Pulzní zdroje

Co chceme?

- **Generování zpravidla obdélníkového signálu**
- **Různé zdroje pro různé účely:**

Rise time *Frekvence* ***Napětí*** ***Výkon***

Zdroje

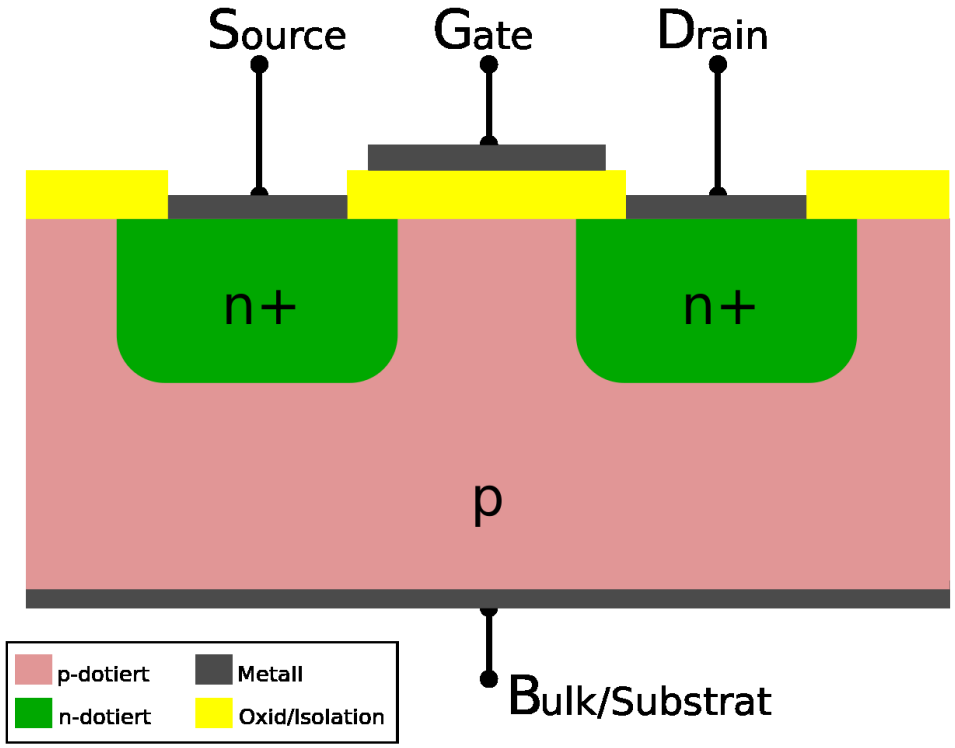
- **Podle doby náběhu (rise time)**
- **Relátko**

  př. 10kV AC,
  5A
  rise time: 3ms
  fall time: 1.5ms

https://www.tme.eu/cz/details/h05-1a69/elektromagneticka-rele-jazyckove/meder/

Zdroje

- **MOSFET tranzistory**
- **Řízení polem**
- **Přesto potřeba kvalitní řízení**



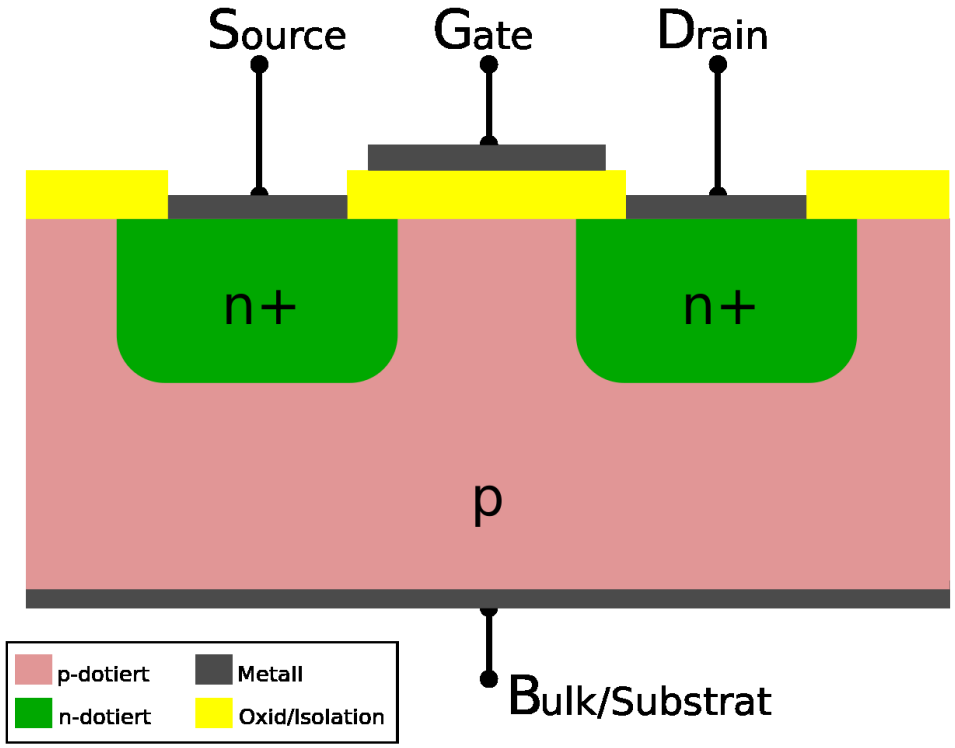
$$i_{Gate} = \frac{\mathrm{d}q}{\mathrm{d}t} = \frac{10\ \mathrm{nC}}{10\ \mathrm{ns}} = 1\ \mathrm{A}$$

Zdroje

- **MOSFET tranzistory**
- **Dříve: pouze Si**

  dnes: SiC, GaN
  -> vyšší f, U

- **Max. napětí v datasheetu je BEZ tolerance!!!!**



IGBT

- **Note to myself … pridat IGBT + HIPIMS**

Zdroje

- **“Pomalé” MOSFET tranzistory**

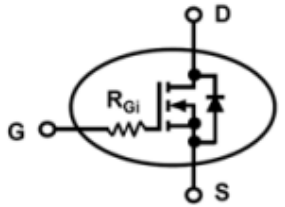
IXYS

High Voltage Power MOSFET **IXTL2N450**

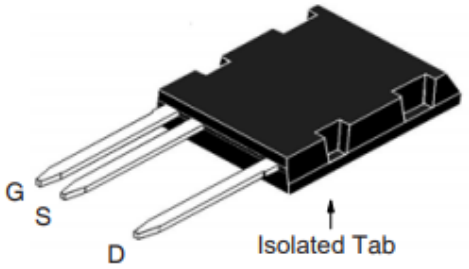
V_{DSS} = 4500V
I_{D25} = 2A
$R_{DS(on)}$ ≤ 20Ω

(Electrically Isolated Tab)

N-Channel Enhancement Mode



ISOPLUS i5-Pak™



G = Gate S = Source
D = Drain

Symbol	Test Conditions	Maximum Ratings	
V_{DSS}	T_J = 25°C to 150°C	4500	V
V_{DGR}	T_J = 25°C to 150°C, R_{GS} = 1MΩ	4500	V
V_{GSS}	Continuous	±20	V
V_{GSM}	Transient	±30	V
I_{D25}	T_C = 25°C	2	A
I_{DM}	T_C = 25°C, Pulse Width Limited by T_{JM}	8	A
P_D	T_C = 25°C	220	W
T_J		- 55 ... +150	°C
T_{JM}		150	°C
T_{stg}		- 55 ... +150	°C
T_L	Maximum Lead Temperature for Soldering	300	°C
T_{SOLD}	Plastic Body for 10s	260	°C
F_C	Mounting Force	20..120 / 4.5..27	N/lb.
V_{ISOL}	50/60Hz, 1 Minute	4000	V~
Weight		8	g

Features

- Silicon Chip on Direct-Copper Bond (DCB) Substrate
- Isolated Mounting Surface
- 4000V~ RMS Electrical Isolation
- Molding Epoxies meet UL 94 V-0 Flammability Classification

Zdroje

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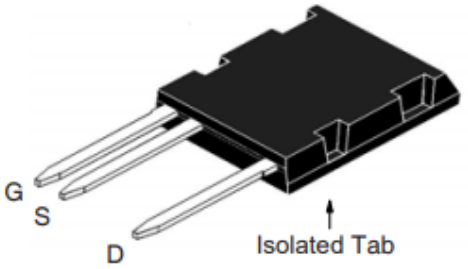
(Electrically Isolated Tab)

IXYS IXTL2N450

Symbol (T$_J$ = 25°C, Unless Otherwise Specified)	Test Conditions	Characteristic Values Min.	Typ.	Max.	
g_{fs}	V_{DS} = 60V, I_D = 0.5 • I_{D25}, Note 1	2.1	3.5		S
C_{iss}	V_{GS} = 0V, V_{DS} = 25V, f = 1MHz		6860		pF
C_{oss}			267		pF
C_{rss}			105		pF
R_{Gi}	Integrated Gate Input Resistance		4.0		Ω
$t_{d(on)}$	**Resistive Switching Times** V_{GS} = 10V, V_{DS} = 1kV, I_D = 1A R_G = 0Ω (External)		40		ns
t_r			34		ns
$t_{d(off)}$			123		ns
t_f			205		ns
$Q_{g(on)}$	V_{GS} = 10V, V_{DS} = 1kV, I_D = 0.5 • I_{D25}		180		nC
Q_{gs}			34		nC
Q_{gd}			83		nC
R_{thJC}				0.56	°C/W
R_{thCS}			0.15		°C/W

Weight	8	g

ISOPLUS i5-Pak™



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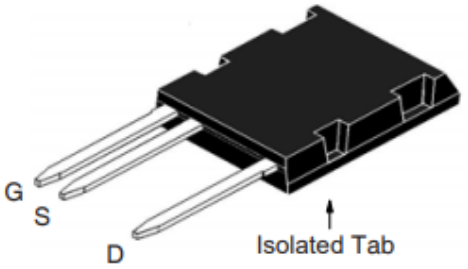
ISOPLUS i5-Pak™



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Zdroje

1 Maximum ratings

For optimum lifetime and reliability, Infineon recommends operating conditions that do not exceed 80% of the

IMZ120R350M1H
CoolSiC™ 1200V SiC Trench MOSFET
Electrical Characteristics

3.3 Switching characteristics

Table 6 Switching characteristics, Inductive load [4]

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
MOSFET Characteristics, T_{vj} = 25°C						
Turn-on delay time	$t_{d(on)}$	V_{DD} = 800V, I_D = 2A, V_{GS} = 0/18V, $R_{G,ext}$ = 2Ω, L_σ = 40nH, diode: body diode at V_{GS} = 0V see Fig. E	-	4.8	-	ns
Rise time	t_r		-	0.7	-	
Turn-off delay time	$t_{d(off)}$		-	10.8	-	
Fall time	t_f		-	19.3	-	
Turn-on energy	E_{on}		-	24	-	µJ
Turn-off energy	E_{off}		-	4	-	
Total switching energy	E_{tot}		-	28	-	
Short circuit withstand time	t_{SC}	V_{DD} = 800V, $V_{DS,peak}$ < 1200V, $V_{GS,on}$ = 15V, $T_{j,start}$ = 25°C		3		µs

	Value	Unit
	1200	V
	4.7 4.7	A
	13	A
	4.7 4.7	A
	13	A
	-7… 23 15… 18 0	V

Zdroje

- **Plazmové spínací prvky**

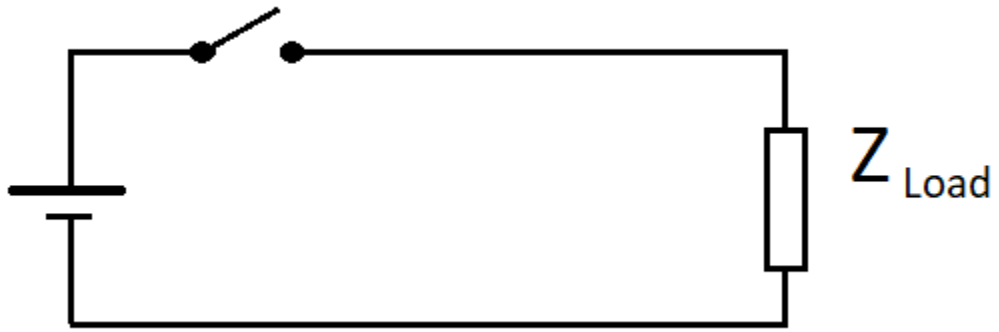
  Vysoké výkony, vysoké napětí, extrémně rychlé

- **Trigatron**
- **Tyratron**

Topologie spínačů

- **Přímé spínání napětí**

  Spínací člěn je *sériově* se zátěží



Topologie spínačů

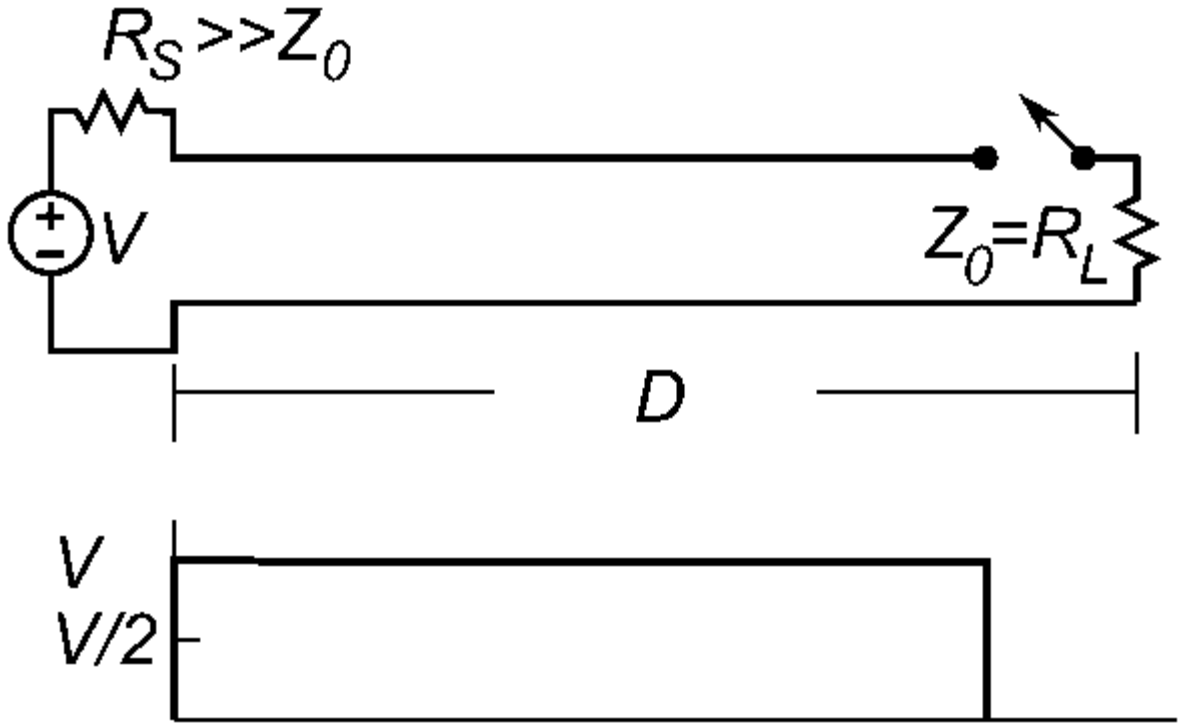
- **Zkratování napětí**

  Spínací člěn je *paralelně* se zátěží

Formovací linka

- **Při ns a sub-ns pulsech je potřeba myslet na odrazy**

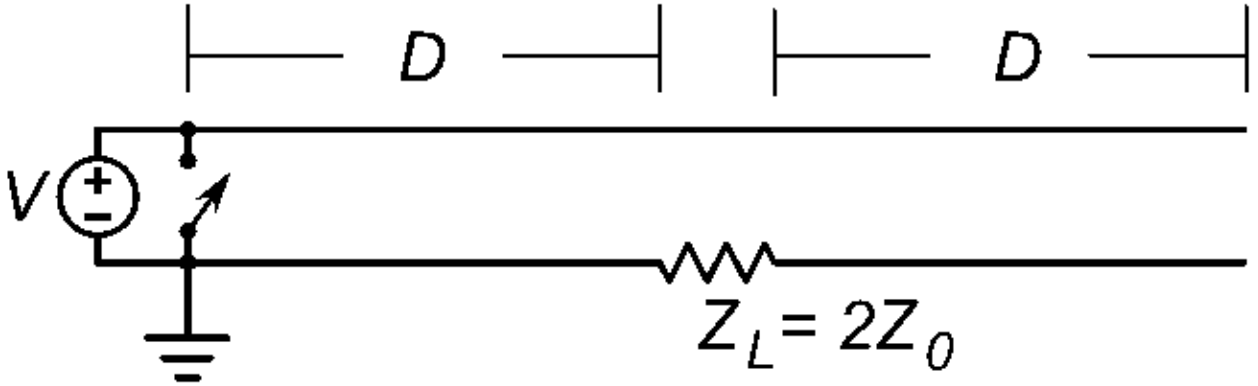
$$\Gamma = \frac{Z_{Load} - Z_0}{Z_{Load} + Z_0}$$



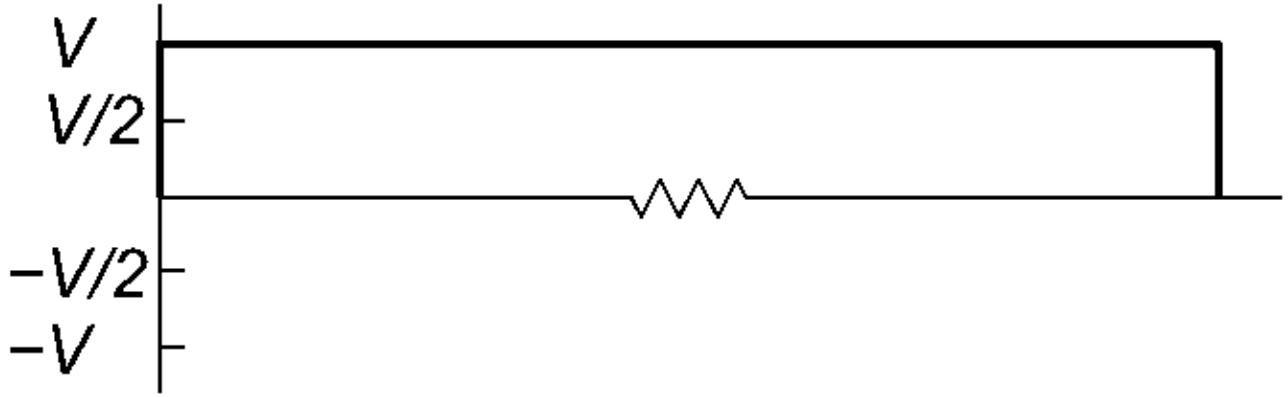
- **Zdroj: en.wikipedia.org/wiki/Pulse-forming_network**

Formovací linka

- **Blumlein transmission line**



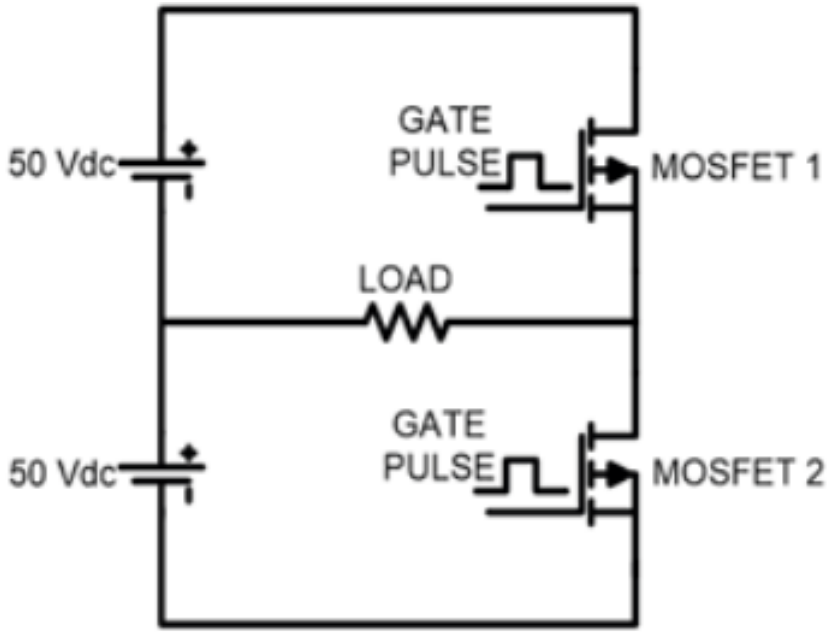
$$\Gamma = \frac{Z_{Load} - Z_0}{Z_{Load} + Z_0}$$



- **Zdroj: en.wikipedia.org/wiki/Pulse-forming_network**

Invertory

- **Trazistory ale dávají vice možností**



- **https://circuitdigest.com/electronic-circuits/single-phase-half-bridge-and-full-bridge-inverter-circuit-using-matlab**

Invertory

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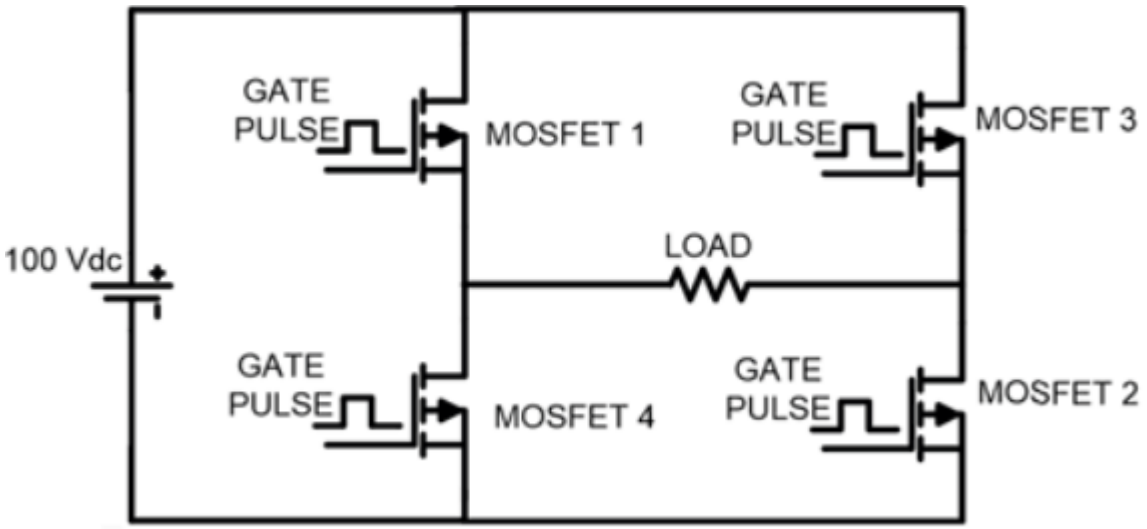

- **https://circuitdigest.com/electronic-circuits/single-phase-half-bridge-and-full-bridge-inverter-circuit-using-matlab**

Realne invertory

- **Realne invertory maji spoustu neduhu ..**

  - Dokmitavani
  - Oscilace
  - Oveshoot

- **Nezalezi jen na soucastkach ale i na topologii (layout)**