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Optimization for Reduction in Defects of Brazing of Shock Loop Tube to Resonator

Chaman Lal Sharma[1], Raj Kumar[2], Bhaskar Dhiman[3]
[1]*Assistant Professors, Mechanical Engineering, Abhilashi University, Mandi, H.P. India*

Abstract: Rejection Y variable shows the rejection percentage and optimization phase done with the help of Minitab software. Various design parameters have been selected to identify for the optimization like heating time, the weight of silver brazing wire, and power rating of the equipment extra. Improve phase revealed that the Weight 0.311 Gms, Heating time 11 Sec, Power rating 5 KW is good in the better condition as compared with the current condition. In the end, the conclusion shows that the bulk supplies of 0.3mm silver ring received and started in the production line and the work standard has been established. By doing daily routine activity checks, after one month there is a drop in the rejection and the cost regarding this has also been achieved.
Keywords: Reduction in Defects of Brazing, Shock Loop Tube, Resonator, DMAIC approach, Resonator Optimization

I. INTRODUCTION

This Owing to the worldwide market, customer's priorities towards the product are constantly improving. It's become necessary to make the product of good quality and least error in the product during manufacturing so that the rejection cost of the product attains less time consuming and fine production will achieve. DMAIC approach can help us to solve the problem arising during the production period and to achieve the target of the quality monthly. The case is quite similar to the problem that arises with the brazing or leakage in the shock loop with the tube or the shock loop to the discharge fitting on the exterior of the shell.

II. PROBLEM FORMULATION

Most of the foreign industries as well as Indian are using the operation of joining the two processes, welding metal welding or brazing. This case is quite similar to the problem that arises with the miss weld or leakage in the shock loop with the tube or back loop to the discharge fitting on the exterior of the shell. An attempt has n made to reduce the rejection of pieces through the six-sigma technique. The reaction rate is very high to reduce that critical examining of the process is sentential. The cost factor should be considered & the rejection chart has to be made and to be arranged step by step.

III. RESEARCH METHODOLOGY

DMAIC is a formal and highly disciplined methodology for reducing process variation to ensure customer satisfaction, cost reduction, and profitability of the organization. States that the fundamental plan behind the Six Sigma philosophy is to monitor the process continuously and aims at elimination/reduction of defects or failures from the manufacturing processes. States that defect can be defined as any deviation in the performance of the critical to quality (CTQ) characteristics.

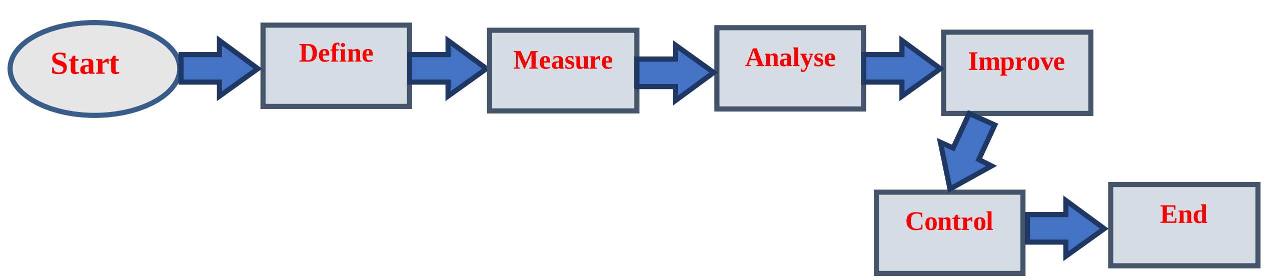

Fig.1 Flow Chart of DMAIC Technique

IV. OBJECTIVES

A. To reduce the rejection rate or correct the work standards.
B. To save the rejection cost and maintain the supply properly.

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V. CASE STUDY CHARTER

1) *Case Title:* Defects reduction in brazing of shock loop tube to the resonator
2) *Case Goal:* To reduce the defects in the compressor plant by applying the DMAIC approach.
3) *Voice of Quality Dept.:* Poor quality and high rejection rate.
4) *Expected Benefit:* A considerable cost saving due to the reduction of the defect.
5) *Expected Customer Benefit:* Enhance customer satisfaction and perception

Table 1
Various parameters for case study

Sr. No.	Parameters			
1.	Process selected	Brazing of Shock Loop & Resonator		
2.	The part number selected for the study	1) Shock Loop 2) Resonator		
3.	The machine selected for study	Induction Brazing Machine		
4.	Other similar part numbers where the optimal setting can be deployed	Nil		
5.	Responses	Description	Types of responses	Specification
		Rejection	variables	Zero
		Total rejection pcs. = 3101 pcs./ month	2	

VI. PLANNING PHASE

The planning phase introduces clear pictures of the product. For the project planning, it shows all the various work detail or schedule that we have to proceed which includes planning, analyze, improve and control. Weekly data shows that how much rejection is coming from the line and which factors have to be concluded or taken into account.

Table 2
Planning variables

Phase	June- 2021				July - 2021				August - 2021			
	W1	W2	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4
Plan												
Analyze												
Improve												
Control												

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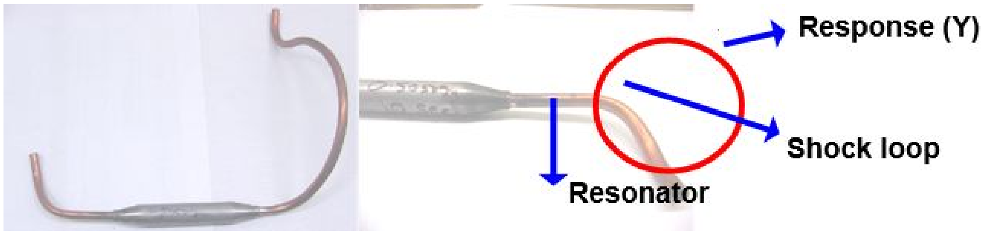

Fig. 2 Image of the Part Being Optimize

TABLE 3
Design Parameters identified for Optimization

No	Parameter	(- Setting)	(+ Setting)
A	Weight of Silver – Grams	0.505	0.311
B	Heating time - Sec	7	10
C	Power rating of equipment - Kw	5	5

A – Weight of Silver brazing wire, B – Heating time, C – Power rating of the equipment, D – Clearance between the resonator and shock loop, E – Position of the resonator in the induction coil, F – Filler material

Fig. 3 Induction Brazing Machine

Fig. 4 Power Control Unit

Fig. 5 Silver Rings

VII. ANALYSIS AND OPTIMIZATION

This phase includes the various results and the following run has been taken that are as follows:

TABLE 4
Checking of Levels and Parameters Identified

Test	- Setting	+ Setting
1st Run	0	4
2nd Run	0.5	3.5
3rd Run	0	4
Median	0	4
Range	0.5	0.5
D (Difference Between Two Medians)	4	
d = Average of Two Ranges	0.5	
D/d	8	

Conclusion: The D/d ratio > 3 The Parameters and Levels Identified are Correct. Now proceed with step one.

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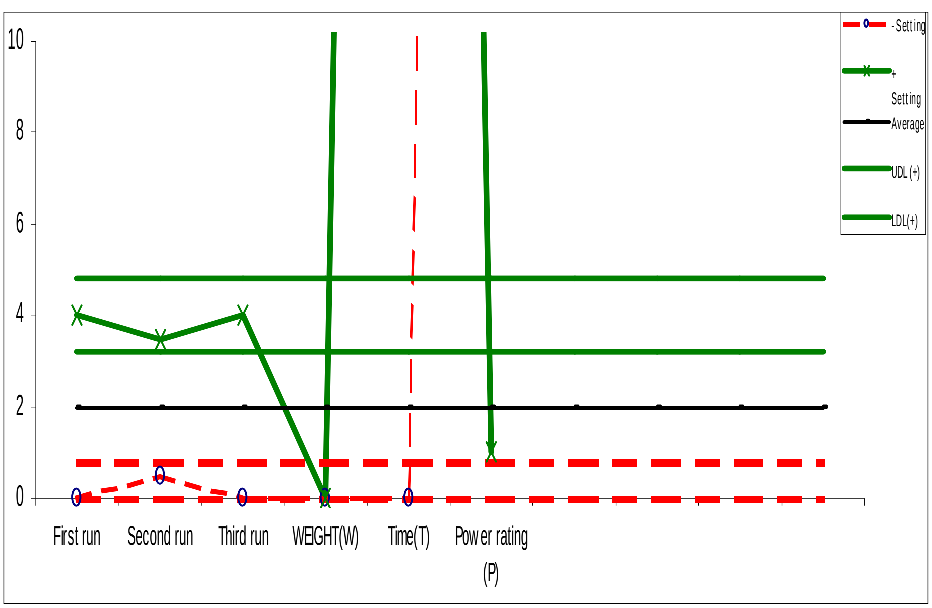
TABLE 4. Step One of the Analysis

Median(+)	4
Median(-)	0
Average of Medians	2
d	0.5
1.45*d	0.725
1.45*d (after rounding off to the same decimal place as data. Always round off to higher number)	0.8
UDL(+) = Median(+) + 1.45*d	4.8
LDL(+) = Median(+) – 1.45*d	3.2
UDL(-) = Median(-) + 1.45*d	0.8
LDL(-) = Median(-) – 1.45*d	0

TABLE 5. Step Two Data Collection

	- Setting	+ Setting	Average	UDL (+)	LDL(+)	UDL (-)	LDL(-)	
First run	0	4	2	4.8	3.2	0.8	0	UDL(+) =M
Second run	0.5	3.5	2	4.8	3.2	0.8	0	LDL(+) =M
Third run	0	4	2	4.8	3.2	0.8	0	UDL(-) =M
WEIGHT(W)	0	0	2	4.8	3.2	0.8	0	LDL(-) =M
Time(T)	0	100	2	4.8	3.2	0.8	0	
Power rating (P)	100	1	2	4.8	3.2	0.8	0	
			2	4.8	3.2	0.8	0	
			2	4.8	3.2	0.8	0	
			2	4.8	3.2	0.8	0	
			2	4.8	3.2	0.8	0	
			2	4.8	3.2	0.8	0	
			2	4.8	3.2	0.8	0	
			2	4.8	3.2	0.8	0	
			2	4.8	3.2	0.8	0	
			2	4.8	3.2	0.8	0	
			2	4.8	3.2	0.8	0	



Graph 1: showing various runs and weight, power, and time

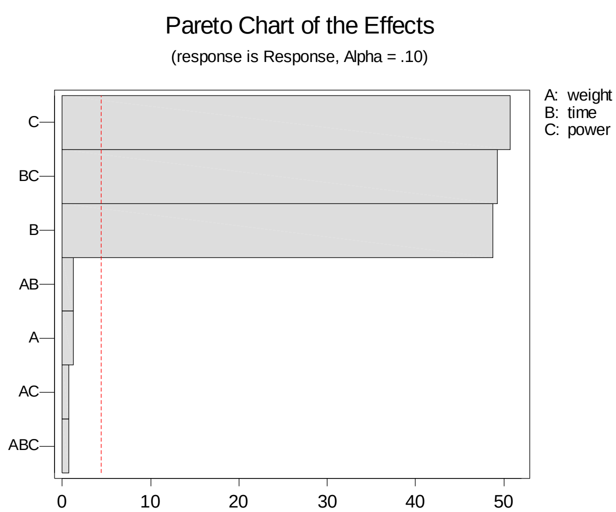
TABLE 6. Analyze Factorial Analysis

			Response
-	-	-	
+	-	-	
-	+	-	
+	+	-	
-	-	+	
+	-	+	

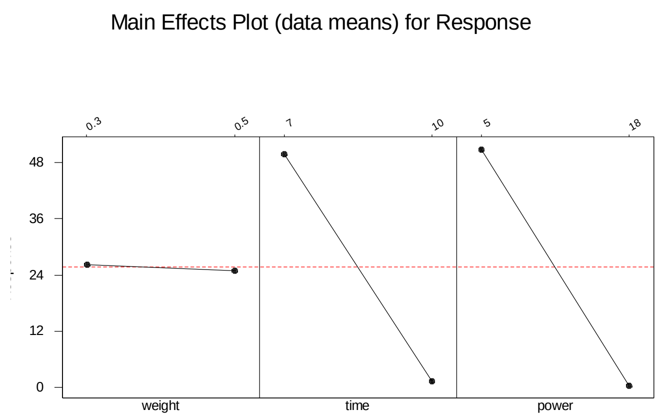
TABLE 7. Data Collection by Method Two

WEIGHT	**TIME**	**POWER**	**Response**
-	-	-	0,0.5,0
+	-	-	0
-	+	-	0
+	+	-	1
-	-	+	100
+	-	+	100
-	+	+	0
+	+	+	4,3.5,4

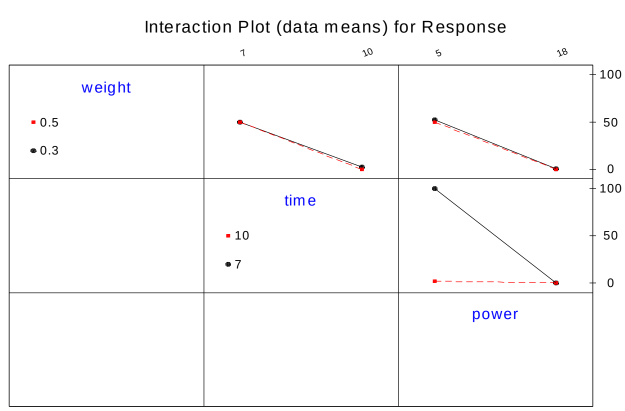
Results: Is there any parameter held at a specific setting because its contribution is not zero Yes/No.
If yes, what are the parameters, and what are the settings (-).



Graph 2 : Factorial plots: (Minitab data)



Graph 3 : Main Effects Plot



Graph 4: Intersection Plot

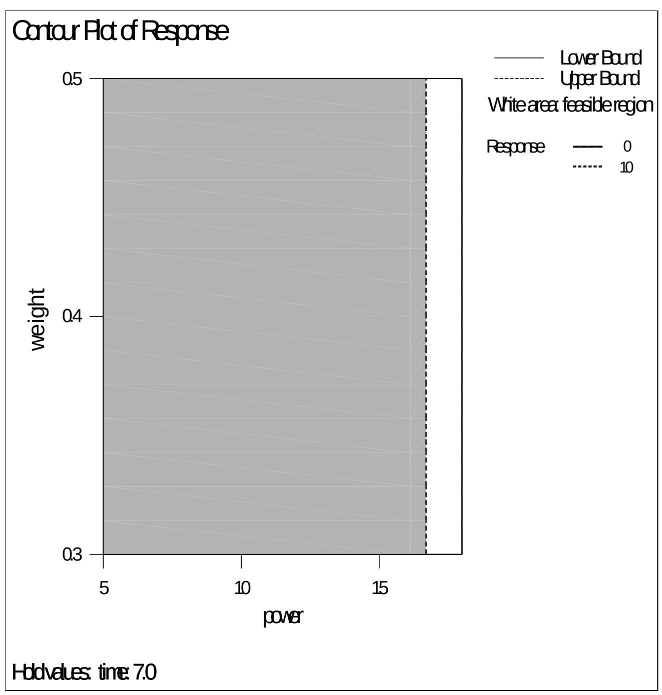
TABLE 8

Coefficients in actual value for making equation

Term	Coeff.
Constant	431.474
Weight	60.1282
Time	-41.8590
Power	-24.2949
Weight*time	-8.58974
Weight*power	2.37179
Time*power	2.37179
Weight*time*power	0.384615

Y = 431.47 + 60.13*w - 41.86*t - 24.30*p - 8.59*w*t - 2.69*w*p + 2.37*t*p + 0.38*w*t*p

The response value (Y) can be calculated if we have the value of the various parameters like weight, power, and time. Now we have to find out the feasible and non-feasible solution to solve the problem reaction. Our next step is to optimize and counterplot for the response through Minitab.

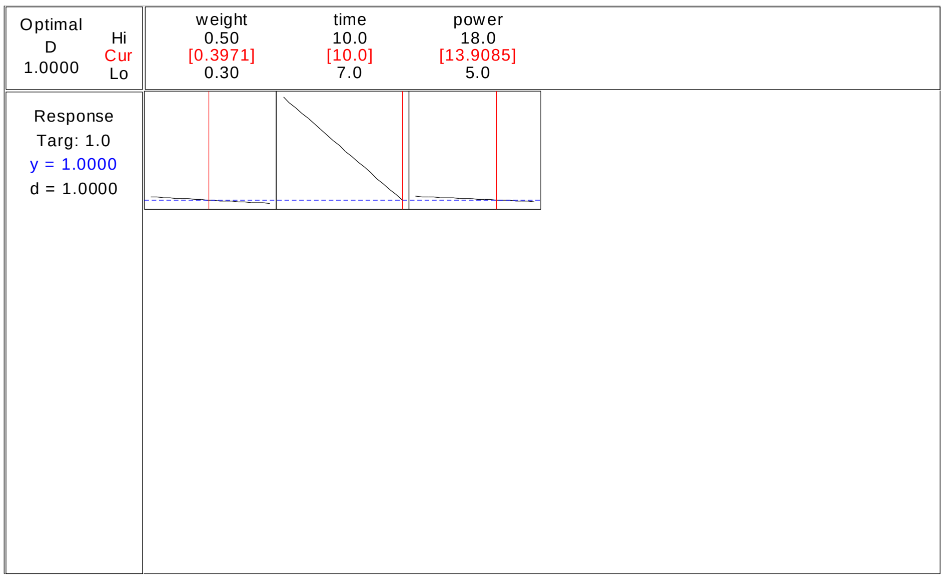


Graph 5: Overlaid Counter Plot

TABLE 9

Various Values for Putting in Equation

Weight	0.3
Time	11
power	5
Y	**-28.213**



Graph 6: Optimal Settings identified using equation

Table 9

Validation using B vs C

1	The part number selected for validation	Shock loop & Resonator
2	Better Condition	Weight – 0.311 Gms, Heating time – 11 Sec, Power rating – 5 KWs
	Current Condition	Weight – 0.505gms, Heating time – 7 Sec, Power rating – 18 KWs
3	Sample size	3
4	Sample type	Batches
5	Response decided for monitoring	Rejections
6	Lot quantity (for batches)	1000 nos

Optimal Settings identified using equation:

Y = 431.47 + 60.13*w - 41.86*t - 24.30*p - 8.59*w*t - 2.69*w*p + 2.37*t*p + 0.38*w*t*p

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Table 10
Data Obtained During Validation

Piece / Lot	Better (B)	Current (C)
1	0	0.1
2	0	0
3	0	0

Fig. 6: Brazed Joint Cutted for Inspect for Penetration

Control: work standard corrected for standardization

1) Standard operating procedure prepared.
2) Bulk supplies of 0.3mm silver ring received and started usage in production.
3) Also implemented for bottom brazing.
4) Machine settings are locked for power and time.

VIII. FUTURE SCOPE

The study can be further extended to solve the problems regarding any field. It gives you an effective path to collect the information about the problem step by step. It is an easy and simple method and is being used in a lot of firms and industries to solve their live problems. It is widely used in engineering and can be used in other fields like marketing, waste management, finance, hospitals, social science, etc. For optimization, this software has the best response and is using widely all over the world. It makes calculations quite easier as compare we use to do manually. Graphical representation is less time-consuming.

IX. RESULTS AND DISCUSSION

By selecting the parts for validation, the shock loop and resonator sample size of three have been choosing. The size or lot quantities for the batches are 1000 in numbers. To reduce the rejection condition of the weight, current or heating time and also power ratings seems to be improved. By using the equation the response value Y has been concluded.

$$Y = 431.47 + 60.13*w - 41.86*t - 24.30*p - 8.59*w*t - 2.69*w*p + 2.37*t*p + 0.38*w*t*p$$

Weight	0.3
Time	11
power	5
Y	**-28.213**

$$Y=431.47+60.13*0.3-41.86*11-24.30*5-8.59*0.3*11-2.69*0.3*5+2.37*11*5+0.38*0.3*11*5= (-28.213)$$

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The response factor objectives show that the nominal factor high/medium/low or outstanding performance of the process with the boundary layers and the results are :

Objective of Y	Higher better/ Lower better / Nominal better
The upper boundary of Y	
The lower boundary of Y	Lower better
The nominal value of Y	

The rejection rate has reduced and the work standard has also been set up properly and the supply is also maintained commonly. DMAIC technique helps us to find the best results step by step by own ourselves. What we have implemented or what we have controlled result for that operation discussed earlier in the cycle operation.

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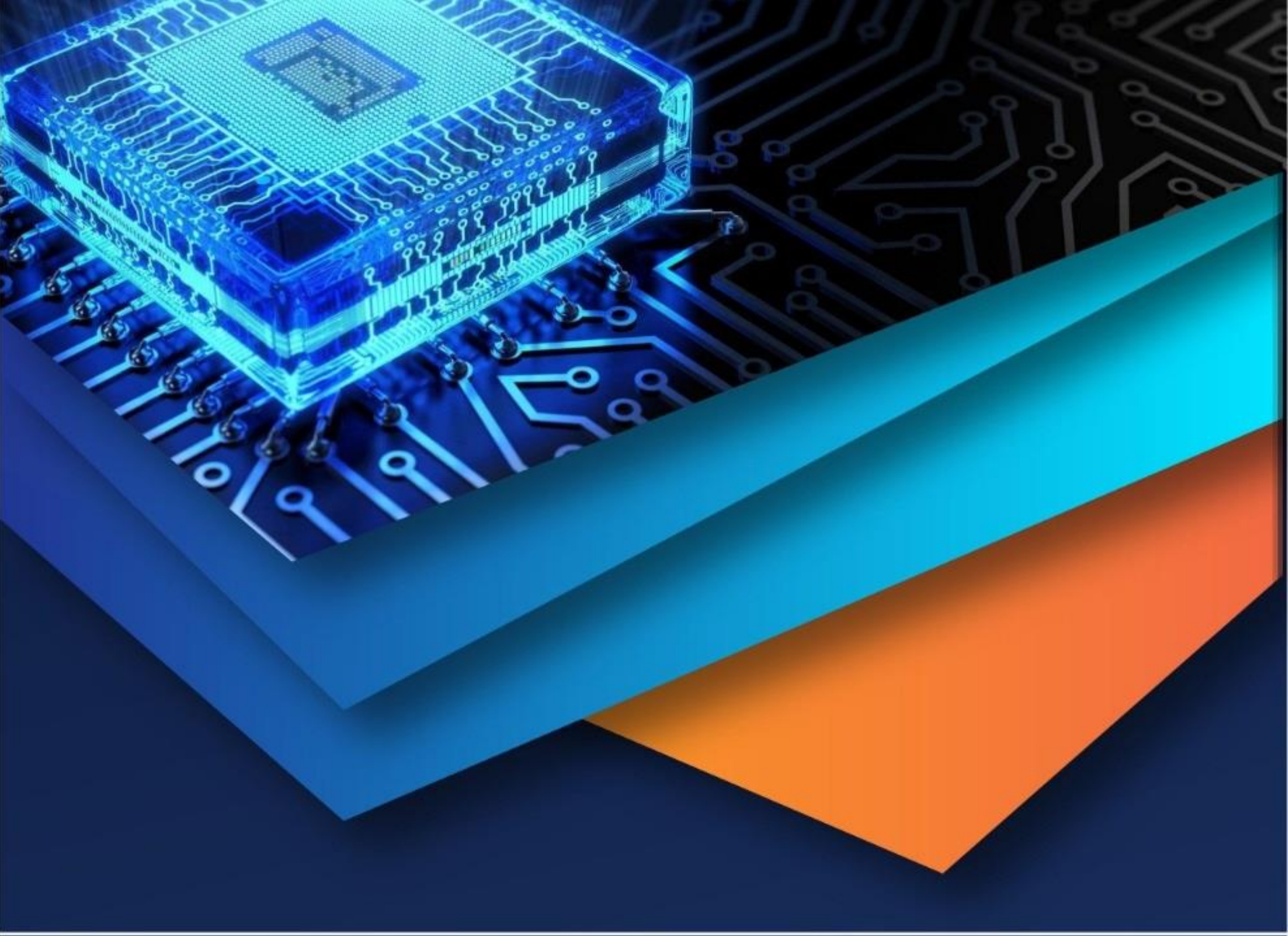

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