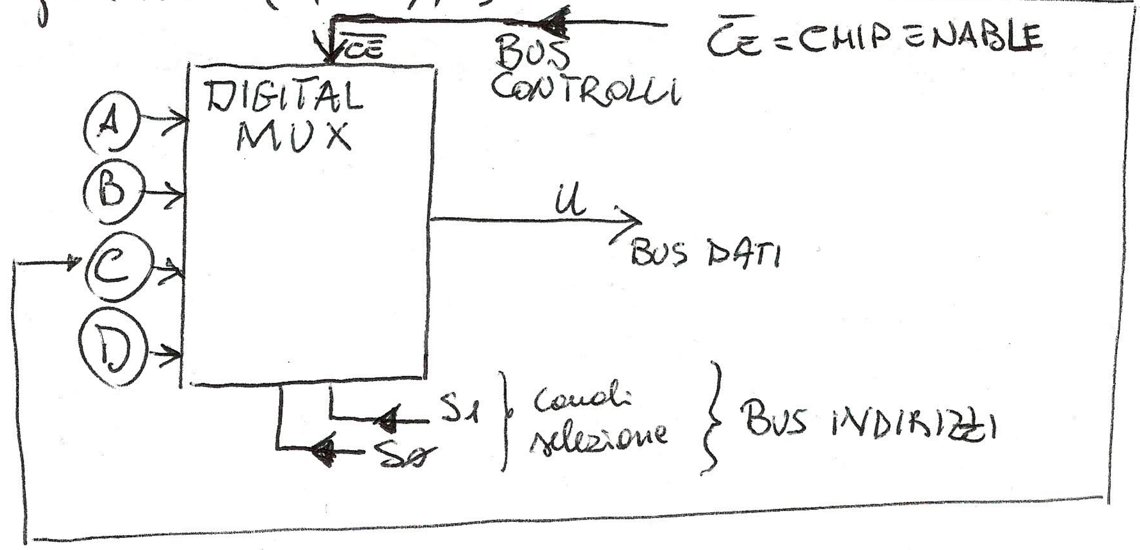
numero ingresso/uscite Arduino

Pin Mode (1, output);
Digital Write (1, low); } Accendere Multiplexer mandando 0 dell'Arduino

Low = 0 / high = 1

Pin Mode (2, output); → S_0 } canali selezione
Pin Mode (3, output); → S_1 }
Pin Mode (4, output); → dati

Digital Write (2, high);
Digital Write (3, low); } per dare Valore C tramite: canali selezione



0 = ACCESO / 1 = SPENTO

$\overline{CE}$	A B C D	S_0	S_1	U	
1	X X X X	X	X	0	
0	0 X X X	0	0	0	
0	1 X X X	0	0	1	→ $A \cdot \overline{S_0}\,\overline{S_1}$
0	X 0 X X	0	1	0	+
0	X 1 X X	0	1	1	→ $B \cdot \overline{S_0}\,S_1$
0	X X 0 X	1	0	0	+
0	X X 1 X	1	0	1	→ $C \cdot S_0\,\overline{S_1}$
0	X X X 0	1	1	0	+
0	X X X 1	1	1	1	→ $D \cdot S_0\,S_1$

Esercizio Progettare un DMUX (digital Musc) a 4 ingressi T1 T2 T3 T4 (=trasduttori digitali) e collegare l'uscita (U) al μC (=micro controller) Arduino scrivendo le righe di programma in MICROC (Scaricare IDE Arduino dal sito) per selezionare uno dei quattro trasduttori.
(svolgimento a pag. ⑥).

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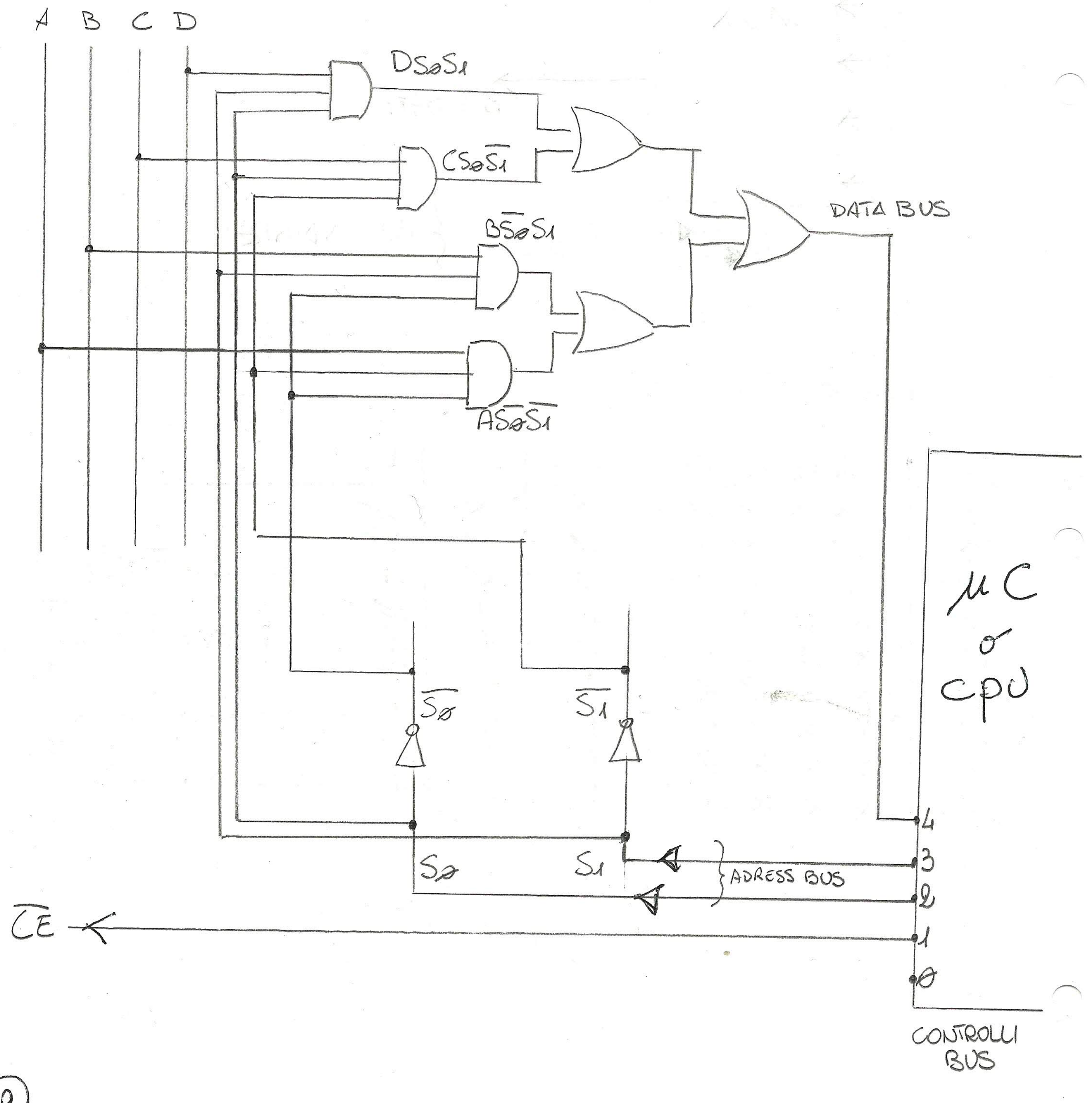
continua da pagina ①

FASE ACQUISIZIONE DATI

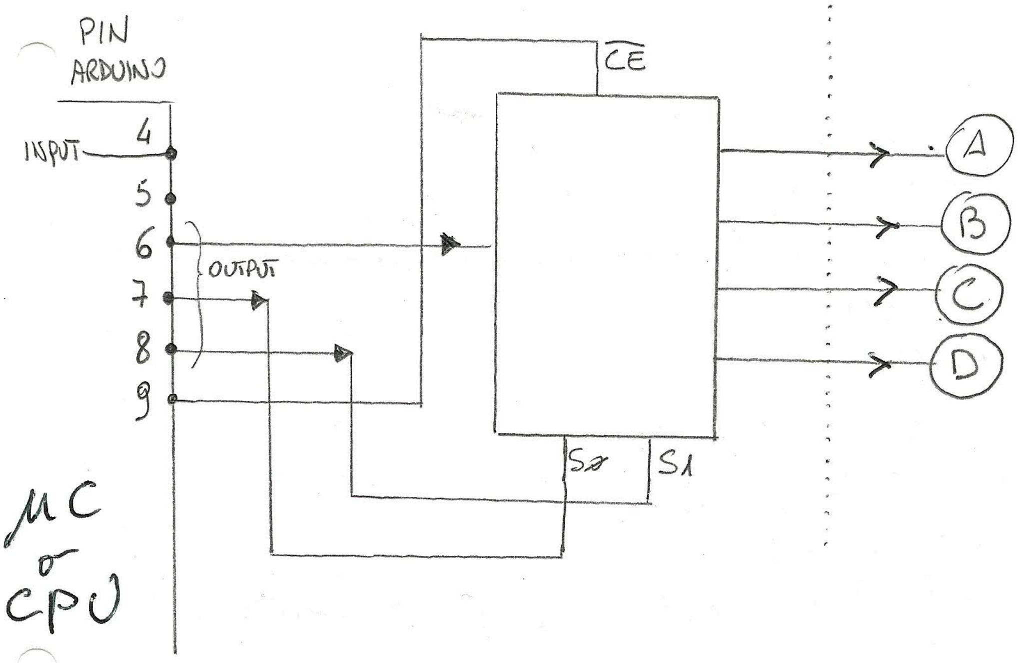
$A\overline{S_0}\overline{S_1} + B\overline{S_0}S_1 + C S_0 \overline{S_1} + D S_0 S_1$



FASE FUNZIONALE

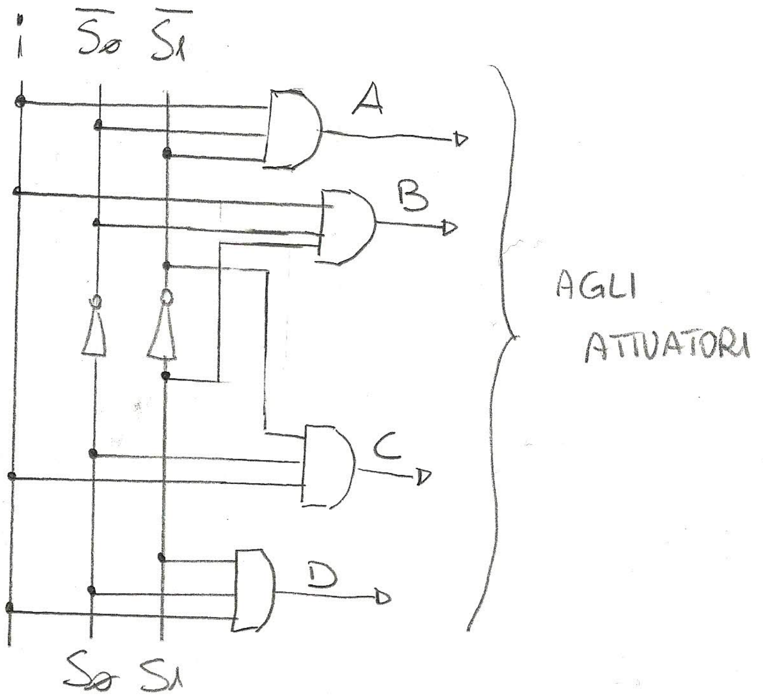
FASE DISTRIBUZIONE

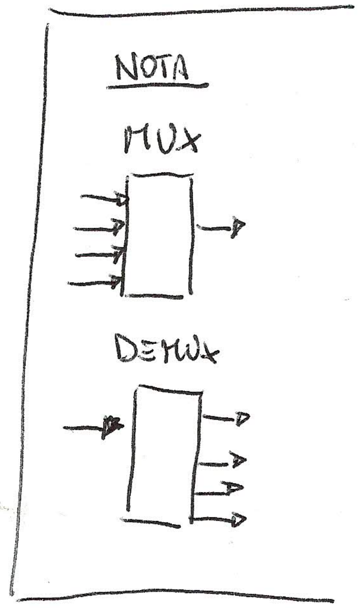
DI DEMUX



i	S_0	S_1	U
x	0	0	$i\overline{S_0}\,\overline{S_1}$ (=A)
x	0	1	$i\overline{S_0}S_1$ (=B)
x	1	0	$iS_0\overline{S_1}$ (=C)
x	1	1	iS_0S_1 (=D)

$\overline{CE}$ sempre = 0

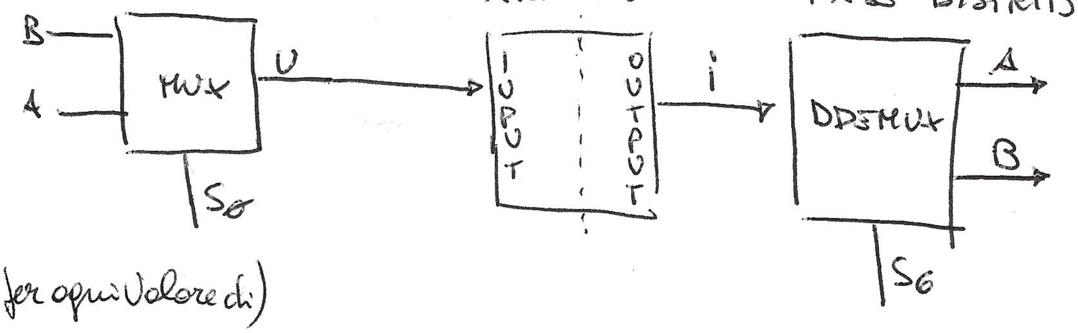




Codice per
<u>Impostazione $\overline{CE}$ e altri pin</u>

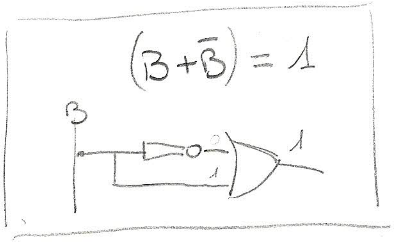
```
void setup()
 { PinMode (4, output);
   PinMode (3, input);   //non si inizializza essendo di INPUT
   PinMode (2, output);
   PinMode (1, output);
   /* CONFIGURAZIONE INIZIALE DEI PIN 1-2-3-4 */
   DigitalWrite (1, low);
   DigitalWrite (2, low);
   DigitalWrite (4, low);  //il CE si imposta per ULTIMO!!
   AnalogRead (3);
 }
void loop()
 {
   ----
   ----
 }
```

MUX digitale 2 ingressi e DEMUX 2 uscite



(x = per ogni valore di)

A	B	S_0	U	
0	x	0	0	
1	x	0	1	--- $A\bar{S}_0$
x	0	1	0	
x	1	1	1	--- BS_0

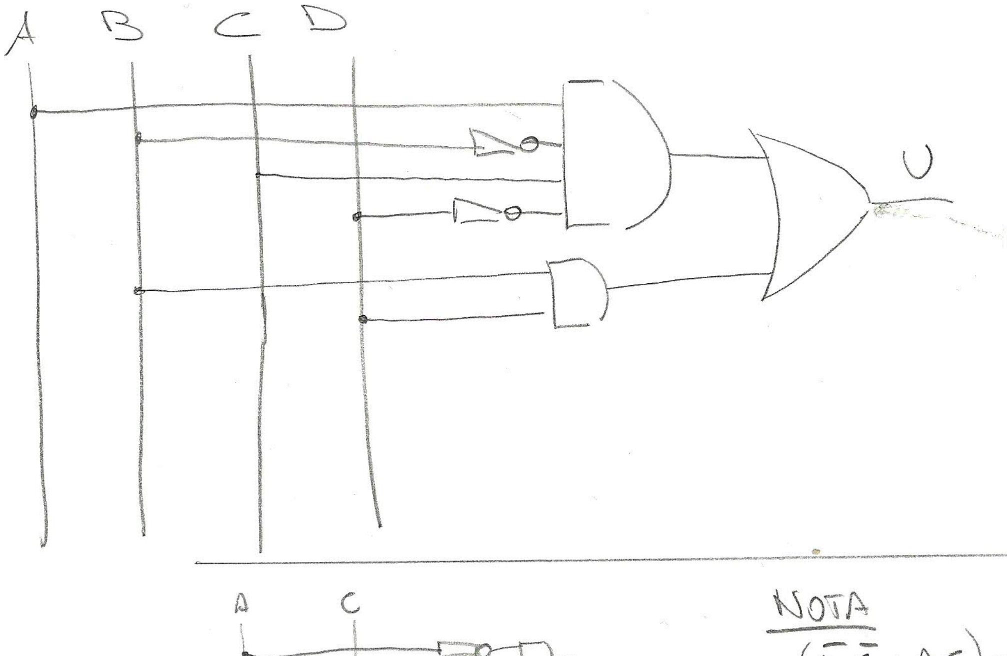


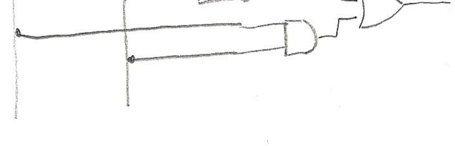
	A	B	C	D
5	0	1	0	1
10	1	0	1	0
15	1	1	1	1

circuito che discrimina sei suoi multipli

$$(\bar{A}B\bar{C}D + A\bar{B}C\bar{D} + ABCD) =$$

$$= \underbrace{BD(\bar{A}\bar{C} + AC)}_{BD \cdot 1} + A\bar{B}C\bar{D} = BD + A\bar{B}C\bar{D}$$





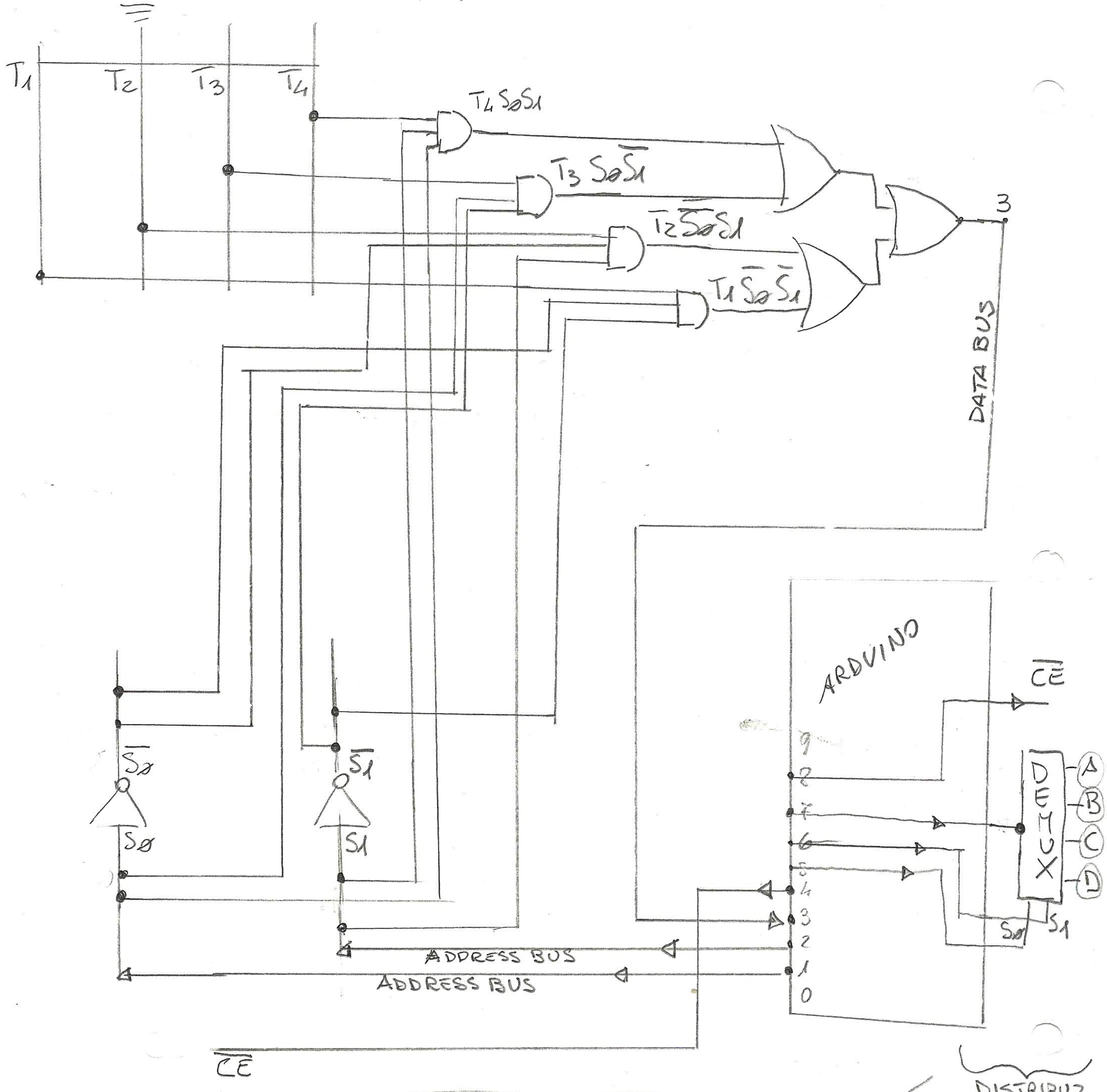
NOTA

$$= (\bar{A}\bar{C} + AC) = 1$$

(MUX A QUATTRO INGRESSI)

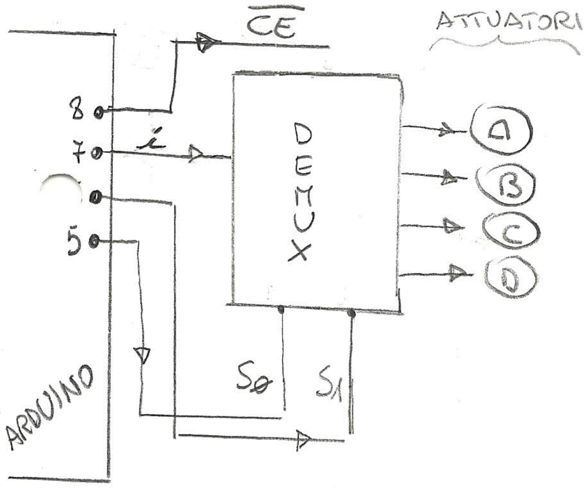
LOW VALUE → $\overline{CE}$

$\overline{CE}$	T_1	T_2	T_3	T_4	S_0	S_1	U	
	TRASDUTTORI							
0	0	x	x	x	0	0	0	
0	1	x	x	x	0	0	1	→ $T_1 \overline{S_0}\, \overline{S_1}$
0	x	0	x	x	0	1	0	+
0	x	1	x	x	0	1	1	→ $T_2 \overline{S_0} S_1$
0	x	x	0	x	1	0	0	+
0	x	x	1	x	1	0	1	→ $T_3 S_0 \overline{S_1}$
0	x	x	x	0	1	1	0	+
0	x	x	x	1	1	1	1	→ $T_4 S_0 S_1$



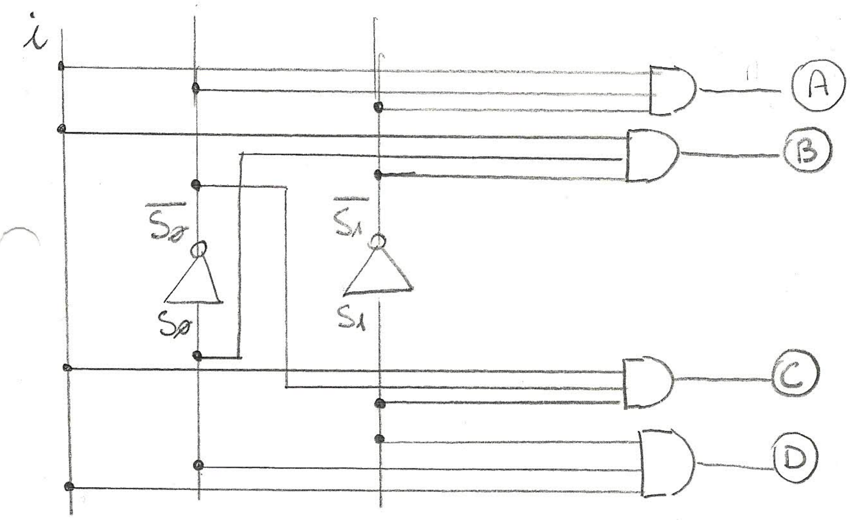
ACQUISIZIONE DATI

DISTRIBUZ. DATI

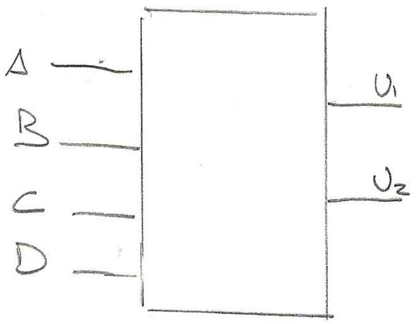


(DEMUX A 4 USCITE)

i	S_0	S_1	U
X	0	0	$i\,\overline{S_0}\,\overline{S_1} \longrightarrow A$
X	0	1	$i\,\overline{S_0}\,S_1 \longrightarrow B$
X	1	0	$i\,S_0\,\overline{S_1} \longrightarrow C$
X	1	1	$i\,S_0\,S_1 \longrightarrow D$



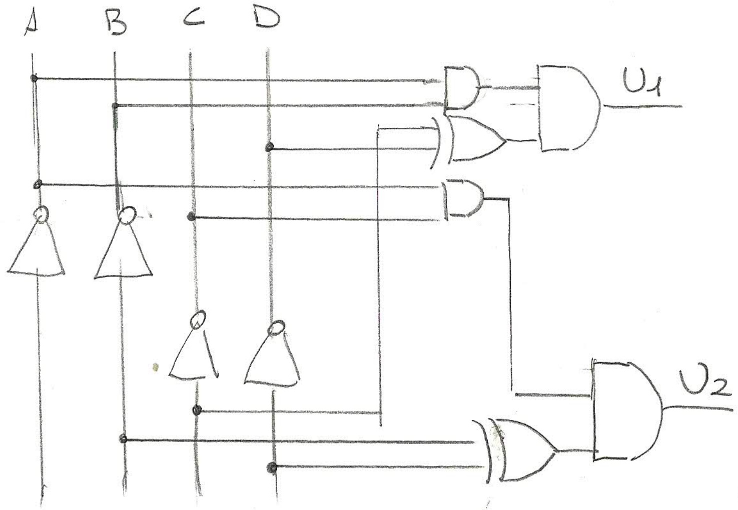
DISTRIBUZIONE DATI



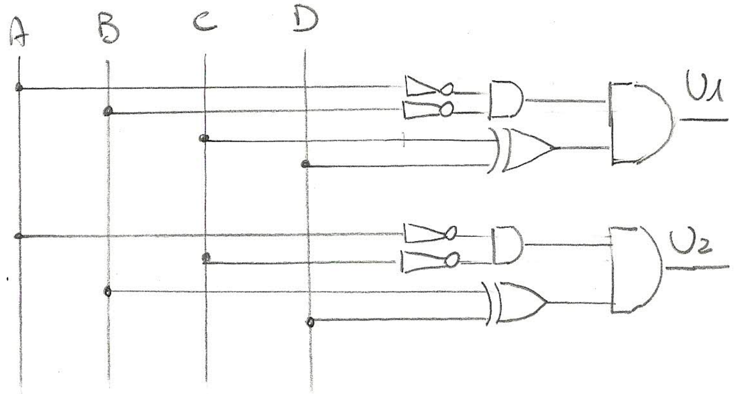
A	B	C	D	U_1	U_2
1	0	0	0	0	0
0	1	0	0	0	1
0	0	1	0	1	0
0	0	0	1	1	1

$$U_1 = \bar{A}\bar{B}C\bar{D} + \bar{A}\bar{B}\bar{C}D = \bar{A}\bar{B}\underbrace{(C\bar{D} + \bar{C}D)}_{XOR}$$

$$U_2 = \bar{A}B\bar{C}\bar{D} + \bar{A}\bar{B}\bar{C}D = \bar{A}\bar{C}\underbrace{(B\bar{D} + \bar{B}D)}_{XOR}$$

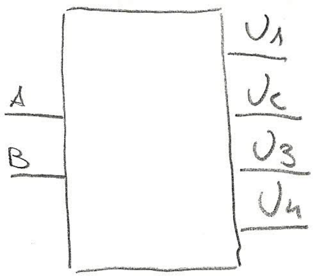


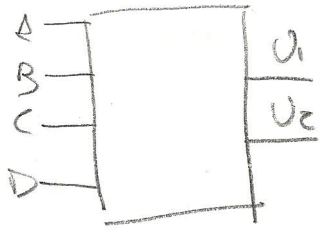
oppure



NOTA = { moltiplicazione AND
somma OR

DECODER (centitorio) ENCODER

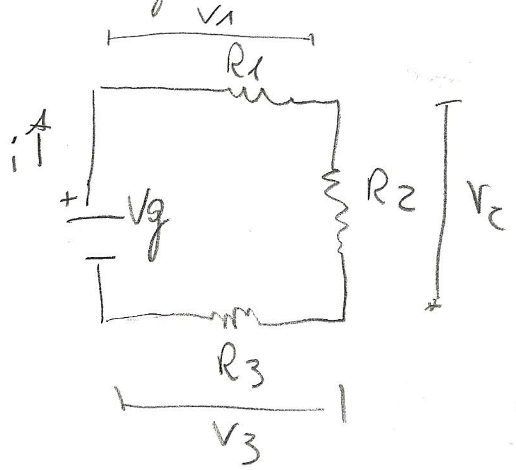




A	B	U_1	U_2	U_3	U_4
Ø	Ø				
Ø	1				
1	Ø				
1	1				

CORRENTE CONTINUA = i (i_{cc})

dal circuito dato calcolare le correnti e le tensioni ai capi di ogni resistenza

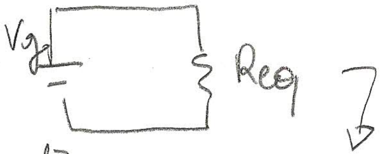


$V_g = 12\ V\ DC$

$R_1 = 500\ \Omega$

$R_2 = 200\ \Omega$

$R_3 = 100\ \Omega$



$$i = \frac{V_g}{R_{eq}} = \frac{12}{800} = \frac{12}{8} \cdot 10^{-2} = 1.5 \cdot 10^{-2}\ A$$

$15\ mA = 15 \cdot 10^{-3}\ A$

$V_1 = R_1 \cdot i = 500 \cdot 15 \cdot 10^{-3} = 7,5 \cdot 10^{-3} = 7.5\ V$ +

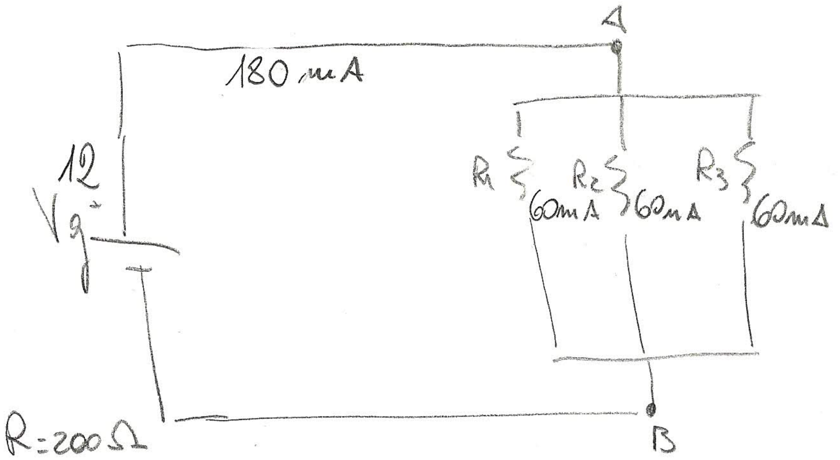
$V_2 = R_2 \cdot i = 200 \cdot 15 \cdot 10^{-3} = 30 \cdot 10^{-3} = 3.0\ V$ +

$V_3 = R_2 \cdot i = 100 \cdot 15 \cdot 10^{-3} = 15 \cdot 10^{-3} = 1.5\ V$ +

$V_G = 12.0\ V$

---

con resistenze in parallelo



$$\frac{1}{R_{eq}} = \left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \cdots\right)$$

$$R_{eq} = \left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \cdots\right)^{-1} = \left(\frac{1+1+1}{R}\right)^{-1} = \left(\frac{3}{R}\right)^{-1} = \frac{R}{3}$$

$$i = \frac{V_g}{R_{eq}} = \frac{12}{\frac{200}{3}} = \frac{36}{200} = 18 \cdot 10^{-2}\ A$$ ← corrente (180 mA)

da mA a A

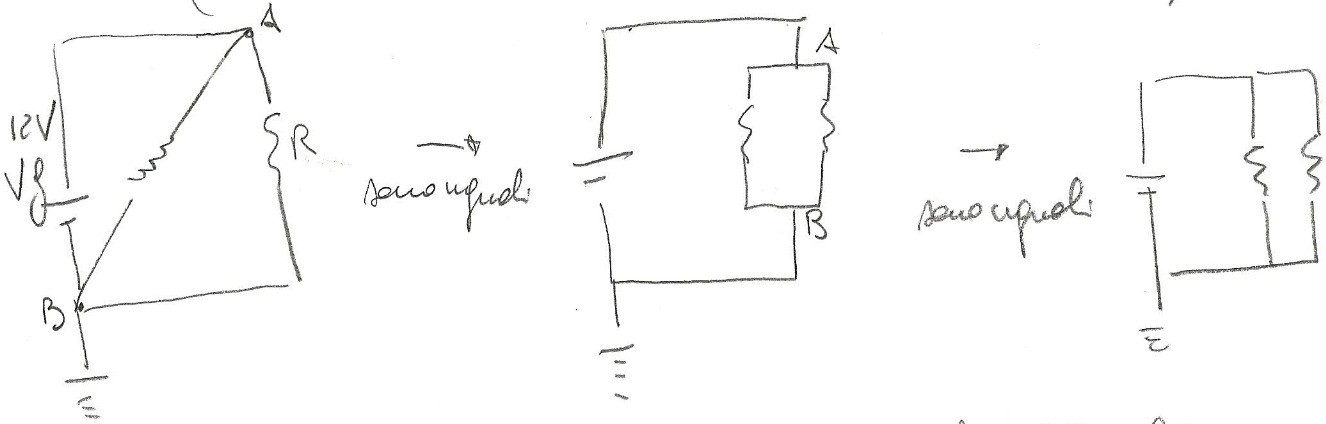
$$V_{AB} = R \cdot i = 200 \cdot 60\ mA = 2 \cdot 10^{2} \cdot 6 \cdot 10^{-2} A = 12\ V$$

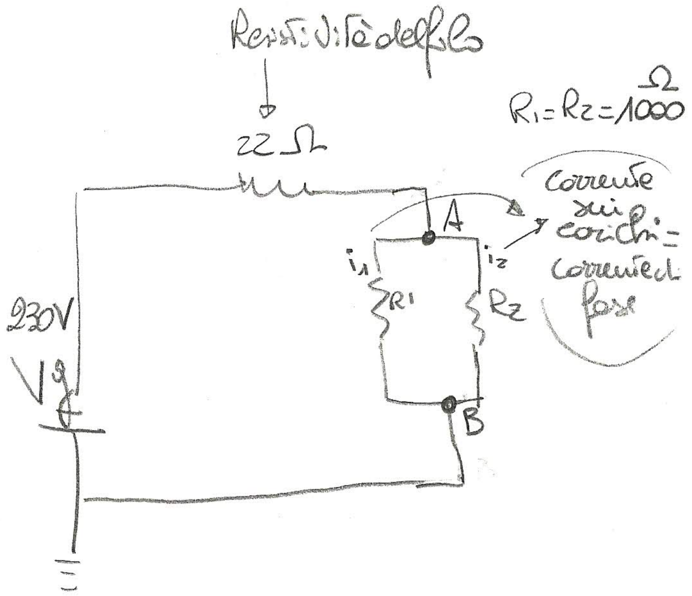
Conduttività: inverso di Resistività
isolante resistività alta

ρ = RHO

$\propto$ direttamente proporzionale

(TRASCURANDO LA RESISTENZA DEL FILO)(*)





(*) nel caso si volesse calcolare si farebbe

resistività cavo Cu (Rame)

Lunghezza cavo in m (2 km)

Sezione filo 1,5 mmq

la Res. filo $= \rho \cdot \frac{L}{S} = x\ \Omega$

$\rho_{Cu} = 1{,}69 \cdot 10^{-8}\ \Omega \cdot m$

$$R_f = \rho \cdot \frac{L}{S} = 1{,}69 \cdot 10^{-8}\ \Omega m \cdot \frac{2000\ m}{1{,}5 \cdot 10^{-6}\ mmq} = \frac{1{,}69}{1{,}5} \cdot 2 \cdot 10 = 22\ \Omega$$

e aumentando la sezione del filo si potrà diminuire la perdita sul filo e non più del 4% di Vg

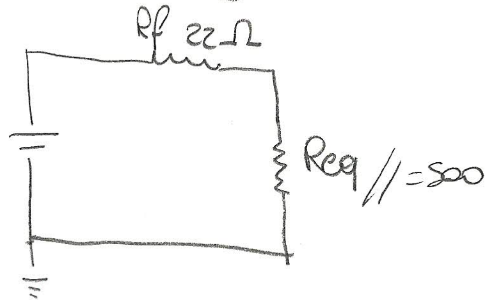
$V_g = 230\ V$

$R_f = 22\ \Omega$

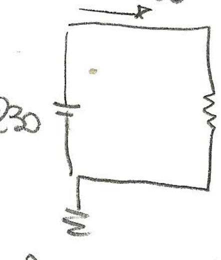
$R = 1\ k\Omega = 1000\ \Omega$

$i_1 = i_2 \qquad i_1 + i_2 = i \qquad i - i_1 - i_2 = \varnothing$ (corrente se ne prende una parte una neg.)

$$R_{eq//} = \left(\frac{1}{R} + \frac{1}{R}\right)^{-1} = \left(\frac{2}{R}\right)^{-1} = \frac{R}{2} = \frac{1000\ \Omega}{2} = 500\ \Omega$$



$i = \frac{230}{522} = 0{,}44\ A \rightarrow I_L$ corrente di linea



corrente di fase $= 0{,}22\ A \left(\frac{0{,}44\ A}{2}\right)$

$V_f = 0.44 \cdot 0.22 = 9,68V$ che vanno paragonati al 4% di V_g

$\frac{230 V \cdot 4}{100} = 9,2$ abbiamo una perdita 9.6V per cui

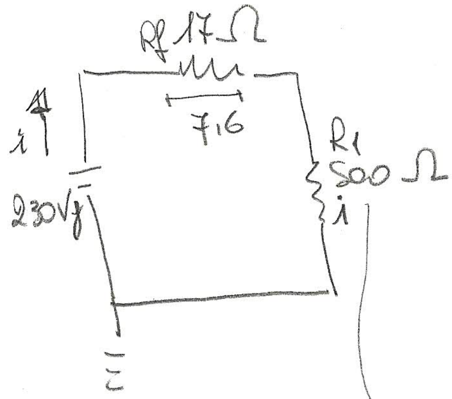
il nostro cavo va aumentato di sezione da 1,5 a 2 mmq

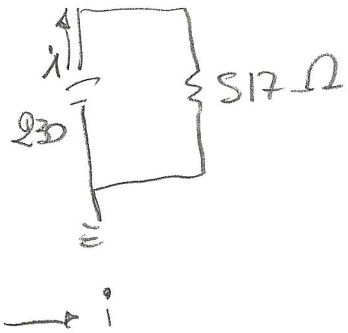
$\rho = 1,69 \cdot 10^{-8}\ \Omega\ m$

$S = 2$ mmq

$R = \frac{1,69 \cdot 10^{-8} \cdot 2 \cdot 10^{3}}{2} \cdot 10^{6} =$

$= 1,69 \cdot 10 = 17\ \Omega$





$i = 0,444$

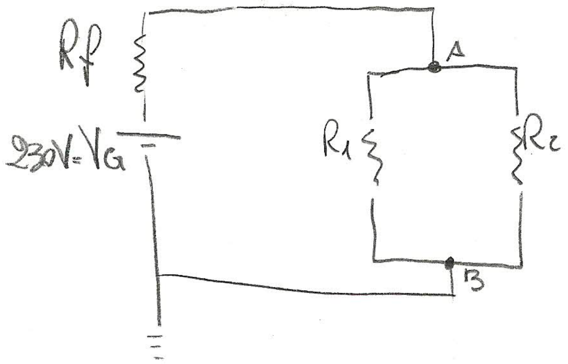
$230 : 100 = 7,6 : x$

$x = \frac{760}{230} = 3,3\%$ il filo da 2 mmq va bene

$i =$

$230V\ (V_g) - (R_f)$

Risolvere il circuito e dimensionare la linea ($V_f < 4\% V_g$) sapendo che: $L = 1000 m$ $S = ?$



$R_1 = 500 \Omega$
$R_2 = 250 \Omega$

doppio corrente (*)
(invers. prop. a ampere)

S	mmq
	1,5
	2,5
	4
	10
	12
	16

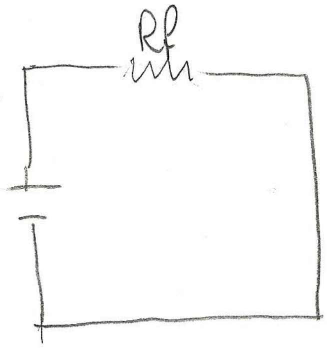
$$R_{eq//} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{R_2 + R_1}{R_1 \cdot R_2} \Rightarrow R_{eq//} \overset{\text{inverto}}{=} \frac{R_1 \cdot R_2}{R_2 + R_1} =$$

$$= \frac{R_1 \cdot \frac{R_1}{2}}{R_1 + \frac{R_1}{2}} \;(*) = \frac{\frac{R_1^2}{2}}{\frac{3R_1}{2}} = \frac{R_1}{3}$$

come fare un sistema con $R_1 = 2R_2$ e si sostituisce R_2 con $\frac{R_1}{2}$

---

covo
L. 10m
Cu $\rho_{cu} = 1,7 \cdot 10^{-8} \Omega m$
$S = 1,5$ mmq

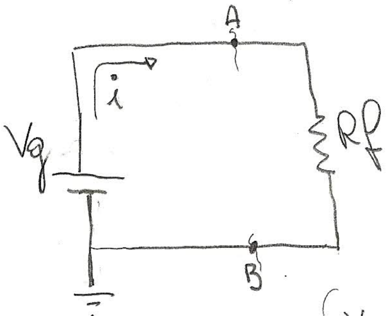


$R = \rho \cdot \frac{L}{S}$ I legge ohm Ω

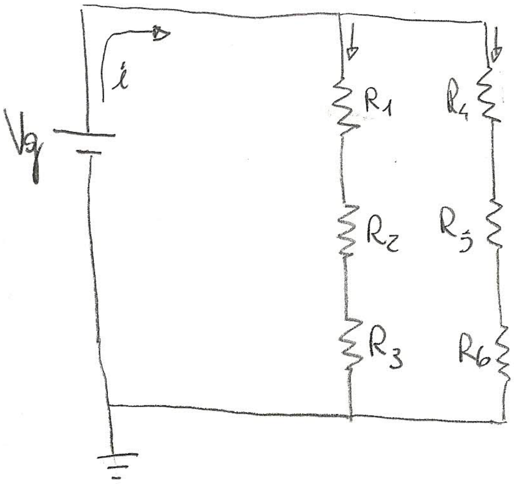
$$R_f = 1,7 \cdot 10^{-8} \Omega m \cdot \frac{10 m}{1,5 \cdot 10^{-6} mq} = \frac{1,7}{1,5} \cdot 10^{-8} \cdot 10^{1} \cdot 10^{6} = \frac{1,7}{1,5} \cdot 10^{-1} \Omega =$$

$1,5 \text{ mmq} = 1,5 \cdot 10^{-6} m^2$
$1 m^2 = 1000 mm \times 1000 mm = 10^6$ mq

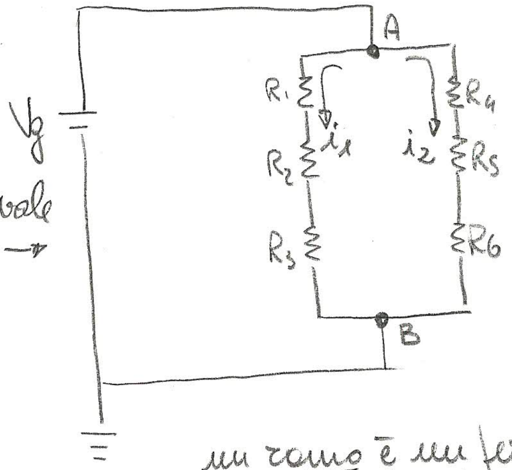
$= 1,1 \cdot 10^{-1} = 0,11 \Omega$



$i = \frac{V_g}{R_f}$ II legge Ω $\begin{cases} V_g = R_f \cdot i \\ R_f = \frac{V_g}{i} \end{cases}$



← equivalente a →



i nodi: (A e B) sono punti in cui affluiscono più correnti

un ramo è un pezzo di circuito fra due nodi

- Resistenze in serie = resistenze che appartengono allo stesso ramo
- Resistenze in parallelo = quando collegate agli stessi nodi

i_1 e i_2 = correnti di fase

i = corrente di linea

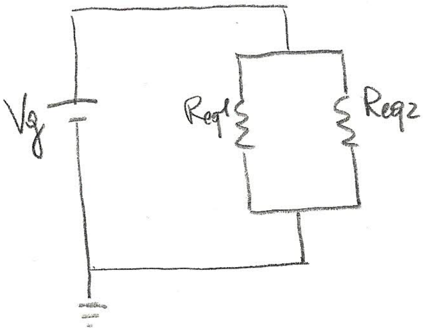
$R_1 = R_4 = 1\ K\Omega$

$R_2 = R_5 = 0{,}5\ K\Omega$

$R_3 = R_6 = 2\ K\Omega$

$V_g = 24$ Volt DC ═══ → corrente continua

1ª semplificazione



Resistenze in serie (basta sommarle per avere quella equivalente)

$Req_1 = R_1 + R_2 + R_3 = 3{,}5\ K\Omega$

$Req_2 = R_4 + R_5 + R_6 = 3{,}5\ K\Omega$

Resistenze in parallelo (inverso delle Req è uguale alla somma degli inversi delle resistenze equivalenti)

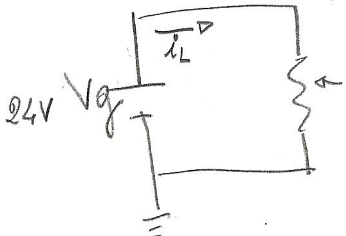
$$\frac{1}{Req_{//}} = \frac{1}{Req_1} + \frac{1}{Req_2} = \left(\frac{Req_1 + Req_2}{Req_1 \cdot Req_2}\right)^{-1} =$$

$$Req_{//} = \frac{Req_1 \cdot Req_2}{Req_1 + Req_2} = \frac{R_{eq}^2}{2 R_{eq}} = \frac{Req}{2}$$

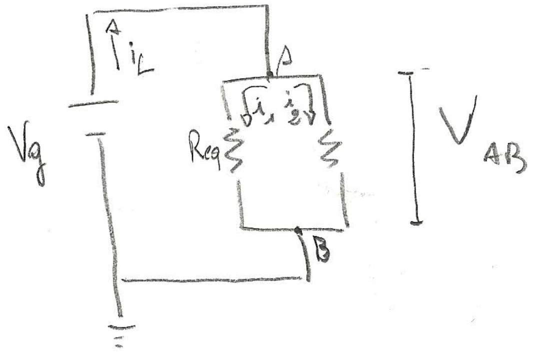
$$Req_{//} = \frac{3{,}5 K\Omega}{2} = 1.75\ K\Omega$$

$$i = \frac{24}{1750} = 0{,}0137\ A = 13{,}7\ mA$$

$$\text{Ampere} = \frac{C}{s}$$



$$\frac{1}{x} = x^{-1}$$



$R_{eq} = 3{,}5$ $\quad V_g = 24V$

i fase $\quad$ i linea

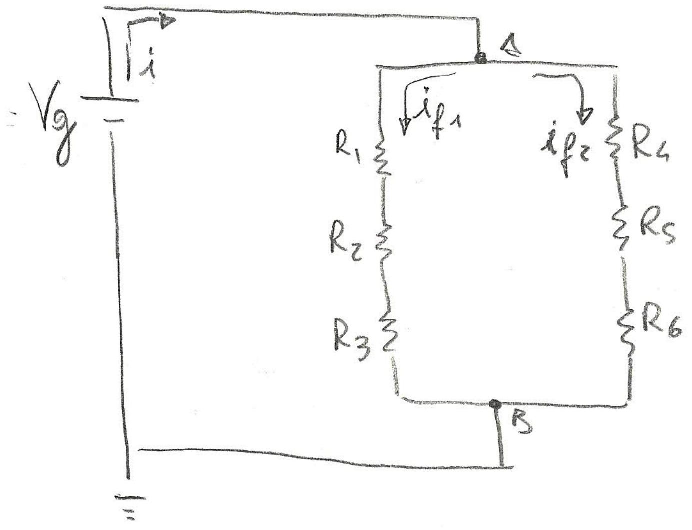
$$i_{f1} = \frac{V_{AB}}{R_{eq1}}$$
$$i_{f2} = \frac{V_{AB}}{R_{eq2}}$$

equival perché $R_{q1} = R_{q2}$ = si ricava che $i_1 + i_2 = i_L$

$$i_{f1} = \frac{V_{AB}}{R_{eq1}} = \frac{24}{3500} = 0{,}06855\ A \quad +$$
$$i_{f2} = \frac{V_{BA}}{R_{eq2}} = \frac{24}{3500} = 0{,}06855\ A$$
$$0{,}1370\ A$$

---

si torna al circuito originario



$i = 0{,}0137 A$

$V_g = 24\ V$ DC

$R_1 = R_4 = 1\ k\Omega$

$R_2 + R_3 = 0{,}5\ k\Omega$

$R_3 + R_6 = 2\ k\Omega$

$i_{f1} = 6{,}85\ mA$

$i_{f2} = 6{,}85\ mA$

$V_{R1} = R_1 \cdot i_{f1}$	$V_{R4} = R_4 \cdot i_{f2}$
$V_{R2} = R_2 \cdot i_{f1}$	$V_{R5} = R_5 \cdot i_{f2}$
$V_{R3} = R_3 \cdot i_{f1}$	$V_{R6} = R_6 \cdot i_{f2}$

$V_{R1} = 10^3 \cdot 6{,}85 \cdot 10^{-3} = 6{,}85\ V$

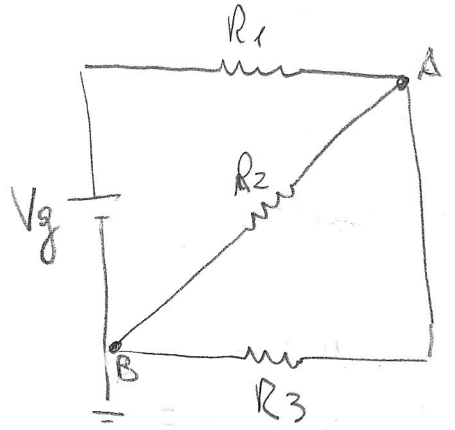
$V_{R2} = 5 \cdot 10^2 \cdot 6{,}85 \cdot 10^{-3} = 3{,}425 V$

$V_{R3} = 2 \cdot 10^3 \cdot 6{,}85 \cdot 10^{-3} = 13{,}7\ V$

$23{,}975\ V$

$\simeq 24V$ quindi OK!!

(SK1)



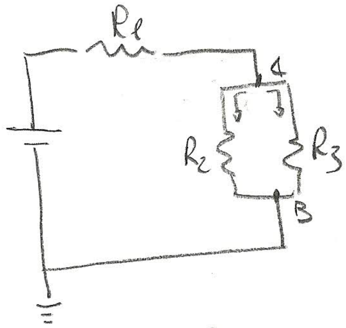
$R_1 = 50\,\Omega$

$R_2 = 100\,\Omega$

$R_3 = 200\,\Omega$

$V_g = 24\,V$

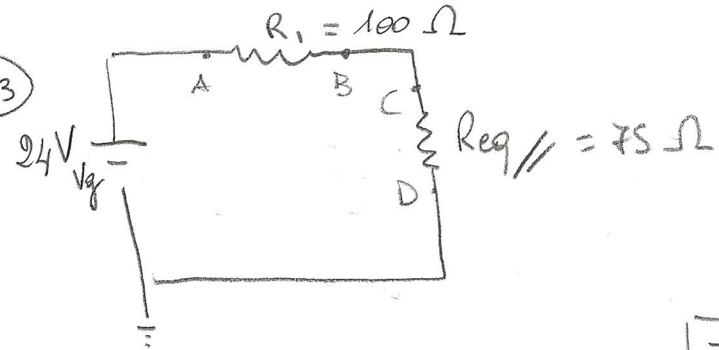
il circuito si semplifica in



(SK2)

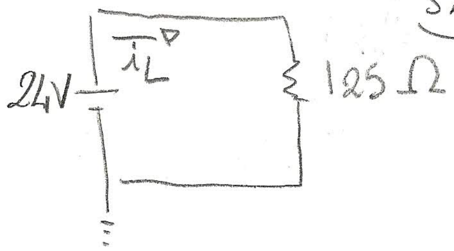
$$R_{eq//} = \frac{R_2 \cdot R_3}{R_2 + R_3} = \frac{100 \cdot 200}{300} = \frac{2 \cdot 10^{4 \, 2}}{3 \cdot 10^{2}} = 75\,\Omega$$

(SK3)



(SK4)

che si semplifica in



$$i_L = \frac{V_g}{R_{eq}} = \frac{24}{125} = 0{,}192 \text{ A}$$

Risalendo allo schema precedente (SK3) calcolo V_{AB} e V_{CD}

$V_{AB} = 50 \cdot 0{,}192 = 9{,}6$ +

$V_{CD} = 75 \cdot 0{,}192 = 14{,}4$

$24\,V$

si risale quindi allo schema SK2 si calcola i_{f2} (in R_2) e i_{f3} (in R_3)

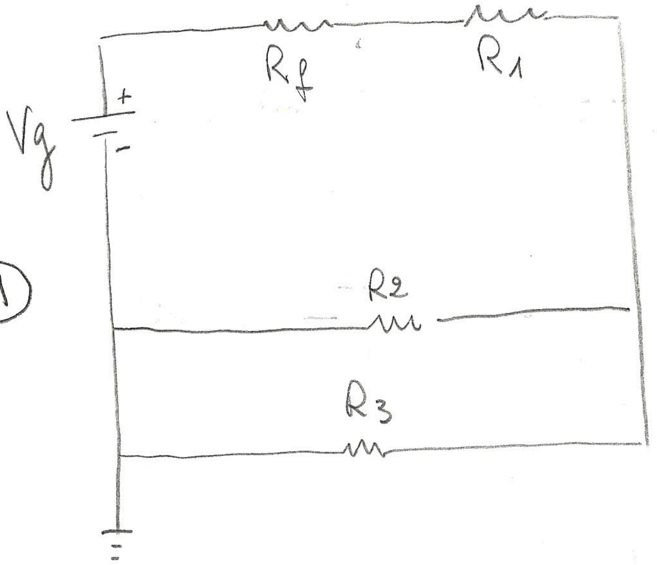
$$i_{f2} = \frac{14.4}{100} = 0{,}144 \text{ A} \quad +$$

$$i_{f3} = \frac{14.4}{200} = 0{,}072 \text{ A}$$

$0{,}216$A (per i decimali non viene 0,192 che doveva venire)

Risolvere il seguente circuito

(SK1)



$V_g = 12\,V$

R_f = resistenza di un filo di Cu

$\rho = 1{,}69 \cdot 10^{-8}\ \Omega \cdot m$

$L = 100\,m$

$S = 2{,}5\ mmq$

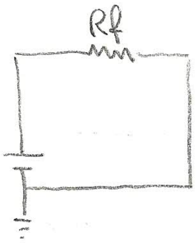
$R_1 = 100\ \Omega$

$R_2 = 200\ \Omega$

$R_3 = 300\ \Omega$

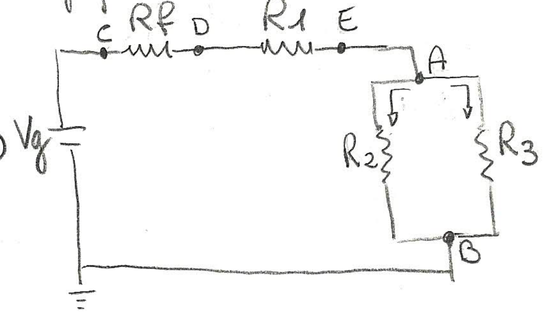
$$R_f = \rho \cdot \frac{L}{S} = 1{,}69 \cdot 10^{-8}\ \Omega \cdot m \cdot \frac{100\ m}{2{,}5 \cdot 10^{-6}\ mq} =$$

$$= \frac{1{,}69}{2{,}5} \cdot 10^{-8} \cdot 10^{2} \cdot 10^{6} = \frac{1{,}69}{2{,}5} = 0{,}676\ \Omega$$



1ª semplificazione

(SK2)

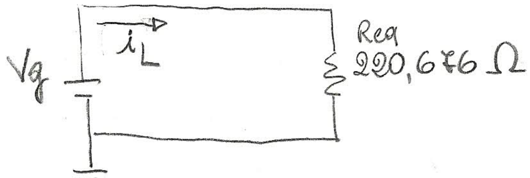


$$R_{eq//} = \frac{R_2 \cdot R_3}{R_2 + R_3} = \frac{200 \cdot 300}{500} = \frac{6 \cdot 10^{4}}{5 \cdot 10^{2}} = 120\ \Omega$$

2ª semplificazione

$$R_f + R_1 + R_{eq//} = 0{,}676 + 100 + 120 = 220{,}676\ \Omega$$

(SK3)



$$i_L = \frac{V_g}{R_{eq}} = \frac{12}{220{,}676} = 0{,}054(37836)\ A$$

Risaliamo allo (SK2) dove calcoliamo V_{AB}, V_{CD} e V_{DE}:

$V_{AB} = 120\ \Omega \cdot 0{,}054\ mA = 6{,}48$ +

$V_{CD} = 0{,}676\ \Omega \cdot 0{,}054\ mA = 0{,}036(504)$ +

$V_{DE} = 100\ \Omega \cdot 0{,}054\ mA = 5{,}4$

$11{,}916\ (504)\ V$ (su 12V di Vg)

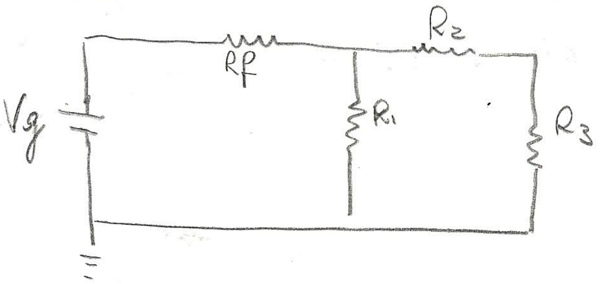
$$i_{f1} = \frac{V_{AB}}{R_2} = \frac{6{,}8}{200} = 0{,}034\ A$$

$$i_{f2} = \frac{V_{AB}}{R_3} = \frac{6{,}8}{300} = 0{,}022(\overline{6})\ A$$

sommandoli ho $0{,}05\overline{6}\,A$ su $0{,}054\ A$

Esercizio

(SK1)

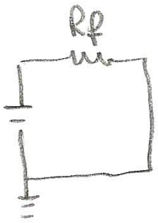


$R_1 = 1 k\Omega$
$R_2 = 0{,}5 k\Omega$
$R_3 = 0{,}5 k\Omega$
$V_g = 24 V$

$L = 10^5 m \quad S = 1{,}5\, mmq \quad \rho = 17 \cdot 10^{-8}$

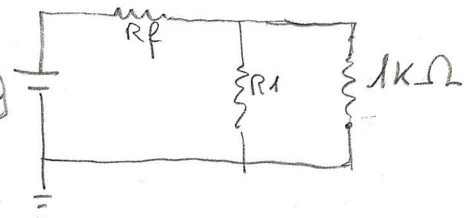
$R_f = \rho \frac{L}{S} = 17 \cdot 10^{-8} \Omega \cdot m \frac{10^5 m}{1{,}5 \cdot 10^{-6} mmq} = \frac{17}{1{,}5} \cdot 10^{-8} \cdot 10^5 \cdot 10^6 =$

$= 11{,}33\overline{3} \cdot 10^3 = 1133{,}\overline{3}\ \Omega$



1^a semplificazione

(SK2)

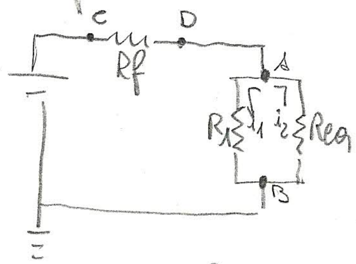


$Req_{I} = R_2 + R_3 = 0{,}5 + 0{,}5 = 1 k\Omega$

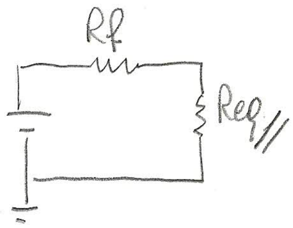
$R_2 = 0{,}5 k\Omega$
$R_3 = 0{,}5 k\Omega$

2^a semplificazione

(SK3)



che diventa

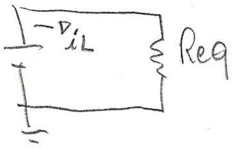


$R_1 = 1 k\Omega$
$Req = 1 k\Omega$

$$Req_{//} = \frac{R_2 \cdot Req}{R_2 + Req} = \frac{1k \cdot 1k}{1k + 1k} = \frac{1K}{2K} = 0{,}5\ k\Omega$$

3^a semplificazione

(SK4)



$Req = R_f + Req_{//} = 1133 + 500 = 1633\ \Omega$

$R_f = 1133\ \Omega$
$Req_{//} = 500\ \Omega$

$$i_L = \frac{V_g}{Req_{//}} = \frac{24}{1633} = 0{,}014(696876)\ A = 14 mA$$

risalgo a SK3

$V_{AB} = Req_{//} \cdot i_L = 0{,}5 k\Omega \cdot 0{,}014 A = 500\Omega \cdot 0{,}014 A = 7$ +

$V_{CD} = R_f \cdot i_L = 1133\ \Omega \cdot 0{,}014 A = 15{,}862$

$= 22{,}862\ V$ (su 24V di Vg)

$$i_{f1} = \frac{V_{AB}}{R_1} = \frac{7}{1k\Omega} = \frac{7}{1000\Omega} = 0{,}007 = 7\ mA\ +$$

$$i_{f2} = \frac{V_{AB}}{Req} = \frac{7}{1k\Omega} = \frac{7}{1000\Omega} = 0{,}007 = 7\ mA$$

$= 14\ mA$ (su 14 mA di i_L)