

# Calculator System - Project Documentation

## 1. Project Overview

### 1.1 Introduction

This document provides a structured overview of the Calculator System implemented using the ATmega32 microcontroller.

The system supports arithmetic and advanced mathematical operations using a keypad for input and an LCD for output.

### 1.2 Goals

- Provide accurate arithmetic and scientific operations.
- Ensure real-time processing of keypad inputs.
- Display operations and results on the LCD.
- Handle user errors such as divide-by-zero or invalid operations.

### 1.3 Scope of Delivery

This document covers the hardware mapping, system architecture, input processing logic, calculation algorithms,

and LCD-based output display used in the calculator project.

## 2. System Architecture

The system uses a single ATmega32 microcontroller, interfaced with a 4x4 keypad and a 16x2 LCD.

Component | Connected To | Function

ATmega32 MCU | Keypad, LCD | Input processing, calculations.

4x4 Keypad | PORTA | User input (numbers, operators).

16x2 LCD | PORTC + Control Pins | Display inputs and results.

## 3. Hardware Implementation and Pin Assignment

### 3.1 Keypad Interface

The 4x4 keypad is connected to PORTA (PA0–PA7). The microcontroller scans rows and reads columns to detect presses.

### 3.2 LCD Interface

Data lines → PORTC (PC0–PC7)

Control lines:

RS → PB0

RW → PB1

EN → PB2

### 3.3 Microcontroller Operation

The ATmega32 handles:

- Keypad scanning
- Operation identification
- Arithmetic & advanced math computations
- LCD result display

## 4. Software Design and Functional Flow

### 4.1 Initialization

- LCD\_init(): Initializes LCD in 4-bit/8-bit mode.
- KEYBAD\_init(): Sets scanning pins.
- Main loop waits for operand and operator input.

### 4.2 Input Handling Logic

Step 1: User enters operand 1.

Step 2: User selects operator (+, -, \*, /, %, ^, S).

Step 3: If needed, user enters operand 2.

Step 4: User presses '=' to compute result.

### 4.3 Supported Operations

- Addition (+)
- Subtraction (-)
- Multiplication (\*)
- Division (/)
- Modulus (%)
- Exponent (^)
- Square root (S)

### 4.4 Error Handling

- Division by zero
- Square root of negative numbers
- Invalid key sequences

## 5. Output Formatting and Display

The result is formatted as a string and displayed on the LCD. If an error occurs, an appropriate error message appears.

## 6. Testing & Validation Checklist

Test Case | Expected Output

Operand input | Displayed correctly

Operator input | Correct operation selected

Divide by zero | Error displayed

Square root negative | Error displayed

Chained calculations | Uses previous result

## 7. Conclusion

The Calculator System demonstrates embedded design principles including keypad input processing, microcontroller arithmetic,

LCD interfacing, and real-time embedded computation.