

Project Title: CARL

Team Name: Group 5

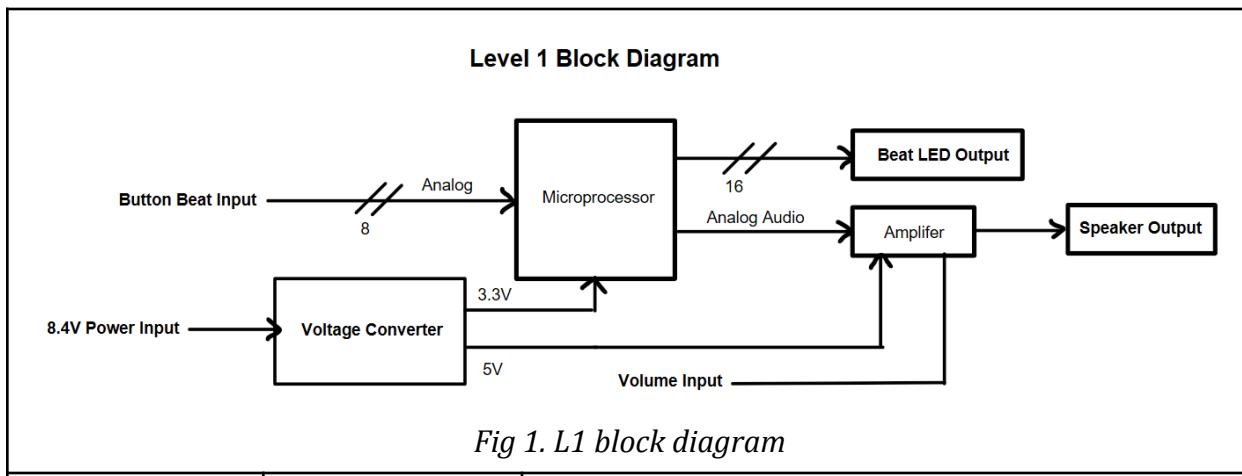
Team Members: Andrew Stanton, Bao Nguyen, Christian Mickelson, Ethan Budde

Date: 12/3/2025

Practicum Test Plan

This test plan is an outline on how C.A.R.L drum machines will be tested to make sure it works as designed. This document includes a test for each sub system, verification test for the main functions, and validation test showing the final system meets all project requirements. The goal is to confirm every part of the design from power, inputs, and outputs functions correctly and reliably in the finished product.

Unit Testing



Unit Test ID	Block ID	Test Description
UT-01	2s Power Input	Verify 2s power are being delivered to 5V and 3V Voltage Regulator
UT-02	5V Power Output	Verify 5V out for the LED driver and Amplifier
UT-03	3V Power Output	Verify 3V out for the Microprocessor, LCD, and GPIO expander
UT-04	Beat Button Input	Confirm Pressing the button sends digital signal to uP
UT-05	Volume Pot	Verify volume is adjustable Via Pot
UT-06	Beat LED Output	Verify Beat LED output expected behavior based on button inputs.
UT-07	Amplifier	Verify Amplifier increase audio signal
UT-08	Speaker Output	Confirm speaker output sound
UT-09	Micropressesor	Test GPIO outputs with a logic analyzer

Verification Test

Verification Test ID	Function / Feature	Test Description
VT-01	Beat Button input	Verify pressing beat buttons record beat into the sequencer
VT-02	Sequence playback	After VT-01, press play and observe the selected beats play back
VT-03	Volume Control	Check that adjusting the volume knob changes the volume of the output sound
VT-04	Beat LED	Verify the Beat LED flashes in respect to the sequencer clock
VT-05	Pattern saving/cloning	After VT-01, press the save button, cycle to a different track, and paste. Observe that the same pattern is copied to the new track
VT-06	Pattern switching	Confirm the switching pattern updates playback to the new pattern
VT-07	System start up	Make sure it turns on in a default state.
VT-08	Speaker output check	Verify speaker output is clean audio sound.

Validation Tests

Validation Test ID	Requirement(Must/Should/May)	Validation Test Description
VAL-01	Must sequence music beats	Verify that the user can enter a series of button presses and the system stores them as a beat sequence.
VAL-02	Must play back sequenced beats	Confirm that a stored beat sequence can be played back in a repeating loop through the speaker.
VAL-03	Must include a speaker	Verify that the product enclosure includes a functioning speaker connected to the audio output.
VAL-04	Must include volume adjustment	Confirm that the user can adjust the volume and that the audio level changes over a usable range.
VAL-05	Must operate independently of a computer or other audio equipment	Verify that the system can power on, sequence, and play beats with only its own power source and controls.
VAL-06	Must have buttons for parameter changes	Confirm that physical buttons exist for changing parameters and that each button reliably changes at least one parameter.
VAL-07	Must be contained in an enclosure	Verify that all electronics are mounted in a physical enclosure suitable for normal handling and use.
VAL-08	Should have audio effects	Confirm that at least one audio effect can be enabled and that it audibly changes the output.

VAL-09	Should have MIDI output	Verify that MIDI output signals are produced according to documented mapping when beats are played.
VAL-10	Should have multiple tracks	Confirm that at least two different sounds can play simultaneously in a single pattern.
VAL-11	Should have display for polyphonic voice	Verify that the display shows information about tracks/voices or pattern parameters while editing/playing.
VAL-12	May have audio line out	Confirm that, if implemented, an audio line-out jack produces the same signal as the speaker output at line level.
VAL-13	May allow the user to add new sounds	Verify that the user can load or select new sounds and use them in a sequence.
VAL-14	May be battery powered	Confirm that the system can run from batteries for a reasonable operating time without external power.

Example Test Case

Test Author: Bao Nguyen						
	Test Case Name:	2S Power Input to Voltage Regulator Output Test			Test ID #:	TC-UT-01
	Description:	<i>This test verifies that the main 2S power input correctly feeds the 5V and 3.3V voltage regulators and that each regulator outputs the correct voltage. This test covers Unit Test UT-01, UT-02, and UT-03.</i>			Type:	<input checked="" type="checkbox"/> white box <input type="checkbox"/> black box <input type="checkbox"/>
Tester Information						
	Name of Tester:				Date:	
	HW/SW Version:	Prototype v1.0			Time:	
	Setup:	<i>Connect the 2S battery or bench power supply to the system input. Use a multimeter to measure the 5V and 3.3V regulator output pads or test points,</i>				
S	Action	Expected Result	P A	F A	N /	Comments
T			S	I	A	
E			S	L		
P						
1	Connect 2S battery or bench supply (6-8.4V) to main input.	System powers on, no smoke, noise, or overheating.				
2	Measure input voltage at regulator VIN pin.	VIN read between 6.0-8.4V				
3	Measure 5V regulator output.	Steady 5.00V ~ +/- 5% ripple				
4	Measure 3.3V regulator output	Steady 3.30V ~ +/- 5% ripple				
5	Power on LED driver and measure 5V under load	Minimum 3.0V maximum 5.5V				
6	Turn on amplifier by playing music and check 5V rail	Voltage does not sag below 4.85V.				
7	Power on the microprocessor and measure 3.3V rail under load.	Voltage is within 3V - 3.5V				
8	Touch regulator to make sure its not burning up	Should be warm and not hot.				
9	Disconnect power	System powers off normally				

	Overall test result:						
--	----------------------	--	--	--	--	--	--

Example Matrix Test (for varying parameters)

Test Author: Bao Nguyen					
	Test Case Name:	Voltage Regulator Stability Test		Test ID #:	MT-PS-01
	Description:	Verify that the 5V and 3.3V voltage regulators maintain proper output voltage across a range of input voltages and system loads. Ensures stable operation under typical and extreme battery conditions.		Type:	<input type="checkbox"/> white box <input checked="" type="checkbox"/> black box <input type="checkbox"/> <hr/> <hr/>
Tester Information					
	Name of Tester:			Date:	
	HW/SW Version:	Prototype v1.0		Time:	
	Setup:	Use a bench power supply in place of the 2S battery. Connect the supply to system input and measure 5V and 3.3V rails at their respective test points with a digital multimeter. Power on loads (LED driver, amplifier, full system) where noted.			
T E S T	INPUTS		EXPECTED OUTPUTS		P A S S F A I L N / A C o m m e n t s
1	VIN = 6.0V (low battery)		Expected 5V Output	Expected 3.3V Output	
2	7.4V (nominal 2S)		4.80–5.10V	3.00–3.35V	
3	8.4V (full 2S charge)		4.80–5.10V	3.00–3.35V	
4	8.4V + LED Driver Load		4.80–5.10V	3.00–3.35V	
5	8.4V + Amplifier Load		4.80–5.10V	3.00–3.35V	
6	6.0V + Full system load		No brown out	No brown out	
	Overall test result:				