DR. BABASAHEB AMBEDKAR MARATHWADA

UNIVERSITY CHH. SAMBHAJINAGAR

PROJECT

REPORT ON

"Automatic Power Factor Control Panel Analysis"

Submitted in the partial fulfilment of the requirement for the award of

degree Of

Bachelor of

Engineering (EEE)

Developed by

Mr. Digvijay Achyut Mathkari

Ms. Vaishali Bhausaheb Tambe

Mr. Adesh Manohar Bhawar

Under the

guidance of

Prof. S.G. Tathe

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AND MANAGEMENT CH. SAMBHAJINAGAR

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This is to certify that project titled

“Automatic Power Factor Control Panel Analysis”

Submitted by

Mr. Digvijay Achyut Mathkari

Ms. Vaishali Bhausaheb Tambe

Mr. Adesh Manohar Bhawar

“Is completed as per requirement of

“Dr. Babasaheb Ambedkar Marathwada University Ch. Sambhajinagar (Mh).

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GUIDED BY | **H.O.D**

Prof. S. G. Tathe | **Prof. S. G. RATHOD**

DIRECTOR | **CAMPUS DIRECTOR**

Prof. H. L. JADHAV | **Dr. C. S. PADMAVAT**

Approval Sheet

This dissertation report entitled **"Automatic Power Factor Control Panel Analysis"** by the author Mr. Digvijay Achyut Mathkari, Ms.Vaishali Bhausaheb Tambe, Mr. Adesh Manohar Bhawar is approved for the degree of Bachelor of Engineering.

Examiners

Guide

HOD

Director

Campus Director

External Examiners

Date: / /2023-24

Place: Chh. Sambhajinagar

DECLARATION

I declare that this written submission represents my ideas in my own words and where other's ideas or words have been included, I have adequately cited and referenced the original sources. I also declare that I have adhered to all principles of academic honesty and integrity & have not misrepresented or fabricated any idea/data/fact/source in my submission. I understand that any violation of the above will cause for disciplinary action by the institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

Date- / / 2024

Signature

Mr. Digvijay Achyut Mathkari

Ms. Vaishali Bhausaheb Tambe

Mr. Adesh Manohar Bhawar

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ABSTRACT

In the present technological revolution power is very important, as the power demand in industrial and commercial load is increases. So we have to discover out the causes of control misfortune and progress the framework. Due to a variety of electrical and power electronics loads, the power system losses it's efficiency, hence causing leading and lagging power factor which gives heavy penalties to consumer by electricity board and also pollute the system environment. So we need to improve the power factor of the electrical system. It can be improved by using APFC system which can maintain constantly high power factor nearer to unity. Most of the load used in industries are inductive in nature due to this they consume reactive power which will affect the generation of plant. But in our ICEEM collage the load is capacitive so the power factor is in leading. The motive of this project is to build an Automatic Power Factor Control (APFC) panel, which is able to control the energy consumptions of a system and Automatically improve its power factor.

Keywords – Power factor, APFC system, Power factor correction, System efficiency, Capacitive load.

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Name of The Student

Mr. Digvijay Achyut Mathkari

Ms.Vaishali Bhausaheb Tambhe

Mr. Adesh Manohar Bhawar

1 INTRODUCTION

1.1 Introduction

In the present situation, power factor is one of the most precious and major issue. Any electrical load that operate on AC system that need apparent power, but apparent power is addition of active power and reactive power, but load consumed active power. Also, reactive power is important for load, because reactive power is the power required by the load and it get return to the power source.

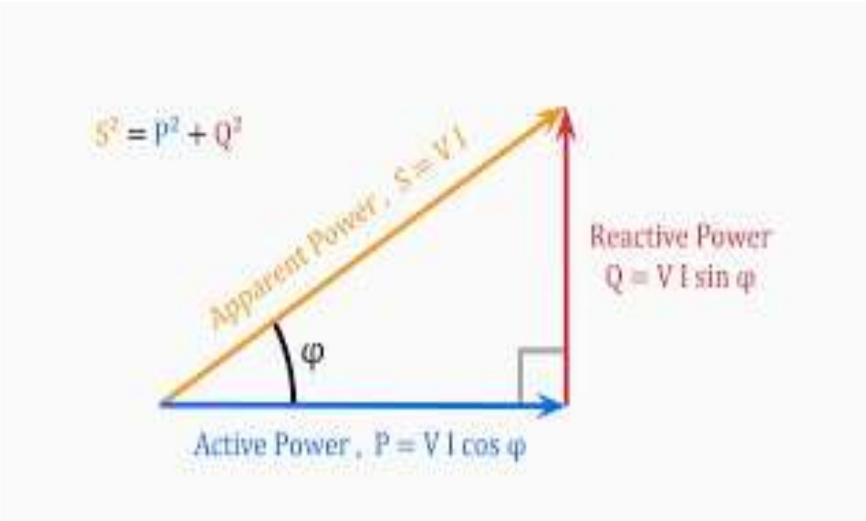


Fig.1.1 Power Triangle

Power factor $\cos\emptyset = \frac{\text{Active power}}{\text{Apparent power}} = \frac{\text{KW}}{\text{KVA}}$

Power factor is ratio of the active power(KW) to the apparent power (KVA) drawn by an electric load. It has been a limited effect on how current is being converted into useful work output and due to the good indicator the load current has effect on the efficiency of the supply system. In collage most of the load i.e. computer, UPS, etc. causing leading power factor that’s why there is loss and wastage of energy which result in high power billing and heavy penalty from electricity department. If the load is unbalanced it is complicated to maintain nearer to unity power factor. To solve this difficulty APFC panel is being used which keeps unity power factor. So many commercial and industrial loads need automatic power factor control system. In present time the cost of the electricity is higher, therefore it is important to compensate the electric power for reducing cost.

1.2 NECESSITY

APFC (Automatic Power Factor Control) panels are necessary for leading power factor for several reasons:

1. Efficiency: Leading power factor occurs when the load in an electrical system is capacitive, typically caused by equipment such as UPS, transformers, or capacitors themselves. A leading power factor reduces the overall system efficiency and increases losses in the distribution network.
2. Utility Penalties: Many utilities impose penalties for poor power factor. These penalties can significantly increase the electricity bill for industrial and commercial consumers. By maintaining a leading power factor close to unity (1), businesses can avoid these penalties.
3. Voltage Stability: Leading power factor can cause voltage instability in the electrical network, leading to voltage sags and fluctuations. APFC panels help stabilize the voltage by compensating for the leading power factor, thus ensuring a stable supply of electricity.
4. Capacity Optimization: By maintaining a leading power factor, the capacity of the electrical distribution system can be optimized. This means that the system can handle more load without requiring additional infrastructure upgrades, saving costs for the utility and consumers alike.
5. Equipment Protection: Operating at a leading power factor can also help in protecting electrical equipment from damage and premature aging. It reduces the stress on equipment such as transformers and cables, thereby extending their lifespan and reducing maintenance costs.

1.3 OBJECTIVES

The objectives of an APFC (Automatic Power Factor Control) panel typically include:

1. Power Factor Improvement: The primary objective is to improve the power factor of the electrical system. This involves reducing reactive power consumption and maintaining power factor close to unity (1), by compensating for a leading power factor.
2. Energy Efficiency: APFC panels help optimize energy usage by reducing losses in the electrical distribution system. By improving the power factor, the overall efficiency of the system increases, leading to energy savings and reduced electricity bills.
3. Utility Cost Reduction: Many utilities impose penalties for poor power factor. By installing APFC panels, businesses can avoid these penalties and reduce their overall electricity costs.
4. Voltage Stability: APFC panels contribute to maintaining voltage stability in the electrical network by compensating for reactive power. This helps prevent voltage fluctuations and ensures a stable supply of electricity to equipment and machinery.
5. Automation and Control: APFC panels are equipped with automatic control systems that monitor and adjust power factor in real-time. This automation ensures efficient operation without the need for constant manual intervention.

1.4 THEMES

The theme of an Automatic Power Factor Correction (APFC) panel could revolve around energy efficiency, sustainability, and optimizing power usage.

1.Energy Efficiency: Highlight the importance of optimizing power factor to reduce energy losses in electrical systems. Emphasize how APFC panels can help industries and businesses operate more efficiently by ensuring that they consume only the necessary amount of electricity.

2.Sustainability: Connect the project theme to the broader goal of sustainability by explaining how improving power factor contributes to reducing greenhouse gas emissions and environmental impact. APFC panels align with sustainability initiatives by promoting efficient use of resources and reducing electricity wastage.

3.Cost Savings: Showcase the financial benefits of installing APFC panels, such as lower electricity bills and reduced maintenance costs due to improved system efficiency. Demonstrate how investing in power factor correction can lead to long-term savings and increased profitability for businesses.

4.Technology and Innovation: Highlight the technological advancements and innovation behind APFC panels. Discuss the features and capabilities of modern APFC panel systems, such as real-time monitoring, automatic adjustment, and integration with smart grid technologies.

5.Industry Application: Explore the diverse applications of APFC panels across various industries, including manufacturing, commercial buildings, data centers, and renewable energy facilities. Illustrate how different sectors can benefit from implementing APFC solutions tailored to their specific power requirements.

2. LITRATURE SURVEY

2.1 Research Paper Referred

1. Design of microcontroller based Thyristor Controlled three-phase static volt-ampere reactive compensator, M. R. AminRajib Baran Roy Engineering

International Conference on Informatics engineering and information science 2014

To confine on system stability and reliability, the reactive power compensation is the fundamental way for Flexible AC Transmission System (FACTS). The variations of reactive power have an effect on the generating units, lines, circuit breakers, transformers, relays and isolators. Moreover the additional current flow associated with reactive power can be cause to increase losses and excessive voltage sags. Therefore the local Volt-Ampere Reactive (VAR) compensator which is comprised of shunt reactors is used in transmission and distribution system for reactive power compensation. The conventional electro-mechanical reactive power compensator is not suitable for its slow switching action which cannot proportionate with the rapid changing system load. The electronic reactive power compensator uses fast switching action than the conventional relay. The Static VAR Compensator (SVC) is the arrangement of Thyristor Switched Capacitor (TSC) and Thyristor Controlled Reactor (TCR). In this paper, microcontroller based three-phase SVC system is designed using thyristor controlled switch. Microcontroller is used for fast and precise switching of the thyristor which adds a significant feature of this designed SVC.

2. A Design of an Automatic Single Phase Power Factor Controller by Using Arduino Uno Rev3, N. H. IshakMuhammad Naim ZainodinN. A. SalimFaizal Muhamad Twon TawiAini Hafiza Mohd Saod Engineering, Computer Science, 2015

This paper presents a computationally accurate technique to design an automatic single phase power factor controller by using microcontroller. The hardware implementation was developed by using Arduino Uno Rev-3 main board which uses the ATmega328 as the microcontroller. The power factor value from the load was measured by using voltage and current transformers, zero crossing detectors, and ATmega328 microcontroller. Zero crossing detectors produced current and voltage signals which will be measured and calculated for the time difference between both signals by ATmega328 microcontroller using appropriate algorithms in order to obtain value of power factor. The ATmega328 is programmed to automatically switch on and off capacitor function in order to control the signal pulse send to relay to connect and disconnect capacitor parallel with the load when energized and de energized if the calculated power factor value is either below 0.9 or above 0.9, respectively. Simulation of the power factor controller model was performed by using Proteus software. Arduino IDE software was used as the compiler for the Arduino Uno. The main objective is to study and develop the technology of automatic single phase power factor controller using Arduino Uno Rev-3 by controlling the power factor of the inductive load near to unity power factor. The results of the power factor value were displayed on the LCD and the power factor is corrected if it falls below 0.9 in order to prevent penalty by the power supplier. The effectiveness of the proposed technique could assist the monitoring unit in order to maintain the power factor at the value set by the utility.

3. Design and Control of Automatic Power Factor Correction APFC for Power Factor Improvement in Oakshippin Primary Substation Soe WinnSu Mon MyintThida Win Ngwe Engineering International Journal of Trend in Scientific… 2018

This paper present a new method for power factor correction and the effect of shunt compensation for various loads. For the system stability and reliability, the reactive power compensation is essential for power system. Among of VAR compensation system, the automatic power factor correction is one of the compensation systems. Power factor control is a major role in the improvement of power system stability. Many of the existing systems are expensive and difficult to manufacture. Fixed capacitor systems are always leading power factor under at any load conditions. This is unhealthy for installations of power system. The proposed system used to reduce the cost of equipment and increase the efficiency of the system. KEYWORD: Reactive Power Compensation, VAR compensator, PF Improvement, Shunt Capacitor, Switching Relay Driver

4. Automatic Power Factor Correction for Single Phase Domestic Loads by Means of Arduino Based TRIAC Control of Capacitor Banks, Waqas AliH. FarooqMohsin JamilA. RehmanRana TaimoorMonib Ahmad, Engineering International Conference on Electrical, 2018

This paper presents the simple and low-cost design of an automatic power factor correction (APFC) system for single phase domestic loads. The proposed design uses TRIACs to switch the capacitor banks in order to correct the power factor of inductive loads. TRIACs are more effective than electro-mechanical relays and hit the high-performance benchmarks. The switching of TRIACs is controlled by an Arduino board. The Arduino is programmed to non-stop monitor and calculate the power factor of the connecting load by sensing the signal from CT, PT and Zero Cross Detectors (ZCDs), and keep the power factor of the load above the reference value (0.9) by appropriately energizing the capacitors in parallel to the connecting load through TRIAC switching. The values of power factor along with the current before and after improvement is displayed on LCD. The hardware prototype of the proposed APFC design is also developed to validate its operation. The satisfactory and acceptable results of the APFC system testing have confirmed that the suggested design yields a reliable output and can be further used in any single phase practical application to ensure the power factor close to unity.

5. Development of IoT Enabled Smart APFC Panel for Industrial Loads, P. BhagavathyR. LathaE. Thamizhmaran Engineering, Computer Science International Conference on Computing, 2019

The main concern of global economy is the generation and use of energy resources. There is a substantial increase in industrial loads that generate harmonics which results low power factor. Power factor is a key factor for improving power competency. The power factor should be as nearer to unity, leading to minimal reactive power. In the proposed work, Internet of Things (IoT) enabled microcontroller based hardware has been developed for automatic correction of power factor. By implement this system, the user can observe the variation of power factor as well as capacitor bank failure through the developed android application. The impact of variation of power factor due to capacitor bank failure is tabulated. Also the extensive results are included to illustrate the effective working of prototype.

6. Three Phase Reactive Power Compensation and Power factor correction by Using Static VAR Compensator (SVC), Ankush C. BawaneA. SheikhA. Halmare

Engineering, Physics,2021

In this paper, a reactive power compensation system using static VAR compensator is presented. To conform on system stability and reliability, the reactive power compensation is the fundamental way for flexible AC transmission systems (FACTS). The variations of reactive power have an effect on the generating units, lines, circuit breakers, transformers, relays and isolators. It can also cause effective voltage sags and increase losses. In the proposed system, the lead time between voltage pulse and current pulse are measured and fed to the interrupt pins of the microcontroller where the program takes over to bring the shunt capacitors to the circuit to get the reactive power compensated. Back-to-back SCRs interfaced through optical isolation from the microcontroller are used in parallel for controlling the capacitor.

7. Design of Control Circuit Using PIC Microcontroller for Automatic Power Factor Correction, Miss D. A Suryawanshi, Mr. Sujit, authors Magan Didul ,Published in International Journal of… 23 May 2022, Engineering

The power quality of AC systems has been a key issue in recent years because to the ever-increasing quantity of electronics equipment, power electronic equipment, and high voltage power systems. The majority of industrial installations in countries have substantial inductive electrical loads, resulting in a lagging power factor that has serious effects for energy users. As a result, reactive power compensation must be performed in the proper manner. Hence, we worked on this project and created Automatic Power Factor Correction (APFC) system using the PIC18f4520 microcontroller. APFC device measures the power factor, line voltage, and line current. The power factor is calculated using the system's voltage and current, and if it falls below a specified value defined by the utility provider, the device immediately activates capacitor banks to compensate for the reactive power. The phase angle and corresponding power factor are calibrated at that time. The mother board calculates the required compensation and activates the appropriate capacitor banks. This strategy can be used to increase the system's stability and efficiency in both industries and homes.

2.2 MARKET SURVEY

Compensators (APFC) Market size is expected to develop revenue and exponential market growth at a remarkable CAGR during the forecast period from 2023–2030. The growth of the market can be attributed to the increasing demand for Active Power Factor Compensators (APFC) owning to the Renewable Energy, Electric Utilities, Industrial & Manufacturing, Others Applications across the global level. It provides insights regarding the lucrative opportunities in the Active Power Factor Compensators (APFC) Market at the country level. The report also includes a precise cost, segments, trends, region, and commercial development of the major key players globally for the projected period.

The Active Power Factor Compensators (APFC) Market report represents gathered information about a market within an industry or various industries. The Active Power Factor Compensators (APFC) Market report includes analysis in terms of both quantitative and qualitative data with a forecast period of the report extending from 2023 to 2030. The report is prepared to take into consideration various factors such as Product pricing, Product or services penetration at both country and regional levels, Country GDP, market dynamics of parent market & child markets, End application industries, major players, consumer buying behavior, economic, political, social scenarios of countries, many others. The report is divided into various segments to offer a detailed analysis of the market from every possible aspect of the market.

The overall report focuses on primary sections such as – market segments, market outlook, competitive landscape, and company profiles. The segments provide details in terms of various perspectives such as end-use industry, product or service type, and any other relevant segmentation as per the market's current scenario which includes various aspects to perform further marketing activity. The market outlook section gives a detailed analysis of market evolution, growth drivers, restraints, opportunities, and challenges, Porter's 5 Force's Framework, macroeconomic analysis, value chain analysis and pricing analysis that directly shape the market at present and over the forecasted period. The drivers and restraints cover the internal factors of the market whereas opportunities and challenges are the external factors that are affecting the market. The market outlook section also gives an indication of the trends influencing new business development and investment opportunities.

3. PERFORMANCE ANALYSIS

3.1 INTRODUCTION

Types of Power Used in AC Circuit

AC circuit power is defined as the quantity of energy delivered by the circuit per unit of time. We will discuss the power factors in AC circuits and the types of power present in AC circuits further.

Alternating Current Power

Types of Power

Power in AC circuits is defined as the amount of energy delivered per unit of time by the circuit. It is used to calculate how much total power is required to run a load. In an AC circuit, the power factor is defined as the ratio of real power (P) and apparent power (S). The power factor can be expressed as a decimal or as a percentage. Alternating Current a current that varies its magnitude and polarity in regular intervals is known as an alternating current. It also can be described as an electrical current which changes or reverses direction on a regular basis.

Power

Electrical power is the rate at which energy is consumed inside a circuit. Therefore, all electrical and electronic devices and gadgets have a maximum amount of electrical power they can safely handle.

In AC circuits, however, the situation is more complicated. There are three types of power.

1. Active power
2. Reactive power
3. Apparent Power

1. Active Power

Active or genuine or real power refers to the quantity of power that is dissipated or that does productive work in the circuit. In power systems, it is calculated in watts but is more commonly expressed in (kilowatts) and (megawatts).It is equivalent to an average amount of $P=VI \cos \phi$ and is indicated by P (capital). The circuit or load is driven by the desired output of an electrical system.

$$P = VI \cos \phi$$

2. Reactive Power

Reactive power is the power that comes back and forth between the source and the load. Reactive power, indicated by the letter Q, is the component that is proportionate to $VI \sin\phi$. This is a power, but it is not calculated in watts because it is a non-active power, so it is calculated in Volt-Amperes-Reactive (VAR). The load power factor determines whether this reactive power is negative or positive. This is due to the fact that inductive loads absorb reactive power, whereas capacitive loads create it.

$$Q=VI \sin \phi$$

3. Apparent Power

The term apparent power refers to the complicated combination of true power and reactive power. The perceived power is equal to the multiplication of voltage and current, regardless of phase angle. The perceived power is helpful in determining the rating of power equipment. It can alternatively be written as the square of current times the impedance of the circuit. It is indicated by the symbol S and is calculated in volt-amperes, with (kilovolt-amperes) and (megavolt-amperes) as practical units.

$$S=VI$$

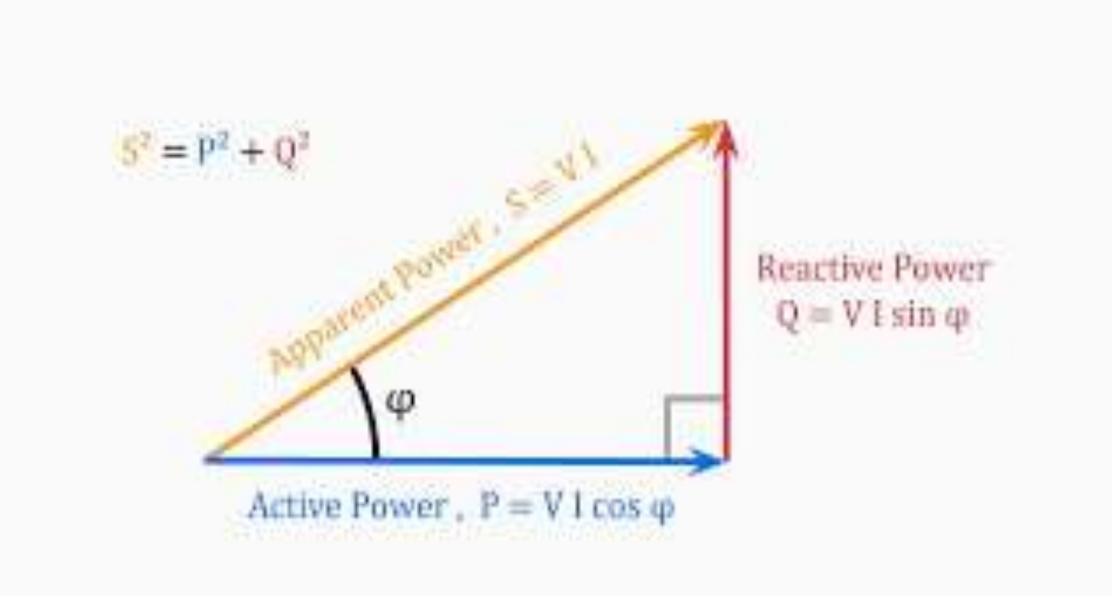


Fig 3.1 Power Triangle

Or we can write as, $S = I^2Z$Power Triangle

A power triangle is the relationship between active power, reactive power and apparent power that can be explained by describing numbers like the vector in the geometrical form.

The total of the squares of two sides (active power and reactive power) equals the squares of the diagonal, according to the Pythagoras theorem (apparent power). i.e.,

$S^2=P^2+Q^2$

That is, $S = \sqrt{((P^2+Q^2)}$

Power Factor

The ratio of the genuine power running across the circuit to an apparent power existing in the circuit is known as the power factor of the alternating current.

Power Factor = True power/Apparent power

Also, $\cos\Phi = R/Z$

Here, R represents resistance and Z represents impedance.

Importance of Power Factor

Power factor is critical because it dictates the quantity of currents flowing through the circuit and, as a result, the wire size that must be used.

3.2 EXPERIMENTAL ANALYSIS

Main meter readings on 19 April and 20 April

	19 April		20 April
	10AM	5PM	10AM
KWh	184385	184430	184674
KVAh	287724	287836	288331
KVARh	188809	188908	189337

Table no. 3.1 Main meter readings on 19 April and 20 April

Power Factor during 10 am to 5 pm on 19 April.

KWh = 184430 – 184385 = 45KWh

KVAh = 287836 – 287724 = 112KVAh

Power factor = $\frac{KWh}{KVAh} = \frac{45}{112}$ = 0.40 lead

Power Factor during 5 pm on 19 April to 10 am 20 April.

KWh = 184674 - 184430 = 244KWh

KVAh = 288331 – 287836 = 495KVAh

Power factor = $\frac{KWh}{KVAh} = \frac{244}{495}$ = 0.49 lead

Main meter readings on 22 April and 23 April

	22 April		23 April
	10AM	5PM	10AM
KWh	185402	185508	185799
KVAh	289712	289905	290456
KVARh	190480	190635	191102

Table no. 3.2 Main meter readings on 22 April and 23 April

Power Factor during 10 am to 5 pm on 22 April.

KWh = 185508 – 185402 = 106KWh

KVAh = 289905 – 289712 = 193KVAh

Power factor = $\frac{KWh}{KVAh} = \frac{106}{193}$ = 0.54 lead

Power Factor during 5 pm on 22 April to 10 am 22 April.

KWh = 185799 - 185508 = 291KWh

KVAh = 290456 – 289905 = 551KVAh

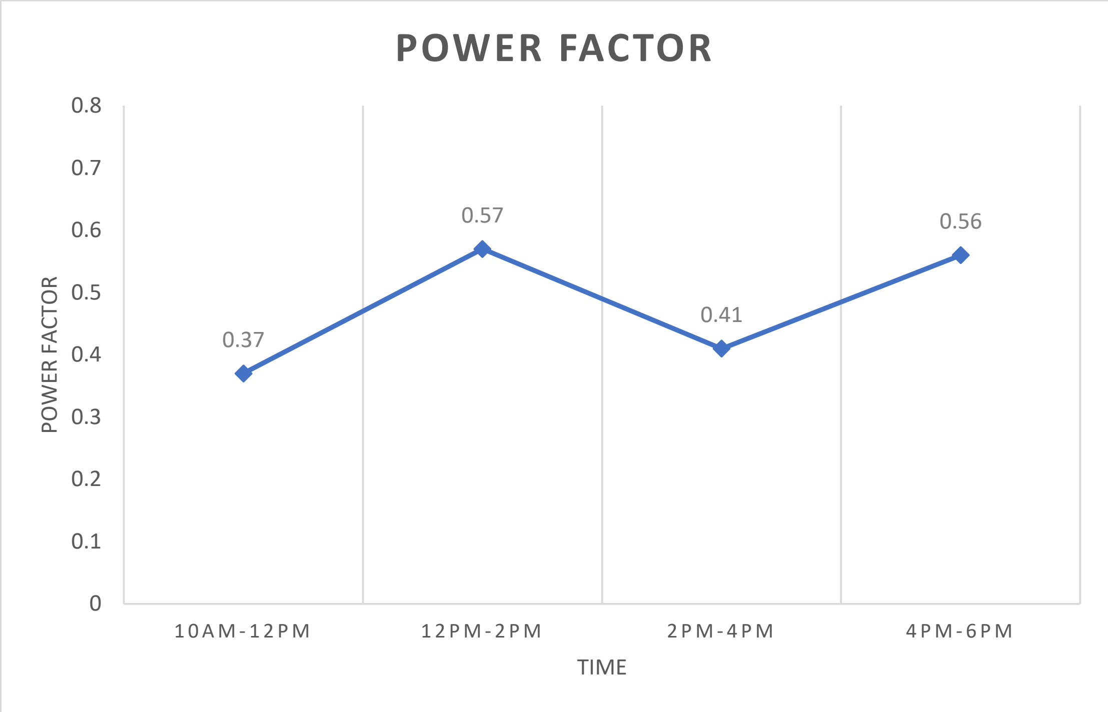
Power factor = $\frac{KWh}{KVAh} = \frac{291}{551}$ = 0.52 lead

Main meter readings on 22 April at every 2 hours' interval

	10AM	12PM	2PM	4PM	6PM
KWh	185799	185818	185842	185864	185900
KVAh	290456	290507	290549	290602	290666
KVARh	191102	191148	191181	191227	191279

Table no.3.3 Main meter readings on 22 April at every 2 hours interval

Power Factor on 22 April , on interval of 2 hrs.



Graph no.3.1 Power Factor on 22 April

LT panel readings on 22 April

	10AM			12PM			2PM			4PM			6PM		
	I (a)	V (v)	W (kw)	I (a)	V (v)	W (kw)	I (a)	V (v)	W (kw)	I (a)	V (v)	W (kw)	I (a)	V (v)	W (kw)
R	39	445	9.4	52	450	12.50	62	450	15	54	450	11	22	450	3.6
Y	42	445	10	50	450	12.50	57	450	13	56	450	11.5	18	450	1.9
B	45	445	10	48	450	11.50	56	450	13.5	47	450	13	22	450	2.4

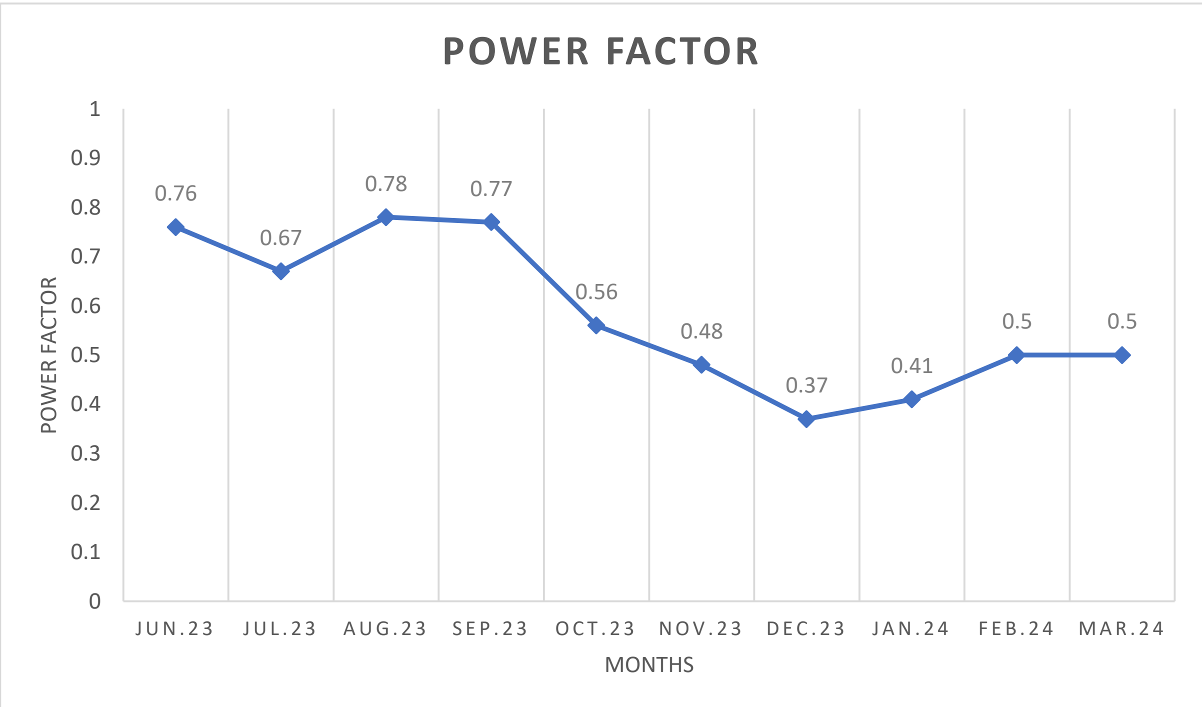
Table no.3.4 LT panel readings on 22 April

From June 2023 to March 2024 average monthly power factor

Months	Power factor
June 2023	0.76
July 2023	0.67
August 2023	0.78
September 2023	0.77
October 2023	0.56
November 2023	0.48
December 2023	0.37
January 2024	0.41
February 2024	0.50
March 2024	0.50

Table no.3.5 From June 2023 to March 2024 average monthly power factor

June 2023 to March 2024 average monthly power factor graph From



Graph no.3.2 Power Factor from June 2023 to March 2024 power factor

Observation readings and penalty form july 2023 to march 2024

Months	KWh	KVAh	Average Power Factor	Penalty in Rupees
July 2023	95794	115438	0.67	14668
August 2023	110320	135187	0.78	10613
September 2023	122760	152024	0.77	10353
October 2023	133460	171636	0.56	20391
November 2023	142680	191202	0.48	22643
December 2023	152712	218885	0.37	31803
January 2024	160356	237910	0.41	19498
February 2024	170040	257697	0.50	22503
March 2024	179633	277328	0.50	21288

Table no.3.6 Observation readings and penalty form July 2023 to March 2024

Sub meter readings on 19 April and 20 April

	19 April		20 April
	10AM	5PM	10AM
KWh	84044	84075	84170
KVAh	174985	175096	175373
KVARh	139833	139939	140194

Table no. 3.7 Sub meter readings on 19 April and 20 April

Power Factor during 10 am to 5 pm on 19 April.

KWh = 84075 – 84044 = 31KWh

KVAh = 175096 – 174985 = 111KVAh

Power factor = $\frac{KWh}{KVAh} = \frac{31}{111}$ = 0.27 lead

Power Factor during 5 pm on 19 April to 10 am 20 April.

KWh = 84170 - 84075 = 95KWh

KVAh = 175373 – 175096 = 277KVAh

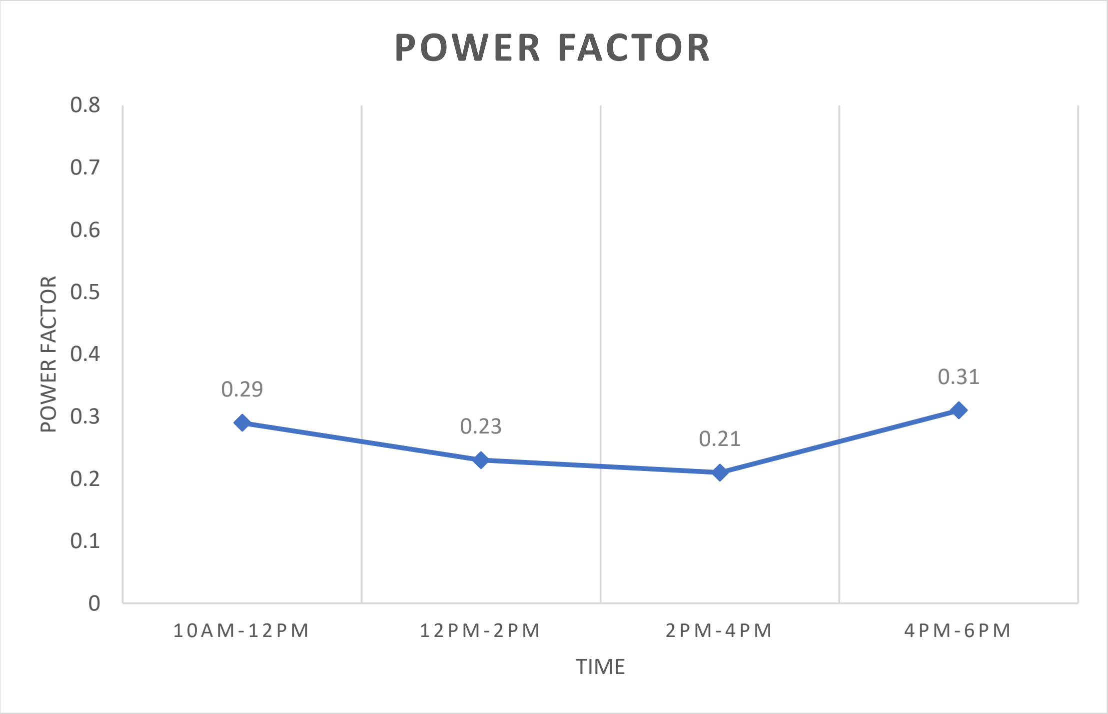
Power factor = $\frac{KWh}{KVAh} = \frac{95}{277}$ = 0.34 lead

Sub meter readings on 22 April on 2 hours of interval.

	10AM	12PM	2PM	4PM	6PM
KWh	84553	84562	84570	84577	84587
KVAh	176572	176603	176637	176669	176701
KVARh	141314	141342	141377	141408	141438

Table no. 3.8 Sub meter readings on 22 April on 2 hours of interval.

Power Factor on 22 April at 2 hours of interval



Graph no. 3.3 Power Factor on 22 April at 2 hours of interval

3.3 Solution

APFC stands for ‘automatic power factor control’. An APFC panel consists of multiple shunt reactors or capacitors of different ratings whose switching can be controlled as per requirement. An APFC is effective as a single-point installation which can be used to control the power factor for a large number of loads, instead of installing shunt reactor at the individual locations of each load.

An APFC panel consists of multiple shunt reactors and a controller. These shunt reactors have different ratings. The current from the circuit is sensed and given as input to the controller. The controller identifies how much reactive power is being generated in the circuit and tries to compensate it by switch in shunt reactors on or off.

Depending on the loads in operation, various levels of kVAr compensation are required to maintain proper power factor. The APFC panel contains a multi-step relay which is connected to multiple shunt reactors and a microprocessor controller which is programmed to control the switching operation of the relay. The voltage and current are measured on the feeder which is providing supply to the entire group of loads to determine the uncompensated power factor. Then, as per the ratings of the different shunt reactors used in the APFC and the measured uncompensated power factor, the controller determines which shunt reactors are to be switched on/off to achieve optimal power factor.

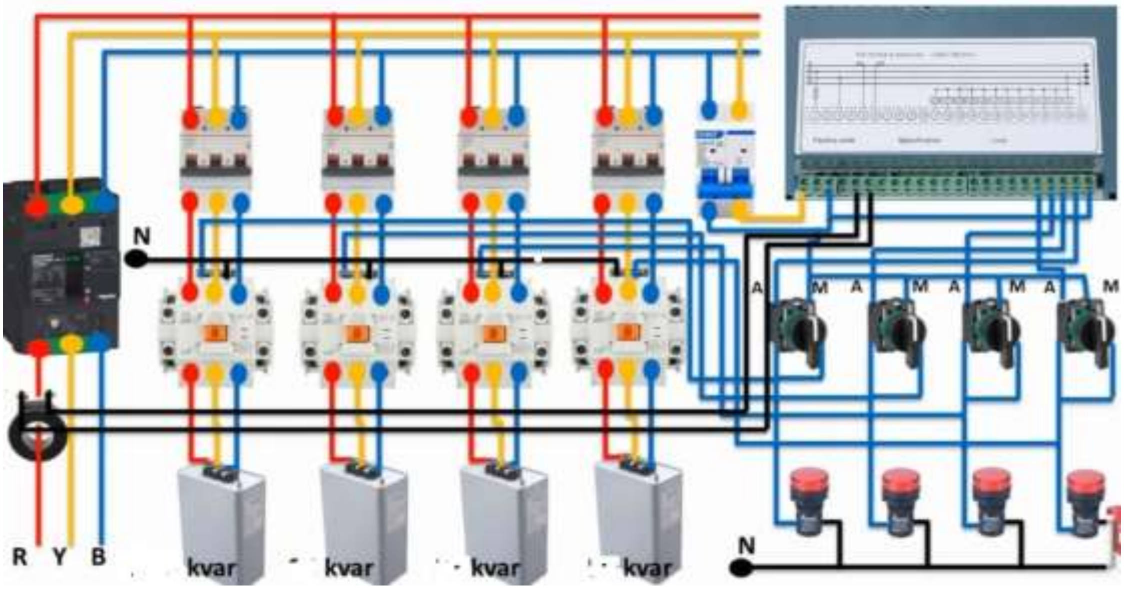


Fig no. 3.2 wiring diagram of APFC Panel

Calculations for required capacity of shunt reactor….

Total connected load = 35kw (average) 50 kw (maximum permission)

Power factor = Active power/ Apparent power = 8856KWH/19786KVAH

Actual power factor=0.44 (leading)

Desired power factor=0.99

Shunt reactor to be calculated =Total connected load*[tan. cos^-1(actual pf) - tan. cos^-1(desired pf)]

50*[tan. cos^-1(0.44) - tan. cos^-1(0.99] 35*[tan. (63.8)-tan. (8.10)] 66.14kvar

But we need compensation of reactive power so,

100-66.14=33.18kvar

Shunt reactor size=42kvar (We are considering extra 9kvar)

Approximate calculations of heat loss in apfc panel (reactor)

Shunt reactor capacity = 42 kvar

Average shunt reactor = 31 kvar

Generally, power loss is 15% of total capacity

15% of 31 =4.65 kwh

For 24 hours it will be

24*4.65 =111.6kwh

For 30 days it will be

111.6*30 =3348 units

Cost of per unit is 10 rupees.

3348* 10 = 33480 rupees.

But we get penalty of rupees 20,000

So a shunt reactor will not be effective in compensating for the leading power factor.

ASVG

A Static VAR (Volt-Ampere Reactive) Generator (SVG) is a power electronics device that controls the flow of reactive power in electrical power systems. It's also known as an active power factor compensator (APFC) or instantaneous step less reactive power compensator.

SVGs are used to improve energy efficiency and solve power quality problems caused by low power factor and reactive power demand. They can absorb or emit reactive power by adjusting the phase and amplitude of the inverter output voltage. SVGs are connected in parallel with the load that requires harmonics mitigation.

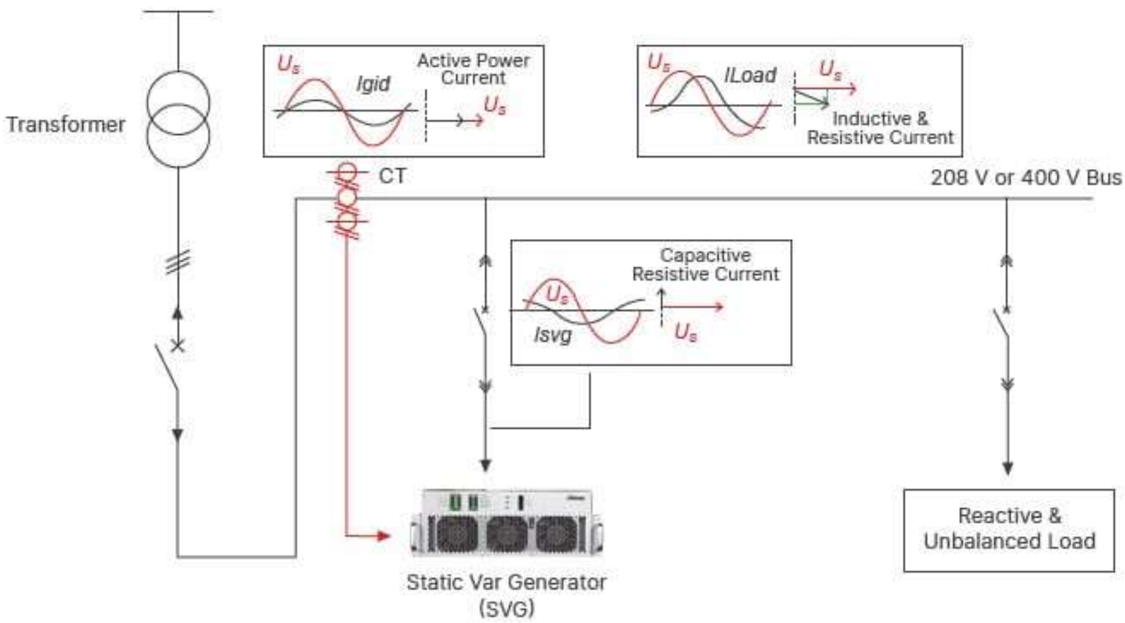


Fig 3.3 SVG diagram

The Static Var Generator, is a reactive power compensation system, used for compensation of normal or dynamic three-phase, balanced or unbalanced loads. The Static Var Generator (SVG) system is composed of a fixed-type Static Var Generator (SVG) module, a door mounted display monitor and a SVG system cabinet. The external CT is used for the detection of load current and extraction of reactive power that needs compensation, based on which, the Static Var Generator (SVG) controller controls the main power circuit to generate reverse reactive current in this way, the load-carrying reactive power is counteracted.

SVG Principle

The principle of the SVG is very similar to that of Active Power Filter, as demonstrated in the picture below. When the load is generating inductive or capacitive current, it makes load current lagging or leading the voltage. SVG detects the phase angle difference and generates leading or lagging current into the grid, making the phase angle of current almost the same as that of voltage on the transformer side, which means fundamental power factor is unit.

Here's a detailed step-by-step explanation of how reactive power compensation is achieved in a Static Var Generator (SVG):

1. Monitoring System Parameters:

- The first step involves continuously monitoring key system parameters such as voltage, current, power factor, and sometimes frequency. These parameters are typically measured using sensors and transducers placed at strategic points in the electrical system.

2. Control System Initialization:

- The control system of the SVG initializes by receiving input data from the monitoring system. This data includes real-time values of voltage, current, and power factor, which are crucial for determining the reactive power compensation requirements.

3. Reference Power Factor Setting:

- The system operator or control algorithm sets a reference power factor value. This value represents the desired power factor that the SVG should maintain in the system. It could be a fixed value or a dynamically changing value based on system conditions.

4. Calculating Reactive Power Requirements:

- Based on the measured parameters and the reference power factor, the control system calculates the reactive power requirements. This calculation considers the difference between the current power factor and the reference power factor, as well as the system's real and reactive power demands.

5. Determining SVG Operation Mode:

- The control system determines whether the SVG should operate in capacitive mode (absorbing reactive power) or inductive mode (injecting reactive power) based on the calculated reactive power requirements. This decision is crucial for controlling the output of the SVG.

6. VSC Control Signals Generation:

- Once the operation mode is determined, the control system generates control signals for the Voltage Source Converter (VSC) components, typically based on Pulse Width Modulation (PWM) techniques. These signals control the amplitude and phase angle of the output voltage from the VSC.

7. Adjusting VSC Output:

- The VSC adjusts its output voltage based on the control signals received from the control system. In capacitive mode, the VSC reduces the amplitude of the output voltage to absorb reactive power. In inductive mode, it increases the amplitude to inject reactive power.

8. Dynamic Response and Feedback:

- The control system continuously monitors the system's response to the SVG's output. It receives feedback from sensors and adjusts the control signals as needed to maintain the desired power factor and voltage stability. This feedback loop ensures a dynamic and accurate reactive power compensation process.

9. Harmonics Control (Optional):

- Some advanced SVGs also incorporate harmonics control features. They modulate the VSC output waveform to mitigate harmonics and improve overall power quality in addition to reactive power compensation.

10. Integration with SCADA or Supervisory Systems:

- SVGs are often integrated with SCADA (Supervisory Control and Data Acquisition) or supervisory systems. This integration allows for centralized monitoring and control of multiple SVGs in a network, optimizing reactive power compensation across the entire grid.

Heat loss calculation in ASVG

Capacity needs to be installed- 50kvar

Generally, power loss is 2.5% of total capacity of ASVG

2.5% of 50 = 1.25Kwh

For 24 hrs it will be

24*1.25= 30kwh

For 30 days it will be

30*30= 900 units

Cost of per unit is 10 rupees

So, 900*10= 9000 rupees

We get penalty of approximately 20000 rupees

Yes, ASVG is effective against the compensating leading power factor.

ADVANTAGES

Some advantages of an SVG include:

1. 3-level topology
2. 98% efficiency
3. Low losses
4. Hybrid compensation
5. Auto voltage stabilization
6. Eliminates grid resonance
7. Dual quad core DSP Processor
8. Inbuilt cloud connectivity

CONCLUSION

As the load is continuously varying with time, we need fully automatic control.

ASVG must be installed to avoid penalty & to mitigate harmonics (due to continuous switching of load)

Static Var Generators (SVGs) and Automatic Power Factor Control (APFC) panels serve different purposes in power systems. Here are the advantages of SVG over APFC panels.

1. **Dynamic Reactive Power Compensation**: SVGs can provide dynamic and continuous reactive power compensation, adjusting to rapid changes in load conditions. This dynamic response helps maintain a stable power factor and voltage profile in the system, which is not possible with traditional APFC panels that operate in a fixed or step-wise manner.

2**. Fast Response Time**: SVGs have a very fast response time, typically in milliseconds, making them highly effective in compensating for sudden changes in reactive power demand. APFC panels may have slower response times due to their switching mechanisms and control algorithms.

3. **Improved Power Quality**: SVGs can improve power quality parameters such as voltage stability, harmonics reduction, and flicker mitigation. They can actively regulate voltage and compensate for harmonic distortions, leading to better overall power quality compared to APFC panels, which primarily address power factor correction.

4**. Energy Efficiency:** SVGs can contribute to energy savings by optimizing reactive power compensation and reducing losses in the distribution system. Their ability to operate at varying loads and conditions improves overall energy efficiency.

Recommended Quotation(sample) –

Quotation

Ref No: SE/2024-182
Revision # 0
Date:27/04/2024

M/s ICEE Management, Aurangabad.
Kind Attn.: - Mr. Dighvijay Sir

Subject : 50 kVAR Advanced Static VAR Generator

Dear Sir,

We have pleasure in making offer for your requirement 50 kVAR Static VAR Generator (SVG).

Please find enclosed following in form of our offer: -

1. Price Schedule
2. Bill Of Material
50 kVAR Advanced Static VAR Generator (SVG) Panel.

We hope you will find our offer in line with your requirement & we look forward to favorable communication from you.

Thanking you,

for Specter Electric.

Yogesh B.(9970615253)

1. **SCHEDULE OF PRICES**

Sr. No.	Description	Qty	UOM	Supply Unit	Price Unit
1	Lumpsum price for design, preparationof detailed drawings, manufacture at vendor's works, Inspection of the following equipment's 50 kVAR Advanced Static VAR Generator (SVG) Panel . Make- Specter Electric	1	No.	225000.00	225000.00
2	Description of Charges	Qty/%	OfferScope	Supply Unit /Rate	Price Unit
2.01	Ex works Price				225000.00
2.02	Transport	0.0%	Excluded	Till Pune	
2.03	Packing	0.0%	Included	Bubble	
2.04	GST	18.00 %	Applicable		40000.00
2.05	Installation		Not Included		
2.06	Commissioning Support		Included		
2.07	Loading at our Factory		SE Scope		
2.08	Unloading at site		Client Scope		
2.09	Transit Insurance		Not Included		
2.10	GST (on item 2.06 to 2.09)	18.00 %			
2.11	Any other charges extra at actual				
2.12	Total 2.01 to 2.11				265500.00

Payment Terms: 80% in advance, 20% before the dispatch
Delivery Period: 5-6 Weeks
Warranty: 15 months from the date of Supply or 12 months from date of commissioning, whichever is earlier
THIS WARRANTY WILL NOT BE VALID IF:

1. Unauthorized person tampered with the unit or External Damage to Panel /Components.
2. The capacitors are subjected to over-voltage beyond the limits as per specifications.
3. If the panels are operated in high ambient temperature.
4. Air filter are found to be choked or not cleaned on regular basis.

EXCLUSIONS:

Our Scope of work shall be limited to items indicated in our Price Schedule &shall exclude the following:
All Erection related material supply & labor part.
1. All type of power & control cables supply, laying & termination required for LT side of transformer tothe incomer of PFC Relay.
2.Approval of Electrical inspector if required.

Note: The ASVG panel consists of sensitive devices like Thyristors, firing cards, Snubber, discharge cards, SMPS etc. which are very sensitive to temperature. SP strongly recommend providing efficient cooling arrangement for Better heat dissipation or Air Conditioning for these panel locations. It is advisable to ensure that the ASVG panels are not placed closeto furnace, heater or corrosive or dusty atmosphere. These simple precautions will ensure longer trouble-free efficient operation and minimize failures.

2.Bill Of Material

1. **50 kVAR Static VAR Generator (SVG).**

General Charactristics	
Electrical Specification	
Rated voltage	400V
Operating Voltage	380V-456V
Electric Connection	3 Phase 4 Wire/ 3 Phase 3 Wire
Rated Frequency	50/60Hz±5%
Compensation Mode	Reactive power compensation
	Harmonic compensation
	3 phase imbalance compensation
	Conventional capacitor switching
Harmonics Filtering Effect	Typically, THDi ≤ 5% at rated load
	(Even with most complex loads).
Filter range	2ndto 25^{th} odd order harmonics
	(Selective or Full compensation)
Rated of Harmonic Reduction	60% of rated ASVG
Target Power Factor	Adjustable from -1.0 to +1.0
3 Phase Load Balancing Effect	≤ 5%, Mitigate negative and zero sequence
Neutral Filtering Capacity	3 times the rated filter current (in case of 4 wire device)
Reactive Power	Both inductive and capacitive reactive
Compensation Capability	power compensation
3 phase imbalance performance	<5%(At the capacity is sufficient)
Imbalance Correction Capability	Mitigate negative and zero sequence
Overall Response time	≤ 5ms
Initial Response time	≤ 50us
Thermal Loss	≤ 2.5% of SVG rated capacity (kVA)
Output Current Limitation	Automatic (100% rated capacity)
Switching/control	25.6kHz frequency
Control Technology	
Human Machine Interface (HMI)	4" HMI(Touched&Colorized LCD Screen)
Topology	3 Level IGBT
Control algorithm	Intelligent FFT,Self-adaptive control algorithm
Controller	DSP+FPGA
Control connection	Fiber or electrical connection
Physical Specification	
IP Grade of Cabinet	IP20
Cooling method	Speed regulation intelligent air cooling PWM Fans
Noise Level	<60db (<45db during low-speed operation)
Protection	Hardware protection, Software protection
Environmental Requirement	
Ambient Temperature	20~55 °C
Relative Humidity	0~95%
Altitude	≤ 2000 at rated capacity;appropriately reduce the capacity
	if it is > 2000(1% derating per 100m

REFERENCES

[1] Reactive power management solutions by LARSEN AND TURBO Switchgear

[2] power electrical by Jignesh Parmar

[3] http://www.electricalnotes-apfcblockdiagram.com/

[4] International standards IEC 60831-1

[5] International standards IEC 60831-2

[6] J. Dungan Glover, Mulukts S.Sarma, Thomas G. Overbye."Power System Analysis and Design",

[7] [POWER FACTOR CORRECTION .] www.nhp.com.au. NHP catalogue -PFC

[8] http://www.electrosome.com

Electricity bill of collage of last 4 months

MAHAVITARAN

Maharashtra State Electricity Distribution Co. Ltd.

BILL OF SUPPLY FOR THE MONTH OF Nov 2023

000002246997130

GSTIN: 27AA ECM2933K1ZB | Website : www.mahadiscom.in | HSN CODE: 27160000

CH. SAMBHAJINAGAR (U:645 | CH. SAMBHAJINAGAR UR : 221 | WALUNJ S/DN. : 672 1

Consumer No. :	490017847403
Consumer Name :	InternationalCentreofExcellence in EnggandMgt
Adresss :	GUT NO 4 & 5 PANDHARPUL WALUJ AURANGABAD AURANGABA D Pandharpur (CT)
Village :	Pincode : 431136

BILL DATE	16-12-2023	1,51,320.00
DUE DATE	05-01-2024	
IF PAID UPTO	22-12-2023	1,50,040.00
IF PAID AFTER	05-01-2024	1,53,210.00
Last Receipt No./Date		/20-11-2023
Last Month Payment		1,61,470.00
Scale / Sector		Small Scale /PUBLIC SECTOR

Email ID :	dir*****@iceemabad.com			Activity :	SCHOOLS AND COLLEGES		
Mobile No. :	94******01	Meter No.:	055-X1962084	Seasonal :	N	Load Shed Ind :	
Tariff :	88 LT-VII B I	Connected Load (KW):	50.00 KW	Urban/Rural Flag :	U	Express Feeder Flag :	N
Contract Demand (KVA) :	63.00	40% of Con. Demand(KVA) :	25.20	Feeder Voltage (KV) :	11	LIS Indicator :	
Sanctioned load (KW) :	50.00 KW						
DTC :	6721907	PC-MR-ROUTE-SEQ :	00-01-0054-1321	BU :	4672	PC :	00

Date of Connection :	20-05-2022	Category :	LT-X PUBLIC SERVICES 20-50KW	GSTIN :	
Supply at :	LT	Elec. Duty :	06	PAN :	
Prev. Highest (Mth) :		Prev. Highest Bill Demand (KVA) :			
Security Deposit Held Rs. :	50,000.00	Addl. S.D. Demanded Rs :	00.00		
Bank Guarantee Rs. :	0.00	S.D. Arrears Rs. :	91,260.00		

BILLING HISTORY

Bill Month	Consumption (Units)	Bill Demand (KVA)	Bill Amount
Oct 2023	9,742	34	1,63,239.02
Sep 2023	12,007	39	1,91,605.45
Aug 2023	14,261	34	2,10,899.55
Jul 2023	10,611	30	1,64,585.92
Jun 2023	10,980	34	1,69,754.95
May 2023	15,210	40	2,20,229.65
Apr 2023	9,418	33	1,39,416.26
Mar 2023	13,343	36	1,84,845.59
Feb 2023	4,710	27	67,982.57
Jan 2023	3,865	25	55,712.09
Dec 2022	3,374	25	50,553.61
Nov 2022	1,254	25	27,918.25

CUSTOMER CARE Toll Free No.

1912, 1800-212-3435, 1800-233-3435

Rule & Procedure for Consumer Grievances Redressal is available at www.mahadiscom.in>consumer portal>CGRF Instead of Printed bill , register for E-bill and avail Rs. 10 per bill as a "Go-green " discount.For registration visit at www.mahadiscom.in->consumer portal->Quick access->Go-green request

For making Energy Bill Payment through RTGS/NEFT mode, use following details

- Beneficiary Name: **MSEDCL**
- Beneficiary Account Number:**MSEDCL01490017847403**
- IFS Code: **SBIN0008965**
- Name of Bank: **STATE BANK OF INDIA**
- Name of Branch: **IFB BKC**
- Bill Amount:**1,51,320.00**

Disclaimer: Please use above bank details only for payment against consumer number mentioned in beneficiary account number.

Important Message

- Consumers can pay online using Net Banking, Credit/Debit cards at https://wss.mahadiscom.in/wss/wss after registration.
- Submit / update your E-mail id and mobile number to Circle office for receiving prompt alerts through SMS.
- Submit / update your PAN and GSTIN to circle office with copies of PAN and GSTIN for verification.
- Special desk is operational for HT Consumers, please contact : htconsumer@mahadiscom.in for any clarification / query or grievance.
- This Electricity Bill should not be use for the address proof and as a proof of property ownership.
- For Any Payment to MSEDCL , ENSURE & INSIST for computerised receipt with unique system generated receipt number. Do not accept handwritten receipts. Pay online to avoid any inconvenience.

CURRENT CONSUMPTION DETAILS

Reading Date	KWH	KVAH	RKVAH (LAG)	RKVAH (LEAD)	KW (MD)	KVA (MD)
Current 30-11-2023	142680.400	191202.200	1378.800	103903.400	47.460	58.340
Previous 31-10-2023	133460.000	171636.000	1378.800	87189.000		
Difference	9220.400	19566.200	0.000	16714.400		
Multiplying Factor	1.000	1.000	1.000	1.000	1.000	1.000
Consumption	8305.000	19566.000	0.000	16714.000	47.000	58.000
LT Metering	0.000	0.000	0.000	0.000	0.000	0.000
Adjustment	0.000	0.000	0.000	0.000		
Assessed Consump	0.000	0.000	0.000		0.000	0.000
Total Consumption	8305.000	19566.000	0.000	16714.000	47.000	58.000

BILLING DETAILS

Billed Demand (KVA)	38	@ Rs.	422
Assessed P.F.		Avg. P.F.	0.480
Billed P.F.	0.480	L.F.	

Consumption Type	Units	Rate	Charges Rs.
Industrial	0	0.00	00.00
Residential	0	0.00	0.00
Commercial	8,305	9.40	78067.00

E.D. on(Rs)	Rate %	Amount Rs.
0.00	0	0.00
0.00	0	0.00
105,318.05	21	22116.79

TOD Zone	Rate	Units	Demand	Charges Rs.
2200 Hrs-0600 Hrs	-01.50	3167	48.00	-4,750.50
0600 Hrs-0900 Hrs & 1200 Hrs-1800 Hrs	00.00	3198	58.00	0.00
0900 Hrs - 1200 Hrs	00.80	126	42.00	100.80
1800 Hrs-2200 Hrs	01.10	1814	58.00	1,995.40

Amount in Words: ONE LAKH FIFTY ONE THOUSAND THREE HUNDRED TWENTY ONLY

Demand Charges	16,036.00
Wheeling Charge @ 01.17	9,716.85
Energy Charges	78,067.00
TOD Tariff EC	-2,654.30
FAC @ 00.50 Ps/U	4,152.50
Electricity Duty (21.00 %)	22,116.79
other charges	00.00
Tax on Sale @ 19.04 Ps/U	1,581.27
P.F. Penal Charges/P.F. Inc.	22,643.38
Charges For Excess Demand	00.00
Debit Bill Adjustment	00.00
TOTAL CURRENT BILL	**1,51,660.00**
Current Interest 13-12-2023	00.00
Principle Arrears	-342.52
Interest Arrears	00.00
Total Bill (Rounded) Rs.	1,51,320.00
Delayed Payment Charges Rs.	1,895.74
Amount Payable05-01-2024 After Amount Rounded to Nearest Rs.(10/-)	**1,53,210.00**

SOLAR NET METER CONSUMPTION DETAILS

SOLAR TARIFF	IMPORT			EXPORT			GENERATION		
	CURRENT	PREVIOUS	Units	CURRENT	PREVIOUS	Units	CURRENT	PREVIOUS	Units

Maharashtra State Electricity Distribution Co. Ltd.

BILL OF SUPPLY FOR THE MONTH OF Jan 2024

000002321998453

GSTIN: **27AAECM2933K1ZB** Website : www.mahadiscom.in HSN CODE: **27160000**

CH. SAMBHAJINAGAR (U:645 CH. SAMBHAJINAGAR UR : 221 WALUNJ S/DN. : 672 1

Consumer No. :	490017847403
Consumer Name :	InternationalCentreofExcellence in EnggandMgt
Adresss :	GUT NO 4 & 5 PANDHARPUL WALUJ AURANGABAD AURANGABA D Pandharpur (CT)
Village :	**Pincode :** 431136

BILL DATE	13-02-2024	1,14,640.00
DUE DATE	04-03-2024	
IF PAID UPTO	20-02-2024	1,13,660.00
IF PAID AFTER	04-03-2024	1,16,080.00
Last Receipt No./Date		/16-01-2024
Last Month Payment		1,74,300.00
Scale / Sector		Small Scale /PUBLIC SECTOR

Email ID :	dir*****@iceemabad.com			**Activity :**	SCHOOLS AND COLLEGES		
Mobile No. :	94******01	**Meter No.:**	055-X1962084	**Seasonal :**	N	**Load Shed Ind :**	
Tariff :	88 LT-VII B I	**Connected Load (KW):**	50.00 KW	**Urban/Rural Flag :**	U	**Express Feeder Flag :**	N
Contract Demand (KVA) :	63.00	**40% of Con. Demand(KVA) :**	25.20	**Feeder Voltage (KV) :**	11	**LIS Indicator :**	
Sanctioned load (KW) :	50.00 KW						
DTC :	6721907	**PC-MR-ROUTE-SEQ :**	00-01-0054-1321	**BU :**	4672	**PC :**	00

Date of Connection :20-05-2022		**Category :**	LT-X PUBLIC SERVICES 20-50KW	**GSTIN :**	
Supply at :	LT	**Elec. Duty :**	06	**PAN :**	
Prev. Highest (Mth) :		**Prev. Highest Bill Demand (KVA) :**			
Security Deposit Held Rs. :	50,000.00	**Addl. S.D. Demanded Rs :**	00.00		
Bank Guarantee Rs. :	0.00	**S.D. Arrears Rs. :**	91,260.00		

BILLING HISTORY

Bill Month	Consumption (Units)	Bill Demand (KVA)	Bill Amount
Dec 2023	9,419	38	1,76,122.92
Nov 2023	8,305	38	1,51,659.49
Oct 2023	9,742	34	1,63,239.02
Sep 2023	12,007	39	1,91,605.45
Aug 2023	14,261	34	2,10,899.55
Jul 2023	10,611	30	1,64,585.92
Jun 2023	10,980	34	1,69,754.95
May 2023	15,210	40	2,20,229.65
Apr 2023	9,418	33	1,39,416.26
Mar 2023	13,343	36	1,84,845.59
Feb 2023	4,710	27	67,982.57
Jan 2023	3,865	25	55,712.09

CUSTOMER CARE Toll Free No. 1912, 1800-102-3435, 1800-233-3435

Rule & Procedure for Consumer Grievances Redressal is available at www.mahadiscom.in>consumer portal>CGRF Instead of Printed bill , register for E-bill and avail Rs. 10 per bill as a "Go-green " discount.For registration visit at www.mahadiscom.in->consumer portal->Quick access->Go-green request

Scan this QR Code with BHIM App for UPI Payment

If paid by QR Code then Prompt Pay Discount/Delay Payment Charges will be adjusted in subsequent bill.

For making Energy Bill Payment through RTGS/NEFT mode, use following details

- Beneficiary Name: **MSEDCL**
- Beneficiary Account Number:**MSEDCL01490017847403**
- IFS Code: **SBIN0008965**
- Name of Bank: **STATE BANK OF INDIA**
- Name of Branch: **IFB BKC**
- Bill Amount:**1,14,640.00**

Disclaimer: Please use above bank details only for payment against consumer number mentioned in beneficiary account number.

Important Message

- Consumers can pay online using Net Banking, Credit/Debit cards at https://wss.mahadiscom.in/wss/wss after registration.
- Submit / update your E-mail id and mobile number to Circle office for receiving prompt alerts through SMS.
- Submit / update your PAN and GSTIN to circle office with copies of PAN and GSTIN for verification.
- Special desk is operational for HT Consumers, please contact : htconsumer@mahadiscom.in for any clarification / query or grievance.
- This Electricity Bill should not be use for the address proof and as a proof of property ownership.
- For Any Payment to MSEDCL , ENSURE & INSIST for computerised receipt with unique system generated receipt number. Do not accept handwritten receipts. Pay online to avoid any inconvenience.

CURRENT CONSUMPTION DETAILS

Reading Date	KWH	KVAH	RKVAH (LAG)	RKVAH (LEAD)	KW (MD)	KVA (MD)
Current 31-01-2024	160356.800	237910.800	1378.800	146254.400	44.580	51.120
Previous 31-12-2023	152712.800	218885.800	1378.800	129174.800		
Difference	7644.000	19025.000	0.000	17079.600		
Multiplying Factor	1.000	1.000	1.000	1.000	1.000	1.000
Consumption	6006.000	19025.000	0.000	17080.000	45.000	51.000
LT Metering	0.000	0.000	0.000	0.000	0.000	0.000
Adjustment	0.000	0.000	0.000	0.000		
Assessed Consump	0.000	0.000	0.000		0.000	0.000
Total Consumption	6006.000	19025.000	0.000	17080.000	45.000	51.000

BILLING DETAILS

Billed Demand (KVA)	33	@ Rs.	422
Assessed P.F.		Avg. P.F.	0.410
Billed P.F.	0.410	L.F.	
Consumption Type	**Units**	**Rate**	**Charges Rs.**
Industrial	0	0.00	00.00
Residential	0	0.00	0.00
Commercial	6,006	9.40	56456.40
E.D. on(Rs)	**Rate %**	**Amount Rs.**	
0.00	0	0.00	
0.00	0	0.00	
77,990.32	21	16377.97	

TOD Zone	Rate	Units	Demand	Charges Rs.
2200 Hrs-0600 Hrs	-01.50	2934	49.00	-4,401.00
0600 Hrs-0900 Hrs & 1200 Hrs-1800 Hrs	00.00	1273	46.00	0.00
0900 Hrs - 1200 Hrs	00.80	0	34.00	0.00
1800 Hrs-2200 Hrs	01.10	1799	51.00	1,978.90

Amount in Words: ONE LAKH FOURTEEN THOUSAND SIX HUNDRED FORTY ONLY

Demand Charges	13,926.00
Wheeling Charge @ 01.17	7,027.02
Energy Charges	56,456.40
TOD Tariff EC	-2,422.10
FAC @ 00.50 Ps/U	3,003.00
Electricity Duty (21.00 %)	16,377.97
other charges	00.00
Tax on Sale @ 19.04 Ps/U	1,143.54
P.F. Penal Charges/P.F. Inc.	19,497.58
Charges For Excess Demand	00.00
Debit Bill Adjustment	00.00
TOTAL CURRENT BILL	**1,15,010.00**
Current Interest 08-02-2024	00.00
Principle Arrears	-369.54
Interest Arrears	00.00
Total Bill (Rounded) Rs.	1,14,640.00
Delayed Payment Charges Rs.	1,437.62
Amount Payable04-03-2024 After Amount Rounded to Nearest Rs.(10/-)	**1,16,080.00**

SOLAR NET METER CONSUMPTION DETAILS

SOLAR TARIFF	IMPORT			EXPORT			GENERATION		
	CURRENT READING	PREVIOUS READING	Units	CURRENT READING	PREVIOUS READING	Units	CURRENT READING	PREVIOUS READING	Units
0000 Hrs-0600 Hrs& 2200 Hrs-2400 Hrs	61,537.60	58,311.40	3,226.00	00.00	00.00	00.00	00.00	00.00	00.00
0600 Hrs-0900 Hrs& 1200 Hrs-1800 Hrs	54,893.00	52,527.60	2,365.00	17,659.80	16,418.80	1,092.00	69,942.00	66,454.00	3,488.00

Maharashtra State Electricity Distribution Co. Ltd.

BILL OF SUPPLY FOR THE MONTH OF Feb 2024

000002356459373

GSTIN: 27AA ECM2933K1ZB | Website : www.mahadiscom.in | HSN CODE: 27160000

CH. SAMBHAJINAGAR (U:645 | CH. SAMBHAJINAGAR UR : 221 | WALUNJ S/DN. : 672 1

Consumer No. :	490017847403
Consumer Name :	InternationalCentreofExcellence in EnggandMgt
Adresss :	GUT NO 4 & 5 PANDHARPUL WALUJ AURANGABAD AURANGABA D Pandharpur (CT)
Village :	Pincode : 431136

BILL DATE	14-03-2024	1,56,770.00
DUE DATE	03-04-2024	
IF PAID UPTO	20-03-2024	1,55,450.00
IF PAID AFTER	03-04-2024	1,58,730.00
Last Receipt No./Date		/20-02-2024
Last Month Payment		1,13,660.00
Scale / Sector		Small Scale /PUBLIC SECTOR

Email ID :	dir*****@iceemabad.com			Activity :	SCHOOLS AND COLLEGES		
Mobile No. :	94******01	Meter No.:	055-X1962084	Seasonal :	N	Load Shed Ind :	
Tariff :	88 LT-VII B I	Connected Load (KW):	50.00 KW	Urban/Rural Flag :	U	Express Feeder Flag :	N
Contract Demand (KVA) :	63.00	40% of Con. Demand(KVA) :	25.20	Feeder Voltage (KV) :	11	LIS Indicator :	
Sanctioned load (KW) :	50.00 KW						
DTC :	6721907	PC-MR-ROUTE-SEQ :	00-01-0054-1321	BU :	4672	PC :	00

Date of Connection :	20-05-2022	Category :	LT-X PUBLIC SERVICES 20-50KW	GSTIN :	
Supply at :	LT	Elec. Duty :	06	PAN :	
Prev. Highest (Mth) :		Prev. Highest Bill Demand (KVA) :			
Security Deposit Held Rs. :	50,000.00	Addl. S.D. Demanded Rs :	00.00		
Bank Guarantee Rs. :	0.00	S.D. Arrears Rs. :	91,260.00		

BILLING HISTORY

Bill Month	Consumption (Units)	Bill Demand (KVA)	Bill Amount
Jan 2024	6,006	33	1,15,009.41
Dec 2023	9,419	38	1,76,122.92
Nov 2023	8,305	38	1,51,659.49
Oct 2023	9,742	34	1,63,239.02
Sep 2023	12,007	39	1,91,605.45
Aug 2023	14,261	34	2,10,899.55
Jul 2023	10,611	30	1,64,585.92
Jun 2023	10,980	34	1,69,754.95
May 2023	15,210	40	2,20,229.65
Apr 2023	9,418	33	1,39,416.26
Mar 2023	13,343	36	1,84,845.59
Feb 2023	4,710	27	67,982.57

CUSTOMER CARE Toll Free No. 1912, 1800-102-3435, 1800-233-3435

Rule & Procedure for Consumer Grievances Redressal is available at www.mahadiscom.in>consumer portal>CGRF Instead of Printed bill , register for E-bill and avail Rs. 10 per bill as a "Go-green " discount.For registration visit at www.mahadiscom.in->consumer portal->Quick access->Go-green request

Scan this QR Code with BHIM App for UPI Payment

If paid by QR Code then Prompt Pay Discount/Delay Payment Charges will be adjusted in subsequent bill.

For making Energy Bill Payment through RTGS/NEFT mode, use following details

- Beneficiary Name: **MSEDCL**
- Beneficiary Account Number:**MSEDCL01490017847403**

- IFS Code: **SBIN0008965**
- Name of Bank: **STATE BANK OF INDIA**
- Name of Branch: **IFB BKC**
- Bill Amount:**1,56,770.00**

Disclaimer: Please use above bank details only for payment against consumer number mentioned in beneficiary account number.

Important Message

- Consumers can pay online using Net Banking, Credit/Debit cards at https://wss.mahadiscom.in/wss/wss after registration.
- Submit / update your E-mail id and mobile number to Circle office for receiving prompt alerts through SMS.
- Submit / update your PAN and GSTIN to circle office with copies of PAN and GSTIN for verification.
- Special desk is operational for HT Consumers, please contact : htconsumer@mahadiscom.in for any clarification / query or grievance.
- This Electricity Bill should not be use for the address proof and as a proof of property ownership.
- For Any Payment to MSEDCL , ENSURE & INSIST for computerised receipt with unique system generated receipt number. Do not accept handwritten receipts. Pay online to avoid any inconvenience.

CURRENT CONSUMPTION DETAILS

Reading Date	KWH	KVAH	RKVAH (LAG)	RKVAH (LEAD)	KW (MD)	KVA (MD)
Current 29-02-2024	170040.600	257697.000	1378.800	162953.200	46.560	54.320
Previous 31-01-2024	160356.800	237910.800	1378.800	146254.400		
Difference	9683.800	19786.200	0.000	16698.800		
Multiplying Factor	1.000	1.000	1.000	1.000	1.000	1.000
Consumption	8856.000	19786.000	0.000	16699.000	47.000	54.000
LT Metering	0.000	0.000	0.000	0.000	0.000	0.000
Adjustment	0.000	0.000	0.000	0.000		
Assessed Consump	0.000	0.000	0.000		0.000	0.000
Total Consumption	8856.000	19786.000	0.000	16699.000	47.000	54.000

BILLING DETAILS

Billed Demand (KVA)	35	@ Rs.		422
Assessed P.F.		Avg. P.F.		0.500
Billed P.F.	0.500	L.F.		
Consumption Type	**Units**	**Rate**		**Charges Rs.**
Industrial	0	0.00		00.00
Residential	0	0.00		0.00
Commercial	8,856	9.40		83246.40
E.D. on(Rs)	**Rate %**	**Amount Rs.**		
0.00	0			0.00
0.00	0			0.00
109,768.32	21			23051.35
TOD Zone	**Rate**	**Units**	**Demand**	**Charges Rs.**
2200 Hrs-0600 Hrs	-01.50	3599	53.00	-5,398.50
0600 Hrs-0900 Hrs & 1200 Hrs-1800 Hrs	00.00	3042	54.00	0.00
0900 Hrs - 1200 Hrs	00.80	252	37.00	201.60

Demand Charges	14,770.00
Wheeling Charge @ 01.17	10,361.52
Energy Charges	83,246.40
TOD Tariff EC	-3,037.60
FAC @ 00.50 Ps/U	4,428.00
Electricity Duty (21.00 %)	23,051.35
other charges	00.00
Tax on Sale @ 19.04 Ps/U	1,686.18
P.F. Penal Charges/P.F. Inc.	22,502.51
Charges For Excess Demand	00.00
Debit Bill Adjustment	00.00
TOTAL CURRENT BILL	**1,57,010.00**
Current Interest 11-03-2024	00.00
Principle Arrears	-238.73
Interest Arrears	00.00

MAHAVITARAN

Maharashtra State Electricity Distribution Co. Ltd.

BILL OF SUPPLY FOR THE MONTH OF Mar 2024

000002388888383

GSTIN: 27AA ECM2933K1ZB | Website : www.mahadiscom.in | HSN CODE: 27160000

CH. SAMBHAJINAGAR (U:645 | CH. SAMBHAJINAGAR UR : 221 | WALUNJ S/DN. : 672 1

Consumer No. :	490017847403
Consumer Name :	InternationalCentreofExcellence in EnggandMgt
Adresss :	GUT NO 4 & 5 PANDHARPUL WALUJ AURANGABAD AURANGABA D Pandharpur (CT)
Village :	Pincode : 431136

BILL DATE	17-04-2024	1,48,240.00
DUE DATE	07-05-2024	
IF PAID UPTO	23-04-2024	1,46,990.00
IF PAID AFTER	07-05-2024	1,50,100.00
Last Receipt No./Date		/19-03-2024
Last Month Payment		1,55,450.00
Scale / Sector		Small Scale /PUBLIC SECTOR

Email ID :	dir*****@iceemabad.com			Activity :	SCHOOLS AND COLLEGES		
Mobile No. :	94******01	Meter No.:	055-X1962084	Seasonal :	N	Load Shed Ind :	
Tariff :	88 LT-VII B I	Connected Load (KW):	50.00 KW	Urban/Rural Flag :	U	Express Feeder Flag :	N
Contract Demand (KVA) :	63.00	40% of Con. Demand(KVA) :	25.20	Feeder Voltage (KV) :	11	LIS Indicator :	
Sanctioned load (KW) :	50.00 KW						
DTC :	6721907	PC-MR-ROUTE-SEQ :	00-01-0054-1321	BU :	4672	PC :	00

Date of Connection :	20-05-2022	Category :	LT-X PUBLIC SERVICES 20-50KW	GSTIN :	
Supply at :	LT	Elec. Duty :	06	PAN :	
Prev. Highest (Mth) :		Prev. Highest Bill Demand (KVA) :			
Security Deposit Held Rs. :	50,000.00	Addl. S.D. Demanded Rs :	00.00		
Bank Guarantee Rs. :	0.00	S.D. Arrears Rs. :	91,260.00		

BILLING HISTORY

Bill Month	Consumption (Units)	Bill Demand (KVA)	Bill Amount
Feb 2024	8,856	35	1,57,008.36
Jan 2024	6,006	33	1,15,009.41
Dec 2023	9,419	38	1,76,122.92
Nov 2023	8,305	38	1,51,659.49
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Jun 2023	10,980	34	1,69,754.95
May 2023	15,210	40	2,20,229.65
Apr 2023	9,418	33	1,39,416.26
Mar 2023	13,343	36	1,84,845.59

CUSTOMER CARE Toll Free No. 1912, 1800-102-3435, 1800-233-3435

Rule & Procedure for Consumer Grievances Redressal is available at www.mahadiscom.in>consumer portal>CGRF Instead of Printed bill , register for E-bill and avail Rs. 10 per bill as a "Go-green " discount.For registration visit at www.mahadiscom.in->consumer portal->Quick access->Go-green request

Scan this QR Code with BHIM App for UPI Payment

If paid by QR Code then Prompt Pay Discount/Delay Payment Charges will be adjusted in subsequent bill.

For making Energy Bill Payment through RTGS/NEFT mode, use following details

- Beneficiary Name: **MSEDCL**
- Beneficiary Account Number:**MSEDCL01490017847403**

- IFS Code: **SBIN0008965**
- Name of Bank: **STATE BANK OF INDIA**
- Name of Branch: **IFB BKC**
- Bill Amount:**1,48,240.00**

Disclaimer: Please use above bank details only for payment against consumer number mentioned in beneficiary account number.

Important Message

- Consumers can pay online using Net Banking, Credit/Debit cards at https://wss.mahadiscom.in/wss/wss after registration.
- Submit / update your E-mail id and mobile number to Circle office for receiving prompt alerts through SMS.
- Submit / update your PAN and GSTIN to circle office with copies of PAN and GSTIN for verification.
- Special desk is operational for HT Consumers, please contact : htconsumer@mahadiscom.in for any clarification / query or grievance.
- This Electricity Bill should not be use for the address proof and as a proof of property ownership.
- For Any Payment to MSEDCL , ENSURE & INSIST for computerised receipt with unique system generated receipt number. Do not accept handwritten receipts. Pay online to avoid any inconvenience.

CURRENT CONSUMPTION DETAILS

Reading Date	KWH	KVAH	RKVAH (LAG)	RKVAH (LEAD)	KW (MD)	KVA (MD)
Current 31-03-2024	179633.200	277328.600	1378.800	179698.000	39.420	45.140
Previous 29-02-2024	170040.600	257697.000	1378.800	162953.200		
Difference	9592.600	19631.600	0.000	16744.800		
Multiplying Factor	1.000	1.000	1.000	1.000	1.000	1.000
Consumption	8610.000	19632.000	0.000	16745.000	39.000	45.000
LT Metering	0.000	0.000	0.000	0.000	0.000	0.000
Adjustment	0.000	0.000	0.000	0.000		
Assessed Consump	0.000	0.000	0.000		0.000	0.000
Total Consumption	8610.000	19632.000	0.000	16745.000	39.000	45.000

BILLING DETAILS

Billed Demand (KVA)	29	@ Rs.	422
Assessed P.F.		Avg. P.F.	0.500
Billed P.F.	0.500	L.F.	

Consumption Type	Units	Rate	Charges Rs.
Industrial	0	0.00	00.00
Residential	0	0.00	0.00
Commercial	8,610	9.40	80934.00

E.D. on(Rs)	Rate %	Amount Rs.
0.00	0	0.00
0.00	0	0.00
103,842.00	21	21806.82

TOD Zone	Rate	Units	Demand	Charges Rs.
2200 Hrs-0600 Hrs	-01.50	4140	37.00	-6,210.00
0600 Hrs-0900 Hrs & 1200 Hrs-1800 Hrs	00.00	2162	45.00	0.00
0900 Hrs - 1200 Hrs	00.80	125	38.00	100.00

Demand Charges	12,238.00
Wheeling Charge @ 01.17	10,073.70
Energy Charges	80,934.00
TOD Tariff EC	-3,708.70
FAC @ 00.50 Ps/U	4,305.00
Electricity Duty (21.00 %)	21,806.82
other charges	00.00
Tax on Sale @ 19.04 Ps/U	1,639.34
P.F. Penal Charges/P.F. Inc.	21,287.61
Charges For Excess Demand	00.00
Debit Bill Adjustment	00.00
TOTAL CURRENT BILL	**1,48,580.00**
Current Interest 14-04-2024	00.00
Principle Arrears	-333.76
Interest Arrears	00.00