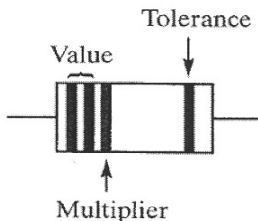


## Electronics

## ELEC4

### Data Sheet

### Unit 4 ELEC 4 Programmable Control Systems

| <b>Resistors</b>                       | Preferred values for resistors (E24) series:<br>1.0, 1.1, 1.2, 1.3, 1.5, 1.6, 1.8, 2.0, 2.2, 2.4, 2.7, 3.0, 3.3, 3.6, 3.9, 4.3, 4.7, 5.1, 5.6, 6.2, 6.8, 7.5, 8.2, 9.1 ohms etc.  |                    |        |   |       |   |       |   |     |   |        |   |        |   |       |   |      |   |        |   |      |   |       |  |
|--|---|--------------------|--------|---|-------|---|-------|---|-----|---|--------|---|--------|---|-------|---|------|---|--------|---|------|---|-------|--|
| <b>Resistor Printed Code (BS 1852)</b> | This code consists of letters and numbers:<br>R means $\times 1$<br>K means $\times 1000$ (i.e. $10^3$ )<br>M means $\times 1\,000\,000$ (i.e. $10^6$ )<br>Position of the letter gives the decimal point<br>Tolerances are given by the letter at the end of the code,<br>F = $\pm 1\%$ , G = $\pm 2\%$ , J = $\pm 5\%$ , K = $\pm 10\%$ , M = $\pm 20\%$ .                                    |                    |        |   |       |   |       |   |     |   |        |   |        |   |       |   |      |   |        |   |      |   |       |  |
| <b>Resistor Colour Code</b>            | <table><tr><th>Number</th><th>Colour</th></tr><tr><td>0</td><td>Black</td></tr><tr><td>1</td><td>Brown</td></tr><tr><td>2</td><td>Red</td></tr><tr><td>3</td><td>Orange</td></tr><tr><td>4</td><td>Yellow</td></tr><tr><td>5</td><td>Green</td></tr><tr><td>6</td><td>Blue</td></tr><tr><td>7</td><td>Violet</td></tr><tr><td>8</td><td>Grey</td></tr><tr><td>9</td><td>White</td></tr></table> | Number             | Colour | 0 | Black | 1 | Brown | 2 | Red | 3 | Orange | 4 | Yellow | 5 | Green | 6 | Blue | 7 | Violet | 8 | Grey | 9 | White |  |
| Number                                 | Colour  |                    |        |   |       |   |       |   |     |   |        |   |        |   |       |   |      |   |        |   |      |   |       |  |
| 0                                      | Black   |                    |        |   |       |   |       |   |     |   |        |   |        |   |       |   |      |   |        |   |      |   |       |  |
| 1                                      | Brown   |                    |        |   |       |   |       |   |     |   |        |   |        |   |       |   |      |   |        |   |      |   |       |  |
| 2                                      | Red   |                    |        |   |       |   |       |   |     |   |        |   |        |   |       |   |      |   |        |   |      |   |       |  |
| 3                                      | Orange  |                    |        |   |       |   |       |   |     |   |        |   |        |   |       |   |      |   |        |   |      |   |       |  |
| 4                                      | Yellow  |                    |        |   |       |   |       |   |     |   |        |   |        |   |       |   |      |   |        |   |      |   |       |  |
| 5                                      | Green   |                    |        |   |       |   |       |   |     |   |        |   |        |   |       |   |      |   |        |   |      |   |       |  |
| 6                                      | Blue  |                    |        |   |       |   |       |   |     |   |        |   |        |   |       |   |      |   |        |   |      |   |       |  |
| 7                                      | Violet  |                    |        |   |       |   |       |   |     |   |        |   |        |   |       |   |      |   |        |   |      |   |       |  |
| 8                                      | Grey  |                    |        |   |       |   |       |   |     |   |        |   |        |   |       |   |      |   |        |   |      |   |       |  |
| 9                                      | White   |                    |        |   |       |   |       |   |     |   |        |   |        |   |       |   |      |   |        |   |      |   |       |  |
|  | Tolerance, gold = $\pm 5\%$ , silver = $\pm 10\%$ , no band = $\pm 20\%$  |                    |        |   |       |   |       |   |     |   |        |   |        |   |       |   |      |   |        |   |      |   |       |  |
| <b>Silicon diode</b>                   | $V_F = 0.7\text{ V}$  |                    |        |   |       |   |       |   |     |   |        |   |        |   |       |   |      |   |        |   |      |   |       |  |
| <b>Silicon transistor</b>              | $V_{be} \approx 0.7\text{ V}$ in the on state, $V_{ce} \approx 0.2\text{ V}$ when saturated   |                    |        |   |       |   |       |   |     |   |        |   |        |   |       |   |      |   |        |   |      |   |       |  |
| <b>Resistance</b>                      | $R_T = R_1 + R_2 + R_3 + \dots$   | series             |        |   |       |   |       |   |     |   |        |   |        |   |       |   |      |   |        |   |      |   |       |  |
|  | $\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \dots$   | parallel           |        |   |       |   |       |   |     |   |        |   |        |   |       |   |      |   |        |   |      |   |       |  |
| <b>Capacitance</b>                     | $\frac{1}{C_T} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \dots$   | series             |        |   |       |   |       |   |     |   |        |   |        |   |       |   |      |   |        |   |      |   |       |  |
|  | $C_T = C_1 + C_2 + C_3 + \dots$   | parallel           |        |   |       |   |       |   |     |   |        |   |        |   |       |   |      |   |        |   |      |   |       |  |
| <b>Time constant</b>                   | $T = CR$ , $T_{1/2} = 0.69 CR$  |                    |        |   |       |   |       |   |     |   |        |   |        |   |       |   |      |   |        |   |      |   |       |  |
| <b>ac theory</b>                       | $I_{\text{rms}} = \frac{I_0}{\sqrt{2}}$   |                    |        |   |       |   |       |   |     |   |        |   |        |   |       |   |      |   |        |   |      |   |       |  |
|  | $V_{\text{rms}} = \frac{V_0}{\sqrt{2}}$   |                    |        |   |       |   |       |   |     |   |        |   |        |   |       |   |      |   |        |   |      |   |       |  |
|  | $X_C = \frac{1}{2\pi fC}$   | reactance          |        |   |       |   |       |   |     |   |        |   |        |   |       |   |      |   |        |   |      |   |       |  |
|  | $X_L = 2\pi fL$   | reactance          |        |   |       |   |       |   |     |   |        |   |        |   |       |   |      |   |        |   |      |   |       |  |
|  | $f = \frac{1}{T}$   | frequency, period  |        |   |       |   |       |   |     |   |        |   |        |   |       |   |      |   |        |   |      |   |       |  |
|  | $f_0 = \frac{1}{2\pi\sqrt{LC}}$   | resonant frequency |        |   |       |   |       |   |     |   |        |   |        |   |       |   |      |   |        |   |      |   |       |  |

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**Operational amplifier**

$$G_V = \frac{V_{out}}{V_{in}}$$

voltage gain

$$G_V = -\frac{R_f}{R_1}$$

inverting

$$G_V = 1 + \frac{R_f}{R_1}$$

non-inverting

$$V_{out} = -R_f \left( \frac{V_1}{R_1} + \frac{V_2}{R_2} + \frac{V_3}{R_3} \right)$$

summing

$$V_{out} = (V_+ - V_-) \frac{R_f}{R_1}$$

difference

**555 Astable and Monstable**

$$T = 1.1RC$$

monostable

$$t_H = 0.7 (R_A + R_B)C$$

$$t_L = 0.7 R_B C$$

astable

$$f = \frac{1.44}{(R_A + 2R_B)C}$$

astable frequency

**Electromagnetic waves**

$$c = 3 \times 10^8 \text{ m s}^{-1}$$

speed in vacuo

**Assembler language microcontroller instructions**

| Mnemonic | Operands | Description                  | Operation              | Flags | Clock cycles |
|----------|----------|------------------------------|------------------------|-------|--------------|
| NOP      | none     | No operation                 | none                   | none  | 1            |
| CALL     | K        | Call subroutine              | stack <= PC<br>PC <= K | none  | 2            |
| RET      | none     | Return from subroutine       | PC <= stack            | none  | 2            |
| INC      | R        | Increments the contents of R | (R) <= (R) + 1         | Z     | 1            |
| DEC      | R        | Decrements the contents of R | (R) <= (R) - 1         | Z     | 1            |
| ADDW     | K        | Add K to W                   | W <= W + K             | Z, C  | 1            |
| ANDW     | K        | AND K with W                 | W <= W • K             | Z, C  | 1            |
| SUBW     | K        | Subtract K from W            | W <= W - K             | Z, C  | 1            |
| ORW      | K        | OR K and W                   | W <= W + K             | Z, C  | 1            |
| XORW     | K        | XOR K and W                  | W <= W ⊕ K             | Z, C  | 1            |
| JMP      | K        | Jump to K (GOTO)             | PC <= K                | none  | 2            |
| JPZ      | K        | Jump to K on zero            | PC <= K if Z=1         | Z=1   | 2            |
| JPC      | K        | Jump to K on carry           | PC <= K if C=1         | C=1   | 2            |
| MOVWR    | R        | Move W to the contents of R  | (R) <= W               | Z     | 1            |
| MOVW     | K        | Move K to W                  | W <= K                 | Z     | 1            |
| MOVRW    | R        | Move the contents of R to W  | W <= (R)               | Z     | 1            |