Scientific Calculator Assignment

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INTRODUCTION

This report details the design and implementation of a scientific calculator based on an Arduino microcontroller. The calculator uses a **4x4 button matrix** for input, along with **Shift and Alpha keys** to extend its functionality. The project integrates essential mathematical operations and scientific functions to provide a compact yet powerful computing tool.

HARDWARE COMPONENTS

- **Arduino Uno (ATmega328P)** – Core processing unit.
- **16x2 LCD Display** – Output device for displaying expressions and results.
- **4x4 Button Matrix** – Input mechanism for digits, operators, and functions.
- **Potentiometer** – Adjusts LCD contrast.
- **Power Source** – 5V supply from USB or battery.

KEYPAD LAYOUT AND FUNCTIONS

The calculator features a **4x4 button layout** with three distinct modes:

0.1 Normal Mode

The default mode provides basic arithmetic operations and digit input.

Row	Column 1	Column 2	Column 3	Column 4	Column 5
1	7	8	9	+	D (Delete)
2	4	5	6	-	S (Shift)
3	1	2	3	*	A (Alpha)
4	0	.	=	/	C (Clear)

TABLE 0: Normal Mode Keypad Layout

0.2 Alpha Mode

Activating the **Alpha** key changes the button functions to advanced scientific operations.

Row	Column 1	Column 2	Column 3	Column 4	Column 5
1	sin	cos	tan	Power	Backspace
2	log	ln	e^x	$\sqrt{}$	(
3	π	x^2	x^3	1/x	)
4	EXP	ANS	M+	M-	MR

TABLE 0: Alpha Mode Keypad Layout

0.3 Shift Mode

Pressing the **Shift** key modifies the button functionality to perform additional mathematical operations.

Row	Column 1	Column 2	Column 3	Column 4	Column 5
1	asin	acos	atan	y^x	CLR
2	10^x	e	abs	cbrt (Cube Root)	[
3	deg	rad	mod	!	]
4	HEX	DEC	BIN	OCT	MC

TABLE 0: Shift Mode Keypad Layout

Software Implementation

The calculator software is developed in **C for Arduino**, utilizing efficient algorithms for function calculations. The logic handles button presses, function execution, and result display.

0.4 Key Processing Algorithm

- Detect button press.
- Determine if **Normal**, **Alpha**, or **Shift** mode is active.
- Map button to corresponding function.
- Perform necessary calculations using optimized **CORDIC algorithm** for trigonometric and exponential functions.
- Display result on the **16x2 LCD**.
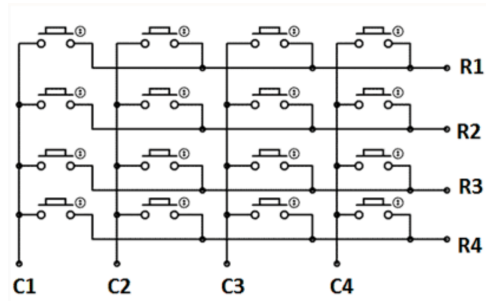
0.5 Expression Evaluation

The calculator uses the **Shunting-Yard Algorithm** to correctly handle operator precedence and parentheses when evaluating mathematical expressions.
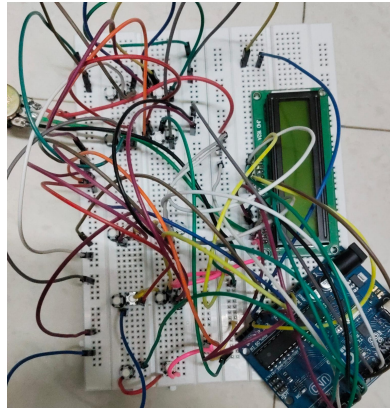
Features

- **Basic Arithmetic**: Addition, subtraction, multiplication, and division.
- **Scientific Functions**: Trigonometry, logarithms, exponentiation, and factorial.
- **Memory Functions**: Store and recall memory values.
- **Number Systems**: Convert between **HEX, DEC, BIN, and OCT**.
- **Multi-Mode Input**: Normal, Alpha, and Shift functions.
- **Parentheses Handling**: Supports complex expressions.

Conclusion

This scientific calculator implementation offers an extensive range of functions in a **compact 4x4 keypad layout**, making it highly efficient for computations. The use of **Shift and Alpha keys** maximizes functionality while keeping hardware requirements minimal. Future enhancements could include improved floating-point precision and additional mathematical operations.

4x4 Button Layout

Scientific Calculator Circuit

REFERENCE

The code has been referenced from https://github.com/EE24BTECH11012/EE1003/blob/c55818859eebe407cd8a028f4a39012ec59f1942/Hardware/Calculator/main.c