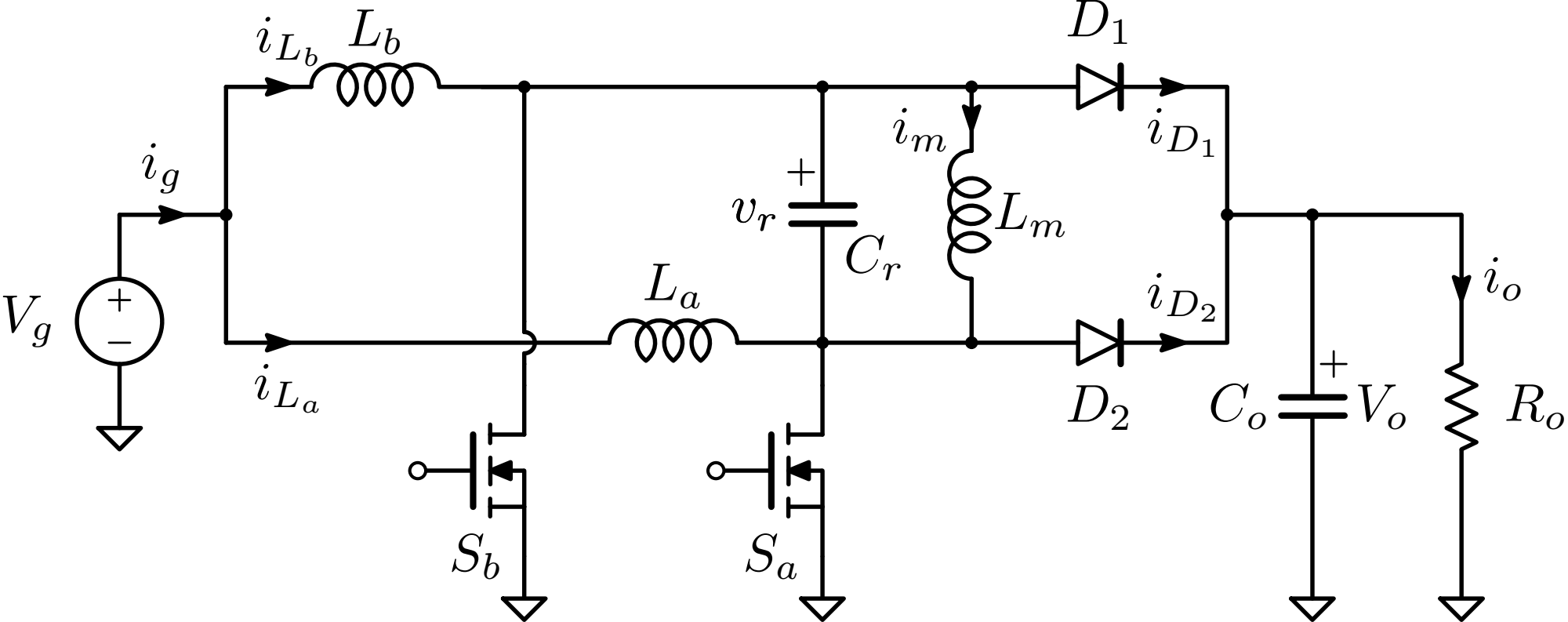
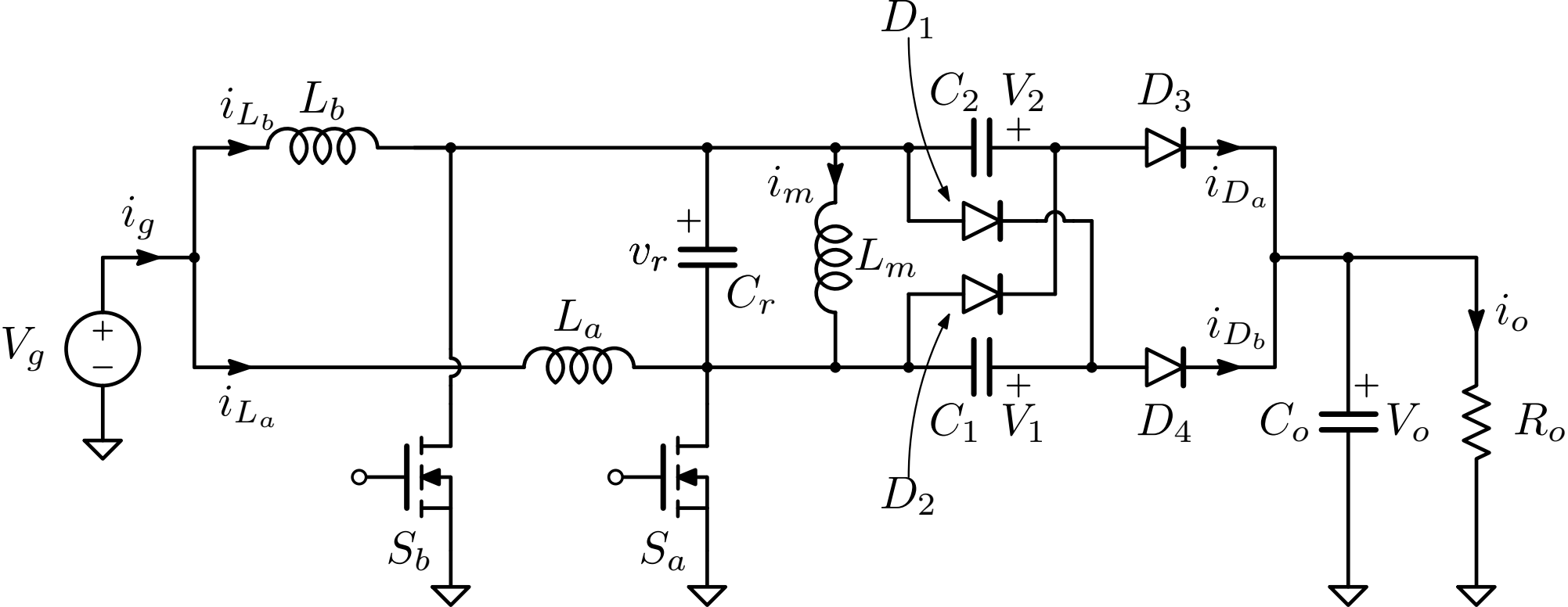
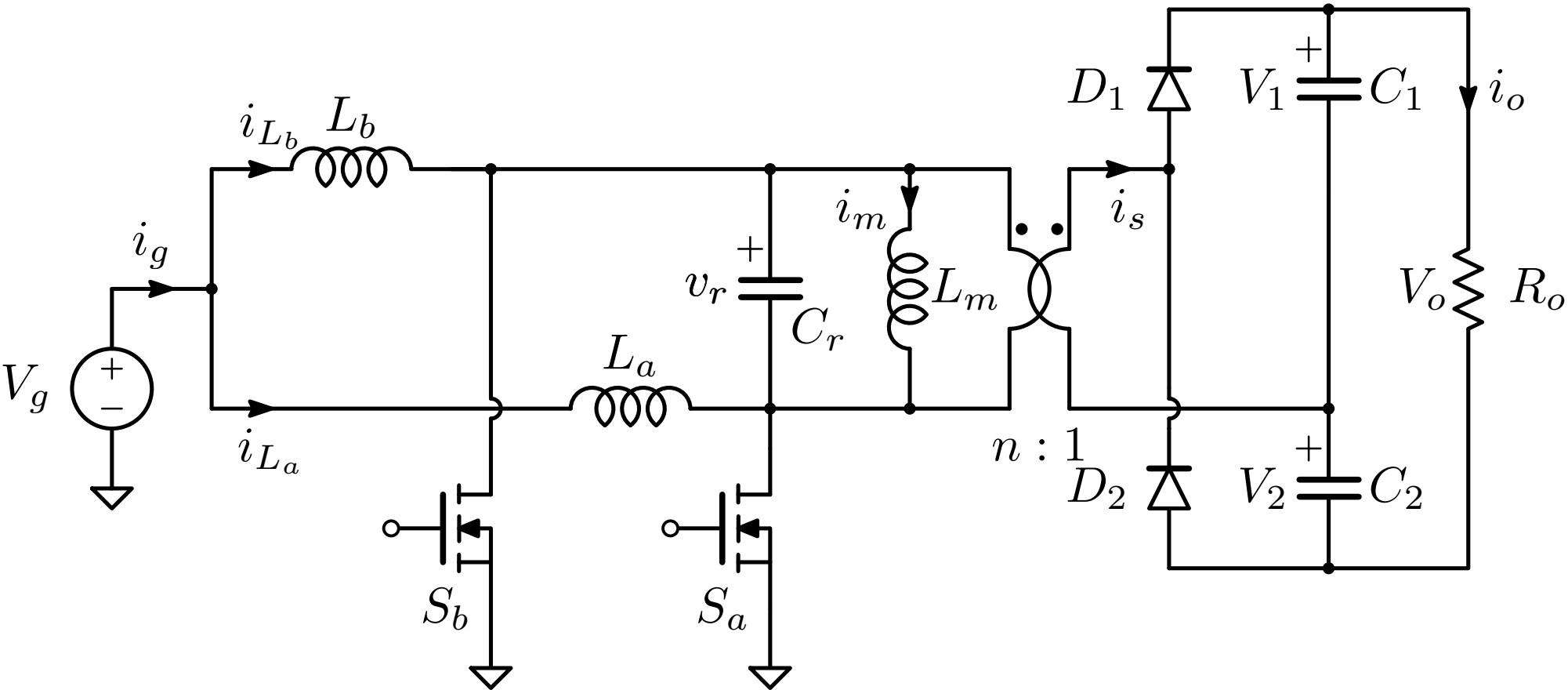
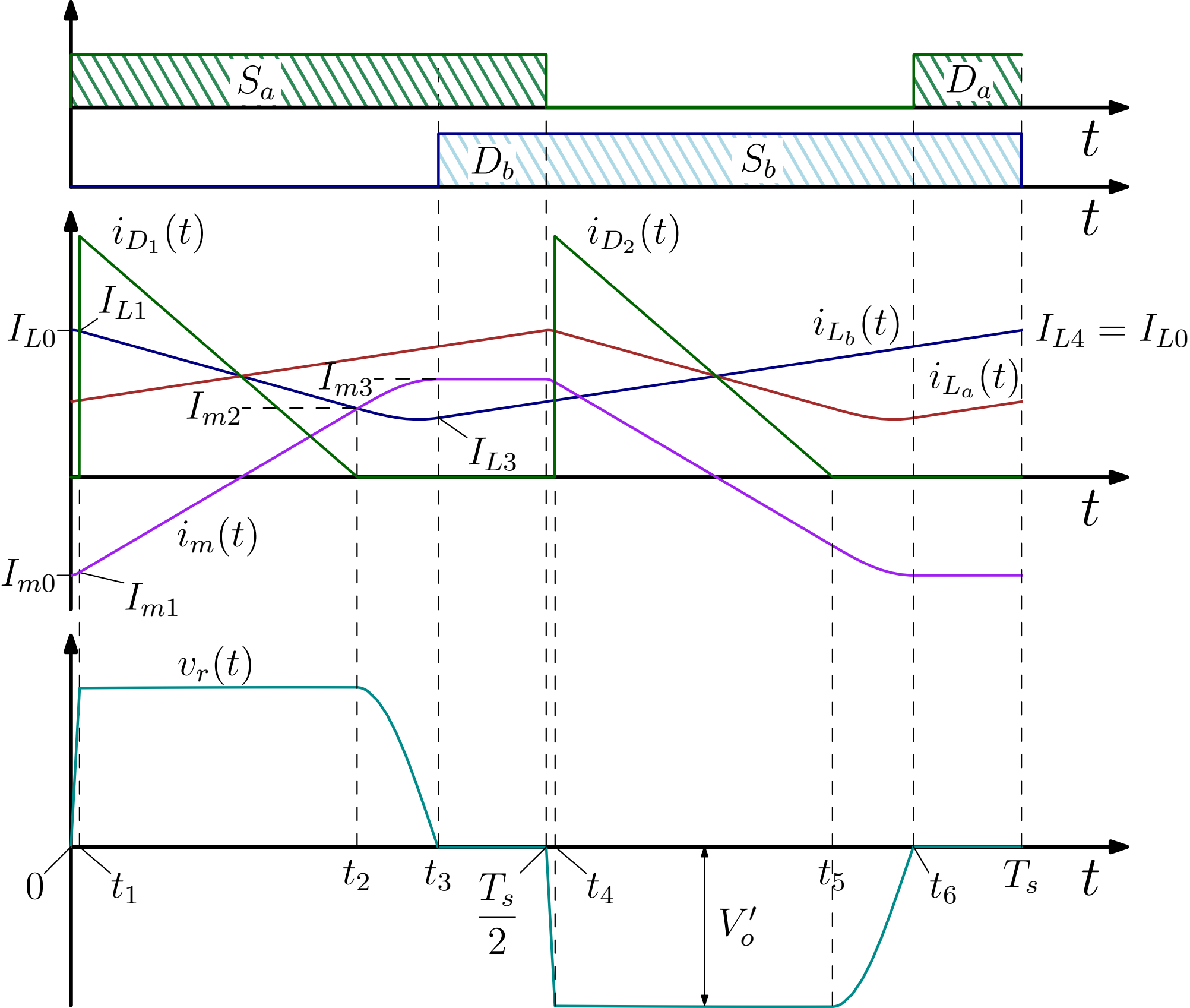
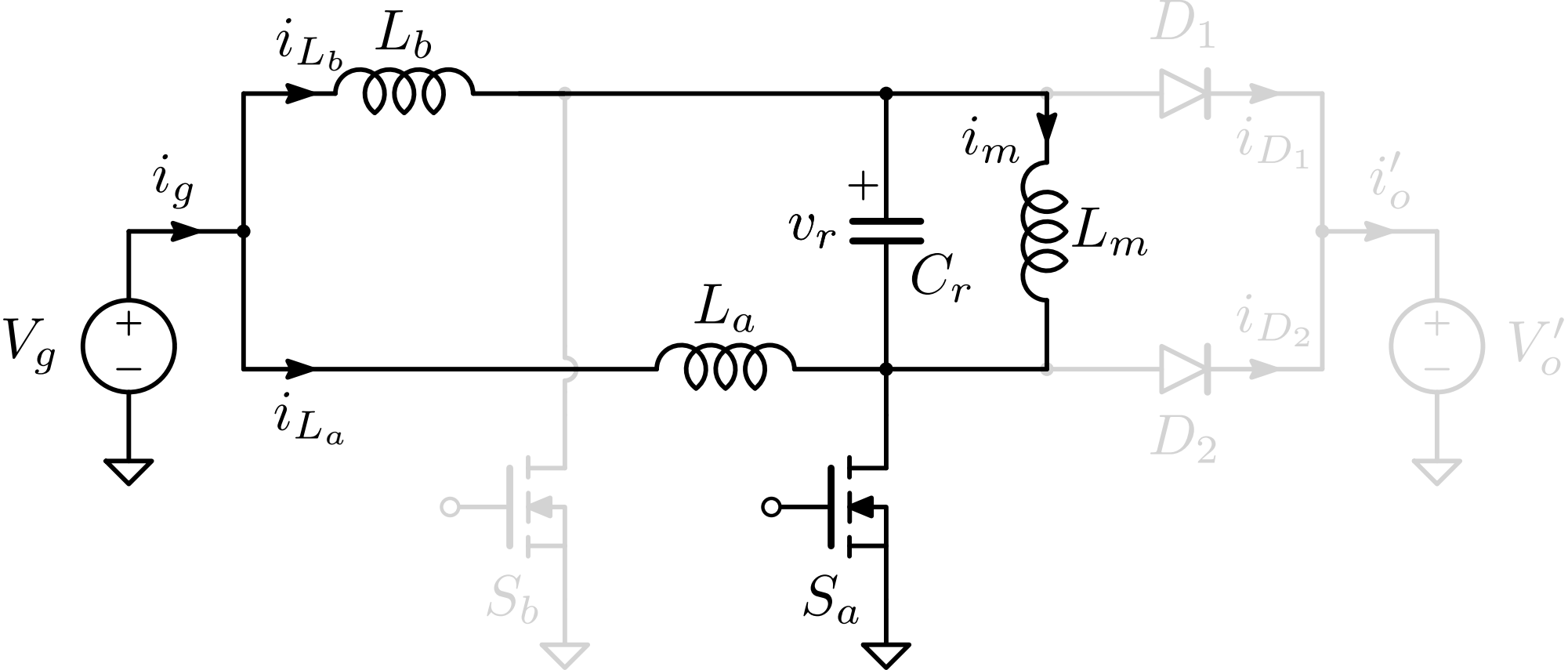
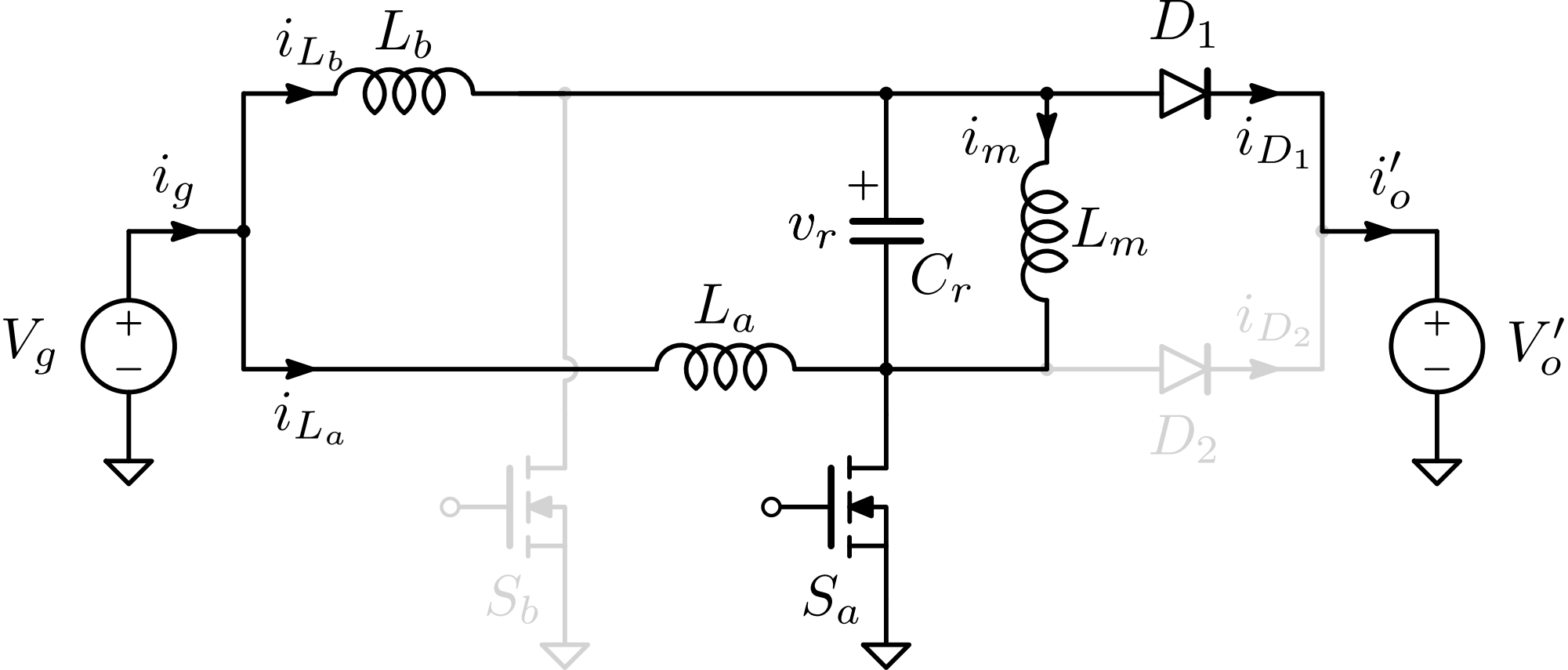

i_{L_b}
L_b
D_1
i_g
i_m
i_{D_1}
v_r
C_r
L_m
V_g
L_a
i_{D_2}
i_o
i_{L_a}
D_2
C_o
V_o
R_o
S_b
S_a

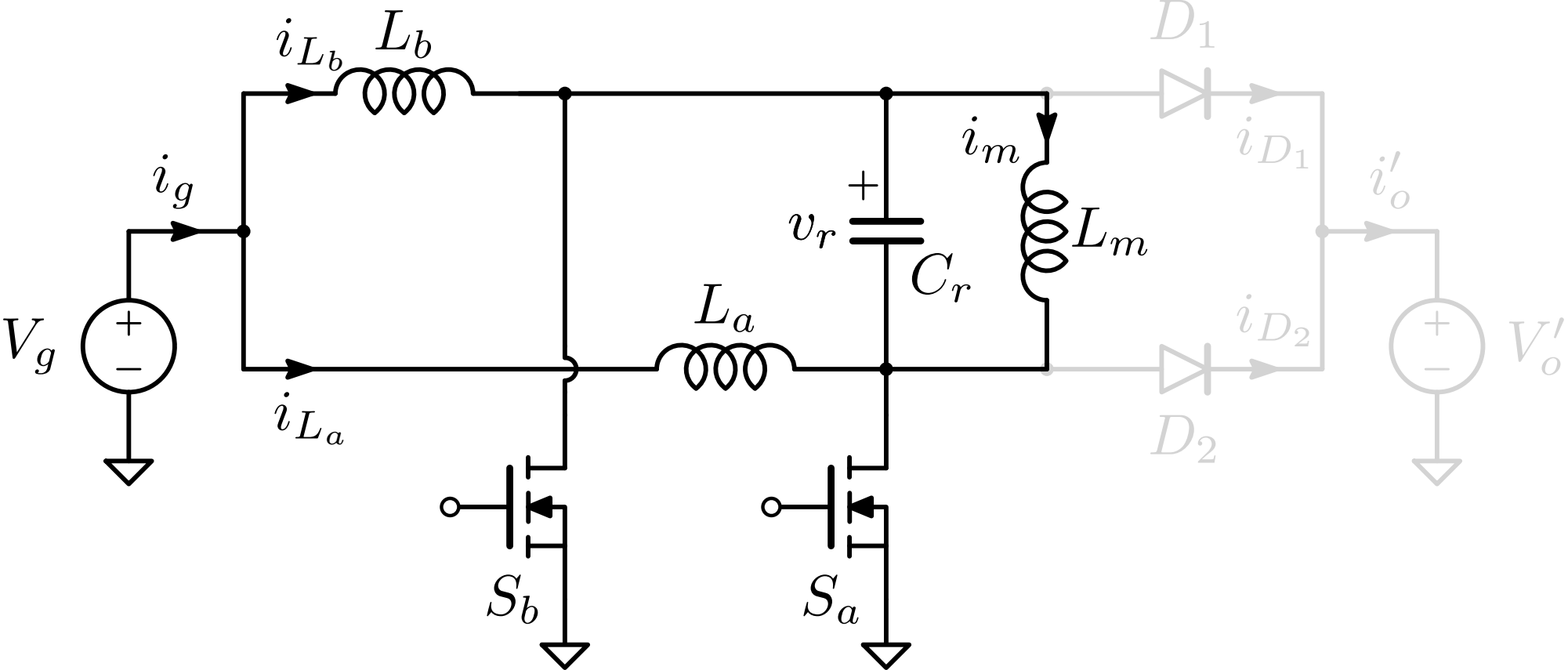

D_1
C_2 V_2
D_3
i_{L_b} L_b
i_m
i_{D_a}
i_g
v_r
L_m
C_r
V_g
L_a
i_o
i_{D_b}
i_{L_a}
C_1 V_1
D_4
C_o V_o
R_o
D_2
S_b
S_a

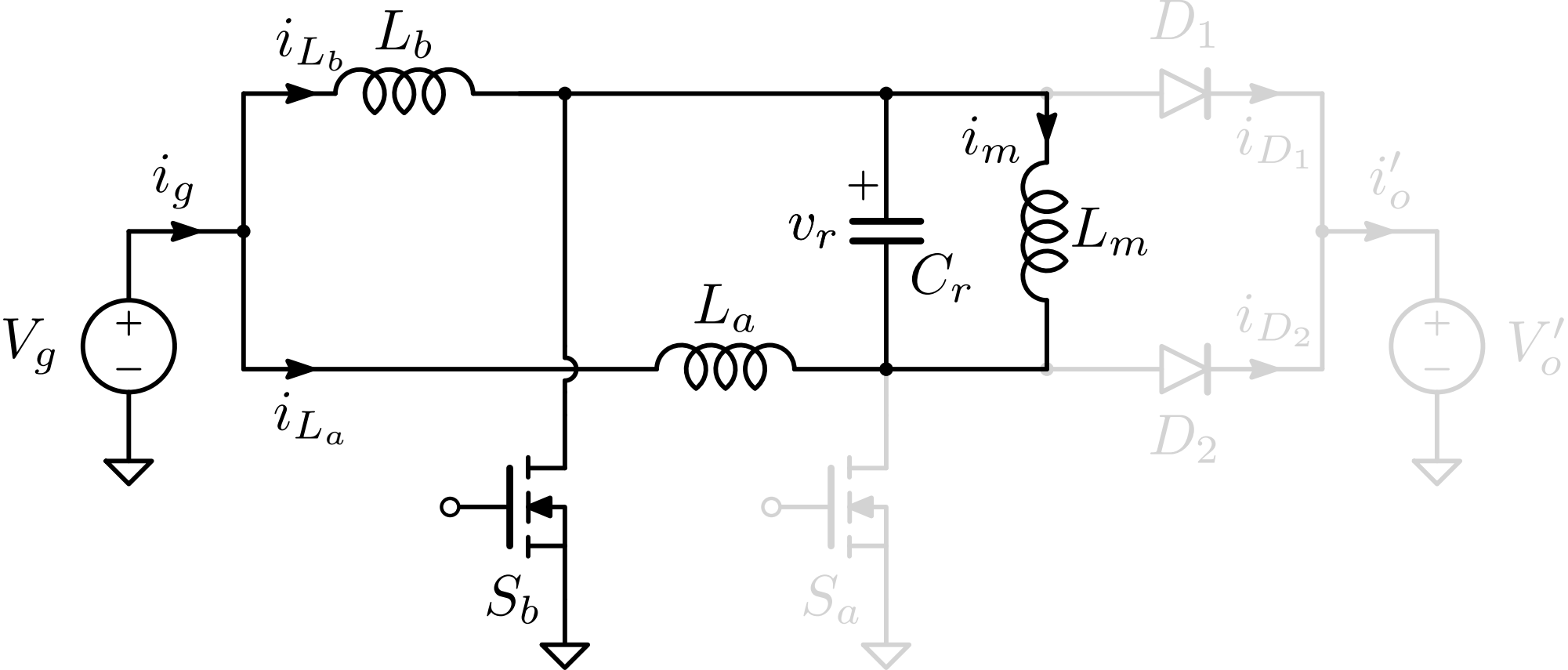

i_{L_b}
L_b
i_g
V_g
i_{L_a}
L_a
v_r
C_r
i_m
L_m
i_s
$n:1$
D_1
V_1
C_1
i_o
V_o
R_o
D_2
V_2
C_2
S_b
S_a

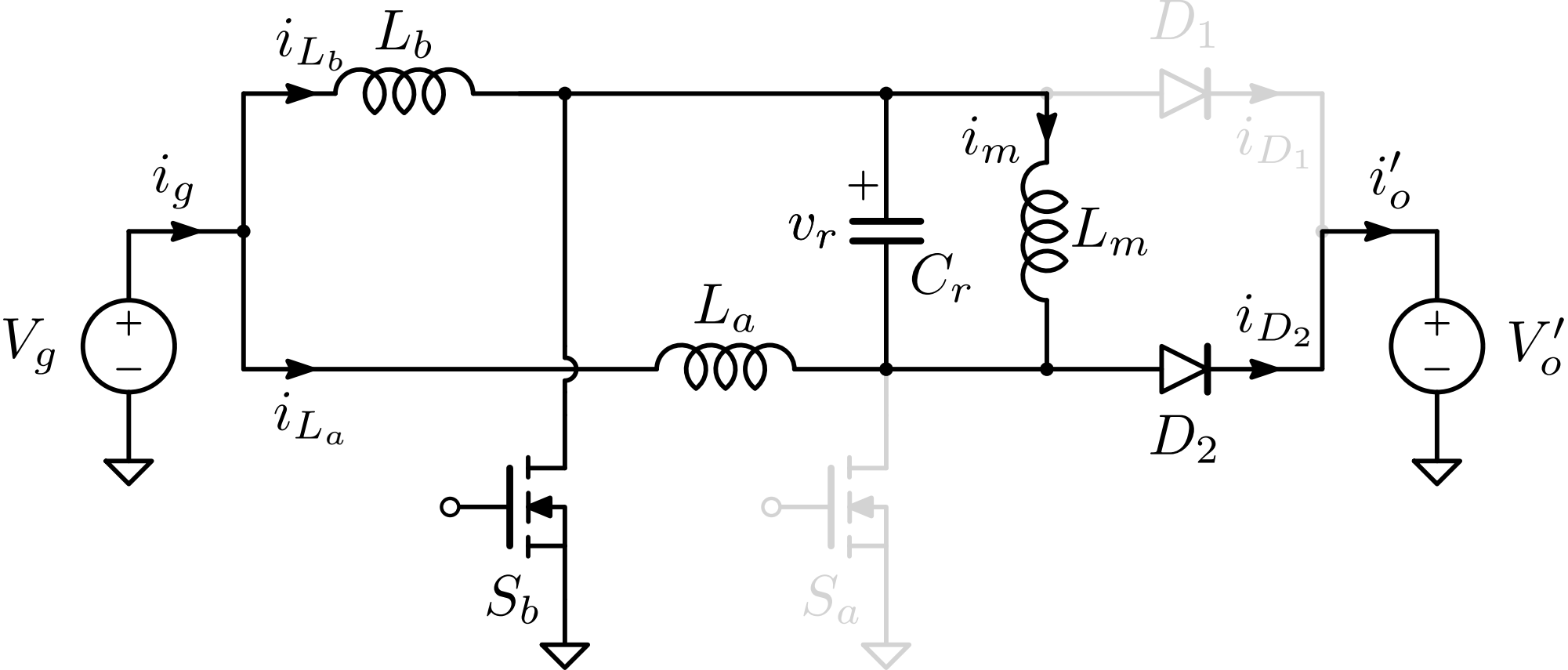

S_a
D_a
t
D_b
S_b
t
$i_{D_1}(t)$
$i_{D_2}(t)$
I_{L1}
I_{L0}
$i_{L_b}(t)$
$I_{L4} = I_{L0}$
I_{m3}
I_{m2}
$i_{L_a}(t)$
I_{L3}
t
$i_m(t)$
I_{m0}
I_{m1}
$v_r(t)$
0
t_1
t_2
t_3
$\frac{T_s}{2}$
t_4
V_o'
t_5
t_6
T_s
t

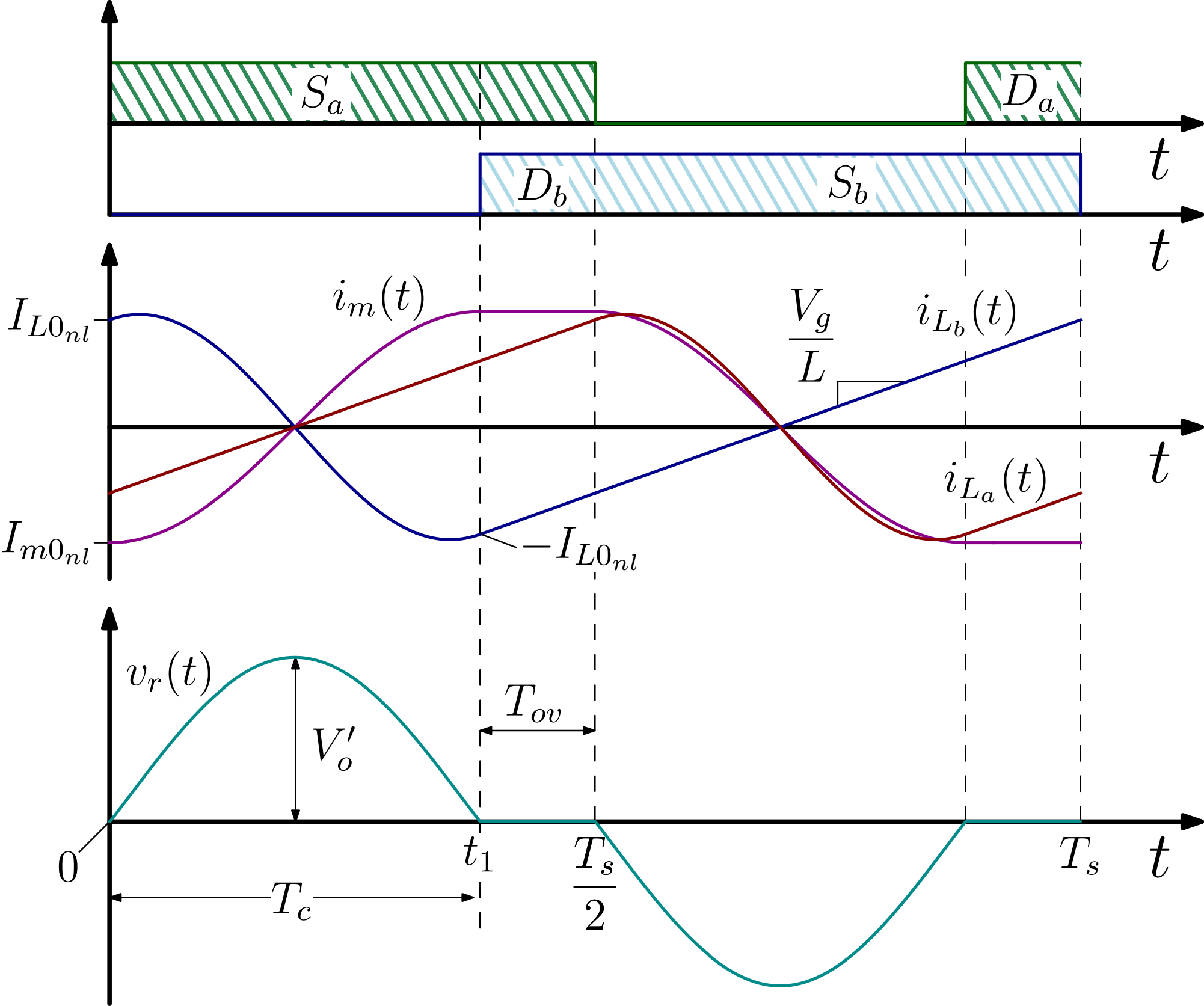

i_{L_b}
L_b
i_g
V_g
i_{L_a}
L_a
v_r
C_r
i_m
L_m
D_1
i_{D_1}
i'_o
i_{D_2}
D_2
V'_o
S_b
S_a

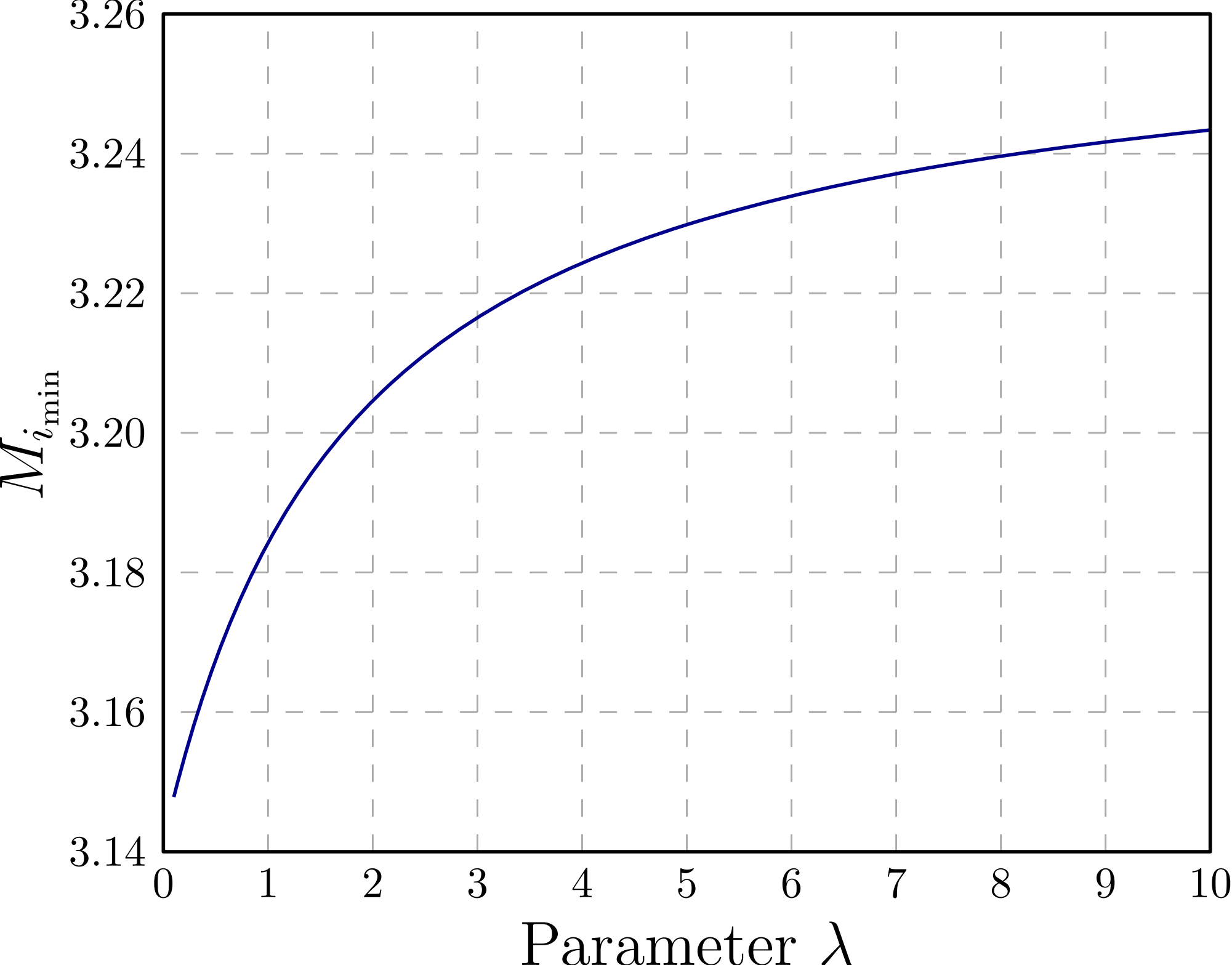

i_{L_b}
L_b
D_1
i_m
i_{D_1}
i_g
v_r
C_r
L_m
i'_o
V_g
L_a
i_{D_2}
V'_o
i_{L_a}
D_2
S_b
S_a

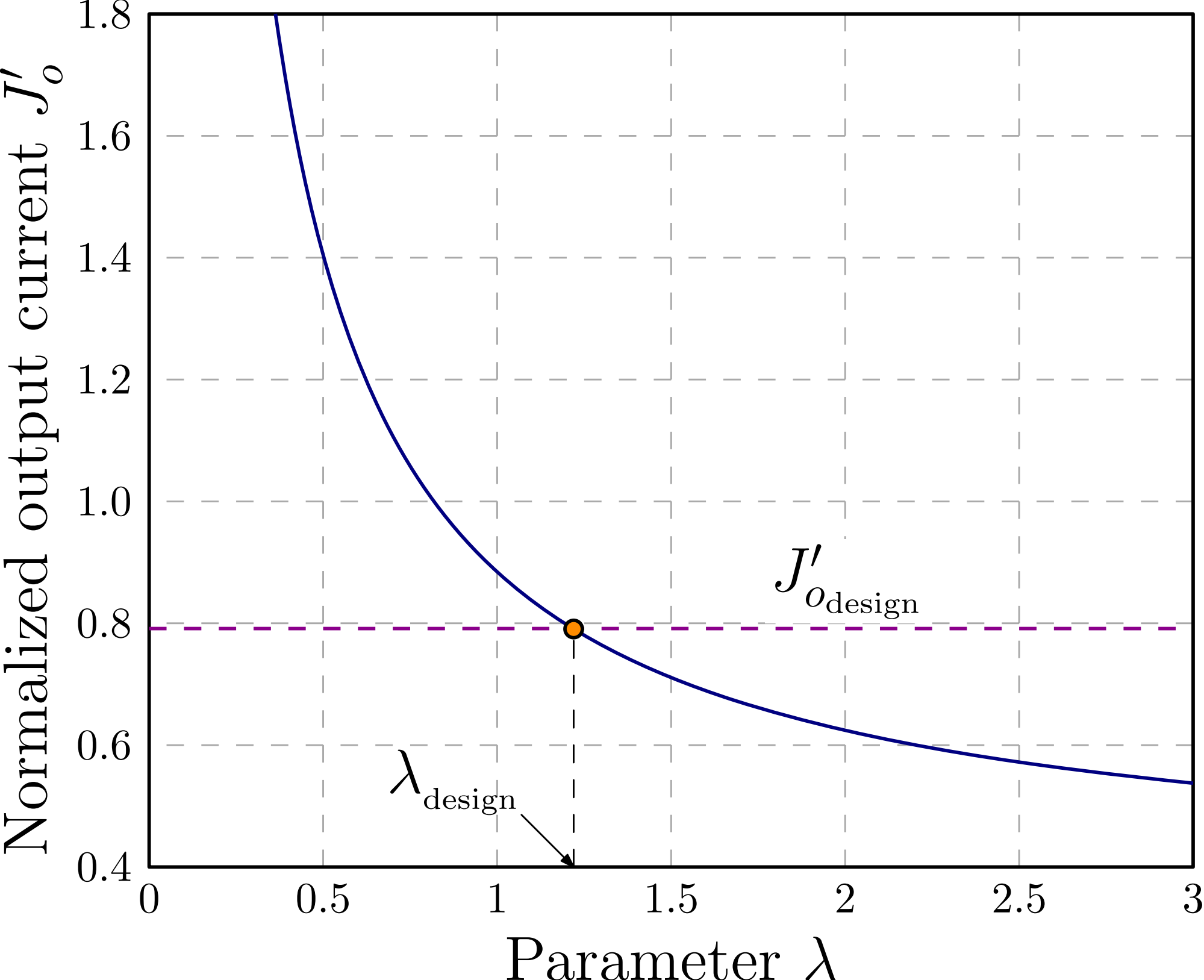

i_{L_b}
L_b
i_g
V_g
i_{L_a}
L_a
v_r
C_r
i_m
L_m
S_b
S_a
D_1
D_2
i_{D_1}
i_{D_2}
i'_o
V'_o

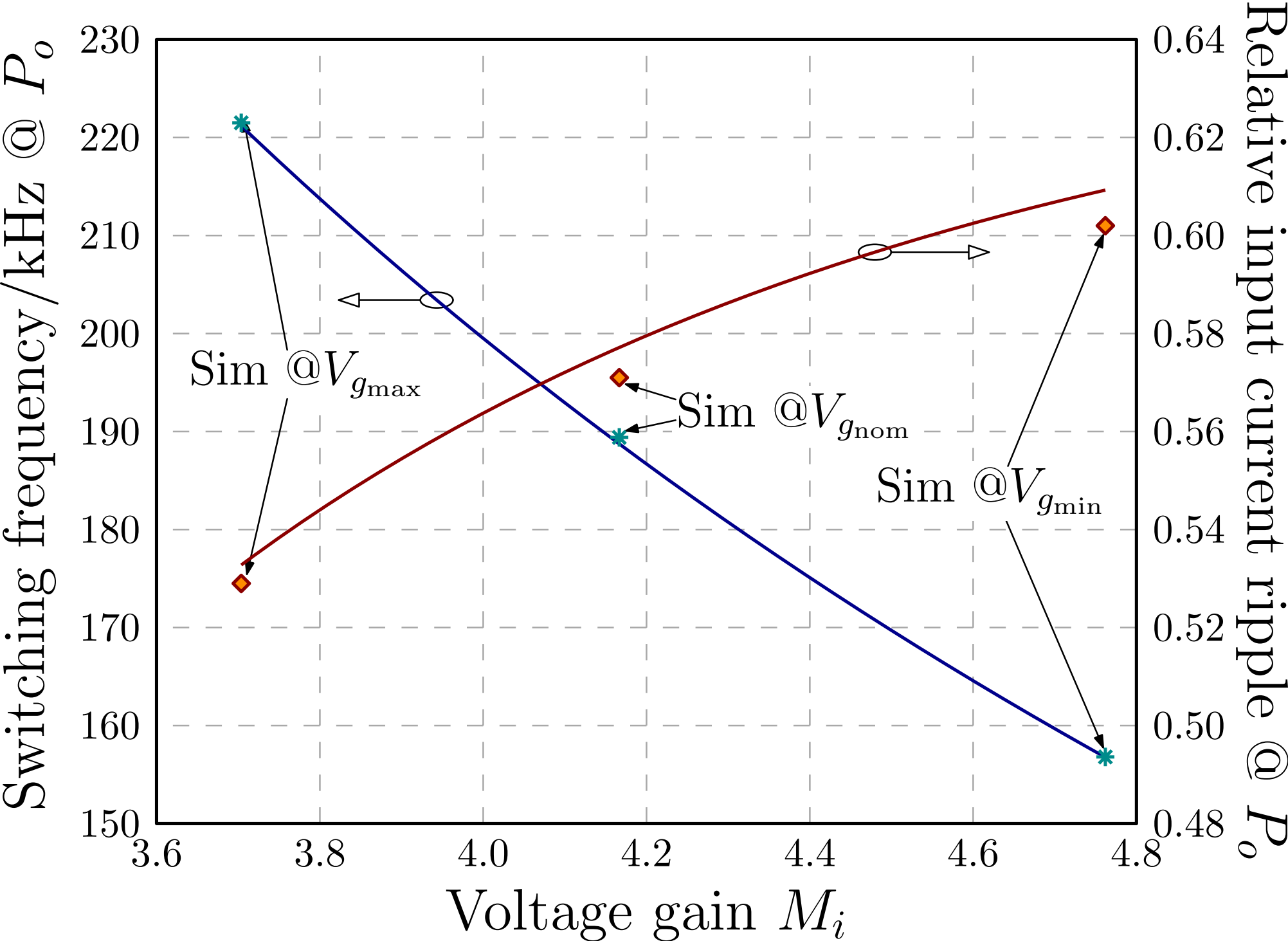

i_{L_b}
L_b
i_g
V_g
i_{L_a}
L_a
S_b
v_r
C_r
i_m
L_m
D_1
D_2
i_{D_1}
i_{D_2}
i'_o
V'_o
S_a

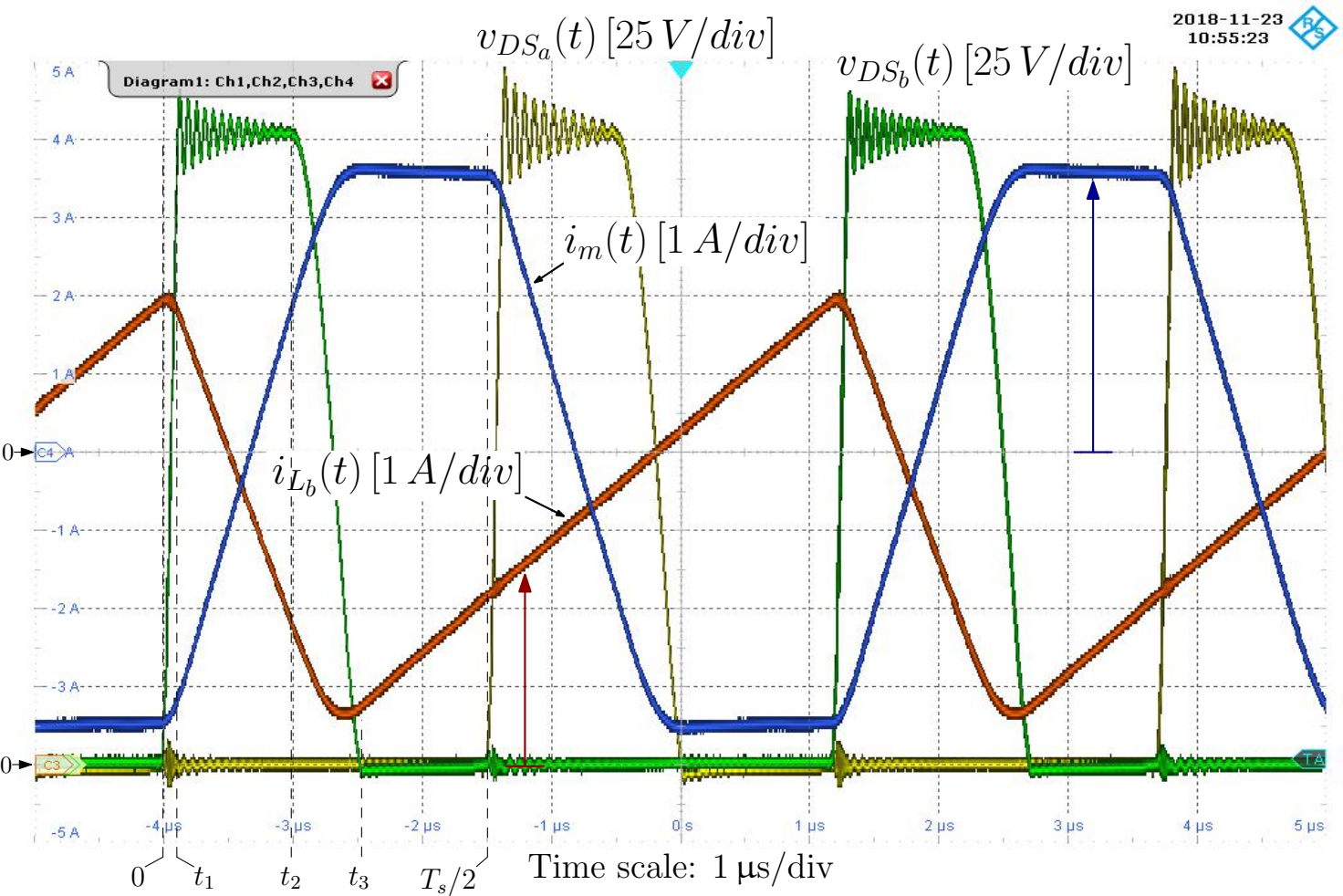

i_{L_b}
L_b
i_g
V_g
i_{L_a}
S_b
L_a
v_r
C_r
i_m
L_m
D_1
i_{D_1}
i_{D_2}
D_2
S_a
i'_o
V'_o

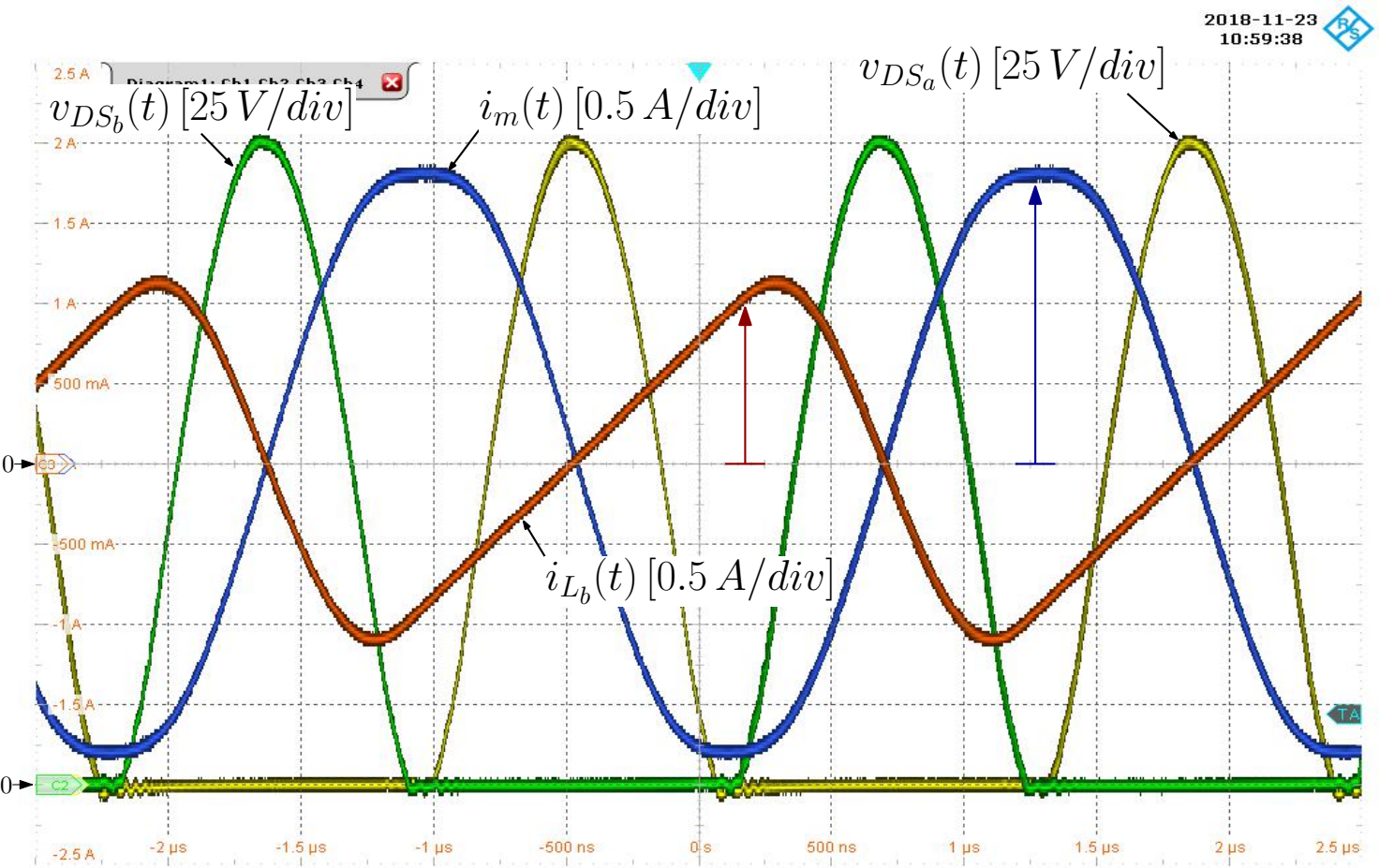

S_a
D_a
t
D_b
S_b
t
$I_{L0_{nl}}$
$i_m(t)$
$\frac{V_g}{L}$
$i_{L_b}(t)$
t
$i_{L_a}(t)$
$I_{m0_{nl}}$
$-I_{L0_{nl}}$
$v_r(t)$
T_{ov}
V_o'
0
t_1
$\frac{T_s}{2}$
T_s
t
T_c


3.26
3.24
3.22
3.20
3.18
3.16
3.14
$M_{i_{\min}}$
0
1
2
3
4
5
6
7
8
9
10
Parameter λ

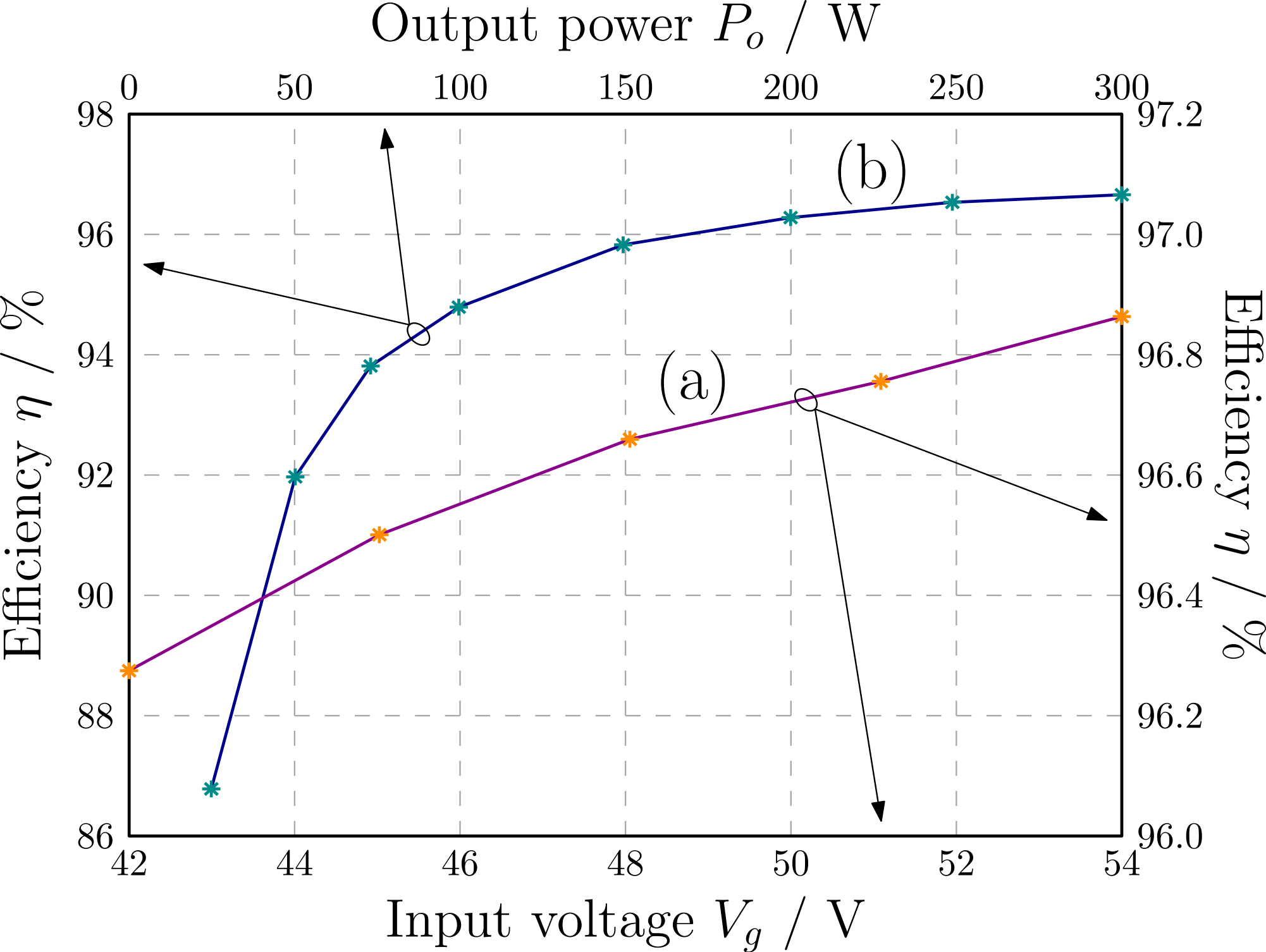

Normalized output current J'_o
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0
0.5
1
1.5
2
2.5
3
Parameter λ
$J'_{o_{\text{design}}}$
λ_{design}

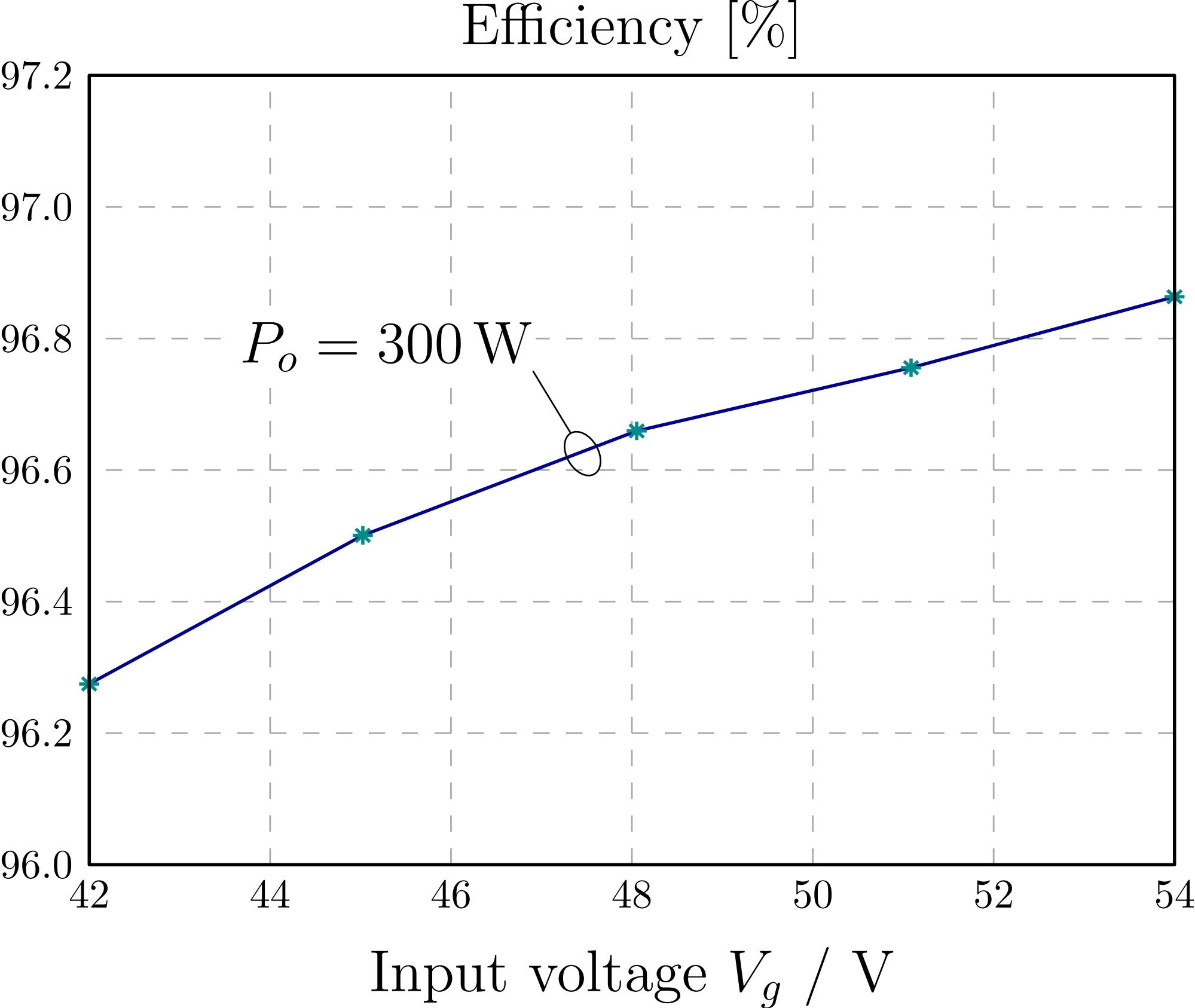

Switching frequency/kHz @ P_o
Relative input current ripple @ P_o
Voltage gain M_i
230
220
210
200
190
180
170
160
150
0.64
0.62
0.60
0.58
0.56
0.54
0.52
0.50
0.48
3.6
3.8
4.0
4.2
4.4
4.6
4.8
Sim @$V_{g\max}$
Sim @$V_{g\text{nom}}$
Sim @$V_{g\min}$

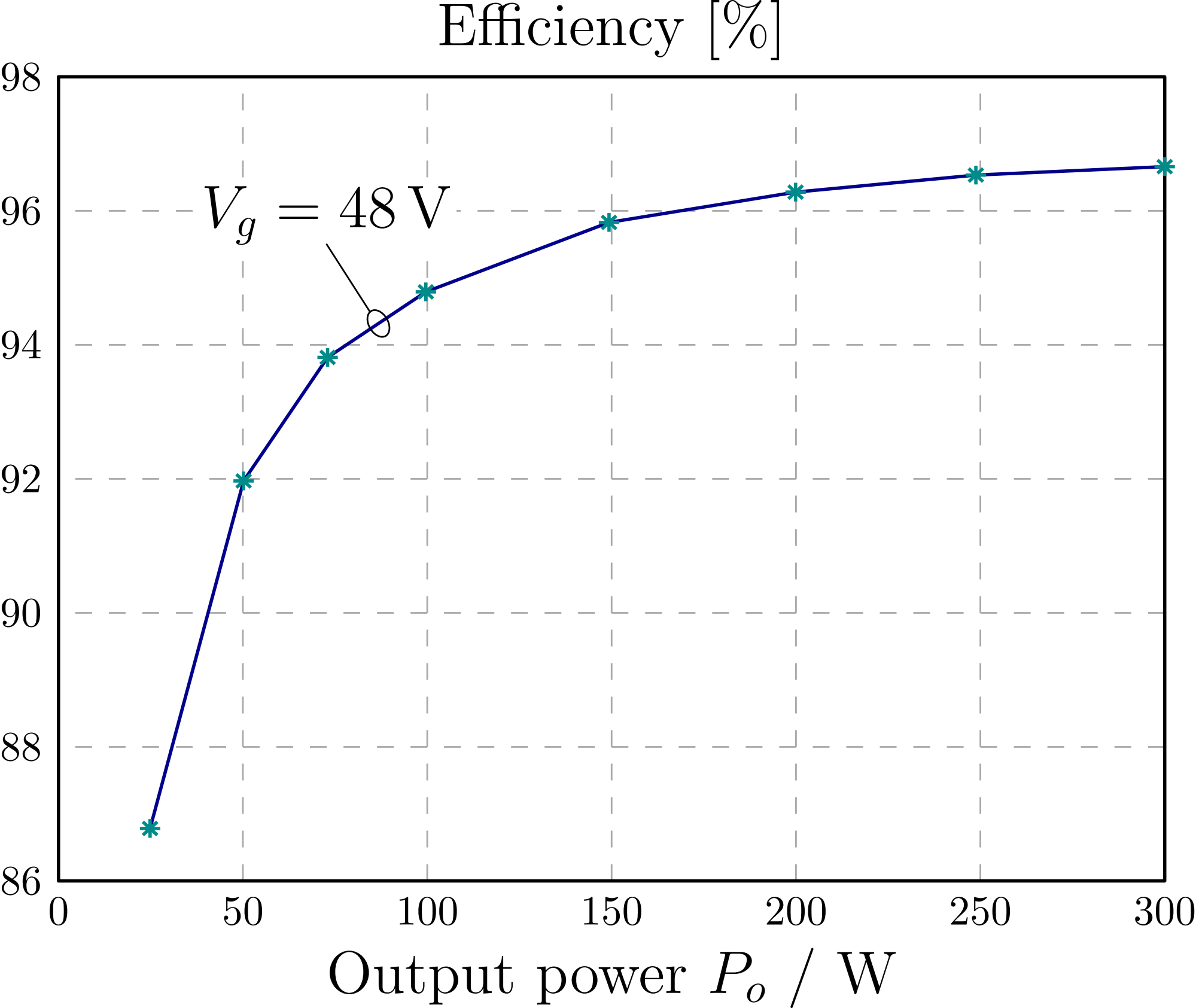

$v_{DS_a}(t)$ [25 V/div]
$v_{DS_b}(t)$ [25 V/div]
$i_m(t)$ [1 A/div]
$i_{L_b}(t)$ [1 A/div]
2018-11-23
10:55:23
Diagram1: Ch1,Ch2,Ch3,Ch4
5 A
4 A
3 A
2 A
1 A
0
-1 A
-2 A
-3 A
-5 A
-4 µs
-3 µs
-2 µs
-1 µs
0 s
1 µs
2 µs
3 µs
4 µs
5 µs
0
t_1
t_2
t_3
$T_s/2$
Time scale: 1 µs/div

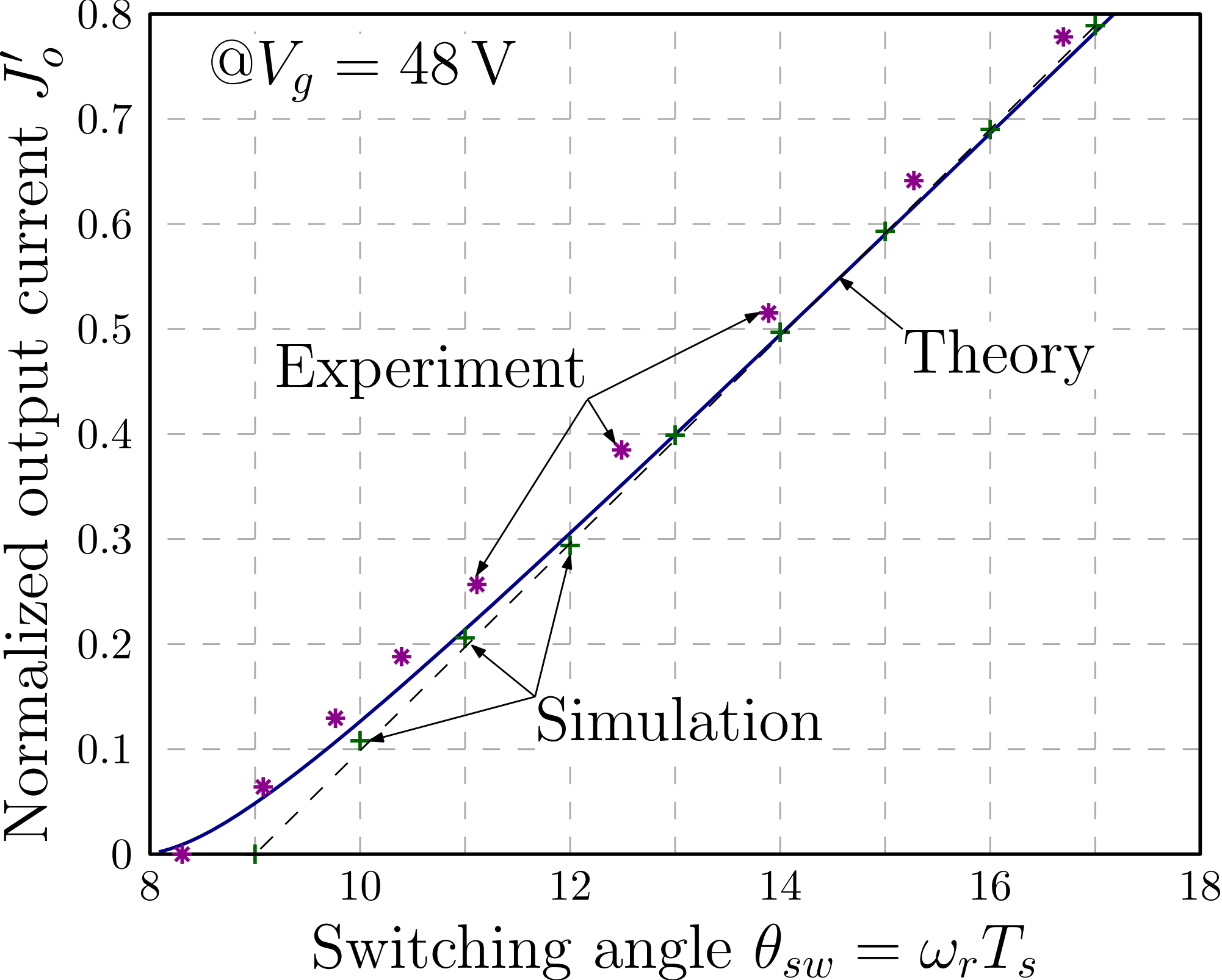


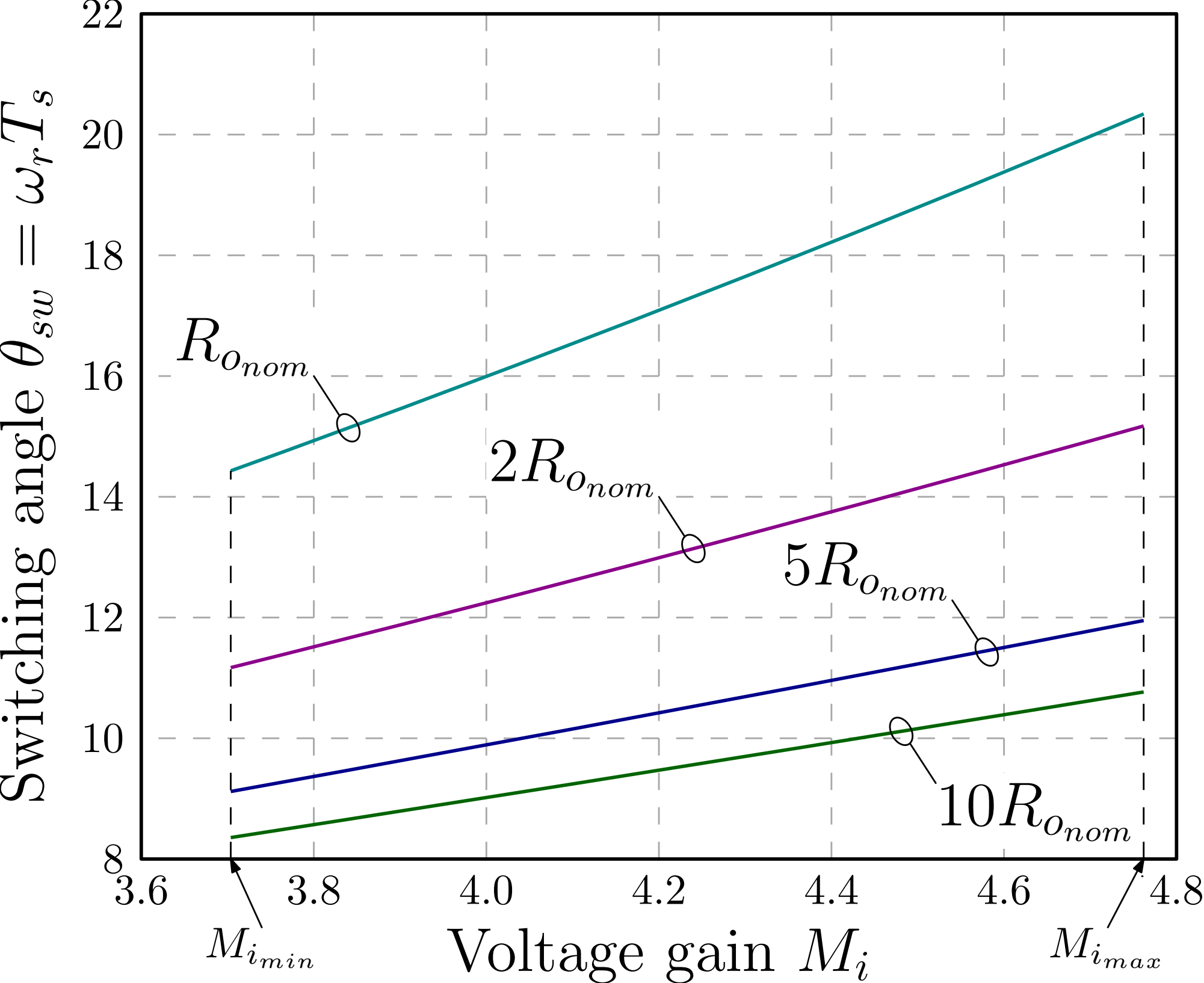
Time scale: 0.5 µs/div

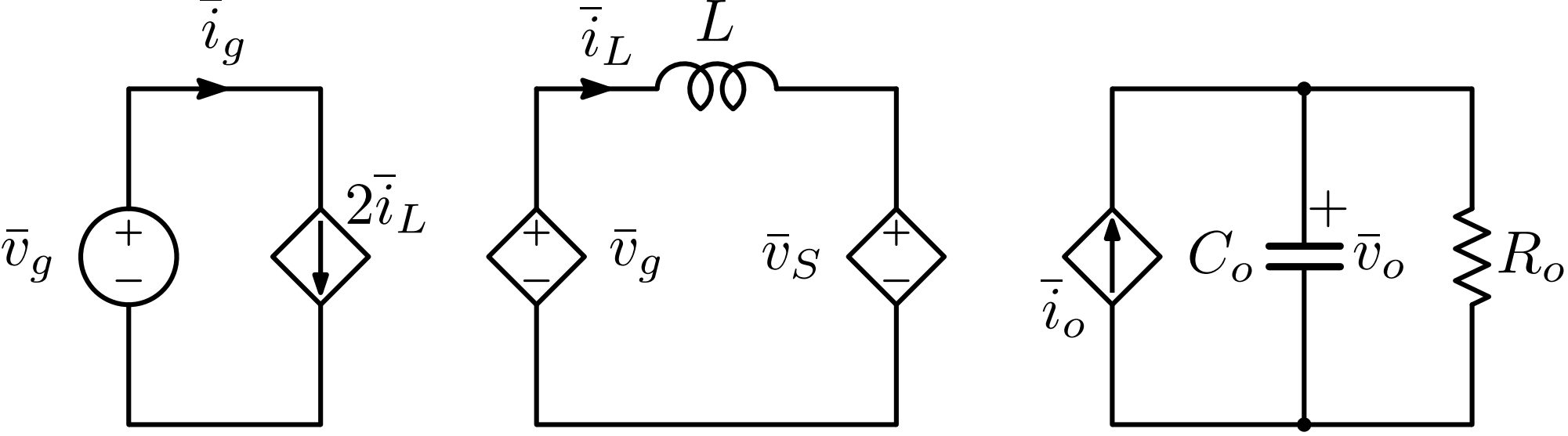

Output power P_o / W
0
50
100
150
200
250
300
98
96
94
92
90
88
86
97.2
97.0
96.8
96.6
96.4
96.2
96.0
Efficiency η / %
Efficiency η / %
(b)
(a)
42
44
46
48
50
52
54
Input voltage V_g / V

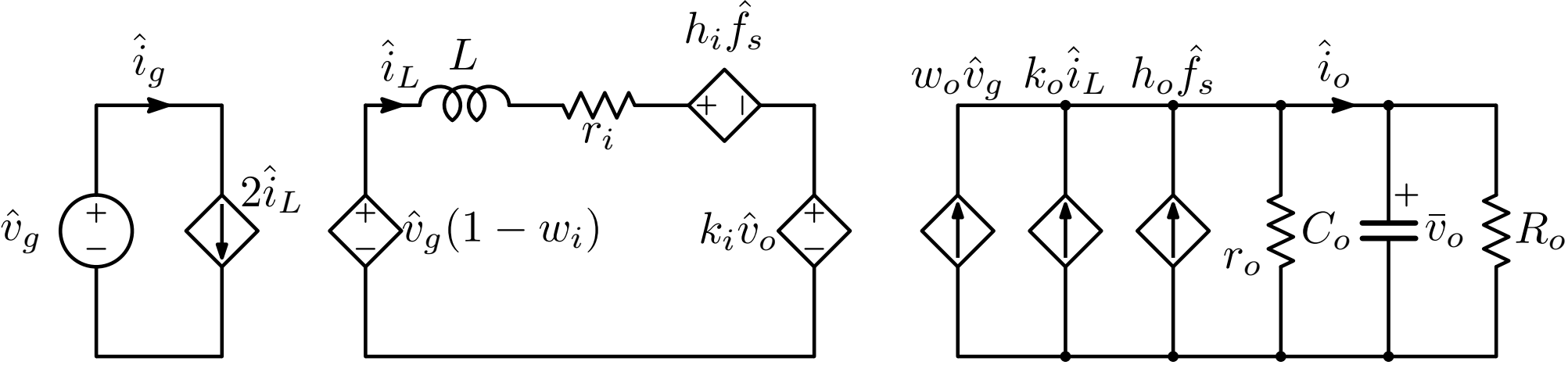

Efficiency [%]
97.2
97.0
96.8
96.6
96.4
96.2
96.0
$P_o = 300\,\mathrm{W}$
42
44
46
48
50
52
54
Input voltage V_g / V

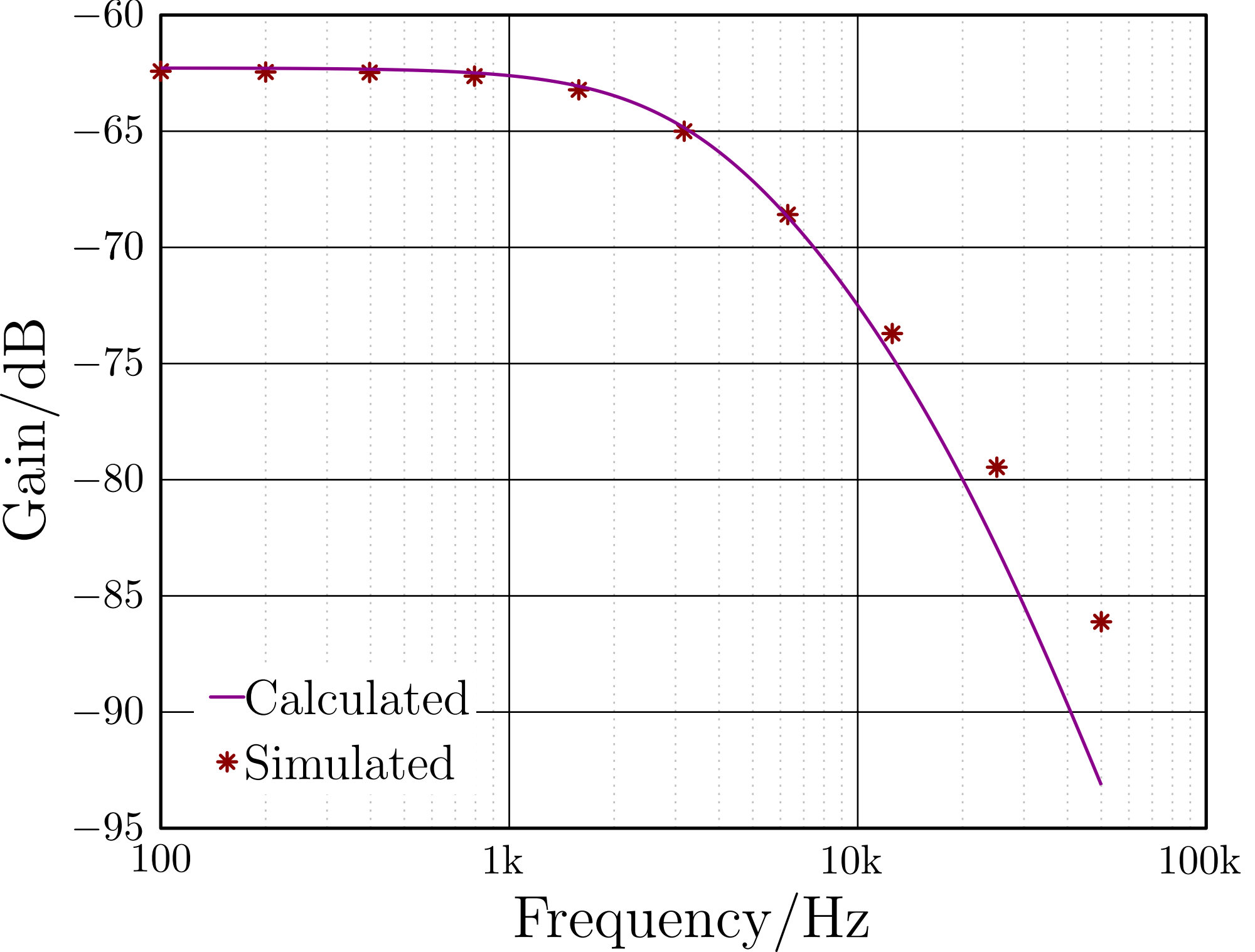

Efficiency [%]
98
96
94
92
90
88
86
$V_g = 48\,\mathrm{V}$
0
50
100
150
200
250
300
Output power P_o / W

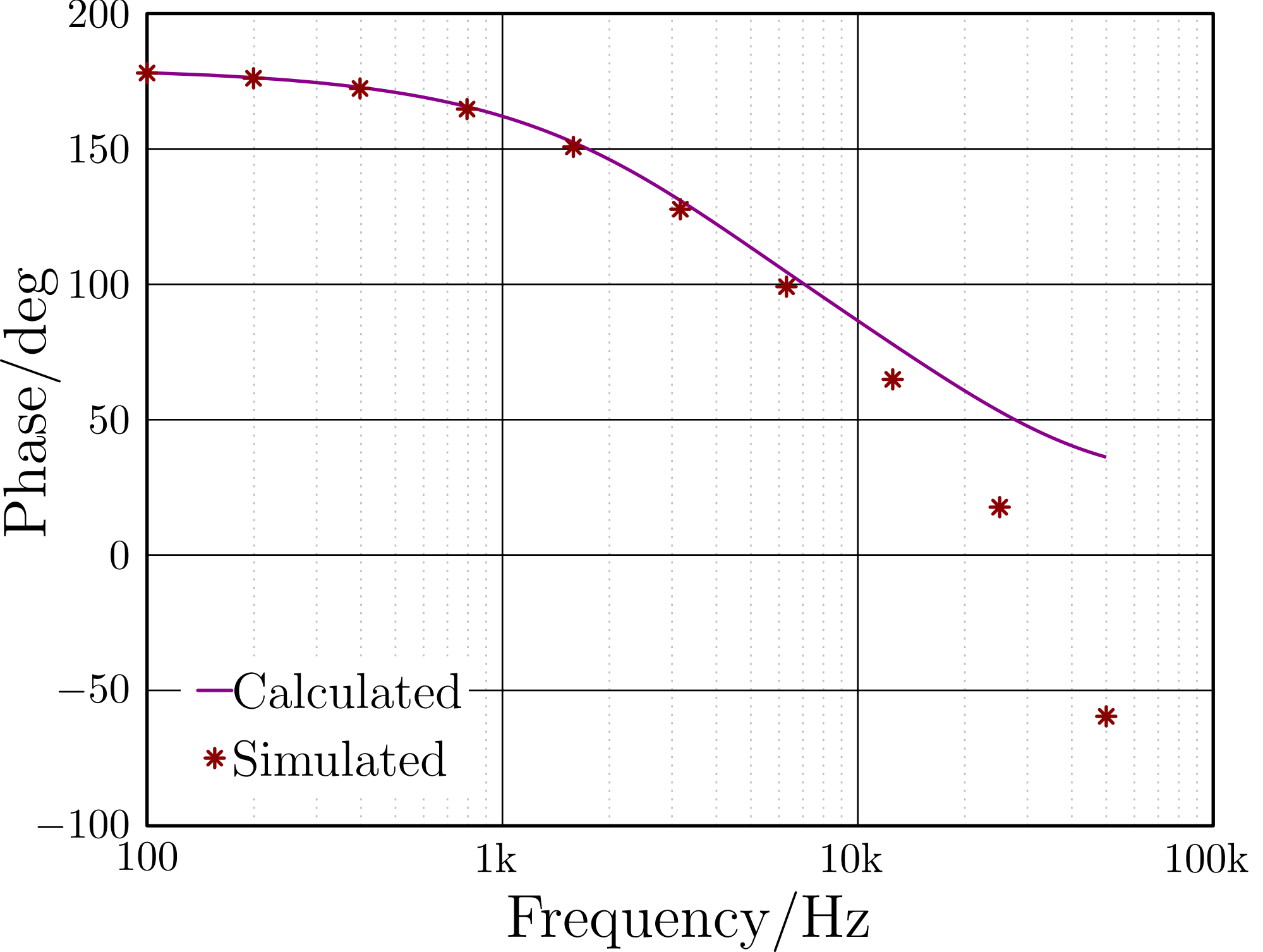

@$V_g = 48\,\mathrm{V}$
Experiment
Theory
Simulation
Normalized output current J'_o
Switching angle $\theta_{sw} = \omega_r T_s$
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
8
10
12
14
16
18

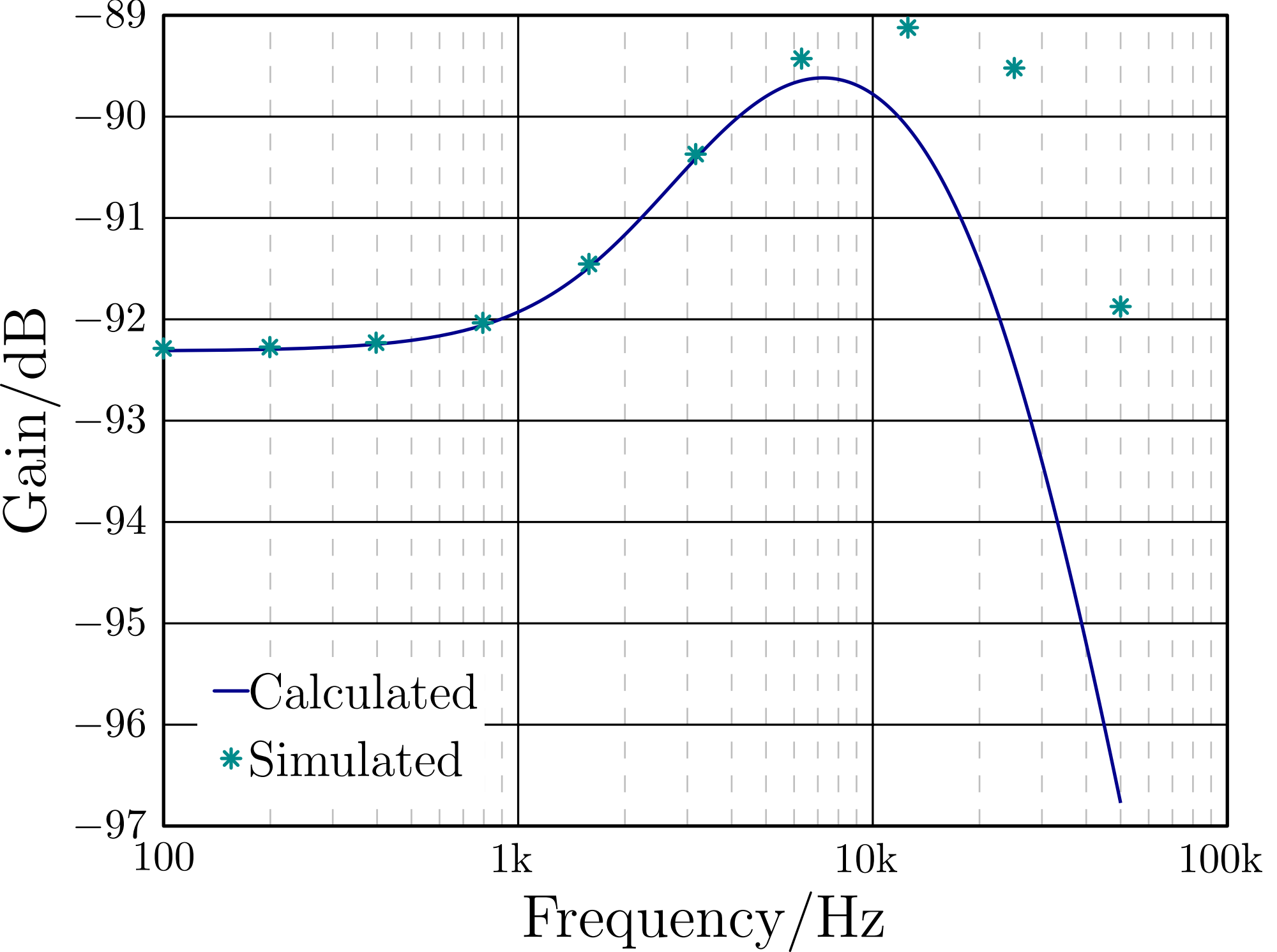

Switching angle $\theta_{sw} = \omega_r T_s$
22
20
18
16
14
12
10
8
3.6
3.8
4.0
4.2
4.4
4.6
4.8
$R_{o_{nom}}$
$2R_{o_{nom}}$
$5R_{o_{nom}}$
$10R_{o_{nom}}$
$M_{i_{min}}$
Voltage gain M_i
$M_{i_{max}}$

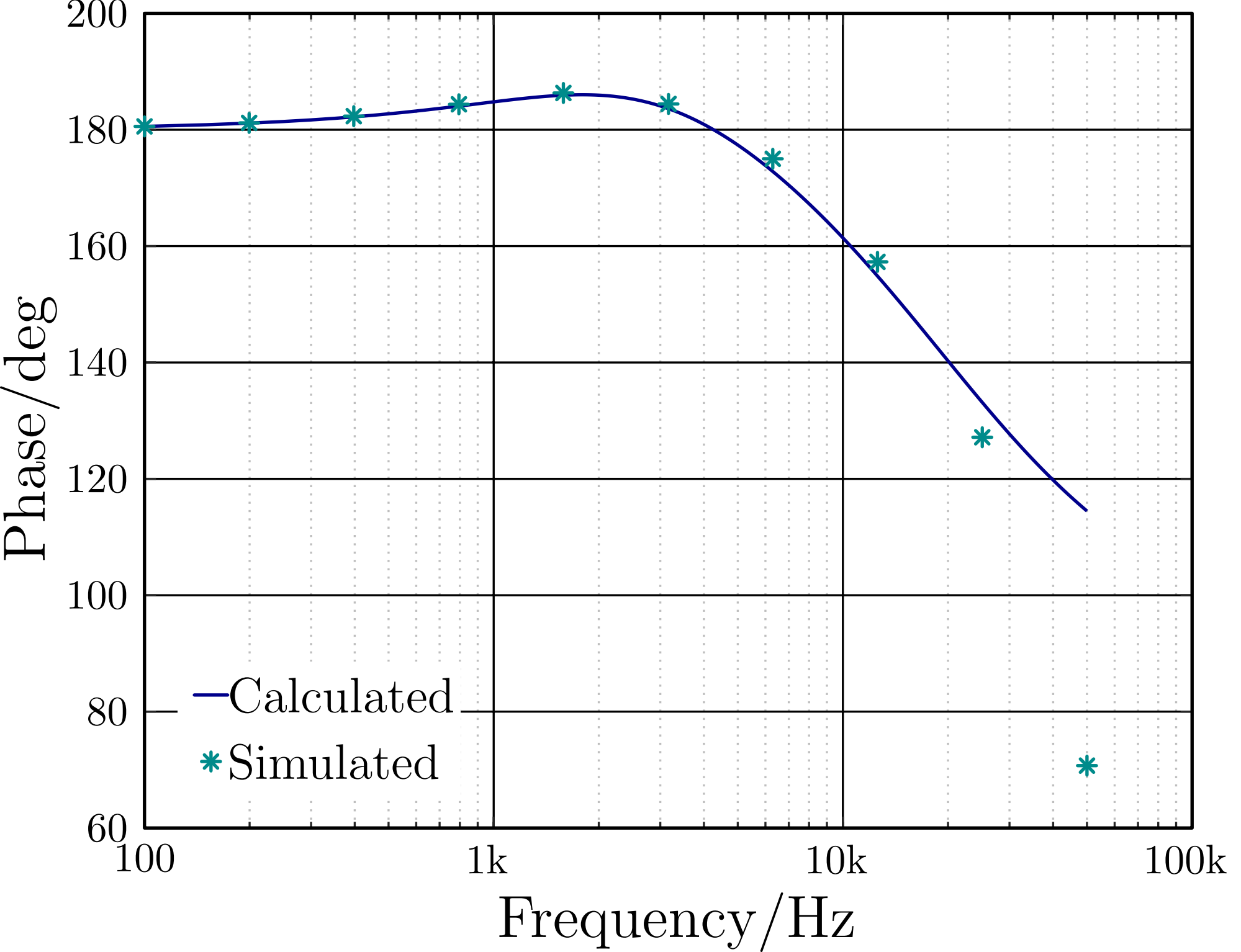

$\bar{i}_g$
$\bar{v}_g$
$2\bar{i}_L$
$\bar{i}_L$
L
$\bar{v}_g$
$\bar{v}_S$
$\bar{i}_o$
C_o
$\bar{v}_o$
R_o

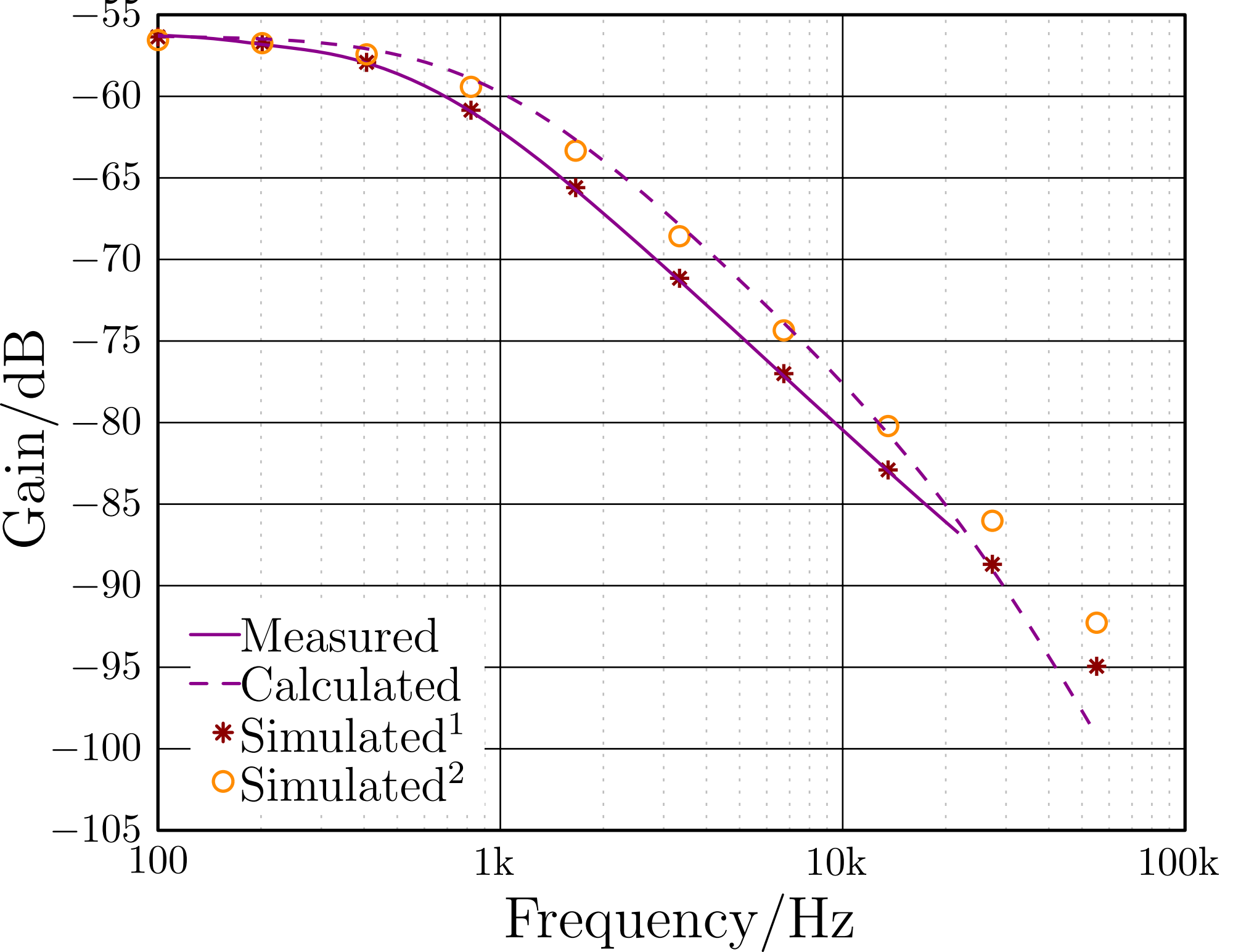

$\hat{i}_g$
$\hat{v}_g$
$2\hat{i}_L$
$\hat{i}_L$
L
r_i
$h_i\hat{f}_s$
$\hat{v}_g(1-w_i)$
$k_i\hat{v}_o$
$w_o\hat{v}_g$
$k_o\hat{i}_L$
$h_o\hat{f}_s$
$\hat{i}_o$
r_o
C_o
$\bar{v}_o$
R_o

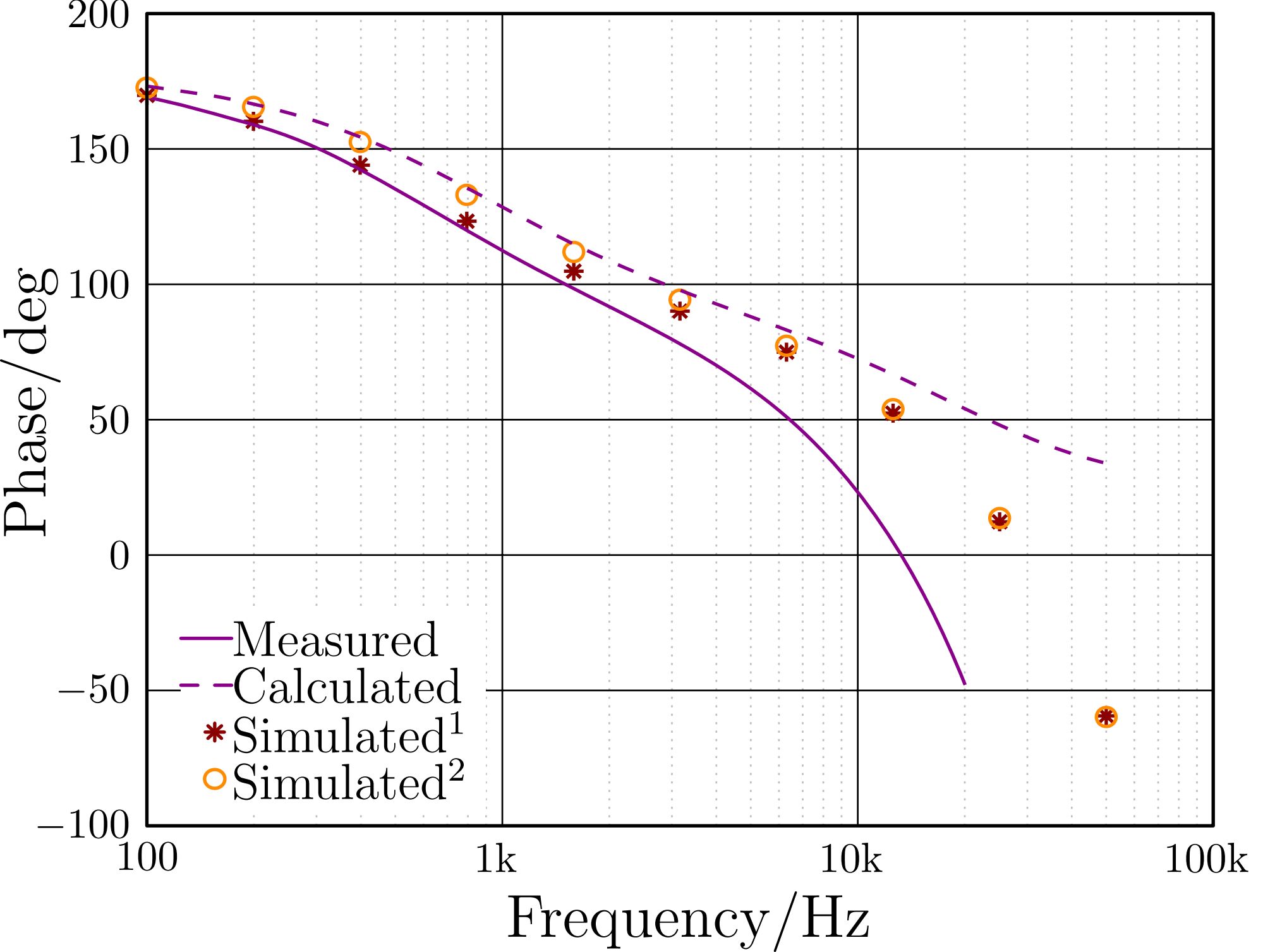

−60
−65
−70
−75
−80
−85
−90
−95
Gain/dB
100
1k
10k
100k
Frequency/Hz
Calculated
Simulated

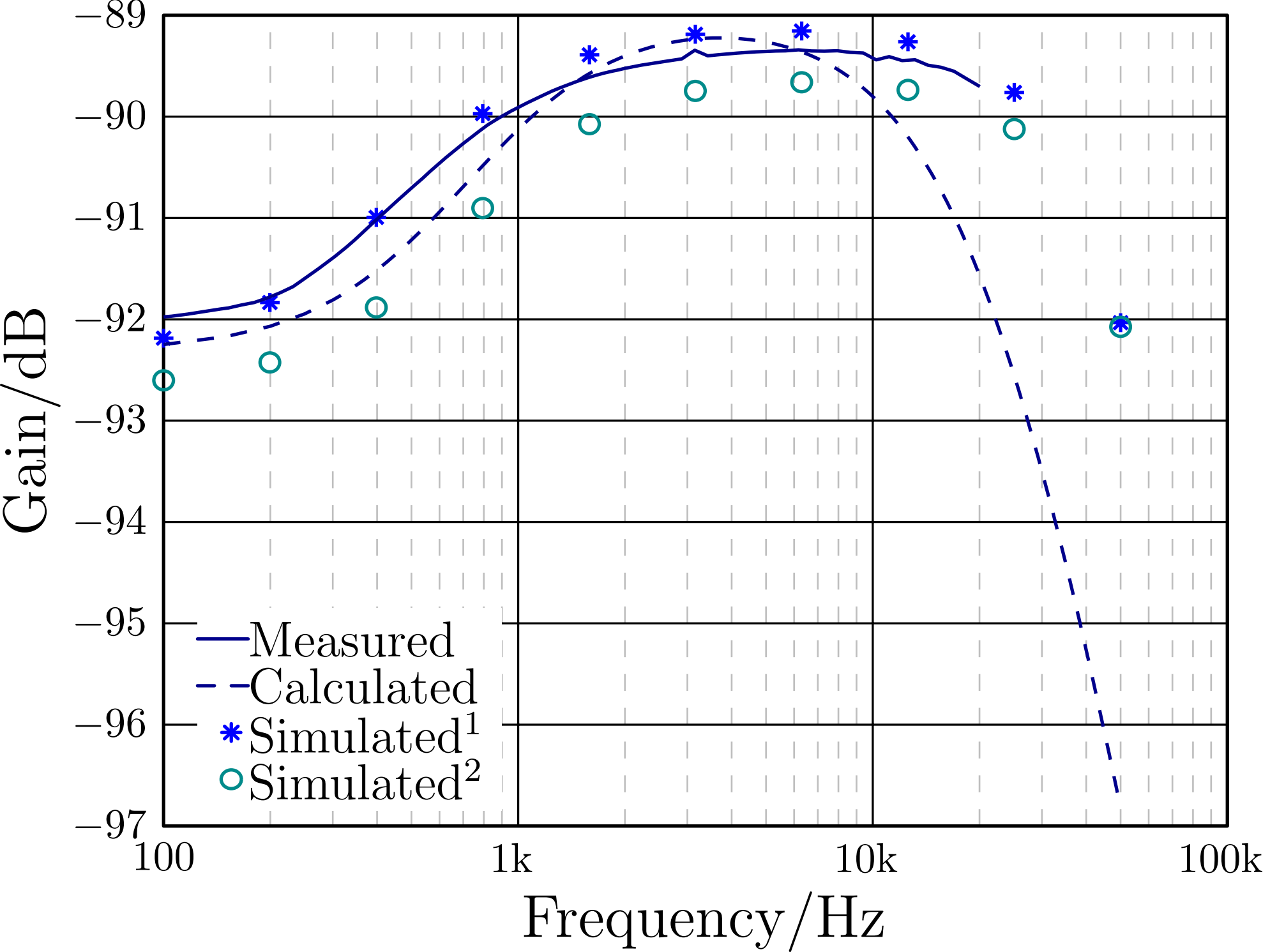

200
150
100
50
0
−50
−100
Phase/deg
100
1k
10k
100k
Frequency/Hz
Calculated
Simulated

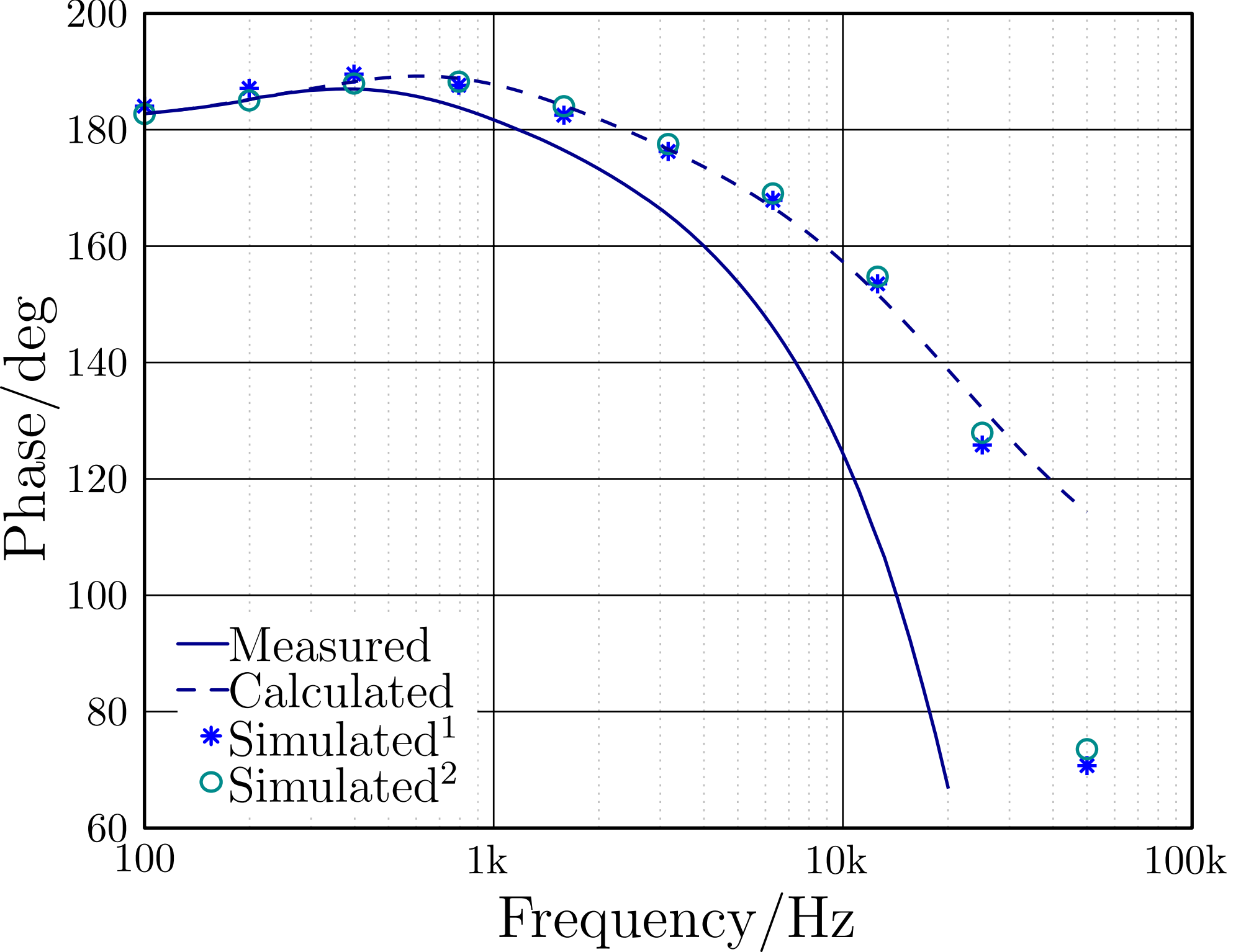

−89
−90
−91
−92
−93
−94
−95
−96
−97
Gain/dB
100
1k
10k
100k
Frequency/Hz
Calculated
Simulated

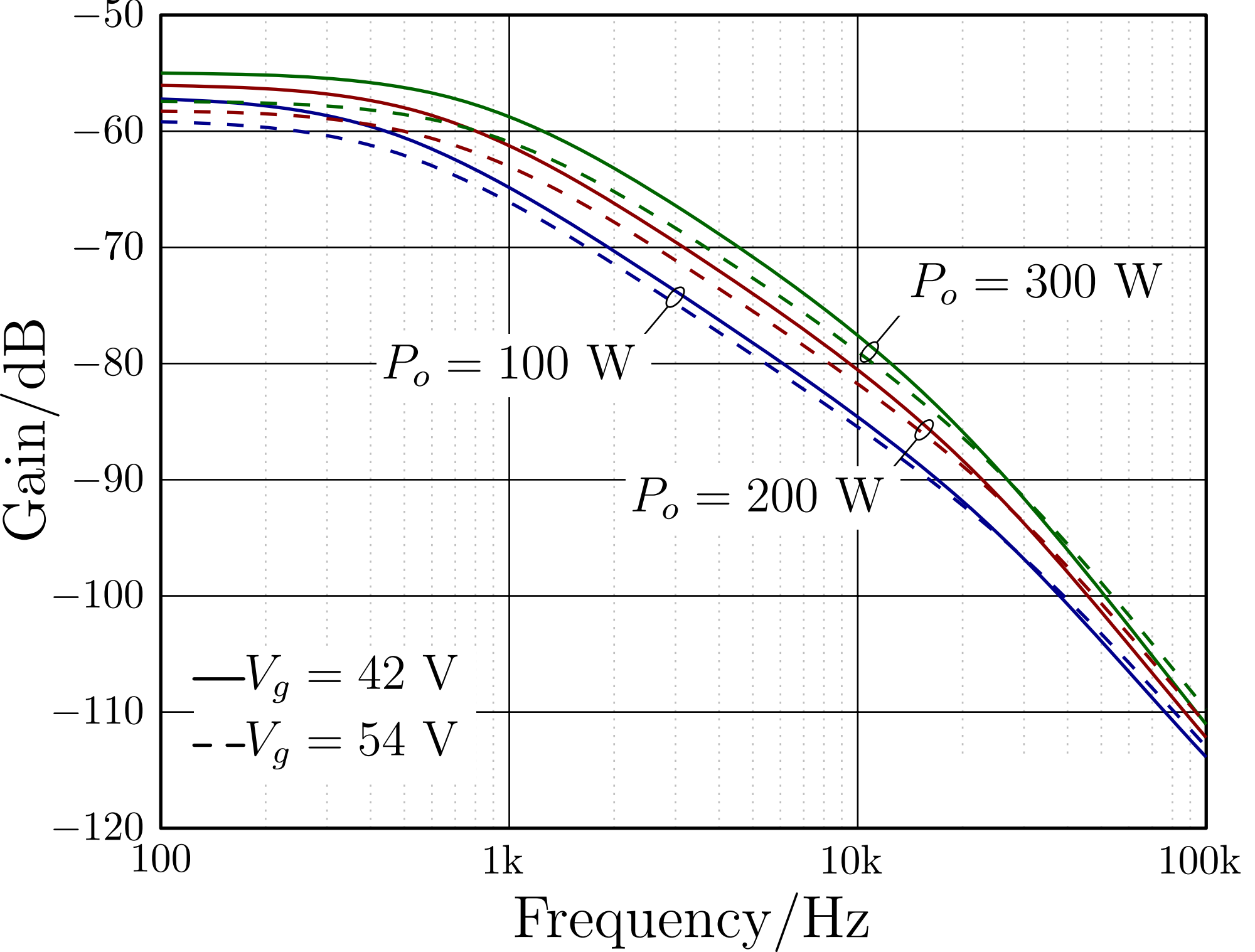

200
180
160
140
120
100
80
60
Phase/deg
100
1k
10k
100k
Frequency/Hz
Calculated
Simulated

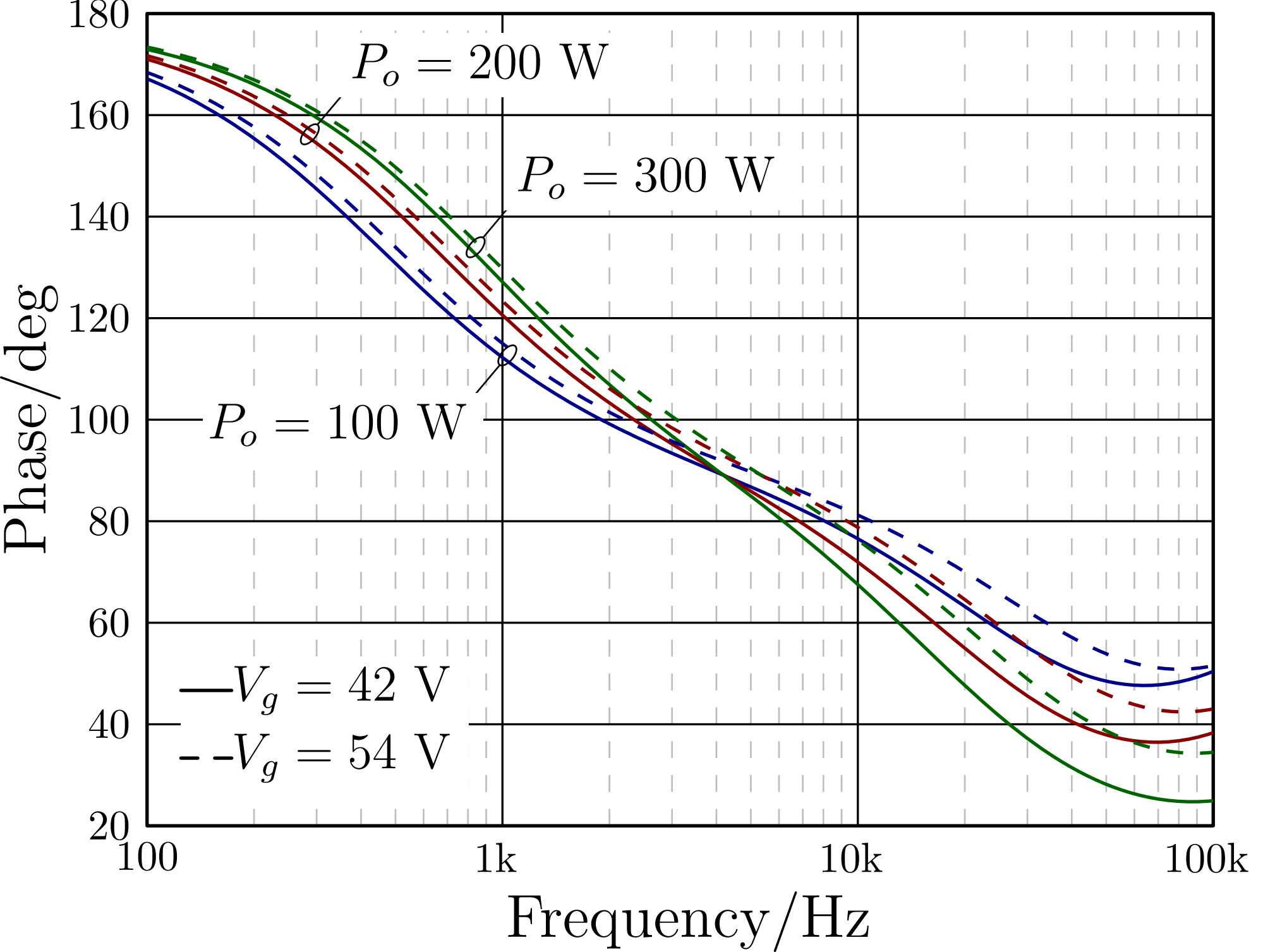

−55
−60
−65
−70
−75
−80
−85
−90
−95
−100
−105
Gain/dB
100
1k
10k
100k
Frequency/Hz
Measured
Calculated
Simulated[1]
Simulated[2]

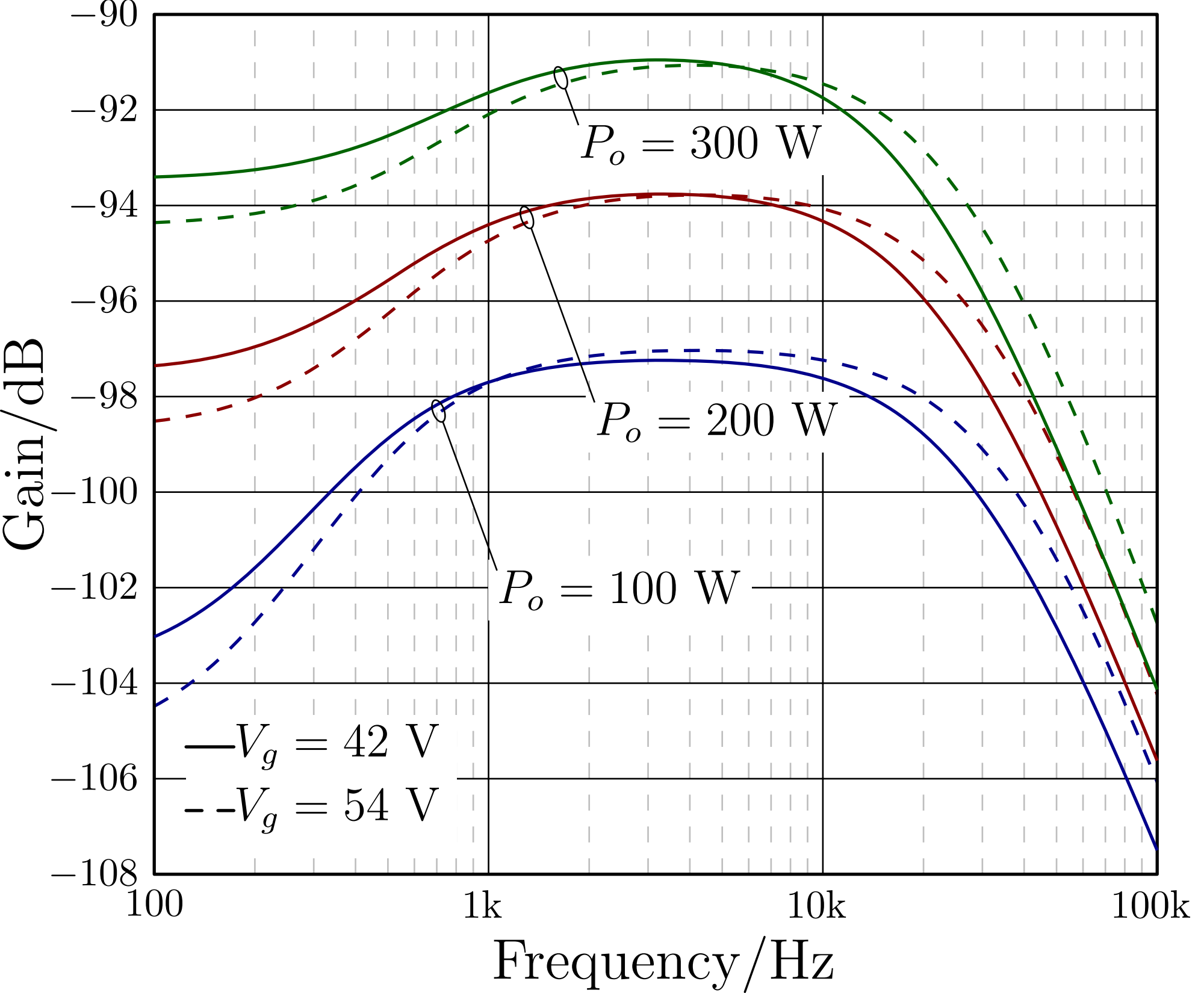

200
150
100
50
0
−50
−100
Phase/deg
100
1k
10k
100k
Frequency/Hz
Measured
Calculated
Simulated[1]
Simulated[2]

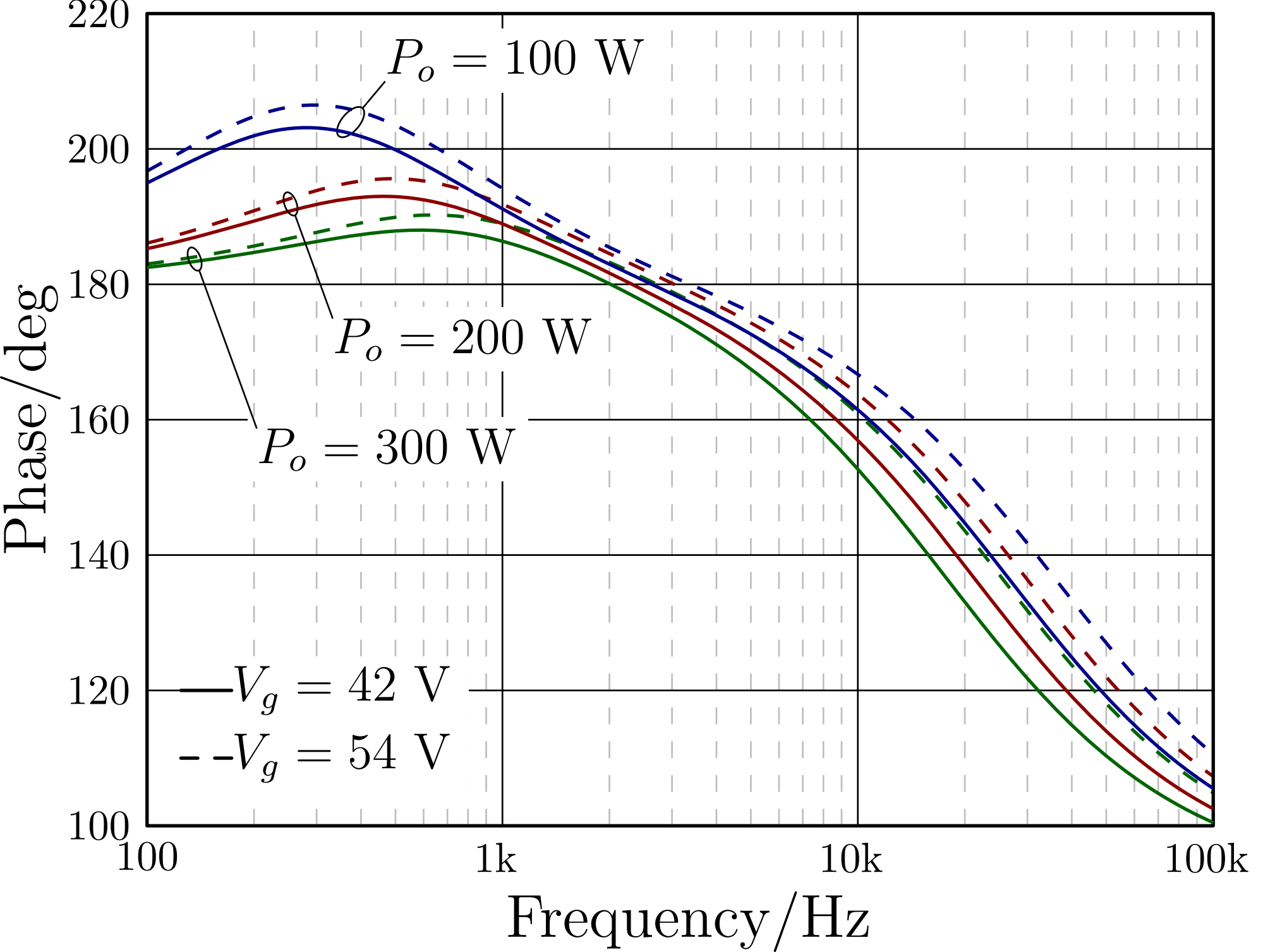

−89
−90
−91
−92
−93
−94
−95
−96
−97
Gain/dB
100
1k
10k
100k
Frequency/Hz
Measured
Calculated
Simulated[1]
Simulated[2]

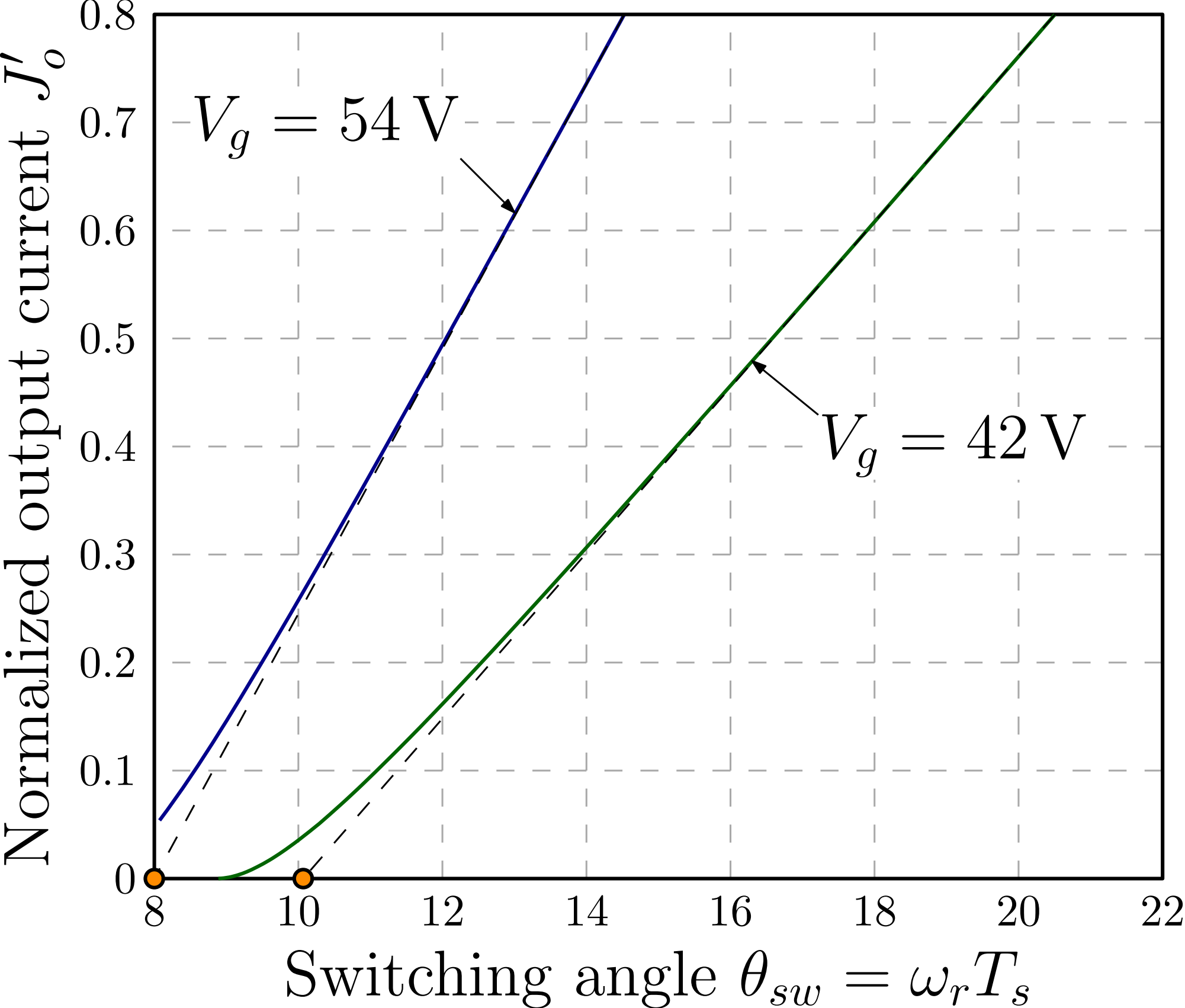

200
180
160
140
120
100
80
60
Phase/deg
100
1k
10k
100k
Frequency/Hz
Measured
Calculated
Simulated[1]
Simulated[2]

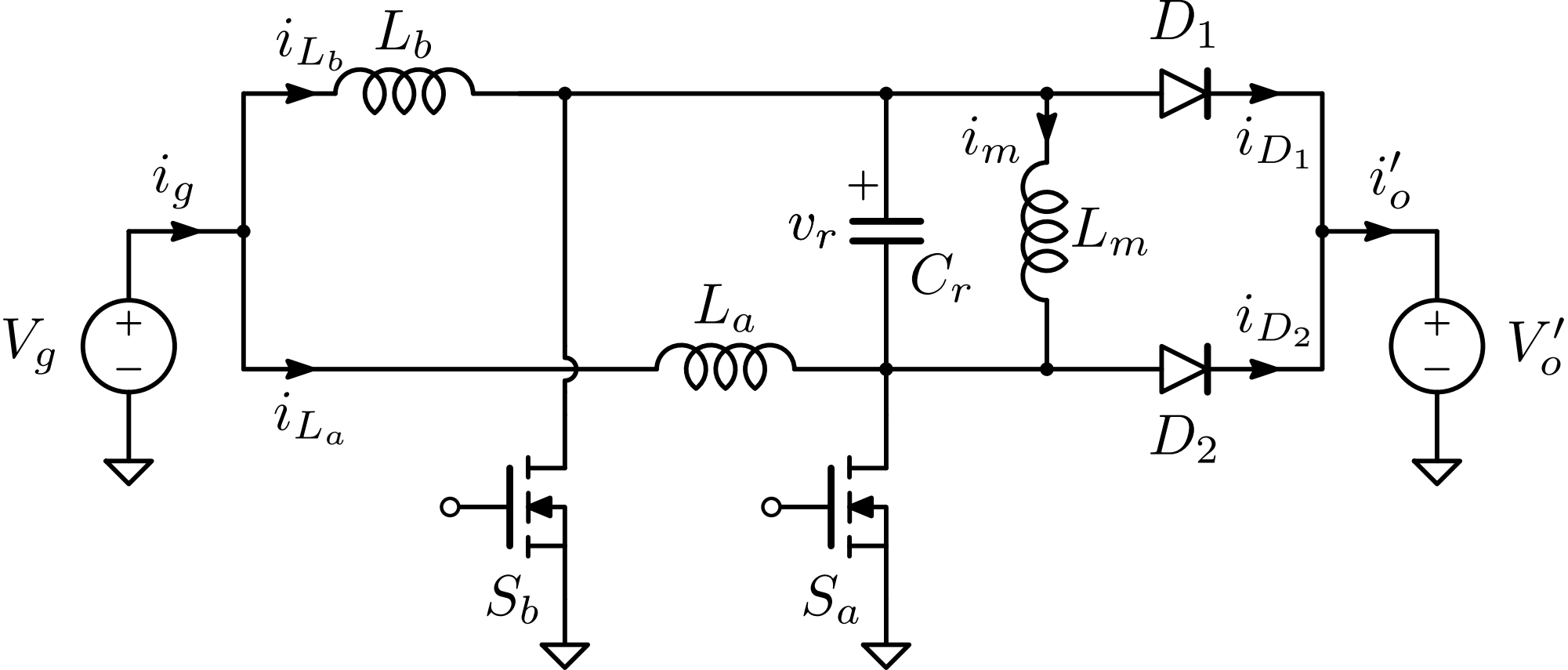

−50
−60
−70
−80
−90
−100
−110
−120
Gain/dB
100
1k
10k
100k
Frequency/Hz
$P_o = 300$ W
$P_o = 100$ W
$P_o = 200$ W
—$V_g = 42$ V
- -$V_g = 54$ V

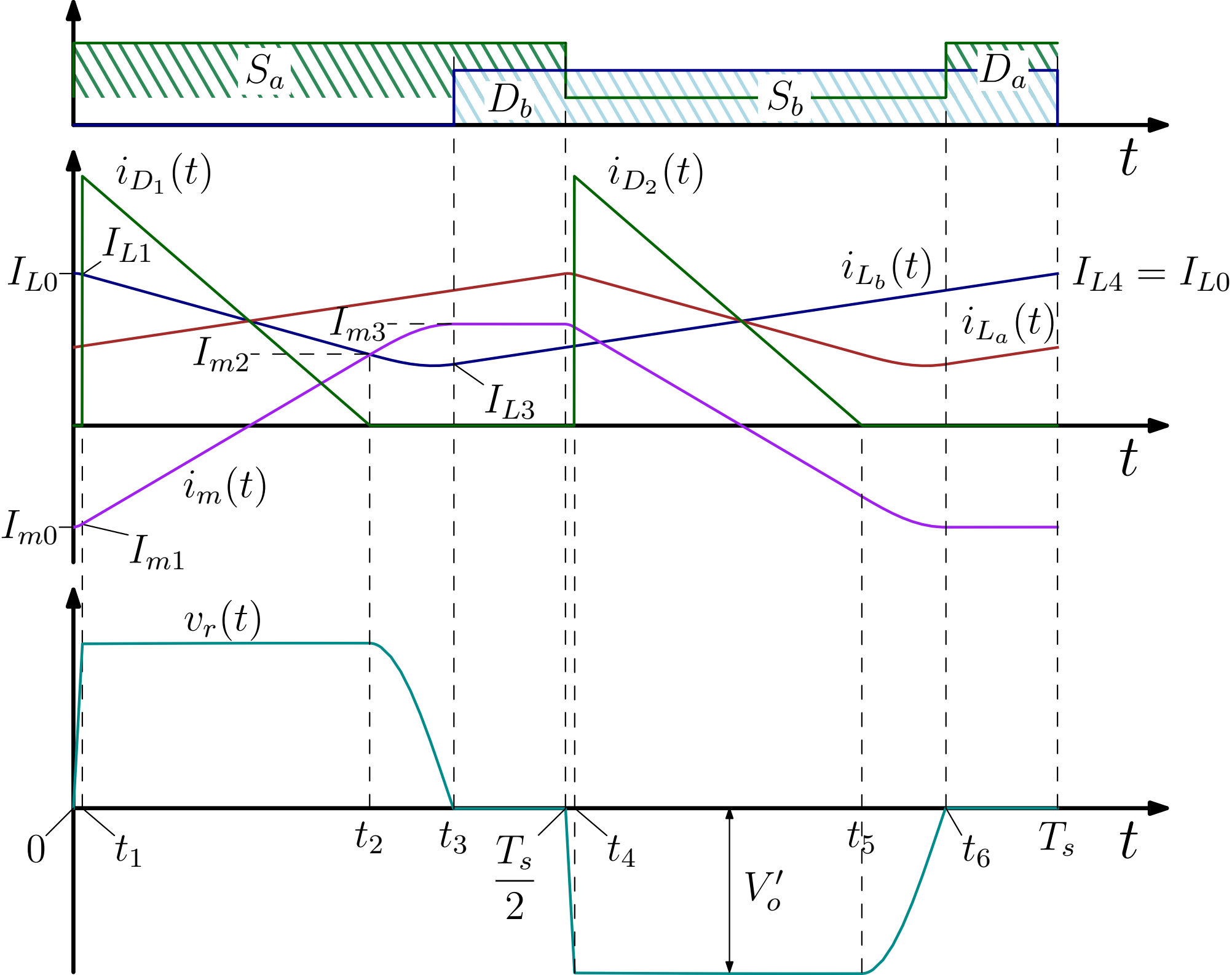

180
160
140
120
100
80
60
40
20
Phase/deg
100
1k
10k
100k
Frequency/Hz
$P_o = 200$ W
$P_o = 300$ W
$P_o = 100$ W
—$V_g = 42$ V
– –$V_g = 54$ V

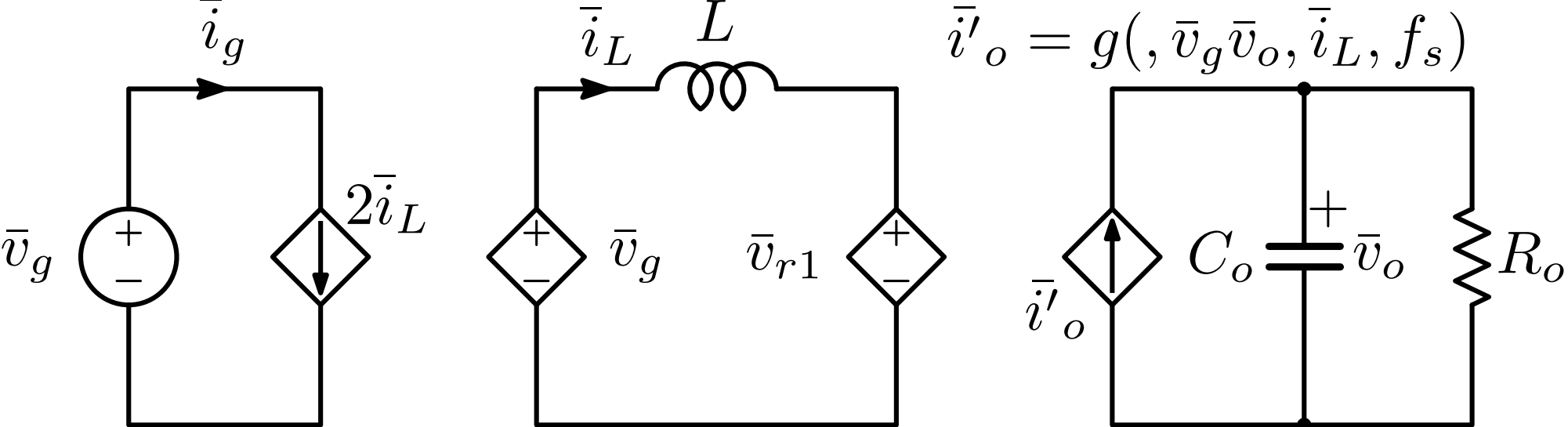

−90
−92
−94
−96
−98
−100
−102
−104
−106
−108
Gain/dB
100
1k
10k
100k
Frequency/Hz
$P_o = 300$ W
$P_o = 200$ W
$P_o = 100$ W
—$V_g = 42$ V
– –$V_g = 54$ V

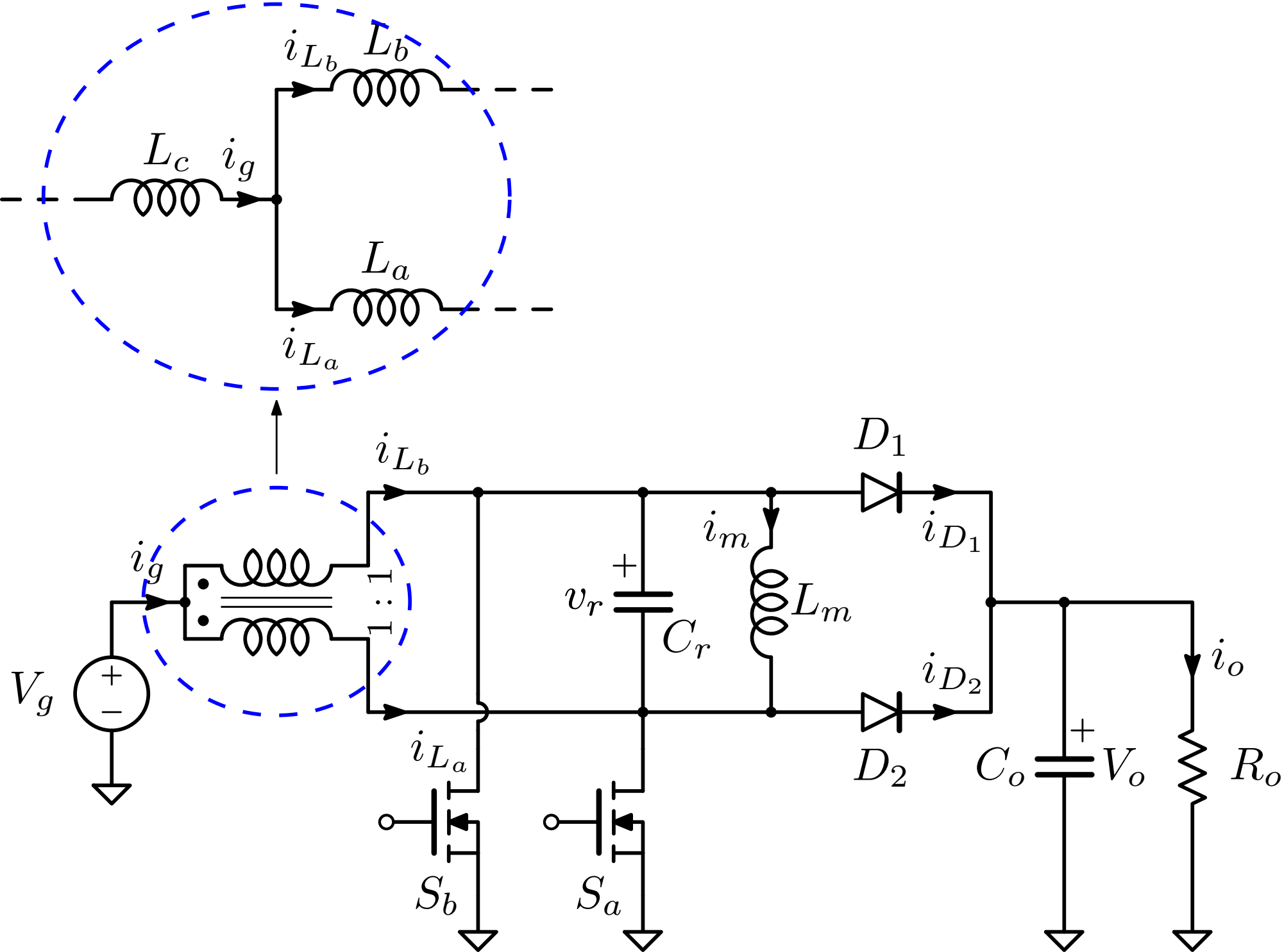

220
200
180
160
140
120
100
Phase/deg
100
1k
10k
100k
Frequency/Hz
$P_o = 100$ W
$P_o = 200$ W
$P_o = 300$ W
—$V_g = 42$ V
– –$V_g = 54$ V

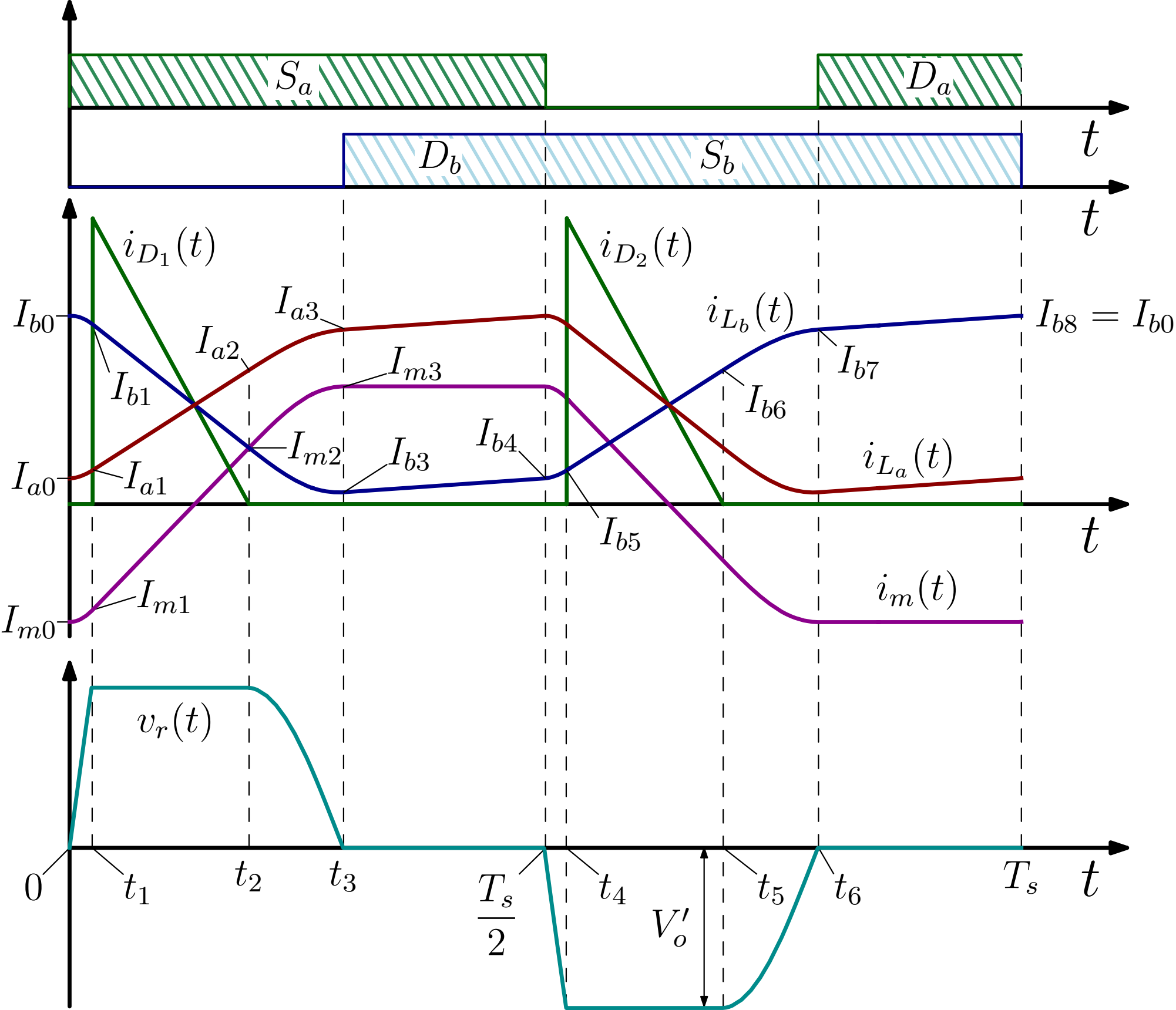

$V_g = 54\,\mathrm{V}$
$V_g = 42\,\mathrm{V}$
Normalized output current J'_o
Switching angle $\theta_{sw} = \omega_r T_s$
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
8
10
12
14
16
18
20
22

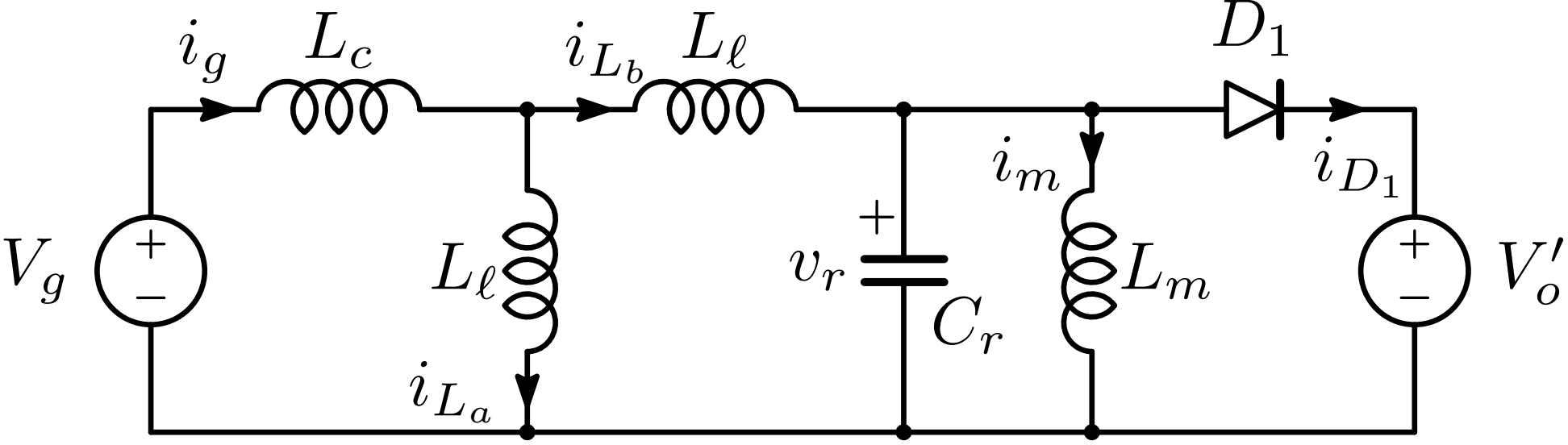

i_{L_b}
L_b
D_1
i_g
i_m
i_{D_1}
i'_o
v_r
C_r
L_m
V_g
L_a
i_{D_2}
V'_o
i_{L_a}
D_2
S_b
S_a

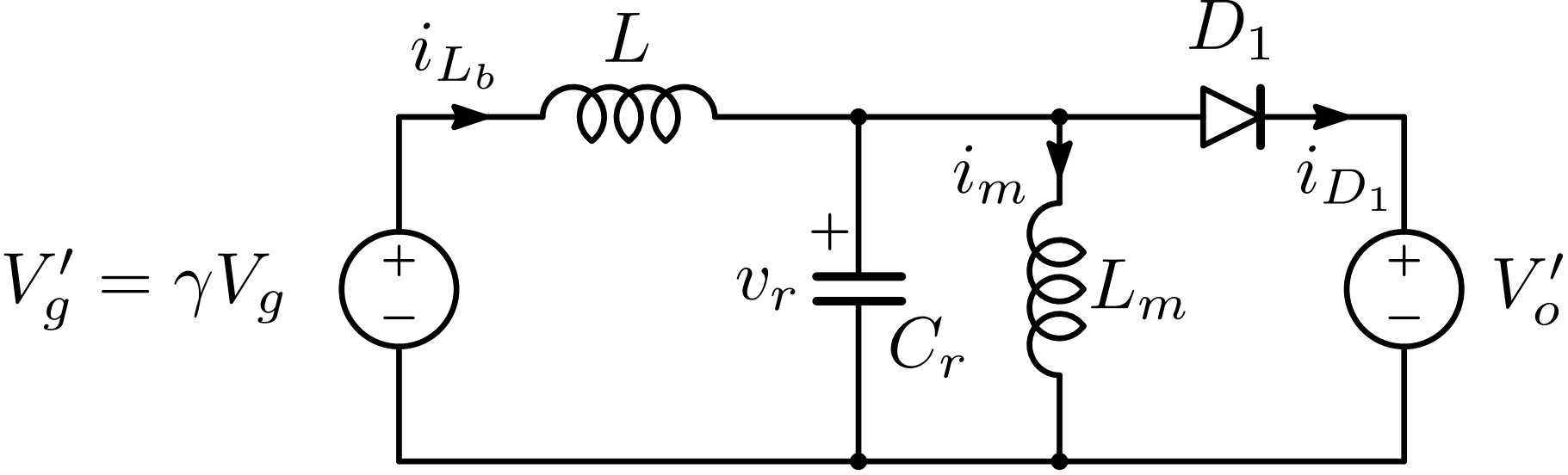

S_a
D_b
S_b
D_a
t
$i_{D_1}(t)$
$i_{D_2}(t)$
I_{L1}
I_{L0}
$i_{L_b}(t)$
$I_{L4} = I_{L0}$
I_{m3}
I_{m2}
$i_{L_a}(t)$
I_{L3}
t
$i_m(t)$
I_{m0}
I_{m1}
$v_r(t)$
0
t_1
t_2
t_3
$\frac{T_s}{2}$
t_4
V_o'
t_5
t_6
T_s
t

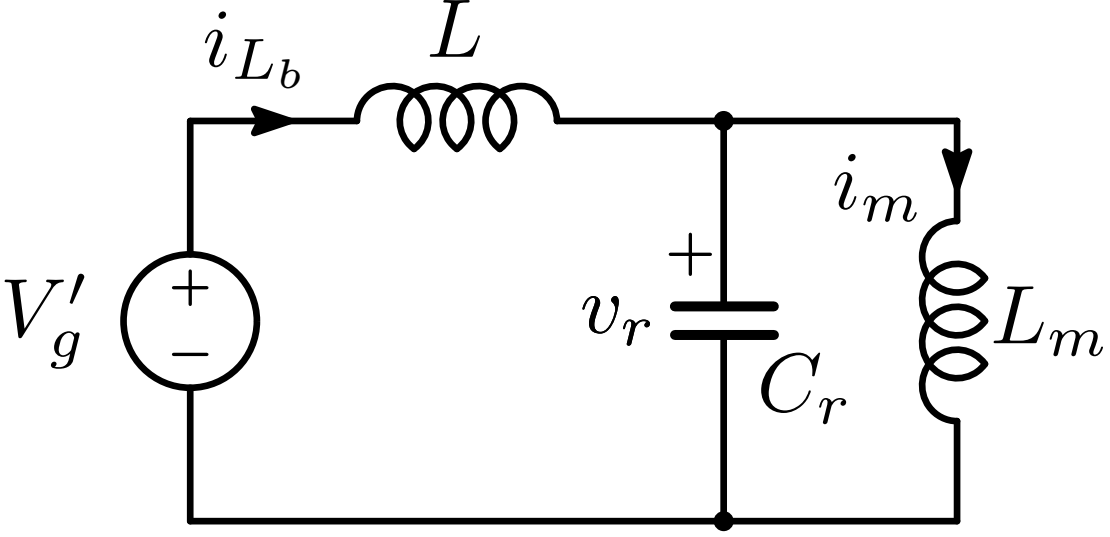

$\bar{i}_g$
$\bar{v}_g$
$2\bar{i}_L$
$\bar{i}_L$
L
$\bar{v}_g$
$\bar{v}_{r1}$
$\bar{i}'_o = g(, \bar{v}_g \bar{v}_o, \bar{i}_L, f_s)$
$\bar{i}'_o$
C_o
$\bar{v}_o$
R_o
$\bar{v}_{r1} = f(, \bar{v}_g \bar{v}_o, \bar{i}_L, f_s)$

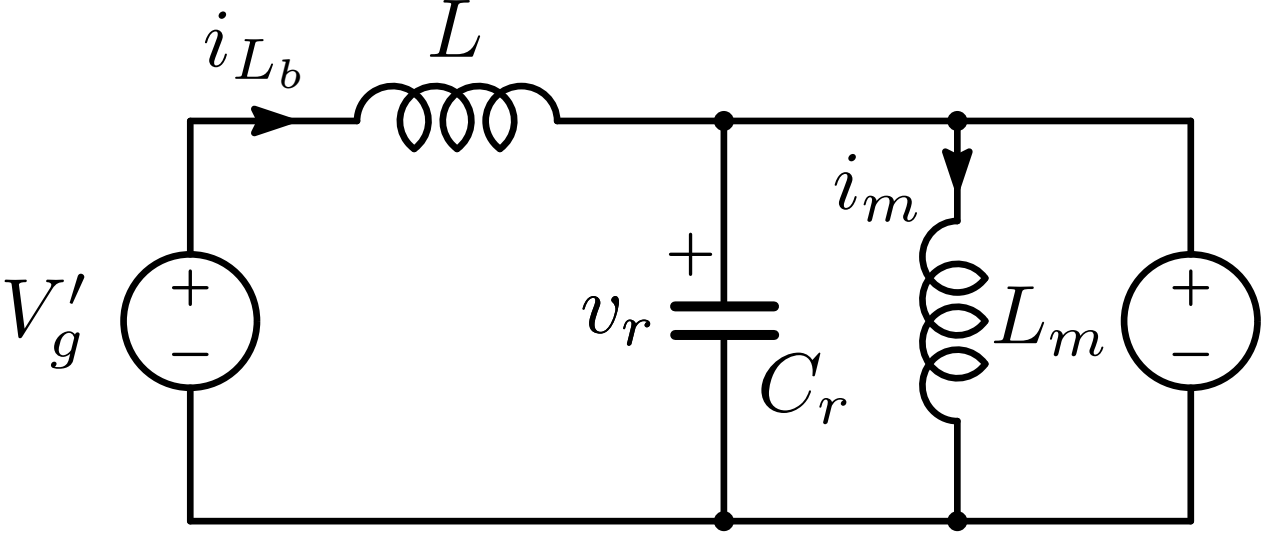

i_{L_b}
L_b
L_c
i_g
L_a
i_{L_a}
i_{L_b}
D_1
i_g
1 : 1
v_r
C_r
i_m
L_m
i_{D_1}
i_{D_2}
i_o
V_g
i_{L_a}
D_2
C_o
V_o
R_o
S_b
S_a

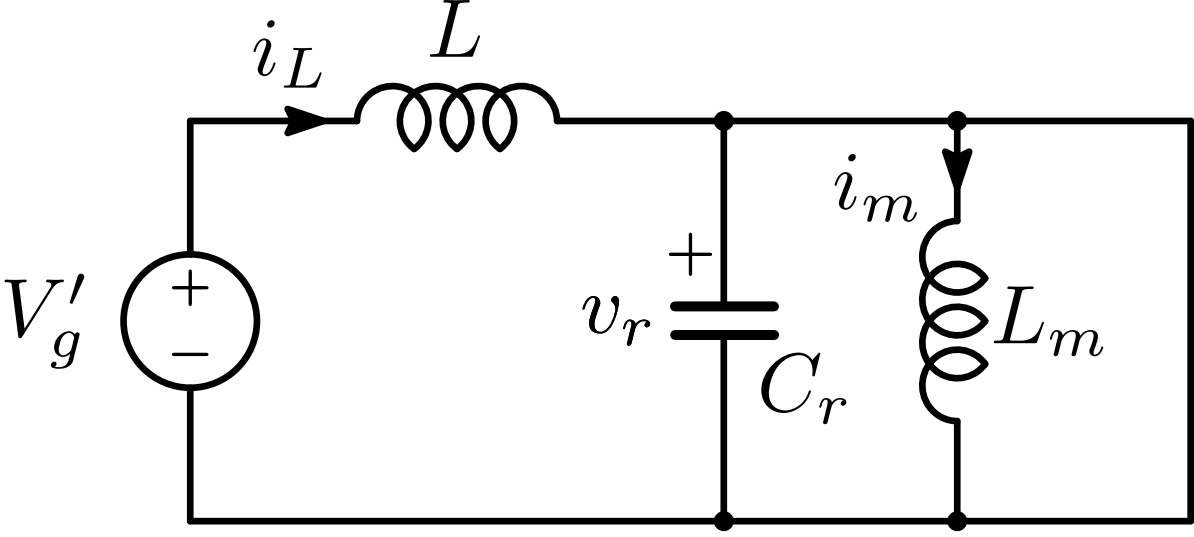

S_a
D_a
t
D_b
S_b
t
$i_{D_1}(t)$
$i_{D_2}(t)$
I_{b0}
I_{a3}
$i_{L_b}(t)$
$I_{b8} = I_{b0}$
I_{a2}
I_{m3}
I_{b7}
I_{b1}
I_{b6}
I_{m2}
I_{b3}
I_{b4}
$i_{L_a}(t)$
I_{a0}
I_{a1}
t
I_{b5}
$i_m(t)$
I_{m1}
I_{m0}
$v_r(t)$
0
t_1
t_2
t_3
$\frac{T_s}{2}$
t_4
V_o'
t_5
t_6
T_s
t

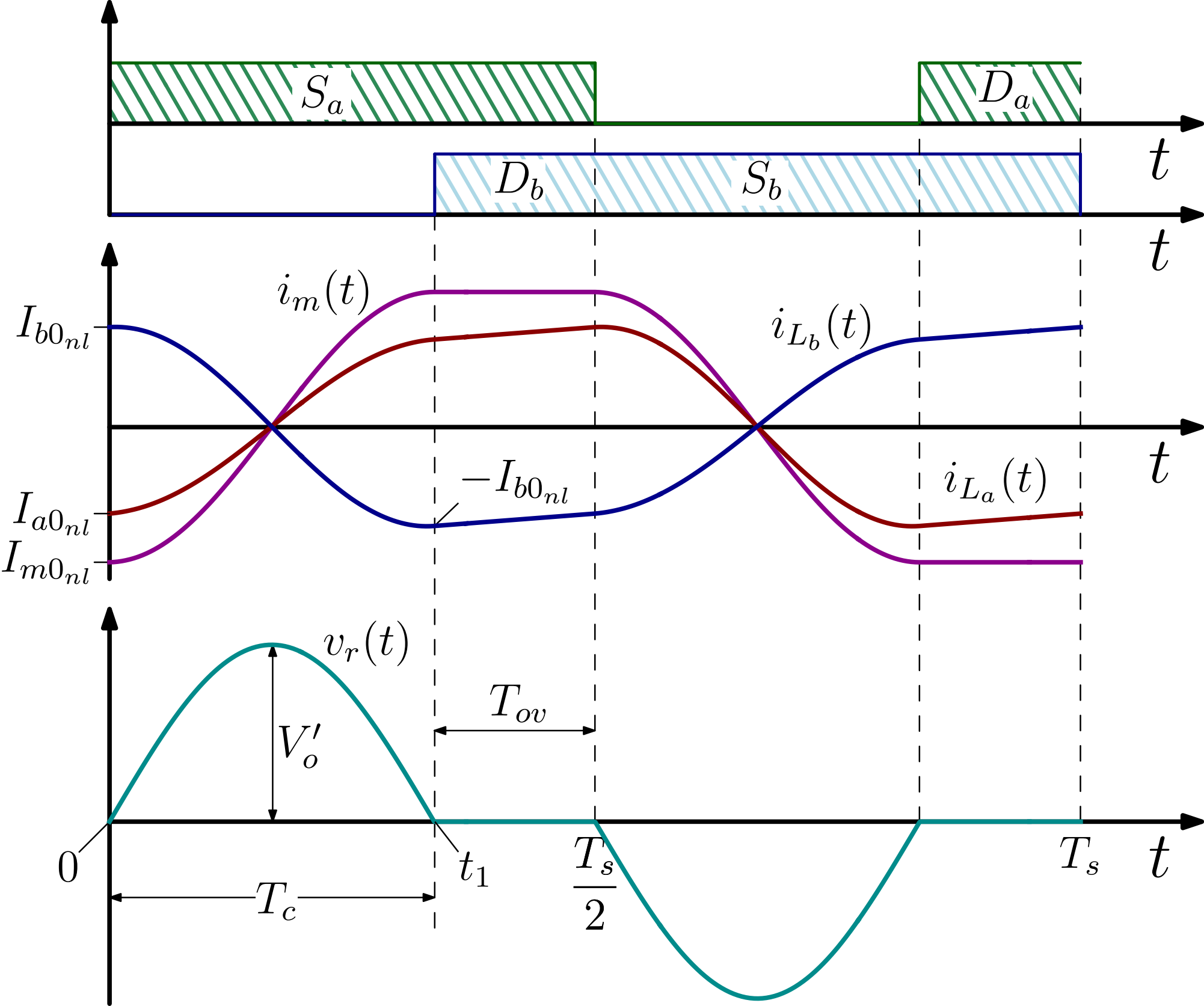

i_g
L_c
i_{L_b}
L_ℓ
D_1
i_m
i_{D_1}
V_g
L_ℓ
v_r
C_r
L_m
V_o'
i_{L_a}

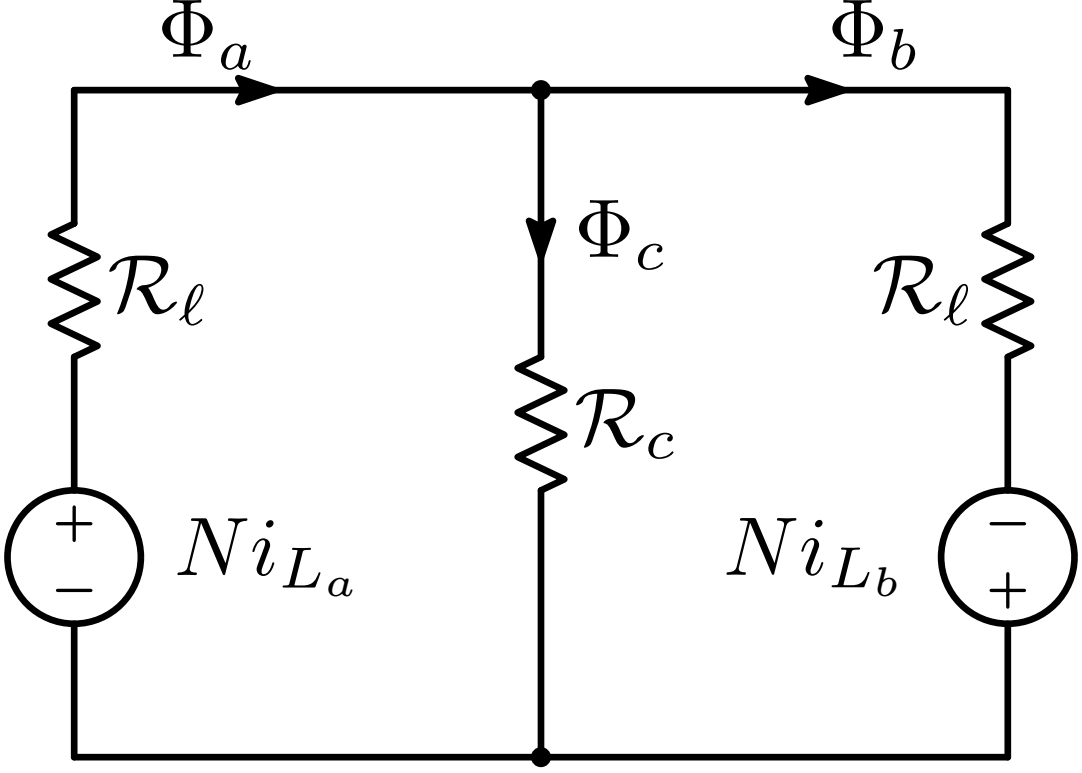

i_{L_b}
L
D_1
i_m
i_{D_1}
$V_g' = \gamma V_g$
v_r
C_r
L_m
V_o'

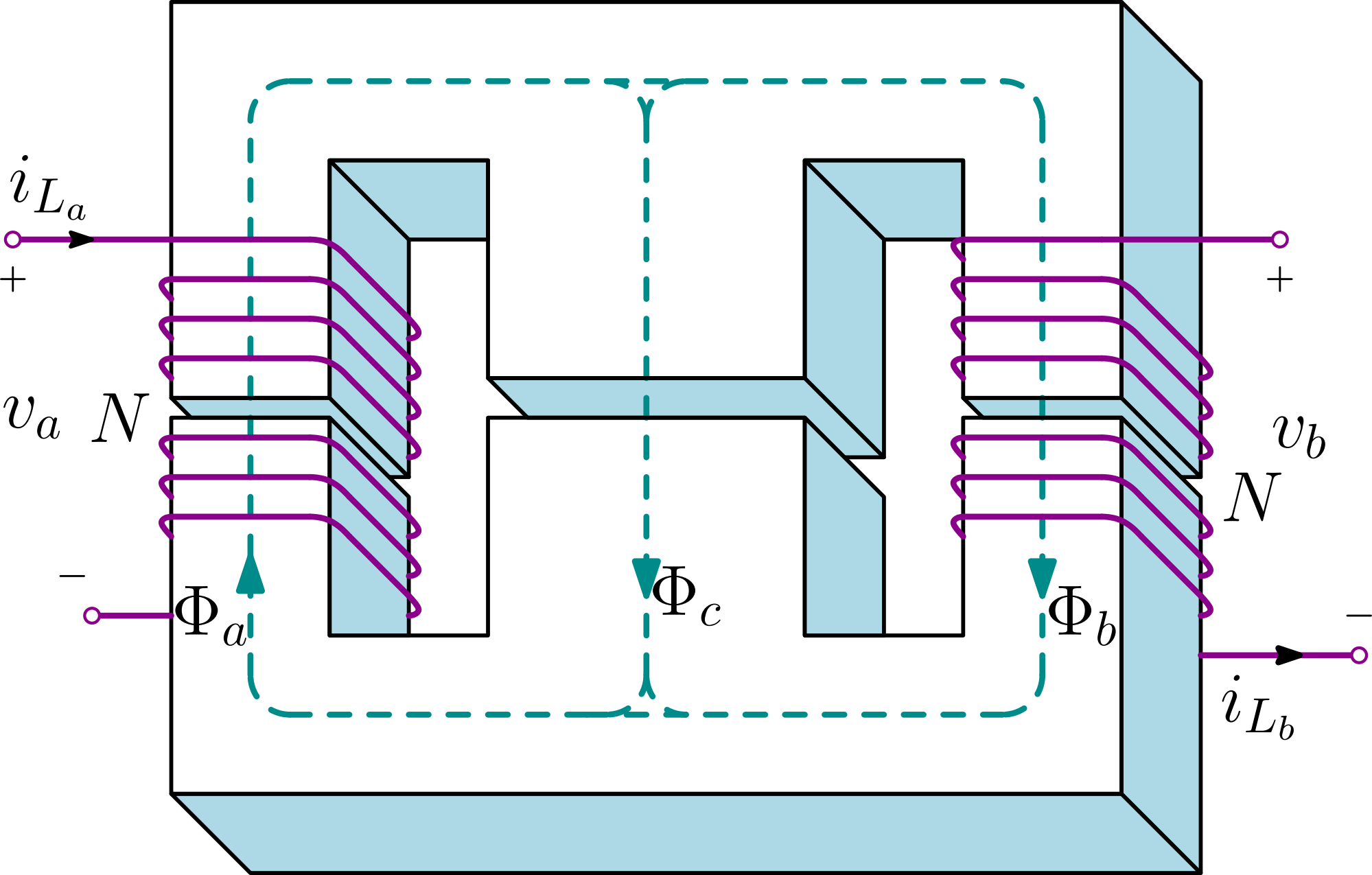

i_{L_b}
L
i_m
V_g'
+
−
+
v_r
C_r
L_m

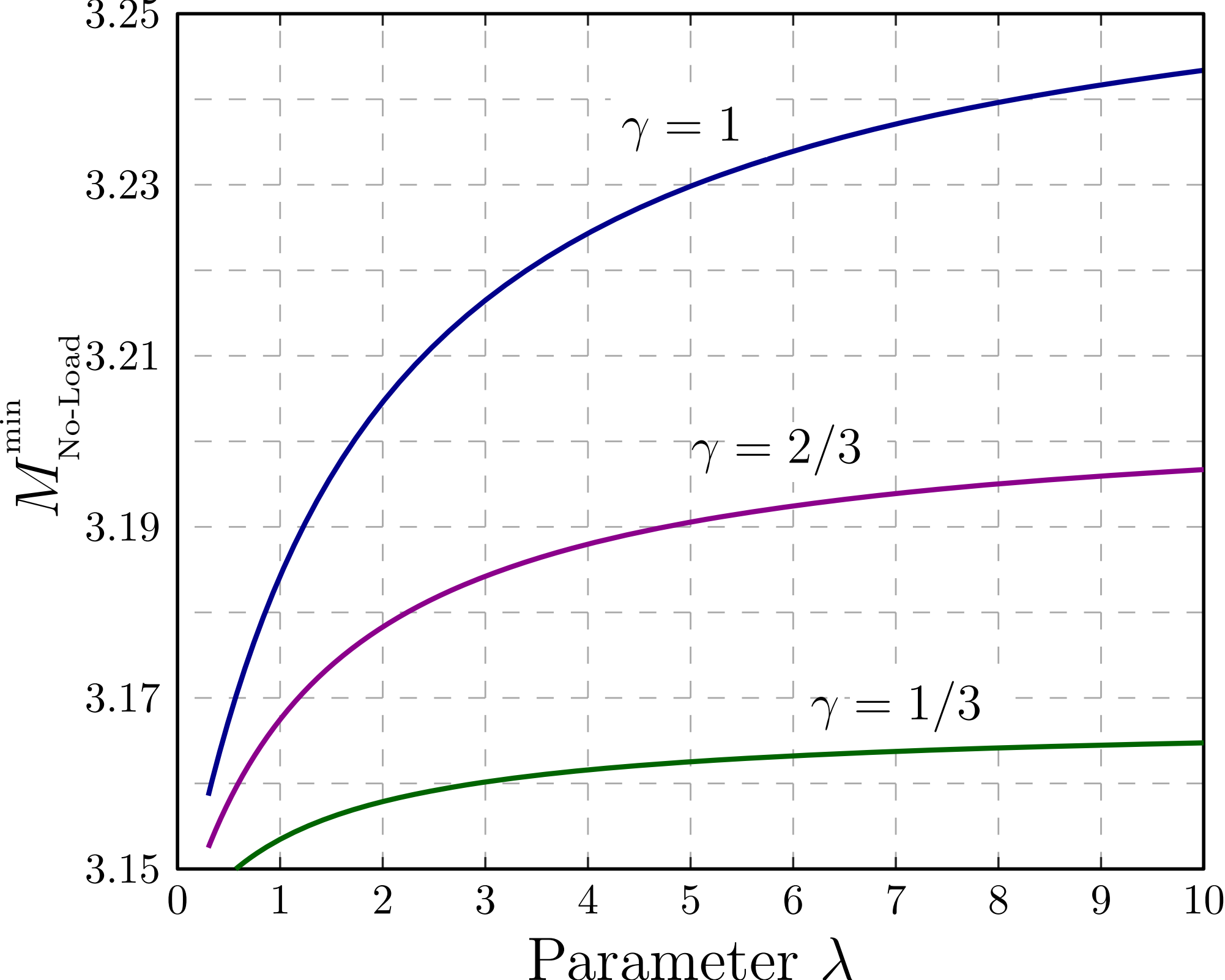

i_{L_b}
L
i_m
V_g'
v_r
C_r
L_m

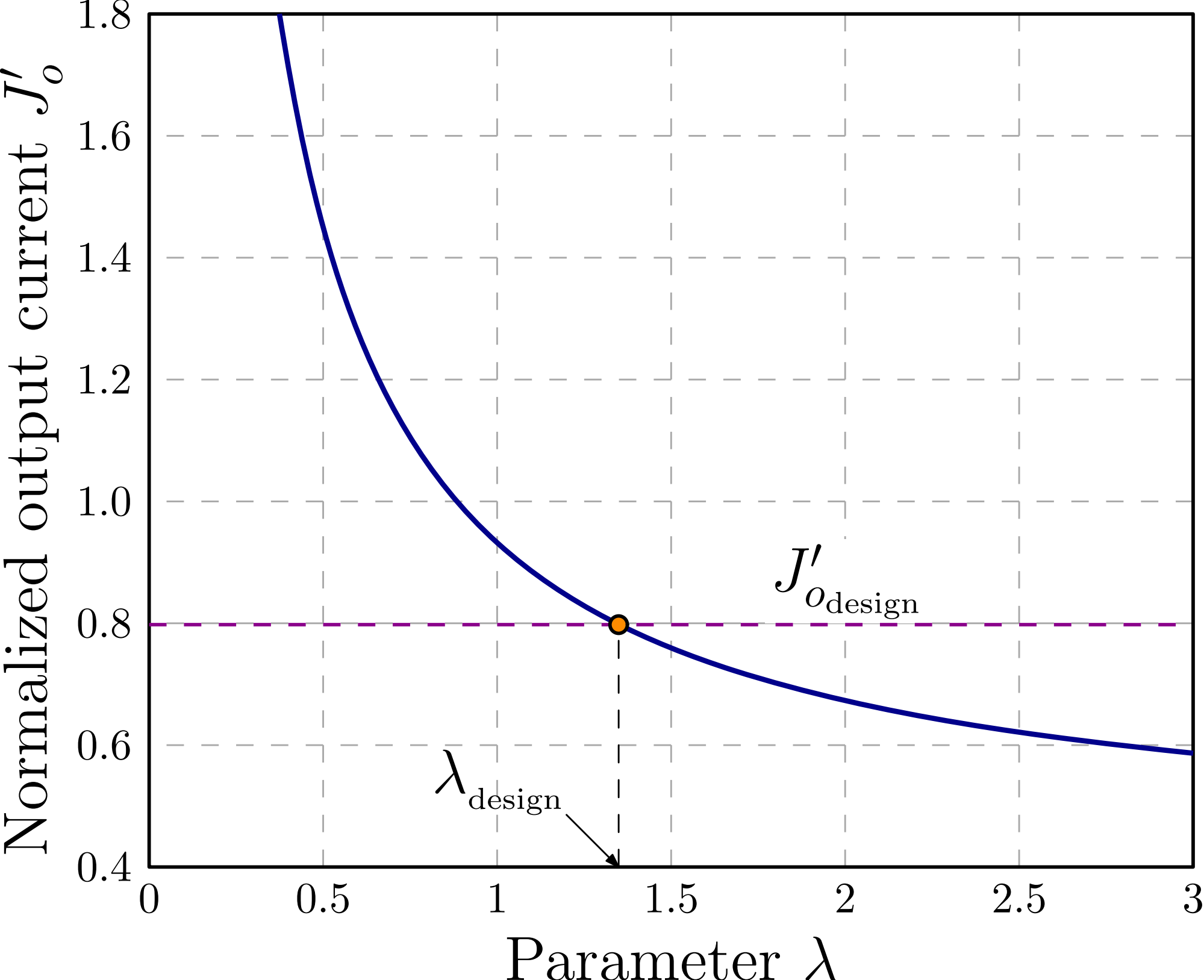

i_L
L
i_m
V_g'
+
−
+
v_r
C_r
L_m

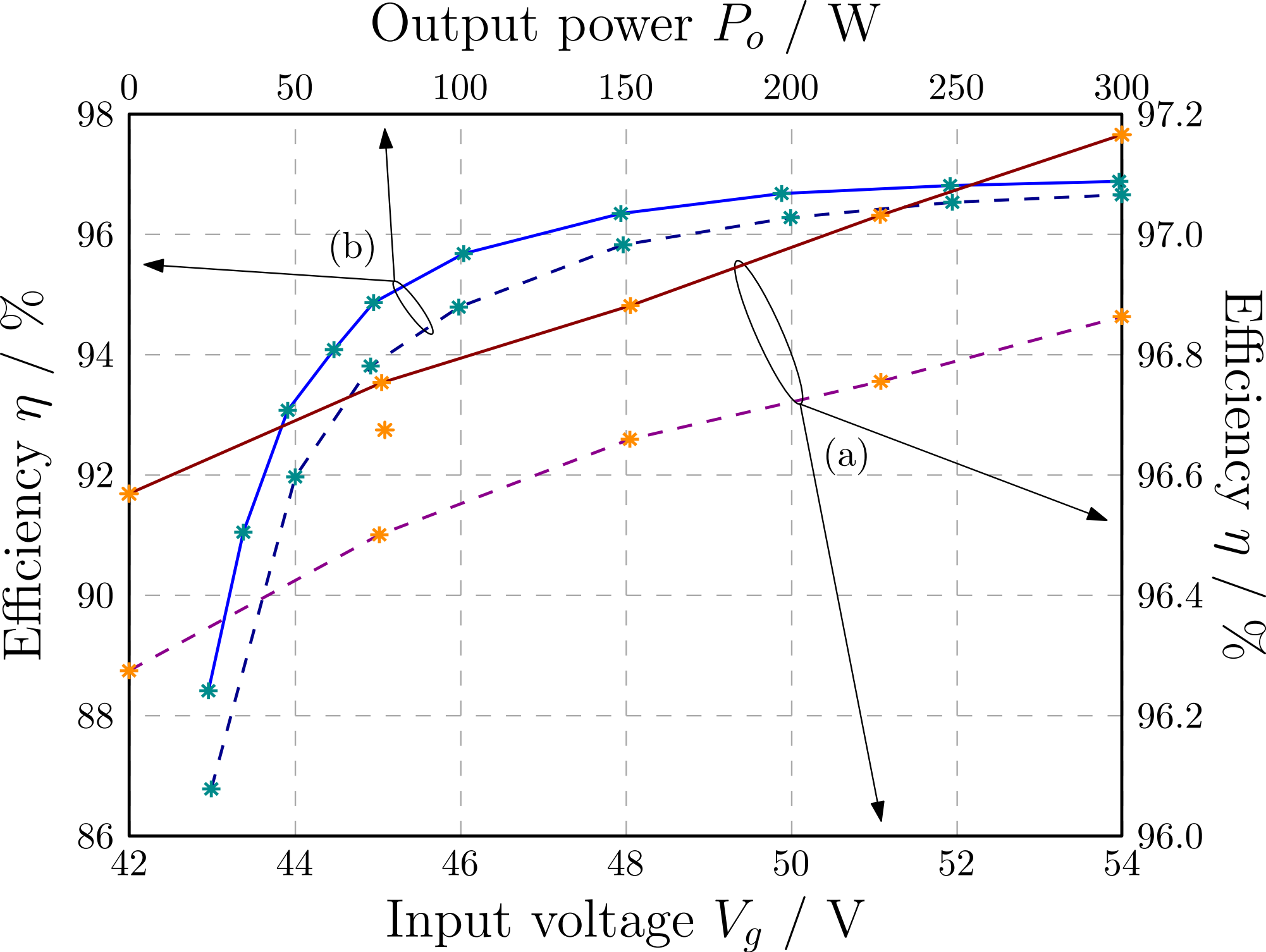

S_a
D_a
t
D_b
S_b
t
$i_m(t)$
$I_{b0_{nl}}$
$i_{L_b}(t)$
t
$-I_{b0_{nl}}$
$i_{L_a}(t)$
$I_{a0_{nl}}$
$I_{m0_{nl}}$
$v_r(t)$
T_{ov}
V_o'
0
t_1
$\frac{T_s}{2}$
T_s
t
T_c

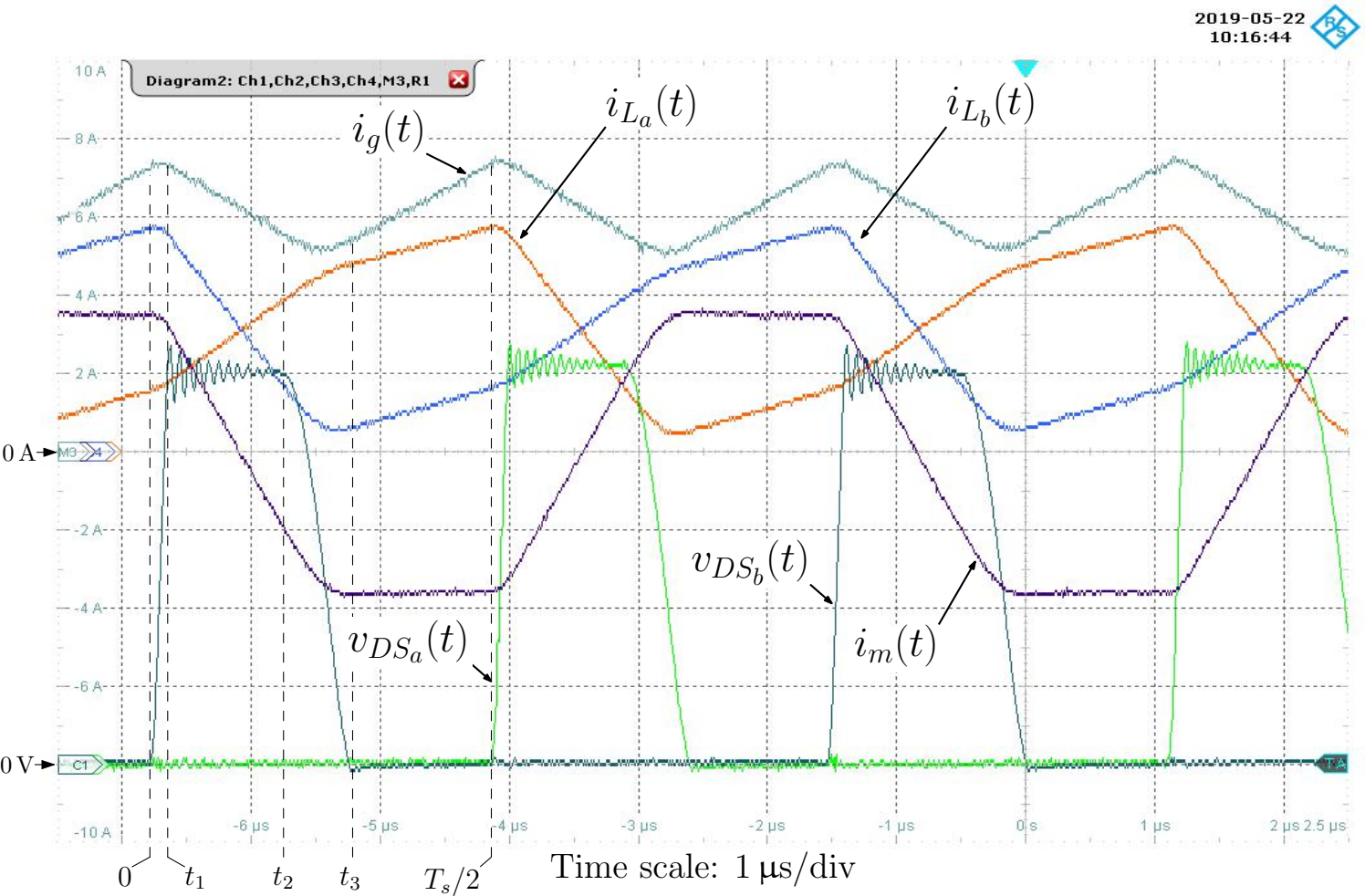

Φ_a
Φ_b
Φ_c
$\mathcal{R}_\ell$
$\mathcal{R}_c$
$\mathcal{R}_\ell$
+
−
Ni_{L_a}
Ni_{L_b}
−
+

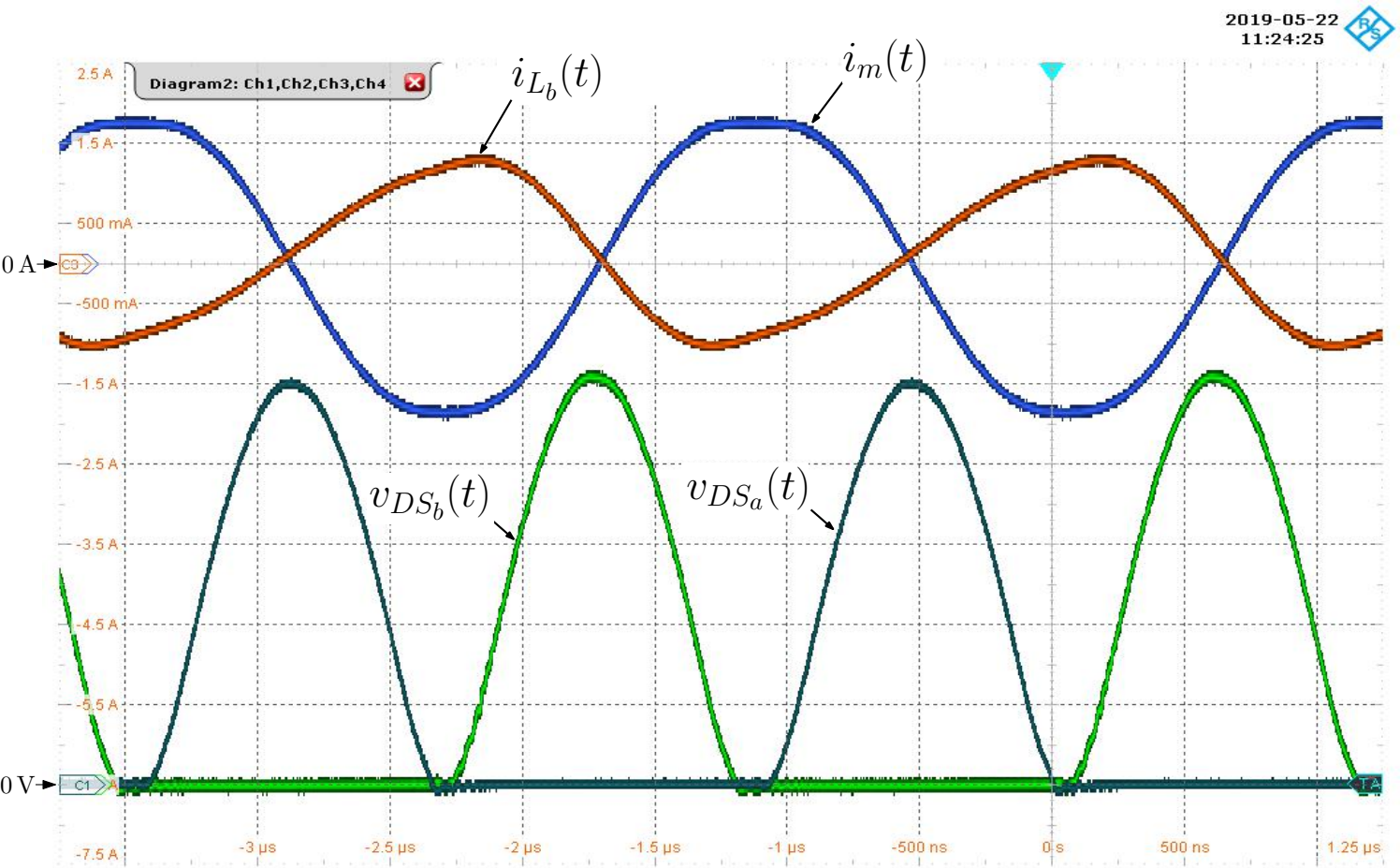

i_{L_a}
+
v_a
N
–
Φ_a
Φ_c
Φ_b
+
v_b
N
–
i_{L_b}


3.25
3.23
3.21
3.19
3.17
3.15
$M^{\min}_{\text{No-Load}}$
$\gamma = 1$
$\gamma = 2/3$
$\gamma = 1/3$
0
1
2
3
4
5
6
7
8
9
10
Parameter λ

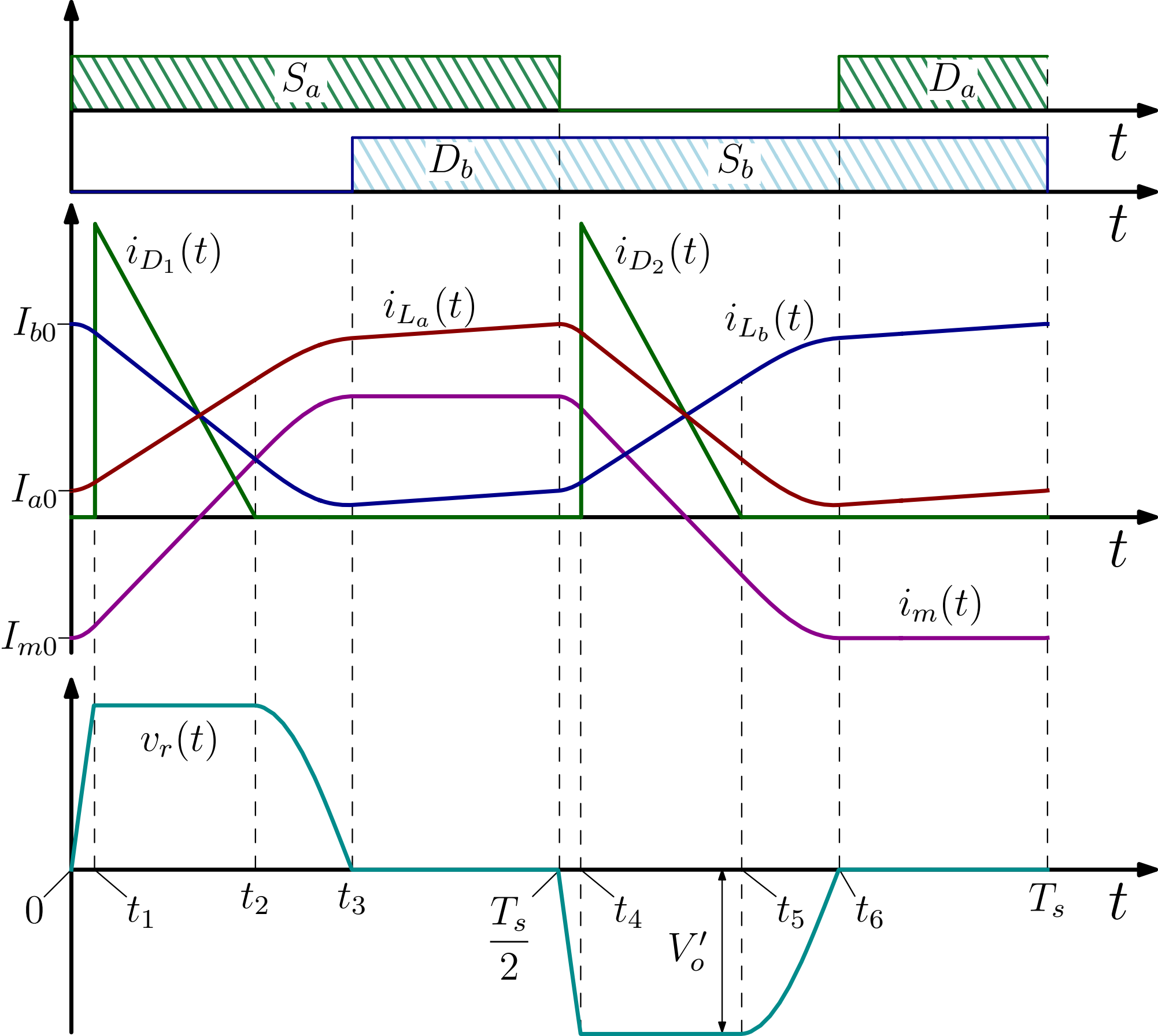

Normalized output current J'_o
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0
0.5
1
1.5
2
2.5
3
Parameter λ
$J'_{o_{\text{design}}}$
λ_{design}

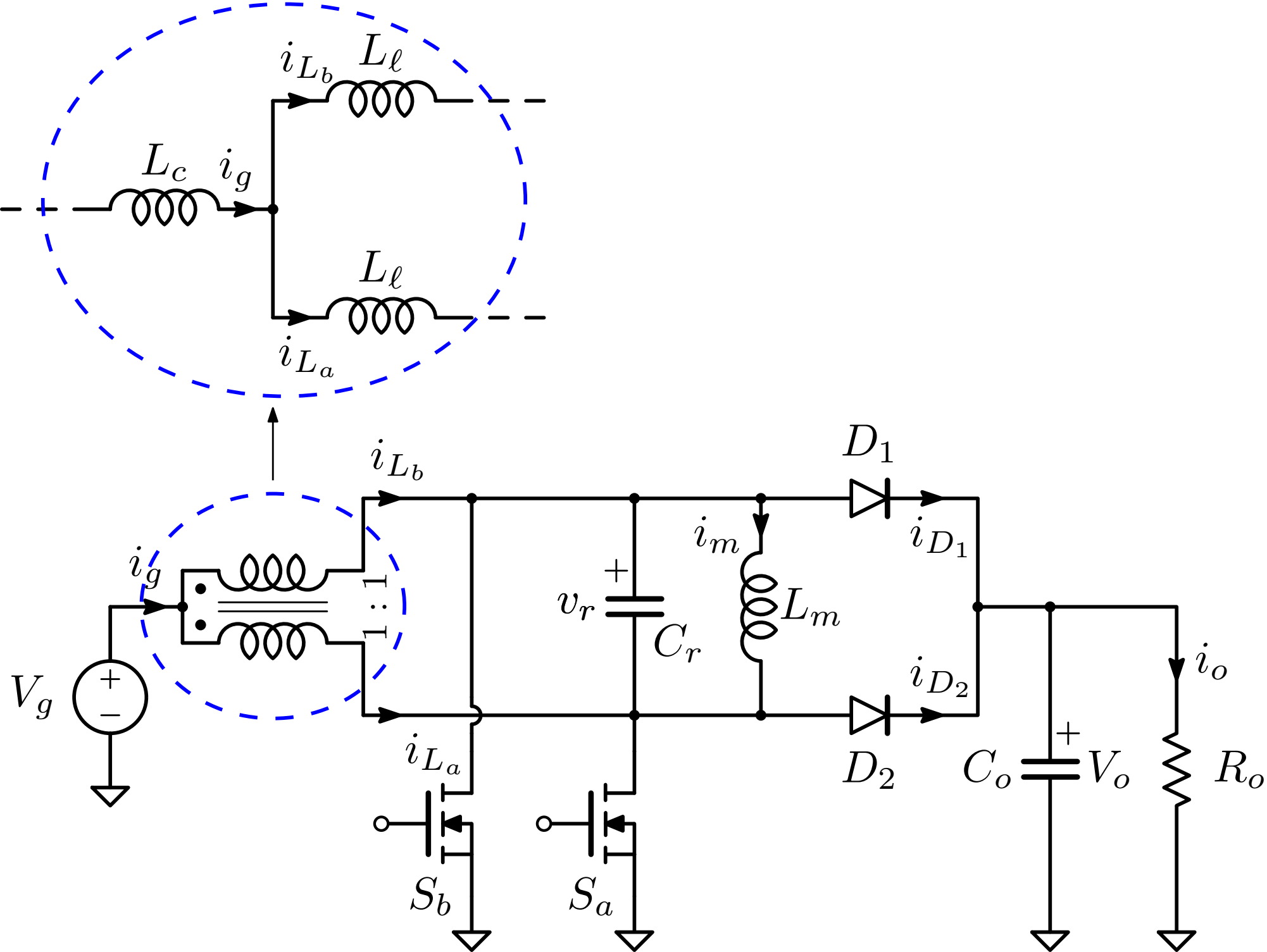

Output power P_o / W
0
50
100
150
200
250
300
98
96
94
92
90
88
86
97.2
97.0
96.8
96.6
96.4
96.2
96.0
Efficiency η / %
Efficiency η / %
(b)
(a)
42
44
46
48
50
52
54
Input voltage V_g / V

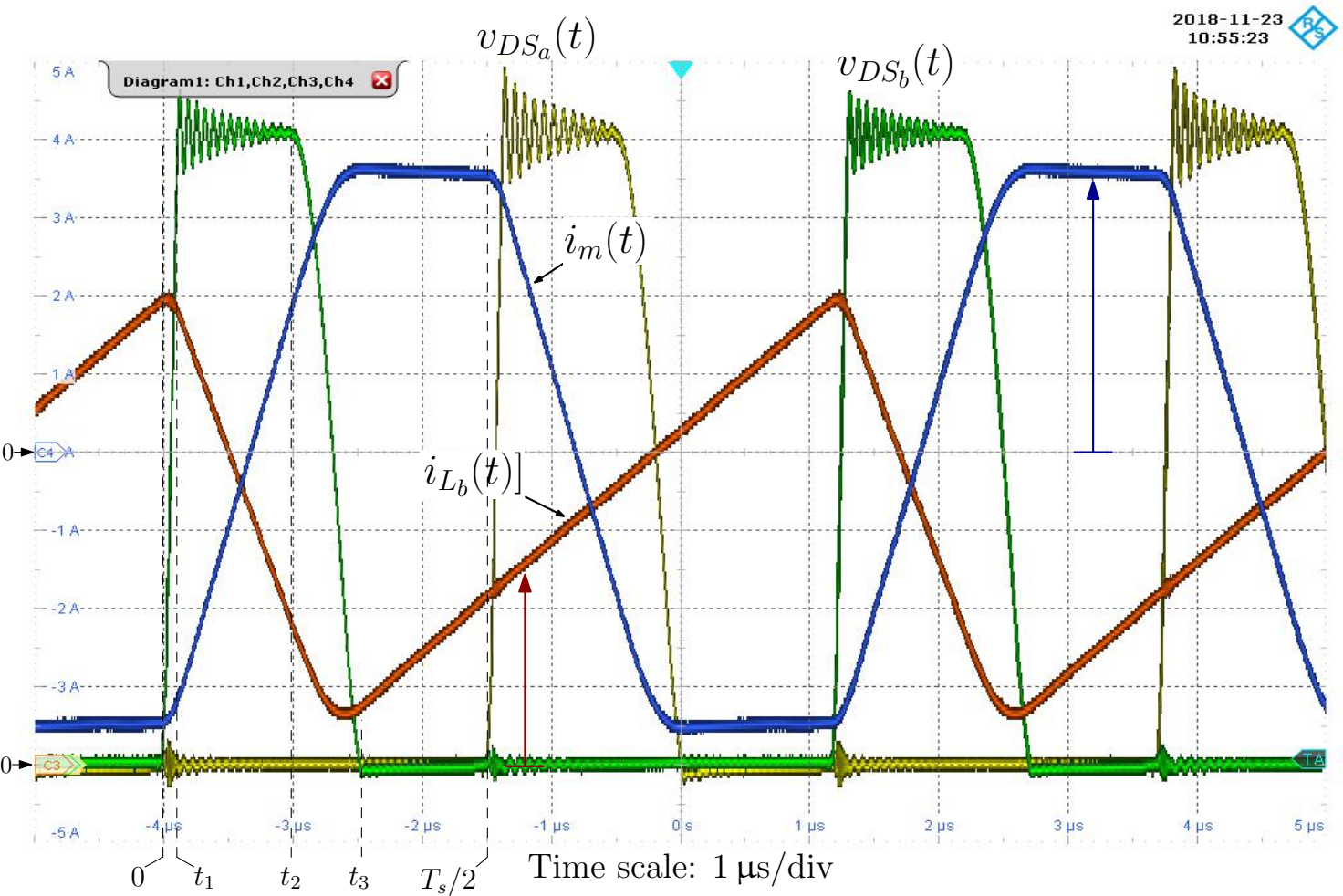

2019-05-22
10:16:44
Diagram2: Ch1,Ch2,Ch3,Ch4,M3,R1
10 A
8 A
6 A
4 A
2 A
0 A
-2 A
-4 A
-6 A
-10 A
0 V
M3
C1
$i_g(t)$
$i_{L_a}(t)$
$i_{L_b}(t)$
$v_{DS_a}(t)$
$v_{DS_b}(t)$
$i_m(t)$
-6 µs
-5 µs
-4 µs
-3 µs
-2 µs
-1 µs
0 s
1 µs
2 µs 2.5 µs
0
t_1
t_2
t_3
$T_s/2$
Time scale: 1 µs/div

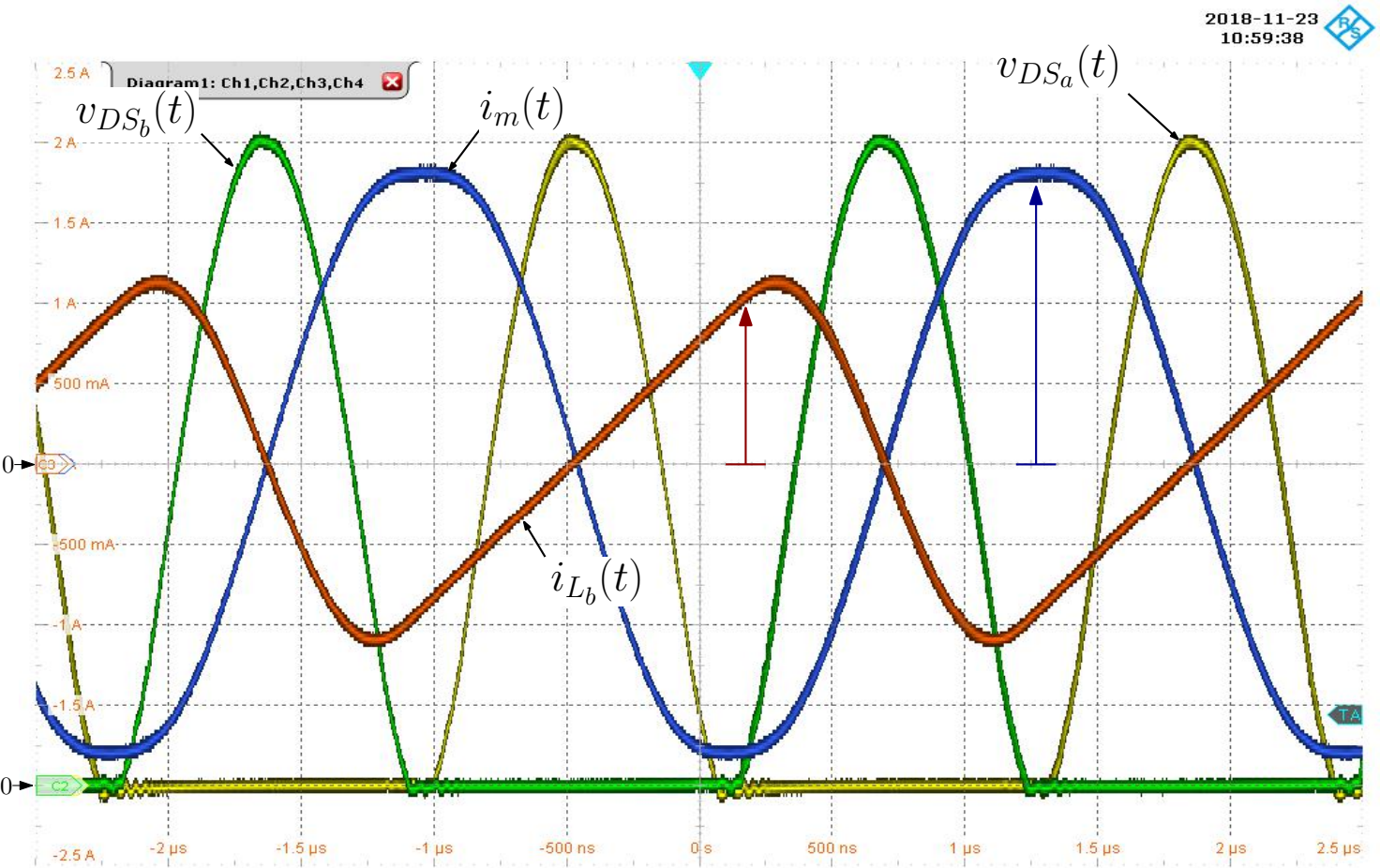


Time scale: 0.5 µs/div

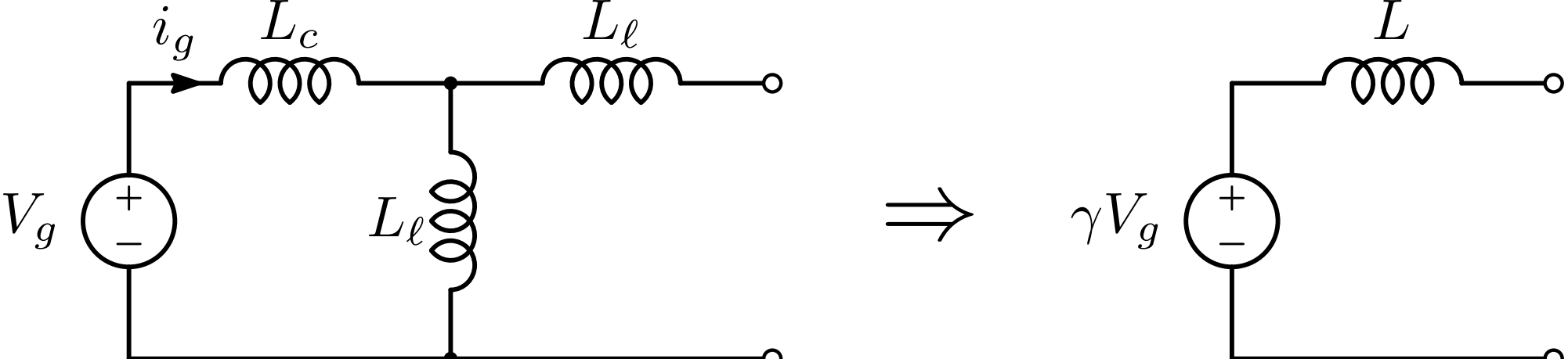

S_a
D_a
t
D_b
S_b
t
$i_{D_1}(t)$
$i_{D_2}(t)$
$i_{L_a}(t)$
$i_{L_b}(t)$
I_{b0}
I_{a0}
t
$i_m(t)$
I_{m0}
$v_r(t)$
0
t_1
t_2
t_3
$\frac{T_s}{2}$
t_4
V_o'
t_5
t_6
T_s
t

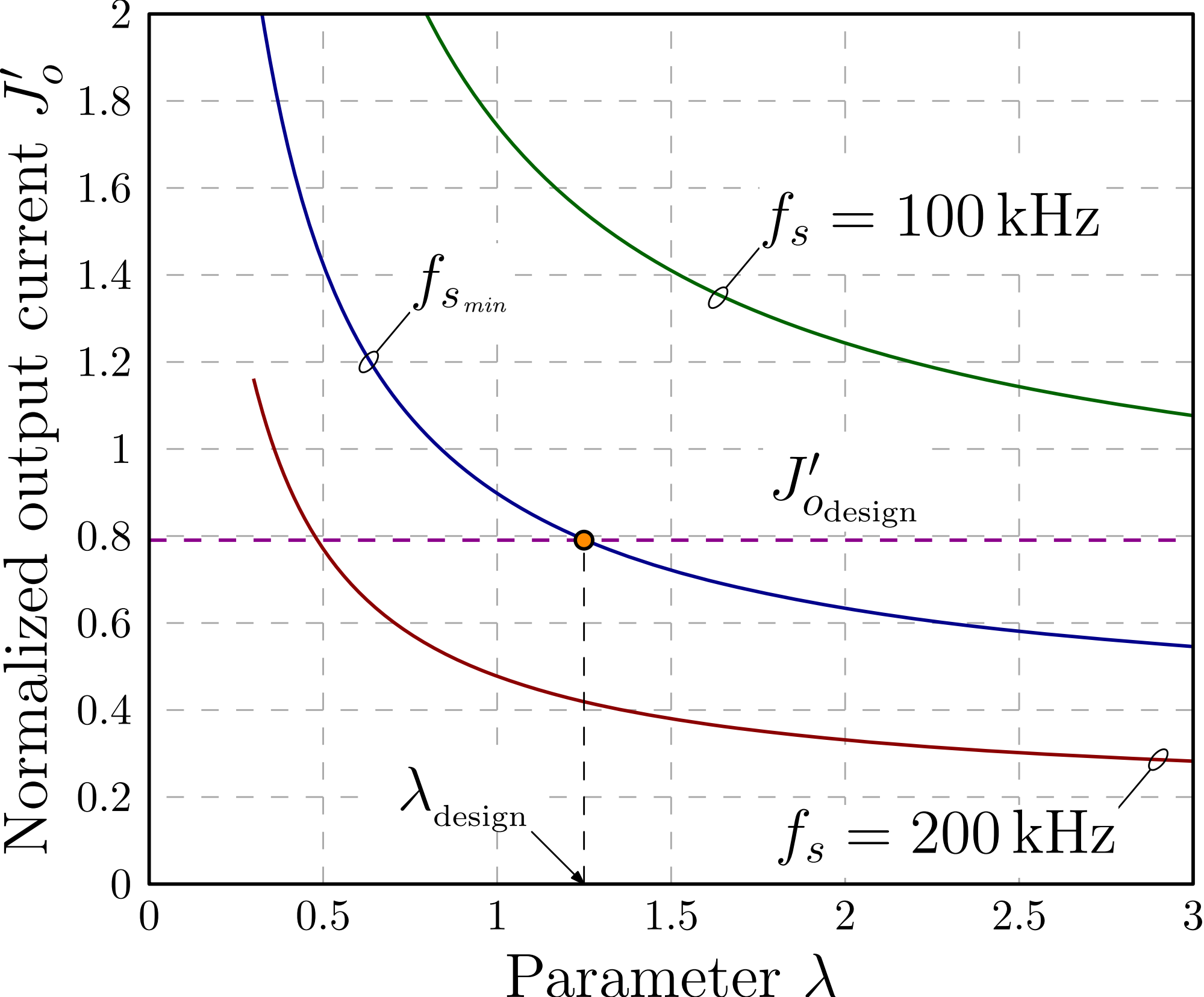

i_{L_b}
L_ℓ
L_c
i_g
L_ℓ
i_{L_a}
i_{L_b}
D_1
i_g
1 : 1
v_r
C_r
i_m
L_m
i_{D_1}
i_{D_2}
i_o
V_g
i_{L_a}
D_2
C_o
V_o
R_o
S_b
S_a

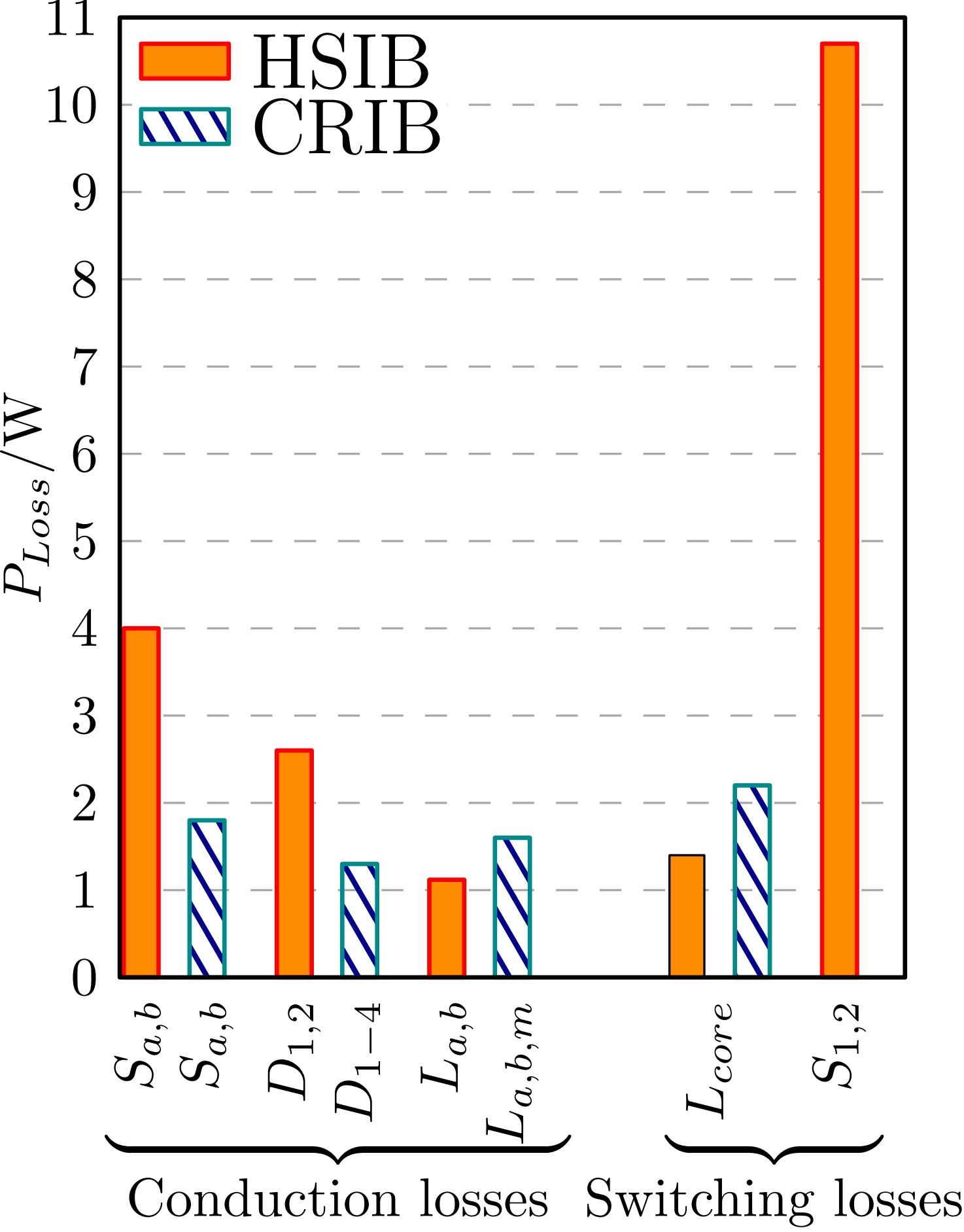

2018-11-23
10:55:23
Diagram1: Ch1,Ch2,Ch3,Ch4
$v_{DS_a}(t)$
$v_{DS_b}(t)$
$i_m(t)$
$i_{L_b}(t)]$
5 A
4 A
3 A
2 A
1 A
0
-1 A
-2 A
-3 A
-5 A
-4 µs
-3 µs
-2 µs
-1 µs
0 s
1 µs
2 µs
3 µs
4 µs
5 µs
0
t_1
t_2
t_3
$T_s/2$
Time scale: 1 µs/div

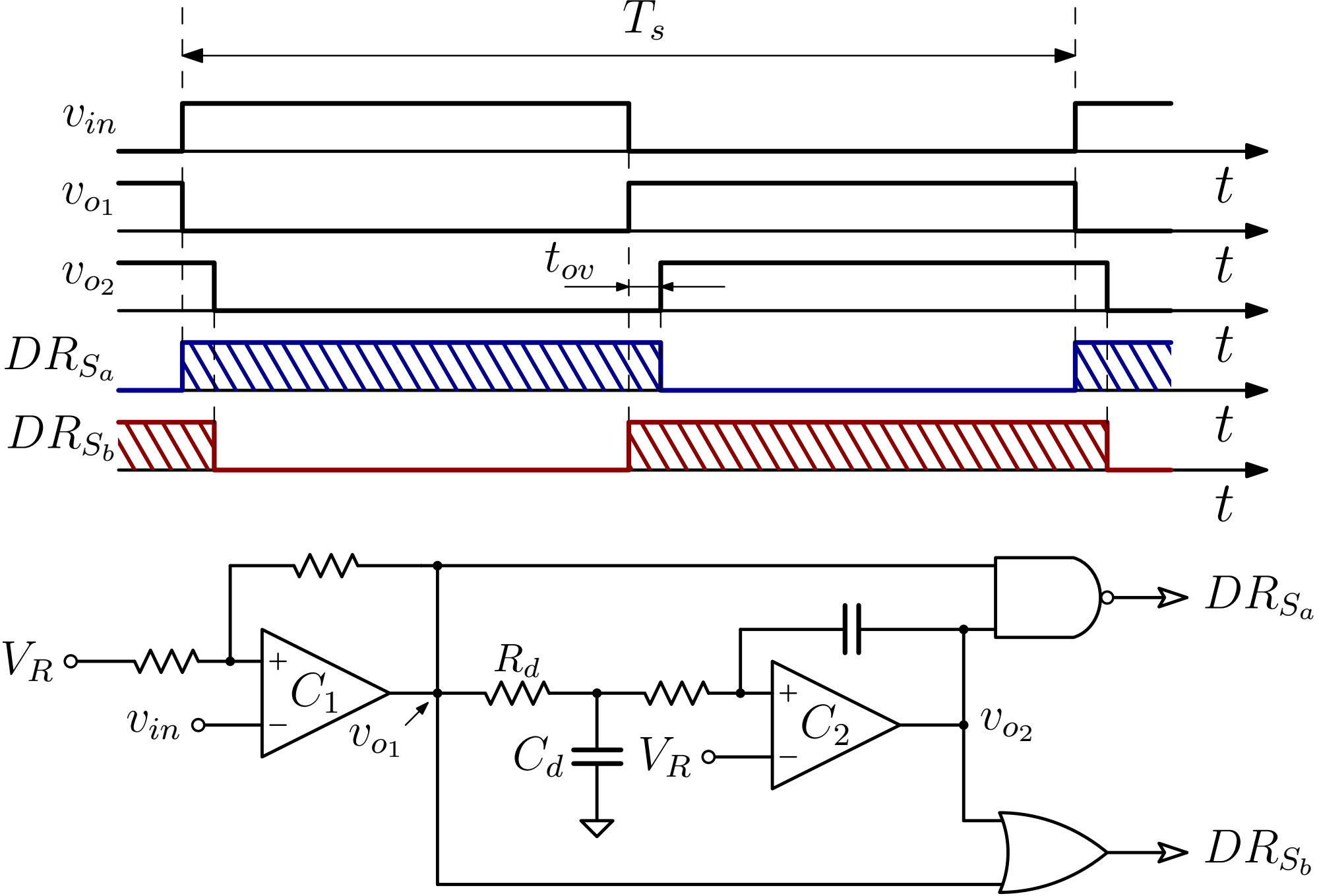


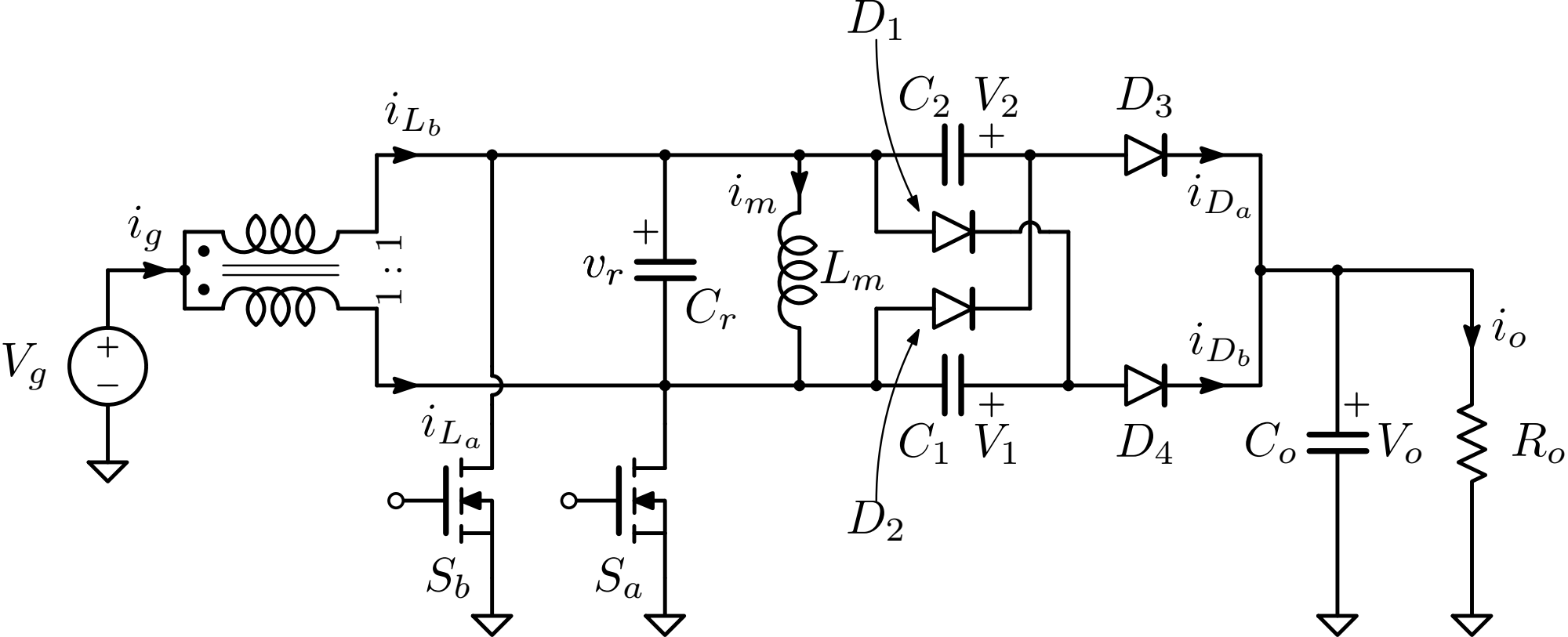
Time scale: 0.5 µs/div

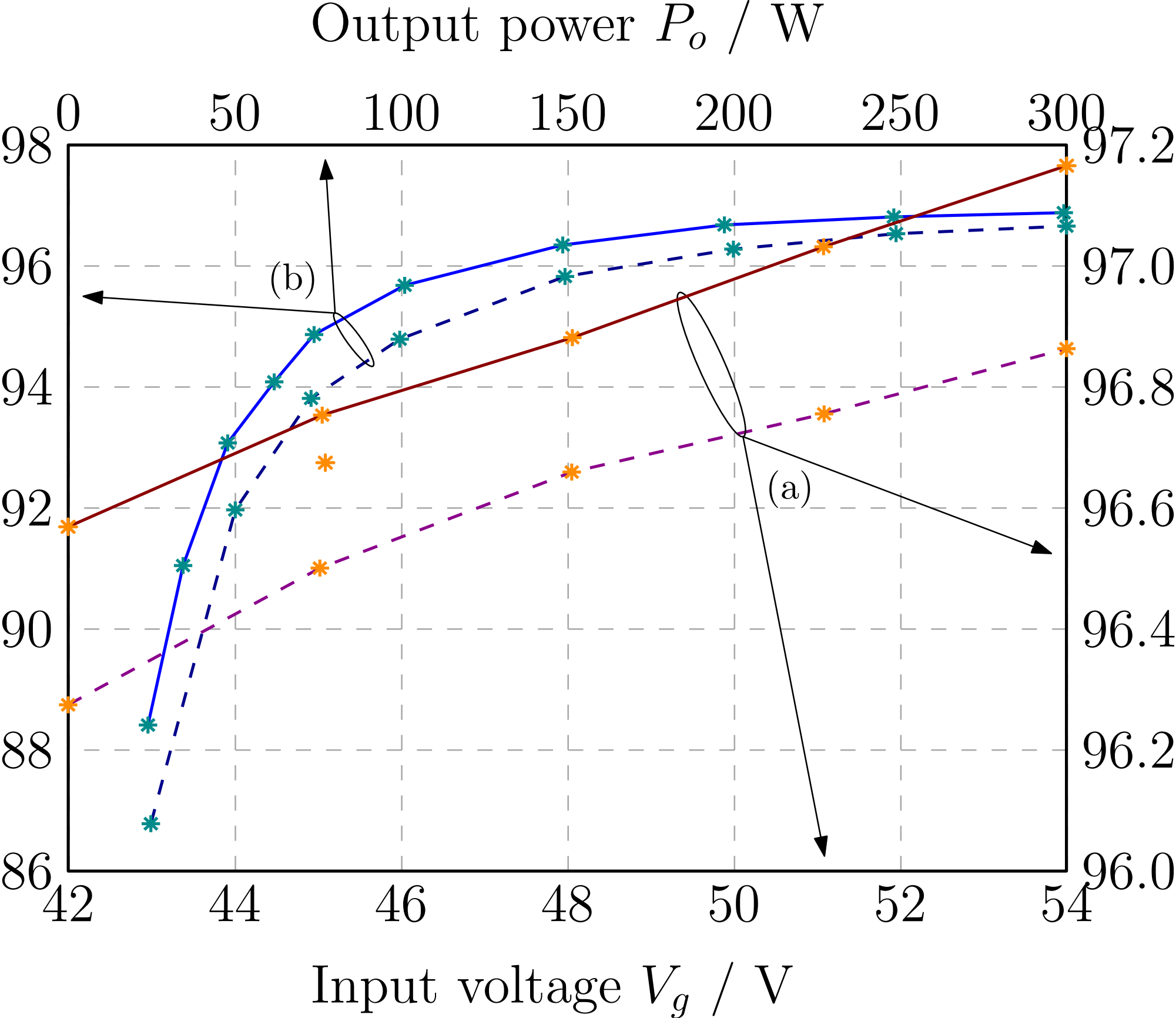

i_g
L_c
L_ℓ
V_g
L_ℓ
$\Rightarrow$
L
γV_g

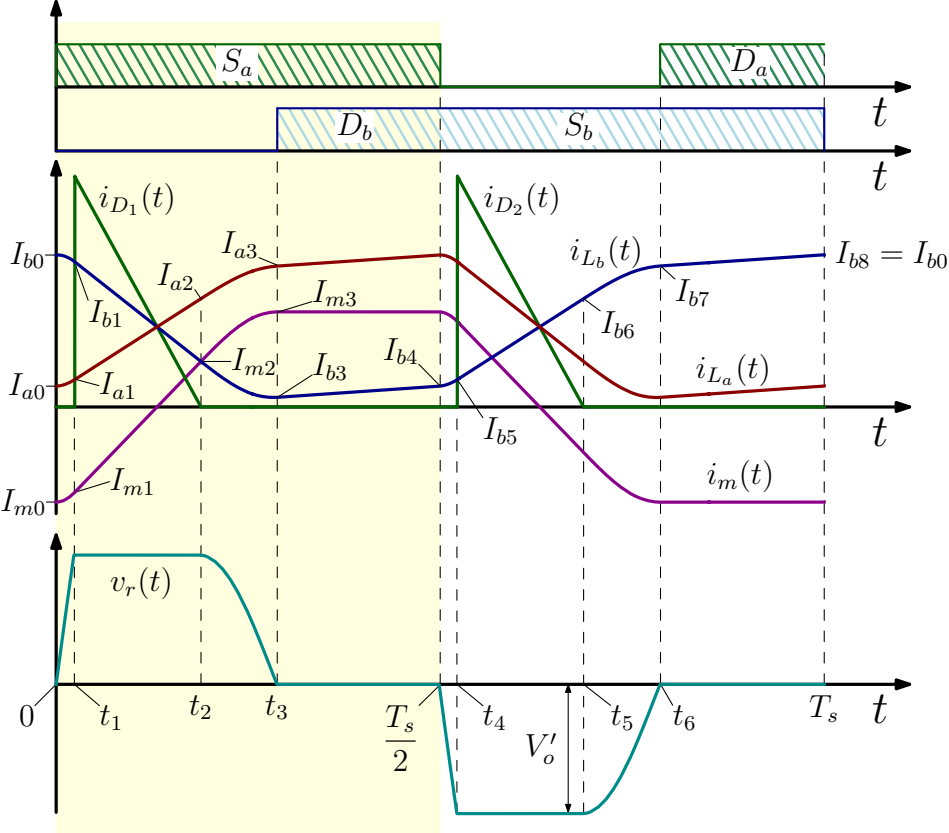

Normalized output current J'_o
Parameter λ
$f_s = 100\,\mathrm{kHz}$
$f_{s_{min}}$
$J'_{o_{\mathrm{design}}}$
$\lambda_{\mathrm{design}}$
$f_s = 200\,\mathrm{kHz}$
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
0
0.5
1
1.5
2
2.5
3

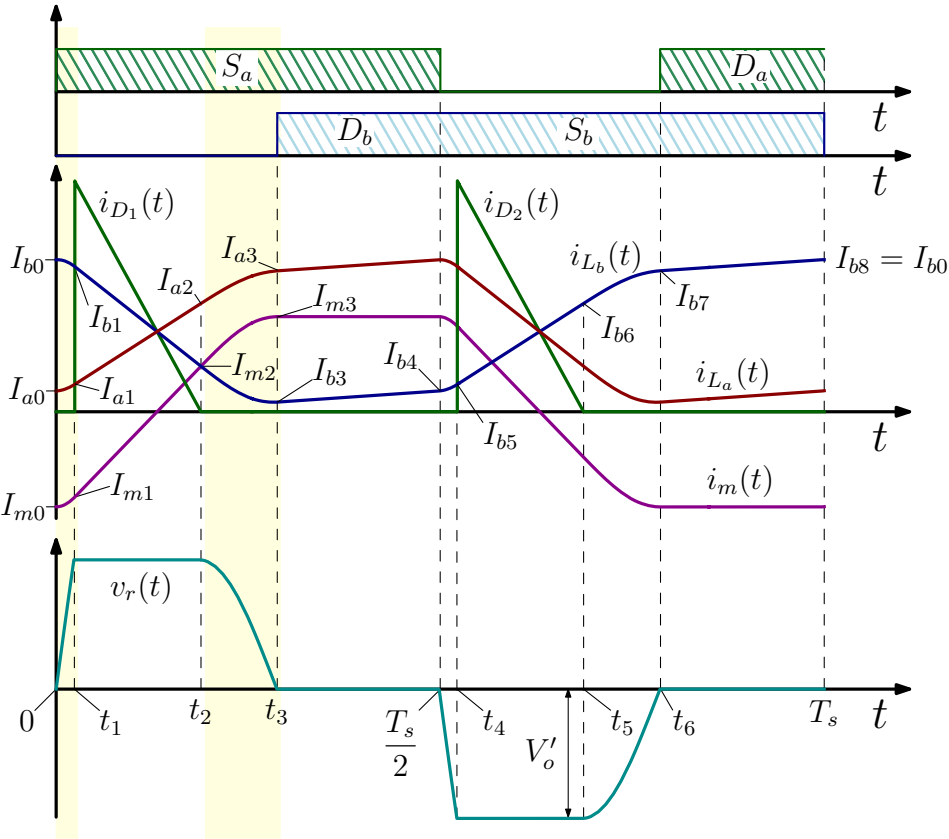

HSIB
CRIB
P_{Loss}/W
0
1
2
3
4
5
6
7
8
9
10
11
$S_{a,b}$
$S_{a,b}$
$D_{1,2}$
D_{1-4}
$L_{a,b}$
$L_{a,b,m}$
L_{core}
$S_{1,2}$
Conduction losses
Switching losses

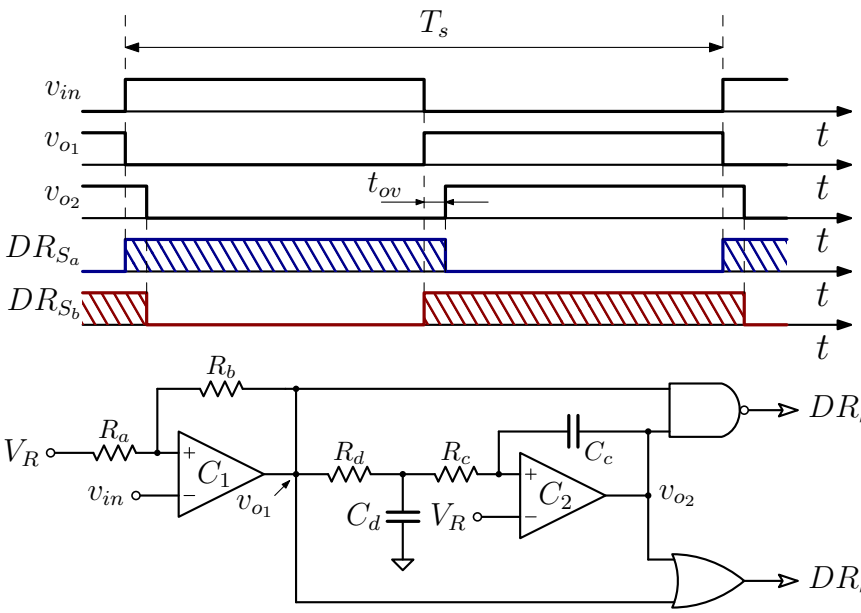

T_s
v_{in}
v_{o1}
v_{o2}
t_{ov}
DR_{S_a}
DR_{S_b}
t
V_R
v_{in}
C_1
v_{o1}
R_d
C_d
V_R
C_2
v_{o2}
DR_{S_a}
DR_{S_b}

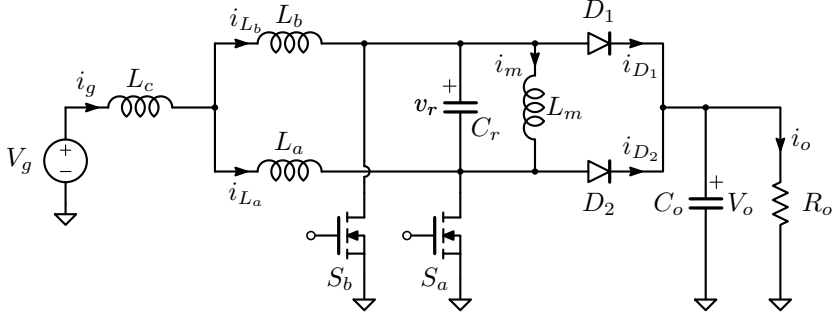

D_1
C_2 V_2
D_3
i_{L_b}
i_m
i_{D_a}
i_g
v_r
L_m
i_o
V_g
C_r
i_{D_b}
i_{L_a}
C_1 V_1
D_4
C_o V_o
R_o
D_2
S_b
S_a

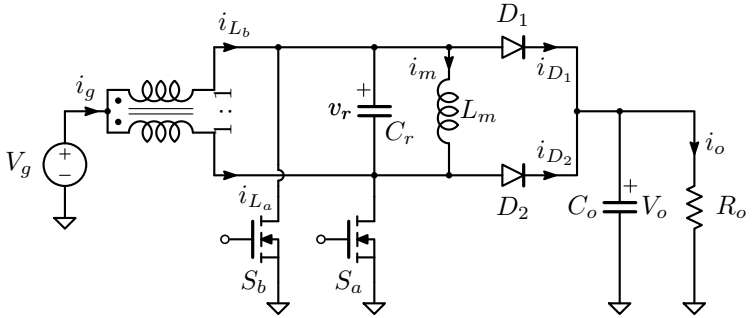

Output power P_o / W
0
50
100
150
200
250
300
98
96
94
92
90
88
86
97.2
97.0
96.8
96.6
96.4
96.2
96.0
(b)
(a)
42
44
46
48
50
52
54
Input voltage V_g / V

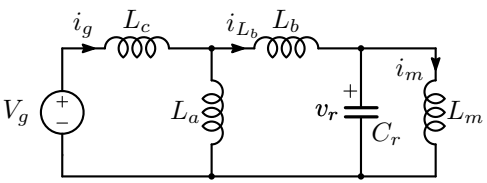

S_a
D_a
t
D_b
S_b
t
$i_{D_1}(t)$
$i_{D_2}(t)$
I_{b0}
I_{a3}
I_{a2}
$i_{L_b}(t)$
$I_{b8} = I_{b0}$
I_{b1}
I_{m3}
I_{b7}
I_{b6}
I_{m2}
I_{b3}
I_{b4}
I_{a0}
I_{a1}
$i_{L_a}(t)$
t
I_{b5}
I_{m0}
I_{m1}
$i_m(t)$
$v_r(t)$
0
t_1
t_2
t_3
$\frac{T_s}{2}$
t_4
V_o'
t_5
t_6
T_s
t

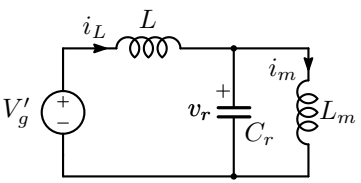

S_a
D_a
t
D_b
S_b
t
$i_{D_1}(t)$
$i_{D_2}(t)$
I_{b0}
I_{a3}
I_{a2}
$i_{L_b}(t)$
$I_{b8} = I_{b0}$
I_{b1}
I_{m3}
I_{b7}
I_{b6}
I_{m2}
I_{b3}
I_{b4}
I_{a0}
I_{a1}
$i_{L_a}(t)$
t
I_{b5}
I_{m0}
I_{m1}
$i_m(t)$
$v_r(t)$
0
t_1
t_2
t_3
$\frac{T_s}{2}$
t_4
V_o'
t_5
t_6
T_s
t

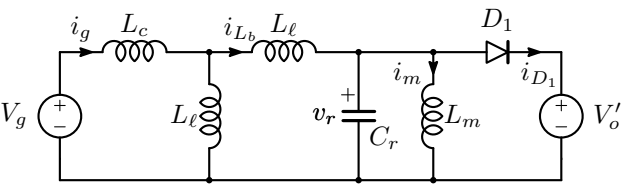

T_s
v_{in}
v_{o_1}
v_{o_2}
t_{ov}
DR_{S_a}
DR_{S_b}
t
R_b
R_a
V_R
v_{in}
C_1
v_{o_1}
R_d
C_d
R_c
C_c
V_R
C_2
v_{o_2}
DR_{S_a}
DR_{S_b}

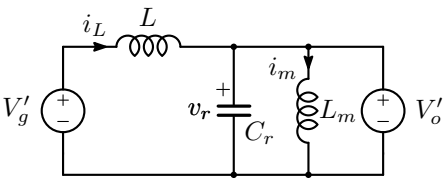

i_{L_b} L_b
D_1
i_g L_c
i_m
i_{D_1}
v_r C_r L_m
V_g
L_a
i_{D_2}
i_o
i_{L_a}
D_2
C_o V_o R_o
S_b S_a

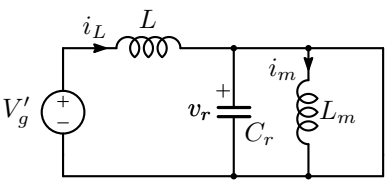

i_{L_b}
D_1
i_g
i_m
i_{D_1}
v_r C_r L_m
V_g
i_{D_2}
i_o
i_{L_a}
D_2
C_o V_o R_o
S_b S_a

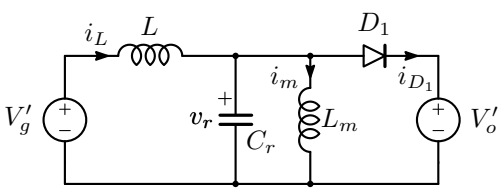

i_g L_c i_{L_b} L_b
i_m
V_g
L_a
v_r C_r L_m

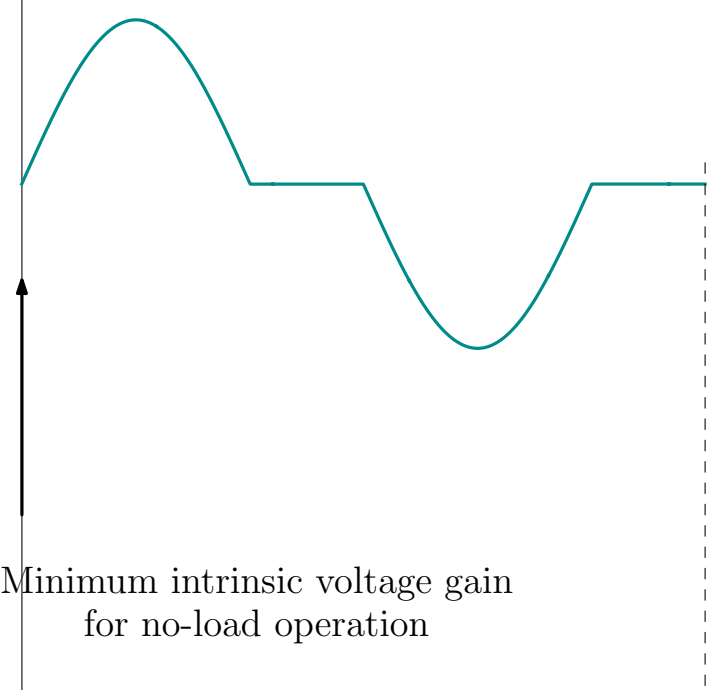

i_L L
i_m
V_g'
v_r C_r L_m


i_g L_c i_{L_b} L_ℓ
D_1
i_m
i_{D_1}
V_g
L_ℓ
v_r C_r L_m
V_o'

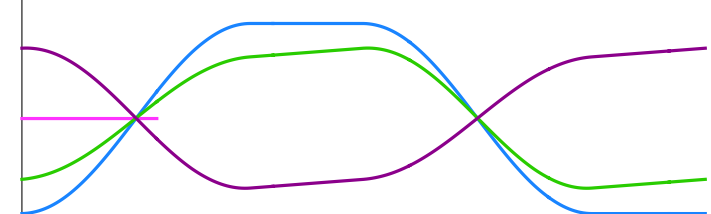

i_L L
i_m
V_g'
v_r C_r L_m
V_o'

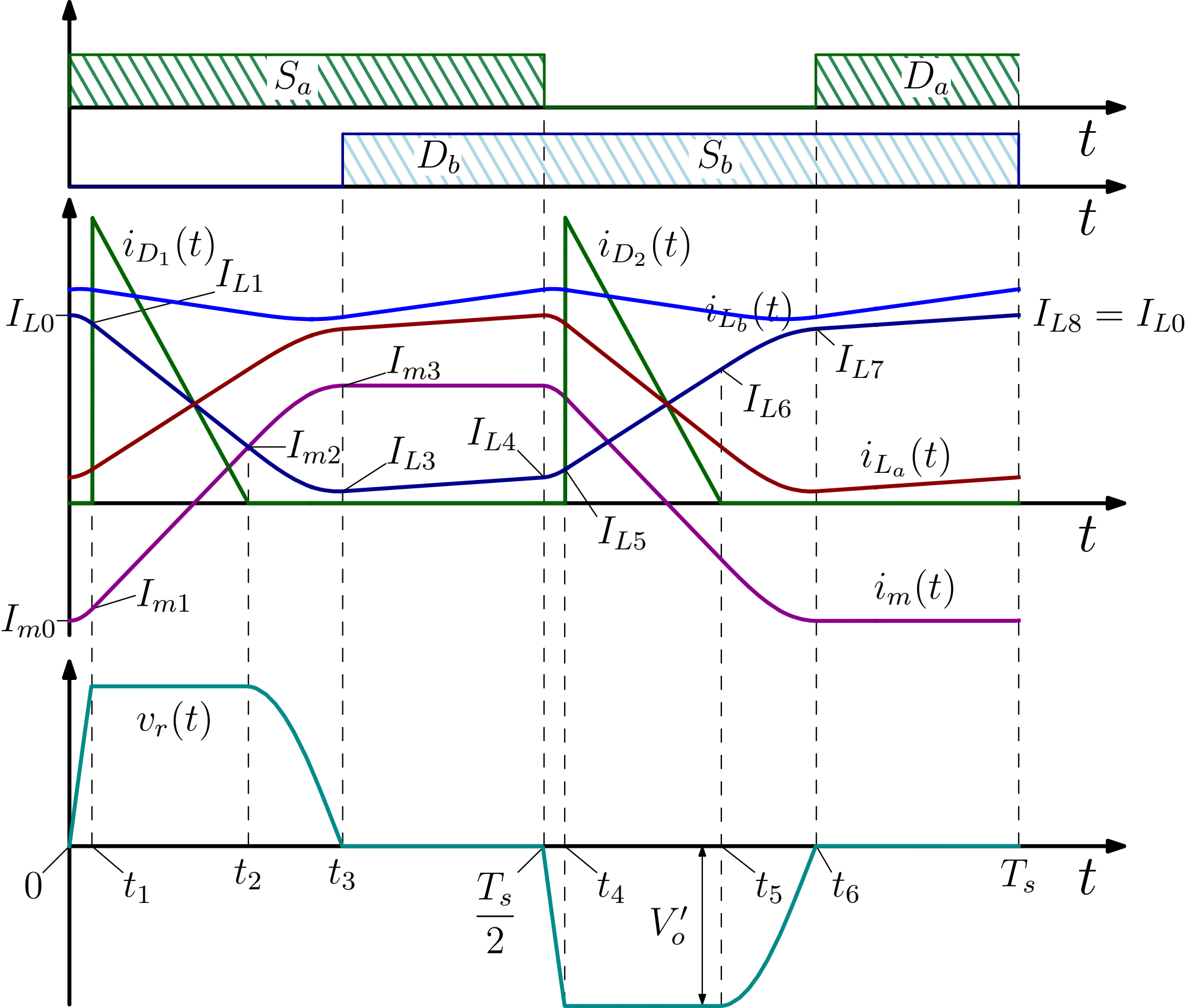

i_L L
i_m
V_g'
v_r C_r L_m

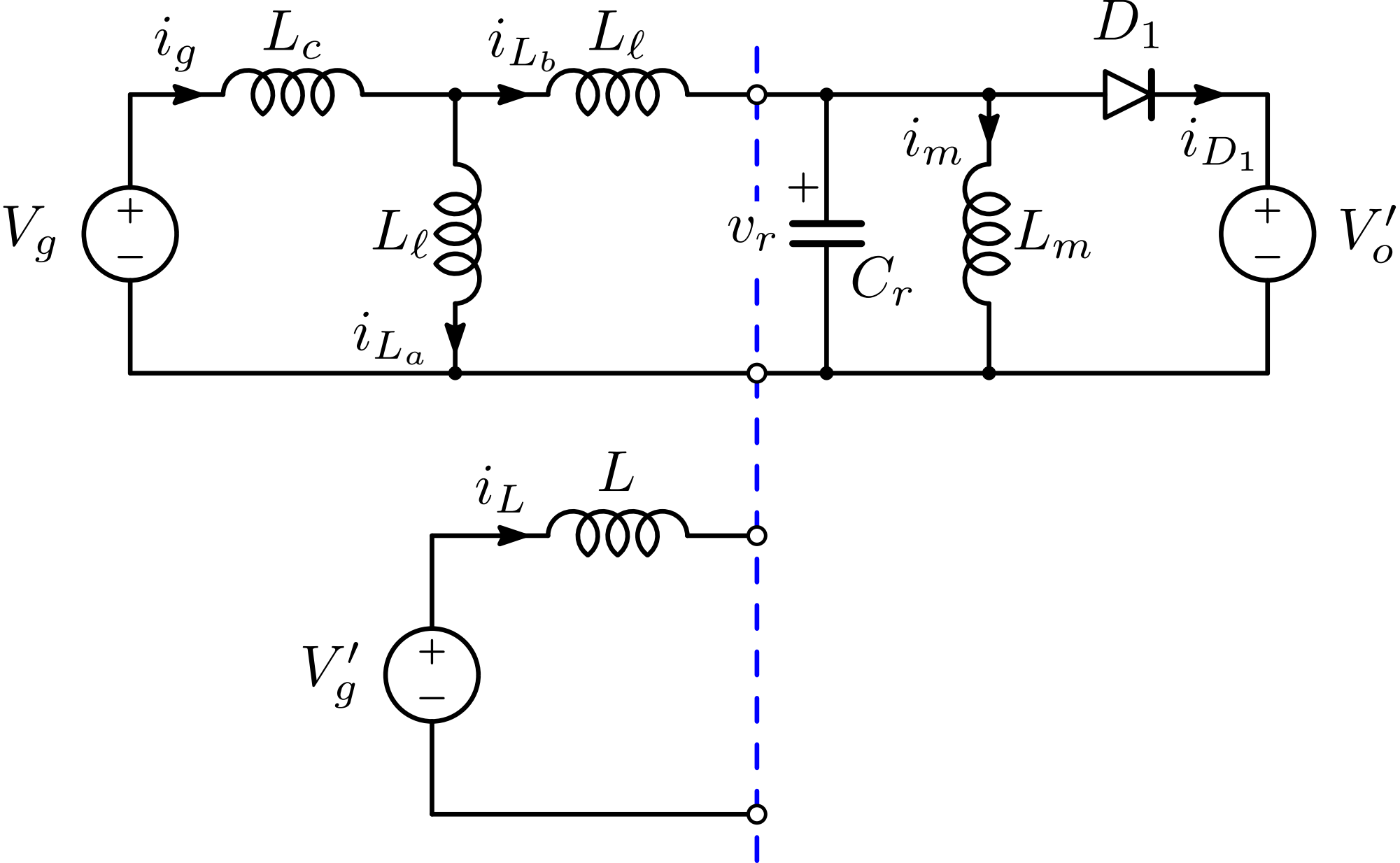

i_L L
D_1
i_m
i_{D_1}
V_g'
v_r C_r L_m
V_o'

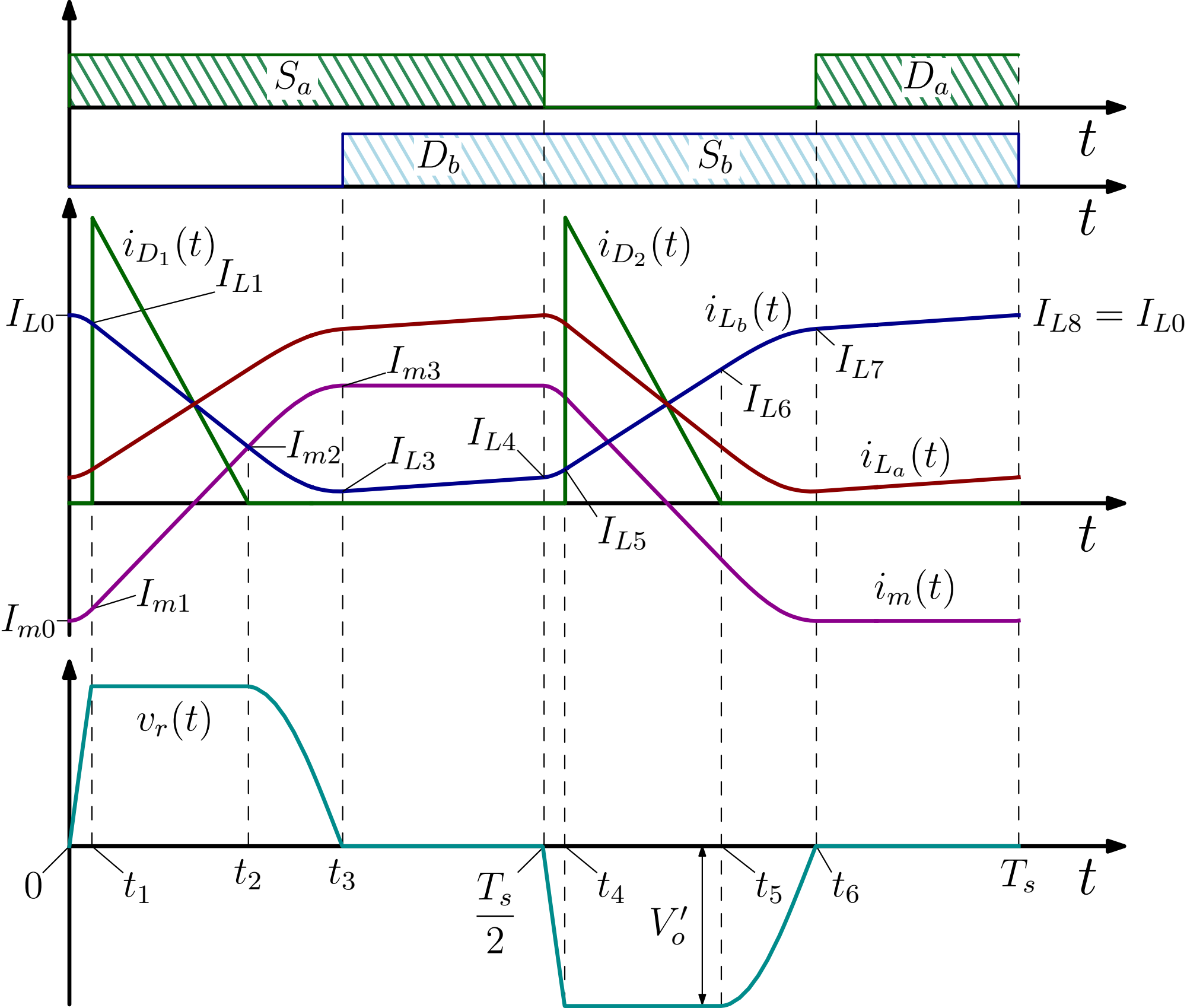


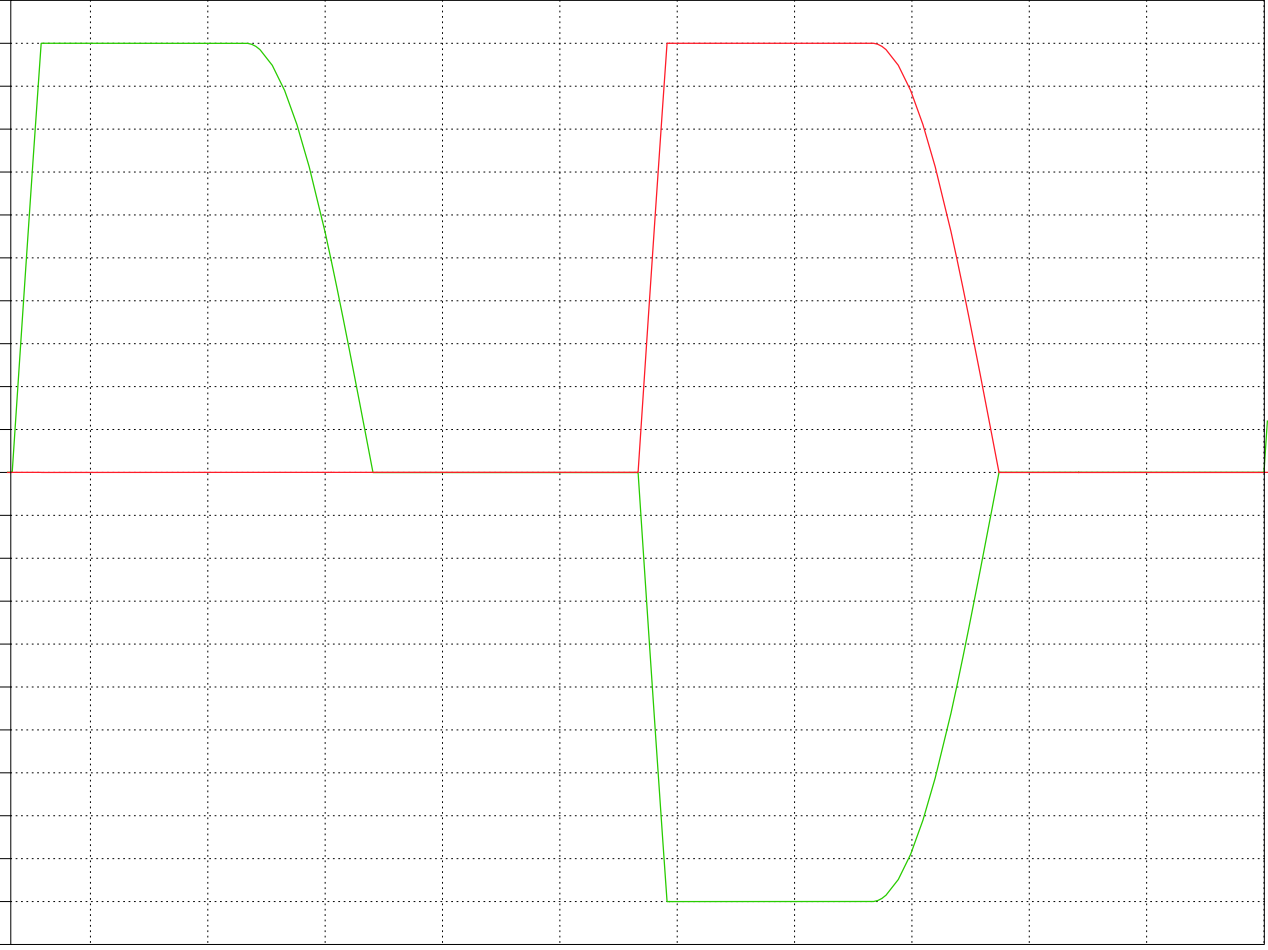
Minimum intrinsic voltage gain
for no-load operation

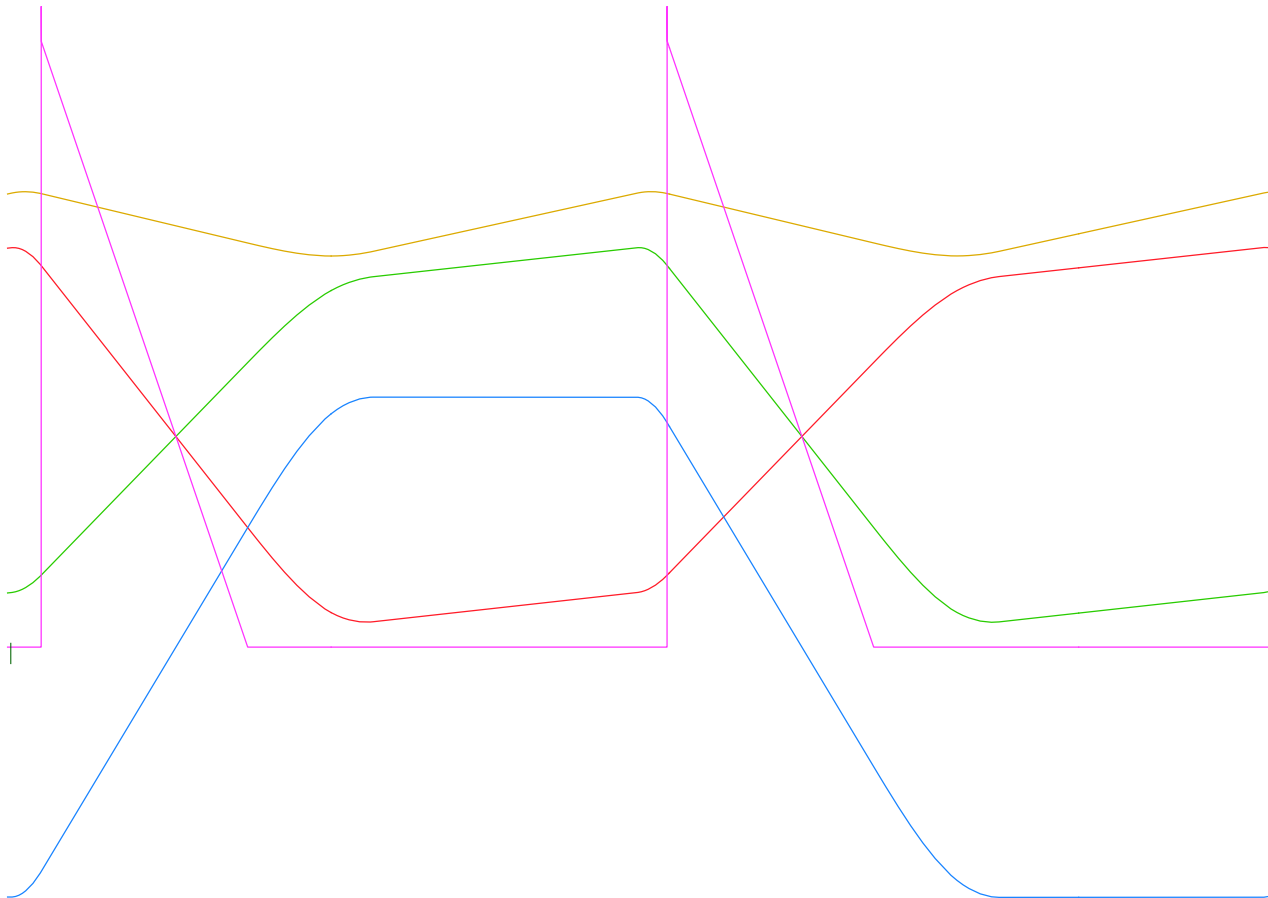


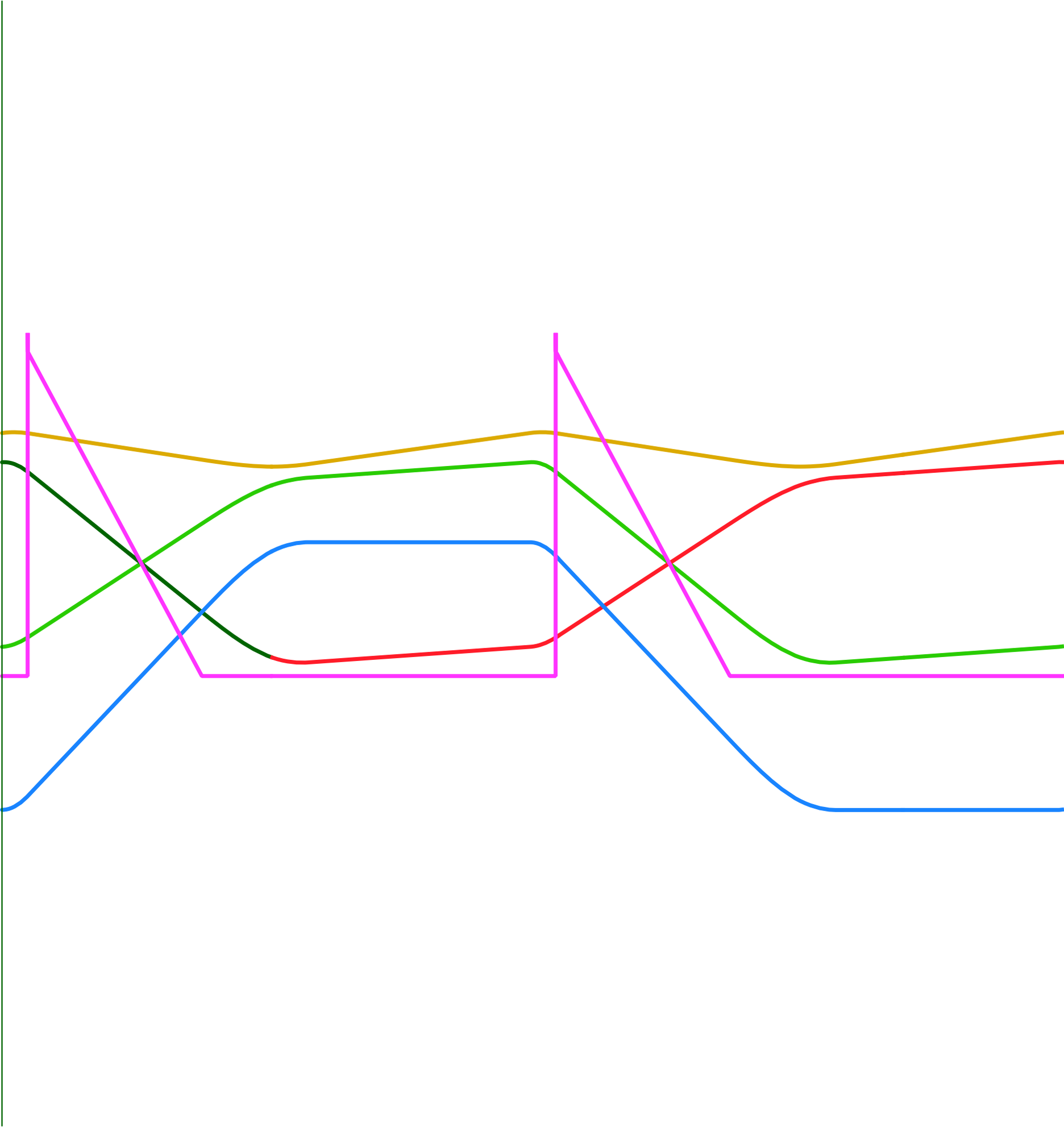

S_a
D_a
t
D_b
S_b
t
$i_{D_1}(t)$
I_{L1}
I_{L0}
$i_{D_2}(t)$
$i_{L_b}(t)$
$I_{L8} = I_{L0}$
I_{m3}
I_{L7}
I_{L6}
I_{m2}
I_{L3}
I_{L4}
$i_{L_a}(t)$
t
I_{L5}
$i_m(t)$
I_{m1}
I_{m0}
$v_r(t)$
0
t_1
t_2
t_3
$\frac{T_s}{2}$
t_4
V_o'
t_5
t_6
T_s
t

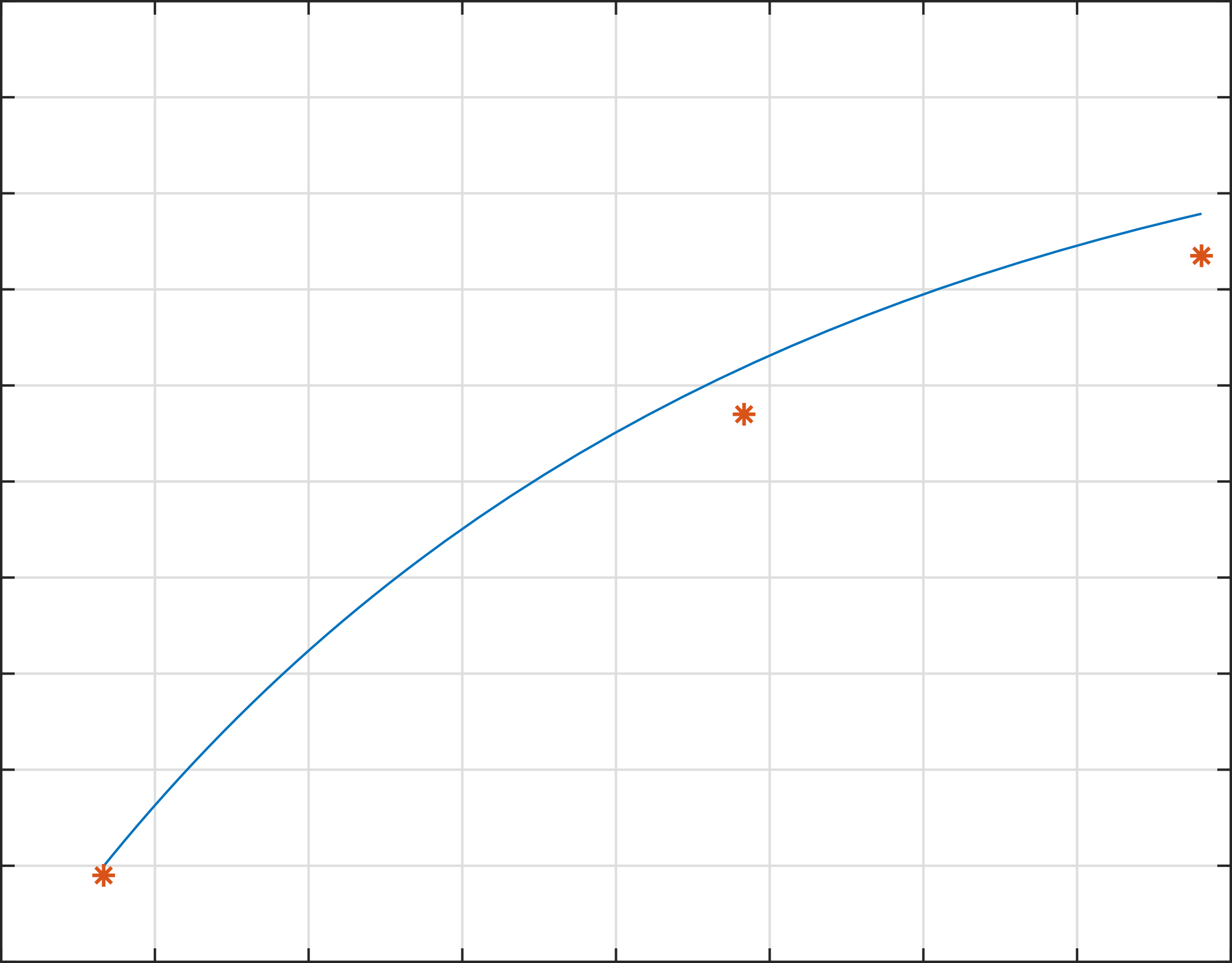

i_g
L_c
i_{L_b}
L_ℓ
D_1
i_m
i_{D_1}
V_g
L_ℓ
v_r
C_r
L_m
V_o'
i_{L_a}
i_L
L
V_g'

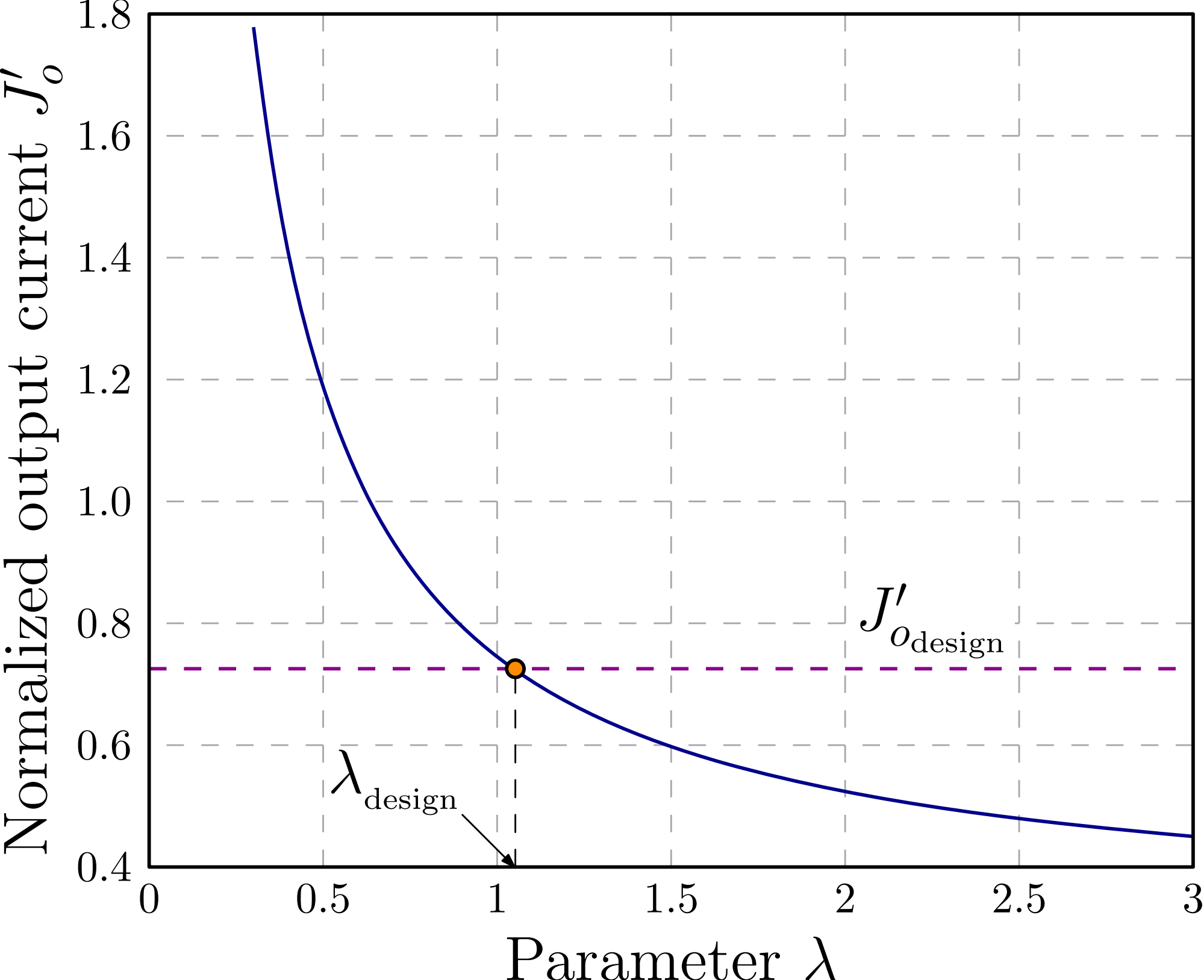

S_a
D_a
t
D_b
S_b
t
$i_{D_1}(t)$
I_{L1}
I_{L0}
$i_{D_2}(t)$
$i_{L_b}(t)$
$I_{L8} = I_{L0}$
I_{m3}
I_{L7}
I_{L6}
I_{m2}
I_{L3}
I_{L4}
$i_{L_a}(t)$
t
I_{L5}
$i_m(t)$
I_{m1}
I_{m0}
$v_r(t)$
0
t_1
t_2
t_3
$\frac{T_s}{2}$
t_4
V_o'
t_5
t_6
T_s
t

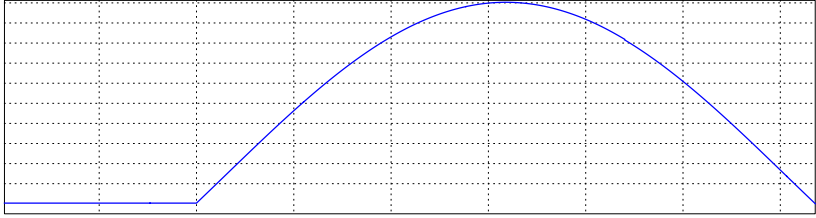


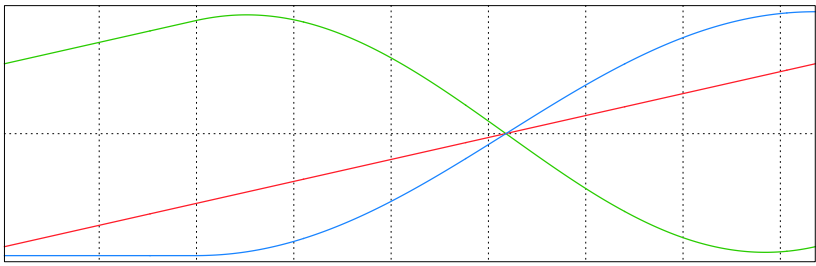


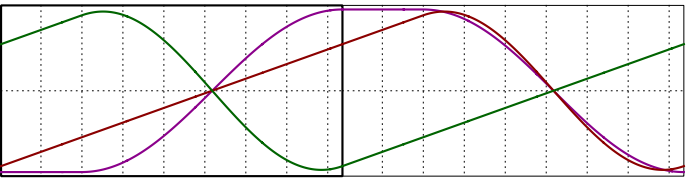


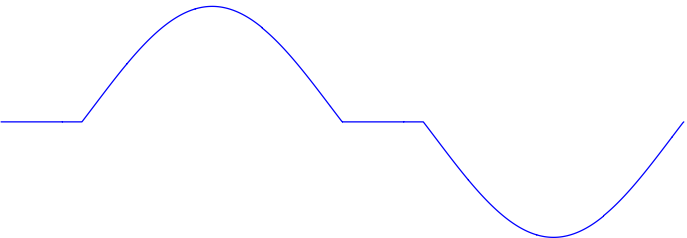


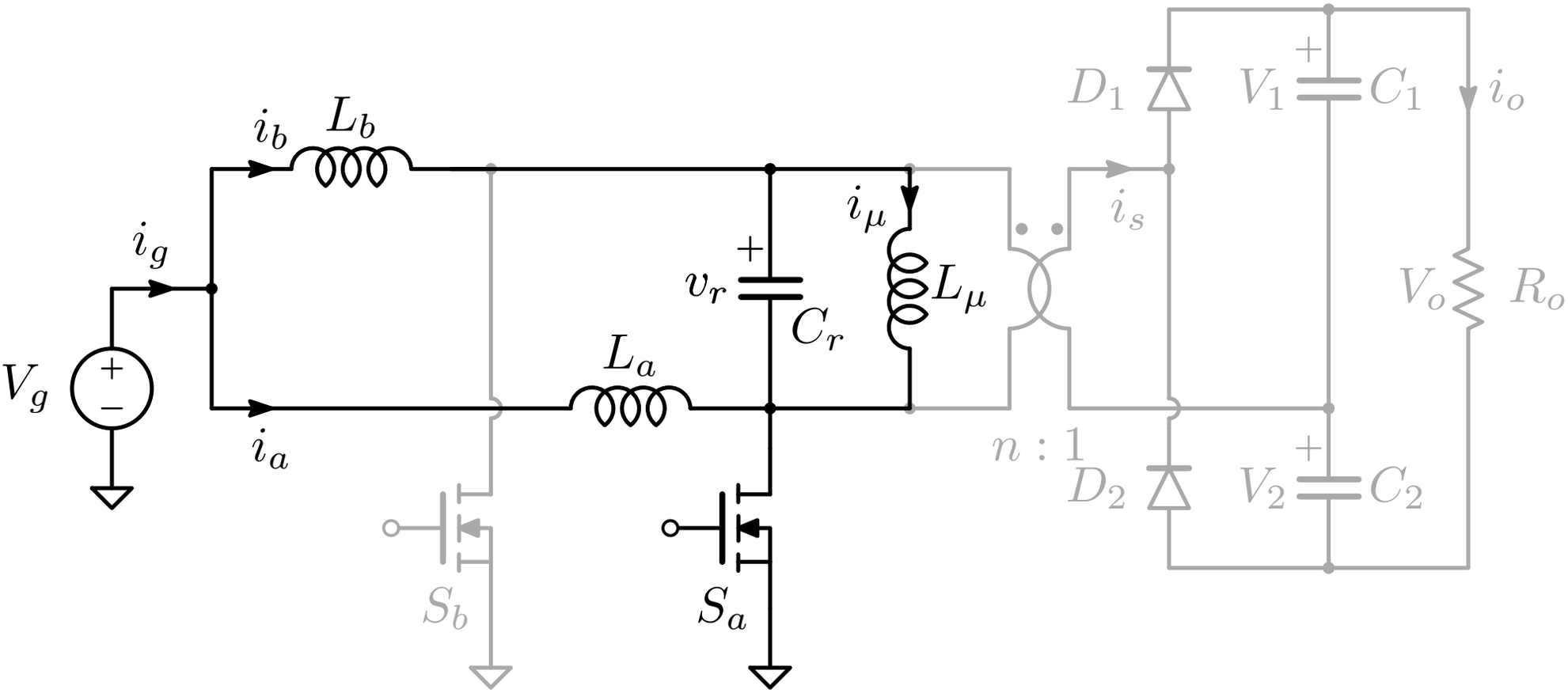

Normalized output current J'_o
Parameter λ
$J'_{o_{\text{design}}}$
λ_{design}
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0
0.5
1
1.5
2
2.5
3

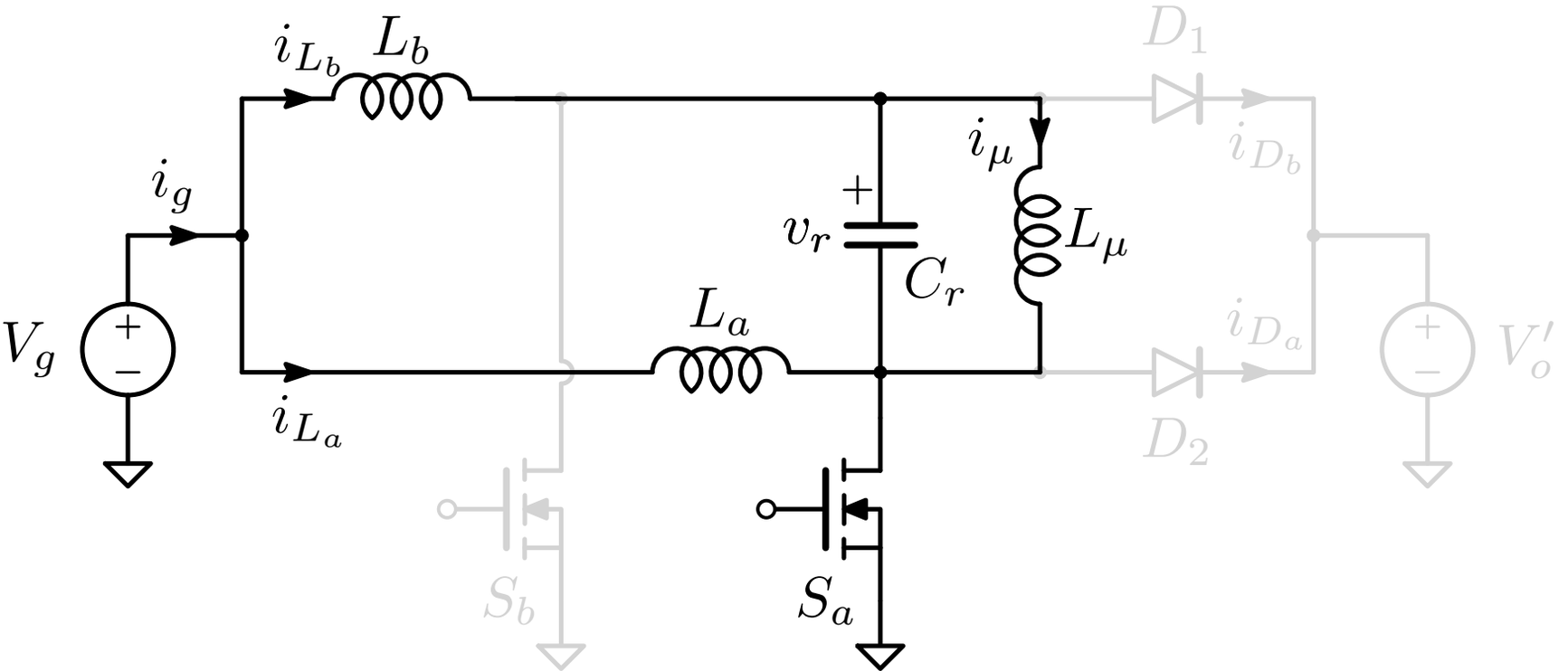


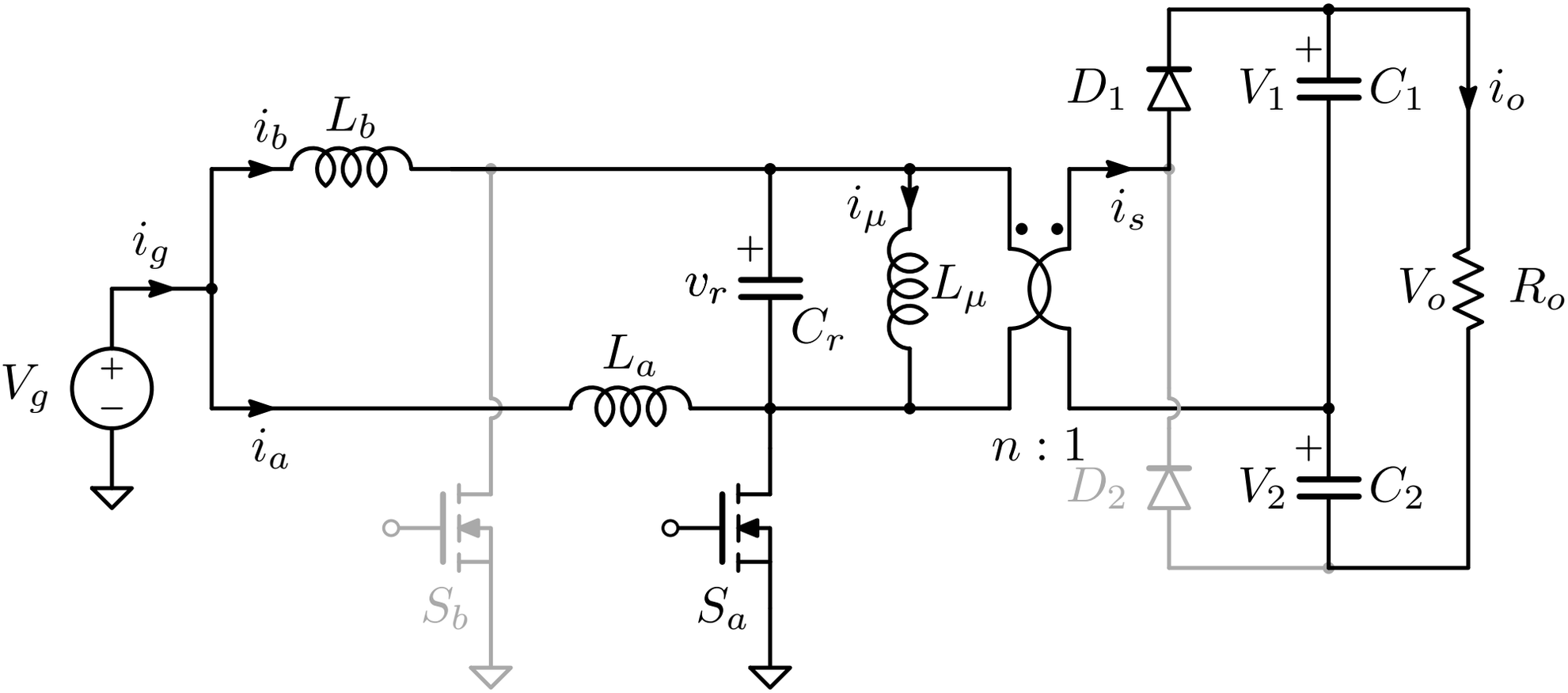


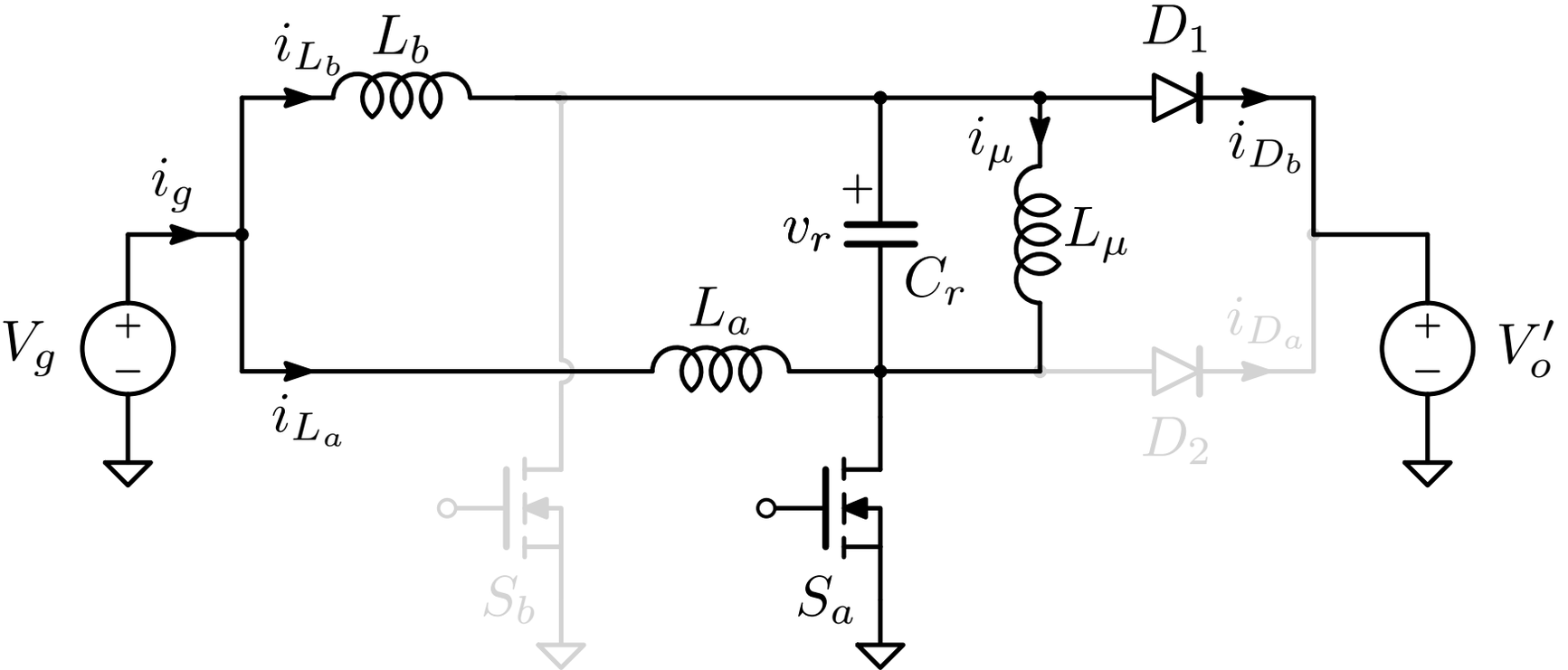


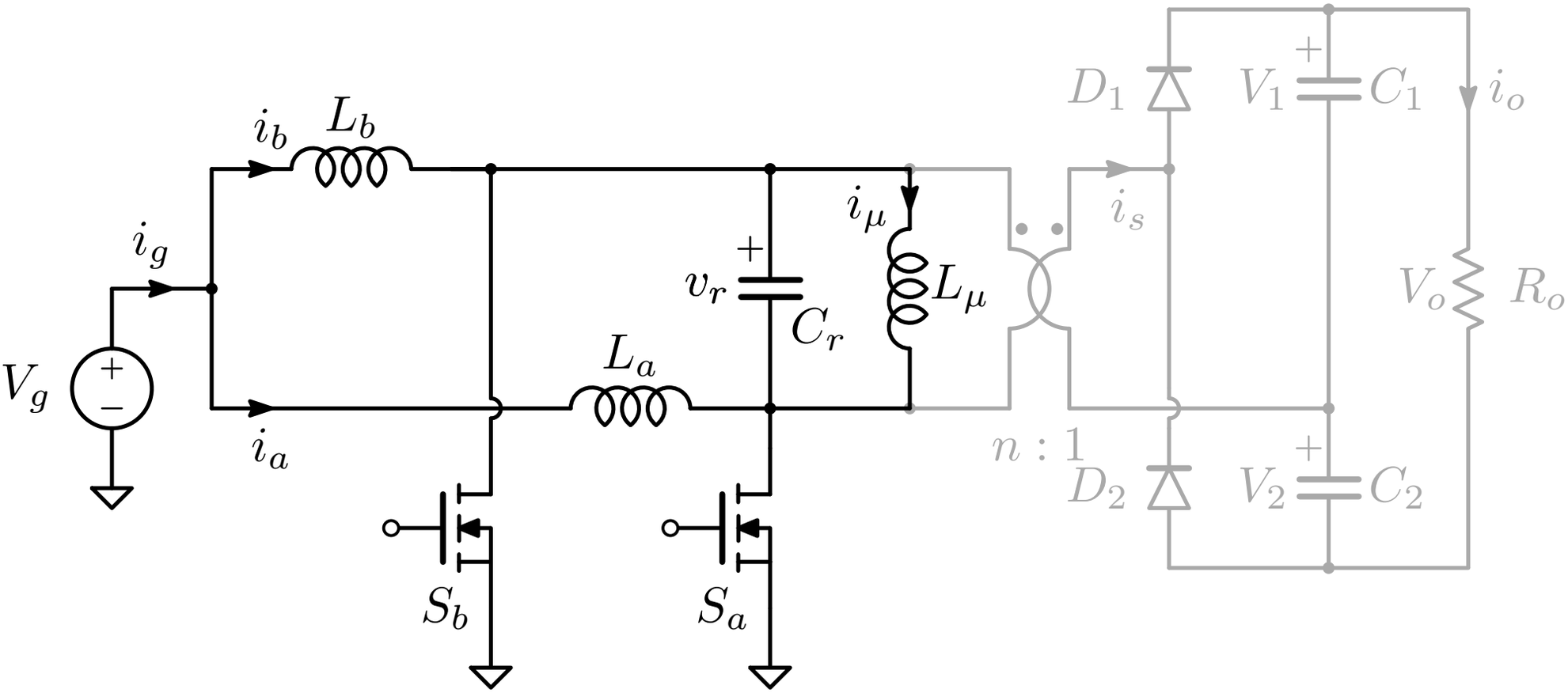


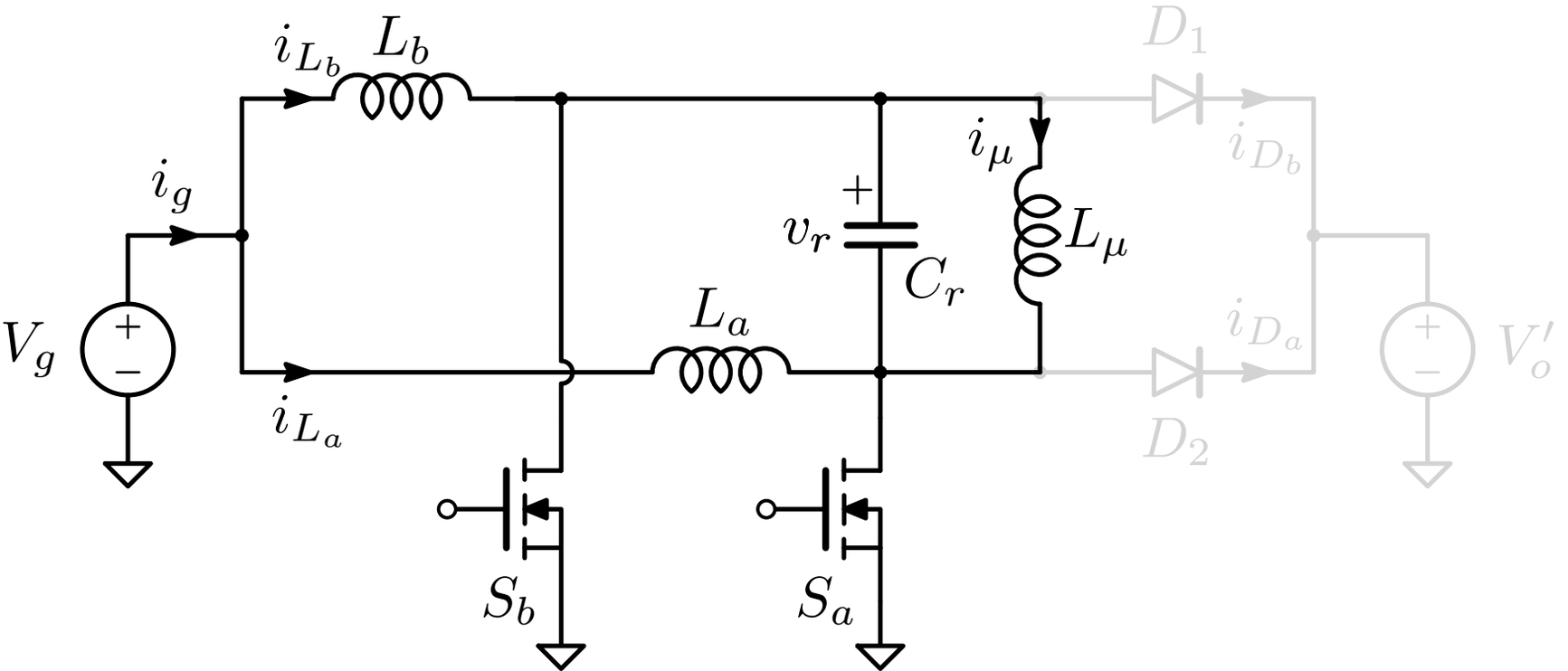

i_b
L_b
i_g
V_g
i_a
L_a
v_r
C_r
i_μ
L_μ
$n:1$
i_s
D_1
V_1
C_1
i_o
V_o
R_o
D_2
V_2
C_2
S_b
S_a

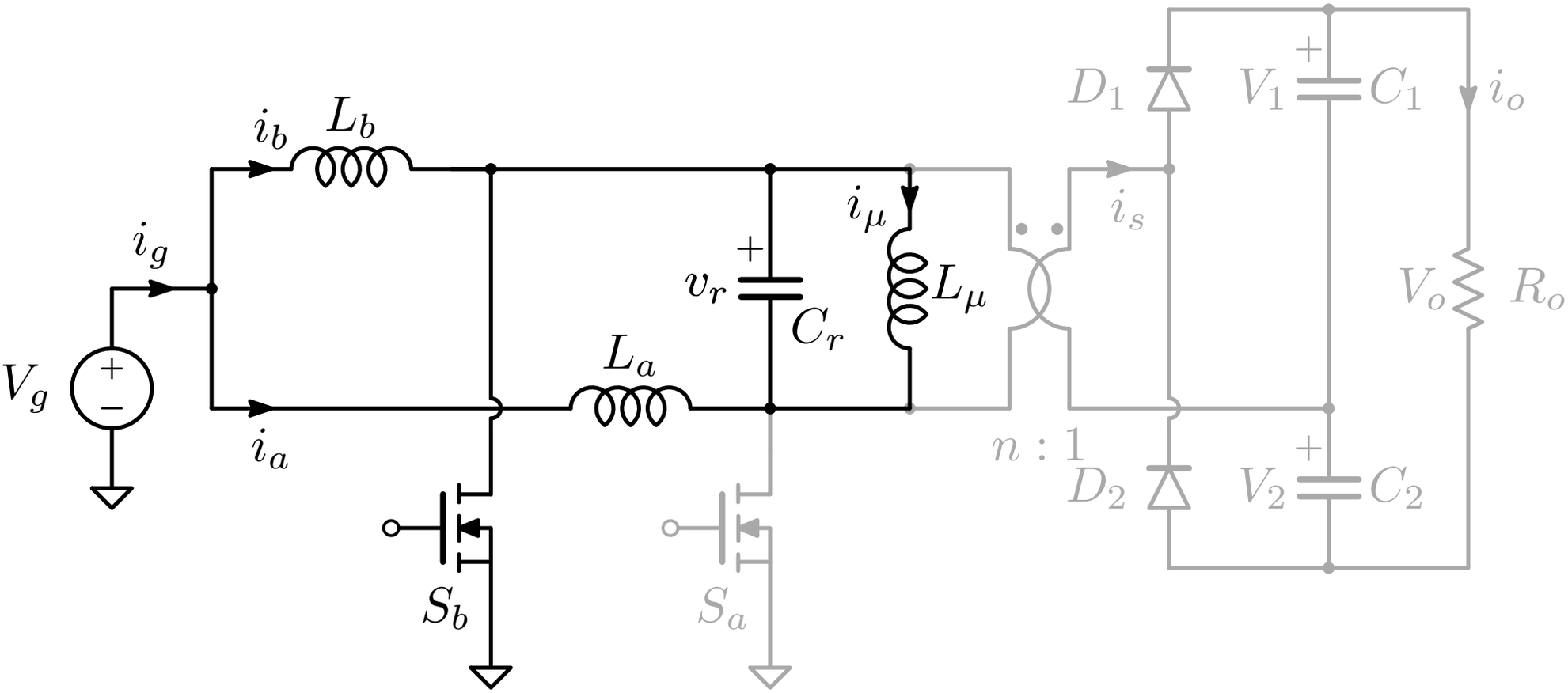

i_{L_b}
L_b
i_g
V_g
i_{L_a}
L_a
v_r
C_r
i_μ
L_μ
D_1
i_{D_b}
i_{D_a}
D_2
V_o'
S_b
S_a

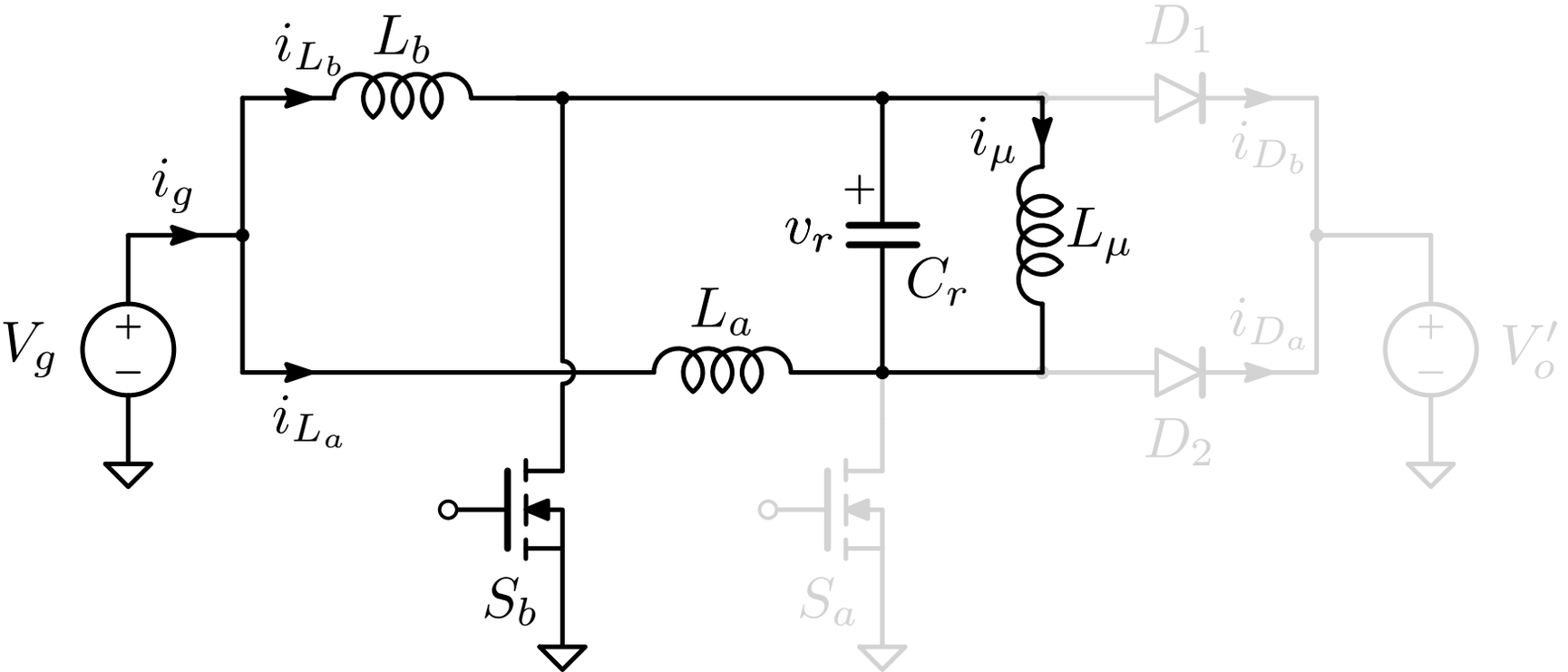

i_b
L_b
i_g
V_g
i_a
L_a
v_r
C_r
i_μ
L_μ
i_s
D_1
V_1
C_1
i_o
V_o
R_o
$n:1$
D_2
V_2
C_2
S_b
S_a

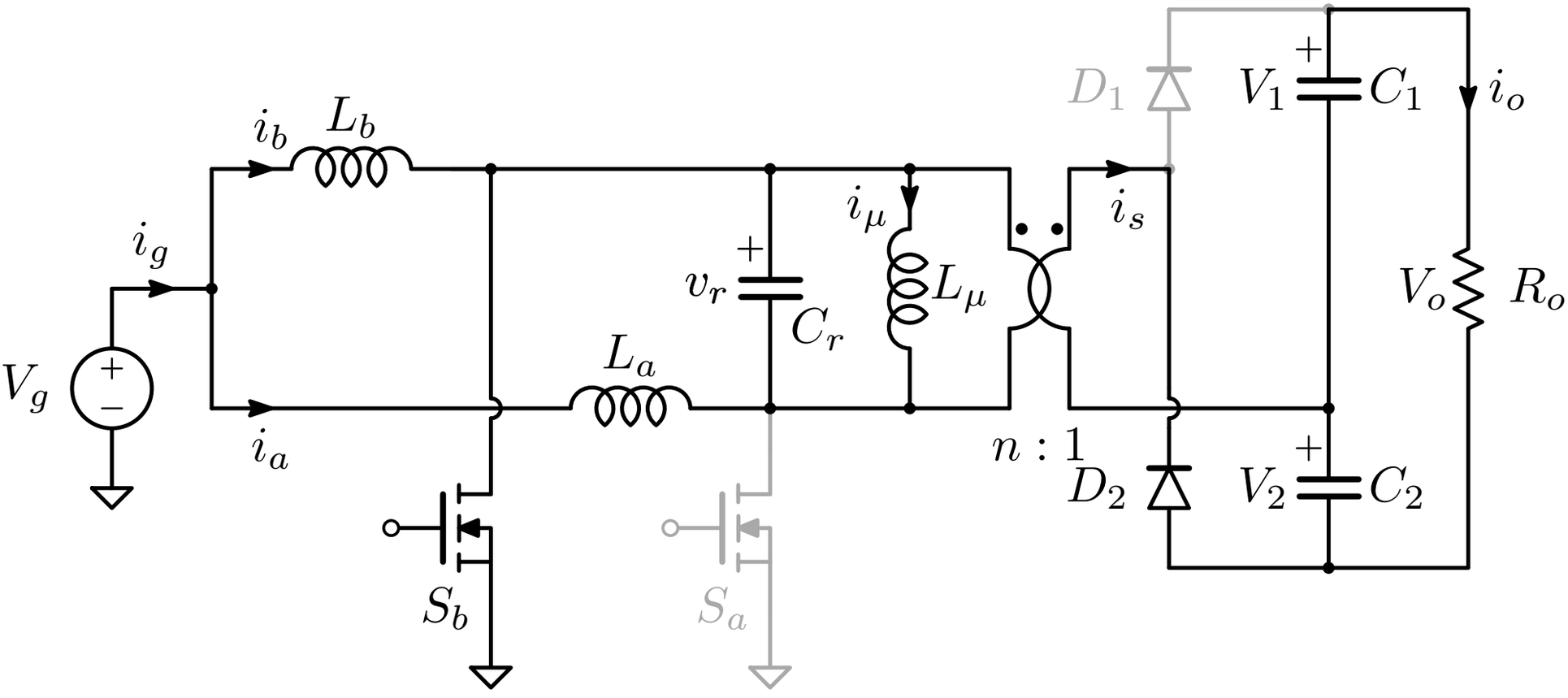

i_{L_b}
L_b
i_g
V_g
i_{L_a}
L_a
v_r
C_r
i_μ
L_μ
D_1
i_{D_b}
i_{D_a}
D_2
V_o'
S_b
S_a

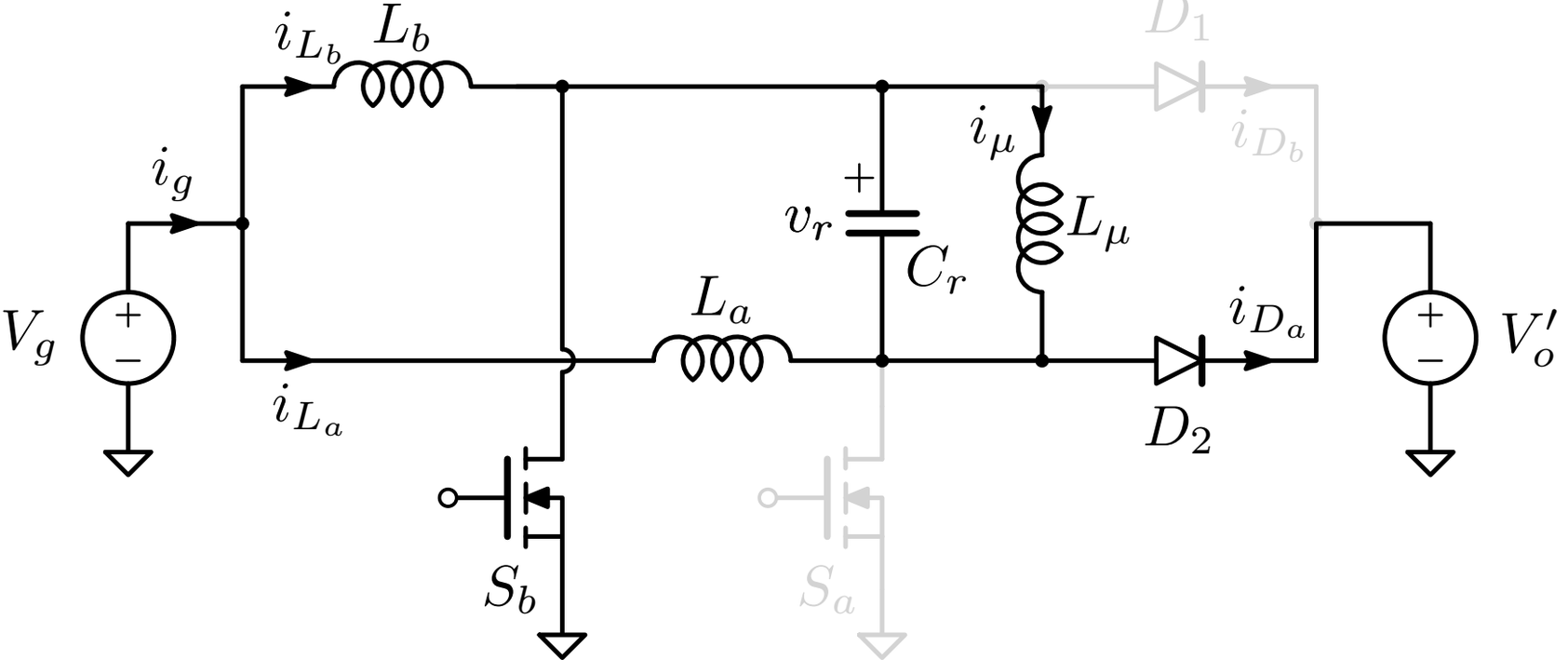

i_b
L_b
i_g
V_g
i_a
L_a
v_r
C_r
i_μ
L_μ
S_b
S_a
$n:1$
i_s
D_1
V_1
C_1
i_o
V_o
R_o
D_2
V_2
C_2

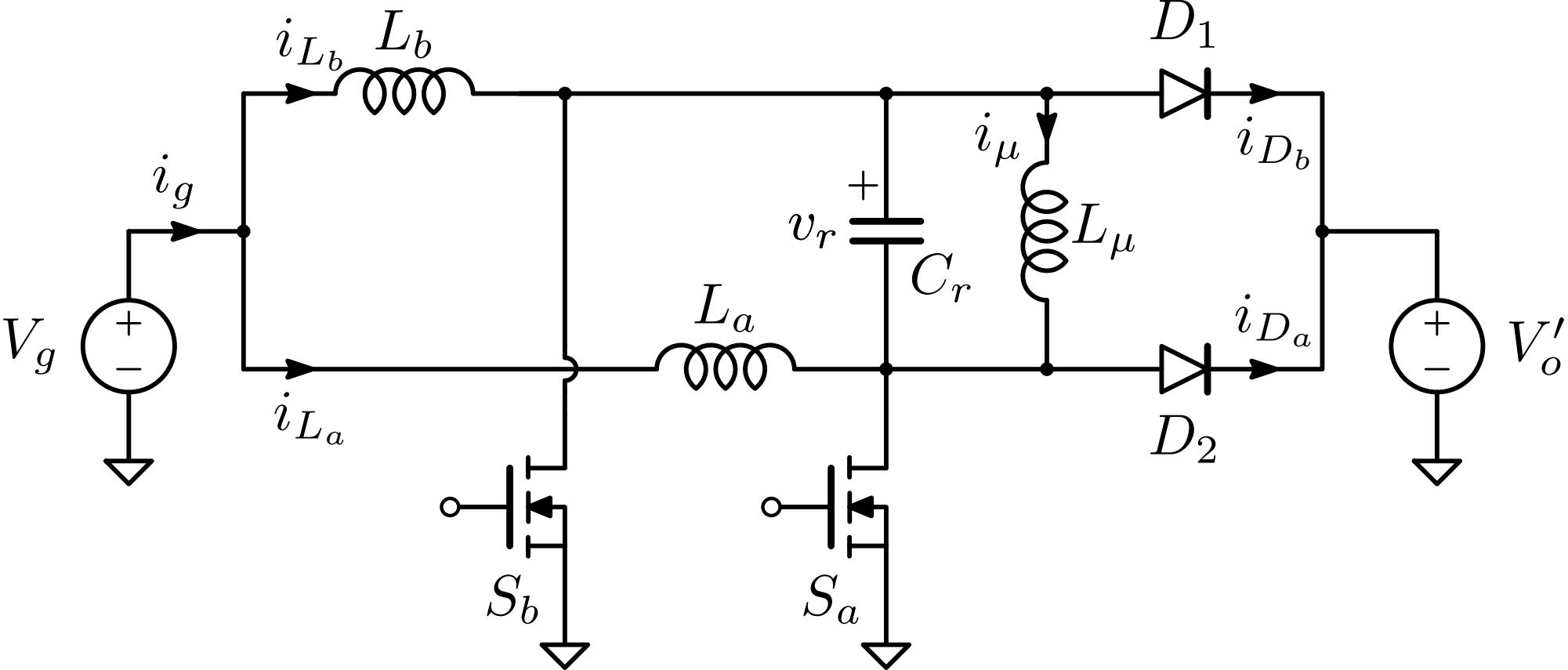

i_{L_b}
L_b
i_g
V_g
i_{L_a}
L_a
v_r
C_r
i_μ
L_μ
S_b
S_a
D_1
i_{D_b}
i_{D_a}
D_2
V_o'

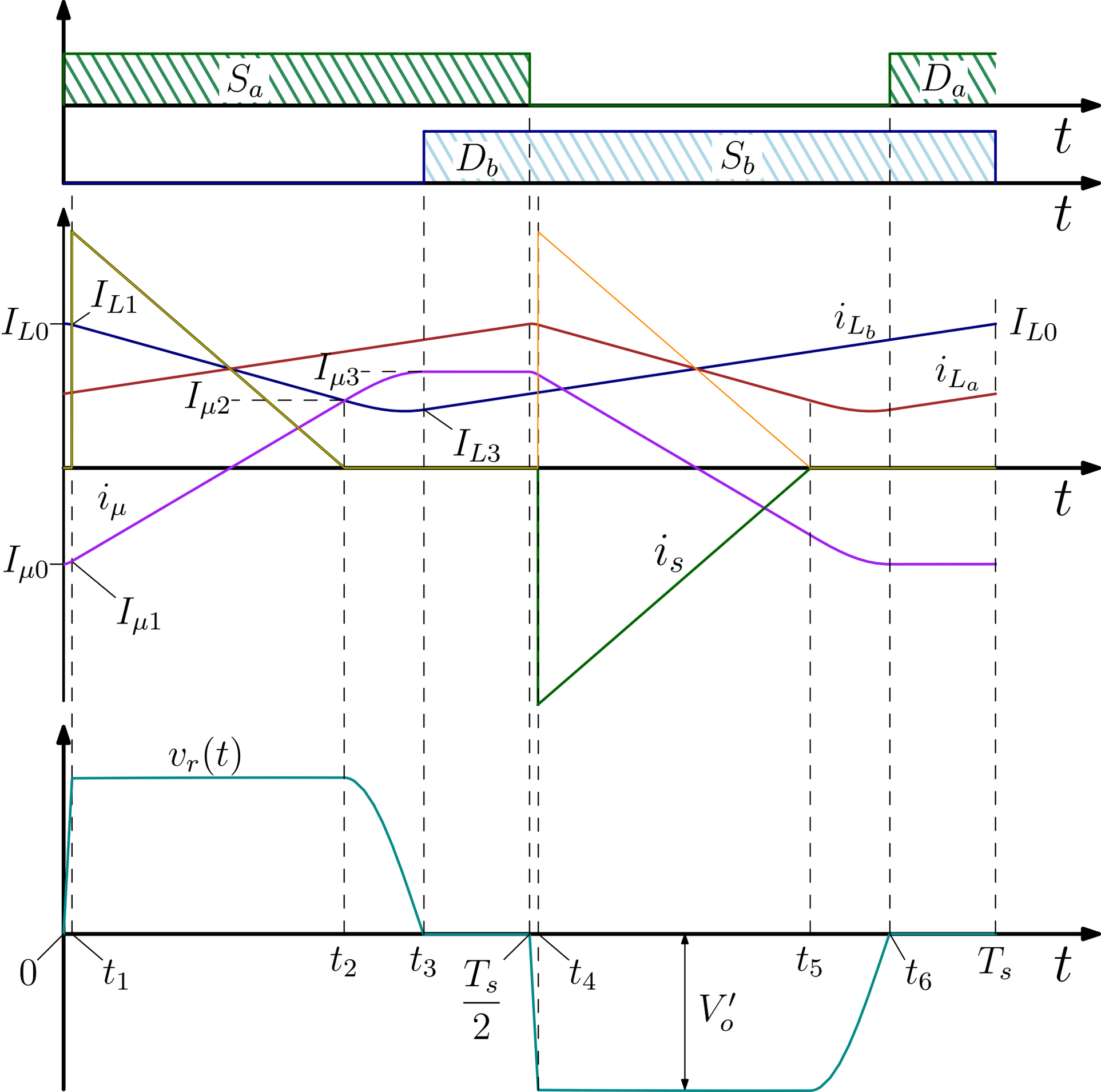

i_b
L_b
i_g
V_g
i_a
S_b
v_r
C_r
L_a
S_a
i_μ
L_μ
$n:1$
i_s
D_1
V_1
C_1
i_o
V_o
R_o
D_2
V_2
C_2

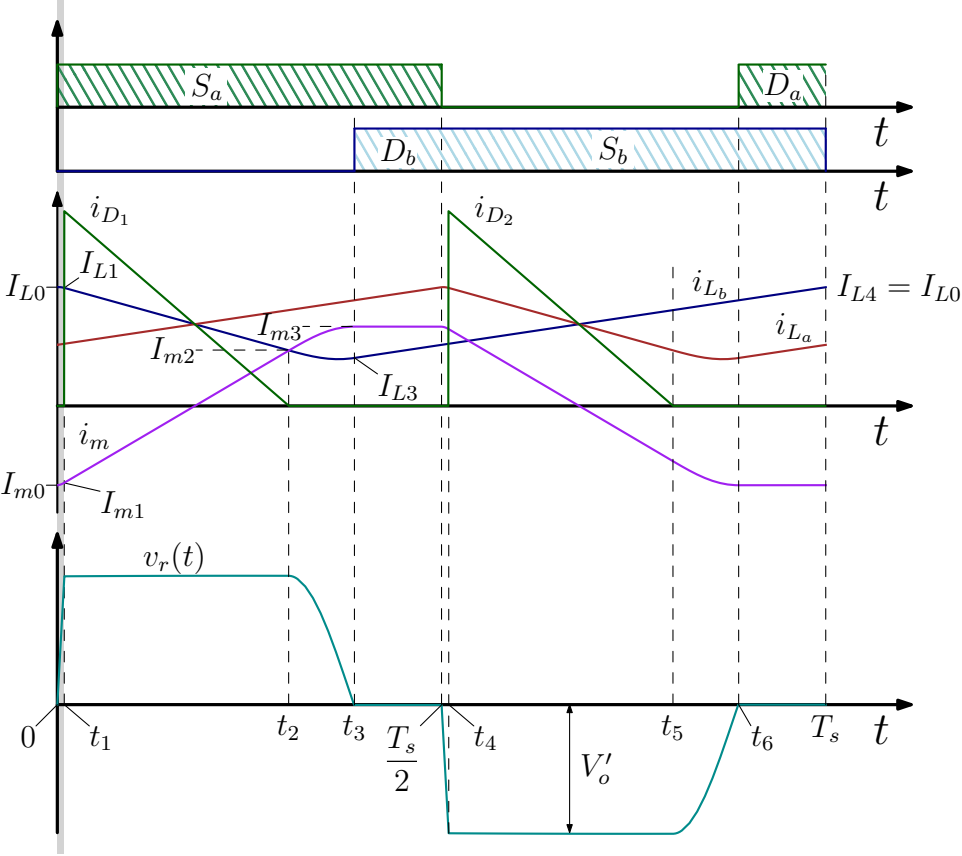

i_{L_b}
L_b
i_g
V_g
i_{L_a}
S_b
v_r
C_r
L_a
S_a
i_μ
L_μ
D_1
i_{D_b}
i_{D_a}
D_2
V_o'

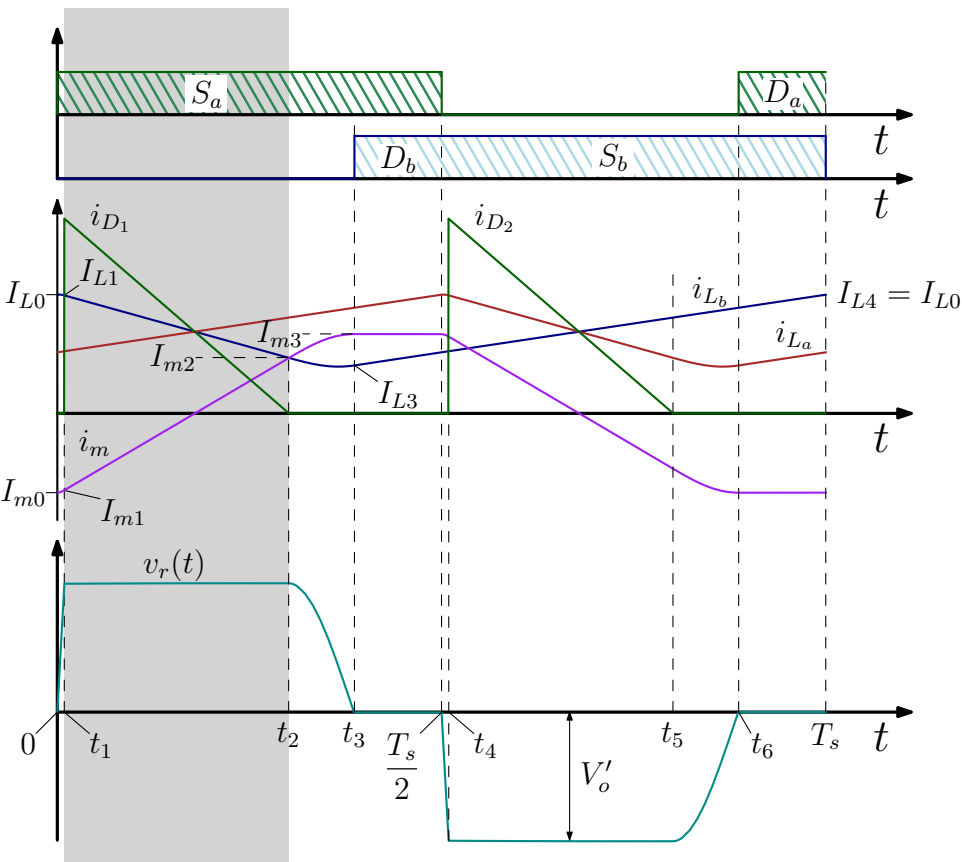

i_b
L_b
i_g
V_g
i_a
L_a
v_r
C_r
i_μ
L_μ
i_s
$n:1$
D_1
V_1
C_1
i_o
V_o
R_o
D_2
V_2
C_2
S_b
S_a

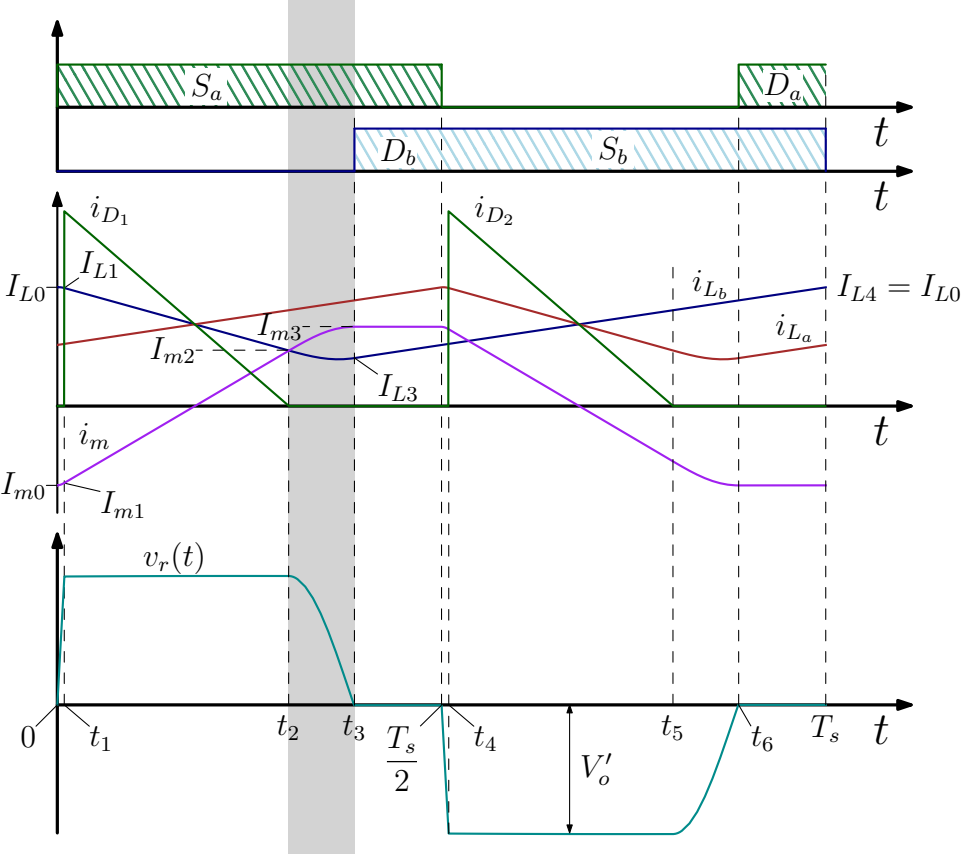

i_{L_b}
L_b
i_g
V_g
i_{L_a}
L_a
v_r
C_r
i_μ
L_μ
D_1
i_{D_b}
i_{D_a}
D_2
V_o'
S_b
S_a

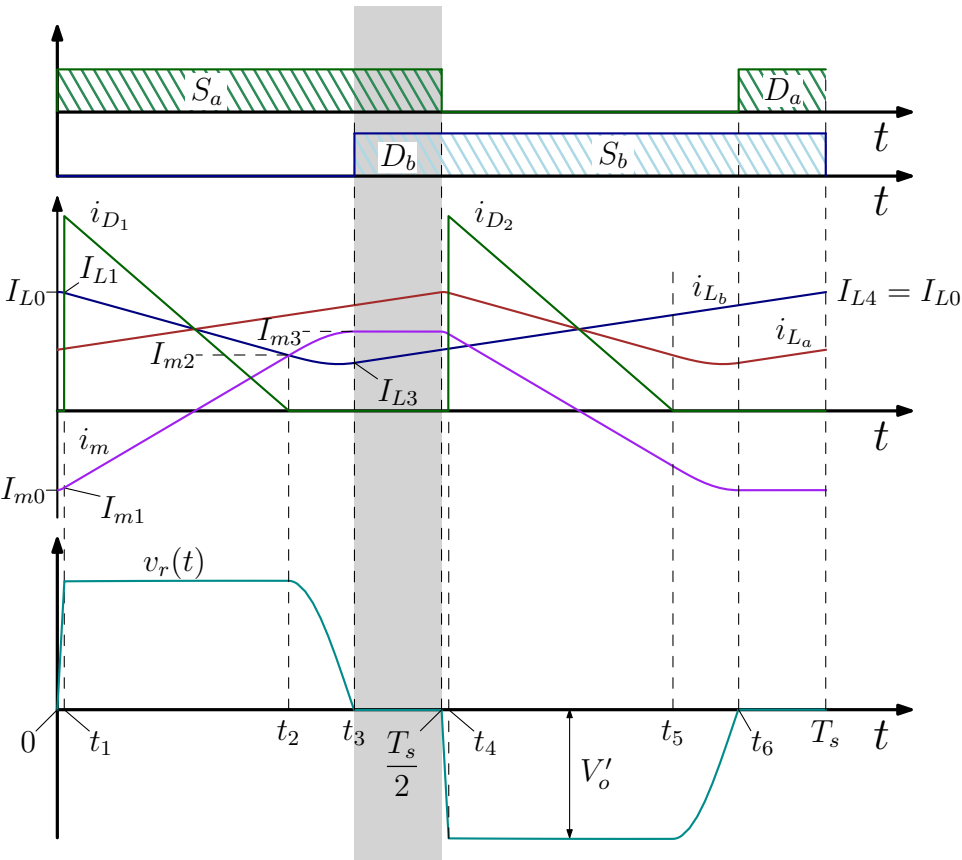

i_{L_b}
L_b
D_1
i_μ
i_{D_b}
i_g
v_r
C_r
L_μ
V_g
L_a
i_{D_a}
V_o'
i_{L_a}
D_2
S_b
S_a

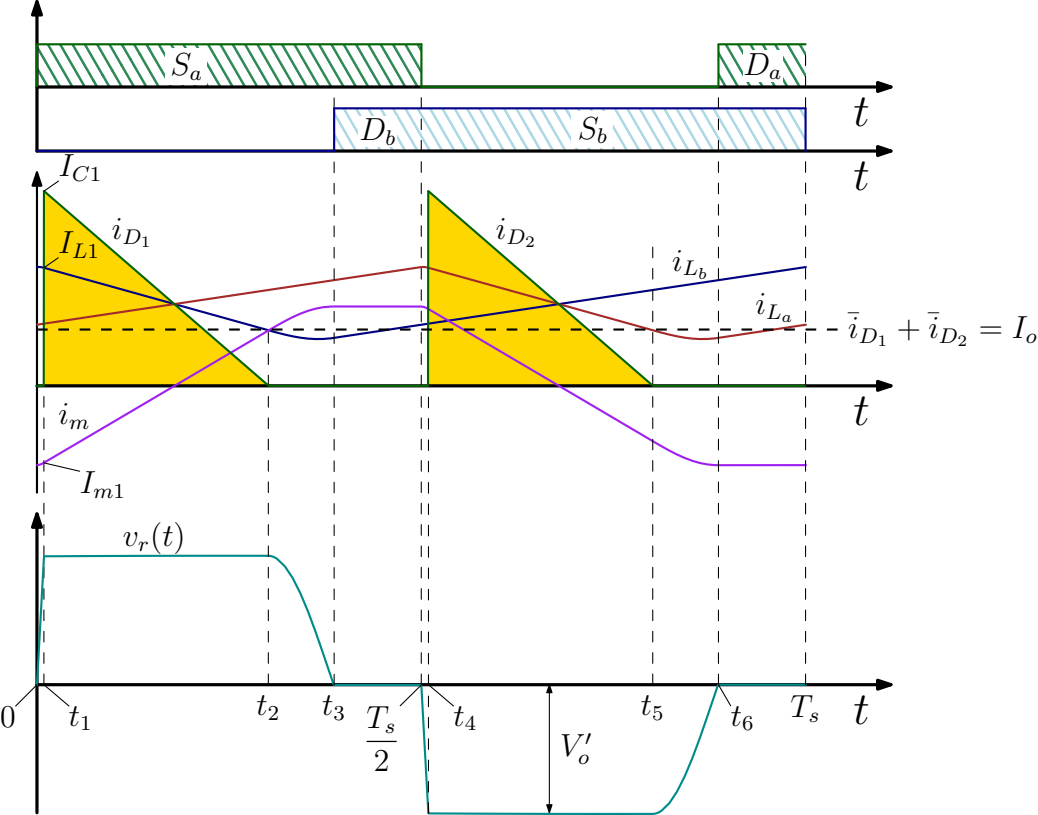

S_a
D_a
t
D_b
S_b
t
I_{L1}
I_{L0}
i_{L_b}
I_{L0}
$I_{\mu 3}$
i_{L_a}
$I_{\mu 2}$
I_{L3}
t
i_μ
i_s
$I_{\mu 0}$
$I_{\mu 1}$
$v_r(t)$
0
t_1
t_2
t_3
$\frac{T_s}{2}$
t_4
V_o'
t_5
t_6
T_s
t

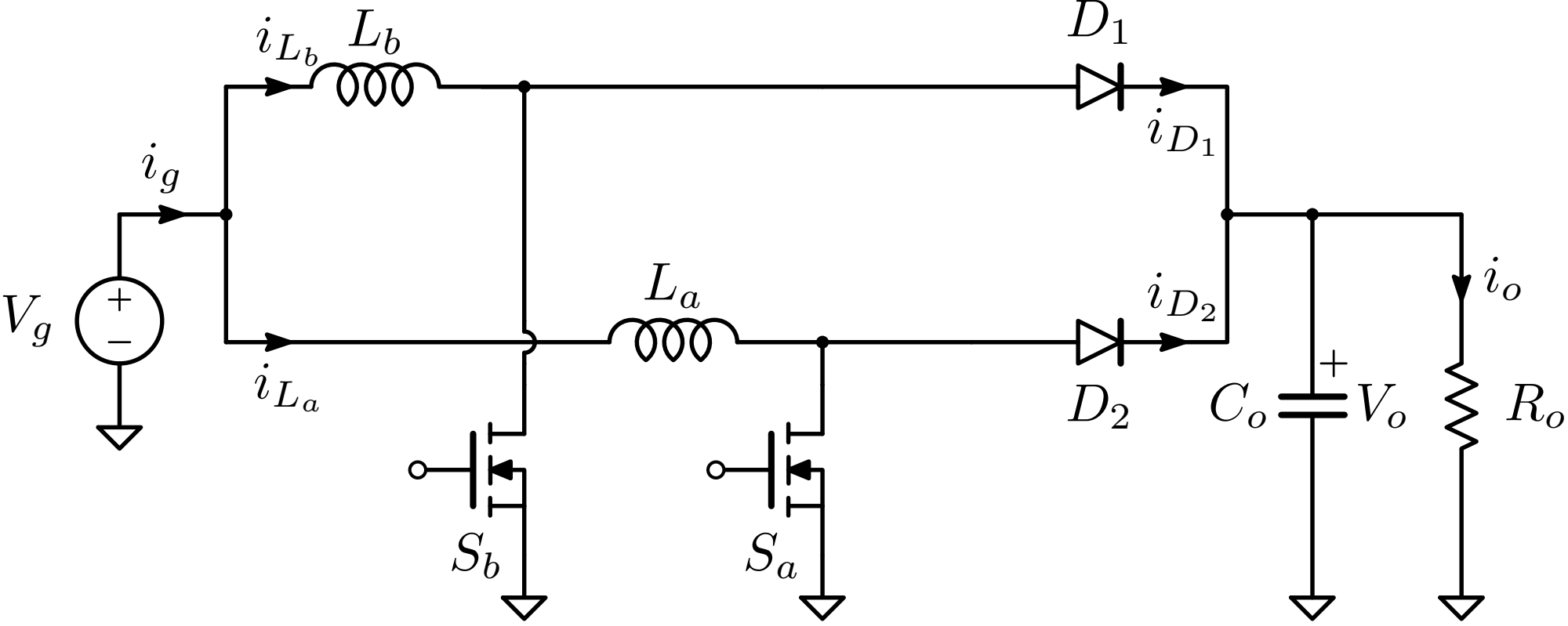

S_a
D_a
t
D_b
S_b
t
i_{D_1}
i_{D_2}
I_{L0}
I_{L1}
i_{L_b}
$I_{L4} = I_{L0}$
I_{m2}
I_{m3}
i_{L_a}
I_{L3}
t
i_m
I_{m0}
I_{m1}
$v_r(t)$
0
t_1
t_2
t_3
$\frac{T_s}{2}$
t_4
V_o'
t_5
t_6
T_s
t

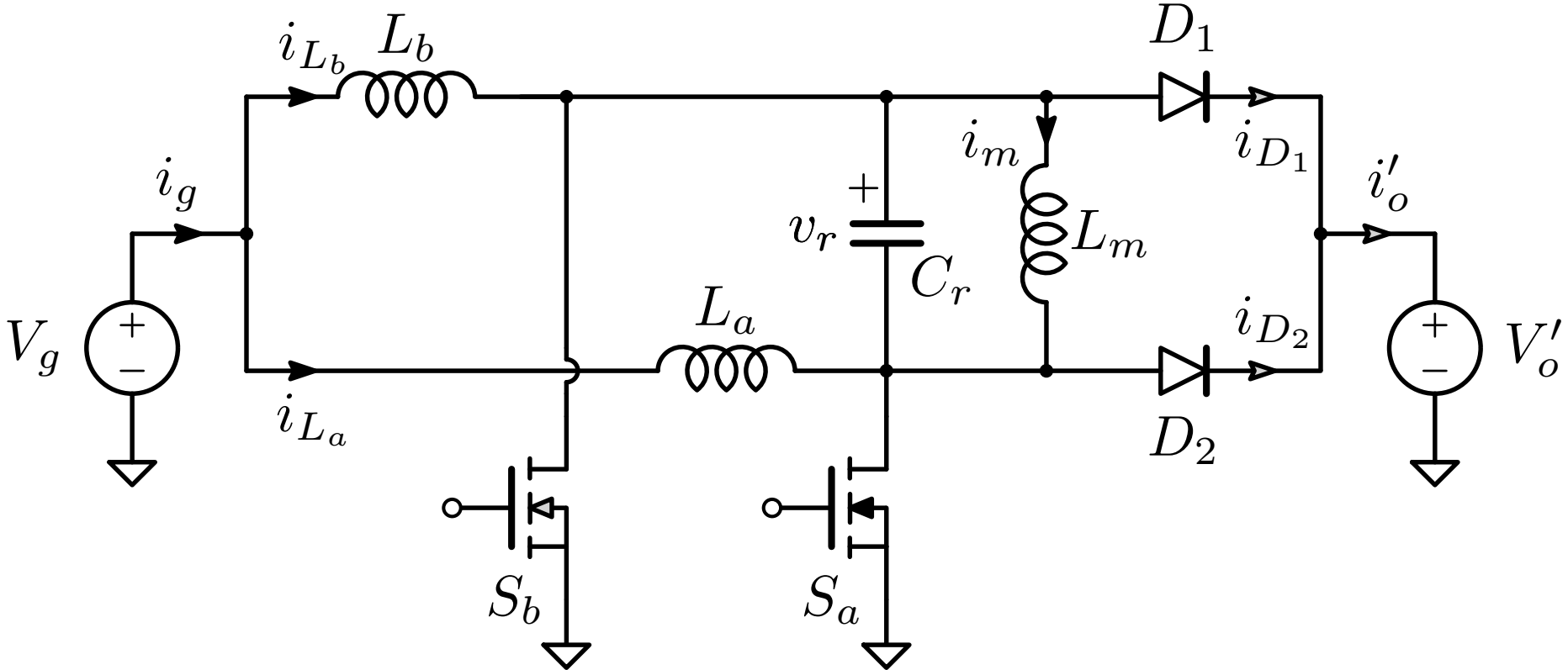

S_a
D_a
t
D_b
S_b
t
i_{D_1}
i_{D_2}
I_{L0}
I_{L1}
i_{L_b}
$I_{L4} = I_{L0}$
I_{m2}
I_{m3}
i_{L_a}
I_{L3}
t
i_m
I_{m0}
I_{m1}
$v_r(t)$
0
t_1
t_2
t_3
$\frac{T_s}{2}$
t_4
V_o'
t_5
t_6
T_s
t

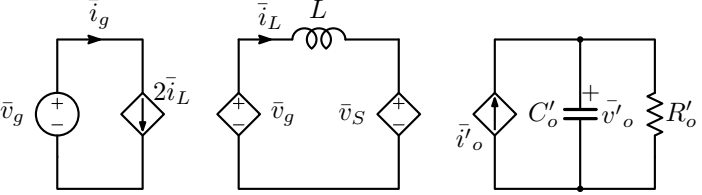

S_a
D_a
t
D_b
S_b
t
i_{D_1}
i_{D_2}
I_{L0}
I_{L1}
i_{L_b}
$I_{L4} = I_{L0}$
I_{m3}
I_{m2}
i_{L_a}
I_{L3}
t
i_m
I_{m0}
I_{m1}
$v_r(t)$
0
t_1
t_2
t_3
$\frac{T_s}{2}$
t_4
t_5
t_6
T_s
t
V_o'

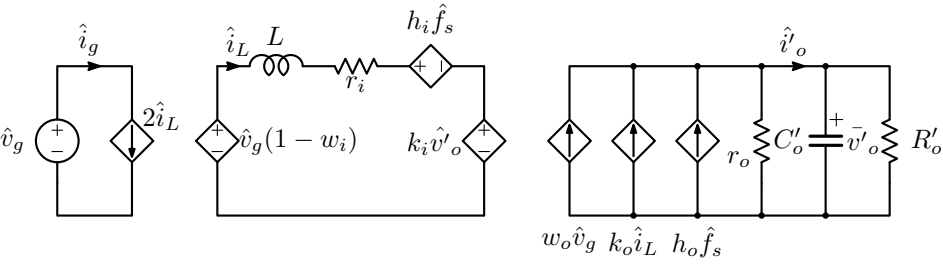

S_a
D_a
t
D_b
S_b
t
i_{D_1}
i_{D_2}
I_{L0}
I_{L1}
i_{L_b}
$I_{L4} = I_{L0}$
I_{m3}
I_{m2}
i_{L_a}
I_{L3}
t
i_m
I_{m0}
I_{m1}
$v_r(t)$
0
t_1
t_2
t_3
$\frac{T_s}{2}$
t_4
t_5
t_6
T_s
t
V_o'

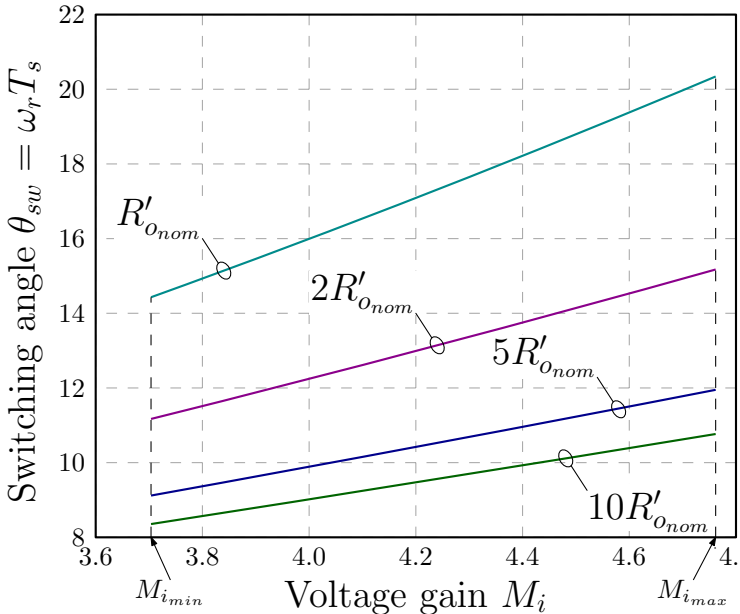

S_a
D_a
t
D_b
S_b
t
I_{C1}
i_{D_1}
I_{L1}
i_{D_2}
i_{L_b}
i_{L_a}
$\bar{i}_{D_1} + \bar{i}_{D_2} = I_o$
t
i_m
I_{m1}
$v_r(t)$
0
t_1
t_2
t_3
$\frac{T_s}{2}$
t_4
V_o'
t_5
t_6
T_s
t

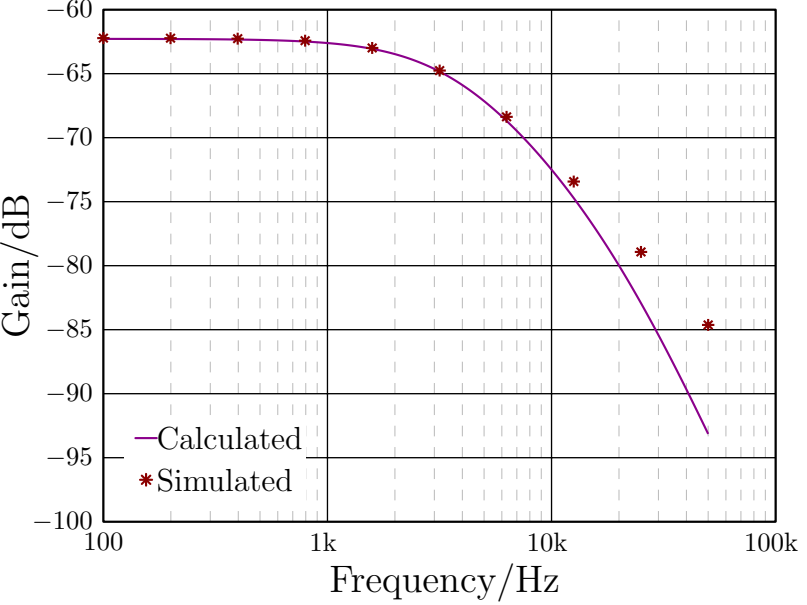

i_{L_b}
L_b
D_1
i_{D_1}
i_g
V_g
L_a
i_{D_2}
i_o
i_{L_a}
D_2
C_o
V_o
R_o
S_b
S_a

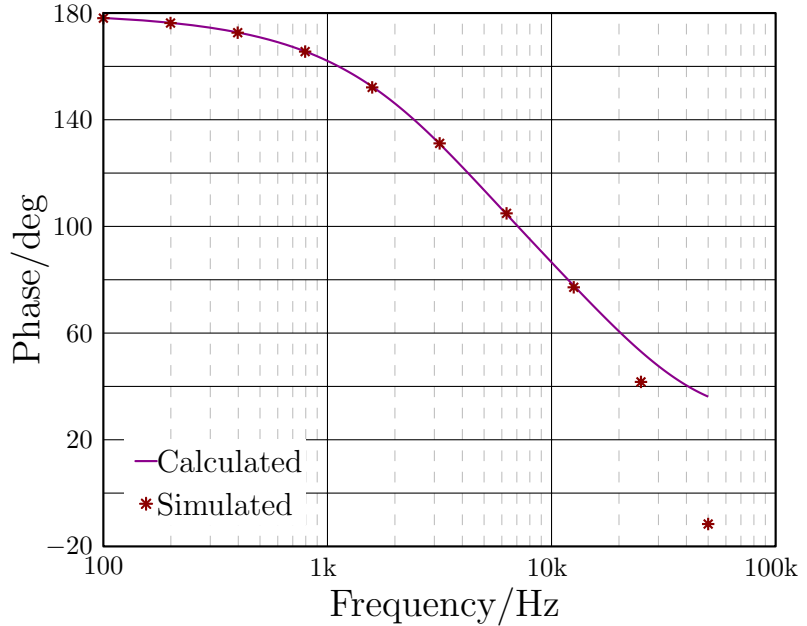

i_{L_b}
L_b
D_1
i_m
i_{D_1}
i_g
v_r
C_r
L_m
i'_o
V_g
L_a
i_{D_2}
V'_o
i_{L_a}
D_2
S_b
S_a

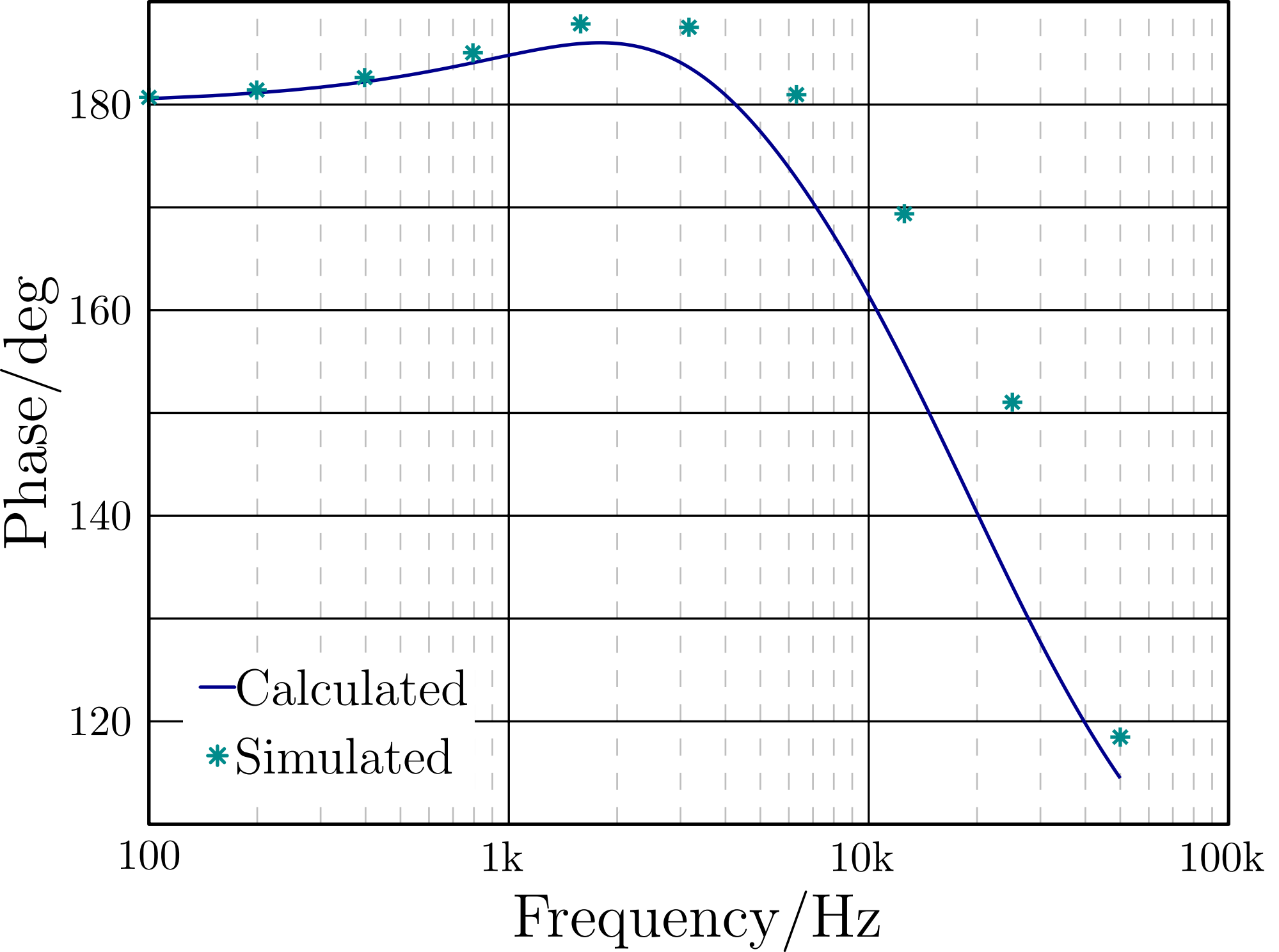

$\bar{i}_g$
$\bar{v}_g$
$2\bar{i}_L$
$\bar{i}_L$
L
$\bar{v}_g$
$\bar{v}_S$
$\bar{i}'_o$
C'_o
$\bar{v}'_o$
R'_o


$\hat{i}_g$
$\hat{v}_g$
$2\hat{i}_L$
$\hat{i}_L$
L
r_i
$h_i\hat{f}_s$
$\hat{v}_g(1-w_i)$
$k_i\hat{v}'_o$
$\hat{i}'_o$
r_o
C'_o
$\bar{v}'_o$
R'_o
$w_o\hat{v}_g$
$k_o\hat{i}_L$
$h_o\hat{f}_s$


Switching angle $\theta_{sw} = \omega_r T_s$
Voltage gain M_i
$R'_{o_{nom}}$
$2R'_{o_{nom}}$
$5R'_{o_{nom}}$
$10R'_{o_{nom}}$
$M_{i_{min}}$
$M_{i_{max}}$
22
20
18
16
14
12
10
8
3.6
3.8
4.0
4.2
4.4
4.6
4.8


−60
−65
−70
−75
−80
−85
−90
−95
−100
Gain/dB
Calculated
Simulated
100
1k
10k
100k
Frequency/Hz


180
140
100
60
20
−20
Phase/deg
Calculated
Simulated
100
1k
10k
100k
Frequency/Hz


180
160
140
120
Phase/deg
100
1k
10k
100k
Frequency/Hz
Calculated
Simulated