



Implementation of I²C Using ARM9 Controller

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ABSTRACT: Data transmission with low power consumption, high speed and simple in design are the major concerns in embedded system. ARM9 is advanced version in microcontrollers with high speed, high performance and low power consumption. In this paper using LPC2929 board of ARM968E-S (from ARM9 family) controller for serial communication at high bit rate is implemented and analyzed. LPC2929 has peripheral interface devices such as I²C, CAN, SPI, EEPROM, ADC/DAC, RS485 etc., The inter-IC (I²C) bus is a bidirectional bus provides communication without data loss. Each device is recognized by a unique address and can function as a receiver-only device or as a transmitter in simplex operation. Work done for this journal involves I²C interface between ARM9 master to 24C02 (EEPROM) slave and read the stored data using RS485 protocol. The software for the system is implemented in Embedded 'C' using the Keil μ vision 4 cross compiler. Results are observed on Hyper Terminal.

KEYWORDS: I²C, EEPROM, ARM9, RS485.

I. INTRODUCTION

Embedded system design is mainly for making and managing communication between various bus interfaces and attaching multiple systems with different interfacing protocols to a main processor with high speed and low power consumption. ARM968E-S is a high performance; low power consumption microcontroller running at frequencies up to 125 MHz^[4]. Embedded systems mainly uses serial communication to communicate with peripherals. I²C is a simple structured serial communication protocol, it gives excellent speed compared to other protocols. I²C uses only two wires for communication serial data line (SDA), serial clock line (SCL), so less number of wires required for connections and provides communication without data loss^[2]. I²C bus supports for multiple masters and slaves. In this paper one master and two slaves are connected.

LPC2929 has on board EEPROM (24C02-EM/S(U2)) it is connected as one of the slave device for I²C protocol, with all memory operations synchronized by the serial clock^[4], External 24C02 EEPROM is connected as second slave and ARM968E-S is connected as master^{[3][4]}. RS485 is a standard interface for serial communication; it is a half duplex, multi-drop network at distances up to 4000ft. It supports several types of connectors, including DB-9 and DB-37. RS232-USB cable is used to communicate with PC to see received data on hyper terminal.

II. BLOCK DIAGRAM AND SPECIFICATIONS

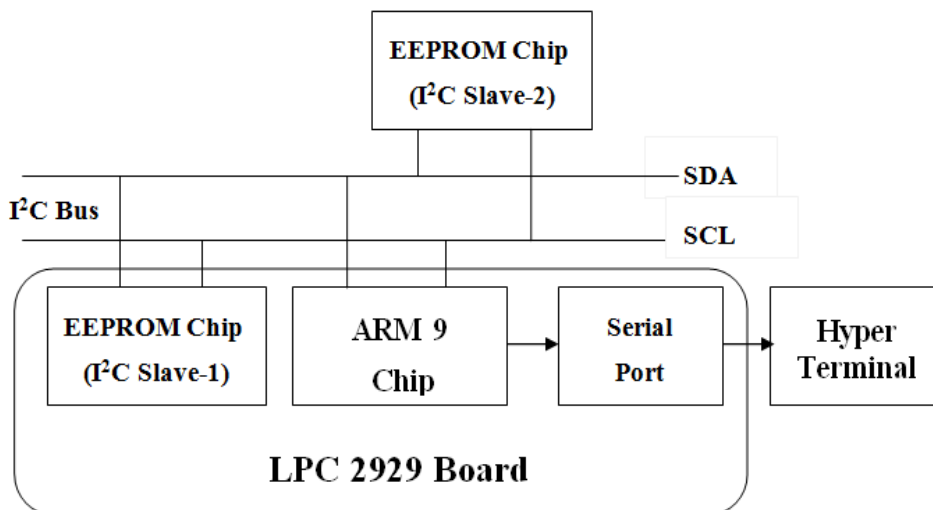


Fig. 1 Block Diagram

I²C:

I²C bus stand for “Inter-integrated circuit” bus. I²C bus is a two-line (serial data line (SDA) and serial clock line (SCL))^[2] serial bus developed in simple inexpensive communication, usually between ICs on the same printed circuit board. It connect low - speed devices like microcontrollers, EEPROMs, ADCs, DACs and other similar peripherals in embedded systems. I²C Devices are processors, EEPROMs, sensors, real-time clocks. It is used as a control interface, I²C devices can also have separate data interface. It was operated in 3 speeds. Those are, Slow (under 100 Kbps), Fast (400 Kbps), High-speed (3.4 Mbps).

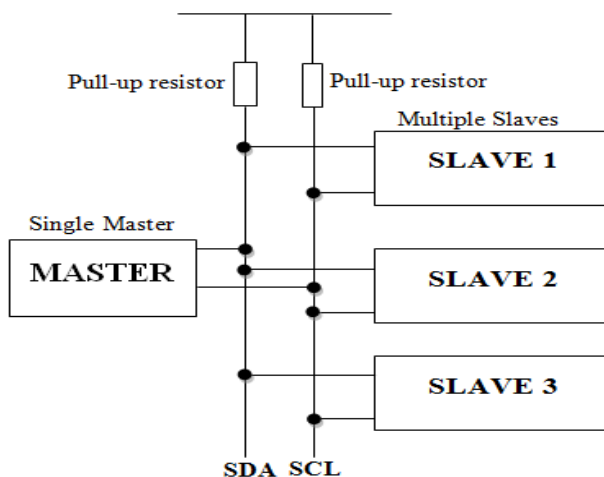


Fig. 2 I²C Block Diagram

I²C bus is popular because it is simple to use, there can be more than one master, only upper bus speed is defined and only two wires with pull-up resistors are needed to connect almost unlimited number of I²C devices. I²C can use even slower microcontrollers with general-purpose I/O pins since they only need to generate correct Start and Stop conditions in addition to functions for reading and writing a byte.



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The communication on an I²C bus is initiated by the bus master. The master generates clock signals (SCL) to permit data transfer. At this time, the device that is addressed is a slave. All communication starts with a START condition and ends with a STOP condition.

EEPROM

EEPROM stands for Electrically Erasable Programmable Read-Only Memory. The AT24C02 is an I²C compatible EEPROM provides 2048bits of serial electrically erasable and programmable read-only memory (EEPROM) organized as 256words of 8 bits each^[3]. The device is optimized for use in many industrial and commercial applications where low-power and low-voltage operation are essential and it can save transmission time, increase the bus utilization time.

ARM9

ARM9 is a high performance, low power consumption microcontroller running at frequencies up to 125 MHz's consisting of 144 pins, in that 104 general-purpose I/O pins. It supports the Thumb instructions and widely accepted for applications which need high speed and high performance in MIPS per Watt^[4]. Each I/O pins have four different functions. ARM9 has Harvard architecture. ARM9 has the separate instruction and data cache memory. It has separate instruction and data buses. It has a five-stage pipeline. It provides faster load and store due to more stages in pipeline. ARM9 gives higher performance than ARM7. The main advantages of ARM9 over ARM7 are

- Decreased heat production and lower overheating risk.
- Clock frequency improvements. Shifting from a three-stage pipeline to a five-stage one lets the clock speed be approximately doubled, on the same silicon fabrication process.
- Cycle count improvements. Many unmodified ARM7 binaries were measured as taking about 30% fewer cycles to execute on ARM9 cores.

Key improvements include:

- Faster loads and stores; many instructions now cost just one cycle. This is helped by both the modified Harvard architecture (reducing bus and cache contention) and the new pipeline stages.
- Exposing pipeline interlocks, enabling compiler optimizations to reduce blockage between stages.

Additionally, some ARM9 cores incorporate "Enhanced DSP" instructions, such as a multiply-accumulate, to support more efficient implementations of digital signal processing algorithms.

ARM9 supports the Thumb instructions and this is available in ARM 9, T, E and J versions. ARM core-based MCUs based on ARM9 are widely accepted for applications needing high speed and performance in MIPS per Watt. The instructions use the byte, half-word (16-bit) and word (32-bit) for operations.

The main features of ARM are large register file R0 to R16, Load and Store Architecture data processing is only in register contents, Uniform and fixed length instructions, High code density, Mostly single-cycle execution, Speed is mostly 1Mhz to 1.25Ghz and In built circuit for debugging.

III.IMPLEMENTATION

Single Slave Mode:

LPC 2929 board and PC with Keil μ vision 4; hyper terminal software and RS232 drivers are taken. Board is powered through USB port of PC and debugger is connected through USB port of PC. Jumpers J11 and J12 on LPC 2929 board are closed for I²C interface. Connect on board RS485 with RS232-USB cable. Program is written in "Embedded C" for writing data into EEPROM through I²C and reading the data from EEPROM through I²C bus including serial communication to see result in hyper terminal.

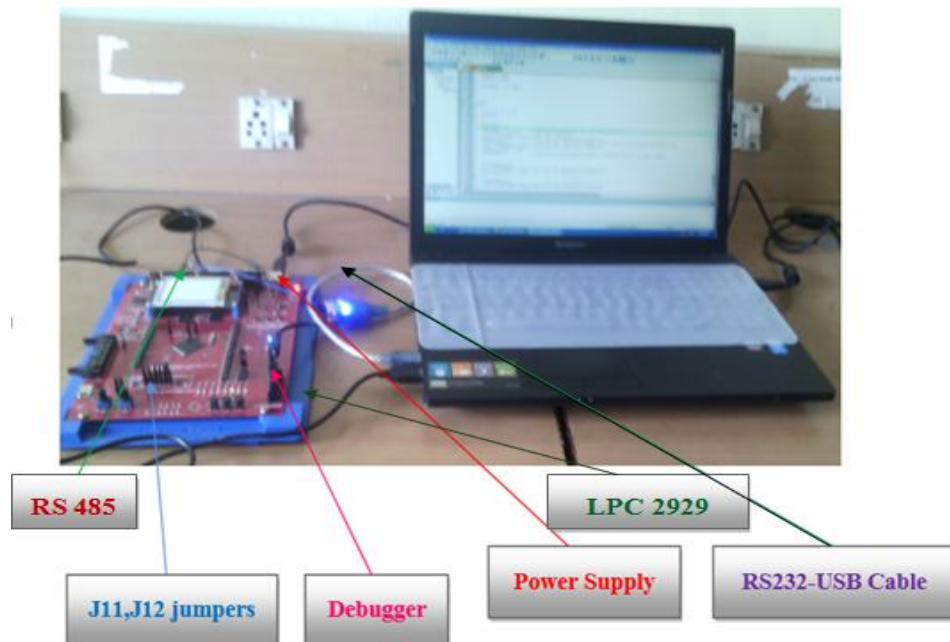


Fig. 3 Hardware Setup

Multiple Slave Mode:

AT24C02 is an external EEPROM, LPC 2929 board have two on board I²C protocols I²C0 and I²C1. Port1 10, 11, 12 and 13 pins are internally connected to this I²C0 and I²C1. In this I²C0, Pin11-SCL is used as Serial Clock line and pin 10-SDA Serial Data line.

AT24C02 consists of 8 pins. In that 5th and 6th pins are SDA and SCL; these two pins are connected to I²C0. 1st, 2nd and 3rd pins are connected to either ground or V_{cc}. These pins decide slave address of the AT24C02. Pins 4 and 8 are connected to ground and V_{cc} respectively. 7th pin is write protect, it is connected to ground.

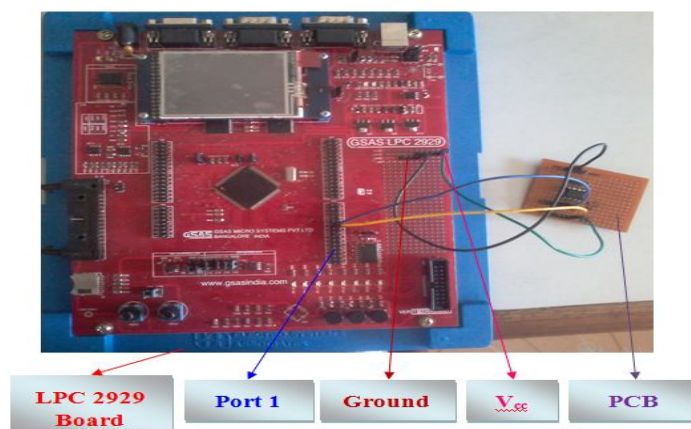


Fig. 4 Hardware Setup for External EEPROM

Connect on board RS485 with RS232-USB cable. Program is written in "Embedded C" for writing data into EEPROM through I²C and reading the data from EEPROM through I²C bus including serial communication to see result in hyper terminal. By giving particular slave address internal EEPROM or External EEPROM is selected.



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IV.RESULTS & DISCUSSION

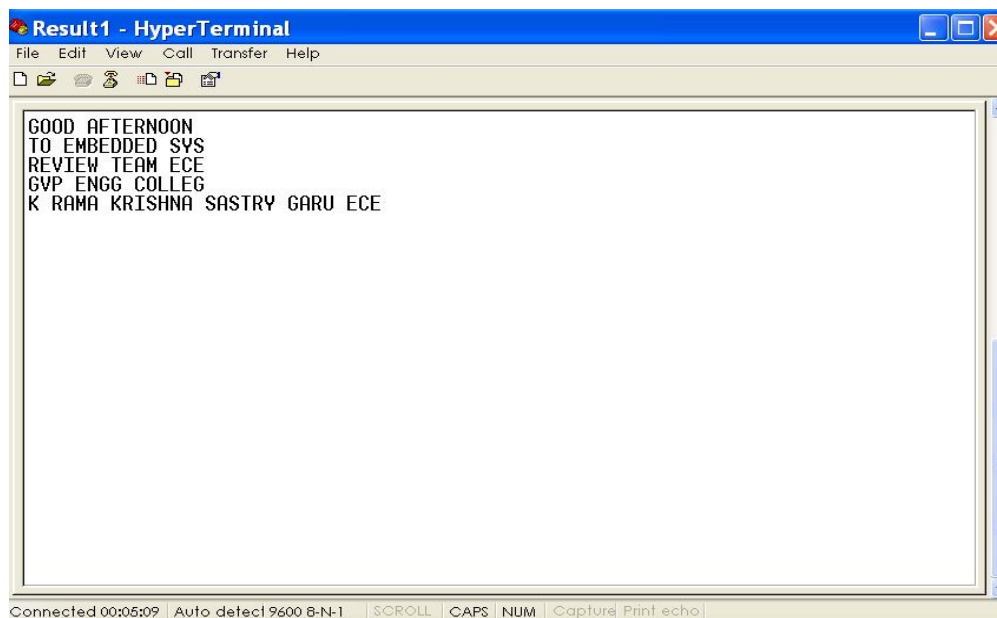


Fig. 5 Result on Hyper Terminal

The first four lines displayed on the HyperTerminal window are read from the Onboard EEPROM and the last line consists of the data read from the externally interfaced EEPROM. The size of the Onboard EEPROM is 2K bits which is divided into 16 pages, each capable of storing 16 bytes of data. The externally interfaced memory is also of 2K bits size, but it consists of 32 pages each capable of storing 8bytes of data.

V.CONCLUSION

In this thesis, the Inter integrated Circuit (I^2C) bus protocol is implemented in Multi-slave mode using LPC2929 evaluation board which consists of ARM968E-S microcontrollers and several other on-board peripherals as well. The slaves used are two EEPROM chips, among which one is on-board and the other is externally interfaced. The results are displayed on HyperTerminal. By using this system, data is transferred with speed of 100kbit/s and distance up to 4000 feet (1200 meters).

REFERENCES

- [1] Phaj Kumar Mehto, Pragya Mishara and Sonu Lal " Design and implementation for interfacing two integrated device using I2C bus", International journal of innovative research in computer and communication engineering, vol.2,issue 3, March 2013.
- [2] I^2C protocol by philips data sheet.
- [3] AT24C02 EEPROM data sheet.
- [4] LPC2929 user manual.