FROM LAYOUT TO MANUFACTURING

FRÁ FYRIRKOMULAGSTEIKNINGU TIL FRAMLEIÐSLU

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Tilgangur þessa verkefnis var að kanna möguleikann á að fækka vinnustundum og auka skilvirkni í hönnun breytilegra tækja og tækjahluta hjá Marel með aðstoð tölvustuddrar hönnunar (CAD) og með aðferðafræði einingarvæðingar (e. modularization).

Þróaður var vinnuferill til að framkalla framleiðslugögn beint upp úr fyrirkomulagsteikningu með hjálp forritunar. Færiband var hannað frá grunni með það í huga að samnýta einingar og ná þannig fram sem mestum sveigjanleika með sem minnstri fyrirhöfn. Prufueintak af færibandinu var framleitt með góðum árangri og þannig gerð prófun á bæði framleiðslugögnum og smíða- og samsetningaleiðbeiningum.

Ferillinn sem þróaður var lofar góðu fyrir framhaldið og gæti reynst gríðarlega mikilvægt skref í áframhaldandi vinnu við að auka skilvirkni, lækka kostnað og stytta afhendingartíma.

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opin ☐ **lokuð** ■ **til:**

Preface

This study was performed in collaboration with and supported by Marel. Marel is the leading global provider of advanced equipment, systems and services to the poultry, fish, meat and further processing industries. Some of the equipment makes extensive use of configurable standard products e.g. conveyors. It is a long-term goal to simplify the design process of these products and thus shorten the delivery time and lower the cost. Until recently the tools required to achieve this goal have been missing. The idea for this project came about after the implementation of the 3D digital factory layout software named Autodesk Factory Design Suite and becoming familiar with the capabilities of parameter-based modeling.

There has furthermore been emphasis on modularization work in Marel in the past few years and lean management has been adopted in both Industry Center Fish IC-Fish and Manufacturing Center in Garðabær. In this project the methodology of modularization and lean management were used to achieve the set goals.

This study could not have been completed in the given time frame without assistance. I am extremely thankful for all the technical support and continuous expert advice, in particular Kristján Pétursson, operational engineer at IC-Fish. I would also like to thank my advisor Arnbjörn Eyþórsson and also Guðbjörg Heiða Guðmundsdóttir and Alexandra Kjeld for their helpful comments.

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Executive Summary

It has been a long term goal at Marel to increase efficiency and to simplify the design process where possible in order to shorten delivery time and lower cost. Modularization was introduced within the company in 2011 to help achieve these goals.

The objective of this study was to investigate whether it is possible to generate manufacturing data automatically from a 3D layout and thus shorten and simplify the mechanical design process in sales projects for the majority of cases in the long term. A pilot case was chosen and run through the new process. Although the process of developing and designing a new concept for conveyors was the most time consuming part of the project, the process itself was the main objective and to create a pathway for other configurable standard products.

This was done through parametric-based design and with the system support of a CAD program, Autodesk Factory Design Suite. An Asset was developed that represents a goose-neck conveyor. The Asset holds a rule that exports relevant information, such as item numbers and dimensions to an Excel sheet. To program required information and data within the ERP system used in Marel, a macro was developed with the in-house software MarelWorks.

A prototype was sent to manufacturing and produced with guidance of an instruction manual that is to cover all configurations of conveyors of a certain form, in this case the goose-neck conveyor.

The results are promising and the method can be used for all design following a set of general rules. The products have to be either standardized or modularized in order to use the developed methods. For what is referred to as configurable standard products, the methodology of parametric design and cut-to-fit modularity is considered to be the most efficient method. As explained in chapter 5.2.1 the 135 standard parts that were designed during this study can form near infinite configurations almost instantaneously, all of them foregoing individual mechanical design.

Whether the product is designed as unchangeable standard, modular or configurable standard (cut-to-fit modular), the key is that the Assets reflect exactly the features of the products they represent and that it should be possible to use parameters in the Asset to refer to part- or module numbers and dimensions if relevant.

Given the positive outcome of the project, it is recommended to finalize the conveyors by developing more assets and put further work into design, both in form of general improvements and in additional modules. Furthermore, it should be evaluated what equipment is to be redefined and redesigned if needed, in order to achieve the long term goal to eliminate mechanical design of 80% equipment in average sold system solution. In this evaluation, it is important to aim for products that fit in the *high volume low complexity* category.

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Glossary

2D	Two Dimensional
3D	Three Dimensional
AFDS	Autodesk Factory Design Suite. 3D digital factory layout software from Autodesk
BOM	Bill of Material
DFM	Design for Manufacturability
DXF	Drawing Exchange Format
CAD	Computer Aided Design
CAM	Computer Aided Manufacturing
Carryways	Support for the belt in the load-bearing travel, see Wearstrip
ERP	Enterprise Resource Planning
Asset	A lightweight 3D block for layout making that represents equipment or modules
IC	Industry Center
iLogic	A programming add-in that is included with Autodesk Inventor
MC	Manufacturing Center
MVP	Minimum Viable Product
PC	Product Center
Returnways	The path the belt follows toward the idler shaft and sprockets
Tacho	Derived from Tachometer. An instrument measuring rotation speed of the belt for the option of tracking a product through the system
Wearstrip	Plastic strips that are added to a conveyor frame to increase the useful life of the frame and the conveyor belting. Also helpful in reducing sliding friction forces

1 Background and Objectives

1.1 About Marel

Marel is the leading global provider of advanced equipment, systems and services to poultry, fish, meat and further processing industries.

Since 2005, Marel has grown significantly through mergers and acquisitions with other companies in the food processing industry. These actions were considered essential to offer a comprehensive portfolio of products and solutions that fulfil customer's needs. This led to an enormous expansion in product range. As a result, the overview of products and transparency of workflows have decreased and the level of complexity has increased. It has been a priority to harmonize the product range structure to obtain a general view within the entire company. For that purpose, Marel started introducing modularization within the company in the year 2011.

Conveyors are an important part of the systems provided by Marel. The conveyors can be defined as configurable standard products. However, the company's growth has led to a larger variety in conveyor design, increased complexity and less standardization.

With more powerful system support and higher technical level manufacturing methods, Marel has become more dependent on these systems and there is a continued need for design of products that should be standard but configurable.

1.2 The Current Workflow from Layout to Manufacturing

When a system solution is sold, it is referred to as *sales project*. In these projects, the design process is split up between the layout design and the mechanical design of individual products. These products typically require modifications or custom add-on equipment required for functionality of the system. These two processes, layout design and mechanical design, are described in chapters 1.2.1 and 1.2.2. The process of mechanical design in sales projects, or the work of *Operational engineer*, is the objective of this study.

1.2.1 Facility Layout Design

In the early years of Marel, the company exclusively developed and produced marine scales. With the growth of the company, it developed other equipment and system solutions as well and started making use of AutoCAD in the purpose of designing facility layouts.

In 2012, Marel introduced the use of the program Autodesk Factory Design Suite (AFDS). After a rather challenging but steadily improving implementation process, it was decided in fall of the year 2013 that from the year 2014 and onwards the Industry Center Fish (IC-Fish) would only publish customer layouts in 3D.

The factory layouts consist of so called Factory Assets. These Assets are lightweight 3D blocks that have the visual appearance and outer dimensions of the products they represent. Assets can be *parametric*, i.e. they can be variable in size and shape and can have variable features, e.g. a Conveyor Asset can be variable in length, height and width, and the motor can be located on the left and right, vertical and horizontal while side guards and flights on belt can be either true or false. Assets can include all those features and more but still remain lightweight. Changes are made easily, fast and efficiently.

The layout design process is entirely dependent on the number and quality of the Assets. What defines a good Asset was not clear in the beginning, since Marel is one of the first customers in the world to adopt AFDS. There were no case studies and the software has furthermore been in continuous development

Today, the status of 3D layout design can be considered to be very good. In many cases, the time frame of 3D layout design is shorter than the top-view 2D layout design was before. After the top-view had been accomplished in the previous 2D workflow, it could be expected to take a week or two to draw up side-views and cross-sections, including room for mistakes, since changes in top-view drawings called for changes in side-view and/or front-view drawings that needed to be carried out manually. In a 3D-layout, all these views and more are available from the beginning, saving time and providing both reliable and more accurate manufacturing data. 3D layouts also provide a clearer picture of the entire system and are as such stronger marketing material, see Figure 1.1.

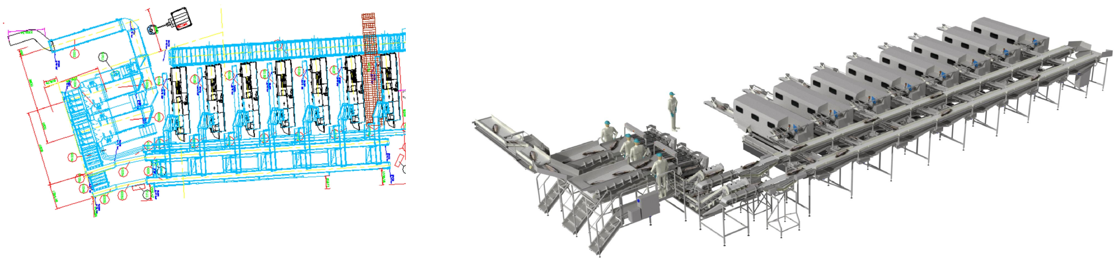


Figure 1.1 2D layout (left) vs 3D layout (right).

The strong status of 3D layout design at Marel today is in author's opinion mainly due to strong focus in IC-Fish during the implementation process and a great effort in building up a good asset library.

The Assets that have been created thus far represent either standard machines or components that cannot be modified, or parametric or configurable blocks that represent items like tables, platforms and conveyors. Parametric assets such as conveyors are expandable in length, height and width and all its features can easily be dependent on just few parameters (see chapter 2.2), e.g. when the length parameter is modified, the number of legs will increase with a longer conveyor or decrease with a shorter one. These simple functions are the basis of this study.

1.2.2 Mechanical Design in Operational Engineering

After a system solution is sold and the layout has been approved, mechanical design can take place. The workflow of getting one conveyor from *fit-for-design* (mechanical) to *fit-for-production* can take from one to two days, depending both on complexity and on the experience and background of the designer. Although new products are usually based on older designs and modular approach has been practiced on some level, the designer's familiarity with older designs and suitable modules varies from one to another.

The growth and globalization of the company and the increased variety in product portfolio has also led to a rapidly growing drawing library, heavily loaded enterprise resource planning system (ERP), and decreased transparency and overview of products and modules. Additionally, in every process step there is the risk of mistakes being made, which can be both time consuming and expensive. As an example, when designing new parts the designer needs to generate 2D drawings, specify the dimensions, write a description for the part, define it as Active in the ERP system and finally generate a .dwg file to enable laser cutting of the part. When modification on a part is required, the designer may need to modify the specified dimensions, add a revision and generate a new .dwg file. Then a new computer aided manufacturing (CAM) program is required and the old one should be deleted. If the new .dwg file, the revision or the new CAM program is forgotten, the problem will not be discovered until the part is handed to workshop welding or assembling a few days later. By simplifying the workflow, standardizing and increasing reusability of parts and eliminating process steps, time can be saved and mistakes can be avoided.

The mechanical design process steps are shown in Figure 1.2.

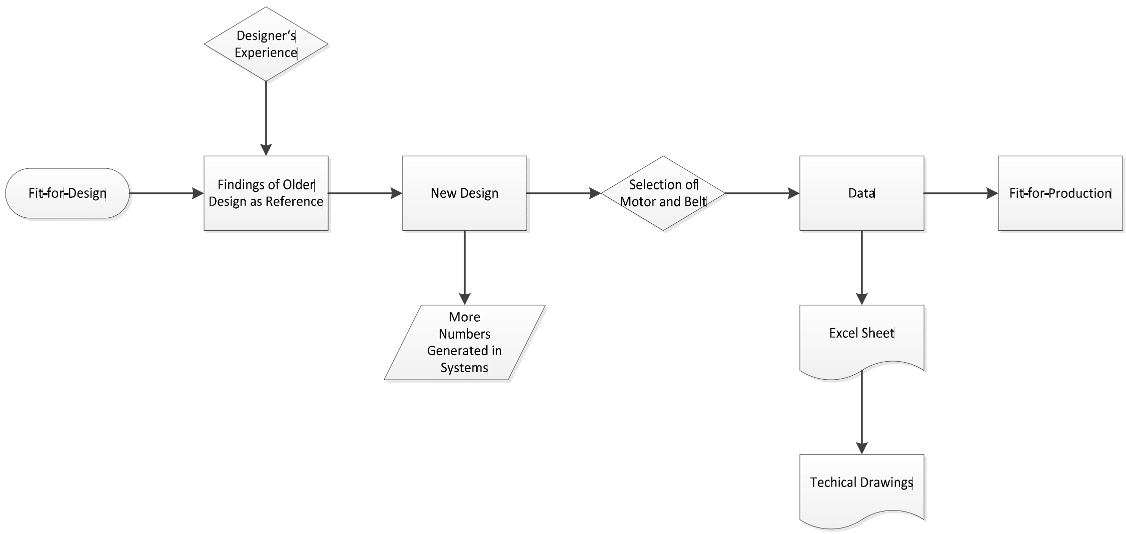


Figure 1.2 Diagram of current workflow of operational engineering

1.3 Problem Statement

The mechanical design process described in chapter 1.2.2 was analyzed, revealing the following disadvantages:

A. Workflow is not standardized and well defined, experience has too much weight.
B. Overview of products and transparency in workflow is lacking.
C. Building Blocks (Modules) are not standardized sufficiently and not established enough.
D. The process is too time-consuming for *standard configurable products*.
E. More process steps allow for more mistakes and errors, thus more waste and delays.
F. Many new numbers generated every day in ERP system and a rapidly growing drawing library, causing even less overview and transparency.

1.4 Goals and Objectives

The goal of this project is to investigate whether it is possible to generate sufficient manufacturing data automatically from a 3D layout and thus shorten or eliminate the mechanical design process in sales projects. The long-term objective is that this can be applied for the majority of Marel's sales projects. For this purpose, a pilot case was chosen and an Asset developed that can generate all the necessary manufacturing data, including standard instructions that cover all possible variants.

The objective of this project is not to revolutionize the current workflow and system support but to develop a method that can easily be assimilated into current systems and can be implemented without much effort.

For better comprehension of the current workflow and for comparison, the current process from layout to manufacturing (as seen on Figure 1.2.) was followed from the beginning to the end. A complete conveyor was designed in SolidWorks and made *fit-for-production* in the ERP system.

After gaining familiarity with both the current workflow and the capabilities of parametric assets, it was looked into which process steps of the current workflow could be eliminated, see Figure 1.3.

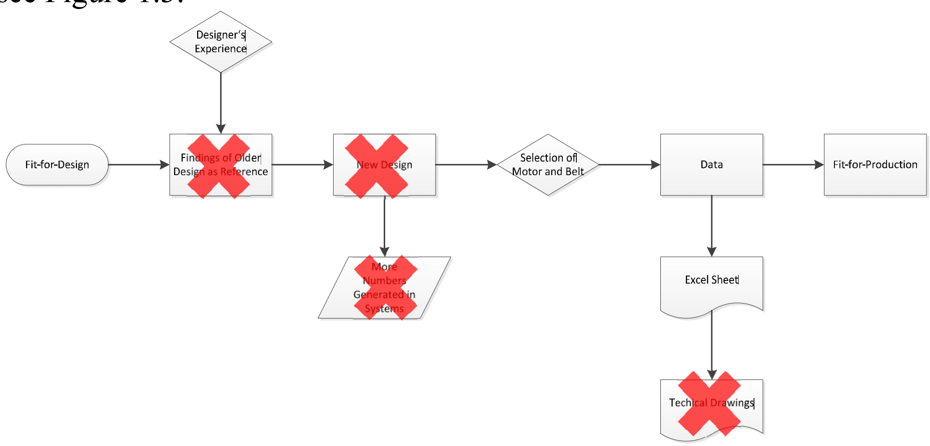


Figure 1.3 Simplified Diagram of Current Workflow of Operational Engineering

2 Theoretical Background

In this section, the theories and methods used to meet the projects goals are reviewed. In order to automate the individual design process, the products need to be well defined and broken down into modules. Then relevant information, such as drawing numbers of required modules, quantity of parts and dimensions of cut-down material needs to be accessible. This can be achieved through the control of parameters.

2.1 Modularization

What is gained with modularization is the ability to offer greater variety in products with as little effort as possible. This is done by breaking the products into building-blocks referred to as modules. When doing so, it is essential to standardize interfaces in order to gain reusability of the modules. Figure 2.1 presents six different types of modularity, explained below.

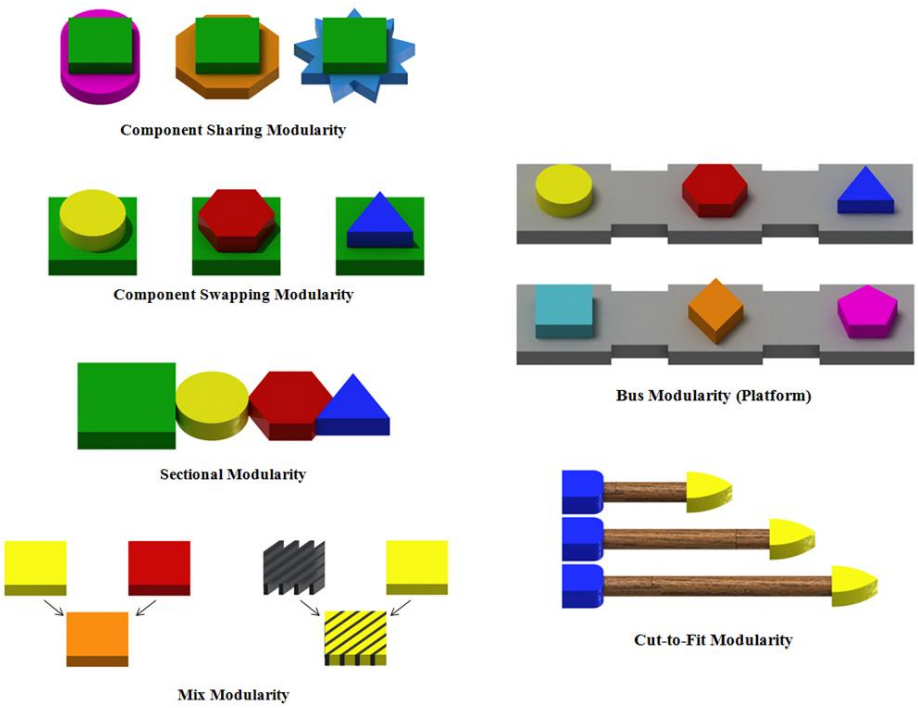


Figure 2.1 Six Different Types of Modularity

Component sharing modularity**:** The same component is shared across product families. An optimal approach to this modularity is in a product line that already has a variety of components, thereby reducing number of parts and cost (Pine, 1993).
Component swapping modularity**:** A complement of the component sharing modularity, both are using the same components to span product variants and product families. Here, different components are paired with a basic product, therefore able to create as many products as number of components allow. (Pine, 1993).
Sectional modularity**:** All modules are combined in any way as long as they are connected at standard *interfaces*. Therefore this is the modular type that brings the greatest degree of variety and customization (Pine, 1993).

***Cut-to-fit Modularity*:** Modules can be adapted by changing their size to fit the customer's demands. This modularity brings great value to customers who need components that can be continually varied to match wants and needs of individuals (Pine, 1993).
***Bus Modularity*:** A standard product is used as a platform where different kinds of components can be attached. (Pine, 1993).
Mix Modularity: A form of modularity where modules lose their unique identity when combined. A common example of mix modularity is custom blended paint. (Springer Reference, 2014)

When companies are dealing with mass customization, modularization is an efficient method to enable multiple product variations while keeping costs low. (Eager A., Elsam K., Gupta R., Velinder M., 2010). Instead of specially design products and solutions for each customer, or spend effort in modifying previously sold products, selecting predefined modules together into a solution will increase optimization of products (Sigdís Ágústsdóttir, Thelma Hrund Kristjánsdóttir, 2013). Although modularization is sometimes referred to as a new product development strategy (Mikkola, J.H., 2001) the concept is not new at all.

The Danish company LEGO presented its famous LEGO brick in the year 1953 (www.lego.com). The company's long lasting success is based on the fact that their principal rule for design has never changed. The holes and studs have standard diameters and are always spaced apart at the same distance, see Figure 2.2. This fact enables new users of LEGO to make use of older generation's collections because all the bricks, old or new, have a common interface, which is key in modularization.

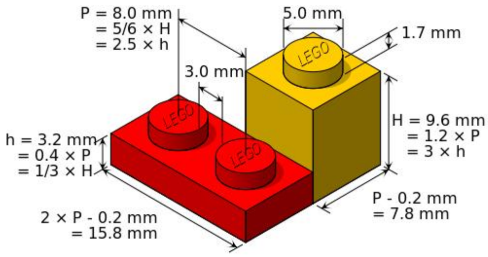


Figure 2.2 Key parameters of LEGO bricks. (Image: www.lowtechmagazine.com)

Another and older example is the company Meccano (see Figure 2.3), first invented by Frank Hornby in 1898, patented under the name "Mechanics Made Easy" in 1901. Meccano is today the only major toy manufacturer in France that still has its production in located in France (www.meccano.com).

Both of these companies have been able to remain true to their principal rules and maintain or strengthen their market position while constantly applying new technologies.

Figure 2.3 Evolution Crane Truck, a modern product from Meccano. (Image: www.meccano.com)

2.2 Parametric Design

For the past decades, computer aided design (CAD) software has been used by architects and designers to visualize their design, design for computer numerical controlled (CNC) machines, cut down prototyping time with digital prototyping and speed up the time-to-market, to name but few benefits of CAD systems.

Parametric design is a fast-growing development of CAD that lets users specify key parameters of their model and make changes interactively. The relationship between parameters is defined and whenever changes in key parameters are made, other parameters of the model will react and update automatically, based on pre-set associative rules. Essentially, it is a form of computer-aided design that allows architects or designers to modify their designs interactively through quick and easy edits (Jabi, 2013; Waguespack, 2013). Parametric design therefore not only a simple and efficient method of designing, but also a valuable tool for meeting market demands easily in times of increased mass customization.

The CAD software Autodesk Inventor is described as *first and foremost 3D parametric modeling software* (Waguespack, 2013). In addition to the basic parametric design concepts, it comes with a programming add-on named iLogic. iLogic enables Inventor users to extend and enhance the design capabilities and automate design tasks.

An example of parts with parametric driven dimensions in sketch is shown in Figure 2.4.

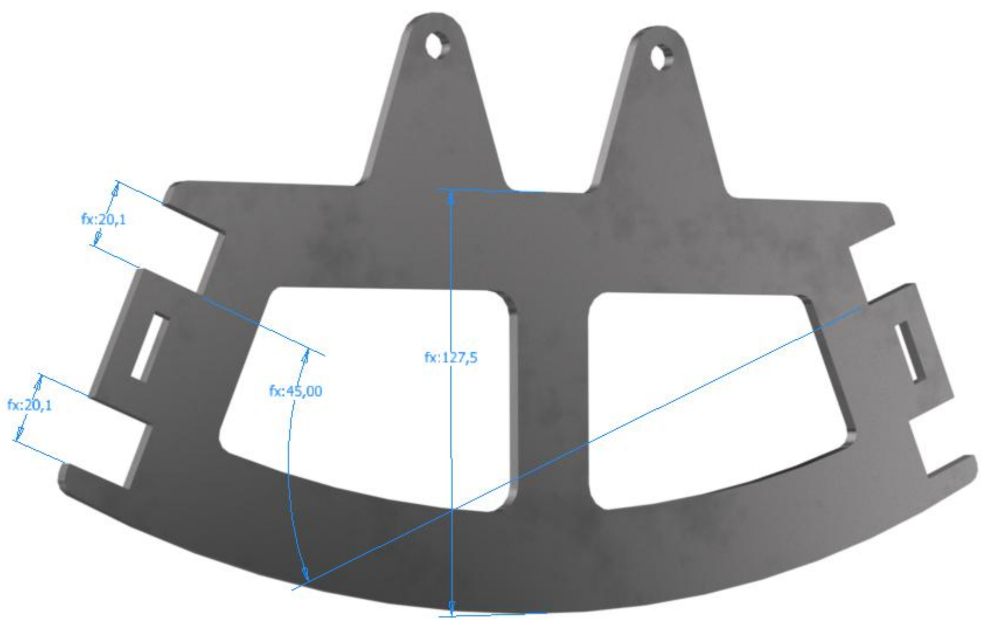


Figure 2.4 Example of equation- or external parameter driven dimensions

3 Materials and Methods

This section explains the work of the project. It was clear early in the process that the main objective, developing a method to generate information automatically and exchanging that information between formats and systems, could be achieved. In order to obtain the best results and to leave the fewest loose ends, most of the effort was put into design, both in Inventor, to establish the relationship between model parameters, and in SolidWorks, to redesign all parts. The work included making of technical drawings, generating files for the computer aided manufacturing (CAM) systems and to generate information for each part and module in the ERP system, Microsoft Dynamics Ax, see Figure 3.1.

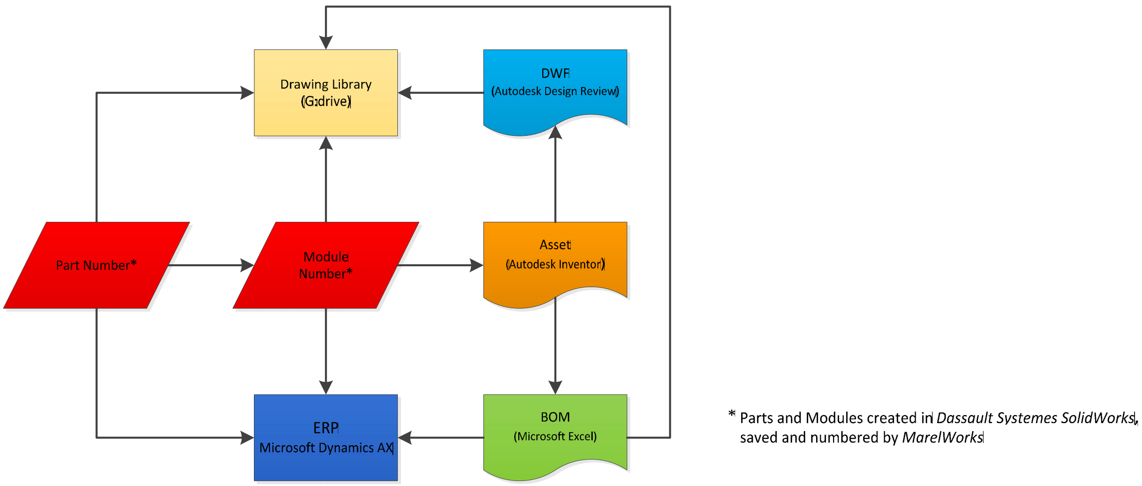


Figure 3.1 Overview of systems and deliverables

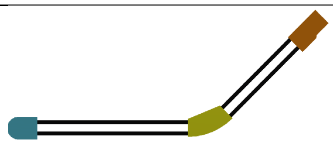
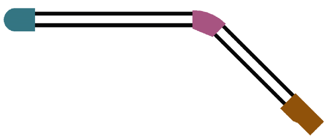
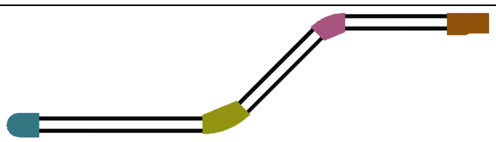
3.1 Choice of Pilot Case

In order to fully try the method under investigation, a full-scale product was developed during the timeframe of this study, from design to manufacturing.

Marel manufactures a number of conveyors of different shapes and sizes, depending on the needs of the customer, see Table 3.1. For the purpose of this study, a goose neck conveyor was chosen as a pilot case. This decision was based on the following criteria:

- Conveyors are common in all systems and the understanding of its functions and value is common amongst stakeholders (sales, engineering, manufacturing, service, customers, etc.)
- Conveyors are for customers usually considered to be non-value-adding products in comparison with the equipment they usually accompany. They have a low profit margin and are considered expensive.
- The goose neck conveyor is ideal to fully demonstrate the capacity and efficiency of the method since its structure includes all modules necessary for other conveyor forms, i.e. straight, incline and decline, see Table 3.1.
- To avoid the risk of developing a concept incompatible with other forms of conveyors due to unsuitable or complex interfaces, a composite conveyor was chosen.

Table 3.1 Overview of conveyor forms.

Description	Image	Included Modules			
Straight		Idle-End			Motor-End
		Straight Run (Cut-to-Fit)			
Incline		Idle-End	Incline		Motor-End
		Straight Run (Cut-to-Fit)			
Decline		Idle-End		Decline	Motor-End
		Straight Run (Cut-to-Fit)			
Goose-Neck		Idle-End	Incline	Decline	Motor-End
		Straight Run (Cut-to-Fit)			

3.1.1 Limitations and Configuration

For the purpose of this study and with the given timeframe, the new design method was developed with the following limitations:

A. The design was completed for a limited option of belt widths (see Table 3.3)
B. Motor and belts are selected afterwards, i.e. selection not generated from layout.
C. The leg structure is not optimized through the layout and might need adjustment during manufacturing.
D. Drip pans were excluded in the project.
E. Tachometric sensor was excluded (needs to be selected manually)
F. No structural calculations or analyses (cost, manufacturing time etc.) were performed in the decision process for raw materials in the conveyor structure.

The result is what the product development theories refer to as *minimum viable product* (MVP).

3.2 Developing Layout Design Assets

Designing a lightweight parametric model as a draft for final design proved to be a helpful method. For comparison, many employees in Marel use 2D design software, e.g. AutoCAD, to make first drafts of what is then later designed in detail. Having the first reference drafts in 3D from the beginning has obvious advantages. The *iterative* design process was thus executed in following steps:

1. Development of an Asset draft.
2. Review of the Asset and its main features and functions.
3. Design of fully detailed model in Inventor.
4. Review of the completed model.
5. Design of all parts and assemblies in SolidWorks.
6. Design of a new Asset with modifications needed after discoveries in the process of detail designing.

3.3 Criteria for Design of the Conveyor

Since no existing conveyor design could be applied to the concept without modification, there was a need for redesign.

3.3.1 Choice of Raw Material in the Conveyor Structure

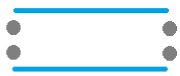
Raw Material in the Conveyor Frame

It was considered essential to use steel bars in the sides of the structure, so that length parameters would be dependent on sawing the raw material and not on laser cutting and use of bending machine. Neither the design of flat patterns nor any CAM programming is required for cutting the raw material. Also, the time of laser cutting and bending is eliminated and more importantly, the waiting time before the sides are being cut or bended is eliminated. What is gained with this is known as *cut-to-fit modularity,* see figure 2.1. Cut-to-fit modularity gives wide variability and increased accuracy for what is needed (down to 1mm or far beyond the tolerance in most layouts), with minimum effort and decreased complexity in the workflow.

The selection of raw materials used in the structure was carried out in a meeting with representatives of mechanical designers in Operational engineering and Innovation in the IC-Fish department. The meeting discussed the advantages and disadvantages of bar type options presented in Table 3.2.

It was decided to avoid hollow sections in the product zone (inside the belt) which can be argued from a hygienic point of view. Hollow sections also require closing all ends which means longer welding paths. Thin strips have too complex interfaces for incline or curved conveyors. Round bar structures have also become increasingly more common in conveyors from Marel. Thus, round bars were selected as the construction material for the pilot case.

Table 3.2 Different types of steel bars available for the conveyor structure.

Bar Type	Cross Section
Round tubes	
Square tubes	
Round bars	
Thin strips	

Belt
Steel

Structures using round bars can be found in Marel's infeed conveying systems for whole salmon. This conveyor type was used as reference in the beginning of the design process, and both round bar diameter (Ø20mm) and spacing between cross beams (330mm) were adopted in the new design. From a structural point of view, this is far beyond requirements for narrower conveyors, but the advantages gained with uniform material and dimensions throughout all belt widths is more important.

Raw Material in Leg Structure

Regarding the selection of raw material in leg structure, it was also essential to use steel bars since leg height can vary greatly between conveyors. The building material needs to be cut down in length without effort, time delays and complexity.

While hollow sections were off the table in the selection of raw material in the conveyor frame, i.a. for hygienic reasons, the legs are defined as a different hygienic zone because they are outside and below the product area.

From structural point of view, tubes give the most rigid structure in comparison with its mass.

It has become more common in the past years at Marel to use round tubes in structures, especially for the salmon industry which actually has the most stringent requirements regarding hygienic design. Round tubes were therefore considered, but it was decided that square tubes were better suited because of their level surfaces which makes them much simpler to work with as construction material, see figure 3.2

Figure 3.2 Comparison of Interfaces on Round- and Square Tubes.

3.3.2 Scope of Designed Configurations

When the choice of raw material in the sides had been made, the design of the components could start. At first it was essential to determine the scope for the pilot case. As mentioned in Chapter 3.1.1, a limited number of belt widths was used, see Table 3.3.

Table 3.3 Scope of Conveyor Design in Pilot Case.

	Belt widths	Angles	Belt Series	Side guard heights
Options	305mm	6°	S800	75mm
	356mm	8°	S1600	100mm
	508mm	10°	S2400	150mm
	610mm	12°		200mm
		15°		
		30°		
		45°		
		60°		
Number of options	**4**	**8**	**3**	**4**

3.3.3 Criteria for Crossbeams Design

Since different belt series affect the sprocket type and would therefore multiply the number of variants in the motor-end modules, it was decided to exclude the sprockets from the module numbers and select them separately. When the belt is selected in the spread sheet afterwards (see chapter 3.2), sprocket type and quantity are generated automatically. That way it is possible to have the recommended number of sprockets (see table 3.4) for all cases without effort or complexity. Cross beams however will be kept the same for all belt series in all forms (e.g. straight, goose neck or curved) for simplification. Series 1600 will set the standard for the rest of the belt series since it has the highest requirements, see table 3.4.

Table 3.4 Recommended numbers of sprockets, carryways and returnways. (Table Derived from Intralox Engineering Manual.)

	Series	S800			S1600			S2400		
		Sprockets	Carryways	Returnways	Sprockets	Carryways	Returnways	Sprockets	Carryways	Returnways
Belt Widths	**305**	3	3	2	**3**	**3**	**2**	3	3	2
	356	3	3	3	**5**	**4**	**3**	3	3	3
	508	5	4	3	**5**	**5**	**3**	5	4	3
	610	5	4	3	**7**	**5**	**3**	5	4	3

At Marel, after decades of experience, the recommended number of returnways will usually be ignored in belt widths less than 500mm. When belt has flights, the third returnway requires a cut out in the flights. This is usually does not apply to narrow belts, and the flight itself adds support and rigidity to the belt. Figure 3.3 explains where sprockets, carryways and returnways are used.

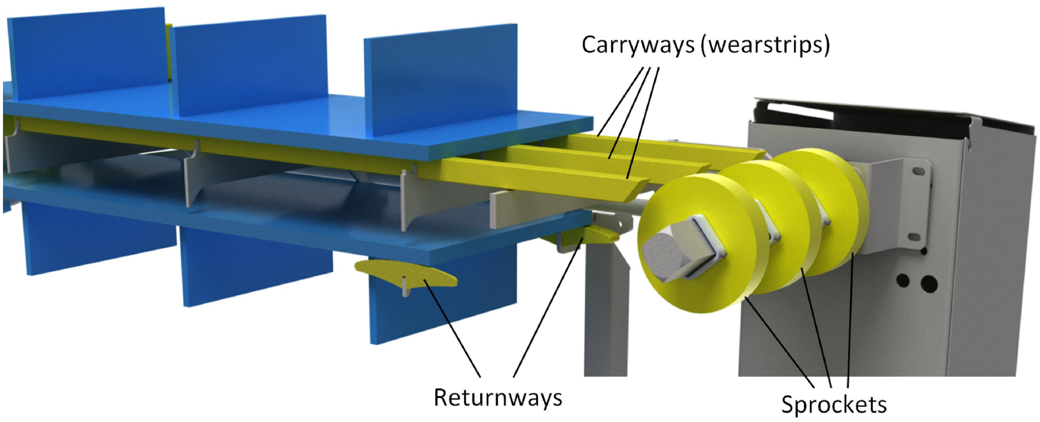


Figure 3.3 Carryways, Returnways and Sprockets.

3.3.4 Lengths of Round Bars in Straight Runs

A consensus on dimensions specifications is essential. When using top-view drawings from 2D layouts, it was common that length was defined from the edges on both sided but it is usually considered better to specify the length from the center of drive shaft to the center of idle shaft, since it is easier to measure accurately, see Figure 3.4.

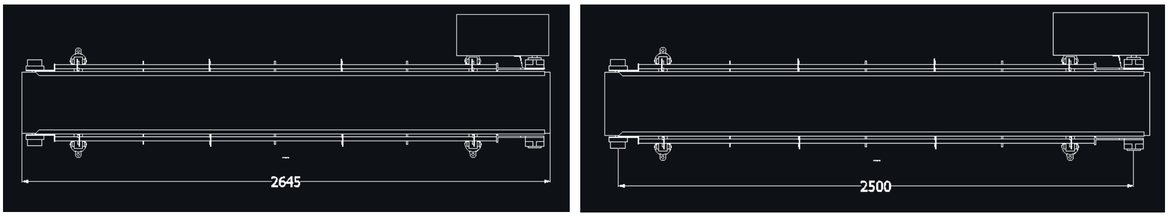


Figure 3.4 Different specification of the same conveyor.

As for the goose neck conveyor, the reference points for length values are at the center of the shafts at the ends and where the belt begins to curve at the incline- and decline modules, i.e. where straight-runs are in plane, see Figure 3.5.

Height parameters represent the dimension from the floor to the top of the belt on horizontal sections.

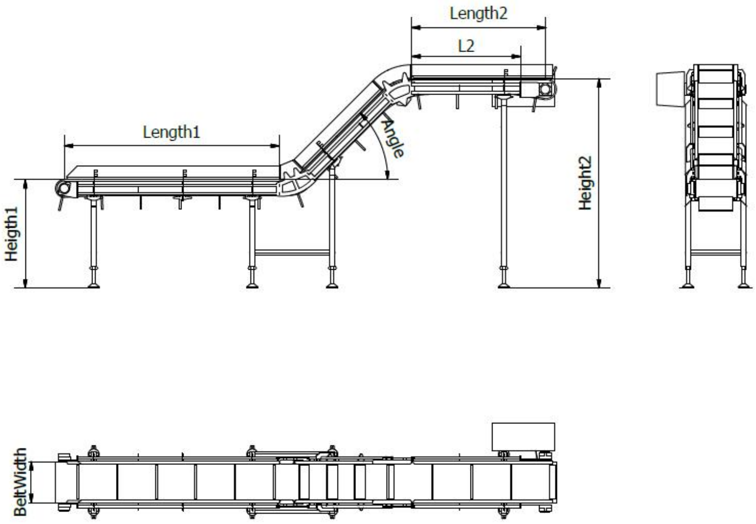


Figure 3.5 Specification of key parameters.

In both sides of both incline- and decline modules, the round bars begin and end at the same point as the belt begins to curve. Generating the length of round bars in the horizontal straight runs was therefore relatively.simple. For the first straight run (Length 1) the round bar length is defined as L1=Length1-96mm, see figure 3.6.

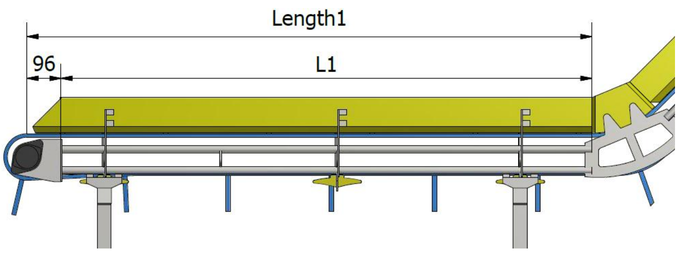


Figure 3.6 Length of round bars in first straight run.

The length of round bars in the second straight run (the slope) is dependant on the angle and the difference between Height1 and Height2. A reference parameter was created to calculate the correct lenght of the round bars: Length3=HeightDifference/sin(Angle), see Figure 3.7

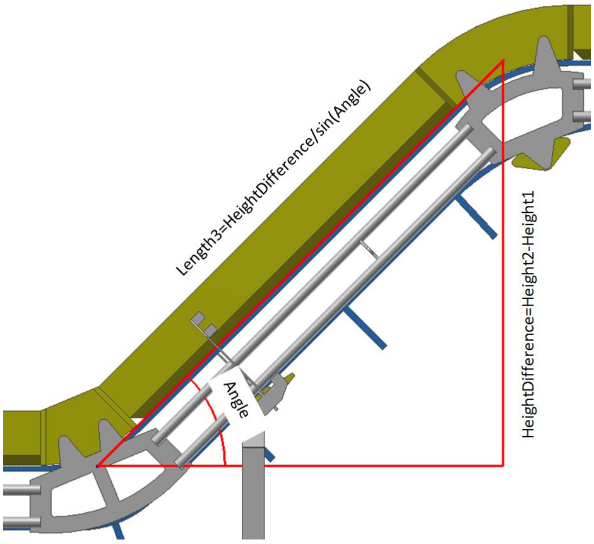


Figure 3.7 Length3 reference parameter.

Then the relation between the parameter Length3 and the actual cut length of the round bar, refered to as L3, was found using trigonometric calculations, see reference dimensions used in calculations in Figure 3.8.

A1 = 314,5 mm + (118 mm * tan(Angle / 2 ul))
a1= (A1) * sin(Angle)
A2 = 272,5 mm + (118 mm * tan((Angle / 2 ul)))
SquareTubeLengthLegs3 = A1 + (A1 * cos(Angle)) - (35 mm * cos(Angle)) - 40 mm
Leg3Height = Leg1Height + a1 + 6,45

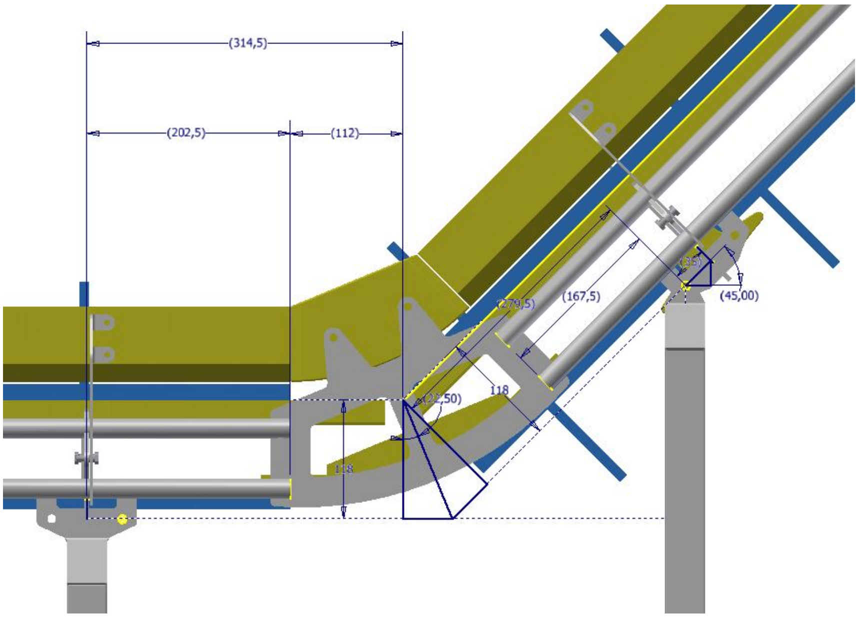


Figure 3.8 Reference dimensions on Incline Module.

3.3.5 Spacing between Cross Beams and Legs

A significant increase in length on a straight run in the conveyor requires an increased number of cross beams and legs, which can easily be determined through parametric-based design. The Rectangular Pattern feature is used for this. Features/Solids and directions are selected, and appropriate values are filled in in boxes for spacing and quantity, see figure 3.9

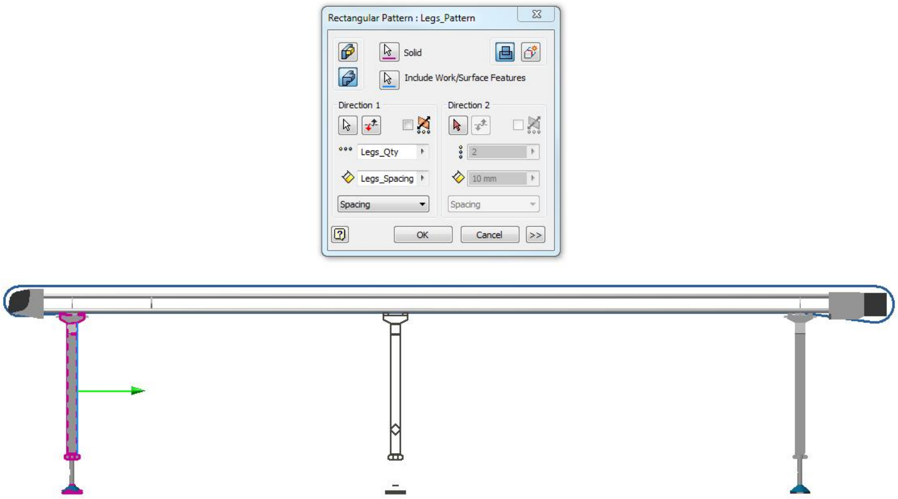


Figure 3.9 The Rectangular Pattern Feature

A simple method to calculate quantity and adjust leg spacing is the following:

`Legs_Qty=Round(Length-Indent1-Indent2)/Legs_Spacing`
where
`Leg_Spacing=(Length-Indent1-Indent2)/(Legs_Qty-1)`, see figure 3.10

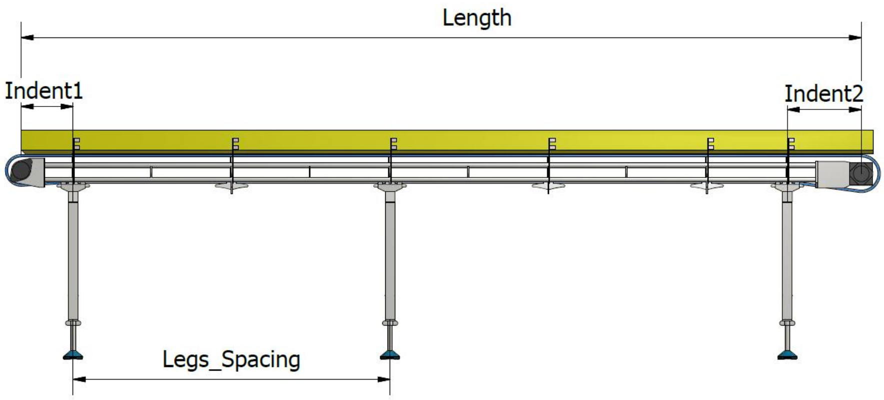


Figure 3.10 Definition of Parameters for Legs_Pattern

In this case the spacing will be variable, causing always the same dimension between legs, regardless of leg quantity or the length of the straight run. However it was decided to have a fixed distance between crossbeams in the conveyor frame. This is for simplification, as it benefits the manufacturing processes to have always the same spacing. It is also a great advantage to have fixed spacing in terms of designing other components or modules that can be attached to the conveyor, such as drip-pans, take-up devices or center-drive modules.

It was also decided that legs should preferable be located where crossbeams are, and as equally spaced as possible. Therefore the rule looks like this:

```
Legs_Qty = Round((Length-Indent1-Indent2)/NominalSpacing)
a = (Length-Indent1-Indent2)/Legs_Qty
x = Round(a/330)
Legs_Spacing = x * 330
End If
```

For the *minimum viable product* (MVP) that was designed, produced and above all used as an instrument to try out a new process during this project, there was no time for explicit evaluation of the dimensions.

3.4 Generating Data from the Layout to the ERP System

The concept of parametric design is the ability to control models in a quick and easy way using just a few key parameters. When a key parameter value is changed it automatically changes other dependent parameters, either in direct relation, see Figure 3.6:

```
L1=Length1-96
```

or with the help of programming in iLogic:

```
If BeltWidth = "305" Then
IdleEnd_Module = "0008-014-10004-03"
Else If BeltWidth = "356" Then
IdleEnd_Module = "0008-014-10004-04"
Else If…
…
End If
```

As explained in chapter 2.2 the relationship between different parameters were well known and served as a basis for this project. The main challenge of the project was to program these values automatically within a format that is supported by the systems currently in use in Marel. Currently, an in-house software named MarelWorks is used for exchanging information automatically between Excel, the CAD and the ERP systems. Being able to generate relevant parameter values in Excel format was therefore an important criterion for the project.

When this had been achieved and relevant information had been generated to an Excel list, a new macro in MarelWorks needed to be developed for the purpose of generating an exploded bill of material (BOM) with all necessary information for the ERP system. That new macro was developed by Sigurður Jósef Árnason in Production Technology Center in Marel as requested by the author of this project.

3.5 Drawings

In order to reduce the workload on operational engineers, the need for making new technical drawings for each configuration sold must be eliminated. To keep the workflow as simple as possible it was decided early on in the process to make a standard instruction manual enabling employees of workshop welding and assembling cells to finalize the production of whatever configuration called for without further explanations or instruction.

However, the food environments that the conveyors can be installed into can vary significantly and there could be need for some adjustments in leg structure, as explained in Chapter 3.1.1., point C. The need for adjustments should be identified in the layout design process and discussed at a *start-up meeting*, which is held during the final stages of mechanical design phase, between project managers and manufacturing.

During the timeframe of this study one goose-neck conveyor was produced and in order to avoid *overproduction* in technical instructions, a *MVP* of drawings was published. Useful feedback was provided and adjustments were made on the instructions.

4 Results

In this section, the main results of the work in this project are presented, including presentations of Assets, manufacturing data, technical drawings and manufacturing instructions. Results of the design work performed in SoldWorks, based on the current workflow, are also presented.

4.1 General Results

A prototype, a goose-neck conveyor, was successfully sent to manufacturing through the new workflow, see Figure 4.1. The developed pathway is satisfactory and there is consensus on the method and results, between sales engineers, operational engineers and representatives of the manufacturing center.

Figure 4.1 The finalized prototype. Photo: SIR, April 4, 2014.

During the period of the study, a whole-fish grading system was sold, including two straight speed-up conveyors. It was decided to use that sales project to try out the new workflow. This was a valuable opportunity to further test the new workflow in a real case. This called for some redesign of components and a new Asset for a straight conveyor. As the straight conveyor is much simpler than the goose-neck form and contains only components that are included in the goose-neck conveyor, it took less than half a work day to complete all the necessary work for the straight conveyor in regards to the Assets, the Excel sheet template and the iLogic rules that generate BOM and cut-list.

4.2 Assets

Parametric Assets representing goose neck conveyors were made. These Assets were made exclusively for belt widths of 305 mm, 356 mm, 508 mm and 610 mm. The visual appearance of the Assets displays their main features and demonstrates their main features with sufficient accuracy, such as their cleanability, see Figure 4.2.

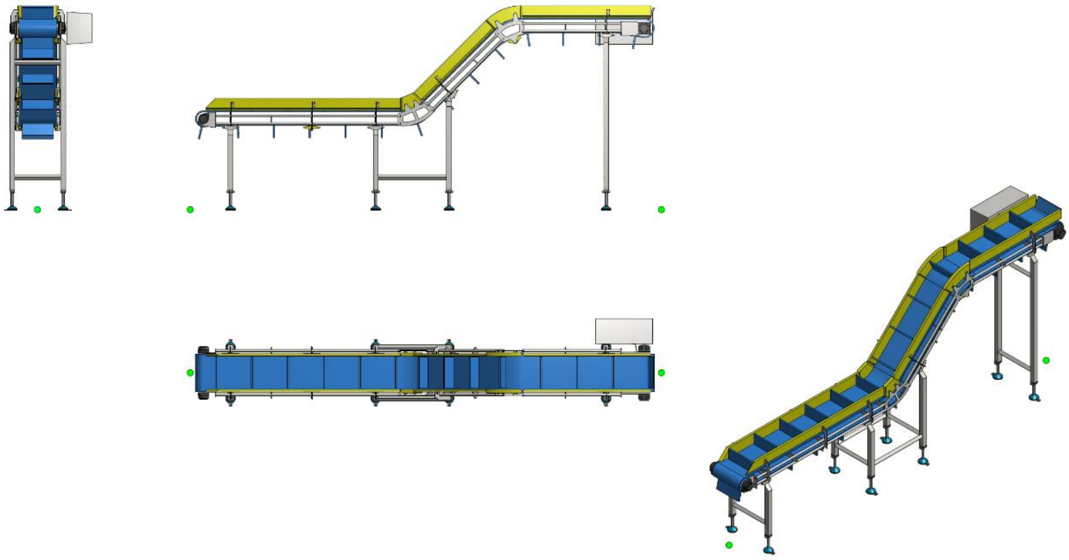


Figure 4.2 Various views of the Assets, roughly displaying the location of connectors.

The key parameters of the assets, selectable parameters in layout design, are as displayed in Figure 4.3. Further explanation of the parameters and their input to manufacturing data and the ERP system are presented in Table 4.1 and Table 4.2.

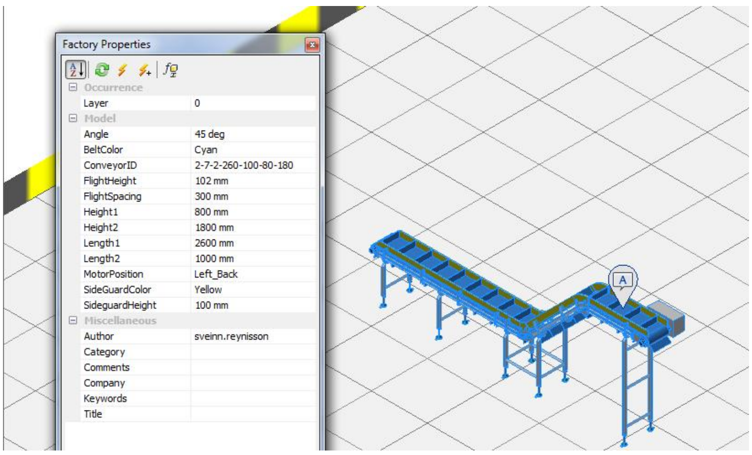


Figure 4.3 The Asset in the Factory Layout enviroment of AFDS.

Table 4.1 Key parameters of the goose-neck conveyor Asset.

Model Parameter	Unit/ Type	Value Type	Values	Affects Parameters
Length1	mm	Type value	Free	L1, CrossBeams1_Qty, CrossBeams2_Qty, H1_Qty, LegModule_Qty, ConveyorID, OrderedBeltLength
Length2	mm	Type value	Free	L2, CrossBeams1_Qty, CrossBeams2_Qty, H2_Qty, LegModule_Qty, ConveyorID, OrderedBeltLength
Height1	mm	Type value	Free	L3, Leg1Height, Leg3Height, W1_Qty, CrossBeams1_Qty, CrossBeams2_Qty, ConveyorID, OrderedBeltLength
Height2	mm	Type value	Free	L3, Leg2Height, Leg3Height, W1_Qty, CrossBeams1_Qty, CrossBeams2_Qty, ConveyorID, OrderedBeltLength
Angle	deg	Multi value list	6, 8, 10, 12, 15, 30, 45, 60	InclineModule, DeclineModule, ConveyorID, OrderedBeltLength, L4, Leg3Height
SideguardHeight	mm	Multi value list	75, 100, 150, 200	SideGuardPartNumber, SideGuardDescr, ConveyorID
FlightHeight	mm	Multi value list	25, 51, 76, 102, 152	None
FlightSpacing	mm	Type free value	Free	None
MotorPosition	Text	Multi value list	Left_Up, Left_Down, Left_Front, Left_Back, Right_Up, Right_Down, Right_Front, Right_Back.	MotorCoverNumber, MotorCoverDescr

As an example of the relationship between parameters, the following changes occur when **Length1** is increased significantly:

- The cut length of the round bars in the first straight run will increase.
- The quantity of crossbeams with belt return support end belt guides will increase
- The quantity of crossbeams 2 will increase.
- The quantity of square tubes in lower legs will increase.
- The quantity of leg module; adjustable legs, clamps and mounting ears will increase.
- The conveyor ID number will change.
- The length of the belt will increase.

Table 4.2 List and description of parameters

Parameter Name	Description	Cell in Excel Sheet
Carryways	Quantity of wearstrips under belt in load-bearing travel.	**B22**
ConveyorID	Identification number of conveyor, unique for each configuration.	**H3**
CrossBeams1_ModuleNumber	Item number of crossbeams 1 in the ERP system	**E9**
CrossBeams1_Qty	Quantity of cross beam modules w. Belt return support	**B9**
CrossBeams2_PartNumber	Item number of crossbeams 1 in the ERP system	**E10**
CrossBeams2_Qty	Quantity of cross beams 2	**B10**
DeclineModule	Item number of the decline module in the ERP system	**E7**
H1_Qty	Quantity of vertical square tubes in lower legs	**B17**
H2_Qty	Quantity of vertical square tubes in higher legs	**B19**
IdleEndModule	Item number of the indle end module in the ERP system	**E5**
InclineModule	Item number of the incline module in the ERP system	**E6**
L1	Cut length of round bars in first straight run.	**F14**
L2	Cut length of round bars in last straight run.	**F15**
L3	Cut length of round bars in slope	**F16**
L4	Cut length of support beams in chair under incline section	**F21**
Leg1Height	Cut length of legs in lower horizontal section	**F17**
Leg2Height	Cut length of legs in higher horizontal section	**F19**
Leg3Height	Cut length of higher leg in chair under incline section.	**F18**
LegModule_Qty	Quantity of Leg Module: Adjustable Legs, Clamps and Mounting Ears (in sets of 2)	**B11**
MotorCoverDescr	Description of motor cover in the ERP system	**D28**
MotorCoverNumber	Item number of the motor cover in the ERP system	**E28**
MotorEndModule	Item number of the motor end module in the ERP system	**E8**
OrderedBeltLength	Ordered belt length	**B31**
SideGuardDescr	Description of side guards material in the ERP system	**D25**
SideGuardPartNumber	Item number of side guards material in the ERP system	**E25**
W1	Cut length of cross beams between legs	**F20**
W1_Qty	Quantity of horizontal square tubes between legs	**B20**

The file size of the Assets is around 4.1 MB each, compared to older versions of the goose neck conveyor that were around 1.9 MB each. The new version, however, demonstrates different designs and displays in more detail, so this is considered to be normal. Experience has shown AFDS users at Marel that there is not a clear a correlation between file size and performance in layout-making, i.e. parameter changes are not necessarily slower in "heavier" assets than in lighter ones.

4.3 Manufacturing Data

When a layout has been finalized and its items defined as fit-for-design, a rule is run that generates a bill of material (BOM) and a cut-list for each conveyor configuration. Relevant information is automatically written into a spreadsheet (see table 4.3) where the item numbers refer to already designed parts and assemblies. Lengths and the quantity of steel bars, round bars or square tubes, are also generated in the same list. If multiple identical conveyors are in the layout they will have the same identification number (ID) and only one Excel sheet is generated for all of them.

Table 4.3 Excel Table Generated from Layout.

				Conveyor 305 45° H800/1550			
con-msgn			**Resp:**	**Customer:**	**Sales ID:**	**Location:**	**Conveyor ID:**
							1-7-2-160-100-80-155
Nr.	Qty		Description	Item Number	Size [mm]	Angles	Comment
1	**1**	**Stk**	**Idle End Module**	**0008-014-10004-03**			
2	**1**	**Stk**	**Incline Module**	**Undefined!**			
3	**1**	**Stk**	**Decline Module**	**Undefined!**			
4	**1**	**Stk**	**Motor End Module**	**0008-014-10003-03**			
5	**5**	**Stk**	**Cross Beam w. Belt Return Support**	**0008-014-10006-03**			
6	3	Stk	Cross Beam	0008-014-20017-03			
7	**3**	**Stk**	**Leg Module - Standard**	**0008-014-10005**			
8	**1**	**Stk**	**Leg Module - Incline**	**0008-014-10008**			
9	**10**	**Stk**	**Fasten. for Sideguard**	**0008-014-10007**			
10	4	Stk	Round Bar 20 mm	702-4301-04011	1504	90°/90°	L1
11	4	Stk	Round Bar 20 mm	702-4301-04011	802	90°/90°	L2
12	4	Stk	Round Bar 20 mm	702-4301-04011	826	90°/90°	L3
13	4	Stk	Square Tube 40x40x2	702-4301-02012	483	90°/45°	H1
14	2	Stk	Square Tube 40x40x2	702-4301-02012	717	90°/45°	H3
15	2	Stk	Square Tube 40x40x2	702-4301-02012	1233	90°/45°	H2
16	5	Stk	Square Tube 30x30x2	702-4301-02009	374	90°/90°	W1
17	2	Stk	Square Tube 30x30x2	702-4301-02009	556	90°/90°	L4
18	3	Stk	Wear Strip PEHD 500 20 x 25	704-0002-12002	1660	90°/90°	Wearstrips L1
19	3	Stk	Wear Strip PEHD 500 20 x 25	704-0002-12002	950	90°/90°	Wearstrips L2
20	3	Stk	Wear Strip PEHD 500 20 x 25	704-0002-12002	927	90°/90°	Wearstrips L3
21	2	Stk	Side Guard PEHD500 20 x 100	704-0003-11003	1620	90°/45°	Sideguards L1
22	2	Stk	Side Guard PEHD500 20 x 100	704-0003-11003	1035	90°/90°	Sideguards L2
23	2	Stk	Side Guard PEHD500 20 x 100	704-0003-11003	807	90°/90°	Sideguards L3
24	**1**	**Stk**	**Motorcover f. Lenze Gkr4 1,1 kW**	**018-0017-00030001**			**Motor Cover**
25	1	Stk	Endwasher for gkr4	018-0017-20580002			
26	1	Stk	Lenze, GKR03 071C32 0,37kW 46Nm 73rpm Motor size=71 i=19,365	727-4003-1015531			Motor
27	8,5	m	S800 Flat Top PP B305 SP239	730-0801-1031812			Belt
28	3	Stk	Intralox Sprocket S800/S850 8 teeth 40x40 square EZ Clean	730-0008-1011907			

Colour	Meaning
Yellow	Generated automatically from layout
Orange	Fill in/Selection of Operational engineer
Green	Generated automatically in relation with selection
White	Fixed (part of template)

An Operational engineer is handed the spreadsheet and fills in few cells and selects motor and belt from a list of options provided in the spreadsheet. Selection of motor and belt was simplified from the existing workflow by limiting the options and storing them in the same document so the need of browsing another system is eliminated and the risk of mistakes in selection reduced.

When selection and necessary modifications have been made, the numbers run through a macro in excel that generates a new expanded BOM in the existing format and publishes all information needed in the ERP system.

4.4 Technical Drawings and Manufacturing Instructions

A standard instruction manual with drawings and comments was produced and is presented in Appendix A. The manual will cover all configurations of a goose-neck conveyor.

4.5 Design of Parts and Modules in SolidWorks

Parts and assemblies within the scope defined in Chapter 3.1.1 were designed and saved to a new folder in Marel's drawing library (no. 0008-014). Overview of the parts can be seen in Table 4.4. See Appendix A for drawings.

Table 4.4 Number of parts and modules designed during the project.

Parts for Conveyor Frame		Production Pool	Variants	Where-used			
				Straight	Incline	Decline	Goose - Neck
Idle End	**0008-014-10004-xx**	**WA**	**4**	**x**	**x**	**x**	**x**
Side in Idle End	**0008-014-90012-01**	**WW**	**1**	**x**	**x**	**x**	**x**
Side in Idle End	0008-014-20042	SM	1	x	x	x	x
Mounting plate for CIP bracket	0008-014-20057	SM	1	x	x	x	x
Side In Idle End - M	**0008-014-90012-02**	**WW**	**1**	**x**	**x**	**x**	**x**
Side in Idle End M	0008-014-20042-M	SM	1	x	x	x	x
Mounting plate for CIP bracket	0008-014-20057	SM	1	-	-	-	-
Shaft in Idle End	0008-014-20045-xx	WA	4	x	x	x	x
Support Wheels for Belt in Idle End	0008-014-20046	TM	1	x	x	x	x
Norm Gear Bearing Ø25	732-3110-25I	PU	1	x	x	x	x
Cross Beam w. Belt Return Support and Side Guide	**0008-014-10006-xx**	**WA**	**4**	**x**	**x**	**x**	**x**
Cross Beams 1	0008-014-20013-xx	SM	4	x	x	x	x
Side Guide for Belt	0004-100-20529	TM	1	x	x	x	x
Undirhald fyrir reim 20x140mm	004-0200-2188	TM	1	x	x	x	x
Cross Beams 2	0008-014-20017-xx	SM	4	x	x	x	x
Incline Module	**Varies**	**WA**	**128**		**x**		**x**
Incline Module Weldment	**Varies**	**WW**	**32**		**x**		**x**
Cross Beams Incline	0008-014-20005-xx	SM	4		x		x
Incline Side	0008-014-20024-xx	SM	8		x		x
Internal Shoe	0008-014-20031-xx	TM	8	x	x	x	x
Incline Sideguard	0008-014-20028-xx	TM	32		x		x
Spacer Ø20/Ø8 L=12 PE	008-0011-2571	TM	1	x	x	x	x
Decline Module	**Varies**	**WA**	**128**			**x**	**x**
Cross Beam Decline	0008-014-20001-xx	SM	4			x	x
Decline Side	0008-014-20021-xx	SM	8			x	x
Internal Shoe	0008-014-20024-xx	TM	1	-	-	-	-
Sideguard for Decline Module	0008-014-20034-xx	TM	32			x	x
Belt Return Support in Decline Module	0008-014-20038	TM	1			x	x
Spacer Ø20/Ø8 L=12 PE	008-0011-2571	TM	1	-	-	-	-
Motor End Module	**0008-014-10003-xx**	**WA**	**4**	**x**	**x**	**x**	**x**
CrossBeam in Motor End	0008-014-20009-xx	SM	4	x	x	x	x
Fastening for Motor	0008-014-20041	SM	1	x	x	x	x
Norm Gear F4 Bearing Ø25 closed	732-3100-1006653	PU	1	x	x	x	x
Norm Gear F4 Bearing Ø25 open	732-3100-1006652	PU	1	x	x	x	x
D-Shaft	0008-014-20062-xx	PU	4	x	x	x	x
Bracket for washing pipe intralox	018-0015-2030	SM	4	x	x	x	x
Spacer Ø16/Ø6,5 L=6 AISI304	007-0009-2375	TM	1	x	x	x	x
Bracket for flange unit	0000-500-20087	PU	1	x	x	x	x
Support for belt	730-0000-1011903	PU	1	x	x	x	x

According to table 4.4, for the decided scope of conveyor design in this project the number of all variants in parts will be 135 and modules will be 268. By removing the side guards in incline and decline modules the parts will remain 135 but module variants will decrease to 76. In order to simplify all procedures, these side guards will be removed in future models.

5 Discussion

In this section, the results of this project are discussed, including limitations and advantages and the potential of further work in this direction.

5.1 Limitations and Configuration of the Pilot Case

As explained in Chapter 3.1.1 there were some limitations to the new design method. Some of them are discussed below.

Configuring other options of belt widths is not a problem, although a limited number of widths were used for this project. It is preferred to add to the Asset library only when the case comes in order to prevent accumulating or *batching* designs that are not needed. The number of parts will not increase that much, but many belt widths may lead to complications and require increased custom design on e.g. chutes and buffers. In addition, it could benefit manufacturing to have as few available belt widths as possible, particularly if conveyor frames are to be welded in a robot in future, in which case fewer belt widths would reduce the number of fixtures and programs.

In regards to the selection of motor and belt, the solution was to store all available options of motors for each conveyor form in the Excel template and make the operational engineer select from a multi-value list. This is a major simplification from current methods and the solution is considered to be satisfactory for now at least.

It was recommended to use “V” or “Y” form of legs for maximum stiffness and minimum contact points to the floor. The automation in the system, the rectangular pattern feature in Inventor, makes it very easy to use an “I” form. Other forms would require complex programming and what is gained with that was not considered to be worth the effort.

Layouts can vary a lot and conveyors can cross and conflict with other equipment in the factory. They might be stand very low or very high, and possibly on uneven floor. There might also be a structure beneath or above the conveyor that they are attached to. The difference between layout environments can be so extreme that it can be argued to automate the conveyor frame only and design leg structures afterwards. The process could be simplified by predefining different leg modules that have to be selected to make an adequate structure case by case.

In regards of automating the selection of tachometric sensor that could be solved in a way where the sales engineer defines a True/False parameter for Tacho in the layout design process. If Tacho is defined as True, then the quantity 1 is generated in the Excel list, if False, then the quantity will be 0. The operational engineer’s selection of belt then defines the number of points on the ‘*tacho-star*’, giving always the correct resolution in relation to belt series.

The evaluation of raw material in regards of structural analysis can take place if considered necessary. If so, it is recommended that past efforts in analyses and calculations will serve as basis for that evaluation. It is however not recommended to go too far in this direction, since the value of lower cost price in steel-bars and less weight is insignificant compared to the value of making one decision on choice of material and maintaining to it.

5.2 Advantages of Modular Design

It is clear in the author's opinion that the design of the product is the most important factor in simplifying the workflow and cutting down engineering hours and cost. The type and capacity of system support is important, but without standardized or modular design, the advantages of attempting a workflow as the one developed during this project would be very limited.

In relation to the case studies described in Chapter 2.1 one of the most important steps forward Marel can take in terms of efficiency in design and manufacturing is to set their standard and mandatory principal design rules.

5.2.1 Advantages of Cut-to-Fit Modularity

As described in Chapter 4.4, the number of all variation of parts for the defined scope of the project is 135. The criteria for design was set up in a spread sheet to get a sense for the relation between number of available configurations and number of parts, see Table 4.3.

For comparison, sheet metal parts in sides were added it increased the number of variations from 135 to 200, when assuming minimum sheet length of 600mm and maximum 3000mm, and increment of 200mm. Based on a set of assumptions, it was calculated that this 200mm increment gave a total of $5.09*10^6$ configurations in a goose-neck conveyor frame, legs excluded. If the increment is 10mm the number would be $42.5*10^9$. And with an even smaller increment of 1mm, the number of configurations will be $42.5*10^{12}$. With less restriction in lengths and height difference and taking into account the legs as well, in 1mm increments, the variants will become near infinite.

In the case of steel bars, manually cut by saw, none of these configurations need individual mechanical design given that the lengths and quantity can be generated automatically.

It is debatable whether such flexibility is essential for Marel's customers. In many cases, such as in on-board systems, a 200mm increment is insufficient. The flexibility was not the prerequisite for the project but decreased complexity and more efficiency. With cut-to-fit modularity and steel bars in structure instead of sheet metal, considerably fewer numbers of parts is required and material flow will improve. Contrary to what comes to many people's mind when hearing the term *standardization*, the result is a significant increase in flexibility with decreased effort and complexity.

5.3 Advantages of Parametric Design

At Marel, which has relatively few but individually different customers, mass production cannot be applied. Mass customization is a more suitable approach. With the low volume and great variety in products, it is important to find ways to be efficient in order to be competitive. Modularization has been named in that purpose, but as described in chapter 2.2, parametric design could benefit mass customization greatly. With the help of its programming add-in, iLogic, Autodesk Inventor adds an option to automatically export to various formats, including drawing exchange format (DXF), which is used by the majority of CAM software. This could benefit Marel in many cases and should be considered. As a result, effortless flexibility would no longer be limited to manual cutting of steel bars, but could be gained in laser-cut sheet metal parts and turned/milled parts as well.

5.3.1 Design for Manufacturability

The objective of this study was to decrease design hours in sales projects and the title is *From Layout to Manufacturing.* Marel's manufacturing center was therefore involved in determining what kind of manufacturing data would be delivered.

During the timeframe of the study, various representatives were involved and the process from layout *through* manufacturing was reviewed in some detail. Ideas for general improvements of manufacturability and material flow were provided during the study, and were helpful in decreasing the delivery time of products in this category.

The goal of cutting down design hours was achieved. Design for manufacturability (DFM) results in a considerably shorter delivery time, which is in favor of both Marel and its customers and gives Marel competitive advantages, see Figure 5.3.

Although outside the scope of this project, there are also potentials in improving material efficiency when manufacturing methods are taken into account in the design process.

Furthermore, with better standardized products, the uniform quality of products across the whole company is guaranteed.

5.4 Timeframe of Workflow

After the layout has been finalized, it takes within a minute to generate the Excel list for each configuration of a conveyor (see Table 4.3) as described in chapter 4.2.

The operational engineer’s input, which was described in chapter 4.2, should take no longer than 5 minutes for the average conveyor. In cases where legs need modifications, additional material is to be selected within the Excel document and should be finalized within half an hour, including drafting the modifications into the Asset.

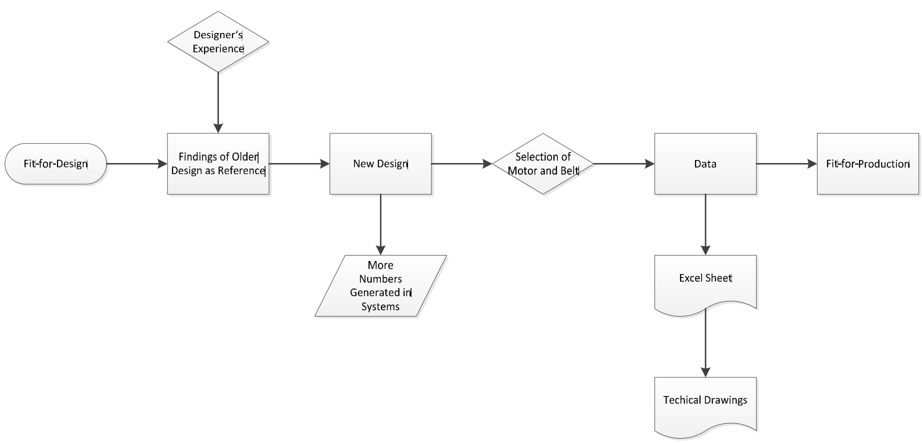


Figure 5.1 Current workflow of operational engineering

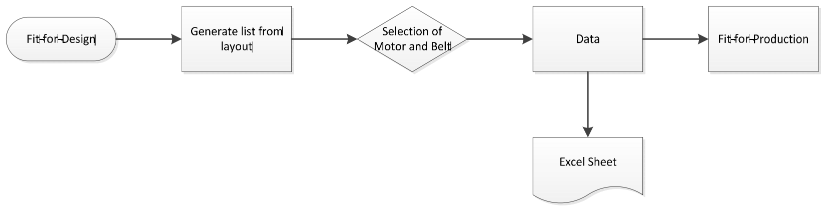


Figure 5.2 Proposed workflow of operational engineering

The comparison of timeframes of different workflows presented in Table 5.1 and Figure 5.3 is based on estimates of experienced designers and does not represent accurate information. The duration of each task in the proposed workflow is based on a rough estimate and assuming that all necessary modules have been designed and are available for use.

Table 5.1 Comparison of timeframes of workflows.

Process / Task	Current Workflow	Proposed workflow
Findings of older design compatible with requirements.	5-60 min	-
New individual design	1-2 days	-
Selection of motor and belt	15 min	1-3 min
Generating BOM	1 min	1 min
Making of technical drawings	3-5 hours	-
Total	**1,5 - 3 days**	**2-4 minutes**

The time estimates presented in Table 5.1 represent a single conveyor. An average sales project in IC-Fish may include 10-20 conveyors. Time savings of the new workflow can prove extremely valuable and increase the throughput in operational engineering and lower cost significantly.

As mentioned in Chapter 1.2.2, each task includes the risk of mistakes being made, which can be both time consuming and expensive. Simplification of the process and fewer tasks required has been achieved through the new workflow. The selection of motor and belt has additionally been limited to available options only, the sprocket no. and the quantity has been automatically linked to the selection of belts. This decreases the risk of mistakes even further and enables less experienced designers to become as efficient as more experienced ones.

As described earlier, it is necessary to set standards on the design to be able to use the new workflow. That will result in more standardized products that are delivered to manufacturing. That gives the manufacturing centers an opportunity to optimize their workflow and cut down manufacturing time even further.

For this study, a thorough investigation on material flow and manufacturing time in general was not carried out. It is however clear that with less sheet metal needed in the conveyor structure and, particularly, with no parts requiring bending inside the sheet metal center, the material flow will increases vastly. This will result in shorter delivery time, to the advantage of both Marel and its customers. A rough estimate of the different workflows in unitless time scale is presented in Figure 5.3.

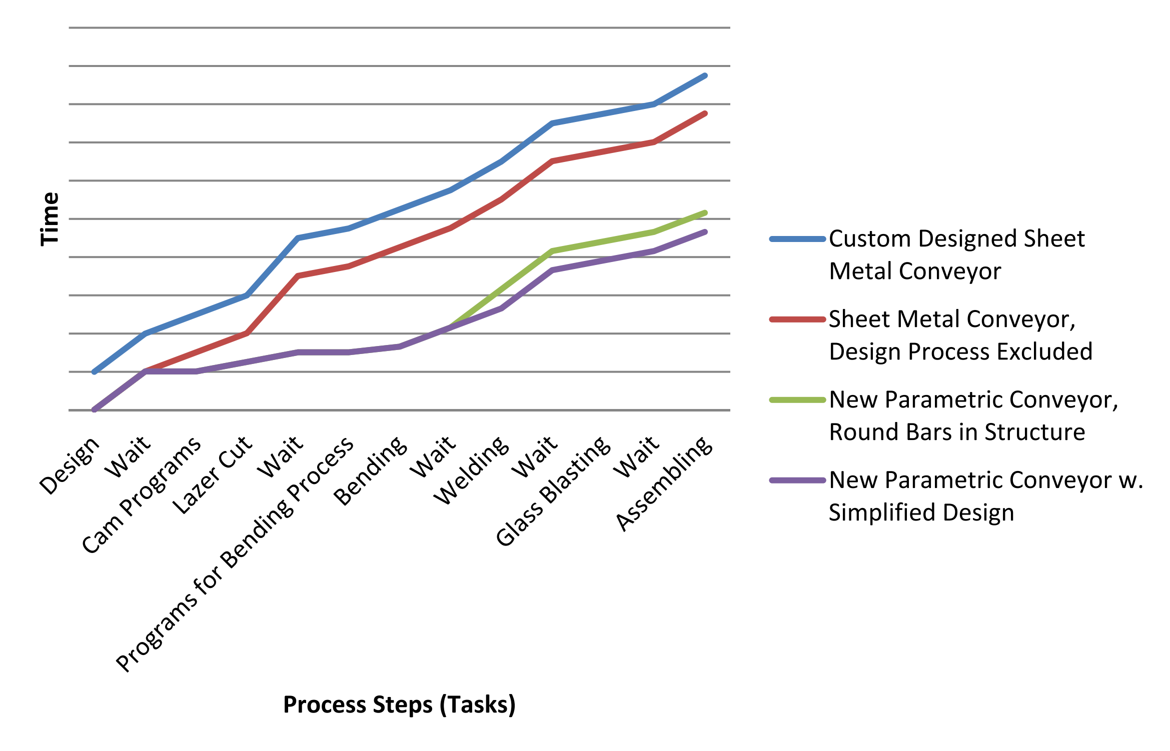


Figure 5.3 Graph showing rough time estimates on workflow.

6 Recommendations

In this section, a few general recommendations are made regarding the implementation of the new workflow.

6.1 Finalizing the Pathway for the Conveyor Family

When the general design of the conveyors has been defined and carried out, the next logical step would be to publish Assets for other forms (straight, incline, decline) using widths that are likely to be the most used to begin with, while attempting to limit the variety in sold belt widths. It is recommended that one Asset is made for each form and each belt width. Curved conveyors, i.e. conveyors that curve to the sides in a horizontal plane have a lower priority due to lower volume and higher complexity level.

6.2 General Design of the Conveyor Structure

After following the prototype through the production steps, many ideas for improvements came up and it is the author's hope that many more will come with future items that will benefit both end users and in-house manufacturing.

In the very beginning of the welding process it was clear that the shape of the cross beams limited in which order the frame was assembled. It was therefore not suitable for construction and needed modification. It was also decided to shorten the welding paths around the round bars as much as possible and not to let the crossbeams stand outside the round bars on the sides, both making it easier to work with on a table and making the structure safer. These actions call for different side guard fasteners as well, see Figure 6.1.

It was also decided to increase the spacing between the round bars in vertical plane. That will close the frame better on top, making the structure safer, and open up the center for better access in terms of cleaning and add greatly to the load bearing capacity and stiffness of the structure.

It is recommended that spacing between crossbeams in the straight runs of the conveyor be increased in order to decrease material consumption, lighten the product and to decrease the duration of the welding process. It is furthermore recommended that one standard distance is chosen in order to standardize more interfaces in the structure. If mounting plates for legs are welded on two crossbeams in a row, there is an interface for bolt-on- or center-drive modules, see Figure 6.3. This needs to be standardized, regardless of the size and shape of the conveyor.

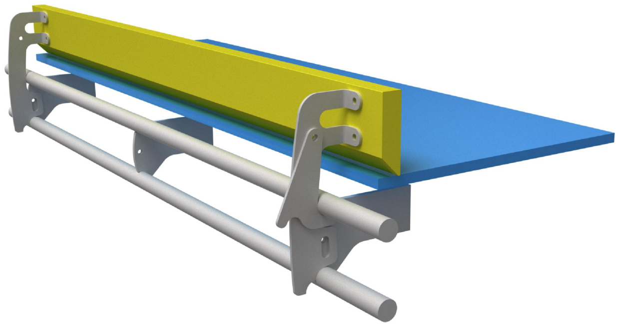


Figure 6.1 Draft for New Design on Conveyor Frame and Side Guard Fasteners

6.3 Design of Additional Modules and Components

When a satisfactory design of a conveyor frame has been accomplished, it is highly recommended to make principal rules regarding interfaces. If the interface is clear, in this case the round bar diameter and the spacing between the round bars, it enables design of standard parts that can be used throughout all conveyor forms and sizes. Some examples of those parts and modules are:

- Thin End
- Fastener for Sensor
- Catch arm
- Solution for Tachometric Sensor
- End Chutes

Other parts, modules and concepts will be described further in the following chapters.

6.3.1 Design of Take-Up units

Particularly in the case of slotted belts, there is a need of tensioning the belt since removing links is available in whole slots only since for tracking abilities in the system, the slot length must always be the same, see Figure 6.2. It is recommended that a bolt-on device using four holes in two mounting plates on each side (see Figure 6.3) is designed with regards to recommendations on page 383 in the Intralox Engineering Manual.

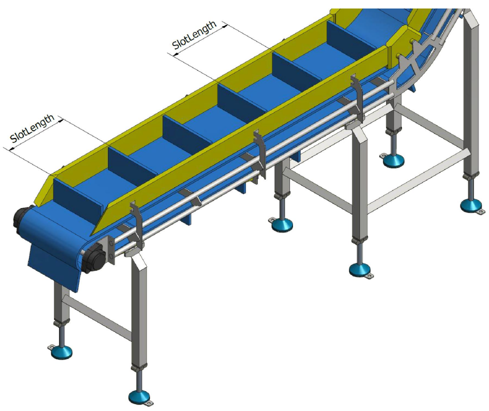


Figure 6.2 Definition of slot length in conveyor belt

6.3.2 Design of Center-Drive Module

Where thin ends and center drive is required, there should be a bolt-on unit as well as the take-up device, see Figure 6.3. Preferably there should be one side plate only that covers all forms and belt widths.

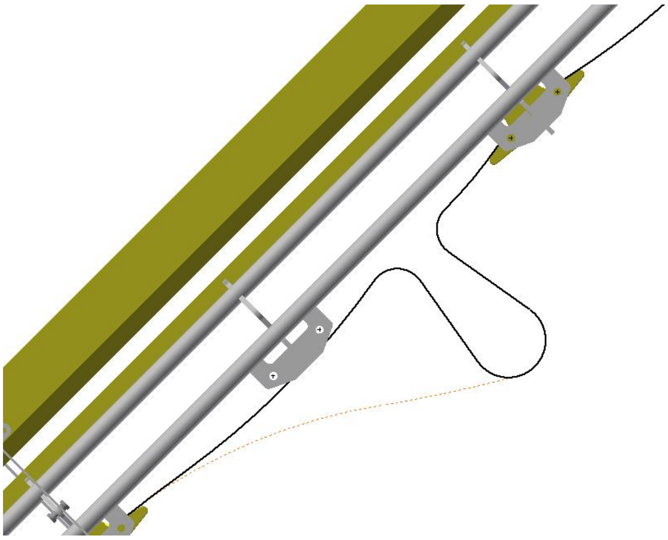


Figure 6.3 Draft of possible pathway of belt using take-up- or center-drive modules

6.3.3 Design of Drip Pans

As explained in chapter 3.1.1, there were no drip pans included in the Asset and no drip pans designed. It was clear that the design of a drip pan would take too long and could not be completed in the time frame of this project.

It is recommended that a suitable drip pan system should be designed for all types of conveyors. Drip pans should be a True/False parameter in the Assets. The lengths should follow the lengths of straight runs in the conveyors and if possible, the length of the drip pans should be accessible from the asset or even written in the spread sheet like the rest of the important dimensions and item numbers.

A mechanical designer in Operational engineering would have to finalize the design of drip pans for each conveyor, but that should only require choosing the length and defining a number of holes. The cross section of the drip pan would be standardized as the position of first holes and distance between holes (in relation with the cross beams in the conveyor frame).

It is also recommended that the design is thoroughly done, hygienic, possibly on hinges and preferably adds rigidity to the structure.

6.4 Raw Material in Structure

It is the author's opinion that taking a strategic decision about the use of raw material would be an important step forward. It should be evaluated whether use of hollow sections (round tubes or square tubes) in structures is sufficient for the majority of Marel's clients, and if it is possible to make this less arguable with some modifications in design.

It is a conclusion of this project that well-defined assets can generate dimensions straight from layout. Therefore it is recommended that in cut-to-length structures, either square tubes or round tubes are used unless otherwise requested and custom design would be carried out. In that case, prizing the solutions as custom designed is necessary. To have one major policy in the use of materials and methods gives the manufacturing centers the opportunity to optimize their workflow around those standards. Templates were made during this project that can contribute to building up square tube structures. This work can be taken further if needed. One of the biggest drawbacks in using square tubes in big volume is the need of washing after cutting. This can be automated and there is a known solution for this issue developed by employees at Marel, Jakob Lárusson and Ólafur Gränz (Ólafur Gränz, 2012).

Customization will always be an option for special needs of the customer, but marginal cases should not set the example for the majority of design concepts at Marel.

6.5 Drawings

In the new workflow, no new technical drawings will be made or generated with each conveyor that will be produced. An instruction manual was made that is expected to cover all configurations of a goose-neck conveyor. When this project will be taken further and other conveyor forms will be defined, each form should have its own instruction manual. This needs to be done in close cooperation with the manufacturing center in order to provide no more or no less than what is needed.

6.6 Next Steps

This project has demonstrated that the proposed workflow is working and is satisfactory. This can be considered a big step forward in order to achieve more efficiency which is one of Marel's key goals. To gain maximum efficiency, the outcome of this project needs dissemination among in-house stakeholders at Marel, such as representatives of other industry centers and product centers. The Assets that will be made in this purpose need to be well presented in the sales network. It is also important to assure good cooperation with the manufacturing centers.

The long term objective at IC-Fish is that 80% of the layouts go through an automated modularized process such as has been developed through this project, while 20% still need custom design. The systems need to be analyzed to determine which layouts can be modularized. It is recommended to start with the lower hanging fruits, i.e. roller conveyors and tables. Work platforms could prove a worthy challenge and would also be a logical step forward.

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7 References

Eager A., Elsam K., Gupta R., Velinder M. (2010). *Modular Design Playbook, Guidelines for Assessing the Benefits and Risks of Modular Design.* The Corporate Executive Board Company.

Falk, Krause, Tiedt (2003). *Töflubók fyrir málm- og véltækni*. IÐNÚ bókaútgáfa, Reykjavík

Lego History Timeline. Downloaded May 5th from http://aboutus.lego.com/en-us/lego-group/the_lego_history.

Meccano History. Downloaded May 5th from http://www.meccano.com/brand/history.html

Michiels, C., & Maassen, H. (2012). *Modularization - Definitions* v0.5. Marel.

Mikkola, J.H. (2001). *Modularity assessment of product architecture: Implications for substitutability and interface management.* Copenhagen Business School Dept. of Industrial Economics and Strategy.

Ólafur Gränz (2012). *Þvottavél fyrir stálefni*. Háskólinn í Reykjavík

Pine, B. J. (1993). *Mass Customizing Products and Services. In B. J. Pine, Mass Customization.* USA: Harvard Business School Press.

Sigdís Ágústsdóttir, Thelma Hrund Kristjánsdóttir (2013). *Integration of modularization within Quotation and Order process.* Technical University of Denmark, Department of Engineering Management

Springer reference (2014) *Encyclopedia of Production and Manufacturing Management*

Unknown author (2014) *Intralox Conveyor Belting Engineering Manual 2014*

Waguespack, C. (2013). *Mastering Autodesk® Inventor® 2014and Autodesk® Inventor® 2014 LT™*. Wiley Publishing, Inc.

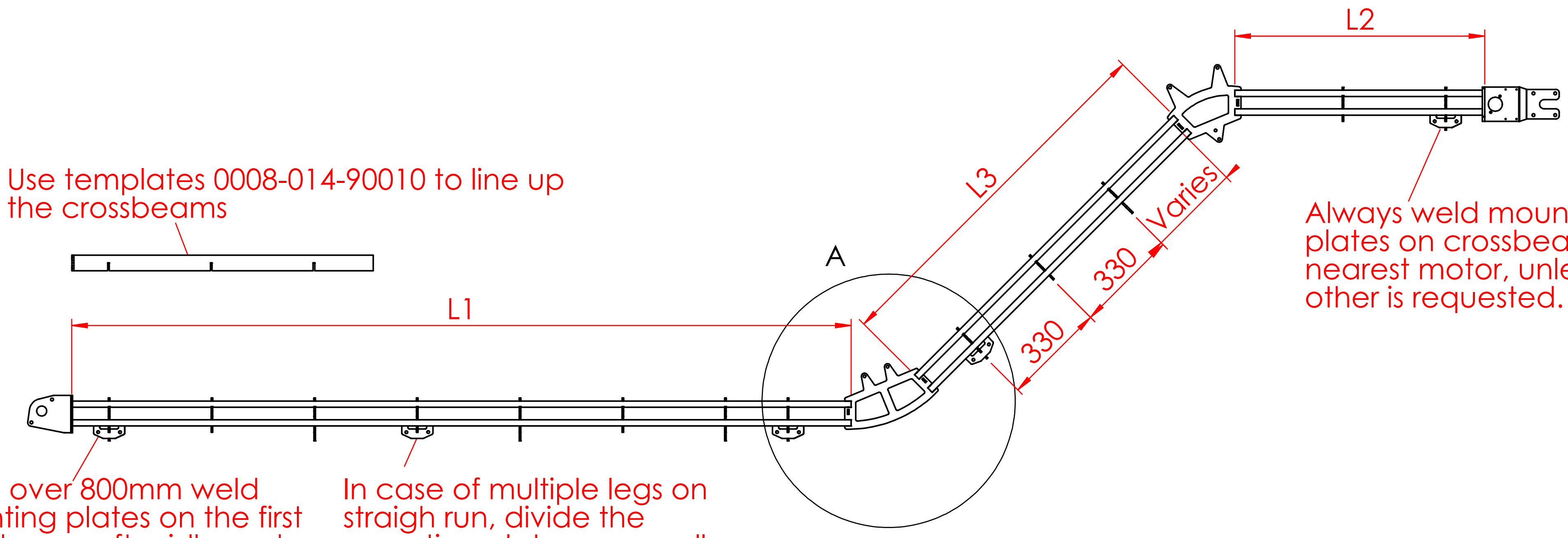
Wassim Jabi (2013). *Parametric Design for Architecture*. Laurence King Publishing Ltd

Appendix A, Technical Drawings

Technical drawings appear in following order:

- Weldment Assemblies
- Module Weldments
- Completed Assemblies
- Modules
- Templates
- Parts

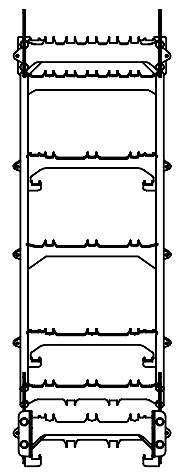
Use templates 0008-014-90010 to line up the crossbeams

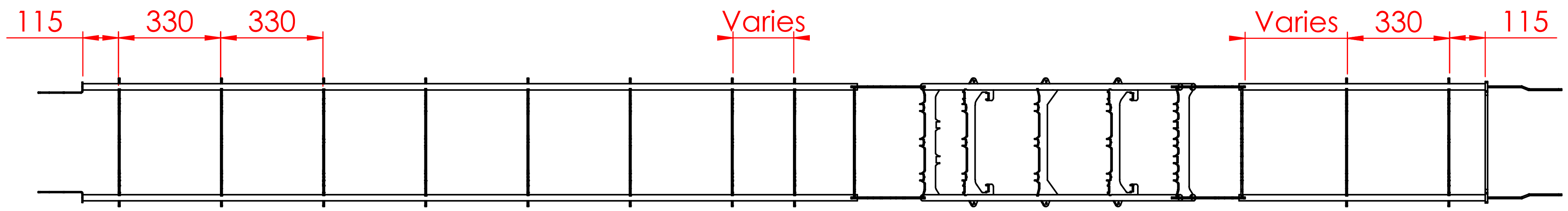


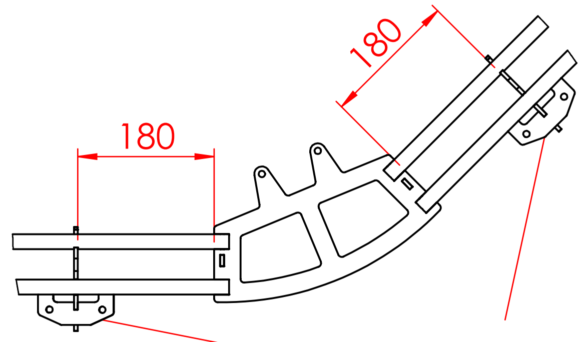
Always weld mounting plates on crossbeam nearest motor, unless other is requested.

If L1 is over 800mm weld mounting plates on the first cross beam after idle end.

In case of multiple legs on straigh run, divide the mounting plates as equally as possible. Use the 3D Asset as reference.

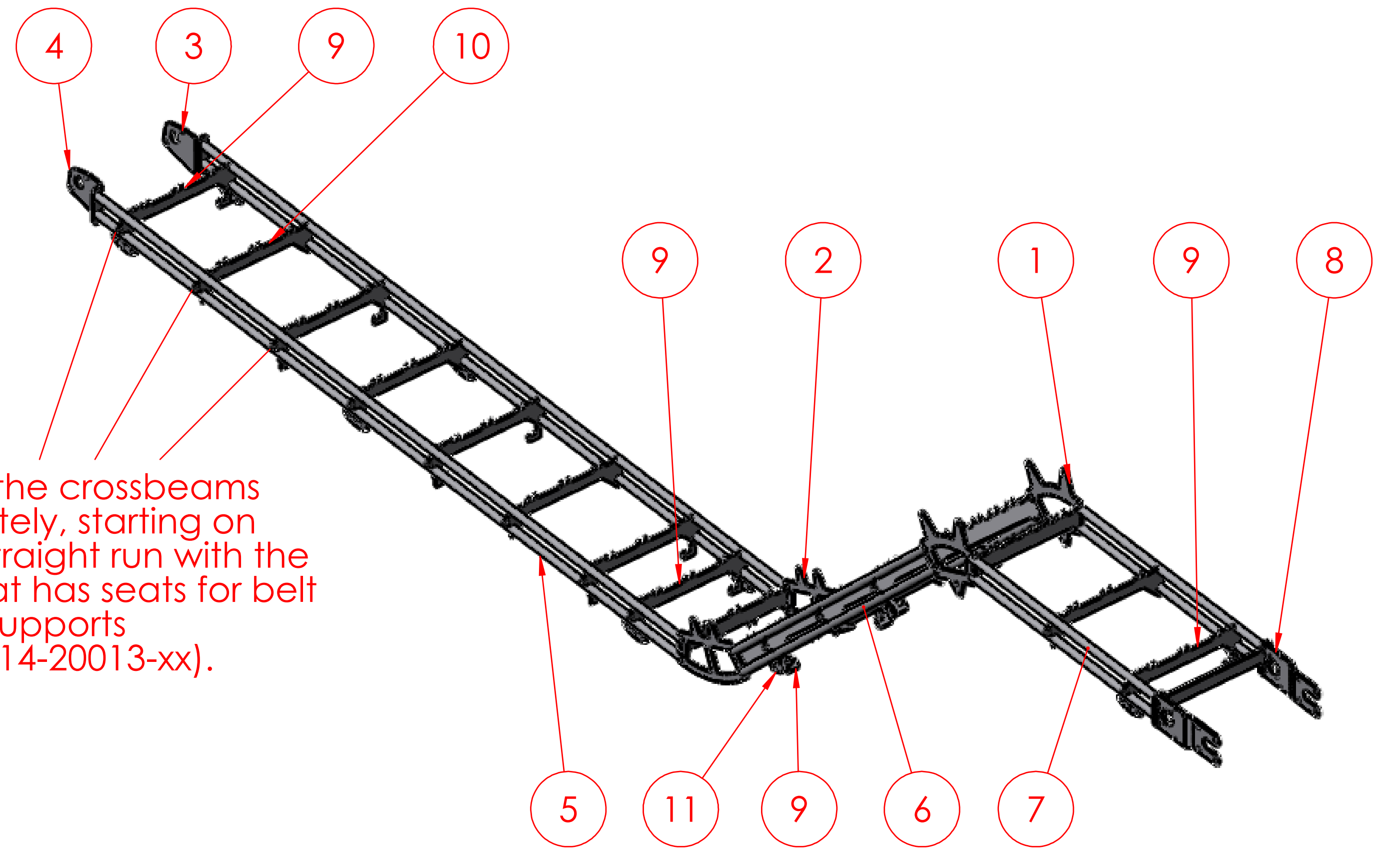






DETAIL A
SCALE 1 : 10

Always weld mounting plates on the nearest crossbeams on both sides of incline module.



Set up the crossbeams alternately, starting on each straight run with the one that has seats for belt return supports (0008-014-20013-xx).

Item	Qty	Description	Item number	Variant	Size	Comment
1	1	Decline Module	Varies			
2	1	Incline Module	Varies			
3	1	Side in idle end	0008-014-20042		173x120	
4	1	Mirror Side in Idle End	0008-014-20042-M		173x120	
5	4	Round Bar ø20-h9 1.4305/AISI 303	702-4305-04012		Varies	L1
6	4	Round Bar ø20-h9 1.4305/AISI 303	702-4305-04012		Varies	L2
7	4	Round Bar ø20-h9 1.4305/AISI 303	702-4305-04012		Varies	
8	1	Motor End	0008-014-90004-xx			
9	Varies	Cross Beam w. Belt Return Support Holders	0008-014-20013-xx		Varies	
10	Varies	Cross Beam	0008-014-20017-xx		Varies	
11	Varies	Mounting Plate for Legs	0008-014-20027		100*40	

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DESIGNER SIRE	DRAWN SIRE	DIVISION -	REPLACES: -	A3
APPROVED -	DATE	TREATMENT	REPLACED BY: -	SCALE: 1:50

TITLE: Goose Neck Conveyor - Weldment

Location:

UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MILLIMETERS According to: ISO 2768-1 and ISO 2768-2 LIN/ANG. : m GEO. Tol : K

SHEET 1 OF 1

REVISION

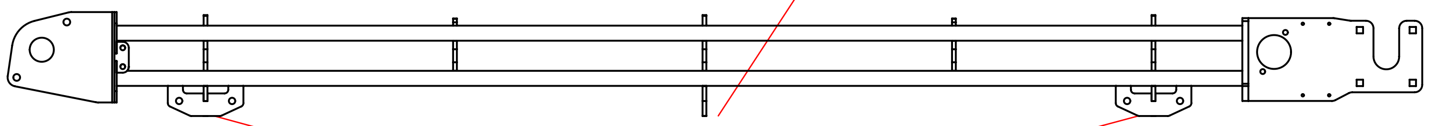
DRAWING NO. -

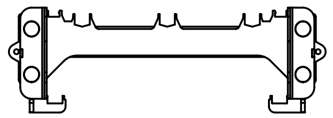
Parametric Conveyor

STATUS: [Status]

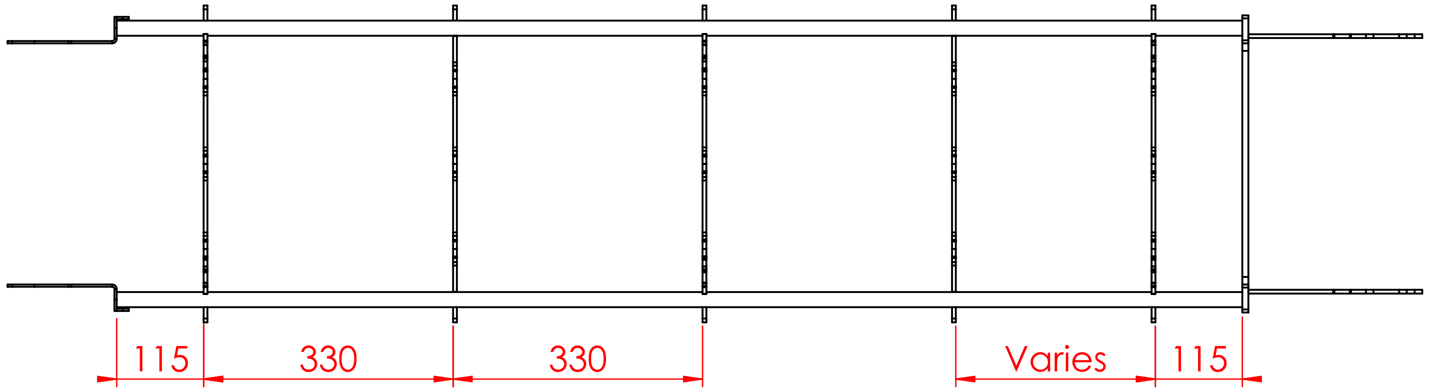
Use templates 0008-014-90010 to line up the crossbeams

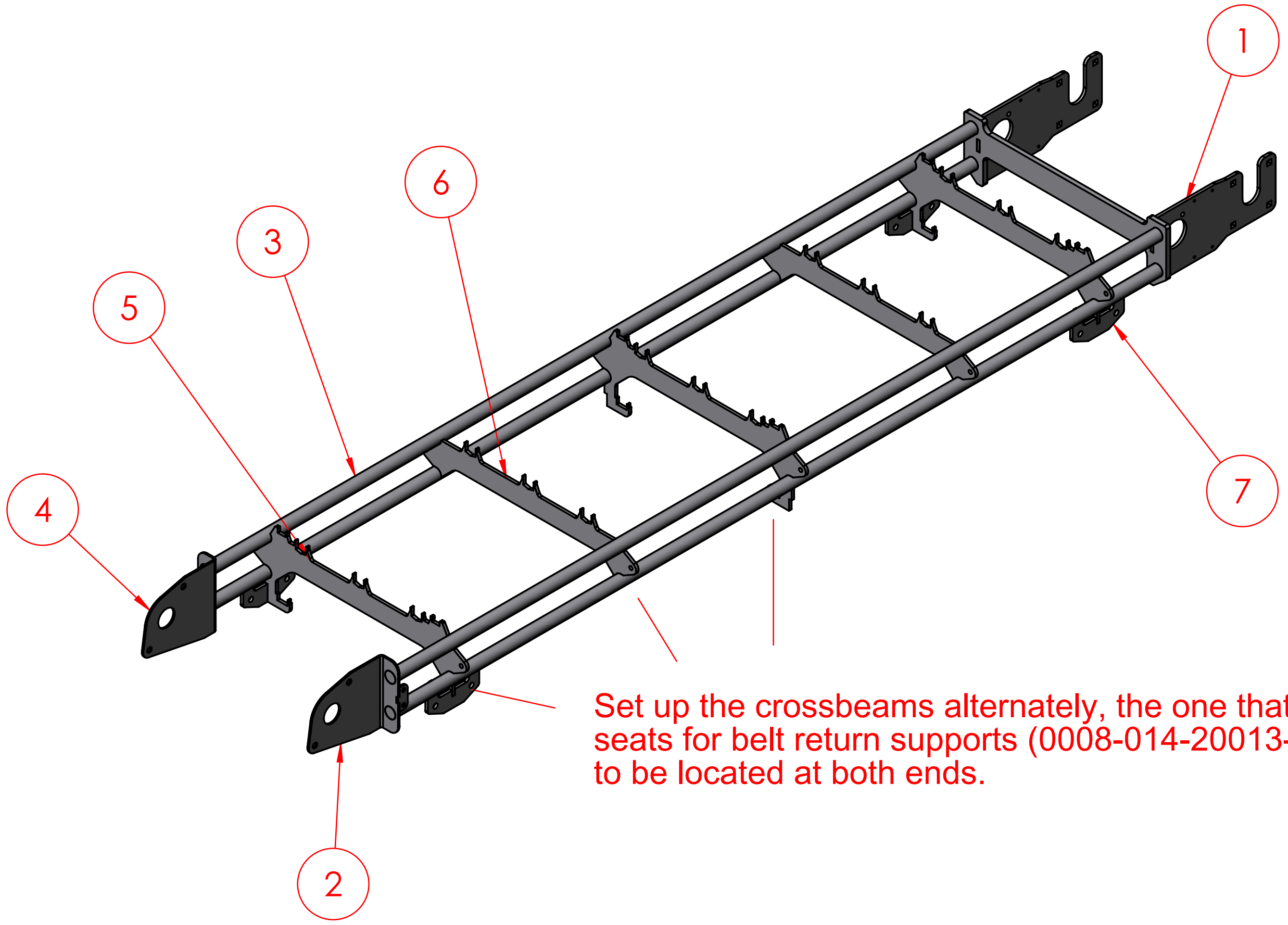
In case of multiple legs, divide the mounting plates as equally as possible. Use the 3D Asset as reference.





Always weld mouting plates on both end crossbeams unless other is requested





Set up the crossbeams alternately, the one that has seats for belt return supports (0008-014-20013-xx) is to be located at both ends.

Item	Qty	Description	Item number	Variant	Size	Comment
1	1	Motor End Weldment	0008-014-90004-xx			
2	1	Side in Idle End	0008-014-90012			
3	4	Round Bar ø20-h9 1.4305/AISI 303	702-4301-04011		L=Varies	
4	1	Side in Idle End	0008-014-90012			
5	Varies	Cross Beam w. Belt Return Support Holders	0008-014-20013-xx		Varies	
6	Varies	Cross Beam	0008-014-20017-xx		Varies	
7	Varies	Mounting Plate for Legs	0008-014-20027		100*40	

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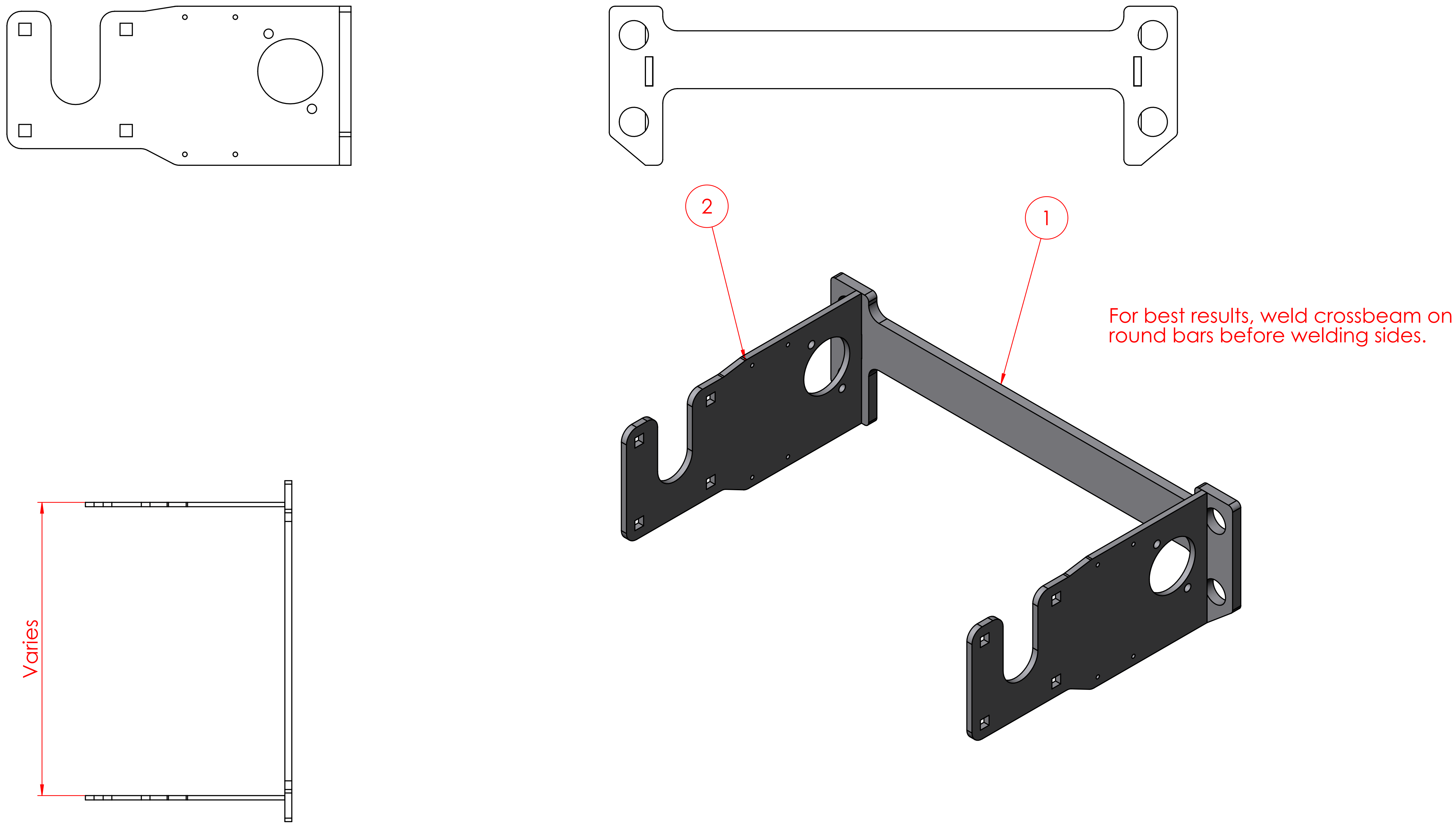
APPROVED - | DATE | TREATMENT | REPLACED BY: - | SCALE: 1:10
TITLE: | Location:
UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MILLIMETERS According to: ISO 2768-1 and ISO 2768-2 LIN/ANG. : m GEO. Tol : K
SHEET 1 OF 1
REVISION
DRAWING NO. - STATUS:

Straight Conveyor Frame [Status] Weldment



Item	Qty	Description	Item number	Variant	Size	Comment
1	1	Crossbeam m.end.	0008-014-20009-xx		393x110	
2	2	Fastening for Motor	0008-014-20041		238*115	

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DESIGNER: SIRE	DRAWN: SIRE	DIVISION: WW - Workshop welding	REPLACES: -
APPROVED: -	DATE: 26.2.2014	TREATMENT:	REPLACED BY: -

A3

SCALE: 1:5

TITLE: Motor End Weldment

Location: GARÐABÆR

UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MILLIMETERS According to: ISO 2768-1 and ISO 2768-2 LIN/ANG. : m GEO. Tol : K

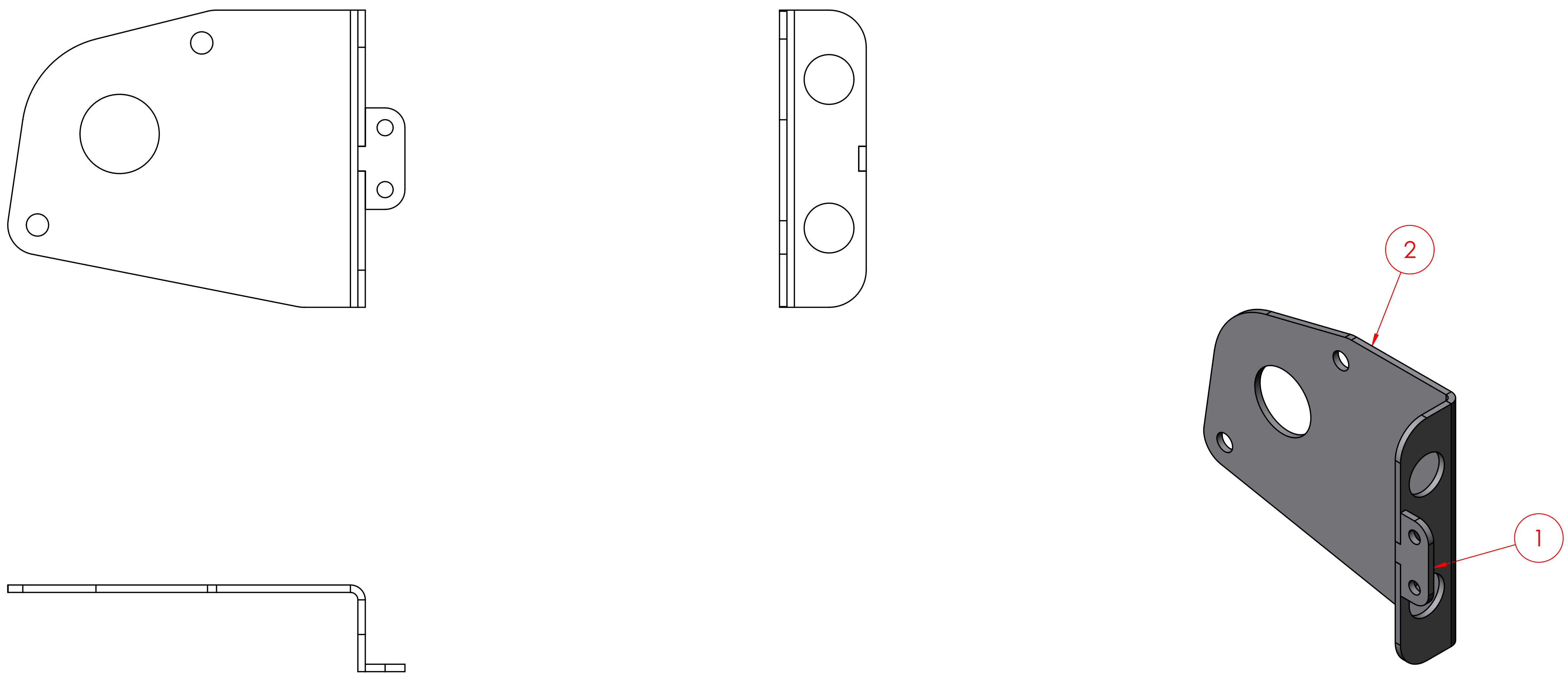
SHEET 1 OF 1

DRAWING NO.: CONVEYORS - PARAMETRIC CONVEYOR

0008-014-90004-xx

STATUS: [ACTIVE]

REVISION: 00



Item	Qty	Description	Item number	Variant	Size	Comment
1	1	Mounting plate for CIP bracket	0008-014-20057		41*19	
2	1	Side in idle end	0008-014-20042		173x120	

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DESIGNER SIRE	DRAWN SIRE	DIVISION WW - Workshop welding	REPLACES: -	A3
APPROVED -	DATE 24.3.2014	TREATMENT	REPLACED BY: -	SCALE: 1:1

TITLE:

Side in Idle End

Location: GARÐABÆR

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN MILLIMETERS
According to:
ISO 2768-1 and ISO 2768-2
LIN/ANG. : m
GEO. Tol : K

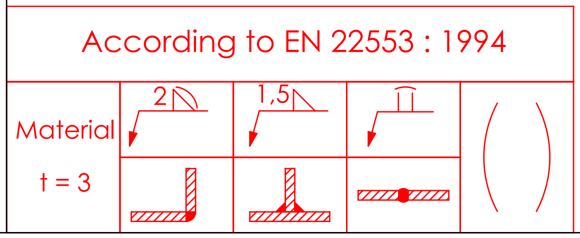
SHEET 1 OF 1

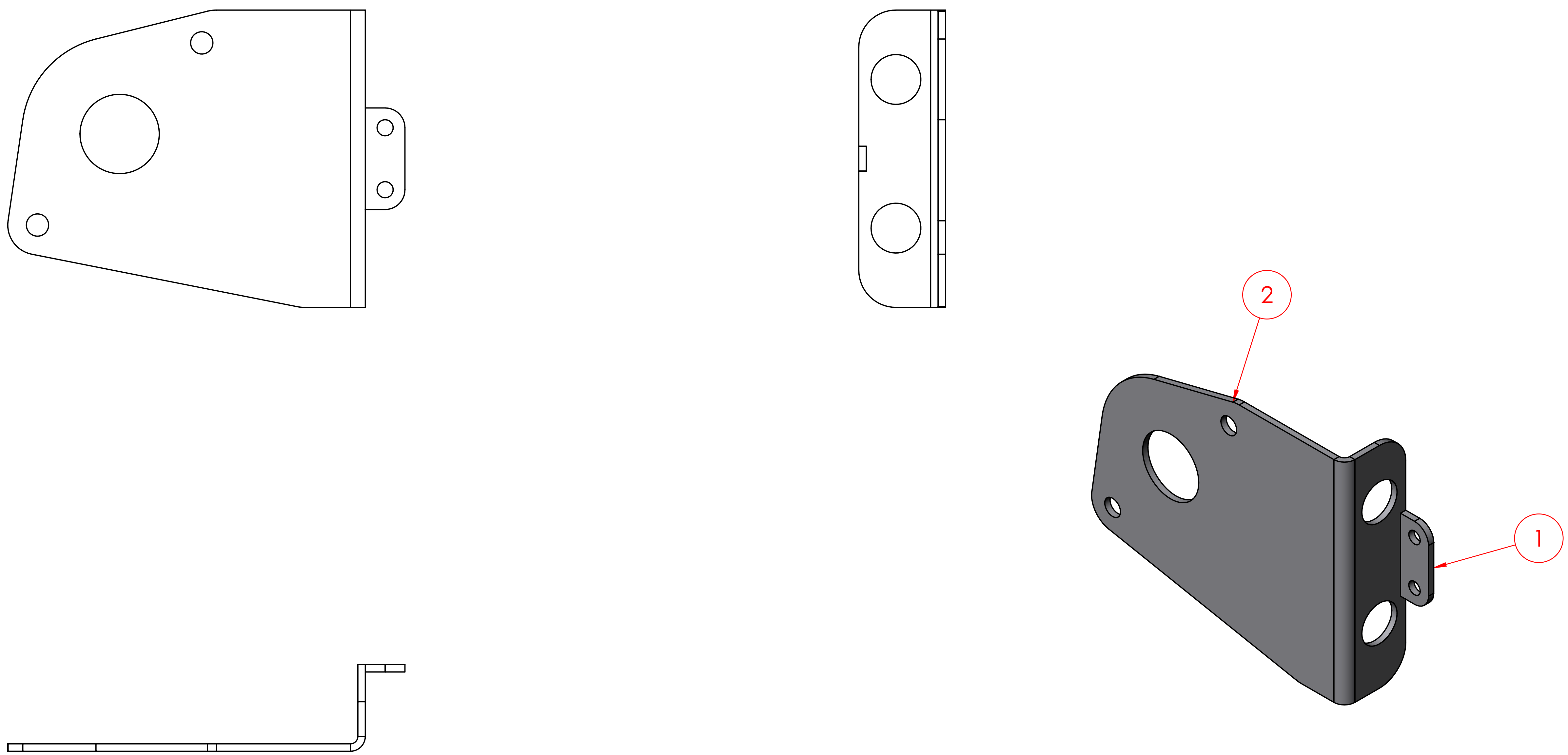
DRAWING NO. CONVEYORS - PARAMETRIC CONVEYOR

STATUS:

0008-014-90012-01 [ACTIVE]

REVISION 00





Item	Qty	Description	Item number	Variant	Size	Comment
1	1	Mounting plate for CIP bracket	0008-014-20057		41*19	
2	1	Side in idle end	0008-014-20042		173x120	

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marel

DESIGNER: SIRE	DRAWN: SIRE	DIVISION: WW - Workshop welding	REPLACES: -	A3
APPROVED: -	DATE: 24.3.2014	TREATMENT:	REPLACED BY: -	SCALE: 1:1

TITLE:
Side in Idle End

Location: GARÐABÆR

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN MILLIMETERS
According to:
ISO 2768-1 and ISO 2768-2
LIN/ANG. : m
GEO. Tol : K

SHEET 1 OF 1

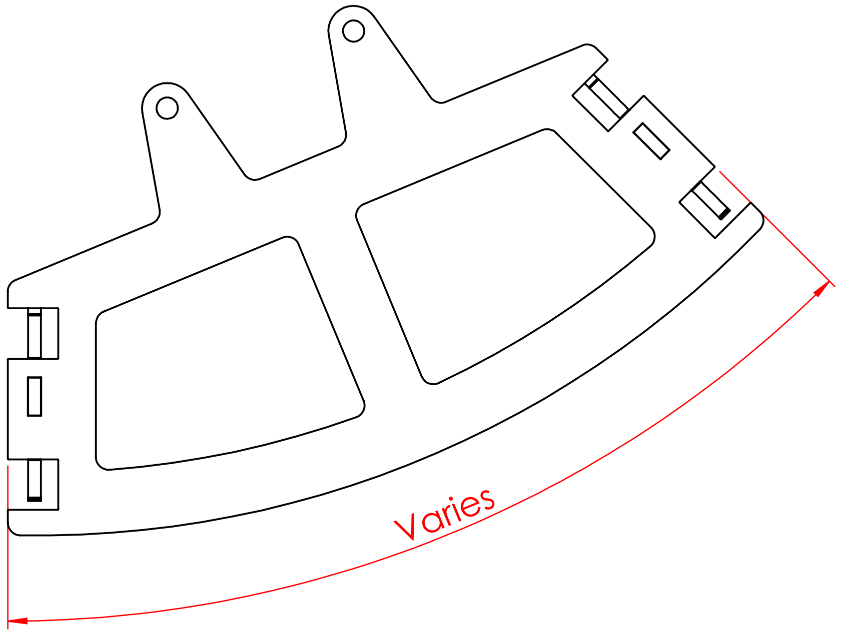
REVISION 00

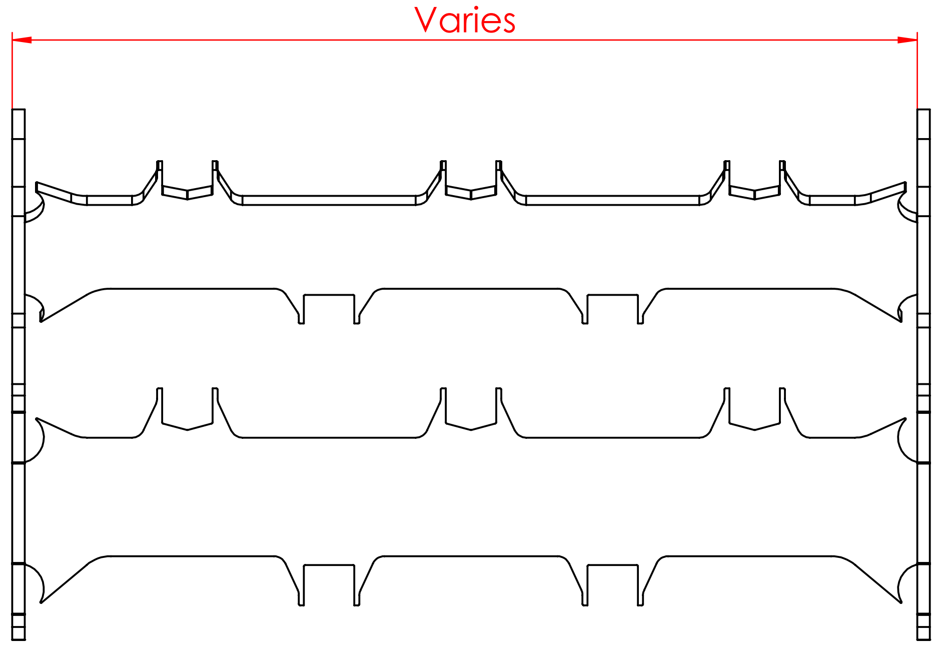
DRAWING NO.
CONVEYORS - PARAMETRIC CONVEYOR
STATUS:
0008-014-90012-02 [ACTIVE]

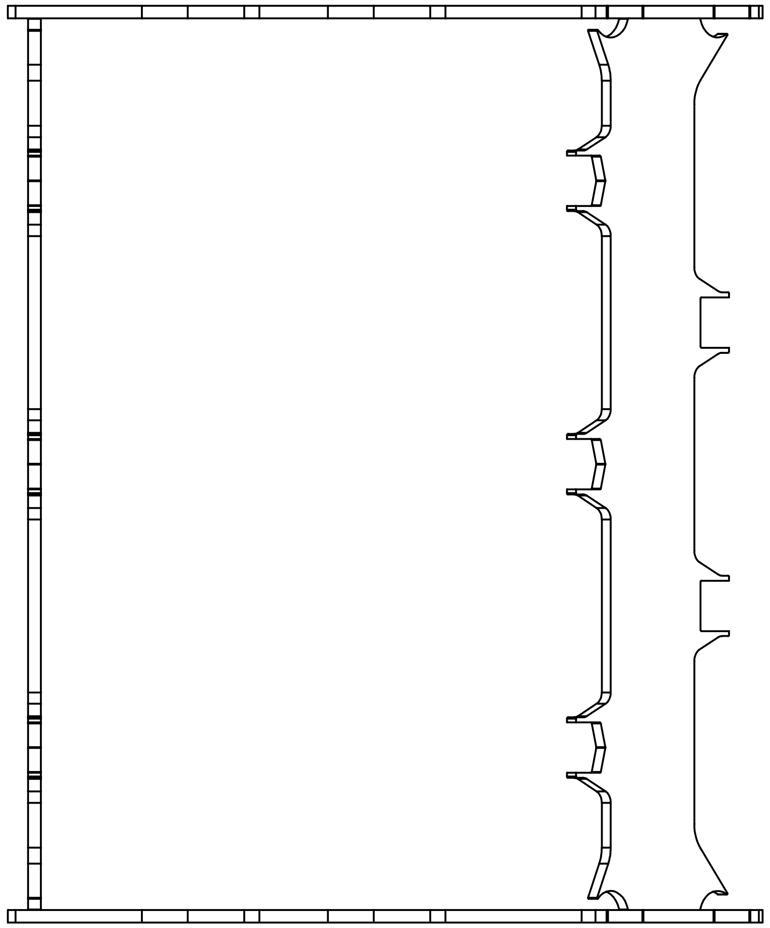
According to EN 22553 : 1994

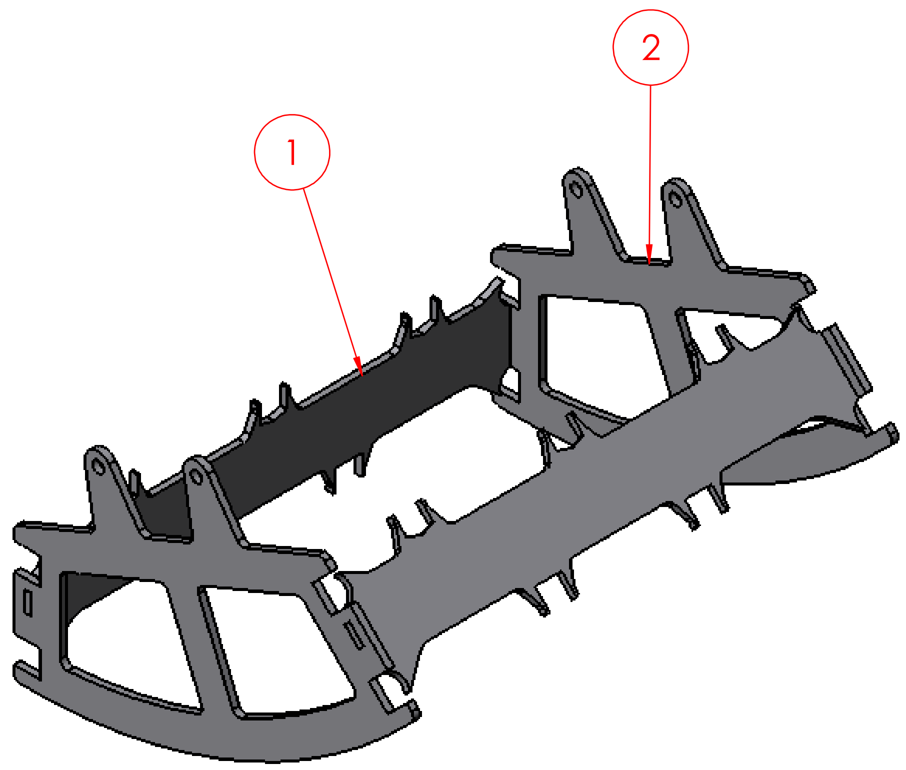
Material
t = 3

2
1,5









According to EN 22553 : 1994				
Material	2,5	2		( )
t = 4				

Item	Qty	Description	Item number	Variant	Size	Comment
1	2	Cross Beam for Incline Module	0008-014-20005-xx		Varies	
2	2	Incline Side Plate	0008-014-20024-xx		Varies	

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DESIGNER SIRE	DRAWN SIRE	DIVISION -	REPLACES: -	A3
APPROVED -	DATE 26.2.2014	TREATMENT	REPLACED BY: -	SCALE: 1:5

TITLE:

Incline Module - Weldment

Location:

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN MILLIMETERS
According to:
ISO 2768-1 and ISO 2768-2
LIN/ANG. : m
GEO. Tol : K

SHEET 1 OF 1

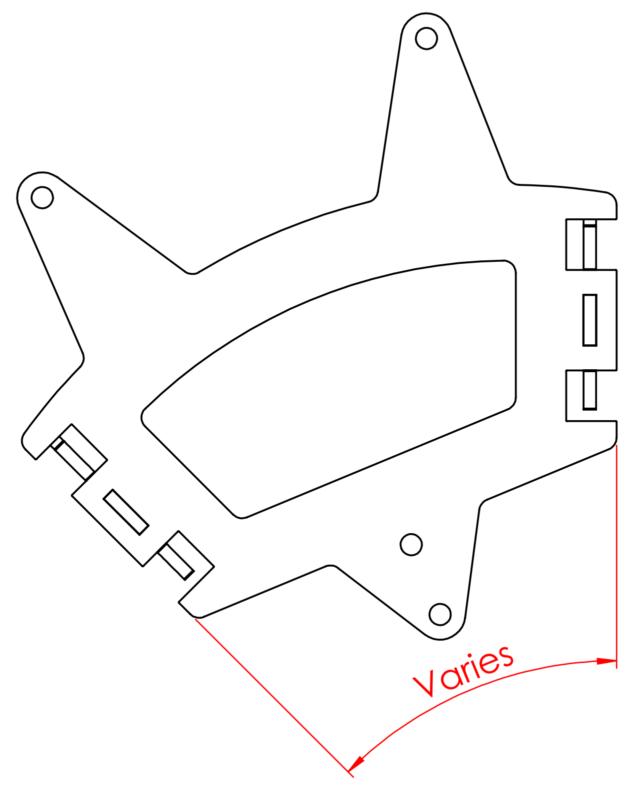
DRAWING NO.

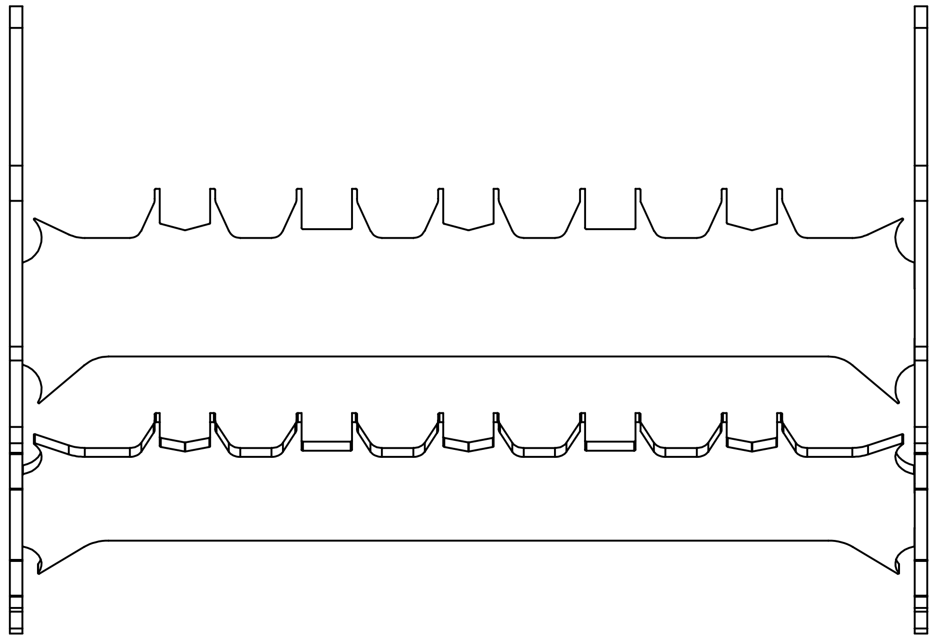
CONVEYORS - PARAMETRIC CONVEYOR

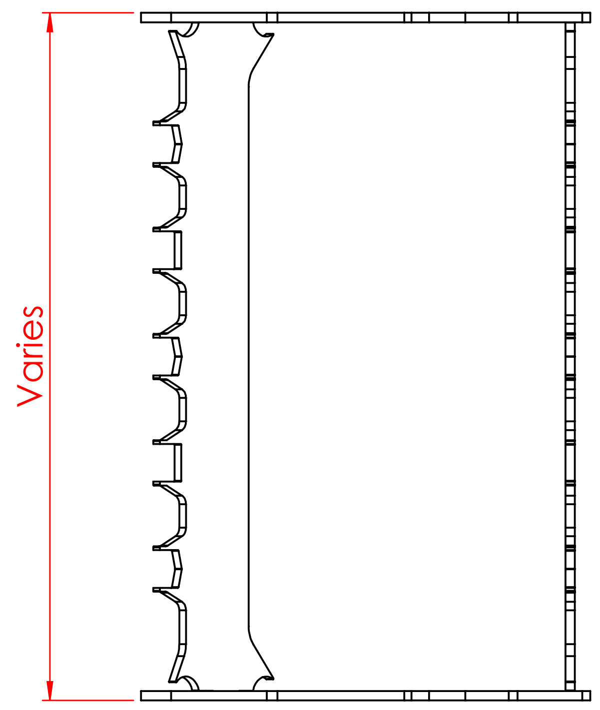
STATUS: [INACTIVE]

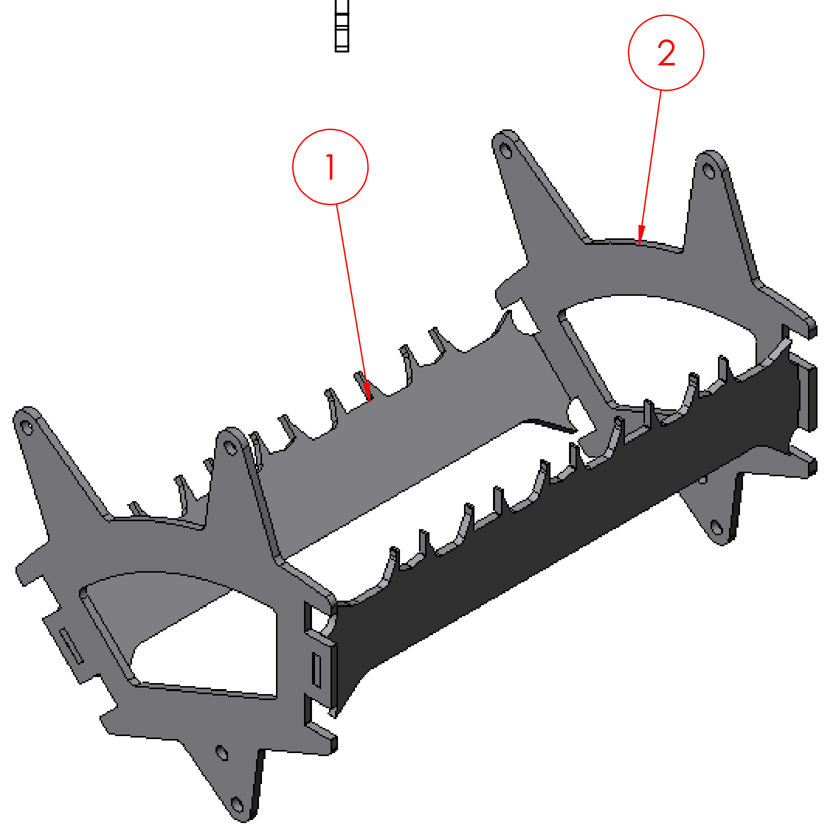
Incline Module - Weldment

REVISION
00









Item	Qty	Description	Item number	Variant	Size	Comment
1	2	Cross Beam for Decline Module	0008-014-20001-xx		Varies	
2	2	Decline Side Plate	0008-014-20021-xx		Varies	

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DESIGNER SIRE	DRAWN SIRE	DIVISION WW - Workshop welding	REPLACES: -	A3
APPROVED -	DATE 26.2.2014	TREATMENT	REPLACED BY: -	SCALE: 1:5

TITLE:

Decline Module - Weldment

Location: GARÐABÆR

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN MILLIMETERS
According to:
ISO 2768-1 and ISO 2768-2
LIN/ANG. : m
GEO. Tol : K

SHEET 1 OF 1

DRAWING NO.

CONVEYORS - PARAMETRIC CONVEYOR

STATUS: [INACTIVE]

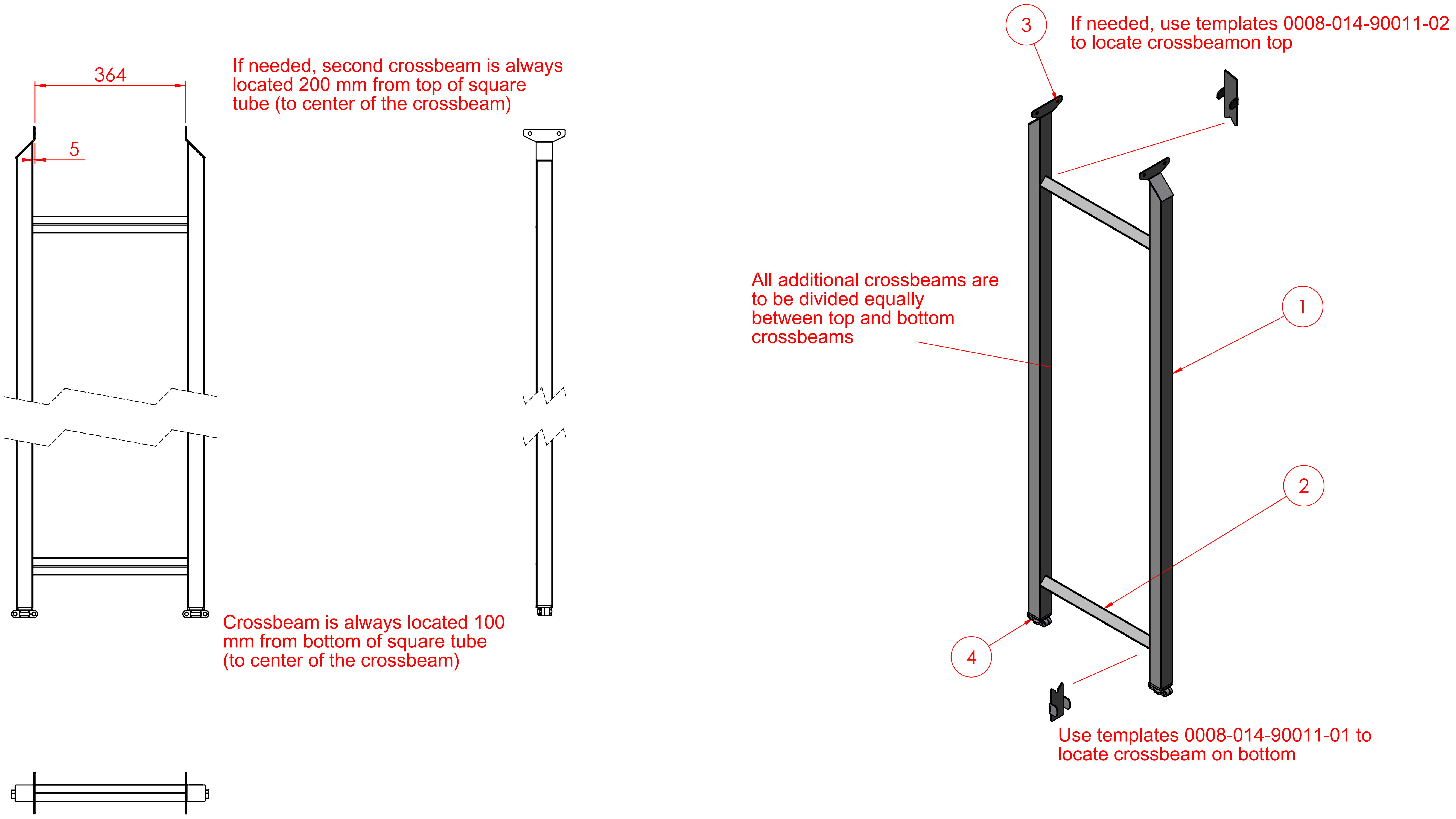
REVISION 00

Decline Module - Weldment

According to EN 22553 : 1994

Material
t = 4

2,5
2



Item	Qty	Description	Item number	Variant	Size	Comment
1	2	Square Tube 40x40x2	702-4301-02012			H1/H2
2	Varies	Square Tube 30x30x2	702-4301-02009			W1
3	2	Ears for Standard Legs	0008-014-20039		94*100	
4	2	Square tube clamp for 20mm feet. Part1	0000-500-20097		40x40x49	

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DESIGNER: SIRE | DRAWN: SIRE | DIVISION: WW - Workshop welding | REPLACES: - | A3

APPROVED: - | DATE: 4.3.2014 | TREATMENT: | REPLACED BY: - | SCALE: 1:20

TITLE:

Legs

Location: GARÐABÆR

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN MILLIMETERS
According to:
ISO 2768-1 and ISO 2768-2
LIN/ANG. : m
GEO. Tol : K

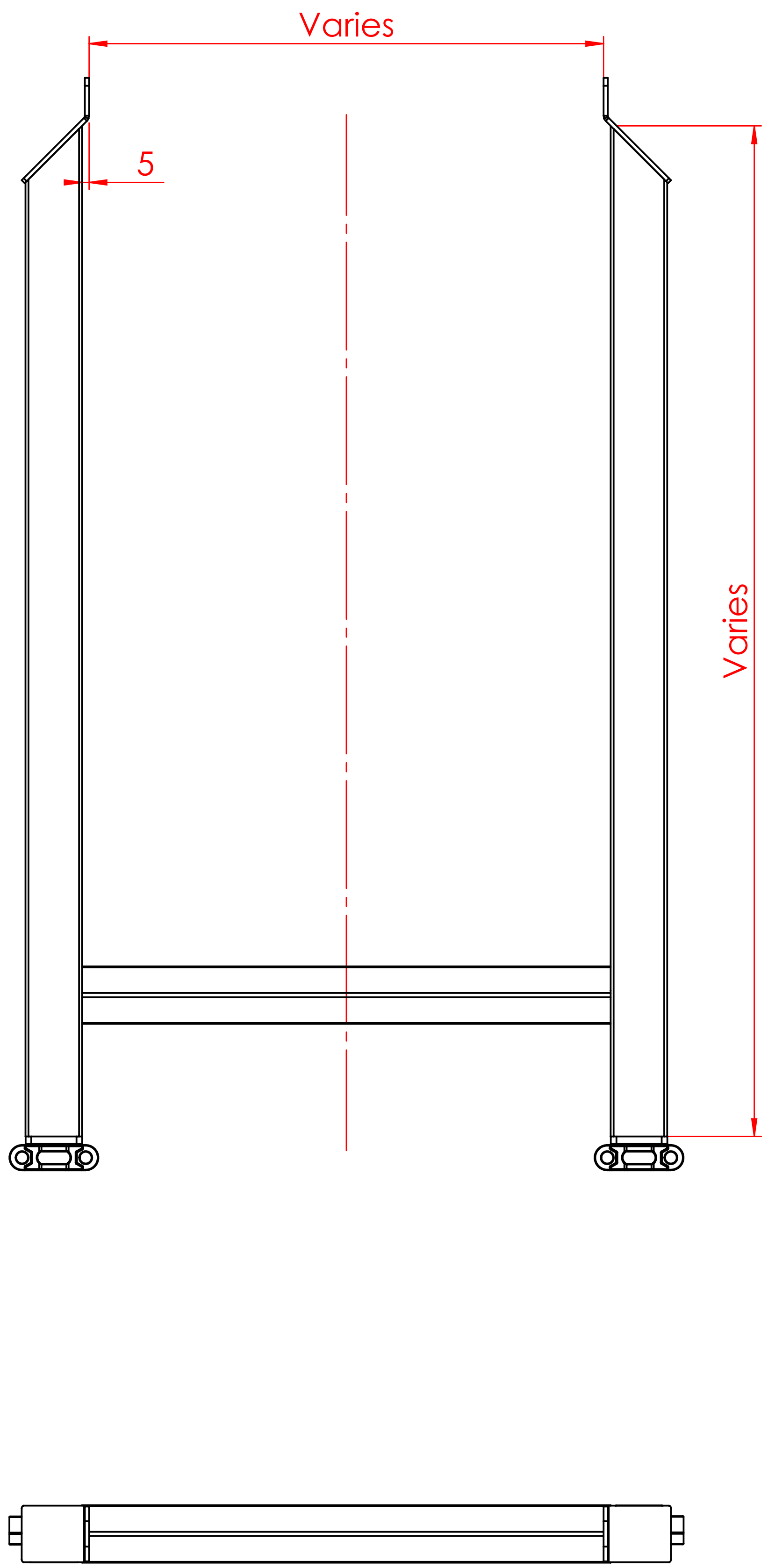
SHEET 1 OF 1

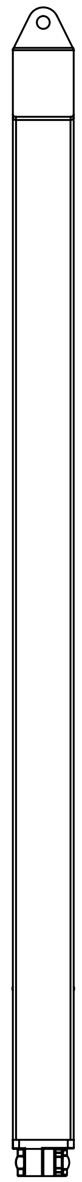
DRAWING NO. CONVEYORS - PARAMETRIC CONVEYOR

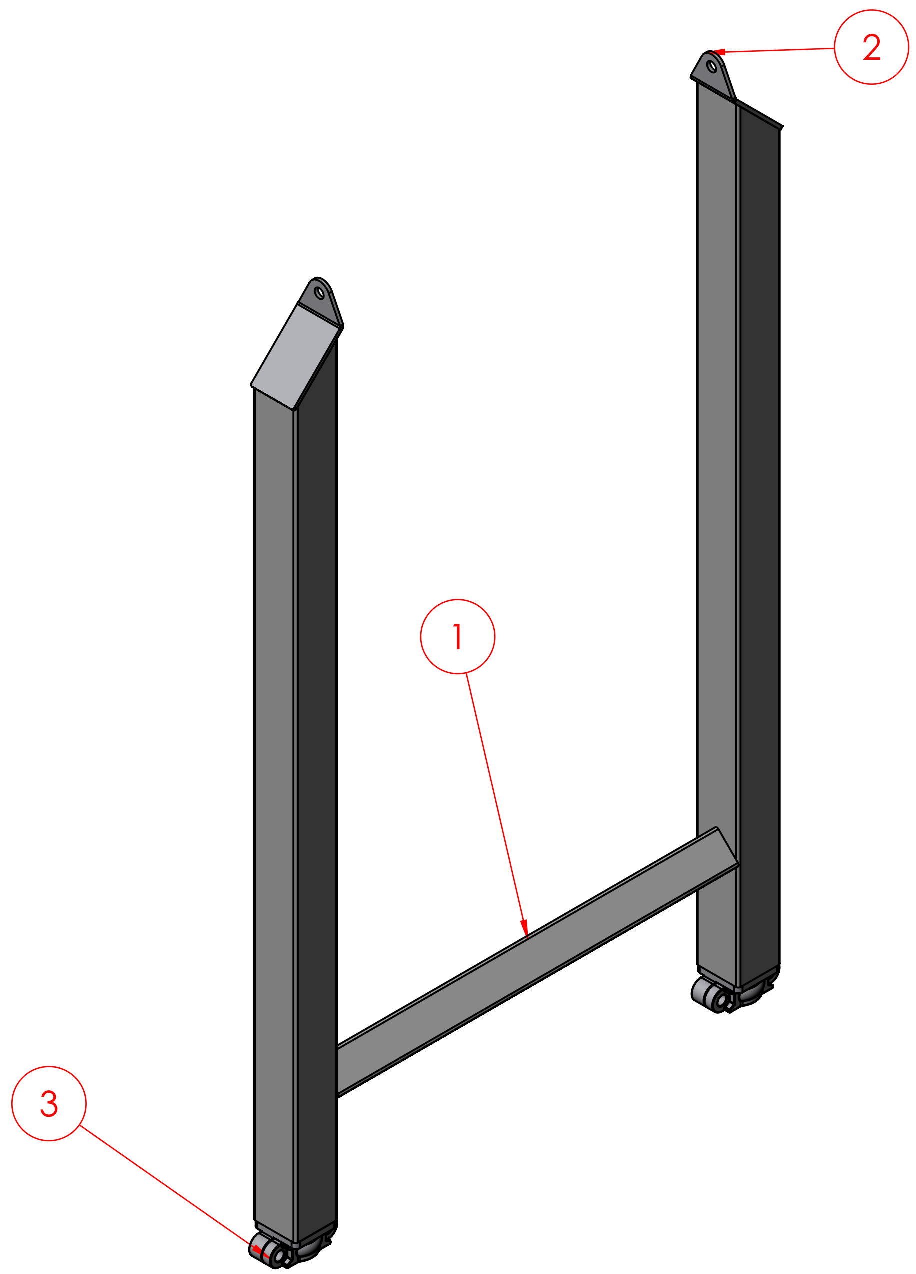
0008-014-90006-xx

STATUS: [ACTIVE]

REVISION 00







Item	Qty	Description	Item number	Variant	Size	Comment
1	1		0008-014-90005-03			
2	2	Ear for Extra Leg	0008-014-20040		92*64	
3	2	Square tube clamp for 20mm feet. Part1	0000-500-20097		40x40x49	

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DESIGNER: SIRE	DRAWN: SIRE	DIVISION: WW - Workshop welding	REPLACES: -	A3
APPROVED: -	DATE: 4.3.2014	TREATMENT:	REPLACED BY: -	SCALE: 1:5

TITLE:

Leg for Incline Frame

Location: GARÐABÆR

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN MILLIMETERS
According to:
ISO 2768-1 and ISO 2768-2
LIN/ANG. : m
GEO. Tol : K

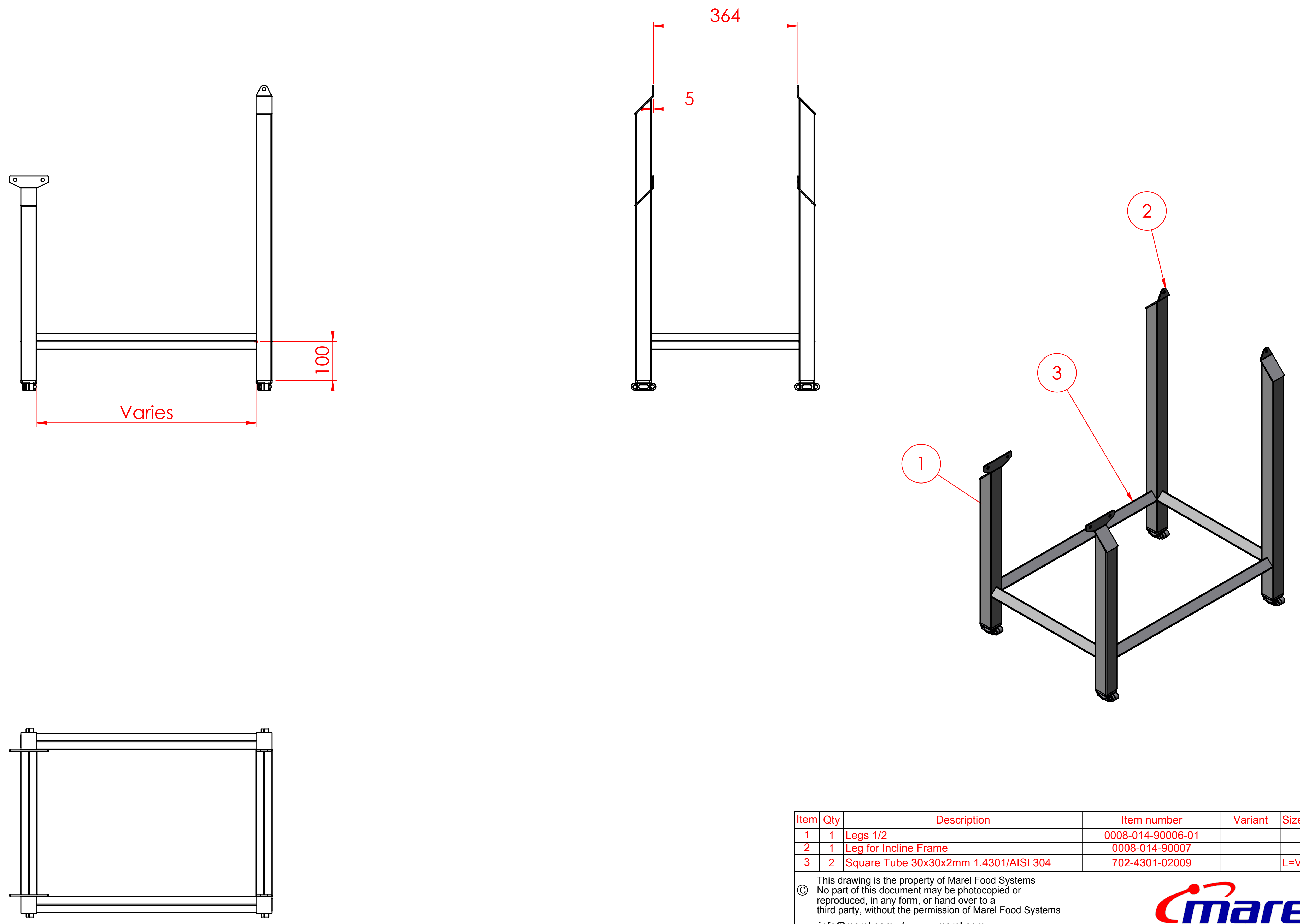
SHEET 1 OF 1

DRAWING NO.
CONVEYORS - PARAMETRIC CONVEYOR

Legs for Incline Frame

STATUS: [ACTIVE]

REVISION 00



Item	Qty	Description	Item number	Variant	Size	Comment
1	1	Legs 1/2	0008-014-90006-01			
2	1	Leg for Incline Frame	0008-014-90007			
3	2	Square Tube 30x30x2mm 1.4301/AISI 304	702-4301-02009		L=Varies	L4

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DESIGNER SIRE	DRAWN SIRE	DIVISION WW - Workshop welding	REPLACES: -	A3
APPROVED -	DATE 4.3.2014	TREATMENT	REPLACED BY: -	SCALE: 1:10

TITLE:

Leg Frame for Incline Section

Location: GARÐABÆR

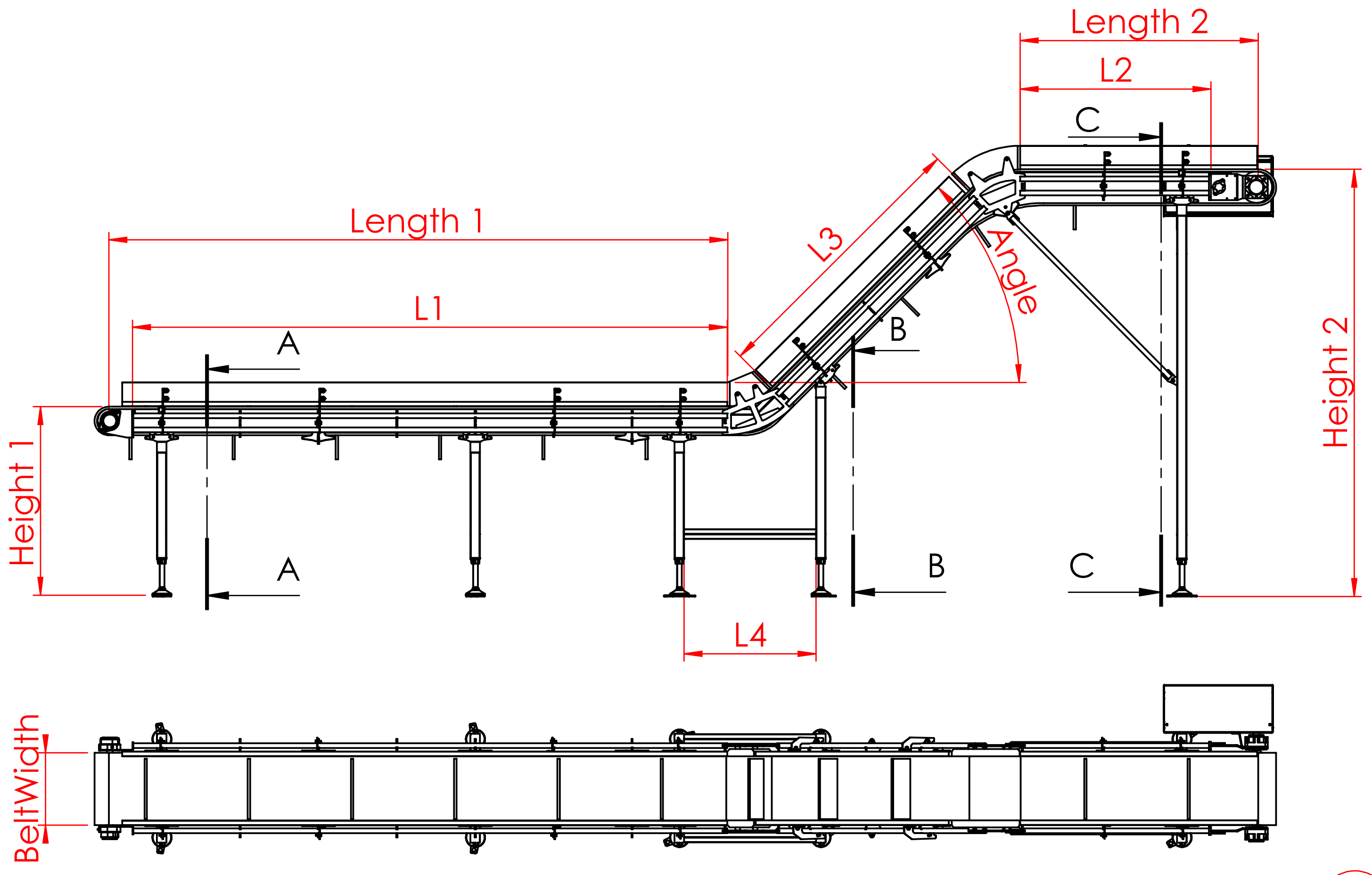
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN MILLIMETERS
According to:
ISO 2768-1 and ISO 2768-2
LIN/ANG. : m
GEO. Tol : K

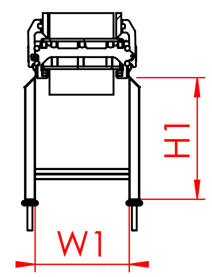
SHEET 1 OF 1

DRAWING NO. CONVEYORS - PARAMETRIC CONVEYOR STATUS:

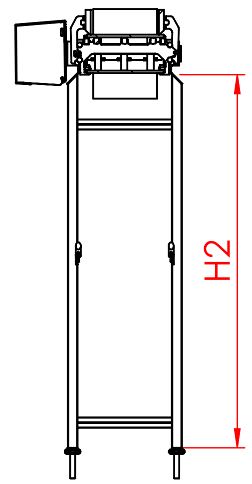
Chair for Incline Section [ACTIVE]

REVISION 00

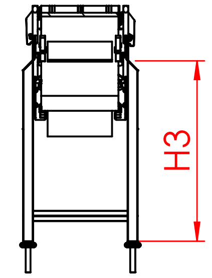




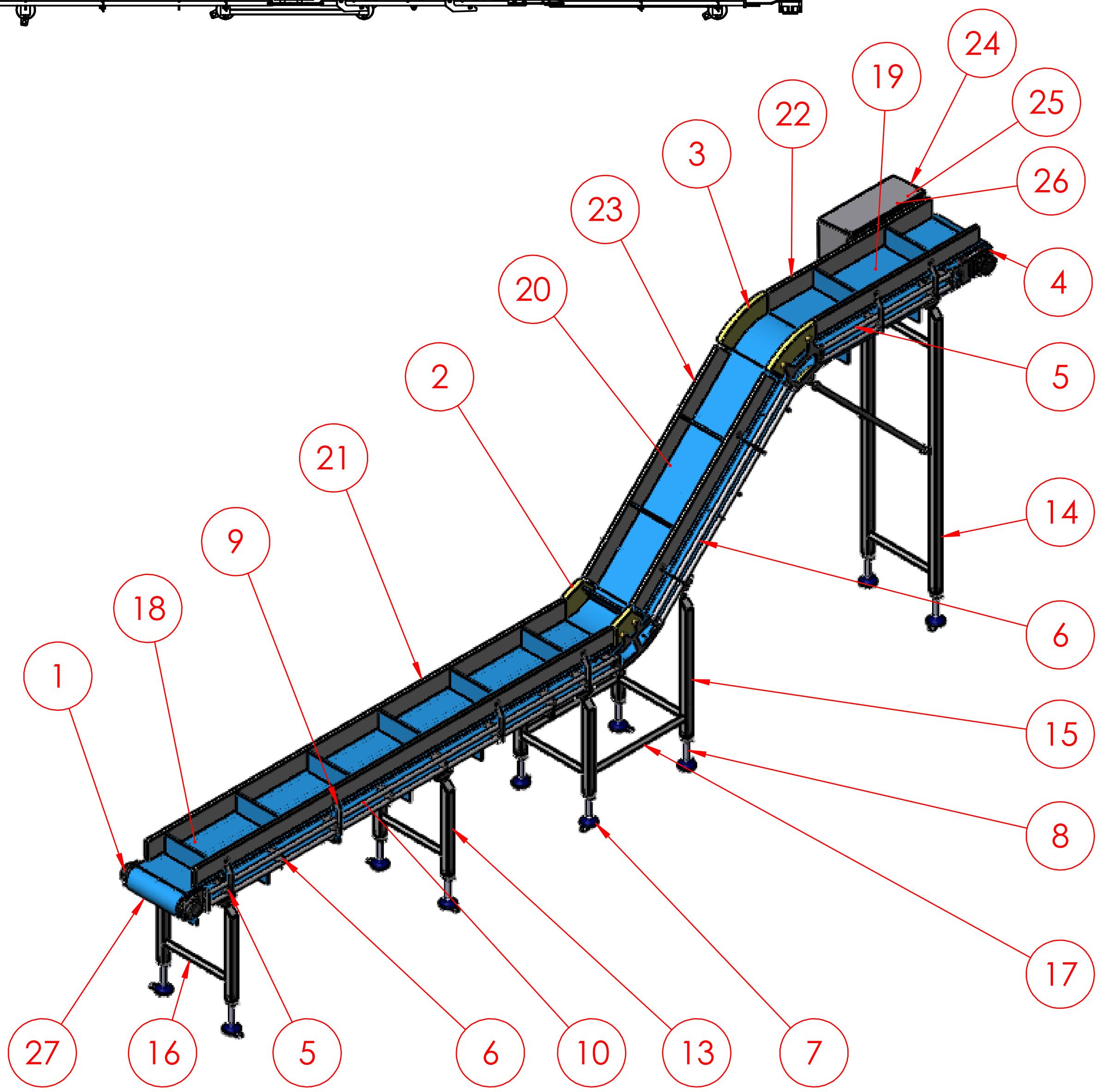
SECTION A-A
SCALE 1 : 30



SECTION C-C
SCALE 1 : 30



SECTION B-B
SCALE 1 : 30



Item	Qty	Description	Item number	Size	Comment
1	1	Idle End Module	Varies		
2	1	Incline Module	Varies		
3	1	Decline Module	Varies		
4	1	Motor End Module	Varies		
5	Varies	Cross Beam w. Belt Return Support	Varies		
6	Varies	Crossbeam	Varies		
7	Varies	Leg Module - Standard	0008-014-10005		
8	1	Leg Module - Incline	0008-014-10008		
9	Varies	Fastening for Sideguard	0008-014-10007		
10	4	Round Bar 20 mm 1.4301/AISI 304	702-4301-04011	L=Varies	L1
11	4	Round Bar 20 mm 1.4301/AISI 304	702-4301-04011	L=Varies	L2
12	4	Round Bar 20 mm 1.4301/AISI 304	702-4301-04011	L=Varies	L3
13	Varies	Square tube 40x40x2 mm 1.4301/AISI 304	702-4301-02012	L=Varies	H1
14	Varies	Square tube 40x40x2 mm 1.4301/AISI 304	702-4301-02012	L=Varies	H2
15	2	Square tube 40x40x2 mm 1.4301/AISI 304	702-4301-02012	L=Varies	H3
16	Varies	Square tube 30x30x2 mm 1.4301/AISI 304	702-4301-02009	L=Varies	W1
17	Varies	Square tube 30x30x2 mm 1.4301/AISI 304	702-4301-02009	L=Varies	L4
18	Varies	Wear Strip PEHD500 20 x 25 x 6000 PE [mm] "V"	704-0002-12002	L=Varies	Wearstr. L1
19	Varies	Wear Strip PEHD500 20 x 25 x 6000 PE [mm] "V"	704-0002-12002	L=Varies	Wearstr. L2
20	Varies	Wear Strip PEHD500 20 x 25 x 6000 PE [mm] "V"	0008-014-90009	L=Varies	Wearstr. L3
21	1L / 1R	Side Guard PEHD500 20 x 100 with 45° opening	Varies	L=Varies	Sideg. L1
22	2	Side Guard PEHD500 20 x 100 with 45° opening	Varies	L=Varies	Sideg. L2
23	2	Side Guard PEHD500 20 x 100 with 45° opening	Varies	L=Varies	Sideg. L3
24	2	Varies	Varies		Motorcover
25	1	Endwasher for gkr4	Varies		
26	1	Varies	Varies		Motor
27	Varies [m]	Varies	Varies		Belt

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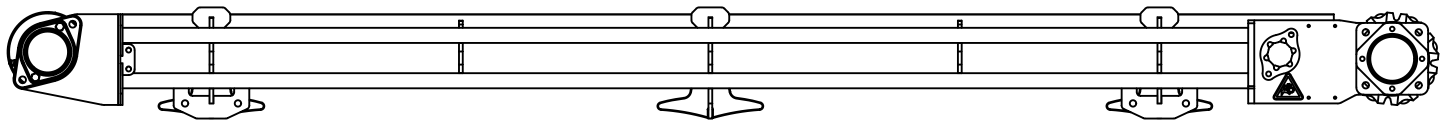
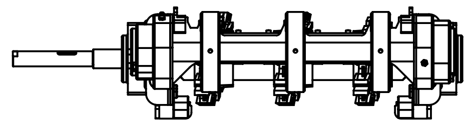
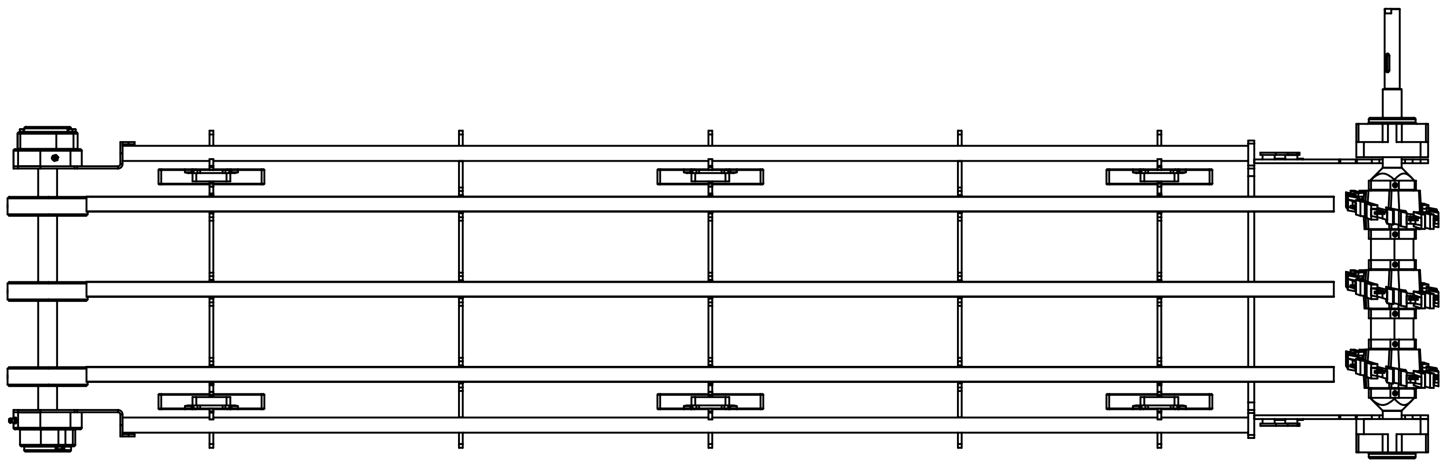
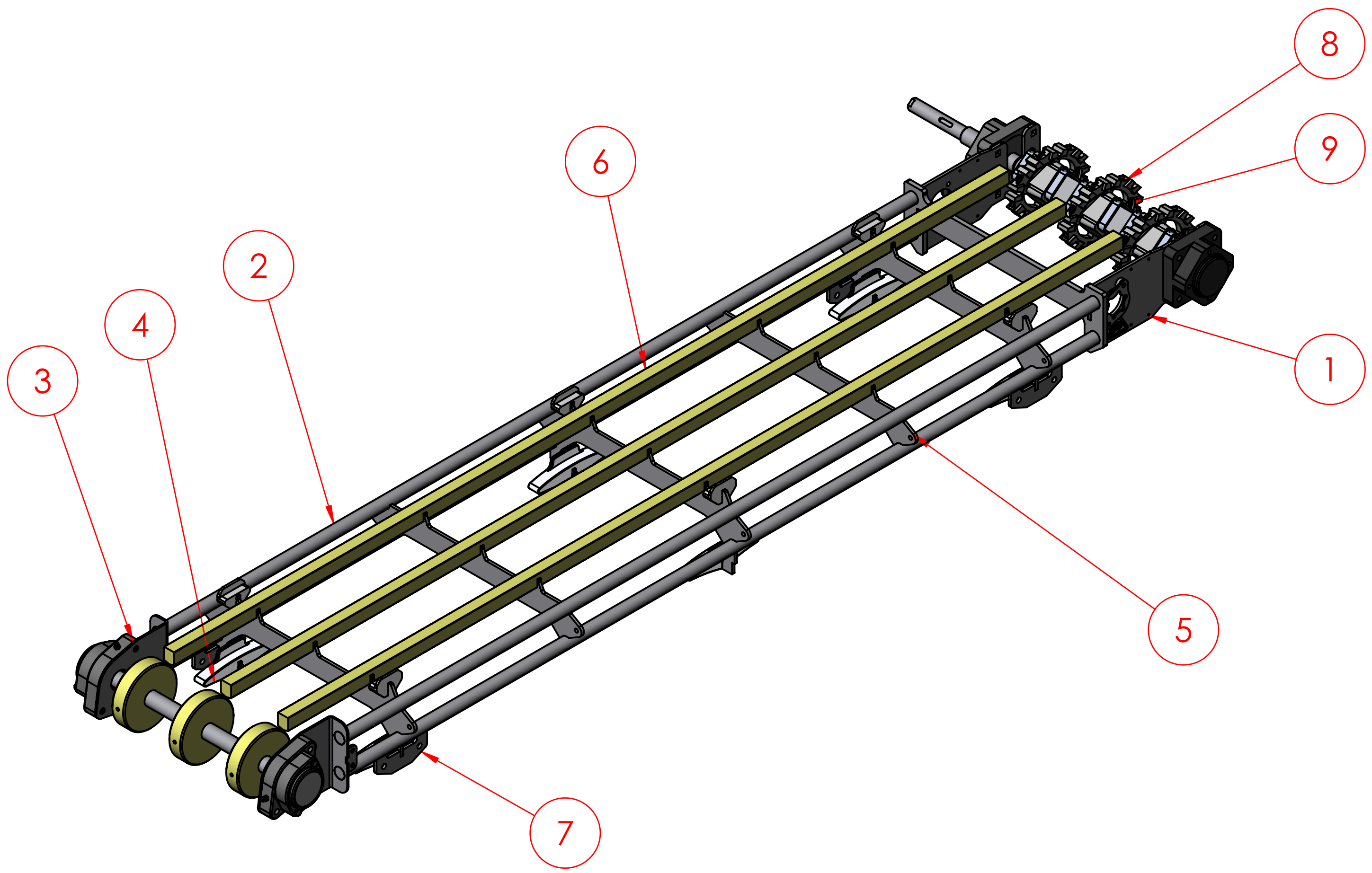
DESIGNER SIRE	DRAWN SIRE	DIVISION WA - Workshop assembling	REPLACES: -	A3
APPROVED -	DATE 4.3.2014	TREATMENT	REPLACED BY: -	SCALE: 1:35
TITLE: Goose Neck Conveyor			Location: GARÐABÆR	
			UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MILLIMETERS According to: ISO 2768-1 and ISO 2768-2 LIN/ANG. : m GEO. Tol : K	SHEET 2 OF 2
DRAWING NO. CONVEYORS - PARAMETRIC CONVEYOR		STATUS:		REVISION 00
Goose Neck Conveyor		[ACTIVE]		









Item	Qty	Description	Item number	Variant	Size	Comment
1	1	Motor End Module	0008-014-10003-xx			
2	4	Round Bar ø20-h9 1.4305/AISI 303	702-4305-04012		L=Varies	
3	1	Idle End w305	0008-014-10004-xx			
4	3	Cross Beam with Belt Return Support	0008-014-10006-xx			
5	2	Cross Beam	0008-014-20017-xx		Varies	
6	3	Wear Strip 20x25	704-0002-12002		L=Varies	
7	4	Mounting Plate for Legs	0008-014-20027		100*40	
8	3	Intralox Sprocket S800/S850 8 teeth 40x40 square EZ Clean	730-0008-1011907			
9	6	Retaining Ring for 40x40 Square	730-0000-1011903			

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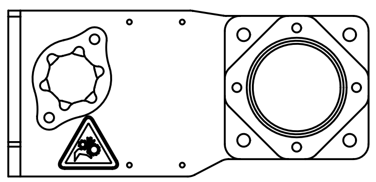
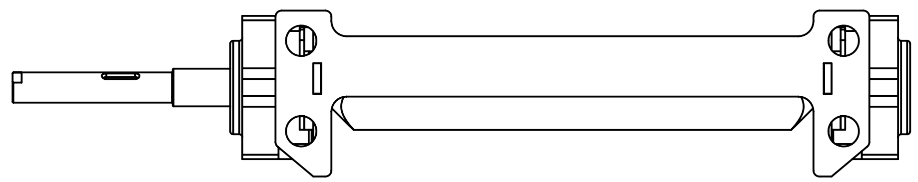
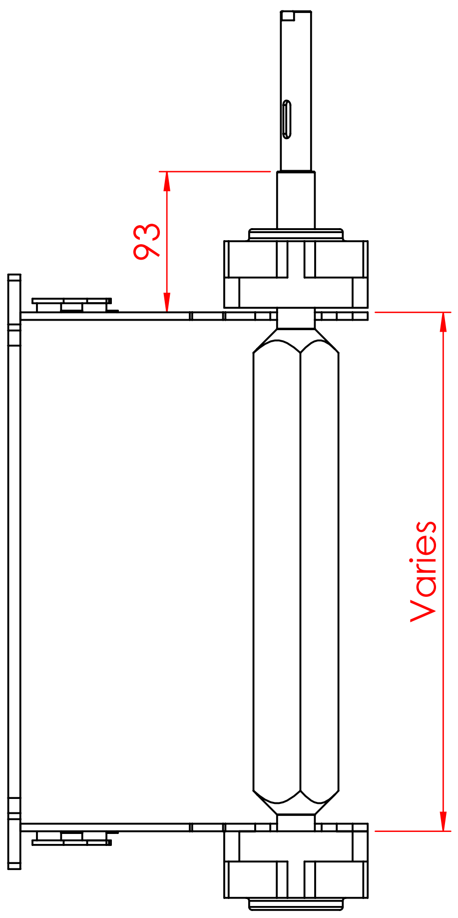
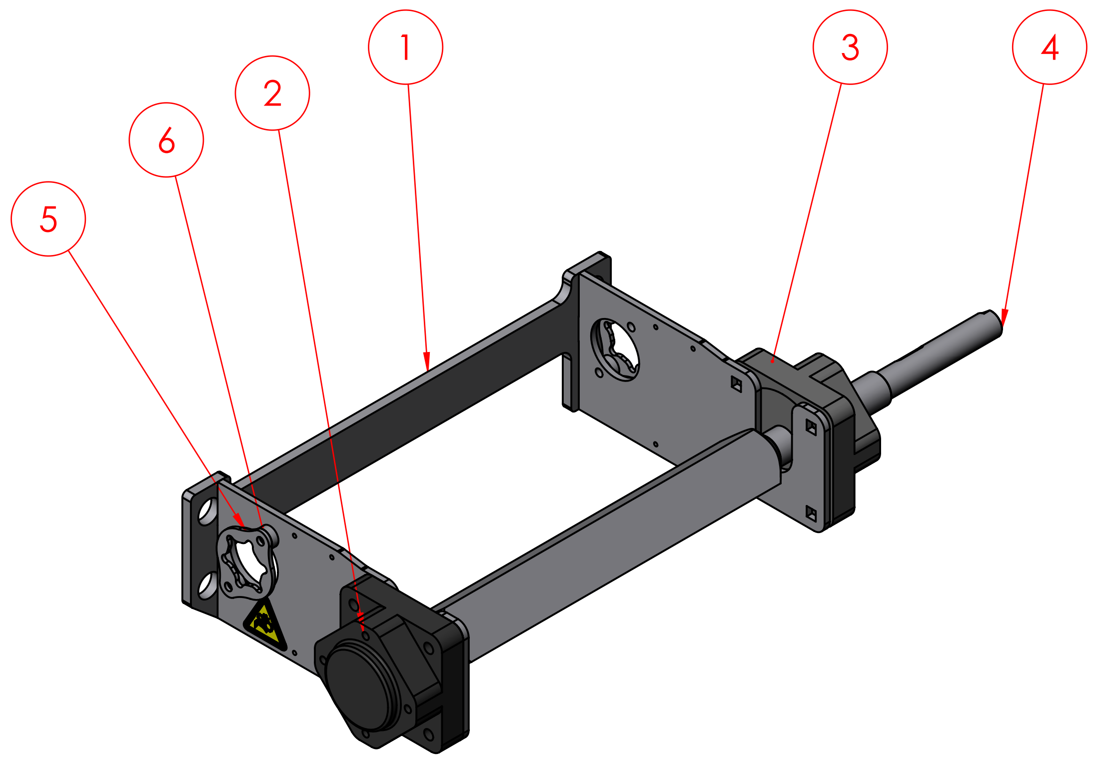
DESIGNER	DRAWN	DIVISION -	REPLACES: -	A3
APPROVED -	DATE	TREATMENT	REPLACED BY: -	SCALE: 1:20
TITLE:			Location:	
			UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MILLIMETERS According to: ISO 2768-1 and ISO 2768-2 LIN/ANG. : m GEO. Tol : K	SHEET 1 OF 1
DRAWING NO. -		STATUS:		REVISION

Straight Conveyor Frame [Status] Assembly









Item	Qty	Description	Item number	Variant	Size	Comment
1	1	Motor End Weldment	0008-014-90004-xx			
2	1	Norm Gear F4 Bearing ø25 closed	732-3100-1006653			
3	1	Norm Gear F4 Bearing ø25 open	732-3100-1006652			
4	1	D-Shaft305	0008-014-20062-xx		L=Varies	
5	2	Bracket for washing pipe intralox	018-0015-2030		52x76	
6	4	Spacer ø16/ø6,5 L=6 AISI304	007-0009-2375		L=6	
7	2	Danger of personal injury caused by rotating parts	804-5101-1024410			

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DESIGNER SIRE	DRAWN SIRE	DIVISION WA - Workshop assembling	REPLACES: -	A3
APPROVED -	DATE 27.2.2014	TREATMENT	REPLACED BY: -	SCALE: 1:5

TITLE:

Motor End Module

Location: GARÐABÆR

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN MILLIMETERS
According to:
ISO 2768-1 and ISO 2768-2
LIN/ANG. : m
GEO. Tol : K

SHEET 1 OF 1

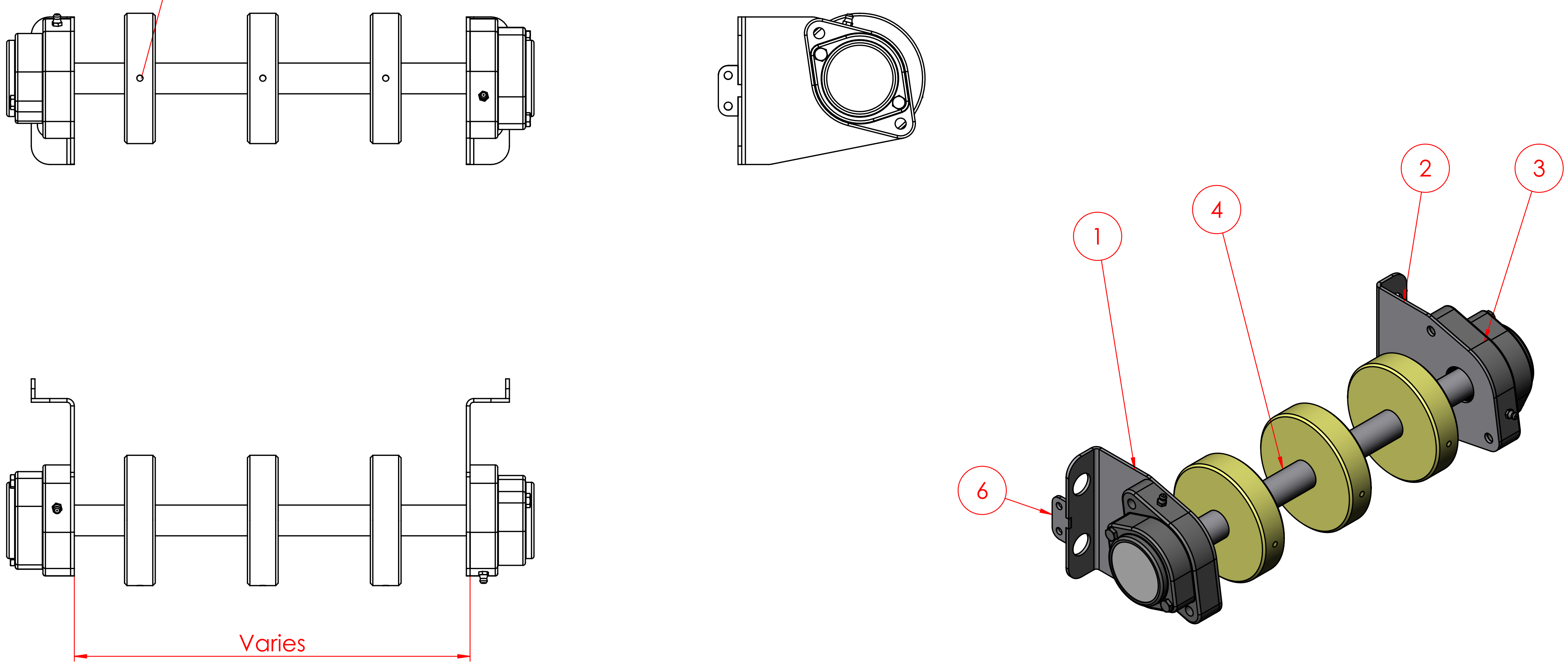
DRAWING NO. CONVEYORS - PARAMETRIC CONVEYOR

0008-014-10003-xx

STATUS: [ACTIVE]

REVISION 00

Mount the Support Wheels with socket set screws M6*30.
Wheels should be in line with wearstrips.



Item	Qty	Description	Item number	Variant	Size	Comment
1	1	Side in idle end	0008-014-20042		173x120	
2	1	Mirror Side in Idle End	0008-014-20042-M		173x120	
3	2	Norm Gear bearing Ø25 closed	732-3110-25l			
4	1	Shaft for Idle End w305	0008-014-20045-xx		L=Varies	
5	Varies	Support Wheel for Belt in Idle End	0008-014-20046		L=25	
6	2	Mounting plate for CIP bracket	0008-014-20057		41*19	

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DESIGNER SIRE | DRAWN SIRE | DIVISION WA - Workshop assembling | REPLACES: - | A3

APPROVED - | DATE 27.2.2014 | TREATMENT | REPLACED BY: - | SCALE: 1:5

TITLE:

Idle End - Assembly

Location: GARÐABÆR

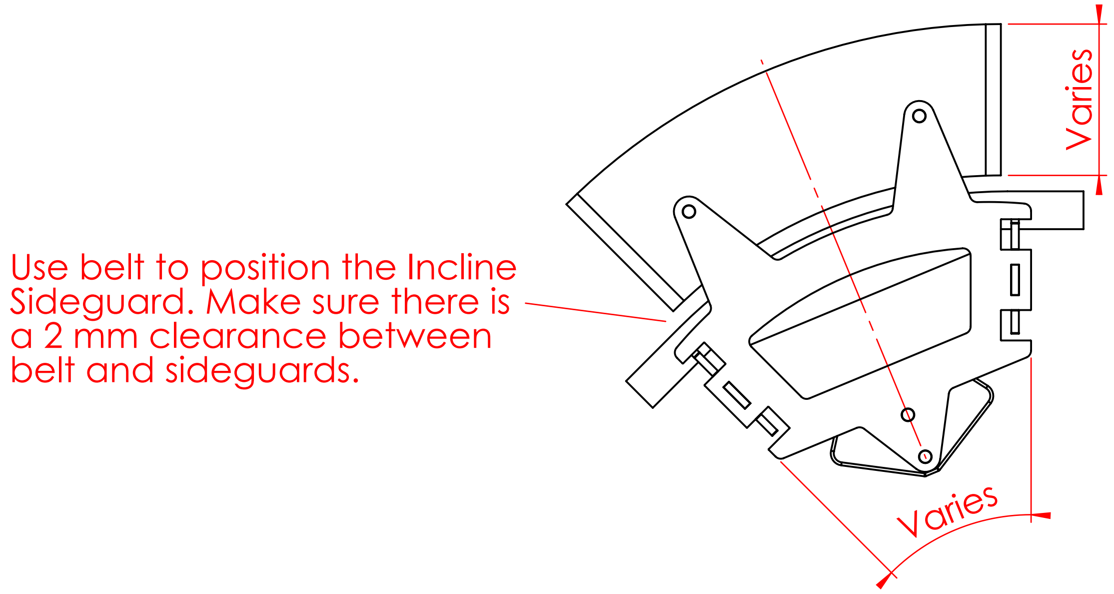
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN MILLIMETERS
According to:
ISO 2768-1 and ISO 2768-2
LIN/ANG. : m
GEO. Tol : K

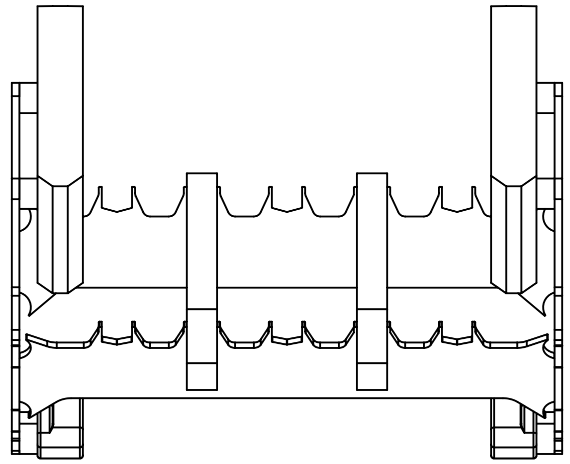
SHEET 1 OF 1

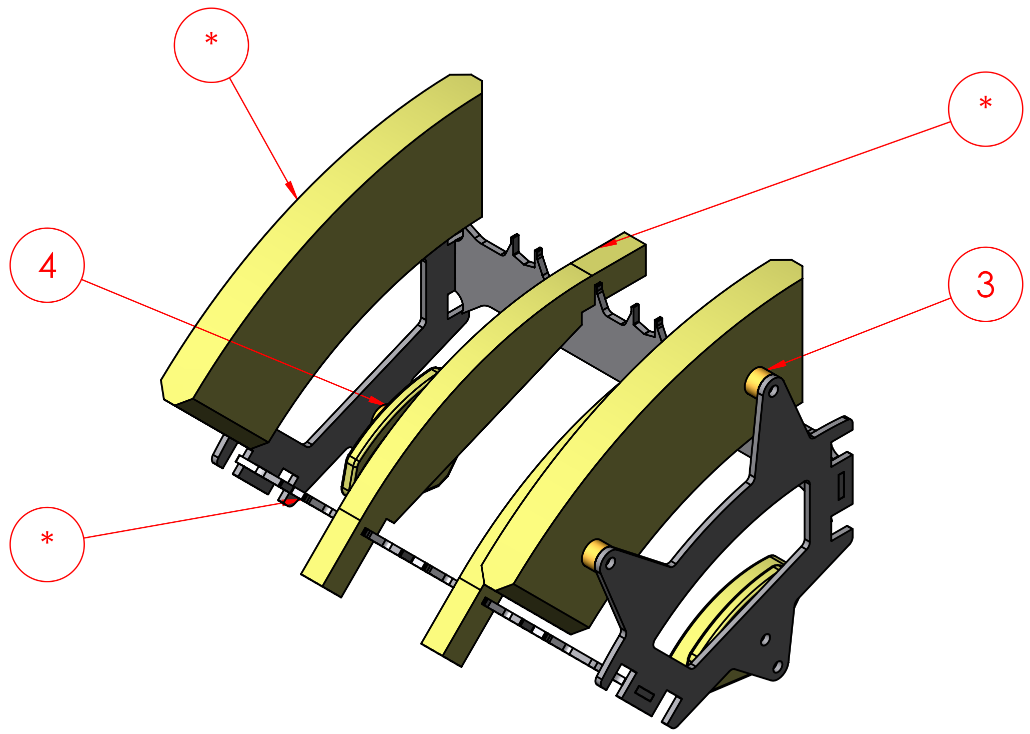
REVISION 00

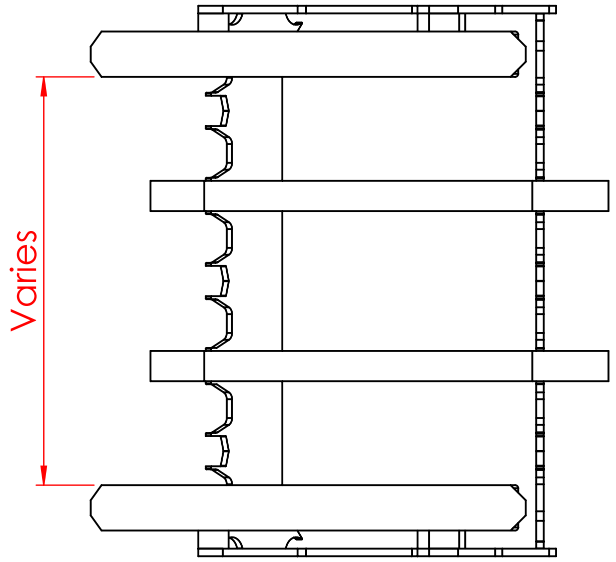
DRAWING NO. CONVEYORS - PARAMETRIC CONVEYOR STATUS:

0008-014-10004-xx [ACTIVE]









Item	Qty	Description	Item number	Variant	Size	Comment
1	1	Decline Module w305 8°	Varies			
2	2	Internal Shoe 30°	0008-014-20031-xx		Varies	
3	8	Spacer ø20/ø8 L=12 PE	008-0011-2571		L=12	
4	2	Belt Return Support in Decline Module	0008-014-20038		Varies	
5	2	Sideguard for Decline Module h100 30°	0008-014-20034-xx		Varies	

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DESIGNER SIRE	DRAWN SIRE	DIVISION WA - Workshop assembling	REPLACES: -	A3
APPROVED -	DATE 26.2.2014	TREATMENT	REPLACED BY: -	SCALE: 1:5

TITLE:

Decline Module

Location: GARÐABÆR

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN MILLIMETERS
According to:
ISO 2768-1 and ISO 2768-2
LIN/ANG. : m
GEO. Tol : K

SHEET 1 OF 1

DRAWING NO. CONVEYORS - PARAMETRIC CONVEYOR

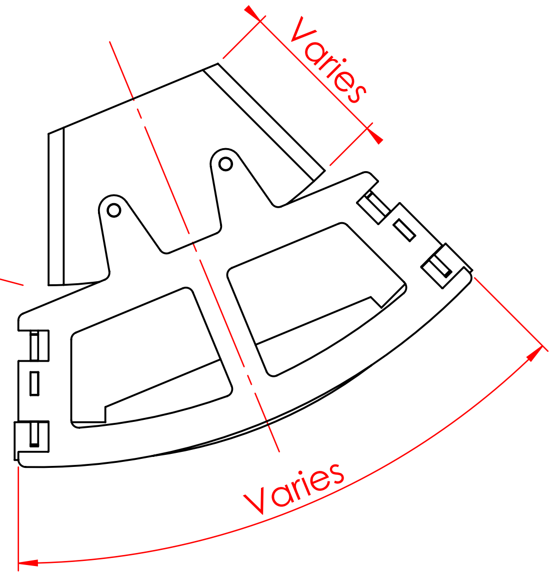
STATUS:

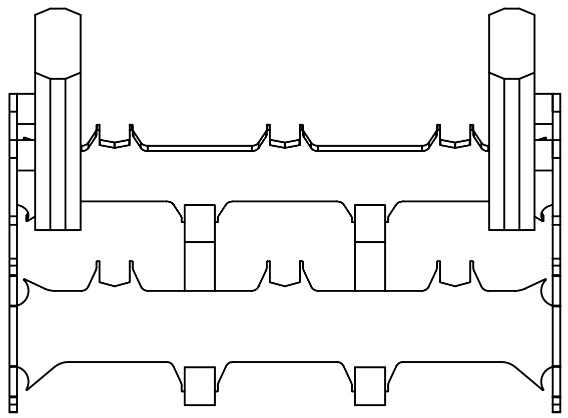
0008-014-10001-XX

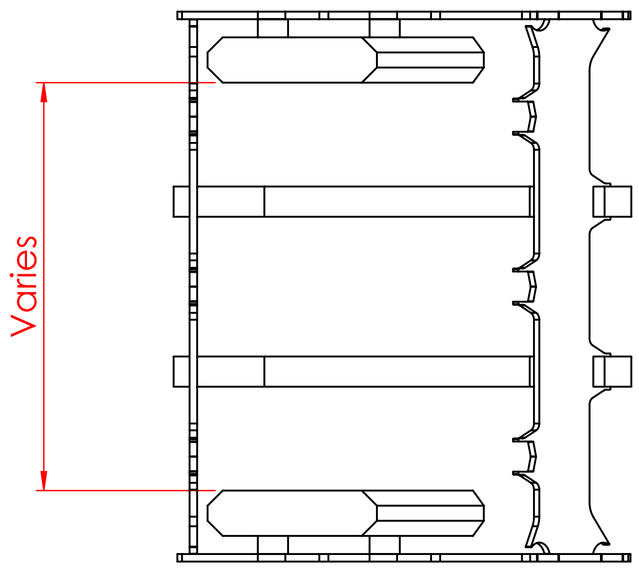
[NONE]

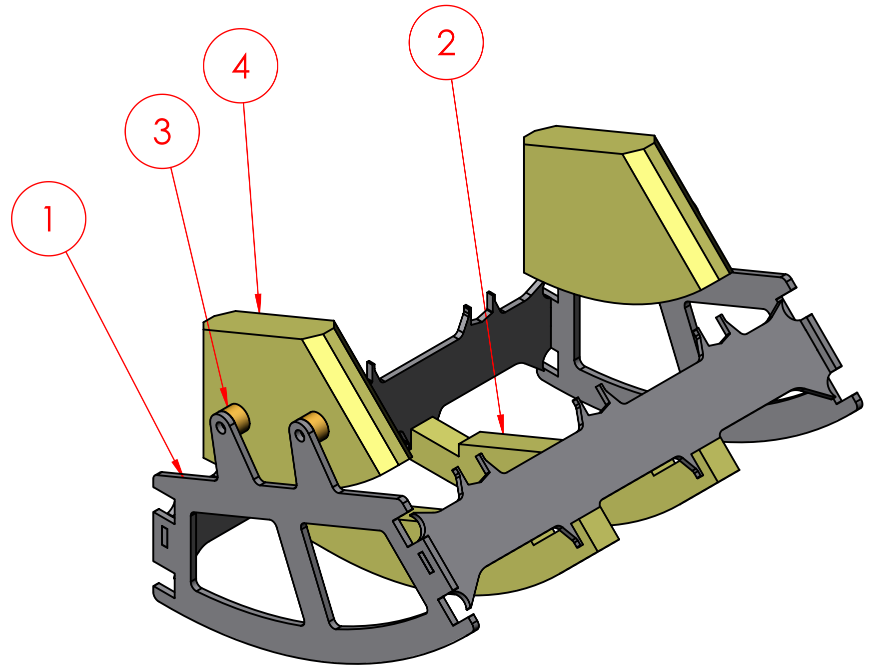
REVISION 00

Use belt to position the Incline Sideguard. Make sure there is a 2 mm clearance between belt and sideguards.









Item	Qty	Description	Item number	Variant	Size	Comment
1	1	Incline Module - Weldment	Varies			
2	2	Internal Shoe	0008-014-20031-xx		Varies	
3	4	Spacer ø20/ø8 L=12 PE	008-0011-2571		L=12	
4	2	Incline Sideguard	0008-014-20028-xx		Varies	

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DESIGNER: SIRE	DRAWN: SIRE	DIVISION: WA - Workshop assembling	REPLACES: -	A3
APPROVED: -	DATE: 26.2.2014	TREATMENT:	REPLACED BY: -	SCALE: 1:5

TITLE: **Incline Module**

Location: GARÐABÆR

UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MILLIMETERS According to: ISO 2768-1 and ISO 2768-2 LIN/ANG. : m GEO. Tol : K

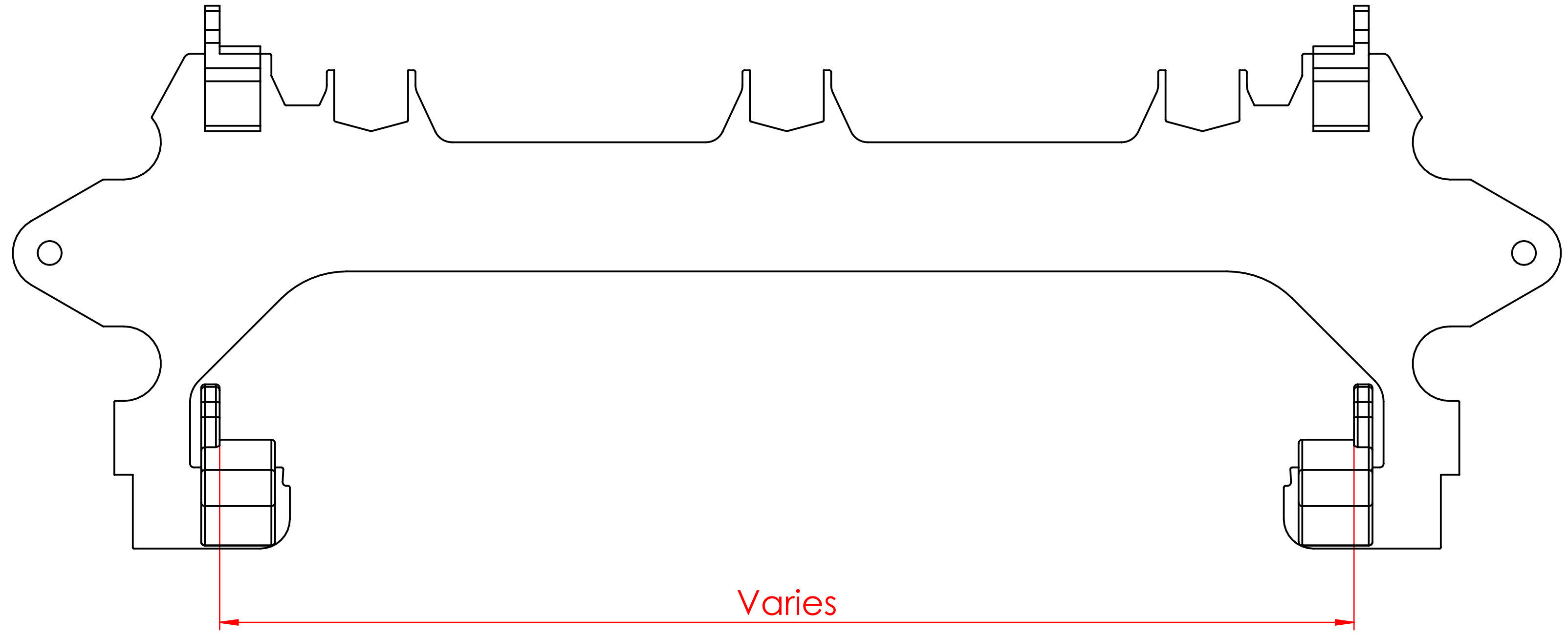
SHEET 1 OF 1

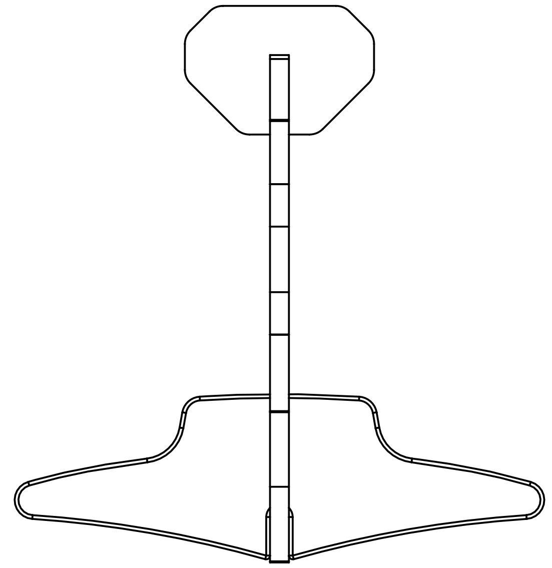
DRAWING NO. CONVEYORS - PARAMETRIC CONVEYOR

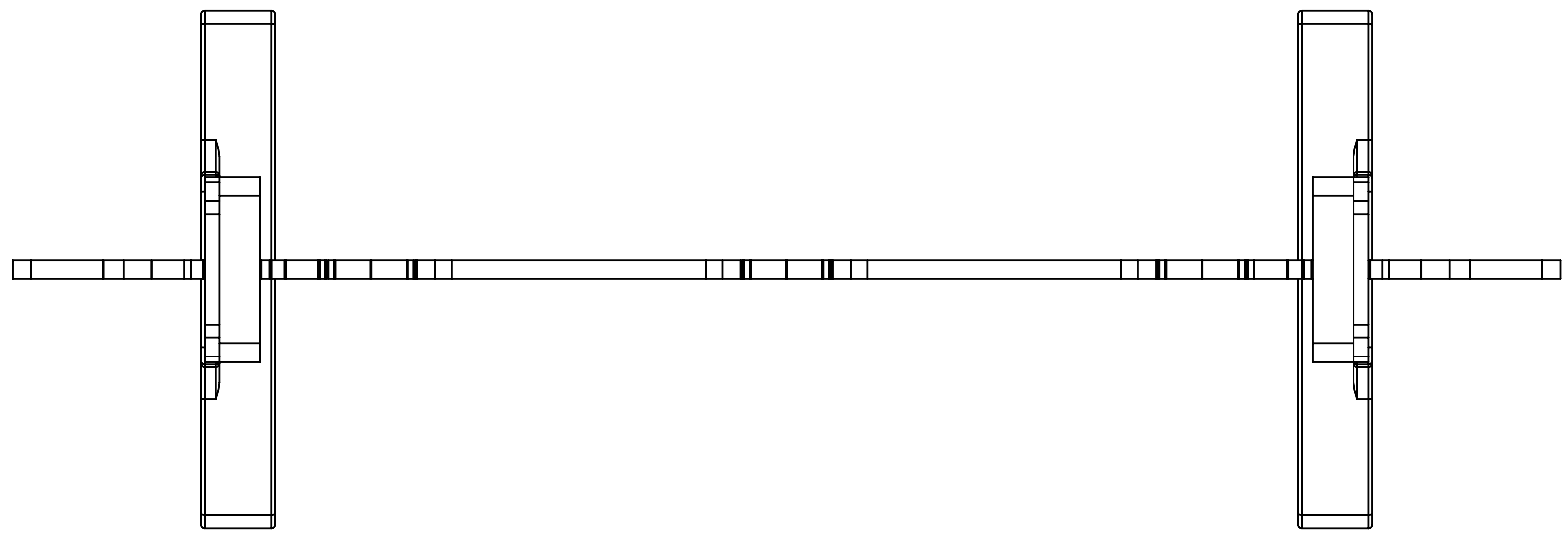
0008-014-10002-xx

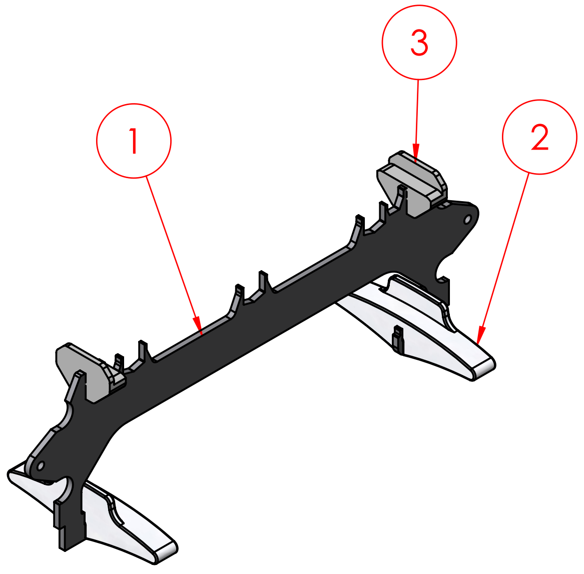
STATUS: [NONE]

REVISION 00









Item	Qty	Description	Item number	Variant	Size	Comment
1	1	Cross Beam w. Belt Return Support Holders	0008-014-20013-xx		Varies	
2	2	Belt return support with side gude 20x140mm	004-0200-21880002		44x140	
3	2	Side guide for belt	0004-100-20529		50x34	

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DESIGNER: SIRE	DRAWN: SIRE	DIVISION: WA - Workshop assembling	REPLACES: - / A3
APPROVED: -	DATE: 27.2.2014	TREATMENT:	REPLACED BY: - / SCALE: 1:5

TITLE: Cross Beam with Belt Return Support

Location: GARÐABÆR

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN MILLIMETERS
According to:
ISO 2768-1 and ISO 2768-2
LIN/ANG. : m
GEO. Tol : K

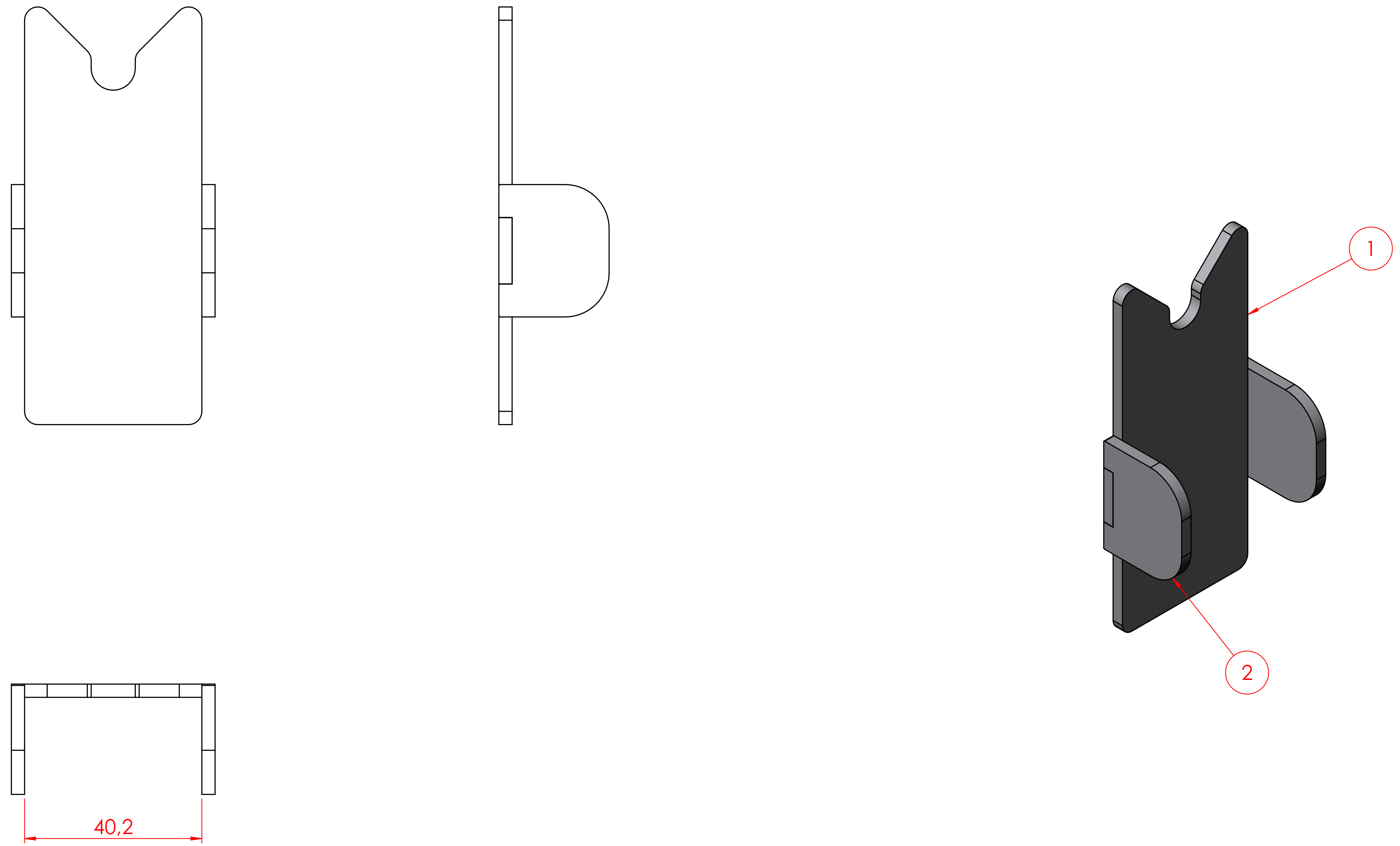
SHEET 1 OF 1

REVISION 00

DRAWING NO. CONVEYORS - PARAMETRIC CONVEYOR

0008-014-10006-xx

STATUS: [ACTIVE]



Item	Qty	Description	Item number	Variant	Size	Comment
1	1	Template for Bottom Crossbeam on Legs	0008-014-20052-01		46,2*94,6	
2	2	Sideplate in Template for Legs	0008-014-20053		25*30	

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DESIGNER SIRE	DRAWN SIRE	DIVISION -	REPLACES: -	A3
APPROVED -	DATE 17.3.2014	TREATMENT	REPLACED BY: -	SCALE: 1:1

TITLE:

Location:

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN MILLIMETERS
According to:
ISO 2768-1 and ISO 2768-2
LIN/ANG. : m
GEO. Tol : K

SHEET 1 OF 1

DRAWING NO.

CONVEYORS - PARAMETRIC CONVEYOR

STATUS:

0008-014-90011-01

[ACTIVE]

REVISION
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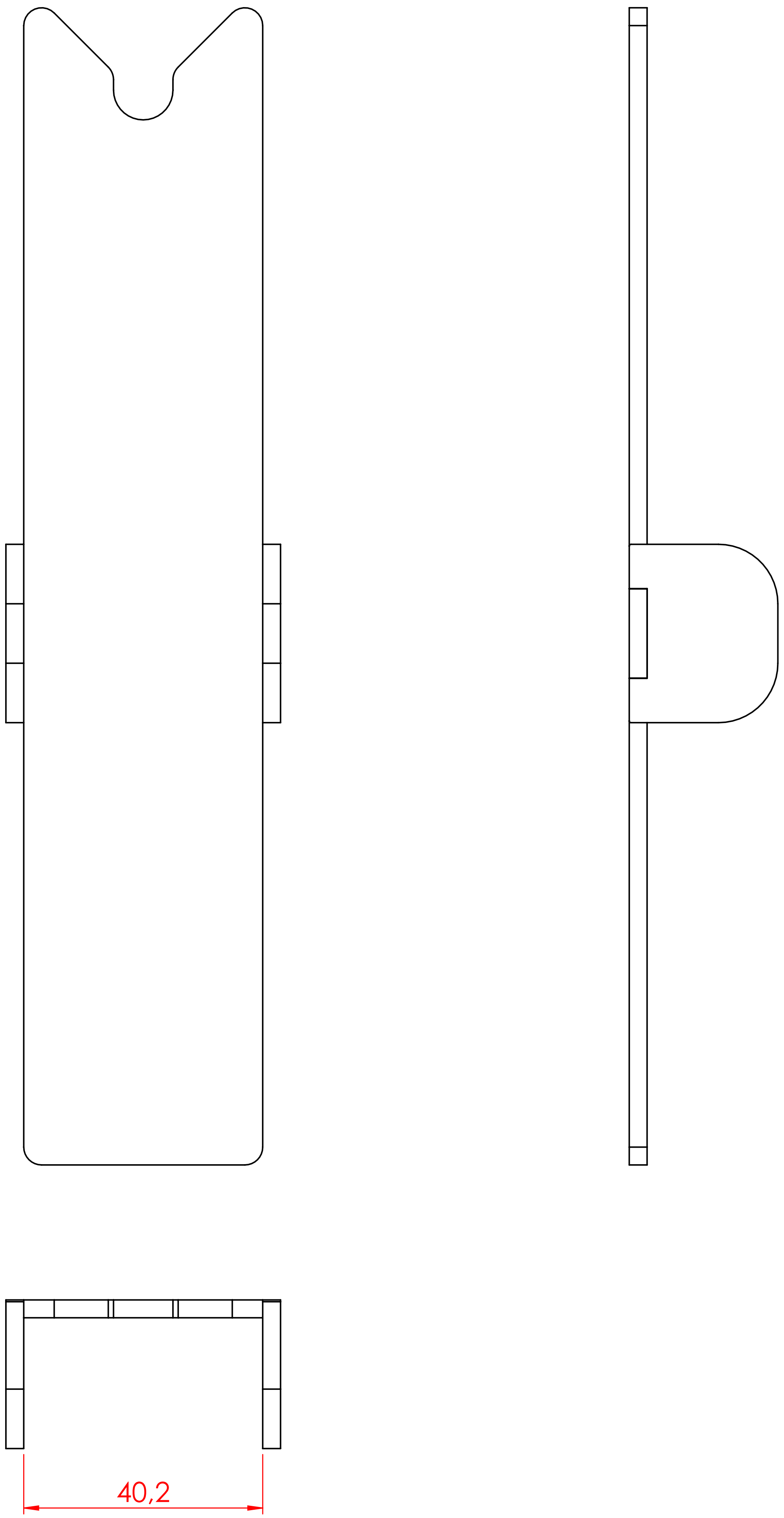

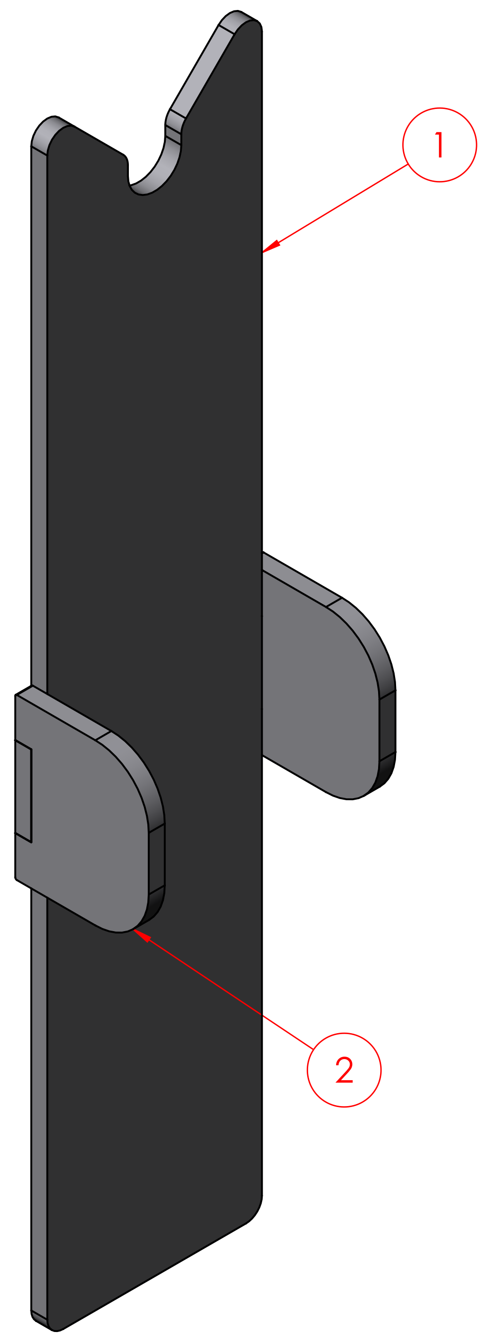

Item	Qty	Description	Item number	Variant	Size	Comment
1	1	Template for Bottom Crossbeam on Legs	0008-014-20052-02		46,2*194,6	
2	2	Sideplate in Template for Legs	0008-014-20053		25*30	

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DESIGNER SIRE	DRAWN SIRE	DIVISION -	REPLACES: -	A3
APPROVED -	DATE 17.3.2014	TREATMENT	REPLACED BY: -	SCALE: 1:1
TITLE:			Location:	

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN MILLIMETERS
According to:
ISO 2768-1 and ISO 2768-2
LIN/ANG. : m
GEO. Tol : K

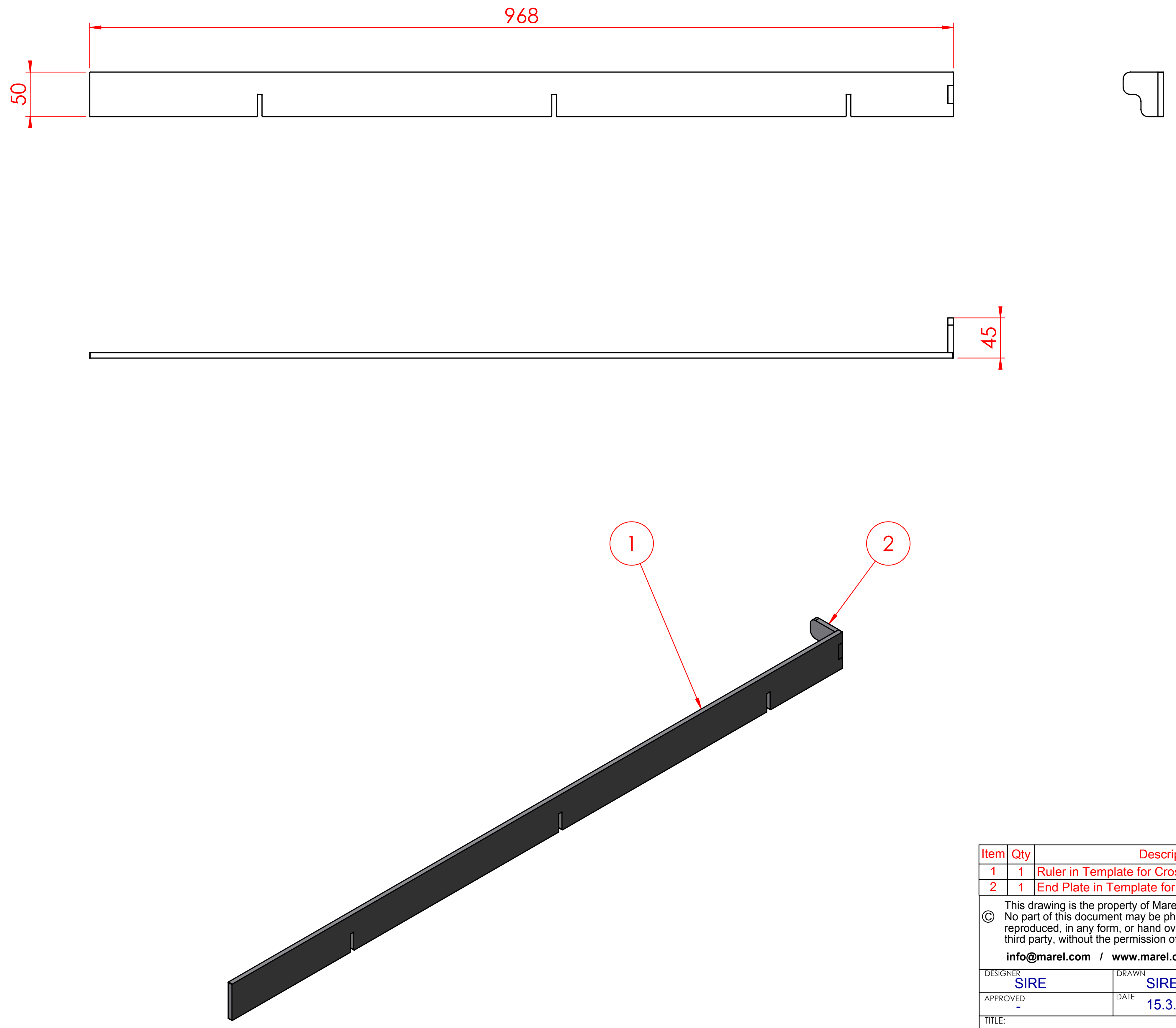
SHEET 1 OF 1

DRAWING NO. CONVEYORS - PARAMETRIC CONVEYOR

0008-014-90011-02

STATUS: [ACTIVE]

REVISION 00



Item	Qty	Description	Item number	Variant	Size	Comment
1	1	Ruler in Template for Crossbeams	0008-014-20054		968*50	
2	1	End Plate in Template for Crossbeams	0008-014-20055		50*45	

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DESIGNER SIRE | DRAWN SIRE | DIVISION - | REPLACES: - | A3

APPROVED - | DATE 15.3.2014 | TREATMENT | REPLACED BY: - | SCALE: 1:5

TITLE:

Template for Crossbeams - Left

Location: GARÐABÆR

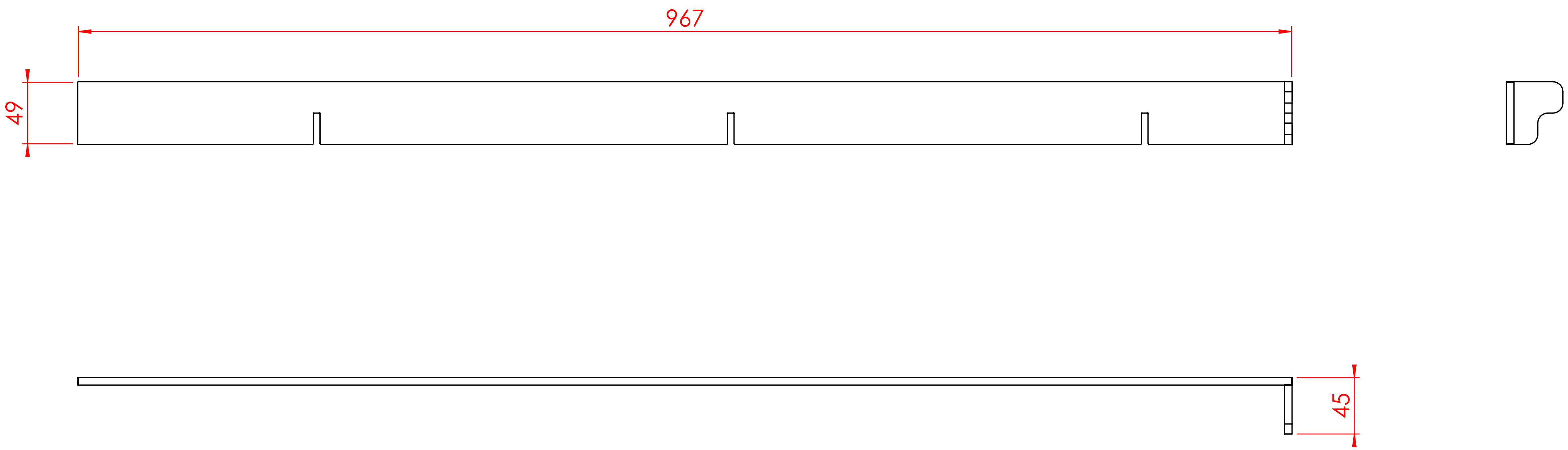
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN MILLIMETERS
According to:
ISO 2768-1 and ISO 2768-2
LIN/ANG. : m
GEO. Tol : K

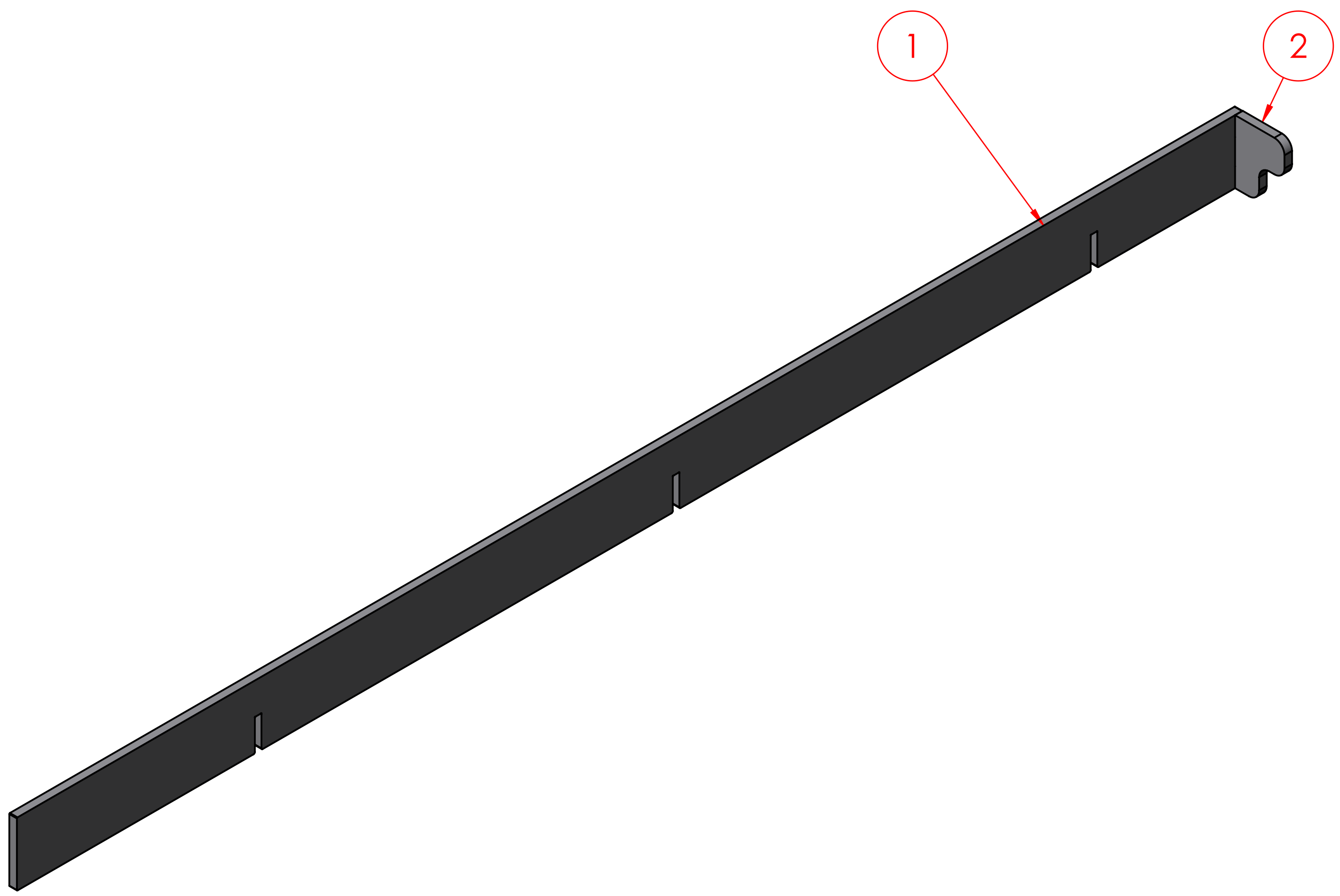
SHEET 1 OF 1

DRAWING NO. CONVEYORS - PARAMETRIC CONVEYOR STATUS:

0008-014-90010-01 [ACTIVE]

REVISION 00





Item	Qty	Description	Item number	Variant	Size	Comment
1	1	Ruler in Template for Crossbeams	0008-014-20054		968*50	
2	1	End Plate in Template for Crossbeams	0008-014-20055		50*45	

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DESIGNER SIRE	DRAWN SIRE	DIVISION WW - Workshop welding	REPLACES: -	A3
APPROVED -	DATE 15.3.2014	TREATMENT	REPLACED BY: -	SCALE: 1:5

TITLE: Template for Crossbeams - Left

Location: GARÐABÆR

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN MILLIMETERS
According to:
ISO 2768-1 and ISO 2768-2
LIN/ANG. : **m**
GEO. Tol : **K**

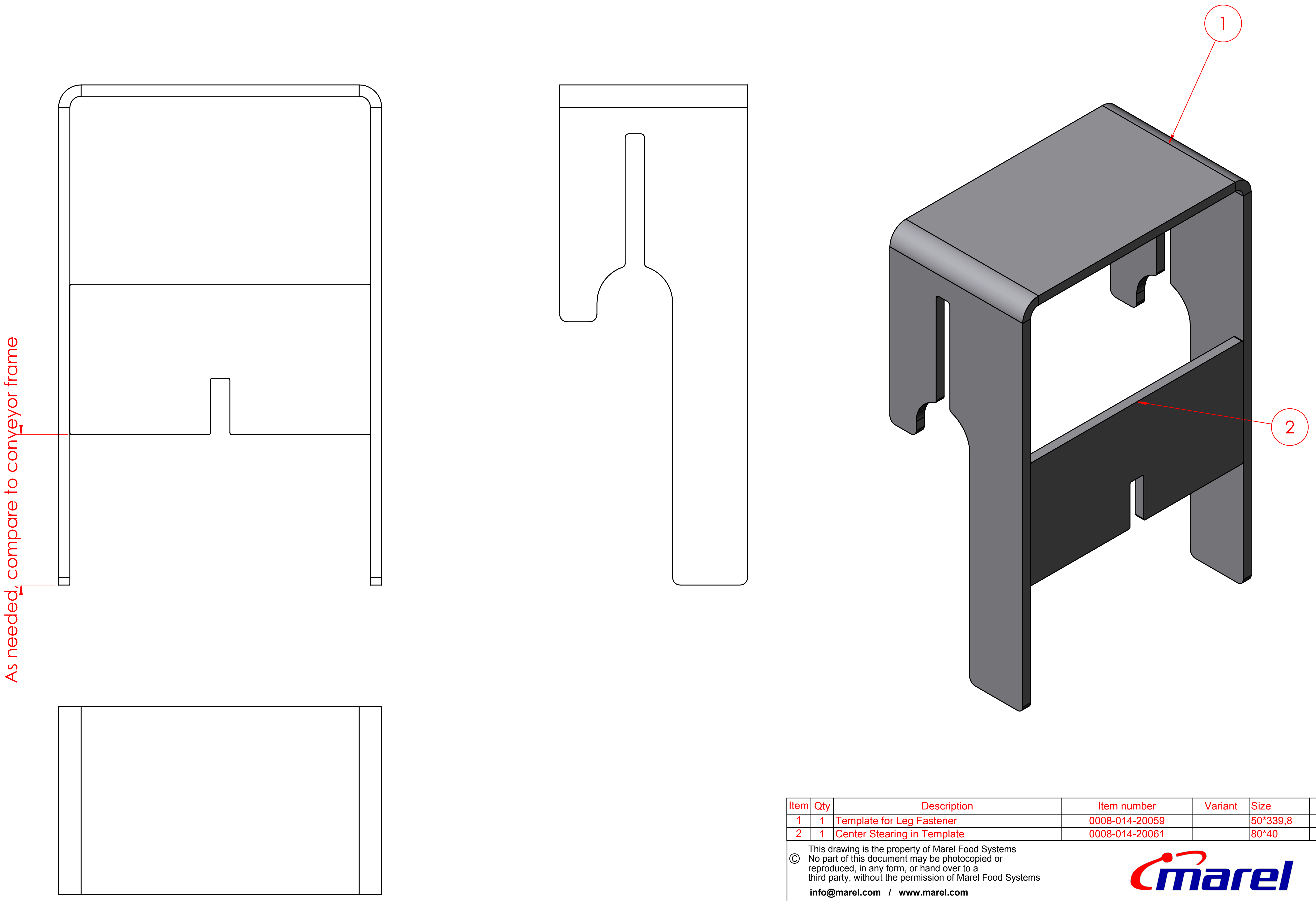
SHEET 1 OF 1

REVISION 00

DRAWING NO. CONVEYORS - PARAMETRIC CONVEYOR

0008-014-90010-02

STATUS: [ACTIVE]



Item	Qty	Description	Item number	Variant	Size	Comment
1	1	Template for Leg Fastener	0008-014-20059		50*339,8	
2	1	Center Stearing in Template	0008-014-20061		80*40	

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DESIGNER SIRE	DRAWN SIRE	DIVISION WW - Workshop welding	REPLACES: -	A3
APPROVED -	DATE 7.4.2014	TREATMENT	REPLACED BY: -	SCALE: 1:2

TITLE:

Template for Mounting Plate

Location: GARÐABÆR

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN MILLIMETERS
According to:
ISO 2768-1 and ISO 2768-2
LIN/ANG. : m
GEO. Tol : K

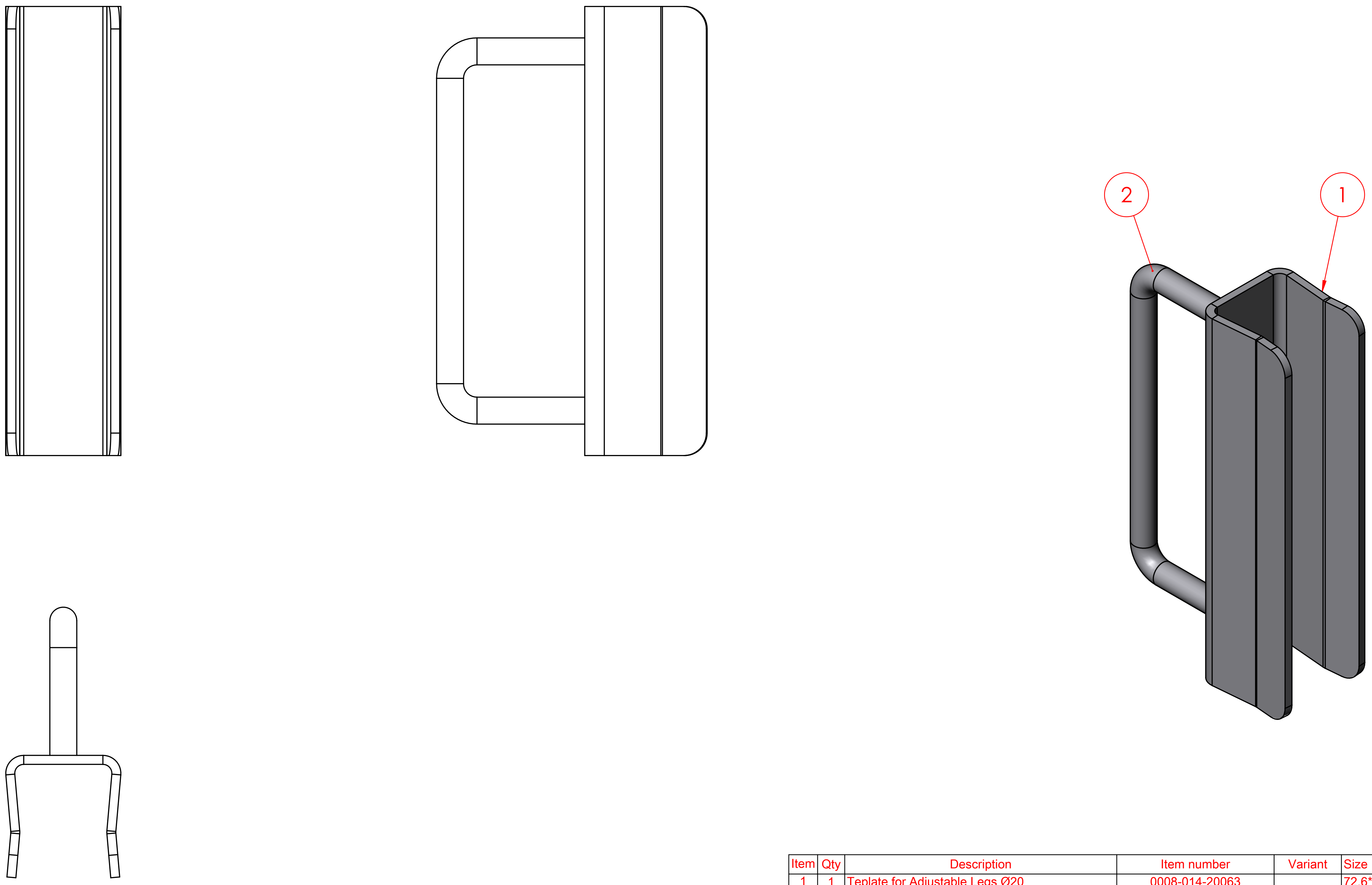
SHEET 1 OF 1

DRAWING NO. CONVEYORS - PARAMETRIC CONVEYOR

0008-014-90013

STATUS: [ACTIVE]

REVISION 00



Item	Qty	Description	Item number	Variant	Size	Comment
1	1	Teplate for Adjustable Legs Ø20	0008-014-20063		72,6*100	
2	1	Handle for Template	0008-014-20064		L=135	

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DESIGNER SIRE	DRAWN SIRE	DIVISION WW - Workshop welding	REPLACES: -	A3
APPROVED -	DATE 22.4.2014	TREATMENT	REPLACED BY: -	SCALE: 1:1

TITLE:

Template for Adjustable Legs Ø20 h100

Location: GARÐABÆR

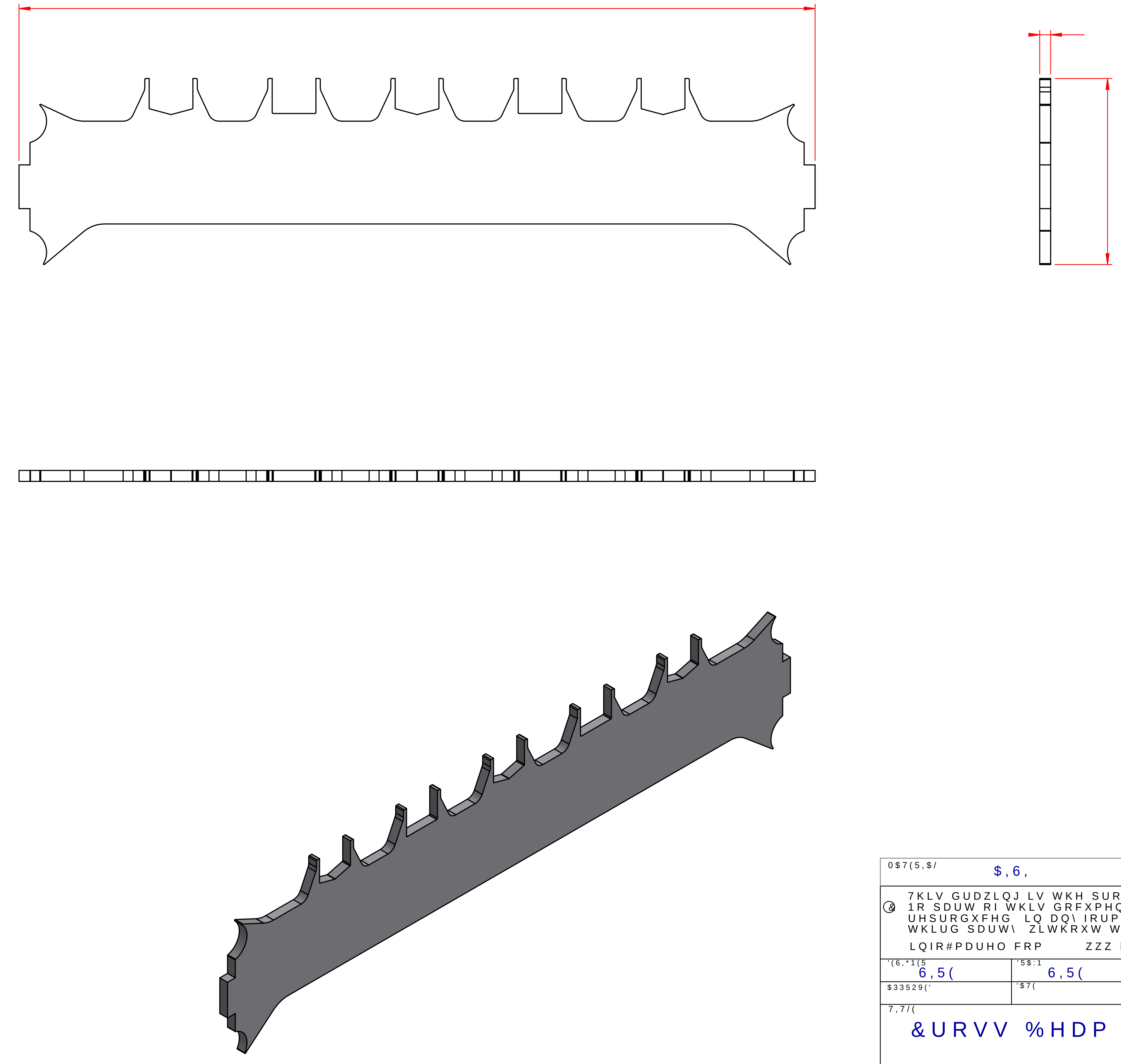
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN MILLIMETERS
According to:
ISO 2768-1 and ISO 2768-2
LIN/ANG. : m
GEO. Tol : K

SHEET 1 OF 1

DRAWING NO. CONVEYORS - PARAMETRIC CONVEYOR STATUS:

0008-014-90014 [ACTIVE]

REVISION 00



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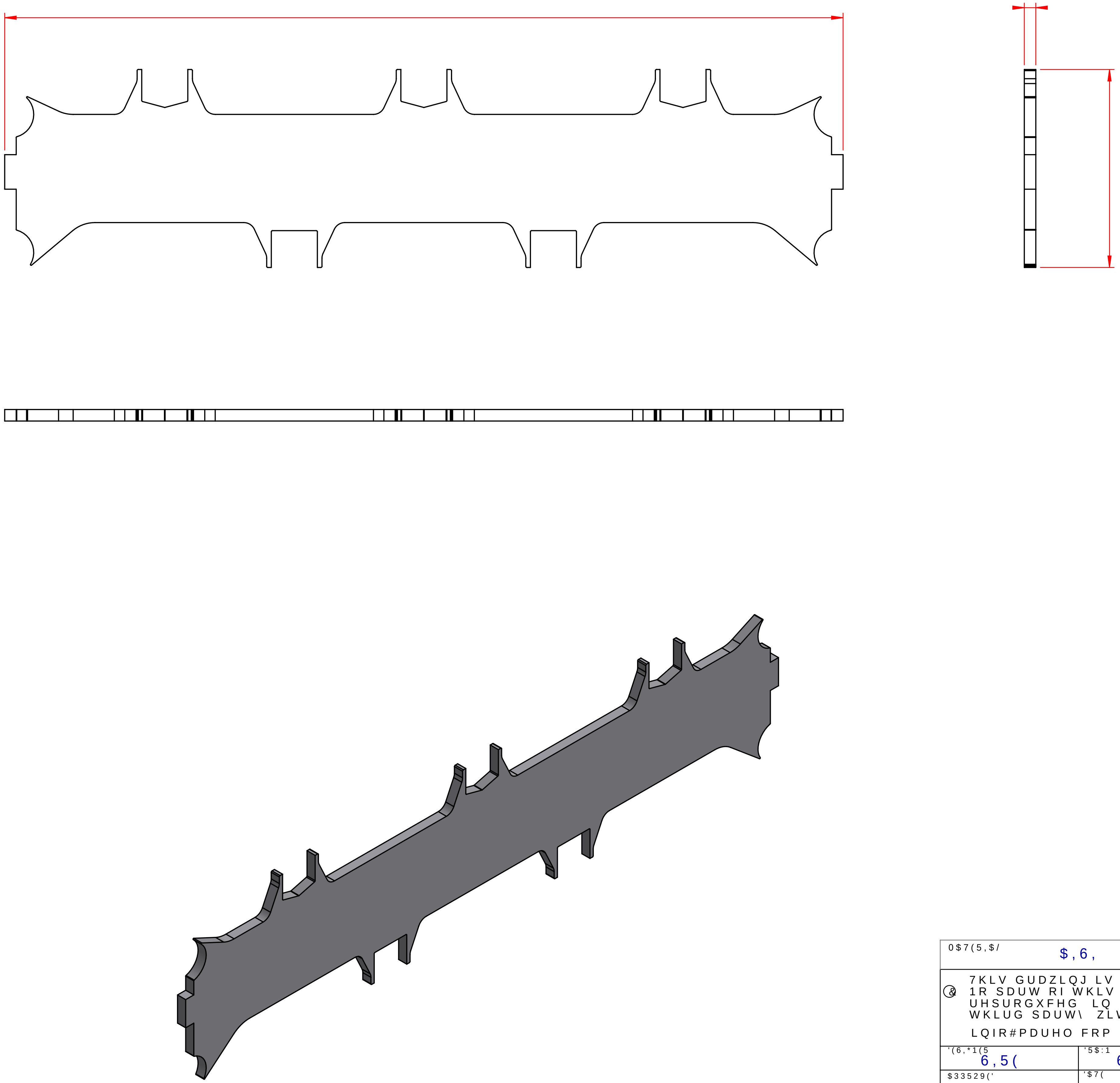

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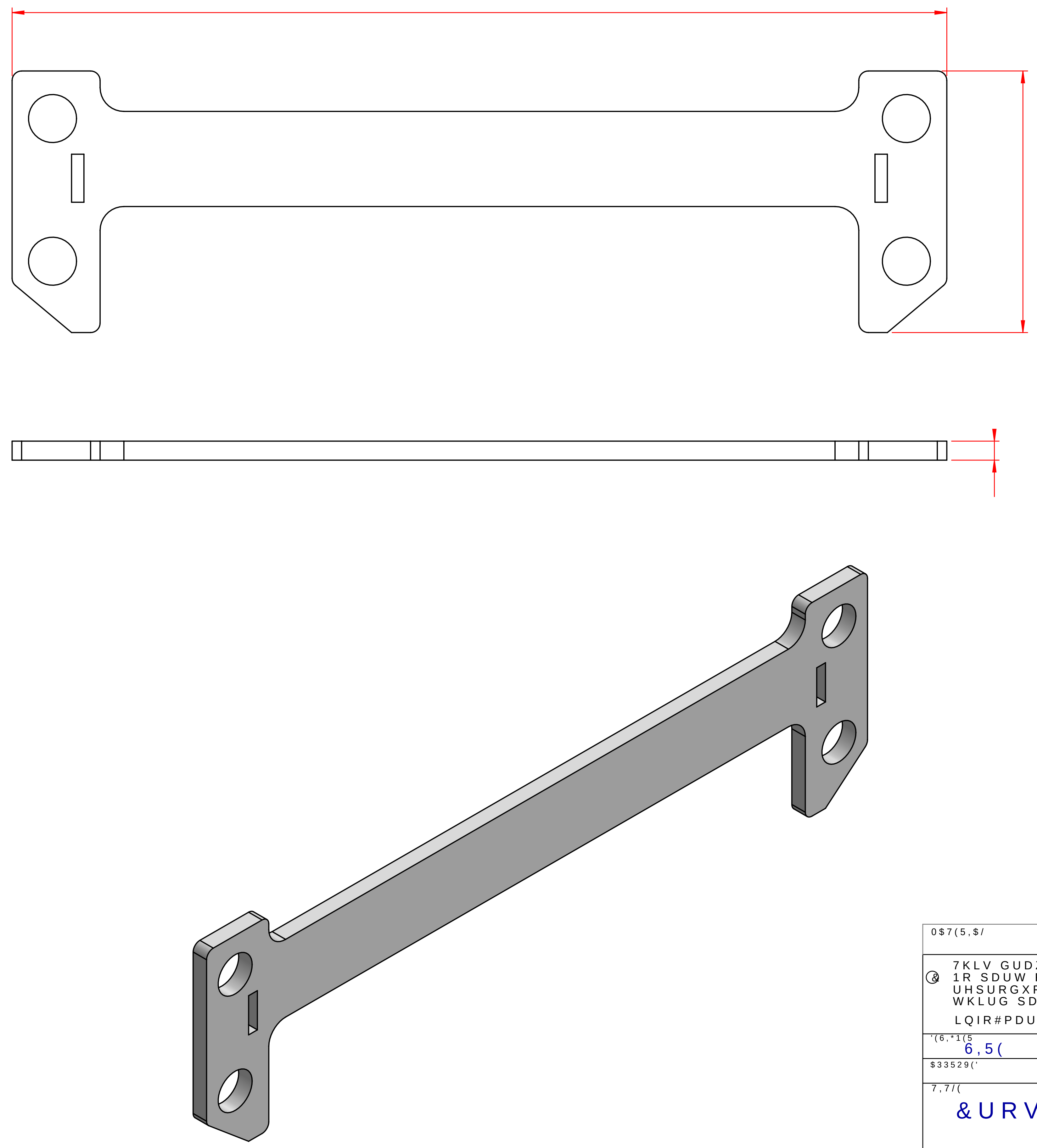

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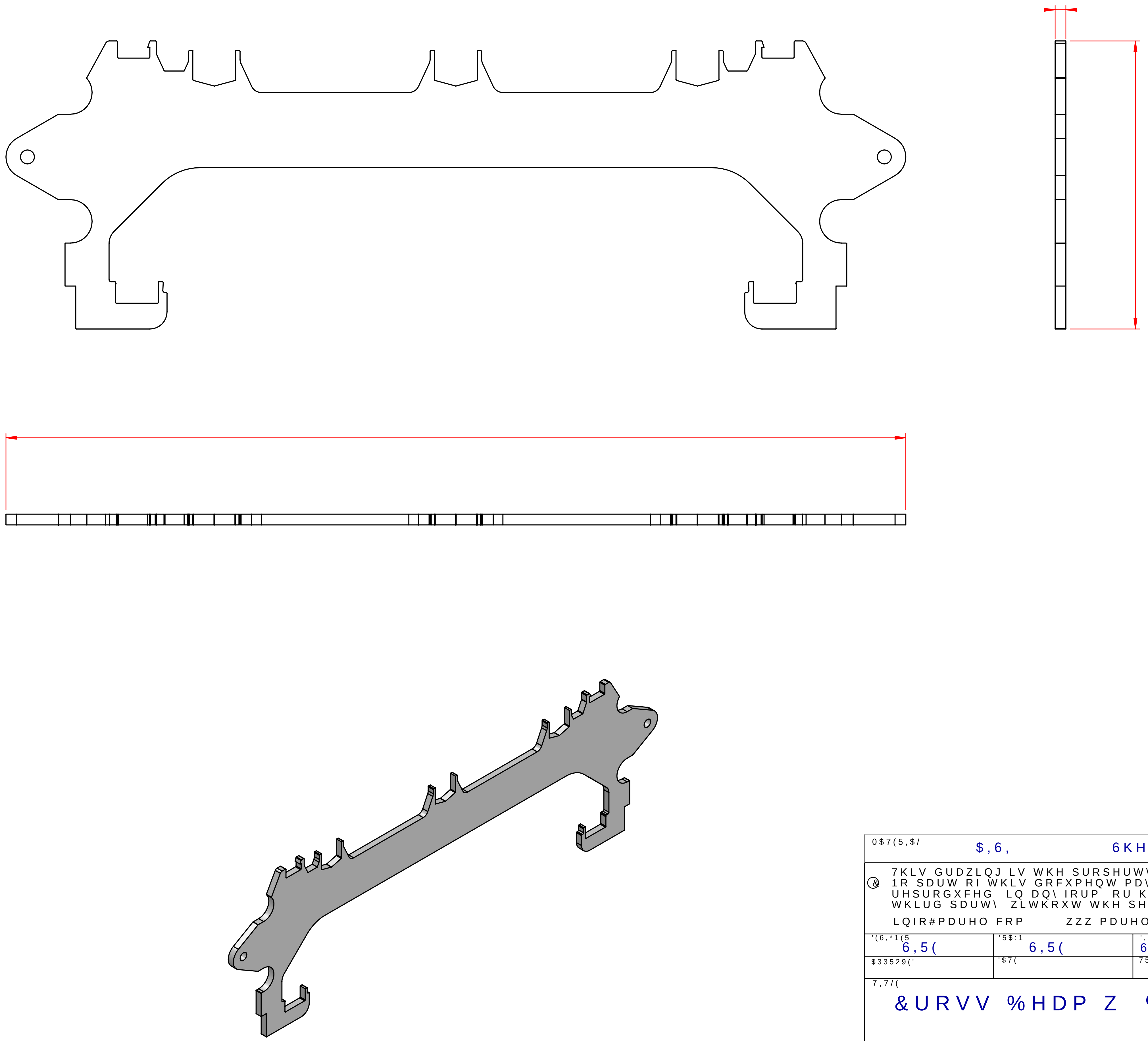

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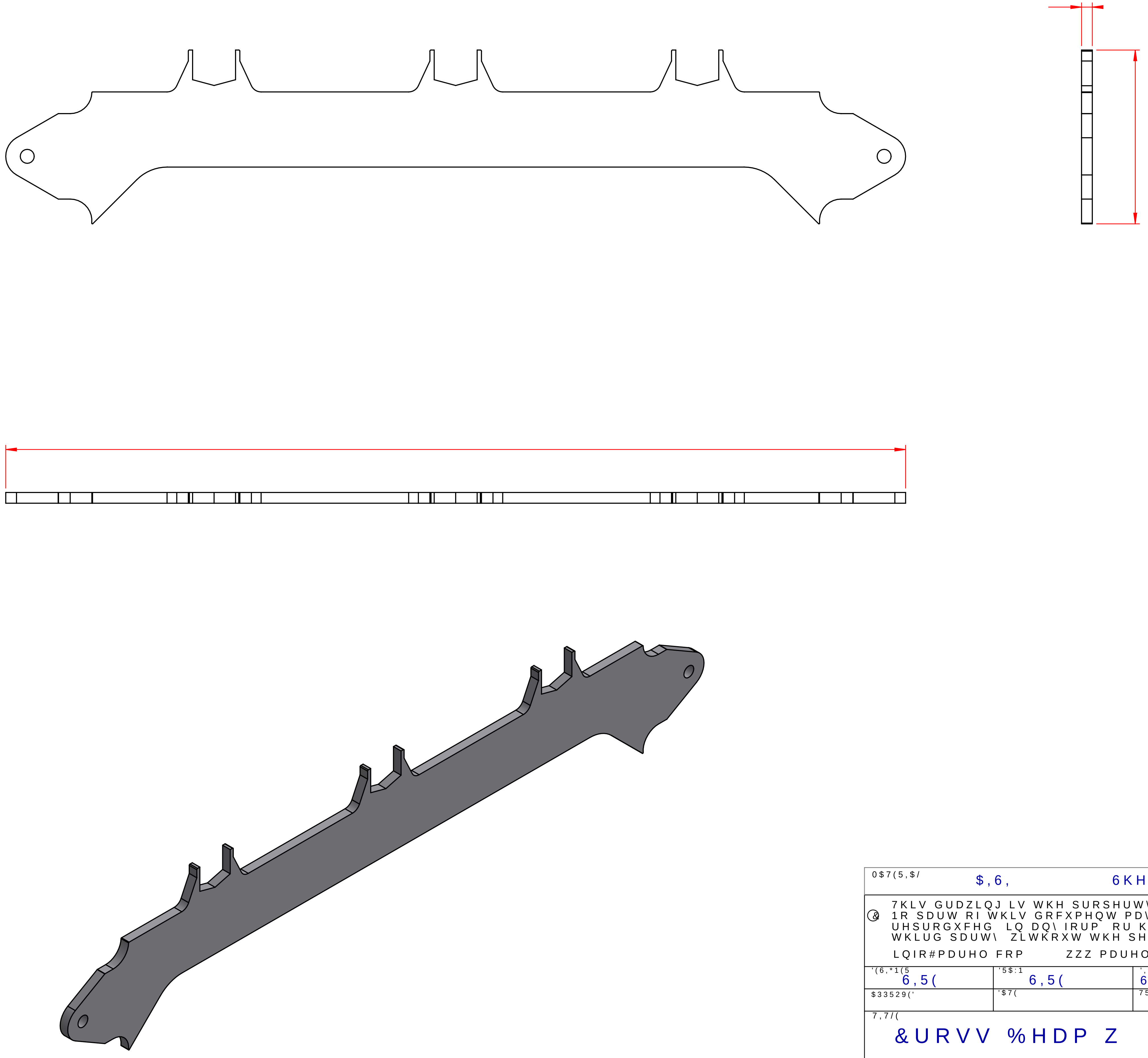

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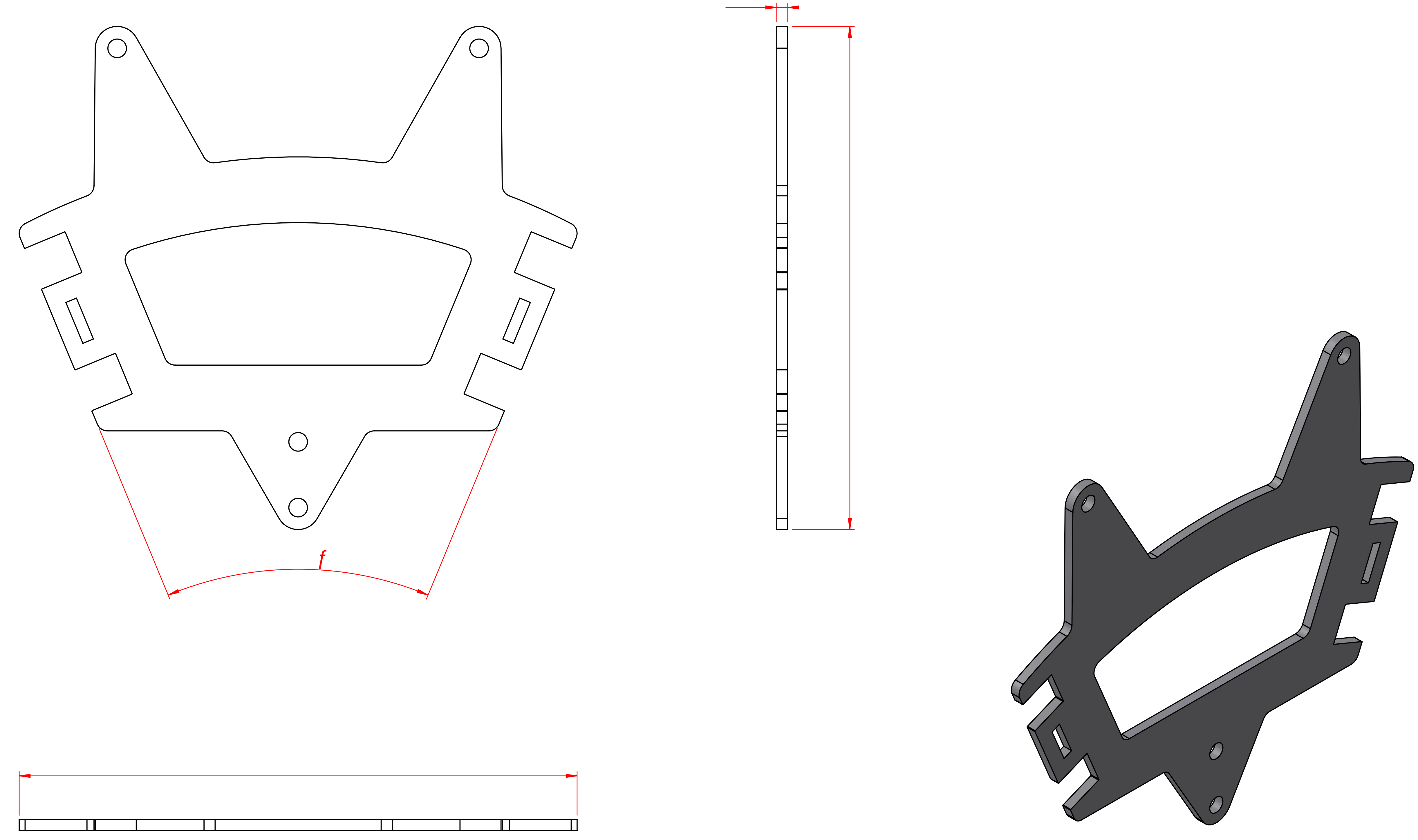

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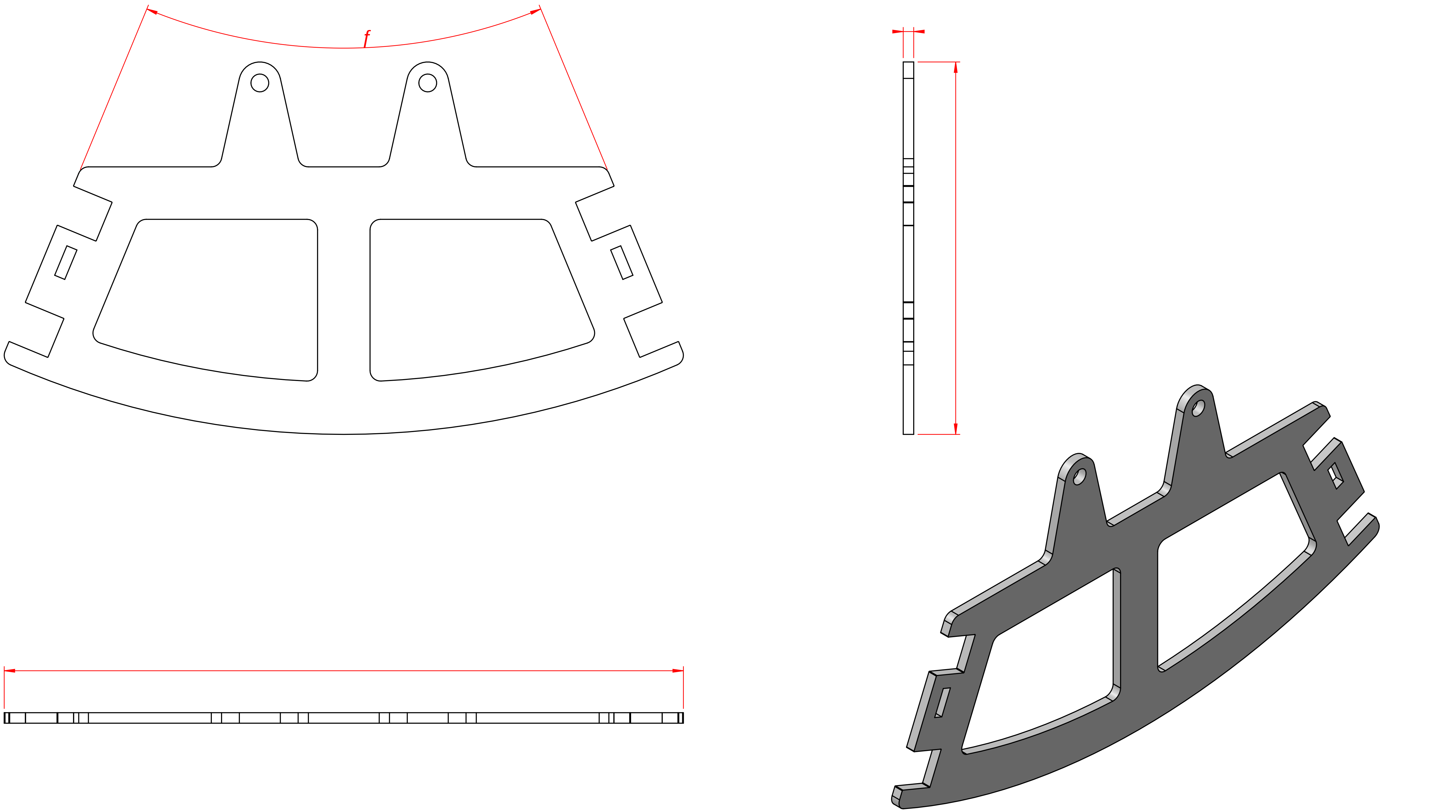

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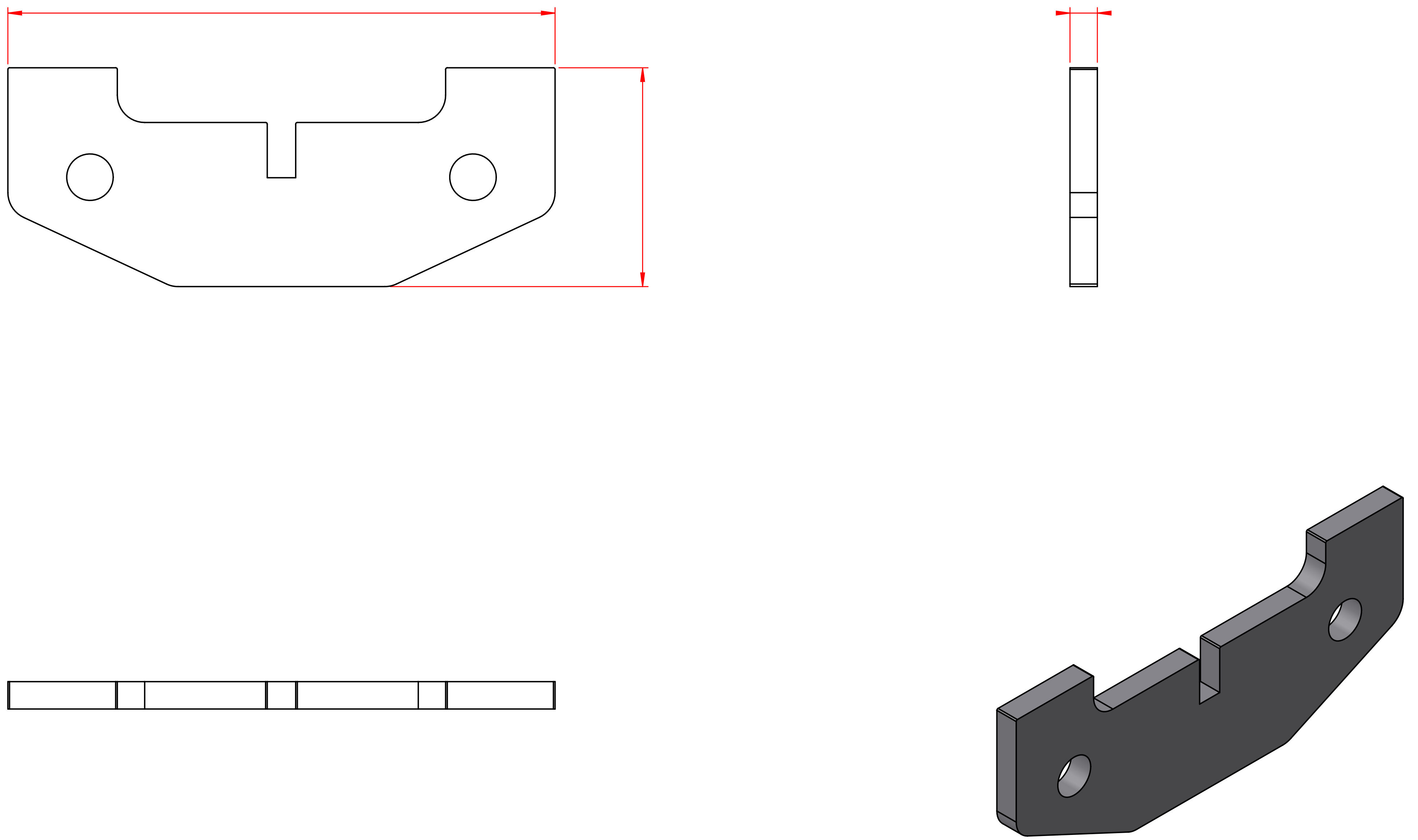

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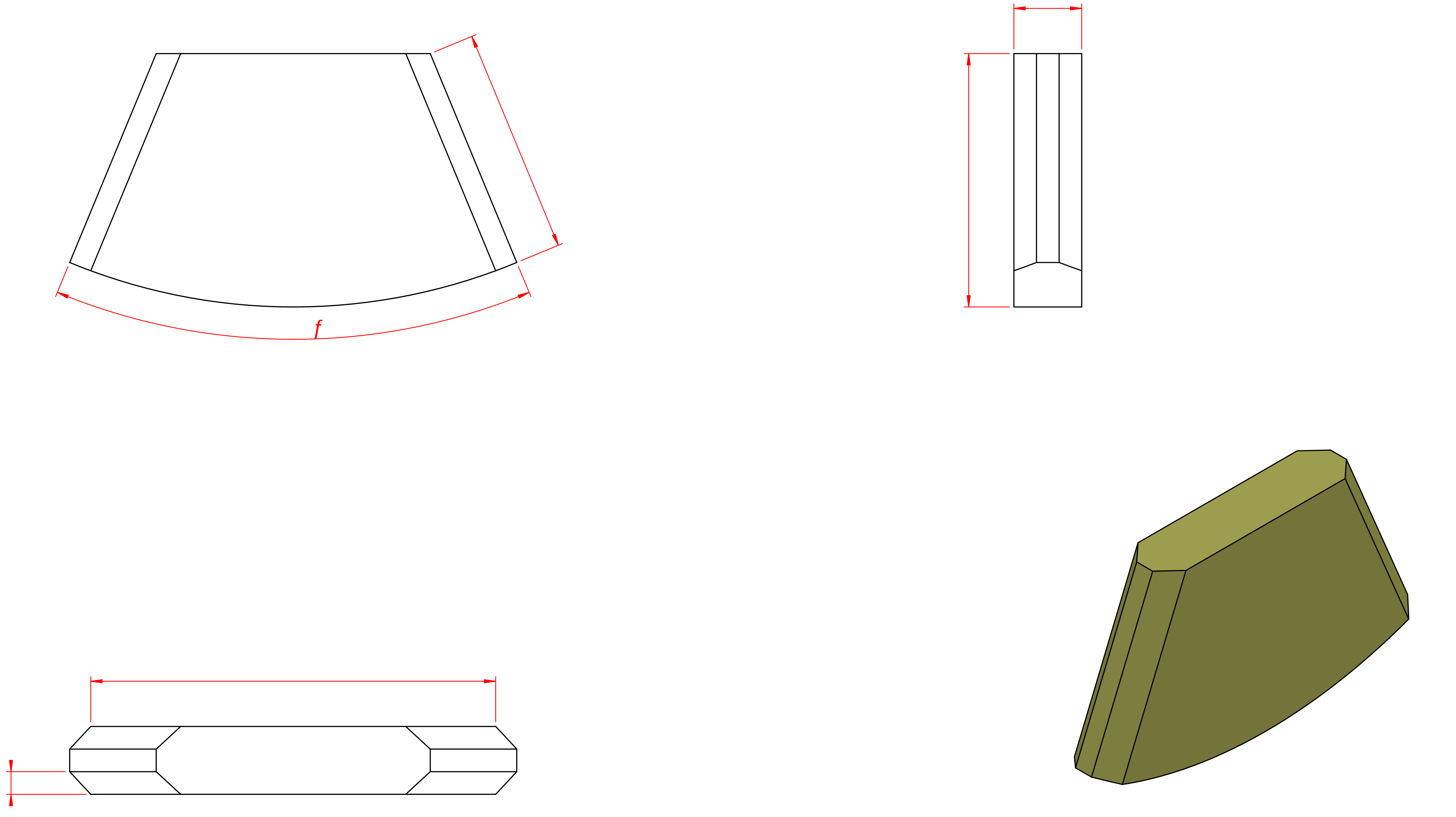

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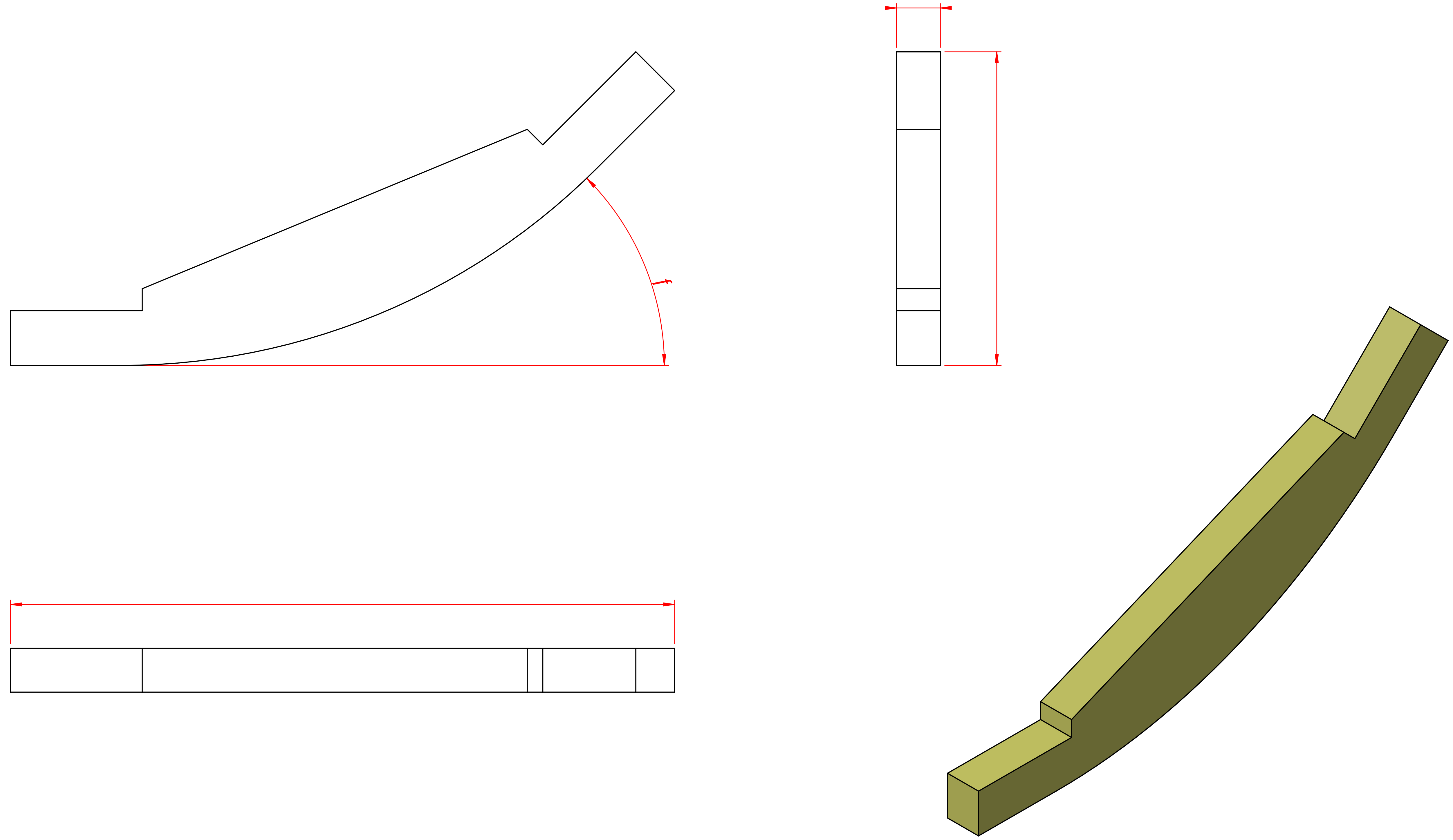

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UHSURGXFHG LQ DQ\ IRUP RU KDQG RYHU WR D
WKLUG SDUW\ ZLWKRXW WKH SHUPLVVLRQ RI 0DUHO)RRG 6\VWHPV
LQIR#PDUHO FRP ZZZ PDUHO FRP

81/(66 27+(5:,6(63(&,),('
',0(16,216 $5(,1 0,//,0(7(56
$FFRUGLQJ WR
,62 DQG ,62
/,1 $1* P
*(2 7RO .

6+((7 2)

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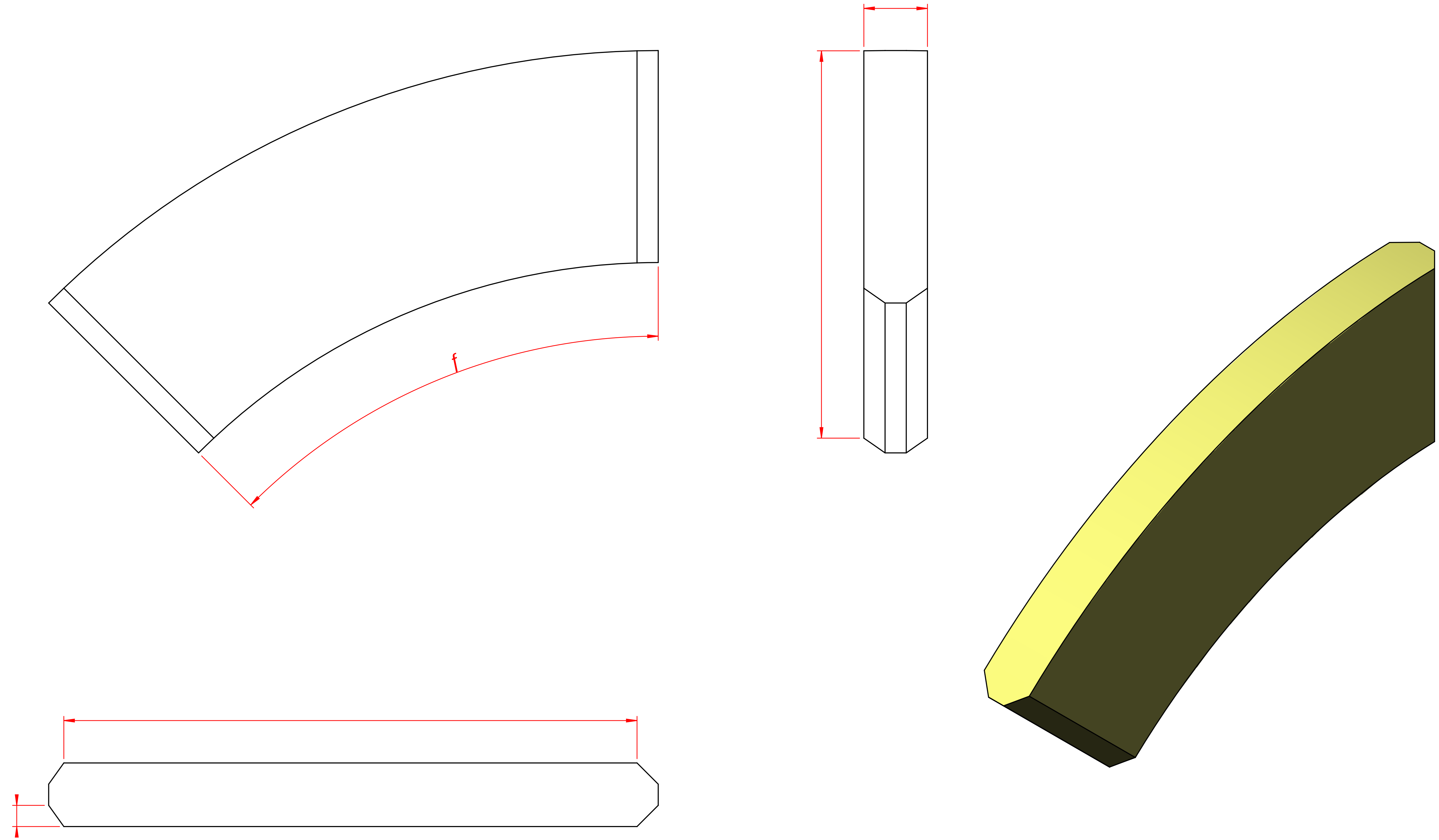

0$7(5,$/ 3(+' | 6KHHW PP | 6,=(

7KLV GUDZLQJ LV WKH SURSHUW\ RI 0DUHO)RRG 6\VWHPV
1R SDUW RI WKLV GRFXPHQW PD\ EH SKRWRFRSLHG RU
UHSURGXFHG LQ DQ\ IRUP RU KDQG RYHU WR D
WKLUG SDUW\ ZLWKRXW WKH SHUPLVVLRQ RI 0DUHO)RRG 6\VWHPV

LQIR#PDUHO FRP ZZZ PDUHO FRP

'(6,*1(5 6,5(	'5$:1 6,5(	',9,6,21 70 7XUQLQJ DQG PLOOLQJ	5(3/$&(6	$
$33529('	'$7(	75($70(17	5(3/$&(' %<	6&$/(

7,7/(

6LGHJXDUG IRU 'HFOLQH 0RGXOH K

/RFDWLRQ

f

81/(66 27+(5:,6(63(&,),(' ',0(16,216 $5(,1 0,//,0(7(56 $FFRUGLQJ WR ,62 DQG ,62 /,1 $1* P *(2 7RO .

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&219(<256 3$5$0(75,& &219(<25

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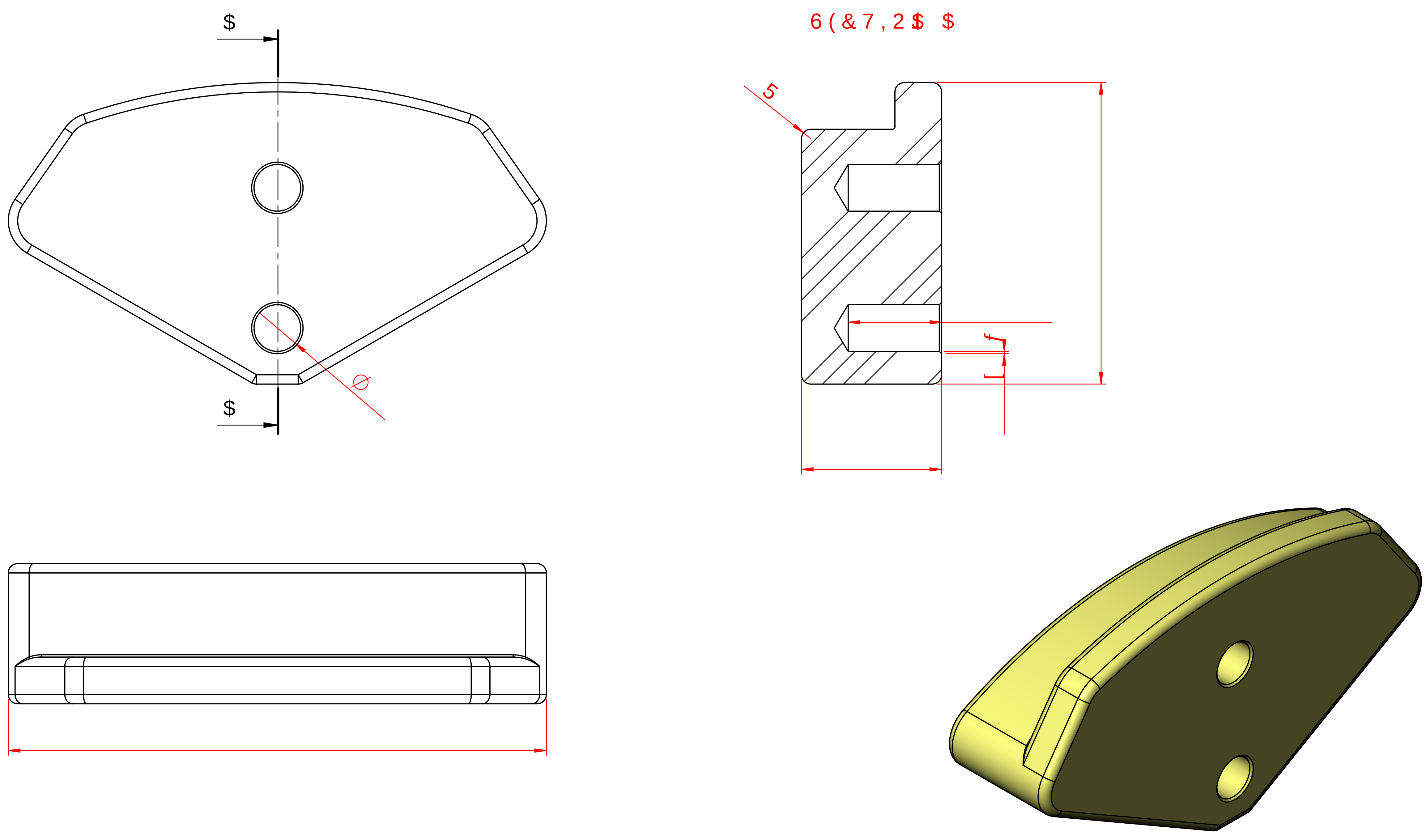

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UHSURGXFHG LQ DQ\ IRUP RU KDQG RYHU WR D
WKLUG SDUW\ ZLWKRXW WKH SHUPLVVLRQ RI 0DUHO)RRG 6\VWHPV

LQIR#PDUHO FRP ZZZ PDUHO FRP

'(6,*1(5 6,5(	'5$:1 6,5(	',9,6,21 70 7XUQLQJ DQG PLOOLQJ	5(3/$&(6	$
$33529('	'$7(	75($70(17	5(3/$&(' %<	6&$/(

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%HOW 5HWXUQ 6XSSRUW LQ 'HFOLQH 0RGXO

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81/(66 27+(5:,6(63(&,),('
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$FFRUGLQJ WR
,62 DQG ,62
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*(2 7RO .

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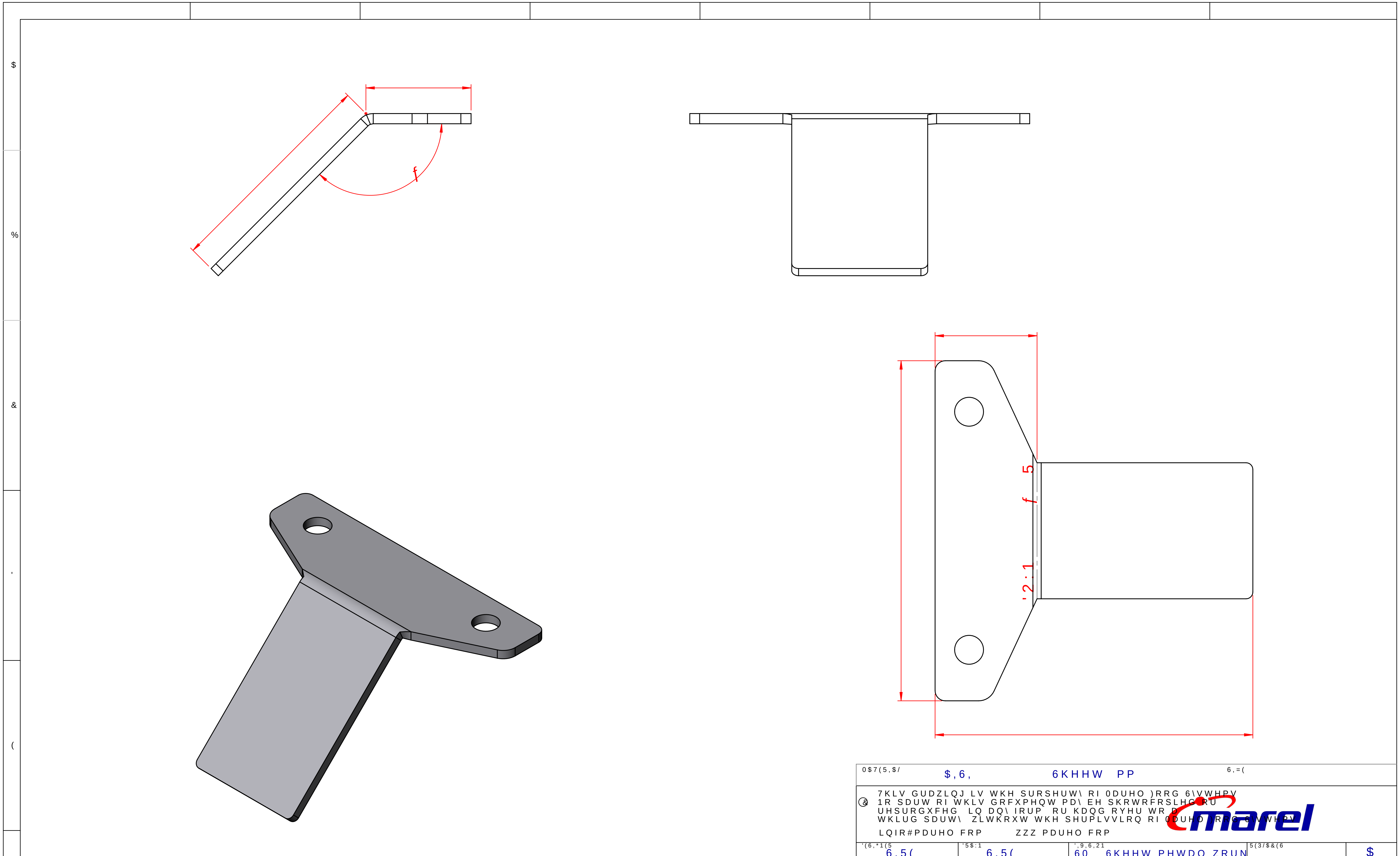

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6,5(	6,5(	60 6KHHW PHWDO ZRUN		$
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(DUV IRU 6WDQGDUG /HJV

/RFDWLRQ *$5ç$%•5

81/(66 27+(5:,6(63(&,),(' ',0(16,216 $5(,1 0,//,0(7(56 $FFRUGLQJ WR ,62 DQG ,62 /,1 $1* P *(2 7RO .

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&219(<256 3$5$0(75,& &219(<25

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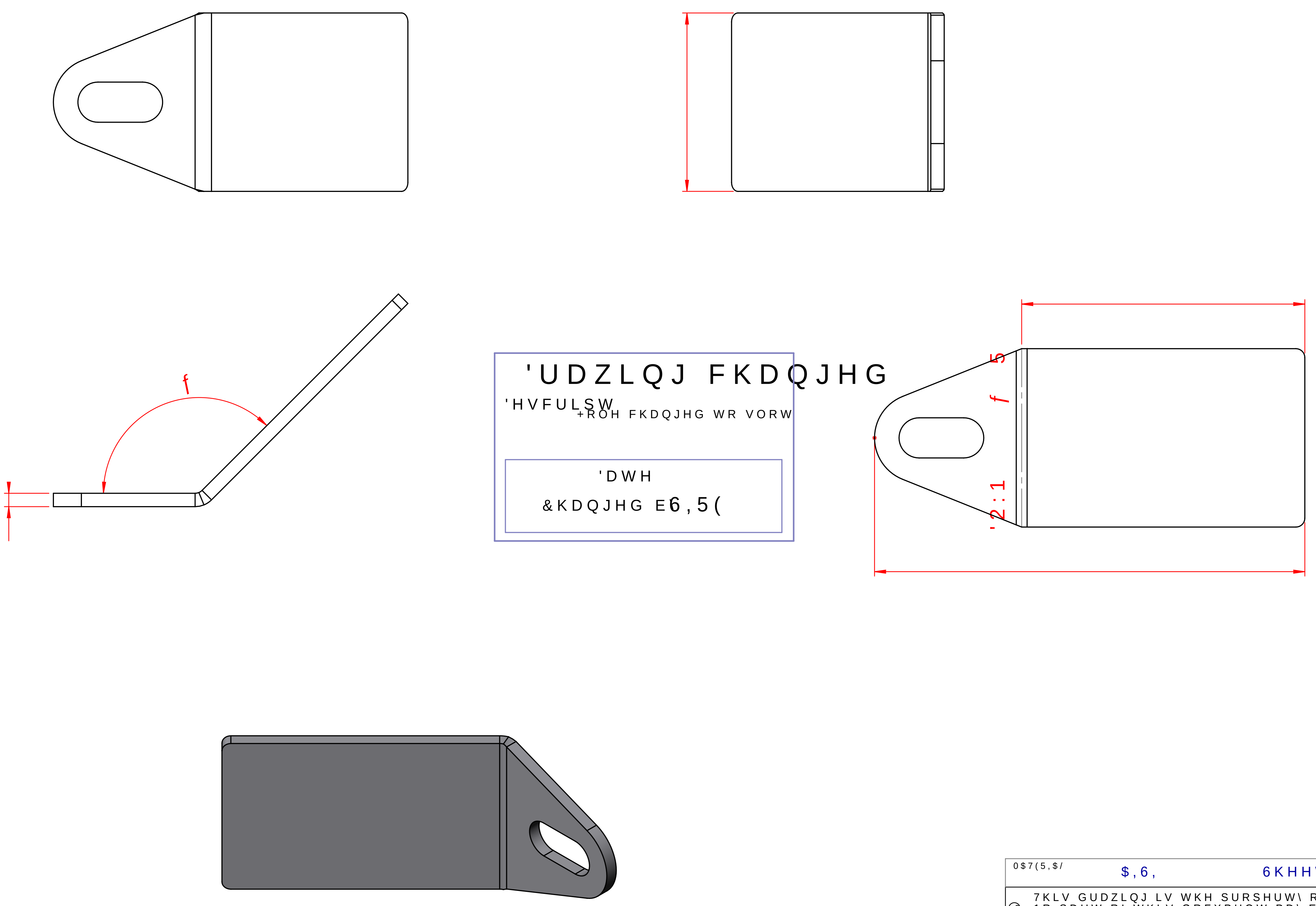
5HY	'DWH	'HVFULSWLRQ	$SSURYH
		+ROH FKDQJHG WR VORW	GRN



'UDZLQJ FKDQJHG

'HVFULSW
+ROH FKDQJHG WR VORW

'DWH
&KDQJHG E6,5(

0$7(5,$/	$,6,	6KHHW PP	6,=(

7KLV GUDZLQJ LV WKH SURSHUW\ RI 0DUHO)RRG 6\VWHPV
1R SDUW RI WKLV GRFXPHQW PD\ EH SKRWRFRSLHG RU
UHSURGXFHG LQ DQ\ IRUP RU KDQG RYHU WR D
WKLUG SDUW\ ZLWKRXW WKH SHUPLVVLRQ RI 0DUHO)RRG 6\VWHPV

LQIR#PDUHO FRP ZZZ PDUHO FRP

marel

'(6,*1(5	'5$:1	',9,6,21	5(3/$&(6	
6,5(	6,5(	60 6KHHW PHWDO ZRUN		$
$33529('	'$7(	75($70(17	5(3/$&(' %<	6&$/(

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(DU IRU ([WUD /HJ

/RFDWLRQ
*$5ç$%•5

81/(66 27+(5:,6(63(&,),('
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$FFRUGLQJ WR
,62 DQG ,62
/,1 $1* P
*(2 7RO .

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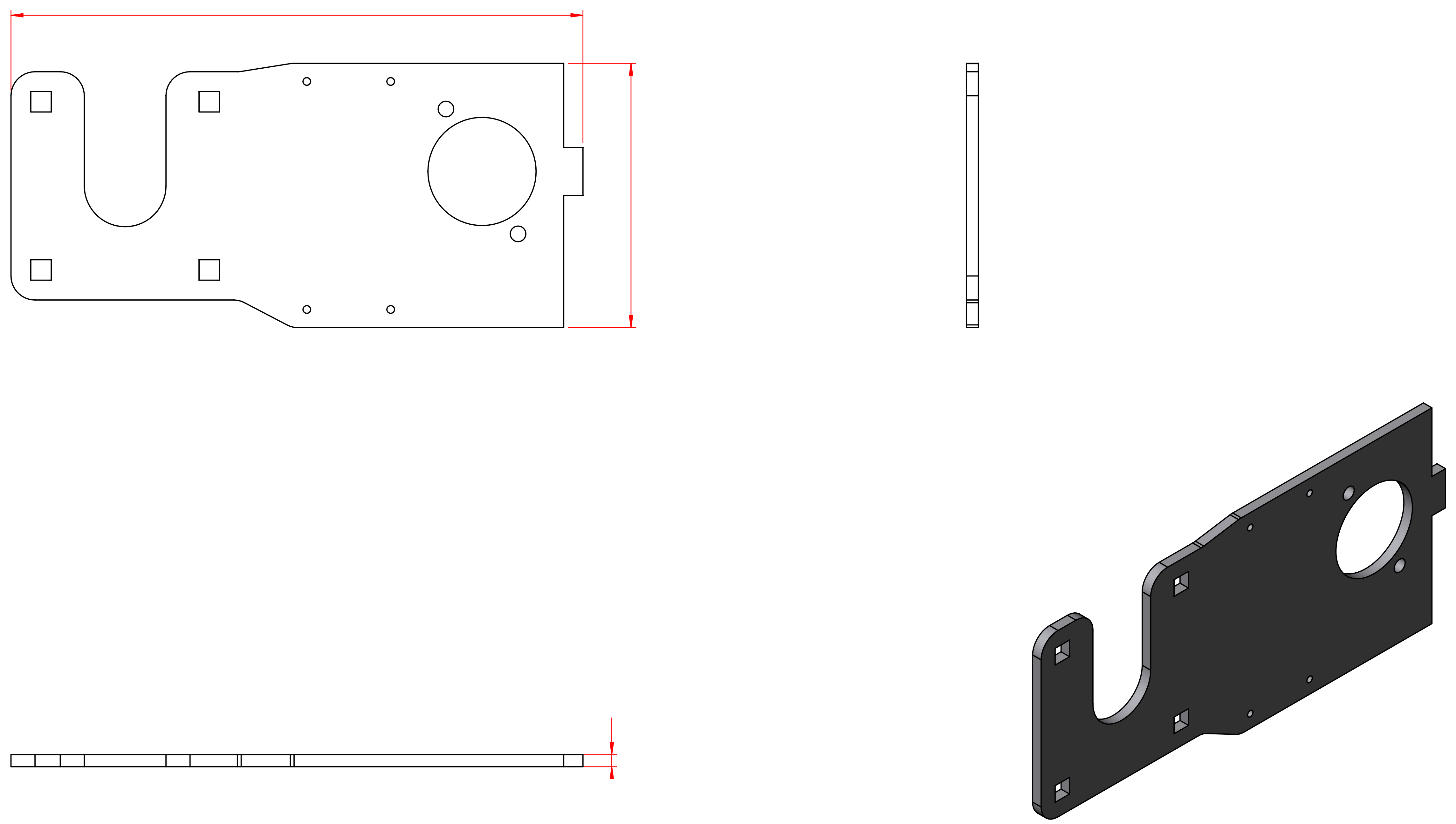

5HY	'DWH	'HVFULSWLRQ	$SSURYH
		1HZ KROH SRVLWLRQ & RULJ &(	6,5(
		'LIIHUHQW)ODW SDWWHUQ EHQGLQJ UHTXLUHG	6,5(
		2SHQ RQ WRS KROHV IRU VDPH KHDG VFUHZV	6,5(

0$7(5,$/ $,6, 6KHHW PP 6,=(

7KLV GUDZLQJ LV WKH SURSHUW\ RI 0DUHO)RRG 6\VWHPV
1R SDUW RI WKLV GRFXPHQW PD\ EH SKRWRFRSLHG RU
UHSURGXFHG LQ DQ\ IRUP RU KDQG RYHU WR D
WKLUG SDUW\ ZLWKRXW WKH SHUPLVVLRQ RI 0DUHO)RRG 6\VWHPV

LQIR#PDUHO FRP ZZZ PDUHO FRP

'(6,*1(5	'5$:1	',9,6,21	5(3/$&(6	
6,5(	6,5(	60 6KHHW PHWDO ZRUN		$
$33529('	'$7(	75($70(17	5(3/$&(' %<	6&$/(

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)DVWHQLQJ IRU 0RWRU

/RFDWLRQ *5ç$%•5

81/(66 27+(5:,6(63(&,),(' ',0(16,216 $5(,1 0,//,0(7(56 $FFRUGLQJ WR ,62 DQG ,62 /,1 $1* P *(2 7RO .

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'5$:,1* 12 &21)(<256 3$5$0(75,& &21)(<25 67$786

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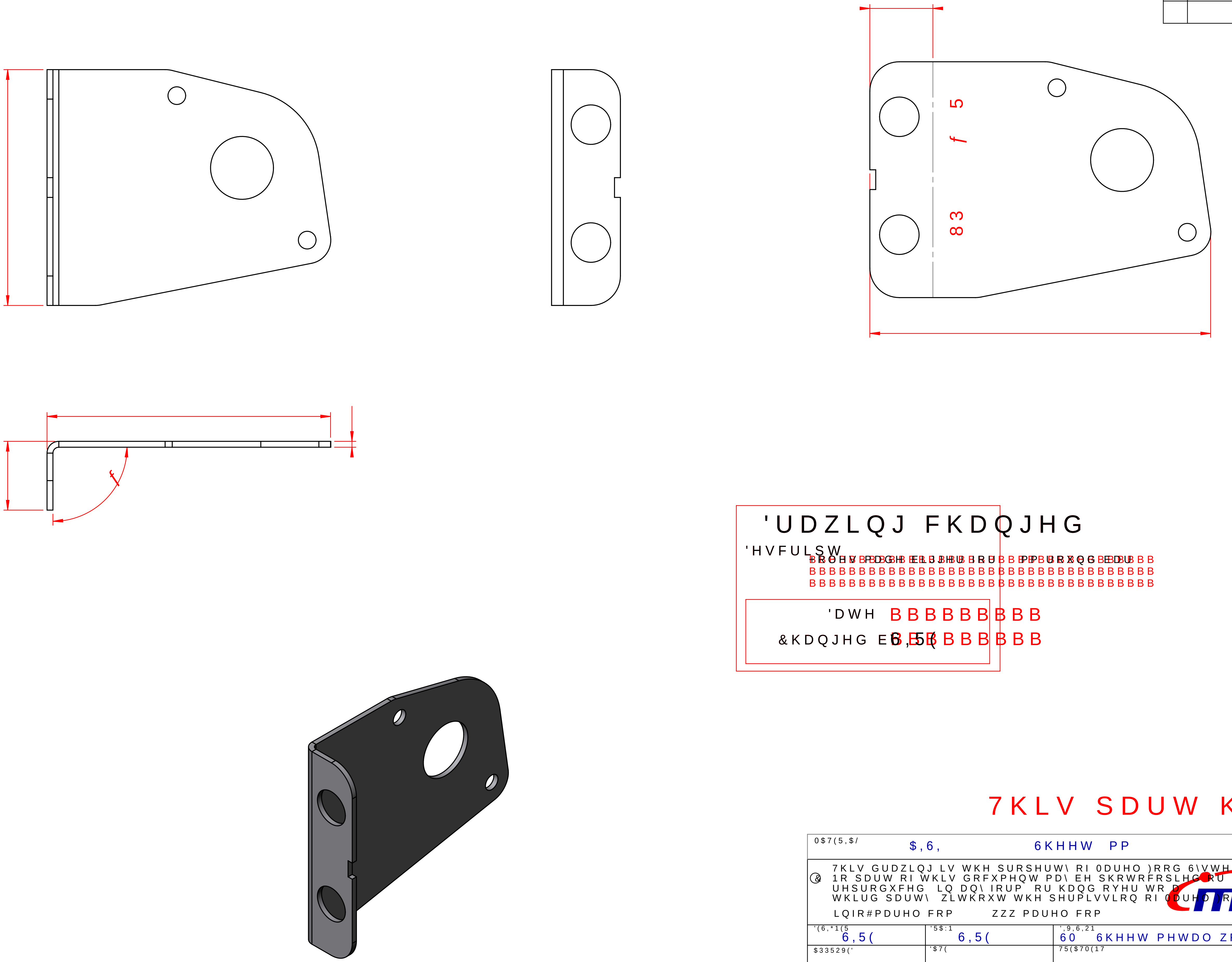
5HY	'DWH	'HVFULSWLRQ	$SSURYH
		+ROHV PDGH ELJJHU IRU URXQG EDU	6,5(



'UDZLQJ FKDQJHG

'HVFULSW +ROHV PDGH ELJJHU IRU URXQG EDU

'DWH BBBBBBBBB

&KDQJHG E\ 6,5(BBBBBB

7KLV SDUW KDV D PLUUR

0$7(5,$/	$,6,	6KHHW PP	6,=([

7KLV GUDZLQJ LV WKH SURSHUW\ RI 0DUHO)RRG 6\VWHPV
1R SDUW RI WKLV GRFXPHQW PD\ EH SKRWRFRSLHG RU
UHSURGXFHG LQ DQ\ IRUP RU KDQG RYHU WR D
WKLUG SDUW\ ZLWKRXW WKH SHUPLVVLRQ RI 0DUHO)RRG 6\VWHPV

LQIR#PDUHO FRP ZZZ PDUHO FRP

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'(6,*1(5 6,5(	'5$:1 6,5(	',9,6,21 60 6KHHW PHWDO ZRUN	5(3/$&(6	$
$33529('	'$7(	75($70(17	5(3/$&(' %<	6&$/(

7,7/(6LGH LQ LGOH HQG

/RFDWLRQ *5ç$%•5

'5$:,1* 12 &219(<256 3$5$0(75,& &219(<25

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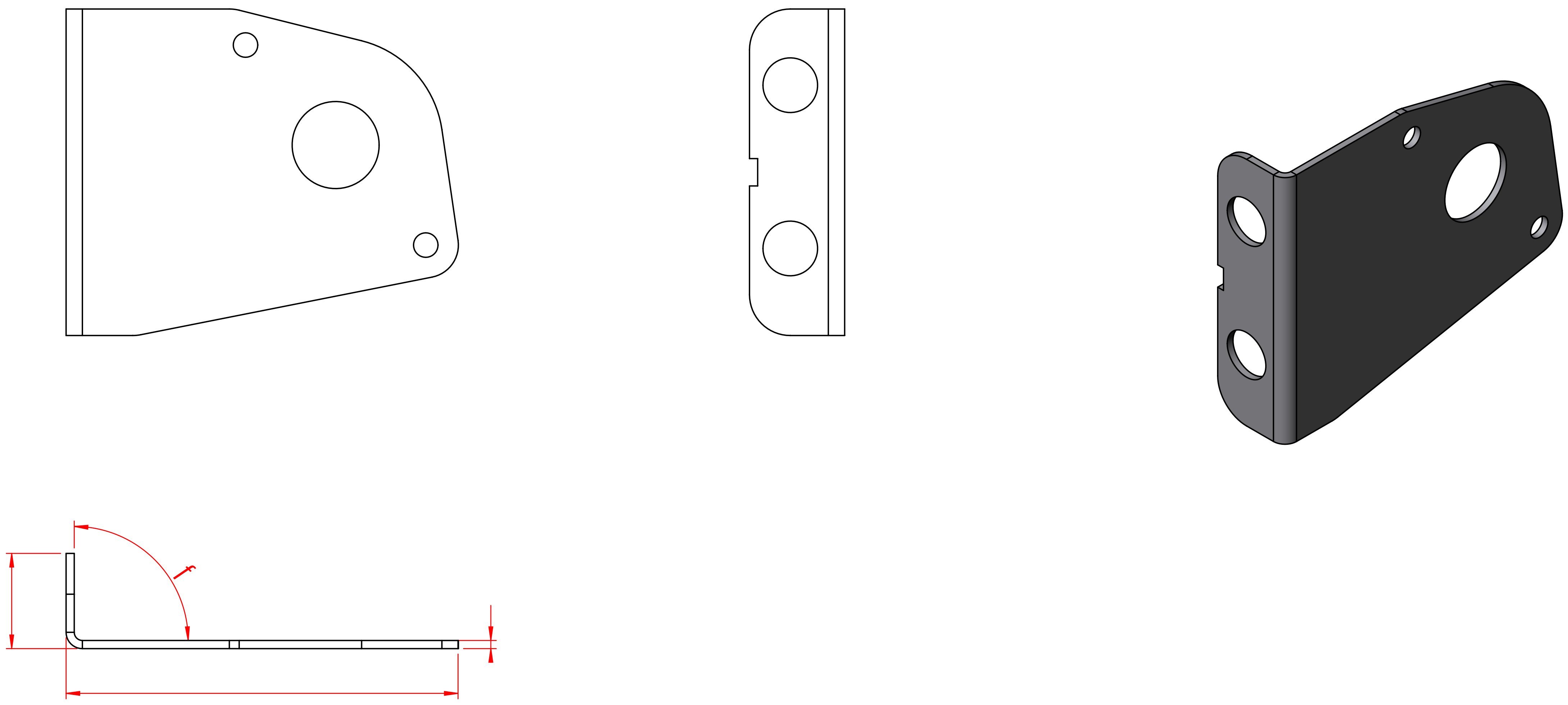

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UHSURGXFHG LQ DQ\ IRUP RU KDQG RYHU WR D
WKLUG SDUW\ ZLWKRXW WKH SHUPLVVLRQ RI 0DUHO)RRG 6\VWHPV

LQIR#PDUHO FRP   ZZZ PDUHO FRP

'(6,*1(5 6,5(	'5$:1 6,5(	',9,6,21 60 6KHHW PHWDO ZRUN	5(3/$&(6	$
$33529('	'$7(	75($70(17	5(3/$&(' %<	6&$/(

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0LUURU 6LGH LQ ,GOH (QG

/RFDWLRQ *$5ç$%•5

81/(66 27+(5:,6(63(&,),(' ',0(16,216 $5(,1 0,//,0(7(56 $FFRUGLQJ WR ,62 DQG ,62 /,1 $1* P *(2 7RO .

'5$:,1* 12 &219(<256 3$5$0(75,& &219(<25

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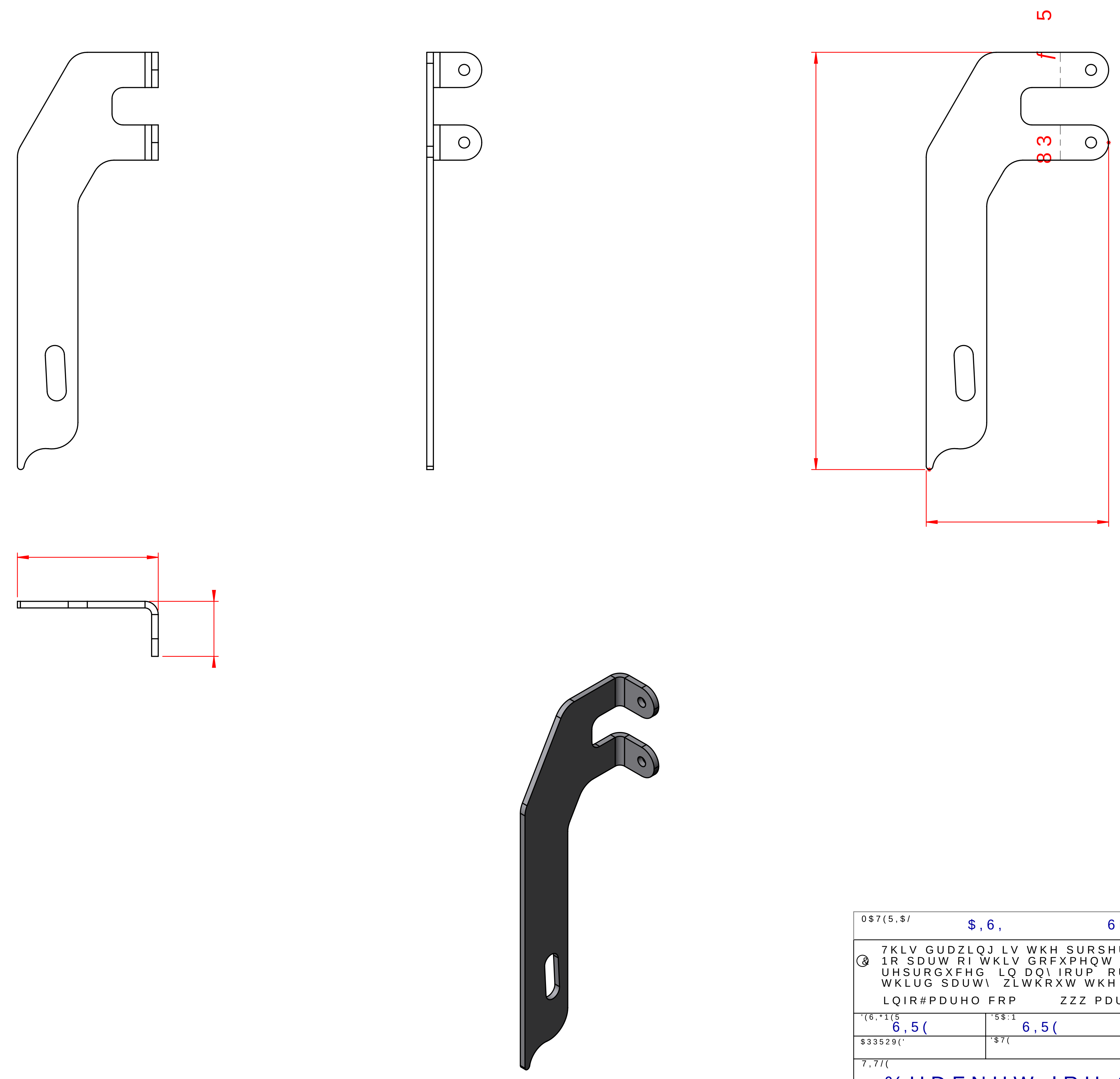

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1R SDUW RI WKLV GRFXPHQW PD\ EH SKRWRFRSLHG RU
UHSURGXFHG LQ DQ\ IRUP RU KDQG RYHU WR D
WKLUG SDUW\ ZLWKRXW WKH SHUPLVVLRQ RI 0DUHO)RRG 6\VWHPV

LQIR#PDUHO FRP   ZZZ PDUHO FRP

'(6,*1(5: 6,5(	'5$:1: 6,5(	',9,6,21: 60 6KHHW PHWDO ZRUN	5(3/$&(6 / $
$33529('	'$7(	75($70(17	5(3/$&(' %< / 6&$/(

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%UDFNHW IRU 3ODVWLF 6LGHJXDUG

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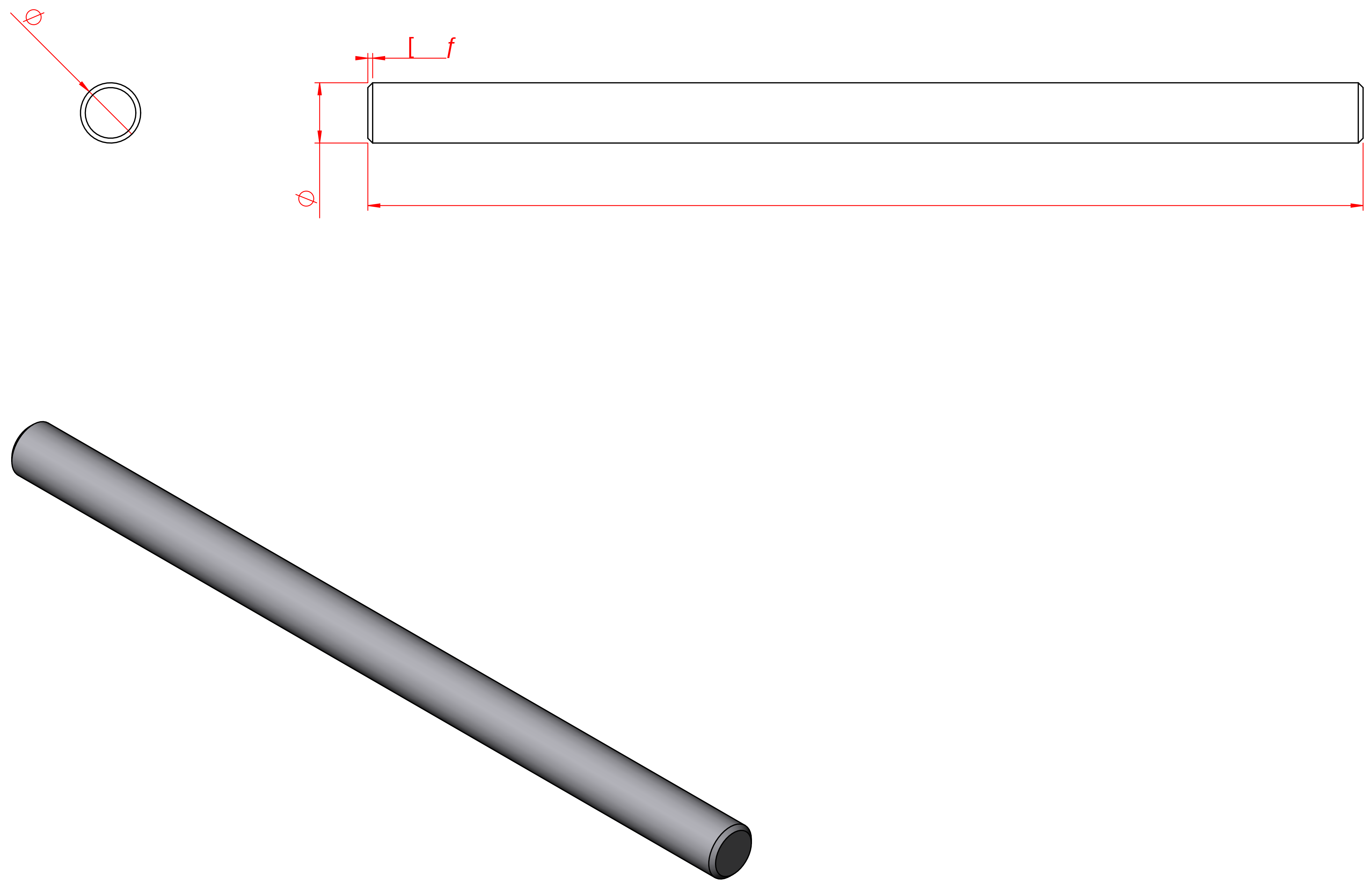

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1R SDUW RI WKLV GRFXPHQW PD\ EH SKRWRFRSLHG RU
UHSURGXFHG LQ DQ\ IRUP RU KDQG RYHU WR D
WKLUG SDUW\ ZLWKRXW WKH SHUPLVVLRQ RI 0DUHO)RRG 6\VWHPV

LQIR#PDUHO FRP   ZZZ PDUHO FRP

'(6,*1(5 6,5(	'5$:1 6,5(	',9,6,21 :$:RUNVKRS DVVHPEOLQJ	5(3/$&(6	$
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/RFDWLRQ
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$FFRUGLQJ WR
,62 DQG ,62
/,1 $1* P
*(2 7RO .

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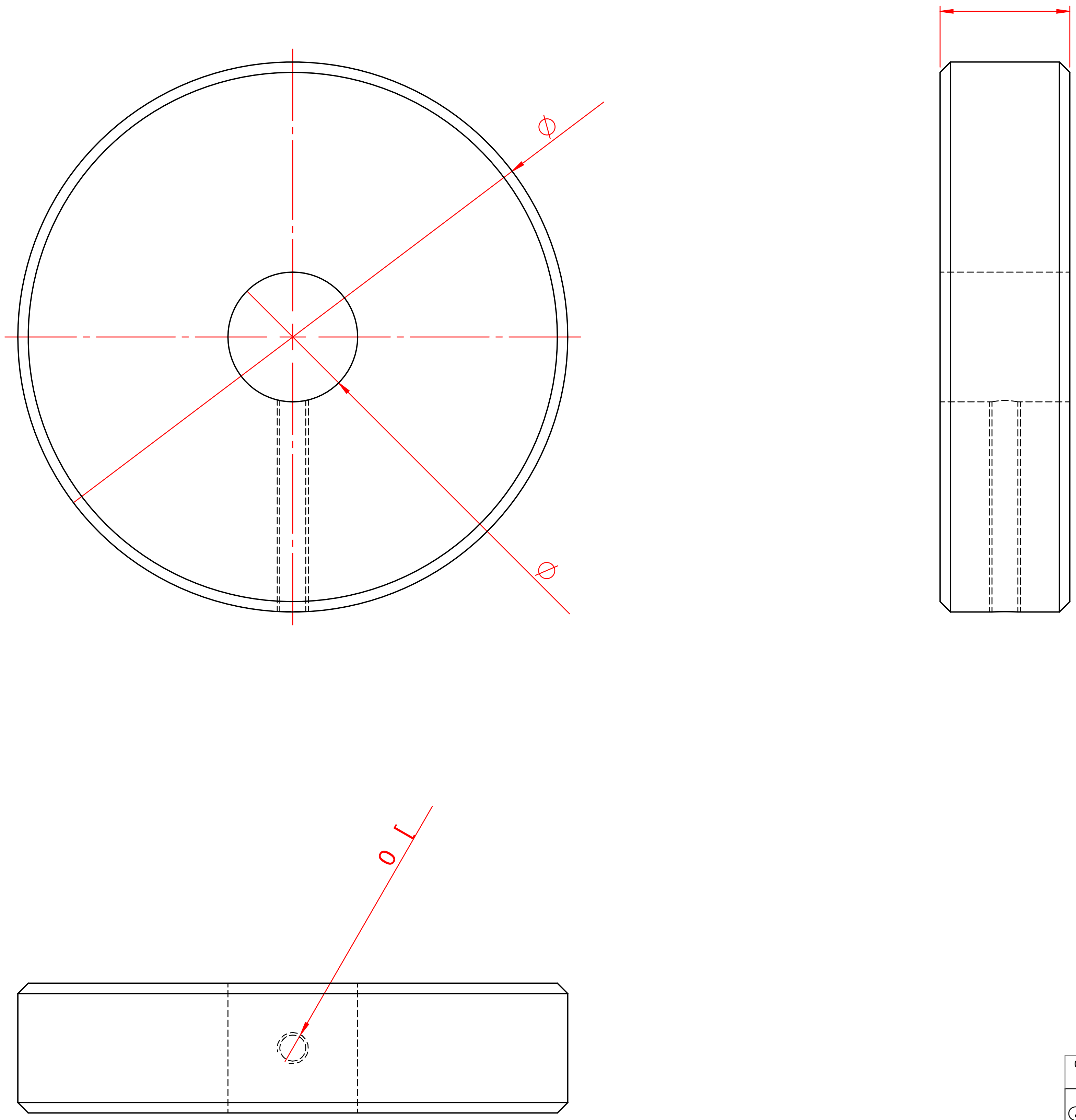

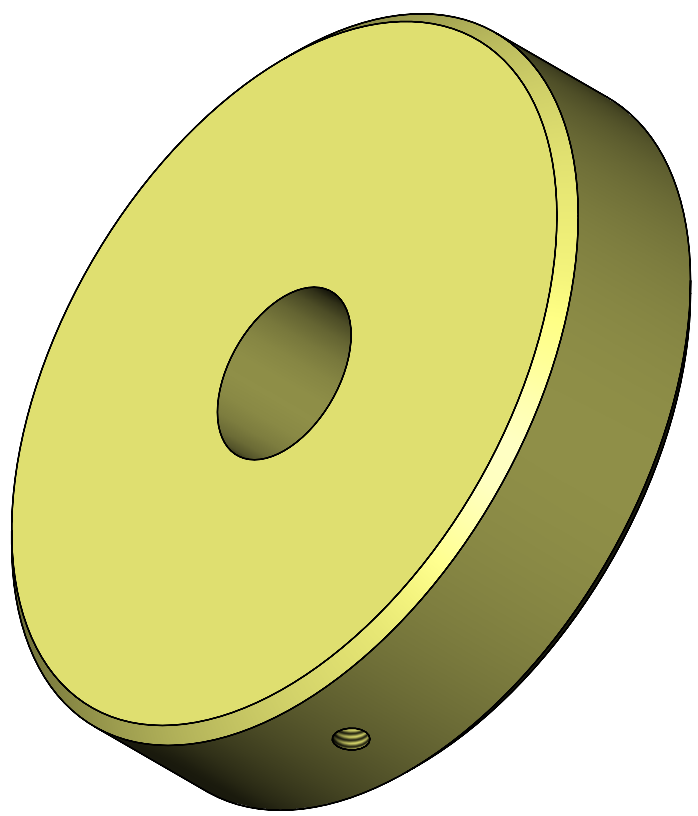

0$7(5,$/ 320 1DWXUDO 5RXQG %DU ¡

6,=(/

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1R SDUW RI WKLV GRFXPHQW PD\ EH SKRWRFRSLHG RU
UHSURGXFHG LQ DQ\ IRUP RU KDQG RYHU WR D
WKLUG SDUW\ ZLWKRXW WKH SHUPLVVLRQ RI 0DUHO)RRG 6\VWHPV
LQIR#PDUHO FRP ZZZ PDUHO FRP

marel

'(6,*1(5 6,5(
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7,7/(
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/RFDWLRQ *$5&$%$5

'5$:,1* 12
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67$786
81/(66 27+(5:,6(63(&,),('
',0(16,216 $5(,1 0,//,0(7(56
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,62 DQG ,62
/,1 $1* P
*(2 7RO .
6+((7 2
5(9,6,21

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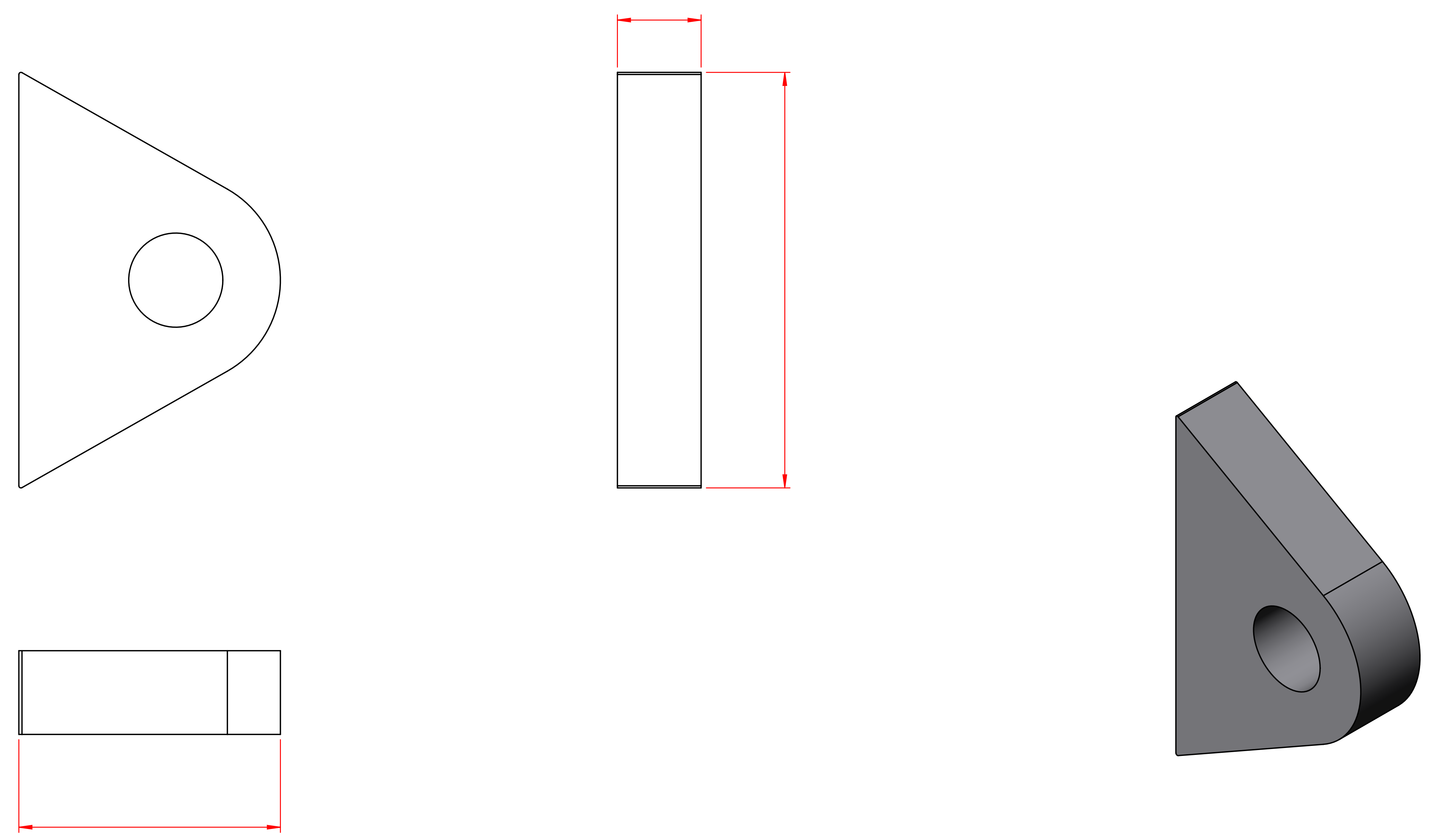

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'(6,*1(5 6,5(	'5$:1 6,5(	',9,6,21 60 6KHHW PHWDO ZRUN	5(3/$&(6	$
$33529('	'$7(	75($70(17	5(3/$&(' %<	6&$/(
7,7/((DU RQ /HJ IRU 6XSSRUW %HDP			/RFDWLRQ *$5ç$%•5	
			81/(66 27+(5:,6(63(&,),(' ',0(16,216 $5(,1 0,//,0(7(56 $FFRUGLQJ WR ,62 DQG ,62 /,1 $1* P *(2 7RO .	6+((7 2
'5$:,1* 12	&21(<256 3$5$0(75,& &21(<25	67$786		5(9,6,21

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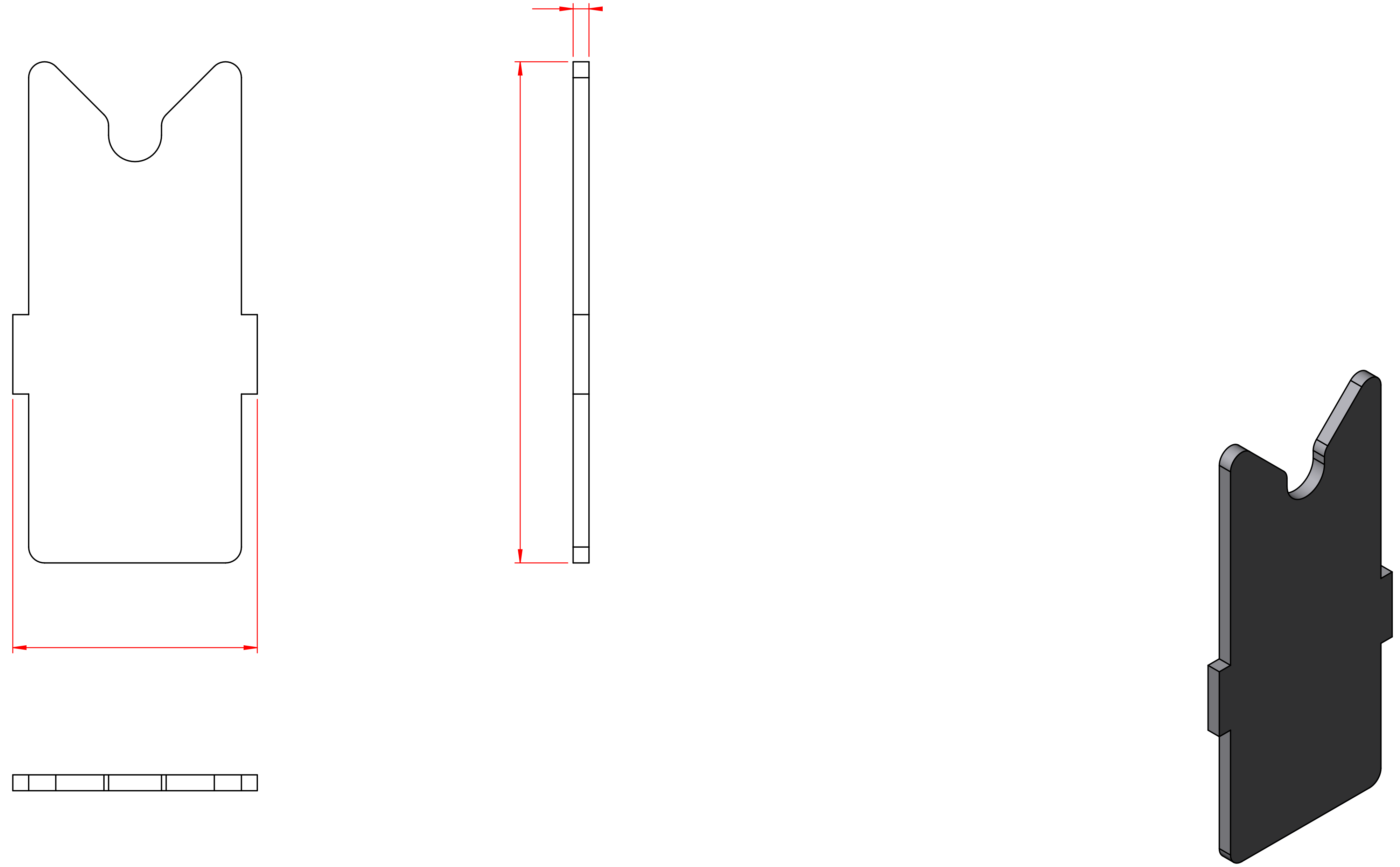

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UHSURGXFHG LQ DQ\ IRUP RU KDQG RYHU WR D
WKLUG SDUW\ ZLWKRXW WKH SHUPLVVLRQ RI 0DUHO)RRG 6\VWHPV

LQIR#PDUHO FRP ZZZ PDUHO FRP

'(6,*1(5 6,5(	'5$:1 6,5(	',9,6,21 60 6KHHW PHWDO ZRUN	5(3/$&(6	$
$33529('	'$7(	75($70(17	5(3/$&(' %<	6&$/(

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7HPSODWH IRU %RWWRP &URVVEHDP RQ /H

/RFDWLRQ *$5ç$%-5

81/(66 27+(5:,6(63(&,),(' ',0(16,216 $5(,1 0,//,0(7(56 $FFRUGLQJ WR ,62 DQG ,62 /,1 $1* P *(2 7RO .

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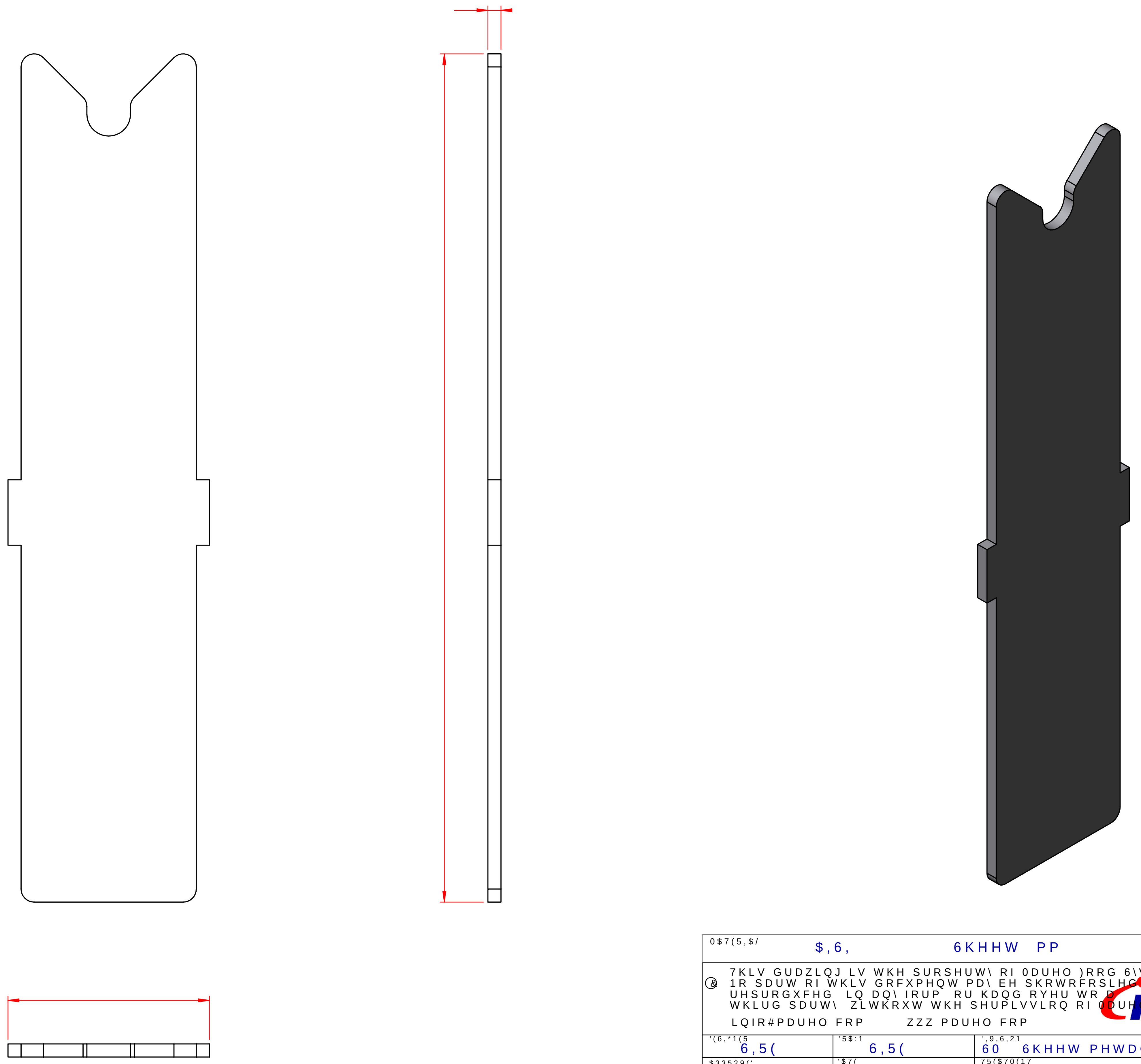

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'(6,*1(5 6,5(	'5$:1 6,5(	',9,6,21 60 6KHHW PHWDO ZRUN	5(3/$&(6	$
$33529('	'$7(	75($70(17	5(3/$&(' %<	6&$/(
7,7/(7HPSODWH IRU %RWWRP &URVVEHDP RQ /HJ			/RFDWLRQ *$5&$%$5	
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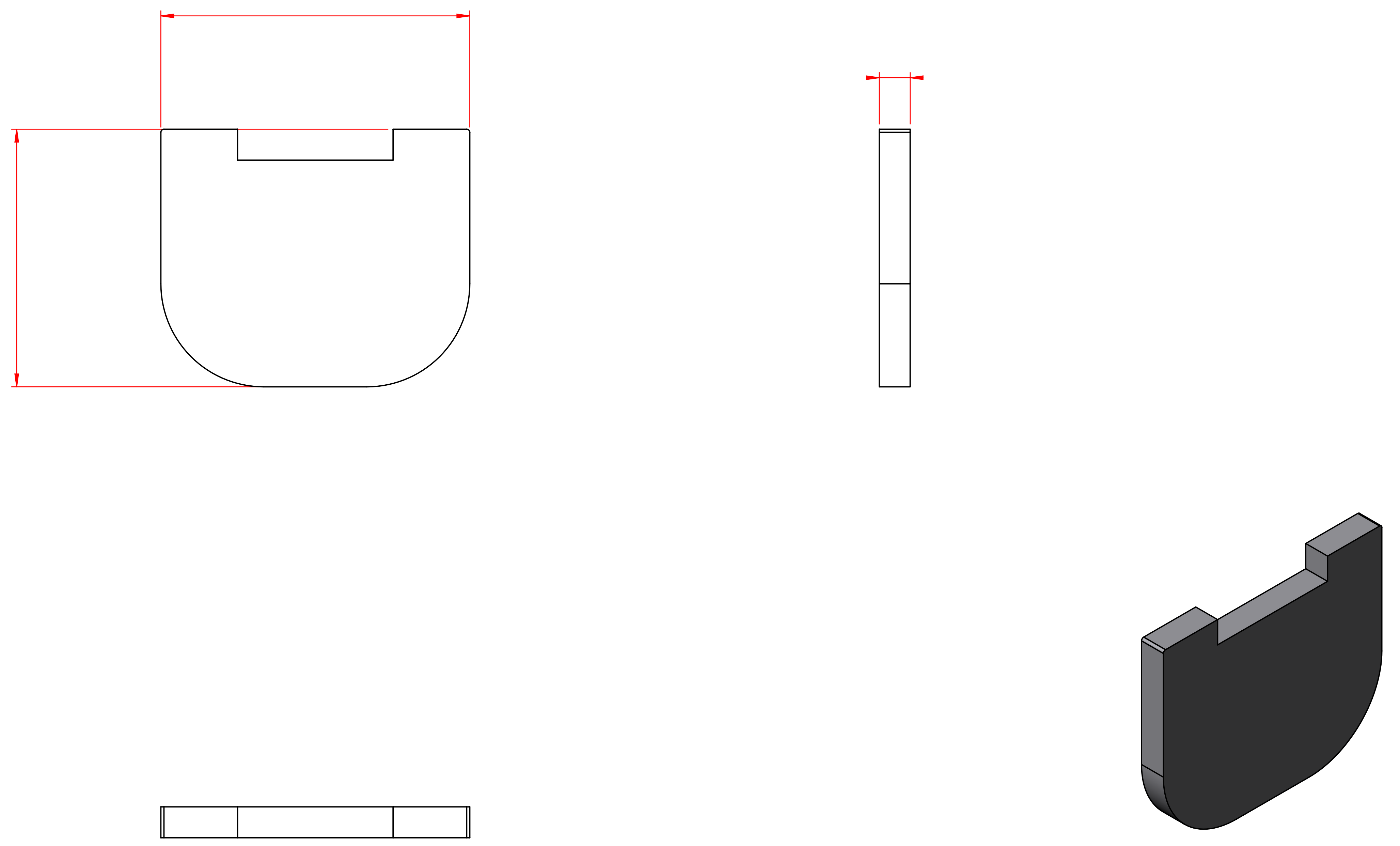

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UHSURGXFHG LQ DQ\ IRUP RU KDQG RYHU WR D
WKLUG SDUW\ ZLWKRXW WKH SHUPLVVLRQ RI 0DUHO)RRG 6\VWHPV

LQIR#PDUHO FRP ZZZ PDUHO FRP

'(6,*1(5	'5$:1	',9,6,21 60 6KHHW PHWDO ZRUN	5(3/$&(6	$
$33529('	'$7(	75($70(17	5(3/$&(' %<	6&$/(

7,7/(

6LGHSODWH LQ 7HPSODWH IRU /HJV

/RFDWLRQ *$5'$%$5

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',0(16,216 $5(,1 0,//,0(7(56
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,62 DQG ,62
/,1 $1* P
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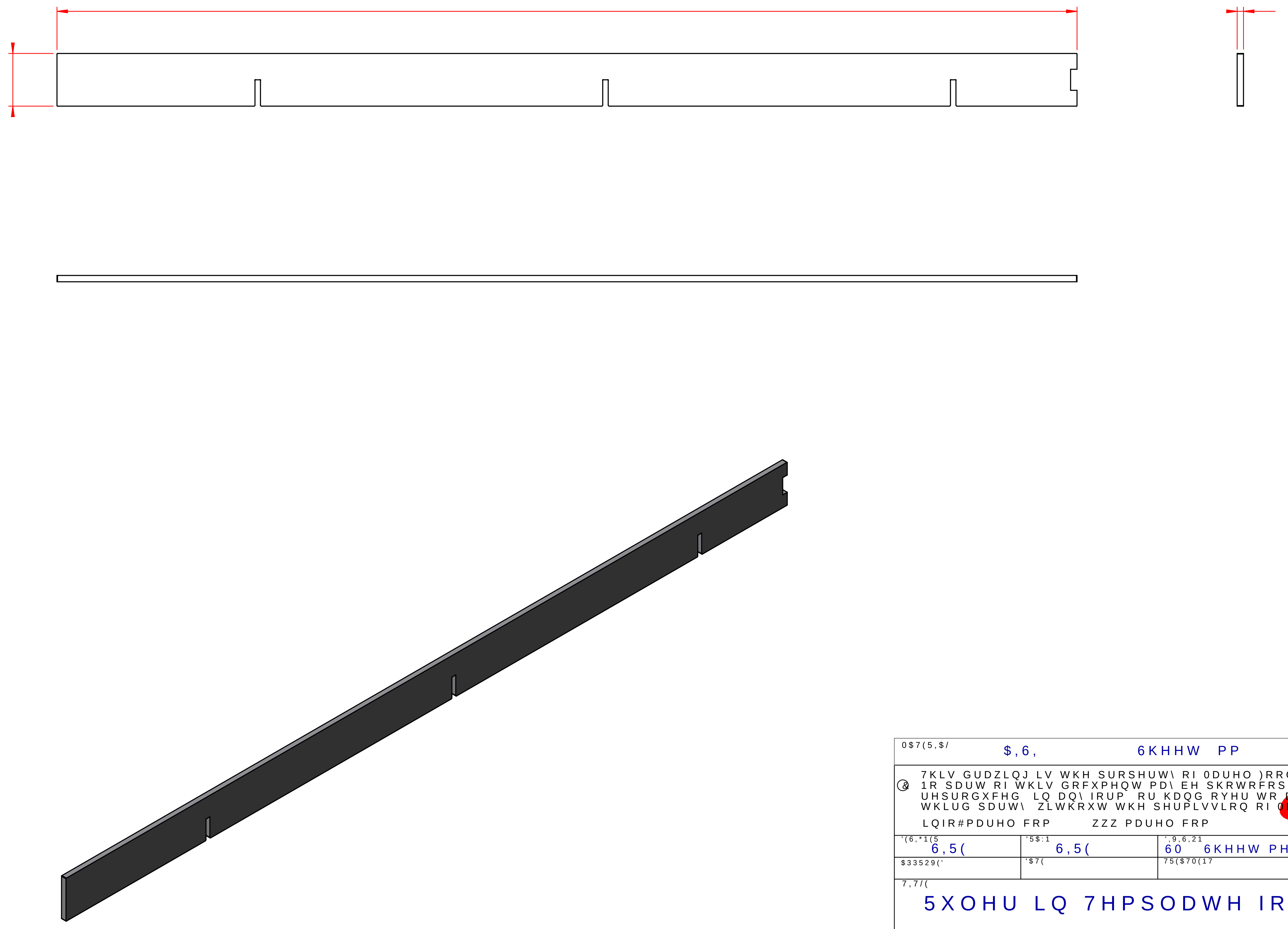
>$&7,9(@



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6,=(

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UHSURGXFHG LQ DQ\ IRUP RU KDQG RYHU WR D
WKLUG SDUW\ ZLWKRXW WKH SHUPLVVLRQ RI 0DUHO)RRG 6\VWHPV

LQIR#PDUHO FRP ZZZ PDUHO FRP

marel

'(6,*1(5	'5$:1	',9,6,21	5(3/$&(6	
6,5(	6,5(	60 6KHHW PHWDO ZRUN		$
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/RFDWLRQ

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'5$:,1* 12 &219(<256 3$5$0(75,& &21 &219(<25

67$786

81/(66 27+(5:,6(63(&,)(' ',0(16,216 $5(,1 0,//,0(7(56 $FFRUGLQJ WR ,62 DQG ,62 /,1 $1* P *(2 7RO .

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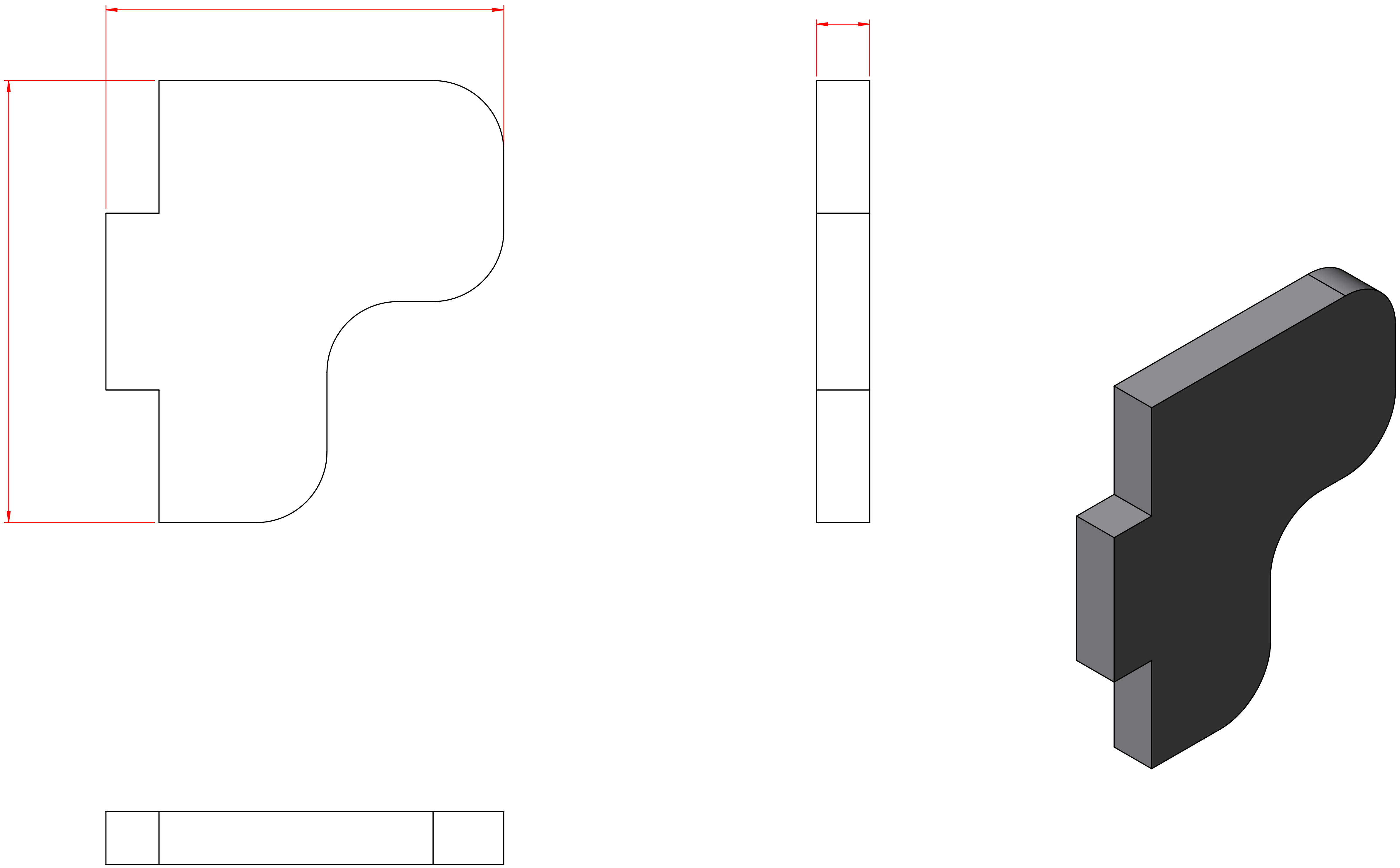

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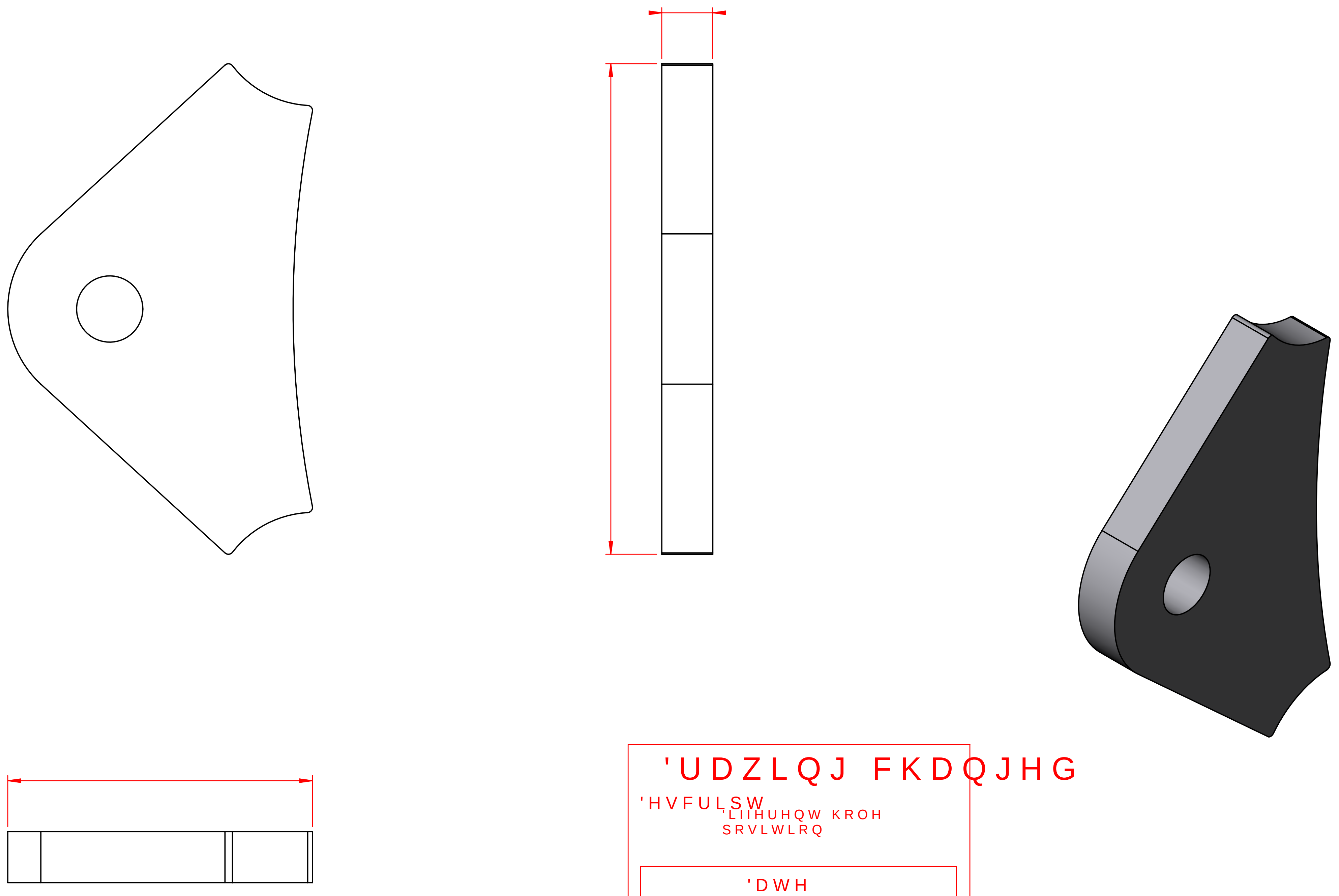
& 7KLV GUDZLQJ LV WKH SURSHUW\ RI 0DUHO)RRG 6\VWHPV 1R SDUW RI WKLV GRFXPHQW PD\ EH SKRWRFRSLHG RU UHSURGXFHG LQ DQ\ IRUP RU KDQG RYHU WR D WKLUG SDUW\ ZLWKRXW WKH SHUPLVVLRQ RI 0DUHO)RRG 6\VWHPV LQIR#PDUHO FRP ZZZ PDUHO FRP				
'(6,*1(5 6,5(	'5$:1 6,5(	',9,6,21 60 6KHHW PHWDO ZRUN	5(3/$&(6	$
$33529('	'$7(	75($70(17	5(3/$&(' %<	6&$/(
7,7/((QG 3ODWH LQ 7HPSODWH IRU &URVVEHDPV			/RFDWLRQ *$5'$%$5	
			81/(66 27+(5:,6(63(&,),(' ',0(16,216 $5(,1 0,//,0(7(56 $FFRUGLQJ WR ,62 DQG ,62 /,1 $1* P *(2 7RO .	6+((7 2)
'5$:,1* 12	&219(<256 3$5$0(75,& &219(<25	67$786		5(9,6,21

>$&7,9(@

5HY	'DWH	'HVFULSWLRQ	$SSURYH
		+ROH VL]H GHFUHDVHG	6,5(
		'LIIHUHQW KROH SRVLWLRQ	6,5(



'UDZLQJ FKDQJHG

'HVFULSW 'LIIHUHQW KROH SRVLWLRQ

'DWH

&KDQJHG E 6,5(

0$7(5,$/	$,6,	6KHHW PP	6,=(

7KLV GUDZLQJ LV WKH SURSHUW\ RI 0DUHO)RRG 6\VWHPV 1R SDUW RI WKLV GRFXPHQW PD\ EH SKRWRFRSLHG RU UHSURGXFHG LQ DQ\ IRUP RU KDQG RYHU WR D WKLUG SDUW\ ZLWKRXW WKH SHUPLVVLRQ RI 0DUHO)RRG 6\VWHPV

LQIR#PDUHO FRP ZZZ PDUHO FRP

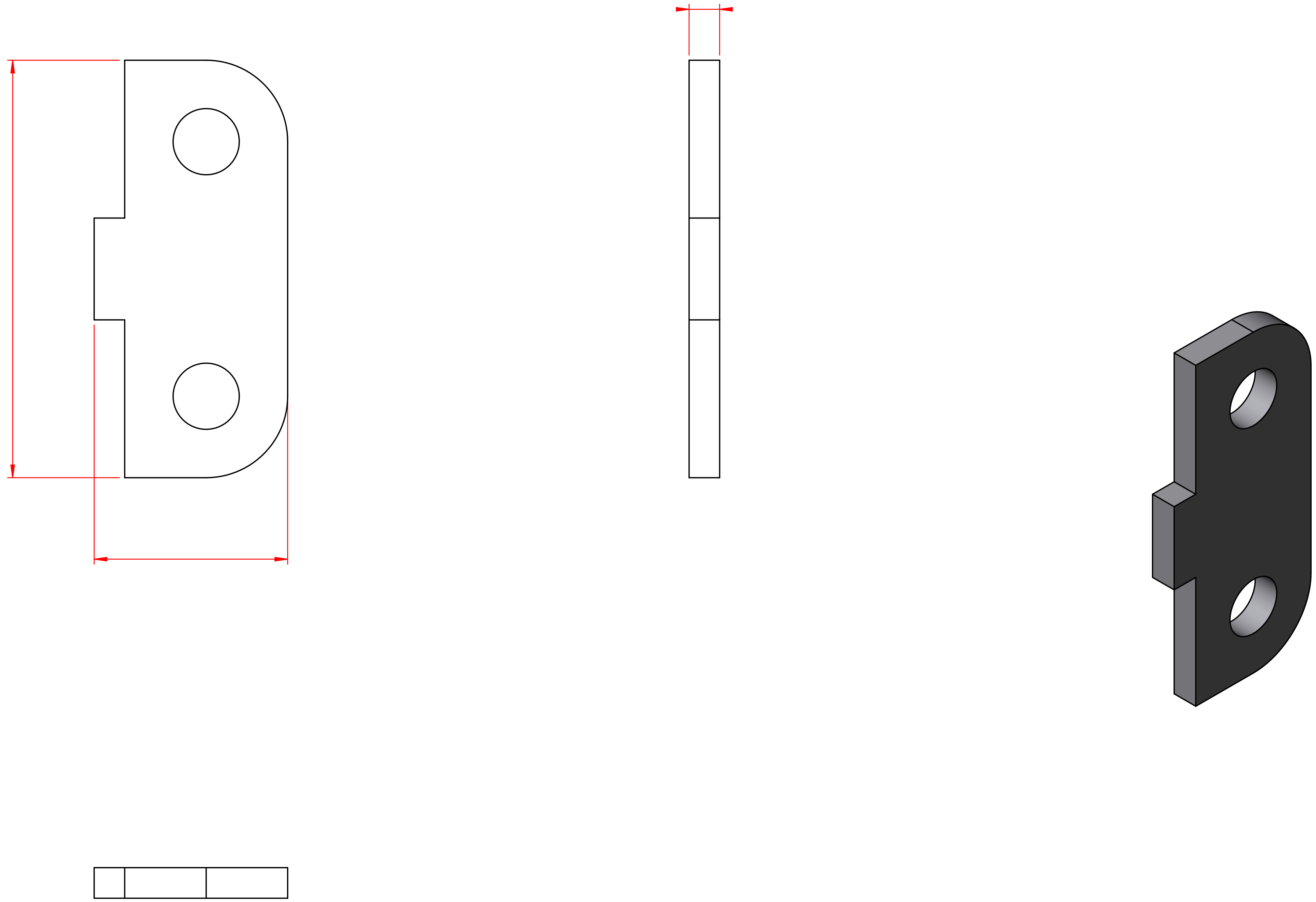
'(6,*1(5	'5$:1	',9,6,21	5(3/$&(6	
6,5(	6,5(	60 6KHHW PHWDO ZRUN		$
$33529('	'$7(	75($70(17	5(3/$&(' %<	6&$/(

7,7/(

(DU IRU ([WUD 6LGHJXDUG)DVWHQHU

'5$:,1* 12	&219(<256 3$5$0(75,& &219(<25	5(9,6,21

>$&7,9(@



0$7(5,$/	$,6,	6KHHW PP	6,=(

7KLV GUDZLQJ LV WKH SURSHUW\ RI 0DUHO)RRG 6\VWHPV
1R SDUW RI WKLV GRFXPHQW PD\ EH SKRWRFRSLHG RU
UHSURGXFHG LQ DQ\ IRUP RU KDQG RYHU WR D
WKLUG SDUW\ ZLWKRXW WKH SHUPLVVLRQ RI 0DUHO)RRG 6\VWHPV

LQIR#PDUHO FRP   ZZZ PDUHO FRP

'(6,*1(5 6,5(	'5$:1 6,5(	',9,6,21 60 6KHHW PHWDO ZRUN	5(3/$&(6	$
$33529('	'$7(	75($70(17	5(3/$&(' %<	6&$/(

7,7/(
0RXQWLQJ SODWH IRU &,3 EUDFNHW

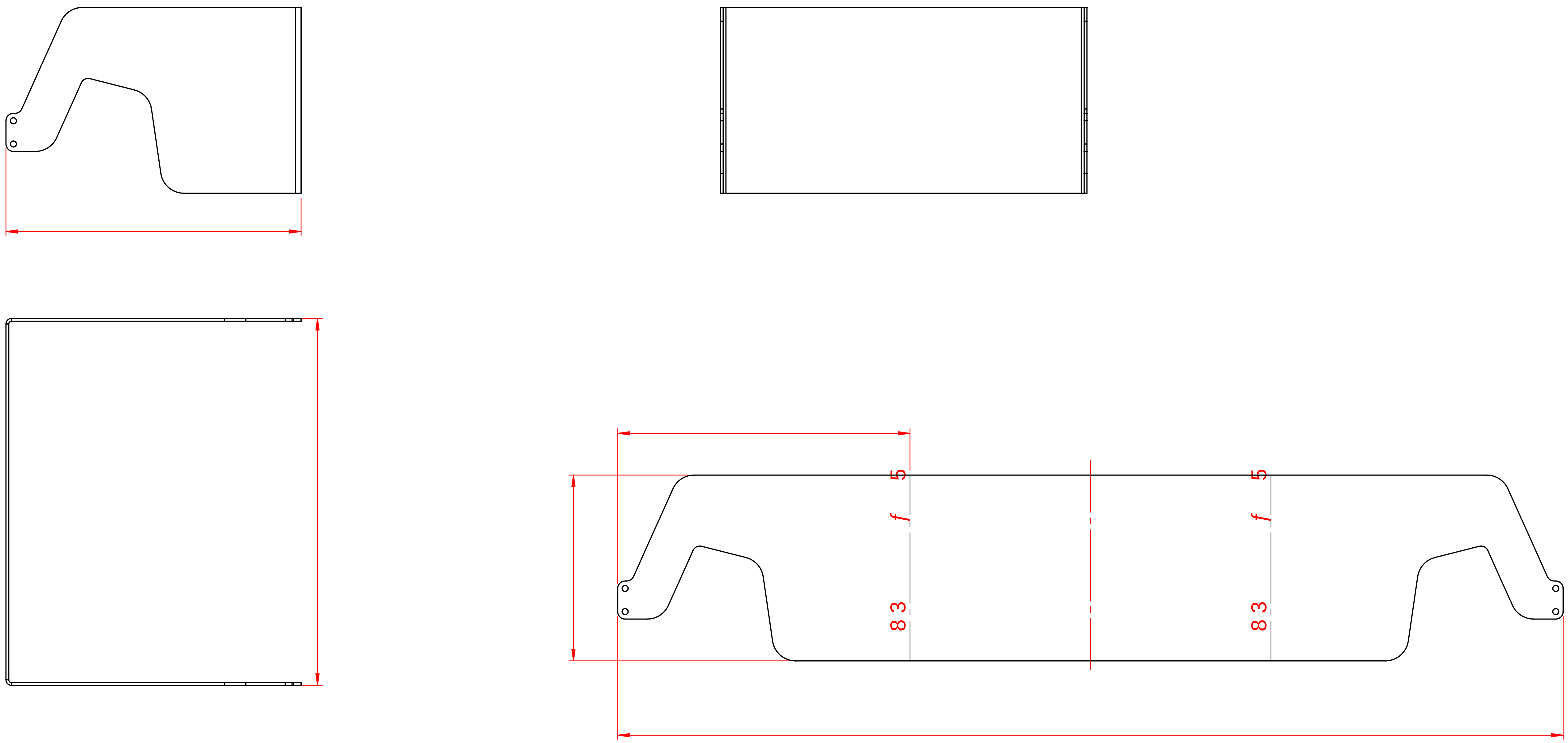
/RFDWLRQ
+$5'/$%(5

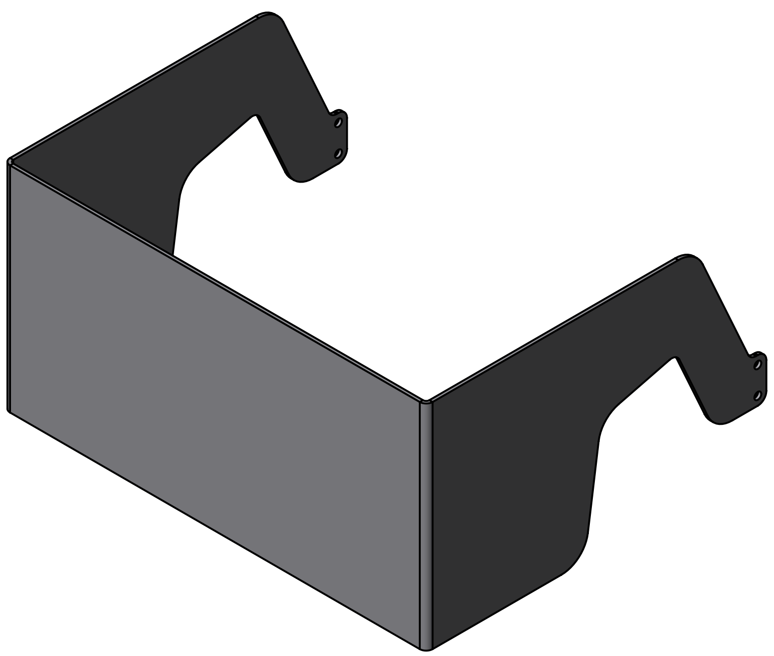
81/(66 27+(5:,6(63(&,),(' ',0(16,216 $5(,1 0,//,0(7(56
$FFRUGLQJ WR ,62 DQG ,62
/,1($5 P
*(2 72/ .

6+((7 2)
5(9,6,21

'5$:,1* 12   &219(<256 3$5$0(75,& &219(<25   67$786

>$&7,9(@





0$7(5,$/ $,6, 6KHHW PP 6,=(

7KLV GUDZLQJ LV WKH SURSHUW\ RI 0DUHO)RRG 6\VWHPV
1R SDUW RI WKLV GRFXPHQW PD\ EH SKRWRFRSLHG RU
UHSURGXFHG LQ DQ\ IRUP RU KDQG RYHU WR D
WKLUG SDUW\ ZLWKRXW WKH SHUPLVVLRQ RI 0DUHO)RRG 6\VWHPV
LQIR#PDUHO FRP ZZZ PDUHO FRP

marel

'(6,*1(5 6,5(| '5$:1 6,5(| ',9,6,21 60 6KHHW PHWDO ZRUN | 5(3/$&(6 | $

$33529(' | '$7(| 75($70(17 | 5(3/$&(' %< | 6&$/(

7,7/( )OLJWKV &RYHU IRU ,GOH (QG

/RFDWLRQ *$5ç$%•5

81/(66 27+(5:,6(63(&,),(' ',0(16,216 $5(,1 0,//,0(7(56
$FFRUGLQJ WR ,62 DQG ,62
/,1 $1* P
*(2 72/ .

6+((7 2) 5(9,6,21

'5$:,1* 12 &219(<256 3$5$0(75,& &219(<25 67$786

>$&7,9(@

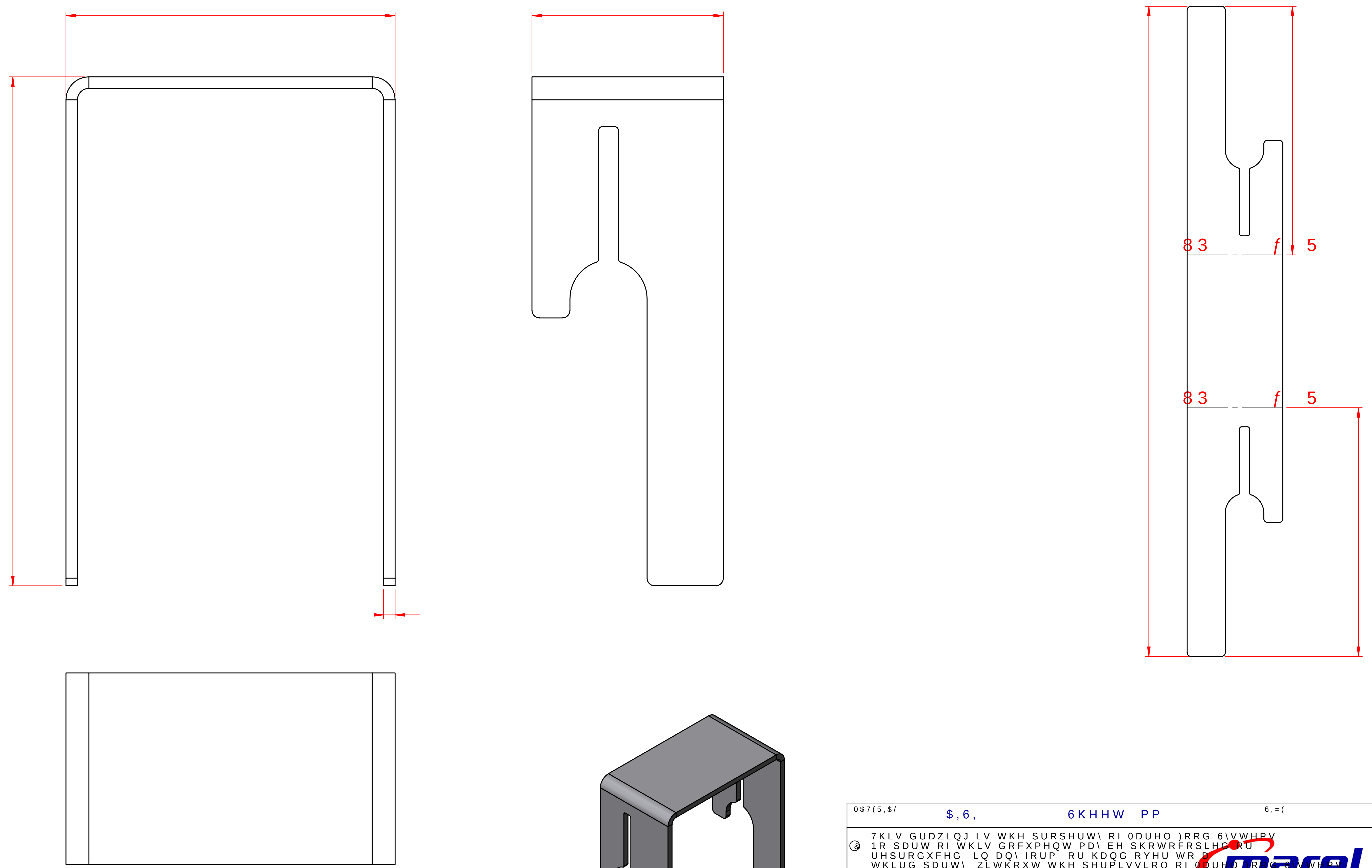
$

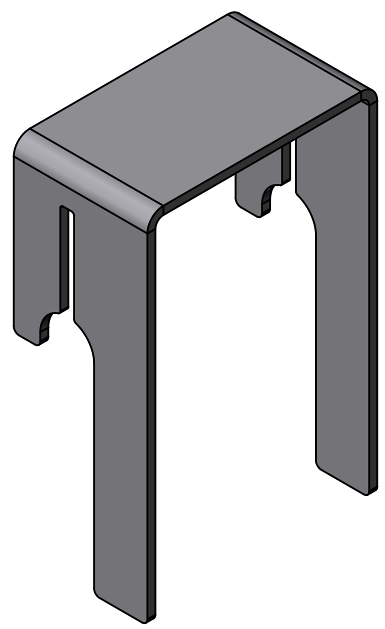
%

&

'

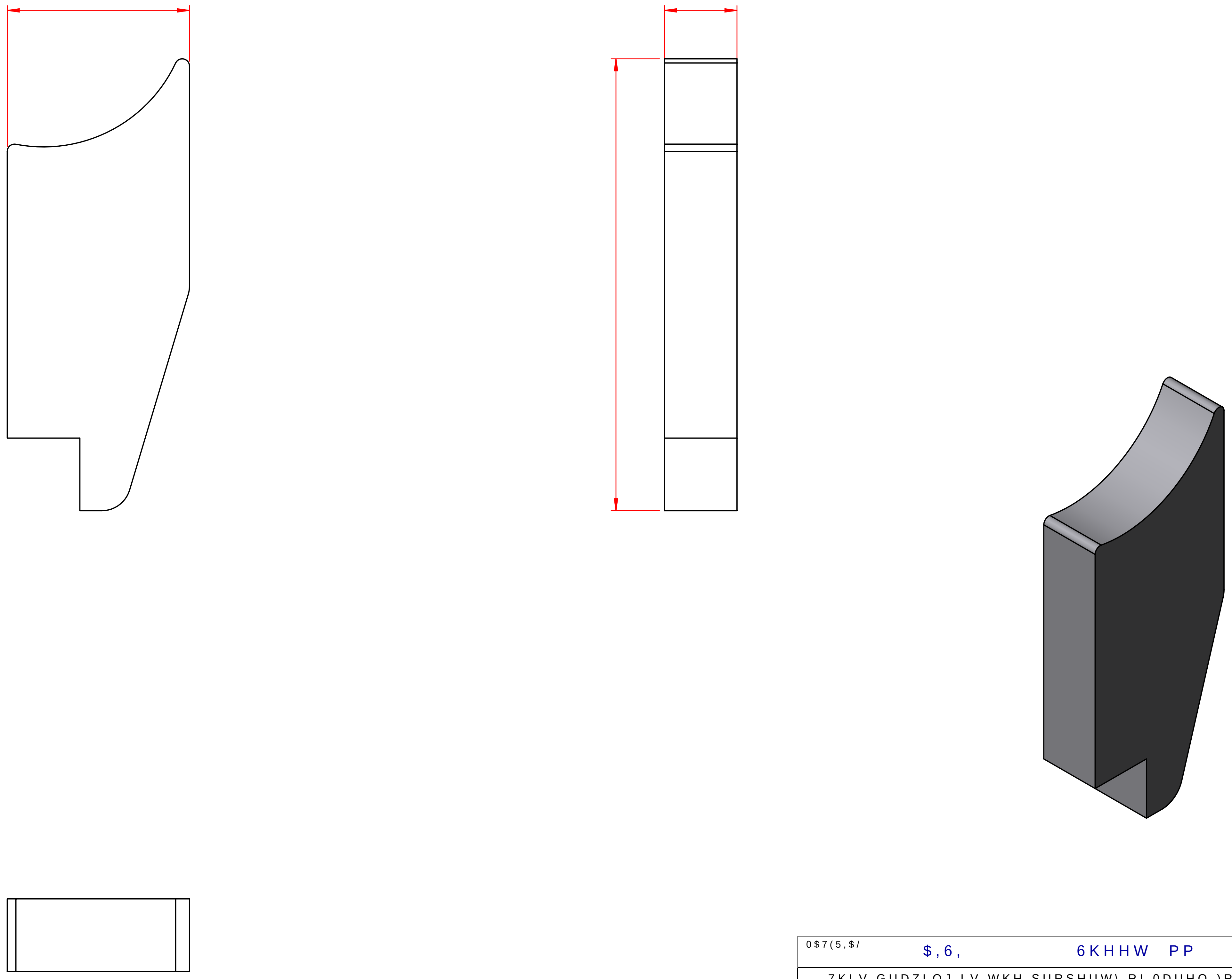
(





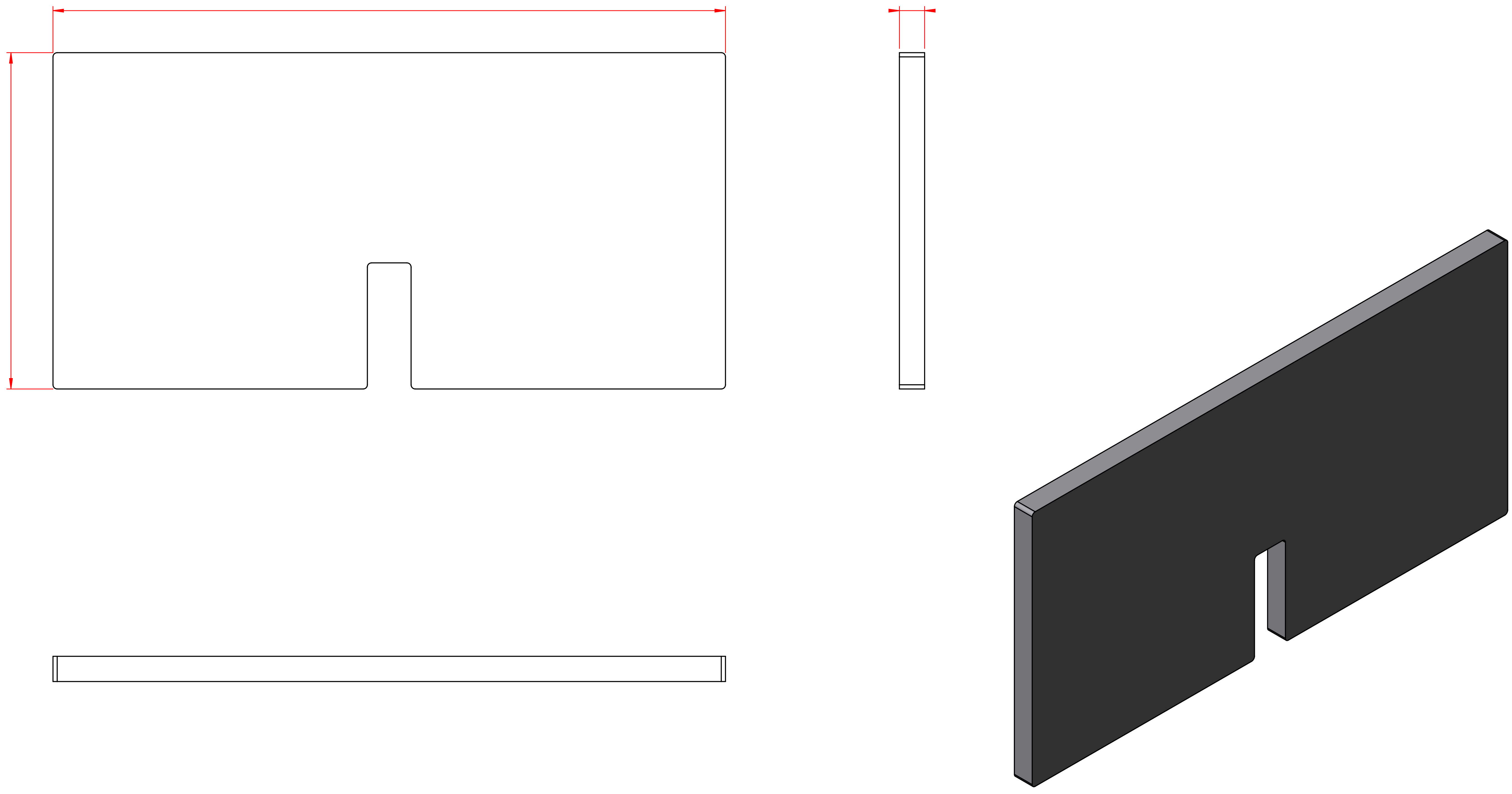
0$7(5,$/	$,6,	6KHHW PP		6,=(
7KLV GUDZLQJ LV WKH SURSHUW\ RI 0DUHO)RRG 6\VWHPV 1R SDUW RI WKLV GRFXPHQW PD\ EH SKRWRFRSLHG RU UHSURGXFHG LQ DQ\ IRUP RU KDQG RYHU WR D WKLUG SDUW\ ZLWKRXW WKH SHUPLVVLRQ RI 0DUHO)RRG 6\VWHPV LQIR#PDUHO FRP ZZZ PDUHO FRP				
'(6,*1(5 6,5(	'5$:1 6,5(	',9,6,21 60 6KHHW PHWDO ZRUN	5(3/$&(6	$
$33529('	'$7(	75($70(17	5(3/$&(' %<	6&$/(
7,7/(7HPSODWH IRU /HJ)DVWHQHU			/RFDWLRQ *5ç$%•5	6((7 2)
'5$:,1* 12	&21(<256 3$5$0(75,& &21(<25		81/(66 27+(5:,6(63(&,),(' ',0(16,216 $5(,1 0,//,0(7(56 $FFRUGLQJ WR ,62 DQG ,62 /,1$* P *(2 7RO .	5(9,6,21

>$&7,9(@



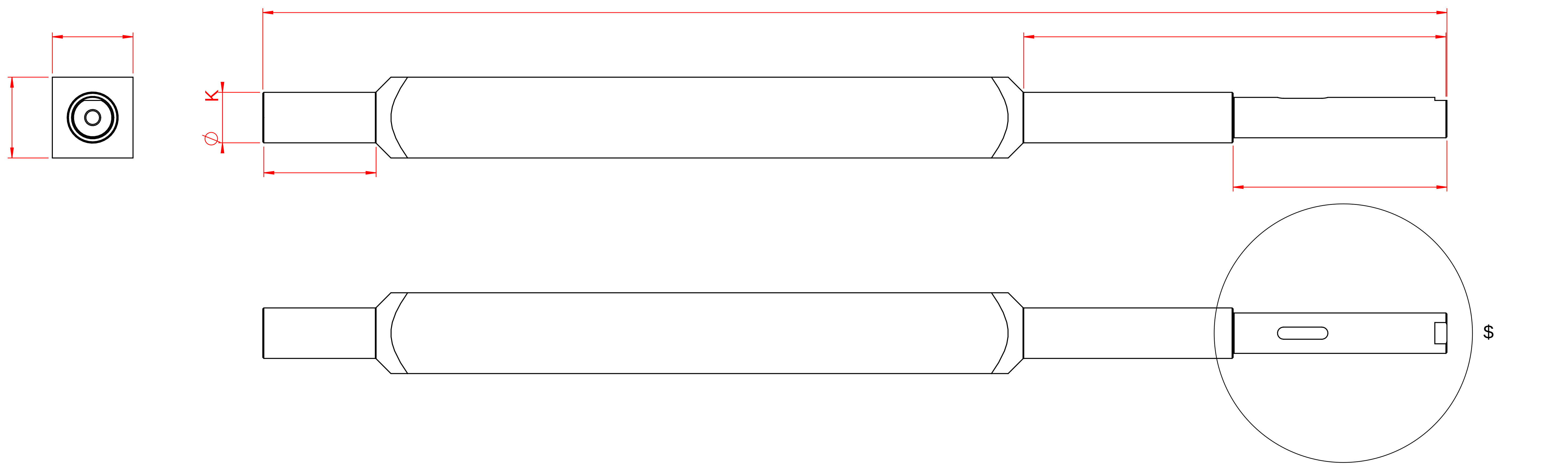
0$7(5,$/ $,6,	6KHHW PP	6,=(	
7KLV GUDZLQJ LV WKH SURSHUW\ RI 0DUHO)RRG 6\VWHPV 1R SDUW RI WKLV GRFXPHQW PD\ EH SKRWRFRSLHG RU UHSURGXFHG LQ DQ\ IRUP RU KDQG RYHU WR D WKLUG SDUW\ ZLWKRXW WKH SHUPLVVLRQ RI 0DUHO)RRG 6\VWHPV LQIR#PDUHO FRP ZZZ PDUHO FRP			
'(6,*1(5 6,5(	'5$:1 6,5(	',9,6,21 60 6KHHW PHWDO ZRUN	5(3/$&(6 $
$33529('	'$7(	75($70(17	5(3/$&(' %< 6&$/(
7,7/(6WHDULQJ IRU 0RXQWLQJ 3ODWH			/RFDWLRQ *$5d$%•5
'5$:,1* 12	&219(<256 3$5$0(75,& &219(<25	67$786	81/(66 27+(5:,6(63(&,),(' ',0(16,216 $5(,1 0,//,0(7(56 $FFRUGLQJ WR ,62 DQG ,62 /,1 $1* P *(2 72/ .
			6+((7 2)
			5(9,6,21

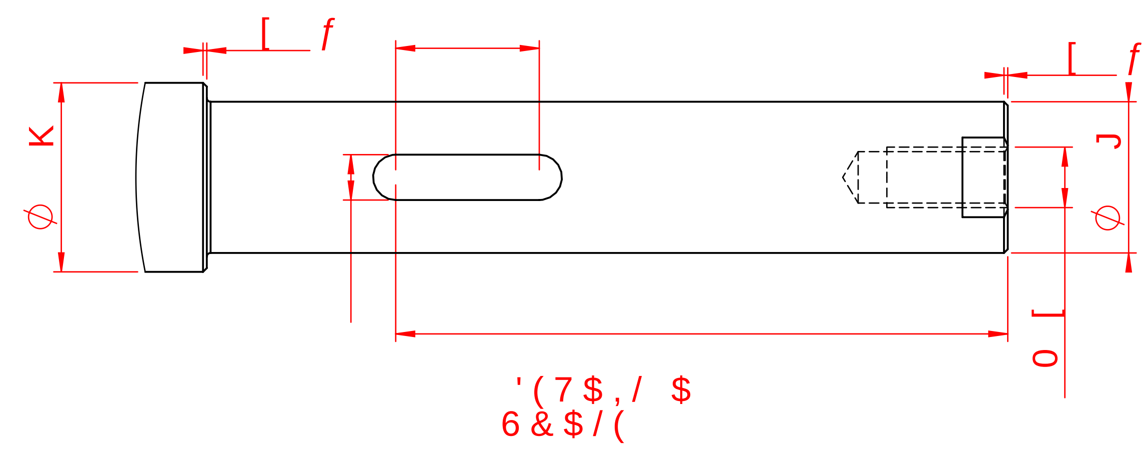
>$&7,9(@

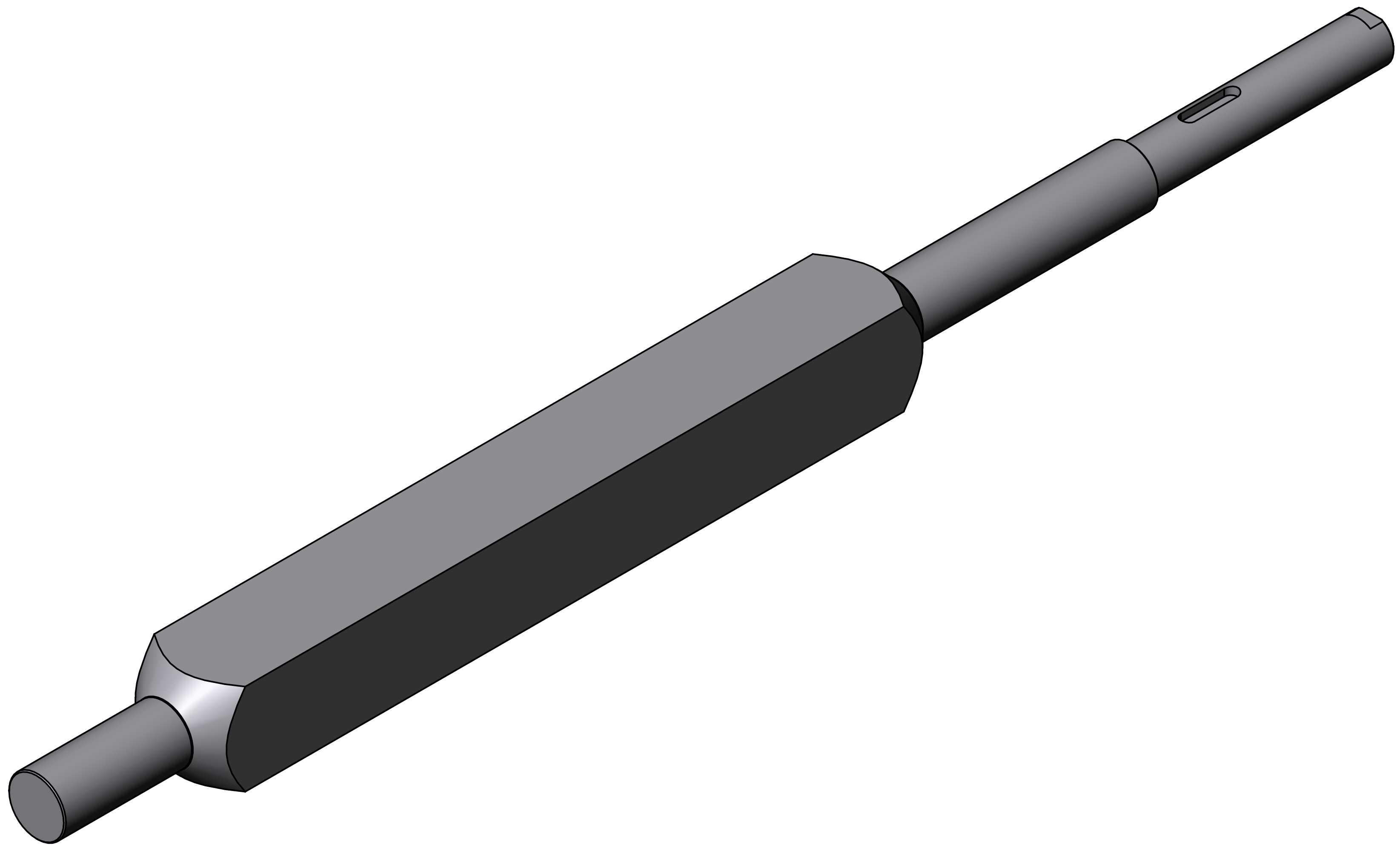


0$7(5,$/ $,6,	6KHHW PP	6,=(	
7KLV GUDZLQJ LV WKH SURSHUW\ RI 0DUHO)RRG 6\VWHPV 1R SDUW RI WKLV GRFXPHQW PD\ EH SKRWRFRSLHG RU UHSURGXFHG LQ DQ\ IRUP RU KDQG RYHU WR D WKLUG SDUW\ ZLWKRXW WKH SHUPLVVLRQ RI 0DUHO)RRG 6\VWHPV LQIR#PDUHO FRP ZZZ PDUHO FRP			
'(6,*1(5 6,5(	'5$:1 6,5(	',9,6,21 60 6KHHW PHWDO ZRUN	5(3/$&(6 $
$33529('	'$7(	75($70(17	5(3/$&(' %< / 6&$/(
7,7/(&HQWHU 6WHDULQJ LQ 7HPSODWH			/RFDWLRQ *$5'$%•5
'5$:,1* 12 &219(<256 3$5$0(75,& &219(<25			81/(66 27+(5:,6(63(&,),(' ',0(16,216 $5(,1 0,//,0(7(56 $FFRUGLQJ WR ,62 DQG ,62 /,1 $1* P *(2 7RO . 6+((7 2) 5(9,6,21

>$&7,9(@







0$7(5,$/ $,6, 6TXDUH %DU KRW UROOHG [PP

7KLV GUDZLQJ LV WKH SURSHUW\ RI 0DUHO)RRG 6\VWHPV
1R SDUW RI WKLV GRFXPHQW PD\ EH SKRWRFRSLHG RU
UHSURGXFHG LQ DQ\ IRUP RU KDQGRYHU WR D
WKLUG SDUW\ ZLWKRXW WKH SHUPLVVLRQ RI 0DUHO)RRG 6\VWHPV

LQIR#PDUHO FRP ZZZ PDUHO FRP

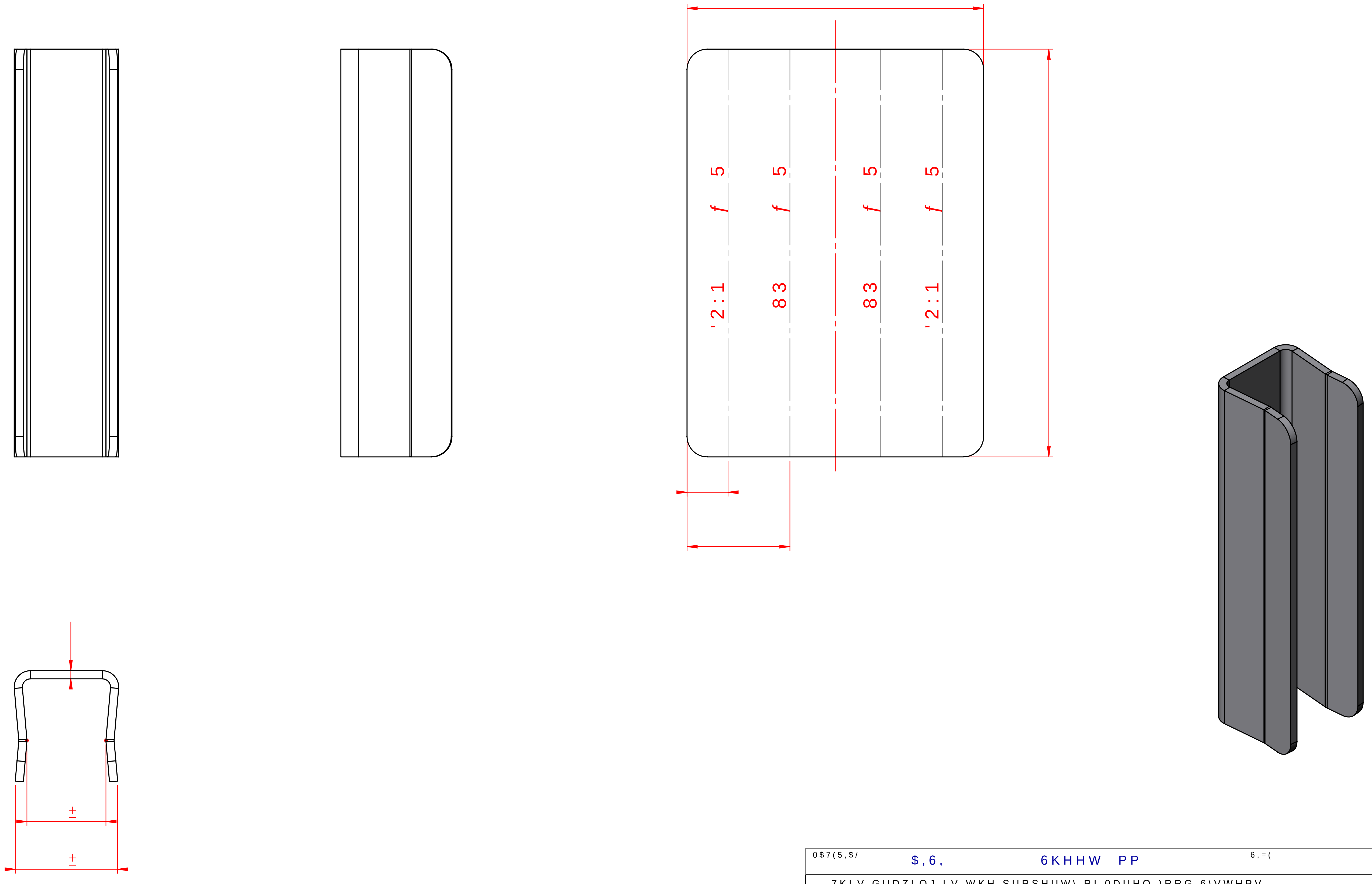
'(6,*1(5 6,5(	'5$:1 6,5(	',9,6,21 70 7XUQLQJ DQG PLOOLQJ	5(3/$&(6	$
$33529('	'$7(	75($70(17	5(3/$&(' %<	6&$/(

7,7/(' 6KDIW

/RFDWLRQ *$5Ç$%•5

'5$:,1* 12 &219(<256 3$5$0(75,& &21 9(<25

>$&7,9(@



0$7(5,$/	$,6,	6KHHW PP	6,=(

7KLV GUDZLQJ LV WKH SURSHUW\ RI 0DUHO)RRG 6\VWHPV
1R SDUW RI WKLV GRFXPHQW PD\ EH SKRWRFRSLHG RU
UHSURGXFHG LQ DQ\ IRUP RU KDQG RYHU WR D
WKLUG SDUW\ ZLWKRXW WKH SHUPLVVLRQ RI 0DUHO)RRG 6\VWHPV

LQIR#PDUHO FRP ZZZ PDUHO FRP

'(6,*1(5 6,5(	'5$:1 6,5(	',9,6,21 60 6KHHW PHWDO ZRUN	5(3/$&(6	$
$33529('	'$7(	75($70(17	5(3/$&(' %<	6&$/(

7,7/(

7HSODWH IRU $GMXVWDEOH /HJV

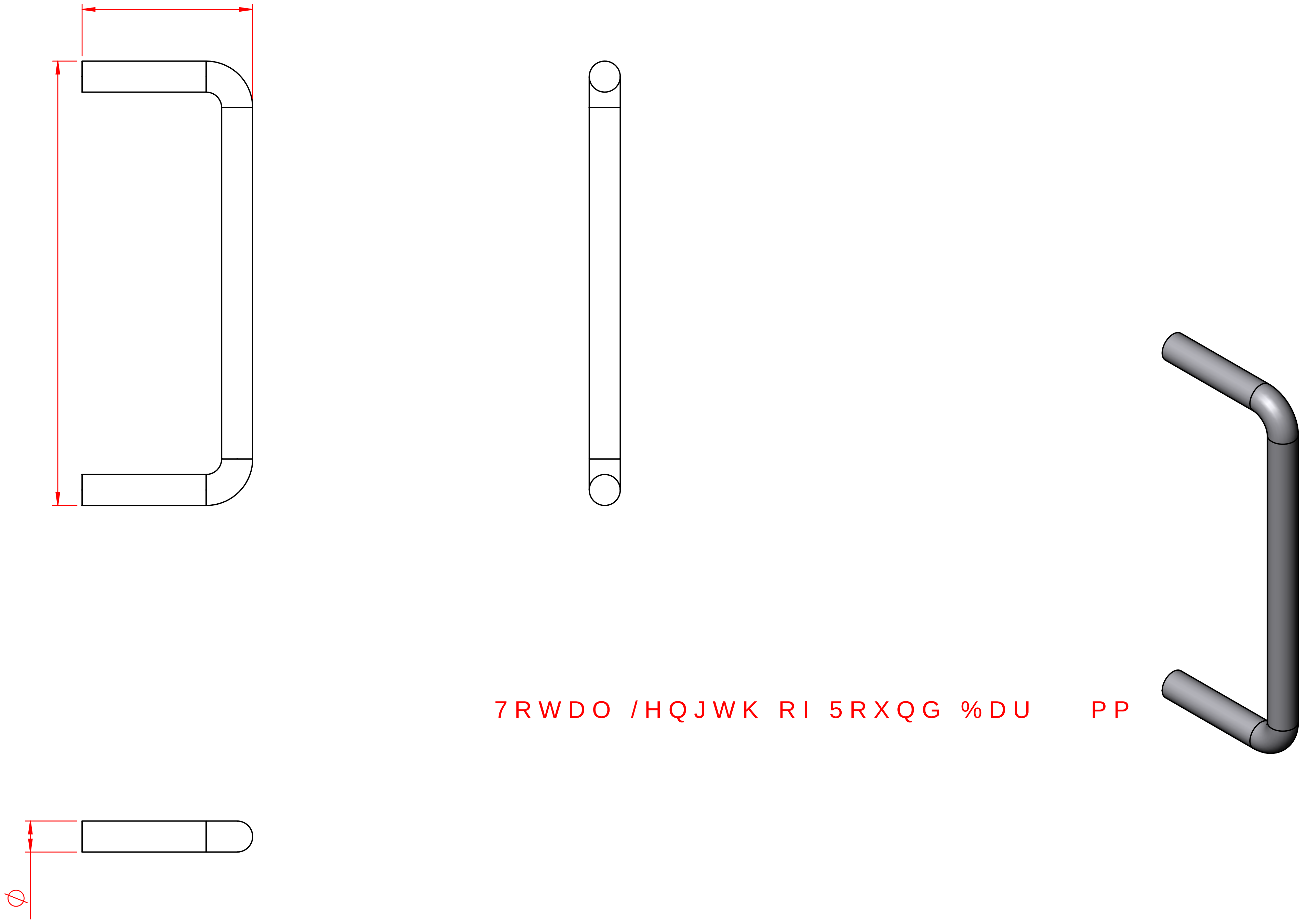
/RFDWLRQ *$5&$%•5

'5$:,1* 12 &219(<256 3$5$0(75,& &219(<25 67$786

81/(66 27+(5:,6(63(&,),(' ',0(16,216 $5(,1 0,//,0(7(56 $FFRUGLQJ WR ,62 DQG ,62 /,1 $1* P *(2 7RO .

6+((7 2) 5(9,6,21

>$&7,9(@



0$7(5,$/ $,6, 5RXQG %DU ¡ PP 6,=(/

7KLV GUDZLQJ LV WKH SURSHUW\ RI 0DUHO)RRG 6\VWHPV 1R SDUW RI WKLV GRFXPHQW PD\ EH SKRWRFRSLHG RU UHSURGXFHG LQ DQ\ IRUP RU KDQG RYHU WR D WKLUG SDUW\ ZLWKRXW WKH SHUPLVVLRQ RI 0DUHO)RRG 6\VWHPV

LQIR#PDUHO FRP ZZZ PDUHO FRP

'(6,*1(5	'5$:1	',9,6,21	5(3/$&(6	
6,5(	6,5(	:: :RUNVKRS ZHOGLQJ		$
$33529('	'$7(	75($70(17	5(3/$&(' %<	6&$/(

7,7/(

+DQGOH IRU 7HPSODWH

/RFDWLRQ *$5ç$%•5

81/(66 27+(5:,6(63(&,),(' ',0(16,216 $5(,1 0,//,0(7(56 $FFRUGLQJ WR ,62 DQG ,62 /,1 $1* P *(2 7RO .

6+((7 2) 5(9,6,21

'5$:,1* 12 &21'(<256 3$5$0(75,& &21'(<25 67$786

&DWIV @ &21

Appendix B, Rules in iLogic

Belt:

```
BeltLength=(((Length1+Length2+Length3)*2)+1000)
FlightsQty=Round(BeltLength/FlightSpacing)
OrderedBeltLength=Round(Round((BeltLength*1.02*0.001), 4) / 0.1) * 0.1
```

CrossBeamPattern:

```
CrossBeams1_1Qty=Round((Length1-250)/660)
CrossBeams2_1Qty=Round((Length1-660)/660)
CrossBeams1_2Qty=Round((Length2-150)/660)
CrossBeams2_2Qty=Round((Length2-500)/660)
CrossBeams1_3Qty=Round((Length3-300)/660
CrossBeams2_3Qty=Round((Length3-660)/660)

If CrossBeams1_1Qty<1 Then
Feature.IsActive("CrossBeam1:1") = False
Else
Feature.IsActive("CrossBeam1:1") = True
End If
If CrossBeams2_1Qty<1 Then
Feature.IsActive("Crossbeam2:1") = False
Else
Feature.IsActive("Crossbeam2:1") = True
End If
If CrossBeams1_2Qty<1 Then
Feature.IsActive("Crossbeam1:2") = False
Else
Feature.IsActive("Crossbeam1:2") = True
End If
If CrossBeams2_2Qty<1 Then
Feature.IsActive("Crossbeam2:2") = False
Else
Feature.IsActive("Crossbeam2:2") = True
End If
If CrossBeams1_3Qty<1 Then
Feature.IsActive("Crossbeam1:3") = False
Else
Feature.IsActive("Crossbeam1:3") = True
End If
If CrossBeams2_3Qty<1 Then
Feature.IsActive("Crossbeam2:3") = False
Else
Feature.IsActive("Crossbeam2:3") = True
End If

CrossBeams1_Qty=CrossBeams1_1Qty+CrossBeams1_2Qty+CrossBeams1_3Qty+1
CrossBeams2_Qty=CrossBeams2_1Qty+CrossBeams2_2Qty+CrossBeams2_3Qty
```

LegsPattern:

```
If Length1 <= 800 Then
Feature.IsActive("Legs1_Pattern") = False
Feature.IsActive("Legs1") = False
Else If Length1 <= 1200 Then
```

```
Feature.IsActive("Legs1_Pattern") = False
Feature.IsActive("Legs1") = True

Else
Feature.IsActive("Legs1") = True
Feature.IsActive("Legs1_Pattern") = True
a = Length1 - 450 'betweenendlegs
b = 1400
Legs1_Qty = Round(a/b)
c = a/Legs1_Qty
x = Round(c/330)
Legs1_Spacing = x * 330
End If

If Length2< 500 Then
Feature.IsActive("Legs2_Pattern") = False
Else
Feature.IsActive("Legs2_Pattern") = True
Legs2_Qty = Ceil((Length2-110)/1300)
cc = (Length2-100)/Legs2_Qty 'Raun gildi betweenlegs
xx = Round(cc/330)
Legs2_Spacing = xx * 330
End If

If Feature.IsActive("Legs1") = False Then
H1Qty=2
Else
H1Qty=2+(Legs1_Qty*2)
End If
```

Incline/DeclineModules:

```
If Angle= "6" Then
InclineModule="Undefined!" 'Drawing number for incline module'
DeclineModule="Undefined!" 'Drawing number for decline module'
Else If Angle= "8" Then
InclineModule="Undefined!" 'Drawing number for incline module'
DeclineModule="Undefined!" 'Drawing number for decline module'
Else If Angle= "10" Then
InclineModule="Undefined!" 'Drawing number for incline module'
DeclineModule="Undefined!" 'Drawing number for decline module'
Else If Angle= "12" Then
InclineModule="Undefined!" 'Drawing number for incline module'
DeclineModule="Undefined!" 'Drawing number for decline module'
Else If Angle= "15" Then
InclineModule="Undefined!" 'Drawing number for incline module'
DeclineModule="Undefined!" 'Drawing number for decline module'
Else If Angle= "30" Then
InclineModule="Undefined!" 'Drawing number for incline module'
DeclineModule="Undefined!" 'Drawing number for decline module'
Else If Angle= "45" Then
InclineModule="Undefined!" 'Drawing number for incline module'
DeclineModule="Undefined!" 'Drawing number for decline module'
Else If Angle= "60" Then
InclineModule="Undefined!" 'Drawing number for incline module'
DeclineModule="Undefined!" 'Drawing number for decline module'
End If
```

ConveyorID:

```
If Angle=6 Then
ID2=1
Else If Angle=8 Then
ID2=2
Else If Angle=10 Then
ID2=3
Else If Angle=12 Then
ID2=4
Else If Angle=15 Then
ID2=5
Else If Angle=30 Then
ID2=6
Else If Angle=45 Then
ID2=7
Else If Angle=60 Then
ID2=8
End If


If SideguardHeight=75 Then
ID3=1
Else If SideguardHeight=100 Then
ID3=2
Else If SideguardHeight=150 Then
ID3=3
Else If SideguardHeight=200 Then
ID3=4
End If

ID4=Round(Length1/10)
ID5=Round(Length2/10)
ID6=Round(Height1/10)
ID7=Round(Height2/10)

ConveyorID=  "1" &"-" &ID2 &"-" &ID3 &"-" &ID4 &"-" &ID5 &"-" &ID6 &"-" &ID7
```

ExportToExcel:

```
'define the file to create/open
myXLS_File = ThisDoc.Path &"/con-msgn_" &ConveyorID

'define Excel Application object
excelApp = CreateObject("Excel.Application")
'set Excel to run visibly, change to True if you want to run it visibly
excelApp.Visible = False
'suppress prompts (such as the compatibility checker)
excelApp.DisplayAlerts = False

'check for existing file
If Dir(myXLS_File) <> "" Then
'workbook exists, open it
excelWorkbook = excelApp.Workbooks.Open(myXLS_File)
ExcelSheet = ExcelWorkbook.Worksheets(1)
Else
'create a new spreadsheet from template
excelWorkbook = excelApp.Workbooks.Add (Template: = "G:\_3D-Modules\FDS Source
files for assets\Marel\Tools and Templates\GooseNeckConveyorSpecs.xltx")
End If

'Insert data into Excel.
With excelApp

    .Range("E1").Select
```

```
    .ActiveCell.FormulaR1C1 = "Conveyor " &BeltWidth &" " &Angle &"° H" &Height1
&"/" &Height2

    .Range("H1").Select
    .ActiveCell.FormulaR1C1 = DateString

    .Range("H3").Select
    .ActiveCell.FormulaR1C1 = ConveyorID

    .Range("E5").Select
    .ActiveCell.FormulaR1C1 = IdleEndModule

    .Range("E6").Select
    .ActiveCell.FormulaR1C1 = InclineModule

    .Range("E7").Select
    .ActiveCell.FormulaR1C1 = DeclineModule

    .Range("E8").Select
    .ActiveCell.FormulaR1C1 = MotorEndModule

    .Range("B9").Select
    .ActiveCell.FormulaR1C1 = CrossBeams1_Qty

    .Range("E9").Select
    .ActiveCell.FormulaR1C1 = CrossBeams1_ModuleNumber

    .Range("B10").Select
    .ActiveCell.FormulaR1C1 = CrossBeams2_Qty

    .Range("E10").Select
    .ActiveCell.FormulaR1C1 = CrossBeams2_PartNumber

    .Range("B11").Select
    .ActiveCell.FormulaR1C1 = LegModule_Qty

    .Range("B13").Select
    .ActiveCell.FormulaR1C1 =
(SideGuardsBrcktsL1_Qty+SideGuardBrcktsL2_Qty+SideGuardBrcktsL3_Qty+1)*2

    .Range("F14").Select
    .ActiveCell.FormulaR1C1 = RoundBarsL1

    .Range("F15").Select
    .ActiveCell.FormulaR1C1 = RoundBarsL2

    .Range("F16").Select
    .ActiveCell.FormulaR1C1 = Round(RoundBarsL3)

    .Range("B17").Select
    .ActiveCell.FormulaR1C1 = H1Qty

    .Range("F17").Select
    .ActiveCell.FormulaR1C1 = Round(Leg1Height)

    .Range("F18").Select
    .ActiveCell.FormulaR1C1 = Round(Leg3Height)

    .Range("B19").Select
    .ActiveCell.FormulaR1C1 = Legs2_Qty*2

    .Range("F19").Select
    .ActiveCell.FormulaR1C1 = Round(Leg2Height)

    .Range("B20").Select
    .ActiveCell.FormulaR1C1 = W1Qty
```

```
    .Range("F20").Select
    .ActiveCell.FormulaR1C1 = BeltWidth+69

    .Range("F21").Select
    .ActiveCell.FormulaR1C1 = Round(SquareTubeLengthLegs3)

    .Range("B22").Select
    .ActiveCell.FormulaR1C1 = Carryways

    .Range("F22").Select
    .ActiveCell.FormulaR1C1 = Length1+60

    .Range("B23").Select
    .ActiveCell.FormulaR1C1 = Carryways

    .Range("F23").Select
    .ActiveCell.FormulaR1C1 = Length2-50

    .Range("B24").Select
    .ActiveCell.FormulaR1C1 = Carryways

    .Range("F24").Select
    .ActiveCell.FormulaR1C1 = Round(Length3-134)

    .Range("D25").Select
    .ActiveCell.FormulaR1C1 = SideGuardDescr

    .Range("E25").Select
    .ActiveCell.FormulaR1C1 = SideGuardPartNumber

    .Range("F25").Select
    .ActiveCell.FormulaR1C1 = Length1+20

    .Range("F26").Select
    .ActiveCell.FormulaR1C1 = Length2+35

    .Range("F27").Select
    .ActiveCell.FormulaR1C1 = Round(Length3-254)

    .Range("D28").Select
    .ActiveCell.FormulaR1C1 = MotorCoverDescr

    .Range("E28").Select
    .ActiveCell.FormulaR1C1 = MotorCoverNumber

    .Range("B31").Select
    .ActiveCell.FormulaR1C1 = OrderedBeltLength

End With

'set all of the columns to autofit
''excelApp.Columns.AutoFit
''uncomment if you want to set all columns to autofit
'save the file
excelWorkbook.SaveAs (myXLS_File)

''close the workbook and the Excel Application
''uncomment if you want to close the xls file at the end
excelWorkbook.Close
excelApp.Quit
'excelApp = Nothing
```

LegCrossBeamsQty:

```
Legs1_CrossBeamQty=Round(( Leg1Height - 400 )/700) + 1 ul
Legs2_CrossBeamQty=Round(( Leg2Height - 400 )/700) + 1 ul
Legs1_1CrossBeamQty=Legs1_CrossBeamQty
Legs3_CrossBeamQty=Round(( Leg3Height - 560 )/500) + 1 ul

If Feature.IsActive("Legs1") = True Then
W1_1=Legs1_CrossBeamQty*Legs1_Qty
Else
W1_1=0
End If
W1Qty=W1_1+(Legs2_CrossBeamQty*Legs2_Qty)+Legs1_1CrossBeamQty+Legs3_CrossBeamQty
```

Sideguards:

```
If SideguardHeight=75 Then
SideGuardPartNumber="704-0003-11002"
SideGuardDescr="Side Guard PEHD500 20 x 75"
Else If SideguardHeight=100 Then
SideGuardPartNumber="704-0003-11003"
SideGuardDescr="Side Guard PEHD500 20 x 100"
Else If SideguardHeight=150 Then
SideGuardPartNumber="704-0003-11005"
SideGuardDescr="Side Guard PEHD500 20 x 150"
Else If SideguardHeight=200 Then
SideGuardPartNumber="704-0003-11006"
SideGuardDescr="Side Guard PEHD500 20 x 200"
End If
```

MotorPosition:

```
Select Case MotorPosition
Case "Left_Up"
Feature.IsActive("MotorLV") = True
Feature.IsActive("MotorRV") = False
Feature.IsActive("MotorLH") = False
Feature.IsActive("MotorRH") = False
LV_Deg=180
MotorCoverNumber="018-0017-00060015"
MotorCoverDescr="Mótorhlíf-Lenze GKR3/4-SEW WA20/25"
Case "Left_Down"
Feature.IsActive("MotorLV") = True
Feature.IsActive("MotorRV") = False
Feature.IsActive("MotorLH") = False
Feature.IsActive("MotorRH") = False
LV_Deg=0
MotorCoverNumber="018-0017-00060015"
MotorCoverDescr="Mótorhlíf-Lenze GKR3/4-SEW WA20/25"
Case "Right_Up"
Feature.IsActive("MotorLV") = False
Feature.IsActive("MotorRV") = True
Feature.IsActive("MotorLH") = False
Feature.IsActive("MotorRH") = False
RV_Deg=180
MotorCoverNumber="018-0017-00060015"
MotorCoverDescr="Mótorhlíf-Lenze GKR3/4-SEW WA20/25"
Case "Right_Down"
Feature.IsActive("MotorLV") = False
Feature.IsActive("MotorRV") = True
Feature.IsActive("MotorLH") = False
Feature.IsActive("MotorRH") = False
RV_Deg=0
MotorCoverNumber="018-0017-00060015"
MotorCoverDescr="Mótorhlíf-Lenze GKR3/4-SEW WA20/25"
```

```
Case "Left_Front"
Feature.IsActive("MotorLV") = False
Feature.IsActive("MotorRV") = False
Feature.IsActive("MotorLH") = True
Feature.IsActive("MotorRH") = False
LH_Deg=180
MotorCoverNumber="018-0017-00030001"
MotorCoverDescr="Motorcover f. Lenze Gkr4 1,1 kW"
Case "Left_Back"
Feature.IsActive("MotorLV") = False
Feature.IsActive("MotorRV") = False
Feature.IsActive("MotorLH") = True
Feature.IsActive("MotorRH") = False
LH_Deg=0
MotorCoverNumber="018-0017-00030001"
MotorCoverDescr="Motorcover f. Lenze Gkr4 1,1 kW"
Case "Right_Front"
Feature.IsActive("MotorLV") = False
Feature.IsActive("MotorRV") = False
Feature.IsActive("MotorLH") = False
Feature.IsActive("MotorRH") = True
RH_Deg=180
MotorCoverNumber="018-0017-00030001"
MotorCoverDescr="Motorcover f. Lenze Gkr4 1,1 kW"
Case "Right_Back"
Feature.IsActive("MotorLV") = False
Feature.IsActive("MotorRV") = False
Feature.IsActive("MotorLH") = False
Feature.IsActive("MotorRH") = True
RH_Deg=0
MotorCoverNumber="018-0017-00030001"
MotorCoverDescr="Motorcover f. Lenze Gkr4 1,1 kW"
End Select
```

FactoryDescriptorRule:

```
Factory_Descriptor = ConveyorID
```

iProperties:

```
iProperties.Value("Project", "Part Number")= "con-msgn-" &ConveyorID
iProperties.Value("Project", "Description")= BeltWidth &" " &Angle &"° " &Height1
&"/" &Height2
```

Colors:

```
Feature.Color("Belt")= BeltColor
Feature.Color("Flight1")= BeltColor
Feature.Color("FlightsPattern")= BeltColor

Feature.Color("SideguardsL3")= SideGuardColor
Feature.Color("SideguardsL2")= SideGuardColor
Feature.Color("SideguardsL1")= SideGuardColor
Feature.Color("SideguardCut")= SideGuardColor
Feature.Color("Spacers")= SideGuardColor
Feature.Color("InclHoldDownShoe")= SideGuardColor
Feature.Color("Chamfer1")= SideGuardColor
Feature.Color("Spacers2")= SideGuardColor
Feature.Color("DclSideGuards")= SideGuardColor
Feature.Color("Chamfer2")= SideGuardColor
Feature.Color("Extrusion16")= SideGuardColor
Feature.Color("Mirror7")= SideGuardColor
Feature.Color("Chamfer3")= SideGuardColor
```

PublishDWF:

```
i = MessageBox.Show("Launch the viewer now?", "Title",MessageBoxButtons.YesNo)
If i = vbYes Then : launchviewer = 1 : Else : launchviewer = 0 : End If

path_and_name = "G:\_Drawings\0008 Conveyors\0008-014 Parametric conveyor\0-
Product\0000\con-msgn_" &ConveyorID
DWFAddIn = ThisApplication.ApplicationAddIns.ItemById("{0AC6FD95-2F4D-42CE-8BE0-
8AEA580399E4}")
oDocument = ThisDoc.Document
oContext = ThisApplication.TransientObjects.CreateTranslationContext
oContext.Type = IOMechanismEnum.kFileBrowseIOMechanism
oOptions = ThisApplication.TransientObjects.CreateNameValueMap
oDataMedium = ThisApplication.TransientObjects.CreateDataMedium

If DWFAddIn.HasSaveCopyAsOptions(oDataMedium, oContext, oOptions) Then
oOptions.Value("Launch_Viewer") = launchviewer
oOptions.Value("Publish_All_Component_Props") = 1
oOptions.Value("Publish_All_Physical_Props") = 1
oOptions.Value("Password") = 0
End If

'Set the destination file name
oDataMedium.FileName = path_and_name & ".dwf"

'Publish document.
Call DWFAddIn.SaveCopyAs(oDocument, oContext, oOptions, oDataMedium)
If launchviewer = 1 Then ThisDoc.Launch(path_and_name & ".dwf")
```