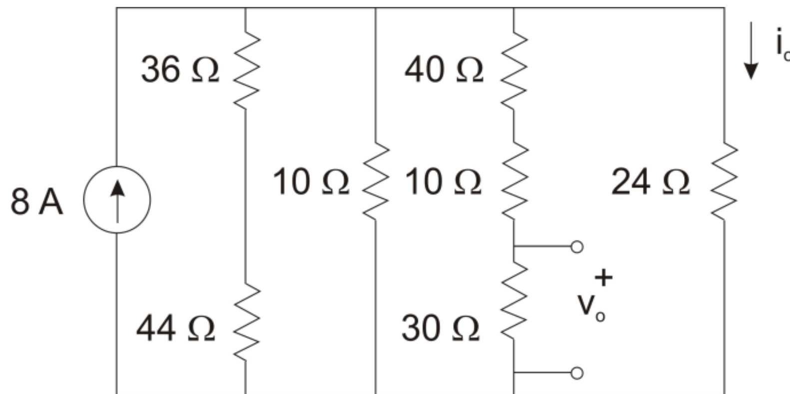
FYSE301 Elektroniikka I osa A

Loppukoe 27.4.2012 Vastaa kaikkiin viiteen kysymykseen

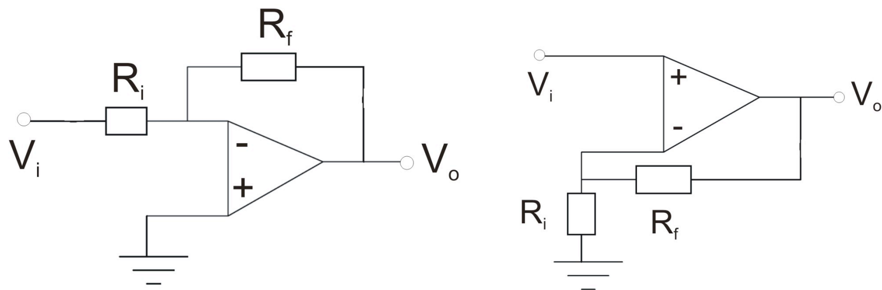
1. Selitä lyhyesti
   a) Theveninin teoreema (2 p)
   b) Itseispuolijohde ja seostettu puolijohde. (2 p)
   c) Piirrä p-kanava JFETin rakenne (poikkileikkauskuva riittää) ja nimeä transistorin osat (2 p)

2. Laske virta i_o ja jännite v_o kuvan 1 piirissä



Kuva 1.

3. a) Kuvaile ideaalisen operaatiovahvistimen ominaisuudet lyhyesti (2 p) b) Kuvassa 2 on esitetty invertoivan ja ei-invertoivan vahvistimen kytkennät. Määritä vahvistus V_o / V_i kummallekin piirille (voit olettaa operaatiovahvistimet ideaalisiksi ja että niiden navat ovat virtuaalisessa oikosulussa). (4 p)



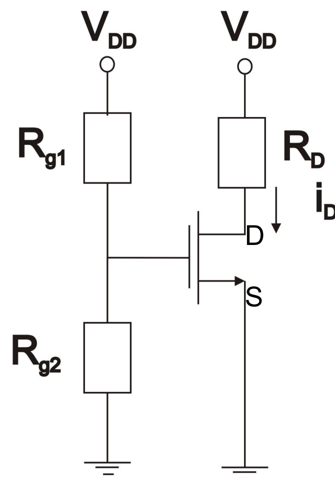
Kuva 2

4. Kuva 3 esittää MOSFET-transistorin biasointikytkentää, jolla lepotilan toimintapiste asetetaan halutuksi. Oletetaan että piirissä on BS170 NMOS transistori (liite).

   (a) Piirrä avaustyypin (enhancement mode) NMOS-transistorin poikkileikkaus, josta selviää transistorin toimintaperiaate. Nimeä transistorin osat. (2 p)

   (b) Määritä liitteen tiedoista mikä on i) hilan (gate) kynnysjännite, ii) virta I_D kun V_{GS}=0 V ja V_{DS}=25 V (2 p)

   (c) Olkoon kuvan 4 mukaisessa kytkennässä V_{DD} = 29 V ja R_D = 10 W. Määritä nieluvirta (I_D) ja nielu-lähdejännite (V_{DS}), kun V_{GS} = 6 V. Kuinka hilavastukset on valittava jotta saadaan V_{GS} = 6 V? Käytä apuna liitettä, jos siltä tuntuu. (2 p)

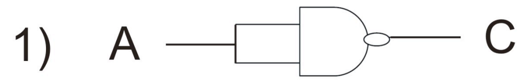


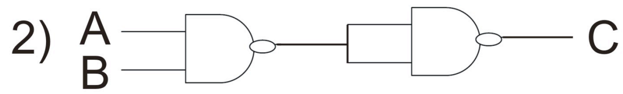
Kuva 3.

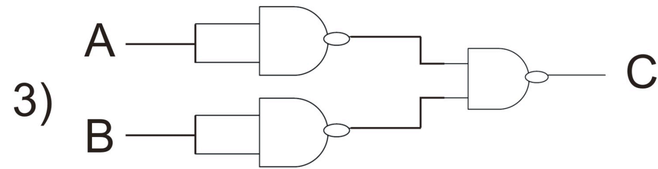
5. a) Kuvassa 4 on esitetty kolme erilaista NAND-porteista koostuvaa piiriä. Määritä kunkin piirin anto C kaikilla A:n ja B:n arvoilla. Minkä loogisen operaation kukin piiri suorittaa? Mikä ominaisuus NAND-portilla on laskemiesi tulosten perusteella? (3 p)

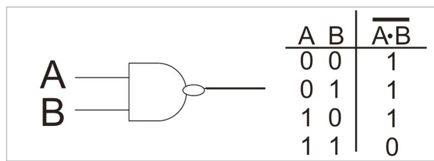
b) Kuvaile sanallisesti ja kuvia apuna käyttäen tyhjennysalueen muodostuminen pn-rajapinnan läheisyyteen. (3 p)

Joitain kenties hyödyllisiä yhtälöitä:
σ=neμ; n=p=n_i; n_i=$e^{-Eg/2kT}$; i=I_s($e^{ev/\eta kT}$-1); i_D=K(v_{GS}-V_T)^2; i_D=I_{DSS}(1-v_{GS}/V_P)^2;
β=α/(1- α);









A	B	$\overline{A \cdot B}$
0	0	1
0	1	1
1	0	1
1	1	0

Kuva 4

FAIRCHILD SEMICONDUCTOR®

March 2010

BS170 / MMBF170
N-Channel Enhancement Mode Field Effect Transistor

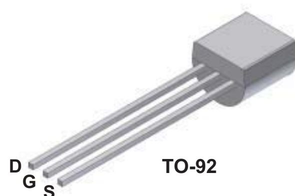
General Description

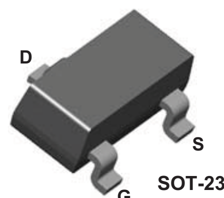
These N-Channel enhancement mode field effect transistors are produced using Fairchild's proprietary, high cell density, DMOS technology. These products have been designed to minimize on-state resistance while provide rugged, reliable, and fast switching performance. They can be used in most applications requiring up to 500mA DC. These products are particularly suited for low voltage, low current applications such as small servo motor control, power MOSFET gate drivers, and other switching applications.

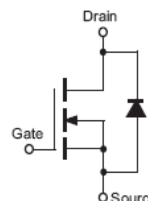
Features

- High density cell design for low $R_{DS(ON)}$.
- Voltage controlled small signal switch.
- Rugged and reliable.
- High saturation current capability.

BS170 **MMBF170**







Absolute Maximum Ratings T_A = 25°C unless otherwise noted

Symbol	Parameter	BS170	MMBF170	Units
V_{DSS}	Drain-Source Voltage	60		V
V_{DGR}	Drain-Gate Voltage ($R_{GS} \leq 1M\Omega$)	60		V
V_{GSS}	Gate-Source Voltage	± 20		V
I_D	Drain Current - Continuous	500	500	mA
	- Pulsed	1200	800	
T_J, T_{STG}	Operating and Storage Temperature Range	- 55 to 150		°C
T_L	Maximum Lead Temperature for Soldering Purposes, 1/16" from Case for 10 Seconds	300		°C

Thermal Characteristics T_A = 25°C unless otherwise noted

Symbol	Parameter	BS170	MMBF170	Units
P_D	Maximum Power Dissipation Derate above 25°C	830 6.6	300 2.4	mW mW/°C
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	150	417	°C/W

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Electrical Characteristics T_A=25°C unless otherwise noted

Symbol	Parameter	Conditions	Type	Min.	Typ.	Max.	Units
OFF CHARACTERISTICS							
BV_{DSS}	Drain-Source Breakdown Voltage	V_{GS} = 0V, I_D = 100µA	All	60			V
I_{DSS}	Zero Gate Voltage Drain Current	V_{DS} = 25V, V_{GS} = 0V	All			0.5	µA
I_{GSSF}	Gate - Body Leakage, Forward	V_{GS} = 15V, V_{DS} = 0V	All			10	nA
ON CHARACTERISTICS (Notes 1)							
$V_{GS(th)}$	Gate Threshold Voltage	V_{DS} = V_{GS}, I_D = 1mA	All	0.8	2.1	3	V
$R_{DS(ON)}$	Static Drain-Source On-Resistance	V_{GS} = 10V, I_D = 200mA	All		1.2	5	Ω
g_{FS}	Forward Transconductance	V_{DS} = 10V, I_D = 200mA	BS170		320		mS
		V_{DS} ≥ 2 $V_{DS(on)}$, I_D = 200mA	MMBF170		320		
Dynamic Characteristics							
C_{iss}	Input Capacitance	V_{DS} = 10V, V_{GS} = 0V, f = 1.0MHz	All		24	40	pF
C_{oss}	Output Capacitance		All		17	30	pF
C_{rss}	Reverse Transfer Capacitance		All		7	10	pF
Switching Characteristics (Notes 1)							
t_{on}	Turn-On Time	V_{DD} = 25V, I_D = 200mA, V_{GS} = 10V, R_{GEN} = 25Ω	BS170			10	ns
		V_{DD} = 25V, I_D = 500mA, V_{GS} = 10V, R_{GEN} = 50Ω	MMBF170			10	
t_{off}	Turn-Off Time	V_{DD} = 25V, I_D = 200mA, V_{GS} = 10V, R_{GEN} = 25Ω	BS170			10	ns
		V_{DD} = 25V, I_D = 500mA, V_{GS} = 10V, R_{GEN} = 50Ω	MMBF170			10	

Note:
1. Pulse Test: Pulse Width ≤ 300µs, Duty Cycle ≤ 2.0%.

Ordering Information

Part Number	Package	Package Type	Lead Frame	Pin array
BS170	TO-92	BULK	STRAIGHT	D G S
BS170_D26Z	TO-92	Tape and Reel	FORMING	D G S
BS170_D27Z	TO-92	Tape and Reel	FORMING	D G S
BS170_D74Z	TO-92	AMMO	FORMING	D G S
BS170_D75Z	TO-92	AMMO	FORMING	D G S
MMBF170	SOT-23	Tape and Reel		

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Typical Electrical Characteristics

BS170 / MMBF170

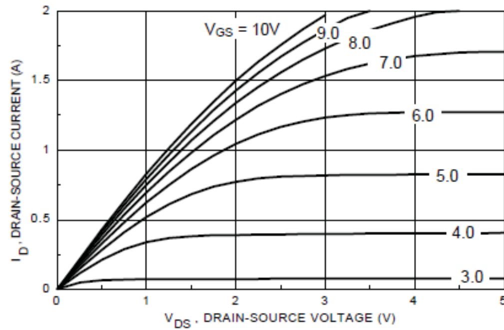

Figure 1. On-Region Characteristics.

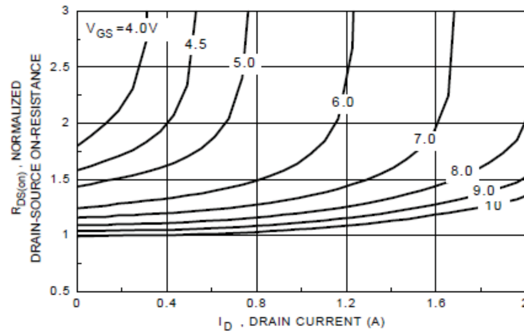

Figure 2. On-Resistance Variation with Gate Voltage and Drain Current.

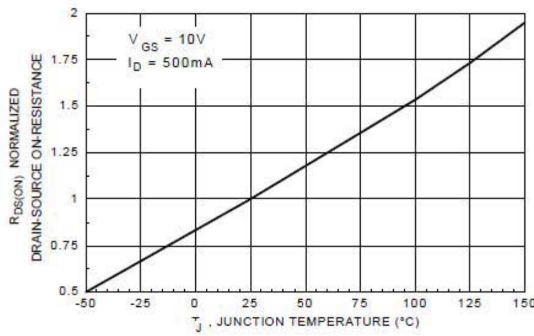

Figure 3. On-Resistance Variation with Temperature.

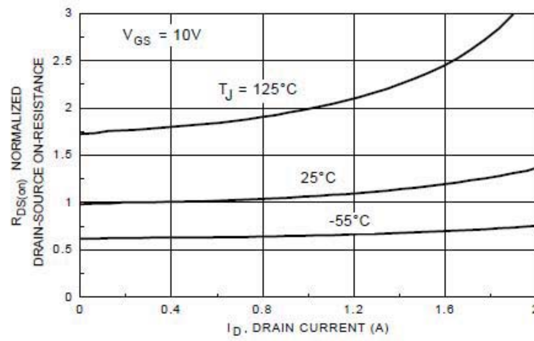

Figure 4. On-Resistance Variation with Drain Current and Temperature.

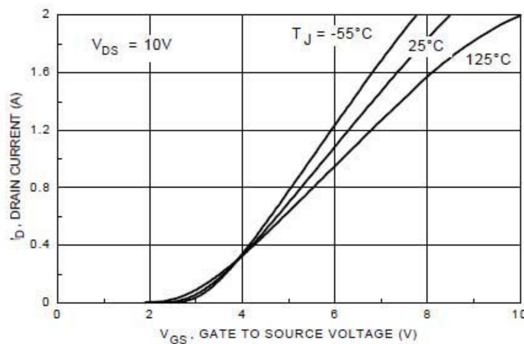

Figure 5. Transfer Characteristics.

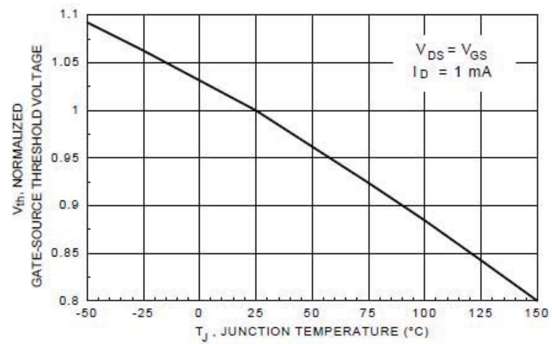

Figure 6. Gate Threshold Variation with Temperature.

Typical Electrical Characteristics (continued)

BS170 / MMBF170

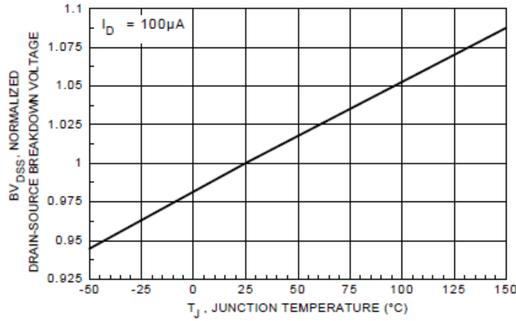

Figure 7. Breakdown Voltage Variation with Temperature.

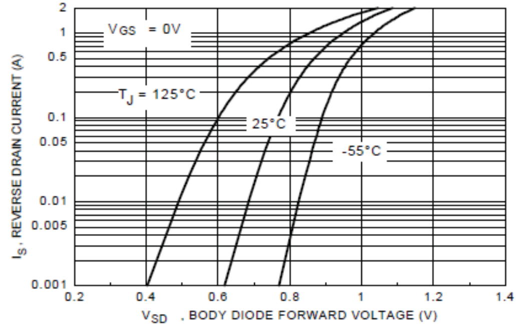

Figure 8. Body Diode Forward Voltage Variation with Current and Temperature.

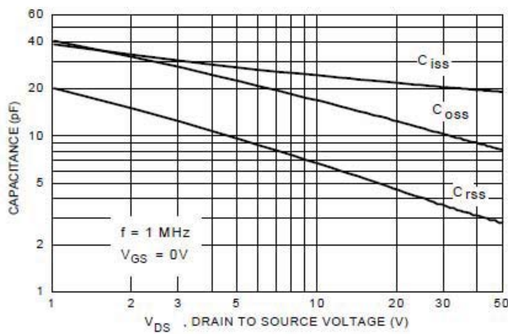

Figure 9. Capacitance Characteristics.

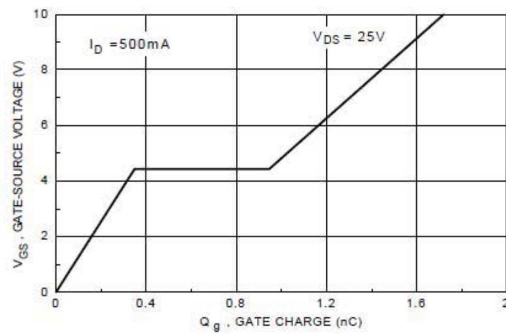

Figure 10. Gate Charge Characteristics.

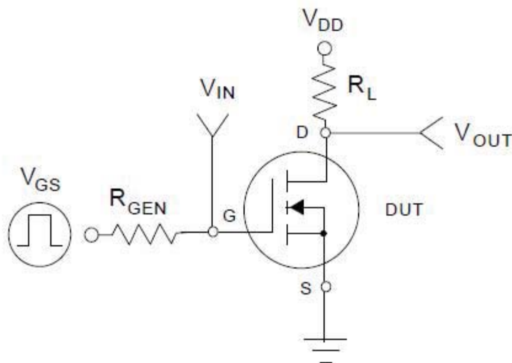

Figure 11. Switching Test Circuit.

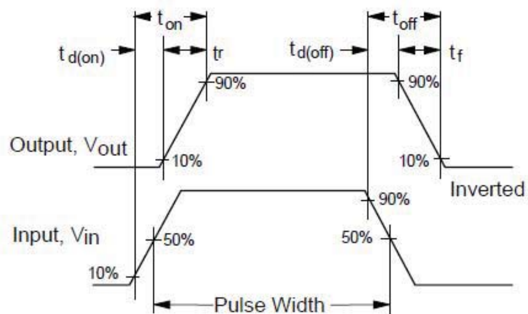

Figure 12. Switching Waveforms.

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Periodic Table of the Elements

hydrogen 1 H 1.0079																		helium 2 He 4.0026
lithium 3 Li 6.941	beryllium 4 Be 9.0122												boron 5 B 10.811	carbon 6 C 12.011	nitrogen 7 N 14.007	oxygen 8 O 15.999	fluorine 9 F 18.998	neon 10 Ne 20.180
sodium 11 Na 22.990	magnesium 12 Mg 24.305												aluminium 13 Al 26.982	silicon 14 Si 28.086	phosphorus 15 P 30.974	sulfur 16 S 32.065	chlorine 17 Cl 35.453	argon 18 Ar 39.948
potassium 19 K 39.098	calcium 20 Ca 40.078		scandium 21 Sc 44.956	titanium 22 Ti 47.867	vanadium 23 V 50.942	chromium 24 Cr 51.996	manganese 25 Mn 54.938	iron 26 Fe 55.845	cobalt 27 Co 58.933	nickel 28 Ni 58.693	copper 29 Cu 63.546	zinc 30 Zn 65.39	gallium 31 Ga 69.723	germanium 32 Ge 72.61	arsenic 33 As 74.922	selenium 34 Se 78.96	bromine 35 Br 79.904	krypton 36 Kr 83.80
rubidium 37 Rb 85.468	strontium 38 Sr 87.62		yttrium 39 Y 88.906	zirconium 40 Zr 91.224	niobium 41 Nb 92.906	molybdenum 42 Mo 95.94	technetium 43 Tc [98]	ruthenium 44 Ru 101.07	rhodium 45 Rh 102.91	palladium 46 Pd 106.42	silver 47 Ag 107.87	cadmium 48 Cd 112.41	indium 49 In 114.82	tin 50 Sn 118.71	antimony 51 Sb 121.76	tellurium 52 Te 127.60	iodine 53 I 126.90	xenon 54 Xe 131.29
caesium 55 Cs 132.91	barium 56 Ba 137.33	57-70 *	lutetium 71 Lu 174.97	hafnium 72 Hf 178.49	tantalum 73 Ta 180.95	tungsten 74 W 183.84	rhenium 75 Re 186.21	osmium 76 Os 190.23	iridium 77 Ir 192.22	platinum 78 Pt 195.08	gold 79 Au 196.97	mercury 80 Hg 200.59	thallium 81 Tl 204.38	lead 82 Pb 207.2	bismuth 83 Bi 208.98	polonium 84 Po [209]	astatine 85 At [210]	radon 86 Rn [222]
francium 87 Fr [223]	radium 88 Ra [226]	89-102 * *	lawrencium 103 Lr [262]	rutherfordium 104 Rf [261]	dubnium 105 Db [262]	seaborgium 106 Sg [266]	bohrium 107 Bh [264]	hassium 108 Hs [269]	meitnerium 109 Mt [268]	ununnilium 110 Uun [271]	unununium 111 Uuu [272]	ununbium 112 Uub [277]		ununquadium 114 Uuq [289]				

*Lanthanide series	lanthanum 57 La 138.91	cerium 58 Ce 140.12	praseodymium 59 Pr 140.91	neodymium 60 Nd 144.24	promethium 61 Pm [145]	samarium 62 Sm 150.36	europium 63 Eu 151.96	gadolinium 64 Gd 157.25	terbium 65 Tb 158.93	dysprosium 66 Dy 162.50	holmium 67 Ho 164.93	erbium 68 Er 167.26	thulium 69 Tm 168.93	ytterbium 70 Yb 173.04
* *Actinide series	actinium 89 Ac [227]	thorium 90 Th 232.04	protactinium 91 Pa 231.04	uranium 92 U 238.03	neptunium 93 Np [237]	plutonium 94 Pu [244]	americium 95 Am [243]	curium 96 Cm [247]	berkelium 97 Bk [247]	californium 98 Cf [251]	einsteinium 99 Es [252]	fermium 100 Fm [257]	mendelevium 101 Md [258]	nobelium 102 No [259]