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Electronic Circuits Testing and Applications

Vehicle Electronics ACHA4031

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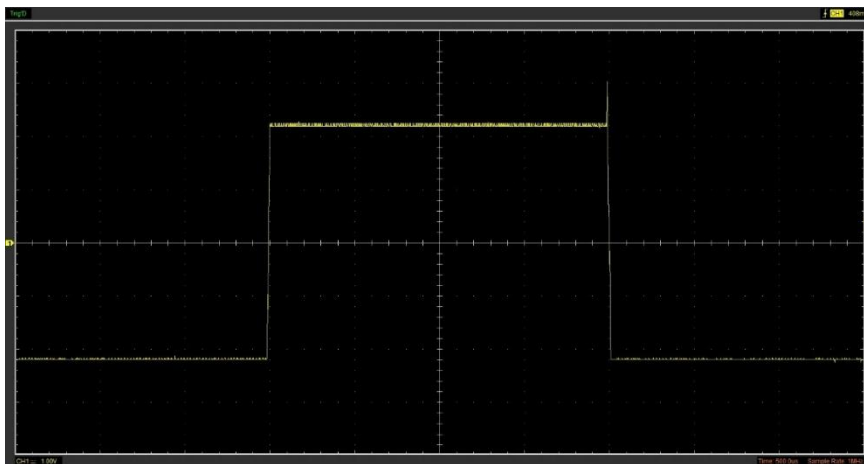
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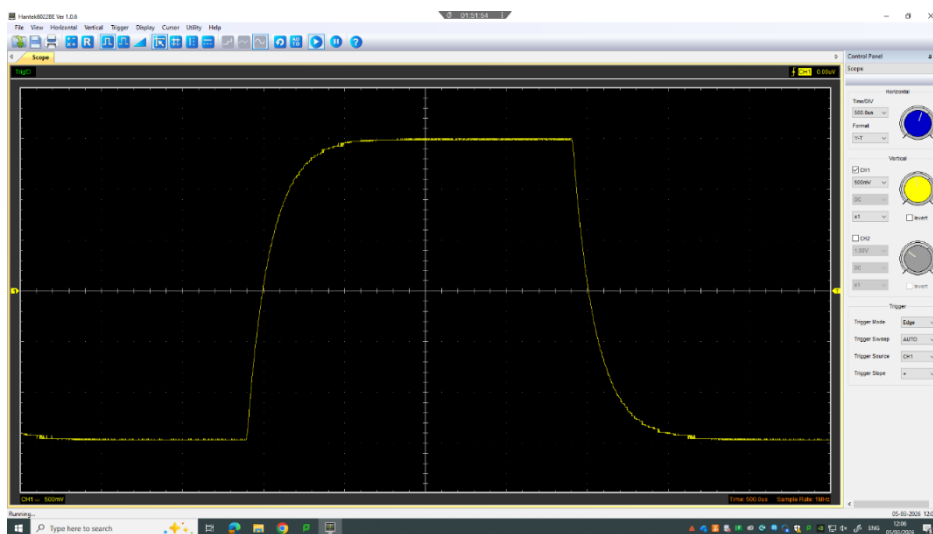
1 Task 3

1.1 Scope Time Division Calculations (6)

1.2 Function Generator output square wave (6)



1.3 Capacitor charge and discharge wave marked at correct points. (6)

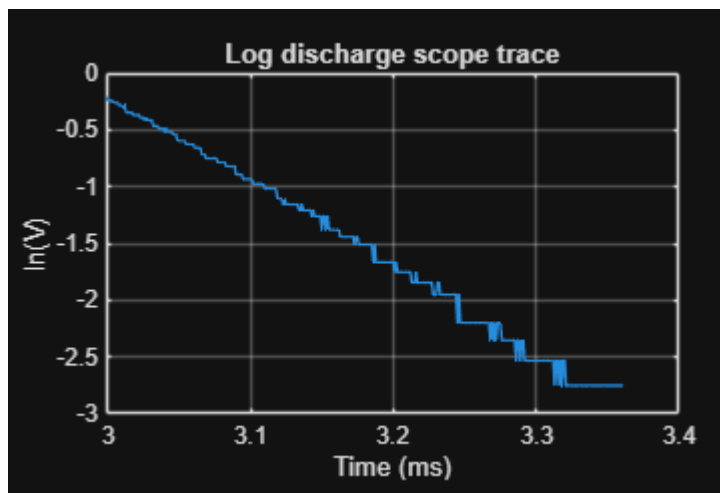


1.4 Basic Capacitor Calculations (6)

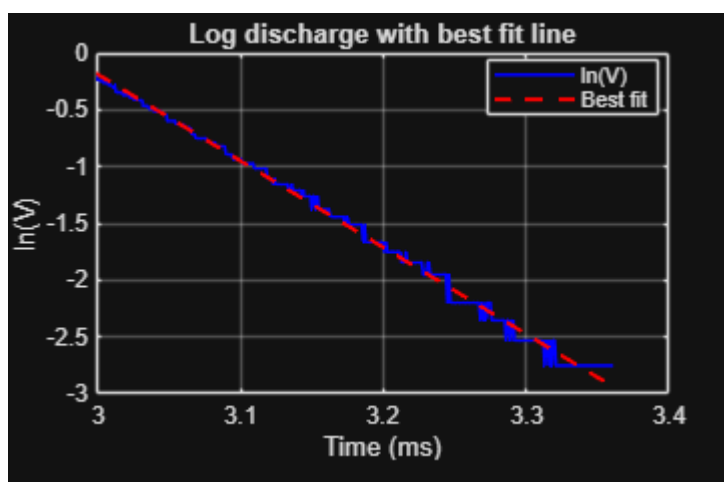
1.5 Capacitor discharge table (5)

Time (s)	Voltage (V)	$\ln(V)$	$dy = y_2 - y_1$	$dx = x_2 - x_1$	dy/dx
0.003	0.7854	-0.2416	x	x	x
0.003039	0.6128	-0.4897	-0.2482	0.000039	-6362.94
0.003078	0.456	-0.7853	-0.2955	0.000039	-7578.1
0.003117	0.3305	-1.107	-0.3217	0.000039	-8249.92
0.003156	0.2364	-1.4423	-0.3353	0.000039	-8596.59
0.003194	0.1737	-1.7504	-0.3081	0.000038	-8107.48
0.003233	0.1266	-2.0668	-0.3164	0.000039	-8112.06
0.003272	0.0952	-2.3517	-0.2849	0.000039	-7305.68
0.003311	0.0795	-2.5314	-0.1797	0.000039	-4608.97
0.003361	0.0638	-2.7524	-0.221	0.00005	-4420.35

1.6 Plot log(V) Gradient (5)



1.7 Gradient Calculations and Compare(8)



1.7.1 Gradient Calculations

1.7.2 Comparison table

	Capacitance	Delta	Percentage difference
Actual	1 μF	x	X
Marker Calculation	1.46 μF	0.46 μF	46.22%
Gradient Calculation	1.5032 μF	0.5032 μF	50.32%

1.8 Capacitor Uses (5)

Capacitors are used widely around the world in various pieces of equipment, electrical, automotive and motorcycle systems as they can store electrical charge, release energy quickly, and can resist changes in voltages suddenly. In electrical circuits they are commonly used as power supply smoothing, signal coupling, decoupling/bypass protection, timing networks and filter circuits that can remove or shape unwanted frequency components. Physics and electronics texts also describe capacitors as short term energy storage devices, which is why they are useful when brief voltage support or pulse discharge is needed.

In automotive and motorcycle applications, capacitors help stabilise electronic supply rails and reduce electrical interference in control systems, important in vehicles because switching between loads and other components can introduce noise and voltage spikes into the system, furthermore in some motorcycles applications a major use is capacitor discharge ignition, where a capacitor stores energy then releases it rapidly to create the high voltage spark needed for ignition, found on many small engines and motorcycle systems (Urone and Hinrichs, 2022; Springerlink Online Service, 2014; Roth, Fisher and Gauthier, 2022).

1.9 Inaccuracies Question (4)

Capacitors are manufactured with a tolerance, so true capacitance is not always exactly equal to the labelled value, some capacitors use time constant circuits which can change value with applied voltage, temperature and ageing which therefore affects the measured RC result. Oscilloscope measurements may also not be perfect because accuracy, noise and resolution can influence the voltage on screen. Probe loading can affect the circuit because the probe adds capacitance and can slightly change the waveform being measured. The setup could also have issues such as breadboard connections, wire resistance etc. (Murata, 2026; Tektronix, n.d.; Keysight, 2026)

1.10 Risk Question (10)

A vehicle CAN bus can be protected from a cyberattack by applying a defence-in-depth approach throughout the vehicle's life cycle. In today's Modern vehicles, cybersecurity cannot be treated as a single technical fix because electrical and electronic systems are highly interconnected and increasingly dependent on software, internal communication networks and external interfaces. Therefore, the CAN bus must be considered as part of a wider cybersecurity engineering process rather than as an isolated component. One of the main risks is that an attacker may gain access to the in-vehicle network and inject, replay or alter CAN messages. If this happens, safety-critical or operationally important vehicle functions could be affected, which may lead to operational disruption, financial loss or even safety consequences.

To reduce this risk, protection should start with a structured threat analysis and risk assessment process. This should identify the valuable assets within the system, the possible threat scenarios affecting them, the attack paths that could be used, the feasibility of those attacks and the resulting risk values. Once these risks are understood, suitable cybersecurity goals can be defined and linked to mitigation measures. In practical terms, CAN-bus protection should include separating critical and non-critical functions where possible, restricting communication through gateways and controlled interfaces, limiting diagnostic and external access, and hardening ECUs so that one compromised component cannot easily affect the rest of the vehicle network.

Effective mitigation also depends on strong process control, not only technical measures. Clear documentation is needed so that the analysis, decisions and controls can be traced and reviewed. Responsibilities must also be defined so that system architects, security engineers, development teams and project personnel all understand their role in managing cybersecurity risks. Verification is equally important, because cybersecurity goals and controls must be checked to confirm that they are complete, correct and consistent with the risks that were identified.

Finally, protection must continue after the vehicle is produced. Cybersecurity does not end at production because new vulnerabilities, attack techniques and weaknesses may appear during operation. For that reason, ongoing monitoring, maintenance, vulnerability handling and communication between stakeholders are necessary. Overall, safeguarding a vehicle CAN bus in line with ISO/SAE 21434 requires continuous risk assessment, secure system architecture, controlled communication paths, documented cybersecurity goals, verification activities and ongoing lifecycle management rather than relying on one single defensive measure (Khalil, Gehrmann and Vogel, 2025).

2 References

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