

KA1732: KIT – FLEXI / INTERVAL TIMER

Electronics Australia Magazine March 1991 (p92 – p95) & Notes

Rev 1.6

Batch No:



**Customers please note:**  
This project has been modified to use two jumpers to select between 'one-shot' and interval timer mode and select the required pre-determined duty cycle.

**PLEASE READ BEFORE COMMENCING CONSTRUCTION**

The guarantee on this kit is limited to the replacement of faulty parts only, as we cannot guarantee the labour content you provide. Our Service Department does not do general service on simple kits and it is recommended that if a kit builder does not have enough knowledge to diagnose faults, that the project should not be started unless assistance can be obtained. Unfortunately, one small faulty solder joint or wiring mistake can take many hours to locate and at normal service rates the service charge could well be more than the total cost of the kit. If you believe that you may have difficulty in building this kit (which is simply a complete set of separate parts made up to a list provided by the major electronics magazines) and you cannot get assistance from a friend, we suggest you return the kit to us IN ITS ORIGINAL CONDITION for a refund under our satisfaction guarantee. Unfortunately, kits cannot be replaced under our satisfaction guarantee once construction has been commenced.

**CONTACTS:**

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For **quality issues** please contact the **Production Manager** at Jaycar Electronics and provide the following information:

- Product Number
- Batch No
- Details of Quality Issue

**Notes and Errata** (at time of print):

The project article has been updated with relevant notes. It will therefore differ from the original article published in the magazine.  
*It is recommended to check the designers/publishers website for further notes and errata since this document was issued, before starting construction.*

| Possible Substitutions |                    |            |                   |
|------------------------|--------------------|------------|-------------------|
| Original Part          | Original Part Desc | Subst Part | Subst. Part Desc. |
| N/A                    |                    |            |                   |

**PARTS LIST**

Please note that catalogue numbers refer to suitable products from the Jaycar product range. Quantities listed refer to the actual number of items required. When purchasing items separately, take pack quantities into account.  
<sup>1</sup> See section about Substitution <sup>2</sup> See section about Notes & Errata <sup>3</sup> Processed Panel not part of Case listed  
Catalogue numbers starting with "E" or listed as "Special Order" (incl. processed panels) are Kit specific and may not be readily available.

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**RESISTOR(S)**

| Cat.#  | Qty* | Description               | Component Ident                  | Location |
|--------|------|---------------------------|----------------------------------|----------|
| RR0610 | 1    | RES 0.5W MTL 39k 1%       | Orange White Black Red Brown     | R4       |
| RR0620 | 1    | RES 0.5W MTL 100k 1%      | Brown Black Black Orange Brown   | R3       |
| RR0630 | 1    | RES 0.5W MTL 270k 1%      | Red Purple Black Orange Brown    | R1       |
| RR0636 | 1    | RES 0.5W MTL 470k 1%      | Yellow Purple Black Orange Brown | R2       |
| RT4022 | 1    | TRIMPOT VRT MINI 100k 5mm | 100K / 104                       | RV1      |

**CAPACITOR(S)**

| Cat.#  | Qty* | Description                              | Component Ident         | Location |
|--------|------|------------------------------------------|-------------------------|----------|
| RE6032 | 2    | CAP ELECT RB 1u 63V 105C P=2mm 5x11mm    | 1uF / 63V               | C1, C3   |
| RE6195 | 1    | CAP ELECT RB 470u 25V 105C P=5mm 10x16mm | 470uF / 25V             | C5       |
| RM7065 | 1    | CAP MKT 10n 100V P=5mm 7.5x2.5x6.5mm     | 0.01uF / 10n / 103      | C2       |
| RM7125 | 1    | CAP MKT 100n 100V P=5mm 7.5x2.5x6.5mm    | 0.1uF / u1 / 100n / 104 | C4       |

**SEMICONDUCTOR(S)**

| Cat.#  | Qty* | Description                              | Component Ident | Location |
|--------|------|------------------------------------------|-----------------|----------|
| PI6500 | 1    | SKT IC TIN/G 8PIN                        |                 |          |
| PI6502 | 1    | SKT IC TIN/G 16PIN                       |                 |          |
| ZC4020 | 1    | IC 4020* 14STAGE BIN COUNT/DIVIDER DIP16 | 4020            | IC2      |
| ZL3555 | 1    | IC NE555 TIMER DIP8                      | NE555           | IC1      |
| ZR1004 | 2    | DIODE 1N4004 400V 1A DO41                | 1N4004          | D2, D3   |
| ZR1100 | 1    | DIODE 1N914/1N4148/BAW76 DO35            | 1N914/1N4148    | D1       |
| ZT2116 | 1    | TRAN BC338 NPN 30V 800mA TO92            | BC338           | Q1       |

**HARDWARE / WIRE(S) / MISCELLANEOUS**

| Cat.#  | Qty*    | Description                              | Component Ident And/Or Location                          |
|--------|---------|------------------------------------------|----------------------------------------------------------|
| EC8164 | 1       | PCB (KA1732) SM NTN V4 38.1X63.5MM 12/07 | with soldermask and overlay                              |
| HM3211 | 1x3way  | HEADER SGL VRT 28WAY P=2.54MM            | for mode selection<br>break into 1x1way and 1x2way       |
| HM3240 | 2       | JUMPER SHUNTS P=2.54MM                   |                                                          |
| HM3250 | 11x2way | HEADER DUAL ROW 40PIN (2X20PIN)          | for duty cycle selection<br>break into 7x2way and 4x2way |
| NS3015 | 1m      | SOLDER 60/40 1mm                         |                                                          |
| SY4052 | 1       | RELAY PCB 12VDC 2x5A@220VAC 285R DPDT    |                                                          |
| WW4032 | 3cm     | WIRE TIN CU 0.71MM 22AWG                 | wire link                                                |

As of December 2001, Silicon Chip Magazine owns the rights to the Electronics Australia Magazine:

This handy little gadget uses just a handful of components to accurately time intervals from a few seconds to a whole day. It can switch a number of different output devices, and may be powered by a battery or mains plugpack.

*By ROB EVANS and updated by Jaycar Electronics with relevant notes.*

The project article has been updated with relevant notes. It will therefore differ from the original article published in the magazine.

While you've probably noticed that this new project has a very simple circuit, don't be fooled into thinking that it has a limited number of uses. On the contrary, it's an example of how a basic 'open-ended' circuit can be used in a wide range of applications, by simply tailoring the end result to suit the job at hand. Although the actual schematic shows the timer in a specific arrangement, its delay time for example can be adjusted over a very wide range by just altering a couple of component values and board connections (more of this later).

So when the need arises for a timing circuit, be it a simple parking meter reminder or the basis of a full-blown watering system, the idea is that you can configure this design to suit. In fact it's the flexible nature of the circuit that prompted us to dub this project the 'Flexitimer'.

### How it works

As you can tell from the schematic diagram, the Flexitimer's circuit really is quite simple. Basically, it consists of a 'clock' oscillator (IC1), a 14-stage ripple counter (IC2) and an output switching transistor.

The clock circuit is based on the ubiquitous 555 timer IC, which is arranged in a standard astable configuration. With the values shown for R1, RV1, R2 and C1, the circuit oscillates at about 1Hz when pin4 (reset) of IC1 is high, and RV1 is set to around its maximum resistance. The resulting squarewave at the 555's output (pin3) is then applied to the counter's clock input (pin10 of IC2).

The counter chip is a 4020 CMOS device which advances its count on each negative transition of the clock pulse, and can be set to the zero state (all outputs low) by a high logic level on the reset pin (pin11). In the Flexitimer, C3, R3 and D1 are arranged as a power-on reset circuit so that the counter will always advance from its 'zero' state.

Since C1 is initially in a discharged state, pin11 will be pulled high and the counter reset when power is first applied to the unit. C1 will then charge via R3, allowing the voltage at pin11 to fall - this reaches a low logic level in around 50ms and the counter is enabled.

IC2 then counts clock pulses from IC1 until the selected counter output goes high, which in turn biases Q1 hard-on via R4. If the Q14 output is used as shown in the schematic, the clock frequency is divided by  $2^{14}$ , or 16,384. Now, if the clock is running at exactly 1Hz, we will have a frequency of around 60 microhertz (1/16384) at the Q14 output - or in more realistic terms, a cycle period of 16,384 seconds. Since this figure represents a full cycle (low-high-low), the output will change to a high state in half of the period, or 8,192 seconds.

At the end of the above period, the high level at Q14 will force Q1 into saturation, which in turn energises the output relay RLA. Since the clock reset pin (pin4 of IC1) is tied to the collector of Q1, the 555 will be enabled during the timing period (pulled high via relay RLA's coil), and disabled after the time has elapsed (pulled low by Q1's collector).

As you would expect, the Q14 output will remain high at the end of the timing period since IC1 is no longer providing clock pulses to the counter. Therefore, with the circuit components as shown, the relay will be energised 2 hours, 16 minutes and 32 seconds (8,192 seconds) after power is applied to the unit. The relay's closing contacts (normally open) may then be used to connect power in an external circuit, or the opening contacts (normally closed) used to disable (disconnect) an active circuit.

The timer's overall delay can be 'fine tuned' by altering the value of the trimpot RV1. In the above example, if RV1 is moved towards the centre of its travel for a resistance of 55.7k, the clock would be theoretically running at 1.13781Hz and the delay time reduced to exactly 2 hours (7200 seconds). This is indeed theoretical however, since in practice the value of the circuit components won't exactly match their rated values - for a specific time delay, RV1 will need to be adjusted on a trial and error basis.

The remaining parts of the circuit are included to protect the semiconductors, and provide a stable supply rail for the 4020 counter chip. For example, D3 is connected in series with the positive supply rail to prevent any current flowing in the circuit if the power supply is connected the wrong way around - that is, with a reversed polarity. The associated capacitors, C5 and C4 help to filter low and high (respectively) frequency interference from the supply rail. Also, D2 damps the back EMF of relay RLA's coil,

while D1 provides a discharge path for C3 when the unit's power supply is disconnected.

### Options

With the circuit connected as shown in the schematic, the Flexitimer will latch the relay in around 2 hours (depending upon the adjustment of RV1). However if the counter's Q13 output is used, the circuit will reset after 4096 clock pulses or 3600 seconds (1 hour). Similarly, the Q12 connection corresponds to 2048 counts or 1800 seconds (30 minutes) - and so on. Finally, the Q4 output (the smallest division in our circuit) will reset the circuit in just 7 seconds.

However the unit can easily be programmed to cover a wide range of other time delays by simply changing the IC1 clock rate, which can be set between fractions of hertz up into many kilohertz. This yields an overall (practical) timing range from a few seconds to about 24 hours.

To help with the calculations we have included a simple BASIC program (Fig.1), which estimates the final delay time of the Flexitimer as determined by the circuit components. The clock frequency is calculated at line 70, the clock duty cycle at line 80, and the overall time in seconds at line 90. If you haven't got the facilities to run the program, you can use a calculator and the equations at the abovementioned line numbers. Note that 'R1' in the program represents the total resistance between pin7 of IC1 and V+ in the circuit diagram. In the practical sense, this would be the actual resistance of RV1 at its current setting, plus the value of R1.

To try out the program, try typing in the component values mentioned in the 'how it works' section where the circuit has been 'fine tuned' (the total value for 'R1' will be 325.7k).

### Rotary switch

If you find that a number of different time delays are necessary for your application, a 12-position rotary switch could be wired into the circuit between the counter outputs and R4. As you would expect, the time is then reduced by a factor of two (halved) as each lower-order Q output is selected.

Also, you may like some visual indication that the timer is operating - the circuit normally appears quite passive until the relay is pulled in. The simplest solution here is to wire a LED and an appropriate limiting resistor (say 1k) in series between the clock output (point X), and ground. The LED will then flash in synch with the clock pulses until the relay is engaged.

### Interval Operation

In it's original configuration the Flexitimer has the drawback that it is a "once only" timer. Once it has timed out, it is effectively disabled.

With a simple modification the Flexitimer can be turned into an Interval Timer, which turns on and off with a 50% duty cycle, for as long as power is applied. So for example, if it is set for a period of 1024s, it will be off for 1024s, on for 1024s and so on.

The modification involves disconnecting IC1/pin4 (reset) from the collector of Q1 and tying IC1/pin4 to V+ (here IC1/pin8).

### DPDT Relay Operation

The original PCB design of the Flexitimer turned a DPDT relay into a STDP relay. This has been revised and the DPDT relay can now switch two signals.

### Other loads

Note that the circuit will operate quite happily with output loads other than the relay coil. If you only need an audible or visual indication that the delay time has elapsed, an electronic buzzer or 12V lamp (or LED/resistor combination) could be installed in place of relay RLA. These can be connected to the PCB at points Y

and Z, or relay RLA's coil connecting pads.

When the Flexitimer is driving these types of loads (say a buzzer or LED) instead of the relay, the circuit may be battery-powered since the overall current consumption is quite low. While the schematic diagram shows a voltage source of 12 to 15 volts, the circuit is quite suited to a standard 9V 216-type battery. To reduce the unit's size even further, you could cut off the section of the PCB that normally supports the relay and use the Y and Z pads to connect the load.

If you are intending to use the relay on the other hand, DO NOT wire its contacts to the 240V mains supply - combining low-powered circuitry and mains voltage on such a small PCB is just too risky.

If experienced constructors still wish to use the circuit in this manner, the relay should be mounted off the PCB and the complete unit housed in an insulated case. Naturally, any exposed mains wiring should be thoroughly insulated, and any switches used must be rated for 240V mains applications.

### Construction

Building the Flexitimer is a very straightforward process, since all of the components fit on one small printed circuit board. Jaycar Electronics' PCB is coded EC8164 v3 and measures 38.1x63.5mm. A jumper allows easy selection of 'one-shot' or interval timer mode. Another jumper selects which counter output is used, providing for a quick way to change the pre-determined duty cycle.

Commence construction by first checking the PCB for any etching anomalies, such as shorted or broken tracks. Then install the components onto the board as shown in the component overlay, working through from the low to high profile parts - pay particular attention to the orientation of the polarised devices such as electrolytic capacitors and semiconductors.

The 4020 IC is a CMOS device, and should be protected against static voltages by earthing the PCB ground track, the soldering iron (which should already be grounded) and the handling tools. Solder the 4020's power supply pins first - these are pin8 (earth) and pin16 (V+).

The final construction stages will depend upon the options you have selected and the final use of the Flexitimer. For portable use with a buzzer or LED output, simply wire an on-off switch in series with the positive battery lead and install the complete unit in a small plastic case. In a fixed application using the relay as an output device, you could mount the timer inside the case of another unit - this might be a watering system, vehicle (it has a large case!), house alarm, etc.

#### Check out time

It is advisable to check that the timer is operating correctly before commencing an ambitious installation job. Fortunately, this is quite simple - just select which mode of operation ('one-shot' or interval timer) and which counter output is required and install the two jumpers accordingly. Then apply power to the circuit and note that the relay is energised by Q1, after the intended time delay (in 'one-shot' mode) and cycles correctly in interval mode. If Q1's collector doesn't go low on the other hand, check that the clock is delivering pulses at point X and the chosen Q output is being driven high after the correct number of counts.

If the clock chip (IC1) is not running, check the level at pin4 - this should be pulled high via the load during the timing period. The reset pin (pin11) of IC2 is worth checking if there is no activity at

any of the counter's Q outputs - this is normally at a low level, except for a brief high-going pulse when power is first applied to the unit.

Note that if the timer is powered by a plug pack that has a high source resistance, the supply rail may initially rise quite slowly (due to the charging action of C5). This means that IC2's reset circuit (C3, R3 and D1) may not function correctly and the counter will not advance from its cleared state, leading to erratic or inaccurate time delays. If this is the case, try increasing the value of R3 to say 330k; this will allow the slower rising edge of V+ to be transferred to the counter's reset pin.

**\*EA/JAYCAR**

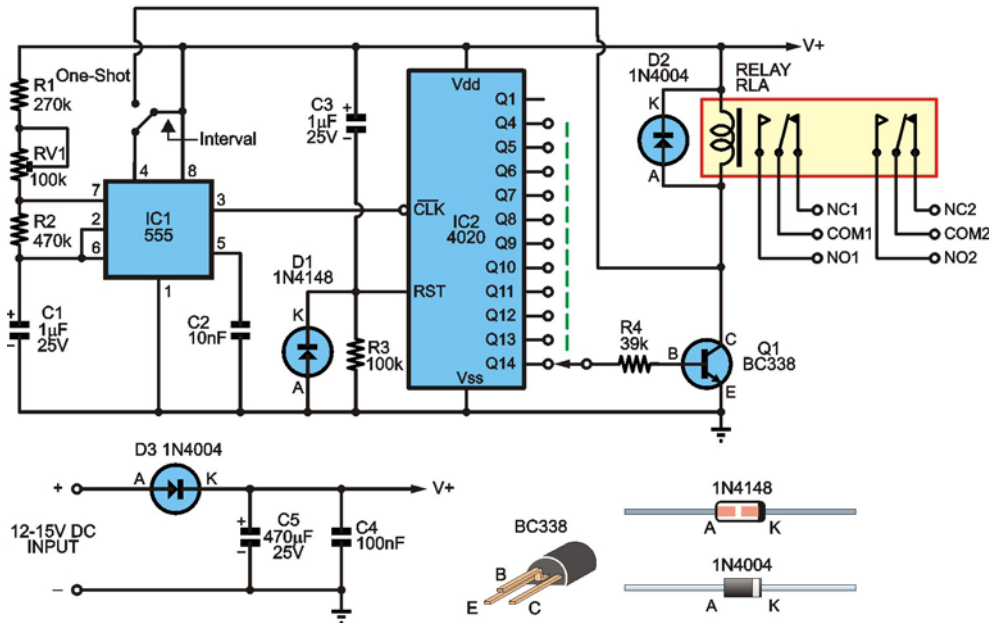
**Fig.1:**

```

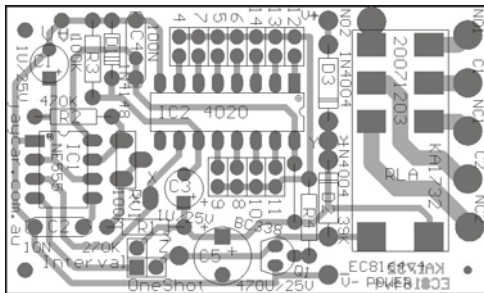
10 PRINT "CHECKS FINAL DELAY TIME OF 'FLEXITIMER'"
20 PRINT
30 INPUT "Value selected for R1 (k)";R1:IF R1=0 THEN SYSTEM
40 INPUT "Value selected for R2 (k)";R2
50 INPUT "Value selected for C1 (uF)";C
60 INPUT "Q output used from counter (n)";N
70 F=1.44*1000/((R1+2*R2)*C)
80 D=100*R2/(R1+2*R2)
90 T=(2^N)/2/F
100 H=FIX(T/3600)
110 M=FIX((T-(H*3600))/60)
120 S=FIX(T-(H*3600)-(M*60))
130 PRINT
140 PRINT "The timer will reset in ";H;" hours, ";M;" minutes and ";S;" seconds"
150 PRINT"- the clock is running at ";F;" Hz, with a ";D;"% duty cycle"
160 GOTO 20

```

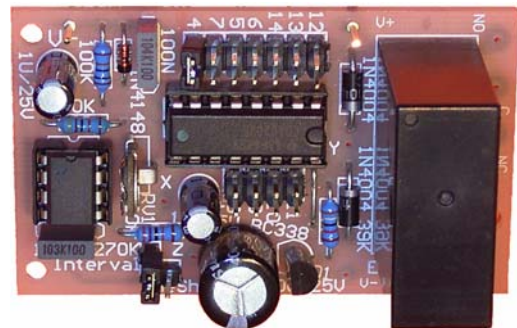
Flexi / Interval Timer



The schematic for the Flexi/Interval Timer. It uses only two ICs - a trusty 555 as the timing clock, driving a 4020 multi-stage binary counter. Transistor Q1 drives the output relay, or other output load.



PCB Overlay



Assembled Project



### COMPONENT IDENTIFICATION

This section will help you to match some of the symbols used in schematics (electronic circuit diagrams) to the physical component used in the actual product. You will see the symbol on the left and the component on the right.

**RESISTORS**

Symbol Component

**4 or 5 Band**  
  
 1/4 or 1/2 Watt

**1 Watt**  
  
 5W or 10W Ceramic

**VARIABLE RESISTORS**

Symbol Component

**Trimpot**  
  
 Potentiometer

**CAPACITORS**

Symbol Component

**Non-Polarised**

**Ceramic**

**MKT**

**Green cap**

**Non-Polarised Electrolytic**

**Polarised**

**Electrolytic**

**Tantalum**

**DIODE / ZENER DIODE**

Symbol Component

**Diode**

**Zener Diode**

**BRIDGE RECTIFIER**

Symbol Component

### COMPONENT IDENTIFICATION

**LED's**

Symbol Component

**INTEGRATED CIRCUIT (IC)**

Symbol (example) Component

Pin 1 (to the left of cutout or mark on IC)

**TRANSISTORS**

Symbol Component

**NPN**

**PNP**

**(FET)**

**TO-92 Body has pin assignments depending on the sub type indicated in brackets.**

**TO-92 (72)**

**TO-18**

**TO-260**

**TO-250**

**TO-260 (N)**

**COMPONENT IDENTIFICATION**

**LAMP**

**MICROPHONE**

**FUSES**

**CRYSTAL**

**BATTERY**

### COMPONENT IDENTIFICATION

### RESISTOR COLOUR CODES

**Examples:**  
 (5 BAND) yellow-purple-black-brown-brown = 4.7 - 0.1% = 4K7 1%  
 (4 BAND) orange-purple-yellow-gold = 3.3 - 4% = 370K 10%

### CAPACITOR CODES

| Microfarads (u) | Nanofarads (n) | Picofarads (p) | EIA code |
|-----------------|----------------|----------------|----------|
| -               | -              | 100pF          | 101      |
| -               | 0.22nF         | 220pF          | 221      |
| 0.001uF         | 1nF            | 1000pF         | 102      |
| 0.0047uF        | 4.7nF          | 4700pF         | 472      |
| 0.01uF          | 10nF           | -              | 103      |
| 0.047uF         | 47nF           | -              | 473      |
| 0.1uF           | 100nF          | -              | 104      |
| 0.47uF          | 470nF          | -              | 474      |
| 1uF             | 1000nF         | -              | 105      |

### ZENER DIODES (1 WATT UNLESS SPECIFIED)

| Part no. | Voltage | Part no. | Voltage |
|----------|---------|----------|---------|
| 1N4728   | 3V3     | 1N4744   | 15V     |
| 1N4729   | 3V6     | 1N4745   | 16V     |
| 1N4730   | 3V9     | 1N4746   | 18V     |
| 1N4731   | 4V3     | 1N4747   | 20V     |
| 1N4732   | 4V7     | 1N4748   | 22V     |
| 1N4733   | 5V1     | 1N4749   | 24V     |
| 1N4734   | 5V6     | 1N4750   | 27V     |
| 1N4735   | 6V2     | 1N4751   | 30V     |
| 1N4736   | 6V8     | 1N4752   | 33V     |
| 1N4737   | 7V5     | 1N4753   | 36V     |
| 1N4738   | 8V2     | 1N4754   | 39V     |
| 1N4739   | 9V1     | 1N4755   | 43V     |
| 1N4740   | 10V     | 1N5349B  | 12V 5W  |
| 1N4741   | 11V     | 1N5352N  | 15V 5W  |
| 1N4742   | 12V     | 1N5374   | 75V 5W  |
| 1N4743   | 13V     |          |         |

### VOLTAGE REGULATORS

**VOLTAGE REGULATORS**

Symbol

**POSITIVE REGULATOR**  
 TO-220 PACKAGE  
 78XX, LM340, LM2940

**NEGATIVE REGULATOR**  
 TO-220 PACKAGE  
 79XX, LM320

**POSITIVE ADJUSTABLE REGULATOR**  
 TO-220 PACKAGE  
 LM317, LM350

**NEGATIVE ADJUSTABLE REGULATOR**  
 TO-220 PACKAGE  
 LM337

**POSITIVE REGULATOR**  
 TO-3 PACKAGE  
 78XX, LM340

**NEGATIVE REGULATOR**  
 TO-3 PACKAGE  
 79XX, LM320

**ADJUSTABLE REGULATOR**  
 TO-92 PACKAGE  
 LM317, LM350

**POSITIVE REGULATOR**  
 TO-92 PACKAGE  
 78LXX

SOT-30

### OHM'S LAW

The most basic law in electronics. The relationship between resistance, voltage and current is determined by Ohm's Law (\*). If you know two out of the three values you can work out the third.

$$V = I \times R$$

$$I = V / R$$

$$R = V / I$$

The formulas are:  
 V is Voltage  
 I is Current in Amps and  
 R is resistance in Ohms



No 1 for Kits  
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**COMPONENT REFERENCE CHART**  
 Ver 1.2 - 01.12.2004