Embedding RFID(Radio Frequency Identification) chip into LPMS(Low Pressure Moulding System) with specific design

Bikash Panthi

Degree Thesis
Plastic Technology
2012

DEGREE THESIS	
Arcada	
Degree Programme:	Plastic Technology
Identification number:	10324
Author:	Bikash Panthi
Supervisor (Arcada):	Marko Voho
Commissioned by:	Arcada

ABSTRACT

Low Pressure Moulding System (LPMS) is a type of injection Moulding system which is used mostly used to encapsulate and protect electronic components environmentally such as flash drives circuit boards. The aim of this engineering thesis is to show detailed steps on designing the product, briefly designing the Mould and how to put the RFID chip directly in Moulding process and finally showing the prototype for the Mould. The product design of this thesis is a door sensor key of Arcada, in the Arcada Logo. New design is named as ARC-Key. What makes this product unique from the original is that it contains Arcada Logo, which is good for marketing purpose, it is attractive, it can be attached to key ring, it looks good then the original rectangular shaped, the cost effective, easy to make, no glue needed in production of the product. The most interesting question the author is trying to answer is: the possibility of the embedding RFID chip while manufacturing of the product. The design of Arc-Key and the Mould were made by the designing analysis software Solid Edge ST3 which was prototyped by use of MasterCAM and HAAS milling machine. In conclusion, comparing with traditional method of gluing 2 half for the product, this research shares 2 steps of injecting the polyamide while manufacturing the product, first to inject the molten polyamide to certain level and after that robot puts RFID chip in the space and then again injecting in RFID chip to make the final product.

Keywords:	RFID, Low Pressure Moulding System
Number of pages:	45
Language:	English
Date of acceptance:	25th February 2013

LIST OF FIGURES

LIST OF TABLES

FOREWORD

This thesis work is done for the purpose of research for Arcada door Key. The planning to make key inbuilt RFID chip, designing the Mould and the product. The idea was originated by the logo of Arcada. Then the concept of Key for the door of Arcada which have the logo, attracted to do this thesis and design the Mould for the key and finally putting the RFID chip into the key. The thesis of Ying Liu, 'Using RFID technology to improve the efficiency of a service line' helped and encouraged me a lot to write this thesis.

I'd like to dedicate this Thesis work to my parents, my brother and sister providing much love, support and motivation all the way from Nepal. Completing this thesis has not been an easy task, and I am sure I could not have done it on my own. To all of the people who have taught me, inspired me, motivated me, and supported me on my journey, I offer my sincerest thanks.

I would like to acknowledge my supervisor, Marko Voho for supervising me on a set of challenging and risky topic. I would also like to thank Henry Ericsson for his priceless help during my thesis work.

I am most thankful to the lecturers in Arcada, Erland Nyroth, Mathew Vihtonen, Mariann Holmberg, Badal Durbo, Marko Voho, Micheal Paronen for leading their wisdom during my educational time in Arcada.

I would like to express my gratitude and love to Kosar Mahdi for cheering me up and supporting me all the way from Britain. Arcada was much more fun because of my friends, Mukunda Adhikari, Kumud Sharma, Sushan Shrestha, Pontus Salminen, and other friends.

Helsinki

Bikash Panthi

Table of Contents

1 INTRODUCTION

This thesis presents the design of sensor key for the door of the Arcada University of Applied Sciences having the design of Arcada logo which is named as ARC-Key. The purpose of this study was to seek about the best way to embed RFID (Radio Frequency Identification) in making of door key using LPMS (Low pressure Moulding system) in the specific design. The goal of this thesis is to find the better solution for making Plastic Key with RFID chip using LPMS than conventional Plastic key with RFID chip.

1.1 BACKGROUND

RFID, radio frequency identification, is defined as a way of identifying unique objects using radio waves. This process is assembled with an antenna, reader, computer, and tag or inlay. The computer is linked to a reader and the reader is then connected with an antenna(s) [Alexis Michelle Chalfant, 2007]. The reader sends a signal to the antennas which start to transmit radio waves. The radio waves reach the tag/inlay, which are placed on a product or package, and are returned back to the antennas. The data returned back in that signal, by the tag, is sent through the reader to the computer where information of user can be seen on the screen and get to be verified. Large companies such as Wal-Mart, Tesco, and US Department of Defense are using RFID technology for their supply chains. [Alexis Michelle Chalfant, 2007] The RFID tag can be attached to an object which can be used for tracking and managing inventory, assets, people, etc. For example, it can be attached in cars, computer equipment, books, mobile phones, etc. [Radio-Frequency Identification-Wikipedia, the free encyclopedia, 2012]

Injection Moulding is one of the most common manufacturing processes of plastics products. It was invented in 1872. 32% of the plastics products are made from injection Moulding. [Plastic Injection Moulding- Thermoplastics, Thermosets Machines, Resins and More, 2012] With the help of injection Moulding many products in the society and industrial items have been made cheap and durable. [Plastic Injection Moulding- Thermoplastics, Thermosets Machines, Resins and More, 2012] LPMS was another invention of injection Moulding process. Low pressures Moulding is a single step process to enclose seal and protect electronics. It uses a simple Mould which allows the process to use much less material then normal injection Moulding process. It does not require housing. Logos or Part numbers can be easily integrated into the Mould which makes this process more beneficial. This is a fast processing system

which injects the plastic and produces the desirable product in seconds. In this thesis study, LPMS 1100was used to as a Low pressure Moulding machine. [Low Pressure Moulding, Henkel, 2012]

Research was done by the student of Arcada, Ying Liu in 'Using RFID technology to improve the efficiency of a service line'. In Liu thesis, Liu planned RFID technology to use for the purchasing food in Arcada Cafeteria. Different applications in Arcada and the working system of RFID technology have been introduced in Liu's thesis.

Several researches were done in regarding RFID, injection Moulding and LPMS. Siemens is doing research regarding the RFID chip to be used widely. Mainly research has been done for the packaging Integrating RFID with Plastic Products and Packaging [Integrating RFID with Plastic Products and Packaging, 2006]. Companies in china have been widely using this technology mainly for the coating or covering of USB chips for making USB sticks, and other electronic parts.

This thesis focuses on the concept that could help the manufacturer to save production costs and time for the Key. Conventional production was done by several production processes. First making parts and then glue them together. It is costly. So in this thesis, the author is trying to design the Mould to help the manufacturer to save production costs and production time by using LPMS and RFID technology in a one production process.

In this thesis study, the author will introduce the use of the Mould tooling in Solid Edge software to optimize the Mould design process.

1.2 RESEARCH OBJECTIVES

The research objectives of this thesis were as follows:

- Part design and Mould design for the key which resembles Arcada Logo
- To study if RFID chip is suitable for low pressure Moulding
- How RFID chip can be included to the Moulding process, if automation is needed to move the chip into the Mould, how the part is Moulded having chip inside the Mould.

2 LITERATURE REVIEW:

2.1 INTRODUCTION TO RFID CHIP

Many service industries, purchasing and distribution logistics industry, manufacturing companies and material flow systems have been commonly using Automatic Identification Procedure (Auto-ID) system in recent years. Automatic identification procedures are used to give information regarding people, animals, goods and products particularly in transit [KLAUS FINKENZELLER, 2003]. There are various kinds of Auto-ID systems which are briefly shown in Figure1.

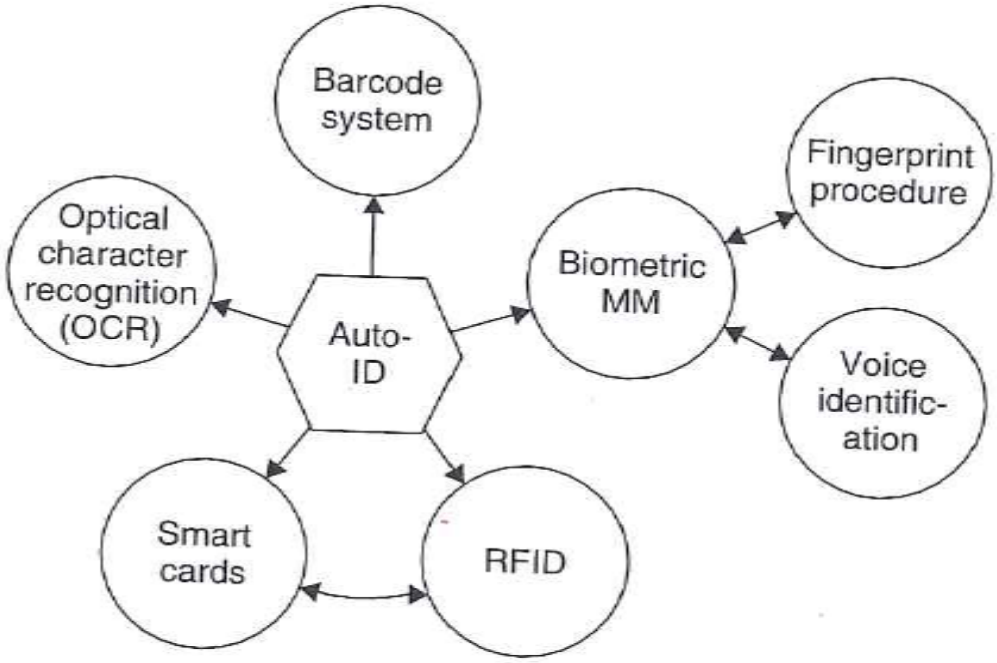

Figure 1: Overview of the most important auto-ID procedures [KLAUS FINKENZELLER, 2003]

RFID, which stands for Radio Frequency Identification, described as an electronic data-carrying device which uses radio frequency to communicate with the server. It is mostly used for automatic identification and tracking. RFID can be used in a variety of applications such as: [Radio-Frequency Identification-Wikipedia, the free encyclopedia, 2012]

Access management

Tracking of goods

Tracking of persons and animals

Toll collection and contactless payment

Machine readable travel documents

Smart dust (for massively distributed sensor networks)

Tracking sports memorabilia to verify authenticity

Airport baggage tracking logistics

RFID have lots of advantages over Barcode system or manual systems. RFID can be read if passed near a reader, even if it not visible or covered by the object whereas bar codes have to be visible to read. It can be read inside cartons, boxes or cases and it can read hundred at a time where as Bar codes can be read only one at a time [Radio-Frequency Identification-Wikipedia, the free encyclopedia, 2012].

Due to the numerous advantages of RFID systems compared with other identification systems, RFID systems are now beginning to take over new mass markets. One example is the use of Arcada door key.

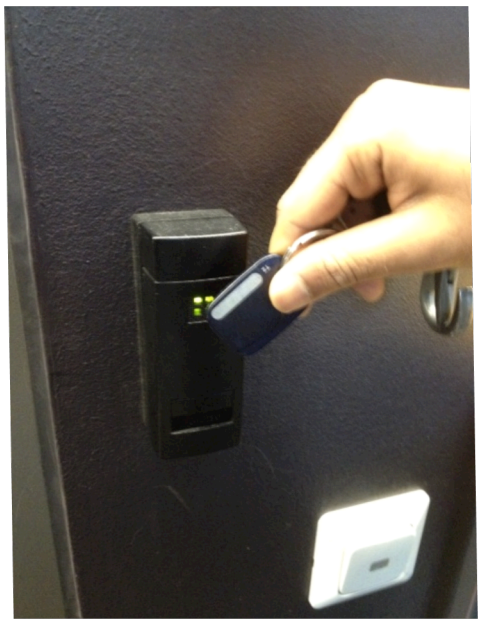

Figure 2: RFID reader and contactless key in practical use [Drawn by Author]

An RFID system is always made up of two components (Figure 3) [RFID Canada- RFID Technology, 2012]:

1. The transponder,
2. The interrogator or reader,

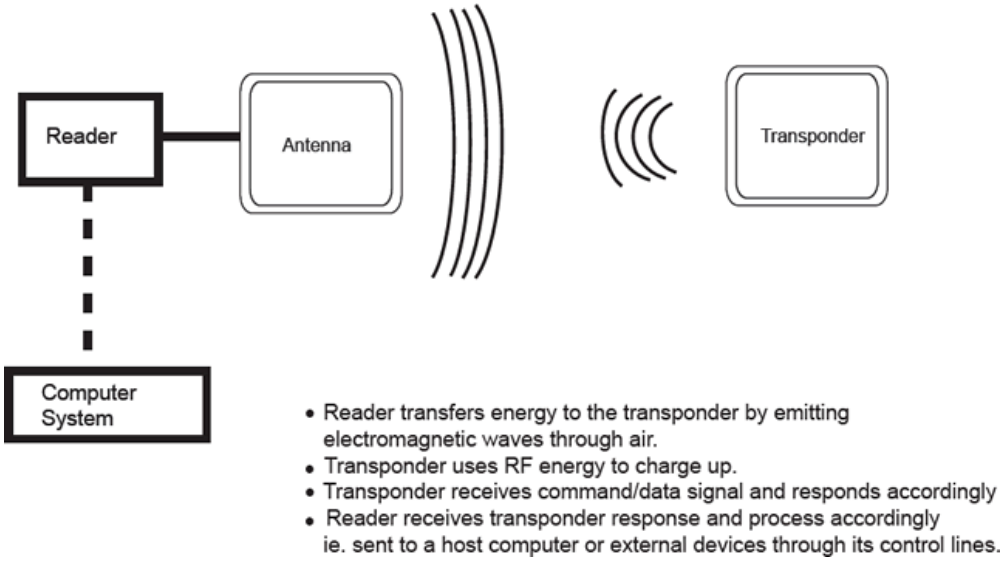

Figure 3: The reader and transponder are the main components of every RFID system [RFID Canada- RFID Technology, 2012]

The main component of this system is the transponder, which is also called as tag or radio tag. The transponder is located on the object which is to be identified. Tag consists of a chip in-built processor, memory and radio transmitter. Normally the memory of the transponder starts from few kilobytes depending on the manufacturer. These transponders communicate through radio frequency to a reader. The readers communicate to main computer via wired or wireless medium. [RFID Canada- RFID Technology, 2012]

The two most popular types of RFID technologies are Active and Passive. Active RFID transponders are self-powered. Active RFID tags have larger memory capacity. Since the power is connected to the tag it can communicate with the longer distance. It is more expensive then passive tags. It have been using in mostly in highway tolls. It is common in Canada's Highways. [RFID Canada- RFID Technology, 2012]

Passive RFID transponder is available with chips. Since they don't have internal power like Active tags, external power have to be supplied to operate the system. The tags therefore powered by an electromagnetic signal, which is transferred from a reader. Then the electro-

magnetic signal is received which will charge the internal capacitor of the transponder and then after supply the power to the reader. The power is required to communicate with the reader. Passive RFID are most common in animal identification, waste management, security and access control, work-in-process, assets tracking and electronic commerce. [RFID Canada-RFID Technology, 2012]

2.1.1 Structure and design of the lock system

The door locking system of Arcada uses passive type RFID. The system is carried out as shown in Figure 3. The lock system contains reader, tags, USB connections and connecting cables as described above in Figure 3. In the system there is also use of stepper motor which is used to open and close door. The steps of the working system are described as (Figure 4) [Gyanendra K Verma and Pawan Tripathi, 2010]:

Step 1: The RFID reader receives the information contains by tag.

Step 2: After it receives the information, the reader the information to the database server for the confirmation, after receiving the tag information, and reader send this information to database for conformation. If it holds, the information stored for further operation.

Step 3: When the information is confirmed the central server conveys the information after receiving queries from the reader.

Step 4: The reader calculate date and time after receiving the reply form server and create a log

Step 5: Once the tag information is confirmed, the system sends the signal to the stepper motor for opening and closing of door.

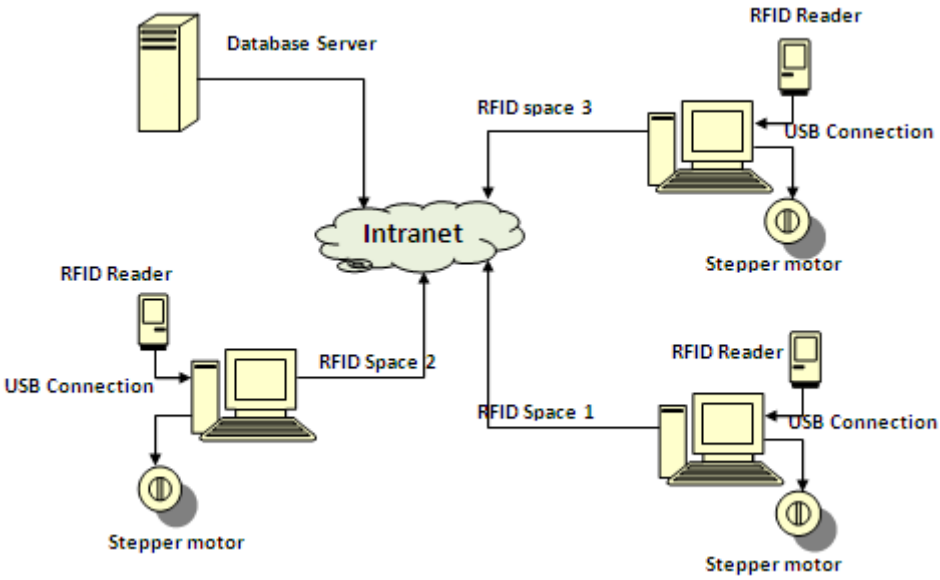

Figure 4: Design of the door lock system [Gyanendra K Verma and Pawan Tripathi, 2010]

2.1.1.1 Working of door lock system

All the necessary information about the user is stored in the system. When a new user is first registered the system asks all the details about the user and the information is then burn to the RFID tag. When a user comes to the entry point and put the tag to the reader, the system checks whether the user is registered or not [Gyanendra K Verma and Pawan Tripathi, 2010]. If the user is not registered then the door does not open. If he/she is the registered user then the information will match to the user's information on the system and the door will open and closes automatically after specific time interval. When the user opens the door or the system stores the check-in info with date and time which is really important for the security system [Gyanendra K Verma and Pawan Tripathi, 2010]. It also set the record of how many times a user have checked in. A flow chart of the key detection and how it works has shown below in Figure 5.

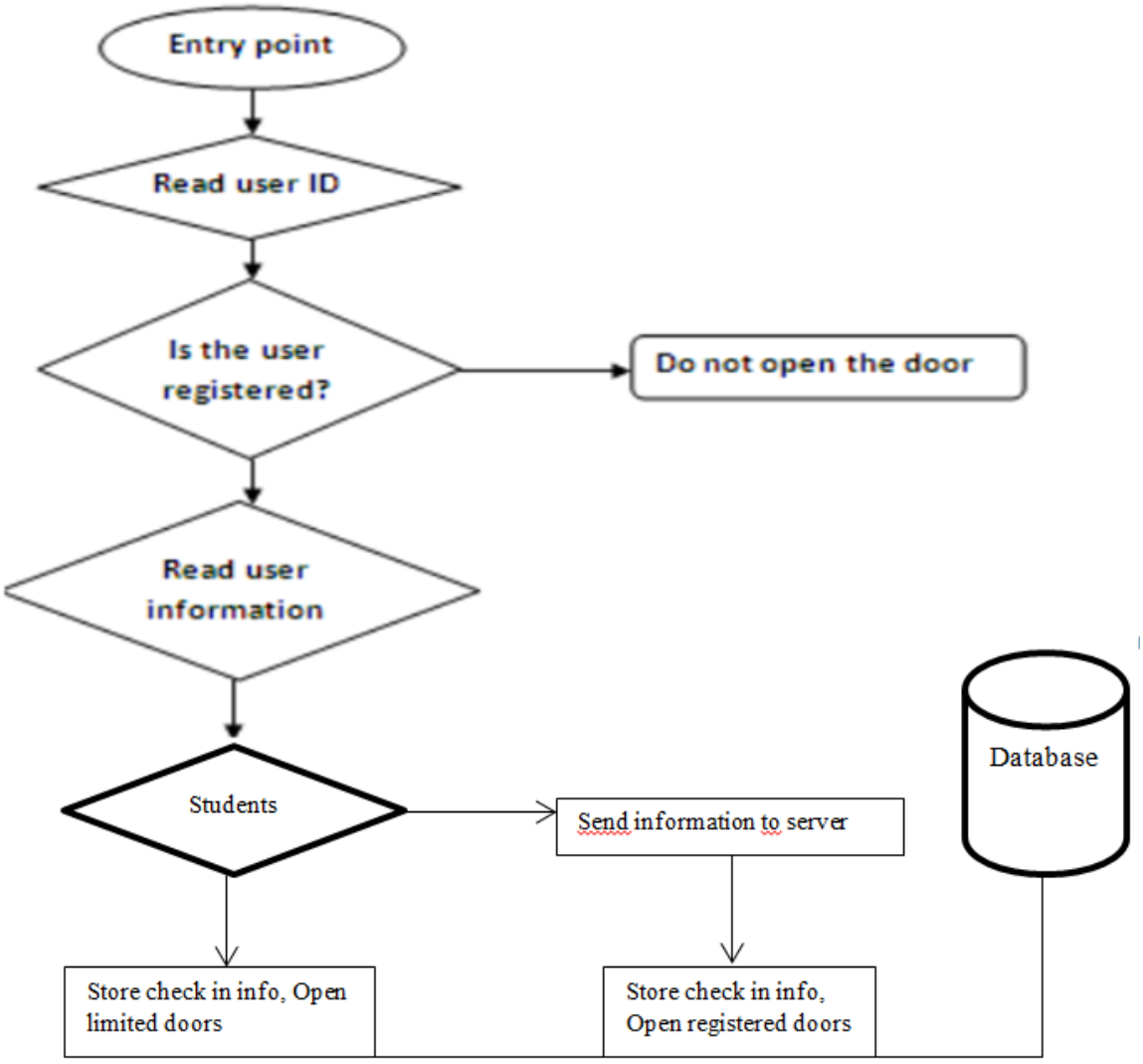

Figure 5: Key detection system [Gyanendra K Verma and Pawan Tripathi, 2010]

2.2 INJECTION MOULD

In the recent years, Injection Moulding is the most common process for manufacturing plastic products. Injection Moulding system has the capacity of making complex geometries in one production step. Due to the production of variety of the product, from small parts to the large products, from combs and DVD casing to complex engineering products like automotive dashboard and hardware parts of an aircraft, the injection Moulding machine have been widely used. Almost in every field the products of injection Moulding is used such as logistics, con-

struction, automotive, household appliances and many more. [Gerd pötsch, Walter michaeli,1995] There are different types of injection Moulding depending on the products.

2.2.1 Low Pressure Moulding System

Low Pressure Moulding System (LPMS) is the type of injection Moulding system. Low pressure Moulding is developed by Siebolt Hettinga [Hans-Peter Heim, H. Potente, 2001]. In Europe Henkel Corporation develop the first machine in 1970s [Low Pressure Moulding- Wikipedia, the free encyclopedia, 2012]. LPMS (LPMS1100) is the injection Moulding system at very low pressure and with hot melt adhesives. [Macromelt Low Pressure Moulding Materials for electronic components, Krayden, Inc, 2012]. It provides significant opportunities for productivity enhancement and cost reduction which is use mostly for electronic components. It can be used to produce cellular structures, thin walled parts, or to in-Mould film and textiles. In automotive, Electronics and thermosets industries this system is mostly popular [Macromelt Low Pressure Moulding Materials for electronic components, Krayden, Inc, 2012].

Figure 6: Lists of products of Low Pressure Moulding System [Macromelt Low Pressure Moulding Materials for electronic components, Krayden, Inc, 2012]

Some benefits of Low Pressure Moulding process are: complete sealing which helps environmental protection from moisture, and vibration, low cost, delicate assemblies can be processed no secondary curing, environmentally friendly [Low Pressure Moulding, Largest of Low pressure Moulding LPMS, 2012], easy to encapsulate, short (15-45) seconds cycle time to complete part and easy for low viscosity materials which can be done with low pressure of 20 to 500 psi. [Low Pressure Moulding, HENKEL, 2012]

Figure 7: Low pressure Moulding machine (LPMS 1100) [Low Pressure Moulding, Largest of Low pressure Moulding LPMS, 2012]

The main goal of using this technique is to fill the cavity at low cavity pressure and with low internal stress. When using low pressure injection moulding techniques the holding pressure needed for injection Moulding to balance volume shrinkage can basically be eliminated and the pressure necessary for compensation of volume contraction while cooling is accomplished by the means of gas. [V. Goodship, J. C. Love, 2002]

2.2.1.1 Process

Due to the low viscosity polyamide material can be used as hot melt adhesives in this system. Polyamide material is melted (typically at 410°F/210°C). Single screw extruder melts the polyamide. The screw pushes the melted plastics to be injected at very low pressure, typically 50 to 200 psi (3.5 to 14 bars) into a relative cold Mould-set (65°F/18°C). [Low Pressure Moulding- Wikipedia, the free encyclopedia, 2012] When the electronics is inserted (manually or automatically by robot) the low viscosity melted polyamide flows slowly into the cavity of the Mould and around the electronics to be encapsulated. Since the Mould is cold, slowly the melted plastic starts to cool down. A Mould cavity is filled in few seconds. As polyamide starts to cool down, it also starts to shrink so continuous injection pressure should be applied in cavity. When the inserted electronic component is fully encapsulated, full clamping force may be applied to the two Mould halves to compensate for shrinkage and achieve the desired dimensions while the Mould is cooled. [David Kazmer, 2007] Since the polyamide molten is not too hot for the electronics so there is no chance of burning the electronics. [Low Pressure Moulding- Wikipedia, the free encyclopedia, 2012] The process as described can be formatted as figure 8:

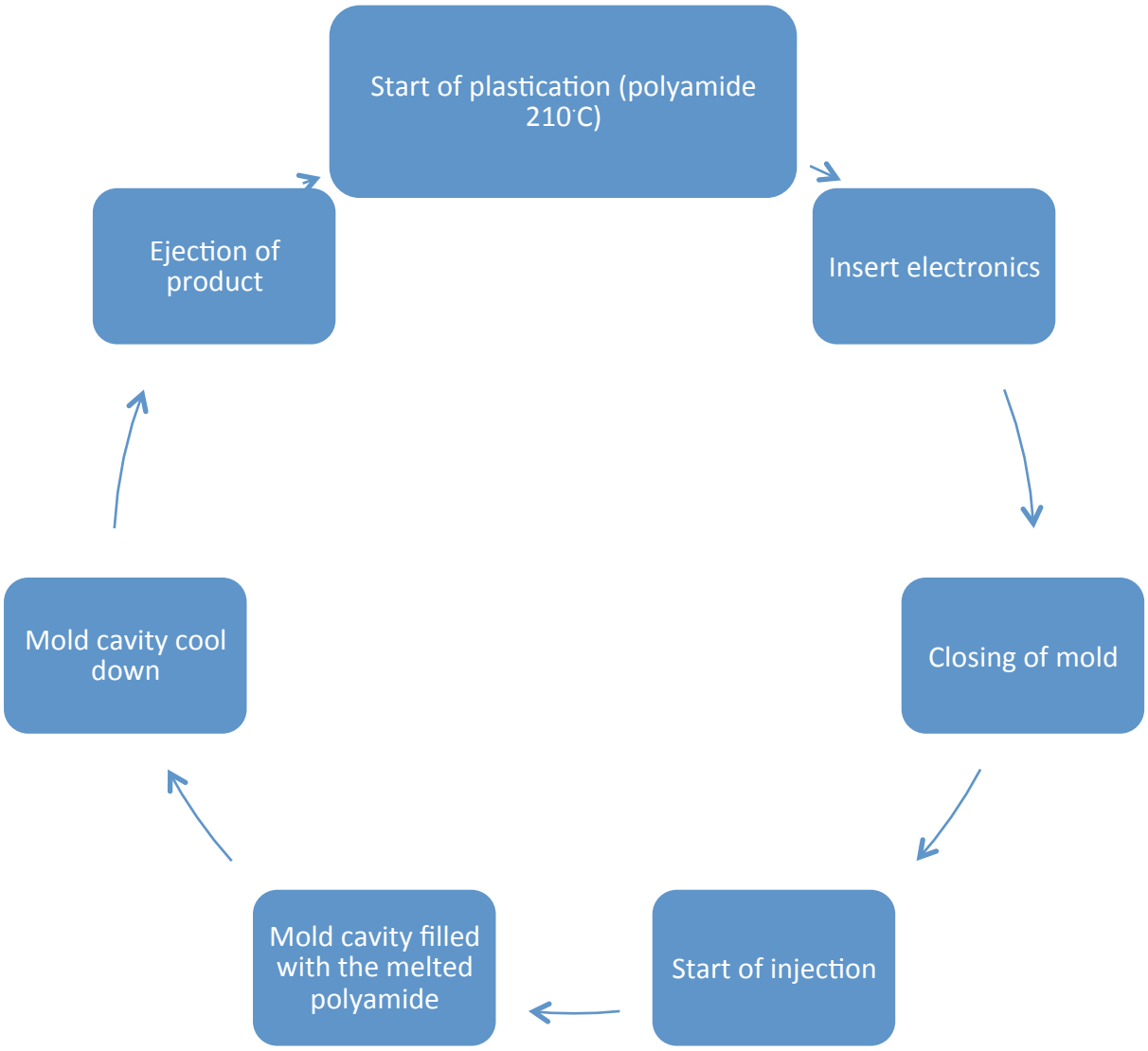

Figure 8: Traditional Low pressure injection Moulding process flow [Drawn by Author]

2.3 SOLID EDGE OVERVIEW

Solid Edge is a 2D/3D computer-aided design (CAD) system for mechanical assembly, part modeling accelerated design and drawing production. [Unigraphics Solution Inc. 2001 pg. 2] Solid Edge was developed with STREAM technology in 1995 by Siemens PLM Software. It is mostly used for assembly modeling, making superior part, drafting, transparent data management and finite element analysis. [Solid Edge: Siemens PLM Software, 2012]

2.3.1 Modeling a part

The first process of design is drawing profiles. When a profile based feature command is selected, the smart step guides to select a plane to draw the profile on, then creates a window oriented to the profile plane so that the 2-D geometry easily be drawn. Drawing tool in Solid Edge makes the process of drawing profiles fast and accurate. [Unigraphics Solution Inc. 2001 pg.60] Then the next step is for any type of design is construction normal protrusions and cutouts. When constructing parts, protrusions and cutouts using regular protrusion and cutout commands can be constructed according to the dimensions. [Unigraphics Solution Inc. 2001 pg, 55]

Treatment features are created by applying face or edge treatments, such as drafts, rounds and chamfers to the part. [Unigraphics Solution Inc. 2001 pg, 74]. A draft features tilts existing parts face to a specified angle relative to a reference plane. A round feature applies a constant or variable radius to one or more part edges. Replacing a model' sharp edges with smooth rounded surface to improve its appearance or function can be easily done with this command. Rounding is edge-based, which means it applies in round edges [Unigraphics Solution Inc. 2001 pg, 75]. A chamfer feature applies a setback relative to a selected part edge. Using Chamfer command the setback with an angle and a setback distance or with two setback values can be defined. Chamfer creates a planner face between two faces along their common edge. [Unigraphics Solution Inc. 2001 pg, 90]

Design modification is done widely in Solid Edge. Drawings and modifications tools work together smoothly, so that sketches can be modified easily. Changing the size, position orientation of an element with the mouse pointer is done in drawing toolbar. [Unigraphics Solution Inc. 2001 pg, 190]

Relationships can also be applied in Solid Edge. it can be applied when drawing or after completion of drawing. By selecting relationship command from Relationships or Drawing toolbar relationship can be set. When a relationship between elements is applied, the elements are modified to reflect the relationship [Unigraphics Solution Inc. 2001]. For example, in figure 9, if a line and arc are not tangent (A), applying relationship modifies one or both elements to make them tangent (B).

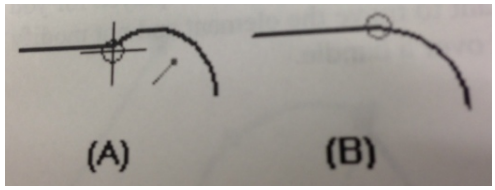

Figure 9: Example of relationship between tangent and straight line [Drawn by Author]

Whether sketching techniques is big or small, relationships make it possible to sketch and evolve, rather than draw every element to its exact measurements. Solid Edge modifications tools like Trimming, Extending, Filleting, Offsetting and Stretching are allowed to change sketch and still maintain applied relationships. [Unigraphics Solution Inc. 2001 pg, 193]

3 METHOD

In this chapter, the method to design a product, Arc-Key (as shown as figure 10) using Solid Edge ST3 will be discussed, continuing with the Mould design for the product. Furthermore, embedding RFID chip in the product with the specific design of the Mould. And finally showing the rapid prototyping of the product using Master CAM.

Figure 10: Arcada logo door key 3D design [Drawn by Author in Solid Edge]

3.1 PRODUCT DESIGN

Product design introduce the ordered feature-based modeling techniques in Solid Edge, such as, Drawing and dimensioning profiles, Using geometric relationships, Constructing and editing features, Ensuring model symmetry and stability. The following figure 11 shows the product design which are universally accepted of dimension (51, 08 mm * 52, 26 mm) with a thickness of 2, 3 mm.

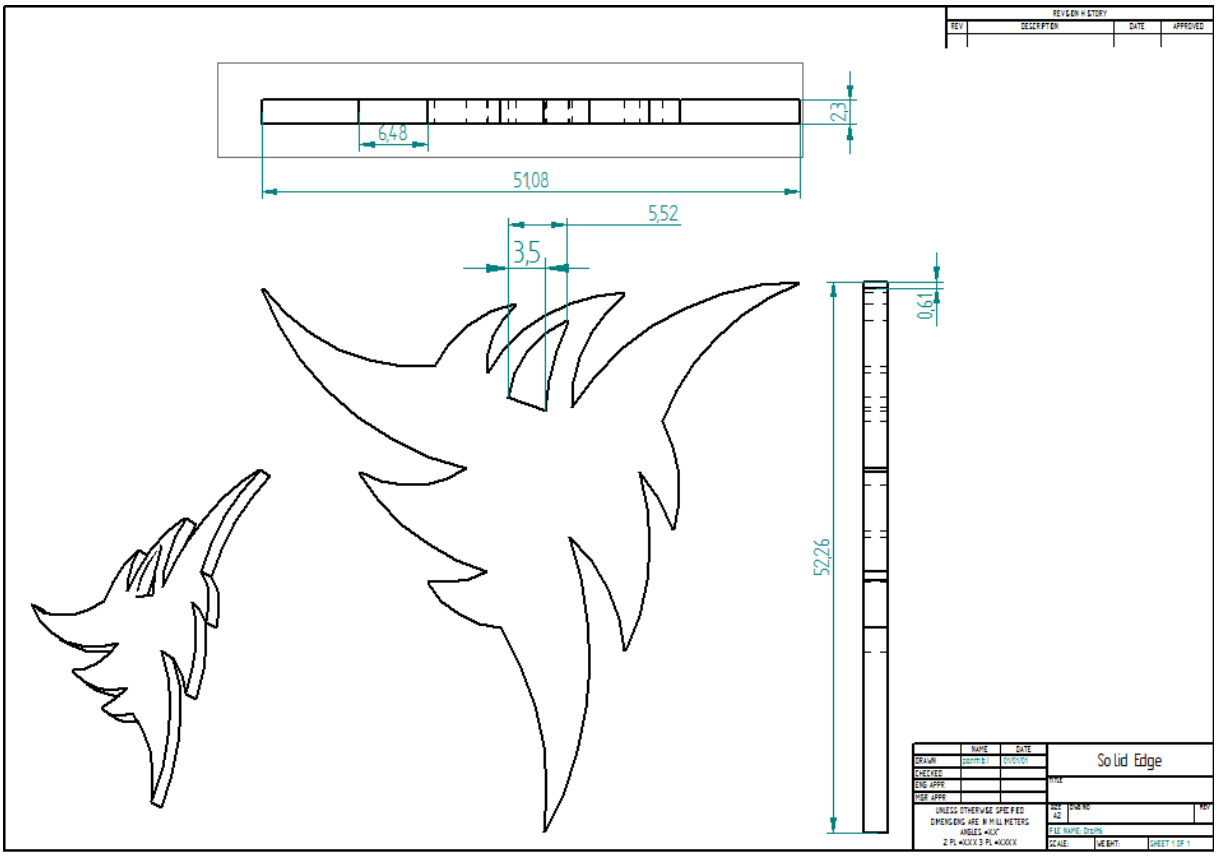

Figure 11: 2D drawings of the Arc-Key [Drawn by Author in Solid Edge]

3.2 MOULD DESIGN

In this chapter, the author briefs on double cavity Mould, how to apply assembly relations between the parts, use of Pathfinder to manage parts on the assembly, how to embed RFID chip in the production process and a short explanation on Sprue for the Mould.

3.2.1 Creating double cavity Mould

Since it is double cavity Mould, there are 2 cavity i.e. injection and ejection part of the cavity Mould. So the first step is to design the injection side cavity Mould. The dimensions of the Mould plate referred from were HASCO (Hasenclever GmbH + Co KG, 2010, Standards K Catalogue) as shown in figure 12,

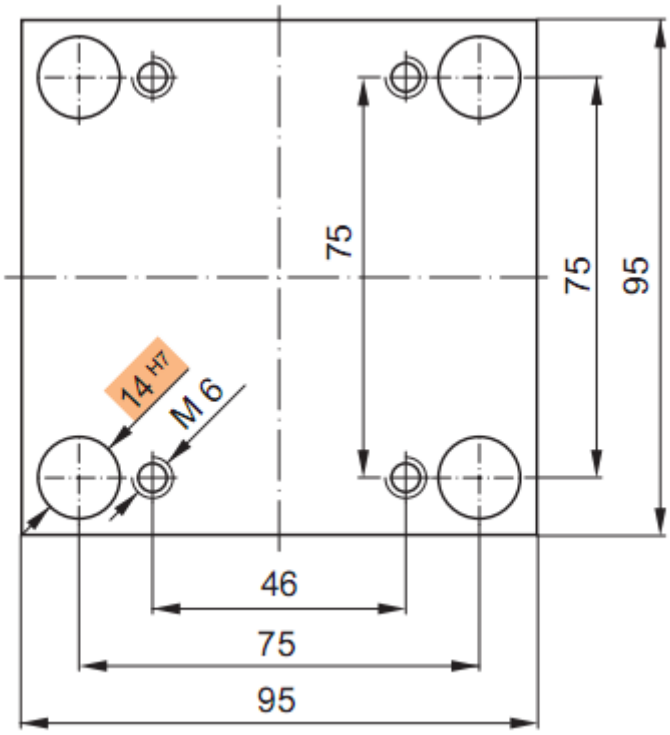

*Figure 12: Dimensions of the Mould Plate 95*95*36 [HASCO Hasenclever GmbH + Co KG, 2010, Standards K Catalogue]*

So on the basis of the figure 12 shown above the Mould plate for injection side was designed, which is the one half of the cavity. Part file was booleaned in the Mould plate and figure 13 was obtained. As seen in figure 13 there is a hole in the middle, the hole was made for the sprue to inject the plastic inside the cavity. The detail information about the sprue is given below in figure.

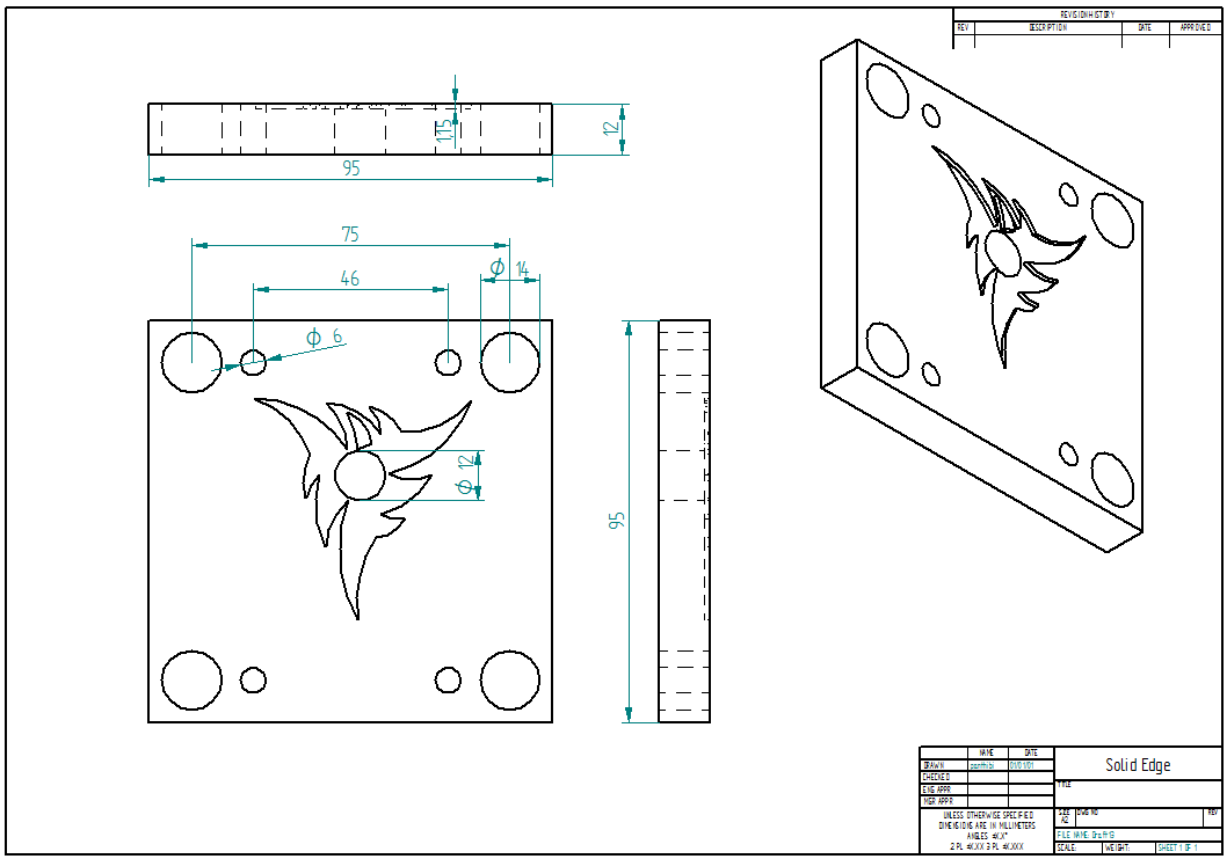

Figure 13: Technical 2D drawing of double cavity Mould (Injection part) [Drawn by Author in Solid Edge]

3.2.1.1 Sprue

Z512/12*27/2.5 sprue is used to design the Mould for this product. The sprue has the diameter of 12mm. The Sprue was designed based on the [HASCO Hasenclever GmbH + Co KG, 2010, Sprue Bushing Z512] as shown in figure 14. The Sprue is to have a 0.5^{o} taper angle with the start diameter of 2.5mm. The requirement of the Sprue bushing is shown on table 1.

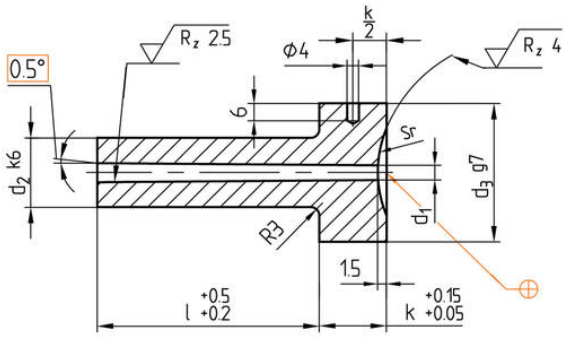

Figure 14: Sprue bushing design [HASCO Hasenclever GmbH + Co KG, 2010, Sprue Bushing Z512]

Order No.	d2 [mm]	l[mm]	d1[mm]	Sr[mm]	k[mm]	d3[mm]	Material No.
Z512/12x27/2,5	12	27	2,5	-	13	28	92959

Table 1: Sprue bushing dimension details [HASCO Hasenclever GmbH + Co KG, 2010, Sprue Bushing Z512]

The second step is to design second half of the cavity. Design process is done in the same way as the first part, which is injection part. The second half is the ejection part as figure 15, where 3 holes were made in the product for ejection pin. The ejection pins push the product after the product is ready.

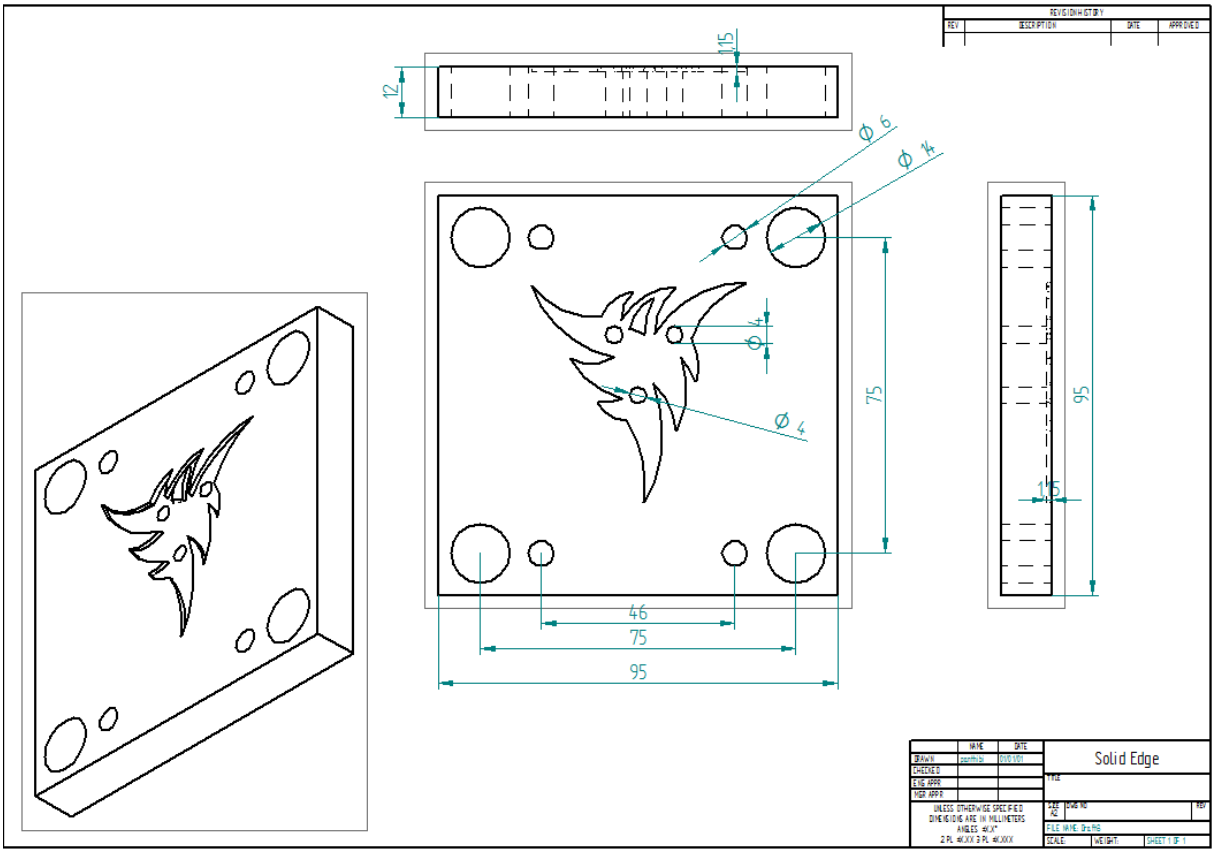

Figure 15: Ejection part of double cavity Mould with ejection hole with dimensions [Drawn by Author in Solid Edge]

3.2.2 Completion of the Mould

Back plate for cavities, Ejector and retaining plate, guiding pillars, spacer blocks, cavity plates, Sprue and Ejector pins completes the Mould. The complete Mould has a property of steel which is shown in figure below. The design is made so that the back plate for the Mould is moveable which have the dimension (95 mm* 95 mm) and thickness 22 mm. The ejector covet plate is made to provide backup for the ejector- retaining plate. Spacer block provides the support for the cavity plate and provides the distance to move ejector-retaining plate. Back plate, injection side which is known as clamping plate, is necessary to secure the stationary side of the Mould.

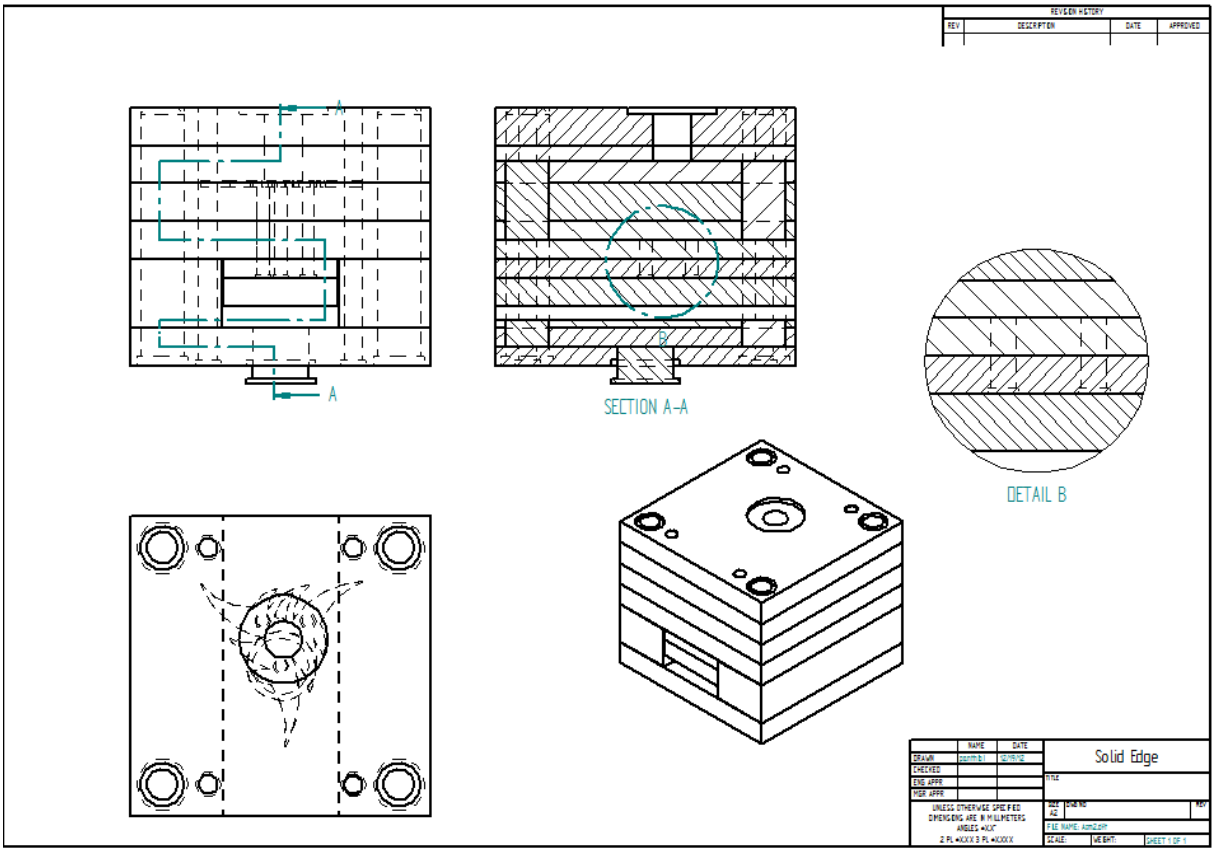

Figure 16: Section view of Mould [Drawn by Author in Solid Edge]

Figure 16 shows the section view in which the complete design is shown in 2D drawings. Section drawing clears the multi-view drawing from different angles. The section view below shows clearly every parts of the Mould which are shown in table 2.

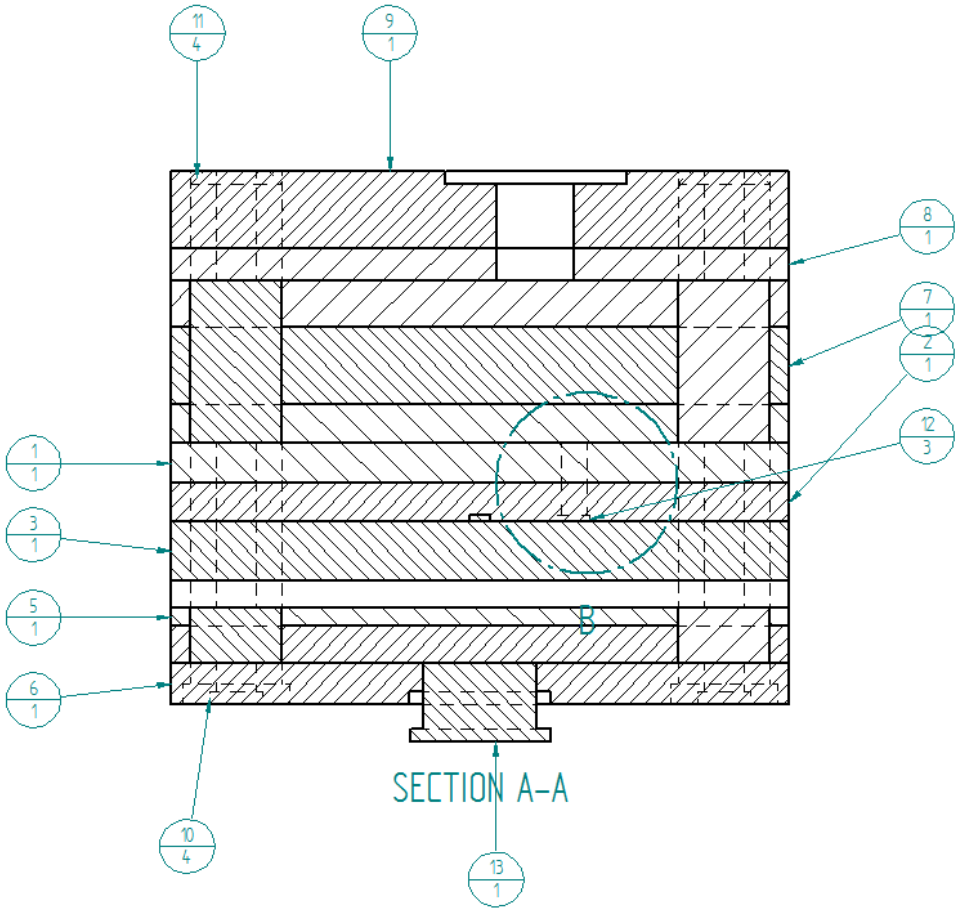

Figure 17: Detailed list of the Mould [Drawn by Author in Solid Edge]

Item no.	Title	Material
1	Back part for cavity injection side (95mm * 95mm *22mm)	Steel
2	Ejector Plate (95mm*36mm)	Steel
3	Retaining plate (95mm *36mm)	Steel
4	Spacer Block (95mm*28mm)	Steel
5	Spacer Block (95mm*28mm)	Steel
6	Support Plate ejection side (95mm*95mm)	Steel
7	Cavity (95mm *95mm)	Steel
8	Cavity (95mm *95mm)	Steel
9	Back part of Core (95mm *95mm)	Steel
10	Guiding pillars (Ø 14mm)	Steel
11	Guiding Pillar (Ø 6mm)	Steel
12	Ejector Pin (Ø 5mm)	Steel
13	Ejector Pin for ejection (Ø 18.5mm)	Steel

Table 2 : Table showing different part list shown in figure 17 [Drawn by Author]

3.2.3 Embedding RFID chip into the part

After the formation of Mould, the following steps was planned to show the process of embedding the RFID chip into the product:

- The design of the Mould was shown above
- After the design, the sprue for the injection of plastic was used of a diameter 12 mm as referenced to HASCO
- 2 steps injection is used in this method
- First step is to inject the molten polyamide into the Mould as shown in figure 18

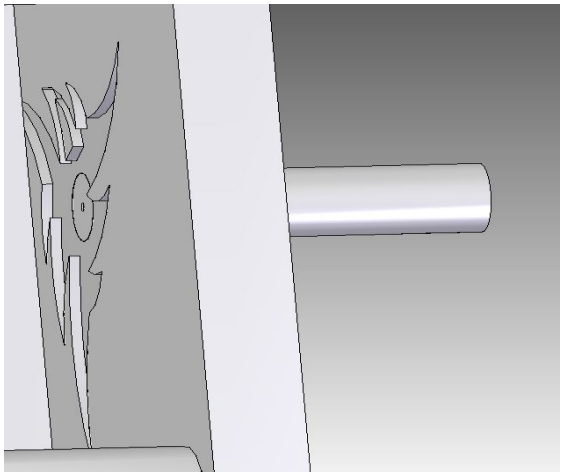

Figure 18: Sprue attached to the injection Mould (inside view) [Drawn by Author in Solid Edge]

- When the Mould closes, the sprue inters into the Mould as shown in figure 19 to inject the plastic, the sprue moves such that it inters inside the Mould 1,65mm then it inject the plastics all over the Mould

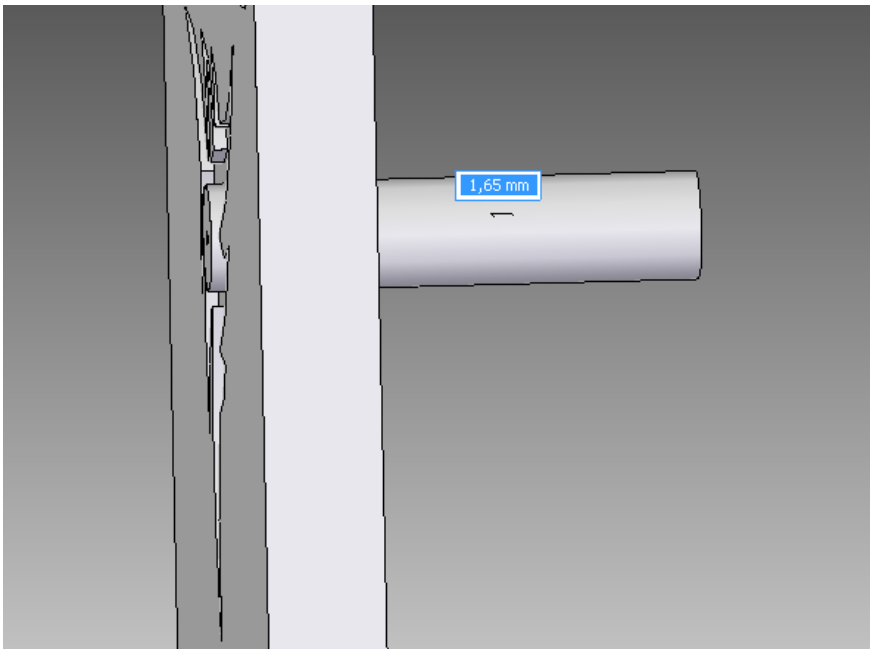

Figure 19: Moving of sprue to 1,6mm [Drawn by Author in Solid Edge]

- Making a hole in a product of 12mm and depth of 1.65mm the Sprue comes in its position as in figure 19

- The Dimensions of RFID Chip as shown

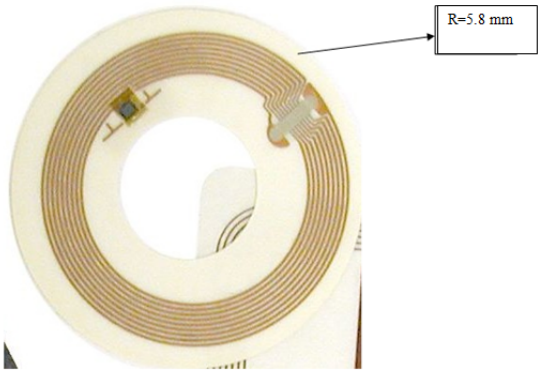

Figure 20: RFID chip with dimensions made in thin plastic (radius 5.8mm thickness 1.2mm)

- The robot was planned to be placed for moving the RFID chip into the Mould
- After that, the robot takes the RFID chip and place in the hole of 12mm*1.65mm, since RFID chip have diameter of 11.6mm it fits into the hole
- When RFID chip is fixed, again the Mould closes and the sprue inject molten Polyamide into the Mould from its original position as shown in figure 21
- After this process the product is ready, when it gets cooled the ejection pin ejects out the product

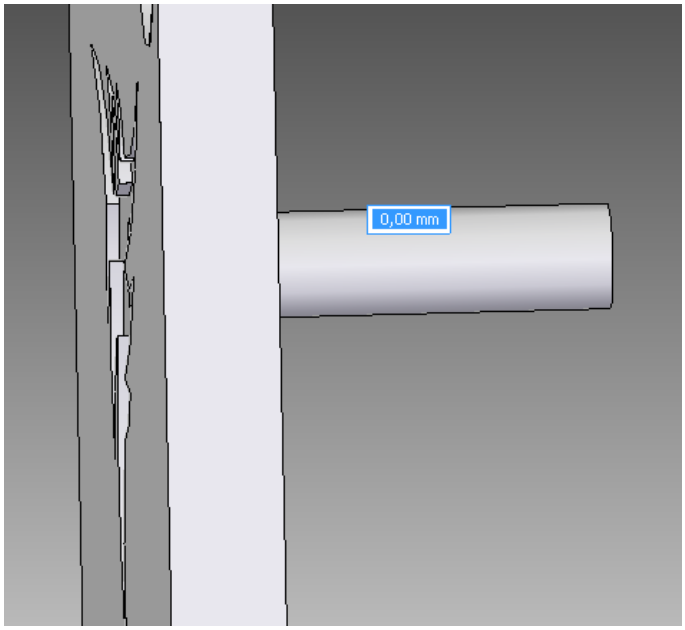

Figure 21: Sprue to the original position (left view)

3.3 PROTOTYPYING OF MOULD

Prototyping is the method of manufacturing the early sample or model to analyze the final product. Prototype is a practical way of showing how the cavity of the product will fit to the Mould plate. Comparing with Aluminum or other metals Ply wood is a soft material and can be find in Arcada Lab, Plywood will be used for making the prototype. Machining with the Plywood has no risk of breaking the tool and can be done with higher feed rate which reduces the time as of Aluminum. For manufacturing of the prototype, HAAS milling machine will be used to mill the Mould plate. MasterCAM is well known software which is used for manufacturing and milling of the parts. HAAS milling machine uses G-Code which can be import from MasterCAM. During the milling Process in MasterCAM, first step will be importing the design from Solid Edge in the extension file of STP/STEP. After importing the design, the pocket tool path will be used to mill the Mould plate. Based on Arcada Plastic Laboratory [Nyroth, E. 2010], list of installed tools for the HAAS 4.00mm Flat end mill and 1mm Spherical End Mill needs is used. The tool path is shown in figure 22 below.

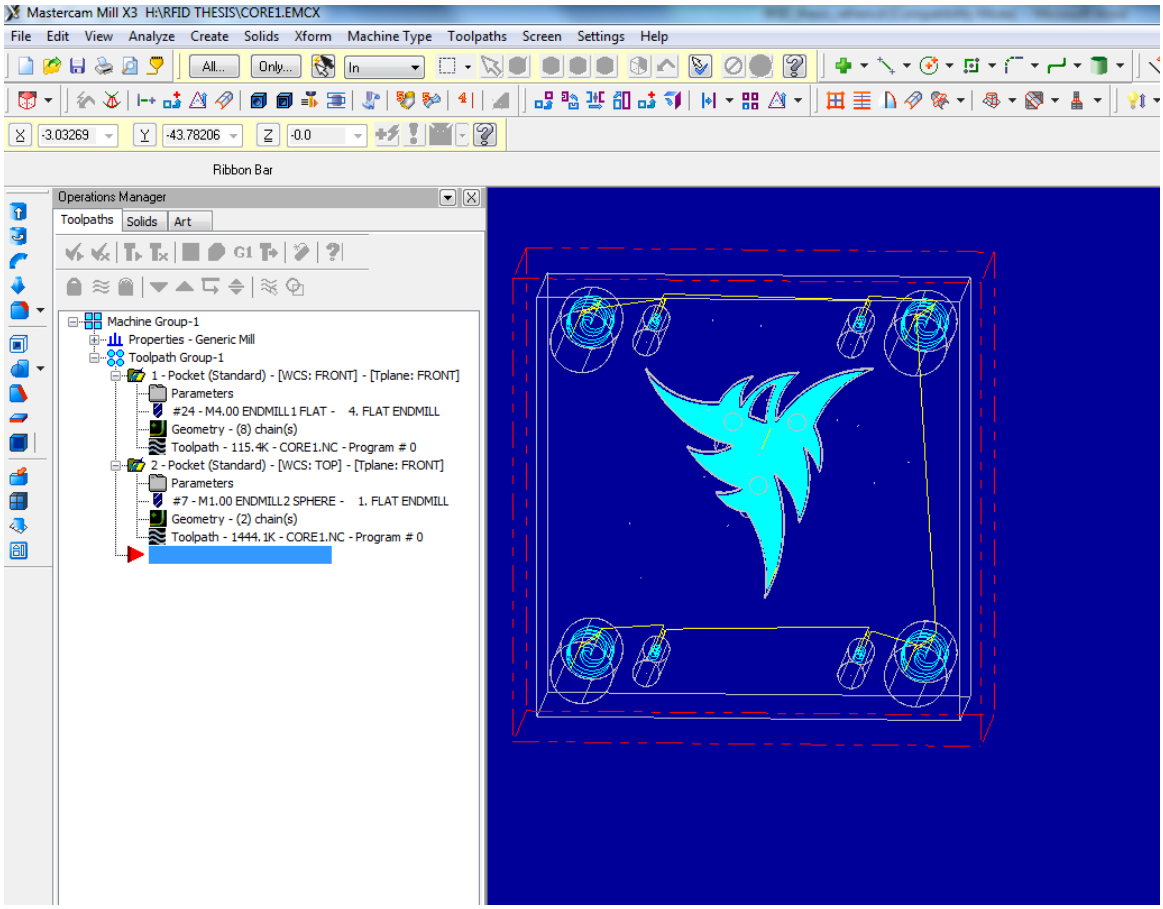

Figure 22: MasterCAM tool path of Arc-Key [Drawn by Author in MasterCAM]

4mm Flat End mill is used to make the holes in the corner for holding guiding pillars. Guiding pillars are used for lock mechanism of the Mould plate. 1 mm spherical mill is needed to mill the cavity part of the Mould. Since there is the need of smooth corners and can easily fit in key chain, 1mm milling tool is used. The tool parameters and setting the speed while machining is shown in figure below. Since it is a plywood material feed rate can be 400 spindle speeds can be 2500, plunge rate to be 300 and retract rate to be 100. With this setting, it takes about 52 minutes to mill the plywood material to form the Mould which is quiet fast way to form a Mould prototype.

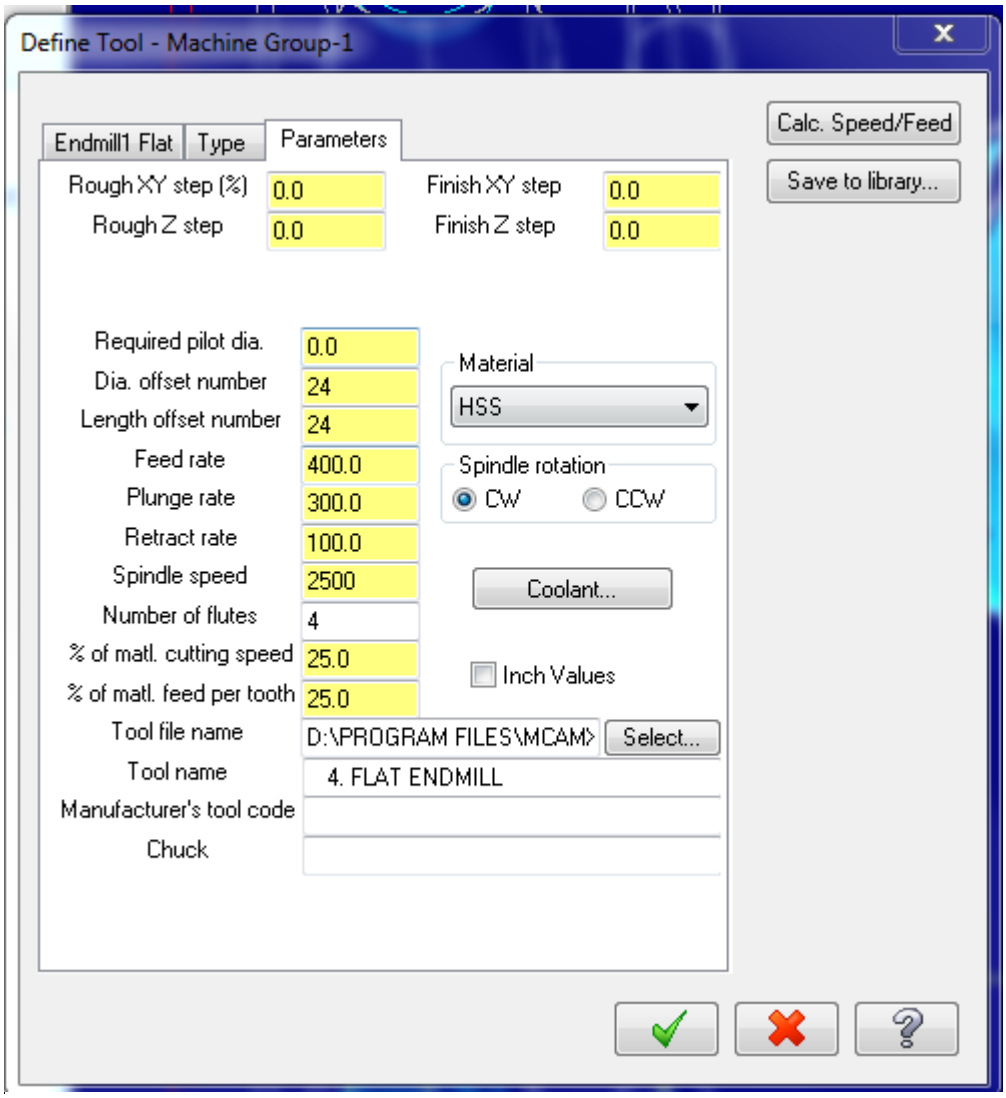

Figure 23: Tool speed settings [MasterCAM]

After defining the tool and regenerating the tool path, verification is done in the MasterCAM for a cavity design. The figure 35 shows the verification of too path in MasterCAM and shows how a cavity fits in a Mould plate 95*95*36mm.

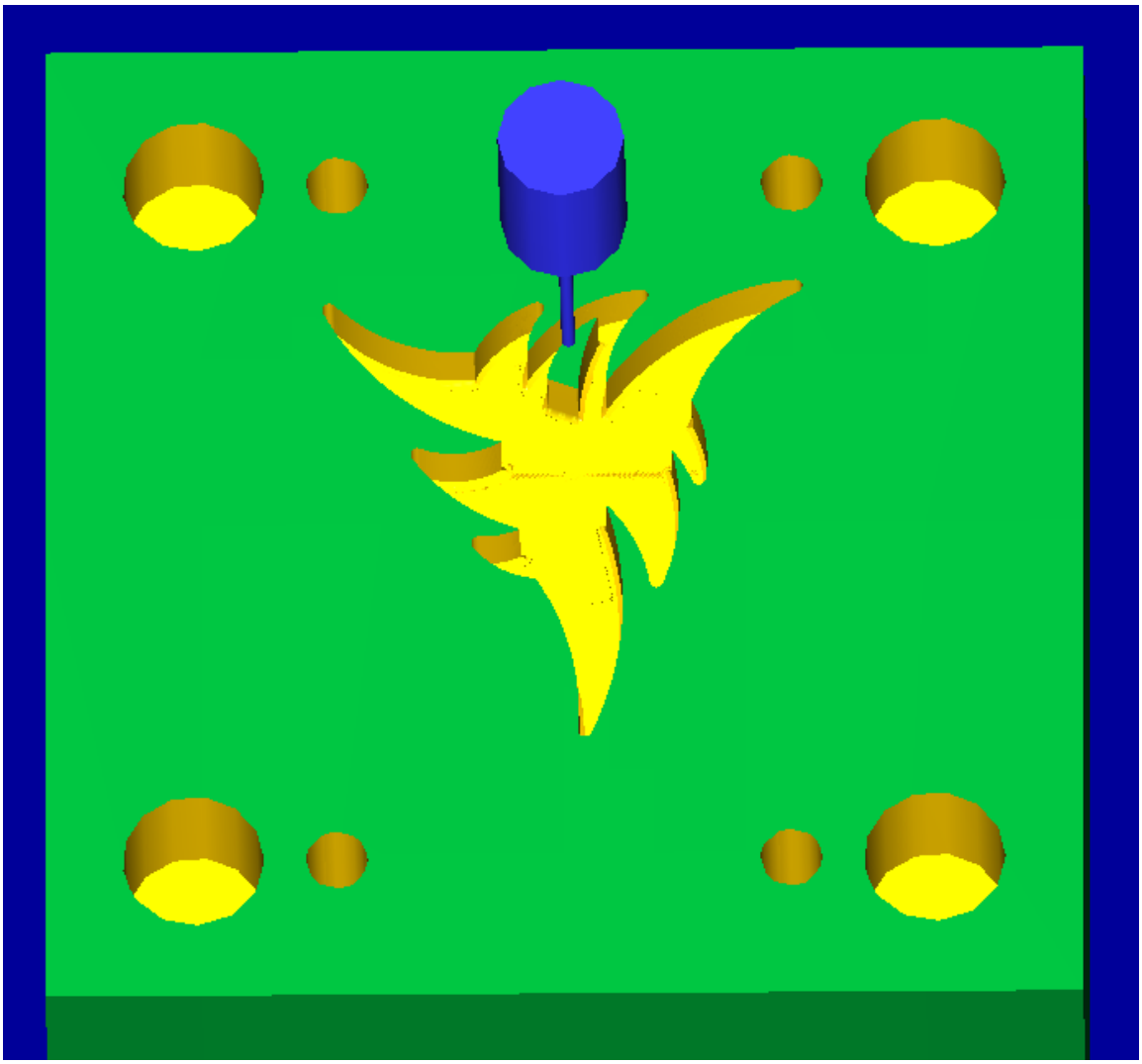

Figure 24: MasterCAM tool verification (Top View)

4 STUDY RESULTS

Here the product was designed with the inbuilt RFID chip. As discussed in chapter 3 above, the product was designed so that RFID chip can be directly placed while injecting the plastic in the Mould. The cycle time for making the product was about 30-75 seconds. The final product is shown in figure 25.

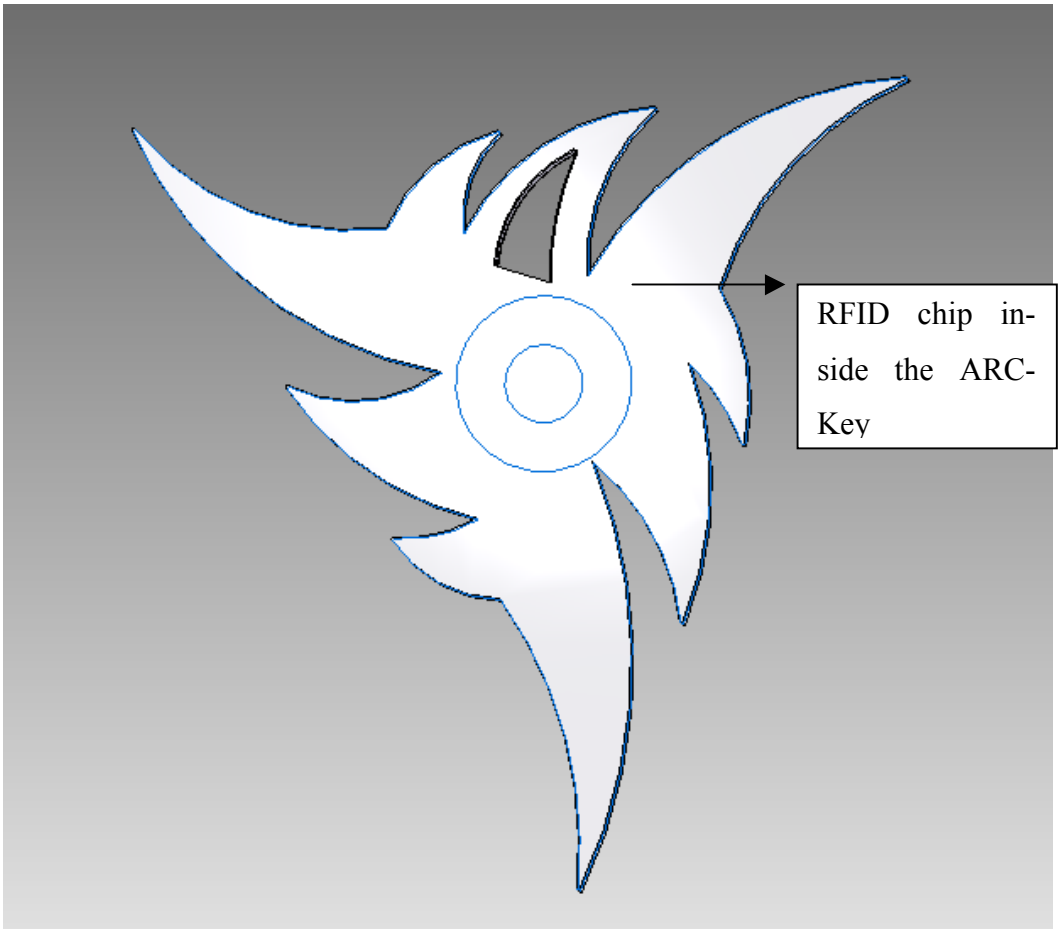

Figure 25: The Complete final product design (ARC-Key) with RFID inbuilt [Drawn by Author in Solid Edge]

The Mould design was also the key part of this thesis. As discussed in method the Mould was designed and described shortly how it works. The following figure 26 shows the exploded design of Mould for ARC-Key. The rapid prototype of the Mould after machining in HAAS milling machine was done. It is made with the plywood material Mould plate and has the thickness of 36 mm.

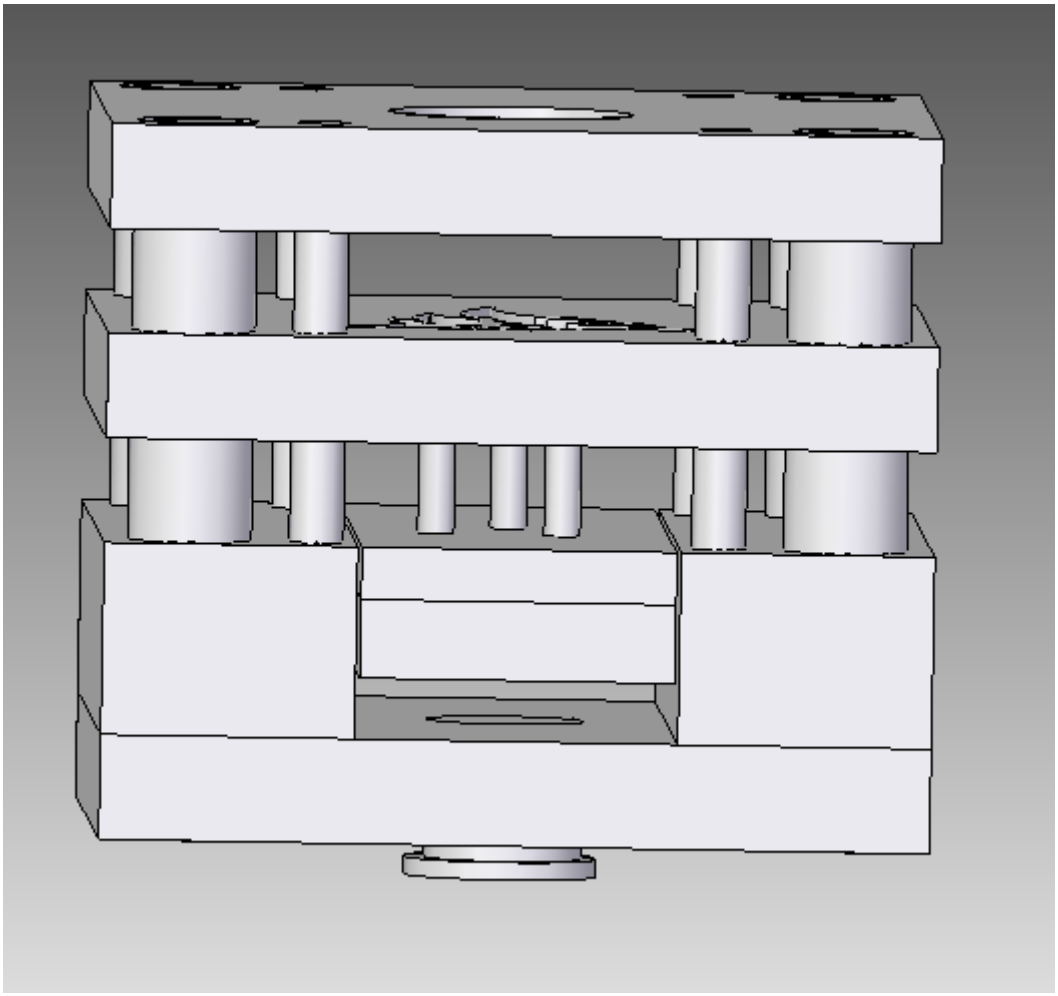

Figure 26: Exploded Mould design for ARC- Key [Drawn by Author in Solid Edge]

Below figure shows the steps of the production process for the product as discussed in chapter 3:

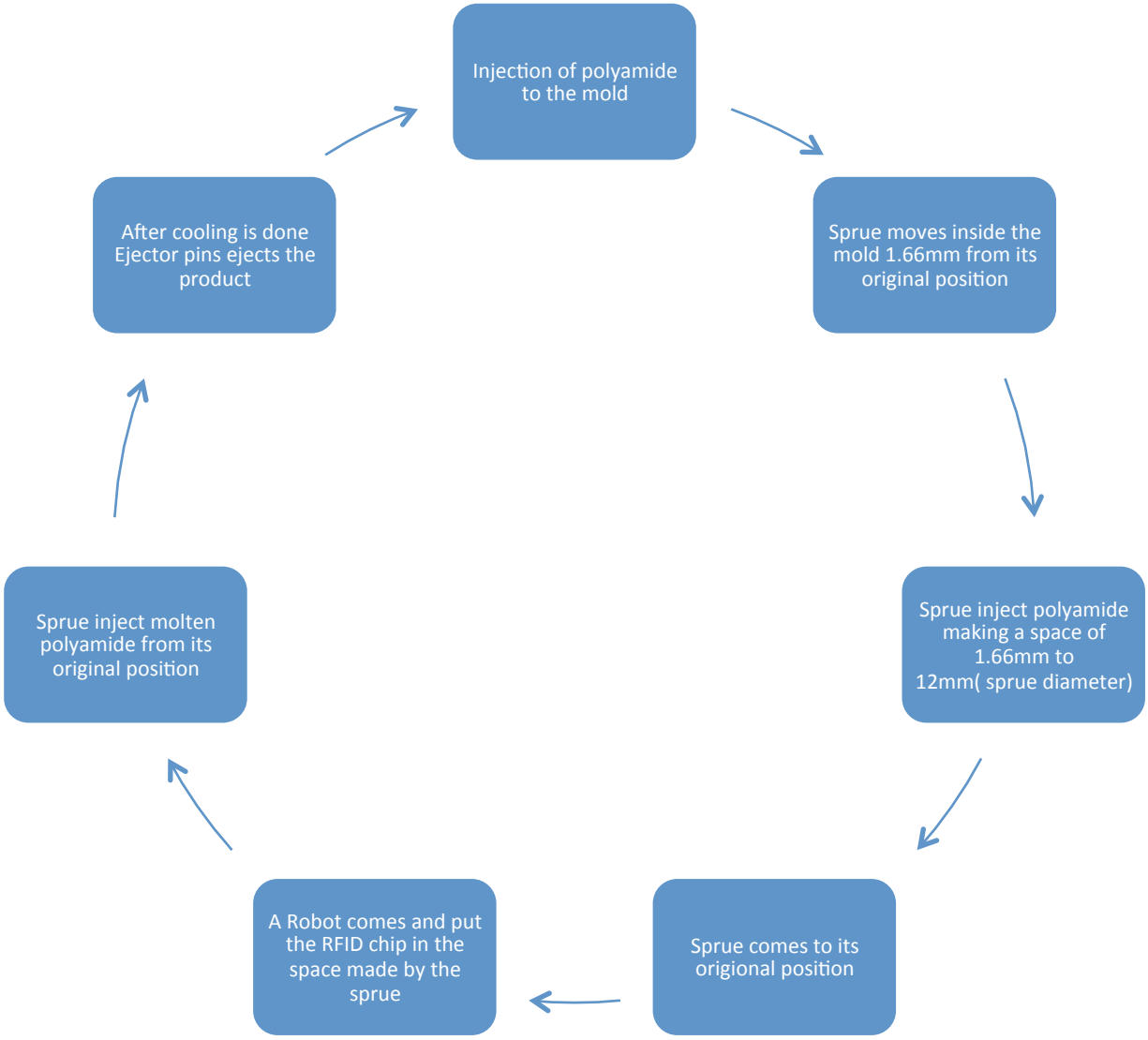

Figure 27: Cycle of product in production [Drawn by Author]

5 CONCLUSION

Product designs are often made to define new look for the product, user friendly, economic, easy for production and various factors. The aim of this study is to draw a new design for the Arcada's sensor Key, showing the concept of Mould design for the Low pressure Moulding system, embedding RFID chip in the design and finally a rapid prototype.

In this engineering thesis study, Solid Edge and MasterCAM were used to designing and prototyping of the Mould and the product. The objective was to design the Arcada Logo, inbuilt Arcada's door Key. At first, Arc-key was designed in Solid edge. The software Solid Edge played an important role in designing the product and the Mould. In making the product first, it was necessary decide how to fit RFID chip into the best possible design for the product. After the design was drawn, double cavity Mould was made. With all the necessary dimensions Arc-Key was successful. It was made such that the design of its Mould was not complicated.

Hereby, the cavity was designed so that the half part of a cavity has an injection hole of 12mm so that sprue can fit in the hole. Sprue Z512/12*27/2.5 was used in the manufacturing process. Polyamide MM6208S was chosen for the ARC-Key. Another half of cavity has 3 ejection holes for the ejection of the product after final product is made. In chapter 4, the process of injection is shown in Figure 27. RFID chip has the diameter of 11.6mm. In this thesis, the author tries to show how RFID chip is embed in the injection process and it is successfully done. Traditionally, it is done with gluing 2 half of the parts and embedding the RFID chip manually.

Hence, this thesis helps to acknowledge the process of manufacturing a product with inbuilt RFID chip. Using MasterCAM and milling in HAAS milling machine at Arcada Lab, the prototype was successfully produced. The prototype which was made in this Engineering thesis helps the product designer or manufacturer, the possibility to make the Mould plate. The real example of the Mould design for double sided cavity Mould is shown in the end of this study.

6 DISCUSSION

For Mould designer, the result of this engineering thesis has shown how the Solid Edge ST3 has been used to assists to get the optimum design of the product. In future, though there raises some mistakes, this software helps in the best way to get the solution. The use of Solid Edge and MasterCAM software saves a significant amount of time in the Mould design process as well as Mould manufacturing process.

Within this thesis study, the author has used LPMS 1100 as to produce the product and design Mould. LPMS 1100 have lots of advantages for making of small product and especially for the circuit boards and chips. There are still certain numbers of things that might be done differently. For example, further research can be done in Injection Moulding machine ENGEL 90CC available in Arcada. Can it be done in this machine with low pressure in Injection Moulding Machine? Several researches need to be done. Mould flow analysis is also something lacks in this Thesis study. Table 3 shows some of the properties of ENGEL 90CC comparing to LPMS 1100.

Properties	ENGEL 90CC Injection Moulding Machine	LPMS 1100
Machine Size mm (Kgs)	2700 Kgs	975x1150x1660 (330Kgs)
Melting Tank Model &Q'ty*	130 litre	LPMS500B (3Liter)x1
Temperature Control Zones	3+ opt. nozzle heating	2
Clamping Force	500 kN	Max.99KN
Clamping Stroke (mm)	510	150
Max. Mould Set Size (mm)	820 *820*610	300*200*150
Costs	25000-50000	10000-25000

Table 3 : Differences of Arcada's Injection machine to LPMS 1100 [Low Pressure Moulding, Largest of Low pressure Moulding LPMS, 2012]

There were lots of ups and downs in trying to design the ARC-Key, and how RFID chip can be placed directly making the product. Lots of designs and research were done due to the complication of making the product directly while injecting the molten plastic. Nevertheless, this engineering thesis

Nevertheless, this engineering thesis is intended to provide brief information regarding RFID chip, how it works, and Low pressure Moulding system. The result to intend RFID chip em-

bed in a product directly in production process, neither after making 2 halves of the cavity and joining them by glue. This result not only points out the advantages of product, also provides the advantages of having LPMS1100, which will be benefited for students. The future research that might be done following this study is to test the production of Arc-key, put the layout of a cooling system for the Mould on the above designs and finally designing an electrode for EDM machine.

7 REFERENCES

Alexis Michelle Chalfant, 2007 EMBEDDING RADIO FREQUENCY IDENTIFICATION INLAYS INTO INJECTION MOULDED FOOD CONTAINERS USING IN MOULD LABELINGTECHNOLOGY,

[ONLINE] Available at: http://ufdcimages.uflib.ufl.edu/UF/E0/02/16/20/00001/chalfant_a.pdf [Accessed 01 October 2012].

David Kazmer, 2007, Injection Mould Design Engineering, page 350

Gerd pötsch, Walter Michaeli, 1995 injection Moulding, an introduction, Munich,Germany pg1

Gyanendra K Verma and Pawan Tripathi, 2010, A Digital Security System with Door Lock System Using RFID Technology, [ONLINE] Available at:http://www.ijcaonline.org/volume5/number11/pxc3871334.pdf. [Accessed 09 October 2012].

Hans-Peter Heim, H. Potente, 2001, Specialized Moulding Techniques: Application, Design, Materials and Processing

HASCO Hasenclever GmbH + Co KG, 2010. Sprue Bushing Z51. [online] Available at: <http://www.hasco.com/gb/content/view/full/16950> [Accessed 22 November 2012]

HASCO Hasenclever GmbH + Co KG, 2010. Standards K Catalogue. [online] Available at: <http://www.hasco.com/gb/content/download/20004/665058/file/K_Katalog%20komp%20DGBF%2009.pdf> [Accessed 22 November 2012]

Integrating RFID with Plastic Products and Packaging. 2006 . [ONLINE] Available at:http://www.plasticsindustry.org/files/events/pdfs/rfid-stigall-062206.pdf [Accessed 09 October 2012].

KLAUS FINKENZELLER, 2003, RFID HANDBOOK, FUNDAMENTALS AND APPLICATION IN CONTACTLESS SMART CARDS AND IDENTIFICATION, MUNICH GERMANY, SECOND EDITION 2003

Low pressure Moulding, HENKEL, 2012 [ONLINE] Available at: http://www.loctite.ph/php/content_data/LT4182_TTE_Macromelt_Brochure.pdf.

[Accessed 09 October 2012].

Low Pressure Moulding - Wikipedia, the free encyclopedia. 2012.low pressure Moulding - Wikipedia, the free encyclopedia. [ONLINE] Available at: http://en.wikipedia.org/wiki/Low_pressure_Moulding . [Accessed 09 October 2012].

Low pressure Moulding Largest of Low Pressure Moulding LPMS. 2012. Low pressure Moulding Largest of Low Pressure Moulding LPMS. [ONLINE] Available at: http://lpms.asia/home_en.htm. [Accessed 09 October 2012].

Macromelt® Low Pressure Moulding Materials for electronic components | Krayden, Inc.. 2012. Macromelt® Low Pressure Moulding Materials for electronic components | Krayden, Inc.. [ONLINE] Available at:http://krayden.com/macromelt-low-pressure-Moulding-materials/. [Accessed 09 October 2012].

Nyroth, E. 2010. List of installed tools_14 [MS Word document], Arcada University of Applied Science. Available at: <https://people.arcada.fi/~nyrothe/> [Accessed 22 November 2012]

Plastic Injection Moulding | Thermoplastics, Thermosets, Machines, Resins and More. 2012. Plastic Injection Moulding | Thermoplastics, Thermosets, Machines, Resins and More. [ONLINE] Available at: http://www.injection-Moulding-resource.org/. [Accessed 09 October 2012].

Radio-frequency identification - Wikipedia, the free encyclopedia. 2012.Radio-frequency identification - Wikipedia, the free encyclopedia. [ONLINE] Available at: http://en.wikipedia.org/wiki/Radio-frequency_identification [Accessed 09 October 2012].

RFID Canada - RFID Technology. 2012. RFID Canada - RFID Technology. [ONLINE] Available at: http://www.rfidcanada.com/rfid.html#foot1. [Accessed 09 October 2012]

Solid Edge Overview: Siemens PLM Software. 2012. Solid Edge Overview: Siemens PLM Software.[ONLINE]Available

at:http://www.plm.automation.siemens.com/en_us/products/velocity/solidedge/overview/index.shtml. [Accessed 09 October 2012].

Solid Edge: Siemens PLM Software. 2012. Solid Edge: Siemens PLM Software. [ONLINE] Available at:http://www.plm.automation.siemens.com/en_us/products/velocity/solidedge/index.shtml. [Accessed 09 October 2012]

Unigraphics Solution Inc. 2001,User's Guide Getting started with Solid Edge, version11 MU28900-ENG, Maryland Heights, MO USA.

V. Goodship, J. C. Love, 2002 Multi-Material Injection Moulding, page 41

8 APENDICES

Macromelt MM6208S Data Sheet

Technical Data Sheet

Macromelt

MM6208S

November 2009

PRODUCT DESCRIPTION

Macromelt® MM6208S provides the following product characteristics:

Technology	Polyamide
Appearance	Black
Product Benefits	• Easy moldability • Good adhesion to a variety of substrates • Excellent moisture resistance • Excellent environmental resistance • Simplified process flow
Application	Molding compound thermoplastic
Typical Application	Encapsulation
Flammability	94 V-0
Operating Temperature	-40 to +130 °C

MM6208S high performance thermoplastic polyamide is designed to meet low pressure molding process requirements. This product can be processed at low processing pressure due to its low viscosity, allowing encapsulation of fragile components without damage. This material produces no toxic fumes in process and provides a good balance of low and high temperature performance. MM6208S exhibits great flexibility in applications requiring strain relief and is ideal for encapsulation of heat-producing components.

MM6208S meets UL 94 V-0 Flammability at 3.175mm thickness. RTI rating of 95°C.

LIQUID-STATE TYPICAL PROPERTIES

Viscosity @ 210 °C, mPa·s (cP)	3,600
Specific Gravity @ 25 °C	0.98
Shelf Life @ 25°C, years	2
Softening Point, °C	150 to 160
Flash Point - See MSDS	

TYPICAL PROCESS DATA

Handling:

Molding Temperature, °C	190 to 230
Typical Cycle Time, seconds	30 to 75

MM6208S has been formulated to provide the best possible moldability and as wide a molding latitude as possible. Much of the final molding parameters will be determined by the mold design. Although molding and curing conditions will vary from situation to situation, recommended starting ranges are shown above.

SOLID-STATE PROPERTIES

Physical Properties:

Thermal Conductivity, W/mk	0.15
Glass Transition Temperature, °C	-42
Shore Hardness, Shore A	78
Elongation , at break,%	600

Electrical Properties:

Dielectric Constant / Dissipation Factor, IEC 60250:	
1MHz	3.7 / 0.084
1 GHz	2.7 / 0.27
1.8 GHz	2.8 / 0.028
Dielectric Strength, kV/mm	23
Volume Resistivity, ohms-cm	1.6×10^{11}

GENERAL INFORMATION

For safe handling information on this product, consult the Material Safety Data Sheet, (MSDS).

Not for product specifications

The technical data contained herein are intended as reference only. Please contact your local quality department for assistance and recommendations on specifications for this product.

Storage

Store product in the unopened container in a dry location. Storage information may be indicated on the product container labeling.

Macromelt® MM6208S will absorb moisture from the air. Material from opened containers should be transferred immediately into air tight containers. Material should be stored in sealed containers in a cool dry location in order to maximize shelf life.

Material removed from containers may be contaminated during use. Do not return product to the original container. Henkel Corporation cannot assume responsibility for product which has been contaminated or stored under conditions other than those previously indicated. If additional information is required, please contact your local Technical Service Center or Customer Service Representative.

Conversions

(°C x 1.8) + 32 = °F
kV/mm x 25.4 = V/mil
mm / 25.4 = inches
N x 0.225 = lb
N/mm x 5.71 = lb/in
N/mm² x 145 = psi
MPa x 145 = psi
N·m x 8.851 = lb·in
N·m x 0.738 = lb·ft
N·mm x 0.142 = oz·in
mPa·s = cP

Henkel

Note

The data contained herein are furnished for information only and are believed to be reliable. We cannot assume responsibility for the results obtained by others over whose methods we have no control. It is the user's responsibility to determine suitability for the user's purpose of any production methods mentioned herein and to adopt such precautions as may be advisable for the protection of property and of persons against any hazards that may be involved in the handling and use thereof. In light of the foregoing, **Henkel Corporation specifically disclaims all warranties expressed or implied, including warranties of merchantability or fitness for a particular purpose, arising from sale or use of Henkel Corporation's products. Henkel Corporation specifically disclaims any liability for consequential or incidental damages of any kind, including lost profits.** The discussion herein of various processes or compositions is not to be interpreted as representation that they are free from domination of patents owned by others or as a license under any Henkel Corporation patents that may cover such processes or compositions. We recommend that each prospective user test his proposed application before repetitive use, using this data as a guide. This product may be covered by one or more United States or foreign patents or patent applications.

Trademark usage

Except as otherwise noted, all trademarks in this document are trademarks of Henkel Corporation in the U.S. and elsewhere. ® denotes a trademark registered in the U.S. Patent and Trademark Office.

Reference 0.0

Americas
+1.949.789.2500

Asia
+8621.3898.4800 & 0518.8515.5305

For the most direct access to local sales and technical support visit: www.henkel.com/electronics