Pearson BTEC Level 3 Nationals Extended Diploma

Window for supervised period:
Monday 6 January 2020 – Friday 17 January 2020

Paper Reference **31725H**

Engineering

Unit 6: Microcontroller Systems for Engineers

Part S

Information Booklet

Do not return this Information Booklet with the Electronic Task Booklet.

Instructions

- This information may be required for learners producing a solution to the task using individual electronic components and/or a prototyping board.
  It is not required by learners producing a solution to the task using only modular electronic devices and project boards.
- If required, read the information carefully.
- You must **not** write your answers in this booklet.
- Only your answers given in the electronic task booklet and audio-visual file will be marked.

Turn over ▶

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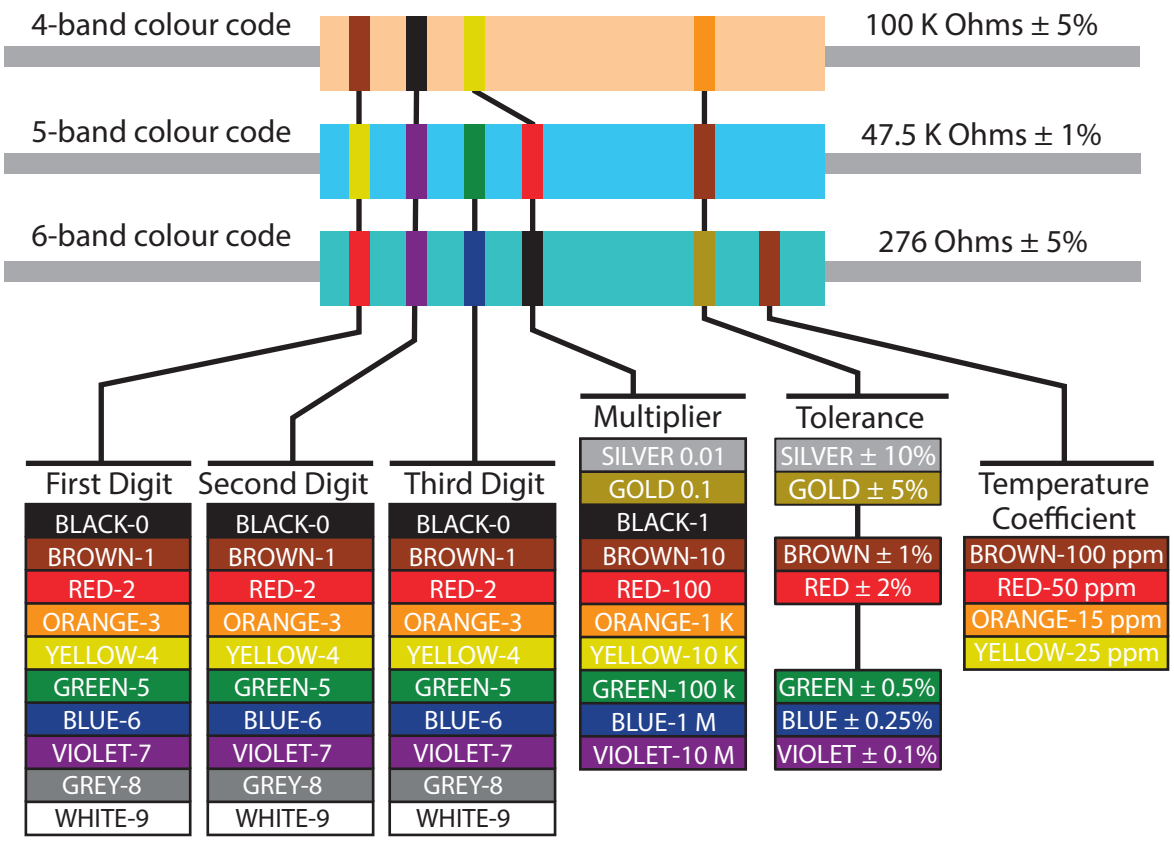
Resistor Colour



Original Equipment Manufacturers' (OEM) Data Sheets

You can refer to data sheets for individual electronic devices, e.g. Liquid Crystal Display (LCD) screens and microcontroller connections, so that you can assemble your prototype solution in an appropriate way.

Use of library code and access to a list of programming commands/instructions

Learners can use software library code as part of their solution to the task, as it is common industry practice when using low level programming languages.

For lower level programming languages, such as 'C', learners can also be given a list of common commands/instructions. The list must only cover the syntax of the commands/instructions. For example, the list may include: 'if (x<5){ } else { }'.

Learners **must not** have access to the internet during the task.

Additional Information for the Unit 6 Set Task

The information below may be useful for learners reading raw Analogue to Digital Converter (ADC) values from discrete temperature sensors and building a solution using individual electronic components. Alternative solutions to read the temperature using software library functions and/or dedicated temperature sensing modules are permitted.

It is not required by learners producing a solution to the task using only modular electronics.

1. As a minimum, the solution should read an analogue port to take readings, but these do not need to be calibrated to a temperature scale, such as degrees Celsius.

2. An alternative approach to point one above, is to use the following information to develop a more **precise solution to the problem**.

(a) A voltage divider circuit can be used to calculate the temperature value.

(b) The voltage divider equation used to read values from a thermistor is:

$R_{therm} = R_{series} * (Analogue_{max} / ADC_{value} - 1)$ - for a pull down resistor

- ADC_{value} is the Analogue to Digital Conversion value
- R_{series} is the value of the resistor in series
- R_{therm} is the resistance of the thermistor at a certain temperature (in degrees Kelvin)
- $Analogue_{max}$ is the maximum value from the port and it is typically 1023 or 255. However, the value will vary depending on the hardware resolution on the ADC channel (8 bit, 10 bit, 12 bit or 16 bit).

(c) The B-parameter equation is used to estimate the temperature using a thermistor:

$$\frac{1}{T} = \frac{1}{T_0} + \frac{1}{B} ln \left(\frac{R}{R_0} \right)$$

- $\mathbf{T_o}$ is the nominal temperature at 25 °C in degrees Kelvin = 298.15 K.
- **B** is the coefficient of the thermistor (e.g. 3950 is a common value).
- $\mathbf{R_o}$ is the nominal resistance of the thermistor (at 25 °C).
- **R** is the measured resistance of the thermistor at a certain temperature.
- **T** is the temperature in degrees Kelvin.

Pearson BTEC Level 3 Nationals Extended Diploma

Window for supervised period:
Monday 6 January 2020 – Friday 17 January 2020

Controlled hours: 12 hours | Paper Reference **31725H**

Engineering

Unit 6: Microcontroller Systems for Engineers
Client Brief

Part S

You must have: Appropriate hardware (including electronic components), programming and word processing software, a calculator, audio-visual equipment and, if required, the Information Booklet.

Instructions

- **Part S** should be undertaken in 12 hours under supervision over no more than 5 consecutive working days. The supervised sessions take place in the 2-week period timetabled by Pearson.
- **Part S** contains material for the completion of the set task under supervised conditions.
- **Part S** is specific to each series and this material must only be issued to learners who have been entered to undertake the task in the relevant series.
- **Part S** should be kept securely until the start of the 12-hour supervised assessment period.
- Answer **all** activities in the Electronic Task Booklet provided and produce an audio-visual recording of the system in operation.

Information

- The total mark for this paper is 80.
- The marks for **each** activity are shown in brackets
  – use this as a guide as to how much time to spend on each activity.

Advice

- Read each activity carefully before you start to answer it.
- Try to answer every activity.
- Check your answers if you have time at the end.

Turn over ▶

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Instructions to Teachers/Tutors

This paper must be read in conjunction with information on conduct for the task in the unit specification and the *BTEC Nationals Instructions for Conducting External Assessments (ICEA)* document. For further details please see the Pearson website.

The set task should be carried out under supervised conditions.

Work should be completed on a computer using appropriate hardware and software as listed in the unit content. Learners should complete the electronic task booklet provided by Pearson. This can be downloaded from the Pearson website. Learners must not have access to the internet. One task booklet and one audio-visual recording must be submitted to Pearson on a USB memory stick or in exceptional circumstances a compact disc (CD) can be submitted instead.

Learners will need access to suitable audio-visual recording equipment and the footage should be recorded in an appropriate file format. The recording must be readable through one of the following software applications: Windows Movie, Real Time, VLC or Quick Time. You must save the recordings in one of the following file types: MPEG, FLV, MOV, WMV or RM.

Centres must make sure that all electronic documents are backed up securely and are kept until the end of the post-results service window.

All learner work must be completed independently and authenticated by the teacher/tutor and/or invigilator before being submitted to Pearson.

Centres are free to arrange the supervised assessment period how they wish provided the 12 hours for producing final outcomes are under the level of control specified, and in accordance with the conduct procedures. The assessment must take place in a 2-week period set by Pearson, once the learner has started **Part S** the assessment must be completed in 5 consecutive working days.

If learners are to produce a solution to the task using individual electronic components and/or a prototyping board, they may need the **Part S** Information Booklet. Centres **can** also provide learners with Original Equipment Manufacturers' Data Sheets for individual electronic devices, e.g. Liquid Crystal Display (LCD) screens and humidity sensors, so that learners can assemble their prototype solution in an appropriate way, but the data sheets **must** not contain any other extraneous handwritten information on them.

Refer carefully to the instructions in this task booklet and the *BTEC Nationals Instructions for Conducting External Assessments (ICEA)* document to ensure that the assessment is supervised correctly. An authentication statement will be required confirming that learner work has been completed as directed.

Learners must not bring anything into the supervised environment or take anything out without teacher/tutor and/or invigilator knowledge and approval. Centres are responsible for putting in place appropriate checks to ensure that only permitted material is introduced into the supervised environment.

Maintaining security

- For **Part S**, learners **must not** have access to the internet.
- During any breaks materials must be kept securely.
- User areas must only be accessible to the individual learners and to named members of staff.
- Learners can only access their work under supervision.
- Learner work must be backed up regularly.
- Any work learners produce under supervision must be kept securely.
- Any materials being used by learners must be labelled and collected in at the end of each period, stored securely and handed back at the beginning of the next period.

Outcomes for submission

Each learner will need to submit:

(a) An electronic task booklet (in PDF format), which contains the following evidence:

- task planning and system design changes made during the development process
- a technical specification with operational requirements
- a test plan
- details and justifications of input/output devices and hardware selected
- system connection diagrams/schematics
- design of the program structure
- annotated copy of all the code
- test data and analysis.

(b) An audio-visual file (recording) of maximum length of three minutes.

Each learner will need to submit evidence using the file names below:

- Electronic task booklet: booklet_[Registration number #]_[surname]_[first letter of first name]
- Audio visual file: file_[Registration number #]_[surname]_[first letter of first name]

A fully completed authentication sheet must be completed by each learner.

The work should be submitted no later than 21 January 2020.

Instructions for Learners

Read the set task information carefully.

This contains all the information you need to complete each activity in the set task.

You will be given more than one timetabled period to complete these tasks in controlled conditions.

You must plan your time accordingly and be prepared to submit all the required evidence by the date specified.

You will complete this set task under supervision and your work will be kept securely during any breaks taken.

You may use a calculator and will have access to a computer, but not the internet.

You must work independently throughout the supervised assessment period and you must not share your work with other learners.

Your teacher/tutor and/or invigilator may clarify the wording that appears in this task but cannot provide any guidance on how to complete the task. You may need to use the Information Booklet.

Outcomes for submission

Each learner will need to submit:

(a) An electronic task booklet (in PDF format), which contains the following evidence:

- task planning and system design changes made during the development process
- a technical specification with operational requirements
- a test plan
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Set Task Brief

Scenario

You are employed by an engineering company that designs control systems to provide a solution to a problem for Barista One90.

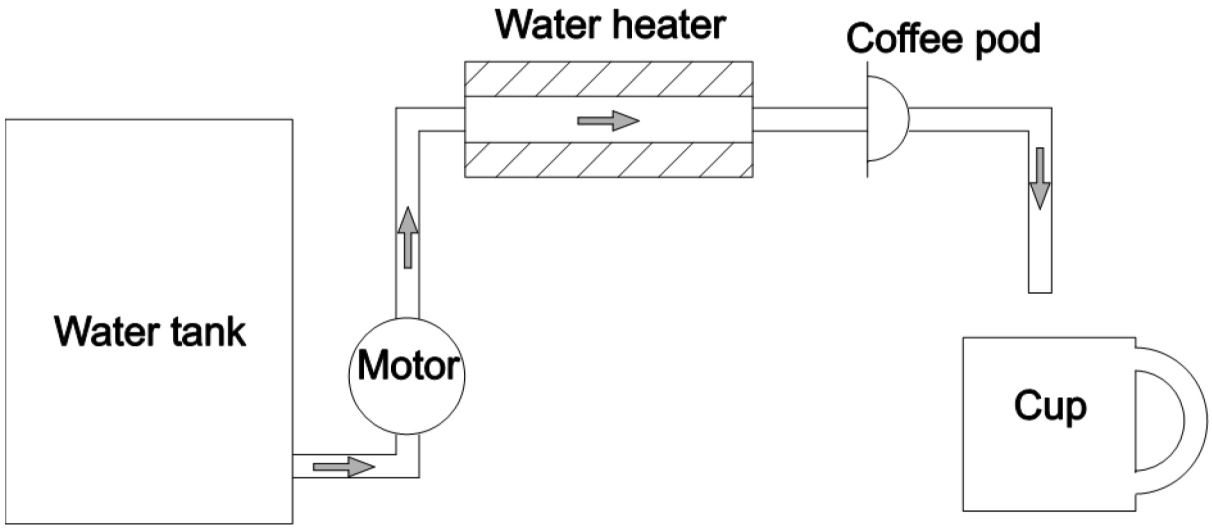
You have been presented with a client brief to develop a prototype control system for a new coffee machine.

Client Brief

Barista One90 manufactures coffee machines for use at home. It is developing a new coffee machine that uses pods for two sizes of coffee:

- an espresso that is a short measure
- a maxi that is a standard measure.

To help you to develop the prototype control system, the client has provided the diagram below of the coffee dispensing process that will be used.



The steps in the coffee dispensing process are:

1. A new single-use coffee pod is placed into the coffee machine.
2. The user selects the size of coffee (espresso or maxi).
3. The water heater turns on.
4. The water heater reaches the correct temperature.
5. The DC motor pumps the water through the water heater.
6. The heated water passes through the coffee pod for either 10 seconds (espresso) or 20 seconds (maxi) into the cup.
7. The water heater turns off.
8. The process restarts from step 1.

To control the coffee dispensing process, Barista One90 has requested a prototype system that will, as a minimum:

- Indicate that either espresso or maxi has been selected.
- Indicate that the water has reached the correct temperature.
- Control the DC motor to run for a set time period of 10 or 20 seconds.
- Indicate that the coffee dispensing process is complete.

If a fault occurs during the coffee dispensing process, the client would like the option to immediately pause the prototype system.

In developing the prototype system you should consider **enhanced user experiences** and how it would deal with any **unexpected events** that may occur.

Health and safety notice

The operation and testing of the prototype system does not require the use of:

- coffee machines
- hot water
- pumps that are connected to motors.

To meet the requirements of an increase in temperature, learners should develop a prototype system that uses a safe, but noticeable change. This could be, **for example**, a temperature change of just a few degrees above **room temperature**, which could be produced by body heat through touching an appropriate sensor.

You need to:

- produce a record of task planning and system design changes made during the development process
- interpret a brief into operational requirements
- design a test plan based on operational requirements
- select and describe appropriate input/output components and how they will work together
- design the program structure
- produce a functional system
- annotate a program or code to demonstrate understanding
- test the system and analyse the outcomes from testing
- produce an audio-visual recording of the system in operation of no longer than three minutes.

Set Task

Task

Design, assemble, program and test a safe prototype system to control the coffee dispensing process that will meet the requirements of the client brief above.

To control the coffee dispensing process, Barista One90 has requested a prototype system that will, as a minimum:

- Indicate that either espresso or maxi has been selected.
- Indicate that the water has reached the correct temperature.
- Control the DC motor to run for a set time period of 10 or 20 seconds.
- Indicate that the coffee dispensing process is complete.

If a fault occurs during the coffee dispensing process, the client would like the option to immediately pause the prototype system.

The client has **not** specified all the prototype system's functions and constraints. These other functions and constraints are for you, as the developer, to determine and justify. For example, the client has not given a specific temperature that the water must reach (other than to state it must be demonstrated just above room temperature).

You must follow an appropriate development process and use a microcontroller.

In developing the prototype system you should consider **enhanced user experiences** and how it would deal with any **unexpected events** that may occur.

You will have a total of 12 hours to complete your prototype system (including testing and documentation and audio-visual recording), which may be split in to several shorter periods.

Health and safety notice

The operation and testing of the prototype system does not require the use of:

- coffee machines
- hot water
- pumps that are connected to motors.

To meet the requirements of an increase in temperature, learners should develop a prototype system that uses a safe, but noticeable change. This could be, **for example**, a temperature change of just a few degrees above **room temperature**, which could be produced by body heat through touching an appropriate sensor.

The stages below will help you to structure your development work.

Activity 1

Task planning and system design changes

You are advised to spend no longer than 1.5 hours on this activity.

- At the start of the task, create a short project time plan/Gantt chart and use it to monitor your progress throughout the rest of the task and make any adjustments as required.
- During the other activities (2 to 5), you should also **record in the Activity 1 section** of your electronic task booklet:
  - what you did in the session
  - details of any issues encountered and solutions discovered
  - action points for the next session.

(Total for Activity 1 = 10 marks)

Activity 2

Analysis of the brief

You are advised to spend no longer than 1.5 hours on this activity.

- By interpreting the client brief into operational requirements, prepare a technical specification for a user friendly system that can handle some unexpected events.
- Prepare a test plan to check the functionality of the final solution against the technical specification and include some unexpected events.

(Total for Activity 2 = 9 marks)

Activity 3

System design

You are advised to spend no longer than 2.5 hours on this activity.

Prepare a user friendly system design that can handle some unexpected events, including:

- The selection and justification of suitable input and output devices.
- A description of the system design covering input and output devices and microcontroller connections.
- A plan for the program structure detailing key system operations.

(Total for Activity 3 = 16 marks)

Activity 4

System assembly and programming

You are advised to spend no longer than 2.5 hours on this activity.

Develop a user friendly system that is well organised, structured and formatted, including:

- Producing the software program and annotating the code.
- The assembly of any hardware (if required).
- Refining the system so that it operates as expected and can handle some unexpected events.

Once completed, insert the annotated code into the electronic task booklet.

(Total for Activity 4 = 16 marks)

Activity 5

System testing and result analysis

You are advised to spend no longer than 1.5 hours on this activity.

- Test the system using the test plan (from **Activity 2**) and include some unexpected events.
- Record the outcome of each test in the template provided.
- Analyse the test results and evaluate the system for conformance against the client brief.

(Total for Activity 5 = 9 marks)

Activity 6

System in operation

You are advised to spend no longer than 2.5 hours on this activity.

Produce an audio-visual recording that demonstrates the system in operation, which should include:

- Your name, learner registration number and centre number at the start.
- A commentary explaining the operation of the user friendly system and how its behaviour is linked with your chosen hardware and the software program.
- Recorded evidence of the outcome from suitable tests including some unexpected events (from **Activity 5**).

(Total for Activity 6 = 20 marks)

(TOTAL FOR TASK = 80 MARKS)