# CHAPTER 16

# BASIC DIGITAL ELECTROHYDRAULIC DEVICES

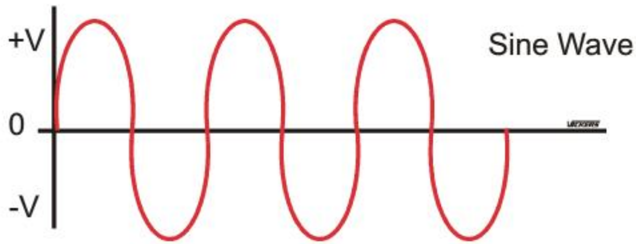



Figure 16-1 Sine wave

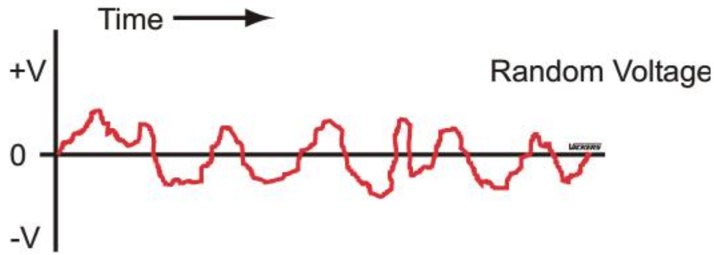



Figure 16-2 Random AC voltage

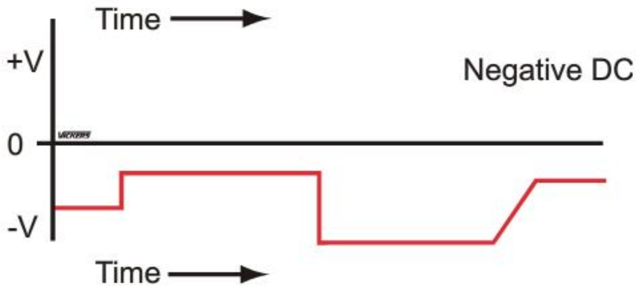



Figure 16-3 Varying negative DC voltage

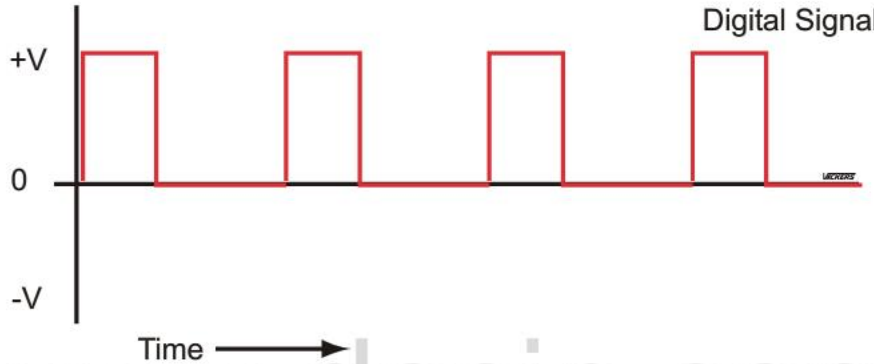



Figure 16-4 Digital signals

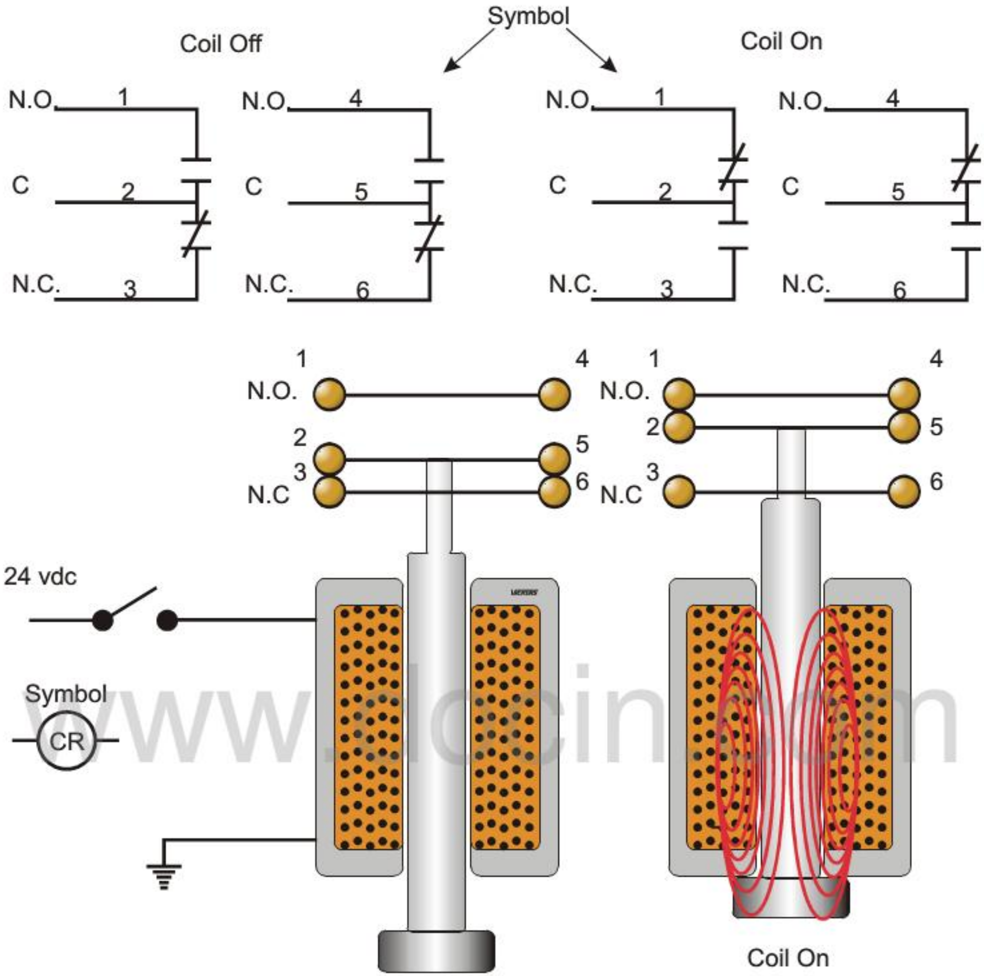



Figure 16-5 Basic relay construction

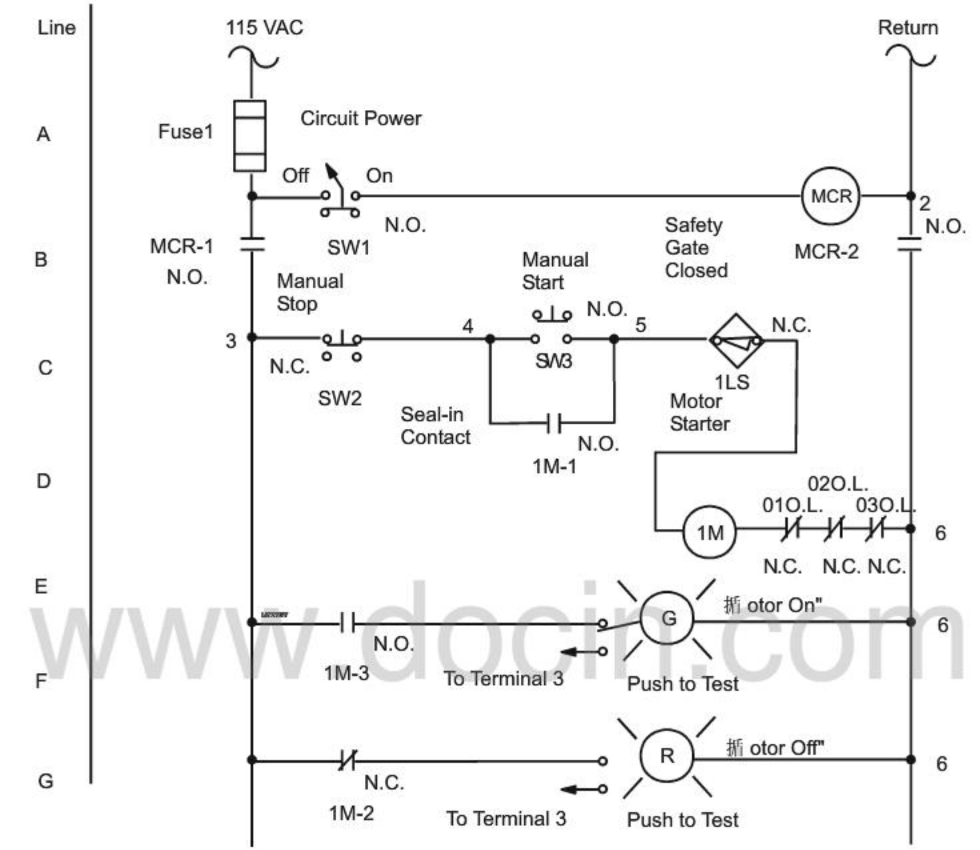



Figure 16-6 115 volt, single phase circuit is used to control a 480 volt, three-phase motor

| | RELAYS | MICROPROCESSORS |
|---|---|---|
| Speed | Slow response (milliseconds) | Fast response (microseconds) |
| Cost | $50 and up | $7.50 to $20 |
| Power Use | Watts | Milliwatts |
| Number of Components Required | Thousands of relays | = 1 microprocessor |
| Size | 0.1 - 6 cubic inches | Less than 0.1 cubic inches |
| Flexibility | Single function | Hundreds of functions |

Figure 16-7 Comparison between relays and microprocessors

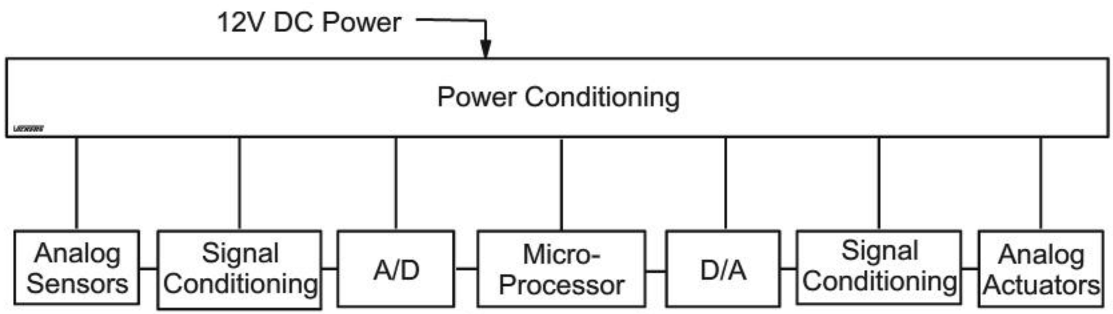



Figure 16-8 Block diagram of a microprocessor based electrohydraulic closes loop control system

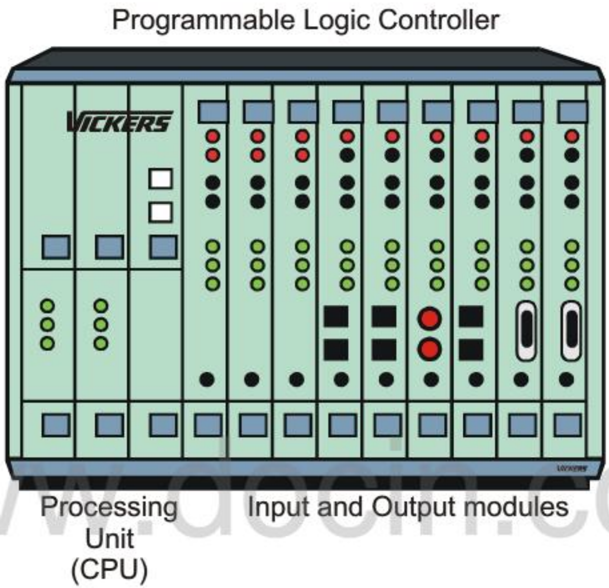



Figure 16-9 Programming logic controller

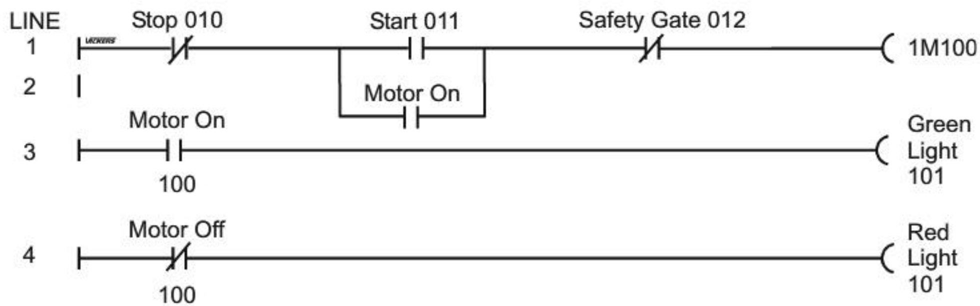



Figure 16-10 PLC ladder diagram for relay logic circuit

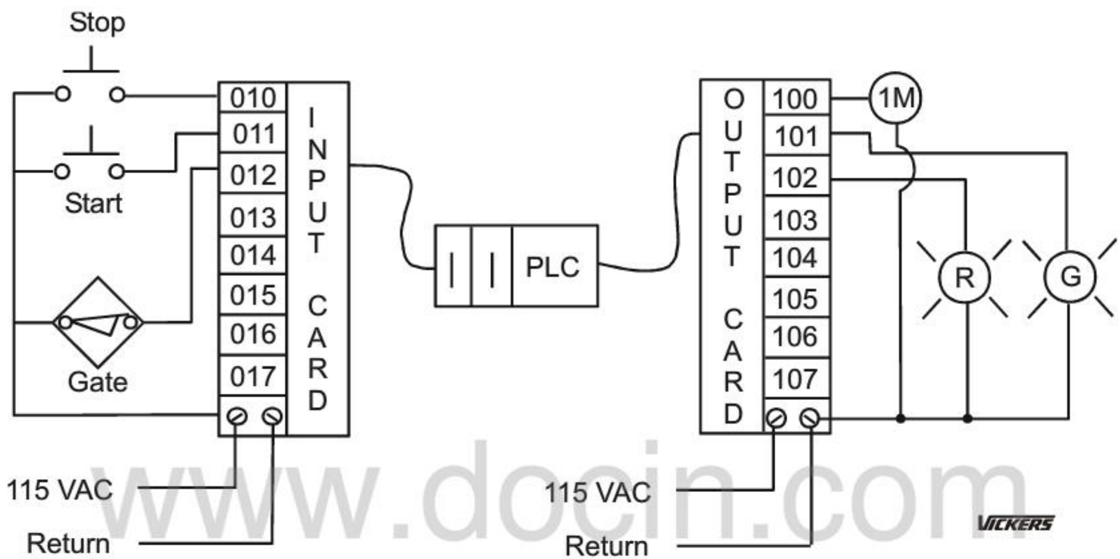



Figure 16-11 PLC wiring diagram for relay logic circuit

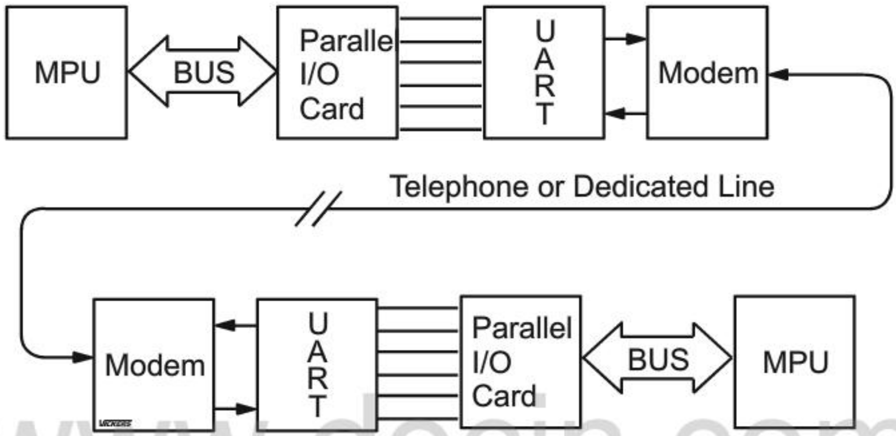





Figure 16-12 Modem used for data transmission

Serial transmission of digital byte $10101110_2$

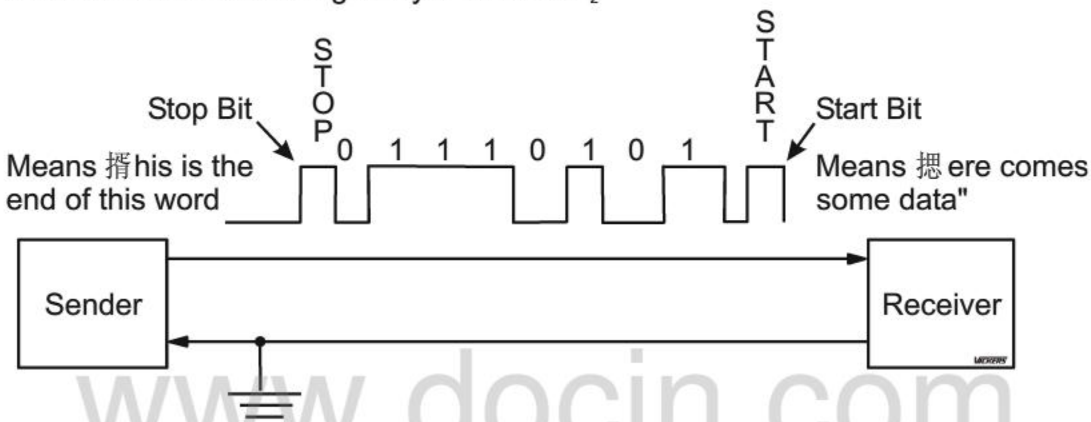



Figure 16-13 Serial data transmission

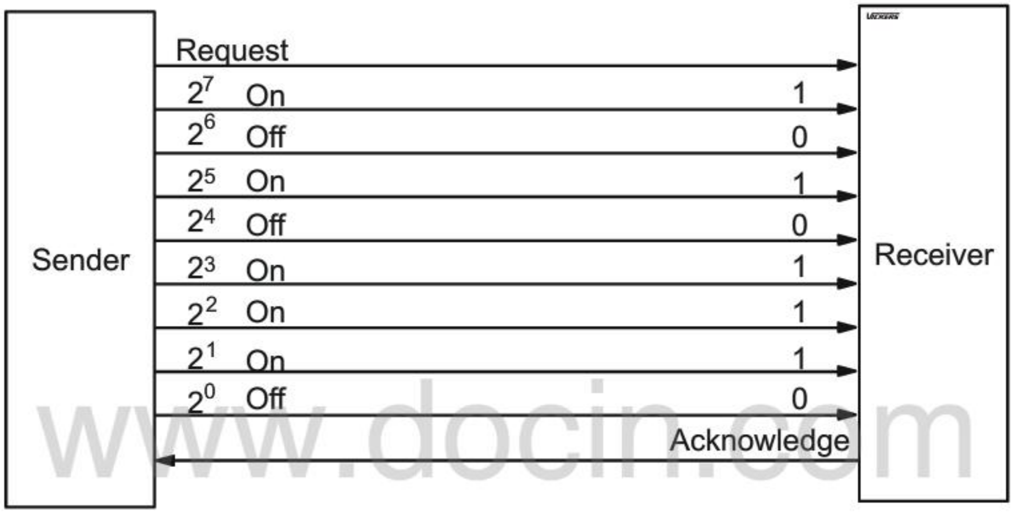
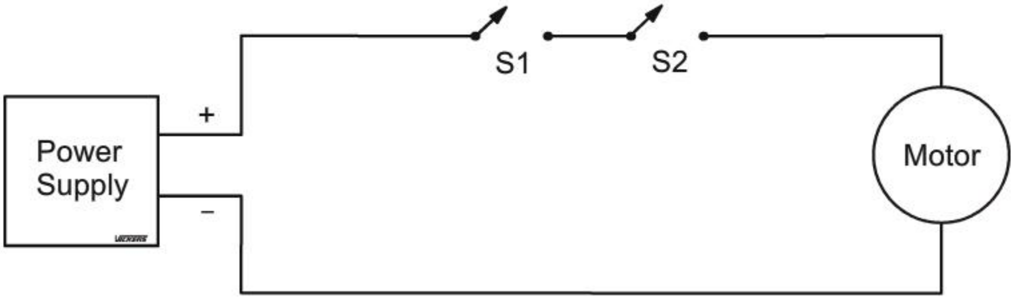


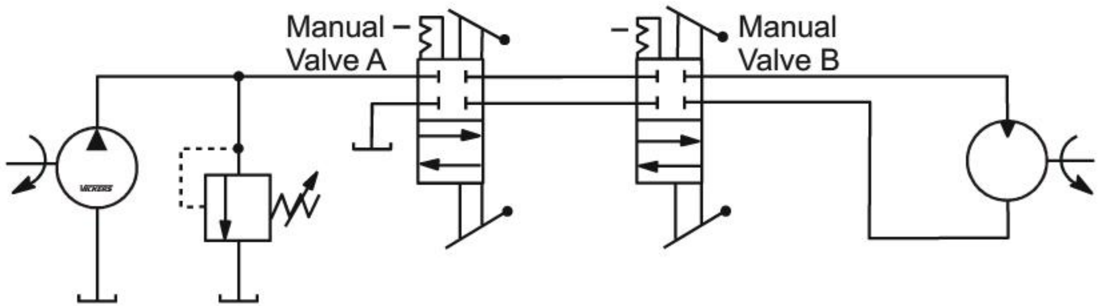

Figure 16-14 Parallel transmission data




Both S1 and S2 must be closed before motor can run



Figure 16-15 Simple electrical AND circuit




Hydraulic equivalent 揂ND" circuit.  Both valves must be opened to run motor



Figure 16-16    Simple hydraulic equivalent of AND control

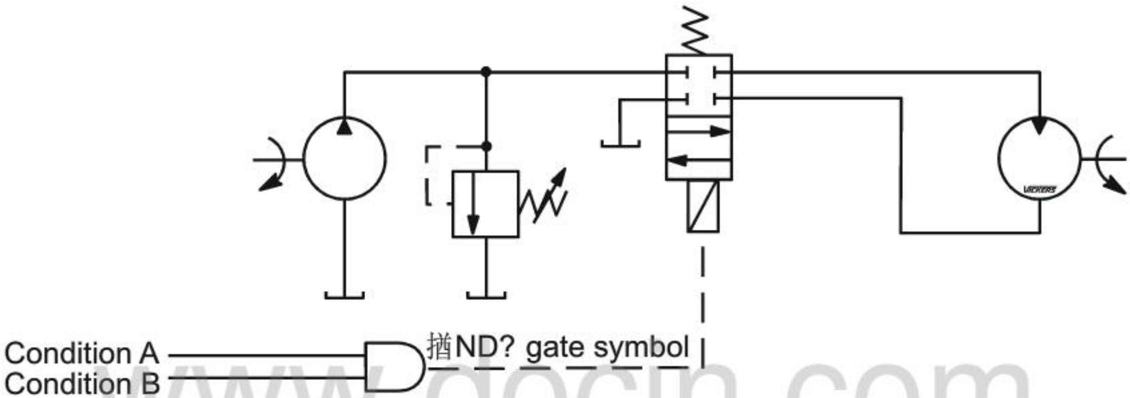
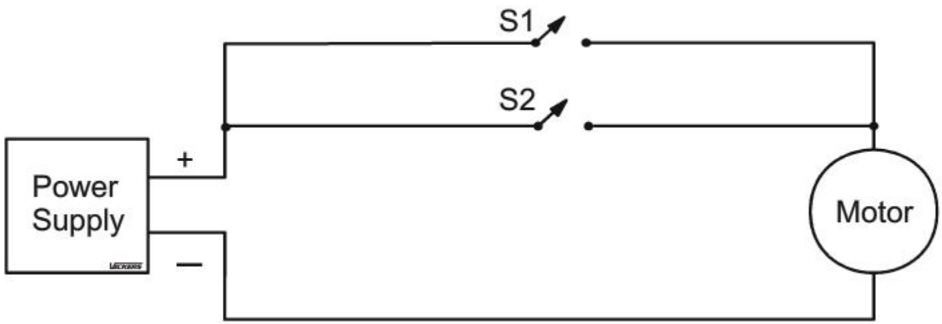




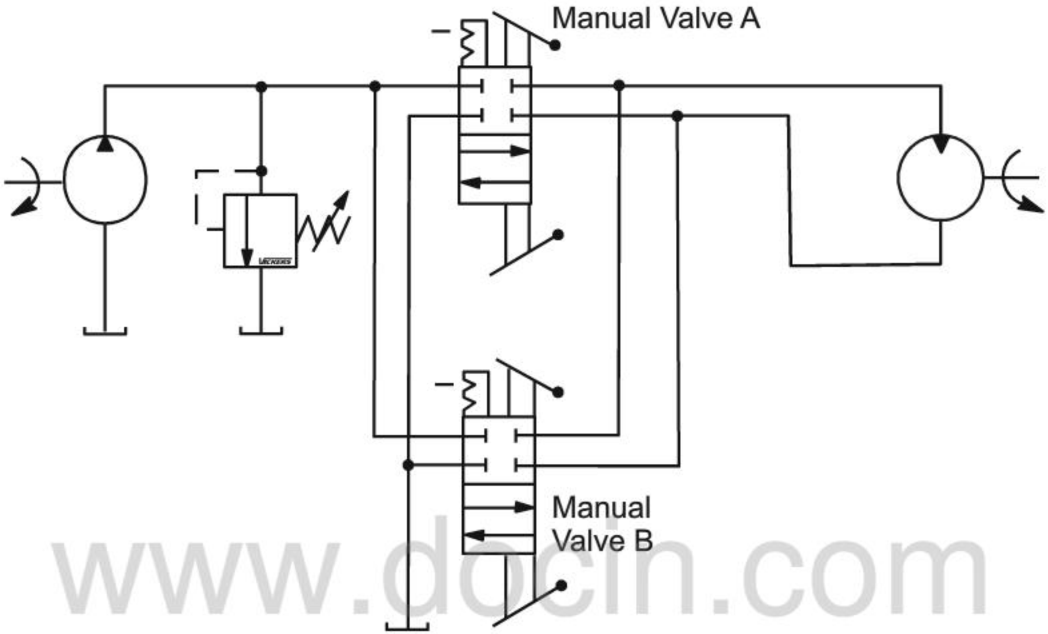

Figure 16-17 Digital AND circuit




Either S1 OR S2 must be closed before motor can run



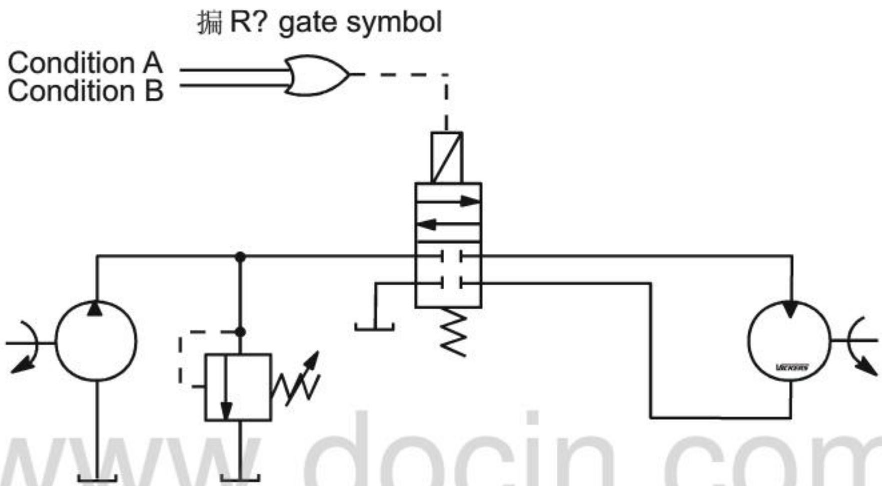
Figure 16-18 Simple electrical OR circuit





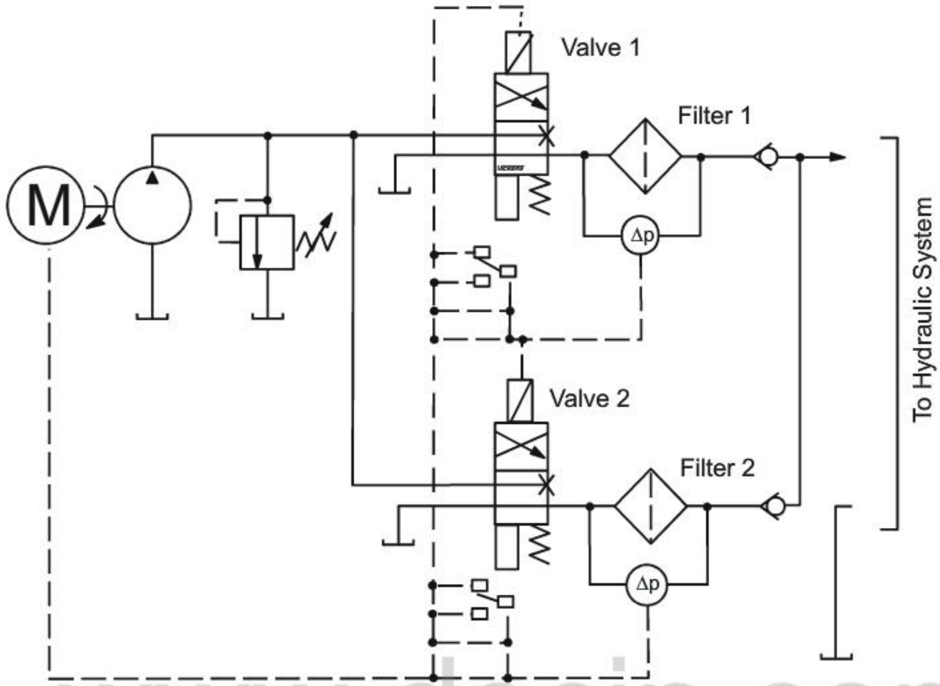

Hydraulic equivalent 搧 R?circuit. Either valve A or B must be opened to run motor

Figure 16-19 Simple Hydraulic equivalent OR circuit




Digital 揊R?circuit.  Valve energized by condition A or B

Figure 16-20    Digital OR circuit




(Δp) = Differential Pressure Switch. Normal condition = Clean Filter = Low Differential Pressure
Contacts time delayed to avoid triggering due to pressure surges.

Valves 1 and 2 are = Solenoid operated, spring offset with monitor switch.
Switch off = Valve off = Oil flow to filter off.

The above circuit will be interlocked to automatically switch to a clean filter and to shut down the motor if both filters are dirty.

Figure 16-21 Machine interlock circuit

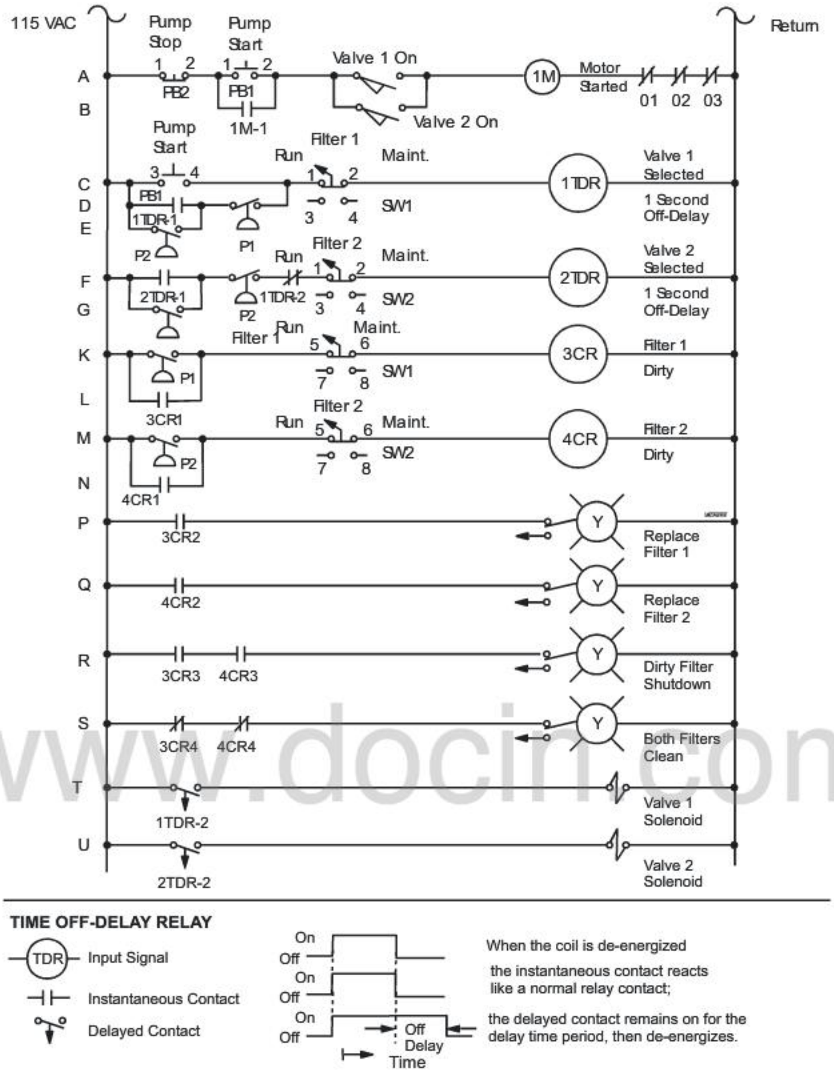



Figure 16-22 Ladder diagram of machine interlock circuit

| DECIMAL | BINARY |
|---|---|
| 0 | 0000 |
| 1 | 0001 |
| 2 | 0010 |
| 3 | 0011 |
| 4 | 0100 |
| 5 | 0101 |
| 6 | 0110 |
| 7 | 0111 |
| 8 | 1000 |
| 9 | 1001 |
| 10 | 1010 |
| 11 | 1011 |
| 12 | 1100 |
| 13 | 1101 |
| 14 | 1110 |
| 15 | 1111 |

Figure 16-23 Binary and decimal equivalents

DECIMAL NUMBER

$3{,}240{,}897_{10}$ Denotes base of number system

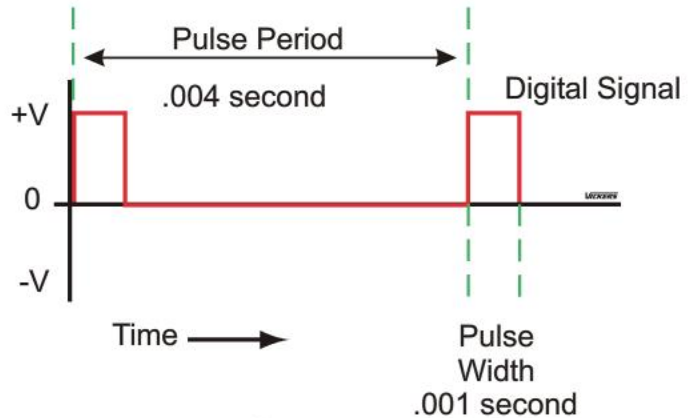
| | | | | | | | |
|---|---|---|---|---|---|---|---|
| DIGIT | 3 | 2 | 4 | 0 | 8 | 9 | 7 |
| POSITION | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| WEIGHT | $10^6$ | $10^5$ | $10^4$ | $10^3$ | $10^2$ | $10^1$ | $10^0$ |
| VALUE | 3,000,000 | 200,000 | 40,000 | 0 | 800 | 90 | 7 |

BINARY NUMBER

MSB $1101101_2$ LSB

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| DIGIT | 1 | 1 | 0 | 1 | 1 | 0 | 1 |
| POSITION | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| WEIGHT | $2^6$ | $2^5$ | $2^4$ | $2^3$ | $2^2$ | $2^1$ | $2^0$ |
| VALUE | 64 | 32 | 16 | 8 | 4 | 2 | 1 |

Figure 16-24 Bit positions values




$$\text{Frequency} = \frac{\#\text{ of pulses}}{\text{Period of pulses}} = \frac{1\text{ pulse}}{.004\text{ second}} = 250\text{ pulses/sec} = 250\text{ Hz}$$

Figure 16-25 Relationship between pulse width and frequency

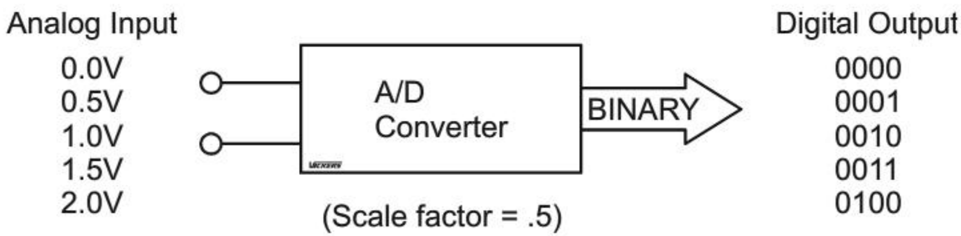



Figure 16-26 Analog-to-Digital converter


Figure 16-27 Digital-to-Analog Converter