HEX SHAPER

L 1009

IPNL

JANV. 1978 M.D.

HEX SHAPER L1009

(conditionneur NIM)

Spécifications

6 canaux identiques dans un tiroir NIM de 1 unité de largeur

Consommations (au total environ 10 W):

+12V, 100mA; +6V, 95mA; -6V, 540mA; -12V, 280mA; -24V, 100mA

Entrée: impédance 50 Ω

impulsions négatives, durée minimum 5 ns

seuil réglable de -10 mV à -300 mV

protégée en continu jusqu'à ±3 V

prise de test: tension continue égale à 10 x la tension de seuil

Sorties: "OUT" NIM double (32 mA)

"$\overline{\text{OUT}}$" NIM simple (16 mA)

"FAST OUT" NIM simple (16 mA), à choix immédiate ("SYNC") ou retardée ("DLYD")

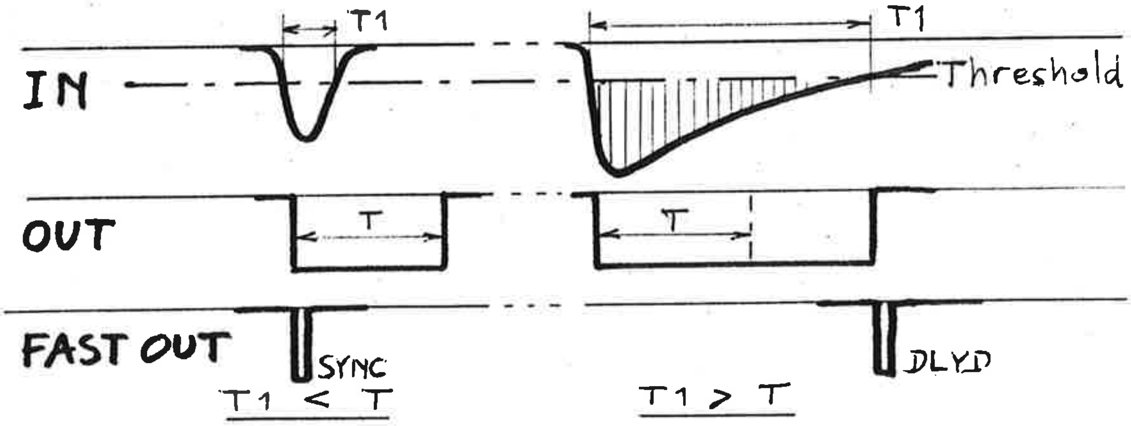
Les impulsions OUT et $\overline{\text{OUT}}$ ont une durée réglable T de 10 ns à plus de 2,5 µs, mais au moins égale à la durée de dépassement du seuil par l'impulsion d'entrée (T1).

L'impulsion FAST OUT est une impulsion brève (10 à 15 ns) synchronisée soit avec le début soit avec la fin de l'impulsion OUT.

La stabilité des durées est de ±1%, mais au minimum de ±1ns.

Le temps de propagation de l'entrée à la sortie est de 10 à 15 ns.

Il est possible de retarder une impulsion par la mise en cascade de deux conditionneurs (utilisation de la sortie FAST OUT DLYD du premier conditionneur).



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Fast shaper

Description of one channel of the L1009 Hex Shaper.

Each channel is built around a fast, sensitive monostable with a more than 150 to 1 output pulse width adjustment. L. Brown [1)] has used the fast comparator AM685 as a monostable; our design improves the thermal stability and range of output duration.

1° The monostable

The input accepts fast negative pulses from -10 mV to -3 V, with a width greater than 5 ns. For an input pulse shorter than the output pulse, the output width is continuously variable from 10 ns to more than 2.5 μs; in any case, the output width is equal either to this preselected value or to the duration of the input pulse above the threshold, which is the greater. No multiple pulsing is observed at the output, even for slowly decaying input pulses.

Figure 1 shows a somewhat simplified diagram of the monostable. The quiescent voltage on the Latch Enable (LE) input of IC1, fixed by D1-3 and the current in P1, is chosen such that, for any current I from some tens of μA to a maximum value I_{max}= 5 mA, the latch is disabled. When Q goes low in response to an input pulse, D4 is cut and the latch is enabled for a time determined by the discharge rate of C1 by I . The LE input has a temperature coefficient (about 3 mV/°C after [1)]) which is not negligible as compared with the-900 mV pulse on Q. The quiescent voltage on LE has thus also been made temperature dependent by close thermal coupling of D1, D2 and IC1; to this effect, D1 and D2 are glued on top of the metal can. The thermal stability of the output width is thus greatly improved; between 20°C and 60°C, it is less than .o4 %/°C at T=2μs and becomes smaller at shorter T.

1) Leonard Brown, Designing with high speed comparators; Advanced Micro Devices Application Note, Dec. 1975

Due to the propagation times in the comparator, very short input pulses just above threshold fail to trigger properly the monostable; the resulting short (about 5ns) malformed pulses observed on $\bar{Q}$ are rejected by the output pulse shortener, which performs an AND between the pulse on $\bar{Q}$ and the same pulse delayed by 7 ns.

For 10 ns output pulses, the maximum periodic repetition rate is slightly greater than 30 MHz.

2^{o} The current source

For the setting of the output width T, a Non Linear Current Source (NLCS) strikes a compromise (curve A, fig.2) between a linear setting (so many ns per turn, curve B) and a constant relative variation setting (so many % of T per turn, curve C) and provides a smooth adjustment of T, without excessive sensitivity at one or another end of the range. Other curves can be obtained by changing the values of the components of the NLCS, as explained in the Appendix.

The multiturn potentiometer P2 adjusts the current I from a low value of about 25 µA (P2 fully cw) to a maximum value of 5 mA (P2 fully ccw) set by P3. Without the amplifier A2, the voltage V_R across R7 would be constant and the variation of I would follow curve B, with the advantage over a simple variable resistor that it does not require a high valued variable resistor with contact resistance problems.

The voltage across R10, proportional to I, is amplified by A2. Increasing I, starting from a low value, increases also V_R, until D4 saturates; from this point onward, the setting of T is linear; this positive feedback provides an expansion of the setting of the first hundreds nanoseconds.

3° The complete circuit

The circuit of a complete channel is shown on fig. 3.

An input diode limiter protects the monostable against transients of more than ±3.5 V; the mean level at the input should not exceed ±5 V, as determined by the allowed dissipation of R_1.

The threshold V_{REF} is set by P_4, the 741 working as a voltage follower and a voltage divider of 10 to 1 ratio to a value between 10 and 300 mV; a voltage equal to $10.V_{REF}$ can be measured on TP.

Two outputs are generated from the signals T and $\overline{T}$:

i) NIM OUT and NIM $\overline{\text{OUT}}$

The ECL levels T and $\overline{T}$ switch a 32 mA current from one output transistor (MPS 2369) to the other, forming a classical ECL to NIM level shifter.

ii) FAST OUT

T and $\overline{T}$ are first differentiated, producing a short (about 10 ns) pulse on the high to low transition of either T or $\overline{T}$, as selected by the DLYD/SYNC switch; this pulse is then converted to a NIM FAST OUT pulse by a current switch. In the SYNC mode, this FAST OUT pulse appears on the leading edge of the monostable pulse; in DLYD mode, on the trailing edge.

4° Procedure of adjustment

See fig. 4.

1° I_{max}

I can be measured directly by removing the jumper

I JUMPER.

P_2 fully ccw; adjust P_3 for I = 5 mA.

2° I_{min}

Verify that I_{min} lies between 25 and 35 uA.

Solder the jumper.

3° Latch Enable quiescent voltage

Inject -200 mV, 5 ns wide pulses at the input.

Threshold (P_4) at 100 mV; max. width (P_2 fully cw).

Observe leading and trailing edge of the 2 to 3 us

output pulse and adjust P_1 so that:

i) the delay between input and output pulse be minimum

ii) there be no time jitter on the trailing edge.

Then the DC level on the LE input should lie

between -1.15 and -1.25 V.

4° Minimum output width

P_2 fully ccw

Adjust C_1 for 10 ns output width.

Appendix: calculation of the NLCS

Let us define by ω the setting of P2, assuming that P3 = 0; ω varies from 0 to 1 when P2 is fully clockwise.

Assume that no current flows out of the base of Q1.

Let us define

$$R_E = \| \begin{matrix} (P2+P3) \\ R10 \end{matrix} \qquad G = 1 + \frac{R12}{R11} \qquad R_p = \| \begin{matrix} R7 \\ R8 \\ R9 \end{matrix}$$

It is easy to show that

$$V_i = R_E \cdot I \qquad (1)$$

$$V_o = G \cdot V_i \qquad (2)$$

$$V_R = \omega \cdot V_i \qquad (3)$$

$$\frac{V_R}{R_p} = \frac{V_Z}{R8} + \frac{V_o}{R9} \qquad (4)$$

The following relation is always true: $I = \frac{V_R}{\omega \cdot R_E}$ (5)

As long as D4 does not conduct, and for all ω greater than $\omega_{min} = G.\frac{R_p}{R9}$, the following relation between I and ω holds:

$$I = \frac{1}{\omega} V_Z \frac{R_p}{R_E R8} \frac{1}{1 - \frac{\omega_{min}}{\omega}} \qquad (6)$$

By comparing (5) and (6), it follows that

$$V_R = V_Z \frac{R_p}{R8} \frac{1}{1 - \frac{\omega_{min}}{\omega}} \quad \text{for } 1 > \omega \geqslant \omega_s \qquad (7)$$

where ω_s is the setting of P2 at which D4 starts to conduct.

For lower values of ω, V_o remains constant and equal to

$$V_{os} \cong V_Z + 0.6$$

From (2) and (3), one calculates that

$$V_R = \omega \frac{V_{os}}{G} \qquad \text{for } 0 < \omega \leqslant \omega_s \qquad (8)$$

The following condition must be respected:

$$\omega_s > \omega_{min}$$

One has to be aware that, as ω approaches ω_{min}, the value of I becomes increasingly sensitive to the values of G, R_p, R9; if $x = \frac{\omega_{min}}{\omega}$, the factor multiplying is

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

Therefore, ω_s ought to be larger than ω_{min} by at least 10%.

Dimensioning the NLCS:

Given: power supplies, V_Z, I_{min}, I_{max}

Choose a reasonable value for R7 : R7 = R_E

(P2 + P3) larger than R10, so that $R_E = \| (R10, P2)$

Hence $R_E < \dfrac{V_Z - 1}{I_{max}}$

Choose $I_s(\omega_s)$ so that it falls between curves B and C.

Defining: $V_{Rmin} = R_E \cdot I_{min}$

$V_{Rs} = R_E \cdot I_s \cdot \omega_s$

$V_{os} \cong V_Z + 0.6$

For $\omega = \omega_s$, D4 must be conducting, so that

$$G = \frac{V_{os}}{I_s \cdot R_E} \quad \text{and} \quad \frac{R12}{R11} = G-1$$

Assuming now that $R_p = R7$,

one can calculate

$$R9 = R_p \frac{V_{os} - G V_{Rmin}}{V_{Rs} - V_{Rmin}}$$

$$R8 = \frac{V_Z}{V_{Rmin}\left(\frac{1}{R_p} - \frac{G}{R_9}\right)}$$

For $I = I_{max}$, $\omega_o = \dfrac{V_{Rs}}{I_{max} \cdot R_E}$; hence P3 = P2 $\dfrac{\omega_o}{1-\omega_o}$

Finally, verify that $\omega_{min} = \dfrac{G.R_p}{R9}$ is sufficiently smaller than ω_s.

If necessary, it is now possible to redo the calculation with better values for R_E, R_p and G.

Note:

curve B is defined by $I = \dfrac{I_{min}}{\omega}$

and curve C by $I = I_{max} \cdot \exp(-\omega/\Omega)$

where $\Omega = 1 / \ln(I_{max}/I_{min})$

Curves A, B and C do not give I_{max} exactly for the same ω, but the difference is not important.

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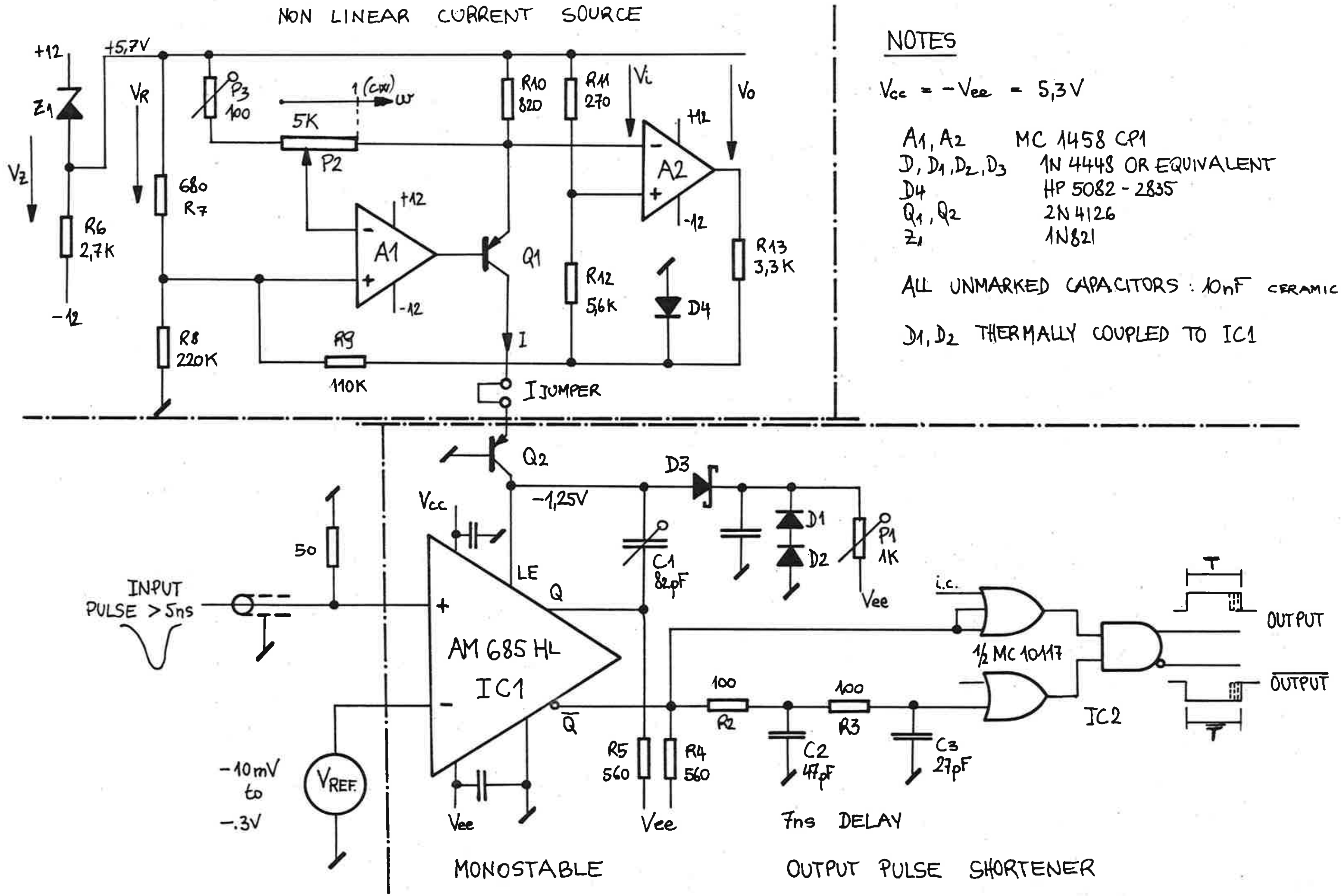

FIG. 1 - MONOSTABLE AND CURRENT SOURCE

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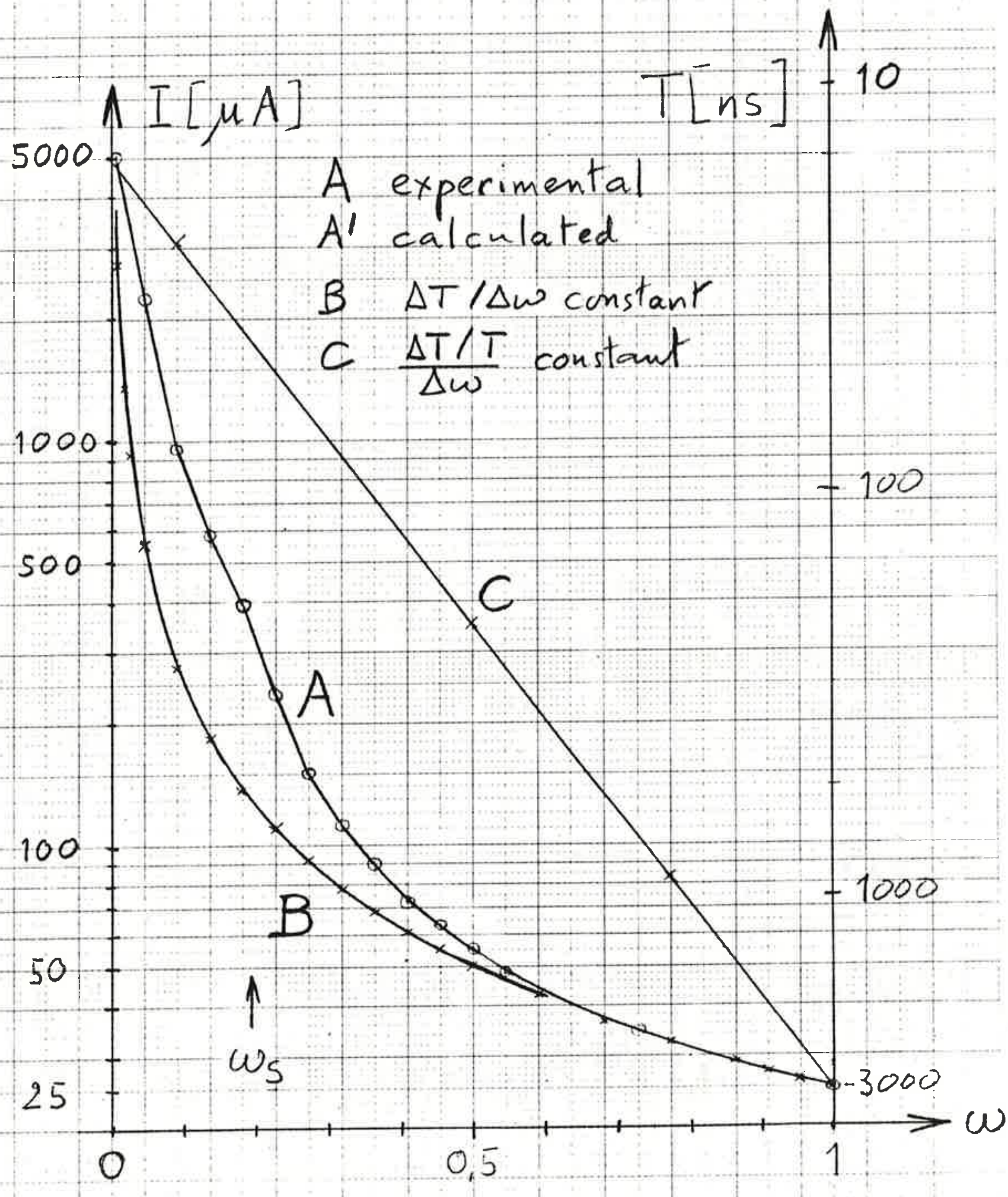

Fig. 2 I and T vs. setting ω
(T measured on $\overline{Q}$ output) JFL 4.XI.77

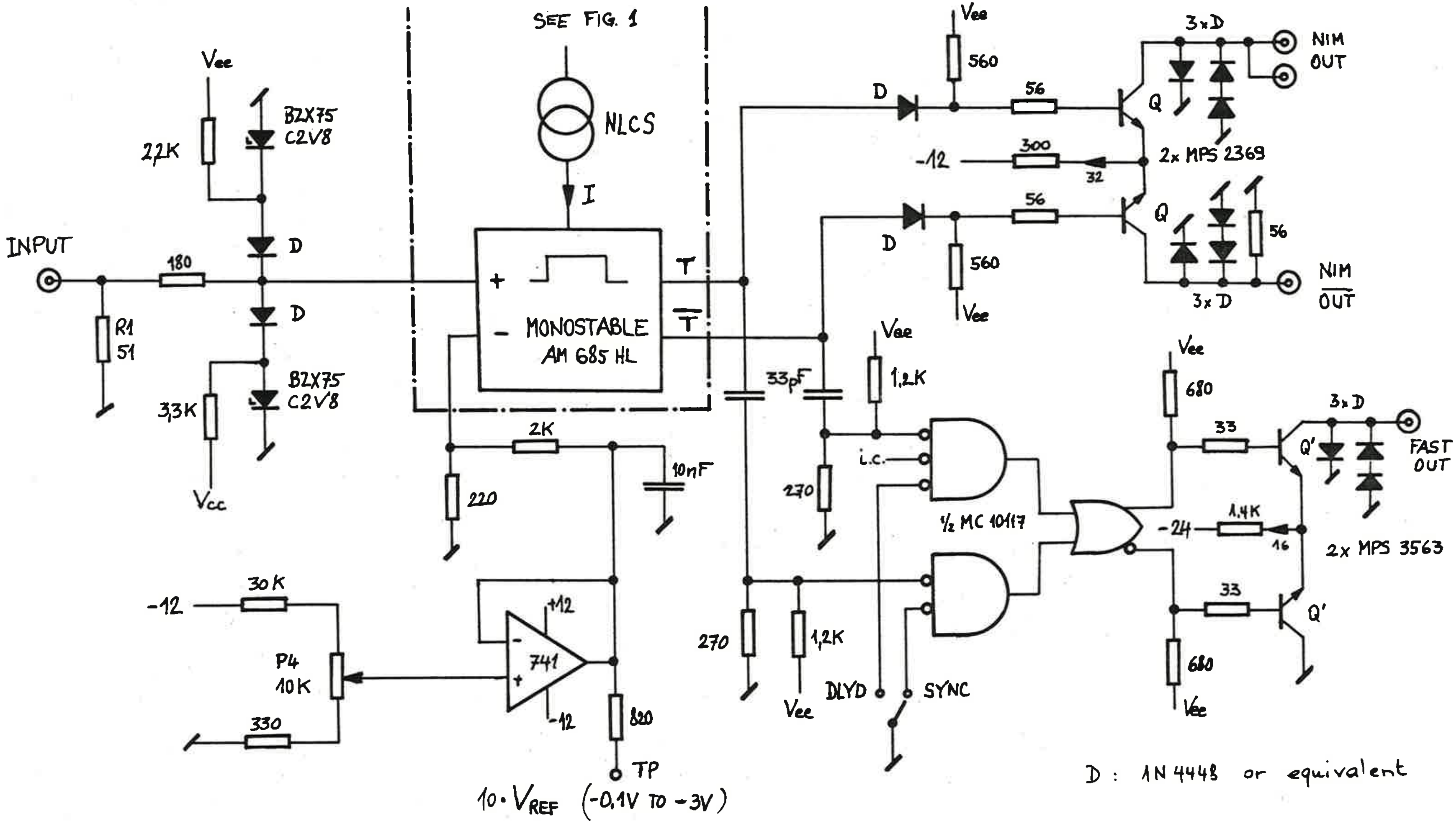

FIG. 3 - A COMPLETE CHANNEL

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