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Automated and Low Cost Parking System for Vehicles and Obstacle Detection Module for Secure Parking

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ABSTRACT

Background: There is shortage of parking zones and those prevailing are not well organized. Everyone wants to park their vehicle properly, which creates chaos at the parking place. The situation calls out for an automated parking system that not only regulates parking in a given area but also keeps the manual control to a bare minimum. Automated parking is a method of parking and exiting cars using sensing devices. **Objective:** To have a parking system that regulates the number of cars that can be parked in a given space at any given time based on the parking space availability and also to make the controlling mechanism as inexpensive as possible. **Results:** The entry and exit of vehicles are facilitated using totally automated gates, which have been provided at the entry and exit of the parking space, which opens on the arrival or departure of a car. Status signals indicate whether a car is currently in the process of entering or leaving the parking space. A display section has been provided, which consists of status signals and a display showing the number of cars present in the parking space at any point of time. It also has a modular design that assists the driver to park the car safely. When the car is not at a safe distance from an obstacle, an alert signal is given to the driver. This module is fitted in the car. **Conclusion:** Control mechanism uses basic digital circuits which makes the design very cheap. It ensures that the parking process takes place in an orderly manner. It also helps the driver to easily identify the free slots available in a parking area, thereby saving fuel and time.

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INTRODUCTION

Increase in number of low cost vehicles has made it very much affordable for many people to buy a car. So automated car parking has become the need of the hour. Malls, apartments, schools all need to have well organized car parking facility and people do not easily get information of parking space as they move around slots to slots in search of space. Various methods have been developed like wireless sensor network system (Tang, V.W.S., 2006), vacant parking space detection (True, N., 2007) and Vision based system (Hamada, R.H. and Patrick Sebastian, 2010).

Parking on multi floors requires all sort of mechanisms to lift the car and controlling the car and elevation all together. Finding space for parking is another emerging problem (Sheng-Fuu Lin and Yung-Yao Chen, 2006). So there is a need to provide information explicitly for drivers by indication through number of cars parked and also having an indication on each slot through led/lights can also help them find their way very easily without wasting much time. As existing system gives very less information and also they employ human for giving signal to drivers. Now having (Sheng-Fuu Lin and Yung-Yao Chen, 2006) vision based needs cameras and again cost increases for installing cameras and whole point of our project is give potential solution for car parking problem by reducing man power, having all types of indication to have hustle free parking and above all cost effective controlling mechanism without using costly sensors, cameras and even without using any microcontrollers.

Everything, right from maintaining the count of vehicles to opening and closing the gate, is automatically controlled. As the circuit uses low cost easily available discrete ICs, it is cost-effective. It requires no attendants, is more cost-effective than conventional garages, and allows more cars to be parked in less space. The automation technology is used to typically double to triple the capacity of conventional parking garages.

Moreover to detect any obstacle or hindrance while parking a car, ultrasonic transmitter and receiver pair along with a comparator is used to drive the buzzer in case an obstacle is encountered close to the car.

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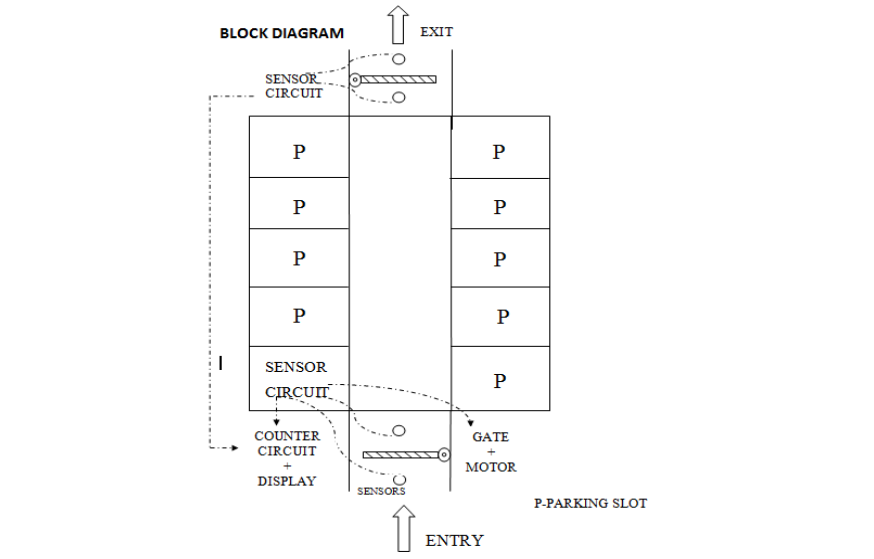
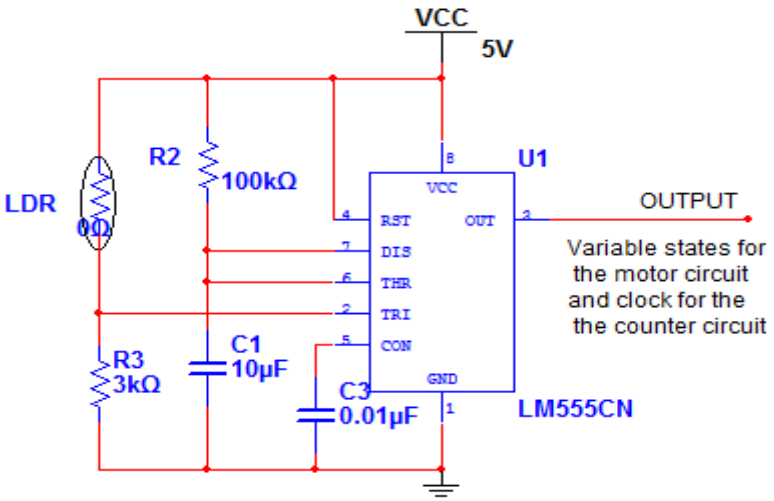


(Total view of model)

Technical Details:
Section 1: Automated Car Parking System:

(i) Sensor Circuit:



This section senses the movement of objects and transfers that information to the gate control section and counter sections. The output of this section acts as input to the motor driver and assists in gate control mechanism.

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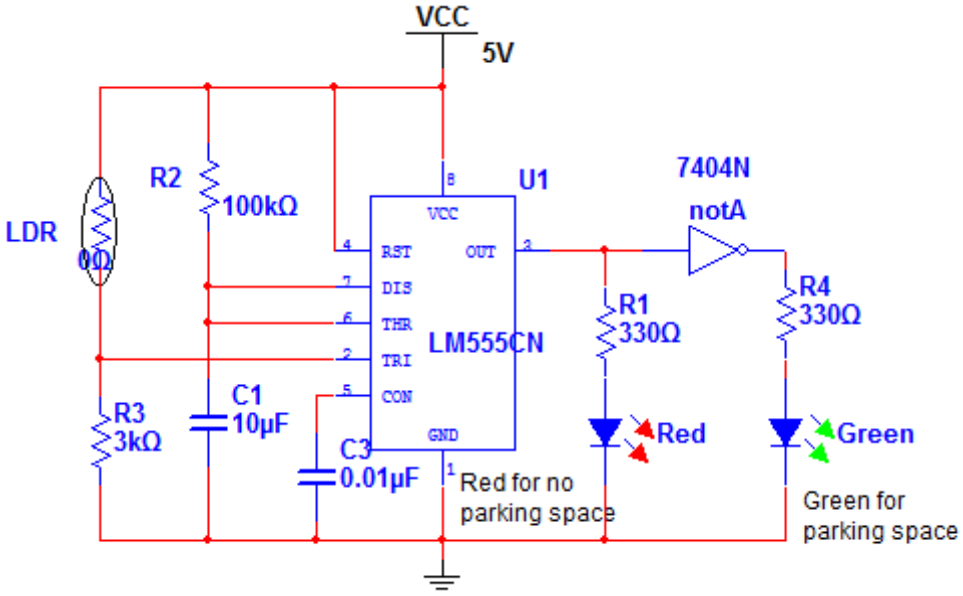
The sensor section is basically a 555timer in monostable mode of operation. The second pin of the timer has a potential divider arrangement with an LDR connected between the supply and pin. The resistance of LDR changes according to ambient light conditions. When light falling on the LDR is blocked, its resistance increases, thus a voltage drop occurs across it. As a result, when a negative trigger is applied to the second pin of the timer, clock pulses of time period, T=1.1 RC is generated.
Here, R=100KΩ, and C=10 µF, the time period comes out to be 1.1s.

The output of two such sensors (A and B) are provided as input to the motor driver IC LN293D, which helps in deciding states for the door to open and close.

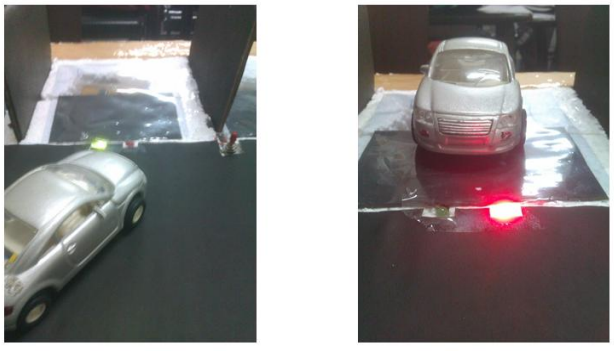
(ii) Parking Slot Indicator Circuit:



This section provides the indication of vacant parking slot at any given time based on the parking slot availability. Identical circuits are placed in the each parking slot so that it indicates whether the car is present in that slot or not. The slot indicator section is based on 555timer working in monostable mode of operation. The second pin of the timer has a potential divider arrangement with an LDR connected between the supply and pin. The resistance of LDR changes according to ambient light conditions. When light falls on it, the resistance of LDR increases, thus a voltage drop occurs across it. As a result, when a negative trigger is applied to the second pin of the timer, clock pulses of time period, T= 1.1 RC is generated.
Here, R=100KΩ, and C=10 µF, the time period comes out to be 1.1s.

The Red LED shows the presence of car being parked. The same signal after inversion is given to the anode of the green LED, which indicates the availability of space for parking.

PARKING SLOT INDICATOR



The red LED shows the presence of car being parked. The same signal after inversion is given to the anode of the green LED, which indicates the availability of space for parking.

(iii) Gate Control Circuit:

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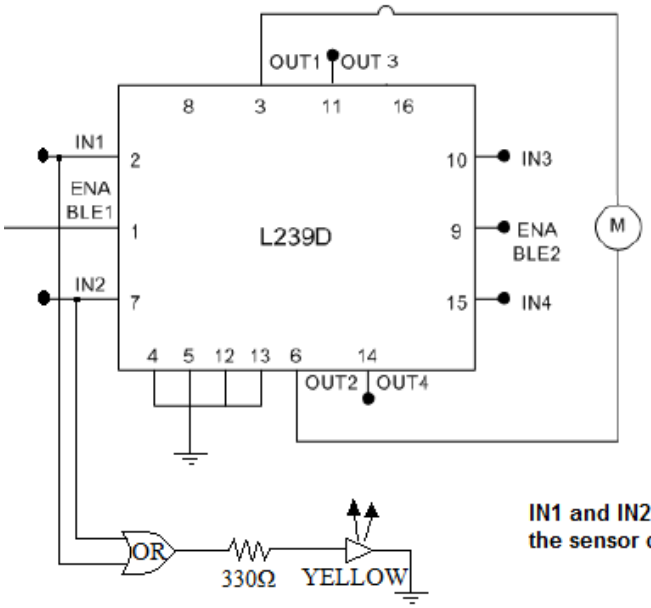


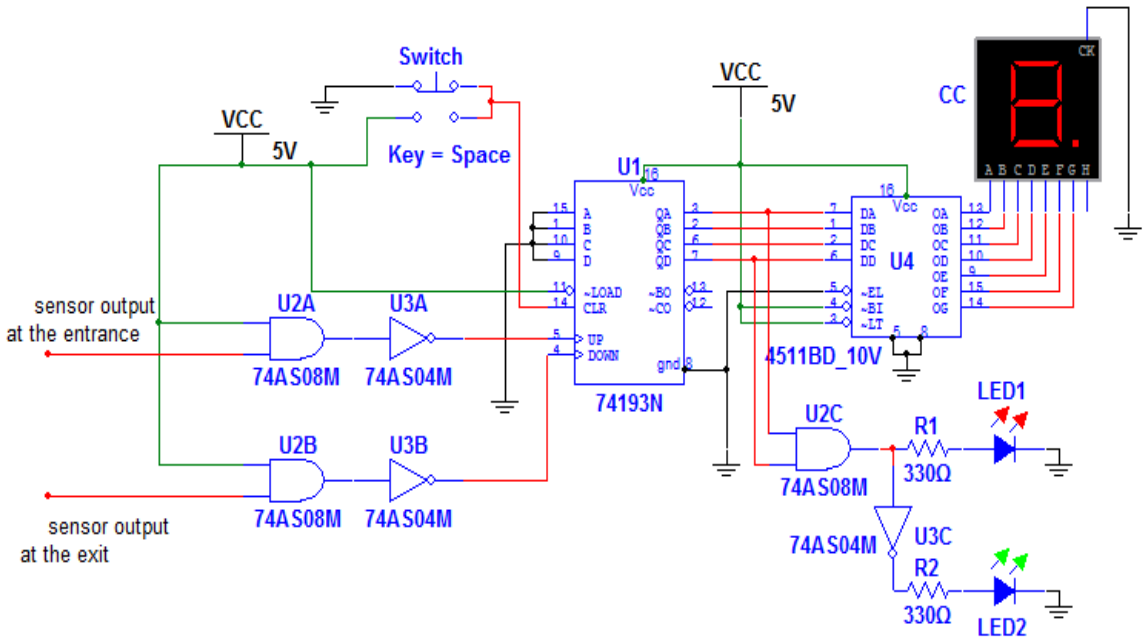
IN1 and IN2 are received from the sensor circuits

The gate control section consists of an L293D motor driver which provides the appropriate logic used for controlling operation of the gate/barrier. Assume that the lower position of the barrier is the default position. The inputs to the motor driver is provided by the sensor circuits which give a high output when a car blocks the light falling on them. Now whenever the input to motor driver at pins 2 and 7 is 1 0 respectively, it causes the motor to rotate, thereby causing the barrier to move such that it opens the gate. Similarly, when the input to motor driver is 0 1, the motor rotates in the opposite direction to lower the barrier, thereby closing the gate. When the input to the motor driver is 0 0 or 1 1, the motor does not rotate. Thus, the movement of the gate is automatically controlled on the arrival or departure of a car. The yellow LED is used to indicate that a car is in the process of parking. It glows when either of the sensors(A or B) is blocked.

Gate opens and closes on the arrival or departure of a car.

The signal from the sensor circuit enables the motor to rotate clockwise or anti-clockwise.

(iv) Counter and Display Circuit:



This section consists of up/down counter IC74193, BCD to 7-segment decoder, display driver IC4511 (to drive a common cathode 7-segment display), and three LEDs (red, yellow and green).

The counter IC74193 is capable of handling up as well as down counts, if configured for the same. The count is incremented by one when a rising edge is encountered on the up pin (pin 5) and decremented by one when a rising edge is encountered on the down pin (pin4). In our circuit, the former occurs when the vehicle has entered in the parking area and the 555 timer configured in monostable mode receives a negative trigger at its second pin which in turn produces a clock for the counter.

For up counting, the 4th pin should be connected to Vcc (+5V) and the 5th pin should receive the clock and for down counting the reverse should happen- 5th pin of the counter to Vcc (+5V) and the 4 pin should receive the clock. This is done automatically by connecting the two inputs – one from Vcc (5V) and the other from the monostable multivibrator to an AND gate (IC 7408) and a not gate (IC 7404) in cascade (basically a NAND gate) so the output is a clock but inverted. This is given to the respective pins for up-counting and down-counting. So when the counter does not receive any clock pulse the value at the 4th and 5th pins are Vcc by default. Only when the sensor is blocked the up/down count pins receive the clock. The count decrements in the same fashion when the sensor connected to the exit is blocked as the car passes through. The preset data pins of the counter IC are connected to VCC, while the load data pin is connected to one end of a push to on switch whose other pin is grounded. Such an arrangement can be used to reset the counter and consequently all drivers and display unit in the circuit.

The four output lines of up/ down counter (74193) are fed to the corresponding pins in the decoder or the driver 4511. The active high outputs of the decoder are connected to their corresponding pins in the 7-segment common-cathode display. The MSB and LSB lines of the outputs of the counter IC10 are given to an AND gate (IC7408). The output from gate 8 is fed to the anode of the red LED, which indicates that nine vehicles are present in the parking area and there is no free slot left. This happens because the output of the lines(binary 9) from the counter makes the extreme lines –the LSB and MSB high causing the AND gate to give a high output to the red LED, thus turning it on.

The same signal after inversion is given to the anode of the green LED,

Which indicates the availability of space for at least one vehicle in the parking area? The yellow LED indicates that a vehicle is either entering or leaving the parking area. Hence, this LED must be on when at least one of the sensors is being cut. When no signal is being cut, the output of the multivibrator is low, keeping the LED off. But as soon as any one of the signals is cut, the output goes high, turning the yellow LED on.

LED Indications

LED	Indication
Yellow	Car is in the process of parking
Red	No vacancy
Green	Parking space available

Section 2: Obstacle Detection.

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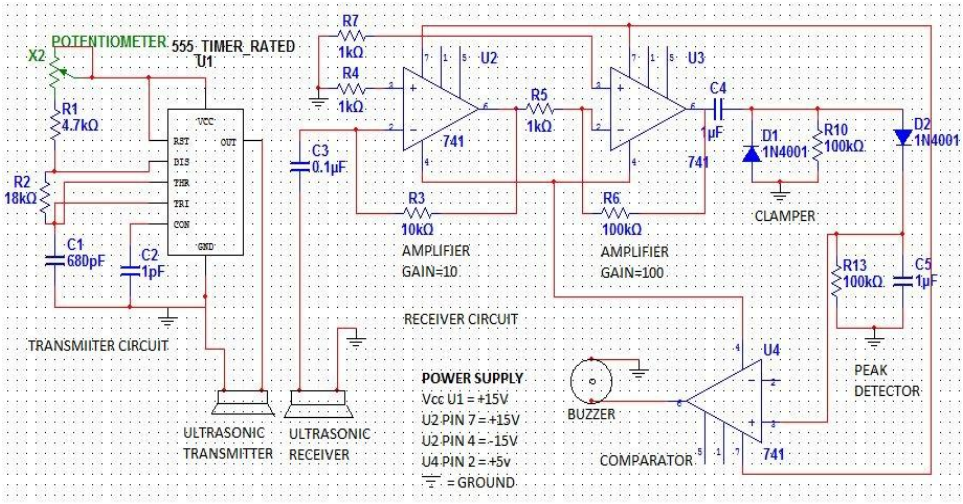


For this particular application, the required components are NE555 (TIMER), Op-amps (741), two 40 kHz ultrasonic transducers (one each for transmitter and receiver), and some discrete components. Ultrasonic generators use piezoelectric materials such as zinc or lead zirconium tartrates or quartz crystal. The material thickness decides the resonant frequency when mounted and excited by electrodes attached on either side of it.

Section II:

Obstacle Detection Module:

The ultrasonic transmitter unit with a 40 kHz pulse burst and expects an echo from the obstacle. This circuit is actually divided in three parts.

In the **first part** it detects any obstacle or hindrance while parking a car. For this purpose a pair of 40 KHz Ultrasonic transmitter and receiver is used. Firstly NE555 IC is used, to generate a square wave, which is given to transmitter in order transmit a 40 kHz ultrasonic signal.

Fig. 1: Ultrasonic transmitter and receiver pair.

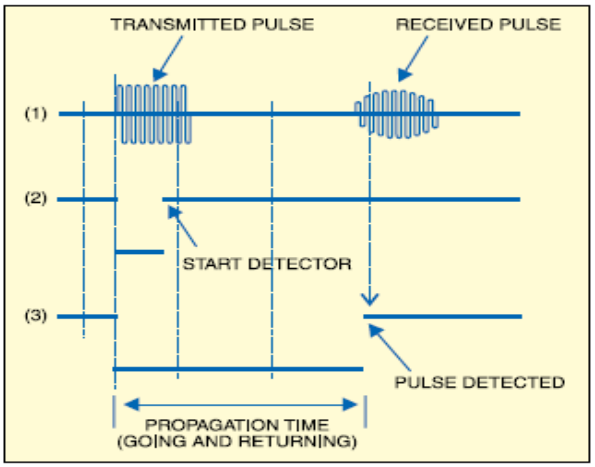


Fig. 2: Transmitted and Received Pulses.

In the **second part**, in case of any obstacle at a distance of say 6-10 cm the receiver receives the signal and generates a 40 kHz sine wave, which is being amplified using two op-amps (741). Then a clamper circuit is used in order to clamp the amplified output from op-amps followed by a peak detector circuit to maintain a constant dc output.

The **third part** of the circuit is comparator. It is set to 5V dc as the fixed value, so if the incoming signal is greater than 5V the comparator will give the +Vsat and the buzzer will go otherwise –Vsat will be the output and no sound will be made by buzzer.

Fig. 3 shows the circuit of the power supply. The 230V AC mains are stepped down by transformer X1 to deliver the secondary Output of 15V-0-15V, 500 mA. The transformer output is rectified by a full-wave bridge rectifier comprising diodes D3 through D6, filtered by capacitors C8 and C9 and then regulated by ICs 7815 (IC5), 7915 (IC6) and 7805 (IC7). Regulators 7815, 7915 and 7805 provide +15V, -15V and +5V regulated supply, respectively. Capacitors C10 through C12 bypass the ripples present in the regulated power supply.

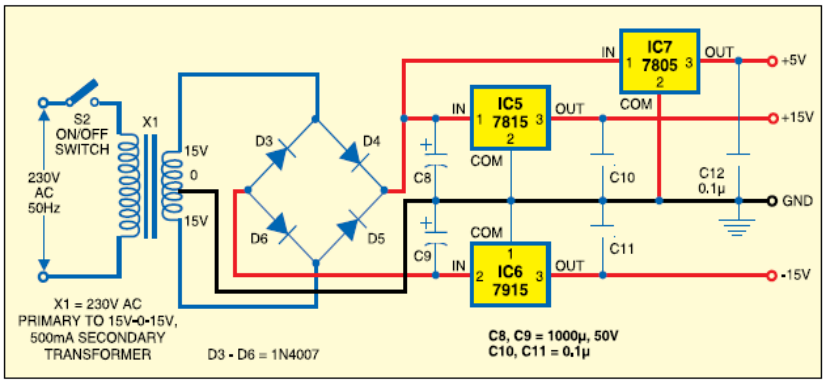
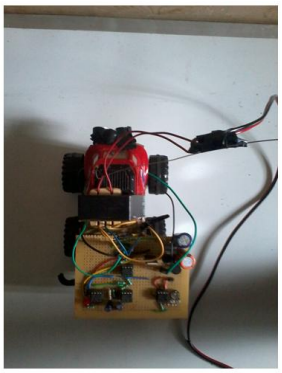
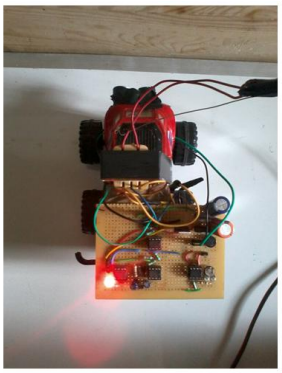


Fig. 3: Power Supply Circuit.



No Obstacle detected



Obstacle detected

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Conclusion:

The advantages include the cost efficiency and the non-requirement of man power once the system is set. The individual sections such as the gate control, sensor circuits and the counter section worked efficiently together. It ensures that the parking process takes place in an orderly manner. It also helps the driver to easily identify the free slots available in a parking area, thereby saving fuel and time.

Also, the obstacle detection module set on a car proved to be an impressive way to alert the driver when an obstacle is encountered. The buzzer alert is instantaneous and therefore, it reduces the chances of a collision taking place by immediately giving an alert signal to the driver.

Future scope of our project is adding extra circuitry to the current system. By cascading counter and display section, we are able to regulate the 99 vehicles.

ACKNOWLEDGEMENT

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