Industrial Power Management Utility Using LabVIEW

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ABSTRACT:In this paper, it proposes to monitor industrial power data and power management using a LabVIEW application. An industrial application can be done using a remote control in today's world. LabVIEW is one of the useful and easy development software to monitor and control the industrial system. This LabVIEW stands for laboratory Instrumentation Engineering Workbench. It is the G programming language. Irrespective of good experience in a programming language, LabVIEW is very easy and user-friendly. By using LabVIEW its ease to communicate with an external real-world signal, as well as one can process this data in programming can produce a result as required. Using this user-friendly software one can design very easy, simple and graphical Human Machine Interface which can be interfaced with external hardware through communication protocol too.

KEYWORDS:LabVIEW, Application, Industrial Power Management, Energy Monitoring, Utility.

I.INTRODUCTION

At the present time, Automation is extremely valuable and one of the important aspects in Industry applications. As well as Industrial Power Management plays a vital role in Industrial automation sector. With the initial investment in embedding an automation in the industry will save the cost in long-term perspective. If there are more hardware circuits, there will more wiring connection and complexity for control. Which is very hard and time-consuming to design traditional complex engineering for a control system with accuracy. But, automation in the industry not only to decreases manpower and complexity but also increase the work performance with accuracy. To manage the power which gets utilized in the industry, you need to keep monitor power consumption daily. So, some industry automation technics will serve this very well. As day by day, the technology is improving, the LabVIEW software made engineering design easy with less hardware. An application using LabVIEW will help to monitor power consumption in the industry. Now distance control is possible with ease, we can use different communication methods like ethernet, wireless technics to communicate with a computer and other industrial devices. LabVIEW can be used to design virtual instruments instead of costly and heavy equipment in the industry.

The LabVIEW is development software of company called National Instruments. LabVIEW stands for Laboratory Virtual Instrumentation Engineering Workbench. It is the G programming language. Where G indicates Graphical. It can also be called as data flow programming because in order to execute the program it depends on block diagram programming structure. Using LabVIEW one can design application to monitor real-world data to analyze or represent data in the various format like Graph, report, display. Compare to text-based programming LabVIEW programming is more flexible and user-friendly because to develop program need to connect the relevant block to each other through wiring. The DAQ hardware used here is a custom designed and fabricated hardware as per requirement of the application. In which there is one energy monitoring IC and one microcontroller to process data from energy monitoring IC and to make it available at peripheral for external accesses through a communication protocol.

In this paper, it proposes a LabVIEW application and communication with embedded hardware. Here. DAQ hardware will grab all energy-related data and will pass it to the connected computer on which LabVIEW application is running. One of the primary objectives of this LabVIEW application is to facilitate an efficient monitoring of power in the industry.

II.HARDWARE

To Acquire data from the real world we will need some measuring hardware and sensors which will measure real-world signals, process them and convert it into the digital world for our use. It can be possible using ready to use DAQ hardware, sensors and open source which are available in the market like Arduino, BananaPi, RaspberryPi, Beaglebone etc. But with the help of an embedded system and hardware, we can build custom DAQ (Data Acquisition) card. Custom hardware gives you more flexibility. You can design it as per your application use. Here we are using STM's product ARM Cortex M0 Microcontroller and Analog Device's Energy metering IC to measure 3 phase power data. Embedded code is written in C/C++ using eclipse IDE. A code is written in such manner that it fetches data from Energy metering IC over SPI communication protocol and then process that power data and make it available at MCU's UART peripheral to communicate with LabVIEW utility through USB.
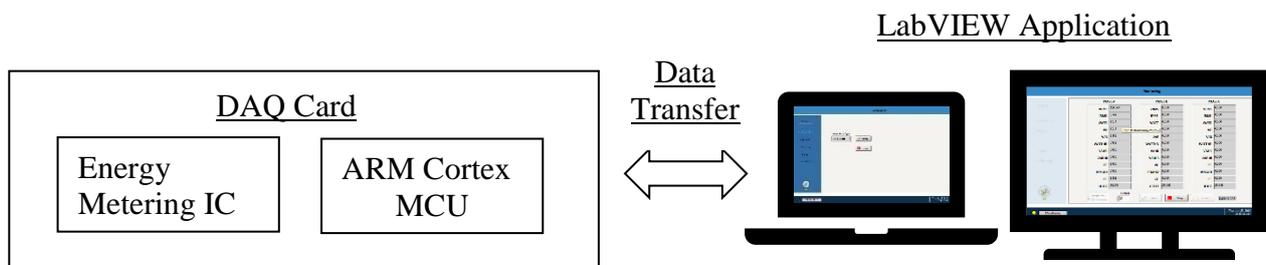
III.APPLICATION DESIGN PATTERN

A design pattern means a well-established solution to a common problem. Design patterns are needed to save time and improve longevity and readability of the code. There are few application design patterns in LabVIEW programming.

1) State Machine/Statecharts,
2) An event-driven user interface,
3) Producer/Consumer,
4) A queued state machine,

Also, there are criteria for well-developed design software application. It's called 'SMoRES'.
• Scalable - Code should be scalable so that it can be scaled to another level.
• Modular - Application should be modular so that the if it could be broken up into well-defined components that it should be standing on their own and working stand alone.
• Reusable - If the code de-coupled from the current application, it could be reused in the future project.
• Extensible - It should be that extensible that new model could be added with less modification.
• Simple - Design solution should be simple which satisfies the listed criteria and all requirements of the application.

For this application Producer/Consumer design pattern is used. Because we wanted to execute loops in parallel and at the asynchronous rate, but as well need to communicate between them. Two or multiple processes need to execute at the same time but need to be independent of each other. Also, need to make sure one doesn't slow down other processes. So, Producer/Consumer design pattern serves this problem's solution. Producer/Consumer design pattern having data independent loops, master-slave relationship, communication, and asynchronization between loops.
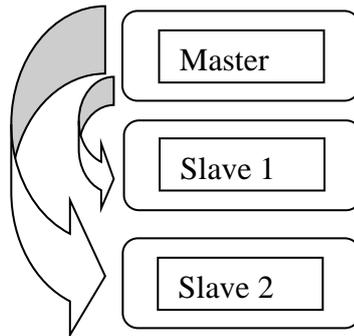
Fig. 2 Master slave Relationship between loops

In the fig 2, It shows Master-Slave relationship between loops. One or more slave loops told by a master loop when they can run. Data-independence allows multi-threading. This allows for the asynchronous execution of loops.
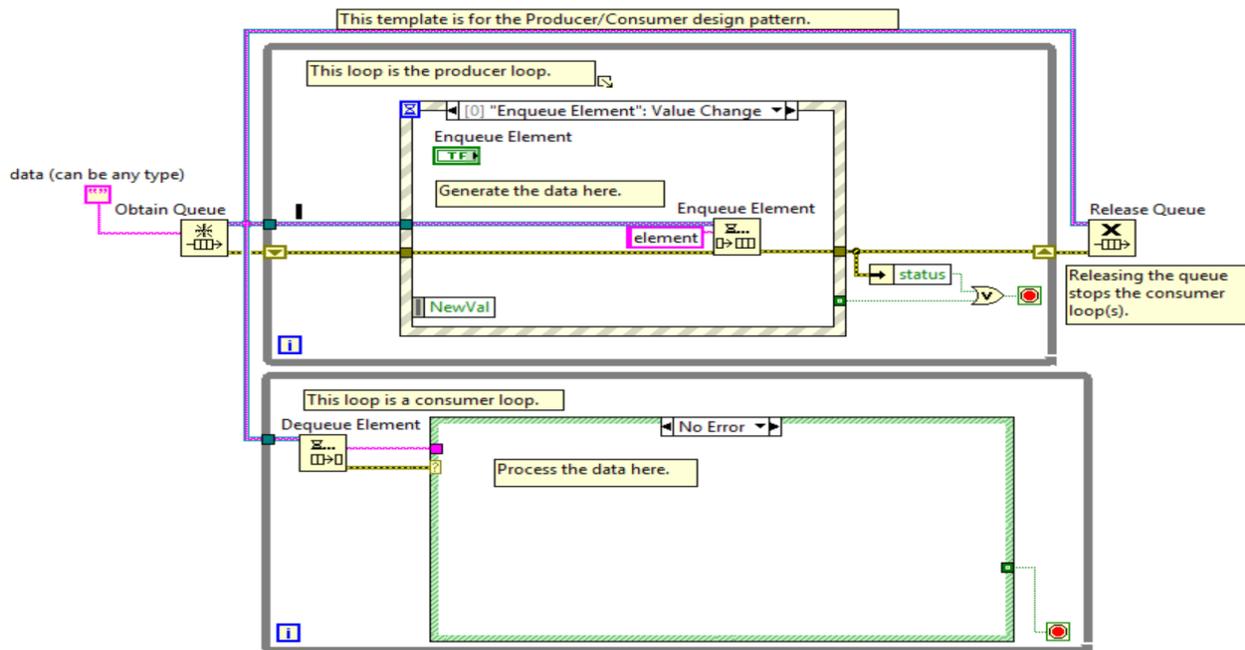
Fig. 3 Producer/Consumer Design Pattern

In fig 3, It shows the Producer/Consumer design pattern. This design pattern is used because to handle multiple processes simultaneously and asynchronous operation of loops. This design pattern is based on a master/slave pattern and it is designed towards enhanced data sharing between multiple loops running at a different speed rate. The producer/consumer design pattern decouple processes that produce and consume at different rate. The loops here are broken into two categories, one that produces and one those consume the data produced. We need to consider multiple producers to one consumer and one queue per consumer.
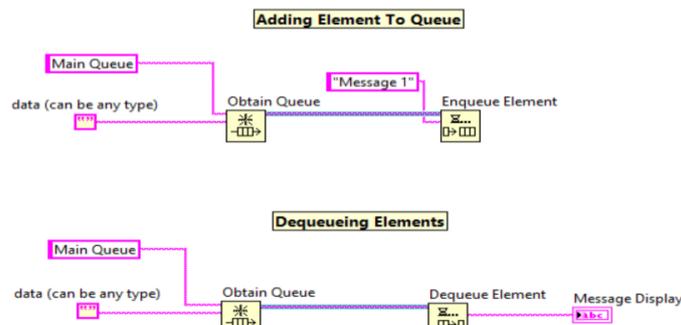
Fig. 4 Data Queues

In above figure 4, It shows data queues. Data queues are used to interact between loops in Producer/Consumer design pattern. The queues are important for the data buffering between Producer and Consumer loop. The producer loop will use this data queues to buffer user interface data for consumer loop. The queues are FIFO based. So, because of first-in/first-out, data will always be analyzed by the consumer in the same order as they are placed into the queue by producer loop. So, the producer will produce data for the consumer, it will be adding data into the queue. Adding data into the queue is called Enqueue. A consumer will be removing data from that queue. Removing data from the queue is called Dequeue.

IV. IMPLEMENTATION IN LABVIEW

In LabVIEW, there are two windows. One is a Block Diagram, and another is a Front panel. The Front panel is a user interface for an end user, and block diagram is for graphical programming. A user interface gives users a method to interact with backend code. It's a medium to communicate with source code by changing the values passed to source code or view the data that the source code computes. In LabVIEW, a user interface is Front End. In application development, during the design phase, it is very important to decide the inputs and outputs for a user interface. You can acquire input a device such as DAQ or reading directly from files and you can display output using indicators like graphs, charts, LEDs or you can log to the file.
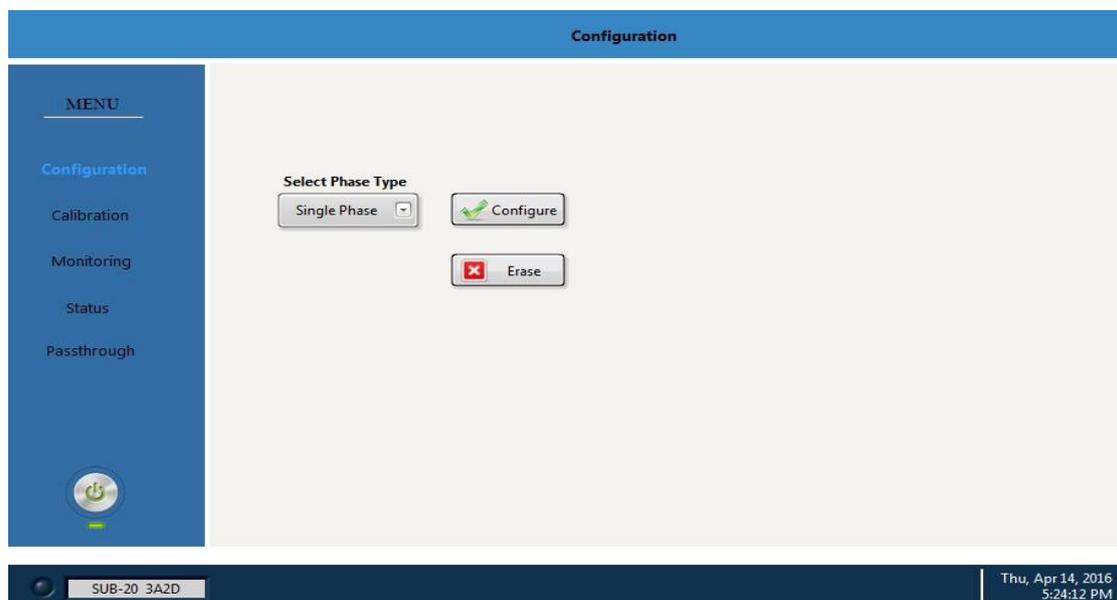
Fig. 5 Front End User Screen

In fig 5, It shows the home screen of power management utility. Here the first step is to configure this utility by selecting phase type from drop-down menu in the configuration tab. There are threetypes of phase to choose. 1) Single phase, 2) Three Phase Wye, 3) Three Phase Delta.

Once clicking on the configuration button. A utility will get configured for respected phase type. Erase Button is to erase utility configuration. So that we can erase all set configuration before switching to another phase type. The utility works in such a manner that to monitor the power data for the respected phase as you select.You need to configure utility to that respected phase type. By doing so, it will enable particular phase monitoring only and disable other, which saves unnecessary data fetching time. For example. If you want to monitor only asingle phase. So, at the backend code for single phase monitoring event, it will only fetch single phasepower data and not all three-phase data. For that case-structure is utilized. Depending on the phase select event in configuration tab will change cases of the case structure.
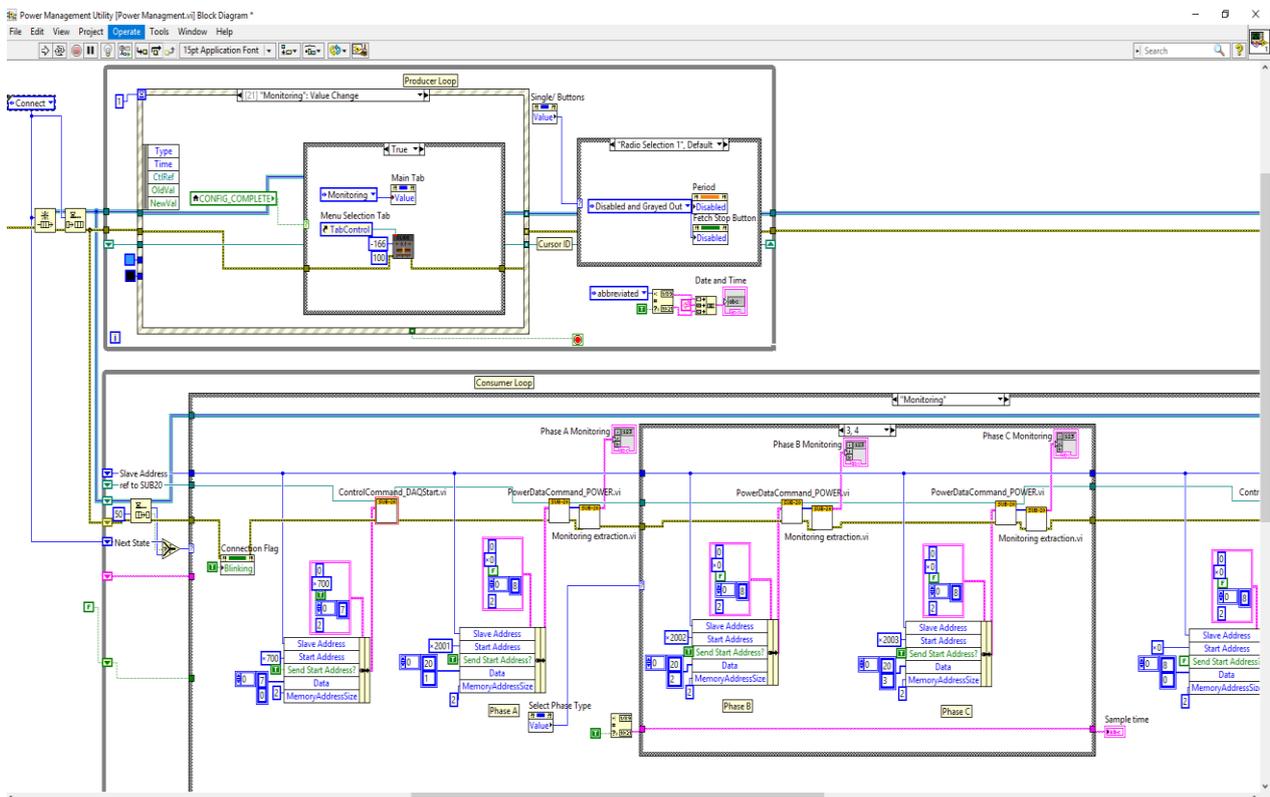
Fig. 6 Block Diagram

In the above figure 6, It's a block diagram of power management utility. As we are using Producer/Consumer design pattern, at the upside of code there is Producer loop and below that there is Consumer loop. Both are interacted by the queued method. Whenever a user clicks push button or makes any event through the front panel of application, an event occurs at event structured in producer loop. This triggered event is handled in respected event and message is passed in the queue for consumer loop. The Consumer loop will dequeue the message element from the queue and serve its respective function as per message. For instance, if a user clicks on the fetch button (appeared in figure 8) then, an event will occur at event structure in producer loop. So, event structure will perform that event and will add the message into the queue for the consumer that perform fetch task. Then Consumer loop will receive this message from dequeuing and it will perform fetch task and will display its output in phase monitoring indicators. See Consumer loop in details below in figure 7.
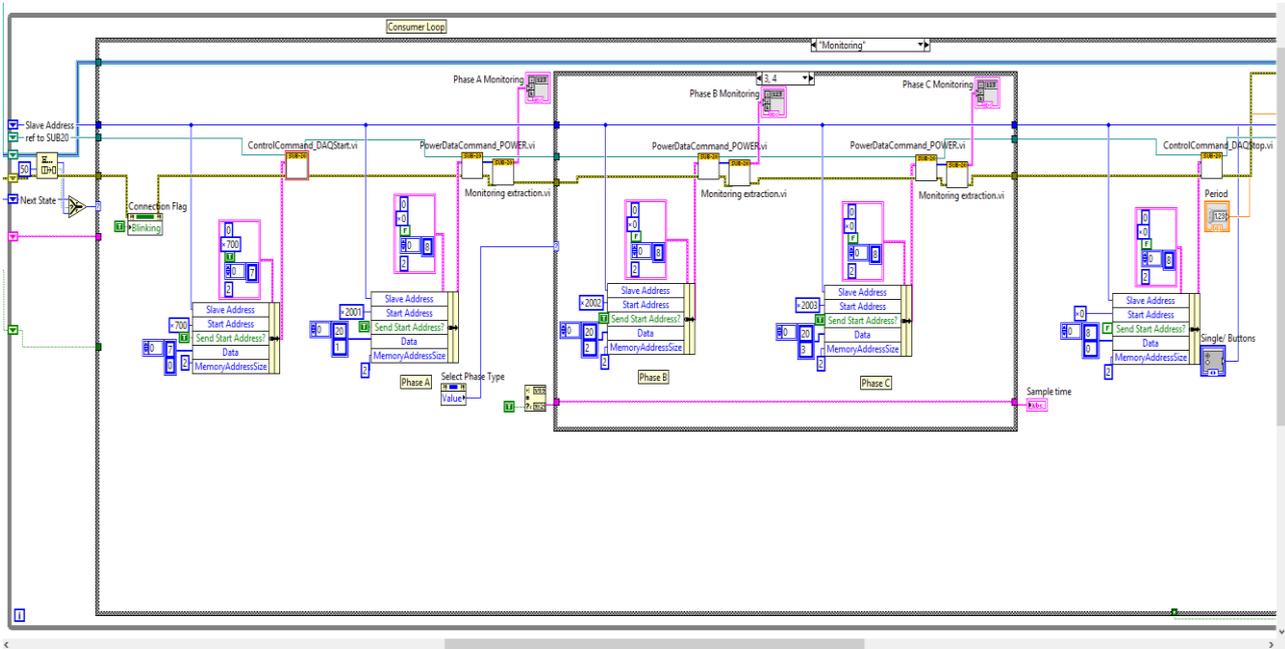
Fig. 7 Consumer Loop
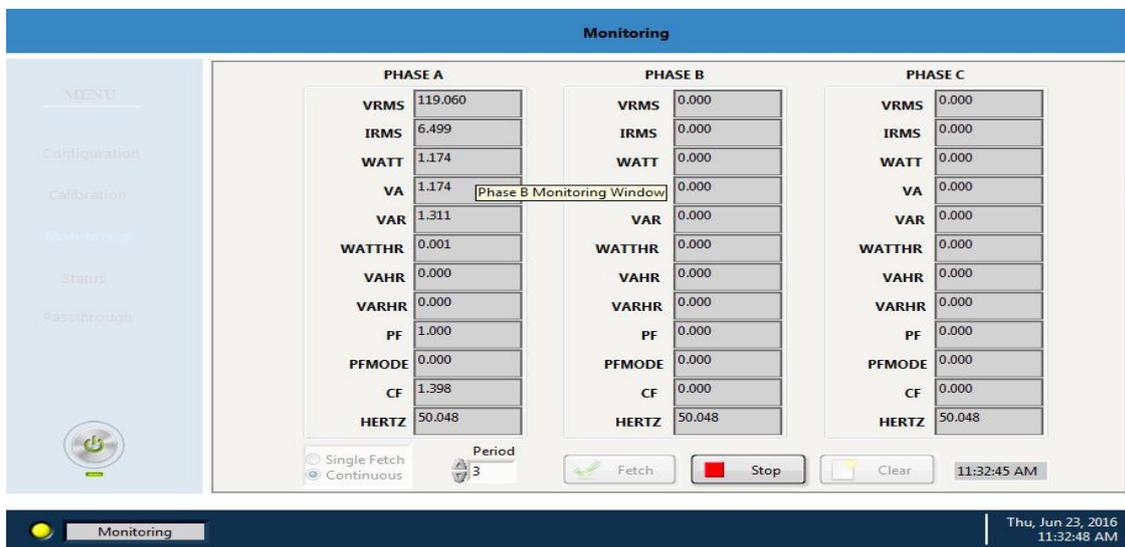
Fig. 8 Three Phase Monitoring Tab

In fig 8, It shows three phase monitoring tab. In which it displays all three-phase AC power parameters like Voltage and Current RMS value, WATT, WATT/hr, Power Factor, Hertz, etc. At the back-end of application, it is fetching a power data from DAQ card and displaying it on the monitoring tab after computing.

There is two option provided here for power data fetch. One is single fetch and other is continuous data fetch for some period. Three push buttons are there. Two are for start & stop fetching and the third push button is to clear monitoring data. Every push-button event is handled by event structure in producer loop. There is one time-stamp indicator next to clear push button. This timestamp indicates the time when data get fetched. All this power data with time stamp get logged in excel sheet for other use.
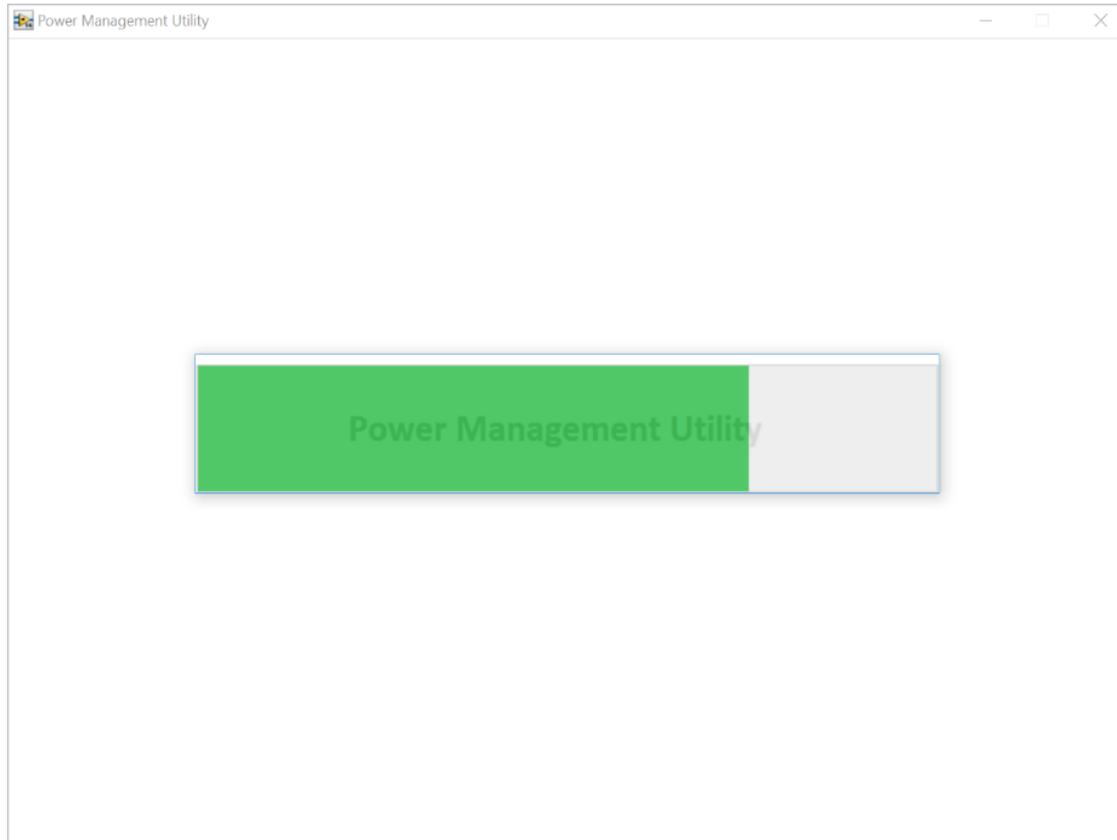
Fig. 9 Progress Bar

In fig 9, It shows a graphical progress bar which used as a part of the front-end/user interface of power management utility. It is a vital thing in application designing, that to create visually appealing, well- structured and organized user interface. Since a user interface is generally what the end client going to work with. In this way, it is vital to make user interface simple, straightforward and intuitive as possible. As said user interface should be visually appealing, so this graphical progress bar gives eye-catching effect instead of simply waiting for the process to wrap up. This graphical progress bar is used to inform a user to wait while process gets finished. One can use graphics like this to make a user interface more visually appealing.

VI.CONCLUSION

In this aggressive world, a product needs to cost worthy that too profoundly effective compared to another contender. All factories have been modernized using automation. The industrial automation played a vital role in this sector. This Power management utility using LabVIEW has a fewpoints of interest over customary power management technology. A large amount of all three-phase power data and power consumption data can be monitored on a single window of the application. No need of all the distinctive sort of power measuring and monitoring devices for every phase and an excessive number of wirings for each one of them. All the power data can be measured and calculate other data like WATT/hr, VRMS, IRMS using only power metering IC and MCU. This information will get exchanged through USB cable to PC on which is LabVIEW application is running. Huge power data logs, daily report generation is additionally done using this application which saves a lot of documentation and man work. Furthermore, this project spares a wiring expense and complexity which can be possible to reduce more in future using wireless communication if required. Moreover, an industrial large power consuming machine's and device's power can be possible to control using further implementation of hardware like relay logic board. The objective of our paper is easily understandable, economical and a user-friendly, visually appealing human-machine interface to monitor industrial power data and management can be done using the LabVIEW application.

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