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Design and manufacturing of waveguide of parabolic antenna using EDM process.

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Abstract

Wireless technology was one of the main areas of research in the world of communication system today and a study of communication incomplete without an understanding of the operation and manufacturing of waveguide of parabolic antenna. Waveguide is an important electromagnetic wave transmission Component of parabolic antenna. potential benefits of parabolic antenna doesn't required any cables to transmitte electromagnetic signal. Designing of waveguide was a most important role before its manufacturing. An attempt is made to design and manufacture the waveguide by varying cross- section using CREO software. Manufacturing of waveguide Carried out by milling, the inner pocket of waveguide was machined by Electrical discharge machining process. Which results accurate surface and suitable for travelling of electromagnetic wave without any disturbance.

Keywords: EDM; Waveguide; Design; Manufacturing

1. Introduction

A parabolic antenna is an antenna that uses a parabolic reflector, a curved surface with the cross-sectional shape of a parabola, to direct the radio waves to the receiver in its focal point. The most common form is shaped like a dish and is popularly called a dish antenna or parabolic dish. The main advantage of a parabolic antenna is that it has high directivity. It functions similarly to a searchlight or flashlight reflector to direct radio waves in a narrow beam, or receive radio waves from one particular direction only. Parabolic antennas have some of the highest gains, meaning that they can produce the narrowest beam widths, of any antenna type[1].

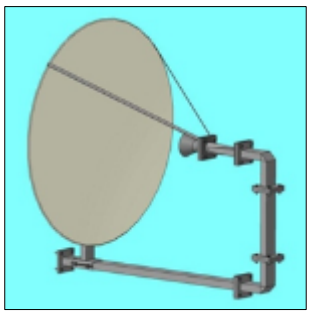

Figure 1 Parabolic Antenna

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A waveguide is a structure that guides waves, such as electromagnetic waves or sound, with minimal loss of energy by restricting the transmission of energy to one direction. Without the physical constraint of a waveguide, wave intensities decrease according to the inverse square law as they expand into three-dimensional space. There are different types of waveguides for different types of waves. The original and most common meaning is a hollow conductive metal pipe used to carry high frequency radio waves, particularly microwaves. Dielectric waveguides are used at higher radio frequencies, and transparent dielectric waveguides and optical fibres serve as waveguides for light. In acoustics, air ducts and horns are used as waveguides for sound in musical instruments and loudspeakers, and specially-shaped metal rods conduct ultrasonic waves in ultrasonic machining.

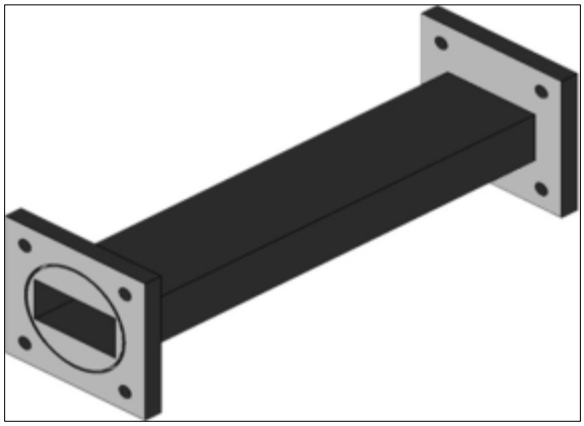

Figure 2 Waveguide

EDM removes material from the electrodes (both work piece and electrode) by supplying current when submerged in dielectric fluid. This dielectric fluid plays major role in material removal by creating plasma, flushing of debris, cooling of electrode and work piece. Generally, this dielectric fluid is hydrocarbon based and causing environmental issues. In this regard, researchers are attempting different approaches to overcome these issues namely dry EDM, near dry EDM and water as dielectric fluid. But, these approaches have few drawbacks in terms of low MRR in dry EDM, high concentrated volatile mixture, chances of explosion in near dry EDM, oxide formation and corrosion effects in water based dielectric. In this decade, recently, vegetable oil is used as dielectric fluid by researchers in EDM process and it is observed for obtaining of sustainability in EDM process [1-12].

Deriset used harmonic search algorithm to optimize process parameters in die sinking EDM process. A regression model was developed to analyze process parameters and the dimensional accuracy of tool overcut. The results of regression method and harmony search method are compared and concluded that peak current is the most influencing process parameters for obtaining minimum tool overcut. Tlili and Ghanem [14] used numerical simulation to realize mechanical behavior of residual stress and work hardening using ABACUS. In their work, a single pulse discharge was used with finite element concept. The result indicated that uniform distribution of heat flux was influenced by residual stress formation and plasma induced pressure was influenced in work hardening effect. Safiei et al. [15] investigated that the performance of die sinking EDM process on SS 316L. In their investigation, MRR, TWR, SR and dimensional accuracy were studied using full factorial and central composite design. Mathematical model was developed and validated statistically. The conclusion showed that the higher MRR, TWR, SR and dimensional accuracy values were obtained at the higher level of peak current. Sharif et al. [16] experimentally studied the effect of process parameters on output characteristics in EDM process of SS 316L using full factorial experimental design. The output characteristics considered were MRR, TWR, SR and dimensional accuracy. Mathematical model was developed and statistically verified using Analysis of Variance (ANOVA). The result indicated that the peak current was influencing the output characteristics. Ahmed et al. [17] experimentally analyzed the effect of input parameters such as current, voltage, pulse on time and pulse off time on MRR, TWR and SR on machining SS 304 using EDM process. ANOVA approach was used to find out the significant [13].

2. Design procedure

Creo is a family of Computer-aided design (CAD) apps supporting product design for discrete manufacturers and is developed by PTC. The suite consists of apps, each delivering a distinct set of capabilities for a user role within product development. Creo runs on Microsoft Windows and provides apps for 3D CAD parametric feature solid modelling, 3D direct modelling, 2D orthographic views, Finite Element Analysis and simulation, schematic design,

technical illustrations, and viewing and visualization. Creo can also be paired with Mastercam (Machining based software) to machine any designed model in a minimal timeframe; Creo has increased the rate of rapid prototyping in the industry tremendously.

Figure 3 Creo logo

Creo Elements and Creo Parametric compete directly with CATIA, Siemens NX/Solid Edge, and SolidWorks. The Creo suites of apps replace and supersede PTC's products formerly known as Pro/ENGINEER, CoCreate, and Product View. Creo has many different software package solutions and features. Creo Illustrate is a good example. Creo Parametric allows users create 3D models with many features such as sweeps, revolves and extrusions. This makes it one of the leading cad software's that is in use for many engineering and technical based careers.

2.1. Step 1

- Open the creo parametric. Click on new, select part module.

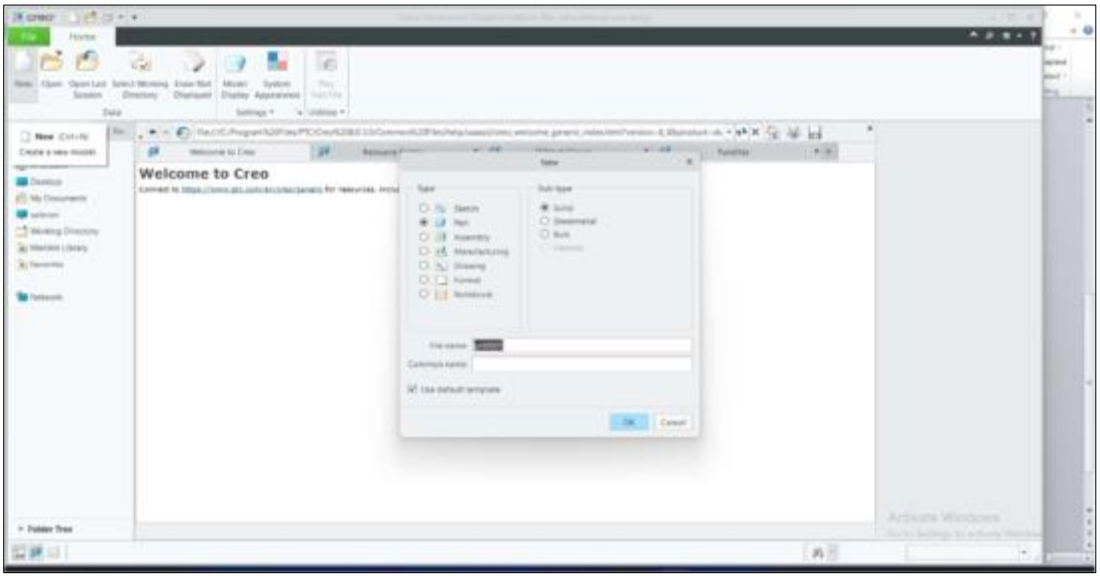

Figure 4 Select Part Module

2.2. Step 2

- Select the top plane, click on sketch.

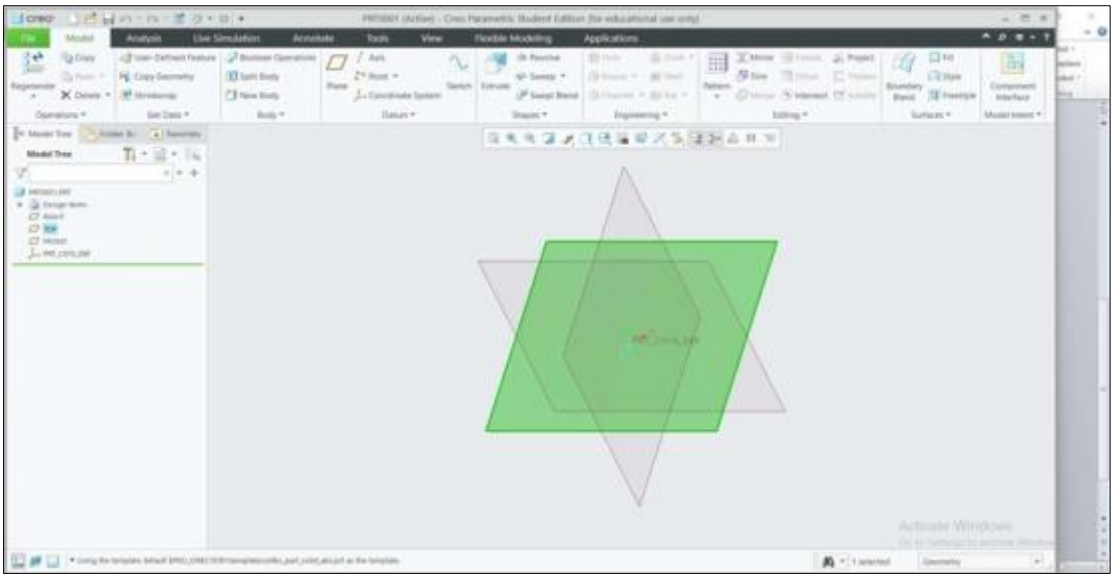

Figure 5 Top Plane

2.3. Step 3

- Draw the rectangle of dimension 70 x70 mm, click on ok.

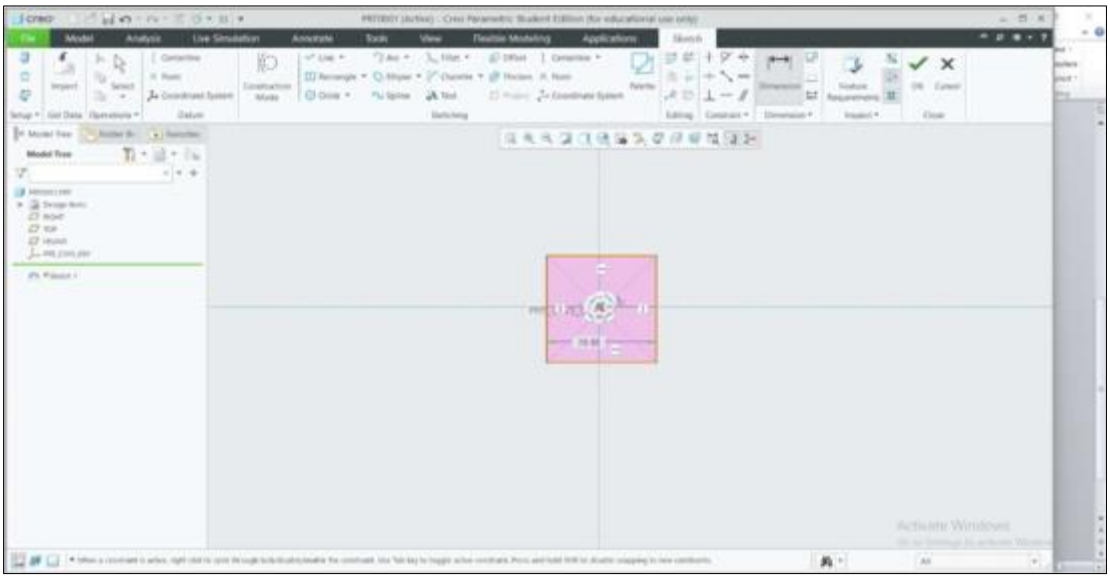

Figure 6 Sketch of Flange

2.4. Step 4

- Extrude the rectangle to the dimension of 8mm. create the plane parallel to the rectangleof offset distance of 60mm.

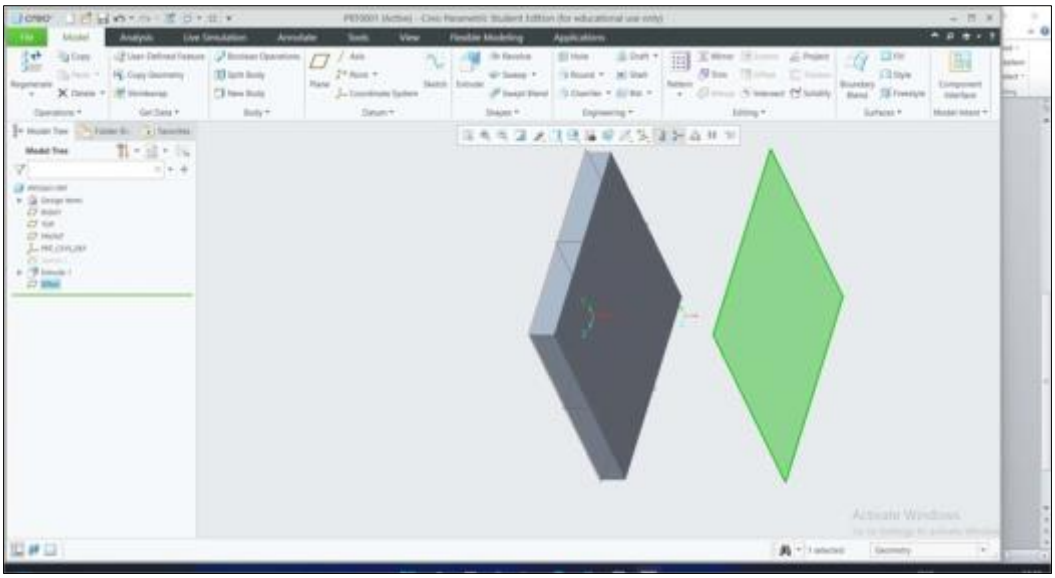

Figure 7 Creating Offset Plane

2.5. Step 5

- With the refer the plane draw the rectangle by following the step 3 & 4.

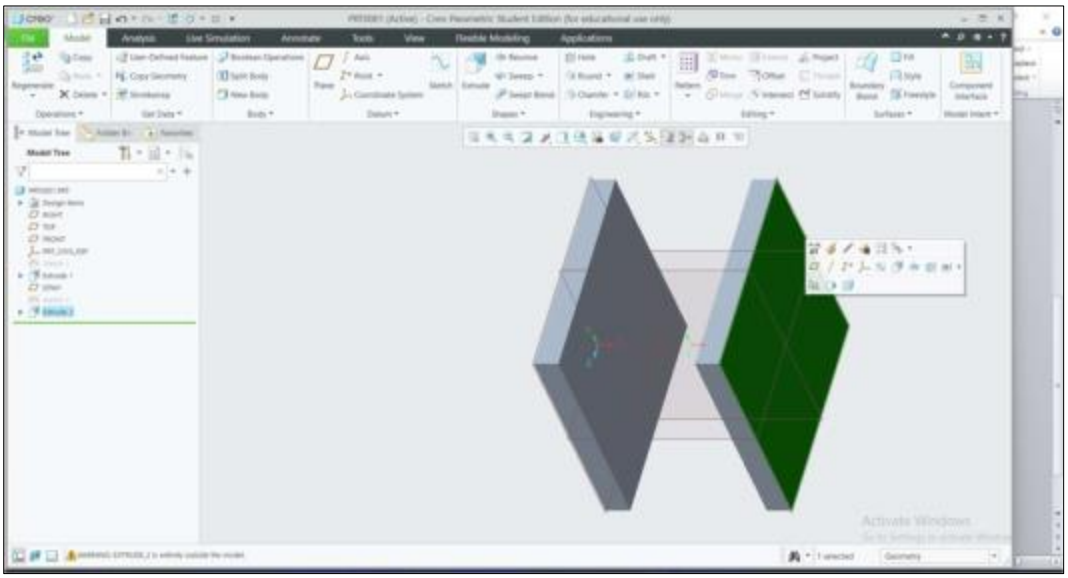

Figure 8 Rectangle 2 Steps 6

2.6. Step 6

- Draw the rectangle of dimensions 46 x 26 mm and 40 x 20 mm. And then extrude theother flange and the select “REMOVE MATERIAL”.

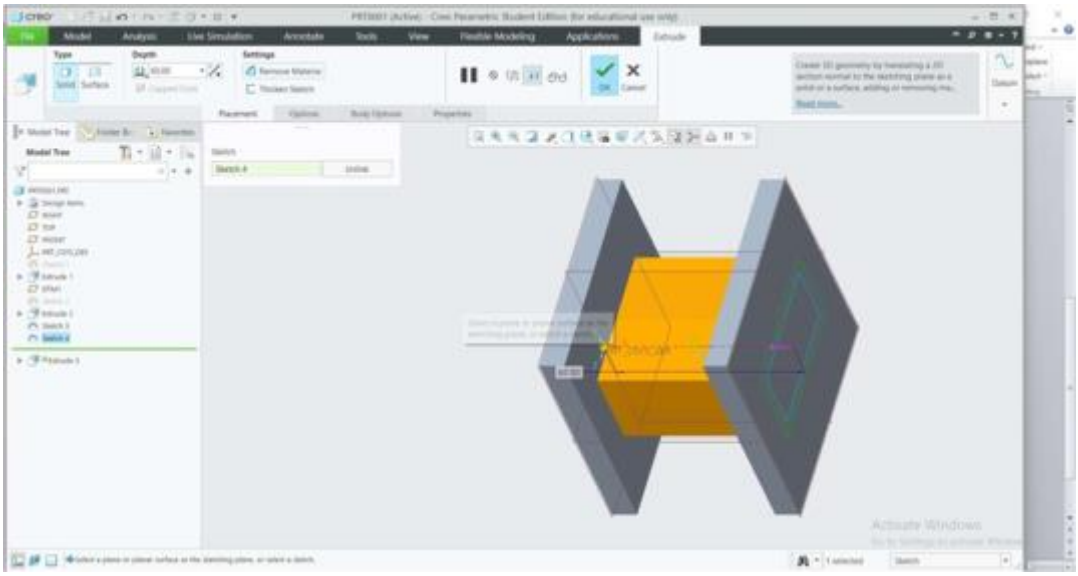

Figure 9 Extrude

2.7. Step 7

- To produce the 4 holes of size 6mm diameter, draw the circle and by selecting mirroroption with reference to the plane draw the circle and select extrude to produce 4 holes.

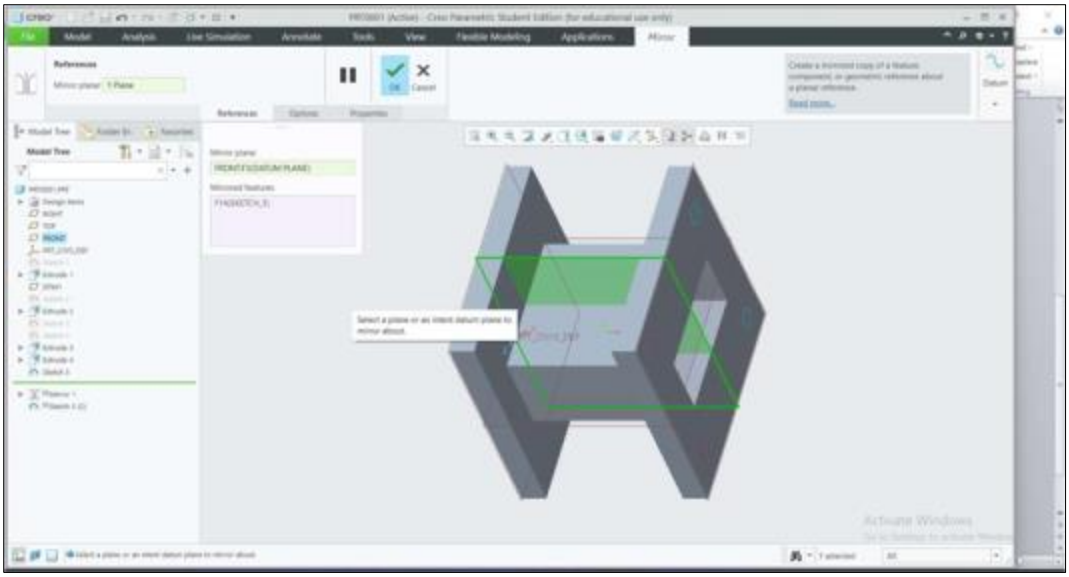

Figure 10 Mirror

2.8. Final sketch of waveguide

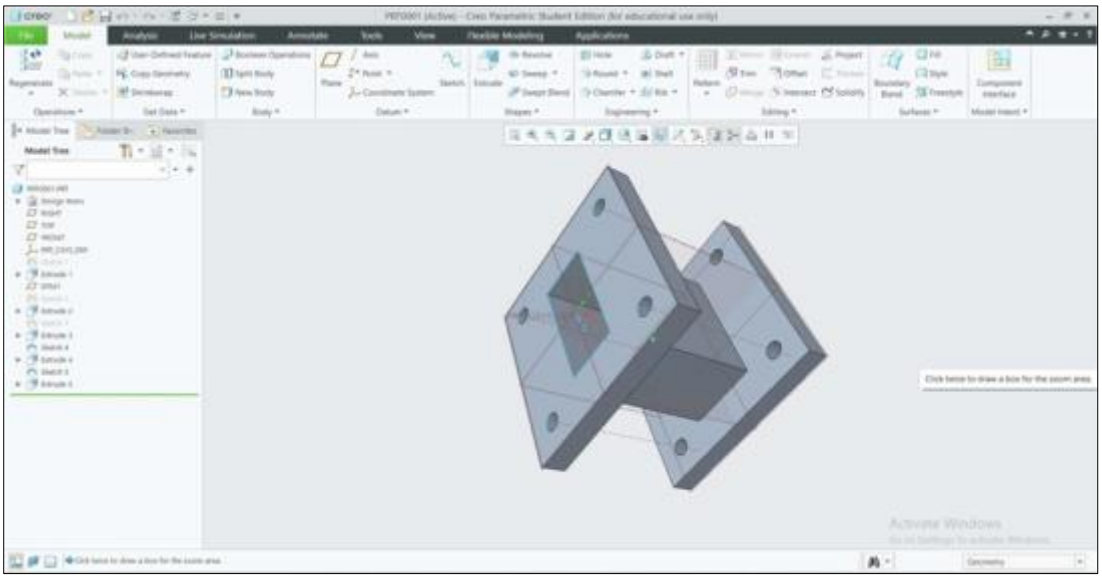

Figure 11 Final Sketch of Waveguide

3. Manufacturing

3.1. Milling operation

Figure 12 Vertical milling machine

3.1.1. Vertical Milling Machine

Vertical Milling Machine is one of the most used operation method. In Vertical Milling Machine, there is a multi-point cutting tool called milling cutter. This machine has vertical spindle which is perpendicular to thework piece. In Vertical Milling Machine, the head is used to swivel or it can be fixed.This can move in upward and downward directions and can move in any directions. Vertical Milling Machine is used to make a different type of operations like a flat surface, grooves, slots etc [24].

3.1.2. Working of Vertical Milling Machine

In this milling machine work piece is fixed without any movement, this used to feed against the cutting tool. Metal removed from the work piece is done in the form of chips,we can move the head in up and down direction or any angles. By this, we can perform many operations like grooves, slots.

3.2. Tools used

Figure 13 Tools Used

3.3. Procedure

- Raw material AL 6061-T6 70 x 70 x 60 mm.

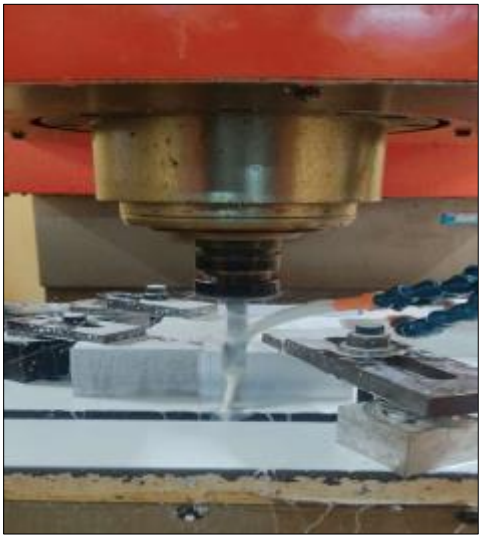

Figure 14 Raw material 70 x70 x 60 mm

3.4. Surface milling

Figure 15 Surface milling

3.4.1. Drilling 8 hole of diameter 6mm.

Figure 16 Drilling holes

Do The Pockett 39.6 X 19.6 Mm As Per Drawing

Figure 17 Pocketing

Maintain Flangee Dimensions 70mm X 70mm X 8 Mm.

Figure 18 Flange

Electrical Discharge Machining is also called or known as Spark machining, spark eroding, burning, die sinking, wire burning or wire erosion. This is a manufacturing operation in which we used to make desired shapes by using an electrical spark. This spark near to 8000 to 12000ºC.

Electrical Discharge machining is the process of metal removal from the worksurface due to an erosion of metal caused by electric spark discharge between the two electrodes tool (cathode) and the work (Anode), separated by a dielectric liquid and subject to an electric voltage.

Figure 19 CNC Electrical Discharge Machine

The process depends upon the tool and work piece not making physical contact. When the voltage between the two electrodes is increased, the intensity of the electric field in the volume between the electrodes becomes greater, causing dielectric break down of the liquid, and produces an electric arc. As a result, material is removed from the electrodes.

4. Conclusion

- Design of waveguide was an important step before manufacturing of waveguide.
- The design of waveguide in Creo software provides 3D CAD parametric feature solid modeling, 2D orthographic views and visualization.
- In comparison with AutoCAD which is mainly used to generate 2D drawings, is better to go for Creo. In AutoCAD there are only few commands by which youcan generate 3D parts. But assembly is not possible in AutoCAD which is possible in Creo.
- The material which had chosen was ALUMINUM 6061 T6 alloy, has good strength to its weight ratio which suitable for manufacturing of wave guide.
- Compared with the conventional machining process, the machining in CNC machines has high accuracy, less time consumption and high surface finish.
- Compare to the milling operation, EDM process can achieve accurate and good surface finish. It result's that the surface finish of the machined surface was 3.2µm.
- Compared with the manufacturing of cylindrical waveguide, manufacturing of rectangular waveguide provides good surface finish. Whereas the manufacturingof cylindrical waveguide follows conventional process.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declare no conflict of interest.

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