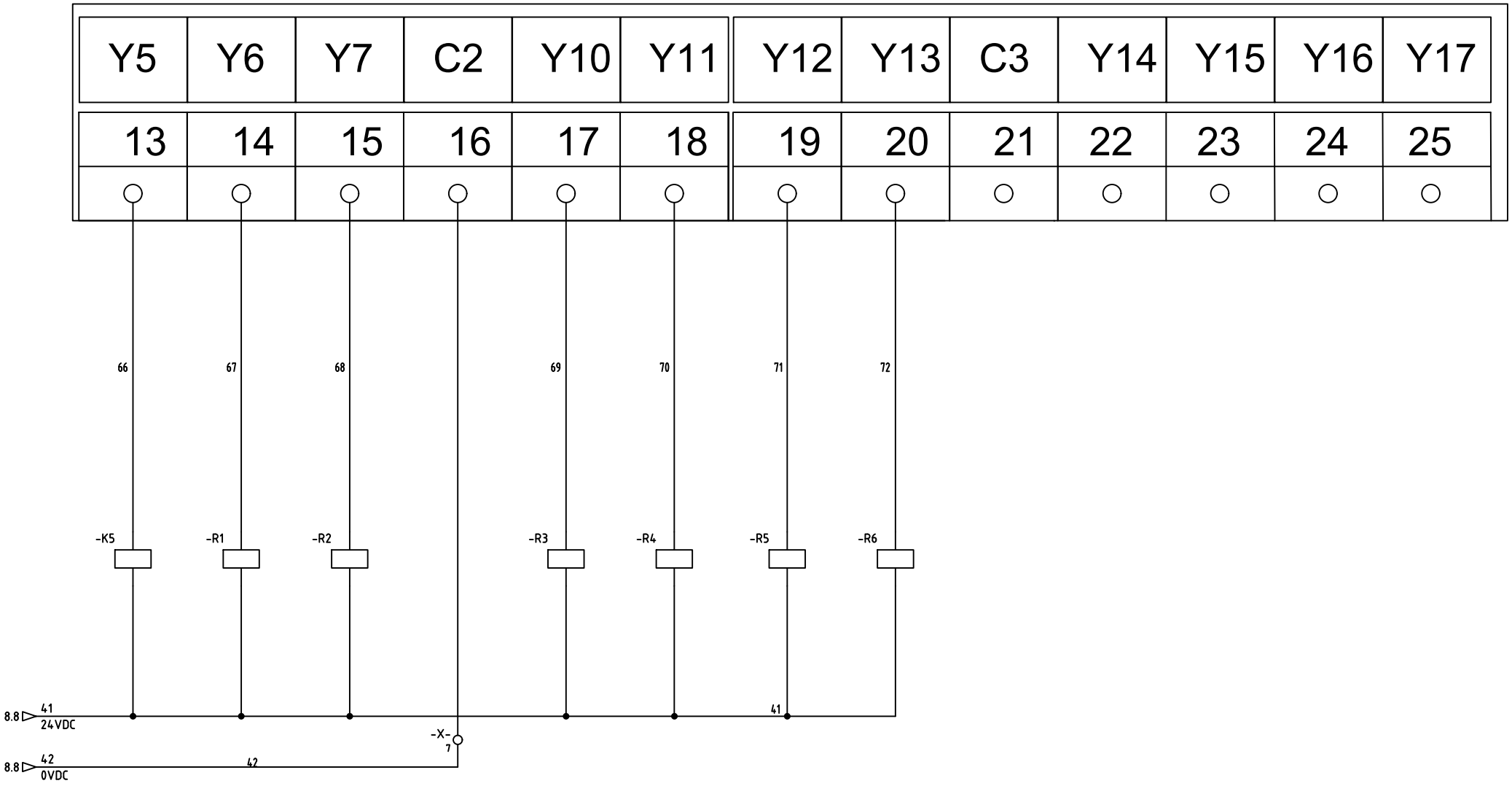
			DESC: Mixing Gypsum Machine	SHEET NO: 8 OF 11

DVP32ES2
(16 DO)

Y5	Y6	Y7	C2	Y10	Y11	Y12	Y13	C3	Y14	Y15	Y16	Y17
13	14	15	16	17	18	19	20	21	22	23	24	25



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			DESC: Mixing Gypsum Machine	SHEET NO: 9 OF 11

PLC Inputs Information

Input No.	Symbol	Description
X0	S1	Piston Magnet Sensor
X1	S2	Piston Magnet Sensor
X2	SF1	1st Emergency Stop
X3	SF2	2nd Emergency Stop
X4	Inverter Alarm	Main Motor Driver Alarm
X5	OL1	Extruder Motor Over Load
X6	OL2	Mixer Motor1 Over Load
X7	OL3	Mixer Motor2 Over Load
X10		Empty
X11		Empty
X12		Empty
X13		Empty
X14		Empty
X15		Empty
X16		Empty
X17		Empty

PLC Outputs Information

Output No.	**Symbol**	**Description**
Y0	MI1	Main Motor Driver FWD
Y1	MI2	Main Motor Driver REV
Y2	K2	Extruder Motor FWD Contactor
Y3	K3	Extruder Motor REV Contactor
Y4	K4	Mixer Motor1 Contactor
Y5	K5	Mixer Motor2 Contactor
Y6	R1	Selector1 FWD Relay
Y7	R2	Selector1 REV Relay
Y10	R3	Selector2 Relay
Y11	R4	Selector3 Relay
Y12	R5	Blower Fan Relay
Y13	R6	Led Relay
Y14		Empty
Y15		Empty
Y16		Empty
Y17		Empty

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Department Industrial Automation

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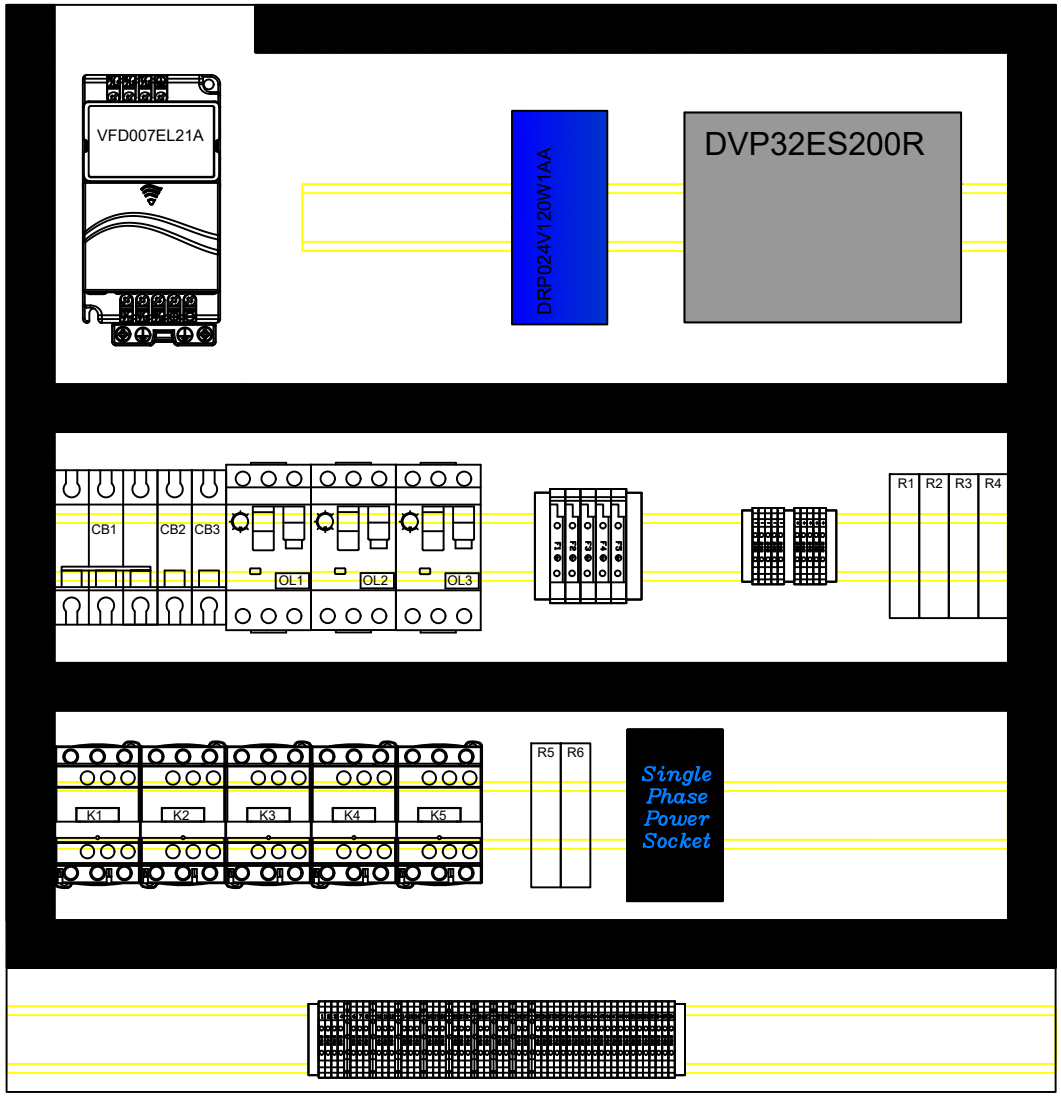
SHEET NO: 10 OF 11

550*570*200 mm



DRAWN BY: Ali & Raed		Palestine Polytechnic University College of Engineering Department Industrial Automation	DWG NO: Graduation Project DESC: Mixing Gypsum Machine	DATE: 05/04/2018 SHEET NO: 11 OF 11

Table of Contents

⚠ WARNING

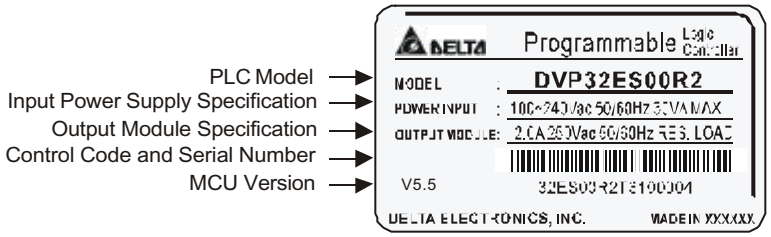
- Always read this manual thoroughly before using DVP PLC.
- AC input power must be disconnected before any maintenance.
- This is an OPEN-TYPE PLC. The PLC must be placed in an enclosure to meet the safety approval of IEC 61131-2 and UL 508.
- The PLC should be kept in an enclosure away from high temperatures, humidity, vibration, corrosive gas, liquid, airborne dust and metallic debrise.
- Do not connect the AC main circuit power supply to any of the input/output terminals, as it will damage the PLC. Ensure all the wiring prior to power up.
- Disconnect all power. Wait one minute for capacitors to discharge before touching internal circuit.
- Some models are equipped with DC power supply output, do not exceed its rated output power.
- Make sure the PLC is properly grounded ⏚, to avoid any electromagnetic noise.

1.1. Model Explanation and Peripherals

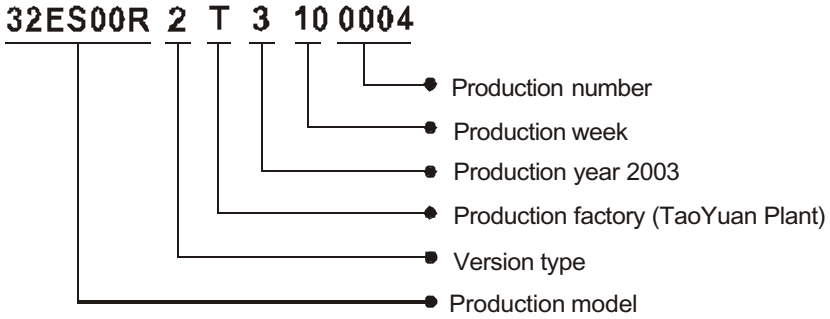
Thank you for choosing DELTA' s PLC DVP Series. The DVP Series has main processing units and extension units. The main processing units offer 14-60 points and the extension units offer 8-32 points. The maximum input/output can be extended up to 128 points. It also can be used on applications according to INPUT/OUTPUT points, power sources, output modules, digital/analog exchanges (A/D & D/A converter). In addition, DVP SS Series has the special modules (AD/DA/PT/TC/XA) used for extending its functions and the maximum special modules can be extended up to 8 units. For more information on the DVP SS Series, refer to the DVP SS Series user manual.

DVP ES/EX/SS MPU is made from improving the functions and specifications of R/T model structure. The additional R2/T2 model has wide improvement in commands type and execution speed. Please refer to the detail information about usable application commands and devices in this manual when using R2/T2 model. The specification in this manual is major for R2/T2 model so that there are some new commands and functions won' t be provided for R/T model.

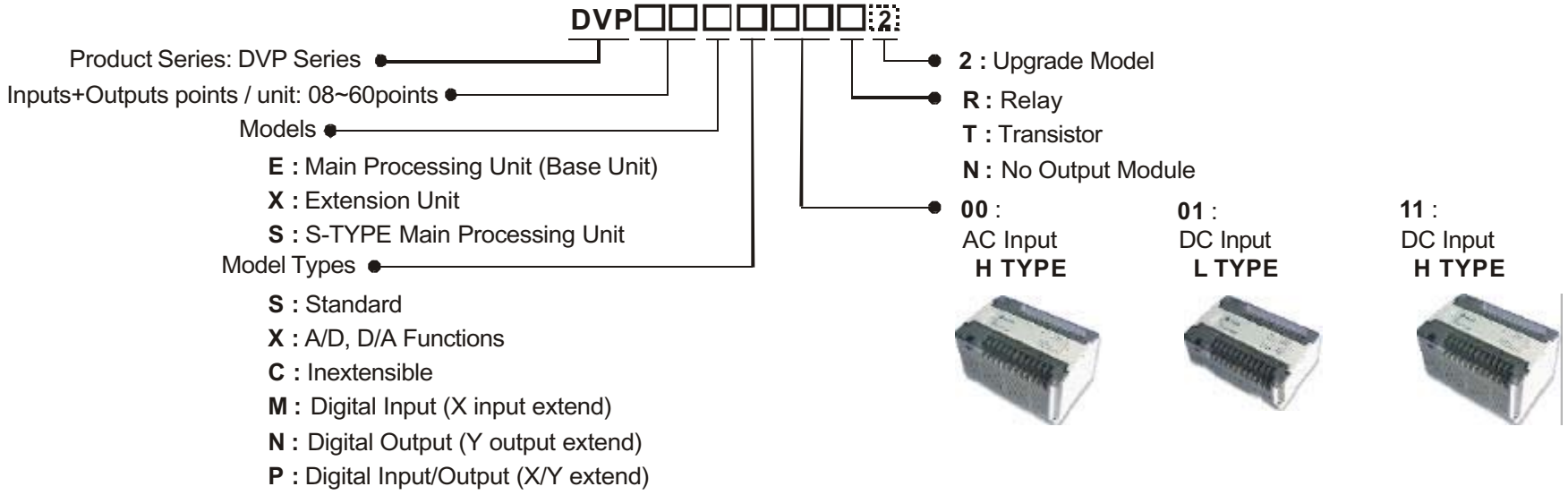
■ Nameplate Explanation



■ Serial Number Explanation



■ Model Explanation



■ Peripheral Equipment

◎ DVPHPP: Handheld Programming Panel
◎ WPLSoft: Windows Ladder Logic Programming Software
◎ DPLSoft: DOS Ladder Logic Programming Software
◎ DVPACAB115: 1.5M Cable (HPP ⇔ PLC, DVPHPP has this cable attached)
◎ DVPACAB215: 1.5M Cable (PC (9 PIN & 25 PIN D-SUB) ⇔ PLC)
◎ DVPACAB230: 3M Cable (PC (9 PIN & 25 PIN D-SUB) ⇔ PLC)
◎ DVPACAB2A30: 3M Cable (PC (9 PIN D-SUB) ⇔ PLC)
◎ DVPACAB230: 3M Cable (PC ⇔ PLC)
◎ DVPACAB315: 1.5M Cable (HPP ⇔ PC)
◎ DVPACAB403: 30cm Cable (MPU-main processing unit⇔Extension Unit or Extension Unit⇔Extension Unit I/O signal extension cable)
◎ DVPAADP01: HPP Power Supply (DVPACAB315 is attached)

1.2. Product Profile and Outline

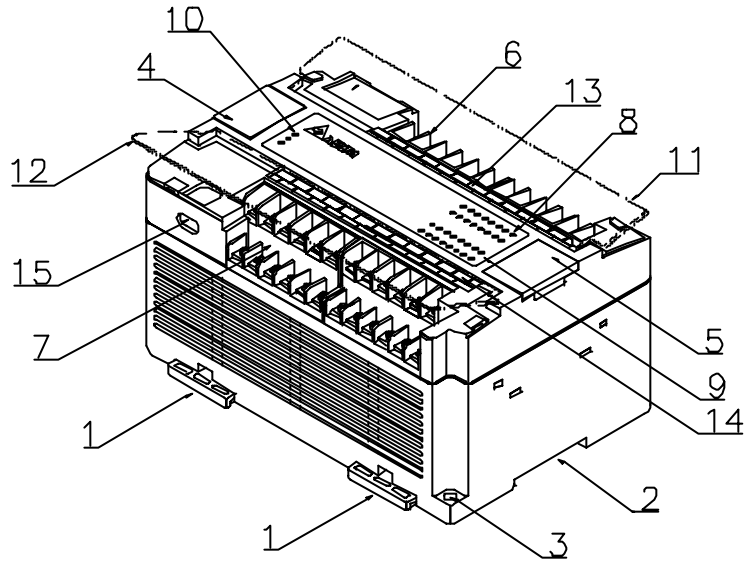


Fig. 1-1: Features of the DVP PLC

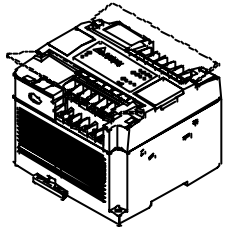
1	DIN rail clip	9	Output indicators
2	DIN rail (35mm)	10	Status indicators, POWER, RUN ERROR
3	Direct mounting holes	11	I/O terminal cover
4	Programming port cover (RS-232)	12	I/O terminal cover
5	Extension port	13	I/O terminal nameplate panel
6	I/O terminals	14	I/O terminal nameplate panel
7	I/O terminals	15	RS-485 Communication port
8	Input indicators		

1.3. Model Numbers

◎ Standard MPU-00

Model	Input / Output					Profile
	Power	Input Unit		Output Unit		
		Point	Type	Point	Type	
DVP14ES00R2	100~240VAC	8	DC Sink or Source	6	Relay	❶
DVP24ES00R2		16		8		❷
DVP32ES00R2		16		16		
DVP60ES00R2		36		24		❺
DVP14ES00T2		8		6	Transistor	❶
DVP24ES00T2		16		8		❷
DVP32ES00T2		16		16		
DVP60ES00T2		36		24		❺

Profile reference



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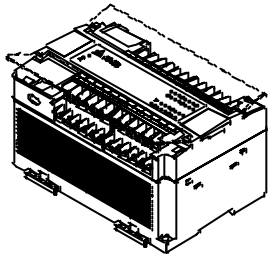
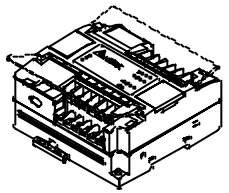


❷

◎ Standard MPU-01

Model	Input / Output					Profile
	Power	Input Unit		Output Unit		
		Point	Type	Point	Type	
DVP14ES01R2	24VDC	8	DC Sink or Source	6	Relay	❸
DVP24ES01R2		16		8		❹
DVP32ES01R2		16		16		
DVP14ES01T2		8		6	Transistor	❸
DVP24ES01T2		16		8		❹
DVP32ES01T2		16		16		



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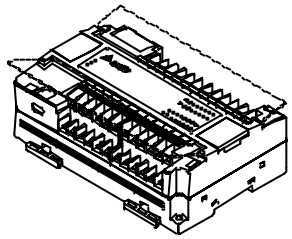

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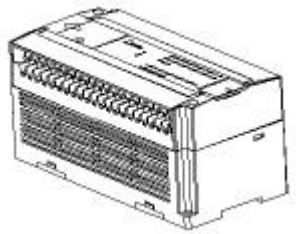
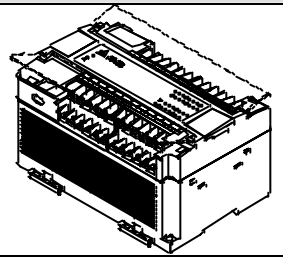


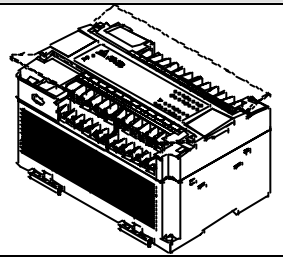
❺

1. Sink or Source connections. Please refer to Chapter 4 Installation and Wiring.
2. Please refer to Chapter 2 Standard Specifications for detailed electrical specifications.

◎ Special Function MPU–00

Model	Input / Output									Profile reference
	Power	Input Unit				Output Unit				
		Point		Type		Point		Type		
		DI	AI	DI	AI	DO	AO	DO	AO	
DVP20EX00R2	100~240VAC	8	4	DC Sink or Source	-20mA~20mA -10V ~ +10 V	6	2	Relay	0~20mA or -10V ~ +10 V (for R/T model) 0V ~ +10 V (for R2/T2 model)	
DVP20EX00T2		8	4			6	2	Transistor		

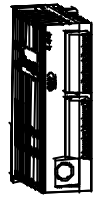
◎ Analog/Digital MPU–11

Model	Input / Output									Profile reference
	Power	Input Unit				Output Unit				
		Point		Type		Point		Type		
		DI	AI	DI	AI	DO	AO	DO	AO	
DVP20EX11R2	24VDC	8	4	DC Sink or Source	-20mA~20mA -10V ~ +10 V	6	2	Relay	0~20mA 0V ~ +10 V	
DVP20EX11T2		8	4			6	2	Transistor		

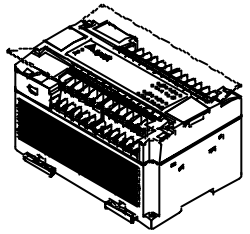
DI（Digital Input） DO（Digital Output）

AI（Analog Input） AO（Analog Output）

◎ Module Standard MPU–11

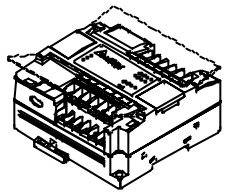
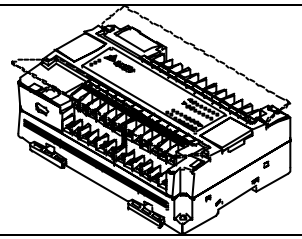
Model	Input / Output					Profile reference
	Power	Input Unit		Output Unit		
		Point	Type	Point	Type	
DVP14SS11R2	100~240VAC	8	DC Sink or Source	6	Relay Transistor	
DVP14SS11T2		8		6		

◎ Digital I/O Extension Unit-00

Model	Input / Output					Profile reference
	Power	Input Unit		Output Unit		
		Point	Type	Point	Type	
DVP24XN00R	100~240VAC	0	DC Sink or Source	24	Relay	
DVP24XP00R		16		8		
DVP32XP00R		16		16		
DVP24XP00T		16		8	Transistor	
DVP24XN00T		0		24		
DVP32XP00T		16		16		

1. Sink or Source connections. Please refer to Chapter 4 Installation and Wiring.
2. Please refer to Chapter 2 Standard Specifications for detailed electrical specifications.

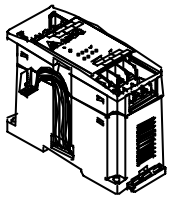
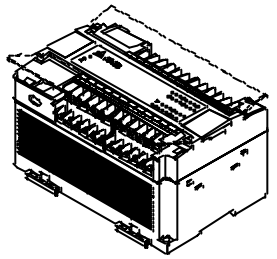
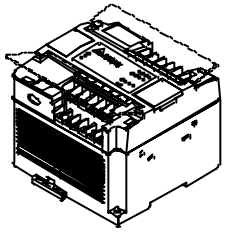
◎ Digital I/O Extension–01 (L-Type)

Model	Power	Input Unit		Output Unit		Profile reference	
		Point	Type	Point	Type		
DVP16XM01N	24VDC	16	DC Sink or Source	0	None	❶	 ❶
DVP16XN01R		0		16	Relay	❷	
DVP24XN01R		0		24			
DVP24XP01R		16		8			
DVP32XP01R		16		16			
DVP16XN01T		0		16	Transistor		 ❷
DVP24XN01T		0		24			
DVP24XP01T		16		8			
DVP32XP01T		16		16			

1. Sink or Source connections. Please refer to Chapter 4 Installation and Wiring.

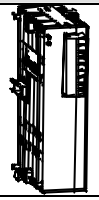
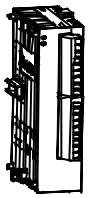
2. Please refer to Chapter 2 Standard Specifications for detailed electrical specifications.

◎ Digital I/O Extension–11 (H-Type)

Model	Power	Input Unit		Output Unit		Profile reference		
		Point	Type	Point	Type			
DVP08XM11N	24VDC	8	DC Sink or Source	0	None	❶	 ❶	 ❸
DVP16XM11N		16		0		❷		
DVP08XN11R		0		8	Relay	❶		
DVP16XN11R		0		16		❸		
DVP24XN11R		0		24				
DVP08XP11R		4		4		❶		
DVP24XP11R		16		8		❸		
DVP32XP11R		16		16				
DVP08XN11T		0		8	Transistor	❶	 ❷	
DVP16XN11T		0		16		❸		
DVP24XN11T		0		24				
DVP08XP11T		4		4		❶		
DVP24XP11T		16		8		❸		
DVP32XP11T		16		16				

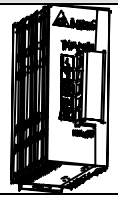
1. Sink or Source connections. Refer to Chapter 4 Installation and Wiring for more information.
2. Refer to Chapter 2 Standard Specifications for detailed electrical specifications.
3. When connects to DVP08XP11R/T, recommend to place at the end of extension units. Refer to Chapter 8 EX MPU and I/O Extension Units for more information.

◎ Digital I/O Extension Units

Model	Power	Input Unit		Output Unit		Profile reference
		Point	Type	Point	Type	
DVP08SM11N	24VDC	8	DC Sink or Source	0	None	
DVP08SN11R		0		8	Relay	
DVP08SN11T		0		8	Transistor	
DVP08SP11R		4		4	Relay	
DVP16SP11R		8		8		
DVP08SP11T		4		4	Transistor	
DVP16SP11T		8		8		

◎ Please refer to each user manual of extension model for the detail of SS special extension module.

◎ Power Output Module

Model	Input Power	Output Power	Profile reference
DVPPS01	100~240VAC （50/60Hz）	Output Voltage: 24VDC Max. Output Current: 1A	

■ General Specifications

Items		Specifications	Remarks
Control Method		Stored program, cyclic scan system	
I/O Processing Method		Batch I/O (refresh)	Direct I/O instruction available
Execution Speed		Basic commands (several μs)	Application commands (10~hundreds μs)
Program Language		Ladder Logic, Instruction, SFC	Including the Step commands
Program Capacity		3792 STEPS	Built-in EEPROM
Instructions		32 Basic sequential commands (Including STL / RET)	97 Application commands (145 including the 32-bit commands)
Auxiliary Relays	General	512+232 Points	M000~M511+ M768~M999
	Latched	256 Points	M512~M767
	Special	280 Points	M1000~M1279
Step Relays (Latched)	Initial Step Point	10 Points	S0~S9
	General Step Point	118 Points	S10~S127
Timers	Digital	64 Points	T0~T63 (100ms time base)
		63 Points	T64~T126 (10ms time base, when M1028 is ON)
		1 Points	T127 (1ms time base)
Counters	General	112 Points	C0~C111 (16-bit counters)
	Latched	16 Points	C112~C127 (16-bit counters)
	High-speed	13 Points 1-Phase 5KHz, 2-Phase 5KHz	C235~C254 (all latched type, 32-bit counters)
Data registers	General	408 Points	D0 ~ D407
	Latched	192 Points	D408~D599
	Special	312 Points	D1000~D1311
Digital/Analog	A→ D	4 Analog Input Channels	10-bit resolution (EX MPU only)
	D→ A	2 Analog Output Channels	8-bit resolution (EX MPU only)
High Speed Pulse Output		2 point (Y0, Y1), pulse output frequency: 10Hz to 10KHz	
Pointers/Interrupt	P / I	P : 64 Points / I : 4 Points	P0~P63 / I001, I101, I201, I301
Index Register	E / F	2 Points	E (=D1028), F (=D1029)
Constants	Decimal K	16-bit: -32768~+32767	32-bit: -2147483648~+2147483647
	Hexadecimal H	16-bit: 0000~FFFF	32-bit: 00000000~FFFFFFFF
Serial Communication		RS-232, RS-485 (2 Ports)	
Protection Features		Password, Execution Time, Illegitimate Command or Operand	
Monitor / Debug		Execution time, Device setting	

■ Electric Specifications 1

Item \ Model	DVP-14ES00□	DVP-24ES00□	DVP-32ES00□	DVP-60ES00□	DVP-20EX00□	DVP-14ES01□	DVP-24ES01□	DVP-32ES01□	DVP-20EX11□
Power Supply Voltage / Fuse	100~240VAC (-15%~10%), 50/60Hz ± 5% / 2 A / 250VAC					24VDC (-15%~10%) / 2 A / 250VAC			
Input Power Operating Characteristics	95-100VAC is needed to start the PLC. If the voltage drops to 70VAC or less, the PLC will stop.					A minimum of 18VDC is needed to start the PLC. If the voltage drops below 17.5VDC, the PLC will stop.			
Maximum Power Loss Time	10ms or less					5ms or less			
Power Consumption	20 VA	25VA	30VA	35VA	30 VA	5.5 W	6.5 W	8 W	10 W
DC24V Supply Current	400mA	400mA	400mA	200mA	400mA	—	—	—	—
Power Protection	DC24V output short circuit					DC24V input polarity			
Withstand Voltage	1500VAC(Primary-secondary), 1500VAC(Primary-PE), 500VAC(Secondary-PE)								
Insulation Resistance	>5 MΩ at 500VDC (Between all inputs/outputs and earth)								
Noise Immunity	ESD: 8KV Air Discharge EFT: Power Line: 2KV, Digital I/O: 1KV, Analog & Communication I/O: 250V Damped-Oscillatory Wave: Power Line: 1KV, Digital I/O: 1KV RS: 26MHz~1GHz, 10V/m								
Grounding	The diameter of grounding wire cannot be smaller than the wire diameter of terminals L and N (All DVP units should be grounded directly to the ground pole).								
Environment	Operation: 0℃~55℃ (Temperature), 50~95% (Humidity); Storage: -25℃~70℃ (Temperature), 5~95% (Humidity) Pollution degree 2								
Vibration /Shock Immunity	Standard: IEC1131-2, IEC68-2-6 (Test Fc) / IEC 1131-2 & IEC68-2-27 (Test Ea)								
Weight (g)	400	552	580	750	536	260	414	430	386

Input Point Electric Specification		
Input Point Type	Digit I/O	Analog I/O (EX)
Input Point Spec.	DC (Sink or Source) 24VDC 5mA	Input Voltage: -10V~+10V (Input Resistance: 40KΩ) Input Current: -20mA~+20mA(Input Resistance: 250Ω)
Active Level (Analog Input Resolution)	OFF→ON Above 10VDC ON→OFF Below 9VDC	Input Voltage Resolution: 10bit Input Current Resolution: 10bit
Reaction Time	About 10ms (Adjust D1020 and D1021 can be 0~15ms)	5ms (Adjusting D1118 can change reaction time)

Output Point Electric Specification			
Output Point Type	Relay-R	Transistor-T	Analog I/O (EX)
Current Spec.	2A/1 point (5A/COM)	0.3A/1point (1.2A/COM)	0~20mA
Voltage Spec.	Below 250VAC, 30VDC	30VDC	0V~+10V
Maximum Load	100 VA (Inductive) 120 W (Resistive)	9W	0.2W
Reaction Time	About 10ms	OFF→ON 20 μs ON→OFF 30 μs	10ms
Resolution	—	—	8 bit

■ Electric Specifications 2

Item \ Model	DVPPS01	DVP14SS11R2/T2	DVP08SM11N	DVP08SN11R/T	DVP08SP11R/T	DVP-16SP11R/T
Power Supply Voltage / Fuse	100~240VAC (50/60Hz)	24VDC (-15%~10%) (has power protect with opposite pole DC input)				
Input Power Operating Characteristics	5ms or less					
Maximum Power Loss Time	--	2A/ 250VAC				
Power Consumption	--	5 W			8 W	
Insulation Resistance	--	>5 MΩ at 500VDC (Between all inputs/outputs and earth)				
Noise Immunity	ESD: 8KV Air Discharge EFT: Power Line: 2KV, Digital I/O: 1KV, Analog & Communication I/O: 250V Damped-Oscillatory Wave: Power Line: 1KV, Digital I/O: 1KV RS: 26MHz~1GHz, 10V/m					
Grounding	The diameter of grounding wire cannot be smaller than the wire diameter of terminals L and N (All DVP units should be grounded directly to the ground pole).					
Environment	Operation: 0℃~55℃ (Temperature), 50~95% (Humidity); Storage: -25℃~70℃ (Temperature), 5~95% (Humidity) Pollution degree 2					
Vibration /Shock Immunity	Standard: IEC1131-2, IEC68-2-6 (Test Fc) / IEC 1131-2 & IEC68-2-27 (Test Ea)					
Weight (g)	210	214/208	128	154 /146	141 /136	162 /154

Input Point Electric Specification	
Input Point Type	DC (Sink or Source)
Input Current	24VDC 7mA
Active Level	OFF→ON Above 10VDC
	ON→OFF Below 9VDC
Reaction Time	About 10ms (Adjust D1020 and D1021 can be 0~15ms)

Output Point Electric Specification		
Output Point Type	Relay-R	Transistor-T
Current Spec.	2A/1 point (5A/COM)	55℃ 0.1A/1 point, 50℃ 0.15A/1 point 45℃ 0.2A/1 point, 40℃ 0.3A/1 point (2A/COM)
Voltage Spec.	Below 250VAC, 30VDC	30VDC
Maximum Load	100 VA (Inductive)	7.2 W
	120 W (Resistive)	
Reaction Time	About 10ms	OFF→ON 15 μs, ON→OFF 25 μs

3.1. Special Auxiliary Relays

◎ PLC Operation Status	
M1000	Normally ON contact (a contact)
M1001	Normally OFF contact (b contact)
M1002	ON only for 1 scan after RUN
M1003	OFF only for 1 scan after RUN
M1004	On when error occurs
M1008	Monitor timer flag (ON: PLC WDT time out)
M1009	24VDC down detection
M1010	PLSY Y0 mode selection. ON: output continuously
◎ Clocks	
M1011	10msec clock
M1012	100msec clock
M1013	1sec clock
M1014	1min clock
◎ Flags	
M1019	Cancel X0~X17 input delay
M1020	Zero flag
M1021	Borrow flag
M1022	Carry flag
M1023	PLSY Y1 mode selection. ON: output continuously
M1024	System used
M1025	Invalid communication request
M1028	10ms time base setting flag
M1029	PLSY Y0 Instruction execution completed flag
M1030	PLSY Y1 Instruction execution completed flag
M1070	The Pulse unit switching (ON: 100 μs) will be conducted at the PWM command.
M1031	Non-holding memory all clear
M1032	Holding memory all clear
M1033	Memory holding at STOP
M1034	All outputs disable
M1039	Constant scan mode

◎ Step Ladder Diagram	
M1040	Step transition inhibit
M1041	Step transition start
M1042	Start pulse
M1043	Origin reset completed
M1044	Origin condition
M1045	All outputs clear inhibit
M1046	STL state setting
M1047	STL monitor enable
◎ Interrupt Inhibit Setting	
M1050	I 001 masked
M1051	I 101 masked
M1052	I 201 masked
M1053	I 301 masked
◎ Error Flags	
M1060	CPU hardware error
M1061	CPU internal malfunction (Flag)
M1062	CPU internal malfunction (BIOS)
M1063	CPU internal malfunction (RAM)
M1064	Operator error
M1065	Syntax error
M1066	Program error
M1067	Program execution error
M1068	Execution error latch (ref. D1068)
◎ PLC Operation Execution	
M1072	PLC RUN command execution
M1073	Grammar inspection flag
M1078	Y0 pulse output/stop control flag
M1079	Y1 pulse output/stop control flag
M1083	From / To mode exchange
◎ RS-485 Communication	
M1120	Communication protocol holding
M1121	Transmission ready

M1122	Sending request
M1123	Receiving completed
M1124	Receiving wait
M1125	Communication reset
M1126	STX/ETX selection
M1127	MODRD, RDST commands. Data receiving completed
M1128	Transmitting / Receiving indication
M1129	Receiving time out
M1130	STX/ETX selection
M1131	M1131=On during the conversion (MODRD/RDST/MODRW data->HEX).
M1140	MODRD / MODWR data received error
M1141	MODRD / MODWR command error
M1142	VFD-A command data received error
M1143	ASCII / RTU mode selections
M1161	8/16-bit mode setting
◎ High Speed Counter (1-phase input)	
M1235	C235 counting mode (on: count down)
M1236	C236 counting mode (on: count down)
M1237	C237 counting mode (on: count down)
M1238	C238 counting mode (on: count down)
M1241	C241 counting mode (on: count down)
M1242	C242 counting mode (on: count down)
M1244	C244 counting mode (on: count down)
◎ High Speed Counter (1-phase 2 inputs)	
M1246	C246 monitor (on: count down)
M1247	C247 monitor (on: count down)
M1249	C249 monitor (on: count down)
◎ High Speed Counter (2-phase inputs)	
M1251	C251 monitor (on: count down)
M1252	C252 monitor (on: count down)
M1254	C254 monitor (on: count down)

3.2. Special Data Registers

◎ PLC System Information	
D1000	Watchdog timer (WDT) value
D1001	DVP model no. + memory cap. /type
D1002	Program memory capacitor
D1003	Sum of program memory
D1004	Error flag number
D1005	System message
D1008	Monitor the STEP position that occurs when timer time out
D1010	Current scan time (unit: 0.1ms)
D1011	Minimum scan time (unit: 0.1ms)
D1012	Maximum scan time (unit: 0.1ms)
D1020	X00~X07 input delay setting (0~15ms)
D1021	X10~X17 input delay setting (0~15ms)
D1022	AB phase counter mode selections
D1025	Communication error code
D1028	Index register E
D1029	Index register F
D1030	Output numbers of Y0 pulse (Low word)
D1031	Output numbers of Y0 pulse (High word)
D1032	Output numbers of Y1 pulse (Low word)
D1033	Output numbers of Y1 pulse (High word)
D1038	When PLC MPU is master, the setting of data response delay time. Time unit is 0.1ms.
D1039	Constant scan time (unit: ms)
◎ Step Ladder Diagram	
D1040	ON state number 1
D1041	ON state number 2
D1042	ON state number 3
D1043	ON state number 4
D1044	ON state number 5
D1045	ON state number 6
D1046	ON state number 7
D1047	ON state number 8

◎ Error Check	
D1061	System detailed error code
D1065	Syntax error code
D1066	Loop error code
D1067	Algorithm error code
D1068	Lock the algorithm error address
D1069	Step number of errors associated with flags M1065~M1067
◎ System Usage	
D1050 ↓ D1055	PLC will automatically convert the ASCII data saved in D1070~D1085 to HEX. Refer to chapter 7 Application Commands for more information.
D1070 ↓ D1085	When the PLC built-in RS-485 communication command receives feedback signals from receiver, the signals will be saved in the registers D1070~D1085. User can use the contents saved in the registers to check the feedback data. Refer to chapter 7 for more details.
D1089 ↓ D1099	When the PLC built-in RS-485 communication command is executed, the transmitting signals will be stored in the registers D1089~D1099. User can use the contents saved in the registers to check the feedback data. Refer to chapter 7 for more details.
D1256 ↓ D1295	ES: MODRW command of RS-485 is built-in. The characters that sent during executing is saved in D1256-D1295. User can check according to the content of these registers. (Using MOV, DMOV, BMOV to move the data in this area in version 4.9.)
D1296 ↓ D1311	ES: PLC system will convert ASCII in the content of the register that user indicates to HEX. (Using MOV, DMOV, BMOV to move the data in this area in version 4.9.)

◎ A/D, D/AConversion (Only EX Model)	
D1056	Present value of analog input channel 0 (CH0)
D1057	Present value of analog input channel 1 (CH1)
D1058	Present value of analog input channel 2 (CH2)
D1059	Present value of analog input channel 3 (CH3)
D1110	Average of analog input channel 0 (CH 0)
D1111	Average of analog input channel 0 (CH 1)
D1112	Average of analog input channel 0 (CH 2)
D1113	Average of analog input channel 0 (CH 3)
D1116	Analog output channel 0 (CH 0)
D1117	Analog output channel 1 (CH 1)
D1118	For EX model only. It is the filter wave time setting between the A/D conversions, and with the default setting as 0 and the unit as 1ms, all will be regarded as 5ms if D1118≦5
◎ PLC System Setting	
D1119	System used (PLC operation mode)
D1121	PLC communication address
◎ RS-485 Serial Communication Port	
D1120	RS-485 communication protocol
D1122	Residual words of transmitting data
D1123	Residual words of receiving data
D1124	Start character definition
D1125	First ending character definition (ETX1)
D1126	Second ending character definition (EXT2)
D1129	RS-485 time-out setting (ms)
D1130	MODBUS return error code record
◎ Auxiliary System Check Information	
D1136	System used (Error diagnosis)
D1137	Address of operator error occurs
D1140	Special extension module number
D1141	System used (Self-diagnosis code)
D1142	Input points (X) of extension unit
D1143	Output points (Y) of extension unit

Additional Information

M: Read Only Relay, can work as a contact yet cannot work as an output coil. But M1131and M1132 are used for system, they can't work as a contact or a output coil.
D: Read Only Register.

Here are the descriptions of the special devices, also refer to chapters 6 and 7 for more details.

Device	Descriptions	Device	Descriptions	Device	Descriptions
M1025	If the PLC receive an illegal communication service request when it is connected with an HPP, PC or HMI (Human-Machine-Interface), the M1025 will be set and save the error code in D1025.	D1001	Users have access to where the software version is saved in Device D1001, e.g. D1001 = H 40**27** is an indication of Version 2.7. HPP is utilized to read the data. When "Knnnnn" is displayed, simply press the <H> key to switch to the HEX display mode.	D1121	Saves the PLC communication addresses. This is a Latched Register.
M1028	OFF: the time base of timer T64~T126 is 100ms. ON: the time base is 10ms.	D1003	Sums up the memory content of the PLC. Users could use this data register to identify the internal program of the PLC.	D1119	Identify the PLC operating mode: 1: A/D operating mode 2: D/A operating mode 3: A/D, D/A operating mode 4: normal mode (DI/DO)
M1143	Used with the MODRD/MODWR commands: OFF: the ASCII mode ON: the RTU mode	D1025	Error Code: 01: illegal command 02: illegal device command 03: requested data exceeds the range 07: checksum error		

3.3. High Speed Counters

Type / Input	1-phase input							1-phase 2 inputs			2-phase inputs		
	C235	C236	C237	C238	C241	C242	C244	C246	C247	C249	C251	C252	C254
X00	U/D				U/D		U/D	U	U	U	A	A	A
X01		U/D			R		R	D	D	D	B	B	B
X02			U/D			U/D			R	R		R	R
X03				U/D		R	S			S			S

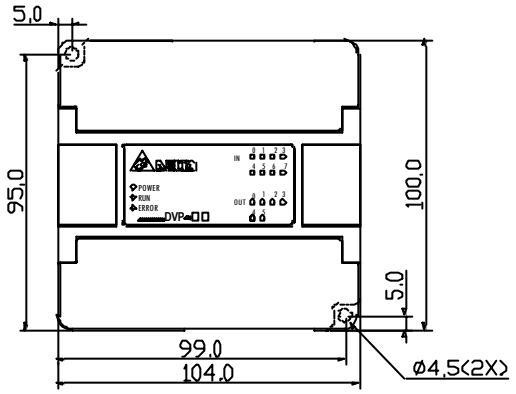
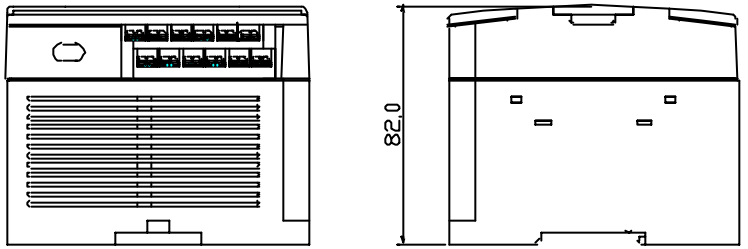
U: Increasing
D: Decreasing
A: A-phase input
B: B-phase input
S: Start input
R: Clear input

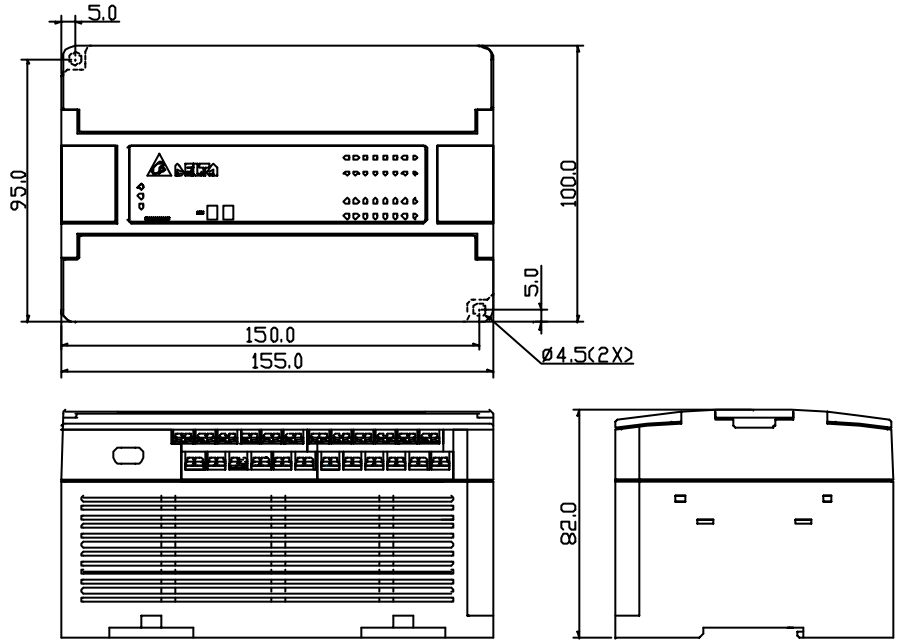
☞ When high speed counters C235~C254 are in use, the inputs of the counter will be disabled for other use.

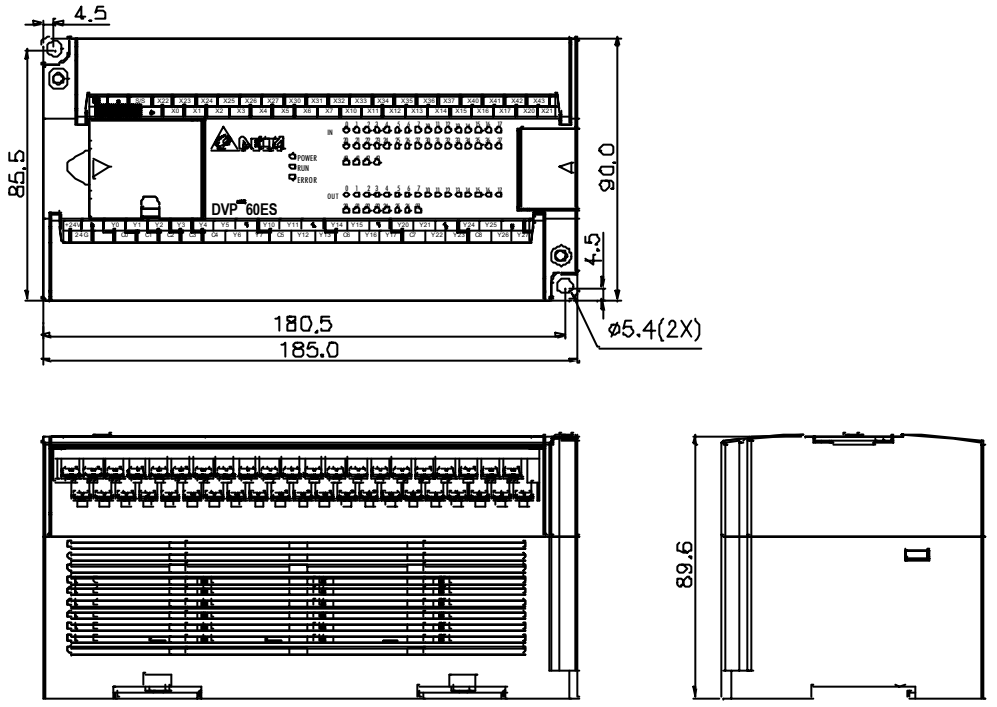
☞ Refer to chapter 7 Application Instructions for more details on API53 DHSCS and API54 DHSCR.

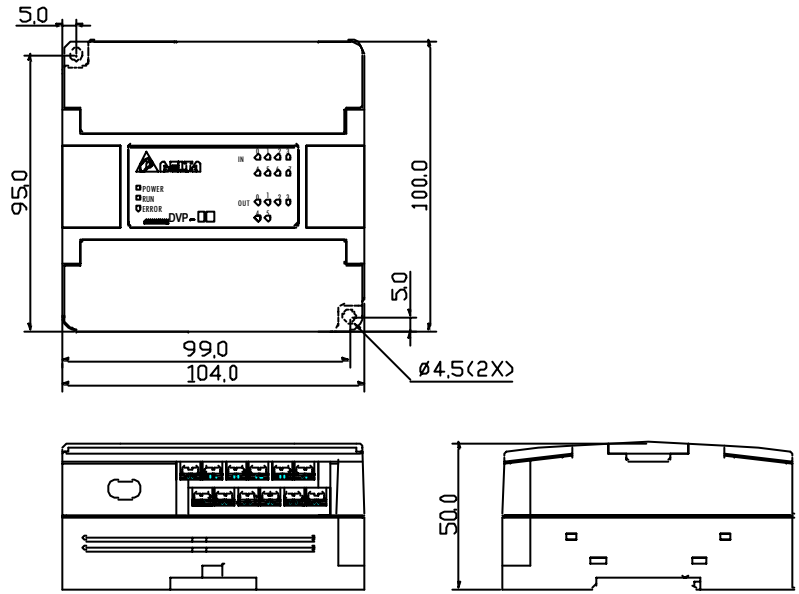
4.1. Dimension and Terminals

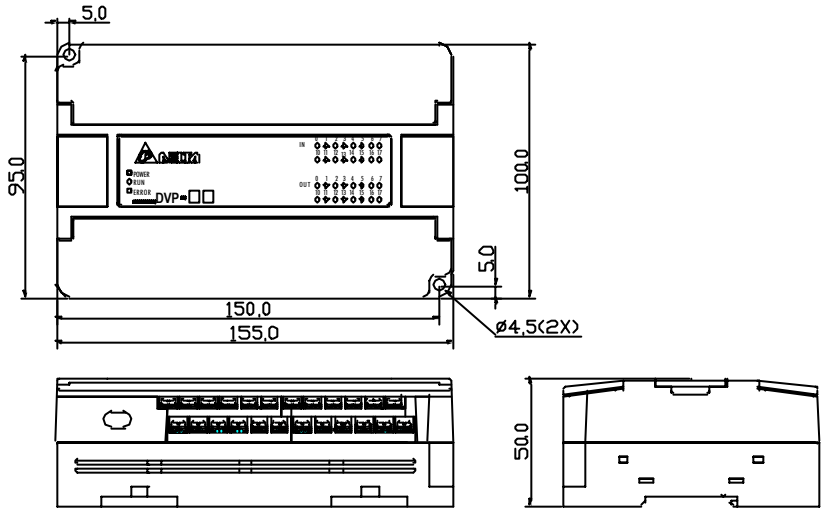
■ Dimensions

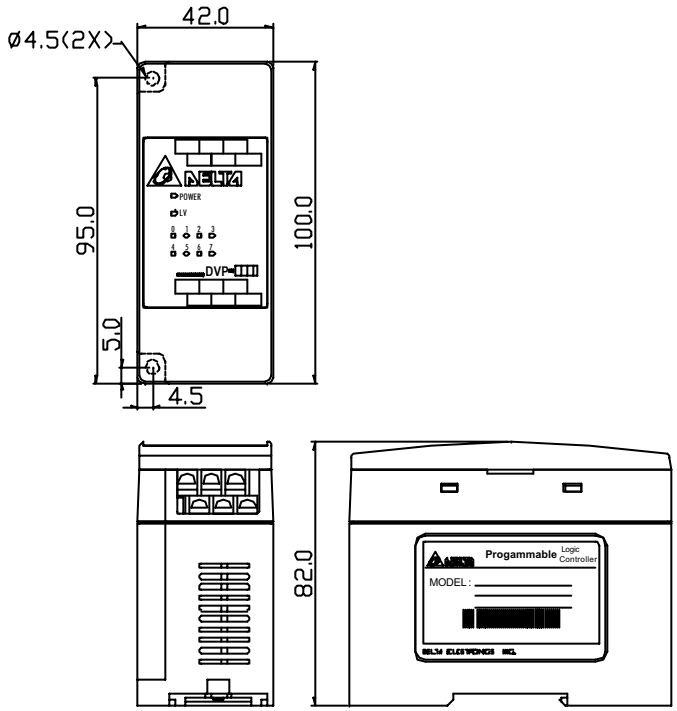
Model		Dimensions
MPU (Including power supply)	DVP14ES00 R2/T2	
Digital I/O Extension Unit (No power supply)	DVP16XM11N	

Model		Dimensions
MPU (Including power supply)	DVP24ES00 R2/T2 DVP32ES00 R2/T2 DVP20EX00 R2/T2	
MPU (No power supply)	DVP20EX11 R2/T2	
Digital I/O Extension Unit (Including power supply)	DVP24XP00 R/T DVP24XN00 R/T DVP32XP00 R/T	
Digital I/O Extension Unit (No power supply)	DVP16XN11 R/T DVP24XN11 R/T DVP24XP11 R/T DVP32XP11 R/T	

Model		Dimensions
MPU (Including power supply)	DVP60ES00 R2/T2	

Model		Dimensions
MPU (No power supply)	DVP14ES01 R2/T2	
Digital I/O Extension Unit (No power supply)	DVP16XM01N	

Model		Dimensions
MPU (No power supply)	DVP24ES01 R2/T2 DVP32ES01 R2/T2	
Digital I/O Extension Unit (No power supply)	DVP16XN01 R/T DVP24XP01 R/T DVP24XN01 R/T DVP32XP01 R/T	

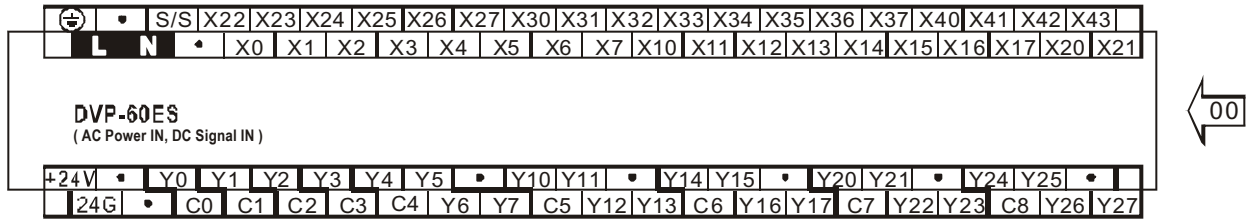
Model		Dimensions
Digital I/O Extension Unit (No power supply)	DVP08XM11N DVP08XN11 R/T DVP08XP11 R/T	

4.2. Terminal Wiring

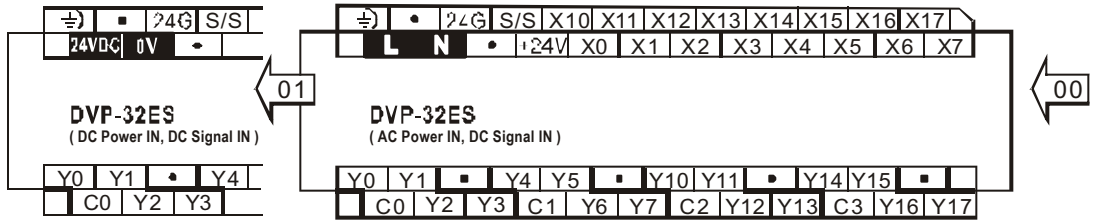
■ Terminal Layouts of the Standard Function MPU

What follows is a complete display of the terminal wiring for all the model types within the DVP Series; refer to locations 13 and 14 on Figure 1-1 of 1.2 Product Profile and Outline for detail.

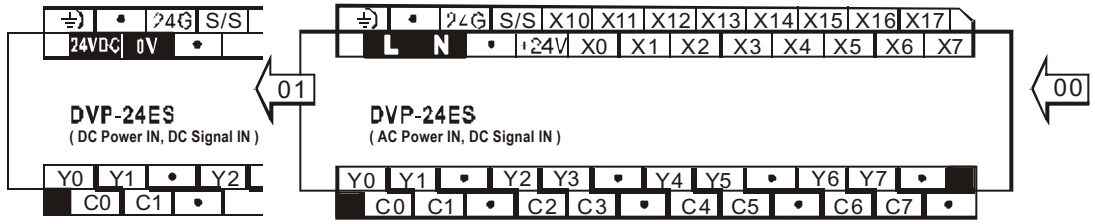
DVP60ES

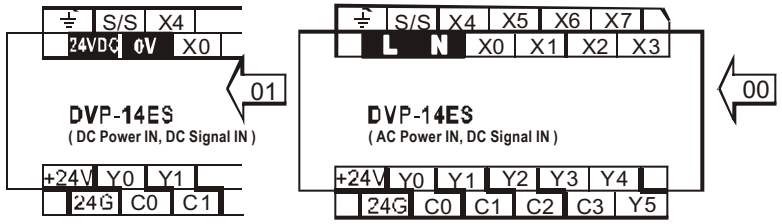


DVP32ES

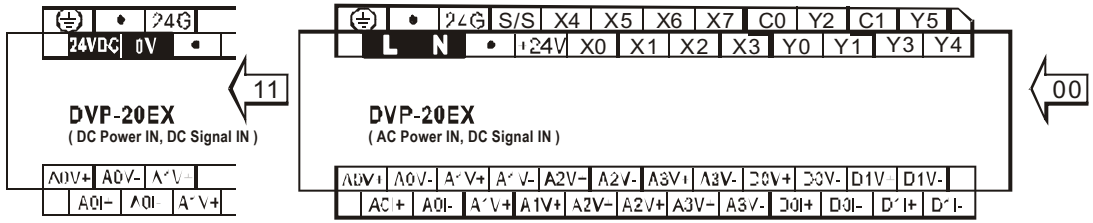


DVP24ES

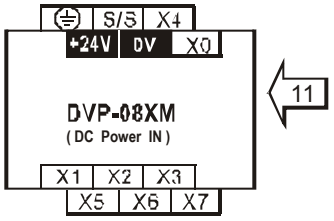
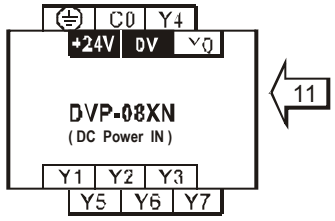
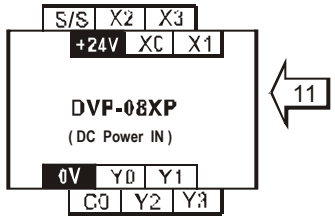


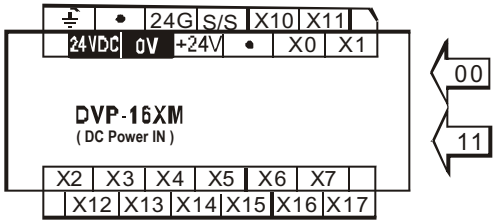
DVP14ES	

■ Terminals Layouts of Special Function MPU

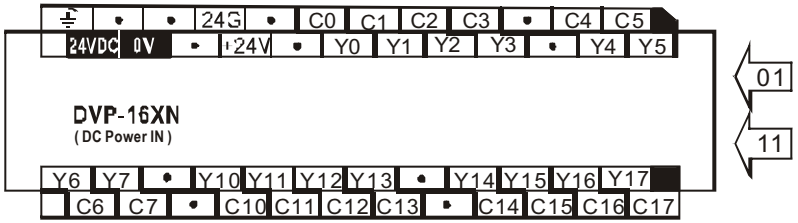
DVP20EX	

■ Terminals Layouts of Digital I/O Extension Unit

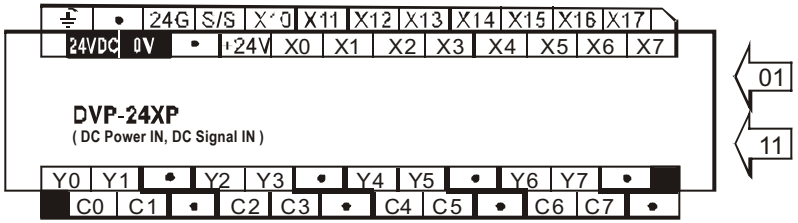
DVP08XM		DVP08XN		DVP08XP	

DVP16XM	

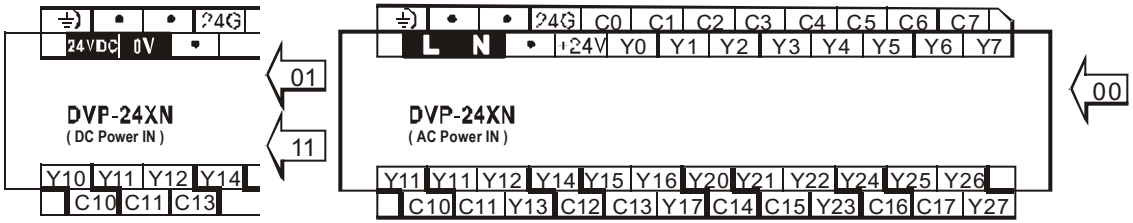
DVP16XN



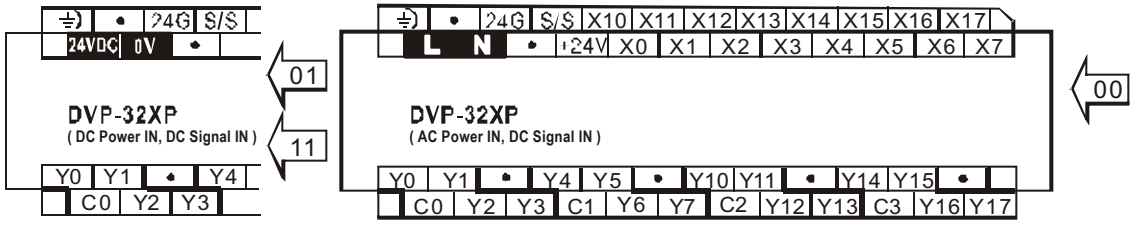
DVP24XP



DVP24XN



DVP32XP



- For the information of terminals layouts of DVP SS Series, refer to the DVP SS Series user manual.

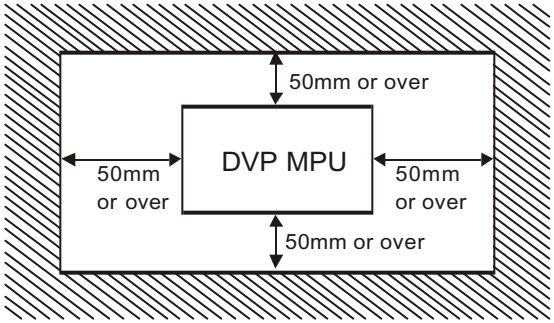
4.3. PLC Mounting Arrangements and Wiring Notes

The installation of the DVP products has been designed to be safe and easy. Whether the products associated with this manual are used as a system or individually, they must be installed in a suitable enclosure. The enclosure should be selected and installed in accordance to the local and national standards.

■ PLC mounting arrangements

PLC should be mounted on a vertical position. To prevent a rise in temperature, units should always be mounted on the back wall of an enclosure. Never mount PLC to the floor or ceiling of the enclosure.
Caution:

1. Do not install units in areas with excessive or conductive dust, corrosive or flammable gas, moisture or rain, excessive heat, regular impact shocks or excessive vibration.
2. Do not allow debris to fall inside the unit during installation, e.g. cut wires, shavings etc. After installation, remove the protective paper band to prevent overheating.
3. Always ensure that units are kept as far as possible from high-voltage cables and equipment.



◎ DIN Rail Installation

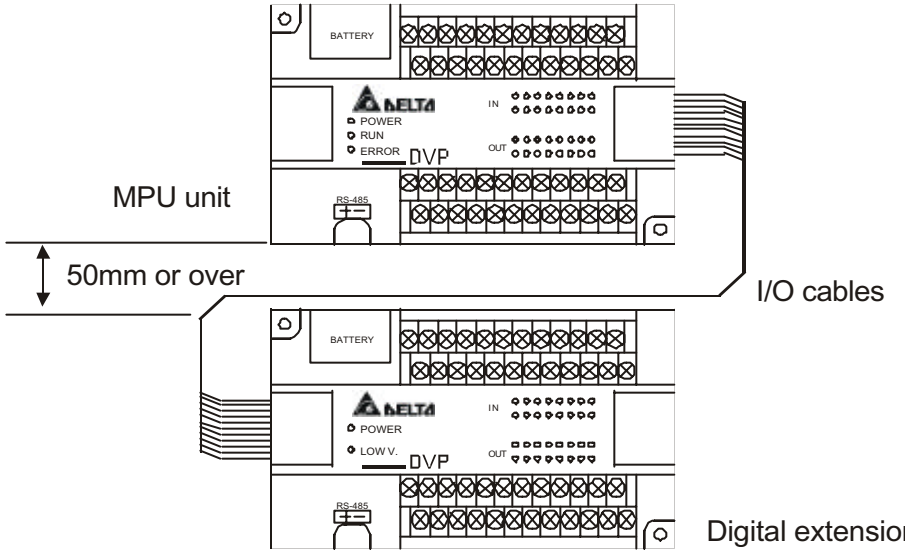
The DVP-PLC can be secured to a cabinet by using DIN rail. The DIN rail should be 35mm high, with a depth of 7.5mm. When mounting the PLC on a DIN rail, please use end brackets to stop any side-to-side motion of the PLC. This will reduce the chance of any wires being pulled loose.

On the bottom of the PLC is a small retaining clip. To secure the PLC to a DIN rail, place it onto the rail and gently push up on the clip. To remove the PLC, pull down on the retaining clip and gently pull the PLC away from the DIN rail.

◎ Direct mounting

Using the specified dimensions and installing the DVP PLC directly on a vertical flat by M4 screws. Make sure you follow the installation guidelines to allow proper spacing from other components.

◎ Parallel connection



1. I/O cables of digital I/O extension unit are easier to be interfered, therefore please keep the I/O cables away from the output cables and power cables at least a 50mm or more distance.

2. The digit I/O extension unit can be connected in parallel, therefore please make sure the I/O cables be firmly connected to the left extension ports of the digit I/O extension unit when connecting one digit I/O extension unit to the other. As for the right extension ports of the digit I/O extension unit, they are used for the next extension.

3. The attached standard cable with the digit I/O extension unit is 80mm. If user desires to work as the left figure shown, please order the specified cable (DVPACAB403, 30cm Cable).

■ Wiring Notes

The following guidelines provide general information on how to wire the I/O connections to DVP PLCs.

☑ Environment

1. **DO NOT** store the PLC in a dusty, smoky, or corrosive atmosphere.
2. **DO NOT** store the PLC in an environment with high temperature or high humidity.
3. **DO NOT** install PLC on a shelf or on an unstable surface.

☑ Construction

1. Some machine fabrication environments may accidentally cause conductive debris to fall through the DVP cooling vents and into the unit. ALL DVP units come with a protective sheet wrapped round the unit, covering the cooling vents. However, it must be removed before electrical operation.
2. There should be a 50mm or more distance between the PLC and other control components. Also, keep the PLC away from high voltage lines & power equipment.

☑ Avoid creating sharp bends in the wires.

☑ Avoid running DC wiring in close proximity to AC wiring.

☑ To minimize voltage drops on long wire runs, consider using multiple wires for the return line.

☑ Avoid running input wiring close to output wiring where possible.

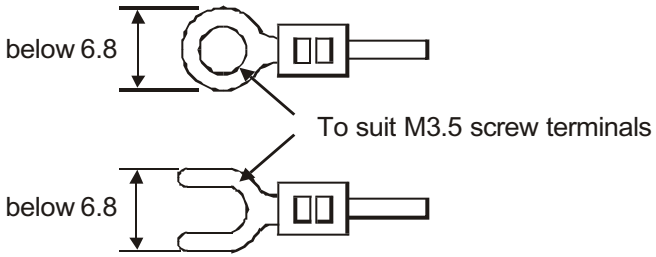
☑ Avoid running wires near high power lines.

☑ Use wire trays for routing where possible.

☑ Use the shortest possible wire length.

☑ Always use a continuous length of wire. Do not splice wires to attain a needed length.

☑ Recommended wire terminations.



1. Cables terminating at a screw terminal of a DVP product should be fitted with insulated crimp terminals, see examples shown at left. Terminal screws should be tightened to between 5 and 8 kg-cm（4.3 and 6.9 in-lbs）. Screw terminals must be secure enough to prevent a loose connection from causing a malfunction.
2. **DO NOT** wire to the No function terminals.
3. Input and output signal wires should not run through the same multi-wire cable, conduit, or near high voltage cables.
4. All low voltage wires should cross high voltage cables at 90° when possible.
5. Use Copper Conductors only
6. 75℃ only

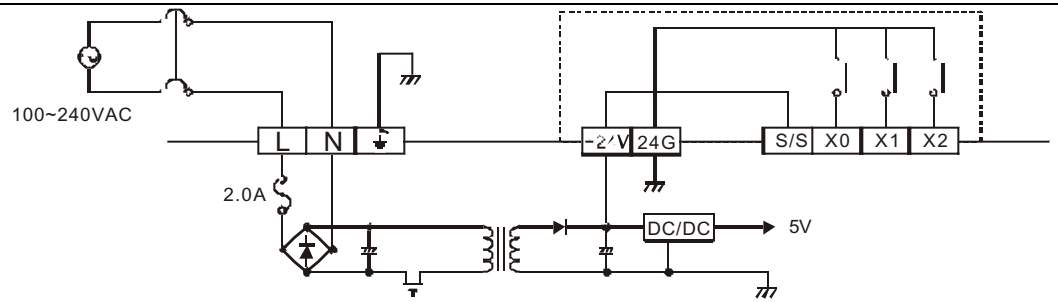
■ Recommended Grounding

For grounding, use at least 2mm^2（AWG14）cable. Ground resistance must be less than 100ohm（Class 3）. The PLC's ground should not be shared with that of the power circuits. While grounding is recommended, if it is not possible, the PLC will still operate correctly without it. Ground terminal : All ground terminals should be linked with 2mm^2（AWG14）cable. The linked terminals should all be connected to a single earth point.

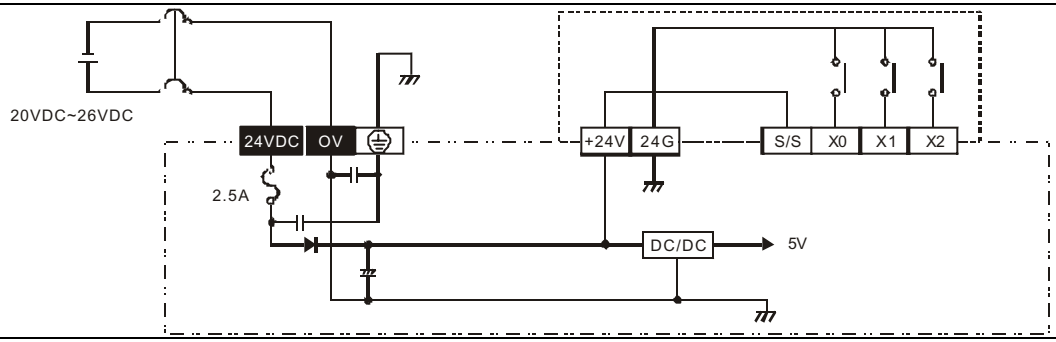
4.4. Wiring Guidelines

■ Power Input Wiring

The following diagram shows various possible external power connections for DVP PLC. When wiring AC power, the 'Live' cable should be connected to the ' L' terminal and the ' Neutral' cable should be connected to the ' N' terminal. When wiring DC power, the ' positive' cable should be connected to the ' +' terminal and the negative should be connected to the '-' terminal. At no time should the power supply terminals be connected to any other terminal on the PLC.

AC Input Type	 ■ The +24V supply output is rated at 0.4 Amperes. DO NOT connect external power supply to this terminal. ■ FUSE Protection: there are internal fuses on all DVP PLCs. However, the fuse does not guarantee the prevention of DVP PLC damage, but it will provide added protection.

When DC voltage is supplied to the PLC, make sure the power is at terminals 24VDC and 0V (power range is 20VDC~26VDC). When voltage is lower than 17.5VDC, PLC will stop operating, all outputs will turn OFF and the ERROR LED will flash continuously.

DC Input Type	

■ Safety Guidelines

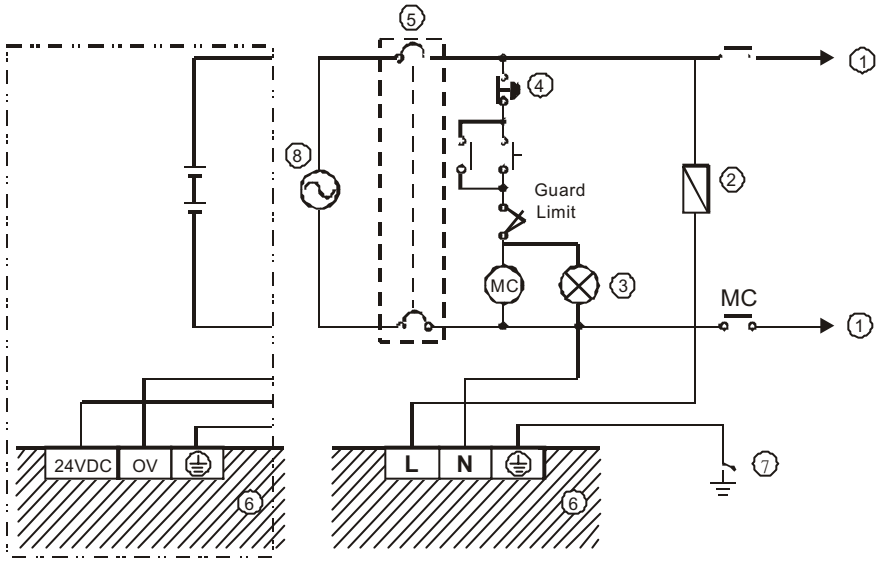
Providing a safe operating environment for personnel and equipment is your responsibility and should be your primary goal during system planning and installation. Automation systems can fail and may result in situations that can cause serious injury to personnel or damage to equipment. Do not rely on the automation system alone to provide a safe operating environment. You should use external electromechanical devices, such as relays or limit switches, which are independent of the PLC application to provide protection for any part of the system that may cause personal injury or damage.

DVP-series PLC input power supply includes two inputs: AC input and DC input. Please take a note of listed items when operating the PLC.

1. When voltage fluctuations are larger than the specified value, connect a constant-voltage transformer.
2. Connect the AC input (100Vac to 240Vac) to terminals L and N. Any AC voltage connected to the +24V terminal or input point will permanently damage the PLC.
3. Service power supply: If the system being installed uses the service supply from both the PLC and powered extension block, then both these units should have their 0V terminals linked. DO NOT however, link the 24V terminals; External DC supplies should not compromise the SELV aspects of the DVP product.

4. When the Momentary Power Loss Time is less than 10ms, the PLC will continue its operation without any interruption. When the Momentary Power Loss Time is longer than 10ms or the input voltage has dropped below minimum values, the PLC will stop its output. When the power returns the PLC will automatically resume operation.

Recommended Wiring for Input Power and Safety Devices.



① Power supply for AC loads
② Circuit protection device (3A Limit)
③ Power ON pilot indicator
④ Emergency stop
The machinery must provide a quick manual method of disconnecting all system power. The disconnect device or switch must be clearly labeled “Emergence Stop”.
⑤ Circuit isolation device (System Power Disconnect)
Using electromechanical devices, such as master control relays and/ or limit switches, to prevent accidental equipment startup at an unexpected time. These devices should be installed in such a manner to prevent any machine operations from occurring.
⑥ DVP MPU (main processing unit)
⑦ Grounding
⑧ Power supply
AC: 100~240VAC, 50/60Hz
DC: 24VDC

■ Input Point Wiring

Prior to performing any wiring, always turn the power off. In some special circumstance, if the user needs to perform wiring to input points while power is on, always stop the PLC. Otherwise, output points may be activated and cause accidently damage to the systems.

PLC Isolation Boundaries: PLC circuitry is divided into three main regions separated by isolation boundaries. Electrical isolation provides safety, so that a fault in one area does not damage another. A transformer in the power supply provides magnetic isolation between primary and secondary sides. Opto-couplers provide optical isolation in Input and Output circuits. This isolates logic circuitry from the field side, where factory machinery connects. Note that the discrete inputs are isolated from the discrete outputs, because each is isolated from the logic side.

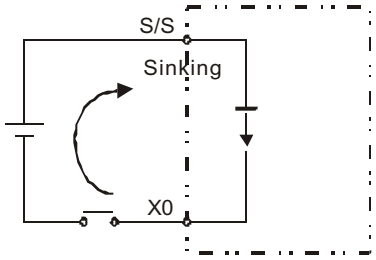
All versions of the DVP PLC have Input / Output circuits that can connect to a wide variety of field devices. DC Input PLCs have two modes of operation: SINK and SOURCE.

Sink = Current flows into the common terminal S/S

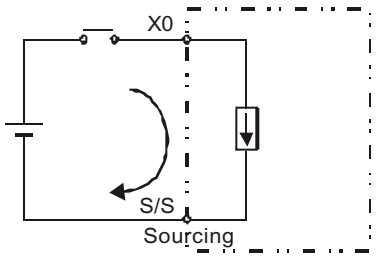
Source = Current flows out of common terminal S/S

For example, we simply connect the common terminal S/S to the supply source(+). By adding the switch, between the supply(-) and the input, we have completed the circuit. Below are two circuit diagrams showing both the sinking and sourcing inputs.

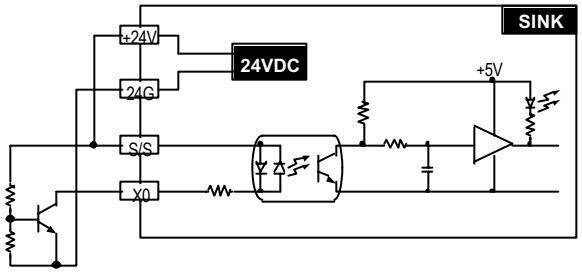
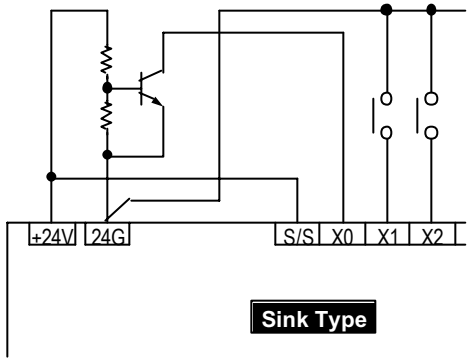
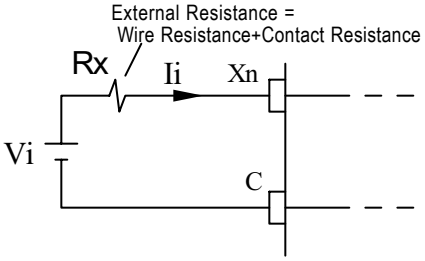
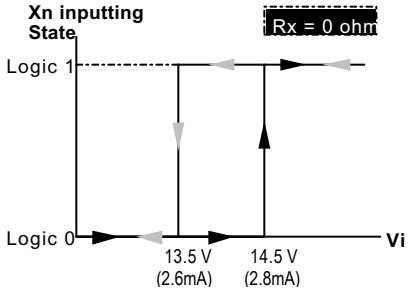
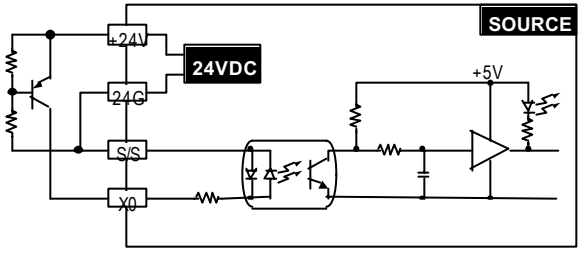
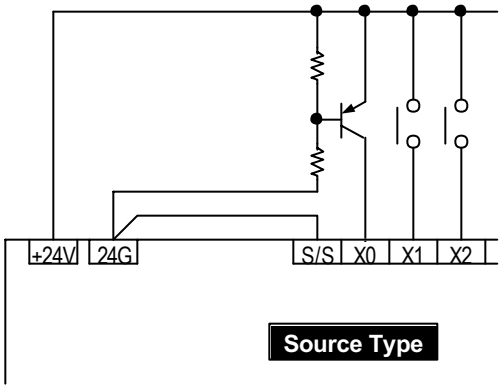
Sinking input



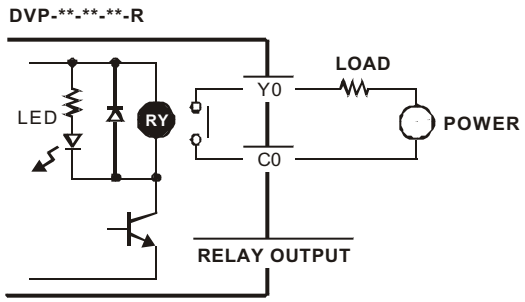
Sourcing input

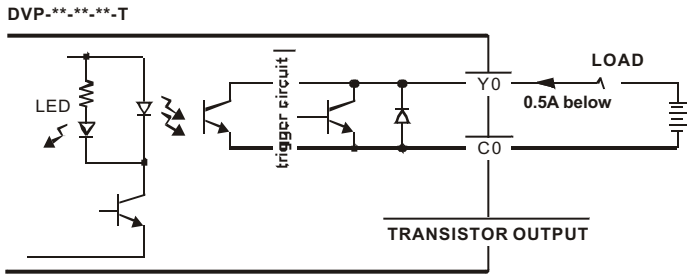


Practically Wiring

	Input Point Loop Equivalent Circuit	Wiring Loop	Voltage Activation Level
DC Type （DC Signal IN） SINK Mode			  If Rx = 100 ohm, the Vi must be greater than 14.8V (14.5V+2.8mA*100), and Xn input state will be logic 1.
DC Type （DC Signal IN） SOURCE Mode	Input Point Loop Equipvalent Circuit 	Wiring Loop 	

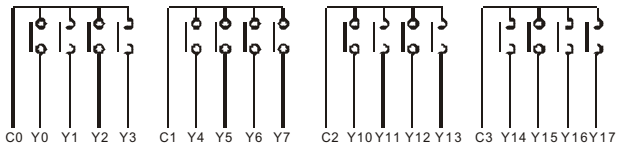
■ Output Point Wiring





1. There are three kinds of DVP-Series PLC outputs: Relay, SSR and Transistor. All relays used in DVP series PLC have passed the standard of IEC 947-5-1 under AC-15 (the rated current and voltage) specification for a cycle test of 6050 times.

2. Be careful with the connection of the common terminals when wiring output terminals. For example, when wiring DVP32ES00R, note that there are sixteen normally-open SPST relays available. They are organized into 4 groups with individual commons. The figure below shows the relays and the internal wiring of the PLC. Note that each group is isolated from the other 3 relay groups:



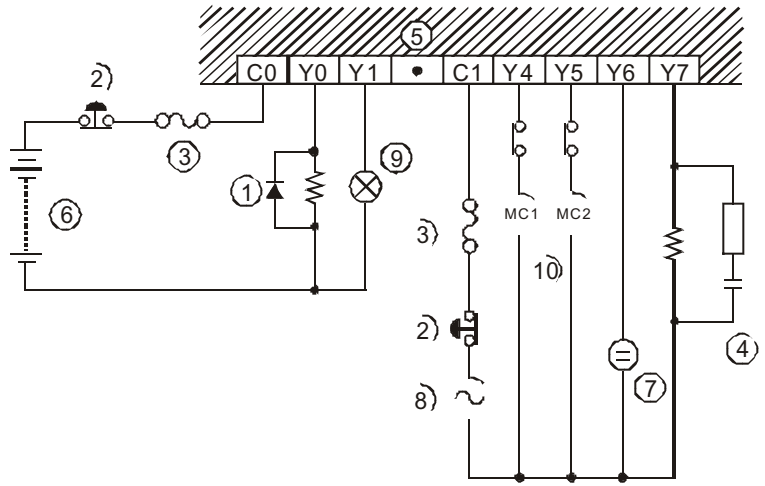
Output terminals Y0 to Y3 share one common terminal C0, and Y4 to Y7 share C1, Y10 to Y13 share C2, Y14 to Y17 share C3.

Other Models please refer to Chap 4.2.

⚠ Output Point Overload Capacity

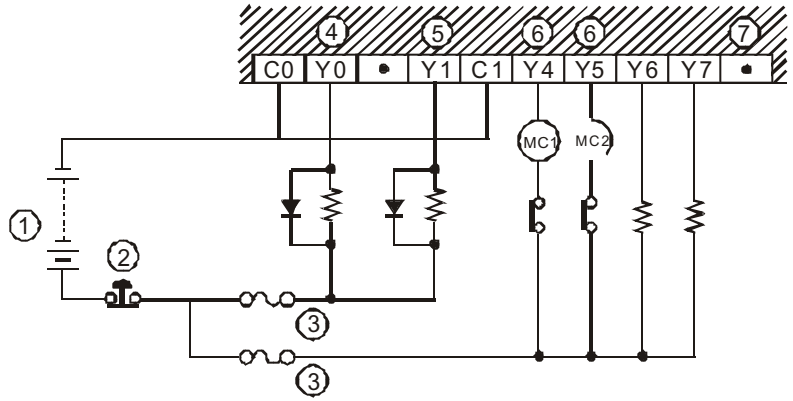
Each output point is capable of 200% of rated current for 5 minutes; the overload capacity of the common point is 150% of rated current for 2 minutes. If the system is over this limit, the PLC output contacts may be damaged and the internal circuit board may be damaged.

◎ Relay Output Wiring Methods



①	Surge absorbing diode: increases relay contact life
②	Emergency stop: use an external switch
③	Fuse: 5 to 10A for every 4 output points to protect the PLC's output circuit.
④	Surge absorber: reduces noise on AC inductive loads
⑤	Unused terminal: do not connect
⑥	DC supply
⑦	Neon lamp
⑧	AC supply
⑨	Incandescent lamp
⑩	Mutually exclusive outputs: Use external hardware interlocks, as well as those in the PLC program, for maximum safety.

◎ Transistor Output Wiring Methods



①	DC supply
②	Emergency stop
③	Fuse
④	If Y0 is used as a pulse train output with PLSY, use a pull up resistor to ensure the output current is greater than 0.01A for correct operation.
⑤	If Y1 is used with PWM, use a pull up resistor to ensure the output current is greater than 0.01A for correct operation.
⑥	Mutually exclusive outputs: use external hardware interlocks, as well as those in the PLC program, for maximum safety.
⑦	Unused terminal: do not connect

■ Power Indication

1. The "POWER ON" LED on the MPU and the Extension Unit will be lit if the power is on. Or if the LED is not lit, it is an indication that the PLC's 24VDC terminal is overloaded, and it is thus necessary to remove the wiring on terminals +24V and 24G, and to provide a 24VDC power supply for each terminal respectively. Moreover, if the ERROR LED blinks continuously, it suggests that the power supply of PLC (+24 V) is low.
2. The "LOW V." LED on the Extension Unit is an indication that the power voltage is low and thus, all outputs of the Extension Unit should be turned off.

■ Preparation, Operation and Test

1. Prior to applying power, please verify the power lines and input/output wiring is correct.
2. If the ERROR LED is not blinking after using the peripheral equipments to write the program into the MPU. It means that the program is legal and the PLC will wait for a RUN command.
3. Enter the RUN command. The RUN LED will light up.
4. Use a HPP or PC to monitor the settings & the data sets of the Timer, the Counter, and the Data Register, and consequently, to perform the ON/OFF functions for the output points. If the ERROR LED is lit (but not blinking), it means that the program setting is over the preset overtime limit, and with this occurrence, please double check the program and perform the ON/OFF functions again (at the time when PLC is returning to the STOP mode).

■ PLC Input/Output Reaction Time

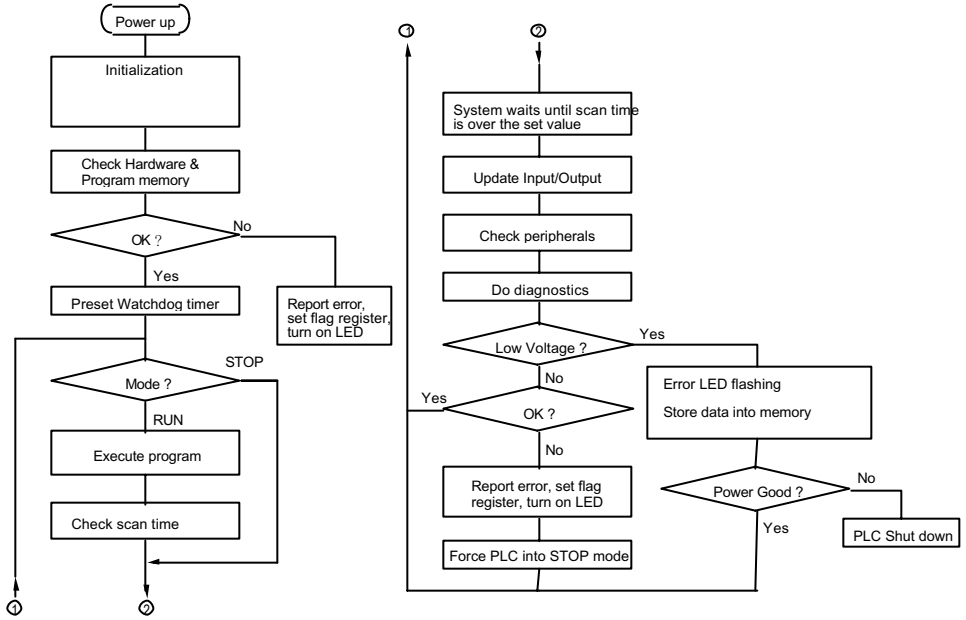
The total reaction time from the input signal to the output operation is calculated as follow:

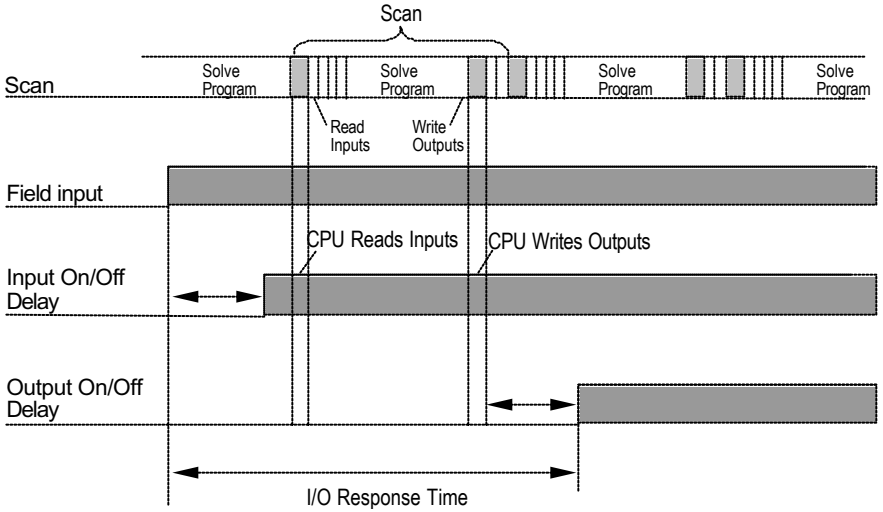
Reaction Time = input delay time +
program scan time +
output delay time

Input delay time	10ms (factory default), 0~15ms adjustable. Please refer to the usage of special devices D1020~1021.
Program scan time	Please refer to the usage of special device D1010.
Output delay time	Relay module: 10ms Transistor module: 20~30 μ s

Please refer to following diagrams for more detail.

- PLC Operation flowchart and timing





In this case, you can calculate the response time by simply adding the following items:

Input Delay + Scan Time + Output Delay = Response Time

■ Basic Instructions Table

Instructions	Functions	Operand	Steps
LD	Load a contact	S, X, Y, M, T, C	1
LDI	Load b contact	S, X, Y, M, T, C	1
AND	Series connection-a contact	S, X, Y, M, T, C	1
ANI	Series connection-b contact	S, X, Y, M, T, C	1
OR	Parallel connection-a contact	S, X, Y, M, T, C	1
ORI	Parallel connection-b contact	S, X, Y, M, T, C	1
OUT	Output Coil	S, Y, M	1
SET	Latch (ON)	S, Y, M	1
ANB	Series connection (Multiple Circuits)	None	1
ORB	Parallel connection (Multiple Circuits)	None	1
MPS	Stores the operation result	None	1
MRD	Reads the operation result (pointer won' t move)	None	1
MPP	Reads, then clears the operation result	None	1
NOP	No operation action	None	1
MC	Master control START command	N0~N7	3
MCR	Master control RESET command	N0~N7	3
RST	Clears the contact or the register	S, Y, M, T, C, D	3
P	Pointer	P0~P63	1
I	Interrupt pointer	I001 / I101 / I201 / I301	1
END	Program END	None	1

☞ The following instructions have API codes associated with them. When using the HPP, users may input API codes, or use the specified keys, TMR, CNT, and DCNT to generate their program.

Table 6.1

API	Instructions	Functions	Operands	Steps
96	TMR	16-bit Timer	T-K or T-D	4
97	CNT	16-bit Counter	C-K or C-D (16-bit)	4
97	DCNT	32-bit Counter	C-K or C-D (32-bit)	6

☞ When using an HPP, the items below may only be entered by their API codes.

API	Instructions	Functions	Operands	Steps
89	PLS	Rising-edge output	Y, M	3
90	LDP	Rising-edge detection operation	S, X, Y, M, T, C	3
91	LDF	Falling-edge detection operation	S, X, Y, M, T, C	3
92	ANDP	Series connection command for the rising-edge detection operation	S, X, Y, M, T, C	3
93	ANDF	Series connection command for the falling-edge detection operation	S, X, Y, M, T, C	3
94	ORP	Parallel connection command for the rising-edge detection operation	S, X, Y, M, T, C	3
95	ORF	Parallel connection command for the falling-edge detection operation	S, X, Y, M, T, C	3
98	INV	Inverting operation	None	1
99	PLF	Falling-edge output	Y, M	3

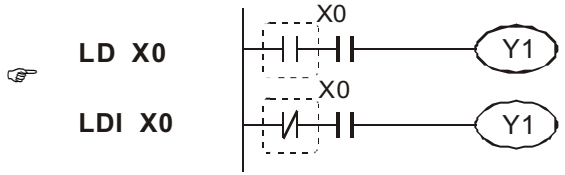
■ Step Ladder Instructions

Instructions	Functions	Operands	Steps
STL	Step transition ladder start instruction	S	1
RET	Step transition ladder return instruction	None	1

■ Contact Instructions

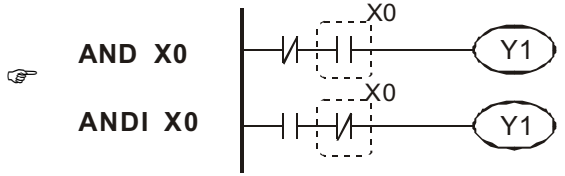
Instruction	Operands					
LD / LDI	S0~S127	X0~X177	Y0~Y177	M0~M1279	T0~T127	C0~C127 C235~C254
	✓	✓	✓	✓	✓	✓

LD is the contact A operation instruction and LDI is the contact B operation instruction.



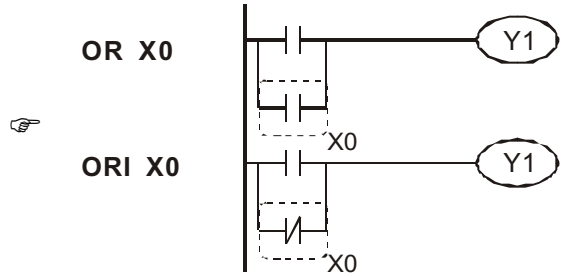
Instruction	Operands					
AND / ANI	S0~S127	X0~X177	Y0~Y177	M0~M1279	T0~T127	C0~C127 C235~C254
	✓	✓	✓	✓	✓	✓

AND is the series connection instruction of one A contact and ANI is the series connection instruction of one B contact.



Instruction	Operands					
OR / ORI	S0~S127	X0~X177	Y0~Y177	M0~M1279	T0~T127	C0~C127 C235~C254
	✓	✓	✓	✓	✓	✓

OR is the parallel connection instruction of one A contact and ORI is the parallel connection instruction of one B contact.

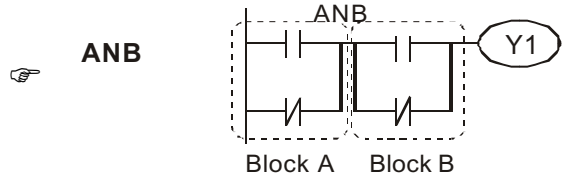


■ Connection Instructions

Instruction	Operands
ANB / ORB	None

This instruction performs the AND operation of block A and block B, and uses it as an operation result.

The symbol of ANB is not a contact symbol but a connection symbol. ANB can be written consecutively up to 8 times. If more ANBs are written consecutively, error indication is given by self-check function and corresponding error code is stored in special register D1004.



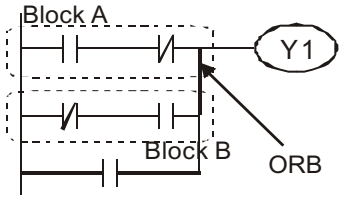
ORB instruction performs the OR operation of block A and Block B, and uses it as an operation result.

ORB performs parallel connection of circuit block with two or more contacts. For parallel connection of circuit blocks which have only one contact, OR and ORI are used and ORB is not required.

The symbol of ORB is not a contact symbol but a connect symbol.

ORB can be written consecutively up to 8 times. If more ORBs are written consecutively, error indication is given by self-check function and corresponding error code is stored in special register D1004.

ORB



Instruction	Operands
MPS / MRD / MPP	None

MPS:

Stores the operation result (ON/OFF) immediately preceding the MPS instruction.

The MPS instuction can be used up to 8 times. However, if an MPP instruction is used between any two MPS instructions, then the total number of MPS instructions is reduced by 1.

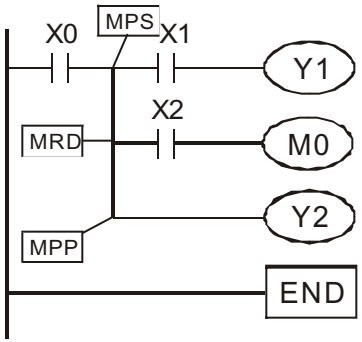
MRD:

Reads the operation result stored by the MPS instruction, and uses the operation result, starting at the next step.

MPP:

Reads the operation result stored by the MPS instruction, and uses the operation result, starting at the next step.

Ladder Diagram



Commands

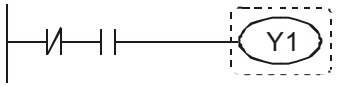
```
LD    X0
MPS
AND   X1
OUT   Y1
MRD
AND   X2
OUT   M0
MPP
OUT   Y2
END
```

■ Output Instructions

Instruction	Operands					
OUT	S0~S127	X0~X177	Y0~Y177	M0~M1279	T0~T127	C0~C127 C235~C254
	✓		✓	✓		

This instruction outputs the operation result for the elements preceding the OUT instruction.

OUT Y1



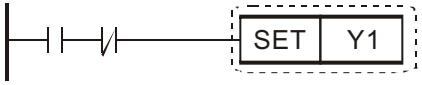
Operation Result	OUT Instruction		
	Coil	Contact	
		No contact	NC contact
OFF	OFF	Non-continuity	Continuity
ON	ON	Continuity	Continuity

Instruction	Operands					
SET	S0~S127	X0~X177	Y0~Y177	M0~M1279	T0~T127	C0~C127 C235~C254
	✓		✓	✓		

When the SET input turns on, the specified device is turned on.

The specified device remains on even if the SET input turns off. The device can be turned off by the RST instruction.

☞ **SET Y1**



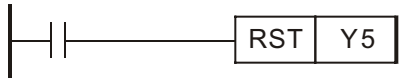
Instruction	Operands					
RST	S0~S127	X0~X177	Y0~Y177	M0~M1279	T0~T127	C0~C127 C235~C254
	✓	✓	✓	✓	✓	✓

When the RST input turns on, the specified device changes as described below:

Device	Status
S, X, Y, M	Coil and contact are turned off.
T, C	Preset value is set to 0, and coil and contact are turned off.
D	Content is set to 0.

When the RST input is off, the status of device does not change.

☞

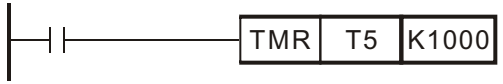


Instruction	Operands	
TMR	T-K	T0~T127, K0~K32767
	T-D	T0~T127, D0~D1143

When the operation result of instructions preceding the TMR instruction are on, the coil of timer turns on and counts up to the set value. When the timer times out (counted value >= set value), the contact is as indicated below.

NO contact	Continuity
NC contact	Non-continuity

☞



When the operation result of instructions preceding the TMR instruction change from ON to OFF, the following occurs.

Timer Coil	Preset Value of Timer	Before Time Out		After Time Out	
		NO contact	NC contact	NO contact	NC contact
OFF	0	Non-continuity	Continuity	Continuity	Non-continuity

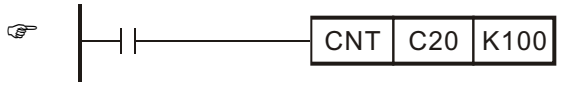
After the timer has timed out, the status of the contact will not change until the RST instruction is executed.

A negative number (-32768 to –1) cannot be set as a set value.

Instruction	Operands	
CNT	C-K	C0~C127, K0~K32767
	C-D	C0~C127, D0~D1143

When the operation result of instructions preceding the CNT instruction has changed from OFF to ON, 1 is added to the count value. When the counter has counted out (count value = set value), the state of the contact is as indicated below.

NO contact	Continuity
NC contact	Non-continuity



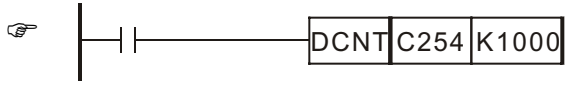
When the operation result of the instructions preceding the CNT instruction remain on, counting is not performed. (It is not necessary to convert the count input into a pulse.)

After the counter has counted out, the count value and the status of the contact will not change until the RST instruction is executed.

A negative number (-32768~-1) cannot be used as a set value. When the set value is 0, the same processing as for 1 is performed.

Instruction	Operands	
DCNT	C-K	C235~C254, K-2147483648~K2147483647
	C-D	C235~C254, D0~D1143

Counters C232 to C255 are used for high speed counters. When the operation result preceding the DCNT has changed from OFF-ON, 1 is added to the count value. When the counter has counted out (count value = set value), the state of the output contact is changed (ON or OFF).



The counted value is not cleared when the operation result is OFF. Use the RST C2XX instruction to clear the counted value and to turn OFF the contact.

■ Master Control Instructions

Instruction	Operands
MC / MCR	N0 ~ N7

MC:

MC is master control start instruction. When the ON/OFF command for the MC is on, operation results from MC to MCR remain unchanged.

Scanning between the MC and MCR instructions is executed even when the ON/OFF command for the MC instruction is OFF. Scan time does not therefore become shorter.

When ON/OFF command for the MC is off, the operation result of MC to MCR is as indicated below.

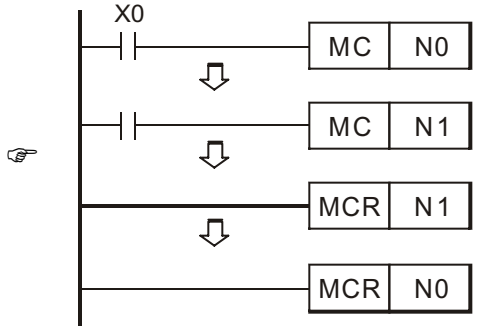
Timers	Count value becomes 0. Coil and contact turn OFF
Counter	Coil turns OFF. Count value and contact hold present status.
Devices in the OUT instruction	All turn OFF.
Devices in the SET, RST instructions	Hold present status.

MCR:

MCR is a master control reset instruction and indicates the end of master control range.

Do not use a contact instruction before the MCR instruction.

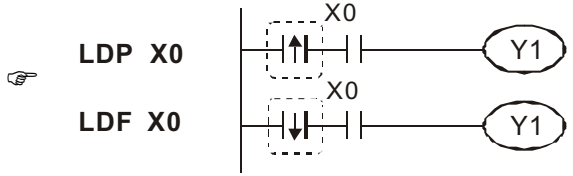
The MC instructions can be used by nesting. Range of each MC instruction is identified by a nesting number. Nesting numbers are used in the range of N0 to N7.



■ Contact Rising/Falling edge Instructions

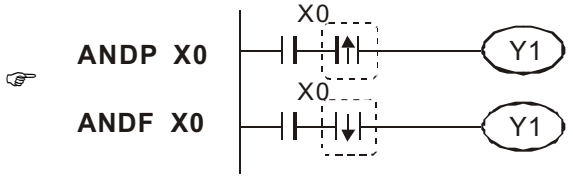
Instruction	Operands					
LDP / LDF	S0~S127	X0~X177	Y0~Y177	M0~M1279	T0~T127	C0~C127 C235~C254
	✓	✓	✓	✓	✓	✓

Rising/Falling-edge detection operation instruction



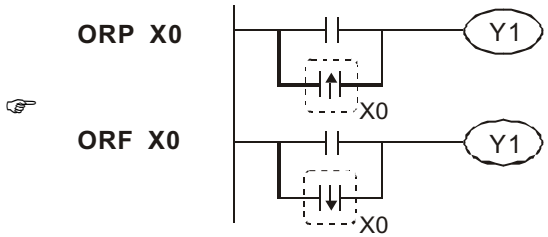
Instruction	Operands					
AND / ANDP	S0~S127	X0~X177	Y0~Y177	M0~M1279	T0~T127	C0~C127 C235~C254
	✓	✓	✓	✓	✓	✓

Series connection command for the rising/falling-edge detection operation.



Instruction	Operands					
ORP / ORF	S0~S127	X0~X177	Y0~Y177	M0~M1279	T0~T127	C0~C127 C235~C254
	✓	✓	✓	✓	✓	✓

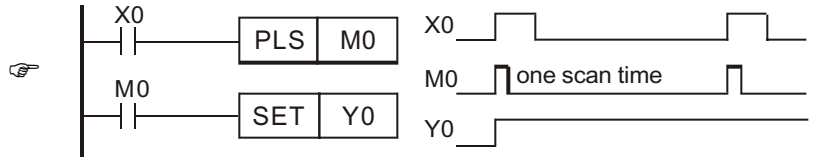
Parallel connection command for the rising/falling-edge detection operation.



■ Rising/Falling edge Output Command

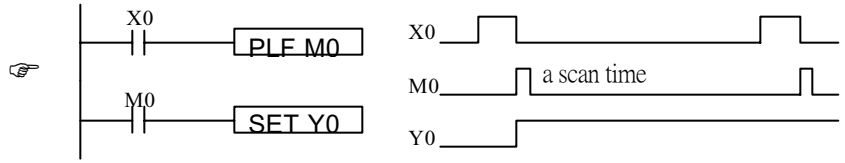
Instruction	Operands					
PLS	S0~S127	X0~X177	Y0~Y177	M0~M1279	T0~T127	C0~C127 C235~C254
			✓	✓		

PLS command: the rising-edge output command. When X0=OFF→ON (the rising-edge is touched off), the PLS command will be executed, and M0 will send out one pulse. Length of this pulse is one scan time.



Instruction	Operands					
PLF	S0~S127	X0~X177	Y0~Y177	M0~M1279	T0~T127	C0~C127 C235~C254
			✓	✓		

PLF command: the falling-edge output command. When X0= ON→OFF (the falling-edge is touched off), the PLF command will be executed, and M0 will send out one pulse. Length of this pulse is one scan time.

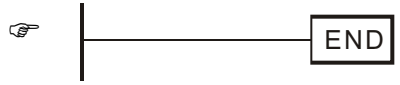


■ Termination Instructions

Instruction	Operands
END	None

This instruction indicates the end of program. At this step, the scan returns to step 0.

The END instruction cannot be used midway through the sequence program or subsequence program. If END processing is necessary halfway through the program, use the FEND instruction.



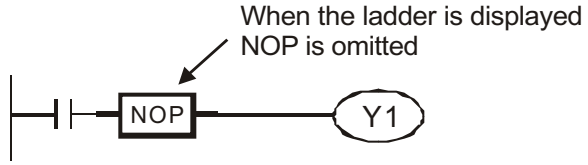
■ Other Instructions

Instruction	Operands
NOP	None

This is a no-operation instruction and has no effect on the previous operation.

NOP is used in the following cases:

1. To provide space for debugging of sequence programs.
2. To delete an instruction without changing the number of steps. (Overwrite with NOP)
3. To delete an instruction temporarily.



Instruction	Operands
P / I	P0 ~ P63 / I001, I101, I201, I301

Pointers (P)

Pointers are used with the jump instructions (CJ, CALL) in two different ways as follows.

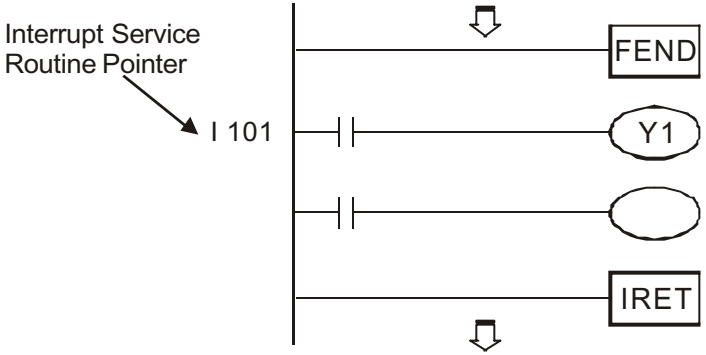
1. Designation of the JUMP destination (CJ) and at the head of destination (Label).
2. Designation of the subroutine destination (CALL) and at the head of the subroutine program (Label).

A label number cannot be used at more than one place. If used, more than once an error will occur.

☞ Pointer P10

Interrupt Pointers (I) :

Interrupt pointers are used as the label at the head of each interrupt program. Each interrupt program begins with an interrupt pointer and ends with the IRET instruction.



☞

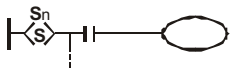
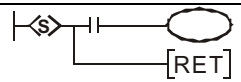
Instruction	Operands
INV	None

Inverting the operation result and use the new data as an operation result.

☞ **INV**

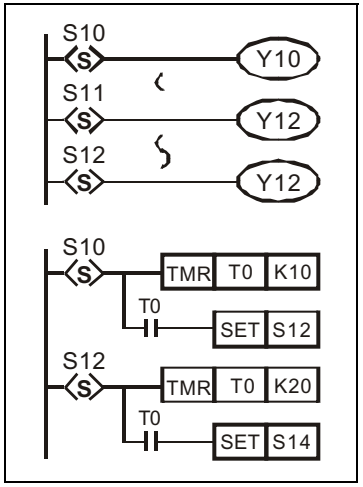
■ Step Ladder Commands

- Symbols and functions:

Command	Functions	Symbol and devices	
STL [Sn]	Step ladder diagram starts		● Command Length: 1 Step ● Device [Sn]: S0~S127 ● Begins from S0~S9 ● Step S can not be repeated
RET	End of step ladder diagram	 RET (return command must be added at the end of STL)	● Command length: 1 Step ● Step point **S** ● RET command is used at the end of the step ladder diagram that begins with S0 to S9.

- Command Instruction

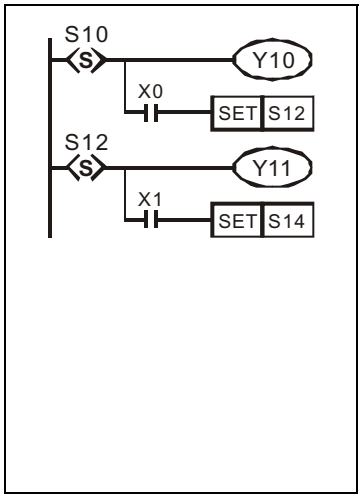
Example:



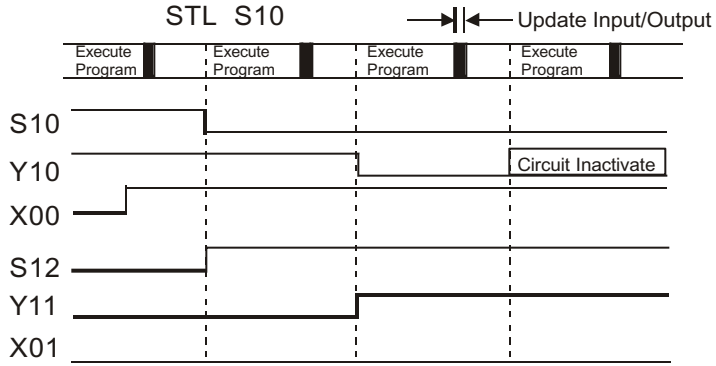
☞ When step point Sn=ON, the subroutine is active, the action will delay for one scan time. Whereas Sn is OFF, the subroutine is inactive.

☞ In the example, the same device (Y12) can be used in different step points. That is, when S11 or S12 step point is activated (ON), Y12 will output. Y2 will be closed during the process that S11 transfer to S12. And then output Y2 after S12 is ON. In this situation, no matter S11 or S12=ON, Y12 will always be ON.

☞ The timer can be repeatedly used in discontinuous step points. (This is a special feature of the step ladder diagram. However, users should try to avoid repeated output relays. You should also avoid using the same coil number that used in step ladder diagram after returning to general ladder diagram.



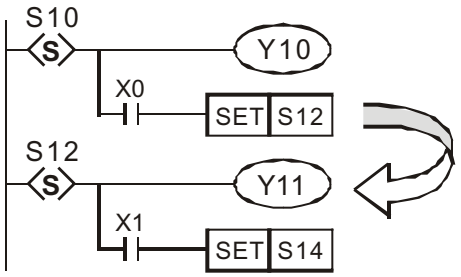
☞ When step point S10 and S12 transition simultaneously (S10➔OFF, S12➔ON, there is a delay for one scan time), and the output Y10 and Y11 will not be ON simultaneously.



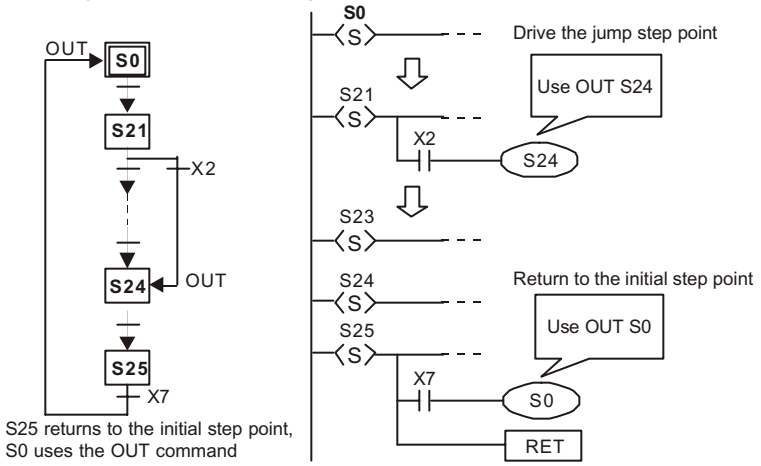
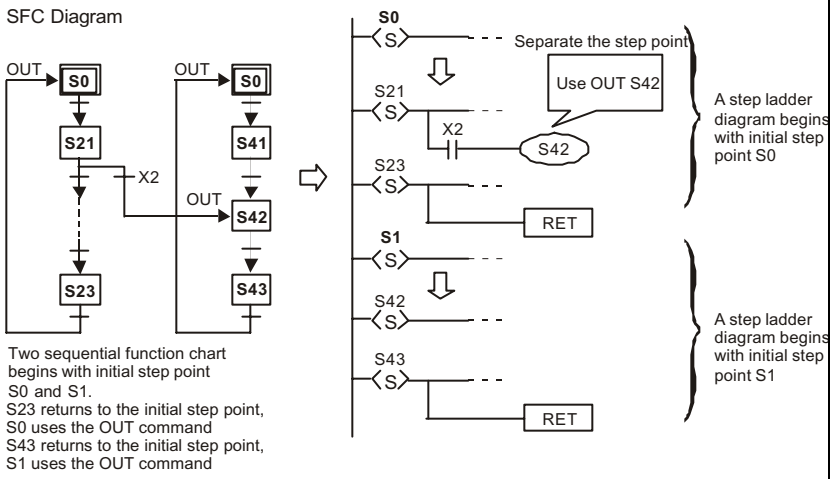
- Step Point Transition

Commands SET Sn and Out Sn are for activating another step point. There are different occasions when these commands are used. Please see the following examples.

SET Sn	The step ladder control that begins with S0 to S9 will move to the next step point, the action of the previous step point will be deleted.

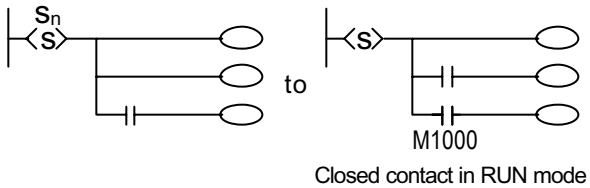


When SET S12 executes, step point will move from S11 to S12. S11 and the output of (Y10) will be deleted.

OUT Sn	Return back to initial step point and step point jump up or jump down to the point that is not sequenced in order within the program or transitions to a different step ladder program. Once the status is shifted, outputs from all the previous motion status points will be deleted.	
	① In a step ladder program, return back to initial step point. ② In a step ladder program, step point jump up or jump down to the point that is not sequenced in order. 	③ Transition to a different step ladder program (begin with different initial step point). 

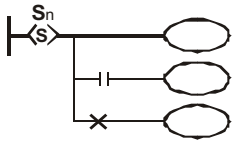
- Note

1. When using LD or LDI commands, user will not be able to write in the no-contact program. The ladder diagram will have to be refined as followed:



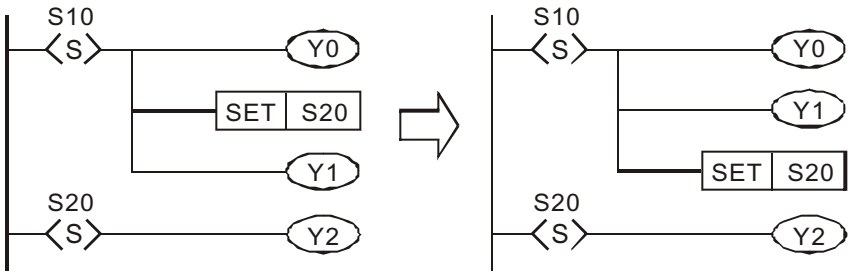
Closed contact in RUN mode

☞ If there already exists an input device, inputs that follow this input device cannot be connected to the end of the STL command directly, for that the current condition requires the operation outcome from both the STL status and the input device. As shown follows.

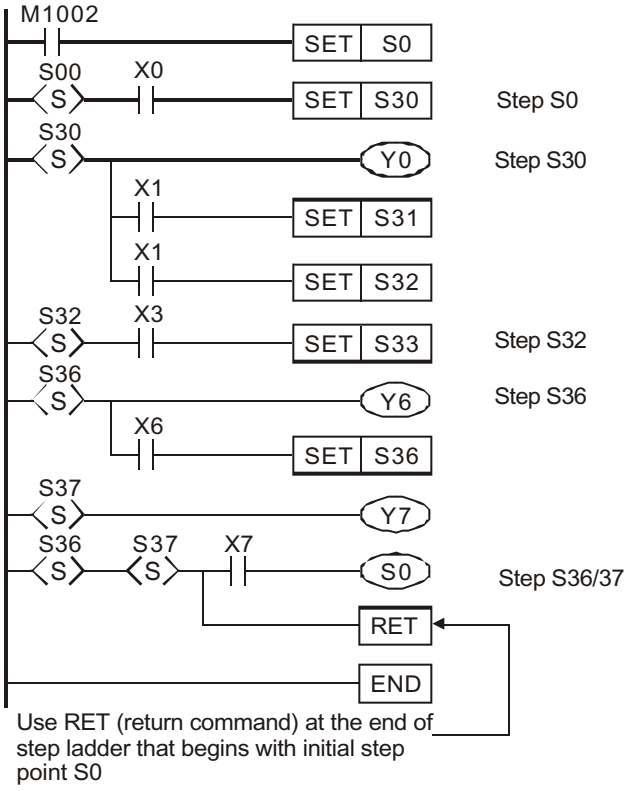


2. Every subroutine of a step point is the same as a general ladder diagram, but there are some limitations to the commands.
   1. Do not use MC/MCR commands in step points.
   2. STL commands cannot be used in Sub-programs and Interrupt programs.
   3. Try to avoid using CJ commands in the STL program, it will complicate the entire program.

3. It is always better to finish all commands before moving to the next step point. The SET Sn command is better to be placed at the end of step point, as shown below.



☞ Step ladder diagram:

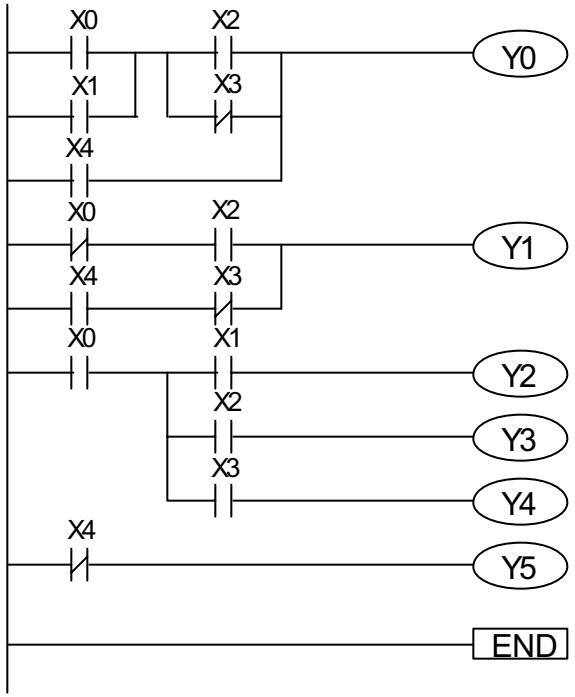


◆ Example: Programming 1 (Excluding Step Ladder Instructions STL/RET)

◆ Using Instruction Coding

Step	Instruction	
0	LD	X0
1	OR	X1
2	LD	X2
3	ORI	X3
4	ANB	
5	OR	X4
6	OUT	Y0
7	LDI	X0
8	AND	X2
9	LD	X4
10	ANI	X3
11	ORB	
12	OUT	Y1
13	LD	X0
14	MPS	
15	AND	X1
16	OUT	Y2
17	MRD	
18	AND	X2
19	OUT	Y3
20	MPP	
21	AND	X3
22	OUT	Y4
23	LDI	X4
24	OUT	Y5
25	END	

◆ Using Ladder Diagram Coding



◆ Example: Programming 2 (including Step Ladder Instructions STL/RET)

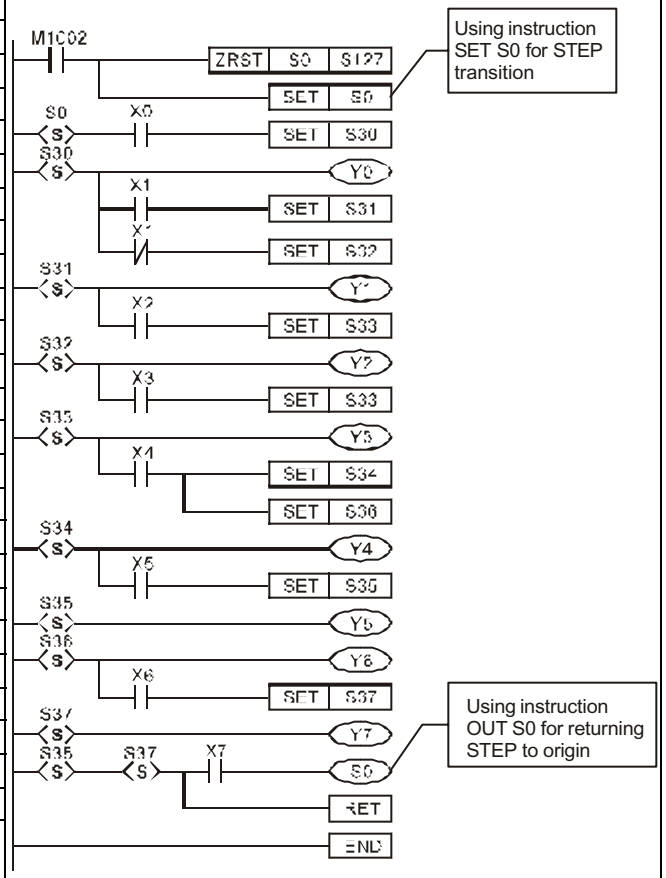
Instruction List

	Step	Instruction		Step	Instruction
	0	LD M1002		29	STL S34
	1	ZRST S0 S127		30	OUT Y4
	6	SET S0		31	LD X5
	7	STL S0		32	SET S35
	8	LD X0		33	STL S35
	9	SET S30		34	OUT Y5
	10	STL S30		35	STL S36
	11	OUT Y0	2*	36	OUT Y6
	12	LD X1		37	LD X6
	13	SET S31		38	SET S37
	14	LDI X1		39	STL S37
	15	SET S32		40	OUT Y7
	16	STL S31		41	STL S35
1*	17	OUT Y1		42	STL S37
	18	LD X2		43	LD X7
	19	SET S33		44	OUT S0
	20	STL S32		45	RET
	21	OUT Y2		46	END
	22	LD X3			
	23	SET S33			
	24	STL S33			
	25	OUT Y3			
	26	LD X4			
	27	SET S34			
	28	SET S36			

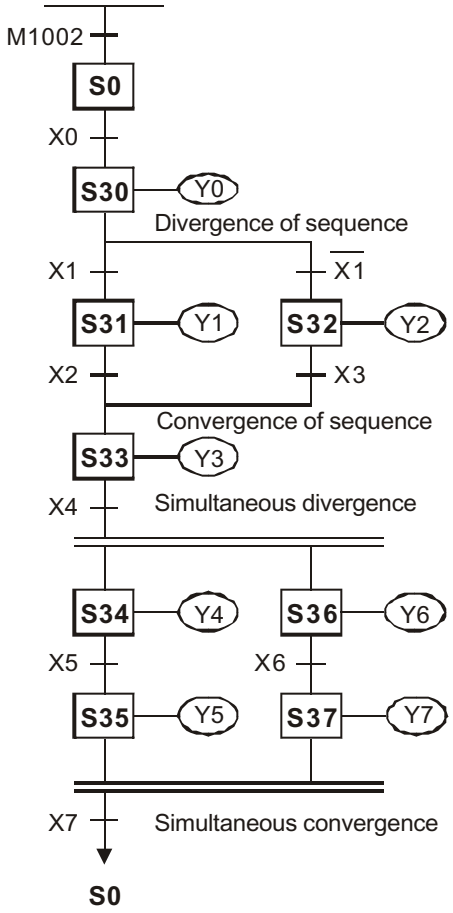
1*: Divergence/convergence of sequence

2*: Simultaneous divergence/convergence sequences

Ladder Diagram



Step Transition Flowchart



■ Application Instructions Structure

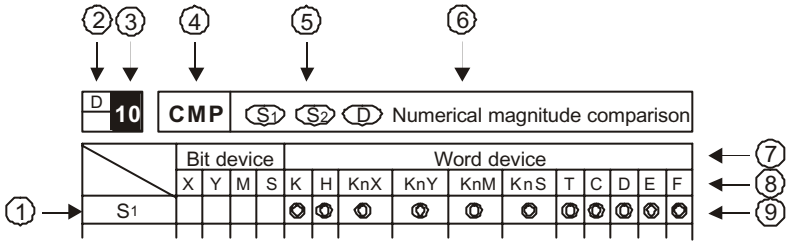
1. Many instructions may be divided into an instruction part and a device as follows:

   Instruction part : Indicates the function.

   Device : Indicates the data for use with that instruction.

2. The application instructions structure may be largely classified as follows with the instruction part and device (s) combined:
   - Instruction part
     Retains the device status and mainly controls the program.
     Example: FEND, IRET,…
   - Instruction part + Source device + Destination device
     Operation is performed using the destination data and operation result is stored to the destination.
     Example: MOV, …
   - Instruction part + Source 1 device + Source 2 device + Destination 1 device + Destination 2 device
     Operation is performed using the source 1 data and source 2 data, and the operation result is stored to the destination.
     Example: ZCP, SFTL, RS, …
   - Others…Combination of the formats above.

■ Instructions Format

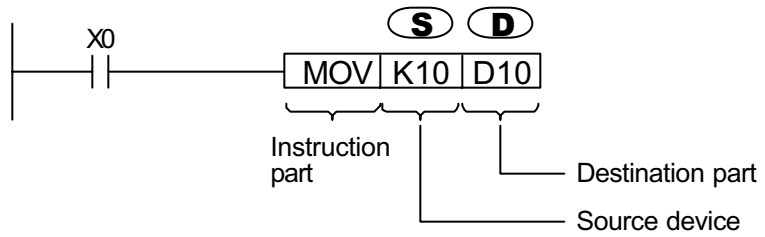


Explanations:

① Operand
② Indicates 32-bit instruction (D is added to the head of instruction, example as above: DCMP)
③ Indicates API number
④ Instruction
⑤ Operand format of the instruction
⑥ Describes the instruction function
⑦ Device types
⑧ Device name
⑨ Symbol ◎ are given to devices which can be used for this operand

■ Application Instructions Input

The application instructions of DVP-Series PLC are controlled by command codes API 00 to API 246. Each command code has its own meaning, for example, API 12 stands for MOV (move data). When using ladder diagram Editor to input programs, you will need to type in the instruction "MOV". If using the HPP to input the program, we will have to enter the API command codes. Each application instruction has its unique operand.



This instruction is to move the value of (S) operand to the appointed (D) operand.

(S):

1. Source data used for operation.
2. Source data may be A:
   - Constant
     Specify the numeric value used for the operation. This value is set while the program is being written and cannot be changed when the program is running.
   - Bit device, word device
     Specify the device, which stores the data used for the operation. The data must be stored to the specified device before the operation is initiated. By changing the data to be stored to the specified device during program run, the data used with the instruction can be changed.

Source operand: if there are more than 1 source operand, then we use (S1), (S2).

(D):

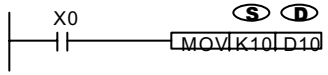
1. Stores data after operation is performed.

Destination operand: if there is more than one operand, then we use (D1), (D2).
If the operand may only be represented as a constant K, H or register D then we will use (m1), (m2) or (n1), (n2).

■ The Length of Operand

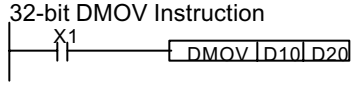
The length of Operand can be divided into two groups: 16-bit and 32-bit to process different length data. A "**D**" before an instruction separates 32-bit from 16-bit instructions.

16-bit MOV Instruction



K10 has been sent to D10.

32-bit DMOV Instruction



Data of (D11,D10) have been sent to (D21,D20)

■ Data format

X, Y, M, S are only be single point ON/OFF, these are defined as a BIT. However, 16-bit (or 32-bit) T, C, D are data registers and are defined as WORDs. We also can add Kn in front of X, Y, M and S to be defined as WORDs, whereas n=1 means 4-bit. So16-bit can be described from K1 to K4, and 32-bit can be described from K1 to K8. For Example, K2M0 means there are 8-bit from M0 to M7.

Move the contents of M0 to M7 to D10 segments 0 to 7, and segments 8 to 15 are set to 0.

■ Bit processing

Bit processing is performed when a bit device (X, Y, M, S) has been specified. Either 1 bit or digit specification processing may be selected.

- 1-bit processing

  When the sequence instruction is used, no more than one bit may be specified.

  For example: LD X10, OUT Y0

- Digit specification processing

  When application instructions are used, the number of digits may need to be specified for the bit device. Up to 32 points can be specified in 4 point increments.

1. 16-bit instruction: K1 to 4 (4 to 16 points)

   When there is digit specification on the source (S) side, the range of numeric values handled as source data are shown below.

- Specified Number of Digits (16-bit Instruction)

K1 (4 points)	0 to 15
K2 (8 points)	0 to 255
K3 (12 points)	0 to 4095
K4 (16 points)	-32768 to 32767

When there is digit specification on the Source side, the number of points set by the digit specification is used on the destination side.

2. 32-bit instruction: K1 to 8 (4 to 32 points).

When there is digit specification on the source (S) side, the range of numeric values handled as source data are as shown below.

- Specified Number of Digits (32-bit Instruction)

K1 (4 points)	0 to 15
K2 (8 points)	0 to 255
K3 (12 points)	0 to 4095
K4 (16 points)	0 to 65535
K5 (20 points)	0 to 1048575
K6 (24 points)	0 to 167772165
K7 (28 points)	0 to 268435455
K8 (32 points)	-2147483648 to 2147483647

■ Handling of Numeric Values

In the DVP PLC series, there are instructions, which handle numeric values in 16 bits and 32 bits format. The highest bits of 16 bits and 32 bits are used for the judgment of positive and negative numbers. Numeric values handed by 16 bits and 32 bits are as follows:

16 bits : -32768 to 32767
32 bits : -2147483648 to 2147483647

- **Double word (32-bit data) processing**

  32-bit data is stored using digit specification of K1 to 8 when it is stored in bit or in word devices.

- Storing data in bit devices

  Refer to **Digit Specification Processing**.

- Storing data in word devices

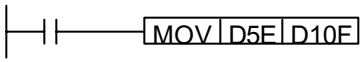
  1) Two consecutive word devices are used to store 32-bit data.

  2) To store the data of bit devices with which digit specification of K1 to K8 was done, refer to **Digit Specification Processing**.

  3) Cautions : If the storing word device is assigned to the final device number of each device, an error will occur.

■ Indirect Assigned Method

E and F represent constants used as operands. They are the same as other operands and may be moved, compared, and be used in the word devices (KnX, KnY, KnM, KnS, T, C, D) to serve as the indirect assigned function, however, they are not to be used in the bit devices (X, Y, M, S) and in the constants (K, H) to serve as the direct assigned function.



When E = 8, F = 14
D5E = D(5+8) = D13
D10F = D(10+14) = D24

Move the content of D13 to D24 when execute this command.

■ Handling of Decimal

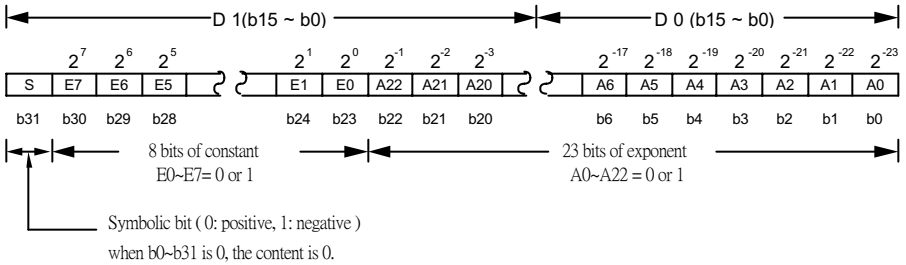
The internal operation of DVP PLC usually gets the value of BIN integer. When operating integer division, the decimal will be erased. For example: 40 ÷3=13, remainder is 1 and the decimal will be erased. But if using decimal operation, you can get decimal.

The application commands relate to decimal point are shown in the following.

API 49 (FLT)	API 110 (D ECMP)	API 111 (D EZCP)	API 118 (D EBCD)
API 119 (D EBIN)	API 120 (D EADD)	API 121 (D ESUB)	API 122 (D EMUL)
API 123 (D EDIV)	API 124 (D EXP)	API 125 (D LN)	API 126 (D LOG)
API 127 (D ESQR)	API 128 (D POW)	API 129 (INT)	API 130 (D SIN)
API 131 (D COS)	API 132 (D TAN)		

Floating point of decimal number system

- The floating point that DVP-PLC uses is binary number system, you should convert floating point of binary number system to decimal number system.
- Floating point of decimal number system is stored in the register with 2 continuous numbers. The register with small number stores constant and the register with greater number stores exponent.
  For example, using register (D1, D0) to store a floating point of decimal number system.
  Floating point of decimal number system = [constant D0] X 10 [exponent D1]
  constant D0 = 1,000 ~ 9,999
  exponent D1 = -41 ~ +35
  the left-most bit of (D1, D0) is symbol bit.
  Besides, constant 100 doesn' t exist in D0 due to 100 will be shown with $1{,}000\times10^{-1}$.
  The usage range of decimal floating point is:
  Minimum absolute value is $1{,}175\times10^{-41}$ and the maximum absolute value is $3{,}402\times10^{35}$.
- Floating point of decimal number system can be used in the following command.



The floating point of binary number system =

$$\pm\left(2^0 + A22\times2^{-1} + A21\times2^{-2} + \cdots + A0\times2^{-23}\right)$$
$$\times 2^{\left(E7\times2^7+E6\times2^6+\cdots+E0\times2^0\right)/\,2^{127}}$$

(For example) A22=1, A21=0, A20=1, A19~A0=0,
E7=1, E6~E1=0, E0=1

The floating point of binary number system =

$$\pm\left(2^0 + 1\times2^{-1} + 0\times2^{-2} + 1\times2^{-3} + \cdots + 0\times2^{-23}\right)$$
$$\times 2^{\left(1\times2^7+0\times2^6+\cdots+1\times2^0\right)/\,2^{127}}$$
$$= \pm1.625\times2^{129}/2^{127} = \pm1.625\times2^2$$

b31 is the bit for positive/negative sign

■ Application Command Chart

API	Mnemonic Codes		Functions		Operand	Steps	
	16-bit	32-bit				16-bit	32-bit
00	CJ	-	Executes the program of specified pointer number when the jump command is on		S	3	-
01	CALL	-	Executes the subroutine program specified by the pointer (P**)		S	3	-
02	SRET	-	Executes the sequence program located at the next step to the CALL instruction		None	1	-
03	IRET	-	Indicates the termination of processing of interrupt program		None	1	-
04	EI	-	Enables the interrupt		None	1	-
05	DI	-	Disables the interrupt program until the EI instruction is executed so that interrupt signals are ignored		None	1	-
06	FEND	-	Terminates the main routine program		None	1	-
07	WDT	-	Resets the watchdog timer in a sequence program		None	1	-
08	FOR	-	Nested loop begins	When the processing of FOR to NEXT instructions is executed "n" times unconditionally, performs the processing of the next step to the NEXT instruction.	S	3	-
09	NEXT	-	Nested loop ends		None	1	-
10	CMP	DCMP	Comparison operation instruction, making numerical magnitude comparison between two pieces of data.		S1, S2, D	7	13
11	ZCP	DZCP	Zone comparison		S1, S2, S, D	9	17
12	MOV	DMOV	Transfers the data of the device specified at source to the device specified at destination		S, D	5	9
14	CML	DCML	Counter transfer		S, D	5	9
15	BMOV	-	Block move		S, D, n	7	-
16	FMOV	DFMOV	Multiple points movement		S, D, n	7	13
17	XCH	DXCH	Data exchange		D1, D2	5	9
18	BCD	DBCD	Converts BIN data of device specified into BCD		S, D	5	9
19	BIN	DBIN	Converts BCD data of device specified into BIN		S, D	5	9
20	ADD	DADD	Performs the addition of BIN data		S1, S2, D	7	13
21	SUB	DSUB	Performs the subtraction of BIN data		S1, S2, D	7	13
22	MUL	DMUL	Performs the multiplication of BIN data		S1, S2, D	7	13
23	DIV	DDIV	Performs the division BIN data		S1, S2, D	7	13
24	INC	DINC	Performs the addition of 1 to the device specified		D	3	5
25	DEC	DDEC	Performs the subtraction of 1 from the device specified		D	3	5
26	WAND	DAND	Performs the logical product of data of device specified		S1, S2, D	7	13
27	WOR	DOR	Performs the logical add of data of device specified		S1, S2, D	7	13

API	Mnemonic Codes		Functions	Operand	Steps	
	16-bit	32-bit			16-bit	32-bit
28	WXOR	DXOR	Performs the exclusive or of the data of device specified	S1, S2, D	7	13
29	NEG	DNEG	Complementary of 2	D	3	5
30	ROR	DROR	Rotate to the right	D, n	5	9
31	ROL	DROL	Rotate to the left	D, n	5	9
32	RCR	DRCR	Rotate to the right with the carrying flag attached	D, n	5	9
33	RCL	DRCL	Rotate to the left with the carrying flag attached	D, n	5	9
34	SFTR	-	Shifts the data of device specified to the right	S, D, n1, n2	9	-
35	SFTL	-	Shift the data of device specified to the left	S, D, n1, n2	9	-
40	ZRST	-	Resets a range of devices specified.	D1, D2	5	-
41	DECO	-	8 ⇨ 256 bit decode	S, D, n	7	-
42	ENCO	-	256 ⇨ 8 bit encode	S, D, n	7	-
43	SUM	DSUM	Sum of the ON bit	S, D	5	9
44	BON	DBON	Determine the ON bit	S, D, n	7	13
45	MEAN	DMEAN	Mean value	S, D, n	7	13
48*	SQR	DSQR	The square root of BIN	S, D	5	9
49*	FLT	DFLT	BIN integer→ decimal of binary number system	S, D	5	9
50	REF	-	Input/Output refresh immediately	D, n	5	-
53	HSCS	DHSCS	High speed counter comparison SET	S1, S2, D	7	13
54	HSCR	DHSCR	High speed counter comparison RESET	S1, S2, D	7	13
57	PLSY	DPLSY	Pulse Output	S1, S2, D	7	13
58	PWM	-	Pulse width modulation output	S1, S2, D	7	-
59	PLSR	DPLSR	Pulse wave output with accel/decel speeds	S1, S2, S3, D	9	17
60	IST		Manual/auto control	S, D1, D2	-	-
66	ALT	-	ON/OFF Alternate command	D	3	-
73	SEGD	-	Decode the 7-step display panel	S, D	5	-
74	SEGL	-	7-step display scan output	S, D, n	7	-
78	FROM	DFROM	Read special module CR data	m1, m2, D, n	9	17
79	TO	DTO	Special module CR data write in	m1, m2, S, n	9	17
80	RS	-	Data communication is performed according to the data in the specified communication area	S, m, D, n	9	-
82	ASCI	-	Converts the specified hexadecimal value into the ASCII code	S, D, n	7	-
83	HEX	-	Converts the specified ASCII code into the hexadecimal value	S, D, n	7	-

API	Mnemonic Codes		Functions	Operand	Steps	
	16-bit	32-bit			16-bit	32-bit
87	ABS	DABS	Absolute value	D	3	5
88	PID	-	PID calculation	S1, S2, S3, D	9	-
100	MODRD	-	Modbus data read command	S1, S2, n	7	-
101	MODWR	-	Modbus data write command	S1, S2, n	7	-
102	FWD	-	Delta inverter VFD-A series forward command	S1, S2, n	7	-
103	REV	-	Delta inverter VFD-A series reverse command	S1, S2, n	7	-
104	STOP	-	Delta inverter VFD-A series stop command	S1, S2, n	7	-
105	RDST	-	Delta inverter VFD-A series status data read command	S, n	5	-
106	RSTEF	-	Delta inverter VFD-A series external fault clearing command	S, n	5	-
110*	ECMP	DECMP	Comparison of decimal of binary system	S1, S2, D	7	13
111*	EZCP	DEZCP	Comparison of the area of decimal of binary system	S1, S2, S, D	9	17
118*	EBCD	DEBCD	Decimal of binary number→ decimal of decimal system	S, D	5	9
119*	EBIN	DEBIN	Decimal of decimal system→ decimal of binary system	S, D	5	9
120*	EADD	DEADD	Addition of decimal of binary system	S1, S2, D	7	13
121*	ESUB	DESUB	Subtraction of decimal of binary system	S1, S2, D	7	13
122*	EMUL	DEMUL	Multiplication of decimal of binary system	S1, S2, D	7	13
123*	EDIV	DEDIV	Division of decimal of binary system	S1, S2, D	7	13
124*	EXP	DEXPP	Exponent obtain command	S, D	5	9
125*	LN	DLN	Natural logarithm obtain command	S, D	5	9
126*	LOG	DLOG	Logarithm obtain command	S1, S2, D	7	13
127	ESQR	DESQR	Square root of decimal of binary system	S, D	5	9
128*	POW	DPOW	Floating value command	S1, S2, D	7	13
129*	INT	DINT	Decimal of binary system → BIN integer	S, D	5	9
130*	SIN	DSIN	SIN operation of decimal of binary system	S, D	5	9
131*	COS	DCOS	COS operation of decimal of binary system	S, D	5	9
132*	TAN	DTAN	TAN operation of decimal of binary system	S, D	5	9
147	SWAP	DSWAP	Swap upper and lower 8-bit	S	3	5
150	MODRW	-	MODBUS data read/write	S1, S2, S3, S4, n	11	-
224	LD=	DLD=	(S1) = (S2)	S1, S2	5	9
225	LD>	DLD>	(S1) > (S2)	S1, S2	5	9

API	Mnemonic Codes		Functions	Operand	Steps	
	16-bit	32-bit			16-bit	32-bit
226	LD<	DLD<	(S1) < (S2)	S1, S2	5	9
228	LD<>	DLD<>	(S1) ≠ (S2)	S1, S2	5	9
229	LD<=	DLD<=	(S1) ≦ (S2)	S1, S2	5	9
230	LD>=	DLD>=	(S1) ≧ (S2)	S1, S2	5	9
232	AND=	DAND=	(S1) = (S2)	S1, S2	5	9
233	AND>	DAND>	(S1) > (S2)	S1, S2	5	9
234	AND<	DAND<	(S1) < (S2)	S1, S2	5	9
236	AND<>	DAND<>	(S1) ≠ (S2)	S1, S2	5	9
237	AND<=	DAND<=	(S1) ≦ (S2)	S1, S2	5	9
238	AND>=	DAND>=	(S1) ≧ (S2)	S1, S2	5	9
240	OR=	DOR=	(S1) = (S2)	S1, S2	5	9
241	OR>	DOR>	(S1) > (S2)	S1, S2	5	9
242	OR<	DOR<	(S1) < (S2)	S1, S2	5	9
244	OR<>	DOR<>	(S1) ≠ (S2)	S1, S2	5	9
245	OR<=	DOR<=	(S1) ≦ (S2)	S1, S2	5	9
246	OR>=	DOR>=	(S1) ≧ (S2)	S1, S2	5	9

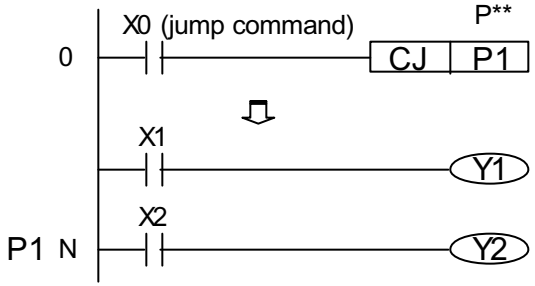
API	Code	Function	Operand	Steps
89	PLS	Rising-edge output	Footnote 1	3
90	LDP	Rising-edge detection operation		3
91	LDF	Falling-edge detection operation		3
92	ANDP	Series connection command for the rising-edge detection operation		3
93	ANDF	Series connection command for the falling-edge detection operation		3
94	ORP	Parallel connection command for the rising-edge detection operation		3
95	ORF	Parallel connection command for the falling-edge detection operation		3
96	TMR	16-bit Timer		4
97	CNT	16-bit Counter		4
97	DCNT	32-bit Counter		6
98	INV	Inverting operation		1
99	PLF	Falling-edge output		3

Footnote 1: API 89~99 belong to the basic commands, and refer to Ch6 Basic Commands for the operand and usage explanations.

Footnote 2: API number with the " *" mark indicates the API commands only support the version V5.4 or above of ES / EX / SS series models.

00 CJ 【P**】 P 00 to P 63 Conditional jump

- Executes the program of specified pointer when the jump command is on.
- Executes the program of the next step when the jump command is off.
- **Program Example**



◎ When X0=ON, program address jumps from 0 to N (label P1) continuing the program, skipping the addresses in between.

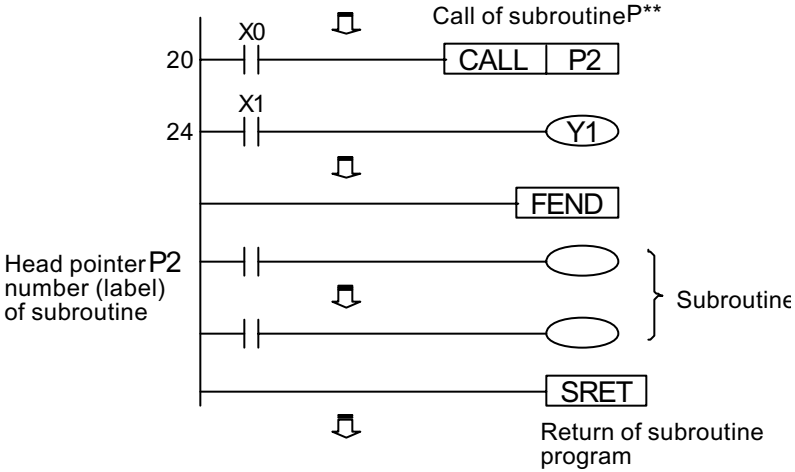
◎ If there is a TMR (timer) in the middle of the address, the timer will stop counting. When X0=OFF, the program will continue from address 0, the CJ command will not be activated, and the timer will continue counting.

01 CALL 【P**】 P 0 to P 63 Call subroutine

- Up to five levels of nesting of the CALL instruction are allowed.
- Executes the subroutine program specified by the pointer (P**)

02 SRET Termination of subroutine program

- Executes the sequence program located at the next step to the CALL instruction when the SRET instruction is executed.
- Indicates the end of subroutine program.
- **Program Example**



◎ When X0 = ON then starts CALL command, jump to P2 and run subroutine. When run SRET command, it will jump back to address 24.

◎ Program continues in the subroutine after the FEND command.

◎ When using CALL command, the numbers of P0 to P63 cannot be duplicated with CJ command.

03 IRET Termination of processing of interrupt program

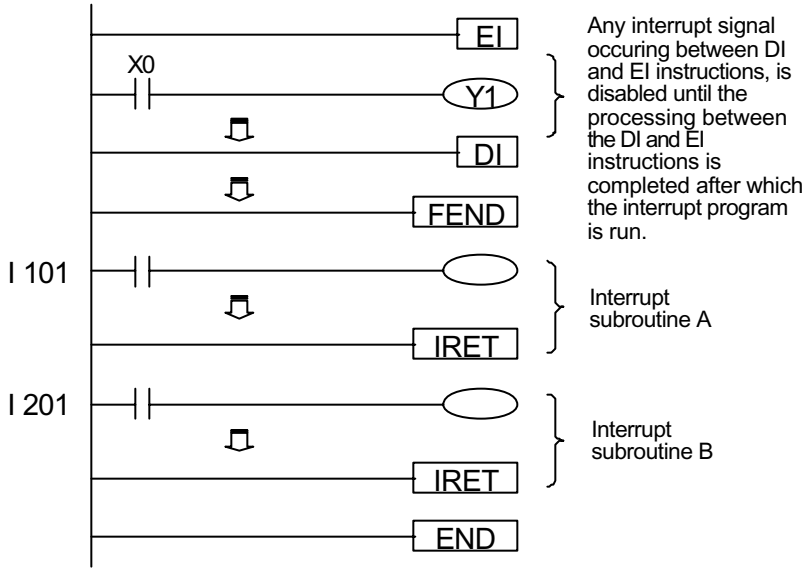
- Indicates the termination of interrupt program.

04 EI Enables interrupt

05 DI Disables interrupt

- During the PLC operation, the program scans the commands between EI and DI, if X001 and X002 are ON, the Interrupt Service Subroutine I 001 and I 201 will be activated when IRET is reached, the main program will resume.

- When interrupting a special auxiliary relay M1050 to M1053, the same interrupting request will not be activated.
- Interrupting cursor (I001 to I201) must be used after the FEND command.
- **Program Example**

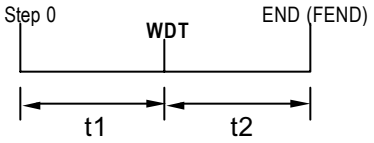


06 FEND Terminates the main routine program

- It has the same function as END command during PLC operation.
- CALL must follow right after FEND command. Interrupt commands also have to follow after FEND command.
- If using several FEND commands, please place the subroutine and interrupt service programs after the last FEND command.

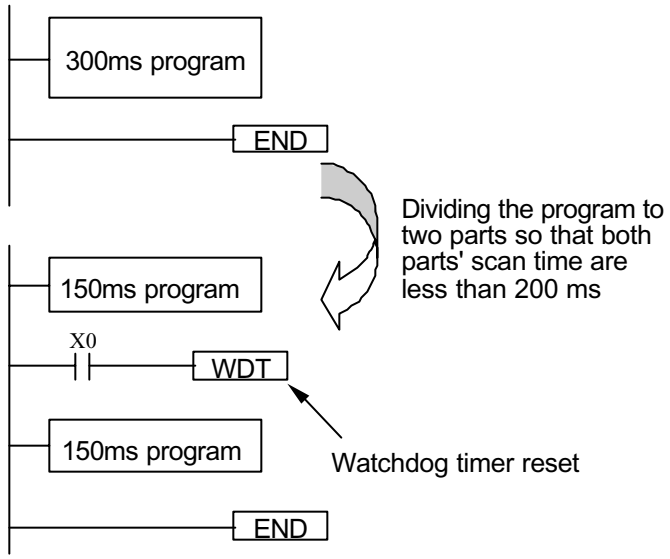
07 WDT Resets the watchdog timer

- Resets the watchdog timer.
- Used when the period of time from step 0 to END (FEND) in the sequence program exceeds the set value of the watchdog timer.
- Set the value of the watchdog timer so "t1" is from step 0 to WDT instruction and "t2" is from the WDT to END (FEND) instruction. (See the diagram below)



- The WDT instruction can be used two or more times during one scan. However, care should be exercised because, during an error, the outputs cannot be turned off immediately.
- If the PLC scan time is more than 200ms, the ERROR LED will flash. The user will have to turn the PLC OFF and then back ON to clear the fault.
- If the program scan time is over 200ms, users can divide the program into 2 parts. Insert the Watchdog Timer in between, so both programs' scanning time will be less than 200ms.
- The WDT time can be changed by the setting value of D1000 (default is 200ms).
- When the ERROR LED of PLC is steady, M1008 and D1008 can be watched.

■ **Program Example**



◎ Program used when the setting of watchdog timer is 200ms and the period of time from 0 to **END** (**FEND**) instruction is 300ms.

08 **FOR** (S) Nested loop begins

Device / Operand	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(S)					◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎

09 **NEXT** Nested loop ends

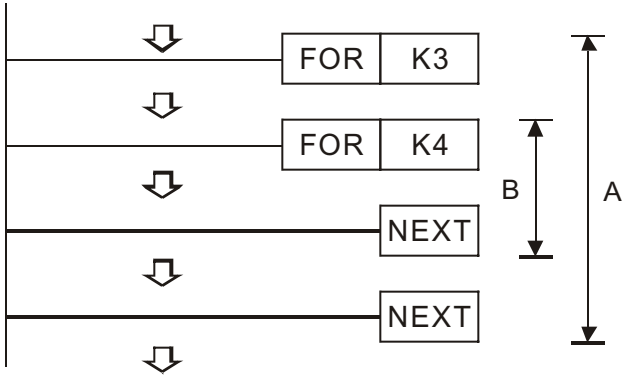
■ **FOR** and **NEXT** instructions are used when "n" nested loops are needed.

■ "n" may be specified as 1 to 32767.

■ When it is not desired to execute the **FOR** to **NEXT** instructions, use the **CJ** command.

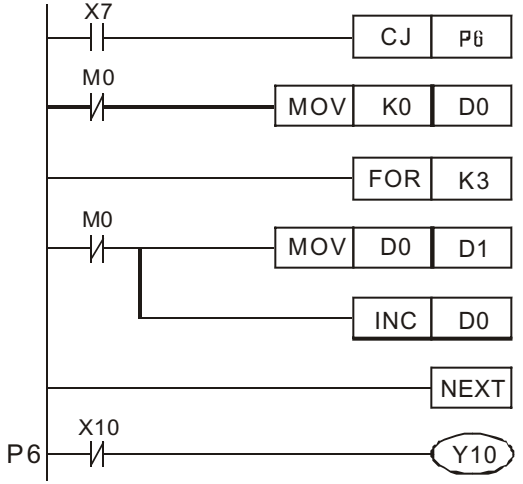
■ Up to four levels of nested **FOR** loops are allowed.

■ For example, loop A operates 3 times but within this loop there is nested loop, B. For every completed cycle of loop A, the loop B will be completed executed 4 times. Therefore, the numbers of loop B operation will be 3 x 4=12 times (A x B).



■ If there are too many loops, the processing time will be executed.

■ **Program Example**

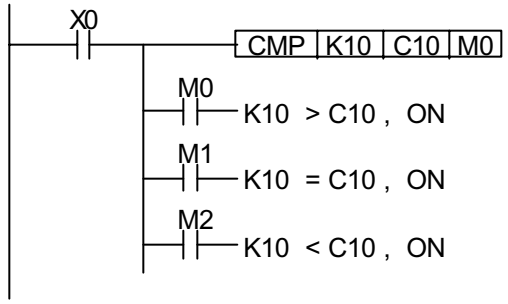


◎ Program which executes the **FOR** to **NEXT** instructions when X7 is off. It does not execute the **FOR** to **NEXT** instructions when X7 is on.

D 10 CMP (S1) (S2) (D) Comparison Output

Operand \ Device	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(S1)					◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎
(S2)					◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎
(D)		◎	◎	◎											

- This function compares the two values that are considered **BIN** values. In the case of comparing hexadecimal. If a numeric value (8 to F) having 1 at the highest bit (B15 in a 16-bit instruction or B31 in a 32-bit instruction) is specified, the comparison will regard the value as the negative of the **BIN** value.
- The comparison instructions verifies 3 items (=, >, <) between the data (S1) and (S2). See the example below.

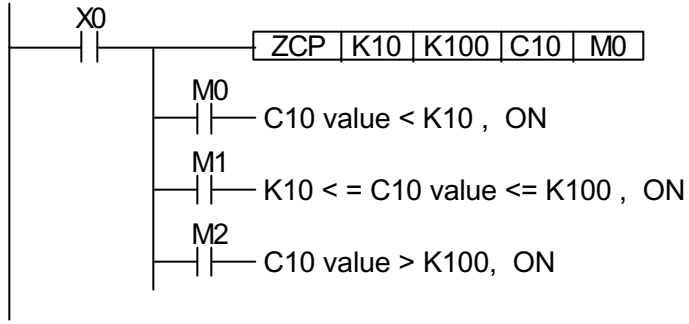


◎ If (D) is set to M0, then M0, M1, M2 will work as the program example as above.

D 11 ZCP (S1) (S2) (S) (D) Zone comparison

Operand \ Device	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(S1)					◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎
(S2)					◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎
(S)					◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎
(D)		◎	◎	◎											

- Compare the value of Operand (S) with its limits (S1) and (S2). If (D) is set to M0, then M0, M1, and M2 will work as follows.



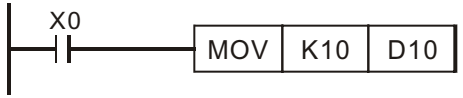
D 12 MOV (S) (D) Data movement

Operand \ Device	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(S)					◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎
(D)								◎	◎	◎	◎	◎	◎	◎	◎

- Transfers the data of device (S) to the device (D).
- If the calculation result is a 32-bit output, (i.e. the application **MUL**) and the data of a 32-bit high-speed counter, users will have to use **DMOV**

command.

■ **Program Example**



◎ When X0 is Off, the content of D10 remain unchanged. If X0 turns On, the data of K10 is moved to D10 data register.

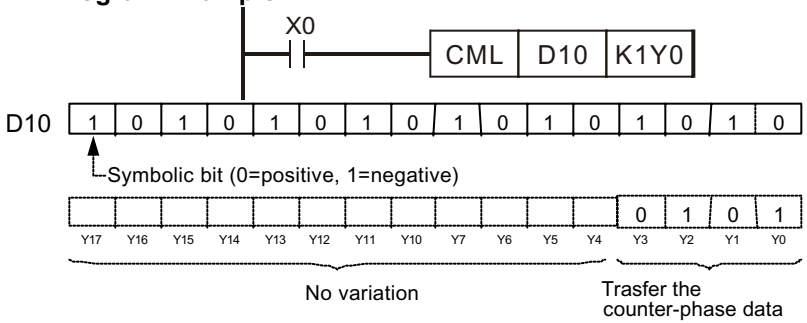
D 14 CML (S) (D) Counter transfer

Operand \ Device	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(S)					◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎
(D)								◎	◎	◎	◎	◎	◎	◎	◎

■ Counter phase the contents of (S) (0→1, 1→0) and have the contents transferred to (D). If the content is of Constant K, this Constant K will be converted to the BIN value automatically.

■ This command can be used during the counter-phase output.

■ **Program Example**



■ When X0 is ON, contents of D10, b0~b3, will be counter transferred to K1Y0.

15 BMOV (S) (D) (n) Block move

Operand \ Device	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(S)											◎	◎	◎		
(D)											◎	◎	◎		
(n)					◎	◎									

■ Move the contents of the n register, with this n register obtained from counting the registers within the (S)-assigned numbers, to the n register within the (D)-assigned number.

■ If the (n)-assigned points exceed the usage range of this device, only those that are within the effective range will be moved.

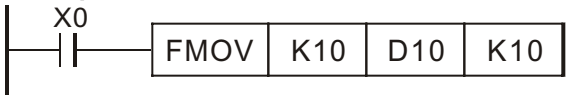
■ **Program Example**

◎ When X0 is ON, move the contents of the three registers D0~D2, to their corresponding registers D10~D12.

D 16 FMOV (S) (D) (n) Multiple points movement

Operand \ Device	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(S)					◎	◎					◎	◎	◎		
(D)											◎	◎	◎		
(n)					◎	◎									

- Move the contents of (S) to the n register, with this n register obtained from counting the registers within the (D) -assigned numbers.
- If the n-assigned points exceed the usage range of this device, only those that are within the effective range will be moved.
- **Program Example**

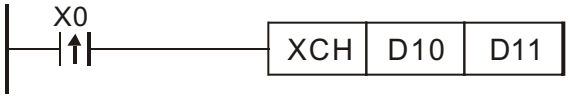


◎ When X0 is ON, move Constant K10 to the ten registers (D10~D19) starting from D10.

D **17** **XCH** (D1) (D2) Data exchange

Device / Operand	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(D1)								◎	◎	◎	◎	◎	◎	◎	◎
(D2)								◎	◎	◎	◎	◎	◎	◎	◎

- Exchange the contents of (D1) and (D2) with each other.
- Generally, it is advised to use the pulse wave contact to drive this command, otherwise, this command will keep going on and on.
- **Program Example**

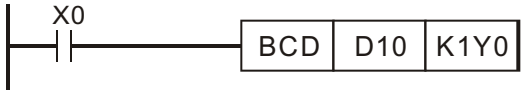


When X0 goes from OFF→ON, contents of D10 and D11 will exchange with each other.

D **18** **BCD** (S) (D) Converts BIN data into BCD

Device / Operand	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(S)							◎	◎	◎	◎	◎	◎	◎	◎	◎
(D)								◎	◎	◎	◎	◎	◎	◎	◎

- Converts **BIN** data (0~9999) of the device (S) into **BCD** and transfers the result to the device (D).
- If the data of source (S) is outside the range of 0 to 9999, there is an operation error and the error flag (M1067 and M1068) turns on.
- **Program Example**

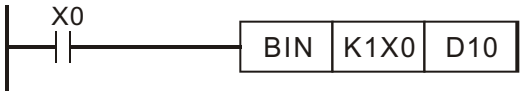


◎ When X0 = ON, the D10 **BIN** value will be converted to **BCD**, and the result saved in K1Y0.

D **19** **BIN** (S) (D) Converts BCD data into BIN

Device / Operand	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(S)							◎	◎	◎	◎	◎	◎	◎	◎	◎
(D)								◎	◎	◎	◎	◎	◎	◎	◎

- Converts **BCD** data (0 to 9999) of device (S) into **BIN** and transfer the result to the device (D).
- If each digit of source (S) is outside the range of 0 to 9, there is an operation error and the error flag (M1067 and M1068) turns on.
- **Program Example**



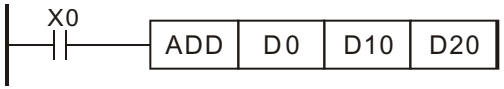
◎ Program which converts the **BCD** data of X0 to X03 into **BIN** and stores the result into D10 when X10 turns on.

D **20** **ADD** (S1) (S2) (D) Performs the addition of BIN data

Operand \ Device	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(S1)					◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎
(S2)					◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎
(D)								◎	◎	◎	◎	◎	◎	◎	◎

■ Performs the addition on **BIN** data (S1) and the **BIN** data (S2), and stores the addition result into the device (D).

■ **Program Example**



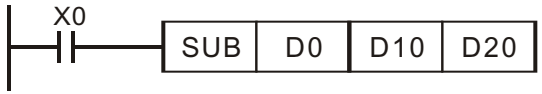
◎ Program which adds the contents of D0 to the content of D10 and outputs the result to D20 when X0 turns on.

D **21** **SUB** (S1) (S2) (D) Performs the subtraction of BIN data

Operand \ Device	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(S1)					◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎
(S2)					◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎
(D)								◎	◎	◎	◎	◎	◎	◎	◎

■ Performs the subtraction of **BIN** data (S1) and the **BIN** data (S2), and stores the subtraction result into the device (D).

■ **Program Example**



◎ Program which outputs the difference between the content of D0 and the content of D10 to D20 when X0 turns on.

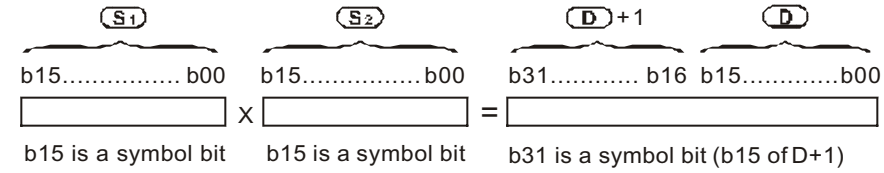
D **22** **MUL** (S1) (S2) (D) Performs the multiplication of BIN data

Operand \ Device	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(S1)					◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎
(S2)					◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎
(D)								◎	◎	◎	◎	◎	◎	◎	◎

■ Performs the Multiplication of **BIN** data (S1) and the **BIN** data (S2), and stores the multiplication result into the device (D).

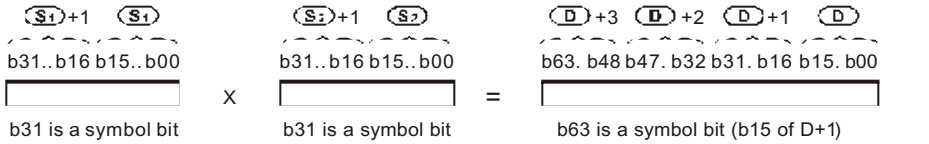
■ The judgment of whether the data of (S1) and (S2) are positive or negative is made at the highest bit (b15) and for (D) at (b31).

■ 16-bit operation



b15=0,S1is a positive value b15=0,S2is a positive value b31=0,Sdis a positive value
b15=1,S1is a negative value b15=1,S2is a negative value b31=1,Sdis a negative value

■ 32-bit operation



b31=0,S(S+1) are positive value b31=0,S(S2+1) are positive value b63=0, D1(D1+1) (D1+2) (D1+3) are positive value
b31=1,S(S+1) are negative value b31=1,S(S2+1) are negative value b63=1, D1(D1+1) (D1+2) (D1+3) are negative value

■ **Program Example** (16-bit)

◎ The above program stores the multiplication result of D0 and D10 in BIN to D20 and D21 when X0 turns on.

◎ The upper 16-bit will be saved in D21 and the lower 16-bit will be saved in the D20.

◎ The polarity of the result is indicated by the OFF/ON of the most significant bit. OFF indicates the value of positive 0 and ON indicates the value of negative 1.

■ **Program Example** (32-bit)

◎ The above program stores the multiplication result of the 32-bit **BIN** data of D0 and D1 and the 32-bit BIN data of D10 and D11 to the 64-bit **BIN** data of D20 to D23.

◎ The polarity of the result is indicated by the OFF/ON of the most significant bit. OFF indicates the value of positive 0 and ON indicates the value of negative 1.

D **23** **DIV** (S1) (S2) (D) Performs the division BIN data

Device / Operand	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(S1)					◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎
(S2)					◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎
(D)								◎	◎	◎	◎	◎	◎	◎	◎

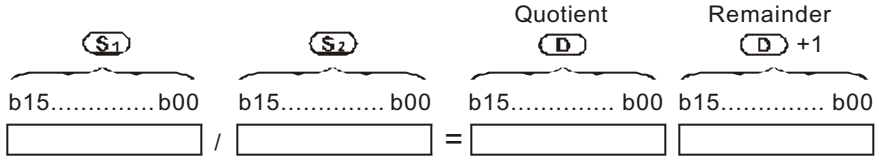
■ Performs the division of **BIN** data (S1) and the **BIN** data (S2), and stores the result into the device (D).

■ In regards to the operation result, the quotient and remainder are stored using 32 bits for a word device, and only the quotient is stored using 16 bits for a bit device.

■ The judgment of whether the data of (S1) and (S2) are positive or negative is made at the highest bit (b15) and for (D), at (b31).

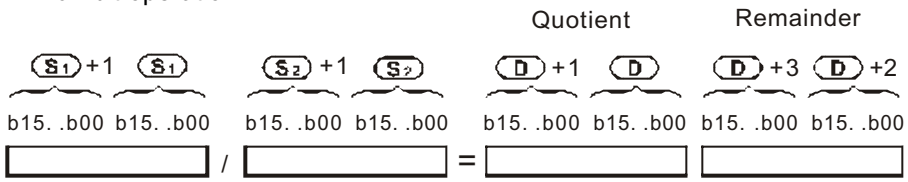
■ When using the DDIV command, the special register (additional special device D) cannot serve as indirect assigned function.

■ 16 bit operation



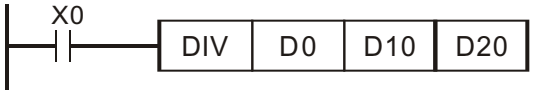
Quotient : Stored to the lower 16 bits.
Remainder : Stored to the upper 16 bits. (Stored only in the case of a word device.

■ 32 bit operation



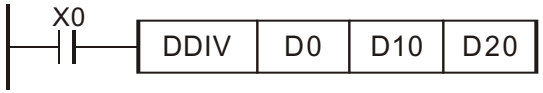
Quotient : Stored to the lower 32 bits.
Remainder : Stored to the upper 32 bits. (Stored only in the case of a word device.

■ **Program Example** (16 bit)



◎ Program which outputs the quotient and remainder, obtained by dividing the data D0 by D10, to D20 and D21 when X0 turns on.

■ **Program Example** (32-bit)



■ When X0 = ON, performs the division of **BIN** data (D1, D0) and **BIN** data (D11, D10), the quotient stored (D21, D20) and the remainder stored in (D23, D22).

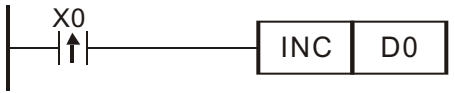
D **24** **INC** (D) Performs the addition of 1

Device / Operand	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(D)								◎	◎	◎	◎	◎	◎	◎	◎

■ Performs the addition of 1 to the device (D).

■ Generally, it is advised to use the pulse wave contact to drive this command, otherwise, this command will keep going on and on.

■ **Program Example**



◎ When X0 = ON, the content of D0 will perform the addition of 1.

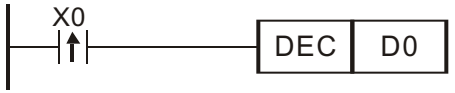
D **25** **DEC** (D) Performs the subtraction of 1

Device / Operand	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(D)								◎	◎	◎	◎	◎	◎	◎	◎

■ Performs the subtraction of 1 from the device (D).

■ Generally, it is advised to use the pulse wave contact to drive this command, otherwise, this command will keep going on and on.

■ **Program Example**



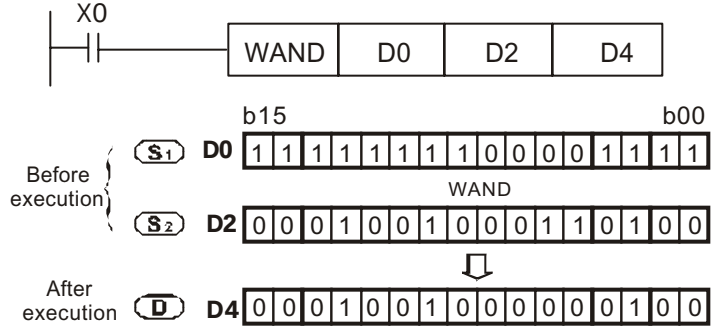
◎ When X0 = ON, Performs the subtraction of 1 from the device (D).

D **26** **WAND** (S1) (S2) (D) Performs the logical product

Device / Operand	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(S1)					◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎
(S2)					◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎
(D)								◎	◎	◎	◎	◎	◎	◎	◎

■ Performs the logical product of the 16-bit data of device (S1) and the 16-bit data of device (S2) per bit, and stores the result into the device (D).

■ **Program Example** (16-bit)

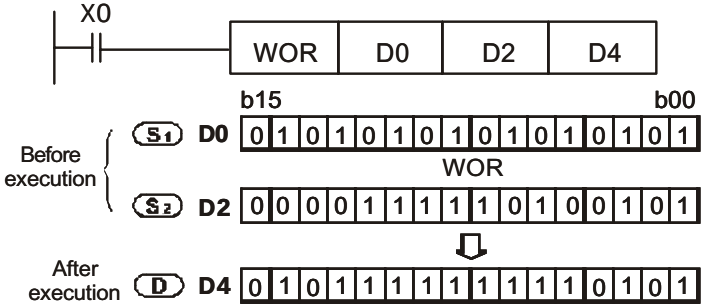


D 27 WOR S1 S2 D Logic or (OR) operation

Operand \ Device	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
S1					◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎
S2					◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎
D								◎	◎	◎	◎	◎	◎	◎	◎

■ Performs the logical add of the 16-bit data of device S1 and the 16-bit data of device S2 per bit, and stores the result into the device D.

■ **Program Example** (16-bit)

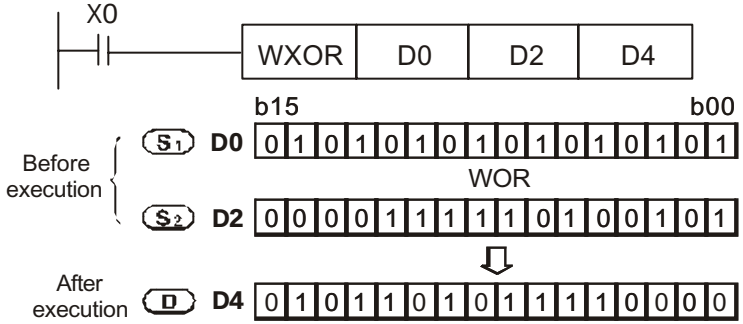


D 28 WXOR S1 S2 D Performs the exclusive logical add

Operand \ Device	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
S1					◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎
S2					◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎
D								◎	◎	◎	◎	◎	◎	◎	◎

■ Performs the exclusive OR of the 16-bit data of device S1 and the 16-bit data of device S2 per bit, and stores the result into the device D.

■ **Program Example** (16-bit)



D 29 NEG D Complementary of 2

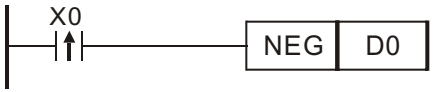
Operand \ Device	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
D								◎	◎	◎	◎	◎	◎	◎	◎

■ Once the command is executed, the assigned device, D, will be served as the complementary of 2.

■ It is generally advised to use the pulse wave contact to drive this

command, otherwise, it will keep going on and on.

■ **Program Example**



◎ When X goes from OFF→ON, every bit of the D0 contents will be countered (0→1, 1→0) and be added with 1, and will then be saved in the original register, D0.

◎ This command could convert the negative BIN value to the positive number, and that is, to get its absolute value.

D 30 ROR (D) (n) Rotate to the right

Operand \ Device	Bit device				Word device										
	X	Y	M	S	K	H	K n X	K n Y	K n M	K n S	T	C	D	E	F
(D)								◎	◎	◎	◎	◎	◎	◎	◎
(n)					◎	◎									

■ Essential condition: n≦16 (16-bit command), n≦32 (32-bit command).

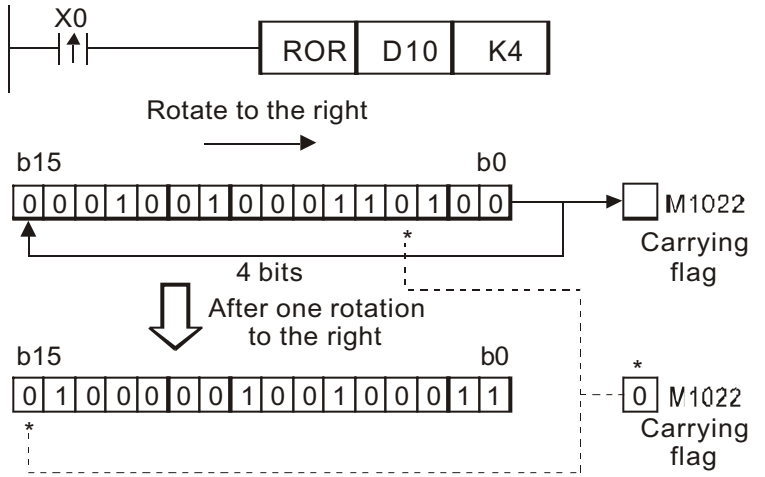
■ The (D) ROR command is used to assign the (32) 16-bit data to conduct the rotate-to-the-right command. The LSB that is rotating to the right simultaneously will be moved to the carrying flag (CY) M1022.

■ It is generally advised to use the pulse wave contact to drive this command, otherwise, it will keep going on and on.

■ When M, Y, S are assigned to serve as the bit operand, only K4 (16-bit) and K8 (32-bit) are effective, e.g. K4M0, K8Y0.

■ Command Motion Explanation

◎ When X0 goes from OFF→ON, the 16 bit data of D10 will rotate 4 bits to the right, as shown in the diagram, and b3 that located at D10 originally will then be moved to the carrying flag (CY) M1022.



D 31 ROL (D) (n) Rotate to the left

Operand \ Device	Bit device				Word device										
	X	Y	M	S	K	H	K n X	K n Y	K n M	K n S	T	C	D	E	F
(D)								◎	◎	◎	◎	◎	◎	◎	◎
(n)					◎	◎									

■ Essential condition: n≦16 (16-bit command), n≦32 (32-bit command).

■ The (D) ROL command is used to assign the (32) 16-bit data to conduct the rotate-to-the-left command. The MSB that is rotating to the left simultaneously will be moved to the carrying flag (CY) M1022.

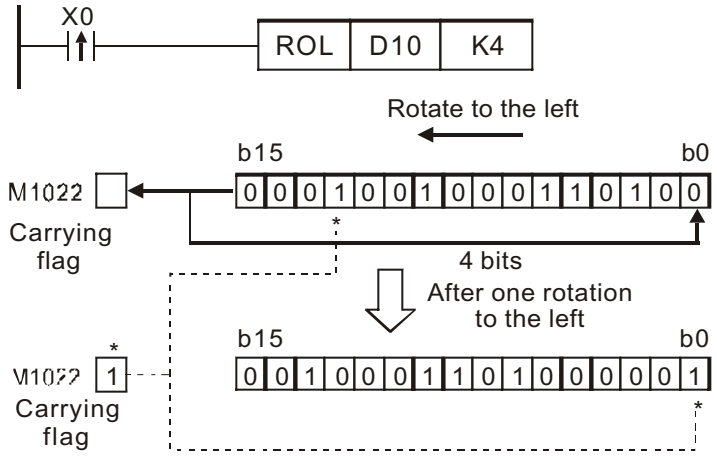
■ It is generally advised to use the pulse wave contact to drive this command, otherwise, it will keep going on and on.

■ When M, Y, S are assigned to serve as the bit operand, only K4 (16-bit) and K8 (32-bit) are effective, e.g. K4M0, K8Y0.

■ Command Motion Explanation

◎ When X0 goes from OFF→ON, the 16 bit data of D10 will rotate 4 bits to the left, as shown in the diagram, and b12 that located at D10

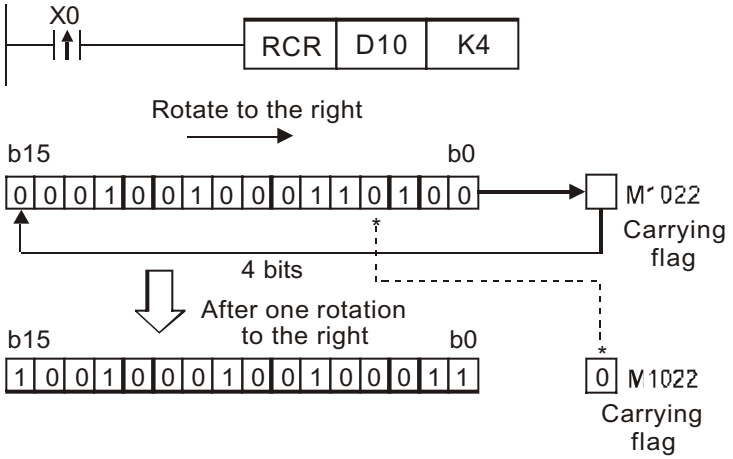
originally will then be moved to the carrying flag (CY) M1022.



D **32** **RCR** (D) (n) Rotate to the right with the carrying flag attached

Operand \ Device	Bit device				Word device										
	X	Y	M	S	K	H	K n X	K n Y	K n M	K n S	T	C	D	E	F
(D)								◎	◎	◎	◎	◎	◎	◎	◎
(n)					◎	◎									

- Essential condition: n≦16 (16-bit command), n≦32 (32-bit command).
- The (D) RCR command is used to assign the (32) 16-bit data with the attached carrying flag (M1022) to conduct the rotate-to-the-right command.
- It is generally advised to use the pulse wave contact to drive this command, otherwise, it will keep going on and on.
- When M, Y, S are assigned to serve as the bit operand, only K4 (16-bit) and K8 (32-bit) are effective, e.g. K4M0, K8Y0.
- Command Motion Explanation
- When X0 goes from OFF→ON, the 16 bit data of D10, along with the attached carrying flag (M1022), will rotate 4 bits to the right, as shown in the diagram, and b3 that located at D10 originally will then be moved to the carrying flag M1022, and that the original contents of the carrying flag M1022 will be moved to the bit of b12.



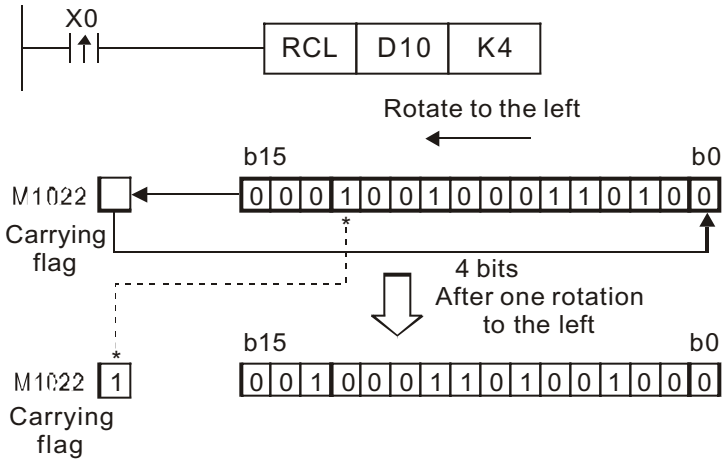
D **33** **RCL** (D) (n) Rotate to the left with the carrying flag attached

Operand \ Device	Bit device				Word device										
	X	Y	M	S	K	H	K n X	K n Y	K n M	K n S	T	C	D	E	F
(D)								◎	◎	◎	◎	◎	◎	◎	◎
(n)					◎	◎									

- Essential condition: n≦16 (16-bit command), n≦32 (32-bit command).
- The (D) RCL command is used to assign the (32) 16-bit data with the attached carrying flag (M1022) to conduct the rotate-to-the-left command.
- It is generally advised to use the pulse wave contact to drive this command, otherwise, it will keep going on and on.

- When M, Y, S are assigned to serve as the bit operand, only K4 (16-bit) and K8 (32-bit) are effective, e.g. K4M0, K8Y0.
- Command Motion Explanation

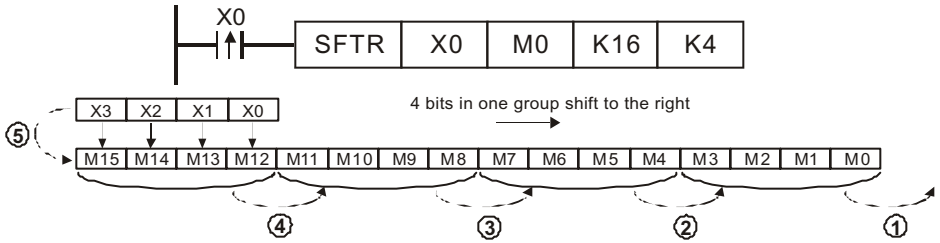
◎ When X0 goes from OFF→ON, the 16 bit data of D10, along with the attached carrying flag (M1022), will rotate 4 bits to the left, as shown in the diagram, and b12 that located at D10 originally will then be moved to the carrying flag M1022, and that the original contents of the carrying flag M1022 will be moved to the bit of b3.



34 SFTR (S) (D) (n1) (n2) Shifts the data of device specified to the right

Operand \ Device	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(S)	◎	◎	◎	◎											
(D)		◎	◎	◎											
(n1)					◎	◎									
(n2)					◎	◎									

- Requirement: n2≦n1≦512. Shifts (n2) data bits of device (S) to the right by (n1) bits. (n2) bits, which begin with (D), are shifted to the right.
- It is generally advised to use the pulse wave contact to drive this command, otherwise, it will keep going on and on.
- **Program Example**



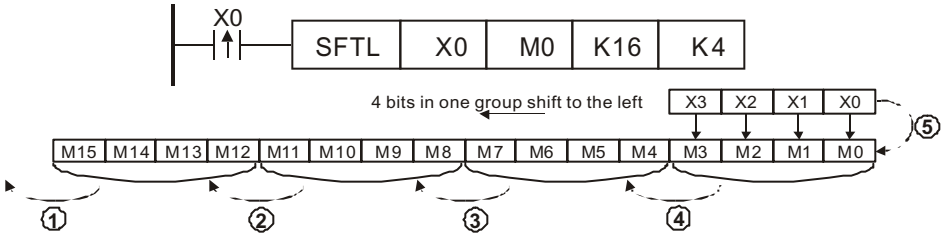
◎ Please Notice: If use the pulse wave contact to drive this command, X0 will shift (n2) bits to the right when X0 is in the rising-edge. If use the normal On contact to drive this command, the bit shifting operation will occur every time during every scan.

35 SFTL (S) (D) (n1) (n2) Shifts the data of device specified to the left

Operand \ Device	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(S)	◎	◎	◎	◎											
(D)		◎	◎	◎											
(n1)					◎	◎									
(n2)					◎	◎									

- Requirement: n2≦n1≦512
- Shifts (n2) data bits of device (S) to the left by (n1) bits. (n2) bits, which begin with (D), are shifted to the left.

■ **Program Example**



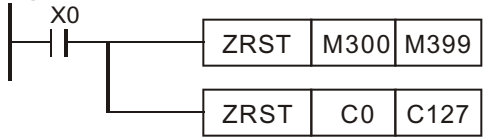
◎ Please Notice: If use the pulse wave contact to drive this command, X0 will shift (n2) bits to the right when X0 is in the rising-edge. If use the normal On contact to drive this command, the bit shifting operation will occur every time during every scan.

40 ZRST (D1) (D2) Resets a range of device specified.

Device / Operand	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(D1)		◎	◎	◎							◎	◎	◎		
(D2)		◎	◎	◎							◎	◎	◎		

■ Requirement: (D1) ≦ (D2), and must be in the same category.

■ **Program Example**



◎ When X0 = O, M300 to M399 will be OFF. The value of C200 to C210 counters will be set to 0.

41 DECO (S) (D) (n) 8 ⇨ 256 bit decode

Device / Operand	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(S)	◎	◎	◎	◎	◎	◎					◎	◎	◎	◎	◎
(m)		◎	◎	◎							◎	◎	◎	◎	◎
(D)					◎	◎									

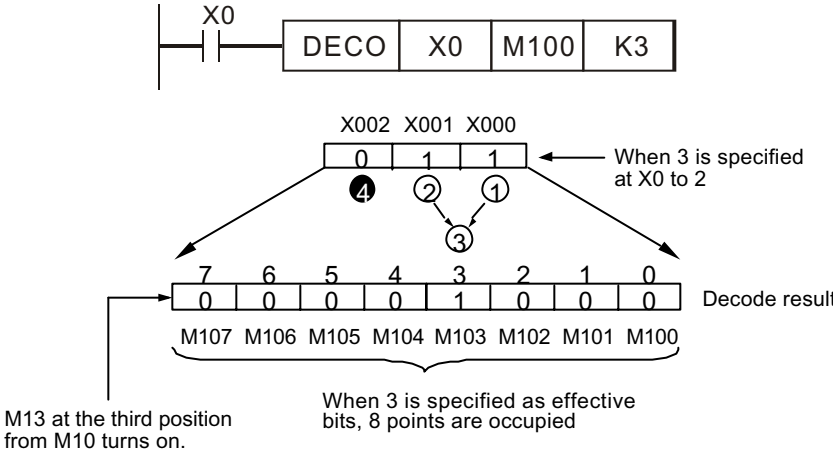
■ Decodes the lower "n" bits of device (S) and stores the result of decode data to 2^n bits which begin with the device (n).

■ For "n", 1 to 8 can be specified.

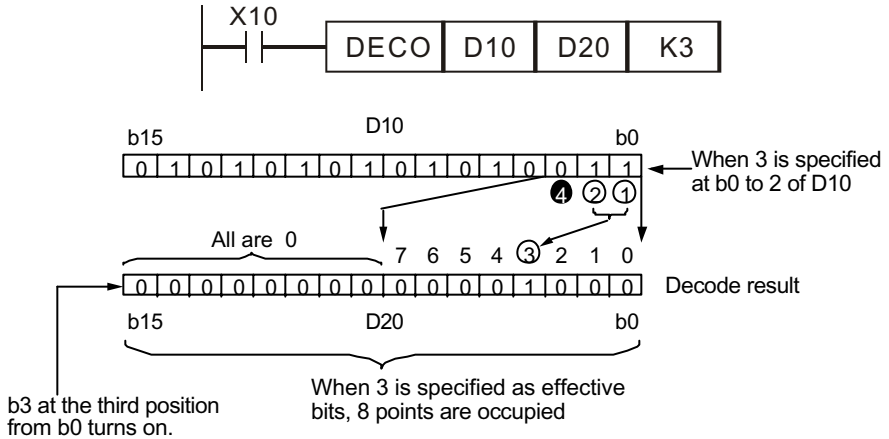
■ When n=0 or n>8 the calculation error will occur.

■ A bit device is treated as one bit and a word device as 16 bits.

■ (D) is used in the case of a bit device, 0<n≦8



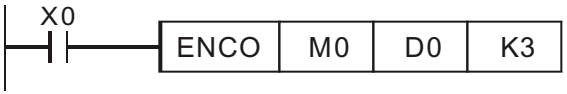
■ (D) is used in the case of a word device, 0<n≦4

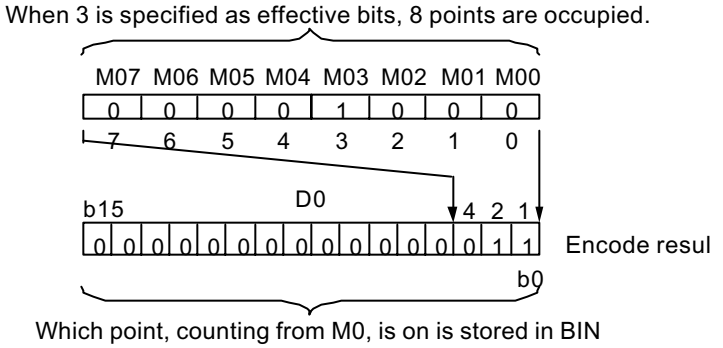


42 ENCO (S) (D) (n) 256 ⇨ 8 bit encode

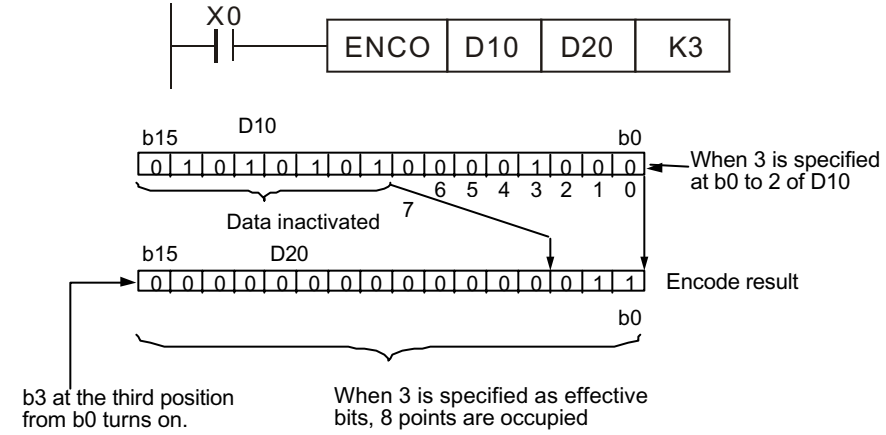
Operand \ Device	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(S)	◎	◎	◎	◎							◎	◎	◎	◎	◎
(D)											◎	◎	◎	◎	◎
(n)					◎	◎									

- Encodes the data of 2^n bits, which begin with (S), and stores the result to (D).
- For (n), 1 to 8 can be specified.
- When n=0 or n>8 the calculation error will occur.
- When multiple bits are 1, processing is performed for the last bit position.
- (S) is used in the case of a bit device, 0<n≦8





- (S) is used in the case of word device, 0<n≦4

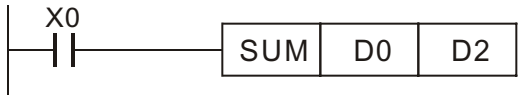


D 43 SUM (S) (D) Sum of the ON bit

Operand \ Device	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(S)					◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎
(D)								◎	◎	◎	◎	◎	◎	◎	◎

■ Count all the bits with "1" as its content within (S), and have this counted number saved in (D).

■ **Program Example**



◎ When X=ON, all the bits that with "1" as its content within D0 will be counted, and have this counted number saved in D2.

◎ If the contents of these 16 bits are "0", the "Zero" flag signal M8020=ON.

◎ When using the 32 bit commands, DSUM or DSUMP, in the above-mentioned program, the total number of the 32 bits within D1 and D0 that possess "1" as its content will be counted and saved in D2, and D3=0.

D 44 BON (S) (D) (n) Determine the ON bit

Operand \ Device	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(S)					◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎
(D)		◎	◎	◎											
(n)					◎	◎									

■ Essential condition: when it is of the 16 bit commands, n=0~15, and when it is of the 32 bit commands, n=0~13.

■ With the content of (S), if the content of the (n) bit is "1", the (D)-assigned bit device will be set as "ON".

■ **Program Example**

◎ When X0=ON and that the 15th bit of D0 is "1", M0=ON.

◎ Once X0 is switched to OFF, M0 will stay at its previous ON/OFF status.

D 45 MEAN (S) (D) (n) Mean value

Operand \ Device	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(S)							◎	◎	◎	◎	◎	◎	◎		
(D)								◎	◎	◎	◎	◎	◎	◎	◎
(n)					◎	◎									

■ Add the contents of the (S)-assigned (n) registers, and have the sum ddivided by (n) to obtain a mean value.To save this mean value in the designated (D).

■ **Program Example**

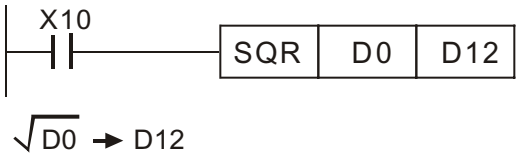
◎ When X0=ON, add up the contents of the 4 registers starting from D10 (assigned by this command), divide the sum by 4 to obtain the mean value.To save the value in the assigned D20.

If there is remainder in this calculation, discard the remainder. If the assigned device number exceeds the normal usable range, only those that within the range could be processed.

D 48 SQR (S) (D) The square root of BIN

Operand \ Device	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(S)					◎	◎							◎		
(D)													◎		

- After getting the sqare root of the content of device that (S) designates, save it into the device that (D) designates.
- The value that (S) can designate is positive number. If (S) designates negative number, PLC will regard it as command operation error, M8067=On and this command won' t be executed.
- (D) just gets the integer of the result and the decimal will be discarded. If there is decimal discarded, carrying flag M1021=On.
- If the operation result of (D) is 0, zero flag M1020=On.
- **Program Example**

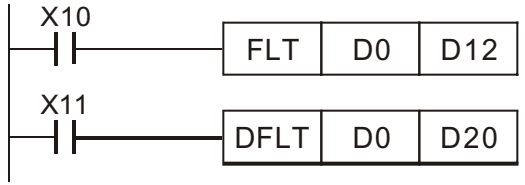


◎ When X10=On, the content of D0 will be saved in D12 after the operation of square root.

D 49 **FLT** (S) (D) BIN integer→ decimal of binary number system

Operand \ Device	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(S)													◎		
(D)													◎		

- (S): change source device. (D): the device that used to save change result.
- When M1081=Off, convert BIN integer to decimal of binary system.
- When M1081=On, convert decimal of binary system to BIN integer (discard the value of decimal)
- Constant K and H will be converted to decimal of binary system in decimal operation so they don' t need to use this command to convert.
- **Program Example**

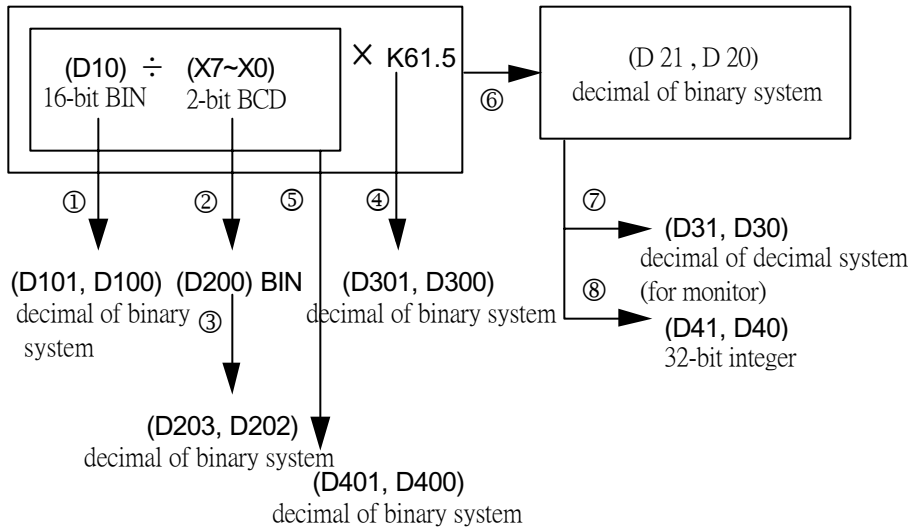


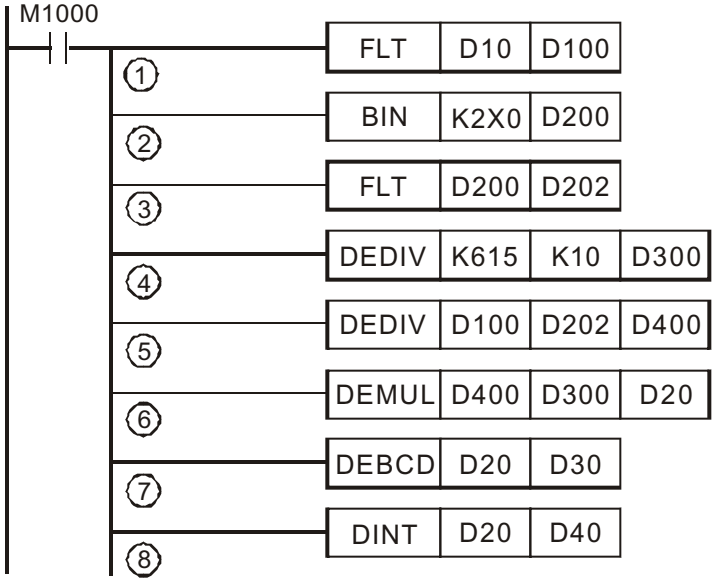
◎ When X10=On, D0(BIN integer) will be converted to D13, D12(decimal of binary system)

◎ When X11=On, D1 and D0(BIN integer) will be converted to D21, D20(decimal of binary system)

- **Program Example**

Using application command to complete the following operation.





- Covert D10(BIN integer) to D101, D100(decimal of binary system).
- Covert the value of X7~X0(BIN integer) to D200(BIN integer).
- Covert D200(BIN integer) to D203, D202 (decimal of binary system).
- Save the result of K615 ÷ K10 to D301, D300 (decimal of binary system)
- Save the result of decimal of binary system of (D101, D100) ÷ (D203, D202) to D401, D400 (decimal of binary system)
- Save the result of decimal of binary system of (D401, D400) × (D301, D300) to D21, D20 (decimal of binary system)
- Covert decimal of binary system (D21, D20) to decimal of decimal system (D31, D30)
- Covert decimal of binary system (D21, D20) to BIN integer D41, D40
- Please refert to page 7-4 Handling of Decimal for detail.

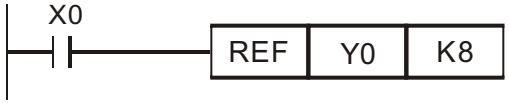
50 REF (D) (n) Input/Output refresh immediately

(D)	X0, X10, Y0, Y10
(n)	K8, K16, H8, H10

- The state of all PLC inputs and outputs will be refreshed after scanning to END. The state of inputs is read from external inputs to save in inputs memory. The output terminals send outputs memory to output device after END command. Therefore, this command can be used during algorithm process when need to input/output the newest data.
- The state of all inputs and outputs may change immediately after they are scanned. If the user does not want to wait for the next scan time, the instruction REF may be used.
- The input points and output points that this command handles is the I/O point of MPU: X0~X17, Y0~Y17
- **Program Example**

◎ When X0 = ON, the 8 input points will be scanned immediately.

- **Program Example**



◎ When X0 = On, the output signal Y0~Y7 (8 points) are sent to output terminal.

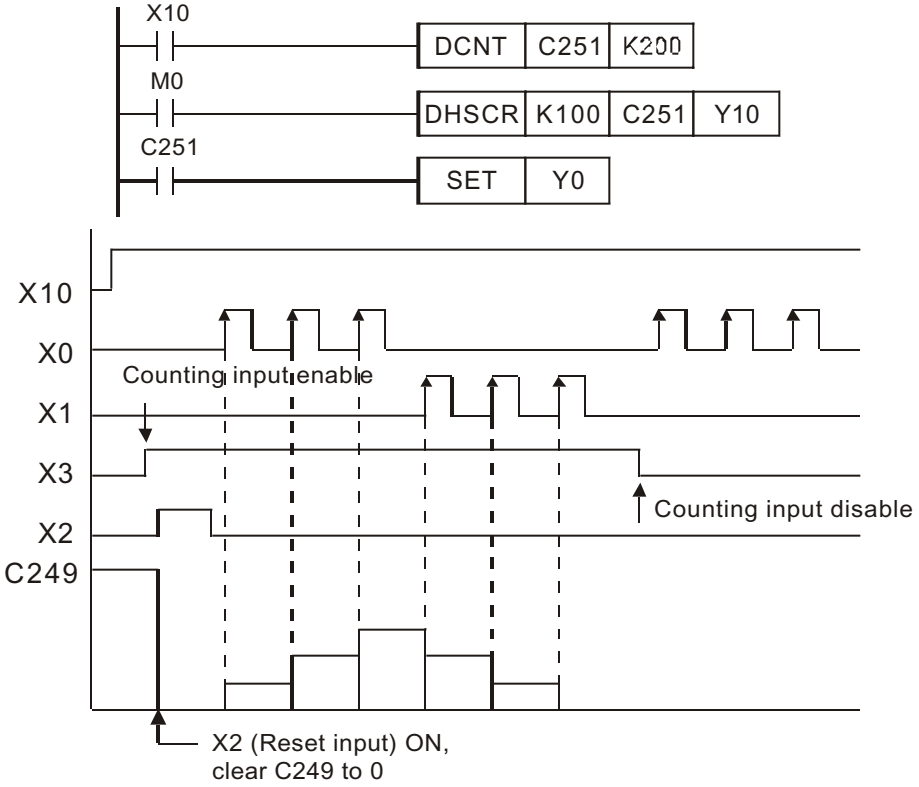
D **53** **HSCS** (S1) (S2) (D) 32-bit High speed counter comparison set

Operand \ Device	Bit device				Word device								
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D
(S1)					◎	◎	◎	◎	◎	◎	◎	◎	◎
(S2)	C235~C254												
(D)		◎	◎	◎									

D **54** **HSCR** (S1) (S2) (D) 32-bit High speed counter comparison reset

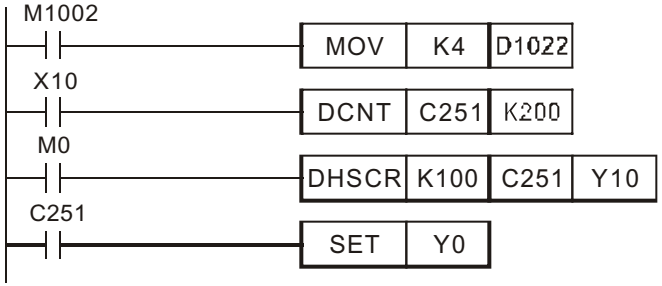
Operand \ Device	Bit device				Word device								
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D
(S1)					◎	◎	◎	◎	◎	◎	◎	◎	◎
(S2)	C235~C254												
(D)		◎	◎	◎									

- There is no 16-bit command for API 53 and API 54. (only 32-bit command, DHSCS and DHSCR are available)
- Users must use X0~X3 for High-Speed Counter inputs.
- The goal of counting is to do a special action when the count (S2) reaches a preset value (S1). A preset is a number you derive and store so the counter will constantly compare and use for other functions.
- The counter compares the current count with up to 4 preset values, which you define by using instruction DHSCS and DHSCR. If (D) is device Y, then only devices Y00~Y17 are effective.
- All high speed counters have its specified high speed counter terminals. Every input rapid pulse by high speed counting use an interrupt process to input signal counting value.
- **Program Example**

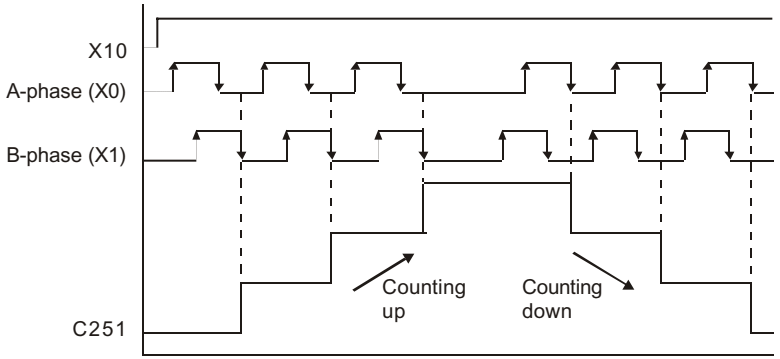


- When M0 = On and the present value of the high speed timer C249 changes from (99 to 100) or (101 to 100), then Y10 will be ON.
- When the present value of high-speed timer C249 changes from (999 to 1000) or (1001 to 1000). C249 will be activated, and Y17 will be ON, but there will be a delay due to the program scan time.
- **Program Example**

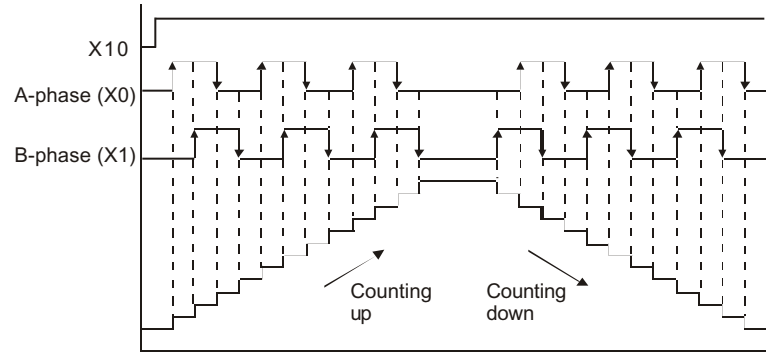
◎ AB phase high speed counter can be changed to inactivated by using D1022 double frequency setting mode when PLC goes from STOP to RUN.



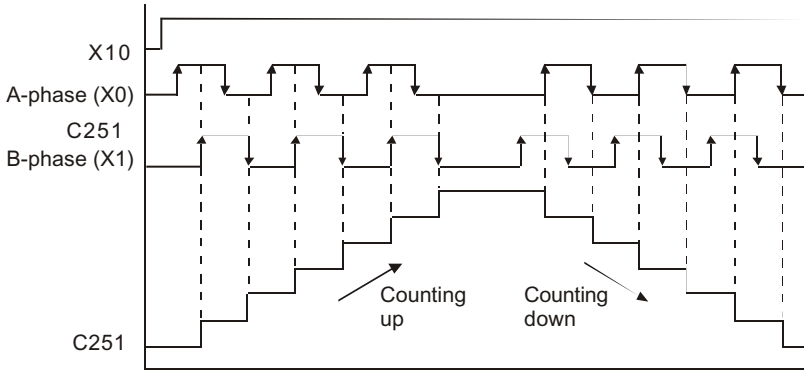
◎ When D1022=K1, the timing diagram of one double frequency will be as follows:



◎ When D1022=K4, the timing diagram of one double frequency will be as follows:



◎ When D1022=other value, the timing diagram of tw0 double frequency will be as follows:



■ When M0 = ON, High speed counter C251 counts as follow:

Count value			Contact status	Y10
101	→	100	No change	No change
100	→	99	OFF	OFF
99	→	100	ON	ON
100	→	101	ON	ON

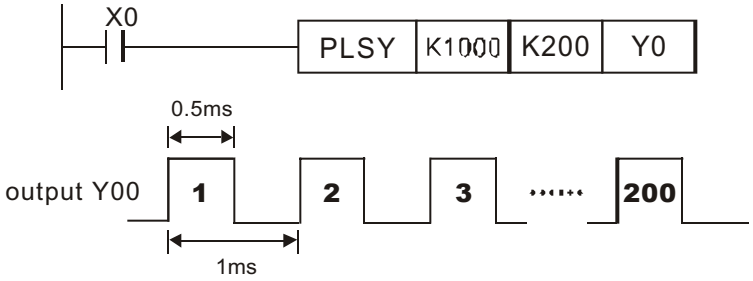
■ When high-speed counter C251' s value changes from (199 to 200) or from (201 to 200), the contact of C251 will be ON and Y10 will be ON. However, there will be scan time delay.

D **57** **PLSY** (S1) (S2) (D) Pulse output

Operand \ Device	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(S1)					◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎
(S2)					◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎
(D)	Y0, Y1														

■ Generate specified frequency and number of pulse commands

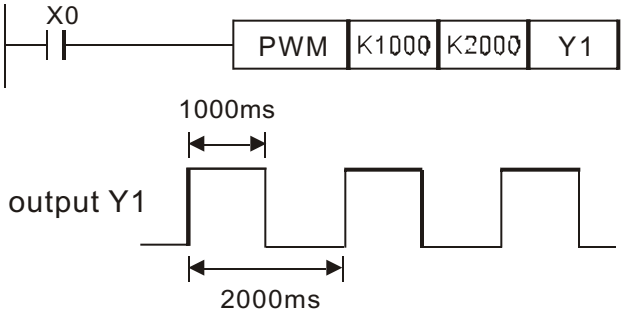
- (S1) specified the frequency 10 ~ 10KHz.
- 10KHz could be reached with single shaft, whereas 5KHz could be reached with dual shaft.
- (S2) specified the pluses. 16-bit: 1 to 32767, 32-bit: 1 to 2147483647
- (D) specified the output Y as output pulse, only Y0, Y1 is effective (please use the transistor output as the output module).
- When M1010 is ON, the Y0 pulse wave would output continuously and would not be restricted to the pulse wave' s quantity. When M10230 is ON, the Y1 pulse wave will output continuously and would not be restricted to the pulse wave quantity.
- After the output of the Y0 pulse wave is completed, M1029 will be set as ON. After the output of the Y1 pulse wave is completed, M1030 will be set as ON. And when the PLSY command is OFF, M1029 or M1030 will be OFF.
- **Program Example**



58 PWM (S1) (S2) (D) Pulse width modulation output

Operand \ Device	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(S1)					◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎
(S2)					◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎
(D)	Y01														

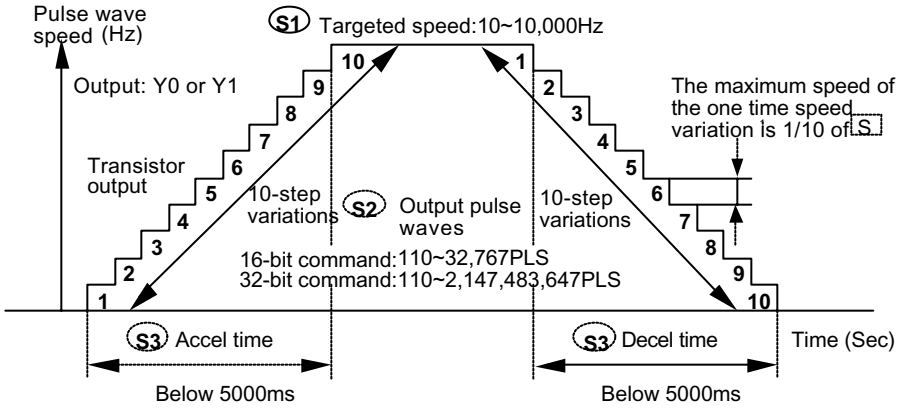
- (S1) specified the pulse width as t: 0 to 32767ms.
- (S2) specified cycle as T: 1 to 32767ms (S1) ≦ (S2).
- (D) specified the output Y as output pulse, only Y01 is effective.
- Once M1070 is of the PWM command, the pulse unit will switch the flag. If ON it is 100 μs, and if OFF, 1ms.
- **Program Example**



59 PLSR (S1) (S2) (S3) (D) Pulse wave output with accel/decel speeds

Operand \ Device	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(S1)					◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎
(S2)					◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎
(S3)					◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎
(D)	Y0, Y1														

- The wave output command with the accel/decel speeds.
- The acceleration is conducted when the pulse wave goes from the static status to reaching its targeted speed, and getting faster when the targeted speed is to be reached. The pulse wave will stop its output once the targeted distance is reached.



■ **Program Example**

◎ Settings of all the operands are as follows.

S1 Maximum speed (H_Z)

- Settings: 10~10,000 (H_Z)
  The maximum speed is deemed to be the multiples of 10, if not, the first unit will be discarded automatically.
- 1/10 of the maximum speed is the one time variation of the accel/decel speed. Note that the condition meets the acceleration requirement of the step motor and would not result in the step motor crash.

S2 Content of the pulse wave output quantity (PLS)

- Settings: 16-bit command: 110~32,767(PLS)
  32-bit command: 110~2,147,483,647(PLS)
  If the setting is below 110, the pulse wave cannot output normally.
- When using the 32-bit command, DPLSR, the output pulse wave quantity is the content of D1 and D0.

S3 Acceleration/Deceleration time (ms)

- Setting: below 5000ms, but have to meet the following three conditions. The accel time and the decel time have to be the same and cannot be set without one another.

① The accel/decel time has to be over 10 times the maximum scan time (contents of D1012). If the setting is below 10 times, the slope of the accel/decel speed will be inaccurate.

② Minimum setting of the accel/decel time could be obtained from the following equation.

$$S_3 \geqslant \frac{90000}{S_1} \times 1.22$$

If the setting is smaller than the result of the above-mentioned equation, the acceleration/deceleration time will be greater, and if the setting is smaller than the minimum setting, the minimum setting will be treated as its regular setting.

③ Maximum setting of the accel/decel time could be obtained from the following equation.

$$S_3 \leqslant \frac{S_2}{S_1} \times 818$$

④ Number of the accel/decel speed variation steps is fixed to be 10.

If the above-mentioned requirements cannot be met, please lower down the maximum speed.

Among all the output Y numbers of the **D**-assigned output pulse wave, only Y0 and Y1 are effective (please use the transistor output module).

◎ The speed range for the pulse wave of this command is 2~10,000H_Z. And if the settings for the high speed and the accel/decel time exceed this range, use the allowable setting within this range for operation.

◎ When X10 is OFF, output will be interrupted, and when turned ON again, counting of the pulse wave will be counted from 0.

◎ It is not acceptable to change the setting of every operand during the execution of the command. The previous setting would only be valid when the command is executed again.

◎ Once the (S2)-set pulse waves are transmitted, the Y0 output will be completed and M1029 =ON, and the Y1 output will be cmpleted and M1030 =ON.

◎ Number of times of the command usage
For commands PLSY (DPLSY), PWM and PLSR (DPLSR), they could only be used once for each output.

60 IST (S) (D1) (D2) Manual/Auto Control

Operand \ Device	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(S)	◎	◎	◎												
(D1)				◎											
(D2)				◎											

■ Command IST is for initializing the special step ladder flow control. Configuring with the special relay to perform as the auto control mode.

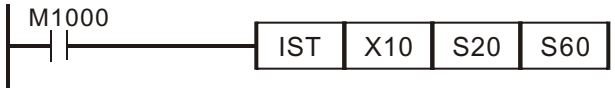
■ (S) starting input device for specified operation mode.

■ (D1) initial step point in automatic control mode.

■ (D2) The largest step point in automatic control mode.

■ (D1), (D2): S20~S127, However, (D2) > (D1).

■ **Program Example**



(S) X20: Manual operation mode
X21: Origin reset mode
X22: Step operation mode
X23: One program cycle operation mode
X24: Continuously operation mode
X25: Origin reset mode starting switch
X26: Step/One cycle/Continuously cycle mode starting switch
X27: Step/One cycle/Continuously cycle mode stopping switch

◎ When command IST is in operation, the listed special relay will automatically switch.

M1040: Step Transition Inhibit
M1041: Step point Transition Start
M1042: Start pulse
M1047: STL Monitoring enable

S0: Manual mode initial step point
S1: Original point back initial step point
S2: Auto mode initial step point

When using the IST command, S10 to S19 are for retruning to the original point. These step points can not be used in other step ladder programs.

66 ALT (D) ON/OFF Alternate command

Operand \ Device	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(D)		◎	◎	◎											

■ **Program Example**

■ When X0 is activated for the first time, M0=ON, Y1=ON. When X0 is activated for the second time, M0=OFF, Y0=ON, Y1=OFF.

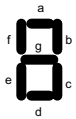
73 SEGD (S) (D) Decode the 7-step display panel

Operand \ Device	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(S)					◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎
(D)								◎	◎	◎	◎	◎	◎	◎	◎

■ **Program Example**

◎ Contents (0~F: 16 bits) of the lower 4 bits (b0~b3) of D0 will be decoded as readable in the 7-step display panel for output. The decoding results will be saved in K2Y0.

◎ Decodimg Chart of the 7-Step Display Panel

16bits	Bit Combi-nation	Composition of the 7-Step Display Panel	Status of Every Step							Data Displayed
			B0(a)	B1(b)	B2(c)	B3(d)	B4(e)	B5(f)	B6(g)	
0	0000		ON	ON	ON	ON	ON	ON	OFF	0
1	0001		OFF	ON	ON	OFF	OFF	OFF	OFF	1
2	0010		ON	ON	OFF	ON	ON	OFF	OFF	2
3	0011		ON	ON	ON	ON	ON	OFF	OFF	3
4	0100		OFF	ON	ON	OFF	OFF	ON	ON	4
5	0101		ON	OFF	ON	ON	OFF	ON	ON	5
6	0110		OFF	OFF	ON	ON	ON	ON	ON	6
7	0111		ON	ON	ON	OFF	OFF	OFF	OFF	7
8	1000		ON	ON	ON	ON	ON	ON	ON	8
9	1001		ON	ON	ON	OFF	ON	ON	ON	9
A	1010		OFF	OFF	OFF	ON	ON	OFF	ON	A
B	1011		OFF	OFF	ON	ON	OFF	OFF	ON	b
C	1100		OFF	ON	OFF	OFF	OFF	ON	ON	C
D	1101		ON	OFF	OFF	ON	OFF	ON	ON	d
E	1110		OFF	OFF	OFF	ON	ON	ON	ON	E
F	1111		OFF	OFF	OFF	OFF	OFF	OFF	OFF	

74 SEGL (S) (D) (n) 7-step display scan output

Operand \ Device	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(S)					◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎
(D)		◎													
(n)					◎	◎									

Note: The usage range of operand n is 0~7. Please refer to function specification chart for device usage range. SEGL command can be used twice in the program. Please refer to footnote for detail.

- (S): display source device of 7-step display. (D): start device of 7-step display scan output (n): polarity setting of output signal and scan signal.
- 8 or 12 continuous external output points that start from this command (D) output 1 or 2 groups of 4 digits of 7-step display by scanning and display the content of (S) on 7-step display. (n) will decide the numbers of groups of 4 digits of 7-step display and also indicate the polaritys of PLC output terminal and 7-step display input terminal.
- The points number of 7-step display output command that a group of 4 digits use is 8 points and 2 groups of 4 digits use are 12 points.
- Scan output terminal will circulate in sequence when this command executes. The condition contact will be changed from OFF to ON and scan output execute again.
- **Program Example**:

◎ When X10=ON, command will start to execute. 7-step display scan loop is composed of Y10~Y17. The value of D10 will be converted to BCD code and send to the first group of 7-step display to display. The value of D11 will be converted to BCD code and send to the second group of 7-step display to display. If any value of D10 or D11 is greater than 9999, operation error will happen.

◎ When X10=ON, Y14~Y17 will scan in circles automatically. Each circle scan needs 12 scan time. M1029=ON is a scan period after a circle scan.

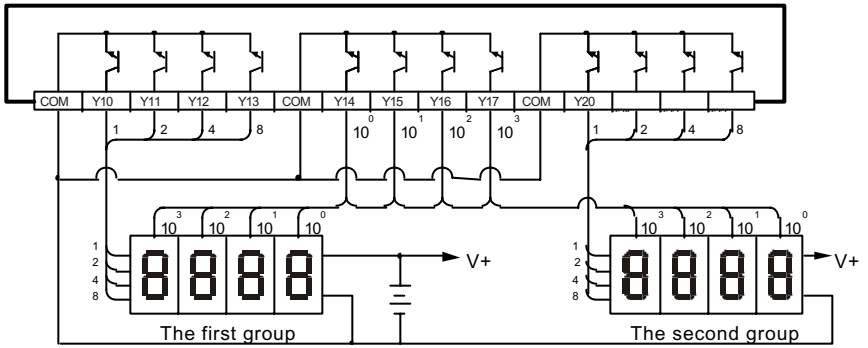
◎ 4 digits of a group, n=0~3.

- After the terminal of 1, 2, 4, 8 of decoded 7-step display connects itself in parallet, they should connect to Y10~Y13 of PLC. Latch terminal of each number connects to Y14~Y17 of PLC individually.
- When X10=ON, the content of D10 will be transmitted to 7-step display to display in sequently according to Y14~Y17 circulates in sequence.

◎ 4 digits of 2 groups, n=4~7.

- After the terminal of 1, 2, 4, 8 of decoded 7-step display connects itself in parallet, they should connect to Y20~Y23 of PLC. Latch terminal of each number and the first group share Y14~Y17 of PLC.
- The content of D10 will be transmitted to the first group of 7-step display and the content of D11 will be transmitted to the second group of 7-step display to display.

◎ 7-step display scan output wiring.



■ Footnote:

◎ The version V4.9 or above of ES / EX / SS series has this command (SEGL).

◎ Version 4.9 of ES / EX / SS series has only a group of 4 digits of 7-step display and use 8 points to output. It only uses SEGL command one time in the program and the usage of n operand is n=0~3.

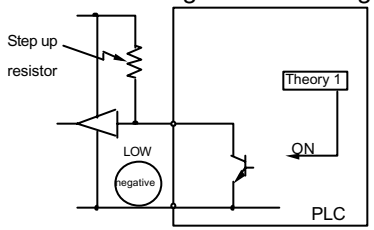
◎ Scan time must be longer than 10ms when executing this command. If scan time is shorter than 10ms, please use fixed scan time function to fix scan time on 10ms.

◎ Please use suitable 7-step display for the transistor that PLC uses to output.

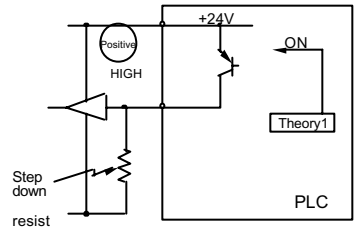
◎ Settings of n: it is used to set the polarity of transistor output loop. It can be set to positive polarity or negative polarity. what 7-step display it connects is a group of 4 digits or two groups of 4 digits.

A. Polarity of PLC output

■ Output loop of NPN transistor: when inner signal is "1", it will output low potential. This logic is called negative polarity.



■ Output loop of PNP transistor: when inner signal is "1", it will output high potential. This logic is called positive polarity.



■ 7-step display polarity

	Positive polarity	Negative polarity
Data input	When high potential, output in BCD type	When low potential, output in BCD type
Scan signal	When high potential, it will display latched.	When low potential, it will display latched.

■ Settings of parameter n

Group number of 7-step display group	A group				2 groups			
The polarity of PLC output terminal and display data input terminal	✓		×		✓		×	
The polarity of PLC output terminal and display scan siganl input terminal	✓	×	✓	×	✓	×	✓	×
n	0	1	2	3	4	5	6	7

✓: is the same. ×: is different

◎ The combination of output polarity of PLC transistor and input polaity of 7-step display can be set by settings of n.

◎ If output polarity of PLC is negative, input polarity of 7-step display is also negative and input terminal of scan signal of 7-step display is positive polarity. n will be 1 when a group of 4 digits and n will be 5 when two groups of 4 digits.

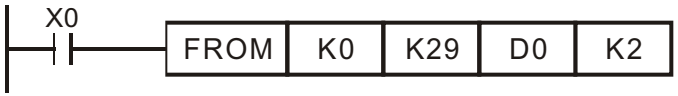
78 FROM (m1) (m2) (D) (n) Read special module CR data

Operand \ Device	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(m1)					◎	◎									
(m2)					◎	◎									
(D)								◎	◎	◎	◎	◎	◎	◎	◎
(n)					◎	◎									

Note: The usage range of operand m_1 is 0~7. The usage range of operand m_2 is 0~35. The usage range of operand n is 36-m2. Please refer to function specification chart for each device usage range.

- (m1): the number for special module. (m2): the number of CR (Control Register) of special module that will be read. (D): the location to save reading data. (n): the data number of reading one time.
- DVP PLC uses this command to read CR data of special module.
- When (D) indicates bit operand, you can use K1~K4 for 16-bit command and K1~K8 for 32-bit command.

- **Program Example**



◎ To read the content of CR#29 of special module#0 to D0 of PLC and to read the content of CR#30 of special module#0 to D1 of PLC. It can read 2 data at one time (n=2).

◎ The command will be executed when X0=ON. The command won't be executed when X0=OFF and the content of previous reading data won't change.

79 TO (m1) (m2) (S) (n) Special module CR data write in

Operand \ Device	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(m1)					◎	◎									
(m2)					◎	◎									
(S)					◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎
(n)					◎	◎									

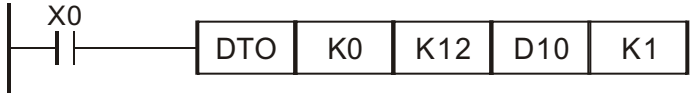
Note: The usage range of operand m_1 is 0~7. The usage range of operand m_2 is 0~35. The usage range of operand n is 36-m2. Please refer to function specification chart for every device usage range.

- (m1): the number of special module. (m2): the number of CR (Control Register) of special module that will be wrote in. (S): the data to write in CR. (n): the data number to write in one time.
- DVP-series PLC uses this command to write data into CR of special module.
- (S): When assigning bit operand, K1~K4 can be used for 16-bit and K5~K8 can be used for 32-bit.

- **Program Example**

◎ Using 32-bit command DTO, program will write D11 and D10 into CR#13 and CR#12 of special module#0. It only writes a group of data at one time (n=1).

◎ The command will be executed when X0=ON and it won't be executed when X0=OFF. The data that wrote in previous won't have any change.



- **Footnote:**

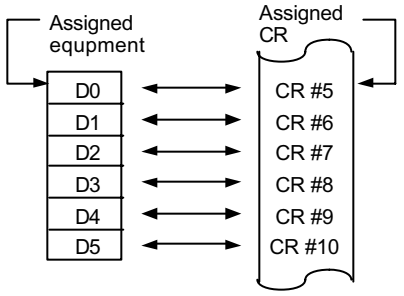
◎ The version 4.9 and above of ES / EX / SS series models support continuous execution commands (FROM, DFROM, TO, DTO). Other version won' t support these commands.

◎ The rule of command operand

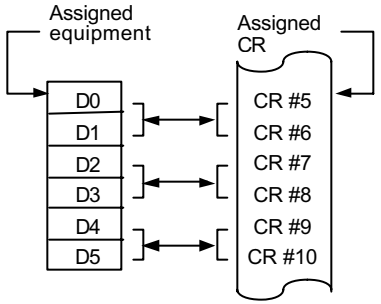
- m1: arrangement number of special module. The number of special module that connects to PLC MPU. The numbering order of special module from the near to the distant of MPU is from 0 to 7. The maximum is 8 special modules and won' t occupy I/O point.
- m2: the number of CR. Built-in 16-bit of 36 groups memory of special module is called CR (Control Register). The number of CR uses decimal digits (#0~#35). All running status and setting values of special module have included.
- If using FROM/TO command, the unit of read/write of CR is one number for one time. If using DFROM/DTO command, the unit of read/write of CR is two numbers in one time.

Upper 16-bit	Lower 16-bit	
CR #10	CR #9	← Assigned CR number

- The number of transmission groups n. The meaning of n=2 of 16-bit command and n=1 of 32-bit are the same.



16-bit command when n=6

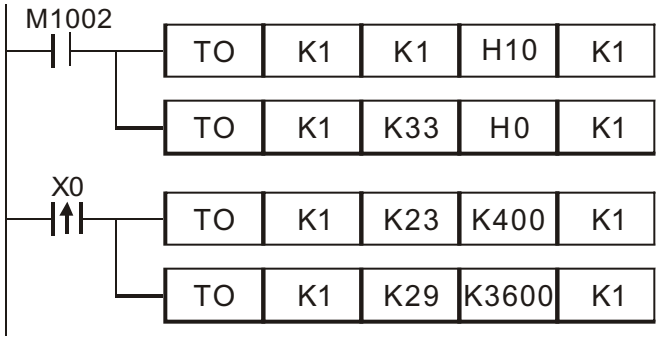


32-bit command when n=3

◎ When FROM/TO command is executed, all interrupts (including external or internal interrupt subroutines) will be prohibited. All interrupts will be executed after FROM/TO command is finished. Besides, FROM/TO command can be put in the subroutine.

■ **FROM / TO Application Program Example Explanation**

For example: Adjust A/D conversion characteristic curve by setting OFFSET value of CH1 to 0V(=$K0_{LSB}$) and GAIN value of CH1 to 2.5V(=$K2000_{LSB}$).



1. Writing H10 to CR#1 of analog input mode no. 1 and set CH2 to mode 2 (current input : +4mA ~ +20mA).
2. Writing H0 to CR#33 and allow to adjust characteristics of CH1 and CH2.
3. When X0 switches from OFF to ON, $K400_{LSB}$ of OFFSET value will be wrote in CR#23 and $K3600_{LSB}$ of GAIN value will be wrote in CR#29.

◎ Switch flag M1083 of EH series model instruction mode function:

- FROM/TO commands will be executed when M1083=OFF. All interrupts (including external or internal interrupt subroutines) will be prohibited. All interrupts will be executed after FROM/TO command is finished. Besides, FROM/TO command can be put in the subroutine.
- If there is any interrupts happen when FROM/TO command is executed during M1083=ON, FROM/TO command will be interrupted to execute interrupt signal. But FROM/TO command can' t be put in the subroutine.

80 RS (S) (m) (D) (n) Data Communication

Operand \ Device	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(S)													◎		
(m)					◎	◎							◎		
(D)													◎		
(n)					◎	◎							◎		

Note: The usage range of operand m is 0~256.The usage range of operand n is 0~256.Please refer to function specification chart for every device usage range.

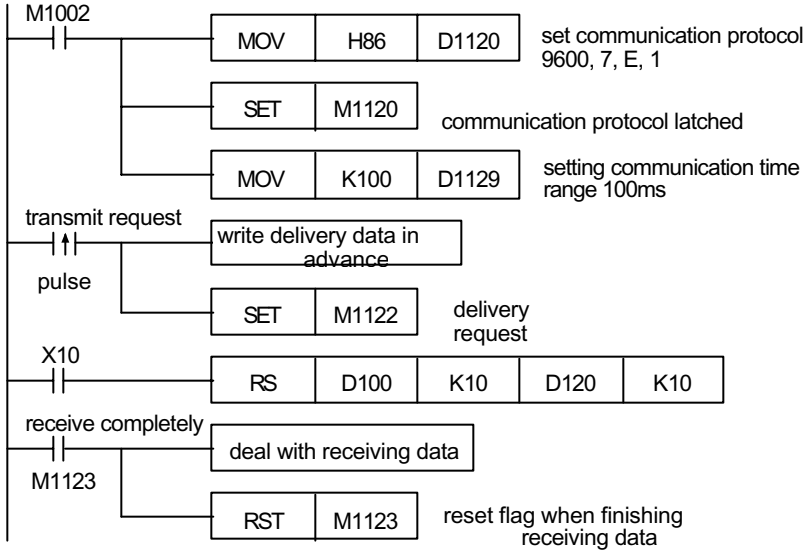
- (S): start device of transmitting data. (m): transmitting data group number. (D): start device of receiving data. (n): receiving data group numbers.
- This instruction is a convenience instruction for MPU to use RS-485 to connect communication interface in series. It saves words data in (S) source data register and sets length (m). It also sets receive data register (D) and length.
- If it doesn't need to transmit data, (m) can be indicated to K0 and if it doesn't need to receive data, (n) can be indicated to K0.
- You can use RS command in the program unlimitedly, but you can't execute two or more RS commands at the same time.
- It is invalid to change delivery data during executing RS command.
- PLC user can transmit data of PLC and peripheral equipment if peripheral equipment has RS-485 series communication and communication format of this equipment is public.
- If communication format of peripheral equipment corresponds with communication format of MODBUS, DVP series PLC provides several convenience communication commands, API 100 MODRD, API 101 MODWR and API 150 MODRW, for user to use. Please refer to individual instruction for detail.
- Please refer to following footnote for flag special auxiliary relay M1120~M1161 and special data register D1120~D1131 that relates to RS-485 communication.

■ **Program Example 1:**

◎ Writing data into the register that starts from D100 and set M1122 (delivery request flag) to ON.

◎ If RS command is executed when X10=ON, PLC will in the state of waiting for transmitting and receiving data. It will start to transmit 10 continuous data that start from D100. M1122 will be set to OFF at the end of transmitting. (Please don't execute RST M1122 by program) After 1ms, it will start to receive external 10 data and save them into continuous registers that start from D120.

◎ When finishing to receive data, M1123 will be set to ON. (Program will set M1123 to OFF when finishing to receive data and in the state of waiting transmitting and receiving. Please don't execute RST M1123 continuously by PLC program.



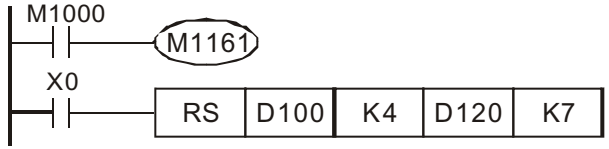
■ **Program Example 2:**

◎ 8 bits mode (M1161=ON) / 16 bits mode (M1161=OFF) switch:

《8 bits mode》:

Head code and tail code of PLC transmission data will be set by using M1126 and M1130 according to D1124~D1126. After setting, PLC will send head code and tail code that set by user automatically when executing RS command.

When M1161=ON, the conversion mode will be 8 bits. 16 bits data will be divided into upper 8 bits and lower 8 bits. Upper 8 bits will be ignored and lower 8 bits will be received and transmitted.



transmit data: (PLC→external machine)

STX	D100 lower	D101 lower	D102 lower	D103 lower	EXT1	EXT2

Head code — (S) source data register will start from lower 8 bits of D100 — tail code 1 — tail code 2

(m) length= 4

receive data: (external machine→PLC)

D120 lower	D121 lower	D122 lower	D123 lower	D124 lower	D125 lower	D126 lower

Head code — (D) receive data register will start from lower 8 bits of D120 — tail code 1 — tail code 2

(n) length= 7

PLC will receive all data that transmits from external machine, including head code and tail code. Please pay attention when setting length (n).

《16 bits mode》:

Head code and tail code of PLC transmitting data is set by using M1126 and M1130 according to D1124~D1126. After setting, PLC will send head code and tail code that set by user automatically when executing RS command.

When M1161=OFF, the conversion mode will be 16 bits. 16 bits data will be divided into upper 8 bits and lower 8 bits to receive and transmit data.

transmit data: (PLC→external machined)

STX	D100 lower	D100 upper	D101 lower	D101 upper	EXT1	EXT2

Head code — (S) Source data register will start from lower 8 bits of D100 — tail code 1 — tail code 2

(m) length= 4

receive data: (external machine→PLC)

D120 lower	D120 upper	D121 lower	D121 upper	D122 lower	D122 upper	D123 lower

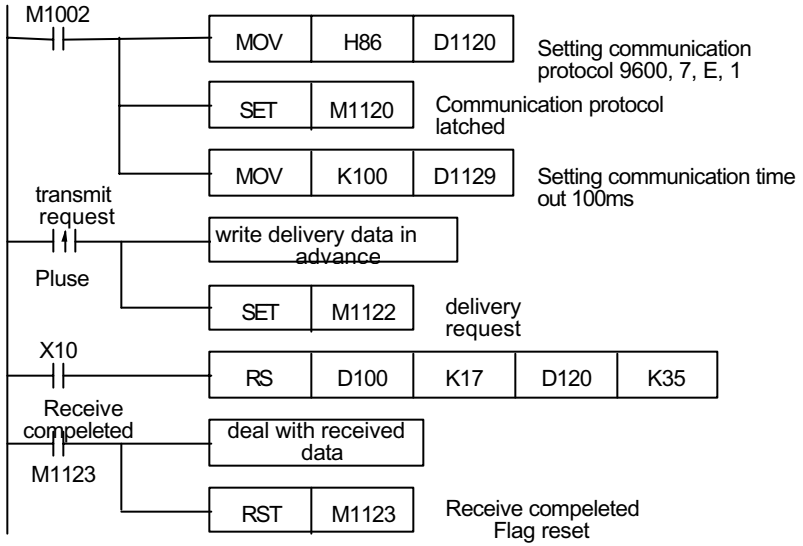
Head code — (D) receive data register will start from lower 8 bits of D120 — tail code 1 — tail code 2

(n) length= 7

PLC will receive all data that transmits from external machine, including head code and tail code. Please pay attention when setting length (n).

■ **Program Example 3:**

◎ When PLC connects to VFD-B series AC drives (ASCII Mode, M1143=OFF), (16 bits Mode, M1161=OFF), it will transmit data to read 6 continuous data that start from VFD-B reference address H2101.



PLC ⇨ VFD-B, PLC transmits: **“: 01 03 2101 0006 D4 CR LF ”**

VFD-B ⇨ PLC, PLC receives: **“: 01 03 0C 0100 1766 0000 0000 0136 3B CR LF ”**

PLC transmits data register (PLC transmits messages)

Register	DATA			
D100 lower	‘ : ’	3AH	STX	
D100 upper	‘ 0’	30 H	ADR 1	ADR (1,0) is AC drive address
D101 lower	‘ 1’	31 H	ADR 0	
D101 upper	‘ 0’	30 H	CMD 1	CMD (1,0) is command code
D102 lower	‘ 3’	33 H	CMD 0	
D102 upper	‘ 2’	32 H	Start data address	
D103 lower	‘ 1’	31 H		
D103 upper	‘ 0’	30 H		
D104 lower	‘ 1’	31 H		
D104 upper	‘ 0’	30 H	Number of data(count by word)	
D105 lower	‘ 0’	30 H		
D105 upper	‘ 0’	30 H		
D106 lower	‘ 6’	36 H		
D106 upper	‘ D’	44 H	LRC CHK 1	LRC CHK (0,1) is fault check code
D107 lower	‘ 4’	34 H	LRC CHK 0	
D107 upper	CR	A H	END	
D108 lower	LF	D H		

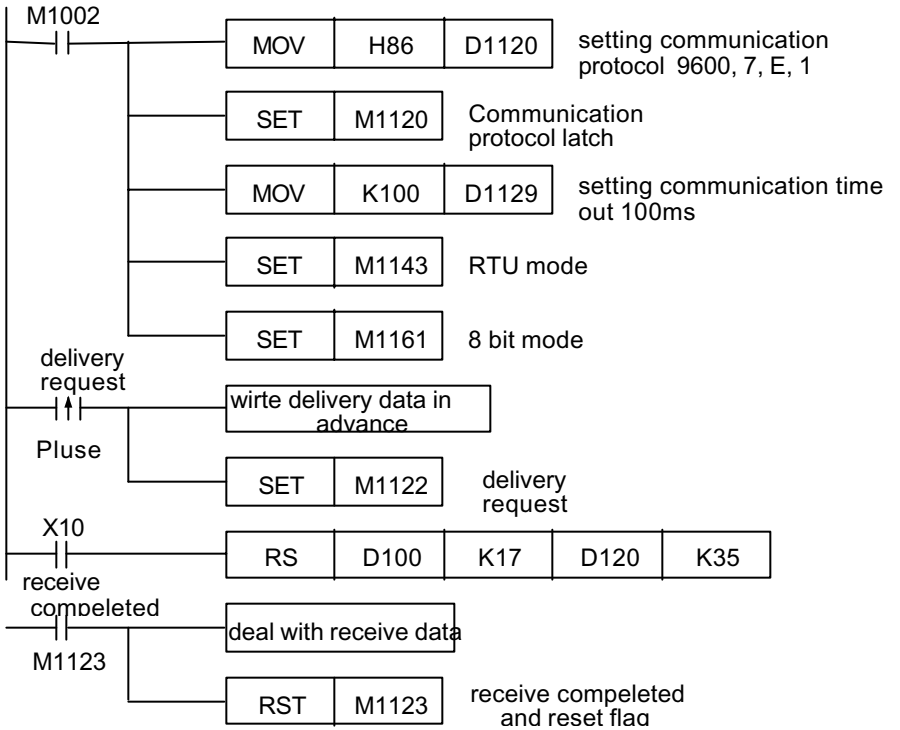
PLC receive data register (VFD-B response messages)

Register	DATA		
D120 lower	‘ : ’	3AH	STX
D120 upper	‘ 0’	30 H	ADR 1
D121 lower	‘ 1’	31 H	ADR 0
D121 upper	‘ 0’	30 H	CMD 1
D122 lower	‘ 3’	33 H	CMD 0
D122 upper	‘ 0’	30 H	Number of data (count by byte)
D123 lower	‘ C’	43 H	
D123 upper	‘ 0’	30 H	Content of address 2101 H
D124 lower	‘ 1’	31 H	
D124 upper	‘ 0’	30 H	
D125 lower	‘0’	30 H	
D125 upper	‘1’	31 H	Content of address 2102 H
D126 lower	‘7’	37 H	
D126 upper	‘ 6’	36 H	
D127 lower	‘ 6’	36 H	

Register	DATA		
D127 upper	‘ 0’	30 H	Content of address 2103 H
D128 lower	‘ 0’	30 H	
D128 upper	‘ 0’	30 H	
D129 lower	‘ 0’	30 H	
D129 upper	‘ 0’	30 H	Content of address 2104 H
D130 lower	‘ 0’	30 H	
D130 upper	‘ 0’	30 H	
D131 lower	‘ 0’	30 H	
D131 upper	‘0’	30 H	Content of address 2105 H
D132 lower	‘1’	31 H	
D132 upper	‘3’	33 H	
D133 lower	‘6’	36 H	
D133 upper	‘0’	30 H	Content of address 2106 H
D134 lower	‘0’	30 H	
D134 upper	‘0’	30 H	
D135 lower	‘0’	30 H	
D135 upper	‘3’	33 H	LRC CHK 1
D136 lower	‘B’	42 H	LRC CHK 0
D136 upper	CR	A H	END
D137 lower	LF	D H	

■ **Program Example 4**

◎ PLC connects to VFD-B AC drive (ASCII Mode, M1143=ON), (16 bits Mode, M1161=ON). To write delivery data, H12, in advance into parameter address of VFD-B H2000.



PLC ⇨ VFD-B, PLC transmits: **01 06 2000 0012 02 07**

VFD-B ⇨ PLC, PLC receives: **01 06 2000 0012 02 07**

PLC transmits data register (transmit messages)

PLC transmits data register (PLC transmits messages)

Registers	DATA	
D100 lower	01 H	Address
D101 lower	06 H	Function
D102 lower	20 H	Data address
D103 lower	00 H	

D104 lower	00 H	Data content
D105 lower	12 H	
D106 lower	02 H	CRC CHK Low
D107 lower	07 H	CRC CHK High

PLC receives data register (response messages of VFD-B)

Registers	DATA	
D120 lower	01 H	Address
D121 lower	06 H	Function
D122 lower	20 H	Data address
D123 lower	00 H	
D124 lower	00 H	Data content
D125 lower	12 H	
D126 lower	02 H	CRC CHK Low
D127 lower	07 H	CRC CHK High

■ **Footnote:**

◎ RS-485 communication RS / MODRD / MODWR / FWD / REV / STOP / RDST / RSTEF / MODRW commands relation flag signal:

Flag	Function Explanation
M1120	It is used to set communication latch. PLC will reset communication protocol setting according to special data register D1120 after the first program scan. When second program scan starts and RS command is executed, it will reset communication protocol setting according to special data register D1120. If communication protocol is fixed, M1120 can be set to ON. At this time, communication protocol setting won't be reset as RS / MODRD / MODWR / FWD / REV / STOP / RDST / RSTEF / MODRW is executed even if D1120 setting is changed.
M1121	It indicates that PLC can transmit data now.
M1122	Transmit request. Users need to set M1122 to ON by pulse command when using RS / MODRD / MODWR / FWD / REV / STOP / RDST / RSTEF / MODRW command to transmit and receive data. If the command above is executing, PLC will transmit and receive data. M1122 will be clear after the commands above finish transmitting.
M1123	Receive completely. M1123 will be set to ON after RS / MODRD / MODWR / FWD / REV / STOP / RDST / RSTEF / MODRW commands finish executing. User can deal with received data when M1123 is set to ON and clear M1123 to OFF when finish handling them.
M1124	Wait for receiving. When M1124 is set to ON, it means PLC is waiting for receiving data.
M1125	Received function disable. When M1125 is set to ON, the state of PLC transmits function disable.
M1126	Please refer to following chart for selecting user/system definition and STX/ETX.
M1127	M1127 should be clear to OFF when MODRD / RDST / MODRW commands finish receiving at ASCII mode.
M1128	transmitting / receiving indication
M1129	Receive time out. This flag will be active, if D1129 is set and receive data doesn't finish within the setting time. If the state disable, M1129 should be clear to OFF.
M1130	Please refer to following chart for selecting users/system definition and STX/ETX.
M1131	M1131=ON during MODRD / RDST / MODRW convert to HEX. Otherwise M1131 will be OFF.
M1140	MODRD / MODWR / MODRW data receive error
M1141	MODRD / MODWR / MODRW command parameter error
M1142	Data receive error of VFD-A convenience command
M1143	ASCII / RTU mode selection, ON is RTU mode and OFF is ASCII mode.
M1161	8/16 bits handle mode selection. ON is 8 bits mode and OFF is 16 bits mode.

◎ Special register of RS-485 communication RS / MODRD / MODWR / FWD / REV / STOP / RDST / RSTEF / MODRW command relative setting

Special register	Function Explanation
D1038	Data response delay time setting when PLC MPU is slave. Time definition (0.1ms)
D1050~D1055	PLC will convert ASCII data of D1070~D1085 to HEX and save hexadecimal data to D1050~D1055.
D1070~D1085	Built-in RS-485 communication convenience command. This command will execute "send" command and receiver will return messages when it receives. These messages will be saved at D1070~D1085. User can check return data by viewing the register content.
D1089~D1099	It is PLC built-in RS-485 communication convenience command. The message that sent when this command is executed will be saved in D1089~D1099. Users can check by viewing the register.
D1120	Please refer to following chart for RS-485 communication protocol.
D1121	Communication address of PLC MPU when PLC MPU is slave.
D1122	Remainder words of delivery data.
D1123	Remainder words of receive data.
D1124	Start word definition (STX). Please refer to chart above.
D1125	The first end word definition. (ETX1) Please refer to chart above.
D1126	The second end word definition. (ETX1) Please refer to chart above.
D1129	Communication time out is abnormal. Time unit (ms). It is used to set time of time out. if it is 0, it means there is no time out. PLC will set M1129 to be ON if receiving time of the first word or between any two words is more than setting after executing RS / MODRD / MODWR / FWD / REV / STOP / RDST / RSTEF / MODRW commands to enter received mode. Please pay attention to clear M1129 after handling.

Special register	Function Explanation
D1130	MODBUS return fault code record.
D1256~D1295	Built-in RS-485 communication convenience command MODRW. The command characters sent when this command is executed will be saved in D1256~D1295. User can check with the content of these registers. (Users only can use MOV, DMOV, BMOV to move the data in this area in version V4.9)
D1296~D1311	PLC will convert ASCII data in the register that user requests to hexadecimal. (Users only can use MOV, DMOV, BMOV to move the data in this area in version V4.9)

◎ D1120: RS-485 communication protocol. Please refer to following chart to set.

	Content	0	1
b0	Data length	7	8
b1 b2	Parity bits	00 : None	
		01 : Odd	
		11 : Even	
b3	stop bits	1 bit	2 bit
b4 b5 b6 b7	0011	(H3) : 300	
	0100	(H4) : 600	
	0101	(H5) : 1200	
	0110	(H6) : 2400	
	0111	(H7) : 4800	
	1000	(H8) : 9600	
	1001	(H9) : 19200	
	1010	(HA) : 38400	
	1011	(HB) : 57600 (only for EH series)	
	1100	(HC) : 115200 (only for EH series)	

	Content	0	1
b8	Start word selection	none	D1124
b9	The first end word selection	none	D1125
b10	The second end word selection	none	D1126
b15~b11	No definition		

◎ Start character and end character of control characters will be defined in the communication format of peripheral equipment when using RS command. Start character and end character can be set in D1124~D1125 by user or defined by machine. When users use M1126, M1130, D1124~D1125 to set start and end character, b8~b9 of D1120 of RS485 communication protocol should be set to 1. Please refer to the following chart for detail.

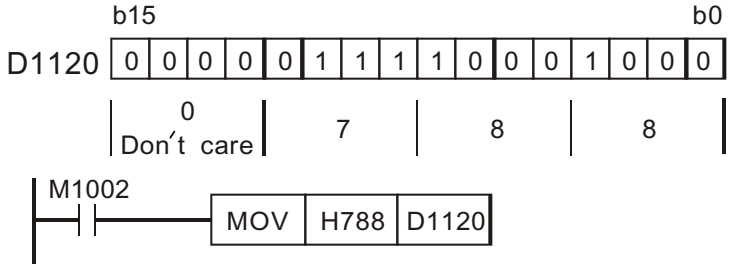
		M1130	
		0	1
M1126	0	D1124: user define D1125: user define D1126: user define	D1124: H 0002 D1125: H 0003 D1126: H 0000（no setting）
	1	D1124: user define D1125: user define D1126: user define	D1124: H 003A（':'） D1125: H 000D（CR） D1126: H 000A（LF）

◎ Example for communication format setting:

Communication format: Baud rate 9600 7, N, 2

STX : ": "
ETX1 : "CR"
EXT2 : "LF"

You can get the communication format H788 via check with chart and write into D1120.



You should pay attention to special auxiliary relay M1126 and M1130 when using STX, EXT1 and EXT2.

◎ M1143: ASCII / RTU mode selection. ON is RTU mode and OFF is ASCII mode.

Take standard MODBUS format to explanation.

ASCII mode (M1143=OFF):

STX	Start word = ': ' (3AH)
Address Hi	Communication address:
Address Lo	8-bit address consists of 2 ASCII codes
Function Hi	Function code:
Function Lo	8-bit function code consists of 2 ASCII codes
DATA (n-1)	Data content:
…….	nx8-bit data content consists of 2n ASCII codes
DATA 0	
LRC CHK Hi	LRC check sum:
LRC CHK Lo	8-bit check sum consists of 2 ASCII code
END Hi	End character:
END Lo	END Hi = CR (0DH), END Lo = LF(0AH)

Communication protocol is made of MODBUS ASCII(American Standard Code for Information Interchange). Each byte consists of 2 ASCII characters. For example: a 1-byte data 64 Hex shown as '64' in ASCII, consists of '6' (36Hex) and '4' (34Hex).

character	'0'	'1'	'2'	'3'	'4'	'5'	'6'	'7'
ASCII code	30H	31H	32H	33H	34H	35H	36H	37H
character	'8'	'9'	'A'	'B'	'C'	'D'	'E'	'F'
ASCII code	38H	39H	41H	42H	43H	44H	45H	46H

Start character (STX): ': ' (3AH)

Communication Address:

'0' '0': broadcast for all driver
'0' '1': toward the drive at the 01 address
'0' 'F': toward the drive at the 15 address
'1' '0': toward the drive at the 16 address . . . . . .
and consequently, the Max. to be reached is 255 ('F' 'F').

Function code:

'0' '3': read the contents of the register.

'0' '6': write one WORD into the register.

'1' '0': write contents of the register.

Data Characters:

The data characters that user transmits.

LRC check:

The LRC check is the added sum from "Address" to "Data Contents". For example, the 01H + 03H + 21H + 02H + 00H + 02H = 29H, then take the complementary of 2, D7H.

End character:

END Hi = CR (0DH), END Lo = LF(0AH)

For example: when the address of the drive is set as 01H, read 2 data contents that exist successively within the register, as shown follows: the address of the start register is 2102H.

Inquiry message:

STX	': '
Address	'0'
	'1'
Function	'0'
	'3'
Start address	'2'
	'1'
	'0'
	'2'
Number of data (count by word)	'0'
	'0'
	'0'
	'2'
LRC Check	'D'
	'7'
END	CR
	LF

Response message:

STX	': '
Address	'0'
	'1'
Function	'0'
	'3'
Number of data (count by byte)	'0'
	'4'
Content of start address 2102H	'1'
	'7'
	'7'
	'0'
Content of address 2103H	'0'
	'0'
	'0'
	'0'
LRC Check	'7'
	'1'
END	CR
	LF

The RTU Mode (M1143=ON):

START	Please refer to following explanation
Address	Communication address: 8-bit binary
Function	Function code: 8-bit binary
DATA (n-1)	Data characters: n×8-bit data
…….	
DATA 0	
CRC CHK Low	CRC check: 16-bit CRC consists of 2 8-bit binary
CRC CHK High	
END	Please refer to following explanation

START:

ES / EX / SS / EP series: keep none input signal to be greater or equal to 10 ms.

EH series:

Baud Rate(bps)	RTU Timeout Timer(ms)	Baud Rate(bps)	RTU Timeout Timer(ms)
300	40	9600	2
600	21	19200	1
1200	10	38400	1
2400	5	57600	1
4800	3	115200	1

Communication Address:

00 H: broadcast all drives
01 H: toward the drive at the 01 address
0F H: toward the drive at the 15 address
10 H: toward the drive at the 16 address…..,
and consequently, the Max. to be reached is 255 (FF H).

Function code:

03 H: read the contents of the register

06 H: write one WORD into the register

01 H: write the contents of the register

Data Characters:

The data contents that user transmits

CRC check:

The CRC check starts from "Address" and ends in "Data Content". Its calculation is as follows:

Step 1: Load the 16-bit register (the CRC register) with FFFFH.

Step 2: Exclusive OR the first 8-bit byte message command with the 16-bit CRC register of the lower bit, then save the result into the CRC register.

Step 3: shift the CRC register one bit to the right and fill in 0 to the higher bit.

Step 4: check the value that shifts to the right. If it is 0, save the new value from step 3 into the CRC register, otherwise, Exclusive OR A001H and the CRC register, then save the result into the CRC register.

Step 5: repeat step 3 and 4 and calculates the 8-bit.

Step 6: Repeat Steps 2~5 for the next 8-bit message command, till all the message commands are processed. And finally, the obtained CRC register value is the CRC check value. What should be noted is that the CRC check must be placed interchangeably in the check sum of the message command.

END:

ES / EX / SS / EP series: keep none input signal to be greater or equal to 10 ms

EH series:

Baud Rate(bps)	RTU Timeout Timer(ms)	Baud Rate(bps)	RTU Timeout Timer(ms)
300	40	9600	2
600	21	19200	1
1200	10	38400	1
2400	5	57600	1
4800	3	115200	1

For example: when the address of the drive is set as 01H, read 2 data contents that exist successively within the register, as shown follows: the address of the start register is 2102H.

Inquiry:

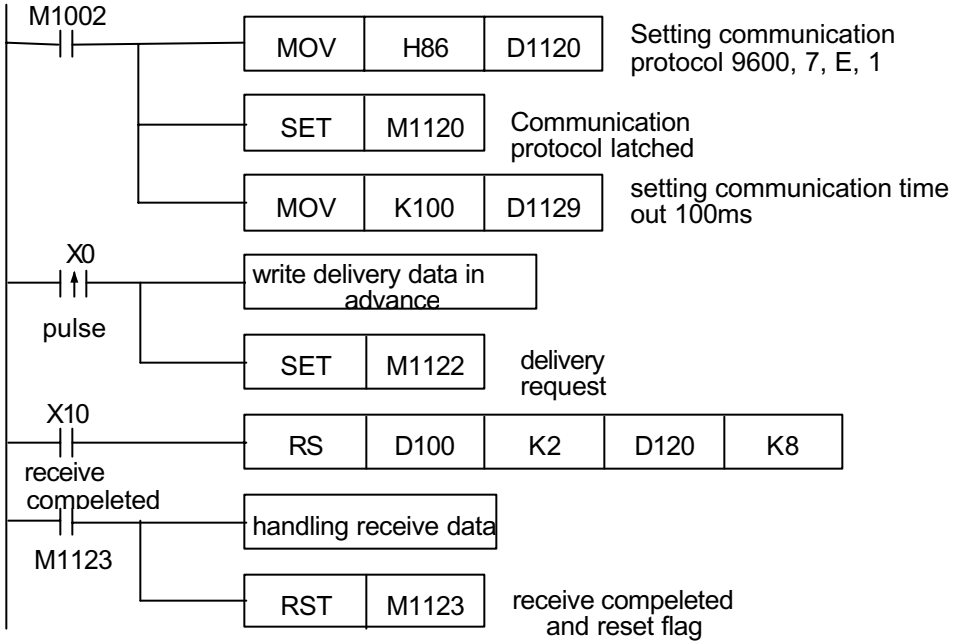
Address	01 H
Function	03 H
Start data address	21 H
	02 H
Number of data (count by word)	00 H
	02 H
CRC CHK Low	6F H
CRC CHK High	F7 H

Response:

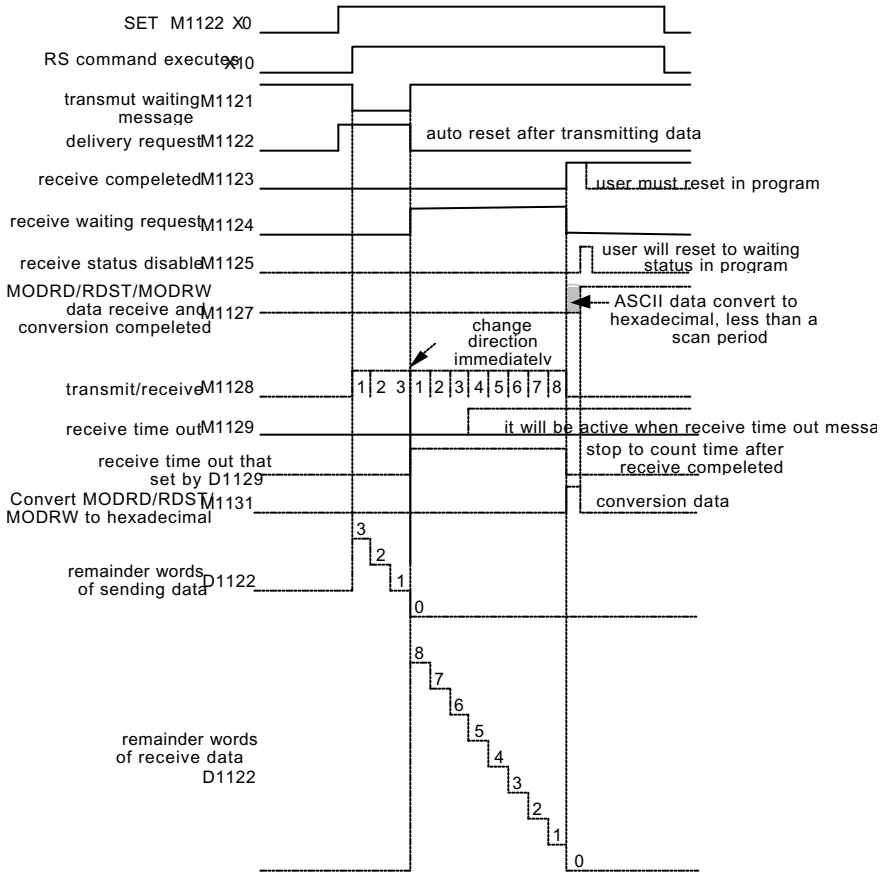
Address	01 H
Function	03 H
Number of data (count by byte)	04 H
Content of data address 8102H	17 H
	70 H
Content of data address 8103H	00 H
	00 H
CRC CHK Low	FE H
CRC CHK High	5C H

1. Timing chart of RS-485 communication program flag:

Timing chart:



Time chart:



82 ASCI (S) (D) (n) Converts HEX into ASCII

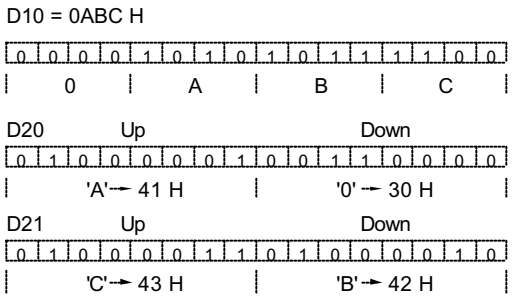
Operand \ Device	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(S)					◎	◎					◎	◎	◎		
(D)											◎	◎	◎		
(n)	1~256														

- Converts the data of lower "n" digits (one digit consists of four bits) of 16-bit data that begins with the device (S) into the ASCII code and stores the result into four point devices that begin with the device (D).
- **Program Example**

- 16-bit conversion (M1161 OFF)

(D10) = 0ABC H '0' = 30H '1' = 31H '5' = 35H
(D11) = 1234 H 'A' = 41H '2' = 32H '6' = 36H
(D12) = 5678 H 'B' = 42H '3' = 33H '7' = 37H
'C' = 43H '4' = 34H '8' = 38H

When n is 4, the bit structure is:



When n=1 to 9:

D * \ n	K1	K2	K3	K4	K5	K6	K7	K8	K9
D20 down	'C'	'B'	'A	'0'	'4'	'3'	'2'	'1'	'8'
D20 up		'C'	'B	'A'	'0'	'4'	'3'	'2'	'1'
D21 down			'C	'B'	'A'	'0'	'4'	'3'	'2'
D21 up				'C'	'B'	'A'	'0'	'4'	'3'
D22 down					'C'	'B'	'A'	'0'	'4'
D22 up						'C'	'B'	'A'	'0'
D23 down							'C'	'B'	'A'
D23 up								'C'	'B'
D24 down									'C'

- 8-bit conversion (M1161 ON)

(D10) = 0ABC H '0' = 30H '1' = 31H '5' = 35H
(D11) = 1234 H 'A' = 41H '2' = 32H '6' = 36H
(D12) = 5678 H 'B' = 42H '3' = 33H '7' = 37H
'C' = 43H '4' = 34H '8' = 38H

When n=2:

When n=1 to 9:

D * \ n	K1	K2	K3	K4	K5	K6	K7	K8	K9
D20	'C'	'B'	'A	'0'	'4'	'3'	'2'	'1'	'8'
D21		'C'	'B	'A'	'0'	'4'	'3'	'2'	'1'
D22			'C	'B'	'A'	'0'	'4'	'3'	'2'
D23				'C'	'B'	'A'	'0'	'4'	'3'
D24					'C'	'B'	'A'	'0'	'4'
D25						'C'	'B'	'A'	'0'
D26							'C'	'B'	'A'
D27								'C'	'B'
D28									'C'

83 HEX (S) (D) (n) Converts ASCII to HEX

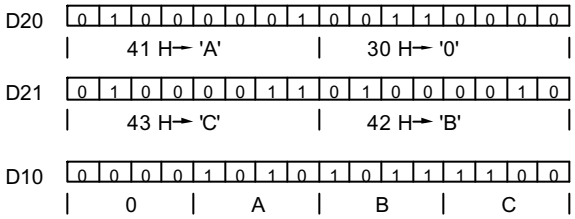
Operand \ Device	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(S)					◎	◎					◎	◎	◎		
(D)											◎	◎	◎		
(n)	1~256														

■ Converts the data of lower "n" digits (one digit consists of four bits) of 16-bit data that begins with the device (S) into the HEX code and stores the result into four point devices that begin with the device (D).

■ **Program Example**

- 16-bit conversion (M1161 OFF)

When n=4,



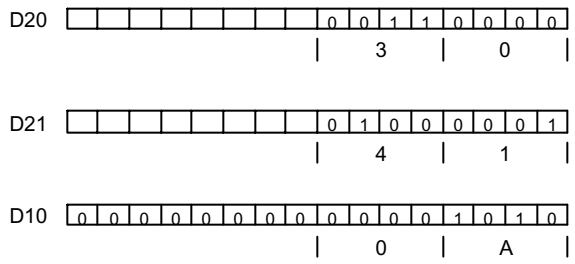
When n=1 to 9:

S *	ASCII code	HEX conversion
D10 down	30 H	0
D10 up	41 H	A
D11 down	42 H	B
D11 up	43 H	C
D12 down	31 H	1
D12 up	32 H	2
D13 down	33 H	3
D13 up	34 H	4
D14 down	35 H	5

n \ D *	D22	D21	D20
1			. . . 0 H
2			. . 0 A H
3			. 0 A B H
4			0 A B C H
5		. . . 0 H	A B C 1 H
6		. . 0 A H	B C 1 2 H
7		. 0 A B H	C 1 2 3 H
8		0 A B C H	1 2 3 4 H
9	. . . 0 H	A B C 1 H	2 3 4 5 H

- 8-bit conversion (M1161 ON)

When n=2:



When n=1 to 9:

S *	ASCII Code	HEX Conversion
D10	30 H	0
D11	41 H	A
D12	42 H	B
D13	43 H	C
D14	31 H	1
D15	32 H	2
D16	33 H	3
D17	34 H	4
D18	35 H	5

n \ D *	D22	D21	D20
1			. . . 0 H
2			. . 0 A H
3			. 0 A B H
4			0 A B C H
5		. . . 0 H	A B C 1 H
6		. . 0 A H	B C 1 2 H
7		. 0 A B H	C 1 2 3 H
8		0 A B C H	1 2 3 4 H
9	. . . 0 H	A B C 1 H	2 3 4 5 H

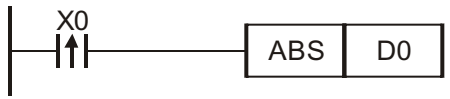
D 87 ABS (D) Absolute value

Operand \ Device	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(D)								◎	◎	◎	◎	◎	◎	◎	◎

■ When the command is executed, take the absolute value of the assigned device, (D).

■ It is generally advised to use the pulse wave contact to drive this command, otherwise, it will keep going on and on.

■ **Program Example**



◎ When X0 goes from OFF→ON, take the absolute value of the D0 contents.

88 PID (S1) (S2) (S3) (D) PID calculation

Operand \ Device	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(S1)													◎		
(S2)													◎		
(S3)													◎		
(D)													◎		

Note: S3 operand occupies continuous 6 devices. Please refer to function specification charts for usage range of each device. Please refer to footnote for the use time of PID command.

■ (S1): target value(SV). (S2): present value(PV). (S3): parameter. (D): output value(MV).

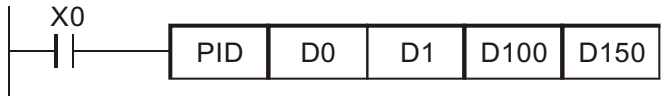
■ Specific command for PID operation control. This scan will execute PID operation when sampling time reaches. PID means Proportion, Integration and Differential. PID control has wide application on mechine equipment, pneumatic equipment and electric eqipment.

■ (S1): target value (SV), (S2): present value (PV), (S3)~(S3) +5: it will start to execute PID command after finishing all parameters setting and save the result to (D). Please give no latch register area for (D) content. (if you want to give (D) content a latch register, please clear latch to 0 when program runs.)

■ **Program Example**

◎ Please finish parameters setting before executing PID command.

◎ The command will be executed when X0=ON and the result will be saved in D150. The command won't be executed when X0=OFF and the previous data won't have any change.



■ **Footnote:**

◎ PID command is only in version V4.9 or above of ES / EX / SS series.

◎ PID command can be used one time in ES / EX / SS / EP series.

◎ It is unlimited for using times of PID command of EH series. But the register number that S3 indicates can't repeat.

◎ (S3) has 6 registers. In above program, the parameter setting area of PID command that (S3) indicates are D100~D105. You should use MOV command to transmit settings to the indication register to set before PID command executes. If the registers that parameters indicate are latch area, please execute MOVP to execute transmitting.

◎ Parameters setting is as follows.

Device No.	Function	Setting range	Explanation
(S3) :	Sampling time (T_S) (unit: 10ms)	1~2,000	If T_S is small than a scan time, PID command will execute a scan time. If T_S=0, it won't act.
(S3) +1:	Propotion gain (K_P)	0~100	
(S3) +2:	Integration gain (K_I)	0~100	

S3 +3:	Differential gain（K_D）	0~100	
S3 +4:	Action direction（Dir）	0: auto control direction 1: forward action (SV→PV) 2: reserve action (PV→SV)	
S3 +5:	deviation (E) range	0~100,	For example: if the range of deviation (E) is 5, output value MV of E between is 0.

◎ If parameter setting exceeds range, the setting will use Max. and Min. value to be settings.

◎ PID commands can be used in interrupt subroutine, step point and CJ command.

◎ Max. range of sampling time T_S is -（a scan time+1ms）~+（a scan time）. If error value has influence on output, please keep the time fixable or execute PID command in interrupt subroutine.

◎ If the settings of sampling time $T_S \leqq$ a scan time, CPU will have error code K6740(PID operation error). At this time, CPU will reset T_S = a scan time to execute PID operand. In this situation, please execute PID command in time interrupt subroutine (I6□□~I8□□).

◎ PV of PID must be a stable value before PID executes operation. Please take note of A/D of these modules conversion time if using input value of DVP-04AD / DVP-04XA / DVP-04PT / DVP-04TC module to do PID operation.

■ Calculation formula for PID command

◎ This command executes PID operation according to speed and test value differential type.

◎ PID operation has two operations, forward and reverse operation. The direction of operation is set by S3 +4. Besides, the settings that have relation to PID operation is set by S3 ~ S3 +5.

◎ Basic operation of PID

Move direction	Calcultaion method of PID
Forward operation automatically	$MV = K_P * E(t) + K_D * PV(t)S + K_I * E(t)\frac{1}{S}$ $E(t) = SV - PV$
Reverse operation	$MV = K_P * E(t) + K_D * PV(t)S + K_I * E(t)\frac{1}{S}$ $E(t) = PV - SV$

Symbols explanations:

MV : Output value

K_P : Porprotion gain

$E(t)$: Deviation value. Forward operation $E(t) = PV - SV$, reverse operation $E(t) = PV - SV$

PV : Test value

SV : Target value

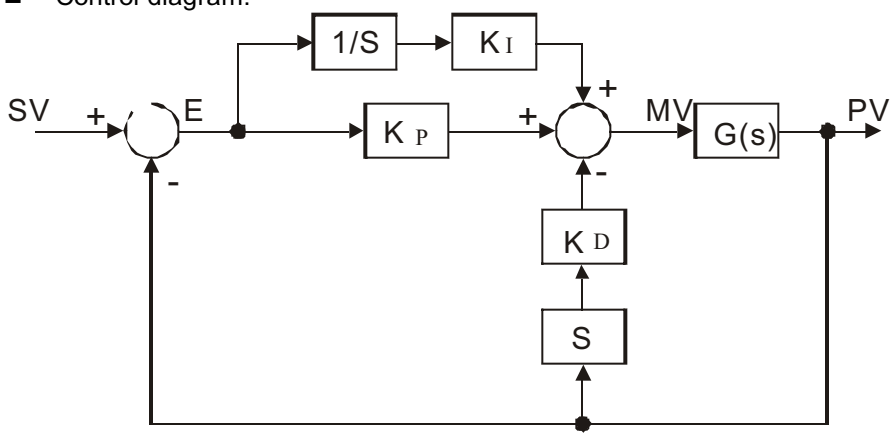
K_D : Differential gain

$PV(t)S$: Differential of $PV(t)$

K_I : Integration gain

$E(t)\frac{1}{S}$: Integration value of $E(t)$

■ Control diagram:



100 MODRD (S1) (S2) (n) MODBUS data read

Device / Operand	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(S1)					◎	◎							◎		
(S2)					◎	◎							◎		
(n)					◎	◎									

■ MODRD is a command for the MODBUS ASCII mode communication. (Version 3.3 and above contain RTU mode, controlled by M1143). The Delta VFD series drives have build-in MODBUS communication. Please refer to the Delta VFD Series Manual for more details.

■ (S1) Communication address: K00000~K00254.

■ (S2) Read out address. If the address setting is illegal, the user will be informed by an error message. The error code will be saved in D1130, at the same time, M1141 will turn ON. For example, 4000H is an illegal address to VFD-S, M1141 will turn ON, D1130=2. Refer to Delta VFD-S series AC drive manual on fault information.

■ (n) Data length,n≦6.

■ The feedback data from peripherial equipment will be saved in D1070 to D1085. PLC will check the data after SAVE function is complete. If there is an error, then M1140 will be ON.

■ Because the feedback data are all ASCII characters, PLC will convert the feedback data to value data and store them in D1050 to D1055.

101 MODWR (S1) (S2) (n) MODBUS Data write

Device / Operand	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(S1)					◎	◎							◎		
(S2)					◎	◎							◎		
(n)					◎	◎									

■ MODWR is a command for the MODBUS ASCII mode communication. (Version 3.3 and above contain RTU mode, controlled by M1143).

■ (S1) Communication address: K00000 to K00254.

■ (S2) Write address. If the address setting is illegal, the user will be informed by an error message. The error code will be saved in D1130, at the same time, M1141 will ON.

■ (n) Write data.

■ The feedback data from perpherial equipment will be saved in D1070 to D1076. PLC will check the data after the SAVE function is complete. If there is an error, M1140 will be ON.

102 FWD (S1) (S2) (n) VFD-A series drive forward command

Operand \ Device	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(S1)					◎	◎							◎		
(S2)					◎	◎							◎		
(n)					◎	◎									

103 REV (S1) (S2) (n) VFD-A series drive reverse command

Operand \ Device	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(S1)					◎	◎							◎		
(S2)					◎	◎							◎		
(n)					◎	◎									

104 STOP (S1) (S2) (n) VFD-A series drive stop command

Operand \ Device	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(S1)					◎	◎							◎		
(S2)					◎	◎							◎		
(n)					◎	◎									

- FWD/REV/STOP are communication commands for Delta A/H series drive, make sure to use the communication overtime setting (D1129) when applying these commands.
- (S1) Communication address: K00000~K00031.
- (S2) ACdrive master frequency setting for VFD-A series: setting of K0000 to K4000 represents 0.0Hz to 400.0Hz. For H series AC drive, the setting of K0000 to K1500 represent 0Hz to 1500Hz.
- (n) command object, n=1 is for one drive. n=2 communicates to all drives connected.
- The feedback data from perpherial equipment will be saved in D1070 to D1080. PLC will check the data after the SAVE function is complete. If there is an error, M1142 will be ON.

105 RDST (S1) (n) VFD-A series drive status read

Operand \ Device	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(S1)					◎	◎							◎		
(n)					◎	◎									

- RDST is a read status instruction used with the VFD-A series drive.
- (S1), Communication address: K00000 to K00031.
- (n) Status object.

  n = 0 Frequency command
  n = 1 Output frequency
  n = 2 Output current
  n = 3 Operation command

There are 11 words in the feedback command message saved in the low byte of address D1070 to D1080.

106 RSTEF (S1) (n) VFD-A series drive reset command

Operand \ Device	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(S1)					◎	◎							◎		
(n)					◎	◎									

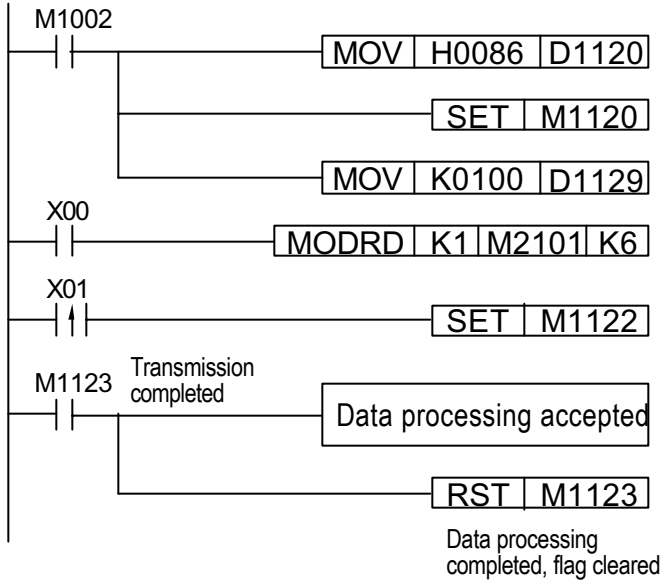
- RSTEF is a drive reset instruction for the VFD-A series drive.
- (S1) Communication address: K00000 to K0031.
- (n) Command object, n=1 is for one drive, n=2 communicates to all drives connected.
- The feedback data from perpherial equipment will be saved in D1070 to D1089. If n=2, PLC will not receive any data.
- Communication example:

1. Connect RS-485 communication between the Delta VFD-S and PLC.

2. Preset the following VFD-S series parameters.

Parameter	Setting Value	Explanations
2-00	4	Master frequency determined by RS-485
2-01	3	Operation command determined by RS-485
9-00	1	Communication address is 01
9-01	1	Transmission speed (baud rate) : 9600 bps
9-04	1	Communication protocol ASCII mode: 7 data bits, Even parity, 1 stop bit (7, E, 1)

3. Use DVP programming tools to input the following program.



4. After the PLC executes a RUN command, input point X00 remains ON, and the input point X01 changes from OFF to ON, PLC will transfer the command MODRD K1 M2101 to the VFD-S series AC drive, and the data will be saved in D1089 to D1095.

5. When PLC receives feedback data, the data will be placed in D1070 to D1076, the ASCII codes will be converted into HEX, and saved in D1050~D1055. Refer to the following example:

PLC ⇨ VFD-S
“010321010006D4”

VFD-S ⇨ PLC
“01 03 0C 0100 1766 0000 0000 0136 0000 3B”

Command Messages :			
D1089 down	‘0’	30 H	ADR 1
D1089 up	‘1’	31 H	ADR 0
D1090 down	‘0’	30 H	CMD 1
D1090 up	‘3’	33 H	CMD 0
D1091 down	‘2’	32 H	Starting Address
D1091 up	‘1’	31 H	
D1092 down	‘0’	30 H	
D1092 up	‘1’	31 H	
D1093 down	‘0’	30 H	Date (Words)
D1093 up	‘0’	30 H	
D1094 down	‘0’	30 H	
D1094 up	‘6’	36 H	
D1095 down	‘D’	44 H	LRC CHK 1
D1095 up	‘4’	34 H	LRC CHK 0

Feedback Messages:				
D1070 down	‘0’	30 H	ADR 1	
D1070 up	‘1’	31 H	ADR 0	
D1071 down	‘0’	30 H	CMD 1	
D1071 up	‘3’	33 H	CMD 0	
D1072 down	‘0’	30 H	Date (Words)	
D1072 up	‘C’	43 H		
D1073 down	‘0’	30 H	Content of address 2101H	PLC will automatically convert ASCII codes and save in D1050 = 0100H
D1073 up	‘1’	31 H		
D1074 down	‘0’	30 H		
D1074 up	‘0’	30 H		
D1075 down	‘1’	31 H	Content of address 2102H	PLC will automatically convert ASCII codes and save in D1051 = 1766H
D1075 up	‘7’	37 H		
D1076 down	‘6’	36 H		
D1076 up	‘6’	36 H		

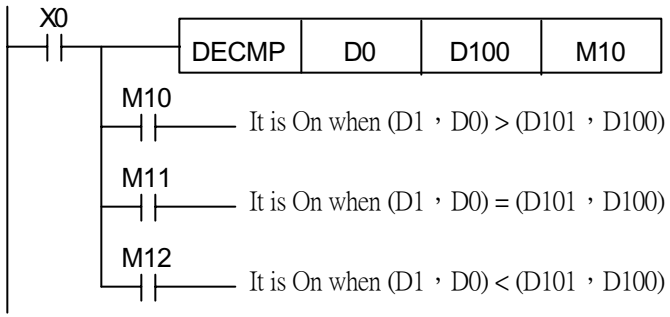
※ ADR (1,0): AC drive
※ CMD (1,0): Command code
※ LRC CHK (0,1): check fault code. Refer to the communication parameters of Delta AC drive user manual for more details.

Feedback:				
D1077 down	‘0’	30 H	Content of address 2103H	PLC will automatically convert ASCII codes and save in D1052 = 0000H
D1077 up	‘0’	30 H		
D1078 down	‘0’	30 H		
D1078 up	‘0’	30 H		
D1079 down	‘0’	30 H	Content of address 2104H	PLC will automatically convert ASCII codes and save in D1053 = 0000H
D1079 up	‘0’	30 H		
D1080 down	‘0’	30 H		
D1080 up	‘0’	30 H		
D1081 down	‘0’	30 H	Content of address 2105H	PLC will automatically convert ASCII codes and save in D1054 = 0136H
D1081 up	‘1’	31 H		
D1082 down	‘3’	33 H		
D1082 up	‘6’	36 H		
D1083 down	‘0’	30 H	Content of address 2106H	PLC will automatically convert ASCII codes and save in D1055 = 0000H
D1083 up	‘0’	30 H		
D1084 down	‘0’	30 H		
D1084 up	‘0’	30 H		
D1085 down	‘3’	33 H	LRC CHK 1	
D1085 up	‘B’	42 H	LRC CHK 0	

D **110** ECMP (S1) (S2) (D) Comparison of decimal of binary system

Operand \ Device	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(S1)					◎	◎							◎		
(S2)					◎	◎							◎		
(D)		◎	◎	◎											

- (S1): the comparison value 1 of decimal of binary system. (S2): the comparison value 2 of decimal of binary system. (D): comparison result, occupies continuous 3 points.
- The comparison result (>, =, <) of value 1 of decimal of binary system and value 2 of decimal of binary system will be showed in (D).
- If the source operand (S1) or (S2) designates constant K or H, command will convert the constant to decimal of binary system to compare.
- If designated device is M10, it will occupy M10~M12.
- **Program Example**



◎ When X0=On and execute DECMP command, one of M10~M12 will be On. When X0=Off and not to execute DECMP command, the state of M10~M12 will be in the state before X0= Off.

- If you need to get the result of ≧, ≦, ≠, you could get by series connection or parellet connection of M10~M12.
- If you want to clear the result, please use RST or ZRST command.
- Please refer to page 7-4 Handling of Decimal for detail.

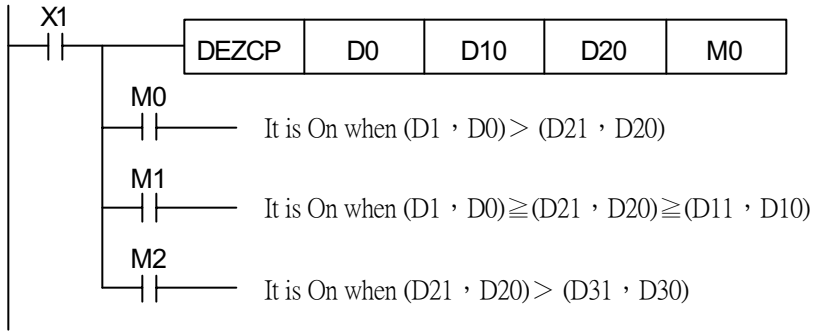
D **111** EZCP (S1) (S2) (D) (D) Comparison of the area of decimal of binary system

Operand \ Device	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(S1)					◎	◎							◎		
(S2)					◎	◎							◎		
(D)					◎	◎							◎		
(D)		◎	◎	◎											

- (S1): lower bound of decimal of binary of area comparison. (S2): upper bound of decimal of binary of area comparison. (S): comparison value of decimal of binary system. (D): comparison result, it will occupy continuous 3 points.
- The compared result of (S), (S1) and (S2) will be saved in (D).
- If source operand (S1) or (S2) designates constant K or H, the command will convert the constant to decimal of binary system to compare.
- When (S1) > (S2), this command will use (S1) to be upper bound

and lower bound for comparison.

- If designated device is M0, it will auto occupy M0~ M2.
- **Program Example**



◎ When X1=On and DEZCP command is executed, one of M0~M2 will be On. When X0=Off and ZCP command is not executed, the state of M0~M2 will be in the state before X1=Off.

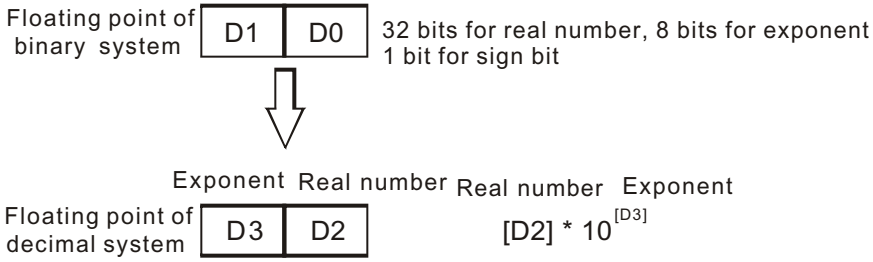
- If you want to clear the result, please use RST or ZRST command.
- Please refer to Page 7-4 Handling of Decimal for detail.

D	118	EBCD (S) (D)	Decimal of binary number→ decimal of decimal system

Device / Operand	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(S)													◎		
(D)													◎		

- (S): data resource. (D): the result of exchange.
- To convert the value of register that (S) designates from decimal of binary system to decimal of decimal system to save in the register that (D) designates.
- The PLC decimal is operated by decimal of binary system. The DEBCD command is the specific command for converting from decimal of binary system to decimal of decimal system.
- **Program Example**

◎ When X0=On, the decimal of binary system in D1, D0 will be converted to decimal of decimal system to save in D3, D2.



- Please refer to Page 7-4 Handling of Decimal for detail.

D	119	EBIN (S) (D)	Decimal of decimal system →decimal of binary system

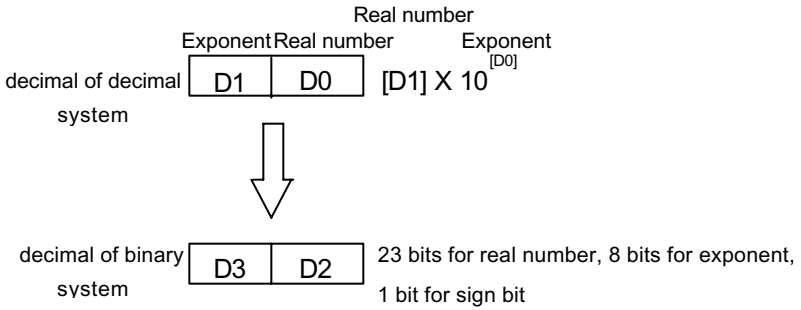
Device / Operand	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(S)													◎		
(D)													◎		

- (S): data resource. (D): the exchange result.
- To convert the value of decimal of decimal system in the register that

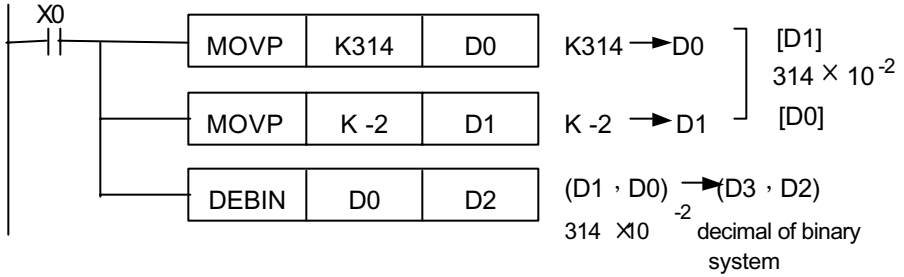
(S) designates to decimal of binary system and save the result in the register that (D) designates.

- DEBIN command is the specific command that used to convert the value from decimal of decimal system to decimal of binary system.
- **Program Example**

◎ When X1=On, the decimal of decimal system in D1, D0 is converted to decimal of binary system to save in D3, D2.



- Before doing decimal operation, you should use FLT（API 49）BIN integer to convert to decimal of binary system. The value that is exchanged must be BIN integer. However, DEBIN command can convert decimal to decimal of binary system.
- **Program Example**



◎ When X0=On, move K314 to D0 and move K-2 to D1 to make up decimal of decimal system ($3.14 = 314 \times 10^{-2}$).

- Please refer to page 7-4 decimal handing for detail.

D	120	EADD (S1) (S2) (D)	Addition of decimal of binary system

Operand \ Device	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(S1)					◎	◎							◎		
(S2)					◎	◎							◎		
(D)													◎		

- (S1): augend. (S2): addend. (D): sum.
- The content of register that (S1) designates adds the content of register that (S2) indicates and save the sum in the register that (D) designates. The all process of addition operation uses decimal of binary system.
- If source operand (S1) or (S2) designates constant K or H, the command will convert the constant to decimal of binary system for addition operation.

■ (S1) and (S2) can designate the same number register. In this situation, when using "continuous" command the register will be added one time in the every scan during the condition contact is On. In general, it uses pulse execution command. (DEADDP).

■ **Program Example**

◎ When X0=On, add the decimal of binary system (D1, D0) and the decimal of binary system (D3, D2) and save the sum in (D11, D10).

■ **Program Example**

■ When X2=On, add the decimal of binary system (D11, D10) and K1234 (auto convert to decimal of binary system) and save the sum in (D21, D20).

■ Please refer to page 7-4 Handling of Decimal for detail.

D	121	ESUB (S1) (S2) (D)	Subtraction of decimal of binary system

Device / Operand	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(S1)					◎	◎							◎		
(S2)					◎	◎							◎		
(D)													◎		

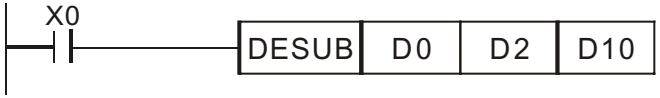
■ (S1): minuend. (S2): subtrahend. (D): difference.

■ Using the content of register that (S1) designates minus the content of register that (S2) designates and save the result in the register that (D) designates. All process of subtraction uses the type of decimal of binary system.

■ If the source operand (S1) or (S2) designates the constant K or H, the command will be convert to decimal of binary system to subtract.

■ (S1) and (S2) can designate the same number register. In this situation, when using "continuous" command the register will be added one time in the every scan during the condition contact is On. in general, it uses pulse execution command (DESUBP).

■ **Program Example**



◎ When X0=On, decimal of binary system (D1, D0) minus decimal of binary system (D3, D2) and save the result to (D11, D10).

■ **Program Example**

◎ When X2=On, K1,234 (auto convert to decimal of binary system) minus the decimal of binary system (D1, D0) and save the result to (D11, D10).

■ Please refer to page 7-4 Handling of Decimal for detail.

D **122** EMUL (S1) (S2) (D) Multiplication of decimal of binary system

Operand \ Device	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(S1)					◎	◎							◎		
(S2)					◎	◎							◎		
(D)													◎		

■ (S1): multiplicand. (S2): multiplicator. (D): product of multiplication.

■ The content of register that (S1) designates multiplied by the content of register that (S2) designates and save the result in the register that (D) designates. All process of multiplication operation uses decimal of binary system.

■ If source operand (S1) or (S2) designates the constant K or H, the command will convert the constant to decimal of binary system.

■ (S1) and (S2) can designate the same number register. In this situation, when using "continuous" command the register will be added one time in the every scan during the condition contact is On. It uses pulse execution command in general (DEMULP).

■ **Program Example**

◎ When X0=On, the decimal of binary system (D1,D0) multiplies the decimal of binary system (D11,D10) and save the result in the register that (D21,D20) designates.

■ **Program Example**

◎ When X2=On, K1,234(auto convert to decimal of binary system)×the decimal of binary system (D1, D0) and save the result in (D11, D10).

■ Please refer to page 7-4 Handling of Decimal for detail.

D **123** EDIV (S1) (S2) (D) Division of decimal of binary system

Operand \ Device	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(S1)					◎	◎							◎		
(S2)					◎	◎							◎		
(D)													◎		

■ (S1): dividend. (S2): divisor. (D): quotient and remainder.

■ The content of register that (S1) designates divided by the content of register that (S2) designates and save the result in the register that (D) designates. All process of division operation uses decimal of binary system.

■ If source operand (S1) or (S2) designates the constant K or H, the command will convert the constant to decimalof binary system.

■ If the content of divisor (S2) is 0, it will be regarded as "operand error" and this command won' t be executed.

■ **Program Example**

◎ When X1=On, the decimal of binary system (D1,D0) divided by the decimal of binary system (D11,D10) and save the remainder in (D21,D20).

■ **Program Example**

◎ When X2=On, the decimal of binary system (D1, D0) ÷ K1234 (auto convert to decimal of binary system) and save the result in (D11, D10).

■ Please refer to page 7-4 Handling of Decimal for detail.

D	127	ESQR	(S) (D)	Square root of decimal of binary system

Device / Operand	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(S)					◎	◎							◎		
(D)													◎		

■ (S): the source device for getting the square root. (D): the result of the square root.

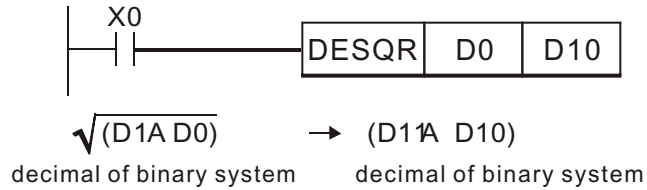
■ Getting the square root of the register that (S) designates and save the result in the rgister that (D) designates. All process uses decimal of binary system.

■ If the source operand (S1) or (S2) designates the constant K or H, the command will convert the constant to decimal of binary system.

If the result of square root is 0, flag M1020=On

■ Source operand is valid when the value is positive. If the value is negative, it will be regarded as "operand error", the command won't be executed and flag M1067=On.

■ **Program Example**



◎ When X0=On, get the square root of decimal of binary system (D1,D0) to save in the register that (D11,D10) designates.

■ **Program Example**

◎ When X2=On, get the square root of K1,234 (auto convert to decimal of binary system) and save the result in (D11, D10).

■ Please refer to page 7-4 Handling of Decimal for detail.

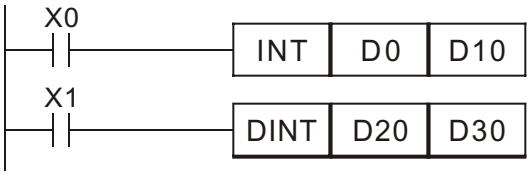
D	129	INT	(S) (D)	Decimal of binary system→BIN integer

Device / Operand	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(S)													◎		
(D)													◎		

■ (S): the source device for converting. (D): conversion result.

■ The register that (S) designates convert from decimal of binary system to BIN integer and save in the register that (D) designates. The decimal of Bin integer will be discarded.

- The function of this command is opposite to API 49 (FLT).
- If the result after converting is 0, zero flag M1020=On.
  If there is any decimal discarded, M1021=On.
  If the result exceeds the following range, M1022=On.
  16-bit command: -32,768~32,767
  32-bit command: -2,147,483,648~2,147,483,647
- **Program Example**



◎ When X0=On, the decimal of binary system (D1, D0) will convert to BIN integer and save the result in (D10). The decimal of BIN integer will be discarded.

◎ When X1=On, the decimal of binary system (D21, D20) will convert to BIN integer and save the result in (D31, D30). The decimal of BIN integer will be discarded.

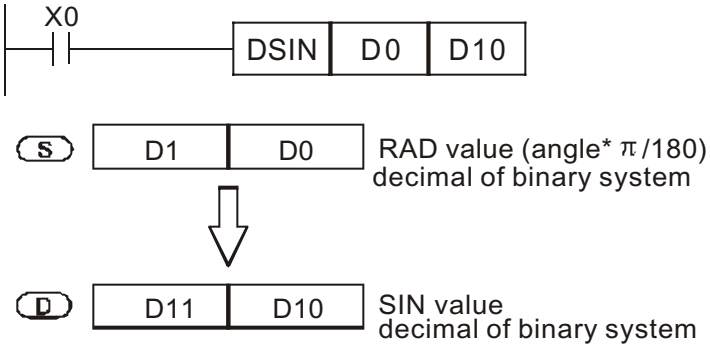
- Please refer to page 7-4 Handling of Decimal for detail.

D 130	SIN (S) (D)	SIN operation of decimal of binary system

Device / Operand	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(S)													◎		
(D)													◎		

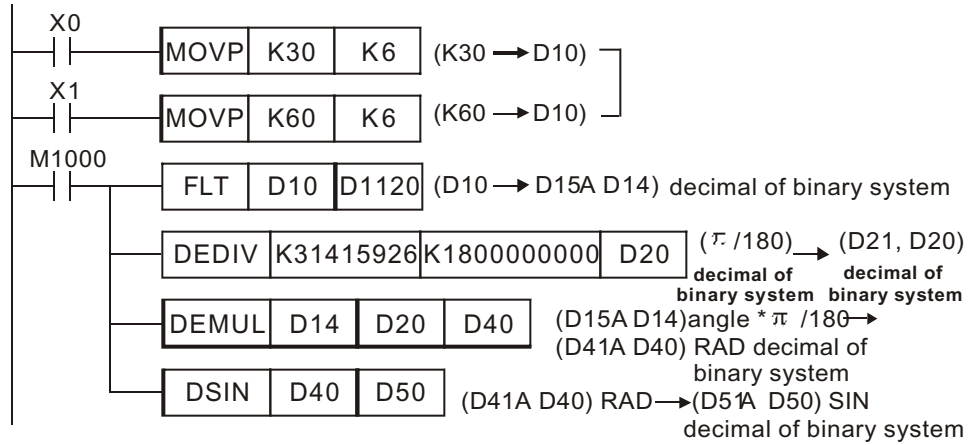
- (S): designated RAD value. (D): the result after converting to SIN.
- RAD value that (S) designates = angle $\times\pi$/180. Save the result of converting to SIN value in the register that (D) designates.

- **Program Example**



◎ When X0=On, save the result after converting the RAD value of decimal of binary system of (D1, D0) to SIN value in (D11, D10). The content is decimal of binary system.

- Selecting angle from input terminal X0 and X1 and convert it to RAD value. Then convert to SIN value.

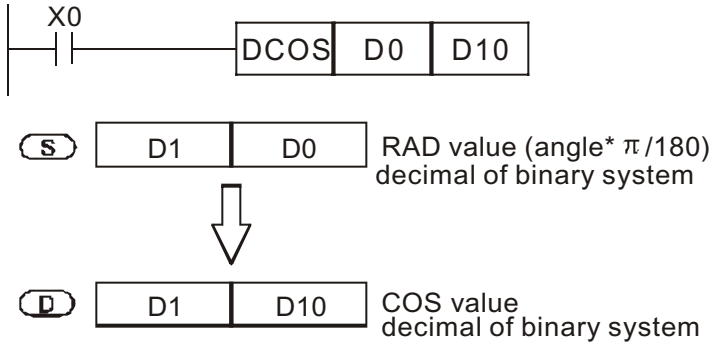


- Please refer to page 7-4 Handling of Decimal for detail.

D 131 COS (S) (D) COS operation of decimal of binary system

Operand \ Device	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(S)													◎		
(D)													◎		

- (S): designated RAD. (D): the result of COS value.
- RAD value that (S) designates = angle × π /180. To get COS value and save in the register that (D) designates.
- **Program Example**



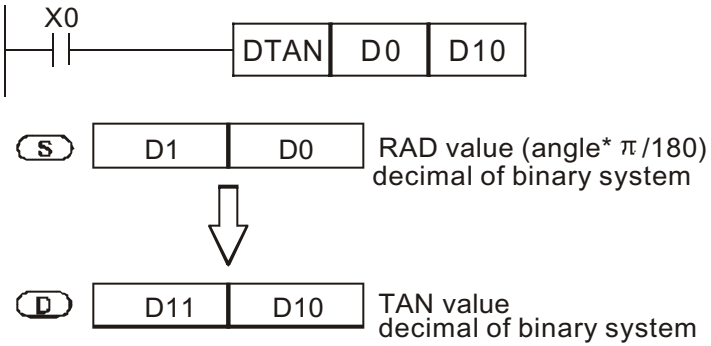
◎ When X0=On, Get the COS value of RAD value of decimal of binary system (D1, D0) and save it in (D11, D10). The content is decimal of binary system.

- Please refer to page 7-4 Handling of Decimal for detail.

D 132 TAN (S) (D) TAN operation of decimal of binary system

Operand \ Device	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(S)													◎		
(D)													◎		

- (S): designated RAD value. (D): the result of TAN value.
- RAD value that (S) designates = angle × π /180. Get TAN value and save the result in the register that (D) designates.
- **Program Example**



◎ When X0=On, RAD value of decimal of binary system of (D1, D0) and convert to TAN value to save in (D11, D10). The content is decimal of binary system.

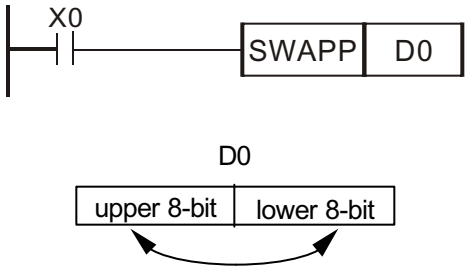
- Please refer to page 7-4 Handling of Decimal for detail.

147 **SWAP** (S) Swap upper and lower 8-bit

Operand \ Device	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(S)								◎	◎	◎	◎	◎	◎	◎	◎

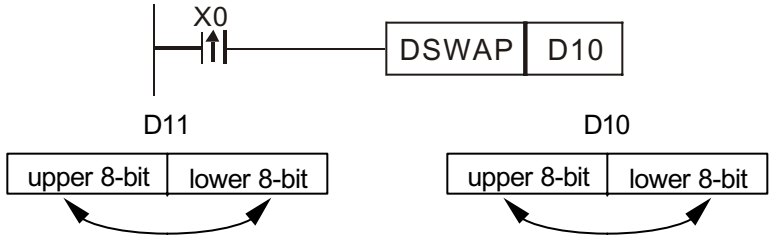
- Note: When operand D is used with equipment F, it can only use 16-bit command. Please refer to function specification charts for usage range of each device.
- (S): the equipment for swapping upper and lower 8-bit
- When being 16-bit command, swapping the content of upper and lower 8-bit.
- When being 32-bit command, swapping the content of upper and lower 8-bit of two registers separately.
- This command is usually pulse execution (SWAPP, DSWAPP).
- **Program Example 1:**

When X0=ON, swapping the content of upper and lower 8-bit of D0.



- **Program Example 2:**

When X0=ON, swapping upper 8-bit and lower 8-bit of D11 and swapping upper 8-bit and lower 8-bit of D10.



- **Footnote:**

The version V4.9 and above of ES / EX / SS series support Continuous execution command (SWAP, DSWAP).

150 **MODRW** (S1) (S2) (S3) (S4) (D) MODBUS data read/write

Operand \ Device	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(S1)					◎	◎							◎		
(S2)					◎	◎							◎		
(S3)					◎	◎							◎		
(S4)													◎		
(D)					◎	◎							◎		

Note: usage range of S1 operand K0~K255. The limitation of S2 operand indication content K3(H3), K6(H6), K16(H10). The usage of n: n=K1~K16. Please refer to function specification charts for usage range of each device.

- (S1): connection device address. (S2): function code. (S3): address of being read or write. (S4): register of being read/write. (n): length of read/write data.

■ (S1): UNIT ADDRESS. The usage range is K0~K255.

■ (S2): FUNCTION CODE. For example: the command of AC drive or DVP-PLC to read many items is H03. Write command of AC drive or DVP-PLC is H06 and the command of write many items is H10.

■ (S3): device address that being read/write data, inner device address of connection device. If address is illegal to the assigned equipment, there will be fault code save in D1130 and at the same time, M1141 will be ON. For example, 4000H is illegal to VFD-S, M1141 will be ON and D1130 = 2. Please refer to VFD-S for fault code.

■ (S3): device address of being read/write

■ (S4): source or destination of being read/write. User can set register to write data length in advance or save data after reading.

■ (n): read/write data length. Assigned range K1~K16(WORD).

■ **Program Example 1:**

◎ Function code K3(H3): read many items data.

1. PLC connects to VFD-S AC drive. (ASCII Mode when M1143=OFF)

2. PLC connects to VFD-S AC drive. (ASCII Mode when M1143=ON)

◎ Receiving data saves in 16 continuous registers that start from D0 with ASCII form when in ASCII mode. PLC will convert the content to Hexadecimal and save into registers D1296~D1311 automatically. M1131=ON when it starts converting to hexadecimal and M1131 will be OFF after finishing converting.

◎ User can MOV, DMOV or BMOV commands to move D1296~D1311 that save hexadecimal data to general register to use. Other command is invalid to this area.

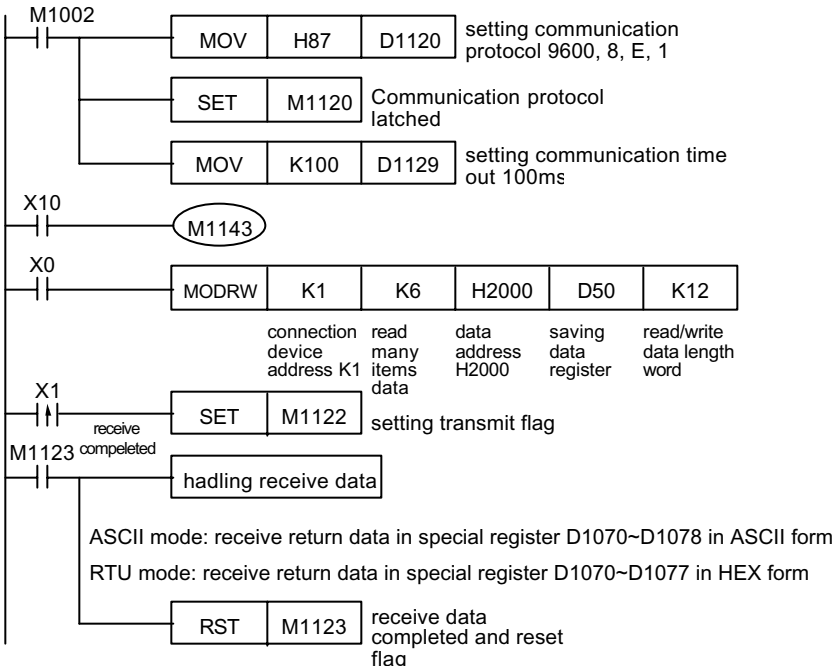
◎ Received data saves in the 16 continuous registers that starts from D0 and designated by users in hexadecimal type in RTU mode. At the same time, D1296~D1311 is invalid.

◎ In ASCII mode or RTU mode, PLC will save the transmission data in D1256~D1295. Users can move these register data to general register by MOV, DMOV or BMOV commands. Other commands are invalid to this area.

◎ Data, return from AC drive, is saved in registers that designate by users. After finishing, PLC will check if the received data is correct automatically. If having faults, M1140 will be set to ON.

◎ Inner data address of AC drive. If address is illegal to assigned equipment, it will have fault code. Fault code will be saved in D1130 and M1141 will be on. For example, 4000H is illegal to VFD-S and M1141=ON and D1130=2. Please refer to VFD-S user manual to fault code.

◎ After M1140= ON or M1141=ON, it will transmit a correct data to AC drive. If return data is correct, M1140 and M1141 will be reset.



■ **Program Example 2:**

◎ Function code K6(H6): write a WORD to register

A. PLC connects to VFD-S AC drive. (ASCII Mode when M1143=OFF)

B. PLC connects to VFD-S AC drive. (ASCII Mode when M1143=ON)

◎ When in ASCII mode, users save data that will be wrote to AC drive in ASCII form in assigned register D0. Data that return from AC drive will be saved in registers D1070~D1076.

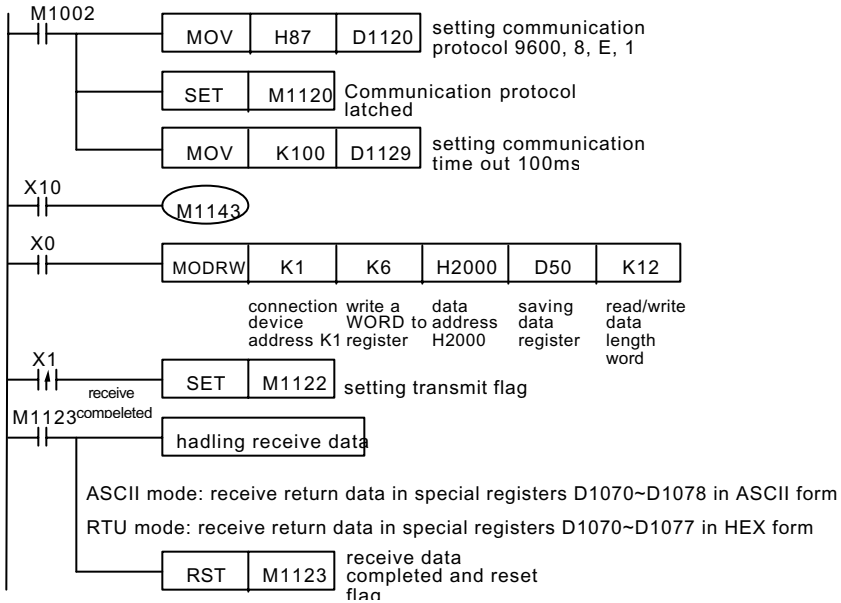
◎ When in RTU mode, users save data that will be wrote to AC drive in HEX form in assigned register D0. Data that return from AC drive will be saved in register D1070~D1076.

◎ When in ASCII mode or RTU mode, PLC will save data that will transmit in transmission registers D1256~D1295. Users can move these data to general registers by using MOV, DMOV or BMOV commands.

◎ After receiving return data from AC drive, PLC will check the receiving data automatically. If having fault, M1140 will be ON.

◎ Inner data address of AC drive. If address is illegal to assigned equipment, it will have fault code. Fault code will be saved in D1130 and M1141 will be ON. For example, 4000H is illegal to VFD-S, M1141 will be ON and D1130=2. Please refer to VFD-S user manual for detail.

◎ After M1140 is ON or M1141 is ON, it will transmit a correct data to AC drive. If return data is correct, M1140 and M1141 will be reset.



■ **Program Example 3:**

◎ Function code K16(H10): write many WORD to register

A. PLC connects to VFD-S AC drive (when M1143=OFF, ASCII Mode)

B. PLC connects to VFD-S AC drive (when M1143=ON, RTU Mode)

◎ When in ASCII mode, users will save data that being wrote to AC drive in 12 continuous registers that start from D0 and designated by user in ASCII form. Data that AC drive return will save in registers D1070~D1076.

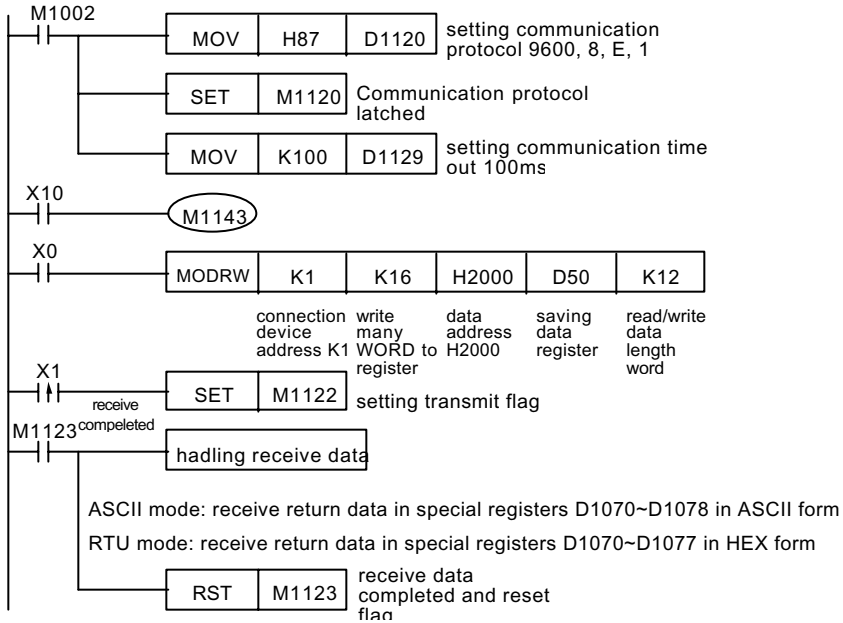
◎ When in RTU mode, users will save data that being wrote to AC drive in 12 continuous registers that start from D0 and designated by user in HEX form. Data that AC drive return will save in registers D1070~D1078.

◎ When in ASCII mode or RTU mode, PLC will save data that being transmitted in registers D1256~D1295. Users can move these data to general registers by using MOV, DMOV or BMOV commands. Other commands are invalid to this area.

◎ After receiving data that return from AC drive, PLC will check it. If there is fault, M1140 will be ON.

◎ Inner data address of AC drive. If address is illegal to assigned equipment, it will have fault code. Fault code will be saved in D1130 and M1141 will be on. For example, 4000H is illegal to VFD-S, M1141 is ON and D1130=2. Please refer to VFD-S user manual for detail.

◎ After M1140 is ON or M1141 is ON, it will transmit a correct data to AC drive. If return data is correct, M1140 and M1141 will be reset.



■ **Footnote:**

1. V4.9 and above of ES / EX / SS series have this command MODRW.
2. Relative flag signal and special register of RS-485 communication MODRW command: please refer to footnote of API 80 RS command for detail.

Flag	Function explanation
M1120	Communication setting latched
M1121	Transmit waiting message
M1122	Delivery request

Flag	Function explanation
M1123	Receive completed
M1124	Receive waiting message
M1125	Receive status disable
M1126	STX/ETX system definition selection
M1127	MODRD / RDST / MODRW commands data receive completed
M1128	Transmitting/receiving indication
M1129	Receive time out
M1130	Users/system definition STX/ETX
M1131	MODRD / MODWR / MODRW data convert to HEX, M1131=ON
M1140	MODRD / MODWR / MODRW data receive error
M1141	MODRD / MODWR / MODRW command parameter error
M1142	VFD-A convenience command data receive error
M1143	ASCII / RTU mode selection, ON is RTU mode

Special register	Function Explanation
D1038	Time setting for data response delay when PLC is slave. Time unit is 0.1ms.
D1070~ D1085	It is PLC built-in RS-485 communication convenience command. This command will send messages during executing and if the receiver receives, it will return messages and save it in D1070~D1085. Users can view return data by this register content.
D1120	RS-485 communication protocol
D1121	PLC communication address
D1122	Remainder characters of delivery data

Special register	Function Explanation
D1123	Remainder characters of received data
D1124	Start text definition（STX）
D1125	Definition of the first end character（ETX1）
D1126	Definition of the second end character（ETX2）
D1129	Communication time out abnormal. Time unit:（ms）
D1130	Return fault code record of MODBUS
D1256~ D1295	This is PLC built-in RS-485 communication convenience command MODRW. The message that this command sends during executing will be saved in D1256~D1295. User can check according to this register content. (In version 4.9, you can use MOV, DMOV, BMOV to move the data in this area.
D1296~ D1311	PLC will convert ASCII saved in the register that users indicate to hexadecimal. (In version 4.9, you can use MOV, DMOV, BMOV to move the data in this area.)

D 224 ↓ 230

LD＊ (S1) (S2) The contact type comparison **LD＊**

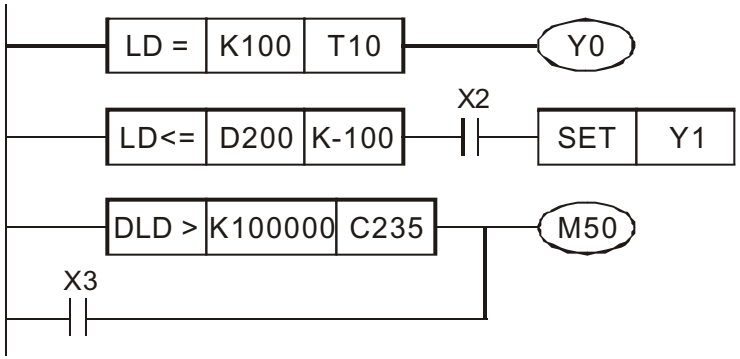
Device / Operand	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(S1)					◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎
(S2)					◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎
＊ : =, >, <, <>, ≦, ≧															

- Compare the contents of (S1) and of (S2). To take "LD=" as an example, if the comparison result is "=", the contact is in continuity, and if it is "≠", the contact is in discontinuity. The LD＊ command could connect directly with the BUS.

- When the left most bit, MSB (the 16-bit command: b15, the 32-bit command: b31), from (S1) and (S2) is 1, this comparison value will be viewed as a negative value for comparison.
- If the 32-bit length counter (C235~) is put into this command for comparison, be sure to use the 32-bit command (DLD∗). If the 16-bit command (LD∗) is utilized, CPU will determine it as "Program Error", and the red "ERROR" indicator on the MPU panel will be blinking, and the CPU will not berunning.
- Motion Conditions of LD∗:

API No.	16-bit command	32-bit command	Continuity condition	Discontinuity condition
224	LD=	DLD=	(S1) = (S2)	(S1) ≠ (S2)
225	LD>	DLD>	(S1) > (S2)	(S1) ≦ (S2)
226	LD<	DLD<	(S1) < (S2)	(S1) ≧ (S2)
228	LD<>	DLD<>	(S1) ≠ (S2)	(S1) = (S2)
229	LD≦	DLD≦	(S1) ≦ (S2)	(S1) > (S2)
230	LD≧	DLD≧	(S1) ≧ (S2)	(S1) < (S2)

- **Program Example**



◎ If the content of counter T10 is equal to K100, Y0=ON.

◎ When the content of D200 is smaller or equal to K –100, and that X2=ON, Y1 will be set as "ON".

◎ If the content of C235 is smaller than K100,000, or when X3=ON, M50=ON.

D 232 ↓ 238

AND∗ (S1) (S2) The series connection contact type comparison AND∗

Device / Operand	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(S1)					◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎
(S2)					◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎

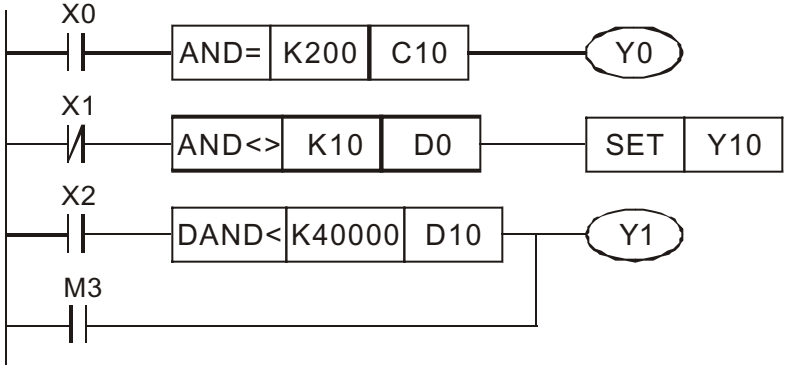
∗ : =, >, <, <>, ≦, ≧

- Compare the contents of (S1) and of (S2), To take "AND=" as an example, if the comparison result is "=", the contact is in continuity, and if it is "≠", the contact is in discontinuity. The AND∗ command is the comparison command that connects with the series connection contact.
- When the left most bit, MSB (the 16-bit command: b15, the 32-bit command: b31), from (S1) and (S2) is 1, this comparison value will be viewed as a negative value for comparison.
- If the 32-bit length counter (C235~) is put into this command for comparison, be sure to use the 32-bit command (DAND∗). Or if the 16-bit command (AND∗) is utilized, CPU will determine it as "Program Error", and the red "ERROR" indicator on the MPU panel will be blinking, and the CPU will not berunning.

■ Motion Conditions of AND∗:

API No.	16-bit command	32-bit command	Continuity condition	Discontinuity condition
232	AND=	DAND=	(S1) = (S2)	(S1) ≠ (S2)
233	AND>	DAND>	(S1) > (S2)	(S1) ≦ (S2)
234	AND<	DAND<	(S1) < (S2)	(S1) ≧ (S2)
236	AND<>	DAND<>	(S1) ≠ (S2)	(S1) = (S2)
237	AND≦	DAND≦	(S1) ≦ (S2)	(S1) > (S2)
238	AND≧	DAND≧	(S1) ≧ (S2)	(S1) < (S2)

■ **Program Example**



◎ If X0=ON and that the current value of counter C10 equals K200, Y0=ON.

◎ If X1=OFF and that the content of register D0 not equal to K –10, Y10 will be set as "ON".

◎ If X2=ON and that the contents of the 32-bit registers D11 and D10 are equal to K40,000, Y1=ON.

D 240 ↓ 246

OR∗ (S1) (S2) The parallel connection contact type comparison OR∗

Operand \ Device	Bit device				Word device										
	X	Y	M	S	K	H	KnX	KnY	KnM	KnS	T	C	D	E	F
(S1)					◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎
(S2)					◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎

∗: =, >, <, <>, ≦, ≧

■ Compare the contents of (S1) and of (S2). Take "OR=" as an example, if the comparison result is "=", the contact is in continuity, and if it is "≠", the contact is in discontinuity. The OR∗ command is the comparison command that connects with the parallel connection contact.

■ When the left most bit, MSB (the 16-bit command: b15, the 32-bit command: b31), from (S1) and (S2) is 1, this comparison value will be viewed as a negative value for comparison.

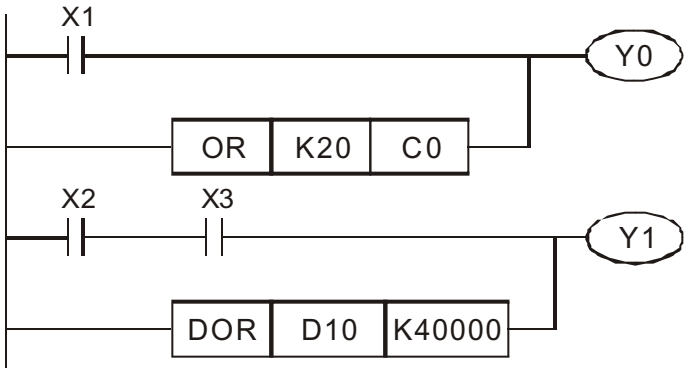
■ If the 32-bit length counter (C235~) is put into this command for comparison, be sure to use the 32-bit command (DOR∗). Or if the 16-bit command (OR∗) is utilized, CPU will determine it as "Program Error", and the red "ERROR" indicator on the MPU panel will be blinking, and the CPU will not be running.

■ Motion Conditions of OR∗:

API No.	16-bit command	32-bit command	Continuity condition	Discontinuity condition
240	OR=	DOR=	(S1) = (S2)	(S1) ≠ (S2)
241	OR>	DOR>	(S1) > (S2)	(S1) ≦ (S2)
242	OR<	DOR<	(S1) < (S2)	(S1) ≧ (S2)

API No.	16-bit command	32-bit command	Continuity condition	Discontinuity condition
244	OR< >	DOR< >	(S1) ≠ (S2)	(S1) = (S2)
245	OR≦	DOR≦	(S1) ≦ (S2)	(S1) > (S2)
246	OR≧	DOR≧	(S1) ≧ (S2)	(S1) < (S2)

■ **Program Example**



◎ If X1=ON, or that the current value of counter C0 is equal to K20, Y0=ON.

◎ If both X2 and X3 are "ON", or that the contents of the 32-bit registers D11 and D10 are greater or equal to K40,000, Y1=ON.

■ EX MPU

EX MPU is a main processing unit with 4 analog inputs and 2 analog outputs. (Refer to Chapter 2 for detailed specifications), methods to be adopted are as follows:

◎ Analog/Digital (A/D)

Analog Input:

Monotonicity with no miss code

Overall Precision:

Non-linearity: ±1% of full scale over temperature.

Maximum error: ±1% of full scale of +10V and +20mA over temperature.

Data format returned to the application program: Binary.

Value of LSB (Least Significant Bit):

Voltage input: 19.53125 mV (10V/512)

Current input: 39.0625 μA (20mA/512)

Input mode: differential

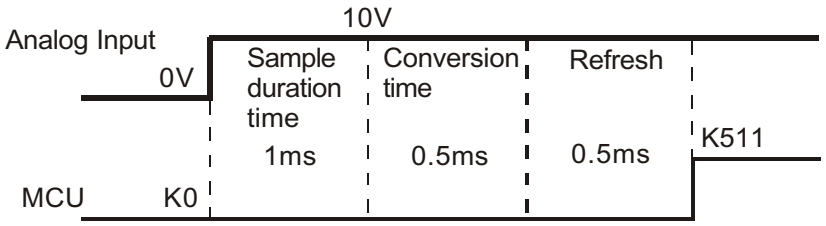
Common mode characteristic (dc 50Hz 60Hz) if applicable: 70dB

Total input system transfer time (TAID + TAIT): 2ms

Sample duration time (including setting time): 1ms

Sample repetition time: 0.5ms

Refresh time: 0.5ms



Input characteristics: Third order

Maximum transition frequency: 200Hz

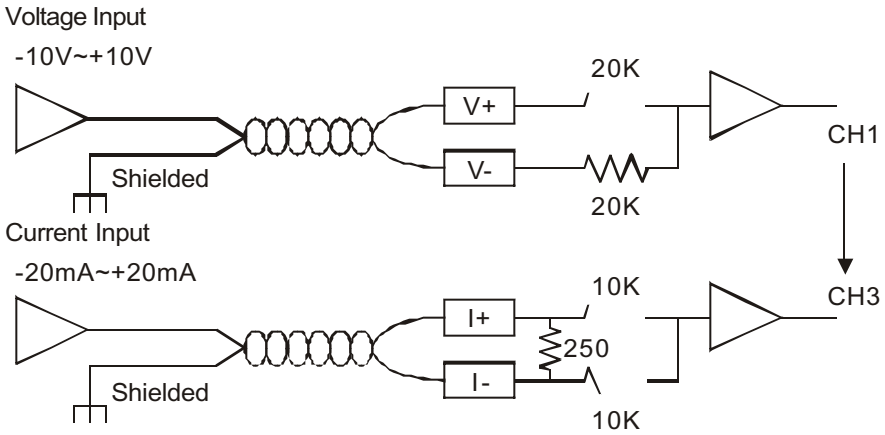
Conversion method: SAR (Successive Approximation Register)

Operating modes: Self-scan

*Please use a twisted pair shielded cable for the analog input/output, this cable should be wired away from powers lines or any other lines which induce noise. (Suggested cable length: under 3m)

*No need for this device to be verified by the factory, and should any problem occurred, please return this device to the original factory or the agent.

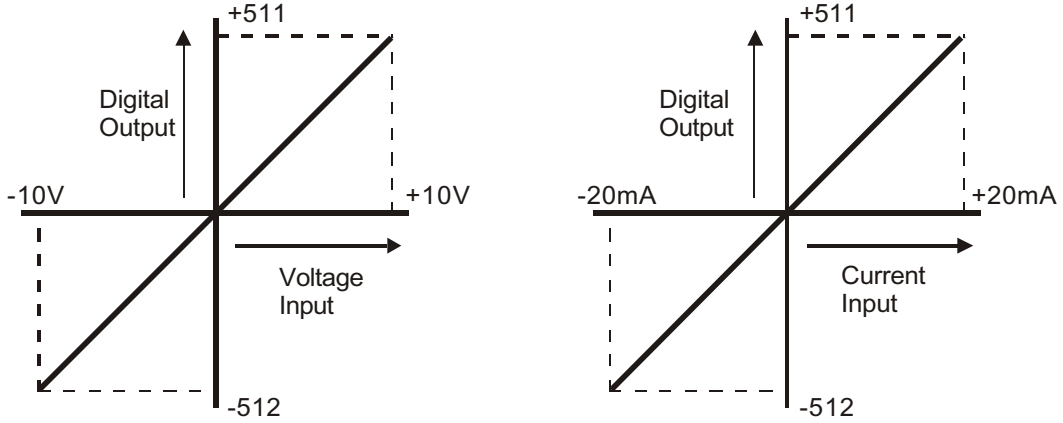
External Wiring Diagram：



1. The analog input is received through a twisted pair shield cable. This cable should be wired separately from power line or any other lines that may induce electrical noise.
2. Connect the ground terminal on the DVP20EX-Series with the grounded terminal on the unit; use class 3 grounding on the unit.

Either voltage or current input can be selected with your choice of input terminal.

Analog input



There are four channels (CH0~CH3) that accept analog inputs. The PLC will convert the analog into a digital format and save it in the corresponding data registers D1110~D1113.

Channel	Analog signals	Reacting time	Input terminals	Resolution (bits)	Accuracy	Analog conversion		Example: Added in +5V to Ch1, and added –5mA to Ch2, the Analog/Digital (A/D) conversions are: D1111 = 256, D1112 = -128
						Reg.	Conversion range	
CH0	Voltage: –10V~+10V Input impedance: 40KΩ Current: -20mA~+20mA Input impedance: 250Ω	5ms	A_0V+~A_0V- A_0I+~A_0I-	10	±1% at full scale of ±10V and ±20mA	D1110	-512~+511	
CH1		5ms	A_1V+~A_1V- A_1I+~A_1I-	10		D1111	-512~+511	
CH2		5ms	A_2V+~A_2V- A_2I+~A_2I-	10		D1112	-512~+511	
CH3		5ms	A_3V+~A_3V- A_3I+~A_3I-	10		D1113	-512~+511	

*This unit may be damaged by input voltages in excess of ±15V or ±30mA.

*If the voltage or current exceeds ±15V or ±30mA during the operation, it will then result in permanent damage to this unit. Users should pay special attention to avoid the above-mentioned incident.

◎ **Digital/Analog (D/A)**

Analog Output:

Monotonicity with no miss code

Overall Precision:

Non-linearity: ±1% of full scale over temperature.

Maximum error: ±1% of full scale of +10V and +20mA over temperature.

Data format returned to the application program: Binary.

Value of LSB (Least Significant Bit):

Voltage output: 78.125 mV

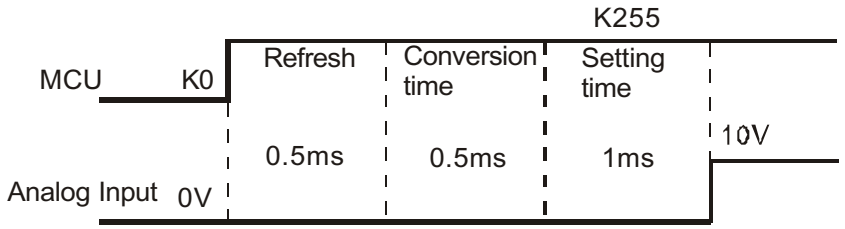
Current output: 78.125 μA

Total input system transfer time (TAID + TAIT) ：2ms

Refresh time:0.5ms

Conversion time:0.5ms

Setting time for full range change = 1ms

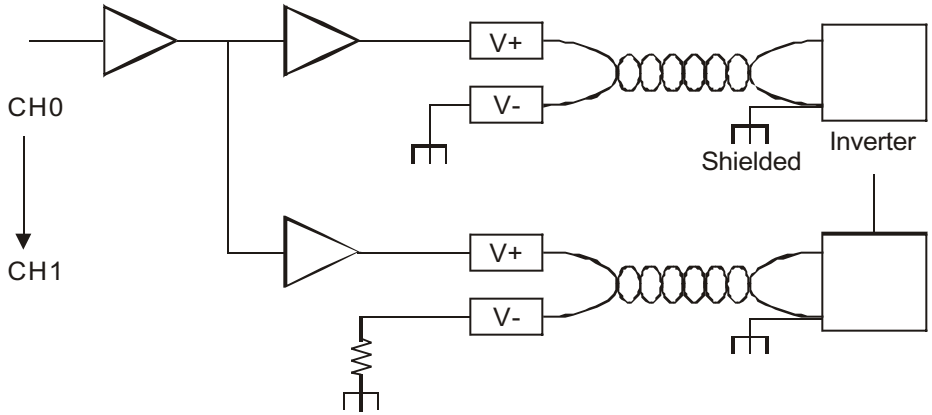


Overshoot : ±1% of full scale

1. The analog output is received through a twisted pair shield cable. This cable should be wired separately from power line or any other lines which may induce electrical noise.

*No need for this device to be verified by the factory, and should any problem occurred, please return this device to the original factory or the agent.

External Wiring Example Diagram：



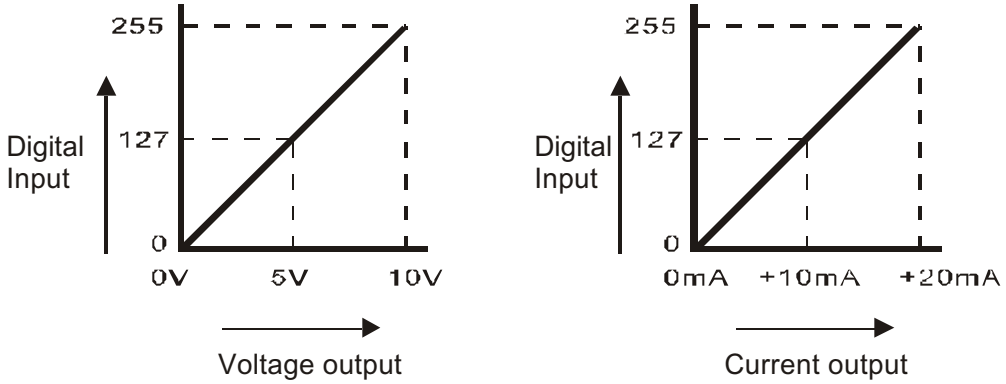
*If the external wiring is not conducted properly, erroneous motions or damages might result, and consequently, if there is the condition of short-circuits for the analog voltage output, it is then very likely that a permanent damage will take place.

Allowed type of loads: floating

Maximum capacitive load (for voltage outputs): 100PF

The responding time from the point where the power is supplied till an output signal is generated: 4 sec

Output ripple: less than 0.1%



There are two channels (CH0~CH1) that convert digital signals saved in D1116~D1117 and output analog signals on specified output terminals.

Channel	Analog signals	Reacting time	Input terminals	Resolution (bits)	Accuracy	Analog conversion		Example:
						Reg.	Conversion range	
CH0	Voltage: 0V~+10V Current: 0mA~+20mA External load resistance: 2K~1MΩ(V), 0~500Ω(I)	5ms	D_0V+~D_0V- D_0I+~D_0I-	8	±1% at full scale of ±10V and 20mA	D1116	0~255	Use MOV command, Let D1116 = 50, D1117 = 90, The signal output will be: CH0 (D0V+,D0V-) ≅ 1.953125V CH1(D1V+, D1V-) ≅ 3.515625 V CH0 (D0I+, D0I-) ≅ 3.90625mA CH1(D1I+, D1I-) ≅ 7.03125mA
		5ms						
CH1		5ms	D_1V+~D_1V- D_1I+~D_1I-	8		D1117	0~255	
		5ms						

* Value 0-255 correspond to current signal 0-20mA so that value 128 corresponds to 10.039mA (20/255 * 128). Value 200 corresponds to 15.686 (20/255 * 200).

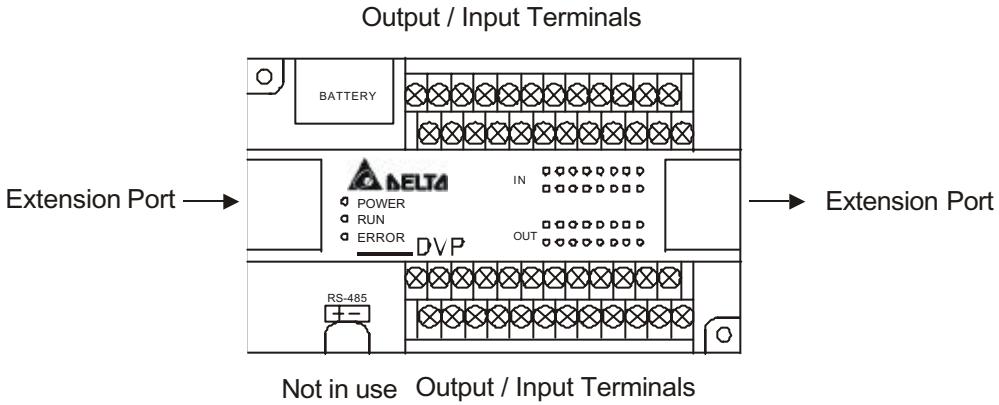
■ I/O Extension Units

The DVP series provides different extension units with specific I/O (please refer to Section 1.1 for specifications). The total input and output points can extend to 256 points. If 256 points are exceeded, the ERROR LED of the MPU will flash.

■ General Specification

Items \ Models	DVP08XN11□ DVP08XP11R	DVP08XM11N DVP16XM01N	DVP-16XN01□	DVP24XP01□	DVP24XN01□ DVP32XP01□	DVP24XP00□ DVP24XN00□ DVP32XP00□
Power Supply Voltage	24VDC (-15%~20%)					100~240VAC (-15%~20%) 50/60Hz ± 5%
Fuse Capacity	2A/250VAC					2A/250VAC
Power consumption (MAX)	5W	5W	6.5W	6.5W	8W	30VA
DC24V supply current	—	—	—	—	—	400mA
Power Protection	—					DC24V output with short-circuit protection
Withstand Voltage	1500VAC(Primary-secondary)，1500VAC(Primary-PE)，500VAC(Secondary-PE)					
Retentive Power Interruption	Continues operation within 5ms					Continues operation within 10ms
Insulation Resistance	>5 MΩ at 500VDC (Between all inputs/outputs and earth)					
Noisy Immunity	ESD: 8KV Air Discharge EFT: Power Line: 2KV, Digital I/O: 1KV, Analog & Communication I/O: 250V Damped-Oscillatory Wave: Power Line: 1KV Digital I/O: 1KV RS: 26MHz~1GHz, 10V/m					
Grounding	The diameter of grounding wire cannot be smaller than the wire diameter of terminals L and N (All DVP units should be grounded directly to the ground pole).					
Operation/Storage Environment	Operation: 0℃~55℃ (Temperature), 50~95% (Humidity); Storage: -25℃~70℃ (Temperature), 5~95% (Humidity) Pollution degree 2					
Vibration /Shock resistance	Standard IEC1131-2, IEC 68-2-6（TEST Fc）/ IEC1131-2 & IEC 68-2-27 (TEST Ea)					
Weight (g)	170/165	160/270	280	434	462/442	600/580

■ I/O Extension Unit Parts and Labels



◎ Status Indicator

1. POWER LED

There is a Power indication LED on the front of the I/O extension unit. When power is on, the POWER LED will light up. If the I/O extension unit LED does not light up and the extension unit is AC power input, please conduct the following test. Remove the **+24V** wire and recheck the LED. If the LED is now ON, then the DC power supply is overloaded and cannot be used. Please use another 24V source.

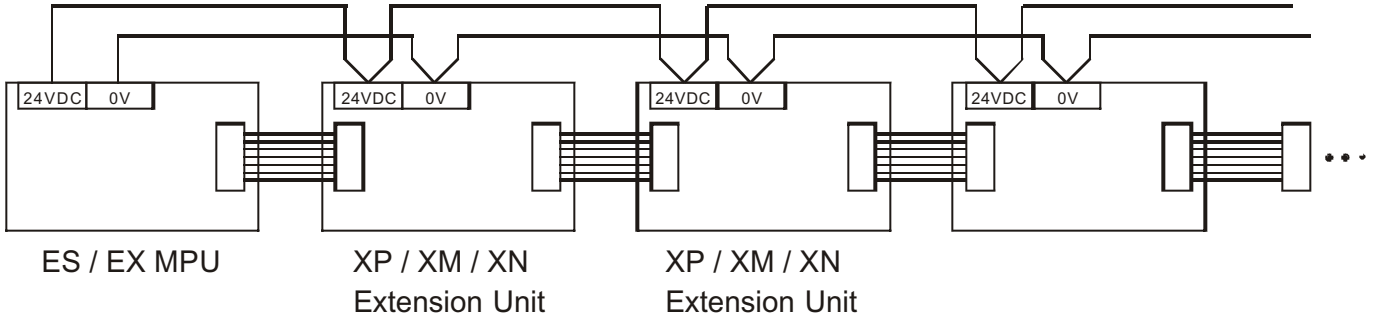
2. LOW V. LED

When the I/O +24V power supply is lower than 17.5V, the extension unit LED of LOW V will light up. At this moment, do not use the **+24V** DC output terminal of the extension unit. Please check your power source.

■ Combined System

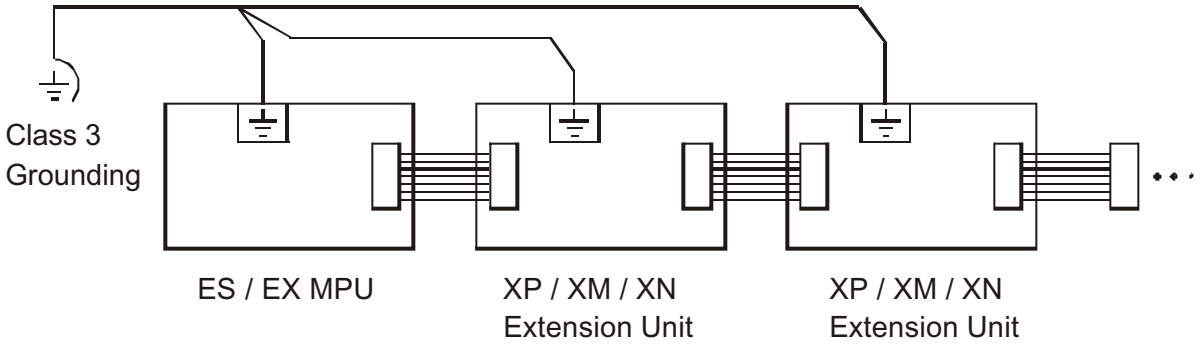
1. Power Terminal

There are two types of power inputs: AC and DC. We can use the +24V output provided by the MPU and supply it to the serial extension units (assuming the DC power supply input is selected). The total current consumed by the extension units cannot exceed the capacity provided by the MPU. Please see the specifications.



If you have the AC power input Extension Units, the connection method is the same as the AC input on the MPU.

2. Grounding



■ Input / Output points numbering order

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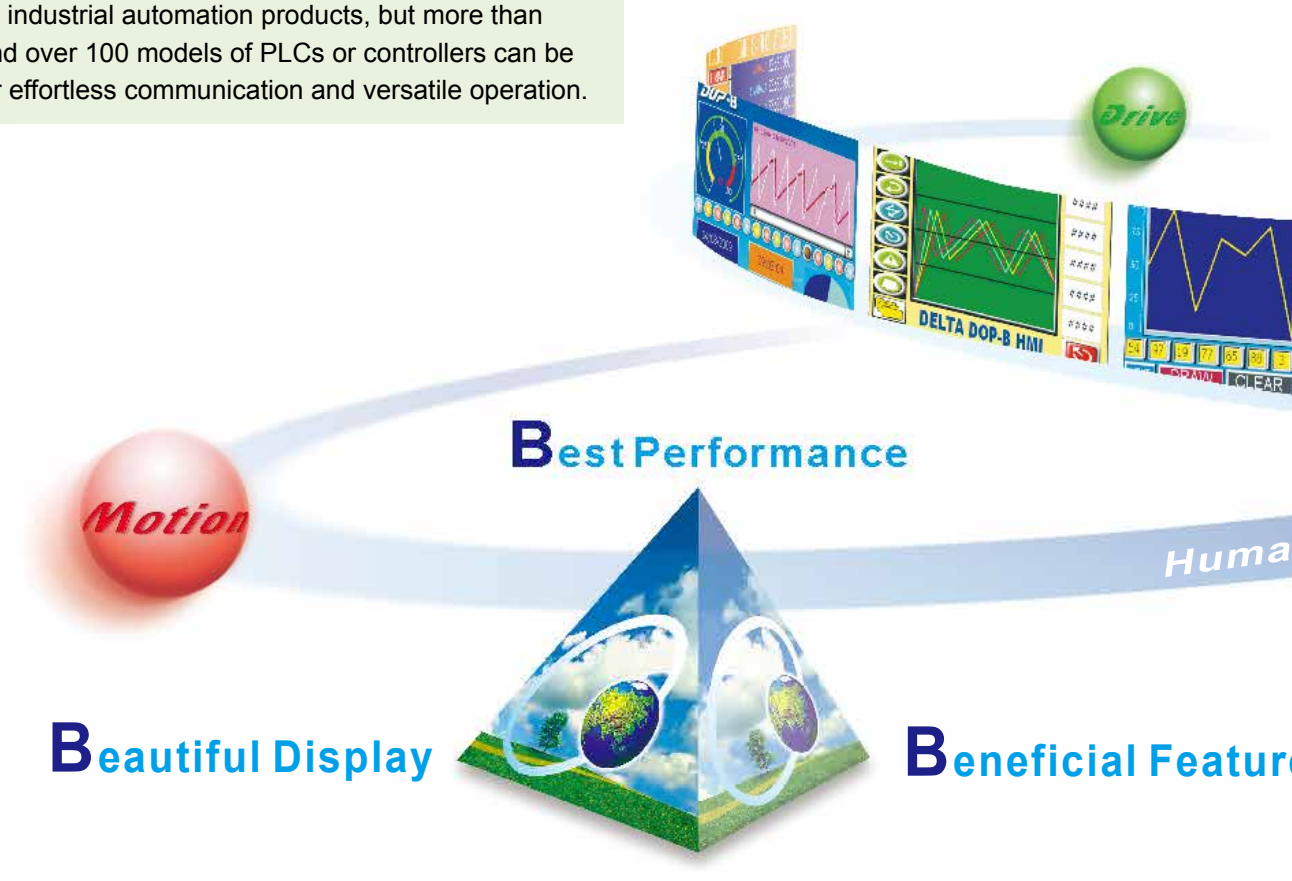

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Product Line-up

DOP-B series

The DOP-B series provides various types and different sizes of touch panel HMIs with multiple dimensions and colors, and also offers fast and convenient control functions to meet the diverse application requirements demanded of industrial automation machines.

<table>
<tr><th colspan="5">DOP-B</th></tr>
<tr><td>4.3 inches Wide</td><td>  </td><td>B03S211
B03E211</td><td>7 inches</td><td>  </td><td>B07S515
B07E515
B07PS515</td></tr>
<tr><td>5.6 inches</td><td>  </td><td>B05S111</td><td>8 inches</td><td>  </td><td>B08S515
B08E515</td></tr>
<tr><td rowspan="3">7 inches Wide</td><td>  </td><td>B07S401K</td><td>10.1 inches</td><td>  </td><td>B10S411
B10S615
B10E615</td></tr>
<tr><td>  </td><td>B07S411K</td><td>10.4 inches</td><td>  </td><td>B10S511
B10VS511
B10PE515</td></tr>
<tr><td colspan="4">  </td><td>B07S410
B07S411
B07E411
B07S415
B07E415
B07PS415</td></tr>
</table>

DOP-H Series

The DOP-H series provides handheld type HMIs and customized teaching pendants for controlling and programming the motion of robot arms and other motion control systems.

DOP-H			
7 inches Wide		H07S425 H07S42A H07S465 H07S46A	H07E425 H07E42A H07E465 H07E46A

DOP-W Series

The DOP-W series offers large-size HMIs that come with high resolution and high brightness touch screens, and should be your first choice to meet customer needs for a wide range of high-end industrial automation applications.

DOP-W		
10.4 inches		W105B
12 inches		W127B
15 inches		W157B

High Quality Display

65,536-color high quality TFT display offers more realistic and vivid images to capture and visualize system and manufacturing processes more quickly.

Audio Output Interface

In case of errors, an alarm alerts users via an audio message in real time.

Supports built-in amplified speaker using 3.5 mm stereo mini jack

- As the broadcast of alarms is triggered by the corresponding bit, the alarm messages can be played and output in different sound files by setting values of word registers.

D100	Sound Files	Audio Messages
1	A.wav	Overcurrent
2	B.wav	Overvoltage
3	C.wav	Overload

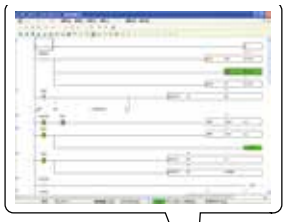
Supports Various Peripherals via USB Hub

Slave (USB-type B)

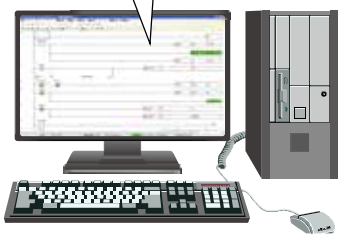
Compatible with Windows Vista / Windows 7

Screen data can be transferred rapidly via USB connection.

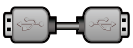
Up to 480Mbps high-speed data transfer via USB v2.0



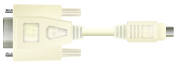
PLC Programming Software: WPLSoft



USB



RS-223

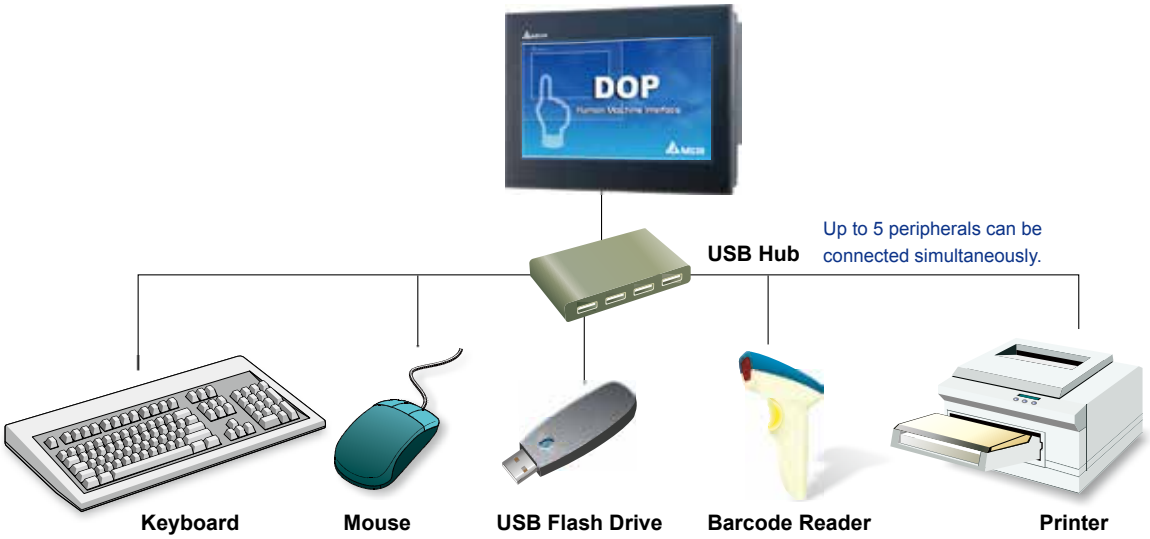


*Supports Delta DVP series PLC only.

Using the bypass function, enable monitoring functions and modify PLC programs directly via the USB connection.

Master (USB-type A)

Various peripherals can be connected via a USB Hub.



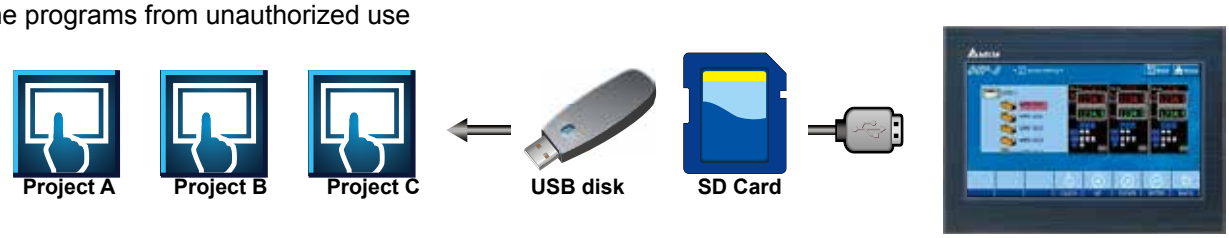
SD Card / USB Disk Versatile Storage Interface

- Exploiting the convenience of an SD card or USB disk, screen data transfer and collection can be quickly performed and the storage capacities of the HMI can be easily increased. No need to worry about data capacity of excessive history and recipe data
- SD card and USB disk are in FAT32 format, fully compatible with Microsoft Windows and allow filenames that exceed eight characters in length

The recipe data can be saved in CSV format and easily edited on an external PC in Excel to effectively save PLC memory.

History and alarm information can also be saved in CSV format and stored to the SD card / USB disk.

- Multiple project screen data can be saved in SD card / USB disk simultaneously and transferred to HMI. No need to connect to a PC
- The data saved in an SD card / USB disk can be encrypted and the number of copies can be limited to protect the programs from unauthorized use

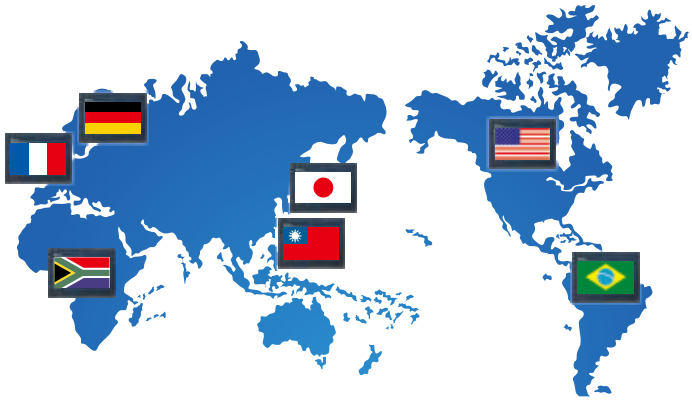


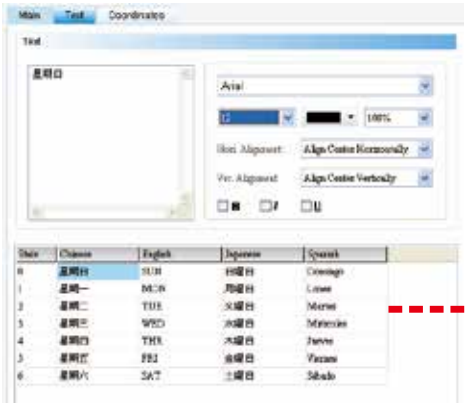
- PLC ladder diagrams can be transferred and backed up via SD card / USB disk even in a location where an external PC is not available
- SD card / USB disk are capable of storing several PLC ladder diagrams

Support Delta DVP series PLC only.

Multilingual Display

Up to 32 languages are available. No need to redesign the screen data! A benefit for marketing the equipment to manufacturers and end users around the world.

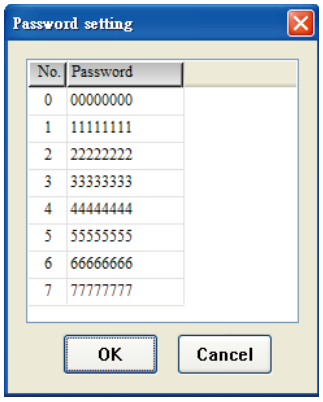


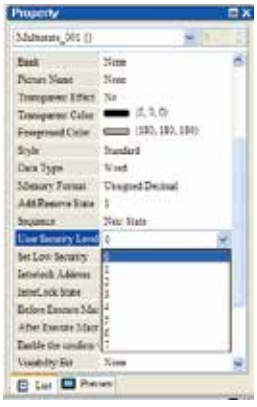


Multilingual editing on a PC in Excel

Password Settings

Provides 8 levels of passwords to set user security and prevent improper use. Only the security level that is equal to or higher than the current setting can use the element.





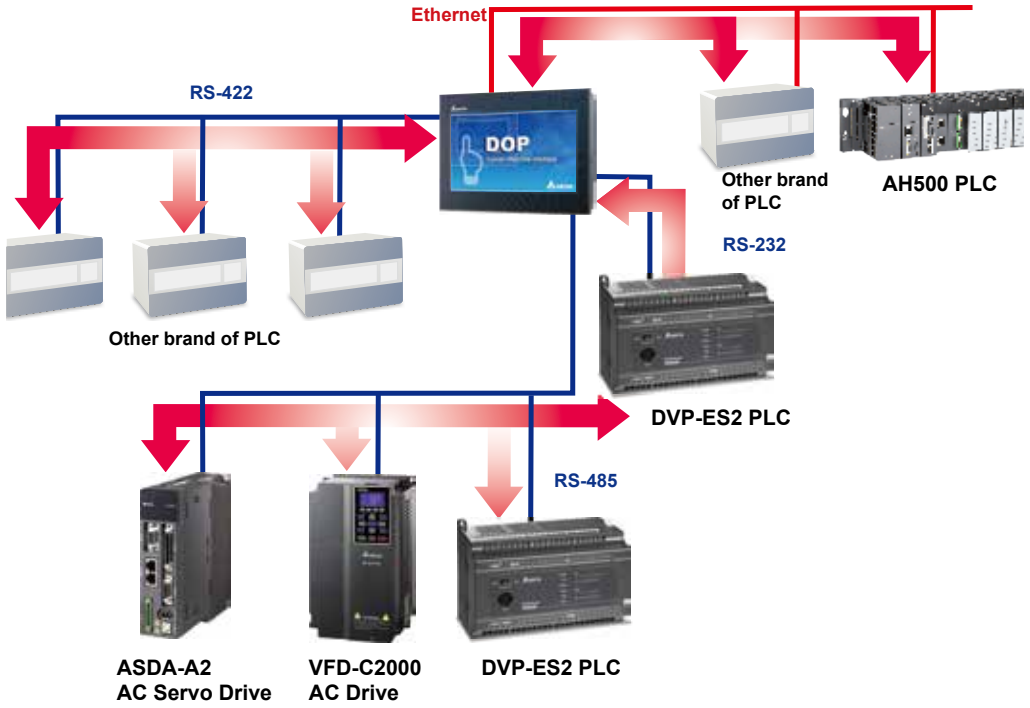
Element Invisible Function

The element on the screen can be hidden by triggering the corresponding bit.

Provides Diverse Communication Interfaces

Easy to communicate with more than 30 brands of PLCs/Controllers

All DOP series models support RS-232/485/422 communication interfaces and over 20 different PLC/Controller drivers. With the aid of an Ethernet interface, it is possible to use four communication interfaces at the same time, easily connecting to various industrial automation devices for a complete communication network link managed by Delta's new DOP series.



VGA Model

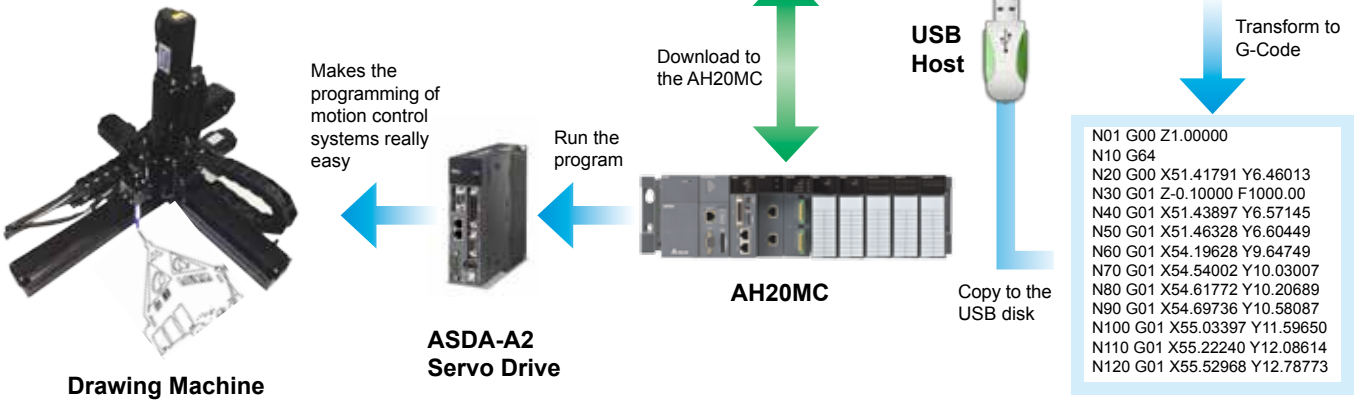
DOP-B10VS511 supports VGA video input which integrates live video and HMI display into one unit. Incorporated with Delta's DMV series machine vision system, Delta offers an integrated solution that delivers precise and reliable control to meet the needs of industry upgrades and bring benefits to our customers around the world.

Specifications	
Input Interface	VGA Input
Resolution	800 x 600 pixels
Scanning Frequency	56 Hz / 60 Hz

Integrates Delta Professional Functions (PS Models Only):

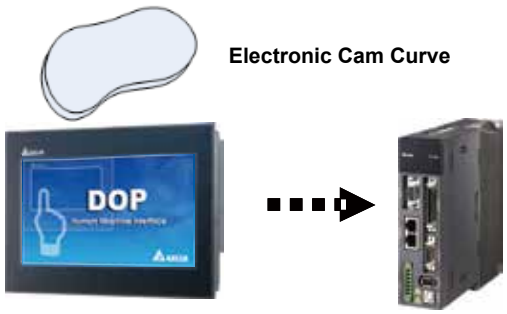
G-Code

- Supports Delta's motion controllers: DVP-10MC / DVP-20PM / AH20MC
- Capable of viewing and changing the G-code files with the HMI
- Supports serial and Ethernet communications



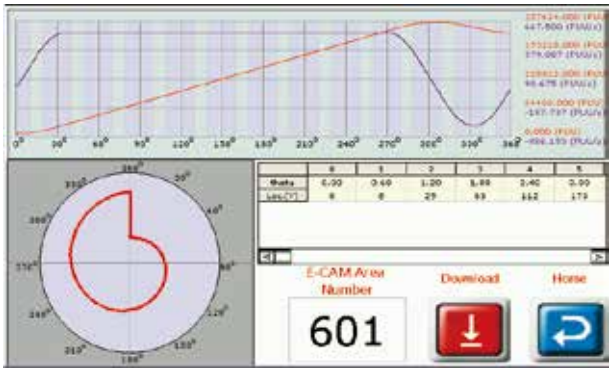
Electronic Cam (E-Cam) Curve Table

- Supports ASDA-A2 series servo drives
- A personal computer is not required. Electronic cam curves can be generated on HMI and downloaded to the ASDA-A2 series servo drive directly

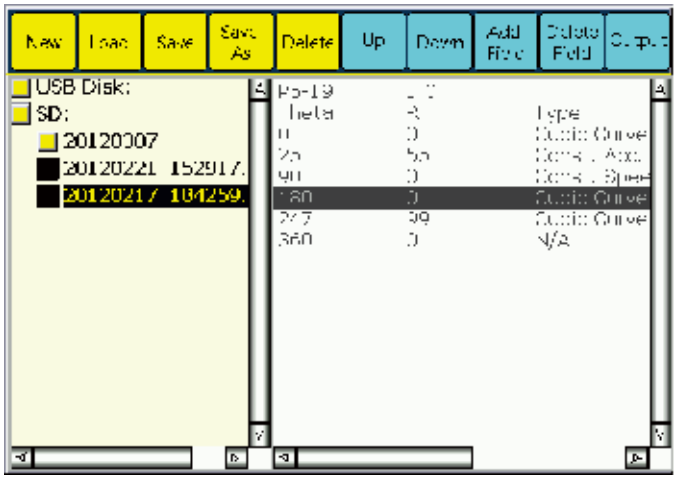


Supports E-Cam table macro for making E-Cam curve on HMI

- Auto rotary shear with sealing zone
- Indirect printing
- Auto rotary shear – cos compensation



Supports cubic curve manual creation



DOP-W Features

The Ultimate in Industrial Versatility

- 1GHz high speed processor for higher computing performance
- Aluminum enclosure: greater vibration resistance and higher tolerance for ambient environments compared with plastic enclosure.
- The enclosure with dark gray mold texturing is easily cleaned and ideal for the medical and food sectors.
- 1024 x 768 pixels high resolution and high brightness display (W127B: 500 cd/m², W157B: 450 cd/m²)
- 256MB Flash ROM
- Highly reliable touch panel with min. 10,000,000 touches

Front Speaker

- The built-in stereo amplifying speaker provides efficient alarm notifications. No additional speaker is required.
- Apart from replacing general alarm with buzzers, functions for playing recorded voice and reminders are available for multiple applications.
- Mechanism design breakthrough. The front panel including the front speaker has acquired the IP65 waterproof certificate.

Multiple Peripheral Interfaces

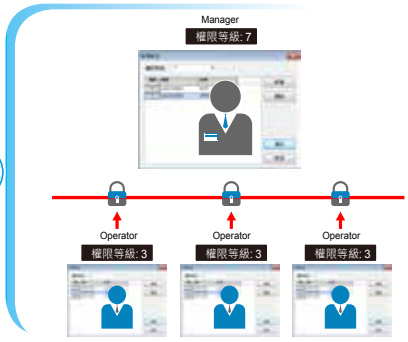
- Supports 2 COM Ports
- Supports 2 Ethernet Ports
- Supports 3 USB Host 2.0 Ports
- Supports SD card
- Apart from traditional mounting, DOP-W also supports the VESA standard mounting interface making wall mounts easier.

***VESA mounting interface is only available on devices above 12 inches.**

Multi-User Authority Management

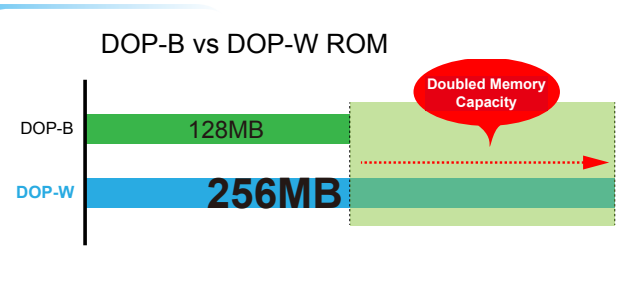
This function allows users to assign authority levels and register passwords to set permissions for different user groups for security control. No need for third-party configuration and set-up costs.

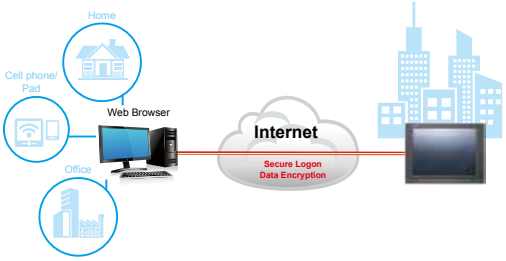
- 8 levels of user authority Level: 0 ~ 7
- 8 sets of user accounts with passwords for each user authority



High-Capacity Memory

- Increased memory capacity stores more nonvolatile data, such as alarm messages and historical records than ever before for power-loss protection.





More Powerful Remote Monitoring Function

- Compatible with eRemote
- Supports VNC Server
- Monitoring by eRemote software or web browser on PC
- Apps for eRemote or VNC Client support Apps on Android devices
- VNC Client supported Apps on iOS devices

*** JAVA is required in web browsers.**

Two Individual Ethernet Ports

- Two individual Ethernet ports are equipped as standard, one is for HMI communication and the other is for external I/O for quick and easy integration.

Multilingual Display

- In addition to English and numbers, 16 languages are supported for a more localized interface

*** Supports English, Traditional Chinese, and Simplified Chinese only during the launching period.**
*** Other languages such as Arabic, French, German, Hebrew, Hindi, Portuguese, Spanish, Japanese, Korean, Thai, Turkish, Russian, and Persian are continually added.**

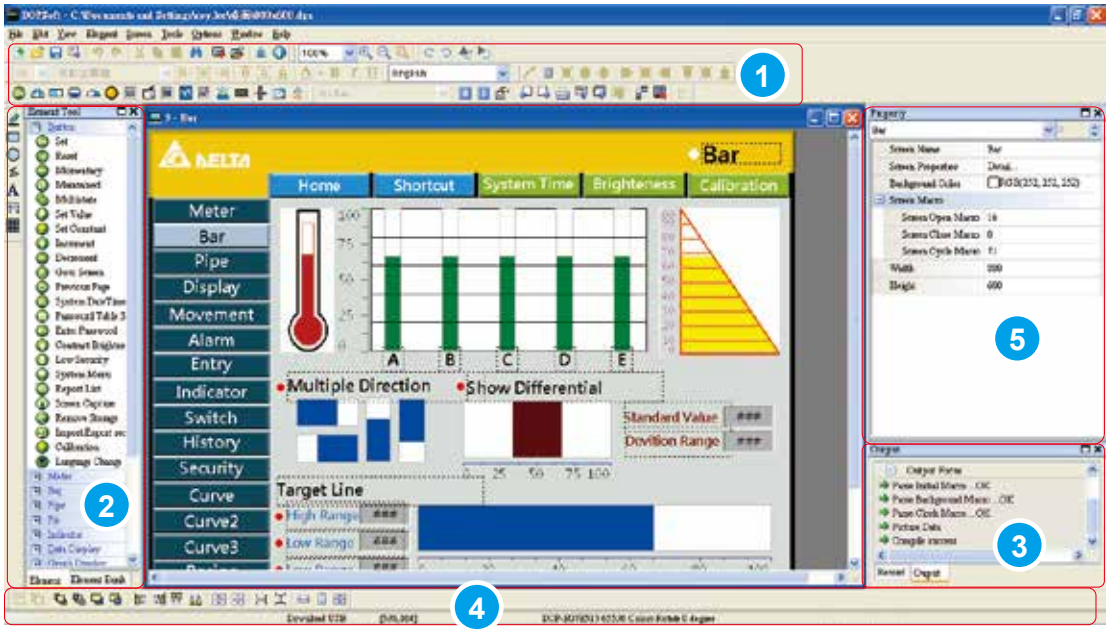
Video Player

- A new video player with self-defined playlist allows users to manage the list based on different applications.

*** Supported Format: MPEG1, MPEG2, WMV**

DOPSoft

The all new and upgraded configuration software provides complete functions and a user-friendly operator interface. Make editing easier than ever with a whole new level of design.



1 Toolbar

Actions such as edit, save, upload and compile can be executed easily just by clicking the attractive and easy-to-see icons on the toolbar.

2 Element Tool Window

The Element Tool Window provides a wide variety of element icons for selection. Use the mouse to select the desired element icon and drag it onto the work place to create a new element.

3 Output Window

The Output Window displays all the editing actions and output messages when the compile function is enabled. Once an error occurs, the error messages are displayed in Output Window as well.

4 Layout Toolbar

The Layout Toolbar offers Bring to Front, Send to Bottom, Align, Across / Down Space Evenly, Make Same Size and other functions for the benefit of creating intricate and beautiful elements.

5 Property Table

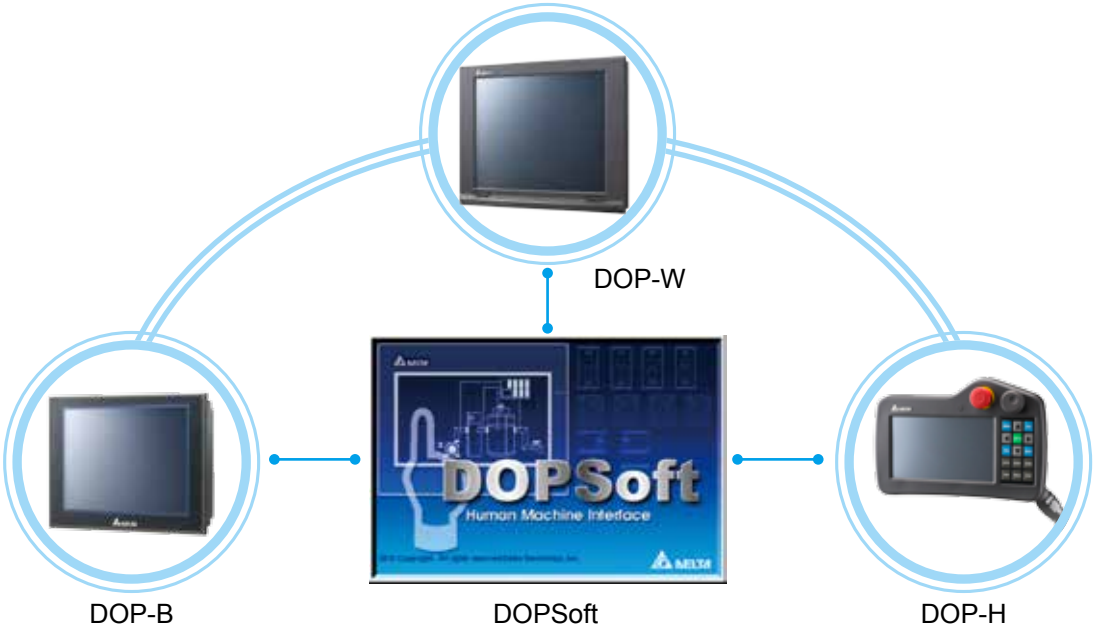
The Property Table displays the element property settings for each element.

Picture Bank

Newly designed picture bank offers more colorful and attractive elements.

Convenient Screen Data Conversion

Compatible with all DOP series, project files can be easily upgraded and converted to DOPSoft format.



The screen data can be converted to different models even if the display size is not the same. The same project can be applied on different models.

***After the screen data is converted, it still needs to confirm the element position, text size and other settings.**

Minimum System Requirements of DOPSoft

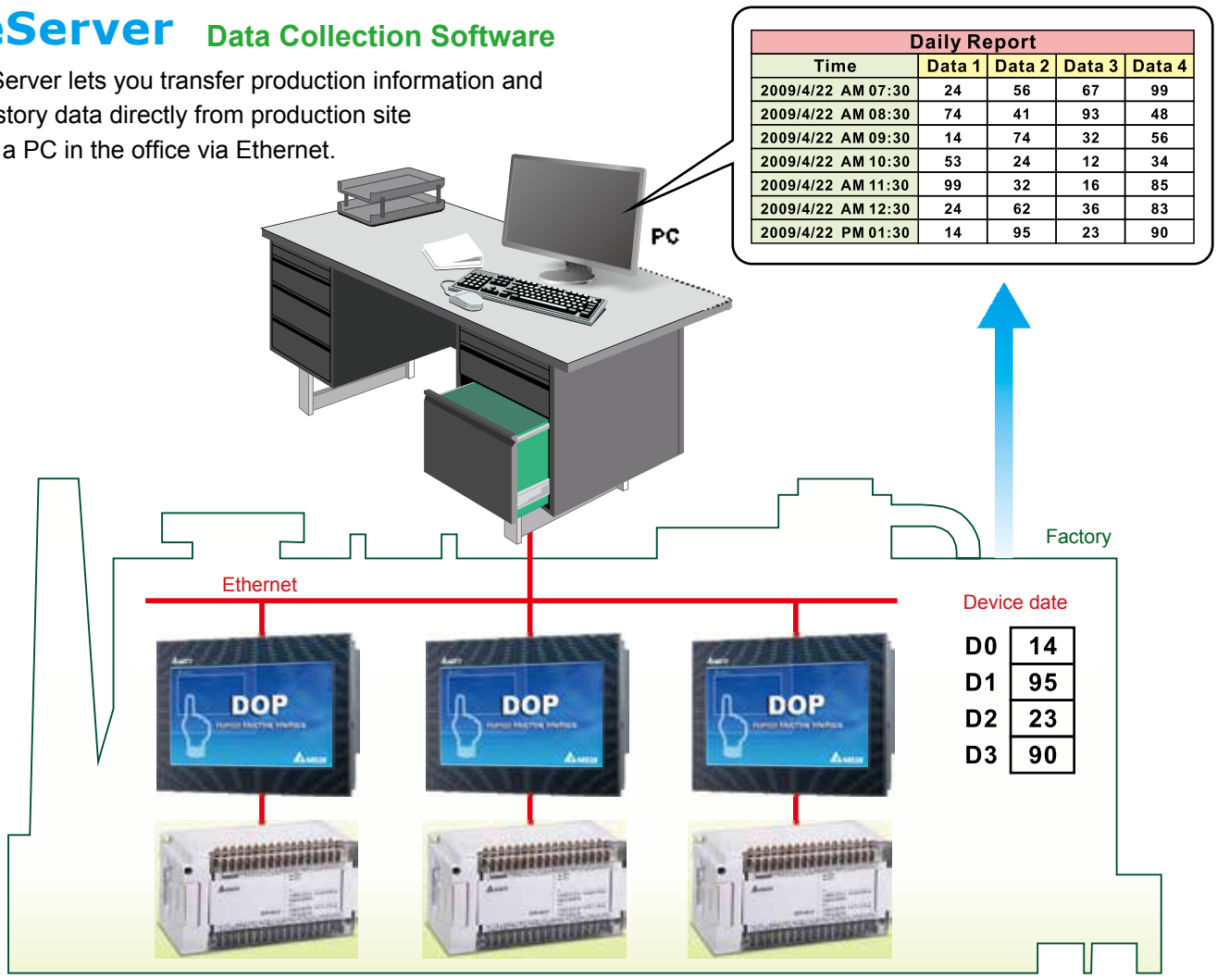
Hardware / Software	System Requirements
CPU	Pentium4 1.6GHz or greater is recommended
Memory	2G MB and above is recommended
Hard Disk	Capacity: 400MB and above
Monitor	Supports resolution: 800 x 600 or higher full-color display
Printer	Printer compatible with Windows 2000 Windows XP / Windows Vista / Windows 7
Operating System	Windows 2000 / Windows XP Windows Vista / Windows 7

***Users can download the DOPSoft configuration software and the user manual at Delta's website via the following link: http://www.deltaww.com**

Solution for Constructing a Network between Office and Production Site via Ethernet

eServer Data Collection Software

eServer lets you transfer production information and history data directly from production site to a PC in the office via Ethernet.



1 Excel Sampling Data

- Collected data can be saved in user-defined Excel files according to purpose and to easily create production reports
- If the formulas in the Excel file are set in advance, the production data, i.e. defective rate, average working hours and capacity utilization rate, and more can be calculated in real time while production data is recorded
- Production data can be saved in daily reports, weekly reports, monthly reports, and others automatically under different settings.

2 Database Sampling Data

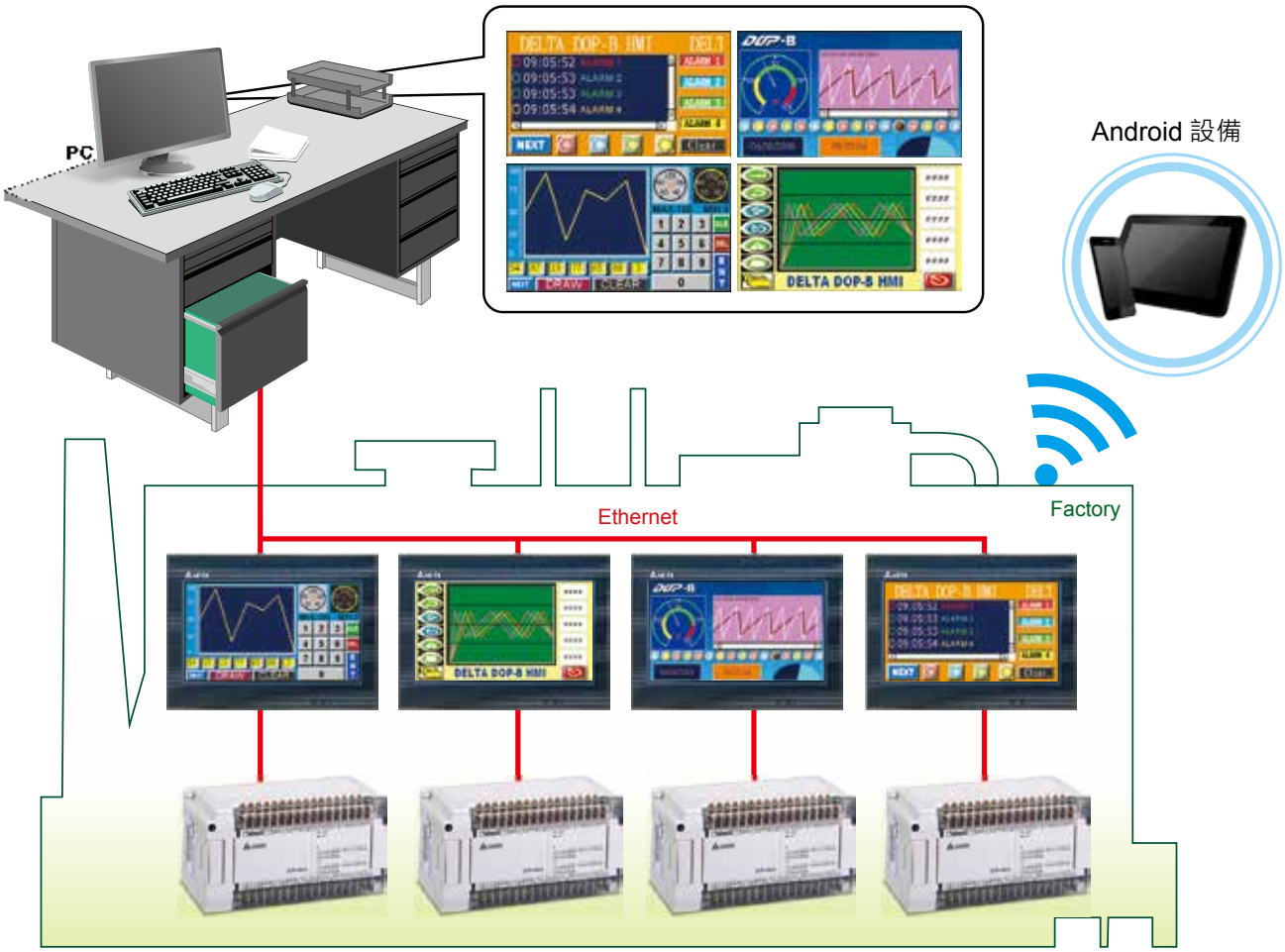
- Users can access any database via ODBC (Open Database Connectivity) interface

3 Recipe Data Transfer

- Users can transfer and backup the recipe data via eServer easily

eRemote Remote Control Software

eRemote lets you view and monitor the same screen shown on the HMI at the production site, and control the manufacturing process via Ethernet. No matter where you are, remote control is easily accomplished.



Minimum System Requirements for eServer / eRemote

Hardware / Software	System Requirements
CPU	Pentium 4,1.6GHz or greater is recommended
Memory	2G MB and above is recommended
Hard Disk	Capacity: 100MB and above
Monitor	Supports resolution: 1024 x 768 or higher full-color display.
Printer	Printer compatible with Windows 2000 / Windows XP / Windows Vista / Windows 7
Operating System	Windows 2000 / Windows XP / Windows Vista / Windows 7

***Users can download the eServer / eRemote software and the user manual at Delta's website via the following link: http://www.deltaww.com**

System Requirements of eRemote App	
Operating System	Android 4.1.2 and later versions
Storage Capacity	860 KB and above

Specifications

DOP-B Series

MODEL		DOP-B03S211	DOP-B03E211	DOP-B05S111	DOP-B07S410	DOP-B07S411	DOP-B07E411	DOP-B07S401K DOP-B07S411K	DOP-B07S415	DOP-B07PS415	DOP-B07E415
LCD MODULE	Display Size and Type	4.3" TFT LCD		5.6" TFT LCD	7" Widescreen TFT LCD						
	Display Colors	65536 colors									
	Resolution (pixels)	480 x 272		320 x 234	800 x 480						
	Backlight	LED Back Light									
	Luminance (cd/m^2)	280	400	200	250	250	250	250	350	350	350
	Backlight Life (hours) (Note 1)	20,000	10,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000
MCU		400 MHz									
Flash ROM (Bytes)		128 MB		128 MB	4MB	128 MB					
RAM (Bytes)		64MB			64MB						
Backup Memory (Bytes)		16MB			32k	16MB					
Buzzer		Multi-Tone Frequency (2K ~ 4K Hz) / 85dB									
AUX		N/A		N/A	N/A						Stereo output
Ethernet		N/A	1 Port (Note 2)	N/A	N/A		1 Port (Note 2)	N/A			1 Port (Note 2)
Memory Card		N/A		N/A	N/A				SD card (supports SDHC)		
USB		1 USB Host Ver 1.1 / 1 USB Client Ver 2.0			1 USB Client Ver 2.0	1 USB Host Ver 1.1 / 1 USB Client Ver 2.0					
Serial COM Port	COM1	RS-232 (Supports hardware flow control) / RS-485		RS-232 (Supports hardware flow control)(Note 2)	RS-232 (Supports hardware flow control)/ RS-485 / RS-422	RS-232 (Supports hardware flow control)			RS-232 (Supports hardware flow control)(Note 2)		
	COM2	RS-422 / RS-S485	RS-422 / RS-485 (Note 2)	RS-232 / RS-485 (Note 2)	N/A	RS-232 / RS-485			RS-232 / RS-422 / RS-485(Note 2)		
	COM3	N/A		RS-422 / RS-485 (Note 2)	N/A	RS-422 / RS-485			RS-232 / RS-422 / RS-485(Note 2)		
VGA Input		N/A		N/A	N/A						
Delta Professional Integration Function		N/A		N/A	N/A					YES	N/A
Function Key		N/A		N/A	N/A			8	N/A		
Perpetual Calendar (RTC)		Built-in									
Cooling Method		Natural air circulation									
Safety Approval		CE / UL									
Waterproof Degree		IP65 / UL type 4x									
Operation Voltage (Note 3)		DC +24V (-10% ~ +15%) (Note2)									
Voltage Endurance		AC500V for 1 minute (between charging DC24 terminal and FG terminals)									
Power Consumption (Note 5)		2.64 W	2.64 W	3.0 W	3.5 W	4 W	4 W	4 W	5 W	5 W	7.5 W
Backup Battery		3V lithium battery CR2032 x 1									
Backup Battery Life		It depends on the temperature used and the conditions of usage, about 3 years or more at 25 °C									
Operation Temp.		0 °C ~ 50 °C									
Storage Temp.		-20 °C ~ +60 °C									
Ambient Humidity		10% ~ 90% RH (0 ~ 40° C), 10% ~ 55% RH (41 ~ 50 °C), Pollution Degree 2									
Vibration		IEC 61131-2 compliant 5Hz ~ 8.3Hz = Continuous: 3.5mm, 8.3Hz ~ 150Hz = Continuous: 1.0g									
Shock		IEC 60068-2-27 compliant 15g peak for 11 ms duration, X, Y, Z directions for 6 times									
Dimensions (W) x (H) x (D) mm		129 × 103 × 39	129 x103 × 39	184 × 144 × 50	215 × 161 × 35.3	215 × 161 × 50	215 x 161 x 50	215 × 161 × 50	215 × 161 × 50	215 × 161 × 50	215 × 161 × 50
Panel Cutout (W) x (H) mm		118.8 × 92.8	118.8 × 92.8	172.4 × 132.4	196.9 × 142.9	196.9 × 142.9	196.9 x 142.9	196.9 × 142.9	196.9 × 142.9	196.9 × 142.9	196.9 × 142.9
Weight		Approx. 230 g	Approx. 264 g	Approx. 670 g	Approx. 700 g	Approx. 820 g	Approx. 820 g	Approx. 820 g	Approx. 970 g	Approx. 970 g	Approx. 970 g

1) The half-life of backlight is defined as original luminance being reduced by 50% when the maximum driving current is supplied to HMI.
2) With built-in isolated power circuit.
3) Please use isolated power supply.
4) Some models are in the process of application for UL and KCC certification. For more information, please consult our distributors.
5) The value of the power consumption indicates the electrical power consumed by HMI with no peripheral devices connected.
   To ensure normal operation, it is recommended using a power supply with a capacity 1.5 ~2 times the value of the power consumption.
6) The content of this catalogue may be revised without prior notice. Please consult our distributors or download the most updated version at http://www.deltaww.com

DOP-B07S515	DOP-B07PS515	DOP-B07E515	DOP-B08S515	DOP-B08E515	DOP-B10S511	DOP-B10VS511	DOP-B10E515	DOP-B10PE515	DOP-B10S411	DOP-B10S615	DOP-B10E615
7" TFT LCD			8" TFT LCD		10.4" TFT LCD				10.1" Widescreen TFT LCD		
65536 colors											
800 x 600			800 x 600		800 x 600				800 x 480	1024 x 600	
LED Back Light											
450	450	450	500	500	300	300	300	300	300	200	200
20,000	20,000	20,000	25,000	25,000	10,000	10,000	10,000	10,000	20,000	15,000	15,000
400 MHz											
128 MB			128 MB		128 MB				128 MB		
64MB			64MB		64MB				64MB		
16MB			16MB		16MB				16MB		
Multi-Tone Frequency (2K ~ 4K Hz) / 85dB											
N/A		Stereo output	N/A	Stereo output	N/A		Stereo output		N/A		Stereo output
N/A		1 Port (Note 2)	N/A	1 Port (Note 2)	N/A		1 Port (Note 2)		N/A		1 Port (Note 2)
SD card (supports SDHC)		SD card (supports SDHC)	SD card (supports SDHC)		N/A		SD card (supports SDHC)		N/A	SD card (supports SDHC)	
1 USB Host Ver 1.1 / 1 USB Client Ver 2.0											
RS-232 (Supports hardware flow control)(Note 2)			RS-232 (Supports hardware flow control)(Note 2)		RS-232 (Supports hardware flow control)	RS-232 (Supports hardware flow control)(Note 2)			RS-232 (Supports hardware flow control)	RS-232 (Supports hardware flow control)(Note 2)	
RS-232 / RS-485(Note 2)			RS-232 / RS-422 / RS-485(Note 2)		RS-232 / RS-485	RS-232 / RS-485(Note2)	RS-232 / RS-422 / RS-485(Note 2)		RS-232 / RS-485	RS-232 / RS-422 / RS-485(Note 2)	
RS-422 / RS-485(Note 2)			RS-232 / RS-422 / RS-485(Note 2)		RS-232 / RS-422 / RS-485	RS-232 / RS-422 / RS-485(Note2)	RS-232 / RS-422 / RS-485(Note 2)		RS-232 / RS-422 / RS-485	RS-232 / RS-422 / RS-485(Note 2)	
N/A			N/A		N/A	Resolution 800x600 pixels Scanning Frequency 56 Hz / 60 Hz	N/A		N/A		
N/A	YES	N/A	N/A		N/A			YES	N/A		
N/A			N/A		N/A				N/A		
Built-in											
Natural air circulation											
CE / UL											
IP65 / UL type 4x											
DC +24V (-10% ~ +15%) (Note2)											
AC500V for 1 minute (between charging DC24 terminal and FG terminals)											
7.68 W	7.68 W	7.68 W	5.2 W	7.8 W	6.1 W	6.1 W	9.6 W	9.6 W	6.6 W	12 W	12 W
3V lithium battery CR2032 x 1											
It depends on the temperature used and the conditions of usage, about 3 years or more at 25 °C											
0 °C ~ 50 °C											
-20 °C ~ +60 °C											
10% ~ 90% RH (0 ~ 40° C), 10% ~ 55% RH (41 ~ 50 °C), Pollution Degree 2											
IEC 61131-2 compliant 5Hz ~ 8.3Hz = Continuous: 3.5mm, 8.3Hz ~ 150Hz = Continuous: 1.0g											
IEC 60068-2-27 compliant 15g peak for 11 ms duration, X, Y, Z directions for 6 times											
184 × 144 × 50	184 × 144 × 50	184 × 144 × 50	227.1 × 174.1 × 61	227.1 × 174.1 × 61	299 × 224 × 51.1	299 × 224 × 51.1	299 × 224 × 51.1	299 × 224 × 51.1	272 × 200 × 61	272 × 200 × 61	272 × 200 × 61
172.4 × 132.4	172.4 × 132.4	172.4 × 132.4	219.4 × 166.5	219.4 × 166.5	285.2 × 210.2	285.2 × 210.2	285.2 × 210.2	285.2 × 210.2	261.3 × 189.3	261.3 × 189.3	261.3 × 189.3
Approx. 800 g	Approx. 800 g	Approx. 800 g	Approx. 1226 g	Approx. 1228 g	Approx. 1700 g	Approx. 1700 g	Approx. 1700 g	Approx. 1700 g	Approx. 1520 g	Approx. 1520 g	Approx. 1520 g

1) The half-life of backlight is defined as original luminance being reduced by 50% when the maximum driving current is supplied to HMI.
2) With built-in isolated power circuit.
3) Please use isolated power supply.
4) Some models are in the process of application for UL and KCC certification. For more information, please consult our distributors.
5) The value of the power consumption indicates the electrical power consumed by HMI with no peripheral devices connected.
To ensure normal operation, it is recommended using a power supply with a capacity 1.5 ~2 times the value of the power consumption.
6) The content of this catalogue may be revised without prior notice. Please consult our distributors or download the most updated version at http://www.deltaww.com

Specifications

DOP-H Series

Model		DOP-H07S425 DOP-H07S42A	DOP-H07S465 DOP-H07S46A	DOP-H07E425 DOP-H07E42A	DOP-H07E465 DOP-H07E46A
LCD MODULE	Display Size and Type	7" Widescreen TFT LCD			
	Display Colors	65536 colors			
	Resolution (pixels)	800 x 480			
	Backlight	LED Back Light			
	Luminance (cd/m^2)	450			
	Backlight Life (hours)(Note 1)	20,000			
MCU		400 MHz			
Flash ROM (Bytes)		128 MB			
RAM (Bytes)		64 MB			
Backup Memory (Bytes)		16 MB			
Buzzer		Multi-Tone Frequency (2K ~ 4K Hz) / 80dB			
Audio Output		N/A			
USB		1 USB Client Ver 2.0			
SD		SD card (supports SDHC)			
Serial COM Port		RS-422 / RS-485(Note 2)		N/A	
Ethernet		N/A		1 Ports(Note2)	
Function Key		15			
Cable Length & Type		End of Model Name: 5 - 5 m End of Model Name: A - 10 m			
Emergency Stop		B-contact: 2 Rated voltage: DC 30V Maximum rated current: 1A Minimum allowable load: DC 5V/1 mA Complies with IEC60947-5-1, EN60947-5-1, IEC60947-5-5, EN60947-5-5, UL 508, and CSA C22.2 No.14, GB 14085.5			
3-Position Operation Switch		A-contact: 1 Rated voltage: DC 30V Maximum rated current: 700 mA Minimum allowable load：DC 3 V/5mA Complies with EN/IEC60947-5-8, IEC60947-5-1, EN60947-5-1, JIS C8201-5-1, UL508, and CSA C22.2 NO. 14 Applicable standards for use with ISO12100-1, -2/EN12100-1, -2, IEC60204-1/EN60204-1, ISO11161/prEN11161, ISO10218/EN775, ANSI/RIA R15.06, ANSI B11.19			
Handwheel		N/A	Rated Voltage: <DC 24V in Resolution: 50(P/R) Output Pulse: Square Output Phase: A, B Phase difference of A and B: 90° ± 45° Max. Frequency response: 200 Hz	N/A	Rated Voltage: <DC 24V in Resolution: 50(P/R) Output Pulse: Square Output Phase: A, B Phase difference of A and B: 90° ± 45° Max. Frequency response: 200 Hz
Perpetual Calendar		Built-in			
Cooling Method		Natural cooling			
Safety Approval		CE			
Waterproof Level of Panel Display		IP55			
Operation Voltage (Note3)		DC +24V (±15%) (with built-in isolated power circuit)(Note2)			
Voltage Endurance		AC500V for 1 minute (between charging (DC24V terminal) and FG terminals)			
Power Consumption (Note 5)		5.6W			
Backup Battery		3V lithium battery CR2450 × 1			
Backup Battery Life		About 5 years or more at 25oC but subjects to the temperature and the conditions during usage.			
Operation Temperature		0°C ~ 40°C			
Storage Temperature		-20 °C ~ +60 °C, 10% ~ 90% RH			
Operating Environment		10% ~ 90% RH【0 ~ 40 °C】; 10% ~ 55% RH【41 ~ 50 °C】; Pollution Degree 2			
Vibration		Conforms to IEC61131-2; Continuous: 5Hz ~ 8.3Hz 3.5 mm, 8.3Hz ~ 150Hz 1G			
Shock		Conforms to IEC60068-2-27; 11ms, 15G Peak , X, Y, Z direction for 6 times			
Dimensions (W) × (H) × (D) mm		257.4 × 170.3 × 71.8 (Emergency stop switch and hook are included.)			
Weight		750 g (cable excluded)			

1) The half-life of backlight is defined as original luminance being reduced by 50% when the maximum driving current is supplied to HMI.
2) With built-in isolated power circuit.
3) Please use isolated power supply.
4) Some models are in the process of application for UL and KCC certification. For more information, please consult our distributors.
5) The value of the power consumption indicates the electrical power consumed by HMI with no peripheral devices connected.
To ensure normal operation, it is recommended using a power supply with a capacity 1.5 ~2 times the value of the power consumption.
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DOP-W Series

MODEL		DOP-W105B	DOP-W127B	DOP-W157B
LCD MODULE	Display Size and Type	10.4″ TFT LCD	12.1″ TFT LCD	15″ TFT LCD
	Display Colors	65536 colors		
	Resolution (pixels)	800 x 600	1024 x 768	
	Backlight	LED Back Light		
	Luminance (cd/m^2)	300	500	450
	Backlight Life (hours)(Note 1)	10,000	30,000	100,000
MCU		1 GHz		
Flash ROM (Bytes)		256 MB		
RAM (Bytes)		256 MB		
Backup Memory		800000 numbers of data (alarm data + historical data)		
Buzzer		Multi-Tone Frequency (2K ~ 4K Hz) / 80dB		
Audio Output		Stereo output	Stereo output / Built in 1.5W Speaker	
USB		1 USB Host Ver 2.0	3 USB Host Ver 2.0	
SD		SD card (supports SDHC)		
Serial COM Port	COM1	N/A		
	COM2	RS-232 / RS-422 / RS-485(Note 2)		
	COM3	RS-232 / RS-422 / RS-485(Note 2)		
Ethernet		2 Ports(Note2)		
Perpetual Calendar (RTC)		Built-in(Note5)		
Cooling Method		Natural air circulation		
Safety Approval		CE / UL		
Waterproof Degree		IP65 / UL type 4x	IP65 / UL type 1	
Operation Voltage (Note3)		DC +24V (-10% ~ +15%)		
Voltage Endurance		AC500V for 1 minute (between charging (DC24V terminal) and FG terminals)		
Power Consumption (Note 6)		13.5W	18.5W	21.6W
Backup Battery		Uses a gold-capacitor instead of a battery, no need to replace batteries		
Backup Battery Life		It can keep the RTC working at least seven days in a working environment where the conditions do not exceed the specifications for DOP-W series.		
Operation Temperature		0°C ~ 50°C		
Storage Temperature		-20°C ~ +60°C, 10% ~ 90% RH		
Ambient Humidity		10% ~ 90% RH [0 ~ 40°C], 10% ~ 55% RH [41 ~ 50°C] Pollution Degree 2		
Vibration		IEC61131-2 compliant 5Hz ≦ f < 8.3Hz = Continuous: 3.5mm, 8.3Hz ≦ f ≦ 150Hz = Continuous: 1.0g		
Shock		IEC 60068-2-27 compliant 15g peak for 11 ms duration, X, Y, Z directions for 6 times		
Dimensions (W) x (H) x (D) mm		299 × 224 × 46.8	313 × 239.5 × 67.5	384.4 × 295.8 × 67.8
Panel Cutout (W) x (H) mm		285.2 × 210.2	302.7 × 228.7	372.4 × 283.7
Weight		Approx. 1750 g	Approx. 2830 g	Approx. 3880 g

1) The half-life of backlight is defined as original luminance being reduced by 50% when the maximum driving current is supplied to HMI.
2) With built-in isolated power circuit.
3) Please use isolated power supply.
4) Some models are in the process of application for UL and KCC certification. For more information, please consult our distributors.
5) The value of the power consumption indicates the electrical power consumed by HMI with no peripheral devices connected.
To ensure normal operation, it is recommended using a power supply with a capacity 1.5 ~2 times the value of the power consumption.
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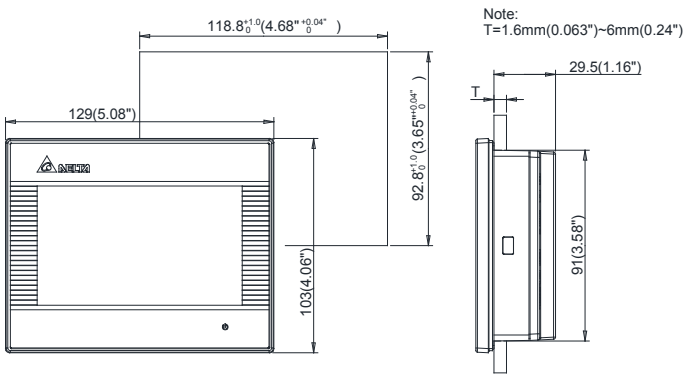
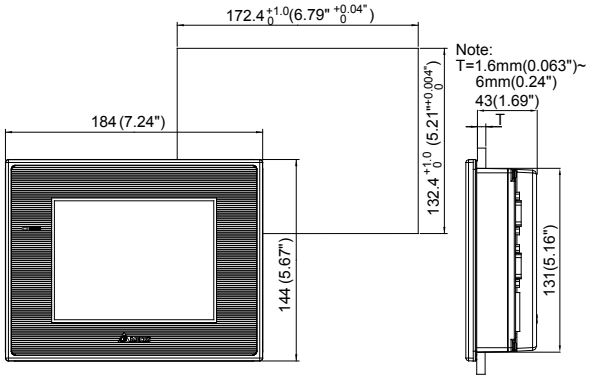
Dimensions Unit: mm (inches)

DOP-B Series

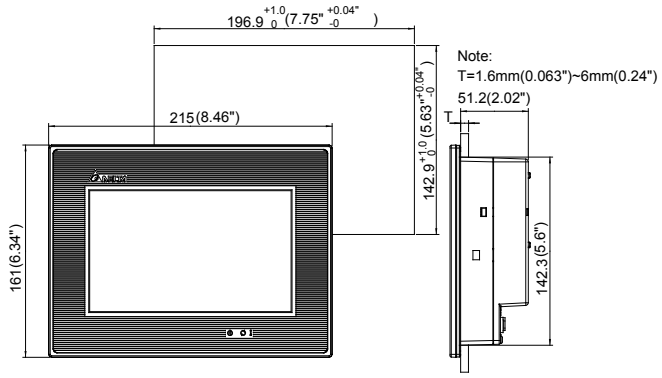
• DOP-B03S(E)211



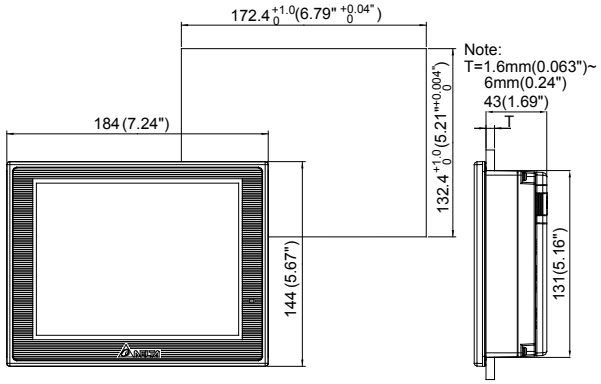
• DOP-B05S111



• DOP-B07S(E)415 / DOP-B07PS415

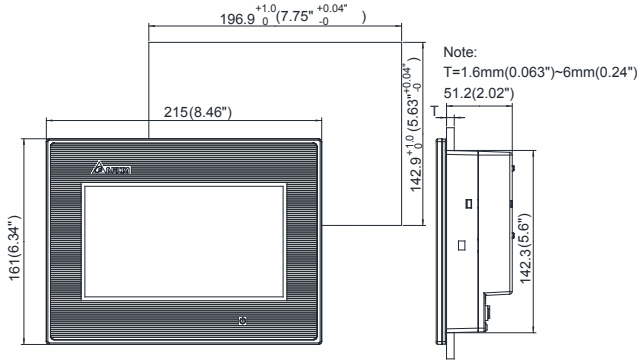


• DOP-B07S(E)515 / DOP-B07PS515

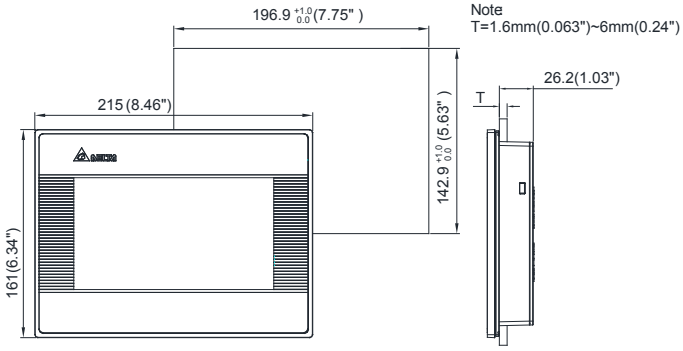


DOP-B Series

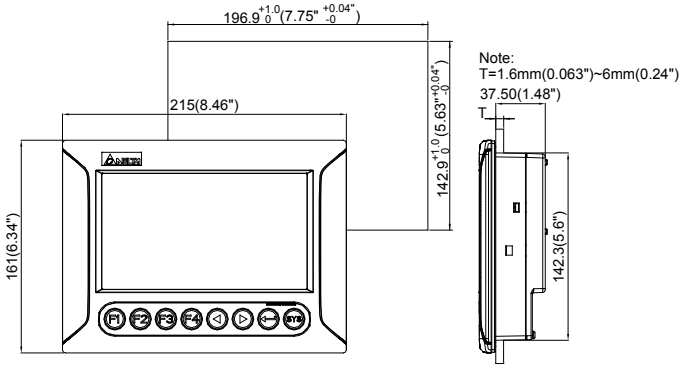
• DOP-B07S411 / B07E411



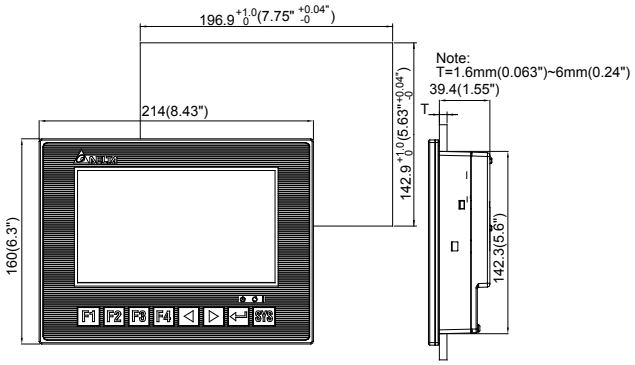
• DOP-B07S410



• DOP-B07S401K



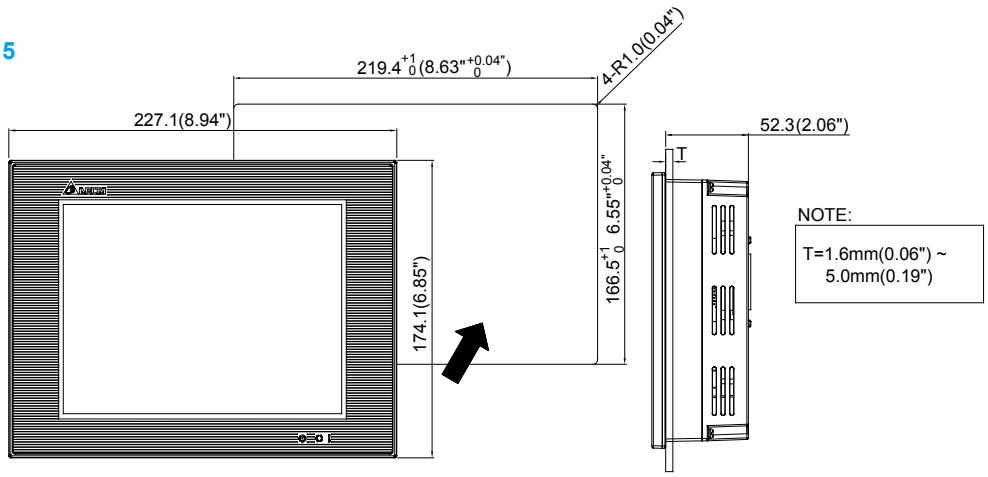
• DOP-B07S411K



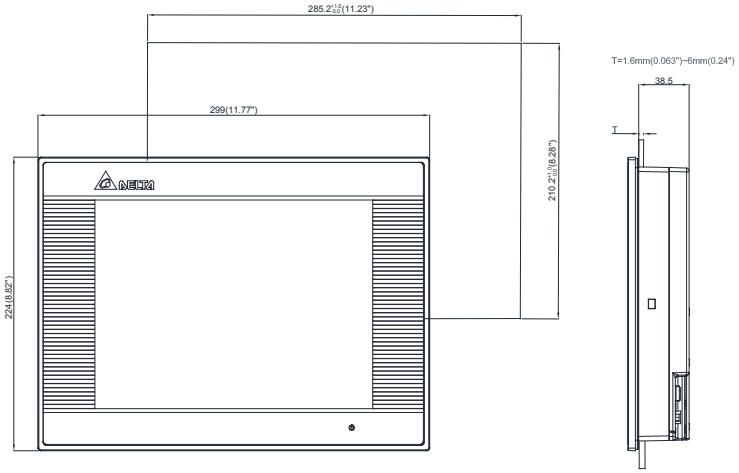
Dimensions Unit: mm (inches)

DOP-B Series

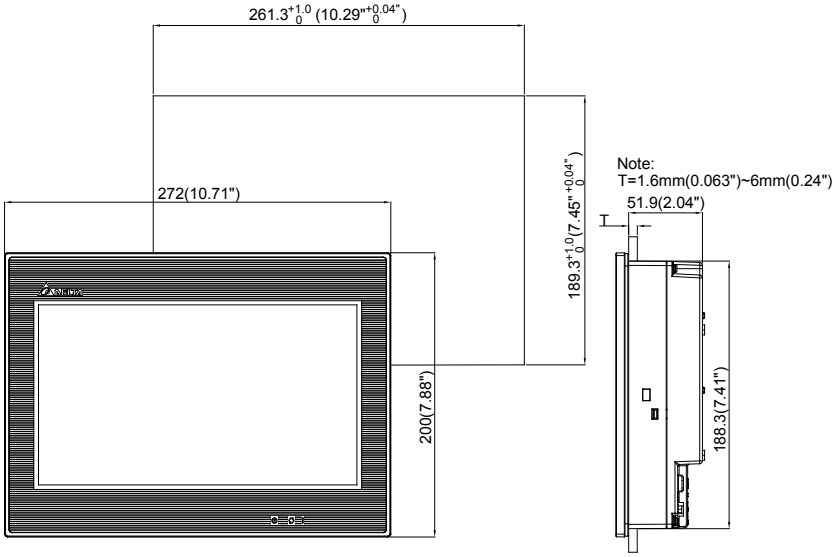
• DOP-B08S(E)515



• DOP-B10S(E)51x / DOP-B10PE515 / DOP-B10VS511



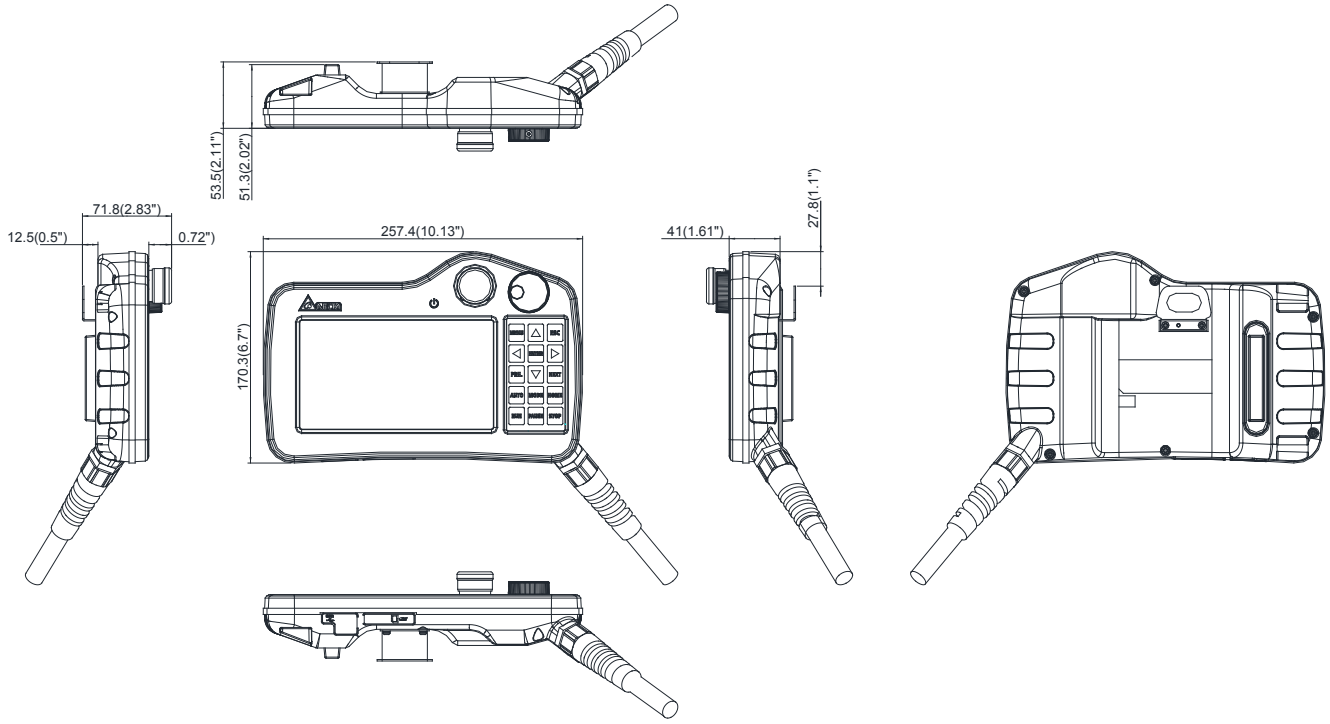
• DOP-B10S(E)615



Dimensions Unit: mm (inches)

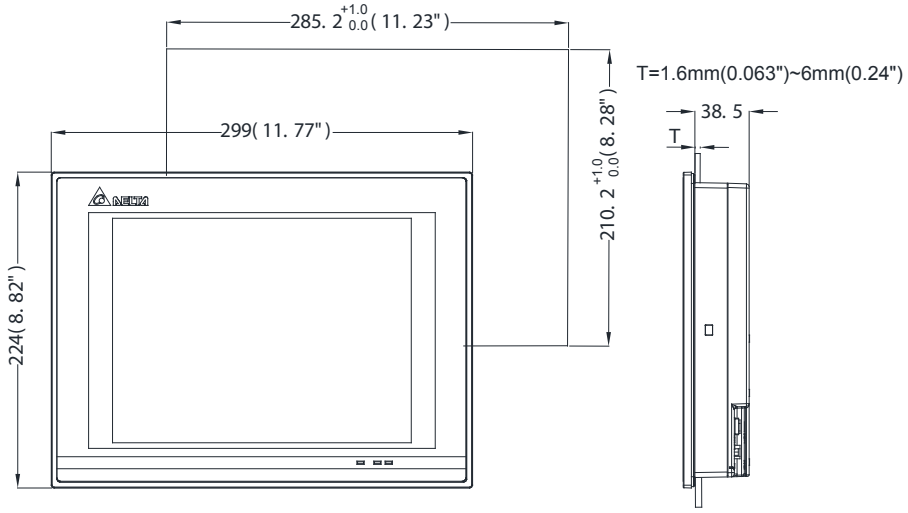
DOP-H Series

• **DOP-H07X4XX**



DOP-W Series

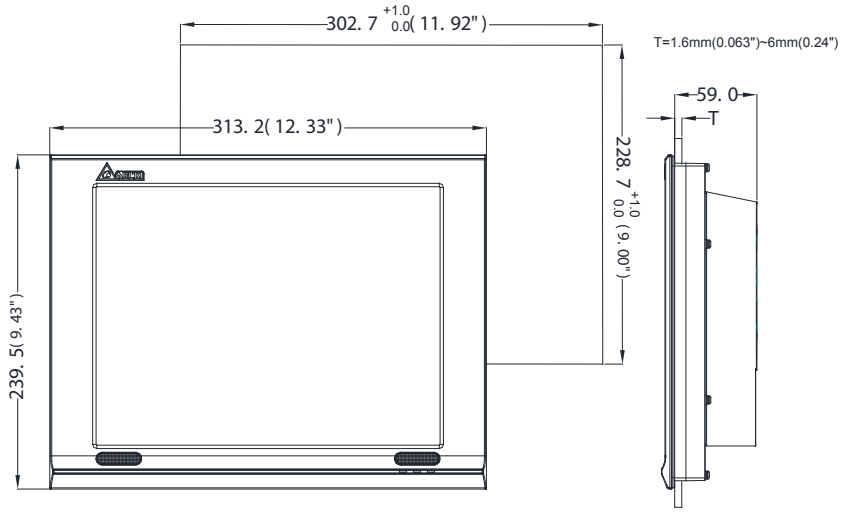
• **DOP-W105B**



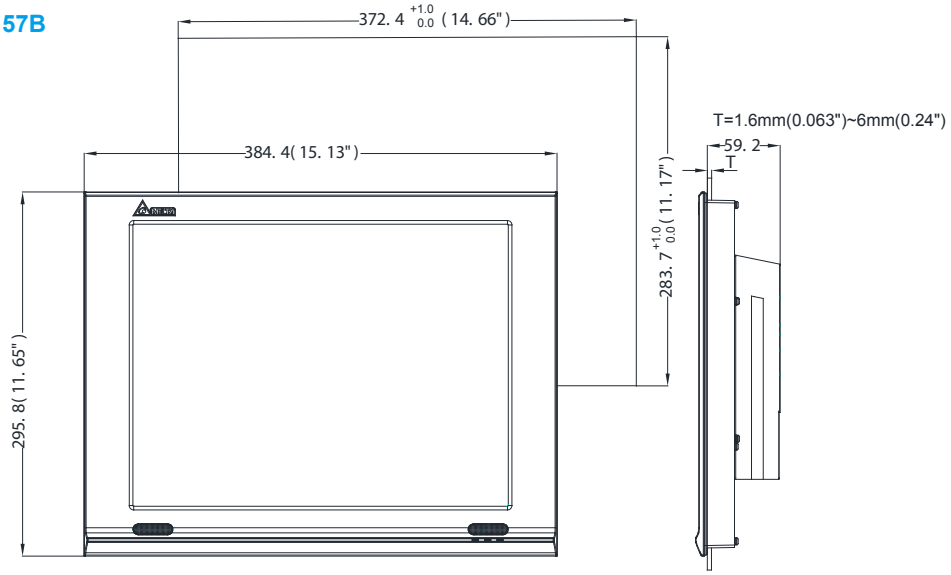
Dimensions Unit: mm (inches)

DOP-W Series

• **DOP-W127B**



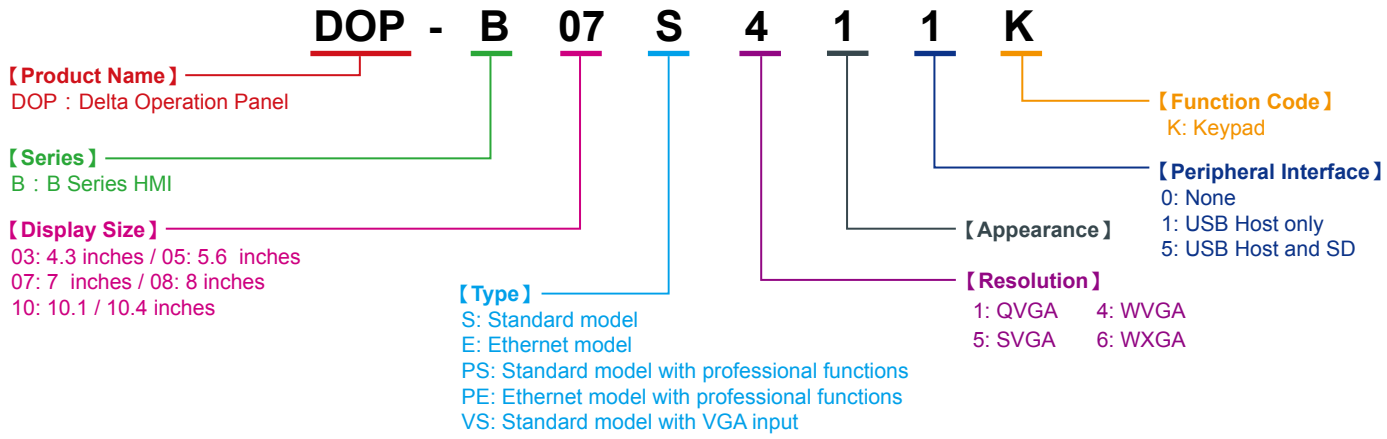
• **DOP-W157B**

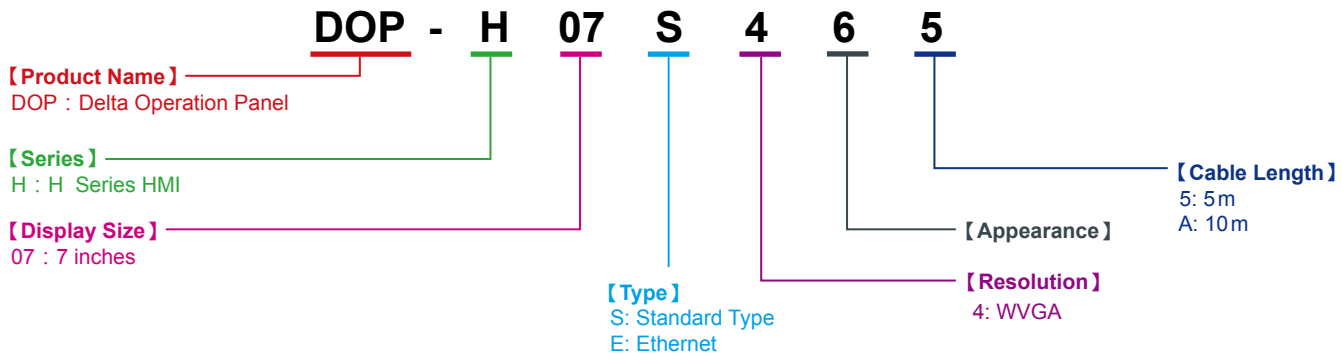


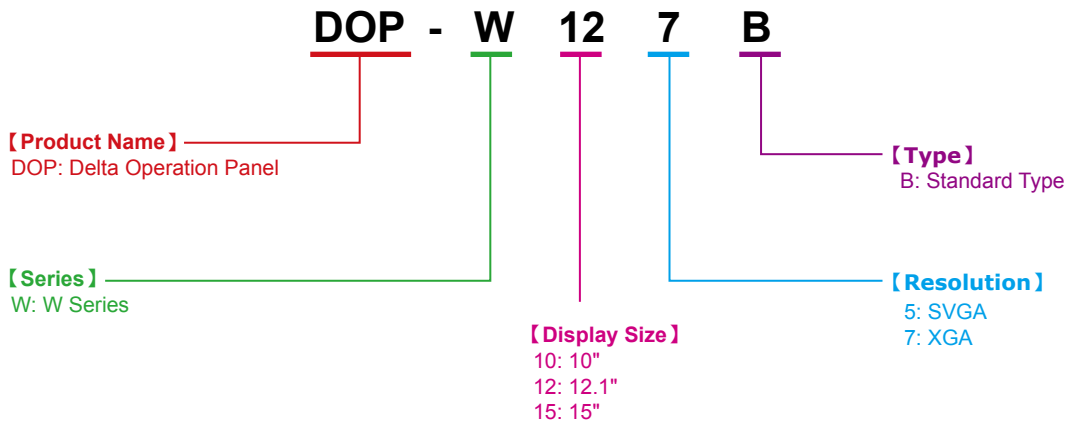
Optional Accessories

Model Name	Description
DOP-CA232DP	DOP-CA232DP: RS-232 Communication Cable for DVP Series PLC (Female Socket)
DVPACAB2A30	DVPACAB2A30: RS-232 Communication Cable for DVP Series PLC (Male Socket)
DOP-CAUSBAB	DOP-CAUSBAB: USB Communication Cable

Ordering Information







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