Enhancing the Performance of Dynamic Weighing System in Automated Production Lines

By

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Submitted to the College of Engineering
in partial fulfillment of the requirements for the
Bachelor degree in Industrial Automation Engineering

Palestine Polytechnic University
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Palestine Polytechnic University

College of Engineering

Department of Electrical Engineering

Hebron - Palestine

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Supervisor Signature

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Testing Committee Signature

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December - 2016

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 عبد القادر الزرو.

الملخص

في خطوط الإنتاج المؤتمتة هناك حاجة ماسة للمحافظة على وزن المنتج ضمن نطاق محدد يمنع من الزيادة أو النقصان في الوزن حسب معايير الجودة و الإنتاج.

يستخدم نظام "فحص الوزن" ضمن خطوط الإنتاج للوصول الى الغاية المطلوبة و ذلك من خلال الحصول على إشارة الوزن المُنتج أثناء مروره بخط الإنتاج، و تتأثر هذه الإشارة من العديد من مصادر التشويش والضجيج مما يؤثر على القراءة الحقيقة للوزن.

يهدف مشروعنا إلى قراءة وزنة المُنتج المتحرك على نظام فحص الوزن ومقارنته بالوزن الفعلي من خلال نظام كهروميكانيكي باستخدام متحكم لقَبول أو رفض المُنتج قبل تعبئته من قبل الأيدي العاملة، وهذا سوف يساهم في زيادة دقة قياس الوزن مع المحافظة على سرعة عملية التوزين والإنتاج.

Abstract

In automated production lines, were the mass of single product must be maintained within predefined weight narrow range, a dynamic weight system is required to attain this objective.

Checkweigher is integrated in the production line to reduce the overweight and underweight of the product by acquiring the weight signal from the load cell which affected by different sources of noise and vibration and extracts the correct weight.

The main objective of this project is read the weight of dynamic product on the checkweigher system and make comparison between it and actual weight through electromechanical system by using controller to accept or refuse the product before packaged by working hands, This will increase weighing accuracy while maintaining or increasing the production speed.

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Chapter One

Introduction

1.1 Overview

The process of product weighing is an essential part of modern industry. There is a constant need for knowing the exact weight of many items, e.g. food, ingredients for production, pharmacology, chemistry, technology, etc. The type and the number of products that require weight control are increasing. According to that, the legal requirements of government bodies need developing to guarantee the exact weight. In production, this means high accuracy and efficiency of weighing. Continuation of this trend brings benefits for both the customer and the producer. That is, manufacturing efficiency is increased; hence, profitability whilst package quality and quantity are assured to the customer's satisfaction.

1.2 Background

A weighing scale is a measuring instrument that is used for determining the weight or mass of an object. Many traditional instruments are used as weighing scales such as scale spring and balance spring. Weighing scales are used in many industrial and commercial applications, and products such as loaded tractor-trailers and medical scales.

In the area of mass production, products are weighed using industrial weighing systems, which are machines that weigh a package dynamically. The weight of the package is estimated while the product has been carried over a load cell weigh by a transport system. Normally the transport system is of a conveyer belt type. The weigh is mounted on a load cell, which is the uncontrollable weighing device capable of weighing an item. A Signal Processing Module (SPM) acquires the electrical signal from weighing device and estimates a value of weight for the passing product as its output.

The checkweigher is one of the most common dynamic weighing system used in almost all modern production lines, different types of products will be passed on the conveyor with different infeed velocities to collect enough data for analysis and simulation. A digital weight indicator is required to interface the weight transducer.

1.3 Objectives

The overall objective is to design, implement a load cell based dynamic weighing system with improved productivity and accuracy. This work is undertaken in the following developments stages: first, analyse the main factors that affect the accuracy of the dynamic weighing system. Then derive and present the exact model of the load cell based dynamic weighing system. The next stage is studying different approaches to identify, minimize or extract error signal from weighing signal. The fourth stage monitoring the value of weight on the (HMI).

1.4 Block Diagram

In generally a checkweigher dynamic weight system incorporates a series of conveyor belts. Checkweighers are known also as belt weighers, in-motion scales, conveyor scales, dynamic scales, and in-line scales. In filler applications, they are known as check scales. Generally, checkweigher has three belts or chain beds:

- **Infeed Conveyor**: An infeed belt that may change the speed of the package and bring it up or down to a speed required for weighing. The infeed is also sometimes used as an indexer, which sets the gap between products to an optimal distance for weighing. It, sometimes, has special belts or chains to position the product for weighing.

- **A Weigh Belt**: This is typically mounted on a weight transducer which can typically be a strain-gauge load cell or a servo-balance (also known as a force-balance), or sometimes known as a split-beam. Some older machines may pause the weigh bed belt before taking the weight measurement. This may limit line speed and throughput.

- **Outfeed Conveyor:** That provides a method of removing an out of tolerance package from the conveyor line. The reject can vary by application. Some require an air-amplifier to blow small products off the belt, but heavier applications require a linear or radial actuator. Some fragile products are rejected by "dropping" the bed so that the product can slide gently into a bin or other conveyor.

The following figure shows the checkweigher in production environment.

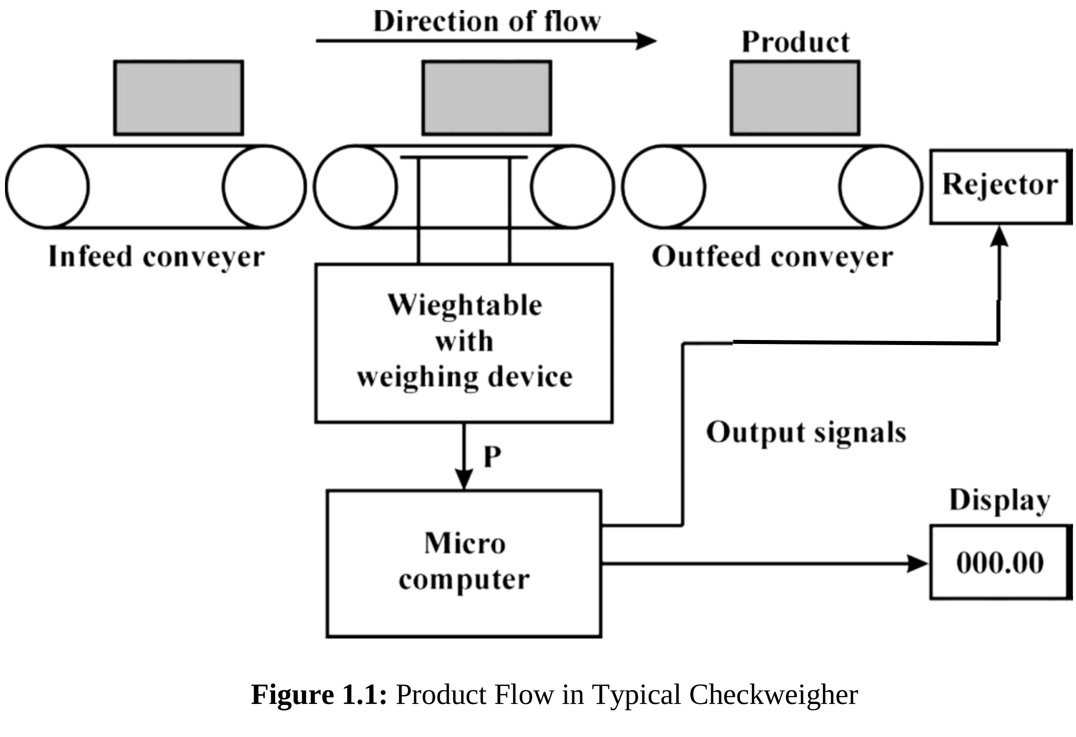


Figure 1.1: Product Flow in Typical Checkweigher

1.5 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)															
Weighing System Chapter (2)															
Theory Chapter (3)															
Electrical Design Chapter(4)															
Mechanical Design Chapter (5)															
Testing and Evaluating Chapter (6)															

Table 1.1: Time Table

2

Chapter Two

WEIGHING SYSTEM

2.1 Introduction

Measuring load is an important and essential part of many industrial and commercial operations. It is crucial to have accurate measurements of the load, as small errors, occurring repeatedly, and lead to substantial loss of revenue. Therefore, weighing systems have an important device; it is denoted as load cell. A load cell is uncontrollable weighing device capable of weighing an article. It is used in a variety of industrial weighing applications.

2.2 Checkweigher System

A checkweigher is a system that weighs items as they pass through a production line, classifies the items by preset weight zones, and ejects or sorts the items based on their classification. Checkweighers weigh 100% of the items on a production line. Typically, an infeed section, scale section, discharge section, rejecter or line divider, and computerized control comprise the physical checkweighing system. Checkweighers and their components vary greatly according to how they are used, the items being weighed, and the environment surrounding them.

2.2.1 Checkweigher System Components

- **Conveyor System**

Conveyors are used to transport product between two or more locations. The variety of products a conveyor system transports is ranges from bolts to pallets and everything in between for distribution and manufacturing systems. See the figure 2.1

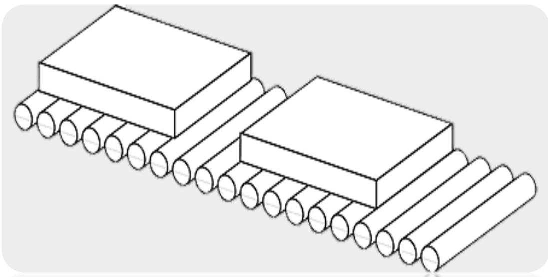


Figure 2.1: Conveyor System

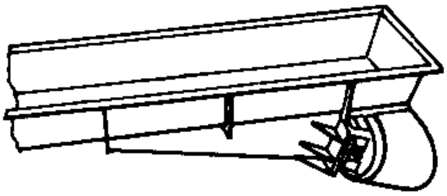
- **Conveyor System Description**

A conveyor moves cardboard boxes, wood boxes, metal boxes and plastic boxes. It can also move bags, components, pallets or other components. Many kinds of conveying systems are available, and are used according to the various needs of different industries. [1]

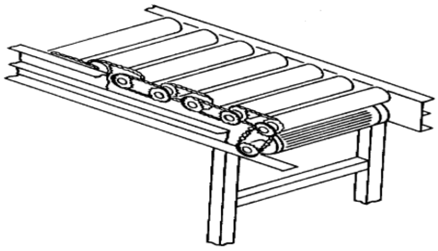
The most famous types of conveyors systems are:

- ✓ Vibrating Conveyor Systems.
- ✓ Roller Conveyor Systems.
- ✓ Vertical Conveyor Systems.
- ✓ Belt Conveyor Systems.

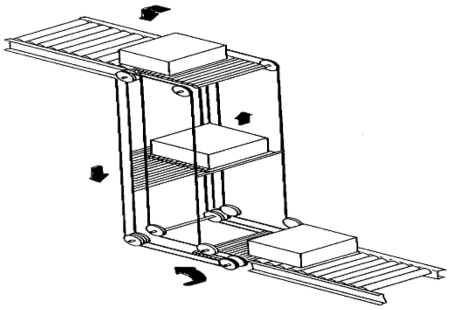
The following figure shows the types of conveyors:



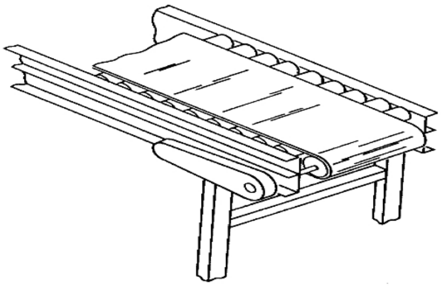
Vibrating Conveyor



Roller Conveyor



Vertical Conveyor



Belt Conveyor

Figure 2.2: Conveyor System Types

2.3 Sensors

A sensor is a device that detects and responds to some type of input from the physical environment. The specific input could be light, heat, motion, moisture, pressure, or any one of a great number of other environmental phenomena. The output is generally a signal that is converted to human-readable display at the sensor location or transmitted electronically over a network for reading or further processing.

2.3.1 Photo Sensors

A Light Sensor generates an output signal indicating the intensity of light by measuring the radiant energy that exists in a very narrow range of frequencies basically called “light”, and which ranges in frequency from “Infra-red” to “Visible” up to “Ultraviolet” light spectrum. See the figure 2.3

Figure 2.3: Light Sensor

The light sensor is a passive devices that convert this “light energy” whether visible or in the infra-red parts of the spectrum into an electrical signal output. Light sensors are more commonly known as “Photoelectric Devices” or “Photo Sensors” because the convert light energy (photons) into electricity (electrons).

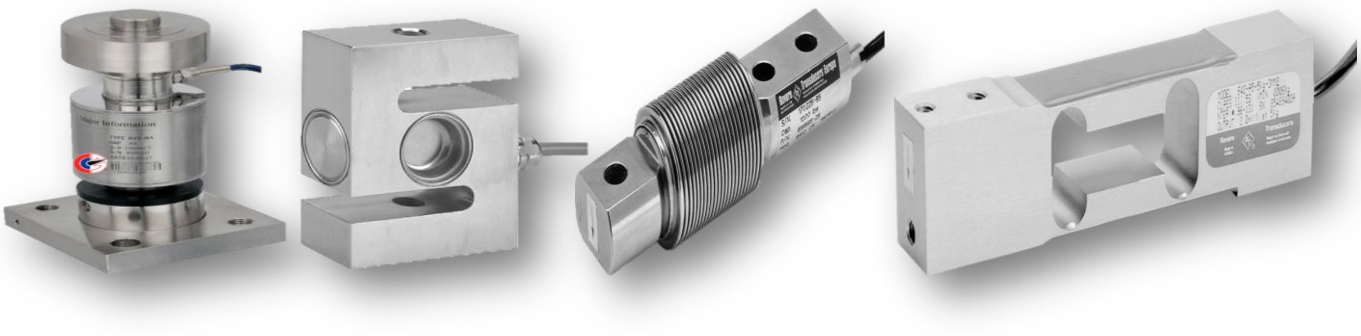
2.3.2 Load Cells

Load cell is an electromechanical device. It can be called a transducer as it converts one form of energy to another mechanical force or stress to electrical energy. A load cell has various characteristics that are measurable. These characteristics are determined by the type of metal used, shape of the load cell and how well it is protected from its environment. To understand load cells better (you can see the reference [2]) there are terms that you need to become familiar with so you can better match the load cell to your application.

Load Cell Description

An electronic weighing system is the electronic system used for dynamic weighing. A weighing system consists of one or more sensors and an intelligent module. The sensor is usually called a load cell and is available in several different types. In industrial weighing systems, there are three types of load cell: Magnetic transducer which measures change in magnetic permeability, oscillating string transducer which measures changes in frequency and the third one is the strain gauge transducer which measure changes in resistance. The three types of load cell are called transducers because it converts the force into a measurable data. In the weighing system used in this thesis we will use the third type.

Majority of the industrial weighing systems use the strain gauge load cell in various types such as traditional canister, s beam, single ended beam, platform load cell, etc., as shown in figure 2.4 it is considered the most common type of load cells in industry due to their low price and great loads area. In addition, it is suitable to be used in the dusty and moist workshop environments.



Traditional Canister S-Beam Load Cell Single Ended Beam Platform Load Cell

Figure 2.4: Load Cell Types

2.4 Rejecters

A reject signal is sent from the checkweigher control to a rejecter on the checkweigher or further downstream. Typically the reject signal consists of a solid state relay with high or low voltage output or a mechanical contact. [3]

A mechanism which removes items from the line flow upon receiving a signal from a control system. The rejecter often consists of a solenoid operated valve, air cylinder, and associated mechanical parts. Majority of the industrial weighing systems use the rejecters various types such as: flipper, dropout, up and out, air jet, and pusher rejecter, etc., as shown in figure 2.5.

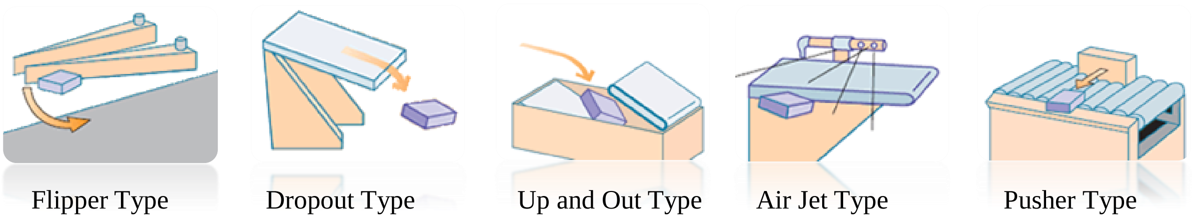


Figure 2.5: Rejecters Types

2.5 PLC (Programmable Logic Control)

A central control system from which one can operate and program functions of several independent or dependent systems. The PLC consists of a user interface, central processor, links to subsidiary system controls, and an electrical control interface.

PLCs have become more and more standard in manufacturing and packaging industries. Some checkweigher manufacturers have designed PLC interfaces to common PLC formats and can now fit into your lines seamlessly. Ask checkweigher manufacturers what level of integration they provide for PLC support.

The most common type of PLC in industry as shown in figure 2.6

Fatek PLC Siemens PLC Delta PLC

Figure 2.6: PLC Types

2.6 HMI (Human Machine Interface)

A Human Machine Interface (HMI) is the user interface that connects an operator to the controller for an industrial system.

Industrial Control Systems (ICS) are integrated hardware and software designed to monitor and control the operation of machinery and associated devices in industrial environments, including those that are designated critical infrastructure. An HMI includes electronic components for signalling and controlling automation systems. See the figure 2.7

Figure 2.7: Delta HMI

HMIs are usually deployed on Windows based machines, communicating with programmable logic controllers (PLC) and other industrial controllers. [4]

2.7 Protection System

2.7.1 Contactors

Contactors are an electrically controlled switch used for switching a power circuit similar to a relay except with higher current ratings. A contactor is controlled by a circuit which has a much lower power level than the switched circuit.

Contactors come in many forms with varying capacities and features. Unlike a circuit breaker, a contractor is not intended to interrupt a short circuit current, contactors range from several amperes to thousands of amperes. The physical size of contactors ranges from a device small enough to pick up with on hand to large device as shown in figure 2.8

Figure 2.8: Contactor

2.7.2 Circuit Breaker (CB)

If a power surge occurs in the electrical wiring, the breaker will trip this means that a breaker that was in the on position will flip to the off position and shut down the electrical power leading from the breaker. Essentially, a circuit breaker is a safety device. When a circuit breaker is tripped it may prevent a fire to start in overloaded circuit, it can also prevent the destruction of the device that is drawing the electricity. See the figure 2.9

Figure 2.9: Circuit Breaker

2.7.3 Overload

Overload relays are intended to protect motors, controllers and branch-circuit conductors against excessive heating due to prolonged motor over currents up to and including locked rotor currents. Protection of the motor and other branch-circuit components from higher currents, due to short circuits or grounds, is a function of branch-circuit fuses, circuit breakers or motor short circuits protectors. The system needs two overloads to protect the motors. See the figure 2.10

Figure 2.10: Overload

2.7.4 Emergency Stop Button

Emergency Stop Button is shown in a figure 2.11 provides safety for humans and the machine; it offers a wide range of safety components for the protection of humans, machine and production goods in emergency situations.

It is the purpose of emergency-stop device to deflect or minimize the risk as quickly as possible and optimally in the event of an emergency arising.

Figure 2.11: Emergency Stop Button

2.7.5 Earth Leakage Circuit Breaker (ELCB)

Is a safety device used in electrical installations with high Earth impedance to prevent shock. It detects small stray voltages on the metal enclosures of electrical equipment, and interrupts the circuit if a dangerous voltage is detected. Once widely used, more recent installations instead use residual current circuit breakers which instead detect leakage current directly. See the figure 2.12

Figure 2.12: Earth Leakage Circuit Breaker

2.8 Pneumatic System

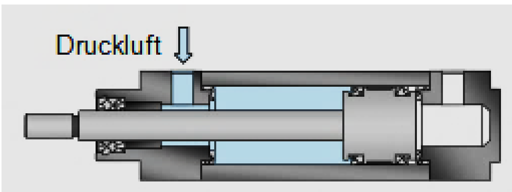
2.8.1 Magnetic Cylinder Sensors

Detecting piston positions with precision, in countless fields of automation, it is essential to monitor the motion processes in pneumatic cylinders. Magnetic cylinder sensors contactlessly detect the piston position of these cylinders and give a switching signal. They are completely maintenance-free and are mounted outside the cylinder. See the figure 2.13. [5]

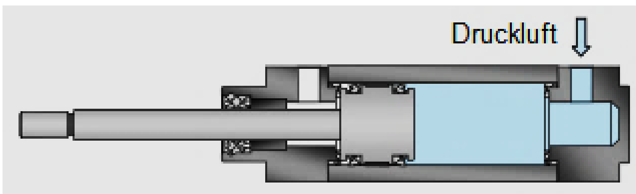
Figure 2.13: Magnetic Cylinder Sensors

2.8.2 Double Acting Cylinder

The double-acting cylinder requires compressed air for every direction of movement. On this type of cylinder, the force both the advancing and retracting direction is built up using compressed air. The simplest way of actuating a double-acting cylinder is by using a 5/2-way valve. See the figure 2.14 **[**6]



Double Acting Cylinder Retracted



Double Acting Cylinder Advanced

Figure 2.14: Double Acting Cylinder

2.8.3 Solenoid Valve

Solenoid valve is an electromechanical device used for controlling liquid or gas flow. The solenoid valve is controlled by electrical current, which is run through a coil. When the coil is energized, a magnetic field is created, causing a plunger inside the coil to move. Depending on the design of the valve, the plunger will either open or close the valve. When electrical current is removed from the coil, the valve will return to its de-energized state. See the figure 2.15

Figure 2.15: Solenoid Valve

3

Chapter Three

Theory

3.1 Load Cell

3.1.1 What is a Load Cell?

A load cell is a sensor or a transducer that converts a load or force acting on it into an electronic signal. This electronic signal can be a voltage change, current change or frequency change depending on the type of load cell and circuitry used. There are many different kinds of load cells. We offer resistive load cells and capacitive load cells. See the figure 3.1

Resistive load cells work on the principle of piezo-resistivity. When a load/force/stress is applied to the sensor, it changes its resistance. This change in resistance leads to a change in output voltage when an input voltage is applied.

Capacitive load cells work on the principle of change of capacitance which is the ability of a system to hold a certain amount of charge when a voltage is applied to it. For common parallel plate capacitors, the capacitance is directly proportional to the amount of overlap of the plates and the dielectric between the plates and inversely proportional to the gap between the plates.

Figure 3.1: Low Profile Aluminum load cell

3.1.2 How do Load Cells Works?

A load cell is made by using an elastic member (with very highly repeatable deflection pattern) to which a number of strain gauges are attached.

In this particular load cell shown in figure 3.2, there are a total of four strain gauges that are bonded to the upper and lower surfaces of the load cell. [7]

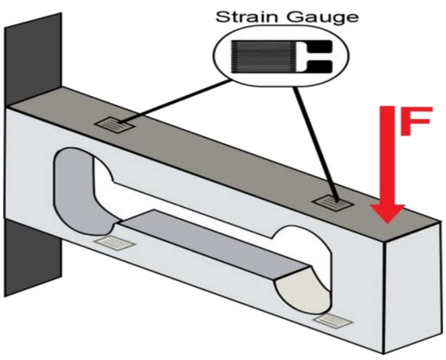


Figure 3.2: Strain Gauges in Load Cell

3.1.3 Strain Gauge

A strain gauge consists of a very fine length of wire that is woven back and forth in a grid and laid on a piece of paper or plastic called its base. A common wire used is a copper nickel alloy with a diameter of about one thousandth of an inch (.001”). The wire is zig-zagged to form a grid so to increase the effective length of the wire that comes under the influence of the force applied to it. Leads are attached to the ends of the gauge. Strain gauges can be made very small, sometimes as small as 1/64”. See the figure 3.3

These gauges are cemented to a strong metal object, commonly referred to as the load receiving element, to make up a load cell. The gauges are configured into a circuit called a *Wheatstone bridge*. [2]

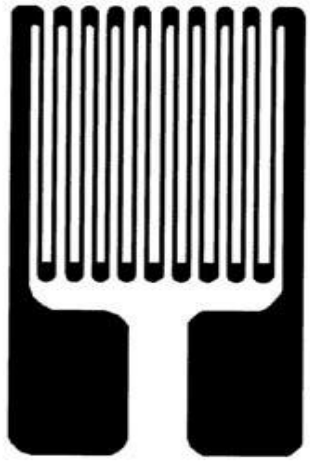


Figure 3.3: Strain Gauge

3.1.4 Wheatstone Bridge Circuit

The four strain gauges are configured in a Wheatstone Bridge configuration with four separate resistors connected as shown in what is called a Wheatstone Bridge Network. An excitation voltage usually 10V is applied to one set of corners and the voltage difference is measured between the other two corners. At equilibrium with no applied load, the voltage output is zero or very close to zero when the four resistors are closely matched in value. That is why it is referred to as a balanced bridge circuit.

When the metallic member to which the strain gauges are attached, is stressed by the application of a force, the resulting strain leads to a change in resistance in one (or more) of the resistors. This change in resistance results in a change in output voltage. This small change in output voltage (usually about 20 mVolt of total change in response to full load) can be measured and digitized after careful amplification of the small mVolt level signals to a higher amplitude 0-5V or 0-10V signal. See the figure 3.4

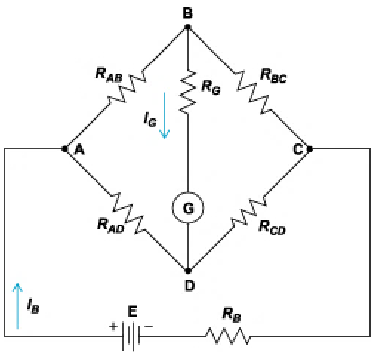


Figure 3.4: Wheatstone Bridge.

3.1.5 Principle of Load Cell

We can take our strain gauge and Wheatstone bridge theories and use them to construct a load cell. We will use a column of steel and glue a strain gauge on each of the four sides of the column. As weight is placed on top of the column, the length of the column would decrease. The column also would become “fatter,” or bulge out. Two strain gauges are placed opposite of each other to respond proportionately to the change in length. [2]

Two other gauges are placed on opposite sides of the column and respond to the change in the column’s bulge. Since one pair of strain gauges become shorter their wire diameters become larger and their resistance decreases. The other pair of strain gauges are positioned so their wires lengthen, thus decreasing their diameter and increasing their resistance. If we hung the same weight from the bottom of the column instead of compressing the column we would be placing tension on it. The column and strain gauges would act in the opposite direction but still stretch and compress the wires by the same amount. See the figure 3.5

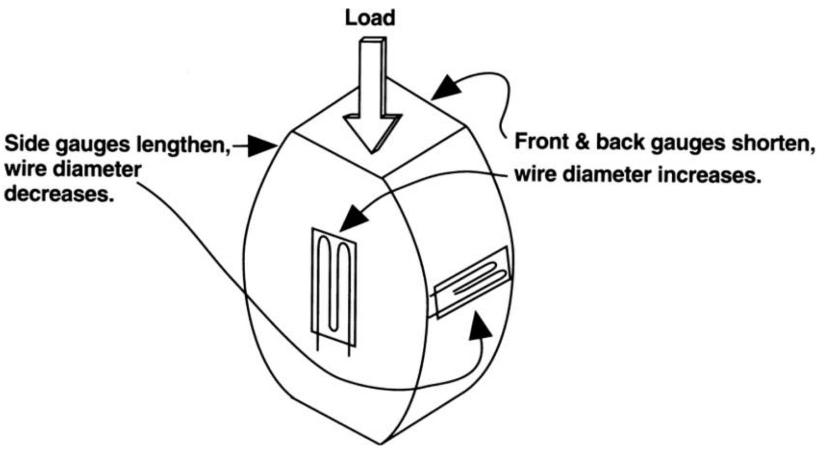


Figure 3.5: Strain Gauge Principle

We can wire our strain gauges into a Wheatstone bridge configuration. We can calibrate the ammeter to read in pounds instead of amps. In effect, we actually have a scale. Of course this is a crude, very inaccurate scale. It is intended to show the basic load cell principle. [2] Load cells are made in different shapes and configurations. The strain gauges are strategically placed for peak performance. See the figure 3.6

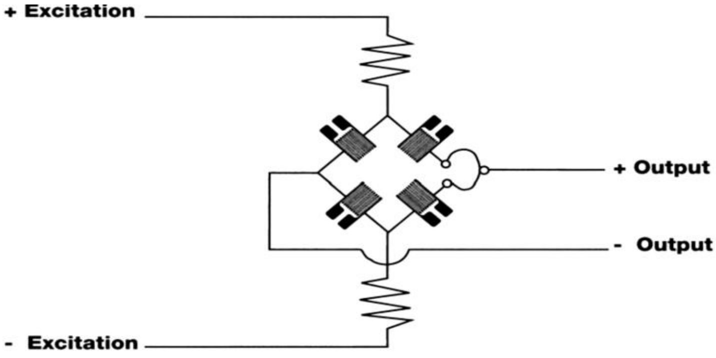


Figure 3.6: load cell principle

The gauge factor GF is defined as:

$$\mathrm{GF} = \frac{\Delta R / R_G}{\in} \qquad \text{………………. Equation (3.1)}$$

Where: ΔR is the change in resistance caused by strain.
R_G is the resistance of the under formed gauge.
$\in$ is strain.

For metallic foil gauges, the gauge factor is usually a little over 2.For a single active gauge and three dummy resistors in a Wheatstone bridge configuration, the output V from the bridge is: [3]

$$\mathrm{v} = \frac{\mathrm{BV.\ GF} .\in}{4} \qquad \text{………………. Equation (3.2)}$$

Where: BV is the bridge excitation voltage.

3.1.6 Load Cell Electrical Theory

The Wheatstone bridge configured above is a simple diagram of a load cell. The resistors marked T1 and T2 represent strain gauges that are placed in tension when load is applied to the cell. The resistors marked C1 and C2 represent strain gauges which are placed in compression when load is applied. [2]

The +In and -In leads are referred to as the +Excitation (+Exc) and -Excitation (-Exc) leads. The power is applied to the load cell from the weight indicator through these leads. The +Out and -Out leads are referred to as the +Signal (+Sig) and -Signal (-Sig) leads. The signal obtained from the load cell is sent to the signal inputs of the weight indicator to be processed and represented as a weight value on the indicator’s digital display.

As weight is applied to the load cell, gauges C1 and C2 compress. The gauge wire becomes shorter and its diameter increases. This decreases the resistances of C1 and C2. Simultaneously, gauges T1 and T2 are stretched. This lengthens and decreased the diameter of T1 and T2, increasing their resistances. These changes in resistances cause more current to flow through C1 and C2 and less current to flow through T1 and T2. Now a potential difference is felt between the outputs or signal leads of the load cell.

Current is supplied by the indicator through the -In lead. Current flows from -In through C1 and through -Out to the indicator. From the indicator current flows through the +Out lead, through C2 and back to the indicator at +In. In order to have a complete circuit we needed to get current from the –In side of the power source (Indicator) to the +In side. You can see we accomplished that. We also needed to pass current through the indicator's signal reading circuitry. We accomplished that as the current passed from the –Out lead through the indicator and back to the load cell through the +Out lead. Because of the high internal impedance (resistance) of the indicator, very little current flows between –Out and +Out.

Since there is a potential difference between the -In and +In leads, there is still current flow from – In through T2 and C2 back to + In, and from -In through C1 and T1 back to +In. The majority of current flow in the circuit is through these parallel paths. Resistors are added in series with the input lines. These resistors compensate the load cell for temperature, correct zero and linearity.

We have replaced the ammeter with a voltmeter which will represent the display on our weight indicator. Also, the leads connected to our indicator are designated +Sig and -Sig. These represent our positive and negative signal leads. The represents our indicator's power supply that provides the precise voltage to excite or power the load cell. The resistance values represent our four strain gauges which make up our load cell.

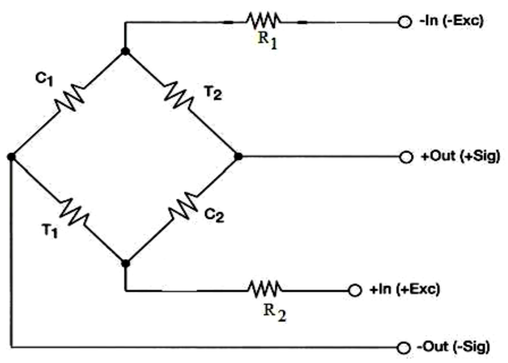


Figure 3.7: Wheatstone bridge

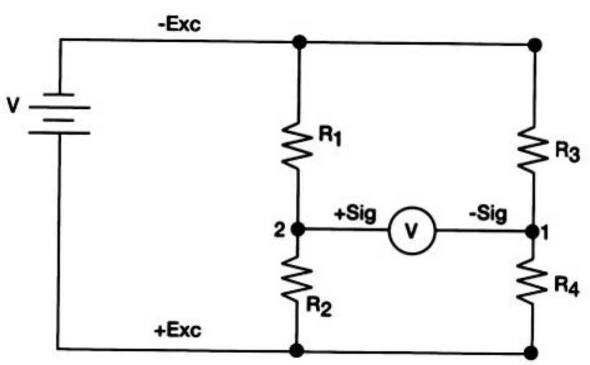


Figure 3.8: Wheatstone bridge with a voltmeter

Now let's place a force on our load cell. Our force caused R1 and R4 to go into tension, which increased their resistances. R2 and R3 went into compression, which decreased their resistances. These changes are depicted in the following diagram.

The current flow in the branch is the branch voltage divided by the branch resistance:

$$I_{R1+R2} = \frac{E_{R1+R2}}{R1+R2} \qquad \text{………………} \quad \text{Equation (3.3)}$$

$$I_{R3+R4} = \frac{E_{R3+R4}}{R3+R4} \quad \text{………………. Equation (3.4)}$$

From the Figure 3.8 the voltage at point 1 and 2, we can use Ohm's Law.

$$E_{R3} = I_{R3}R_3 \quad \text{………………. Equation (3.5)}$$

$$E_{R1} = I_{R1}R_1 \quad \text{………………. Equation (3.6)}$$

3.2 Wiring

A load cell may have a cable with four or six wires. A six-wire load cell, besides having +Ve and -Ve signal and +Ve and -Ve excitation lines, also has +Ve and -Ve sense lines. These sense lines are connected to the sense connections of the indicator.

These lines tell the indicator what the actual voltage is at the load cell. Sometimes there is a voltage drop between the indicator and load cell. The sense lines feed information back to the indicator. The indicator either adjusts its voltage to make up for the loss of voltage, or amplifies the return signal to compensate for the loss of power to the cell.

Load cell wires are color coded to help with proper connections. The load cell calibration data sheet for each load cell contains the color code information for that cell. Rice Lake Weighing Systems also provides a load cell wiring color guide on the back cover of our Load Cell Product Selection Guide. [2]

3.3 Calibration Data

Each load cell is furnished with a calibration data sheet or calibration certificate. This sheet gives you pertinent data about your load cell. The data sheet is matched to the load cell by model number, serial number and capacity. Other information found on a typical calibration data sheet is output expressed in mV/V, excitation voltage, non-linearity, hysteresis, zero balance, input resistance, output resistance, temperature effect on the output and zero balance, insulation resistance and cable length. The wiring color code is also included on the calibration data sheet.

3.4 Output

A load cell's output is not only determined by the weight applied, but also by the strength of the excitation voltage and its rated mV/V full scale output sensitivity.

3.5 Mechanical Theory

3.5.1 Bearing [In this part two cases for chosen the Bearing:]

Case1: No thrust loading just radial loading

1. Compute Fx *and* Fy by applying static equilibrium equations to the shaft supported by the bearing. See the figure 3.9.

2. Find the resultant radial load:

$$F_r = \sqrt{F_x^{\ 2} + F_y^{\ 2}} \quad \text{.................. Equation (3.7)}$$

$$F_D = a_f\, V\, F_r \quad \text{.................. Equation (3.8)}$$

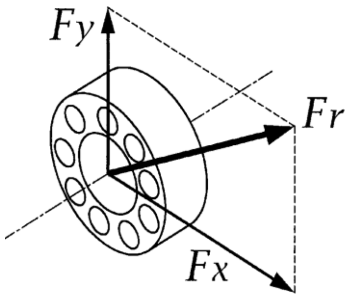


Figure 3.9: Free Body Diagram of Ball Bearing

Where: F_r is radial load on the bearing.
F_x is the force acting on the x-axis.
F_y is the force acting on the y-axis.
F_D is Design load.
a_f is Application factor we take its value from (Table 4 -1), used because loads are often variable (non-steady) and may increase during operation.
V: rotation factor, takes into account whether the inner or outer race rotates

$$V = \begin{cases} 1.0 \text{ rotating inner ring} \\ 2.0 \text{ rotating outer ring} \end{cases}$$

Usually the inner race of the bearing rotates.

3. Assume the desired life (LD) and Reliability (RD)

$$X_D = \frac{L_D}{L_{10}} = \frac{L_D}{10^6} \quad \text{.................. Equation (3.9)}$$

Where: X_D is Life ratio.
L_D is Design Life.
L_{10} is Rating life and its value equal one million revaluation.

4. Calculate the required catalog rating:

$$C_{10} = \left(\frac{L_D}{L_{10}}\right)^{1/a} * F_D \quad \text{.................. Equation (3.10)}$$

Where: C_{10} is Catalog Rating.

5. Check the catalog and we select a suitable bearing from (Table4-3)

Case2: Radial and thrust loading

1. Compute *Fx* and *Fy* and *Fa* by applying static equilibrium equations to the shaft supported by the bearing.

3. Find the resultant radial load:

$$F_r = \sqrt{F_x{}^2 + F_y{}^2} \qquad \text{………………. Equation (3.11)}$$

And calculate the ratio:

$$F_a/V\ F_r \qquad \text{………………. Equation (3.12)}$$

4. Assume the desired life (*LD*) and Reliability (*RD*)

$$X_D = \frac{L_D}{L_{10}} = \frac{L_D}{10^6} \qquad \text{………………. Equation (3.13)}$$

4. Start with assumed *Fe* (set the initial trial: $F_e = a_f.V.F_r$)

5. Compute C_{10} using:

$$C_{10} = \left(\frac{L_D}{L_{10}}\right)^{1/a} * \ F_e \qquad \text{………………. Equation (3.14)}$$

Factor of Safety:

Is a term describing the capacity of a system beyond the expected loads or actual load. Essentially is how much stronger the system is than it usually needs to be for an intended load.

$$n = \frac{s_y}{t} \qquad \text{………………. Equation (3.15)}$$

Where: n is Factor of Safety

s_y is Share stress

t is Material cross section

And we have two type of shear stress:

1) Single shear

$$\tau_{avg} = \frac{P}{A} = \frac{F}{A}$$ .... Equation (3.16)

2) Double shear

$$\tau_{avg} = \frac{P}{A} = \frac{F}{2A}$$ .... Equation (3.17)

If the acceleration is known to be constant, the different equation relating time, position, velocity, and acceleration can be integrated.

- $V = V_i + a_c t$ .... Equation (3.18)
- $S_f = S_i + V_i t + \frac{1}{2} a_c t^2$ .... Equation (3.19)
- $V^2 = V_i^2 + 2a_c(S - S_i)$ .... Equation (3.20)

Where: V is velocity
V_i is Initial velocity
a_c is Constant acceleration
t is Time
S_f is Final distance
S_i is Initial distance

If the path of motion is expressed in polar coordinates, the velocity and acceleration component can be related to the time derivative of r and θ

- $V_r = r^{\circ}$ .... Equation (3.21)
- $V_\theta = r\theta^{\circ}$ .... Equation (3.22)
- $a_r = r^{\circ\circ} - r\theta^{\circ 2}$ .... Equation (3.23)
- $a_\theta = r\theta^{\circ\circ} + 2r^{\circ}\theta^{\circ}$ .... Equation (3.24)

Where: V_r is Radial Velocity
r is Position Vevtor
V_θ is Angular Velocity
a_r is Radial Acceleration
a_θ is Angular Acceleration

4

Chapter Four

Electrical Design

4.1 Electrical Design

We have two types of load:

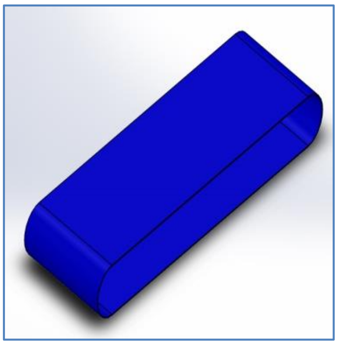
1- Dead load
2- Live load

4.1.1 Dead Load

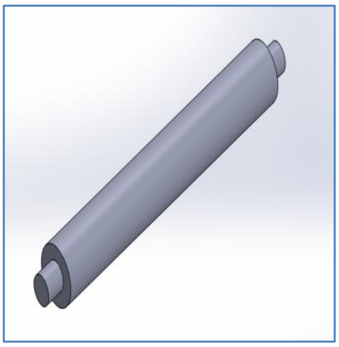
We have a many parts of conveyor that have different wieghts and this wieghts are the dead load in the load cell:

- ✓ **The Belt,** we weighing it and equal 0.5 kg.
- ✓ **The Roller,** we weighing it and equal 0.5 kg.
- ✓ **The Bearing,** we weighing it and equal 0.05 kg.
- ✓ **The Pulley,** we weighing it and equal 0.1 kg.
- ✓ **The Sidebar,** we weighing it and equal 0.5 kg.
- ✓ **The Conveyor Carrier,** we weighing it and equal 0.5 kg.
- ✓ **The Motor and Gear ratio,** we weighing it and equal 5 kg.

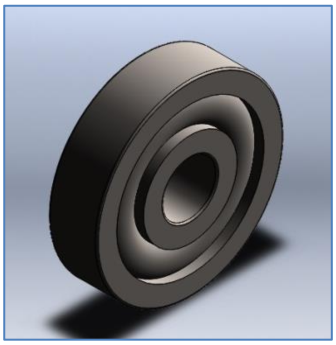
The following figure shows the dead load component of convyor:



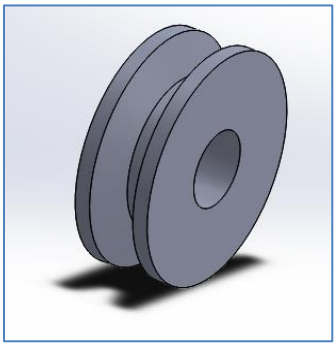
The Belt



The Roller

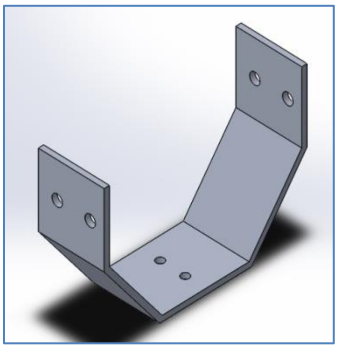


The Bearing



The Pulley

The Sidebar



The Conveyor carrier

Figure 4.1: Dead load Component of Convyor

According to this data we want calculate the total dead load weight of the conveyor:

$$\text{dead load} = \text{belt weight} + 2\text{roller weight} + 4\text{bearing weight} + 2\text{sidebar weight}$$
$$+\text{Conveyor carrier weight} + \text{motor and gear weight} \qquad \text{....... Equation (4.1)}$$

$$\text{dead load} = 0.4\text{kg} + (2 * 0.5)\text{kg} + (4 * 0.05)\text{kg} + (2 * 1)\text{kg} + 0.5\text{kg} + 5\text{kg}$$
$$= 9.1\text{kg}.$$

4.1.2 Live Load

It is the different wieghts that pass on the conveyor and the range of this wieghts from 0.0kg to 5.0 kg.

To choose the suitable load cell we will calculate the max wieght on the load cell.

$$\text{max weight} = \text{dead load} + \text{max live load} \qquad \text{............ Equation (4.2)}$$
$$\text{max weight} = 9.1\text{kg} + 5\text{kg} = 14.1\text{kg}$$

According to the max weight we will choose the ***Low Profile Aluminium load cell*** that have weight min 0.0 kg and the max weigh is 5kg due to the datasheet that attachment in (Appendix B).

4.1.3 Internal Design for the Load Cell

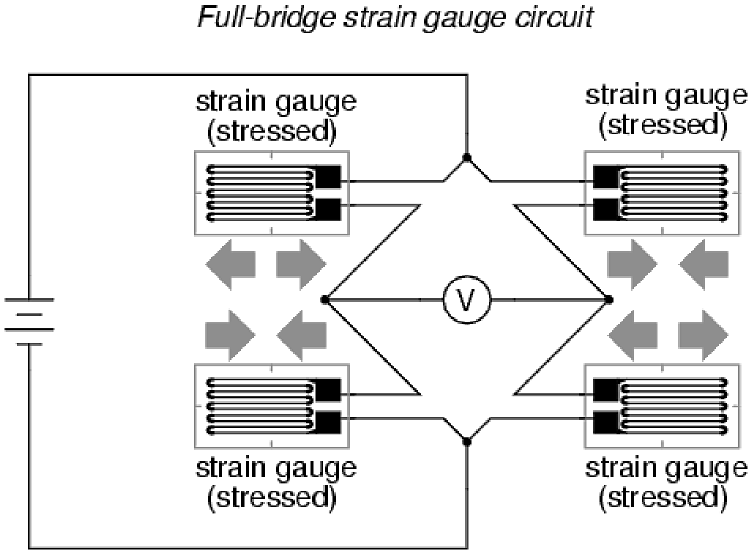


Figure 4.2: Internal Design for the Load Cell

Gauge Factor

The gauge factor GF is defined as:

$$GF = \frac{\Delta R / R_G}{\epsilon} \quad \text{………… Equation (4.3)}$$

Where ΔR: is the change in resistance caused by strain.

R_G: is the resistance of the under formed gauge.

ϵ: is strain.

For metallic foil gauges, the gauge factor is usually a little over 2. For single active gauge and three dummy resistors in a Wheatstone bridge configuration, the output V from the bridge is:

$$v = \frac{BV.\ GF .\epsilon}{4} \quad \text{………… Equation (4.4)}$$

Where BV: is the Bridge Excitation Voltage.

We can’t determine the change on gauge factor that effect on output signal that happen when we effect on the load cell by different weights; because the relationship between output signal and the weight is not defined in datasheet and we will find this difference by experiment.

4.2 Power Circuit

4.2.1 Symbol Address

Name	Symbol
Circuit Breaker	Q1
Earth Leakage	Q2
Contactor 1	KM1
Contactor 2	KM2
Over Load 1	RT1
Over Load 2	RT2
Motor 1	M1
Motor 2	M2

Table 4.1: Symbol Data for Power Circuit

4.2.2 Power Circuit Connection

4.3 Control Circuit

4.3.1 Inputs Symbol

Name	Symbol	Address	Description
Emergency	EM	X0	Digital input
NC Overload 1	SRT 1	X1	Digital input
NC Overload 2	SRT 2	X2	Digital input
Photo Sensor 1	S0	X3	Digital input
Photo Sensor 2	S1	X4	Digital input
Sensor Cylinder 1	S2	X5	Digital input
Sensor Cylinder 2	S3	X6	Digital input
Sensor Cylinder 3	S4	X7	Digital input

Table 4.2: Inputs Symbol Data for PLC Program Connections

4.3.2 Outputs Symbol

Name	Symbol	Address	Description
Contactor	KM1	Y0	Motors
Coil 1	Y1	Y1	Cylinder 1
Coil 2	Y2	Y2	Cylinder 2
Coil 3	Y3	Y3	Cylinder 3

Table 4.3: Outputs Symbol Data for PLC Program Connections

4.3.3 PLC Program Connections

4.3.4 Connection Module Load Cell

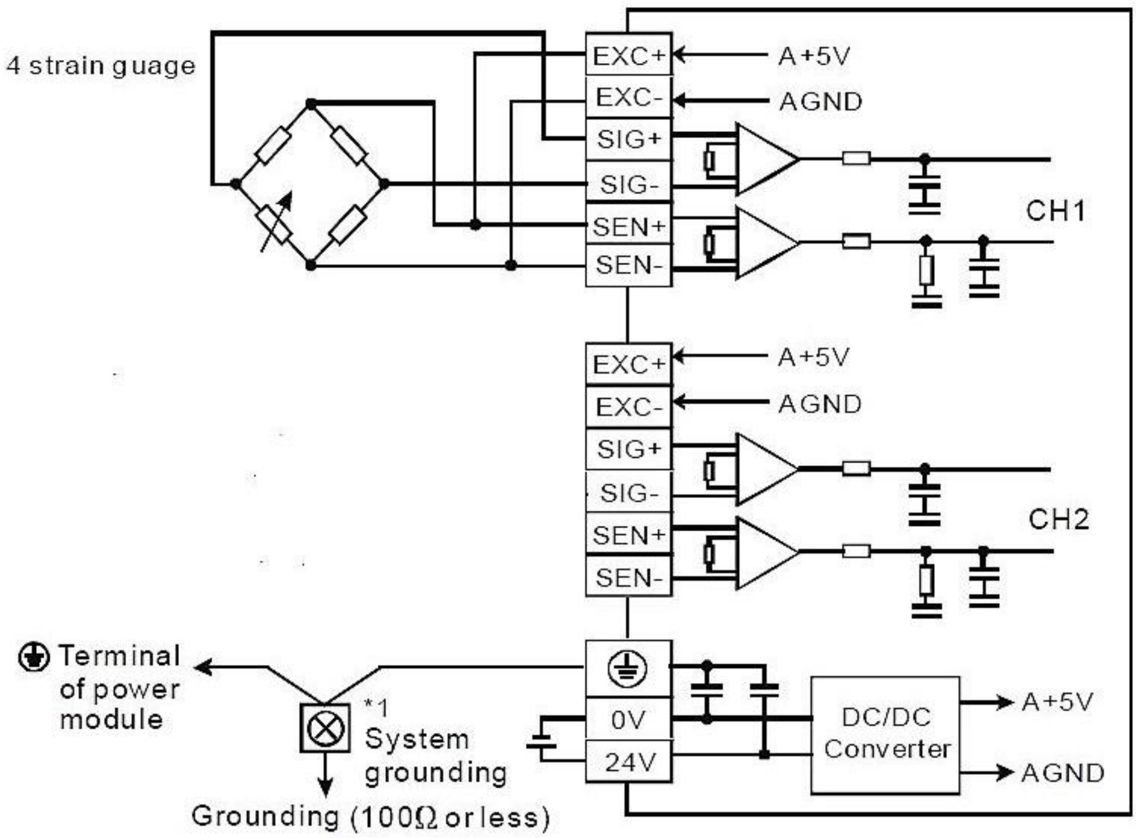


Figure 4.3: Connection Module Load Cell

4.4 Pneumatic Circuit

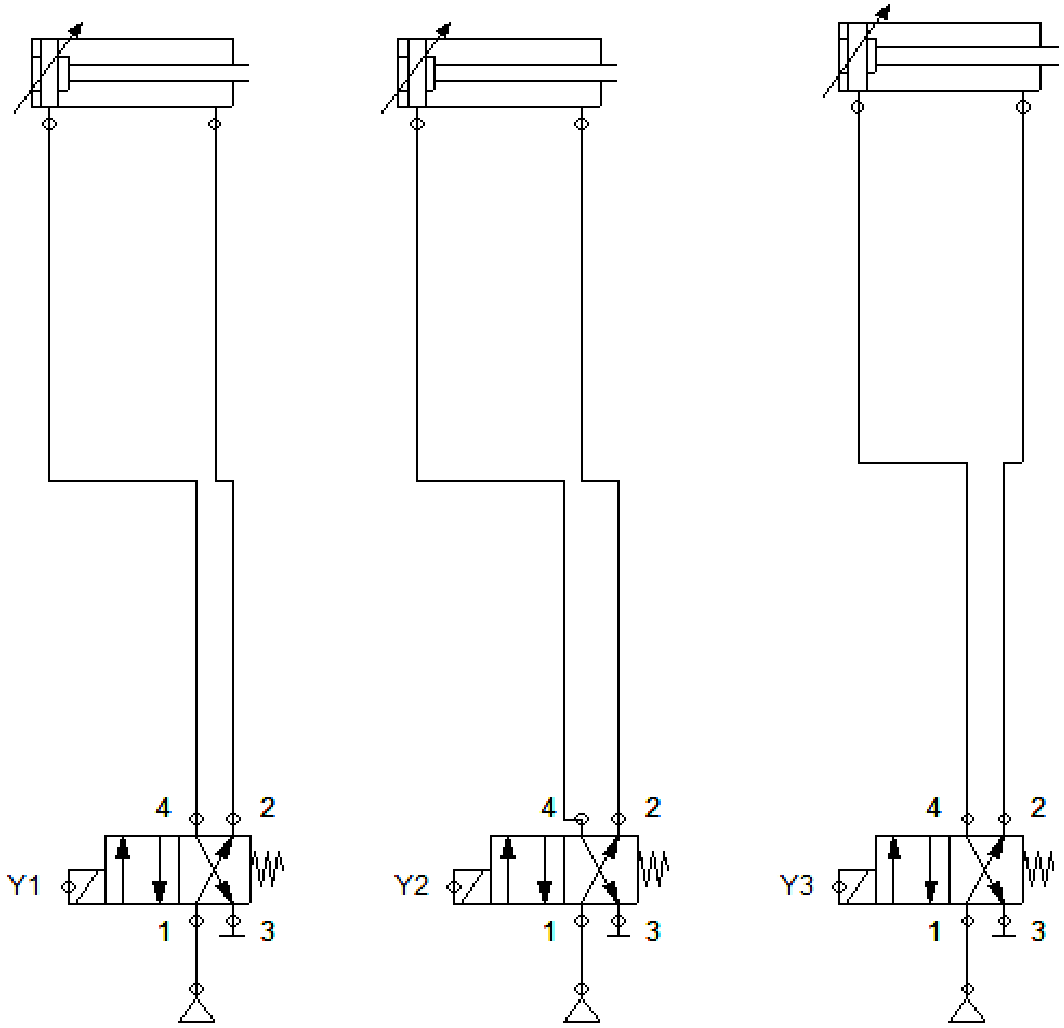


Figure 4.4: Connection Pneumatic Circuit

5

Chapter Five

Mechanical Design

5.1 Design of Conveyor

5.1.1 Design Bearing of Conveyor

In the design of conveyor bearing we consider that there is no thrust loading, and the loading is only radial.

Step 1: At first, we will compute F_x and F_y by applying static equilibrium equations to the shaft supported by the bearing.

$$s_f = s_i + v_i\,t + \frac{1}{2}\,a\,t^2 \qquad \text{............. Equation (5.1)}$$

Where s_f : The distance from the middle to the end of the conveyor.
s_i : The initial distance, and equal zero.
v_i : Initial velocity of the belt.
a : Acceleration of the belt.

For Checkweigher:

$$0.075 = \frac{1}{2}at^2$$

$$0.15 = a(1.33)^2$$

$$a = \frac{0.15}{1.7689} = 0.084 \;\; m^2/sec$$

$$45 \to 60\ sec$$

$$1 \to t\ \ sec$$

$$t\ sec = \frac{60}{45} = 1.33\ sec$$

For Infeed and Outfeed Conveyor:

$$0.20 = \frac{1}{2}\ at^2$$

$$0.40 = a(3.54)^2$$

$$a = \frac{0.40}{12.57} = 0.031 \;\; m^2/sec$$

$$F_x = m_1 * a$$

$$F_y = m_1 * g + \frac{1}{2} m_2 * g$$

$$1.33\ sec \to 0.15m$$

$$t\ sec \to 0.4m$$

$$t\ sec = \frac{0.4 * 1.33}{0.15} = 3.54\ sec$$

Where

F_x: Force on the x − axis.
F_y: Force on the y − axis.
a : acceleration of the belt.
m_1: mass of the object.
m_2: mass of the roller.

For Checkweigher:

F_x= 5 * 0.084 = 0.42 N

$F_y = 5 * 9.81 + \frac{1}{2} * 0.5 * 9.81$ =51.5 N.

For Infeed and Outfeed Conveyor:

F_x= 5 * 0.031 = 0.1589 N

$F_y = 5 * 9.81 + \frac{1}{2} * 0.5 * 9.81$ =51.5 N.

Step 2: Now we find the resultant radial load (F_r)

For Checkweigher:

$$F_r = \sqrt{{F_x}^2 + {F_y}^2} = \sqrt{(0.42)^2 + (51.5)^2}$$

$F_r = 51.5$ N.

$$\theta = \tan^{-1}\frac{F_Y}{F_X} = \tan^{-1}\frac{51.5}{0.42} = 89.53°$$

For Infeed and Outfeed Conveyor:

$$F_r = \sqrt{{F_x}^2 + {F_y}^2} = \sqrt{(0.1589)^2 + (51.5)^2}$$

$F_r = 51.5$ N.

$$\theta = \tan^{-1}(\frac{F_Y}{F_X}) = \tan^{-1}(\frac{51.5}{0.1589}) = 89.82°$$

Where F_r: Force resaltant.

Specifying FD

The design load can be defined by:

$F_D = a_f * V * Fr$ ……………. Equation (5.2)

Where: a_f is application factor (Table 5-1), used because loads are often variable (non-steady) and may increase during operation.

V rotation factor, takes into account whether the inner or outer race rotates ring outer rotating 1.2 ring inner rotating 0.1V usually the inner race of the bearing rotate (i.e., V=1).[8]

V = 1 (rotating inner ring).

a_f= 1 (machinery with no impact).

$F_D = 1 * 1 * 51.5 = 51.5$ N. **Are the same for Checkweigher, Infeed and Outfeed Conveyor.**

Step 3: Assuming the desired life (L_D) and Reliability (R_D), we find X_D

$X_D = \frac{L_{Dh}}{L_{10}}$ ……………Equation (5.3)

$L_{Dh} = L_{Dh} * N * 60$

$\ddot{\theta} = \frac{a}{r}$

Where: $\ddot{\theta}$: angular accelaration of the pully.

r: radious of the pully.

X_D: Life ratio.

L_D: Desired life (revolutions).

L_{10}: Rating life (revolutions) =1 million rev.

L_{Dh} =30000 (general industrial machinery). (Table 5-2)

N: speed motor.

$0.15\text{m} \rightarrow 0.05\text{m}$

$x \text{ rev} \rightarrow 1 \text{ rev}$

$x \text{ rev} = \frac{0.15}{0.05} = 3$

$= 3 \text{ rev/m}$

$0.05\text{m} \rightarrow 0.01\text{m}$

$y \text{ rev} \rightarrow 1 \text{ rev}$

$y \text{ rev} = \frac{0.05}{0.01} = 5$

$x_{rev} * y_{rev} = 3*5$

= 15 turn of motor per piece.

For Checkweigher:

Length of the conveyor = 0.15 m.

Diameter of the roller = 0.05 m.

Diameter of the rod = 0.01 m.

$$\ddot{\theta} = \frac{0.084}{0.01} = 8.4 \text{ m/s}$$

$$\text{N} = 15 \frac{\text{rev}}{\text{m}} * \frac{1\text{m}}{1.33 \text{ sec}} * \frac{60 \text{ sec}}{1 \text{ min}} = 676.67 \text{ rpm}$$

$$L_{Dh} = 30000 * 676.67 * 60 = 1218.006 * 10^6$$

$$X_D = \frac{1218.006*10^6}{1 * 10^6} = 1218.006\text{Hp}$$

For Infeed and Outfeed Conveyor:

Length of the conveyor = 0.40 m.

Diameter of the roller = 0.05 m.

Diameter of the rod = 0.01 m.

$$\ddot{\theta} = \frac{0.031}{0.01} = 3.1 \text{ m/s}$$

$$\text{N} = 40 \frac{\text{rev}}{\text{m}} * \frac{1\text{m}}{3.54 \text{ sec}} * \frac{60 \text{ sec}}{1 \text{ min}} = 685.7 \text{ rpm}$$

$$L_{Dh} = 30000 * 685.7 * 60 = 1234.28 * 10^6$$

$$X_D = \frac{1234.28*10^6}{1 * 10^6} = 1234.28\text{h}$$

$0.40\text{m} \rightarrow 0.05\text{m}$

xrev → 1 rev

$$\text{x rev} = \frac{0.40}{0.05} = 8$$
$$= 3 \text{ rev/m}$$

$0.05\text{m} \rightarrow 0.01\text{m}$

yrev → 1 rev

$$\text{y rev} = \frac{0.05}{0.01} = 5$$

x rev * y rev=8*5=40 turn of motor per piece

Step 4: Calculate the required catalog rating:

$C_{10} = X_D^{1/a} * F_D$ Where $C_{10:}$ is Catalog rating. a = 3 (ball bearing)

$$a = \begin{cases} 3 & \textit{for ball bearing} \\ 3.33 & \textit{for roller bearing} \end{cases}$$

For Checkweigher:

C_{10} =$(1218.006)^{1/3} * 51.5 = 549.99\text{N} \rightarrow 0.54999$ KN

For Infeed and Outfeed Conveyor:

C_{10} =$(1234.28)^{1/3} * 51.5 = 552.43\text{N} \rightarrow 0.55243\text{KN}$

Step 5: Check the catalog and select a suitable bearing from (Table 5-3)

For Checkweigher:

C10 =0.54999 KN, Bore=10 mm, OD = 30 mm.

For Infeed and Outfeed Conveyor:

C10 =0.55243 KN, Bore=10 mm, OD = 30 mm.

Figure 5.1: Angular Contact Ball Bearing

5.2 Calculating the Torque of the Conveyor

$$T = J_e\ddot{\theta} + F_r.r \quad \ldots\ldots\ldots\ldots\ldots \text{ Equation (5.4)}$$

Where J_e: is equivalent moment inertia.
T: Torque.

5.2.1 Calculate the total moment inertia of checkweigher conveyor

- $J_{Bearing} = \frac{\pi}{2}(r_{out} - r_{inner})^4$ .... Equation (5.5)

Where $\mathrm{r_{out}}$: is outradious.

r_{inner}: $is\ innerradious.$

For checkweigher:	For Infeed and Outfeed Conveyor:
$J_{Bearing} = \frac{\pi}{2}(0.028 - 0.01)^4$ $= 1.6489 * 10^{-7}\ Kg/m^2$	$J_{Bearing} = \frac{\pi}{2}(0.028 - 0.01)^4$ $= 1.6489 * 10^{-7}\ Kg/m^2$

- $J_{object} = V^2 * m$ .... Equation (5.6)

Where V: is velocity of conveyor.

For Checkweigher:	For Infeed and Outfeed Conveyor:
$45\ object \rightarrow 60\ sec.$ $X\ object \rightarrow 60\ sec.$ $X = \frac{45 * 60}{60}$ $= 45\ object/s$ $v = \frac{0.15}{1.33} = 0.1127\ m/s$	$45\ object \rightarrow 60\ sec.$ $X\ object \rightarrow 60\ sec.$ $X = \frac{45 * 60}{60}$ $= 45\ object/s$ $v = \frac{0.40}{3.5} = 0.1142\ m/s$
$J_{object} = 0.1127^2 * 55$ $= 0.0635\ Kg/m^2$	$J_{object} = 0.1142^2 * 5$ $= 0.0653\ Kg/m^2$

- $J_{Belt} = \frac{V*m_3}{w}$ …………… Equation (5.7)

$Where\ m_3: is\ mass of the Belt.$
$w: angular velocity.$

For Checkweigher:	For Infeed and Outfeed Conveyor:
$w = \frac{2\pi N}{60}$ $w = \frac{2\pi * 676.67}{60}$ $= 70.8\ s^{-1}$	$w = \frac{2\pi N}{60}$ $w = \frac{2\pi * 685.7}{60}$ $= 71.8\ s^{-1}$
$J_{Belt} = \frac{0.1127 * 0.4}{70.8}$ $= 6.367 * 10^{-4}\ Kg/m^2$	$J_{Belt} = \frac{0.1142\ * 0.4}{71.81}$ $= 6.36211 * 10^{-4}\ Kg/m^2$

- $J_{roller} = \frac{1}{4} m_4 r^2 + \frac{1}{3} m_4 l^2$ …………… Equation (5.8)

Where $m_4: is\ mass of the roller.$
$l: length of the roller.$

For checkweigher:	For Infeed and Outfeed Conveyor:
$J_{roller} = \frac{1}{4} *\ 0.5 * (0.025)^2 + \frac{1}{3} * 0. * 0.14^2$ $= 3.344 * 10^{-3}\ Kg/m^2$	$J_{roller} = \frac{1}{4} *\ 0.5 * (0.025)^2 + \frac{1}{3} * 0.5 * 0.14^2$ $= 3.344 * 10^{-3}\ Kg/m^2$

For Checkweigher:

$J_e = 2 * J_{roller} + 4 * J_{Bearing} + J_{object} + J_{Belt}$ …………… Equation (5.9)

$J_e = (2 * 3.344 * 10^{-3}) + (4 * 1.6489 * 10^{-7}) + (0.0635) + (6.367 * 10^{-4})$

$= 0.0708\, Kg/m^2$

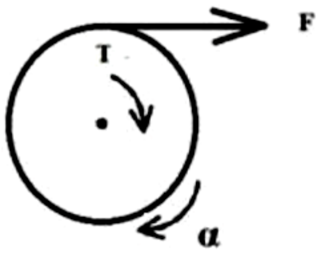


Figure 5.2: Free body Diagram of Cylinder

$\mathrm{T = J_e \ddot{\theta} + F_r . r}$ …………… Equation (5.10)

$= 0.0708 * 8.4 + 51.5 * 0.01 = 1.109\ \mathrm{N.m}$

For Infeed and Outfeed Conveyor:

$J_e = J_{pully} + 2 * J_{roller} + 4 * J_{Bearing} + J_{object} + J_{Belt}$

$J_e = (1.5707 * 10^{-8}) + (2 * 3.344 * 10^{-3}) + (4 * 1.6489 * 10^{-7})$

$+(0.0653) + (6.36211 * 10^{-4})$.

$= 0.07262\, Kg/m^2$

$J_{e(total)} = J_e * 2$

$J_{e(total)} = 0.07262 * 2 = 0.1452\, Kg/m^2$

$\mathrm{T = J_{e(total)} \ddot{\theta} + F_r . r}$

$= 0.1452 * 3.1 + 51.5 * 0.01 = 0.9652\ \mathrm{N.m}$

5.3 Calculating the Power of the Motor

$$P_{out} = w.T \quad \ldots\ldots\ldots\ldots\ldots \text{ Equation (5.11)}$$

$$H_p = \frac{P_{out}}{746} \quad \ldots\ldots\ldots\ldots\ldots \text{ Equation (5.12)}$$

$$H_{p(safty\ factor)} = \alpha * H_p$$

Where H_p: $is\ hourse\ power.$

α: $isasaftyfactor\ equal$ 1.13

For Checkweigher:	**For Infeed and Outfeed Conveyor:**
$p_{out} = 70.8 * 1.109 = 78.58$ Watt.	$p_{out} = 71.81 * 0.9652 = 69.31$Watt.
$H_p = \frac{78.58}{746} = 0.105 H_p$	$H_p = \frac{69.31}{746} = 0.0929 H_p$
$H_{p(safty\ factor)} = 1.13 * 0.105$	$H_{p(safty\ factor)} = 1.13 * 0.0929$
$= 0.119 H_p$	$= 0.104\ H_p$

After we make a calculation, we choose a motor 0.18 HP, 1500 rpm, 3-phase as shown in figure

Figure 5.3: Electrical Motor

5.4 Final Design Machine

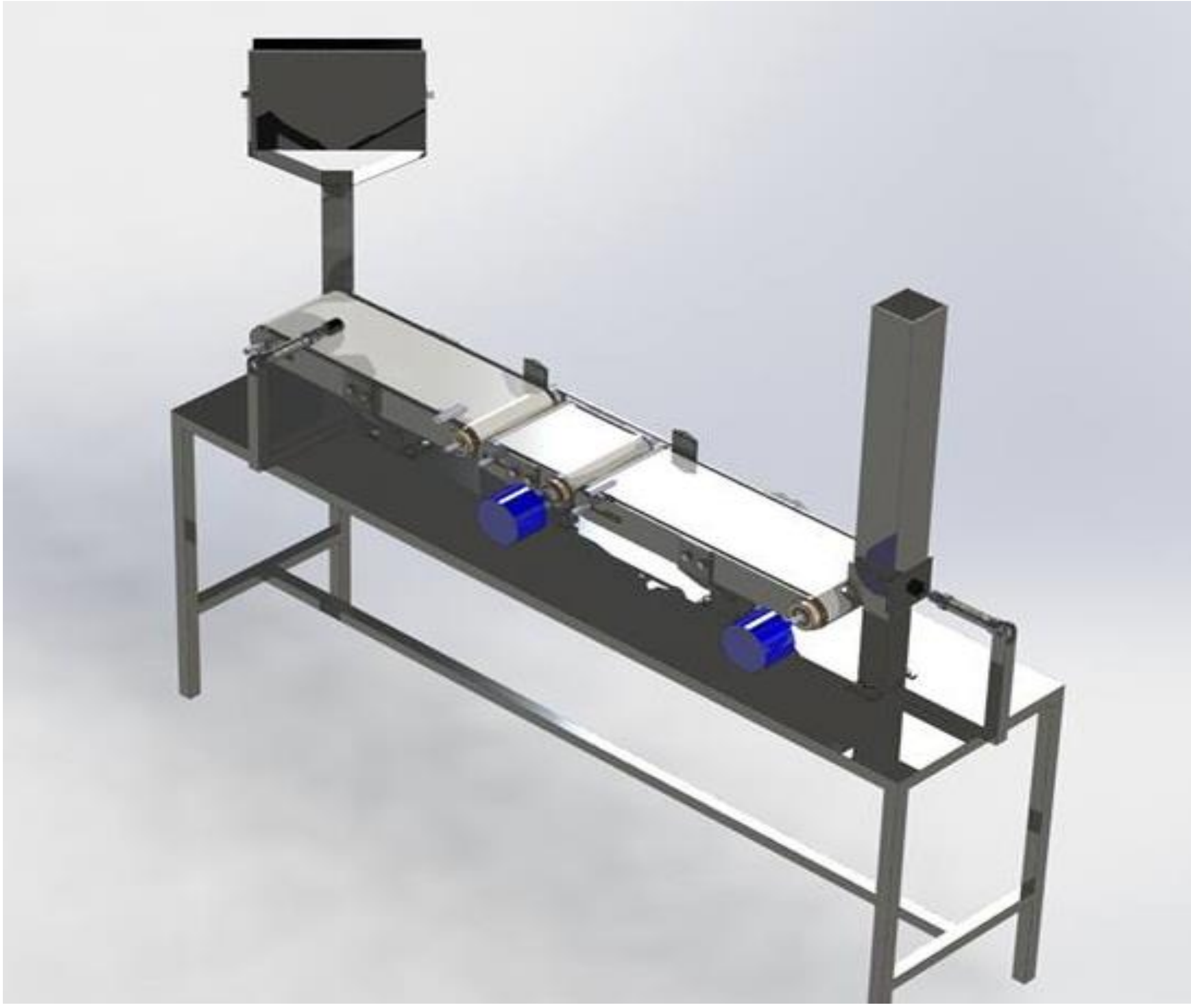


Figure 5.4: Final Design Machine

6

Chapter Six

Testing and Evaluating

6.1 Introduction

6.2 Experimental Result

6.3 Recommendations

6.4 Future Work

6.5 Project Cost

6.1 Introduction

This chapter provides experimental result and some recommendations from the work learned from this project. In this chapter we are listing some goals hope to be accomplished or at least under attention.

6.2 Experimental Result

We made some experiments on parts of our project and these are some of results:

1. By interring the object to the infeed conveyer by push object by the pneumatic piston and translate the object to the checkweigher.
2. When the object passing on the checkweigher loaded on the load cell, the load cell reads its weight and sends this read to the PLC, then the PLC display the weight of the object on the HMI.
3. Then the PLC compare the read if it's equal the specified weight or not, if the reads value equal the specified weight the PLC send command to reject object to the right side otherwise send command to reject object to the left side .

6.3 Recommendations

1. The load cell should be put in isolated region so is not affected for noising.
2. The load cell is more sensitive so you should be more careful when installed it.
3. In this machine you should do the maintenance every 6 months to extend the life of the machine.

6.4 Future Work

The following tasks are suggested as future work:

1. The project can be improved for more accuracy and can it used for weighing very small weight and very large weight.
2. Improving the project for used in variable introduction line, not just in packaging machine.
3. Improving the project by using different type of reject better than the arm reject for more reliability.
4. Improving the project so that becomes more diagnostic.

6.5 Project Cost

Description	Price
PLC…………………………..	1200 ₪
PLC Module ……………....	850 ₪
PLC Power Supply ………	200 ₪
HMI ………………………	1450 ₪
USB Cable for PLC ………	100 ₪
Pneumatic Valve ………….	200 ₪
Electrical Works ………….	600 ₪
Mechanical Design ……….	800 ₪
Mechanical Works ………..	800 ₪
Motors ……………………	300 ₪
Load Cell …………………	200 ₪
Electrical Board …………..	400 ₪
Total Price	**7100 ₪**

Table 6.1: Project Cost

References

[1] http://www.cisco-eagle.com/catalog/c-3344-what-is-a-conveyor.aspx.

[2] Rice Lake, Wisconsin, USA 54868, LOAD CELL HANDBOOK A Comprehensive Guide to Load Cell Theory, Construction and Use.

[3] http://www.us.anritsu-industry.com/rejector-systems.aspx.

[4] http://whatis.techtarget.com/definition/human-machine-interface-HMI.

[5] http://www.baumer.com/us-en/products/presence-detection/magnetic-sensors/magnetic-cylinder-sensors.

[6] https://www.festo.com/wiki/en/Pneumatic_cylinders.

[7] http://www.loadstarsensors.com/what-is-a-load-cell.html.

[8] Mechanical Engineering Design, chapter11-bearings-yousef 9th edition.

Appendix A

Appendix B

Appendix C

Appendix D

Appendix E

Appendix F

Appendix G

Type of Application	Load Factor
Precision gearing	1.0–1.1
Commercial gearing	1.1–1.3
Applications with poor bearing seals	1.2
Machinery with no impact	1.0–1.2
Machinery with light impact	1.2–1.5
Machinery with moderate impact	1.5–3.0

Table 5-1:
Application factor, a_f

Domestic appliances	1000–2000
Aircraft engines	1000–4000
Automotive	1500–5000
Agricultural equipment	3000–6000
Elevators, industrial fans, multipurpose gearing	8000–15 000
Electric motors, industrial blowers, general industrial machines	20 000–30 000
Pumps and compressors	40 000–60 000
Critical equipment in continuous, 24-h operation	100 000–200 000

Source: Eugene A. Avallone and Theodore Baumeister III, eds., *Marks' Standard Handbook for Mechanical Engineers*, 9th ed. New York: McGraw-Hill, 1986.

Table 5-2:
Recommended design life for bearings

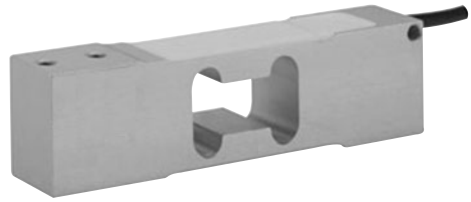
Bore, mm	OD, mm	Width, mm	Fillet Radius, mm	Shoulder Diameter, mm d_S	d_H	Load Ratings, kN Deep Groove C_{10}	C_0	Angular Contact C_{10}	C_0
10	30	9	0.6	12.5	27	5.07	2.24	4.94	2.12
12	32	10	0.6	14.5	28	6.89	3.10	7.02	3.05
15	35	11	0.6	17.5	31	7.80	3.55	8.06	3.65
17	40	12	0.6	19.5	34	9.56	4.50	9.95	4.75
20	47	14	1.0	25	41	12.7	6.20	13.3	6.55
25	52	15	1.0	30	47	14.0	6.95	14.8	7.65
30	62	16	1.0	35	55	19.5	10.0	20.3	11.0
35	72	17	1.0	41	65	25.5	13.7	27.0	15.0
40	80	18	1.0	46	72	30.7	16.6	31.9	18.6
45	85	19	1.0	52	77	33.2	18.6	35.8	21.2
50	90	20	1.0	56	82	35.1	19.6	37.7	22.8
55	100	21	1.5	63	90	43.6	25.0	46.2	28.5
60	110	22	1.5	70	99	47.5	28.0	55.9	35.5
65	120	23	1.5	74	109	55.9	34.0	63.7	41.5
70	125	24	1.5	79	114	61.8	37.5	68.9	45.5
75	130	25	1.5	86	119	66.3	40.5	71.5	49.0
80	140	26	2.0	93	127	70.2	45.0	80.6	55.0
85	150	28	2.0	99	136	83.2	53.0	90.4	63.0
90	160	30	2.0	104	146	95.6	62.0	106	73.5
95	170	32	2.0	110	156	108	69.5	121	85.0

Table 5-3:
Dimension and load rating for single-row 0.2-series
deep-groove and angular-contact ball bearing.

Low Profile Aluminum Load Cell

FEATURES

- Capacities 1–200 kg
- Aluminum construction
- Single-point 400 x 400 mm platform
- OIML R60 and NTEP approved
- IP66 protection
- Available with metric and UNC threads
- **Optional**
  - ATEX, FM, and IECEx approvals available
  - High stiffness version available for dynamic weighing applications



APPLICATIONS

- Bench scales
- Counting scales
- Grocery scales

DESCRIPTION

Model 1042 is a low profile single-point load cell designed for direct mounting in weighing platforms.

Its small physical size, combined with high accuracy and low cost, makes this load cell ideally suited for retail, bench and counting scales.

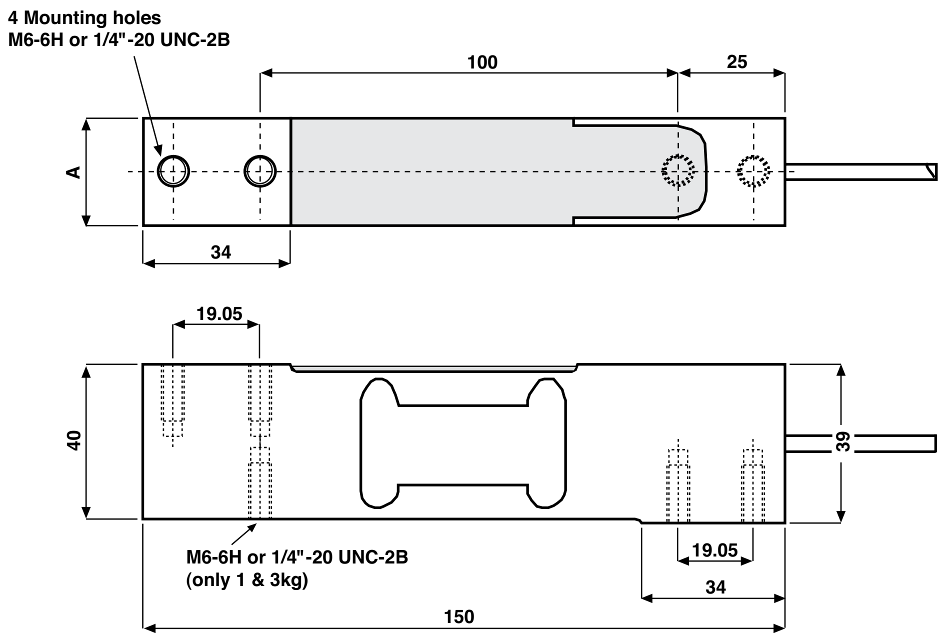
Capacities of 5 kg and above are supplied as standard in anodized aluminum. This high accuracy load cell is approved to NTEP and other stringent approval standards, including OIML R60.

A humidity resistant protective coating assures long-term stability over the entire compensated temperature range.

The two additional sense wires feed back the voltage reaching the load cell. Complete compensation of changes in lead resistance due to temperature change and/or cable extenstion, is achieved by feeding this voltage into the appropriate electronics.

OUTLINE DIMENSIONS in millimeters

Capacity, kg	A
1–30	20
50–200	25.4



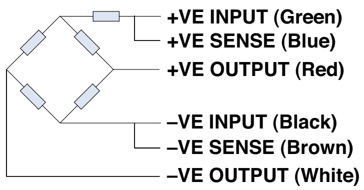
VPG Transducers
Celtron • Revere • Sensortronics • Tedea-Huntleigh

Low Profile Aluminum Load Cell

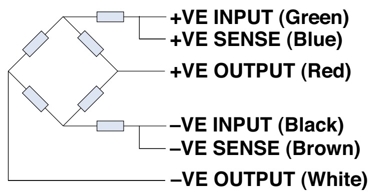
SPECIFICATIONS					
PARAMETER	**VALUE**				**UNIT**
Rated capacity—R.C. (E_{max})	1[1], 3, 5, 7, 10, 15, 20, 30, 50, 75, 100, 150[1], 200[1]				kg
NTEP/OIML accuracy class	NTEP	Non-Approved	C3[2]	C6[3]	
Maximum no. of intervals (n)	5000 single	1000	3000	6000[4]	
Y = E_{max}/V_{min}	10000	1400	6000	10000	Maximum available 20000
Rated output—R.O.	2.0				mV/V
Rated output tolerance	0.2				±mV/V
Zero balance	0.2				±mV/V
Zero return, 30 min.	0.0100	0.0500	0.0170	0.0083	±% of applied load
Total error (per OIML R60)	0.0200	0.0300	0.0200	0.0100	±% of rated output
Temperature effect on zero	0.0014	0.0100	0.0023	0.0014	±% of rated output/°C
Temperature effect on output	0.0010	0.0030	0.0010	0.00058	±% of applied load/°C
Eccentric loading error	0.0042	0.0074	0.0049	0.0024	±% of rated load/cm
Temp. range, compensated	–10 to +40				°C
Temp. range, safe	–30 to +70				°C
Maximum safe central overload	150				% of R.C.
Ultimate central overload	300				% of R.C.
Excitation, recommended	10				VDC or VAC RMS
Excitation, maximum	15				VDC or VAC RMS
Input impedance	415±20				Ω
Output impedance	350±3				Ω
Insulation resistance	>2000				MΩ
Cable length	1[5]				m
Cable type	6 wire, PVC, single floating screen				Standard
Construction	Plated (anodize) aluminum				
Environmental protection	IP66				
Platform size (max)	400 x 400				mm
Recommended torque	Up to 30 kg: 7.0 35 kg and above: 10.0				N*m

[1] 1 kg and 200 kg not approved by OIML; 150 and 200 kg are not approved by NTEP.
[2] 50% utilization.
[3] 60% utilization.
[4] 6000 divisions from 20 kg to 100 kg.
[5] Options: 4-wire cable; different cable lengths; side cable entry.
All specifications subject to change without notice.

WIRING SCHEMATIC DIAGRAM
(Unbalanced bridge configuration)



WIRING SCHEMATIC DIAGRAM
(Balanced bridge configuration)



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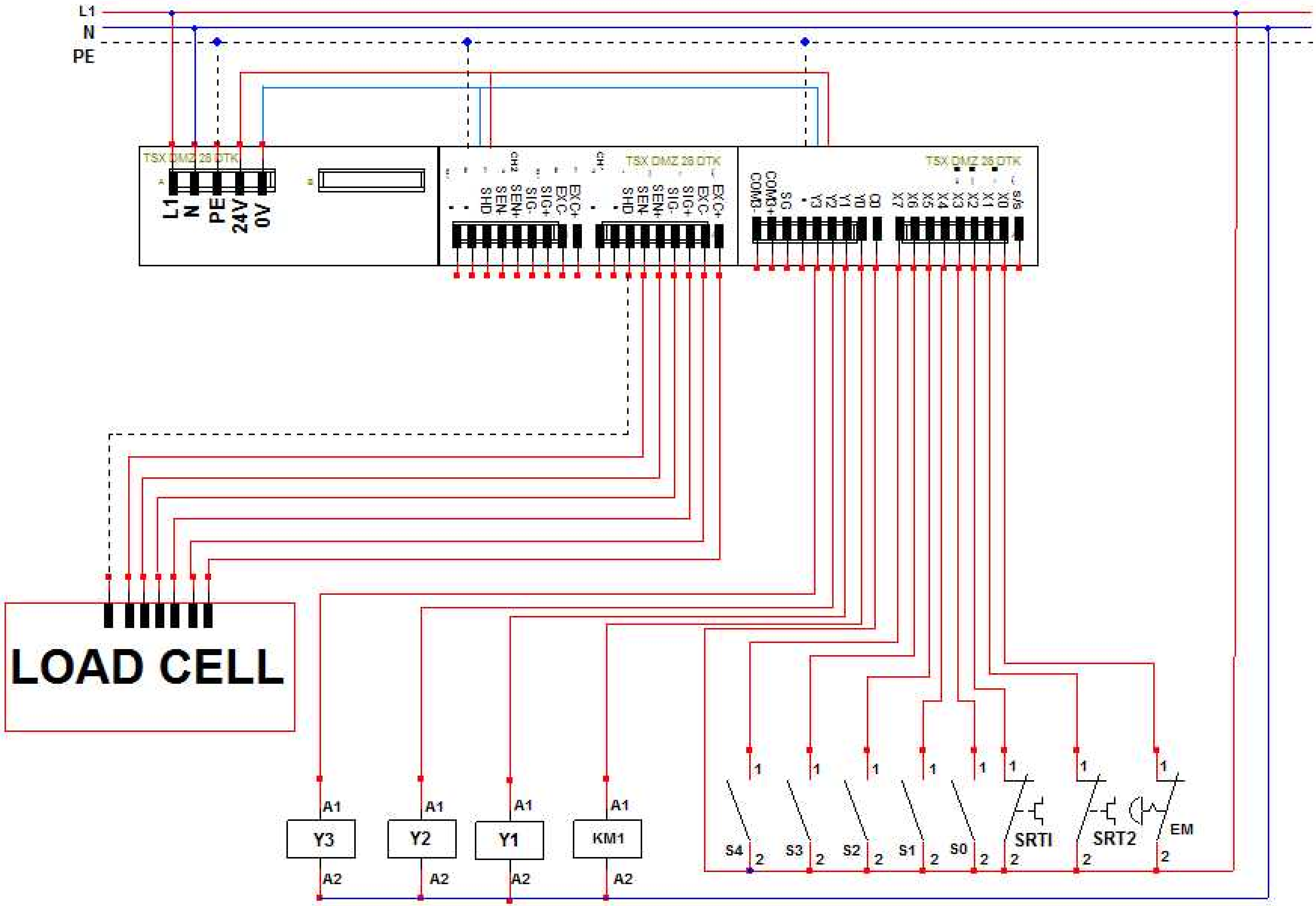
4.3 Control Circuit



DATALOGIC

SENSORS

S50/S51

Extended range of standard "One for All" photoelectric tubular M18 sensors

- All optic functions and LASER models
- M18 flat plastic with universal mounting
- Available in M18 metal housing
- Axial or radial optics, cable or connector
- Standard 4-wire NO-NC NPN or PNP output

APPLICATIONS

-Processing and Packaging machinery
-Conveyor lines, material handling
-Ceramics intralogistics
-Automated warehousing

c UL us LISTED (*)

(*) Axial models.
ATEX II 3DG

S50/S51		
Through beam		0...20 m 0...60 m (class 1 LASER) (S50)
Retroreflective (on R2 reflector)		0,1...4 m
Polarized retroreflective		0,1...4 m (S50) 0,1...3 m (S51) 0,1...16 m (class 1 LASER) (S50)
Retroreflective for transparent (on R2 reflector)		0,1...1,3 m (S50)
Diffuse proximity		short distance 0...100 mm medium distance 0...400 mm (S50) 0...450 mm (S51) long distance 0...700 mm long distance LASER 0...350 mm
Fixed focus		100 mm (S50)
Background suppression		50...100 mm (S50)
Through beam with fiber optic		0...100 mm (S50)
Diffuse proximity with fiber optic		0...30 mm (S50)
Contrast sensor		10 ±2 mm
Luminescence sensor		0...20 mm
Power supply	Vdc	10...30 V
	Vac	
	Vac/dc	
Output	PNP	▪
	NPN	▪
	NPN/PNP	
	relay	
	other	
Connection	cable	▪
	connector	▪
	pig-tail	
Approximate dimensions (mm)		M18x 55/68
Housing material		PBT, nickel plated brass
Mechanical protection		IP67

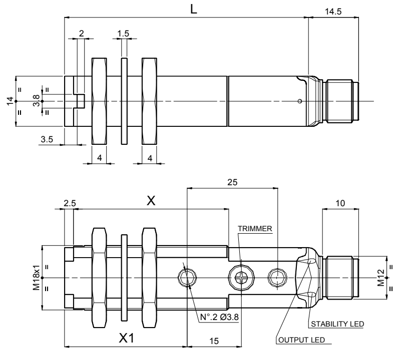
TECHNICAL DATA	
Power supply	10 ... 30 Vdc (limit values)
Ripple	2 Vpp max.
Consumption (output current excluded)	35 mA max. (mod. S50...A00/B01/C01/C10/C21/D00/E01/T01) 30 mA max. (mod. S50...F01/M03, S51...A00/B01/C01/C10/C20/F00) 25 mA max. (mod. S50...W03/U03)
Light emission	red LED 630 nm (mod. S50...D00/E01, S50-PA/MA...M03) red LED 660 nm (mod. S50...B01/T01, S51...B01) red LED 670 nm (mod. S50-PS/MS...M03) IR LED 880 nm (mod. S50/51...A00/C01/C10/C20/C21/G00) white LED 400-700 nm (mod. S50...W03) UV LED 370 nm (mod. S50...U03) red Laser 650 nm (mod. S50...G00/F01/B01/C01)
Setting	sensivity trimmer (mod. B01/C01/C21/E01/F01/T01) teach-in push-button (mod. M03/W03/U03)
Operating mode	LIGHT mode on N.O. output / DARK mode on N.C. output (mod.S50...C01/C10/C21/D00/M03/U03) DARK mode on N.O. output / LIGHT mode on N.C. output (mod.S50...A00/B01/E01/F01/T01/W03) white wire or pin 2 connected to +10...30V LIGHT mode/ to 0V DARK mode (mod. S51) white wire or pin 2 not connected LIGHT mode (mod. S51...C01/C10/C20)/ DARK mode (mod. S51...A00/B01/F00)
Indicators	yellow OUTPUT LED (S50, S51, excl. mod. G00) green STABILITY LED (mod. S50...B01/C01/C21/E01/F01), POWER LED (mod. S50...G00, S51) green/red READY/ERROR LED (mod. S50...M03/W03/U03)
Output	PNP or NPN; NO; NC (mod. S50)
Output current	100 mA max.
Saturation voltage	2 V max.
Response time	0,5 ms (mod. S50...A00/B01/T01/C10/C21/C01/D00/E01/U03) 2 ms (mod. S50...F01/G00) 1 ms (mod. S50...M03, S51...A00/B01/C01/C10/G00) 4 ms (mod. S51...F00) 100 μs (mod. S50...W03) 333 μs (Laser mod. S50)
Switching frequency	1 kHz (mod. S50...A00/B01/T01/C10/C21/C01/D00/E01/U03) 250 Hz (mod. S50...F01/G00) 500 Hz (mod. S50...M03, S51...A00/B01/C01/C10/G00) 120 Hz (mod. S51...F00) 5 kHz (mod. S50...W03) 1,5 kHz (Laser mod. S50)
Connection	2 m cable Ø 4 mm, M12 4-pole connector
Dielectric strength	500 Vac, 1 min between electronics and housing
Insulating resistance	>20 MΩ, 500 Vdc between electronics and housing
Electrical protection	class 2
Mechanical protection	IP67
Ambient light rejection	according to EN 60947-5-2
Vibrations	0,5 mm amplitude, 10 ... 55 Hz frequency, for every axis (EN60068-2-6)
Shock resistance	11 ms (30 G) 6 shock for every axis (EN60068-2-27)
Housing material	Plastic version PBT Metal version nickel plated brass
Lens material	PMMA
Operating temperature	-25 ... 55 °C (Laser mod.) -10 ... 50 °C
Storage temperature	-25 ... 70 °C
Weight	Plastic version 75 g max. cable vers. (90 g max. mod. M03), 25 g max. conn. vers. (40 g max. mod. M03) Metal version 110 g max. cable vers. (125 g max. mod. M03), 60 g max. conn. vers. (75 g max. mod. M03)

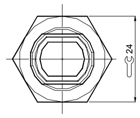
S50

DIMENSIONS

PLASTIC

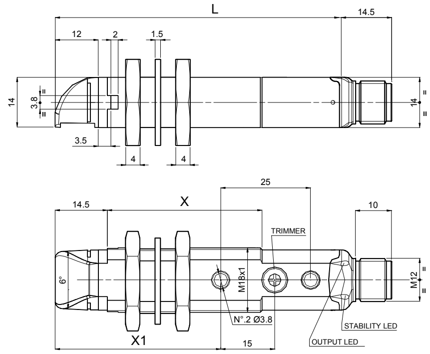
AXIAL VERSION

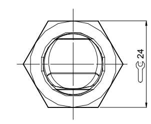




	MODELS	
	with trimmer	without trimmer
L	67	57
X	43	42
X1	34	24

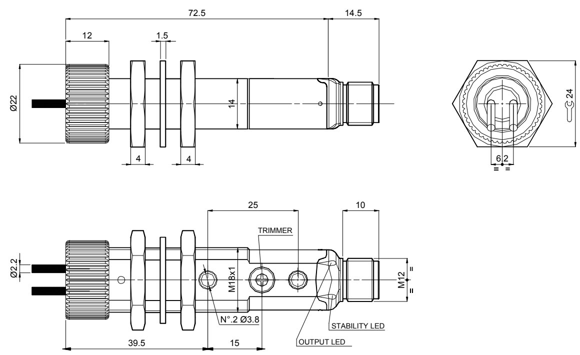
RADIAL VERSION





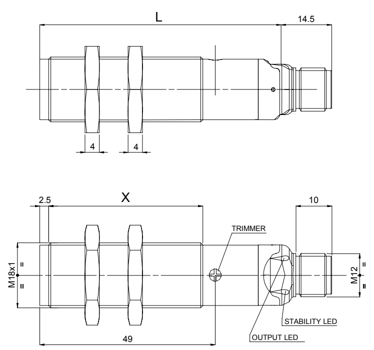
	MODELS	
	with trimmer	without trimmer
L	79	69
X	43	42
X1	46	36

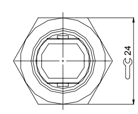
FIBRE OPTIC VERSION



METAL

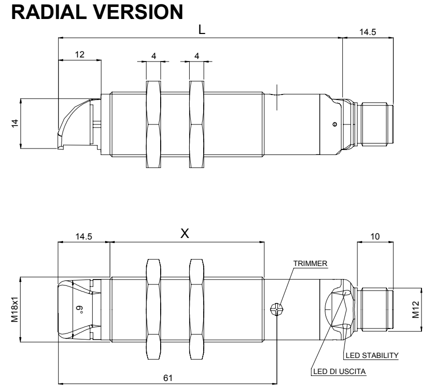
AXIAL VERSION

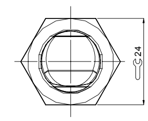




	MODELS	
	with trimmer	without trimmer
L	67	57
X	43	38

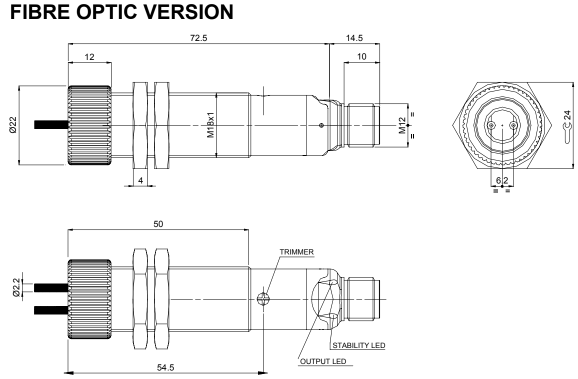
RADIAL VERSION





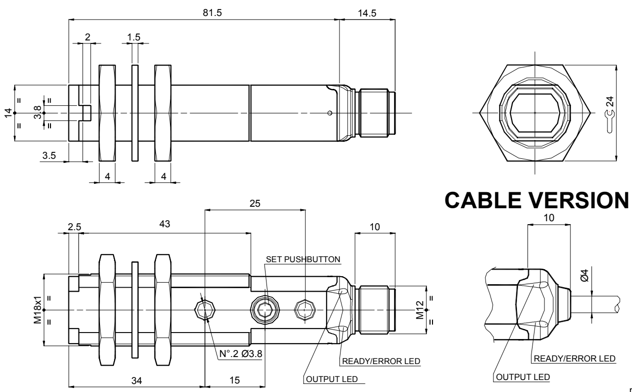
	MODELS	
	with trimmer	without trimmer
L	79	69
X	43	38

FIBRE OPTIC VERSION

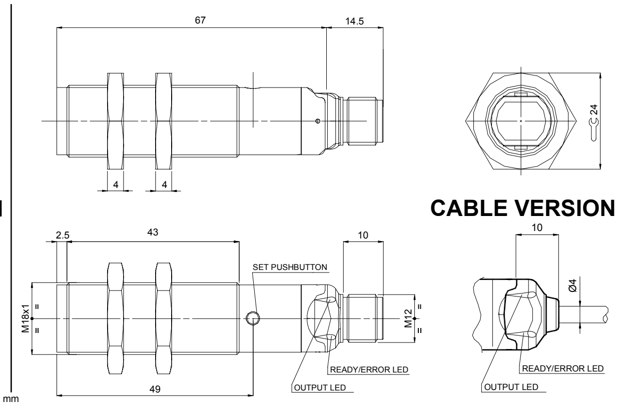


BACKGROUND SUPPRESSION AXIAL VERSION

PLASTIC

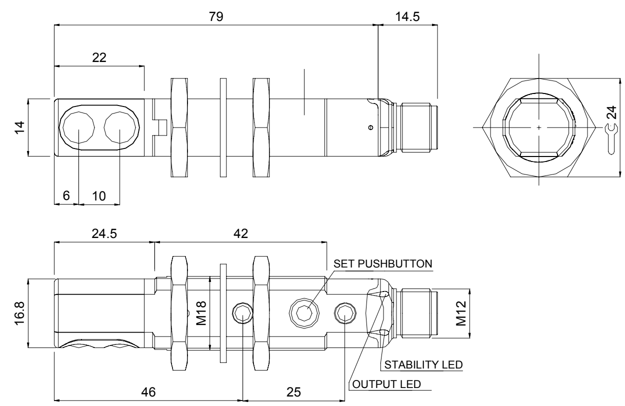


METAL

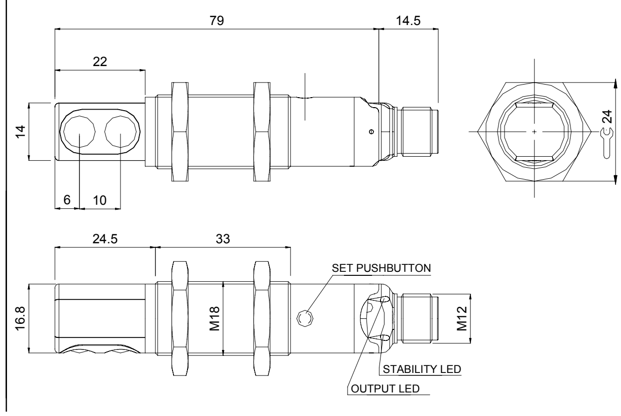


BACKGROUND SUPPRESSION RADIAL VERSION

PLASTIC

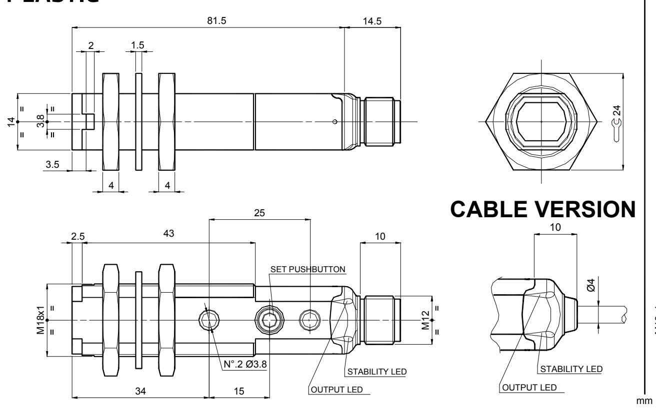


METAL

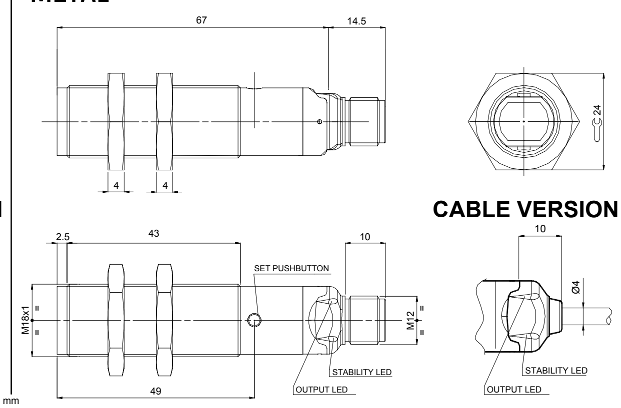


LUMINESCENCE AND CONTRAST

PLASTIC



METAL



CONNECTIONS

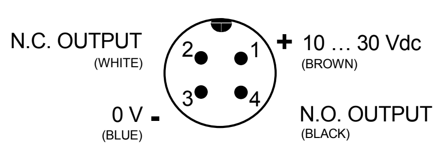
CABLE

BROWN	1	+ 10 … 30 Vdc
WHITE	2	N.C. OUTPUT
BLACK	4	N.O. OUTPUT
BLUE	3	– 0 V

Through beam emitter

BROWN	1	+ 10 … 30 Vdc
WHITE	2	TEST +
BLACK	4	TEST / NOT USED (Laser version)
BLUE	3	– 0 V

M12 CONNECTOR

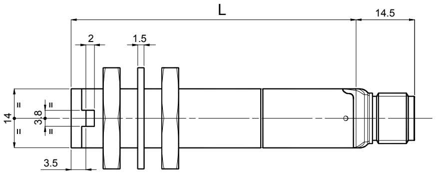


S51

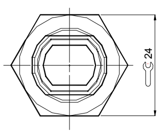
DIMENSIONS

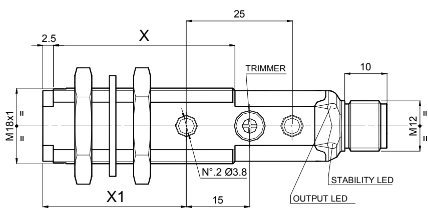
PLASTIC

AXIAL VERSION

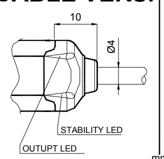


	MODELS	
	with trimmer	without trimmer
L	67	57
X	43	42
X1	34	24

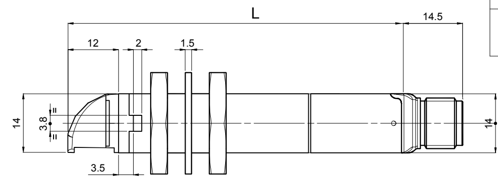




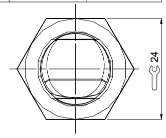
CABLE VERS.

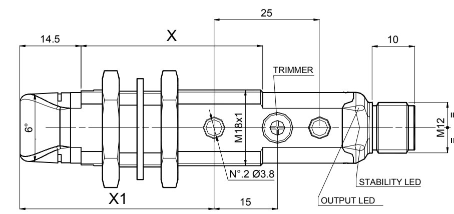


RADIAL VERSION

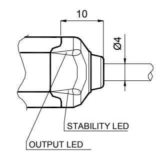


	MODELS	
	with trimmer	without trimmer
L	79	69
X	43	42
X1	46	36



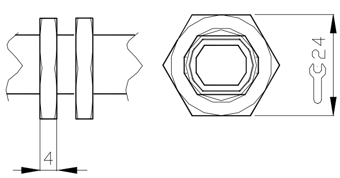


CABLE VERS.

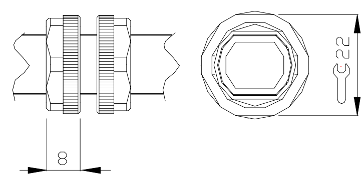


mm

CH.24 PLASTIC NUTS

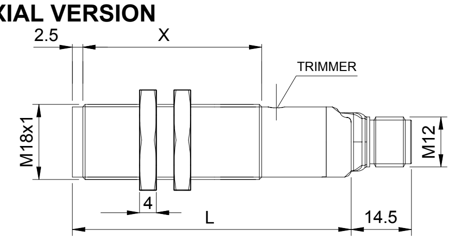


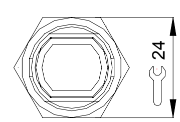
CH.22 PLASTIC NUTS



METAL

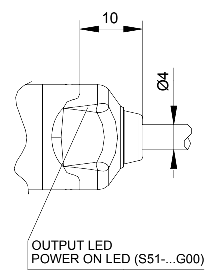
AXIAL VERSION



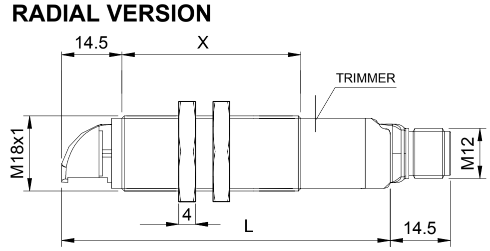


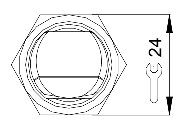
	MODELS	
	B01/C01/F00	A00/C10/G00
L	67	57
X	43	38

CABLE VERSION



RADIAL VERSION



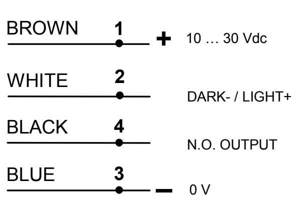


	MODELS	
	B01/C01/F00	A00/C10/G00
L	79	69
X	43	38

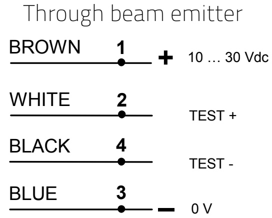
mm

CONNECTIONS

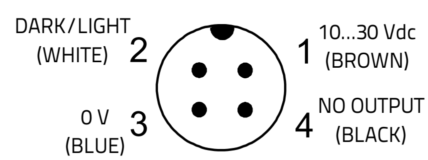
CABLE



Through beam emitter



M12 CONNECTOR

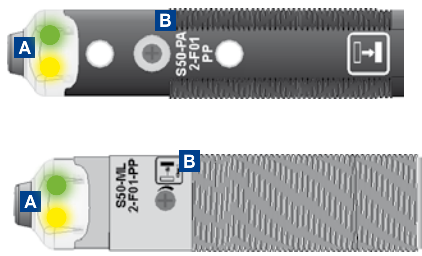


S50/S51

INDICATORS AND SETTINGS

S50-XX...A00/B01/C01/C21/E01/F01/T01

S51-XX...B01/C01

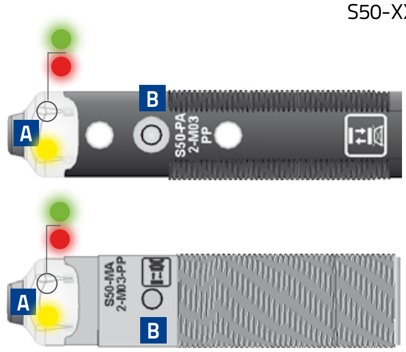


A OUTPUT status LED Yellow
STABILITY LED Green (Only Receiver)
POWER ON LED Green (Only Emitter)

B Adjustment trimmer (receiver)

Single-turn trimmer for sensitivity adjustment. Rotate in a clockwise direction to increase the operating distance.

S50-XX-M03/W03/U03



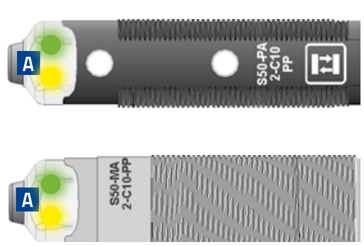
A OUTPUT status LED Yellow
READY LED Green
ERROR LED Red

B Teach-in push-button

Teach-in button for setting.
EASYtouch™ provides two setting modes: standard or fine, both obtained by pressing the push-button only once.
Please refer to instructions manual for operating details.

S50-XX-C10

S51-XX-A00/C10/C20/F00/G00



A00/C10/C20/F00

A OUTPUT status LED Yellow
STABILITY LED green

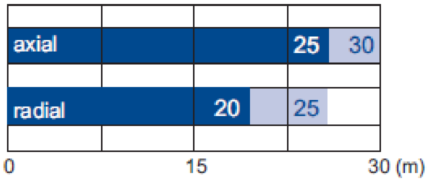
G00

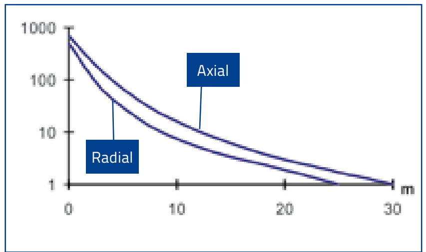
OUTPUT status LED yellow (Only Emitter G00)

Tubular Sensors - S50/S51

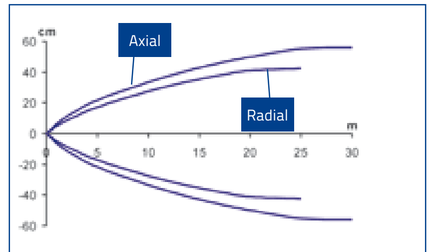
S50 DETECTION DIAGRAMS

G/F INFRARED EMISSION





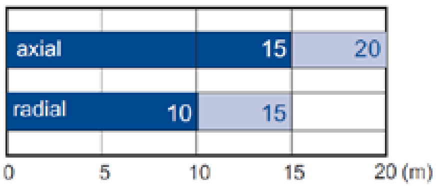
Excess gain

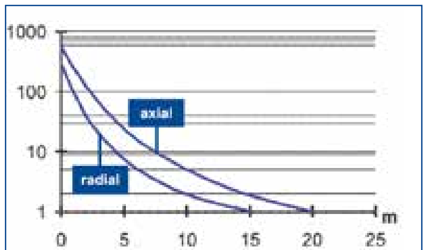


Detection area

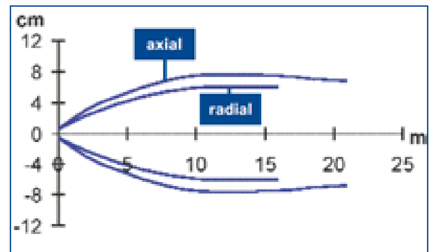
Recommended operating distance

Maximum operating distance





Excess gain

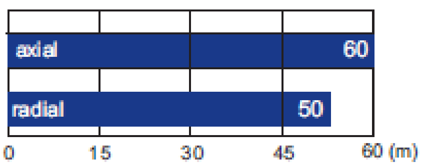


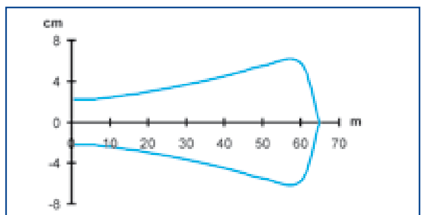
Detection area

Recommended operating distance

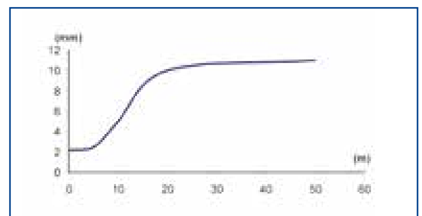
Maximum operating distance

G/F LASER RED EMISSION



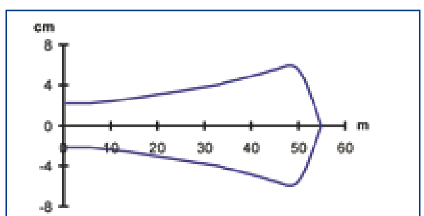


Detection area - axial

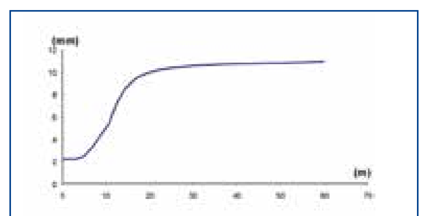


Resolution - axial

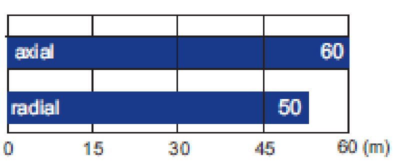
Operating distance

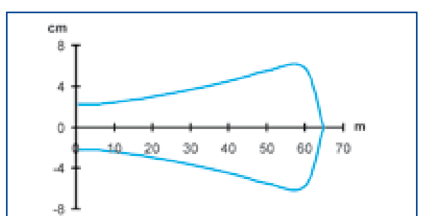


Detection area - radial

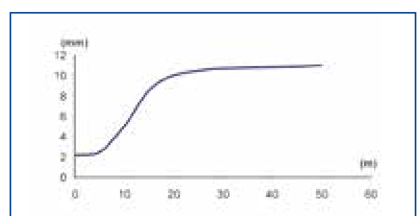


Resolution - radial



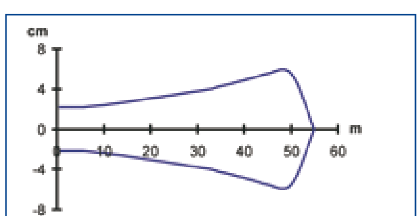


Detection area - axial

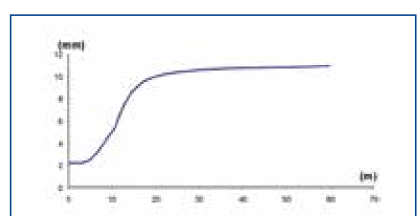


Resolution - axial

Operating distance

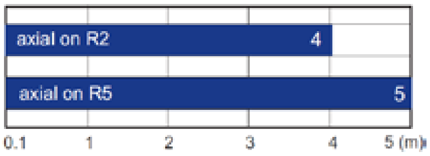


Detection area - radial

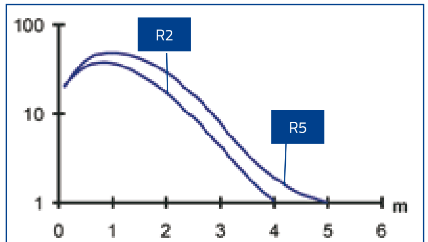


Resolution - radial

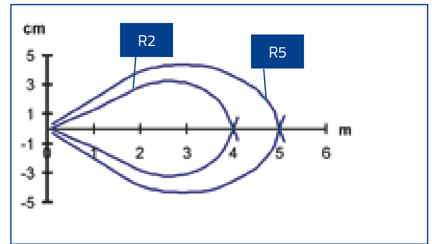
A INFRARED EMISSION



Operating distance

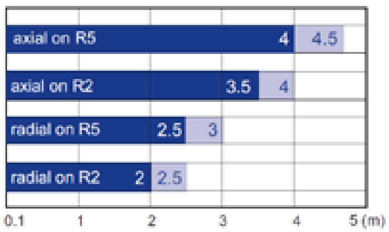


Excess gain



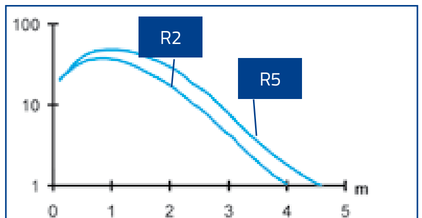
Detection area

B RED EMISSION

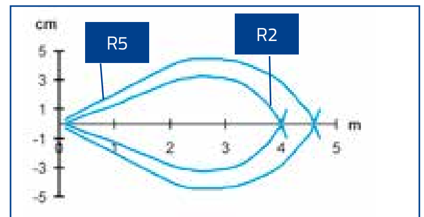


Recommended operating distance
Maximum operating distance

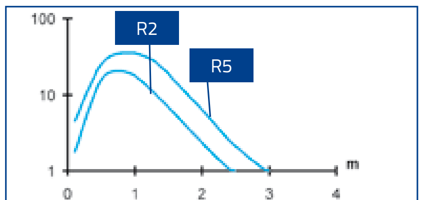
High efficiency reflectors can be used to obtain larger operating distances.
Refer to **Reflectors** (A.01).



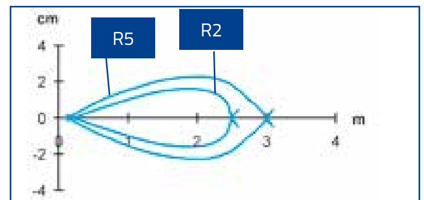
Excess gain - axial



Detection area - axial

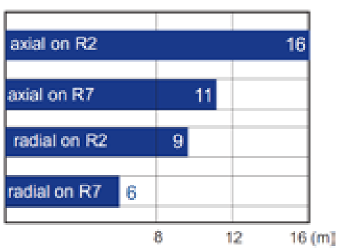


Excess gain - radial



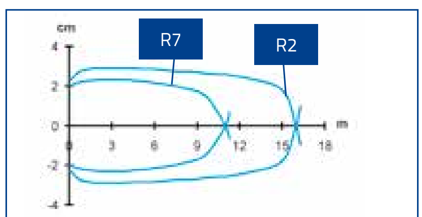
Detection area - radial

B LASER RED EMISSION

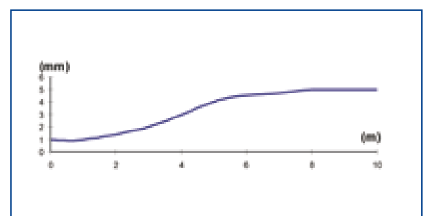


Operating distance

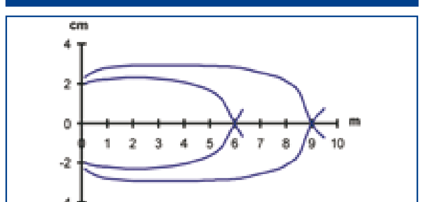
High efficiency reflectors can be used to obtain larger operating distances.
Refer to **Reflectors** (A.01).



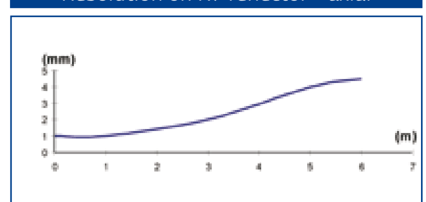
Detection area - axial



Resolution on R7 reflector - axial

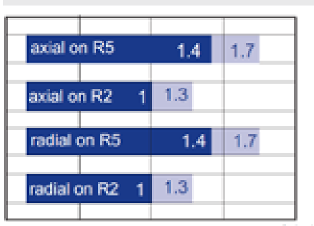


Detection area - radial

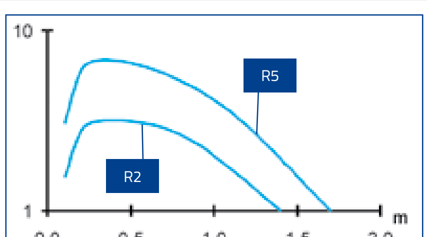


Resolution on R7 reflector - radial

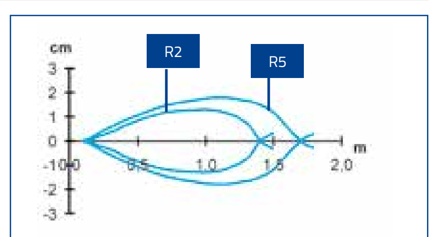
T RED EMISSION



Recommended operating distance
Maximum operating distance



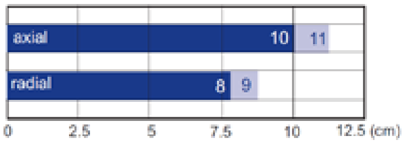
Excess gain



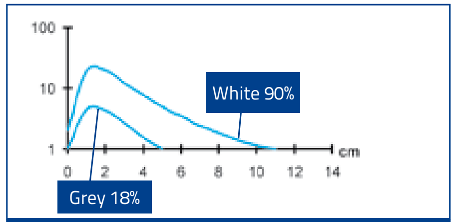
Detection area

High efficiency reflectors can be used to obtain larger operating distances.Refer to **Reflectors**.

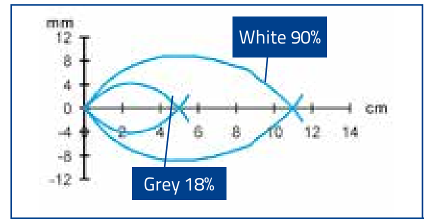
C SHORT INFRARED EMISSION



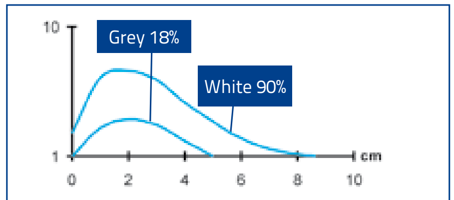
Recommended operating distance
Maximum operating distance



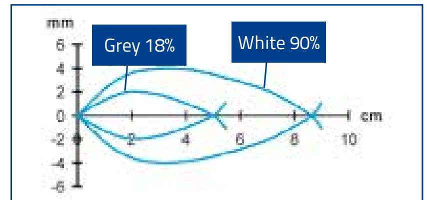
Excess gain - axial



Detection area - axial

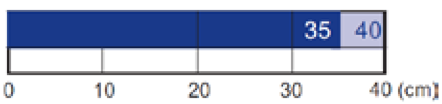


Excess gain - radial

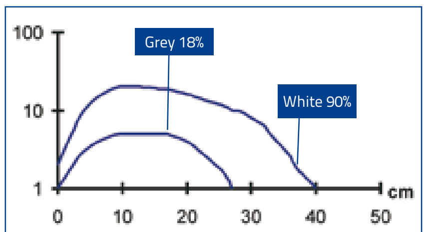


Detection area - radial

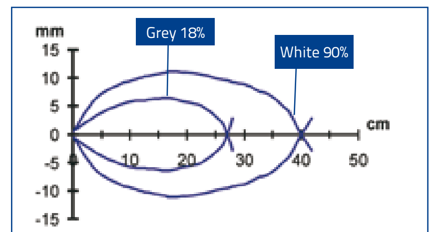
C MID INFRARED EMISSION



Recommended operating distance
Maximum operating distance

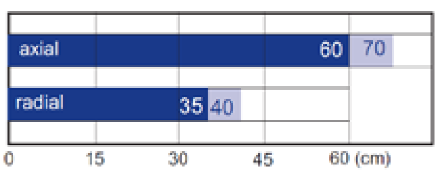


Excess gain

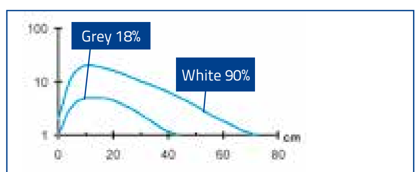


Detection area

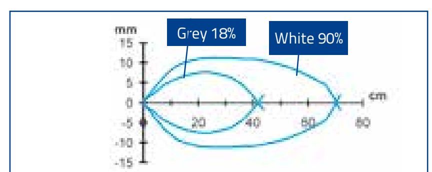
C LONG INFRARED EMISSION



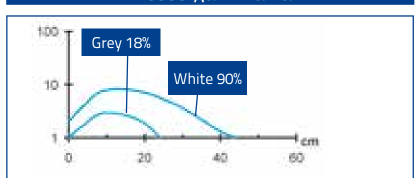
Recommended operating distance
Maximum operating distance



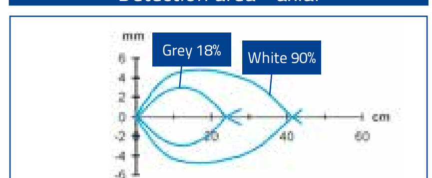
Excess gain - axial



Detection area - axial

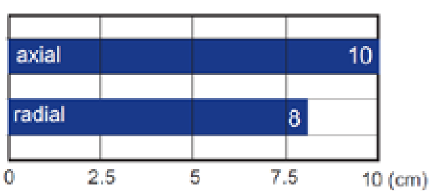


Excess gain - radial

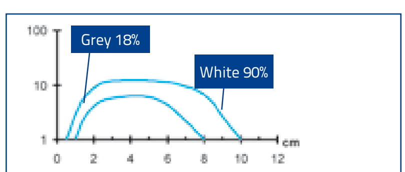


Detection area - radial

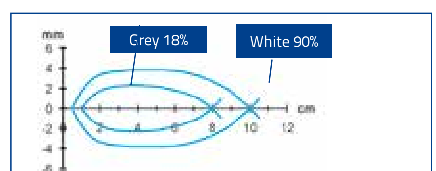
D RED EMISSION



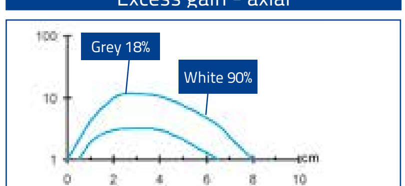
Operating distance



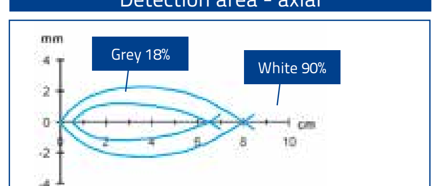
Excess gain - axial



Detection area - axial



Excess gain - radial

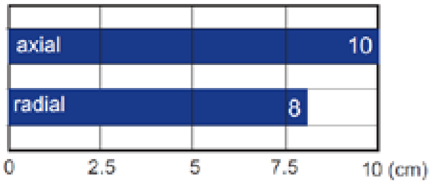


Detection area - radial

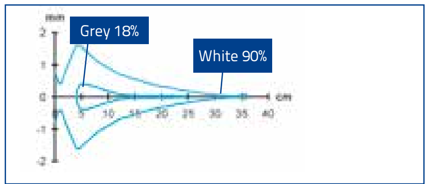
Tubular Sensors - S50/S51

DATALOGIC

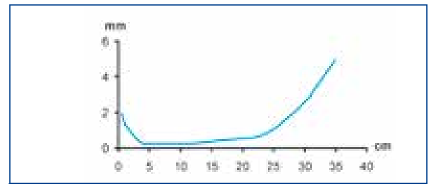
C LASER RED EMISSION



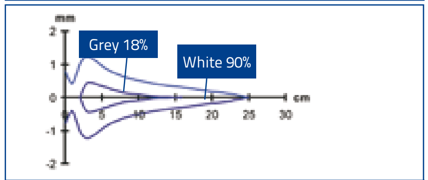
Operating distance



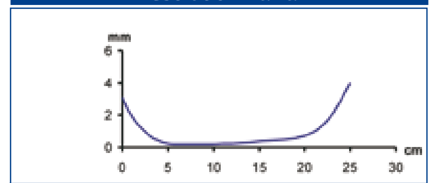
Detection area - axial



Resolution - axial

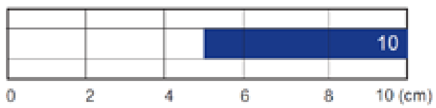


Detection area - radial

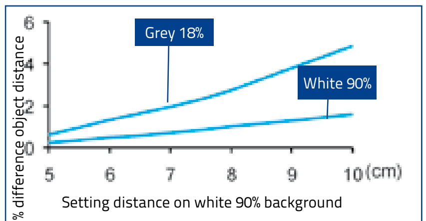


Resolution - radial

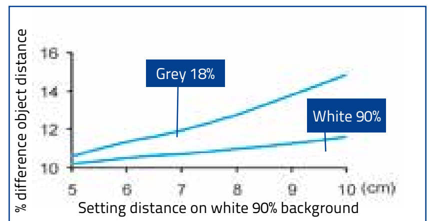
M AXIAL RED EMISSION



Operating distance

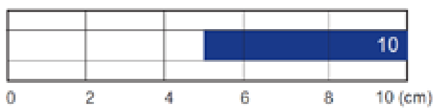


Detection difference with EASYtouch™ acquisition

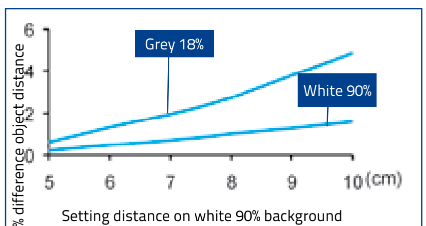


Detection difference with fine acquisition

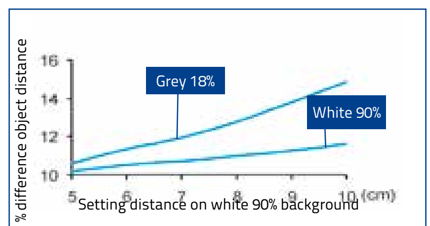
M RADIAL RED EMISSION



Operating distance

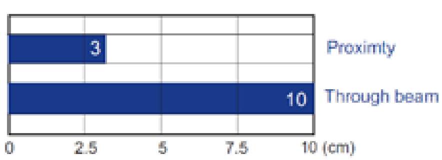


Detection difference with EASYtouch™ acquisition



Detection difference with fine acquisition

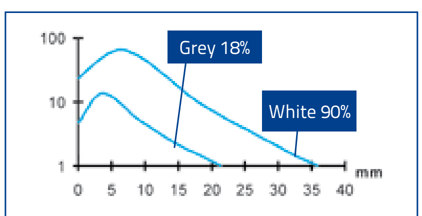
E RED EMISSION



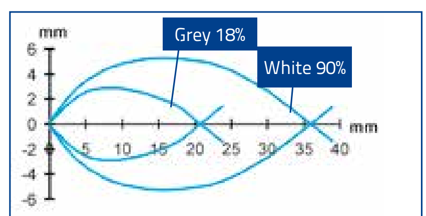
Operating distance with standard fibers

Standard Fiber-optics:
OF-42-ST-20 proximity
OF-43-ST-20 through beam

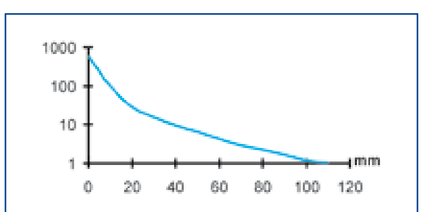
High efficiency fiber-optics or accessory lenses can be used to obtain larger operating distances.



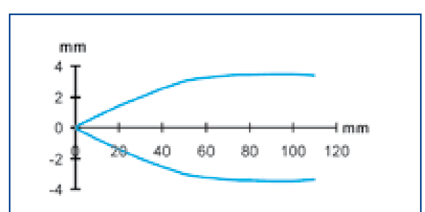
Excess gain - proximity *



Detection area - proximity *



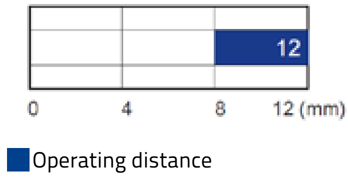
Excess gain - through beam *

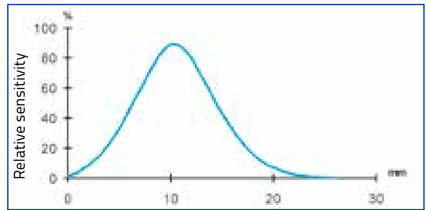


Detection area - through beam *

* standard Fiber-optics

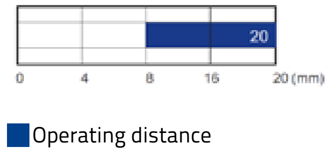
W WHITE EMISSION

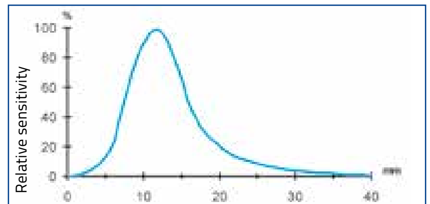




Operating distance

U UV EMISSION

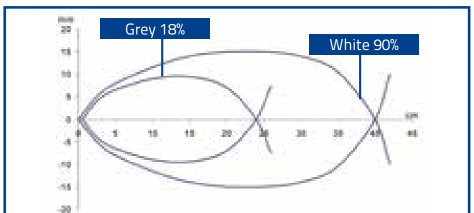




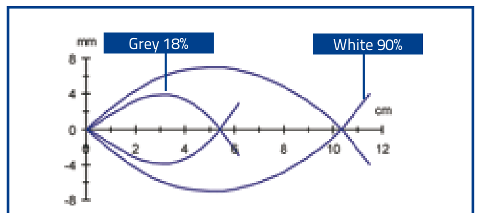
Operating distance

S51 DETECTION DIAGRAMS

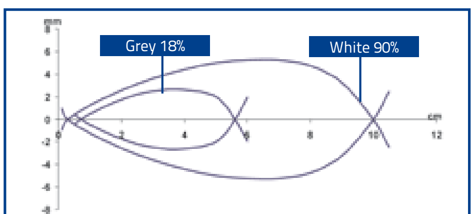
M18 STANDARD



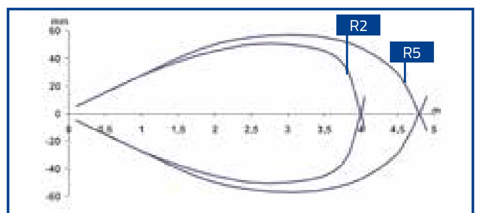
C01 - long diffuse proximity



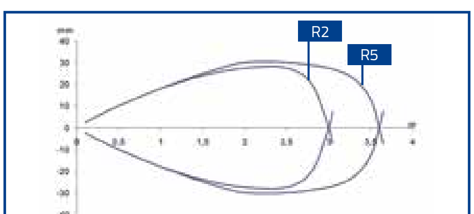
C10 - short diffuse proximity



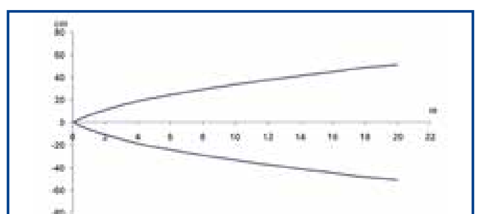
C20 - narrow beam proximity



A00 - retroreflective

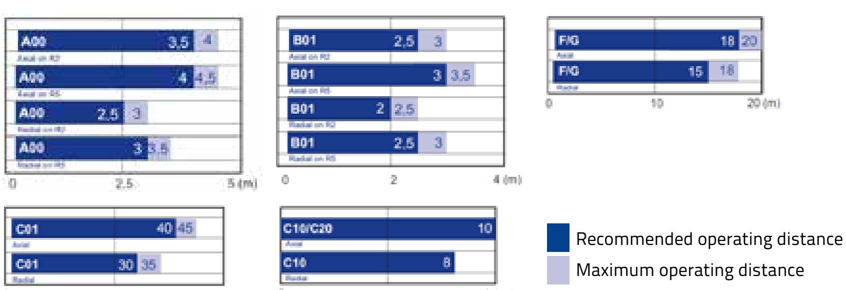


B01 - polarized retroreflective



F00/G00 - through beam

Note: the diagrams indicate the detection area typical of the axial optic versions; the maximum operating distance of the radial optic versions decreases as indicated in the tables given below



MODEL SELECTION AND ORDER INFORMATION

S50 PLASTIC MODELS					
OPTIC FUNCTION	EMISSION	CONNECTION	OUTPUT	MODEL	ORDER No.
Retroreflective	LED, Axial optic	2m Cable	NPN	S50-PA-2-A00-NN	952002090
			PNP	S50-PA-2-A00-PP	952002080
		M12 Connector	NPN	S50-PA-5-A00-NN	952002110
			PNP	S50-PA-5-A00-PP	952002100
Polarized retroreflective	LED, Axial optic	2m Cable	NPN	S50-PA-2-B01-NN	952001610
			PNP	S50-PA-2-B01-PP	952001010
		M12 Connector	NPN	S50-PA-5-B01-NN	952001500
			PNP	S50-PA-5-B01-PP	952001020
	LED, Radial optic	2m Cable	NPN	S50-PR-2-B01-NN	952001780
			PNP	S50-PR-2-B01-PP	952001030
		M12 Connector	NPN	S50-PR-5-B01-NN	952001720
			PNP	S50-PR-5-B01-PP	952001040
	LASER, Axial optic	2m Cable	NPN	S50-PL-2-B01-NN	952001870
			PNP	S50-PL-2-B01-PP	952001360
		M12 Connector	NPN	S50-PL-5-B01-NN	952001840
			PNP	S50-PL-5-B01-PP	952001370
	LASER, Radial optic	2m Cable	NPN	S50-PH-2-B01-NN	952001950
			PNP	S50-PH-2-B01-PP	952001940
		M12 Connector	NPN	S50-PH-5-B01-NN	952001970
			PNP	S50-PH-5-B01-PP	952001960
Long Diffuse proximity	LED, Axial optic	2m Cable	NPN	S50-PA-2-C01-NN	952001620
			PNP	S50-PA-2-C01-PP	952001050
		M12 Connector	NPN	S50-PA-5-C01-NN	952001510
			PNP	S50-PA-5-C01-PP	952001060
	LED, Radial optic	2m Cable	NPN	S50-PR-2-C01-NN	952001790
			PNP	S50-PR-2-C01-PP	952001070
		M12 Connector	NPN	S50-PR-5-C01-NN	952001730
			PNP	S50-PR-5-C01-PP	952001080
	LASER, Axial optic	2m Cable	NPN	S50-PL-2-C01-NN	952001880
			PNP	S50-PL-2-C01-PP	952001380
		M12 Connector	NPN	S50-PL-5-C01-NN	952001850
			PNP	S50-PL-5-C01-PP	952001390
	LASER, Radial optic	2m Cable	NPN	S50-PH-2-C01-NN	952001990
			PNP	S50-PH-2-C01-PP	952001980
		M12 Connector	NPN	S50-PH-5-C01-NN	952002010
			PNP	S50-PH-5-C01-PP	952002000
Short Diffuse proximity	LED, Axial optic	2m Cable	NPN	S50-PA-2-C10-NN	952001630
			PNP	S50-PA-2-C10-PP	952001240
		M12 Connector	NPN	S50-PA-5-C10-NN	952001520
			PNP	S50-PA-5-C10-PP	952001250
	LED, Radial optic	2m Cable	NPN	S50-PR-2-C10-NN	952001800
			PNP	S50-PR-2-C10-PP	952001490
		M12 Connector	NPN	S50-PR-5-C10-NN	952001740
			PNP	S50-PR-5-C10-PP	952001480
Medium Diffuse proximity	LED, Axial optic	2m Cable	NPN	S50-PA-2-C21-NN	952002170
			PNP	S50-PA-2-C21-PP	952002160
		M12 Connector	NPN	S50-PA-5-C21-NN	952002190
			PNP	S50-PA-5-C21-PP	952002180
Fixed focus	LED, Axial optic	2m Cable	NPN	S50-PA-2-D00-NN	952001640
			PNP	S50-PA-2-D00-PP	952001090
		M12 Connector	NPN	S50-PA-5-D00-NN	952001530
			PNP	S50-PA-5-D00-PP	952001100
	LED, Radial optic	2m Cable	NPN	S50-PR-2-D00-NN	952001810
			PNP	S50-PR-2-D00-PP	952001110
		M12 Connector	NPN	S50-PR-5-D00-NN	952001750
			PNP	S50-PR-5-D00-PP	952001120
Fiber optic	LED, Axial optic	2m Cable	NPN	S50-PA-2-E01-NN	952001650
			PNP	S50-PA-2-E01-PP	952001130
		M12 Connector	NPN	S50-PA-5-E01-NN	952001540
			PNP	S50-PA-5-E01-PP	952001140

Tubular Sensors - S50/S51

DATALOGIC

OPTIC FUNCTION	EMISSION	CONNECTION	OUTPUT	MODEL	ORDER No.
Through beam receiver	LED, Axial optic	2m Cable	NPN	S50-PA-2-F01-NN	952001660
			PNP	S50-PA-2-F01-PP	952001150
		M12 Connector	NPN	S50-PA-5-F01-NN	952001550
			PNP	S50-PA-5-F01-PP	952001160
	LED, Radial optic	2m Cable	NPN	S50-PR-2-F01-NN	952001820
			PNP	S50-PR-2-F01-PP	952001170
		M12 Connector	NPN	S50-PR-5-F01-NN	952001760
			PNP	S50-PR-5-F01-PP	952001180
	LASER, Axial optic	2m Cable	NPN	S50-PL-2-F01-NN	952001890
			PNP	S50-PL-2-F01-PP	952001400
		M12 Connector	NPN	S50-PL-5-F01-NN	952001860
			PNP	S50-PL-5-F01-PP	952001410
	LASER, Radial optic	2m Cable	NPN	S50-PH-2-F01-NN	952002030
			PNP	S50-PH-2-F01-PP	952002020
		M12 Connector	NPN	S50-PH-5-F01-NN	952002050
			PNP	S50-PH-5-F01-PP	952002040
Through beam emitter	LED, Axial optic	2m Cable	-	S50-PA-2-G00-XG	952001190
		M12 Connector	-	S50-PA-5-G00-XG	952001200
	LED, Radial optic	2m Cable	-	S50-PR-2-G00-XG	952001210
		M12 Connector	-	S50-PR-5-G00-XG	952001220
	LASER, Axial optic	2m Cable	-	S50-PL-2-G00-XG	952001420
		M12 Connector	-	S50-PL-5-G00-XG	952001430
	LASER, Radial optic	2m Cable	-	S50-PH-2-G00-XG	952002060
		M12 Connector	-	S50-PH-5-G00-XG	952002070
Background suppression	LED, Axial optic	2m Cable	NPN	S50-PA-2-M03-NN	952001670
			PNP	S50-PA-2-M03-PP	952001230
		M12 Connector	NPN	S50-PA-5-M03-NN	952001560
			PNP	S50-PA-5-M03-PP	952001000
	LED, Radial optic	2m Cable	NPN	S50-PS-2-M03-NN	952001900
			PNP	S50-PS-2-M03-PP	952001910
		M12 Connector	NPN	S50-PS-5-M03-NN	952001920
			PNP	S50-PS-5-M03-PP	952001930
Retroreflective for transparent	LED, Axial optic	2m Cable	NPN	S50-PA-2-T01-NN	952001690
			PNP	S50-PA-2-T01-PP	952001260
		M12 Connector	NPN	S50-PA-5-T01-NN	952001580
			PNP	S50-PA-5-T01-PP	952001270
	LED, Radial optic	2m Cable	NPN	S50-PR-2-T01-NN	952001830
			PNP	S50-PR-2-T01-PP	952001280
		M12 Connector	NPN	S50-PR-5-T01-NN	952001770
			PNP	S50-PR-5-T01-PP	952001290
Luminescence	LED, Axial optic	2m Cable	NPN	S50-PA-2-U03-NN	952001700
			PNP	S50-PA-2-U03-PP	952001300
		M12 Connector	NPN	S50-PA-5-U03-NN	952001590
			PNP	S50-PA-5-U03-PP	952001310
Contrast	LED, Axial optic	2m Cable	NPN	S50-PA-2-W03-NN	952001710
			PNP	S50-PA-2-W03-PP	952001320
		M12 Connector	NPN	S50-PA-5-W03-NN	952001600
			PNP	S50-PA-5-W03-PP	952001330

S50 METAL MODELS					
OPTIC FUNCTION	EMISSION	CONNECTION	OUTPUT	MODEL	ORDER No.
Retroreflective	LED, Axial optic	2m Cable	NPN	S50-MA-2-A00-NN	952022090
			PNP	S50-MA-2-A00-PP	952022080
		M12 Connector	NPN	S50-MA-5-A00-NN	952022110
			PNP	S50-MA-5-A00-PP	952022100
Polarized retroreflective	LED, Axial optic	2m Cable	NPN	S50-MA-2-B01-NN	952021500
			PNP	S50-MA-2-B01-PP	952021000
		M12 Connector	NPN	S50-MA-5-B01-NN	952021660
			PNP	S50-MA-5-B01-PP	952021200
	LED, Radial optic	2m Cable	NPN	S50-MR-2-B01-NN	952021600
			PNP	S50-MR-2-B01-PP	952021140
		M12 Connector	NPN	S50-MR-5-B01-NN	952021760
			PNP	S50-MR-5-B01-PP	952021340
	LASER, Axial optic	2m Cable	NPN	S50-ML-2-B01-NN	952021820
			PNP	S50-ML-2-B01-PP	952021400
		M12 Connector	NPN	S50-ML-5-B01-NN	952021850
			PNP	S50-ML-5-B01-PP	952021440
	LASER, Radial optic	2m Cable	NPN	S50-MH-2-B01-NN	952021950
			PNP	S50-MH-2-B01-PP	952021940
		M12 Connector	NPN	S50-MH-5-B01-NN	952021970
			PNP	S50-MH-5-B01-PP	952021960
Long Diffuse proximity	LED, Axial optic	2m Cable	NPN	S50-MA-2-C01-NN	952021510
			PNP	S50-MA-2-C01-PP	952021010
		M12 Connector	NPN	S50-MA-5-C01-NN	952021670
			PNP	S50-MA-5-C01-PP	952021210
	LED, Radial optic	2m Cable	NPN	S50-MR-2-C01-NN	952021610
			PNP	S50-MR-2-C01-PP	952021150
		M12 Connector	NPN	S50-MR-5-C01-NN	952021770
			PNP	S50-MR-5-C01-PP	952021350
	LASER, Axial optic	2m Cable	NPN	S50-ML-2-C01-NN	952021830
			PNP	S50-ML-2-C01-PP	952021410
		M12 Connector	NPN	S50-ML-5-C01-NN	952021860
			PNP	S50-ML-5-C01-PP	952021450
	LASER, Radial optic	2m Cable	NPN	S50-MH-2-C01-NN	952021990
			PNP	S50-MH-2-C01-PP	952021980
		M12 Connector	NPN	S50-MH-5-C01-NN	952022010
			PNP	S50-MH-5-C01-PP	952022000
Short Diffuse proximity	LED, Axial optic	2m Cable	NPN	S50-MA-2-C10-NN	952021520
			PNP	S50-MA-2-C10-PP	952021020
		M12 Connector	NPN	S50-MA-5-C10-NN	952021680
			PNP	S50-MA-5-C10-PP	952021220
	LED, Radial optic	2m Cable	NPN	S50-MR-2-C10-NN	952021620
			PNP	S50-MR-2-C10-PP	952021490
		M12 Connector	NPN	S50-MR-5-C10-NN	952021780
			PNP	S50-MR-5-C10-PP	952021480
Medium Diffuse proximity	LED, Axial optic	2m Cable	NPN	S50-MA-2-C21-NN	952022130
			PNP	S50-MA-2-C21-PP	952022120
		M12 Connector	NPN	S50-MA-5-C21-NN	952022150
			PNP	S50-MA-5-C21-PP	952022140
Fixed focus	LED, Axial optic	2m Cable	NPN	S50-MA-2-D00-NN	952021530
			PNP	S50-MA-2-D00-PP	952021030
		M12 Connector	NPN	S50-MA-5-D00-NN	952021690
			PNP	S50-MA-5-D00-PP	952021230
	LED, Radial optic	2m Cable	NPN	S50-MR-2-D00-NN	952021630
			PNP	S50-MR-2-D00-PP	952021160
		M12 Connector	NPN	S50-MR-5-D00-NN	952021790
			PNP	S50-MR-5-D00-PP	952021360

Tubular Sensors - S50/S51

OPTIC FUNCTION	EMISSION	CONNECTION	OUTPUT	MODEL	ORDER No.
Fiber optic	LED, Axial optic	2m Cable	NPN	S50-MA-2-E01-NN	952021880
			PNP	S50-MA-2-E01-PP	952021040
		M12 Connector	NPN	S50-MA-5-E01-NN	952021890
			PNP	S50-MA-5-E01-PP	952021240
Through beam receiver	LED, Axial optic	2m Cable	NPN	S50-MA-2-F01-NN	952021540
			PNP	S50-MA-2-F01-PP	952021050
		M12 Connector	NPN	S50-MA-5-F01-NN	952021700
			PNP	S50-MA-5-F01-PP	952021250
	LED, Radial optic	2m Cable	NPN	S50-MR-2-F01-NN	952021640
			PNP	S50-MR-2-F01-PP	952021170
		M12 Connector	NPN	S50-MR-5-F01-NN	952021800
			PNP	S50-MR-5-F01-PP	952021370
	LASER, Axial optic	2m Cable	NPN	S50-ML-2-F01-NN	952021840
			PNP	S50-ML-2-F01-PP	952021420
		M12 Connector	NPN	S50-ML-5-F01-NN	952021870
			PNP	S50-ML-5-F01-PP	952021460
	LASER, Radial optic	2m Cable	NPN	S50-MH-2-F01-NN	952022030
			PNP	S50-MH-2-F01-PP	952022020
		M12 Connector	NPN	S50-MH-5-F01-NN	952022050
			PNP	S50-MH-5-F01-PP	952022040
Through beam emitter	LED, Axial optic	2m Cable	-	S50-MA-2-G00-XG	952021060
		M12 Connector	-	S50-MA-5-G00-XG	952021260
	LED, Radial optic	2m Cable	-	S50-MR-2-G00-XG	952021180
		M12 Connector	-	S50-MR-5-G00-XG	952021380
	LASER, Axial optic	2m Cable	-	S50-ML-2-G00-XG	952021430
		M12 Connector	-	S50-ML-5-G00-XG	952021470
	LASER, Radial optic	2m Cable	-	S50-MH-2-G00-XG	952022060
		M12 Connector	-	S50-MH-5-G00-XG	952022070
Background suppression	LED, Axial optic	2m Cable	NPN	S50-MA-2-M03-NN	952021550
			PNP	S50-MA-2-M03-PP	952021070
		M12 Connector	PNP	S50-MA-5-M03-PP	952021270
	LED, Radial optic	2m Cable	PNP	S50-MS-2-M03-PP	952021910
		M12 Connector	PNP	S50-MS-5-M03-PP	952021930
Retroreflective for transparent	LED, Axial optic	2m Cable	NPN	S50-MA-2-T01-NN	952021570
			PNP	S50-MA-2-T01-PP	952021090
		M12 Connector	NPN	S50-MA-5-T01-NN	952021730
			PNP	S50-MA-5-T01-PP	952021290
	LED, Radial optic	2m Cable	NPN	S50-MR-2-T01-NN	952021650
			PNP	S50-MR-2-T01-PP	952021190
		M12 Connector	NPN	S50-MR-5-T01-NN	952021810
			PNP	S50-MR-5-T01-PP	952021390
Luminescence	LED, Axial optic	M12 Connector	PNP	S50-MA-5-U03-PP	952021300
Contrast	LED, Axial optic	2m Cable	PNP	S50-MA-2-W03-PP	952021110
		M12 Connector	NPN	S50-MA-5-W03-NN	952021750
			PNP	S50-MA-5-W03-PP	952021310

S51 MODELS

OPTIC FUNCTION	HOUSING/OPTIC	CONNECTION	OUTPUT	MODEL	ORDER No.
Retroreflective	Nickel Plated Brass, Axial	2m Cable	NPN	S51-MA-2-A00-NK	952701601
			PNP	S51-MA-2-A00-PK	952701541
		M12 Connector	NPN	S51-MA-5-A00-NK	952701801
			PNP	S51-MA-5-A00-PK	952701531
	Nickel Plated Brass, Radial	2m Cable	NPN	S51-MR-2-A00-NK	952701711
			PNP	S51-MR-2-A00-PK	952701651
		M12 Connector	NPN	S51-MR-5-A00-NK	952701911
			PNP	S51-MR-5-A00-PK	952701851
	Plastic, Axial	2m Cable	NPN	S51-PA-2-A00-NK	952701071
			PNP	S51-PA-2-A00-PK	952701001
		M12 Connector	NPN	S51-PA-5-A00-NK	952701331
			PNP	S51-PA-5-A00-PK	952701261
	Plastic, Radial	2m Cable	NPN	S51-PR-2-A00-NK	952701201
			PNP	S51-PR-2-A00-PK	952701131
		M12 Connector	NPN	S51-PR-5-A00-NK	952701461
			PNP	S51-PR-5-A00-PK	952701391

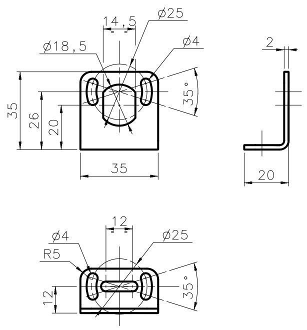
Tubular Sensors - S50/S51

OPTIC FUNCTION	HOUSING/OPTIC	CONNECTION	OUTPUT	MODEL	ORDER No.
Polarized retroreflective	Nickel Plated Brass, Axial	2m Cable	NPN	S51-MA-2-B01-NK	952701611
			PNP	S51-MA-2-B01-PK	952701551
		M12 Connector	NPN	S51-MA-5-B01-NK	952701811
			PNP	S51-MA-5-B01-PK	952701761
	Nickel Plated Brass, Radial	2m Cable	NPN	S51-MR-2-B01-NK	952701721
			PNP	S51-MR-2-B01-PK	952701661
		M12 Connector	NPN	S51-MR-5-B01-NK	952701921
			PNP	S51-MR-5-B01-PK	952701861
	Plastic, Axial	2m Cable	NPN	S51-PA-2-B01-NK	952701081
			PNP	S51-PA-2-B01-PK	952701011
		M12 Connector	NPN	S51-PA-5-B01-NK	952701341
			PNP	S51-PA-5-B01-PK	952701271
	Plastic, Radial	2m Cable	NPN	S51-PR-2-B01-NK	952701211
			PNP	S51-PR-2-B01-PK	952701141
		M12 Connector	NPN	S51-PR-5-B01-NK	952701471
			PNP	S51-PR-5-B01-PK	952701401
Medium diffuse proximity	Nickel Plated Brass, Axial	2m Cable	NPN	S51-MA-2-C01-NK	952701621
			PNP	S51-MA-2-C01-PK	952701561
		M12 Connector	NPN	S51-MA-5-C01-NK	952701821
			PNP	S51-MA-5-C01-PK	952701771
	Nickel Plated Brass, Radial	2m Cable	NPN	S51-MR-2-C01-NK	952701731
			PNP	S51-MR-2-C01-PK	952701671
		M12 Connector	NPN	S51-MR-5-C01-NK	952701931
			PNP	S51-MR-5-C01-PK	952701871
	Plastic, Axial	2m Cable	NPN	S51-PA-2-C01-NK	952701091
			PNP	S51-PA-2-C01-PK	952701021
		M12 Connector	NPN	S51-PA-5-C01-NK	952701351
			PNP	S51-PA-5-C01-PK	952701281
	Plastic, Radial	2m Cable	NPN	S51-PR-2-C01-NK	952701221
			PNP	S51-PR-2-C01-PK	952701151
		M12 Connector	NPN	S51-PR-5-C01-NK	952701481
			PNP	S51-PR-5-C01-PK	952701411
Short diffuse proximity	Nickel Plated Brass, Axial	2m Cable	NPN	S51-MA-2-C10-NK	952701631
			PNP	S51-MA-2-C10-PK	952701571
		M12 Connector	NPN	S51-MA-5-C10-NK	952701831
			PNP	S51-MA-5-C10-PK	952701521
	Nickel Plated Brass, Radial	2m Cable	NPN	S51-MR-2-C10-NK	952701741
			PNP	S51-MR-2-C10-PK	952701681
		M12 Connector	NPN	S51-MR-5-C10-NK	952701941
			PNP	S51-MR-5-C10-PK	952701881
	Plastic, Axial	2m Cable	NPN	S51-PA-2-C10-NK	952701101
			PNP	S51-PA-2-C10-PK	952701031
		M12 Connector	NPN	S51-PA-5-C10-NK	952701361
			PNP	S51-PA-5-C10-PK	952701291
	Plastic, Radial	2m Cable	NPN	S51-PR-2-C10-NK	952701231
			PNP	S51-PR-2-C10-PK	952701161
		M12 Connector	NPN	S51-PR-5-C10-NK	952701491
			PNP	S51-PR-5-C10-PK	952701421
Narrow beam proximity	Nickel Plated Brass, Axial	M12 Connector	PNP	S51-MA-5-C20-PK	952701961
Through beam receiver	Nickel Plated Brass, Axial	2m Cable	NPN	S51-MA-2-F00-NK	952701641
			PNP	S51-MA-2-F00-PK	952701581
		M12 Connector	NPN	S51-MA-5-F00-NK	952701841
			PNP	S51-MA-5-F00-PK	952701781
	Nickel Plated Brass, Radial	2m Cable	NPN	S51-MR-2-F00-NK	952701751
			PNP	S51-MR-2-F00-PK	952701691
		M12 Connector	NPN	S51-MR-5-F00-NK	952701951
			PNP	S51-MR-5-F00-PK	952701891
	Plastic, Axial	2m Cable	NPN	S51-PA-2-F00-NK	952701121
			PNP	S51-PA-2-F00-PK	952701051
		M12 Connector	NPN	S51-PA-5-F00-NK	952701381
			PNP	S51-PA-5-F00-PK	952701311
	Plastic, Radial	2m Cable	NPN	S51-PR-2-F00-NK	952701251
			PNP	S51-PR-2-F00-PK	952701181
		M12 Connector	NPN	S51-PR-5-F00-NK	952701511
			PNP	S51-PR-5-F00-PK	952701441
Through beam emitter	Nickel Plated Brass, Axial	2m Cable	-	S51-MA-2-G00-XG	952701591
		M12 Connector	-	S51-MA-5-G00-XG	952701791
	Nickel Plated Brass, Radial	2m Cable	-	S51-MR-2-G00-XG	952701701
		M12 Connector	-	S51-MR-5-G00-XG	952701901
	Plastic, Axial	2m Cable	-	S51-PA-2-G00-XG	952701061
		M12 Connector	-	S51-PA-5-G00-XG	952701321
	Plastic, Radial	2m Cable	-	S51-PR-2-G00-XG	952701191
		M12 Connector	-	S51-PR-5-G00-XG	952701451

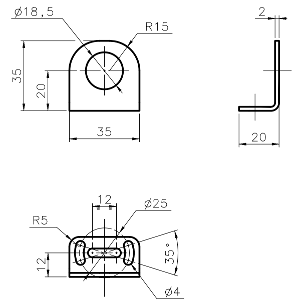
S50/S51

ACCESSORIES

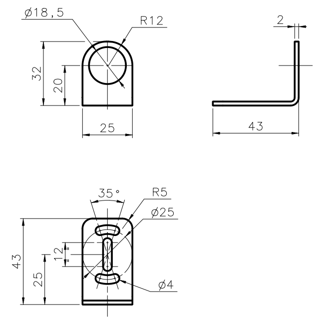
ST-5010



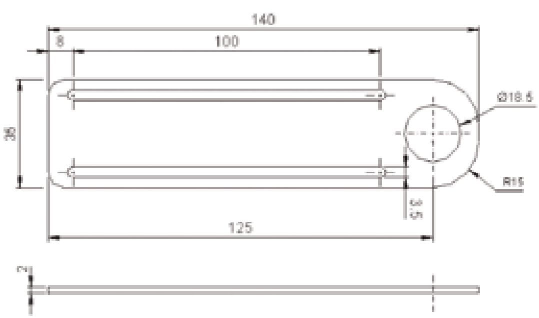
ST-5011



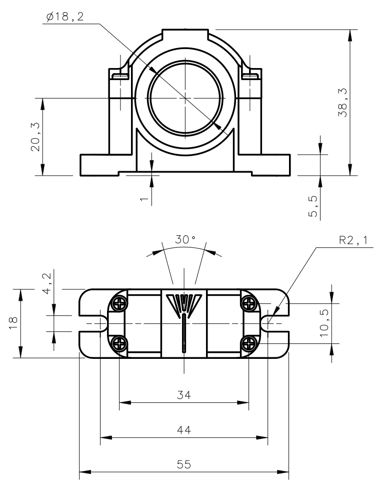
ST-5012



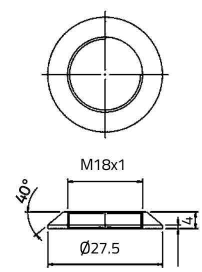
ST-5017



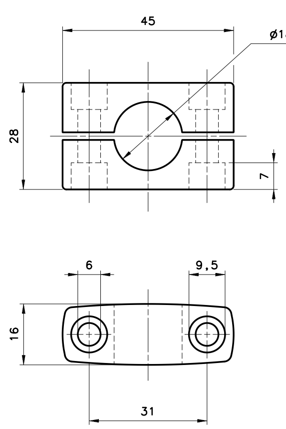
SWING-18



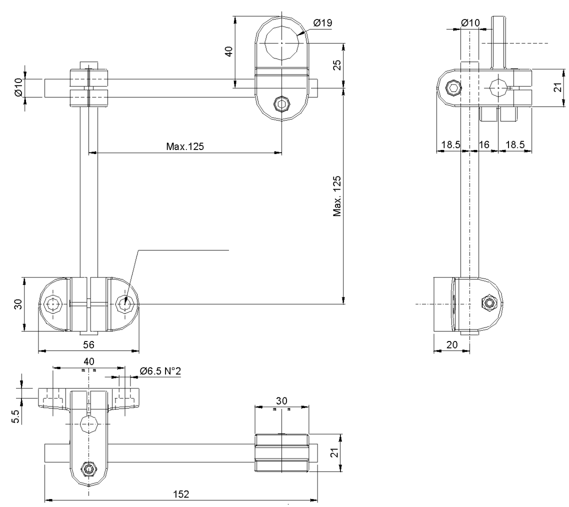
PLASTIC NUT



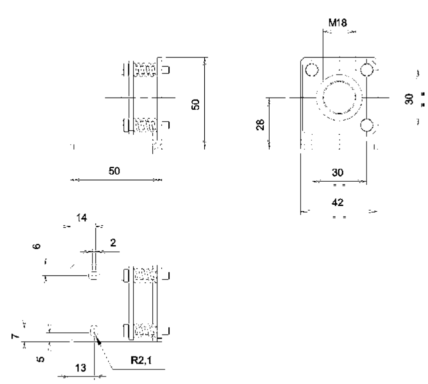
SP-40



JOINT 18



MICRO 18



mm

MODEL	DESCRIPTION	ORDER No.
ST-5010	M18/14 mounting bracket	95ACC5230
ST-5011	M18 mounting bracket short	95ACC5240
ST-5012	M18 mounting bracket long	95ACC5250
ST-5017	M18 mounting bracket	95ACC5270
S50 EASY -IN	M18/14 EASY in™ adjustable mounting support	95ACC 5300
JOINT -18	M18 jointed support	95ACC 5220
MICRO -18	support with micrometric regulation for tubular M18 sensors	95ACC 1380
ST1218	M12/M18 mounting brackets	95ACC3340
ST1830	M18/M30 mounting brackets	95ACC3350
SP-40	mounting bracket tubular	95ACC1370
SWING-18	adjustable support for M18 tubular sensors	895000006
PLASTIC NUT	flared mounting nut	95ACC2630
MEK -PROOF	front protection (only for metal models)	G5000001

CABLES

TYPE	DESCRIPTION	LENGTH	MODEL	ORDER No.
Axial M12 Connector	4-pole, grey, P.V.C.	3 m	CS-A1-02-G-03	95A251380
		5 m	CS-A1-02-G-05	95A251270
		7 m	CS-A1-02-G-07	95A251280
		10 m	CS-A1-02-G-10	95A251390
	4-pole, P.U.R.	2 m	CS-A1-02-R-02	95A251540
		5 m	CS-A1-02-R-05	95A251560
Radial M12 Connector	4-pole, grey, P.V.C.	3 m	CS-A2-02-G-03	95A251360
		5 m	CS-A2-02-G-05	95A251240
		7 m	CS-A2-02-G-07	95A251245
		10 m	CS-A2-02-G-10	95A251260
	4-pole, P.U.R.	2 m	CS-A2-02-R-02	95A251550
		5 m	CS-A2-02-R-05	95A251570
Radial M12 Connector with LED (for PNP N.O. sensors)	4-pole, grey, P.V.C.	3 m	CS-A2-12-G-03	95A251400
		5 m	CS-A2-12-G-05	95A251350
		10 m	CS-A2-12-G-10	95A251370
Axial M12 Connector	4-pole, shielded, black, P.V.C.	3 m	CV-A1-22-B-03	95ACC1480
		5 m	CV-A1-22-B-05	95ACC1490
		10 m	CV-A1-22-B-10	95ACC1500
		15 m	CV-A1-22-B-15	95ACC2070
		25 m	CV-A1-22-B-25	95ACC2090
Radial M12 Connector		3 m	CV-A2-22-B-03	95ACC1540
		5 m	CV-A2-22-B-05	95ACC1550
		10 m	CV-A2-22-B-10	95ACC1560
Axial M12 Connector	4-pole, U.L., black, P.V.C.	3 m	CS-A1-02-U-03	95ASE1120
		5 m	CS-A1-02-U-05	95ASE1130
		10 m	CS-A1-02-U-10	95ASE1140
		15 m	CS-A1-02-U-15	95ASE1150
		25 m	CS-A1-02-U-25	95ASE1160
	4-pole, black	Connector- not cabled	CS-A1-02-B-NC	G5085002
Radial M12 Connector		Connector- not cabled	CS-A2-02-B-NC	G5085003

Sensor Switch
(CS1-F CS1-U CS1-S CS1-J CS1-D CS1-G CS1-R Series)

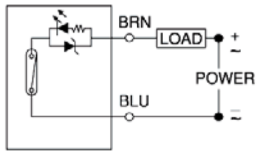
Ordering Code

CS1 - F

Model — Type

CS1-F : Sensor switch for cylinder

Connect Diagram

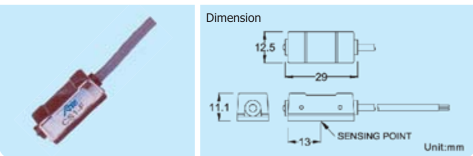


Specifications

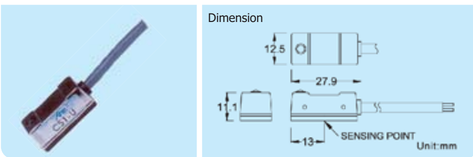
Model NO	CS1-F	CS1-U	CS1-S	CS1-J	CS-D	CS1-G	CS1-R
Wiring method	2 Wire type						
Switching logic	SPST Normally open						
Operating voltage	5~240V DC/AC						
Sensor type	Reed switch						
Switching current	100 mA max.					50 mA max.	
Contact rating	10 W max.					6 W max.	
Temperature range	-10 ~ 70°C						
Enclosure classification	IEC 529 IP67						
Indicator light	LED						

Sensor Switch type

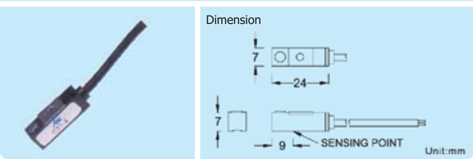
CS1-F



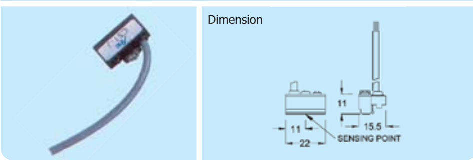
CS1-U



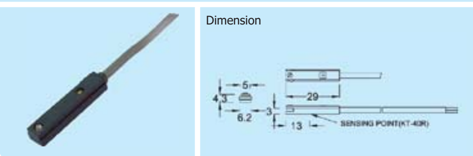
CS1-S



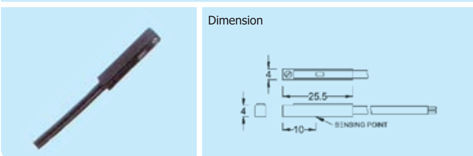
CS1-J



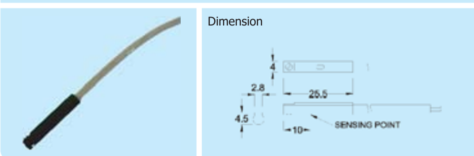
CS1-D



CS1-G



CS1-R



- Piston ∅ 5/16“ to 1”
- Stroke lengths up to 20”
- Double-acting
- Meets the highest requirements for running characteristics, service life and load carrying ability
- Extensive range of accessories

Detailed product information ➔ www.festo.com/catalog/dsnu

Product Range Overview							
Function	Type	Piston ∅ [in]	Stroke [in]	Force [lbf]	Variants		
					P	PPV	A
Double-acting	DSNU	5/16, 3/8, 1/2, 5/8, 3/4, 1	0.04 … 20	5.2 … 66.3	■	■1)	■

1) Adjustable as of Piston ∅ 5/8”

Variants

P Flexible cushioning at both ends

PPV Adjustable air cushioning at both ends

A Magnet for position sensing

Type	Piston ∅ [in]	Standard Stroke [in]	Variable Stroke1) [in]
DSNU	5/16, 3/8	1/2, 1, 2, 3, 4	0.04 … 4
	1/2, 5/8	1/2, 1, 2, 3, 4, 5, 6, 8	0.04 … 8
	3/4	1/2, 1, 2, 3, 4, 5, 6, 8, 10, 12	0.04 … 12
	1	1/2, 1, 2, 3, 4, 5, 6, 8, 10, 12	0.04 … 20

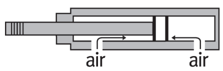
1) Reliable position sensing requires a minimum stroke of 0.4 inch.

Contents

Round Cylinders DSNU – Inch Series

Technical Data

Double-acting



Diameter
5/16 ... 1 in

Stroke length
0.04 ... 20in

General Technical Data						
Piston ∅ [in]	5/16	3/8	1/2	5/8	3/4	1
Pneumatic connection	10-32 UNF	10-32 UNF	10-32 UNF	10-32 UNF	1/8″ NPT	1/8″ NPT
Piston rod thread	6-32 UNC	6-32 UNC	10-32 UNF	10-32 UNF	5/16-24 UNF	3/8-24 UNF
Constructional design	Piston					
	Piston rod					
	Cylinder barrel					
Cushioning	Flexible cushioning rings at both ends (P)			Adjustable air cushioning at both ends (PPV)		
Cushioning length (PPV) [in]	–			0.47	0.59	0.67
Magnet for position sensing[1]	Optional					

1) Position sensing via magnetic proximity sensor (ordered separately, see accessories).

Operating Pressure [psi]						
Piston ∅ [in]	5/16	3/8	1/2	5/8	3/4	1
Operating medium	Compressed air in accordance with ISO 8573-1:2010 [7:4:4]					
Note on operating/pilot medium	Operation with lubricated medium possible (in which case lubricated operation will always be required)					
Operating pressure	22.1 ... 147.0	14.7 ... 147.0				

Ambient Conditions	
Ambient temperature[1] [°F]	−4 ... +176
Corrosion resistance class CRC[2]	2

1) Note operating range of proximity sensors
2) Corrosion resistance class 2 according to Festo standard 940 070
Components with moderate corrosion resistance for use in normal industrial environments subjected to contact with coolants or lubricating agents.

Forces [lbf] and Impact Energy [ft-lbf]						
Piston ∅ [in]	5/16	3/8	1/2	5/8	3/4	1
Theoretical force at 90 psi, extending	6.7	10.6	15.3	27.2	42.5	66.3
Theoretical force at 90 psi, retracting	5.2	9.0	11.5	23.4	35.5	55.5
Max. impact energy at the end positions	0.02	0.04	0.05	0.11	0.15	0.22

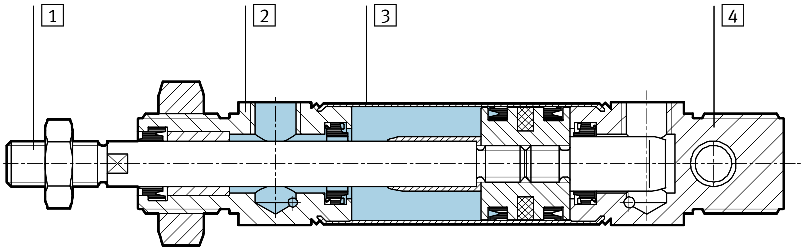
Weights [oz]						
Piston ∅ [in]	5/16	3/8	1/2	5/8	3/4	1
Product weight with 0 inch stroke	1.22	1.32	2.65	3.17	6.59	8.40
Additional weight per 1 inch stroke	0.20	0.25	0.36	0.41	0.64	0.99

Round Cylinders DSNU – Inch Series

Technical Data, Ordering Data

Materials

Sectional view



DSNU		
1	Piston rod	High-alloy stainless steel
2	Bearing cap	Wrought aluminum alloy
3	Cylinder barrel	High-alloy stainless steel
4	End cap	Wrought aluminum alloy
–	Seals	Polyurethane, nitrile rubber

Ordering Data

Piston ∅ [in]	Stroke [in]	Part No.	Type	LT
5⁄16	½	**546394**	**DSNU-5/16”-1/2”-P-A**	**1D**
	1	**546393**	**DSNU-5/16”-1”-P-A**	**1D**
	2	**546395**	**DSNU-5/16”-2”-P-A**	**1D**
	3	**546396**	**DSNU-5/16”-3”-P-A**	**3D**
	4	**546397**	**DSNU-5/16”-4”-P-A**	**3D**
	0.04 … 4	**548482**	**DSNU-5/16”-…-P-A**	**3D**
3⁄8	½	**546399**	**DSNU-3/8”-1/2”-P-A**	**1D**
	1	**546398**	**DSNU-3/8”-1”-P-A**	**1D**
	2	**546400**	**DSNU-3/8”-2”-P-A**	**1D**
	3	**546401**	**DSNU-3/8”-3”-P-A**	**3D**
	0.04 … 4	**548483**	**DSNU-3/8”-…-P-A**	**3D**
½	½	**546387**	**DSNU-1/2”-1/2”-P-A-B**	**1D**
	1	**546386**	**DSNU-1/2”-1”-P-A-B**	**1D**
	2	**546388**	**DSNU-1/2”-2”-P-A-B**	**1D**
	0.04 … 8	**548484**	**DSNU-1/2”-…-P-A**	**3D**
5⁄8	1	**546389**	**DSNU-5/8”-1”-PPV-A-B**	**1D**
	2	**546390**	**DSNU-5/8”-2”-PPV-A-B**	**1D**
	3	**546391**	**DSNU-5/8”-3”-PPV-A-B**	**1D**
	4	**546392**	**DSNU-5/8”-4”-PPV-A-B**	**1D**
	0.04 … 8	**548501**	**DSNU-5/8”-…-PPV-A**	**3D**

Piston ∅ [in]	Stroke [in]	Part No.	Type	LT
¾	1	**546403**	**DSNU-3/4”-1”-PPV-A**	**1D**
	2	**546406**	**DSNU-3/4”-2”-PPV-A**	**1D**
	3	**546407**	**DSNU-3/4”-3”-PPV-A**	**1D**
	4	**546408**	**DSNU-3/4”-4”-PPV-A**	**1D**
	5	**546409**	**DSNU-3/4”-5”-PPV-A**	**1D**
	6	**546410**	**DSNU-3/4”-6”-PPV-A**	**1D**
	8	**546411**	**DSNU-3/4”-8”-PPV-A**	**1D**
	10	**546404**	**DSNU-3/4”-10”-PPV-A**	**1D**
	12	**546405**	**DSNU-3/4”-12”-PPV-A**	**1D**
	0.04 … 12	**548536**	**DSNU-3/4”-…-PPV-A**	**3D**
1	½	**546413**	**DSNU-1”-1/2”-PPV-A**	**3D**
	1	**546412**	**DSNU-1”-1”-PPV-A**	**1D**
	2	**546416**	**DSNU-1”-2”-PPV-A**	**1D**
	3	**546421**	**DSNU-1”-3”-PPV-A**	**1D**
	4	**546417**	**DSNU-1”-4”-PPV-A**	**1D**
	5	**546418**	**DSNU-1”-5”-PPV-A**	**1D**
	6	**546419**	**DSNU-1”-6”-PPV-A**	**1D**
	8	**546420**	**DSNU-1”-8”-PPV-A**	**1D**
	10	**546414**	**DSNU-1”-10”-PPV-A**	**1D**
	12	**546415**	**DSNU-1”-12”-PPV-A**	**1D**
	0.04 … 20	**548437**	**DSNU-1”-…-PPV-A**	**3D**

LT = Lead time **1D** typically ships same day/next day **3D** typically ships within 3 days

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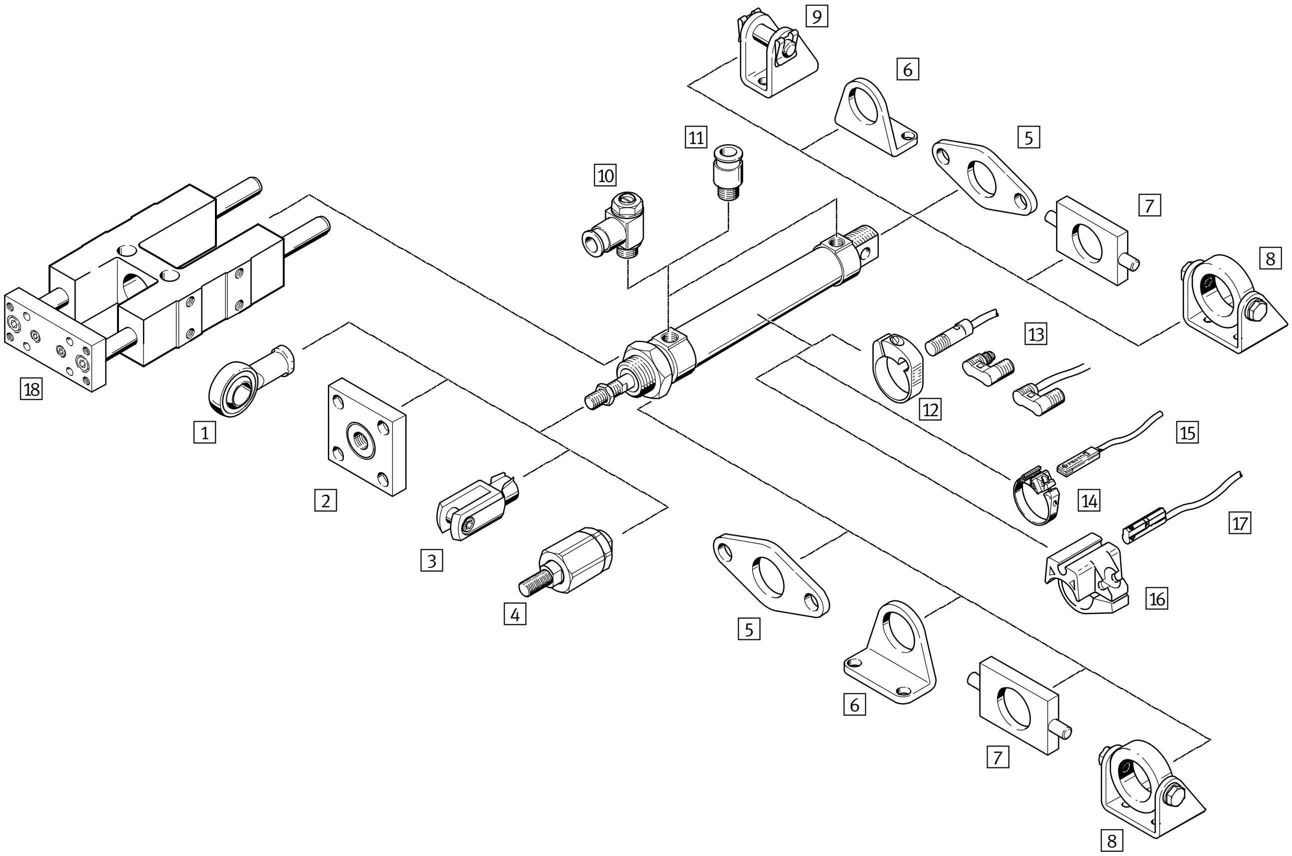


Mounting Attachments and Accessories		
		➔ Page/Internet
1	Rod eye SGS	9
2	Coupling piece KSZ	ksz
3	Rod clevis SG	9
4	Self-aligning rod coupler FK	9
5	Flange mounting FBN	9
6	Foot mounting HBN/HF	9
7	Swivel mounting WBN	9
8	Swivel mounting SBN	sbn
9	Clevis foot LBN	9

Mounting Attachments and Accessories		
		➔ Page/Internet
10	One-way flow control valve GRLA	9
11	Push-in fitting QB	9
12	Sensor mounting kit SMBR	smbr
13	Proximity switch SMEO/SMTO	smto
14	Sensor mounting kit SMBR-8	9
15	Proximity switch SME/SMT-8	9
16	Sensor mounting kit SMBR-10	smbr-10
17	Proximity switch SME/SMT-10	9
18	Guide unit FEN	fen

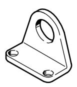
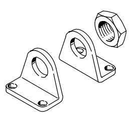
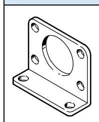
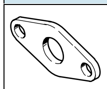
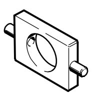
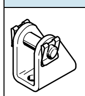
Round Cylinders DSNU – Inch Series

Accessories

FESTO

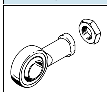
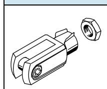
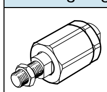
Ordering Data – Mounting Attachments

Technical Data ➔ www.festo.com/catalog/<type> or <order code>

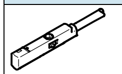
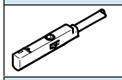
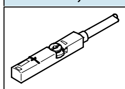
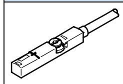
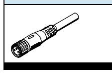
	For ∅ [in]	Part No.	Type
Foot mounting HBN			
	5/16, 3/8	**5123**	**HBN-8/10x1**
	1/2, 5/8	**5125**	**HBN-12/16x1**
	3/4, 1	**5127**	**HBN-20/25x1**
	5/16, 3/8	**5124**	**HBN-8/10x2**
	1/2, 5/8	**5126**	**HBN-12/16x2**
	3/4, 1	**5128**	**HBN-20/25x2**
Foot mounting HF			
	5/16, 3/8	**11243**	**HF-5/16”-3/8”-A**
	1/2, 5/8	**11244**	**HF-1/2”-5/8”-A**
	3/4, 1	**11245**	**HF-3/4”-1”-A**
Flange mounting			
	5/16, 3/8	**5129**	**FBN-8/10**
	1/2, 5/8	**5130**	**FBN-12/16**
	3/4, 1	**5131**	**FBN-20/25**
Swivel mounting			
	5/16, 3/8	**8608**	**WBN-8/10**
	1/2, 5/8	**8609**	**WBN-12/16**
	3/4, 1	**8610**	**WBN-20/25**
Clevis foot			
	5/16, 3/8	**6057**	**LBN-8/10**
	1/2, 5/8	**6058**	**LBN-12/16**
	3/4, 1	**6059**	**LBN-20/25**

Ordering Data – Piston Rod Attachments

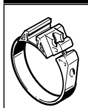
Technical Data ➔ www.festo.com/catalog/<type> or <order code>

	For ∅ [in]	Part No.	Type
Rod eye			
	5/16, 3/8	**532693**	**SGS-6-32**
	1/2, 5/8	**532694**	**SGS-10-32**
	3/4	**532695**	**SGS-5/16-24**
	1	**532696**	**SGS-3/8-24**
Rod clevis			
	5/16, 3/8	**11127**	**SG-6-32**
	1/2, 5/8	**546552**	**SG-UNF10-32-B**
	3/4	**546574**	**SG-UNF5/16”-24-B**
	1	**546540**	**SG-UNF3/8”-24-B**
Self-aligning rod coupler			
	5/16, 3/8	**532702**	**FK-6-32**
	1/2, 5/8	**532703**	**FK-10-32**
	3/4	**532704**	**FK-5/16-24**
	1	**532705**	**FK-3/8-24**

Ordering Data – Proximity Sensors and Connecting Cables

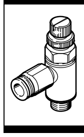
	Description	Part No.	Type
Proximity sensor for C-slot, magneto-resistive – N/O contact Technical data ➔ 173			
	PNP, cable, 8 ft	**551373**	**SMT-10M-PS-24V-E-2,5-L-OE**
	PNP, plug	**551375**	**SMT-10M-PS-24V-E-0,3-L-M8D**
Magnetic reed – N/O contact Technical data ➔ 174			
	Cable, 8 ft	**551369**	**SME-10M-ZS-24V-E-2,5-L-OE**
	Plug	**551367**	**SME-10M-DS-24V-E-0,3-L-M8D**
Proximity sensor for T-slot, magneto-resistive – N/O contact Technical data ➔ 169			
	PNP, cable, 8 ft	**574335**	**SMT-8M-A-PS-24V-E-2,5-OE**
	PNP, plug	**574334**	**SMT-8M-A-PS-24V-E-0,3-M8D**
	NPN, cable, 8 ft	**574338**	**SMT-8M-A-NS-24V-E-2,5-OE**
	NPN, plug	**574339**	**SMT-8M-A-NS-24V-E-0,3-M8D**
Magnetic reed – N/O contact Technical data ➔ 170			
	Cable, 8 ft	**543862**	**SME-8M-ZS-24V-K-2,5-OE**
	Plug	**543861**	**SME-8M-DS-24V-K-0,3-M8D**
Connecting cable, straight socket			
	8 ft	**541333**	**NEBU-M8G3-K-2.5-LE3**

Ordering Data – Mounting Kits for Proximity Sensors SMT/SME-8

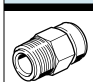
	For ∅ [in]	Part No.	Type
	5/16	**175091**	**SMBR-8-8**
	3/8	**175092**	**SMBR-8-10**
	1/2	**175093**	**SMBR-8-12**
	5/8	**175094**	**SMBR-8-16**
	3/4	**175095**	**SMBR-8-20**
	1	**175096**	**SMBR-8-25**

Ordering Data – One-way Flow Control Valves for Exhaust Air Flow Control

Technical Data ➔ 253

Function	For ∅ [in]	Tubing O.D. [in]	Part No.	Type
	5/16, 3/8,	5/32	**564840**	**GRLA-10-32-UNF-QB-5/32-U**
	1/2, 5/8	1/4	**564842**	**GRLA-10-32-UNF-QB-1/4-U**
	3/4, 1	5/32	**534656**	**GRLA-1/8-QB-5/32-U**
		1/4	**534658**	**GRLA-1/8-QB-1/4-U**

Ordering Data – Push-in Fittings QB Technical Data ➔ 245

Function	For ∅ [in]	Tubing O.D. [in]	Part No.	Type
	5/16, 3/8,	3/16	**533268**	**QB-10-32-UNF-3/16-U**
	1/2, 5/8	1/4	**533269**	**QB-10-32-UNF-1/4-U**
	3/4, 1	3/16	**533272**	**QB-1/8-3/16-U**
		1/4	**533273**	**QB-1/8-1/4-U**

Lead Time LT for all products on this page: **1D** typically ships same day/next day

DSNU Standard Cylinders meet ISO 6432 mounting, rod, bore and thread dimension specifications for easy interchangeability.

- Piston ∅ 8 to 25 mm
- Stroke lengths up to 500 mm
- Double-acting
- Meets the highest requirements for running characteristics, service life and load carrying ability
- Extensive range of accessories

Detailed product information ➔ www.festo.com/catalog/dsnu

Product Range Overview

Function	Version	Piston ∅ [mm]	Stroke [mm]	Force [N]	Variants P	Variants PPS	Variants PPV	Variants A
Double-acting	DSNU							
	Basic version	8, 10, 12	1 … 500	30 … 68	■	–	–	■
		16, 20, 25		121 … 295	–	■	■	■

Variants

P	Flexible cushioning rings/pads at both ends	PPS	Pneumatic cushioning, self-adjusting at both ends	PPV	Pneumatic cushioning, adjustable at both ends	A	Position sensing

Contents

Note: All metric products can be used within inch tubing systems via hybrid fittings (➔ Overview on page 240)

Standard Cylinders DSNU – Metric Series, to ISO 6432

Technical Data, Ordering Data

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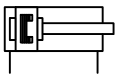
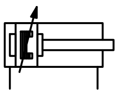




Materials
End caps: Wrought aluminum alloy
Housing: High-alloy stainless steel
Piston rod: High-alloy steel
Seals: Polyurethane, nitrile rubber

Technical Data							
Piston ∅		8	10	12	16	20	25
Pneumatic connection		M5	M5	M5	M5	G⅛	G⅛
End of piston rod		Male thread					
Piston rod thread		M4	M4	M6	M6	M8	M10x1.25
Cushioning		Flexible cushioning rings/pads at both ends			Pneumatic cushioning, adjustable at both ends		
					Pneumatic cushioning, self-adjusting at both ends		
Cushioning length[1]	[mm]	–		9	12	15	17
Theoretical force at 6 bar, advancing	[N]	30	47	68	121	189	295
Theoretical force at 6 bar, retracting	[N]	23	40	51	104	158	247
Max. torque at the piston rod[2]	[Nm]	–	–	0.10	0.10	0.20	0.45
∅/length at 0 mm stroke	[mm]	19/86	19/86	24/105	24/111	32/132	32/141

1) Applies exclusively to pneumatic cushioning adjustable at both ends (PPV).
2) Applies exclusively to variants with protection against rotation (Q).

Operating Conditions			
Piston ∅		8	10 … 25
Operating medium		Compressed air in accordance with ISO 8573-1:2010 [7:4:4]	
Note on operating/pilot medium		Operation with lubricated medium possible (in which case lubricated operation will always be required)	
Operating pressure	[bar]	1.5 … 10	1 … 10[1]
Ambient temperature[2]	[°C]	−20 … +80	

1) Piston ∅ 12 mm, pneumatic cushioning adjustable at both ends: 2 … 10 bar.
2) Note operating range of proximity sensors.

Ordering Data – P Variant

Piston ∅ [mm]	Stroke [mm]	Part No.	Type	LT
8	10	**19177**	**DSNU-8-10-P-A**	**1D**
	25	**19178**	**DSNU-8-25-P-A**	**1D**
	40	**19179**	**DSNU-8-40-P-A**	**1D**
	50	**19180**	**DSNU-8-50-P-A**	**1D**
	80	**19181**	**DSNU-8-80-P-A**	**3D**
	100	**19182**	**DSNU-8-100-P-A**	**3D**
	1 … 200	**14326**	**DSNU-8-…-P-A**	**3D**
10	10	**19183**	**DSNU-10-10-P-A**	**1D**
	25	**19184**	**DSNU-10-25-P-A**	**1D**
	40	**19185**	**DSNU-10-40-P-A**	**1D**
	50	**19186**	**DSNU-10-50-P-A**	**1D**
	80	**19187**	**DSNU-10-80-P-A**	**3D**
	100	**19188**	**DSNU-10-100-P-A**	**3D**
	1 … 200	**14325**	**DSNU-10-…-P-A**	**3D**

Piston ∅ [mm]	Stroke [mm]	Part No.	Type	LT
12	10	**19189**	**DSNU-12-10-P-A**	**1D**
	25	**19190**	**DSNU-12-25-P-A**	**1D**
	40	**19191**	**DSNU-12-40-P-A**	**1D**
	50	**19192**	**DSNU-12-50-P-A**	**1D**
	80	**19193**	**DSNU-12-80-P-A**	**3D**
	100	**19194**	**DSNU-12-100-P-A**	**3D**
	125	**19195**	**DSNU-12-125-P-A**	**3D**
	160	**19196**	**DSNU-12-160-P-A**	**3D**
	200	**19197**	**DSNU-12-200-P-A**	**3D**
	1 … 200	**14324**	**DSNU-12-…-P-A**	**3D**

LT = Lead time **1D** typically ships same day/next day **3D** typically ships within 3 days

Standard Cylinders DSNU – Metric Series, to ISO 6432

Ordering Data

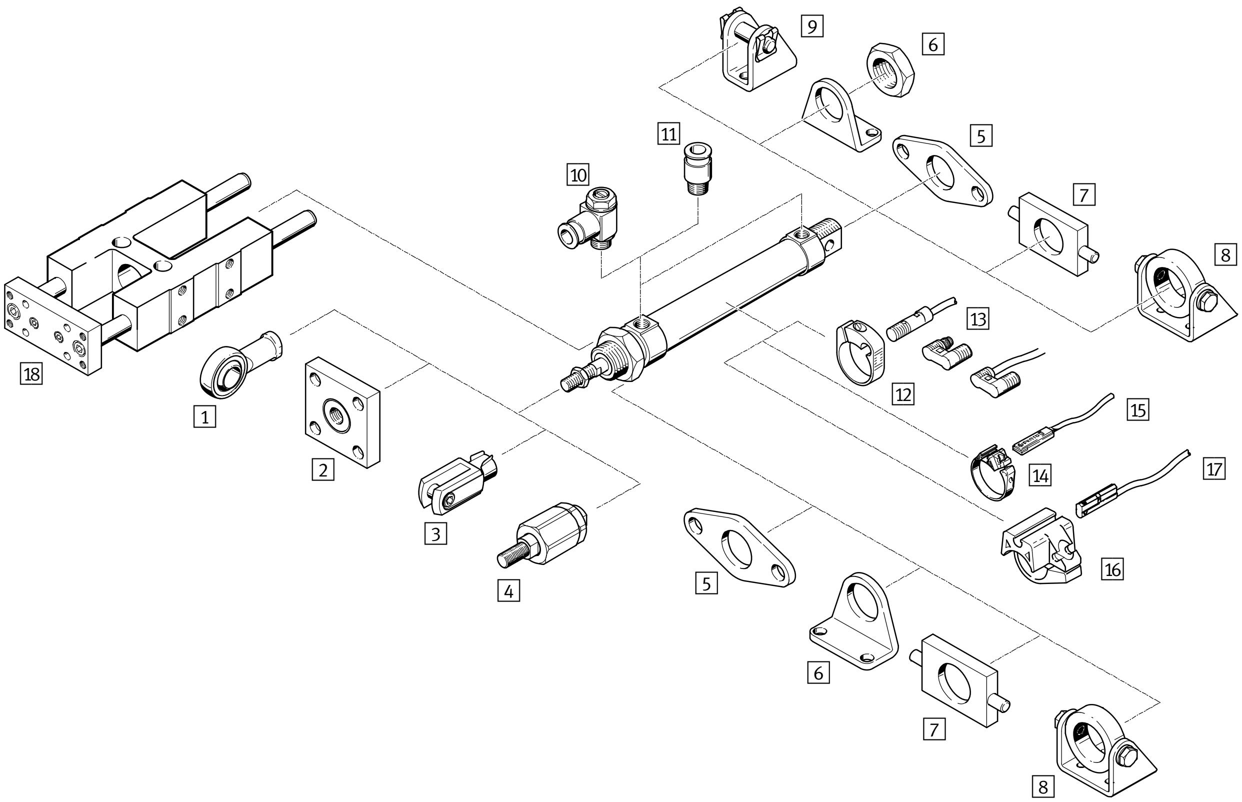
Ordering Data – PPS and PPV Variant

Piston ∅ [mm]	Stroke [mm]	Part No.	Type	LT
16	25	**559263**	**DSNU-16-25-PPS-A**	**1D**
	40	**559264**	**DSNU-16-40-PPS-A**	**1D**
	50	**559265**	**DSNU-16-50-PPS-A**	**1D**
	80	**559266**	**DSNU-16-80-PPS-A**	**1D**
	100	**559267**	**DSNU-16-100-PPS-A**	**1D**
	125	**559268**	**DSNU-16-125-PPS-A**	**1D**
	160	**559269**	**DSNU-16-160-PPS-A**	**1D**
	200	**559270**	**DSNU-16-200-PPS-A**	**1D**
20	25	**559271**	**DSNU-20-25-PPS-A**	**1D**
	40	**559272**	**DSNU-20-40-PPS-A**	**1D**
	50	**559273**	**DSNU-20-50-PPS-A**	**1D**
	80	**559274**	**DSNU-20-80-PPS-A**	**1D**
	100	**559275**	**DSNU-20-100-PPS-A**	**1D**
	125	**559276**	**DSNU-20-125-PPS-A**	**1D**
	160	**559277**	**DSNU-20-160-PPS-A**	**1D**
	200	**559278**	**DSNU-20-200-PPS-A**	**1D**
	250	**559279**	**DSNU-20-250-PPS-A**	**1D**
	300	**559280**	**DSNU-20-300-PPS-A**	**1D**
	320	**559281**	**DSNU-20-320-PPS-A**	**3D**
25	25	**559282**	**DSNU-25-25-PPS-A**	**1D**
	40	**559283**	**DSNU-25-40-PPS-A**	**1D**
	50	**559284**	**DSNU-25-50-PPS-A**	**1D**
	80	**559285**	**DSNU-25-80-PPS-A**	**1D**
	100	**559286**	**DSNU-25-100-PPS-A**	**1D**
	125	**559287**	**DSNU-25-125-PPS-A**	**1D**
	160	**559288**	**DSNU-25-160-PPS-A**	**1D**
	200	**559289**	**DSNU-25-200-PPS-A**	**1D**
	250	**559290**	**DSNU-25-250-PPS-A**	**1D**
	300	**559291**	**DSNU-25-300-PPS-A**	**1D**
	320	**559292**	**DSNU-25-320-PPS-A**	**3D**
	400	**559293**	**DSNU-25-400-PPS-A**	**3D**
	500	**559294**	**DSNU-25-500-PPS-A**	**3D**

Piston ∅ [mm]	Stroke [mm]	Part No.	Type	LT
16	25	**33973**	**DSNU-16-25-PPV-A**	**1D**
	40	**19229**	**DSNU-16-40-PPV-A**	**1D**
	50	**19230**	**DSNU-16-50-PPV-A**	**1D**
	80	**19231**	**DSNU-16-80-PPV-A**	**3D**
	100	**19232**	**DSNU-16-100-PPV-A**	**3D**
	125	**19233**	**DSNU-16-125-PPV-A**	**3D**
	160	**19234**	**DSNU-16-160-PPV-A**	**3D**
	200	**19235**	**DSNU-16-200-PPV-A**	**3D**
	1 … 320	**14320**	**DSNU-16-…-PPV-A**	**3D**
20	25	**33974**	**DSNU-20-25-PPV-A**	**1D**
	40	**19236**	**DSNU-20-40-PPV-A**	**1D**
	50	**19237**	**DSNU-20-50-PPV-A**	**1D**
	80	**19238**	**DSNU-20-80-PPV-A**	**1D**
	100	**19239**	**DSNU-20-100-PPV-A**	**1D**
	125	**19240**	**DSNU-20-125-PPV-A**	**1D**
	160	**19241**	**DSNU-20-160-PPV-A**	**1D**
	200	**19242**	**DSNU-20-200-PPV-A**	**1D**
	250	**19243**	**DSNU-20-250-PPV-A**	**1D**
	300	**19244**	**DSNU-20-300-PPV-A**	**1D**
	320	**34720**	**DSNU-20-320-PPV-A**	**3D**
	1 … 320	**14321**	**DSNU-20-…-PPV-A**	**3D**
25	25	**33975**	**DSNU-25-25-PPV-A**	**1D**
	40	**19245**	**DSNU-25-40-PPV-A**	**1D**
	50	**19246**	**DSNU-25-50-PPV-A**	**1D**
	80	**19247**	**DSNU-25-80-PPV-A**	**1D**
	100	**19248**	**DSNU-25-100-PPV-A**	**1D**
	125	**19249**	**DSNU-25-125-PPV-A**	**1D**
	160	**19250**	**DSNU-25-160-PPV-A**	**1D**
	200	**19251**	**DSNU-25-200-PPV-A**	**1D**
	250	**19252**	**DSNU-25-250-PPV-A**	**1D**
	300	**19253**	**DSNU-25-300-PPV-A**	**1D**
	320	**34721**	**DSNU-25-320-PPV-A**	**3D**
	400	**35193**	**DSNU-25-400-PPV-A**	**3D**
	500	**35194**	**DSNU-25-500-PPV-A**	**3D**
	1 … 500	**14322**	**DSNU-25-…-PPV-A**	**3D**

LT = Lead time **1D** typically ships same day/next day **3D** typically ships within 3 days

Peripherals Overview

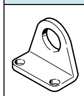
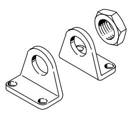
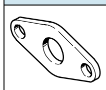
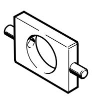
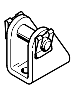


Accessories		
		→ Page/Internet
1	Rod eye SGS	27
2	Coupling piece KSG/KSZ	ksg, ksz
3	Rod clevis SG	27
4	Self-aligning rod coupler FK	27
5	Flange mounting FBN	27
6	Foot mounting HBN	27
7	Swivel mounting WBN	27
8	Swivel mounting SBN	sbn
9	Clevis foot LBN	27

Accessories		
		→ Page/Internet
10	One-way flow control valve GRLA	27
11	Push-in fitting QS	27
12	Mounting kit SMBR	smbr
13	Proximity sensor SMEO/SMTO-4	smto
14	Mounting kit SMBR-8	27
15	Proximity sensor SME/SMT-8	27
16	Mounting kit SMBR-10	smbr-10
17	Proximity sensor SME/SMT-10	27
18	Guide unit FEN	fen

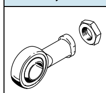
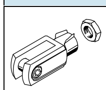
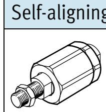
Ordering Data – Mounting Attachments

Technical Data → www.festo.com/catalog/‹type› or ‹order code›

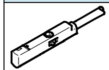
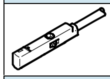
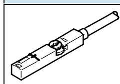
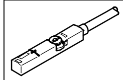
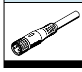
Designation	For ∅ [mm]	Part No.	Type
Foot mounting			
	8, 10	**5123**	**HBN-8/10x1**
	12, 16	**5125**	**HBN-12/16x1**
	20, 25	**5127**	**HBN-20/25x1**
	8, 10	**5124**	**HBN-8/10x2**
	12, 16	**5126**	**HBN-12/16x2**
	20, 25	**5128**	**HBN-20/25x2**
Flange mounting			
	8, 10	**5129**	**FBN-8/10**
	12, 16	**5130**	**FBN-12/16**
	20, 25	**5131**	**FBN-20/25**
Swivel mounting			
	8, 10	**8608**	**WBN-8/10**
	12, 16	**8609**	**WBN-12/16**
	20, 25	**8610**	**WBN-20/25**
Clevis foot			
	8, 10	**6057**	**LBN-8/10**
	12, 16	**6058**	**LBN-12/16**
	20, 25	**6059**	**LBN-20/25**

Ordering Data – Piston Rod Attachments

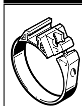
Technical Data → www.festo.com/catalog/‹type› or ‹order code›

Designation	For ∅ [mm]	Part No.	Type
Rod eye			
	8, 10	**9253**	**SGS-M4**
	12, 16	**9254**	**SGS-M6**
	20	**9255**	**SGS-M8**
	25	**9261**	**SGS-M10x1,25**
Rod clevis			
	8, 10	**6532**	**SG-M4**
	12, 16	**3110**	**SG-M6**
	20	**3111**	**SG-M8**
	25	**6144**	**SG-M10x1,25**
Self-aligning rod coupler			
	8, 10	**6528**	**FK-M4**
	12, 16	**2061**	**FK-M6**
	20	**2062**	**FK-M8**
	25	**6140**	**FK-M10x1,25**

Ordering Data – Proximity Sensors and Connecting Cables

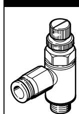
	Description	Part No.	Type
Proximity sensor for C-slot, magneto-resistive – N/O contact			Technical data → 173
	PNP, cable, 2.5 m	**551373**	**SMT-10M-PS-24V-E-2,5-L-OE**
	PNP, plug	**551375**	**SMT-10M-PS-24V-E-0,3-L-M8D**
Magnetic reed – N/O contact			Technical data → 174
	Cable, 2.5 m	**551369**	**SME-10M-ZS-24V-E-2,5-L-OE**
	Plug	**551367**	**SME-10M-DS-24V-E-0,3-L-M8D**
Proximity sensor for T-slot, magneto-resistive – N/O contact			Technical data → 169
	PNP, cable, 2.5 m	**574335**	**SMT-8M-A-PS-24V-E-2,5-OE**
	PNP, plug	**574334**	**SMT-8M-A-PS-24V-E-0,3-M8D**
	NPN, cable, 2.5 m	**574338**	**SMT-8M-A-NS-24V-E-2,5-OE**
	NPN, plug	**574339**	**SMT-8M-A-NS-24V-E-0,3-M8D**
Magnetic reed – N/O contact			Technical data → 170
	Cable, 2.5 m	**543862**	**SME-8M-ZS-24V-K-2,5-OE**
	Plug	**543861**	**SME-8M-DS-24V-K-0,3-M8D**
Connecting cable, straight socket			
	2.5 m	**541333**	**NEBU-M8G3-K-2.5-LE3**

Ordering Data – Mounting Kits for Proximity Sensors SMT/SME-8

	For ∅ [mm]	Part No.	Type
	8	**175091**	**SMBR-8-8**
	10	**175092**	**SMBR-8-10**
	12	**175093**	**SMBR-8-12**
	16	**175094**	**SMBR-8-16**
	20	**175095**	**SMBR-8-20**
	25	**175096**	**SMBR-8-25**

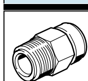
Ordering Data – One-way Flow Control Valves for Exhaust Air Flow Control

Technical Data → 253

Function	For ∅ [mm]	Tubing O.D. [mm]	Part No.	Type
	8, 10,	4	**197577**	**GRLA-M5-QS-4-RS-D**
	12, 16	6	**197578**	**GRLA-M5-QS-6-RS-D**
	20, 25	4	**197580**	**GRLA-1/8-QS-4-RS-D**
		6	**197581**	**GRLA-1/8-QS-6-RS-D**

Ordering Data – Push-in Fittings QB

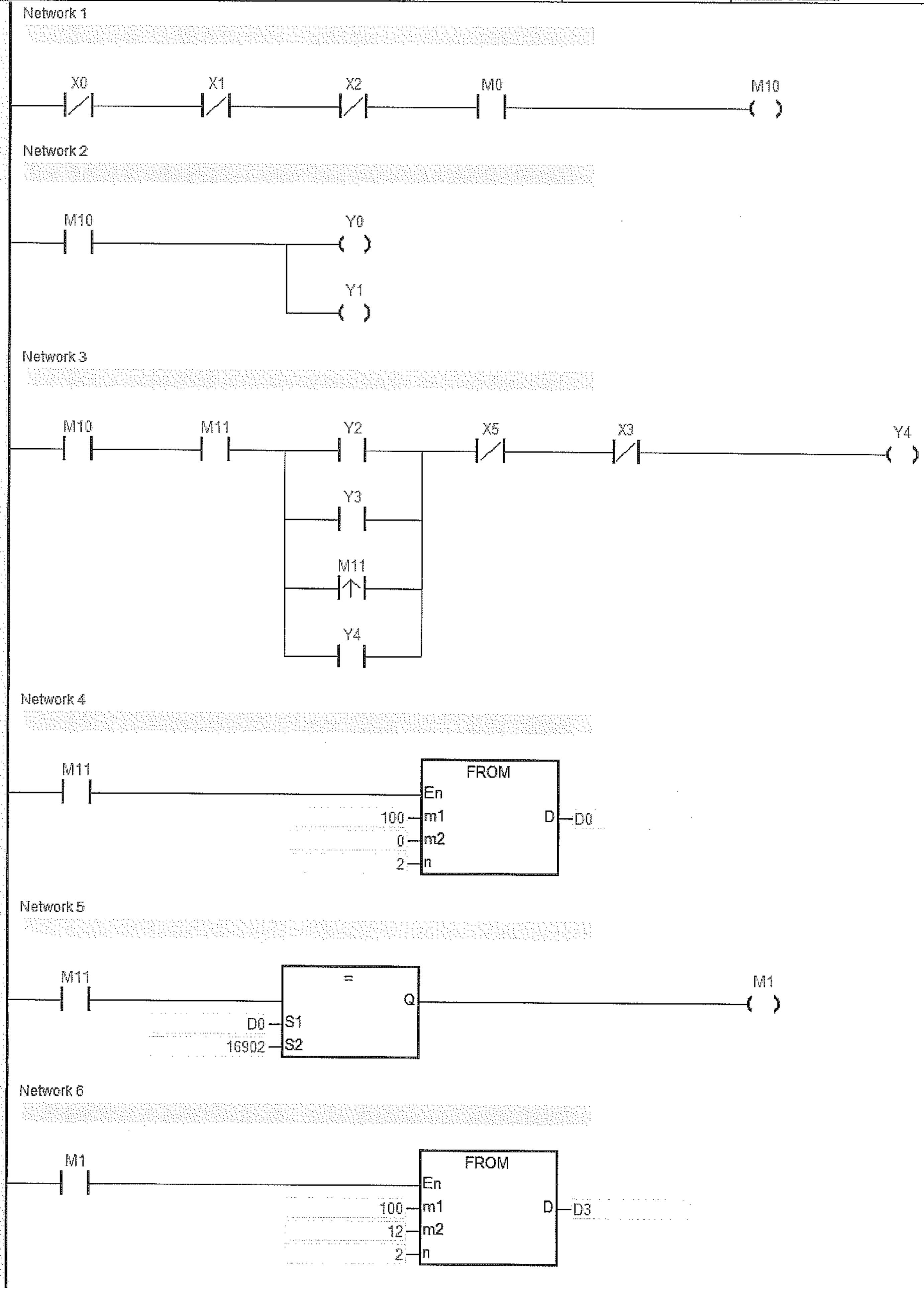
Technical Data → 245

Function	For ∅ [mm]	Tubing O.D. [mm]	Part No.	Type
	8, 10,	4	**153304**	**QSM-M5-4**
	12, 16	6	**153306**	**QSM-M5-6**
	20, 25	4	**153001**	**QS-1/8-4**
		6	**153002**	**QS-1/8-6**

Lead Time LT for all products on this page: **1D** typically ships same day/next day

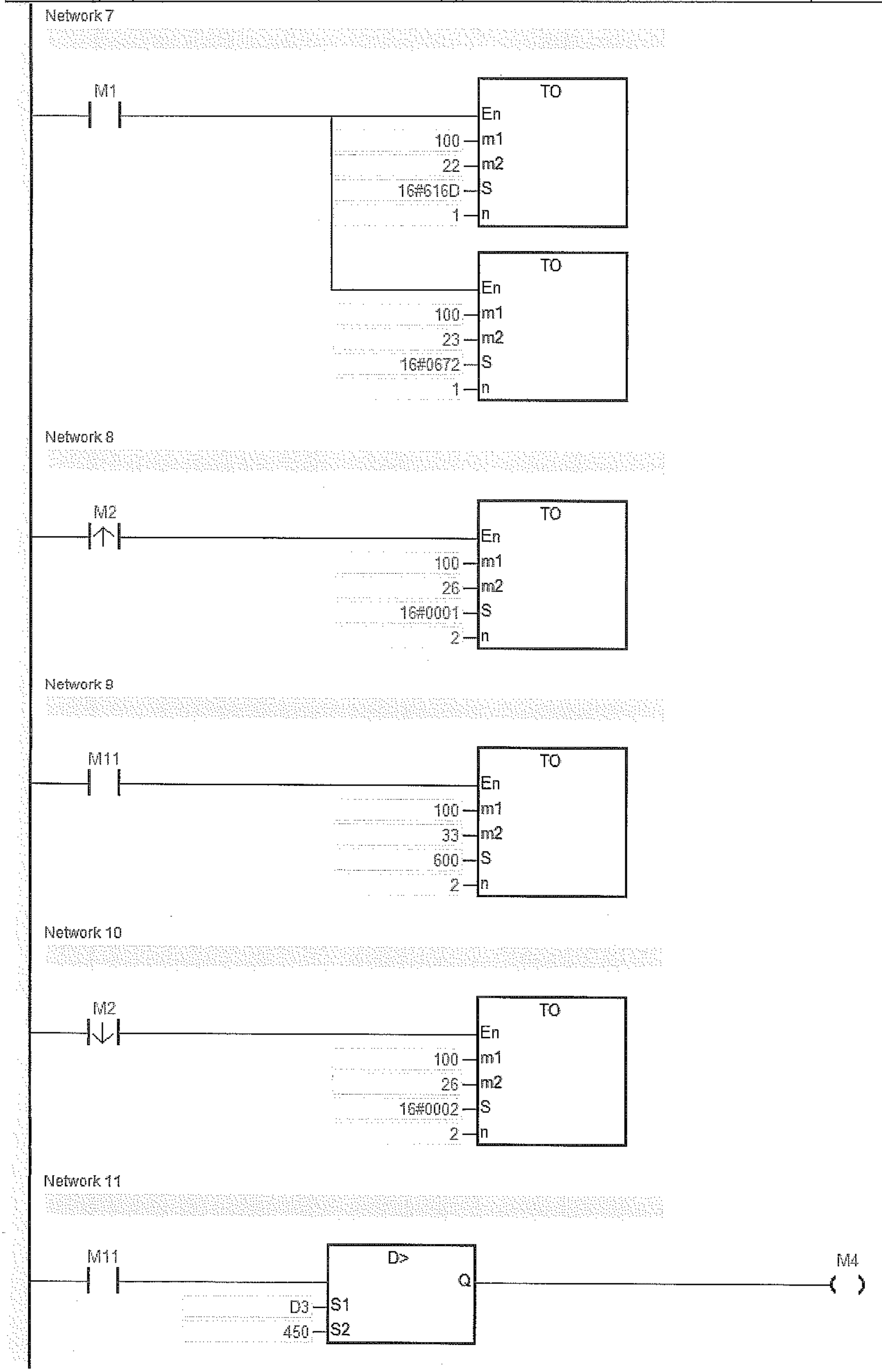
Prog0

Declaration Type	Identifiers	Address	Type	Initial Value	Identifier Comment



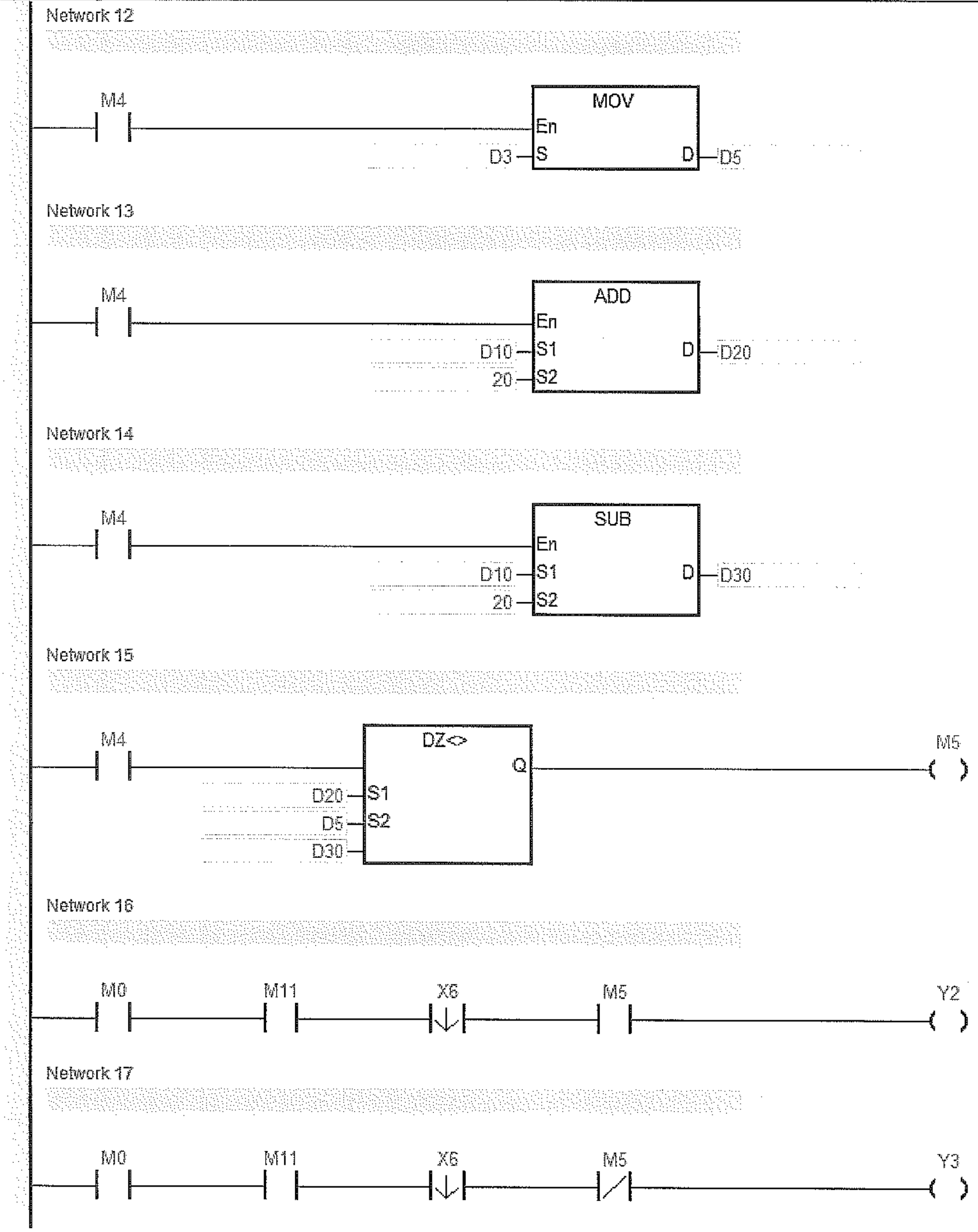
Prog0

Declaration Type	Identifiers	Address	Type	Initial Value	Identifier Comment

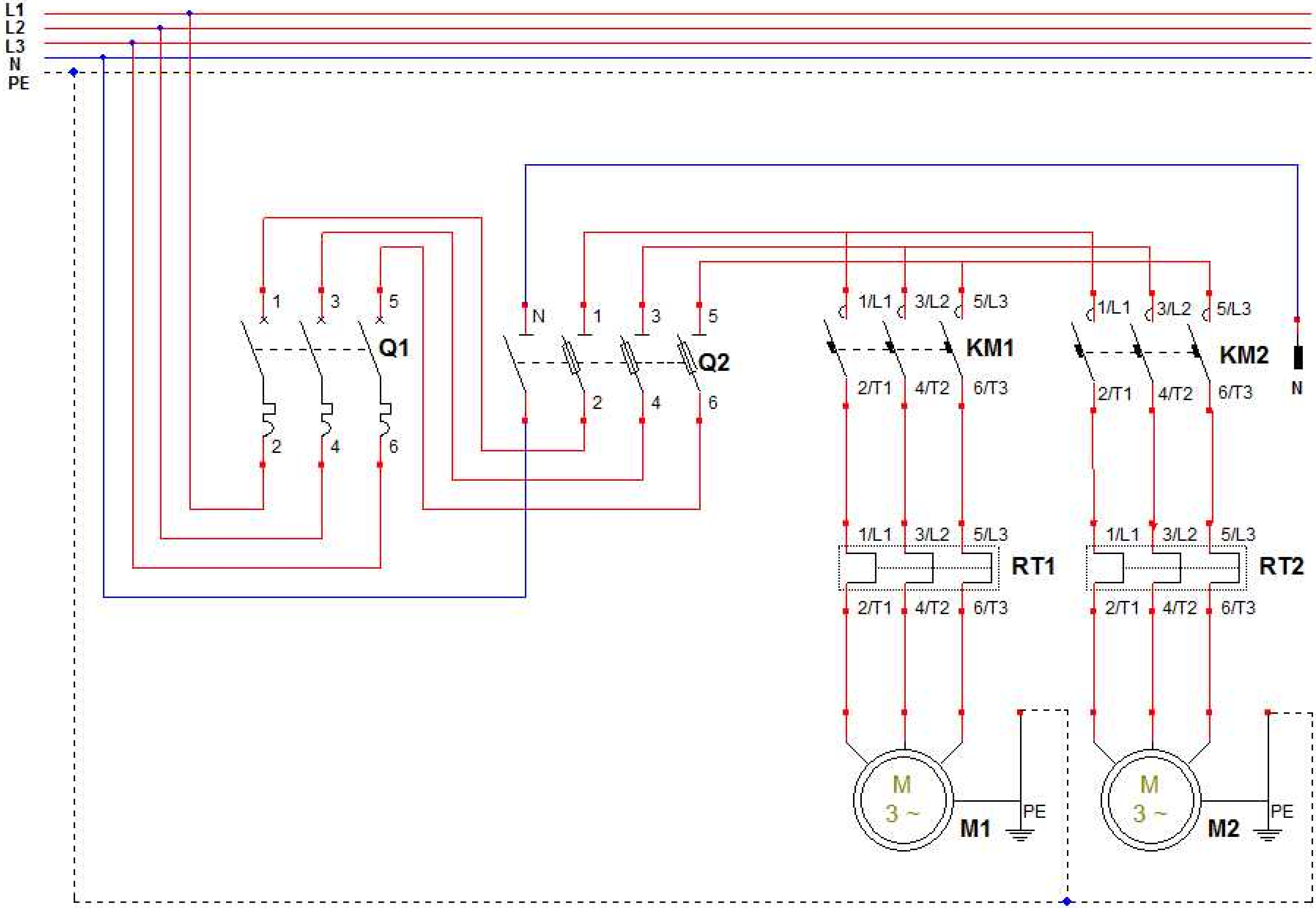


Prog0

Declaration Type	Identifiers	Address	Type	Initial Value	Identifier Comment



4.2 Power Circuit



2010-09-24
5012602300-2LC0

DELTA ELECTRONICS, INC.

DVP02LC-SL

INSTRUCTION SHEET
安裝說明
安装说明
BILGI DÖKÜMANI

- *Load Cell Module*
- *Load Cell* 秤重模組
- *Load Cell* 秤重模块
- *Load Cell Modülü*

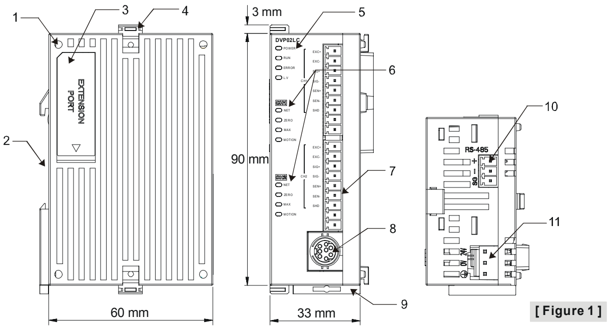
http://www.delta.com.tw/industrialautomation

DVP-1071070-01

Thank you for choosing Delta's DVP series PLC. Delta releases DVP02LC-SL load cell module of weight measurement function. DVP02LC-SL provides 24-bit resolution applicable for 4-wire or 6-wire load cells with various eigenvalues. Therefore, the response time can be adjusted in coordination with each other according to users' needs. On this basis, the market requirements on weight measurement can easily be met.

- This instruction sheet provides introductory information on electrical specifications, general specifications, installation and wiring.
- This is an OPEN TYPE I/O module and therefore should be installed in an enclosure free of airborne dust, humidity, electric shock and vibration. The enclosure should prevent non-maintenance staff from operating the device (e.g. key or specific tools are required to open the enclosure) in case danger and damage on the device may occur.
- DO NOT connect the input AC power supply to any of the I/O terminals; otherwise serious damage may occur. Check all the wiring again before switching on the power. Make sure the ground terminal ⏚ is correctly grounded in order to prevent electromagnetic interference.
- The tightening torque for I/O terminal block is 1.95 kg-cm (1.7 in-lbs). Use 60/75°C copper conductors only.

■ Product Profile & Dimensions



[Figure 1]

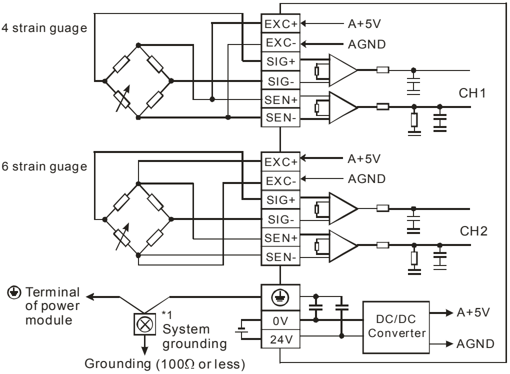
1. Mounting hole of the I/O module	2. DIN rail mounting slot (35mm)
3. I/O module connection port	4. I/O module clip
5. Status indicator (POWER, RUN, ERROR and L.V)	6. Function status indicator (NET, ZERO, MAX, MOTION)
7. I/O terminals	8. RS-232 port
9. Mounting slot clip	10. RS-485 port
11. DC power input	

■ I/O Terminal Layout

EXC+	EXC-	SIG+	SIG-	SEN+	SEN-	SHD	●	●	EXC+	EXC-	SIG+	SIG-	SEN+	SEN-	SHD	●	●
CH1									CH2								

DVP02LC-SL

■ External Wiring



[Figure 2]

Note 1: Please connect the ⏚ terminal on both the power module and Load Cell module to the system earth point and ground the system contact or connect it to the cover of power distribution cabinet.

■ Electrical Specifications

Load cell module	Voltage output
Rated power supply voltage/ power consumption	24 VDC (-15 to +20%) / 3W
Voltage Boundary	18 to 31.2 VDC
Max. current consumption	125 mA
Input signal range	± 40 mVDC
Sensibility	+5 VDC +/-10%
Internal resolution	24 bits
Communication port	RS-232, RS-485
Applicable sensor type	4-wire or 6-wire strain gauge
Temperature coefficient span	≤ ± 50 ppm/K v. E
Temperature coefficient zero point	≤ ± 0.4 μV/K
Linearity error	≤ 0.02%
Response time	2, 10, 20, 40, 80 ms × channels
4 measuring ranges	0 to 1 mV/V, 0 to 2 mV/V, 0 to 4 mV/V, 0 to 6mV/V
Max. distance for connecting to load cell	100 M
Max. current output	5 VDC * 300 mA
Permitted load cell resistance	40 to 4,010 Ω
Common mode rejection (CMRR @50/60 Hz)	≥100dB
Dynamic value filter	Setting range: K1 to K5
Average value filter	Setting range: K1 to K100
Isolation method	500 VAC between digital circuits and Ground 500 VAC between analog circuits and Ground 500 VAC between analog circuits and digital circuits

Load cell module	Voltage output
Series connection to DVP-PLC MPU	Connectable to the left side of MPU, numbered from 100 to 107 according to the position of module from the closest to farthest to MPU.
Operation / storage temperature	Operation: 0 to 55°C (temp.), 50 to 95% (humidity), pollution degree 2 Storage: -25 to 70°C (temp.), 5 to 95% (humidity)
Vibration / shock immunity	International standards: IEC61131-2, IEC 68-2-6 (TEST Fc)/ IEC61131-2 & IEC 68-2-27 (TEST Ea)

- Complying with DIN1319-1, the tolerance of measured value should be ≤ 0.05% under 20°C + 10K temperature range.
- When the corrected ambient temperature and the actual temperature have a difference of more than 10°C, it is suggested that you re-correct it.

■ Control Register

CR#	Add.	Attrib.		Register name	Explanation
#0	H1000	O	R	Model name	Set up by the system: DVP02LC-SL model code = H'4206
#1	H1001	O	R	Firmware version	Display the current firmware version in hex.
#2	H1002	O	R/W	Characteristic value	Mode 0 (H'0000): 1 mV/V Mode 1 (H'0001): 2 mV/V, default Mode 2 (H'0002): 4 mV/V Mode 3 (H'0003): 6 mV/V
#3	H1003	O	R/W	Reaction time for measurement	Mode 0 (H'0000): 2 ms Mode 1 (H'0001): 10 ms Mode 2 (H'0002): 20 ms Mode 3 (H'0003): 40 ms Mode 4 (H'0004): 80 ms, default
#4	H1004	O	R	Average value of all channels	Sum up CH1 average value and CH2 average value and equalize them. Equation: (CH1 average value + CH2 average value)/2
#6	H1006	X	R/W	CH1 to CH2 read tare weight	Read present average value as tare weight value bit0: CH1; bit1: CH2; bit2 to bit15: reserved
#7	H1007	O	R/W	CH1 to CH2 gross/net weight	Display present weight as Gross (K0) or Net (K1). bit0 to bit3: CH1; bit4 to bit7: CH2; bit8 to bit15: reserved. Take CH1 for example: bit3 to bit0 = 0000, gross; bit3 to bit0 = 0001, net; bit3 to bit0 = 1111, channel disabled.
#8	H1008	O	R/W	CH1 tare weight	The user can write in the weight or read it by commands. Default: K0; Range: -K32,768 to K32,767.
#9	H1009	O	R/W	CH2 tare weight	
#10	H100A	O	R/W	CH1 average times	Default: K10; Range: K1 to K100. When the set value exceeds the range, it will automatically be changed to K1 or K100.
#11	H100B	O	R/W	CH2 average times	
#12	H100C	X	R	CH1 average weight	Display average weight.
#13	H100D	X	R	CH2 average weight	
#14	H100E	X	R	CH1 present weight	Display present weight.
#15	H100F	X	R	CH2 present weight	
#16	H1010	O	R/W	CH1 standstill times	Default: K5 Range: K1 to K500
#17	H1011	O	R/W	CH2 standstill times	

CR#	Add.	Attrib.		Register name	Explanation
#18	H1012	O	R/W	CH1 standstill range	Default: K10 Range: K1 to K10,000
#19	H1013	O	R/W	CH2 standstill range	
#20	H1014	O	R/W	CH1 decimal place	Default: K2 Range: K1 to K4
#21	H1015	O	R/W	CH2 decimal place	
#22	H1016	O	R/W	CH1 unit of measurement	Enter max. 4 ASCII words. CR#22, CR#24: High word CR#23, CR#25: Low word
#23	H1017	O	R/W	CH1 unit of measurement	
#24	H1018	O	R/W	CH2 unit of measurement	
#25	H1019	O	R/W	CH2 unit of measurement	
#26	H101A	X	R/W	Weight correction command	For the user to correct the weight. Default: H'0000 H'0001: CH1 Reset to zero command H'0002: CH1 Weight base point command H'0003: CH2 Reset to zero command H'0004: CH2 Weight base point command
#33	H1021	O	R/W	CH1 weight base point	For CR#33 to CR#34 default = K1,000; Range: K-32,768 to K32,767 Steps for correction: Take CH1 for example 1: Place no weights on the load cell 2: Set up CR#26 command = "H'0001" 3: Place standard weights on load cell 4: Write the weight of the weights on the plate into CR#33. 5: Set up CR#26 command = "H'0002"
#34	H1022	O	R/W	CH2 weight base point	
#35	H1023	O	R	CH1 max. weight	Set up the max. weight. When the measured value exceeds the set value, error codes will be recorded.
#36	H1024	O	R	CH2 max. weight	
#37	H1025	O	R/W	Upper limit for CH1 zero point check	Reference for reset to zero. When the weight is within this range, the status code will be set to "zero bit", indicating the current zero weight status. Default: K10 Range: K-32,768 to K32,767
#38	H1026	O	R/W	Upper limit for CH2 zero point check	
#39	H1027	O	R/W	Lower limit for CH1 zero point check	Reference for reset to zero. When the weight is within this range, the status code will be set to "zero bit", indicating the current zero weight status. Default: K-10 Range: K-32,768 to K32,767
#40	H1028	O	R/W	Lower limit for CH2 zero point check	
#41	H1029	X	R/W	Saving set value (H'5678)	Save the present set value and write all the set values into the internal Flash for use next time DVP02LC-SL is switched on. H0: No action, Default H'FFFF: Saving is successful H'5678: Write to internal Flash When H'5678 is written in, all set values will be saved in Flash. When the saving is completed, CR#41 will become H'FFFF. If the value written in is not H'5678, it will automatically return to H0, e.g. write K1 into CR# to return to K0.

CR#	Add.	Attrib.		Register name	Explanation
#43	H102B	X	R/W	CH1 filter percentage	Default: K2 Range: K1 to K5 (Unit: 10%)
#44	H102C	X	R/W	CH2 filter percentage	
#45	H102D	X	R/W	CH1 filter average value	Display average weight after filtering. Condition to enable filter: average time ≥ 30
#46	H102E	X	R/W	CH2 filter average value	
#50	H1032	X	R	Status code	b0 (H'0001): CH1 zero weight (empty) b1 (H'0002): CH2 zero weight (empty) b2 (H'0004): CH1 exceeds max. weight (overload) b3 (H'0008): CH2 exceeds max. weight (overload) b4 (H'0010): CH1 stable measured value b5 (H'0020): CH2 stable measured value b6 ~ b15: Reserved
#51	H1033	X	R	Error code	Store all the error statuses. See "Error Code Table" below. Default: H'0000
#52	H1034	O	R/W	RS-232 node address	For CR#52, CR#54 default = 1 Range: K1 to K255 For CR#53, CR#55 default = H'0000; Range: ASCII, 9600, 7, E, 1. See "Communication Format Table" below.
#53	H1035	O	R/W	RS-232 communication setting	
#54	H1036	O	R/W	RS-485 node address	
#55	H1037	O	R/W	RS-485 communication setting	
Symbols: O means latched. X means not latched. R means can read data. W means can write data.					

▲ Error Code Table for CR#51:

bit	Content	Error	bit	Content	Error
b0	K1 (H'0001)	Power supply abnormality	b1	K2 (H'0002)	Hardware abnormality
b2	K4 (H'0004)	CH1 conversion error	b3	K8 (H'0008)	CH1 SEN voltage error
b4	K16 (H'0010)	CH2 conversion error	b5	K32 (H'0020)	CH2 SEN voltage error
b6 ~ b15	K64 (H'0040)	Reserved			

✐Note: Every error status is decided by its corresponding bit, so there might be more than 2 error statuses occurring at the same time. 0 refers to no error; 1 refers to error occurring.

▲ Communication Format Table for CR#53, CR#55:

bit15	bit14~bit8	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0
ACSII/RTU	Reserved	Baudrate				Data length	Stop bit	Parity	

Description					
bit15	ACSII/RTU	0	ASCII	1	RTU
bit7~bit4	Baudrate	0	9,600 bps	1	19,200 bps
		2	38,400 bps	3	57,600 bps
		4	115,200 bps	5	Else none
bit3	Data length (RTU = 8 bits)	0	7	1	8
bit2	Stop bit	0	1 bit	1	2 bits
bit1~bit0	Parity	0	Even	1	Odd
		2	None	3	None