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홀 센서를 이용한 자동연료공급 제어장치에 관한 연구

(A Study on the Auto Fuel Feeding Control System using Hall Sensor)

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요 약

일반적으로 유체나 연료 공급 장치는 모터를 제어하기 위한 특별한 센서가 필요하고, 센서를 부착하기 위한 보조 장치와 부착하기 위한 공간이 필요하다. 또한 신호선 및 기타 배선 등이 필요하여 어려운 점이 따르게 된다. 본 논문에서는, 불편함과 문제점을 해결하기 위하여 홀센서를 이용한 제어시스템을 제안하였고, 시스템의 제어원리는 모터 동작 단계에 따라 전류 흐름에 차이가 발생한다는 것을 이용하였다. 또한 제어 시스템이 우수할 뿐만 아니라 센서 설치에 따른 고장을 줄일 수 있었고, 재료비 및 인건비를 절감할 수 있다. Auto-Pumping 시스템은 Soft-Ware적응용을 통해 모든 유체 공급 시스템에 적용할 수 있으며, 차후에 시스템을 이용한 여러 종류의 장치를 개발할 수 있으리라 본다.

Abstract

Usually, fluid or fuel supply device need space to need special sensor to control motor, attaches with ancillary equipment to attach sensor. Also, difficult point follows need signal line and other circuit etc.

In this paper, used that proposed control system that use hall sensor to solve discomfort and problem and difference control principle of system happens in current flow according to motor action step. Also, could reduce breakdown by sensor establishment, reduce material costs and personnel expenses as well as control system superior. Auto-pumping system sees that will can apply, develop several kind of device that use system hereafter to all fluid supply systems through soft-ware adaptation.

Keywords : Hall sensor, Current control, Auto fuel feeding control system, Electron control unit.
Current sensor unit

I. Introduction

Kind of present feeding pump is passivity and electric motion two method greatly.

Passivity to be first method when need simplicity control use is profitable, electric motion that second method controls flowing of fluid and can assume that profitable when wish to realize automatic control that supply the necessity amount in necessary time^[1].

But, even if fuel oil of diffusion bulk is dried up while operate as well as automation difficult being by

simplicity on-off control case of most fuel feeding system, pump is operated continuously power and damage of pump can occur^[2].

Also, can not confirm remained oil and pump operation status.

Therefore, while worker is refuels discomfort which must watching continuation remained oil and pump operation status breeds.

Specially, can assume that when supply fluid night or in winter season field warfare, this inconvenience added more.

In this paper, wishes to develop auto pumping control system that one-touch operation and auto-stop and warning alram device threaded to solve problem^[3].

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II. Development of auto fuel feeding control system

1. System schematic diagram

Figure 1 is basis input/output item necessary to need micom system that can foretell logic to request control that auto fuel feeding control system requires harmoniously and micom achieves logic judgment.

Uses micom of one-chip form to realize output that micom wants being input and also miniaturize system.

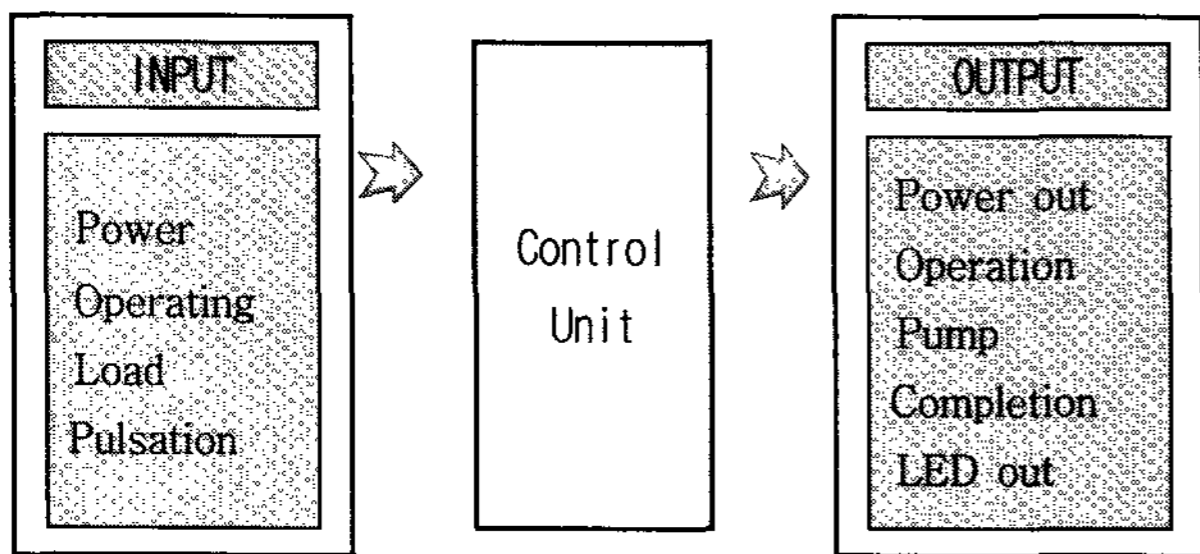


그림 1. 입력 및 출력도

Fig. 1. Input and output schematic diagram.

표 1. Pic16F84 사양

Table 1. PIC16F84 specification.

Specification				
Program Memory		EEPROM Bytes	RAM Bytes	I/O Pins
Bytes	Words			
1792	1024*14	64	68	13

Specification		
Timer/WDT	Max Speed	Other Features
8bit 1-WDT	10MHz	20mA Source 25mA Sink per I/O

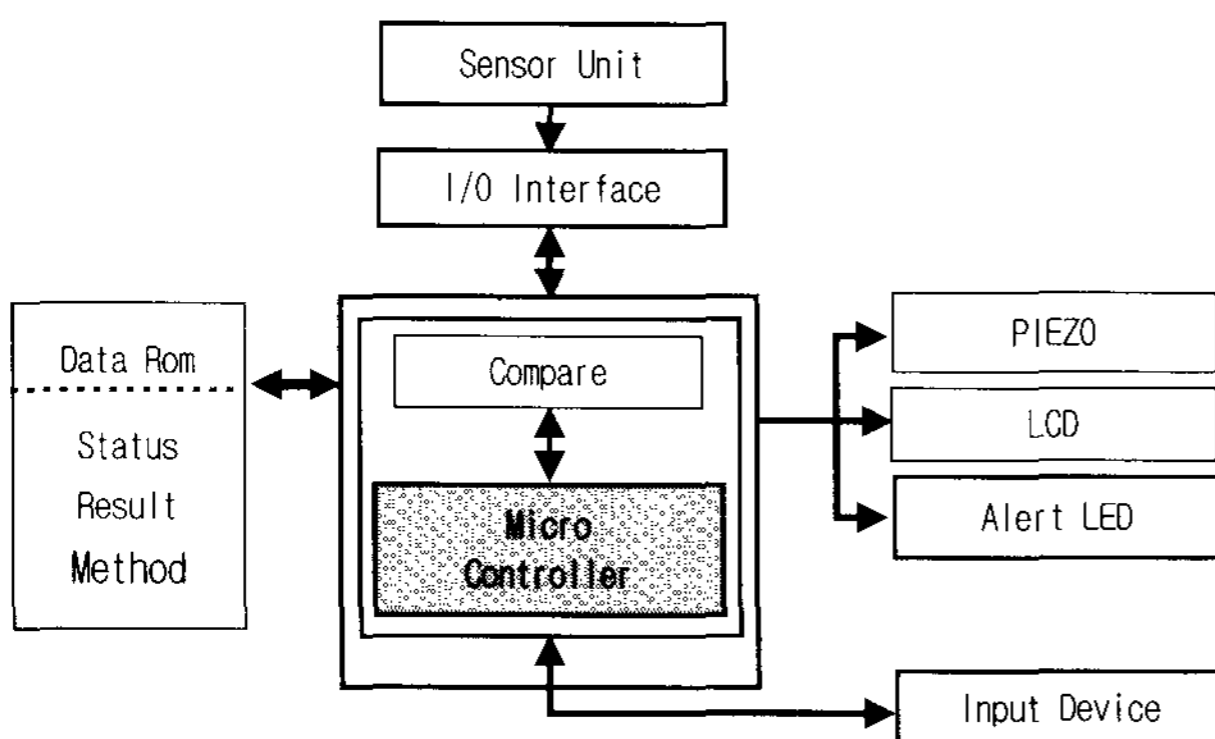


그림 2. 자동 연료공급 제어 시스템 하드웨어 구성도

Fig. 2. Auto fuel feeding control system hardware diagram.

Micom choose uses MICROCHIP of company PIC16F84.

This chip is 16 bit CMOS microcontroller that thread FLASH ROM^[4]. Table 1 is the specification of chip.

Interface system of auto pumping control system is consisted of control by microcontroller with ECU (electron control unit) connection signal conversion department memory department and power department is included.

Figure 2 is explaining the action process of interface system.

Control system is inspects and diagnoses pumping state continuously.

This state information is transmitted by microcontroller.

Information and state contents through of memory part communication that input from

sensor detected and information changed to form that transmission available and is sent to output controlling part again.

Sensor, interface circuit, micro controller, operation switch, memory, alarm system that display details schematic diagram of auto fuel feeding control system by block diagram, is consisted of display system etc.

2. Power supplies department

Power supply voltage that input from outside uses bridge diode and regulator 2 kinds to supply power stably in control department regardless of dimension and direction of outside voltage of input department.

And establish capacity input department, output department and write input, output surge did so that can receive stabilization voltage of voltage protection and output.

Also, regulator installs protection against heat board to keep away malfunction by calorification and did so that effect may be minimized in reply.

Power of motor that is used in pump drive composes circuit to drive using input voltage.

3. Sensor unit composition

Need to watch conduct of pump to control this system harmoniously.

Develop and used CSU(current sensor unit) to sense and foretell flowing current to pump.

Because can use in control sensing current that developed CSU passes in electric motor power supply line directly, advantage that use can be simple and correct control.

Developed CSU miniaturizes and did so that can compose hardware simply to establish in control department board.

If apply CSU to general control system, there is advantage that bracket for sensor sticking or no necessity as well as can realize control that want fixing unit that see without alteration of control unit. Also, control wire for sensor input output is no necessity.

Did so that CSU applied to system threads in control board passivity measurement current line and voltage that proportional in the current are netted by output.

These CSU principle and structure are as following. CSU structure did to do direction silicon steel plate to make core of ring shape, and wind 2 order coil here, and pierce passivity measurement current (1 order wire) on center hole of the ring.

Output current { $\delta I_{20}(\text{out})$ } is output of 1 of number of turns minute of piercing current (δI_{1i}) be gotten make.

Output current that piercing current is ideal in case of alternating current is appearing in (1) way.

$$\delta I_{20}(\text{out}) = \delta I_{1i} / n \tag{1}$$

(n ; 2 order coil number of turns)

This time, magnetic resistance coefficient of core is R_{mi} , if magnetic circuit length becomes L, output voltage (δv_{20}) is appearing in (2) way.

$$\delta v_{20} = \delta I_{20}(\text{out}) * R_{mi} * L \tag{2}$$

But, output voltage falls some by core loss or leakage magnetic flux etc. of actuality core ashes.

If known that union coefficient is K, output voltage is appearing in (3) way.

$$\delta v_{20} = K * \delta I_{20}(\text{out}) * R_{mi} * L \tag{3}$$

Do greatly sectional area of core to optimize union diagram and do so that 2 order number of turns n may be many.

Also, electron degree use many adhesive so that load resistance may be small.

CSU of this paper did to get good output in special quality DC attaching hall sensor in preceding descriptions structure.

Also, noise effect decreases getting into passivity measurement semi-conductor and perfection insulation and power loss department is very decrescent.

Additional, tractability is good that output response special quality fast and becomes linearization and structure becomes straightforwardly^[5].

Figure 3 is show CSU sensor part hall sensor attached.

If current (DC, AC, DC+AC) passes on main line sensor of preceding descriptions structure, magnetic flux (ϕ) that is proportional to current on gap being created, magnetic flux by structure that is pierced by right angle on hall sensor side.

When magnetic flux (ϕ) is pierced to hall sensor, hall voltage (δV_h) that proportional to main line current between terminal a-b if spill control current (I_c) on right angle direction of magnetic flux happens.

This time, hall voltage is appearing in(4) way.

$$\delta V_h = K \times \delta I_c \times \phi \tag{4}$$

Hall voltage(V_h) that is appearing in(4) way has

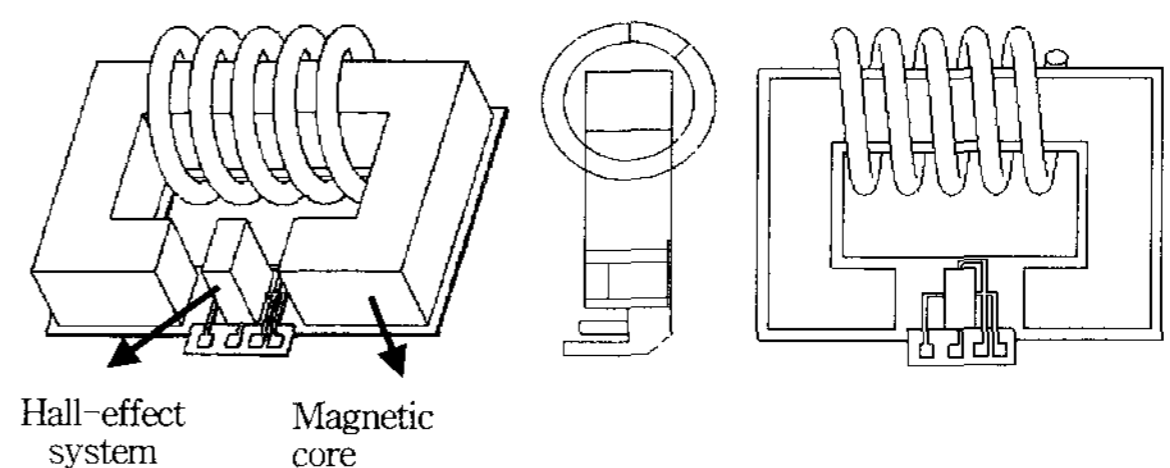


그림 3. CSU 감지부
Fig. 3. CSU sensing part.

amplifier to amplify the output because little voltage of tens mV and insert hybrid integrate circuit for noise prevention.

This time, if 1 order current more than double passes in rated current, because core is gotten saturated, linearity of output voltage about input current is lost^{[6][7]}.

Also, static electricity, overvoltage must observe in change of off-set voltage thereby because inequality voltage of hall sensor are increased.

When use high-frequency current, because of damage of core, cause that temperature of core is ascending happens.

When establish current sensor, have better use shield wire input and output to prevent noise.

Also, in case sensor becomes fragrant edible wild aster department in strong self-discipline, distortion of waveform shows.

Therefore, must observe on establishment position direction.

Sensor current value by motor load using current perception sensor of preceding descriptions, and did to control parallel after input this value in micom using comparator and A/D converter.

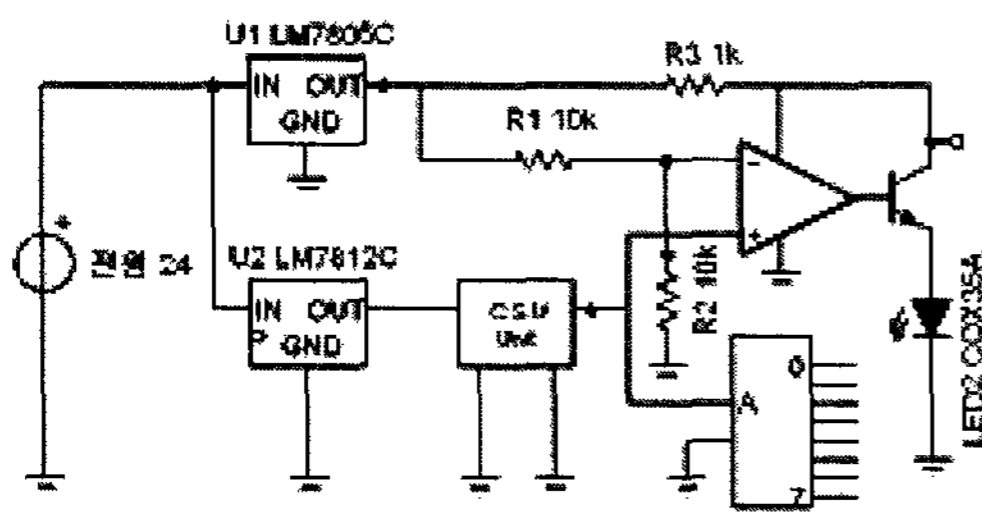


그림 4. CSU 설계 회로도
Fig. 4. CSU design circuit.

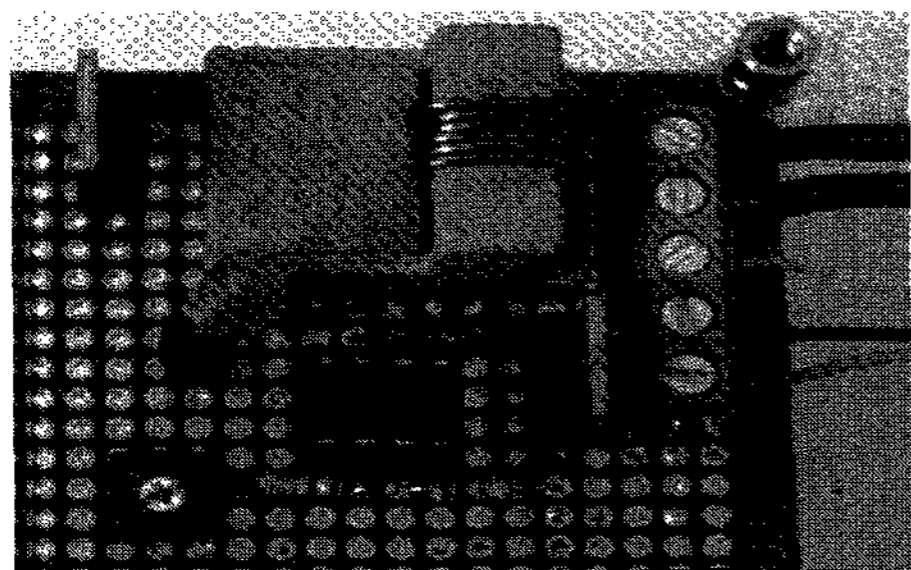


그림 5. CSU 시작품
Fig. 5. CSU prototype.

Figure 4 is manufactured CSU circuit diagram using current sensor. Figure 5 is manufactured prototype using current sensor

4. Output unit

Relay output for motor drive of output system when control on-off can produce surge voltage and malfunction and damage of control department can happen.

That join to establish photo-coupler between relay and control department to prevent and execute shield do.

Photo-coupler use KPC614 or K815P that output department consists of darlington structure to realize enough relay action receiving input of 5[V] -20mA of micom.

Output does to drive by normalcy control circuit without system that special among others.

III. Controller design

1. Hardware compositions

Figure 6 is consisted of output system that inform current perception unit, input system that input key value, various driving situations that input comparator and 10BIT A/D value sensing 24LC32A EEPROM, motor current to read and stores PIC order's microcontroller, data by control that appear main schematic diagram of hardware, and is consisted of power supply system and so on that supply TC and other power supply.

In this paper, microphone role controller's characteristic for used controller is as following.

- (1) 8 stacks
- (2) Total 35 assembler mnemonic command
- (3) 14 interrupt source
- (4) I/O port current drive ability 20mA SYNC/25mA source
- (5) 8 bit timers 2 and 16 bit timer 1 internal
- (6) EEPROM is one million times ERASE/WRITE possible
- (7) 2 CCP module (capture/compare/PWM module)
- (8) 10 bit AD converter is 8 channels internal

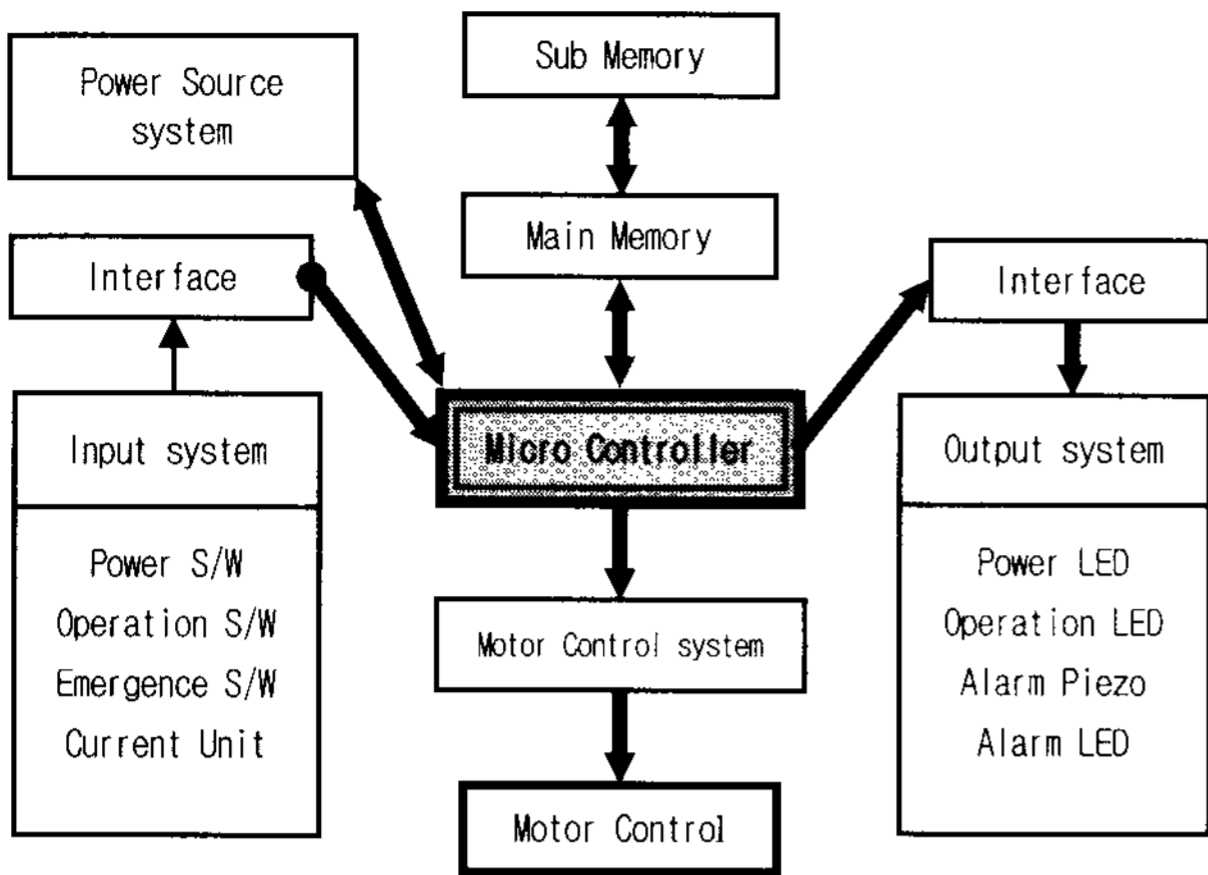


그림 6. 하드웨어 구성도
Fig. 6. Hardware schematic diagram.

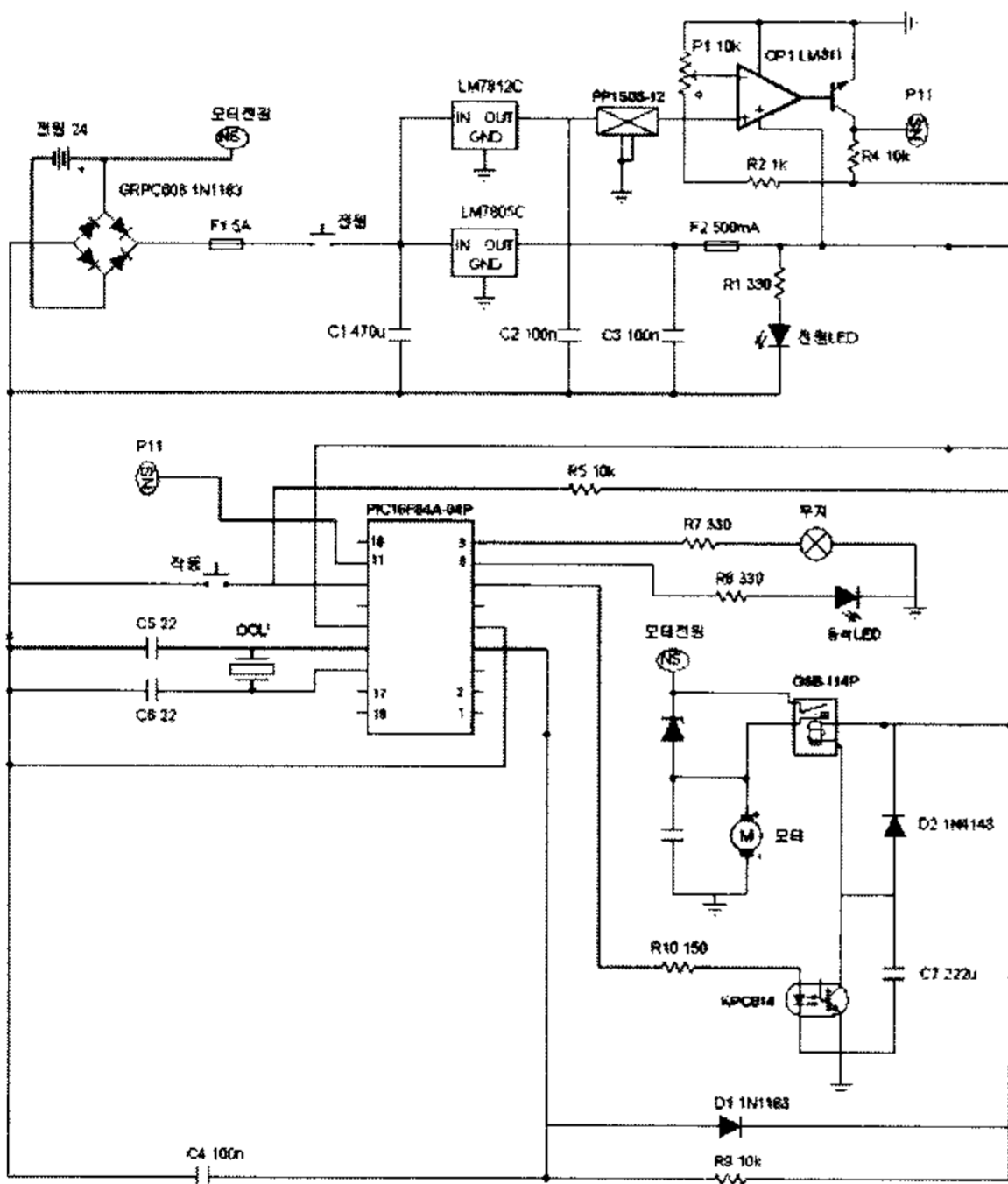


그림 7. 자동 연료 공급 제어장치 회로도
Fig. 7. Auto fuel feeding control system circuit.

- (9) USART internal
- (10) 8 bit parallels slave port internal
- (11) Brown-out detection function

Figure 6 is hardware schematic diagram of do auto fuel feeding control system who use micom.

Figure 7 is auto fuel feeding control system schematic diagram of to foundation a manufacture design circuit diagram be.

2. Software compositions

Basis composition of control makes system that

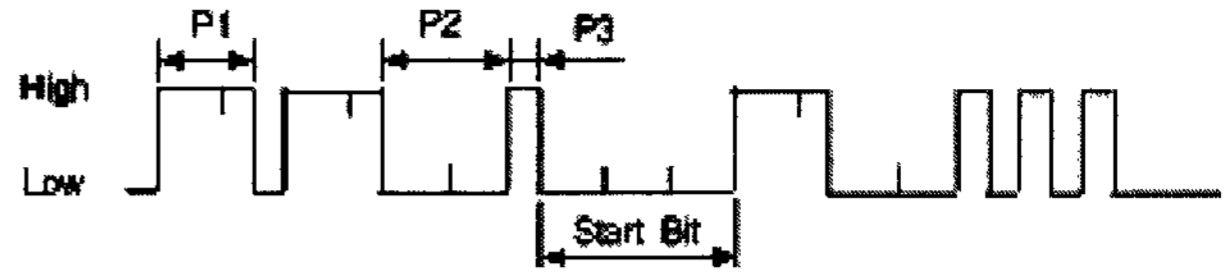


그림 8. 파형 검출 부
Fig. 8. Waveform of sections.

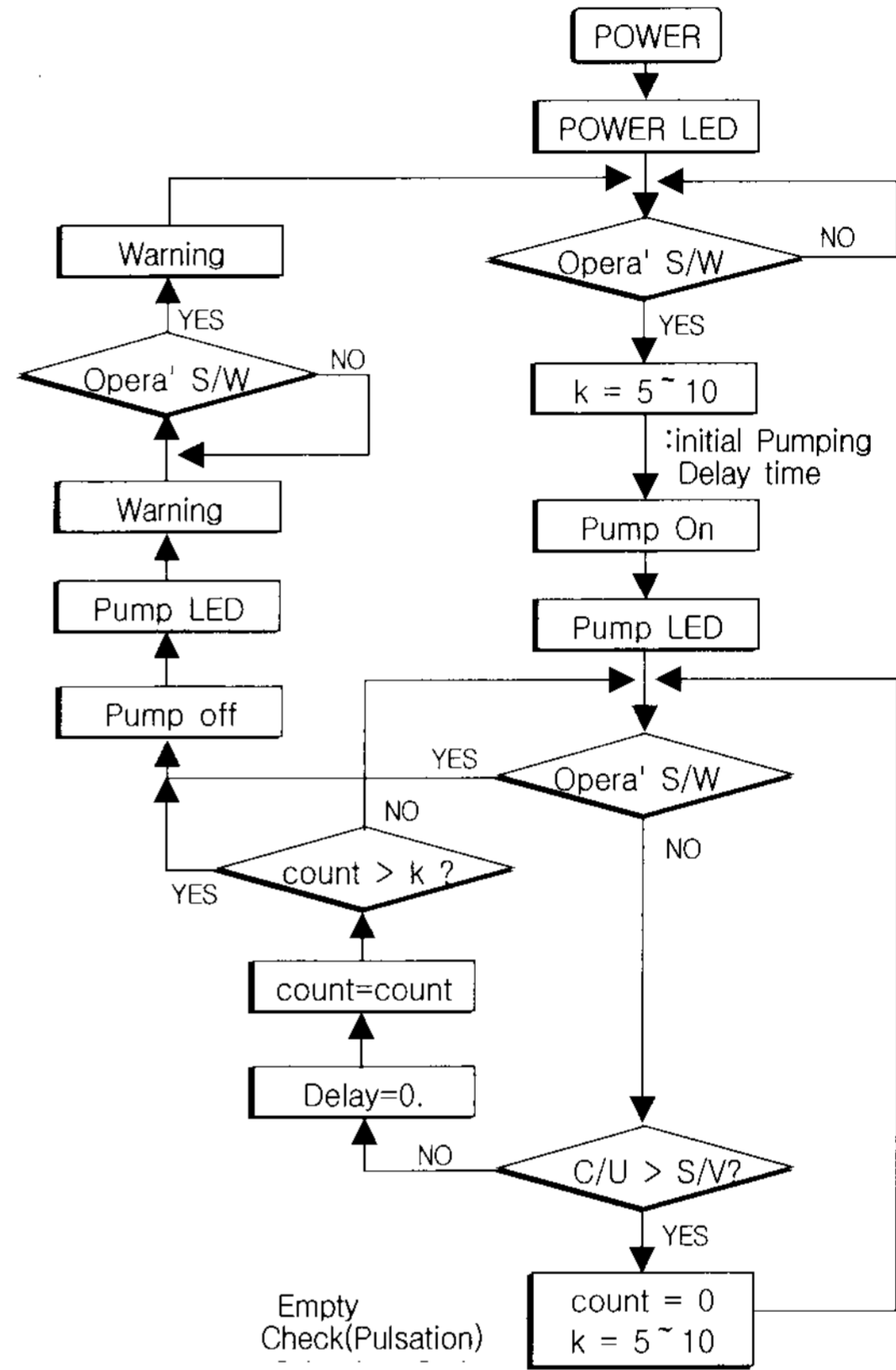


그림 9. 자동 연료 공급 제어 장치 제어 흐름도
Fig. 9. Flow chart of auto fuel feeding control system.

operation person can execute duty from beginning to completion automatically and inform the result to driver if press one touch operation button compose software to be embodied^{[8][9]}.

Vane pump special quality of pump operation, countermeasure should be considered in reply because pulsation happens and current value that deposited to electric motor.

Detect and pulse must choose among falling edge/raising edge to comparator to control, and system chose falling edge method.

To use falling edge cycle of waveform by each state to clause of time define must.

Figure 8 is expresses example of waveform and each section.

- (1) P1 : section that appear 10 units.
- (2) P2 : division bit section of 10 unit and 1 unit.
- (3) P3 : section that appear 1 unit.
- (4) Start bit : bit section to appear beginning of something wrong code.
- (5) End bit : not.
- (6) Code palingenesis more than when have something wrong code. (occurrence from error code is small cost).

Initial Pumping Delay Time flow chart in figure 9 is early establishment time from inhalation hole to sensor perception, constant decided according to length of pipe and viscosity of fluid.

If experiment incidental and value are less than 5 problem happens in early sensing, could know that sensitivity drops if big than 10. In this paper, could get good result establishing Initial Pumping Delay Time to 5~10 interval

3. Controller manufactures

Figure 10 is system that manufacture hardware of figure 3 real to foundation.

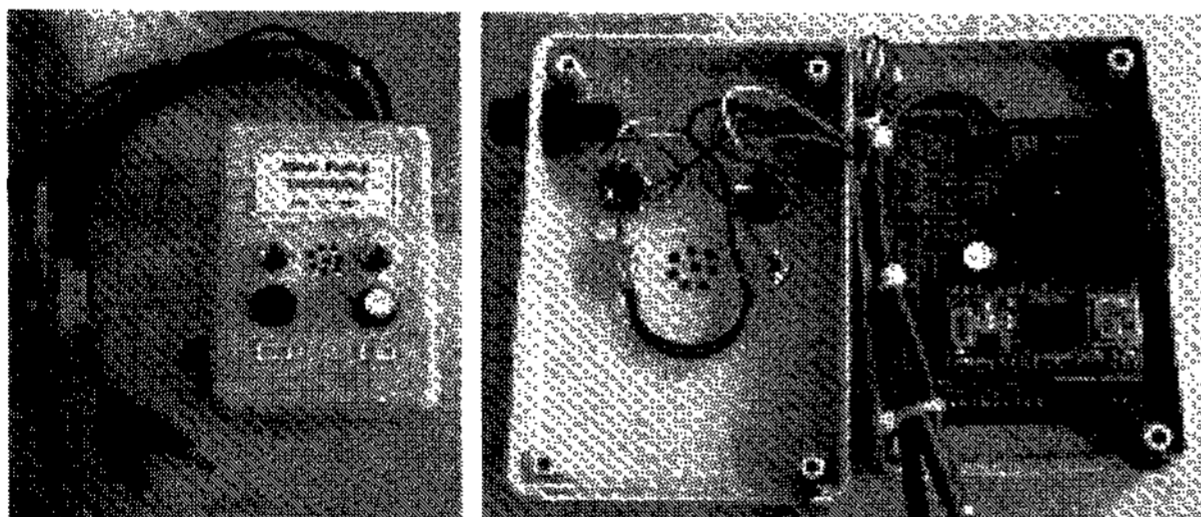


그림 10. 제작 완료된 제어기
Fig. 10. Manufacture completed controller.

4. Performance experiment and estimation

Figure 11 is established manufactured controller to real system.

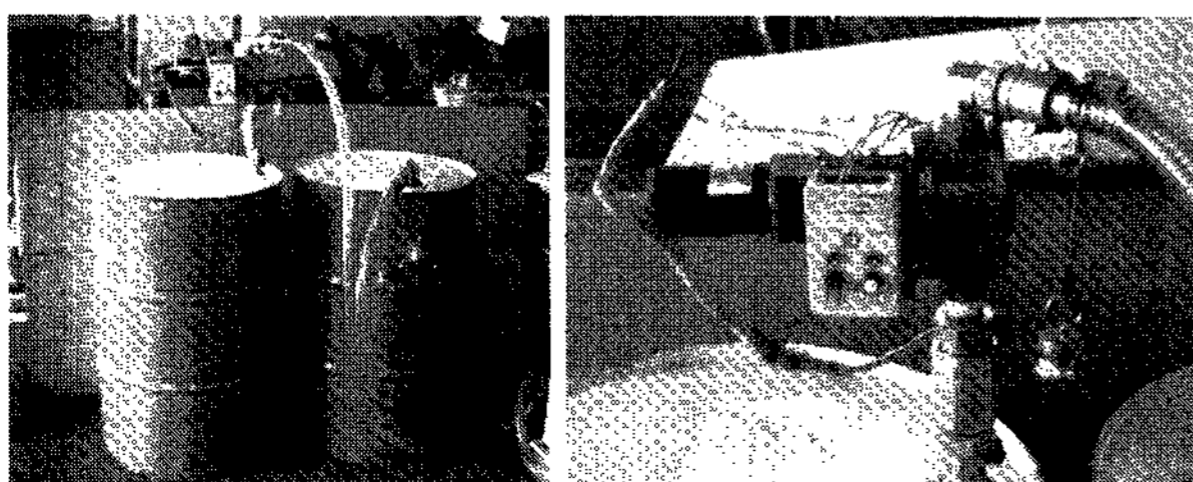


그림 11. 제어 장치 성능 실험
Fig. 11. Control unit performance experiment.

표 2. 성능 시험 결과

Table 2. Performance experiment result.

Order	Fluid amount (ℓ)	Transfer amount (ℓ)	Residual amount (ℓ)	Down time after operation (s)	Party transfer amount during minute (ℓ/min)
1	210	208.5	1.5	268	46.6
2	210	208.7	1.3	270	46.3
3	210	206.9	3.1	260	47.7
4	210	208.5	1.5	268	46.6
5	210	208.2	1.8	266	46.9
6	210	208.1	1.9	267	46.7
7	210	208.3	1.7	264	47.3
8	210	207.9	2.1	265	47.0
9	210	208.5	1.5	269	46.5
10	210	208.4	1.6	271	46.1
11	210	208.1	1.9	266	46.9
12	210	208.1	1.9	267	46.7
13	210	208.3	1.7	271	46.1
14	210	208.2	1.8	268	46.6
15	210	208.4	1.6	267	46.8
Average	210	208.2	1.8	267	46.7

Showed superior performance result in table 2 experimenting do auto fuel feeding control system who develop.

- (1) Pump protection sensor operation that safety system is good.
- (2) The party during minute transfer amount showed that satisfy in request performance by 40 ℓ/min strangenesses in rated control.
- (3) Showed control performance that action of controller wants according to fluid transfer.

IV. Conclusion

In this paper, showed that appear incidental automatic supply and stoplight superior control performance result that execute a fluid supply experiment using auto pumping control system, supplying fluid of a 200L drum almost without residual quantity within 3 minutes by 47(ℓ/min) about per minute pump control and fluid supply ability.

Also, showed excellent performance is in establishment, full equipment and the breakdown rate

executing control by motor current without special sensor device.

Also, there is advantage that could reduce material costs, personnel expenses and production cost etc. in aspect of manufacture and it is no group to apply to full equipment system night warfare because there is no breakdown region as well as superior concern in external appearance.

Therefore, see that can develop various device that use system hereafter being judged that can apply to next generation all fluid supply systems.

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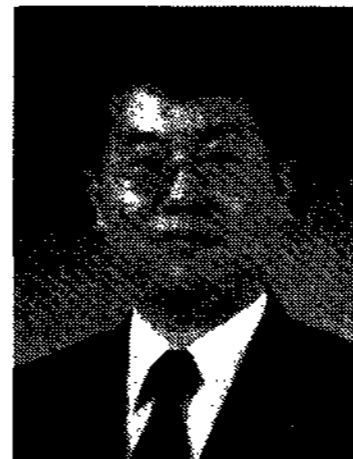
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