SYSTEM OF CONTROLLERS BASED ON MICROCHIP PIC16F877

Serafim Dimitrov Tabakov

Department of Electronics, T.U.-Sofia , "Kiment Ohridski" N8, Sofia 1000, Bulgaria, phone: +35929653901, savmit@yahoo.com

Keywords: microcontrollers, industrial controllers, ISO 9000/2000, quality standards

This paper presents a system of low-cost industrial universal controllers developed for modernization of SMD placement machine. The controllers are based on Microchip 16FXXX FLASH series microcontrollers and gives a possibility for future system developing. The modernization is necessary in connection with introducing of industrial quality standards in PCB's manufacturing. Also the new hardware and software gives a possibility to use old machines to place new packages like miniature 0402, 0201 and BGA.

The SMD placement machines are used to assemble components onto a PCB (Printed Circuit Board). In KTPPME of T.U.-Sofia exist two pick and place machines made by Dynapert. The reasons of current modernization are:

- old and not reliable hardware based on three 8-bit 6502 microprocessors
- the software for machine control is not flexible
- need to use CAD/CAM output files for machine control
- need the work process be responsible to quality control standards like ISO9000/2000

The Dynapert MPS-109 pick and place machine moves the components from the feeders to the placement position on the PCB using stepping drivers for X, Y, Z and Q (component rotation) axis, and vacuum nozzles to hold it back. One problem in this process is ensuring fast component placing speed. The motors used in MPS-109 to move pick-up head are low-power stepping drivers and need good acceleration algorithms for reach to maximum speed, accuracy and repeatability. By this reason it is very complicate to use one low-cost controller to drive all machine motors and solenoids. In this case much better will be using system of separate controllers for X- and Y-axis motors. Also using the same controllers for other tasks we can reduce the cost of the system.

The proposed system, based on new hardware has three identical controllers. In the development of all controllers are used PIC16F877. This microcontroller with FLASH program memory gives possibility to easy reprogramming of all system and

future developments. The I^2C interface is choused for system bus. That gives possibility for fast and safety communication between controllers with minimum connections – only two wires.

As was mentioned above the system configuration includes three identical controllers. The block-scheme of the system is presented on a fig.1. There is a PC, one master and two slave controllers. The difference between master and slaves is only in software. Due to included drivers, all slaves are accessed from master as I^2C EEPROM memory like 24CXXX. The PC has access to any of special function registers of any microcontroller. The I^2C interface works in 7-bit address mode and the system may includes up to 126 slaves, because address 0 (zero) is reserved from Microchip.

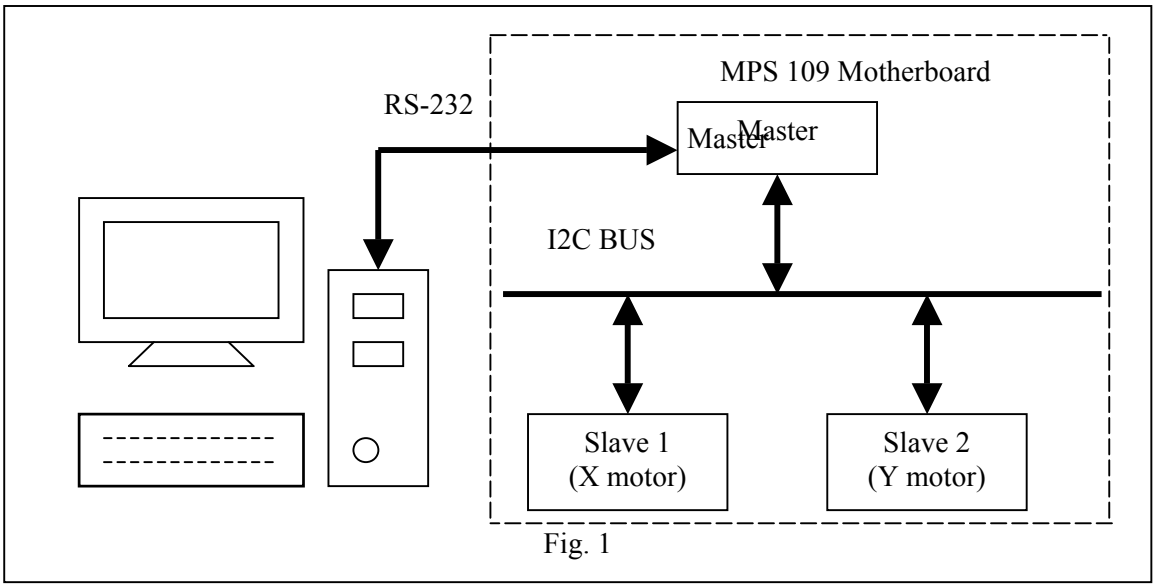

Fig. 1

The master controller performs the next operations:

- recalculation of the components coordinates;
- driving of vacuum and air valves solenoids.

Except driving X and Y-motors two slave controllers employ the free time when horizontal movements are not executed to obtain some machine parameters like vacuum and air-pressure levels, temperature of power drivers for motors and solenoids and temperature of motors corpus. The RS-232 interfaces of slave controllers are used for commands control dump.

Electrical schematic of controllers is showed on Fig.2. Basic configuration of every controller includes:

- RS232 interface
- I2C interface (for system bus)
- 8 digital inputs
- 8 digital outputs
- 5 digital bi-directional pins

Every controller may also consists:

- 32KB external RAM

- 8 analog inputs or 8 digital inputs/outputs

The base of controllers is MICROCHIP PIC16F877 with 8K program FLASH memory, 256B RAM and 256B EEPROM. This type of micro-controllers includes a lot of hardware subsystems – 3 timers, I2C/SPI, UART, parallel slave port and many over.

Every controller is made on single EURO format board and use EURO slot to connect with motherboard. the blocks described as "RS-232" (Fig.2) and "ADC_D/IN" present the serial interface level transducer and analog signal buffers respectively.

The "MUX8to16" block is used to multiply 8-bit port_D bus to 16-bit address bus and 8-bit data bus for 32KB RAM memory 43256. The use of only 8 pins multiplexed address/data on PORT_D was necessary to have maximum microcontrollers pins for input/output functions. Master controller uses external RAM memory for executing program. Slaves use it for temporary saving of machine parameters – temperature, vacuum and air levels, and others.

The role of transistors Q1 and Q2 is buffering I^2C data and clock signals.

Implementation of microcontroller with internal EEPROM gives a preference to easy correct some of manufacturing parameters – machine speed, and movement algorithms. For example in current software modification the internal EEPROM of slave controllers is used to save acceleration constants for horizontal head movements. The EEPROM of the master controller contains constants that determine Z and Q movement speeds and some time parameters for nozzle, and feeders driving.

The controllers use external power DC source that can be from 8 to 20 volts.

The tests of new system are not fully completed, but presented some advantages on this construction decision:

- easy modification of manufacturing parameters for better quality of manufacturing process
- flexible machine driving algorithms
- no system failures due using new better type connectors on motherboard and controllers
- possibility to use CAD/CAM files to drive machine working
- possibility to save manufacturing process parameters for future analysis related to quality standards

The future improvements will include developing of CAM software for PC as main managing system.

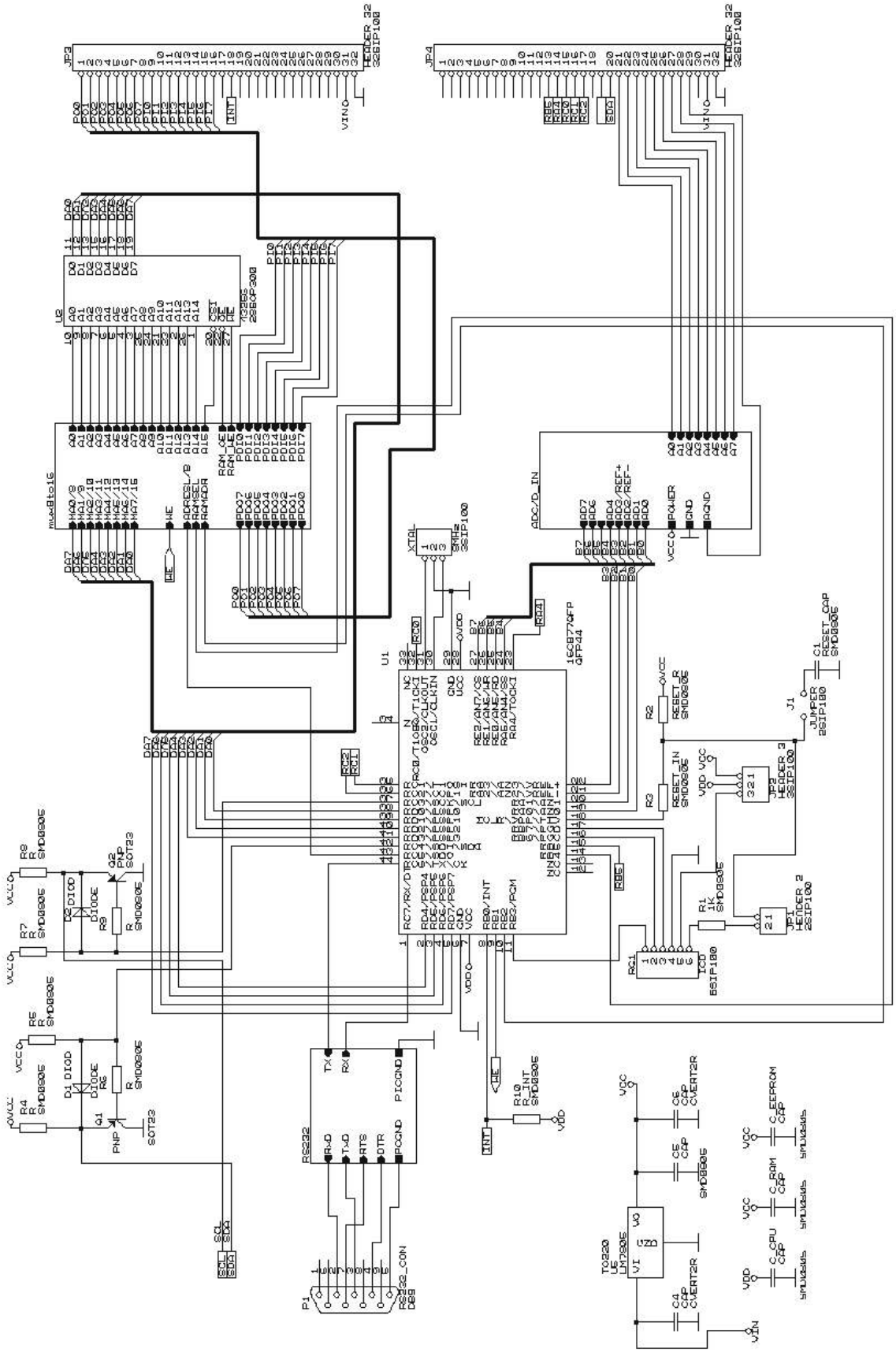

Fig.2