Worst Case Circuit Analysis for Clear View Mirror Board

Scope: Verifying reliability under extreme conditions

Application: Advanced Driver Assistance Systems

Ensuring a clear view is vital for safe driving. The Clear View interior mirror transforms the traditional rearview mirror with multiple rear-facing cameras. These cameras deliver a live video feed, effectively eliminating blind spots. This real-time display enhances situational awareness, leading to better decision-making on the road. The Clear View interior mirror significantly improves safety and boosts driver confidence, offering an unparalleled driving experience.

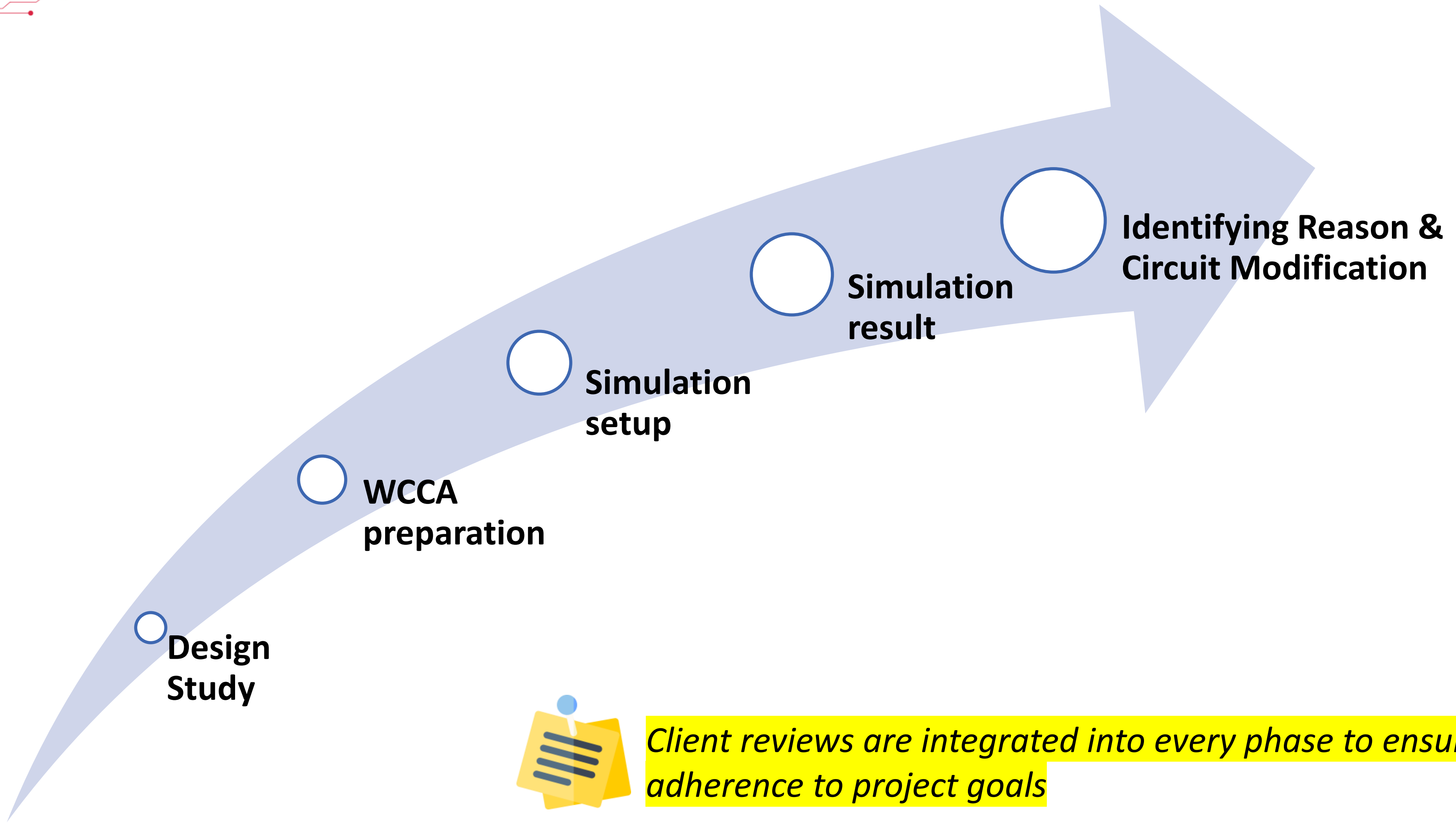
WCCA – Challenges

We are tasked with identifying the power circuit's maximum and minimum threshold voltages to minimize fluctuations that could impact other circuits. This is essential for maintaining a stable power supply and ensuring the reliability of connected systems.

Challenges:

- The worst-case scenario for the power levels in this circuit was being determined, with a particular focus on the 9.6V supply
- Three major integrated circuits (ICs) on this board were relying on this 9.6V power source, and power was being covertly provided to the cameras (RH OSM, LH OSM, Trailer, CHMSL of the cars) by these ICs.
- The worst-case conditions of the power outputs were being verified based on the recommendations provided by the ICs used on the board.
- SPICE models were being prepared for all power components.

WCCA –SoW



Client reviews are integrated into every phase to ensure adherence to project goals

Design Study

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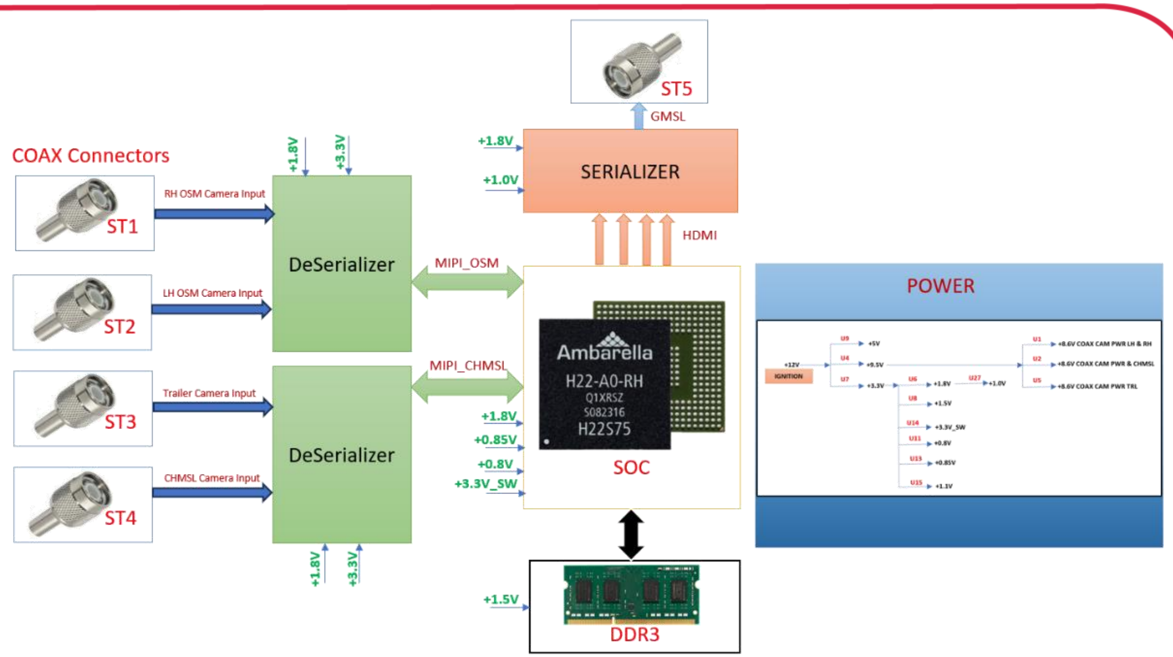
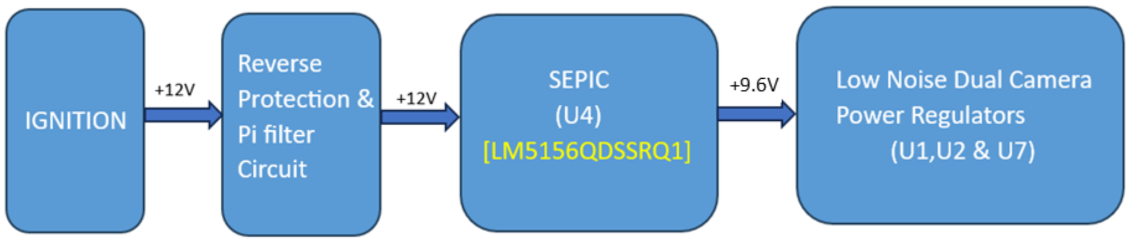
- Multiple cameras positioned around the vehicle capture video signals from various angles (RH OSM, LH OSM, Trailer, CHMSL) and transmit them via Coax connectors.
- Upon reaching the destination, the signals are deserialized by components U16 and U17, processed by the System on Chip (SoC)U6 for tasks like image recognition and object detection, and then serialized by component U22.
- The serialized video output is then prepared for distribution, display, and storage through another Coax connector.





- The +12V supply from the Port Ignition is safeguarded by a Reverse Protection circuit to prevent damage from accidental reverse connections..
- The power flows through a Pi filter circuit that removes noise and interference, ensuring a clean and stable power signal.
- The SEPIC (U4) IC converts the +12V input to a regulated +9.6V output, ideal for the system's components.

WCCA Preparation

The entire circuit schematic was meticulously analyzed.

Essential input data was collected to identify significant fluctuations within the 9.6V circuit

This data was used to conduct a Worst Case Circuit Analysis (WCCA).

Each power circuit was verified against the specifications detailed in the relevant IC datasheets.

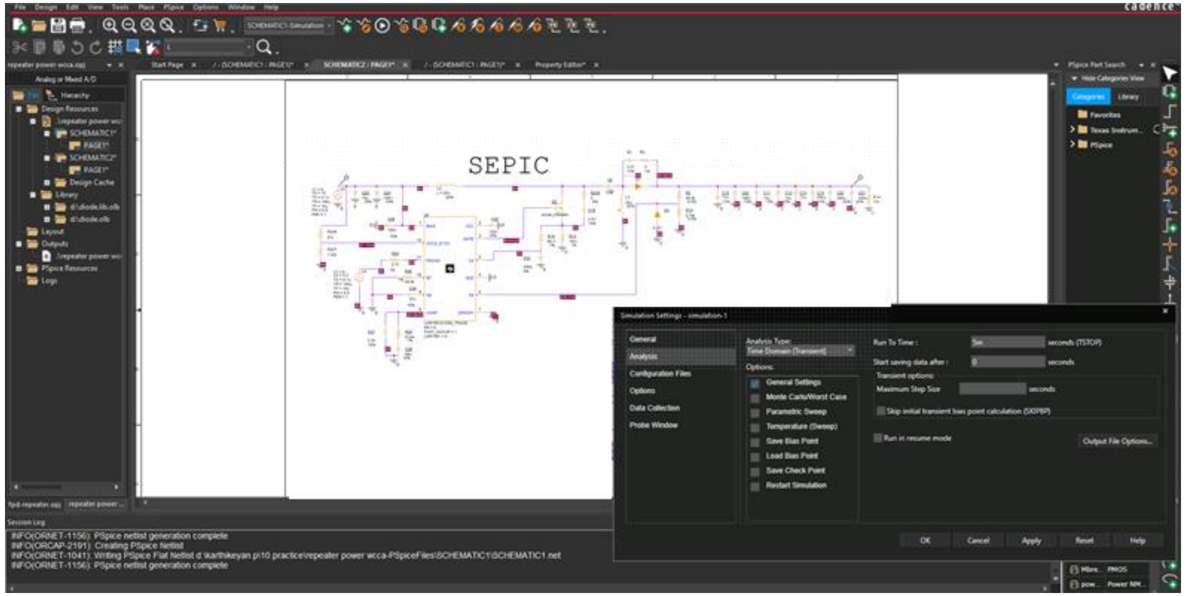
Identifying Reason & Circuit Modification

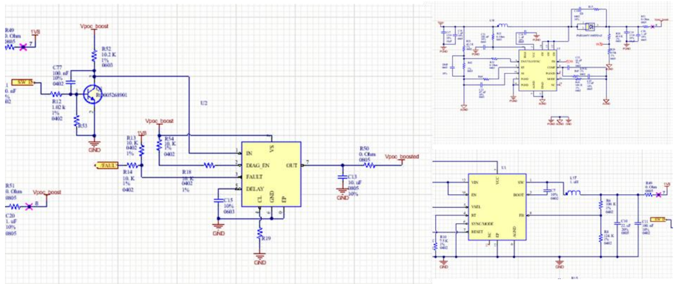
Simulation setup

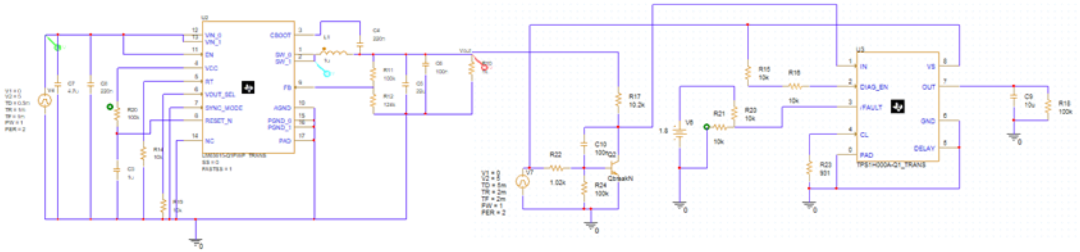
Power Circuits

Analyzing power circuits under worst-case conditions is crucial. These conditions can have a significant impact on the performance of other ICs. Ensuring proper functionality in these scenarios is essential for overall system reliability.

Simulation setup



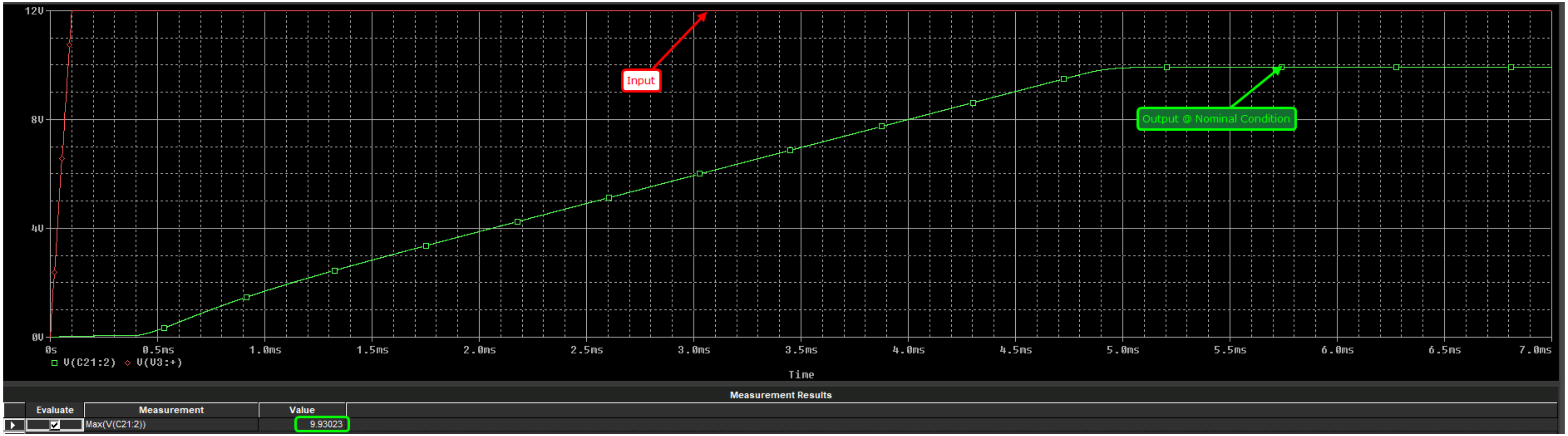




Simulation tool : PSpice

Simulation result: (SEPIC)

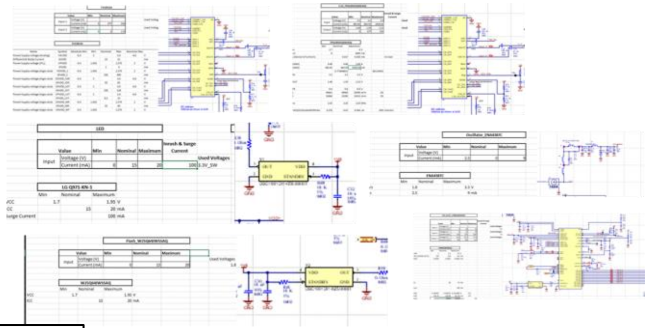
The SEPIC (U4) is outputting **9.93V instead of the intended 9.6V**, which may **impact** the power supplied to the Components.



Identifying Reason & Modifying Circuit

Circuit Calculation Process

- Theoretical calculations for all circuits are carried out based on the specifications provided in the manufacturer datasheets. This approach ensures accurate analysis and design by utilizing detailed component information and guidelines.
- The calculations revealed that **voltage variations are caused by the feedback resistor values** in the SEPIC.
- Based on the required output voltage, the resistor values were modified according to the calculations.



Calculations

Based on the datasheet (SEPIC) reference, the Output voltage is Calculated using the below formula,

$$V_{LOAD} = V_{REF} \times \left(\frac{R_{FBT}}{R_{FBB}} + 1\right)$$

V_{REF}	FB reference	LM5156, LM51561	0.99	1	1.01	V
Gm	Transconductance			2		mA/V
	COMP sourcing current	V_{COMP} = 1.2 V	180			uA
	COMP clamp voltage	COMP rising (V_{UVLO} = 2.0 V)	2.5	2.8		V
	COMP clamp voltage	COMP falling		1	1.1	V

From above table, $\mathbf{V_{REF} = 1\ V}$,

For this Circuit, $R_{FBT} = R_8 = 50K\Omega$, $R_{FBB} = R_{10} = 5K\Omega$.

$$Vout = VREF(\frac{R8}{R10} + 1)$$

$$= 1(\frac{45K}{5K} + 1)$$

= 1 (9+1)

$Vout$ **= 10V**

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From above table, $\mathbf{V_{REF} = 1\ V}$,

For this Circuit, $R_{FBT} = R_8 = 49.9K\Omega$, $R_{FBB} = R_{10} = 5.76K\Omega$.

$$Vout = VREF(\frac{R8}{R10} + 1)$$

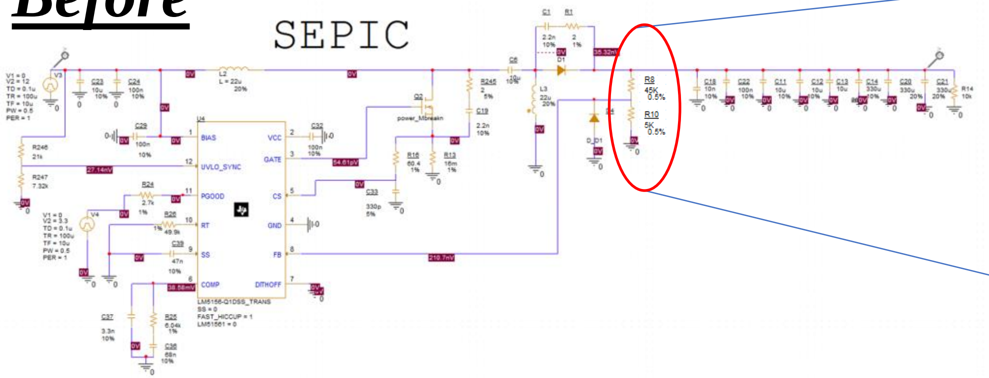
$$= 1(\frac{49.9K}{5.76K} + 1)$$

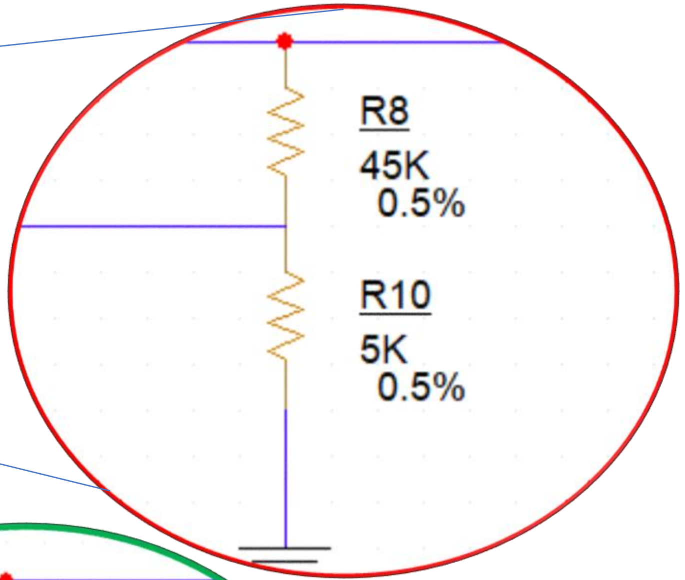
= 1 (8.66319+1)

$Vout$ **= 9.66319 V**

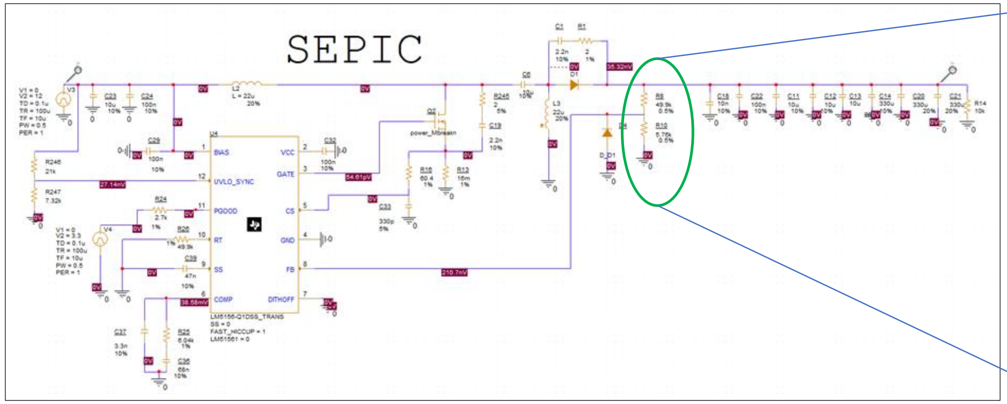
WCCA – Circuit Modification

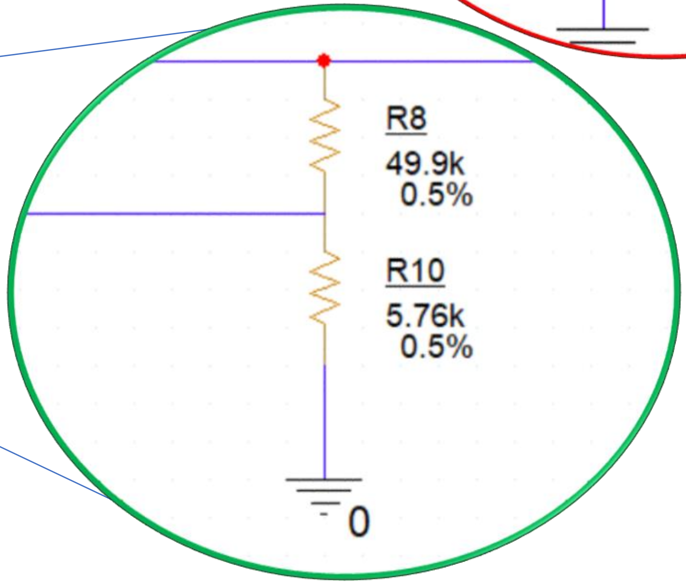
Before





After



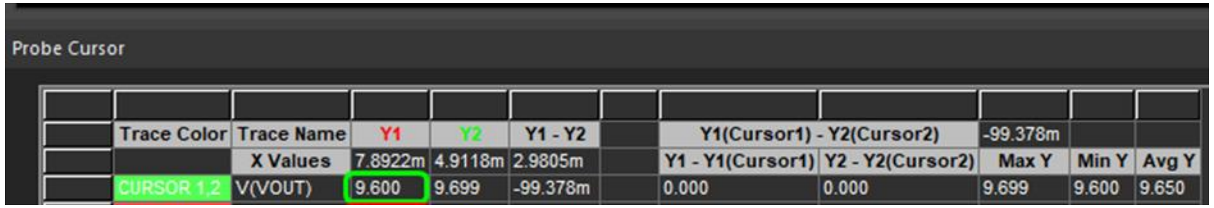


➢ Feedback resisters values are changed as follows,

- **R8**,from 45K to 49.9k
- **R10**, from 5K to 5.76K

Final Outcome

Simulation result



Probe Cursor

Trace Color	Trace Name	Y1	Y2	Y1 - Y2		Y1(Cursor1) - Y2(Cursor2)		-99.378m		
	X Values	7.8922m	4.9118m	2.9805m		Y1 - Y1(Cursor1)	Y2 - Y2(Cursor2)	Max Y	Min Y	Avg Y
CURSOR 1,2	V(VOUT)	9.600	9.699	-99.378m		0.000	0.000	9.699	9.600	9.650

As a result of our efforts, we achieved a **9.6V output** for the SEPIC.

Final Outcome

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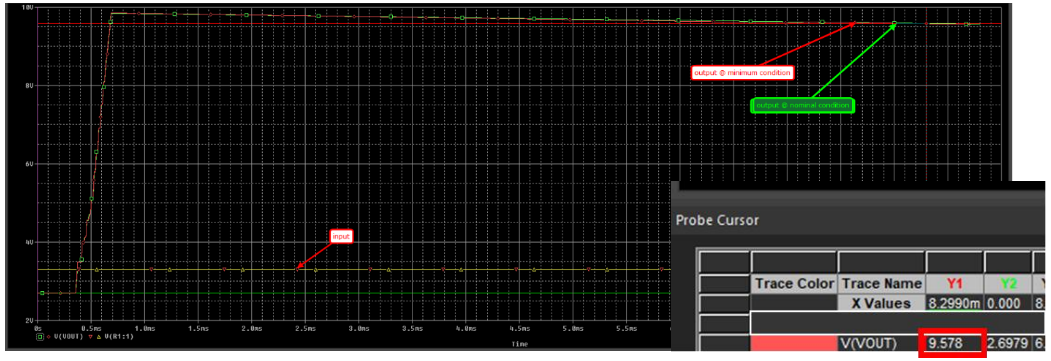
WCCA Analysis:

EVA Analysis results - Minimum:

Monte Carlo Analysis results:

EVA Analysis results - Maximum:



EVA Analysis results:

Existing Design			Proposed Design		
Minimum	Nominal	Maximum	Minimum	Nominal	Maximum
9.808 V	9.93 V	10.061 V	9.578 V	9.6 V	9.615 V

A Heartfelt Customer’s Voice

We are excited to present a testimonial from one of our satisfied clients.

"We are truly impressed with the exceptional work and dedication demonstrated by the team in overcoming the challenges in our hardware design project through worst-case circuit analysis. Their solution to adjust the component values and select cost-effective components with optimal performance is commendable. The quick turnaround time in completing this analysis showcases their efficiency and commitment. This modified design aligns perfectly with our requirements and enhances the efficiency of other circuits. It's a significant milestone in our journey, and we look forward to continued collaboration with such a talented and reliable team."

Conclusion

We successfully delivered analysis results that exactly matched the client's expectations, demonstrating our commitment to excellence and technical proficiency.

Our partnership blends technical expertise with personalized service, ensuring that we consistently deliver high-quality results.

We are dedicated to providing exceptional analysis services, reflecting our capabilities and reliability in producing superior outcomes.

Our focus remains on excellence, offering tailored solutions that align with our technical expertise and the client’s specific needs.

Through our commitment to quality and precision, we consistently achieve outstanding results that reinforce our dependability and expertise.