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Introduction

Research Background

Power Semiconductor
↓
Prevails everywhere
Among them...
IGBTs form a large market in power electronics industry

What is IGBT ?

MOSFET + Bipolar transistor → Taking both advantages → IGBT

- Drive power : Low
- Breakdown voltage : High
- Switching speed : Slow
- Conduction loss : Low
- On-resistance : Low

Problems of IGBT

Tail current at turn-off
Wiring inductance on collector terminal side
Parasitic capacitor between each terminal

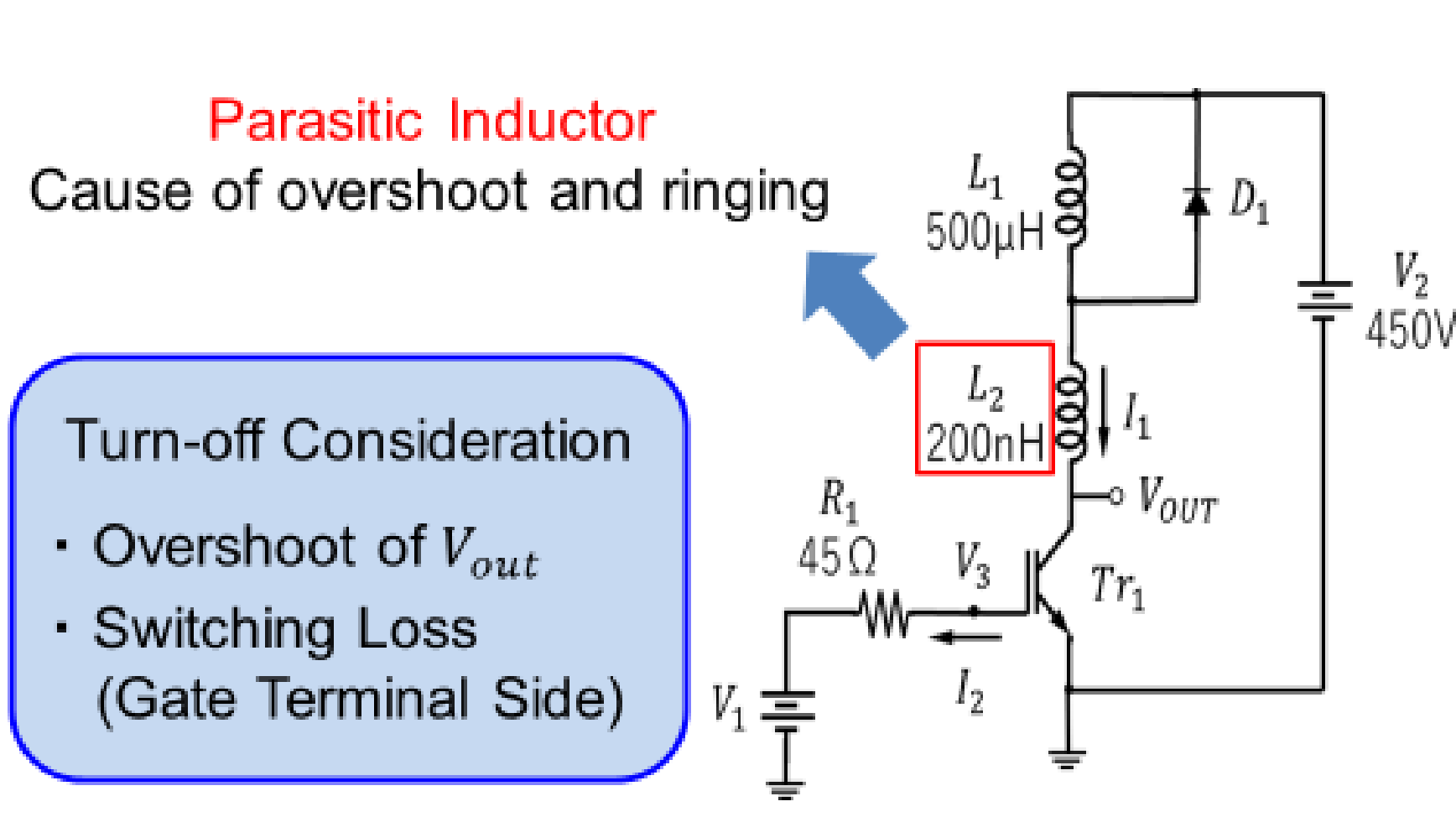
↓ Cause

- Switching Loss
- Excessive Overshoot
- Ringing

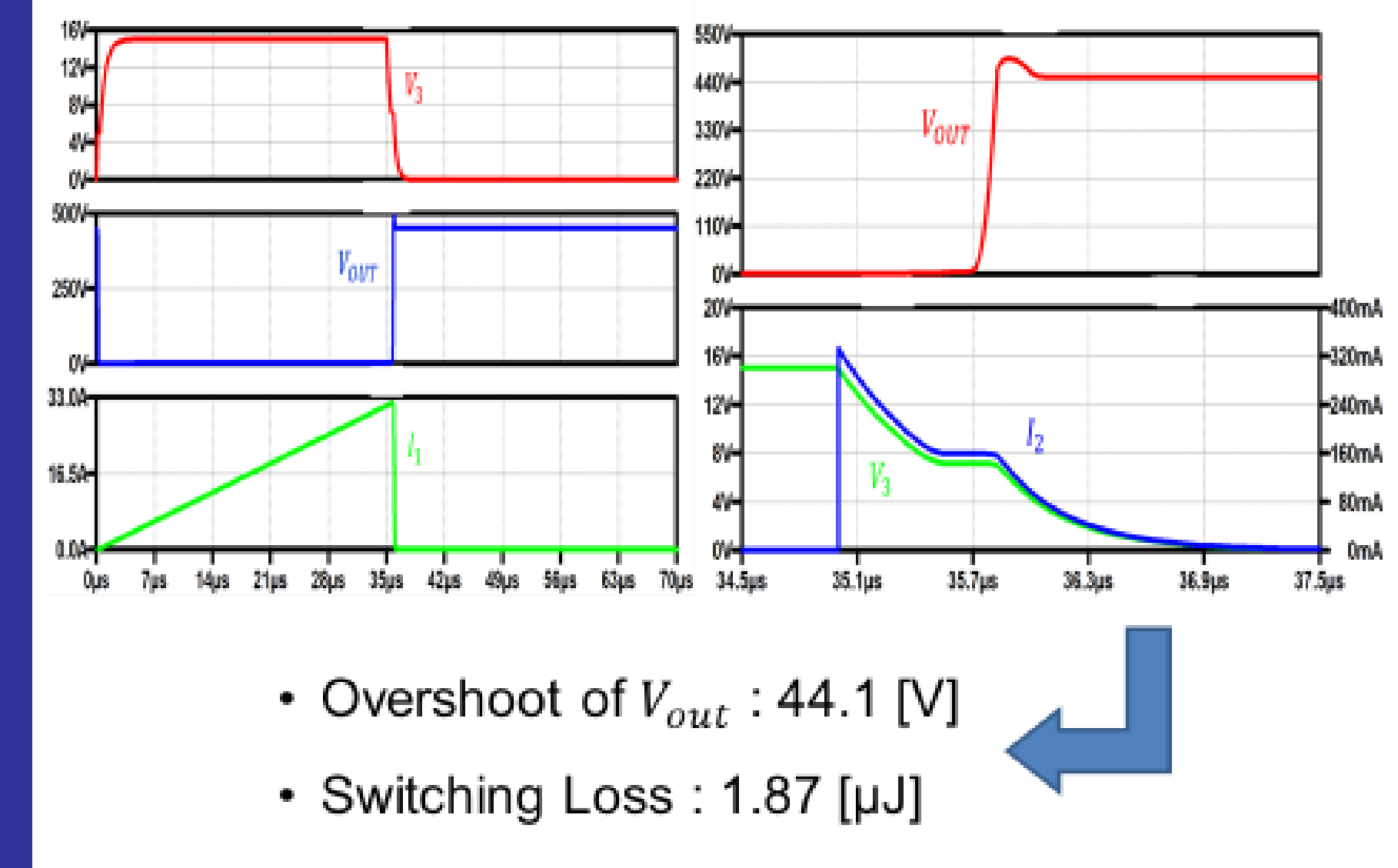
Research Goal and Approaches

- Research Goal
 - Improve power loss and excessive overshoot during switching
- Approaches
 1. Drive IGBT with current source
 - Reduction of switching loss
 2. Adjust the amount of current during switching
 - Reduction of overshoot

IGBT Evaluation Circuit



Evaluation Circuit Turn-off Characteristics (Voltage Drive)



Proposed

Multiple Peak Current Mirror Circuit

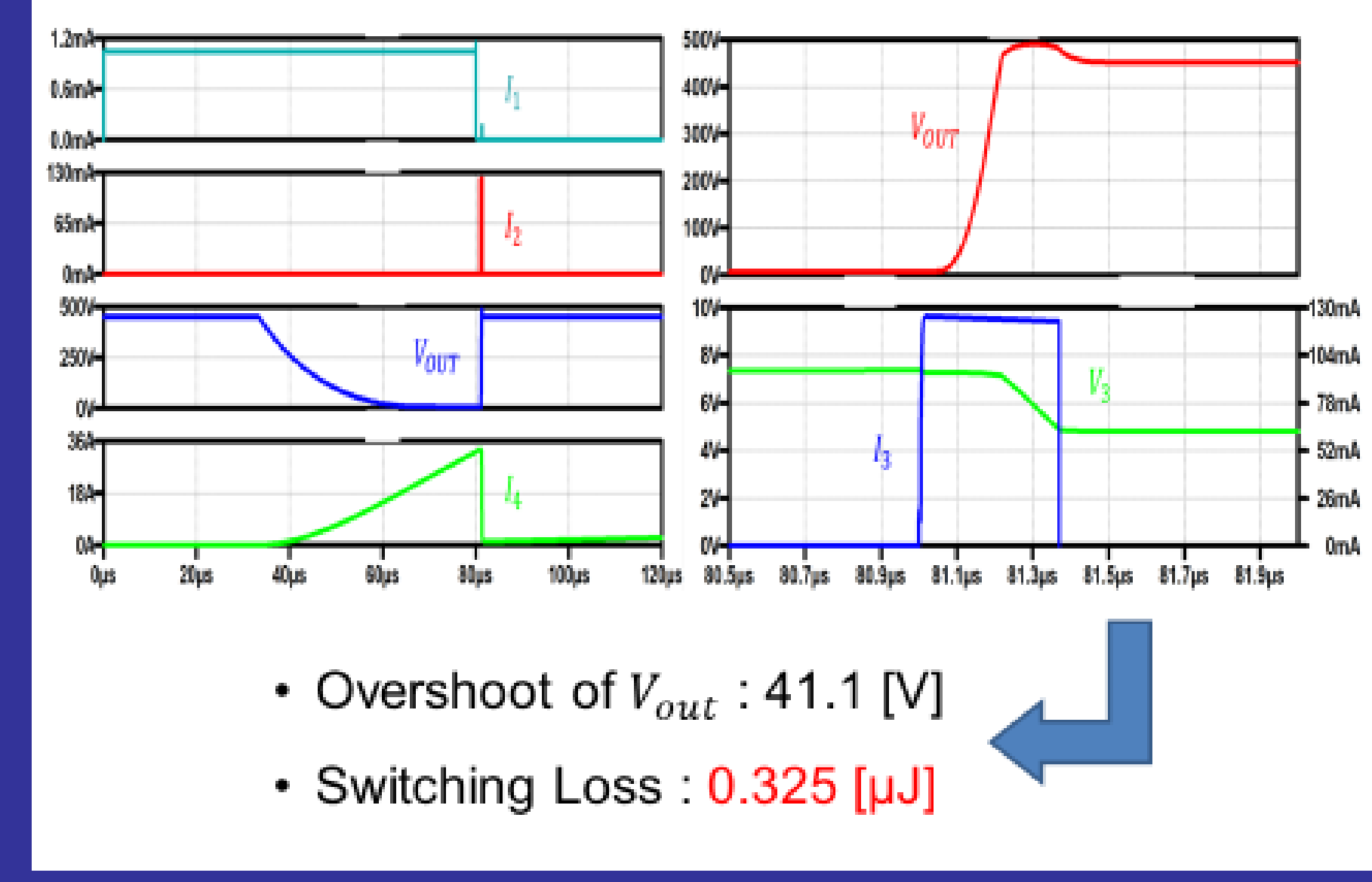
$M_6 \sim M_{13}$ $\phi W/L$: Large
↓
 I_{OUT} 's response to change in V_1 : Slow

Proposed Circuit

Current source for turn-on IGBT

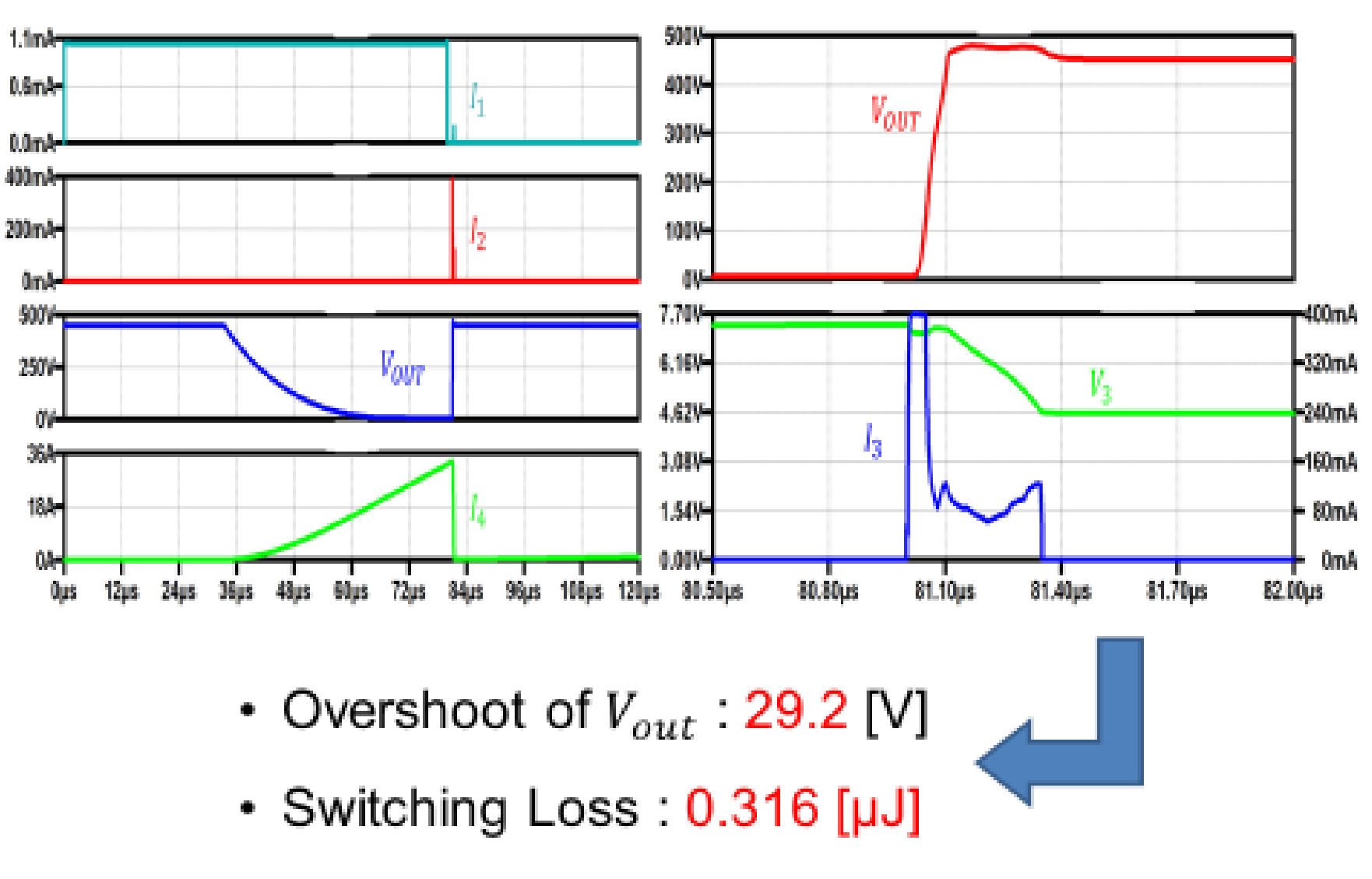
Current source to turn-off IGBT

Constant Current Method



Conclusion

Current Adjustment Method



Comparison of 3 Methods

	Overshoot of V_{out} [V]	Switching Loss [μ s]
Voltage Drive Method	44.1	1.87
Constant Current Method	41.1	0.352
Current Adjustment Method	29.2	0.316

Switching loss is greatly reduced by current drive
Reduces overshoot by current adjustment method

Summary and Challenge

- Summary**
- Gate power loss reduction by driving IGBT with current source
 - The overshoot at turn-off reduction by adjusting the amount of extraction current
- Challenge**
- Examination of switching loss on the collector terminal side