FACTFILE:
GCSE
Technology and Design

OPTION A: ELECTRONIC AND MICROELECTRONIC CONTROL SYSTEMS

Rewarding Learning

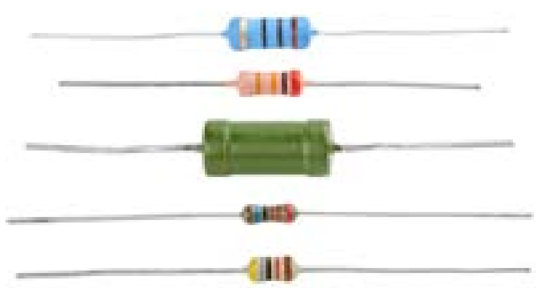
2.5 Resistors. The E12 and E24 Series

Learning Outcomes

You should be able to:

- compare the E12 and E24 series of preferred values;
- determine the nearest preferred value of a resistor using the E12 and E24 series;
- demonstrate knowledge and understanding of tolerance and perform relevant calculations (tolerance limited to 5% and 10%).

Real resistor values (the E12 and E24 series)



You may have noticed that resistors are not available with every possible value, for example 22k and 47k are readily available, but 25k and 50k are not.

Why is this? Imagine that you decided to make resistors every 10 Ohm giving 10, 20, 30, 40, 50 and so on. That seems OK, but what happens when you reach 1000? It would be pointless to make 1000, 1010, 1020, 1030 and so on because for these values 10 is a very small difference, too small to be noticeable in most circuits.

To produce a sensible range of resistor values you need to increase the size of the 'step' as the value increases. The standard resistor values are based on this idea and they form a series which follows the same pattern for every multiple of ten.

E12 series and preferred values

The E12 series has 12 values for each multiple of ten; it is used for resistors with 10% tolerance. The values are 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82, ... then it continues 100, 120, 150 etc. Notice how the E24 series has smaller value steps in between the gaps.

1.0, 1.2, 1.5, 1.8, 2.2, 2.7, 3.3, 3.9, 4.7, 5.6, 6.8, 8.2

The E12 series is the one most frequently used for resistors. It allows you to choose a value within 10% of the precise value you need. This is sufficiently accurate for almost all projects and it is sensible because most resistors have a tolerance of ±10%

E24 Series

The preferred values for the E24 series of resistors are:

1.0, 1.1, 1.2, 1.3, 1.5, 1.6, 1.8, 2.0, 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
and multiples that are ten times greater

Tolerance

Instead of sequential values of resistance from 1Ω and upwards, certain values of resistors exist within certain tolerance limits. The tolerance of a resistor is the maximum difference between its actual value and its named value and is generally expressed as a plus or minus percentage value. For example, a 1kΩ ±10% tolerance resistor may have a maximum and minimum resistive value of:

Maximum Resistance Value
1kΩ or 1000Ω + 10% = 1,100Ω

Minimum Resistance Value
1kΩ or 1000Ω – 10% = 900Ω

Then using this example, a 1kΩ ±10% tolerance resistor may have a maximum value of 1100Ω and a minimum value of 900Ω resulting in a difference of some 200Ω for the same value resistor.

In most electrical or electronic circuits this 10% tolerance of the same resistor is generally not a problem, but when close tolerance resistors are specified for high accuracy circuits such as filters or oscillators etc, then the correct tolerance resistor needs to be used, as a 10% or even 20% tolerance resistor cannot generally be used to replace 2% or even a 1% tolerance type.

Points to consider:

If you are looking for a preferred value for example, of a resistance of 333Ω on the E12 series, you would need to go to the closest preferred value resistor in that series; in this case the value would be 330Ω.

If you are looking for a preferred value for example, of a resistance of 555Ω on the E24 series, you would need to go to the next sized preferred value resistor in that series; in this case the value would be 560Ω.

For resistors acting as protective resistors in front of an LED, the next sized preferred resistor in the series should be chosen.

The E12 series has a tolerance of ±10%, so a 1K resistor could have values between 900Ω and 1100Ω.

The E24 series has a tolerance of ±5%, so a 1K resistor could have values between 950Ω and 1050Ω.

This really means that the value of E24 series resistors should be more accurate, with more chance of it being closer to its actual value.

Past Paper Questions

SAM 2016
Q.1a

1 **(a)** A manufacturer produces resistors with values in either the E12 or E24 series.

(i) Explain the difference between these two series **and** give an advantage in being able to select a resistor from the E24 series compared to the E12 series.

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______________________________ [2]

The E24 series is shown in **Table 1** below.

Table 1

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

(ii) A value of 770 Ω has been calculated for a resistor in a circuit.

What is the nearest preferred value that is available from the E24 series?

______________________________ [2]

SAM 2011
Q.1b/c

(b) Two resistors are shown in **Fig. 1** and **Fig. 2** below. Each resistor has four coloured bands, the fourth band is off-set from the other three bands.

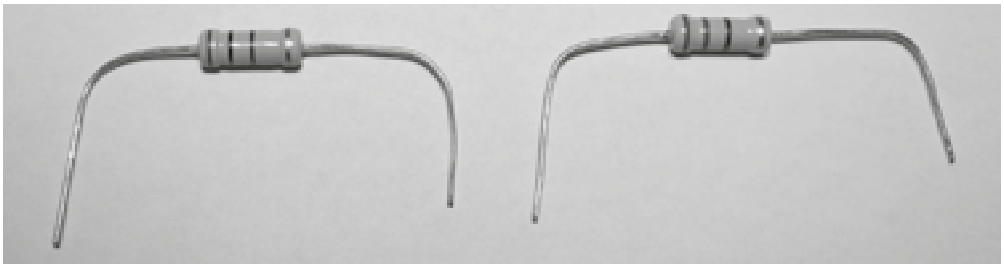

Fig. 1 (47 kΩ) **Fig. 2 (2.2 kΩ)**

(i) State the value of each resistor in **Ω**s.

47 k**Ω** = ____________**Ω** 2.2 k**Ω** = ____________**Ω** [2]

(ii) Use the information below to identify the colours of the first three bands for the resistor in **Fig. 1**.

0 = Black	1 = Brown	2 = Red	3 = Orange	4 = Yellow
5 = Green	6 = Blue	7 = Violet	8 = Grey	9 = White

Band 1 _________ Band 2 _________ Band 3 _________ [3]

(c) **(i)** If, in **Fig. 1**, the fourth band is coloured silver (10%) and in **Fig. 2** the fourth band is coloured gold (5%), use notes and calculations to show the information that can be obtained for each resistor.

Fig. 1 notes ____

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Fig. 1 calculations

Fig. 2 notes ____

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Fig. 2 calculations

[6]