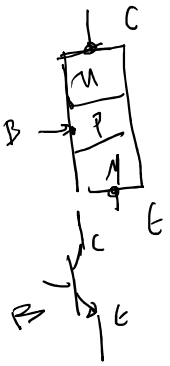
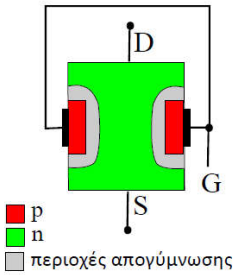
BJT-npn

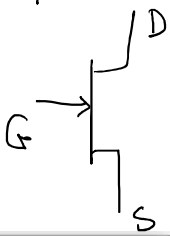


JFET τύπου



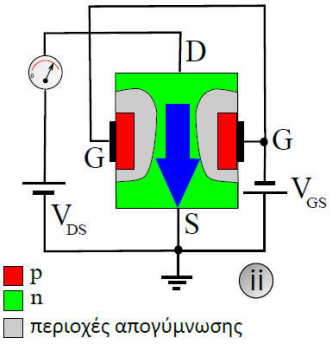
D: Drain, S: Source, G: Gate

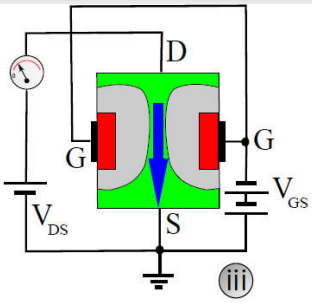
ΗΛΕΚΤΡΙΚΟ ΑΝΑΛΟΓΟ



→ n-channel

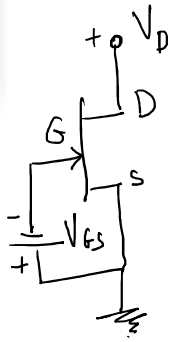
Bipolar Transistor (BJT)	Field Effect Transistor (FET)
Emitter - (E) >>	Source - (S)
Base - (B) >>	Gate - (G)
Collector - (C) >>	Drain - (D)

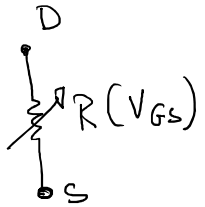




ΑΥΞΑΝΕΤΑΙ ΤΟ V_{GS} → ΜΕΙΩΝΕΤΑΙ ΤΟ ΡΕΥΜΑ I_D

ΗΛΕΚΤΡΙΚΟ ΑΝΑΛΟΓΟ

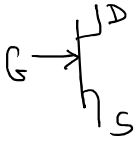




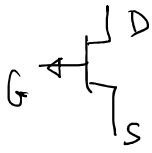
Αν αυξηθεί αρκετά η V_{GS} τότε $I_D = 0$

Το κατώφλι ονομάζεται $V_{GS}(off)$

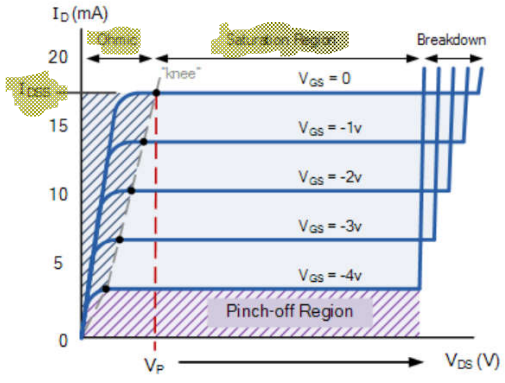
N-CHANNEL JFET



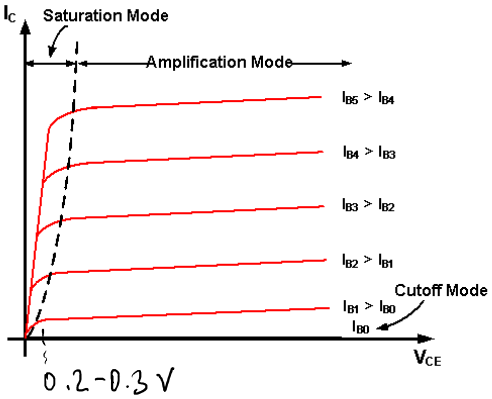
P-CHANNEL

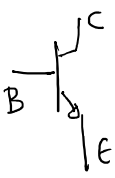


ΧΑΡΑΚΤΗΡΙΣΤΙΚΗ (I_D, V_{DS}) JFET n-CHANNEL



ΧΑΡΑΚΤΗΡΙΣΤΙΚΗ (I_C, V_{CE}) BJT npn





2N5457, 2N5458

JFETs - General Purpose

N−Channel − Depletion

N−Channel Junction Field Effect Transistors, depletion mode (Type A) designed for audio and switching applications.

Features

- N−Channel for Higher Gain
- Drain and Source Interchangeable
- High AC Input Impedance
- High DC Input Resistance
- Low Transfer and Input Capacitance
- Low Cross−Modulation and Intermodulation Distortion

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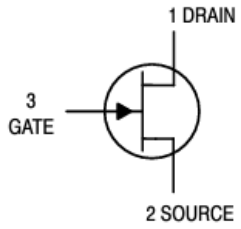
http://onsemi.com



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain−Source Voltage	V_{DS}	25	Vdc
Drain−Gate Voltage	V_{DG}	25	Vdc
Reverse Gate−Source Voltage	V_{GSR}	−25	Vdc
Gate Current	I_G	10	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	310 2.82	mW mW/°C
Operating Junction Temperature	T_J	135	°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Gate – Source Breakdown Voltage (I_G = –10 μAdc, V_{DS} = 0)		$V_{(BR)GSS}$	–25	–	–	Vdc
Gate Reverse Current (V_{GS} = –15 Vdc, V_{DS} = 0)		I_{GSS}	–	–	–1.0	nAdc
(V_{GS} = –15 Vdc, V_{DS} = 0, T_A = 100°C)			–	–	–200	
Gate–Source Cutoff Voltage (V_{DS} = 15 Vdc, i_D = 10 nAdc)	2N5457	$V_{GS(off)}$	–0.5	–	–6.0	Vdc
	2N5458		–1.0	–	–7.0	
Gate–Source Voltage		V_{GS}				Vdc
(V_{DS} = 15 Vdc, i_D = 100 μAdc)	2N5457		–	–2.5	–	
(V_{DS} = 15 Vdc, i_D = 200 μAdc)	2N5458		–	–3.5	–	
ON CHARACTERISTICS						
Zero–Gate–Voltage Drain Current (Note 1)	2N5457	I_{DSS}	1.0	3.0	5.0	mAdc
(V_{DS} = 15 Vdc, V_{GS} = 0)	2N5458		2.0	6.0	9.0	
DYNAMIC CHARACTERISTICS						
Forward Transfer Admittance (Note 1)	2N5457	$\|Y_{fs}\|$	1000	3000	5000	μmhos
(V_{DS} = 15 Vdc, V_{GS} = 0, f = 1 kHz)	2N5458		1500	4000	5500	
Output Admittance Common Source (Note 1) (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1 kHz)		$\|Y_{os}\|$	–	10	50	μmhos
Input Capacitance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1 kHz)		C_{iss}	–	4.5	7.0	pF
Reverse Transfer Capacitance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1 kHz)		C_{rss}	–	1.5	3.0	pF

1. Pulse Width ≤ 630 ms, Duty Cycle ≤ 10%.

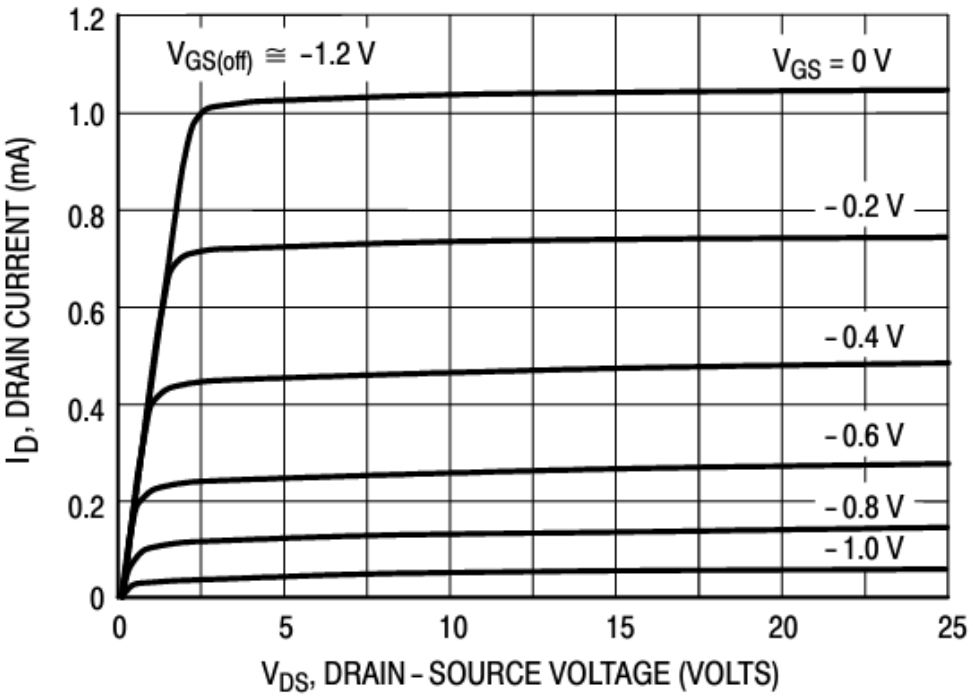
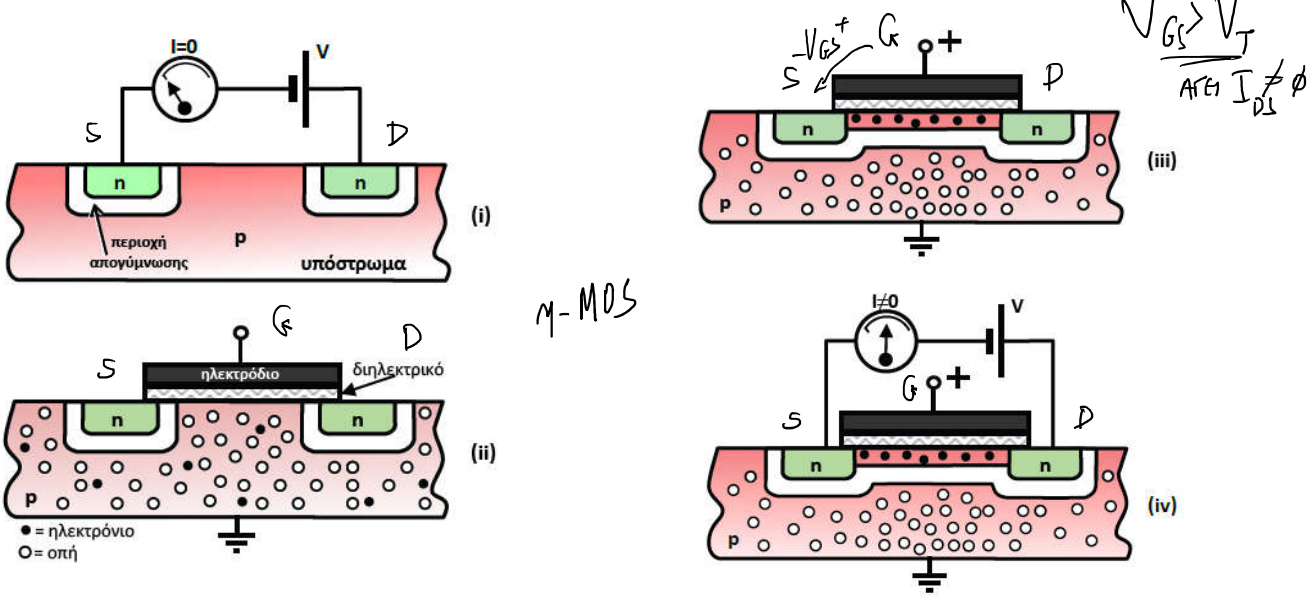


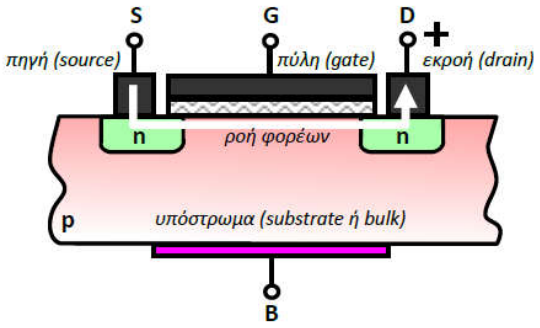
Figure 2. Typical Drain Characteristics

MOS-FET ΕΠΑΓΩΓΗΣ / ΠΡΟΕΛΑΥΝΟΜΕΝΗΣ ΚΑΝΑΛΙΟΥ

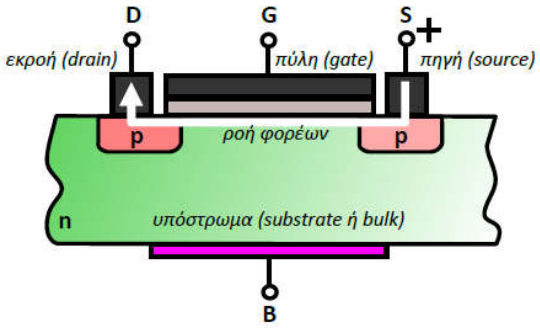
ENHANCEMENT MOSFET



Μ-MOS



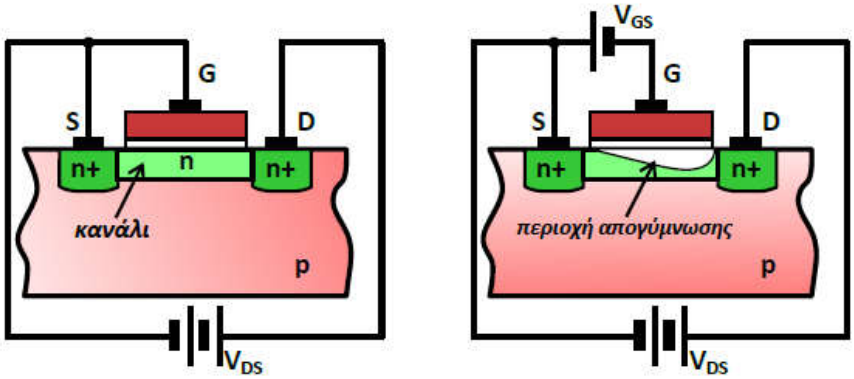
Σχήμα 4.5 *Τρανζίστορ nMOS: Δομή, ακροδέκτες, συμβολισμοί*



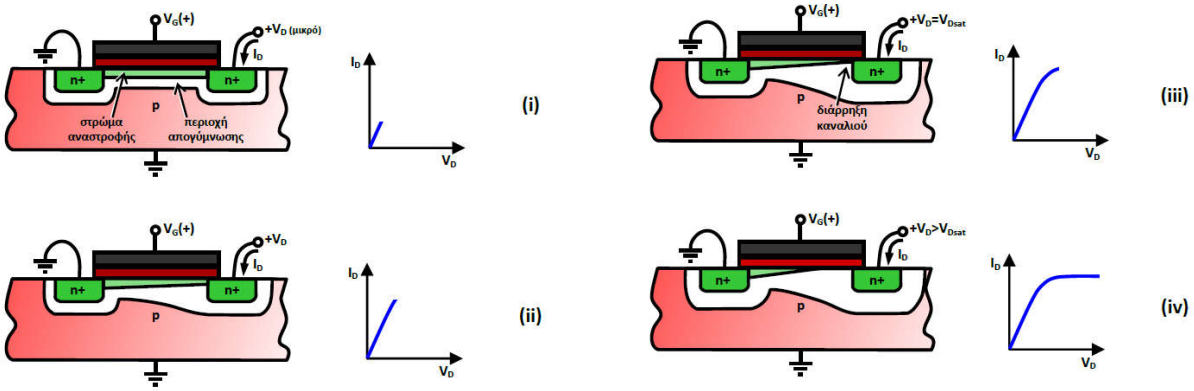
Σχήμα 4.6 *Τρανζίστορ pMOS: Δομή, ακροδέκτες, συμβολισμοί*

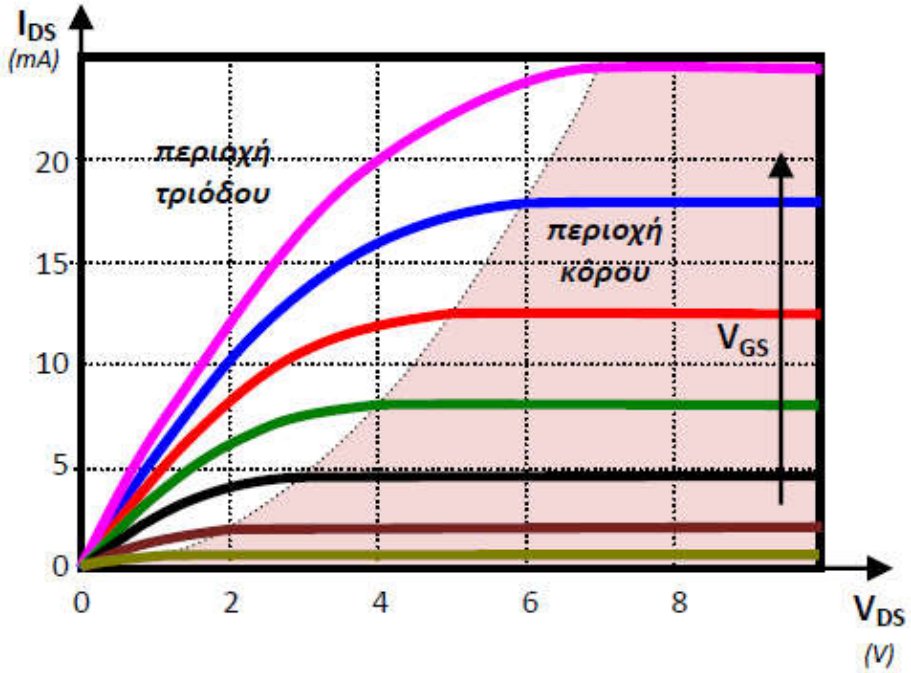
ΔΙΑΦΟΡΕΤΙΚΟΣ ΤΥΠΟΣ MOSFET ΑΠΟΓΥΜΝΩΣΗΣ ΚΑΝΑΛΙΟΥ

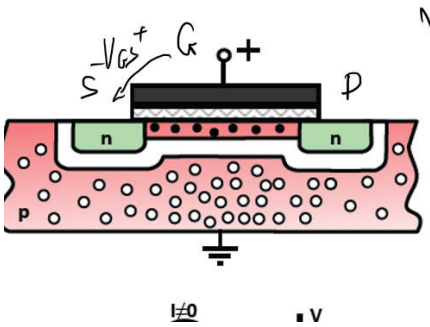
DEPLETION MOSFET



ΧΑΡΑΚΤΗΡΙΣΤΙΚΗ (I_D, V_D)







$V_{GS} > V_T$ ΑΡΑ $I_{DS} \neq 0$

I≠0 V

Πίνακας 4.1 *Μαθηματικές εκφράσεις για το τρανζίστορ nMOS*

ΠΕΡΙΟΧΗ ΛΕΙΤΟΥΡΓΙΑΣ	ΣΥΝΘΗΚΕΣ	ΡΕΥΜΑ ΚΑΝΑΛΙΟΥ (I_{DS})
Αποκοπής	$V_{GS} < V_T$	0
Τριόδου	$V_{DS} < V_{GS} - V_T, \quad V_{GS} > V_T$	$K_n \left[2 (V_{GS} - V_T) V_{DS} - V_{DS}^2\right]$
Κόρου	$V_{DS} > V_{GS} - V_T, \quad V_{GS} > V_T$	$K_n (V_{GS} - V_T)^2$

όπου: $K_n = \frac{1}{2} \cdot \frac{\mu_n \varepsilon}{t_{ox}} \cdot \frac{W}{L}$

ΠΑΡΑΤΗΡΗΣΕΙΣ: 1. ΠΕΡΙΟΧΗ ΤΡΙΟΔΟΥ: I_{DS} ΓΡΑΜΜΙΚΟ ΩΣ ΠΡΟΣ V_{GS} ;)

ΠΑΡΑΤΗΡΗΣΕΙΣ: 1. ΠΕΡΙΟΧΗ ΤΡΙΟΔΟΥ: I_{DS} ΓΡΑΜΜΙΚΟ ΩΣ ΠΡΟΣ V_{GS} 😊

$$I_{DS} = \left(2 k_M V_{DS}\right) V_{GS} + Q$$

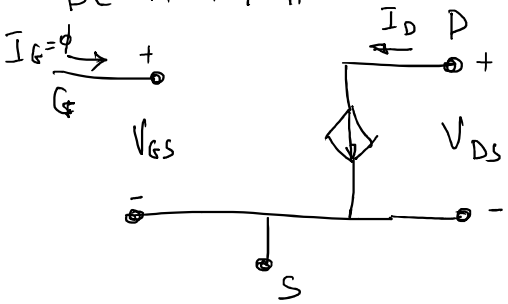
2. ΠΕΡΙΟΧΗ ΚΟΡΟΥ I_{DS} ΜΗ ΓΡΑΜΜΙΚΟ ΩΣ ΠΡΟΣ V_{GS}

$$I_{DS} = k_M (V_{GS} - V_T)^2 = k_M V_{GS}^2 - \left(2 k_M V_T\right) V_{GS} + k_M V_T^2$$

ΗΛΕΚΤΡΙΚΑ ΙΣΟΔΥΝΑΜΑ ΓΙΑ NMOS

ΛΕΙΤΟΥΡΓΙΑ ΚΟΡΟΥ

DC ΑΝΑΛΥΣΗ.

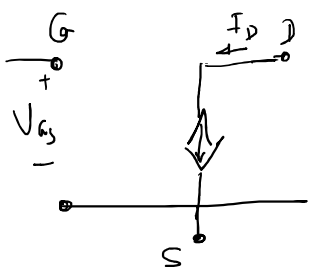


$$I_D = k_M (V_{GS} - V_T)^2$$

$$V_{GS} \geq V_T$$

$$V_{DS} \geq V_{GS} - V_T$$

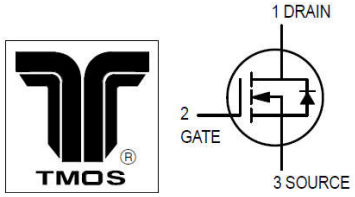
ΛΕΙΤΟΥΡΓΙΑ ΤΡΙΟΔΟΥ

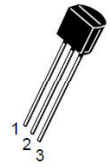


ΤΥΠΙΚΟ NMOS

TMOS FET Switching
N–Channel — Enhancement

BS170



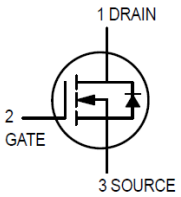


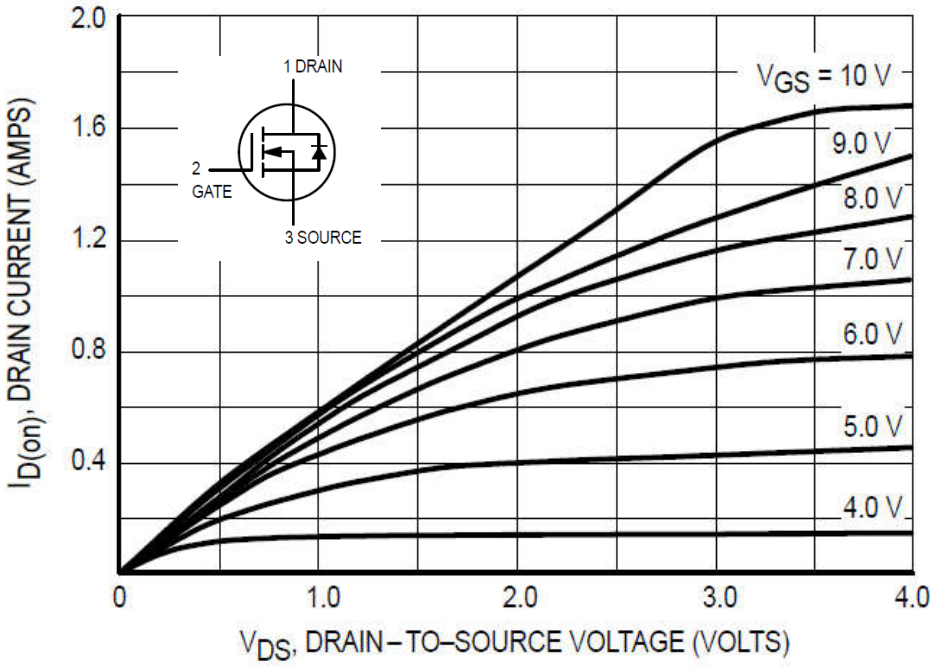
CASE 29–04, STYLE 30
TO–92 (TO–226AA)

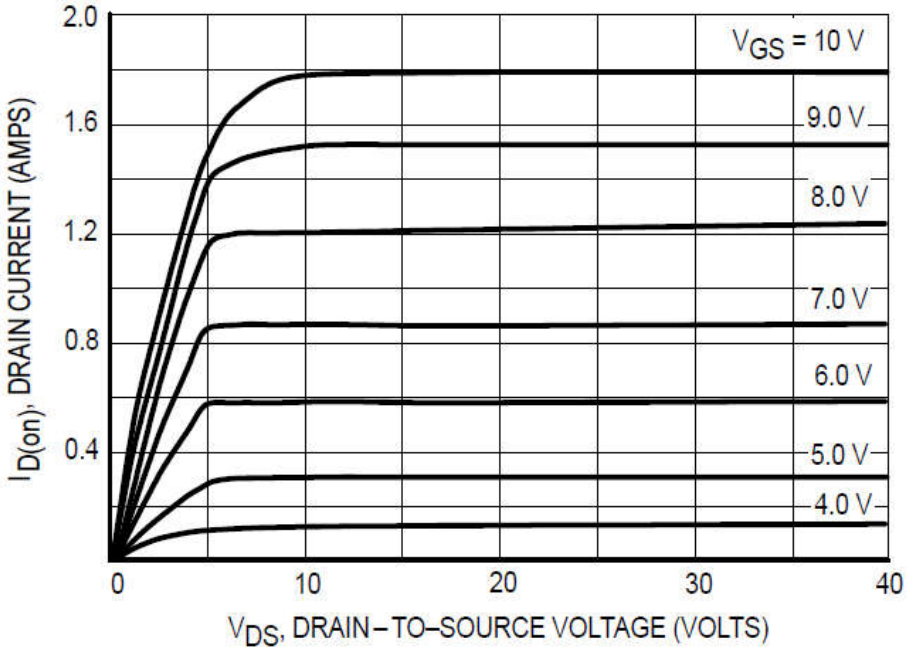
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain–Source Voltage	V_{DS}	60	Vdc
Gate–Source Voltage — Continuous — Non–repetitive ($t_p \leq 50$ μs)	 V_{GS} V_{GSM}	 ±20 ±40	 Vdc Vpk
Drain Current(1)	I_D	0.5	Adc
Total Device Dissipation @ T_A = 25°C	P_D	350	mW
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

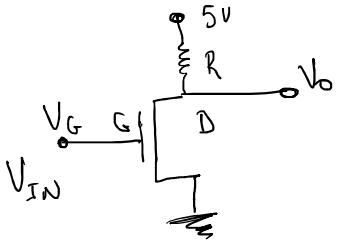
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Gate Reverse Current (V_{GS} = 15 Vdc, V_{DS} = 0)	I_{GSS}	—	0.01	10	nAdc
Drain–Source Breakdown Voltage (V_{GS} = 0, I_D = 100 μAdc)	$V_{(BR)DSS}$	60	90	—	Vdc
ON CHARACTERISTICS(2)					
Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 1.0 mAdc)	$V_{GS(Th)}$	0.8	2.0	3.0	Vdc
Static Drain–Source On Resistance (V_{GS} = 10 Vdc, I_D = 200 mAdc)	$r_{DS(on)}$	—	1.8	5.0	Ω
Drain Cutoff Current (V_{DS} = 25 Vdc, V_{GS} = 0 Vdc)	$I_{D(off)}$	—	—	0.5	μA
Forward Transconductance (V_{DS} = 10 Vdc, I_D = 250 mAdc)	g_{fs}	—	200	—	mmhos
SMALL–SIGNAL CHARACTERISTICS					
Input Capacitance (V_{DS} = 10 Vdc, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	—	—	60	pF
SWITCHING CHARACTERISTICS					
Turn–On Time (I_D = 0.2 Adc) See Figure 1	t_{on}	—	4.0	10	ns
Turn–Off Time (I_D = 0.2 Adc) See Figure 1	t_{off}	—	4.0	10	ns



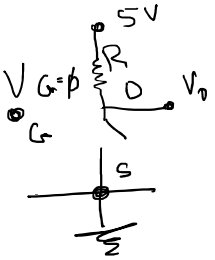




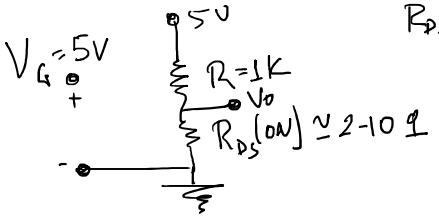
ΠΑΡΑΔΕΙΓΜΑΤΑ ΧΡΗΣΗΣ nMOS



ΑΝ $V_{IN} < V_T \Rightarrow V_o = 5V$



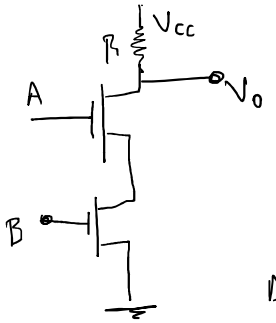
ΑΝ $V_{IN} > V_T \Rightarrow V_o = \frac{R_{DS}}{R_{DS}+R} \cdot 5V \Rightarrow$ $R_{DS} \ll R$ $\Rightarrow V_o \simeq 0V$



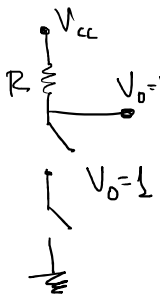
ΤΟ ΚΥΚΛΩΜΑ ΛΕΙΤΟΥΡΓΕΙ ΕΑΝ ΠΥΛΗ NOT

V_{IN}	V_o
(5V) ON	OFF (0V)
(0V) OFF	ON (5V)

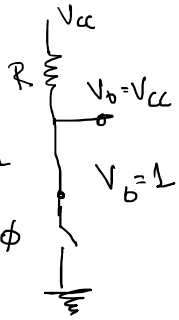
ΠΥΛΗ NAND

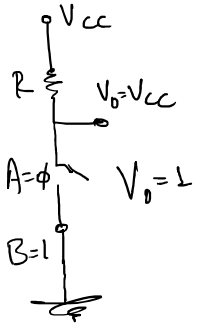


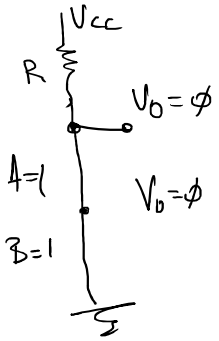
$A = 0$
$B = 0$



$A = 1$
$B = 0$

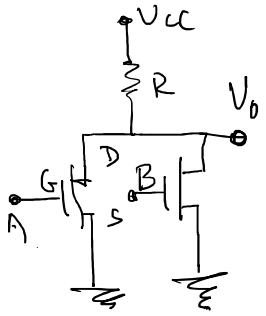


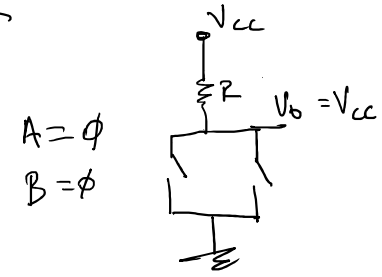


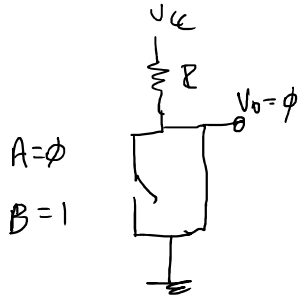


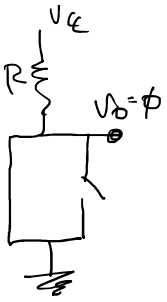
A	B	V_o
0	0	1
0	1	1
1	0	1
1	1	0

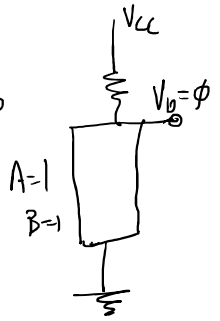
ΠΥΛΗ NOR







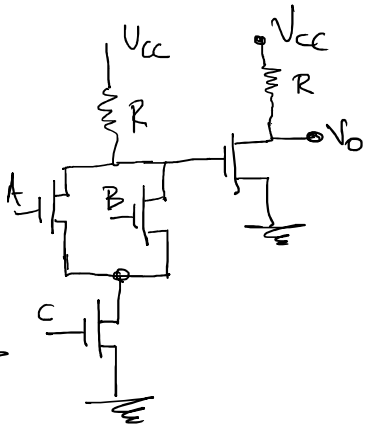




A	B	V0
0	0	1
0	1	0
1	0	0
1	1	0

ΠΙΝΑΚΑΣ ΕΙΣΟΔΟΥ/ΕΞΟΔΟΥ ΓΙΑ ΤΟ ΚΥΚΛΩΜΑ:

A	B	C	V0
0	0	0	
0	0	1	
0	1	0	
1	0	0	
0	1	1	
1	0	1	
1	1	0	
1	1	1	

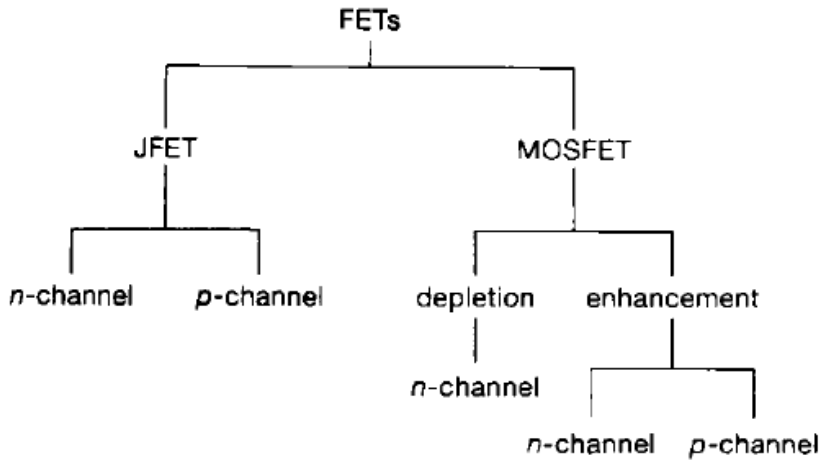


ΠΑΤΟΥΜΕ ΓΙΑ nMOS ΣΤΗΝ ΠΕΡΙΟΧΗ ΤΡΙΟΔΟΥ

Αν $V_{DS} << V_{GS} - V_T \Rightarrow I_D = \begin{cases} \frac{1}{R_{ON}} V_{DS}, & V_{GS} \geq V_T \\ 0, & V_{GS} < V_T \end{cases}$

ΓΙΑ { BS170 nMOS } $R_{ON} \simeq 2\text{-}5\,\Omega$

$V_T \simeq 2\,V$



↑ ΤΑ ΠΙΟ ΣΥΝΗΘΗ FET ΠΟΥ ΧΡΗΣΙΜΟΠΟΙΟΥΝΤΑΙ ΕΤΣΙ ΕΦΑΡΜΟΓΕΣ.