

**TOSHIBA**

**Simple, Convenient and High performance!  
Toshiba Online Circuit Simulator**

Toshiba Electronic Devices & Storage Corporation

# Agenda

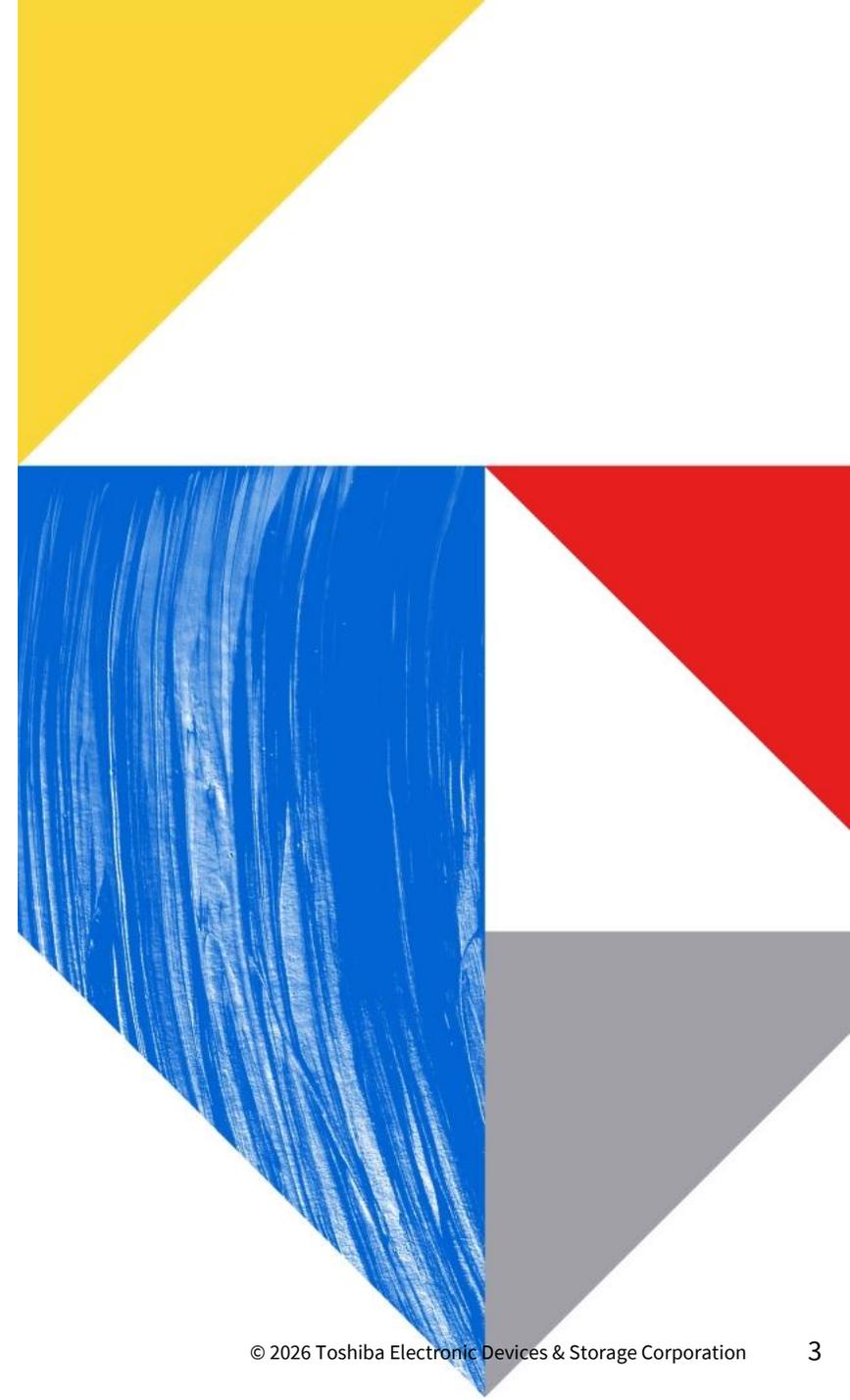
01 Introduction

02 Operation Instructions

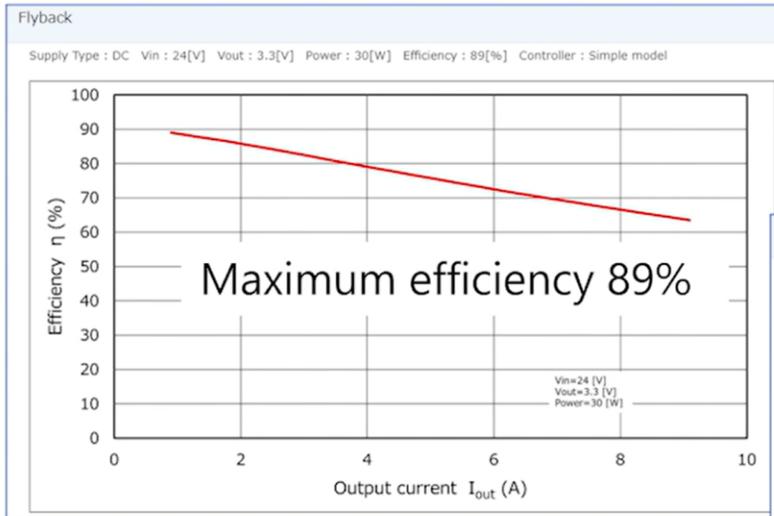
03 Summary

# 01

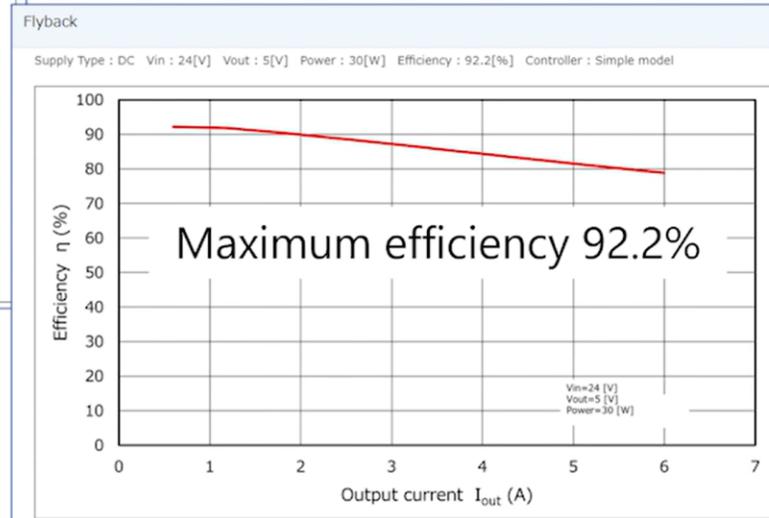
## Introduction



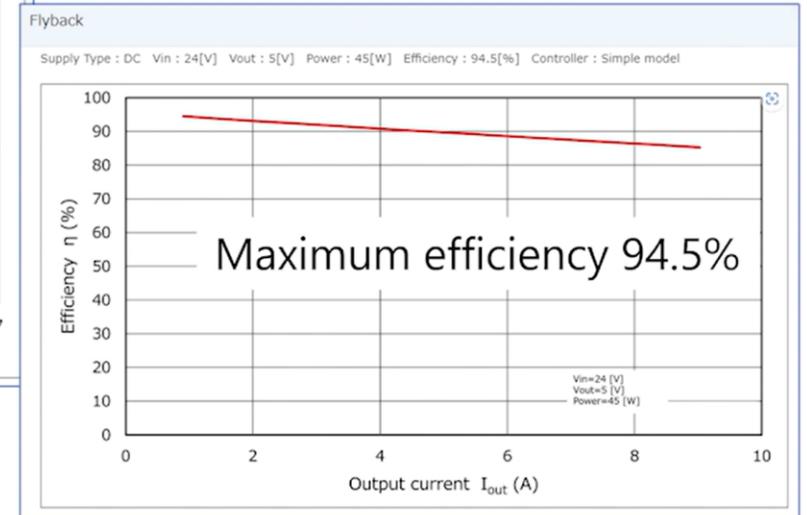
# Design of switching power supply circuits



MOSFET  
Primary= Product A  
Secondary= Product C



MOSFET  
Primary= Product A  
Secondary= Product B



MOSFET  
Primary= Product D  
Secondary= Product B

※The image is a simulator image and may differ from the actual screen

# Selection of MOSFET

[Back to Topology Select]

INPUT Vin : 24 [V]

OUTPUT Vout : 5 [V]

OUTPUT Power : 30 [W] (Current 6A)

Switching Freq : 100 [kHz]

Parts	Product Name	VDSS[V]	RON[mΩ] VGS=10V	Qg[nC] VGS=10V
Q1 Search	<input checked="" type="radio"/> TPN22006NH	60	22.0	12
	<input type="radio"/> TPN19008QM	80	19.0	16
	<input type="radio"/> TK30E06N1	60	15.0	16
	<input type="radio"/> TK30A06N1	60	15.0	16
	<input type="radio"/> TPN14006NH	60	14.0	15

Parts	Product Name	VDSS[V]	RON[mΩ] VGS=10V	Qrr[nC]
Q2 Search	<input checked="" type="radio"/> TPH4R803PL	30	4.8	14
	<input type="radio"/> TPH3R003PL	30	3.0	25
	<input type="radio"/> TPN2R903PL	30	2.9	17
	<input type="radio"/> TPH2R903PL	30	2.9	17
	<input type="radio"/> TPH2R003PL	30	2.0	43

DC-DC / Flyback

Fast mode (not calculate power loss)  
Accurate mode (Calculate power loss)

Run ?

Window1

Time 0 - 50.4 [μSec]

1:Q1:[TPN22006NH]Q2:[TPH4R803PL] Vin:24[V] Vout:5[V] Pout:30[W]

Graph1

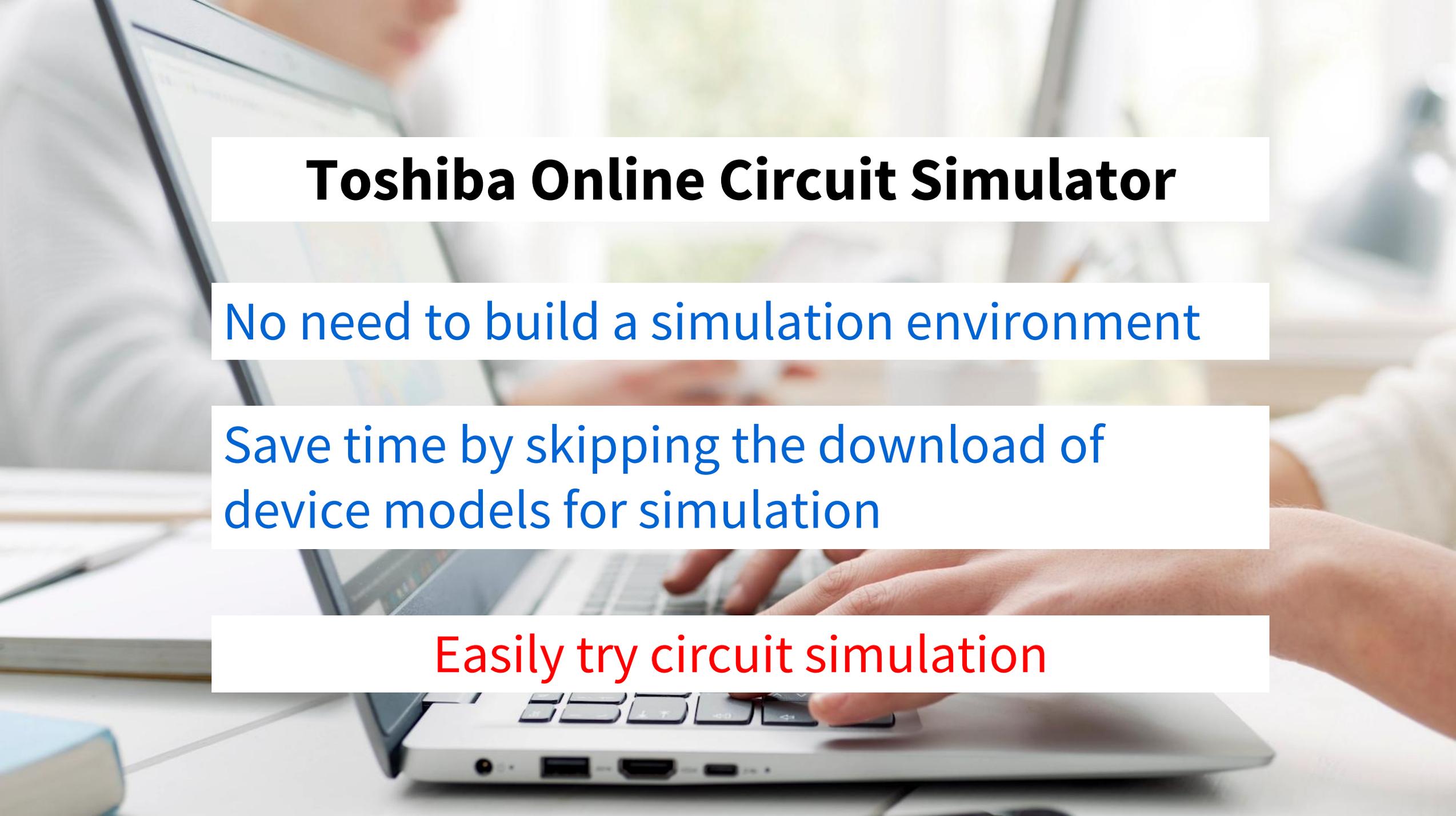
Window2

Time 0 - 50.4 [μSec]

1:Q1:[TPN22006NH]Q2:[TPH4R803PL] Vin:24[V] Vout:5[V] Pout:30[W]

Graph1

※The image is a simulator image and may differ from the actual screen

A person is using a laptop in a classroom or office setting. The background is blurred, showing other people and desks. The text is overlaid on the image in white boxes.

# **Toshiba Online Circuit Simulator**

No need to build a simulation environment

Save time by skipping the download of device models for simulation

**Easily try circuit simulation**

# Online Circuit Simulator

**TOSHIBA** Toshiba Electronic Devices & Storage Corporation Asia-Pacific - English CONTACT US

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## Online Circuit Simulator

### Update Information

- Dec.2025 A PCB Illustration Window has been added to the AC-DC and DC-DC Half-Bridge sections.
- Nov.2025 A Interleaved PFC topology has been added to the AC-DC converter.
- Oct.2025 A PCB Illustration Window has been added to the AC-DC and DC-DC Flyback, and the DC-DC Non-Isolated\_Buck\_Converter sections.
- Apr.2025 A Six-Phase Inverter has been added to the AC-DC converter.

List of Simulation Target Topologies Features Function Introduction/Operation Procedure Related information Contacts

The Online Circuit Simulator allows users to verify and select MOSFETs. Operation is easily verified without the hassle of building a simulation environment and downloading element models. By changing the MOSFET and circuit constants and comparing the simulation result waveforms and power conversion efficiency, you can identify the MOSFET that matches the target specifications.

Login is required to use the circuit simulator.

Start Simulation

Easy to simulate circuitry on Web

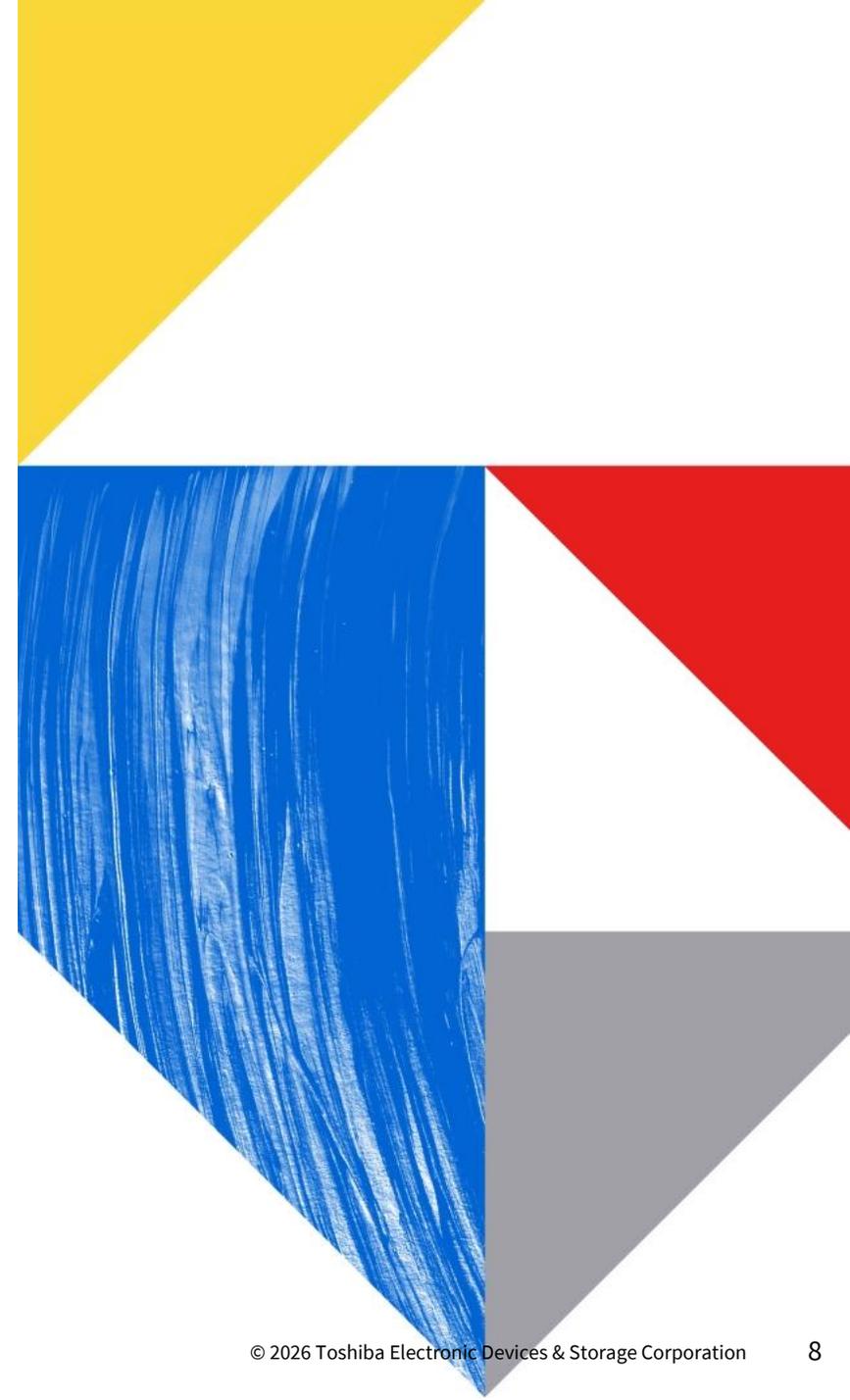
Supporting MOSFET Selection

Comparison of waveform and power conversion efficiency is possible

<https://toshiba.semicon-storage.com/ad/semiconductor/design-development/online-circuit-simulator-introduction.html>

# 02

## Operation Instructions



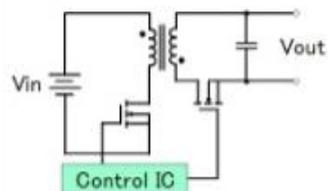
# Topology selection

ALL

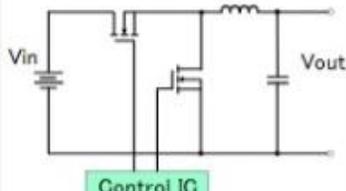
DC-DC

AC-DC

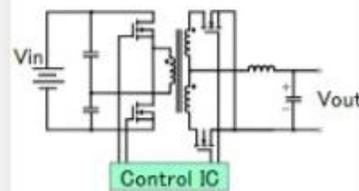
## •DC-DC



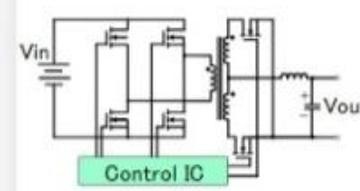
Flyback



Non-Isolated\_Buck\_Converter

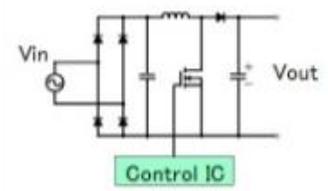


Half-Bridge

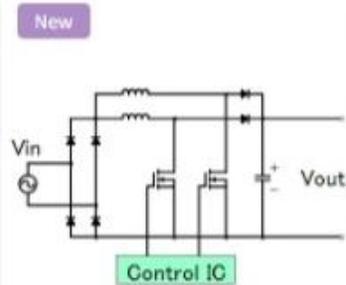


Full-Bridge

## •AC-DC -PFC (First Stage of AC-DC Converter)



Single\_PFC



Interleaved\_PFC

# Initial screen after topology selection

Four Power Supply Specifications

[Back to Topology Select]

INPUT Vin : 24 [V]

OUTPUT Vout : 5 [V]

OUTPUT Power : 30 [W] (Current 6A)

Switching Freq : 100 [kHz]

MOSFET list

Parts	Product Name	Vdss[V]	RON[mΩ] VGS=10V	Qg[nC] VGS=10V
Q1 Search	<input checked="" type="radio"/> TPN22006NH	60	22.0	12
	<input type="radio"/> TPN19008QM	80	19.0	16
	<input type="radio"/> TK30E06N1	60	15.0	16
	<input type="radio"/> TK30A06N1	60	15.0	16
	<input type="radio"/> TPN14006NH	60	14.0	15
Parts	Product Name	Vdss[V]	RON[mΩ] VGS=10V	Qrr[nC]
Q2 Search	<input checked="" type="radio"/> TPH4R803PL	30	4.8	14
	<input type="radio"/> TPH3R003PL	30	3.0	25
	<input type="radio"/> TPN2R903PL	30	2.9	17
	<input type="radio"/> TPH2R903PL	30	2.9	17
	<input type="radio"/> TPH2R003PL	30	2.0	43

DC-DC / Flyback

Fast mode (not calculate power loss) | Accurate mode (Calculate power loss)

Window1

Time 0 - 50.39 [μSec]

1:Q1:[TPN22006NH]Q2:[TPH4R803PL] Vin:24[V] Vout:5[V] Pout:30[W]

Graph1

V(drain1) V(drain2) V(gate1) V(gate2)

Window2

Time 0 - 50.39 [μSec]

1:Q1:[TPN22006NH]Q2:[TPH4R803PL] Vin:24[V] Vout:5[V] Pout:30[W]

Graph1

V(out) I(Rout)

※The image is a simulator image and may differ from the actual screen

# Switching MOSFET

[\[Back to Topology Select\]](#)

INPUT Vin :  [V]

OUTPUT Vout :  [V]

OUTPUT Power :  [W] (Current 6A)

Switching Freq :  [kHz]

Parts	Product Name	VDSS[V]	RON[mΩ] VGS=10V	Qg[nC] VGS=10V
Q1 <input type="button" value="Search"/>	<input checked="" type="radio"/> <a href="#">TPN22006NH</a>	60	22.0	12
	<input type="radio"/> <a href="#">TPN19008QM</a>	80	19.0	16
	<input type="radio"/> <a href="#">TK30E06N1</a>	60	15.0	16
	<input type="radio"/> <a href="#">TK30A06N1</a>	60	15.0	16
	<input type="radio"/> <a href="#">TPN14006NH</a>	60	14.0	15

Characteristic items

# Switching MOSFET

[Back to Topology Select] < DC-DC / Flyback

INPUT Vin : 24 [V] **Fast mode** (not calculate power loss)

OUTPUT : [ ] [V]

OUTPUT : [ ] [V]

Switching : [ ] [V]

Parts : [ ]

Product Name: [ ] Qg(VGS=10V): [ ] - [ ] [nC]

Vdss: 57.37 - [ ] [V] Qrr: [ ] - [ ] [nC]

RON(VGS=10V): [ ] - [ ] [mΩ] Package: ALL [v] [Search](#)

HitCount 377 **Characteristics**  View.(Max 3 items)

1 item

Product Name	<input checked="" type="checkbox"/> Vdss[V]	<input type="checkbox"/> ID[A]	<input type="checkbox"/> Ciss[nF]	<input checked="" type="checkbox"/> Qg[nC] VGS=10V	<input checked="" type="checkbox"/> Ron[mΩ] VGS=10V	<input type="checkbox"/> Ron[mΩ] VGS=4.5V	<input type="checkbox"/> Qoss[nC]	<input type="checkbox"/> trr[ns]	<input type="checkbox"/> Qrr[nC]	Package	Gen	Type
<input type="checkbox"/> <a href="#">TPH1R306P1</a>	60	260.0	6.25	91	1.28	2.3	77.5	44	39	SOP Advance	U-MOSIX-H	High-speed switching
<input type="checkbox"/> <a href="#">TPW1R306PL</a>	60	260.0	6.25	91	1.29	2.3	77.5	47	48	DSOP Advance	U-MOSIX-H	High-speed switching
<input type="checkbox"/> <a href="#">TPH1R306PL</a>	60	260.0	6.25	91	1.34	2.3	77.5	47	48	SOP Advance	U-MOSIX-H	High-speed switching
<input type="checkbox"/> <a href="#">TPH1R306PL1</a>	60	280.0	6.25	91	1.34	2.3	77.5	47	48	SOP Advance(N)	U-MOSIX-H	High-speed switching
<input type="checkbox"/> <a href="#">TK100E06N1</a>	60	263.0	10.5	140	2.3	-	-	100	220	TO-220	U-MOSVIII-H	High-speed switching
<input type="checkbox"/> <a href="#">TPH2R306NH</a>	60	130.0	4.7	72	2.3	-	-	-	-	SOP Advance	U-MOSVIII-H	High-speed switching
<input type="checkbox"/> <a href="#">TPH2R306NH1</a>	60	190.0	4.7	72	2.3	-	91	56	76	SOP Advance(N)	U-MOSVIII-H	High-speed switching
<input type="checkbox"/> <a href="#">TPH2R306PL1</a>	60	190.0	4.18	60	2.3	4.2	51	49	57	SOP Advance(N)	U-MOSIX-H	High-speed switching
<input type="checkbox"/> <a href="#">TPH2R506PL</a>	60	160.0	4.18	60	2.5	4.4	51	49	57	SOP Advance	U-MOSIX-H	High-speed switching
<input type="checkbox"/> <a href="#">TK100A06N1</a>	60	263.0	10.5	140	2.7	-	-	100	220	TO-220SIS	U-MOSVIII-H	High-speed switching
<input type="checkbox"/> <a href="#">TK3R2E06PL</a>	60	160.0	5	71	3.2	4.7	66	55	72	TO-220	U-MOSIX-H	High-speed switching
<input type="checkbox"/> <a href="#">TK3R3A06PL</a>	60	88.0	5	71	3.3	4.9	66	55	72	TO-220SIS	U-MOSIX-H	High-speed switching
<input type="checkbox"/> <a href="#">TPH3R506PL</a>	60	135.0	3.4	55	3.5	6.7	39	37	36	SOP Advance	U-MOSIX-H	High-speed switching
<input type="checkbox"/> <a href="#">TK4R3A06PL</a>	60	68.0	3.28	48.2	4.3	7.2	39	47	57	TO-220SIS	U-MOSIX-H	High-speed switching
<input type="checkbox"/> <a href="#">TK4R3E06PL</a>	60	106.0	3.28	48.2	4.3	7.2	39	47	57	TO-220	U-MOSIX-H	High-speed switching
<input type="checkbox"/> <a href="#">TK4R4P06PL</a>	60	106.0	3.28	48.2	4.4	7.1	39	47	57	DPAK	U-MOSIX-H	High-speed switching
<input type="checkbox"/> <a href="#">TPH4R606NH</a>	60	85.0	3.05	49	4.6	-	-	-	-	SOP Advance	U-MOSVIII-H	High-speed switching

Traces

V(out)

I(Rout)

# Product-detailed display of MOSFET

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## TPN22006NH

Power MOSFET (N-ch single 30V<VDSS≤60V)

Switched Mode Power Supply Library

Online Circuit Simulator

Stock Check

Inquiry

Parametric search

ALL

Data sheet

Application Note

Other

Data sheet

TPN22006NH Data sheet/Japanese[Sep,2025]

PDF: 373KB

Data sheet

TPN22006NH Data sheet/English[Sep,2025]

PDF: 254KB

Simulation Model

PSpice Model[Jan,2024]

ZIP: 42KB

Application Notes

**TOSHIBA** TPN22006NH  
MOSFETs Silicon N-channel MOS (U-MOS18-H)  
**TPN22006NH**

**1. Applications**

- Switching Voltage Regulator
- Motor Drivers
- DC-DC Converters

**2. Features**

- (1) Small footprint due to a small and thin package
- (2) High-speed switching
- (3) Small gate charge  $Q_{gs} = 4.5 \text{ nC (typ.)}$
- (4) Low drain-source on-resistance  $R_{ds(on)} = 18 \text{ m}\Omega \text{ (typ.)}$
- (5) Low leakage current:  $I_{leak} = 10 \mu\text{A (max)} \text{ (} V_{GS} = 0 \text{ V)}$
- (6) Enhancement mode:  $V_{GS} = 2.0 \text{ to } 10 \text{ V (} V_{DS} = 10 \text{ V, } I_D = 0.1 \text{ mA)}$

**3. Packaging and Internal Circuit**

1, 2, 3: Source  
4: Gate  
5, 6, 7, 8: Drain

Start of commercial production

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Data Sheet

**TOSHIBA** Power MOSFET Electrical Characteristics Application Note

**1.2.2. Effective output capacitance (energy related)**

Effective output capacitance (energy related)  $C_{oss}$  is the fixed capacitance calculated to give the same stored energy as  $C_{oss}$  while the drain-source voltage rises from 0V to the specified voltage.

Expressing  $E_{oss}$  in  $C_{oss}$  is as follows.

$$E_{oss} = \frac{C_{oss} \times V_{DS}^2}{2}$$

In addition,  $E_{oss}$  is equal to the value obtained by integrating the amount of charge  $Q=C \cdot V$  on the capacitance characteristic curve from the drain-source voltage of 0V to the specified  $V_{DS}$ , so the following formula holds:

$$\frac{C_{oss} \times V_{DS}^2}{2} = \int_0^{V_{DS}} V \times C(V) dV$$

Therefore,  $C_{oss}$  is expressed as follows.

$$C_{oss} = \frac{2}{V_{DS}^2} \int_0^{V_{DS}} V \times C(V) dV$$

$C(V)$ : function of output capacitance  $C_{oss}$  dependent on  $V_{DS}$

$C_{oss}$  is used when it is necessary to calculate as capacitive energy in the design of power supplies, etc.

**1.2.3. Effective output capacitance (time related)**

Effective capacitance (time related)  $C_{oss}$  is the fixed effective capacitance calculated to give the same charging time as  $C_{oss}$  while the drain-source voltage rises from 0V to the specified voltage.

Expressing the charge amount  $Q_{oss}$  in  $C_{oss}$  is as follows.

$$Q_{oss} = C_{oss} \times V_{DS}$$

In addition,  $Q_{oss}$  is equal to the value obtained by integrating the  $C(V)$  in the capacitance characteristic curve from the drain-source voltage of 0V to the specified  $V_{DS}$ , so the following formula holds:

If the charging (discharging) current is the same on the left and right in the following formula, the charging (discharging) time is also same.

$$C_{oss} \times V_{DS} = \int_0^{V_{DS}} C(V) dV$$

Therefore,  $C_{oss}$  is expressed as follows.

$$C_{oss} = \frac{1}{V_{DS}} \int_0^{V_{DS}} C(V) dV$$

$C(V)$ : function of output capacitance  $C_{oss}$  dependent on  $V_{DS}$

$C_{oss}$  is used for time calculation purposes in the design of power supplies, etc.

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# Folding Input/Output Settings and MOSFET List

[Back to Topology Select]

INPUT Vin : 24 [V]

OUTPUT Vout : 5 [V]

OUTPUT Power : 30 [W] (Current 6A)

Switching Freq : 100 [kHz]

DC-DC / Flyback

Fast mode (not calculate power loss)

Accurate mode (Calculate power loss)

DC-DC / Flyback

Fast mode (not calculate power loss)

Accurate mode (Calculate power loss)

Parts	Product Name	Vdss[V]	Ron[mΩ]	Qgin[C]
Q1 Search	<input checked="" type="radio"/> TPN22006NH	60	22.0	12
	<input type="radio"/> TPN19008QM	80	19.0	16
	<input type="radio"/> IK30E06N1	60	15.0	16
	<input type="radio"/> IK30A06N1	60	15.0	16
	<input type="radio"/> IPN14006NH	60	14.0	15
Q2 Search	<input checked="" type="radio"/> TPH4R803PL	30	4.8	14
	<input type="radio"/> TPH3R003PL	30	3.0	25
	<input type="radio"/> TPN2R903PL	30	2.9	17
	<input type="radio"/> IPH2R903PL	30	2.9	17
	<input type="radio"/> IPH2R003PL	30	2.0	43

Window1

Time 0 - 50.39 [μSec]

1:Q1:[TPN22006NH]Q2:[TPH4R803PL] Vin:24[V] Vout:5[V] Pout:30[W]

Graph1

Window

Time 0 - 50.39 [μSec]

1:Q1:[TPN22006NH]Q2:[TPH4R803PL] Vin:24[V] Vout:5[V] Pout:30[W]

Graph1

Window1

Time 0 - 50.39 [μSec]

1:Q1:[TPN22006NH]Q2:[TPH4R803PL] Vin:24[V] Vout:5[V] Pout:30[W]

Graph1

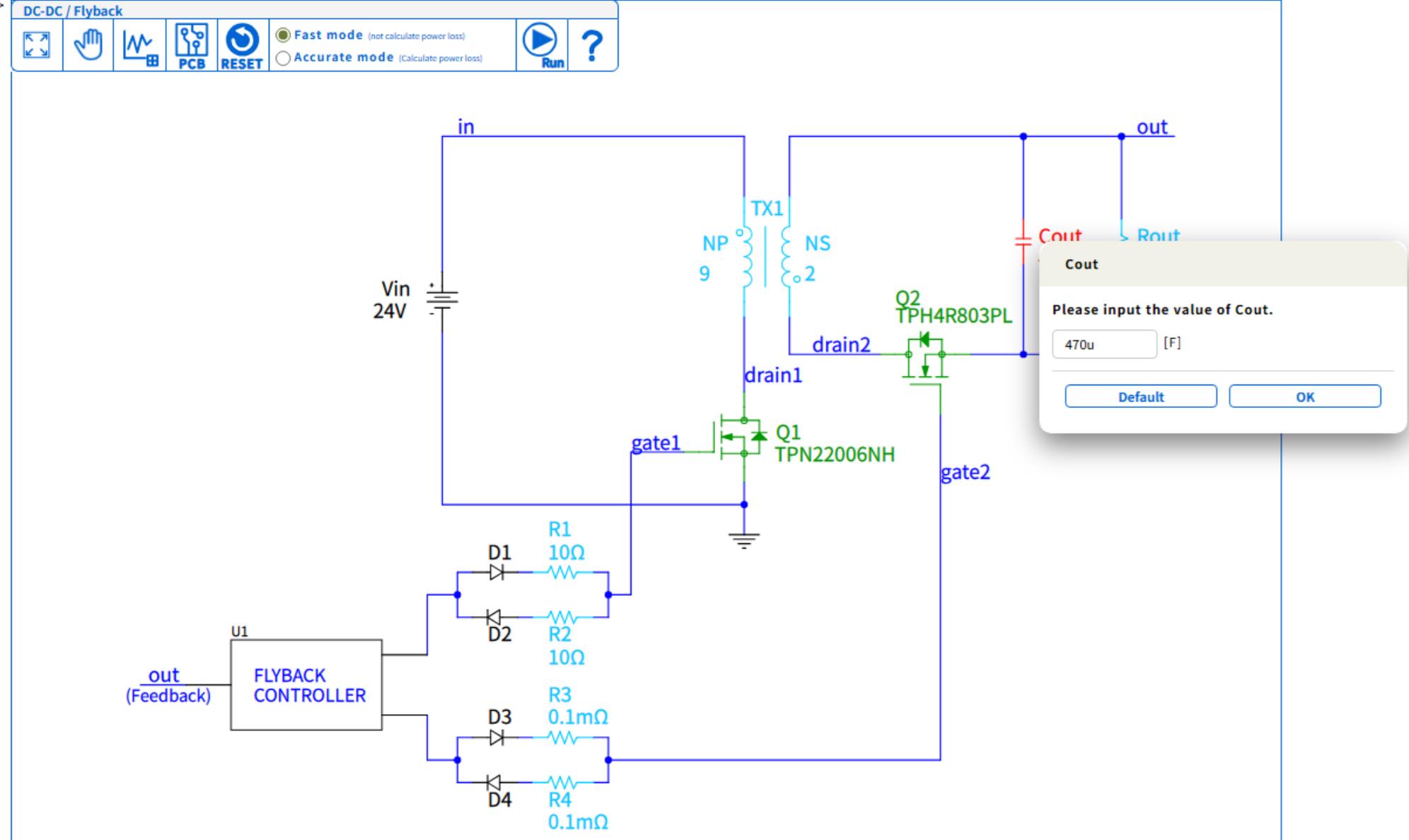
Window2

Time 0 - 50.39 [μSec]

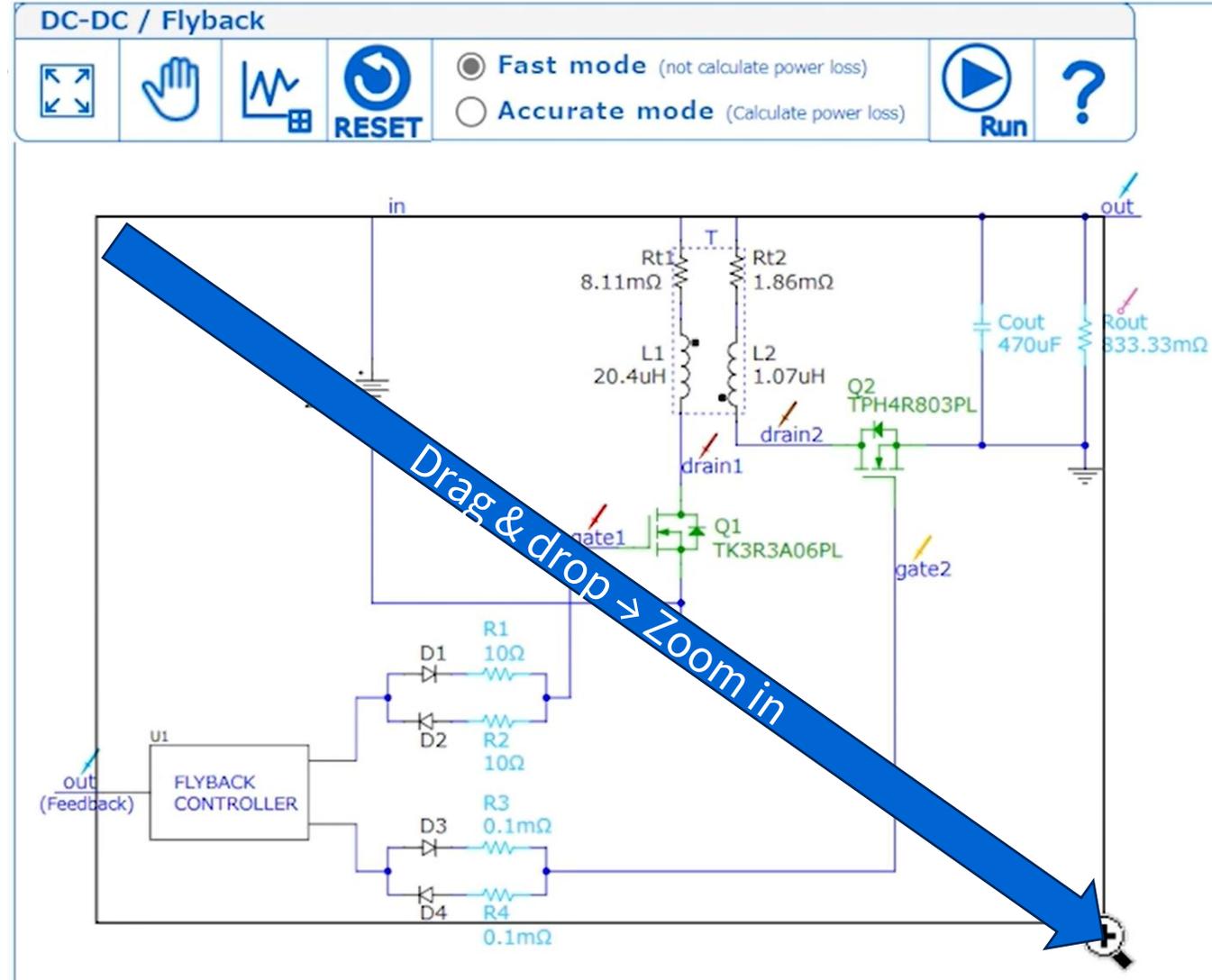
1:Q1:[TPN22006NH]Q2:[TPH4R803PL] Vin:24[V] Vout:5[V] Pout:30[W]

Graph1

# Changing the circuit constant

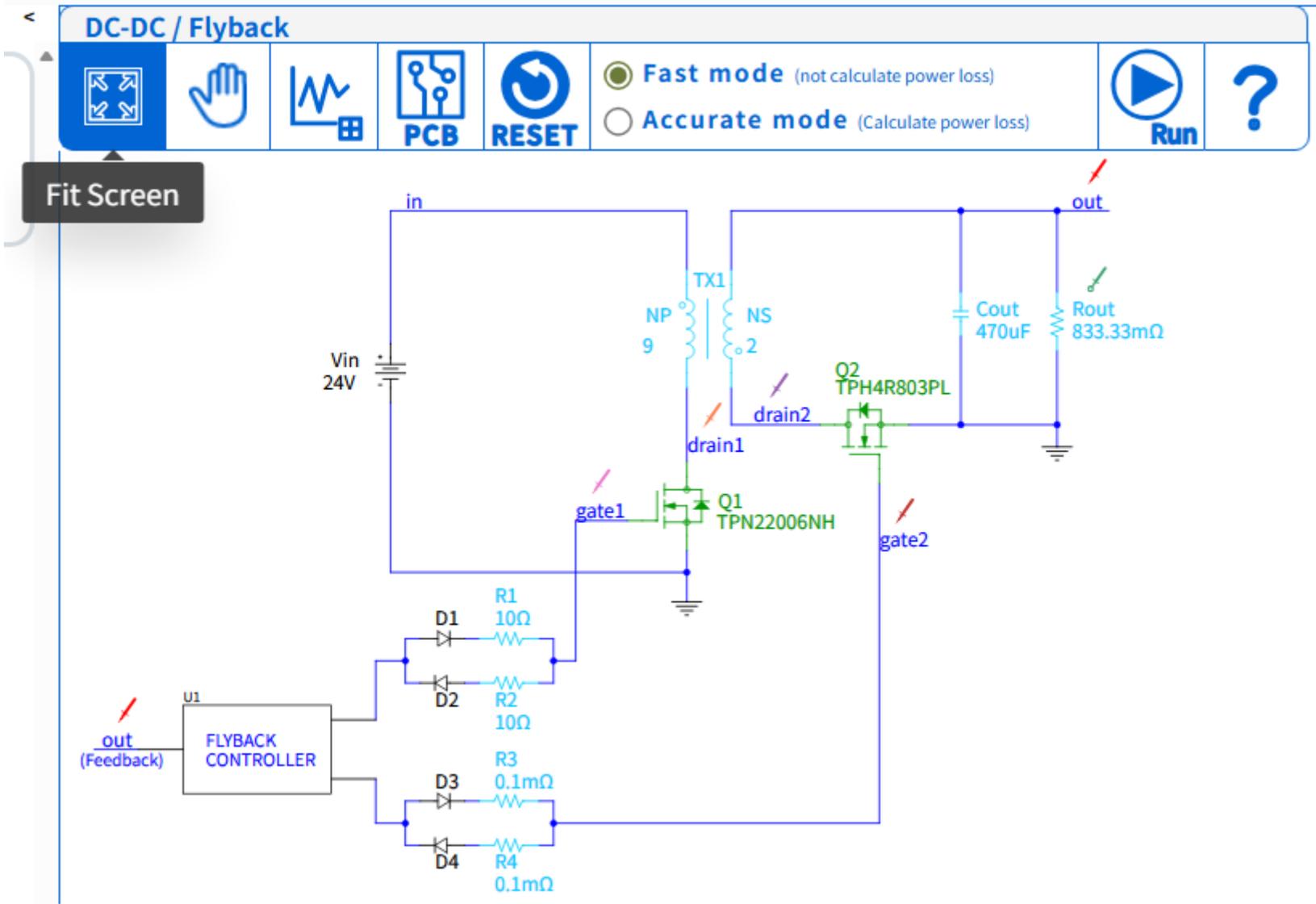


# Resizing the schematic

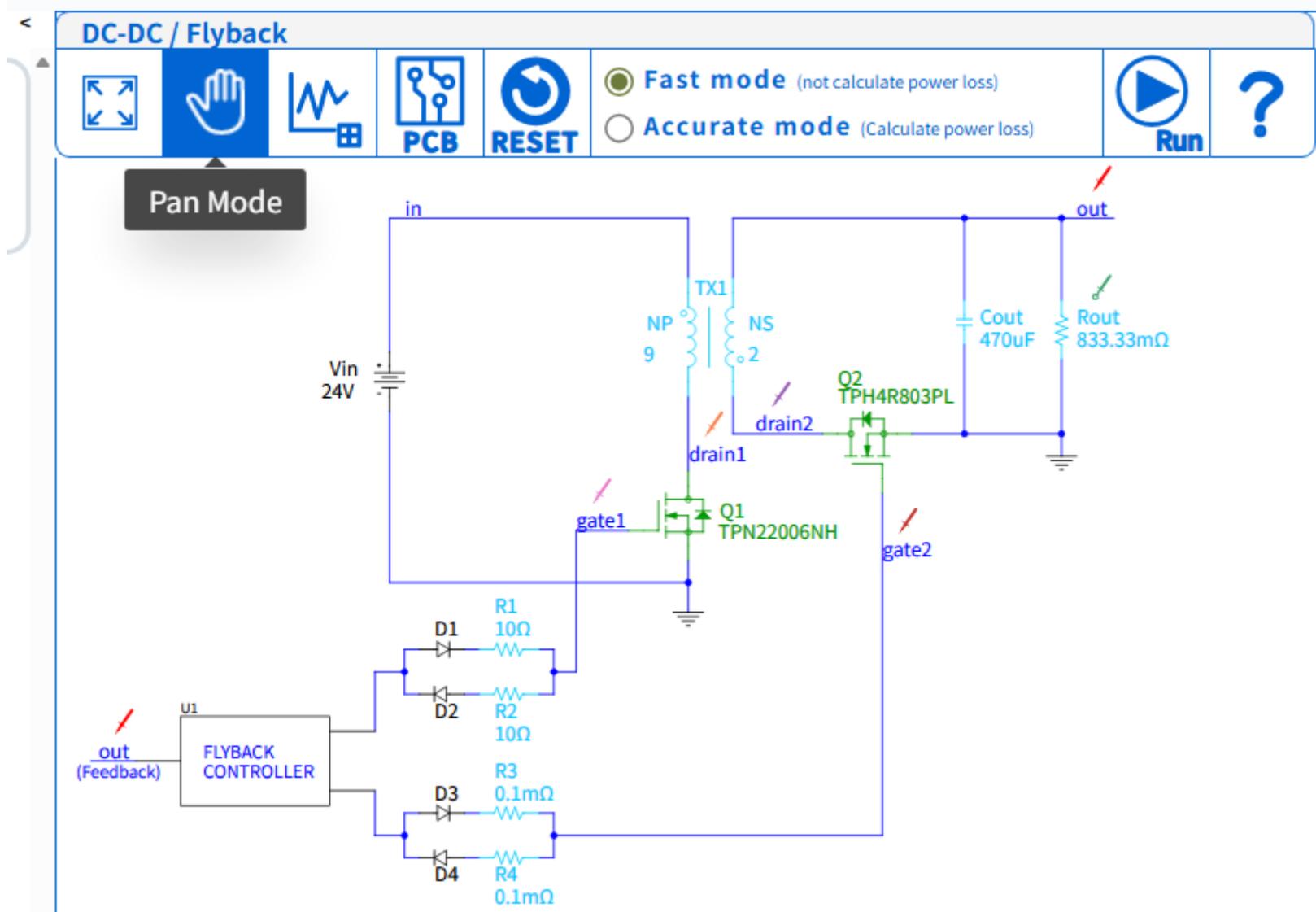


Zooming in and out of the schematic can also be done by pressing Ctrl and using the scrollwheel on the mouse.

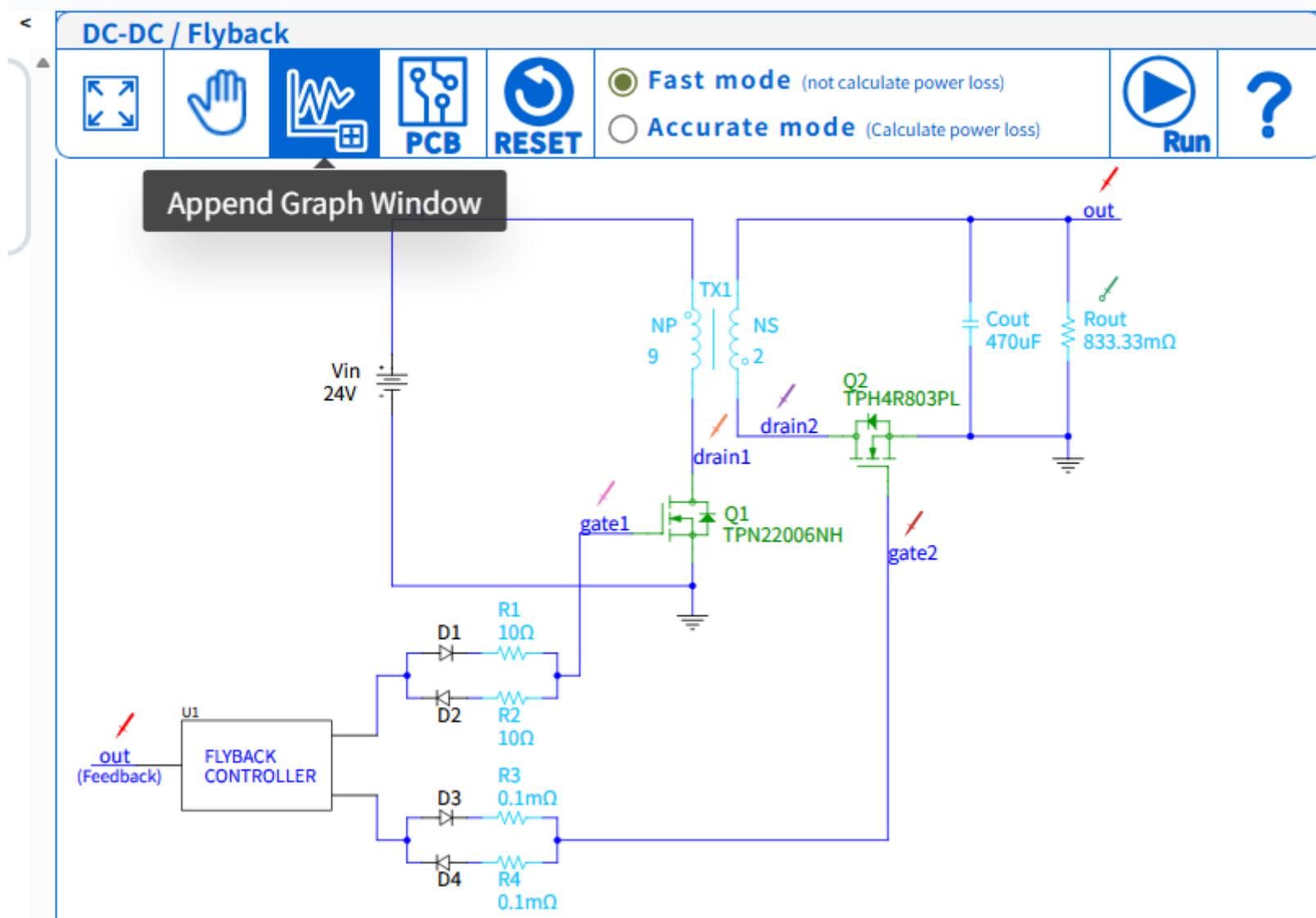
# General view of circuit diagram



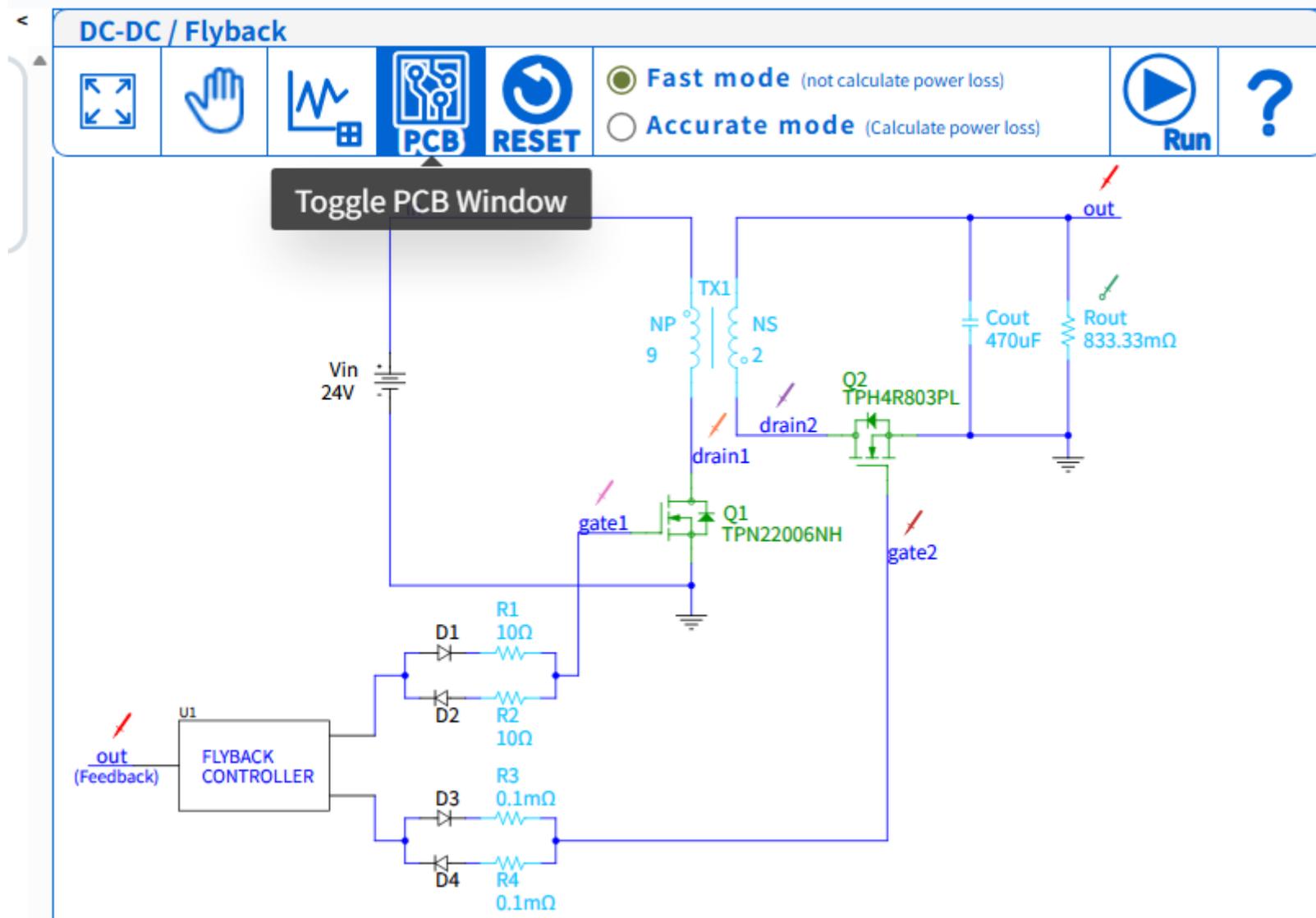
# Moving the schematic



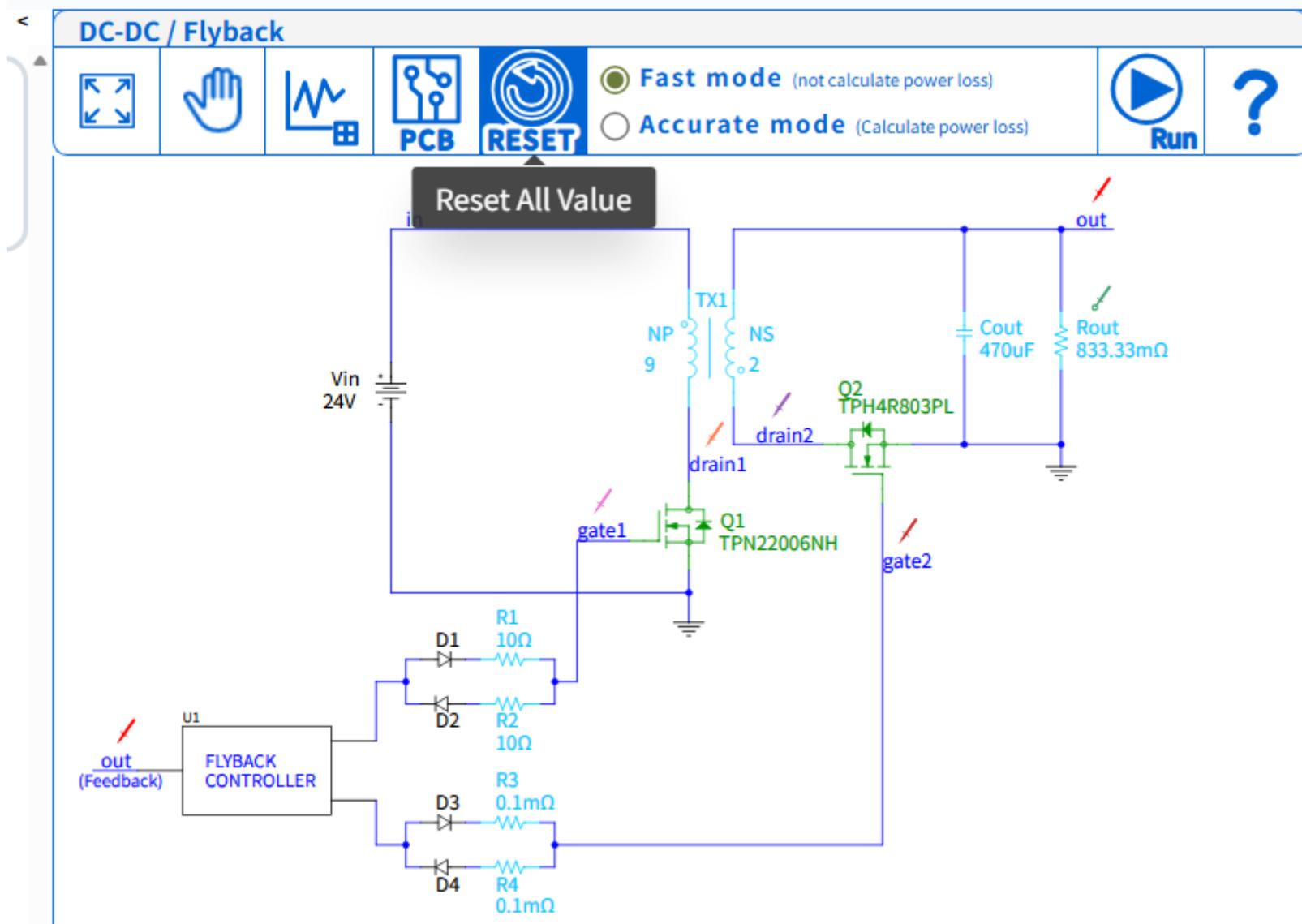
# Adding a Graph Screen



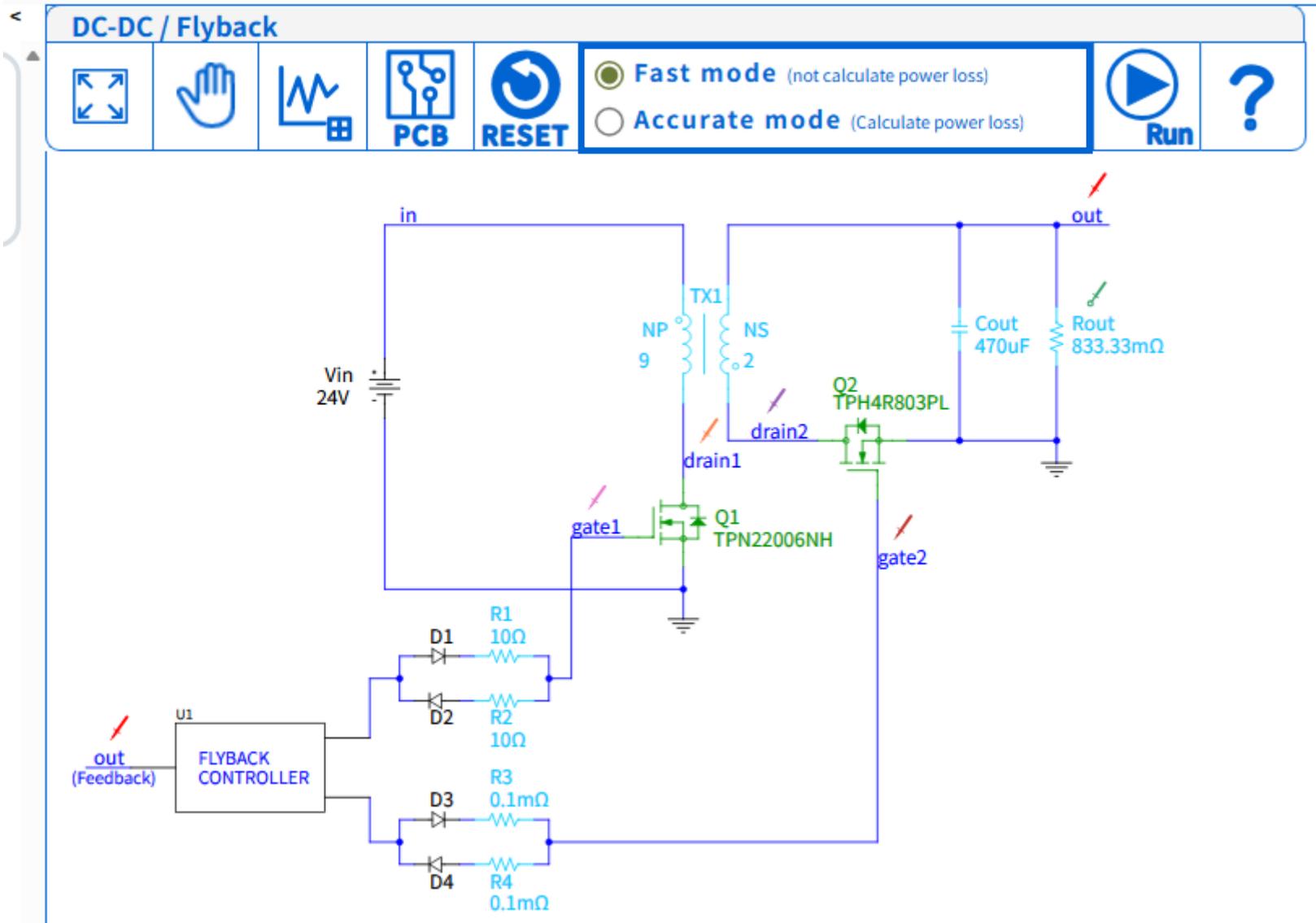
# PCB window



# Reset All Value



# Simulation Mode Selection



# Running a Simulation

DC-DC / Flyback

Fast mode (not calculate power loss)  
Accurate mode (Calculate power loss)

Run

Run Simulation

in

out

Vin 24V

TX1

NP 9

NS 2

drain2

drain1

Q2 TPH4R803PL

gate2

gate1

Q1 TPN22006NH

Cout 470uF

Rout 833.33mΩ

R1 10Ω

R2 10Ω

R3 0.1mΩ

R4 0.1mΩ

D1

D2

D3

D4

u1 FLYBACK CONTROLLER

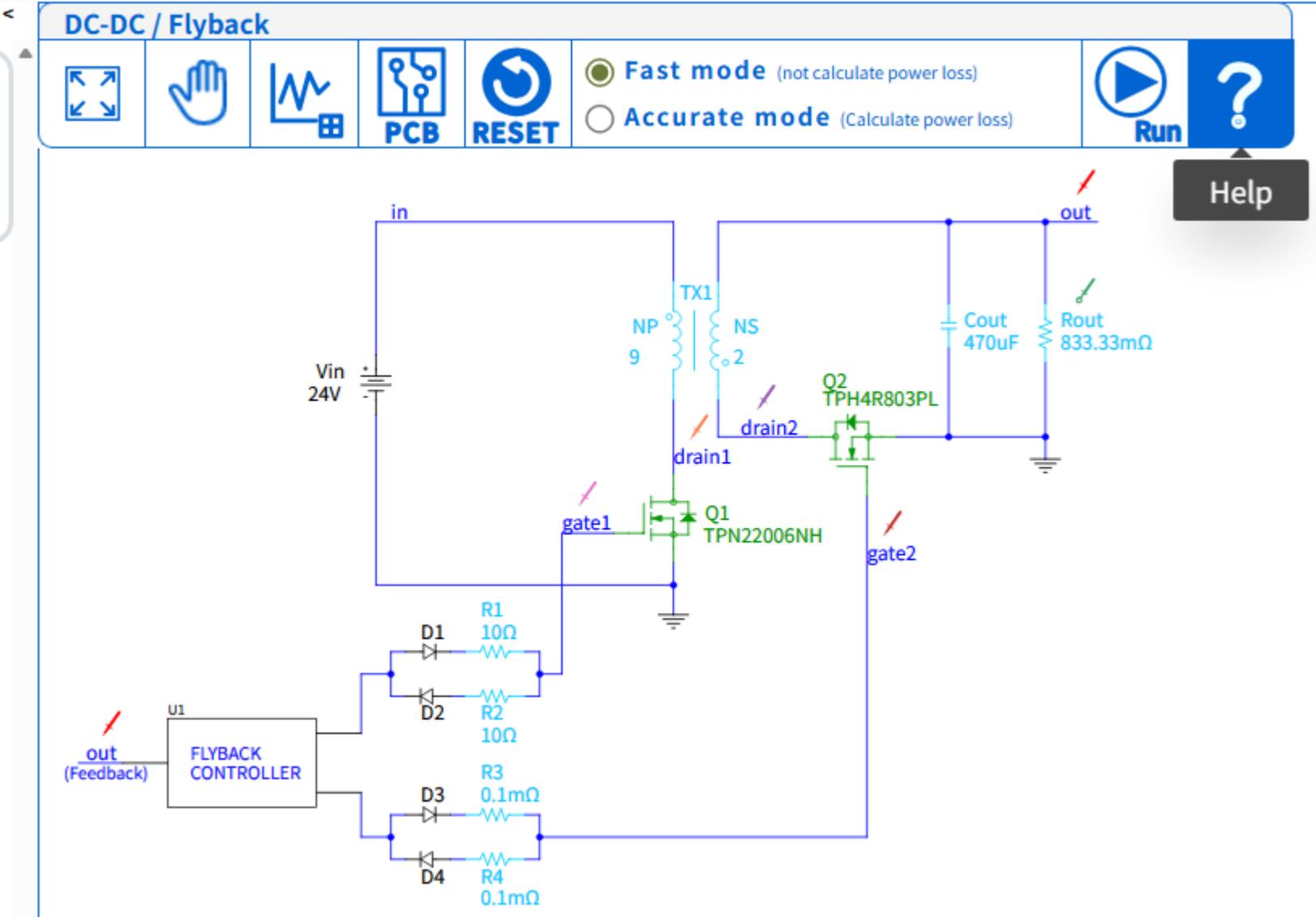
out (Feedback)

Do you want to create new window for simulation results?

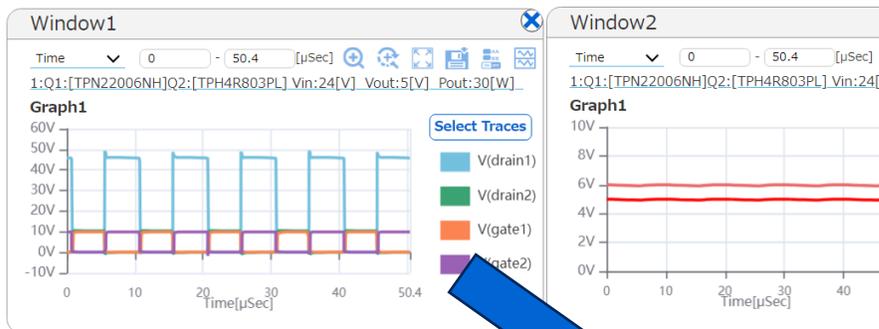
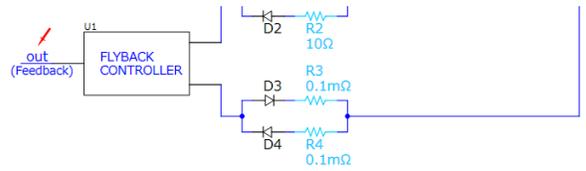
- Yes, Create new window, and Close existing window.
- Yes, Create new window.
- No, Add to existing window.

OK Cancel

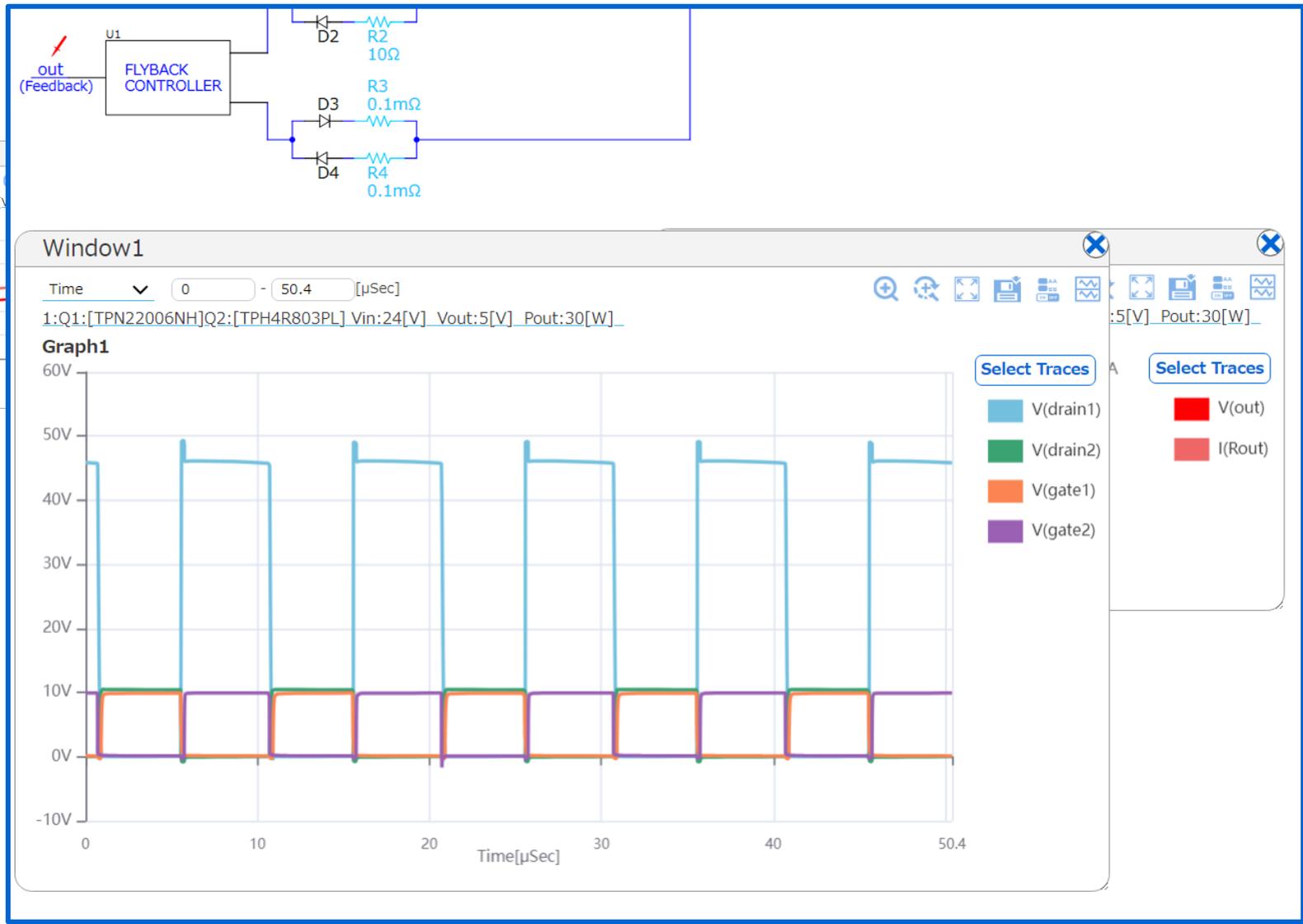
# Help indication



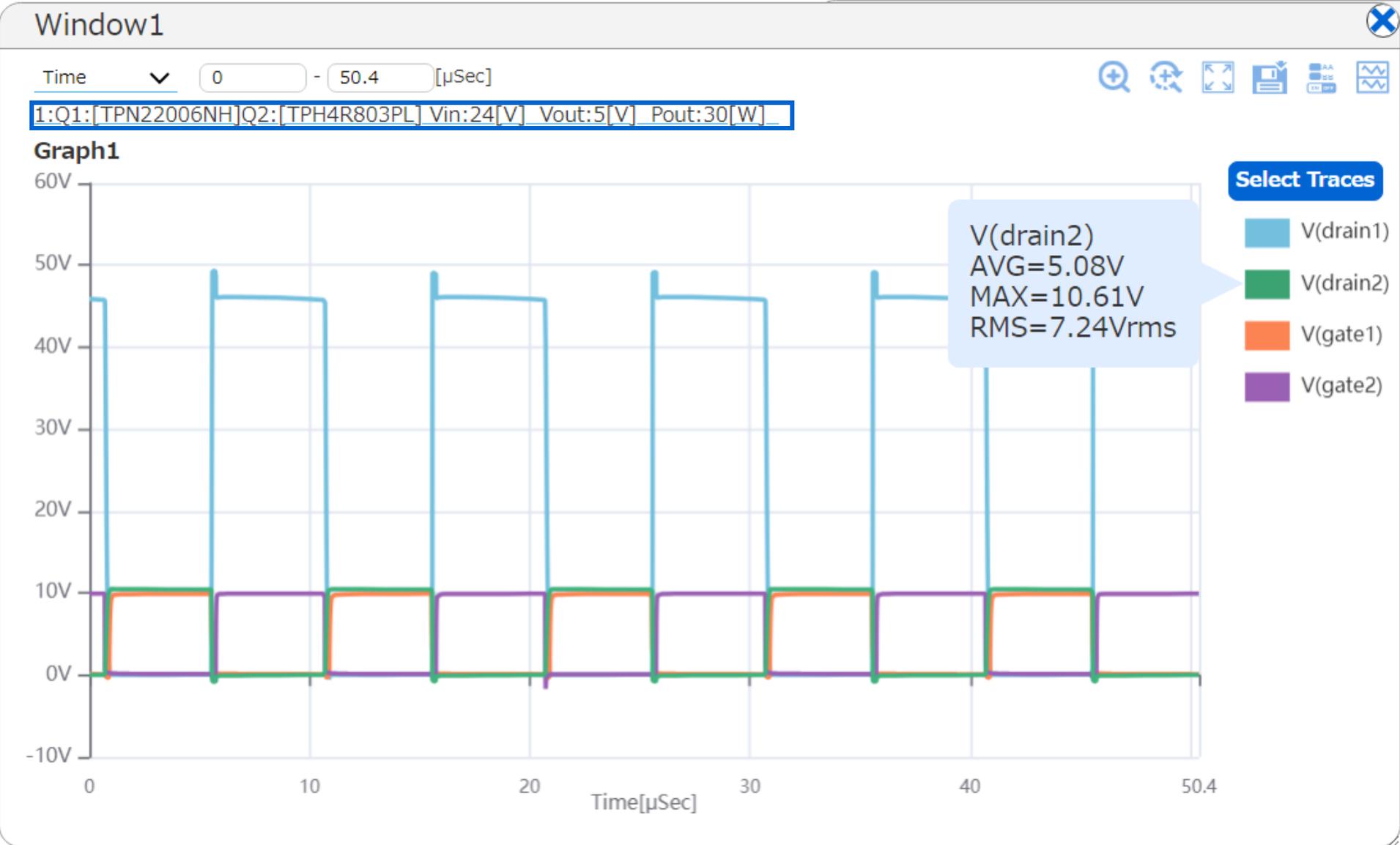
# Resizing the Graph Screen



Drag → Enlarge



# Information display of simulation results



# Select waveform to display

**Select Visible Traces**

**Graph1**

V(drain1)	V(drain2)
V(gate1)	V(gate2)
V(in)	V(out)
I(L1)	I(L2)
I(Q1.gate)	I(Q1.drain)
I(Q2.gate)	I(Q2.drain)
I(Rout)	I(Vin)
Loss(Q1)	Loss(Q2)

Calculation (ex.  $V_{gs1} = V(\text{gate1}) - V(\text{drain2})$ )

=  Select Type Add

Close

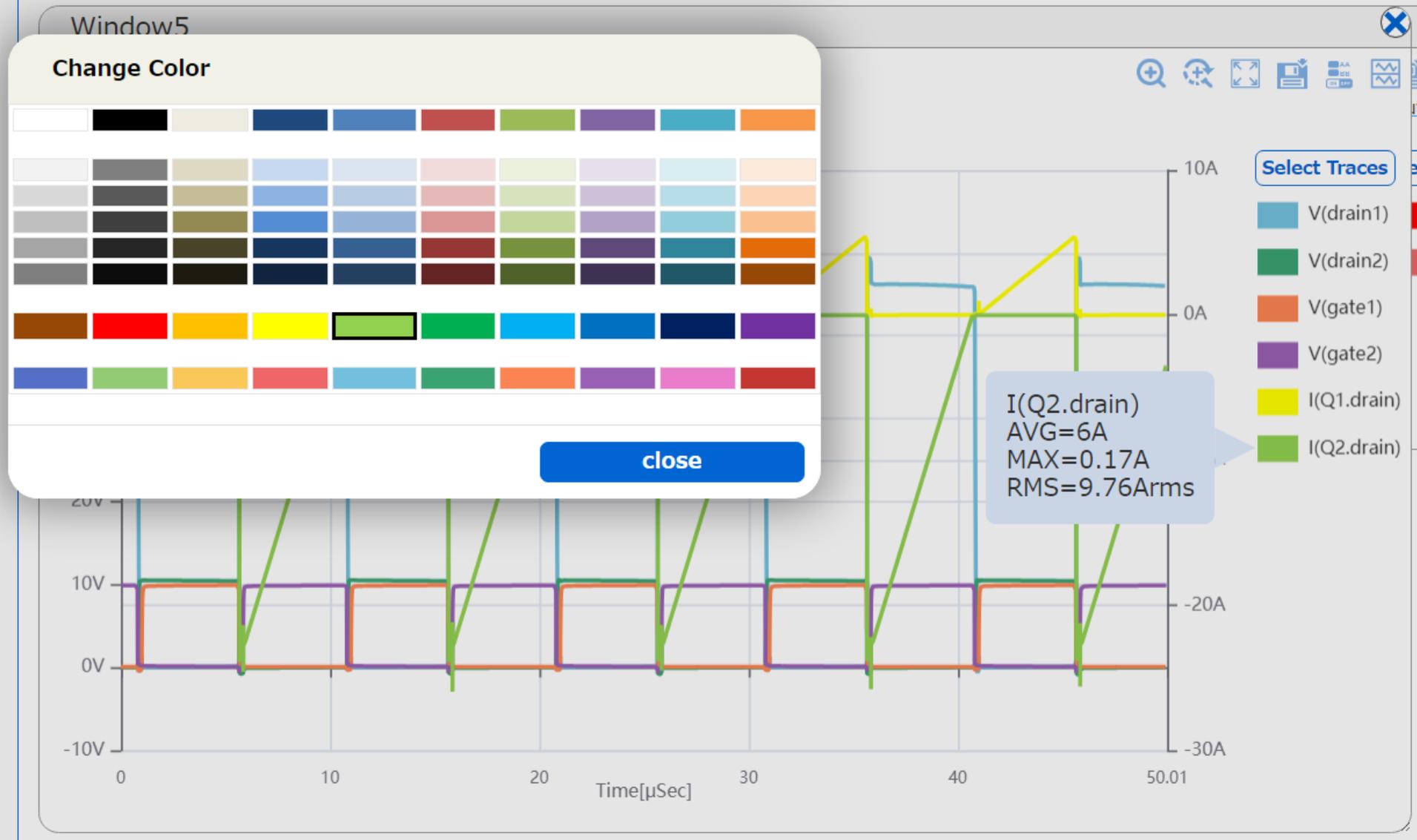
**Select Traces**

- V(drain1)
- V(drain2)
- V(gate1)
- V(gate2)
- I(Q1.drain)
- I(Q2.drain)

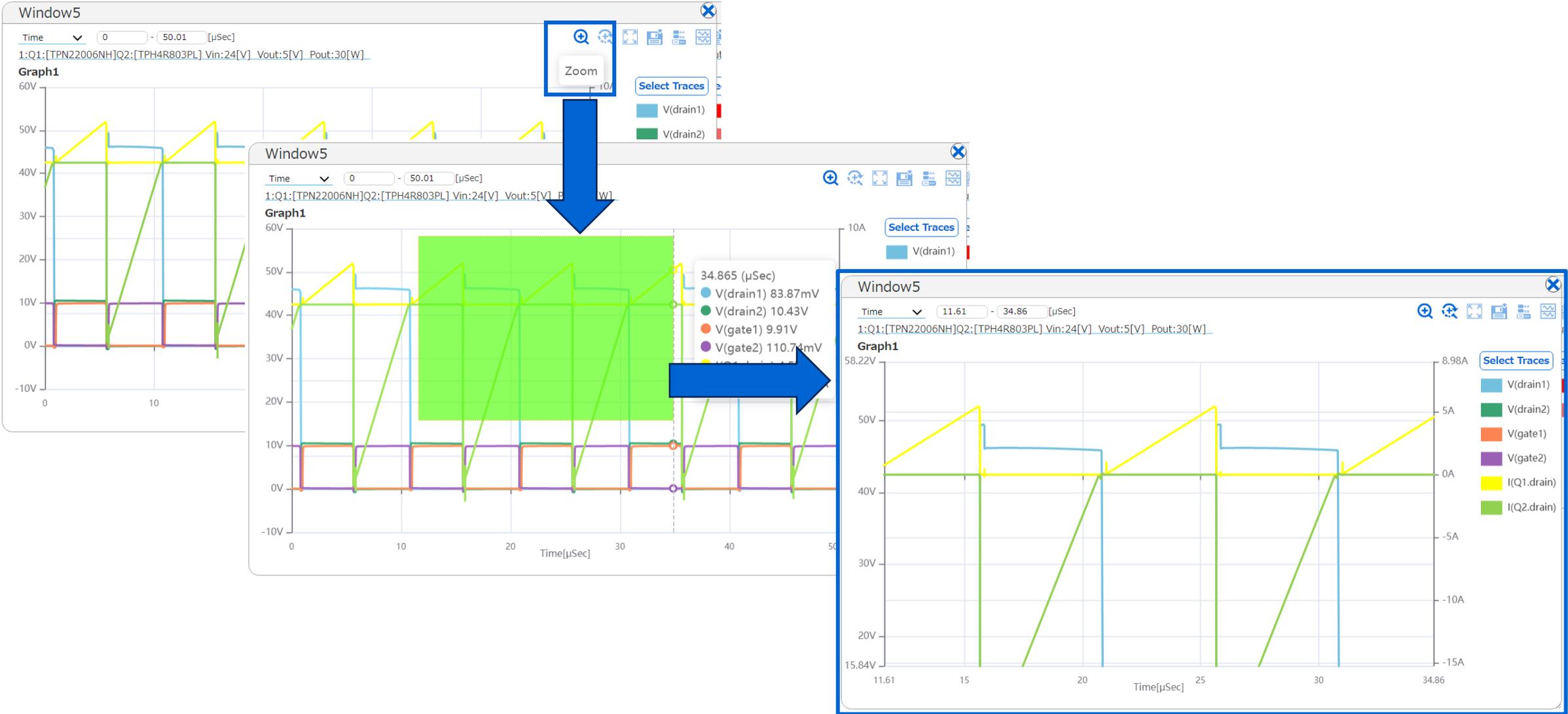
Time[μSec]

Y-axis: -10V, -20V, -30V, 0A, 10A

# Changing waveform color

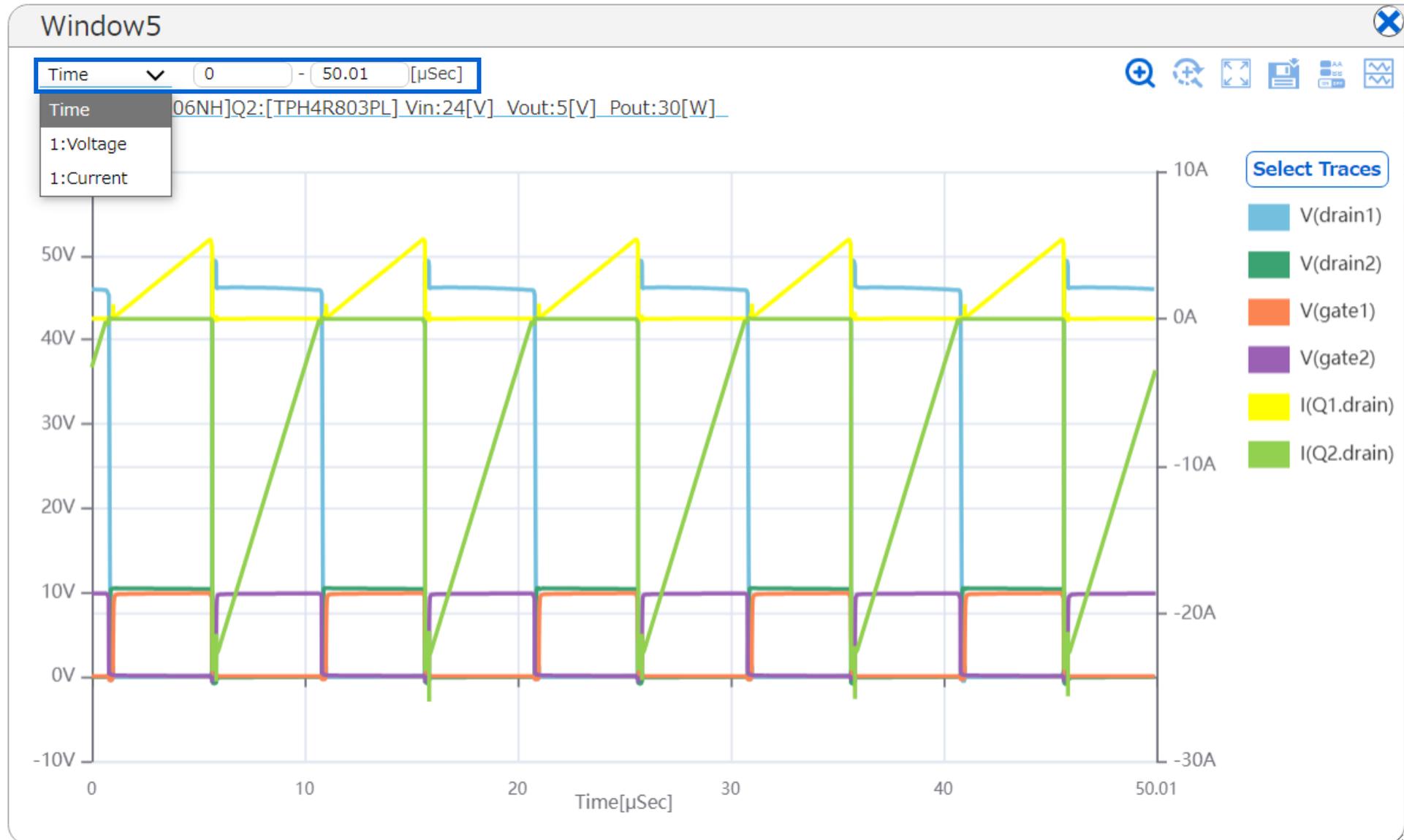


# Chart Zoom and Zoom Undo

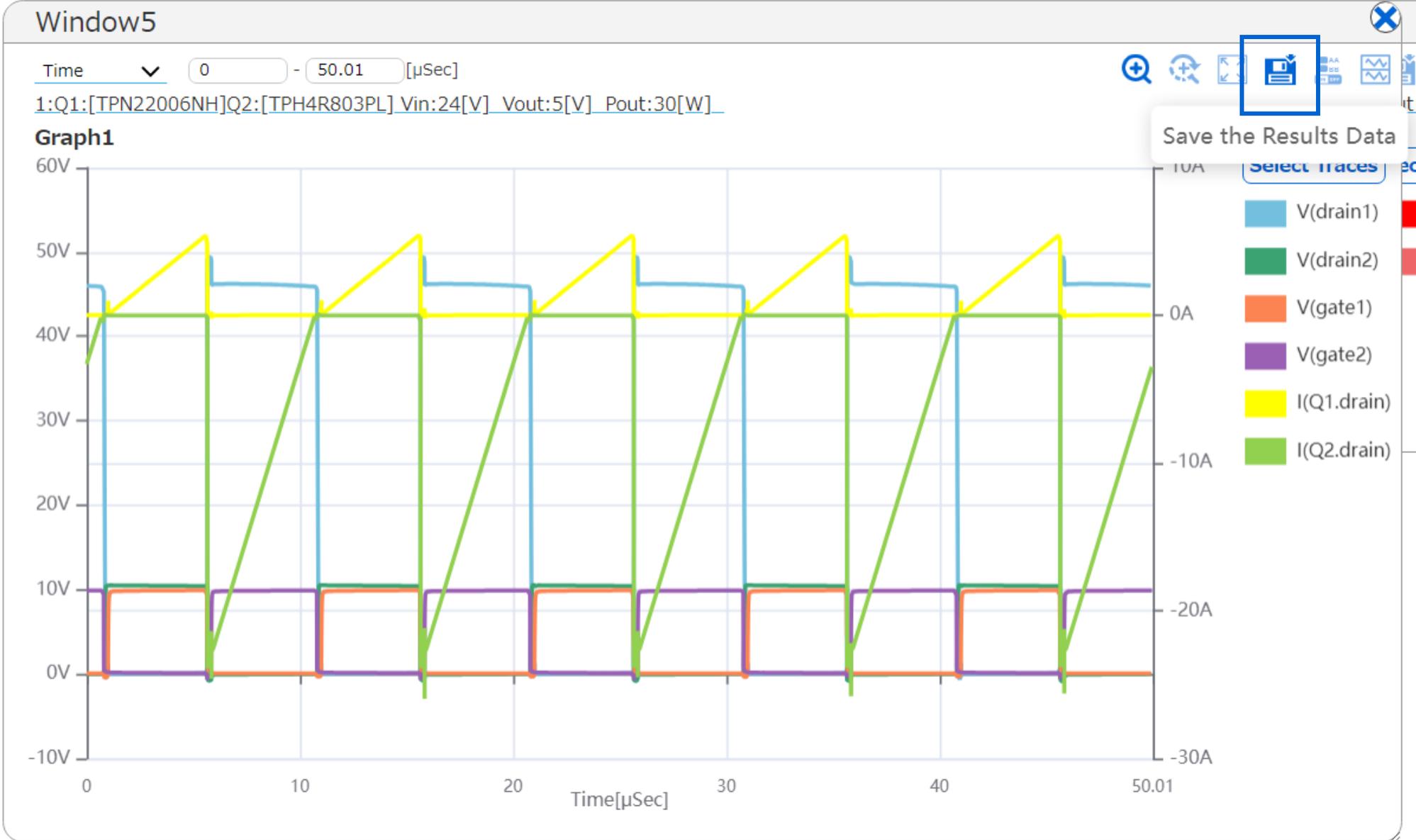


You can also use the mouse scroll wheel to zoom in or out.

# Enlarged range specification of graph

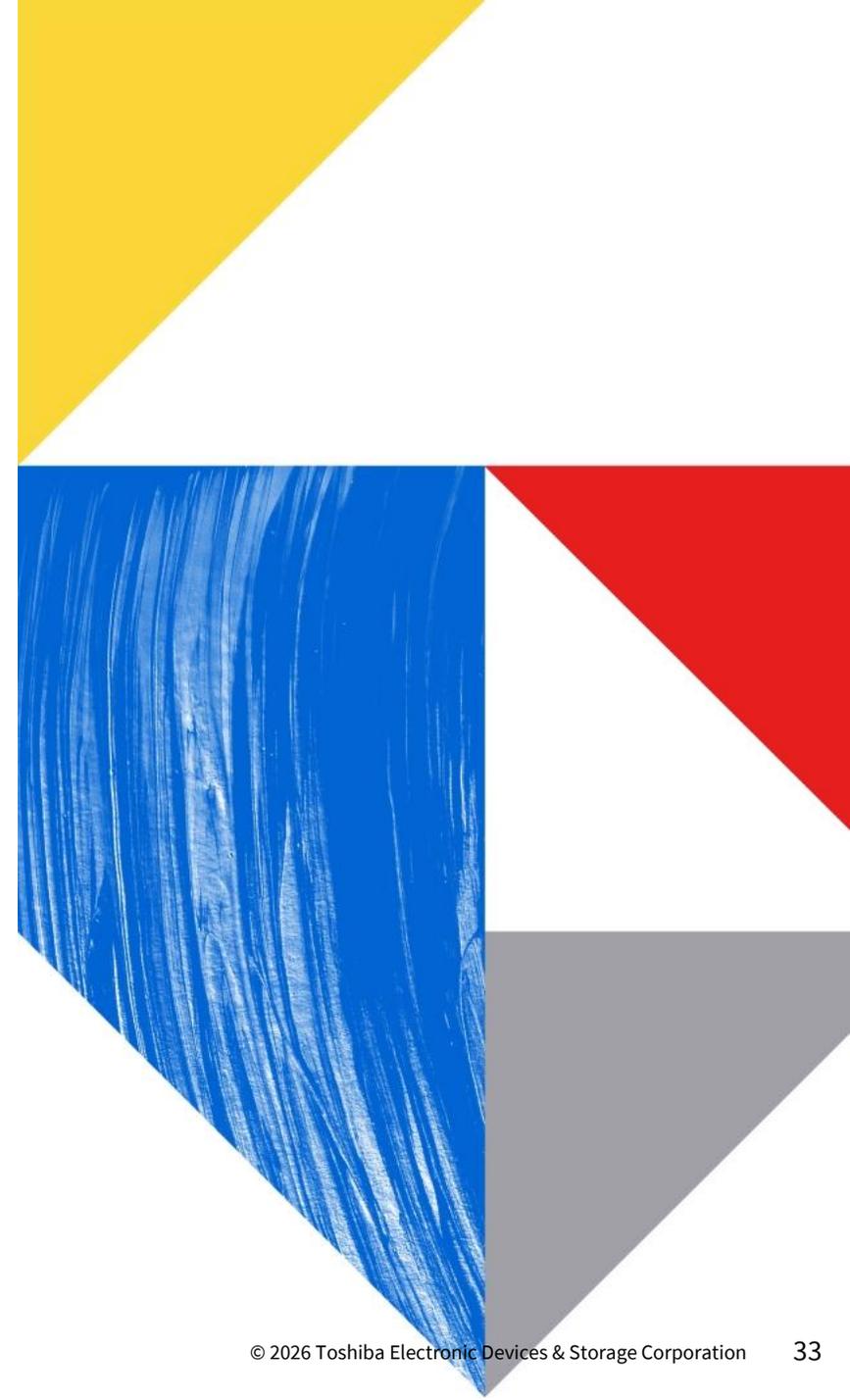


# Saving Data in CSV Files



# 03

## Summary



# Toshiba Online Circuit Simulator

By registering “my ToshibaSemicon”, you can use it free of charge

Easily try circuit simulation with just a web browser.

Select circuits and MOSFETs efficiently according to specifications.

**Please make full use of the online circuit simulator!**

# TOSHIBA

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