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Electric Meter with Reliability Credit and Cost Control

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***Abstract*: The present system of energy billing in India is error prone and also time and labour consuming. Errors get introduced at every stage of energy billing like errors with electro-mechanical meters, human errors while noting down the meter reading and error while processing the paid bills and the due bills. The remedy for this drawback is a prepaid energy billing. A GSM-based Energy Recharge Interface which contains a prepaid card equivalent to a mobile SIM card. The prepaid card communicates with the power utility using GSM communication network. Once the prepaid card is out of balance, the consumer load is disconnected from the utility supply by the latching Relay (contactor). The power utility can recharge the prepaid card remotely through SMS mode base on customer requests. GSM-Based Recharge System (GBRS) for single phase prepaid meter has been modelled and simulated in Matlab/Simulink environment. A prior billing is bound to do away with the problems of unpaid bills and human error in meter readings, thereby ensuring justified revenue for the utility. In electric meter with reliability credit and cost control we have provide only one time extra credit when consumer needed in emergency. The cost of the energy charge per unit as per government rules and regulations is controlled by the authorized person only. So that charges of energy per unit is managed.**

Keywords: **GSM (Global System for Mobile), RTC (Real Time Clock), PIC Controller.**

I. INTRODUCTION

The revolution of mobile technology has made the PREPAID system prominent in INDIA. There are many brighter faces of PREPAID system person has to simply pay in advance for any future consumption. So we have decided to make the prepaid electric meter with extra credit and cost control. GSM Modem is mainly used to introduce the pre-paid concept in electric meter. GSM which stands for Global System for Mobile Communication is widely used mobile communication architecture used in most of the countries. With the help of GSM modem one can embed a feature of pre-paid through mobile, also one can recharge electric meter through mobile by SMS. The GSM modem loads the recharge amount in one of the register of controller. For each pulses received at interrupt pin, the controller decrement the content of the register which is equivalent to the recharged amount left. If the content of the register falls below the threshold level, the controller activates the GSM to send a message to the user which indicates that amount left in the meter is low. In this paper, we implement the centralized monitoring of energy consumption, while making it prepaid. i.e., consumers can recharge their Energy Meters for an amount of their choice. Recharging is similar to that of a mobile phone.

The GSM transmits the exchanged data between the end-users, which are the EB Station and the customer. The use of GSM module provides a feature of pre-paid through SMS. The keypad is used to get banking information from an electricity customer, and the LCD will display the user's account balance and the present electricity rate. PIC controller count the amount of energy consumed and display the remaining amount of energy on the LCD. When the balance goes below the threshold, the GSM module will automatically send a reminder text message to the user to refill the account. Once this amount expires, the connection will be terminated automatically, using the relays within the meter itself.

To implement the project ELECTRIC METER WITH RELIABILITY CREDIT AND COST CONTROL, the consumer has to buy an GSM recharge card and fit in the prepaid energy meter kit. Once the card is fitted, the user should press the recharge button which will load the system as per the value of the recharge card. An LCD is used to read the units value. For every 1000 units, 1 unit is subtracted. The count and unit values are stored in the GSM card and data is not lost even when there is power failure. Once the recharged units become zero, the system generates continuous beep sound and current becomes zero. For reusing the system, a new recharge card has to be fitted. On completion of recharge, the current supply starts again.

II. SYSTEM ANALYSIS

A. Existing System

The existing traditional method for retrieving the energy meter data and billing is not convenient and time consuming, a billing strategy via SMS which is convenient and reduces the manpower. This system is a boon for remote monitoring and automatic tariff updating. This system gives the information regarding meter reading, power cut, total load used and tempering on request or regularly in particular interval through SMS. This information is being sent and received by concerned energy Provider Company with the help of Global System for Mobile communication (GSM) network.

1) Merits:

-Reduces the labor cost

- Increase meter reading accuracy

- Saves both time and money

B. Proposed System

In this section, we present an electric meter with reliability credit and cost control we have provide only one time extra credit when consumer needed in emergency. The cost of the energy charge per unit as per government rules and regulations is controlled by the authorized person only. So that charges of energy per unit is managed. And also byusing rtc the time limit is credited to consumer.

1) Merits:

-Extra credit is provided.

-No cut-off at night time.

III. SYSTEM DESIGN

1. Description Of Block Diagram

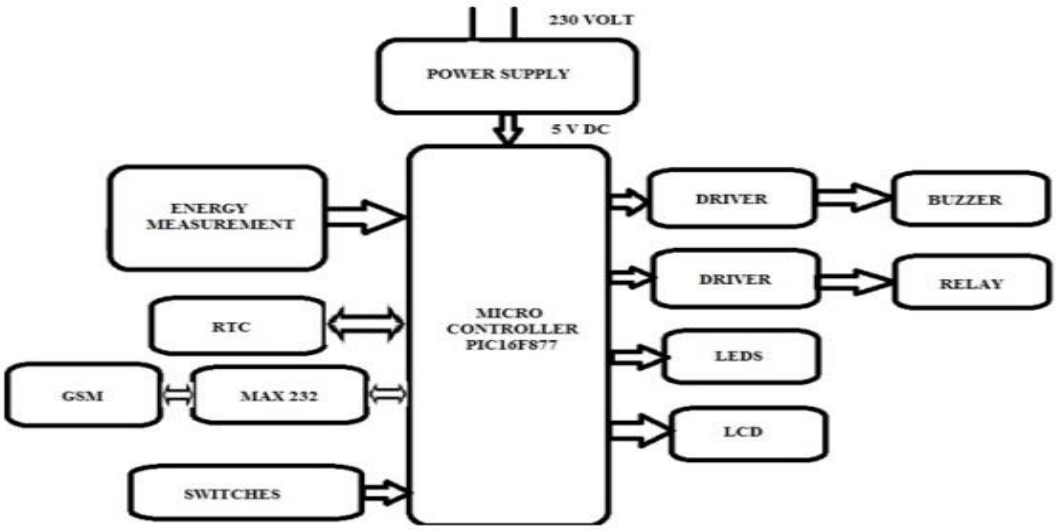


Figure 1: Block Diagram of Electric Meter

A. Power supply

In this section we have Transformer, Bridge rectifier, are connected serially and voltage regulators for +5V and +12V (7805 and 7812) via a capacitor (1000µF) in parallel are connected parallel as shown in the circuit diagram below. Each voltage regulator output is again is connected to the capacitors of values (100µF, 10µF, 1 µF, 0.1 µF) are connected parallel through which the corresponding output (+5V or +12V) are taken into consideration.

B. Energy Measurement IC

The AD7751 is a high-accuracy fault-tolerant electrical energy measurement IC that is intended for use with 2-wire distribution systems. The part specifications surpass the accuracy requirements as quoted in the IEC1036 standard. The only analog circuitry used in the AD7751 is in the ADCs and reference circuit. All other signal processing (e.g., multiplication and filtering) is carried out in the digital domain. This approach provides superior stability and accuracy over extremes in environmental conditions and over time.

The AD7751 incorporates a novel fault detection scheme that warns of fault conditions and allows the AD7751 to continue accurate billing during a fault event. The AD7751 does this by continuously monitoring both the phase and neutral (return) currents. A fault is indicated when these currents differ by more than 12.5%. Billing is continued using the larger of the two currents. The AD7751 supplies average real power information on the low-frequency outputs F1 and F2. These logic outputs may be used to directly drive and electromechanical counter or interface to an MCU.

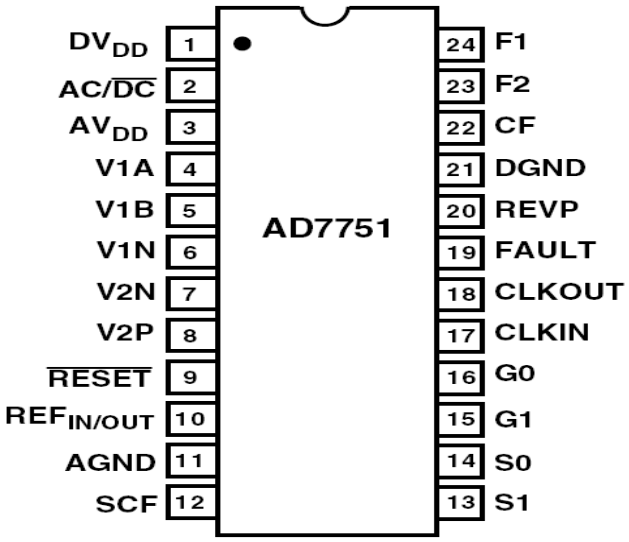


Figure 2: Pin Diagram of AD7751

The CF logic output gives instantaneous real power information. This output is intended to be used for calibration purposes. The AD7751 includes a power supply monitoring circuit on the AVDD supply pin. The AD7751 will remain in a reset condition until the supply voltage on AVDD reaches 4 V. If the supply falls below 4 V, the AD7751 will also be reset and no pulses will be issued on F1, F2, and CF. Internal phase matching circuitry ensures that the voltage and current channels are matched whether the HPF in Channel 1 is on or off. The AD7751 also has anticreep protection. The AD7751 is available in 24-lead DIP and SSOP packages.

C. Microcontroller PIC16F877

***a) Micro controller Core Features*:**

i. High performance RISC CPU
ii. Only 35 single word instructions to learn
iii. All single cycle instructions except for program branches which are two cycle
iv. Operating speed: DC - 20 MHz clock input

v. DC - 200 ns instruction cycle
vi. Up to 8K x 14 words of FLASH Program Memory,
vii. Up to 368 x 8 bytes of Data Memory (RAM)
viii. Up to 256 x 8 bytes of EEPROM Data Memory
ix. Pinout compatible to the PIC16C73B/74B/76/77
x. Interrupt capability (up to 14 sources)
xi. Eight level deep hardware stack
xii. Direct, indirect and relative addressing modes
xiii. Power-on Reset (POR)
xiv. Power-up Timer (PWRT) and Oscillator Start-up Timer (OST)
xv. Watchdog Timer (WDT) with its own on-chip RC
xvi. oscillator for reliable operation
xvii. Programmable code protection
xviii. Power saving SLEEP mode
xix. Selectable oscillator options
xx. Low power, high speed CMOS FLASH/EEPROM technology
xxi. Fully static design
xxii. In-Circuit Serial Programming. (ICSP) via two pins
xxiii. Single 5V In-Circuit Serial Programming capability
xxiv. In-Circuit Debugging via two pins
xxv. Processor read/write access to program memory
xxvi. Wide operating voltage range: 2.0V to 5.5V
xxvii. High Sink/Source Current: 25 ma
xxviii. Commercial, Industrial and Extended temperature Ranges
xxix. Low-power consumption: - < 0.6 ma typical @ 3V, 4 MHz

a. 20 µA typical @ 3V, 32 kHz
b. < 1 µA typical standby current

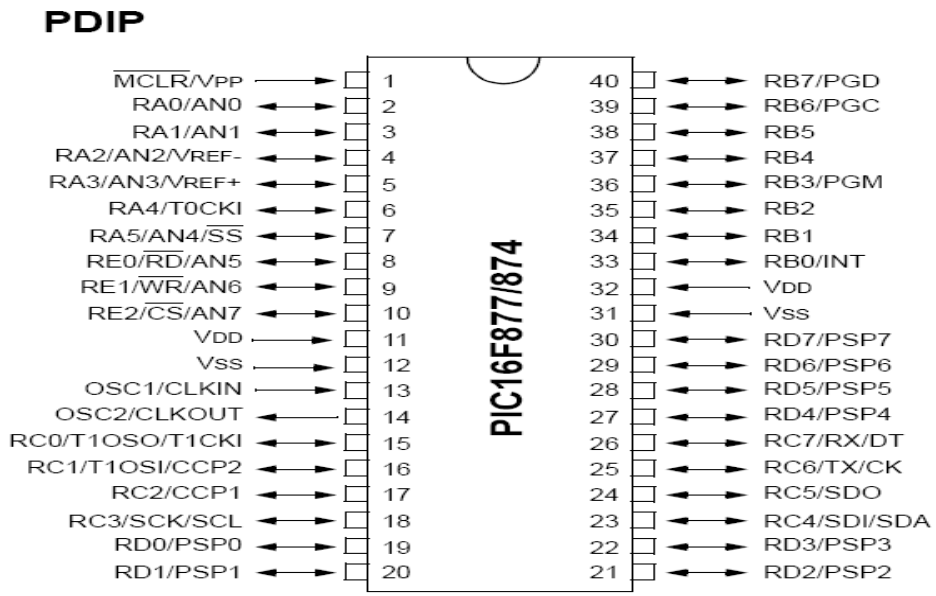


Figure 3: Pin Diagram of Microcontroller PIC16F877

b) Peripheral Features:

i. Timer0: 8-bit timer/counter with 8-bit prescaler
ii. Timer1: 16-bit timer/counter with prescaler, Can be incremented during SLEEP via external crystal/clock
iii. Timer2: 8-bit timer/counter with 8-bit period register, prescaler and postscaler
iv. Two Capture, Compare, PWM modules
    a. Capture is 16-bit, max. resolution is 12.5 ns
    b. Compare is 16-bit, max. resolution is 200 ns
    c. PWM max. resolution is 10-bit
v. 10-bit multi-channel Analog-to-Digital converter
vi. Synchronous Serial Port (SSP) with SPI. (Master mode) and I2C. (Master/Slave)
vii. Universal Synchronous Asynchronous Receiver
viii. Transmitter (USART/SCI) with 9-bit address detection
ix. Parallel Slave Port (PSP) 8-bits wide, with external RD, WR and CS controls (40/44-pin only)
x. Brown-out detection circuitry for Brown-out Reset (BOR)

D. Real time clock (RTC – DS1307)

This is used to maintain the current time in off line processing. The DS1307 Serial Real-Time Clock is a low power; full binary-coded decimal (BCD) clock/calendar plus 56 bytes of NV SRAM. Address and data are transferred serially via a 2-wire, bi-directional bus. The clock/calendar provides seconds, minutes, hours, day, date, month, and year information. The end of the month date is automatically adjusted for months with fewer than 31 days, including corrections for leap year. The clock operates in either the 24-hour or 12-hour format with AM/PM indicator. The DS1307 has a built-in power sense circuit that detects power failures and automatically switches to the battery supply.

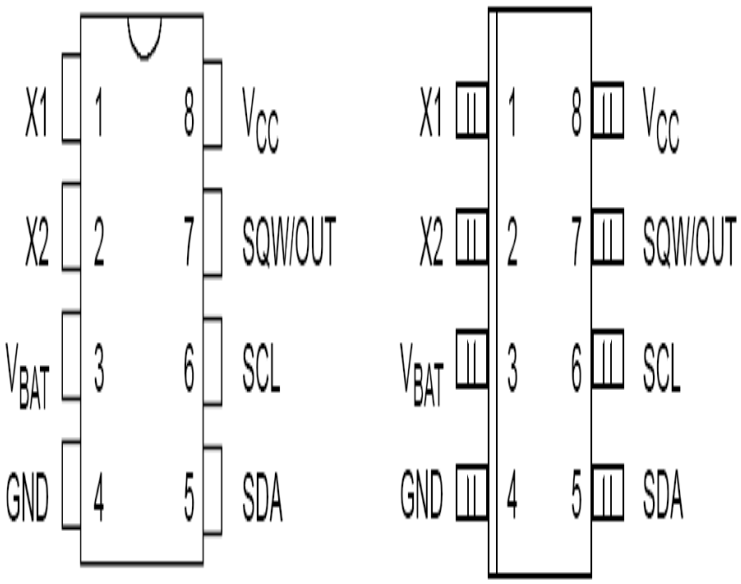
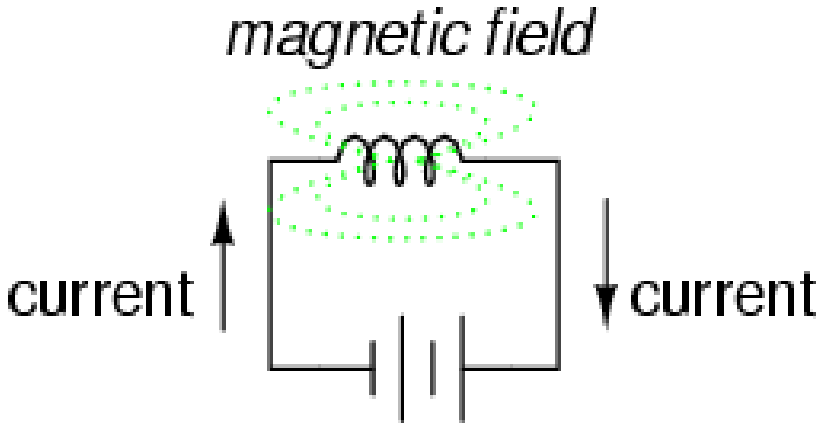


Figure 4: DS1307 8-PIN DIP(300MIL) and DS1307Z 8-PIN SOIC(150MIL)

E. Relay

A relay is an electrical switch that opens and closes under the control of another electrical circuit. In the original form, the switch is operated by an electromagnet to open or close one or many sets of contacts. A relay is able to control an output circuit of higher power than the input circuit, it can be considered to be, in a broad sense, a form of an electrical amplifier.



An electric current through a conductor will produce a magnetic field at right angles to the direction of electron flow. If that conductor is wrapped into a coil shape, the magnetic field produced will be oriented along the length of the coil. The greater the current, the greater the strength of the magnetic field, all other factors being equal.

F. GSM (Global System for Mobile communications)

GSM (Global System for Mobile communications) is a cellular network, which means that mobile phones connect to it by searching for cells in the immediate vicinity. GSM networks operate in four different frequency ranges. Most GSM networks operate in the 900 MHz or 1800 MHz bands. Some countries in the Americas use the 850 MHz and 1900 MHz bands because the 900 and 1800 MHz frequency bands were already allocated.

Figure 5: GSM Module

GSM also pioneered a low-cost, to the network carrier, alternative to voice calls, the Short t message service (SMS, also called "text messaging"), which is now supported on other mobile standards as well. Another advantage is that the standard includes one worldwide Emergency telephone number, 112. This makes it easier for international travellers to connect to emergency services without knowing the local emergency number.

Features

- Dual band GSM/GPRS 900/1800MHz.
- Configurable baud rate.
- SIM card holder.

- Built in network status LED.
- Inbuilt powerful TCP/IP protocol stacks for internet data transfer over GPRS.

G. MAX232 Driver Receiver

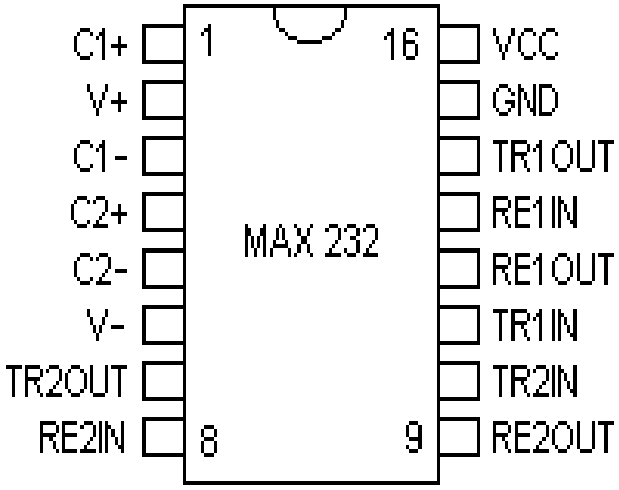


Figure 6: MX232 Driver

The MAX232 from Maxim was the first IC which in one package contains the necessary drivers (two) and receivers (also two), to adapt the RS-232 signal voltage levels to TTL logic. It became popular, because it just needs one voltage (+5V) and generates the necessary RS-232 voltage levels (approx. -10V and +10V) internally. This greatly simplified the design of circuitry. And this made the IC so popular. Circuitry designers no longer need to design and build a power supply with three voltages (e.g. -12V, +5V, and +12V), but could just provide one +5V power supply, e.g. with the help of a simple 78x05 voltage converter.

It should be noted that the MAX232 is just a driver/receiver. It does not generate the necessary RS-232 sequence of marks and spaces with the right timing, it does not decode RS-232 signal, it does not provide a serial/parallel conversion. All it does is to convert signal voltage levels. Generating serial data with the right timing and decoding serial data has to be done by additional circuitry, e.g. by a 16550 UART or one of these small micro controllers who get more and more popular.

H. LED (Light Emitting Diode)

A light-emitting diode (LED) is a semiconductor diode that emits light when an electrical current is applied in the forward direction of the device, as in the simple LED circuit. The effect is a form of electroluminescence. where incoherent and narrow-spectrum light is emitted from the p-n junction.

Applications

i. Automotive applications with LEDS

Instrument Panels & Switches, Courtesy Lighting, CHMSL, Rear Stop/Turn/Tai, Retrofits, New Turn/Tail/Marker Lights.

ii. Consumer electronics & general indication

Household appliances, VCR/ DVD/ Stereo/Audio/Video devices, Toys/Games Instrumentation, Security Equipment, Switches.

iii. Mobile applications with LEDs

Mobile Phone, PDA's, Digital Cameras, Lap Tops, General Backlighting.

I. LCD (Liquid Cristal Display)

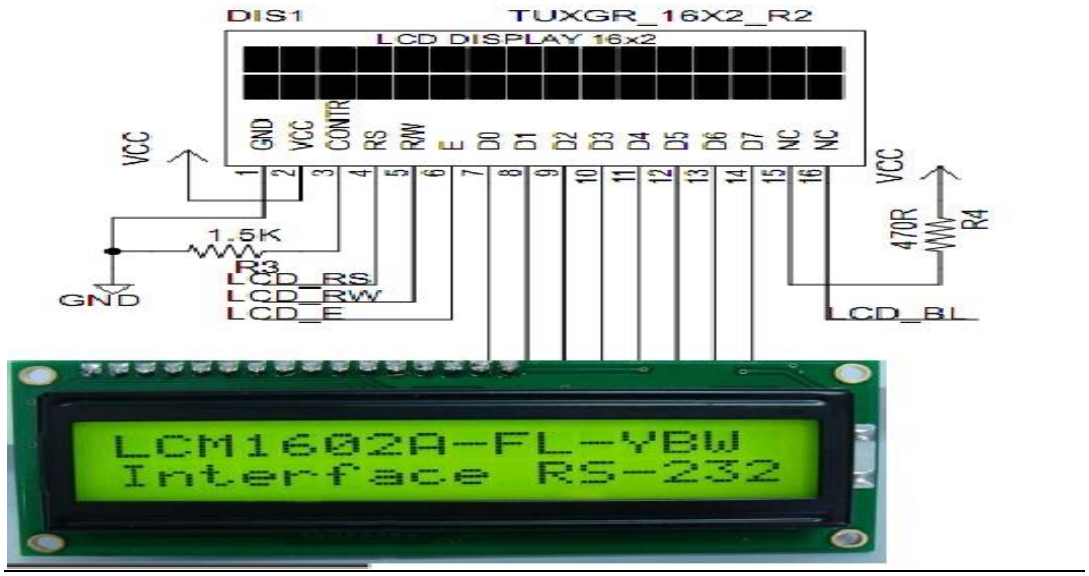


Figure 7: 16*2 LCD Display

A liquid crystal display (LCD) is a thin, flat display device made up of any number of color or monochrome pixels arrayed in front of a light source or reflector. Each pixel consists of a column of liquid crystal molecules suspended between two transparent electrodes, and two polarizing filters, the axes of polarity of which are perpendicular to each other. Without the liquid crystals between them, light passing through one would be blocked by the other. The liquid crystal twists the polarization of light entering one filter to allow it to pass through the other.

a) Features of LCD Display

i. Easy interface with 4 it or 8-bit MPU.
ii. Built in dot matrix LCD controller with 5x7 or 5x10 character font.
iii. Built in character generated ROM, when provides 160 characters with font 5x7 dots and 32 characters with fonts 5x10 dots.
iv. Internal CG RAM for user defined fonts 5x7 (8 characters) or 5x10 (4 characters).
v. Internal automatic reset circuit at power on.
vi. Built in oscillator circuit (No external clock required).
vii. Wide Ranges of instructions functions are: Clear Display, Cursor Home, Display On | Off, Cursor On | Off, Cursor shift, and Display shift.

IV. SOFTWARE REQUIREMENT

A. Hardware

Circuit of the Project

B. Software

Keil µ4 version

PICBASIC Plus 2.00 Compilers

IC-Prog 1.05A Prototype Programmer

C. Language

Embedded C

V. CONCLUSION

The system proposed in this Paper provide only one time extra credit when consumer needed in emergency. The cost of the energy charge per unit as per government rules and regulations is controlled by the authorized person only. So that charges of energy per unit is managed.

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