IMPLEMENTATION OF EMBEDDED SYSTEM USING MICROCONTROLLER BASED TOYS

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ABSTRACT

Embedded systems involve the programming of devices, objects and things to behave in a particular way. In other words, it is the science and engineering of automating hardwares into various functionalities through the use of programmable devices like microcontrollers. The description of the concept of embedded system without practical illustration is mere theoretical abstraction. This paper presents the implementation of an embedded system using microcontroller based toys. Electronic tools and components were selected as appropriate. As described in the block and circuit diagrams, the various components were connected. The other steps included installing the Proteus Software for the design and simulation. In like pattern, the Micro C Programming tools were installed on a Windows 7 Operating System Computer through which the Micro C program was developed and deployed on the PIC.The design was incorporated into cotton material baby toys which produce divers light and sound sequence at the press of certain control buttons.Implementing an embedded system such as developing a baby toy requires the understanding of several design resources including both software and hardware. Circuitry design, fixing, loosening and sowing, soldering of physical components on the xeroboard are the hardware side whereas writing the micro C program and simulating it are the software side. A well designed circuit with therequisiteMicro C or Assembly Language program that has been simulated on proteus will behave exactly the same way when implemented in real life provided the selection of components is right. Thus an embedded system is implemented.

Keywords*:* Embedded systems, microcontroller, toys, circuit, Light Emitting Diodes

INTRODUCTION

Malinowski and Yu (2011) defined Embedded Systems as the software implemented in hardware in order to realize specified real-time functionalities. Also, Dorottya, Zhendong and Levente (2015) described an embedded system as computing system built into a larger system, designed for dedicated functions. Embedded system are designed for the purpose of controlling the data in other electronic system, embedded systems are applicable in some electronic devices such as automated teller machines (ATM), Aerospace, also used in Global positioning system, telecommunication systems, equipment for networking, and mobile phones, etc.

LITERATURE REVIEW

In embedded system there are exist many threats and vulnerabilities that result to lose of vital information and so on. Dorottya, et. al. (2015) conducted a systematic review of the existing threats and vulnerabilities in embedded system based on public available data, and the attack taxonomy they derived provides information on how an embedded system can be attack, so the system provides security assistant during analysis and design of embedded system. Muhammad, Muhammad and Aamir (2015) focuses on the identification and classification of newly researches practiced pertaining to embedded system, although, they presented the trends, approaches and tools to support model based system engineering (MSBE) for the development of embedded system. Padma et al (2014) proposed the design of a wireless LPG leakage monitoring system, this system has the ability to continuously monitor the level of LPG inside the cylinder with the aid of load sensor, besides this system can automatically book another cylinder using GSM module. Cyrill, Alvin and Ian (2014) presented a mechanism that can boot up a system directly from a storage device and also has the competent of initializing an embedded system prior to activating a CPU. Mariano et. al. (2014) described three fundamental stages of an algorithm of biometric which includes; Acquisition, Pre-processing and Dynamic time warping, for online signature verification system. Siliang et al (2014) addressed a sequential algorithm for the Multiscale noise Tuning Stochastic Resonance (MSTSR) method using acoustic signal analysis for detecting and diagnosing the train bearing faults in an embedded system and the important aspect of this work is that the algorithm occupies low memory and reduces the computation complexity when it processes the real-valued signal in sequence. Senthilkumar, Gopalakrishnan and Sathish (2014) proposed a technique of image capturing in an embedded system based on Raspberry pi board and based on their experimental result it is more convenient than the PC-based face recognition system due to its lower power consumption, smaller and lighter. Nowadays most of the equipment used for healthcare in the hospitals and homes are computerized and embedded system, these computerized equipment are used for monitoring the well-being of people, to detect emergency situations and also to enhance the quality of care. Carmine et al (2014) presented and discussed an embedded telehealth system for continuous, automatic, and remote monitoring of real-time fall emergencies, this system consist of a microwave radar sensor and wirelessly connected base station for data processing. Subhas and Mukhopadhya (2015) reviewed the reported literature on wearable sensors and devices for monitoring human activities and also the issues to be addressed to tackle the challenges. Roberto, Daniele and Marco (2015) presented an intelligent system to analyses Customer Behavior Analysis inside retail store, they described the setting-up of a low cost system for the indoor localization and customer interaction, developed with a complex infrastructure of wireless embedded system. Zhuosheng, et al (2014) proposed a systematic methodology for a chaotic map based real-time video encryption and decryption system with the implementation of Advanced RISC Machine embedded hardware, but the main feature of the method employed is that, the scrambling-antiscrambling of RGB tricolor pixel positions and encryption-decryption of pixel values are realized at the same time in order to enhance the security. Alessandro and Stefano (2014), based on the specification of contracts on component, addressed the problem of verifying the architectural decomposition of an embedded system. Lorenz, Dominik and Marc (2015) used a multithread and published/subscribed design pattern and as well provided a unix like software interface for microcontroller applications. Jan, et al (2013) developed system that can exhibits reliable and fast estimation of the relative position of the pattern, thus the system developed is suited to meet requirements for a vision based stabilization of robotic swarm. Wen-Tsai and Yao-Chi (2011) utilized zigbee wireless transmission technology for remote monitoring although the system attempted to use the zigbee embedded system to improve industrial safety quality. Jerome, Bechir and Laurent (2008) used a process of rapid prototyping to build distributed real-time and embedded systems around architecture analysis and design language they focused on constraints to build and qualify system in a timely manner and to master implementation and dimensioning issues.

METHODOLOGY

The materials and method followed in the implementation of this embedded system enumerated thus:

Selection of design tools and components

The design tools were selected and procured. Below are the lists of components selected and used for the design:

1. Transistor
2. LM7805 Regulator
3. 9Volts Battery
4. Buzzer

5. LED (Green, yellow and Red)
6. Crystal Oscillator
7. Resistors
8. Capacitors
9. PIC 16F877A Microcontroller
10. On/Off Switch
11. Play/ Display Buttons
12. Wires/Cables
13. Needle
14. Thread
15. Easyway Printed Circuit Board (PCB)

The transistor is made of a solid piece of a semiconductor material, with three terminals for connection to an external circuit. The 5V DC Regulator (LM7805) is an electricalregulator designed to automatically maintain a constant voltage level. The light-emitting diode (LED) is a semiconductor device that emits incoherent narrow-spectrum light when electrically biased in the forward direction. The 12Mhz crystal oscillator is an electronic oscillator circuit that uses the mechanical resonance of a vibrating crystal of piezoelectric material to create an electrical signal with a very precise frequency. A microcontroller is basically an integrated circuit which contains both a microprocessor and peripherals. The external peripherals contained in a microcontroller include memory, input-output lines and timers. (Ibrahim, 2014; Ibrahim, 2012; and Ibrahim 2008).

Design of block diagram

The block diagram as shown in Figure 1 contains the Microcontroller unit which is the heart of the whole system. It houses the program that will determine the operation of the complete system. The algorithm of the system operation will be written using Micro C language and burned into the ROM of the microcontroller. The microcontroller is powered by the power supply unit which equally supplies voltage to the other components of the block. This unit comprises of microcontroller, crystal oscillator, resistor, and capacitor. Power supply unit is the unit that supplies power to the whole system. The microcontroller requires 5Volts.

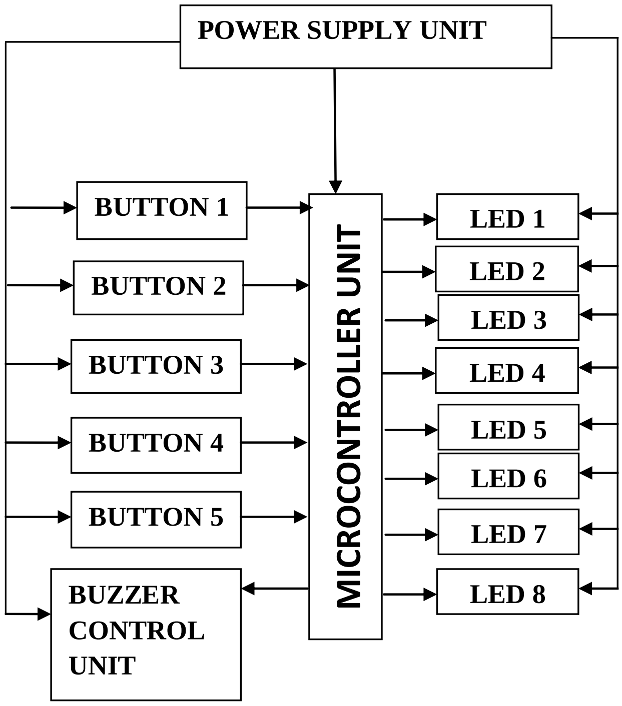

Figure 1 Block Diagram of Design

Installing Software (for example Proteus)

Proteus is simulation software for microcontroller based designs. The software contains all the components needed to design this project. It was strongly recommended that all programs are exited before commencing the installation of proteus according to manufacturer's prescription. The Microchip PICkit setup was run on the system specification aforementioned.

Installing Micro C Programming tool

Micro C is a programming language from the C family used for developing embedded systems. The system requirement/specifications are:

- Windows 7 Operating System
- Intel core i5
- HDD 500
- RAM 4GB
- 64bits

Micro C is a high level language and it is closer to human language that assembly. Figure 2 shows the process of the Micro C loading.

Figure 2 Micro C Program for PIC loading

Designing the circuit on proteus

The PIC16F1877A was selected from the PIC 16F Family. The PIC has 40 pins. The pin 40, 39,38,37 and 36 are connected to one terminal each of 10k resistor respectively with each of the other terminal grounded. Each of the pins is also connected to the one terminal each of the play buttons. The other terminals of the switches are connected to the output of the LM08 regulator. A resistor is also connected to the output terminal and pin 1 MCLR of the PIC. A capacitor is also connected with on leg to the output and the other leg to the ground of the regulator. The positive side of the 9Volts battery is connected to the input of the regulator through the ON/OFF Switch. The buzzer is connected to the battery and the collector of the transistor. The base of the transistor was connected to Pin 18 of the PIC. The emitter of the transistor is grounded. Each of pins 19, 20, 21, 22, 27, 28, 29 and 30 was connected through 330 ohms resistor to a LED respectively with the other side of the LED grounded. Figure 3 shows the Proteus simulation loading whereas the circuit diagram is shown in Figure 4

Figure 3 Proteus Design Suite Loading

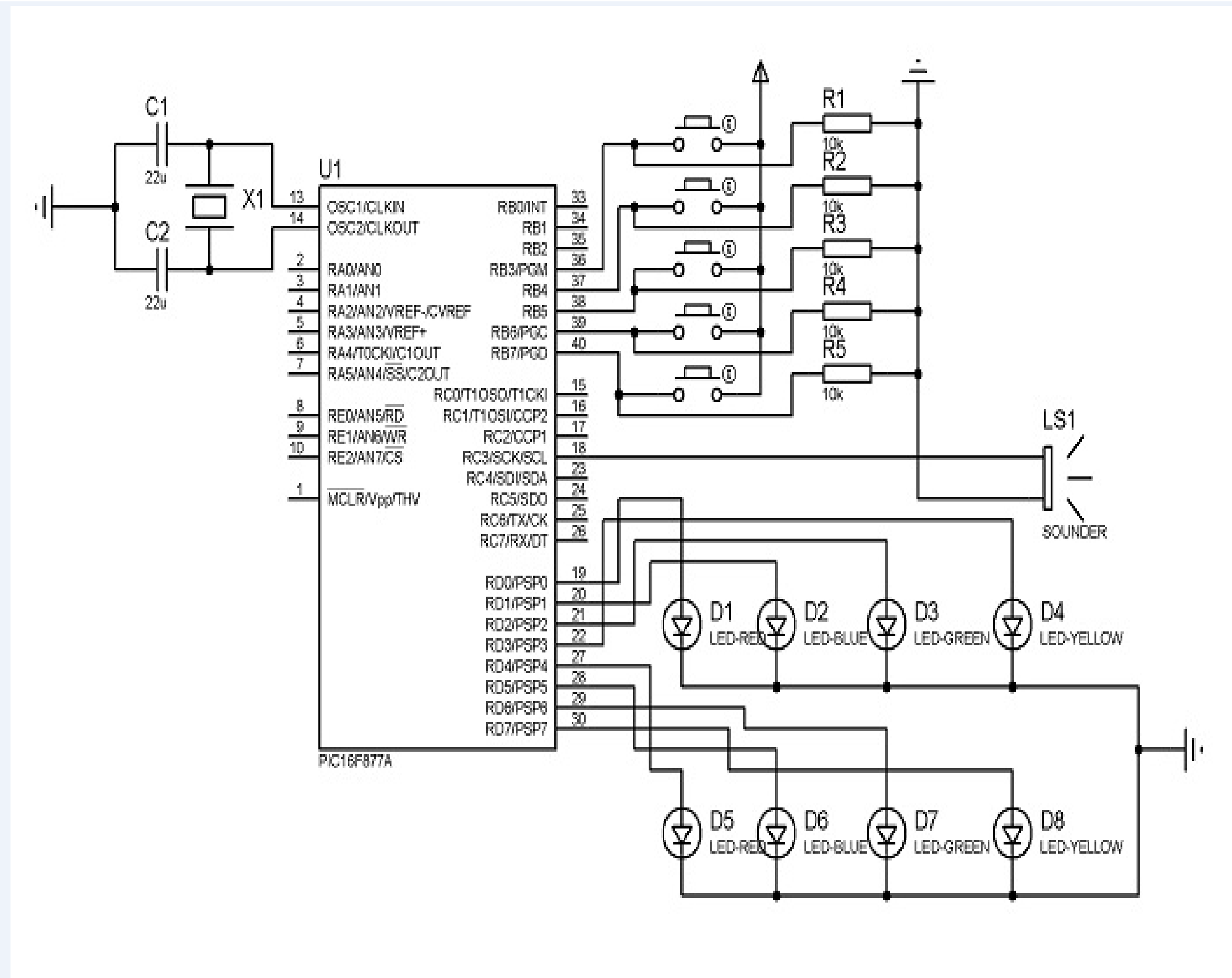

Figure 4 Circuit diagram of the design

Developing the Micro C program

Five steps were involved in developing the program and the five steps are:

1. Identifying the problem and defining the problem accurately so as to know the type of solutions. The goal of the program was well defined.

2. Devising the method of solution. This involved designing an algorithm to aid in the designing of solutions
3. Writing the program. The algorithm above was converted into appropriate programming statement.
4. Testing and debugging of the code
5. Maintenance, organization and proper Documentation were done for the program.

Deploying the program on the PIC

The PIC was plugged into the PIC socket on an Easyway Printed Circuit Board (PCB). The PIC was fixed into its slot on the board and the PCN was connected through an appropriate cable to the computer in which the resources lie. Thefollowingsteps were taken to build the program on the PIC.

1. Click the Mikroprogram suite on your software
2. Select the MCU family as PIC16F
3. Select the MCU as PIC16F1877A
4. Select erase to erase/format the microcontroller unit.
5. Select the code
6. Select write to write into the microcontroller
7. Remove the PIC from the board

Hardware design

Set up the design as explained earlier on. The toys are opened and the designs are appropriately fixed to the suitable places on/in the toy surfaces. The design board is inside the toy well covered while the buzzer, LEDs and switches are fixed neatly outside the toy. The clothing materials of the toys are sown back.

RESULTS AND DISCUSSION

The design, as explained and described in the previous sessions, was implemented into holistic products ready for exhibition. Figure 5 shows the implementation that is embedded inside the toy while Figure 6, Figure 7 and Figure 8 show two implementations of our design as Teddy Toy and Tortoise Toy. Figure 6 shows the front view of the Teddy toy whereas Figure 7 shows the back view where the ON/OFF switch lies. Figure 8 shows the dorsal view of the Tortoise toy.

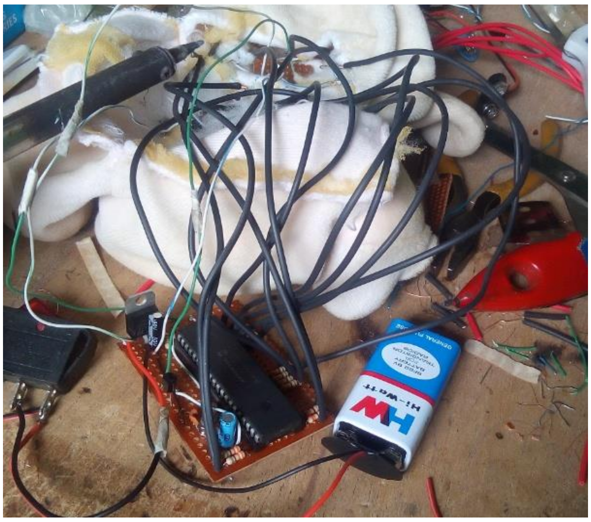

Figure 5 Implementation of the design

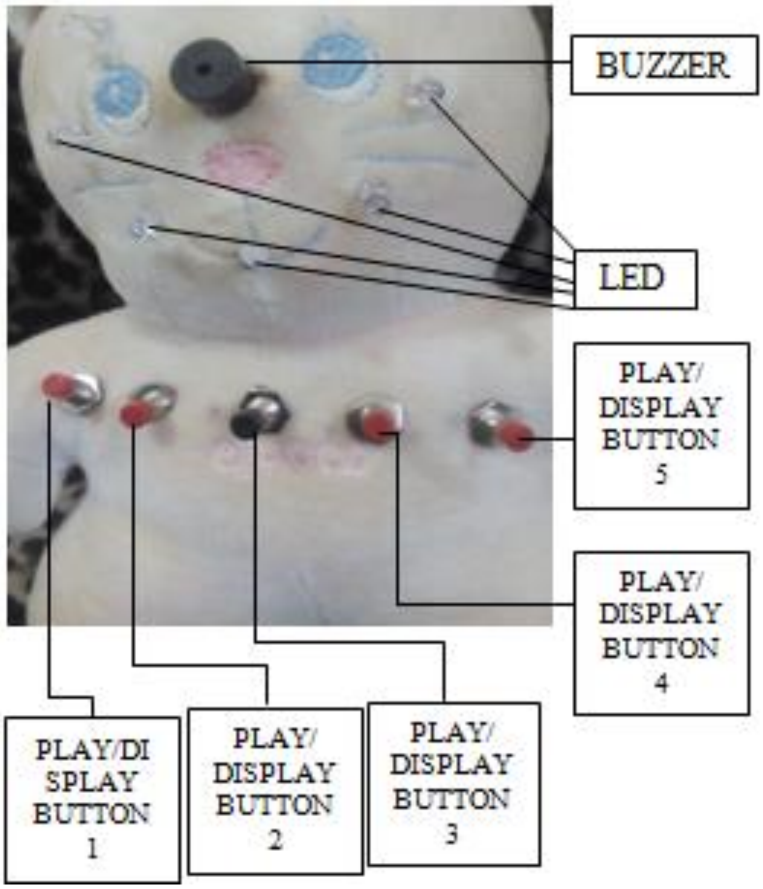

Figure 6 Front view of the implementation

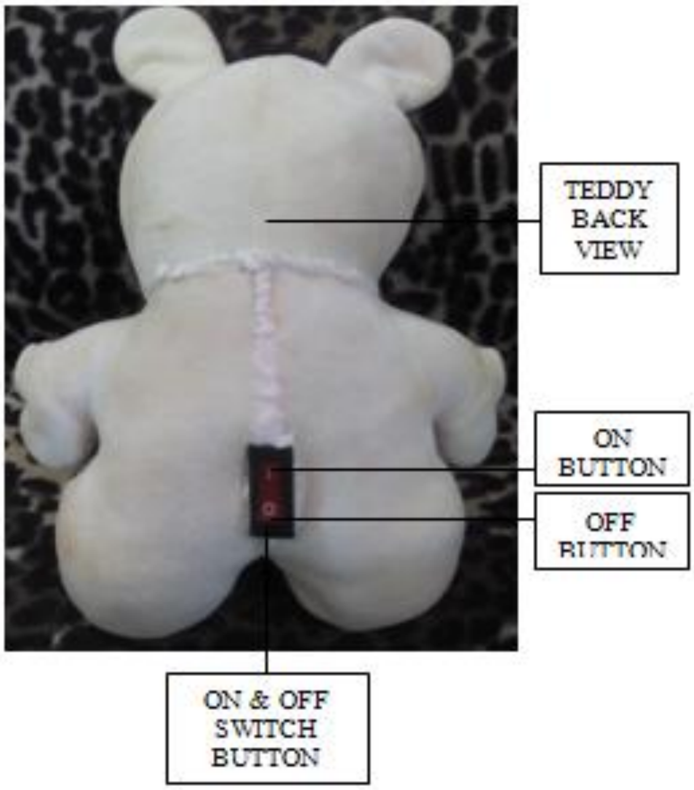

Figure 7 Back view of the implementation

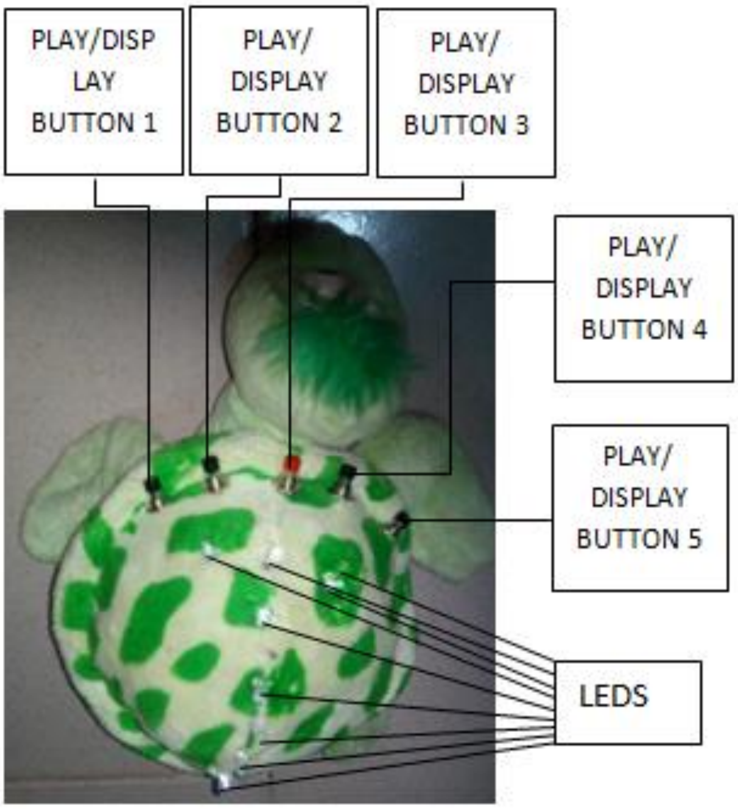

Figure 8 Dorsal view of Tortoise Toy

CONCLUSION

The goal of this paper was to implement an embedded system through the design and constructions of baby toys with light and sound sequence and this was quite achieved at the end. Two sets of baby toys with light and sound sequences were delivered as the design products. The following conclusions were reached:

1. Implementing embedded systems such as developing a baby toy requires the understanding of several design resources including both software and hardware. Circuitry design, fixing, loosening and sowing, soldering of physical components on the xeroboard, are the hardware side whereas writing the micro C program and simulating it is the software side.
2. A well designed circuit with a necessary program that has been simulated on proteus will behave exactly thesame way when implemented in real life provided the selection of components is right.

RECOMMENDATION

The following recommendations were suggested to individuals or corporate entities embarking on further or similar design:

1. Proper safety precautions should be ensured while carrying out necessary implementations like this design. The safety precautions include:
    - Carefulness against burns from soldering iron
    - Avoiding shock from naked cables
    - Proper laboratory tools should be used without compromise.

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2. Tools and materials should be procured from reliable sources to avoid labouring on bad products. Testing of the components may be necessary if possible to ensure workability before deploying, soldering or using.

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