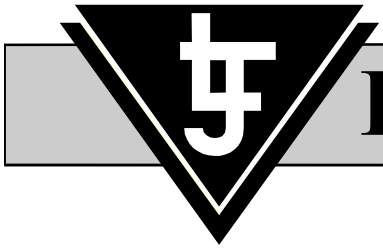

LJ Technical Systems

An Introduction to Microprocessor Technology

Instructor's Solutions

MP628/A

Issue Number: MP628/A

Written by: LJ Technical Publications Dept.

LJ Technical Systems Ltd.
Francis Way
Bowthorpe Industrial Estate
Norwich. NR5 9JA. England
Telephone: (01603) 748001
Fax: (01603) 746340

LJ Technical Systems Inc.
85, Corporate Drive, Holtsville,
11742-2007, New York, USA.
Telephone: (631) 758 1616
Fax: (631) 758 1788

Contents

LJ Technical Systems

Chapter 1 Basic Systems

This chapter is concerned with giving students the ability to identify systems and then to recognize the input(s), output(s) and process(es) of these systems. Encourage students to find examples of systems around their homes and/or workplace and then identify the input(s), output(s) and process(es) of these systems.

Emphasize that a number of systems will have more than single input(s), output(s) and process(es). It is particularly important to note that many systems require power as an additional input.

Solutions to Student Assessment 1

1. An orderly grouping of physical or abstract objects which perform a definite function is called:
   c **a system**

2. Signals which enter a system from the external environment are called:
   d **inputs**

3. Signals which leave a system for the external environment are called:
   c **outputs**

4. In addition to the input signal voltage, the other input to a simple voltage amplifier system is the:
   b **DC power input**

5. A television receiver is a system which has:
   a **two inputs and two outputs**

6. Which one of the following devices can <u>not</u> receive output data from a microcomputer:
   d **keypad**

Chapter 2 Transducers

This chapter introduces the student to transducers of various types. Students should also be given the opportunity to handle and examine everyday transducers if at all possible.

Simple demonstrations can prove to be a valuable learning aid.

Solutions to Student Assessment 2

1. The type of device which converts energy from one form to another is called a:
   c **transducer**

2. The potentiometer can be used to directly measure:
   a **displacement**

3. The transducer which converts electrical current into visible light of a specific wavelength is the:
   c **light emitting diode**

4. A transducer which converts visible or infra-red light into an electrical current is a:
   b **phototransistor**

5. Ultrasonic transducers operate at a frequency:
   d **above that of human hearing**

6. Which transducer has its properties changed when it is bent?
   b **a strain gauge**

Chapter 3 System Flowcharts

This chapter allows the student to gain some experience in the use of flowcharts as a means of describing system behavior. This is an important precursor to the use of flowcharts to describe the action of programs.

Group development of flowcharts for everyday activities will emphasize the need for programs to take account of all possible eventualities and to act accordingly.

Solutions to Student Assessment 3

1. A flowchart is used:
   a **to describe processes within a system**

2. A typical use for a flowchart is to describe:
   d **computer programs**

3. The operation represented by the flowchart symbol shown below is:
   c **an input/output**

4. A decision symbol is used where:
   a **more than one outcome is possible**

Continued ...

Solutions to Student Assessment 3 Continued ...

5. The symbol shown below is only used when:

   b **a connection is to be made**

6. If a flowchart symbol had the statement "Wait for a button to be pressed", the type of symbol used would be:

   c **process**

Chapter 4 Complex System Case Study

The domestic washing machine will be a familiar sequence system for most students and is particularly relevant in relation to the replacement of electro-mechanical controllers with microcontrollers.

The purpose of this case study is to guide the student into thinking in terms of breaking a complex problem down into a large number of simple steps. This skill is essential when attempting to write assembly language control programs.

Solutions to Student Assessment 4

1. A domestic washing machine is an example of a:
   a **System**

2. An example of a sub-system would be:
   b **the hot water valve of a washing machine**

3. In a washing machine, the "Temperature Correct" signal would be an output of:
   c **the tub**

4. An electrical signal converted to a mechanical force is an example of:
   a **a sub-system process**

5. In the flowchart shown earlier for a washing machine program, the first decision to be made in the program is:
   b **is the tub full?**

Continued ...

Solutions to Student Assessment 4 Continued ...

6. Many years ago, program instructions were operated by:
   b **cam/switch sets**

7. The controller is an example of:
   c **a sub-system**

Chapter 5 Analog and Digital Systems

It is important that students can distinguish between analog and digital systems since this will have very important consequences in choosing suitable transducers and control strategies in applications involving microprocessors.

It is vital that students understand the difference between discrete and continuous signals. The audio compact disc player can be a useful case study in this respect.

Solutions to Student Assessment 5

1. Signals which may only have a fixed number of levels are called:
   b digital signals

2. Analog signals are also known as:
   b continuous signals

3. An example of an analog system is a:
   c transistor radio

4. An automobile oil pressure warning lamp is controlled by a:
   a digital signal

5. Why is a D-A converter required on a microcomputer?
   d Some output devices may require analog signals

6. If a potentiometer was used as an input device, the device required by the microcomputer to read this data would be:
   a an A-D converter

Chapter 6 Binary and Decimal Numbering Systems

This work is essential but is often found to be tedious by the student. Once the essentials are understood it is beneficial to use conversion tables or calculators. This will limit the time devoted to performing repetitive conversions.

Experience has shown that the weighted column techniques are the most reliable for students at this level.

Complementary arithmetic should not be introduced at this stage.

Solutions to Student Assessment 6

1. Binary numbers are represented in powers of:
   a **2**

2. To convert a binary number into decimal, the most straightforward method to use is:
   c **weighted columns**

3. The decimal equivalent of 1010_2 is:
   b **10_{10}**

4. The decimal equivalent of 0111_2 is:
   c **7_{10}**

5. The decimal equivalent of 110101_2 is:
   c **53_{10}**

Continued ...

Solutions to Student Assessment 6 Continued ...

6. The decimal equivalent of 11011001_2 is:
   a **217_{10}**

7. The binary equivalent of 6_{10} is:
   d **0110_2**

8. The binary equivalent of 11_{10} is:
   a **1011_2**

9. The binary equivalent of 396_{10} is:
   b **110001100_2**

10. The binary equivalent of 638_{10} is:
    c **1001111110_2**

Chapter 7 The Hexadecimal Numbering System

Solutions to Student Assessment 7

1. Hexadecimal numbers are represented in powers of:
   d **16**

2. Hexadecimal is used because:
   a **Conversions between hexadecimal and binary are easier and less time consuming than between decimal and binary.**

3. The hexadecimal equivalent of 1011_2 is:
   b **B_H**

4. The hexadecimal equivalent of 10100110_2 is:
   c **$A6_H$**

5. The hexadecimal equivalent of 11011011_2 is:
   b **DB_H**

6. The hexadecimal equivalent of 111010101_2 is:
   d **$1D5_H$**

7. The binary equivalent of $F3_H$ is:
   d **$1111\ 0011_2$**

Continued ...

Solutions to Student Assessment 7 Continued ...

8. The binary equivalent of $D9A_H$ is
   a **$1101\ 1001\ 1010_2$**

9. The hexadecimal equivalent of the decimal number 67_{10} is:
   c **43_H**

10. The hexadecimal equivalent of the decimal number 127_{10} is:
    b **$7F_H$**

11. The decimal equivalent of the hexadecimal number 88_H is:
    c **136_{10}**

12. The decimal equivalent of the hexadecimal number 200_H is:
    b **512_{10}**

Chapter 8 Microelectronic Circuits

This chapter introduces the student to microelectronic devices. An EPROM can be handed around the group so that students can examine the device. If a low power microscope is available it can be used to examine the chip more closely. Various packaging techniques can be discussed.

The main purpose of this chapter is to give the student a simple model for the architecture of a microcomputer system. The broad functions of each component should be emphasized. One of the LJ range of open plan microcomputer boards can be used to demonstrate the various components of the simple model. Ensure that students fully understand this model since it is essential for their understanding of subsequent work.

Solutions to Student Assessment 8

1. Any miniaturized, complete functional electronic circuit can be called:
   d **an integrated circuit**

2. Which of the following is not a reason for the development of the IC?
   c **An IC can be soldered into a circuit board.**

3. The number of transistors contained within an LSI IC is
   c **Up to 1000**

4 Which 3 main units are required to form a microcomputer?
   a **Microprocessor, Memory Unit, I/O Unit.**

Continued ...

Solutions to Student Assessment 8 Continued ...

5. Microcomputers which perform a single function are called:
   b **dedicated systems**

6. Which of the following is an example of a memory unit?
   c **RAM**

7. Which of the following is an example of an I/O device?
   b **PIO**

8. Which of the following is not a function of the CPU?
   c **Storing programs**

9. Which of the following is a bi-directional bus:
   c **Data bus**

10. How many locations can an 8-bit Address bus identify?
    d **256_{10}**

Chapter 9 The Central Processing Unit

This chapter is designed to build upon the simple model of a microcomputer from the previous chapter. The CPU is now examined in rather more detail.

Any attempts at covering Fetch/Execute operations are best left until the students have had some programming experience.

Solutions to Student Assessment 9

1. Which of the following is not contained within the Control Section of the CPU?
   c Accumulator

2. The advantage of internal registers is that:
   b They can be accessed via internal buses.

3. The value held by the Program Counter is output on the:
   c Address bus

4. The function of the Accumulator is to:
   a act as a temporary store.

5. The unit of the CPU which is connected directly to the Control bus is the:
   d Control Signal Generator

6. The result of an ALU operation is usually returned to the:
   b Accumulator

7. The unit of the CPU which indicates the status of the most recent ALU operation is the:
   c Flag Register

Chapter 10 The Memory Unit

This chapter is also designed to build upon the simple model of a microcomputer. The Memory is now examined in rather more detail. Use one of the LJ microcomputer boards to point out memory devices. Memory maps are an important consideration but address decoding techniques are not appropriate to this level.

Solutions to Student Assessment 10

1. Memory which loses its contents when the power is removed, is said to be:
   a **volatile**

2. A program stored in ROM is often referred to as:
   d **firmware**

3. The term EPROM means:
   b **Erasable Programmable Read Only Memory**

4. Continuous exposure of an EPROM's window to sunlight, will, over time:
   c **erase its contents**

5. RAM is used for:
   b **temporary data storage**

6. A memory map is required to show:
   d **where in memory programs may or may not be stored**

7. In the example memory map shown earlier, the type of memory which is available between addresses 4000_H and 4300_H is:
   b **System RAM**

Chapter 11 The Input/Output Unit

This is the third chapter which expands upon the simple model of a microcomputer. The Input/Output Interface is examined rather more closely. Again an LJ microcomputer board can be used to indicate practical devices. Keep discussion of the internal architecture and programming of programmable I/O devices to a minimum since these details are not really appropriate to this level.

Solutions to Student Assessment 11

1. I/O devices are required so that microcomputers can:
   b **communicate with external devices**

2. Typically a programmable I/O device provides two parallel I/O ports, each of which contains:
   b **8 bits**

3. Interfacing is required to:
   a **match different systems together**

4 Which of the following is not a possible cause of interfacing problems?
   c **Register incompatibility**

5. One method of overcoming a timing incompatibility is by:
   b **handshaking**

6. When interfacing a computer to a peripheral, code conversion may be required because:
   b **not all peripherals use pure binary codes**

7. Which of the following statements is not true?
   d **Serial communication is faster than parallel communication**