CIRCUITOS ELECTRÓNICOS COMPROBADOS

VOLUMEN 1

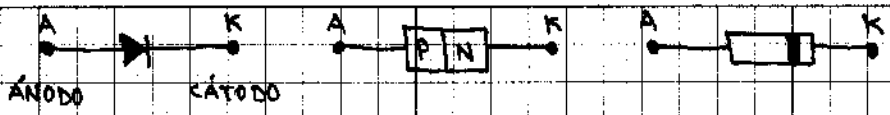
DEFINICIONES, DATOS Y APLICACIONES

REALIZACIÓN JJV

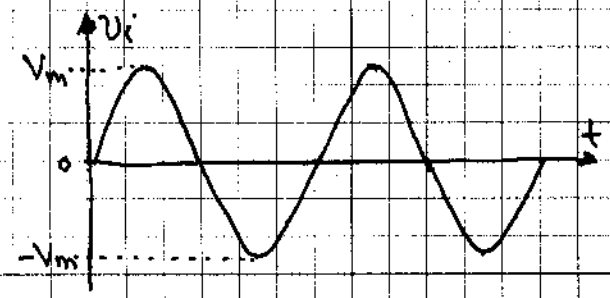
2002

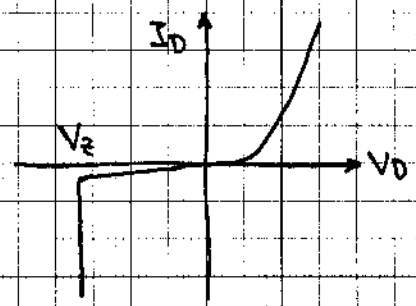
EL DIODO

EL DIODO



RECTIFICADOR

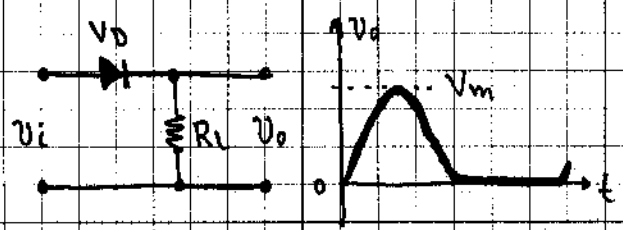


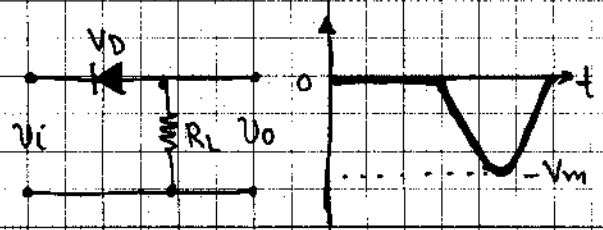


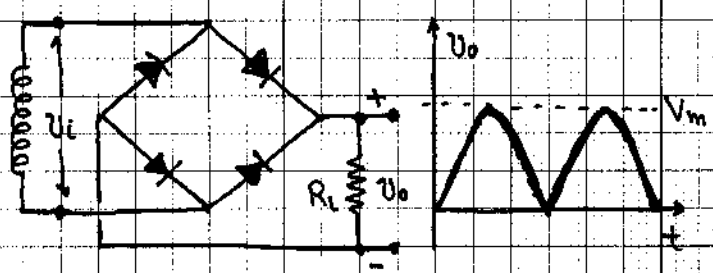
USOS
- RECTIFICADOR
- BLOQUEO
- DETECCION

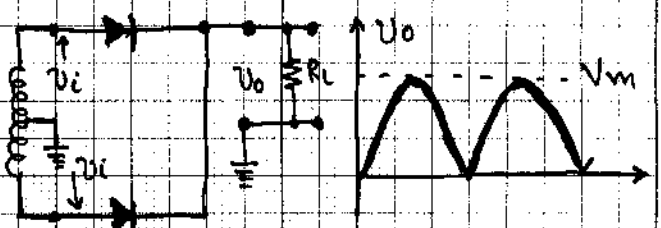
PARA TODO CIRCUITO SE USARÁ LA SEÑAL SENOIDAL, CUANDO SEA v_i

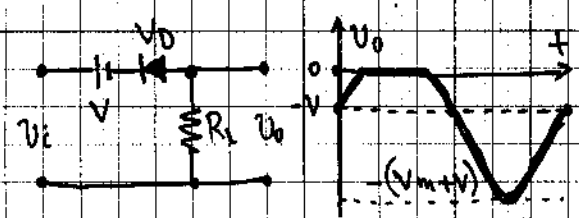
GRÁFICA DE COMPORTAMIENTO DE LOS DIODOS EN GENERAL.

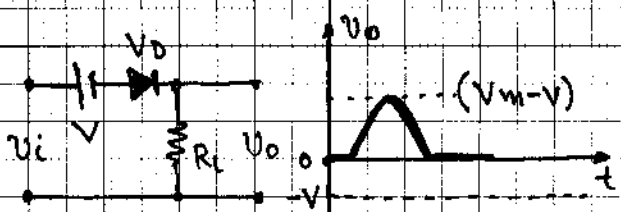


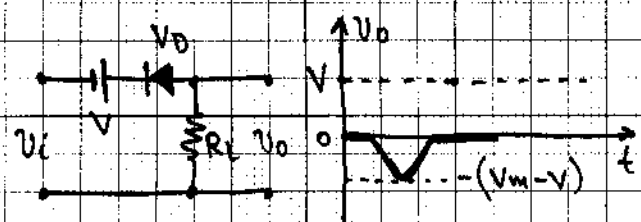


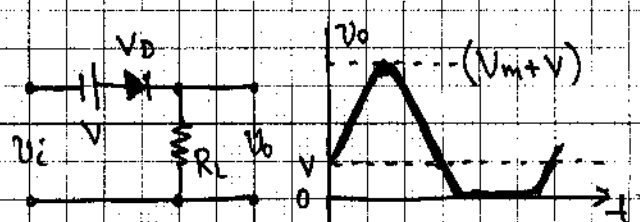


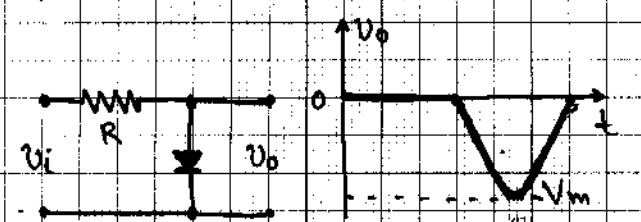


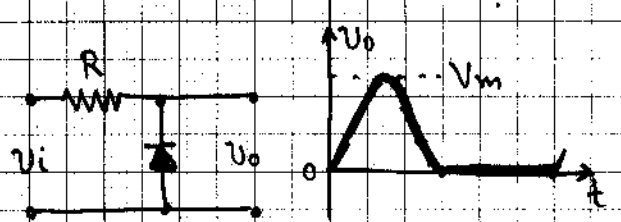




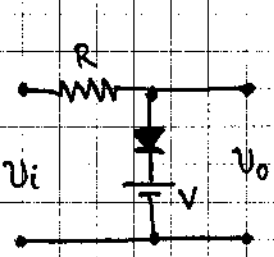


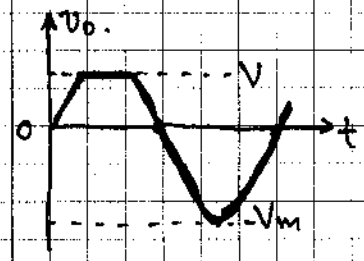


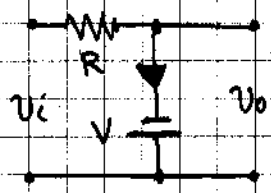


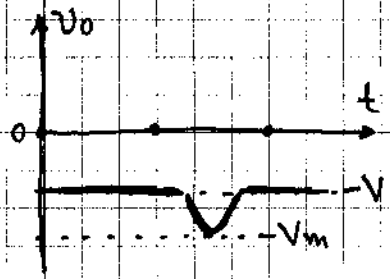


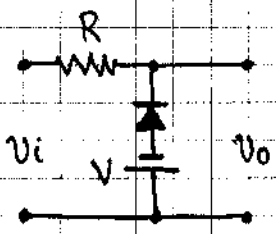
EL DIODO CONTINUACIÓN...

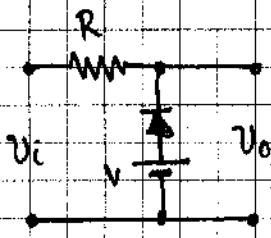


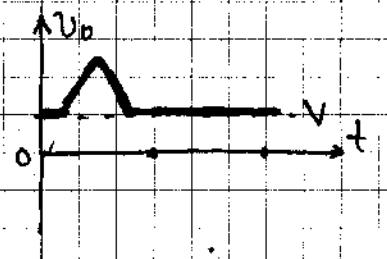


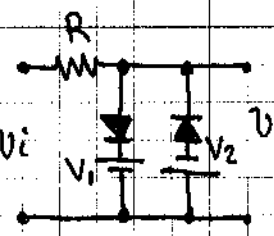


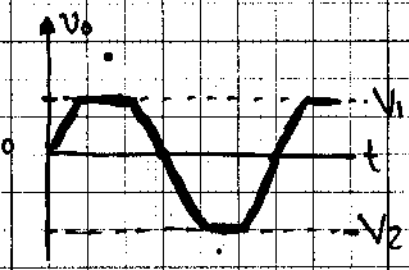






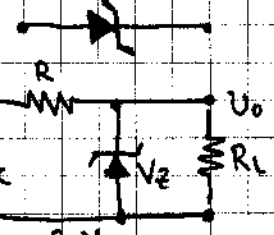






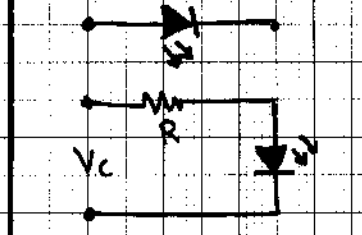
OTROS TIPOS DE DIODOS

DIODO ZENER (REGULADOR)

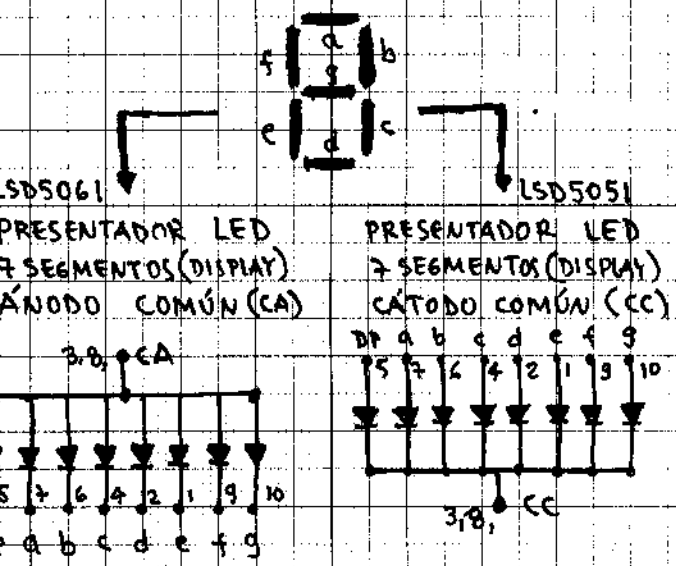


$V_Z = \frac{R_L V_C}{R + R_L} = V_O$

DIODO EMISOR DE LUZ (LED)



$V_C = I_{LED} R + V_{LED}$



DIODO SCHOTTKY (PORTADOR DE ALTA ENERGÍA)

DIODO VARACTOR (VARICAP)

DIODO TUNEL

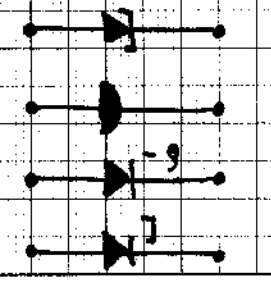
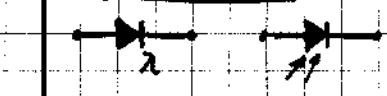


FOTO DIODO



DIODO PIN

DIODO PARA MICROONDAS

EL DIODO CONTINUACIÓN...

VOLT PIV	CORRIENTE EN AMPERIOS 1	3
50	1N4001	1N5400
100	1N4002	1N5401
200	1N4003	1N5402
400	1N4004	1N5404
600	1N4005	1N5406
800	1N4006	1N5407
1000	1N4007	1N5408

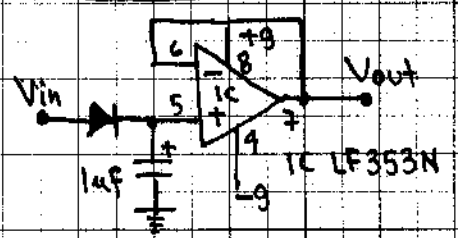
DIODOS RECTIFICADORES DE USO COMÚN, 1 Y 3 A.

DIODO DE PEQUEÑAS SEÑALES
1N914 / 1N4148
(75 PRV, 10mA a 25mA)

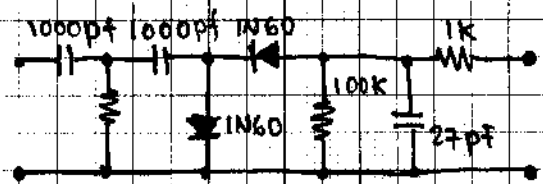
VOLT ZENER	POTENCIA EN WATT 1/2	1	VOLT ZENER	POTENCIA EN WATT 1/2	1
2.4	1N5221	—	6.8	1N5235	1N4736
2.5	1N5222	—	7.5	1N5236	1N4737
2.7	1N5223	—	8.2	1N5237	1N4738
3.0	1N5225	—	9.1	1N5238	1N4739
3.3	1N5226	1N4728	10.0	1N5240	1N4740
3.6	1N5227	1N4729	11.0	1N5241	1N4741
3.9	1N5228	1N4730	12.0	1N5242	1N4742
4.3	1N5229	1N4731	13.0	1N5343	1N4743
4.7	1N5230	1N4732	14.0	1N5244	—
5.1	1N5231	1N4733	15.0	1N5245	1N4744
5.6	1N5232	1N4734	16.0	1N5246	1N4745
6.0	1N5233	—	17.0	1N5247	—
6.2	1N5234	1N4735	18.0	1N5248	1N4746

DIODOS ZENER DE USO COMÚN, 1/2 Y 1 WATT.

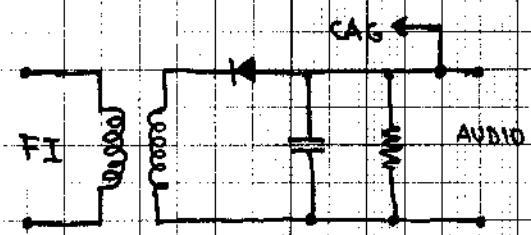
CIRCUITOS DE APLICACIÓN



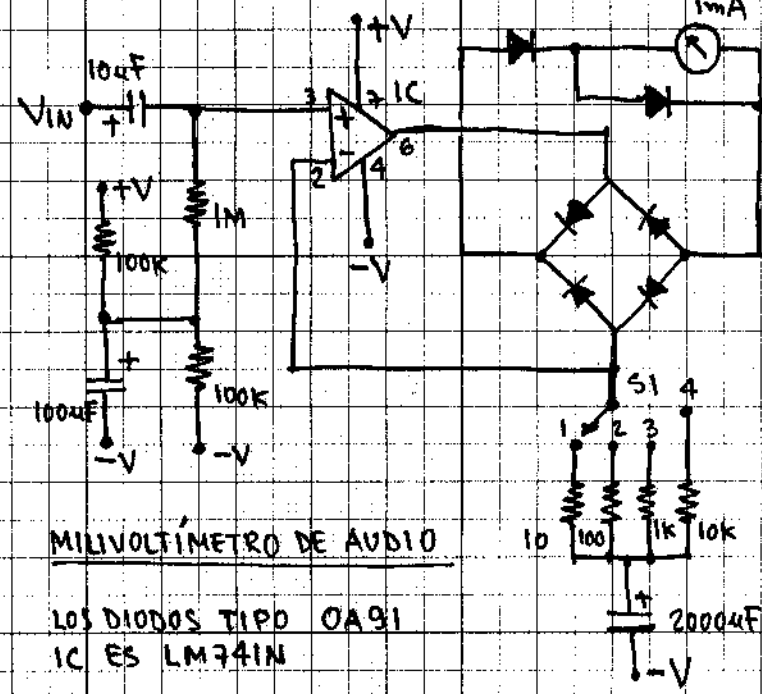
DETECTOR DE PICOS



DETECTOR PARA OSCILOSCOPIO (50Ω)



CIRCUITO DETECTOR DE AUDIO DE RADIO AM, ETAPA FI



MILIVOLTÍMETRO DE AUDIO

LOS DIODOS TIPO OA91
IC ES LM741N

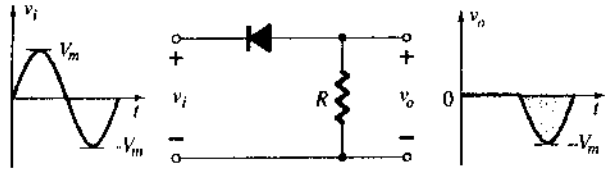
ESCALAS	
1	10mV
2	100mV
3	1000mV
4	10000mV

- IMPEDANCIA DE ENTRADA 1MΩ.
- ESTE CIRCUITO OPERA DESDE 8Hz A 50KHz EN FORMA PLANA

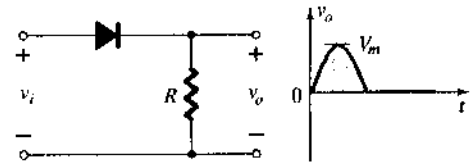
EL DIODO CONTINUACIÓN . . .

Recortadores simples en serie (diodos ideales)

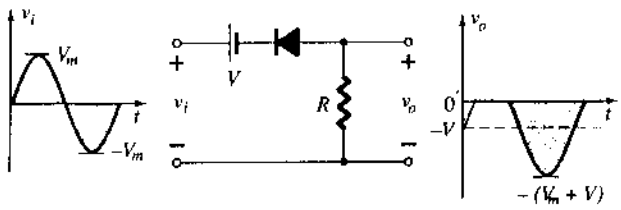
POSITIVO

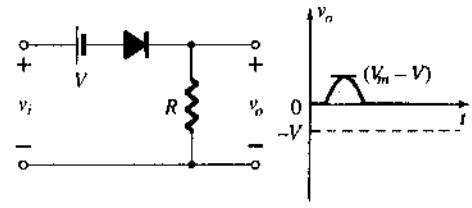


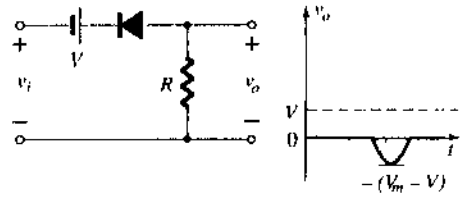
NEGATIVO

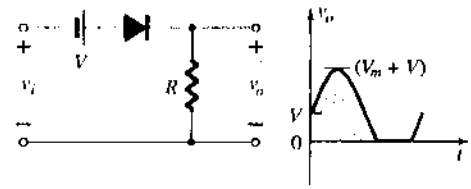


Recortadores polarizados en serie (diodos ideales)

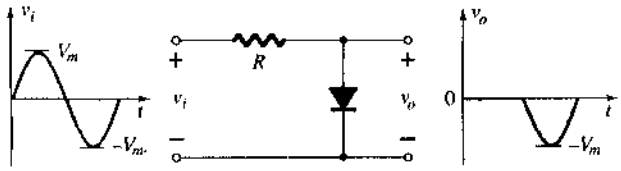


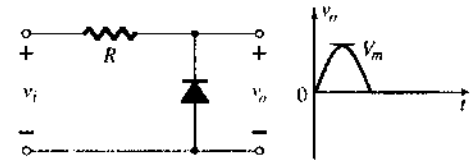




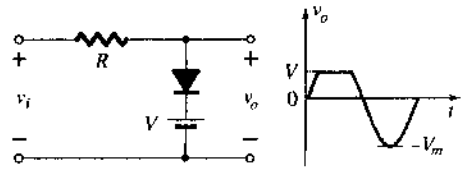


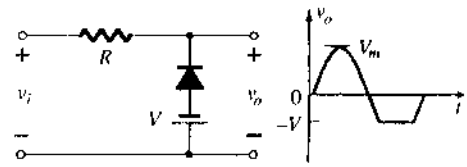
Recortadores simples en paralelo (diodos ideales)

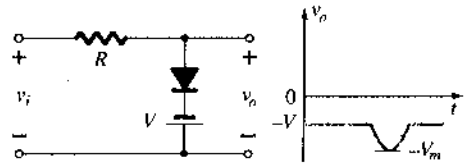


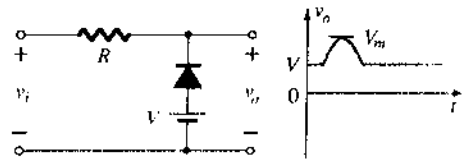


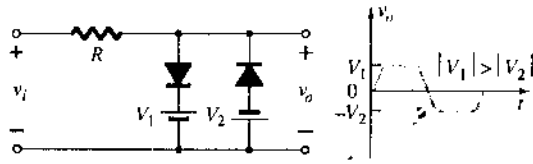
Recortadores polarizados en paralelo (diodos ideales)



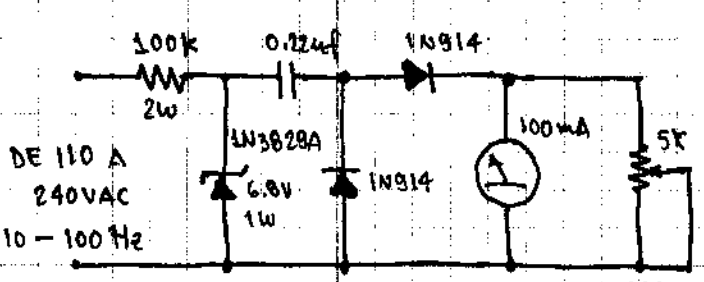




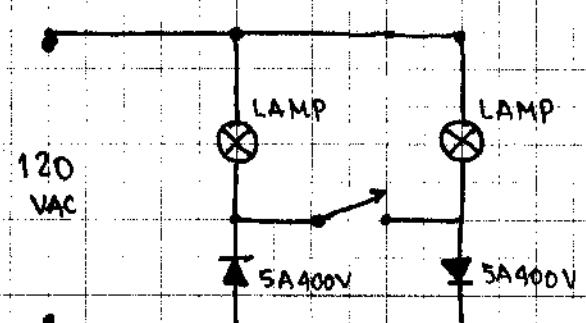




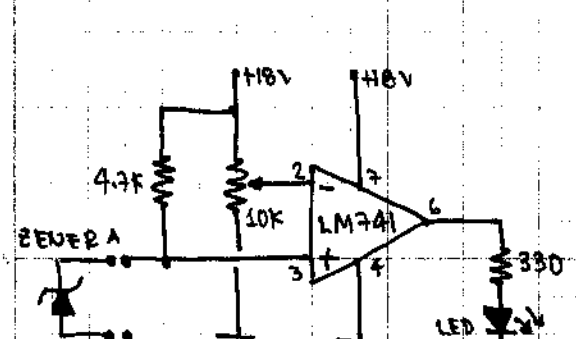
EL DIODO CONTINUACIÓN . . .



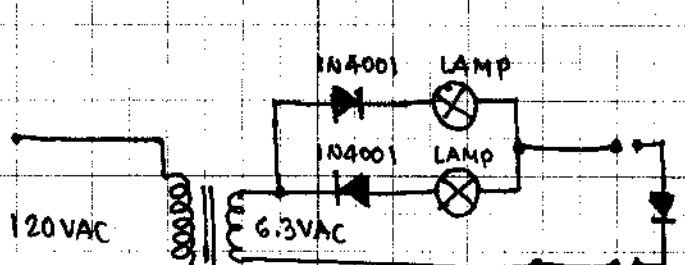
MEDIDOR DE FRECUENCIA DE RED



FLOODLAMP POWER CONTROL

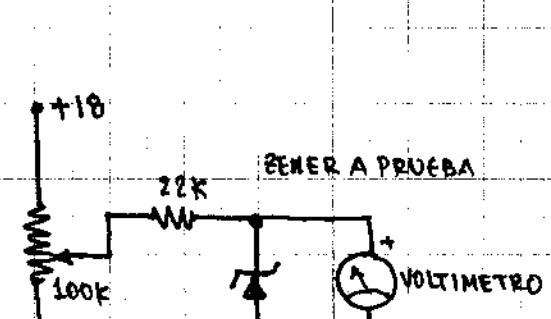


PROBADOR DE ZENER

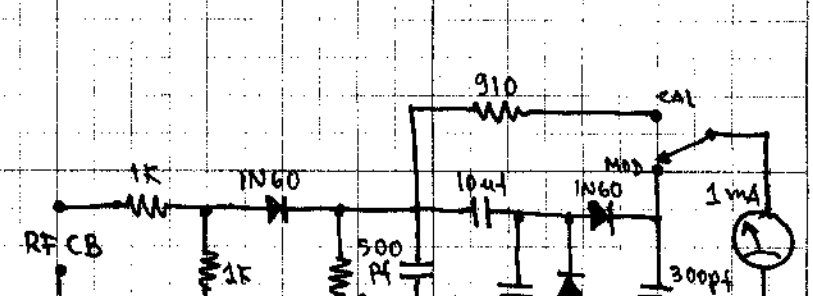


PROBADOR DE DIODOS

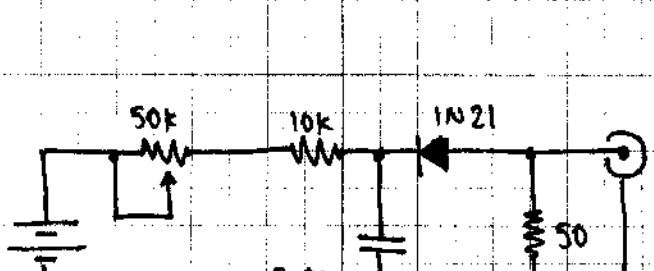
DIODO A PRUEBA



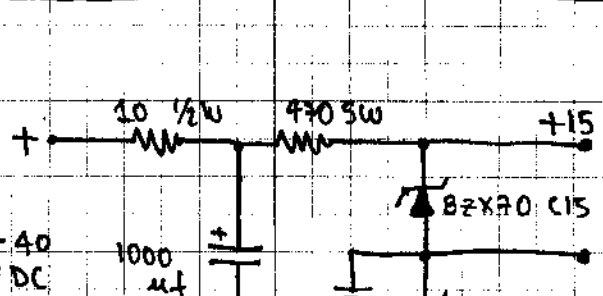
PROBADOR DE ZENER



MONITOR DE MODULACIÓN BANDA CIUDADANA



GENERADOR DE RUIDO (WIDEBAND)

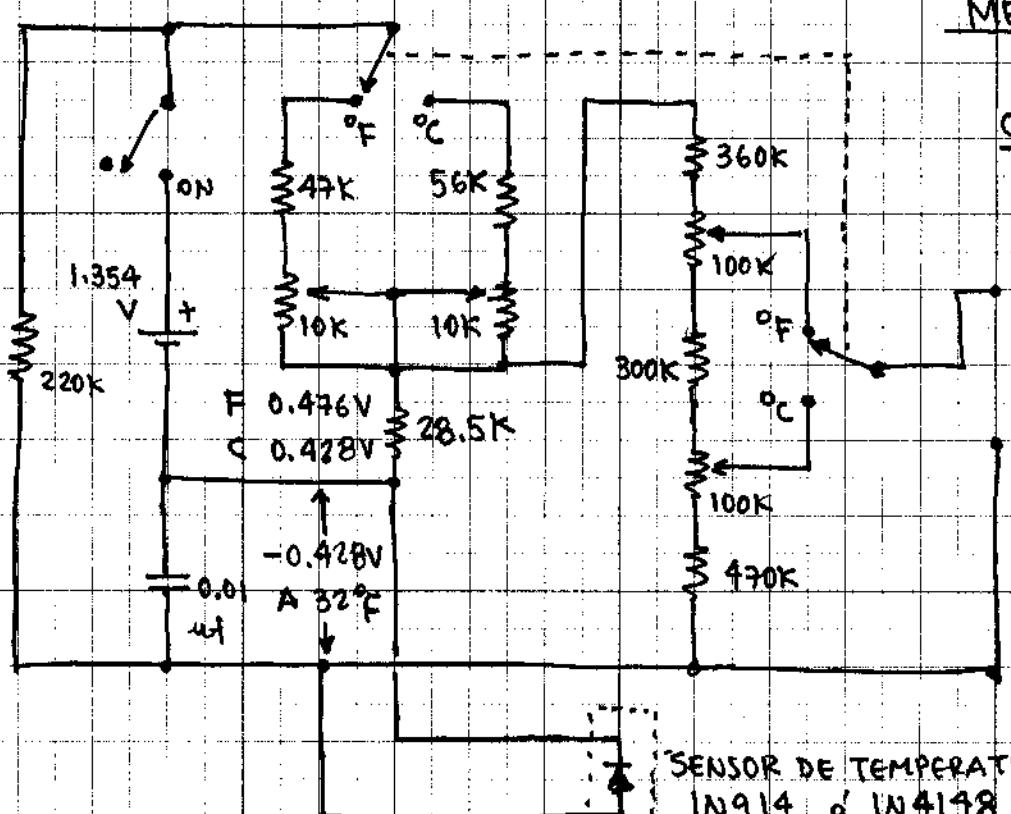


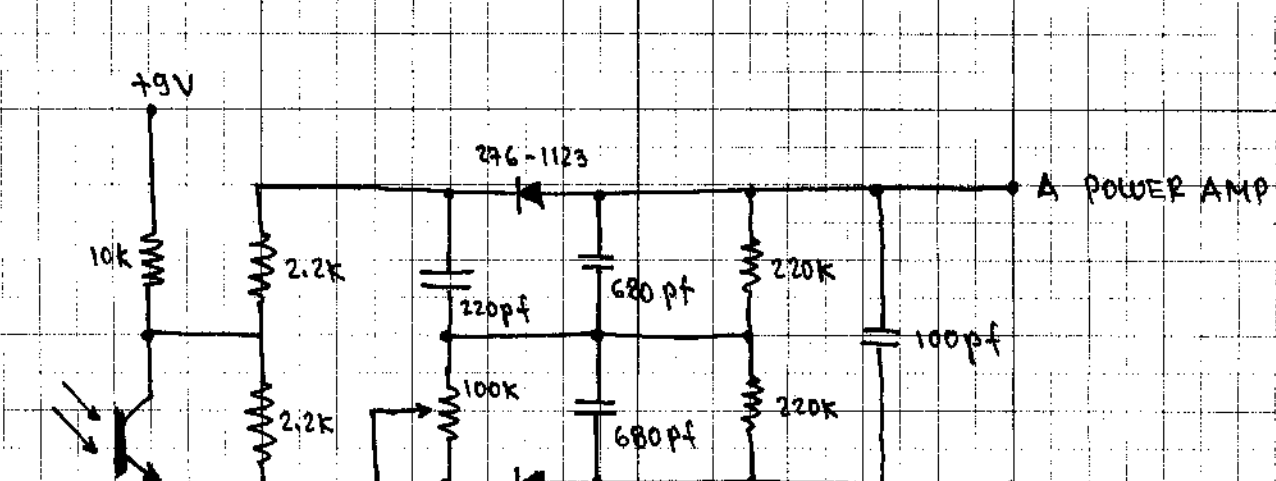
FUENTE DE VOLTAJE SALIDA DUAL

PAPEL MILIMETRADO HERALD

EL DIODO CONTINUACIÓN . . .

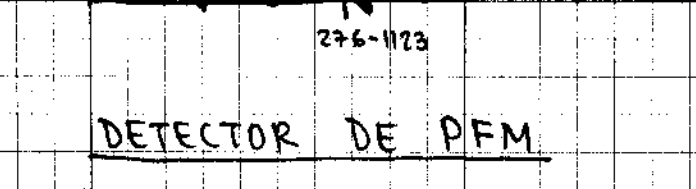
MEDIDOR DE TEMPERATURA CON DIODO





DETECTOR DE PFM

PFM (PULSE FREQUENCY MODULATION)



PROTECTOR DE MEDIDOR DC

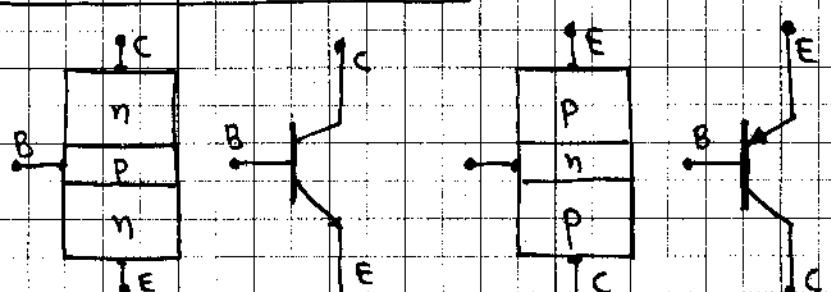
PAPEL MILIMETRADO HERALD

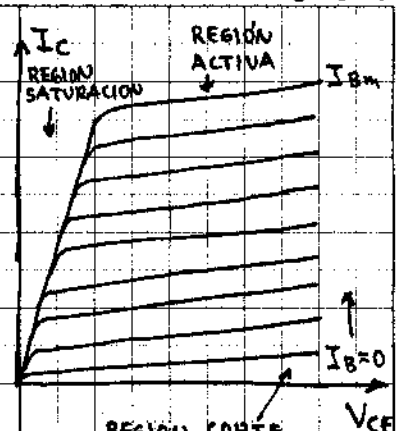
EL TRANSISTOR BIPOLAR

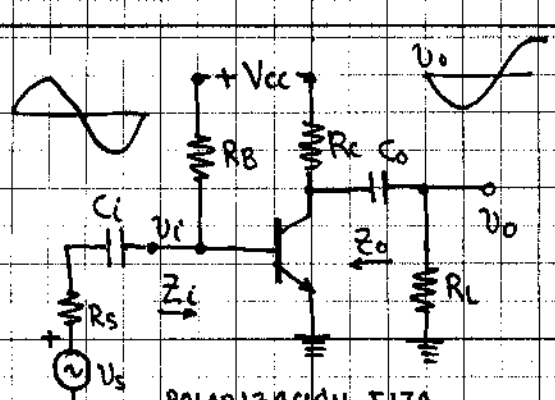
(BJT)

PAPEL MILIMETRADO HERALD

EL TRANSISTOR BIPOLAR BJT







POLARIZACIÓN FIJA

$$A_V = \frac{v_o}{v_i} \qquad A_i = \beta$$

$$= \frac{-(R_L \| R_C)}{r_e}$$

$$= \frac{-h_{fe}}{h_{ie}}(R_L \| R_C)$$

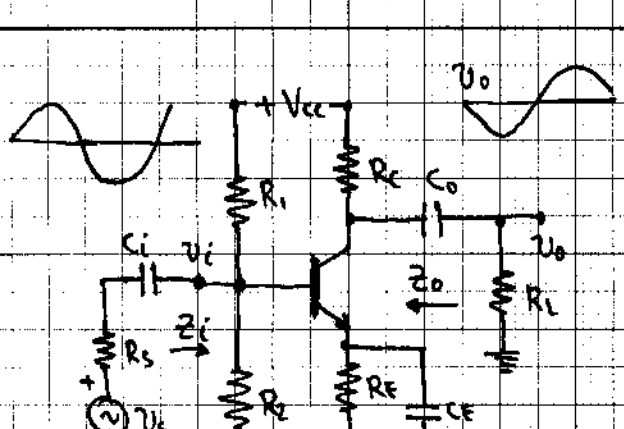
con r_o

$$= \frac{(R_L \| R_C \| r_o)}{r_e}$$

$Z_i = R_B \| \beta r_e \rightarrow Z_o = R_C$

$= R_B \| h_{ie} \rightarrow \quad = R_C$

$= R_B \| \beta r_e \rightarrow \quad = R_C \| r_o$



POLARIZACIÓN POR DIVISOR DE VOLTAJE

$$A_V = \frac{-(R_L \| R_C)}{r_e}$$

$$= \frac{-h_{fe}}{h_{ie}}(R_L \| R_C)$$

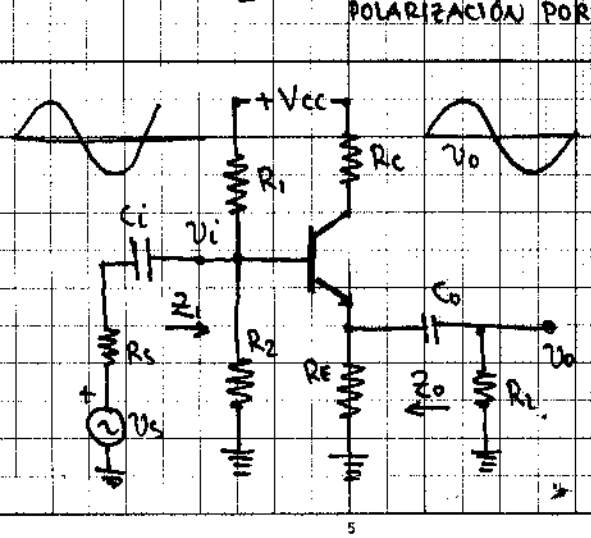
con r_o

$$= \frac{-(R_L \| R_C \| r_o)}{r_e}$$

$Z_i = R_1 \| R_2 \| \beta r_e \qquad Z_o = R_C$

$= R_1 \| R_2 \| h_{ie} \qquad = R_C$

$= R_1 \| R_2 \| \beta r_e \qquad = R_C \| r_o$



$A_V \cong 1$

$\cong 1$

con r_o

$\cong 1$

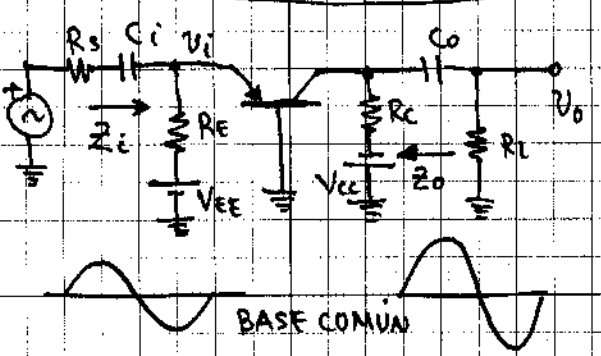
$Z_i \quad R_E' = R_L \| R_E \qquad R_S' = R_S \| R_1 \| R_2$

$Z_i = R_1 \| R_2 \| \beta (r_e + R_E') \qquad Z_o = R_E \| \left(\frac{R_S'}{\beta} + r_e\right)$

$= R_1 \| R_2 \| (h_{ie} + h_{fe} R_E') \qquad Z_o = R_E \| \left(\frac{R_S'}{\beta}\right)$

$= R_1 \| R_2 \| \beta (r_e + R_E') \qquad Z_o = R_E \| \left(\frac{R_S'}{\beta} + r_e\right)$

EL TRANSISTOR BIPOLAR CONTINUACIÓN . . .



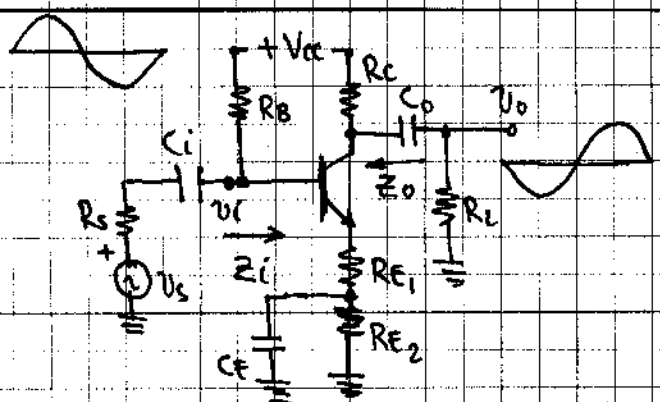
BASE COMÚN

$$A_v = \frac{-(R_L \| R_C)}{r_e} \qquad Z_i = R_E \| r_e \qquad Z_o = R_C$$

$$= \frac{-h_{fb}}{h_{ib}}(R_L \| R_C) \qquad = R_E \| h_{ib} \qquad = R_C$$

con r_o

$$= \frac{-(R_L \| R_C \| r_o)}{r_e} \qquad = R_E \| r_e \qquad = R_C \| r_o$$

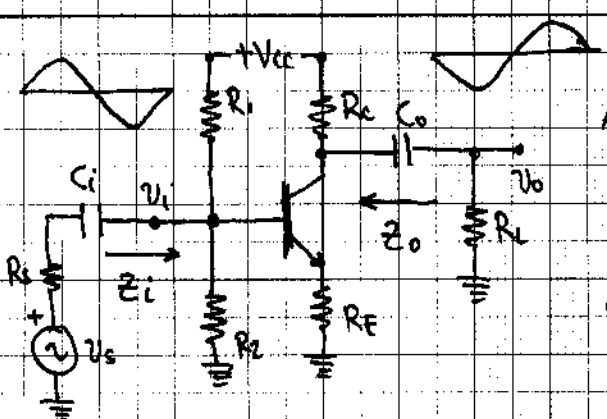


$$A_v = \frac{-(R_L \| R_C)}{R_{E_1}} \qquad Z_i = R_B \| \beta(r_e + R_{E_1}) \qquad Z_o = R_C$$

$$'' \qquad = R_B \| (h_{ie} + h_{fe} R_{E_1}) \qquad = R_C$$

con r_o

$$'' \qquad = R_B \| \beta(r_e + R_{E_1}) \qquad \cong R_C$$

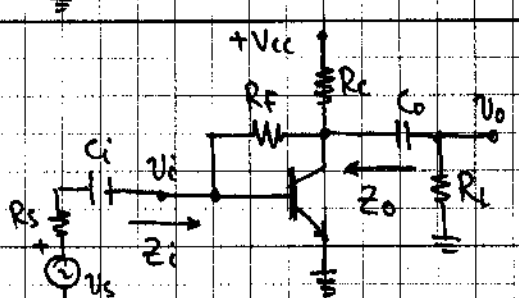


$$A_v = \frac{-(R_L \| R_C)}{R_E} \qquad Z_i = R_1 \| R_2 \| \beta(r_e + R_E) \qquad Z_o = R_C$$

$$'' \qquad Z_i = R_1 \| R_2 \| (h_{ie} + h_{fe} R_E) \qquad = R_C$$

con r_o

$$'' \qquad = R_1 \| R_2 \| \beta(r_e + R_E) \qquad \cong R_C$$

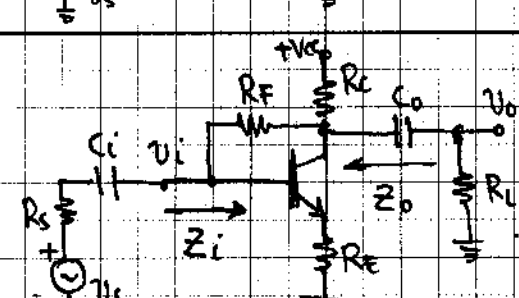


$$A_v = \frac{-R_L \| R_C}{r_e} \qquad Z_i = \beta r_e \| \frac{R_F}{|A_v|} \qquad Z_o = R_C$$

$$= \frac{-h_{fe}}{h_{ie}}(R_L \| R_C) \qquad = h_{ie} \| \frac{R_F}{|A_v|} \qquad = R_C$$

con r_o

$$= \frac{(R_L \| R_C \| r_o)}{r_e} \qquad = \beta r_e \| \frac{R_F}{|A_v|} \qquad = R_C \| R_F \| r_o$$



$$A_v = \frac{-(R_L \| R_C)}{R_E} \qquad Z_i = \beta R_E \| \frac{R_F}{|A_v|} \qquad Z_o = R_C \| R_F$$

$$'' \qquad = \frac{-(R_L \| R_C)}{R_E} \qquad = h_{fe} R_E \| \frac{R_F}{|A_v|} \qquad = R_C \| R_F$$

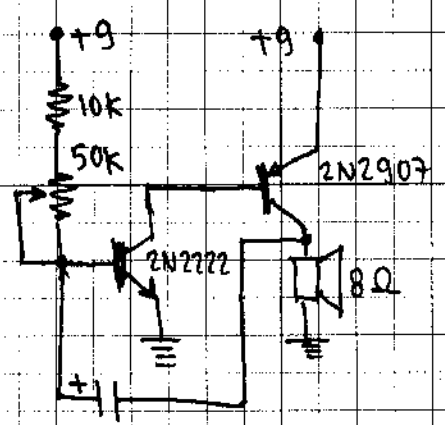
con r_o

$$= \frac{-(R_L \| R_C)}{R_e} \qquad = \beta R_E \| \frac{R_F}{|A_v|} \qquad = R_C \| R_F$$

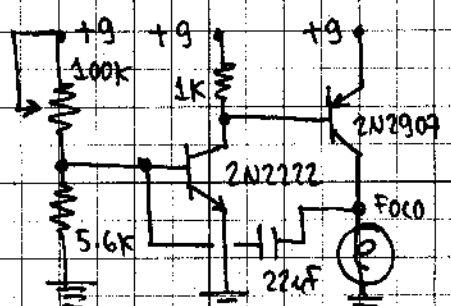
PAPEL MILIMETRADO HERALD

EL TRANSISTOR BIPOLAR CONTINUACIÓN...

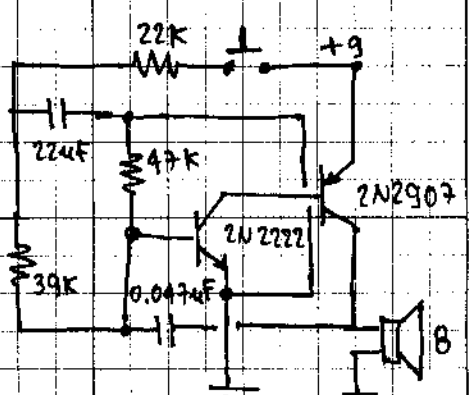
APLICACIONES



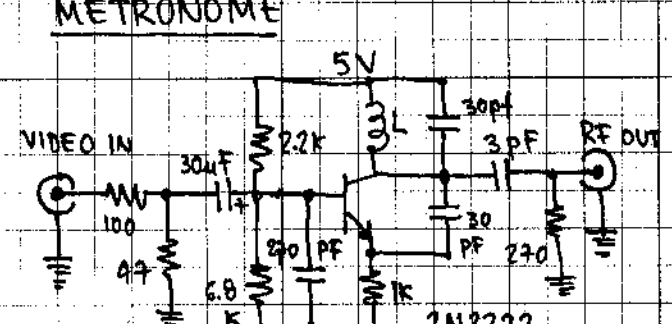
METRONOME



FLASHEADOR

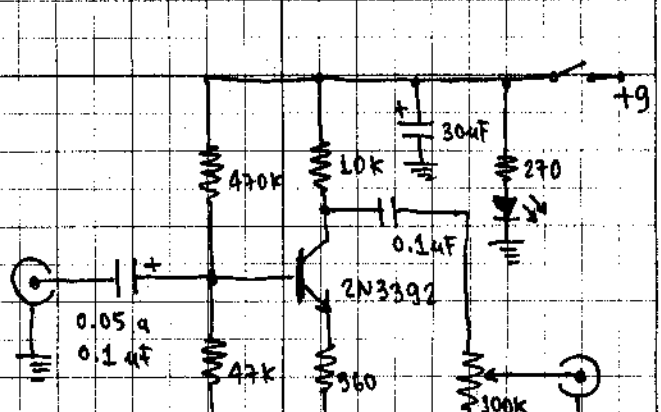


SIRENA

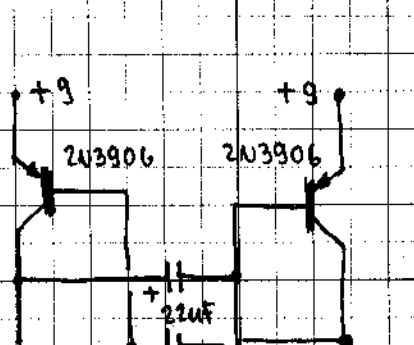


MODULADOR DE VIDEO CM 2, 3

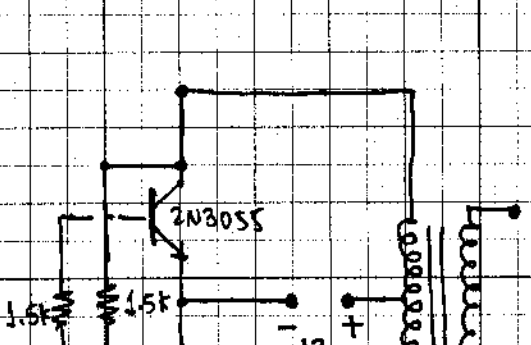
L: BOBINA 22AWG 3 3/4 VUELTAS EN UN LAPIZ DE DIAMETRO



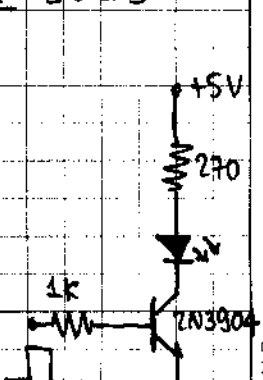
AUDIO BOOSTER 20dB



FLASHEADOR LED ALTERNO



INVERSOR DE POTENCIA

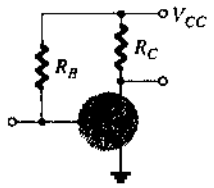
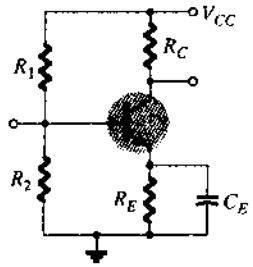
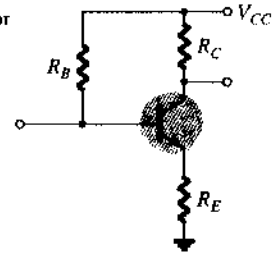
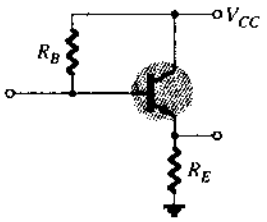
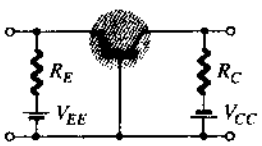
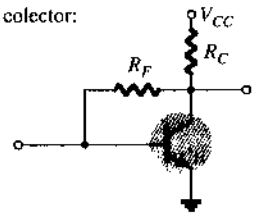


MANEJADOR LED

PAPEL MILIMETRADO HERALD

EL TRANSISTOR BIPOLAR CONTINUACION . . .

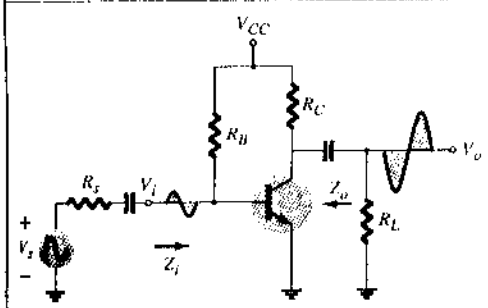
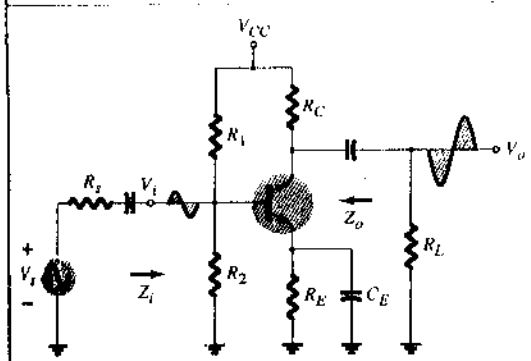
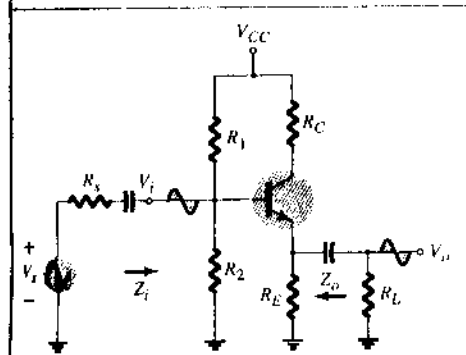
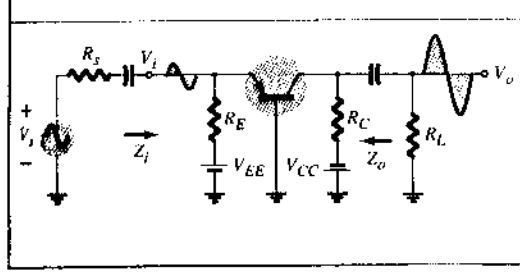
Niveles relativos para los parámetros importantes de los amplificadores de transistor de EC, BC y CC.

Configuración	Z_i	A_v	A_i	Z_o
Polarización fija: 	Media: (1 kΩ) $\cong \beta r_e$	Alta: (−200) $\cong -\frac{R_C}{r_e}$	Alta: (100) $\cong \beta$	Media: $\cong R_C$ (r_o = 40 kΩ)
Polarización por divisor de voltaje: 	Media: (1 kΩ) $\cong R' \| \beta r_e$ ($R' = R_1 \| R_2$)	Alta: (−200) $\cong -\frac{R_C}{r_e}$	Alta: (50) $= \frac{\beta R'}{R' + \beta r_e}$	Media: $\cong R_C$ (r_o = 40 kΩ)
Polarización de emisor sin derivación: 	Alta: (100 kΩ) $\cong \beta R_E$	Baja: (−5) $\cong -\frac{R_C}{R_E}$	Alta: (50) $= \frac{\beta R_B}{R_B + \beta R_E}$	Media: $\cong R_C$ (r_o = 40 kΩ)
Emisor seguidor: 	Alta: (100 kΩ) $\cong R_B \| \beta R_E$	Baja: $\cong 1$	Alta: (−50) $\cong \frac{-\beta R_B}{R_B + \beta R_E}$	Baja: (20 Ω) $\cong r_e$ (r_o = 40 kΩ)
Base común: 	Baja: (20 Ω) $\cong r_e$	Alta: (200) $\cong \frac{R_C}{r_e}$	Baja: $\cong -1$	Media: $\cong R_C$ (r_o = 2 MΩ)
Retroalimentación en colector: 	Media: (1 kΩ) $= \beta r_e \| \frac{R_F}{\|A_v\|}$	Alta: (−200) $\cong -\frac{R_C}{r_e}$	Alta: (50) $= \frac{\beta R_F}{R_F + \beta R_C}$	Media: $\cong R_C \| R_F$ (r_o = 40 kΩ)

PAPEL MILIMETRADO HERALD

EL TRANSISTOR BIPOLAR CONTINUACIÓN . . .

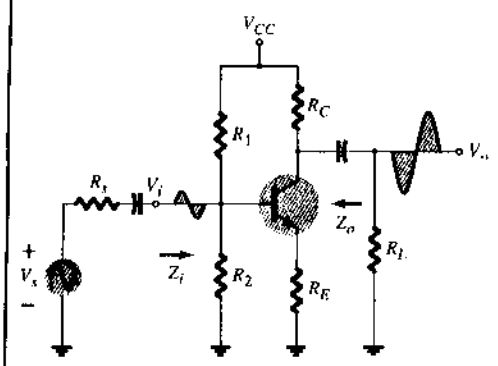
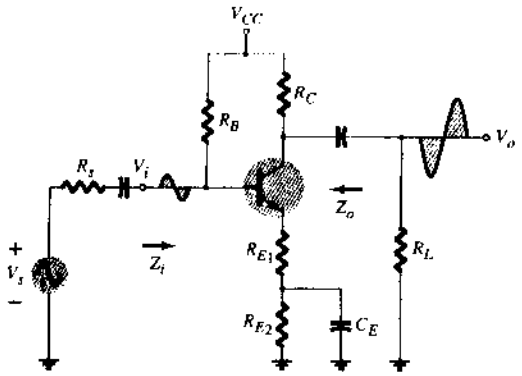
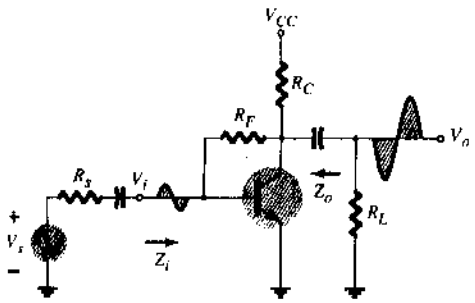
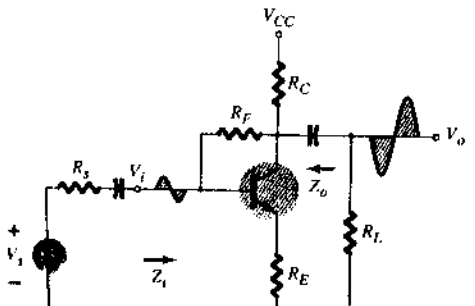
Resumen de configuraciones de transistor (A_v, Z_i, Z_o)

Configuración	$A_v = V_o/V_i$	Z_i	Z_o
	$\frac{-(R_L\|\|R_C)}{r_e}$	$R_B\|\|\beta r_e$	R_C
	$\frac{-h_{fe}}{h_{ie}}(R_L\|\|R_C)$	$R_B\|\|h_{ie}$	R_C
	Al incluir r_o: $\frac{-(R_L\|\|R_C\|\|r_o)}{r_e}$	$R_B\|\|\beta r_e$	$R_C\|\|r_o$
	$\frac{-(R_L\|\|R_C)}{r_e}$	$R_1\|\|R_2\|\|\beta r_e$	R_C
	$\frac{-h_{fe}}{h_{ie}}(R_L\|\|R_C)$	$R_1\|\|R_2\|\|h_{ie}$	R_C
	Al incluir r_o: $\frac{-(R_L\|\|R_C\|\|r_o)}{r_e}$	$R_1\|\|R_2\|\|\beta r_e$	$R_C\|\|r_o$
	$\cong 1$	$R_E' = R_L\|\|R_E$ $R_1\|\|R_2\|\|\beta(r_e + R_E')$	$R_s' = R_s\|\|R_1\|\|R_2$ $R_E\|\|\left(\frac{R_s'}{\beta} + r_e\right)$
	$\cong 1$	$R_1\|\|R_2\|\|(h_{ie} + h_{fe}R_E')$	$R_E\|\|\left(\frac{R_s' + h_{ie}}{h_{fe}}\right)$
	Al incluir r_o: $\cong 1$	$R_1\|\|R_2\|\|\beta(r_e + R_E')$	$R_E\|\|\left(\frac{R_s'}{\beta} + r_e\right)$
	$\cong \frac{-(R_L\|\|R_C)}{r_e}$	$R_E\|\|r_e$	R_C
	$\cong \frac{-h_{fb}}{h_{ib}}(R_L\|\|R_C)$	$R_E\|\|h_{ib}$	R_C
	Al incluir r_o: $\cong \frac{-(R_L\|\|R_C\|\|r_o)}{r_e}$	$R_L\|\|r_e$	$R_C\|\|r_o$

PAPEL MILIMETRADO HERALD

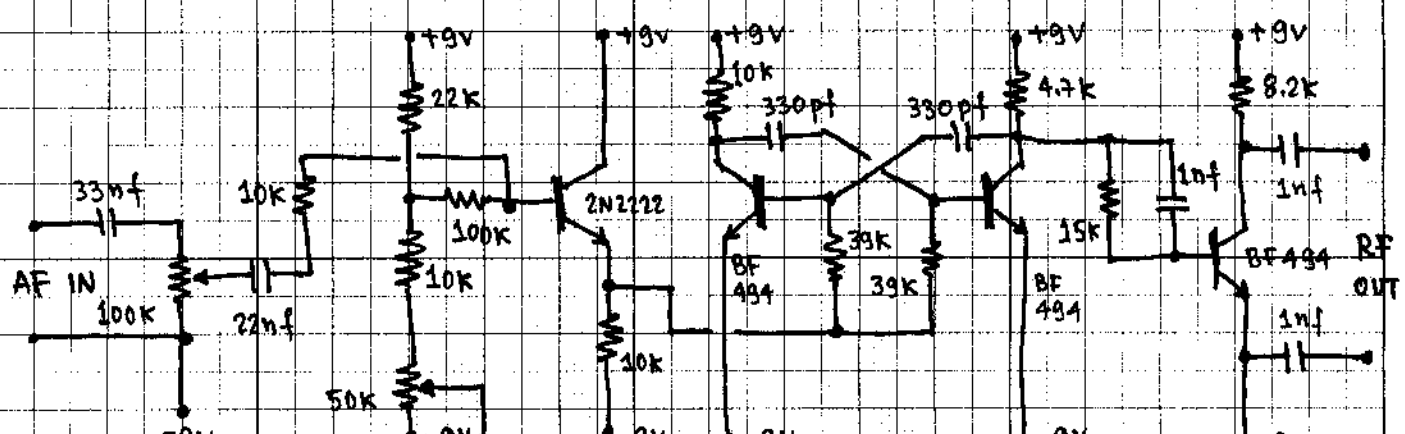
EL TRANSISTOR BIPOLAR CONTINUACIÓN . . .

Resumen de configuraciones de transistor (A_v, Z_i, Z_o) (Continuación)

Configuración	$A_v = V_o/V_i$	Z_i	Z_o
	$\frac{-(R_L\|\|R_C)}{R_E}$	$R_1\|\|R_2\|\|\beta(r_e + R_E)$	R_C
	$\frac{-(R_L\|\|R_C)}{R_E}$	$R_1\|\|R_2\|\|(h_{ie} + h_{fe}R_E)$	R_C
	Al incluir r_o: $\frac{-(R_L\|\|R_C)}{R_E}$	$R_1\|\|R_2\|\|\beta(r_e + R_E)$	$\cong R_C$
	$\frac{-(R_L\|\|R_C)}{R_{E_1}}$	$R_B\|\|\beta(r_e + R_{E_1})$	R_C
	$\frac{-(R_L\|\|R_C)}{R_{E_1}}$	$R_B\|\|(h_{ie} + h_{fe}R_{E_1})$	R_C
	Al incluir r_o: $\frac{-R_L\|\|R_C}{R_{E_1}}$	$R_B\|\|\beta(r_e + R_{E_1})$	$\cong R_C$
	$\frac{-(R_L\|\|R_C)}{r_e}$	$\beta r_e\|\|\frac{R_F}{\|A_v\|}$	R_C
	$\frac{-h_{fe}}{h_{ie}}(R_L\|\|R_C)$	$h_{ie}\|\|\frac{R_F}{\|A_v\|}$	R_C
	Al incluir r_o: $\frac{-(R_L\|\|R_C\|\|r_o)}{r_e}$	$\beta r_e\|\|\frac{R_F}{\|A_v\|}$	$R_C\|\|R_F\|\|r_o$
	$\frac{-(R_L\|\|R_C)}{R_E}$	$\beta R_E\|\|\frac{R_F}{\|A_v}$	$\cong R_C\|\|R_F$
	$\frac{-(R_L\|\|R_C)}{R_E}$	$h_{fe}R_E\|\|\frac{R_F}{\|A_v\|}$	$\cong R_C\|\|R_F$
	Al incluir r_o: $\cong \frac{-(R_L\|\|R_C)}{R_E}$	$\cong \beta R_E\|\|\frac{R_F}{\|A_v\|}$	$\cong R_C\|\|R_F$

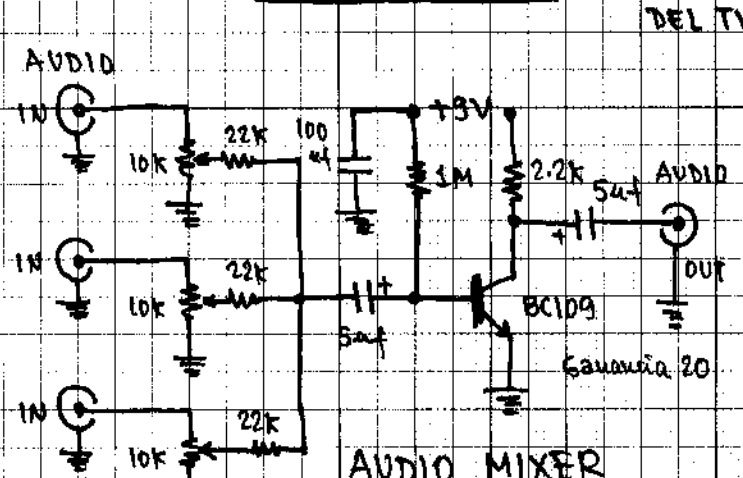
PAPEL MILIMETRADO HERALD

EL TRANSISTOR BIPOLAR CONTINUACIÓN . . .

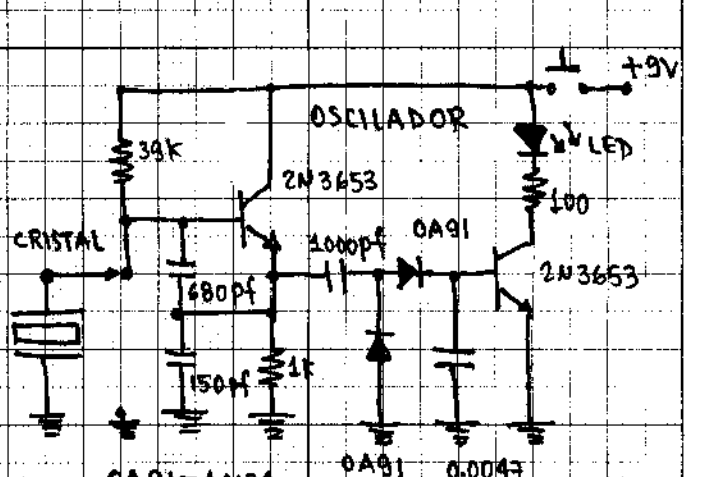


AUDIO ESCOPIO

LA ENTRADA AF, AFECTA LA SALIDA DE VIDEO DEL TV, CH 2,3,4 ; RF OUT A 300Ω.

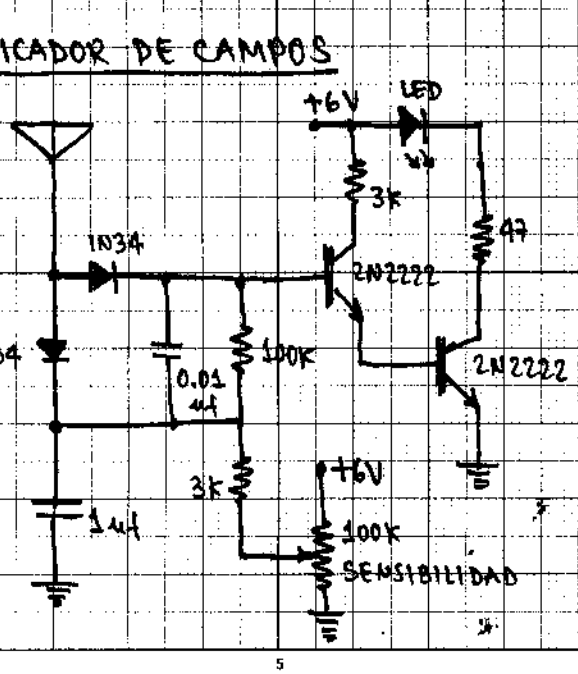


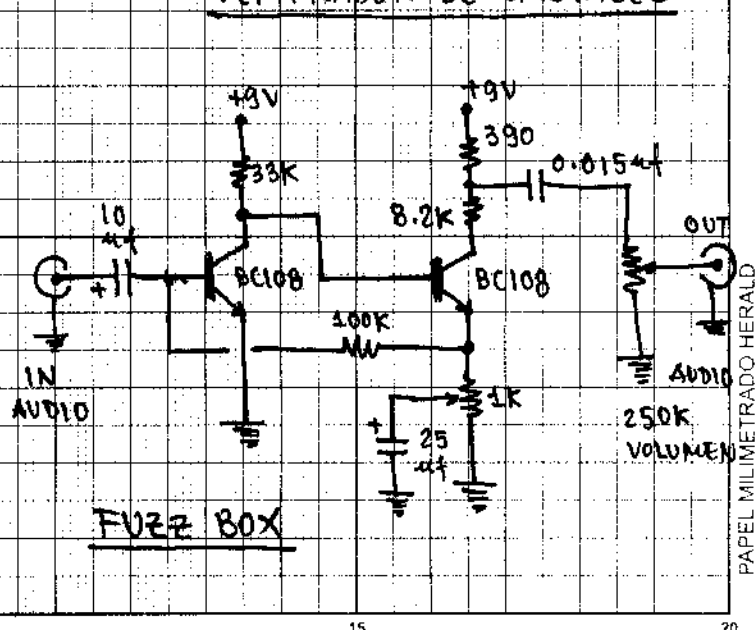
AUDIO MIXER



VERIFICADOR DE CRISTALES

INDICADOR DE CAMPOS

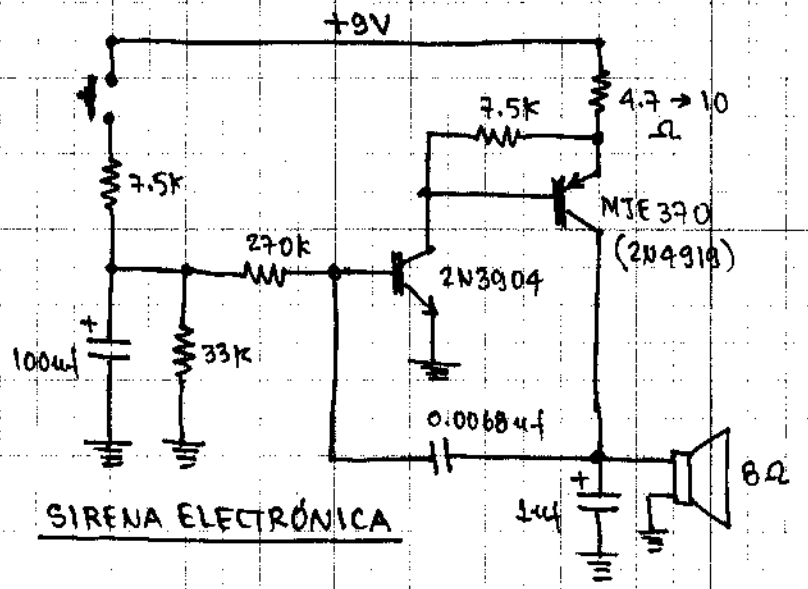




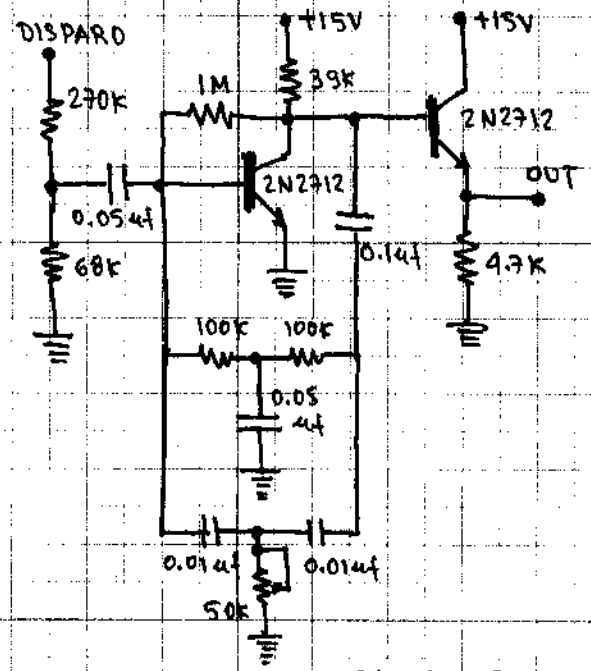
FUZZ BOX

PAPEL MILIMETRADO HERALD

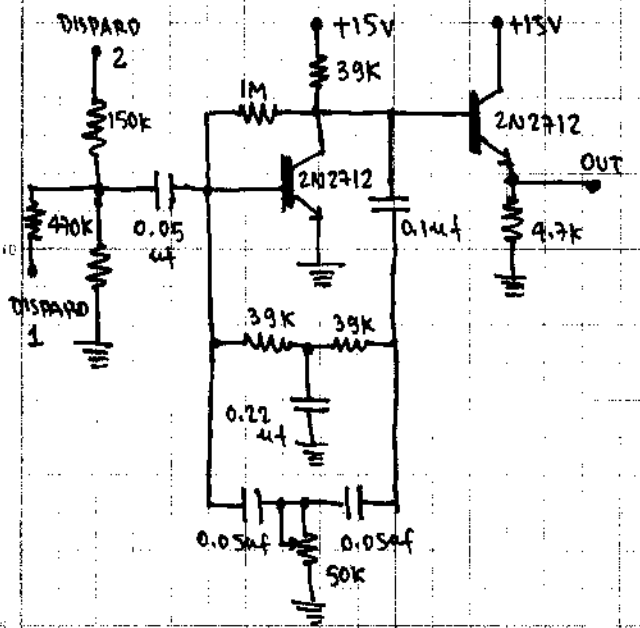
EL TRANSISTOR BIPOLAR CONTINUACIÓN . . .



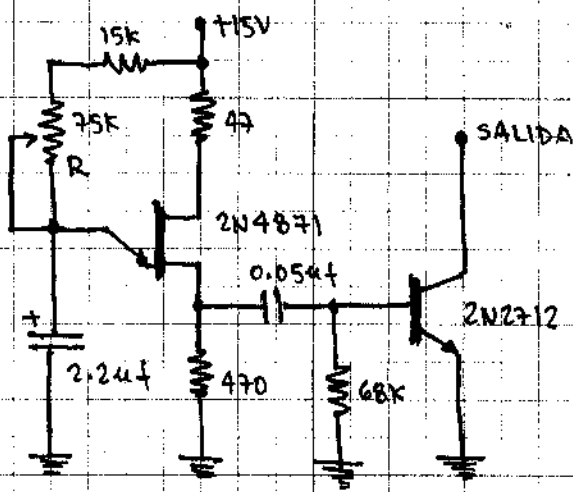
SIRENA ELECTRÓNICA



GENERADOR MUSICAL, SONIDO CONGA



GENERADOR MUSICAL, SONIDO BASS

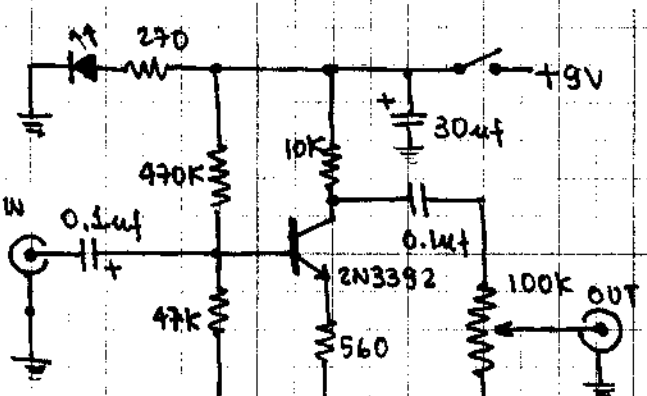


R: 75K CONTROL DE TEMPO PARA AJUSTE DE DISPARO
SALIDA: COLECTOR ABIERTO PARA DIFERENTES USOS
UJT: OSCILADOR DE RELAJACIÓN.

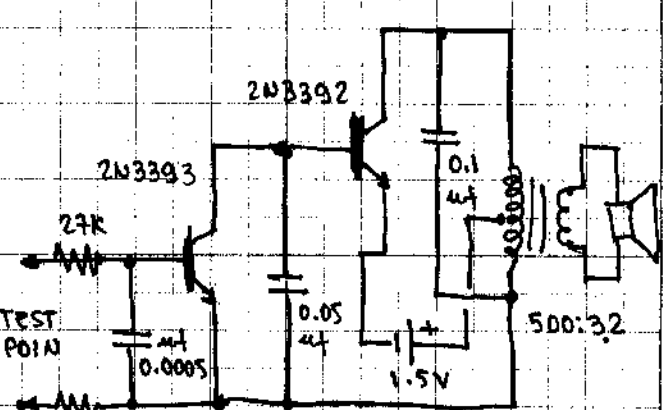
GENERADOR DE PULSOS PARA MÚSICA

PAPEL MILIMETRADO HERALD

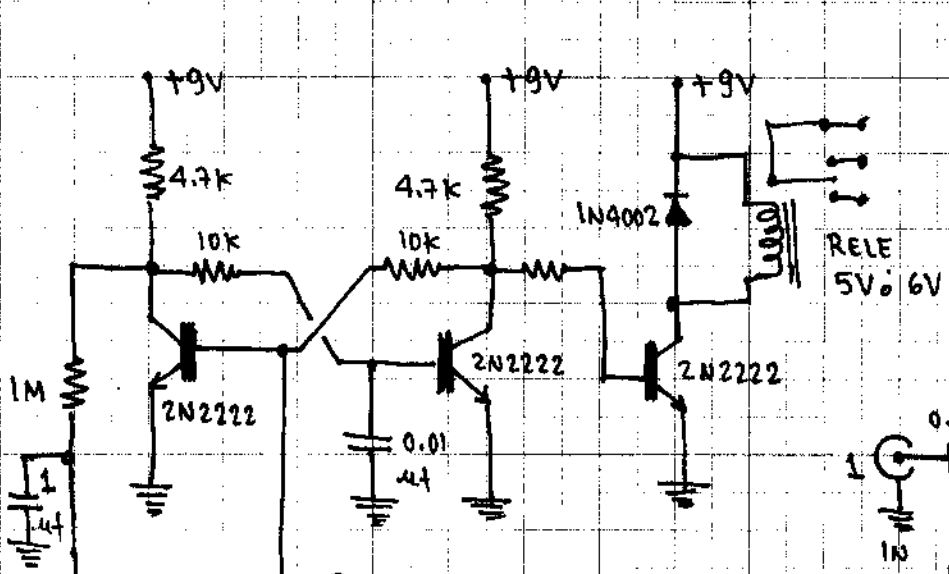
EL TRANSISTOR BIPOLAR CONTINUACIÓN...



AMPLIFICADOR BOOSTER DE AUDIO

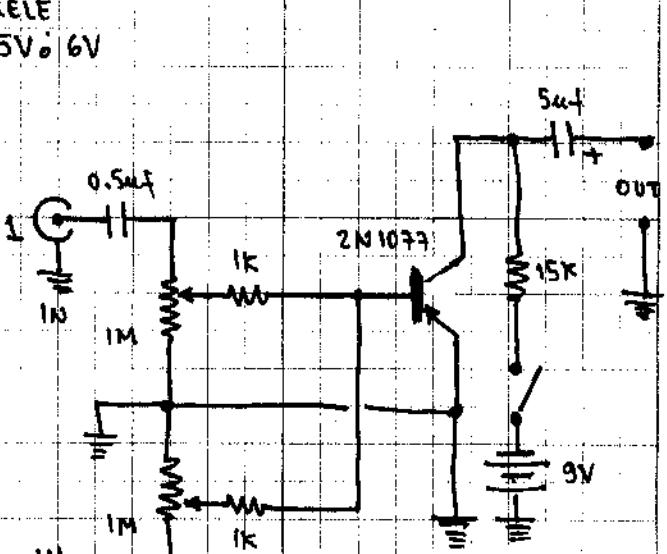


PROBADOR DE CONTINUIDAD AUDIBLE



PUSH ON — PUSH OFF

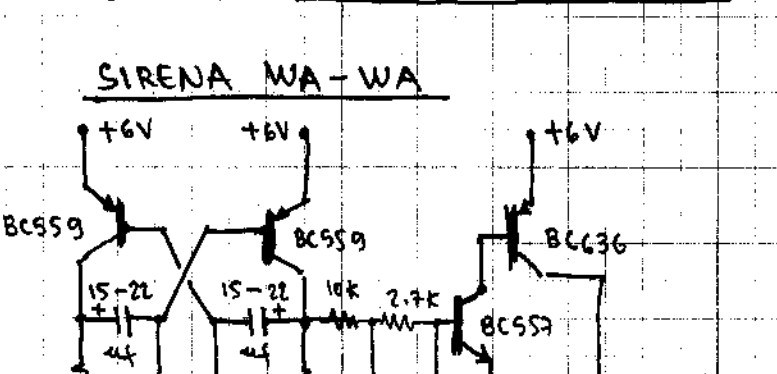
INTERRUPTOR ELECTRÓNICO



MEZCLADOR

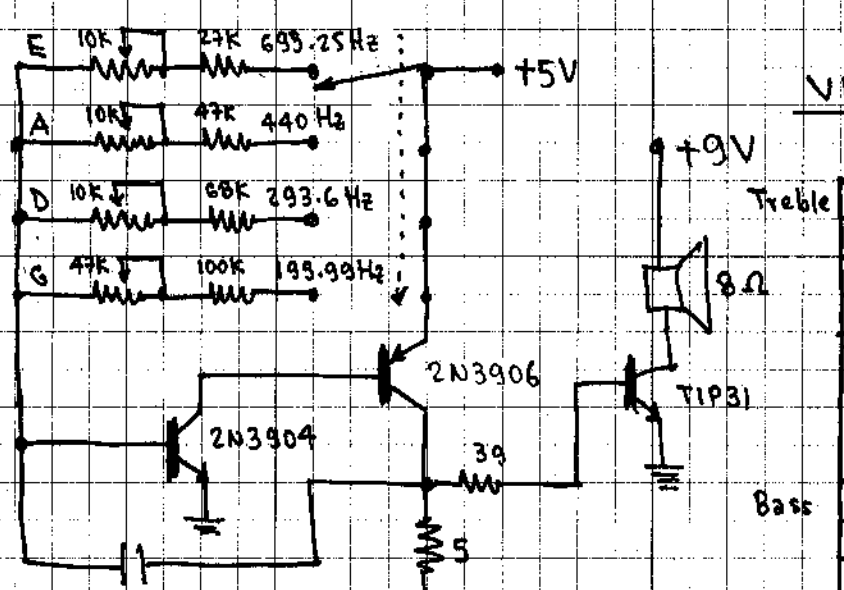
MEZCLA 2 MICRÓFONOS

SIRENA WA-WA



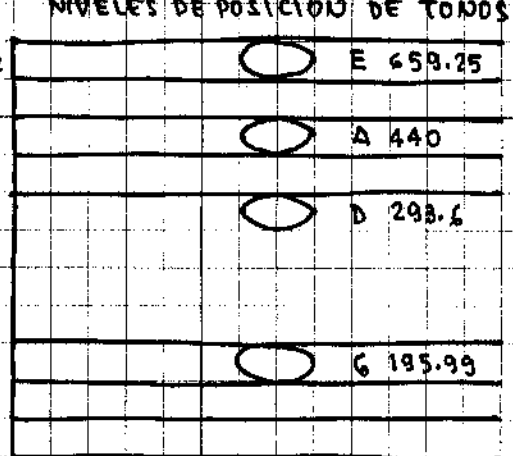
PAPEL MILIMETRADO HERALD

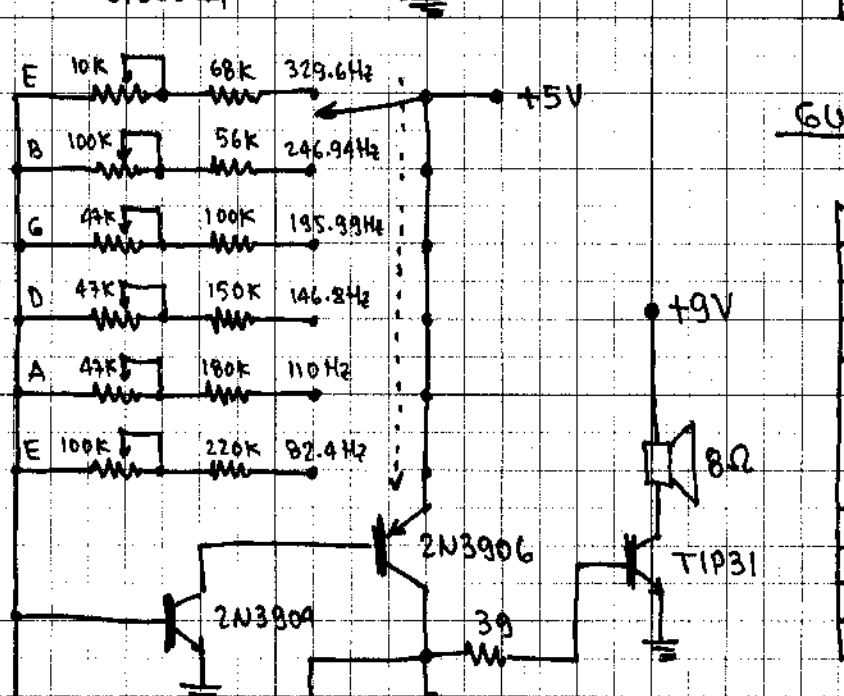
EL TRANSISTOR BIPOLAR CONTINUACIÓN...



VIOLIN TUNER

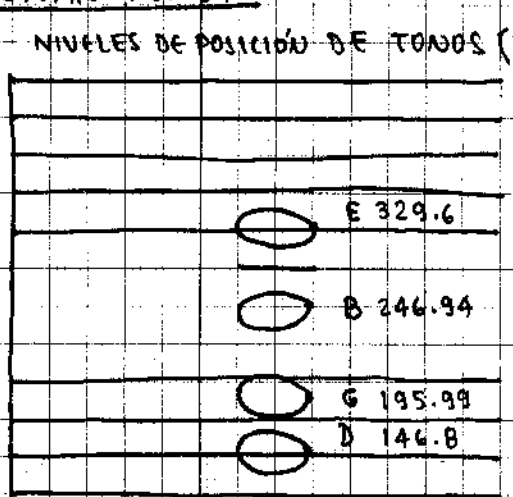
NIVELES DE POSICIÓN DE TONOS (Hz)





GUITAR TUNER

NIVELES DE POSICIÓN DE TONOS (Hz)



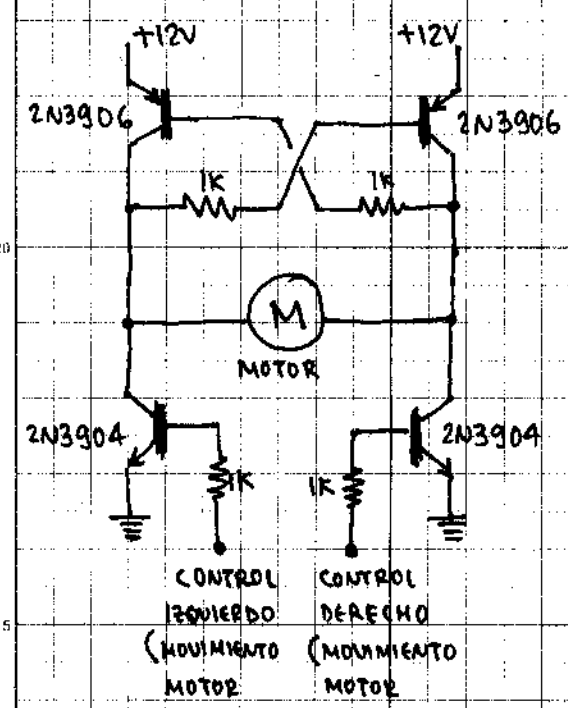
VER PAGINA AL-16

NOTAS MUSICALES DE INTERÉS Y SUS RESPECTIVOS TONOS EN Hz.

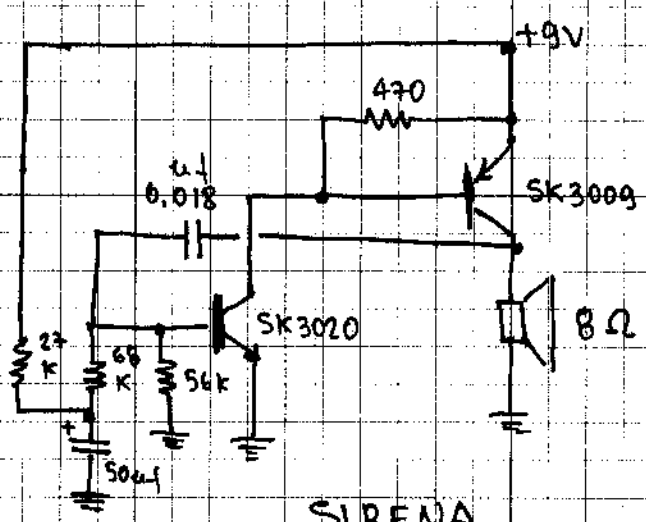
	DO	DO#	RE	RE#	MI	FA	FA#	SOL	SOL#	LA	LA#	SI
OCTAVA	C	C#	D	D#	E	F	F#	G	G#	A	A#	B
1ª					41.20	43.65	46.24	48.99	51.91	55.0	58.29	61.73
2ª	65.40	69.29	73.41	77.78	82.40	87.30	92.49	97.99	103.82	110.0	116.54	123.47
3ª	130.81	138.59	146.83	155.56	164.81	174.61	184.99	195.99	207.65	220.0	233.08	246.94
4ª	261.62	277.18	293.66	311.12	329.62	349.22	369.99	391.99	415.30	440.0	466.16	493.88
5ª	523.25	554.36	587.32	622.54	659.25	698.45	739.98	783.99	830.60			

PAPEL MILIMETRADO HERALD

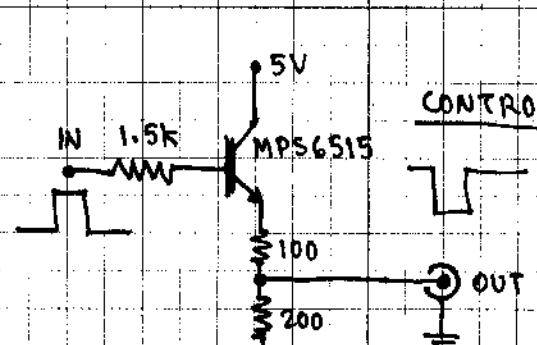
EL TRANSISTOR BIPOLAR CONTINUACIÓN . . .



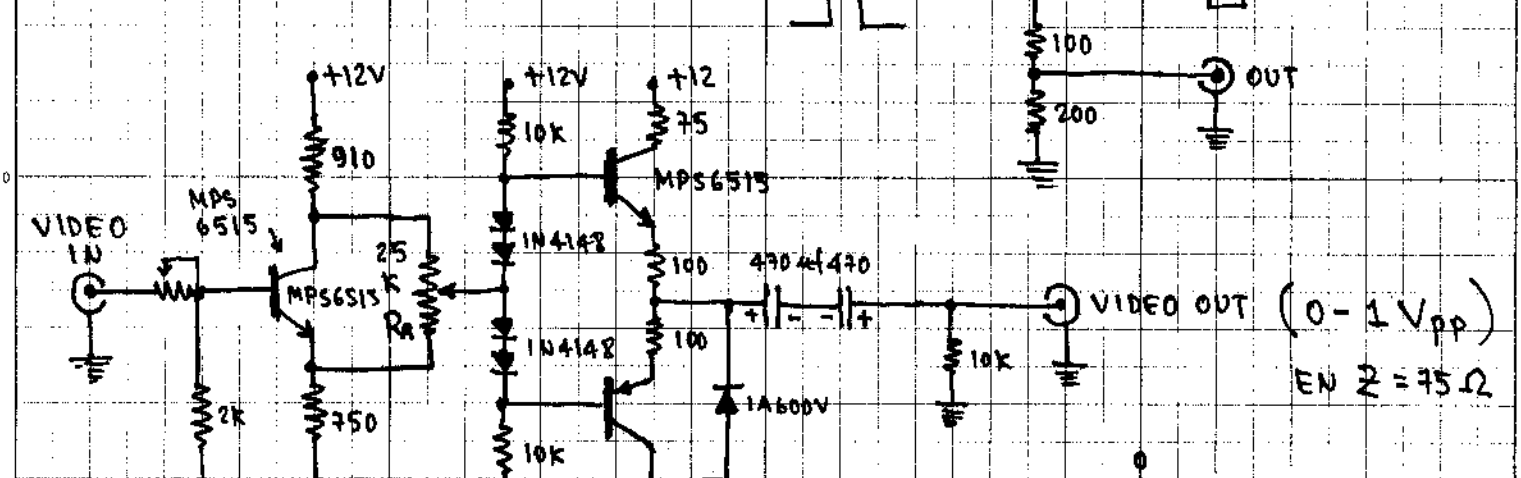
CONTROL DE MOTOR DC



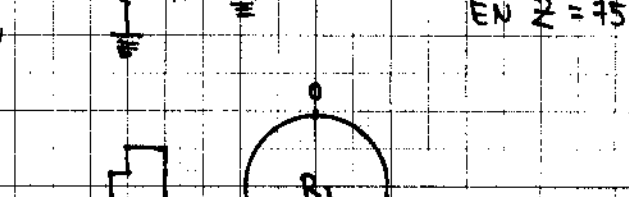
SIRENA



CONTROL DIGITAL



R1: 25K LINEAL



CONTROL POLARIDAD DEL VIDEO

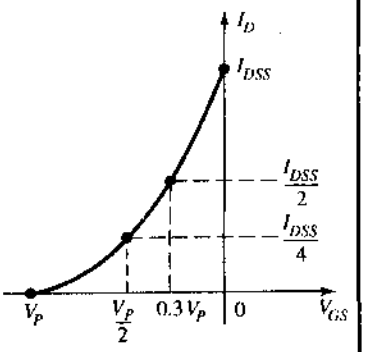
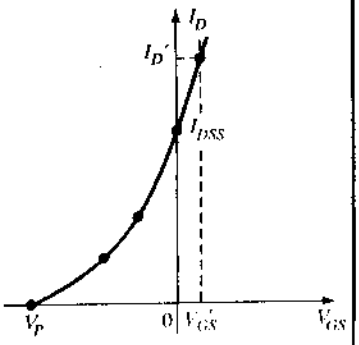
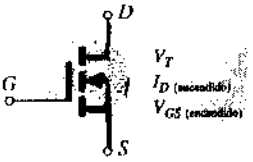
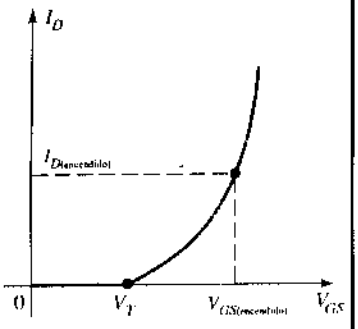
PAPEL MILIMETRADO HERALD

EL TRANSISTOR DE EFECTO DE CAMPO (FET)

PAPEL MILIMETRADO HERALD

EL TRANSISTOR DE EFECTO DE CAMPO FET

Transistores de efecto de campo

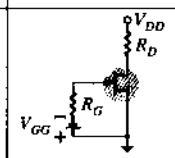
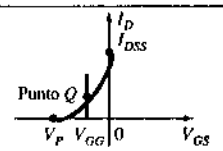
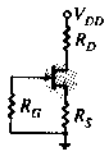
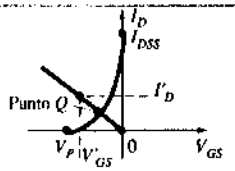
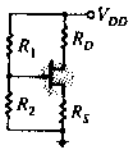
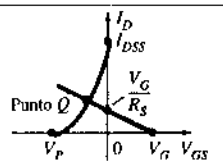
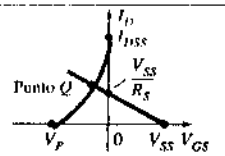
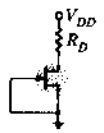
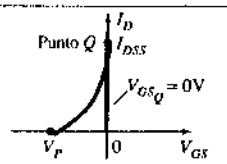
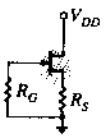
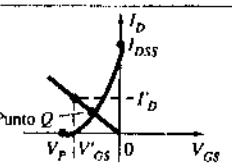
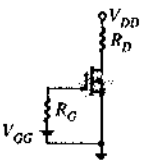
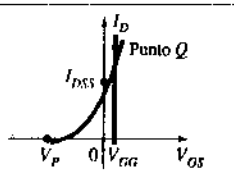
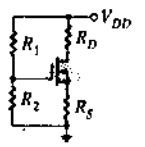
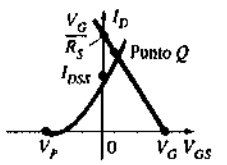
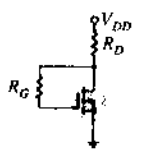
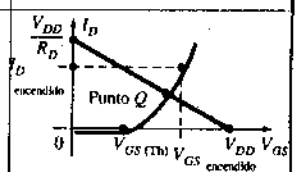
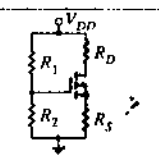
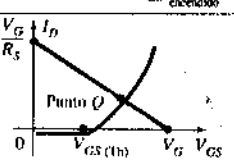
Tipo	*Símbolo relaciones básicas*	*Curva de transferencia*	*Resistencia y capacitancia de entrada*
JFET (canal *n*)	$I_G = 0$ A, $I_D = I_S$ $I_D = I_{DSS}(1-\frac{V_{GS}}{V_P})^2$		$R_i > 100$ MΩ C_i: (1 – 10) pF
MOSFET Tipo decremental (canal *n*)	$I_G = 0$ A, $I_D = I_S$ $I_D = I_{DSS}(1-\frac{V_{GS}}{V_P})^2$		$R_i > 10^{10}$ Ω C_i: (1 – 10) pF
MOSFET Tipo incremental (canal *n*)	$I_G = 0$ A, $I_D = I_S$  $I_D = k(V_{GS} - V_T)^2$ $k = \frac{I_{D(encendido)}}{(V_{GS(encendido)} - V_T)}$		$R_i > 10^{10}$ Ω C_i: (1 – 10) pF

PAPEL MILIMETRADO HERALD

EL TRANSISTOR DE EFECTO DE CAMPO CONTINUACIÓN . . .

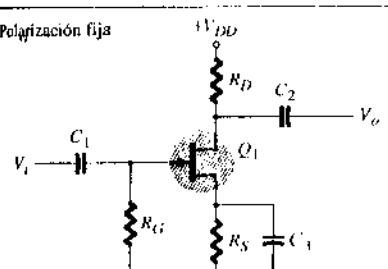
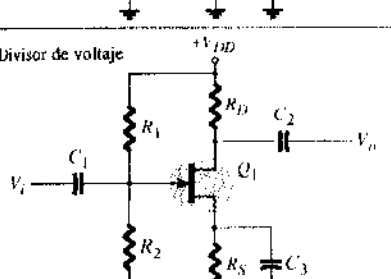
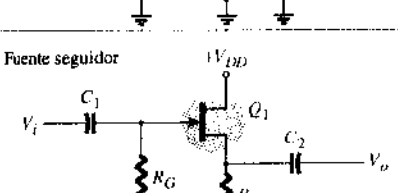
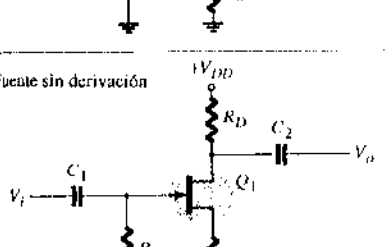
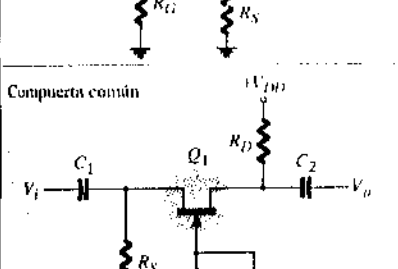
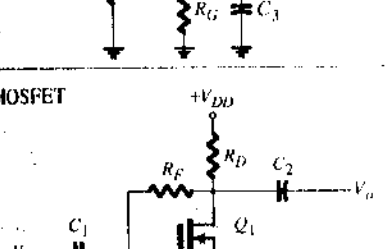
J J V

Configuraciones FET de polarización

Tipo	*Configuración*	*Ecuaciones pertinentes*	*Solución gráfica*
JFET Polarización fija		$V_{GS_Q} = -V_{GG}$ $V_{DS} = V_{DD} - I_D R_S$	
JFET Autopolarización		$V_{GS} = -I_D R_S$ $V_{DS} = V_{DD} - I_D(R_D + R_S)$	
JFET Polarización por divisor de voltaje		$V_G = \frac{R_2 V_{DD}}{R_1 + R_2}$ $V_{GS} = V_G - I_D R_S$ $V_{DS} = V_{DD} - I_D(R_D + R_S)$	
JFET Fuente dual		$V_{GS} = V_{SS} - I_D R_S$ $V_{DS} = V_{DD} + V_{SS} - I_D(R_D + R_S)$	
JFET ($V_{GS_Q} = 0$ V)		$V_{GS_Q} = 0$ V $I_{D_Q} = I_{DSS}$	
JFET ($R_D = 0\ \Omega$)		$V_{GS} = -I_D R_S$ $V_D = V_{DD}$ $V_S = I_D R_S$ $V_{DS} = V_{DD} - I_D R_S$	
MOSFET de tipo decremental *(Todas las configuraciones anteriores más casos donde V_{GS_Q} = +voltaje) Polarización fija		$V_{GS_Q} = +V_{GG}$ $V_{DS} = V_{DD} - I_D R_S$	
MOSFET de tipo decremental Polarización por divisor de voltaje		$V_G = \frac{R_2 V_{DD}}{R_1 + R_2}$ $V_{GS} = V_G - I_D R_S$ $V_{DS} = V_{DD} - I_D(R_D + R_S)$	
MOSFET de tipo incremental Configuración con retroalimentación		$V_{GS} = V_{DS}$ $V_{GS} = V_{DD} - I_D R_D$	
MOSFET de tipo incremental Polarización por divisor de voltaje		$V_G = \frac{R_2 V_{DD}}{R_1 + R_2}$ $V_{GS} = V_G - I_D R_S$	

PAPEL MILIMETRADO HERALD

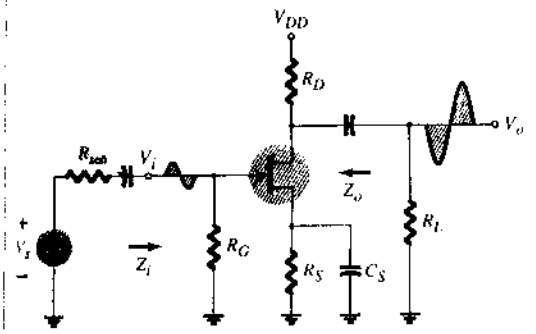
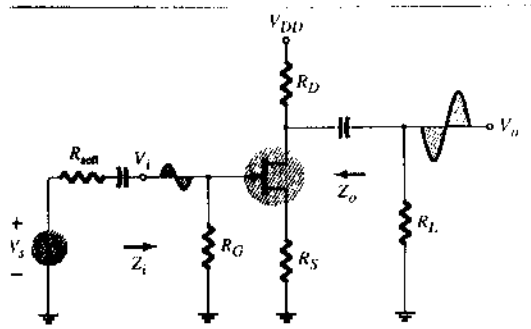
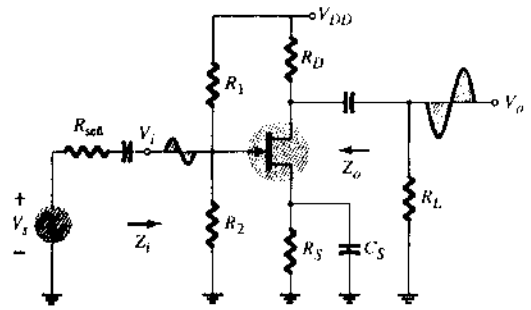
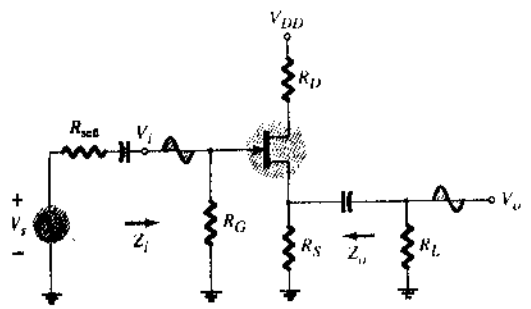
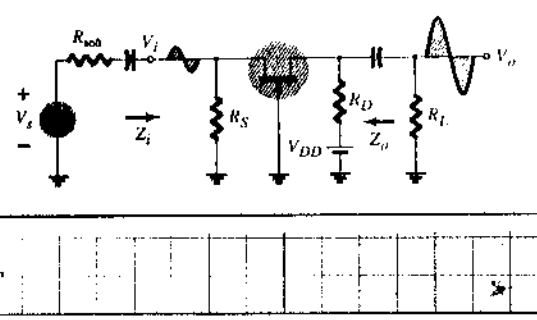
EL TRANSISTOR DE EFECTO DE CAMPO CONTINUACIÓN . . .

Configuración	Zi	Av	Zo
Polarización fija 	Alta (10 MΩ) $= R_G$	Media (−20) $= -g_m(R_D\|\|r_d)$	Media (2 kΩ) $= (R_D\|\|r_d)$
Divisor de voltaje 	Media (1 MΩ) $= R_1\|\|R_2$	Media (−20) $= -g_m(R_D\|\|r_d)$	Media (2 kΩ) $= (R_D\|\|r_d)$
Fuente seguidor 	Alta (10 MΩ) $= R_G$	Baja $\cong 1$	Baja (100 Ω) $= \left(R_s\|\|r_d\|\|\frac{1}{g_m}\right)$
Fuente sin derivación 	Alta (10 MΩ) $= R_G$	Baja (−2) $= -\frac{g_m R_D}{1 + g_m R_s}$	Media (2 kΩ) $= (R_D\|\|r_d)$
Compuerta común 	Baja (1 kΩ) $= R_s$	Media (+20) $= g_m(R_D\|\|r_d)$	Media (2 kΩ) $\cong (R_D\|\|r_d)$
MOSFET 	Media (1 MΩ) $= \frac{R_G}{1 + g_m(R_D\|\|r_d)}$	Media (+20) $= -g_m(R_D\|\|r_d)$	Media (2 kΩ) $= (R_D\|\|r_d)$

PAPEL MILIMETRADO HERALD

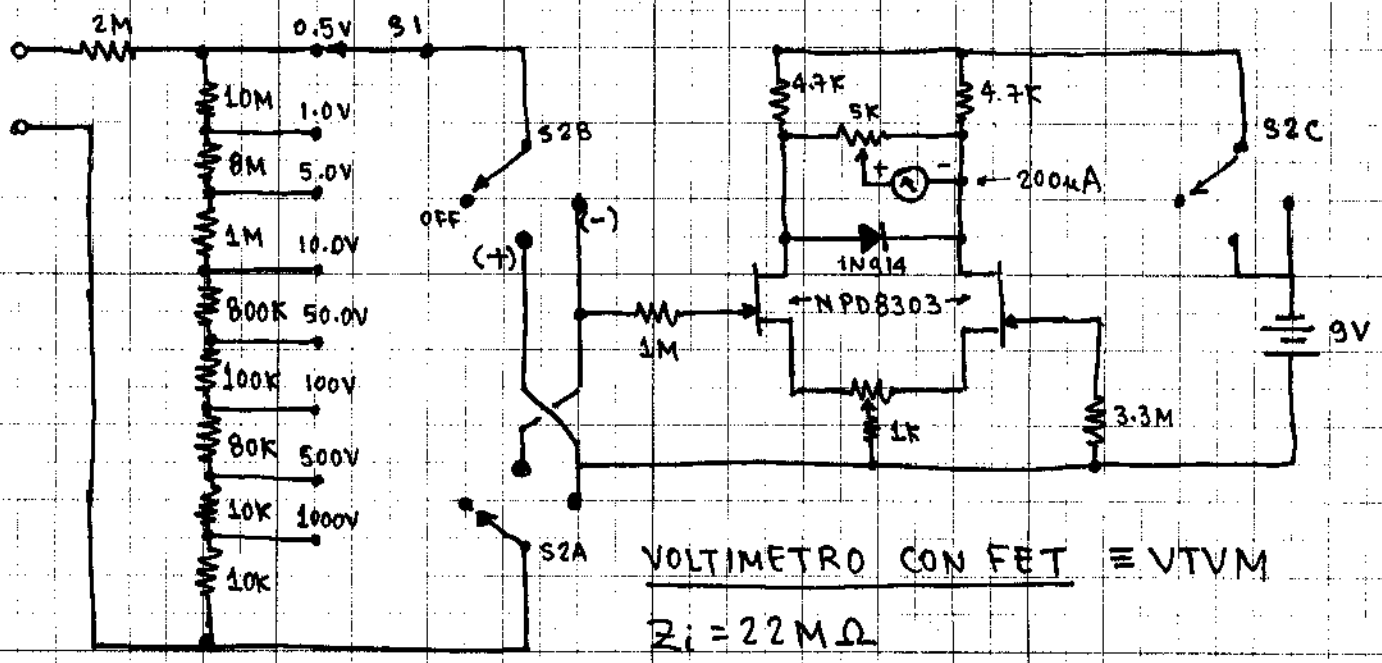
EL TRANSISTOR DE EFECTO DE CAMPO CONTINUACIÓN...

(Continuación)

Configuración	$A_v = V_o/V_i$	Z_i	Z_o
	$-g_m(R_D\|\|R_L)$ Al incluir r_d: $-g_m(R_D\|\|R_L\|\|r_d)$	R_G R_G	R_D $R_D\|\|r_d$
	$\dfrac{-g_m(R_D\|\|R_L)}{1+g_mR_S}$ Al incluir r_d: $\dfrac{-g_m(R_D\|\|R_L)}{1+g_mR_S+\dfrac{R_D+R_S}{r_d}}$	R_G R_G	$\dfrac{R_D}{1+g_mR_S}$ $\cong \dfrac{R_D}{1+g_mR_S}$
	$-g_m(R_D\|\|R_L)$ Al incluir r_d: $-g_m(R_D\|\|R_L\|\|r_d)$	$R_1\|\|R_2$ $R_1\|\|R_2$	R_D $R_D\|\|r_d$
	$\dfrac{g_m(R_S\|\|R_L)}{1+g_m(R_S\|\|R_L)}$ Al incluir r_d: $=\dfrac{g_mr_d(R_S\|\|R_L)}{r_d+R_D+g_mr_d(R_S\|\|R_L)}$	R_G R_G	$R_S\|\|1/g_m$ $\dfrac{R_S}{1+\dfrac{g_mr_dR_S}{r_d+R_D}}$
	$g_m(R_D\|\|R_L)$ Al incluir r_d: $\cong g_m(R_D\|\|R_L)$	$\dfrac{R_S}{1+g_mR_S}$ $Z_i=\dfrac{R_S}{1+\dfrac{g_mr_dR_S}{r_d+R_D\|\|R_L}}$	R_D $R_D\|\|r_d$

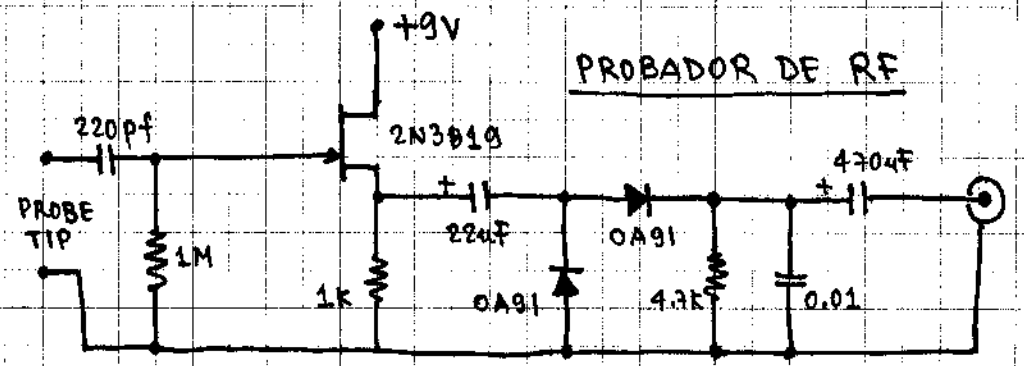
PAPEL MILIMETRADO HERALD

EL TRANSISTOR DE EFECTO DE CAMPO CONTINUACIÓN . . .



VOLTIMETRO CON FET ≡ VTVM

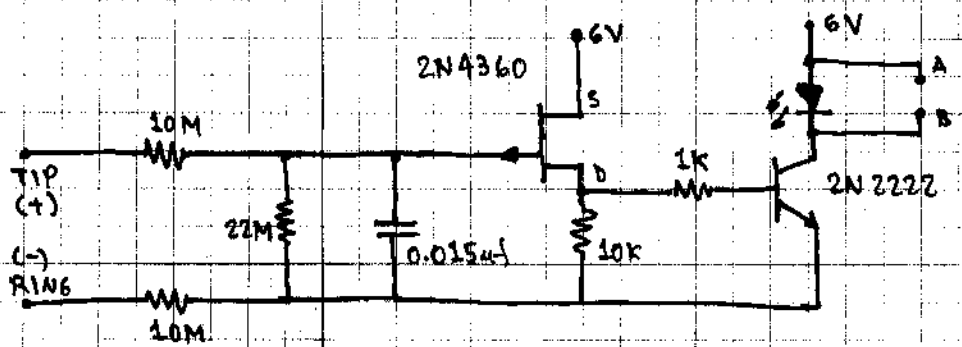
$Z_i = 22 M\Omega$



PROBADOR DE RF

RESPONDE DE 100KHz A 50MHz

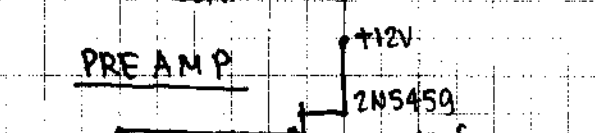
DETECTA AM



INTERRUPTOR DE ESTADO SOLIDO ACTIVADO POR LINEA TELEFÓNICA

CONECTAR RELE EN PUNTOS A, B.

PRE AMP



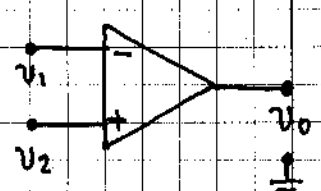
ATENUADOR VARIABLE

PAPEL MILIMETRADO HERALD

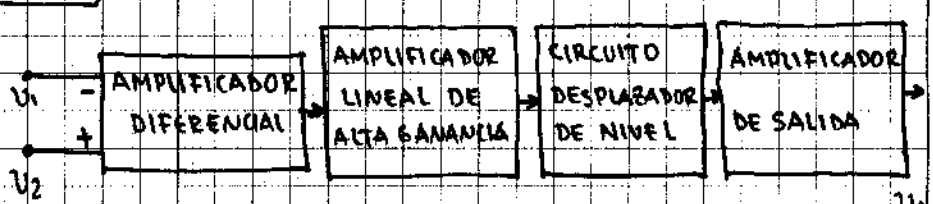
EL AMPLIFICADOR OPERACIONAL (OP AMP)

PAPEL MILIMETRADO HERALD

EL AMPLIFICADOR OPERACIONAL

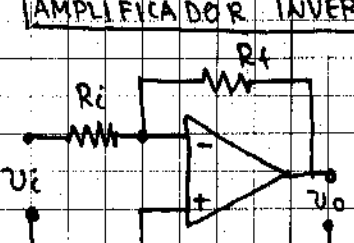


EQUIVALE



CONFIGURACIÓN EN CASCADA DEL AMP-OP EN BLOQUE.

AMPLIFICADOR INVERSOR



$$Z_{in} = R_i$$

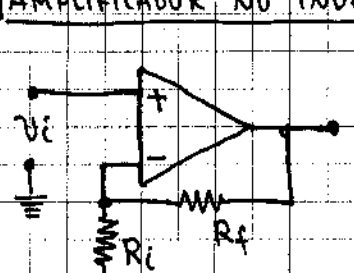
$$v_0 = -\frac{R_f}{R_i} v_i$$

$$A_v = -\frac{R_f}{R_i} = \frac{v_0}{v_i}$$

CARACTERISTICAS GENERALES IDEALES

- GANANCIA DE LAZO ABIERTO = INFINITA	- ANCHO DE BANDA EN LAZO ABIERTO ES INFINITA
- RESISTENCIA DE ENTRADA ES INFINITA	- VOLTAJE EN MODO DIFERENCIAL = CERO
- RESISTENCIA DE SALIDA ES CERO	- RECHAZO EN MODO COMÚN ES INFINITA
- VOLTAJES Y CORRIENTES DE DESVIACION DE SALIDA (OFFSET) = CERO	- CORRIENTES DE ENTRADA = CERO

AMPLIFICADOR NO INVERSOR

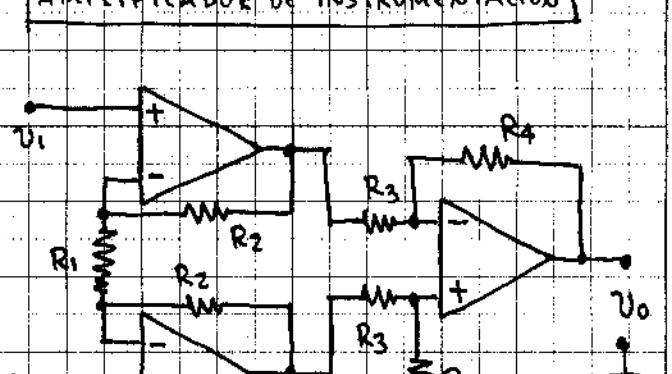


$$Z_{in} = \infty$$

$$v_0 = \left(1 + \frac{R_f}{R_i}\right) v_i$$

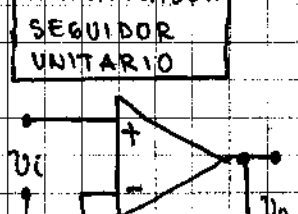
$$A_v = \left(1 + \frac{R_f}{R_i}\right) = \frac{v_0}{v_i}$$

AMPLIFICADOR DE INSTRUMENTACION



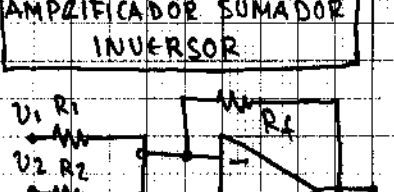
$$v_0 = \frac{R_4}{R_3}\left(1 + \frac{2R_2}{R_1}\right) v_2 - v_1$$

AMPLIFICADOR SEGUIDOR UNITARIO



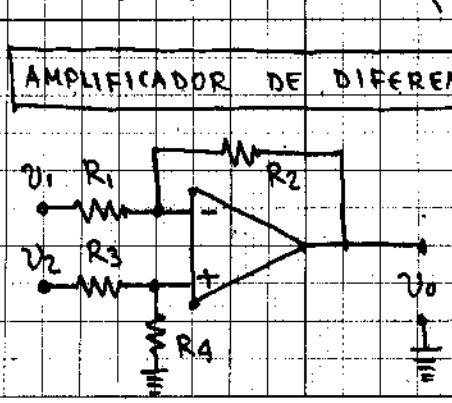
$$v_0 = v_i \quad Z_{in} = \infty$$

AMPLIFICADOR SUMADOR INVERSOR



$$v_0 = -\left(\frac{R_f}{R_1} v_1 + \frac{R_f}{R_2} v_2 + \frac{R_f}{R_3} v_3\right)$$

AMPLIFICADOR DE DIFERENCIA



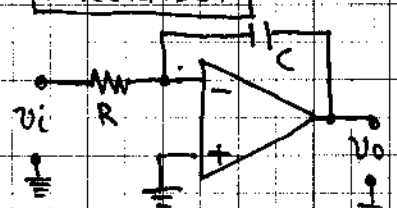
$$v_0 = \left(1 + \frac{R_2}{R_1}\right)\left[\frac{\frac{R_4}{R_3}}{1 + \frac{R_4}{R_3}}\right] v_2 - \frac{R_2}{R_1} v_1$$

$$\text{si } \frac{R_4}{R_3} = \frac{R_2}{R_1} \longrightarrow v_0 = \frac{R_2}{R_1}(v_2 - v_1)$$

PAPEL MILIMETRADO HERALD

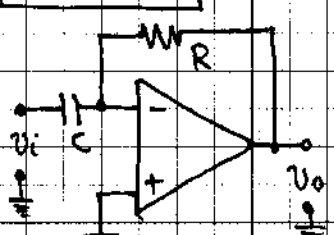
EL AMPLIFICADOR OPERACIONAL CONTINUACIÓN . . .

INTEGRADOR



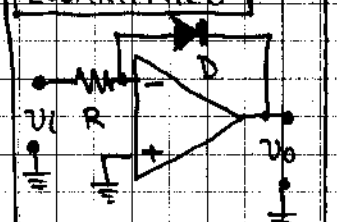
$$v_o(t) = -\frac{1}{RC}\int v_i(t)\,dt$$

DERIVADOR



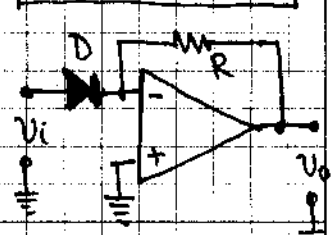
$$v_o(t) = -RC\frac{dv_i(t)}{dt}$$

LOGARÍTMICO



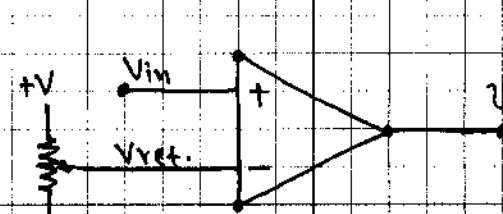
$$v_o = -V_T \ln\left(\frac{v_i}{I_S R}\right)$$

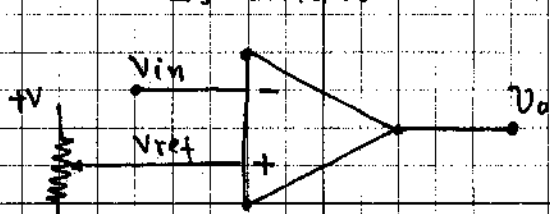
ANTILOGARITMICO

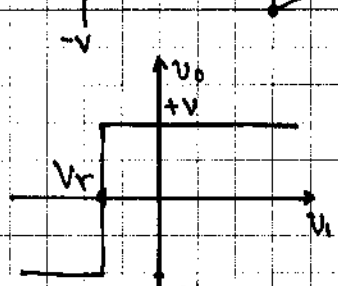


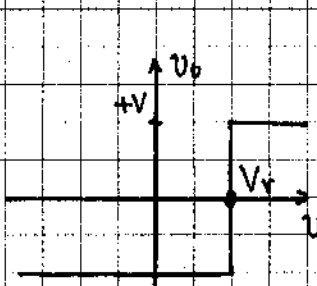
$$v_o = -I_S R\, e^{v_i/V_T}$$

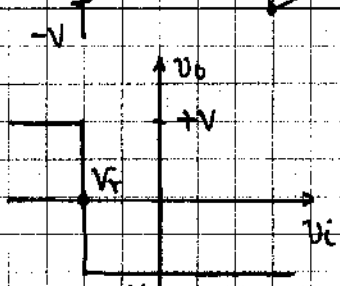
I_S = CORRIENTE DE SATURACION

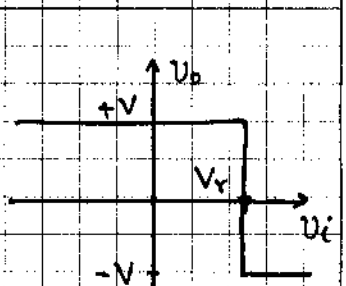










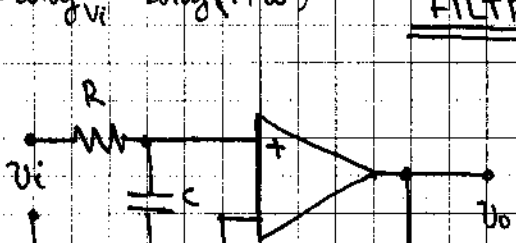


CIRCUITO COMPARADOR ($V_{ref} = V_r$ EN (−)) CIRCUITO COMPARADOR ($V_{ref} = V_r$ EN (+))

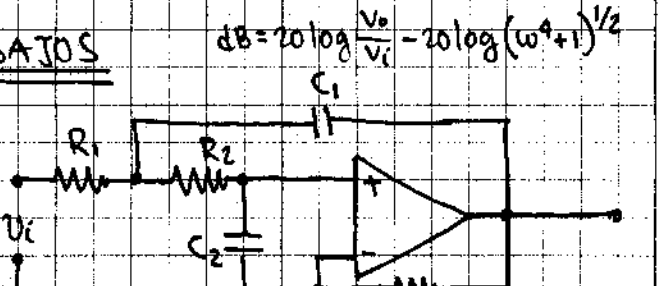
$$dB = 20\log\frac{V_o}{V_i} - 20\log\left(1+\omega^2\right)^{1/2}$$

FILTROS PASA BAJOS

$$dB = 20\log\frac{V_o}{V_i} - 20\log\left(\omega^4+1\right)^{1/2}$$



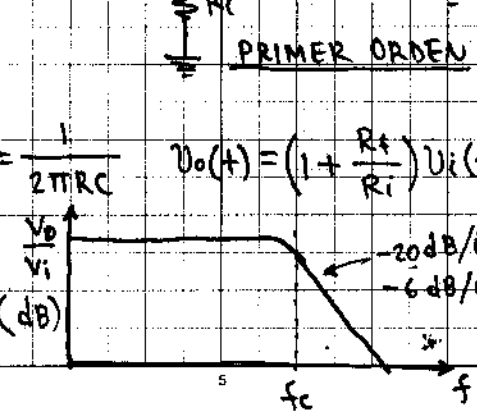
PRIMER ORDEN



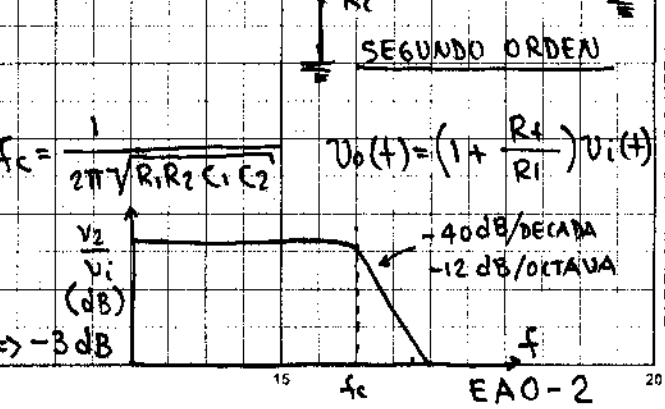
SEGUNDO ORDEN

$$f_c = \frac{1}{2\pi RC} \qquad v_o(t) = \left(1+\frac{R_f}{R_i}\right)v_i(t)$$

$$f_c = \frac{1}{2\pi\sqrt{R_1R_2C_1C_2}} \qquad v_o(t) = \left(1+\frac{R_f}{R_1}\right)v_i(t)$$



PARA f_c $\frac{V_o}{V_i}$ => −3 dB



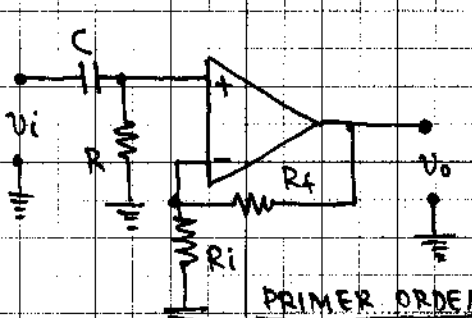
PAPEL MILIMETRADO HERALD

EL AMPLIFICADOR OPERACIONAL CONTINUACIÓN . . .

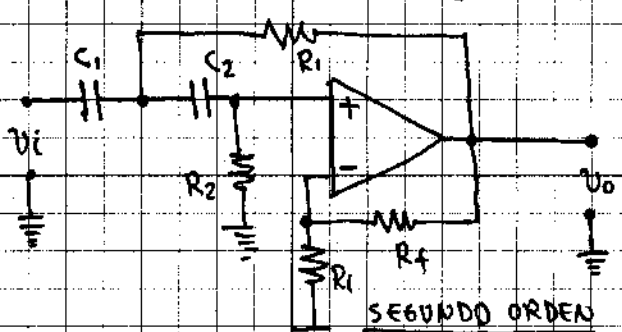
$$dB = 20\log\frac{v_o}{v_i} + 20\log\left[\frac{\omega}{(1+\omega^2)^{1/2}}\right]$$

FILTROS PASA ALTOS

$$dB = 20\log\frac{v_o}{v_i} - 20\log\left[\left(\frac{1}{\omega}\right)^4 + 1\right]^{1/2}$$



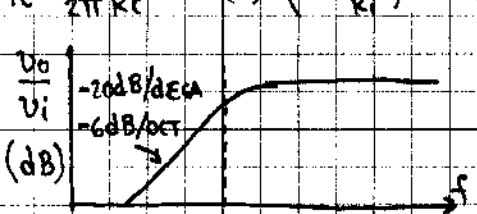
PRIMER ORDEN



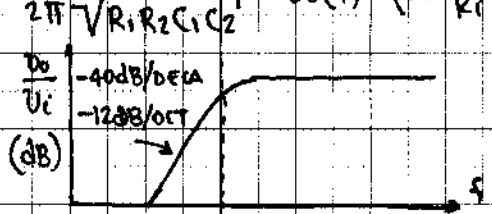
SEGUNDO ORDEN

$$f_c = \frac{1}{2\pi RC} \qquad v_o(t) = \left(1 + \frac{R_f}{R_i}\right) v_i(t)$$

$$f_c = \frac{1}{2\pi\sqrt{R_1 R_2 C_1 C_2}} \qquad v_o(t) = \left(1 + \frac{R_f}{R_i}\right) v_i(t)$$

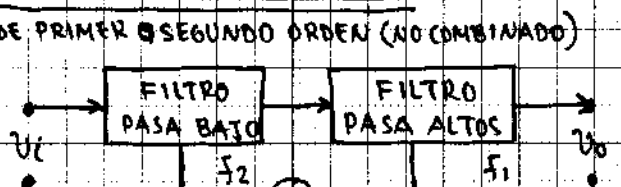


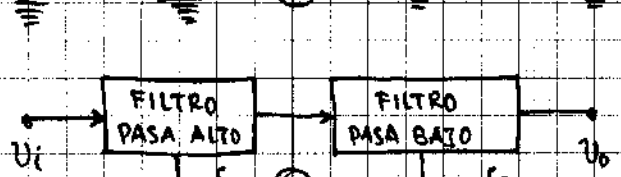
Para f_c $\frac{v_o}{v_i} \Rightarrow -3dB$



FILTROS PASA BANDA

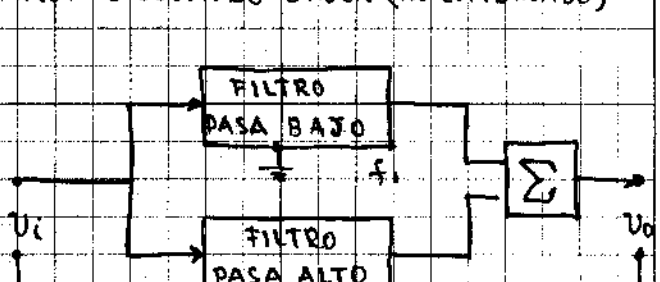
DE PRIMER O SEGUNDO ORDEN (NO COMBINADO)

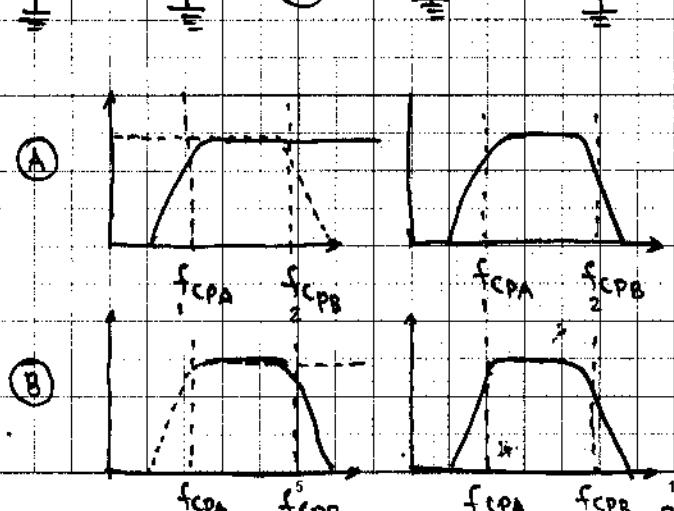




FILTROS ELIMINA BANDA

DE PRIMER O SEGUNDO ORDEN (NO COMBINADO)



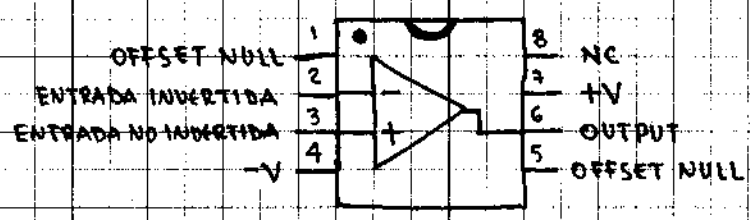


PAPEL MILIMETRADO HERALD

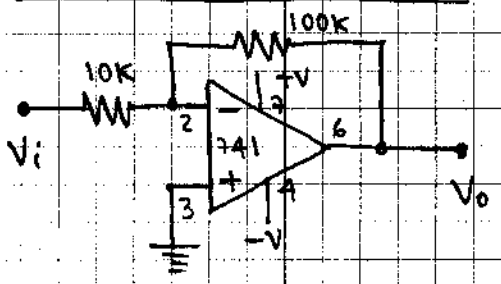
EL AMPLIFICADOR OPERACIONAL CONTINUACIÓN . . . APLICACIONES

LM741CN

EL MAS POPULAR IC AMP-OP
USADO PARA PROPÓSITOS GENERALES



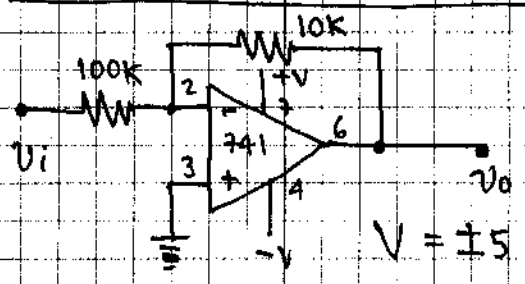
AMPLIFICADOR INVERSOR



$V = \pm 5$ A 18

$V_o = -10 V_i$

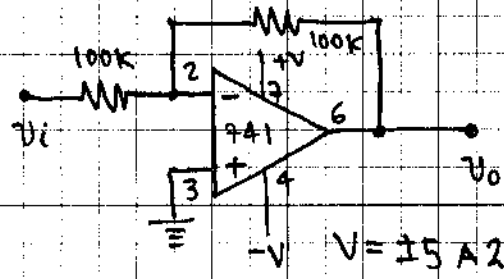
AMPLIFICADOR INVERSOR



$V = \pm 5$ A 18

$V_o = -0.1 V_i$

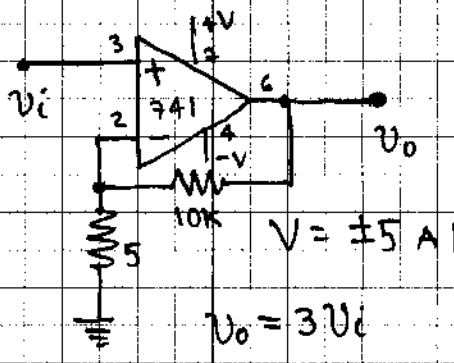
AMPLIFICADOR INVERSOR



$V = \pm 5$ A 24

$V_o = -V_i$

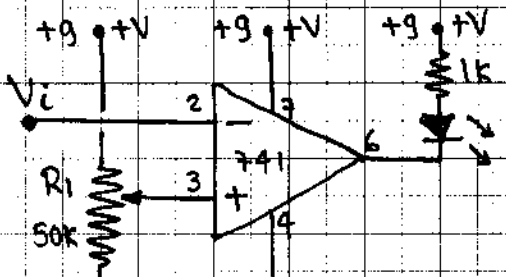
AMPLIFICADOR NO-INVERSOR



$V = \pm 5$ A 18

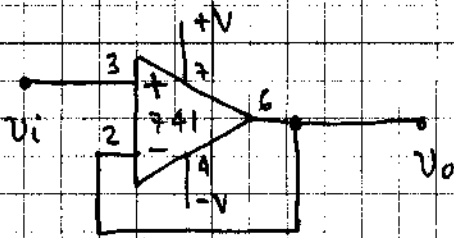
$V_o = 3 V_i$

DETECTOR DE NIVEL



R1: SE FIJA AL VOLTAJE NECESARIO DE DETECCIÓN, CON NIVEL DE UMBRAL MÁXIMO DE 9 V.

AMPLIFICADOR NO-INVERSOR GANANCIA UNITARIA - SEGUIDOR

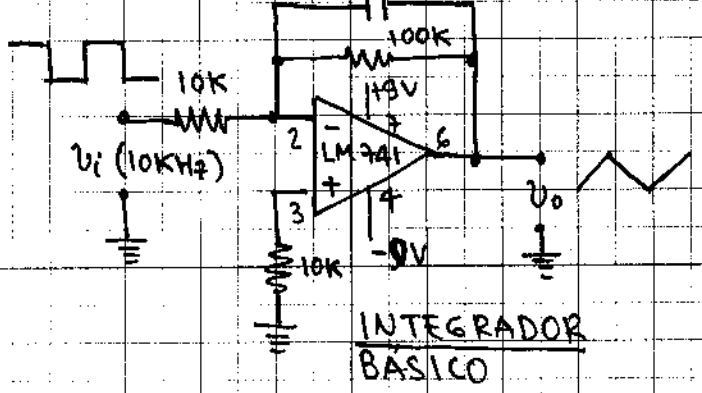


$V = \pm 5$ A 18

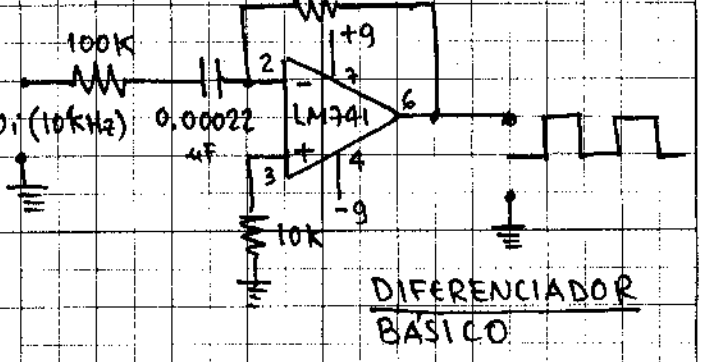
$V_o = V_i$

PAPEL MILIMETRADO HERALD

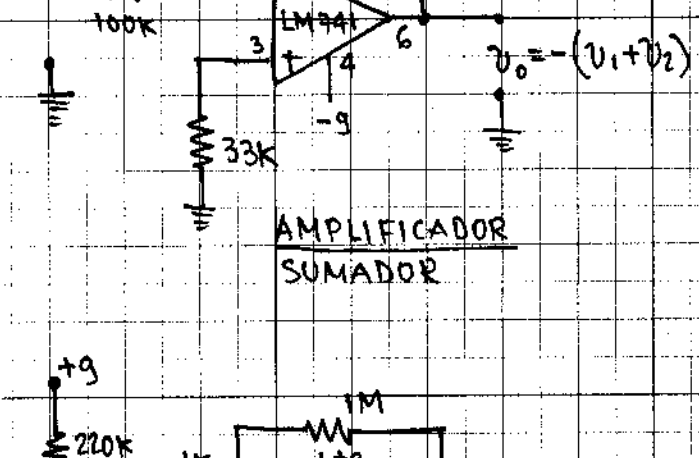
EL AMPLIFICADOR OPERACIONAL CONTINUACIÓN . . .



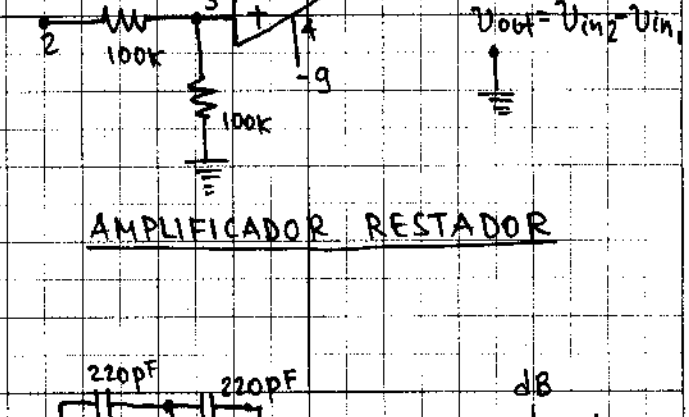
INTEGRADOR BÁSICO



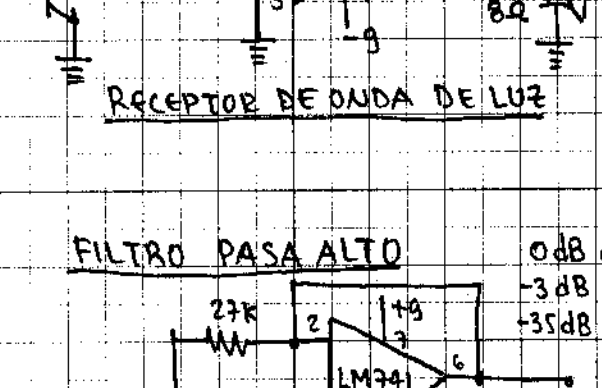
DIFERENCIADOR BÁSICO



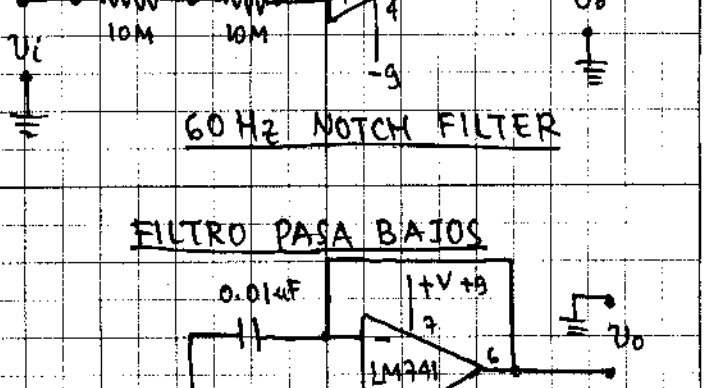
AMPLIFICADOR SUMADOR



AMPLIFICADOR RESTADOR



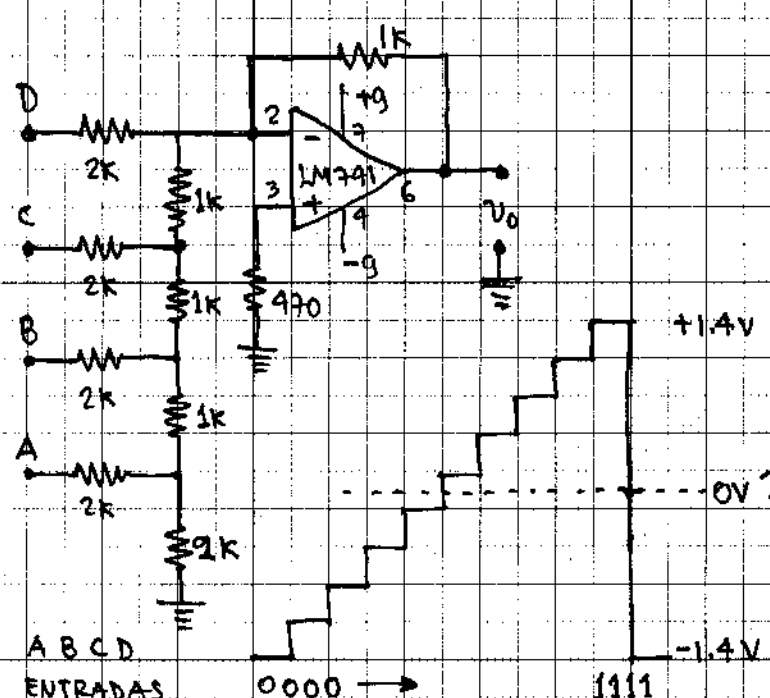
RECEPTOR DE ONDA DE LUZ



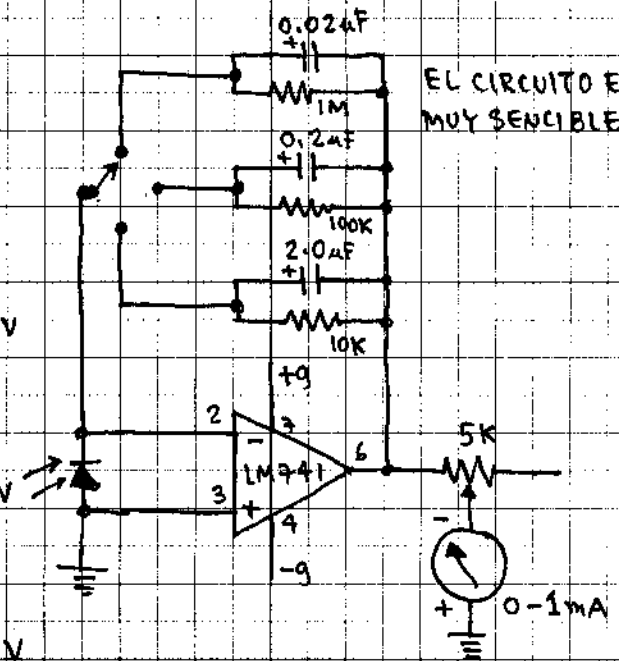
60 Hz NOTCH FILTER

PAPEL MILIMETRADO HERALD

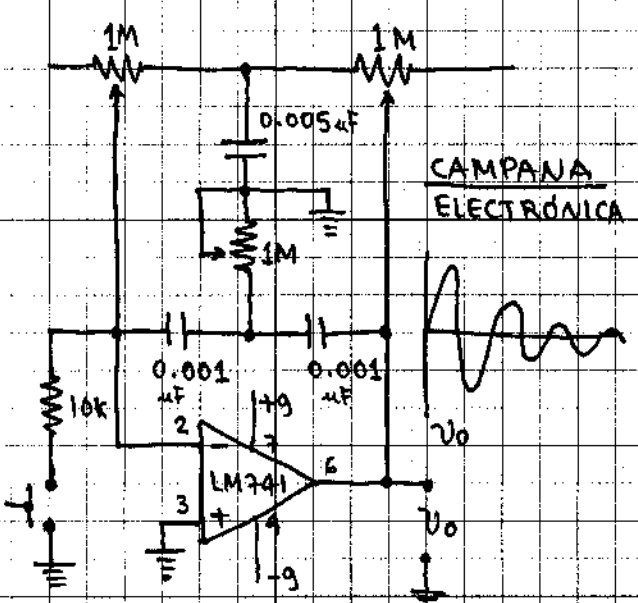
EL AMPLIFICADOR OPERACIONAL CONTINUACIÓN . . .



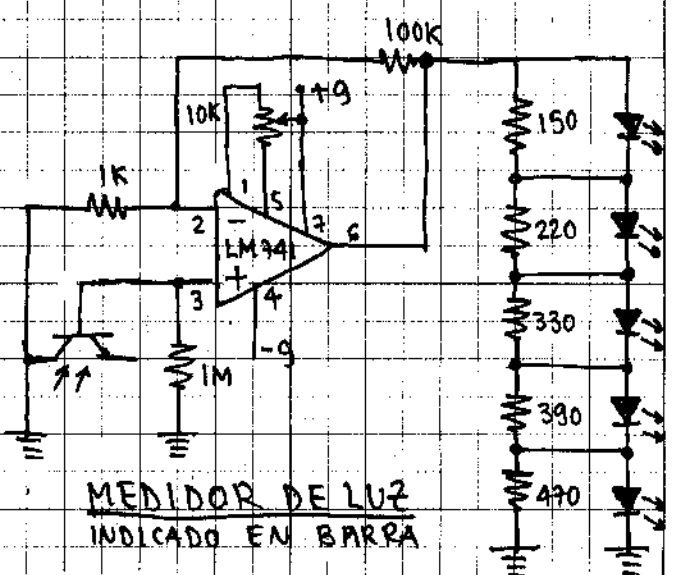
CONVERTIDOR D/A 4 BIT



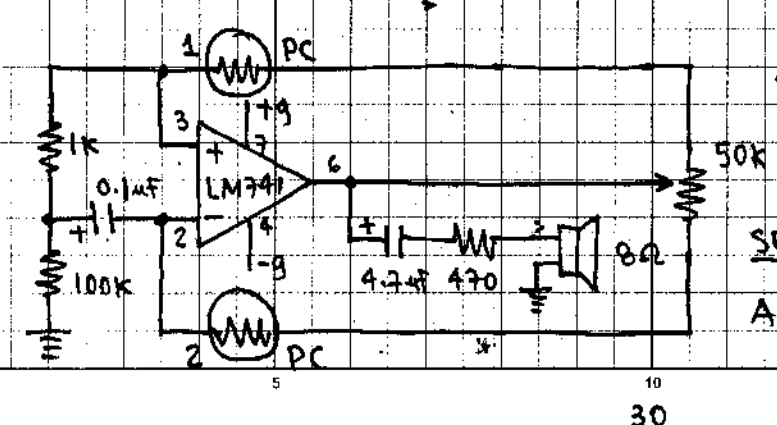
MEDIDOR DE POTENCIA ÓPTICA



CAMPANA ELECTRÓNICA



MEDIDOR DE LUZ
INDICADO EN BARRA



PC: FOTOCELDAS CdS

CON LUZ EN 1PC BAJA EL TONO

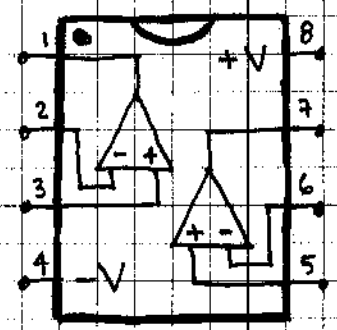
CON LUZ EN 2PC SUBE EL TONO

SENSOR DE LUZ AUDIBLE

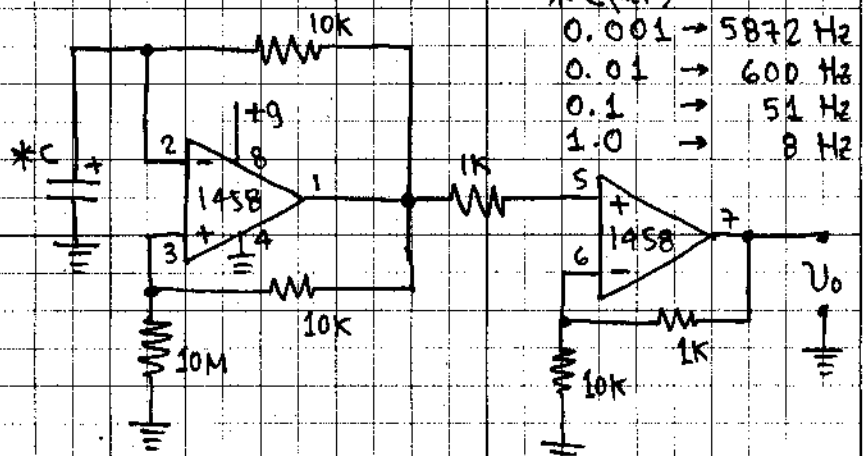
PAPEL MILIMETRADO HERALD

EL AMPLIFICADOR OPERACIONAL CONTINUACIÓN . . .

MC1458N



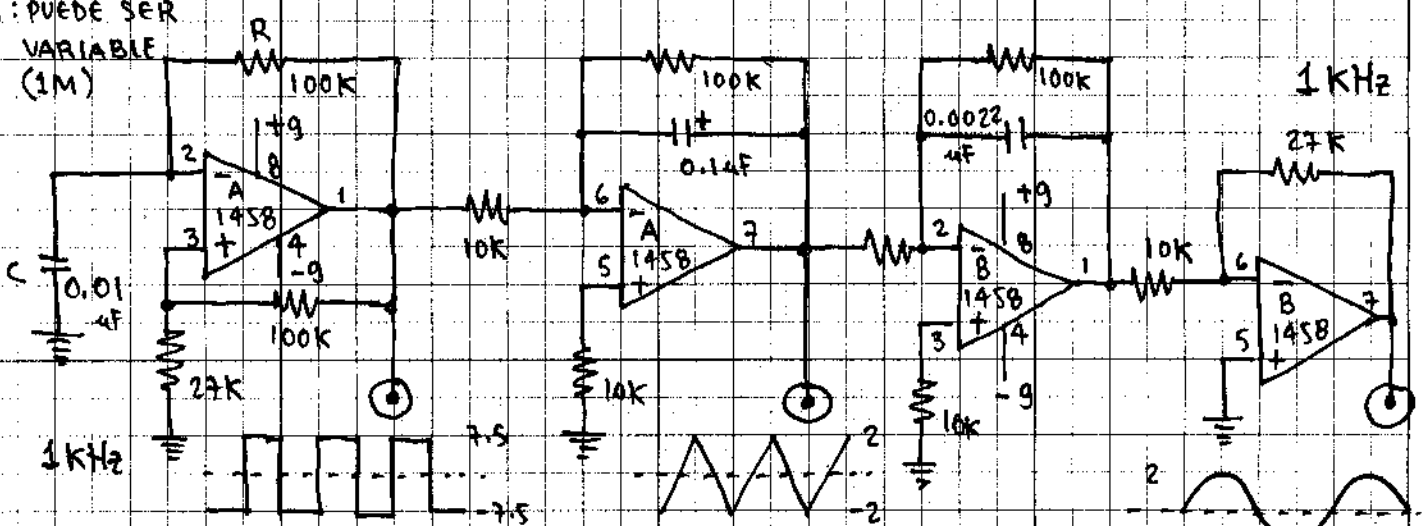
FUNCIONALMENTE ES IGUAL AL LM741N, SOLAMENTE QUE ES DUAL.



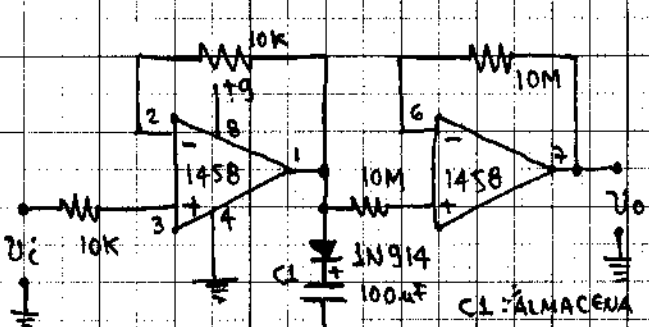
*C(μF)		
0.001	→	5872 Hz
0.01	→	600 Hz
0.1	→	51 Hz
1.0	→	8 Hz

GENERADOR DE PULSO

R: PUEDE SER VARIABLE (1M)

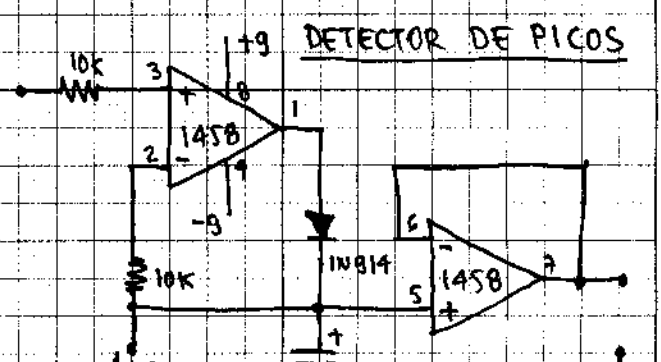


GENERADOR DE FUNCIONES



C1: ALMACENA EL VOLTAJE PICO

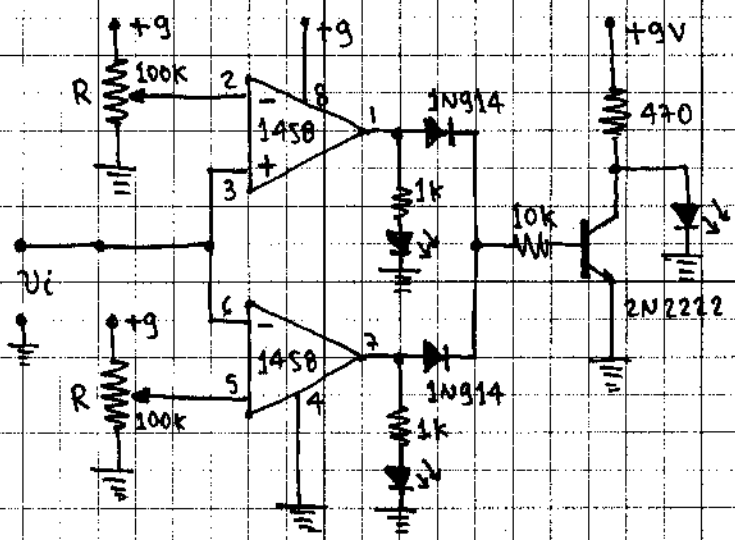
DETECTOR DE PICOS



DETECTOR DE PICOS

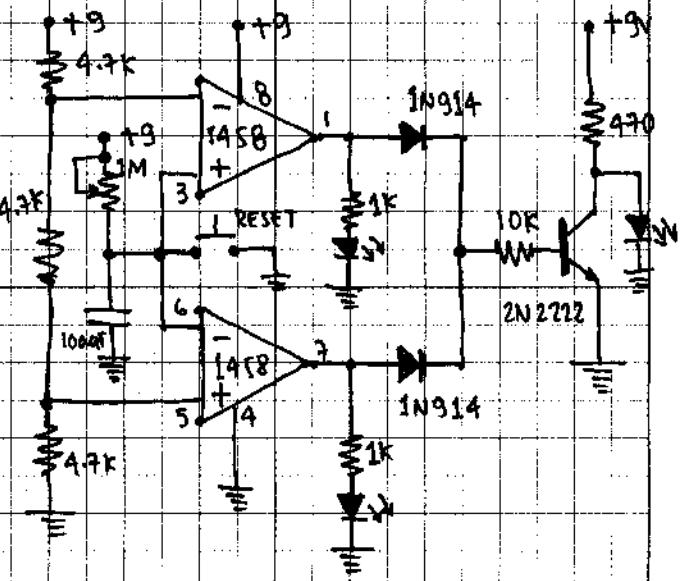
PAPEL MILIMETRADO HERALD

EL AMPLIFICADOR OPERACIONAL CONTINUACIÓN . . .



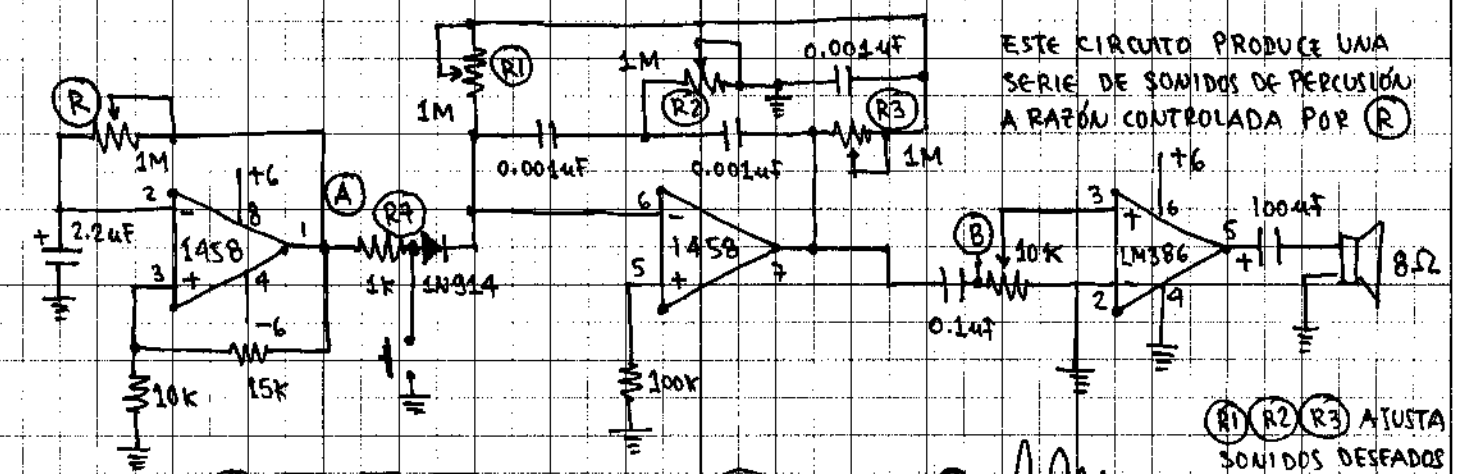
COMPARADOR DE VENTANA

EL VALOR DE R SE AJUSTA PARA OBTENER LOS VALORES DE REFERENCIA EN LA VENTANA



SECUENCIADOR DE 3 PASOS

USANDO COMPARADOR DE VENTANA



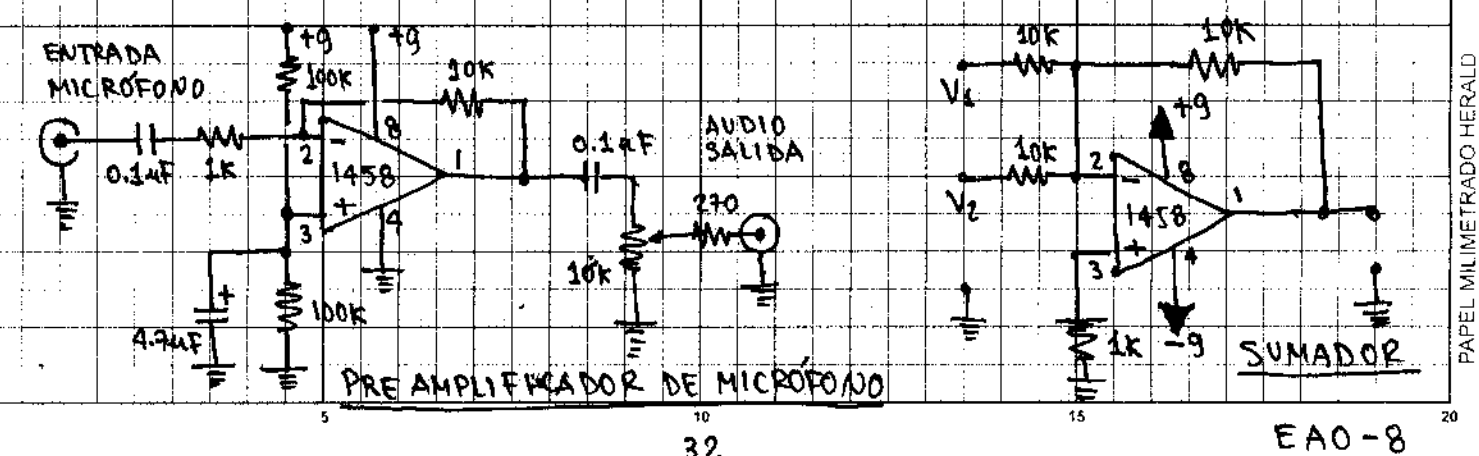
ESTE CIRCUITO PRODUCE UNA SERIE DE SONIDOS DE PERCUSIÓN A RAZÓN CONTROLADA POR (R)

(R1) (R2) (R3) AJUSTA SONIDOS DESEADOS

REMOVIENDO (R7) SE USA MANUAL.

(B) AL AMPLIFICADOR (OPCIÓN)

GENERADOR DE SONIDOS DE PERCUSIÓN SINTETIZADOS

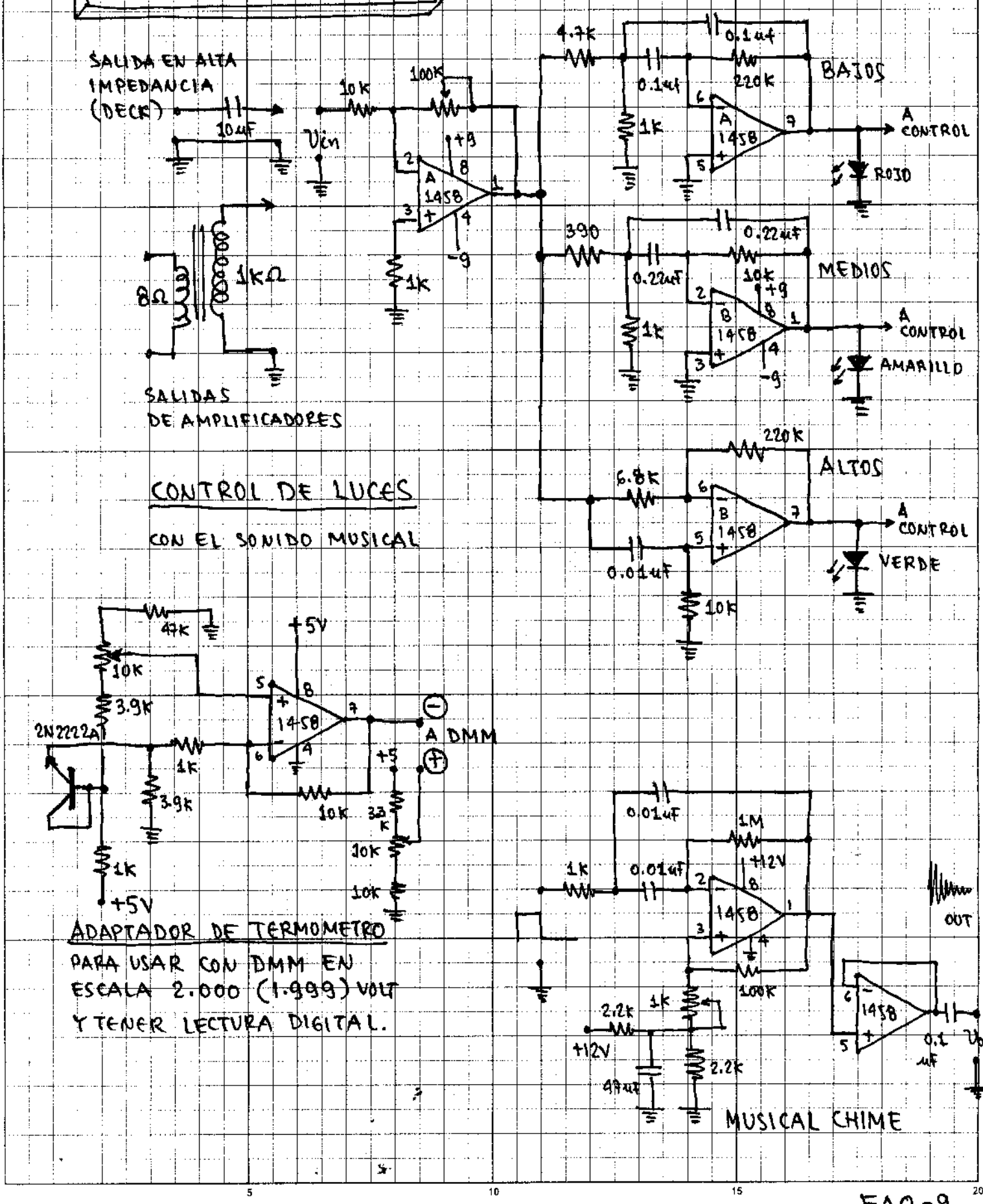


PRE AMPLIFICADOR DE MICRÓFONO

PAPEL MILIMETRADO HERALD

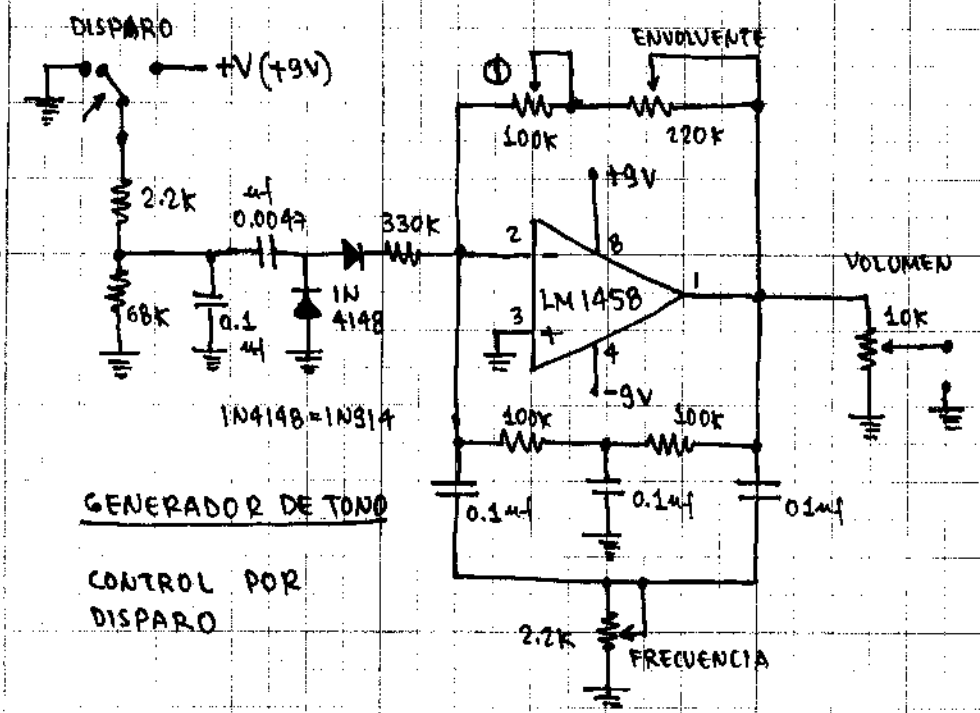
EL AMPLIFICADOR OPERACIONAL

CONTINUACIÓN . . .



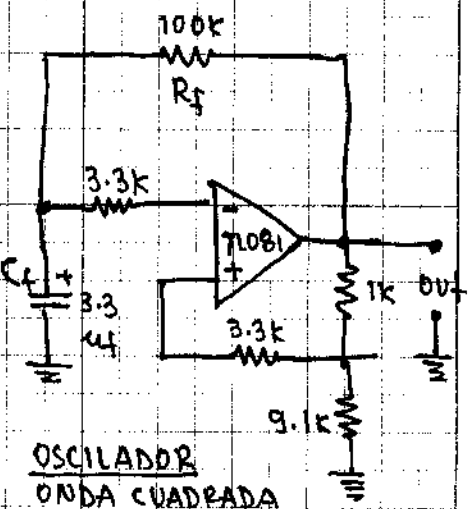
PAPEL MILIMETRADO HERALD

EL AMPLIFICADOR OPERACIONAL CONTINUACIÓN . . .



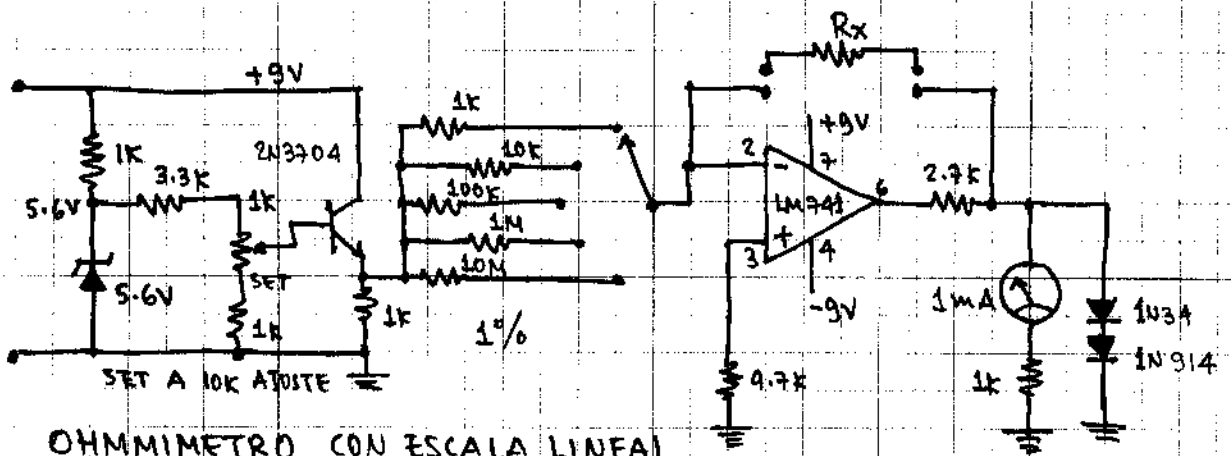
GENERADOR DE TONO

CONTROL POR DISPARO

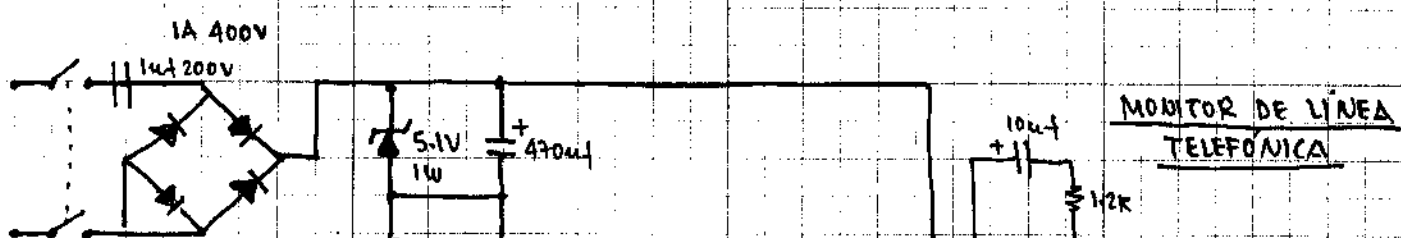


OSCILADOR ONDA CUADRADA

$$Hz\ 0.5 \approx f = \frac{1}{2\pi R_f C_f}$$



OHMMIMETRO CON ESCALA LINEAL

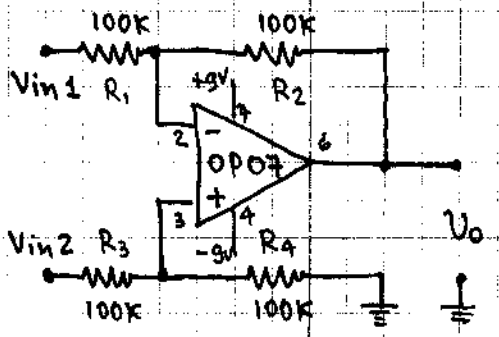


MONITOR DE LÍNEA TELEFÓNICA

PAPEL MILIMETRADO HERALD

EL AMPLIFICADOR OPERACIONAL

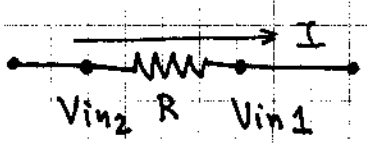
CONTINUACIÓN . . .



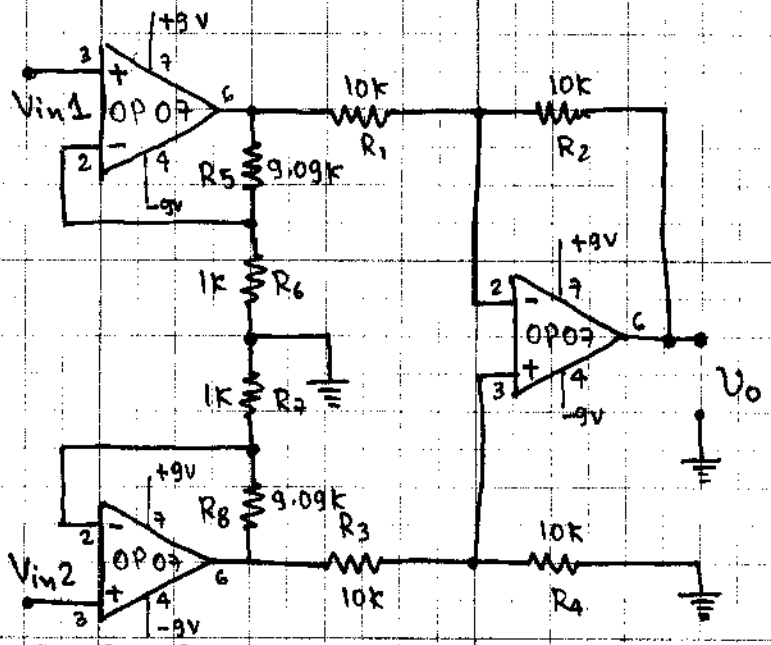
$R_1 = R_3$ y $R_2 = R_4$

$$V_o = (V_{in2} - V_{in1})\frac{R_2}{R_1}$$

AMPLIFICADOR RESTADOR



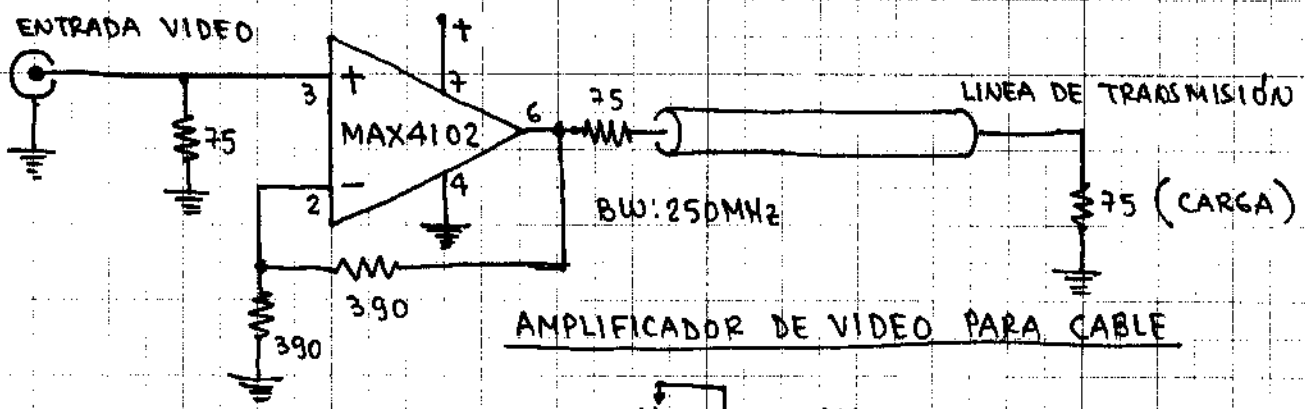
AMPLIFICADORES DE INSTRUMENTACIÓN



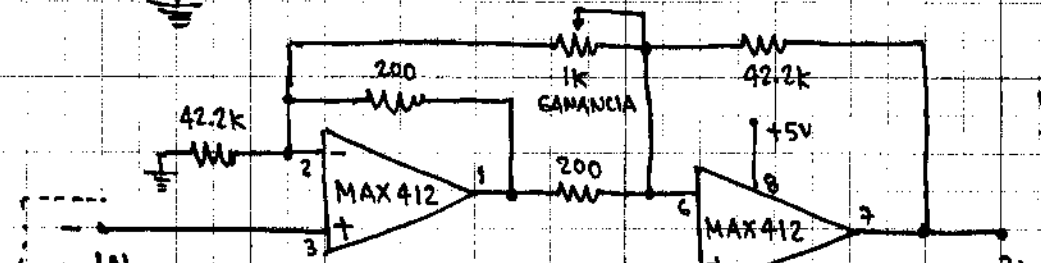
$R_1 = R_3 \quad R_2 = R_4 \quad R_5 = R_8 \quad R_6 = R_7$

$$V_o = (V_{in2} - V_{in1})\left[1 + \frac{R_5}{R_6}\right]\frac{R_2}{R_1}$$

AMPLIFICADOR RESTADOR



AMPLIFICADOR DE VIDEO PARA CABLE

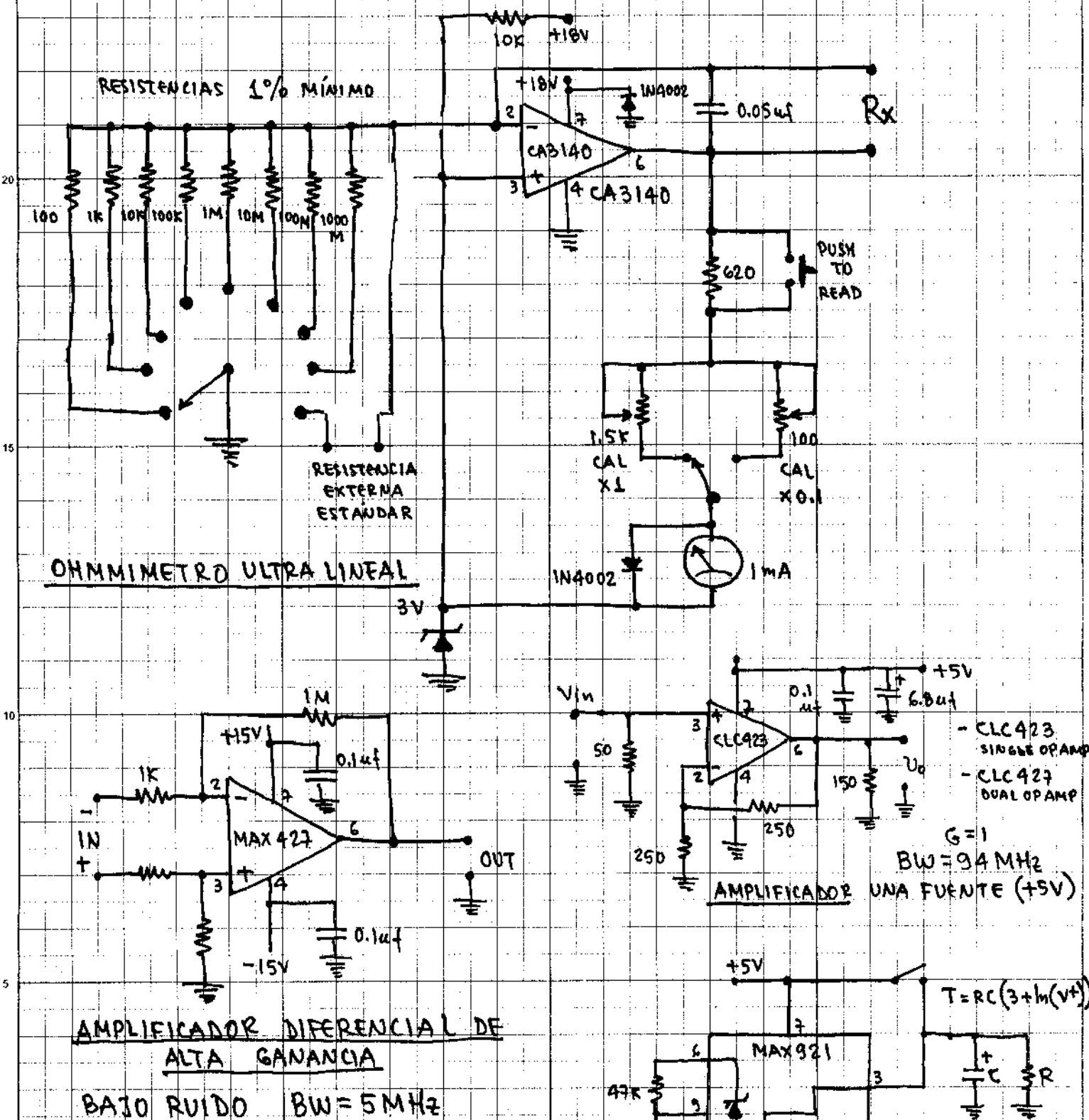


RESISTENCIAS SON DEL 1% MÁXIMO.

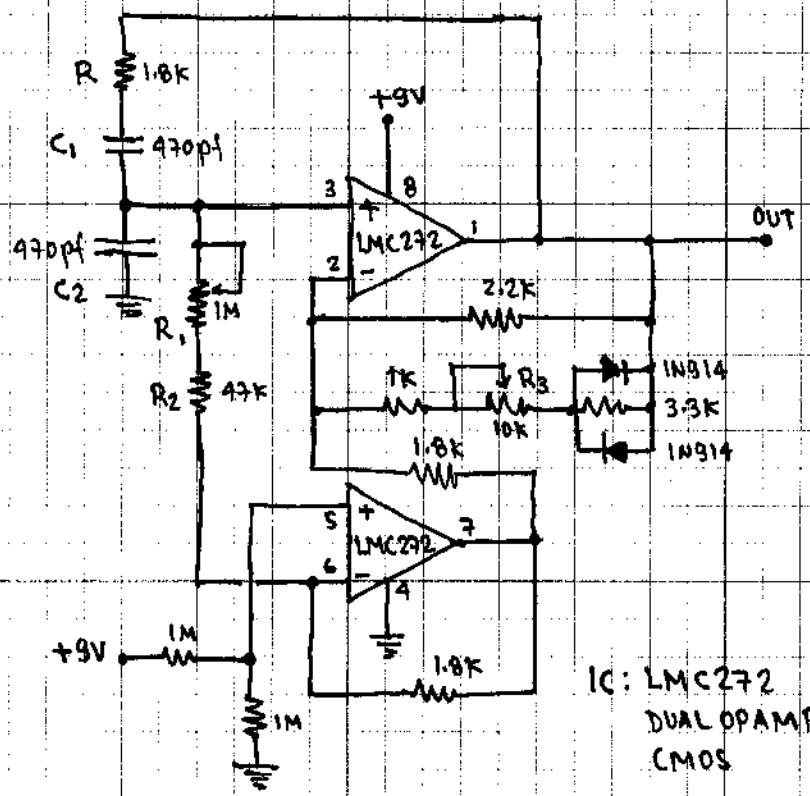
PODRÁ USAR IC's
MAX 410 (MONO)
MAX 414 (QUAD)

AMPLIFICADOR DE DIFERENCIA DE INSTRUMENTACIÓN

EL AMPLIFICADOR OPERACIONAL CONTINUACIÓN...



EL AMPLIFICADOR OPERACIONAL CONTINUACIÓN



OSCILADOR PUENTE DE WEIN

CONTROL Y AJUSTE DE FRECUENCIA R_1

CONTROL Y AJUSTE DE AMPLITUD R_3

$$f_{osc} \approx \frac{1}{2\pi\sqrt{C_1 C_2 R (R_1 + R_2)}}$$

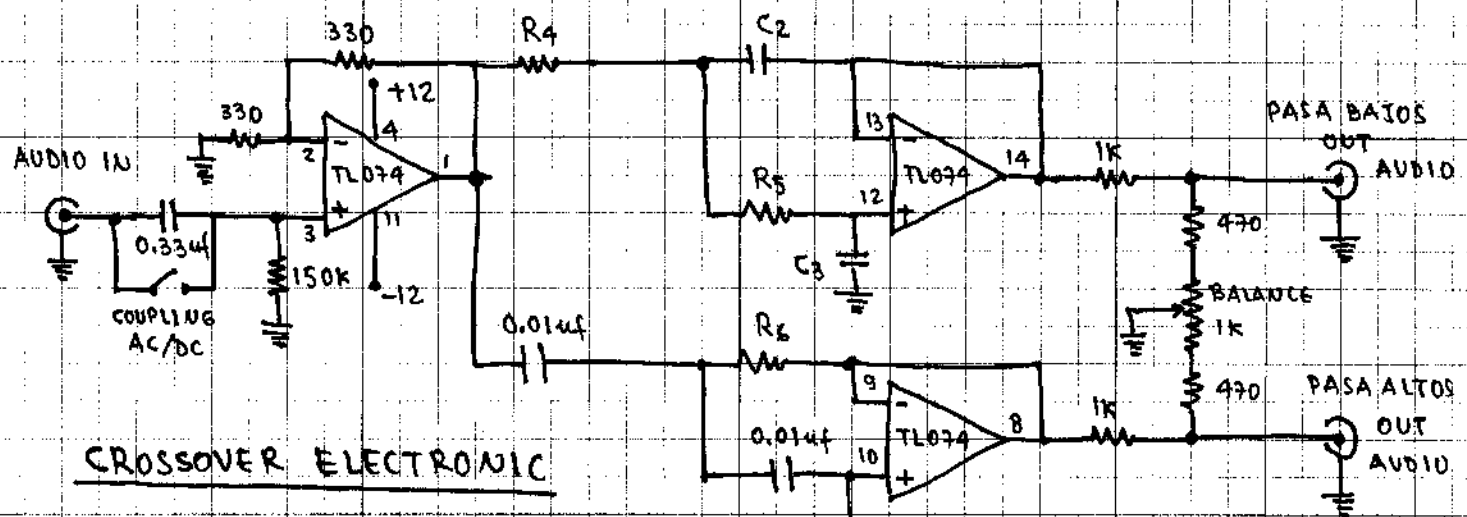
Rango de frecuencia

6.4 KHz A 30 KHz

Rango de amplitud

2.8 Vpp A 8.6 Vpp

IC: LMC272
DUAL OPAMP
CMOS



CROSSOVER ELECTRONIC

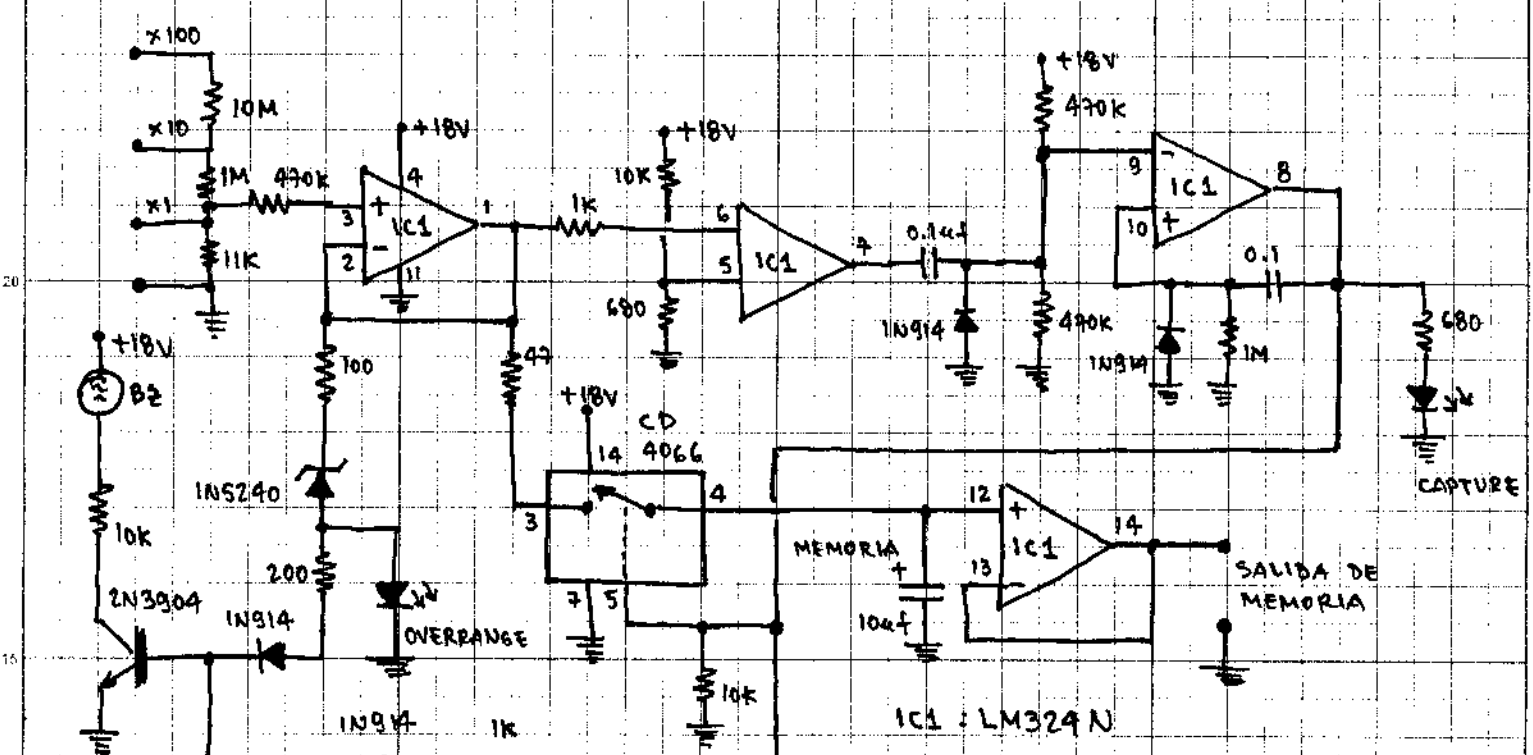
FREQ (Hz)	R4 = R5	R6	R7	C2	C3
750	15K	15K	30K	0.002	0.01
1000	10.2K	11.25K	22.51K	0.002	0.01
1250	8.2K	9K	1.8K	0.01	0.005
1500	15K	7.5K	15K	0.022	0.01
2000	5.1K	5.62K	11.25K	0.01	0.005
2500	8.2K	4.5K	9K	0.01	0.005
3000	15.0K	3.75K	7.5K	0.005	0.0025
Hz	Ω	Ω	Ω	μF	μF

SALIDAS
CONECTARSE A LINE IN
DE LOS POWER AMP.
2 CANALES

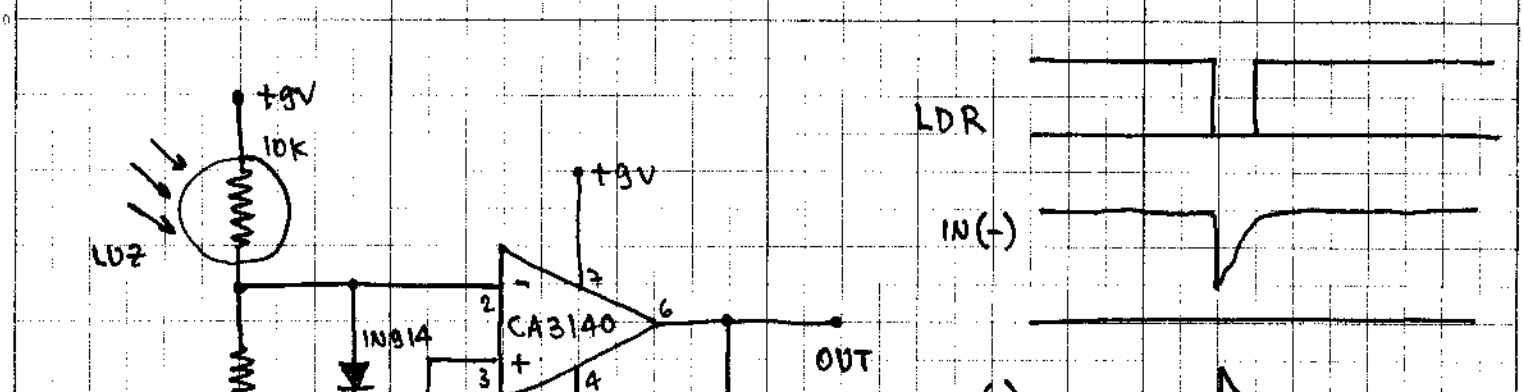
ENTRADA
MONOAURAL

PAPEL MILIMETRADO HERALD

EL AMPLIFICADOR OPERACIONAL CONTINUACIÓN . . .



MEMORIA DE SEÑAL ANALÓGICA



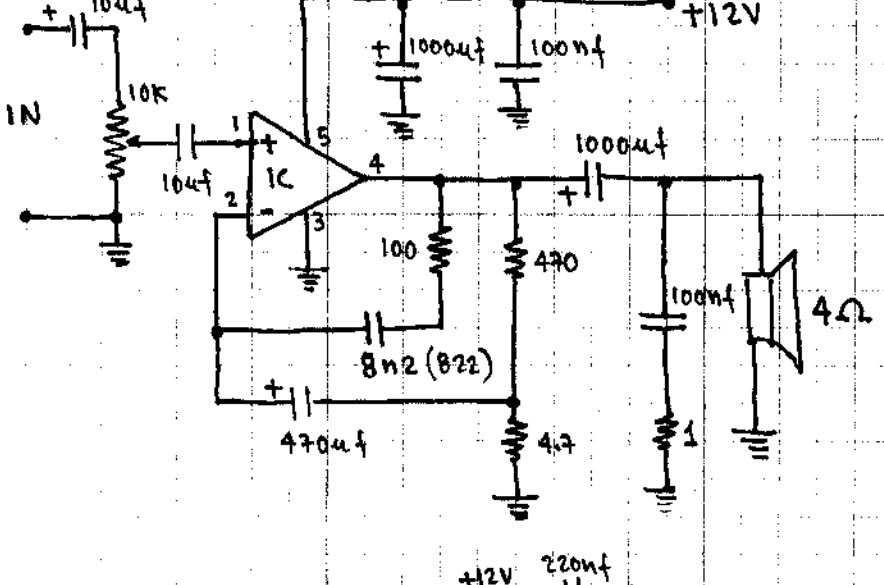
CONTROL ACTIVADO POR LUZ

PAPEL MILIMETRADO HERALD

AMPLIFICADOR DE AUDIO

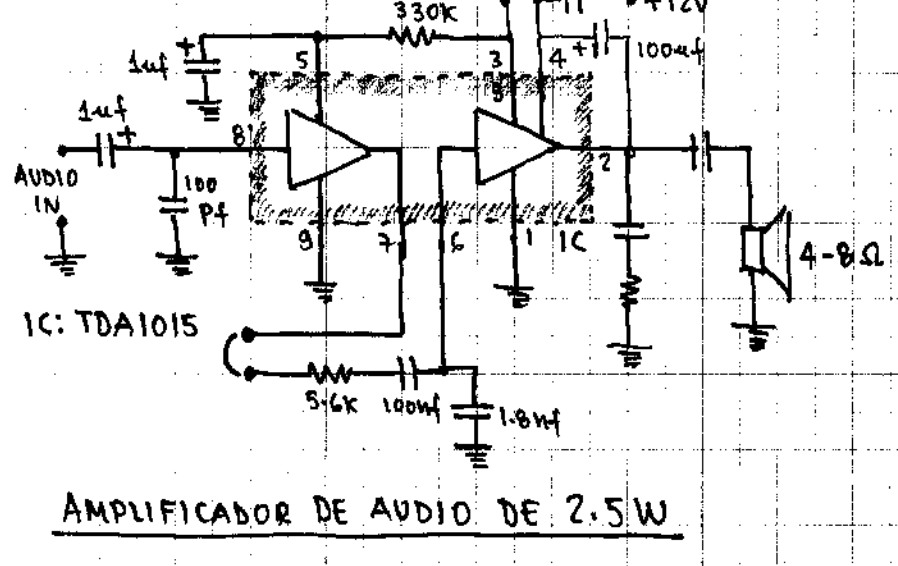
PAPEL MILIMETRADO HERALD

AMPLIFICADORES DE AUDIO

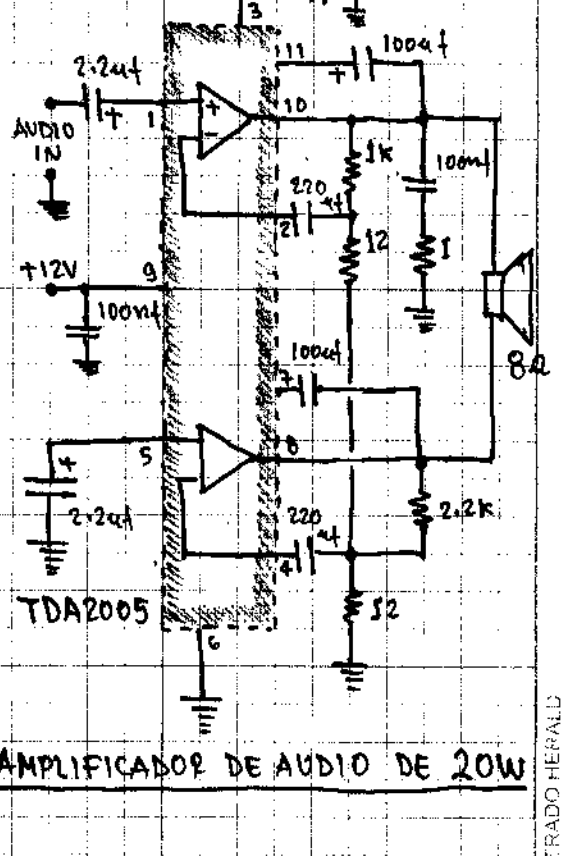


AMPLIFICADOR DE AUDIO

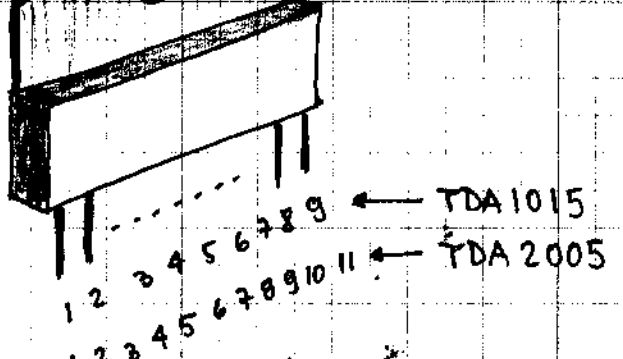
	LM383T (LM2002)	7W
IC	TDA2002	6W
	TDA2003	8W



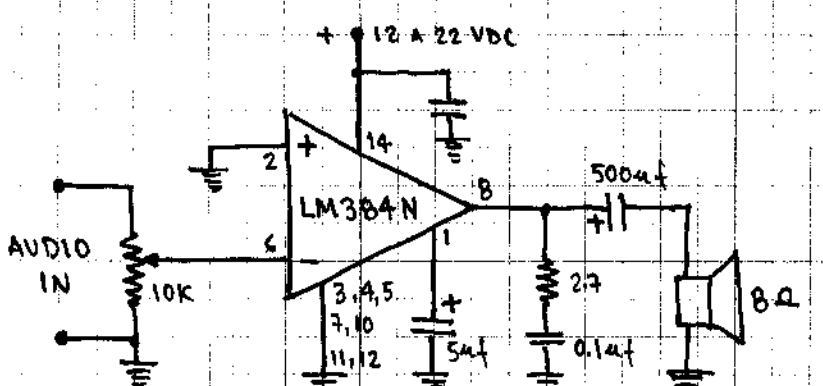
AMPLIFICADOR DE AUDIO DE 2.5W



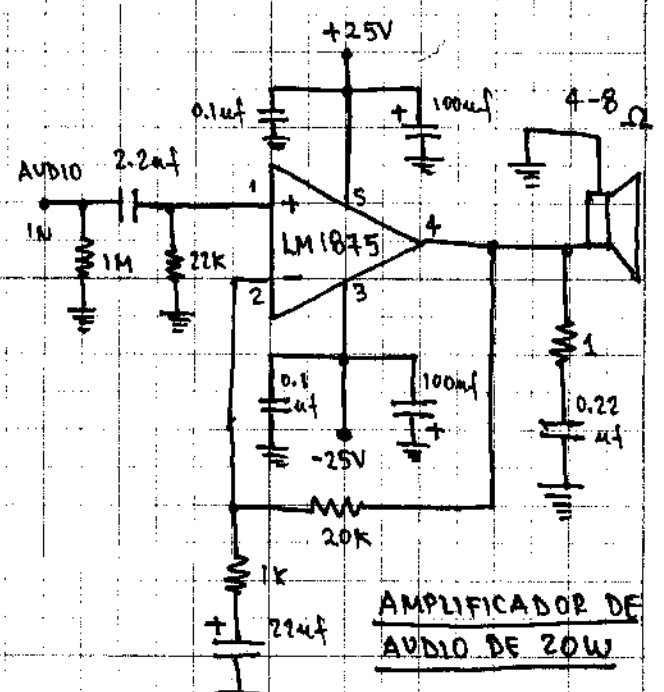
AMPLIFICADOR DE AUDIO DE 20W



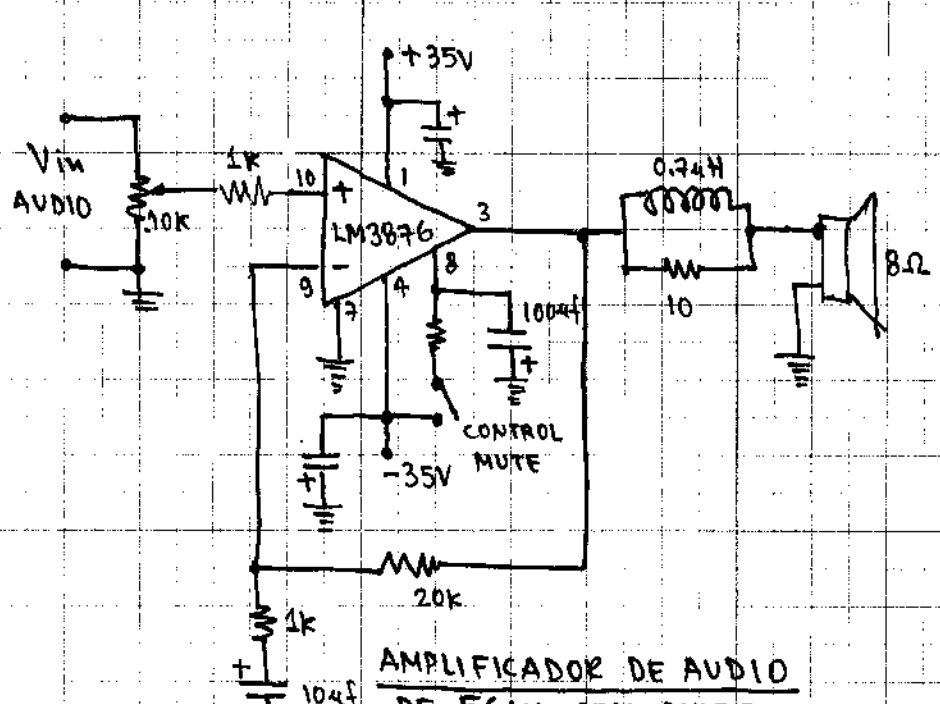
AMPLIFICADORES DE AUDIO CONTINUACIÓN . . .



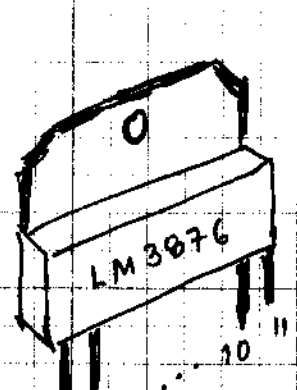
AMPLIFICADOR DE AUDIO DE 5W

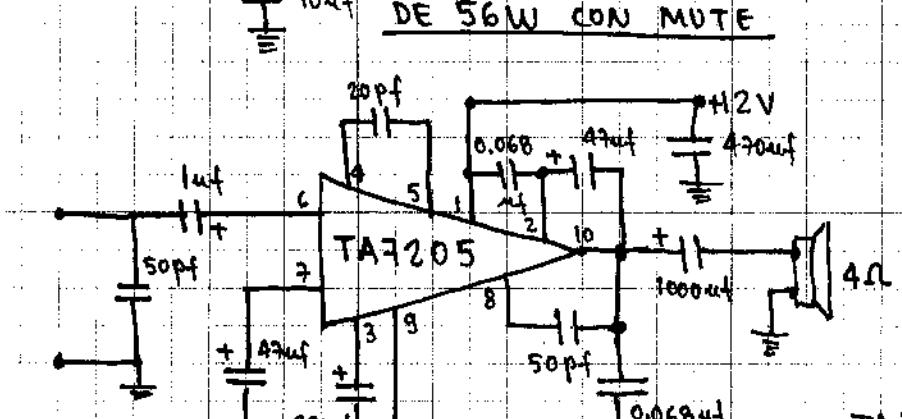


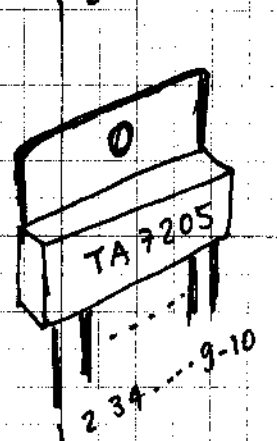
AMPLIFICADOR DE AUDIO DE 20W



AMPLIFICADOR DE AUDIO DE 56W CON MUTE





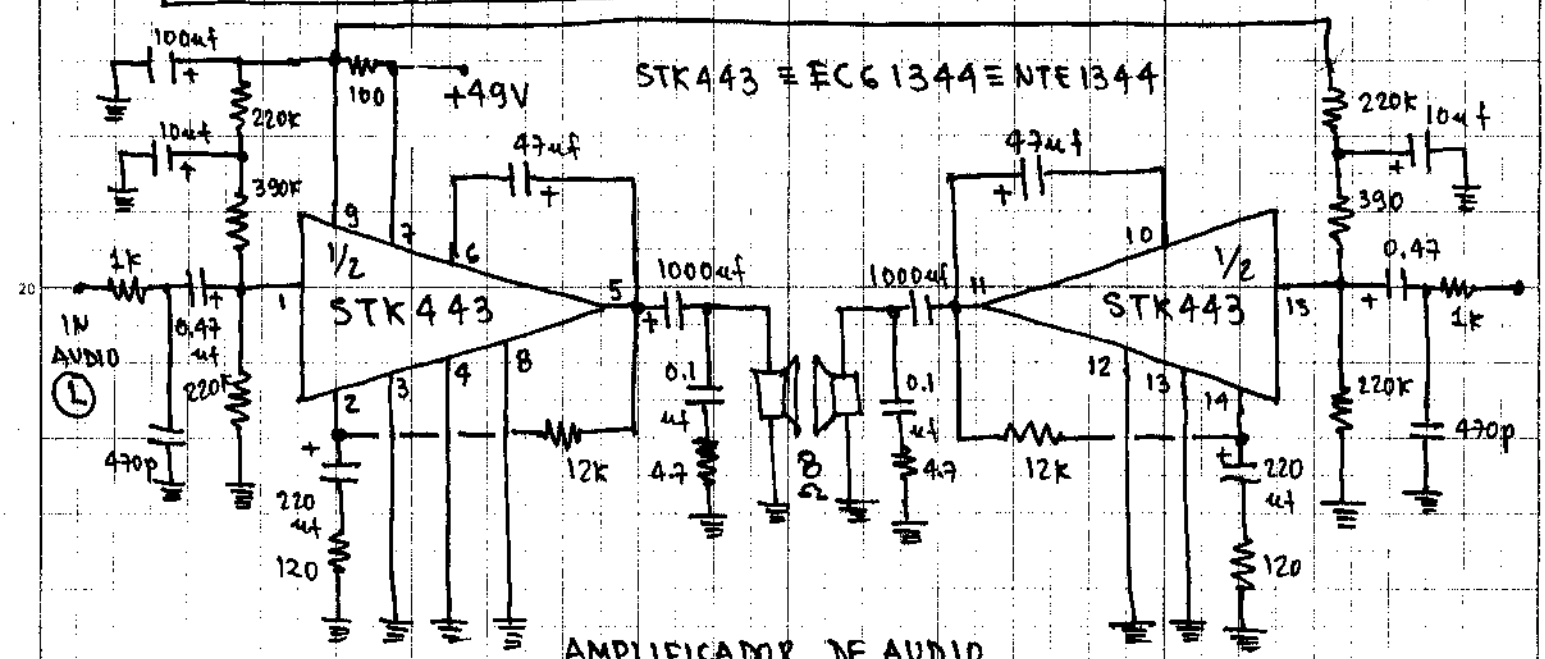


TA7205
≡ECG/NTE 1155
≡TA8205

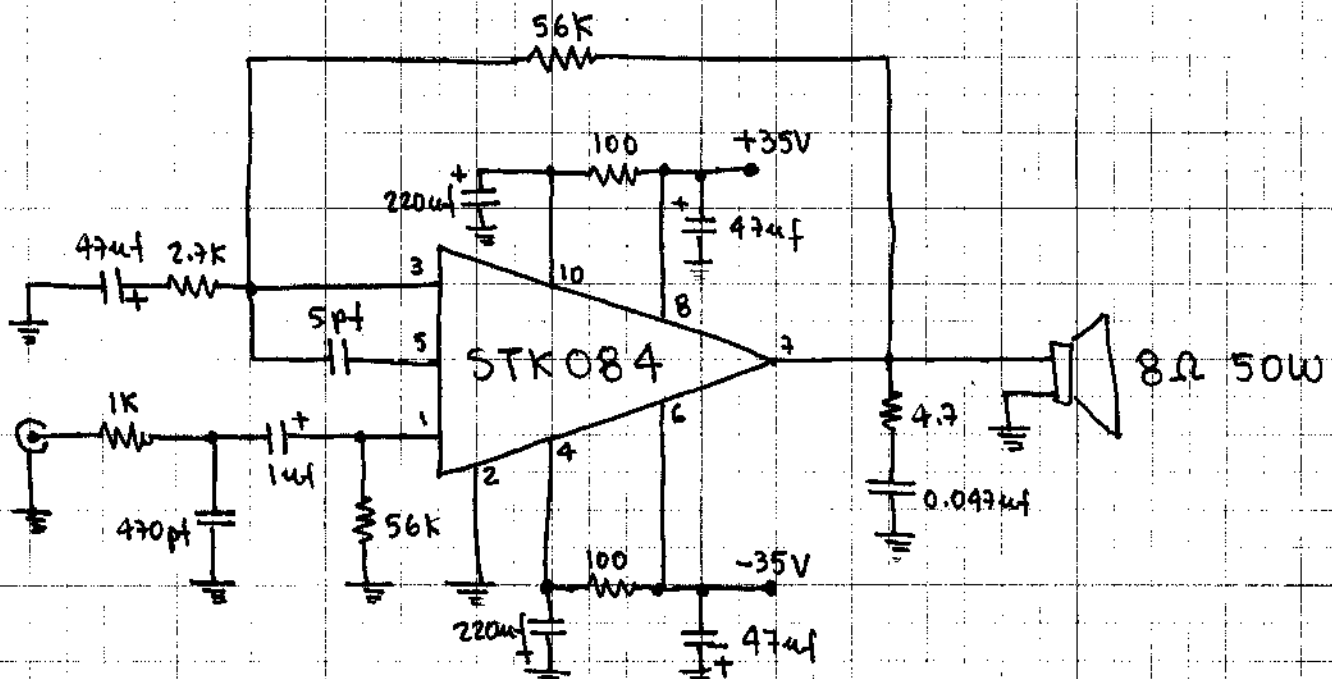
AMPLIFICADOR DE AUDIO 5-8 W

AMPLIFICADORES DE AUDIO

CONTINUACIÓN . . .



AMPLIFICADOR DE AUDIO ESTEREO DE 25W/CANAL



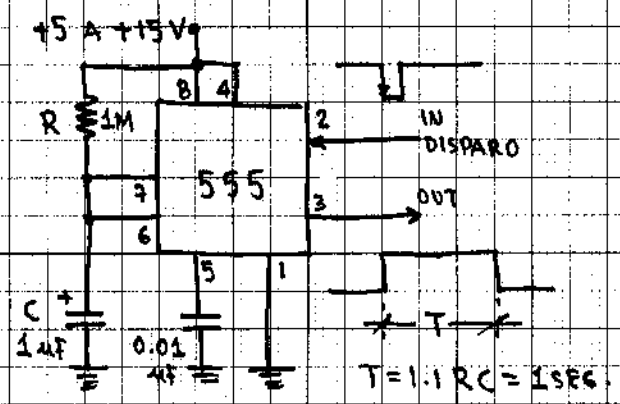
AMPLIFICADOR DE AUDIO MONOAURAL DE 50W

PAPEL MILIMETRADO HERALD

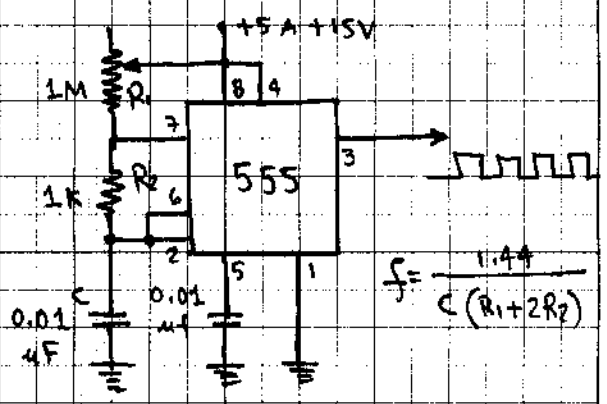
APLICACIONES LINEALES

PAPEL MILIMETRADO HERAS

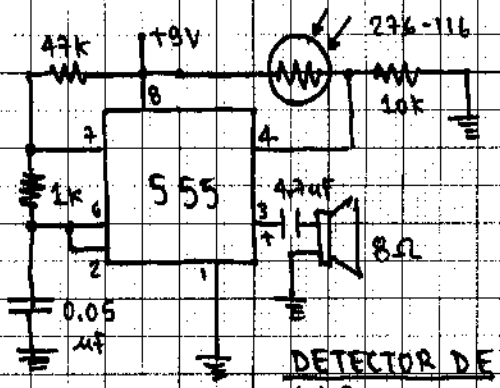
APLICACIONES LINEALES



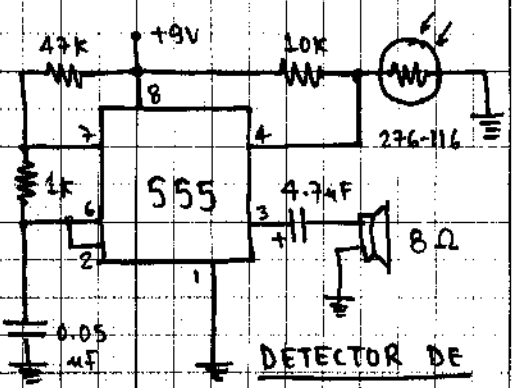
ONE SHOT TIMER



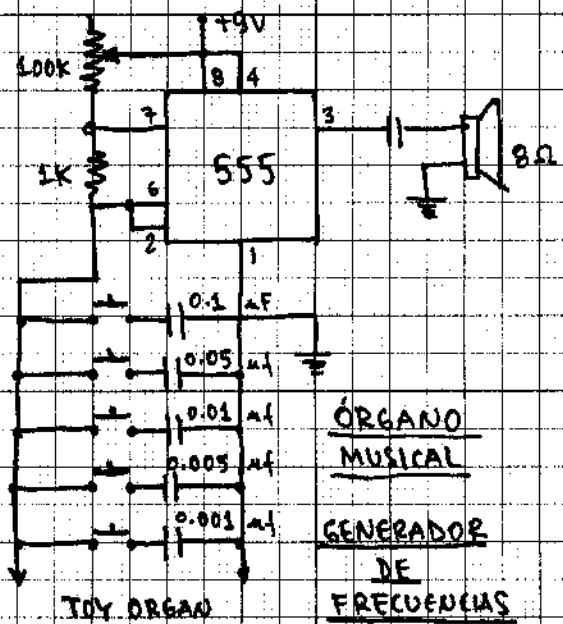
GENERADOR DE PULSO



DETECTOR DE LUZ

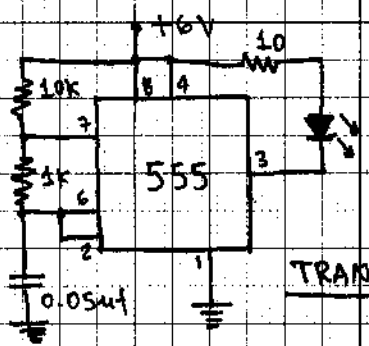


DETECTOR DE OSCURIDAD



ÓRGANO MUSICAL

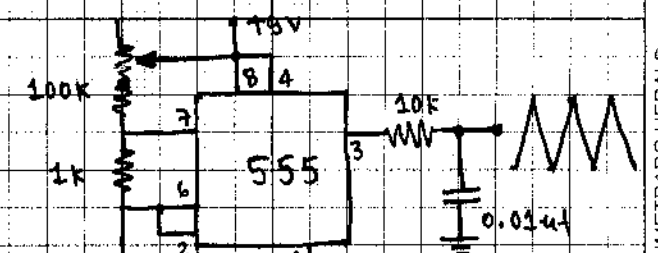
GENERADOR DE FRECUENCIAS



LED INFRAROJO

f: 4.8KHz

TRANSMISOR IR-LED

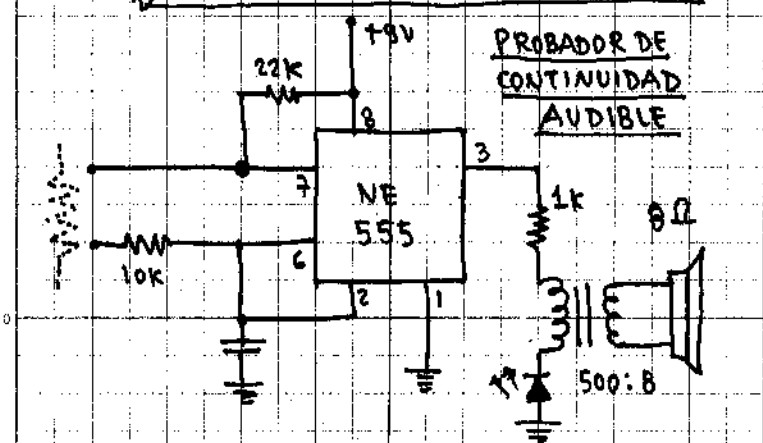


GENERADOR ONDA TRIANGULAR

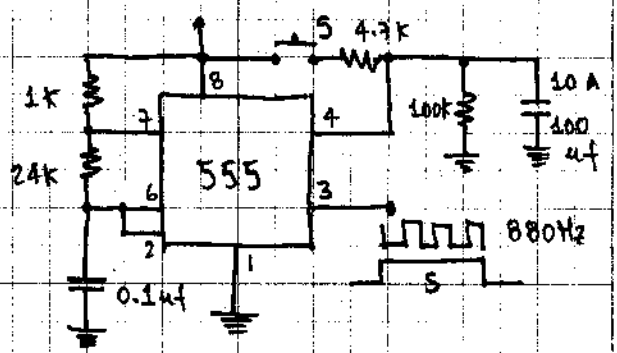
PAPEL MILIMETRADO HERALD

APLICACIONES LINEALES

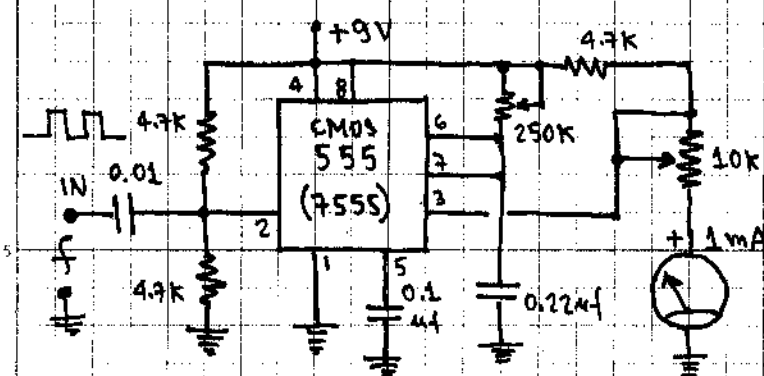
CONTINUACIÓN . . .



PROBADOR DE CONTINUIDAD AUDIBLE

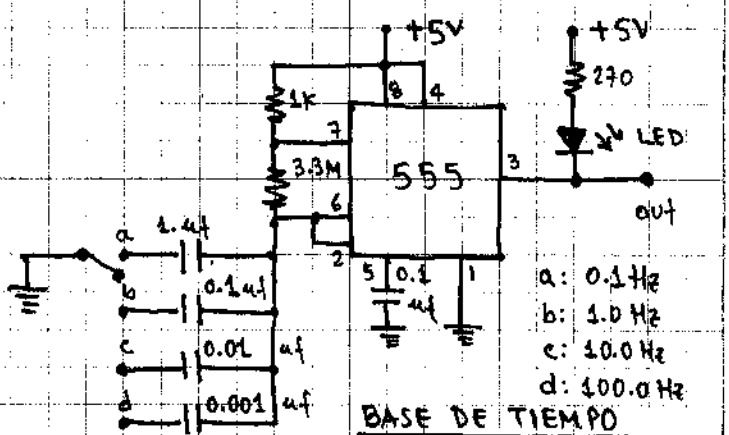


GENERADOR DE RÁFAGA DE TONOS
ONE-SHOT TONE BURST



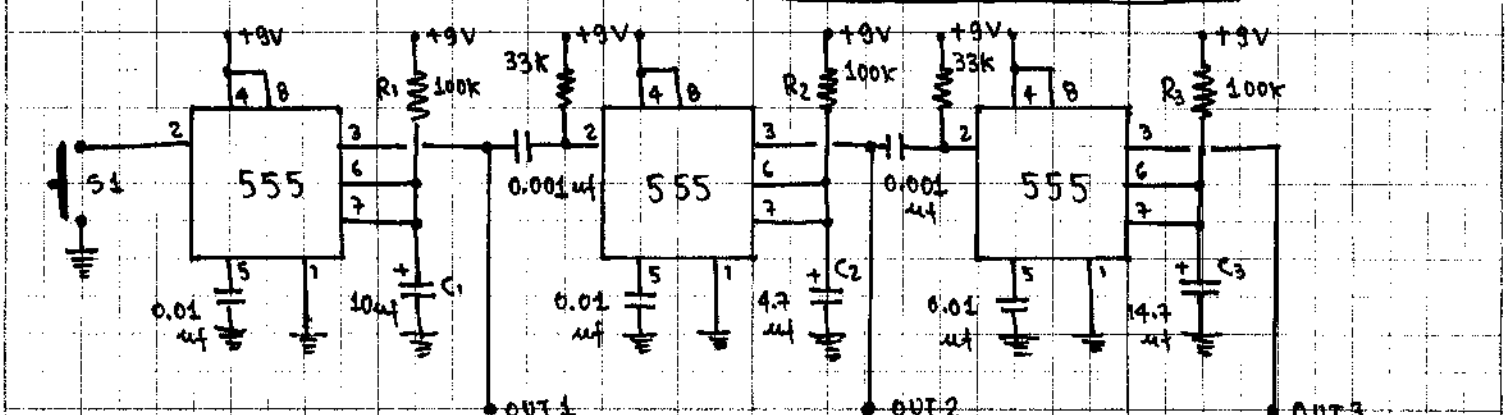
R:250K : CALIBRACIÓN
R:10K : AJUSTE CERO

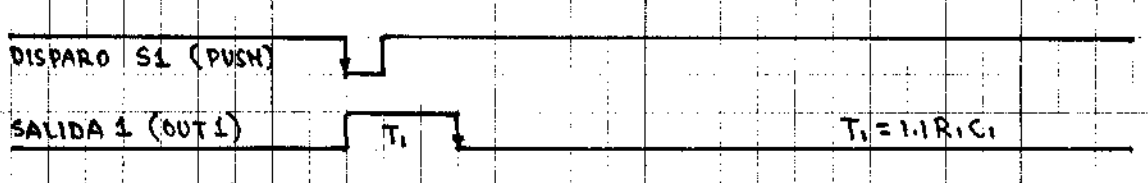
MEDIDOR DE FRECUENCIA



BASE DE TIEMPO

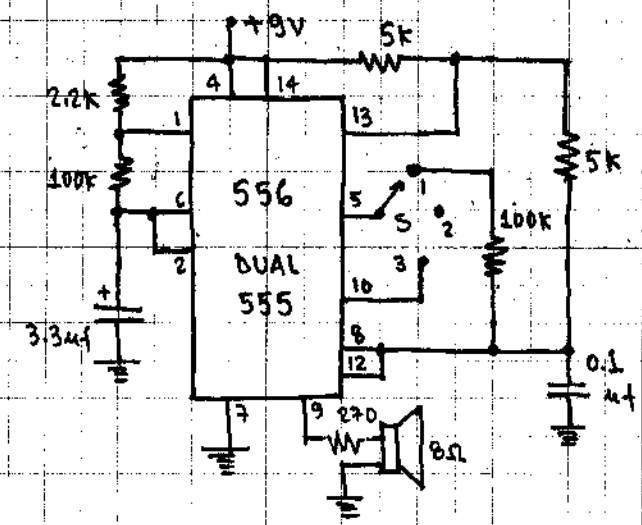
SECUENCIADOR DE TIEMPO



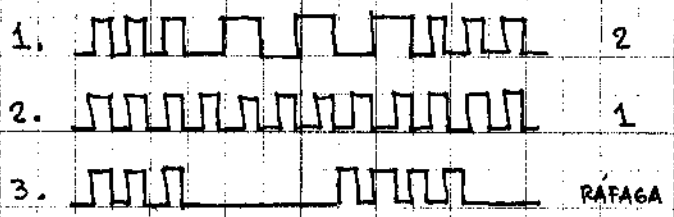


PAPEL MILIMETRADO HERALD

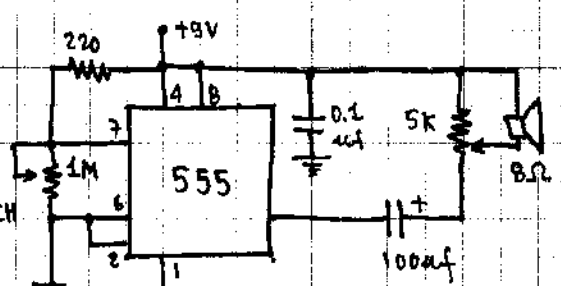
APLICACIONES LINEALES CONTINUACIÓN . . .



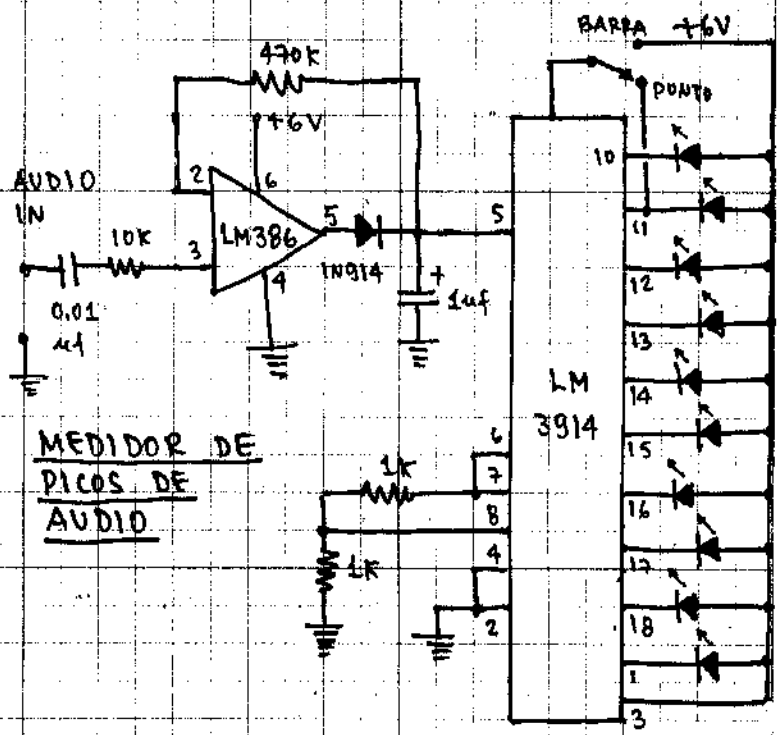
POSICIÓN S:



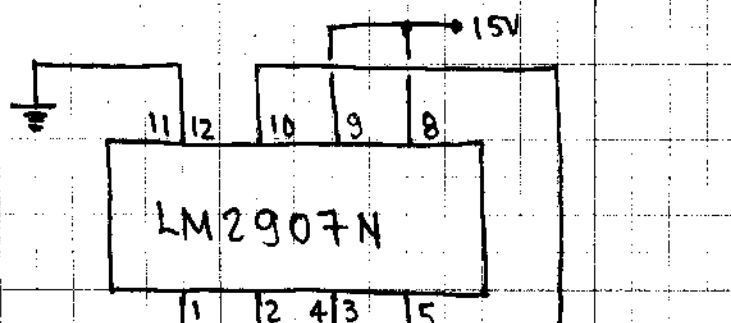
GENERADOR DE EFECTOS DE TONOS



REPELENTE DE MOSQUITOS



MEDIDOR DE PICOS DE AUDIO



CONVERTIDOR DE FRECUENCIA A VOLTAJE

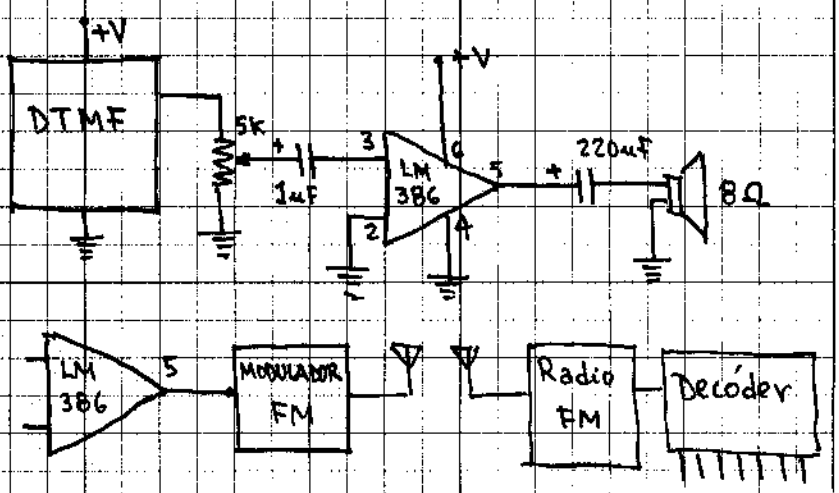
$V_{OUT} = 67Hz \times V$

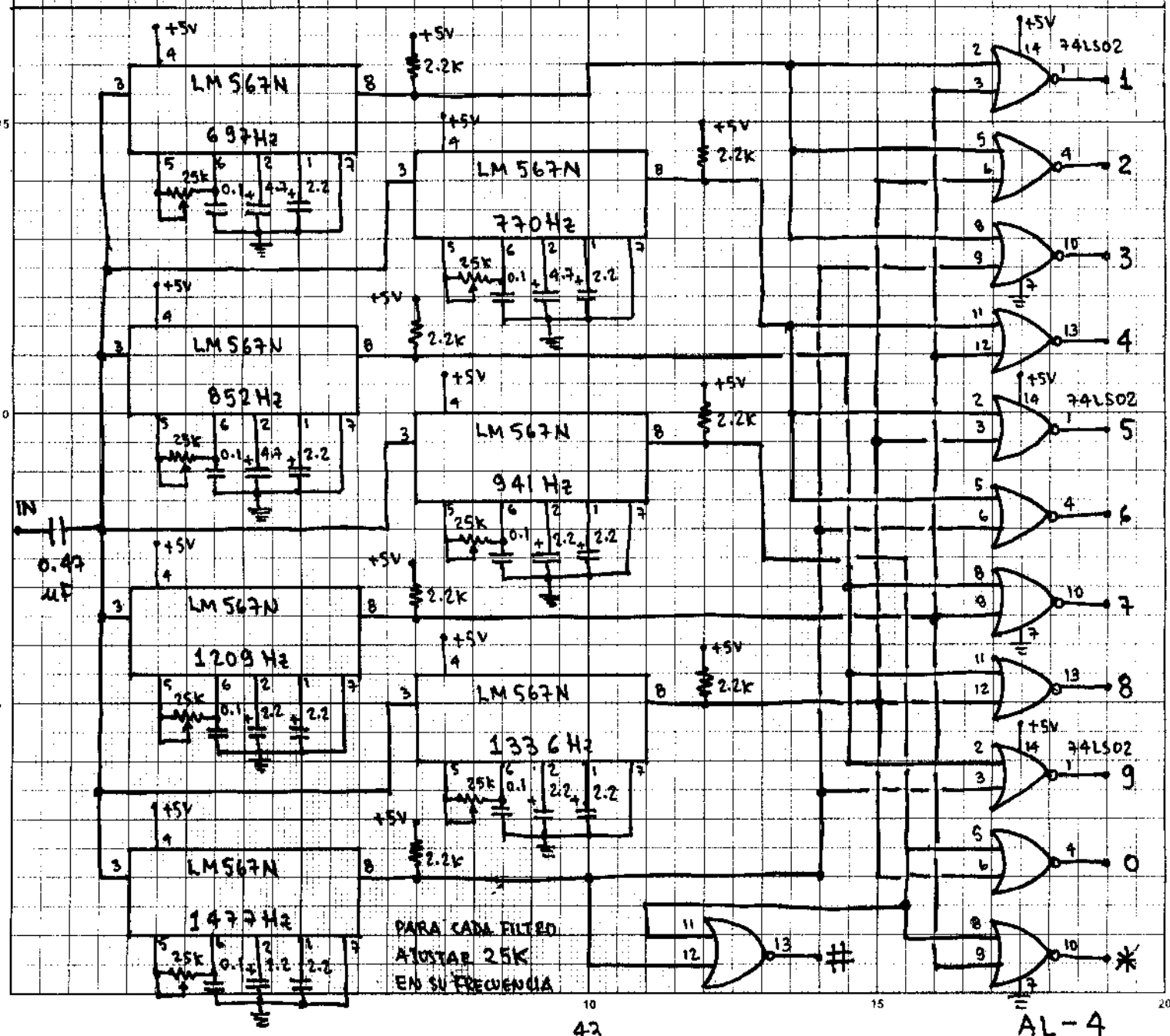
PAPEL MILIMETRADO HERALD

TOUCH-TONE CODER - DECODER

↓ Hz →	1209	1336	1477	1633
697	1	2	3	A
770	4	5	6	B
852	7	8	9	C
941	*	0	#	D

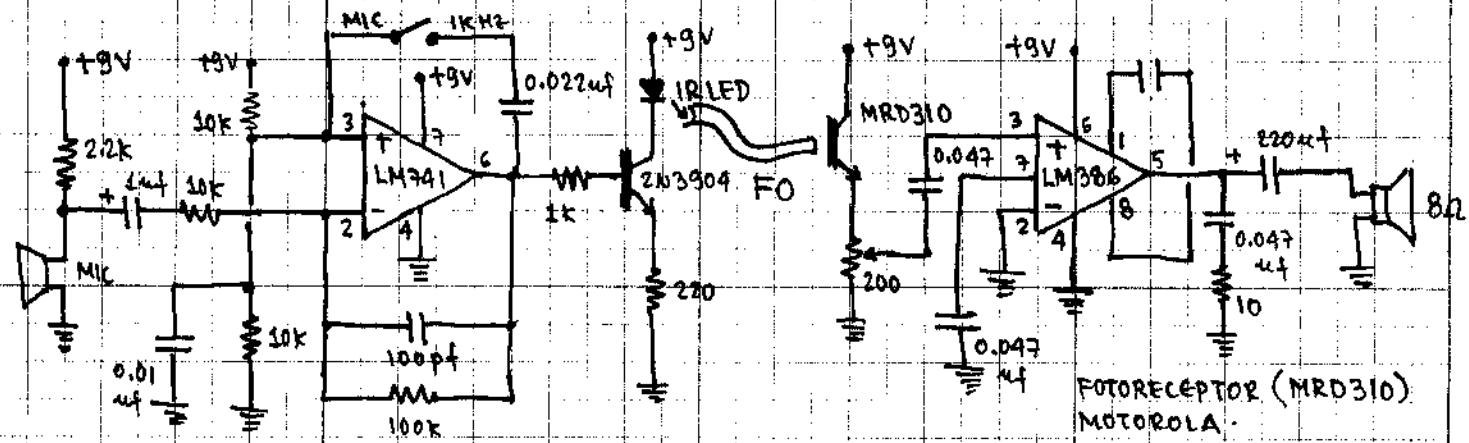
CÓDIGO DTMF (SALIDA TELÉFONO)



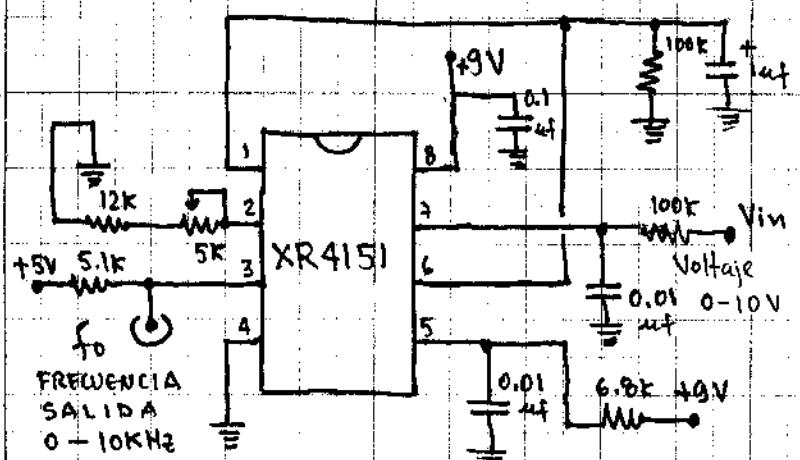


PAPEL MILIMETRADO HERALD

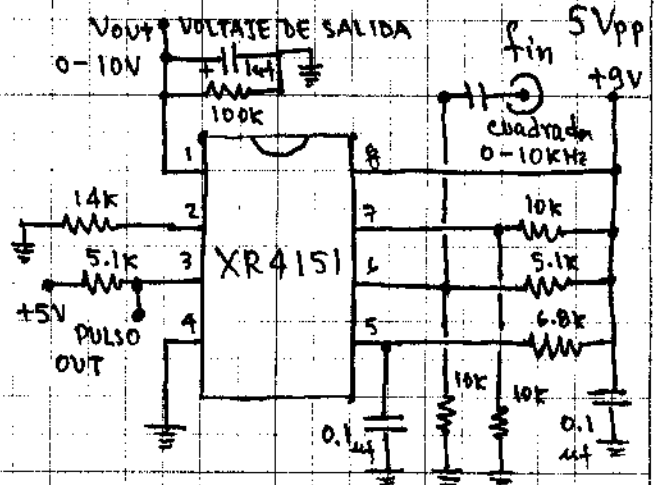
APLICACIONES LINEALES CONTINUACIÓN . . .



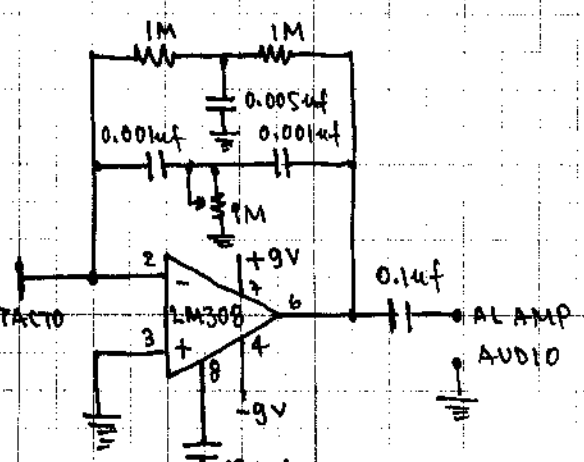
ENLACE DE FIBRA ÓPTICA o SOLO INFRARROJO



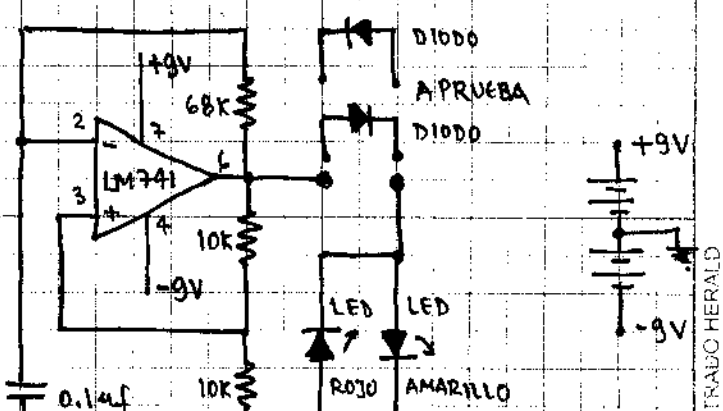
CONVERTIDOR DE VOLTAJE A FRECUENCIA



CONVERTIDOR DE FRECUENCIA A VOLTAJE

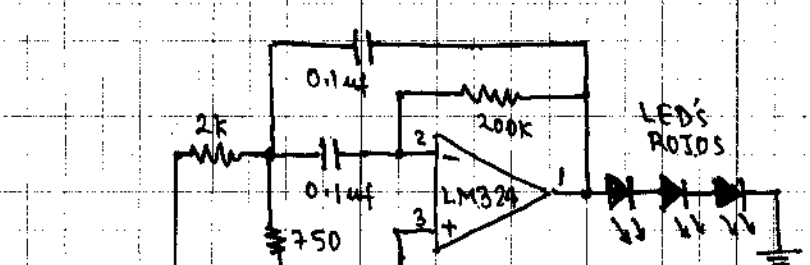


GENERADOR DE SONIDO DE TAMBOR

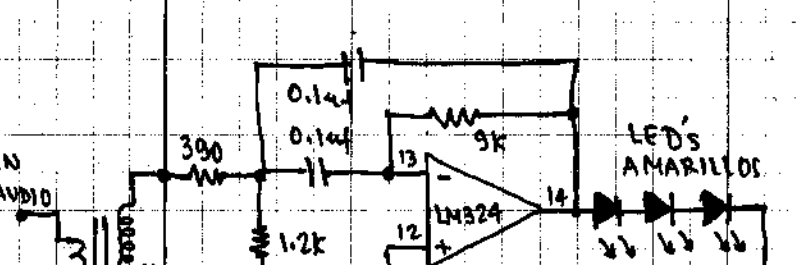


PROBADOR DE DIODOS

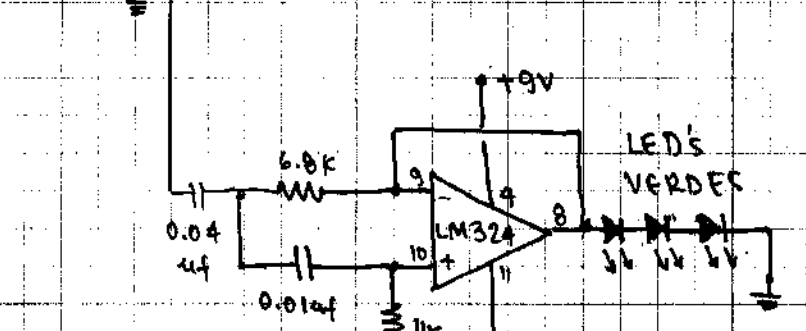
APLICACIONES LINEALES CONTINUACIÓN...



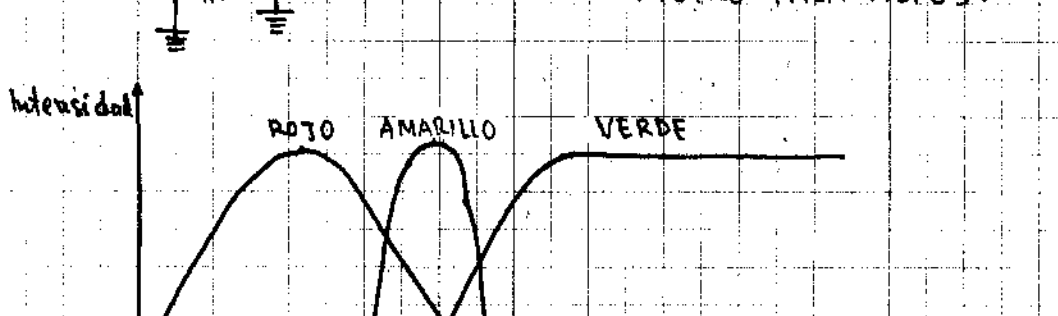
FILTRA LAS SEÑALES DE BAJA FRECUENCIA.
DE 1 A 70 Hz DEJA PASAR.
FILTRO PASA BANDA.



FILTRA LAS SEÑALES DE MEDIANA FRECUENCIA
DE 25 A 85 Hz DEJA PASAR.
FILTRO PASA BANDA.

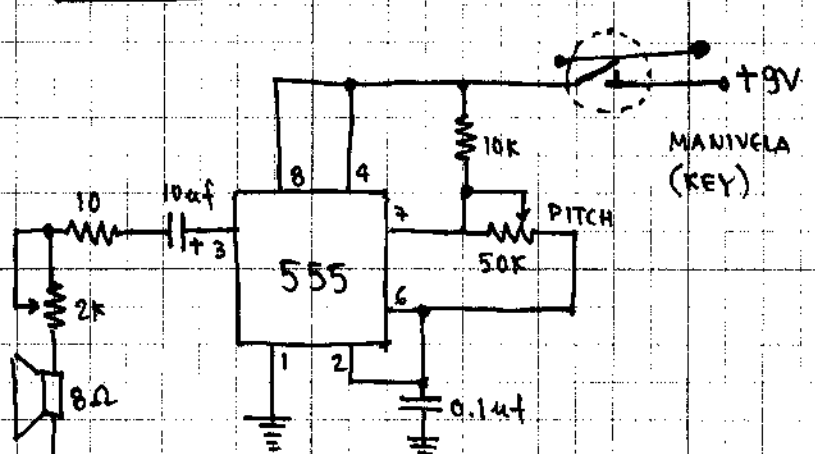


FILTRA LAS SEÑALES DE ALTA FRECUENCIA
DE 75 Hz EN ADELANTE
FILTRO PASA ALTOS.



APLICACIONES LINEALES

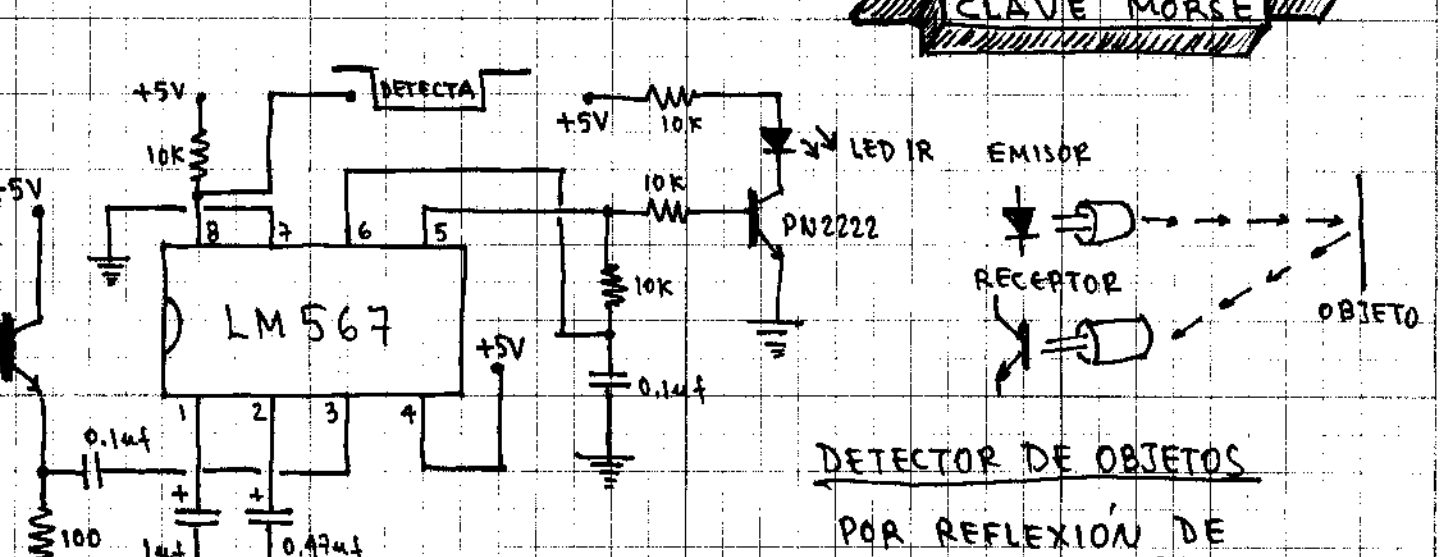
CONTINUACIÓN...



OSCILADOR PARA PRÁCTICA DE CLAVE MORSE

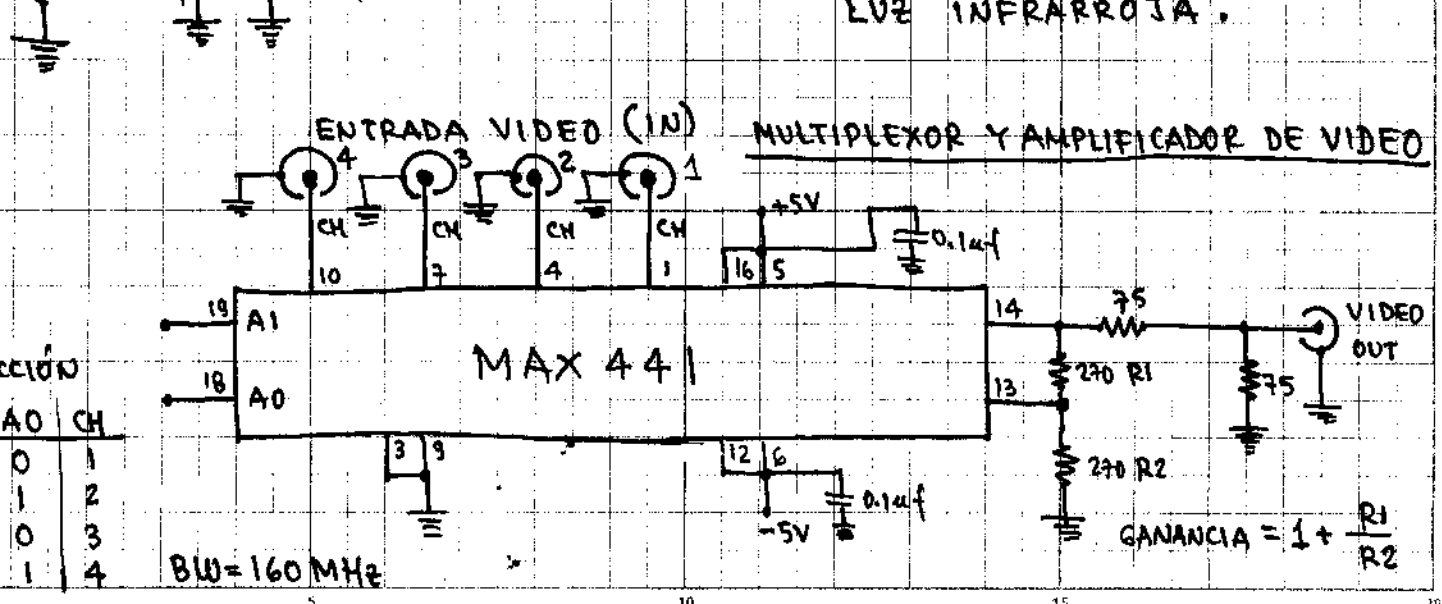
A	• —	S	• • •
B	— • • •	T	—
C	— • — •	U	• • —
D	— • •	V	• • • —
E	•	W	• — —
F	• • — •	X	— • • —
G	— — •	Y	— • — —
H	• • • •	Z	— — • •
I	• •	1	• — — — —
J	• — — —	2	• • — — —
K	— • —	3	• • • — —
L	• — • •	4	• • • • —
M	— —	5	• • • • •
N	— •	6	— • • • •
O	— — —	7	— — • • •
P	• — — •	8	— — — • •
Q	— — • —	9	— — — — •
R	• — •	0	— — — — —

CLAVE MORSE



DETECTOR DE OBJETOS POR REFLEXIÓN DE LUZ INFRARROJA.

MULTIPLEXOR Y AMPLIFICADOR DE VIDEO

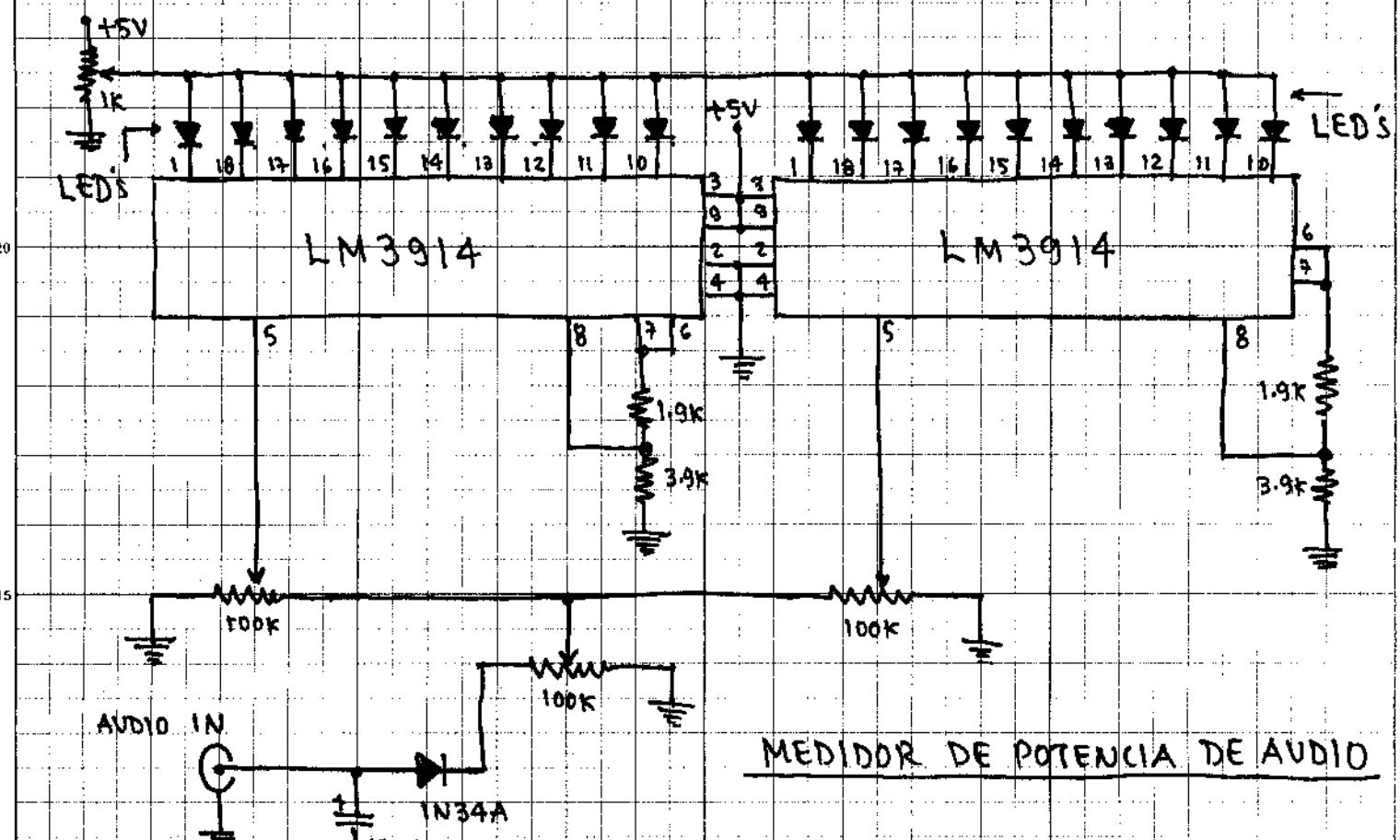


SELECCIÓN		
A1	A0	CH
0	0	1
0	1	2
1	0	3
1	1	4

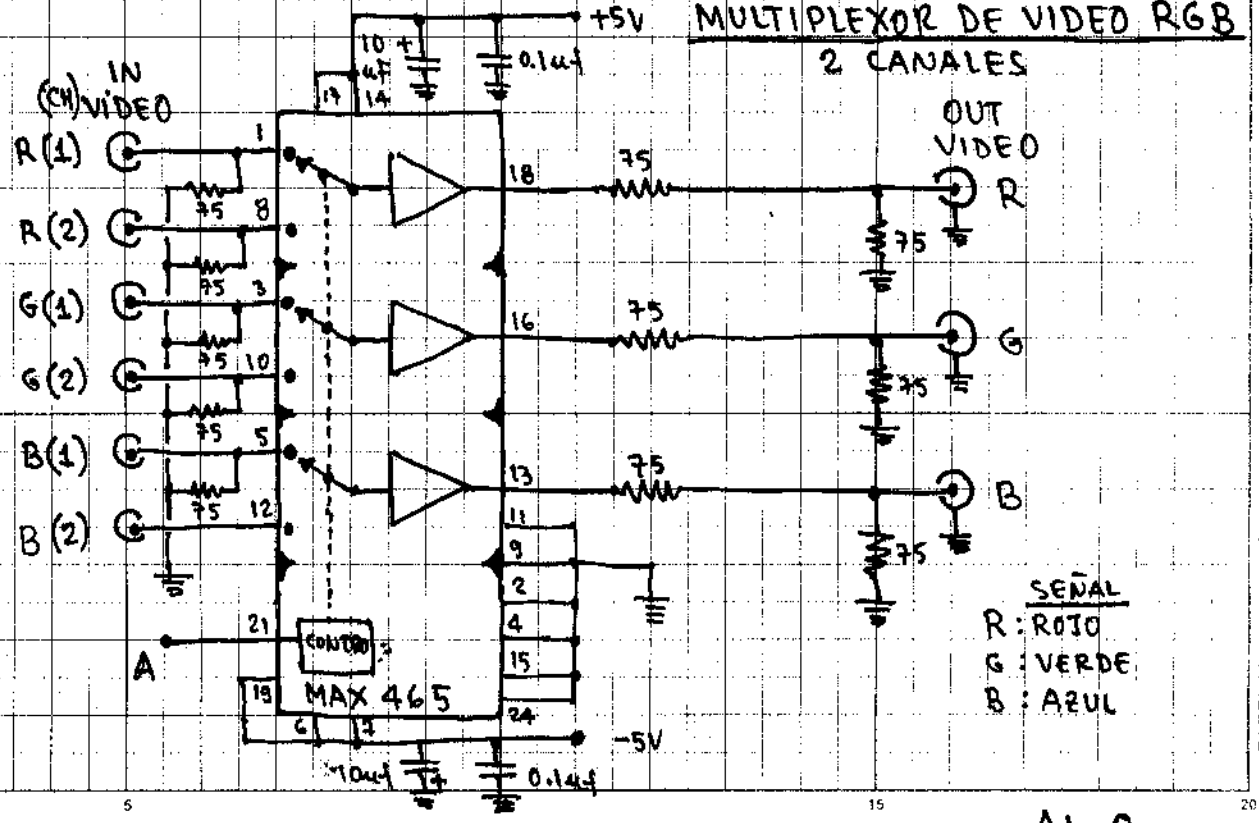
BW = 160 MHz

PAPEL MILIMETRADO HERALD

APLICACIONES LINEALES CONTINUACIÓN . . .



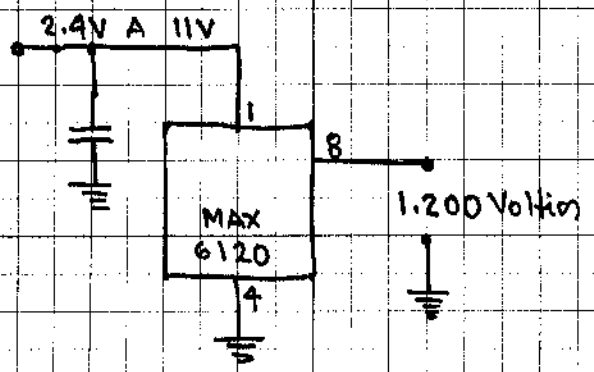
MEDIDOR DE POTENCIA DE AUDIO



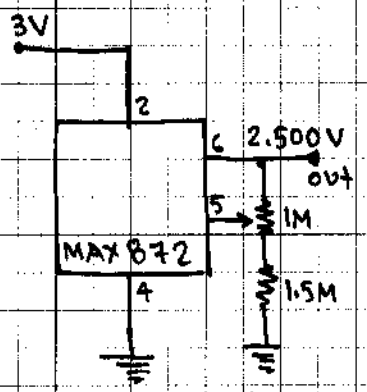
MULTIPLEXOR DE VIDEO RGB 2 CANALES

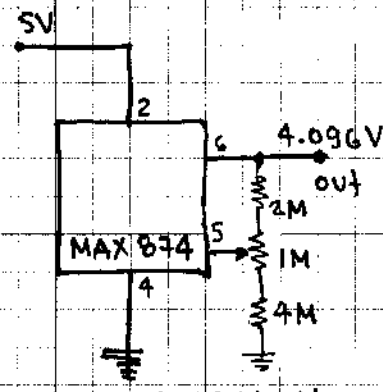
APLICACIONES LINEALES

CONTINUACIÓN . . .

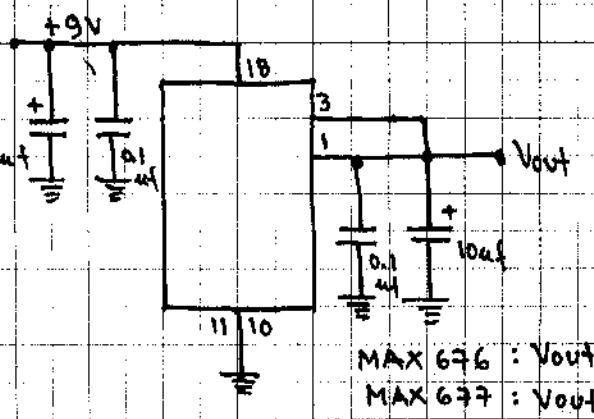


VOLTAJE DE REFERENCIA DE PRECISIÓN DE 1.200 Voltios

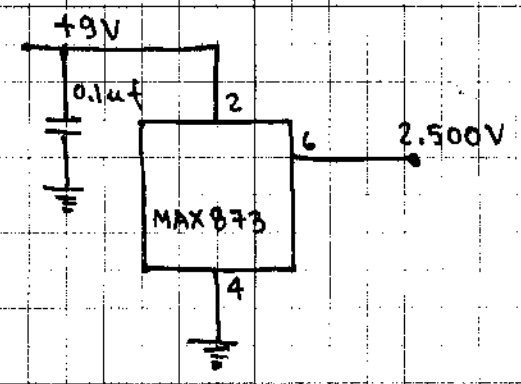




VOLTAJES DE REFERENCIA DE PRECISIÓN

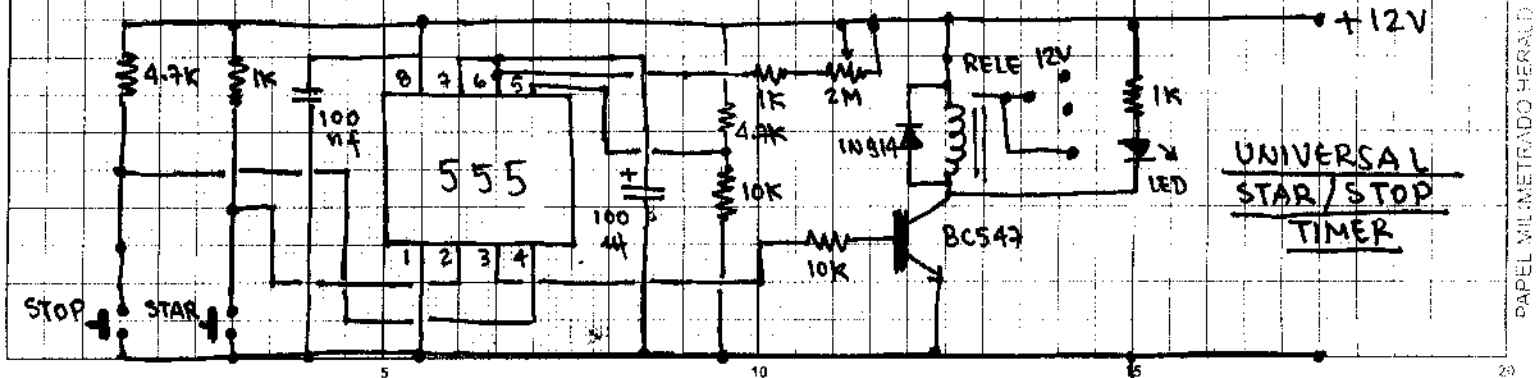


VOLTAJE DE REFERENCIA DE PRECISIÓN



VOLTAJE DE REFERENCIA DE PRECISIÓN

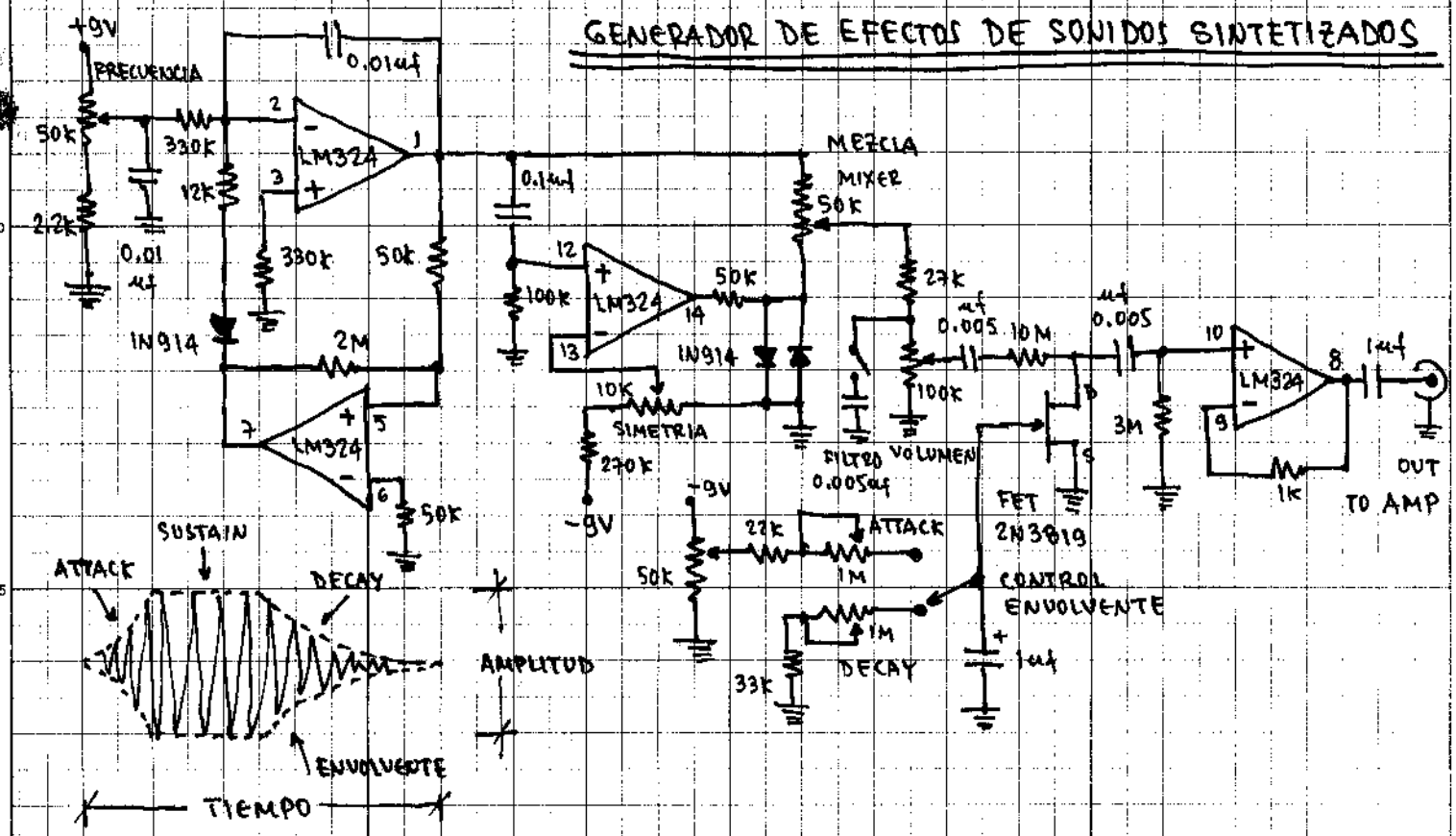
NOTA: ESTOS DISPOSITIVOS, SIRVEN PARA APLICACIONES EN CONVERTIDORES ANALÓGICOS A DIGITAL Y DIGITAL A ANALÓGICO, U OTROS EN ADQUISICIÓN DE DATOS O CIRCUITOS COMPARADORES, ETC. O CALIBRACIÓN DE EQUIPOS.



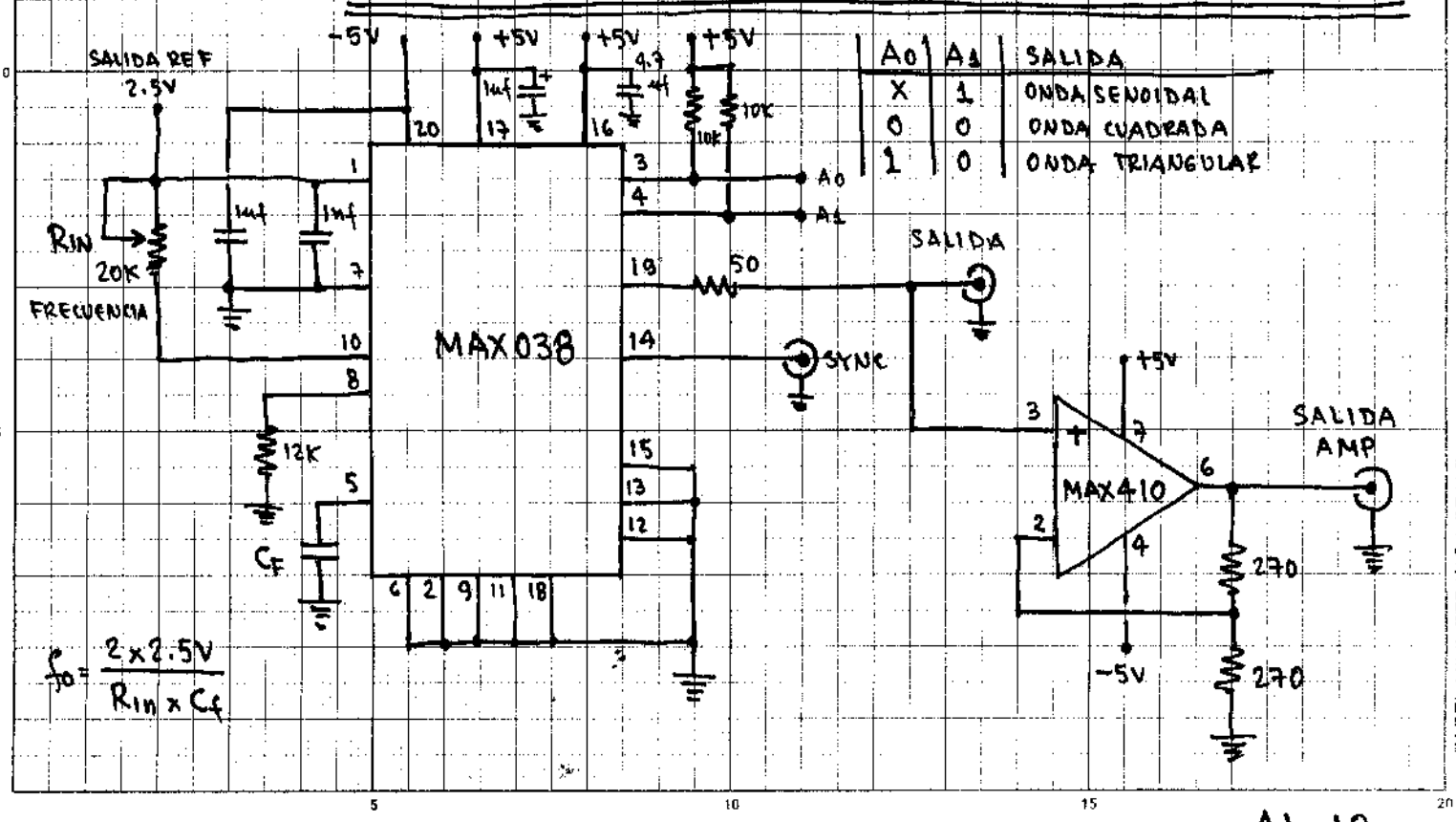
UNIVERSAL STAR/STOP TIMER

APLICACIONES LINEALES CONTINUACIÓN...

GENERADOR DE EFECTOS DE SONIDOS SINTETIZADOS



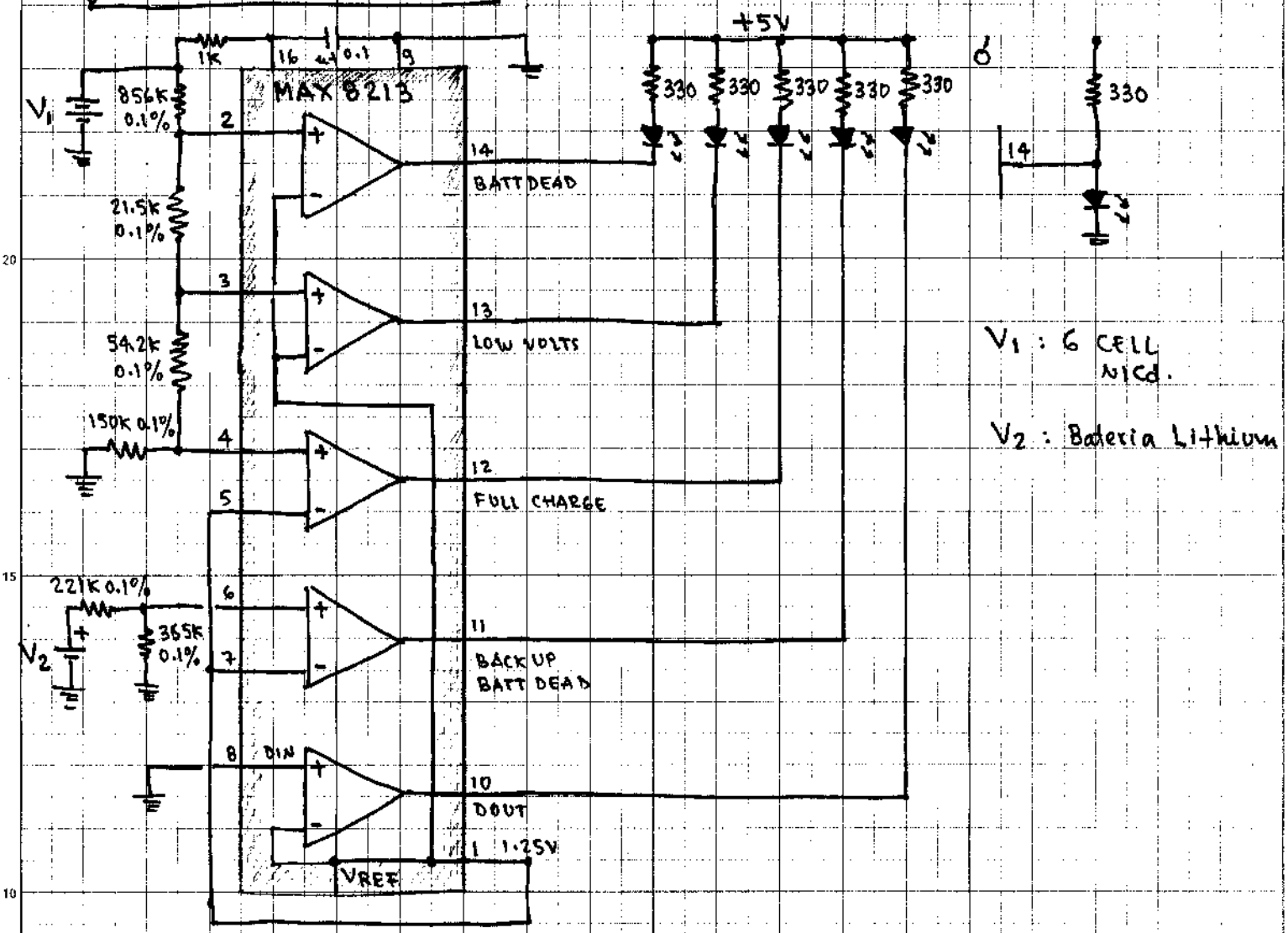
GENERADOR DE FUNCIONES, CON CONTROL DE SALIDA, DIGITAL



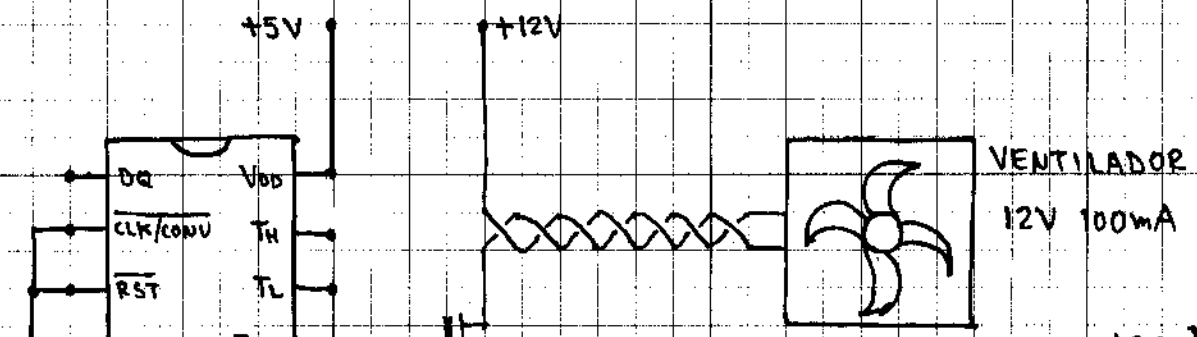
A0	A1	SALIDA
X	1	ONDA SENOIDAL
0	0	ONDA CUADRADA
1	0	ONDA TRIANGULAR

$$f_o = \frac{2 \times 2.5V}{R_{in} \times C_f}$$

APLICACIONES LINEALES CONTINUACIÓN . . .

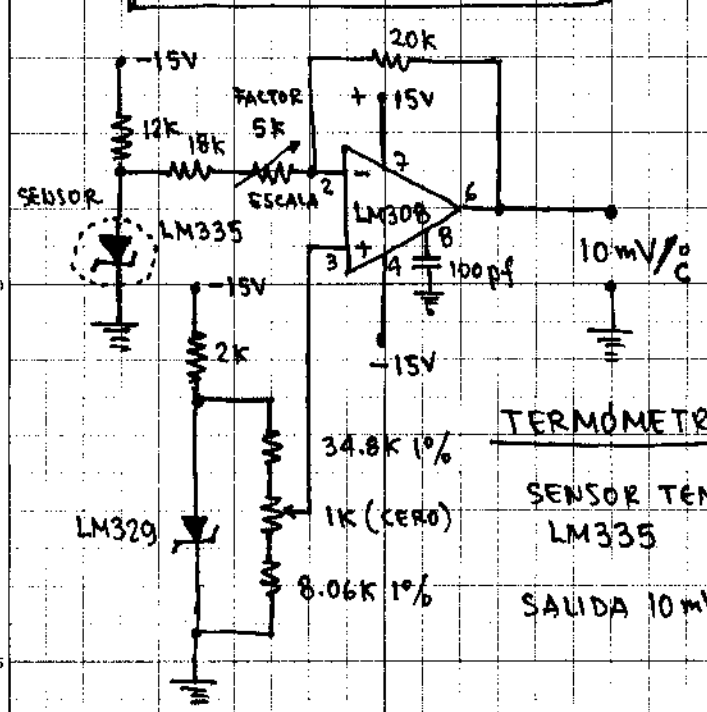


MONITOR DE VOLTAJE UNIVERSAL



CIRCUITO DE CONTROL DE TEMPERATURA

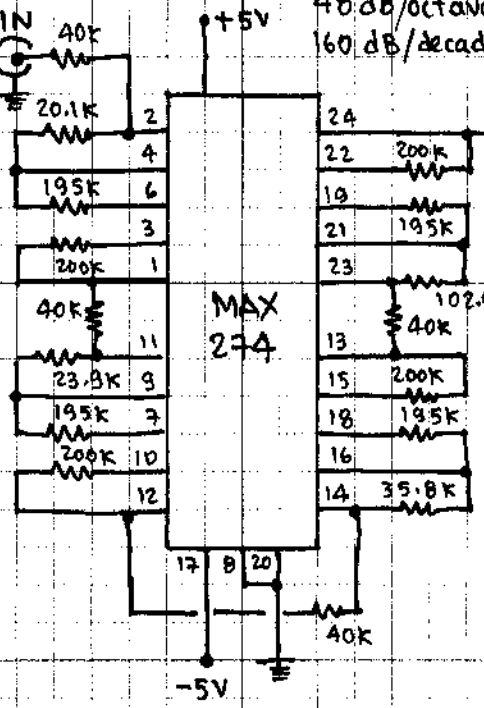
APLICACIONES LINEALES CONTINUACIÓN...



TERMÓMETRO

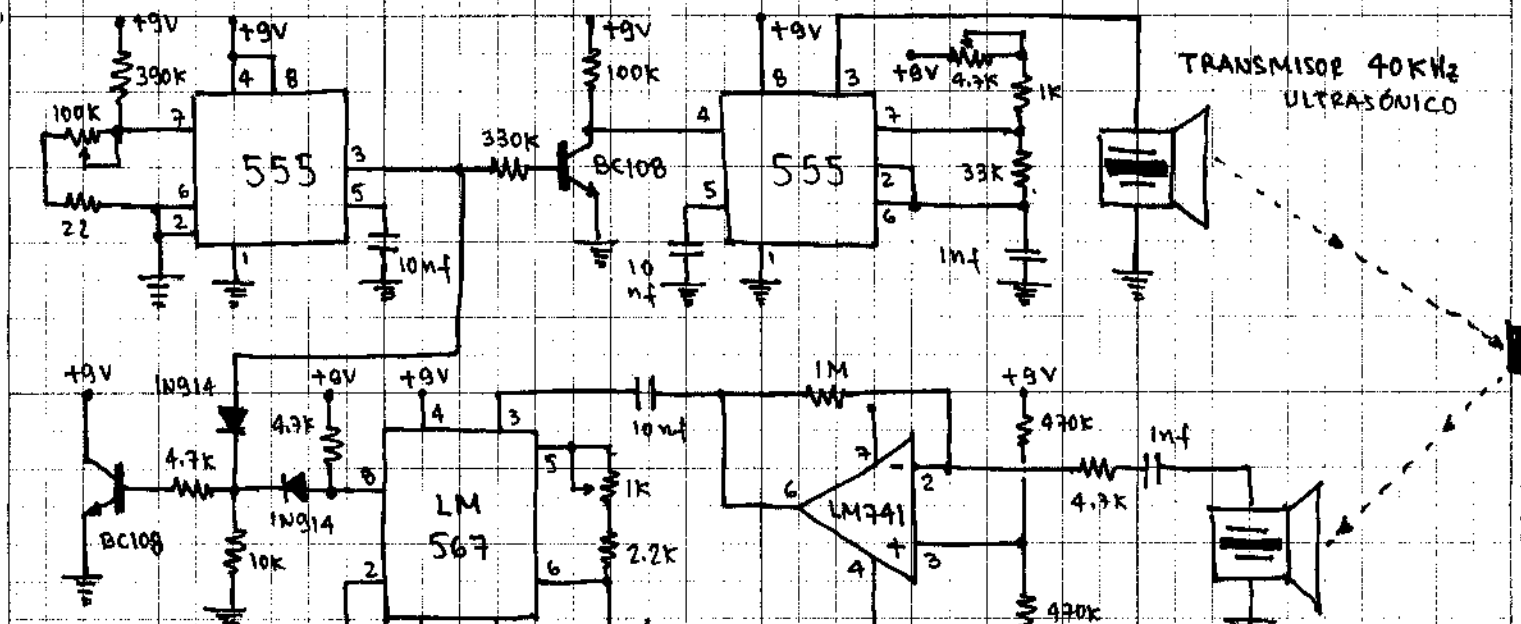
SENSOR TEMP. LM335

SALIDA 10 mV/°C



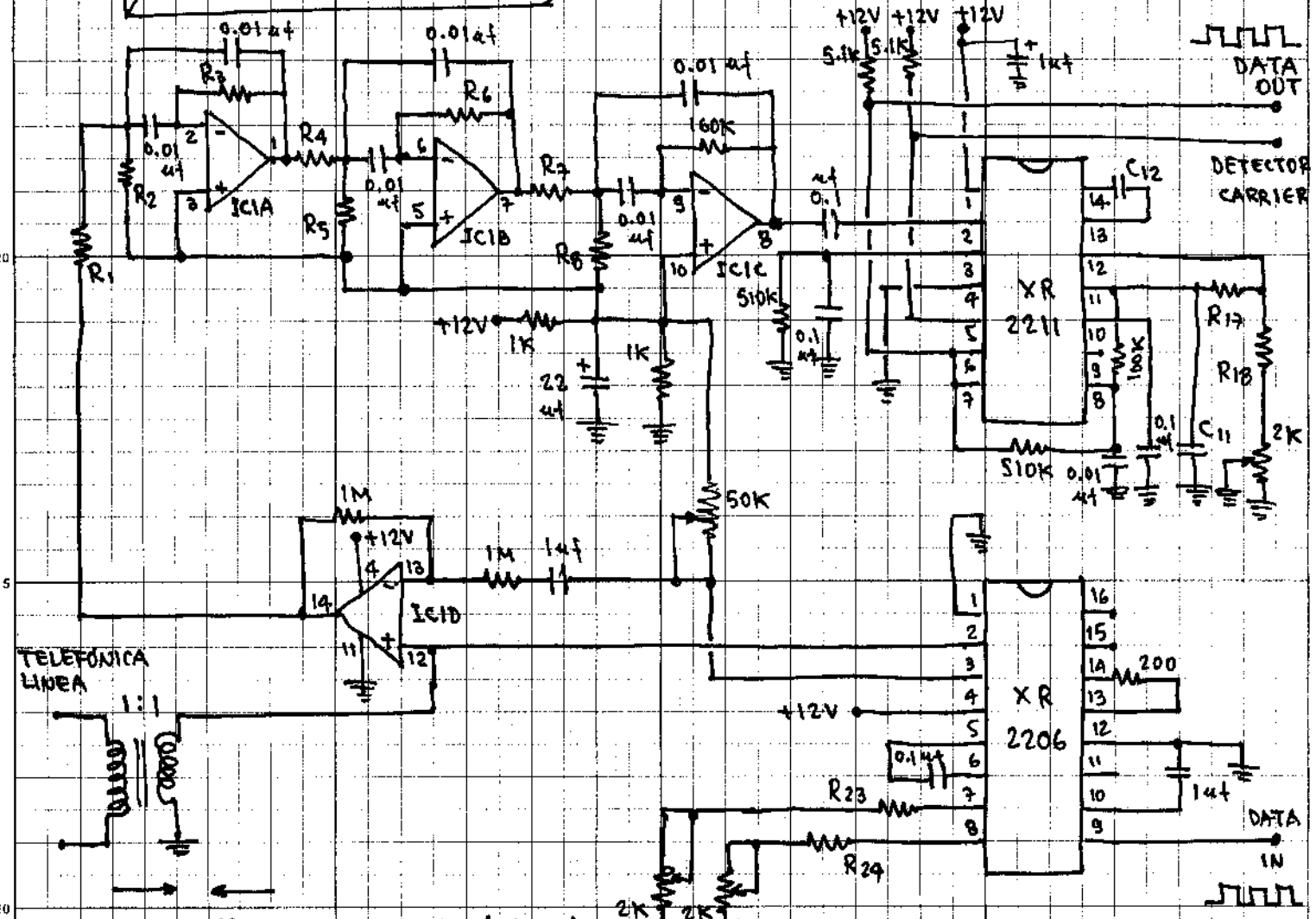
FILTRO DE 8º ORDEN BUTTERWORTH PASA BAJOS DE 10 KHz

IC MAX 274/275 FILTRO UNIVERSAL 4º u 8º ORDEN



DETECTOR DE OBJETOS CON ULTRASÓNIDO

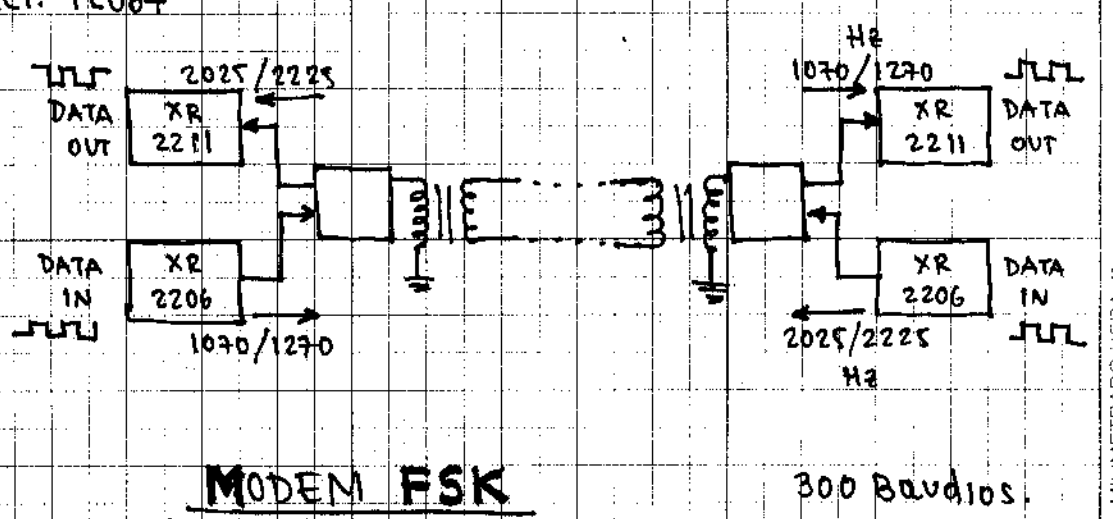
APLICACIONES LINEALES CONTINUACIÓN . . .



R1	40.2K	47.5K
R2	499	191
R3	270K	357K
R4	60.4K	39.4K
R5	680	160
R6	383K	270K
R7	29.9K	20K
R8	1.21K	360
R17	47K	100K
R18	7.5K	9.1K
R23	3.9K	8.2K
R24	3.6K	6.8K
↓	2025 / 2225	↑ 1070 / 1270

C11: 0.022uf 0.01uf
C12: 0.1uf 0.047uf

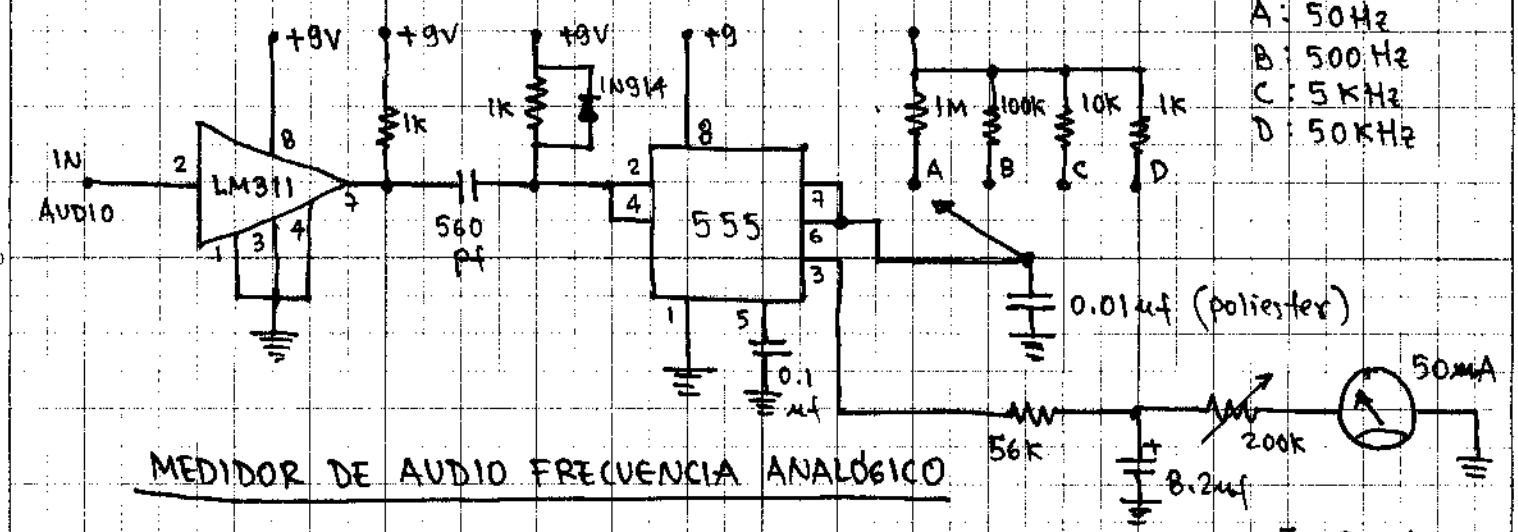
IC1: TL084



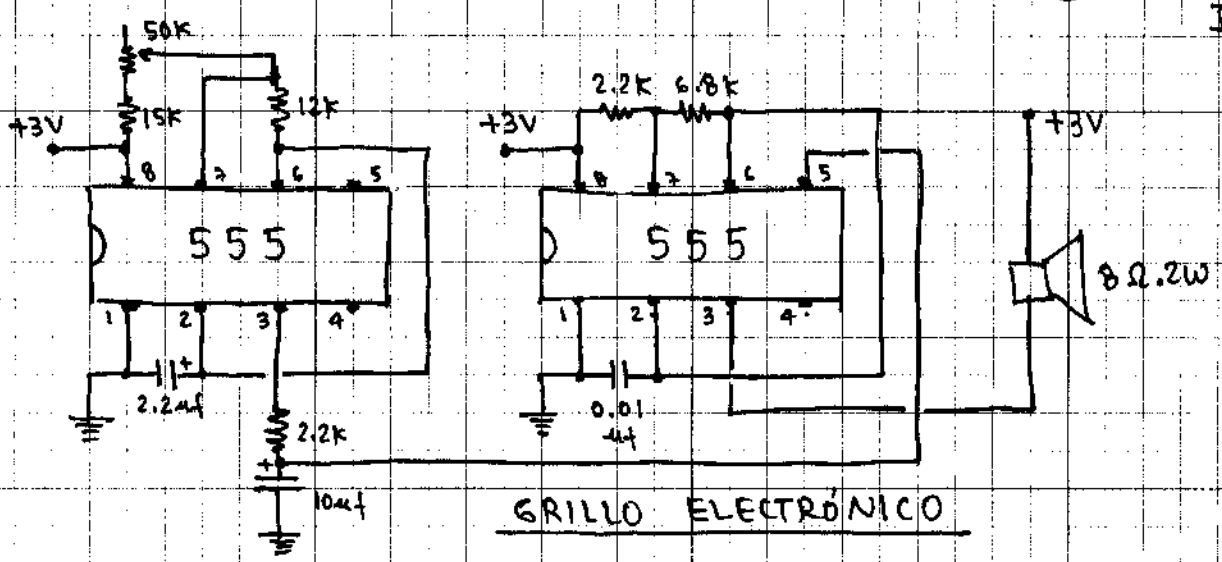
MODEM FSK

300 Baudios.

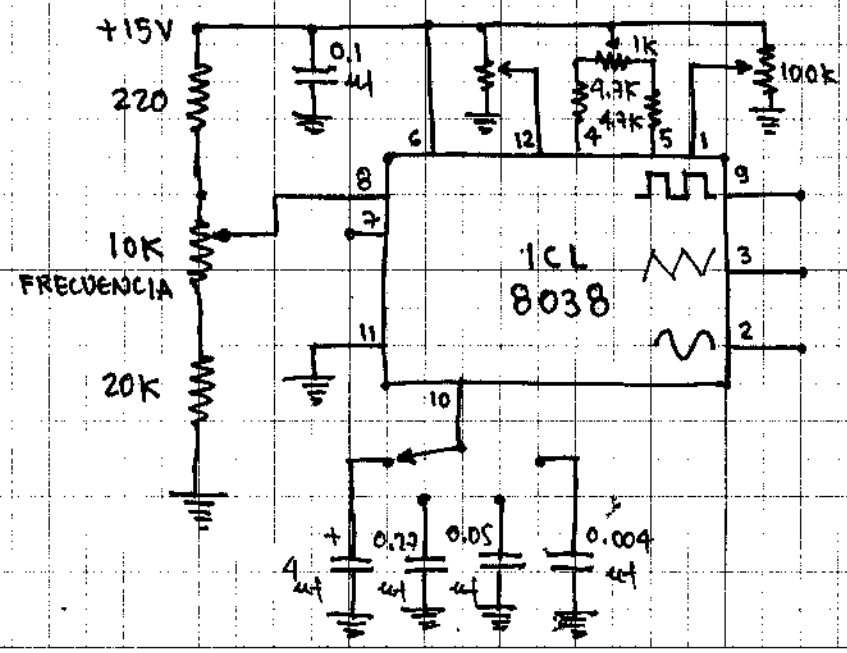
APLICACIONES LINEALES CONTINUACIÓN...



MEDIDOR DE AUDIO FRECUENCIA ANALÓGICO



GRILLO ELECTRÓNICO



GENERADOR DE FUNCIONES

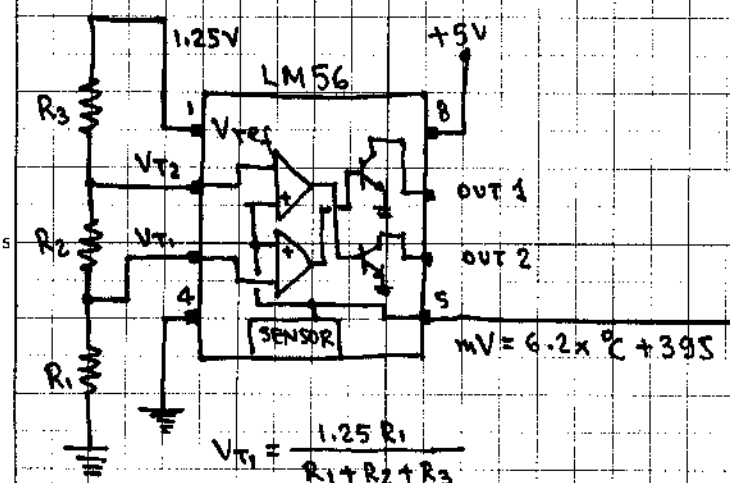
DE 1Hz A 24KHz

PAPEL MILIMETRADO HERALD

APLICACIONES LINEALES CONTINUACIÓN . . .

LM56 ≡ DS56

CONTROL TERMOSTATO



$$V_{T_1} = \frac{1.25\,R_1}{R_1+R_2+R_3}$$

$$V_{T_2} = \frac{1.25\,(R_1+R_2)}{R_1+R_2+R_3}$$

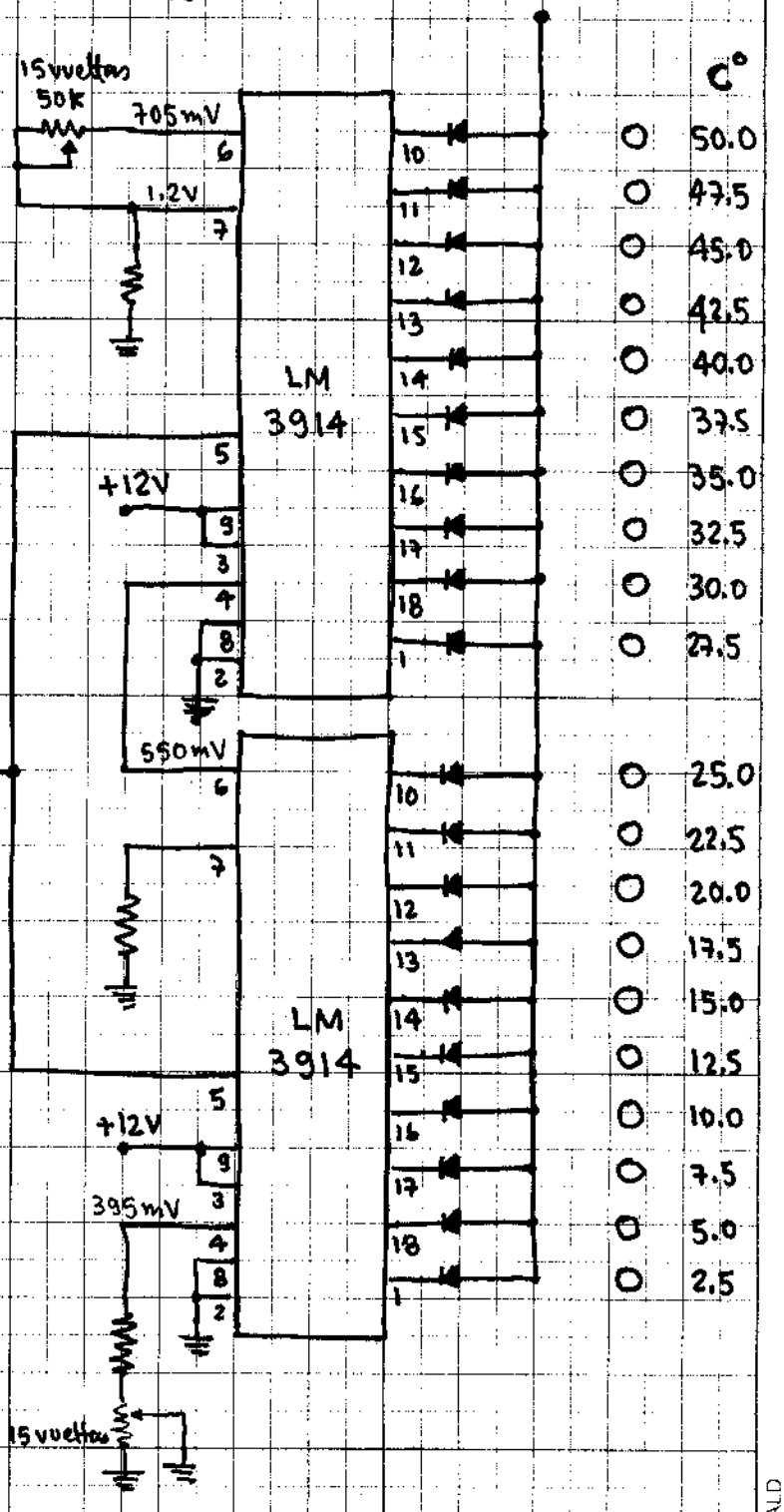
$$R_1+R_2+R_3 = 27K$$

$$V_{T_1} \text{ ó } V_{T_2} = (6.2\,mV \times {}^\circ C) + 395\,mV$$

$$R_1 = \frac{27K \times V_{T_1}}{1.25}$$

$$R_2 = \frac{27K \times V_{T_2}}{1.25} - R_1$$

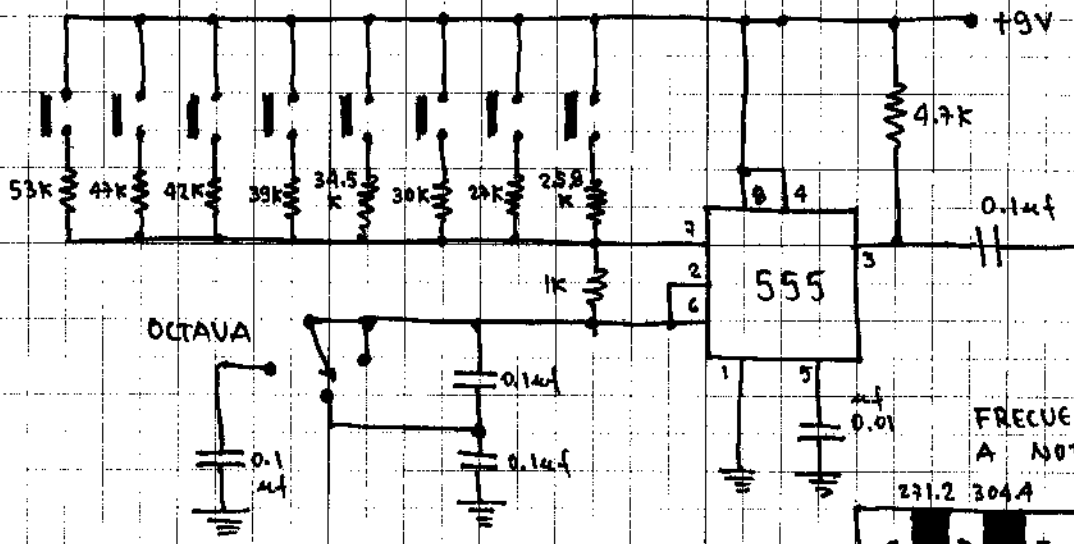
$$R_3 = 27K - R_1 - R_2$$



MEDIDOR DE TEMPERATURA EN PASOS DE 2.5 °C A 50.0 °C

PAPEL MILIMETRADO HERALD

APLICACIONES LINEALES CONTINUACIÓN . . .

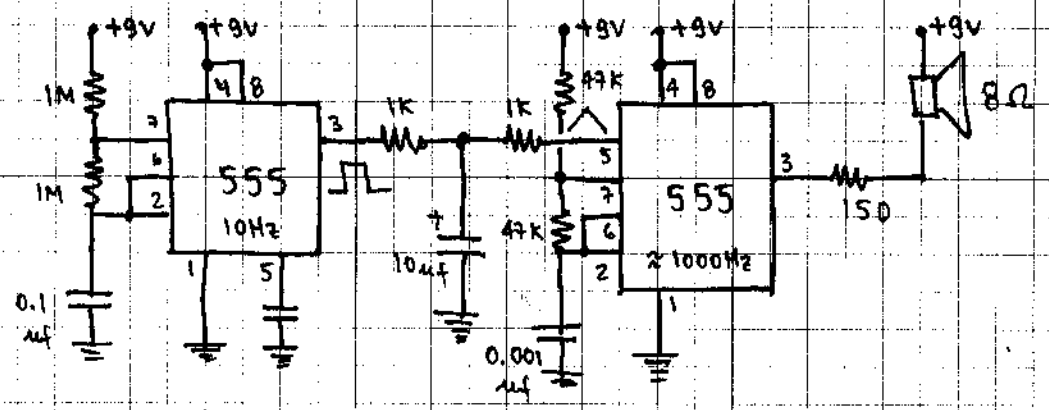


FRECUENCIAS ASIGNADAS A NOTAS MUSICALES.

	271.2	304.4		362	406.4	456.1		Hz
C	D	E	F	G	A	B	C	
DO	RE	MI	FA	SOL	LA	SI	DO	
256	287.3	322.5	341.7	383.6	430.5	483.3	512	Hz

ÓRGANO ELECTRÓNICO

CON CAMBIO DE OCTAVA



IMITADOR DE CANTO DE AVES

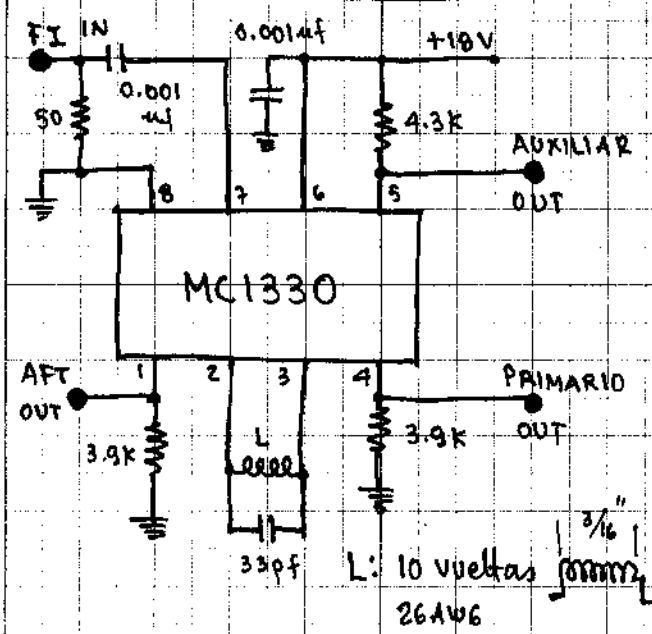
NOTAS MUSICALES PARA ALGUNOS INSTRUMENTOS

VER PÁGINA TRA-10

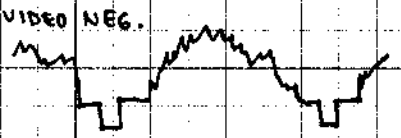
INSTRUMENTOS	E	F	G	A	B	C	D	E	F	G	A	B	C	D	E	F	G	A	B	C	D	E	G	A	B	C	D	E
VIOLIN/MANDOLINA																	X				X			X				X
GUITARRA								X			X			X			X		X			X						
BAJO	X			X			X			X																		

PAPEL MILIMETRADO HERALD

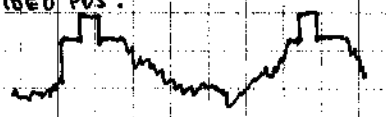
APLICACIONES LINEALES CONTINUACIÓN . . .



FI: 45.75 MHz
AFT OUT: 4.5MHz AUDIO FI
PRIMARIO OUT:
VIDEO NEG.

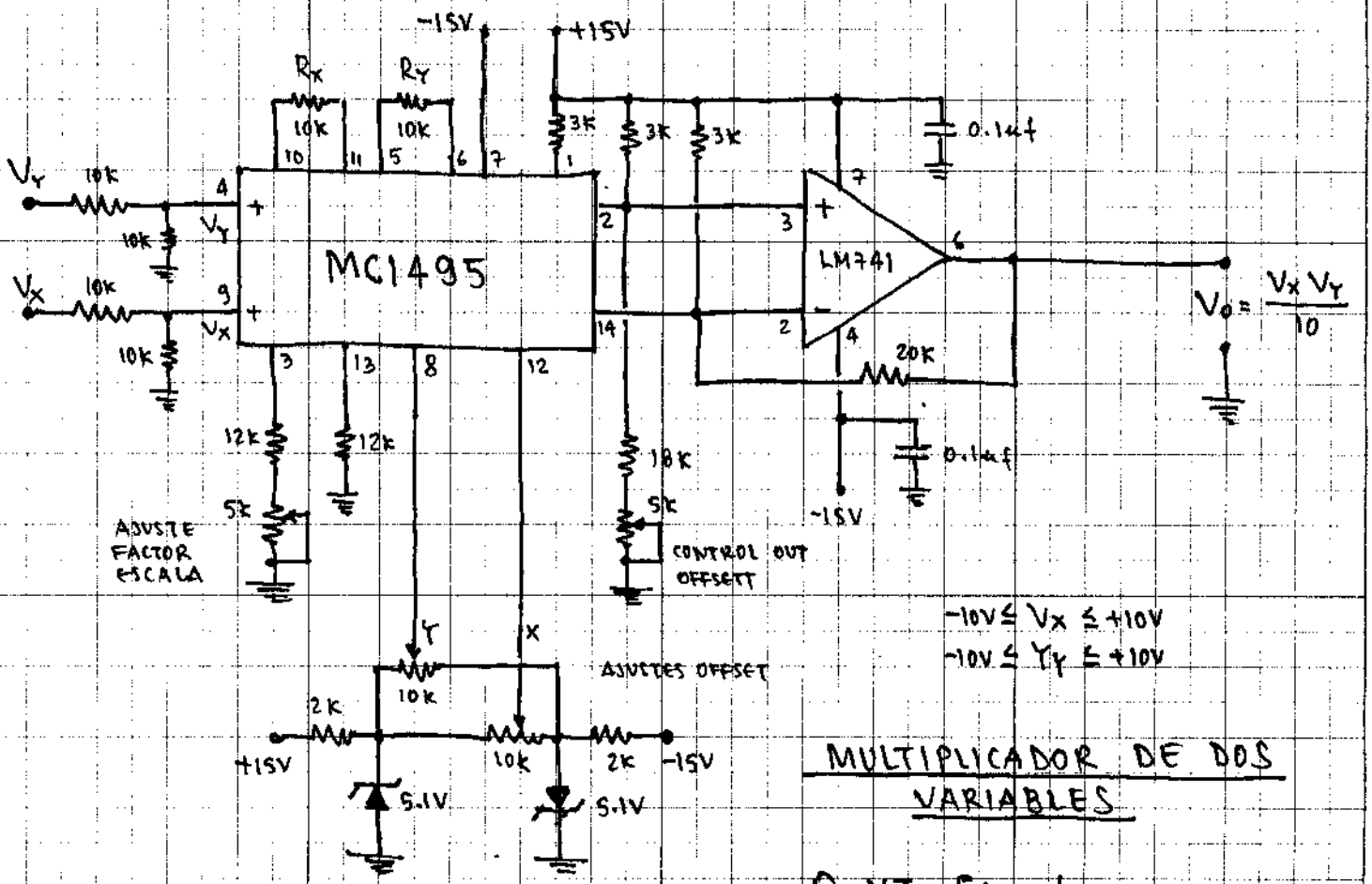


AUXILIAR OUT:
VIDEO POS.



CONVERSIÓN DE GRADOS DE TEMPERATURA
°C = °K − 273.15 °C = 0.56 °F − 17.78
°K = °C + 273.15 °K = 0.56 °F + 255.37
°F = 1.8 °C + 32 °F = 1.8 °K − 495.67
°C = GRADOS CELCIUS °K = GRADOS KELVIN °F = GRADOS FAHRENHEIT
°C = GRADOS CELCIUS ó CONOCIDO COMO CENTÍGRADOS

DETECTOR DE VIDEO



$V_o = \frac{V_x V_y}{10}$

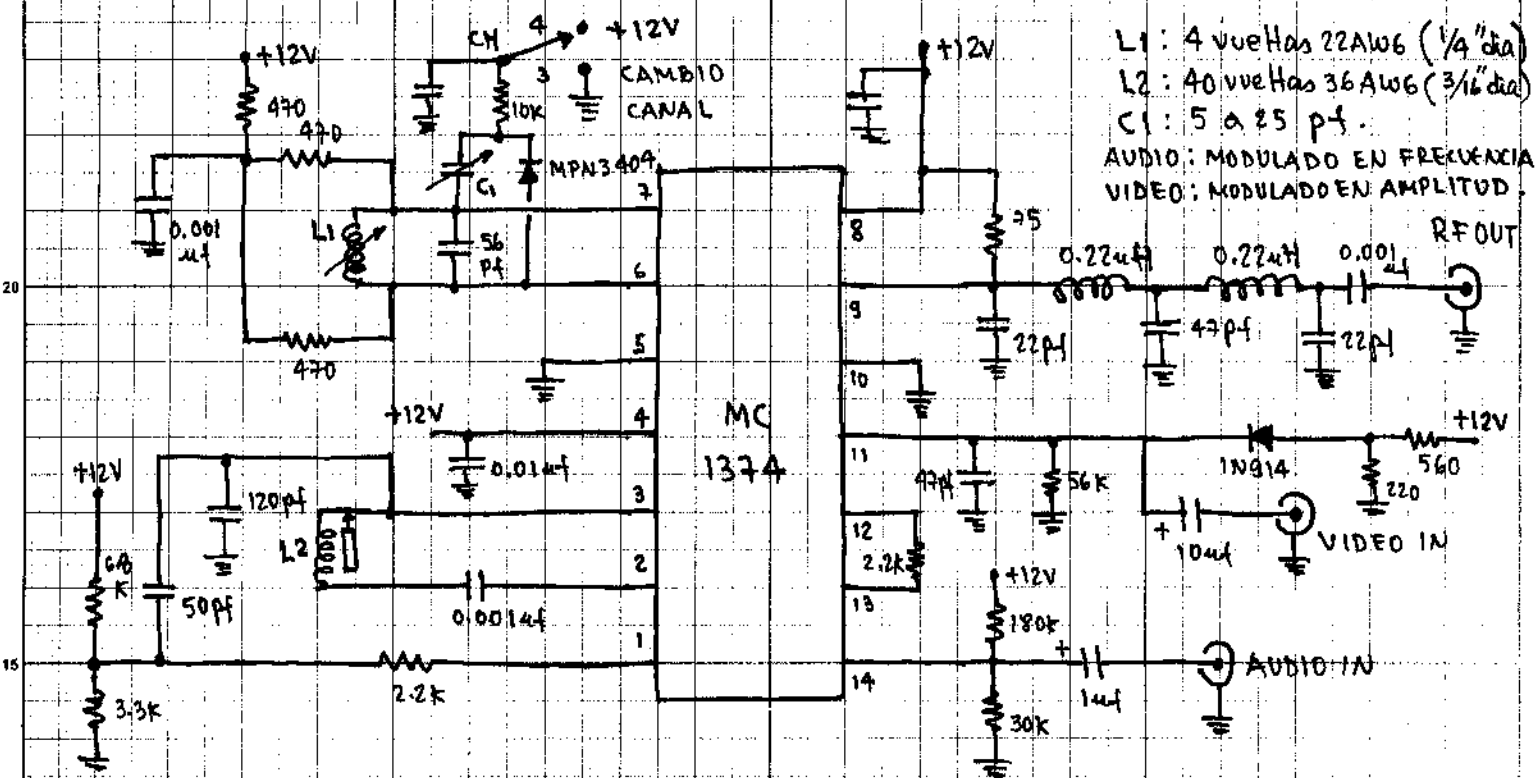
$-10V \leq V_x \leq +10V$
$-10V \leq V_y \leq +10V$

MULTIPLICADOR DE DOS VARIABLES

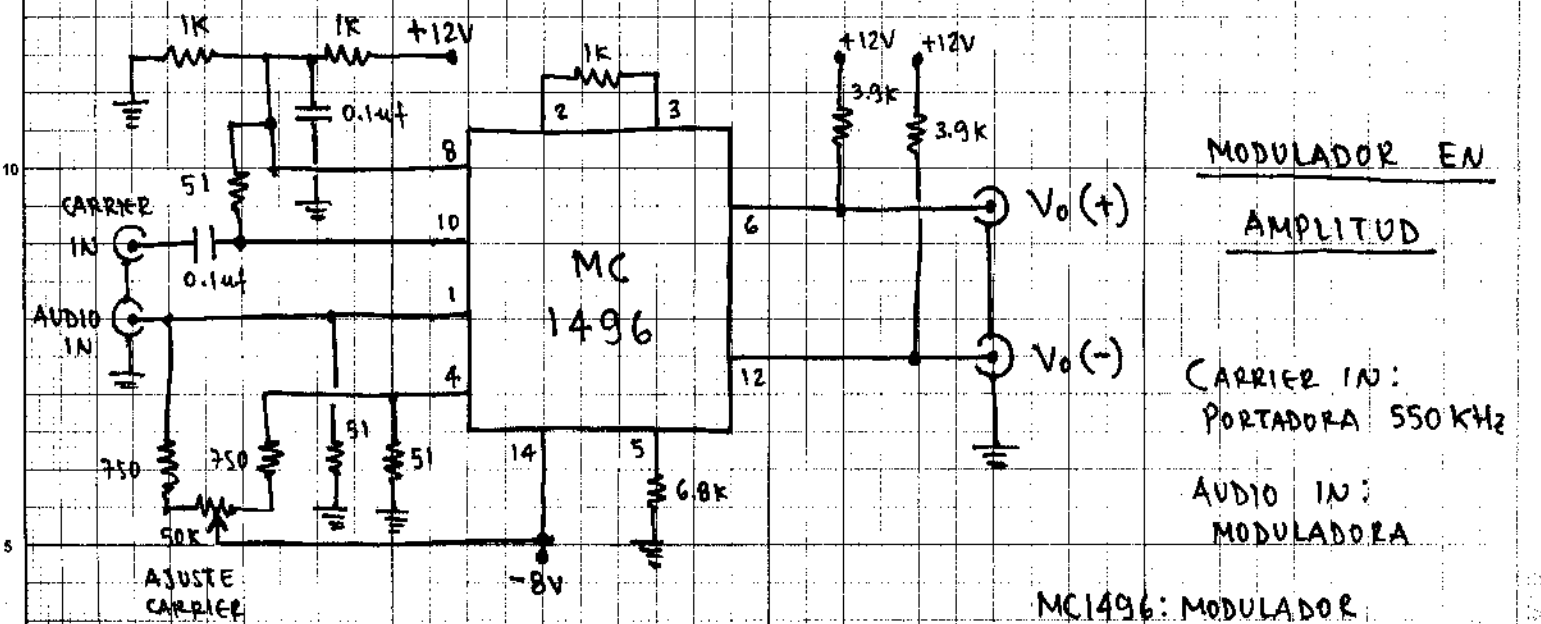
P = VI Ejemplo.

PAPEL MILIMETRADO HERALD

APLICACIONES LINEALES CONTINUACIÓN...



MODULADOR DE SEÑAL DE AUDIO Y VIDEO PARA TV



MODULADOR EN AMPLITUD

CARRIER IN: PORTADORA 550 KHz

AUDIO IN: MODULADORA

MC1496: MODULADOR BALANCEADO

SE PODRÁ AJUSTAR PARA SUPRIMIR PORTADORA.

CIRCUITOS DIGITALES TTL

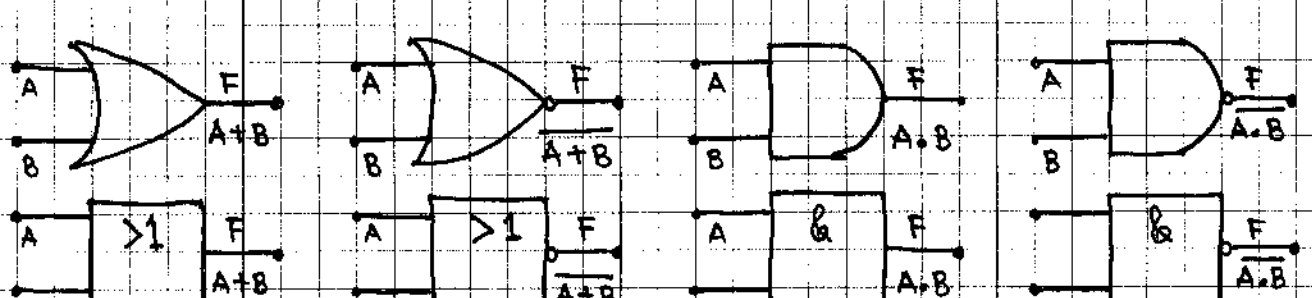
FAPE. MILIMETRADO HERA. 3

CIRCUITOS DIGITALES

LÓGICO ALTO = 1 = +V LÓGICO BAJO = 0 = GND

FAMILIAS LOGICAS

- ECL
- DTL
- RTL
- IIL
- CMOS 4000, 14000, 74CXX, 74HCXX, 74HCTXX
- TTL 74XX, 74HXX, 74LXX, 74LSXX, 74SXX, 74ASXX, 74ALS, 74FXX, 74ACXX, ETC.



A	B	F
0	0	0
0	1	1
1	0	1
1	1	1

OR (O)

A	B	F
0	0	1
0	1	0
1	0	0
1	1	0

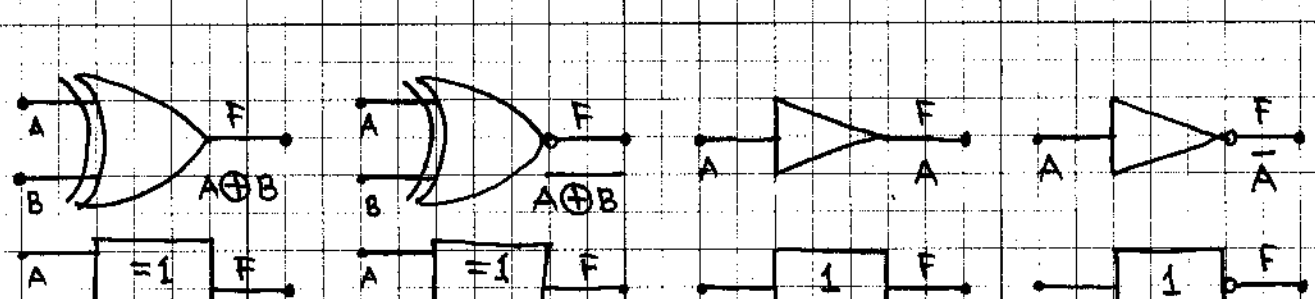
NOR (NO-O)

A	B	F
0	0	0
0	1	0
1	0	0
1	1	1

AND (Y)

A	B	F
0	0	1
0	1	1
1	0	1
1	1	0

NAND (NO Y)



A	B	F
0	0	0
0	1	1
1	0	1
1	1	0

EX-OR (O-EXC)

A	B	F
0	0	1
0	1	0
1	0	0
1	1	1

EX-NOR (NO-O EXC)

A	F
0	0
1	1

NO INVERSOR

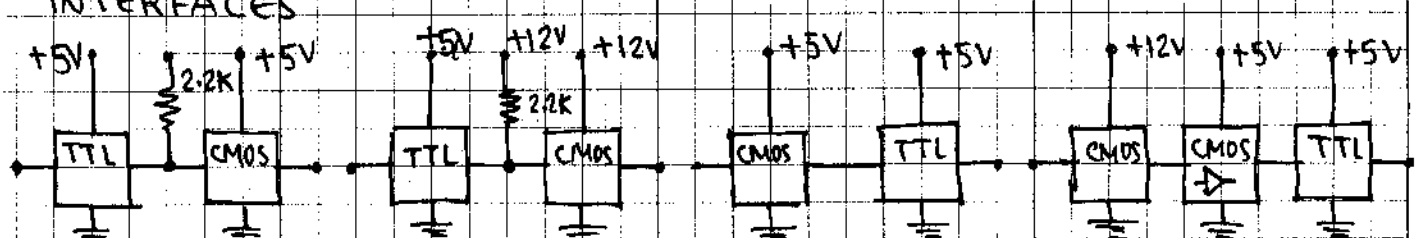
A	F
0	1
1	0

INVERSOR

PAPEL MILIMETRADO HERALD

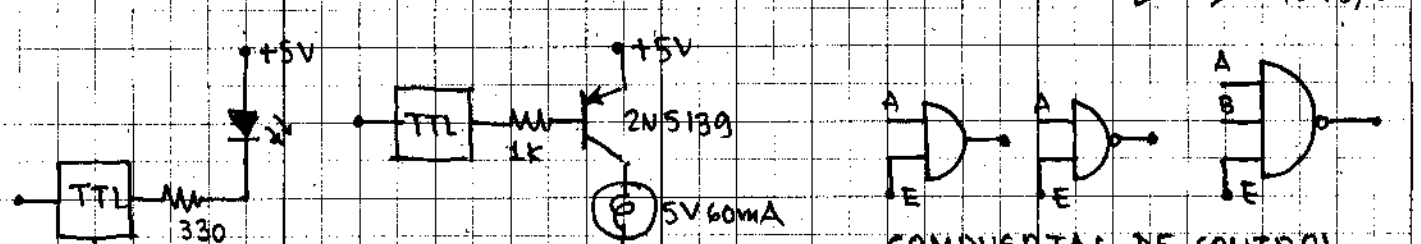
CIRCUITOS DIGITALES CONTINUACIÓN . . .

INTERFACES



TTL A CMOS TTL A CMOS CMOS A TTL CMOS A TTL

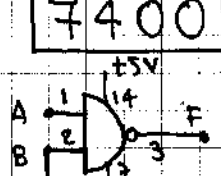
4049/50



COMPUERTAS DE CONTROL

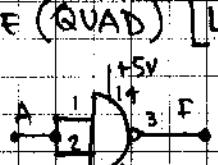
TTL

7400 NAND GATE (QUAD) [LS, ALS, S, F, L]



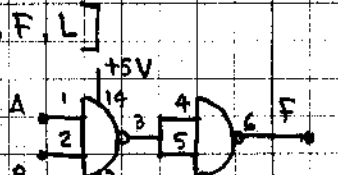
A	B	F
0	0	1
1	0	1
0	1	1
1	1	0

COMPUERTA DE CONTROL



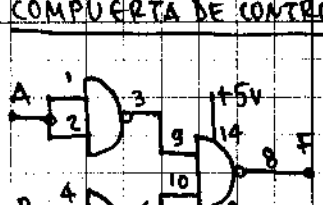
A	F
0	1
1	0

INVERSOR



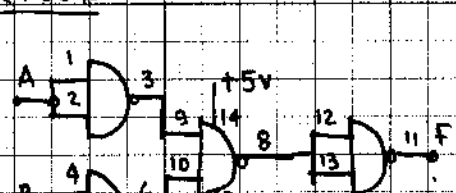
A	B	F
0	0	0
0	1	0
1	0	0
1	1	1

COMPUERTA AND



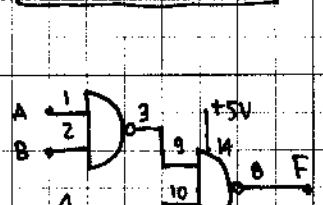
A	B	F
0	0	0
0	1	1
1	0	1
1	1	1

COMPUERTA OR



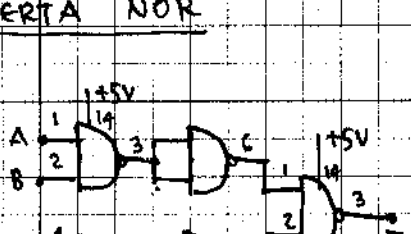
A	B	F
0	0	1
0	1	0
1	0	0
1	1	0

COMPUERTA NOR



A	B	C	D	F
X	X	1	1	1
1	1	X	X	1
1	1	1	1	1

COMPUERTA AND-OR

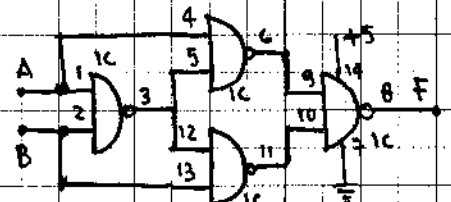


A	B	C	D	F
0	X	X	X	1
X	0	X	X	1
X	X	0	X	1
X	X	X	0	1
1	1	1	1	0

COMPUERTA NAND DE 4 ENTRADAS

PAPEL MILIMETRADO HERALD

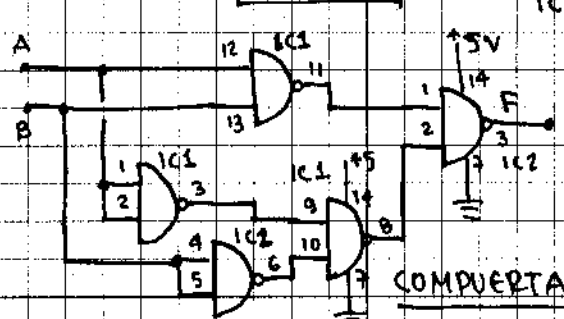
CIRCUITOS DIGITALES CONTINUACIÓN . . . 7400



A	B	F
0	0	0
0	1	1
1	0	1
1	1	0

COMPUERTA EX-OR

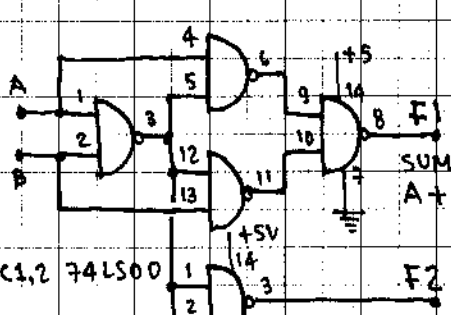
1C74LS00



IC1,2, 74LS00

A	B	F
0	0	1
0	1	0
1	0	0
1	1	1

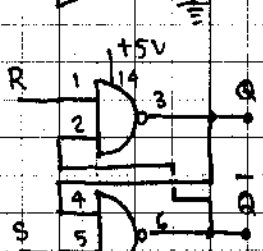
COMPUERTA EX-NOR



IC1,2 74LS00

A	B	F1	F2
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

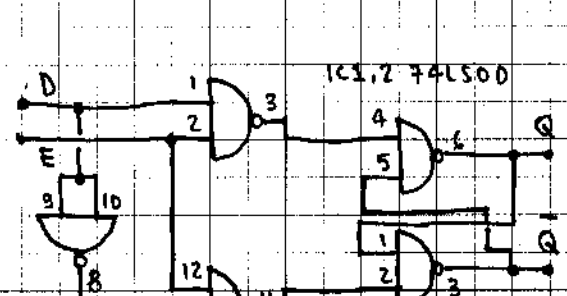
SUMADOR



R	S	Q	$\overline{Q}$
0	0	NO	CIERTO
0	1	1	0
1	0	0	1
1	1	NO CAMBIA	

FLIP FLOP RS
MEMORIA (LATCH)

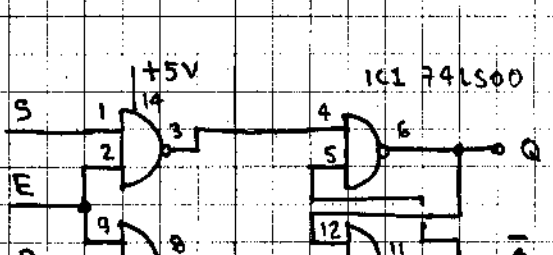
IC1 74LS00



IC1,2 74LS00

FLIP FLOP D

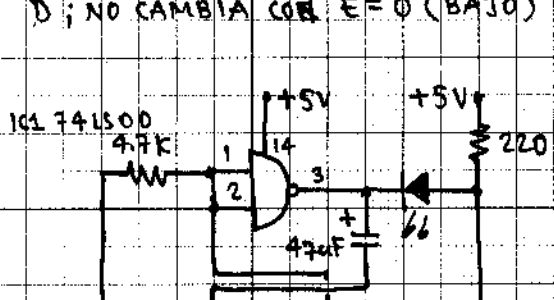
CUANDO EL HABILITADOR (ENABLE "E") ESTÁ EN ALTO (1), Q CAMBIA CON D; NO CAMBIA CON E=0 (BAJO)



IC1 74LS00

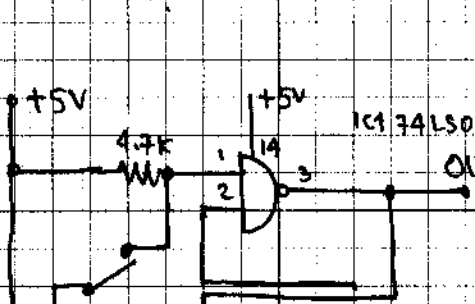
FLIP FLOP RS
CON ENABLE

OPERA, CUANDO E=1
CUANDO E=0, IGNORA A R,S.



IC1 74LS00

FLASHEADOR DUAL

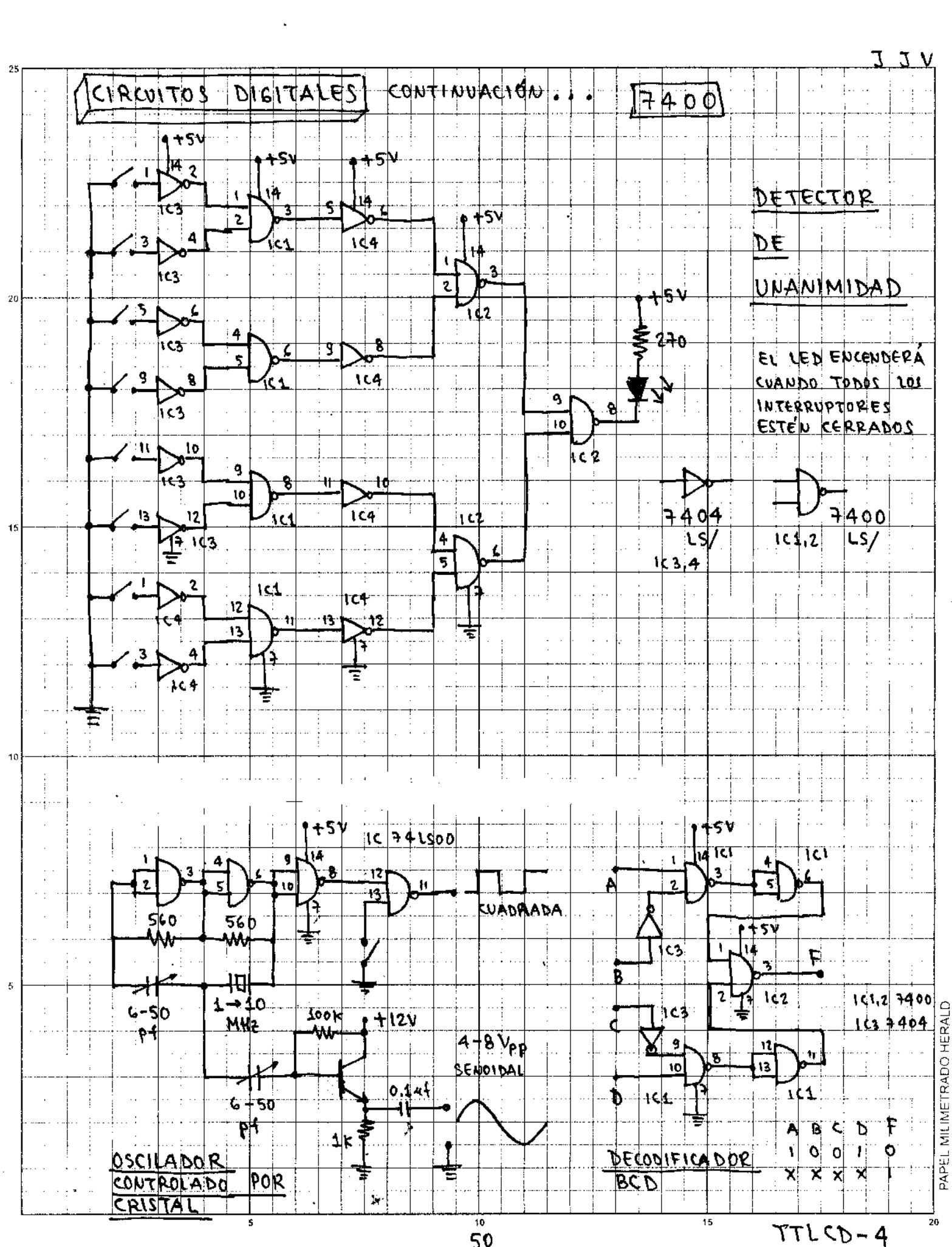


IC1 74LS00

INTERRUPTOR SIN REBOTE

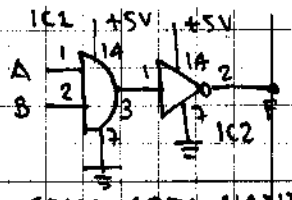
PAPEL MILIMETRADO HERALD

CIRCUITOS DIGITALES CONTINUACIÓN . . . 7400



CIRCUITOS DIGITALES CONTINUACIÓN . . .

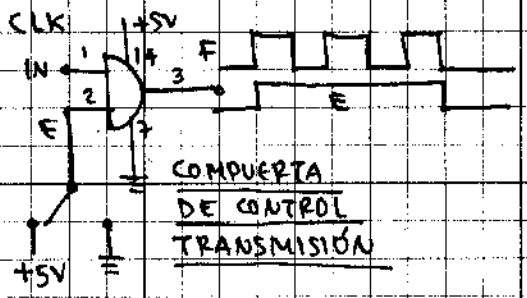
IC1 74LS08
IC2 74LS04



A	B	F
0	0	1
0	1	1
1	0	1
1	1	0

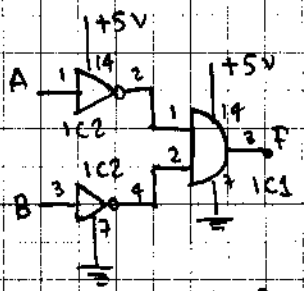
COMPUERTA NAND

IC 74LS08

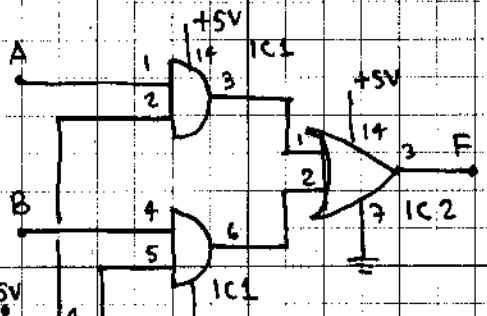


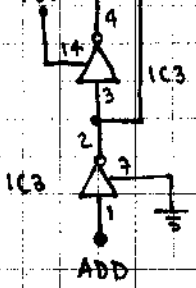
COMPUERTA DE CONTROL TRANSMISIÓN

IC1 74LS08
IC2 74LS04



COMPUERTA NOR

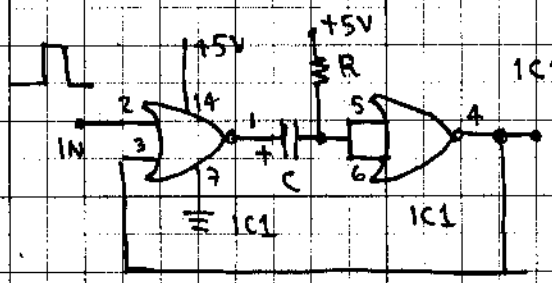




IC1 74LS08
IC2 74LS32
IC3 74LS04

SELECTOR DE DATOS DE ENTRADA (2 IN)

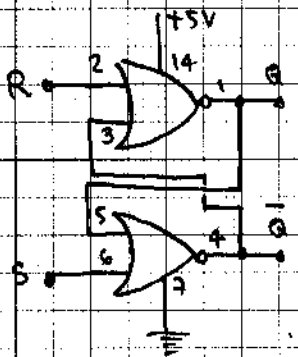
ADD ADDRESS	B DATA	A IN	F OUT
0	X	0	0
0	X	1	1
1	0	X	0
1	1	X	1



IC1 74LS02

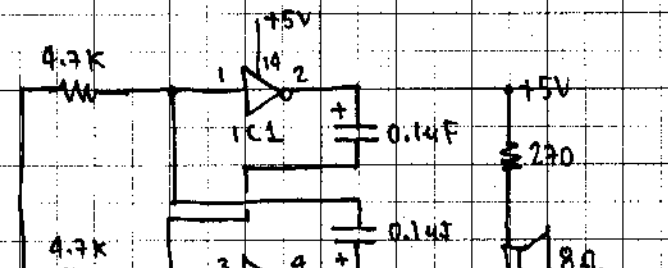
ONE SHOT (MONOESTABLE)

EL PULSO DE SALIDA ES APROXIMAD 0.8RC



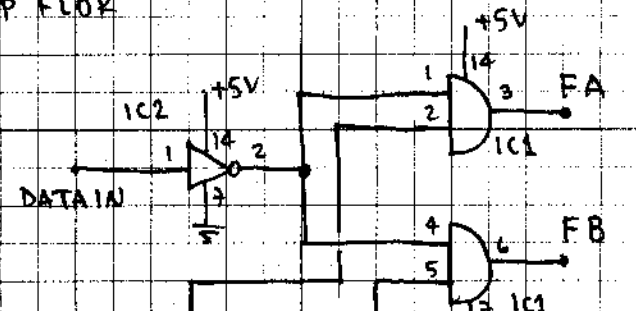
R	S	Q	$\bar{Q}$
0	0	NO	CAMBIO
0	1	1	0
1	0	0	1
1	1	NO	CERTERO

RS LATCH
FLIP FLOP



IC1 74LS04

OSCILADOR DE AUDIO

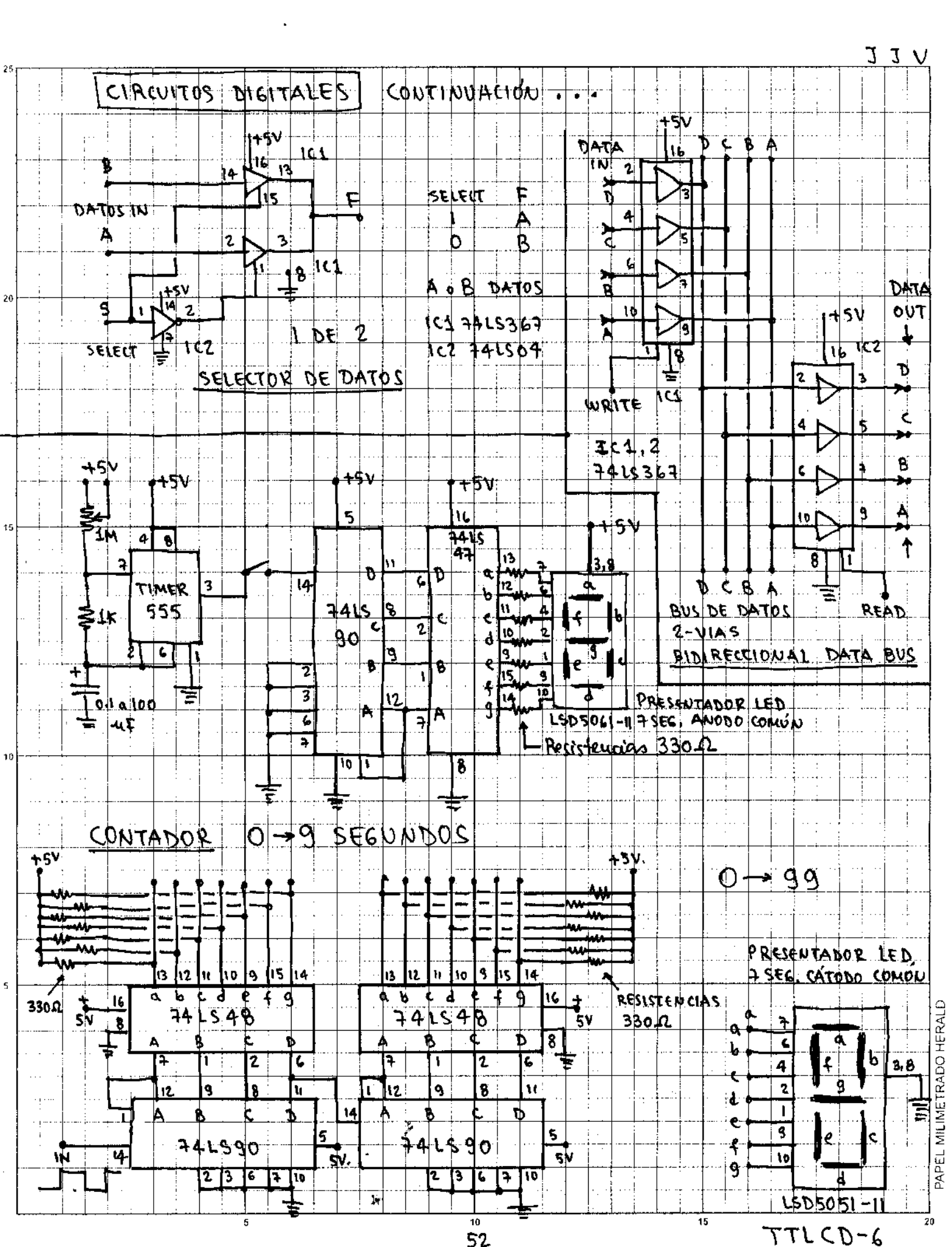


IC1 74LS08
IC2 74LS04

DEMULTIPLEXOR 1 DE 2

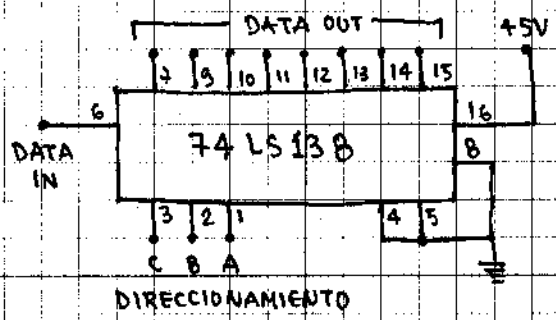
PAPEL MILIMETRADO HERALD

CIRCUITOS DIGITALES CONTINUACIÓN . . .

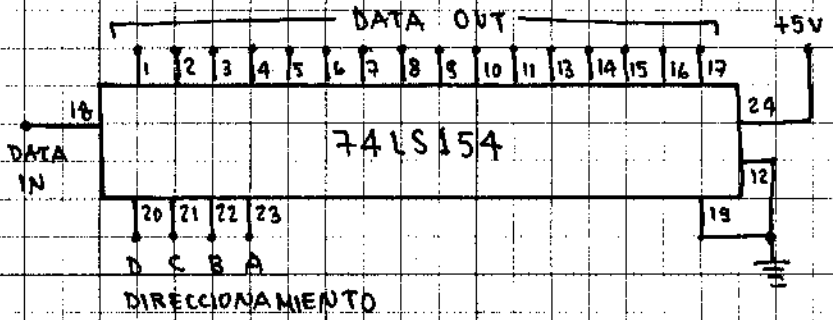


PAPEL MILIMETRADO HERALD

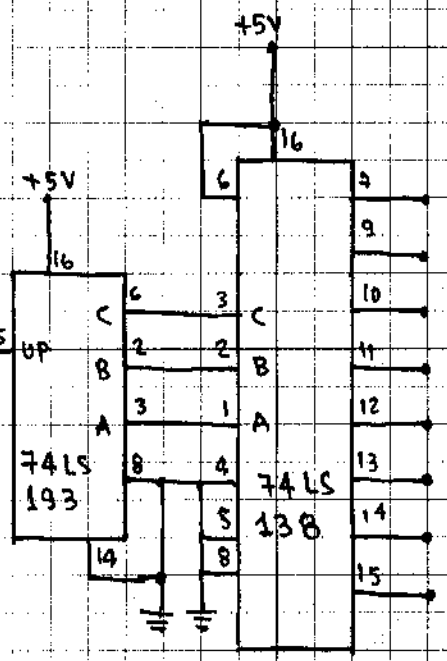
CIRCUITOS DIGITALES CONTINUACIÓN...



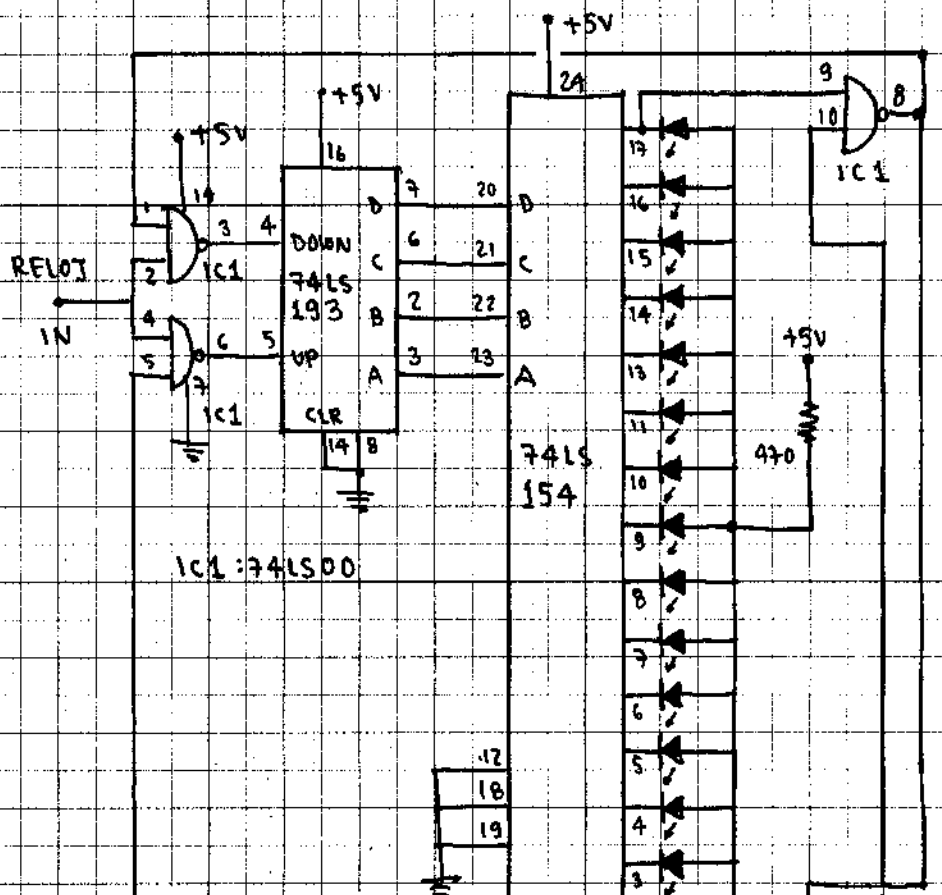
DEMULTIPLEXOR 1 A 8
DECODIFICADOR 3 A 8



DEMULTIPLEXOR 1 A 16
DECODIFICADOR 4 A 16



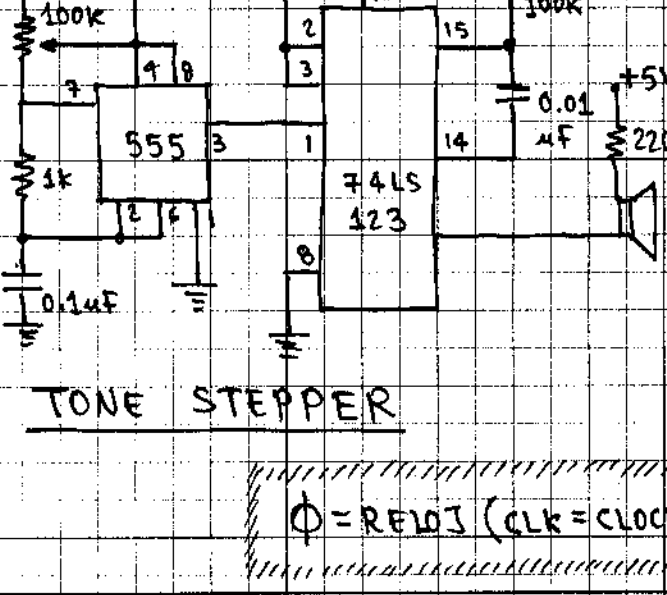
SECUENCIADOR HACIA ADELANTE 1-8
POR PASO DE RELOJ



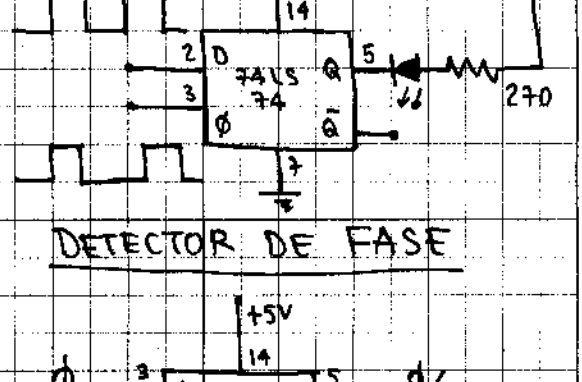
SECUENCIADOR HACIA ADELANTE Y HACIA ATRAS. 1 → 16 16 → 1
POR PASO DE RELOJ.

PAPEL MILIMETRADO HERALD

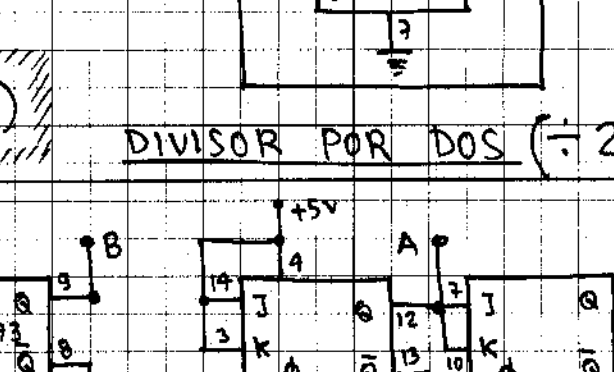
CIRCUITOS DIGITALES CONTINUACIÓN . . .



TONE STEPPER

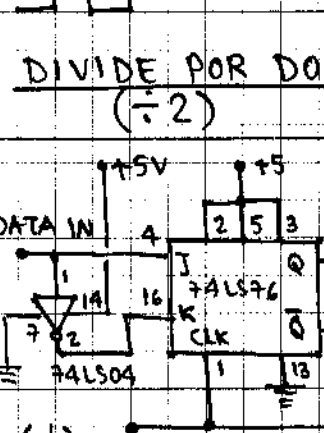


DETECTOR DE FASE

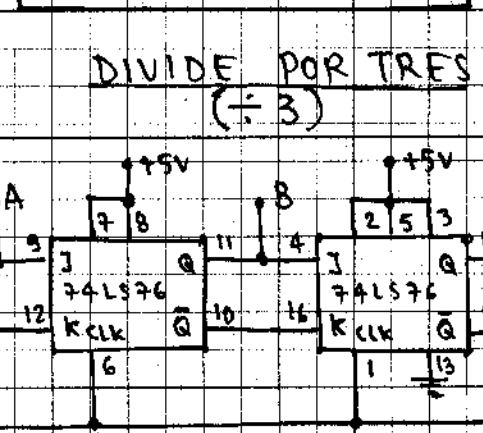


Φ = RELOJ (CLK = CLOCK)

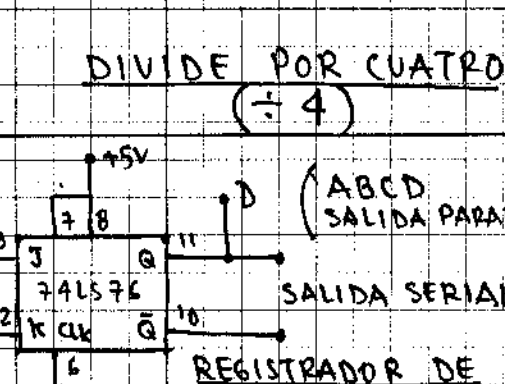
DIVISOR POR DOS (÷ 2)



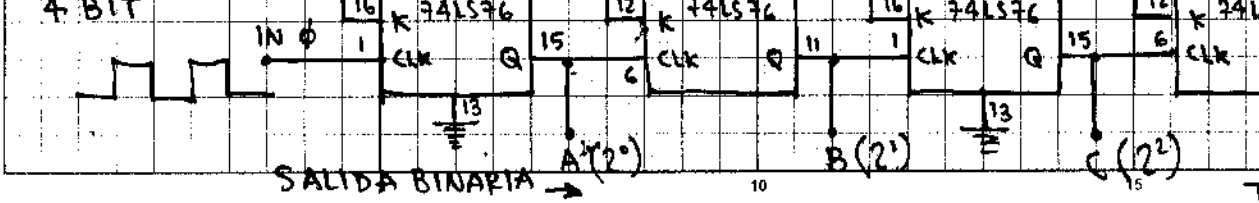
DIVIDE POR DOS (÷ 2)



DIVIDE POR TRES (÷ 3)



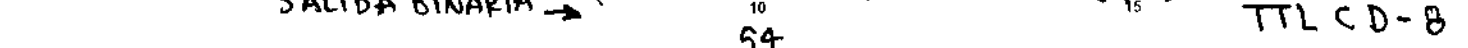
DIVIDE POR CUATRO (÷ 4)



(ABCD SALIDA PARALELA)

SALIDA SERIAL

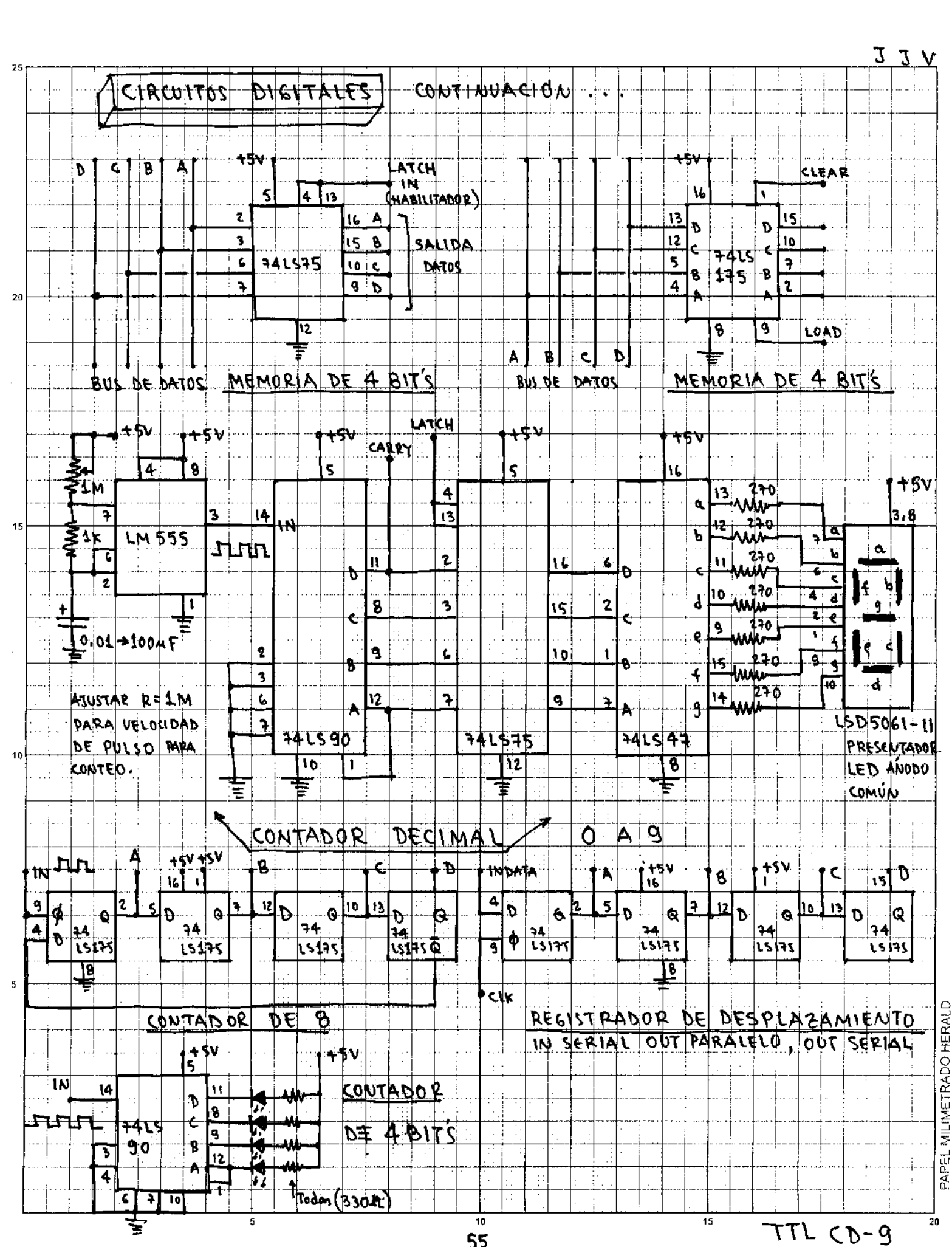
REGISTRADOR DE DESPLAZAMIENTO 4 BIT PARALELO O SERIE



TTL CD-8

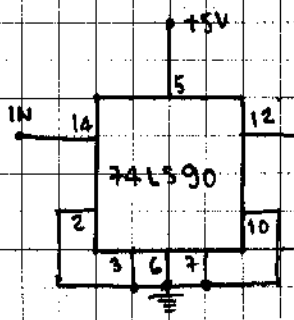
PAPEL MILIMETRADO HERALD

CIRCUITOS DIGITALES CONTINUACIÓN . . .

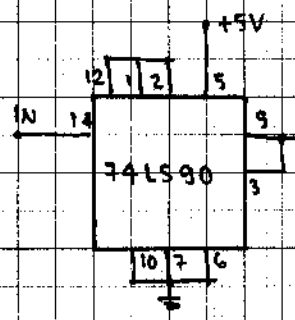


PAPEL MILIMETRADO HERALD

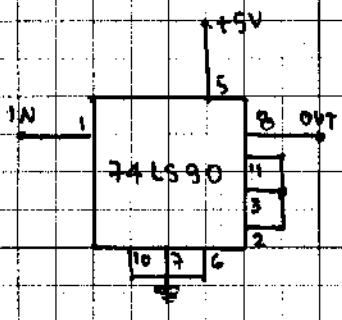
CIRCUITOS DIGITALES CONTINUACIÓN . . .



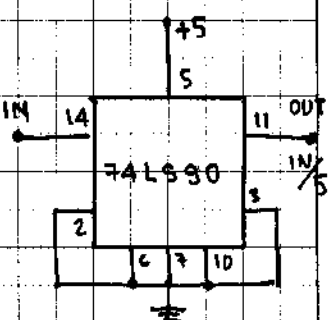
DIVIDE POR 2



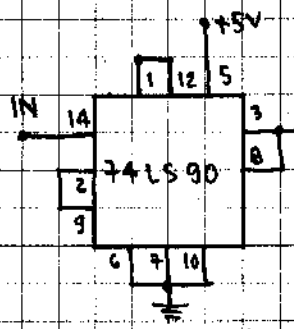
DIVIDE POR 3



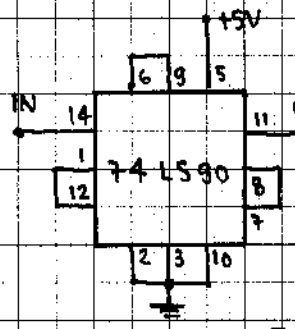
DIVIDE POR 4



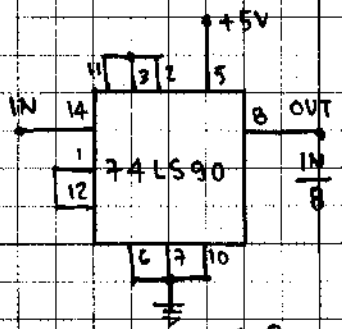
DIVIDE POR 5



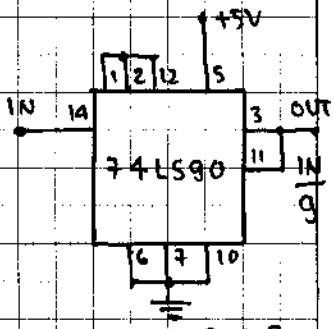
DIVIDE POR 6



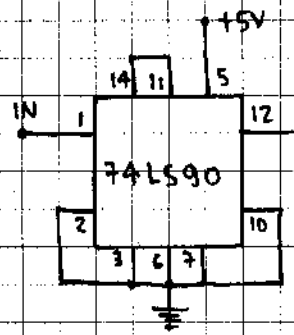
DIVIDE POR 7



DIVIDE POR 8



DIVIDE POR 9



DIVIDE POR 10

PARA TODOS LOS DIVISORES:

TREN DE PULSO A LA ENTRADA (IN)

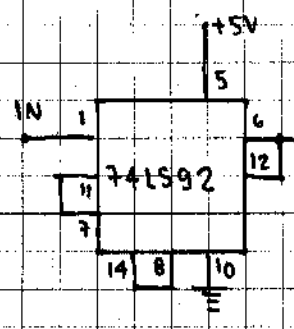
EJ:

2 KHz (IN)
1 KHz (OUT) ÷2

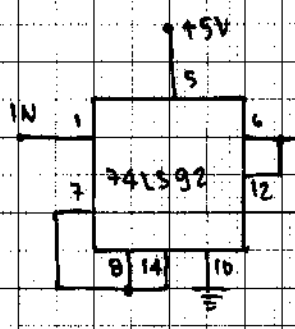
9 KHz (IN)
3 KHz (OUT) ÷3

8 KHz (IN)
1 KHz (OUT) ÷8

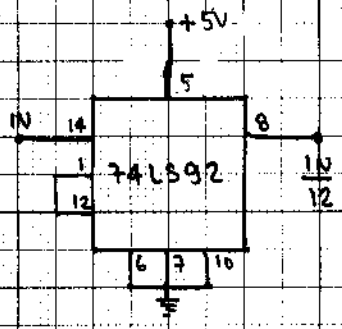
600 Hz (IN)
60 Hz (OUT) ÷10



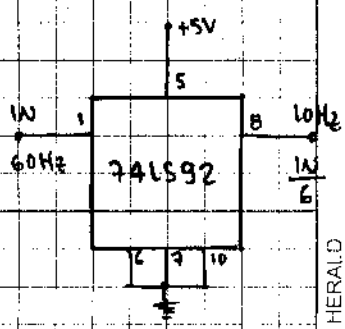
DIVIDE POR 7



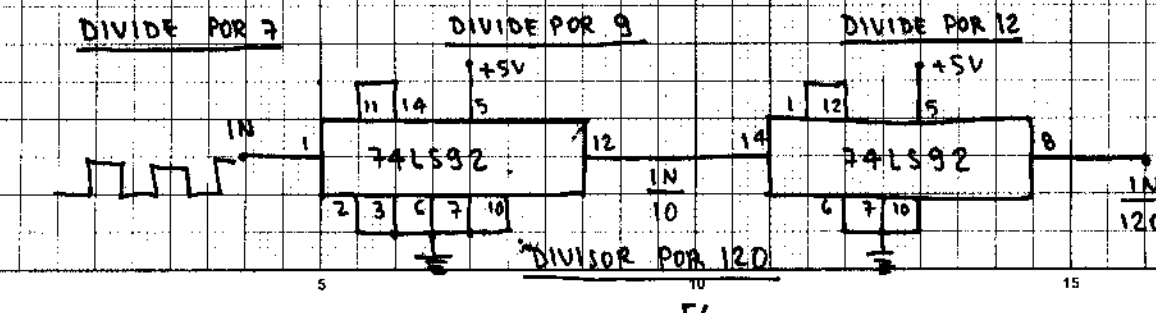
DIVIDE POR 9



DIVIDE POR 12



DIVIDE POR 6

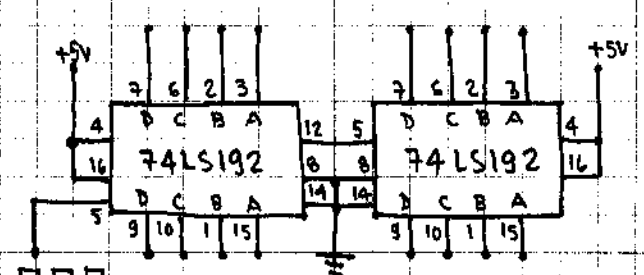


DIVISOR POR 120

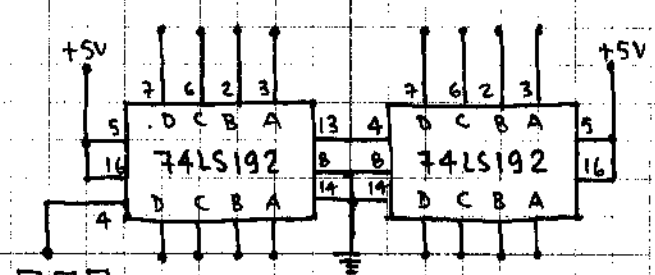
PAPEL MILIMETRADO HERALD

CIRCUITOS DIGITALES

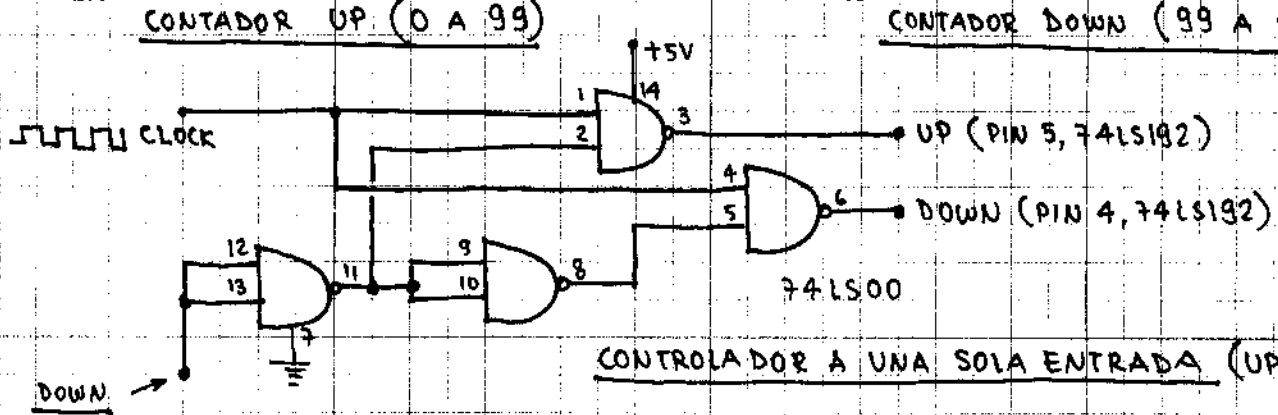
CONTINUACIÓN . . .



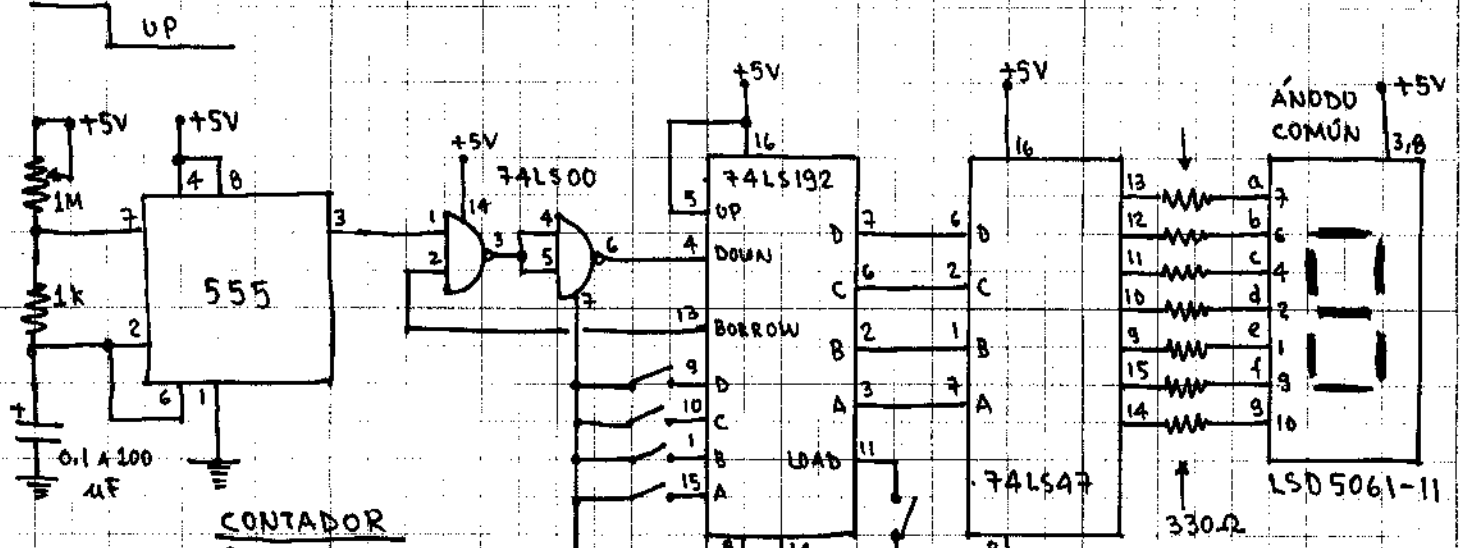
CONTADOR UP (0 A 99)



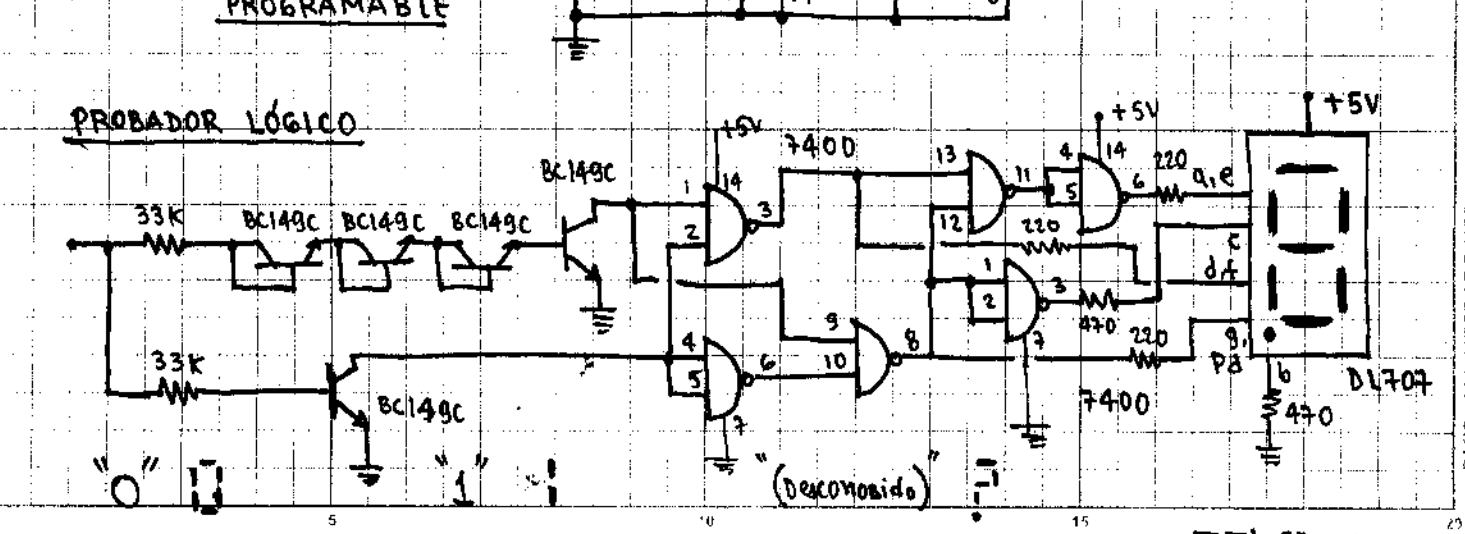
CONTADOR DOWN (99 A 0)



CONTROLADOR A UNA SOLA ENTRADA (UP, DOWN)

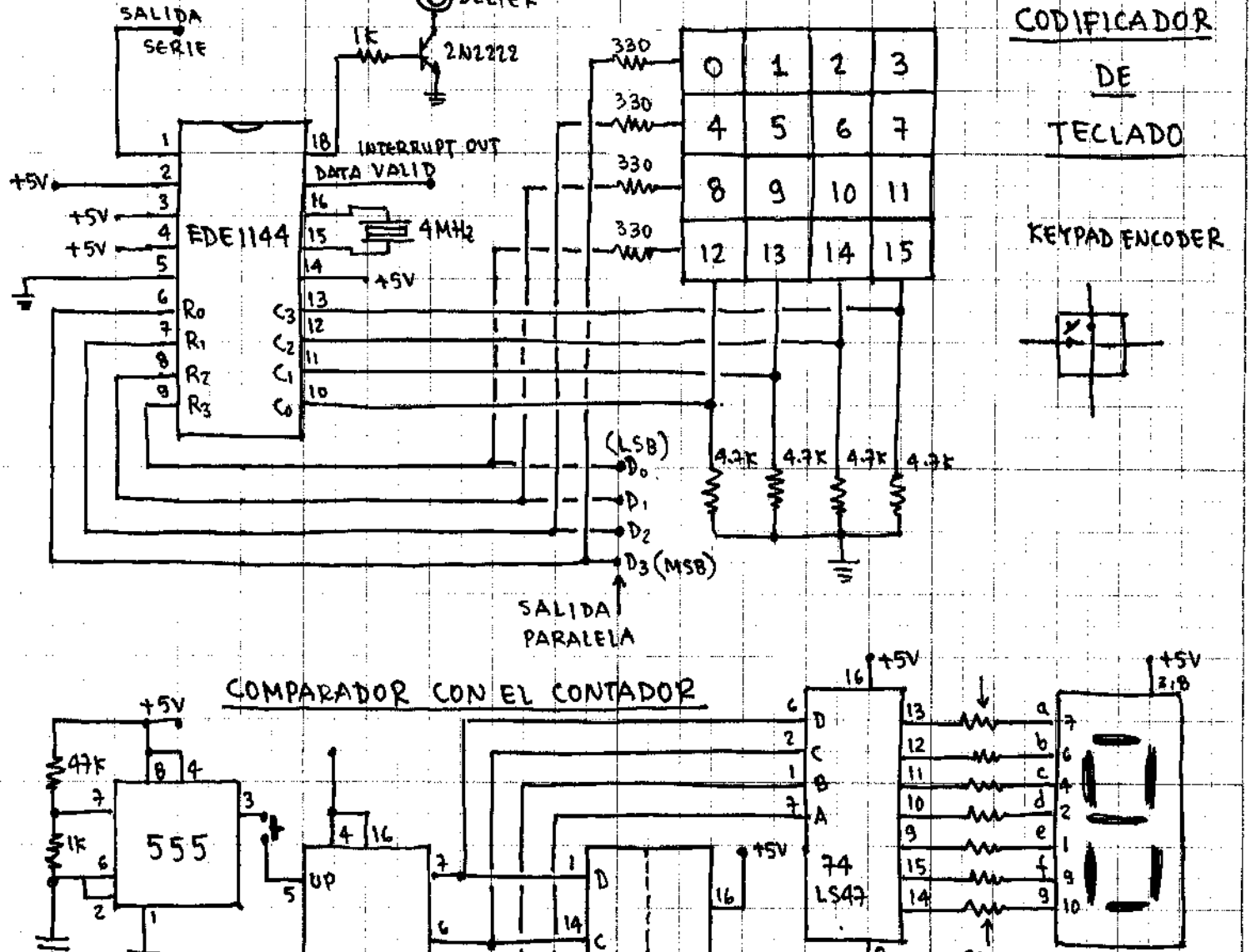


CONTADOR PROGRAMABLE

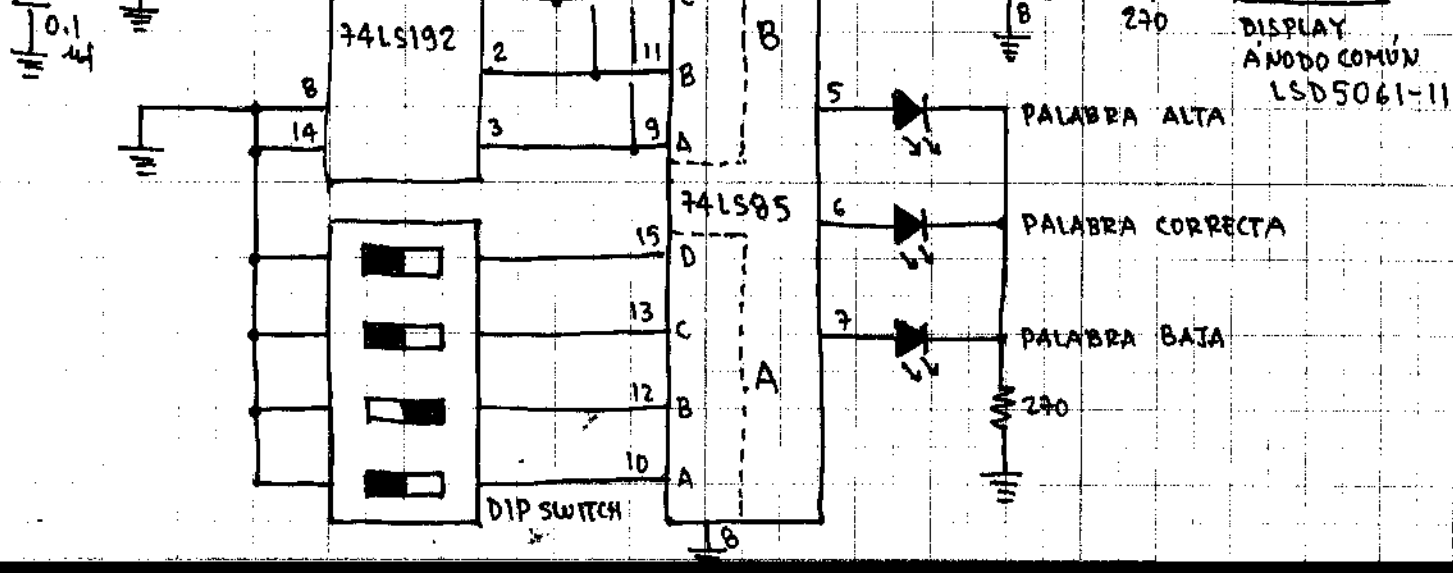


PAPEL MILIMETRADO HERALD

CIRCUITOS DIGITALES CONTINUACIÓN . . .

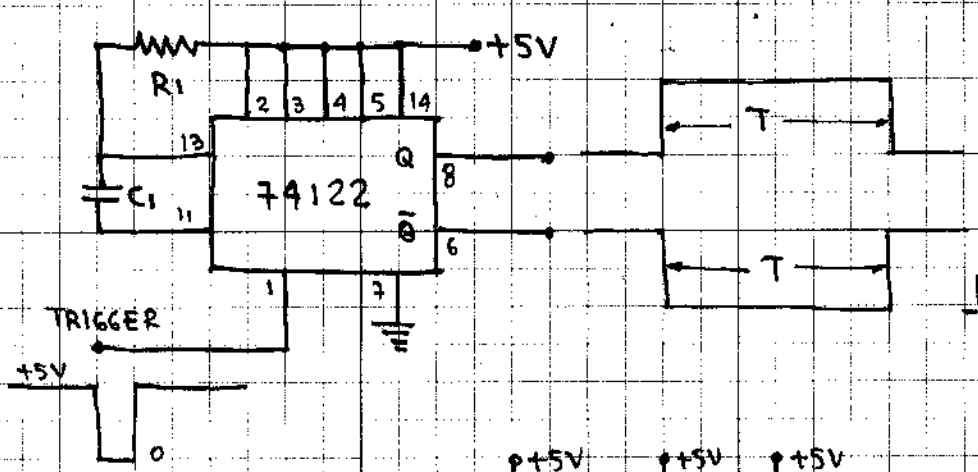


COMPARADOR CON EL CONTADOR



PAPEL MILIMETRADO HERALD

CIRCUITOS DIGITALES CONTINUACIÓN ...

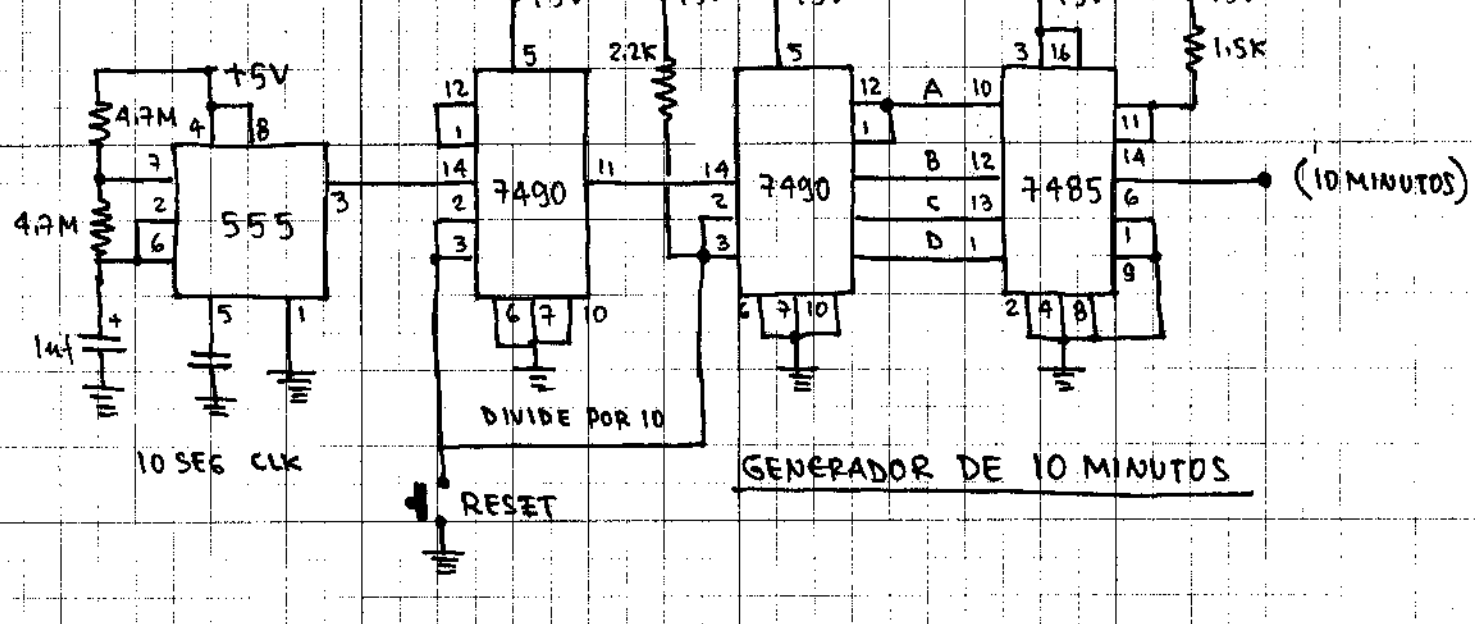


$$T = 0.37\, R_1 C_1 \left[1 + \frac{0.7}{R_1}\right]$$

R_1 : EN KILOOHMS

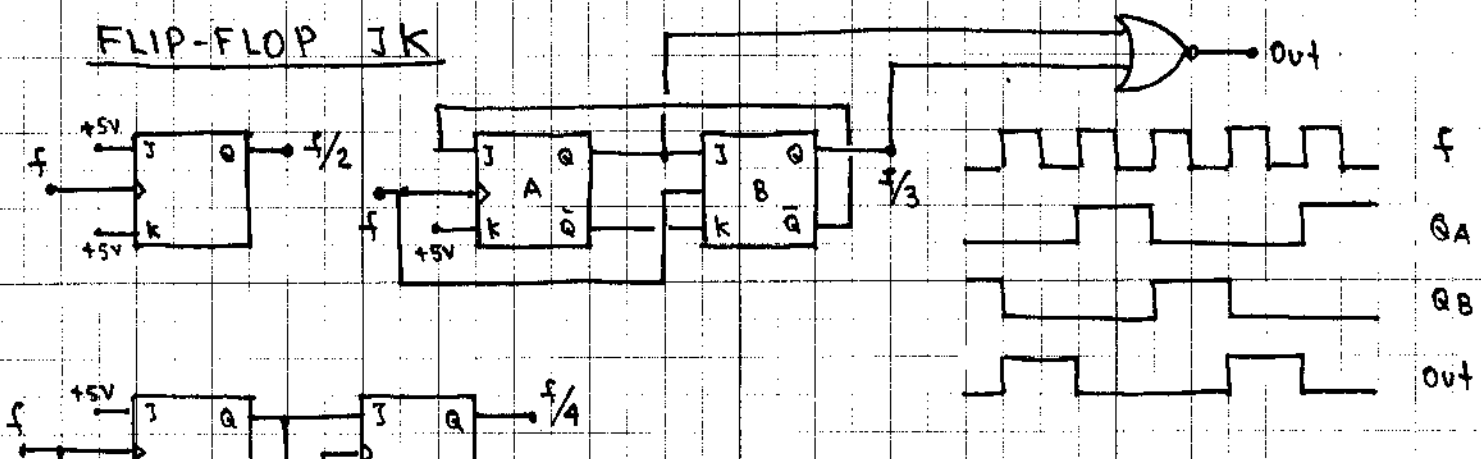
C_1 : EN PICOFARADIOS

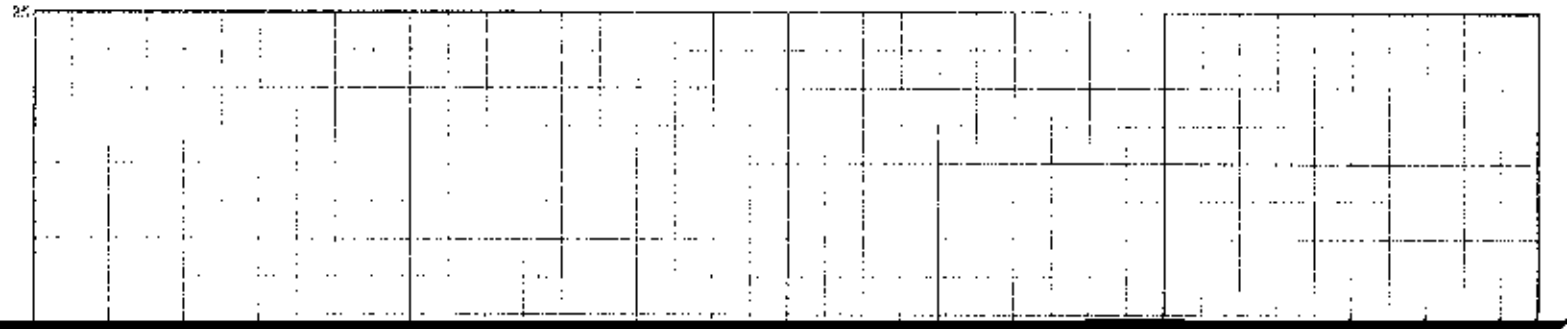
MONOESTABLE (ONE SHOT)



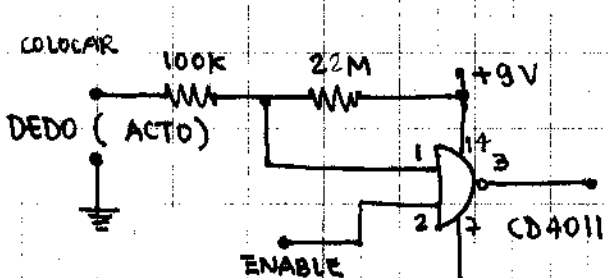
GENERADOR DE 10 MINUTOS

FLIP-FLOP JK

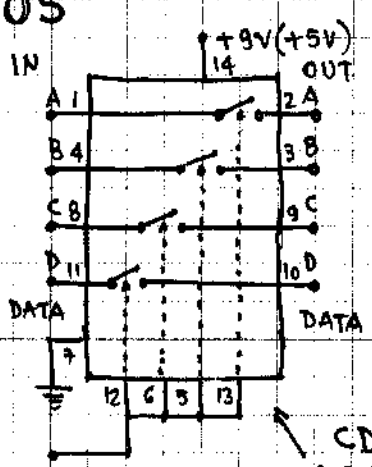




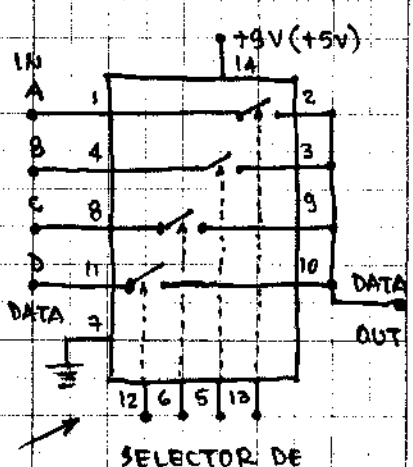
CIRCUITOS DIGITALES CMOS



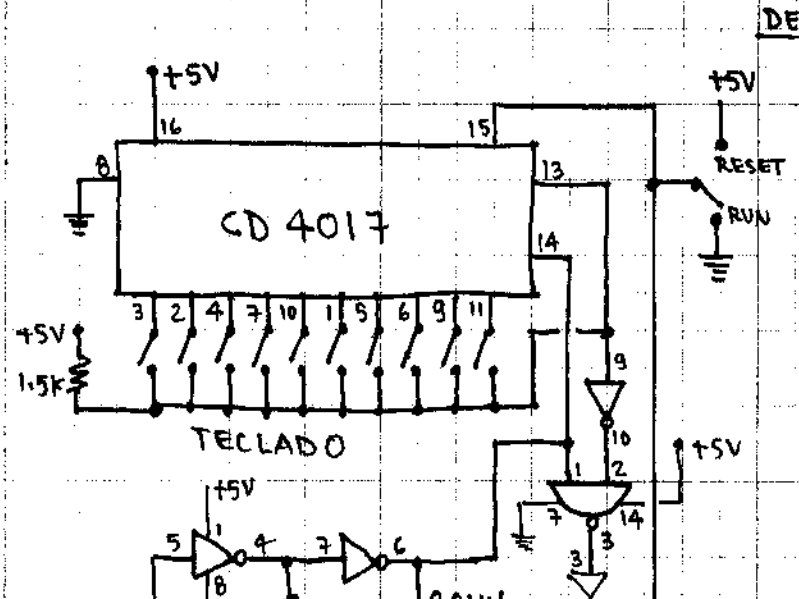
INTERRUPTOR DE TACTO



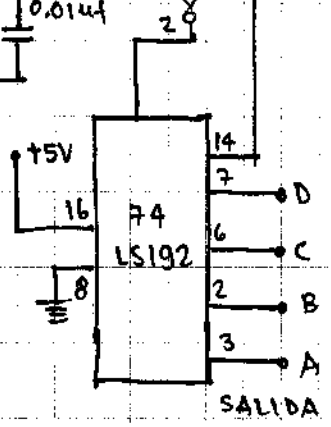
CONTROL DE BUS DE DATOS



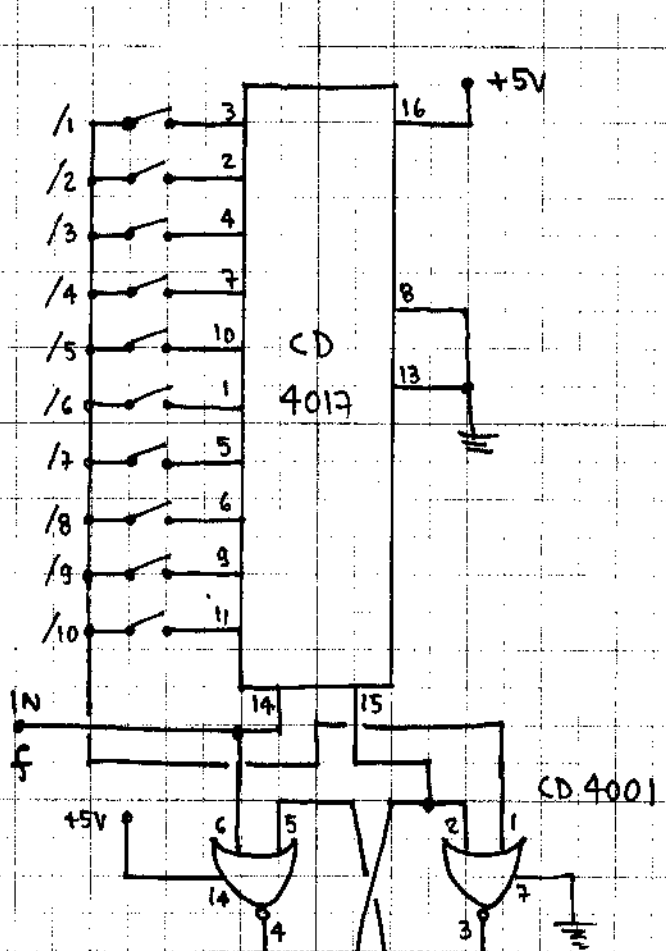
SELECTOR DE DATOS



INVERSORES : CD 4049
NAND : CD 4011



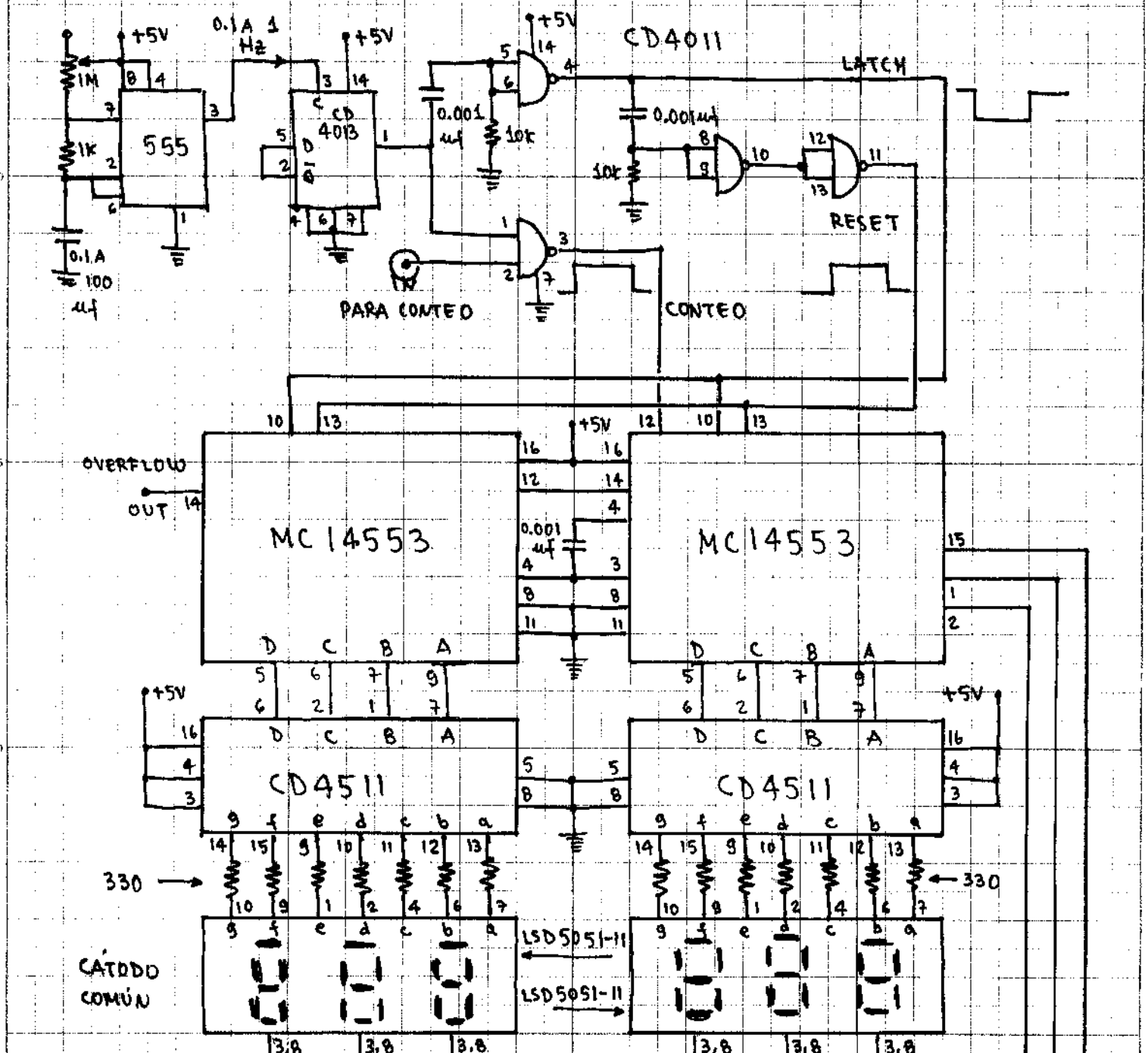
TECLADO A BCD



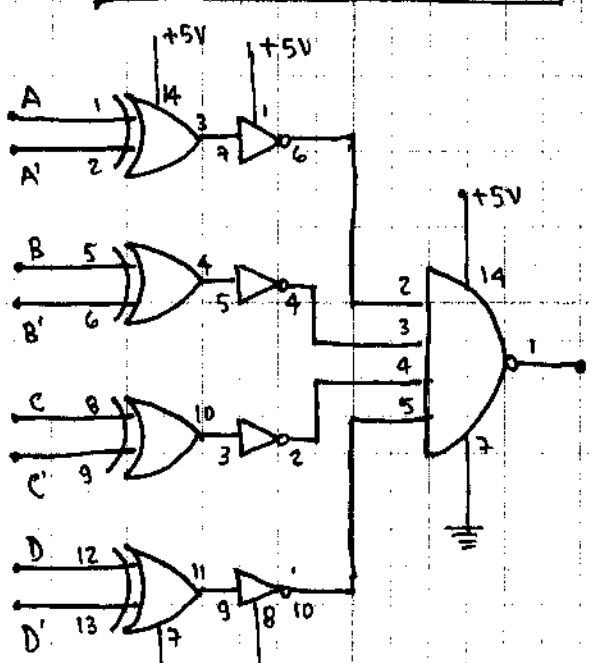
DIVISOR DE FRECUENCIAS

CIRCUITOS DIGITALES

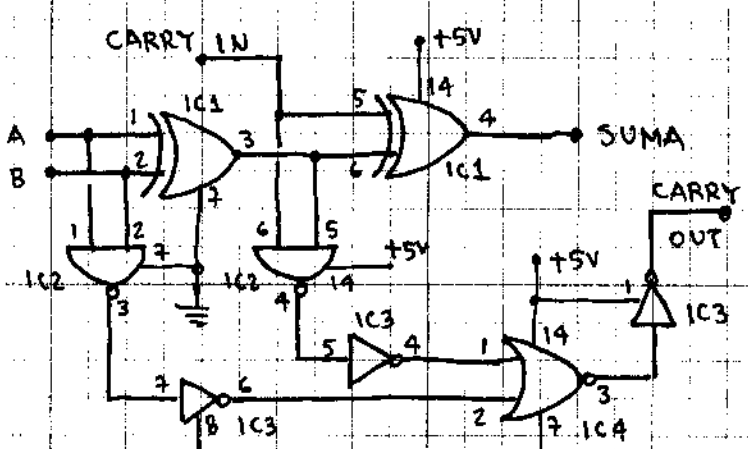
CONTINUACIÓN . . .



CIRCUITOS DIGITALES CONTINUACIÓN . . .

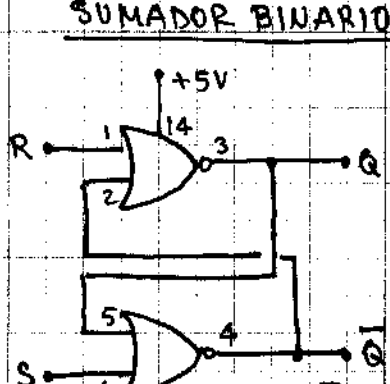


COMPARADOR DE 4 BITS



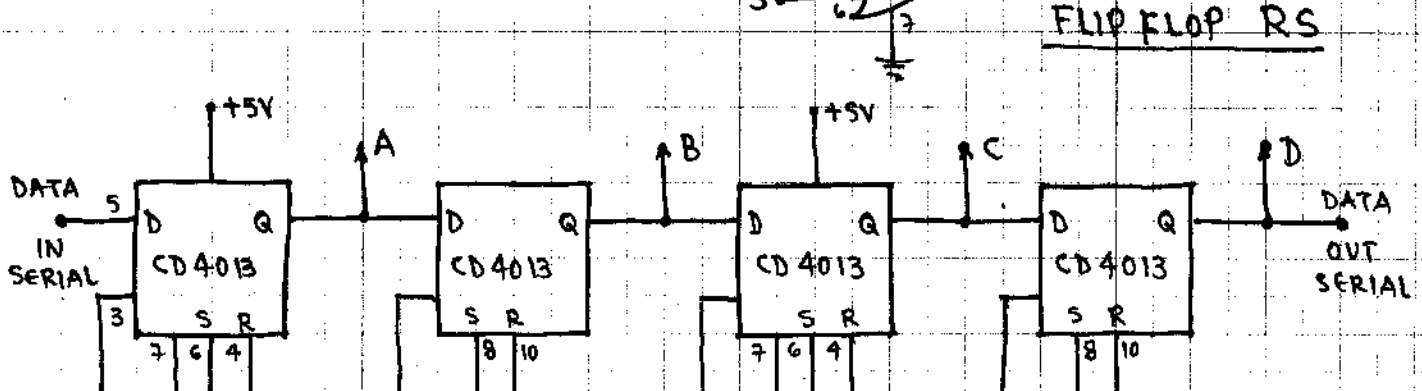
IC1 : CD4070 IC2 : CD4011
IC3 : CD4049 IC4 : CD4001

SUMADOR BINARIO COMPLETO



R	S	Q	$\bar{Q}$
0	0	NO CAMBIA	
0	1	1	0
1	0	0	1
1	1	INVALIDO	

FLIP FLOP RS



REGISTRADOR DE DESPLAZAMIENTO

ENTRADA : SERIE
SALIDA : SERIE Y PARALELO

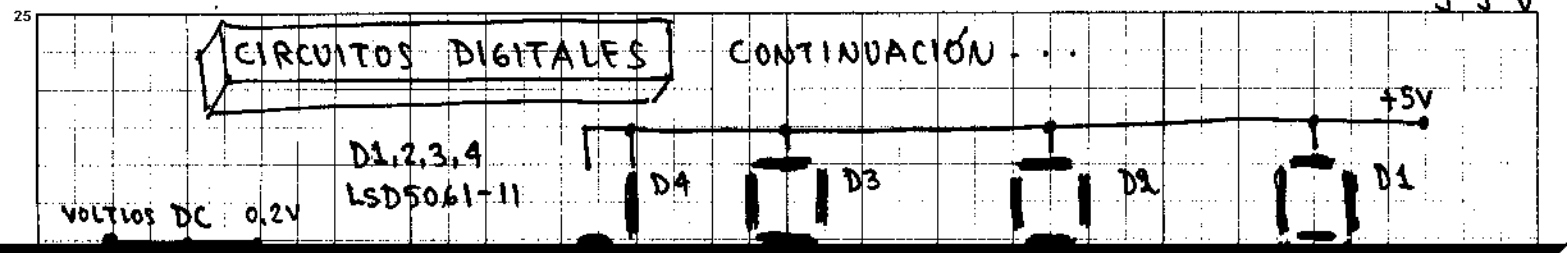
JJV

CIRCUITOS DIGITALES CONTINUACIÓN . . .

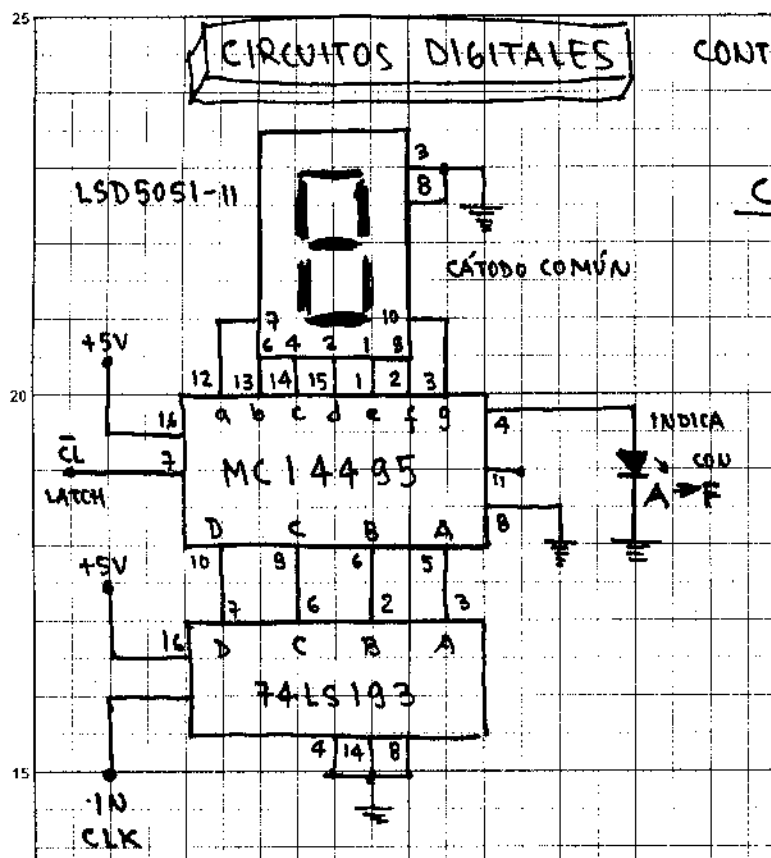
LSD5061-11 LSD5061-11 LSD5061-11 LSD5061-11

J J V

CIRCUITOS DIGITALES CONTINUACIÓN . . .



CIRCUITOS DIGITALES CONTINUACIÓN . . .

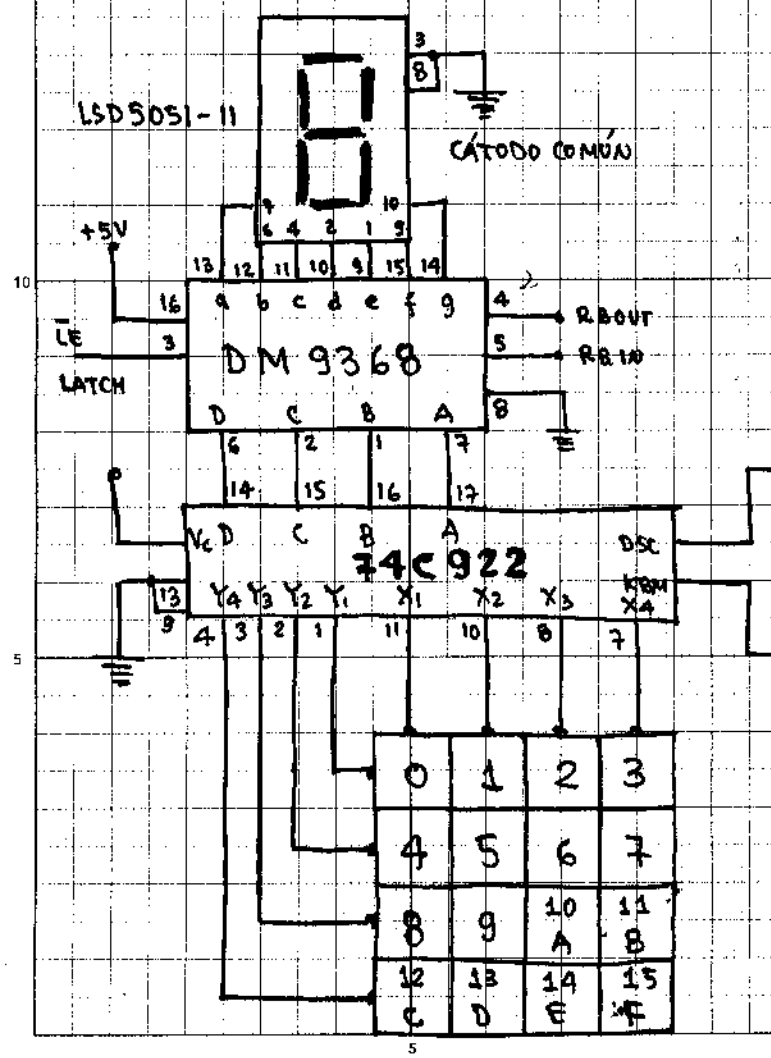


CONTADOR HEXADECIMAL

0 1 2 3 4 5 6 7 8 9 A b C d E F

MC14495
BCD A 7 SEGMENTOS
DECODIFICADOR HEXADECIMAL
LATCH - DECODER - DRIVER

74LS93
CONTADOR DE 4 BIT UP/DOWN



TECLADO 0 → 15, SALIDA BCD

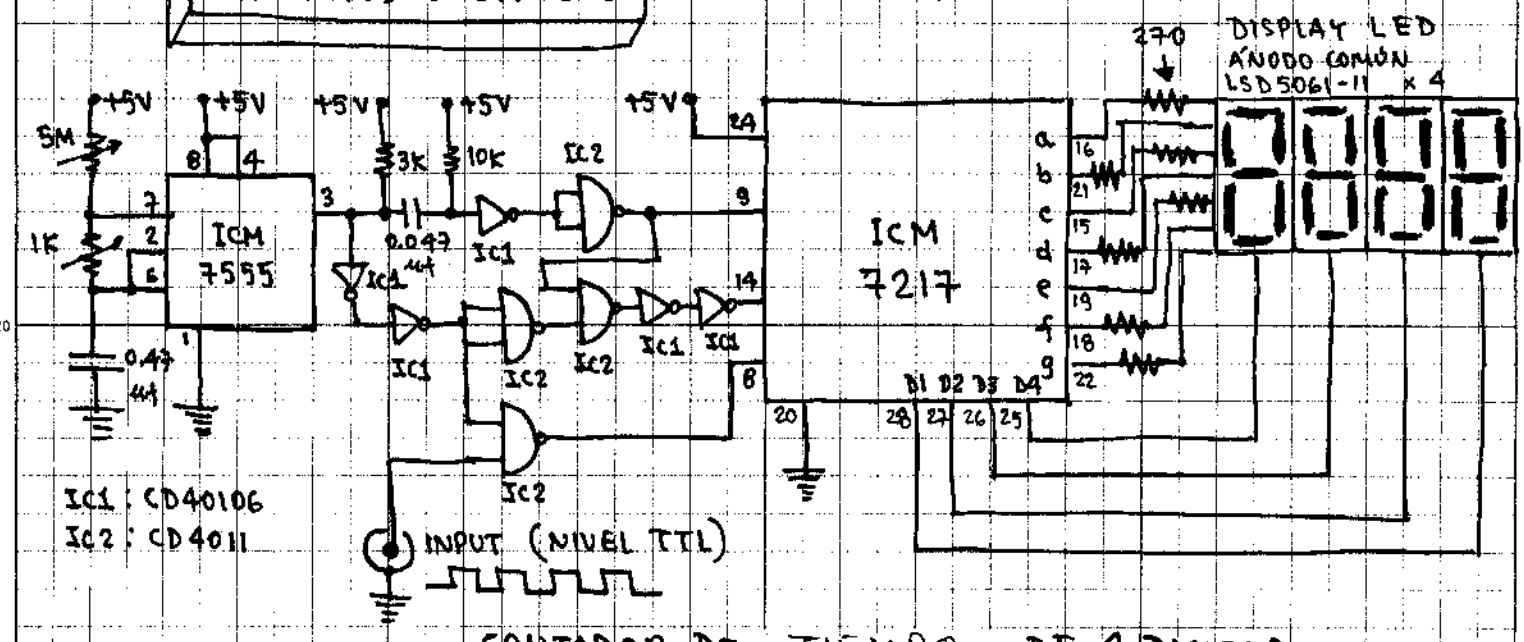
DM9368
DECODIFICADOR HEXADECIMAL
BCD A 7 SEGMENTOS
LATCH - DECODER - DRIVER

0 1 2 3 4 5 6 7 8 9 A b C d E F

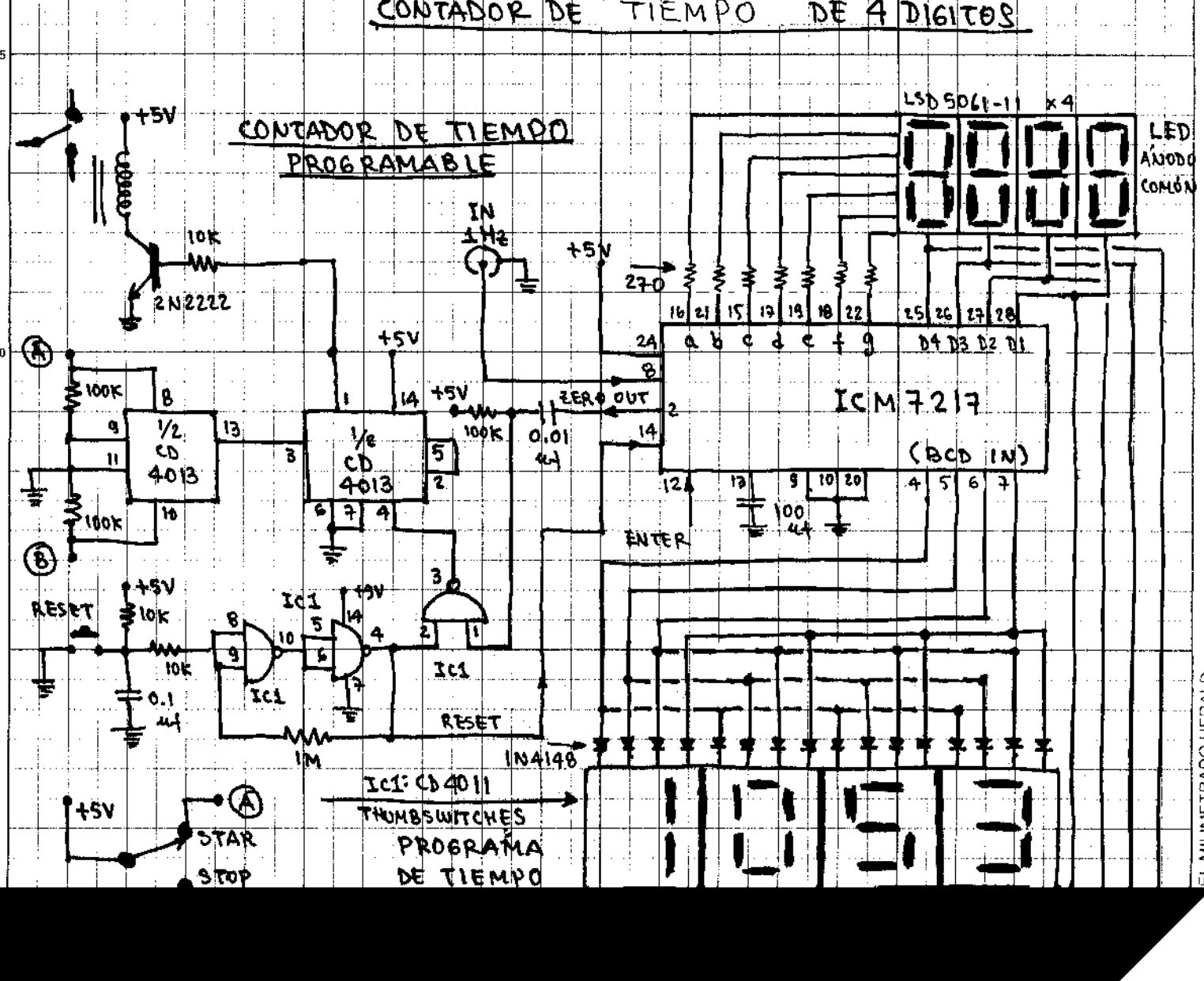
LAS SALIDAS A, B, C, D BCD, SE PUEDE USAR PARA OTROS PROYECTOS U OTRAS APLICACIONES.

IC 74C922 CONVERTIDOR TECLADO A BCD. HEXA-DECIMAL

CIRCUITOS DIGITALES CONTINUACIÓN...

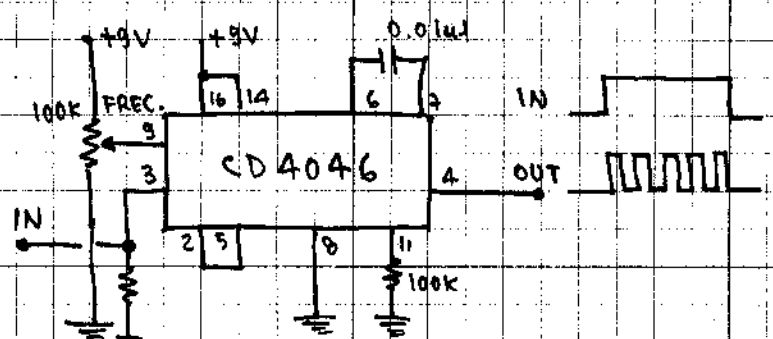


CONTADOR DE TIEMPO DE 4 DIGITOS

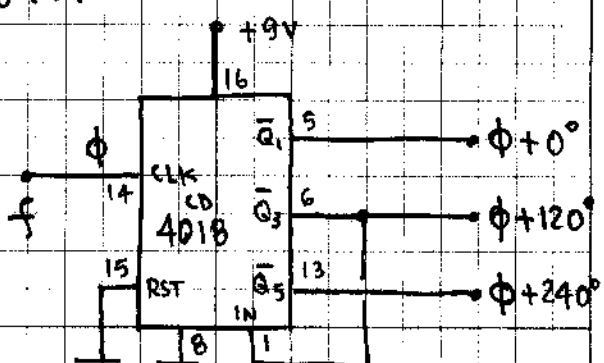


EL MILIMETRADO HERALD

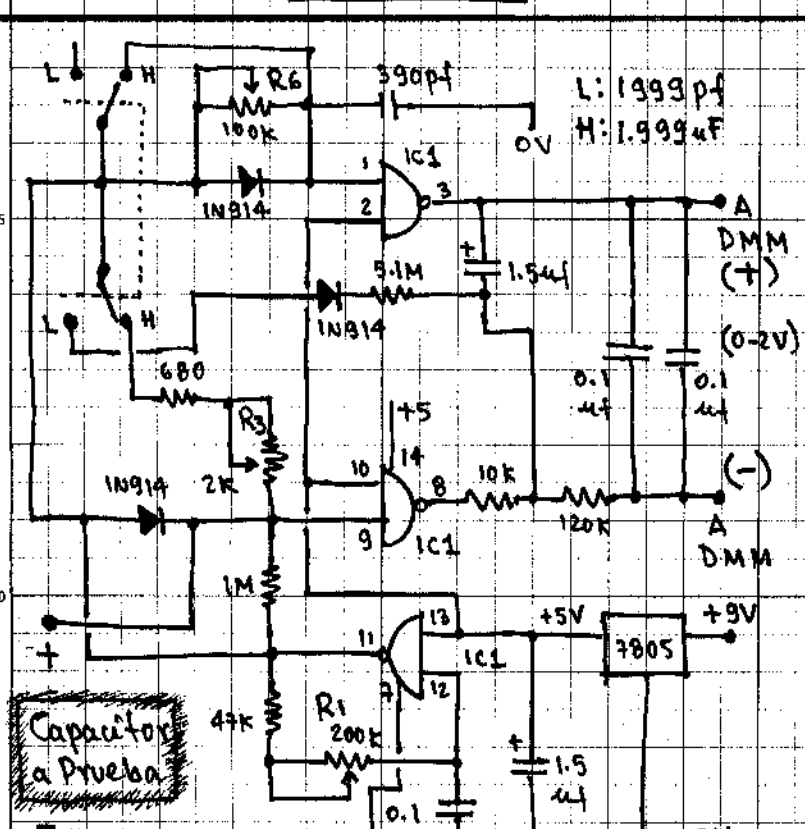
CIRCUITOS DIGITALES CONTINUACIÓN . . .



OSCILADOR CONTROLADO POR VOLTAJE



GENERADOR DE 3 FASES

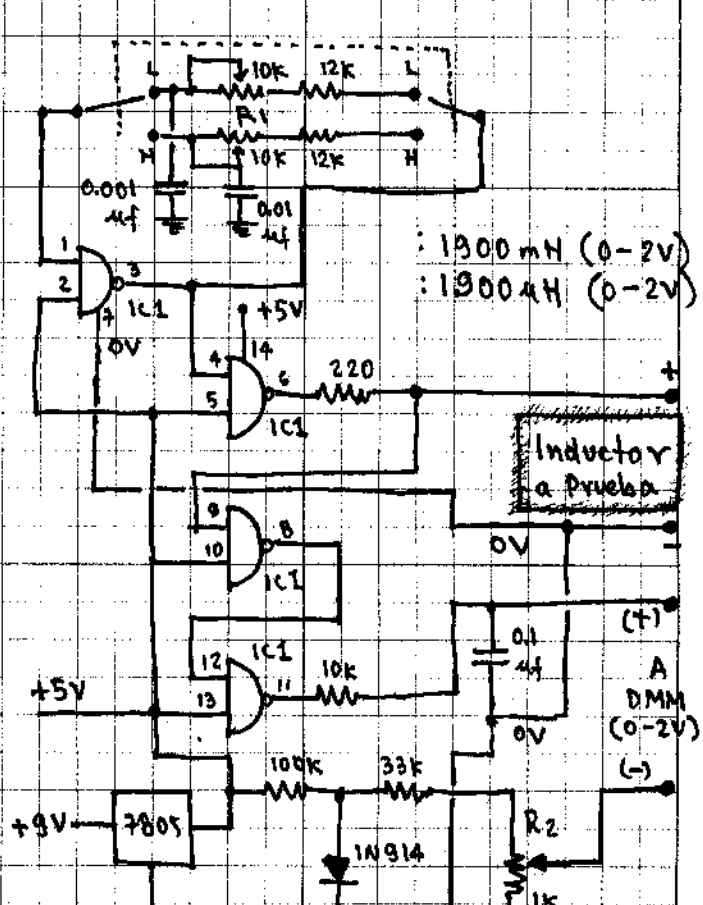


IC1: 74HC132 ADAPTADOR

CAPACÍMETRO

DMM: Multimetro Digital en escala Voltios 0-2.
Ajustar R6: a cero lectura

1000pf = 1.000V (Ajustar R_1)
1uf = 1.000V (Ajustar R_3)



: 1900 mH (0-2V)
: 1900 uH (0-2V)

IC1: 74HC132

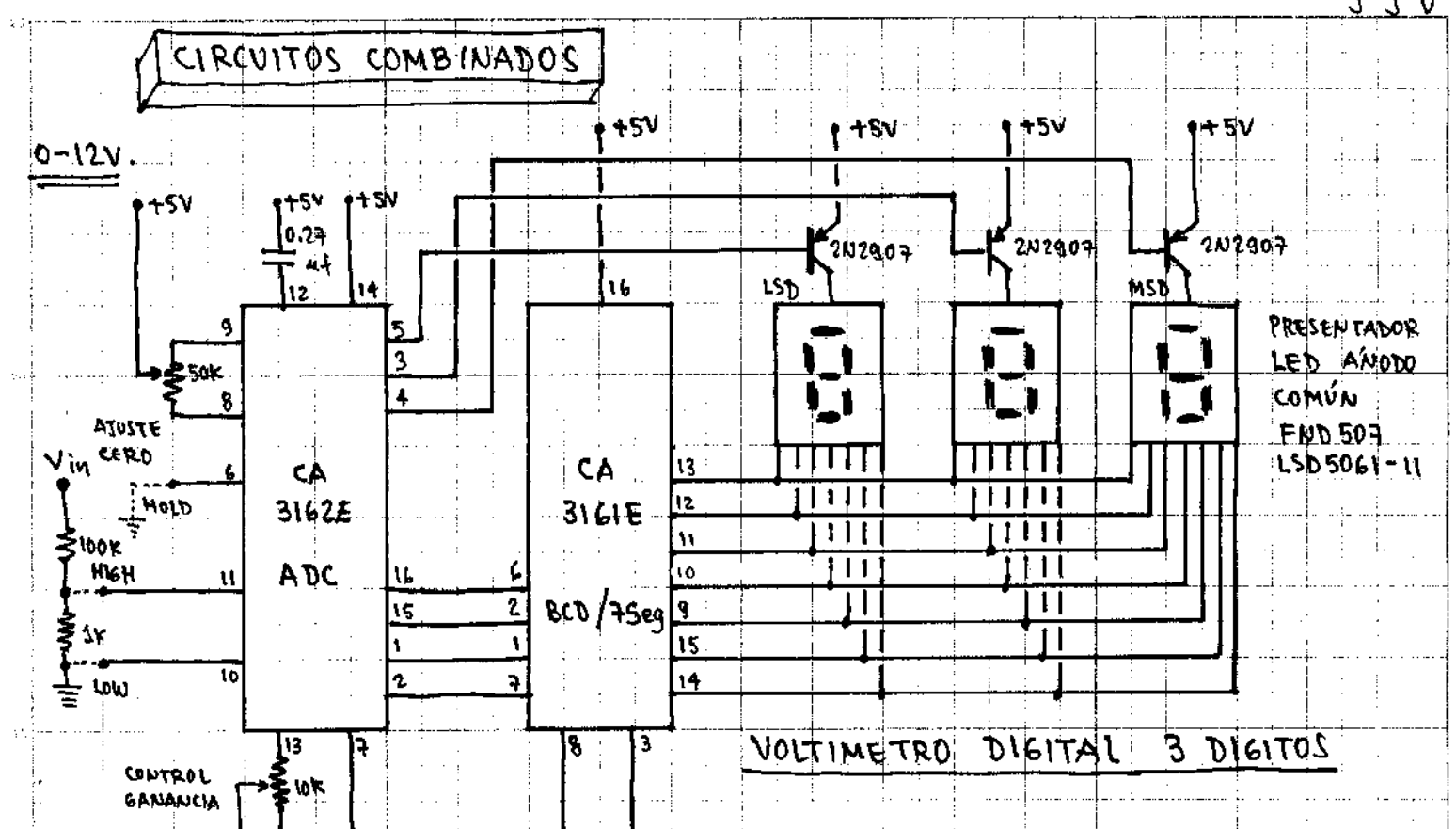
INDUCTÍMETRO ADAPTADOR

DMM: USAR MULTIMETRO DIGITAL en escala voltios 0-200 mV y 0-2 Voltios
Ajustar R_2 para cero lectura.
400 uH = 0.4 Voltios escala H

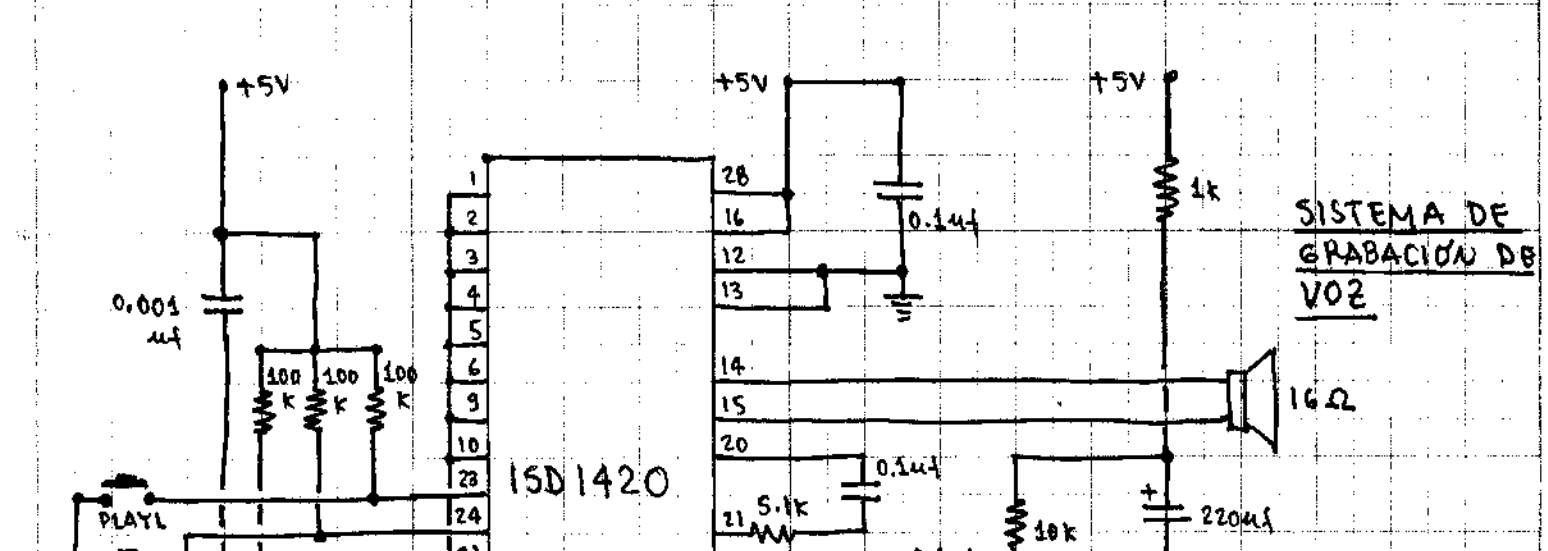
PAPEL MILIMETRADO HERALD

CIRCUITOS COMBINADOS

CIRCUITOS COMBINADOS

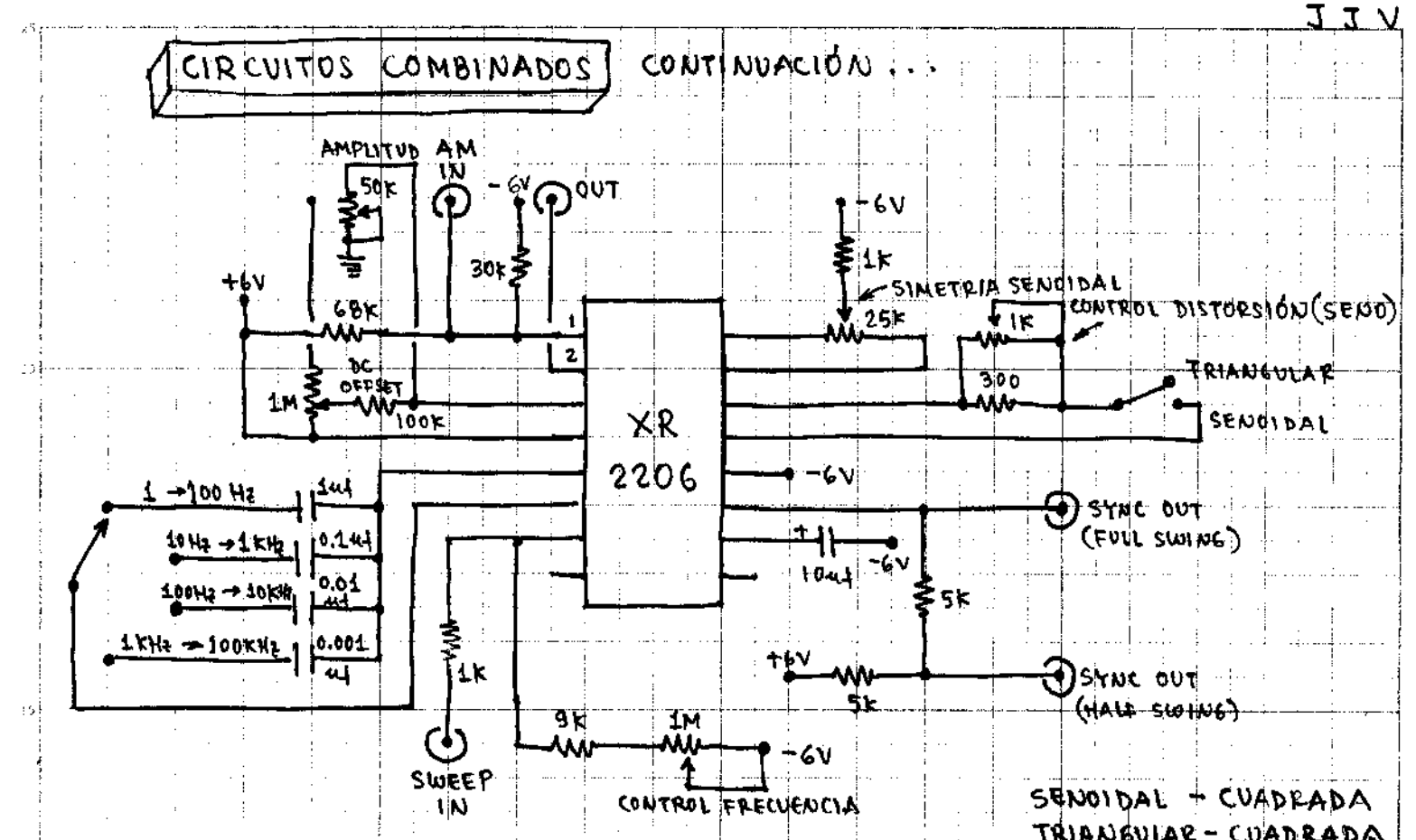


VOLTIMETRO DIGITAL 3 DIGITOS



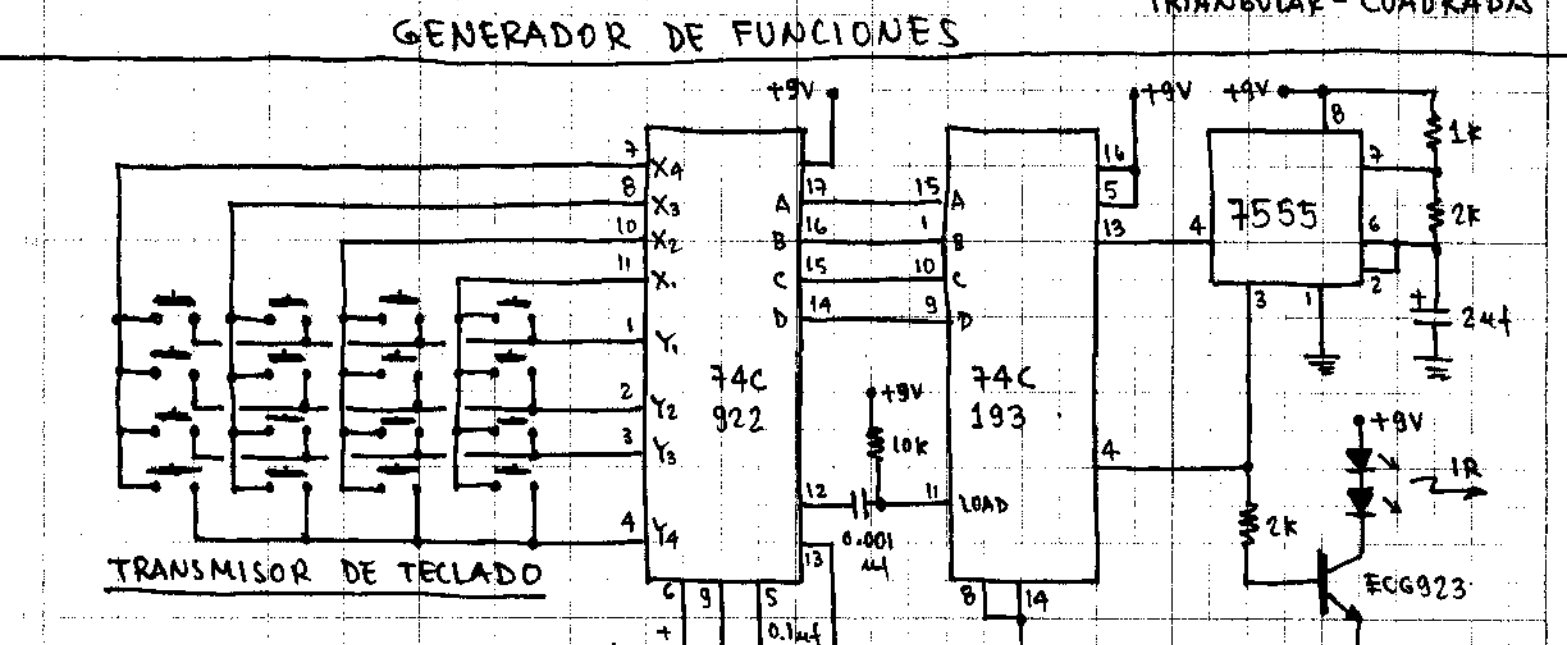
SISTEMA DE GRABACIÓN DE VOZ

CIRCUITOS COMBINADOS CONTINUACIÓN . . .

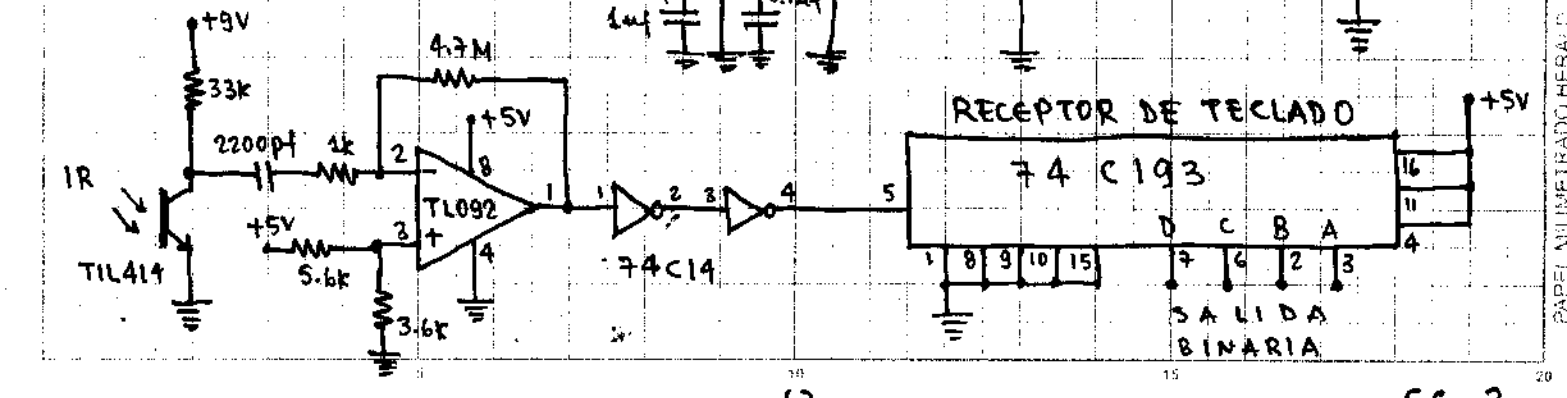


SENOIDAL → CUADRADA
TRIANGULAR - CUADRADA

GENERADOR DE FUNCIONES

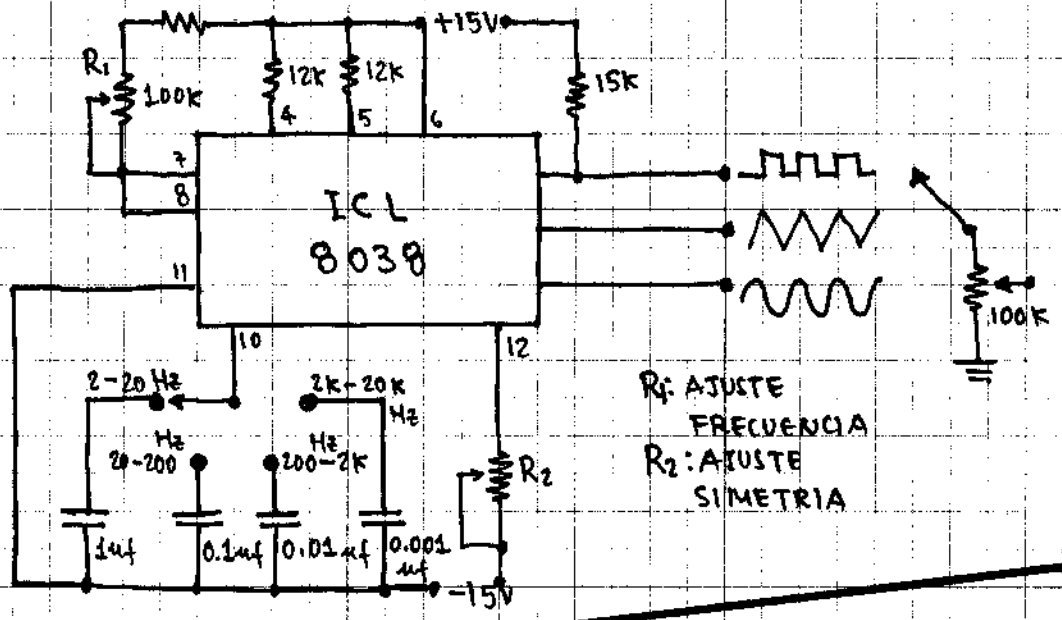


TRANSMISOR DE TECLADO



CIRCUITOS COMBINADOS

CONTINUACIÓN . . .



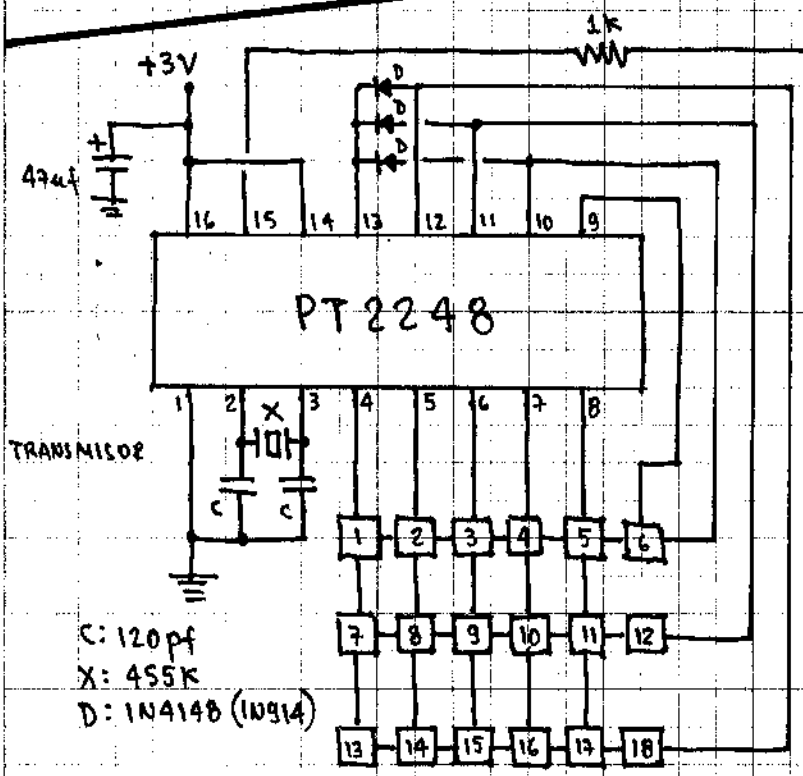
GENERADOR DE FUNCIONES

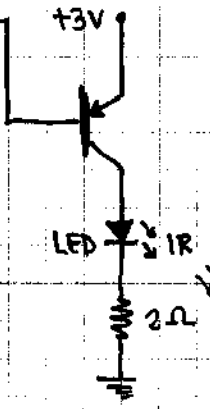
3 formas de ondas simultaneas.

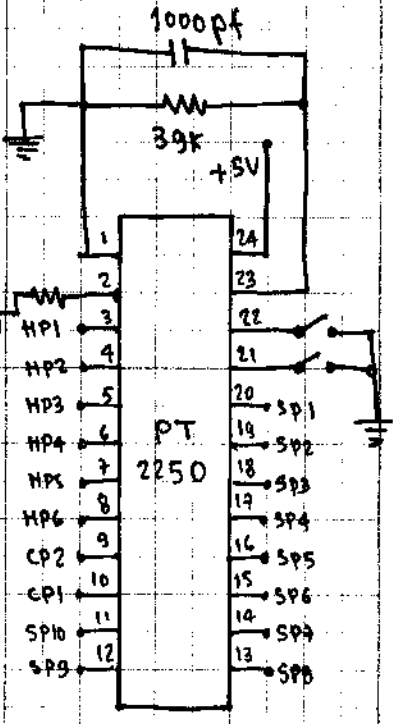
f_{out}: 2Hz a 20KHz

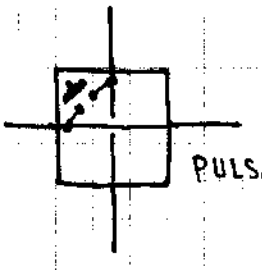
R1: AJUSTE FRECUENCIA

R2: AJUSTE SIMETRIA









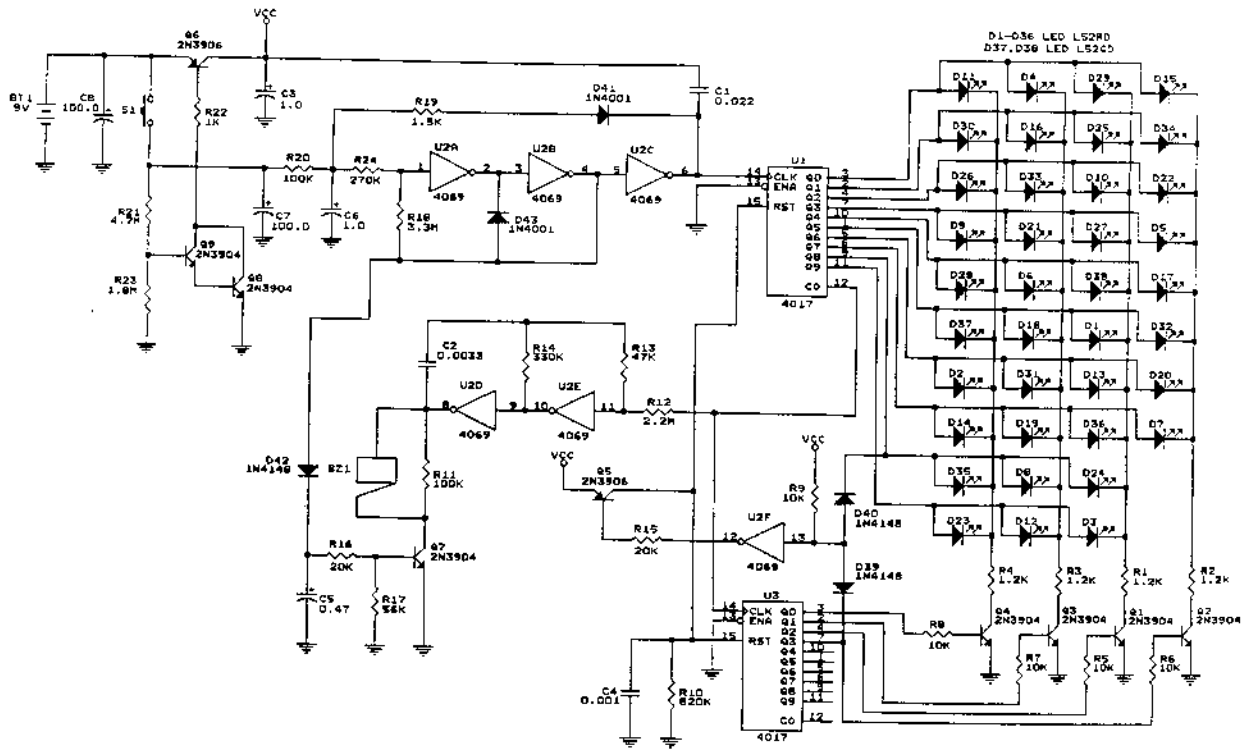
PULSADOR

CONTROL REMOTO

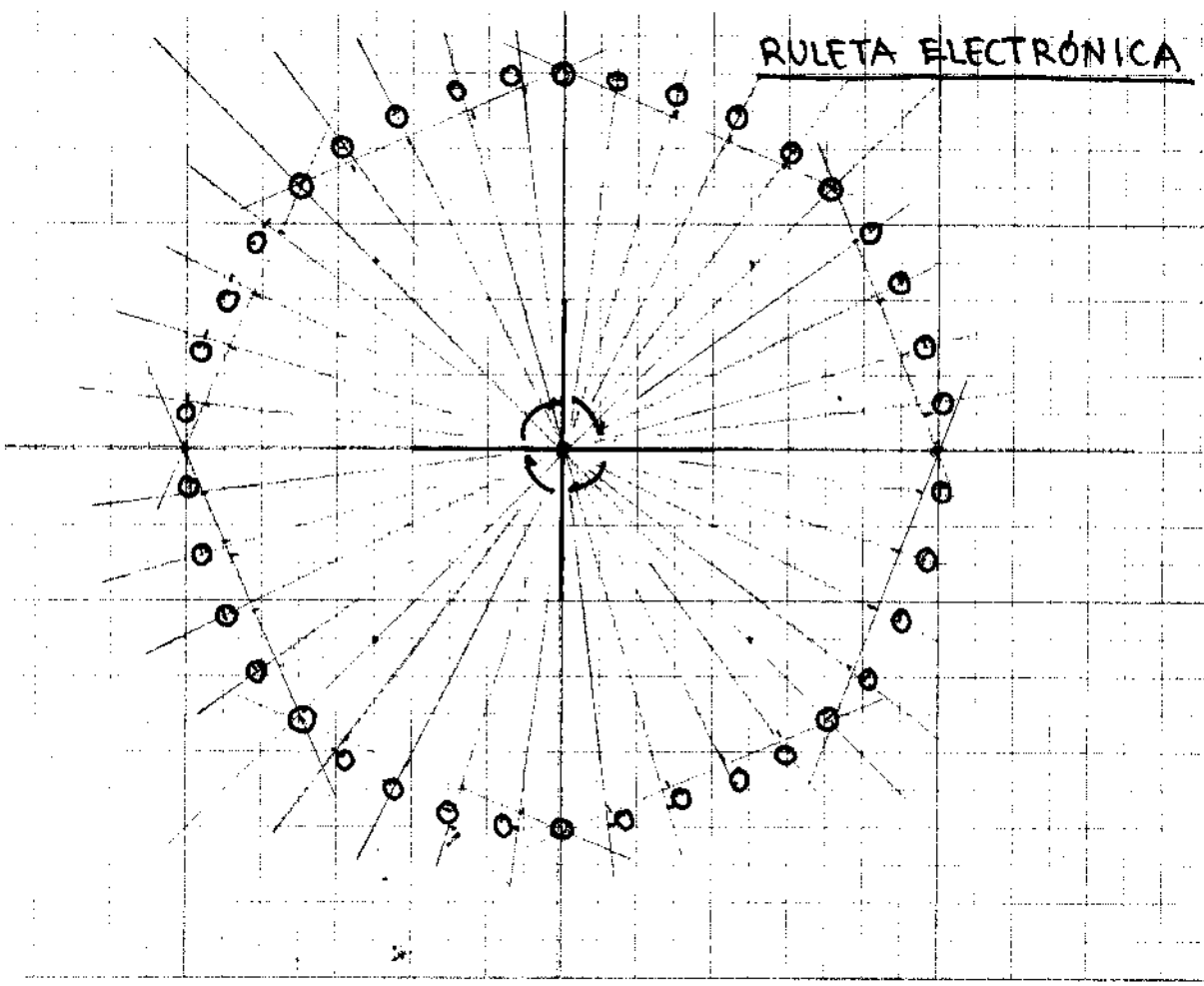
POR INFRARROJO

PAPEL MILIMETRADO HERALD

CIRCUITOS COMBINADOS CONTINUACIÓN . . .

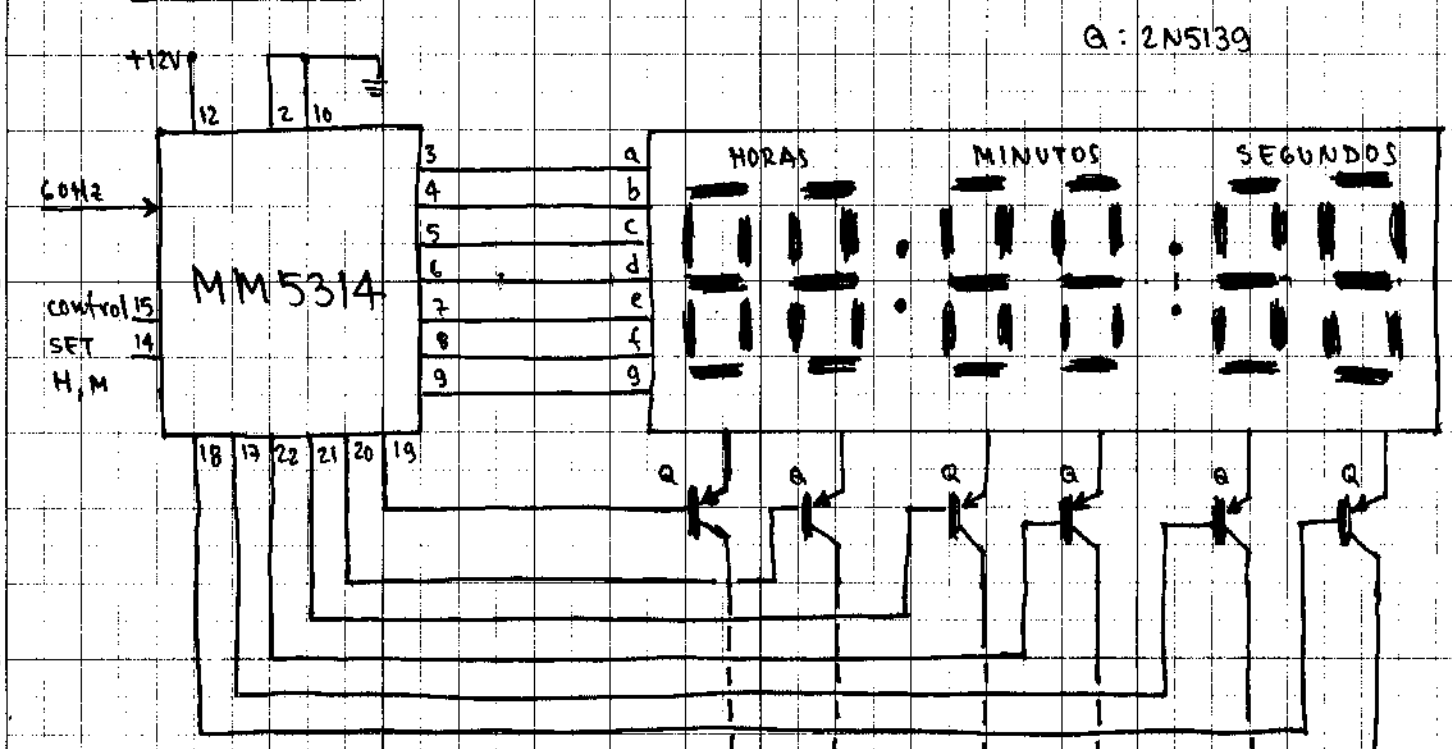


RULETA ELECTRÓNICA

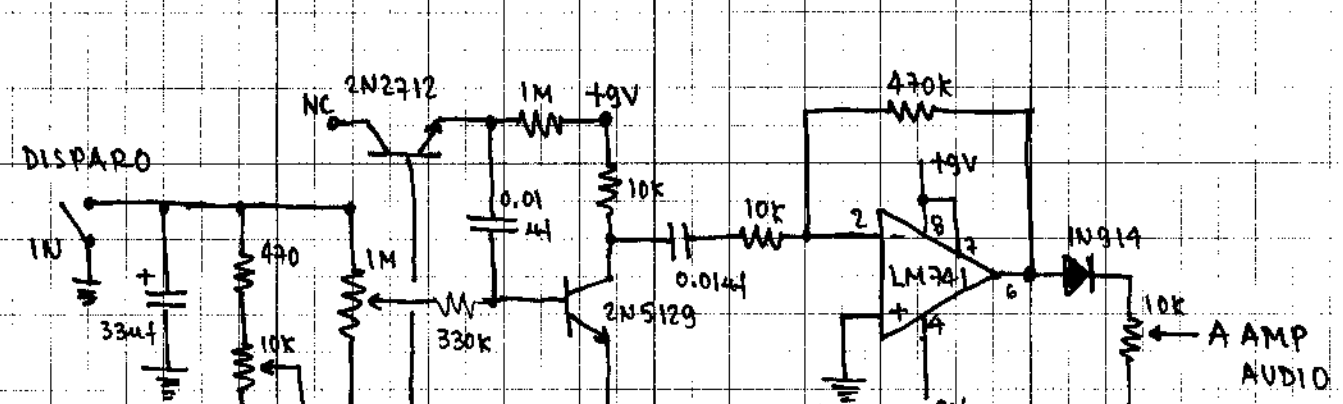


PAPEL MILIMETRADO HERAUD

CIRCUITOS COMBINADOS CONTINUACIÓN . . .

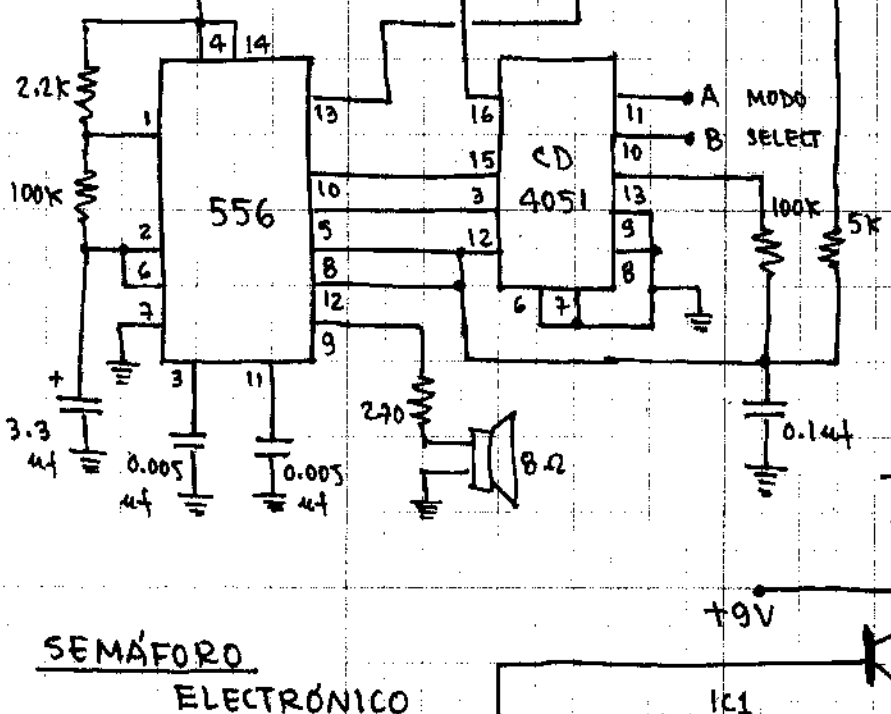


RELOJ DIGITAL 6 DIGITOS



GENERADOR DE EFECTOS DE SONIDO MUSICAL - PLATILLO Y TAMBOR

CIRCUITOS COMBINADOS CONTINUACIÓN . . .

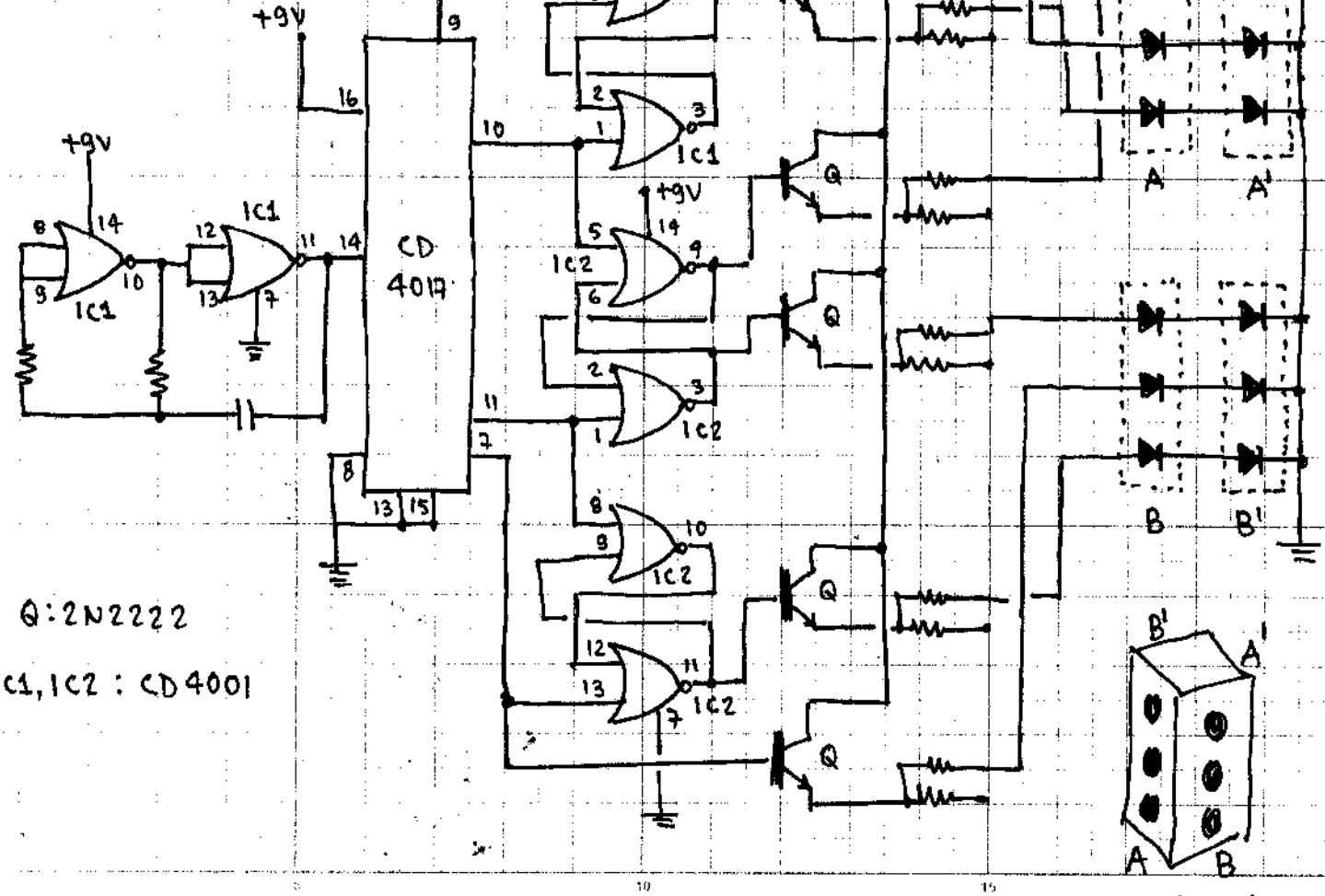


MODO DE SELECCIÓN

B	A	TONO SALIDA
0	0	2 TONOS
0	1	1 TONO
1	0	RÁFAGA DE TONOS
1	1	METRONOME

GENERADOR UNIVERSAL DE TONOS DE 3 ESTADO

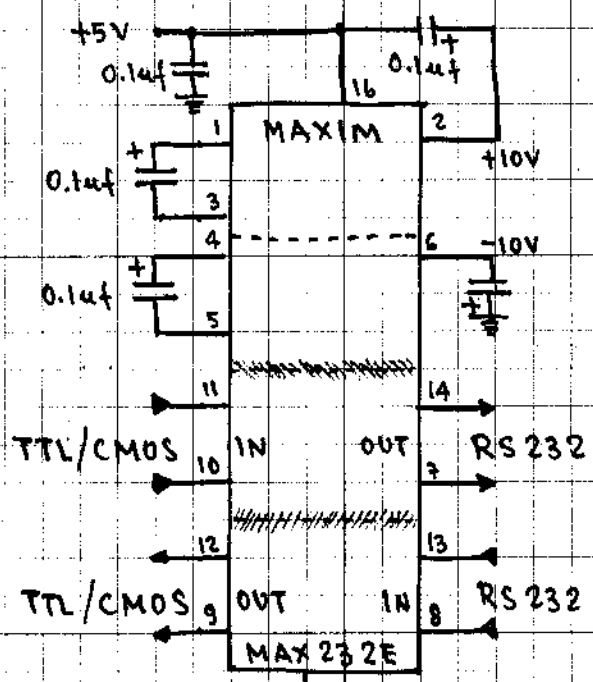
SEMÁFORO ELECTRÓNICO



Q: 2N2222

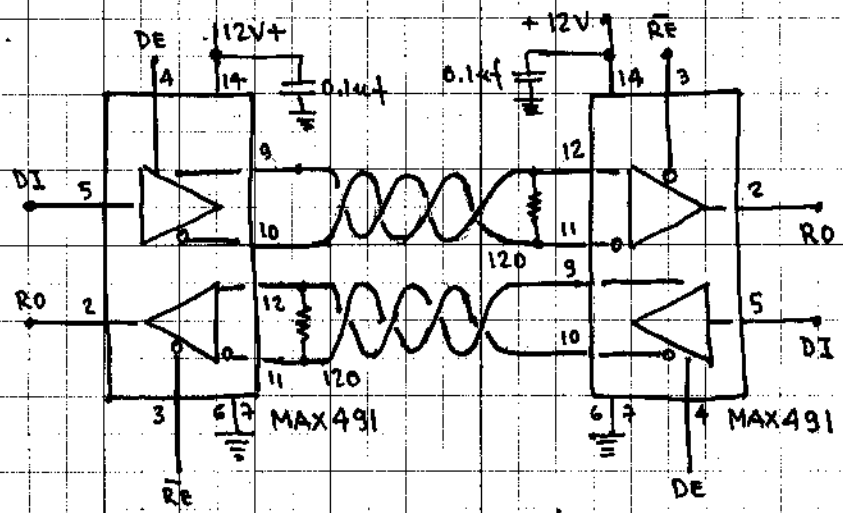
IC1, IC2 : CD4001

CIRCUITOS COMBINADOS CONTINUACIÓN...



INTERFACE RS232 / TTL/CMOS

TRANSMISOR Y RECEPTOR
TRANSCEIVERS

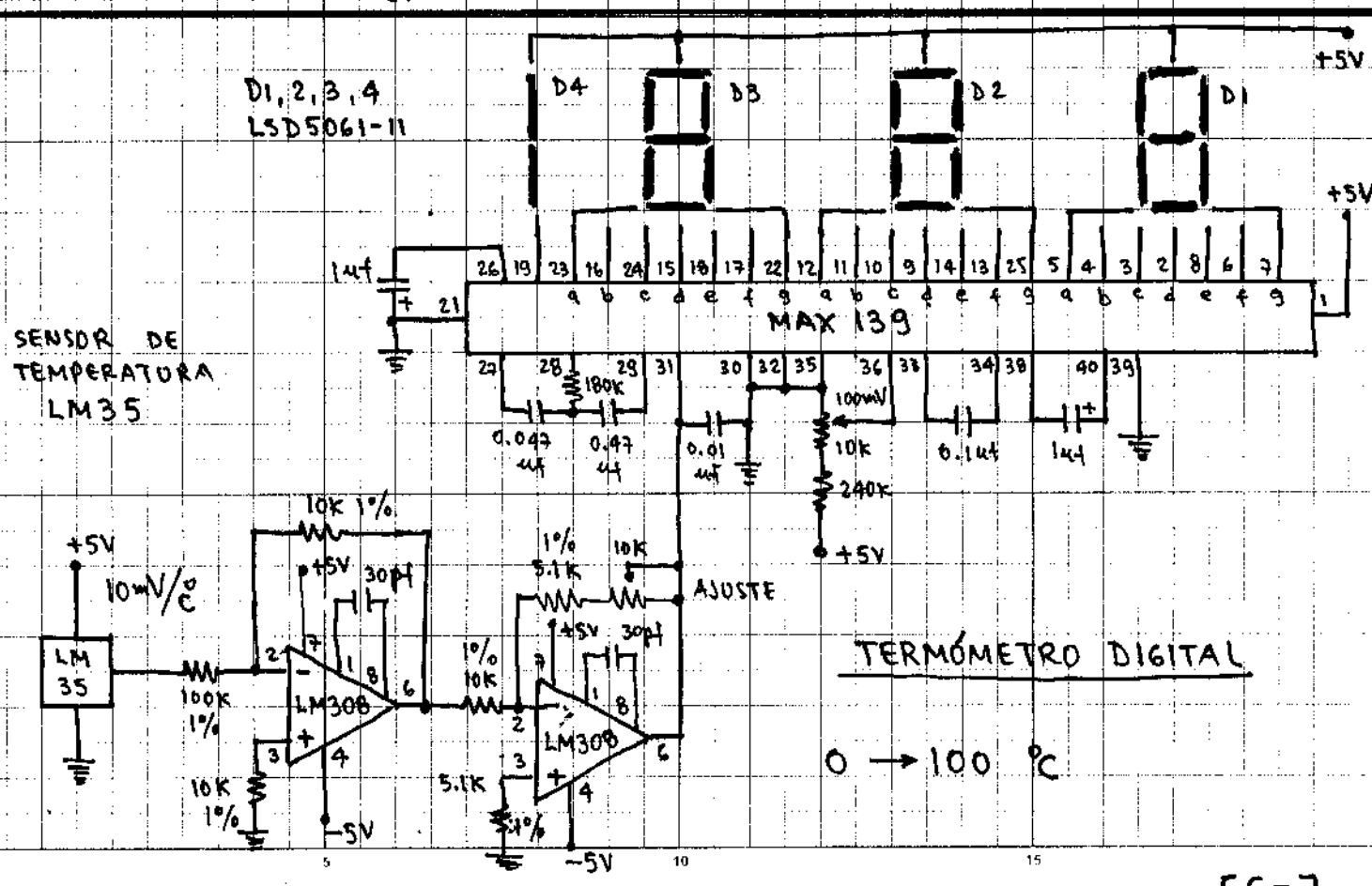


INTERFACE RS485/RS422

TRANSMISOR Y RECEPTOR
TRANSCEIVER

OTROS IC INTERFACE RS485/RS422

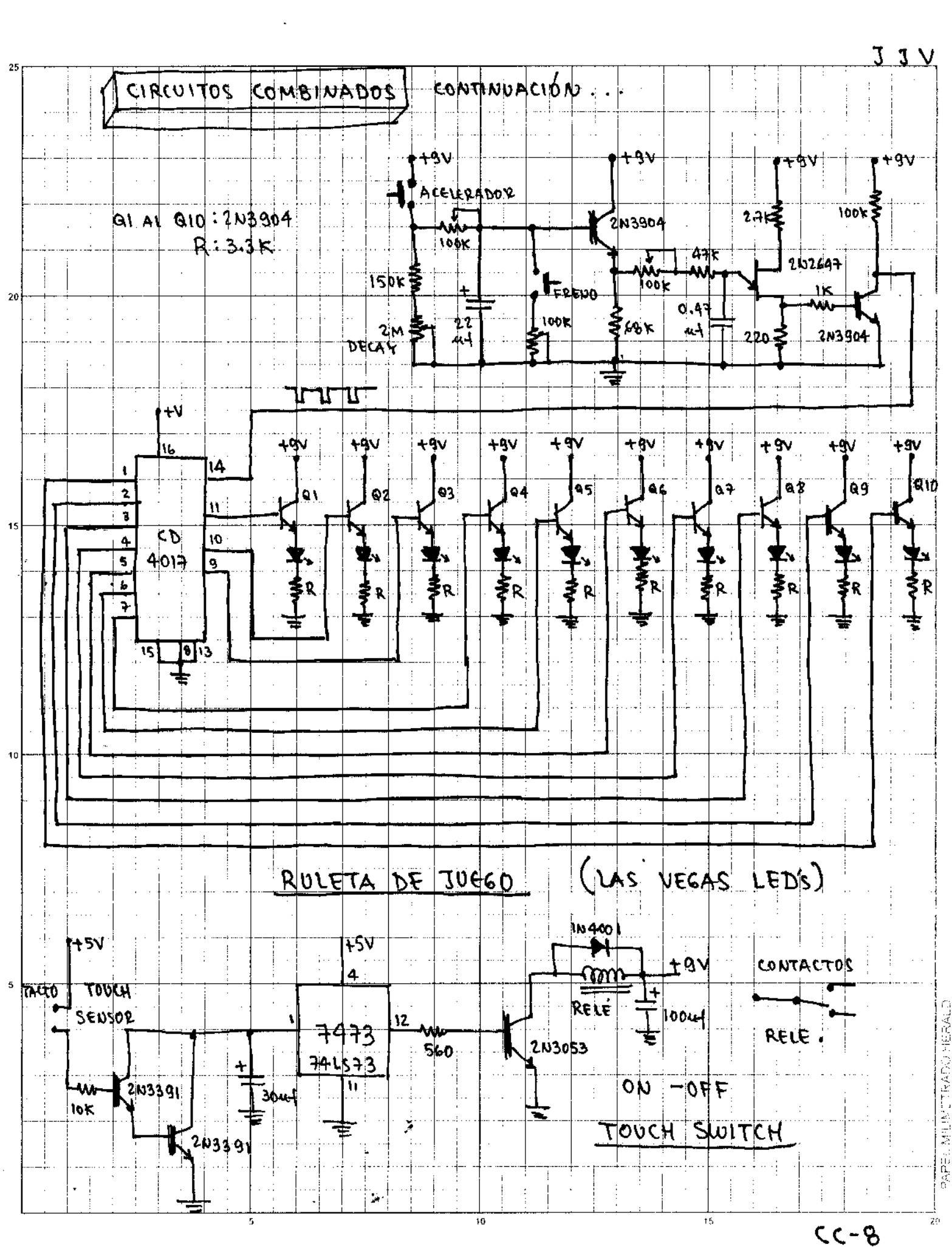
MAX 3483 F DUP 2W
MAX 3490 F DUP 4W
MAX 3081 F DUP 4W



TERMÓMETRO DIGITAL

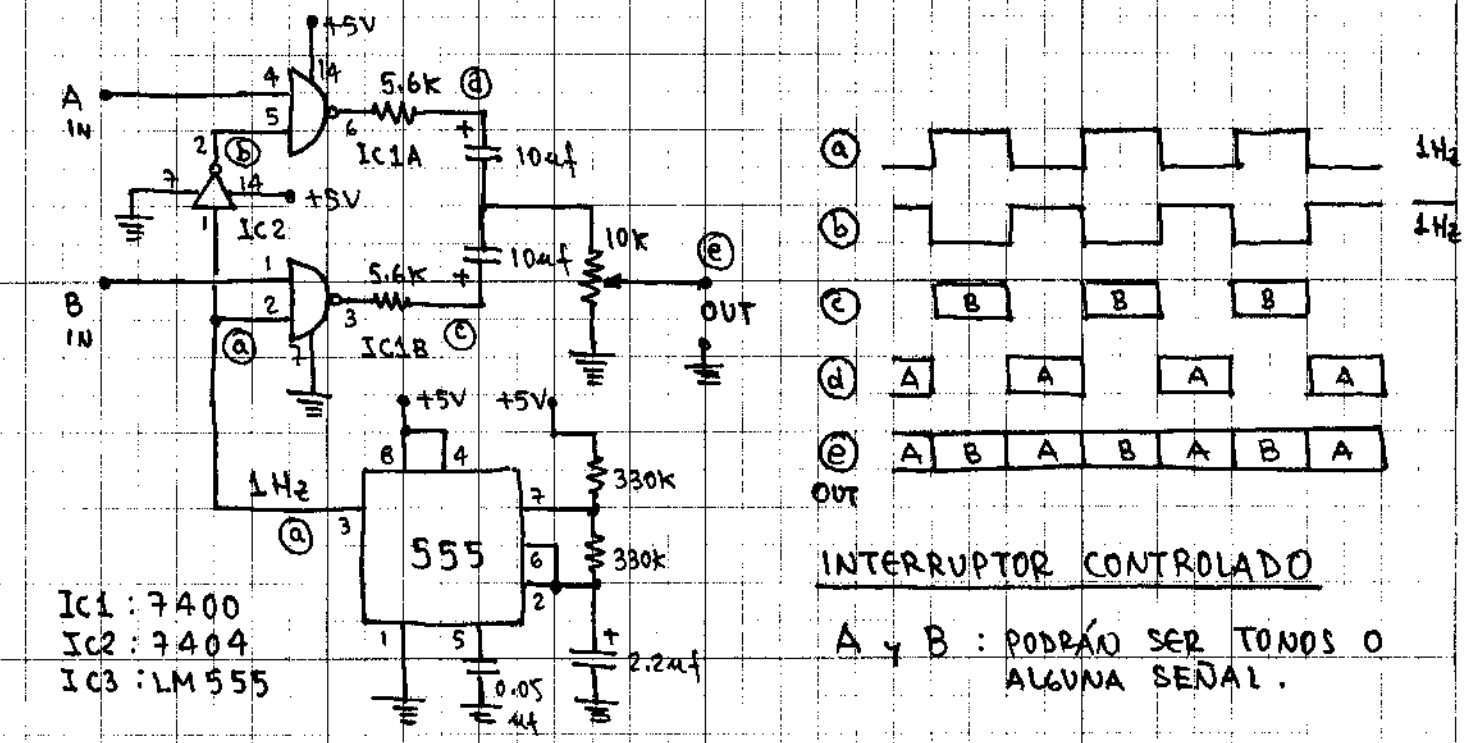
0 → 100 °C

CIRCUITOS COMBINADOS CONTINUACIÓN . . .



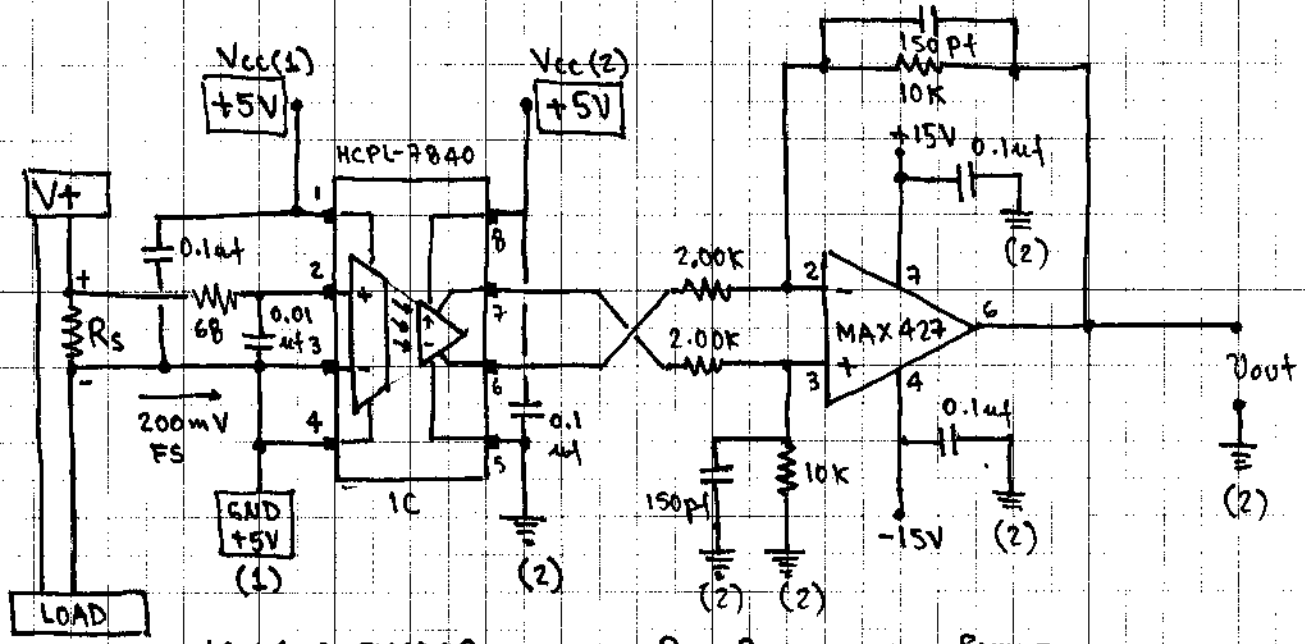
CIRCUITOS COMBINADOS

CONTINUACIÓN . . .



INTERRUPTOR CONTROLADO

A y B : PODRÁN SER TONOS O ALGUNA SEÑAL.



IC : AMPLIFICADOR ANALÓGICO OPTOAISLADO
- HCPL-7840 ó
- HCPL-7820

Rs : RESISTENCIA SHUNT PARA MEDICIÓN DE CORRIENTE

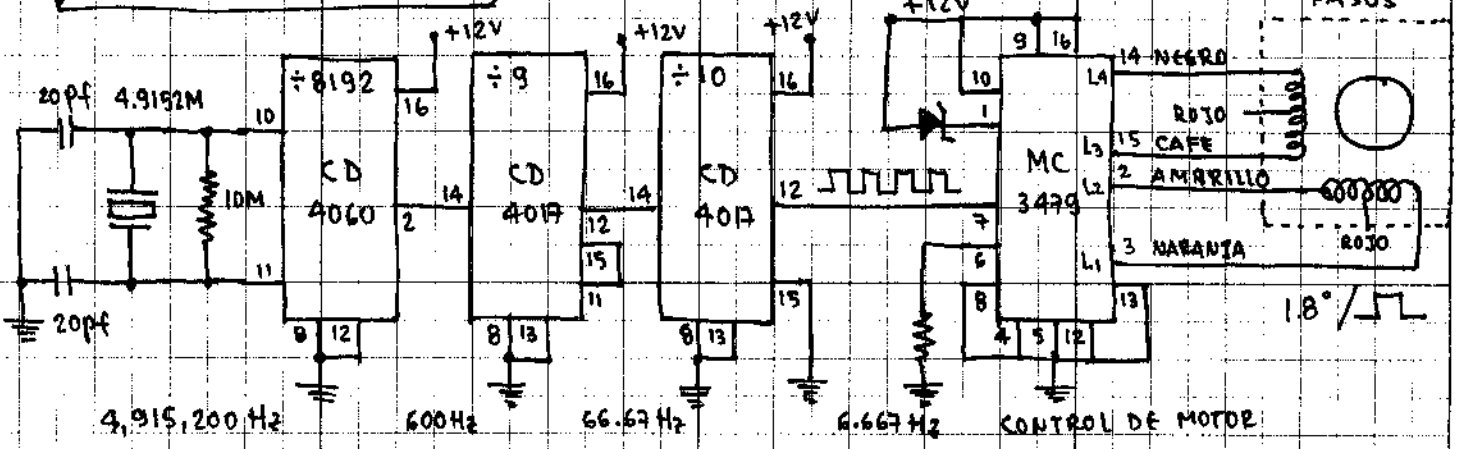
50 mΩ	3W	7.75A	0.39 V	390mV
20 mΩ	3W	12.25A	0.25 V	250mV
10 mΩ	3W	17.32A	0.17 V	170mV
5 mΩ	5W	31.62A	0.16 V	160mV
0.4 mΩ	9W	150.00A	0.06 V	60mV

MEDICIÓN DE CORRIENTE DE CARGA

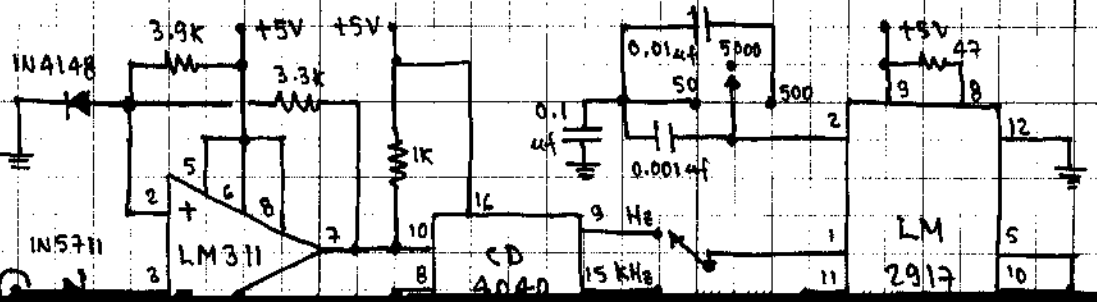
OPTICAMENTE AISLADO

JJV

CIRCUITOS COMBINADOS CONTINUACIÓN . . .



CONTROL DE MOTOR SINCRONIZADO CON MOVIMIENTO DE LA TIERRA



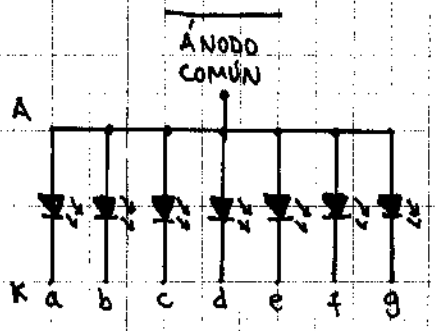
PASOS	LECTURA
50	Hz
500	Hz
5000	Hz
50	KHz
500	KHz
5000	KHz

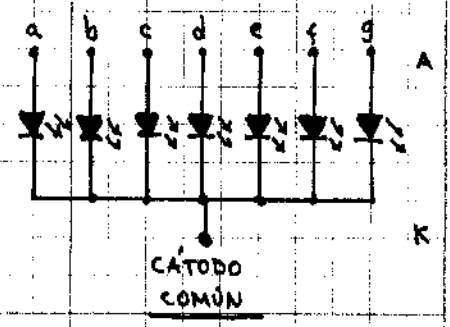
CIRCUITOS

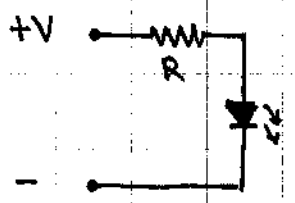
J J V

OPTOELECTRÓNICA

DIODO EMISOR DE LUZ (LED)

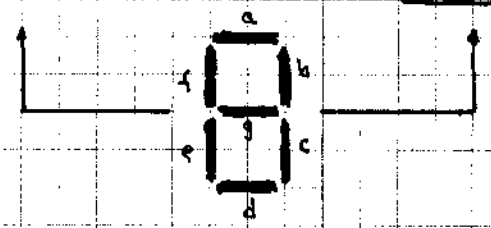






$I_{LED} \approx 20mA$

$V_{LED} \approx 2.7V$



PRESENTADOR LED 7 SEGMENTOS

QT OPTOELECTRONICS

Optoisolators

Fig. 1 Photo-Transistor Output

Fig. 2 Photo-Darlington Output

Fig. 3 High-Speed Transistor Output

Fig. 4 High Gain Split Darlington Output

Fig. 5 AC Input Photo-Transistor Output

Fig. 6 High Voltage Photo-Darlington Output

Fig. 7 Dual Channel High Speed Transistor Output

Fig. 8 Dual Split Darlington Output

Fig. 9 Dual Photo-Transistor Output

Fig. 10 SMT Dual Photo Transistor Output

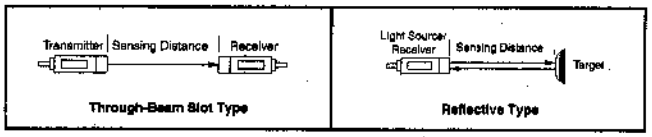
Fig. 11 Non-zero Crossing Triac Output

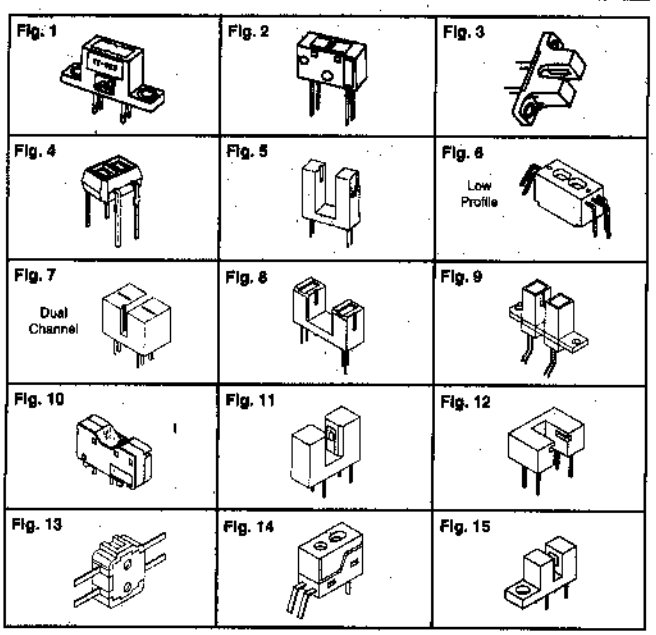
OPTOELECTRÓNICA CONTINUACIÓN....

OMRON.

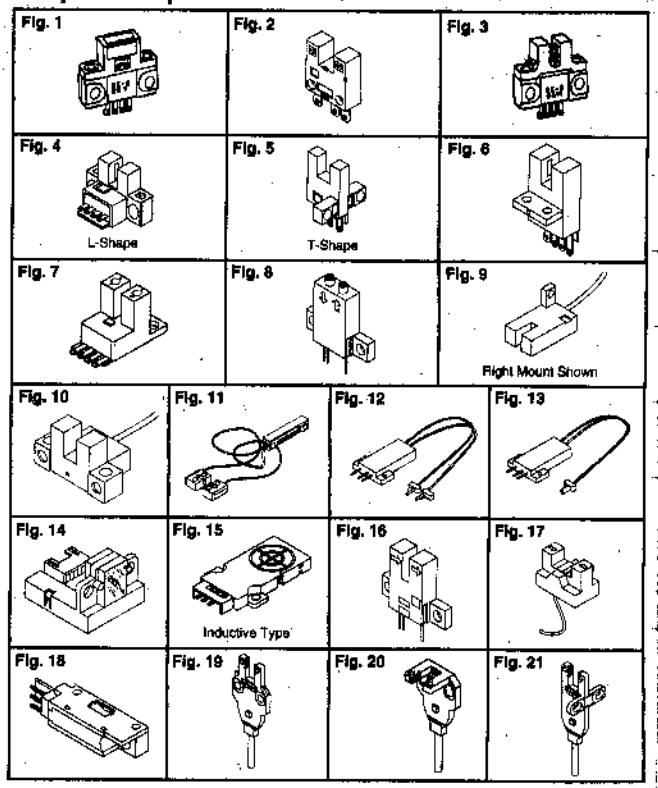
Non-Amplified Optical Sensors

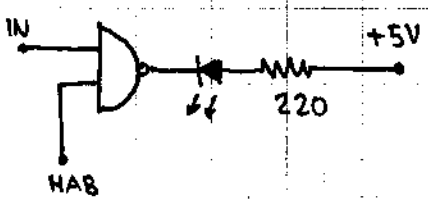
Omron's optical sensors are designed to meet the needs of positioning, detection of components and objects, cam-timer switching-control and robotic control. Available in two types: nonamplified optical sensors are low cost, fast response optical sensors used mainly in design-in processes. Amplified optical sensors are ideal for plug and play applications where external light does not affect performance and wide input voltages can be applied.

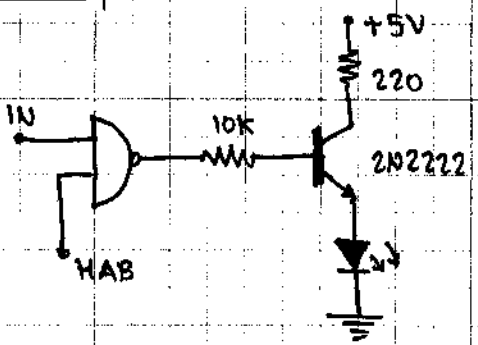


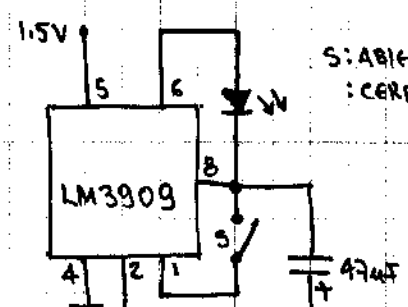


Amplified Optical Sensors

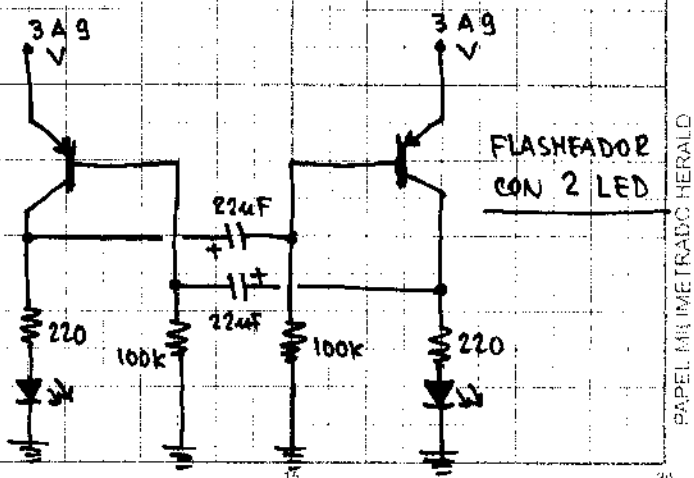






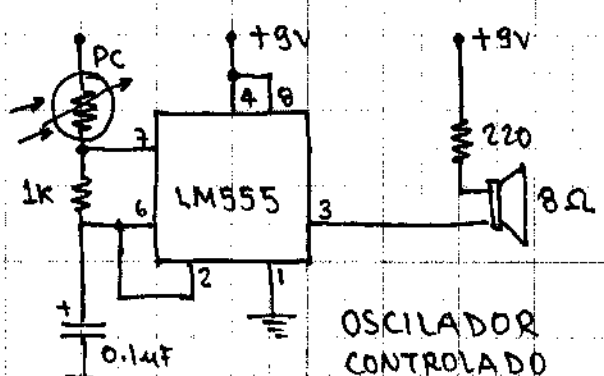


FLASHEADOR CON LED



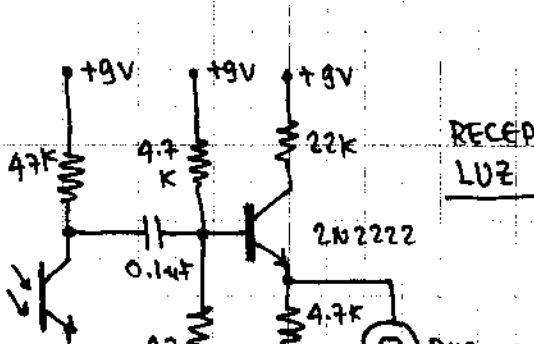
PAPEL MILIMETRADO HERALD

OPTOELECTRÓNICA CONTINUACIÓN . . .



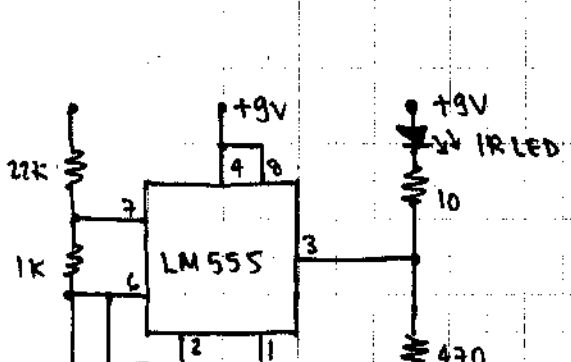
OSCILADOR CONTROLADO POR LUZ

PC: FOTORESISTENCIA

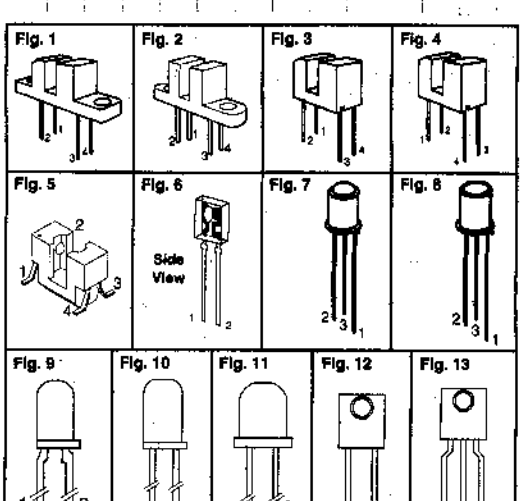


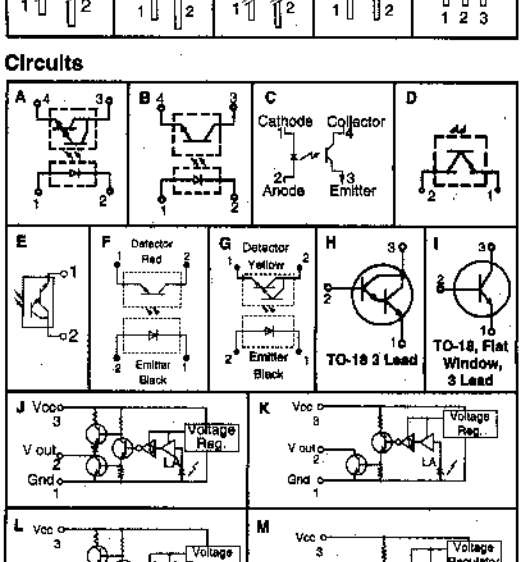
RECEPTOR DE LUZ

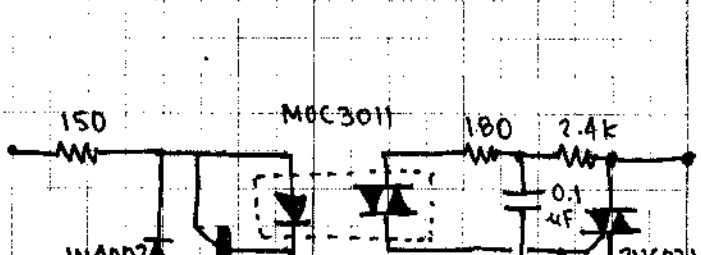
FOTOTRANSISTOR



TRANSMISOR INFRARROJO

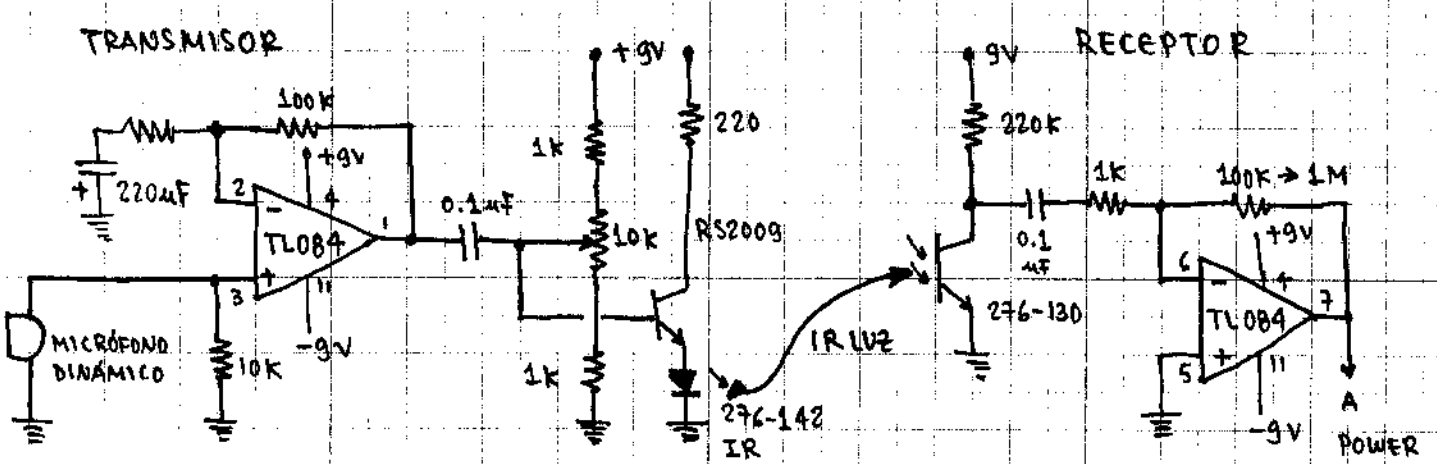




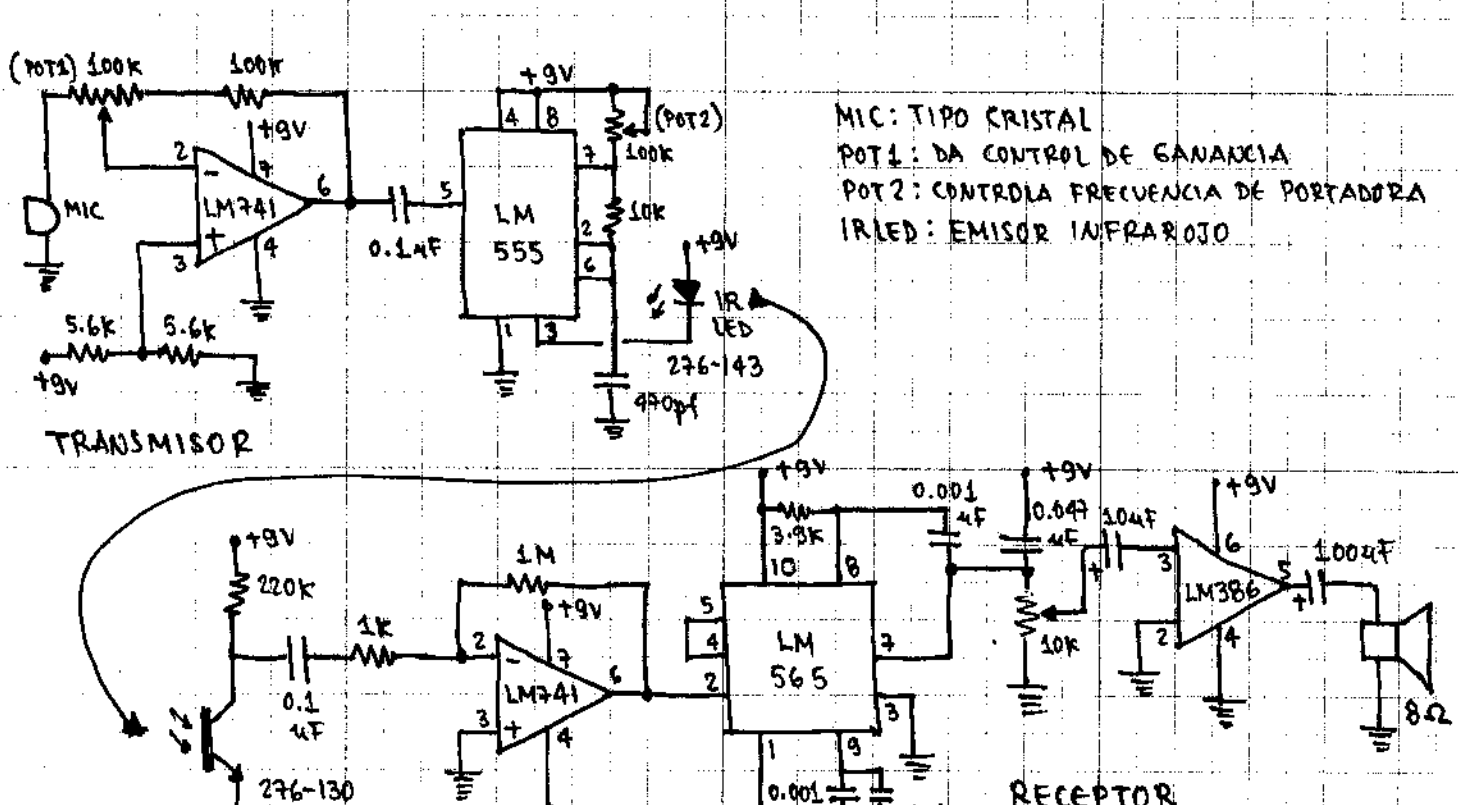


RELÉ DE ESTADO SÓLIDO

OPTO ELECTRONICA CONTINUACIÓN . . .



COMUNICADOR DE VOZ POR INFRAROJO

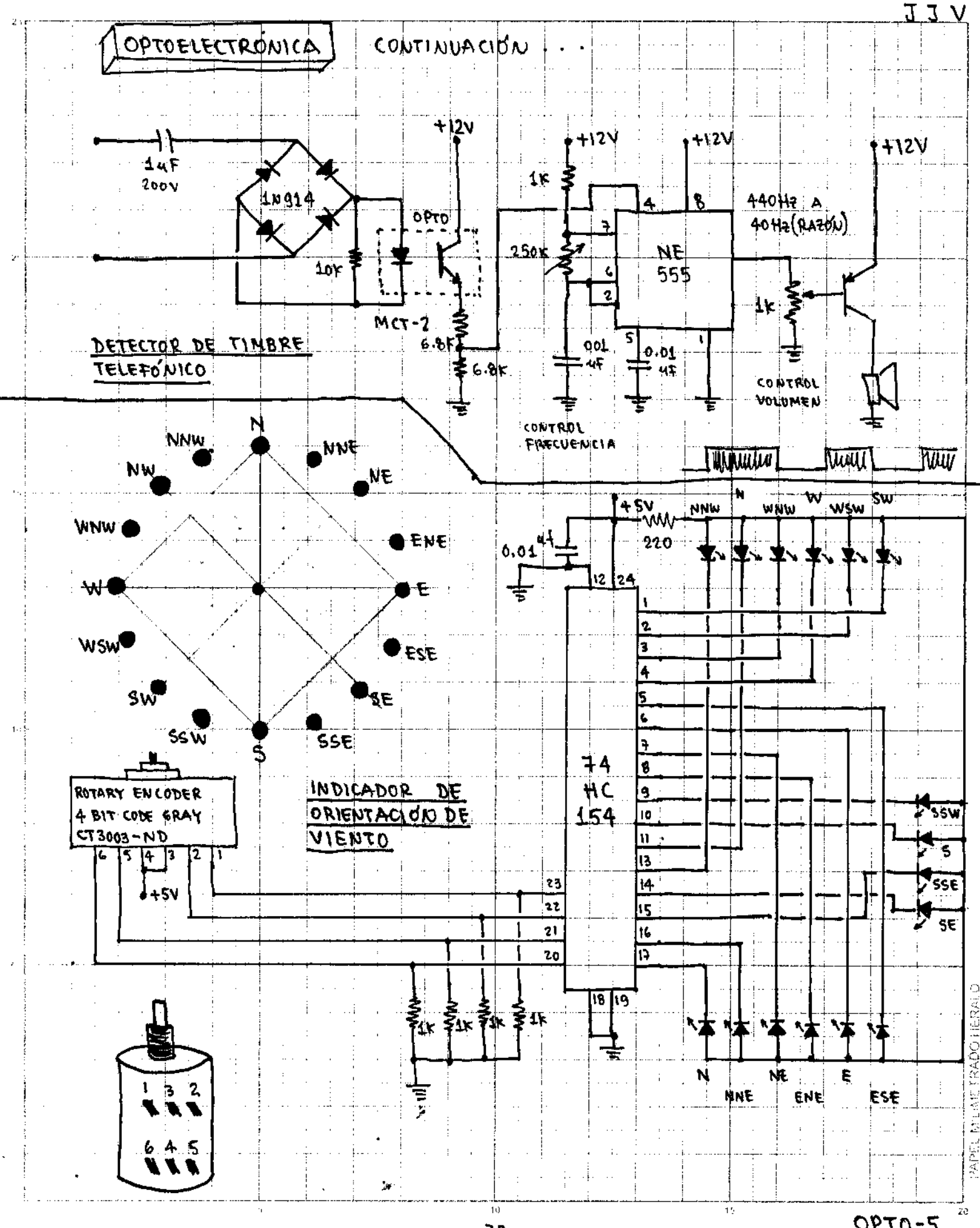


MIC: TIPO CRISTAL
POT1: DA CONTROL DE GANANCIA
POT2: CONTROLA FRECUENCIA DE PORTADORA
IRLED: EMISOR INFRAROJO

COMUNICADOR DE VOZ POR INFRAROJO CON MODULACION DE PULSO

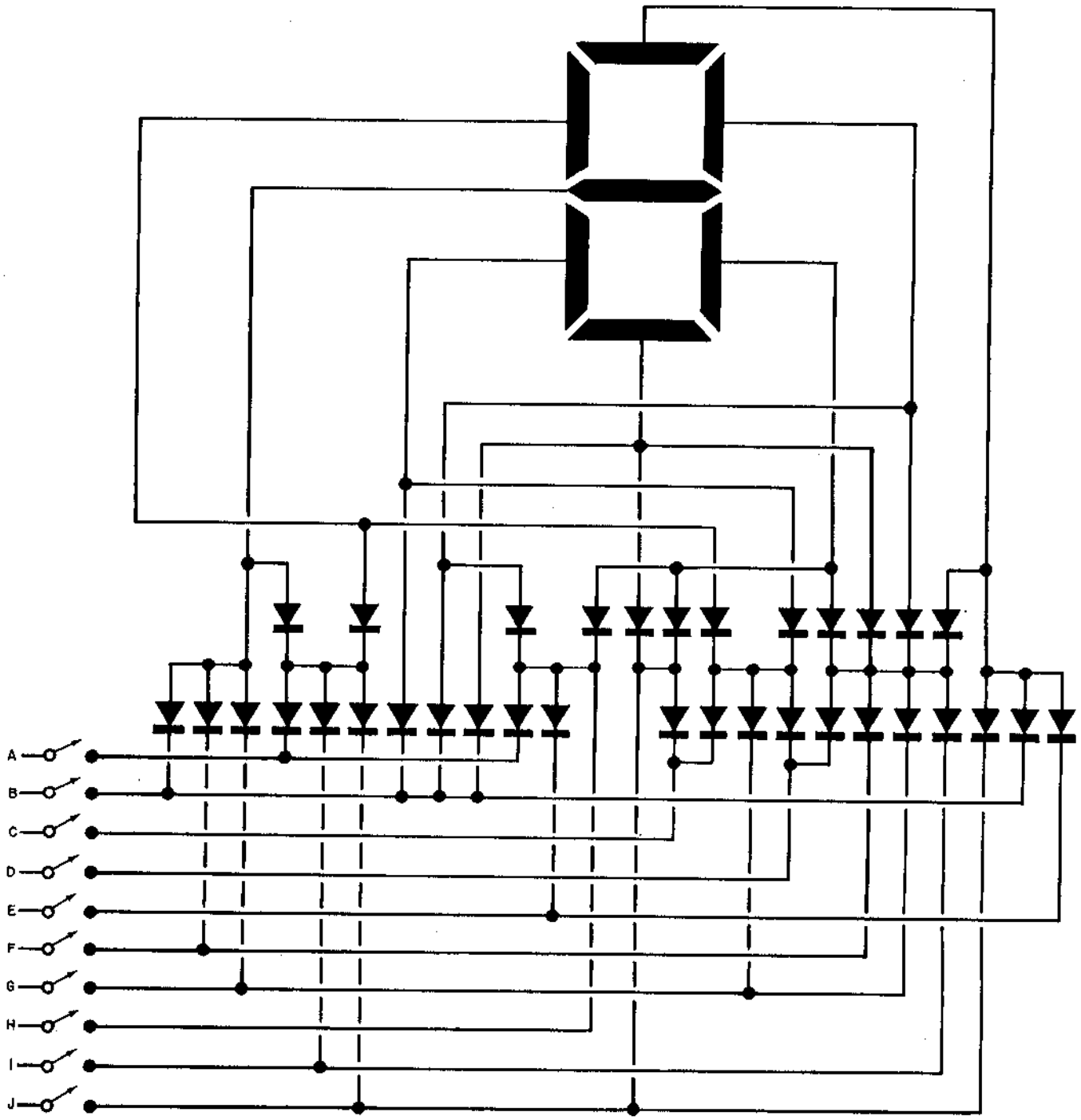
OPTOELECTRÓNICA

CONTINUACIÓN . . .



OPTOELECTRONICA CONTINUACIÓN . . .

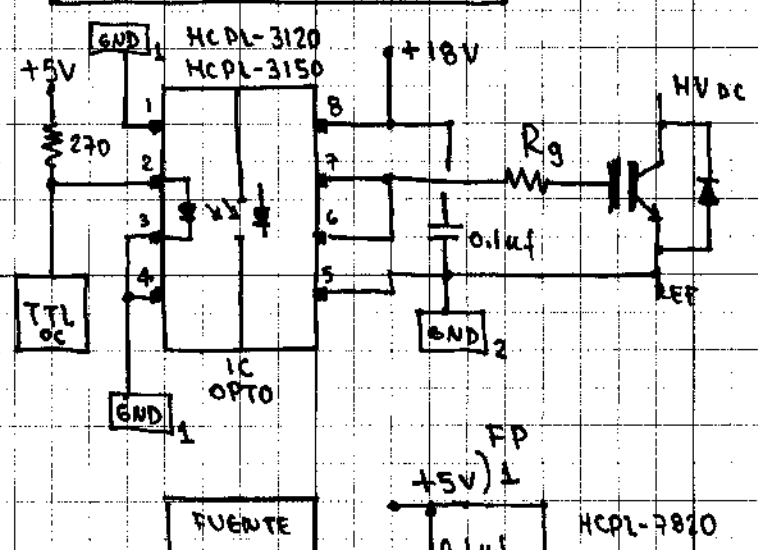
PRACTIQUE Y ESTUDIE



PRACTIQUE SUS HABILIDADES Y CONOCIMIENTOS DEL DIODO Y EL LED INVESTIGUE CUANDO SE OPRIME CADA INTERRUPTOR, QUE SEÑAL APARECE PRESENTADA EN LOS LED'S (7 SEGMENTOS).

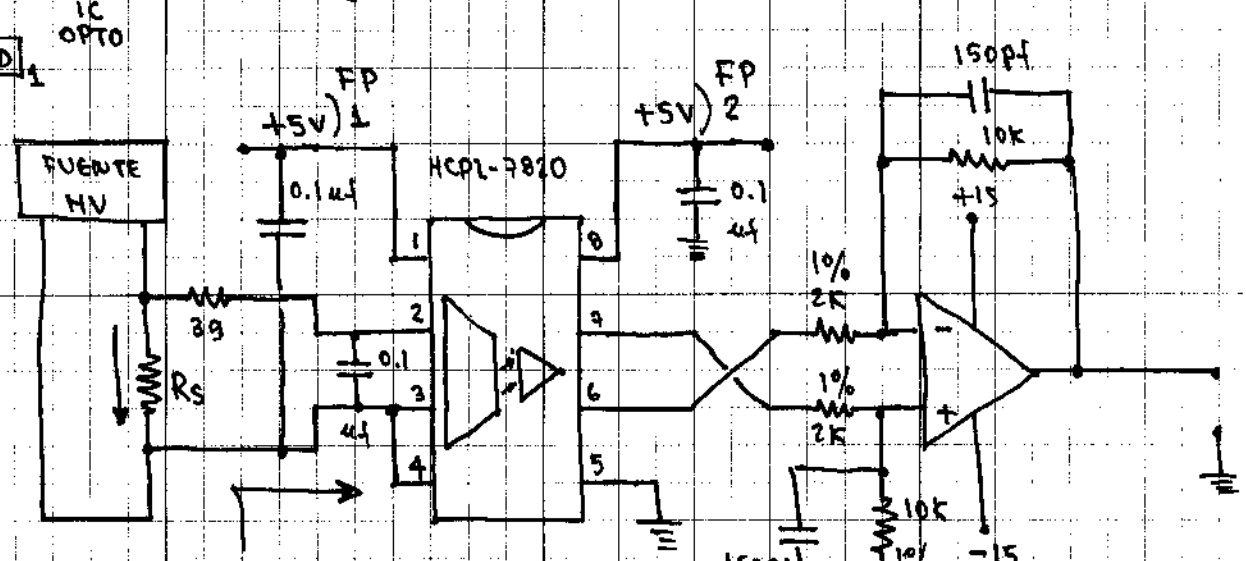
A-4 B-2 C-6 D-0 E-3 F-1 G-7 H-8 I-9 J-5

OPTOELECTRÓNICA CONTINUACIÓN...

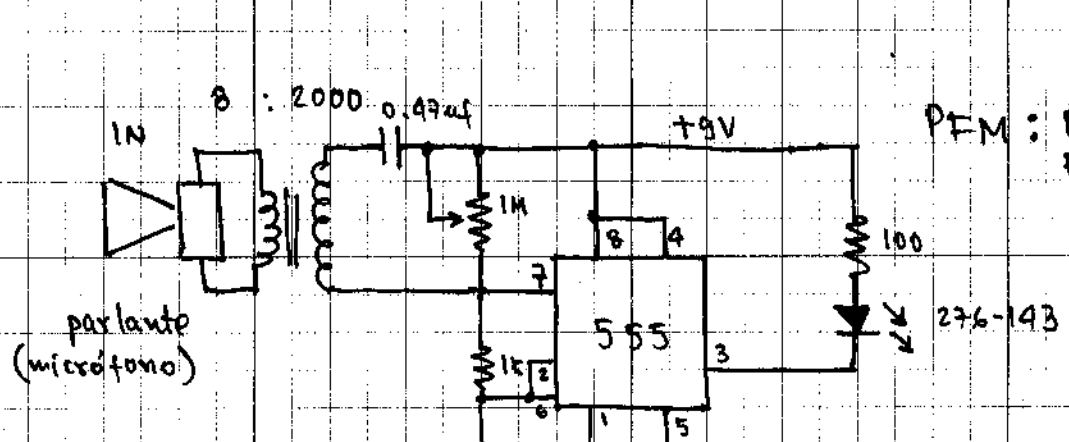


CONTROL TOTAL AISLADO A IGBT

* TRANSISTOR IGBT 0.6A Rg = 30.5Ω
  ICOPTO HCPL-3150
* TRANSISTOR IGBT 2.5A Rg = 8Ω
  ICOPTO HCPL-3120



MEDICIÓN DE CORRIENTE CON AMPLIFICADOR OPERACIONAL OPTO AISLADO



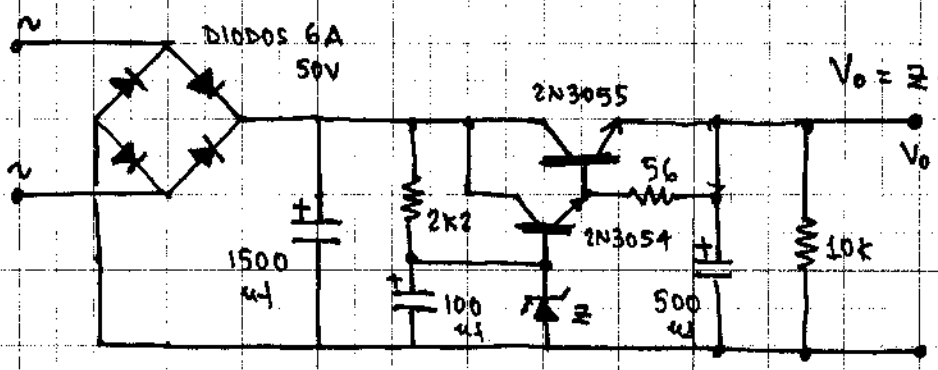
PFM : PULSE FREQUENCY MODULATION

MODULADOR PFM EN LUZ

FUENTES DE PODER

PAPEL MILIMETRADO HERALD

FUENTES DE PODER

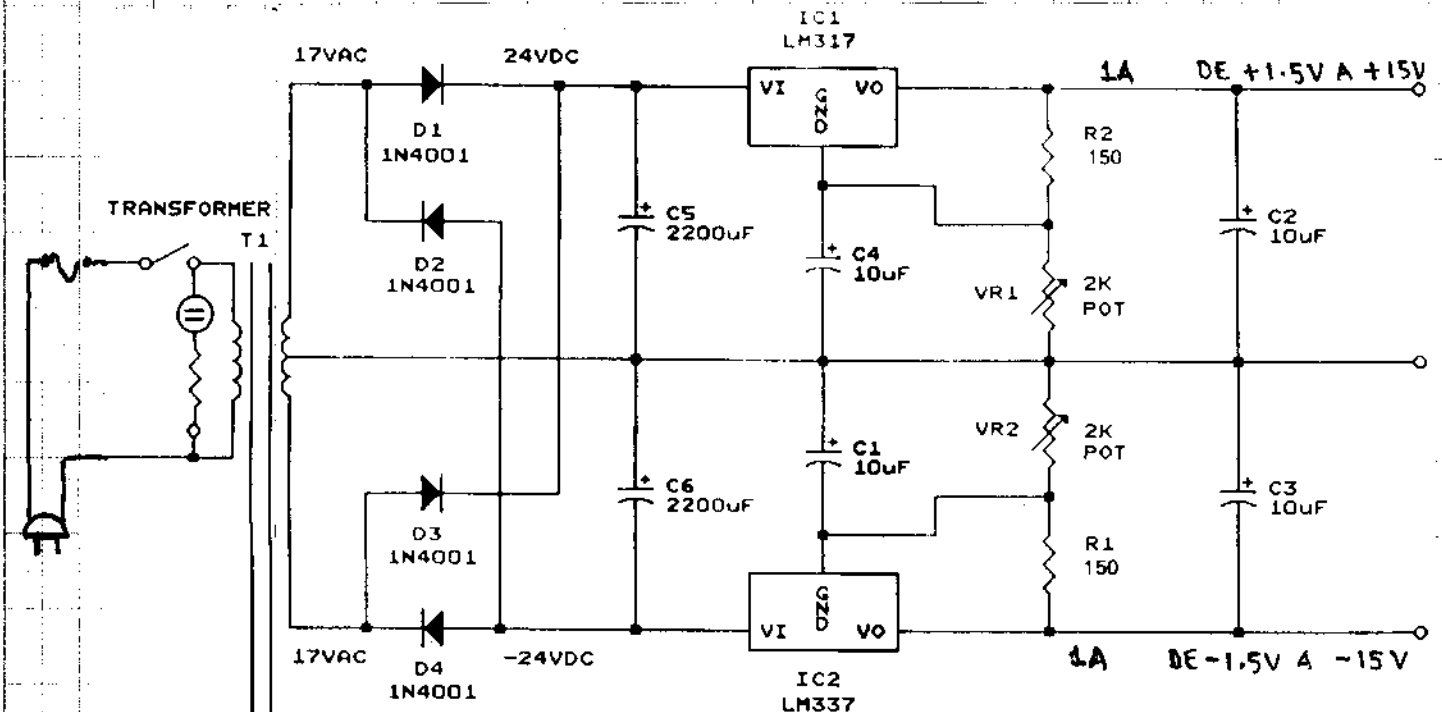


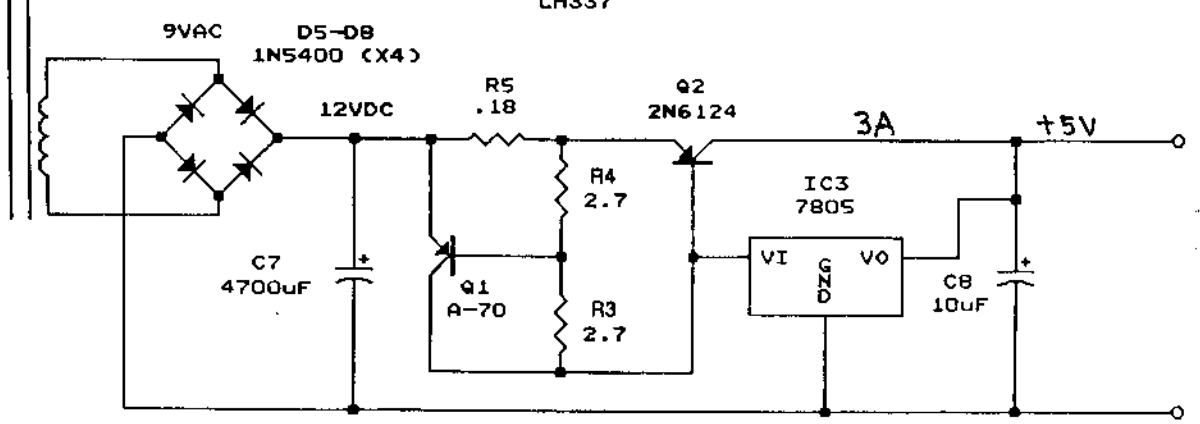
$V_o = Z + 1.2$ VOLT

$Z = V_o - 1.2$

FUENTE DE PODER

BAJO RIPPLE



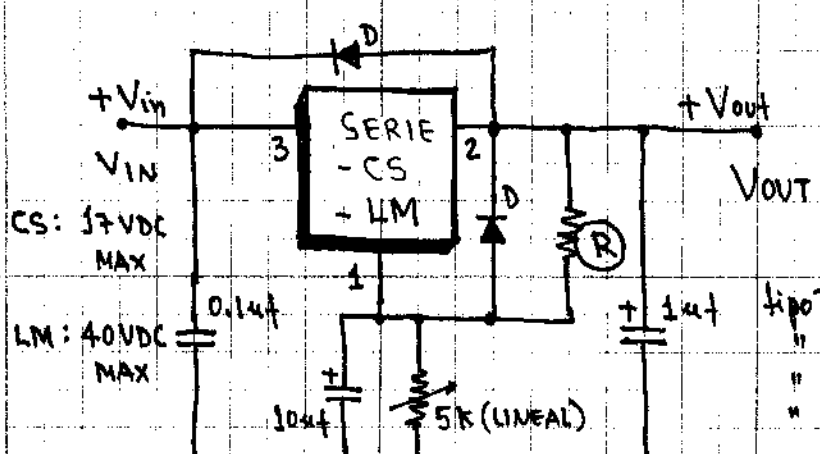


FUENTE DE PODER TRIPLE

+VARIABLE 1A
-VARIABLE 1A
+5V FIJA 3A

PAPEL MILIMETRADO HERALD

FUENTES DE PODER CONTINUACIÓN . . .



REGULADOR DE VOLTAJE CS (+)

$V_{IN\,MAX}$ = 17VDC PARA SERIE CS

V_{OUT} = 1.254 A 12.0 VDC

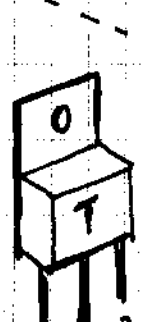
tipoT	CS5203A-1	SALIDA 3.0A
"	CS5204-1	SALIDA 4.0A
"	CS5205-1	SALIDA 5.0A
"	CS5206-1	SALIDA 6.0A

REGULADORES VARIABLES POSITIVO CHERRY SEM. (R): 560Ω

REGULADOR DE VOLTAJE LM POSITIVO

$V_{IN\,MAX}$ = 35VDC PARA SERIE LM

V_{OUT} = 1.25 A 28.0 VDC



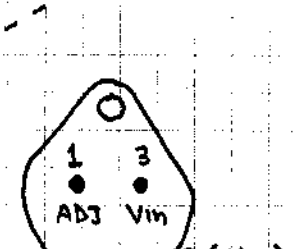
1: ADJ
2: VOUT
3: VIN

TIPO "T"
TO220

LM 317 T/K	SALIDA 1.5A
LM 350 T/K	SALIDA 3.0A
LM 338 T/K	SALIDA 5.0A

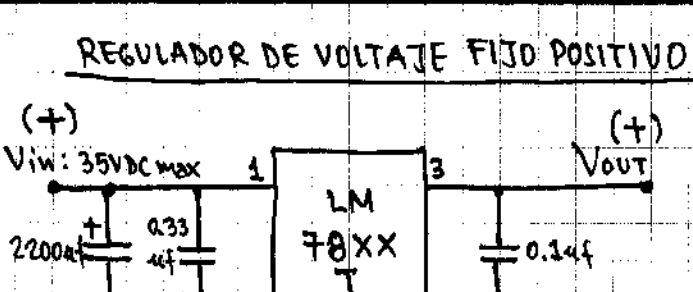
REGULADORES VARIABLES POSITIVO NATIONAL SEM. (R) = 240Ω

REGULADOR DE VOLTAJE VARIABLE *



TIPO "K"
TO3

REGULADOR DE VOLTAJE FIJO POSITIVO



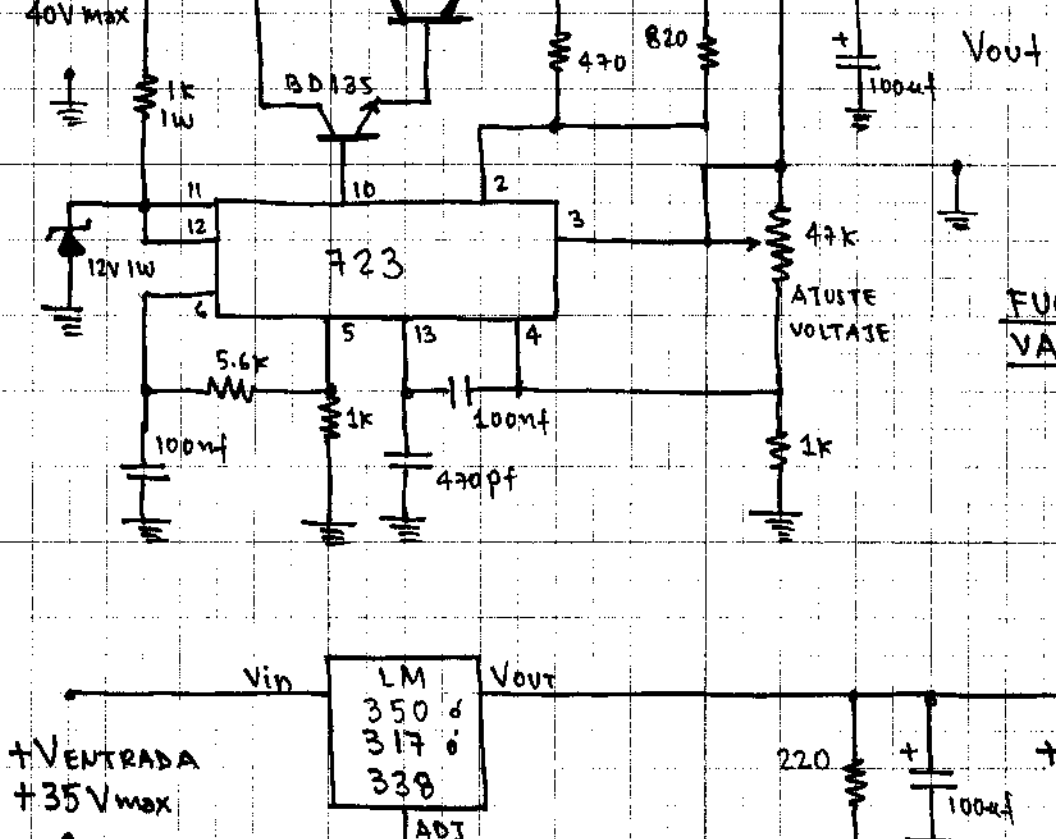
LM7805T/K	SALIDA +5V 1A
LM7806T/K	SALIDA +6V 1A
LM7812T/K	SALIDA +12V 1A
LM7815T/K	SALIDA +15V 1A
LM323K	SALIDA +5V 3A

REGULADOR DE VOLTAJE FIJO NEGATIVO

LM7905T	SALIDA -5V 1A
LM7912T	SALIDA -12V 1A
LM7915T	SALIDA -15V 1A

PAPEL MILIMETRADO HERALD

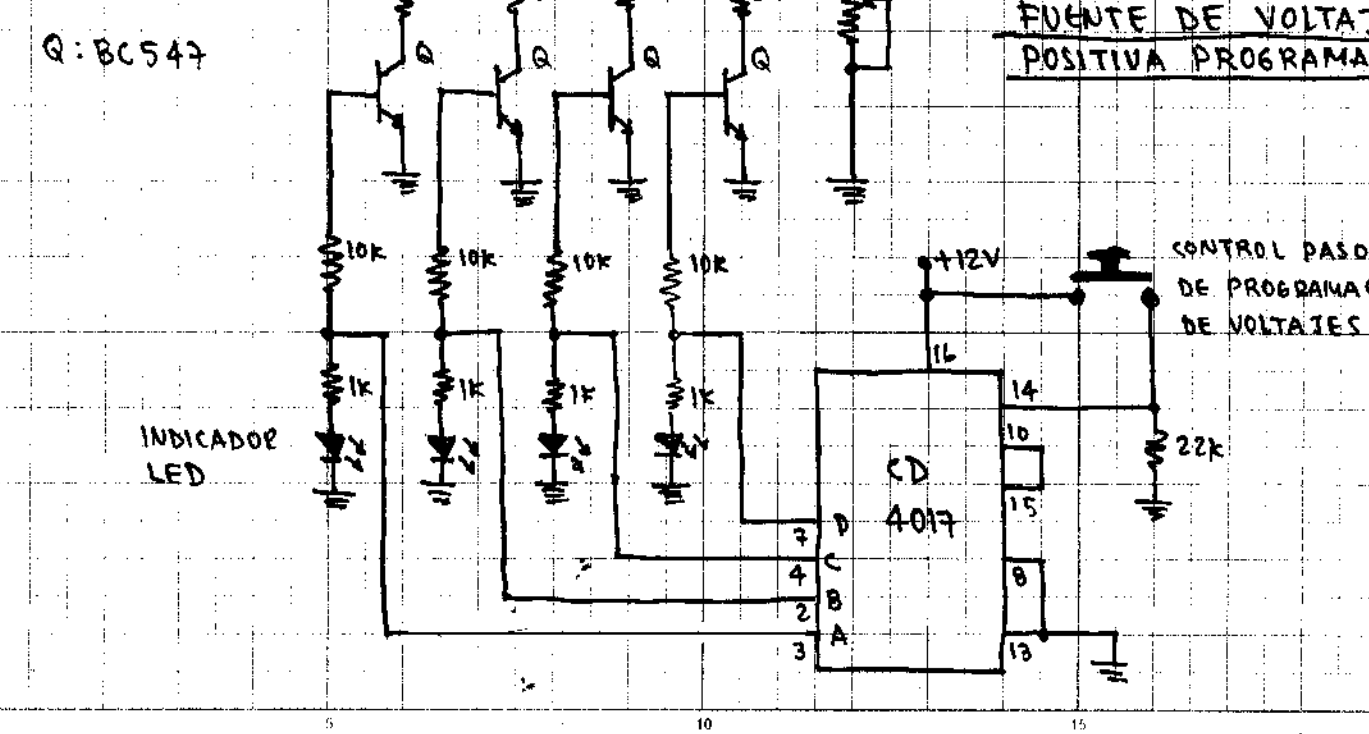
FUENTES DE PODER CONTINUACIÓN . . .



$V_{out} = 0.5$ A 37V

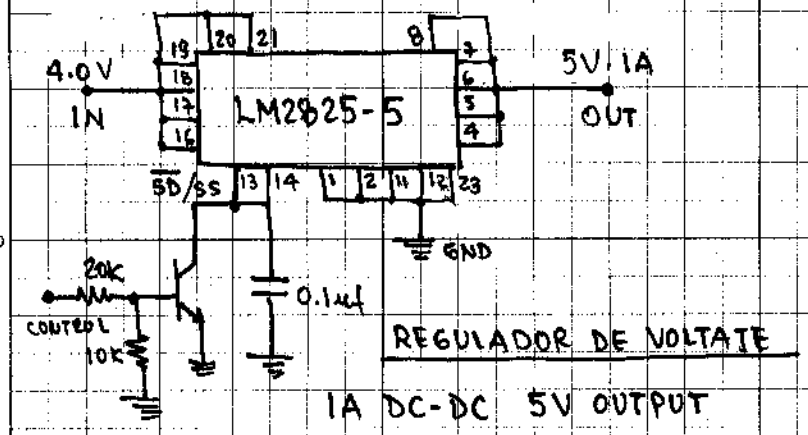
$I_{out} = 2$ A 4 A

FUENTE DE PODER VARIABLE POSITIVA



FUENTE DE VOLTAJE POSITIVA PROGRAMABLE

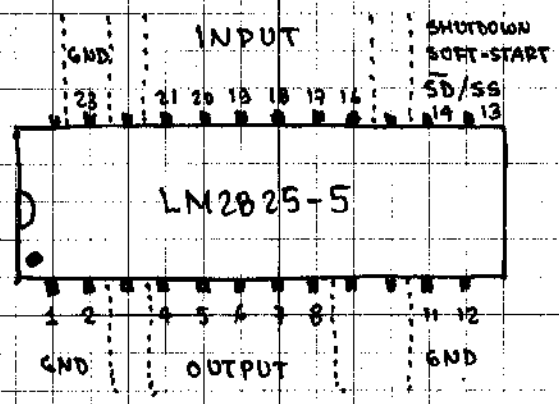
FUENTES DE PODER CONTINUACIÓN...



REGULADOR DE VOLTAJE

1A DC-DC 5V OUTPUT

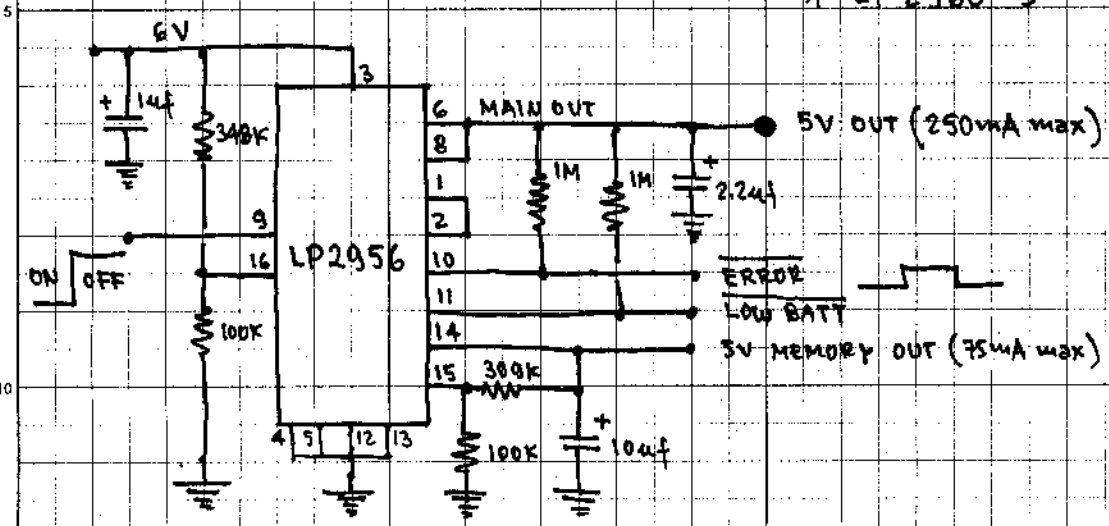
ON OFF CONTROL (SD/SS)



CONVERTIDOR DC:DC

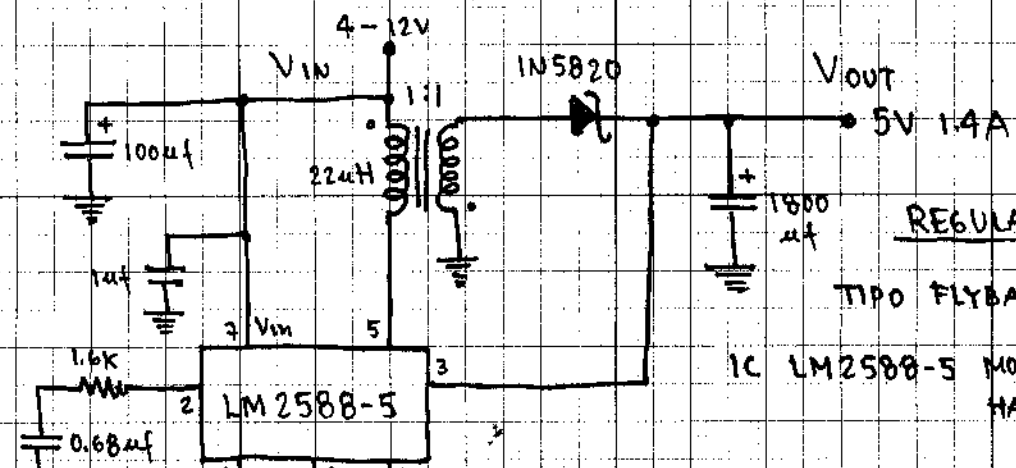
OTROS IC REGULADORES DE BAJA CORRIENTE

* LP2953-3.3 3.3V 250 mA max
* LP 2960-5 5.0V 500 mA max



REGULADOR DE VOLTAJE

MICROPOTENCIA (250mA max)



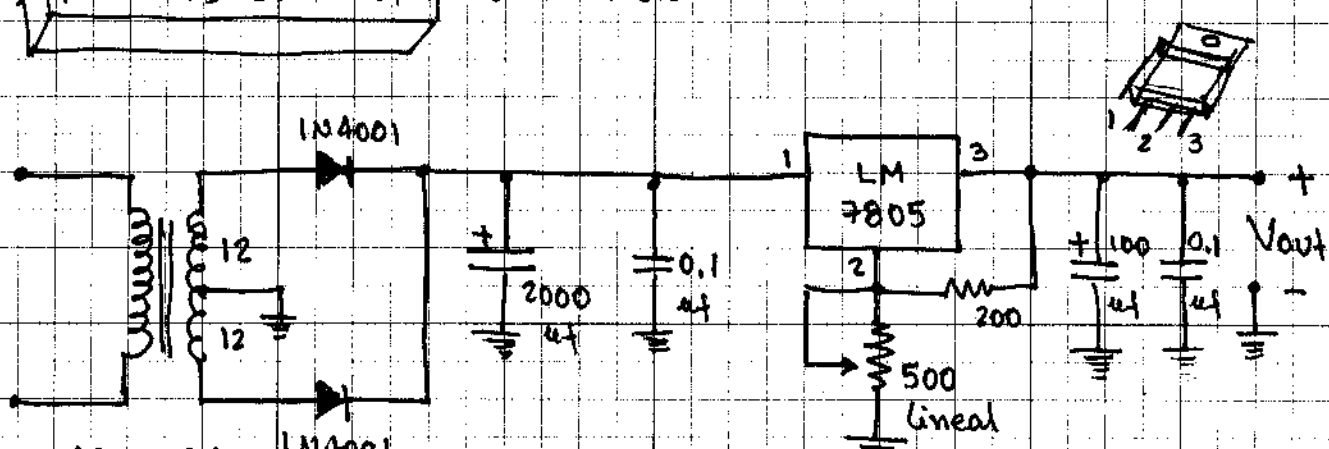
REGULADOR DE VOLTAJE

TIPO FLYBACK, SWITCHER

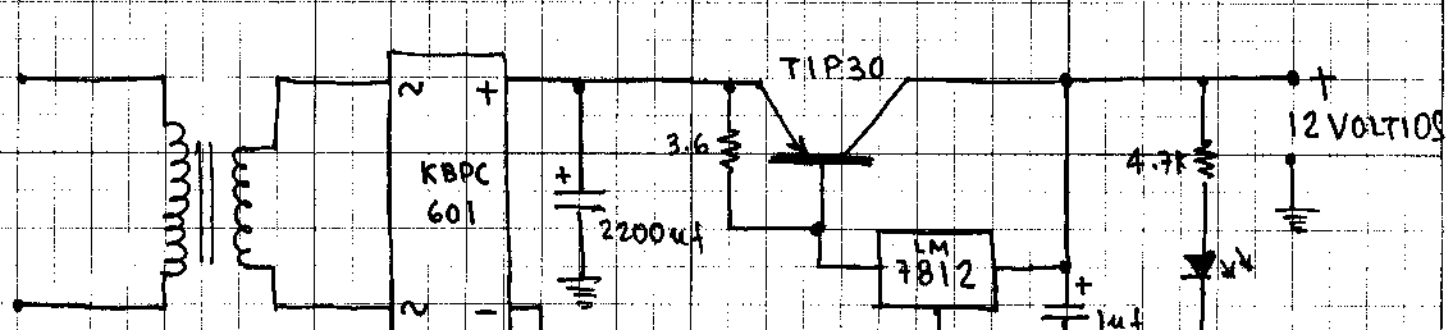
IC LM2588-5 MODIFICANDO TRANSFORMADOR HASTA 5A 5V

OTRO IC REGULADOR TIPO FLYBACK, SWITCHER
LP2585-5 (5V, 3A)

FUENTES DE PODER CONTINUACIÓN . . .

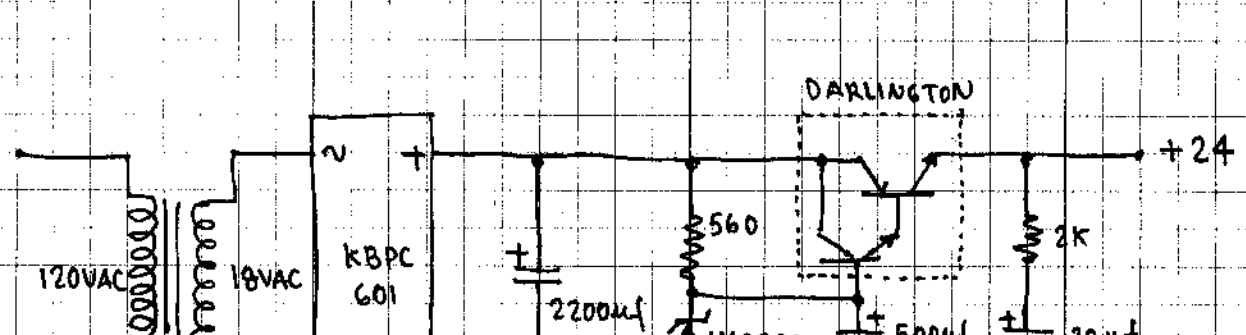


FUENTE DE VOLTAJE VARIABLE 5 → 15 VDC



TIP30 ó TIP32
(1A) (3A)

FUENTE DE VOLTAJE PARA RADIO DE CARRO 12VOLTIOS



FUENTE DE PODER DE 24V 1.5A
3.5A

ELECTRÓNICA DE POTENCIA (TIRISTORES)

PAPEL MILIMETRADO HERALD

ELECTRÓNICA DE POTENCIA

CARACTERISTICAS Y SIMBOLOS DE ALGUNOS DISPOSITIVOS DE POTENCIA

Dispositivos	Simbolos	Caracteristicas
Diodo	A, I_D, K, V_{AK}	I_D, 0, V_{AK}
Tiristor	A, I_A, G, K	I_A, Disparo de compuerta, 0, V_{AK}
TIRISTOR SITH INDUCCIÓN ESTATICO	A, G, K	Disparo de compuerta, I_A, 0, V_{AK}
GTO DESACTIVADO POR COMPUERTA	A, I_A, G, K	
MCT CONTROLADO POR MOS	A, K, G	
TRIAC	A, I_A, B, G	I_A, Disparo de compuerta, 0, V_{AB}, Disparo de compuerta
LASCR	A, I_A, K, G	I_A, Disparo de compuerta, 0, V_{AK}
NPN BJT	I_B, B, I_C, C, I_E, E	I_C, I_{Bn}, $I_{Bn} > I_{B1}$, I_{B1}, 0, V_{CE}
TRANSISTOR BIPOLAR IGBT COMPUERTA AISLADA	G, C, I_C, E, I_E	I_C, V_{GSn}, $V_{GSn} > V_{GS1}$, V_{GS1}, V_T, 0, V_{CE}
MOSFET de canal N.	G, D, I_D, S	I_D, V_{GS0}, $V_{GS1} > V_{GSn}$, V_{GSn}, 0, V_{DS}
TRANSISTOR SIT INDUCCIÓN ESTATICO	D, S	I_D, $V_{GS1} = 0$ V, $V_{GS1} < V_{GSn}$, V_{GSn}, 0, V_{DS}

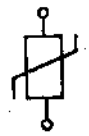
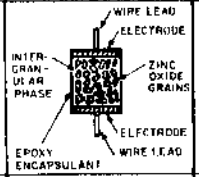
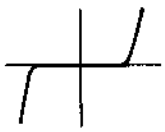
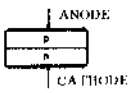
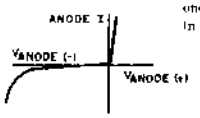
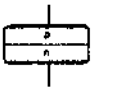
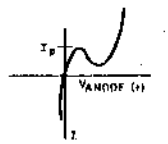
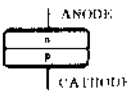
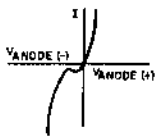
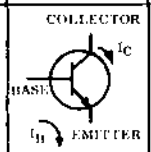
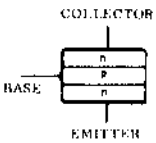
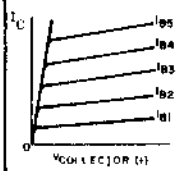
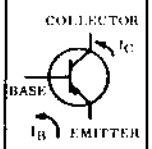
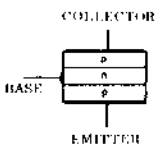
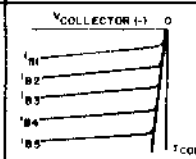
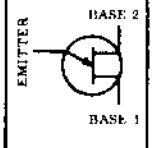
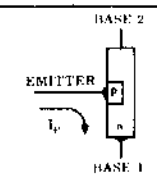
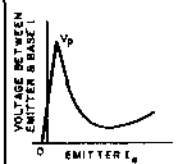
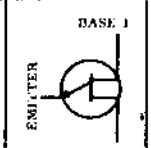
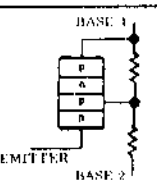
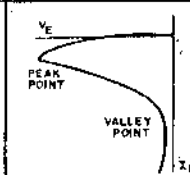
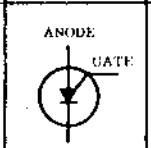
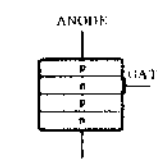
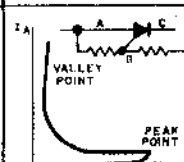
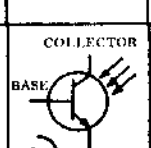
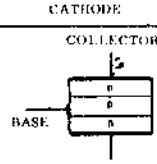
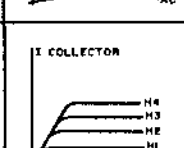
RCT, GATT

PAPEL MILIMETRADO HERALD

ELECTRÓNICA DE POTENCIA CONTINUACIÓN . . .

J J V

SEMICONDUCTOR COMPONENTS

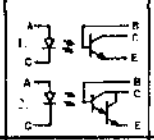
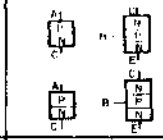
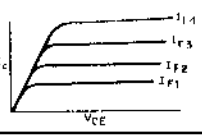
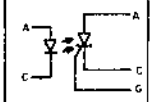
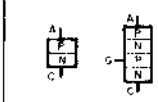
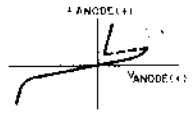
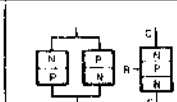
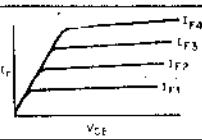
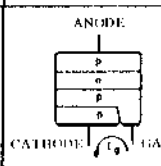
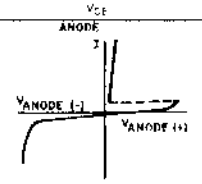
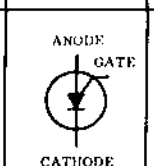
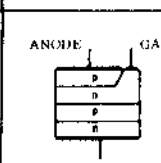
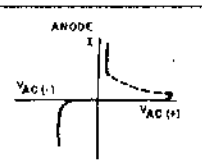
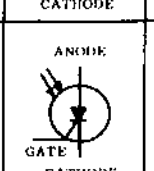
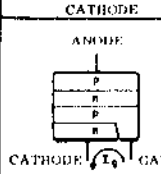
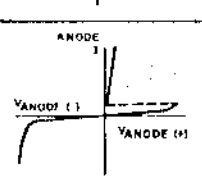
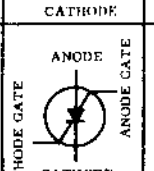
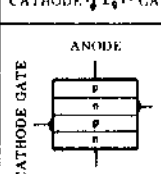
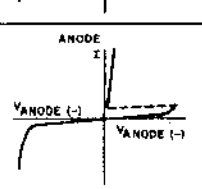
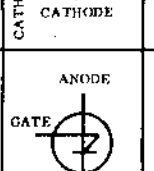
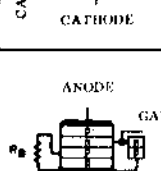
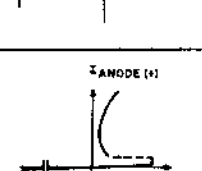
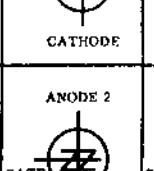
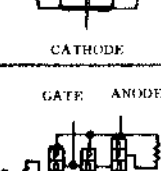
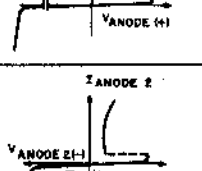
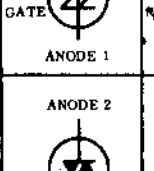
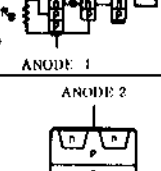
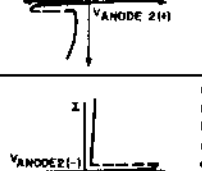
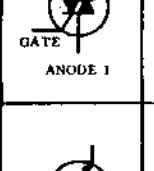
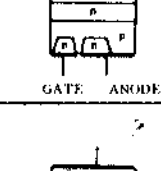
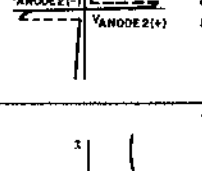
NAME OF DEVICE	CIRCUIT SYMBOL	COMMONLY USED JUNCTION SCHEMATIC	ELECTRICAL CHARACTERISTICS	MAJOR APPLICATIONS
GE-MOV® Varistor			 When exposed to high energy transients, the varistor impedance changes from a high standby value to a very low conducting value, thus clamping the transient voltage to a safe level.	Voltage transient protection High voltage sensing Regulation
Diode or Rectifier			 Conducts easily in one direction, blocks in the other	Rectification Blocking Detecting Steering
Tunnel Diode			 Displays negative resistance when current exceeds peak point current I_p	UHF converter Logic circuits Microwave circuits Level sensing
Back Diode			 Similar characteristics to conventional diode except very low forward voltage drop	Microwave mixers and low power oscillators
n-p-n Transistor			 Constant collector current for given base drive	Amplification Switching Oscillation
p-n-p Transistor			 Complement to n-p-n transistor	Amplification Switching Oscillation
Unijunction Transistor (UJT)			 Unijunction emitter blocks until its voltage reaches V_p; then conducts	Interval timing Oscillation Level Detector SCR Trigger
Complementary Unijunction Transistor (CUJT)			 Functional complement to UJT	High stability timers Oscillators and level detectors
Programmable Unijunction Transistor (PUT)			 Programmed by two resistors for V_p, I_p, I_v. Function equivalent to normal UJT.	Low cost timers and oscillators Long period timers SCR trigger Level detector
Photo Transistor			 Incident light acts as base current of the photo transistor	Tape readers Card readers Position sensor Tachometers

PAPEL MILIMETRADO HERALD

ELECTRÓNICA DE POTENCIA CONTINUACIÓN . . .

J J V

SEMICONDUCTOR COMPONENTS

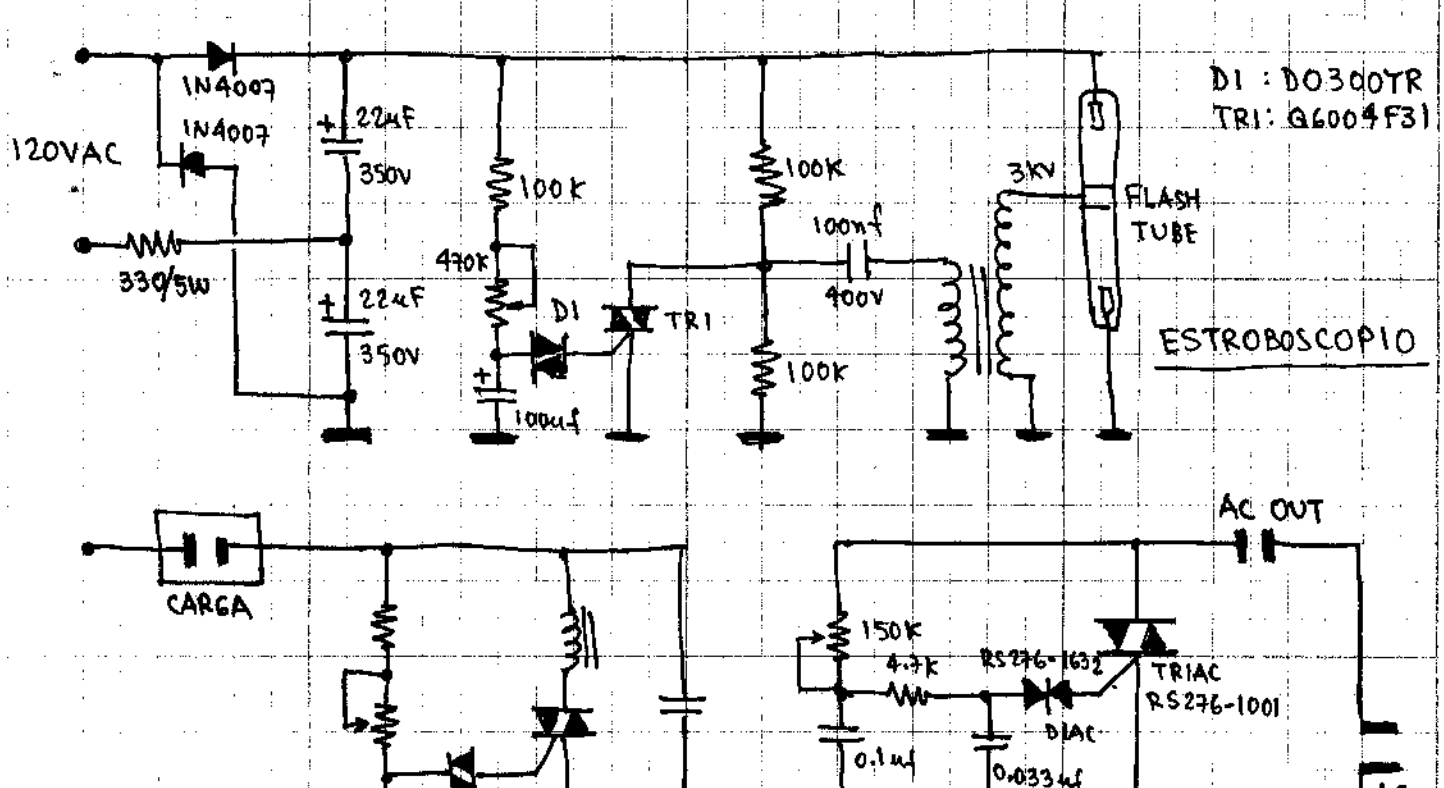
NAME OF DEVICE	CIRCUIT SYMBOL	COMMONLY USED JUNCTION SCHEMATIC	ELECTRICAL CHARACTERISTICS		MAJOR APPLICATIONS
Opto Coupler 1) Transistor (H11A, H16A) 2) Darlington (H11B, H15B) Outputs				Output characteristics are identical to a normal transistor/Darlington except that the LED current (I_F) replaces the base drive (I_B)	Isolated interfacing of logic systems with other logic systems, power semiconductors and electro-mechanical devices. Solid state relays.
Opto Coupler SCR Output (H11C)				With Anode voltage (+) the SCR can be triggered with a forward LED current. (Characteristics identical to a normal SCR except that LED current (I_F) replaces gate trigger current (I_G).	Isolated interfacing of logic systems with AC power switching functions. Replacement of relays, microswitches.
AC Input Opto Coupler (H11AA)				Identical to a "standard" transistor coupler except that LED current can be of either polarity	Telecommunications - ring signal detection, monitoring line usage. Polarity insensitive solid state relay. Zero voltage detector
Silicon Controlled Rectifier (SCR)				With anode voltage (+), SCR can be triggered by I_G, remaining in conduction until anode I is reduced to zero	Power switching Phase control Inverters Choppers
Complementary Silicon Controlled Rectifier (CSCR)				Polarity complement to SCR	Ring counters Low speed logic Lamp driver
Light Activated SCR* LASCR				Operates similar to SCR, except can also be triggered into conduction by light falling on junctions	Relay Replacement Position controls Photoelectric applications Slave flashes
Silicon Controlled Switch* (SCS)				Operates similar to SCR except can also be triggered on by a negative signal on anode-gate. Also several other specialized modes of operation	Logic applications Counters Nixie drivers Lamp drivers
Silicon Unilateral Switch (SUS)				Similar to SCS but zener added to anode gate to trigger device into conduction at ~ 8 volts. Can also be triggered by negative pulse at gate lead.	Switching Circuits Counters SCR Trigger Oscillator
Silicon Bilateral Switch (SBS)				Symmetrical bilateral version of the SUS. Breaks down in both directions as SUS does in forward.	Switching Circuits Counters TRIAC Phase Control
Triac				Operates similar to SCR except can be triggered into conduction in either direction by (+) or (-) gate signal	AC switching Phase control Relay replacement
Diac Trigger				When voltage reaches trigger level (about 35 volts), abruptly switches down about 10 volts.	Triac and SCR trigger Oscillator

TIR-3

PAPEL MILIMETRADO HERALD

ELECTRÓNICA DE POTENCIA

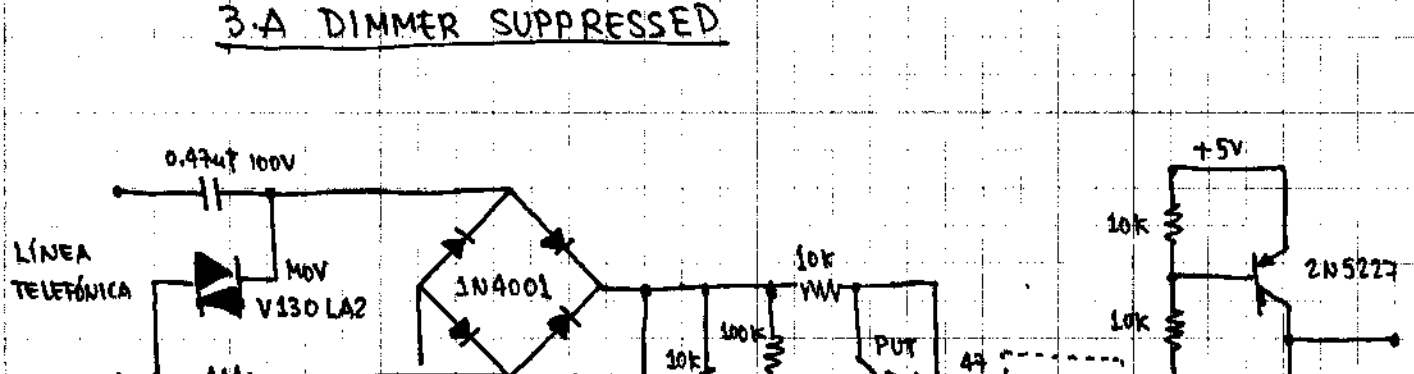
CONTINUACIÓN . . .



ESTROBOSCOPIO

3.A DIMMER SUPPRESSED

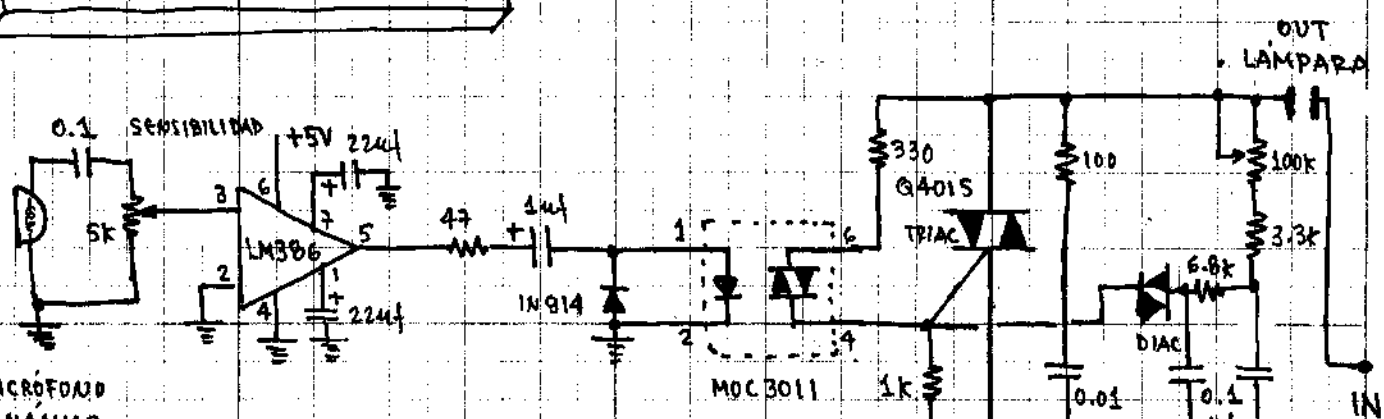
CONTROL DE CARGA



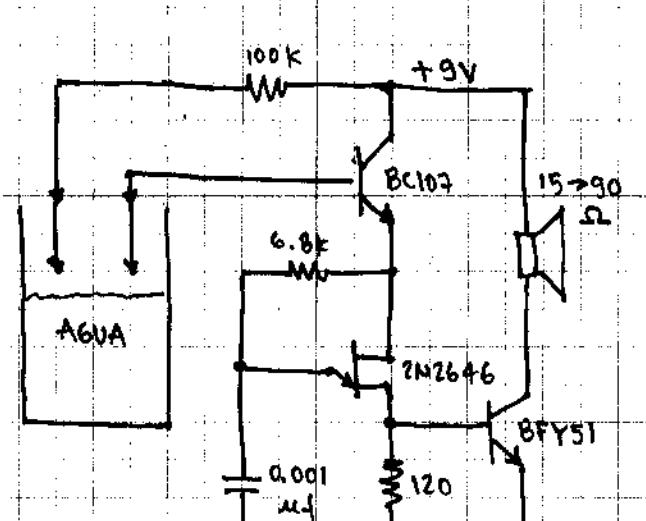
DETECTOR DE TIMBRE TELEFÓNICO

ELECTRÓNICA DE POTENCIA

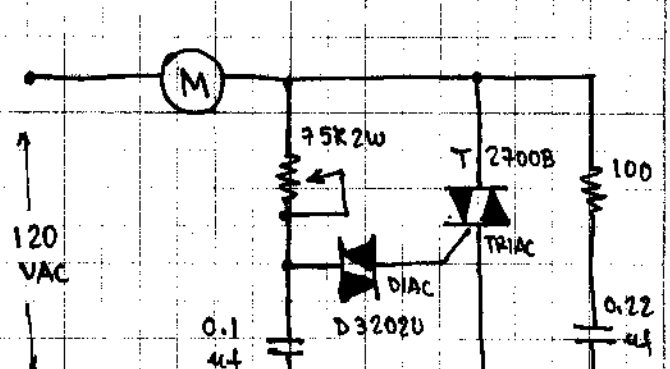
CONTINUACIÓN . . .



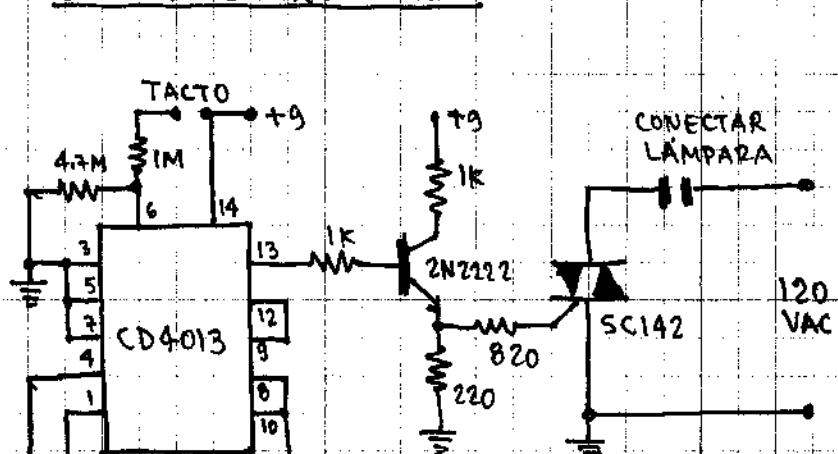
CONTROL DE LÁMPARA ACTIVADO POR VOZ



DETECTOR DE NIVEL DE AGUA



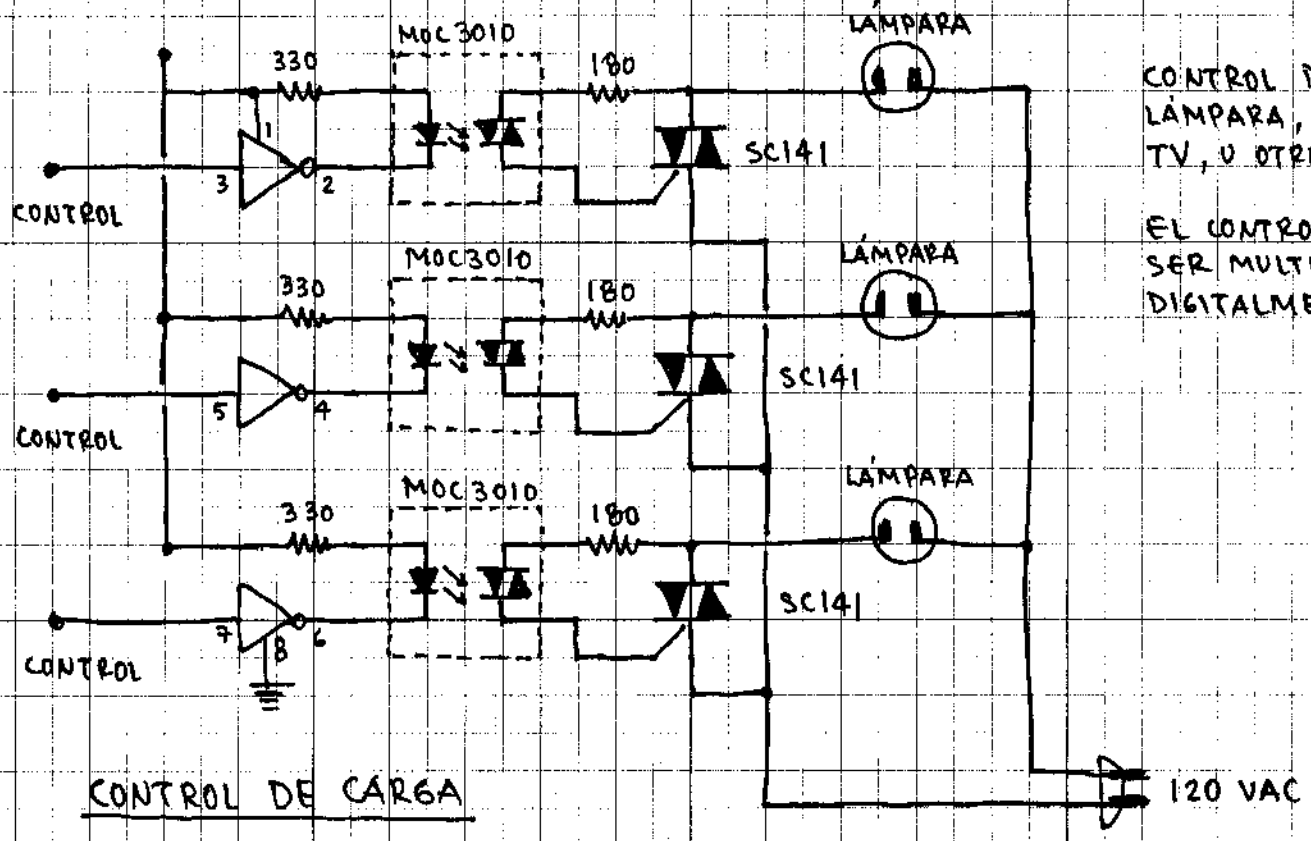
CONTROL DE MOTOR DE INDUCCIÓN



CONTROL DE LÁMPARA POR TACTO

PAPEL MILIMETRADO HERALD

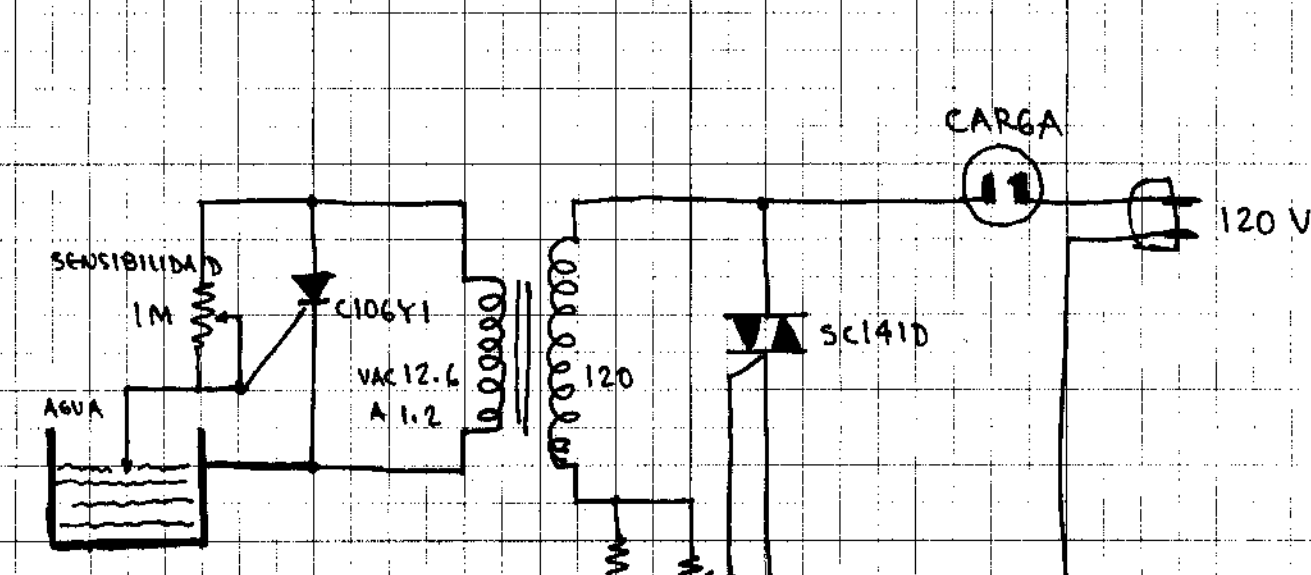
ELECTRÓNICA DE POTENCIA



CONTROL DE CARGA LÁMPARA, COCINA TV, U OTRO EQUIPO

EL CONTROL PODRÁ SER MULTIPLEXADO DIGITALMENTE.

CONTROL DE CARGA



SENSOR DE NIVEL D AGUA Y CONTROL DE CARGA

DATOS IMPORTANTES

PAPEL MILIMETRADO HERALD

J J V

RESISTENCIAS Y CONDENSADORES

1%, 1%

Phycomp Standard Resistor Values

1.00	1.05	1.10	1.15	1.21	1.27	1.33	1.40	1.47	1.54	1.62	1.69	1.78	1.87	1.96	2.05	2.15	2.26	2.37	2.49	2.61	2.74	2.87	3.01	3.16	3.32	3.48	3.65	3.83	4.02	4.22	4.42	4.64	4.87	5.11	5.36
1.02	1.07	1.12	1.18	1.24	1.30	1.37	1.43	1.50	1.58	1.65	1.74	1.82	1.91	2.00	2.10	2.21	2.32	2.43	2.55	2.67	2.80	2.94	3.09	3.24	3.40	3.57	3.74	3.92	4.12	4.32	4.53	4.75	4.98	5.23	5.49
1.04	1.09	1.15	1.21	1.27	1.33	1.40	1.47	1.54	1.62	1.69	1.78	1.87	1.96	2.06	2.16	2.26	2.37	2.49	2.61	2.74	2.87	3.01	3.16	3.32	3.48	3.65	3.83	4.02	4.22	4.42	4.64	4.87	5.11	5.36	5.62
1.06	1.12	1.18	1.24	1.30	1.37	1.43	1.50	1.58	1.65	1.74	1.82	1.91	2.00	2.10	2.21	2.32	2.43	2.55	2.67	2.80	2.94	3.09	3.24	3.40	3.57	3.74	3.92	4.12	4.32	4.53	4.75	4.98	5.23	5.49	5.76
1.07	1.15	1.21	1.27	1.33	1.40	1.47	1.54	1.62	1.69	1.78	1.87	1.96	2.06	2.16	2.26	2.37	2.49	2.61	2.74	2.87	3.01	3.16	3.32	3.48	3.65	3.83	4.02	4.22	4.42	4.64	4.87	5.11	5.36	5.62	5.90
1.10	1.18	1.24	1.30	1.37	1.43	1.50	1.58	1.65	1.74	1.82	1.91	2.00	2.10	2.21	2.32	2.43	2.55	2.67	2.80	2.94	3.09	3.24	3.40	3.57	3.74	3.92	4.12	4.32	4.53	4.75	4.98	5.23	5.49	5.76	6.04
1.13	1.21	1.27	1.33	1.40	1.47	1.54	1.62	1.69	1.78	1.87	1.96	2.06	2.16	2.26	2.37	2.49	2.61	2.74	2.87	3.01	3.16	3.32	3.48	3.65	3.83	4.02	4.22	4.42	4.64	4.87	5.11	5.36	5.62	5.90	6.19
1.15	1.23	1.30	1.37	1.43	1.50	1.58	1.65	1.74	1.82	1.91	2.00	2.10	2.21	2.32	2.43	2.55	2.67	2.80	2.94	3.09	3.24	3.40	3.57	3.74	3.92	4.12	4.32	4.53	4.75	4.98	5.23	5.49	5.76	6.04	6.34
1.18	1.26	1.33	1.40	1.47	1.54	1.62	1.69	1.78	1.87	1.96	2.06	2.16	2.26	2.37	2.49	2.61	2.74	2.87	3.01	3.16	3.32	3.48	3.65	3.83	4.02	4.22	4.42	4.64	4.87	5.11	5.36	5.62	5.90	6.19	6.49
1.20	1.28	1.35	1.43	1.50	1.58	1.65	1.74	1.82	1.91	2.00	2.10	2.21	2.32	2.43	2.55	2.67	2.80	2.94	3.09	3.24	3.40	3.57	3.74	3.92	4.12	4.32	4.53	4.75	4.98	5.23	5.49	5.76	6.04	6.34	6.65
1.21	1.29	1.37	1.45	1.53	1.62	1.69	1.78	1.87	1.96	2.06	2.16	2.26	2.37	2.49	2.61	2.74	2.87	3.01	3.16	3.32	3.48	3.65	3.83	4.02	4.22	4.42	4.64	4.87	5.11	5.36	5.62	5.90	6.19	6.49	6.81
1.24	1.32	1.40	1.47	1.55	1.63	1.72	1.80	1.89	1.99	2.09	2.19	2.30	2.42	2.53	2.66	2.79	2.92	3.06	3.21	3.37	3.53	3.71	3.89	4.08	4.28	4.49	4.71	4.94	5.19	5.44	5.71	5.99	6.28	6.59	6.91
1.27	1.35	1.43	1.51	1.59	1.68	1.76	1.85	1.95	2.05	2.15	2.26	2.37	2.49	2.61	2.74	2.87	3.01	3.16	3.32	3.48	3.65	3.83	4.02	4.22	4.42	4.64	4.87	5.11	5.36	5.62	5.90	6.19	6.49	6.81	7.15
1.30	1.38	1.46	1.54	1.62	1.71	1.80	1.89	1.99	2.09	2.19	2.30	2.42	2.53	2.66	2.79	2.92	3.06	3.21	3.37	3.53	3.71	3.89	4.08	4.28	4.49	4.71	4.94	5.19	5.44	5.71	5.99	6.28	6.59	6.91	7.25
1.33	1.41	1.49	1.58	1.66	1.74	1.84	1.93	2.03	2.13	2.24	2.35	2.47	2.59	2.71	2.85	2.99	3.14	3.29	3.45	3.62	3.79	3.98	4.17	4.37	4.59	4.81	5.05	5.30	5.56	5.83	6.12	6.42	6.73	7.06	7.41
1.37	1.45	1.53	1.62	1.69	1.78	1.87	1.97	2.07	2.17	2.28	2.40	2.52	2.64	2.77	2.91	3.05	3.21	3.36	3.53	3.71	3.88	4.08	4.28	4.49	4.71	4.94	5.19	5.44	5.71	5.99	6.28	6.59	6.91	7.25	7.60
1.40	1.48	1.56	1.65	1.74	1.82	1.91	2.01	2.11	2.21	2.32	2.45	2.57	2.69	2.82	2.96	3.11	3.26	3.42	3.59	3.76	3.95	4.15	4.35	4.56	4.79	5.02	5.267	5.53	5.80	6.08	6.38	6.69	7.02	7.36	7.72
1.43	1.51	1.59	1.68	1.76	1.85	1.95	2.05	2.15	2.26	2.37	2.49	2.61	2.74	2.87	3.01	3.16	3.32	3.48	3.65	3.83	4.02	4.22	4.42	4.64	4.87	5.11	5.36	5.62	5.90	6.19	6.49	6.81	7.15	7.50	7.87
1.47	1.54	1.62	1.71	1.79	1.88	1.98	2.08	2.19	2.30	2.41	2.53	2.66	2.79	2.92	3.06	3.21	3.37	3.53	3.71	3.88	4.08	4.28	4.49	4.71	4.94	5.19	5.44	5.71	5.99	6.28	6.59	6.91	7.25	7.60	7.97
1.50	1.58	1.65	1.74	1.82	1.91	2.01	2.11	2.21	2.32	2.43	2.55	2.67	2.80	2.94	3.09	3.24	3.40	3.57	3.74	3.92	4.12	4.32	4.53	4.75	4.98	5.23	5.49	5.76	6.04	6.34	6.65	6.98	7.32	7.68	8.06
1.54	1.62	1.69	1.78	1.87	1.96	2.06	2.16	2.26	2.37	2.49	2.61	2.74	2.87	3.01	3.16	3.32	3.48	3.65	3.83	4.02	4.22	4.42	4.64	4.87	5.11	5.36	5.62	5.90	6.19	6.49	6.81	7.15	7.50	7.87	8.25
1.58	1.65	1.74	1.82	1.91	2.00	2.10	2.21	2.32	2.43	2.55	2.67	2.80	2.94	3.09	3.24	3.40	3.57	3.74	3.92	4.12	4.32	4.53	4.75	4.98	5.23	5.49	5.76	6.04	6.34	6.65	6.98	7.32	7.68	8.06	8.45
1.62	1.69	1.78	1.87	1.96	2.06	2.16	2.26	2.37	2.49	2.61	2.74	2.87	3.01	3.16	3.32	3.48	3.65	3.83	4.02	4.22	4.42	4.64	4.87	5.11	5.36	5.62	5.90	6.19	6.49	6.81	7.15	7.50	7.87	8.25	8.66
1.65	1.74	1.82	1.91	2.00	2.10	2.21	2.32	2.43	2.55	2.67	2.80	2.94	3.09	3.24	3.40	3.57	3.74	3.92	4.12	4.32	4.53	4.75	4.98	5.23	5.49	5.76	6.04	6.34	6.65	6.98	7.32	7.68	8.06	8.45	8.87
1.69	1.78	1.87	1.96	2.06	2.16	2.26	2.37	2.49	2.61	2.74	2.87	3.01	3.16	3.32	3.48	3.65	3.83	4.02	4.22	4.42	4.64	4.87	5.11	5.36	5.62	5.90	6.19	6.49	6.81	7.15	7.50	7.87	8.25	8.66	9.09
1.74	1.82	1.91	2.00	2.10	2.21	2.32	2.43	2.55	2.67	2.80	2.94	3.09	3.24	3.40	3.57	3.74	3.92	4.12	4.32	4.53	4.75	4.98	5.23	5.49	5.76	6.04	6.34	6.65	6.98	7.32	7.68	8.06	8.45	8.87	9.31
1.78	1.87	1.96	2.06	2.16	2.26	2.37	2.49	2.61	2.74	2.87	3.01	3.16	3.32	3.48	3.65	3.83	4.02	4.22	4.42	4.64	4.87	5.11	5.36	5.62	5.90	6.19	6.49	6.81	7.15	7.50	7.87	8.25	8.66	9.09	9.53
1.82	1.91	2.00	2.10	2.21	2.32	2.43	2.55	2.67	2.80	2.94	3.09	3.24	3.40	3.57	3.74	3.92	4.12	4.32	4.53	4.75	4.98	5.23	5.49	5.76	6.04	6.34	6.65	6.98	7.32	7.68	8.06	8.45	8.87	9.31	9.76
1.87	1.96	2.06	2.16	2.26	2.37	2.49	2.61	2.74	2.87	3.01	3.16	3.32	3.48	3.65	3.83	4.02	4.22	4.42	4.64	4.87	5.11	5.36	5.62	5.90	6.19	6.49	6.81	7.15	7.50	7.87	8.25	8.66	9.09	9.53	10.000
1.91	2.00	2.10	2.21	2.32	2.43	2.55	2.67	2.80	2.94	3.09	3.24	3.40	3.57	3.74	3.92	4.12	4.32	4.53	4.75	4.98	5.23	5.49	5.76	6.04	6.34	6.65	6.98	7.32	7.68	8.06	8.45	8.87	9.31	9.76	10.24
1.95	2.05	2.15	2.26	2.37	2.49	2.61	2.74	2.87	3.01	3.16	3.32	3.48	3.65	3.83	4.02	4.22	4.42	4.64	4.87	5.11	5.36	5.62	5.90	6.19	6.49	6.81	7.15	7.50	7.87	8.25	8.66	9.09	9.53	10.000	10.49
1.96	2.06	2.16	2.26	2.37	2.49	2.61	2.74	2.87	3.01	3.16	3.32	3.48	3.65	3.83	4.02	4.22	4.42	4.64	4.87	5.11	5.36	5.62	5.90	6.19	6.49	6.81	7.15	7.50	7.87	8.25	8.66	9.09	9.53	10.000	10.49
2.00	2.10	2.21	2.32	2.43	2.55	2.67	2.80	2.94	3.09	3.24	3.40	3.57	3.74	3.92	4.12	4.32	4.53	4.75	4.98	5.23	5.49	5.76	6.04	6.34	6.65	6.98	7.32	7.68	8.06	8.45	8.87	9.31	9.76	10.24	10.75
2.05	2.15	2.26	2.37	2.49	2.61	2.74	2.87	3.01	3.16	3.32	3.48	3.65	3.83	4.02	4.22	4.42	4.64	4.87	5.11	5.36	5.62	5.90	6.19	6.49	6.81	7.15	7.50	7.87	8.25	8.66	9.09	9.53	10.000	10.49	11.000

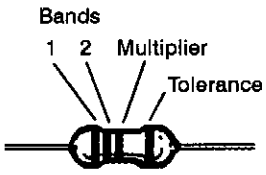
5%, 5%

Phycomp Standard Resistor Values

0.9	1.6	2.9	5.1	9.1	16	30	56	100	180	330	600	1.0K	1.8K	3.3K	6.1K	10K	18K	33K	56K	100K	180K	330K	600K	1.0M	1.8M	3.3M	6.1M	10M							
1.0	1.8	3.3	6.0	10	18	33	62	110	200	360	620	1.1K	2.0K	3.6K	6.2K	11K	20K	36K	62K	110K	200K	360K	620K	1.1M	2.0M	3.6M	6.2M	11M							
1.1	2.0	3.6	6.2	11	20	36	68	120	220	390	680	1.2K	2.2K	3.9K	6.8K	12K	22K	39K	68K	120K	220K	390K	680K	1.2M	2.2M	3.9M	6.8M	12M							
1.2	2.2	3.9	6.8	12	22	39	75	130	240	430	750	1.3K	2.4K	4.3K	7.5K	13K	24K	43K	75K	130K	240K	430K	750K	1.3M	2.4M	4.3M	7.5M	13M							
1.3	2.4	4.3	7.5	13	24	43	82	150	270	470	820	1.5K	2.7K	4.7K	8.2K	15K	27K	47K	82K	150K	270K	470K	820K	1.5M	2.7M	4.7M	8.2M								
1.5	2.7	4.7	8.2	15	27	51	91	160	300	510	910	1.6K	3.0K	5.1K	9.1K	16K	30K	51K	91K	160K	300K	510K	910K	1.6M	3.0M	5.1M	9.1M								

IDENTIFYING RESISTOR VALUES

Use the following information as a guide in properly identifying the value of resistors.



BAND 1 1st Digit	
Color	Digit
Black	0
Brown	1
Red	2
Orange	3
Yellow	4
Green	5
Blue	6
Violet	7
Gray	8
White	9

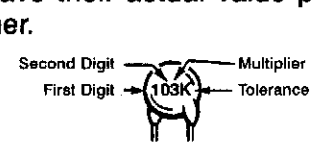
BAND 2 2nd Digit	
Color	Digit
Black	0
Brown	1
Red	2
Orange	3
Yellow	4
Green	5
Blue	6
Violet	7
Gray	8
White	9

Multiplier	
Color	Multiplier
Black	1
Brown	10
Red	100
Orange	1,000
Yellow	10,000
Green	100,000
Blue	1,000,000
Silver	0.01
Gold	0.1

Resistance Tolerance	
Color	Tolerance
Silver	±10%
Gold	±5%
Brown	±1%
Red	±2%
Orange	±3%
Green	±.5%
Blue	±.25%
Violet	±.1%

IDENTIFYING CAPACITOR VALUES

Capacitors will be identified by their capacitance value in pF (picofarads) or μF (microfarads). Most capacitors will have their actual value printed on them. Some capacitors may have their value printed in the following manner.



Multiplier	For the No.	0	1	2	3	4	5	8	9
	Multiply By	1	10	100	1K	10K	100K	.01	0.1

The above value is 10 x 1,000 = 10,000pF or .01μF
The letter K indicates a tolerance of ±10%
The letter J indicates a tolerance of ±5%

Note: The letter "R" may be used at times to signify a decimal point; as in 3R3 = 3.3

PAPEL MILIMETRADO HERALD

DATOS-1

DATOS DE RADIO COMUNICACIONES

J J V

ESPECTRO DEL SISTEMA RADIO ELECTRICO

20	a	20K	(Hz)	AF	AUDIO FRECUENCIAS
3K	a	30K	(Hz)	VLF	FRECUENCIAS MUY BAJAS
30K	a	300K	(Hz)	LF	BAJA FRECUENCIAS
300K	a	3M	(Hz)	MF	FRECUENCIAS MEDIAS
3M	a	30M	(Hz)	HF	ALTA FRECUENCIAS
30M	a	300M	(Hz)	VHF	MUY ALTA FRECUENCIAS
300M	a	3,000M	(Hz)	UHF	ULTRA ALTA FRECUENCIAS
3,000M	a	30,000M	(Hz)	SHF	SUPER ALTA FRECUENCIAS
30,000M	a	Y MAS	(Hz)		FRECUENCIAS EXTREMADAMENTE ALTAS

BANDA DE RADIO DIFUSION COMERCIAL

AMPLITUD MODULADA (AM)				FRECUENCIA MODULADA (FM)				
525	a	1610	(KHz)	88	a	108	(MHz)	PORTADORAS
455			(KHz)	10.7			(MHz)	FRECUENCIA INTERMADIA (FI)
				19			(KHz)	PORTADORA PILOTO ESTEREOFONIA
				38			(KHz)	SUBPORTADORA ESTEREOFONIA
				67			(KHz)	SUBPORTADORA SCA

BANDA DE RADIO DIFUSION COMERCIAL DE TELEVISION

	PROCESO DE MODULACION	FRECUENCIA INTERMEDIA (FI)		FRECUENCIA PILOTO
SEÑAL DE AUDIO	FRECUENCIA MODULADA	41.25	(MHz)	
SEÑAL VIDEO	AMPLITUD MODULADA	45.75	(MHz)	
SUBPORTADORA DE COLOR	MODULACION EN FASE	42.17	(MHz)	3.579545
SINCRONISMO HORIZONTAL	AMPLITUD MODULADA		(KHz)	15.75
SINCRONISMO VERTICAL	AMPLITUD MODULADA		(Hz)	60

BANDA			CANALES RECIBIDOS				BANDA
54	a	88	(MHz)	2	al	6	VHF
174	a	216	(MHz)	7	al	13	VHF
470	a	490	(MHz)	14	al	83	UHF

ASIGNACION DE FRECUENCIAS POR CANAL DE TV

PORTADORA VIDEO (MHz)	CH	PORTADORA SONIDO (MHz)	PORTADORA VIDEO (MHz)	CH	PORTADORA SONIDO (MHz)
FRECUENCIA DE TELEVISION VHF			639.25	42	643.75
55.25	2	59.75	645.25	43	649.75
61.25	3	65.75	651.25	44	655.75
67.25	4	71.75	657.25	45	661.75
77.25	5	81.75	663.25	46	667.75
83.25	6	87.75	669.25	47	673.75
175.25	7	179.75	675.25	48	679.75
181.25	8	185.75	681.25	49	685.75
187.25	9	191.75	687.25	50	691.75
193.25	10	197.75	693.25	51	697.75
199.25	11	203.75	699.25	52	703.75
205.25	12	209.75	705.25	53	709.75
211.25	13	215.75	711.25	54	715.75
FRECUENCIA DE TELEVISION UHF			717.25	55	721.75
471.25	14	475.75	723.25	56	727.75
477.25	15	481.75	729.25	57	733.75
483.25	16	487.75	735.25	58	739.75
489.25	17	493.75	741.25	59	745.75
495.25	18	499.75	747.25	60	751.75
501.25	19	505.75	753.25	61	757.75
507.25	20	511.75	759.25	62	763.75
513.25	21	517.75	765.25	63	769.75
519.25	22	523.75	771.25	64	775.75
525.25	23	529.75	777.25	65	781.75
531.25	24	535.75	783.25	66	787.75
537.25	25	541.75	789.25	67	793.75
543.25	26	547.75	795.25	68	799.75
549.25	27	553.75	801.25	69	805.75
555.25	28	559.75	807.25	70	811.75
561.25	29	565.75	813.25	71	817.75
567.25	30	571.75	819.25	72	823.75
573.25	31	577.75	825.25	73	829.75
579.25	32	583.75	831.25	74	835.75
585.25	33	589.75	837.25	75	841.75
591.25	34	595.75	843.25	76	847.75
597.25	35	601.75	849.25	77	853.75
603.25	36	607.75	855.25	78	859.75
609.25	37	613.75	861.25	79	865.75
615.25	38	619.75	867.25	80	871.75
621.25	39	625.75	873.25	81	877.75
627.25	40	631.75	879.25	82	883.75
633.25	41	637.75	885.25	83	889.75

ASIGNACION DE FRECUENCIAS PARA RADIO CB BANDA CIUDADANA

CANAL CB	FRECUENCIA (KHz)
1	26.965
2	26.975
3	26.985
4	27.005
5	27.015
6	27.025
7	27.035
8	27.055
9	27.065
10	27.075
11	27.085
12	27.105
13	27.115
14	27.125
15	27.135
16	27.155
17	27.165
18	27.175
19	27.185
20	27.205
21	27.215
22	27.225
23	27.255
24	27.235
25	27.245
26	27.265
27	27.275
28	27.285
29	27.295
30	27.305
31	27.315
32	27.325
33	27.335
34	27.345
35	27.355
36	27.365
37	27.375
38	27.385
39	27.395
40	27.405

MULTIPLOS Y SUBMULTIPLOS

1,000,000,000,000	10^{12}	TERA	T
1,000,000,000	10^{9}	GIGA	G
1,000,000	10^{6}	MEGA	M
1,000	10^{3}	KILO	K
100	10^{2}	HECTO	H
10	10^{1}	DECA	Da
0.1	10^{-1}	deci	d
0.01	10^{-2}	centi	c
0.001	10^{-3}	mili	m
0.000,001	10^{-6}	micro	u
0.000,000,001	10^{-9}	nano	n
0.000,000,000,001	10^{-12}	pico	p
0.000,000,000,000,001	10^{-15}	femto	f
0.000,000,000,000,000,001	10^{-18}	atto	a

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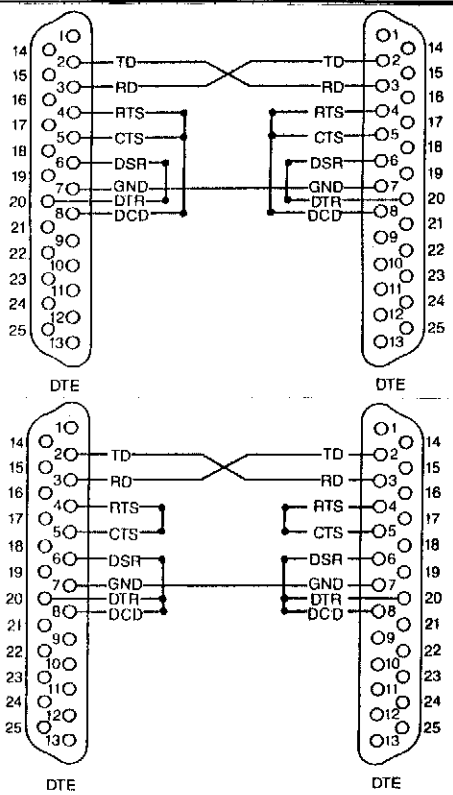
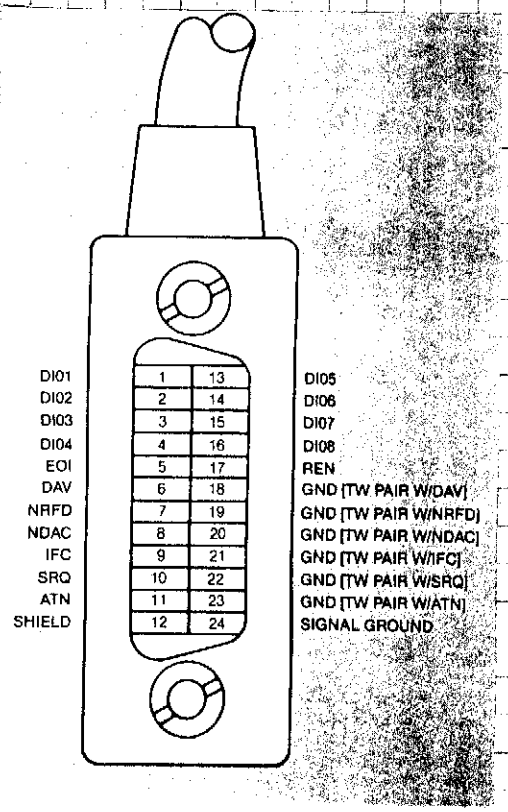
DATOS DE CONEXIONES DE PC

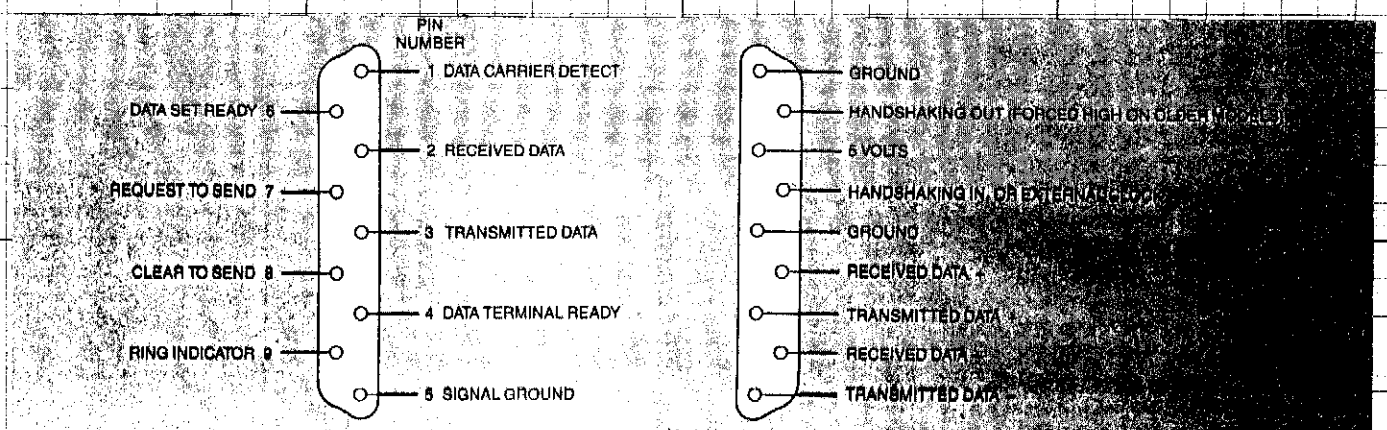
J J V

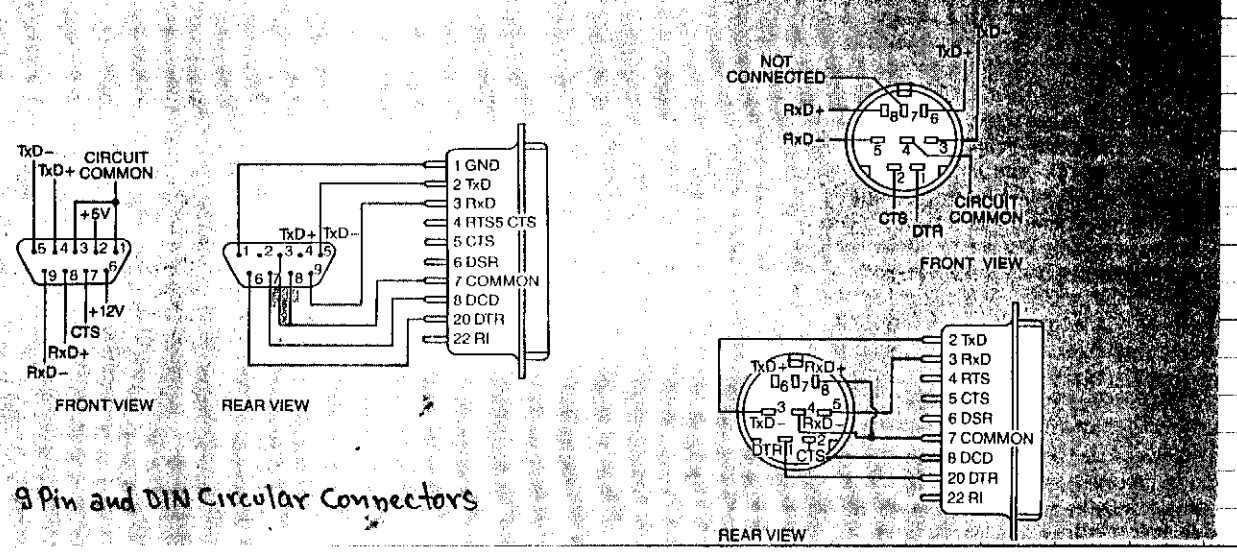


- RS-232 DTE to DTE Connections with Handshaking Jumpers



- IEEE-488 Connector

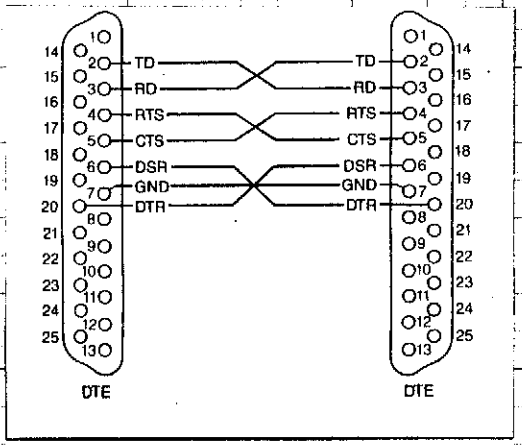




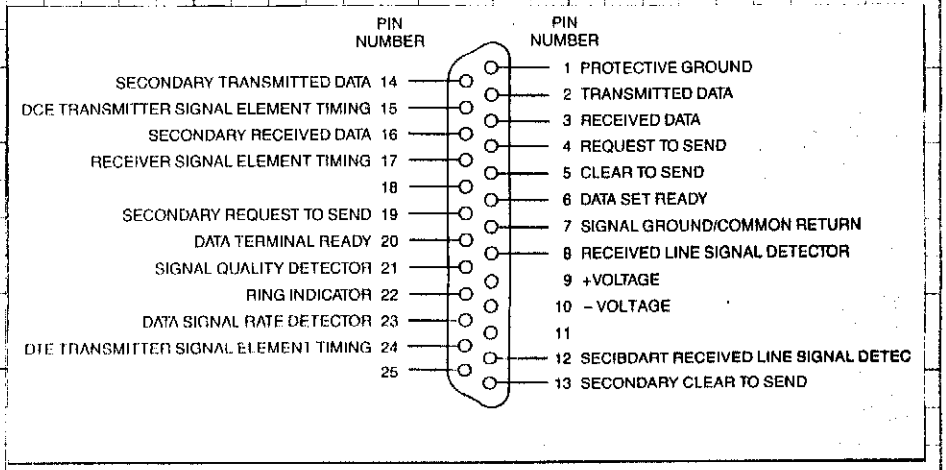
RS-232 9 Pin and DIN Circular Connectors

PAPEL MILIMETRADO HERALD

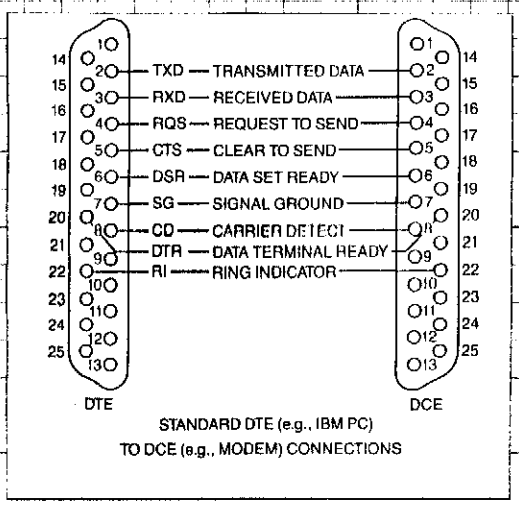
DATOS-3



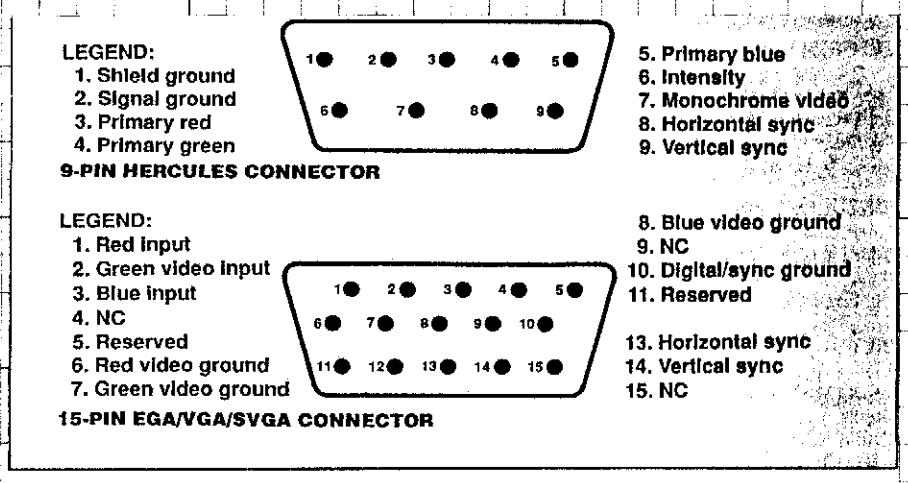
- RS-232 DTE to DTE Connections



- RS-232 DTE Connector Pinouts



- RS-232 DTE to DCE Connections



Video input connector of a text-only monitor, as well as the connector for EGA, VGA, and SVGA monitors.

MONITORES

– Listing of Adapter Card Specifications

Video System	Horizontal Resolution	Vertical Resolution	# of Color	Horizontal Scan Rate	Vertical Scan Rate	Type
MDA	720	350	Mono	18,432Hz	50Hz	Digital
HGA	720	348	Mono	8,432Hz	50Hz	Digital
RGB	640	480	Infinite	15,734Hz	60Hz	Analog
CGA	300	200	4 of 16	15,750Hz	60Hz	Digital
	640	200				
EGA	640	200	16 of 64	21,800Hz	60Hz	Digital
		350				
VGA	640	350	256 of	31,500Hz	60-70Hz	Analog
		400	256,000			
		480				
SVGA	800	600	256 of	35,200Hz	56-72Hz	Analog
	1024	768	256,000			
	1280	1024				
8514/A	1024	768	256	31,500Hz	60-70Hz	Analog
XGA	640	480	65,536	31,500Hz	60-70Hz	Analog
	1024	768	256			
TI34010	1024	768	256	31,500Hz	60-70Hz	Analog

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DATOS DE ELECTRICIDAD

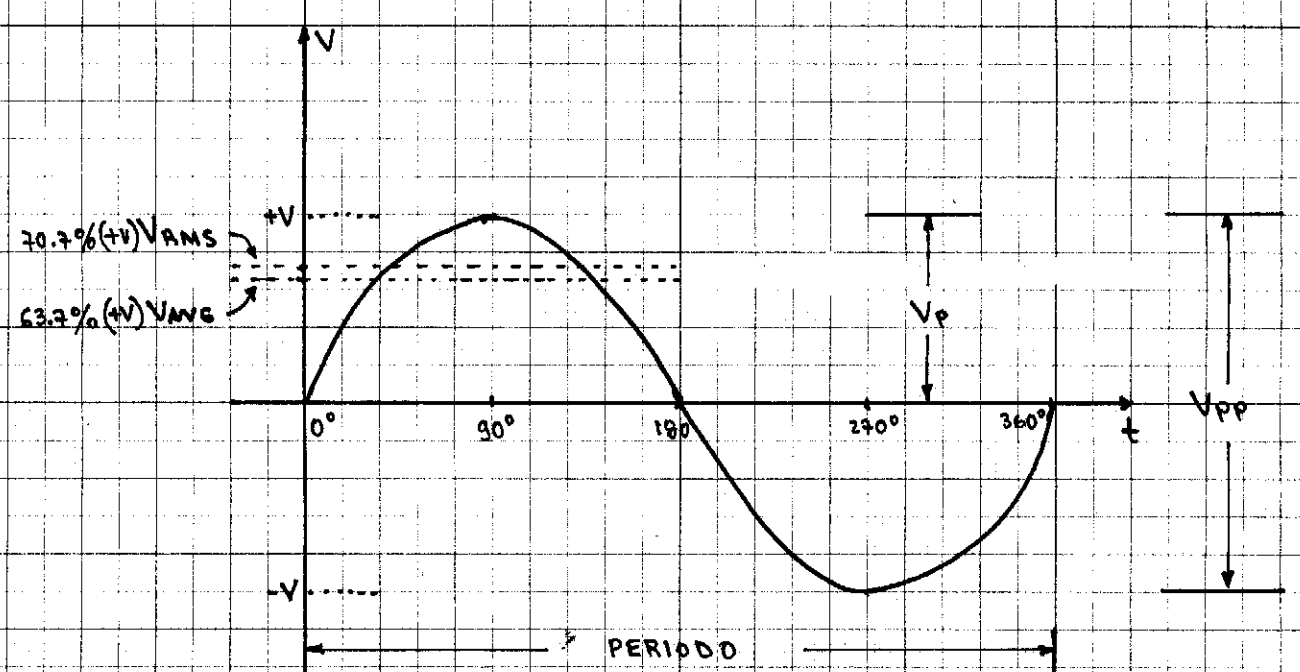
J J V

FÓRMULAS PARA ELECTRICIDAD

POTENCIA	VOLTAJE	CORRIENTE
WATTS	VOLTIOS	AMPERIOS
(W)	(V)	(I)
$V*I$	$I*R$	V/R
I^2R	W/I	W/V
V^2/R	$(W*R)^{1/2}$	$(W/R)^{1/2}$
	DC AC	DC

RESISTENCIA	CONDENSADORES	BOBINAS
OHMS	CAPACITANCIA	INDUCTANCIAS
(Ω)	FARADIOS	HENRIOS
V/I	C	L
V^2/W	(F)	(H)
W/I^2	$X_C=1/2\pi fC$	$X_L=2\pi fL$

V_{PP}:	VOLTAJE PICO A PICO	$= 2V_P$
V_{RMS}:	VOLTAJE EFECTIVO	$= 0.707V_P$
V_{AVG}:	VOLTAJE PROMEDIO	$= 0.637V_P$
f:	FRECUENCIA	= 1/PERIODO



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ANTENAS

Representación general

Antena transmisora

Antena receptora

Antena transmisora-receptora para emisión-recepción no simultánea

Antena telescópica, de extensión

Antena de televisor, para UHF (Ultra-altas frecuencias)

Dipolo

Dipolo doblado

Dipolo doblado con tres directores y un reflector

Antena de cuadro

Antena equilibrada

Antena de radio equilibrada

Antena rómbica

Antena parabólica con galonado rectangular

Antena de ranura con alimentador rectangular

Reflector parabólico o cilíndrico

Reflector en forma de esquina

AUDIO Y VIDEO

Altavoz (parlante)

Parlante para ultrasonidos

Parlante electrostático

Auriculares

Auífono monofónico

Auífono estéreo

Auriculares estéreo

Auífono y micrófono

Cabeza lectora en general

(**) R grabación P reproduc. E borradora R/P K borrado Cabeza

Cabeza de grabación (Record)

Cabeza de reproducción (Playback)

Cabeza de borrado

Cabeza de escritura, lectura y borrado

Cabeza estéreo

Reproducción

Rebobinado

Avance rápido

Grabador de cinta

Grabación en cinta

Grabador estéreo de cinta

Lector de cinta (playback)

Grabador de cintas de video (blanco y negro)

Grabador de video de color

Borrado de cinta

Cápsula bifónica (uso general)

Cápsula estéreo

Cápsula piezoeléctrica

Cápsula dinámica

Micrófono

Micrófono de condensador

Micrófono de cristal

Micrófono de carbón

Micrófono dinámico

Micrófono estéreo

Micrófono push pull

TV color

Monitor de TV blanco y negro

Cámara de TV color

Cámara de TV en blanco y negro

Contraste

Saturación de color

Control de tono

Control de tono

BLOQUES FUNCIONALES

Amplificadores:

Amplificador con 1 entrada (no-inversor) 1

Amplificador con 2 entradas

Amplificador con 2 salidas

Amplificador diferencial con 2 salidas en fase (opuesto (divisor de fase)

Amplificador de ganancia ajustable

Amplificador con realimentación externa

Amplificador con atenuador incorporado

Amplificador con control externo de c.c.

Amplificador con control automático de volumen

Amplificador magnético, símbolo para diagramas de bloques

Amplificador diferencial (operacional o comparador)

Amplificador Norton

Funciones específicas:

Bloque rectificador de corriente alterna

Convertidor ca/cc

Convertidor c.c.

Rectificador inversor

Inversor (entrada c.c. salida corriente alterna)

Variador

Multiplicador de frecuencia

Divisor de frecuencia

Inversor de impulsos

Formador de impulsos

Convertidor de impedancias

Iniciador automático (starter)

Iniciador semiautomático

Contador

Comparador

Expansor

Corrector de disparidad

Batería

Amortiguamiento

Atenuador fijo

Atenuador variable

Variador direccional de fase

Girador

Transmisor telemétrico

Receptor telemétrico

Aislador

Moderador o discriminador

BATERIAS, PILAS

Pila (elemento, una celda) 2

Pila (batería multicelda) 3

Batería con tensión regulable

BOMBILLAS, LAMPARAS

Lámpara incandescente

Lámpara fluorescente

Lámpara de Neón (el punto indica que la bombilla se ha llenado con gas)

BOBINAS Y TRANSFORMADORES

Bobina con núcleo de aire

El punto, o asterisco, se utiliza para señalar el extremo inicial (polaridad) de la bobina 4

Inductor con derivaciones (taps)

Inductor con núcleo Fe Si (hierro-silicio)

Inductor con núcleo de ferroxcube 5

Inductor con núcleo ajustable

Transformador con núcleo de aire

Transformador con núcleo Fe Si (hierro-silicio)

Transformador núcleo ferroxcube 6

Transformador con acoplamiento variable

Transformador con núcleo ajustable

Transformador apantallado 7

Transformador con imán móvil

Transformador para frecuencia intermedia (FI)

Autotransformador 8

Transformador de potencia (fuente de alimentación)

El punto es opcional, e indica cual extremo ha sido el comienzo, o el final, al devanar cada inductor

Transformador con bobinas de núcleo saturable

Transformador con núcleo magnético y pantalla 9

Transformador con inductancia ajustable

En una bobina 10 En ambas bobinas 11

Transformador con derivaciones (taps) en uno de los devanados

Transformador monofásico con regulación continua de corriente

Transformador variable

Auto trasnf.

CLAVIJAS Y TOMAS

Clavija

macho (plug) hembra (jack)

Conectores separables

Clavija coaxial macho

Clavija coaxial hembra

Toma monofónico para auífono

con interruptor de pantalla

Toma estéreo para auífono, con interruptor de pantalla

plug (clavija macho tipo RCA)

jack (toma hembra tipo RCA)

Clavija enchufe para alimentación de equipos

Tomacorriente hembra no polarizado

Tomacorriente hembra polarizado

CIRCUITOS INTEGRADOS

Los puntos indican que el dispositivo (Chip) puede tener más patillas (pines)

Entradas Salida

CI

CONDENSADORES

Condensador no polarizado de valor fijo 12

Condensador variable para sintonía 13

Condensador variable doble de operación simultánea mediante un eje común (en tandem)

Condensador ajustable (Trimmer) 14

Condensador de estator dividido

Electrolítico (polarizado) 15

Electrolítico doble, con negativo común 16

Polarizado sensible

a la temperatura a la tensión

Condensador electrolítico no polarizado

Condensador pasante ("passmuro") 17

DIODOS

Rectificador 18

Zener 19

Túnel 20

Gunn, Impatt 21

Pin

Schottky 22

Fotodiodo (sensible a la luz)

Diodo emisor de luz (LED)

Rectificador Túnel

Varicap 23

Limitador o supresor de tensión para voltaje bipolar 24

De corriente constante

Snap (de conmutación instantánea) (Charge storage) (step recovery)

Que utiliza el efecto de la temperatura (sensible al calor)

DATOS-6

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FUNCIONES LOGICAS

Amplificadores (Buffer)

Amplificador no inversor o adaptador de señales (Buffer) a un sistema digital

Entrada — Salida

Amplificador divisor de fase (normal e inversor)

Entrada — Salidas

Divisor de fase

Amplificador con inversión a la salida ("negación" del nivel lógico presente en la entrada)

Entrada (IN) — Salida (OUT)

Inversión a la salida

Inversor con entrada disparada por un circuito Schmitt (Schmitt Trigger)

Amplificador con inversión de salida a la entrada

Inversión a la entrada

Amplificador (Buffer) con inversión a la entrada

ACOPLAMIENTO POR SEÑAL ALTERNA

El elemento sólo responde a un cambio de nivel ascendente o descendente en la entrada, tal como ocurre cuando se tiene un condensador en serie con la entrada.

PUERTA Y (AND GATE)

La salida es nivel H (alto) sólo cuando todas las entradas están simultáneamente en nivel H.

A, B — Salida

AND de 2 entradas

A, B — Salida

AND de 4 entradas

Función AND implementada con varios componentes (puerta AND "alambrada")

A, B, C — Salida

PUERTA NO-Y (NAND GATE)

La salida es nivel L (bajo) sólo cuando todas las entradas están simultáneamente en nivel H (alto)

Salida

NAND de 2 o más entradas

NAND de 4 entradas

NAND de 4 entradas (tipo Schmitt Trigger)

Puerta NAND con entradas negadas (invertidas)

Entrada "normal" — Salida — Entrada "amplificada"

PUERTA O (OR GATE)

La salida es nivel H (alto) cuando una o más entradas está en nivel H.

OR de 2 entradas

OR de 8 entradas

Puerta OR de 2 o más entradas

Puerta OR de 3 o más entradas

PUERTA NO-O (NOR GATE)

La salida es nivel L (bajo) cuando una o más entradas está en nivel H.

NOR de 2 entradas

A, B — Salida

NOR con negación (inversión) en la entrada

NOR de 4 entradas

PUERTA O EXCLUSIVA (EXOR GATE)

La salida es nivel H (alto) sólo cuando una, y sólo una, de las entradas está en nivel H (alto)

EXOR de 2 o más entradas

Salida

PUERTA NO-O EXCLUSIVA (EXNOR GATE)

La salida es nivel L (bajo) sólo cuando una, y sólo una, de las entradas está en nivel H.

INSTRUMENTOS

LETRAS QUE PUEDEN REEMPLAZAR AL ASTERISCO

DB o DBM	Medidor de decibelios
MA	Miliamperímetro
O	Ohmetro
R	Medidor de grabación
T	Medidor de sintonía
V	Voltímetro
VOM	Medidor de voltios y ohmios
VTVM	Voltímetro de válvulas
VU	Indicador de volumen, medidor de nivel de audio.
W	Vatímetro (Wattmeter)

Amperímetro

Voltímetro

Voltímetro 25

Indicador de coseno de φ

Fasímetro

Frecuencímetro

Amperímetro con cero al centro

Ohmímetro

Ondómetro

Osciloscopio 26

Galvanómetro

Termómetro o pirómetro

Tacómetro

Indicador de radiación

Gasímetro de humos

Instrumento de medida de bobina móvil con imán permanente

Medidor de corientes

Instrumento de medida de bobina móvil con rectificador incorporado

Cámara de ionización

Detector de termoluminiscencia

INTERRUPTORES CONMUTADORES

Interruptor SPST (un polo un tiro) 27

Interruptor SPDT (un polo doble tiro) 28

Interruptor DPST (doble polo, un tiro)

Interruptor DPDT (doble polo, doble tiro)

Pulsador, contacto normal abierto

Pulsador, contacto cerrado

Conmutador multiposiciones

Conmutador (interrumpe el contacto antes de hacer el de la siguiente posición)

Conmutador (interrumpe el contacto sólo cuando ha hecho el contacto de la siguiente posición)

Conmutador deslizable

Conmutador multicontacto

CONTACTOS DE CONTROLES AUTOMATICOS

Presóstato (por presión de gas)

Termostato (por temperatura)

Por nivel de líquidos

Interruptor operado por flujo

Para accionar con el pie

CONTACTOS DE RELEVADOR (RELAY)

Reed switch

Conecta — N.A. 29

Desconecta — N.C.

Transfiere 30

MULTIVIBRADORES (FLIP-FLOPs)

Biestables asíncronos

Flip-flop tipo R-S (Set-Reset)

Set, Reset — Salida, Salida invertida (*)

Set, Reset — Salida, Salida invertida

Con mando a través de puertas AND

Flip-flop tipo T (Toggle)

Toggle (cinch) — Salida, Salida invertida (*)

Flip-flop tipo J-K

Salida invertida (*)

Flip-Flop Sincrónico

Tipo J-K

Salida invertida (*)

Toggle — Salida invertida

Flip-flop tipo D, sincrónico

Flip-flop sincrónico tipo R-S (*)

Astable

Generador de impulsos (*)

Monoestable (single-shot) (Temporizador)

SS — Salida (*)

Salida

Disparador de Schmitt (trigger) (*)

(*)

OPTOELECTRONICA

Célula voltaica

LDR (Fotorresistencia)

LED (diodo luminiscente)

Fotodiodo

Fotodiodo bidireccional

(NPN)

(PNP)

Fotodiodo de 2 segmentos, cátodo común (PNP)

Fotodiodo de 4 cuadrantes

Fototransistor NPN, base no conectada

Fototransistor NPN, base conectada

Foto-FET (J)

(NPN) (PNP)

LAS (Light-activated switch)

LASCR (Fototiristor)

LASCS (Light activated silicon controlled switch)

Foto-darlington

Optoacopladores Aisladores

LED - Fotodiodo

LED - LDR

Neon - LDR — Lámpara - LDR

LED - Fototransistor

LED - Fotodarlington

Con puerta NAND fotodirectora

Con fotodiodo y transistor amplificador de salida

con LASCR

con foto triac

RELEVOS Y SUS CONTACTOS

Contactos: NC, C, NO

Bobina

Relé lento a la excitación

Relé polarizado magnéticamente

Bobinas de relevador (relay) diferencial

Bobina (relay coil), electroimán o solenoide para operar la armadura con los contactos 31

Bobina (solenoide) para válvulas eléctricas

Relevador (relé) de acción rápida

Relé de desactivación rápida

Relé de desactivación lenta

Relé láminas (Reed) 32

Contacto NO (normal abierto)

Contacto NC (normal cerrado) 33

RESISTORES

Resistor normal 34

Resistor variable 35

Resistor con derivaciones (TAPS)

Resistor para ser usado como fusible

Resistor variable de variación continua

Resistor variable por escalones

Resistor de ajuste predeterminado

Resistor variable de contacto móvil (Potenciómetro)

Resistor de contacto móvil de variación continua

Resistor de contacto móvil variable por escalones

Resistor potenciométrico de ajuste predeterminado

Resistor TDR (dependiente de la temperatura) 36

Resistor NTC (disminuye su resistencia al aumentar la temperatura) 37

Resistor PTC (aumenta su resistencia al subir la temperatura) 38

Resistor VDR (dependiente del voltaje) 39

Fotorresistor (LDR) 40

Resistor sensible a la humedad

Impedancia 41

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SINCROS

Receptor de par tomar síncrono; también TR tipo sincro

Transmisor diferencial, transmisor sumador (TDX)

Transmisor (sumador diferencial) de alta potencia (TDX)

Receptor (sumador) diferencial de alta potencia (TDR)

Transmisor de control sincro mostrando sus terminales

Sincro resolver; sincro RS (con bobinados de compensación)

Sincro resolver; sincro tipo RS (sin bobinados de compensación)

Sistema transmisor sincro con control grueso fino de 60 Hz

Receptor de control sincro de c.c. de 8 etapas (escalones)

Receptor de control sincro con carga impermeable gobernado por A.F.

TRANSISTORES (Pueden inscribirse en un círculo)

Transistor (NPN)

Transistor PNP

Schottky NPN

UJT (Ununión monopositiva) (Base Tipo P)

UJT (Ununión programable) (Base Tipo N)

PUT (Unión programable)

Darlington NPN

Transistor multiemisor NPN

Transistor con efecto de avalancha (NPN)

Fototransistor (NPN)

Transistor PNP Tetrodo

TIRISTORES (pueden inscribirse en un círculo)

SCR (Rectificador controlado de silicio) 42

SCS (Interruptor controlado de silicio) 43

Schottky PNPN de 4 capas

Diac (Interruptor unidireccional) 44

Diac (Interruptor bidireccional)

Triac (Interruptor bidireccional controlado) 45

SUS (Interruptor unilateral de silicio) 46

SBS (Interruptor bilateral de silicio) 47

Tiristor de desconexión puerta canal N (controlado por ánodo)

Tiristor de desconexión, puerta canal P (controlado por cátodo)

Tiristor de conducción inversa, puerta canal N (controlado por ánodo)

Tiristor de conducción inversa, puerta canal P (controlado por cátodo)

TRANSISTORES MOS-FET e IGFET CANAL N

Canal N: flecha apuntando hacia el dispositivo. Canal P: flecha en sentido contrario. Todos los símbolos que siguen pueden también orientarse con o sin círculo

Tipo empobrecimiento (depletion), 3 terminales

Tipo empobrecimiento, tetrodo unido al surtidor, 3 terminales

Tipo empobrecimiento, 4 terminales

Tipo empobrecimiento, 2 puertas, 5 terminales

Tipo enriquecimiento (enhancement) 3 terminales

Tipo enriquecimiento, tetrodo unido al surtidor, 3 terminales

Tipo enriquecimiento, 4 terminales

Tipo enriquecimiento, 2 puertas, 5 terminales

TRANSISTORES JFET

(Transistores de efecto de campo)

Canal N

Canal P

TRANSDUCTORES

Transductor, símbolo general (indicación dentro)

Transductor bobinado

Transductor de medio ciclo con un bobinado de control

Termopar

Termopar con aislador aislado

Termopar con aislador no aislado

Termopar con aislador no aislado en sentido inverso

Generador de efecto Hall

Transductor de metal

Sistema magnetoestrictivo

Calibrador de alambre para dilatación y compresión

Bimetal

TERMINOS COMUNES

Ω	Ohmio	nF	Nanofaradio (1000 picofaradios)
kΩ	1000 (kilo) ohmios	pF	Picofaradio
MΩ	1 millón (mega) ohmios	H	Henrio
μF	Microfaradio (1000 nanofaradios)	mH	Milihenrio
		μH	Microhenrio
		mA	Miliamperio
		μA	Microamperio
		V	Voltio
		mV	Milivoltio

TRANSMISIONES Y MICROONDAS

Frecuencia portadora

Frecuencia portadora reducida

Frecuencia portadora suprimida

Posición de pulso o modulación de la fase de pulso

Modulación de pulso

Modulación de la amplitud de pulso

Modulación del intervalo de pulsos

Modulación de la duración de pulso

Modulación en frecuencia

Modulación en fase

Línea de retardo coaxial

Línea de retardo de mercurio con transductores piezoeléctricos

Línea de retardo de material sólido con transductores piezoeléctricos

Guiaondas coaxial

Detector de ondas estacionarias

Cavidad resonante

Cable bifilar con pantalla a tierra

Cable coaxial con pantalla a tierra

Línea de cinta desequilibrada

Conductor bifilar entrelazado

Línea de cinta equilibrada

Guiaondas circular rectangular

Guiaondas flexible

Guiaondas giratorio (twisted)

Acoplamiento por barrido al espacio

Acoplamiento por barrido a una línea de transmisión

Acoplamiento por bucle de un cable coaxial a un guiaondas circular con conexiones de c.c a tierra

Supresor de modo para transmisión por cable coaxial y por guiaondas

Circular direccional fijo reversible

Filtro de modo

Filtro de paso bajo de paso alto

Filtro de paso de banda banda eliminada

Desplazador de fase adaptado

Acoplador direccional doble

VALVULAS DE VACIO

Diodo Triodo Tetrodo

Pentodo Rectificador de voltaje

Tiratrón Ignitrón Disparador de cátodo frío

TRC (tubo de rayos catódicos, o pantalla de osciloscopio o televisor)

Célula fotoeléctrica

Tubo de rayos X de cátodo caliente y haz de enfoque

con rejilla de control

Tubo de rayos X con pantalla a tierra

Tubo de rayos X de doble ánodo con ánodo rotativo

Magnetrón "Transit-time"

Magnetrón sintonizable

Magnetrón resonante con salida coaxial

Magnetrón resonante con imán permanente

Klistron reflex con cavidad integral

Klistron de doble cavidad con cavidad integral

Tubo transmite recibe, tubo TR

Elementos de Válvulas

Placa

Placas formadoras de haz

Fotocátodo

Cátodo frío

Llena con gas

Filamento

Cátodo

Grilla (rejilla)

VARIOS

Fusibles (símbolos generales)

Fusible de operación rápida

Fusible de operación lenta

Líneas subterráneas

Líneas submarinas

Generador sinusoidal

Generador de tensión

Generador de corriente

Equipos universales c.c/c.a (para ambas corrientes)

Explosor (Saltachispas)

Diapasón oscilador

Timbre

Escintilador

Puente de Graetz (rectificador de onda completa)

Fuentes de corriente

Línea de retardo 48

Motor 49

Motor de inducción

Protectores (Breakers) para abrir circuitos

Térmico Manual

Transductor ultrasónico

Cristal piezoeléctrico determinante de frecuencia

Cristales tipo cristal para transductores

Monocristales Estacas

Radiación nuclear

Imán permanente

Conductores entrelazados

Conductor blindado

Conductores que se cruzan sin que haya conexión eléctrica entre ellos

Conductores que se unen para formar conexión eléctrica entre ellos

Punto común de conexión, usado para simplificar el esquema. En la práctica, todos los conductores que terminan con este símbolo deben unirse eléctricamente

Unión Tierra (B.-) Chasis

Masa

Tierra sin ruido

Punto de prueba (test point). Es una sonda (pin) que se conecta a cierta parte del circuito y se vincula al diagrama fácil del técnico, para posteriores comprobaciones del funcionamiento. Puesto que usualmente cada sección tiene su punto de prueba, se numeran secuencialmente para su identificación

TP3 TP4 50

Pantalla

DATOS-8

PAPEL MILIMETRADO HERALD

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VOLUMEN 1

DEFINICIONES, DATOS Y APLICACIONES

REALIZACIÓN JJV

2002

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