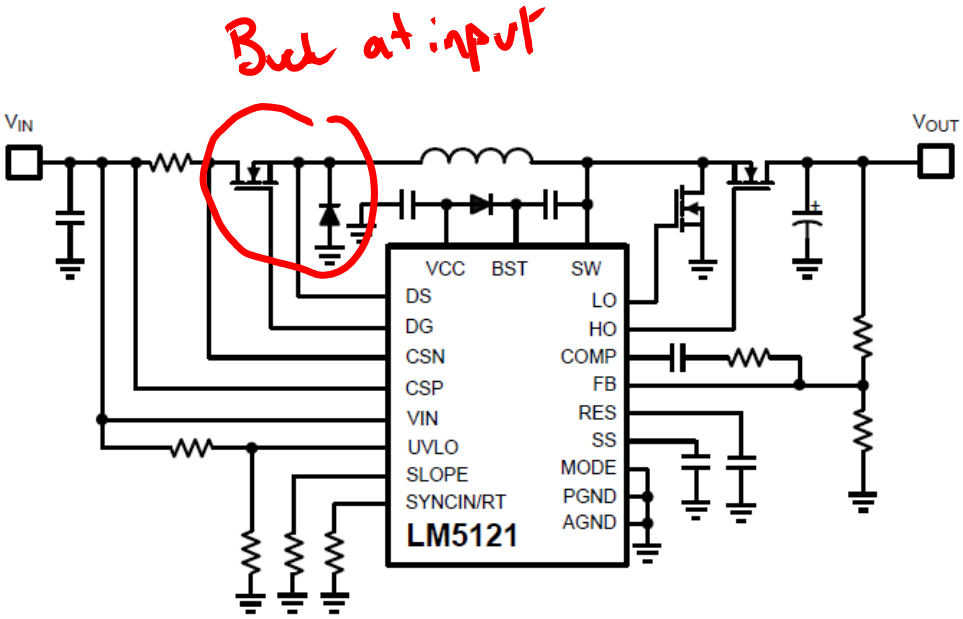
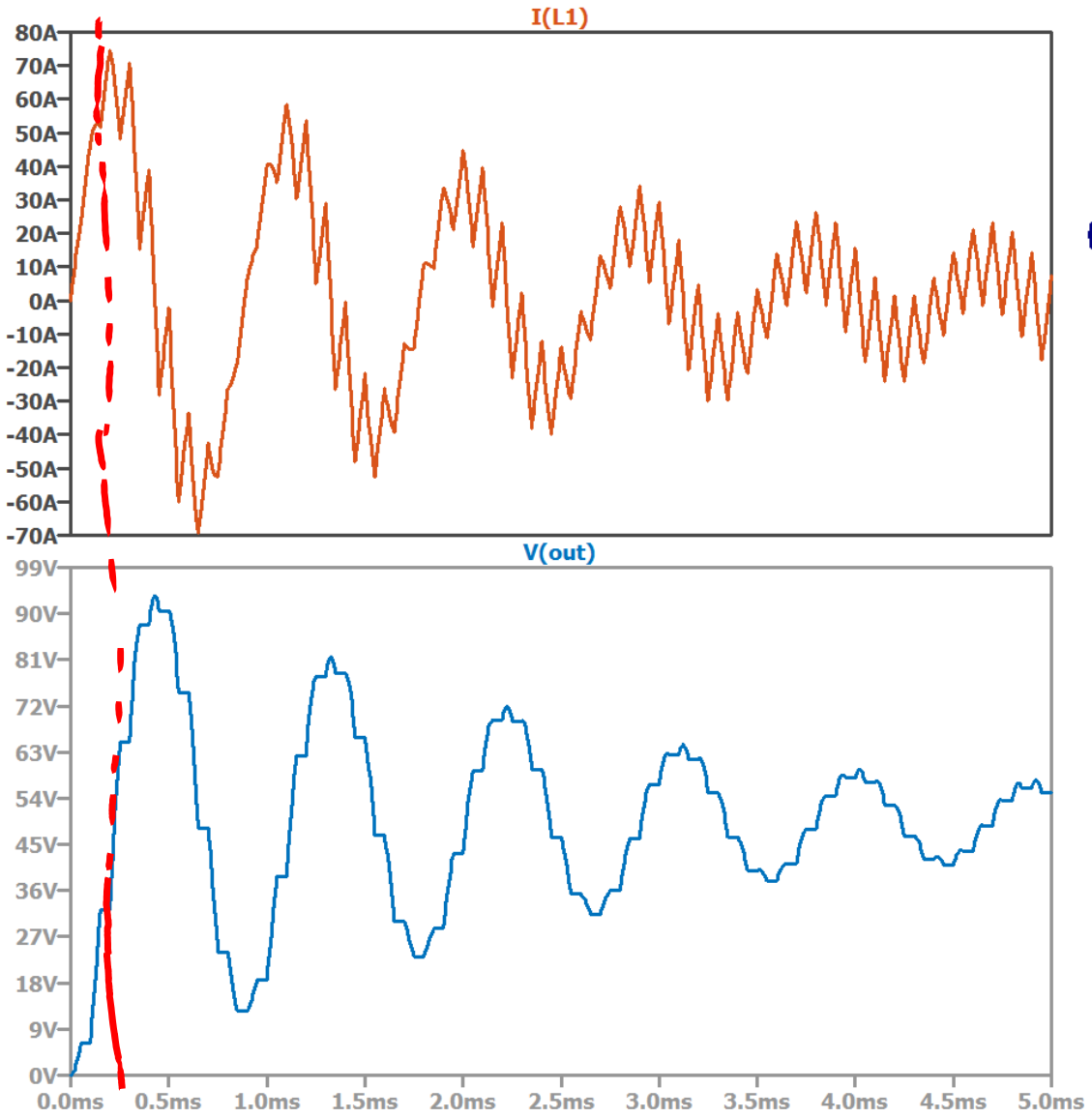
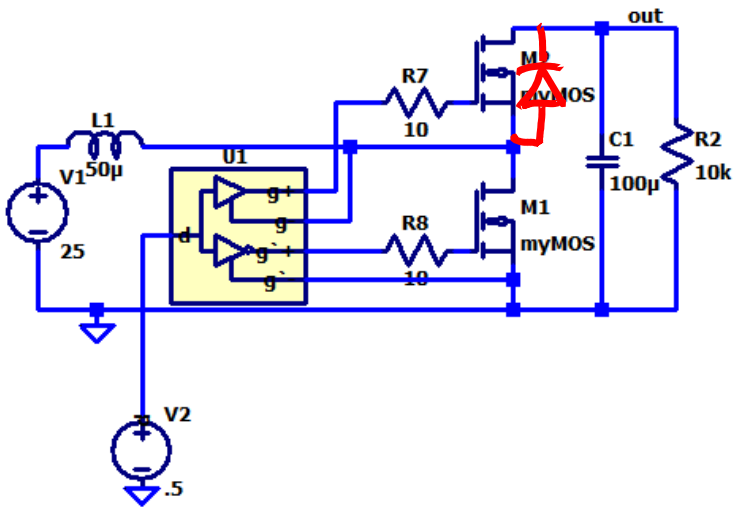
Application to Experiment 4



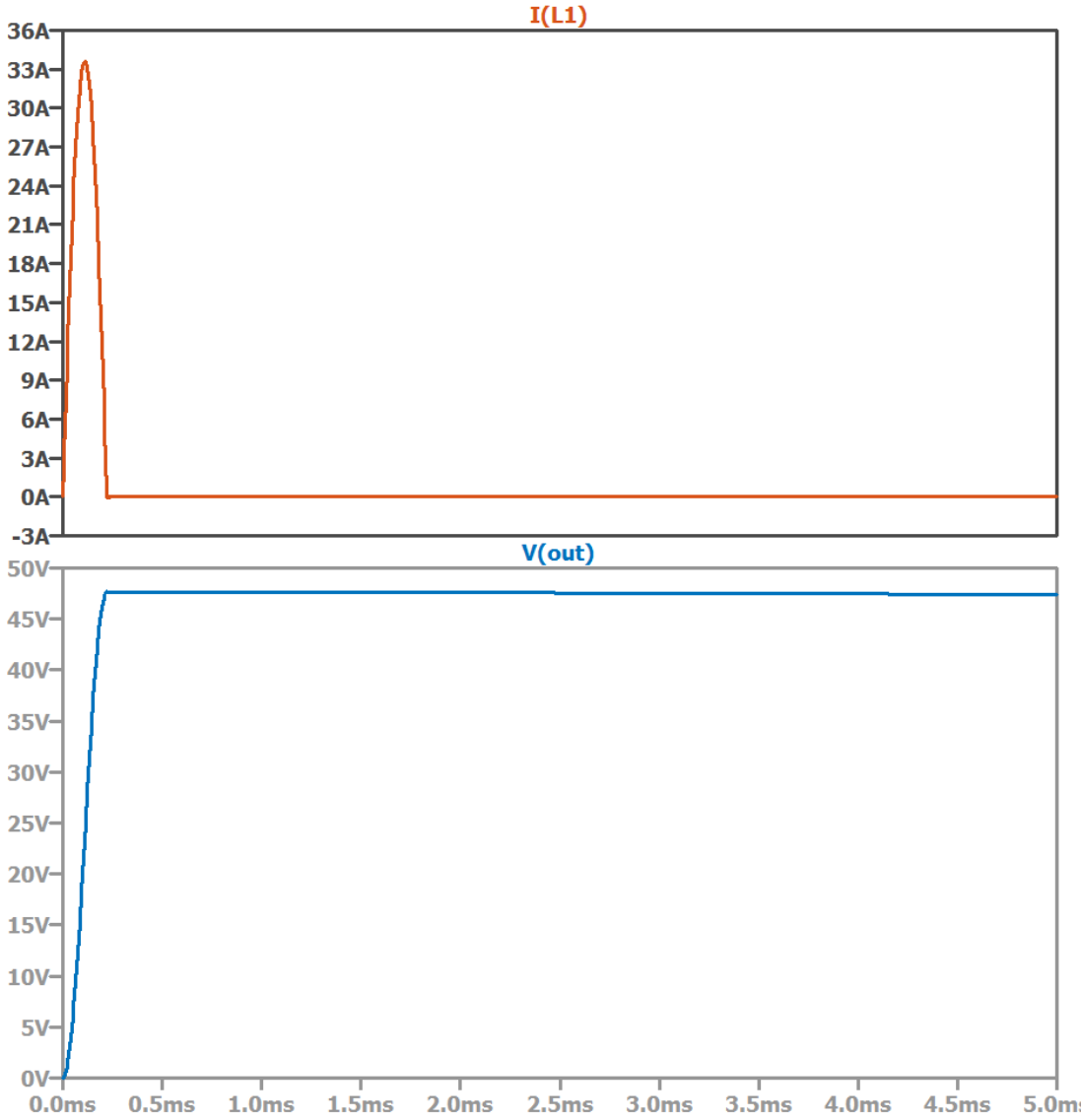
- Complex switching controller
- **Read** the datasheet first

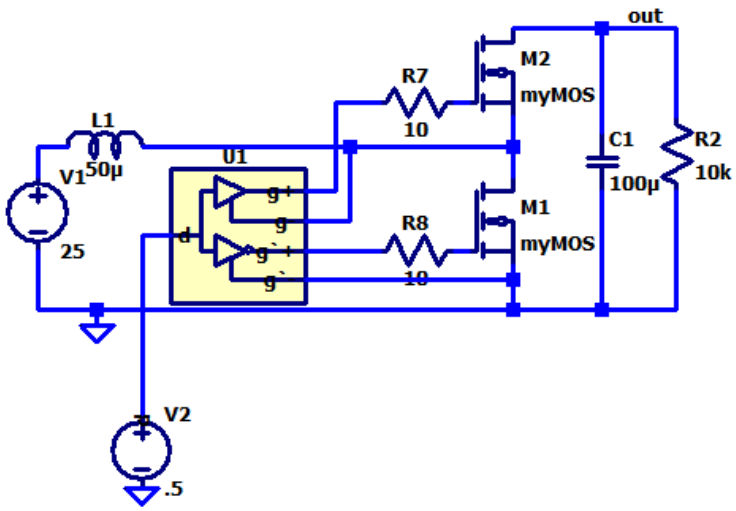
Startup: Switching



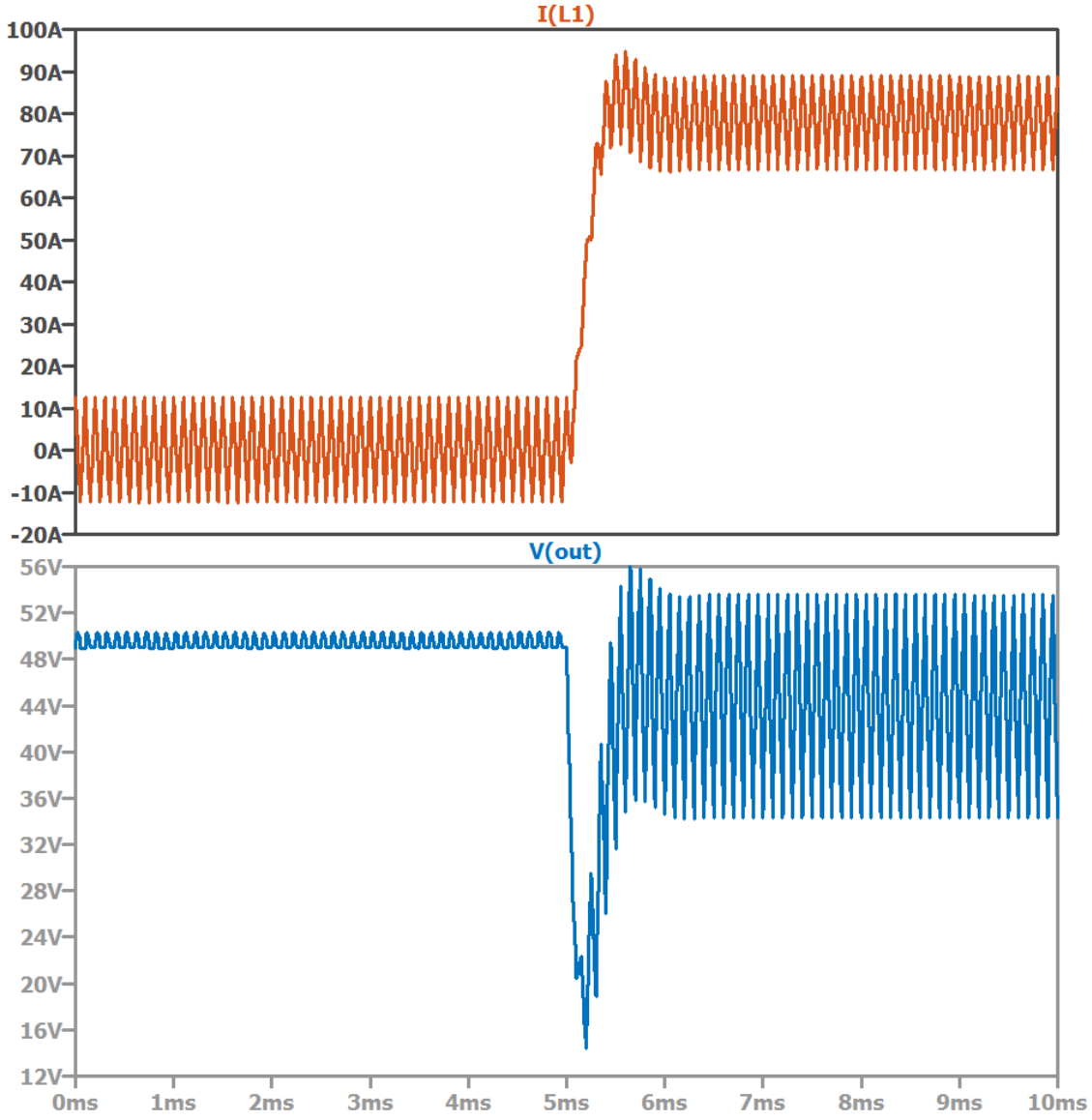


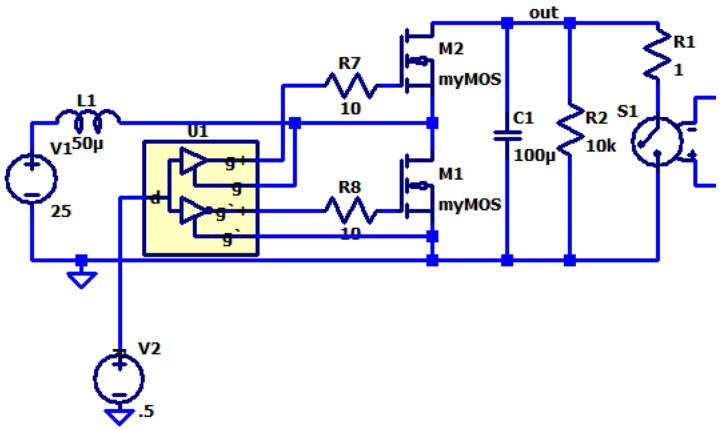
Startup: No Switching



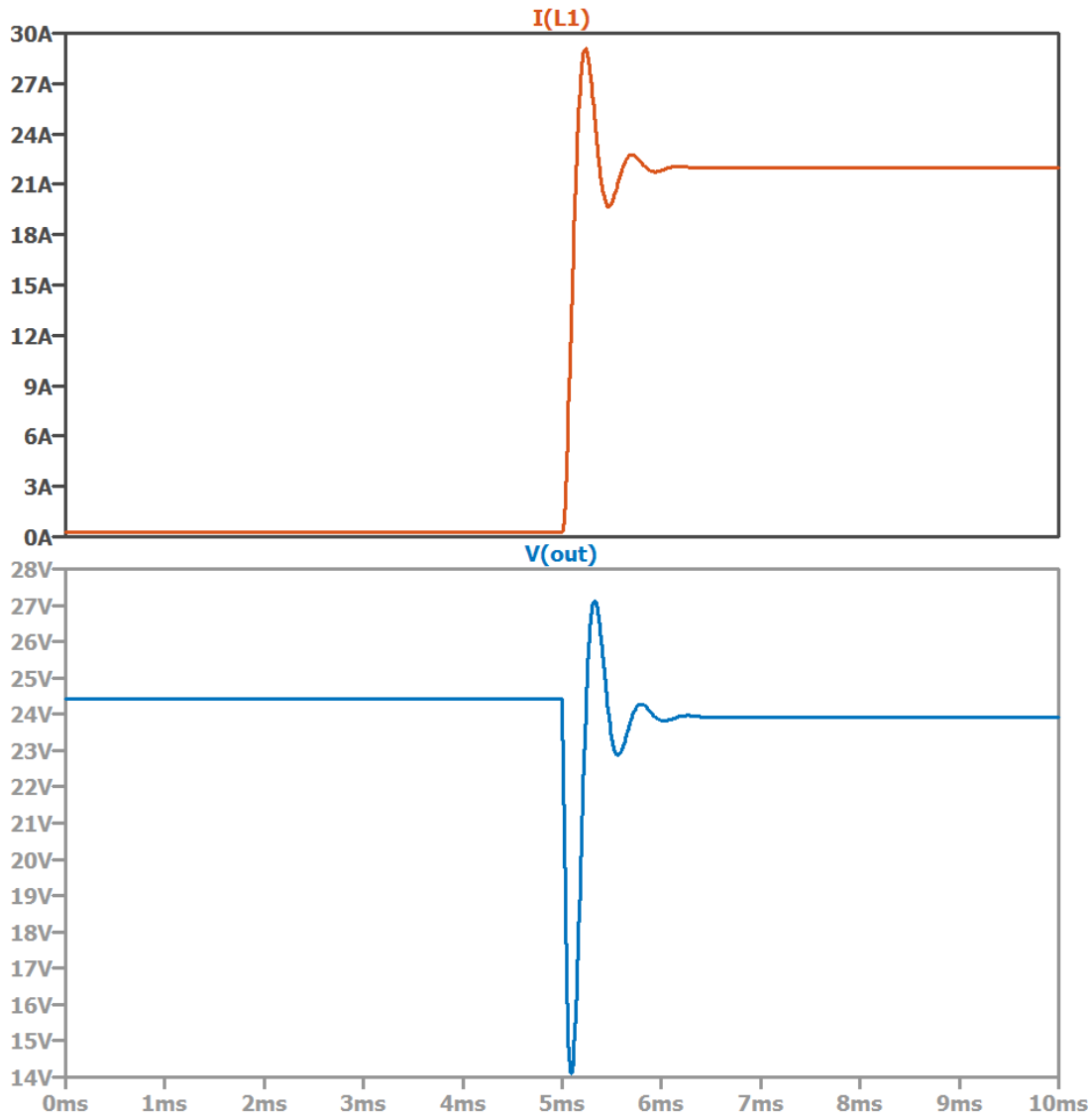


Short-Circuit: Switching

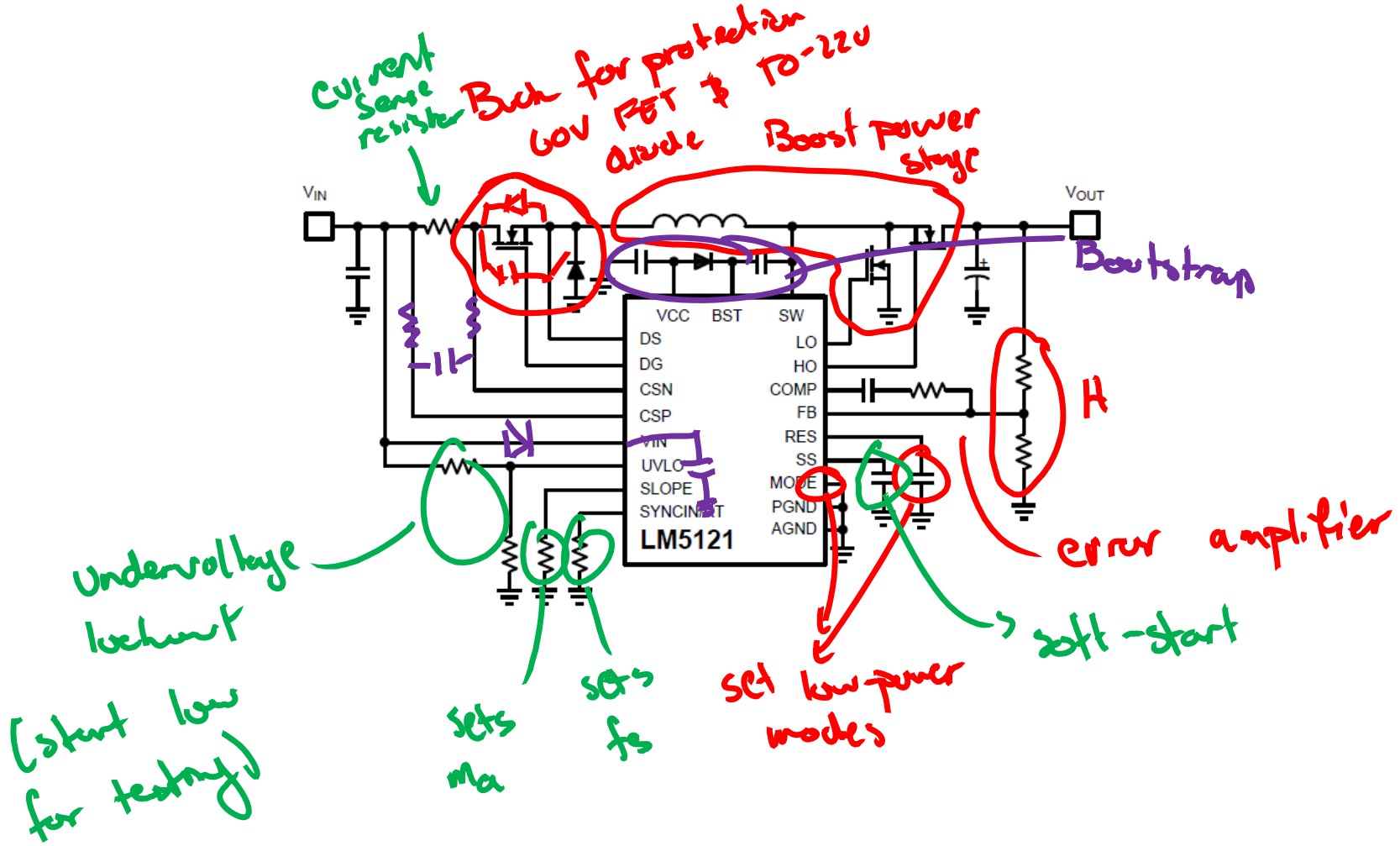


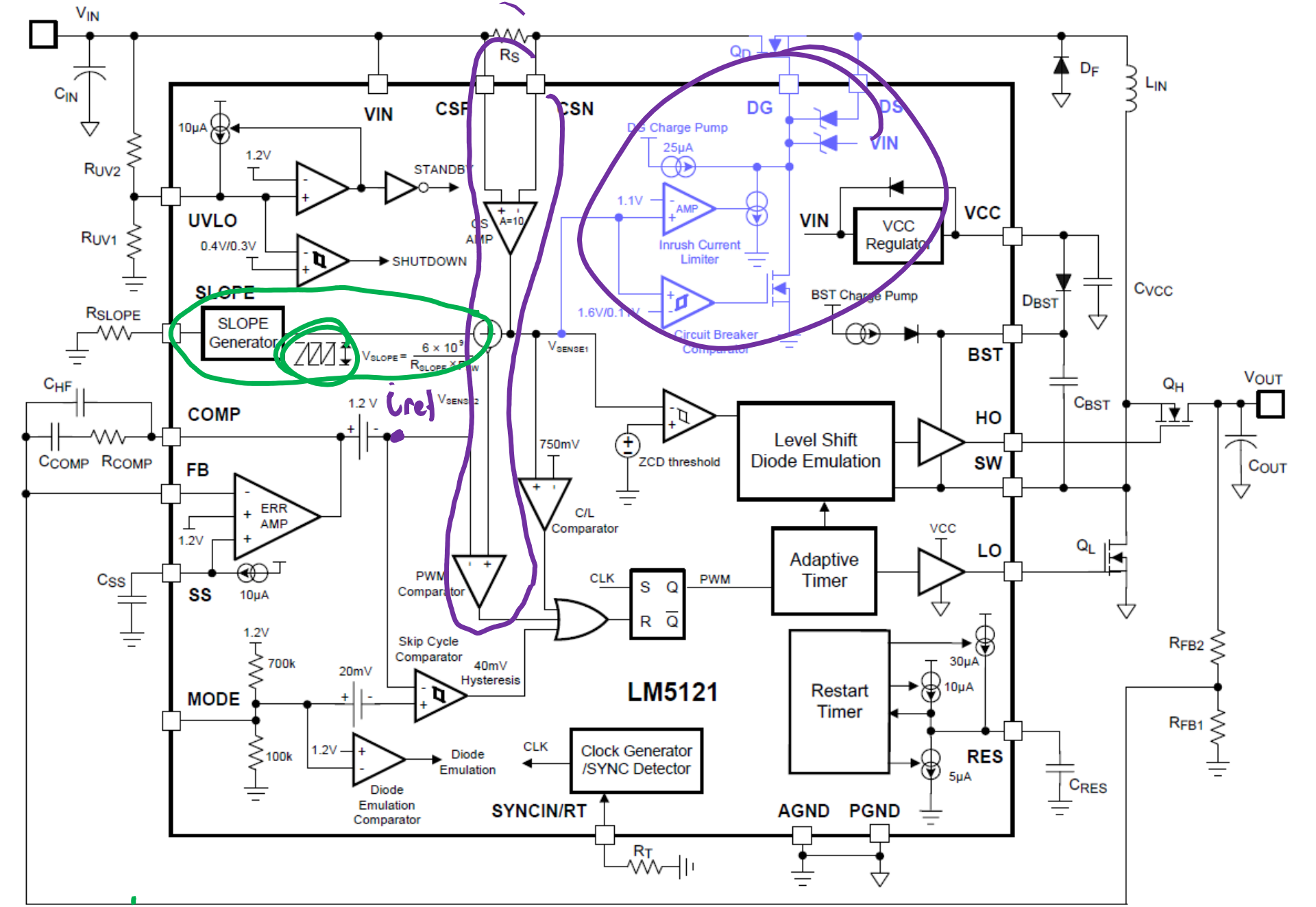


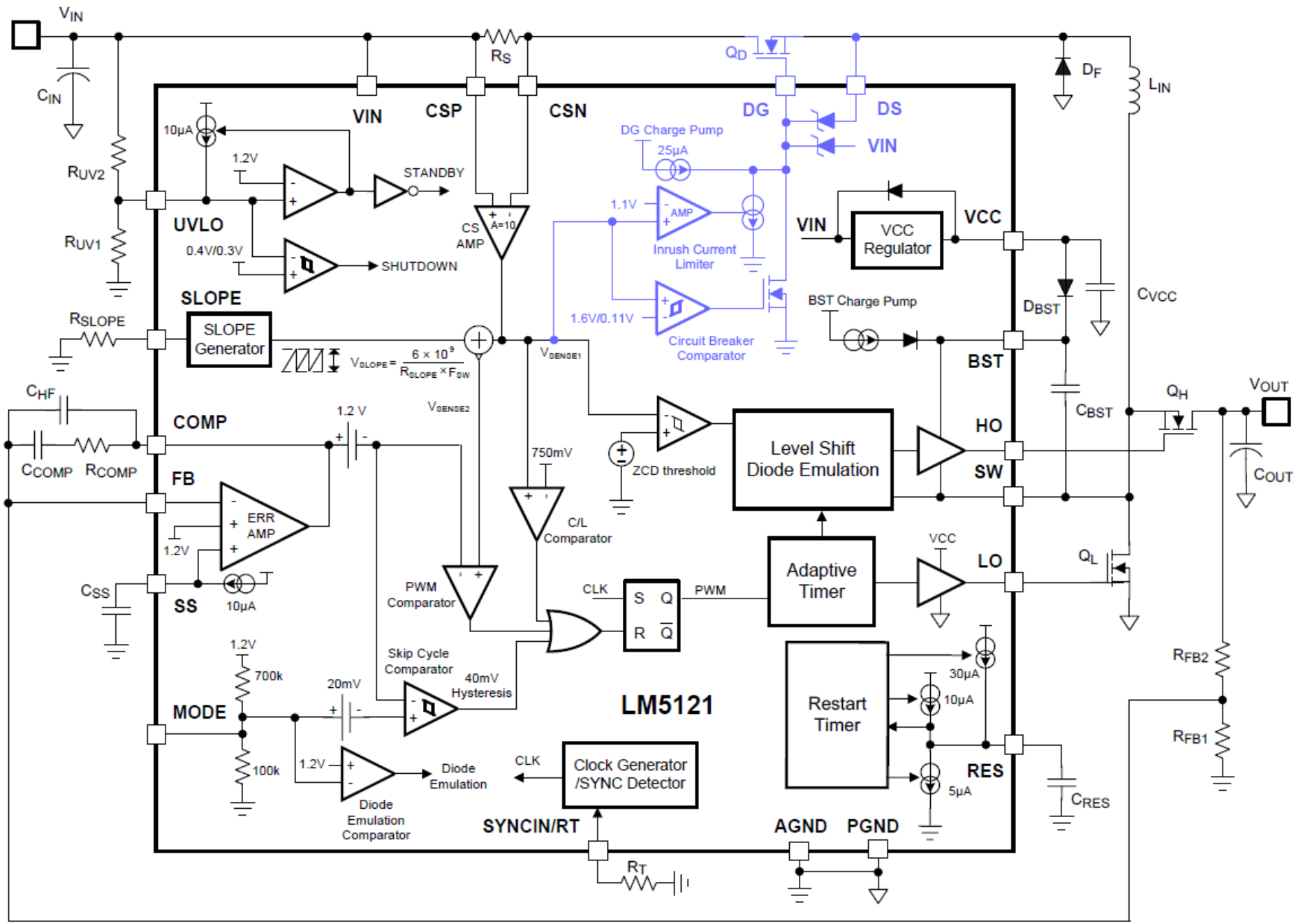
Short-Circuit: No Switching



LM5121: Functionality




VIN
CIN
RUV2
RUV1
10µA
1.2V
UVLO
0.4V/0.3V
STANDBY
SHUTDOWN
VIN
CSP
CSN
RS
CS AMP
A=10
SLOPE
RSLOPE
SLOPE Generator
VSLOPE = 6 × 10^9 / (RSLOPE × Fsw)
VSENSE1
VSENSE2
CHF
COMP
CCOMP
RCOMP
1.2 V
Vref
FB
ERR AMP
1.2V
CSS
SS
10µA
750mV
C/L Comparator
ZCD threshold
PWM Comparator
CLK
S Q
R Q
PWM
Level Shift Diode Emulation
Adaptive Timer
VCC
HO
SW
LO
QH
QL
VOUT
COUT
CBST
DBST
CVCC
DF
LIN
QD
DG
DS
DS Charge Pump
25µA
1.1V
AMP
Inrush Current Limiter
1.6V/0.1V
Circuit Breaker Comparator
VIN
VCC Regulator
VCC
BST Charge Pump
BST
1.2V
700k
MODE
100k
20mV
Skip Cycle Comparator
40mV Hysteresis
1.2V
Diode Emulation
Diode Emulation Comparator
CLK
Clock Generator /SYNC Detector
SYNCIN/RT
RT
LM5121
Restart Timer
30µA
10µA
5µA
RES
CRES
AGND
PGND
RFB2
RFB1


VIN
CIN
RUV2
RUV1
RS
VIN
CSP
CSN
10µA
1.2V
STANDBY
UVLO
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VSLOPE = 6 × 10^9 / (RSLOPE × FSW)
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PWM Comparator
750mV
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ZCD threshold
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Q
R
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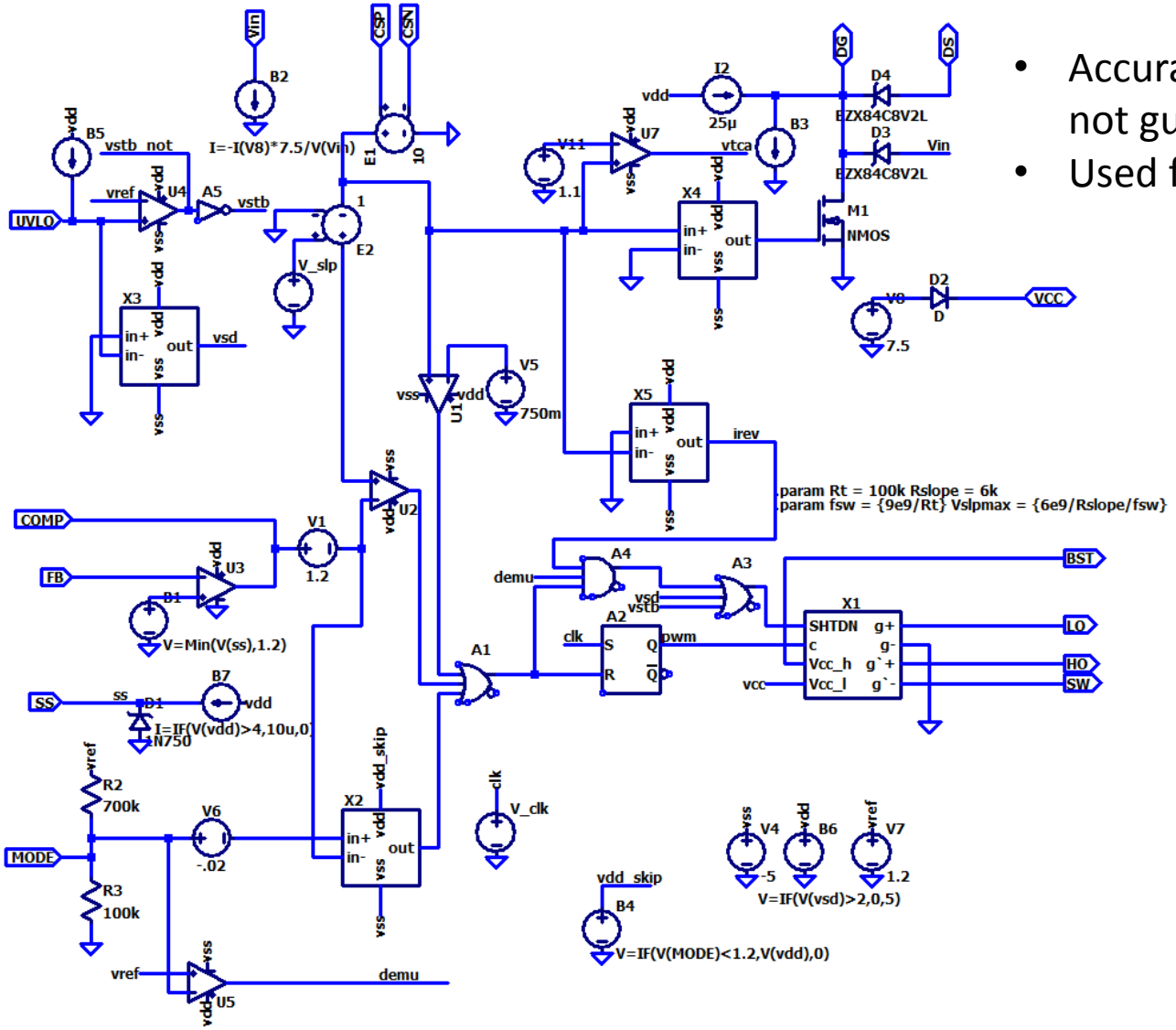
1.2V
Diode Emulation
Diode Emulation Comparator
CLK
Clock Generator /SYNC Detector
SYNCIN/RT
RT
AGND
PGND
Restart Timer
30µA
10µA
5µA
RES
CRES
QD
DG
DS
VIN
DG Charge Pump
25µA
1.1V
AMP
Inrush Current Limiter
1.6V/0.11V
Circuit Breaker Comparator
VIN
VCC Regulator
VCC
BST Charge Pump
DBST
CVCC
BST
CBST
QH
VOUT
COUT
DF
LIN
RFB2
RFB1

Internal Functional Model in LTSpice

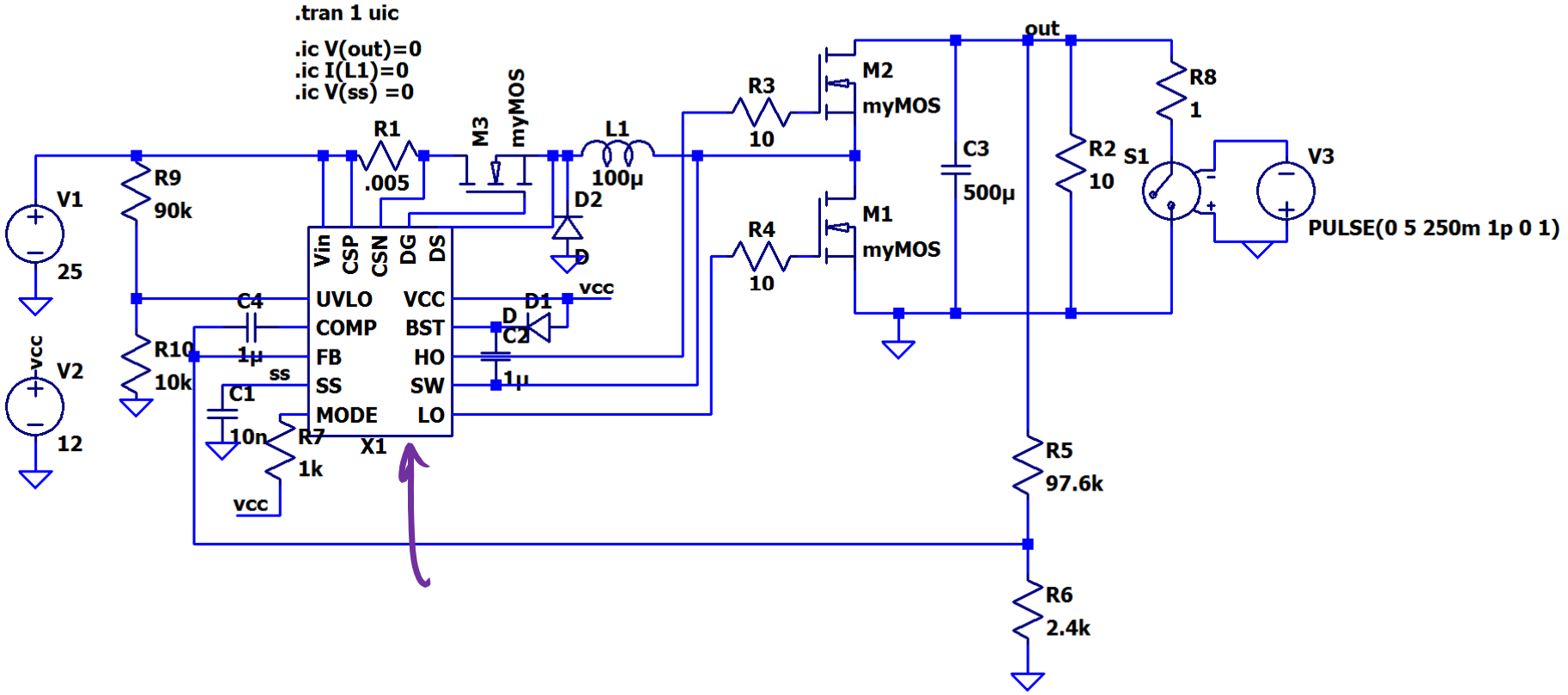


- Accuracy/functionality not guaranteed
- Used for insight only

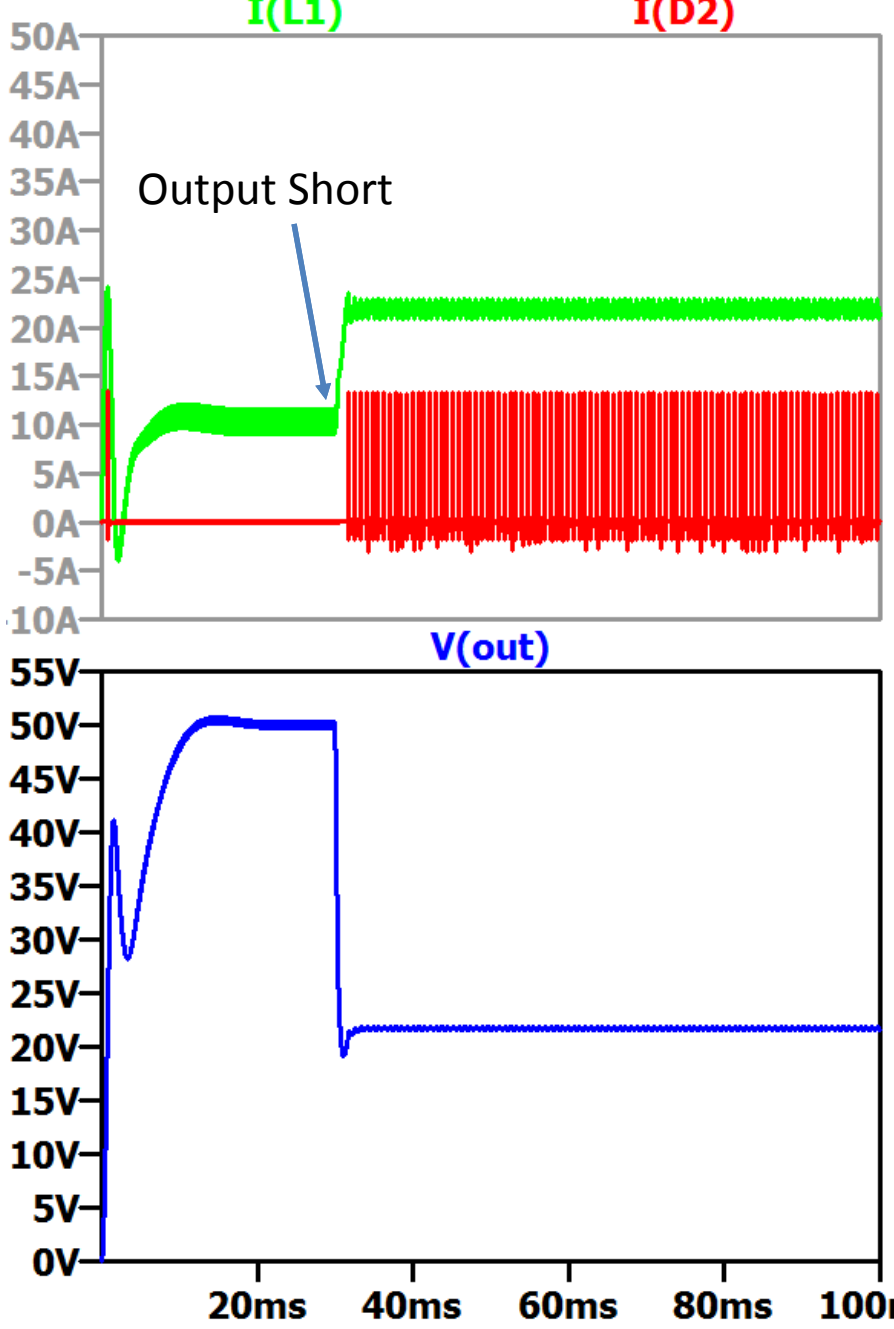
In-Circuit Simulation

.model mysw sw(Von=3 Voff=2 Ron=.1 Roff = 1Meg)

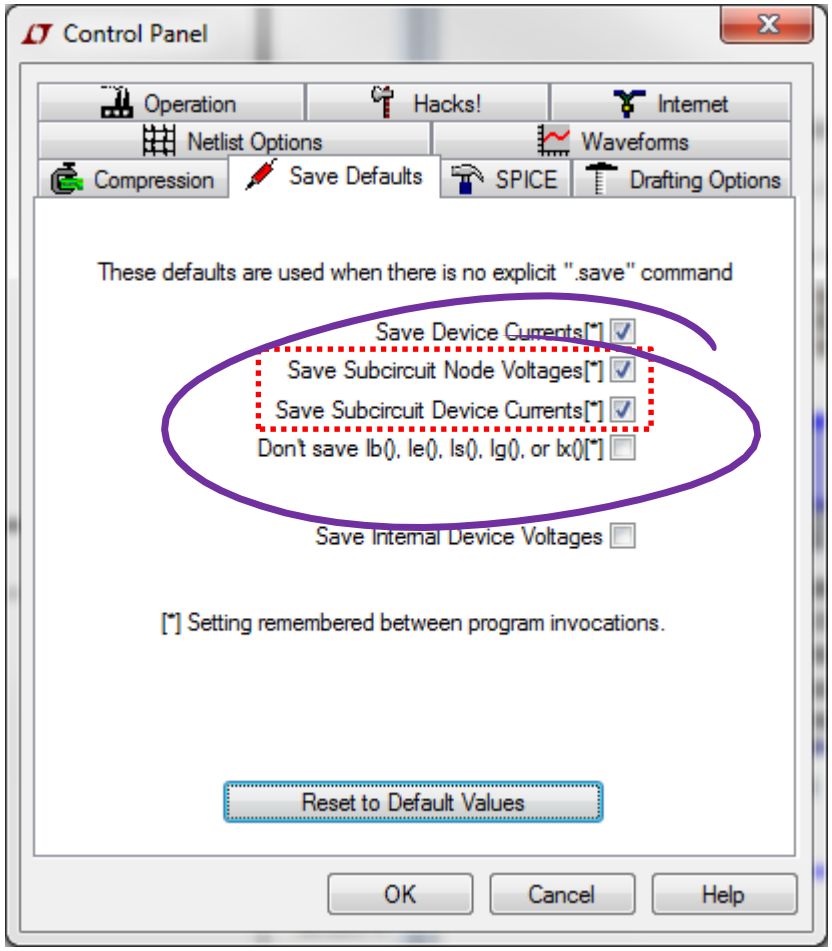
.model myMOS VDMOS(Rg=1 Vto=4.5 Rd=14m Rs=10m Rb=17m Kp=30 Cgdmax=.5p Cgdmin=.05n Cgs=.2n Cjo=.03p Is=88p)



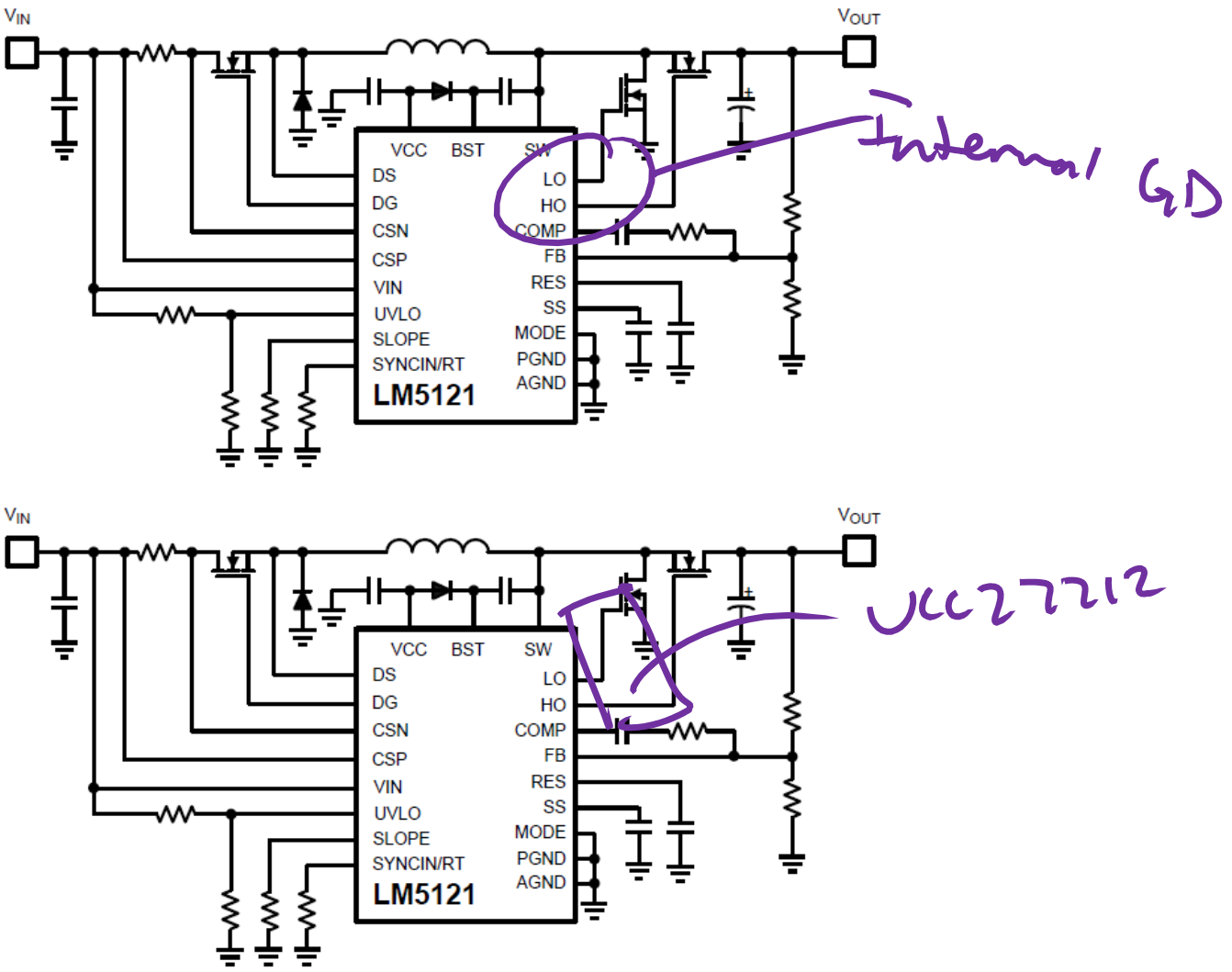
Sim Results


I(L1)
I(D2)
50A
45A
40A
35A
30A
25A
20A
15A
10A
5A
0A
-5A
-10A
Output Short
V(out)
55V
50V
45V
40V
35V
30V
25V
20V
15V
10V
5V
0V
20ms
40ms
60ms
80ms
100ms

A Tip: Debug Internal of Subcircuit



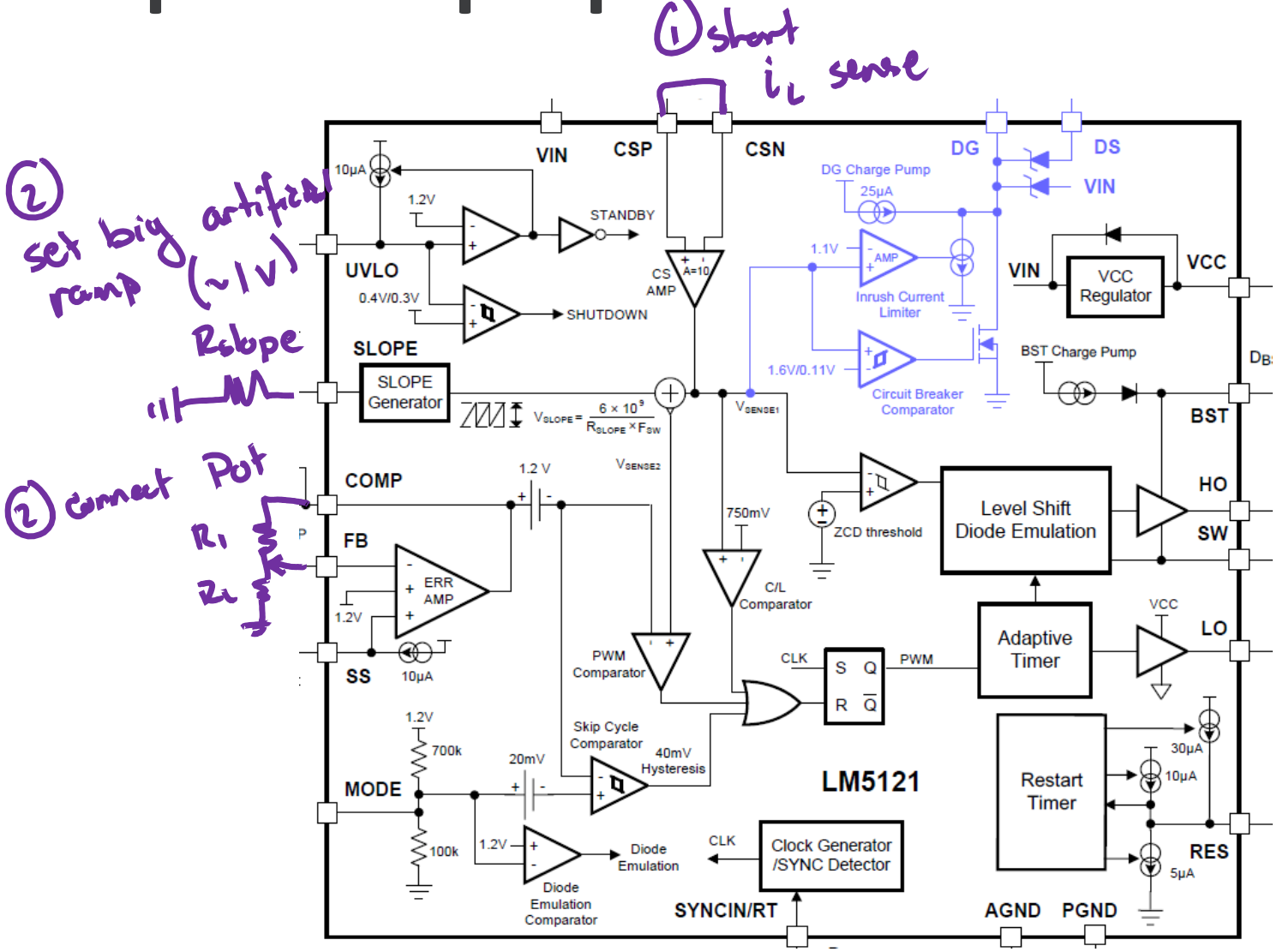
Experiment 4: Gate Driver Selection



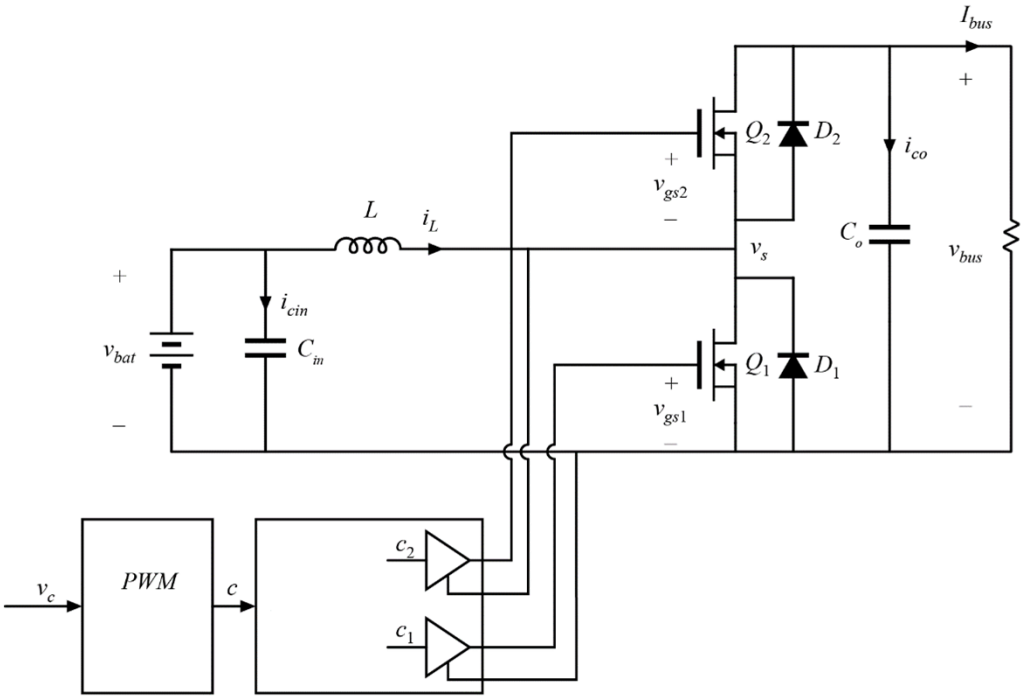
Experiment 4: Closing the Loop

- Closed-loop operation in steps
  1. Open-loop operation with LM5121 modulator
     - Requires “tricking” LM5121
  2. Closed-loop current regulation
  3. Closed-loop voltage and current regulation

Open-Loop Operation

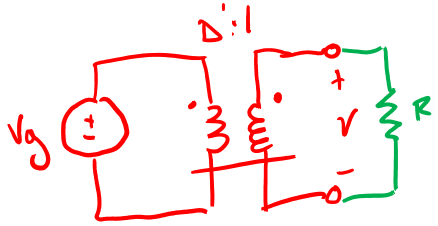


Setting the Electronic Load



Low-frequency model

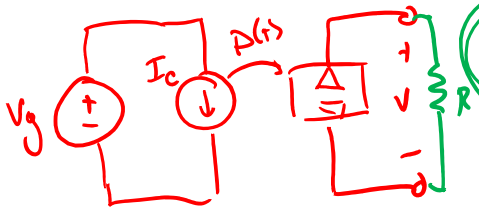
(1) Open Loop:



$V = \frac{V_g}{D'}$

$P_{out} = \left(\frac{V_g}{D'}\right)^2 \frac{1}{R}$

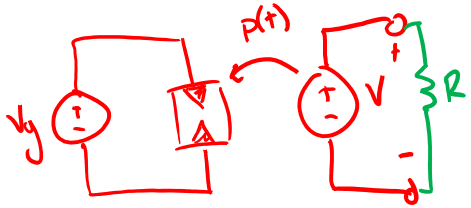
(2) Current Loop Only Large R = large voltage!



$V = \sqrt{I_c V_g R}$

$P_{out} = I_c V_g$

(3) Voltage & Current Loop



$V = V_{ref}$

$P_{out} = \frac{V_{ref}^2}{R}$

Be careful with how you set electronic load

Safest: (1) & (3) current or resistance

(2) voltage